Sea Level Rise in the Tampa Bay Region

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I. INTRODUCTION

A. Regional Background

Located on the west coast of Florida, the Tampa Bay region is favored with nearly 700 miles of shoreline. Much of this shoreline runs along Tampa Bay which covers 398 square miles at high tide. The bay is popular for sports and recreation and also supports one of the world's most productive natural systems. The estuary is designated as an Estuary of National Significance. The estuarine environment, with the mixing of fresh and salt water, provides the ecosytems and the natural communities that support a diverse group of marine wildlife. This includes over 200 species of fish and 25 species of shore and wading birds. [1]

Along the western side of the Tampa Bay region lies a barrier island system running from Longboat Key (Manatee County) on the south to Anclote Key (Pinellas and Pasco Counties) on the north. The barrier islands of the Tampa Bay region are highly developed but also have predominantly sandy beaches. Much of the Pasco County coast in the northern part of the region is made up of coastal marsh wetlands. This marshland provides a natural buffer between the Gulf of Mexico and the mainland.

The region's 43 local governments had an estimated 2005 population of more than 2.7 million residents. This figure is forecast to reach nearly 3 million in 2010 and 3.2 million in 2015. While growth slowed slightly during the 1990s, an average of nearly 500 people per week continue to move into the region.[2]

The following is a brief description of the region's four counties:

Hillsborough County: Hillsborough County has the fourth largest population in the State, ranks first in population in the region and has the largest land area with 1,051 square miles. The County seat is the City of Tampa, which is the largest urban center in

[1] Tampa Bay Estuary Program website: http://www.tbep.org/estuary.html
[2] Tampa Bay Regional Planning Council. (2005) Future of the Region: A Strategic Regional Policy Plan for the Tampa Bay Region (p.7). Pinellas Park, FL.

the region and the state's third largest city in area behind Jacksonville and Miami. The County's estimated 2005 population was 1,131,546.[2]

Manatee County: Manatee County, with 741 square miles of land area, has six incorporated municipalities of which the City of Bradenton is the largest. The County's estimated 2005 population was 304,364. [2]

Pasco County: Pasco County, with a land area of 745 square miles, has the highest percentage of undeveloped land in the region. Its major cities are New Port Richey, Dade City, and Zephyrhills. The County's estimated 2005 population was 406,898. [2]

Pinellas County: Pinellas County, at 280 square miles, is the smallest in land area. It is also the most densely-populated county in Florida with more than 3,385 people per square mile in 2005. Twenty-four municipalities are located within Pinellas County with St. Petersburg being the largest; it is the fourth largest city in the State. The County's estimated 2005 population was 947,744. [2]

B. Purpose

High population growth rates of coastal and riverine areas make it vital that land-use planners begin to prepare for the rise of sea levels in these areas. The coastline and areas along our rivers are in many cases highly developed with residential, commercial, and recreational uses. With continuing population growth in Florida, coastal and riverine areas will continue to develop. This includes the almost 25,000 km (15,534 miles) of Florida's coast located below 3.5 meters (11.5 feet) in elevation[3]. As sea levels rise, these areas will flood. For this reason, planners must begin to examine the land areas within their respective counties and municipalities and decide which land uses will be protected, if any. Consideration must also be given to what the estimated cost of holding back the sea will be. Even though estimates of sea level rise are not significantly high for

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[3] Titus, G., & Richman, C. (2001) Maps of Lands Vulnerable to Sea Level Rise: Modeled Elevations along the U.S. Atlantic and Gulf Coasts. *Climate Research: 18* (3).

the near future, it is still imperative to begin long-range planning efforts to identify shore protection strategies now.

With this impetus, the Tampa Bay Regional Planning Council (TBRPC) has been contracted by the Southwest Florida Regional Planning Council (SWFRPC), through a grant from the United States Environmental Protection Agency (USEPA), to participate in a nationwide project promoting awareness of, and planning for, sea level rise. The other coastal regional planning councils throughout the state are also participating in this study.

The Florida studies are part of the USEPA's national effort to encourage the long-range thinking necessary to plan for sea level rise and its potential impacts. With this project, the USEPA hopes to ensure the long-term survival of coastal wetlands and to diminish losses to life and property from coastal hazards, such as erosion and inundation. These goals are shared between the regional planning councils of Florida and other coastal states including New Jersey, North Carolina, and Maryland, where similar studies have been conducted.

Overall, this sea level rise project hopes to stimulate government planning for adaptation to sea level rise effects on uplands and wetlands. This project seeks to accomplish this goal by creating maps that visualize the anticipated response of local governments to sea level rise, based on current land use designations and future planning policies. Governments should then be able to use these created maps as guides for future land use and zoning decisions within coastal and riverine areas.

C. Approach

Based on the most recent research estimates of sea level rise in the next 200 years, the current five-foot contour line was determined to be the mean sea level shoreline for mapping purposes. Although the exact level of sea rise is very uncertain, five-foot contour line intervals are commonly used in many types of mapping. In addition, five-foot contour intervals are the most detailed available in many areas of Florida and to be consistent statewide five-foot intervals are used. Astronomically high tides must also be

accounted for, which means allowing for a few additional feet of sea level rise above the five-foot shoreline. To remain comparable to the other Florida studies the ten-foot contour line must be used as the default sea level rise line for mapping purposes. Keep in mind that this does not indicate that such a rise in sea level is expected anytime soon, but is rather an estimate of the rise expected over the next two hundred years, if global warming conditions continue at their present pace.

In order to make assumptions about shore protection scenarios, a determination of future land use was necessary to define anticipated responses. To determine the protection scenarios of 0-10' upland areas, knowledge of the generalized land uses were defined based on local government future land use maps. It is generally being assumed that protection is almost certain for existing developed land/areas and extensively used parks. Protection is assumed to be reasonably likely for less densely developed areas and moderately used parks. Undeveloped areas and minimally used parks are assumed to be unlikely to be protected. Conservation lands, both privately and publicly owned, have generally been understood to be areas of "no protection." These assumptions, along with the GIS analysis steps are more thoroughly discussed in the Map Development Methodology and Mapping Analysis sections of this report.

II. ESTIMATES OF SEA LEVEL RISE

A. Causes and Indications of Sea Level Rise

Increasing concentrations of carbon dioxide and other gases in the atmosphere have been warming the globe since humans began to release them. This is the process commonly known as the "greenhouse effect." The average surface temperature of the planet has risen by approximately 1° F (0.6°C) in the last 100 years, coinciding with the increase in concentration of greenhouse gases in the atmosphere. All of the warmest years on record have happened since 1980. Global warming is expected to raise surface temperatures by a few more degrees within the coming century. [4]

The EPA estimates that there will be a 50% chance of a 1°C change in temperature by 2050, while there is a 90% probability of a 0.31°C rise in temperature. There is a 5% cumulative probability that temperatures will rise by more than 2°C in fifty years. By 2100 there is a 90% chance that a change in temperature equal to last century's will occur (0.6°C). A rise in temperature of 2°C by 2100 has a 50% probability, while there is a 5% prospect of a 4.7°C increase in global temperatures.[5]

The global change in temperature caused by the "greenhouse effect" is likely to have a number of consequences that will combine to cause sea levels to rise. As surface temperatures rise, added heat will penetrate the ocean and cause the layers of the ocean to warm and expand by 20 cm by the year 2100.[6] These warmer temperatures may melt portions of the Greenland Ice Sheet and small glaciers, which could contribute increases of 2.9 cm[7] and 8.7 cm[8], respectively, to the 22nd century's sea level. The melting of Antarctic ice sheets, however, is not expected to contribute to global sea level rise until after the year 2100. This is due to the fact that Antarctic ice sheets are already floating in the ocean and displacing water. Only if the acceleration of Antarctic ice streams conveying ice into the ocean increase substantially will Antarctic contributions to sea

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[4] Titus, G., & Narayanan, V. (1995). *The Probability of Sea Level Rise*. Washington, DC: U.S. Environmental Protection Agency.
[5] Id. at 50.
[6] Id. at 124.
[7] Id. at 82.
[8] Id. at 119.

level rise be substantive. This is unlikely, however, because the increased precipitation caused by warmer air temperatures will outpace an acceleration of ice streams.[9]

By the year 2050 there is a 50% probability of average global sea levels rising by 15 cm. There is a 90% likelihood that sea level will rise by at least 4.6 cm and a one-in-ten chance of a 28 cm rise. Research results for the year 2100 find that the probable sea level rise will be 34 cm. Sea level rise for 2100 at the 90% probability is 10 com, while there is a 10% chance of a 65 com sea level rise. Two hundred years from now there is a 50-50 likelihood that sea levels will raise by 81 cm. By 2200 there is a nine-in-ten chance of a sea level rise of at least 22 cm and a 10% probability of 196 cm sea level rise. Although very unlikely, there is a 1% chance of sea levels rising 42 cm, 104 cm, and 409 cm in the years 2050, 2100, and 2200, respectively.[10]

B. Sea Level Rise Estimates in the Tampa Bay Region

The EPA document, "The Probability of Sea Level Rise," provides the recommended procedure for estimating sea level rise at a specific location. An estimation of sea level rise at a particular location can be found by using the following formula: local(t) = normalized(t) + (t-1990) * trend, where (t) is sea level rise. This equation is simply the addition of the normalized sea level projection for a specific year to the current rate of sea level rise from 1990 to a specific year in the future. The normalized projections provided in Table 2 "estimate the extent to which future average global sea level rise will exceed what would have happened if current trends simply continued."[11] The current global rate of sea level rise is 1.8 mm/yr[12], while sea level rise in the Tampa Bay region (St Petersburg, Florida) is rising at 2.3 mm/yr. An historical rise rate of more than 2.5 mm/yr is common along much of the U.S. coast.[13] The historic rates of sea level rise at various locations in the United States can be found in Table 3.

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[9] Id. at 125.
[10] Id. at 128.
[11] Id. at 144.
[12] Id.
[13] Id. at 145.

As an example, to find the estimation of the 50% probability of sea level rise in the Tampa Bay region of Florida in 2100, the following steps would be taken. As noted previously, the historic rate of sea level rise in this region has been 2.3 mm/yr. The historic rate of rise (2.3 mm/yr) is multiplied by the number of years from 1990 to 2100 (110). At that rate, sea level can be expected to rise 25.3 cm by 2100. For the year 2100, Table 2 provides a normalized sea level projection of 25 cm for the 50% probability. The rate projected from the current rate of rise of 25.3 cm is added to the normalized projection of 25 cm. This results in a year 2100 sea level rise estimate of 50.3 cm at the 50% probability. It is important to note the normalized projections provided by the EPA are estimates of future sea rise and not based on hard statistics.[14] Full results for estimates of sea level rise in the years 2025, 2050, 2075, 2100, 2150, and 2200 can be viewed in Table 1.

[14] Id. at 145-146.

TABLE 1
ESTIMATED SEA LEVEL RISE FOR THE TAMPA BAY REGION*

Sea Level Projection by Year

Probability (%)	2025		2050		2075		2100		2150		2200	
	cm	inches	cm	inches	cm	inches	cm	inches	cm	inches	cm	inches
90	7	2.8	13	5.0	20	7.7	26	10.4	40	15.7	53	21.0
80	9	3.6	17	6.6	26	10.1	35	13.9	53	20.8	71	28.1
70	11	4.4	20	7.8	30	11.6	41	16.3	63	24.7	85	33.6
60	12	4.7	22	8.6	34	13.2	45	17.8	72	28.3	99	39.1
50	13	5.1	24	9.4	37	14.4	50	19.8	80	31.4	112	44.2
40	14	5.5	27	10.6	41	16.0	55	21.8	90	35.4	126	49.7
30	16	6.3	29	11.3	44	17.1	61	24.1	102	40.1	146	57.6
20	17	6.7	32	12.5	49	19.1	69	27.3	117	46.0	173	68.2
10	20	7.9	37	14.5	57	22.3	80	31.6	143	56.2	222	87.5
5	22	8.7	41	16.1	63	24.6	91	35.9	171	67.2	279	110.0
2.5	25	9.9	45	17.6	70	27.4	103	40.7	204	80.2	344	135.6
1	27	10.6	49	19.2	77	30.1	117	46.2	247	97.2	450	177.3
Mean	13	5.1	25	9.8	38	14.8	52	20.6	88	34.6	129	50.9

*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". Basically, the formula is multiplying the historic sea level rise (2.3 mm/yr) in the Tampa Bay region (closest point used is St. Petersburg, 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 has 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.

TABLE 2

ESTIMATING SEA LEVEL RISE AT A SPECIFIC LOCATION

Normalized Sea Level Projections, Compared with 1990 Levels (cm)[15]

Cumulative Probability (%)	Sea Level Projection by Year					
	2025	2050	2075	2100	2150	2200
10	-1	-1	0	1	3	5
20	1	3	6	10	16	23
30	3	6	10	16	26	37
40	4	8	14	20	35	51
50	5	10	17	25	43	64
60	6	13	21	30	53	78
70	8	15	24	36	65	98
80	9	18	29	44	80	125
90	12	23	37	55	106	174
95	14	27	43	66	134	231
97.5	17	31	50	78	167	296
99	19	35	57	92	210	402
Mean	5	11	18	27	51	81

[15] Id. at 145.

TABLE 3
HISTORIC RATE OF SEA LEVEL RISE AT VARIOUS LOCATIONS
IN THE UNTIED STATES (mm/yr)

Atlantic Coast

Eastport, ME 2.7
Portland, ME 2.2
Boston, MA 2.9
Woods Hole, MA 2.7
Newport, RI 2.7
New London, CT 2.1
Montauk, NY 1.9
New York, NY 2.7
Sandy Hook, NJ 4.1
Atlantic City, NJ 3.9
Philadelphia, PA 2.6
Lewes, DE 3.1
Annapolis, MD 3.6
Solomons, Is., MD 3.3
Washington, DC 3.2
Hampton Rds., VA 4.3
Portsmouth, VA 3.7
Wilmington, NC 1.8
Charleston, SC 3.4
Ft. Pulaski, GA 3.0
Fernandina, FL 1.9
Mayport, FL 2.2
Miami Beach, FL 2.3

Gulf Coast

Key West, FL 2.2
St. Petersburg, FL 2.3
Pensacola, FL 2.4
Grand Isle, LA 10.5
Eugene Island, LA 9.7
Sabine Pass, TX 13.2
Galveston, TX 6.4
Freeport, TX 14.0
Padre Island, TX 5.1

Pacific Coast

Honolulu, HI 1.6
Hilo, HI 3.6
San Diego, CA 2.1
La Jolla, CA 2.0
Newport, CA 1.9
Los Angeles, CA 0.8
Santa Monica, CA 1.8
San Francisco, CA 1.3
Alameda, CA 1.0
Crescent City, CA -0.6
Astoria, OR -0.3
Seattle, WA 2.0
Neah Bay, WA -1.1
Sitka, AK -2.2
Juneau, AK -12

III. CURRENT POLICIES AND TRENDS IN COASTAL MANAGEMENT

Very few policies at any level of government were specifically designed to respond to the effects of sea level rise caused by global warming. However, many coastal management and planning and zoning guidelines can prepare governments and citizens for rising sea levels. The Coastal Zone Management Subgroup of Intergovernmental Panel on Climate Change Response Strategies Working Group (1990) has identified three basic categories of adaptive responses to sea level rise. The three broadly identified categories are: **retreat, accommodation, and protection.**

Retreat[16] is the policy of abandoning lands and structures in coastal zones and allowing marine ecosystems to move inland. In this response, there is no effort to protect land from sea level rise. Governments exercising the retreat option generally prevent development in prone areas, allow development with conditions for abandonment (e.g. rolling easements) and/or withdraw subsidies for construction in danger zones. Governments can restrict development in coastal areas through a variety of policies. These approaches usually include land acquisitions, setbacks, low densities, planning and zoning restrictions on coastal land use, and banning the redevelopment of damaged structures.

Accommodation[17] allows for land use and occupancy of vulnerable areas to continue, but with no attempts to prevent flooding or inundation. It is a hybrid of retreat and protection, because structures are protected while floodplains and shorelines advance farther inland. Governments favoring accommodation can strengthen flood preparations, prohibit activities that may destroy protective coastal resources and/or deny government flood insurance coverage of inhabitants of vulnerable areas. Strengthened flood preparations may include countering rising seas and high winds through building code requirements, improvement of drainage and education. Like retreat, accommodation requires advance planning by local governments. Local governments must also accept that valuable land may be lost to rising seas. Although accommodation is a common short-term response, it may be less useful in the long run. While it may be practical in some circumstances to maintain habitable homes as wetlands advance onto people's

[16] *IPCC-Coastal Zone Management Subgroup. (1990) Strategies for Adaption to Sea Level Rise.*
[17] Id.

yards, eventually the wetlands would become inundated and homes would be standing in the water.

Protection[18] involves using structural, defensive measures to protect the land from the sea so that land use can continue. Shores can be protected by hard structures such as seawalls, revetments and dikes, or by soft structural techniques like beach nourishment and elevating land surfaces with fill. Unlike the first two options, protection has a dramatic impact on both the immediate environment and ecosystems beyond the immediate area. The cost to wetlands, unprotected uplands and offshore fisheries must be assessed before protective measures are constructed.

A. Federal Policies

Policies included in the Coastal Zone Management Act, the Coastal Barrier Resources Act, the Clean Water Act, the Rivers and Harbors Act and the National Flood Insurance Act address many of the effects of sea level rise.

The Coastal Zone Management Act (CZMA) of 1972[19] is the federal law that created and guides the United States' coastal management programs. Congress created the CZMA to deal with the threats to the country's coastal zone caused by increasing and competing demands on the land and water of the zone. The CZMA establishes the coastal management policy of the US as preserving, protecting, developing, and, where possible, restoring or enhancing the resources of the nation's coastal zone by encouraging and assisting the states to exercise, develop and implement their own coastal management programs. Congress also specifically addressed the issue of sea level rise in the Act:

> "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."
>
> "The Congress finds and declares that it is the national policy --- the management of coastal development to minimize the loss of life and property caused by improper

[18] Id.
[19] 16 USC 1451-1464, Chapter 33; P.L. 92-583, October 27, 1972; 86 Stat. 1280.

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."

The provisions of the CZMA are realized through the Coastal Zone Management Program (CZMP), which is administered by NOAA. The CZMP is a voluntary federal-state partnership that has provided cost-sharing grants to states to develop and implement their own coastal zone management plans. The CZMP has based eligibility for federal approval of state plans on several factors. Each state's plan is required to define boundaries of the state's coastal zone, identify uses within the area to be regulated by the state plan, the criteria for regulations of such uses and the guidelines for priorities of uses within the coastal zone. Subsequent to approval of the plan, NOAA grants are awarded for implementation of the state's coastal management plan. In addition to providing financial assistance, the CZMP also supports the states by offering mediation, technical services and information, and participation in priority state, regional, and local forums. Thirty-four states and territories with federally approved coastal management programs participate in the CZMP. Almost all of the nation's shoreline (99.9%) is currently managed by the CZMP. The main effect of the CZMA on the issue of sea level rise is to make state policymakers aware of the matter when they create their own coastal management plans.

Another piece of federal legislation that has a bearing on coastal management policies is the Coastal Barrier Resources Act (CoBRA)[20] enacted in 1982. CoBRA was designed to protect barrier islands along the US coast. Coastal barrier islands are located off the mainland coast and protect the mainland by receiving the majority of the ocean's energy contained in winds, waves and tides. Coastal barriers also protect and maintain productive ecosystems that exist within this protective zone. In drafting the law, Congress found that certain actions and programs of the Federal Government have subsidized and permitted development on coastal barriers and the result has been the loss of barrier

[20] Public Law 97-348 (96 Stat. 1653; 16 U.S.C. 3501 et seq.) Barrier Resources Act (CoBRA)

resources, threats to human life, health, and property, and the expenditure of millions of tax dollars each year.

CoBRA established a Coastal Barrier Resources System, which designated various undeveloped coastal barrier islands for inclusion in the System. The boundaries of the System are contained on maps kept on file by the Department of the Interior. CoBRA prohibits various federal actions and policies from occurring on islands within the System. The following areas in the Tampa Bay region are within the CoBRA System[21]:

Hillsborough County: Egmont Key, Cockroach Bay

Manatee County: Longboat Key, DeSoto Point, Rattlesnake Key, Bishop Harbor, Passage Key

Pinellas County: The Reefs, Sand Key, Mandalay Point, Caladesi Island, Honeymoon Island, Anclote Key (also in Pasco County)

The act places several restrictions on Federal government expenditures that encourage development or modification of a coastal barrier. No new expenditures or federal assistance can be used on coastal barrier islands for the following projects:

1) The construction or purchase of any structure, appurtenance, facility, or related infrastructure;
2) The construction or purchase of any road, airport, boat landing facility, or other facility on, or bridge or causeway to, any System unit; and
3) The carrying out of any project to prevent the erosion of, or to otherwise stabilize, any inlet, shoreline, or inshore area, except that such assistance and expenditures may be made available on (certain designated units) for purposes other than encouraging development and, in all units, in cases where an emergency threatens life, land, and property immediately adjacent to that unit.

Notwithstanding the previous restrictions, CoBRA does provide exceptions to limitations on a variety of expenditures with the barrier system. These include military and Coast Guard activities; maintenance of federal navigation channels; maintenance of certain

[21] Found at http://www.fws.gov/cep/cbrunits.html.

publicly owned roads, structures and facilities; scientific research; and non-structural projects for shoreline stabilization that mimics, enhances or restores a natural stabilization system. (While shoreline stabilization may immediately bring beach nourishment to mind, it is a more ecologically friendly process than simply dumping sand on a beach. Non-structural shore erosion control projects usually use bioengineering to create protective vegetative buffers stabilizing stream banks and shorelines and creating near-shore habitats for aquatic species and waterfowl.) Another feature of the Act is the prohibition of national flood insurance or HUD assistance to any projects within the barrier system that facilitate an activity not consistent with CoBRA's provisions. CoBRA is a good start in the prevention of development in areas that will be most affected by the effects of sea level rise.

The National Flood Insurance Program (NFIP)[22] is another important component of federal coastal management policy. The National Flood Insurance Program is administered by the Federal Emergency Management Agency (FEMA), with its primary goal being to save lives and reduce future property losses from flooding. The National Flood Insurance Program is a voluntary program based upon a mutual agreement or partnership between the federal government and local communities. This partnerhip provides that the federal government will make federally backed flood insurance available to home and business owners in communities that agree to adopt and enforce comprehensive floodplain management standards designed to reduce flood damages. NFIP transfers most of the costs of private property flood losses from the taxpayers to people who choose to live within floodplains through insurance premiums and increased construction standards.

Community response to this requirement involves the adoption of land use, zoning and building code standards that, at a minimum, include the design and construction standards of the NFIP. The minimum National Flood Insurance Program design and construction standards are applicable to all new construction, substantial damages and substantial improvements to existing structures located in Special Flood Hazard Areas or in Special Flood Hazard Areas that have not yet been identified by FEMA. The Special Flood

[22] 44 CFR 60.3

Hazard Areas represent the statistical chance of a 100-year flood occurring in any given year. The 10-year flood has a one-percent chance of occurring in any given year.

NFIP imposes stricter requirements on communities in the V-Zones of Flood Insurance Rate Maps. These are locales in coastal high hazard areas located along coastlines that are subject to high water levels, wave action, and erosion from strong storms and hurricanes. The wind and resultant waves and tidal surges associated with these storms cause high velocity water to sweep over nearby land. Generally, the V-Zone indicates the inland extent of a three-foot breaking wave atop a storm surge. These areas are extremely hazardous to life and property.

There are a number of building requirements that NFIP requires for new construction or substantial improvements in coastal high hazard areas to be able to withstand wind and waves. New buildings and improvements must:

- Obtain and maintain the elevation of the bottom of the lowest horizontal structural member of the lowest floor.
- Be located landward of mean high tide and no new construction is allowed over water.
- Be elevated so that the bottom of the lowest horizontal structural member of the lowest floor is at or above the base flood elevation (BFE), on a pile or column foundation.
- Allow the space below the lowest elevated floor to be free of obstruction or must be enclosed with non-supporting breakaway walls, open lattice-work, or insect screening designed to collapse under wind and water loads without causing damage to structural supports or the elevated structure.
- Not use fill for structural support buildings.
- Prohibit manmade alteration of sand dunes and mangrove stands that would increase potential flood damage.

As previously noted, the Coastal Barrier Resources Act (CoBRA) prohibits new NFIP coverage for new or substantially improved structures in any coastal barrier in the

CoBRA system. More details on NFIP's influence on State and local policies can be found in following sections.

The Clean Water Act of 1972 is another federal law that has an impact on the health of our nation's coastal areas and wetlands. Section 404 of the Clean Water Act sets national policy for the discharge of dredged or fill material into the nation's navigable waters and adjacent wetlands. The Act has even been interpreted to have authority over inland wetlands. Section 404 gives jurisdictional responsibility for issuing dredge permits to the U.S. Army Corps of Engineers (COE). The Environmental Protection Agency has responsibility for developing and interpreting the criteria used to permit issuances.

The Clean Water Act prohibits the discharge of dredged or fill material at a specific site if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem or if the discharge will cause or contribute to significant degradation of U.S. waters. Practicable alternatives, under the Act, include activities that do not include a discharge into U.S. waters or discharge into waters other than the specific site requested. Degradation caused to U.S. waters is deemed to have significant adverse effects to human health and welfare, aquatic life stages and ecosystems, ecosystem diversity and productivity, and recreational, aesthetic and economic values. Discharges from established and ongoing farming, ranching, and forestry activities are exempt from Section 404 provisions.

To receive a permit to discharge dredge materials, the applicant must prove to the Army COE that he or she has taken steps to avoid wetland impacts where practicable, minimize potential impacts to wetlands and provide compensation for any remaining, unavoidable impacts through activities to restore or create wetlands. States also have a role in Section 404 decisions, through State program general permits, water quality certification, or program assumption.[23]

[23] 40 CFR Part 230 – Section 404 (b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material.

An additional federal law that gives the Army COE additional authority over construction in navigable waters and wetlands is the Rivers and Harbors Act (RHA).[24] Sections 9 & 10 of the Act authorize the Army COE to regulate the construction of any structure or work within navigable waters of the United States. The types of structures the RHA allows the Army COE to regulate include the following: wharves, breakwaters, or jetties; bank protection or stabilization projects; permanent mooring structures, vessels, or marinas; intake or outfall pipes; canals; boat ramps; aids to navigation; or other modifications affecting the course, location condition, or capacity of navigable waters.

When issuing permits for construction of the aforementioned structures, the Army CPE must consider the following criteria: (1) the public and private need for the activity; (2) reasonable alternative locations and methods; and (3) the beneficial and detrimental effects on the public and private uses to which the area is suited. The Army COE is also required to consult with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service to protect and serve wildlife resources.

B. State Policies

Similarly to the federal policies, few State policies address the issue of sea level rise specifically. However, State coastal guidelines that cover beach management policies can be used to respond to sea level rise concerns. These policies are included in the Coastal Construction Line Program, the Beach Erosion Control Program, Coastal Building Zone and Strategic Beach Management Plans.

The Florida Beach and Shore Preservation Act was enacted by Florida's legislature to preserve and protect Florida's beach and dune system. Beaches and dunes are the first line of defense against storms, acting as a buffer between the sea and coastal development. One of the programs authorized by the Beach and Shore Preservation Act to be an essential element in the protection effort is the Coastal Construction Control Line (CCCL) Program. [25]

[24] (33 U.S.C. Section 401 et seq.)
[25] Beach and Shore Preservation Act, Florida Statutes (s.) Chapter 161.

The CCCL Program was designed to protect Florida's beach and dune system from irresponsible construction that could weaken, damage, or destroy the health of the dune system. Structures built too close to the sea can inhibit the beach and dune system from its natural recovery processes and can cause localized erosion. Improperly constructed structures are a threat to other nearby coastal structures should they be destroyed by storms. The CCCL Program gives the State the jurisdiction to apply stringent siting and design criteria to construction projects within the Control Line. It must be noted that the CCCL is not a setback line, but is rather a demarcation line of the State's authority.

The Coastal Construction Control Line is marked at the landward limit of coastal areas subject to the effects of a 100-year storm surge. While wind and flooding may intrude further inward than the 100-year storm surge area, effects landward of the CCCL are considerably less than within the CCCL. Within the CCCL, the State prohibits the construction or siting of structures that would cause a significant adverse impact to the beach and dune system, result in the destabilization of the system or would destroy marine turtle habitat. To meet these requirements, structures are required to be located a sufficient distance from the beach and frontal dune and must also be sited in a way that does not remove or destroy natural vegetation. The CCCL also requires all structures to be constructed to withstand the wind and water effects of a 100-year storm surge event. This involves creating structures that meet American Society Civil Engineering 7-88 Sect. 6 wind design standard for 110 mph winds and 115 mph for the Keys. Water standards include a foundation design to withstand a 100-year storm event—including the effects of surge, waves, and scouring. There is no prohibition of rebuilding under the CCCL Program. Due to highly erosionary effects, the CCCL Program discourages the construction of rigid coastal armoring (seawalls) and instead encourages property owners' use of other protection methods, such as foundation modification, structure relocation, and dune restoration.

Another similar endeavor to regulate coastal construction is the Coastal Building Zone (CBZ). The CBZ was established as part of the Coastal Protection Act of 1985 to protect coastal areas and to protect life and property. The CBZ is similar to the Coastal Construction Line Program in that it is a regulatory jurisdiction, rather than a setback

line. The CBZ envelops land from the seasonal high water line to 1500 feet landward of the CCCL. In those areas fronting on the ocean but not included within an established CCCL, the Coastal Building Zone includes the land area seaward of the most landward V-Zone line, as established by NFIP's flood maps. The V-Zone is an area likely to experience a wave greater than 3 feet high with storm surge or areas within the 100-year storm event used by the CCCL program. Local governments enforce the Coastal Building Zone as part of their building codes rather than the State. The CCCL and CBZ are referenced in the building codes of the Tampa Bay region's coastal counties.

Within the CBZ, new construction is required to meet the Standard Building Code 1997 wind design standard of 110 mph and 115 mph for the Keys. As for water standards, structures are required to meet National Flood Insurance Program requirements or local flood ordinance requirements, whichever are stricter. Foundations must also be designed to withstand a 100-year storm surge. CBZ construction standards are less stringent than CCCL standards. This is due to the fact that NFIP flood maps have lower base flood elevations for 100-year storm events than do CCCL studies.

Another State effort to protect Florida's beaches, authorized by the Beach and Shore Prevention Act, is the Beach Erosion Control Program (BECP).[26] The BECP is the primary program that implements the Florida Department of Environmental Protection's beach management recommendations. The BECP was created to coordinate the efforts of local, State, and Federal governments in protecting, preserving and restoring Florida's coastal resources. One of the activities of this program is the offering of financial assistance to counties, local governments and other special districts for shore protection and preservation efforts. The BECP will provide up to 50 percent of project costs. The mix between Federal, State and local funds is different for each project.

Beach management activities eligible for funding from the BECP include beach restoration and nourishment activities, project design and engineering studies, environmental studies and monitoring, inlet management planning, inlet sand transfer,

[26] Found at http://www.dep.state.fl.us/beaches/programs/bcherosn.htm.

dune restoration and protection activities, and other beach erosion prevention related activities.

Another endeavor of the BECP is the development and maintenance of a Strategic Beach Management Plan (SBMP) for Florida. The SBMP is a multiyear repair and maintenance strategy to carry out the proper state responsibilities of a comprehensive, long-range, statewide program of beach erosion control; beach preservation, restoration, and nourishment; and storm and hurricane protection. The SBMP[27] is divided into specific beach management plans for Florida's coastal regions, including the Southwest Gulf region. The Southwest Gulf region includes both Manatee and Pinellas Counties which are included in this study.

Florida also has one of the largest land and water (including wetlands) acquisition programs in the country called "Florida Forever."[28] The revenue for this program is used for restoration, conservation, recreation, water resource development, historical preservation, and capital improvements on acquired conservation lands. Land acquisition is almost exclusively voluntary, as the State wishes to avoid using its power of eminent domain. The funding for this program comes from $3 billion in bond issues over a 10-year period, which is being paid back from an excise tax. Florida Forever funds are distributed annually to various governmental agencies for land and water acquisition: Department of Environmental Protection (38%), Water Management Districts (35%), Florida Communities Trust (24%), Department of Agriculture/Forestry (1.5%), and the Fish and Wildlife Commission (1.5%). Since the program began in 1999, Florida Forever funds have been used to protect over 270,000 acres of natural floodplains, nearly 500,000 acres of significant water bodies, over 24,000 acres of fragile coastline, and over 520,000 acres of functional wetlands.[29]

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[27] Florida Department of Environmental Protection. (2000). Strategic Beach Management Plan: Southwest Gulf Region. Tallahassee, FL: Author.
[28] Found at http://edis.ifas.ufl.edu/FE331
[29] Found at http://www.dep.state.fl.us/lands/acquisition/FloridaForever/default.htm

C. Local Government Policies

Although no counties directly reference sea level rise in their building codes or comprehensive plans, all of the Tampa Bay region's counties have coastal management elements in their comprehensive plans. Within the coastal management elements each of the counties have goals, objectives, and/or policies related to sea level rise issues.

Hillsborough County[30]

Objective 2: There shall continue to be no net loss of wetland acreage authorized in the coastal area of Hillsborough County. The County shall continue to seek to achieve a measurable annual increase in restored tidal wetland acreage through the continued restoration of degraded natural wetlands until all economically and environmentally feasible tidal wetland restoration is accomplished.

Objective 5: The County shall stabilize those man-made beaches prone to erosional problems and shall only support development of man-made estuarine beaches in environmentally-acceptable locations.

Objective 6: Residential population centers within the coastal high hazard area shall be limited to those areas planned to accommodate such development through the provision of adequate public facilities and services. Such development must meet storm velocity standards and be provided with adequate hurricane evacuation capability

Objective 9: Historic resources shall be protected, preserved or utilized in a manner which protects and preserves their continued existence. Once a site has been scientifically excavated, then development may proceed without preserving the site.

Objective 10: Limit public expenditures for infrastructure and facilities in the coastal high hazard area.

Objective 13: The level of service standards, phasing of infrastructure, and areas of service within the coastal area shall be as established in the public facilities elements, Transportation

[30] Hillsborough County, FL Comprehensive Plan.

Element, Recreation and Open Space Element, and Capital Improvements Element of the Comprehensive Plan, and the County shall limit its public infrastructure expenditures in the coastal high hazard area.

Manatee County[31]

Objective 4.3.1: Limit development type, density and intensity within the Coastal Planning Area and direct population and development areas outside of the Coastal Storm Vulnerability Area to mitigate the potential negative impacts of natural hazards in this area.

Objective 4.3.2: Minimize public expenditures on infrastructure for new development within the Coastal Planning Area to limit replacement costs in case of damage from natural hazards.

Pasco County[32]

Objective 1.3 Protect, enhance, and restore beach and dune areas through implementation of policies within a comprehensive management plan by 1999 and through continued adherence to the construction standards established in the Pasco County Coastal Construction Code.

Objective 2.1 Implement land use criteria for the coastal planning area which prioritizes the siting and development of water-dependent and other shoreline uses.

Objective 2.2 Limit density within the Coastal High Hazard Area through limitations on density for property in the Future Land Use Plan, restrictions on extensions of public infrastructure, and implementation of flood damage prevention regulations.

Objective 2.4 Limit public infrastructure expenditures for land development within the Coastal High Hazard Area.

[31] Manatee County, FL Comprehensive Plan.
[32] Pasco County, FL Comprehensive Plan.

Objective 4.1 Implement and enforce procedures for the preservation of historic resources within the coastal planning area of Pasco County.

Pinellas County[33]

Objective 1.3: Pinellas County shall restrict development within the coastal high hazard area, and shall direct population concentrations out of the coastal high hazard area.

Objective 1.4: Pinellas County shall restrict public expenditures that subsidize development in the coastal high hazard area.

Objective 2.1: Pinellas County shall continue implementation of the Pinellas County Beach Enhancement Five-Year Program to restore altered beaches and dunes and shall annually update this program.

Objective 2.2: Pinellas County shall continue to protect the stability of the dune systems and the beach itself by utilizing construction standards, development regulations and other appropriate measures that minimize the impacts of man on the beach and dune systems.

Objective 3.1: Public access to the beaches and shorelines of Pinellas County shall be increased through acquisition, development, and expansion of facilities.

[33] Pinellas County, FL Comprehensive Plan.

IV. MAP DEVELOPMENT METHODOLOGY

A. Topographic Study Area

Similar to other sea level rise planning studies in Florida, this study considers all land below the 10-foot (NGVD) contour. 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 five 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.

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 only depicting 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 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 most vulnerable, limiting the study area to such a low land would exclude many areas that are 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 will experience greater flooding as sea level rises. 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 1000 feet of the shore, even if it is above the 10-foot contour, for two reasons. First, 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 1000-foot extension is somewhat arbitrary; we chose that distance primarily to be consistent with similar studies in other states. Second, extending the study area 1000 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.

The TBRPC used elevation polygons from the Southwest Florida Water Management District along with LIDAR derived GRID elevations, when available, to determine the study area within this project.

B. Protection Scenarios

After all uplands from 0'-10' and lands within 1000' feet of shore were determined protection scenarios had to be assigned to the sections in the study area. The protection scenarios in the maps that accompany this study illustrate the areas that planners within this region expect will be protected, or not protected, from erosion and inundation in the future. Those expectations incorporate state policies and regulations, local concerns, land-use data, and general planning judgment.

Generally, the first step in assigning a protection scenario is to determine the general land use categories of the uplands within the study area in a particular county. Existing and future land use layers were obtained from GIS information and data obtained from the

county planning agencies and the Southwest Florida Water Management District (SWFWMD). Counties within the Tampa Bay region use different future land use category classifications, but these categories can generally be summarized as including the following: rural, low-density residential, medium-density residential, high-density residential, commercial, mixed use, industrial, agriculture, conservation, and recreation/open space. Generally, residential, commercial, mixed use, and industrial lands were determined to be "almost certain" or "reasonably likely" to be protected. Conservation lands and land with no prospect for development were generally labeled as "unlikely" to be protected or not to be protected.

Three land use categories are typically designated as "protection almost certain." The first land use category is existing developed land within extensively developed areas and/or designated growth areas. The second category is future development within extensively developed areas and/or designated growth areas. This developed land or future growth area includes residential, commercial, mixed use, and industrial uses. It is understood that every effort will be made to protect highly developed land from saltwater intrusion. This is due to the economic value of these lands and the high population density in these areas. The third land use category deemed as "protection almost certain" is parks extensively used for purposes other than conservation and which have current protection or are surrounded by protected lands. Examples of this type of land are parks with highly used launching ramps or sports venues located on-site. Because these parks exist primarily for recreational and not exclusively for conservation purposes, they are almost certain to be protected from sea level rise.

Land uses within the scenario "protection reasonably likely" will probably be protected, but there is a plausible reason to not expect protection. The land uses within this scenario include less densely developed areas, future development outside of growth areas, extensively developed CoBRA coastal areas, and private beaches. Moderately used parks used for purposes other than conservation, future development where a park or refuge is also planned, agricultural areas with historical shore protection, and military lands where protection is not certain are also included in this approach. As with the previous scenario, it is easy to assume that these mostly privately owned areas are too valuable (whether for

economic, recreational, or social reasons) to abandon. However, because these areas are not extensively developed yet, they have not reached the point of critical mass where it would be inconceivable for policymakers and landowners to allow them to retreat.

Areas unlikely to be protected are places where lands are probably going to retreat, but where there is no absolute policy against shore protection. Generally, these are areas where land values are low compared with shore protection. In the case of privately owned non-conservation lands, shore protection would not be cost effective compared to the value for the land. Land expected to become part of a nature reserve, but not guaranteed, is also in this category. "Protection unlikely" areas include undeveloped privately-owned lands, un-bridged barrier islands or lightly-developed coastal high hazard areas, minimally-used parks, undeveloped areas where most of the land will be part of wildlife refuge but where development is also planned and conservation easements preclude shore protection.

The final protection scenario is termed as "no protection." This includes lands certain not to be protected because they are conservation lands where shore protection is absolutely prohibited. Private lands owned by conservation groups, conservation easements that preclude shore protection, wildlife refuges and parks with a policy preference for natural occurring processes and public lands/parks with little or no prospect for public use are within this category.

Wetlands were also mapped in this project. Most authors have concluded that wetlands could not keep pace with a significant acceleration in sea level rise and thus, that the area of wetlands converted to open water will be much greater than the area of dry land converted to wetlands. Moreover, in areas where dikes protect farmland or structures, all wetlands could be lost.[34]

Although land use categories were the general determinants for assigning protection scenarios, other factors (such as local planner input and CoBRA guidelines) were also

[34] Titus, J., et. al. (1991). Greenhouse effect and sea level rise: The coast of holding back the sea. *Coastal Management: Volume 19.*

authoritative. These factors are included in Table 4, as provided by EPA and SWFRPC.[35] This table contains the matrix used by GIS staff to identify protection scenarios for the study area. County-specific differences in these decisions and site-specific departures from the statewide approach are discussed in the county-specific sections of this report. The sea level rise maps for all of the counties in the study area are included in Appendix A.

Within the study area depicted on this project's maps, the following protection scenarios and accompanying colors were used:

- Protection almost certain: Brown;
- Protection reasonably likely: Red;
- Protection unlikely: Blue;
- No Protection: Light Green;
- Non-tidal wetlands: Purple; and
- Tidal wetlands: Dark Green.

C. Wetlands Mapping

After all of the land within the study area had been assigned a protection scenario, or identified as wetlands, an additional step was taken within the study area. In an attempt to increase the detail of the sea level rise protection scenario maps, a distinction was created between tidal and non-tidal wetlands. This distinction was identified by using the Florida Land Use and Cover Classification System (FLUCCS) values in the Land Use Land Cover data provided by Southwest Florida Water Management District (SWWMD). Using this data in combination with some additional spatial analysis and comparison with some National Wetlands Inventory data allowed for tidal and non-tidal wetlands to be identified.

The basic procedure used to create the new wetlands layer containing tidal information is as follows:

[35] Jim Titus of EPA prepared a summary of the approaches taken by other states and Dan Trescott of SWFRPC converted this summary into a table and then adapted it for the situation in Florida.

1. Selected all features from study_area03_final with attribute "Sea_Rise" = "Wetlands".
2. Exported the selected features to a new shapefile: lulc_study_area_wetlands
3. Created a "Tidal" field in lulc_study_area_wetlands for "Y" or "N" representing Tidal or Non-Tidal.
4. Distinguished where possible wetlands as either Tidal or Non-Tidal using the FLUCCS code field. (See FLUCCS code list in Appendix B)[36]
5. Selected the features that were not categorized in step 4 and exported these to a new shapefile: lulc_study_area_wetlands_export
6. Categorized/distinguished the features of lulc_study_area_wetlands_export based on location in relation to other categorized features and the coastline. When applicable the National Wetlands Inventory data was consulted.
7. Combined/merged lulc_study_area_wetlands_export with the original lulc_study_area_wetlands to have a complete wetlands study area layer with all features categorized as either Tidal or Non-Tidal.
8. Used this combined shapefile: lulc_study_area_wetlands_final for mapping (placed on top of the study_area03_final layer in the map layout).

D. Local Stakeholder Review

The scope of this project requires local government staff to review the draft sea level rise maps for each county. Local planners are the best authorities to identify whether specific areas of their regions will be protected, or not, against sea level rise. Table 4 of this report, "State-wide Approach for Identifying Likelihood of Land Use Protection," recognizes instances where existing land use data formats may not be complete enough to be able to identify a protection scenario for a land area. Local planner input is particularly helpful in determining the future status of currently undeveloped areas. Whether an undeveloped area outside of a growth area will be developed in the future is a determinant of the protection status of the locale. Local planner information is also invaluable in determining whether park areas or conservation lands will, or should, be protected against sea level rise.

During February, March and April 2006, the Tampa Bay Regional Planning Council hosted meetings to present and review the sea level rise study and draft response maps. In addition to the hosted meetings, TBRPC staff distributed, by mail and email, background

[36] Florida Land Use and Cover Classification System (FLUCCS) descriptions and tidal distinctions as provided by Dan Trescott, Southwest Florida Regional Planning Council.

material and draft maps to all local governments in the project study area (38 local planning agencies) to solicit comments.

Comments received by mail, email, and telephone have been included as follows:

- Manatee County Comprehensive Planning Division recommended the following changes based on current growth patterns and future land use designations:
    - South of SR 684, change the red and blue parcels along Sarasota Bay to brown parcels through to the Manatee/Sarasota County line.
    - Change the blue parcel on the southeast shoreline of Palma Sola Bay to brown.
    - North of the Manatee River, east of the US 41 bridge, change the blue parcels to brown through to Interstate-75.
    - North of the Manatee River, on the west side of Interstate-75, change the blue parcels to red. (Based on additional discussions this was changed to brown.)
    - South of the Manatee River, east of Interstate-75, change the blue parcels that extend into the river to brown.
    - The blue parcels south of the designated wetlands should be changed to red. (Based on additional discussions this was changed to brown.)

- The City of Bradenton Planning and Community Development Department provided detailed local maps of two areas that needed to be adjusted based on newly approved projects.
    - At the extreme east end of Bradenton, the Tidewater Preserve project along the Manatee River requires a change from blue to brown.
    - At the extreme west end of Bradenton, on Perico Island, the Arvida-Perico project requires a change from blue to brown.

Some of the more general comments received at the meetings as well as through email communications include:

- Should provide alternative study area delineations that look at the various probabilities of specific levels of sea rise in the different time frames.

- It is difficult to generate interest in an event, such as sea level rise, which is projected 50 to 100 years in the future, when current hazards such as stormwater flooding, tropical storms, and hurricanes require mitigation and are overwhelming many mitigation planning groups.

- Need to look at areas that are somewhat inland of the coast, but included in the current study area, in respect to man-made structures/landforms that may actually protect these areas from sea level rise (at least to some extent).

For more detailed discussion of the local stakeholder review please refer to Appendix C.

TABLE 4

STATE-WIDE APPROACH FOR IDENTIFYING LIKELIHOOD OF LAND USE PROTECTION[1]

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 (WMD) 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 Water Management Districts.
	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.
	Mobile home developments outside of coastal high hazard, expected to gentrify, or connected to central sewer and water	
Protection Reasonably Likely (red)	Existing development within less densely developed areas, outside of growth areas.	Developed Lands identified from WMD existing FLUCCS; Growth areas identified from local planner input, local comprehensive plans and current regional hurricane evacuation studies.
	Mobile home development within a coastal high hazard area[4] that is neither anticipated to gentrify nor on central water and sewer, and	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 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 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
	Dredge Spoil Areas likely to continue to receive spoils or be developed, and hence unlikely to convert to tidal wetland as sea level rises	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 ; Non-growth 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.
	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

	Dredge Spoil Areas unlikely to continue to receive spoils or be developed, and hence likely to convert to tidal wetland as sea level rises	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:
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 ft. elevations exist within 1,000 feet of the rising sea or color can't 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.

V. MAPPING ANALYSIS

A. Regional Results

The study area of the Tampa Bay region, including portions of Hillsborough, Manatee, Pasco, and Pinellas Counties, consists of 185,456 acres (290 square miles) of uplands and 64,170 acres (100 square miles) of wetlands. Therefore, a ten foot rise in sea level would affect approximately 250,000 acres (390 square miles) of the coastline, excluding water bodies. This accounts for almost 18% of the land within the four county Tampa Bay region. According to the 2000 U.S. Census, the population in the coastal census block groups within the study area is approximately 805,000 in 428,000 dwelling units.[37] This is most likely a conservative estimate and, due to the increasing growth in the Tampa Bay region, these figures could be magnified in coming decades. Though the majority of coastal areas of the region are developed, many areas can expect infill development and redevelopment in the future and this will increase both the number of people and dwelling units located in the study area. Additionally, the vast majority of planned open space is located inland of the study area.

Table 5 illustrates the breakdown of the various land uses in the study area subject to sea level rise. With much of the Tampa Bay region, especially along the coast, being fully developed, residential land use is the single largest use that would be affected by sea level rise. Combining the three residential land use categories in Table 5 accounts for 68% (156 square miles) of the upland study area. The next largest upland land use type subject to inundation is conservation lands, comprising 16% (37 square miles) of the study area. Mixed use and industrial land uses follow closely behind with 12% (28 square miles) and 11% (26 square miles) of the upland study area, respectively. The remaining upland study area is comprised of mostly rural (5%), commercial (4%), agriculture (4%), recreation/open space (7%), and public/semi-public (10%) future land uses.

[37] Census block groups were used as the units of GIS analysis because they represented the best available data to estimate population and dwelling units at this scale. The analysis consisted of all census block groups that had their center (of the block group) within the study area. This technique has been shown in previous GIS analyses to provide a pretty representative estimate of the intended population for the given study area. The estimates provided here may be on the lower end of population estimates due to the sometimes non-contiguous characteristics of the study area.

The percentages and acreage of protection scenarios assigned to land uses in the study area can be found in Table 6. As can be seen in the table, land where shore protection is almost certain accounts for more than 175000 acres, which is over 64% of the study area. Wetlands and water comprise just over 32% of the study area.

Table 5: Future Land Use breakdown of acreage in the region subject to sea level rise.

Tampa Bay Region: Land Use Acreage Subject to Sea Level Rise					
Future Land Use	***Hillsborough***	***Manatee***	***Pasco***	***Pinellas***	***Totals***
Rural	1957	5151	247	0	7355
Low-Density Residential	5623	6356	782	15060	27821
Medium-Density Residential	13833	14409	11702	5830	45774
High-Density Residential	3483	4621	651	17543	26298
Commercial	1685	1336	281	2681	5983
Mixed Use	5120	7721	2019	3112	17972
Industrial	9464	1705	638	4743	16550
Agriculture	5491	981	1	0	6473
Conservation / Environmental	7853	1341	5217	9079	23490
Rec/Open Space	614	922	894	7630	10060
Public/Semi-Public	9501	2164	96	2504	14265
Water	7220	3326	1915	5411	79235
Wetlands	8070	4644	777	0	13491
Transportation/Right-of-Way	2263	678	132	13	3086
Unknown	439	799	15	1814	3067
Totals	82616	56154	25367	75420*	239558*

* Totals for both the region and Pinellas County are not equal in Tables 5 & 6 due to data compatibility and coverage issues between the Pinellas Future Land Use (FLU) data provided by the Property Appraiser's Office and the other data sets used for this project. This difference can mostly be explained in that many wetland and water features within the study area are not assigned a specific future land use because of the compatibility and coverage issue. In addition, some areas that would likely be categorized as "transportation/right-of-way" are unaccounted for in Table 5 above and therefore contribute to the unequal totals.

Table 6: Acreage by Likelihood of Shore Protection

Tampa Bay Region: Acreage Per Protection Scenario						
Protection Scenarios	*Hillsborough*	*Manatee*	*Pasco*	*Pinellas*	*Totals*	*% of Study Area*
No Protection	815	53	17	474	1359	0.5%
Protection Unlikely	4809	309	901	1034	7053	2.6%
Protection Reasonably Likely	6	146	0	1272	1424	0.5%
Protection Almost Certain	47736	36776	12338	78770	175620	64.3%
Wetlands	23611	13240	8916	18402	64169	23.5%
Tidal	19738	9986	6302	14515	50541	18.5%
Non-Tidal	3873	3254	2614	3887	13628	5.0%
Water	5638	5629	3198	9171	23636	8.6%
Totals	82615	56153	25370	109123*	273261*	100.0%

Table 7 presents the same results, expressed as a percentage of the dry land within the study area. 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 along the majority of the Tampa Bay region's shores. Existing conservation lands, however, should ensure that some wetlands will be able to adjust to rising sea levels. This is most evident in southwestern Hillsborough County where conservation lands along Tampa Bay are shown as protection unlikely on the sea level rise maps.

Table 7: Percentage of Dry Land by Likelihood of Shore Protection

Tampa Bay Region: Percentage of Dry Land by Likelihood of Shore Protection					
Protection Scenarios	*Hillsborough*	*Manatee*	*Pasco*	*Pinellas*	*Region*
No Protection	1.5%	0.0%	0.0%	0.6%	0.7%
Protection Unlikely	9.0%	0.1%	0.7%	1.3%	3.8%
Protection Reasonably Likely	0.0%	0.0%	0.0%	1.6%	0.8%
Protection Almost Certain	89.5%	99.9%	99.3%	96.5%	94.7%

B. Hillsborough County

Hillsborough County is included in the Sea Level Rise project due to its location adjacent to Tampa Bay, as well as for its tidally-influenced rivers (Alafia, Hillsborough, and Little Manatee). The entire western border of the county is included in the study because it is affected by the tidal influence of Tampa Bay. Hillsborough County has over 130 linear miles of shoreline.

Data Used for Study and Maps

The datasets used for the study of Hillsborough County are compiled from multiple sources. The maps and analyses are based on the following layers:

Layer	Source
Hillsborough County Future Land Use	Hillsborough County Planning Commission
Plant City Future Land Use	Hillsborough County Planning Commission
Tampa Future Land Use	Hillsborough County Planning Commission
Temple Terrace Future Land Use	Hillsborough County Planning Commission
Street Centerlines	Geographic Data Technology, Inc. (GDT)
Existing Land Use	Southwest Florida Water Management District
Elevation Polygons (derived from 2-foot contours)	Southwest Florida Water Management District
Environmental Sensitivity Index - Structures	Florida Marine Research Institute
Coastal Barrier Resources System	Federal Emergency Management Agency
National Wetlands Inventory	United States Fish & Wildlife Service

Future Land Use – All of the future land use layers for Hillsborough County are merged together as a single layer. The future land use designations in the future land use layer for Hillsborough County have been generalized into the following designations:

Rural	Agriculture
Low-Density Residential	Conservation/Environmental
Medium-Density Residential	Recreation/Open Space
High-Density Residential	Public/Semi-Public
Very-High-Density Residential	Water
Commercial	Wetlands
Mixed Use	Transportation/Right-of-Way
Industrial	Unknown

Street Centerlines – The streets layer is used for general reference and mapping purposes.

Existing Land Use – The Southwest Florida Water Management District maintains this layer. This layer is used to differentiate uplands, wetlands, and water based on the FLUCCS field values.

Elevation Polygons – The elevation polygons are compiled from the contours maintained by Southwest Florida Water Management District. The ArcGIS 9 Spatial Analyst Extension was used to convert the contour line file into a GRID raster surface. This GRID file was then used to identify the study area and converted into a polygon shapefile.

Environmental Sensitivity Index – The ESI polylines layer is maintained by the Florida Marine Research Institute and was used to locate man-made structures, such as sheltered and exposed solid structures and riprap, which are currently protecting areas of the Tampa Bay region's shoreline.

Coastal Barrier Resources System (CBRS) – The locations of barrier resources which fall under the Coastal Barrier Resources Act (CoBRA) is maintained within the Federal Emergency Management Agency's Flood Mapping GIS data for the Tampa Bay region.

National Wetlands Inventory (NWI) – The locations of specific types of wetlands within the region is maintained by the U.S. Fish and Wildlife Service. These polygons were used in an attempt to verify locations of tidal and non-tidal wetlands within the study area as identified using FLUCCS values.

Mapping Procedures

The following procedures were performed to create the final layer and maps for Hillsborough County:

1. Created an Elevation polygon layer that only contained land with elevation 10 feet or below.
2. Unioned Land Use Land Cover (LULC) with Elevation to create: study_area01

3. Selected all study_area01 features with Elevation = 5 or 10
4. Add to selection all study_area01 within 1000 feet of the shoreline.
5. Exported the selected features to a new shapefile: study_area02
6. Clipped Future Land Use (FLU) with study_area02 to create: study_area_FLU
7. Unioned study_area02 with study_area_FLU to create: study_area03_final
8. Created an "Acres" and "Sea_Rise" field in study_area03_final to calculate area and protection levels.
9. Applied the statewide approach by assigning the appropriate protection scenarios in the "Sea_Rise" field for the features in study_area03_final.
10. Analyzed the protection scenarios for Hillsborough County to ensure that they followed the criteria set forth by the overall Sea Level Rise project standards and made additional changes as recommended by local planner review and by comments received from SWFRPC.

General County Protection Scenario Discussion

The areas of Hillsborough County included in the study area for this project are generally already developed or have been identified as locations for development in the near future. Some exceptions to this are in areas in the southern portion of the county which are currently held as conservation lands. The City of Tampa is the only incorporated city within the identified study area.

As can be seen in Tables 5, 6, and 7, the majority of land in the study area of Hillsborough County has been given a protection scenario of "almost certain" and most of the land is designated for future land use of residential or industrial. There is also approximately 9% of the dry land that has been given a "protection unlikely" scenario and the majority of this land falls either in the conservation/environmental or the public/semi-public future land use category.

Deviations from the Statewide Approach

In this section, specific areas of Hillsborough County will be discussed that have been represented on the sea level rise protection scenario maps in possible deviation from the Statewide Approach (Table 4). Deviations have been made for some areas within the region and are based on local planner input and discussions throughout the review process. Almost all of the deviations from the Statewide Approach are due to unique characteristics of some areas of the county.

MacDill Air Force Base

Although military lands with uncertain protection are recommended to be given a "reasonably likely" protection scenario, MacDill Air Force Base has such strategic importance nationally as well as for the Tampa Bay region it has been designated as "protection almost certain". Some undeveloped portions of the Air Force Base may not be protected but this cannot be anticipated at this time and therefore the entire area is shown as "almost certain".

Southern Portion of the County (west of US 41)

In the southern reaches of the county and along the coast there is a lot of conservation land shown on the sea rise map as wetlands and "protection unlikely". Although southern Hillsborough County is under tremendous development pressure, this area is mostly in public ownership and is categorized as conservation land on future land use maps. For these reasons it is anticipated that this coastal area is "unlikely" for protection from sea level rise.

Davis Island

Just south of the Hillsborough River and downtown Tampa, Davis Island is highly developed and is the location of Tampa General Hospital. It is only reasonable to assume that this area is "almost certain" to be protected.

C. Manatee County

Manatee County is included in the Sea Level Rise project due to its location at the mouth of Tampa Bay and adjacent to the Gulf of Mexico. The county also contains the tidally-influenced Manatee River as well as an intercoastal waterway and barrier island system along its western extent. Manatee County has over 145 linear miles of shoreline.

Data Used for Study and Maps

The datasets used for the study of Manatee County are compiled from multiple sources. The maps and analyses are based on the following layers:

Layer	Source
Manatee County Future Land Use	Manatee County Property Appraiser's Office
Street Centerlines	Geographic Data Technology, Inc. (GDT)
Existing Land Use	Southwest Florida Water Management District
Elevation Polygons (derived from LIDAR)	Florida International University
Environmental Sensitivity Index - Structures	Florida Marine Research Institute
Coastal Barrier Resources System	Federal Emergency Management Agency
National Wetlands Inventory	United States Fish & Wildlife Service

Future Land Use – The future land use layer for Manatee County was compiled from the parcel data obtained from the Property Appraiser's Office. The future land use designations in the future land use layer for Manatee County have been generalized into the following designations:

Rural	Agriculture
Low-Density Residential	Conservation/Environmental
Medium-Density Residential	Recreation/Open Space
High-Density Residential	Public/Semi-Public
Very-High-Density Residential	Water
Commercial	Wetlands
Mixed Use	Transportation/Right-of-Way
Industrial	Unknown

Street Centerlines – The streets layer is used for general reference and mapping purposes.

Existing Land Use – The Southwest Florida Water Management District maintains this layer. This layer is used to differentiate uplands, wetlands, and water based on the FLUCCS field values.

Elevation Polygons – The elevation polygons are compiled from GRID raster files that were derived from LIDAR data. The ArcGIS 9 Spatial Analyst Extension was used to identify the study area and create the elevation polygon layer. This data was provided by Florida International University and was simultaneously being used for the Tampa Bay Region Hurricane Evacuation Study Update.

Environmental Sensitivity Index – The ESI polylines layer is maintained by the Florida Marine Research Institute and was used to locate man-made structures, such as sheltered and exposed solid structures and riprap, which are currently protecting areas of the Tampa Bay region's shoreline.

Coastal Barrier Resources System (CBRS) – The locations of barrier resources which fall under the Coastal Barrier Resources Act (CoBRA) is maintained within the Federal Emergency Management Agency's Flood Mapping GIS data for the Tampa Bay region.

National Wetlands Inventory (NWI) – The locations of specific types of wetlands within the region is maintained by the U.S. Fish and Wildlife Service. These polygons were used in an attempt to verify locations of tidal and non-tidal wetlands within the study area as identified using FLUCCS values.

Mapping Procedures

The following procedures were performed to create the final layer and maps for Manatee County:

1. Created an Elevation polygon layer that only contained land with elevation 10 feet or below.
2. Unioned Land Use Land Cover (LULC) with Elevation to create: study_area01
3. Selected all study_area01 features with Elevation = 5 or 10
4. Add to selection all study_area01 within 1000 feet of the shoreline.
5. Exported the selected features to a new shapefile: study_area02
6. Clipped Future Land Use (FLU) with study_area02 to create: study_area_FLU
7. Unioned study_area02 with study_area_FLU to create: study_area03_final
8. Created an "Acres" and "Sea_Rise" field in study_area03_final to calculate area and protection levels.
9. Applied the statewide approach by assigning the appropriate protection scenarios in the "Sea_Rise" field for the features in study_area03_final.
10. Analyzed the protection scenarios for Manatee County to ensure that they followed the criteria set forth by the overall Sea Level Rise project standards and made additional changes as recommended by local planner review and by comments received from SWFRPC.

General County Protection Scenario Discussion

The areas of Manatee County included in the study area for this project are generally already developed or have been identified as locations for development in the near future. Some exceptions to this are in areas of current coastal wetlands along the northern shoreline as well as in some areas along the intercoastal waterway. The cities of Palmetto (north of the Manatee River) and Bradenton (south of the Manatee River) are the two major mainland areas of population and infrastructure concentration.

As can be seen in Tables 5, 6, and 7, the majority of land in the study area of Manatee County has been given a protection scenario of "almost certain" and most of the land is designated for future land use of residential or mixed uses.

Deviations from the Statewide Approach

In this section, specific areas of Manatee County will be discussed that have been represented on the sea level rise protection scenario maps in possible deviation from the Statewide Approach (Table 4. Deviations have been made for some areas within the region and are based on local planner input and discussions throughout the review process. Almost all of the deviations from the Statewide Approach are due to unique characteristics of some areas of the county.

Coquina Beach (southernmost point of Anna Maria Island)

The Coquina Beach Park area of Anna Maria Island, just north of Longboat Key, has been given a protection scenario of "reasonably likely" because of its strategic location along Gulf Drive and relatively high levels of use.

Low-Lying Areas Along the Manatee River

Some of the low-lying areas along the Manatee River have been given a protection scenario of "almost certain" despite the lack of development currently at these sites. These areas have recently been approved for future medium to high-density development and therefore are expected to be protected.

D. Pasco County

Pasco County is included in the Sea Level Rise project due to its location adjacent to the Gulf of Mexico and for the low-lying wetland areas present along much of its western coastline. Pasco County has over 31 linear miles of shoreline.

Data Used for Study and Maps

The datasets used for the study of Pasco County are compiled from multiple sources. The maps and analyses are based on the following layers:

Layer	Source
Pasco County Future Land Use	Pasco County GIS
New Port Richey Future Land Use	City of New Port Richey Planning
Port Richey Future Land Use	City of Port Richey Planning
Street Centerlines	Geographic Data Technology, Inc. (GDT)
Existing Land Use	Southwest Florida Water Management District
Elevation Polygons (derived from LIDAR)	Southwest Florida Water Management District
Environmental Sensitivity Index - Structures	Florida Marine Research Institute
Coastal Barrier Resources System	Federal Emergency Management Agency
National Wetlands Inventory	United States Fish & Wildlife Service

Future Land Use – The three future land use layers for Pasco County needed for the identified study area are merged together as a single layer. The future land use designations in the future land use layer for Pasco County have been generalized into the following designations:

Rural	Agriculture
Low-Density Residential	Conservation/Environmental
Medium-Density Residential	Recreation/Open Space
High-Density Residential	Public/Semi-Public
Very-High-Density Residential	Water
Commercial	Wetlands
Mixed Use	Transportation/Right-of-Way
Industrial	Unknown

Street Centerlines – The streets layer is used for general reference and mapping purposes.

Existing Land Use – The Southwest Florida Water Management District maintains this layer. This layer is used to differentiate uplands, wetlands, and water based on the FLUCCS field values.

Elevation Polygons – The elevation polygons are compiled from GRID raster files that were derived from LIDAR data and contour lines. The ArcGIS 9 Spatial Analyst Extension was used to identify the study area and create the elevation polygon layer. The LIDAR and contour data is maintained by Southwest Florida Water Management District. A combination of LIDAR and 2-foot contours was used because of the limited coverage (primarily only close to the immediate coast) of the available LIDAR data. This data was simultaneously being used for the Tampa Bay Region Hurricane Evacuation Study Update.

Environmental Sensitivity Index – The ESI polylines layer is maintained by the Florida Marine Research Institute and was used to locate man-made structures, such as sheltered and exposed solid structures and riprap, which are currently protecting areas of the Tampa Bay region's shoreline.

Coastal Barrier Resources System (CBRS) – The locations of barrier resources which fall under the Coastal Barrier Resources Act (CoBRA) is maintained within the Federal Emergency Management Agency's Flood Mapping GIS data for the Tampa Bay region.

National Wetlands Inventory (NWI) – The locations of specific types of wetlands within the region is maintained by the U.S. Fish and Wildlife Service. These polygons were used in an attempt to verify locations of tidal and non-tidal wetlands within the study area as identified using FLUCCS values.

Mapping Procedures

The following procedures were performed to create the final layer and maps for Pasco County:

1. Created an Elevation polygon layer that only contained land with elevation 10 feet or below.
2. Unioned Land Use Land Cover (LULC) with Elevation to create: study_area01
3. Selected all study_area01 features with Elevation = 5 or 10
4. Add to selection all study_area01 within 1000 feet of the shoreline.
5. Exported the selected features to a new shapefile: study_area02
6. Clipped Future Land Use (FLU) with study_area02 to create: study_area_FLU
7. Unioned study_area02 with study_area_FLU to create: study_area03_final
8. Created an "Acres" and "Sea_Rise" field in study_area03_final to calculate area and protection levels.
9. Applied the statewide approach by assigning the appropriate protection scenarios in the "Sea_Rise" field for the features in study_area03_final.
10. Analyzed the protection scenarios for Pasco County to ensure that they followed the criteria set forth by the overall Sea Level Rise project standards and made additional changes as recommended by local planner review and by comments received from SWFRPC.

General County Protection Scenario Discussion

The areas of Pasco County included in the study area for this project are generally already developed or have been identified as locations for development in the near future. Some exceptions to this are in areas of current coastal wetlands along the western shoreline. The cities of New Port Richey and Port Richey are the two major incorporated municipalities within the study area. The remainder of the coastal study area is in the unincorporated portion of Pasco County.

As can be seen in Tables 5, 6, and 7, the majority of land in the study area of Pasco County has been given a protection scenario of "almost certain" and most of the land is designated for future residential land use.

E. Pinellas County

Pinellas County is included in the Sea Level Rise project due to its location in relation to Tampa Bay and the Gulf of Mexico. As a peninsula Pinellas County is surrounded on three sides by open water. The county has a barrier island system and intercoastal

waterway which runs along almost the entire western coastline. Pinellas County has over 215 linear miles of shoreline.

Data Used for Study and Maps

The datasets used for the study of Pinellas County are compiled from multiple sources. The maps and analyses are based on the following layers:

Layer	Source
Pinellas County Future Land Use	Pinellas County Property Appraiser's Office
Street Centerlines	Geographic Data Technology, Inc. (GDT)
Existing Land Use	Southwest Florida Water Management District
Elevation Polygons (derived from LIDAR)	University of Florida
Environmental Sensitivity Index - Structures	Florida Marine Research Institute
Coastal Barrier Resources System	Federal Emergency Management Agency
National Wetlands Inventory	United States Fish & Wildlife Service

Future Land Use – The future land use layer for Pinellas County was compiled from the parcel data obtained from the Property Appraiser's Office. The future land use designations in the future land use layer for Pinellas County have been generalized into the following designations:

Rural	Agriculture
Low-Density Residential	Conservation/Environmental
Medium-Density Residential	Recreation/Open Space
High-Density Residential	Public/Semi-Public
Very-High-Density Residential	Water
Commercial	Wetlands
Mixed Use	Transportation/Right-of-Way
Industrial	Unknown

Street Centerlines – The streets layer is used for general reference and mapping purposes.

Existing Land Use – The Southwest Florida Water Management District maintains this layer. This layer is used to differentiate uplands, wetlands, and water based on the FLUCCS field values.

Elevation Polygons – The elevation polygons are compiled from GRID raster files that were derived from LIDAR data. The ArcGIS 9 Spatial Analyst Extension was used to identify the study area and create the elevation polygon layer. This data was provided by University of Florida and was simultaneously being used for the Tampa Bay Region Hurricane Evacuation Study Update.

Environmental Sensitivity Index – The ESI polylines layer is maintained by the Florida Marine Research Institute and was used to locate man-made structures, such as sheltered and exposed solid structures and riprap, which are currently protecting areas of the Tampa Bay region's shoreline.

Coastal Barrier Resources System (CBRS) – The locations of barrier resources which fall under the Coastal Barrier Resources Act (CoBRA) is maintained within the Federal Emergency Management Agency's Flood Mapping GIS data for the Tampa Bay region.

National Wetlands Inventory (NWI) – The locations of specific types of wetlands within the region is maintained by the U.S. Fish and Wildlife Service. These polygons were used in an attempt to verify locations of tidal and non-tidal wetlands within the study area as identified using FLUCCS values.

Mapping Procedures

The following procedures were performed to create the final layer and maps for Pinellas County:

1. Created an Elevation polygon layer that only contained land with elevation 10 feet or below.
2. Unioned Land Use Land Cover (LULC) with Elevation to create: study_area01
3. Selected all study_area01 features with Elevation = 5 or 10
4. Add to selection all study_area01 within 1000 feet of the shoreline.
5. Exported the selected features to a new shapefile: study_area02
6. Clipped Future Land Use (FLU) with study_area02 to create: study_area_FLU_final.
7. Created an "Acres" and "Sea_Rise" field in study_area03_final to calculate area and protection levels.
8. Applied the statewide approach by assigning the appropriate protection scenarios in the "Sea_Rise" field for the features in study_area03_final.

9. Analyzed the protection scenarios for Pinellas County to ensure that they followed the criteria set forth by the overall Sea Level Rise project standards and made additional changes as recommended by local planner review and by comments received from SWFRPC.

General County Protection Scenario Discussion

The areas of Pinellas County included in the study area for this project are generally already developed or, in many cases, undergoing redevelopment. Other than a few parks along the barrier islands and in the Gateway area, the coastal lands in Pinellas County are heavily developed with residential and commercial land uses.

As can be seen in Tables 5, 6, and 7, the majority of land in the study area of Pinellas County has been given a protection scenario of "almost certain" and most of the land is designated for future residential land use.

Deviations from the Statewide Approach

In this section, specific areas of Pinellas County will be discussed that have been represented on the sea level rise protection scenario maps in possible deviation from the Statewide Approach (Table 4). Deviations have been made for some areas within the region and are based on local planner input and discussions throughout the review process. Most all deviations from the Statewide Approach are due to unique characteristics of some areas of the county.

Honeymoon Island (northern extent of the barrier island chain)

The portion of Honeymoon Island State Park extensively used by the public has been given a "reasonably likely" protection scenario due to its level of use and the fact that it is connected to the mainland by the Causeway Boulevard Bridge.

Caladesi Island (just south of Honeymoon Island)

Caladesi Island State Park has been given an "unlikely" protection scenario because this park is not connected with the mainland by bridge and has limited facilities. Though relatively heavily used, this park is only accessible by ferry and private boat and therefore is unlikely to be protected from sea level rise. This area on the map appears to show

Caladesi Island being connected by land to Clearwater Beach, but this area is normally underwater except during extremely low tide.

Sand Key (just south of Clearwater Beach)

This park has been designated with the "reasonably likely" protection scenario because of its strategic location between Clearwater Beach and the other Pinellas County barrier islands. This park is heavily used, provides a public beach and is accessed via Gulf Boulevard, the major road along the barrier island chain.

Fort DeSoto (southern end of the barrier island chain)

The majority of Fort DeSoto Park has been categorized as protection "reasonably likely" due to its heavy public use and its connection to the mainland via the Pinellas Bayway.

VI. CONCLUSION

This report, and the accompanying maps depicting response scenarios, is intended to stimulate local government planners and citizens to think about the issue of sea level rise. Although this project covers a timeframe of 200 years, it would be a mistake to assume that thinking about sea levels rising can be put off to a future time. The sea is already rising and many shores are already eroding. It is important to keep in mind that an effective response may require a lead-time of many decades. If we develop areas where wetland migration is preferred in the long run, it might take a lead-time of 50-100 years to relocate the development. Even in areas we decide to protect, shore protection measures can take decades to plan and implement.

The relevance of planning for sea rise can also be seen by the events of the hurricane season in 2004 and 2005. As hurricanes headed toward this area and other Gulf Coast regions, official forecasters predicted that storm surges in some areas could rise above the ten-foot contour mapped for this project. One need only look at areas of the Tampa Bay Region, such as the barrier islands, to witness the erosionary effects of rising seas. With strong hurricane seasons projected to continue into the future, because of warmer ocean waters, the events of the past two hurricane seasons will repeat themselves. High storm surge and erosion are not effects that will wait until the year 2200. They are occurring now in our region.

The rate of development and increase in population in the Tampa Bay Region are other important factors in starting the preliminary stages of planning for sea level rise now. As sea levels continue to rise, much of the currently developed, increasingly populated, area can be expected to be flooded. Planners must begin to decide which land areas in their counties and municipalities will be protected, if any, against sea level rise and what the coast of holding back the sea will be. Citizens living in these areas must also know the costs associated with protection against sea rise.

This project's creation of maps is only a depiction of the expected response scenarios to sea level rise, based on the best currently available data and knowledge. Local planners may decide in the future that it may be wise to retreat from lands currently deemed to be protected lands, due to costs and environmental considerations. It is important to repeat that this project is only a start to anticipatory planning for sea level rise.

Appendix A:

Anticipated Response Maps

Appendix B:

Florida Land Use and Cover Classification System (FLUCCS)

Florida Land Use and Cover Classification System

T = Tidal
NT = Non-Tidal

(f) 600 WETLANDS

For the purpose of discussion in this manual, Wetla are those areas where the water table is at, near or above the land surface for a significant portion of most years. The hydrologic regime is such that aquatic or hydrophytic vegetation usually is established, although alluvial and tidal flats may be non-vegetated. Wetlands are frequently associated with topographic low lying areas. Examples of Wetlands include marshes, mudflats, emergent vegetation areas and swamps. Shallow water areas with submerged aquatic vegetation are usually, but not always, classed as water and not included in the Wetlands category.

Extensive parts of some river flood plains qualify as Wetlands. These do not include agriculture land where seasonal wetness or short-term flooding may provide an important component of the total annual soil moisture necessary for crop production. But uncultivated wetlands yielding products such as wood or which are grazed by livestock are retained in the Wetlands category.

Wetlands drained for any purpose belong to other land use categories whether they be Agriculture, Rangeland, Forested Uplands or Urban and Built-up. When the drainage is discontinued and such use ceases, classification reverts to Wetlands after characteristic vegetation is re-established. Wetlands managed for wildlife purposes may show short-term changes in vegetation type and wetness condition as different management practices are prescribed but they are properly classified as Wetlands.

The user of this manual should be aware of the fact that the above definition of a Wetland is tailored to the limitations imposed upon image analysis which must classify wetlands according to evidence recorded by remotely sensed images. On-site field verification may prove capable of better defining a specific site about its classification as a wetland. A more detailed definition of a wetland is provided in Florida Statue 373.019(17) and is more appropriate for use in conjunction with on-site field study.

610 Wetland Hardwood Forests

may depend on how close to coast.

Wetland Hardwood Forests are those Wetland areas which meet the crown closure requirements for forestland as outlined under the Upland Forest Classification (400) <minimum 10 percent closure>. To be included in the Wetland Hardwood Forest category, the stand must be 66 percent or more dominated by wetland hardwood species, either salt or freshwater.

611 Bay Swamps

NT

This category is composed of dominant trees such as loblolly bay, sweetbay magnolia, swamp bay, with slash pine and loblolly pine as an associated component at times. Large gallberry, fetterbush, wax myrtle and titi are included in the understory vegetation.

612 Mangrove Swamps

T

This coastal hardwood community is composed of red and/or black mangrove which is pure or predominant. The major associates include white mangrove, buttonwood, cabbage palm and sea grape.

613 Gum Swamps

NT

This forest community is composed of swamp tupelo (blackgum) or water tupelo (tupelogum), or Ogeechee tupelo which is pure or predominant. Associate species may include bald cypress and a great variety of wet site tolerant hardwood species widely variant in composition.

614 Titi Swamps

NT

This community is composed of often extremely dense stands of black titi and cyrilla which are either the pure or predominant species. Major associated species include bays, cypress, tupelos and a great variety of wetland hardwoods. At times titi can dominate non-wetland sites in the absence of a natural fire regime.

615 Stream and Lake Swamps (Bottomland)

NT

This community, often referred to as bottomland or stream hardwoods, is usually found on but not restricted to river, creek and lake flood plain or overflow areas. This category has a wide variety of predominantly hardwood species of which some of the more common components include red maple, river birch,

water oak, sweetgum, willows, tupelos, water hickory, bays, and water ash and buttonbush. Associated species include cypress, slash pine, loblolly pine and spruce pine.

616 Inland Ponds and Sloughs

NT

These communities are associated with depressions and drainage areas that are not associated with streams or lakes. One or a combination of the following species will generally be predominant: Pond cypress, swamp tupelo, water tupelo, titi or willows, Carolina ash and pond apple.

617 Mixed Wetland Hardwoods

Close to coast

This category is reserved for those wetland hardwood communities which are composed of a large variety of hardwood species tolerant of hydric conditions yet exhibit an ill defined mixture of species.

618 Willow and Elderberry

NT

In this community willow is pure or predominant species. In some areas of Florida such as in Paynes Prairie State Preserve elderberry is the primary associate species.

619 Exotic Wetland Hardwoods

NT

This category is a wetland with a dominant exotic species such as Brazilian pepper, melaleuca, or other exotic species.

620 Wetland Coniferous Forests

NT

Wetland Coniferous Forests are wetlands which meet the crown closure requirements for coniferous forests (see 400 and 410) and are the result of natural generation. These communities are commonly found in the interior wetlands in such as places as river flood plains, bogs, bayheads and sloughs.

621 Cypress

NT

This community is composed of pond cypress or bald cypress which is either pure or predominant. In the case of pond cypress, common associates are swamp tupelo, slash pine and black titi. In the case of bald

cypress, common associates are water tupelo, swamp cottonwood, red maple, American elm, pumpkin ash, Carolina ash, overcup oak and water hickory. Bald cypress may be associated with laurel oak, sweetgum and sweetbay on less moist sites. Note that some authorities do not distinguish between the two varieties of cypress.

622 Pond Pine

NT This category is composed of pond pine which is either pure or predominant on hydric soils. Its major associate is titi. Minor associates include sweetbay, loblolly bay, red bay and swamp tupelo.

623 Atlantic White Cedar

NT In this community, Atlantic White Cedar is the indicator species although it may not always be the most abundant. Its common associates include slash pine, cypress, swamp tupelo, sweetbay, red bay, loblolly bay, black titi and red maple.

624 Cypress - Pine - Cabbage Palm

NT This community includes cypress, pine and/or cabbage palm in combinations in which no species achieves dominance. Although not strictly a wetlands community, it forms a transition between moist upland and hydric sites.

625 Hydric Pine Flatwoods

NT Forest with a sparse to moderate canopy of Slash pine. The understory is grasses, wiregrass, forbs, and at times with sparse saw palmetto.

626 Hydric Pine Savanna

NT This community is an open forest with a sparse canopy of longleaf and/or slash pines with a ground cover of grasses, forbs, and wetland shrubs.

627 Slash Pine Swamp Forest

NT This community is a typically a domed swamp or strand dominated by slash pine, also pond cypress, swamp black gum, loblolly bay, sweet bay, and swamp bay. This is usually a depression feature in the landscape.

630 Wetland Forested Mixed

This category includes mixed wetlands forest communities in which neither hardwoods or conifers achieve a 66 percent dominance of the crown canopy composition.

631 Wetland Scrub

This community is associated with topographic depressions and poorly drained soil. Associated species include pond cypress, swamp tupelo, willows, and other low scrub with no dominate species. The Loxahatchee Slough area is an example of this classification.

640 Vegetated Non-Forested Wetlands

Vegetated Non-forested Wetlands include marshes and seasonably flooded basins and meadows. These communities are usually confined to relatively level, low-lying areas. This category does not include areas which have a tree cover which meets the crown closure threshold for the forested categories When the forest crown cover is less than the threshold for wetland forest or is non-woody, it will be included in this category. Sawgrass and cattail are the predominant species in freshwater marshes while spartina and needlerush are the predominant species in the saltwater marsh communities.

641 Freshwater Marshes

The communities included in this category are characterized by having one or more of the following species predominate:

Sawgrass	-	Cladium jamaicensis
Cattail	-	Typha domingenis Typha latifolia
	-	Typha angustifolia
Arrowhead	-	Sagittaria sp.
Maidencane	-	Panicum hemitomon
Buttonbush	-	Cephalanthus occidentalis
Cordgrass	-	Spartina bakeri
Giant Cutgrass	-	Zizaniopsis miliacea
Switchgrass	-	Panicum virgatum

Bulrush	-	Scirpus americanus Scirpus validus Scirpus robustus
Needlerush	-	Juncus effusus
Common Reed	-	Phragmites communnis Phragmites australis
Arrowroot	-	Thalia dealbata Thalia geniuclata

If the community is 66 percent or more dominated by a single species by cover, one of the following Level IV classifications will be employed.

6411 Sawgrass

6412 Cattail

6413 Spike Rush

6414 Maidencane

6415 Dog fennel and low marsh grasses

6416 Arrowroot

6417 Freshwater Marsh with shrubs, brush, and vines

6418 Giant Cutgrass

642 Saltwater Marshes

The communities included in this category will be predominated by one or more of the following species:

Cordgrasses	-	Spartina alterniflora Spartina cynosuroides Spartina patens Spartina spartinae
Needlerush	-	Juncus roemerianus
Seashore Saltgrass	-	Distichlis spicata
Saltwort	-	Batis maritima
Glassworts	-	Salicornia sp.
Fringerush	-	Finbristylis castanea
Salt Dropseed	-	Sporobolus virginicus
Seaside Daisy	-	Borrichia frutescens
Salt Jointgrass	-	Paspalum vaginatum

If the community is 66 percent or more dominated by a single species by cover, one of the following Level IV

classifications will be employed.

6421 Cordgrass

6422 Needlerush

643 Wet Prairies

This classification is composed predominately of grassy vegetation on hydric soils and is usually distinguished from marshes by having less water and shorter herbage. These communities will be predominated by one or more of the following species:

Sawgrass	-	Cladium jamaicensis
Maidencane	-	Panicum hemitomon
Cordgrasses	-	Spartina bakeri Spartina patens
Spike Rushes	-	Eleocharis sp.
Beach Rushes	-	Rhynchospora sp.
St. Johns Wort	-	Hypericum sp.
Spiderlily	-	Hymenocallis palmeri
Swamplily	-	Crinum Americanum
Yellow-eyed Grass	-	Xeric ambigua
Whitetop Sedge	-	Dichromena colorata

644 Emergent Aquatic Vegetation

This category of wetland plant species includes both floating vegetation and vegetation which is found either partially or completely above the surface of water.

6441 Water Lettuce - Pistia stratiotes

6442 Spatterdock - Nuphar sp.

6443 Water Hyacinth - Eichhornia sp.

6444 Duck Weed - Lemna sp.

6445 Water Lily - Nymphaeacea

645 Submergent Aquatic Vegetation

This category of wetland vegetation is composed of those aquatic species or communities found growing completely below the surface of the water.

6451 Hydrilla - Hydrilla verticillata
646 Treeless Hydric Savanna

This category is typically dominated by wiregrass or cutthroat grass along with wetland plant associates. This is a treeless variant of class 626.

650 Non-Vegetated

Non-vegetated wetlands are those hydric surfaces on which vegetation is found lacking due to the erosional effects of wind and water transporting the surface material so rapidly that the establishment of plant communities is hindered or the fluctuation of the water surface level is such that vegetation cannot become established. Additionally, submerged or saturated materials often develop toxic conditions of extreme acidity. Tidal flats, shorelines and intermittent ponds are the main components of this category.

651 Tidal Flats

This category is composed of that portion of the shore environment protected from wave action, as in the case of estuaries, comprised primarily of muds transported by tidal channels. An important characteristic of the tidal flat environment is its alternating tidal cycle of submergence and exposure to the atmosphere.

652 Shorelines

This category is normally defined as the interface between the land mass and a water body. Shorelines are formed primarily by physical or biological agents resulting in environments such as coral reefs and barrier beaches. The shore is defined as the zone extending from the low tide mark to the farthest point inland to which wave action transports beach materials.

653 Intermittent Ponds

This category of wetland is defined as a waterbody which exists for only a portion of the year. It may be referred to as a seasonal waterbody. Its existence relies upon water received directly from precipitation, runoff or spring flow.

654 Oyster Bars

Appendix C:

Local Stakeholder Review

LOCAL STAKEHOLDER REVIEW

On February 3, 2006, and again on April 7, 2006, the Tampa Bay Regional Planning Council hosted a Regional Planning Advisory Committee (RPAC) meeting to present, review and discuss the sea level rise study and the related draft anticipated response maps. RPAC is made up of planners from throughout the region that represent the local counties, municipalities, and other planning agencies. The attendees of the formal review RPAC meeting of April 7, 2006 are shown on the sign-in sheet in this appendix on page 75. The attendees of this meeting represented all four counties and many of the municipalities included in the Tampa Bay Region Sea Level Rise Study. Both RPAC meetings consisted of a presentation giving an introduction and background to the project and concluded with group discussion and comments.

To facilitate review by local governments within the study area, who were unable to attend either RPAC meeting, TBRPC staff distributed, by mail and email, project background material and draft maps. This distribution provided the local government planners with the necessary materials to review and comment on the sea level rise project and maps. The mail and email distribution of materials included all local planning agencies located within the study area as well as the Local Mitigation Strategy (LMS) Workgroups in each county.

Overall, between the RPAC meetings and the mail and email solicitation of comments, more than 40 local planning agencies were contacted. The contacted agencies by county are as follows:

Hillsborough County

Hillsborough County Planning and Growth Management Department
Hillsborough County Planning Commission
Hillsborough County Local Mitigation Strategy Workgroup
City of Tampa Planning and Management Department

Manatee County

Manatee County Planning Department
Manatee County Local Mitigation Strategy Workgroup
City of Anna Maria, City Clerk's Office
City of Bradenton Planning and Community Development Department

City of Bradenton Beach, City Clerk's Office
City of Holmes Beach, City Clerk's Office
City of Longboat Key Planning, Zoning, & Building Department
City of Palmetto Planning & Zoning Department

Pasco County

Pasco County Growth Management Department
Pasco County Local Mitigation Strategy Workgroup
City of Port Richey, City Manager's Office
City of New Port Richey Community Development Department

Pinellas County

Pinellas County Planning Department
Pinellas Planning Council
Pinellas County Local Mitigation Strategy Workgroup
Town of Belleair, Town Manager's Office
City of Belleair Beach, City Manager's Office
City of Belleair Bluffs Planning & Zoning Department
Town of Belleair Shore, Town Clerk's Office
City of Clearwater Planning Department
City of Dunedin Community Services Department
City of Gulfport Community Development Department
City of Indian Rocks Beach, City Manager's Office
Town of Indian Shores, Town Clerk's Office
City of Largo Community Development Department
City of Madeira Beach Community Development Department
Town of North Redington Beach, Town Clerk's Office
City of Oldsmar Planning and Redevelopment Department
City of Pinellas Park Community Planning Department
Town of Redington Beach, Town Clerk's Office
Town of Redington Shores, Town Administrator's Office
City of Safety Harbor, Assistant City Manager's Office
City of St Pete Beach Planning Department
City of St Petersburg Planning Department
City of Seminole, City Manager's Office
City of South Pasadena, City Attorney's Office
City of Tarpon Springs Planning & Zoning Department
City of Treasure Island Planning Department

The majority of local governments who provided comment on the sea level rise maps stated that the anticipated response maps were sufficient in representing the likelihood of land use protection based on the statewide approach that was being used for the project. They felt that the maps, which showed the majority of land as "protection almost

certain", reflected their opinions that the already developed coastal areas of the region would be protected from a rise in sea level. With this said, the local governments did acknowledge that realistically all of this land area would not be able to be protected depending on the sea level rise scenario and that difficult decisions would have to be made when faced with the overwhelming costs of holding back the sea.

In addition to the comments discussed in Section IV the following comments were received during the RPAC meetings and through local government discussion on the anticipated response maps:

- Most parks within the region are moderately to heavily used and therefore in most cases, depending on location, would be expected to be protected from sea level rise.
- Several comments suggested that a "sensitivity analysis" be performed to depict the impact of other scenarios then the base scenario that EPA has prescribed. For example, what would be the impacts of a less or more rapid rise over a shorter time period? This analysis may engage county decision makers at a higher level than is currently taking place.
- Several local governments (i.e. Tampa, Pinellas Park, St Petersburg, and Pinellas Planning Council) provided general verbal comments indicating that they had reviewed the report/maps but did not provide specific written comments.

PLEASE PRINT!!!

REGIONAL PLANNING ADVISORY COMMITTEE

April 7, 2006, 1:30 p.m.

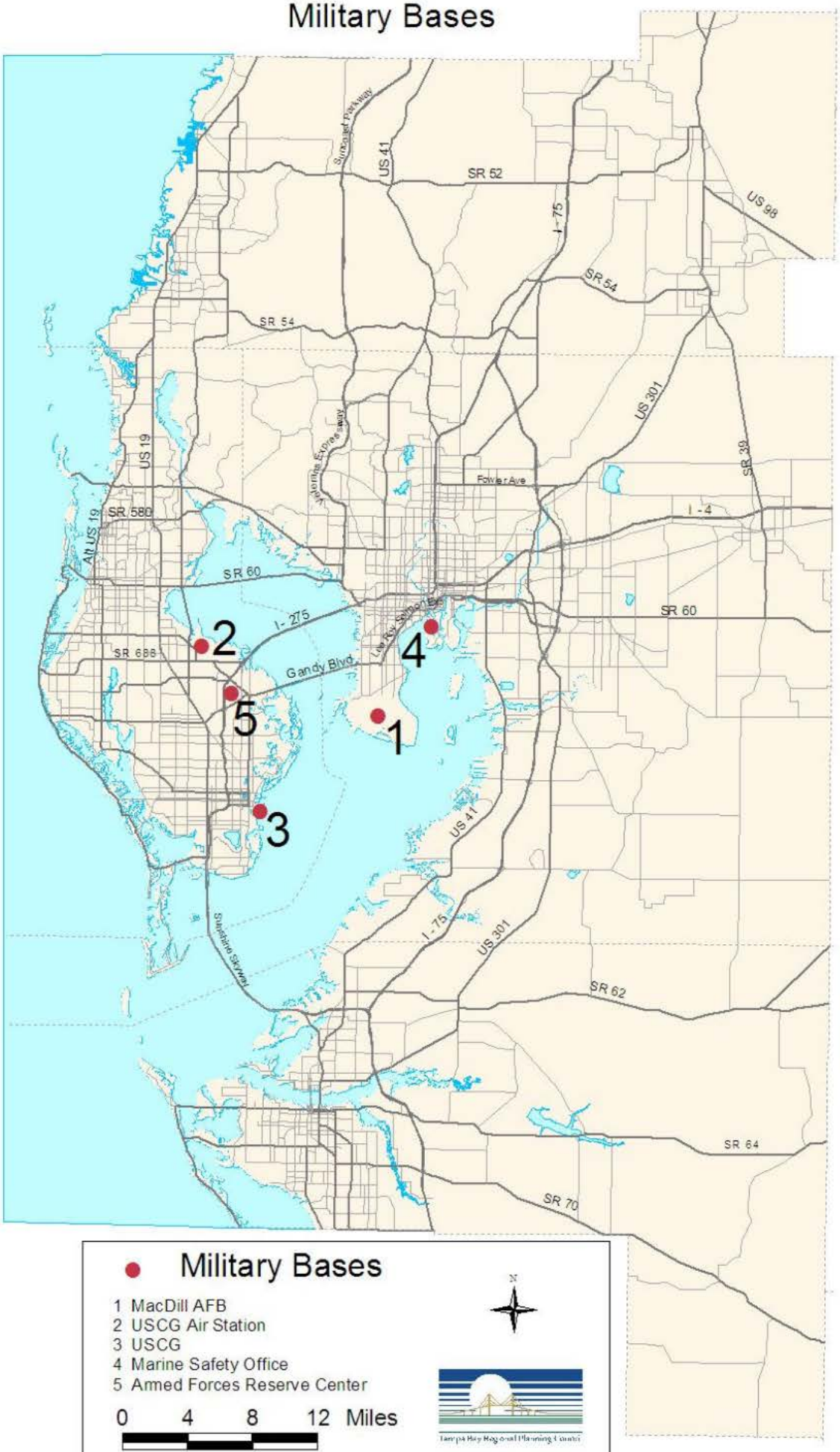
PLEASE SIGN IN

NAME	TITLE AND/OR PROXY	AGENCY
Bob Bray	Director	Pinellas Park
STEVE ELLIOT	PRESIDENT	ELLIOT CONSULTING
Bill HASTINGS	Sr. Consultant	ELLIOT Consulting
PAUL GEISZ	PLANNER	ST. PETE
Derek Kilborn	Planner	St. Pete
DAWN TAYLOR	PLANNING DIRECTOR	INDIAN ROCKS BEACH
Michael Lord	Planner	Manatee
MATT ARMSTRONG	PLANNER II	PASCO
RICHARD TONERO	SR. PLANNER	PASCO
Shawn College	Hills. Plnng Comm.	Exec Planner
Ric HARTMAN	PALMETTO PLANNER	CITY of PALMETTO
Brian Smith	Plan Director	Pinellas County
Glenn Bailey		
Lynn Rosekrist	City Planner	City of Treasure Island
Lenny Pflueger	~~PPC~~ Principal Planner	PPC

Appendix D:

Strategic Regional Policy Plan
Military Bases Map

MAP #8
Military Bases



Taken from:
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A Strategic Regional
Policy Plan for the
Tampa Bay Region
September 2005