VOLUME 1-7

STATEWIDE REGIONAL EVACUATION STUDY PROGRAM

CENTRAL FLORIDA REGION

TECHNICAL DATA REPORT

CHAPTER II

REGIONAL HAZARDS ANALYSIS

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CHAPTER II
REGIONAL HAZARDS ANALYSIS

A. Hazards Identification and Risk Assessment

The regional evacuation studies in Florida have focused specifically on the hurricane hazard. Considering our vulnerability to tropical storms and hurricanes as well as the complex nature of the evacuation and emergency response and recovery, the priority of hurricane planning remains a necessity. However, history has also demonstrated a need to address other significant hazards which have the potential for initiating major evacuations.

The Statewide Regional Evacuation Study (SRES), utilizing the Statewide Hazard Mitigation Plan (SHMP, 2009), identified the major hazards facing the state and further focused on those hazards which had the potential for initiating a multi-jurisdictional evacuation. A number of factors were considered in assessing the risk of each hazard event, including the frequency of occurrence, the severity of the event and the areas vulnerable to its impact.

These factors were assigned numerical values in the assessment as follows:

1. Frequency of Occurrence

a. Annual Event
b. Every 5 years or less
c. Every 6-10 years
d. Every 11-30 years
e. Greater than 30 years

2. Vulnerability Factors

a. Low
b. Moderate
c. High
d. Extreme
e. Catastrophic

3. Vulnerability Impact Areas

a. Population
b. Property
c. Environment
d. Operations

There are twelve major hazards that were identified in the Statewide Hazard Mitigation Plan. They include floods, coastal storms and hurricanes; severe storms and tornadoes; wildfire; drought and extreme heat; winter storms and freezes; erosion, sinkholes, landslides and seismic events; tsunamis; technological (hazardous materials, etc.); terrorism and mass migration. These hazards are itemized in **Table II-1**.

Table II-1
Hazards Identified in Florida[1]

Hazard	Methodology of Identification	Significant Concerns	Potential to Initiate a Regional Evacuation
Floods (including related potential for dam failure)	• Review of past disaster Declarations. • Review of Federal Flood Insurance Rate Maps (FIRMs). • Input from state floodplain manager. • Identification of NFIP repetitive loss properties in the state.	• Florida is affected by flooding nearly every year. • Floods have caused extensive damage and loss of life in the state in the past. • The most recent federally declared disaster event (Feb 8 2007) in Florida included flooding from severe storms. • There are a number of dams in the state that could impact the nearby population.	Yes; although more difficult to determine which areas are vulnerable to a particular event.

[1] Statewide Hazard Mitigation Plan (SHMP), 2009

Hazard	Methodology of Identification	Significant Concerns	Potential to Initiate a Regional Evacuation
Coastal Storms & Hurricanes	• Review of past disaster declarations. • Review of National Climatic Data Center (NCDC) Severe Storms Database. • National Oceanographic and Atmospheric Association (NOAA) climatology data. • Research including new media and the Internet.	• Hurricanes and coastal storms affect Florida every year. • Hurricanes have caused extensive damage and loss of life across the state for the last 50 years. • 8 out of the last 10 federally declared disaster events in Florida were hurricanes.	Yes; this hazard requires the evacuation of coastal areas and mobile home residents, even in minor tropical storm events. Major hurricanes can have catastrophic impacts.
Severe Storms & Tornadoes	• Review of past disaster declarations. • Review of National Climatic Data Center (NCDC) Severe Storms Database. • National Weather Service input and data. • Public input including newspapers and media.	• Florida experiences a tornado nearly every year. • Tornadoes have caused extensive damage and loss of life to county residents. • The two most recent federally declared disaster event in Florida (Feb 8 and Feb 3 2007) were a severe storm with tornadoes.	No; these events provide little to no warning and the specific areas can not be determined prior to the event. Exceptions: Tornado warnings can send residents to safe rooms or mobile home parks, community centers, etc.

Hazard	Methodology of Identification	Significant Concerns	Potential to Initiate a Regional Evacuation
Wildfire	• Florida Division of Forestry statistics and input. • USDA Forest Service Fire, fuel, and WUI mapping. • Input from FL DEM about wildfires and the EOC activations. • Public input including newspapers and media.	• Florida experiences wildfires every year. • Development in much of the state is occurring at the Wildland-Urban Interface (WUI). • Cyclical drought patterns result in increases of brush and other dry materials. This increases the overall risk for significant fires. • Fires in 2007 were significant due to the number and magnitude including closures to the interstate system.	Yes; while we can determine areas that may be more vulnerable and plan accordingly, it is difficult to predict where a wildfire may ignite.
Drought & Extreme Heat	• National Weather Service data. • National Oceanographic and Atmospheric Association (NOAA) paleoclimatology data. • The US Drought Monitor. • Keetch Byram Drought Index (KBDI). • Agricultural community throughout the state.	• Significant drought trends during the last 10 years including moderate and severe drought index conditions in 2007 and 2008 for parts of the state. • Drought has a severe economic impact on the state due to the large amounts of citrus, agriculture and livestock.	No; this event does not typically initiate an evacuation.

Hazard	Methodology of Identification	Significant Concerns	Potential to Initiate a Regional Evacuation
Winter Storms and Freezes	• Review of past disaster declarations. • Review of NCDC Severe Storms Database. • National Weather Service input and data. • Public input including newspapers and media.	• Florida is affected by winter storms cyclically. • Significant freezes particularly during the 1980s that affected the citrus industry. • 5 federally declared disasters since 1971. • The population is unprepared for cold weather with many having inadequate heating capabilities.	No; this event does not typically initiate an evacuation; although cold weather shelters may be opened for homeless, special needs or those with no power.
Erosion	• Coordination with the Florida Department of Environmental Protection – Bureau of Beaches and Coastal systems. • ***Statewide Hazard Mitigation Plan*** – interview and input. • *Evaluation of Erosion Hazards*, the report from the Heinz Center that was presented to FEMA in April 2000. • Public input including newspapers and media.	• Due to the gradual, long-term erosion, as many as one in four houses along the coast could fall into the ocean in the next 60 years. • Eighty to 90 percent of the nation's sandy beaches are facing erosion problems. • Significant economic impact for the state due to property damages, loss of actual beach front real estate and affects on tourism.	No; this event does not typically initiate an evacuation, but it may result in a retreat from the coast over long period of time or following a major coastal storm.

Hazard	Methodology of Identification	Significant Concerns	Potential to Initiate a Regional Evacuation
Sinkholes, Landslides and Seismic Events	• Coordination with the Florida Geographical Survey. • The Florida Sinkhole Database. • Coordination with the Florida Department of Transportation. • Input from the Central United States Earthquake Consortium. • USGS Landslide Hazard maps.	• Sinkholes are a common feature of Florida's landscape. • 2843 sinkholes have been reported in the state since the 1970s. • Growing issues as development continues in high risk areas. • Impact on the roads and physical infrastructure of the state. • Earthquake risk is considered extremely low.	Earthquake is considered very low risk. Sinkholes, while prevalent, will not initiate an evacuation at a regional scale.
Tsunamis	• Input from the NOAA Center for Tsunami Research. • Coordination with the Florida Division of Emergency Management. • Input from the United States Geological Survey.	• Tsunamis are a common event that occurs in large bodies of water. • Almost all perimeters of Florida's boundaries are made up of large bodies of water. • Recent Tsunamis from around the world have caused widespread destruction. • Residential and commercial developments along Florida's coastlines are at risk to the effects of Tsunamis.	This event has an extremely low probability of occurrence. If a Cumbre Vieja tsunamis event were to occur, it could have a catastrophic impact on the east coast of Florida. A maximum of 6 hours would be available for evacuations. Typically, there is little to no warning.

Hazard	Methodology of Identification	Significant Concerns	Potential to Initiate a Regional Evacuation
Technological	• Coordination with the State Emergency Response Commission. • Interaction with the Local Emergency Planning Committees (LEPC). • Coordination with the Nuclear Regulatory Commission (NRC). • Communications with the FL Department of Environmental Protection.	• Numerous accidental hazardous material releases occur every year. • Potential for human and environmental impacts. • Threat of radiation from a nuclear related incident.	Yes, these incidents may initiate evacuations, but it is impossible to predict precise location, extent and timing. Nuclear power plant evacuation planning conducted w/NRC.
Terrorism	• Coordination with FEMA and Department of Homeland Security. • Coordination with the Florida Department of Law Enforcement (FDLE). • Interaction with local law enforcement agencies.	• National priority with federal government requirements. • Potential for devastating impacts to life and Infrastructure. • Protection for the citizens of Florida and the USA.	Yes, these incidents may initiate evacuations, but it is impossible to predict precise location, extent and timing.
Mass Migration	• Coordination with the US Citizens and Immigration Service (USCIS). • Data from local law enforcement.	• Historic precedence for migration to Florida by boat. • Large amounts of unpatrolled coastlines.	No; evacuation is not the problem.

For purposes of the SRES, the potential evacuation from (1) Coastal storms and Hurricanes, (2) Inland / Riverine floods (including related potential for dam failure) and (3) Wildfires and the Urban Interface will be analyzed in detail.

As indicated above, any evacuation initiated by a tsunami, terrorist event or a hazardous material incident will have little or no-warning. Therefore; the location, scope and extent of the evacuation response will be difficult to predict or model prior to the incident. Planning for those events; however, is ongoing at the state, regional and local levels. The identification of key infrastructure and facilities, vulnerable areas, response capabilities and mitigation strategies will be discussed in the hazards profile of each of these potential hazards.

The hazards analysis shall identify the potential hazards to the region and shall include investigations of:

- General Information about each hazard (Hazards Profile);
- History of activity in the region; and
- A geo-spatial analysis of the potential effects of the hazard, i.e. inundation areas, wind fields, dam locations, urban interface, etc.

The vulnerability analysis will then identify the following:

- Human and social impacts including the identification of the population-at-risk, potential shelter and mass care demand, evacuee behavioral assumptions and the vulnerability of critical facilities; and
- The potential for multiple hazard impacts such as the release of hazardous materials in a wildfire or flooding event or security risks following a hurricane.

B. Coastal Storms and Hurricanes

1. Coastal Storms / Hurricane Hazard Profile

A hurricane is defined as a weather system with a closed circulation developing around a low pressure center over tropical waters. The winds rotate counterclockwise in the Northern Hemisphere (clockwise in the Southern Hemisphere). *Tropical storms and hurricanes act as safety valves that limit the build-up of heat and energy in the tropical regions by maintaining the atmospheric heat and moisture balance between the tropics and the pole-ward latitudes* (Statewide Hazard Mitigation Plan (SHMP, 2009). Tropical cyclones are named when their winds reach tropical storm strength (sustained 39 mph).

- **Tropical Depression**: The formative stages of a tropical cyclone in which the maximum sustained (1-minute mean) surface wind is <39 mph.

- **Tropical Storm:** A warm core tropical cyclone in which the maximum sustained surface wind (1-minutes mean) ranges from 39 to <74 mph.

- **Hurricane:** A warm core tropical cyclone in which the maximum sustained surface wind (1 minute mean) is at least 74 mph.

The table below displays the Saffir-Simpson Scale used to define and describe the intensity of hurricanes. The central pressure of the hurricanes is measured in millibars or inches. The wind speed is also a significant indicator in determining the category of the storm. The wind speed is tied to both wind damage and potential storm surge and resulting coastal flooding damages.

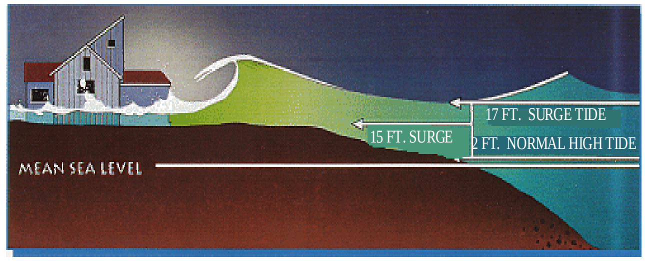
It should be noted that the range of storm surge is highly dependent upon the configuration of the continental shelf (narrow or wide) and the depth of the ocean bottom (bathymetry). A narrow shelf or one that drops steeply from the shoreline and subsequently produces deep water in close proximity to the shoreline tends to produce a lower surge but higher and more powerful storm waves. This is the situation along the Atlantic Ocean side of the state. However, the Gulf Coast of Florida has a long gently sloping shelf and shallow water depths and can expect a higher surge but smaller waves. South Dade County is an exception to these general rules due to Biscayne Bay (wide shelf and shallow depth). In this instance, a hurricane has a larger area to "pileup" water in advance of its landfall. Nowhere is the threat of storm surge more prevalent than in Apalachee Bay region. The Big Bend region of the state extends out into the Gulf of Mexico creating a naturally enclosed pocket. This area has some the highest computer projected storm surge heights in the entire nation.

Hurricanes Dennis, Katrina and Ike also demonstrated that the size of the hurricane can significantly impact the potential storm surge. These storms which had particularly large radii of maximum winds produced storm surge comparable to much more intense categories of storm if measured using only wind speeds. This storm characteristic will be modeled to determine its impact on the ultimate storm surge.

Table II-2
Saffir-Simpson Hurricane Wind Scale

CATEGORY		CENTRAL PRESSURE		WINDS (MPH)	DAMAGE POTENTIAL
		MILLIBARS	INCHES		
1		>980	>28.94	74-95	Damage primarily to trees & foliage, signs, unanchored mobile homes, flooding in low-lying areas, minor pier damage, some small craft torn from moorings.
2		965-979	28.50-28.91	96-110	Considerable damage to foliage & trees; major damage to mobile homes, signs, roofing materials of buildings; windows; coastal roads and low-lying areas cut off by rising water; considerable damage to piers and marinas.
Major Hurricanes	3	945-964	27.91-28.41	111-130	Foliage torn from trees; large trees uprooted; Signs down; roofing, window and door damage; Some structural damage to buildings. Mobile homes destroyed. Serious flooding at coast with structures damaged by battering waves and floating debris.
	4	920-944	27.17-27.88	131-155	Shrubs and trees blown down; all signs down. Extensive damage to roofing materials, windows and doors. Complete roof failure on many residences. Complete destruction of mobile homes. Major destruction of coastal structures and erosion of beaches.
	5	<920	<27.17	>155	Shrubs and trees blown down; considerable damage to roofs of buildings; all signs down. Very severe and extensive damage to windows and doors. Complete failure of many residences and industrial buildings. Extensive shattering of glass. Complete destruction of mobile homes. Major / complete destruction of coastal structures.

2. Hurricane Hazards



The five major hazards produced by a hurricane are the storm surge, high winds, tornadoes and rainfall (freshwater flooding) and the potential for hazardous material incidents.

NOTE: Due to the land locked geography of the Central Florida Region, storm surge will only be considered for the area immediately surrounding Lake Okeechobee and the extreme southwest corner of DeSoto County. High winds, tornadoes and freshwater flooding will present the greatest threat to our region.

The **storm surge** is the abnormal rise in water level caused by the wind and pressure forces of a hurricane or tropical storm. Storm surge produces most of the flood damage and drownings associated with storms that make landfall or that closely approach the coastline. Of the hurricane hazards, the storm surge is considered to be the most dangerous as nine out of ten hurricane-related deaths are caused by drowning.

The **high winds** also can have a devastating effect on persons outside, in mobile homes, in unsound, substandard structures or in structures with unprotected windows or glass exposures. An earlier study[2] (TBRPC, 1986) concluded that while a fully-engineered multi-story structure could withstand the storm surge of a major storm, without protection on the windows and other cladding, occupants within any structure would be at serious risk. This factor held true for all types of structures exposed to sustained winds in excess of 115 mph. The winds of Hurricane Andrew (1992) caused major destruction in South Florida throwing the insurance industry into a tail spin.

Rainfall associated with hurricanes varies with hurricane size, forward speed and other meteorological factors. The rainfall associated with a hurricane is from 6-12 inches on average, with higher amounts common. **Freshwater flooding** has historically not been considered a life-threatening hazard. However, over the past 20 years, freshwater flooding had become the leading cause of death related to hurricanes. This is due in part to the successful evacuation planning efforts in the United States which had significantly reduced the number of deaths (in the U.S.) related to storm surge. Hurricane Katrina tragically illustrated the danger of storm surge flooding in both Louisiana and Mississippi. However, it is also recognized that many coastal and inland residents do not recognize the risk associated with freshwater flooding, especially when driving. In response, a national program, *"Turn Around, Don't Drown"* was implemented in 2002. The

[2] Hurricane Shelter Alternative Study, TBRPC and USACOE, 1986

freshwater flooding associated with a hurricane, may also inundate potential evacuation routes and prevent persons from evacuating areas vulnerable to storm surge. Flooded roads and storm drains resulted in fatal accidents in many areas either during the effects of Hurricanes or immediately following. At least one death was directly attributed the results of freshwater flooding following Hurricane Charley in 2004. A portion of Highway 60 was washed out between Bartow and Lake Wales and a driver, unable to see the hole, drove into it. He died as a result of the combination of internal injuries and drowning. Hurricanes can also produce tornadoes that add to the storm's destructive power. Tornadoes are most likely to occur in the right-front quadrant of the hurricane. However, they are often found well away from the center of the hurricane embedded in the rain bands. Some hurricanes seem to produce no tornadoes, while others develop multiple ones. Studies have shown that more than half of the landfalling hurricanes produce at least one tornado; Hurricane Buelah (1967) spawned 141 according to one study.

Like Murphy's Law, sometimes one emergency event can trigger another. Facilities which generate or store quantities of potentially hazardous materials, propane storage facilities, natural gas pipeline terminals, fuel storage facilities and tank farms all pose an additional potential threat in a hurricane.

3. Storm Surge: The SLOSH Model

The principal tool utilized in this study for analyzing the expected hazards from potential hurricanes affecting the study area is the Sea, Lake and Overland Surges from Hurricanes (**SLOSH**) numerical storm surge prediction model. The SLOSH computerized model predicts the storm surge heights that result from hypothetical hurricanes with selected various combinations of pressure, size, forward speed, track and winds. Originally developed for use by the National Hurricane Center (NHC) as a tool to give geographically-specific warnings of expected surge heights during the approach of hurricanes, the SLOSH model is utilized in regional studies for several key hazard and vulnerability analyses.

The SLOSH modeling system consists of the model source code and model basin or grid. SLOSH model grids must be developed for each specific geographic coastal area individually, incorporating the unique local bay and river configuration, water depths, bridges, roads and other physical features. In addition to open coastline heights, one of the most valuable outputs of the SLOSH model for evacuation planning is its predictions of surge heights over land, thus predicting the degree of propagation of the surge into inland areas. There are two separate SLOSH basins that are used to model storm surge in the Central Florida Region. The Lake Okeechobee basin models storm surge that may potentially affect southern Okeechobee County and far southeast Highlands County. The Fort Myers basin models storm surge from

Charlotte Harbor that may affect the Peace River watershed, especially in far southwest DeSoto County near the mouth of the river.

The newest generation of the SLOSH model basin incorporated in the 2010 Statewide Regional Evacuation Study reflects major improvements, including higher resolution basin data and grid configurations. Faster computer speeds allowed additional hypothetical storms to be run for the creation of the MOMs (maximum potential storm surge) values for each category of storm. Storm tracks were run in ten different directions for both the Lake Okeechobee and Fort Myers basins. For each set of tracks in a specific direction, storms were run at forward speeds of 5, 15, and 25 mph for the Lake Okeechobee basin, and 5,10,15,20, and 25 mph for the Fort Myers basin. For each direction, at each speed, storms were run at two different sizes (20 and 35 statute mile radius of maximum winds) for both basins.

Each scenario was run at both mean tide and high tide for the Fort Myers basin. Both tide levels are now referenced to North American Vertical Datum of 1988 (NAVD88) as opposed to the National Geodetic Vertical Datum of 1929 (NGVD29). Each scenario was run for the Lake Okeechobee basin at lake depths of 12, 13, 14, 15, 16 & 20 feet.

Once again, for the Central Florida Region it must be noted that the SLOSH model is only relevant in the southern areas of Okeechobee County, a very small and rural area in the southeast portion of Highlands County, and in parts of DeSoto County along the Peace River, especially in the extreme southwest part of the county just to the north of where the Peace River flows into Charlotte Harbor.

a. Hypothetical Storm Simulations

Surge height depends strongly on the specifics of a given storm including forward speed, angle of approach, intensity or maximum wind speed, storm size, storm shape, and landfall location. The SLOSH model was used to develop data for various combinations of hurricane strength, wind speed, and direction of movement. Storm strength was modeled by use of the central pressure (defined as the difference between the ambient sea level pressure and the minimum value in the storm's center), the storm eye size and the radius of maximum winds using the five categories of hurricane intensity as depicted in the Saffir-Simpson Hurricane Scale (see **Table II-2**) plus a hypothetical tropical storm intensity (for the Fort Myers basin).

The modeling for each tropical storm/hurricane category was conducted using the mid-range pressure difference ($\triangle$p, millibars) for that category. In addition the model simulates the storm filling (weakening upon landfall) and radius of maximum winds (RMW) increase.

Ten storm track headings (WSW, W, WNW, NW, NNW, N, NNE, NE, E, ENE) were selected as being representative of storm behavior in the Southeastern and Southwestern Central Florida region (Okeechobee & DeSoto Counties respectively), based on observations by forecasters at the National Hurricane Center.

Additional inputs into the model included depths of water within Lake Okeechobee and Charlotte Harbor, and the heights of the terrain and barriers onshore (all measurements were made relative to NAVD88). A total of 41,960 runs for the two basins were made, based on the different parameters shown in **Tables II-3a & II-3b**.

Table II-3a
Lake Okeechobee Basin Hypothetical Storm Parameters

Direction	Speeds (mph)	Size (Radius of Maximum winds)	Intensity	Tides	Tracks	Runs
WSW	5,15,25 mph	20 statute miles & 35 statute miles	1 through 5	12, 13, 14, 15, 16, 20, ft.	7	1,218
W	5,15,25 mph	20 statute miles & 35 statute miles	1 through 5	12, 13, 14, 15, 16, 20, ft.	9	1,566
WNW	5,15,25 mph	20 statute miles & 35 statute miles	1 through 5	12, 13, 14, 15, 16, 20, ft.	8	1,392
NW	5,15,25 mph	20 statute miles & 35 statute miles	1 through 5	12, 13, 14, 15, 16, 20, ft.	8	1,392
NNW	5,15,25 mph	20 statute miles & 35 statute miles	1 through 5	12, 13, 14, 15, 16, 20, ft.	8	1,392
N	5,15,25 mph	20 statute miles & 35 statute miles	1 through 5	12, 13, 14, 15, 16, 20, ft.	8	1,392
NNE	5,15,25 mph	20 statute miles & 35 statute miles	1 through 5	12, 13, 14, 15, 16, 20, ft.	8	1,392
NE	5,15,25 mph	20 statute miles & 35 statute miles	1 through 5	12, 13, 14, 15, 16, 20, ft.	8	1,392
ENE	5,15,25 mph	20 statute miles & 35 statute miles	1 through 5	12, 13, 14, 15, 16, 20, ft.	8	1,392
E	5,15,25 mph	20 statute miles & 35 statute miles	1 through 5	12, 13, 14, 15, 16, 20, ft.	8	1,392
					TOTAL	13,920

Directions, speeds, (Saffir/Simpson) intensities, number of tracks and the number of runs.

Table II-3b
Fort Myers Basin Hypothetical Storm Parameters

Direction	Speeds (mph)	Size (Radius of Maximum winds)	Intensity	Tides	Tracks	Runs
WSW	5, 10,15, 20, 25 mph	20 statute miles & 35 statute miles	T.S., 1 through 5	Mean/ High	27	3,240
W	5, 10,15, 20, 25 mph	20 statute miles & 35 statute miles	T.S., 1 through 5	Mean/ High	27	3,240
WNW	5, 10,15, 20, 25 mph	20 statute miles & 35 statute miles	T.S., 1 through 5	Mean/ High	23	2,760
NW	5, 10,15, 20, 25 mph	20 statute miles & 35 statute miles	T.S., 1 through 5	Mean/ High	21	2,520
NNW	5, 10,15, 20, 25 mph	20 statute miles & 35 statute miles	T.S., 1 through 5	Mean/ High	23	2,760
N	5, 10,15, 20, 25 mph	20 statute miles & 35 statute miles	T.S., 1 through 5	Mean/ High	29	3,480
NNE	5, 10,15, 20, 25 mph	20 statute miles & 35 statute miles	T.S., 1 through 5	Mean/ High	26	3,120
NE	5, 10,15, 20, 25 mph	20 statute miles & 35 statute miles	T.S., 1 through 5	Mean/ High	29	3,480
ENE	5, 10,15, 20, 25 mph	20 statute miles & 35 statute miles	T.S., 1 through 5	Mean/ High	30	3,600
E	5, 10,15, 20, 25 mph	20 statute miles & 35 statute miles	T.S., 1 through 5	Mean/ High	26	3,120
					TOTAL	31,320

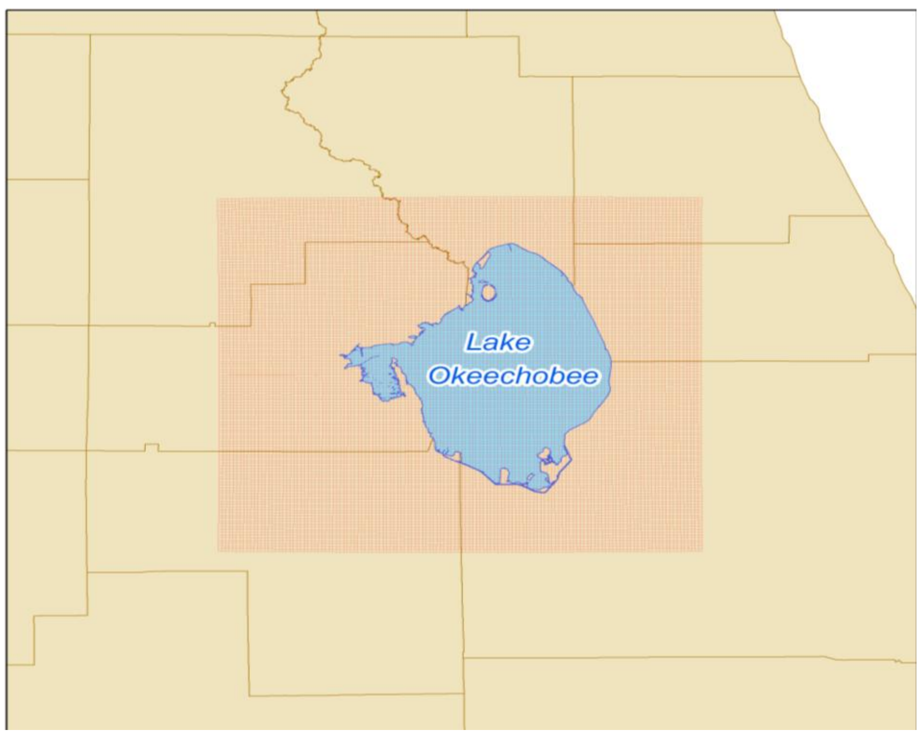
Directions, speeds, (Saffir/Simpson) intensities, number of tracks and the number of runs. Tropical storms (T.S.) are larger but weaker than the weakest (Category 1) hurricane.

b (1). The Grid for the Lake Okeechobee SLOSH Model

Figure II-1a illustrates the area covered by the grid for the Okeechobee SLOSH model basin. To determine the surge values the SLOSH model uses a nearly-square rectangular grid as its unit of analysis with 128 arc lengths ($1 \leq I \geq 128$). and 135 radials ($1 \leq J \geq 135$). The Okeechobee SLOSH basin grid differs from most other basins that use telescoping elliptical grids which decrease in resolution over deep water where detail is not as important. There is no deep water in the Okeechobee SLOSH basin, and because the lake is completely surrounded by land, the resolution of the grid is approximately the same throughout the basin to provide sufficient resolution of the storm surge at the lakeshore, along rivers, and in other areas inundated by storm surge.

The grid size for the Okeechobee SLOSH basin is approximately 0.15 to 0.17 square miles (96 to 109 acres) for each of the grid cells.

Figure II-1a
Okeechobee SLOSH Grid



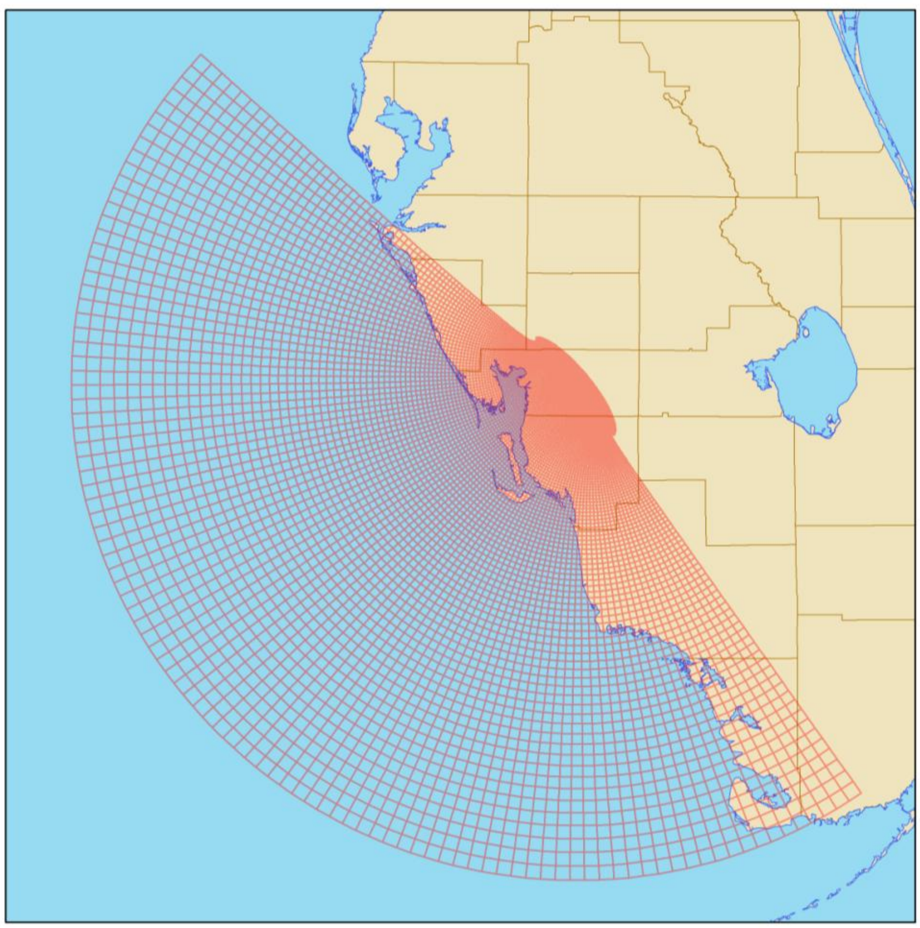
b (2). The Grid for the DeSoto County SLOSH Model

Figure II-1b illustrates the area covered by the grid for the Ft. Myers SLOSH model basin. To determine the surge values the SLOSH model uses a telescoping elliptical grid as its unit of analysis with 105 arc lengths (1 ≤ I ≥ 105). and 99 radials (1 ≤ J ≥ 99). Use of the grid configuration allows for individual calculations per grid square which is beneficial in two ways: (1) provides increased resolution of the storm surge at the coastline and inside the harbors, bays and rivers, while decreasing the resolution in the deep water where detail is not as important; and (2) allows economy in computation.

The grid size for the Fort Myers SLOSH basin varies from approximately 0.002 square miles (1.8 acres) closest to the pole (I = 1) to the grids on the outer edges (Gulf of Mexico) where each grid is approximately 15.5 square miles (9,920 acres).

Figure II-1b illustrates the area covered by the grid for the DeSoto County SLOSH Model.

Figure II-1b
DeSoto SLOSH Grid



c. Storm Scenario Determinations

As indicated, the SLOSH model is the basis for the "hazard analysis" portion of coastal hurricane evacuation plans. Thousands of hypothetical hurricanes are simulated with various Saffir-Simpson Wind categories, forward speeds, landfall directions, and landfall locations. An envelope of high water containing the maximum value a grid cell attains is generated at the end of each model run. These envelopes are combined by the NHC into various composites which depict the possible flooding. One useful composite is the MEOW (Maximum Envelopes of Water) which incorporates all the envelopes for a particular category, speed, and landfall direction.

Once surge heights have been determined for the appropriate grids, the maximum surge heights are plotted by storm track and tropical storm/hurricane category. These plots of maximum surge heights for a given storm category and track are referred to as Maximum Envelopes of Water (MEOWs). The MEOWs or Reference Hurricanes can be used in evacuation decision-making when and if sufficient forecast information is available to project storm track or type of storm (different landfalling, paralleling, or exiting storms).

The MEOWs provide information to the emergency managers in evacuation decision making. However, in order to determine a scenario which may confront the county in a hurricane threat 24-48 hours before a storm is expected, a further compositing of the MEOWs into Maximums of the Maximums (MOMs) is usually required.

The MOM (maximum of the MEOW's) combines all the MEOWs of a particular category. The MOMs represent the maximum surge expected to occur at any given location, regardless of the specific storm track/direction of the hurricane. The only variable is the intensity of the hurricane represented by category strength (Category 1-5).

The MOM surge heights, which are furnished by the National Hurricane Center, have 2 values, mean tide and high tide. Mean tide has 0" tide correction. High tide has a 1' tide correction added to it. All elevations are now referenced to the NAVD88 datum. The surge heights were provided within the SLOSH grid system as illustrated on **Figures II-2a** and **II-2b**. The range of maximum surge heights (high and low) for each county in the region, based upon the model, is provided for each category of storm on **Table II-4**. It should be noted again that these surge heights represent the maximum surge height recorded in the county including inland and back bay areas where the surge can be magnified dependent upon storm parameters.

Figure II-2a: Lake Okeechobee SLOSH Grid with Surge Values

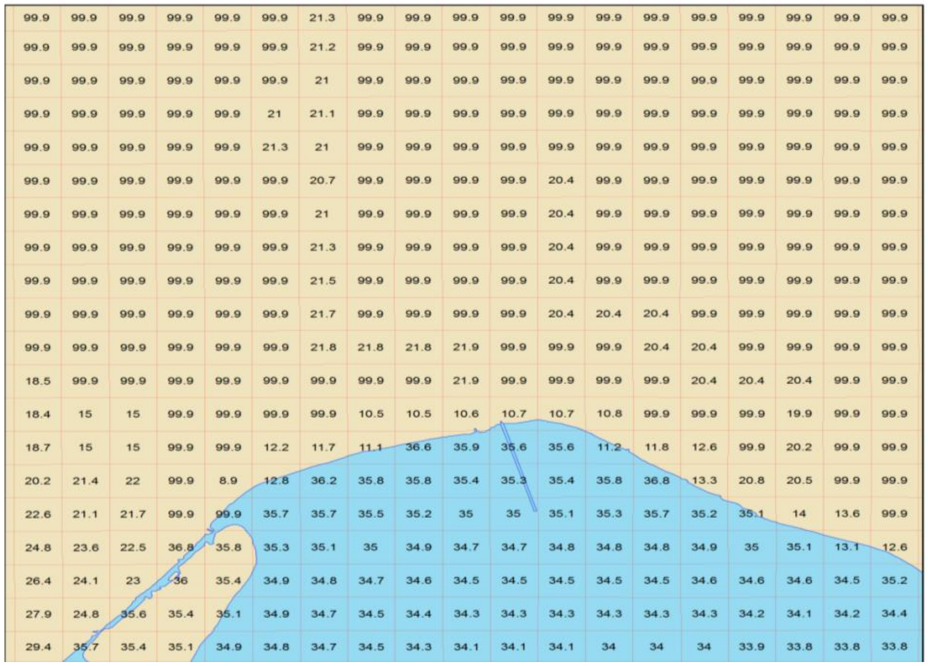


Figure II-2b: DeSoto County SLOSH Grid with Surge Values

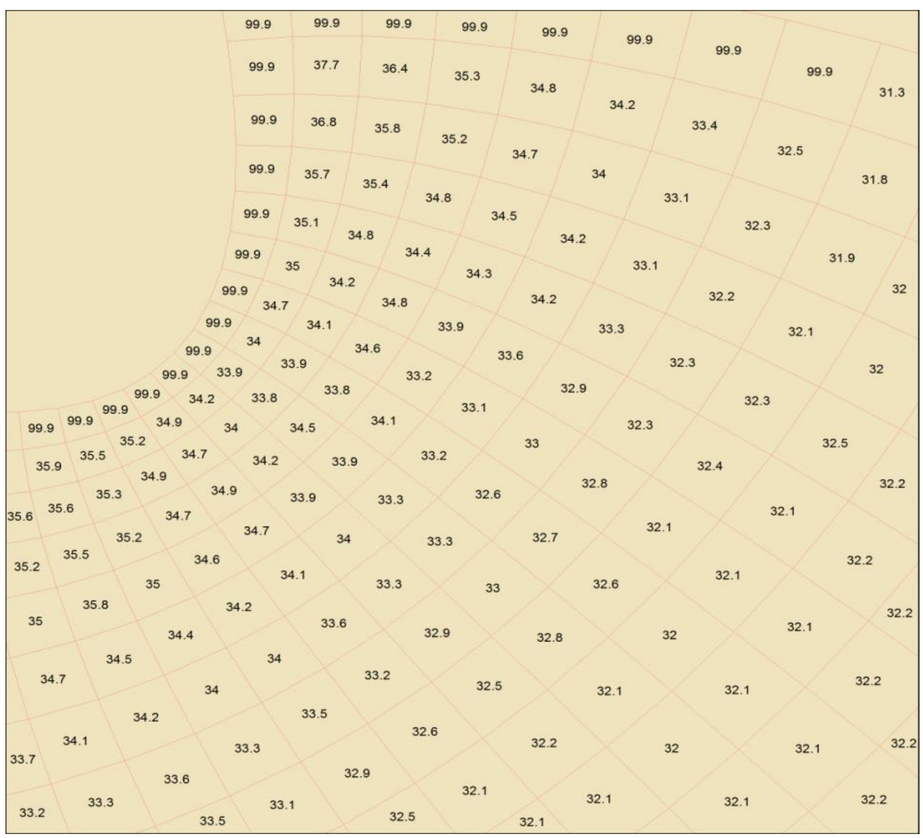


Table II-4
Potential Tide Height(s)* by County
(In feet above NAVD88)

**Storm Strength	DeSoto	Highlands	Okeechobee
Category 1	5.1 – 7.0	N/A	18.9 – 22.8
Category 2	14.1 – 16.3	N/A	19.0 – 26.2
Category 3	21.3 – 24.6	28.5 – 31.6	19.5 – 29.7
Category 4	26.6 – 31.7	24.2 – 37.1	20.3 – 34.4
Category 5	30.4 – 37.7	27.6 – 37.7	16.0 – 35.5

** Surge heights represent the maximum values from selected SLOSH MEOWs*
***Based upon the category of storm on the Saffir-Simpson Hurricane Scale*

d. Determining Storm Surge Height and Flooding Depth

SLOSH and SLOSH related products reference storm surge heights relative to the model vertical datum, in this case NAVD88. In order to determine the inundation depth of surge flooding at a particular location the ground elevation (relative to NAVD88) at that location must be subtracted from the potential surge height. It is important to note that one must use a consistent vertical datum when post-processing SLOSH storm surge values

Surge elevation, or water height, is the output of the SLOSH model. At each SLOSH grid point, the water height is the maximum value that was computed at that point. With the new SLOSH Model, water height is calculated relative to NAV88.

Within the SLOSH model, an average elevation is assumed within each grid square. Height of water above terrain was not calculated using the SLOSH average grid elevation because terrain height may vary significantly within a SLOSH grid square. For example, the altitude of a 1-mile grid square may be assigned a value of 1.8 meters (6 feet), but this value represents an average of land heights that may include values ranging from 0.9 to 2.7 meters (3 to 9 feet). In this case, a surge value of 2.5 meters (8 feet) in this square would imply a 0.7 meters (2 feet) average depth of water over the grid's terrain. However, in reality within the grid area portion of the grid would be "dry" and other parts could experience as much as 1.5 meters (5 feet) of inundation. Therefore, in order to determine the storm tide limits, the depth of surge flooding above terrain at a specific site in the grid square is the result of subtracting the terrain height determined by remote-sensing from the model-generated storm surge height in that grid square.[3]

As part of the Statewide Regional Evacuation Study, all coastal areas as well as the area surrounding Lake Okeechobee was mapped using laser terrain mapping (Light Imaging Detection and Ranging - LIDAR) providing the most comprehensive, accurate and precise topographic data for this analysis. For the Central Florida Region, keep in mind that the LIDAR used in DeSoto County was collected in 2008. The water inundation calculations are based off of the data provided to the Southwest Florida Region and then mathematically interpolated based on known geography as you move upstream along the Peace River. As a general rule, the vertical accuracy of the laser mapping is within a 15 centimeter tolerance. However, it should be noted that the accuracy of these elevations is limited to the precision and tolerance in which the horizontal accuracy for any given point is recorded. Other factors such as artifact removal algorithms (that remove buildings and trees) can affect the recorded elevation in a particular location. For the purposes of this study, the horizontal accuracy can not be assumed to be greater than that of a standard USGS 7 minute quadrangle map, or a scale of 1:24,000**.**

The Storm Tide Limits based on the SLOSH MOMs have been determined using the methodology described above, mapped and published in the ***Storm Tide Atlas***.

e. Variations to Consider

Variations between modeled versus actual measured storm surge elevations are typical of current technology in coastal storm surge modeling. In interpreting the data, emergency planners should recognize the uncertainties characteristic of mathematical models and severe weather systems such as hurricanes. The storm surge elevations developed for this study and presented in the Storm Tide Atlas should be used as guideline information for planning purposes.

(1). Storm Surge and Wave Height

Regarding interpretation of the data, it is important to understand that the configuration and depth (bathymetry) of the Gulf bottom will have a bearing on surge and wave heights. A narrow shelf, or one that drops steeply from the shoreline and subsequently produces deep water in close proximity to the shoreline, tends to produce a lower surge but a higher and more powerful wave.

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3 Note: This represents the regional post-processing procedure. When users view SLOSH output within the SLOSH Display Program, the system still uses average grid cell height when subtracting land.

That said; wave height is of little concern for the DeSoto County area as it is protected by the barrier islands and Charlotte Harbor. Storm surge is possible but would require a hurricane approach in a very narrow route to generate a surge that will back up the Peace River Basin. During Hurricane Charley (2004) the storm track basically paralleled the Peace River. There was minimal storm surge associated with the passing of the storm but there were great concerns when the large amounts of rain water moved southward creating freshwater flooding issues.

Due to the artificially controlled shallow depth and the gentle slope of the bottom of Lake Okeechobee, combined with the surrounding Herbert Hoover Dike, there is little chance for overtopping. There is concern, however, of a breach in the dike which would cause a freshwater flooding event **NOT** as a result of SLOSH. Flood waters moving to the south may be prevented from entering Lake Okeechobee in order to artificially control of the depth of the lake. This action could easily create a freshwater flooding situation many miles to the north along the Kissimmee River Basin.

(2). Forward Speed

Under actual storm conditions, it may be expected that a hurricane moving at a slower speed could have higher coastal storm surges than those depicted from model results. This could be a major concern in the Lake Okeechobee area. At the same time, a fast-moving hurricane would have less time to move storm surge water up river courses to more inland areas. For example, a very fast moving hurricane (such as Hurricane Charley in 2004) created little immediate storm surge in the DeSoto County area. This was followed 18 – 24 hours later by freshwater flooding as the storm water moved to the south along the Peace River.

(3). Radius of Maximum Winds

As indicated previously, the size of the storm or radius of maximum winds (RMW) can have a significant impact on storm surge especially in the Lake Okeechobee basin. Storm surge will impact the Peace River basin to a lesser degree. All of the hypothetical storms were run at two different sizes, 25 mile radius of maximum winds and 30 mile radius of maximum winds.

(4). Astronomical Tides

Surge heights were provided for both mean tide and high tide. Both tide levels are referenced to the North American Vertical Datum of 1988. The storm tide limits reflect high tide in the region.

f. Storm Tide Atlas

The surge inundation limits (MOM surge heights minus the ground elevations) are provided as GIS shape files and graphically displayed on maps in the *Hurricane Storm Tide Atlas for the Central Florida Region*. The *Atlas* was prepared by Tampa Bay Regional Planning Council with input and coordination with the Central Florida Planning Council as part of the contract with the State of Florida, Division of Emergency Management, and is to be considered to be a part of this study effort. The maps prepared for the *Atlas* consist of base maps (1:24000) including topographic, hydrographic and highway files (updated using 2008 county and state highway data). Detailed shoreline and storm tide limits for each category of storm were determined using the region's geographic information system (GIS). **Figures II-3a** & **II-3b** present a compilation of the *Storm Tide Atlas* for the Okeechobee and DeSoto Counties respectively.

g. Factors Influencing Model Accuracy

The purpose of the maps contained in this Atlas is to reflect a "worst-probable" scenario of the hurricane storm surge inundation and to provide a basis for the hurricane evacuation zones and study analyses. While the storm tide delineations include the addition of an astronomical mean high tide and tidal anomaly (Total +2 ft. Adjustment); it should be noted that the data reflects only stillwater saltwater flooding.

Local processes, such as <u>waves</u>, <u>rainfall</u> and <u>flooding from overflowing rivers</u>, are usually included in observations of storm surge height, but are not surge and are not calculated by the SLOSH model. It is incumbent upon local emergency management officials and planners to estimate the degree and extent of freshwater flooding, as well as to determine the magnitude of the waves that will accompany the surge.

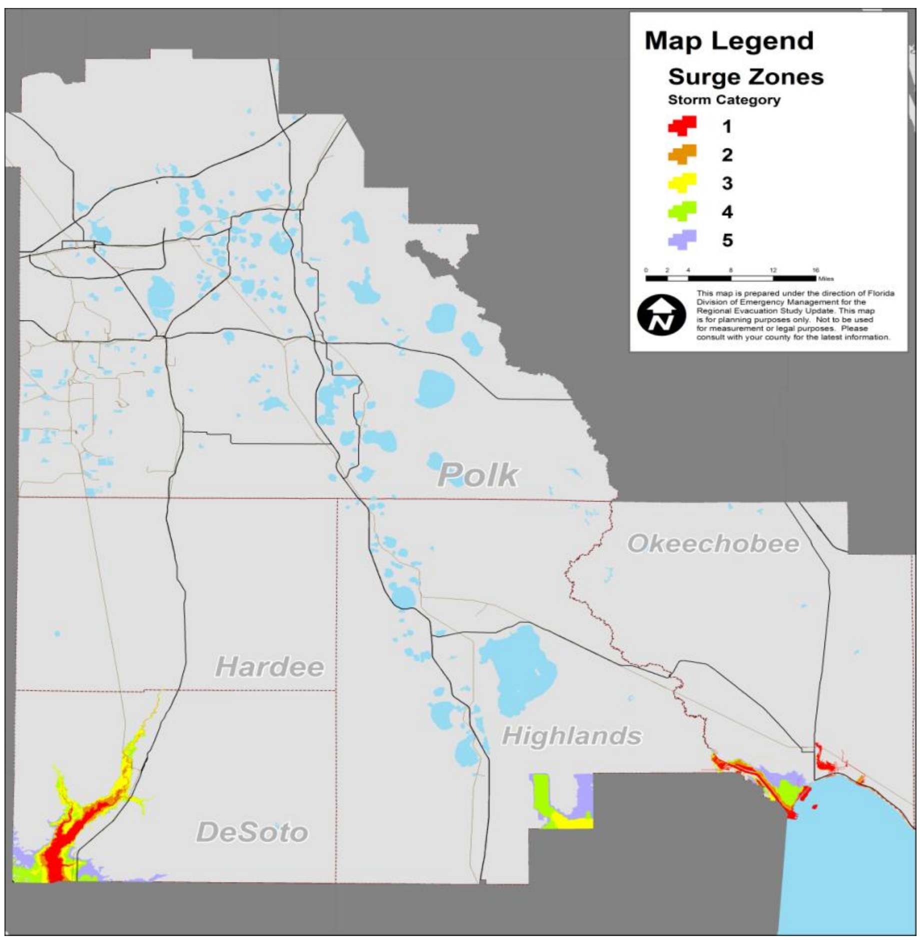
Therefore, it is important to recognize that even if the model supplied accurate data on storm positions, intensities and sizes, the computed surge may contain errors of ± 20% of observed water levels. These errors primarily stem from three factors:

- maps that are outdated which may result in inaccuracies of topography or bathymetry;
- anomalous water heights which can affect the local sea level; and
- local processes, such as waves, astronomical tides, rainfall and flooding from overflowing rivers, which are not calculated by the SLOSH model.

NOTE: The calculation of tides only applies to the DeSoto County models. These tides could possibly affect the normal outflow of the Peace River causing a backup of water that when combined with the storm surge could lead to more flooding in the inland areas than at the mouth of the river.

NOTE: While there are "tides" in Lake Okeechobee they are of such an insignificant variation that they are not used in these calculations.

Figure II-3
Central Florida Region Storm Tide Map



4. Hurricane Wind Analysis

As discussed previously, hurricane winds are a devastating element of the hurricane hazard. Based on the Saffir-Simpson Hurricane Scale (see **Table II-2**), hurricane-force winds range from sustained winds of 74 mph to more than 155 mph.

The intensity of a landfalling hurricane is expressed in terms of categories that relate wind speeds and potential damage. According to the Saffir-Simpson Hurricane Scale, a Category 1 hurricane has lighter winds compared to storms in higher categories. **A Category 4 hurricane** would have winds between 131 and 155 mph and, on the average, would usually be expected to **cause 100 times the damage of the Category 1 storm.** Depending on circumstances, less intense storms may still be strong enough to produce damage, particularly in areas that have not prepared in advance.

Tropical storm-force winds are strong enough to be dangerous. For this reason, emergency managers plan to have their evacuations complete and their personnel sheltered **before the onset of tropical storm-force winds**, not hurricane-force winds.

Hurricane-force winds can easily destroy poorly constructed buildings and mobile homes. Debris such as signs, roofing material, and small items left outside become flying missiles in hurricanes. Extensive damage to trees, towers, water and underground utility lines (from uprooted trees), and fallen poles cause considerable disruption.

High-rise buildings are also vulnerable to hurricane-force winds, particularly at the higher levels, since wind speed tends to increase with height. Recent research suggests you should stay below the tenth floor, but still above any floors at risk for flooding. It is not uncommon for high-rise buildings to suffer a great deal of damage due to windows being blown out. Consequently, the areas around these buildings can be very dangerous.

The strongest winds usually occur in the right side of the eye wall of the hurricane. Wind speed usually decreases significantly within 12 hours after landfall. Nonetheless, **winds can stay above hurricane strength well inland.** Hurricane Hugo (1989), for example, battered Charlotte, North Carolina (which is 175 miles inland) with gusts to nearly 100 mph. Tropical Storm Fay turned northeastward on August 19, 2008, making landfall early that day on the southwestern coast of the Florida peninsula at Cape Romano with maximum winds of 60 mph. Even after moving inland, Fay strengthened, exhibiting what resembled a classical eye in radar and satellite imagery, and it reached its peak intensity of about 65 mph as it passed over the western shores of Lake Okeechobee. During August 20-23 however, Fay continued interaction with the landmass of northern Florida causing the cyclone to weaken slightly. Fay's maximum winds remained 50-60 mph during most of that period.

Several key factors should be remembered in regard to wind speeds. First, there is evidence that gusts rather than sustained winds cause the majority of damage associated with severe weather. The methodology described above does not specifically address wind gusts, and does not address building codes/standards or construction practices.

a. Wind Risk Assessment: Inland Wind Model

The **Inland High Wind Model** can be used by emergency managers to estimate how far inland strong winds extend. The inland wind estimates can only be made shortly before landfall when the windfield forecast errors are relatively small. This information is most useful in the decision-making process to decide which people might be most vulnerable to high winds at inland locations.

Onshore winds at the coast will decrease as the storm system moves across the land as a result of friction characteristics. The National Hurricane Center has developed adjustment ratios to account for this effect. In addition, as the wind path continues around the storm, further reduction in wind speed occurs until equilibrium is reached or the wind path again crosses the coast to an open water area. The onshore and offshore winds are assumed to reach equilibrium after being over any underlying friction surface a distance of 10 nautical miles.

There are four friction categories defined as follows:

1. Open water;

2. Awash - normally dry ground with tree or shrub growth, hills or dunes (non-inundated from storm surge);

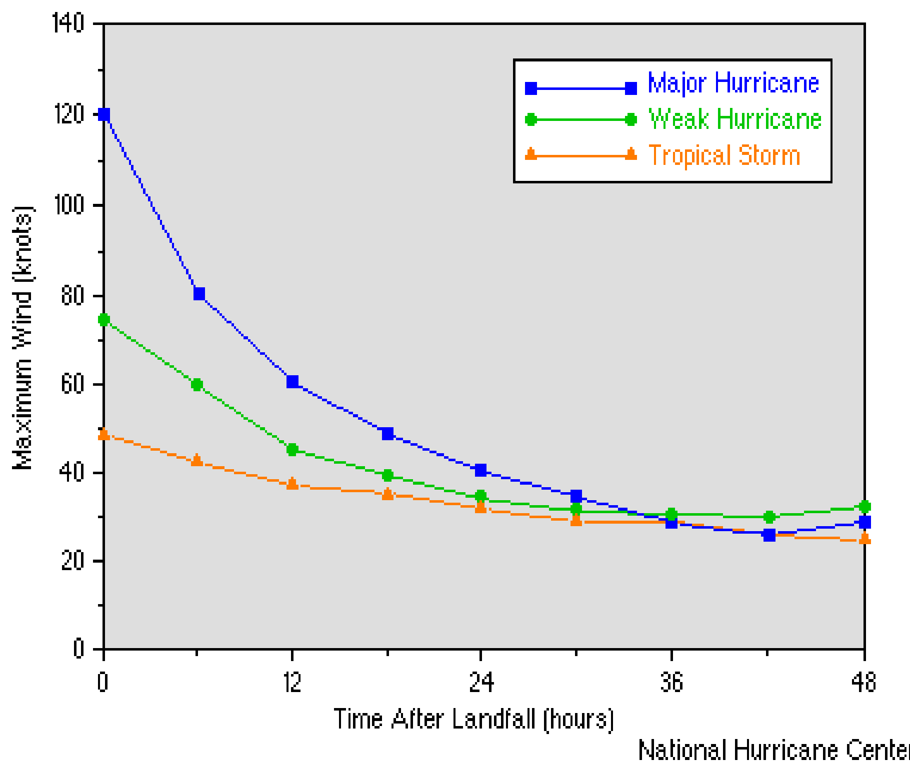
3. Land - relatively flat non-inundated terrain or buildings;

4. Rough terrain - major urban areas, dense forests, etc.

The graph below shows how wind speed rapidly decreases once a tropical cyclone reaches land. Part of the reason for this is that the roughness of the terrain increases friction, slowing the air. Another reason is that, once the storm is over land, it is usually cut off from the heat and moisture sources that sustain it. However, wind gusts (as opposed to the sustained winds shown in the graph) may actually increase because the greater turbulence over land mixes faster air to the surface in short bursts.

The graph shows that the sustained winds in a hurricane will decrease at a relatively constant rate (approximately half the wind speed in the first 24 hours). Therefore, the faster the forward speed of a landfalling hurricane, the further the inland penetration of hurricane force winds.

Figure II-4
Inland Wind Decay



(Source: http://www.nhc.noaa.gov/HAW2/english/wind/wind_decay.shtml)

This wind model was taken from the Tampa Bay Evacuation Study since the track of this hurricane would have placed our counties in the dangerous right front quadrant of the storm. The inland wind model was developed by Mark DeMaria (NOAA/NWS/TPC) and John Kaplan (NOAA/AOML/HRD).[4] The model applies a simple two parameter decay equation to the hurricane wind field at landfall to estimate the maximum sustained surface wind as a storm moves inland. This model can be used for operational forecasting of the maximum winds

[4] Kaplan, J., DeMaria, M., 1995: **A Simple Empirical Model for Predicting the Decay of Tropical Cyclone Winds After Landfall.** J. App. Meteor., 34, No.11, 2499-2512.

of landfalling tropical cyclones. It can also be used to estimate the maximum inland penetration of hurricane force winds (or any wind threshold) for a given initial storm intensity and forward storm motion.

A model wind field, which illustrates the combined wind profiles from hurricanes striking the coast at different locations, has been developed for each category of hurricane and forward speed of the storm system. It demonstrates the potential wind speeds at different locations based upon a "*maximum of wind*" analysis.[5] **Figures II-5** and **II-6** illustrate the Maximum Inland Extent of Winds for Hurricanes Approaching the Gulf and East Coasts, respectively, from any direction. Looking at the results by hurricane category, the increase in winds is highlighted. By reviewing the results across the table, the dramatic impact of the forward speed on the wind is apparent.

(*Map source: www.nhc.noaa.gov/aboutmeow.shtml*)

[5] One storm alone will not produce the following inland winds. This is the **combination** of multiple storm tracks and is for planning purposes.

Figure II-5
Maximum Inland Extent of Winds for Hurricanes Approaching the Gulf Coast

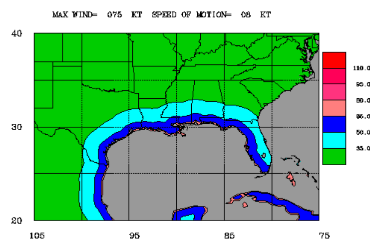
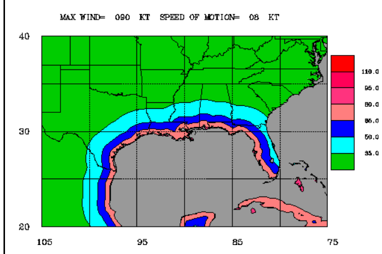
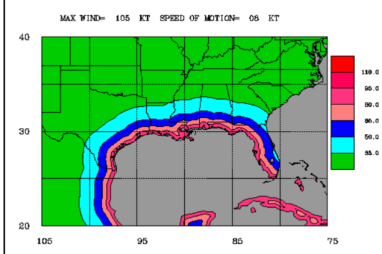
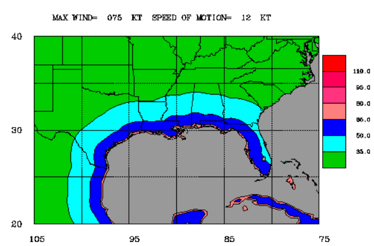
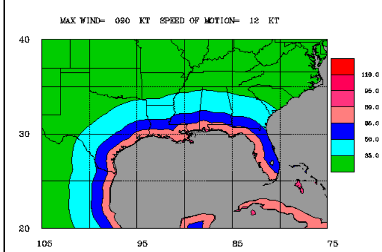
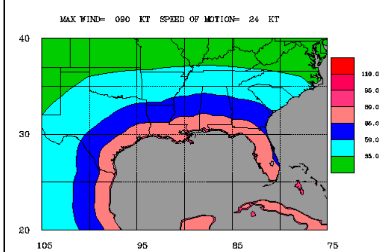
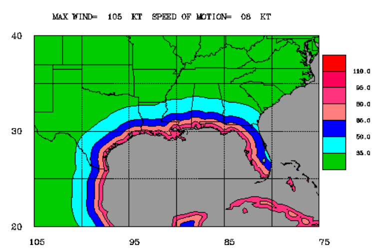
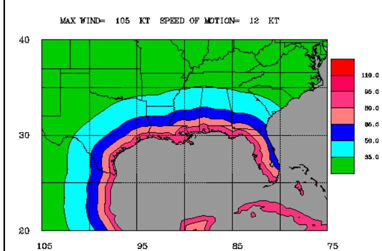
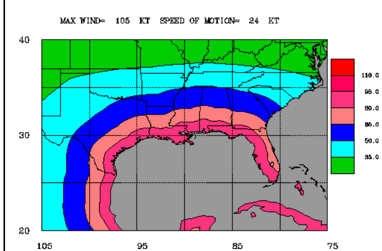
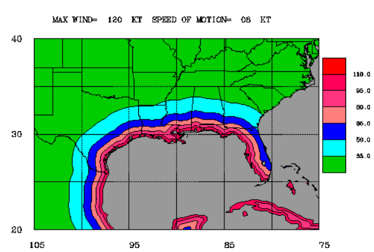
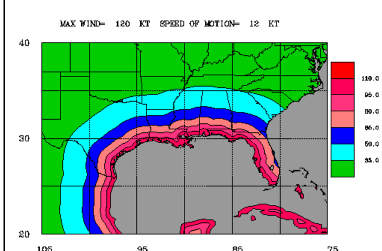
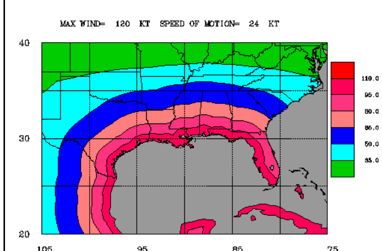
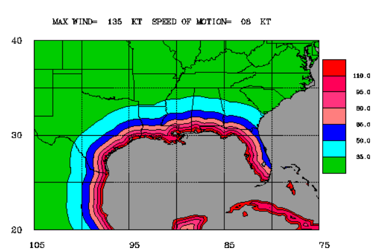
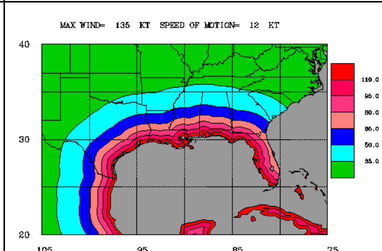
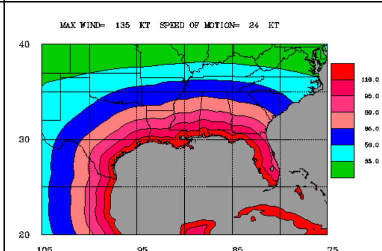
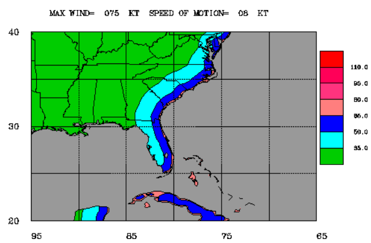
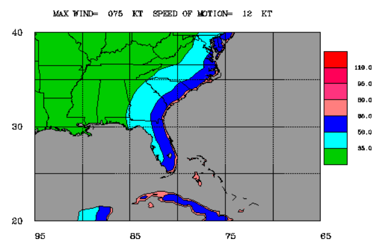
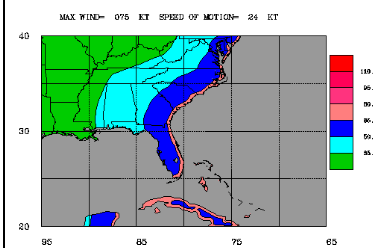
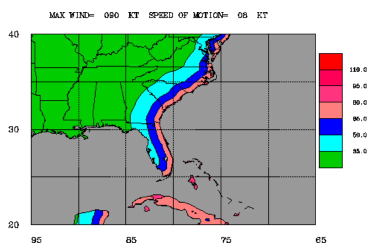
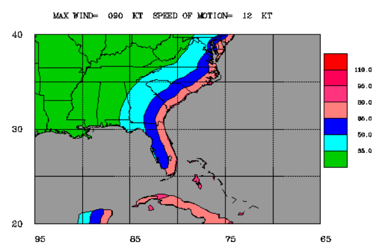
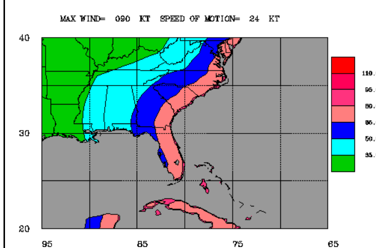
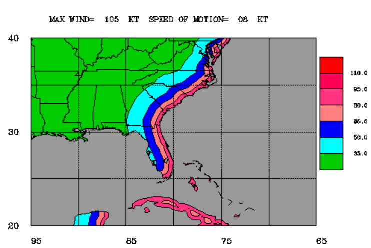
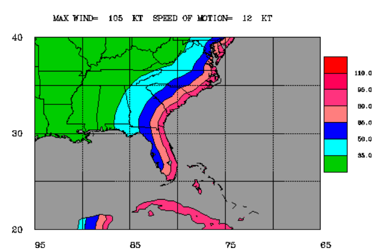
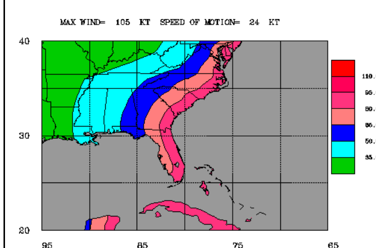
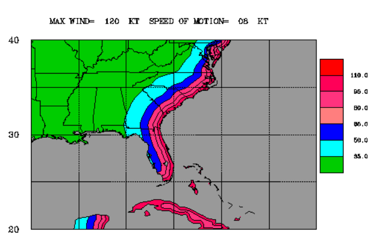
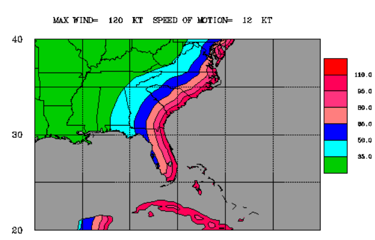
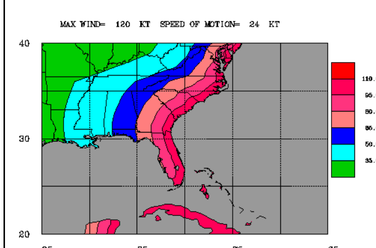
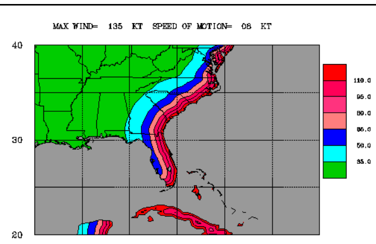
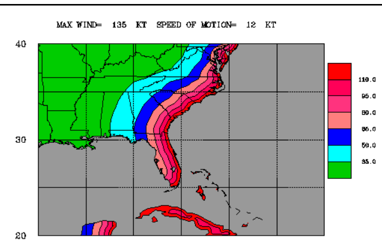
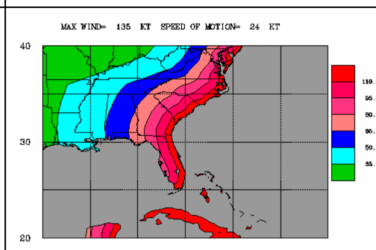
Cat	Forward Speed – 8 kts	Forward Speed – 12 kts	Forward Speed – 24 kts
1			
2			
3			
4			
5			

Figure II-6
Maximum Inland Extent of Winds for Hurricanes Approaching the East Coast

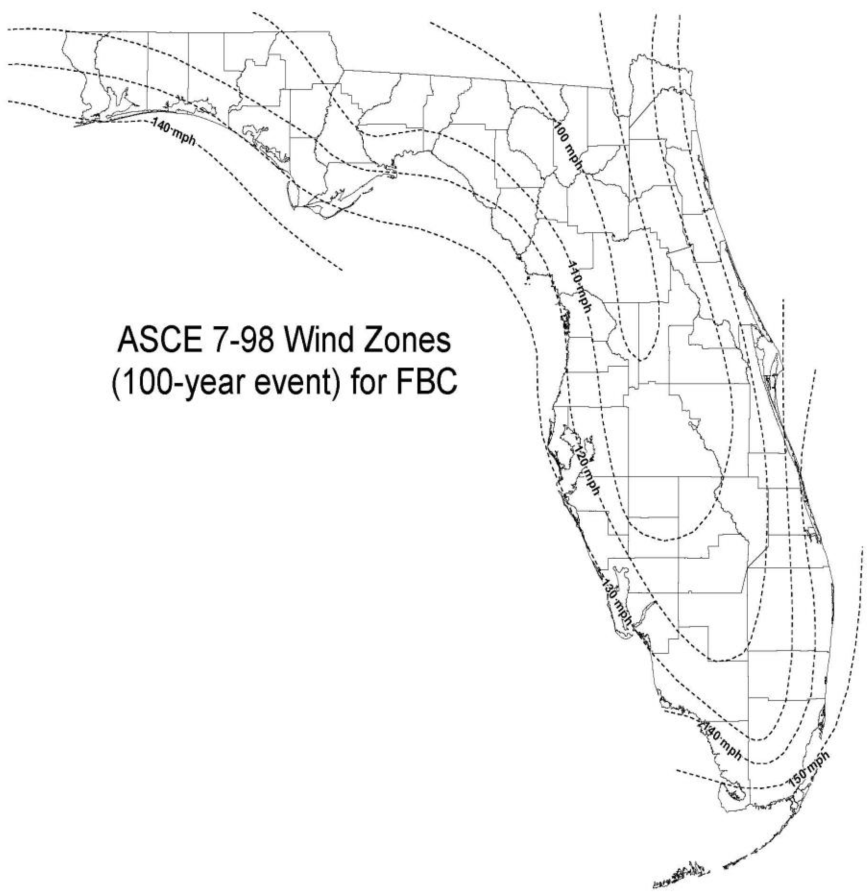
Cat	Forward Speed – 8 kts	Forward Speed – 12 kts	Forward Speed – 24 kts
1			
2			
3			
4			
5			

b. Wind Risk Assessment: Florida Building Code

In March of 2002, a Statewide Building Code was fully adopted and implemented in Florida. A critical element of that new building code was the adoption of stricter building standards based upon wind hazard associated with hurricanes. To establish variable building standards for locales throughout Florida, the American Society of Civil Engineer's Standard 7 for the 1998 (ASCE 7-98) was adopted. The ASCE 7-98 provides wind risk assessments for areas throughout Florida along with associated building standards.

Figure II-7 presents the ASCE 7-98 Wind Contour of the 100-year 3-minute wind.

Figure II-7
ASCE 7-98 Wind Zones

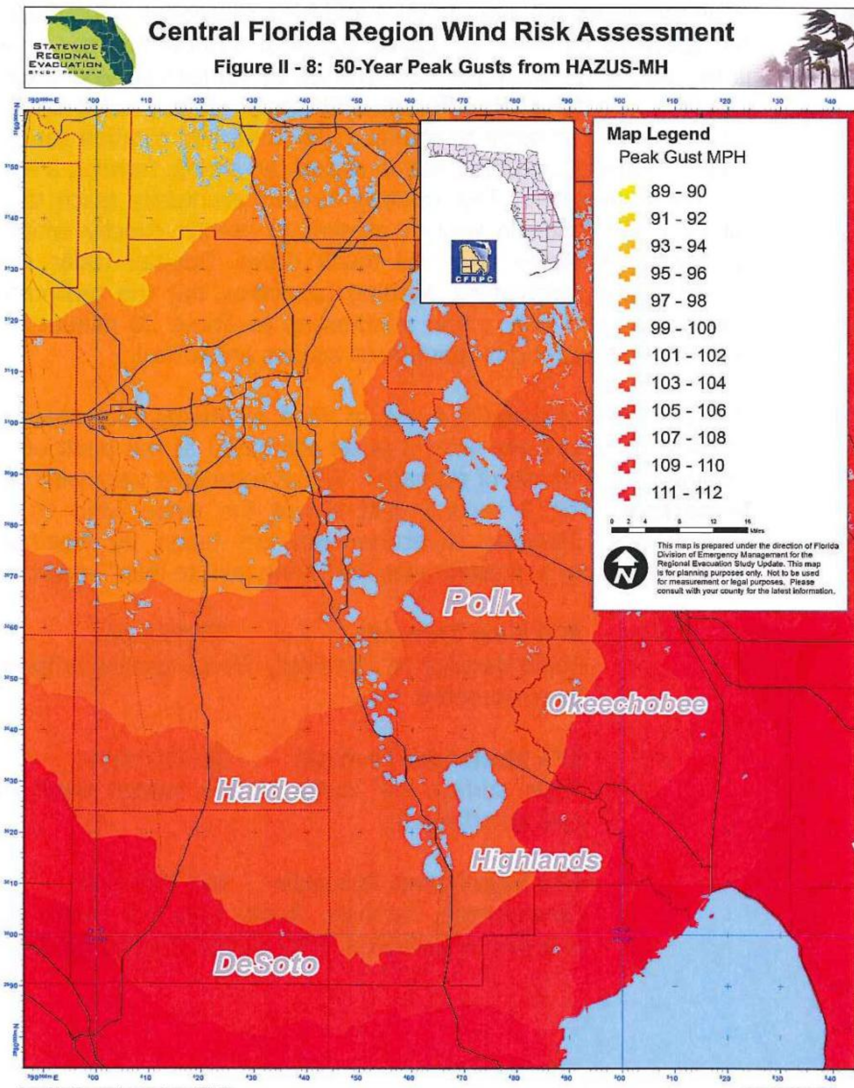


Source: FBC: Florida Building Code 2001, Chapters 2, 16, 17, & 22 ASCE 7-98: "Minimum Design Loads for Buildings and Other Structures", by American Society of Civil Engineers.

c. Wind Risk Assessment: (Hazards US Multi-Hazard - HAZUS-MH)

HAZUS-MH also includes a vulnerability analysis incorporating other factors such as housing stock, vegetation and friction coefficients based on land cover. **Figure II-8** provides a level 1 wind risk assessment using this tool.

Figure II-8
Hurricane Wind Risk Assessment (HAZUS-MH)



5. Tornadoes

In general, tornadoes associated with hurricanes are less intense than those that occur in the Great Plains (see the **Enhanced Fujita-Pearson Intensity Scale** below). Nonetheless, the effects of tornadoes, added to storm surge and inland flooding and the larger area of hurricane-force winds, can produce substantial damage.

Sixty–nine percent of all tornadoes are weak tornadoes, EF0-EF2 sizes. Twenty-nine percent of all tornadoes are strong and can last 20 minutes or longer. Two percent of all tornadoes fall into the EF-4 and EF-5 categories. The most powerful tornadoes are spawned by what are called supercell thunderstorms. These are storms that, under the right conditions, are affected by horizontal wind shears (winds moving in different directions at different altitudes.) These wind shears cause horizontal columns of air to begin to rotate. This horizontal rotation can be tilted vertically by violent updrafts, and the rotation radius can shrink, forming a vertical column of very quickly swirling air. This rotating air can eventually reach the ground, forming a tornado. We have no way at present to predict exactly which storms will spawn tornadoes or where they will touch down. Doppler radar systems have greatly improved the forecaster's warning capability, but the technology usually provides lead times from only a few minutes up to about 30 minutes. Consequently, early warning systems and preparedness actions are critical.

The Enhanced F-scale is a set of wind estimates (not measurements) based on damage*.* It uses three-second gusts estimated at the point of damage based on a judgment of 8 levels of damage[6]. These estimates vary with height and exposure. **Important**: The 3 second gust is not the same wind as in standard surface observations. Standard measurements are taken by weather stations in open exposures, using a directly measured, "one minute mile" speed.

- **EF0 Gale Tornado** 65-85 mph
  Some damage to chimneys. Tree branches broken off. Shallow rooted trees uprooted.

- **EF1 Moderate Tornado** 86-110 mph
  Peels surface off roofs. Mobile homes overturned. Moving autos pushed off roads.

- **EF2 Significant Tornado** 111-135 mph
  Considerable damage. Roofs torn off frame houses. Large trees snapped or uprooted. Light-object missiles generated.

[6] listed at www.spc.noaa.gov/faq/tornado/efscale.html

- **EF3 Severe Tornado** 136-165 mph
  Severe damage. Roofs and some walls torn off well constructed homes. Trains overturned. Most trees in forests uprooted. Heavy cars lifted off ground.

- **EF4 Devastating Tornado** 166-200 mph
  Well-constructed houses leveled. Structures with weak foundations blown off some distance. Cars thrown and large missiles generated.

- **EF5 Devastating Tornado** Over 200 mph
  Strong frame houses lifted off foundations and disintegrated. Automobile-sized missiles fly through the air in excess of 100 mph. Trees debarked.

Table II-5
Enhanced Fujita-Pearson Tornado Intensity Scale

Damage f scale	Little Damage	Minor Damage	Roof Gone	Walls Collapse	Blown Down	Blown Away
	f0	f1	f2	f3	f4	f5

Windspeed F scale	F0	F1	F2	F3	F4	F5
m/s	17 m/s – 32	32 – 50	50 – 70	70 – 92	92 – 116	116 – 142
mph	40 mph – 73	73 – 113	113 – 158	158 – 207	207 – 261	261 – 319

To convert f scale into F scale, add the appropriate number

Weak Outbuilding	-3	f3	f4	f5	f5	f5	f5
Strong Outbuilding	-2	f2	f3	f4	f5	f5	f5
Weak Framehouse	-1	f1	f2	f3	f4	f5	f5
Strong Framehouse	0	F0	F1	F2	F3	F4	F5
Brick Structure	+1	-	f0	f1	f2	f3	f4
Concrete Building	+2	-	-	f0	f1	f2	f3

Fig. 2.4-1 The Fujita tornado scale (F scale) pegged to damage-causing windspeeds. The extent of damage expressed by the damage scale (f scale) varies with both windspeed and the strength of structures.

6. Hazardous Materials

Like Murphy's Law, sometimes one emergency event can trigger another. Facilities which generate or store quantities of potentially hazardous materials, propane storage facilities, natural gas pipeline terminals, fuel storage facilities and tank farms all pose an additional potential threat in a hurricane. Identifying the location of these facilities is important to (1) provide additional information to facility managers to secure their operation and protect the employees, facility and inventory before the storm and (2) to assist emergency responders in safe re-entry into areas after the storm has passed. It may also serve to identify where mitigation strategies should be implemented to reduce the risk to resident and the environment.

The Hazard Materials Information System (HMIS) database was accessed to identify the current Extremely Hazardous Substances (EHS) facilities – also known as Section 302 facilities – in the Central Florida Region. The geo-coded inventory of the Section 302 facilities is included in the **Critical Facility Inventory Data Base**. The Maps depicting the 302 facilities are included in the appendices. The data base inventory and vulnerability assessments are considered For Official Use Only (FOUO) and are not available to the public for security reasons. Evacuation for Hazardous Material incidents will be discussed later in the chapter.

7. Freshwater Flooding and the Inundation of Evacuation Routes

Inland Riverine and freshwater flooding often becomes a significant factor as a result of tropical storms and hurricanes. Typically, the rainfall associated with, and in advance of, a hurricane does not in itself necessitate the emergency evacuation of residents during the passage of a hurricane unlike storm surge. Following a storm however, the coastal flooding and rainfall – particularly from slow moving storms - necessitates an evacuation of flooded inland residents' days after as swollen rivers and streams breach their bank or levees.

As noted previously, *due to Tropical Storm Fay's (2008) very slow motion, storm-total rainfall amounts in some areas were staggering, including a few locations in east-central Florida that received more than two feet of rain. Fay's rain-induced floods caused significant damage and were directly responsible for numerous deaths in the Dominican Republic, Haiti and Florida.* (www.nhc.noaa.gov)

Inland flooding will be discussed later in the chapter as a separate hazard. In regards to hurricane evacuation; however, rainfall may cause the early inundation of roadways sought as evacuation routes by vehicles attempting to escape from areas vulnerable to the approaching storm surge. In addition, given Florida climatology and the normal summer weather, flooding may occur as a disassociated event prior to the hurricane, flooding evacuation routes and saturating the ground.

Those roadways known historically to be vulnerable from freshwater flooding have been identified by the county and municipal emergency management/law enforcement/ emergency response personnel. These routes, including those which were inundated or forced to close during recent flooding events, are presented on maps in the following Appendices.

Contingency plans including rerouting, sandbagging and pumping will be coordinated with local and state law enforcement and the State Department of Transportation. The impacts of road closures, rain and ambient conditions on evacuation times are addressed in the transportation analysis. An evacuation simulation of the closing of these major routes was modeled as part of the transportation analysis to determine the impact on clearance times.

Rainwater inundation of evacuation routes must be addressed in an evacuation plan. The planning strategy to address this problem is to plan for the passage of all vehicles over such roadways before substantial rainfall from the hurricane was expected to arrive. Hourly records of rainfall rates and accumulation for past hurricanes indicate that rates high enough to surpass drainage capabilities normally parallel in time the arrival of sustained tropical storm-force winds. Utilizing this as an assumption of the timing of freshwater roadway inundation, the pre-landfall hazards time quantification for sustained tropical storm-force winds will also compensate for early rainfall inundation of evacuation routes.

8. History of Hurricanes in the Central Florida Region

Hurricanes are a natural yet very dangerous phenomenon and one for which the Central Florida Region must always be prepared. Packing 74-200 mph winds and potential storm surge, hurricanes represent a serious threat to the safety of residents and visitors and economic health of this region.

Until recently Emergency Management and atmospheric scientists agreed that global weather patterns have moved back into a period of increased tropical storm activity and of increased frequency of major hurricanes, a category 3 or higher on the Saffir-Simpson Hurricane Scale (See **Table II-2**), particularly in the state of Florida. However, recent identification of an "El Nino" trend may change this thought. Typically in an El Nino period there are fewer storms but they may be more intense than in other weather patterns. An analysis of hurricane activity since the 1920's demonstrates that hurricane activity appears cyclical and that, after a period of relative inactivity since the early 1960's, the state of Florida is in a more active period.

Until the 1840's Florida hurricanes were only experienced in the cities and ports along the east coast, the northwest panhandle and the Keys. But the new settlements along the southwest coast soon began to confront devastating hurricanes. In 1848, the "small village" of Tampa was hit by a major hurricane causing the tide in the bay to rise fifteen feet above normal. The massive flood completely inundated Fort Brooke as well as the stores and homes along Tampa Bay. *"After the hurricane, Tampa was a scene of devastation. Magnificent old oaks were toppled by the hurricane's winds. At Fort Brooke the barracks, horse shed, and other structures were gone. The pine forest north of the garrison was filled with wreckage and debris. The hurricane's powerful surge had shifted sand all along the coast and reshaped many of the keys near Tampa Bay. Navigation routes were filled in and closed, making charts of the area produced before 1848 almost useless after the hurricane. In terms of intensity and destruction, the 1848 storm remains perhaps the greatest in Tampa's history."* (Barnes, 1999) Two weeks later, another storm made landfall along the west coast. Its effects were felt from Cape San Blas to Tampa Bay. Fort Brooke again experienced approximately 10 feet of storm surge.

During the period 1875-1997, 77 hurricanes struck the state of Florida. Historians identify a flurry of major hurricane activity in the late 20's, the 1930's and 1940's. In the 1920's, a time characterized by economic prosperity and growth in the resort areas of Florida, the Tampa Bay area was just beginning to feel the effects of "Florida fever" when it experienced its worst hurricane in over seventy years in October of 1921. The hurricane of 1921 produced a storm surge of 10.5 feet which was the highest recorded since the hurricanes of 1848. Locally, it created both Longboat Pass (which now separates the City of Bradenton Beach and Longboat Key) and Hurricane Pass in Dunedin. Passage Key, located between Egmont Key and Anna Maria Island, before the storm, was the home to a fishing village and fresh water lake. Following the storm and continuing today, Passage Key is a sand bar with little vegetation and a National Bird Sanctuary.

The 1928 Okeechobee Hurricane caused the banks of Lake Okeechobee to rise 15 feet and drown 1200 people. This hurricane of September 1928 remains Florida's "single greatest tragedy", with an official death toll of 2500 (Barnes, 1998 and Blake, 2007). It should be noted that the 1928 Lake Okeechobee storm was one of the main factors that led to the construction of the Herbert Hoover Dike that now surrounds the lake.

Hurricane Donna (1960) was the only <u>major</u> hurricane to make landfall in Florida in a over a decade. The brunt of the hurricane was felt in the Keys, Collier and Lee counties; however, gusts were recorded at 120 mph in Manatee County and at over 100 mph in Polk County.

Listed below are several significant hurricanes that had direct impact upon our region. While this listing is not all inclusive, it represents those storms that had the greatest impact.

a. Hurricane History Through the Year 2000.

Great Miami Hurricane 1926

The "Great Miami" Hurricane was first spotted as a tropical wave located 1,000 miles east of the Lesser Antilles on September 11th. The system moved quickly westward and intensified to hurricane strength as it moved to the north of Puerto Rico on the 15th. Winds were reported to be nearly 150 mph as the hurricane passed over the Turks Islands on the 16th and through the Bahamas on the 17th. Little in the way of meteorological information on the approaching hurricane was available to the Weather Bureau in Miami. As a result, hurricane warnings were not issued until midnight on September 18th, which gave the booming population of South Florida little notice of the impending disaster.

The Category 4 hurricane's eye moved directly over Miami Beach and downtown Miami during the morning hours of the 18th. This cyclone produced the highest sustained winds ever recorded in the United States at the time, and the barometric pressure fell to 27.61 inches as the eye passed over Miami. A storm surge of nearly 15 feet was reported in Coconut Grove. Many casualties resulted as people ventured outdoors during the half-hour lull in the storm as the eye passed overhead. Most residents, having not experienced a hurricane, believed that the storm had passed during the lull. They were suddenly trapped and exposed to the eastern half of the hurricane shortly thereafter. Every building in the downtown district of Miami was damaged or destroyed. The town of Moore Haven on the south side of Lake Okeechobee was completely flooded by lake surge from the hurricane. Hundreds of people in Moore Haven alone were killed by this surge, which left behind floodwaters in the town for weeks afterward.

The hurricane continued northwestward across the Gulf of Mexico and approached Pensacola on September 20th. The storm nearly stalled to the south of Pensacola later that day and buffeted the central Gulf Coast with 24 hours of heavy rainfall, hurricane force winds, and storm surge. The hurricane weakened as it moved inland over Louisiana later on the 21st. Nearly every pier, warehouse, and vessel on Pensacola Bay was destroyed.

The great hurricane of 1926 ended the economic boom in South Florida and would be a $90 billion disaster had it occurred in recent times. With a highly transient population across southeastern Florida during the 1920s, the death toll is uncertain since more than 800 people were missing in the aftermath of the cyclone. A Red Cross report lists 373 deaths and 6,381 injuries as a result of the hurricane.

San Felipe-Okeechobee Hurricane 1928

This classic Cape Verde hurricane was first detected over the tropical Atlantic on September 10, although it likely formed several days earlier. It moved westward through the Leeward Islands on the 12th. It then turned west-northwestward, scoring a direct hit on Puerto Rico on the 13th (the feast of San Felipe) as a Category 4 hurricane. The hurricane continued west-northwestward through the Bahamas and made landfall near Palm Beach, Florida on September 16. It turned north-northeastward over the Florida Peninsula on the 17th, a motion which brought the remains of the storm to eastern North Carolina on the 19th. It then turned northward and merged with a non-tropical low over the eastern Great Lakes on September 20.

No reliable wind readings are available from near the landfall area in Florida. However, Palm Beach reported a minimum pressure of 27.43 inches, making this the fourth strongest hurricane of record to hit the United States. In Puerto Rico, San Juan reported 144 mph sustained winds, while Guayama reported a pressure of 27.65 inches. Additionally, a ship just south of St. Croix, United States Virgin Islands (USVI) reported a pressure of 27.50 inches, while Guadeloupe in the Leeward Islands reported a pressure of 27.76 inches.

This hurricane caused heavy casualties and extensive destruction along its path from the Leeward Islands to Florida. The worst tragedy occurred at inland Lake Okeechobee in Florida, where the hurricane caused a lake surge of 6 to 9 ft that inundated the surrounding area. 1,836 people died in Florida, mainly due to the lake surge. An additional 312 people died in Puerto Rico, and 18 more were reported dead in the Bahamas. Damage to property was estimated at $50,000,000 in Puerto Rico and $25,000,000 in Florida.

Hurricane Donna 1960

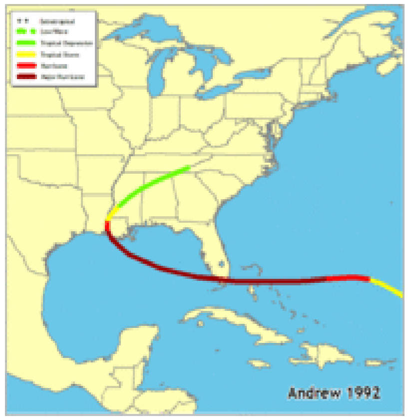
One of the all-time great hurricanes, Donna was first detected as a tropical wave moving off the African coast on August 29. It became a tropical storm over the tropical Atlantic the next day and a hurricane on September 1. Donna followed a general west-northwestward track for the following five days, passing over the northern Leeward Islands on the 4th and 5th as a Category 4 hurricane and then to the north of Puerto Rico later on the 5th. Donna turned westward on September 7 and passed through the southeastern Bahamas. A northwestward turn on the 9th brought the hurricane to the middle Florida Keys the next day at Category 4 intensity. Donna then curved northeastward, crossing the Florida Peninsula on September 11, followed by eastern North Carolina (Category 3) on the 12th, and the New England states (Category 3 on Long Island and Categories 1 to 2 elsewhere) on the 12th and 13th. The storm became extratropical over eastern Canada on the 13th.

Donna is the only hurricane of record to produce hurricane-force winds in Florida, the Mid-Atlantic states, and New England. Sombrero Key, Florida reported 128 mph sustained winds with gusts to 150 mph. In the Mid-Atlantic states, Elizabeth City, North Carolina reported 83 mph sustained winds, while Manteo, North Carolina reported a 120 mph gust. In New England, Block Island, Rhode Island reported 95 mph sustained winds with gusts to 130 mph.

Donna caused storm surges of up to 13 ft in the Florida Keys and 11 ft surges along the southwest coast of Florida. Four to eight foot surges were reported along portions of the North Carolina coast, with 5 to 10 foot surges along portions of the New England coast. Heavy rainfall of 10 to 15 inches occurred in Puerto Rico, 6 to 12 inches in Florida, and 4 to 8 inches elsewhere along the path of the hurricane.

The landfall pressure of 27.46 inches makes Donna the fifth strongest hurricane of record to hit the United States. It was responsible for 50 deaths in the United States. One hundred and fourteen deaths were reported from the Leeward Islands to the Bahamas, including 107 in Puerto Rico caused by flooding from the heavy rains. The hurricane caused $387 million in damage in the United States and $13 million elsewhere along its path.

Hurricane Andrew 1992



One of the most destructive United States hurricanes of record started modestly as a tropical wave that emerged from the west coast of Africa on August 14. The wave spawned a tropical depression on August 16, which became Tropical Storm Andrew the next day. Further development was slow, as the west-northwestward moving Andrew encountered an unfavorable upper-level trough. Indeed, the storm almost dissipated on August 20 due to vertical wind shear. By August 21, Andrew was midway between Bermuda and Puerto Rico and turning westward into a more favorable environment. Rapid strengthening occurred, with Andrew reaching hurricane strength on the 22nd and Category 4 status on the 23rd. After briefly weakening over the Bahamas, Andrew regained Category 4 status as it blasted its way across south Florida on August 24. The hurricane continued westward into the Gulf of Mexico where it gradually turned northward. This motion brought Andrew to the central Louisiana coast on August 26 as a Category 3 hurricane. Andrew then turned northeastward, eventually merging with a frontal system over the Mid-Atlantic states on August 28.

While Hurricane Andrew only struck our southernmost areas, it did however, affect the entire state in many ways. Only two other hurricanes in history, both category 5 storms - the Labor Day storm of 1935, Camille in 1969 - were stronger than Hurricane Andrew when they made landfall in the United States. It struck South Florida with a storm surge of over 16 feet and winds which gusted over 175 mph. The scale of the disaster was enormous and the massive recovery that ultimately ensued was of epic proportions. The damages were staggering - surpassing $50 billion – affecting emergency management policies and procedures, insurance industry and land development regulations (including the statewide building code).

Reports from private barometers helped establish that Andrew's central pressure at landfall in Homestead, Florida was 27.23 inches, which makes it the third most intense hurricane of record to hit the United States. Andrew's peak winds in south Florida were not directly measured due to destruction of the measuring instruments. An automated station at Fowey Rocks reported 142 mph sustained winds with gusts to 169 mph (measured 144 ft above the ground), and higher values may have occurred after the station was damaged and stopped reporting. The National Hurricane Center had a peak gust of

164 mph (measured 130 ft above the ground), while a 177 mph gust was measured at a private home. Additionally, Berwick, LA reported 96 mph sustained winds with gusts to 120 mph.

Andrew produced a 17 ft storm surge near the landfall point in Florida, while storm tides of at least 8 ft inundated portions of the Louisiana coast. Andrew also produced a killer tornado in southeastern Louisiana.

Andrew is responsible for 23 deaths in the United States and three more in the Bahamas. The hurricane caused $26.5 billion in damage in the United States, of which $1 billion occurred in Louisiana and the rest in south Florida. The vast majority of the damage in Florida was due to the winds. Damage in the Bahamas was estimated at $250 million.

b. The 2004 Hurricane Season

In 2004, the state of Florida was hit by an unprecedented four (4) hurricanes: Charley, Frances, Ivan, and Jeanne.

Hurricane Charley - August 9 – 14, 2004

Charley originated from a tropical wave, developing into a tropical depression on August 9 about 115 miles south-southeast of Barbados. The depression strengthened within a low-shear environment to a tropical storm early the next day in the eastern Caribbean, and became a hurricane on the 11th near Jamaica. Charley's center passed about 40 miles southwest of the southwest coast of Jamaica, and then passed about 15 miles northeast of Grand Cayman as the hurricane reached Category 2 strength on the 12th. Charley turned to the north-northwest and continued to strengthen, making landfall in western Cuba as a category 3 hurricane with 120 M.P.H. maximum winds. Charley weakened just after its passage over western Cuba; its maximum winds decreased to about 110 M.P.H. by the time the center reached the Dry Tortugas around 8 am on the 13th.

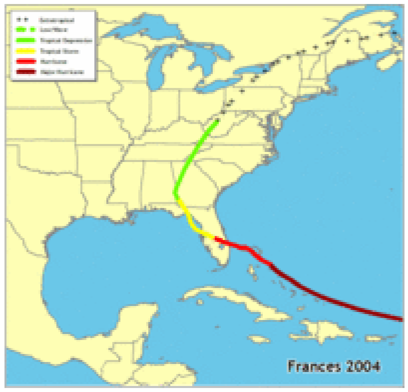
Charley then came under the influence of an unseasonably strong mid-tropospheric trough that had dropped from the east-central United States into the eastern Gulf of Mexico. The hurricane turned north-northeastward and accelerated toward the southwest coast of

Florida as it began to intensify rapidly; dropsonde measurements indicate that Charley's central pressure fell from 964 mb to 941 mb in 4.5 hours. By 10 am, the maximum winds had increased to near 125 M.P.H., and three hours later had increased to 145 M.P.H. - category 4 strength. Charley made landfall with maximum winds near 150 M.P.H. on the southwest coast of Florida just north of Captiva Island around 3:45 pm. An hour later, Charley's eye passed over Punta Gorda. The hurricane then crossed central Florida, passing near Arcadia, Wauchula, Bartow and Lakeland. It then continued to the northeast and passed over Kissimmee and Orlando. Charley was still of hurricane intensity around midnight when its center cleared the northeast coast of Florida near Daytona Beach. After moving into the Atlantic, Charley came ashore again near Cape Romain, South Carolina near midday on the 14th as a category 1 hurricane. The center then moved just offshore before making a final landfall at North Myrtle Beach. Charley soon weakened to a tropical storm over southeastern North Carolina and became extratropical on the 15th as it moved back over water near Virginia Beach.

Charley was the strongest hurricane to hit the United States since Andrew in 1992 and, although small in size, caused catastrophic wind damage in Charlotte, DeSoto, Hardee counties and lesser damage in Polk County, Florida. Serious damage occurred well inland over the Florida peninsula. The Central Florida Region, which was just to the right of centerline for the 24 hour forecast track, ordered evacuations in Polk and Hardee.

Although ferocious, Charley was a very small hurricane at its Florida landfall, with its maximum winds and storm surge located only about 6-7 miles from the center. This helped minimize the extent and amplitude of the storm surge, which likely did not exceed 7 feet. However, the hurricane's violent winds devastated Punta Gorda and neighboring Port Charlotte. Rainfall amounts were generally modest, less than 8 inches. Charley also produced 16 tornadoes in Florida, North Carolina and Virginia. The total U. S. damage is estimated to be near $15 billion, making Charley the second costliest hurricane in U.S. history. Casualties were remarkably low, given the strength of the hurricane and the destruction that resulted. Charley was directly responsible for ten deaths in the United States. There were also four deaths in Cuba and one in Jamaica.

Hurricane Frances - August 25 – Sept. 8, 2004



Frances developed from a tropical wave, becoming a tropical depression on August 25 several hundred miles west-southwest of the southern Cape Verde Islands, reaching tropical storm status later that day, and a hurricane the following day. Frances moved generally west-northwestward for the next several days, passing north of the Leeward Islands on the 31st and just north of the Turks and Caicos Islands on the 2nd. During this time, Frances' peak winds reached 145 M.P.H. (category 4) on two occasions while the hurricane underwent a series of concentric eyewall cycles. Westerly wind shear then caused Frances to weaken to a category 2 hurricane by the time it passed over the northwestern Bahamas on the 4th. Frances made landfall near Stuart, Florida just after midnight on the 5th with 105 M.P.H. (category 2) maximum winds. Frances gradually weakened as it moved slowly across the Florida Peninsula, and became a tropical storm just before emerging into the northeastern Gulf of Mexico early on September 6. Frances made a final landfall in the Florida Big Bend region that afternoon as a tropical storm. Frances weakened over the southeastern United States and became extratropical over West Virginia on the 9th.

Frances produced a storm surge of nearly 6 feet at its Florida east coast landfall, and caused widespread heavy rains and associated freshwater flooding over much of the eastern United States, with a maximum reported rainfall of 18.07 inches at Linville Falls, North Carolina. Frances was also associated with an outbreak of over 100 tornadoes throughout the southeastern and mid-Atlantic states. Eight deaths resulted from the forces of the storm - seven in the United States and one in the Bahamas. U.S. damage is estimated to be near $8.9 billion, over 90% of which occurred in Florida.

Hurricane Ivan - September 2-24, 2004

Ivan developed from a large tropical wave that crossed the west coast of Africa on August 31, and spawned a tropical depression two days later. The depression reached storm strength on September 3rd (one of only a dozen on record to do so south of 10EN) and continued to strengthen. By the 5th, Ivan had become a hurricane about 1150 miles east of the southern Windward Islands. Eighteen hours later Ivan became the southernmost storm to reach major hurricane status, at 10.2EN. Ivan was a category 3 hurricane when the center passed about 7 miles south of Grenada, a path that took the northern eyewall of Ivan directly over the island. In the Caribbean, Ivan became a category 5 hurricane, with winds of 160 M.P.H., on the 9th when it was south of the Dominican Republic, and on two occasions the minimum pressure fell to 910 mb. The center of Ivan passed within about 20 miles of Jamaica on the 11th and a similar distance from Grand Cayman on the 12th, with Grand Cayman likely experiencing sustained winds of category 4 strength. Ivan then turned to the northwest and passed through the Yucatan channel on the 14th, bringing hurricane conditions to extreme western Cuba. Ivan moved across the east-central Gulf of Mexico, making landfall as a major hurricane with sustained winds of near 120 M.P.H. on the 16th just west of Gulf Shores, Alabama.

Ivan weakened as it moved inland, producing over 100 tornadoes and heavy rains across much of the southeastern United States, before merging with a frontal system over the Delmarva Peninsula on the 18th. While this would normally be the end of the story, the extratropical remnant low of Ivan split off from the frontal system and drifted southward in the western Atlantic for several days, crossed southern Florida, and re-entered the Gulf of Mexico on the 21st. The low re-acquired tropical characteristics, becoming a tropical storm for the second time on the 22nd in the central Gulf. Ivan weakened before it made its final landfall in southwestern Louisiana as a tropical depression on the 24th.

Ivan's storm surge completely over-washed the island of Grand Cayman, where an estimated 95% of the buildings were damaged or destroyed. Surge heights of 10-15 feet occurred along the Gulf coast during Ivan's first U.S. landfall. Peak rainfall amounts in the Caribbean and United States were generally 10-15 inches. The death toll from Ivan stands at 92 - 39 in Grenada, 25 in the United States, 17 in Jamaica, 4 in Dominican Republic, 3 in Venezuela, 2 in the Cayman Islands, and 1 each in Tobago and Barbados. U.S. damage is estimated to be near $14.2 billion, the third largest total on record.

Ivan caused extensive damage to coastal and inland areas of the United States. Portions of the Interstate 10 bridge system across Pensacola Bay, Florida were severely damaged in several locations as a result of severe wave action on top of the 10-15 ft storm surge. As much as a quarter-mile of the bridge collapsed into the bay. The U.S Highway 90 Causeway across the northern part of the bay was also heavily damaged. To the south of Pensacola, Florida, Perdido Key *bore the brunt of Ivan's fury and was essentially leveled. In addition, extensive beach erosion caused severe damage to or the destruction of numerous beachfront homes, as well as apartment and condominium buildings. Thousands of homes in the three-county coastal area of Baldwin, Escambia, and Santa Rosa were damaged or destroyed. Cleanup efforts alone in Escambia County resulted in debris piles that were more than three-quarters of a mile long and 70 feet high. In all, Ivan was the most destructive hurricane to affect this area in more than 100 years. Strong winds also spread well inland damaging homes, and downing tress and power lines. At one point, more than 1.8 million people were without power in nine states.* (www.nhc.noaa.gov)

Hurricane Jeanne - September 13 – 28, 2004

Jeanne formed from a tropical wave, becoming a tropical depression on September 13 near the Leeward Islands, and strengthening to a tropical storm the next day. Moving west-northwestward, Jeanne struck Puerto Rico on the 15th with 70 M.P.H. winds and then strengthened to a hurricane just before making landfall in the Dominican Republic. Jeanne spent nearly 36 hours over the rough terrain of Hispaniola, generating torrential rainfall before emerging into the Atlantic north of the island. Steering currents in the western Atlantic were weak, and Jeanne moved slowly through and north of the southeastern Bahamas over the next five days while it gradually regained the strength it had lost over Hispaniola. By the 23rd, high pressure had built in over the northeastern United States and western Atlantic, causing Jeanne to turn westward. Jeanne strengthened and became a major hurricane on the 25th while the center moved over Abaco and then Grand Bahama Island. Early on the 26th, the center of Jeanne's 60-mile-wide eye crossed the Florida coast near Stuart, at virtually the identical spot that Frances had come ashore three weeks earlier. Maximum winds at the time of landfall are estimated to be near 120 M.P.H.

Jeanne weakened as it moved across central Florida, becoming a tropical storm during the afternoon of the 26th near Tampa, and then weakening to a depression a day later over central Georgia. The depression was still accompanied by heavy rain when it moved over the Carolinas, Virginia, and the Delmarva Peninsula on the 28th and 29th before becoming extratropical.

Jeanne produced extreme rain accumulations in Puerto Rico and Hispaniola, with nearly 24 inches reported in Vieques. Rains from the cyclone resulted in historic floods in Puerto Rico, and deadly flash-floods and mudslides in Haiti, where over 3000 people lost their lives and roughly 200,000 were left homeless. Three deaths occurred in Florida, and one each in Puerto Rico, South Carolina, and Virginia. In the United States, damage is estimated to be near $6.9 billion.

Winds were somewhat higher in the Central Florida Region for Hurricane Jeanne than Hurricane Frances resulting in wind damage and minimal coastal flooding. Areas still flooded from Frances (three weeks before) received additional flood waters. (www.nhc.noaa.gov)

c. The 2005 Hurricane Season

The impact of the 2005 Atlantic hurricane season and the resulting death, injury, destruction, and population displacement were unprecedented in U.S. history. During 2005, 15 tropical storms became hurricanes. For the first time, four major hurricanes made landfall in the United States; three of those reached Category 5 intensity.

Some of the worst effects were felt from Hurricane Katrina. While this storm did not seriously impact the state of Florida; it did however, have a significant impact on emergency management and hurricane planning at the national, state and local levels.

Hurricane Katrina - August 23 -30, 2005

Katrina was one of the most devastating hurricanes in the history of the United States. It is the deadliest hurricane to strike the United States since the Palm Beach-Lake Okeechobee hurricane of September 1928. It produced catastrophic damage - estimated at $75 billion in the New Orleans area and along the Mississippi coast - and is the costliest U. S. hurricane on record.

This horrific tropical cyclone formed from the combination of a tropical wave, an upper-level trough, and the mid-level remnants of Tropical Depression Ten. A tropical depression formed on August 23 about 200 miles southeast of Nassau in the Bahamas. Moving northwestward, it became Tropical Storm Katrina during the following day about 75 miles east-southeast of Nassau. The storm moved through the northwestern Bahamas on August 24-25, and then turned westward toward southern Florida. Katrina became a hurricane just before making landfall near the Miami-Dade/Broward county line during the evening of August 25. The hurricane moved southwestward across southern Florida into the eastern Gulf of Mexico on August 26. Katrina then strengthened significantly, reaching Category 5 intensity on August 28. Later that day, maximum sustained winds reached 175 M.P.H. with an aircraft-measured central pressure of 902 mb while centered about 195 miles southeast of the mouth of the Mississippi River. Katrina turned to the northwest and then north, with the center making landfall near Buras, Louisiana at 1110 UTC August 29 with maximum winds estimated at 125 M.P.H. (Category 3). Continuing northward, the hurricane made a second landfall near the Louisiana/Mississippi border at 1445 UTC with maximum winds estimated at 120 M.P.H. (Category 3). Weakening occurred as Katrina moved north-northeastward over land, but it was still a hurricane near Laurel, Mississippi. The cyclone weakened to a tropical depression over the Tennessee Valley on 30 August. Katrina became an extratropical low on August 31 and was absorbed by a frontal zone later that day over the eastern Great Lakes.

Katrina brought hurricane conditions to southeastern Louisiana, southern Mississippi, and southwestern Alabama. The Coastal Marine Automated Network (C-MAN) station at Grand Isle, Louisiana reported 10-minute average winds of 87 mph at 0820 UTC August 29 with a gust to 114 M.P.H. Higher winds likely occurred there and elsewhere, as many stations were destroyed, lost power, or lost communications during the storm. Storm surge flooding of 25 to 28 feet above normal tide level occurred along portions of the Mississippi coast, with storm surge flooding of 10 to 20 feet above normal tide levels along the southeastern Louisiana coast. Hurricane conditions also occurred over southern Florida and the Dry Tortugas. The National Hurricane Center reported sustained winds of 69 M.P.H. at 0115 UTC August 26 with a gust to 87 M.P.H. Additionally, tropical storm conditions occurred along the northern Gulf coast as far east as the coast of the western Florida Panhandle, as well as in the Florida Keys. Katrina caused 10 to 14 inches of rain over southern Florida, and 8 to 12 inches of rain along its track inland from the northern Gulf coast. Thirty-three tornadoes were reported from the storm.

Katrina is responsible for approximately 1200 reported deaths, including about 1000 in Louisiana and 200 in Mississippi. Seven additional deaths occurred in southern Florida. Katrina caused catastrophic damage in southeastern Louisiana and southern Mississippi. Storm surge along the Mississippi coast caused total destruction of many structures, with the surge damage extending several miles inland. Similar damage occurred in portions of southeastern Louisiana southeast of New Orleans. The surge overtopped and breached levees in the New Orleans metropolitan area, resulting in the inundation of much of the city and its eastern suburbs. Wind damage from Katrina extended well inland into northern Mississippi and Alabama. The hurricane also caused wind and water damage in Miami-Dade and Broward counties.

Presumably, most of the deaths in Louisiana were directly caused by the widespread storm surge-induced flooding and its miserable aftermath in the New Orleans area. The vast majority of the fatalities in Mississippi probably were directly caused by the storm surge in the three coastal counties. In Florida, three of the direct fatalities were caused by downed trees in Broward County, and the three others were due to drowning in Miami-Dade County. Two deaths were also reported in Georgia, with one directly caused by a tornado and the other occurring in a car accident indirectly related to the storm. Alabama reported two indirect fatalities in a car accident during the storm. Despite the fact that inland fresh water floods produced the majority of fatalities due to tropical cyclones during the past few decades, Katrina provides a grim reminder that storm surge poses the greatest potential cause for large loss of life in a single hurricane in this country.

Where Katrina ranks among the deadliest hurricanes on record in the United States is somewhat uncertain, due to the unknown number of fatalities caused directly by this hurricane and by some others in the past. Katrina is surpassed by the Galveston, Texas hurricane in 1900 that claimed at least 8000 lives, and it appears to be surpassed by the 1928 Lake Okeechobee, Florida hurricane with over 2500 fatalities. If the assumption is correct that most of the Katrina-related fatalities were caused directly by the storm, then Katrina ranks as the third deadliest hurricane in the United States since 1900, and the deadliest in 77 years.

The extent, magnitude, and impacts of the damage caused by Katrina are staggering and are well beyond the scope of this report to fully describe. Thousands of homes and businesses throughout entire neighborhoods in the New Orleans metropolitan area were destroyed by flood. Strong winds also caused damage in the New Orleans area, including downtown where windows in some high rise buildings were blown out and the roof of the Louisiana Superdome was partially peeled away. The storm surge of Katrina struck the Mississippi coastline with such ferocity that entire coastal communities were obliterated, some left with little more than the foundations upon which homes, businesses, government facilities, and other historical buildings once stood. Despite being more distant from the eye of Katrina, the storm surge over Dauphin Island, Alabama destroyed or damaged dozens of beachfront homes and cut a new canal through the island's western end. Many of the most severely impacted areas along the northern Gulf coast could take years to completely rebuild. Katrina's heavy rains in southern Florida flooded some neighborhoods, primarily in Miami-Dade County. Many other structures from Florida and Georgia westward to Louisiana that avoided surge or fresh water floods, including some areas well inland, were damaged by strong winds and tornadoes. Considerable damage to some homes and agricultural facilities was caused by several tornadoes in Georgia. Strong winds caused significant tree damage throughout much of Mississippi and Alabama. Combining all of the areas it impacted, Katrina left about three million people without electricity, some for several weeks.

The economic and environmental ramifications of Katrina have been widespread and could in some respects be long-lasting, due to impacts on large population and tourism centers, the oil and gas industry, and transportation. The hurricane severely impacted or destroyed workplaces in New Orleans and other heavily populated areas of the northern Gulf coast, resulting in thousands of lost jobs and millions of dollars in lost tax revenues for the impacted communities and states. Along the Mississippi coast, several large casinos on floating barges were damaged or destroyed when the surge pushed them onshore. Major beach erosion occurred along the tourism-dependent coasts of Mississippi and Alabama. A significant percentage of United States oil refining capacity was disrupted after the storm due to flooded refineries, crippled pipelines, and several oil rigs and platforms damaged, adrift or capsized. Several million gallons of oil were spilled from damaged facilities scattered throughout southeastern Louisiana. While several facilities have since resumed operations, oil and natural gas production and refining capacity in the northern Gulf of Mexico region remains less than that prior to Katrina. Additionally, key transportation arteries were disrupted or cut off by the hurricane. Traffic along the Mississippi River was below normal capacity for at least two weeks following the storm and major highways into and through New Orleans were blocked by floods. Several major bridges along the northern Gulf coast were destroyed, including several in Mississippi and the Interstate 10 Twin Span Bridge connecting New Orleans and Slidell, Louisiana.

Estimates of the insured property losses caused by Katrina vary considerably and range between about $20 billion and $60 billion. The American Insurance Services Group (AISG) estimates that Katrina is responsible for $38.1 billion of insured losses in the United States. A preliminary estimate of the total damage cost of Katrina is assumed to be roughly twice the insured losses (using the AISG estimate), or about $75 billion. This figure would make Katrina far and away the costliest hurricane in United States history. Even after adjusting for inflation, the estimated total damage cost of Katrina is roughly double that of Hurricane Andrew (1992). Normalizing for inflation and for increases in population and wealth, only the 1926 hurricane that struck southern Florida surpasses Katrina in terms of damage cost. However, this would not be the case if the values on the higher end of the range of Katrina estimates are later found to be the most accurate. The Insurance Information Institute reports that, mostly due to Katrina but combined with significant impacts from the other hurricanes striking the United States this year, 2005 was by a large margin the costliest year ever for insured catastrophic losses in this country.

Hurricane Wilma - October 15-25, 2005

The massive and powerful Wilma formed from a broad area of disturbed weather that stretched across much of the Caribbean Sea during the second week of October. A surface low pressure system gradually became defined near Jamaica on October 14, leading to the formation of a tropical depression on October 15 about 220 miles east-southeast of Grand Cayman. The cyclone moved erratically westward and southward for two days while slowly strengthening into a tropical storm. Wilma became a hurricane and began a west-northwestward motion on October 18. Later that day, Wilma began to explosively deepen. The aircraft-measured minimum central pressure reached 882 mb near 0800 UTC October 19. This pressure was accompanied by a 2-4 mile wide eye. Wilma's maximum intensity is estimated to have been 185 mph a few hours after the 882 mb pressure. On October 20, Wilma weakened slightly and turned northwestward toward the northeastern Yucatan Peninsula. Late on October 21, the slow-moving hurricane made landfall over Cozumel, followed by landfall early the next day over the northeastern Yucatan Peninsula - both at Category 4 intensity. Wilma moved slowly and weakened over northeastern Yucatan, emerging over the Gulf of Mexico early on October 23 as a Category 2 hurricane. Later that day it accelerated northeastward toward southern Florida. The hurricane strengthened over the Gulf waters, and its center made landfall near Cape Romano around 1030 UTC October 24 as a Category 3 hurricane. The eye crossed the Florida Peninsula in less than five hours, moving into the Atlantic just north of Palm Beach as a Category 2 hurricane. Wilma briefly re-intensified just east of Florida weakening thereafter. The hurricane moved rapidly northeastward over the western Atlantic and became extratropical about 230 miles southeast of Halifax, Nova Scotia late on October 25. The remnants of Wilma were absorbed by another low late the next day.

Wilma brought hurricane conditions to the northeastern Yucatan Peninsula and the adjacent islands, as well as to southern Florida. In Mexico, Cancun reported 10-minute average winds of 100 M.P.H. with a gust to 130 M.P.H. at 0000 UTC October 22, while Cozumel reported a pressure of 928.0 mb late on October 21. The Isla Mujeres reported 62.05 inches of rain during the hurricane's passage. In Florida, a South Florida Water Management District (SFWMD) station in Lake Okeechobee reported 15-minute average winds of 92 M.P.H. with a gust to 112 M.P.H. at 1500 UTC October 24, while a nearby SFWMD station in Belle Glade reported a gust to 117 M.P.H. Ten tornadoes occurred in Florida due to Wilma.

Twenty-two deaths have been directly attributed to Wilma: 12 in Haiti, 1 in Jamaica, 4 in Mexico, and 5 in Florida. The hurricane caused severe damage in northeastern Yucatan, including Cancun and Cozumel, and widespread damage estimated at $16.8 billion in southern Florida. Wilma also produced major floods in western Cuba.

The 882 mb pressure reported in Wilma is the lowest central pressure on record in an Atlantic hurricane, breaking the old record of 888 mb set by Hurricane Gilbert in September 1988. The central pressure fell 88 mb in 12 hours, which shatters the record of 48 mb in 12 hours held by Hurricane Allen in August 1980.

d. The 2006, 2007 and 2008 Hurricane Seasons

The 2006 Hurricane season was a much quieter season for the state of Florida, with only one hurricane affecting the state, Hurricane Ernesto, which was actually a tropical storm when it impacted Florida. Tropical Storm Alberto also crossed the eastern Florida panhandle. The 2007 Hurricane Season was also a relatively quite season, with no hurricanes directly affecting the State of Florida.

The 2008 Atlantic Hurricane Season marked the end of a season that produced a record number of consecutive storms to strike the United States and ranks as one of the more active seasons in the 64 years since comprehensive records began. Overall, the season is tied as the fourth most active in terms of named storms (16) and major hurricanes (five), and is tied as the fifth most active in terms of hurricanes (eight) since 1944, which was the first year aircraft missions flew into tropical storms and hurricanes.

For the first time on record, six consecutive tropical cyclones (Dolly, Edouard, Fay, Gustav, Hanna and Ike) made landfall on the U.S. mainland and a record three major hurricanes (Gustav, Ike and Paloma) struck Cuba. This is also the first Atlantic season to have a major hurricane (Category 3) form in five consecutive months (July: Bertha, August: Gustav, September: Ike, October: Omar, November: Paloma).

The National Hurricane Center attributes the 2008 above-normal season to conditions that include:

- An ongoing multi-decadal signal. This combination of ocean and atmospheric conditions has spawned increased hurricane activity since 1995.

- Lingering La Niña effects. Although the La Niña that began in the Fall of 2007 ended in June, its influence of light wind shear lingered.

- Warmer tropical Atlantic Ocean temperatures. On average, the tropical Atlantic was about 1.0 degree Fahrenheit above normal during the peak of the season.

In 2008 Tropical Storm Fay made history as the only storm on record to make landfall four times in the state of Florida, and to prompt tropical storm and hurricane watches and warnings for the state's entire coastline (at various times during its August lifespan).

Though Florida was spared a direct hit from a major hurricane, Floridians saw major flooding throughout the State from Tropical Storm Fay. Fay came ashore in the Florida Keys August 18 and continued northward up the Florida Peninsula. Fay made records as the first storm to make four landfalls in one state impacting the Florida Keys, South Florida, exiting off the east coast and coming back inland near Flagler Beach and exiting off the Gulf Coast and making landfall again near Carrabelle. The slow-moving storm also caused record rainfall and flooding throughout the state with some areas getting as much as 25 inches of rain. Millions of dollars in damage and 15 deaths were caused in Florida by Fay. (www.noaa.nhc.gov)

Hurricane Gustav brought tropical storm force winds to the Florida Keys and storm surge and severe thunderstorms to the Florida Panhandle. As Gustav headed for the Louisiana coast, many residents evacuated to Florida to escape the storm. Many Florida counties, in conjunction with the American Red Cross, opened shelters throughout the state for evacuees. (www.noaa.nhc.gov)

9. Probability of Future Hurricane Events

Table II-6 provides the number of direct hits on the mainland U.S. coastline (1900-1996) for individual states. Florida is divided into four sections. The Central Florida Region is predominately located in the Southwest area with Okeechobee County in the Southeast area. (Please note that the Florida Keys are also included in the SW area.)

Table II-6
U.S. Mainland Hurricane Strikes by State (1851-2006)

Area	Category					All (1-5)	Major (3-5)
	1	2	3	4	5		
U.S. (Texas to Maine)	110	73	75	18	3	279	96
Texas	23	18	12	7	0	60	19
Louisiana	18	14	15	4	1	52	20
Mississippi	2	5	8	0	1	16	9
Alabama	16	4	6	0	0	26	6
Florida	43	33	29	6	2	113	37
(Northwest)	26	17	14	0	0	57	14
(Northeast)	12	8	1	0	0	21	1
(Southwest)	18	10	8	4	1	41	13
(Southeast)	13	13	11	3	1	41	15
Georgia	15	5	2	1	0	23	3
South Carolina	18	6	4	2	0	30	6
North Carolina	24	14	11	1	0	50	12
Virginia	7	2	1	0	0	10	1
Maryland	1	1	0	0	0	2	0
Delaware	2	0	0	0	0	2	0
New Jersey	2	0	0	0	0	2	0
Pennsylvania	1	0	0	0	0	1	0
New York	6	1	5	0	0	12	5
Connecticut	5	3	3	0	0	11	3
Rhode Island	3	2	4	0	0	9	4
Massachusetts	6	2	3	0	0	11	3
New Hampshire	1	1	0	0	0	2	0
Maine	5	1	0	0	0	6	0

Notes: State totals will not necessarily equal U.S. totals, and Florida totals will not necessarily equal sum of sectional totals.

Table II-7 provides the total of major hurricane direct hits on the mainland (1900-1996) by month. Most major hurricanes occur in the later part of the hurricane season in September, October and November. Category one and two hurricanes tend to "spring up" in the Caribbean affecting the southwest Florida area in the early part of the season.

Table II-7
Major Hurricane Direct Hits on the U.S. Coastline
1851-2006 by Month

Area	Jun	Jul	Aug	Sep	Oct	All
U.S. (Texas to Maine)	2	4	30	44	16	96
Texas	1	1	10	7	0	19
(North)	1	1	3	2	0	7
(Central)	0	0	2	2	0	4
(South)	0	0	5	3	0	8
Louisiana	2	0	7	8	3	20
Mississippi	0	1	4	4	0	9
Alabama	0	1	1	4	0	6
Florida	0	2	6	19	10	37
(Northwest)	0	2	1	7	3	13
(Northeast)	0	0	0	1	0	1
(Southwest)	0	0	2	5	6	13
(Southeast)	0	0	4	8	3	15
Georgia	0	0	1	1	1	3
South Carolina	0	0	2	2	2	6
North Carolina	0	0	4	8	1	13
Virginia	0	0	0	1	0	1
Maryland	0	0	0	0	0	0
Delaware	0	0	0	0	0	0
New Jersey	0	0	0	0	0	0
Pennsylvania	0	0	0	0	0	0
New York	0	0	1	4	0	5
Connecticut	0	0	1	2	0	3
Rhode Island	0	0	1	3	0	4
Massachusetts	0	0	0	3	0	3
New Hampshire	0	0	0	0	0	0
Maine	0	0	0	0	0	0

Taken from The Deadliest, Costliest, and Most Intense United States Hurricanes of this Century [NOAA Technical Memorandum NWS TPC-5] Updated in 2007. http://www.nhc.noaa.gov/pdf/NWS-TPC-5.pdf . Storms can affect more than one area in the state. Therefore, the total number of storms affecting Florida is less than the total number affecting all regions.

a. Monthly Zones of Origin and Hurricane Tracks

The figures below (**Figures II-9 - II-14**) show the zones of origin and tracks for different months during the hurricane season. These figures only depict average conditions-and hurricanes can originate in different locations and travel much different paths from the average. Nonetheless, having a sense of the general pattern can give you a better picture of the average hurricane season for your area.

Figure II-9
Prevailing Tracks - June

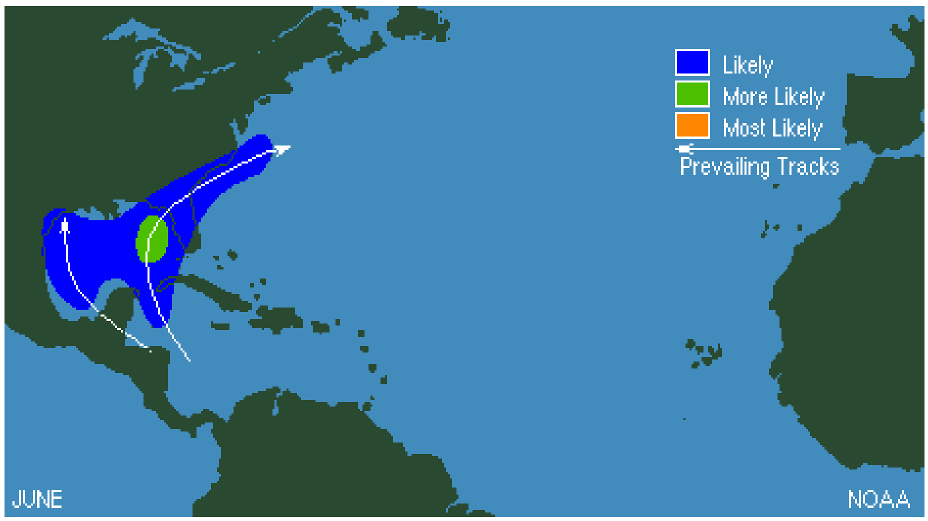


Figure II-10
Prevailing Tracks - July

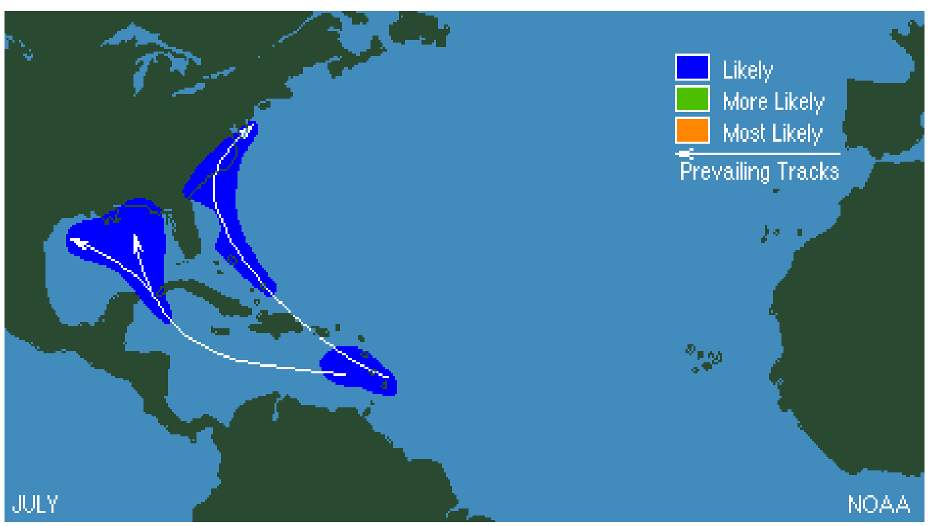


Figure II-11
Prevailing Tracks - August

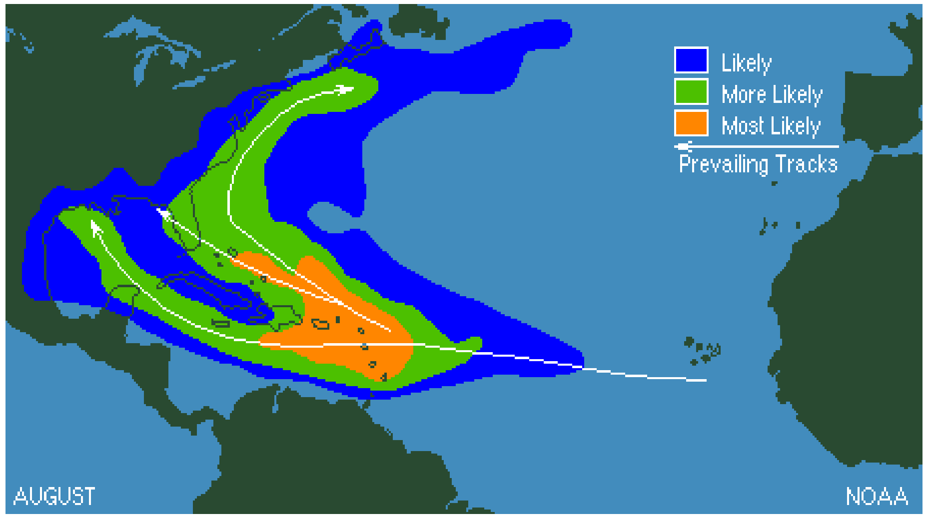


Figure II-12
Prevailing Tracks - September

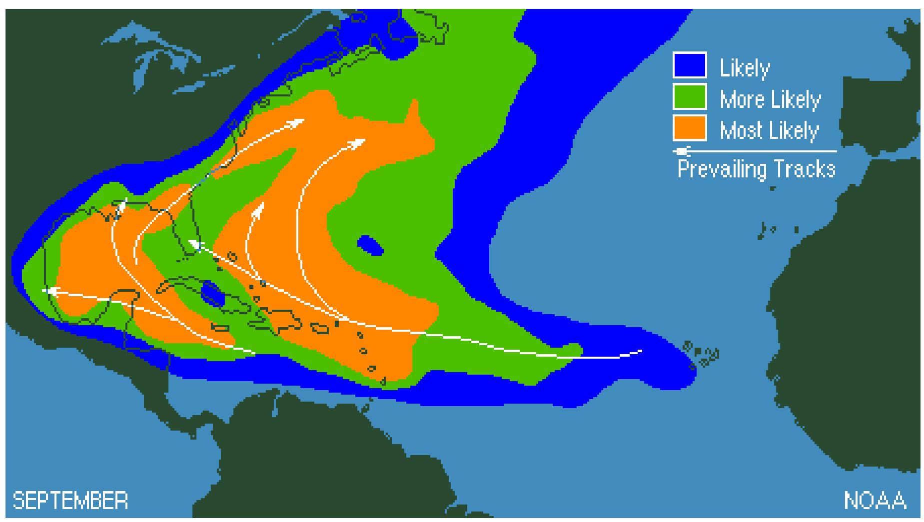


Figure II-13
Prevailing Tracks - October

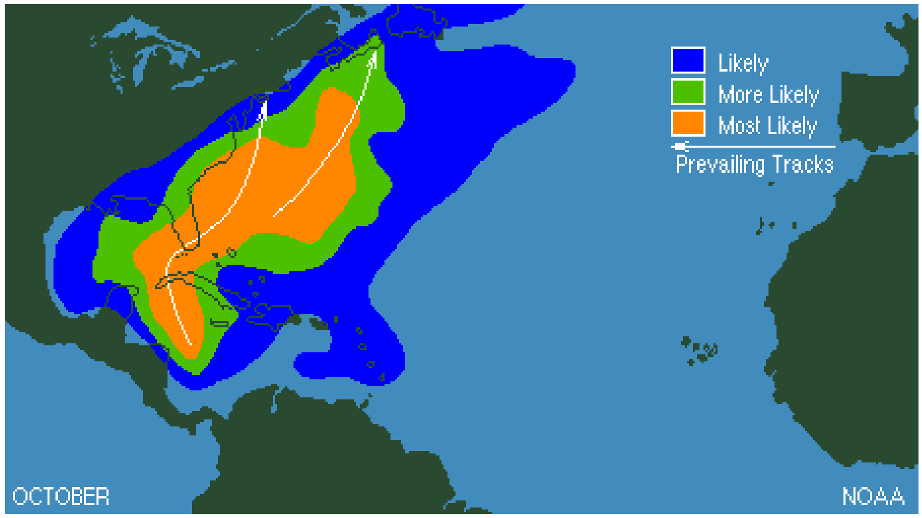
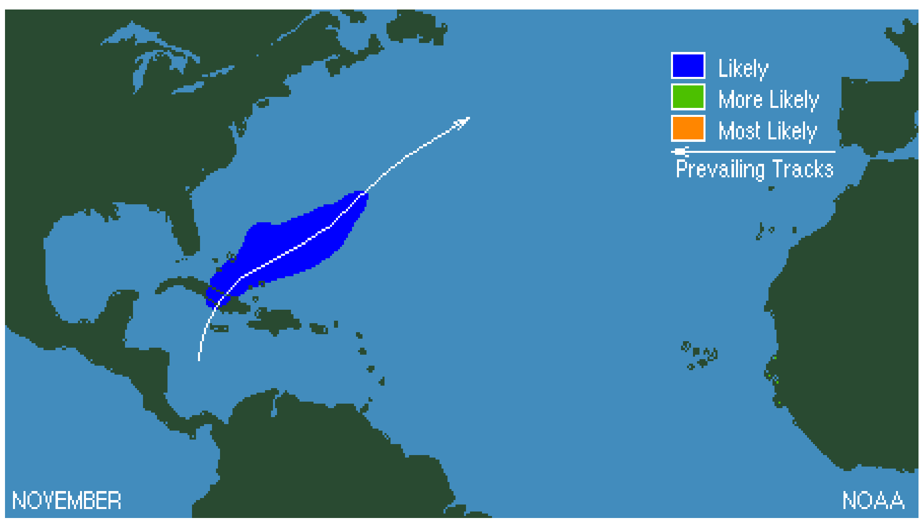


Figure II-14
Prevailing Tracks - November



b. NOAA Historical Analysis for the Region

In the Tables below, the National Hurricane Center provided a list of all the tropical storms and hurricanes that have passed within 100 nautical miles of two selected points Lake Wales (**Table II-8a**) & Sebring (**Table-8b**) within the Central Florida Region. The National Hurricane Center also provided graphics to show the hurricane return intervals for these cities (**Tables II-15 a & b**). These two cities give you a snapshot of hurricane activity in the northwest corner of our region (Lake Wales) and the center of our region (Sebring).

To show the variance of hurricane activity within our region we have also provided historical data for hurricanes passing within 50 nautical miles of two other cities; Arcadia and Okeechobee. The City of Arcadia is in the Southwest portion of our region near the area where the Peace River flows into Charlotte Harbor. The City of Okeechobee is in the Southeast portion of our region on the northern coast of Lake Okeechobee. There are no return interval graphics for Arcadia or Okeechobee.

Table II-8a
Tropical Storms and Hurricanes Passing Within 100 NM of Lake Wales, FL (1870-2007)

TROP STORMS AND HURRICANES PASSING WITHIN 100 NMi of LAKE WALES, FL 1870-2007

1 STORM INDEX NUMBER	2 STORM NAME	3 YEAR	4 MONTH	5 DAY	6 STORM NUMBER FOR YEAR	7 MAX WIND AT STORM CENTER (SEE NOTES)	8 CPA (CLOSEST POINT OF APPROACH)	9 DDD/SS.S DDD=HEADING SS.S=FORWARD SPEED AT CPA
1	NOT NAMED	1870	OCT	21	9	77(67)	70 (SE)	045/17.3
2	NOT NAMED	1871	AUG	17	3	100(73)	8 (NE)	327/ 8.9
3	NOT NAMED	1871	AUG	25	4	90(70)	28 (NE)	309/ 9.6
4	NOT NAMED	1872	OCT	23	5	50(40)	31 (NNW)	061/15.0
5	NOT NAMED	1873	SEP	23	4	50(47)	49 (NW)	042/16.6
6	NOT NAMED	1873	OCT	7	5	100(88)	41 (SE)	046/27.3
7	NOT NAMED	1874	SEP	28	6	70(70)	96 (NW)	035/19.7
8	NOT NAMED	1876	OCT	20	5	87(80)	63 (ESE)	030/15.9
9	NOT NAMED	1878	JUL	2	1	37(35)	95 (SE)	048/16.2
10	NOT NAMED	1878	SEP	8	5	90(40)	98 (SW)	303/ 3.4
11	NOT NAMED	1879	OCT	27	7	60(57)	85 (NNW)	057/25.9
12	NOT NAMED	1880	AUG	29	4	90(82)	29 (NNE)	283/ 4.5
13	NOT NAMED	1880	OCT	8	9	70(70)	84 (NW)	050/22.5
14	NOT NAMED	1885	AUG	24	2	80(80)	73 (ENE)	348/12.4
15	NOT NAMED	1886	JUL	18	4	70(70)	78 (WNW)	027/11.8
16	NOT NAMED	1887	OCT	30	16	40(37)	46 (NW)	055/16.0
17	NOT NAMED	1888	AUG	17	3	80(70)	81 (SSW)	288/11.3
18	NOT NAMED	1888	SEP	8	5	49(39)	16 (SW)	315/ 8.0
19	NOT NAMED	1889	JUN	17	2	45(45)	97 (NW)	049/15.1
20	NOT NAMED	1889	OCT	6	9	42(41)	87 (ESE)	021/31.7
21	NOT NAMED	1891	OCT	7	7	40(40)	85 (SE)	036/13.4
22	NOT NAMED	1892	OCT	24	9	45(42)	3 (SSE)	075/15.6
23	NOT NAMED	1893	AUG	27	6	105(105)	88 (ENE)	337/11.0
24	NOT NAMED	1893	OCT	12	9	105(105)	90 (NE)	025/13.6
25	NOT NAMED	1894	SEP	28	4	90(70)	2 (WNW)	009/10.2
26	NOT NAMED	1896	OCT	9	5	50(39)	60 (SE)	054/12.6
27	NOT NAMED	1897	SEP	21	3	60(47)	0 (NE)	023/11.0
28	NOT NAMED	1898	AUG	2	1	45(33)	18 (SSW)	291/15.4
29	NOT NAMED	1899	JUL	31	2	62(53)	96 (SW)	315/ 8.7
30	NOT NAMED	1899	OCT	5	6	50(40)	35 (NW)	045/17.9
31	NOT NAMED	1901	AUG	11	4	51(39)	65 (SSW)	284/ 7.4
32	NOT NAMED	1903	SEP	12	3	65(55)	45 (SW)	303/ 9.1
33	NOT NAMED	1904	OCT	18	3	43(38)	70 (SSW)	284/ 5.7
34	NOT NAMED	1906	OCT	22	8	40(30)	2 (W)	185/10.0
35	NOT NAMED	1908	JUN	29	3	39(35)	0 (WSW)	319/ 8.7
36	NOT NAMED	1909	AUG	30	7	38(30)	3 (WNW)	020/ 8.8
37	NOT NAMED	1910	OCT	18	5	97(85)	16 (W)	360/ 8.0
38	NOT NAMED	1915	AUG	1	1	69(63)	63 (NE)	310/ 5.2
39	NOT NAMED	1916	MAY	15	1	40(40)	17 (WSW)	338/ 5.9
40	NOT NAMED	1916	AUG	26	7	37(30)	42 (E)	358/10.5
41	NOT NAMED	1920	SEP	30	5	50(48)	82 (NNW)	063/28.5
42	NOT NAMED	1921	OCT	26	6	105(100)	41 (NNW)	057/11.4
43	NOT NAMED	1925	DEC	1	2	69(61)	9 (NW)	035/17.0
44	NOT NAMED	1926	JUL	28	1	90(87)	57 (NE)	324/ 7.4
45	NOT NAMED	1926	SEP	18	6	109(107)	87 (SSW)	299/12.3
46	NOT NAMED	1928	AUG	8	1	83(48)	27 (NE)	312/ 6.0
47	NOT NAMED	1928	AUG	13	2	55(53)	89 (WSW)	332/ 9.2
48	NOT NAMED	1928	SEP	17	4	130(93)	0 (SSE)	324/10.8
49	NOT NAMED	1930	SEP	9	2	35(35)	50 (NW)	049/ 4.6
50	NOT NAMED	1933	JUL	31	5	70(55)	31 (S)	270/ 2.6
51	NOT NAMED	1933	SEP	4	12	110(99)	4 (SW)	308/10.6
52	NOT NAMED	1934	MAY	28	1	42(37)	63 (ESE)	027/15.7
53	NOT NAMED	1934	JUL	23	3	40(40)	88 (NNW)	247/16.4
54	NOT NAMED	1935	SEP	4	2	98(93)	89 (WSW)	332/ 8.8
55	NOT NAMED	1937	JUL	30	1	40(40)	51 (NW)	046/13.3
56	NOT NAMED	1937	AUG	30	3	50(49)	71 (NNE)	291/11.2
57	NOT NAMED	1939	AUG	12	2	70(60)	5 (NNE)	300/12.2
58	NOT NAMED	1940	AUG	3	2	35(35)	67 (NNW)	238/11.8
59	NOT NAMED	1941	OCT	6	5	98(93)	82 (SW)	314/19.3
60	NOT NAMED	1944	OCT	19	11	110(89)	31 (W)	009/16.2

NOTES:
Datetimes are UTC, winds are in knots and distances are in nautical miles (nmi). Directions in column 8 refer to bearing of storm from site at the closest point of approach (CPA). Two winds are listed in column 7. First is the maximum wind anywhere within the 100 nmi scan radius. Second (in parenthesis) is the maximum wind at CPA. If this is <34 kts, it is treated as a weak tropical storm (34kts) in tables and charts. Site location (degs and degs/100) is 27.91N 81.60W.

CHART 1A (Page 1)

Table II-8a (cont.)
Tropical Storms and Hurricanes Passing Within 100 NM of Lake Wales, FL (1870-2007)

TROP STORMS AND HURRICANES PASSING WITHIN 100 NMi of LAKE WALES, FL 1870-2007

1 STORM INDEX NUMBER	2 STORM NAME	3 YEAR	4 MONTH	5 DAY	6 STORM NUMBER FOR YEAR	7 MAX WIND AT STORM CENTER (SEE NOTES)	8 CPA (CLOSEST POINT OF APPROACH)	9 DDD/SS.S DDD=HEADING SS.S=FORWARD SPEED AT CPA
61	NOT NAMED	1945	JUN	24	1	80(70)	78 (NNW)	060/11.5
62	NOT NAMED	1945	SEP	5	7	35(35)	72 (SW)	315/18.1
63	NOT NAMED	1945	SEP	16	9	103(88)	10 (W)	350/12.6
64	NOT NAMED	1946	OCT	8	5	73(65)	57 (W)	006/18.1
65	NOT NAMED	1946	NOV	2	6	35(28)	9 (NE)	325/ 9.6
66	NOT NAMED	1947	SEP	23	6	50(50)	81 (NNW)	013/ 8.2
67	NOT NAMED	1948	SEP	22	7	77(76)	100 (SE)	036/ 6.9
68	NOT NAMED	1949	AUG	27	2	112(85)	2 (SW)	308/11.3
69	EASY	1950	SEP	6	5	110(60)	26 (NNW)	059/ 3.8
70	KING	1950	OCT	18	11	87(68)	20 (ENE)	340/17.2
71	HOW	1951	OCT	2	8	60(58)	61 (SSE)	037/15.9
72	HAZEL	1953	OCT	9	12	60(55)	37 (SE)	054/22.0
73	JUDITH	1959	OCT	18	11	47(43)	62 (S)	082/18.1
74	DONNA	1960	SEP	11	5	93(68)	14 (W)	009/12.3
75	CLEO	1964	AUG	28	5	80(60)	44 (ENE)	343/ 6.3
76	ALMA	1966	JUN	9	1	92(90)	97 (WSW)	331/17.5
77	ABBY	1968	JUN	4	1	57(53)	7 (SE)	040/ 5.4
78	GLADYS	1968	OCT	19	8	70(70)	75 (NW)	040/ 8.0
79	JENNY	1969	OCT	3	13	35(30)	32 (ESE)	025/11.9
80	SUBTROP	1974	JUN	25	1	55(52)	37 (NW)	049/19.8
81	SUBTROP	1974	OCT	7	11	43(40)	85 (E)	360/12.8
82	DOTTIE	1976	AUG	19	5	42(39)	85 (E)	357/16.4
83	DAVID	1979	SEP	4	4	85(85)	58 (ENE)	345/11.3
84	DENNIS	1981	AUG	18	4	38(35)	34 (E)	009/11.2
85	SUBTROP	1982	JUN	18	2	43(40)	79 (NW)	040/28.7
86	BARRY	1983	AUG	25	2	40(28)	14 (SSE)	246/11.5
87	ISIDORE	1984	SEP	28	10	48(45)	3 (SSW)	302/10.6
88	BOB	1985	JUL	24	2	57(47)	65 (E)	354/11.1
89	CHRIS	1988	AUG	28	3	42(40)	86 (ENE)	347/20.6
90	KEITH	1988	NOV	23	12	55(39)	8 (SSE)	065/14.6
91	MARCO	1990	OCT	11	13	55(48)	68 (WSW)	348/ 8.2
92	GORDON	1994	NOV	16	7	55(47)	45 (SE)	053/15.4
93	ERIN	1995	AUG	2	5	75(54)	12 (NNE)	288/14.1
94	JERRY	1995	AUG	24	10	35(35)	12 (NE)	323/ 9.6
95	MITCH	1998	NOV	5	13	55(54)	78 (SSE)	069/28.3
96	IRENE	1999	OCT	16	9	65(65)	80 (E)	007/ 8.0
97	GABRIELLE	2001	SEP	14	8	60(45)	12 (NNW)	035/ 9.2
98	EDOUARD	2002	SEP	5	5	35(22)	71 (NNW)	247/ 7.6
99	CHARLEY	2004	AUG	13	3	125(85)	4 (NNW)	019/21.2
100	FRANCES	2004	SEP	5	6	91(60)	8 (SSW)	296/ 7.9
101	JEANNE	2004	SEP	26	10	105(72)	11 (SSW)	305/ 8.6
102	TAMMY	2005	OCT	5	20	44(41)	77 (ENE)	334/13.5
103	WILMA	2005	OCT	24	22	102(102)	98 (SE)	047/26.7
104	ERNESTO	2006	AUG	30	6	43(35)	45 (E)	009/11.1
105	BARRY	2007	JUN	2	2	38(35)	59 (NNW)	018/28.8

NOTES:
Datetimes are UTC, winds are in knots and distances are in nautical miles (nmi). Directions in column 8 refer to bearing of storm from site at the closest point of approach (CPA). Two winds are listed in column 7. First is the maximum wind anywhere within the 100 nmi scan radius. Second (in parenthesis) is the maximum wind at CPA. If this is <34 kts, it is treated as a weak tropical storm (34kts) in tables and charts. Site location (degs and degs/100) is 27.91N 81.60W.

CHART 1A (Page 2)

Table II-8b
Tropical Storms and Hurricanes Passing Within 100 NM of Sebring, FL (1870-2007)

TROP STORMS AND HURRICANES PASSING WITHIN 100 NMi of SEBRING, FL 1870-2007

1 STORM INDEX NUMBER	2 STORM NAME	3 YEAR	4 MONTH	5 DAY	6 STORM NUMBER FOR YEAR	7 MAX WIND AT STORM CENTER (SEE NOTES)	8 CPA (CLOSEST POINT OF APPROACH)	9 DDD/SS.S DDD=HEADING SS.S=FORWARD SPEED AT CPA
1	NOT NAMED	1870	OCT	21	9	80(68)	45 (SE)	045/17.4
2	NOT NAMED	1871	AUG	17	3	100(78)	17 (NE)	315/ 8.7
3	NOT NAMED	1871	AUG	25	4	90(80)	42 (NE)	311/ 9.3
4	NOT NAMED	1872	OCT	23	3	30(43)	37 (NNW)	080/13.4
5	NOT NAMED	1873	SEP	23	4	50(50)	71 (NW)	035/15.0
6	NOT NAMED	1873	OCT	7	5	100(92)	17 (SE)	046/27.3
7	NOT NAMED	1876	OCT	20	5	90(82)	44 (ESE)	028/16.5
8	NOT NAMED	1878	JUL	2	1	40(33)	72 (SE)	049/16.1
9	NOT NAMED	1878	SEP	8	5	90(40)	43 (SW)	308/ 5.4
10	NOT NAMED	1880	AUG	29	4	90(67)	51 (NNE)	283/ 4.5
11	NOT NAMED	1885	AUG	24	2	80(77)	71 (ENE)	346/13.5
12	NOT NAMED	1886	JUL	18	4	70(70)	97 (WNW)	019/12.0
13	NOT NAMED	1887	OCT	30	16	40(38)	71 (NW)	055/16.0
14	NOT NAMED	1888	AUG	17	3	98(73)	60 (SSW)	289/10.6
15	NOT NAMED	1888	SEP	8	5	46(35)	4 (SW)	309/ 8.0
16	NOT NAMED	1889	OCT	6	9	42(40)	70 (ESE)	030/26.9
17	NOT NAMED	1891	OCT	7	7	40(40)	63 (ESE)	034/12.6
18	NOT NAMED	1892	JUN	11	1	35(35)	99 (SSE)	058/11.6
19	NOT NAMED	1892	OCT	24	9	45(42)	24 (WNW)	075/15.6
20	NOT NAMED	1893	AUG	27	6	105(105)	91 (ENE)	333/10.9
21	NOT NAMED	1893	OCT	12	9	105(105)	98 (NE)	323/13.5
22	NOT NAMED	1894	SEP	26	4	90(75)	15 (WNW)	011/11.7
23	NOT NAMED	1896	OCT	9	5	50(40)	34 (SE)	055/13.7
24	NOT NAMED	1897	SEP	21	3	60(48)	17 (WNW)	023/11.0
25	NOT NAMED	1898	AUG	2	1	42(32)	3 (NNE)	280/19.4
26	NOT NAMED	1899	JUL	31	2	60(48)	84 (SW)	313/ 8.7
27	NOT NAMED	1899	OCT	5	6	50(40)	59 (NW)	049/17.6
28	NOT NAMED	1901	AUG	11	4	51(38)	43 (SSW)	285/ 7.4
29	NOT NAMED	1903	SEP	12	3	70(57)	30 (SW)	308/10.0
30	NOT NAMED	1904	OCT	18	3	50(39)	49 (SSW)	294/ 5.7
31	NOT NAMED	1906	OCT	22	8	36(30)	13 (W)	185/10.0
32	NOT NAMED	1907	SEP	19	2	34(32)	92 (SSW)	290/11.5
33	NOT NAMED	1909	JUN	29	3	42(35)	8 (NE)	325/ 8.9
34	NOT NAMED	1909	AUG	30	7	43(30)	13 (WSW)	350/ 6.5
35	NOT NAMED	1909	SEP	26	9	34(30)	82 (SE)	033/10.0
36	NOT NAMED	1910	OCT	18	5	100(70)	25 (W)	001/ 9.0
37	NOT NAMED	1915	AUG	1	1	65(65)	79 (NE)	304/ 5.3
38	NOT NAMED	1916	MAY	14	1	40(40)	14 (WSW)	336/ 6.8
39	NOT NAMED	1916	AUG	25	7	39(32)	36 (E)	356/10.1
40	NOT NAMED	1921	OCT	25	6	105(101)	67 (WNW)	057/11.9
41	NOT NAMED	1924	OCT	21	7	80(60)	92 (SSE)	073/ 8.5
42	NOT NAMED	1925	DEC	1	2	65(60)	31 (NW)	037/20.9
43	NOT NAMED	1926	JUL	28	1	92(90)	84 (ENE)	330/ 7.0
44	NOT NAMED	1926	SEP	18	6	113(108)	69 (SSW)	299/12.3
45	NOT NAMED	1928	AUG	8	1	85(60)	40 (NE)	312/ 6.0
46	NOT NAMED	1928	AUG	13	2	55(54)	83 (WSW)	326/ 9.6
47	NOT NAMED	1928	SEP	17	4	130(98)	10 (NE)	317/13.4
48	NOT NAMED	1929	SEP	29	2	90(89)	94 (SW)	309/ 8.0
49	NOT NAMED	1930	SEP	9	2	35(35)	75 (NW)	050/ 4.6
50	NOT NAMED	1932	AUG	30	3	58(53)	83 (SSW)	301/11.5
51	NOT NAMED	1933	JUL	31	5	72(57)	5 (S)	270/ 6.8
52	NOT NAMED	1933	SEP	4	12	115(73)	10 (NE)	311/14.8
53	NOT NAMED	1934	MAY	28	1	40(38)	44 (ESE)	027/19.7
54	NOT NAMED	1935	SEP	3	2	100(97)	84 (WSW)	330/11.9
55	NOT NAMED	1936	JUN	15	1	40(40)	100 (S)	096/19.9
56	NOT NAMED	1936	JUL	29	5	80(58)	92 (SW)	315/10.0
57	NOT NAMED	1937	JUL	30	1	40(40)	75 (NW)	045/13.3
58	NOT NAMED	1937	AUG	30	3	50(50)	91 (NNE)	291/11.2
59	NOT NAMED	1939	AUG	12	2	70(60)	22 (NNE)	300/12.2
60	NOT NAMED	1940	AUG	3	2	35(35)	93 (WNW)	239/10.9

NOTES:
Datetimes are UTC, winds are in knots and distances are in nautical miles (nmi). Directions in column 8 refer to bearing of storm from site at the closest point of approach (CPA). Two winds are listed in column 7. First is the maximum wind anywhere within the 100 nmi scan radius. Second (in parenthesis) is the maximum wind at CPA. If this is <34 kts, it is treated as a weak tropical storm (34kts) in tables and charts. Site location (degs and degs/100) is 27.49N 81.44W.

CHART 1A (Page 1)

Table II-8b (cont.)
Tropical Storms and Hurricanes Passing Within 100 NM of Sebring, FL (1870-2007)

TROP STORMS AND HURRICANES PASSING WITHIN 100 NMi of SEBRING, FL 1870-2007

1 STORM INDEX NUMBER	2 STORM NAME	3 YEAR	4 MONTH	5 DAY	6 STORM NUMBER FOR YEAR	7 MAX WIND AT STORM CENTER (SEE NOTES)	8 CPA (CLOSEST POINT OF APPROACH)	9 DDD/SS.S DDD=HEADING SS.S=FORWARD SPEED AT CPA
61	NOT NAMED	1941	OCT	6	5	102(95)	70 (SW)	313/18.8
62	NOT NAMED	1944	OCT	19	11	110(96)	44 (N)	009/16.2
63	NOT NAMED	1945	SEP	5	7	35(35)	63 (WSW)	325/18.1
64	NOT NAMED	1945	SEP	16	9	107(93)	13 (WSW)	343/12.6
65	NOT NAMED	1946	OCT	8	5	73(65)	68 (N)	006/16.1
66	NOT NAMED	1946	NOV	2	6	40(30)	18 (NE)	319/10.8
67	NOT NAMED	1947	SEP	17	4	135(122)	84 (SSE)	255/ 7.5
68	NOT NAMED	1947	SEP	23	6	50(50)	94 (N)	010/ 8.2
69	NOT NAMED	1947	OCT	12	8	75(75)	100 (SE)	041/10.8
70	NOT NAMED	1948	SEP	22	7	88(77)	78 (SE)	037/ 7.5
71	NOT NAMED	1949	AUG	27	2	118(90)	13 (NE)	308/11.3
72	EASY	1950	SEP	6	5	110(61)	52 (NNW)	066/ 3.7
73	KING	1950	OCT	18	11	98(72)	21 (ENE)	339/17.2
74	HOW	1951	OCT	2	8	60(58)	35 (SSE)	063/15.6
75	NOT NAMED	1952	FEB	3	1	45(45)	92 (SE)	040/29.1
76	NOT NAMED	1953	AUG	29	3	45(40)	90 (S)	090/12.6
77	HAZEL	1953	OCT	9	12	60(55)	12 (SE)	054/22.0
78	JUDITH	1959	OCT	18	11	48(43)	36 (S)	082/18.1
79	DONNA	1960	SEP	11	5	105(76)	25 (N)	360/12.2
80	CLEO	1964	AUG	27	5	85(65)	42 (E)	354/ 6.1
81	ISBELL	1964	OCT	15	11	95(85)	78 (SE)	046/20.0
82	ALMA	1966	JUN	9	1	95(93)	94 (WSW)	336/17.2
83	ABBY	1968	JUN	4	1	58(55)	15 (NNW)	032/ 6.6
84	GLADYS	1968	OCT	19	8	70(70)	98 (NW)	040/ 8.0
85	JENNY	1969	OCT	3	13	40(30)	14 (ESE)	025/11.6
86	SUBTROP	1974	JUN	25	1	55(52)	61 (NW)	049/19.8
87	SUBTROP	1974	OCT	7	11	45(42)	78 (E)	355/12.3
88	DOTTIE	1976	AUG	19	5	41(38)	78 (E)	357/16.5
89	DAVID	1979	SEP	3	4	85(85)	57 (ENE)	349/ 8.5
90	DENNIS	1981	AUG	18	4	37(35)	23 (E)	359/ 4.0
91	BARRY	1983	AUG	25	2	40(27)	12 (NNW)	246/11.5
92	ISIDORE	1984	SEP	27	10	50(45)	14 (NNE)	298/10.2
93	BOB	1985	JUL	24	2	55(43)	59 (E)	334/11.1
94	CHRIS	1988	AUG	28	3	41(37)	83 (E)	352/14.4
95	KEITH	1988	NOV	23	12	55(39)	19 (NNW)	065/14.6
96	MARCO	1990	OCT	11	13	55(55)	71 (WSW)	347/ 8.2
97	GORDON	1994	NOV	16	7	55(47)	20 (SE)	053/15.4
98	ERIN	1995	AUG	2	5	75(63)	33 (NNE)	290/14.2
99	JERRY	1995	AUG	24	10	35(35)	22 (NE)	312/ 8.0
100	MITCH	1998	NOV	5	13	55(54)	52 (SSE)	069/28.3
101	HARVEY	1999	SEP	21	8	50(48)	93 (S)	076/27.6
102	IRENE	1999	OCT	16	9	65(65)	69 (E)	004/ 8.1
103	GABRIELLE	2001	SEP	14	8	60(48)	34 (NW)	038/11.5
104	CHARLEY	2004	AUG	13	3	125(85)	20 (NNW)	019/21.2
105	FRANCES	2004	SEP	5	6	93(67)	11 (NNE)	294/ 9.7
106	JEANNE	2004	SEP	26	10	105(78)	7 (NNE)	300/ 9.9
107	TAMMY	2005	OCT	5	20	43(39)	80 (ENE)	335/10.9
108	WILMA	2005	OCT	24	22	105(101)	74 (SE)	049/26.6
109	ERNESTO	2006	AUG	30	6	40(35)	33 (E)	009/11.2
110	BARRY	2007	JUN	2	2	40(37)	76 (NNW)	020/28.7

NOTES:
Datetimes are UTC, winds are in knots and distances are in nautical miles (nmi). Directions in column 8 refer to bearing of storm from site at the closest point of approach (CPA). Two winds are listed in column 7. First is the maximum wind anywhere within the 100 nmi scan radius. Second (in parenthesis) is the maximum wind at CPA. If this is <34 kts, it is treated as a weak tropical storm (34kts) in tables and charts. Site location (degs and degs/100) is 27.49N 81.44W.

CHART 1A (Page 2)

Table II-9a(1) – Lake Wales Summary for Hurricanes and Tropical Storms
Number of Years: 138 Number of Hurricanes and Tropical Storms: 105 Mean Number of Occurrences per Year 0.76 Mean Recurrence Interval: 1.31 Years

Table II-9a(2) – Sebring Summary for Hurricanes and Tropical Storms
Number of Years: 138 Number of Hurricanes and Tropical Storms: 110 Mean Number of Occurrences per Year 0.79 Mean Recurrence Interval: 1.25 Years

Table II-9b(1) – Lake Wales Summary of Hurricanes
Number of Years: 138 Number of Hurricanes: 36 Mean Number of Occurrences per year: .26 Mean Recurrence Interval: 3.8 Years

Table II-9b(2) – Sebring Summary of Hurricanes
Number of Years: 138 Number of Hurricanes: 41 Mean Number of Occurrences per year: .297 Mean Recurrence Interval: 3.36 Years

Figure II-15a
Hurricane Return Intervals for the Central Florida Region Associated with Lake Wales

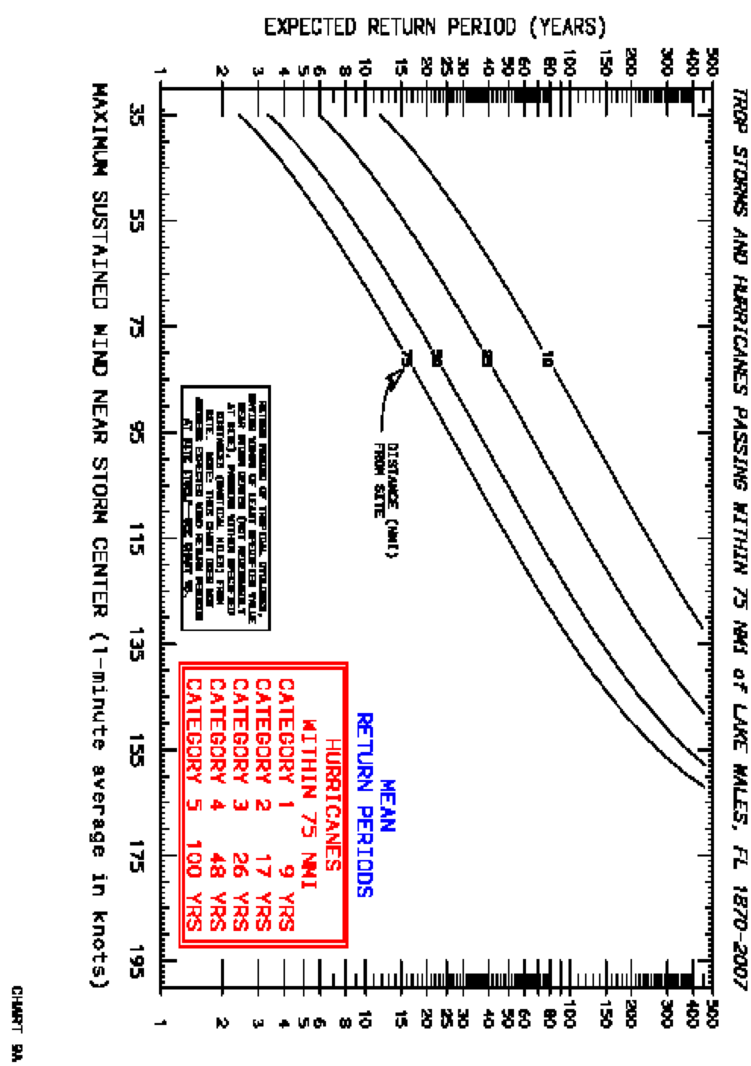
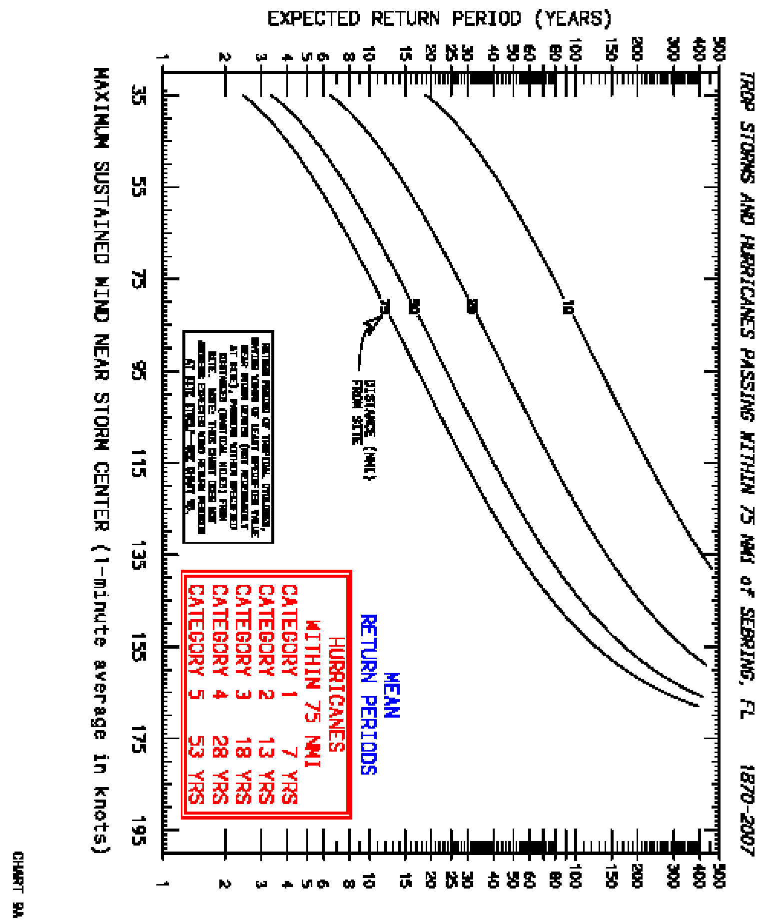


Figure II-15b
Hurricane Return Intervals for the Central Florida Region Associated with Sebring



C. Freshwater Flooding: The 100-Year Flood Plain

1. Inland/Riverine Flooding Profile

Flooding refers to the *general or temporary conditions of partial or complete inundation of normally dry land areas by surface water runoff from any source* (**Statewide Hazard Mitigation Plan**, 2009). The State of Florida and the Central Florida Region are affected by a large number of weather systems which result in flooding.

Flooding can be divided into two major categories: Coastal and Riverine. As indicated previously, interrelated hazards, such as hurricanes and severe storms, can result in both types of flooding, sometimes in difference locations. Many areas of Florida are susceptible to flooding from both storm surge and watershed runoff.

Coastal flooding is usually the result of a severe weather system such as a tropical cyclone, hurricane, tropical storm or "northeaster" which contains the element of wind. The damaging effects of coastal floods are caused by a combination of higher water levels of the storm surge, the winds, rains, erosion and battering by debris. Loss of life and property damage are often more severe since it involves velocity wave action and accompanying winds.

Riverine flooding is associated with a river's watershed, which is the natural drainage basin that conveys water runoff from rain. Riverine flooding occurs when the flow of runoff is greater than the carrying capacities of the natural drainage systems. Rain water that is not absorbed by soil or vegetation seeks surface drainage lines following natural topography lines. These lines merge to form a hierarchical system of rills, creeks, streams and rivers. Generally, floods can be slow or fast rising depending on the size of the river or stream. The rivers in north Florida drain portions of Alabama and Georgia, and excessive rainfall in those states often causes flood conditions in Florida.

Flash floods are much more dangerous and flow much faster than riverine floods. They can result from tropical storms, dam failures or excessive rain and snow. Flash floods pose more significant safety risks because of the rapid onset, the high water velocity, the potential for channel scour and the debris load.

The variations of flooding including severe thunderstorms, hurricanes, seasonal rain and other weather-related conditions are a natural part of the earth's hydrologic system; however, when buildings and infrastructure are constructed within the natural drainage system, there are significant losses.

Based on frequency, floods are the most destructive category of natural hazards in the United States. The loss of life, property, crops, business facilities, utilities and transportation are major impacts of flooding. Economic losses from impacts to major transportation routes and modes, public health and other environmental hazards are key factors in long-term recovery. (**Statewide Hazard Mitigation Plan**, 2009)

2. Probability of Flooding: (Flood Insurance Rate Maps – FIRMs)

The probability of freshwater flooding has been quantified by the Federal Emergency Management Agency (FEMA) through the National Flood Insurance Program. Areas subject to flooding, the Velocity Zone, 100-year flood plain and the 500-year floodplain, have been delineated on Flood Insurance Rate Maps (FIRMs) for every jurisdiction in the region. Moderate to low risk areas include zones B, C and X. High risk areas include zones A, AE, AH, AO, and AR. High risk coastal areas include the Velocity zones (Zones V, VE, V1-V30 and undetermined risk areas (Zone D). See **Table II-10** for Definitions of NFIP Zones.

NOTE: There are no electronic maps available for the flood zones in Okeechobee County. All other flood zones in the region are depicted on **Figure II-16**

The model used to determine the flood plain, like the SLOSH MEOWs or MOMs and the Inland Wind model, is a cumulative model. In other words, it is based on several storm events; no one storm will inundate all the areas within the flood zone. In addition, because there is a return interval (1% or greater chance of flooding in any given year) associated with the flood level; there is a basis for planning and cost-benefit analysis.

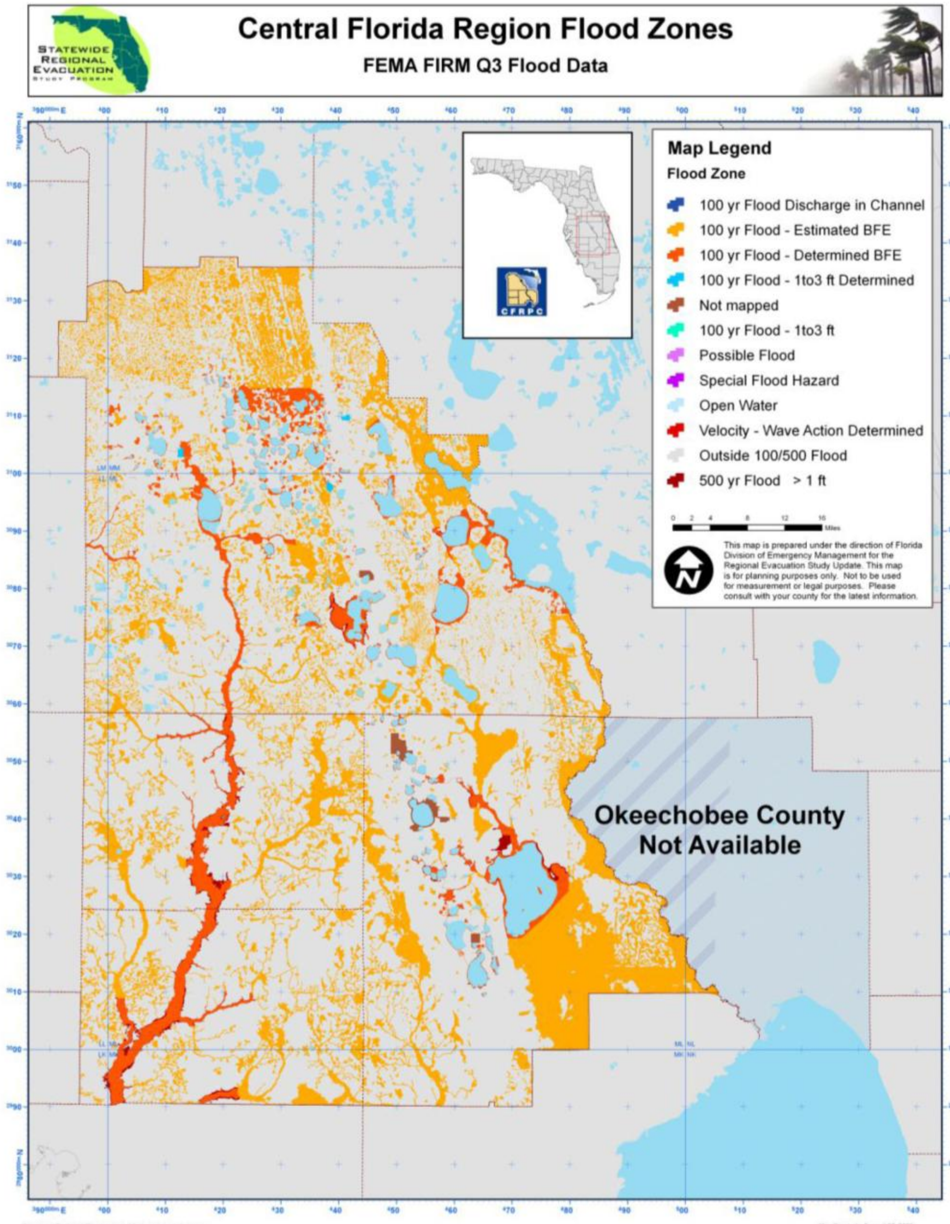
While the 6-12 inches of rain typically associated with a hurricane is not considered life-threatening, freshwater flooding along rivers and streams, can and does cause significant property damage and has the potential of causing personal injury and deaths. Hurricane Floyd (September 1999) caused billions of dollars in property damage in North Carolina alone. Over the past two decades, freshwater flooding had become a leading cause of death in hurricane events with most of those deaths the result of driving or walking in flood waters.

In order to identify the potential magnitude of inland flooding, the 100-year flood plain was delineated using FEMA's most recent digital files. County maps illustrating the 100-year flood plain are presented in the Maps section of Chapter IV Appendices. Within the flood zone, it is recognized that there are properties which have sustained repeated damage from flooding and are extremely susceptible to flood damage. These local neighborhoods should be warned prior to hurricane events that flooding is very probable. Flood plain acreage, broken down by county, is contained in **Table II-11**.

Table II-10
Definitions of NFIP Zones

AE	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. In most instances, base flood elevations (BFEs) derived from detailed analyses are shown at selected intervals within these zones.
X500	An area inundated by 500-year flooding; an area inundated by 100-year flooding with average depths of less than 1 foot or with drainage areas less than 1 square mile; or an area protected by levees from the 100-year flooding.
X	Areas outside the 1-percent annual chance floodplain, areas of 1% annual chance sheet flow flooding where average depths are less than 1 foot, areas of 1% annual chance stream flooding where the contributing drainage area is less than 1 square mile, or areas protected from the 1% annual chance flood by levees. No Base Flood Elevations or depths are shown within this zone. Insurance purchase is not required in these zones.
A	Flood zone area with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas; no depths of base flood elevations are shown within these zones.
ANI	An area that is located within a community of county that is not mapped on any published FIRM.
IN	An area designated as within a "Special Flood Hazard Area" (of SFHA) on a FIRM. This is an area inundated by 100-year flooding for which no BFEs or velocity may have been determined. No distinctions are made between the different flood hazard zones that may be included within the SFHA. These may include Zones A, AE, AO, AH, AR, A99, V, or VE.
VE	Coastal areas with a 1% or greater chance of flooding and an additional hazard associated with storm waves. These areas have a 26% chance of flooding over the life of a 30-year mortgage. Base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
UNDES	A body of open water, such as a pond, lake, ocean, etc., located within a community's jurisdictional limits that has no defined flood hazard.
AO	River or stream flood hazard areas, and areas with a 1% or greater chance of shallow flooding each year, usually in the form of sheet flow, with an average depth ranging from 1 to 3 feet. These areas have a 26% chance of flooding over the life of a 30-year mortgage. Average flood depths derived from detailed analyses are shown within these zones.
D	Areas with possible but undetermined flood hazards. No flood hazard analysis has been conducted. Flood insurance rates are commensurate with the uncertainty of the flood risk.
AH	Areas with a 1% annual chance of shallow flooding, usually in the form of a pond, with an average depth ranging from 1 to 3 feet. These areas have a 26% chance of flooding over the life of a 30-year mortgage. Base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
V	Coastal areas with a 1% or greater chance of flooding and an additional hazard associated with storm waves. These areas have a 26% chance of flooding over the life of a 30-year mortgage. No base flood elevations are shown within these zones.
100IC	An area where the 100-year flooding is contained within the channel banks and the channel is too narrow to show to scale. An arbitrary channel width of 3 meters is shows. BFEs are not shown in this area, although they may be reflected on the corresponding profile.

Figure II- 16
Central Florida Region Flood Zones
FEMA FIRM Q3 Flood Data



The total acreage within the flood plain by county is presented below. It was calculated using the total acreage as determined by the Soil Conservation Service and the FEMA FIRM Maps as of 2009.

Table II-11
Flood Plain Acreage by County
Central Florida Region

County	Total Acreage	Flood Plain Acreage	Percentage of Acreage in Flood Plain
DESOTO	406,867	101,573	24.9%
HARDEE	403,200	95,749	23.7%
HIGHLANDS	708,139	279,239	39.4%
OKEECHOBEE	499,200	No Data Available	N/A
POLK	1,287,094	566,452	44.0%

Source: Soil Conservation Service (Total Acreage); FEMA (Digital Inventory of Flood Plain Acreage), 2009

3. Dam Failure

A flood event may also trigger a dam failure. The dam impounds water in the reservoir, or upstream area. The amount of water impounded is measured in acre-feet.[7] *Dam failures are not routine but the results can be significant. Two factors influence the potential severity of a dam failure: (1) the amount of water impounded and (2) the density, type and value of the development downstream.* (Statewide Hazard Mitigation Plan, 2009)

The "dam hazard" is a term indicating the potential hazard to the downstream area resulting from failure or mis-operation of the dam or facilities. According to the USGS National Inventory of Dams, there are 143 dams in the Central Florida Region which have been identified by their hazard risk of low, significant and high.

- *Low hazard: A dam where failure or mis-operation results in no probable loss of human life and low economic and/or environmental loss. Losses are principally limited to the owner's property.*

- *Significant hazard: A dam where failure or mis-operation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities or impact other concerns. These dams are often located in predominantly rural or agricultural area but could be located in areas with population and significant infrastructure.*

- *High – A dam where failure or mis-operation will probably cause loss of human life.* **(Statewide Hazard Mitigation Plan, 2009).**

[7] Hazard Reference: H = High, S = Significant, L = Low

Table II-12
Dams in the Central Florida Region

DAM NAME	NIDID	LONGITUDE	LATITUDE	COUNTY	RIVER	HAZARD	USNG
G-90	FL00440	-81.41	27.34	HIGHLANDS	JACK CREEK	H	17R ML 59445 24161
STRUCTURE 65B	FL00286	-81.19	27.46	OKEECHOBEE	KISSIMMEE RIVER (C-38)	L	17R ML 81226 37400
HENRY CREEK LOCK	FL00297	-80.71	27.16	OKEECHOBEE	HENRY CREEK	H	17R NL 28732 04190
CULVERT NO. 9	FL00294	-82.2849	30.44089	OKEECHOBEE	LOCAL DRAINAGE CANAL	H	17R LP 76622 68342
STRUCTURE 65C	FL00287	-81.11	27.4	OKEECHOBEE	KISSIMMEE RIVER (C-38)	L	17R ML 89125 30745
STRUCTURE 65D	FL00288	-81.02	27.31	OKEECHOBEE	KISSIMMEE RIVER (C-38)	L	17R ML 98021 20772
STRUCTURE 65E	FL00290	-80.95	27.22	OKEECHOBEE	KISSIMMEE RIVER (C-38)	L	17R NL 04951 10804
KI-2	FL26002	-80.9365	27.21065	OKEECHOBEE	KISSIMMEE RIVER	H	17R NL 06291 09769
CULVERT NO. 7	FL00296	-82.2983	30.41094	OKEECHOBEE	LEMKIN CREEK	H	17R LP 75293 65038
STRUCTURE 193 (HURRICANE GATE NO.6)	FL00291	-80.79	27.2	OKEECHOBEE	TAYLOR CREEK	H	17R NL 20798 08605
PUMPING STATION 133	FL00292	-80.81	27.2	OKEECHOBEE	LEVEE D4 BORROW DITCH	H	17R NL 18817 08602
STRUCTURE 191	FL00295	-80.76	27.19	OKEECHOBEE	CANAL 59 & NUBBIN SLOUGH	L	17R NL 23772 07503
KI-1	FL26001	-80.9053	27.1892	OKEECHOBEE	KISSIMMEE RIVER	H	17R NL 09382 07395
CULVERT NO. 6	FL00298	-80.8805	27.16416	OKEECHOBEE	LOCAL DRAINAGE CANAL	H	17R NL 11843 04623
CULVERT NO. 8	FL00293	-80.7797	27.2024	OKEECHOBEE	LOCAL DRAINAGE CANAL	H	17R NL 21821 08872
P-4	FL83458	-81.93	27.81	POLK		S	17R ML 08398 76502
KEYSVILLE (E)	FL10051	-82.02	27.81	POLK		S	17R LL 99533 76573
KEYSVILLE (W)	FL10050	-82.04	27.81	POLK		S	17R LL 97563 76589
K-8	FL83456	-82.06	27.81	POLK		S	17R LL 95593 76606
NORALYN N-9	FL00193	-81.84	27.8	POLK		L	17R ML 17255 75331
KINGSFORD K-3	FL00644	-82.01	27.8	POLK	MIZELLE CREEK	S	17R ML 00509 75457
KEYSVILLE (S)	FL10052	-82.03	27.8	POLK		S	17R LL 98538 75473
FORT MEADE PR-6	FL00578	-81.77	27.79	POLK		H	17R ML 24144 74178

Hazard Reference: H = High, S = Significant, L = Low

DAM NAME	NIDID	LONGITUDE	LATITUDE	COUNTY	RIVER	HAZARD	USNG
KINGSFORD K-2	FL00209	-82.05	27.8	POLK		L	17R LL 96568 75490
PR 1-2 (PEACE RIVER)	FL00211	-81.76	27.79	POLK		H	17R ML 25129 74171
PHOSPHORIA P-2	FL00658	-81.89	27.81	POLK	PEACE RIVER	S	17R ML 12338 76473
NORALYN N-11C	FL00189	-81.86	27.82	POLK		L	17R ML 15301 77560
WEST POLK K-1	FL00210	-82.04	27.8	POLK		L	17R LL 97553 75481
NORALYN N-10	FL00208	-81.84	27.81	POLK		L	17R ML 17263 76438
FORT MEADE PR-4	FL00579	-81.77	27.81	POLK	PEACE RIVER	H	17R ML 24158 76393
KEYSVILLE (N)	FL10048	-82.04	27.82	POLK		S	17R LL 97572 77697
KEYSVILLE (N-CENTER)	FL10049	-82.04	27.82	POLK		S	17R LL 97572 77697
K-7	FL83475	-82	27.82	POLK		H	17R ML 01512 77664
K-7	FL83451	-82	27.82	POLK		H	17R ML 01512 77664
SILVER CITY SA NO 6 PH2	FL00212	-81.91	27.78	POLK		L	17R ML 10343 73164
NORALYN N-15	FL00203	-81.87	27.82	POLK		L	17R ML 14316 77567
S-6 ROCKLAND MINE	FL00620	-81.88	27.72	POLK	WHIDDEN CREEK	L	17R ML 13252 66496
NORALYN N-11A	FL00646	-81.86	27.82	POLK	CAMP BRANCH	S	17R ML 15301 77560
NORALYN N-13	FL00204	-81.85	27.82	POLK		L	17R ML 16286 77553
NORALYN N-4	FL00670	-81.83	27.82	POLK	PEACE RIVER	S	17R ML 18255 77539
WEST POLK A-7	FL00201	-82.01	27.83	POLK		L	17R ML 00536 78780
WEST POLK A-8	FL00200	-82	27.83	POLK		L	17R ML 01521 78772
WEST POLK A-10	FL00205	-81.99	27.82	POLK		L	17R ML 02497 77656
PAYNE CREEK SETTLING AREA NO 2	FL00238	-81.93	27.71	POLK		L	17R ML 08314 65424
F2B	FL83461	-82.08	27.66	POLK		S	17R LL 93477 60006
F2C	FL83462	-82.05	27.66	POLK		S	17R LL 96436 59980
FORT GREEN FG-1	FL00572	-82.01	27.67	POLK	PAYNE CREEK	S	17R ML 00390 61055
PALMETTO SETTLING AREA NO 1	FL00252	-81.93	27.67	POLK		L	17R ML 08281 60993
PALMETTO SETTLING AREA NO 2	FL00253	-81.93	27.67	POLK		L	17R ML 08281 60993
PALMETTO	FL00255	-81.93	27.67	POLK		L	17R ML 08281 60993

Hazard Reference: H = High, S = Significant, L = Low

DAM NAME	NIDID	LONGITUDE	LATITUDE	COUNTY	RIVER	HAZARD	USNG
SETTLING AREA NO 4							
PALMETTO SETTLING AREA NO 5	FL00256	-81.93	27.67	POLK		L	17R ML 08281 60993
PALMETTO SETTLING AREA NO 6	FL00257	-81.93	27.67	POLK		L	17R ML 08281 60993
SETTLING AREA A DIKE	FL00251	-81.86	27.68	POLK		L	17R ML 15192 62051
FORT GREEN FG-2	FL00571	-82.01	27.69	POLK	PAYNE CREEK	S	17R ML 00409 63271
FORT GREEN FG-3	FL00573	-82	27.7	POLK	PAYNE CREEK	S	17R ML 01404 64371
AREA D	FL00235	-82.01	27.71	POLK		L	17R ML 00427 65486
GARDINIER AREA E	FL00623	-81.86	27.72	POLK	WHIDDEN CREEK	S	17R ML 15223 66482
PAYNE CREEK SETTLING AREA NO 1	FL00237	-81.93	27.71	POLK		L	17R ML 08314 65424
FM 1-2 (FORT MEADE)	FL00214	-81.83	27.77	POLK		H	17R ML 18218 72001
PAYNE CREEK SETTLING AREA NO 3	FL00239	-81.93	27.71	POLK		L	17R ML 08314 65424
PAYNE CREEK SETTLING AREA NO 4	FL00240	-81.93	27.71	POLK		L	17R ML 08314 65424
PAYNE CREEK SETTLING AREA NO 5	FL00241	-81.93	27.71	POLK		L	17R ML 08314 65424
SETTLING AREA C & C DIKE	FL00247	-81.87	27.71	POLK		L	17R ML 14230 65381
WATSON SA NO 10	FL00248	-81.76	27.71	POLK		L	17R ML 25075 65309
AREA C	FL00236	-82	27.72	POLK		L	17R ML 01422 66586
CS-11	FL83455	-81.78	27.83	POLK		S	17R ML 23187 78615
SETTLING AREA D DIKE	FL00231	-81.86	27.72	POLK		L	17R ML 15223 66482
WATSON SA N09 BOWLEGS	FL00232	-81.78	27.73	POLK		L	17R ML 23117 67537
ES-TECH SA-13	FL00639	-81.77	27.73	POLK	PEACE RIVER	L	17R ML 24102 67531
AREA E	FL00228	-82.04	27.74	POLK		L	17R LL 97497 68834
ROCKLAND MINE S-1	FL00226	-81.86	27.74	POLK		L	17R ML 15239 68697
FM 3 (FORT MEADE)	FL00221	-81.83	27.75	POLK		H	17R ML 18203 69785
PAYNE CREEK	FL00242	-81.93	27.71	POLK		L	17R ML 08314 65424

Hazard Reference: H = High, S = Significant, L = Low

DAM NAME	NIDID	LONGITUDE	LATITUDE	COUNTY	RIVER	HAZARD	USNG
SETTLING AREA NO 6							
SOUTH RIDGEWOOD/ CLARK JAMES DAM	FL00194	-81.9	27.88	POLK		L	17R ML 11410 84235
MULBERRY S (1)	FL10076	-81.91	27.9	POLK		S	17R ML 10442 86458
BARTOW-2	FL00191	-81.88	27.89	POLK		L	17R ML 13387 85328
MULBERRY (4)	FL10056	-81.95	27.89	POLK		S	17R ML 06496 85380
MULBERRY (1)	FL10053	-81.96	27.89	POLK		S	17R ML 05512 85388
MULBERRY W	FL10087	-81.89	27.88	POLK		S	17R ML 12394 84228
MULBERRY (CTR)	FL10086	-81.89	27.88	POLK		S	17R ML 12394 84228
MULBERRY (9)	FL10061	-81.95	27.88	POLK		S	17R ML 06488 84272
MULBERRY N	FL10084	-81.89	27.88	POLK		S	17R ML 12394 84228
MULBERRY W (CTR)	FL10075	-81.9	27.9	POLK		S	17R ML 11426 86450
MULBERRY (8)	FL10060	-81.94	27.88	POLK		S	17R ML 07472 84264
MULBERRY (7)	FL10059	-81.94	27.88	POLK		S	17R ML 07472 84264
MULBERRY (6)	FL10058	-81.94	27.88	POLK		S	17R ML 07472 84264
MULBERRY (12)	FL10064	-81.95	27.88	POLK		S	17R ML 06488 84272
MULBERRY (11)	FL10063	-81.95	27.88	POLK		S	17R ML 06488 84272
WEST POLK A-9	FL00202	-81.99	27.83	POLK		L	17R ML 02506 78764
MULBERRY NW	FL10085	-81.89	27.88	POLK		S	17R ML 12394 84228
P-11	FL13003	-81.85	27.93	POLK	SADDLE CREEK	S	17R ML 16370 89739
SADDLE CREEK SC-7	FL00560	-81.84	28.12	POLK	SADDLE CREEK	L	17R MM 17499 10781
SADDLE CREEK SA-1	FL00565	-81.88	28.12	POLK	SADDLE CREEK	S	17R MM 13570 10808
SADDLE CREEK SA-2	FL00564	-81.9	28.12	POLK	SADDLE CREEK	S	17R MM 11606 10823
SADDLE CREEK SETTLING AREA NO 5	FL00178	-81.9	28.11	POLK		S	17R MM 11598 09715
LAKE HARTRIDGE DAM	FL00179	-81.73	28.08	POLK	LAKE CONINE	S	17R MM 28277 06280
P-7	FL13001	-81.68	28.05	POLK	P7 CANAL	S	17R MM 33171 02928
MULBERRY S (2)	FL10077	-81.91	27.9	POLK		S	17R ML 10442 86458
P-8	FL13002	-81.64	28.03	POLK	P8 CANAL	S	17R MM 37090 00691

Hazard Reference: H = High, S = Significant, L = Low

DAM NAME	NIDID	LONGITUDE	LATITUDE	COUNTY	RIVER	HAZARD	USNG
MULBERRY E	FL10074	-81.91	27.9	POLK		S	17R ML 10442 86458
MULBERRY N	FL10073	-81.91	27.91	POLK		S	17R ML 10450 87566
WEST AKINS DAM	FL00185	-81.95	27.91	POLK		H	17R ML 06514 87595
MULBERRY SW	FL10082	-81.87	27.9	POLK		S	17R ML 14379 86429
MULBERRY E	FL10081	-81.88	27.9	POLK		S	17R ML 13395 86436
MULBERRY NE	FL10080	-81.88	27.9	POLK		S	17R ML 13395 86436
MULBERRY W	FL10078	-81.9	27.9	POLK		S	17R ML 11426 86450
MULBERRY (5)	FL10057	-81.95	27.88	POLK		S	17R ML 06488 84272
P-6	FL13000	-81.7	28.05	POLK	P6 CANAL	S	17R MM 31205 02939
BRADLEY JXN 6	FL10094	-81.92	27.84	POLK		S	17R ML 09408 79818
CLEAR SPRINGS CS-4	FL00675	-81.82	27.85	POLK	PEACE RIVER	S	17R ML 19263 80856
CLEAR SPRINGS N-12	FL00197	-81.84	27.85	POLK		L	17R ML 17293 80870
NORALYN N-14	FL00196	-81.85	27.85	POLK		L	17R ML 16309 80876
BRADLEY JUNCTION S	FL10071	-81.94	27.85	POLK		S	17R ML 07447 80941
NI 1 (NICHOLS)	FL00206	-82	27.85	POLK		H	17R ML 01539 80988
BRADLEY JXN 5	FL10093	-81.9	27.84	POLK		S	17R ML 11377 79804
MULBERRY (10)	FL10062	-81.95	27.88	POLK		S	17R ML 06488 84272
BRADLEY JXN 3	FL10091	-81.91	27.84	POLK		S	17R ML 10393 79811
BRADLEY JUNCTION E (CTR)	FL10070	-81.94	27.86	POLK		S	17R ML 07455 82049
BRADLEY JXN 2	FL10090	-81.92	27.84	POLK		S	17R ML 09408 79818
BRADLEY JUNCTION 1	FL10089	-81.92	27.84	POLK		S	17R ML 09408 79818
WEST POLK A-4	FL00199	-81.99	27.84	POLK		L	17R ML 02515 79872
NICHOLS N-3	FL00577	-82.01	27.84	POLK	ALAFIA RIVER	S	17R ML 00545 79888
KINGSFORD A-11	FL00664	-82.02	27.84	POLK	ALAFIA RIVER	S	17R LL 99560 79896
NICHOLS N-4	FL00576	-82.02	27.84	POLK	ALAFIA RIVER	S	17R LL 99560 79896
BRADLEY JXN 4	FL10092	-81.91	27.84	POLK		S	17R ML 10393 79811
NICHOLS (W)	FL10044	-82.03	27.87	POLK		S	17R LL 98603 83228
MULBERRY (3)	FL10055	-81.95	27.88	POLK		S	17R ML 06488 84272

Hazard Reference: H = High, S = Significant, L = Low

DAM NAME	NIDID	LONGITUDE	LATITUDE	COUNTY	RIVER	HAZARD	USNG
MULBERRY (2)	FL10054	-81.95	27.88	POLK		S	17R ML 06488 84272
MULBERRY S	FL10088	-81.89	27.87	POLK		S	17R ML 12386 83120
MULBERRY E	FL10083	-81.89	27.87	POLK		S	17R ML 12386 83120
MULBERRY N	FL10065	-81.94	27.87	POLK		S	17R ML 07464 83157
NICHOLS (E)	FL10047	-82.02	27.87	POLK		S	17R LL 99588 83220
CLEAR SPRINGS CS-8	FL00652	-81.78	27.85	POLK	PEACE	S	17R ML 23201 80831
NICHOLS (W-CENTER)	FL10045	-82.03	27.87	POLK		S	17R LL 98603 83228
BRADLEY JUNCTION S (CTR)	FL10069	-81.94	27.86	POLK		S	17R ML 07455 82049
CLEAR SPRINGS N-12A	FL00653	-81.84	27.86	POLK	PEACE RIVER	S	17R ML 17301 81977
NORALYN N-14	FL00668	-81.86	27.86	POLK	SIX MILE CREEK	H	17R ML 15332 81991
BRADLEY JUNCTION W (CTR)	FL10068	-81.93	27.86	POLK		S	17R ML 08440 82041
BRADLEY JUNCTION N (CTR)	FL10067	-81.93	27.86	POLK		S	17R ML 08440 82041
BRADLEY JUNCTION NW	FL10066	-81.93	27.86	POLK		S	17R ML 08440 82041
BRADLEY JUNCTION NE	FL10072	-81.94	27.86	POLK		S	17R ML 07455 82049
NORALYN N-5	FL00673	-81.83	27.83	POLK	PEACE RIVER	S	17R ML 18263 78647
NICHOLS (E-CENTER)	FL10046	-82.03	27.87	POLK		S	17R LL 98603 83228

Source: USACE (2009)

Hazard Reference: H = High, S = Significant, L = Low

4. History of Inland Flooding

Based on data collected by the National Climatic Data Center (NCDC), there were 914 flooding events in Florida between 1993 and 2006, for an average of 70 flooding events per year. Total property damages were estimated at $1.278 billion with an additional $947.081M in crop-related damages.

Below is a summary of the major flooding events in the Central Florida Region from 1993-2008.

March 1998, El Nino Effect: On March 1st, Alachua, Baker, Bradford, Citrus, Clay, Columbia, DeSoto, Duval, Flagler, Gilchrist, Hamilton, Hillsborough, Marion, Nassau, Pasco, Putnam, St. Johns, Suwannee, Union Counties were flooded. More than 2,800 homes and over 175 businesses were destroyed and property damage totaled $25.5 million. Flooding was claimed to be related to El Nino.

September 2001, Tropical Storm Gabrielle: Heavy rainfall of six to eight inches with isolated pockets in excess of nine inches associated with Tropical Storm Gabrielle occurred over most of Manatee and southern portions of Pinellas and Hillsborough counties. Widespread road, home and business flooding occurred over large portions of Manatee County, mainly from Anna Maria east across Bradenton to Parrish. Minor to moderate road and home flooding occurred over southern Pinellas and Hillsborough Counties, mainly along the coast and low-lying areas. In Pasco County, rainfall of five to eight inches occurred over a broad portion of the county with most of the road and residential flooding occurring along the U.S. Highway 301 corridor from Dade City south to Zephyrhills. Overall property damage estimate was $26 million.

June 23, 2003: A series of severe thunderstorms swept through southwest Central Florida during June 21-24, 2007. Precipitation associated with these storms resulted in flooding in parts of several Florida counties including Charlotte, Citrus, DeSoto, Dixie, Hardee, Levy, Manatee, Sarasota, and Taylor. Floodwater from these thunderstorms caused damage to public and private property amounting to more than $11 million and damaged or destroyed more than 100 homes.

A federal disaster declaration allowed the affected state and local governments to apply for aid. The relief aid would pay up to 75 percent of the approved costs for debris removal, emergency services related to the disaster, and the repair or replacement of damaged public facilities. The aid was authorized under a major disaster declaration issued by President Bush following a review of FEMA's analysis of the state's request for federal relief. The declaration covers damage to public property from severe storms and flooding beginning on June 13.

June 23, 2003, Dam Failure: The Manatee River flooded on June 23, 2003 in Manatee County, Florida in conjunction with complications of a dam malfunction. More than a foot of rain fell in Manatee County and two of its neighboring counties that led to the complications of the event. During several days of rain, two of the dam's spillways were opened but the third spillway jammed, prompting emergency officials to order hundreds of homes evacuated as water approached the top of the 50-foot-high dam. Two homes collapsed during the deluge and many others were inundated completely. Red Cross shelters in Arcadia and Sarasota housed more than 230 evacuees from the 600 homes that were threatened in Manatee County's riverside and lakeside communities. An additional shelter opened at Port Charlotte to house local families displaced by the continuous flooding conditions.

February 03, 2006, Flash Floods: The combination of tropical moisture flowing into a line of thunderstorms and an approaching upper level disturbance allowed a train of intense thunderstorms to repeatedly cross over parts of the Tampa Bay area. Between eight and more than 11 inches of rain fell in roughly a five-hour period in a five-mile wide stripe extending from Madeira Beach northeast through Pinellas Park, then across Old Tampa Bay to west Tampa, including Tampa International Airport. The area of heaviest rain was so concentrated that downtown St. Petersburg, less than 10 miles away, recorded less than an inch of rain during the same period. The torrential rains caused flash flooding in the areas where more than eight inches fell. The flash flooding prompted the mayor of St. Petersburg to term the event a "hundred year flood." In Lealman, an entire mobile home community was evacuated, and at least 60 of the homes were flooded. A partial roof collapse was reported at a big box store in St. Petersburg. Water pouring into the store washed out several cash register stands and injured one employee as he was washed into the parking lot. Another roof collapsed at Treasure Island. Hundreds of vehicles were stranded by the flood waters. Total property damage was estimated at $2.0 million. Pinellas County Rain Reports Pinellas Park (Upper Highlands Canal): 11.17 inches. Saint Petersburg/Clearwater International Airport: 8.20 inches Seminole: 7.01 inches Largo: 6.44 inches; Clearwater: 5.81 inches; Hillsborough County Rain Reports Tampa International Airport: 8.24 inches; Citrus Park: 6.90 inches; and Thonotosassa: 4.35 inches.

There were no hurricanes that directly affected the State of Florida during 2007.

August 18 – 22, 2008, Tropical Storm Fay: Tropical Storm Fay was the only storm on record to make landfall four separate times. Over a period of nearly a week, Tropical Storm Fay went back and forth across the state with some areas receiving as much as 25 inches of rainfall. Although Brevard County was especially hard hit, extensive flooding was recorded as far south as St. Lucie and Okeechobee Counties and as far north as Duval County and the City of Jacksonville. Overall there were millions of dollars in flood damages and a total of 15 deaths directly attributed to Tropical Storm Fay.

5. Repetitive Loss Areas

The location of repetitive loss structures[8] helps to identify specific areas in the community where flooding continues to be a problem and where mitigation efforts should be concentrated. For many of these floodprone areas, mitigation will involve significant property owner investment and will probably be delayed until redevelopment/ reconstruction occurs. New construction or significant remodeling will require adherence to current floodplain management regulations. In regards to evacuation planning, these areas are important to consider as they represent the most vulnerable areas subject to flooding from significant rainfall and minor tropical storm activity. In addition, these areas may not be coastal or reside in hurricane evacuation areas. Therefore, the residents in these areas may constitute additional evacuation impacts.

The repetitive loss properties and repetitive loss areas are addressed in the County Local Mitigation Strategies (LMSs). A breakdown of the properties by structure type is provided in **Table II-13** below.

[8] A "repetitive-loss property" is one that has suffered two or more flood losses over 10 years with the cumulative cost of repairs equaling or exceeding 50 percent of the value of the structure. Increased Cost of Compliance for repetitive-loss structures is available only in communities that have repetitive-loss provisions in their floodplain-management ordinances and track repetitive-loss damages.

Table II-13
Repetitive Loss Properties

Community Name	Community Number	Mitigated ?	City	Occupancy	Zone	Losses	Average Pay	As of Date	County Name	County #
ARCADIA, CITY OF	120073	NO	ARCADIA	SINGLE FMLY	AE	3	25,206.81	03/31/2010	DESOTO COUNTY	027
ARCADIA, CITY OF	120073	NO	ARCADIA	SINGLE FMLY		3	5,165.15	03/31/2010	DESOTO COUNTY	027
ARCADIA, CITY OF	120073	NO	ARCADIA	SINGLE FMLY		5	13,646.19	03/31/2010	DESOTO COUNTY	027
ARCADIA, CITY OF	120073	NO	ARCADIA	SINGLE FMLY	AE	2	17,870.23	03/31/2010	DESOTO COUNTY	027
ARCADIA, CITY OF	120073	NO	ARCADIA	SINGLE FMLY	AE	5	35,704.93	03/31/2010	DESOTO COUNTY	027
ARCADIA, CITY OF	120073	NO	ARCADIA	SINGLE FMLY	AE	3	25,213.82	03/31/2010	DESOTO COUNTY	027
DESOTO COUNTY*	120072	NO	ARCADIA	ASSMD CONDO	AE	2	4,238.92	03/31/2010	DESOTO COUNTY	027
DESOTO COUNTY*	120072	NO	ARCADIA	NON RESIDNT	A	2	29,042.07	03/31/2010	DESOTO COUNTY	027
DESOTO COUNTY*	120072	NO	ARCADIA	NON RESIDNT	AE	2	1,576.98	03/31/2010	DESOTO COUNTY	027
DESOTO COUNTY*	120072	NO	ARCADIA	SINGLE FMLY	AE	3	40,175.60	03/31/2010	DESOTO COUNTY	027
DESOTO COUNTY*	120072	NO	ARCADIA	SINGLE FMLY	AE	3	17,742.37	03/31/2010	DESOTO COUNTY	027
DESOTO COUNTY*	120072	NO	ARCADIA	SINGLE FMLY	AE	2	40,267.08	03/31/2010	DESOTO COUNTY	027
DESOTO COUNTY*	120072	NO	ARCADIA	SINGLE FMLY	AE	2	19,264.66	03/31/2010	DESOTO COUNTY	027
DESOTO COUNTY*	120072	NO	ARCADIA	SINGLE FMLY	AE	2	41,155.92	03/31/2010	DESOTO COUNTY	027
DESOTO COUNTY*	120072	NO	ARCADIA	SINGLE FMLY	AE	2	9,693.00	03/31/2010	DESOTO COUNTY	027
DESOTO COUNTY*	120072	NO	ARCADIA	SINGLE FMLY	EMG	2	1,765.35	03/31/2010	DESOTO COUNTY	027
DESOTO COUNTY*	120072	NO	ARCADIA	SINGLE FMLY	AE	2	2,105.64	03/31/2010	DESOTO COUNTY	027
DESOTO COUNTY*	120072	NO	ARCADIA	SINGLE FMLY	AE	5	12,558.66	03/31/2010	DESOTO COUNTY	027
DESOTO COUNTY*	120072	NO	ARCADIA	SINGLE FMLY	AE	2	12,063.89	03/31/2010	DESOTO COUNTY	027
DESOTO COUNTY*	120072	NO	ARCADIA	SINGLE FMLY	AE	3	13,808.83	03/31/2010	DESOTO COUNTY	027
DESOTO COUNTY*	120072	NO	ARCADIA	SINGLE FMLY	AE	4	25,680.40	03/31/2010	DESOTO COUNTY	027
DESOTO COUNTY*	120072	NO	ARCADIA	SINGLE FMLY	A	2	3,978.96	03/31/2010	DESOTO COUNTY	027
DESOTO COUNTY*	120072	NO	ARCADIA	SINGLE FMLY	AE	2	15,765.87	03/31/2010	DESOTO COUNTY	027
DESOTO COUNTY*	120072	NO	ARCADIA	SINGLE FMLY	A	2	7,618.73	03/31/2010	DESOTO COUNTY	027
DESOTO COUNTY*	120072	NO	ARCADIA	SINGLE FMLY	AE	2	11,616.40	03/31/2010	DESOTO COUNTY	027
DESOTO COUNTY*	120072	NO	ARCADIA	SINGLE FMLY	AE	2	21,592.22	03/31/2010	DESOTO COUNTY	027
DESOTO COUNTY*	120072	NO	ARCADIA	SINGLE FMLY	AE	3	29,878.04	03/31/2010	DESOTO COUNTY	027
DESOTO COUNTY*	120072	NO	ARCADIA	SINGLE FMLY	AE	6	20,754.60	03/31/2010	DESOTO COUNTY	027

Community Name	Community Number	Mitigated ?	City	Occupancy	Zone	Losses	Average Pay	As of Date	County Name	County #
HARDEE COUNTY*	120103	NO	ONA	ASSMD CONDO	X	6	31,785.41	03/31/2010	HARDEE COUNTY	049
HARDEE COUNTY*	120103	NO	ONA	SINGLE FMLY	X	2	6,193.53	03/31/2010	HARDEE COUNTY	049
HARDEE COUNTY*	120103	NO	WAUCHULA	SINGLE FMLY	X	2	11,475.57	03/31/2010	HARDEE COUNTY	049
HARDEE COUNTY*	120103	NO	WAUCHULA	SINGLE FMLY	X	2	2,846.20	03/31/2010	HARDEE COUNTY	049
HARDEE COUNTY*	120103	NO	WAUCHULA	SINGLE FMLY	X	2	3,866.58	03/31/2010	HARDEE COUNTY	049
ZOLFO SPRINGS, TOWN OF	120106	NO	ZOLFO SPRINGS	SINGLE FMLY	A	2	8,501.72	03/31/2010	HARDEE COUNTY	049

Community Name	Community Number	Mitigated ?	City	Occupancy	Zone	Losses	Average Pay	As of Date	County Name	County #
HIGHLANDS COUNTY *	120111	NO	LAKE PLACID	2-4 FAMILY	A	2	10,792.59	03/31/2010	HIGHLANDS COUNTY	055
HIGHLANDS COUNTY *	120111	NO	LAKE PLACID	SINGLE FMLY	A02	2	9,420.16	03/31/2010	HIGHLANDS COUNTY	055
HIGHLANDS COUNTY *	120111	NO	OKEECHOBEE	SINGLE FMLY	A	2	7,100.00	03/31/2010	HIGHLANDS COUNTY	055
HIGHLANDS COUNTY *	120111	NO	LORIDA	SINGLE FMLY	A02	3	18,736.05	03/31/2010	HIGHLANDS COUNTY	055
HIGHLANDS COUNTY *	120111	NO	LAKE PLACID	SINGLE FMLY	X	2	5,608.43	03/31/2010	HIGHLANDS COUNTY	055
HIGHLANDS COUNTY *	120111	NO	LAKE PLACID	SINGLE FMLY	AE	3	24,233.47	03/31/2010	HIGHLANDS COUNTY	055

Community Name	Community Number	Mitigated ?	City	Occupancy	Zone	Losses	Average Pay	As of Date	County Name	County #
OKEECHOBEE COUNTY *	120177	NO	OKEECHOBEE	NON RESIDNT	A02	2	46,364.81	03/31/2010	OKEECHOBEE COUNTY	093
OKEECHOBEE COUNTY *	120177	NO	OKEECHOBEE	SINGLE FMLY	A	2	15,068.87	03/31/2010	OKEECHOBEE COUNTY	093
OKEECHOBEE COUNTY *	120177	NO	OKEECHOBEE	SINGLE FMLY	A	2	9,970.38	03/31/2010	OKEECHOBEE COUNTY	093
OKEECHOBEE COUNTY *	120177	NO	OKEECHOBEE	SINGLE FMLY	X	2	17,559.05	03/31/2010	OKEECHOBEE COUNTY	093
OKEECHOBEE COUNTY *	120177	NO	OKEECHOBEE	SINGLE FMLY	A02	2	5,450.50	03/31/2010	OKEECHOBEE COUNTY	093
OKEECHOBEE COUNTY *	120177	NO	OKEECHOBEE	SINGLE FMLY	A	2	9,145.36	03/31/2010	OKEECHOBEE COUNTY	093
OKEECHOBEE COUNTY *	120177	NO	OKEECHOBEE	SINGLE FMLY	C	2	11,320.64	03/31/2010	OKEECHOBEE COUNTY	093
OKEECHOBEE COUNTY *	120177	NO	OKEECHOBEE	SINGLE FMLY	C	3	5,592.23	03/31/2010	OKEECHOBEE COUNTY	093
OKEECHOBEE COUNTY *	120177	NO	OKEECHOBEE	SINGLE FMLY	C	2	6,072.10	03/31/2010	OKEECHOBEE COUNTY	093
OKEECHOBEE COUNTY *	120177	NO	OKEECHOBEE	SINGLE FMLY	B	3	20,125.59	03/31/2010	OKEECHOBEE COUNTY	093
OKEECHOBEE COUNTY *	120177	NO	OKEECHOBEE	SINGLE FMLY	A	2	19,946.05	03/31/2010	OKEECHOBEE COUNTY	093
OKEECHOBEE COUNTY *	120177	NO	OKEECHOBEE	SINGLE FMLY	B	2	12,502.83	03/31/2010	OKEECHOBEE COUNTY	093

Community Name	Community Number	Mitigated ?	City	Occupancy	Zone	Losses	Average Pay	As of Date	County Name	County #
DAVENPORT, CITY OF	120410	NO	DAVENPORT	SINGLE FMLY	X	2	1,469.94	03/31/2010	POLK COUNTY	105
HAINES CITY, CITY OF	120266	NO	HAINES CITY	SINGLE FMLY	A	2	2,488.51	03/31/2010	POLK COUNTY	105
HIGHLAND PARK, VILLAGE OF	120386	NO	MIAMI LAKES	SINGLE FMLY	AE	2	5,350.24	03/31/2010	POLK COUNTY	105
LAKELAND, CITY OF	120267	YES	LAKELAND	SINGLE FMLY	C	3	30,393.93	03/31/2010	POLK COUNTY	105
LAKELAND, CITY OF	120267	YES	LAKELAND	SINGLE FMLY	C	2	2,182.36	03/31/2010	POLK COUNTY	105
MULBERRY, CITY OF	120268	NO	MULBERRY	SINGLE FMLY	A	2	6,002.64	03/31/2010	POLK COUNTY	105
POLK COUNTY*	120261	NO	LAKELAND	NON RESIDNT	A	2	2,926.50	03/31/2010	POLK COUNTY	105
POLK COUNTY*	120261	NO	LAKELAND	NON RESIDNT	A	3	72,334.07	03/31/2010	POLK COUNTY	105
POLK COUNTY*	120261	NO	LAKELAND	NON RESIDNT	X	2	61,870.93	03/31/2010	POLK COUNTY	105
POLK COUNTY*	120261	NO	POLK CITY	SINGLE FMLY	X	2	1,017.60	03/31/2010	POLK COUNTY	105
POLK COUNTY*	120261	NO	LAKELAND	SINGLE FMLY	X	4	51,356.95	03/31/2010	POLK COUNTY	105
POLK COUNTY*	120261	NO	LAKELAND	SINGLE FMLY	AE	2	2,773.49	03/31/2010	POLK COUNTY	105
POLK COUNTY*	120261	NO	LAKELAND	SINGLE FMLY	C	2	9,017.88	03/31/2010	POLK COUNTY	105
POLK COUNTY*	120261	NO	LAKELAND	SINGLE FMLY	A	2	24,125.87	03/31/2010	POLK COUNTY	105
POLK COUNTY*	120261	NO	LAKELAND	SINGLE FMLY	A	2	2,145.69	03/31/2010	POLK COUNTY	105
POLK COUNTY*	120261	NO	FROSTPROOF	SINGLE FMLY	AE	2	4,114.35	03/31/2010	POLK COUNTY	105
POLK COUNTY*	120261	NO	FROSTPROOF	SINGLE FMLY	AE	2	4,385.99	03/31/2010	POLK COUNTY	105
POLK COUNTY*	120261	NO	MULBERRY	SINGLE FMLY	C	2	1,564.31	03/31/2010	POLK COUNTY	105
POLK COUNTY*	120261	NO	LAKELAND	SINGLE FMLY	AE	6	15,678.42	03/31/2010	POLK COUNTY	105
POLK COUNTY*	120261	NO	LAKELAND	SINGLE FMLY	X	3	17,957.45	03/31/2010	POLK COUNTY	105
POLK COUNTY*	120261	NO	HAINES CITY	SINGLE FMLY	AE	2	5,613.04	03/31/2010	POLK COUNTY	105
POLK COUNTY*	120261	NO	LAKELAND	SINGLE FMLY	C	2	20,048.56	03/31/2010	POLK COUNTY	105
POLK COUNTY*	120261	NO	LAKELAND	SINGLE FMLY	AE	3	19,356.40	03/31/2010	POLK COUNTY	105
POLK COUNTY*	120261	NO	MULBERRY	SINGLE FMLY	X	2	9,958.92	03/31/2010	POLK COUNTY	105
POLK COUNTY*	120261	NO	LAKE WALES	SINGLE FMLY	X	3	12,896.54	03/31/2010	POLK COUNTY	105
POLK COUNTY*	120261	NO	DAVENPORT	SINGLE FMLY	A	2	1,995.90	03/31/2010	POLK COUNTY	105
POLK COUNTY*	120261	NO	HAINES CITY	SINGLE FMLY	AE	2	4,349.71	03/31/2010	POLK COUNTY	105
POLK COUNTY*	120261	NO	LAKE WALES	SINGLE FMLY	X	3	86,242.72	03/31/2010	POLK COUNTY	105
POLK COUNTY*	120261	NO	LAKELAND	SINGLE FMLY	C	4	15,863.61	03/31/2010	POLK COUNTY	105
POLK COUNTY*	120261	NO	LAKE WALES	SINGLE FMLY	X	2	4,431.74	03/31/2010	POLK COUNTY	105
POLK COUNTY*	120261	NO	LAKELAND	SINGLE FMLY	AE	2	6,990.15	03/31/2010	POLK COUNTY	105
POLK COUNTY*	120261	YES	BARTOW	SINGLE FMLY	AE	2	32,520.22	03/31/2010	POLK COUNTY	105
POLK COUNTY*	120261	YES	BARTOW	SINGLE FMLY	AE	3	28,088.24	03/31/2010	POLK COUNTY	105

Community Name	Community Number	Mitigated ?	City	Occupancy	Zone	Losses	Average Pay	As of Date	County Name	County #
POLK COUNTY*	120261	YES	BARTOW	SINGLE FMLY	AE	3	34,185.21	03/31/2010	POLK COUNTY	105
POLK COUNTY*	120261	YES	LAKELAND	SINGLE FMLY	C	3	122,086.49	03/31/2010	POLK COUNTY	105
WINTER HAVEN, CITY OF	120271	NO	WINTER HAVEN	SINGLE FMLY	X	2	21,499.77	03/31/2010	POLK COUNTY	105

*Source: **Local Mitigation Strategy** Plans for DeSoto, Hardee, Highlands, Okeechobee and Polk Counties, Florida Division of Emergency Management, NFIP (Numbers based on latest Repetitive Loss List dated 06/30/09)*

D. Wildfires and the Urban Interface

Florida is home to millions of residents who enjoy the state's beautiful scenery and warm climate. But few people realize that these qualities also create severe wildfire conditions. Each year, thousands of acres of wildland and many homes are destroyed by fires that can erupt at any time of the year from a variety of causes, including arson, lightning and debris burning. Adding to the fire hazard is the growing number of people living in new communities built in areas that were once wildland. This growth places even greater pressure on the state's wildland firefighters. As a result of this growth, fire protection becomes everyone's responsibility (Florida Division of Emergency Management, 2008 http://www.floridadisaster.org/bpr/EMTOOLS/wildfire/wildfire.htm).

1. Wildfire Hazard Profile

A wildfire is any fire occurring in the wildlands (i.e. grasslands, forest, brushland, etc). Wildfires have burned across the woodlands of Florida for centuries and are part of the natural management of much of Florida's ecosystems. (**Statewide Hazard Mitigation Plan, 2009**) There are four types of forest fires:

- Surface fires – the most common type of wildfire burns along the floor of the forest, moving slowly killing or damaging trees.
- Ground fires (muck fires) are usually started by carelessness and burn on or below the forest floor. These fires are hard to detect and even harder to extinguish.
- Crown fires are spread rapidly by the wind and move fastest of all types of fires by jumping along the tops of trees.
- Wildland-Urban Interface – WUI fires are in a geographical area where structures and other human development meet or intermingle with wildlands or vegetative fuels.

Florida's typical fire season is from January to May. During relatively dry months, the potential for wildfires increases dramatically. The driest months, combined with low humidity and high wind, have the highest number of fires reported (January, February and March). During these months, fine fuels (i.e.

grass, leaves, pine needles) are in optimal burning condition. The largest number of lightning-caused fires occurs in July, coinciding with the peak of the thunderstorm season.

Each wildfire, especially near development, can threaten human life, structures and natural resources. Urban development has moved into wildland areas where the hazard is more severe and fire control is more difficult.

2. History of Wildfire in the Region

Florida's typical forest fire season is the dry portion of the year, between January and May. The largest numbers of naturally-caused fires occur in July due to lightning and coincide with the height of the thunderstorm season. However, lightning accounts for only 11.7% of the fires started during 1974 - 1990. Other sources are manmade, including arson, carelessness, debris/trash burning, and operating equipment which may emit sparks. Because so much of the county is comprised of timber lands, a major portion of the county is vulnerable to forest fires, although the threat to the population at large is not considered significant.

In the Spring of 1985, a drought, which had been underway in the state since August 1984, created numerous spot fires around the state. On May 16, 1985, a wildfire was discovered west of the Palm Coast Development in Flagler County. Palm Coast is a 42,000 acre planned community situated in the coastal plain flat woods along the East Coast of Florida. A wildfire burned through Palm Coast and destroyed 100 homes, damaged 200 more and burned 13,000 acres. This disaster was a mixed wildland urban interface fire associated with urban sprawl type development where the hydro-period is drastically altered and cuts the land into many unmanaged tracts of fire vulnerable wildlands.

In 1989, there were a record number of acres burned (645,326) as a result of 7,291 fires. A large percentage of the acres burned were located in the Everglades. A record number of wildfires occurred in 1981, with 14,042 fires that burned 587,400 acres as a result of a drought that started in July of 1980 and continued throughout 1981. In 1985, another drought stricken year, there were 8,261 fires that burned 443,811 acres.

From 1981 through 1996, an average of 6,080 wildfires occurred per year, burning 219,725 acres. Because of changing weather conditions, the yearly figures range from a low of 3,985 wildfires (86,944 acres burned) in 1991 to a record high of 14,042 wildfires (587,400 acres burned) in 1981. Florida experienced a record high (645,326 acres burned) in 1989 as a result of drought conditions around the state.

The beginning months of 1998 brought widespread flooding. After the rain stopped, severe drought conditions developed and lasted from April thru June of 1998. As a result of the extreme drought conditions, high temperatures and buildup of flammable wildland fuels, the 1998 wildfires began. The first fire broke out on May 25, 1998 in the Apalachicola National Forest. In a two-month period, almost 500,000 acres of the state had burned in approximately 2,300 separate wildfires. The cost of this event reached over $160 million. The wildfires of 1998 damaged or destroyed over 300 homes and the value of lost timber exceeded $300 million.

Spring/Summer 2007 - The wildfires that put much of Florida in a several weeks-long smoky haze were started May 5 by a lightning strike on Bugaboo Island in Georgia's Okefenokee National Wildlife Refuge. Thick smoke from area wildfires forced officials to close stretches of I-75 and I-10 in northern Florida. A section of I-95 in Duval County, from Pecan Park to State Road A1A, was also closed due to smoke, as was a section of I-75 in Broward County, near fire-ravaged Collier County in southern Florida. The fires scorched at least 212,000 acres, according to the joint information center, a coalition of state and federal agencies. Of those acres, 101,000 were in Florida and about 111,000 were in Georgia. Interstate 75 was closed from Valdosta, Georgia, south to Lake City, Florida and Interstate 10 was closed from Sanderson, Florida, eastward to Live Oak.

3. Wildland-Urban Interface (WUI)

The Florida Division of Forestry (DOF) provides risk maps for wildfire. The web-based risk system produces maps for Level of Concern (LOC), Fuels, Wildland Fire Susceptibility Index (WFSI), and the likelihood of the number of fires per 1000 acres per year (FOA). Unfortunately, the website does not offer a vulnerability output in terms of dollars lost and the data was last updated in 2005. Data layers are in the process of being updated for the release of DOF's new web-based mapping risk assessment program, due out in late 2009 or early 2010.

a. Methodology

The Wildland Fire Risk Assessment System (FRAS) combines indices of Wildland Fire Susceptibility and Fire Effects to generate a "Level of Concern" map. Data layers used to develop the Wildland Fire Susceptibility Index include: fuel and crown closure classifications and non-burnable areas from Landsat TM data, and topographic and fire weather data from existing data sets.

The Fire Effects Index uses data layers derived from a variety of existing data sets. These data include location of critical facilities, forest plantations, utility corridors, urban interface areas, roads, and firefighting resource locations; as well as, suppression cost--based on soil and fuel types.

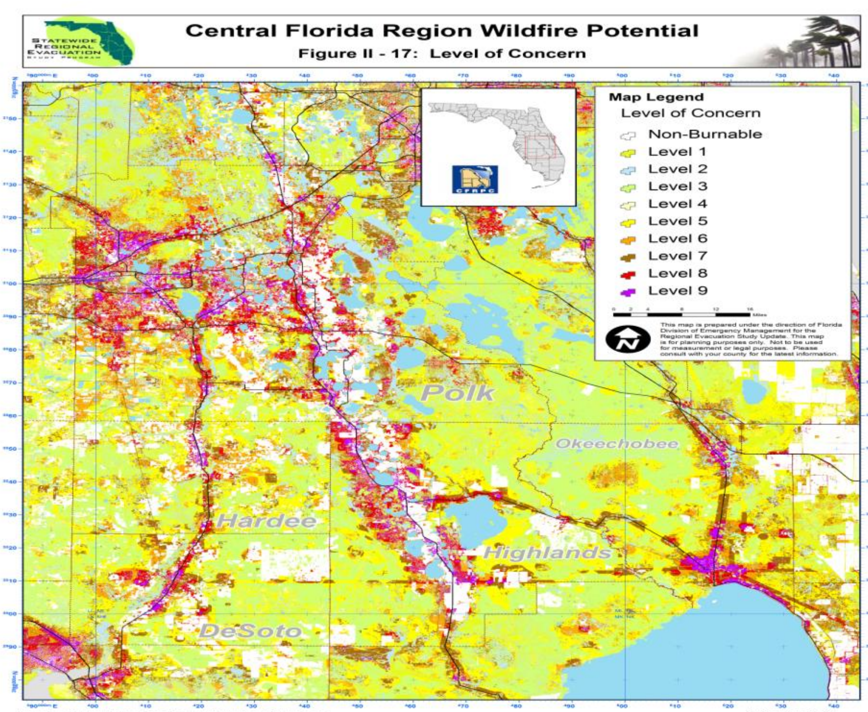
The Levels of Concern (LOC) were computed by multiplying the Wildland Fire Susceptibility Indices by the Fire Effects Indices. The LOC values were then assigned to nine categories of risk and mapped for each Florida Division of Forestry District.

Another component of FRAS is the Fire Response Accessibility Index (FRAI). The FRAI is a relative measure of travel time from the nearest fire station to a particular mapped cell. Values are assigned to one of six categories of time ranging from class 1 (greater than 120 minutes) to class 6 (0-14 minutes). Accessibility is based on the location of roads and wildland firefighting resource dispatch stations. The Fire Response Accessibility Index is coupled with the Levels of Concern data on District maps.

The fire behavior model, FlamMap is used in FRAS. FlamMap calculates the behavior of a fire occurring in each 30x30 meter cell under defined weather conditions given topographic, fuels, and crown closure data.

Figure II-17 illustrates the risk for wildfire within the region using the data provided by the Florida Division of Forestry.

Figure II-17
Central Florida Region Wildfire Potential



E. Hazardous Material Incidents

1. Overview

Hazardous Materials are part of everyday life in America. The good things chemicals bring into our lives have become vital to us. Although major chemical emergencies are extremely rare, there always remains a chance that one will occur. In the State of Florida, the county emergency management agency's plan for hazardous material incidents and coordinate regionally for response through the Local Emergency Planning Committees (LEPCs)

2. History of the Local Emergency Planning Committees (LEPCs)

Public awareness of the potential danger from accidental releases of hazardous substances has increased over the years as serious chemical accidents have occurred around the world, including a significant release in Bhopal, India in 1984 which killed thousands and a more localized event in Institute, West Virginia. In response to this public concern and the hazards that exist, EPA began its Chemical Emergency Preparedness Program (CEPP) in 1985. CEPP was a voluntary program to encourage state and local authorities to identify hazards in their areas and to plan for potential chemical emergencies. This local planning complemented emergency response planning carried out at the national and regional levels by the National Response Team and Regional Response Teams organized by EPA, the U.S. Coast Guard, and the National Oceanic and Atmospheric Administration (NOAA).

The following year, Congress enacted many of the elements of CEPP in the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA), also known as Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This law required states to establish State Emergency Response Commissions and Local Emergency Planning Committees to develop emergency response plans for each community. EPCRA also required facilities to make information available to the public on the hazardous chemicals they have on site. EPCRA's reporting requirements foster a valuable dialogue between industry and local communities on hazards to help citizens become more informed about the presence of hazardous chemicals that might affect public health and the environment. According to OSHA requirements, workers on site also have a right to know about the hazardous chemicals to which they could be exposed.

Within the Central Florida Region, Local Emergency Planning Committee (LEPC) District VII, was created in 1988 to help the public and emergency responders address hazardous materials public safety issues. The focus of the committee is on planning, regional coordination, education and awareness. Every state has LEPCs. In Florida, the LEPCs are organized in conjunction with the eleven Regional Planning Councils which provide staff support with funding from the Florida Division of Emergency Management.

District VII LEPC, which includes DeSoto, Hardee, Highlands, Okeechobee, and Polk counties, meets quarterly beginning in February of each year. LEPC members are appointed by the State Emergency Response Commission for Hazardous Materials (SERC); a policy board appointed by the Governor, which administers the hazardous materials (HAZMAT) laws for the U.S. Environmental Protection Agency (EPA) at the Florida level; and at the local level, through the 11 LEPCs statewide. The Chairman of the SERC is the Secretary of the Department of Community Affairs and the Alternate Chairman is the Director of the Division of Emergency Management. Membership of the LEPC represents 18 occupational categories as follows: Elected State Official, Elected Local Official, Emergency Management, Firefighting, First Aid (EMS), Health Organizations, Law Enforcement, Local Environmental, Hospital, Transportation, Broadcast media, Print Media, Community Groups (i.e. Red Cross, etc), Facility Owners, Facility Operators, Non-Elected Local Officials, Water Management District Rep (SWFWMD), and Interested Citizen.

3. LEPC Mission Statement

The LEPC mission is to partner with citizens, facilities, and local emergency management officials to protect communities from the adverse effects of hazardous materials in District VII.

To support this goal, the LEPC is committed to the following objectives:

a. The LEPC shall **prepare a regional hazardous materials emergency plan** which indicates the facilities that store, use, or produce hazardous substances at or above established threshold amounts and that are located in the region;

- Data collected is used by the each LEPC to develop plans used in responding to and recovering from a release or spill of hazardous or toxic substances. These plans are reviewed and updated by the LEPC annually and are approved by DCA on behalf of the State Emergency Response Commission.

b. The LEPC shall serve as the **repository for regional reports** filed under EPCRA;

- In the past, more than 3600 facilities in the Central Florida LEPC District 7 area have reported their chemical inventories consisting of over 25,000 listings of both hazardous and extremely hazardous substances under Sections 311/312 of EPCRA. These reports are available for public review at the LEPC office.

c. The LEPC shall direct regional implementation activities and perform associated outreach functions to **increase awareness and understanding** of and compliance with the EPCRA as well as the Risk Management Planning (RMP) programs.

d. The LEPC shall play an active role in **risk communication, public education, industry outreach, mitigation, and emergency planning** associated with the Clean Air Act and Risk Management Planning.

4. Hazards Analysis of Hazardous Materials

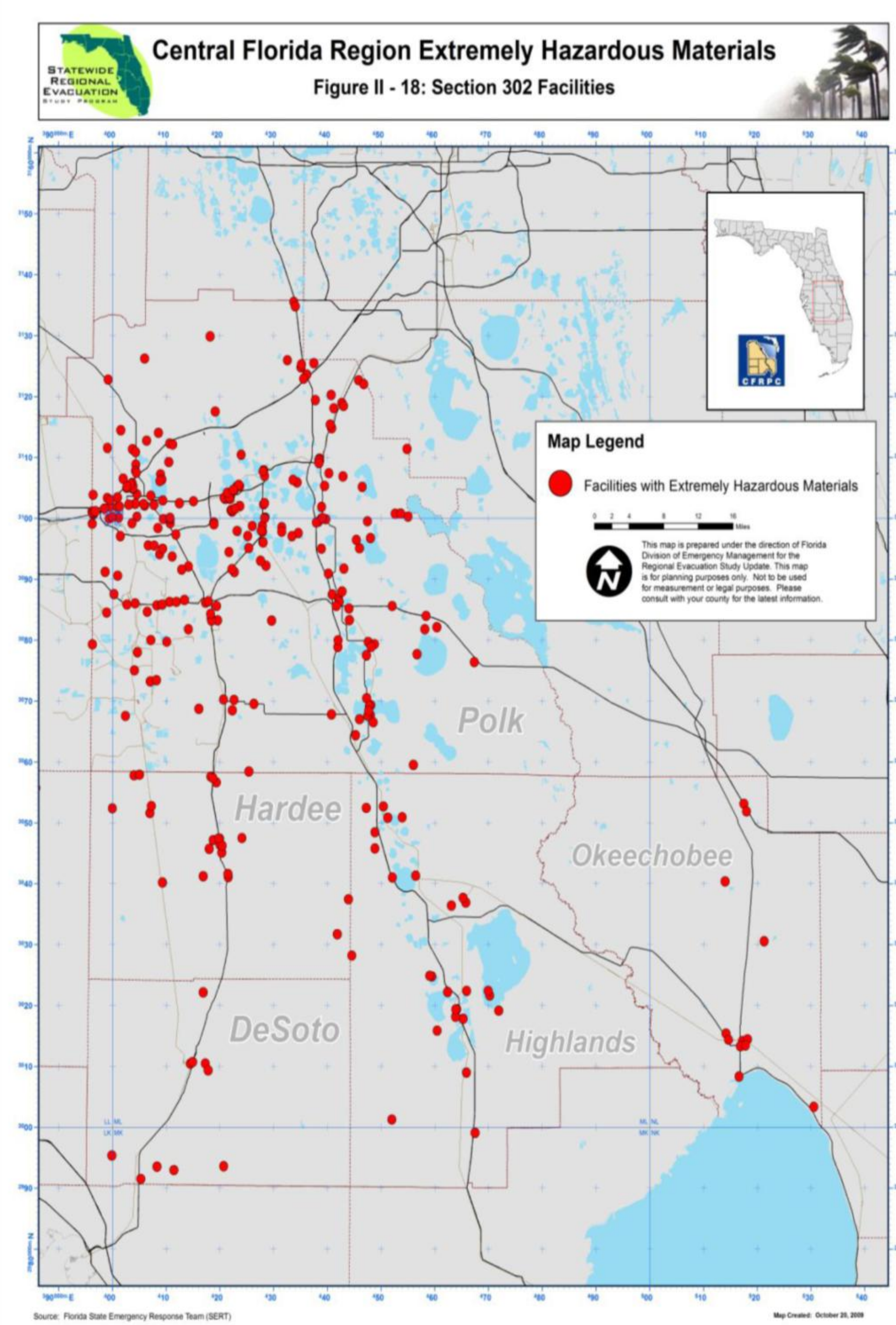
The hazard analysis assesses the amount(s) of material(s) present and the relative risk they represent to the surrounding community and public facilities.

Any facility, public or private, that has **extremely hazardous materials** at or above established threshold amounts on site at any given time during the year, is required to report annually. This facility is referred to as a Section 302 facility (relating to the clause in EPCRA which pertains to Extremely Hazardous Substances facilities). A hazards analysis on the facility is usually performed on a biennial basis. See **Figure II-18** for maps showing the general location of Section 302 facilities in the region.

In addition, any facility which possesses in excess of 10,000 pounds, a hazardous material for which the Occupational Safety and Health Administration (OSHA) requires the facility to keep a Material Safety Data Sheet is also required to render the annual report.

While the number of hazardous substance facilities continues to increase as awareness of the law reaches various segments of the community, EPCRA has been successful in reducing, over the years, facilities possessing extremely hazardous substances (EHSs) by encouraging that they seek alternative products which do not require reporting and thus, payment of the reporting fee. The reporting deadline each year is March 1st. Within District VII, there are 289 Section 302 (EHS) facilities reporting in 2008 and 686 facilities reporting under Sections 311/312.

Figure II-18
Section 302 Facilities in the Central Florida Region



District 7 possesses less than 10 % (8.5%) of the total Section 302 chemicals by weight and volume in the State of Florida. District VII had the second highest number of hazardous material incidents for 2007, 125 total, this was <6% of the total of 2,125 incidents statewide. This is attributed to the safety commitments of the district's largest facilities and their outstanding safety records. It must be pointed out that many of these releases involved anhydrous ammonia or sulfuric acid and most occurred when transferring chemicals from transportation systems to storage tanks. Of the eleven districts in the state, District 7 ranked 6th in the total number of releases throughout the state. Additionally, some of the ammonia releases were from attempted thefts of anhydrous ammonia, an essential ingredient in the manufacture of methamphetamines. District VII's reported ten top Section 302 chemicals for 2007 are found in Table II-14 below:

Table II-14
District VII Top Ten Section 302 Chemicals

Chemical	2006 Maximum Inventory (lbs)	2007 Maximum Inventory (lbs)	Change from 2006	Percent of State-Wide Inventory
Sulfuric Acid	220,295,964	79,886,376	(-) 140,409,588	19.5%
Anhydrous Ammonia*	7,905,313	4,145,932	(-) 3,759,381	1.27%
Aldicarb	512,523	868,811	(+) 356,288	35.8%
Chlorine*	887,650	779,130	(-) 108,520	0.379%
Bromomethane (Methyl Bromide)	124,200	142,110	(+) 17,910	1.89%
Hydrogen Fluoride # (Hydrofluoric Acid)	114,121	115,108	(+) 987	38.76%
Dimethoate #	**	106,870	**	54.47%
Endosulfan	133,328	97,626	(-) 35,702	25.55%
Methomyl # (Ethanimidothioic Acid)	**	88,315	**	26.21%
Nitric acid* #	**	87,883	**	3.09%

** These chemicals are also covered under the Clean Air Act, Section 112)*
*** Did not appear on the 2006 list for District VIII*
 # This is the first appearance of these chemicals on the top-ten list
*Source, SERC for Hazardous Materials**, Annual Report 2008***

a. CAMEOfm, MARPLOT and ALOHA Update

Accidental releases involving hazardous chemicals occur frequently in the United States. Therefore, the U.S. Environmental Protection Agency (EPA), the National Oceanic and Atmospheric Administration (NOAA) and firefighters collaborated to develop the Computer Aided Management of Emergency Operations (CAMEO) software system more than twenty years ago. The CAMEO system is a combination of three programs which work independently or in conjunction to give hazardous materials planners and first responders the tools to plan for and respond to hazardous materials releases. As technology has advanced, numerous revisions have been made to the software. The most recent update was released in February 2006.

One of the programs, CAMEO filemaker (CAMEOfm), contains a chemical library which provides planners and responders with important information on a multitude of chemicals and chemical mixtures. The program also allows the user to create a chemical information database for individual facilities that have hazardous materials on site. CAMEOfm can automatically calculate a vulnerable zone for a simulated or actual chemical release based on specific data entered by the user. The Chemical Library was also updated with the latest Acute Exposure Guideline Levels (AEGLs). The AEGLs are Toxic Levels of Concern that can be used to predict the area in which a toxic gas concentration may be high enough to harm people. Finally, minor changes were made to the Reactivity Report that is used to predict possible reactions that might occur when two or more chemicals are mixed.

The second program, Mapping Application for Response and Planning of Local Operational Tasks (MARPLOT), is a typical Geographic Information System (GIS) with multiple layers which allow the user to view major roads, secondary roads, water bodies, railroads, and other features on selected maps. It also allows the user to plot features like chemical facilities and critical facilities (schools, hospitals, day care centers, etc.) and identify evacuation routes on the maps. MARPLOT may be used in conjunction with CAMEOfm to map a vulnerable zone around a release point and identify populations within the zone that may be affected by a chemical release. The upgraded version of MARPLOT correctly displays multiple plume footprints.

The third program, Arial Locations of Hazardous Atmospheres (ALOHA), was developed to allow the user to model dispersion of a hazardous chemical release. ALOHA gives emergency planners and responders the capability to model chemical plumes. The user chooses from a variety of criteria such as, location, date, time, atmospheric conditions, type/size of container, assorted hole sizes and shapes, source (puddle, gas pipeline etc.) to plot a footprint. In the updated version of ALOHA, users can now estimate the hazards associated with jet fires (flares), pool fires, vapor cloud explosions, Boiling Liquid Expanding Vapor Explosions (BLEVEs), and flammable regions (flashfires) as well as downwind toxic threats.

Over the years, CAMEO has become the most widely used hazardous materials emergency planning and response tool in Florida and the United States. In fact, Florida now requires electronic submission of hazards analyses in CAMEOfm format from local emergency planners. The software is provided at no cost and can be downloaded from the EPA website (http://www.epa.gov/ceppo/cameo/).

b. Central Florida Hazardous Material Emergency Plan

Comprehensive planning depends upon a clear understanding of what hazards exist and what risk they pose for the community. To gain this understanding, the Florida Division of Emergency Management, has contracted with the counties in the Central Florida Local Emergency Planning Committee (LEPC) district to conduct site-specific hazard analyses for airborne releases of extremely hazardous substances (EHSs) covered under Section 302 of EPCRA. The hazards analyses are made available to the Central Florida LEPC and serve as the basis for developing and revising the emergency response plans that are mandatory under the law.

The hazards analyses included in this section of the plan are designed to consider all potential acute health hazards within the Central Florida LEPC area and to identify which hazards are of high priority and should be addressed in the emergency response planning process. There are hundreds of facilities in the Central Florida LEPC area that are subject to the requirements of EPCRA and the number that have notified the State Emergency Response Commission for Hazardous Materials (SERC), the LEPC, and the local jurisdictional fire department in accordance with the provisions of EPCRA have grown significantly. A complete set of hazards analyses are available through LEPC District 7, located with the Central Florida Regional Planning Council. Hazards analyses will be updated as other existing and/or new facilities come into compliance with the requirements of EPCRA.

The hazards analysis for the Central Florida LEPC area consists of the following three components:

(1). Hazards Identification - provides specific information on situations that have the potential for causing injury to life or damage to property.

A hazards identification includes information about:

1) Chemical identities;

2) The location of facilities that use, produce, process, or store hazardous materials;

3) The type and design of chemical container or vessel;

4) The quantity of material that could be involved in an airborne release; and

5) The nature of the hazard (e.g., airborne toxic vapors or mists which are the primary focus of this guide; also other hazards such as fire, explosion, large quantities stored or processed, handling conditions) most likely to accompany hazardous materials spills or releases.

(2). Vulnerability Analysis - identifies areas in the community that may be affected or exposed, individuals in the community who may be subject to injury or death from certain specific hazardous materials, and what facilities, property, or environment may be susceptible to damage should a hazardous materials release occur. A comprehensive vulnerability analysis provides information on:

(a) The extent of the vulnerable zones (i.e., an estimation of the area that may be affected in a significant way as a result of a spill or release of a known quantity of a specific chemical under defined conditions);

(b) The population, in terms of numbers, density, and types of individuals that could be within a vulnerable zone;

(c) The private and public property that may be damaged, including essential support systems and transportation facilities and corridors; and

(d) The environment that may be affected, and the impact of a release on sensitive natural areas and endangered species.

(3). Risk Analysis - is an assessment by the community of the likelihood (probability) of an accidental release of a hazardous material and the actual consequences that might occur, based on the estimated vulnerable zones. The risk analysis is a judgment of probability and severity of consequences based on the history of previous incidents, local experience, and the best available current technological information. It provides an estimation of:

(a) The likelihood (probability) of an accidental release based on the history of current conditions and controls at the facility, consideration of any unusual environmental conditions, or the possibility of simultaneous emergency incidents;

(b) Severity of consequences of human injury that may occur, the number of possible injuries and deaths, and the associated high-risk groups; and

(c) Severity of consequences of damage to critical facilities, property, and the environment.

The hazards analyses summaries for 344 facilities in the Central Florida LEPC area that have reported to the State Emergency Response Commission are maintained in the ***Regional Hazardous Material Emergency Response Plan.***

Emergencies involving hazardous materials can be postulated as ranging from a minor emergency with no off-site effects to a major emergency that may result in an off-site release of hazardous/toxic materials. The overall objective of chemical emergency response planning and preparedness is to minimize exposure for a spectrum of emergencies that could produce off-site levels of contamination in excess of Levels of Concern (LOCs) established by the US Environmental Protection Agency. Minimizing this exposure will reduce the consequences of an emergency to persons in the area nearby facilities that manufacture, store or process hazardous materials.

No specific emergency sequence can be isolated as the model for which to plan because each emergency could have different consequences, both in nature and degree. As an alternative to defining a specified emergency, the regional plan identifies various parameters for planning which are based upon knowledge of the possible consequences, timing, and release characteristics of a spectrum of emergencies. The Regional Hazardous Materials Emergency Response Plan then establishes the appropriate response for each level of threat. Therefore the Statewide Regional Evacuation Study will not specifically address hazardous material incidents.

c. Regional Hazardous Materials Commodity Flow Study

The Section 302 Facility Hazards Analysis discussed in the previous section identifies hazardous materials at fixed facilities, but does not address potential hazards arising from the transportation hazardous materials. LEPCs often perform Regional Hazardous Materials Commodity Flow studies to determine what hazardous materials are being transported through their respective regions. The District VII LEPC has not performed a Regional Hazardous Materials Commodity Flow Study in recent years.

F. Terrorism and Domestic Security

1. Overview

Terrorism is the use of force or violence against persons or property in violation of the criminal laws of the United States for purposes of intimidation, coercion, or ransom.

Terrorists often use threats to:

- Create fear among the public.
- Try to convince citizens that their government is powerless to prevent terrorism.
- Get immediate publicity for their causes.

Acts of terrorism include threats of terrorism; assassinations; kidnappings; hijackings; bomb scares and bombings; cyber attacks (computer-based); and the use of chemical, biological, nuclear and radiological weapons.

High-risk targets for acts of terrorism include military and civilian government facilities, international airports, large cities, and high-profile landmarks. Terrorists might also target large public gatherings, water and food supplies, utilities, and corporate centers. Further, terrorists are capable of spreading fear by sending explosives or chemical and biological agents through the mail.

a. Explosions

Terrorists have frequently used explosive devices as one of their most common weapons. Terrorists do not have to look far to find out how to make explosive devices; the information is readily available in books and other information sources. The materials needed for an explosive device can be found in many places including variety, hardware, and auto supply stores. Explosive devices are highly portable using vehicles and humans as a means of transport. They are easily detonated from remote locations or by suicide bombers.

Conventional bombs have been used to damage and destroy financial, political, social, and religious institutions. Attacks have occurred in public places and on city streets with thousands of people around the world injured and killed.

b. Biological Threats

Biological agents are organisms or toxins that can kill or incapacitate people, livestock, and crops. The three basic groups of biological agents that would likely be used as weapons are bacteria, viruses, and toxins. Most biological agents are difficult to grow and maintain. Many break down quickly when exposed to sunlight and other environmental factors, while others, such as anthrax spores, are very long lived. Biological agents can be dispersed by spraying them into the air, by infecting animals that carry the disease to humans and by contaminating food and water. Delivery methods include:

- Aerosols - biological agents are dispersed into the air, forming a fine mist that may drift for miles. Inhaling the agent may cause disease in people or animals.
- Animals - some diseases are spread by insects and animals, such as fleas, mice, flies, mosquitoes, and livestock.
- Food and water contamination - some pathogenic organisms and toxins may persist in food and water supplies. Most microbes can be killed, and toxins deactivated, by cooking food and boiling water. Most microbes are killed by boiling water for one minute, but some require longer.
- Person-to-person - spread of a few infectious agents is also possible. Humans have been the source of infection for smallpox, plague, and the Lassa viruses.

c. Chemical Threats

Chemical agents are poisonous vapors, aerosols, liquids, and solids that have toxic effects on people, animals, or plants. They can be released by bombs or sprayed from aircraft, boats, and vehicles. They can be used as a liquid to create a hazard to people and the environment. Some chemical agents may be odorless and tasteless. They can have an immediate effect (a few seconds to a few minutes) or a delayed effect (2 to 48 hours). While potentially lethal, chemical agents are difficult to deliver in lethal concentrations. Outdoors, the agents often dissipate rapidly. Chemical agents also are difficult to produce.

A chemical attack could come without warning. Signs of a chemical release include people having difficulty breathing; experiencing eye irritation; losing coordination; becoming nauseated; or having a burning sensation in the nose, throat, and lungs. Also, the presence of many dead insects or birds may indicate a chemical agent release.

d. Nuclear Blast

A nuclear blast is an explosion with intense light and heat, a damaging pressure wave, and widespread radioactive material that can contaminate the air, water, and ground surfaces for miles around. A nuclear device can range from a weapon carried by an intercontinental missile launched by a hostile nation or terrorist organization, to a small portable nuclear devise transported by an individual. All nuclear devices cause deadly effects when exploded, including blinding light, intense heat (thermal radiation), initial nuclear radiation, blast, fires started by the heat pulse, and secondary fires caused by the destruction.

(1) Hazards of Nuclear Devices

The extent, nature, and arrival time of these hazards are difficult to predict. The geographical dispersion of hazard effects will be defined by the following:

- Size of the device. A more powerful bomb will produce more distant effects.
- Height above the ground the device was detonated. This will determine the extent of blast effects.
- Nature of the surface beneath the explosion. Some materials are more likely to become radioactive and airborne than others. Flat areas are more susceptible to blast effects.
- Existing meteorological conditions. Wind speed and direction will affect arrival time of fallout; precipitation may wash fallout from the atmosphere.

(2) Radioactive Fallout

Even if individuals are not close enough to the nuclear blast to be affected by the direct impacts, they may be affected by radioactive fallout. Any nuclear blast results in some fallout. Blasts that occur near the earth's surface create much greater amounts of fallout than blasts that occur at higher altitudes. This is because the tremendous heat produced from a nuclear blast causes an up-draft of air that forms the familiar mushroom cloud. When a blast occurs near the earth's surface, millions of vaporized dirt particles also are drawn into the cloud. As the heat diminishes, radioactive materials that have vaporized condense on the particles and fall back to

Earth. The phenomenon is called radioactive fallout. This fallout material decays over a long period of time, and is the main source of residual nuclear radiation.

Fallout from a nuclear explosion may be carried by wind currents for hundreds of miles if the right conditions exist. Effects from even a small portable device exploded at ground level can be potentially deadly.

Nuclear radiation cannot be seen, smelled, or otherwise detected by normal senses. Radiation can only be detected by radiation monitoring devices. This makes radiological emergencies different from other types of emergencies, such as floods or hurricanes. Monitoring can project the fallout arrival times, which will be announced through official warning channels. However, any increase in surface build-up of gritty dust and dirt should be a warning for taking protective measures.

In addition to other effects, a nuclear weapon detonated in or above the earth's atmosphere can create an electromagnetic pulse (EMP), a high-density electrical field. An EMP acts like a stroke of lightning but is stronger, faster, and shorter. An EMP can seriously damage electronic devices connected to power sources or antennas. This includes communication systems, computers, electrical appliances, and automobile or aircraft ignition systems. The damage could range from a minor interruption to actual burnout of components. Most electronic equipment within 1,000 miles of a high-altitude nuclear detonation could be affected. Battery-powered radios with short antennas generally would not be affected. Although an EMP is unlikely to harm most people, it could harm those with pacemakers or other implanted electronic devices.

e. Radiological Dispersion Device

Terrorist use of an RDD—often called "dirty nuke" or "dirty bomb"—is considered far more likely than use of a nuclear explosive device. An RDD combines a conventional explosive device—such as a bomb—with radioactive material. It is designed to scatter dangerous and sub-lethal amounts of radioactive material over a general area. Such RDDs appeal to terrorists because they require limited technical knowledge to build and deploy compared to a nuclear device. Also, the radioactive materials in RDDs are widely used in medicine, agriculture, industry, and research, and are easier to obtain than weapons grade uranium or plutonium.

The primary purpose of terrorist use of an RDD is to cause psychological fear and economic disruption. Some devices could cause fatalities from exposure to radioactive materials. Depending on the speed at which the area of the RDD detonation was evacuated or how successful people were at sheltering-in-place, the number of deaths and injuries from an RDD might not be substantially greater than from a conventional bomb explosion.

The size of the affected area and the level of destruction caused by an RDD would depend on the sophistication and size of the conventional bomb, the type of radioactive material used, the quality and quantity of the radioactive material, and the local meteorological conditions—primarily wind and precipitation. The area affected could be placed off-limits to the public for several months during cleanup efforts.

2. The Regional Domestic Security Task Forces (RDSTFs)

Following 9/11, Florida divided itself into seven (7) Regional Domestic Security Task Forces. These regions follow the FDLE regions within the State. The Central Florida Region is split between FDLE Region 4 in Tampa and FDLE Region 6 in Ft. Myers. Polk and Hardee Counties belong to Region 4 and DeSoto, Highlands and Okeechobee belong to Region 6.

The goal of the RDSTF is to provide a regional response to any Weapon of Mass Destruction (WMD) or terrorist incident that may occur within the State. It allows smaller counties that do not have lots of resources to draw from those that do. It also allows these smaller counties to provide assistance to larger metropolitan areas if an event occurs there. Addressing security issues at a regional level also allows for "economies of scale" for homeland security funds, especially in recent years as the amount of DHS funding to the States has decreased. Florida has been routinely hailed as a model for domestic security planning throughout the nation as a result of this regional approach.

3. History of Events

There have been no terrorist events in recent history in the Central Florida Region.

4. Vulnerability Assessments

The Regional Domestic Security Task Forces (RDSTFs) in the state are in the process of identifying critical infrastructure and key resources (CI/KR) as defined by Department of Homeland Security (DHS) in the National Infrastructure Protection Plan (NIPP). This information will allow for county and regional profiles to be developed outlining risk versus vulnerabilities. Once compiled, the region will use a tiering methodology developed by DHS and modified to support regional needs to prioritize the identified CI/KR and vulnerability assessment will be completed to support mitigation efforts. Emergency Operating Plans have been developed and validated to respond to emergency events ensuring the citizens of Florida are protected and safe when responding to emergency events.

Similar to Hazardous Material incidents, no specific emergency sequence can be isolated as the model for which to plan for evacuation caused by a terrorist event because each emergency could have different consequences, both in nature and degree. As an alternative to defining a specified emergency, the regional and county plans identify various parameters for planning which are based upon knowledge of the possible consequences, timing, and target characteristics of a spectrum of emergencies. The plan then establishes the appropriate response for each level of threat. Therefore, the Statewide Regional Evacuation Study will not address terrorist acts specifically.

G. Nuclear Power Plant Incidents

Florida is home to five commercial nuclear reactors located at three sites.

a. Crystal River Nuclear Power Plant (Northwest of Crystal River)

b. St. Lucie Nuclear Power Plant (Southeast of Ft. Pierce)

c. Turkey Point Nuclear Power Plant (South of Miami)

Two additional reactors are located in Alabama near the State line.

Farley Nuclear Power Plant (Southeast of Dothan, Alabama)

The Division of Emergency Management's Radiological Emergencies Program has the overall responsibility for coordination of the response to a nuclear power plant emergency by federal, state and local agencies. The Division also has the overall authority and responsibility for updating and coordinating the plans with other response organizations.

The **Nuclear/Radiological Incident Annex** provides an organized and integrated capability for a timely, coordinated response by Federal agencies to terrorist incidents involving nuclear or radioactive materials (Incidents of National Significance), and accidents or incidents involving such material that may or may not rise to the level of an Incident of National Significance. The Department of Homeland Security (DHS) is responsible for overall coordination of all actual and potential Incidents of National Significance, including terrorist incidents involving nuclear materials.

Therefore, the Central Florida Region Evacuation Study will not address nuclear power plant incidents.

H. Tsunami

Tsunamis, also called seismic sea waves or, incorrectly, tidal waves, generally are caused by earthquakes, less commonly by submarine landslides, infrequently by submarine volcanic eruptions and very rarely by a large meteorite impact in the ocean. Submarine volcanic eruptions have the potential to produce truly awesome tsunami waves.

The possibility of a tsunami impacting the Atlantic or Gulf Coasts of Florida is considered to be remote. This is because most tsunamis are associated with major earthquakes. The Atlantic Ocean basin is not ringed by large faults as is the Pacific, which is associated both with earthquakes and tsunamis. It is thought that rare underwater landslides would pose a greater risk in the Atlantic Ocean. The Caribbean region has a history of both earthquakes and tsunamis. They do not appear to have impacted Florida's coastlines. However because of the horrific tsunami that impacted South East Asia in December 2004 and in recognition of the fact that a tsunami occurrence is possible, the Federal government has decided to expand its warning system to include the Atlantic and Gulf Coasts of the United States.

There is no history of significant tsunami activity in the region.

Although it is highly unlikely that a tsunami will impact Florida, it is not impossible. It is vital to know (and instruct children) that if the ocean suddenly recedes from the shore do not stand and stare. It is necessary immediately to run uphill or away from the shore and go to the highest location possible which may mean up the stairs of a substantial building. Everyone should be aware that no matter where in the world they are, if the sea is observed to recede from the shore, they should immediately run for high ground.

Since it is impossible to predict the exact location, timing or extent of a tsunami event, tsunami hazards are not specifically addressed in the Statewide Regional Evacuation Study.