

East Central Florida

by

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Chapter 6: EAST CENTRAL FLORIDA

by

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EXECUTIVE SUMMARY

The large number of hurricanes in 2004 reminded us that the coast of Florida is very vulnerable to changes in climate and sea level. During a period of relative calm, development has concentrated along our coasts, with many residents not always aware of the possibility that the climate might return to a period of frequent and intense hurricanes.

It is important to understand that our shorelines constantly change because of erosion, sedimentation, and sea level rise. During the last century, sea level rose approximately 6–9 inches worldwide and 9 inches along the coast of East Central Florida. The U.S. Environmental Protection Agency (EPA) has been analyzing the causes, effects, and possible responses to sea level rise. EPA's 1995 report, *The Probability of Sea Level Rise*, estimates that if humanity continues to emit greenhouse gases into the atmosphere, mean sea level could rise 1–2 feet in the next century and 5 feet over the next 150–300 years.

Rising sea level has the potential to substantially change the U.S. coastal zone. Studies by EPA and others have concluded that such a rise will force coastal communities to make a fundamental decision: preserve the coastal environment by fostering a gradual evacuation along some parts of the nation's coastal zone, preserve coastal development by implementing shore protection measures that eliminate wetlands and shallow water ecosystems, or preserve both coastal development and coastal ecosystems through innovative but expensive land-use planning and new technologies.

The EPA is conducting a nationwide study to provide local governments with a better understanding of the effects of sea level rise on their community and strategies they can use to respond to the anticipated changes along their coastline. The East Central Florida Regional Planning Council (ECFRPC) was contracted by the Southwest Florida Regional Planning Council (SWFRPC) through a grant from the EPA to participate in this study, which includes all coastal states along the eastern seaboard. ECFRPC hopes to increase the level of awareness about sea level rise and implications for Brevard and Volusia counties. Long-term planning strategies are offered as a means of preparing for the predicted sea level rise.

This report includes maps created for the coastal zones of Brevard and Volusia counties that distinguish the shores that are likely to be protected from erosion, inundation, and flooding, from those shores where natural shoreline retreat likely will take place. The maps divide coastal lowlands into four categories: areas where shore protection is almost certain (brown), likely (red), or unlikely (blue), and areas where current environmental policies would preclude shore protection and enable wetlands to migrate inland (light green). The maps also show wetlands (dark green). The study focused on the lowest 240 square miles, using a common mapping benchmark for defining low coastal land: the 10-foot contour. More than 141,000 acres of uplands and almost 96,000 acres of wetlands, almost 15 percent of the Brevard and Volusia combined area, are in this area and hence would be directly affected by a continued rise in sea level.

The maps show that, for all practical purposes, past and planned development have already made it inevitable that property will be protected and the inland migration of wetlands will be blocked and

eventually eliminated along 30 percent of Brevard County and 60 percent of Volusia County shores. Existing conservation lands, however, ensure that wetlands will be able to adjust to rising sea level along the shores of about 45 percent and 15 percent of the two counties, respectively. Perhaps most important, we still have a realistic opportunity to choose between wetland migration and the type of coastal development that causes a gradual loss of wetlands for approximately 25 percent of the land in each county.

The Brevard and Volusia coastline is an important ecological and economical resource for the region and state. Land use is a state and local responsibility, and decisions should be made concerning the protection of developed and undeveloped land before it becomes too expensive or impossible to protect the shoreline and property. The counties and cities are presented, through this study, with options for decision making on land use and the protection of common infrastructure, property, resources, and the economic base of the community from sea level rise.

The decision whether to preserve wetlands or armor the coast in the face of rising sea level must be made within the context of the comprehensive plans of Brevard and Volusia counties, both of which recognize the potential adverse impacts of sea level rise on their communities. The Brevard County comprehensive plan addresses sea level rise in Policy 4.9, stating, “Brevard County shall continue to collect and make available to the public information related to sea level changes.” The Volusia County comprehensive plan states, in section 11.4.1.21, “Volusia County should continue to monitor sea level rise science to determine when and if a sea level rise event will affect the County. Based on pertinent data, the county will act accordingly.”

This report leaves little doubt that a continuation of rising sea level will affect Brevard and Volusia counties. The key question is, When? The answer depends on our priorities as well as on scientific uncertainties regarding how much the sea level will rise in the next century and beyond. In some cases, it is reasonable to wait and respond as the sea rises. Infrastructure changes, however, may require a lead time of a few decades, and land use decisions last centuries. If we want to preserve more than half of our coastal environment as sea level rises, we must develop policies to ensure such a preservation before the rest of our coastal zone is developed. Doing so need not impair property values; but a failure to act soon would preclude opportunities to preserve the coastal environment in a cost-effective manner.

Even if we are satisfied with preserving approximately one-third of our coastal wetland ecosystems, we are most likely to protect property values, and the commercial, industrial, tourism and residential economies, if we start factoring the implications of rising sea level into the planning process now rather than later. Low-lying developed areas will have to be either elevated or protected by dikes. By deciding now which form of protection is most appropriate, we can ensure that development and redevelopment are consistent with the long-term evolution of our communities, and thereby minimize the cost and community disruptions that might otherwise result from a rising sea.

INTRODUCTION

From the beginning of time through today, the Earth has constantly changed through both slow and abrupt changes in atmosphere, geosphere, temperature, and biota. Shorelines are some of the most unique places on Earth because they are the only place on Earth where the geosphere, atmosphere, and hydrosphere meet.¹ Shorelines constantly change depending on sediment deposition and erosion over time from fluctuations in sea level.

Early changes in sea level are believed to be a result of changes in ocean volume and the “glacio-hydro-isostatic effect,” or changes in ice and water loads.² The mean surface temperature of the Earth has increased since the Industrial Revolution, coinciding with an increase in the concentration of greenhouse gases in the atmosphere. Whether these recent changes are due to anthropogenic factors or to the natural cycle of the Earth has been discussed and debated for years.³ One of the debated impacts of this increase in greenhouse gases is the acceleration of sea level rise.¹ If greenhouse gases continue to be released into the atmosphere at the current rate, the EPA estimates that the mean sea level rise in the next 200 years will reach approximately 5 feet.³

The East Central Florida Regional Planning (ECFRPC) has been contracted by the Southwest Florida Regional Planning Council (SWFRPC) through a grant from the U.S. Environmental Protection Agency (EPA) to participate in a nationwide project promoting planning for and awareness of sea level rise. The other regional planning councils along the Atlantic Coast (Northeast Florida, Treasure Coast, and South Florida) are also participating in this study; and the cooperative agreement between EPA and SWFRPC contemplates extending the study to include the entire coast of Florida. The Florida studies are part of a national effort by the EPA to encourage the long-term thinking required to deal with the impacts of sea level rise issues.

Each of the studies are developing maps that distinguish the areas likely to be protected^a as the sea rises from the areas where shores will probably retreat naturally, either because the cost of holding back the sea is greater than the value of the land or because there is a current policy of allowing the shore to retreat. These maps are intended for two very different audiences:

- *State and local planners and others concerned about long-term consequences.* Whether one is trying to ensure that a small town survives, that coastal wetlands are able to migrate inland, or some mix of both, the most cost-effective means of preparing for sea level rise often requires implementation several decades before developed areas are threatened.³² EPA seeks to accelerate the process by which coastal governments and private organizations plan for sea level rise. The first step in preparing for sea level rise is to decide which areas will be elevated or protected with dikes or seawalls and which areas will be abandoned to the sea.
- *Policy makers and citizens concerned about long-term climate change.* Governments at all levels and many citizens are considering measures to reduce greenhouse gas emissions. The urgency of doing so depends in part on the consequences of climate change and sea level

^aFor purposes of this study, “protect” generally means some form of human intervention that prevents dry land from being inundated or eroded. The most common measures are rock revetments, bulkheads, dikes, beach nourishment and elevating land with fill.

rise. Those consequences in turn depend to a large degree on the extent to which local coastal area governments will permit or undertake sea level rise protection efforts.³³ In addition, the United Nations Framework Convention on Climate Change, signed by President Bush in 1992, commits the United States to taking appropriate measures to adapt to the consequences of global warming.

This study analyzes present and future land use and various coastal policies. The maps that accompany this study illustrate the areas that planners within this region expect will be protected from erosion and inundation in the coming decades. Those expectations incorporate state policies and regulations, local concerns, land-use data, and general planning judgment. Within the study area, our maps use the following colors:

- Brown—areas that almost certainly will be protected if and when the sea rises enough to threaten them.
- Red—areas that probably will be protected, but where it is still reasonably possible that shores might retreat naturally if development patterns change or scientists were to demonstrate an ecological imperative to allow wetlands and beaches to migrate inland.
- Blue—areas that probably will not be protected, generally because property values are unlikely to justify protection of private lands or the land is not planned for development and is situated to allow for wetland migration or a buffer, but in some cases because managers of publicly owned lands are likely to choose not to hold back the sea.
- Light Green—areas where existing policies would preclude holding back the sea. These areas include both publicly and privately owned lands held for conservation purposes.

We generally show wetlands as dark green.

The East Central Florida Regional Planning Council's study area included Brevard and Volusia County coastal areas. Maps have been developed to illustrate critical areas in the counties that may be affected by a 5 foot rise in sea level rise as well as where the ocean would be held back or where development may retreat. Geographic information systems (GIS) was used to develop the maps and land use impact analysis of the coastal areas below the 10 foot NGVD contour.^b The 10-foot contour was estimated as the maximum elevation that may periodically be flooded by a 5 foot rise in sea level.⁵

^b Until recently, most topographic maps provided contours that measured elevation above the National Geodetic Vertical Datum of 1929. That datum represented mean sea level for the tidal epoch that included 1929, at approximately 20 stations around the United States. The mean water level varied at other locations relative to NGVD, and inland tidal waters are often 3–6 inches above mean sea level from water draining toward the ocean through these rivers and bays. Because sea level has been rising, mean sea level is above NGVD29 almost everywhere along the U.S. Atlantic Coast

The study area, the coastal areas of Brevard and Volusia counties, is divided into uplands (141,410 acres, 221 square miles) and wetlands (95,812 acres, 150 square miles) below 10 feet in elevation. The study area is approximately 237,222 total acres, which comprise 14.5 percent of the combined area of both counties. According to the 2000 census, the current population in the coastal census tracts within the study area is approximately 503,000 in 260,000 dwelling units. Certain census tracts are completely within the study area while others are partial. Therefore, these estimates are high end approximations based on the census tract information. Volusia is expected to have a population of 350,000 in 183,000 dwelling units by 2020, and Brevard's 2020 population is expected to be 199,000 in 104,000 dwelling units.^{c,d} Therefore, the study area is expected to have a population of roughly 550,000 residents in 287,000 dwelling units by 2020.

Tourism is Florida's number one industry, bringing in approximately \$46.7 billion in 1999.⁷ Major tourist destinations such as Daytona Beach, Cocoa Beach, and Melbourne Beach are included in the study area. Therefore, sea level rise will affect not only the residents but tourist destinations as well, which may result in dramatic effects on the economic well-being of the counties.⁸

Sea level rise can have various effects on the coastline. Inundation and higher flood elevations can occur. Shoreline erosion is another effect related to sea level rise. Also, because of higher water tables caused by sea level rise, salt water intrusion and contamination of the aquifer may occur, contaminating wells and thus affecting the local economy.^{8,9}

This project is the first detailed study to examine the potential effects of sea level rise on East Central Florida. Currently, land use regulations address flood mitigation and not sea level rise. The comprehensive plans in Brevard and Volusia counties minimally address the issue of sea level rise. Section 11.4.1.21 of the Volusia County comprehensive plan states, "Volusia County should continue to monitor sea level rise science to determine when and if a sea level rise event will affect the County. Based on pertinent data, the county will act accordingly." The Brevard County comprehensive plan addresses sea level rise in Policy 4.9, stating, "Brevard County shall continue to collect and make available to the public information related to sea level changes."

As is discussed in further detail in this report, many regulations designed for flood mitigation also could be used as sea level rise planning. Development continues, however, and more infrastructure is incorporated into coastal areas without adequate planning for the effects or costs of flooding, erosion, and storm damage caused by sea level rise.¹⁰ According to the USGS, the study area is considered a high vulnerability area since it contains a barrier island with a low coastal slope. Therefore, this lack of planning for future sea level rise can be costly to the community. The ECFRPC hopes that this report will bring more local awareness to the issue of sea level rise and aid local governments of Brevard and Volusia counties in long-term planning for sea level rise so that both property and the environment can be preserved.

c Volusia County MPO 2020 Long Range Transportation Plan-Refinement. Volusia County Metropolitan Planning Organization: November 2000. 4 June 2004. <www.volusiacountympo.com/documents/documents_lrtp.html>

d Riger, J. "RE: Long Range Plan 2020" jriger@ciesthatwork.com (09 April 2004).

Figure 1 shows the land vulnerable to sea level rise in East Central Florida. Table 1 lists the area vulnerable to sea level rise by county. Map 1 shows the results of this study.

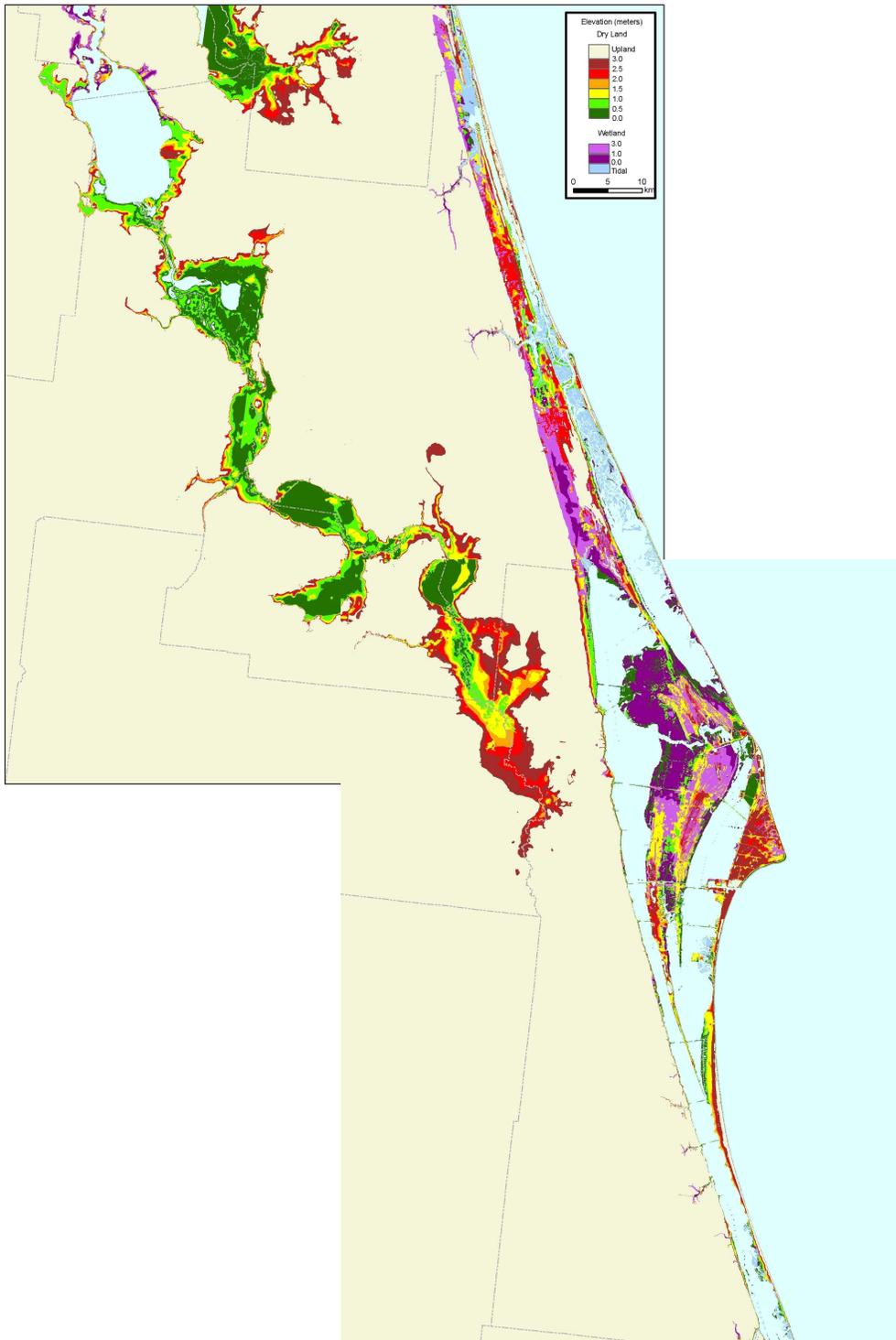


Figure 1. Elevations of Land Close to Sea Level East Central Florida. Elevations are relative to spring high water. Source: See Table 1.

Table 1. Area of Land Close to Sea Level by County (square kilometers)										
County	Elevations (m) above spring high water									
	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00
Volusia	186	307	412	458	556	644	683	728	790	830
Brevard	106	190	351	400	462	582	635	729	912	1029
Total	292	497	763	858	1018	1226	1317	1456	1701	1859

Source: Titus et al. (2009) using approach of Titus and Wang (2008). See endnote 4.

THE CHANGES AND CAUSES OF SEA LEVEL RISE

Evidence from the past 10,000 to 20,000 years indicates sea level variations occurred on the order of every few thousand years. Figure 2 shows the historical Florida shoreline between 1.8 million and 10,000 years ago. Data also indicate that over the past 6,000 years, sea volume increased, causing a sea level rise of 2.5–3.5 meters. The early changes in sea level rise are believed to be a result of changes in the ocean volume and the “glacio-hydro-isostatic effect,” or changes in ice and water loads.²

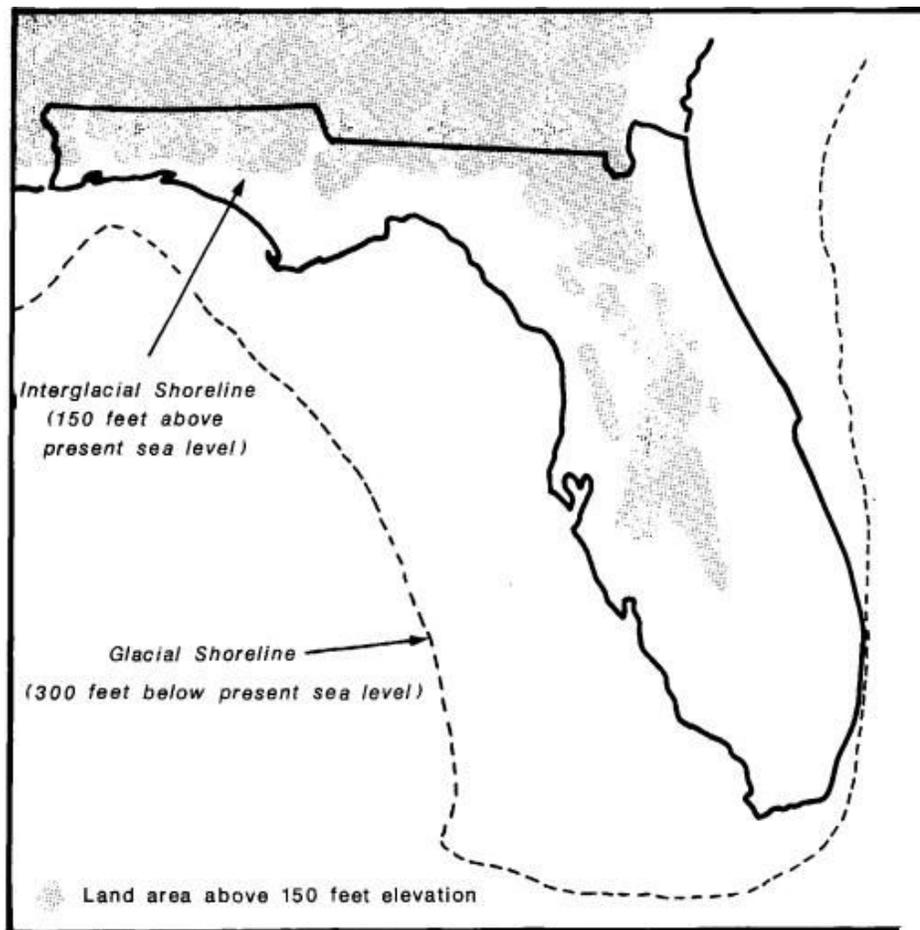


Figure 2: Florida shoreline 1.8 million to 10,000 years ago.¹¹

Global Contributors

When comparing data over the past 100 years to that of the past two millennia, the rate of sea level rise has increased as a result of glacial mass changes and thermo-expansion.² In addition, tectonic movements and neotectonics (postglacial rebounds) are also possible contributors to changes in the global ocean volume.⁸ These causes of sea level rise may be a result of or accentuated by the debated global climatic change possibly accelerated by human impacts.

Data have shown the mean surface air temperature of the Earth has increased by 0.5°C over the past 100 years, coinciding with the increase in concentration of greenhouse gases in the atmosphere.³ Although the climate of the Earth has always fluctuated, the increased concentration of certain gases in the atmosphere may be accelerating the warming processes.¹² Figure 3 illustrates the atmospheric temperature increase from 1861 to 1988, relative to 1950 to 1979. The boxes in the graph represent temperature anomalies in the 5 year period and the line represents the 5 year mean.

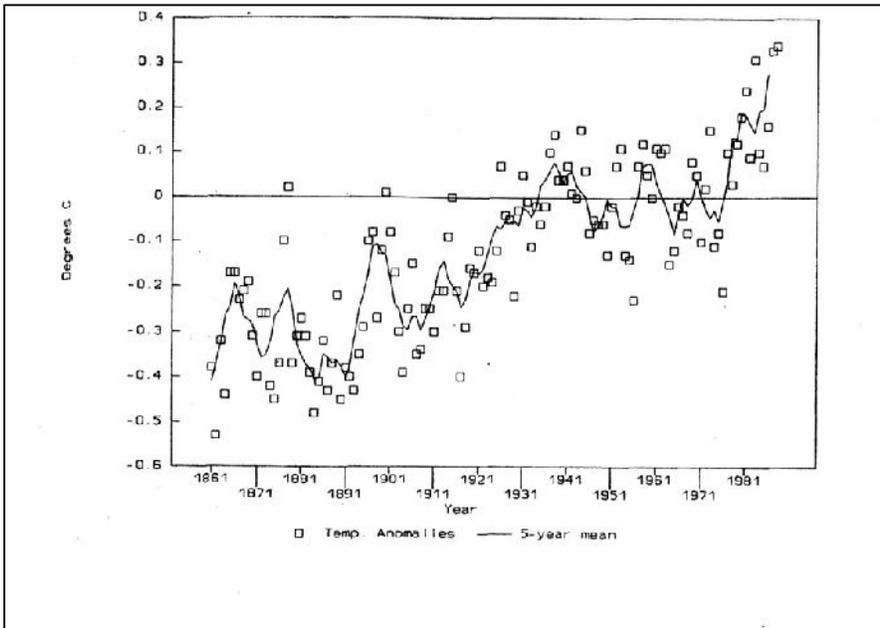


Figure 3: Global Mean Temperature Change: Combined land, air, and sea surface temperatures, from 1861 to 1981, relative to 1950 to 1979 (Daniels, 1992).

If conditions continue as the current trend indicates, air temperature may increase by 1.5°C to 4.5°C over the next 100 years.¹³ The EPA estimates that by 2050, air temperature will rise 1°C to 2°C by 2100. There is only a 10 percent chance that the temperature will increase more than 4°C over the next 100 years. There is, however, a 90 percent probability that temperature will rise 0.6°C over the temperature rise of the previous century.³ Also, according to Peter Clark (2003) of Oregon State University, global warming may also cause the disruption of North Atlantic currents, resulting in the cooling of Europe. The atmospheric warming, in turn, would then eventually melt the Antarctic ice sheet and cause the currents to move again, resulting in sea level rise and inundated coastal regions.

Another contributor to sea level rise could be thermal expansion and glacial changes.² Thermal expansion, the expansion of water due to heating, depends on the amount of heat penetrating into the deeper and intermediate waters. As Figure 4 depicts, mean sea level fluctuates closely with the sea surface temperature as thermal expansion would indicate. There is, however, a delay in thermal expansion when compared to the increase in air temperature. This results in a larger thermal expansion than increase in air temperature at a certain time. The EPA estimates that, by 2100, thermal expansion of the ocean will reach approximately 20 cm.³

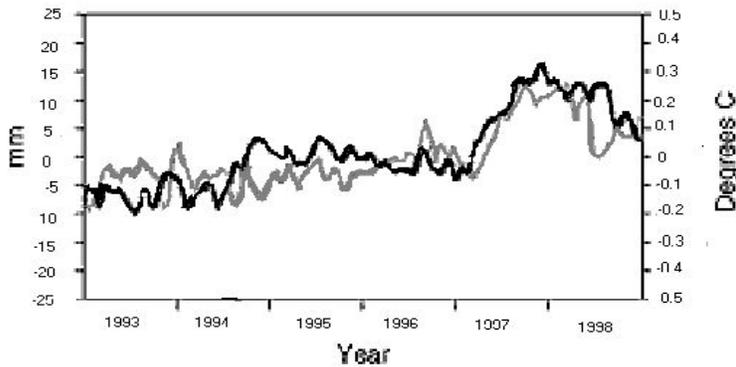


Figure 4: Global mean sea level variations (light line) computed from the TOPEX/POSEIDON satellite altimeter data compared with the global averaged sea surface temperature variations (dark line) for 1993 to 1998 (Cazenave et al., 1998, updated). The seasonal components have been removed from both time-series.²

Figure 5 illustrates the probability distributions of the melting of various glaciers from greenhouse effects on sea level rise. The Daniels et al. graph shows that, when comparing the above, Greenland may have the greatest probability of contributing to sea level rise and Antarctica has the least. Changes in glacial volume can affect sea level in two ways. Some water from the glaciers enters the sea, thus increasing the volume of the ocean. Also, by changing the volume of the glaciers, there is less displacement of the water; thus sea level rises although the ocean volume may not.¹⁴

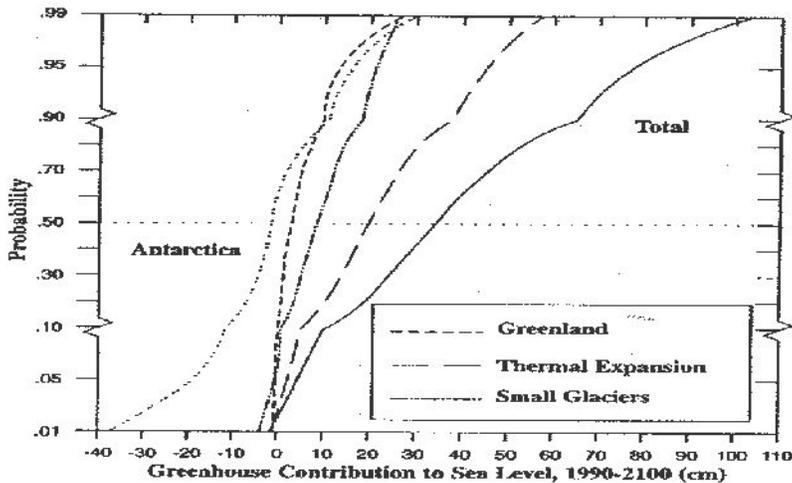


Figure 5: Cumulative probability distributions showing the contribution of thermal expansion, small glaciers, Greenland, and Antarctica to sea level from 1900–2100.¹³

Sea Level Rise in East Central Florida

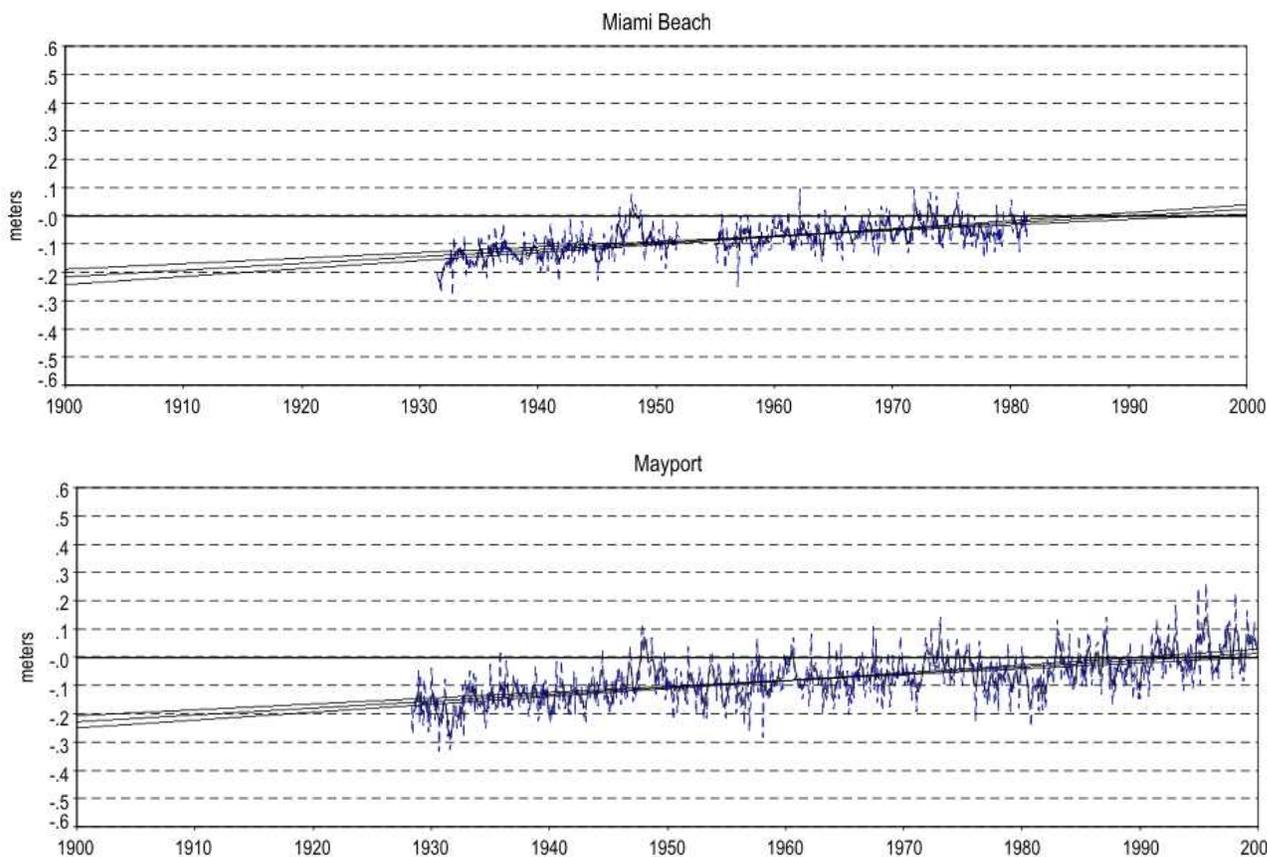
Table 2, provided by the SWFRPC, is the probability of sea level rise in East Central Florida based on Tables 9-1 and 9-2 from the EPA publication “The Probability of Sea Level Rise.” Table 2 predicts the probability of various sea level rise scenarios over the next 200 years along the coastline of east central Florida. For example, there is a 90 percent probability there will be more than a 1 foot rise in sea level by 2150 along the Florida coast. However, there is a 50 percent probability that this rise could be seen by 2075. The table also suggests a 30 percent chance that sea level will rise 2 feet in the next century and 5 feet in the next 200 years.

Table 2: Estimated sea level rise for East Central Florida

Probability (%)	Sea Level Projection by Year											
	2025		2050		2075		2100		2150		2200	
	cm	inches	cm	inches	cm	inches	cm	inches	cm	inches	cm	inches
90	6.7	2.6	12.2	4.8	18.7	7.4	25.2	9.9	38.2	15.0	51.2	20.2
80	8.7	3.4	16.2	6.4	24.7	9.7	34.2	13.5	51.2	20.2	69.2	27.2
70	10.7	4.2	19.2	7.6	28.7	11.3	40.2	15.8	61.2	24.1	83.2	32.8
60	11.7	4.6	21.2	8.3	32.7	12.9	44.2	17.4	70.2	27.6	97.2	38.3
50	12.7	5.0	23.2	9.1	35.7	14.1	49.2	19.4	78.2	30.8	110.2	43.4
40	13.7	5.4	26.2	10.3	39.7	15.6	54.2	21.3	88.2	34.7	124.2	48.9
30	15.7	6.2	28.2	11.1	42.7	16.8	60.2	23.7	100.2	39.4	144.2	56.8
20	16.7	6.6	31.2	12.3	47.7	18.8	68.2	26.9	115.2	45.4	171.2	67.4
10	19.7	7.8	36.2	14.3	55.7	21.9	79.2	31.2	141.2	55.6	220.2	86.7
5	21.7	8.5	40.2	15.8	61.7	24.3	90.2	35.5	169.2	66.6	277.2	109.1
2.5	24.7	9.7	44.2	17.4	68.7	27.0	102.2	40.2	202.2	79.6	342.2	134.7
1	26.7	10.5	48.2	19.0	75.7	29.8	116.2	45.7	245.2	96.5	448.2	176.5
Mean	12.7	5.0	24.2	9.5	36.7	14.4	51.2	20.2	86.2	33.9	127.2	50.1

*The results of this table are based on using Tables 9-1 and 9-2 of the EPA report "The Probability of Sea Level Rise".¹⁵ Basically, the formula is multiplying the historic sea level rise (2.2 mm/yr) in East Central Florida (closest point used is Mayport, FL., Table 9-2) by the future number of years from 1990 plus the Normalized Sea Level Projections in Table 9-1. In summary, the EPA report relied on various scientific opinions regarding sea level changes affected by factors such as radiative forcing caused by both greenhouse gases and sulfate aerosols, global warming and thermal expansion, polar temperatures and precipitation, and the contributions to sea level from Greenland, Antarctica, and small glaciers.

Ocean levels have been monitored by stations around the world. According to most of these monitoring stations, mean sea level has increased steadily over the past century.¹⁶ The two graphs in Figures 6 and 7 illustrate data from the two closest NOAA sea level monitoring stations to the study area, Mayport to the north and Miami Beach to the south. As both graphs illustrate, sea level along the east coast of Florida has been increasing for at least the past 70 years.



Figures 6 and 7: Monthly sea level variations at the Miami Beach and Mayport monitoring stations over the past 70 years

Miami Beach monitoring station shows a mean sea level trend of 2.39 mm/year based on data from 1931 to 1981. Mayport exhibits a mean sea level trend of 2.43 mm/year (0.80 feet/century) based on data from 1928 to 1999.¹⁷

Global vs. Relative Sea Level Rise

Global sea level rise is a result of increasing global ocean volume. The measurements of global sea level rise are the same regardless of the location on Earth. Relative sea level rise is the measure of the increase or decrease of sea level relative to land in specific locations. Relative sea level measurements will vary from location to location as a result of the primary contributors to the rise.⁸ Local trends in subsidence or emergence can cause local variances in ocean levels.⁹ For example, subsidence of the coastal region can be caused by extensive development. Land, under the weight of development, sinks below its original elevation. Increased development also means increased use of resources. The overpumping of wells, both oil and water, also leads to land subsidence. Since the magnitude of possible causes of sea level rise varies from site to site, relative sea level rise is important because it measures the cumulative effects of all the causes of sea level on a local basis.¹⁴ Therefore, focusing on relative sea level rise rather than global sea level rise is important in local planning to protect shorelines.

In a study by the Oak Ridge National Laboratory, three sea level rise scenarios were calculated for Daytona Beach with its current local subsidence rate of 0.513 mm/year using a sea level rise trend for Daytona Beach of 2.013 mm/year.¹³ Table 3 illustrates the sea level rise scenarios, without including land subsidence, of the Daniel’s study based on the International Panel on Climate Change Business as Usual for 2100.

Table 3: Sea Level Rise Scenarios (cm) for Daytona Beach, Florida, used in Daniels et al. Study.

Scenario	Year				
	2000	2025	2050	2075	2100
A. Low Scenario	2	6.5	14	22	31
B. Moderate Scenario	5	7	32	48	66
C. High Scenario	8	27	50	78	110

The sea level rise scenarios in the Daniels et al. study were then calculated using the subsidence rate of Daytona Beach, resulting in Table 4. Local subsidence, as evident from the data, creates relative sea level rise of 5.6 cm by 2100 along the Volusia coastline, in addition to global sea level rise. When increased ocean volume is combined with local subsidence, relative sea level may be even higher along the coastline, as evident from the data in Table 4. Depending upon the scenario, subsidence can account for 5 percent – 18 percent of the rise in sea level 2100.

Table 4. Relative sea level rise (cm) for Daytona Beach, Florida. Present subsidence rate for Daytona Beach is 0.513 mm/year. The current sea level rise scenario represents local subsidence only¹³.

	Year		
	1988	2050	2100
Current (as of 1988)*	0	3.1	5.6
A. Low		17.1	36.6
B. Moderate		35.1	71.6
C. High		53.1	115.6

Effects Related to Sea Level Rise

General

Coastlines could be affected by simple sea level rise with the “retreat” of the shoreline. Natural occurrences such as storm surges and waves may reach beyond current levels, and floodplains may be subjected to more effects as well. As a result, the total area affected by sea level rise and storm events could be larger than the land area projected to be covered with water.² Issues of sea level rise reach far beyond inundation and flooding. As sea level rises, salt water intrusion that can contaminate private and public wells, increased erosion, a loss of infrastructure and wetlands, and effects on the National Flood

Insurance Program may occur.⁸ Sea level rise would force wetland migration that, with continued development, may be impeded if no open land exists to where the wetland may migrate.⁹ With wetland, beach, and spoil island loss from no protection against sea level rise, the coastline can expect to have a decline in critical habitats and productivity.¹ Also, the larger, more powerful waves resulting from increasing sea level accelerate beach erosion.¹⁶

Although sea level rise contributes to or exacerbates these effects, it is not the lone culprit. Increasing development along the coast creates a greater withdrawal from the aquifer. This, in turn, enables the salt water wedge to move farther inland, contaminating the groundwater. Surface waters and wetlands may also be affected by saltwater intrusion. Shoreline erosion can be caused by both boat traffic and inlet stabilization.¹ Major hurricanes and Nor'easters are culprits of massive beach erosion and destruction, such as the 1984 Thanksgiving Day Nor'easter. A storm of this magnitude has a return period of 10–20 years. Currents, such as the powerful Florida Gulf Stream, are active transporters of beach sediment.¹⁶ All aspects of shore erosion, however, must be considered in our study because shoreline protection or natural wetland migration is not dependent on the cause of erosion. Also, areas already experiencing erosion may indicate how similar areas may respond to sea level rise.¹

Local Issues

The Florida Department of Environmental Protection, Bureau of Beaches and Coastal Systems updated the “Critical Erosion” List in 2003. Erosion is considered critical when there is a threat of loss of one of the following four interests: recreation, wildlife habitat, upland development, or important cultural resources. If a certain area has substantial erosion, but no public or private interests are threatened, the area is considered a “noncritical erosion area” and close monitoring is required. Approximately 41.7 miles of coastline in the study area are listed as “critical erosion” and 13.4 miles are “noncritical,” making up almost half of the beaches/coastline in the study area.¹⁸

According to the Volusia County comprehensive plan, most of the county coastline accreted over that past 115 years, although erosion was experienced in the 1970s. This erosion then slowed in the 1980s.¹⁹ More than 16 miles of beach in Volusia County, however, are classified as critical. The erosion threatens the area’s tourism, development, and recreational interests. Although the entire county is not experiencing major erosion issues, more than an 8 mile stretch of beach between Ormond Beach, Daytona Beach, and Daytona Beach Shores is critically eroded. Although Bethune Beach is armored by a rock revetment and New Smyrna Beach is to receive sand from Ponce Inlet, just under 8.5 miles of the beaches are critically eroding in these areas. North of Ponce de Leon Inlet is a small stretch of beach, less than 1 mile long, that is critically eroding and threatening the State Park’s recreational well-being. Finally, a 1 mile stretch of the Canaveral National Seashore is listed as noncritical erosion.¹⁸

Brevard County has 25 miles of critically eroding beaches, including a 24.6 mile stretch of beach southward from Canaveral Inlet. Because of Brevard County’s beach restoration program, beaches in Canaveral, Indialantic, and Melbourne have been renourished, along with proposals for Melbourne Beach, Indialantic, and Cocoa Beach. These areas consist of high density development with major tourist recreation interests. In south Brevard, a 0.4 mile stretch of beach is critically eroding. Although two areas north of Cape Canaveral are considered noncritical, no monitoring is taking place.¹⁸

With almost half of the beaches in the study area considered critically eroding or eroding substantially, it is apparent that some action has taken place to protect the area from the destruction associated with erosion. It is extremely important to protect the beaches in these counties because of the dependence of the local economy on the beach tourist industry. Although the steps taken by the jurisdictions to protect the beaches, development, and infrastructure are for erosion purposes, these actions can be used to prepare and protect the coast from expected sea level rise as well.

Using data from a NOAA study in 1980 and 2004 Volusia County data and analyzing them in ArcView, more than 5,000 parcels in the study area are protected through armoring. By 2003, Volusia County increased their armoring from under 1,800 parcels to almost 2,500 parcels. (Current data for Brevard County are unavailable.) As seen in Figure 8, beach armoring through seawalls is common in northern Volusia County.

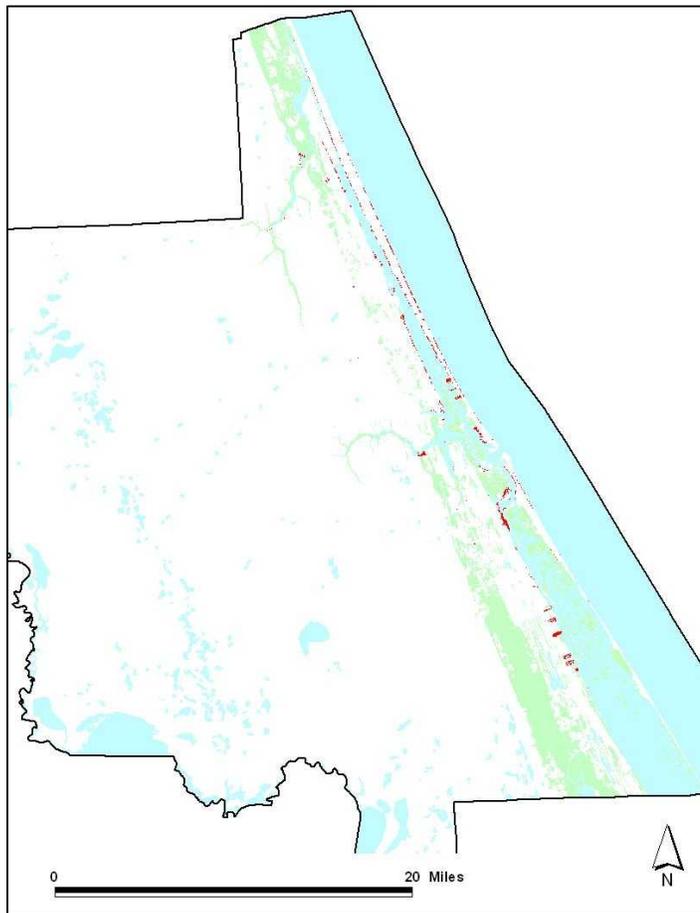


Figure 8: Seawalls along the Volusia County Coastline, represented in red.

Volusia County does not have an active beach nourishment program. A beach erosion feasibility study completed in December 2003, however, examined the need for renourishment of the southern beaches. The report analyzed the main causes of erosion in the area, including storms, currents, and sea level rise. Brevard County has been actively renourishing the coastline for years. More than 500 parcels in Brevard County front renourished beach, comprising almost 12 miles of renourished beach, and a half-mile of natural accretion due to Cape Canaveral. Figure 9 illustrates the areas of Brevard County with beach renourishment.

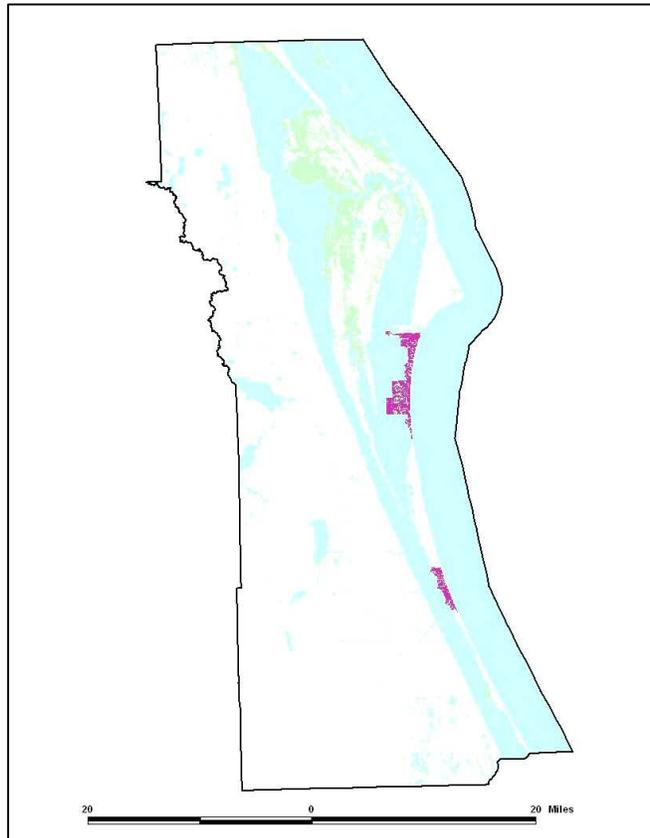


Figure 9: Areas of Brevard County with Beach Renourishment

SEA LEVEL RISE POLICIES

Although policies for sea level rise are not explicit on the local level or even the state level, current policies for coastal management can be used for protection against sea level rise. Land use, development, and economic growth may also influence how the certain areas would respond to sea level rise.

Federal Policies

Policies in the federal government concerning the protection of the shore from erosion, inundation, and sea level rise, whether directly or indirectly stated, influence the protection scenario of the coastline from sea level rise. Federally owned undeveloped coastal land most likely would not be protected from sea level rise, even without a direct policy. Conservation agencies generally follow the National Park Service policy of allowing nature to take its course, thus allowing the shoreline to naturally erode, wetlands to migrate, or land to become inundated. National Wildlife Refuges generally allow wetland migration.³⁶ Because the northern barrier island of Brevard County, the Cape, is federally owned, shore protection is unlikely for much of this barrier. With the Kennedy Space Center in the area, however, the protection of areas in the Cape is more likely.

Although the federal government does not directly regulate privately owned dry lands, it does require landowners to obtain permits to fill wetlands under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act. Although bulkheads and stone revetments are allowed, they are considered fill when constructed in areas flooded by the tides and hence require a permit.^e As sea level rises and the shore erodes, even if the armoring is built inland of mean high water, eventually they will sit within the tides and a permit will be required for repair or replacement.³⁶

The Clean Water Act and federal estuary programs are motivators for local governments to create setbacks for septic tanks and runoff. These setbacks will allow for retreat of a period of time while sea level rises. With continued erosion and sea level rise, however, the setback buffer eventually will be eliminated.³⁶

The Coastal Barrier Resources Act (CoBRA), administered through the U.S. Fish and Wildlife Service, was enacted during the Reagan Administration by a coalition of environmental organizations and fiscal conservatives. The environmental objectives were to protect ecologically sensitive land, geologically vulnerable land, and the aesthetic and recreational values of barrier islands. The fiscal objective was to stop federal subsidies of coastal development. The law prohibits the expenditure of federal money on new structures in these CoBRA areas. (Federal funding can be used for repair of bridges, utilities, or structures built before October 1983 and for removal of debris after a disaster.²⁰) The statute also precludes federal flood insurance, beach nourishment, and federally backed mortgages. Although CoBRA does not prohibit development, the law tends to discourage development in these areas.³⁶

^eAlthough state ownership of tidelands extends up to the mean high water mark, federal jurisdiction includes all “waters of the United States.” Although the precise meaning of US waters must occasionally be litigated in the courts (especially with respect to inland wetlands that are only connected to navigable waters), there is no doubt that it includes all tidal wetlands as well as nontidal wetlands immediately adjacent to tidal wetlands.

East Central Florida includes nine CoBRA areas: five in Canaveral and one each in Ponce Inlet, Ormond by the Sea, Spessard Holland Park, and Coconut Point. In this region, the CoBRA areas generally are undeveloped, except for the southern CoBRA areas of Brevard County. The majority of the CoBRA areas are in the Cape Canaveral National Seashore, which is primarily wetlands. As a result, the area is likely to be left to allow wetland migration. In the northern area of the region, the CoBRA areas are mostly wetlands or sparsely developed dry land. Some areas have no bridge access or are undeveloped islands in the middle of wetlands. Beach nourishment and other forms of shore protection may not be cost-effective in these areas.

In the southern portion of the region, however, the CoBRA areas are more developed, because of island access and lack of wetlands in the immediate area. Although federal funding for beach nourishment, flood insurance, and other programs is unavailable in this area, the level of development in the area appears to be great enough for property owners to protect their land through other funds. For example, property owners might vote to create a special taxing district to fund beach nourishment. Another possibility would be to petition for the reversal of the CoBRA designation. In short, in the region of Volusia and Brevard counties, land with CoBRA designations mostly likely would be left to retreat naturally as sea level rises, with the possible exception of southern Brevard County.

Subsidies for stabilizing harbor entrances through jetties and beach nourishment for highly developed shores have been provided by the federal government. Although many areas of the shoreline are armored with seawalls, a major storm may destroy the wall and result in beach erosion of 50–100 feet.³⁶ The federal subsidy for beach nourishment enables the shore to be protected, which in this beach tourist region is critical. Brevard County, the southern portion of the region, has continued beach renourishment for many years. Some federal policies, such as the federal flood insurance, indirectly encourage and allow dense development in the coastal area because of the lower risk of coastal construction. As a result of flood regulations, improvements have been made that allow homes to withstand greater damage and remain standing although the beach has eroded. The federal government wetland program allows for wetland armoring, which is addressed in the section on state policies.³⁶

The Coastal Zone Management Act specifically addresses sea level rise and the need for the study and development of plans for addressing land subsidence and sea level rise. The act states that coastal states must anticipate and plan for sea level rise to prevent or reduce the threats to property and life along the coast (and other hazard areas). Although specific policies and procedures are not discussed, the CZMA declares that coastal development must be managed to minimize the loss of property and life due to sea level rise, salt water intrusion, and the destruction of natural protective features.²¹

State Policies

Florida has no specific policy on sea level rise. However, as on the federal level, coastal management policies address consequences of sea level rise (e.g., coastal erosion, flooding, and wetland loss) as well as factors that will tend to help determine how the state ultimately responds to sea level rises (e.g., beach nourishment, seawall construction, conservation lands, coastal development).

In 1965, the Department of Environmental Protection began the coastal construction regulatory program. In 1970, a setback from the mean high water line was established at 50 feet. In 1978, however, when the setback line was renamed coastal construction control line (CCCL), it was stated that the CCCL should be representative of the 100 year storm surge. Any structure seaward of the CCCL should be able to withstand the wind and waves of the 100 year storm, and 110 mph winds.²²

The purpose of the CCCL is to protect the beach and dune system and therefore allow for public access to the beaches, decrease erosion attributed to development, and protect upland structures. Within the CCCL zone, a 30 year erosion setback exists, which is determined on a site by site basis by evaluating historical measurements by Department of Environmental Protection. This erosion setback does not, however, factor in sea level rise. Permits for major structures seaward of the erosion setback are prohibited except for piers, coastal or shore protection structures, and single family dwellings meeting specific requirements.²²

The National Flood Insurance Program, established in 1968, encouraged local governments to adopt regulations to decrease the costs associated with flooding. If the local government adopted such regulations, homeowners in the jurisdiction would be able to collect money from the program. If the city did not adopt such regulations, however, homeowners would be ineligible for the funding. This would include federally insured lenders.²²

The Coastal Protection Act, which encompasses land from the seasonal high water line to 1500 feet landward of the CCCL, was enacted in 1985 by the Florida State Legislature. For barrier islands, however, the coastal building zone is the land from the seasonal high water line to 5,000 feet landward of the established CCCL or the entire island, whichever is less. Its aim is to protect private property and the natural environment from damage through construction standards. The elevation and foundation requirements are based on NFIP regulations, and the standard wind code applies. CCCL construction standards are stricter than those regulated by the local governments in the Coastal Building Zone.²²

Seeing the need to protect and restore the beaches throughout Florida, the Florida Legislature adopted a comprehensive beach management program. Implementing beach management planning is essentially performed through the Beach Erosion Control Program. The program works with local, state, and federal entities to preserve and restore beaches. To receive funding, the activities slated for the beach must include restoration and nourishment activities, environmental studies and monitoring, dune restoration and protection activities, inlet sand transfer, inlet management planning, project design and engineering studies, and other activities designed to protect the beach from erosion.²² Although this program is associated with erosion, the activities funded through the program are important planning solutions to sea level rise and its associated erosion.

A Strategic Beach Management Plan has been developed for the Cape Canaveral and Indian River Coast areas as well as the coast of Volusia County. The Brevard County Shore Protection Project, a federal project authorized in 1968, restored the shoreline south from Port Canaveral Inlet to Indialantic-Melbourne beach. In 1996, the project was reauthorized with nourishment of the beach from South Jetty to Patrick Air Force Base, and north of Indialantic to Spessard Holland Park. The Indian River County Shore Protection Project was authorized in 1986 for Sebastian Inlet Park and the city of Vero Beach. In

Volusia County, Ponce de Leon Inlet is dredged every three years, with the shoreline north of the inlet receiving the dredged sand. There are no beach nourishment programs currently in place in Volusia County, however, although feasibility studies are being conducted.²³

Florida is aware of the importance of its beaches and the protection of private structures and infrastructure, as well as the extensive beach erosion problem along the beaches. Therefore, no one can install rigid shoreline armoring without first obtaining a permit from the Department of Environmental Protection. If DEP determines that these structures are unnecessary or will impede beach restoration projects, DEP may require removal even of structures that had been previously permitted.

Along estuarine shores, Florida statutes discourage the construction of vertical sea walls, which may threaten wetlands. The State prefers that property owners and local governments employ riprap or other and gently sloping artificial shorelines, with wetland vegetation. To obtain a permit for a new vertical wall in wetlands, one of the following conditions must be present: the construction would be located in a port, the construction is necessary to build a marina or public facilities, the construction is in a canal which is currently occupied by vertical seawalls, or the construction is by a public utility serving the public.²⁴

Florida has programs to help acquire land for conservation purposes. Coastal land may be acquired if it is necessary to protect, manage, conserve, or restore important ecosystems to enhance or protect coastal, recreational, fish, or wildlife resources. Florida has enacted the Florida Preservation Act 2000, Florida Forever Act, Florida Forever Act Trust Fund, Conservation and Recreation Lands Trust Fund, and the Florida Communities Trust program to promote and enable acquisition of public land. Through the Department of Environmental Protection, a certain amount of funds is used expressly for the acquisition of coastal lands.²² Acquiring public land now along the coast will help to create a setback or a buffer for the developed areas as sea level rises. This will allow the shoreline to naturally erode without endangering development.

Local Policies

Currently, no specific sea level rise policies exist on the local level. The Volusia County comprehensive plan in section 11.4.1.21 states, “Volusia County should continue to monitor sea level rise science to determine when and if a sea level rise event will affect the County. Based on pertinent data, the county will act accordingly.”¹⁹ The Brevard County comprehensive plan Policy 4.9 states, “Brevard County shall continue to collect and make available to the public, information related to sea level rise changes.”²⁵ Current policies dealing with erosion, development, shore protection, and flood hazard mitigation together, however, form an implicit response to sea level rise.

As evident from county and city comprehensive plans, local entities have the common goal to reduce the impact of damage from a storm on property, life, public facilities, and natural resources. This goal is achieved by discouraging new development in coastal high hazard areas through limiting new public expenditures in those areas, limiting housing densities, and not financing new local transportation

corridors unless there is no other cost-feasible alternative.^f Also, as the coastline changes, Brevard County will reevaluate the Brevard Coastal Setback Line and the Brevard Coastal Construction Line.^{19,25} In unprotected areas, adjusting the setback will aid in the reduction of property and infrastructure loss as sea level rises.

According to local comprehensive plans, seawall construction on the local level must be consistent with the standards set by the state. In Volusia County, new vertical seawalls may be built only where there is serious threat to health, safety, principal buildings, or public infrastructure. A dune system with vegetation must be established over the sea wall to prevent the wall from being exposed. However, Volusia County prefers to use sloping stabilization with vegetation in lieu of vertical seawalls. Development adjacent to estuarine and riverine shorelines must maintain a buffer zone to conserve the vegetation and wetlands. Volusia County takes priority in preserving coastal and riverine wetlands. Therefore, activities around wetlands should enhance them and natural buffer zones or setbacks should be incorporated landward of all protected wetlands.¹⁹

In Volusia County, the CCCL line varies depending on protection already in place. For open ocean coasts without seawalls, the CCCL is located behind the landward base of the foredune ridge. The ridge should be allowed to expand landward by having a buffer between the ridge and building construction.¹⁹

Brevard County prohibits new shoreline hardening structures along the Atlantic Ocean north of Patrick Air Force Base. South of the base, no new hardening structures are allowed along the Atlantic Ocean unless they are for emergency provisions as noted in Florida Statutes Chapter 163.3187 (1) (a). If no other alternative is feasible, the County will allow vertical wood, rock, or concrete walls that may also require dune restoration or revegetation. If more than 50 percent of a seawall is in need of repair, it is considered new construction; therefore, a permit is needed. In areas of wetlands, natural buffer zones or setbacks are required landward of all protected wetlands. Hardening of an estuarine shoreline in Brevard County is only allowed when a serious threat is posed to life and property. Like Volusia County, vegetation and other stabilization methods are encouraged. To help ensure no net loss of wetlands, Brevard County requires a 15 foot natural buffer around isolated wetlands and a 50 foot natural buffer around all others.²⁵

Oceanfront development in Brevard County must maintain 50 percent of its native dune vegetation and no vegetation can be removed seaward of the CCCL. The county also requires a 200 foot shoreline protection buffer from the ordinary or mean high waterline. Only passive uses may be used seaward of the buffer.²⁵

In Volusia County, the Environmental Management Services Group supports and sponsors shoreline habitat reclamation. Activities include dune restoration, shoreline stabilization, and regulation of urban shoreline redevelopment.¹⁹ Also, beach nourishment efforts in the southern region of the study area (Brevard County) are extensive.

^fCoastal High Hazard Areas include all areas that would be inundated with storm surge from a Category 1 Hurricane. It is part of Hurricane Vulnerability Zone, which is the portion of the unincorporated county that is evacuated during a Category 3 hurricane (111–130 mph wind and storm surge of 9–12 feet).

Both Volusia and Brevard encourage the acquisition of public land for conservation and enhancement of coastal resources. Efforts such as these may be used to protect the shoreline from sea level rise. Each county has programs to help conserve important land in the county. The Friends of the Scrub is an organization found in Brevard County aimed at protecting the scrub jay habitat.²⁷ Brevard County's Environmentally Endangered Lands Program (EEL) has acquired 18,000 acres of endangered land mostly through assistance from the state and the Saint Johns River Water Management District.²⁸ Both Volusia County and Brevard County share the Regional Land Trust for the Indian River Lagoon to create conservation easements.

In 1987, the Volusia County Land Acquisition Program came into effect to acquire land that meets resource conservation goals and objectives. Approximately 2,320 acres of recreation and environmentally endangered lands have been purchased in the coastal area through the program. An additional 47,000 acres of coastal zone land are federally, state, and county owned resource and park lands. These lands are undevelopable.¹⁹ Volusia County property owners can also donate or sell land to the Volusia County Land Trust and the Volusia County Greenways and Parks Program/Land Acquisition and Management. The Greenways and Parks Program works to protect open spaces that are managed for conservation or recreation purposes by creating corridors to link major parks and communities. In 2000, Volusia Forever was created. It is anticipated that over the life to the program, \$100 million will be raised to finance the acquisition, improvement, and management of environmentally sensitive lands, water resources, and recreational lands.²⁷

By continuing land acquisition on the local, county, state, and federal level, a buffer can be created along areas of the coast, also allowing land for wetland migration or development movement.

Private

Development in the study area includes single family, multifamily which includes apartments, town homes, and condos, and a number of resorts, hotels, and motels. Some cities such as Indian Harbour Beach have a high concentration of luxury homes, while other cities are geared toward the tourism industry, such as Daytona Beach. Daytona Beach Shores is the fastest growing city in Volusia County and consists of a 5.5 mile stretch of high rise condominiums, hotels, motels, townhouses, and single family dwelling.^{26, 35} In the study area, various types of housing are protected by seawalls and beach renourishment: single family and multifamily housing as well as commercial due to the resorts and dependence of the study area on its beaches and tourists.

The development trend in the study area is that of buildout in all upland areas, except that which is owned by the federal government. This is evident in that the study area consists of more than 31,000 acres of undeveloped uplands. The majority of this undeveloped upland is situated in wetland areas, between wetlands and development, or scattered in other developed areas. There currently exist little or no large tracts to use for retreat purposes in the study areas, especially on the barrier island. In the southern portion of the study area, where development is less intense, there exists more undeveloped land. This part of the barrier island, however, is very narrow and has wetlands bordering areas. Therefore, because of lack of open space for development, the continued use of beach restoration and seawalls will be of great importance in protecting this part of the study area from sea level rise.

Private land owners have several options for conserving their land. Programs on the federal, state, and local levels as well as private organizations allow private land owners to donate, sell, or create conservation easements with some associated financial and tax benefits . Private land owners may opt to create a conservation easement on their property. This easement is a legal agreement that limits the amount of development on the property. The agreement between the government, land trust, or other agency and the property owner protects the conservation or agricultural interests. Benefits to the private land owner include not only ensuring that the land is managed to their intent, but they may receive income tax savings through a charitable tax deduction, decrease in real property taxes due to the reduced market value of the land by creating the conservation easement, no federal gift and estate taxes, and the exclusion of the easement property from the federal estate tax.²⁷

Property owners also have the option to donate land or a portion of their land to a land trust, public agency, or nonprofit organization. As with creating an easement, the ecological or agricultural values of the land will be maintained. Also, the owner may experience a decrease in income tax and federal estate taxes. A third option is for a Bargain Sale or Charitable Sale of the land. In this option, a portion of the value of the land is sold while a portion is donated. This will result in charitable income tax deductions as well as savings on capital gains taxes.²⁷

Land donations, easements, and sales can be made to a number of public and private organizations. On the national level, the Natural Resources Conservation Service administers the Farmland Protection Program and the Wetlands Reserve Program. The USFWS Partners for Fish and Wildlife program works to restore wildlife habitat on private land. The Nature Conservancy has a number of programs for the public land owner such as the Immediate Land Donation Program and the Charitable Remainder Unitrust Program. Other national organizations include the Sustainable Forests Alliance, The Conservation Fund, the Land Trust Alliance, The Trust for Public Land, the Wildlife Land Trust, The Farmland Stewardship Program, and the Stewardship America.²⁷

On the state level, Florida offers the Florida Forever Program, which replaced the Preservation 2000 Program. This program works toward the restoration of damaged environmental systems, increased public access, increased protection through conservation easements, and public lands management. The Florida Division of Forestry oversees the Rural and Family Lands Act, conserving agricultural land. Finally, the Conservation Trust for Florida helps protect vital rural land.²⁷

By acquiring easements or land along the coast, a natural buffer can be created to protect development from the effects of sea level rise as well as avoid development in critical hazard areas.

SEA LEVEL RISE PROTECTION SCENARIO MAP METHODS

The current trends and policies provide a basis for developing maps depicting the region's likely responses to sea level rise. Those responses will depend on the development in the area, current and future policies, and the state of shore protection along the coastline. Land uses may change; therefore, we must analyze the future land use as well as the current densities in the study area. The majority of dry land within the study area has been developed and portions of the barrier island have high density. In East Central Florida, as with other coastal areas in this state, planners are unable to foresee circumstances that would lead residential areas near the coast to revert to agriculture or forest. Therefore, this area may not see dramatic changes in densities or development of areas of currently open space. Nevertheless, the likelihood of future shore protection depends on the status of the land when it becomes threatened by erosion or inundation, so preparing maps that depict future shore protection must consider both future land use plans and existing land use.

Study Area

As with all the sea level rise planning studies in Florida, this study considers all land below the 10-foot (NGVD) contour.⁸ The selection of this study area does not imply that we are predicting—or even analyzing the consequences of—a 10-foot rise in sea level. Because tidal influence can extend almost to the 5-foot contour, the 10-foot contour is approximately the highest elevation that might be inundated by tides were sea level to rise 5 feet over the next few hundred years—but that is not the primary reason we used the 10-foot contour to delineate the study area. In addition, current Category 3 Hurricane storm surge reaches at least 9 feet. Even with a 5 foot rise in sea level, a storm surge will reach beyond the current 10-foot contour to the 15-foot contour. Therefore, the 10-foot contour study area does not include all areas that would be effected by major hurricane as seen in 2004.

During the original design of this study, EPA and SWFRPC sought to identify a study area that could be implemented throughout Florida and that would include all land that might be significantly affected by sea level rise during the next century. If possible, they also sought to include land that might be affected over a longer period of time, but that goal had to be balanced against the extra cost of studying a larger study area. All things being equal, it is better to make the study area over-inclusive rather than under-inclusive: If someone later needs a map depicting only land below the 8-foot contour, then it would be very easy to subdivide our data and only show shore protection for land below the 8-foot contour. By contrast, if someone needs a map that includes some areas inland of our original study area, they will have to repeat our study for these higher areas.

The quality of topographic information varies throughout Florida. Some counties have LIDAR, and some water management districts have 2-foot contours. Nevertheless, the best topographic maps for

⁸ Until recently, most topographic maps provided contours that measured elevation above the National Geodetic Vertical Datum of 1929. That datum represented mean sea level for the tidal epoch that included 1929, at approximately 20 stations around the United States. The mean water level varied at other locations relative to NGVD, and inland tidal waters are often 3–6 inches above mean sea level from water draining toward the ocean through these rivers and bays. Because sea level has been rising, mean sea level is above NGVD29 almost everywhere along the U.S. Atlantic Coast

some portions of Florida have 5-foot contour intervals. Therefore, the only realistic choices for a statewide study area were the 5-, 10-, 15- and 20-foot contours.

Considering the criteria, EPA and SWFRPC decided that a 10-foot contour would probably be the most appropriate study area for Florida. Although the land below 5 feet is the most vulnerable, limiting the study area to such low land would exclude many areas that are potentially vulnerable to sea level rise during the next century. Statewide, most of the land between 5 and 10 feet is already below the base flood elevation for a 100-year storm, and hence will experience greater flooding as sea level rises. In East Central Florida, land with a 5 foot elevation is generally within the coastal high hazard zone; thus a 5 foot rise in sea level would bring all land below the 10-foot contour within the coastal high hazard zone. Finally, topographic contours are only estimates. Under the National Mapping Standards, up to 10 percent of the land can be higher or lower than the map indicates, by more than one-quarter of the contour interval. Thus a substantial amount of land depicted as between 5 and 10 feet may in reality be between 3 and 4 feet; using the 10-foot contour to delineate the study area helps to ensure that this very low land is considered.

The study area also includes all land within 1,000 feet of the shore, even if it is above the 10-foot contour. Rising sea level and other coastal processes can cause beaches, dunes, bluffs, and other land to erode even though it may have sufficient elevation to avoid direct inundation by rising water levels. The 1,000-foot extension is somewhat arbitrary; we chose that distance primarily to be consistent with similar studies in other states.^h Extending the study area 1,000 feet inland also ensures that the study area is large enough to be seen along the entire shore on the county-scale maps produced by this study.

Data Collection and Compilation

Future land use shapefiles or hard copy maps were obtained by contacting each jurisdiction and county in the study area.ⁱ The Existing Land Use and Five Foot Topography Polygon shapefiles were downloaded from the St. Johns River Water Management District Website.

Topographic

Five foot interval topographic polygons were downloaded from the St. Johns River Water Management District website. The file was digitized from USGS 24k scale maps. Each quadrant of Volusia and Brevard County was downloaded and then merged into one shapefile for each county. A field named “Elevation” was added to the attribute table and elevations were categorized as “0–5 ft,” “5–10 ft,” and “Above 10 ft.”^j

^hMaryland’s land-use rules to protect Chesapeake and other coastal bays apply to land within 1000 feet of the shore.

ⁱThe jurisdictions in the study area include Brevard County, Cape Canaveral, Cocoa, Cocoa Beach, Indian Harbour Beach, Malabar, Melbourne, Melbourne Beach, Palm Bay, Palm Shores, Rockledge, Satellite Beach, and Titusville. Also, Volusia County, Daytona Beach, Daytona Beach Shores, Edgewater, Holly Hill, New Smyrna Beach, Oak Hill, Ormond Beach, Ponce Inlet, Port Orange, and South Daytona.

^jWe are uncertain whether these data are just their rendering of the well-known USGS 1:24,000 scale maps, measured relative to NGVD29.

Existing Land Use

Using the Florida Land Use Cover Classification Code System (FLUCCS), all land uses were classified as water, wetlands, and uplands. Changes applied to the shapefile were as follows: “canals and locks,” “slough waters,” and “embayments not opening” were classified as water; “beaches other than swimming beaches” were classified as uplands. The Existing Land Use Map was unioned with the topographic data to determine the study area of the 10 foot elevation and below.^k

Future Land Use

Shapefile maps sent from the jurisdictions were reviewed for inconsistencies, corrections, and missing areas. Areas marked as “Unknown” on city FLU shape files were compared to the county FLU files and were categorized accordingly. If no FLU category existed, if possible, the unknown areas were classified as the surrounding land uses indicated or as noted by the city planner. Maps of cities currently not using GIS were digitized using Arc View GIS. By incorporating aerial photographs from Florida Geographic Data Library, street shape files, and city municipality files, city FLU maps were digitized and compared for accuracy. Areas within the cities maintaining the county FLU classifications were checked against county FLU maps and the correct classifications were recorded. Future land use categories were also reclassified into the categories in Table 5. The original and reclassified maps were sent to each city for review and to ensure the maps and reclassifications were consistent with the cities’ Future Land Use Categories. After collaborating with individual cities, the maps were revised if necessary. All changes suggested by the jurisdictions were made to the shape file.

Table 5: Categories of Future Land Use Used in Project

Estate (1 un/4.9 ac – 1 un/ 0.9ac) ^l	Industrial
Single Family Residential (1 un/ 1 ac – 5.9 un/ac)	Mining
Multi Family Residential (>= 6 un/ac)	Military
Agriculture	Wetlands
Preserve	Water
Commercial	

When the shape files were merged using ArcView 3.2, many of the boundaries were inconsistent and overlapping. This was possibly due to the various original projections used by the different cities, as well as the base maps used to create the files. Therefore, a new Future Land Use file was created for the study area using the existing land use file and city boundaries. A new field called “Future Land Use” was added to the Existing Land Use shape file and the “Uplands” were populated according to the data received from each jurisdiction. Wetlands were classified according to the existing land use codes assuming current wetlands will remain intact. Because we used the SJRWMD Existing Land Use as the

^kAs discussed later in the text, our final maps also include all land within 1,000 feet of the shore, to account for possible shore erosion and to ensure that in areas where the ground near the water is relatively high, the study area is still large enough to show up on county-scale maps.

^lThe residential land use criteria were taken from the SWFRPC Sea Level Rise Project to maintain consistency.

base map, however, some issues were encountered when classifying beaches because most jurisdictions do not classify beaches on their future land use. Therefore, any known beach or undeveloped upland without a future land use classification from the previous maps were given the classification “Preserve.” By doing this, we can easily recognize and change any areas that are in fact beaches or undeveloped land but not conservation. Changes to these areas were made during the protection classification step. Therefore, in the shape file itself, some coastal areas with the attribute “Preserve” may not actually be conservation areas.

Critical Facilities

Critical facility lists, which include municipal, county, federal, and private facilities, were obtained from Volusia and Brevard counties. Volusia County critical facilities were determined using the county guidelines that any facility labeled with a 2 or 3 on the facility assessment list is considered a critical facility. Facilities without a number but within the surge zone were added to the critical facility list. According to Volusia County, a critical facility is “any facility that cannot go more than 24 hours without operational capability.”²⁹ Addresses for each critical facility in Volusia County were researched through the reports provided by Volusia County, from internet resources, and by contacting individual cities or departments. A shape-file was created and addresses were geocoded using ArcView 3.2. Facilities with no street address were mapped by the closest cross streets or were given middle address numbers for the appropriate street. The Brevard County critical facility list was provided by the Emergency Management Division in an Access database. Therefore, the database was brought into ArcView 3.2 and the points were mapped according to the GPS coordinates provided in the database.

Critical facilities outside the study area were deleted from the file. Other facilities not included due to type included any facility deemed not necessary such as nongovernmental facilities, churches, businesses, nursing homes, etc.^m The remaining critical facilities were included on the map as a point of interest for the jurisdictions, to indicate the number and types of critical facilities that would be affected by sea level rise. Critical facilities were represented by black points. Critical facilities included in this study are as follows:

NASA	Emergency Operations Centers
Water Treatment Plant	Wastewater Treatment Plant
Police Department	Utility Plant
Fire Department	Hospital
School	Lift Stations
Air Force Base	Central Services
Water towers	Wells
Sewer Pump Stations	Armory
Stormwater Pumping Station	Industrial Park
Evac	

^m Performed per methods sent by SWFRPC. A list of other critical facilities in the study area not included on the map is found in the Appendices

Protection Scenario Classifications

General Classifications

Our primary objective was to divide land within the study area into one of four categories: protection almost certain (brown), protection likely (red), protection unlikely (blue), and no protection (light green). Current trends, policies, and development are the most important factors used to determine protection scenario classifications. Table 6 illustrates the initial general scenarios classifications for the various land uses that all of the Florida studies are following. By using Future and Existing Land Use densities and categories, the majority of the study area was initially classified as directed in the state-wide classification Table 6. All polygons labeled “water” and “wetlands” based on the existing land use field were selected and copied to the new “Scenario” field. All “Uplands” polygons were then classified initially according to Table 6. To aid in initial classification, various shape files were used. A CoBRA shape file was downloaded from the Florida Geographic Data Library and a shape file available on the ECFRPC’s network was used for District Owned Land, land currently or potentially public owned. The Volusia County GIS department provided the planning council with a sea wall shape file and Brevard County was the source for a beach renourishment shape file. As the study progressed on site by site basis, however, some areas were changed because of surrounding areas or other considerations.

Our maps generally followed those categories because they are appropriate for East Central Florida.³¹ There is relatively little doubt that developed areas will be protected, with the possible exception of low-density areas without water and sewer, and CoBRA areas along the Atlantic Ocean, where the absence of federal subsidies might conceivably make sure protection unlikely if beach nourishment costs escalate in the future. Aside from those exceptions, the demand for a home near the coast is so great that property values can easily justify shore protection costs. Even though we recognize that tastes can change, we have been unable to identify any plausible reason to expect an inland migration of coastal residents comparable to the coastal migration that took place during the last 50 years. At the other extreme, there is relatively little doubt that within conservation areas, dry lands will gradually be flooded by as sea level rises, with the possible exception of those adjacent to key federal installations such as the Kennedy Space Center.

Undeveloped areas where growth is expected will almost certainly be protected if they are developed, but until they become development, it is still possible for conservation organizations to make arrangements that would allow wetlands to migrate inland in some of these areas. Therefore, most undeveloped lands where development is expected is likely to be protected. In some areas, even undeveloped areas are almost certain to be protected because the development is imminent or the land is already surrounded by developed areas that are certain to be protected.

Outside of the public lands, only about 2 percent of the coastal lowlands in our area are unlikely to become developed. Those lands include remote areas where development is impractical, and some privately owned agricultural and forest preservation areas. Shore protection is unlikely in these areas, either because shore protection costs are likely to be greater than the value of the land lost from allowing the shore to retreat or—in the case of lands with conservation easements—because allowing natural

processes to proceed is more consistent with the conservation ethic. Nevertheless, no policies would prevent owners from protecting their lands, so protection unlikely is a reasonable designation.

The approach does not always have a perfect one-to-one correspondence with the available data. For example, some land use categories (e.g., parks) could be certain, likely, or unlikely to be protected, depending on the fates of surrounding lands and specific purposes to which property is put. Moreover, although the Florida land use categories are all mutually exclusive, we also considered other data. Since some areas did not fall into one category, other determining factors may have been used to classify the area, including site specific review.

Table 6.

STATEWIDE APPROACH FOR IDENTIFYING LIKELIHOOD OF LAND USE PROTECTION¹

Likelihood of Protection ²	Land-Use Category	Source Used to Identify Land Area
Protection Almost Certain (brown)	Existing developed land (FLUCCS Level 1-100 Urban and Built-up) within extensively developed areas and/or designated growth areas.	Developed lands identified from water management districts (WMDs) existing Florida Land Use, Cover and Forms Classification System (FLUCCS) as defined by Florida Department of Transportation Handbook (January 1999); growth areas identified from planner input and local comprehensive plans.
	Future development within extensively developed areas and/or designated growth areas (residential/office/commercial/industrial).	Generalized Future Land Use Maps from local comprehensive plans, local planner input, and WMD.
	Extensively-used parks operated for purposes other than conservation and have current protection ³ or are surrounded by brown colored land uses.	County-owned, state-owned, and federally owned lands (based on local knowledge) or lands defined as 180 Recreational on the Level 1 FLUCCS, local planner input and Florida Marine Research Info System (FMRIS) for current protection measures.
Protection Likely (red)	Existing development within less densely developed areas, outside of growth areas, mobile home development not anticipated to gentrify, not on central water and sewer, and within a coastal high hazard area. ⁴	Developed lands identified from WMD existing FLUCCS; growth areas identified from local planner input, local comprehensive plans and current regional hurricane evacuation studies.
	Projected future development outside of growth areas could be estate land use on Future Land Use Map.	Local planner input
	Moderately-used parks operated for purposes other than conservation and have no current protection or are surrounded by red land uses.	County-owned, state-owned, and federally owned lands (based on local knowledge) or lands defined as 180 Recreational on the Level 1 FLUCCS, local planner input, and FMRIS.
	Coastal areas that are extensively developed but are ineligible for beach nourishment funding due to CoBRA (or possibly private beaches unless case can be made that they will convert to public)	Flood Insurance Rate Maps for CoBRA, local knowledge for beach nourishment.
	Undeveloped areas where most of the land will be developed, but a park or refuge is also planned, and the boundaries have not yet been defined so we are unable to designate which areas are brown and which are green; so red is a compromise between	Local planner input.
	Agricultural areas where development is not expected, but where there is a history of erecting shore protection structures to protect farmland.	Local planner input.
	Military Lands in areas where protection is not certain.	FLUCCS Level 173.
Protection Unlikely (blue)	Undeveloped privately owned that are in areas expected to remain sparsely developed (i.e., not in a designated growth area and not expected to be developed) and there is no history of erecting shore protection structures to protect farms and forests.	Undeveloped lands identified from WMD existing FLUCCS Level 1-160 mining, 200 Agriculture, 300 Rangeland, 400 Upland Forest, 700 barren land ; Nongrowth areas identified from planner input, local comprehensive plans, Flood Insurance Rate Maps for CoBRA and current regional hurricane evacuation studies.
	Unbridged barrier island and CoBRA areas or within a coastal high hazard area that are not likely to become developed enough to justify private beach nourishment.	Flood Insurance Rate Maps for CoBRA, local knowledge for beach nourishment and local planner input.

Table 6.		
STATEWIDE APPROACH FOR IDENTIFYING LIKELIHOOD OF LAND USE PROTECTION¹		
Likelihood of Protection²	Land-Use Category	Source Used to Identify Land Area
	Minimally used parks operated partly for conservation, have no current protection or are surrounded by blue colored land uses, but for which we can articulate a reason for expecting that the shore might be protected.	County-owned, state-owned, and federally owned lands (based on local knowledge) or lands defined as preserve on Future Land Use Map, local planner input, and FMRIS.
	Undeveloped areas where most of the land will be part of a wildlife reserve, but where some of it will probably be developed; and the boundaries have not yet been defined so we are unable to designate which areas are brown and which are green; so blue is a compromise between red and green.	Local planner input
	Conservation easements (unless they preclude shore protection)	Local planner input.
No Protection (light green)	Private lands owned by conservation groups (when data available)	Private conservation lands.
	Conservation easements that preclude shore protection	Local planner input.
	Wildlife Refuges, portions of parks operated for conservation by agencies with a policy preference for allowing natural processes (e.g., National Park Service)	Local planner input.
	Publicly owned natural lands or parks with little or no prospect for access for public use.	County-owned, state-owned, and federally owned lands (based on local knowledge) defined as preserve on the Future Land Use Map and local planner input.
Notes:		
<ol style="list-style-type: none"> 1. These generalized land use categories describe typical decisions applied in the county studies. County-specific differences in these decisions and site-specific departures from this approach are discussed in the county-specific sections of this report. 2. Colored line file should be used in areas where less than 10 foot elevations exist within 1,000 feet of the rising sea or color cannot be seen on ledger paper map. 3. Current protection may include sea walls, rock revetments, beach renourishment, levees, spreader swales, or dikes. 4. Coastal High Hazard Area defined in Rule 9J-5 FAC as the Category 1 hurricane evacuation zone and/or storm surge zone. 		

Site Specific Classifications

After classifying land areas according to Table 6, changes were performed based on site by site analysis. Aerial photographs were used to observe current density, and/or surrounding density if the land was currently undeveloped, and types of development (i.e., expensive housing, apartments, hotels, resorts, open space, recreation area with development, etc). Also taken into account were the future land use and location of property relative to wetlands. Let us examine these exceptions from the initial classifications in detail.

Environmental aspects as well as social and economic aspects must be considered when classifying sea level rise protection scenarios. Undeveloped land around wetlands could be used to allow wetland

migration and preserve habitat and functions. Therefore, large areas of currently open/undeveloped land behind wetlands or between wetlands were classified as protection likely based on the statewide approach, although the future land use category is developed. Current low density development areas near wetlands or water bodies planning for greater development were also classified as protection likely. By limiting the development in these areas to its current density, less money would need to be expended to protect the property and infrastructure, and the property owners may be able to relocate their homes. If development were to build out in these areas, the cost to the public or jurisdiction may be greater and there would be no room for wetland migration.

An example of such a situation is located on the middle barrier island in Brevard County, just past the military and government land and north of SR A1A. This section of upland includes sporadic high and low density development between large areas of undeveloped land. The uplands are within and surrounded by wetlands with a preserve to the east. Because of the current low development in the area as well as the surrounding wetlands and preserve, our maps classify most of this area as protection likely. Four areas have high-density development, and hence we classified them as protection almost certain.” Therefore, our maps recognize that the undeveloped areas probably will be developed and protected, but that they might remain undeveloped to allow for a buffer to protect the developed portions of the island and to allow for wetland migration. The maps also recognize that residents of areas with light development could relocate to the existing highly developed areas. This could reduce the cost of protecting infrastructure such as roads and wells as well as create open space to act as a buffer for the more developed areas.

Our maps show the area just north of the NASA Causeway on the mainland in Brevard County as protection almost certain (brown) because the area is currently developed. The area south of the NASA Causeway is also developed and certain to be protected. Between these two areas is a large area of undeveloped property bordered by a large wetland and the causeway. If the future land use map and Table 6 together were used to classify this area, the area would be classified as protection likely because of the anticipated development. Nevertheless, it is realistic to assume that this area is also certain to be protected, because an inlet between the developed communities would not be desirable. Because a road already exists in this corridor, it would provide the best area for development. The entire area would be protected by raising the infrastructure or building seawalls. From an environmental perspective, however, it may be preferable if property owners in this undeveloped area traded rights of development for rights to develop within other undeveloped areas surrounded by development. This would allow the area to be used for wetland migration and environmental buffers. Regardless of whether the area is protection almost certain or protection likely, US 1 would need to be raised to either keep the connectivity of the two developed areas or the entire area would be raised because of development (more would need to be done to protect the entire area than only raising US 1). Therefore, because of the current lack of development, it is currently classified as protection likely to acknowledge the opportunity for either development or wetland migration. If the area was classified as protection almost certain, one might conclude that we are saying that there would be no opportunity for the land to be used for wetland or habitat migration; the land would be protected as the surrounding developed land. By classifying this area as protection likely, the option is left open to use the land in an environmental capacity or to develop the land and protect it.

The blue lands within this area are agricultural lands classified according to Table 6. One might have expected that we would change them to red given the surrounding land classifications. Nevertheless, they border wetlands, will not be developed, and are likely to provide an opportunity for wetland and habitat migration or serve as a buffer if the surrounded area is indeed protected. We do not mean to suggest that an inlet will form. When these maps are produced at a small scale, one should see a narrow (e.g., 300 foot) area that probably will be protected to prevent an inlet from forming; but otherwise, wetland migration is likely.

Other small undeveloped lands surrounded by areas with a certain classifications were classified according to the surrounding scenarios. If protection is almost certain, it is not foreseeable that the open land would be left to give way to the ocean if the surrounding areas are to be protected. The land may also be protected to allow for future development for areas that may need to retreat.

Following EPA's national approach as well as the statewide approach, all military and NASA property in undeveloped areas were colored red. This designation is meant to convey our uncertainty rather than a specific expectation that shore protection is likely.¹ According to the "Supremacy Clause" of the U.S. Constitution, federal governmental land is exempt from local and state regulations. Also, because the area is in an undeveloped area, one cannot be certain as to how the government will address this issue and future land uses.³⁰ Most of this area is located on the Cape and situated in wetlands and preserve areas. In northern Brevard, however, a few sporadic military uplands were located within a CoBRA area. We decided not to follow the national and statewide approaches in these areas because they are small isolated areas outside the major military installations. These "developments" areas would most likely be moved to other more densely developed areas. Therefore, we classified these areas as protection unlikely and colored them blue.⁰

As mentioned previously, some issues were encountered when classifying beach areas and undeveloped land along the beach in which jurisdictions did not include in future land use maps. Therefore, the easternmost sections (beaches and adjacent undeveloped land) of the barrier islands of both Brevard and Volusia counties were classified on a site by site basis.

Some beaches were classified as "Preserve" on the recommendation of jurisdictions during the course of the study. For example, in Brevard County, New Smyrna Beach identified a beach area classified as conservation, and thus classified as no protection, while the beach on the north side of this area is a recreational beach. Beaches experiencing beach renourishment, based on the shape file from Brevard

¹EPA's project manager, Jim Titus, advised all contractors and grantees on this project that in his personal opinion, it is not appropriate for EPA to speculate on what the Department of Defense will choose to do with its coastal lands. He also points out that the Department of Defense is exempt from state and local regulations. EPA studies represent military bases as red to highlight the uncertainty, not to indicate that shore protection is likely. EPA hopes to eventually obtain an opinion from the Department of Defense regarding the most reasonable assumption for sea level rise studies, once all of the state-specific studies are complete. Nevertheless, the EPA studies classify military bases in urban areas as shore protection almost certain, because doing so does not require speculation regarding military intention—in such areas, even if the base were to close, it would require shore protection given its location in an area being protected in its entirety.

⁰The shapefiles we make available to SWFRPC and EPA designate military lands, so our departure from the general approach will not prevent others from modifying the maps if better information regarding DOD or NASA intentions becomes available.

County, were classified as protection almost certain. All land areas in Brevard County that are behind renourished beaches were classified as protection almost certain because of current protection already in place. Otherwise, beaches were given the same classification as the surrounding area, unless otherwise suggested by the local governments or are located in a CoBRA area, in which they were classified as no protection. For example, in Brevard County, a CoBRA area exists along the southern end of the barrier island. The beach in this area has been classified as no protection while the undeveloped uplands have been classified as protection unlikely, and the small areas of developed uplands are classified as protection likely.

Seawalls are an important form of protection for sea level rise, whether they are built to protect property from erosion or flooding. A shape-file of all current seawall armoring was obtained from Volusia County GIS Department. All property behind a seawall, including the adjacent beach, was classified as protection almost certain because of the existing protection. Current data for seawalls were unavailable for Brevard County. A shape-file downloaded from the NOAA website provided seawall data up to 1980. These data were used in the same capacity as the Volusia County file. Much of the property in the region, however, was already classified as protection almost certain because of beach renourishment or existing development.

Agricultural areas were classified according to Table 6. Review of the map, however, revealed that small agricultural areas exist in Brevard County and are surrounded by areas of reasonable or almost certain protection. In these cases, the farms will probably be rezoned for residential as development occurs around them. Therefore, these small plots, surrounded by current development or planned development, where the plan still contemplates agriculture, were classified according to the surrounding protection scenario. Areas such as these are found along the mainland of Brevard County and north of A1A in the middle barrier island.

Only Brevard County has a future land use of mining, and the area is inland and surrounded by undeveloped land, wetlands, and single family (low density) development. Therefore, the mining future land use was classified as protection likely, as is the surrounding area.

Local Stakeholder Review

Finally, local review of the maps was important in classifying land areas. Initially, during the first few months of 2004, we provided draft maps that focused exclusively on the role of elevation in the classification process. Volusia County and cities were sent draft maps to review in which areas below 5 feet were classified as protection unlikely and areas between 5 and 10 feet were classified as protection likely.^P Each jurisdiction was asked to review and change the protection scenarios based on the

^PThese initial draft maps and guidelines were created and sent to Volusia County before we had fully considered the feasibility of shore protection and the infeasibility of a large-scale abandonment of the coast. The more in-depth classification guidelines and Table 6, later provided to the ECFRPC by SWFRPC and EPA, helped us and the localities realize that shore protection is feasible—and often already occurring—in low-lying developed areas.

protection scenario guidelines (see Table 6^q). Responses from Volusia County and the cities did not result in significant changes. Volusia County stated the 200 year time frame exceeded their 20 year planning policy and therefore they had no suggested changes to the initial maps.^r Daytona Beach Shores emailed a response of “no suggested changes” to the map. As the study progressed, however, the city was classified almost entirely as protection almost certain because of density and sea walls around the city. The City of New Smyrna Beach recommended the entire city to be classified as protection almost certain. Some discussion took place with Ormond Beach concerning the purpose and process of the study and the process of local review. No changes, however, were suggested by city staff. Finally, the City of Daytona Beach questioned the underlying assumptions of the study and had no comments to make about the map. After the local reviews, and with further discussion with the EPA and SWFRPC and follow-up analysis of the coastal areas using aerials and both the existing and future land use maps, the Volusia County map was modified based on the methodology previously described.

After the issues and lack of responses from Volusia County, we took a different approach with Brevard County. Rather than providing a map that considered only elevations and asking for comments and changes based on the general guidelines, we prepared a map based on those guidelines.^s The maps were then sent to the appropriate jurisdictions. In Brevard County, the cities of Cocoa, Cocoa Beach, Palm Bay, Indian Harbour Beach, Cape Canaveral, Satellite Beach, Malabar, and Palm Shores responded with suggestions to the maps.

- *The City of Cocoa* suggested the marina be classified as protection almost certain because of residences and offices in the marina. Also, it was suggested that Lee Wenner and MacFarland parks be classified as protection almost certain because of the location, use of, and walls at the parks.
- *The City of Cocoa Beach* informed the ECFRPC that the parks are protected by beach renourishment and should be classified as protection almost certain.
- *Palm Bay* reviewed the maps and stated they had no additional comments or suggestions for the study area.
- *The City of Indian Harbour Beach* stated the entire city should be classified as protection almost certain. The northeast island of the city was originally classified as protection likely because of density; however, the city stated the area is newly developed and the most expensive housing in the city. The parks along the coast are hardened as well.
- *The City of Cape Canaveral’s* planner suggested the entire city be classified as protection almost certain because of development patterns.
- *The City of Satellite Beach* pointed out a park that is used for conservation purposes as well as another park used as recreation. These areas are represented on the map as protection

^qThe current version of Table 6 was developed after this round of reviews, but the overall guidance was very similar. The key difference between Volusia and Brevard is that we asked Volusia to use guidance based on land use to revise maps that were based on elevations. We asked Brevard, by contrast, to review maps based on land use.

^rThe original draft report left many readers with the impression that the study is primarily focused on events 200 years hence, because of our explanation of the study area. We tried to revise the report so that it is more clear that shore protection may be required in the next few decades along most shores, and that the study is meant to inform planners about the long-term consequences of the decisions they make during the next comprehensive plan revision.

^sWe prepared the initial map for Brevard based on the more specific guidelines in Table 6. Instead of relying on the jurisdictions to make the classifications as with Volusia County, the ECFRPC classified the study area initially based on the above guidelines. These initial maps were then sent to the jurisdictions for more site by site review.

unlikely and protection likely, respectively. Otherwise, the city's protection scenario appeared accurate.

- *The City of Malabar* had no additional comments for the map.
- *The Town of Palm Shores* informed the ECFRPC that Palm Shores is built on a 20 foot bluff and is not in a flood zone. The Future Land Use category of low density has recently been changed to medium density and since roads have been widened, lands once inaccessible are now accessible. Therefore, the entire town should be classified as protection almost certain.

All suggestions offered by jurisdictions were documented and the maps were changed accordingly. Given the experience from jurisdictions within Brevard County, we concluded that providing localities with a first-cut sea level rise planning map based on familiar land use classifications and established policies is a more effective way to engage local government than simply providing a map with elevations and asking the localities to develop the classifications from scratch.

Although it was not practical to engage in a second round of interactions with each of the localities in Volusia County, we provided the County Emergency Management Department with the revised map and explained the revisions and logic over the phone. Since the first submittal, East Central Florida had experienced three hurricanes in rapid succession. Of the three, Hurricanes Charley and Frances inflicted the most damage, which included severe erosion along the barrier islands. In Volusia County, most beaches lost their primary dunes and the buildings behind them suffered varying levels of damage. Volusia County Emergency Management expressed interest in the study, recognizing the additional damage that could be caused by a 5 foot increase in water levels. They requested the RPC to explore the possibility of updating the Regional Hurricane Evacuation Study and the potential for incorporating the results of the study into the storm surge models.

Further analysis and changes of the maps continued during the project as new information, directions, and comments were made available. Additionally, in November 2003, SWFRPC informed us that the study area should include all land within 1,000 feet of the shore to account for possible erosion and ensure that the protection classification is visible in county-scale maps.^t As a result, we added the 1,000-foot buffer to the mainland of Brevard County and assigned protection classifications. SWRPC further suggested that the areas above 10 feet on the barrier islands of Brevard and Volusia counties be assigned a protection classification. This was also completed. The above changes, however, were not reviewed by the appropriate jurisdictions because of time constraints.^u

^tThis issue had not come up in the original study done by SWFRPC, because all land in that region within 1,000 feet of the shore is below the 10-foot contour anyway. Although EPA had provided drafts of reports from other states at the outset of this project, EPA, SWFRPC, and the other RPCs did not discuss the need for this buffer until SWFRPC has a conference call with the various RPCs during a visit by the EPA's project manager in November 2003.

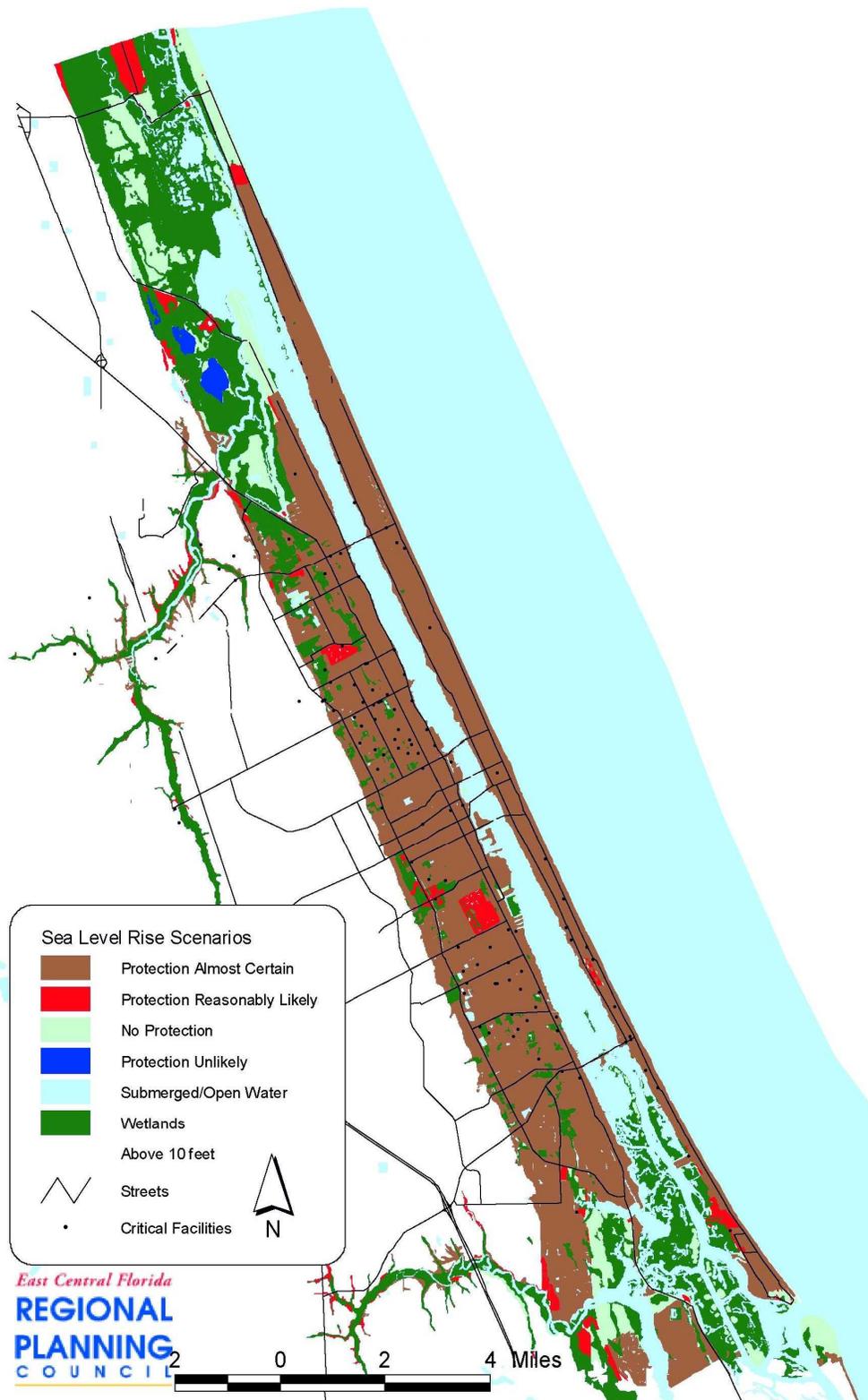
^uThe lack of review is probably not problematic. Including entire barrier islands within the study area makes the maps less confusing, but we know of no reason why the portion of a barrier island above 10 feet in elevation would have any different fate than surrounding portions, given that erosion—not—inundation is the primary impact on both the beach and the high ground immediately inland of the beach. Similarly, inclusion of land within 1,000 feet of the shore simply makes the maps easier to read, but we know of no areas where the land between 500 and 1,000 feet from the shore would have a different classification than land 0 to 500 feet from the shore. The only exception would be some CoBRA areas where we had already dealt with that issue.

Finally, the protection scenarios were colored according to the project guidelines. Table 7 describes each protection scenario and the corresponding color.

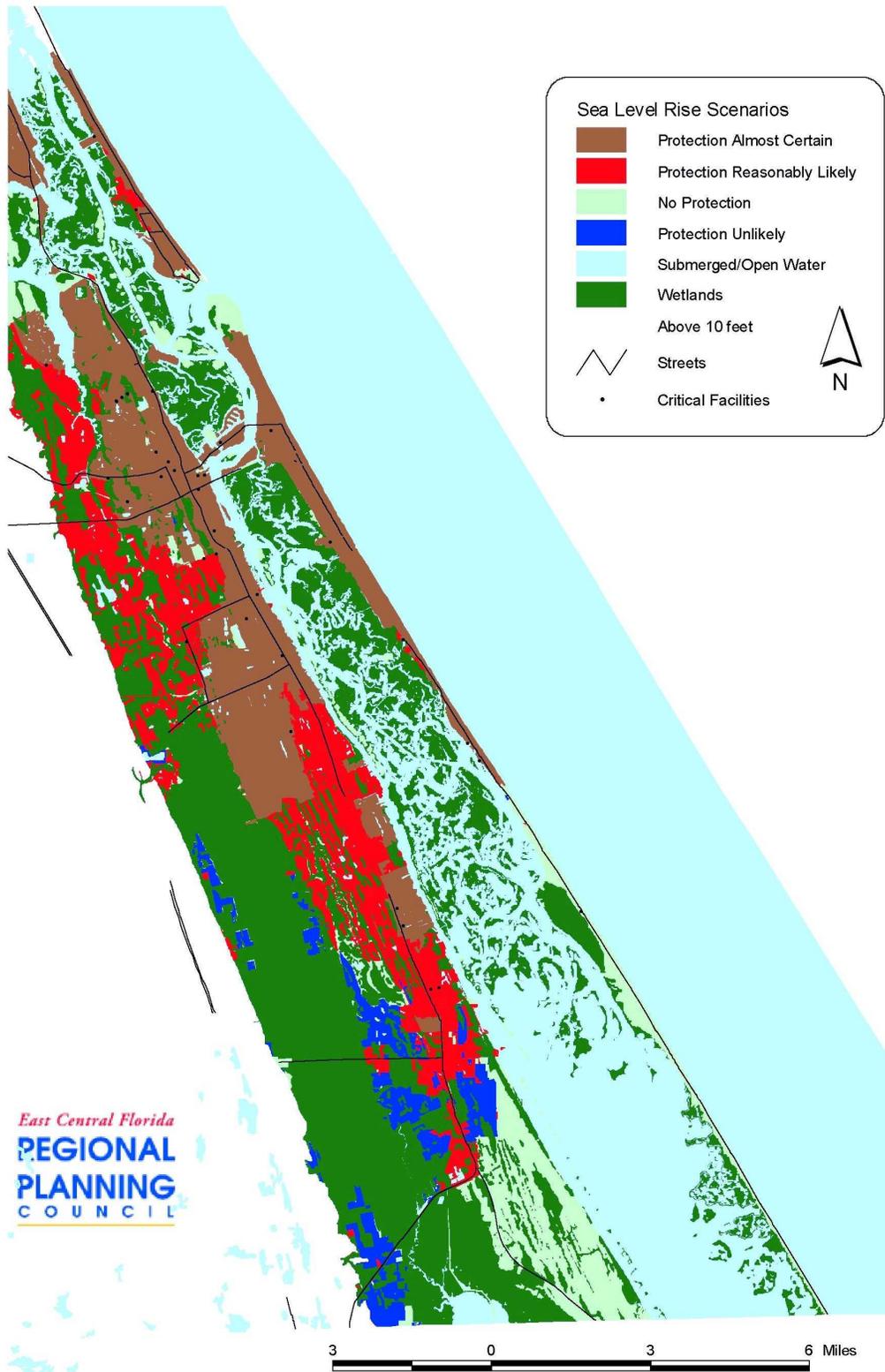
Table 7: Categories on final map and corresponding colors.

Conservation	No Protection	Light Green
Wetlands	Wetlands	Dark Green
Water	Water	Light Blue
Uplands	Protection Unlikely	Blue
Uplands	Protection Likely	Red
Uplands	Protection Almost Certain	Brown
Critical Facilities	Reference	Black

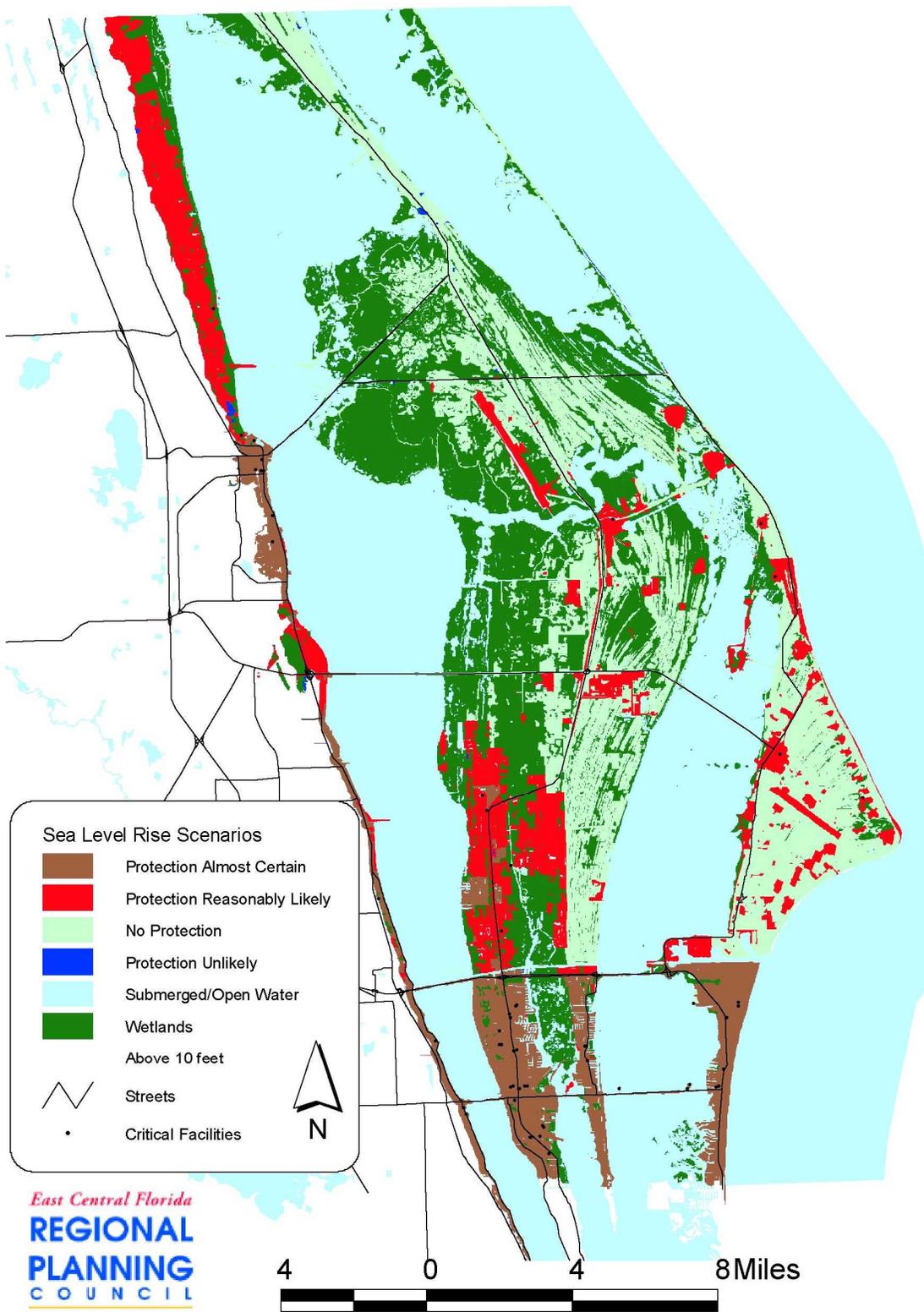
Adobe Files of each map were created, which allows for easy distribution via the Internet and display on the East Central Florida Regional Planning Council website. Map 2 shows the likelihood of shore protection for Volusia County, and Map 3 shows the likelihood of shore protection for Brevard County.



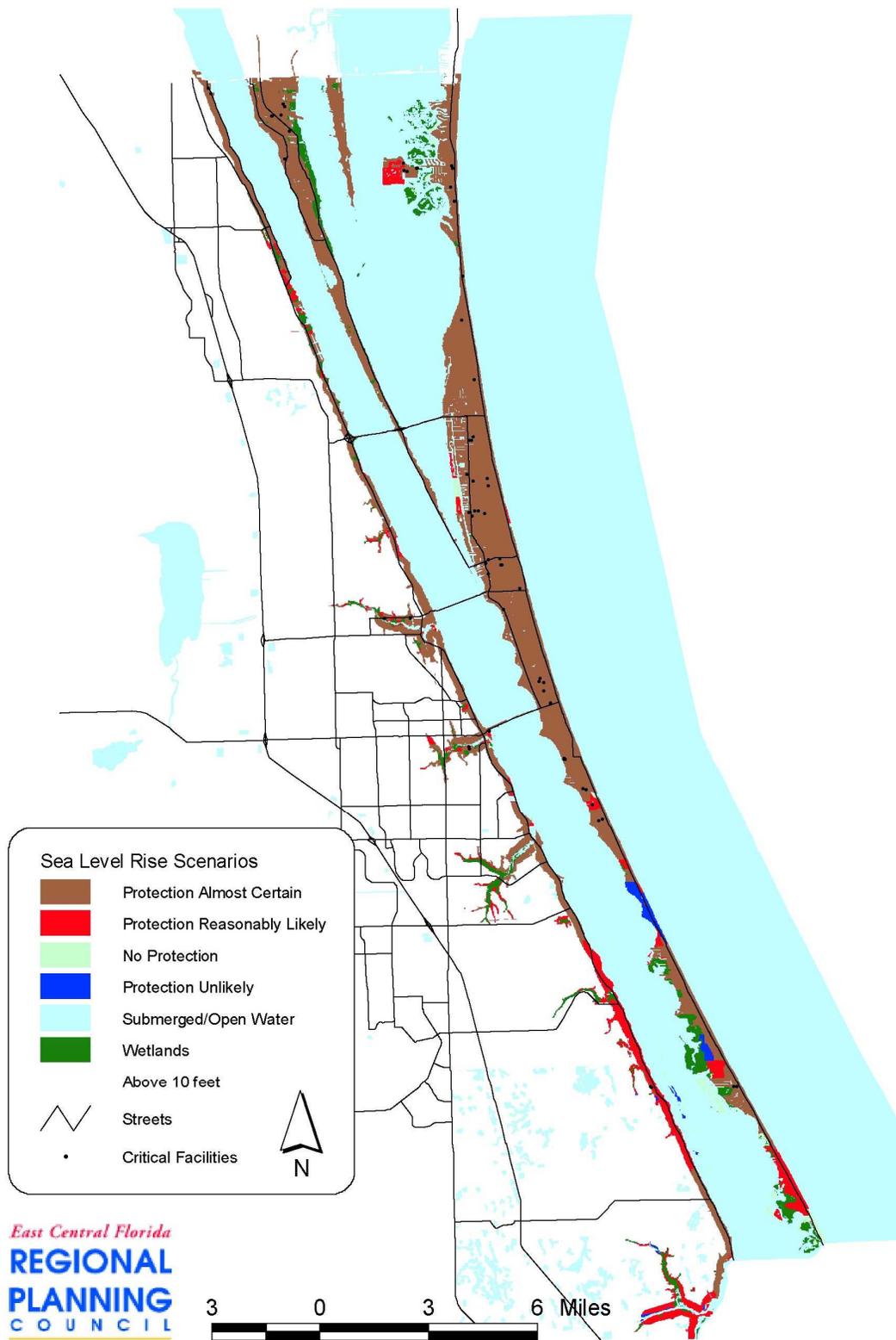
Map 2a: Northern Volusia County: Likelihood of Shore Protection



Map 2b: Southern Volusia County: Likelihood of Shore Protection



Map 3a: Northern Brevard County: Likelihood of Shore Protection



Map 3b: Southern Brevard County: Likelihood of Shore Protection

Recommended Scale

The scale for the maps of Volusia County and Brevard County were 1:100,000 and 1:150000, respectively. This scale was used to provide the maps at the largest scale possible with the counties cut into two 11 × 17 maps each. The Adobe files were then created to allow users to zoom in to specific areas.

ANALYSIS

The study area of Volusia and Brevard counties consists of 153,464 acres (240 square miles) of uplands and 95,950 acres (150 square miles) of wetlands. Therefore, a 5 foot rise in sea level would affect more than 250,000 acres (390 square miles) of the coastline, excluding water bodies. This accounts for approximately 18 percent of the land within Brevard and Volusia counties. According to the 2000 census, the current population in the coastal census tracts found completely or partially within the study area was approximately 503,000 in 260,000 dwelling units.^v Coastal Volusia is expected to have a population of 350,000 in 183,000 dwelling units by 2020 and Brevard's 2020 coastal population is expected to be 199,000 in 104,000 dwelling units. Therefore, the entire study area is expected to have fewer than 550, 000 residents in 287,000 dwelling units by 2020.

Table 8 illustrates the breakdown of the various land uses in the study area that are subject to sea level rise. Wetlands and preserves make up the largest percentage of the study area while the most developed and developable land use subject to sea level rise is single family residential at 46,000 acres.

Table 8: Breakdown of acreage in East Central Florida subject to sea level rise.

Future Land Use	Brevard	Volusia	Total	Square Miles	% of Study Area
Agriculture	246	2674	2920	5	0.653
Commercial	16002	9211	25213	39	5.637
Industrial	1616	2690	4306	7	0.963
Estate	2029	3773	5802	9	1.297
Multi Family	8035	6423	14458	23	3.233
Single Family	23471	22815	46286	72	10.349
Preserve	41194	10809	52003	81	11.627
Military	1908	0	1908	3	0.427
Mining	12	0	12	0	0.003
Wetlands	53613	42395	96008	150	21.466
Unknown	447	51	498	1	0.111
Water	165933	31903	197836	309	44.234
Total Acreage	314506	132744	447250	699	100.000%

The protection scenarios assigned in the region break down as shown in Table 9. For example, the land where shore protection is almost certain accounts for 65,000 acres (102 square miles), which is 15 percent of the study area. Wetlands and water comprise 65 percent of the study area.

^v Census tracts were used because the analysis was performed through GIS and the available data were census tracts. The analysis consists of all the tracts that are entirely or partly in the study area. Therefore, the population analysis includes a population projection for the entire study area and immediate surrounding areas. As a result, the projection numbers are a high end estimate.

Table 9: Acreage by Likelihood of Shore Protection – East Central Florida Region

Protection Scenarios	Brevard	Volusia	Total	Square Miles	% of Study Area
No Protection	40976	10287	51263	80	11.46
Protection Unlikely	618	2990	3608	6	0.81
Protection Likely	21620	11358	32978	52	7.37
Protection Almost Certain	31740	33812	65552	102	14.66
Wetlands	53613	42395	96008	150	21.47
Submerged/Open Water	165933	31902	197835	309	44.23
Total Acreage	314500	132744	447244	699	100.00

Table 10 presents the same results expressed as a percentage of the dry land within the study area. For all practical purposes, past and planned development has already made it inevitable that property will be protected and the inland migration of wetlands will be blocked along 30 percent of Brevard and 60 percent of Volusia County shores. Existing conservation lands, however, ensure that wetlands will be able to adjust to rising sea level along the shores of about 45 percent and 15 percent of the two counties coastal areas, respectively. Perhaps most important, we still have a realistic opportunity to choose between wetland migration or the type of coastal development that causes a gradual loss of wetlands for approximately 25 percent of the land in each county. Given current trends, a substantial portion of that land (5 percent) in Volusia County probably will not be protected, enabling wetlands to migrate.

Table 10: Percentage of Dry Land by Likelihood of Shore Protection

Protection Likelihood	Brevard	Volusia	Region
No Protection	43.2	17.6	33.4
Protection Unlikely	0.7	5.1	2.4
Protection Likely	22.8	19.4	21.5
Protection Almost Certain	33.4	57.9	42.7

Sea Level Rise Planning Solutions

Beaches erode 100 to 200 feet with every 1 foot rise in sea level. With a 50 percent chance of the sea level rising 4 feet by 2200, the beaches could erode 200 to 800 feet. Therefore, because most of the waterfront homes are located within 100 to 200 feet of the high water mark, these homes may be largely affected by sea level rise.³² This can be very costly when protecting high density areas. "Land use is a state and local responsibility."³² Therefore, it is important for decisions be made concerning the protection of developed and undeveloped land before it becomes too expensive or impossible to protect the shoreline and property. To determine the areas needing protection, coastal managers should look for relative sea level rise in specific areas. Each regional area has specific forces determining the extent of sea level rise, sea level decline, and inundation. These forces include vertical land movement, coastal erosion, saltwater intrusion, and high water tables.⁸

In the United States, a 1 meter rise in sea level may result in the loss of 50 to 82 percent of coastal wetlands provided all shores are protected. A 2 meter rise could result in a loss of 60 to 90 percent of the wetlands.³³ It is estimated, however, by protecting only developed areas, less wetlands would be lost because they would have the ability to migrate with the rising sea. Through protecting only developed areas, a 1 meter rise may inundate only 29 to 69 percent of wetlands, 20 percent less than by protecting the entire coastline. A 2 meter rise could result in a 61 to 80 percent loss, not a significant difference from protecting the entire coastline. Since the Southeast contains 85 percent of the coastal wetlands, 90 to 95 percent of the wetland loss would take place in this region.³³ This may become a large area of concern for Florida when the time comes to decide how to protect property owners, the natural shoreline, and natural resources.

To prevent or prepare for the negative impacts associated with sea level rise, it is important to begin planning for both the short and long term. Every problem has a number of solutions, and the best solution may vary from site to site. The study area of the Brevard and Volusia coastline is an important ecological and economical resource for the region and the state. Therefore, the best solutions should be planned well enough in advance to protect the resources and property of the region. Some solutions may require immediate action while others may take place over the course of 200 years; yet the best solutions may be a mix of techniques, structures, and planning.

Regulating Land Use

Comprehensive Planning

The Florida State Legislature enacted the Comprehensive Planning program to address development activity in Florida. The comprehensive plan process addresses the future in a realistic effort by implementing various environmental, social, and economic policies. Comprehensive plans address issues such as location and type of land development, allowable infrastructure in various areas, and coastal and environmental management.

Local comprehensive plans and zoning could be used to limit building in critical areas and provide policies to regulate the type of building and communities desired. These plans are currently used not only to regulate building but also to protect natural areas to ensure the natural migration and change of natural habitats along the coast.¹

Future land use plans, found in the comprehensive plan, may be an important regulatory tool to protect infrastructure and property from the effects of sea level rise. It can provide specific goals and objectives concerning development, especially in critical areas. Future land use plans also address areas needed for conservation. Analysis of areas along the coast that should be preserved to aid in protection of the coastline should be performed and identified in the land use plans.¹ The plans and regulations can be adjusted to regulate critical areas, thus minimizing the negative effects of sea level rise, economically, physically, and socially.

Future land use plans can be used to limit the density and type of development allowed in critical areas. This would be most effective, however, only in undeveloped areas or locations that have not been built out yet. Although most of the developable land in the study area has already been developed, there are still areas currently undeveloped or with low density development. By limiting or discouraging development in these areas, sea level rise may have less impact on infrastructure, the economy, and private property. Future building in critical areas could also be aimed toward activities related to the ocean and therefore continue to be used as sea level rises.¹ This would keep the property value and allow the local government to use the areas to create local revenue. Although amending the future land use section of the comprehensive plan may be a short-term task and the development that may occur may also be short to long term, the effects of these changes will provide long-term planning for protection from sea level rise. Without proper planning for the future and poor land use goals and objectives, the effects of sea level rise can be more costly over time.¹

Other changes to comprehensive plans concerning future development in areas in danger of sea level rise can include making new structures in critical areas be temporary and portable. For example, Maine developed the Coastal Sand Dune Rules, which require structures interfering with the landward migration of the natural dune system or migration of a sea level rise of up to 3 feet to be mobile and move with the migrating dunes.³ Placing regulations on new infrastructure (or rebuilding after destruction), such as limiting it to areas outside the critical zones, would be an important change to comprehensive plans. This would encourage development in these areas and limit development in areas likely to be affected by sea level rise. The Volusia and Brevard County comprehensive plans discuss the above. Therefore, this is a step in protection against sea level rise. It is important to make certain the suggestions in the comprehensive plan are stringent and followed.

Zoning Regulations

Zoning is the legal aspect of development that regulates a variety of parameters that must be followed by the developer to ensure the safety and welfare of the jurisdiction's citizens. Zoning regulations include where a structure is to be placed on the property, maximum allowable structure height, amount of site coverage, and allowable densities.¹ As with the comprehensive plan, regulating zoning regulations in critical areas can be an important tool in protecting property, resources, infrastructure, and the economy from sea level rise.

For site-specific development, zoning regulations can be amended to regulate where a structure can be placed on a lot, the size or height of the structure, and the densities of a development.¹ The placement of a structure on a lot may be of critical importance on beachfront property. The placement could allow for the beach to naturally migrate. Setbacks can be issued and purchased by the government to ensure public beach access.³

Planned Unit Development

Planned Unit Development regulations take zoning to another level. The plans address issues that are unique to a specific parcel of land and the zoning regulations on a PUD may be changed to best fit the land to be developed. Just as changing zoning regulations can protect critical areas, changing regulations in PUDs can help limit development, create natural buffers to allow environmental processes to continue naturally, and allow more open space to ensure areas for mitigation. Also, placing restrictions on development, such as writing building regulations to withstand sea level rise or requiring structures to be mobile so that they may be relocated as sea level rises, is important to protect private property and investments. Mitigation for off site areas can be increased so that it may be used if the land's future land use must be eliminated.¹

Developments of Regional Impact

Florida enacted the Development of Regional Impact program to assess development proposals that may have multi-jurisdictional impact. This process is important if one jurisdiction's DRI will affect the sea level rise regulations, mitigations, or policies of another jurisdiction. However, because DRI requires jurisdictions to work together, and then have the approval of the State and Planning Council, many recommendations can be made to ensure the DRI considers local comprehensive plans in regard to sea level rise.¹ It may also allow for more cooperation and awareness throughout the region to ensure the best policies and regulations are in effect to protect investments and resources in the coastal communities.

Public and Critical Facilities Location

The development of a region is based generally on the location of certain public facilities and infrastructure. Development of schools, hospitals, and major roadways encourages development and growth in the surrounding areas. To limit development in critical areas, a public policy change to place future public facilities and infrastructure outside these critical areas could reduce the impacts of sea level rise on property and resource loss and the cost of protection.¹

Regulations can also be placed on the locations of critical facilities. Structures on the coast may need to be rebuilt or modified to deal with sea level rise and/or the policies the communities may create for beach structures. Any future critical facility construction or reconstruction could be recommended to be placed away from any area vulnerable to sea level rise. More coastal communities may implement such policies for future land use and modeling simulations could be performed. Modifications of structure design, especially emergency buildings, will prepare for the future estimated rise in sea level and associated storm surge.

Critical facilities in vulnerable areas could be relocated by moving the entire structure with its contents or moving the contents only to a new location. The decision would depend on the type of facility, availability of developable property, and cost analysis of relocation. If only the contents of the facility are relocated, the vulnerable building could be either demolished or used in a capacity coinciding with sea level rise.¹

Public Acquisition and Preservation

Open Space Controls

Open space can be classified as public or private. Private lands are owned by a private land owner and may include yards, commercial buffer areas, golf course, agricultural fields, forests, or even private conservation areas. Public lands include right of ways, parks, and conservation and preservation areas. As sea level rises, open space acting as shoreline buffers or outside wetlands will help allow the shore to naturally retreat and wetlands to migrate, as well as shore habitats. Having an appropriate amount of open space could limit the amount of development in critical areas and therefore decrease the loss of expenditure to protect the area and decrease the loss of property.¹ Open space could also be mitigated to provide areas for structures to move if necessary when sea level rises. These areas of open space could be used in a method that is compatible with sea level rise while providing an income to the region.

To protect natural habitat such as wetlands or estuaries, public land acquisition may be a feasible solution. This land acquisition could take place through donations, purchase, or expropriation. Leasebacks, the acquisition of land by a public agency which then sells the land to third parties with the stipulation of open space requirements, and sale backs, similar to the above but the land is acquired by the government and sold to private developers with open space regulations, could also be used to ensure open space in critical areas.¹

Rolling Easements

The best scenario for low density mainland areas may be a rolling easement as the sea rises. Rolling easements are an attractive option because if the sea level does not rise to expected levels, money would not be spent. If the sea level does rise, the provisions will have been well planned and established before the easements would be in effect. Protecting low value property below the expected rise in sea level would not be realistic because the land would have to be raised at least 5 feet to keep it from becoming inundated. In this scenario, the property would continue to be used beneficially until it must give way to the ocean. Primarily, rolling easements are a warning for the property owner that, eventually, the property may be useless.³²

Public Acquisition and Preservation Programs

Besides obtaining land to limit development to decrease funds spent on protection, acquiring critical areas for habitat migration and reestablishment ensures natural shorelines and resources for the future. Finding funding to acquire such land, however, may not be feasible at one time. Spanning land acquisitions over time, acquiring the most important areas first, could be more economical. Placing tax exemptions on undeveloped land may encourage private owners to keep the land open.¹

Public land could be acquired through full fee title or through the acquisition of land use easements. The transfer of private land to public is full fee title acquisition and its use can be compatible with changes in sea level. For example, using land acquired by this method as a public park would decrease the cost of damage if there were few or no buildings. The use of a park may be able to change as sea level rises, especially if land is acquired with buildings on it. As needed the buildings could be moved or demolished and the land's use could change as needed. Private ownership still remains when land easements are acquired. Restrictions on the easement, However, can limit the possible damage of sea level rise to structures.¹ These easements may provide enough buffer on the property to protect the structures. This could reduce the property owner's protection cost because building a seawall, renourishing a beach, or relocating may not be necessary.

Areas of Critical State Concern

Areas of Critical State Concern is a state program that designates critical areas based on the qualities of the land. A critical area must be of environmental, historical, natural, or archaeological importance to the region or state, have major public investment, or present major development potential. This program can be used to control development in areas subjected to sea level rise. The regulations set forth in a critical area are the responsibility of the local government. The state is empowered to regulate land development in a critical area if the local government fails to properly regulate the development and administer its responsibilities.¹ Designating areas subjected to sea level rise as critical may be an important step in controlling development and reducing the economic impact of protecting or moving a number of structures.

Transfer of Development Rights

When one area is considered less desirable for development, rights may be transferred between property owners. The development rights that were on the parcel of land are moved to a parcel where development is more desirable. The property can then be used in a less intensive manner or one compatible with sea level rise.¹

Density development rights can be used to keep development in areas subjected to sea level rise to a minimum and transfer the density rights outside the critical areas. Owners outside the area could develop at higher densities than originally allowed if they purchase density development rights from land owners in areas to be affected by sea level rise. If the property owner then chooses to develop the land, it could be used in a less intense capacity.¹

For the transfer of development/density rights to work, the property owner outside the critical area must be zoned for densities lower than that which is desirable by the developer. If the densities are already acceptable, the developer may not purchase the development rights. Other restrictions on the land that may limit the densities could include environmental and political ones. It is also important to determine if the growth that would then occur in the area would be acceptable and committed in terms of infrastructure and public facilities.¹

Engineered Solutions

Beach Renourishment

An effective possibility for resort communities would be to raise the island, or even mainland area, in place by pumping in sand from offshore. To raise the island in place, sand is used to raise lots, roads, and houses. Sand would also be added underwater to maintain the beach slope. Sand would not be needed to raise the entire area. Lots containing buildings could potentially be raised with cheaper materials than sand.¹ To deal with small levels of sea level rise, sand would need to be added only to the beach profile. As sea level rises, more sand may be needed to be added further in land to compensate for the continued beach nourishment. Consequently, pumping sand onto the island may result in bays becoming deeper and wider from the sand extraction, thus resulting in increased wetland erosion.⁹

Beach renourishment projects are generally expensive, time consuming, and large scale. The study area, however, depends on the beach for tourism and the economy. Therefore, protecting the beaches in Brevard and Volusia counties is of great importance now and in the future. Brevard County does have an active beach renourishment program; Volusia County, however, does not.

Seawalls

Seawalls are found in the study area and may continue to be an important protection option for property owners along the coastline. To keep the walls from cutting under because of increased erosion associated with sea level rise and greater wave energy, beach renourishment, especially in front of seawalls, may be a critical element. This would decrease the chances of the wall crumbling. Engineering a seawall is an option that could be done now depending on the view of the property owner, the erosion experienced on the property, and whether a form of beach renourishment is active in the area. A seawall could, however, be built further in the future as sea level rises.

The Army Corps of Engineers has the authority to issue permits to build erosion control features such as bulkheads as long as no vegetated wetlands are filled.³² If the property owner is able to fill wetlands to protect their property or compensate for the beachfront loss, they must obtain a permit issued by the Corps. By receiving this permit, the property owner must create new wetlands or enhance degraded wetlands.³² Building hard structures to protect property, however, does not allow wetlands to migrate. It is recommended that wetlands be allowed to migrate in response to rise in sea level to continue to serve as habitat, water filtration system, and mainland protection. If wetland loss of an armored shoreline is compared to wetland loss of unarmored shoreline, 38 to 61 percent of wetlands will be lost if the shore is protected, while only 17 to 43 percent will be lost if the shore is unprotected.³²

Public Awareness

Public awareness and response plays a critical role in preparing for sea level rise. Through hearings, seminars, and workshops, the public can be informed of where sea level rise is expected to impact property and the choices they have as property owners if their property is located in such an area. It is important to make the public aware of the short-term and long-term responses, policies, and actions available to deal with sea level rise. Specialized media and journals oriented toward various workforce communities are valuable mediums to reach audiences such as engineers, planners, architects, and the like. Public involvement in creating policies and regulations to deal with sea level rise can influence the passage of legislation. Legislation passed could affect the way a community responds to sea level rise.

CONCLUSION

Rule 9J-5 of the Florida Administrative Code does not indicate that local governments are required to address planning for future sea level rise.³⁴ Currently, there are no known regulations in effect in Brevard or Volusia County to deal with sea level rise. In the Volusia County comprehensive plan, Policy 11.4.1.21 states that the county will monitor sea level rise to determine when the rise will affect the county and will then act accordingly. Brevard County Policy 4.9 states, “Brevard County shall continue to collect and make available to the public, information related to sea level rise changes.” If statewide and local decisions and efforts are not made to implement ways to protect the shorelines from sea level rise, property owners may take a step in the wrong direction, both economically and environmentally, to protect their property. Issuing statewide regulations could ensure that the most economically and environmentally sound efforts are made to ensure the future of the region’s coastline.

As is evident from this study, a considerable number of acres of the Brevard and Volusia county coast may be affected from a potential 5 foot rise in sea level. The areas affected include barrier islands as well as the mainland. Because of the importance of the beach community to the economic well-being of the region, important decisions to protect the natural and developed coastline of the counties could eventually be inevitable. Depending on the area affected, the solution to sea level rise and the implementation costs may vary. Also, the timing to implement the solution may be a critical factor. Should local governments decide through this study and other studies performed in the county that sea level rise evidence does exist and could potentially affect the county, the local government and property owners may begin the initial steps to decide on the constraints, areas, solutions, policies, and costs of protecting the region. By beginning initial steps to plan for future sea level rise, the financial and environmental burdens may be eased on the future citizens of the county.

Policies such as redefining zoning, land use, and density regulations could take effect in the near future and prevent more development in critical areas. Other solutions such as retreating or building seawalls may not be necessary until protection is absolutely crucial. It may be beneficial, however, for the decision and planning for such a project to be made in advance to ensure the best research, engineering, costs, and funding. Solutions phased over time (i.e., beach renourishment and land acquisition) researched, and analyzed now could maximize benefits and cut costs associated with damage and inundation.

This study documents the possible impacts of sea level rise on the coast of Brevard and Volusia counties. Therefore, in keeping with county policy, if the county and local governments determine that this study, combined with other sea level rise studies, provides enough evidence to begin discussion and more studies on how to protect the coastline from the projected sea level rise, the solutions presented in this study may be a stepping stone. The county and cities are presented, through this study, with options for decision making on land use and protection of common infrastructure and the economic base of the community. Many changes in policies and probable solutions to sea level rise will need to be researched for specific local costs and effects. Each area needing protection may benefit differently from various solutions. In developing areas, the EPA recommends impact assessments of sea level rise on manmade and natural coastal features. Land use planning processes are recommended to coincide with the impact assessment.³ By performing research now and making proactive changes to the infrastructure and management of the coastlines, the problems associated with future sea level rise may be limited and less costly.⁸

The future is always hard to predict with precision. Changes made in the present may influence the predictions made for the future. Tegardless of the predictions for the future, however, local governments, county government, and property owners are presented with possible solutions for protecting the valuable coastline of the region as well as the impacts a possible 5 foot rise of sea level may cause. If the sea level does not rise to the predicted levels, at least society was prepared and perhaps changes were made to lower losses in floods and reduce beach erosion. If sea level rises to the predicted levels and preparations have been implemented, there may be less loss of natural habitat, property, infrastructure, and money.

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Appendix A

EAST CENTRAL FLORIDA REGIONAL PLANNING COUNCIL

SCOPE OF WORK AND METHODOLOGY

SEA LEVEL RISE MAPPING AND LOCAL GOVERNMENT REVIEW AND APPROVAL

A. Mapping Requirements (Completion Date 12/31/03 or sooner)

1. A five-foot rise in sea level within 200 years will be analyzed by the East Central Florida Regional Planning Council (ECFRPC) for the counties of Brevard and Volusia Counties. The estimated rate of sea level rise over the next 200 years and the probability of that rise for the Southeast Florida region will be provided in a table by the Southwest Florida Regional Planning Council (SWFRPC) based on an Environmental Protection Agency (EPA) report Title "The Probability of Sea Level Rise".
2. Based on the five-foot rise in 200 years, the new mean sea level shoreline will be at the current five-foot contour line. Furthermore, when adding a few feet for an astronomical high tide the sea level will be at the seven or eight-foot contour line. However, because seven or eight-foot contour lines are not readily available the ten foot contour line must be used. Therefore, the ECFRPC study area for a five-foot rise will be everything below the ten-foot contour line.
3. The maps for each county will include the following:
 - A. Water features shown light cyan
 - B. Wetlands shown as dark green
 - C. 0' to 10' Uplands, not protected from sea level rise shown as light green
 - D. 0' to 10' Uplands, protection likely but wetland migration possible shown as dark red
 - E. 0' to 5, 0' to 10' or 5' to 10' Uplands, protection not likely shown as blue
 - F. 0' to 5, 0' to 10' or 5' to 10' Uplands, protection definite shown as brown
 - G. Above 10' shown as white
 - H. Critical Facilities 0' to 5' Protection not recommended shown as dark blue
 - I. Critical Facilities 5' to 10' Protection definite shown as brown
 - J. Roads shown as thin black lines
 - K. Above 10' shown as white
 - L. North arrow symbol and scale.
4. To complete the maps features discussed above the ECFRPC will use the best

Appendix B

Volusia County Comprehensive Plan (Sea Level Rise Section)

GOALS, OBJECTIVES, AND POLICIES

GOAL:

11.4 Protect, enhance and restore the functioning of the beach and dune systems and prohibit development activities that would damage or destroy such systems.

OBJECTIVE:

11.4.1 Maintain standards to minimize the impacts of structures and development on beach and dune systems and where necessary initiate dune restoration programs.

POLICIES:

11.4.1.21 Volusia County should continue to monitor sea level rise science to determine when and if a sea level rise event will affect the County. Based on pertinent data, the County will act accordingly.

Appendix C

Brevard County Comprehensive Plan (Sea Level Rise Section)

Objective 4

Brevard County shall implement and improve as necessary a comprehensive beach and dune management program which protects, enhances and restores a naturally functioning beach system as funding is available.

Policy 4.9

Brevard County shall continue to collect and make available to the public information related to sea level changes.

Appendix D

Coastal Zone Management Act (Sea Level Rise Sections)

§ 1451. Congressional findings (Section 302)

(l) Because global warming may result in a substantial sea level rise with serious adverse effects in the coastal zone, coastal states must anticipate and plan for such an occurrence.

§ 1452. Congressional declaration of policy (Section 303)

The Congress finds and declares that it is the national policy—

2) to encourage and assist the states to exercise effectively their responsibilities in the coastal zone through the development and implementation of management programs to achieve wise use of the land and water resources of the coastal zone, giving full consideration to ecological, cultural, historic, and esthetic values as well as the needs for compatible economic development, which programs should at least provide for—

B) the management of coastal development to minimize the loss of life and property caused by improper development in flood-prone, storm surge, geological hazard, and erosion-prone areas and in areas likely to be affected by or vulnerable to sea level rise, land subsidence, and saltwater intrusion, and by the destruction of natural protective features such as beaches, dunes, wetlands, and barrier islands,

(K) the study and development, in any case in which the Secretary considers it to be appropriate, of plans for addressing the adverse effects upon the coastal zone of land subsidence and of sea level rise; and

(3) to encourage the preparation of special area management plans which provide for increased specificity in protecting significant natural resources, reasonable coastal-dependent economic growth, improved protection of life and property in hazardous areas, including those areas likely to be affected by land subsidence, sea level rise, or fluctuating water levels of the Great Lakes, and improved predictability in governmental decision making;

§ 1453. Definitions (Section 304)

For the purposes of this title--

(1) The term "coastal zone" means the coastal waters (including the lands therein and thereunder) and the adjacent shorelands (including the waters therein and thereunder), strongly influenced by each other and in proximity to the shorelines of the several coastal states, and includes islands, transitional and intertidal areas, salt marshes, wetlands, and beaches. The zone extends, in Great Lakes waters, to the international boundary between

the United States and Canada and, in other areas, seaward to the outer limit of State title and ownership under the Submerged Lands Act (43 U.S.C. 1301 et seq.), the Act of March 2, 1917 (48 U.S.C. 749), the Covenant to Establish a Commonwealth of the Northern Mariana Islands in Political Union with the United States of America, as approved by the Act of March 24, 1976 (48 U.S.C. 1681 note), or section 1 of the Act of November 20, 1963 (48 U.S.C. 1705), as applicable. The zone extends inland from the shorelines only to the extent necessary to control shorelands, the uses of which have a direct and significant impact on the coastal waters, and to control those geographical areas which are likely to be affected by or vulnerable to sea level rise. Excluded from the coastal zone are lands the use of which is by law subject solely to the discretion of or which is held in trust by the Federal Government, its officers or agents.

1456b. Coastal Zone Enhancement Grants (Section 309)

(a) For purposes of this section, the term "coastal zone enhancement objective" means any of the following objectives:

- (1) Protection, restoration, or enhancement of the existing coastal wetlands base, or creation of new coastal wetlands.
- (2) Preventing or significantly reducing threats to life and destruction of property by eliminating development and redevelopment in high-hazard areas, managing development in other hazard areas, and anticipating and managing the effects of potential sea level rise and Great Lakes level rise.

Appendix E

Brevard County Critical Facilities							
FACILITY NAME	ADDRESS	CITY	STATE	ZIP	FACILITY NUMBER	LATITUDE	LONGITUDE
MELBOURNE BEACH FIRE STATION	505 OCEAN AVE	MELBOURNE BEACH	FL	32951000	1200944000002	28.067780	-80.564440
MELBOURNE BEACH PUBLIC WORKS DEPT	507 OCEAN AVE	MELBOURNE BEACH	FL	32951000	1200944000003	28.067780	-80.564440
MELBOURNE BEACH TOWN HALL	507 OCEAN AVE	MELBOURNE BEACH	FL	32951000	1200944000004	28.067780	-80.564440
MELBOURNE FIRE STATION #1	865 EAU GALLIE BLVD.	MELBOURNE	FL	32935000	12009439750010	28.128330	-80.635560
MELBOURNE WWTP-GRANT ST	2300 GRANT STREET	MELBOURNE	FL	32901000	12009439750021	28.073610	-80.609720
SATELLITE BEACH FIRE DEPARTMENT	1390 S. PATRICK DRIVE	SATELLITE BEACH	FL	32937000	12009644000001	28.188330	-80.606940
SATELLITE BEACH POLICE DEPARTMENT	510 CINNAMON DRIVE	SATELLITE BEACH	FL	32937000	12009644000002	28.109170	-80.580280
SATELLITE BEACH PUBLIC WORKS	530 CINNAMON DRIVE	SATELLITE BEACH	FL	32937000	12009644000003	28.172220	-80.610280
SCHOOL BOARD, AUDUBON ELEMENTARY	1201 N. BANANA RIVER DRIVE	MERRITT ISLAND	FL	32927800	12009442750004	28.376940	-80.668610
SCHOOL BOARD, CAPE VIEW ELEMENTARY	8440 NORTH ROSALIND	CAPE CANAVERAL	FL	32920219	12009102500004	28.391670	-80.599440
SCHOOL BOARD, EDGEWOOD JUNIOR HIGH	180 E. MERRITT AVENUE	MERRITT ISLAND	FL	32953349	12009442750006	28.361670	-80.696940
SCHOOL BOARD, FAIRGLEN ELEMENTARY	201 INDIAN TRAIL	COCOA	FL	32927590	12009131500025	28.438060	-80.760280
SCHOOL BOARD, GARDENDALE ELEMENTARY	301 GROVE BLVD.	MERRITT ISLAND	FL	32953449	12009442750007	28.378890	-80.707780
SCHOOL BOARD, GEMINI ELEMENTARY	2100 OAK STREET	MELBOURNE BEACH	FL	32951279	12009440000005	28.054440	-80.554440
SCHOOL BOARD, HOOVER JUNIOR HIGH SCHO	1 HAWK HAVEN DRIVE	INDIALANTIC	FL	32903299	12009333750003	28.100280	-80.575560
SCHOOL BOARD, INDIALANTIC ELEMENTARY	1050 NORTH PALM AVE	INDIALANTIC	FL	32903309	12009333750004	28.099720	-80.573330
SCHOOL BOARD, JEFFERSON JUNIOR HIGH	1275 S. COURTENAY PARKWAY	MERRITT ISLAND	FL	32952389	12009442750008	28.334720	-80.686940
SCHOOL BOARD, MERRITT ISLAND HIGH SCH	100 EAST MUSTANG WAY	MERRITT ISLAND	FL	32953319	12009442750009	28.376390	-80.700280
SCHOOL BOARD, MILA ELEMENTARY	288 W. MERRITT AVE	MERRITT ISLAND	FL	32953472	12009442750010	28.361670	-80.702220
SCHOOL BOARD, OCEAN BREEZE ELEMENTARY	1101 CHEYENNE DRIVE	INDIAN HARBOUR BEAC	FL	32937369	12009334500002	28.149440	-80.591940
SCHOOL BOARD, ROOSEVELT K-8 SCHOOL	1400 MINUTEMEN CAUSEWAY	COCOA	FL	32931209	12009131500027	28.316670	-80.631390
SCHOOL BOARD, SEA PARK ELEMENTARY	300 SEA PARK BOULEVARD	SATELLITE BEACH	FL	32937219	12009644000004	28.202500	-80.605560
SCHOOL BOARD, TITUSVILLE HIGH SCHOOL	150 TERRIER TRAIL	TITUSVILLE	FL	32780473	12009719000018	28.594720	-80.806110
SCHOOL BOARD, TROPICAL ELEMENTARY	885 S. COURTENAY PARKWAY	MERRITT ISLAND	FL	32952499	12009442750011	28.341110	-80.694720
TITUSVILLE POLICE DEPT. SUB-STATION	1026 PALMETTO	TITUSVILLE	FL	32796000	12009719000020	28.609440	-80.808610

Brevard County Critical Facilities

FACILITY NAME	ADDRESS	CITY	STATE	ZIP	FACILITY NUMBER	LATITUDE	LONGITUDE
TITUSVILLE, CITY HALL ANNEX	445 S. WASHINGTON AVE.	TITUSVILLE	FL	32796000	12009719000023	28.609440	-80.807220
TITUSVILLE, MUNICIPAL MARINA	451 MARINA ROAD	TITUSVILLE	FL	32796000	12009719000024	28.621390	-80.811390
SATELLITE BEACH POLICE DEPT	565 CASSIA BLVD	SATELLITE BEACH	FL	0	12009644000005	28.170870	-80.604810
INDIAN HARBOUR BCH	40 CHEYENNE CT	INDIAN HARBOUR BEACH	FL	0	12009334500003	28.146110	-80.598060
COCOA BCH POLICE DEPT	20 S ORLANDO AVE	COCOA	FL	32932	12009131500030	28.309200	-80.610850
INDIALANTIC POLICE DEPT	220 FIFTH AVE	INDIALANTIC	FL	32903	12009333750005	28.090890	-80.570130
MELBOURNE BEACH POLICE DEPT	505 CINNAMON DR	MELBOURNE BEACH	FL	32951	12009440000006	28.067430	-80.564700
LEWIS CARROLL ELEMENTARY	1 SKYLINE BLVD	MERRITT ISLAND	FL	32953		28.393850	-80.699900
CAPE VIEW ELEMENTARY	8440 N ROSALIND AV	CAPE CANAVERAL	FL	0	12009102500005	28.392800	-80.599380
DEVINE MERCY CATHOLIC SCHOOL	1940 N COURTENAY PKWY	MERRITT ISLAND	FL	32953		28.390830	-80.702980
PALM CHAPEL CHRISTIAN SCHOOL	1890 N COURTENAY PKWY	MERRITT ISLAND	FL	32953		28.389260	-80.702750
GARDENDALE ELEMENTARY	GROVE BLVD	MERRITT ISLAND	FL	32953		28.378720	-80.706800
AUDUBON ELEMENTARY	1201 N BANANA RIVER DR	MERRITT ISLAND	FL	32953		28.377040	-80.669280
MERRITT ISLAND HIGH	100 E MUSTAND WAY	MERRITT ISLAND	FL	32953		28.376250	-80.701400
CHURCH OF OUR SAVIOUR	5301 N ATLANTIC AV	COCOA	FL	0	12009131500037	28.366240	-80.607230
EDGEWOOD JUNIOR HIGH	180 E MERRITT AV	MERRITT ISLAND	FL	32953		28.361750	-80.695550
MILA ELEMENTARY	288 W MERRITT AV	MERRITT ISLAND	FL	32953		28.361650	-80.703280
BARRY UNIVERSITY	41 E MERRITT AV	MERRITT ISLAND	FL	32953		28.360630	-80.699360
MERRITT ISLAND CHRISTIAN SCHOO	140 MAGNOLIA AV		FL	0		28.356050	-80.701700
ST MARKS ACADEMY	4 CHURCH ST	COCOA	FL	0	12009131500039	28.353650	-80.724900
TROPICAL ELEMENTARY	885 S COURTENAY PKY	MERRITT ISLAND	FL	32953		28.341340	-80.695080
THOMAS JEFFERSON JR HIGH	1275 S COURTENAY PKWY	MERRITT ISLAND	FL	32953		28.334560	-80.686970
MICHAEL BIEBINK SCHOOL	1900 S TROPICAL TR	MERRITT ISLAND	FL	32953		28.323070	-80.689350
COCOA BEACH HIGH	1500 MINUTEMEN CSWY	COCOA	FL	0	12009131500041	28.317550	-80.626830
THEODORE ROOSEVELT K-8	1400 MINUTEMEN CSWY	COCOA	FL	0	12009131500042	28.317540	-80.626300
COCOA BEACH CHRISTIAN SCHOOL	830 S ATLANTIC AV	COCOA	FL	0	12009131500044	28.303290	-80.609400
EMBRY RIDDLE AERONAUTICAL UNIV	1140 SCHOOL AV		FL	0		28.228120	-80.602380

Brevard County Critical Facilities

FACILITY NAME	ADDRESS	CITY	STATE	ZIP	FACILITY NUMBER	LATITUDE	LONGITUDE
SEA PARK ELEMENTARY	300 SEA PARK BLVD	SATELLITE BEACH	FL	0	1200964400006	28.202500	-80.604360
SATELLITE HIGH	300 SCORPION CT	SATELLITE BEACH	FL	0	1200964400007	28.186360	-80.597400
SPESSARD L HOLLAND ELEMENTARY	50 HOLLAND CT	SATELLITE BEACH	FL	0	1200964400008	28.185400	-80.604000
DELAURA JUNIOR HIGH	300 JACKSON AV	SATELLITE BEACH	FL	0	1200964400009	28.183450	-80.597000
SURFSIDE ELEMENTARY	401 CASSIA BLVD	SATELLITE BEACH	FL	0	1200964400010	28.171450	-80.598800
ESPECIALLY FOR CHILDREN	1230 BANANA RIVER DR	INDIAN HARBOUR BEAC	FL	0	12009334500004	28.152100	-80.597990
OCEAN BREEZE ELEMENTARY	1101 CHEYENNE DR	INDIAN HARBOUR BEAC	FL	0	12009334500005	28.149570	-80.591760
BREVARD CO PUBLIC SAFETY - STA #83	5455 OLD DIXIE HIGHWAY	GRANT	FL	32949000		27.928330	-80.528060
BREVARD CO ROAD & BRIDGE-CENTRAL AREA	555 CONE ROAD	MERRITT ISLAND	FL	32952000	12009442750002	28.345830	-80.689440
BREVARD CO ROAD AND BRIDGE-TRAFFIC OP	580 MANOR DRIVE	MERRITT ISLAND	FL	32952000	12009442750003	28.345000	-80.688890
BREVARD CO WWTP-SO BEACHES REGIONAL	2800-S. HIGHWAY A1A	MELBOURNE BEACH	FL	32951000	12009440000001	28.041670	-80.547220
CAPE CANAVERAL WWTP	600 TOWER BOULEVARD	CAPE CANAVERAL	FL	32920000	12009102500003	28.393060	-80.619440
COCOA BEACH POLICE DEPT	2 SOUTH ORLANDO AVENUE	COCOA	FL	32931000	12009131500008	28.325000	-80.645830
COCOA BEACH WATER RECLAMATION	1600 WESTEND MINUTEMEN CAUSEWAY	COCOA	FL	32931000	12009131500011	28.325000	-80.645830
COCOA BEACH, FIRE STATION #1	25 SOUTH ORLANDO AVENUE	COCOA	FL	32931000	12009131500013	28.325000	-80.645830
COCOA BEACH, FIRE STATION #2	151 WEST VOLUSIA LANE	COCOA	FL	32931000	12009131500014	28.325000	-80.645830
HOSPITAL, CAPE CANAVERAL	P.O. BOX 320069 (STATE ROAD #520)	COCOA	FL	32932006	12009131500016	28.361110	-80.622220
INDIALANTIC FIRE STATION	216 FOURTH AVE	INDIALANTIC	FL	32903000	12009333750001	28.090830	-80.570280
INDIAN HARBOUR BEACH POLICE DEPT	2055 S. PATRICK DRIVE 40 CHEYENNE COUR	INDIAN HARBOUR BEAC	FL	32937000	12009334500001	28.146110	-80.598000
SCHOOL BOARD, CARROLL ELEMENTARY	1 SKYLINE BLVD.	MERRITT ISLAND	FL	32953309	12009442750005	28.394440	-80.699720
SCHOOL BOARD, COCOA BEACH HIGH SCHOOL	1500 MINUTEMAN CAUSEWAY	COCOA	FL	32931209	12009131500021	28.316670	-80.631390
RIVERSIDE CHRISTIAN ACADEMY	3333 N RIVERSIDE DR	INDIALANTIC	FL	0	12009333750006	28.130720	-80.591230
EAU GALLIE HIGH	1400 COMMODORE BLVD	MELBOURNE	FL	0	12009439750046	28.128360	-80.647680
HERBERT C HOOVER JUNIOR HIGH	1 HAWK HAVEN DR	INDIALANTIC	FL	0	12009333750007	28.101550	-80.575040
INDIALANTIC ELEMENTARY	1050 N PALM AV	INDIALANTIC	FL	0	12009333750008	28.096430	-80.573360
GEMINI ELEMENTARY	2100 OAK ST	MELBOURNE BEACH	FL	0	12009440000007	28.054730	-80.556130

Brevard County Critical Facilities

FACILITY NAME	ADDRESS	CITY	STATE	ZIP	FACILITY NUMBER	LATITUDE	LONGITUDE
TITUSVILLE HIGH	150 TERRIER TRAIL	TITUSVILLE	FL	0	12009719000036	28.592330	-80.804240
ST TERESA CATHOLIC SCHOOL	207 OJIBWAY AV	TITUSVILLE	FL	0	12009719000041	28.580950	-80.803880
FAIRGLEN ELEMENTARY	201 INDIAN TRAIL	COCOA	FL	0	12009131500047	28.438050	-80.760470
CAPE CANAVERAL HOSPITAL	701 W COCOA BEACH CAUSEWAY	COCOA	FL	0	12009131500051	28.358820	-80.623370
FIRE STATION	113 HOPKINS AV S	TITUSVILLE	FL	32796	12009719000048	28.613630	-80.808070
FIRE STATION	6400 TROPICAL TRL N	MERRITT ISLAND N	FL	0		28.471710	-80.710810
FIRE STATION	300 ALMA BLVD	MERRITT ISLAND	FL	32953	12009442750012	28.384130	-80.707780
FIRE STATION	840 BANANA RIVER DR N	MERRITT ISLAND NE	FL	0		28.371070	-80.668090
FIRE STATION	151 VOLUSIA LA W	COCOA	FL	32931	12009131500053	28.359170	-80.610440
FIRE STATION	902 AIRPORT RD	MERRITT ISLAND	FL	32952	12009442750013	28.341560	-80.690660
FIRE STATION	25 ORLANDO AV S	COCOA	FL	32931	12009131500056	28.317340	-80.609920
FIRE STATION	299 SEA PARK BLVD	SATELLITE BEACH	FL	0	12009644000012	28.204050	-80.603700
FIRE STATION	216 FOURTH AV	INDIALANTIC	FL	32903	12009333750010	28.090890	-80.570260
FIRE STATION	2550 A1A HWY S	MELBOURNE BEACH	FL	31951	12009440000008	28.047800	-80.551680
FIRE STATION	5455 OLD DIXIE HWY	GRANT	FL	32949		27.928230	-80.527540
FIRE STATION	7400 A1A HWY	SUNNYLAND BEACH	FL	32951		27.927300	-80.486910
FIRE STATION	190 JACKSON AV	CAPE CANAVERAL	FL	32920	12009102500007	28.386930	-80.604730
FIRE STATION	1390 PATRICK DR S	SATELLITE BEACH	FL	0	12009644000013	28.172390	-80.606750
FIRE STATION	505 OCEAN AV.	MELBOURNE BEACH	FL	32951	12009440000009	28.067460	-80.564230
FIRE STATION	600 WALLACE AV	INDIAN HARBOUR BEAC	FL	0	12009334500012	28.139750	-80.583490
FIRE STATION	505 1/2 OCEAN AV.	MELBOURNE BEACH	FL	0	12009440000010	28.067290	-80.564230
FIRE STATION	418 PINE ST	TITUSVILLE	FL	0	12009719000053	28.610060	-80.810910
FIRE STATION		INDIAN HARBOUR BEAC	FL	0	12009334500013	28.150510	-80.599370
FIRE STATION		PAFB	FL	0		28.271290	-80.606580
BCU - SYKES CREEK REGIONAL WWTP			FL	0		28.423890	-80.705670
SOUTH BREVARD WATER CO-OP			FL	0		27.927320	-80.488580
SOUTH BREVARD WATER CO-OP			FL	0		27.927320	-80.488580
CITY OF COCOA - BANANA RIVER PUMP STA			FL	0		28.359490	-80.654480
CITY OF MELBOURNE - GRANT STREET WRF		MELBOURNE	FL	0	12009439750090	28.073070	-80.609480

Brevard County Critical Facilities

FACILITY NAME	ADDRESS	CITY	STATE	ZIP	FACILITY NUMBER	LATITUDE	LONGITUDE
CITY OF MELBOURNE - GRANT STREET WRF		MELBOURNE	FL	0	12009439750091	28.073070	-80.609480
CITY OF TITUSVILLE - SAND POINT WRF		TITUSVILLE	FL	0	12009719000065	28.623660	-80.816940
CITY OF TITUSVILLE - SAND POINT WRF		TITUSVILLE	FL	0	12009719000066	28.623660	-80.816940
CITY OF TITUSVILLE - SAND POINT WRF		TITUSVILLE	FL	0	12009719000067	28.623660	-80.816940
BCU - SOUTH BEACHES REGIONAL WWTP			FL	0		28.040750	-80.548760
BCU - SOUTH BEACHES REGIONAL WWTP			FL	0		28.040750	-80.548760
CITY OF COCOA BEACH - WATER RECLAM. F		COCOA	FL	0	12009131500068	28.317120	-80.632630
COLONY PARK UTILITIES - WWTP			FL	0		28.478030	-80.712420
NASA - JOHN F. KENNEDY SPACE CENTER (			FL	0		28.586670	-80.650360
NASA - JOHN F. KENNEDY SPACE CENTER (			FL	0		28.586670	-80.650360
NASA - JOHN F. KENNEDY SPACE CENTER (			FL	0		28.586670	-80.650360
NASA - JOHN F. KENNEDY SPACE CENTER (			FL	0		28.586670	-80.650360
NASA - JOHN F. KENNEDY SPACE CENTER (			FL	0		28.586670	-80.650360
NASA - JOHN F. KENNEDY SPACE CENTER (			FL	0		28.586670	-80.650360
NASA - JOHN F. KENNEDY SPACE CENTER (			FL	0		28.586670	-80.650360
NASA - JOHN F. KENNEDY SPACE CENTER (			FL	0		28.586670	-80.650360
NASA - JOHN F. KENNEDY SPACE CENTER (			FL	0		28.586670	-80.650360
NASA - JOHN F. KENNEDY SPACE CENTER (			FL	0		28.586670	-80.650360
PATRICK AIR FORCE BASE			FL	0		28.253240	-80.607630
CAPE CANAVERAL 36 A&B			FL	0		28.472710	-80.540790
CAPE CANAVERAL #40			FL	0		28.561680	-80.577350
CAPE CANAVERAL #40			FL	0		28.561680	-80.577350
CAPE CANAVERAL #40			FL	0		28.561680	-80.577350
CAPE CANAVERAL #41			FL	0		28.583180	-80.583090
CAPE CANAVERAL #41			FL	0		28.583180	-80.583090
CAPE CANAVERAL #41			FL	0		28.583180	-80.583090
CAPE CANAVERAL AIR FORCE STATION			FL	0		28.490980	-80.577390
CAPE CANAVERAL AIR FORCE STATION			FL	0		28.490980	-80.577390
CAPE CANAVERAL AIR FORCE STATION			FL	0		28.490980	-80.577390
SEWER LIFT STATION # 45	DIXON/INDIAN RIVER DR.	COCOA	FL	0	12009131500089	28.391360	-80.738890
SEWER LIFT STATION # 1	100 RIVERSIDE DR.	COCOA	FL	0	12009131500132	28.360470	-80.727030
BCU - SYKES CREEK REGIONAL WWTP			FL	0		28.423890	-80.705670
SOUTH BREVARD WATER CO-OP			FL	0		27.927320	-80.488580
SOUTH BREVARD WATER CO-OP			FL	0		27.927320	-80.488580

Brevard County Critical Facilities

FACILITY NAME	ADDRESS	CITY	STATE	ZIP	FACILITY NUMBER	LATITUDE	LONGITUDE
CITY OF COCOA - BANANA RIVER PUMP STA			FL	0		28.359490	-80.654480
CITY OF MELBOURNE - GRANT STREET WRF			FL	0		28.073070	-80.609480
CITY OF MELBOURNE - GRANT STREET WRF			FL	0		28.073070	-80.609480
CITY OF TITUSVILLE - SAND POINT WRF			FL	0		28.623660	-80.816940
CITY OF TITUSVILLE - SAND POINT WRF			FL	0		28.623660	-80.816940
CITY OF TITUSVILLE - SAND POINT WRF			FL	0		28.623660	-80.816940
BCU - SOUTH BEACHES REGIONAL WWTP			FL	0		28.040750	-80.548760
BCU - SOUTH BEACHES REGIONAL WWTP			FL	0		28.040750	-80.548760
CITY OF COCOA BEACH - WATER RECLAM. F			FL	0		28.317120	-80.632630
AT&T - CELLULAR ONE MERRITT ISLAND			FL	0		28.449850	-80.700180
COLONY PARK UTILITIES - WWTP			FL	0		28.478030	-80.712420
NASA - JOHN F. KENNEDY SPACE CENTER (			FL	0		28.586670	-80.650360
NASA - JOHN F. KENNEDY SPACE CENTER (			FL	0		28.586670	-80.650360
NASA - JOHN F. KENNEDY SPACE CENTER (			FL	0		28.586670	-80.650360
NASA - JOHN F. KENNEDY SPACE CENTER (			FL	0		28.586670	-80.650360
NASA - JOHN F. KENNEDY SPACE CENTER (			FL	0		28.586670	-80.650360
NASA - JOHN F. KENNEDY SPACE CENTER (			FL	0		28.586670	-80.650360
NASA - JOHN F. KENNEDY SPACE CENTER (			FL	0		28.586670	-80.650360
NASA - JOHN F. KENNEDY SPACE CENTER (			FL	0		28.586670	-80.650360
NASA - JOHN F. KENNEDY SPACE CENTER (			FL	0		28.586670	-80.650360
NASA - JOHN F. KENNEDY SPACE CENTER (			FL	0		28.586670	-80.650360
PATRICK AIR FORCE BASE			FL	0		28.253240	-80.607630
CAPE CANAVERAL AIR FORCE STATION			FL	0		28.490980	-80.577390
CAPE CANAVERAL AIR FORCE STATION			FL	0		28.490980	-80.577390
CAPE CANAVERAL AIR FORCE STATION			FL	0		28.490980	-80.577390
BCU - SYKES CREEK REGIONAL WWTP			FL	0		28.423890	-80.705670
SOUTH BREVARD WATER CO-OP			FL	0		27.927320	-80.488580
SOUTH BREVARD WATER CO-OP			FL	0		27.927320	-80.488580
CITY OF COCOA - BANANA RIVER PUMP STA			FL	0		28.359490	-80.654480
CITY OF MELBOURNE - GRANT STREET WRF			FL	0		28.073070	-80.609480
CITY OF MELBOURNE - GRANT STREET WRF			FL	0		28.073070	-80.609480

Brevard County Critical Facilities							
FACILITY NAME	ADDRESS	CITY	STATE	ZIP	FACILITY NUMBER	LATITUDE	LONGITUDE
CITY OF MELBOURNE - FRONT ST. BOOSTER			FL	0		28.080040	-80.599780
PRAXAIR - LINDE DIV. AIR SEPERATION P			FL	0		28.674300	-80.827990
CITY OF TITUSVILLE - SAND POINT WRF			FL	0		28.623660	-80.816940
CITY OF TITUSVILLE - SAND POINT WRF			FL	0		28.623660	-80.816940
CITY OF TITUSVILLE - SAND POINT WRF			FL	0		28.623660	-80.816940
BCU - SOUTH BEACHES REGIONAL WWTP			FL	0		28.040750	-80.548760
BCU - SOUTH BEACHES REGIONAL WWTP			FL	0		28.040750	-80.548760
CITY OF COCOA BEACH - WATER RECLAM. F			FL	0		28.317120	-80.632630
COLONY PARK UTILITIES - WWTP			FL	0		28.478030	-80.712420
PATRICK AIR FORCE BASE			FL	0		28.253240	-80.607630
NORTHGATE PROPERTIES - WTP & WWTP			FL	0		28.586670	-80.650360
FIRE STATION	1116 PINETREE DR	INDIAN HARBOUR BEAC	FL	32937000	12009334500008	0.000000	0.000000

APPENDIX G

VOLUSIA COUNTY CRITICAL FACILITIES			
FACILITY	ADDRESS	CITY	ADDRESS

South Beach Fire Station	4840 S. Atlantic Ave	County	4840 S. ATLANTIC AVE
Police Department	170 West Granada Blvd	Ormond Beach	170 WEST GRANADA BLVD
Fire Station	160 E. Granada Blvd	Ormond Beach	160 E. GRANADA BLVD
Fire Station	170 W. Granada Blvd	Ormond Beach	170 W. GRANADA BLVD
BT Utility Plant	35 Breakaway Trail	Ormond Beach	35 BREAKAWAY TRAIL
Halifax Onc. L/S	W. Granada Blvd	Ormond Beach	0 W. GRANADA BLVD
Lift Station 11 M	Timberline Tr & Main Tr	Ormond Beach	TIMBERLINE TR. & MAIN TR.
Lift Station 5 M	Misner's Branch & SR 40	Ormond Beach	MISNERS TR & GRANADA BLVD
Lift Station 8 M	N. Nova Rd & Florida East Coast Railroad	Ormond Beach	N. NOVA RD & FLORIDA EAST COAST RAI
Lift Station 8 M 3	River Bluff Dr & La Costa CT	Ormond Beach	RIVER BLUFF DR & LA COSTA CT
Lift Station 6 P	Neptune & John Anderson	Ormond Beach	NEPTUNE & JOHN ANDERSON
Lift Station 9 M	Main Tr & Shady Branch Tr	Ormond Beach	MAIN TR & SHADY BRANCH TR
Standish Ground Tank	Standish Dr. & John Anderson Dr.	Ormond Beach	STANDISH DR. & JOHN ANDERSON DR.
Water Plant	301 Jefferson St	Ormond Beach	301 JEFFERSON St
Water Tower	Airport Rd. & Leeway Tr.	Ormond Beach	AIRPORT RD. & LEEWAY TR.
WWTP	N. Orchard & Wilmette Ave	Ormond Beach	N. ORCHARD & WILMETTE AVE
Civil - Daytona	250 N. Beach Street	Daytona Beach	250 N. BEACH STREET
Fire Station #1	301 S. Beach St.	Daytona Beach	301 S. BEACH ST.
Fire Station #5	627 Nova Rd.	Daytona Beach	627 NOVA RD.
Central Services	950 Bellevue	Daytona Beach	948 BELLEVUE
Lift Station 97	2500 LPGA Blvd	Daytona Beach	2500 LPGA BLVD
Lift Station 100	100 Tournament Dr.	Daytona Beach	100 TOURNAMENT DR
Criminal Justice Center	251 North Ridgewood Ave	Daytona Beach	251 NORTH RIDGEWOOD AVE
Daytona Beach Police Dept.	990 Orange Ave	Daytona Beach	990 ORANGE AVE
Daytona Beach Police Dept.	510 Harvey Ave	Daytona Beach	510 HARVEY Ave
Master Pump Station	117 Seaway Ave	Daytona Beach Shores	117 SEAWAY AVE
River Point Sewer Station	3400 S. Peninsula	Daytona Beach Shores	3500 S. PENINSULA
Sewer Pump Station #1	3751 Cardinal Blvd	Daytona Beach Shores	3751 CARDINAL BLVD
Sewer Pump Station #2	113 Dunlawton Blvd	Daytona Beach Shores	113 DUNLAWTON BLVD
Sewer Pump Station #3	133 Atares Ave	Daytona Beach Shores	133 ATARES AVE
Sewer Pump Station #4	2800 S. Atlantic Ave	Daytona Beach Shores	2800 S. ATLANTIC AVE
Sewer Pump Station #5	2422 S. Atlantic Ave	Daytona Beach Shores	2422 S. ATLANTIC AVE
VOLUSIA COUNTY CRITICAL FACILITIES			
FACILITY	ADDRESS	CITY	ADDRESS
Sewer Pump Station #7	Florida Shores Blvd & S. Peninsula	Daytona Beach Shores	FLORIDA SHORES BLVD & S. PENINSULA
Sewer Pump Station #9	2900 S. Atlantic Ave	Daytona Beach Shores	2900 S. ATLANTIC AVE
Fire Station	2628 Hibiscus Dr.	Edgewater	2628 HIBISUCS DR
Fire Station	1651 S. Ridgewood	Edgewater	1651 S. RIDGEWOOD
Police Department	135 E. Park Ave	Edgewater	135 E. PARK AVE
Elevated water tank	Jarecki Ave.	Holly Hill	JARECKI AVE & LPGA BLVD

Lift Station #1	475 Carswell Ave	Holly Hill	475 CARSWELL AVE
Lift Station #10	410 Dorothy Ave	Holly Hill	410 DOROTHY AVE
Lift Station #2	231 Riverside Dr.	Holly Hill	231 RIVERSIDE DR.
Lift Station #3	504 Riverside Dr.	Holly Hill	504 RIVERSIDE DR.
Lift Station #4	345 10th St.	Holly Hill	345 10TH ST.
Lift Station #5	946 Riverside Dr.	Holly Hill	946 RIVERSIDE DR.
Lift Station #6	1136 State Ave	Holly Hill	1136 STATE AVE
Lift Station #7	1300 Riverside Dr.	Holly Hill	1300 RIVERSIDE DR.
Lift Station #9	1601 Riverside Dr	Holly Hill	1601 RIVERSIDE DR
Lift Station #10-A	429 3rd St	Holly Hill	429 3RD ST
Lift Station #11	440 Magnolia Ave	Holly Hill	440 MAGNOLIA AVE
Lift Station #11-A	702 Commercial Ave	Holly Hill	702 COMMERCIAL AVE
Lift Station #12	620 Center Ln.	Holly Hill	620 CENTER LN
Lift Station #13	397 Dubs Dr.	Holly Hill	397 DUBS DR.
Lift Station #14	660 6th St.	Holly Hill	660 6TH ST.
Lift Station #16	834 8th St.	Holly Hill	834 8TH ST.
Lift Station #17	566 10th St.	Holly Hill	566 10TH ST.
Lift Station #17-A	1017 Chippewa Tr.	Holly Hill	1017 CHIPPEWA TR.
Lift Station 17-B	Great Oaks Circle	Holly Hill	GREAT OAKS & CHEROKEE
Lift Station 18	460 Walker St.	Holly Hill	460 WALKER ST.
Lift Station 18-A	1000 15th St.	Holly Hill	1000 15TH ST.
Lift Station 19	407 Flomich St.	Holly Hill	407 FLOMICH ST.
Lift Station 20	926 Flomich St.	Holly Hill	926 FLOMICH ST.
Lift Station 21	1000 Walker St.	Holly Hill	1000 WALKER ST.
Lift Station 24	944 Alabama Ave	Holly Hill	944 ALABAMA AVE
Lift Station 25	500 Calle Grande St	Ormond Beach	500 CALLE GRANDE
Well #6	455 LPGa Blvd	Holly Hill	455 LPGa BLVD
Well #11	Jarecki St. & LPGa BLVD	Holly Hill	JARECKI ST. & LPGa BLVD.
Well #12	1200 Center Ave	Holly Hill	1200 CENTER Ave
VOLUSIA COUNTY CRITICAL FACILITIES			
FACILITY	ADDRESS	CITY	ADDRESS
Well #12 C	15th St. & Center Ave	Holly Hill	15TH ST. & CENTER AVE
District 5/ Law Enforcement Services	101 E. Canal St.	New Smyrna Beach	101 E. CANAL ST.
Fire Station 51	103 Faulkner St.	New Smyrna Beach	103 FAULKNER ST.
Fire Station 52	309 Columbus Ave.	New Smyrna Beach	309 COLUMBUS AVE.
Fire Station 53	1400 N. Dixie Freeway	New Smyrna Beach	1400 N. DIXIE FREEWAY
Fire Station 54	813 Mary Ave	New Smyrna Beach	813 MARY AVE
Lift Station 08 - Submersible	Gorman Ct. & 10th St.	New Smyrna Beach	GORMAN CT. & 10TH ST.
Lift Station 14 - Can	Wayne Av & Lynn St	New Smyrna Beach	WAYNE AVE & LYNN ST.
Lift Station 58 - Submersible	Saxon Dr.	New Smyrna Beach	SAXON DR & CEDAR DUNES
Lift Station 59 - ABG	2051 Pioneer Rd	New Smyrna Beach	2051 PIONEER RD
Lift Station 63	2600 Turnbull Estates	New Smyrna Beach	2600 TURNBULL ESTATES

Lift Station 68 - Submersible	Engram Rd. & Ladyfish Rd.	New Smyrna Beach	ENGRAM RD. & LADYFISH RD.
Lift Station 69 - Submersible	Engram Rd. & Redfish Rd.	New Smyrna Beach	ENGRAM RD. & REDFISH RD.
Lift Station 70 - Submersible	Turtlemound Rd. and Starfish Rd.	New Smyrna Beach	TURTLEMOUND RD. & STARFISH RD.
Police Department	4680 S. Peninsula Dr.	Ponce Inlet	4680 S. PENINSULA DR.
Fire Station	46800 S. Peninsula Dr.	Ponce Inlet	4680 S. PENINSULA DR.
Fire Station #2	5839 Trailwood Dr.	Port Orange	5839 TRAILWOOD DR.
Lift Station - Emerald Isle PI #1	4332 S. Peninsula Dr.	Port Orange	4332 S. PENINSULA DR.
Police Station	1672 S. Ridgewood Ave	South Daytona	1672 S. RIDGEWOOD AVE
Fire Station	1672 S. Ridgewood Ave	South Daytona	1672 S. RIDGEWOOD AVE
Fire Station	2107 Brian Ave	South Daytona	2107 BRIAN AVE
Aspen Lake Stormwater Pumping Station	922 Aspen Dr.	South Daytona	922 ASPEN DR.
Lift Station #01	1690 S. Palmetto Ave	South Daytona	1690 S. PALMETTO AVE
Lift Station #02	501 Big Tree Rd.	South Daytona	503 BIG TREE RD.
Lift Station #04	2323 Anastasia Dr.	South Daytona	2323 ANASTASIA DR.
Lift Station #05	635 Violet St.	South Daytona	635 VIOLET ST.
Lift Station #06	808 Valencia Rd,	South Daytona	808 VALENCIA RD,
Lift Station #08	2451 S. Ridgewood Ave	South Daytona	2451 S. RIDGEWOOD AVE
Lift Station #09	29 Sandusky Circle	South Daytona	29 SANDUSKY CIRCLE
Lift Station #10	918 Reed Canal Rd.	South Daytona	918 REED CANAL RD.
Lift Station #11	8 1/2 Spinnaker	South Daytona	8 1/2 SPINNAKER
Lift Station #12	2025 Hickorywood Dr.	South Daytona	2025 HICKORYWOOD DR.
Lift Station #13	2938 Lantern Dr.	South Daytona	2938 LANTERN DR.
Lift Station #14	794 Aspen Dr.	South Daytona	794 ASPEN DR.
VOLUSIA COUNTY CRITICAL FACILITIES			
FACILITY	ADDRESS	CITY	ADDRESS
Lift Station #17	1610 Magnolia Ave	South Daytona	1610 MAGNOLIA AVE
Lift Station #18	115 Bryan Cave Rd.	South Daytona	115 BRYAN CAVE RD.
Reed Canal Stormwater Control	740 Reed Canal Rd.	South Daytona	740 REED CANAL RD.
Sherwood Dr. Stormwater Pumping St.	2165 Sherwood Dr.	South Daytona	2165 SHERWOOD DR.
Law Enforcement Services	101 E. Canal St.	New Smyrna Beach	101 E. CANAL ST.
VOTRAN	950 Big Tree Rd.	New Smyrna Beach	950 BIG TREE RD.
EVAC	112 Carswell Ave	Daytona Beach	112 CARSWELL AVE
Armory	725 Ballough Rd	Daytona Beach	725 BALLOUGH RD
Chisolm Head Start Center	531 Mary Ave	New Smyrna Beach	531 MARY AVE
Ormond Beach Middle School	151 Domicilio Ave	Ormond Beach	151 DOMICILIO AVE
Ormond Beach Element. School	100 Corbin Ave	Ormond Beach	100 CORBIN AVE
Osceola Elementary School	100 Osceola Ave	Ormond Beach	100 OSCEOLA AVE
Holly Hill Middle School	1200 Center Ave	Holly Hill	1200 CENTER AVE.
Holly Hill Elementary School	1500 Center Ave.	Holly Hill	1500 CENTER AVE
Seabreeze High School	2700 N. Oleander Ave	Daytona Beach	2700 N. OLEANDER AVE
Bethune Cookman College	640 Dr Mary McLeod Bethune Blvd	Daytona Beach	640 DR MARY MCLEOD BETHUNE BLVD
Turie T Small Elem. School	800 South St.	Daytona Beach	800 SOUTH ST

Campbell Middle School	601 S. Keech St.	Daytona Beach	601 S. KEECH ST.
South Daytona Elem. School	600 Elizabeth Pl	South Daytona	600 ELIZABETH PL
Sugar Mill Elementary School	1101 Charles St.	Port Orange	1101 CHARLES ST.
Port Orange Elementary School	402 Dunlawton Ave	Port Orange	402 DUNLAWTON AVE
Longstreet Elementary School	2724 S. Peninsula Dr.	Daytona Beach	2724 S. PENINSULA DR.
New Smyrna Beach High School	100 Barracuda Blvd	New Smyrna Beach	100 BARRACUDA BLVD
Chisholm Elementary School	557 Ronnoc Ln.	New Smyrna Beach	557 RONNOC LN
Read-Pattillo Elementary School	400 Sixth St.	New Smyrna Beach	400 SIXTH ST.
New Smyrna Beach Middle School	1200 S. Myrtle Ave	New Smyrna Beach	1200 S. MYRTLE AVE
Edgewater Elementary School	500 S. Old County Rd.	Edgewater	500 S. OLD COUNTY RD.
Halifax County Fire Station	1580 Derbyshire Rd.	County	1580 DERBYSHIRE RD.
Port Orange County Fire Station	4200 S. Ridgewood Ave	County	4200 RIDGEWOOD AVE
Turnbull County Fire Station	1850 Pioneer Tr.	County	1850 PIONEER TR.
Massey Industrial Park	635 Airpark Rd.	County	635 AIRPARK RD.
New Smyrna Beach Brannon Memorial	105 S. Riverside Dr.	New Smyrna Beach	105 S. RIVERSIDE DR.
South Waterfront Park WTP	4632 Nellie St.	Edgewater	4632 NELLIE ST.
Holly Hill Industrial Area	Flomich St. and Railroad	Holly Hill	FLOMICH ST & RAILROAD
City of Holly Hill/07164 - WTPA	453 11 ST.	Holly Hill	453 LPGA BLVD
VOLUSIA COUNTY CRITICAL FACILITIES			
FACILITY	ADDRESS	CITY	ADDRESS
Golden Bay WWTP	200 Golden Bay Blvd	Oak Hill	GOLDEN BAY BLVD & CHEROKEE DR
New Smyrna Beach Airport Ind. Park	1504 Industrial Drive	New Smyrna Beach	1499 INDUSTRIAL DRIVE
Bert Fish Medical Center	401 Palmetto St.	New Smyrna Beach	401 PALMETTO ST.
Memorial Hospital-Ormond Beach	246 S. Atlantic Ave	Ormond Beach	246 S. ATLANTIC AVE
New Smyrna Airport Ind. Park	1500 Airway Circle	New Smyrna Beach	1500 AIRWAY CIRCLE
New Smyrna Airport Ind. Park	404 United Dr.	New Smyrna Beach	404 UNITED DR.
New Smyrna Airport Industrial Park	1486 Turnbull Bay Rd	New Smyrna Beach	1486 TURNBULL BAY RD
Holly Hill Industrial Area	LPGA Blvd & Enterprise Ct.	Holly Hill	LPGA BLVD & ENTERPRISE CT.
A T & T /21146	400 Carswell Ave	Daytona Beach	400 CARSWELL AVE

Appendix F
Responses from Jurisdictions Concerning Draft
Protection Scenario Maps

I highlighted emails that add insight. However, the emails need to be divided into two groups:

Volusia County: Reactions to Draft Maps based on Elevations

Brevard County Reaction to Draft Maps based on the general guidelines.

I think that dates and a map should make this a reasonably easy task.

Message From: Danielle McCain [dmccain@malabartown.org]
Sent: Wednesday, March 17, 2004 9:06 AM
To: 'tara'
Subject: Malabar

Tara, I received the color map and decriptive text. Mr. Booth said what he could see looked fine but the area picture doesn't show all of Malabar. It only shows the very southern part of Malabar. I didn't know if you knew that. Thanks for allowing us this input.

From: Planning4u2@aol.com
Sent: Tuesday, March 02, 2004 2:08 PM
To: tara@ecfrpc.org
Subject: Re: Sea Level Rise Map Comments
Tara,

All the area in Red should be the Brown color. There probably shouldn't be any red on the map based on the development patterns. Also the area in green that runs along the northern portion of the City should be brown east of A1A.

That large red area shown is almost entirely under construction most of which are 45 foot condos.

If you have any questions, please call me 407-249-1503.

Sincerely,

Todd Peetz, AICP
City Planner
Cape Canaveral

From: Planning4u2@aol.com
Sent: Tuesday, March 02, 2004 3:58 PM
To: tara@ecfrpc.org

Subject: Re: Sea Level Rise Map Comments
Tara,

The beaches have undergone multiple renourishment efforts and my understanding is they will in the future as well. As the Port channel fills with sand they pump it out to get to the Cape Canaveral side.

My understanding is they brought in sand from some other part of the County and it was not consistent with what is on the beach and that is why the beach surf isn't all that clear. Anyway, as sea levels rise, life will get interesting for those living in Cape Canaveral.

If you have any other questions, let me know.

From: tara [tara@ecfrpc.org]
Sent: Thursday, February 19, 2004 10:35 AM
To: 'Nelson T. Lau'
Subject: responses to sea level rise

Mr. Lau,

Thank you for your response and I will make the changes you suggest.

As for your comments:

1. Since this park is a recreational park and surrounded by almost certain protection, I can change the park to "Reasonably Likely" or "Almost Certain". If the park is capacity constrained by the amount of land (i.e. Ballfield, intensely used park, or boatyard – examples given by EPA) then it may be best to assign it "Almost Certain protection". (It appears to me that it would be considered the above). However, if the natural shore is a key feature and there is plenty of land to allow for erosion, then the "Reasonably Likely" classification may be more appropriate. I will await your response on what classification to assign this park.
2. I will classify Whitley Marina as "Protection Almost Certain"
3. I will classify the area as "Protection Almost Certain"
4. See number 1. I will await your response on what classification to assign this park.

Responses to other comments:

1. Since the areas with the drainage ditches and canals are well behind areas that are greater than 10 feet in elevation and are not directly feeding/connected to the Indian River, we are going to take them off the map. Also, these areas would almost certainly not be reached or affected by the estimated 5 foot rise of sea level. Therefore, the areas focused on in Cocoa will be east of US 1.
2. I only focused on the area of the city which had land elevations 10 feet and under so that the necessary areas were more visible. This is why the western areas are not included on the map I emailed you.

-----Original Message-----

From: Nelson T. Lau [mailto:nlau@cocoafl.org]

Sent: Wednesday, February 18, 2004 8:23 AM

To: tara

Subject: RE: Cocoa Scenario Review

Hi Tara,

I reviewed the map, which contains the protection scenarios. I drew black arrows on the image where I think that the classification should be changed from "Protection Reasonably Likely" to "Protection Almost Certain". The map is attached in the original format you submitted to me. Here are my comments by arrow number:

1. McFarland Park: This park is a personal watercraft launching facility, which is a City of Cocoa park. To the north and south are single-family homes. Are parks not considered for protection?
2. The Whitley marina area contains a residential and professional office condominium. It should warrant as much protection as similar structures to the south, which are classified as "Protection Almost Certain".
3. This narrow strip is the edge of the westbound lanes of State Road 520 and the bridge which leads to and from Merritt Island (to the east). The absence of protection here would undermine road infrastructure.
4. Lee Wenner Park: This is another personal watercraft launching facility, and is a joint Brevard County/City of Cocoa Park. It is improved with parking facilities, playground equipment, boardwalks, docks, etc. Are parks not considered for protection?

Here are my other comments, which are separate from the four (4) arrows...

- On the left part of the map, there are many narrow strips of red. These are drainage ditches and canals. What is the policy regarding these?
- The City of Cocoa limits extends westward to Adamson Road. I have included the current city limits maps, which is in PDF format.

Thanks!
Nelson.

Hi Tara,

I concur with the information you sent to me.

I reviewed the map again and I noticed that by numbers 2, 3, and 4, there are still two small doughnut hole areas that are classified as "Protection Unlikely". They should be reclassified because everything around them is "Protection Almost Certain".

With all these changes, it appears that the entire shoreline along Cocoa will now be classified as "Protection Almost Certain".

Thank you,
Nelson Lau.

-----Original Message-----

From: tara [mailto:tara@ecfrpc.org]
Sent: Monday, March 01, 2004 4:31 PM
To: Nelson T. Lau
Subject: Cocoa Parks

Mr. Lau,

In response to the picture you sent concerning Lee Wenner and MacFarland Parks

- 1) Lee Wenner : I would suggest classifying as "Protection Almost Certain" as it is in close proximity to a major bridge, there appears to be "sea walls" already in place which would indicate protection practices already in effect. Also, it appears as though it is an intensely used park.
- 2) MacFarland park: I would suggest to classify as "Protection almost certain" as well just for the fact that it is surrounded by single family homes that would most likely be protected and this land would also be protected as to 1) aid in the protection of the surrounding houses. Or 2) this land could be protected to allow for natural erosion of the shore of the park. (I personally would assume scenario #1).

Therefore, I would suggest the parks be classified as "Protection Almost Certain". If you agree with this or would rather change either park to "Protection Reasonably Likely", let me know so that I may make the changes to the map.

Thank you.

Tara M. McCue
East Central Florida Regional Planning Council
407.623.1075

From: Tony Caravella [tcaravella@cityofcocoabeach.com]
Sent: Friday, February 13, 2004 11:52 AM
To: tara
Subject: RE:

Tara – I've reviewed the map and have some questions: Some areas identified as white has finished floor elevations lower than 10 feet, but most probably protected by a seawall (from canal). It appears light green are parks regardless of their location relative to the ocean, which these land areas would be protected by beach renourishment. I'm confused with the different shades of green identified on the island areas. Although these lands are identified as conservation on the City's future land use map I do not have knowledge that they may be classified as wetlands.

As to protection from flooding and hurricanes, the City implements the Florida Building Code and does have flood protection regulations for construction.

Anthony Caravella, AICP
Development Services Director
City of Cocoa Beach
321-868-3297 - Phone
321-868-3378 – Fax

From: Dave Watkins [watkid@palmbayflorida.org]
Sent: Tuesday, March 09, 2004 4:31 PM
To: tara
Subject: RE: Palm Bay sea level rise map
Ms. McCue:

Thanks for looking at our comments. I don't believe the City desires to change any of the proposed classifications at this time.

David Watkins
Planning Manager

From: Bruce Cooper [bcooper@satellitebeach.org]
Sent: Thursday, March 04, 2004 10:31 AM
To: 'tara'
Subject: RE: Sea Level Rise Map Comments

Dear Tara,
Appreciate your time today going over the map. Attached is a couple of notes that I have discussed with you. Let me know if you need anything else.
Based on your comments and the intent of the map, I believe that the map represents the City as intended.

Have a great day.
Bruce Cooper
Planning Director

-----Original Message-----

From: Collins, Belinda [mailto:CollinsB@CODB.US]
Sent: Tuesday, January 13, 2004 3:46 PM
To: tara
Subject: Review of Daytona Beach

Tara,

I forwarded your request to our Engineering Department and the following concerns were raised:

1. What is the purpose of the map ? If it is to establish another set of limits on land use the department is opposed to the effort does not endorse it nor does it wish to be subject to any restrictions that the development of such a map might be used to “legitimize” such restrictions.
2. When is the five-foot sea level rise projected to occur ? The department feels that there are many more issues of immediate and vital concern to which both the EPA and the Regional Planning Council could more beneficially direct their resources.
3. It was also suggested that this effort may need to be reconsidered before it goes any further.

I would appreciate a response to these concerns so that they may be properly addressed. Thank you for your help.

Belinda Collins, AICP

Principal Planner

City of Daytona Beach

From: Mark Rakowski [mrakowski@cityofnsb.com]
Sent: Thursday, January 29, 2004 9:08 AM
To: 'tara'
Subject: RE: sea level rise map

Tara,

I must say I am having a very difficult time understanding what you are driving at with this map and so is everyone else in my office. I will try to explain my confusion below after each one of your sentences. I suspect if we are having difficulty with this other jurisdictions are or may not be responding to your request.

I wish I could help more. Sorry

Mark

-----Original Message-----

From: tara [mailto:tara@ecfrpc.org]
Sent: Monday, January 26, 2004 10:43 AM
To: mrakowski@cityofnsb.com

Subject: sea level rise map

Mr. Rakowski.

I received your letter today concerning the sea level rise map. The purpose of the map is to provide the EPA (and cities) with a tool that can be used to depict the areas of the coastline that may be affected by a potential five foot rise in sea level and the areas property owners would most likely protect and those areas which would not. [Rakowski, Mark] I don't understand why anybody would not try to protect every property within the City. The data from the map will also be analyzed. [Rakowski, Mark] Analyzed for what? What we present to you is a map created using the future land use maps sent by each jurisdiction. [Rakowski, Mark] How are the future land use designations represented at all with this map? We have classified the map into general categories and elevations of 0'-5'; and 5'-10'. [Rakowski, Mark] The map reads 0' - 5' and 0' - 10' and not as you described. The red and blue currently represent developed/planned developed areas (red 5-10' and blue 0-5'). [Rakowski, Mark] I think I understand this. We understand that according the category definitions I had sent you, the color classifications of many areas would change. [Rakowski, Mark] How can you change the elevation on the ground? Do you mean change the description of the colors? We do not know your jurisdiction's property value and development as well as you and that is why we are asking you to change classifications as you see fit. [Rakowski, Mark] The entire beachside (barrier island) is high property value as well as the North Causeway and lands along the river. In fact much of the mainland is fairly high property value compared to neighboring communities. However, the definition of high property value is fairly subjective. Also, are we going to protect land only based on its value? The City often has high value land very close to not as high value land. If one parcel were to be protected then the other would be. We are asking you to review any blue areas. Any areas currently colored blue that fall under the red or brown definitions, indicate on the map and we will change them as you recommend. [Rakowski, Mark] The red definition does not apply to our City. It seems as that definition is the opposite of the definition of our City. The Brown definition more closely fits the City except the part about the protection. If sea level rises 5-feet the area will be flooded unless some large levee system is built. (We provided the definitions so that you may be able to review and reclassify the areas. We thought by originally classifying the developed areas into elevations, it may be easier for your review of the property.) [Rakowski, Mark] This doesn't make sense to me. You do not need to change any red to blue because the blue color is only for property below five feet in elevation. [Rakowski, Mark] According to your map most of the City is 0' -5' and I don't think that is correct if you are referring to elevation above sea level.

Light green includes agriculture and preserve areas. [Rakowski, Mark] On the map you provided the light green areas are golf courses, schools, spoil islands and parks, essentially. If there is a mistake and you feel some of these areas should be classified differently, please indicate as such and if possible include the future land use classification so we may change that as well. [Rakowski, Mark] I don't think I can begin to change the map since it does not seem appropriate at all for our City.

For the wetland migration/mitigation, it would constitute as both. Yes, it would include areas that could be acquired for future wetlands, but may also be areas left open for wetlands to migrate to as sea level rises. [Rakowski, Mark] This is about the only section that makes any sense for our City.

I hope this helps. [Rakowski, Mark] Sorry to say that it doesn't really. Perhaps this map is appropriate for a rural area but I don't think it makes any sense for an urban community.

If you have any further questions or concerns, please feel free to contact me at 407.623.1075[Rakowski, Mark] I don't mean to appear to be uncooperative but the map doesn't fit in with our community to the point that I don't think we can comment on it.

Thank you.
Tara M. McCue
East Central Florida Regional Planning Council
407.623.1075

From: Mark Rakowski [mrakowski@cityofnsb.com]
Sent: Thursday, January 29, 2004 9:15 AM
To: 'tara'
Subject: RE: sea level rise color classifications

The entire City needs to be brown except that there is no protection. Would you be available for a conference call some time so you can try to explain this to our City Engineer and perhaps we can together figure out what you are trying to get with this map?

Mark

From: Ben Dyer [BDyer@co.volusia.fl.us]
Sent: Tuesday, January 27, 2004 8:39 AM
To: tara@ecfrpc.org
Cc: John Thomson; Montye Beamer; Ron Paradise
Subject: Re: Sea level rise map

Tara

The County has no adopted policy or plan to address the issues contained in the "Sea Level Rise Map". Therefore we have not developed categories or classifications as mentioned in your transmission below. As such the categories "Right to protection, but protection unlikely" or "Protection reasonably likely" or "Protection Almost certain" have no relevance at this time for local planning initiatives in unincorporated Volusia County. The "Sea Level Rise Map" is a theoretical document covering a geologic span of time and we do not feel it should serve as a present basis to make local land use recommendations.

As most of the area shown in the "Sea Level Rise Map" affects incorporated areas of the County you would need to contact individual Coastal Cities to find out how they view the proposed Map and its categories and classifications.

I hope this clarifies the County staff position, please call me if you have any questions.