4.0 HAZARD IDENTIFICATION, VULNERABILITY, AND RISK

The purpose of this chapter is to describe the hazards facing St. Lucie County in terms of potential impact, vulnerability, and loss. The hazards faced in St. Lucie County fit into three general classifications – natural, technological, and societal hazards. Natural hazards include floods, hurricanes/tropical storms, tornadoes, thunderstorms, lightning, wildland fires, muck fires, extreme temperatures, soil/beach erosion, severe droughts, seismic hazards, agricultural pests and diseases, and epidemics. Tsunamis are not addressed in this plan because of the low probability of occurrence. According to the State Hazard Mitigation Plan, there have only been four occurrences of tsunamis in Florida since 1886. Technological hazards include radiological accidents, power failures, hazardous materials accidents, transportation system accidents, wellfield contaminations, communication failures, and military ordnance. Societal hazards include terrorism and sabotage, civil disturbance, immigration crises, societal alienation, substance abuse, and economic collapses.

The hazard identification subsections of this chapter describe each hazard and provide historical events and impacts if available. When available, maps are provided to illustrate the location and extent of the hazards.

Disasters are classified by the magnitude of their effect. The recognized classification system is as follows (Indian River County Department of Emergency Services, 2002):

- Minor Disaster: Any disaster that is likely to be within the response capabilities of local government and results in only minimal need for State or Federal assistance.
- Major Disaster: Any disaster that will likely exceed local capabilities and require a broad range of State and Federal assistance. The FEMA will be notified, and potential Federal assistance will be predominantly recovery-oriented.
- Catastrophic Disaster: Any disaster that will require massive State and Federal assistance, including immediate military involvement. Federal assistance will involve response as well as recovery needs.

The vulnerability assessment for each hazard describes the community assets and potential impact for each hazard. A community's vulnerability depends on the extent of hazard exposure and the value of potentially vulnerable assets. Higher risk areas with higher potential damage warrant mitigation practices that are more extensive. Communities in this situation may rely on land use and site design rather than on relatively simple measures such as building codes and hardening existing structures. Other factors that influence vulnerability and are important for communities to consider when selecting mitigation practices are for pre-disaster mitigation, the amount of undeveloped and underdeveloped land, and in the case of post-disaster mitigation, the amount of developed land within the community (FDCA, 2003). There are three types of vulnerability – individual, social, and biophysical. Individual vulnerability describes the susceptibility of a person or a structure to potential harm from hazards. Social vulnerability describes demographic characteristics of social groups that make them more or less susceptible to the adverse impacts of hazards. Biophysical vulnerability examines the distribution of hazardous conditions arising from a variety of initiating events such as natural hazards, chemical contaminants, or industrial accidents (Cutter, 2001).

Factors influencing vulnerability include, but are not necessarily limited to a community's location, type of construction, demographics, and cultural characteristics. **Table 4.1** lists the general hazards to which St. Lucie County is vulnerable and indicates their projected impact potential across the entire spectrum of community exposure and services. The hazards identified in **Table 4.1** and discussed here are organized based on the maximum projected impact potential (i.e., hazards capable of producing the maximum community-wide impact, such as hurricanes and floods, are discussed first). This does not mean other identified hazards are less important or less worthy of mitigation, only that their potential to affect the total community is lower.

In order to effectively plan hazard mitigation projects and allocate scarce financial resources, a community's vulnerability to a specific hazard must be coupled with other critical factors to perform a risk assessment.

Risk, or the probability of loss depends on three elements:

- Frequency - How frequently does a known hazard produce an impact within the community?
- Vulnerability - How vulnerable is a community to the impacts produced by a known hazard? and
- Exposure - What is the community's exposure in terms of life and property to the impacts produced by a specific hazard?

Once these three factors are established, the risk level faced by a community with regard to any specific hazard can be calculated using the "Risk Triangle" approach (Crichton, 1999; see **Figure 4.1**).

In this approach, these three factors become the sides of a triangle, and the risk or probability of loss is represented by the triangle's area (**Figure 4.1a**). The larger the triangle, the higher the community's risk with respect to a given hazard. If a community reduces any of these three factors, they reduce their risk or probability of loss. For example, if a community reduces its exposure to hurricanes, as has actually happened historically, by moving from a barrier island to the mainland, they will reduce their exposure and therefore their risk of loss (**Figure 4.1b**). Likewise, if a community reduces its vulnerability to hurricanes by strengthening its buildings, it also will reduce its risk of loss (**Figure 4.1c**).

In St. Lucie County, the overall exposure was determined by a risk assessment model called MEMPHIS (Mapping for Emergency Management, Parallel Hazard Information System) developed by the FDCA. **Table 4.2** displays the structure types in St. Lucie County with the highest exposure.

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Table 4.1. Preliminary identification and projected impact potential for St. Lucie County hazards.

Hazard Category	Projected Impact Potential																			
	Excessive wind	Excessive water	Damaging hail	Soil/beach erosion	Electric power outage	Surface and air transportation disruption	Navigable waterway impairment	Potable water system loss or disruption	Sewer system outage	Telecommunications system outage	Human health and safety	Psychological hardship	Economic disruption	Disruption of community services	Agricultural/fisheries damages	Damage to critical environmental resources	Damage to identified historical resources	Fire	Toxic releases	Stormwater drainage impairment
Natural Hazards																				
Floods		X		X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
Hurricanes/tropical storms	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Tornadoes	X				X	X				X	X	X	X							
Severe thunderstorms/lightning	X	X	X		X	X				X	X	X	X					X		X
Droughts													X		X	X		X		
Temperature extremes					X						X	X	X		X	X				
Agricultural pests and diseases											X	X	X		X	X				
Wildland/Urban Interface Zones					X	X				X	X	X	X	X	X	X		X	X	
Muck fires						X					X		X		X	X		X	X	
Soil/beach erosion				X			X						X			X				X
Seismic hazards						X													X	
Epidemics											X	X	X	X	X					
Technological Hazards																				
Hazardous materials accidents						X					X	X	X	X				X	X	

Table 4.1. (Continued).

Hazard Category	Projected Impact Potential																			
	Excessive wind	Excessive water	Damaging hail	Soil/beach erosion	Electric power outage	Surface and air transportation disruption	Navigable waterway impairment	Potable water system loss or disruption	Sewer system outage	Telecommunications system outage	Human health and safety	Psychological hardship	Economic disruption	Disruption of community services	Agricultural/fisheries damages	Damage to critical environmental resources	Damage to identified historical resources	Fire	Toxic releases	Stormwater drainage impairment
Radiological accidents including nuclear power plant accidents					X	X				X	X	X	X	X		X			X	
Communications failures										X			X	X						
Transportation system accidents						X	X				X		X	X				X		
Wellfield contamination								X	X		X	X	X	X						
Power failure (outages)					X	X		X	X	X	X	X	X	X						
Unexploded military ordnances											X	X				X			X	
Societal Hazards																				
Civil disturbances						X					X	X	X	X			X			
Terrorism and sabotage					X	X		X		X	X	X	X			X	X	X	X	
Immigration crises											X	X	X	X						
Societal alienation											X	X								
Substance abuse											X	X								
Economic collapses											X	X	X	X						

INSERT FIGURE 4.1

Table 4.2. Total exposure by structure type, St. Lucie County, 2004.

Rank	Structure Type	Exposure
1.	Single Family	$4,012,413,440
2.	Condominia	$1,120,845,440
3.	Orchard, Groves, Citrus	$555,168,768
4.	Grazing Land Soil Class I	$221,906,272
5.	Public Schools	$130,951,904

Source: Florida Department of Community Affairs, 2004a.

In terms of natural hazards, there is very little if anything that can be done to change the frequency with which they produce impacts in a community. Mitigation planning relative to natural hazards must therefore focus on reducing the community's vulnerability or exposure. In terms of technological and societal hazards, the most cost effective type of mitigation is to limit or reduce the frequency with which such hazards actually occur.

At the time of publication, detailed risk assessments were only available for the flood, hurricane, tornado, sinkhole, and wildland fire hazards. Data sources used to prepare the hazard vulnerability and risk assessments are documented in **Appendix D**.

4.1 NATURAL HAZARDS

St. Lucie County is susceptible to a number of natural hazards with the potential to cause extensive damage within the community. The cost of responding to and recovering from these disasters has proven to be significant. Planning for these events before they occur can significantly reduce costs in the future. This subsection will now discuss those hazards in more detail below.

Section 4.1.9.4 identifies vulnerability for each natural hazard by incorporated jurisdiction and population centers. Two of the hazards, seismic hazards and muck fires, are identified in light of the requirements FEMA has set for local mitigation plans; however, neither hazard has relevance in St. Lucie County. A brief synopsis provides a general description of the vulnerability of structures by hazard type that occur in St. Lucie County.

Flooding. There are a number of areas within the City of Fort Pierce that experience flooding. A number of them are limited to intersections. These occur for the most part in single family residential areas. Significant flooding is also experienced in three unincorporated areas, White City, Lakewood Park, and Indian River Estates. All three are primarily single family residential neighborhoods.

Hurricane/Tropical Storm. Hurricanes and tropical storms are major rain and wind events that affect the entire County. However, unique to hurricanes is surge. The St. Lucie County mainland is protected by Hutchinson Island, a barrier island extending the length of St. Lucie County. Most of the island is under the jurisdiction of St. Lucie County; although, a portion of the island, the area south of the St. Lucie Inlet, is within the City of Fort Pierce. Nearly all of the high rise residential development is located on Hutchinson Island; much of it is subject to the effects of storm surge. In addition, areas along the west shore of the Intracoastal Waterway are also subject to surge, but not to the degree of the areas that are adjacent to the Atlantic Ocean. However, in 2004, the effects of storm surge resulting from Hurricanes Frances and Jeanne caused significant damage to many commercial structures in the downtown area. This included the destruction of the City's marina and damage to structures in the waterfront redevelopment area. Areas outside downtown Fort Pierce contain, for the most part, single family structures with a scattering of shopping centers along the major roadways.

Tornado. Areas within the County designated as having moderate vulnerability to tornadoes are primarily low density, single family home areas. However, there are a couple of areas, North Hutchinson Island and downtown Ft. Pierce, that consist of higher density development, primarily 20-story high rise condominiums and commercial structures.

Severe Thunderstorm/Lightning. In general, the entire county is at risk to severe thunderstorms and lightning. As indicated in **Section 4.1.9.4**, the City of Fort Pierce and City of Port St. Lucie have a high vulnerability to this hazard. Both communities for the most part, consist of low density residential neighborhoods comprised of single family structures. However, there have been some non-residential structures that have been damaged in the past, such as the St. Lucie County International Airport.

Drought. While most areas in the County exhibit low vulnerability to drought, the West County area has a moderate vulnerability to drought. The western areas of the County are primarily agricultural, either planted in citrus or serving as open range for cattle. Few structures exist in this area, ones that do are either homes associated with farms or agricultural structures such as barns.

Temperature Extremes. This hazard can have a dramatic effect on the agricultural industry in St. Lucie County. The citrus industry is affected by both heat/drought and freezing conditions. These western areas of the County consist of scattered farm residences, farmworker housing, and agricultural barns. Temperature extremes also impact the senior population since the elderly have less tolerance to temperature extremes than the general population. The elderly (retirees) live in a mix of housing, many in condominiums and others in single family structures.

Agricultural Pests and Disease. Again, the western areas of the County are primarily adversely impacted by agricultural pests and disease. As described above, this area of the County consists primarily of scattered farm residences, farmworker housing, and agricultural barns.

Wildland/Urban Interface Zone. As documented in **Section 4.1.9.4**, there are three areas in the County vulnerable to wildland fire, City of Port St. Lucie, Lakewood Park, and West County area. Both the City and Lakewood Park are predominantly single family, one-story homes. Single family homes on farms, barns, and farmworker housing characterize the West County area.

Soil/Beach Erosion. Beach erosion along the Atlantic Ocean has long been a major issue facing St. Lucie County. Critical erosion occurs primarily on South Hutchinson Island (see **Section 4.1.9.4**). One place is at the St. Lucie Inlet in Fort Pierce. This area is a mix of residential-type structures, some small two- and three-story condominiums, with most of the structures being single family homes with a sprinkling of duplexes. The other area where significant erosion has occurred is south of the Florida Power & Light power plant, extending south to the St. Lucie/Martin County line. This portion of the island is fairly narrow and contains many high rise residential condominium structures that were permitted in the 1970's and 80's.

Epidemic. Not surprisingly, vulnerability to epidemics closely mirrors the County's major population centers. With the exception of the commercial development in downtown Fort Pierce and along the major roadways in the City of Port St. Lucie, White City, and Lakewood Park, most of the structures are detached single family homes.

4.1.1. Floods

4.1.1.1 Hazard Identification

In St. Lucie County, several variations of flood hazards occur due to the different effects of severe thunderstorms, hurricanes, seasonal rains, and other weather-related conditions. For the majority of the County, the primary causes of flooding are hurricanes or tropical storms. However, the County's low-lying topography, combined with its subtropical climate, make it vulnerable to riverine as well as storm associated flooding.

Flooding in St. Lucie County results from one or a combination of both of the following meteorological events:

1) Tidal surge associated with northeasters, hurricanes, and tropical storms; and
2) Overflow from streams and swamps associated with rain runoff.

When intense rainfall events occur, streams and drainage ditches tend to reach peak flood flow concurrently with tidal water conditions associated with coastal storm surge. This greatly increases the probability of flooding in the low-lying areas of the coastal zone. Areas along the Indian River are particularly susceptible to flooding under these conditions. The most flood prone areas in the eastern portion of the County feature poorly drained soils, a high water table, and relatively flat terrain, all of which contribute to flooding problems. Flat terrain and heavily wooded areas aggravate flood problems by preventing rapid drainage in some areas.

Riverine flooding occurs when the flow of rainwater runoff exceeds the carrying capacities of the natural drainage systems. During extended periods of heavy rainfall, certain low-lying neighborhoods within the County are subject to considerable flood damage and isolation caused by the inability of natural and mechanical drainage systems to effectively remove the water. Heavy rainfalls can cause considerable damage to County infrastructure including: roadbeds, bridges, drainage systems, and the water supply.

The buildup of uncontrolled sediment contributes to the problem of inadequate drainage in natural and mechanical drainage systems. When a storm produces an overwhelming amount of stormwater runoff, the accumulation of loose sediment causes flooding by clogging the drainage systems.

In comparison to riverine flooding, coastal flooding is usually the result of a severe weather system such as a tropical storm or hurricane. The damaging effects of coastal floods are caused by a combination of storm surge, wind, rain, erosion, and battering by debris. All coastal property and inhabitants are subject to severe damage and loss of life resulting from floods caused by hurricane-associated storm surge. Some coastal properties, road arteries, and bridge approaches are subject to severe flooding caused by rare astronomical tides as well.

Frequencies from flooding associated with rain events other than tropical storms and hurricanes are more difficult to estimate. Eastern Florida shows an annual dry cycle stretching from early November through mid-May. During this part of the year, monthly rainfall rarely exceeds 3.5 to 4.0 inches per month. The wet season, beginning in mid-May and running through late October, shows monthly rainfall levels in the area to be between 6.0 to 8.5 inches. Heaviest rainfall usually occurs in June and September. In St. Lucie County, the eastern or coastal section of the County receives more rain than the western section. This rainfall pattern coupled with the hurricane season (June through November) makes St. Lucie County particularly vulnerable to flooding associated with tropical storms and hurricanes because they typically occur when the water table is high and the ground is saturated.

Historical Flooding Events. Hurricane of September 1903. This hurricane made landfall near West Palm Beach on 11 September 1903 and exited the state near Tampa Bay on 12 September. Maximum recorded winds were only 78 mph; however, 14 deaths were attributed to this storm, and one ship was wrecked near Jupiter, Florida. Damages specific to St. Lucie County are not recorded.

Hurricane of July 1926. A Category 1 hurricane with winds of 90 mph made landfall near Jupiter, Florida on the morning of 27 July 1926. This hurricane circled inland along Florida's east coast and exited the State at the Florida-Georgia border on 28 July; by that time it had been downgraded to a tropical storm. St. Lucie County experienced strong winds and flooding.

Hurricane of September 1928. This hurricane made Florida landfall near the City of Palm Beach as a strong Category 4 hurricane with one of the lowest barometric pressures ever recorded in this area (928.9 millibars [27.43 inches]). This was the fifth most intense hurricane ever to make landfall in U.S. territory. It reached Lake Okeechobee with very little decrease in intensity and moved across the lake's northern shoreline. This sent a massive storm surge southward, flooding lower areas on the southern and western edge of the lake. In all, 1,836 people were killed and another 1,870 injured during this storm's passage. Nearly all the loss of life was in the Okeechobee area and was caused by overflowing of the lake along its southwestern shore. While all central Florida was affected by this killer storm, St. Lucie County experienced mainly wind damage and flooding from the associated rains.

Hurricane of September 1933. This major Category 3 hurricane passed over Jupiter Island with a barometric pressure of 947.5 millibars (27.98 in). Maximum winds recorded were 127 mph. There was considerable property damage all along the Florida east coast, mostly in the area between Jupiter and Fort Pierce. Severe waterfront damage was reported in Stuart. Moderate damage was reported from St. Lucie County, including considerable flooding in the lower areas of the County.

Hurricane of August 1939. This weak hurricane made landfall near Fort Pierce on the morning of 11 August and crossed the state in a northwesterly direction, exiting to the Gulf of Mexico near Crystal River on 12 August. Minimal damage and flooding were experienced in St. Lucie County.

Hurricane of June 1945. This hurricane entered Florida from the Gulf of Mexico, making landfall near Cedar Key and moving east-northeast to exit the state near St. Augustine. St. Lucie County received rain and wind from this storm.

Flood of Fall 1947. This flood is generally considered to be the most severe flood recorded in southern Florida. Heavy rainfall, including the rains from two hurricanes, occurred over a period of 5 months. Many parts of St. Lucie County were flooded for months, and there was extensive damage to dairy pastures and agriculture in general. Such a flooding event would be much more significant today because of the increase in land development.

Hurricane of August 1949. This Category 3/Category 4 hurricane made landfall in Florida between Delray and Palm Beach with winds of 130 mph and a barometric pressure of 954.0 millibars (28.17 inches). As it moved inland, its center passed over the northern part of Lake Okeechobee. The levees in that area held, and no major flooding occurred. Damages in Florida were estimated at $45 million. Tides of 11.3 feet at Fort Pierce, 8.5 feet at Stuart, and 6.9 feet at Lake Worth were reported. Stuart sustained severe damage in this storm. Statewide, over 500 people lost their homes as a result of this storm.

Flood of October 1953. As in 1947, this flood was preceded by 5 months of heavier than normal rainfall, which included a tropical storm in October. June through October rainfall was approximately 48 inches. Damage was heaviest in the beef cattle industry, with extensive losses of improved pasture land, which required supplemental feeding of cattle. Vegetable growers and dairy farmers also suffered significant losses as a result of this flood.

Flood of June 1959. Heavy rains across most of central Florida associated with and following a tropical depression, caused extensive flooding in poorly drained and low-lying agricultural areas and some residential sections. Considerable pasture land and some citrus land in St. Lucie County was inundated. Some highways also sustained damage from these flood waters.

Hurricane (Donna) of September 1960. Hurricane Donna was the sixth most intense U.S. hurricane at landfall. This storm crossed the Florida Keys into the Gulf of Mexico and then turned back toward the northeast and struck the Florida mainland just south of Naples. It then turned north moved across Ft. Meyers, where it turned again to the northeast, moved across the state, and exited Florida just north of Daytona Beach. Rainfall ranged from 5 to 10 inches in an 80- to 100-mile wide belt following this storm's track. Lakes and streams overflowed their banks and forced the evacuation of many homes throughout central Florida. The high water closed many roads, including portions of Route 60 in Indian River County and Routes 78 and 70 in St. Lucie County, and inundated considerable agricultural land. At least 12 people were killed statewide, and more than 1,794 people were injured.

Hurricane (Agnes) of June 1972. Hurricane Agnes moved through the Gulf of Mexico off Florida's west coast. While it never struck the central Florida mainland, it spawned the worst severe weather outbreak in Florida history. The outer rainbands covered virtually the entire peninsula and spawned numerous tornadoes. There were 6 people killed and 40 injured in Okeechobee, 1 killed and 7 injured in LaBelle, 40 injured in Big Coppit Key, 2 injured in Bassinger, 3 injured in Haines City, 4 injured in Crystal Springs, 11 injured in Malabar, and 12 injured in Cape Canaveral. Most of those injured lived in manufactured housing. Damage estimates totaled $5 million to public property and $36 million to private property.

Hurricane (David) of September 1979. Hurricane David moved over the Dominican Republic with winds of 165 mph, but weakened drastically before reaching Florida's east coast. David raked the eastern coast line of Florida from Palm Beach County northward. Officially classed as a minimal hurricane, its strongest winds were offshore when it made landfall approximately 20 miles south of Melbourne. Tides were 3 to 5 feet above normal along the eye track and 1 to 2 feet above normal elsewhere along the Florida east coast. Light to moderate erosion was reported along the St. Lucie County coastline. Storm rainfall was quite variable from location to location. Totals generally ranged from 6 to 9 inches, but some stations reported as much as 11 inches during the storm's passage.

The Great Thanksgiving Holiday East Coast Storm of 1984. A strong low pressure system developed east of Florida, and coupled with a high pressure system to the northwest produced an extremely strong pressure gradient leading to gale force winds and high seas along the entire Florida east coast. Heavy rains fell over most of central Florida, and this surface runoff, coupled with the wind packing of seawater along the coast resulted in extensive coastal erosion and flooding. Many coastal structures were damaged or destroyed including several in St. Lucie County.

Flood of September 1985. Between 20 and 24 September 1985, approximately 14 inches of rain fell in the City of Fort Pierce, 7 inches during a 7-hour period over the night of 20 September. Flooding of streets and houses was widespread, especially in the central areas around Five Mile Creek and Ten Mile Creek. Large numbers of people were evacuated from their homes. Flood elevations during this storm approximated the hundred year levels and were greater in many locations.

Flood of January 1989. On 21 and 22 January 1989, St. Lucie County experienced a gale with subtropical storm characteristics that caused extensive beach erosion and dropped 4 to 6 inches of rain across the County. This caused ponding of water in low-lying areas. Several homes were damaged. Road flooding caused several accidents.

Hurricane Andrew of August of 1992. Andrew was a small and ferocious Cape Verde hurricane that wrought unprecedented economic devastation along a path through the northwestern Bahamas, the southern Florida peninsula, and south-central Louisiana. Damage in the U.S. is estimated to be near 25 billion, making Andrew the most expensive natural disaster in U.S. history. The tropical cyclone struck southern Dade County, Florida, especially hard, with violent winds and storm surges characteristic of a Category 4 hurricane on the Saffir/Simpson Hurricane Scale, and with a central pressure (922 millibars) that is the third lowest this century for a hurricane at landfall in the U.S. In Dade County alone, the forces of Andrew resulted in 15 deaths and up to one-quarter million people left temporarily homeless. An additional 25 lives were lost in Dade County from the indirect effects of Andrew. The direct loss of life seems remarkably low considering the destruction caused by this hurricane.

Tropical Storm (Gordon) of October 1994. Following a similar track to Hurricane Donna of 1960, Tropical Storm Gordon crossed the Florida Keys into the Gulf of Mexico and then turned back to the northeast and struck the mainland Florida peninsula near Fort Myers on 13 October. It moved across the state and exited Florida into the Atlantic just north of

Vero Beach on 16 October. Although the maximum sustained winds reported from Gordon were only 53 mph, the storm caused 8 deaths and 43 injuries.

St. Lucie County had experienced a period of extensive growth during the 1970's and 1980's. Most of this growth took place in the form of residential and commercial land development in the eastern and southern portion of the County close to the Intracoastal Waterway and St. Lucie River. The rain event associated with Tropical Storm Gordon in October 1994 was the most significant rain event to occur after this period of development. Essentially, the County received 17+ inches of rain over a 3-day period. Rainfall was not evenly dispersed over the whole County.

Statewide, damages associated with Gordon totaled over $400 million. Agricultural interest sustained $275 million in damages primarily from the widespread flooding. Vegetable and citrus crops were damaged particularly hard. Exacerbating the flooding associated with Tropical Storm Gordon was the fact that prior to October 1994 St. Lucie County had a very wet year. Rainfall recorded through September of that year had reached 74 inches before the Gordon event occurred. Altogether, St. Lucie County received approximately 100 inches of rain in 1994, making that year the wettest year since 1913.

Hurricane (Erin) of August 1995. Hurricane Erin made landfall near the Sebastian Inlet on 2 August 1995. Brevard County bore the brunt of this storm with sustained winds of approximately 100 mph. While St. Lucie County was spared most of the damages associated with Erin's wind field, heavy rains of up to 8 inches in 3 hours were associated with the backside of this storm, and flooding occurred in low-lying areas along the County's northern edge.

The Unamed Storm of October 1995. Almost exactly 1 year after the Tropical Storm Gordon flooding incident in 1994, a stalled frontal system dropped over 15 inches of rain on St. Lucie County over a period of 39 hours. In the intervening year between these two events, some communities in the southern part of St. Lucie County had conducted a number of mitigation projects and initiatives designed to improve drainage and prevent flooding in known flood prone areas.

Tropical Storm (Mitch) of October 1998. Hurricane Mitch was one of the deadliest storms in Atlantic history. By the time it reached Florida on 4 and 5 November 1998, it had been downgraded to a tropical storm. St. Lucie County received significant rains from this storm, which passed almost directly over the southern part of the County. Extensive agricultural damage was reported throughout western St. Lucie County, and significant flooding again occurred in the Port St. Lucie area.

Hurricane Floyd of September 1999. This large Category 4 storm moved parallel to the southeast Florida coast. While the storm did not make landfall in Florida, it did impact Florida coastal communities. Peak gusts associated with the storm were estimated to be as high as 155 mph. Fifty-seven deaths and $1.3 billion in insured losses were attributed to the storm. Readings taken in Fort Pierce indicate that sustained winds were 33 mph, and peak wind gusts were up to 49 mph. The City of Fort Pierce experienced flooding and property damage during this event. The City of Port St. Lucie activated a special needs shelter and was federally declared. Damages in the City were estimated around $100,000.

Hurricane Irene of October 1999. This Category 2 hurricane made landfall in the Keys and moved north, heading back out to sea at the Jupiter Inlet. Insured property losses in Dade, Broward, and Palm Beach counties exceeded $600 million. Total insured losses from the rest of the state totaled $200 million. Over 700,000 customers were left without power following the storm. Readings taken in Fort Pierce indicate that sustained winds were 42 mph, and peak wind gusts were up to 51 mph. The City of Fort Pierce sustained both flooding and wind damage during Irene. The FPUA incurred over $1.3 million in damage to a 12-inch water main on South AIA and a 36-inch sewer line at the wastewater treatment plant. The City of Port St. Lucie experienced flooding citywide and was federally declared with an estimated $100,000 in damage.

Tropical Storm Leslie of October of 2000. This tropical storm mainly impacted Miami-Dade and Broward counties, causing $700 million in damage, $500 million of which were agricultural crop losses.

Hurricane Gabrielle of September 2001. This hurricane made landfall on the west coast of Florida and traveled northeast across the state. The storm spawned a total of 18 tornadoes in the state. Insured losses associated with this storm totaled $115 million. Total damage is estimated to be nearly $230 million. Readings taken in Fort Pierce indicate that sustained winds reached 26 mph, and peak wind gusts were up to 37 mph. Rain meters in Fort Pierce indicated 1.97 inches of rainfall during this period.

The City of Port St. Lucie, directed by the City Council, has installed swale liners and supported the maintenance of roads that experience chronic flooding. The City also has a proactive drainage management program to maintain drainage basins.

4.1.1.2 Vulnerability Assessment

Flooding events can have the following potential impacts within a community:

- Excessive water;
- Soil/beach erosion;
- Electric power outage;
- Surface and air transportation disruption;
- Navigable waterway impairment;
- Potable water system loss or disruption;
- Sewer system outage;
- Human health and safety;
- Psychological hardship;
- Economic disruption;
- Disruption of community services;
- Agricultural/fisheries damage;
- Damage to critical environmental resources;
- Damage to identified historical resources;
- Fire;
- Toxic releases; and
- Stormwater drainage impairment.

In the Coastal Management Element of the Comprehensive Plan, St. Lucie County identified several areas subject to coastal and riverine flooding.

Hutchinson Island. In general, almost all of North Hutchinson Island would be vulnerable to a Category 1 storm, except for State Road A1A, which would be impacted by a Category 2 storm. On South Hutchinson Island, all of the island would be vulnerable to a

Category 1 storm including State Road A1A, except for discontinuous strands, which would be impacted by Category 2 storms, probably near higher dune elevations.

North of Fort Pierce. A majority of the land area between U.S. Highway 1 and the Indian River Lagoon would be vulnerable to a Category 1 storm. Each successively greater storm would extend the impact area further inland. U.S. Highway 1 would be the western limit from the area near St. Lucie Village south to Taylor Creek. The Category 3 storm also would extend inland several thousand feet along both sides of Taylor Creek, covering an area of less than one square mile (part of which would be in Fort Pierce).

South of Fort Pierce. Probably due to elevations, it would take storm-surges from Category 4 and 5 storm events to reach and cover Indian River Drive, respectively, for approximately the first 4 to 5 miles stretch south of the City. Apparently, the even greater elevation for the next several miles south is such that no storm surge from any category storm event would rise up the bluff. However, in the last few miles, it would only take a Category 1 storm surge to reach and cover the road, and successively greater storm surges would extend inland up to 1,500 feet.

Mainland Along the River. There would be some surge flowing inland along the North Fork of the St. Lucie River up to or near the 10-foot contour (National Geodetic Vertical Datum [NGVD] elevation).

NFIP. In response to mounting losses from flooding nationwide, the U.S. Congress initiated the NFIP in 1968. The program is administered through FEMA. Under this program, FEMA produces Flood Insurance Rate Maps (FIRMs), which show areas subject to various levels of flooding under different conditions (see **Figure 4.2**; see **Table 4.3** for key for figure). This flood risk information is based on historic, meteorological, hydrologic, and hydraulic data, as well as open-space conditions, flood control works, and development. The FIRMs for St. Lucie County were updated in July 1998. Flood plains designated on the FIRMs are based on the 1% annual flood chance or the 100-year flood event. The 500-year flood event with a 0.2% annual chance of occurrence is used to designate other areas of the community, which may have some vulnerability to flooding.

Table 4.3. Key for **Figure 4.2**.

Zone	Description
A	An area inundated by 1% annual chance flooding, for which no Base Flood Elevations (BFEs) have been determined.
AE	An area inundated by 1% annual chance flooding, for which BFEs have been determined.
AH	An area inundated by 1% annual chance flooding (usually an area of ponding), for which BFEs have been determined; flood depths range from 1 to 3 feet.
AO	An area inundated by 1% annual chance flooding, for which average depths and velocities have been determined; flood depths range from 1 to 3 feet.
UNDES	A body of water, such as a pond, lake, ocean, etc., located within a community's jurisdictional limits, that has no defined hazard.
VE	An area inundated by 1% annual chance flooding with velocity hazard (wave action); no BFEs have been determined.
X	An area that is determined to be outside the 1% and 0.2% annual chance flood plains.
X500	An area inundated by 0.2% annual chance flooding; an area inundated by 1% annual chance flooding with average depths of less than 1 foot or with drainage areas of less than 1 square mile; or an area protected by levees for 1% annual chance flooding.

Insert Figure 4.2

St. Lucie County's Flood Insurance Study was conducted in 1991 (FEMA, 1991). In that report, water discharge rates were determined for several flood sources throughout the County. **Table 4.4** lists the peak discharge in cubic feet per second (cfs) for the identified flood sources.

Table 4.4. Flooding source discharge, St. Lucie County, 1991.

Flooding Source and Location	Drainage Area (sq. miles)	Peak Discharge (cfs)			
		10-Year	50-Year	100-Year	500-Year
North Fork of St. Lucie River					
At Kitching Cove	260.5	8,960	14,370	17,580	25,580
At Mud Cove	150.3	4,560	7,420	9,090	13,520
At Prima Vista Blvd	117.0	4,620	7,490	9,150	13,490
Ten Mile Creek					
At Confluence of Five Mile Creek	87.8	3,940	6,410	7,820	11,560
At Sunshine State Parkway	61.4	3,070	5,010	6,110	9,010
At 11-Mile Road	56.3	2,890	4,710	5,750	8,470
At McCarty Road	36.3	2,010	3,300	4,020	5,5940
Ten Mile Creek Tributary					
At mouth	17.2	1,370	2,254	2,733	4,000
Taylor Creek					
At Canal C-1 (Fort Pierce Farms)	4.3	510	848	1,024	1,489
At St. Lucie Blvd	3.5	412	690	833	1,214
At Dirt Road	1.5	231	390	470	689
Moores Creek					
At mouth	3.4	786	1,276	1,536	2,186
At 17th Street	2.4	522	858	1,034	1,497
At 25th Street	1.8	450	741	890	1,283
Five Mile Creek					
At confluence with North Fork of St. Lucie River	11.4	1,325	2,178	2,634	3,808
At Edwards Road	9.5	1,182	1,944	2,634	3,808
At State Road 70	4.9	798	1,320	1,591	2,289
At Whiteway Dairy Road	3.4	626	1,054	1,268	1,823
At Peterson Road	1.8	401	670	805	1,160
Platts Branch					
At Sunrise Blvd.	1.6	324	537	645	925
At Oleander Blvd	4.4	281	470	564	809
At U.S. Highway 1	0.8	174	282	350	507
Blakeslee Creek					
At confluence with North Fork of St. Lucie River	*	2,163	N/A	3,405	
About 5,500 feet upstream from confluence	0.8	232	N/A	463	

Table 4.4. (Continued).

Flooding Source and Location	Drainage Area (sq. miles)	Peak Discharge (cfs)			
		10-Year	50-Year	100-Year	500-Year
Blakeslee Creek Tributary					
About 1,500 feet upstream of mouth	*	306	N/A	610	
Winters Creek					
At confluence with North Fork of St. Lucie River	*	1,185	N/A	1,865	N/A

* Total drainage area for Blakeslee Creek, Blakeslee Creek Tributary, and Winters Creek is approximately 18.6 square miles.

Source: Federal Emergency Management Agency, 1991.

According to LBFH, Inc. District Engineer for the Fort Pierce Farms Water Control District, 10 Mile Creek contains excess vegetation, which creates obstruction to flow as controlled by the District's Varn Structure at Gordy Road. There have been no recent damages; however, the creek has the potential for large-scale effects and damages during extreme events.

In addition to the FIRMs, there are two numerical models that predict the effects of storm surge in St. Lucie County. The older model, developed by NOAA, is called the Sea, Lake and Overland Surges from Hurricanes (SLOSH) model. **Table 4.5** estimates the potential storm surge water height in feet above NGVD 88 for specific locations within the County based on the SLOSH model.

Table 4.5. Potential storm surge water height in feet above National Geodetic Vertical Datum 88 for specific locations in St. Lucie County.*

Location	Storm Strength		
	Category 1	Category 3	Category 5
North Hutchinson Island across from Link Port	6.9	9.5	13.6
North Hutchinson Island at Queen's Cove	6.8	9.2	13.1
Fort Pierce Inlet	6.0	9.1	12.9
West side of the Indian River at the Indian River and St. Lucie County Line	5.6	8.8	14.2
West side of the Indian River east of Indrio Road	5.0	9.0	13.7
St. Lucie Village	5.0	9.0	13.2
Port of Fort Pierce	5.8	9.1	13.0
Seaway Drive Bridge - west side	5.8	9.1	13.0
A1A on South Hutchinson Island at Jennings Cove	6.8	9.2	12.9
West bank of the Indian River north of the Midway Boulevard and River Road intersection	4.9	10.0	13.6
North Fork of the St. Lucie River at White City	5.9	6.9	7.6
North Fork of the St. Lucie River south of Prima Vista Boulevard	5.4	6.4	7.0

* Based on Sea, Lake and Overland Surges from Hurricanes model projections.

Figure 4.3 shows the storm Category 3 Surge Zone as predicted by the TAOS model for St. Lucie County. According to the Florida Assessment of Coastal Trends, 52% of residents in St. Lucie County live in the Category 1 Surge Zone (FDEP, 2000).

The State of Florida is able to model hurricane storm surge as well as wind and property damage. This model, know as The Arbiter Of Storms (TAOS) model, predicts storm surge height and wind field intensity for Category 1 through Category 5 hurricanes. **Figure 4.4** shows St. Lucie County's storm surge vulnerability in a Category 5 hurricane based on the TAOS model. When evaluating these data, it is important to remember the TAOS projections are based on multiple model runs combining all the worst possible hurricane paths and strikes. Consequently, the TAOS projections presented here must be considered the Maximum of Maximums (MOM), or absolute worst-case scenario.

Documented Repetitive Losses. For this analysis, documented repetitive losses are restricted to the narrow FEMA definition and represent only those properties whose owners have made more than one claim on their flood insurance policies as recorded by the NFIP.

As of December 2003, the unincorporated area of St. Lucie County showed a total of 16 repetitive loss properties with a total of 51 repetitive losses and a Community Rating System (CRS) rating of 7. The City of Fort Pierce had four repetitive loss properties with a total of eight repetitive losses and a CRS rating of 9. There were no repetitive loss properties reported from the Town of St. Lucie Village, and at the time, the community was not a member of CRS. The City of Port St. Lucie showed a total of 1 repetitive loss property with a total of 2 repetitive losses, and a CRS rating of 8. **Table 4.6** documents the number of repetitive flood loss properties by jurisdiction.

Identified Problem Areas. The St. Lucie County Public Works Department has identified the following areas in St. Lucie County as flood prone areas due to storm surge:

- The entire North Fork of the St. Lucie River;
- Ten Mile Creek;
- Five Mile Creek;
- North Hutchinson Island and North A-1-A;
- South Hutchinson Island and South A-1-A;
- South Beach at Jetty Park;
- The North Savannas;
- The South Savannas;
- Hidden River Estates Subdivision;
- River Park Subdivision;
- Old Dixie Highway;
- Nuclear Power Plant on South Hutchinson Island; and
- Outfall Structures at the Lakewood Park Subdivision.

Roads that experience chronic flooding are addressed in St. Lucie County's Stormwater Master Plan and the Comprehensive Growth Management Plan. The County addresses the issue of maintaining drainage basins in the Stormwater Master Plan and Road and Bridge management plans.

INSERT FIGURE 4.3

INSERT FIGURE 4.4

Table 4.6. Repetitive loss properties for St. Lucie County and incorporated areas.*

Community No.	Community Name	No. of Repetitive Loss Properties	No. of Claimed Repetitive Losses	Total Building Payment	Total Content Payment	CRS Rating
120285	St. Lucie County	16	51	$609,194.38	$267,618.55	7
120286	City of Fort Pierce	4	8	N/A	N/A	9
120287	City of Port St. Lucie	1	2	$6,710.79	$6,900.70	8
120288	Town of St. Lucie Village	0	0	Community not in CRS program		

* Based on the Federal Emergency Management Agency's 1998 Florida Repetitive Loss List and 15 December 1998 data provided by Danny Hinson, National Flood Insurance Program/CRS Insurance Service Office, Inc.

CRS = Community Rating System.

N/A = not available.

St. Lucie County has identified 48 specific areas within the unincorporated portion of the County where storm water drainage is a known problem. Identified flood prone roadways consist of the following:

In the Indian River Estates area

- Easy Street;
- Savannah Street;
- Howard Street;
- Bradley Streeet;
- Myrtle Drive;
- Seagrape Drive;
- Palm Drive;
- Birch Drive;
- Hickory Drive;
- Sunset Drive;
- Raintree Trail;
- Tangelo Drive;
- Spruce Drive;
- Cassia Drive;
- Bamboo Drive;
- Balsam Drive;
- Papaya Drive; and
- Yucca Drive.

In the White City area

- Citrus Avenue;
- Oleander Avenue;
- Osceola Drive;
- Seminole Drive;
- Coral Street;
- Echo Street;
- Saeger Avenue;
- Flood Road;
- Buckeye Drive;
- Gopher Ridge Road;
- Fleetwood Lane;
- Kingswood Lane; and
- Driftwood Lane.

Other unincorporated areas

- Bell Avenue at South 25th Street;
- Lennard Road at Walton Road;
- Deerwood Lane; and
- Rosewood Lane.

Within the City of Fort Pierce, the following areas have been identified as flood prone:

- Oleander Boulevard and the streets east to U.S. Highway 1 between Georgia Avenue and Emil Drive;
- South 15th Street;
- South 16th Street;
- South 3rd Avenue;
- Shamrock Road;
- Kelly Court;
- Hispana Avenue;
- The intersection of Wyoming Avenue and South 13th Street;
- The intersection of 25th Street and Virginia Avenue;
- The intersection of South 33rd Street and Okeechobee Road;
- South 33rd Street between Dairy Road and Orange Avenue;
- The intersection of South 10th Street and Georgia Avenue;
- The intersection of South 10th Street and Florida Avenue;
- The intersection of South 10th Street and Delaware Avenue;
- The intersection of Delaware Avenue and Court Street;
- The intersection of Delaware Avenue and South 7th Street;
- The intersection of South 7th Street and Georgia Avenue;
- The intersection of South 6th Street and Georgia Avenue;
- The intersection of South 5th Street and Florida Avenue;
- The intersection of South 7th Street and Boston Avenue;
- The intersection of South 6th Street and Citrus Avenue;
- The intersection of South 5th Street and Boston Avenue;
- The intersection of South 5th Street and Orange Avenue;
- The intersection of 9th Street and Avenue D;
- The intersection of Means Court and Avenue D;
- The intersection of 13th Street and Avenue D;
- The intersection of Indian River Drive and Terminal Drive;
- Indian River Drive from 2nd Street to Seaway Drive;
- The intersection of 13th Street and Mobiles Terrace;
- The intersection of 18th Street and Avenue I;
- Avenue G from 22nd to 24th Street;
- Avenue I from 22nd to 24th Street;
- Avenue K from North 19th Street to North 24th Street;
- Avenue M from North 19th Street to North 21st Street; and
- The intersection of North 17th Street and Avenue M.

Within the City of Port St. Lucie, the following areas have been identified as flood prone:

- Zullo Street (Section 19);
- South of Section 39;
- Airoso Boulevard and Eyerly Avenue;
- Gatlin Boulevard;
- Westmoreland Boulevard;

- Walton Road (a major evacuation route from Hutchinson Island to I-95); and
- California and Savona Boulevard Intersection.

In addition to these identified flood prone areas, only two pump stations, the Tiffany Pump Station and the Blackwell Pump Station, handle storm water from all of Sections 29, 30, and 40, which encompass the Mid Port area. If either of these pump stations fail, there will be extensive flooding in the Mid Port area.

Flood Water Sources and Frequency of Occurrence. Sources of flood waters in St. Lucie County include

- The Atlantic Ocean;
- The Fort Pierce Inlet;
- The St. Lucie Inlet and North Fork of the St. Lucie River;
- Ten Mile Creek;
- Taylor Creek;
- Moores Creek;
- Five Mile Creek;
- Platts Branch;
- Blakes Lee Creek;
- Winters Creek;
- Canal C-25;
- Canal C-24; and
- Canal C-23.

4.1.1.3 Risk Assessment

Flooding is the single hazard producing the most recurrent impacts in St. Lucie County. All communities within St. Lucie County are vulnerable to both hurricanes and flooding, but they are not all vulnerable for the same reasons. The barrier island communities such as the Fort Pierce beach area and the unincorporated areas of Hutchinson Island obviously are highly vulnerable to both wind and storm surge damage from hurricanes. Due to the presence of the Fort Pierce Inlet, mainland Fort Pierce also is highly vulnerable to flooding associated with hurricane winds and storm surge. Central Port St. Lucie and the White City area are vulnerable to storm surge related flooding along the North Fork of the St. Lucie River and the canals in those areas. Wind packing of the water within the Indian River Lagoon also may produce substantial flooding along low-lying river front property away from the inlet. Communities away from the water such as St. Lucie West, Lakewood Park, and the unincorporated areas north of Fort Pierce along U.S. Highway 1, are more vulnerable to wind damage from hurricanes and flooding associated with rain rather than storm surge.

Flooding other than that associated with storm surge usually results from heavy rainfall events occurring in association with stalled fronts, tropical storms, and occasionally hurricanes. Not all of the area within any given jurisdiction is equally vulnerable to flooding, but all jurisdictions have specific areas where flooding is a recurring problem.

The following risk assessment data for flooding in St. Lucie County are based on data developed for the MEMPHIS model. **Table 4.7** illustrates the number and value of structures in each of the FEMA-identified flood zones. The zone with the highest number of structures and structure value is the X zone, which is known as the 500-year flood zone. **Table 4.8** describes the definitions of each of the FEMA flood zones.

Table 4.7. Flooding exposure, St. Lucie County, 2004.

Flood Zone	Total Number of Structures	Total Value of Structures	Total Population in Flood Zone
AE	12,338	$1,105,037,440	14,603
X500	2,785	$243,436,368	0
X	65,092	$5,242,612,864	164,211
A	590	$63,665,612	649
VE	1,639	$126,114,592	2,412
UNDES	347	$61,235,168	2,434
AH	2,409	$145,427,232	7,180
OFF FIRM	25	$1,646,847	1,206

Source: Florida Department of Community Affairs, 2004a.

Table 4.8. Federal Emergency Management Agency flood zones.

Zone	Description
A	An area inundated by 1% annual chance flooding, for which no Base Flood Elevations (BFEs) have been determined.
AE	An area inundated by 1% annual chance flooding, for which BFEs have been determined.
AH	An area inundated by 1% annual chance flooding (usually an area of ponding), for which BFEs have been determined; flood depths range from 1 to 3 feet.
ANI	An area not included in mapping.
AO	An area inundated by 1% annual chance flooding, for which average depths and velocities have been determined; flood depths range from 1 to 3 feet.
OFFFIRM	An area located off of the Flood Insurance Rate Map.
UNDES	A body of water, such as a pond, lake, ocean, etc., located within a community's jurisdictional limits that has no defined hazard.
VE	An area inundated by 1% annual chance flooding with velocity hazard (wave action); no BFEs have been determined.
X	An area that is determined to be outside the 1% and 0.2% annual chance flood plains.
X500	An area inundated by 0.2% annual chance flooding; an area inundated by 1% annual chance flooding with average depths of less than 1 foot or with drainage areas of less than 1 square mile; or an area protected by levees for 1% annual chance flooding.

Table 4.9 illustrates the total number and value of structures as well as the population expected to be flooded given certain storm event levels. The following table provides information on structures either subject to wave or current action, flood, or neither.

Table 4.9. Flooding exposure, St. Lucie County, 2004.

Exposure	100-Year Flood	50-Year Flood	25-Year Flood	10-Year Flood
Total Number in Wave/Current	1,216	796	350	0
Total in Flood	12,177	11,614	10,005	8,830
Total in Neither	71,832	72,815	74,870	76,695
Total Value in Wave/Current	$74,993,704	$48,519,472	$15,557,274	0
Total Value in Flood	$1,148,998,528	$1,085,277,952	$950,687,424	$839,527,552
Total Value in Neither	$5,947,187,712	$6,037,379,072	$6,204,940,800	$6,331,675,648
Population in Wave/Current	990	0	0	0
Population in Flood	15,820	16,810	16,810	12,589
Population in Neither	175,885	175,885	175,885	180,106

Source: Florida Department of Community Affairs, 2004a.

Table 4.10 displays the flood exposure associated with the five different hurricane intensities in St. Lucie County. The table provides information on the number and value of structures subject to wave action and flooding.

Table 4.10. Hurricane flood exposure, St. Lucie County, 2004.

Exposure	Category 5	Category 4	Category 3	Category 2	Category 1
Total Number in Wave/Current	15,985	10.323	6,321	1,181	369
Total Number in Flood	42,526	32,593	21,909	11,590	10,164
Total Number in Neither	26,714	42,309	56,995	72,454	74,962
Total Value in Wave/Current	$1,400,671,872	$948,473,792	$583,848,704	$71,159,408	$16,551,156
Total Value in Flood	$3,249,192,960	$2,510,739,456	$1,723,959,936	$1,096,858,240	$968,325,184
Total Value in Neither	$2,521,348,096	$3,711,997,184	$4,863,406,080	$6,001,160,064	$6,186,306,048
Population in Wave/Current	22,996	16,246	3,674	990	0
Population in Flood	109,073	78,004	55,740	15,820	16,810
Population in Neither	60,626	98,445	133,281	175,885	175,885

Source: Florida Department of Community Affairs, 2004a.

The MEMPHIS data provide a calculation that will determine the savings in average annualized loss that can be experienced given 1 foot of flood mitigation. **Table 4.11** illustrates this calculation. The biggest mitigation gains would be mitigation of flood hazards in condominiums and single family houses.

Table 4.11. Mitigation savings by structure type.

Rank	Structure Type	Reduction in Average Annualized Loss
1.	Condominia	$11,115,624
2.	Single Family	$9,750,788
3.	Orchard, Groves, Citrus	$407,012
4.	Mobile Homes	$151,731
5.	Multi-Family Housing (<10 units)	$79,762

Source: Florida Department of Community Affairs, 2004a.

4.1.2 Hurricanes/Tropical Storms

4.1.2.1 Hazard Identification

Hurricanes are tropical cyclones with winds that exceed 74 mph and blow counter-clockwise about their centers in the Northern Hemisphere. They are essentially heat pumping mechanisms that transfer the sun's heat energy from the tropical to the temperate and polar regions. This helps to maintain the global heat budget and sustain life. Hurricanes are formed from thunderstorms that form over tropical oceans with surface temperatures warmer than 81° Fahrenheit (26.5° Celsius). The ambient heat in the sea's surface and moisture in the rising air column set up a low pressure center and convective conditions that allow formation of self sustaining circular wind patterns. Under the right conditions, these winds may continue to intensify until they reach hurricane strength. This heat and moisture from the warm ocean water is the energy source of a hurricane. Hurricanes weaken rapidly when deprived of their energy source by traveling over land or entering cooler waters.

When a hurricane threatens the coast, advisories are issued by the National Hurricane Center (NHC). The storm's current location and intensity are described along with its projected path. Advisories are issued at 6-hour intervals: 5:00 A.M., 11:00 A.M., 5:00 P.M., and 11:00 P.M., Eastern Time.

In addition to advisories, the NHC may issue a hurricane watch or warning. A hurricane watch indicates that hurricane conditions are a possibility and may threaten the area within 36 hours. A hurricane warning is issued when winds of at least 74 mph are to be expected in the area within 24 hours.

Advisories and hurricane watches and warnings will frequently refer to the category of the storm. Hurricanes are classified using the Saffir-Simpson scale as follows:

- Category 1: Winds 74 to 95 mph
- Category 2: Winds 96 to 110 mph

- Category 3: Winds 111 to 130 mph
- Category 4: Winds 131 to 155 mph
- Category 5: Winds more than 155 mph

For many years, the risk of significant loss of life and property due to hurricanes seemed small. Many, if not the majority of existing homes and businesses along the U.S. Atlantic and Gulf Coasts were located there during the 1970's and 1980's, a period of relatively inactive hurricane formation. Most of the people currently living and working in coastal areas have never experienced the impact of a major hurricane. Hurricanes that impacted Florida during the 1970's and 80's were infrequent and of relatively low intensity. Homeowners, business interest, and government officials grew to regard hurricane risk as manageable by private insurance supplemented occasionally by Federal disaster funding and subsidized flood insurance. The hurricane risk did not seem sufficient to warrant increased investment in mitigation. Two major hurricanes, Hugo in 1989 and Andrew in 1992, forced a re-evaluation of this risk assessment. While experts sometimes disagree on the annual cost, all sources agree that Hurricane Andrew was the most costly hurricane event ever to affect the U.S. Insured losses from Hurricane Andrew topped $17 billion, and most sources agree that the total cost of Hurricane Andrew exceeded $25 billion.

Florida is the most vulnerable state in the nation to the impacts of hurricanes and tropical storms. South central Florida is particularly exposed to the dangers presented by hurricanes due to its topography. The region is largely a flat, low-lying plain. The potential for property damage and human casualties in St. Lucie County has been increased by the rapid growth of the County over the last few decades, particularly along the coastline. Population risk also has been exacerbated by some complacency due to the recent period of reduced hurricane frequency.

Florida not only has the most people at risk from hurricanes, but it also has the most coastal property exposed to these storms. Over the 20-year period between 1980 and 2000, Florida's population increased by 68%, while the value of insured residential property rose from $178 billion in 1980 to $882 billion in 2002, an increase of 395%. Between 1980 and 1993, the insured value of commercial property rose from $155 billion to $453 billion, an increase of 192%.

Hurricane damage occurs through two means:

1) High winds; and
2) Storm surge.

Generally it is the wind that produces most of the property damage associated with hurricanes, while the greatest threat to life is from flooding and storm surge. Although hurricane winds can exert tremendous pressure against a structure, a large percentage of hurricane damage is caused not from the wind itself, but from flying debris. Tree limbs, signs and sign posts, roof tiles, metal siding, and other loose objects can become airborne missiles that penetrate the outer shells of buildings, destroying their structural integrity and allowing hurricane winds to act against interior walls not designed to withstand such forces. Once a structure's integrity is breached, the driving rains associated with hurricanes can enter the structure and completely destroy its contents.

Hurricane winds are unique in several ways:

1) They are more turbulent than winds in most other types of storms;
2) They are sustained for a longer period of time (several hours) than any other type of atmospheric disturbance;
3) They change slowly in direction, thus they are able to seek out the most critical angle of attack on a given structure; and
4) They generate large quantities of flying debris as the built environment is progressively damaged, thus amplifying their destructive power.

In hurricanes, gusts of wind can be expected to exceed the sustained wind velocity by 25% to 50%. This means a hurricane with sustained winds of 150 mph will have wind gusts exceeding 200 mph. The wind's pressure against a fixed structure increases with the square of the velocity. For example, a 100-mph wind will exert a pressure of approximately 40 pounds per square foot on a flat surface, while a 190-mph wind will exert a force of 122 pounds per square foot on that same structure. In terms of a 4- x 8-foot sheet of plywood nailed over a window, there would be 1,280 pounds of pressure against this sheet in a 100-mph wind, and 3,904 pounds or 1.95 tons of pressure against this sheet in a 190-mph wind.

The external and internal pressures generated against a structure vary greatly with increases in elevation, shapes of buildings, openings in the structures, and the surrounding buildings and terrain. Buildings at ground level experience some reductions in wind forces simply because of the drag exerted by the ground against the lowest levels of the air column. High-rise buildings, particularly those located along the beachfront will receive the full strength of a hurricane's winds on their upper stories. Recent studies estimate that wind speed increases by approximately 37% just 15 feet above ground level.

The wind stream generates uplift as it divides and flows around a structure. The stream following the longest path around a building, generally the path over the roof, speeds up to rejoin the wind streams following shorter paths, generally around the walls. This is the same phenomenon that generates uplift on a aircraft's wing. The roof in effect becomes an airfoil that is attempting to "take off" from the rest of the building. Roof vortexes generally concentrate the wind's uplift force at the corners of a roof. These key points can experience uplift forces two to five times greater than those exerted on other parts of the roof.

Once the envelope of the building has been breached through the loss of a window or door, or because of roof damage, wind pressure on internal surfaces becomes a factor. Openings may cause pressurizing or depressurizing of a building. Pressurizing pushes the walls out, while depressurizing will pull the walls in. Internal pressure coupled with external suction adds to the withdrawal force on sheathing fasteners. Damages from internal pressure fluctuations may range from blowouts of windows and doors to total building collapse due to structural failure.

During Hurricane Andrew, catastrophic failure of one- and two-story wood-frame buildings in residential areas was observed more than catastrophic failures in other types of buildings. Single-family residential construction is particularly vulnerable because less engineering oversight is applied to its design and construction. As opposed to hospitals and public buildings, which are considered "fully engineered," and office and industrial buildings, which are considered "marginally engineered," residential construction is considered "non-engineered." Historically, the bulk of wind damage experienced nationwide has occurred to residential construction. Fully engineered construction usually performs well in high winds due to the attention given to connections and load paths. **Figure 4.5** graphically illustrates the expected wind fields across St. Lucie County during a Category 3 hurricane based on the TAOS model.

Hurricane winds generate massive quantities of debris that can easily exceed a community's entire solid waste capacity by three times or more. Debris removal is an integral first step toward recovery, and as such, must be a critical concern of all those tasked with emergency management and the restoration of community services.

A storm surge is a large dome of water often 50 to 100 miles wide and rising anywhere from 4 to 5 feet in a Category 1 hurricane up to 20 feet in a Category 5 storm. The storm surge arrives ahead of the storm's actual landfall, and the more intense the hurricane is, the sooner the surge arrives. Water rise can be very rapid, posing a serious threat to those who have waited to evacuate flood prone areas. A storm surge is a wave that has outrun its generating source and become a long period swell. The surge is always highest in the right-front quadrant of the direction the hurricane is moving in. As the storm approaches shore, the greatest storm surge will be to the north of the hurricane eye.

Such a surge of high water topped by waves driven by hurricane force winds can be devastating to coastal regions. The stronger the hurricane and the shallower the offshore water, the higher the surge will be. In addition, if the storm surge arrives at the same time as the high tide, the water height will be even greater. The storm tide is the combination of the storm surge and the normal astronomical tide.

Damage during hurricanes may also result from possible spawned tornadoes, and inland flooding associated with heavy rainfall that usually accompany these storms. Hurricane Andrew, a relatively "dry" hurricane, dumped 10 inches of rain on south Florida and left many buildings extensively water damaged. Rainwater may seep into gaps in roof sheathing and saturate insulation and ceiling drywall, in some cases causing ceilings to collapse.

Crop damage is another powerful effect of hurricanes and tropical storms. Recently, Tropical Storm Mitch dropped as much as 10 inches of rain in some south Florida areas, which resulted in approximately $20 million in crop damage in Palm Beach County alone (Associated Press, 1998). According to the 2001 Florida Statistical Abstract, of St. Lucie County's 366,400 total land acreage, 227,414 acres are farmland. With 62% of its land area being farmed, St. Lucie County is particularly vulnerable to crop damage resulting from the wind and rain from hurricanes and tropical storms.

The Coastal Management Element of the Comprehensive Plan identified the following critical hurricane evacuation links:

- North Bridge;
- South Bridge;
- South A1A;
- Indian River Drive;
- Jensen Beach Bridge (for South Island County residents);
- Indrio Road;

INSERT FIGURE 4.5

- SR 70;
- Walton Road;
- Port St. Lucie Boulevard;
- Prima Vista Boulevard;
- Midway Road;
- Florida Turnpike; and
- I-95.

Historic Events. From 1930 through 1959, a total of 58 hurricanes struck the U.S. mainland; 25 of which were Category 3 or higher (major storms). Between 1960 and 1989, 43 hurricanes struck the U.S. of which only 16 were Category 3 or stronger. Most hurricane experts feel we are entering a period of increased hurricane formation similar to the levels seen in the 1930's and 1940's. Current hurricane risk calculations are complicated by climatic factors suggesting the potential for even greater hurricane frequency and severity in all of the world's hurricane spawning grounds. Since 1995, there have been 33 Atlantic hurricanes, and there were 10 in 1998 alone. Global warming may cause changes in storm frequency and the precipitation rates associated with storms. A modest 0.9º Fahrenheit (0.5º Celsius) increase in the mean global temperature will add 20 days to the annual hurricane season, and increase the chances of a storm making landfall on the U.S. mainland by 33%. The warmer ocean surface also will allow storms to increase in intensity, survive in higher latitudes, and develop storm tracts that could shift farther north, producing more U.S. landfalls.

Currently, an average of 1.6 hurricanes strike the U.S. every year. Severe (Category 4 or 5 on the Saffir-Simpson scale) hurricanes strike the U.S. on the average of one every 5.75 years. Annually, hurricanes are estimated to cause approximately $1.2 billion in damages. The proximity of dense population to the Atlantic Ocean, as well as the generally low coastal elevations, significantly increase the County's vulnerability. The potential for property damage and human casualties in St. Lucie County has increased over the last several decades, primarily because of the rapid growth this County has experienced since 1970, particularly along the vulnerable coastline areas.

Since 1886, 51 storms of hurricane intensity have passed within 125 miles of St. Lucie County. This represents an average of one hurricane every 2 years. The number of direct hits on the southeastern Florida coastline between 1899 and 1999 has been as follows:

- Category 1 Storms (winds 74 to 95 mph) = 5 storms (4% annual probability);
- Category 2 Storms (winds 96 to 110 mph) = 10 storms (10% annual probability);
- Category 3 Storms (winds 111 to 130 mph) = 7 storms (7% annual probability);
- Category 4 Storms (winds 131 to 155 mph) = 6 storms (6% annual probability); and
- Category 5 Storms (>155 mph) = 1 storm (1% annual probability).

The St. Lucie County Health Department provides Special Medical Needs Shelters during the response phase of major hurricane events. The County has addressed the issue of Australian pine susceptibility to heavy rain and wind events in the Land Development Code – Environmental Preservation.

4.1.2.2 Vulnerability Assessment

Hurricane events can have the following potential impacts within a community:

- Excessive wind;
- Excessive water;
- Soil/beach erosion;
- Electric power outage;
- Surface and air transportation disruption;
- Navigable waterway impairment;
- Potable water system loss or disruption;
- Sewer system outage;
- Telecommunications system outage;
- Human health and safety;
- Psychological hardship;
- Economic disruption;
- Disruption of community services;
- Agricultural/fisheries damage;
- Damage to critical environmental resources;
- Damage to identified historical resources;
- Fire;
- Toxic releases; and
- Stormwater drainage impairment.

Table 4.12 illustrates the expected debris accumulation in St. Lucie County in cubic yards per acre. The St. Lucie County Comprehensive Emergency Management Plan identifies designated debris drop-off locations throughout the County.

Table 4.12. Debris accumulation in St. Lucie County in cubic yards per acre.

Jurisdiction	Tropical Storm	Category 1	Category 2	Category 3	Category 4	Category 5
St. Lucie County	54,871	338,924	1,036,934	2,646,440	6,207,163	20,337,420
Fort Pierce	1,342	9,261	26,576	115,525	408,418	848,515
Port St. Lucie	1,037	6,694	24,056	57,236	119,698	249,443
St. Lucie Village	274	1,851	6,245	14,871	36,143	81,474

Source: The Arbiter of Storms model.

4.1.2.3 Risk Assessment

All communities within St. Lucie County are highly vulnerable to hurricanes, but they are not all vulnerable for the same reasons. The barrier island communities (Hutchinson Island) are obviously highly vulnerable to both wind and storm surge damage from hurricanes. The communities fronting on St. Lucie County's estuaries and rivers are also highly vulnerable to flooding associated with hurricane winds and storm surge. Communities away from the water may be more vulnerable to wind damage from hurricanes. Inland communities may have less hurricane vulnerability from flooding but more hurricane vulnerability from wind damage due to their older or less substantial type of construction.

Both the City of Fort Pierce and St. Lucie Village are old, historical communities of Florida's east coast. Their age alone makes them particularly vulnerable to hurricane damage. Both cities have old, historically significant structures, whose loss would represent the loss of irreplaceable cultural resources. The age and construction type of much of the housing in Fort Pierce, and to a lesser extent St. Lucie Village, indicate that both communities would be very hard hit by a major storm. The City of Port St. Lucie is located at a greater distance from the ocean, and most of the construction there is relatively recent.

The risk assessment data for hurricanes in St. Lucie County are based on the MEMPHIS model. **Table 4.13** illustrates the total exposure to wind damage for four different event categories.

Table 4.13. Wind damage exposure, St. Lucie County, 2004.

Exposure	100-Year Event	50-Year Event	25-Year Event	10-Year Event
Total Number Moderate Damage	6,676	8	0	0
Total Number Light Damage	78,549	85,217	85,225	22,540
Total Number No Damage	0	0	0	62,685
Total Value Moderate Damage	$579,513,024	$266,317	0	0
Total Value Light Damage	$6,591,734,272	$7,170,982,400	$7,171,248,640	$1,910,658,048
Total Value No Damage	0	0	0	$5,260,524,032
Population Moderate Damage	17,783	0	0	0
Population Light Damage	174,912	192,695	192,695	59,239
Population No Damage	0	0	0	133,456

Source: Florida Department of Community Affairs, 2004a.

Table 4.14 illustrates the total exposure to wind damage for the five hurricane intensity categories.

Table 4.14. Hurricane wind damage exposure, St. Lucie County, 2004.

Exposure	Category 5	Category 4	Category 3	Category 2	Category 1
Total Number Destroyed	53,937	0	0	0	0
Total Number Severely Damaged	30,114	21,800	0	0	0
Total Number Heavy Damage	1,174	58,312	0	0	0
Total Number Moderate Damage	0	5,113	83,938	2,264	0
Total Number Light Damage	0	0	1,287	82,961	85,225
Total Value Destroyed	$4,110,738,944	0	0	0	0
Total Value Severely Damaged	$2,758,868,992	$1,617,078,144	0	0	0
Total Value Heavy Damage	$301,612,704	$4,804,990,464	0	0	0
Total Value Moderate Damage	0	$749,148,928	$6,822,398,464	$240,065,024	0
Total Value Light Damage	0	0	$348,841,952	$6,931,181,056	$7,171,248,640
Population in Destroyed	124,199	0	0	0	0
Population in Severely Damaged	68,496	36,639	0	0	0
Population in Heavy Damage	0	146,824	0	0	0
Population in Moderate Damage	0	9,232	191,616	1,203	0
Population in Light Damage	0	0	1,079	191,489	192,695

Source: Florida Department of Community Affairs, 2004a.

A calculation was made to determine the reduction in wind losses when mitigation is implemented. **Table 4.15** illustrates the reduction in average annual loss when structures are mitigated for an additional 5 miles per hour.

Table 4.15. Wind mitigation savings, St. Lucie County, 2004.

Rank	Structure Type	Reduction in Average Annual Loss
1.	Single Family	$3,837,293
2.	Condominia	$1,255,685
3.	Orchards, Groves, Citrus	$407,012
4.	Grazing Land Soil Class I	$157,461
5.	Mobile Homes	$151,731

Source: Florida Department of Community Affairs, 2004a.

Table 4.16 depicts the mitigation savings that can be achieved for wind-related hazards by each hurricane intensity category.

Table 4.16. Wind related exposure and mitigation savings, St. Lucie County, 2004.

Hurricane Category	Total Exposure	Exposure After Mitigation	Mitigation Savings
Category 1	$223,479,984	$143,013,040	$80,466,944
Category 2	$711,780,736	$528,862,560	$182,918,176
Category 3	$1,748,163,072	$1,406,076,032	$342,087,040
Category 4	$3,850,668,000	$3,274,736,640	$575,951,360
Category 5	$6,669,348,864	$6,213,571,680	$455,777,184

Source: Florida Department of Community Affairs, 2004a.

Table 4.17 depicts the mitigation savings that can be achieved for the flood hazard by each hurricane intensity category.

Table 4.17. Flood related exposure and mitigation savings, St. Lucie County, 2004.

Hurricane Category	Exposure	Exposure After Mitigation	Mitigation Savings
Category 1	$195,802,448	$118,454,384	$77,348,064
Category 2	$349,640,160	$268,874,944	$80,765,216
Category 3	$725,756,416	$591,502,976	$134,253,400
Category 4	$1,982,937,984	$1,614,153,632	$368,804,352
Category 5	$2,918,851,072	$2,497,979,392	$420,871,680

Source: Florida Department of Community Affairs, 2004a.

4.1.3 Tornadoes

4.1.3.1 Hazard Identification

A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud extending to the ground. It is generated by a thunderstorm or hurricane when cool air overrides a layer of warm air, forcing the warm air to rise rapidly. The most common type of tornado, the relatively weak and short-lived type, occurs in the warm season, with June being the peak month. The strongest, most deadly tornadoes occur in the cool season, from December through April (FDCA, 2004b). Occasional windstorms accompanied by tornadoes, such as the winter storm of 1993, also are widespread and destructive.

When a tornado threatens, only a short amount of time is available for life-or-death decisions. The NWS issues two types of alerts:

- A tornado watch, which means that conditions are favorable for tornadoes to develop.
- A tornado warning, which means that a tornado has actually been sighted.

Tornadoes are classified using the Fujita-Pearson scale depicted in **Table 4.18**.

Table 4.18. Fujita-Pearson scale.

F = Intensity	P = Path Length	W = Mean Width
F0 = Light Damage	P0 = less than 1 mile	W0 = less than 0.01 mile
F1 = Moderate Damage	P1 = 1.0 to 3.1 miles	W1 = 0.01 to 0.03 mile
F2 = Considerable Damage	P2 = 3.2 to 9.9 miles	W2 = 0.04 to 0.09 mile
F3 = Severe Damage	P3 = 10.0 to 31.0 miles	W3 = 0.10 to 0.31 mile
F4 = Devastating Damage	P4 = 32.0 to 99.0 miles	W4 = 0.32 to 0.99 mile
F5 = Catastrophic Damage	P5 = 100 miles or greater	W5 = 1.00 miles or wider

Historic Events. Florida ranks third in the U.S. in the number of tornado strikes, and the first in the number of tornadoes per square mile. The odds of a tornado striking any specific point in southeastern Florida are 0.04, or once per 250 years.

The damage from a tornado is a result of the high wind velocity and wind-blown debris. Florida's average is 75 tornadoes annually since 1950, causing an average of 3 fatalities and 60 injuries each year (FDCA, 2004c). According to FDCA on-line hazard maps, there have been 8 light-damage, 1 moderate-damage, and 1 significant-damage tornadoes in St. Lucie County between 1961 and 1990. **Table 4.19** below illustrates the associated wind speeds with each of the tornado damage categories used in the FDCA map.

Table 4.19. Wind speed category.

Category	Wind Speed (mph)
Light	40-72
Moderate	73-112
Significant	113-157
Severe	158-206
Devastating	207-260
Incredible	261-318

Source: Florida Department of Community Affairs, 2003.

The National Climatic Data Center (NCDC) indicates that there have been a total of 36 tornado incidents in St. Lucie County since 1953. The majority of the events have been F0 and F1, but one F3 on April 15, 1958 cut a path 15 miles long and 33 yards wide and caused an estimated $250,000 in property damage. NCDC data also indicate that there have been 27 tornado-related injuries, 2 deaths, and $4,313,000 in property damage associated with tornado events in the County. **Table 4.20** describes some of the tornado events that have occurred within the County.

Table 4.20. Tornado incidents, St. Lucie County, 1953 – 2003.

Date	Magnitude	Path Length (miles)	Path Width (yards)	Description
April 15, 1958	F3	15	33	None available
May 8, 1979	F0	5	30	None available
April 11, 1982	F0	5	50	None available
July 10, 1995	F0	0	10	Minor damage in Spanish Lakes mobile home community - $50,000 property damage (FP)
February 2, 1998	F0	0	50	Touched down on Hutchinson Island - $30,000 property damage (FP)
March 9, 1998	F1	1	50	Caused damage at St. Lucie County Fairgrounds and overturned airplanes at the airport - $3.2 million property damage (FP)
June 4, 2001	N/A	N/A	N/A	$10,000 property damage (FP)
May 14, 2002	F0	0	20	7 miles north of FP -$20,000 property damage
July 27, 2002	F1	0	30	Touched down in FP and damaged 70 cars - $100,000 property damage

FP = Fort Pierce.
Source: National Climatic Data Center, 2004.

4.1.3.2 Vulnerability Assessment

Tornado events can have the following potential impacts within a community:

- Excessive wind;
- Electric power outage;
- Surface and air transportation disruption;
- Telecommunications system outage;
- Human health and safety;
- Psychological hardship; and
- Economic disruption.

St. Lucie County's vulnerability to tornadoes is compounded by the high concentration of mobile home residents in large mobile home communities. According to the 2000 Census, there are 11,595 mobile homes in St. Lucie County, representing 12.7% of the total housing units in the County. Five municipalities within St. Lucie County have significant concentrations of mobile homes. River Park has a total of 740 mobile homes, representing 28.4% of the total housing units. Fort Pierce North has a total of 827 mobile homes, representing 26.7% of the total housing units. Fort Pierce has a total of 1,107 mobile homes, representing 6.4% of the total housing units, and, Fort Pierce South has a total of 143 mobile homes, representing 6.4% of the total housing units (U.S. Census, 2004).

4.1.3.3 Risk Assessment

Historical data indicate the frequency of tornadoes in St. Lucie County is relatively low, but some specific communities have a moderate to high vulnerability to this hazard due to the type of construction or numbers of mobile homes (manufactured housing units) within their boundaries. These communities include the greater Fort Pierce area and River Park. At the time of publication, no data were available to model loss in St. Lucie County from tornadoes.

According to the MEMPHIS risk assessment model, all of St. Lucie County lies in the 1 in 500 probability category for tornado risk. There are a total of 85,225 structures valued at $7,171,248,640 and 192,695 residents in the County.

4.1.4 Severe Thunderstorms

4.1.4.1 Hazard Identification

A severe thunderstorm is defined as a thunderstorm containing one or more of the following phenomena: hail ¾ inches or greater, winds gusting in excess of 57.5 mph, and/or a tornado (NOAA, NWS, 1994). Severe weather can include lightning, tornadoes, damaging straight-line winds, and large hail. Most individual thunderstorms only last several minutes; however, some can last several hours.

Long-lived thunderstorms are called super cell thunderstorms. A super cell is a thunderstorm that has a persistent rotating updraft. This rotation maintains the energy release of the thunderstorm over a much longer time than typical, pulse-type thunderstorms, which occur in the summer months. Super cell thunderstorms are responsible for producing the majority of severe weather, such as large hail and tornadoes (NOAA, NWS, 2003). Downbursts also are occasionally associated with severe thunderstorms. A downburst is a strong downdraft resulting in an outward burst of damaging winds on or near the ground. Downburst winds can produce damage similar to a strong tornado. Although usually associated with thunderstorms, downbursts can occur with showers too weak to produce thunder (NOAA, NWS, 2003). Strong squall lines can also produce widespread severe weather, primarily very strong winds, and/or microbursts. A squall is a sudden violent gust of wind often associated with rain or snow (Merriam-Webster Dictionary, 2003).

When a severe thunderstorm approaches, the NWS will issue an advisory. According to NOAA, NWS (1994), two possible advisories are as follows:

Severe Thunderstorm Watch: Conditions are favorable for the development of severe thunderstorms.

Severe Thunderstorm Warning: Severe weather is imminent or occurring in the area.

Historic Events. In 1997, thunderstorms spawned 103 tornadoes, injured 121 people, and produced over $38 million in property damage statewide. According to FDCA's on-line hazard maps, St. Lucie County averages more than 70 days with thunderstorms per year, with the most frequent occurrences being between the months of July and September. NCDC indicates that there have been 26 thunderstorm incidents in St. Lucie County since 1953, causing $56,000 in property damage. On 26 June 1996, 81 mile an hour wind gusts were recorded at the Fort Pierce Airport, causing $120,000 in property damage. On 20 August 1999, thunderstorm winds caused $1,000 in property damage. On 27 August 2002, thunderstorm associated wind damaged several mobile homes in the Spanish Lakes community. Thunderstorm wind caused $1,000 in property damage on 18 March 2003. NCDC has recorded 24 incidents of hail in St. Lucie County since 1953. The average accumulation for these events in the County is 1.2 inches.

4.1.4.2 Vulnerability Assessment

Thunderstorm events can have the following potential impacts within a community:

- Excessive wind;
- Excessive water;
- Damaging hail;
- Electric power outage;
- Surface and air transportation disruption;
- Telecommunications system outage;
- Human health and safety;
- Psychological hardship;
- Economic disruption;
- Fire; and
- Stormwater drainage impairment.

Vulnerability to severe thunderstorms and lightning is high in St. Lucie County, but many jurisdictions and population centers have only moderate vulnerabilities relative to these hazards. This variation in relative levels of vulnerability is again due primarily to construction practices and community characteristics. Working communities have a higher vulnerability to economic impacts by lightning than residential or retirement communities. All other factors being equal, residential and retirement communities have a historically higher vulnerability in terms of lightning fatalities.

4.1.4.3 Risk Assessment

At the time of publication, no model was available to determine potential loss in St. Lucie County due to severe thunderstorms. The County can expect losses similar to those in the past. Typical storms in the past have caused around $2,000 in property damage.

4.1.5 Lightning

4.1.5.1 Hazard Identification

Perhaps the most dangerous and costly effect of thunderstorms is lightning. As a thunderstorm grows, electrical charges build up within the thunder cloud. Oppositely charged particles gather at the ground below. The attraction between positive and negative charges quickly grows strong enough to overcome the air's resistance to electrical flow. Racing toward each other, the charges connect and complete the electrical circuit. Charge then surges upward from the ground at nearly one-third the speed of light and produces a bright flash of lightning (Cappella, 1997).

Historic Events. On average, lightning kills more people than any other weather event. Florida leads in the nation in lightning related deaths and injuries (Alachua County Office of Emergency Management, 2004). Most lightning strike fatalities occur in June, July, and August. Between 1959 and 1994, there have been 345 lightning-related deaths in Florida (National Lightning Safety Institute, 2004c). Florida also has the most strikes, about 12 strikes per square kilometer per year in some places (National Lightning Safety Institute, 2004b). Nationwide, lightning-related economic losses amount to over $5 billion per year, and the airline industry alone loses approximately $2 billion a year in operating costs and passenger delays from lightning (National Lightning Safety Institute, 2004a).

According to FDCA's on-line hazard maps, between 1959 and 1996, St. Lucie County recorded 7 lightning-related deaths and 11 injuries. The NCDC, however, indicates that there were 5 major lightning events causing $70,000 in property damage and causing 4 injuries. On October 26, 1994, lightning struck a switchyard at the St. Lucie nuclear power plant, causing a small fire and damaging a transformer. On August 3, 1998, lightning caused an explosion and fireball when a natural gas pipeline station was struck.

4.1.5.2 Vulnerability Assessment

Working communities have a higher vulnerability to economic impacts from lightning than residential or retirement communities. All other factors being equal, residential and retirement communities have a historically higher vulnerability in terms of lightning fatalities.

Lightning events can have the following potential impacts within a community:

- Excessive wind;
- Excessive water;
- Damaging hail;
- Electric power outage;
- Surface and air transportation disruption;
- Telecommunications system outage;
- Human health and safety;
- Psychological hardship;
- Economic disruption;
- Fire; and
- Stormwater drainage impairment.

4.1.5.3 Risk Assessment

At the time of publication, no model was available to predict loss associated with lightning. The County can expect losses similar to those experienced in the past.

4.1.6 Wildland/Urban Interface Zone

4.1.6.1 Hazard Identification

Recent wildland fires that burned throughout Florida, specifically central Florida, are examples of the increasing wildland fire threat, which results from the Wildland/Urban

Interface. The Wildland/Urban Interface is defined as the area where structures and other human development meet with undeveloped wildland or vegetative fuels (FEMA, 1996). As residential areas expand into relatively untouched wild lands, forest fires increasingly threaten people living in these communities. Most wildland fires in the County occur in Florida's dry season, from January through May.

There are three different classes of wildland fires: surface, ground, and crown. A surface fire is the most common type and burns along the floor of a forest, moving slowly and killing or damaging trees. A ground fire is usually started by lightning and burns on or below the forest floor. Crown fires spread rapidly by wind and move quickly by jumping along the tops of trees. Wildland fires are usually identified by dense smoke that fills the area for miles around.

Rural and large tracts of unimproved lands are susceptible to brush and forest fires capable of threatening life, safety, and property in adjacent developed areas if not effectively controlled. Wildland fires are caused by numerous sources including arson, smoker carelessness, individuals burning debris, equipment throwing sparks, and children playing with matches. However, more fires are caused by lightning strikes and coincide with the height of the thunderstorm season. A major wildland fire can leave a large amount of scorched and barren land, and these areas may not return to pre-fire conditions for decades. If the wildland fire destroys the ground cover, other potential hazards may develop (e.g., erosion) (FEMA, 1996).

Structures in the Wildland/Urban Interface Zone are vulnerable to ignition by three different sources: radiation, convection, and firebrands (National Wildland/Urban Interface Fire Protection Program, 1997). Radiating heat from a wildland fire can cause ignition by exposure to the structure. The chances of ignition increase as the size of the flames increases, surface area exposed to flames increases, length of exposure time increases, and distance between the structure and the flames decreases. Ignition of a structure by convection requires the flame to come in contact with the structure. Contact with the convection column is generally not hot enough to ignite a structure. Clearing to prevent flame contact with the structure must include any materials capable of producing even small flames. Wind will tilt the flame and the convection column uphill, increasing the chance of igniting a structure. Firebrands also pose a threat to structures in the Wildland/Urban Interface Zone. A firebrand is a piece of burning material that detaches from a fire due to strong convection drafts in the burning area. A firebrand can be carried a long distance (around 1 mile) by fire drafts and winds. The chance of a firebrand igniting a structure depends on the size of the firebrand, how long it burns after contact, and the materials, design, and construction of the structure.

Some plant and animal communities in south central Florida have come to depend on frequent lightning-ignited wildland fires for their continued existence. Many threatened and endangered species depend on the periodic burning of dense scrub. Fire suppression and landscape fragmentation have disrupted this natural cycle, but a long-term policy of prescribed burns might help restore balance to the system.

Historic Events. From 1981 through 1996, an average of 6,080 wildland fires occurred per year, burning 219,725 acres. Because of changing weather conditions, the yearly figures range from a low of 3,985 wildland fires (with 86,944 acres burned) in 1991 to a record high of 14,042 wildland fires (with 587,400 acres burned) in 1981.

Since 1998, more than 21,000 wildland fires have devastated over 1.3 million acres and destroyed more than 1,000 structures. In 1998, the previous El Niño conditions subsided, causing drought conditions and 4,890 wildland fires, which burned 506,350 acres. The drought continued in 1999, with 5,636 wildland fires destroying 355,197 acres. In 2000, another drought stricken year, 212,415 acres were burned from 6,718 wildland fires. In 2001, the drought continued with 403,740 acres burned from 4,804 wildland fires (FDOF, 2003). These fires resulted in numerous fire complexes being developed each of those 4 years. This taxed the State's firefighting resources and those of other agencies in the state, and required assistance from other states. The largest contingent of air firefighting resources ever collected responded to the wildland fires of 1998 in Florida. The Mallory Swamp fire, one of the single largest and most costly wildland fire in Florida history, burned 57,200 acres near Perry, Florida in May 2001, costing an estimated $6.7 million. **Table 4.21** illustrates the number and total acreage of wildland fires in St. Lucie County in 2002 by ignition type.

Table 4.21. Wildland fire occurrence, St. Lucie County, 2002.

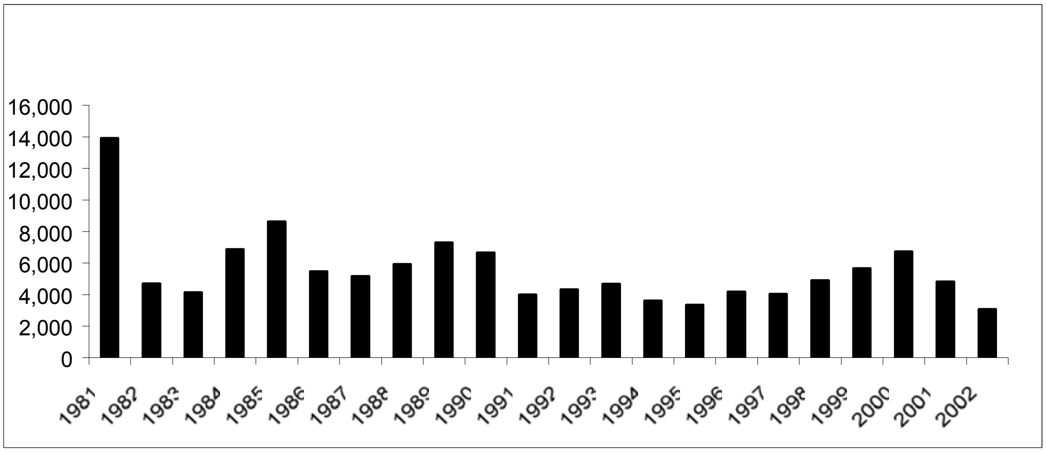
Type of Wildland fire	Number	Acres
Railroad	46	1,320
Smoking	47	127
Campfire	60	1,106
Children	164	7,266
Equipment	205	2,022
Miscellaneous	321	5,166
Unknown	423	4,574
Incendiary	457	10,683
Lightning	625	17,643
Debris	717	6,934
Total	3,065	56,841

Source: Florida Division of Forestry, 2003.

Figures 4.6 and **4.7** illustrate the number of wildland fires and the acres burned statewide between 1981 and 2002, respectively.

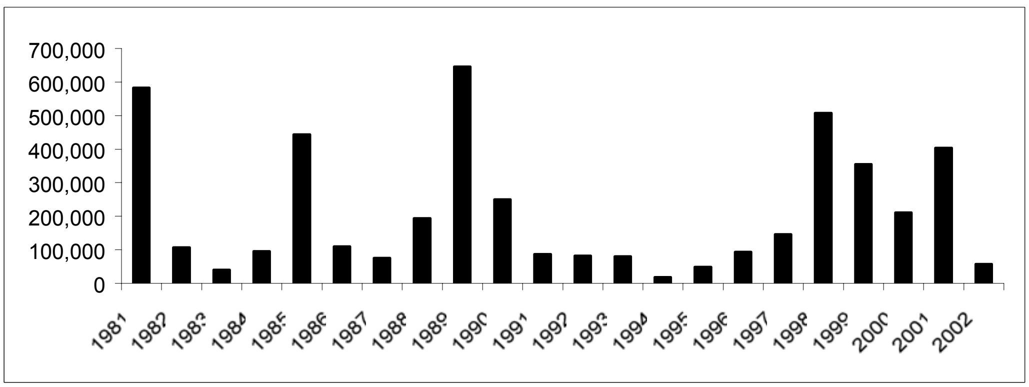
Data on wildland fire for St. Lucie County indicate that between 1993 and 2003, there has been a total of 263 wildland fires, which have burned 42,964 acres. Lightning, debris, or children were the most common ignition source for wildland fires in St. Lucie County (FDOF, 2004). In 1999, a wildland fire in Port St. Lucie burned nearly 2,400 acres, destroyed nearly 50 homes, and damaged 30 others. This disaster received a Federal Disaster Declaration with damages totaling $950,000.

Figure 4.6. Number of wildland fires, State of Florida, 1981-2002.



Source: Florida Division of Forestry, 2004.

Figure 4.7. Wildland fire acres burned, State of Florida, 1981-2002.



Source: Florida Division of Forestry, 2004.

4.1.6.2 Vulnerability Assessment

Wildland fires can have the following potential impacts within a community:

- Electric power outage;
- Surface and air transportation disruption;
- Telecommunications system outage;
- Human health and safety;
- Psychological hardship;
- Economic disruption;
- Disruption of community services;
- Agricultural/fisheries damage;
- Damage to critical environmental resources;
- Fire; and
- Toxic releases.

According to the 2001 Florida Statistical Abstract, approximately 366,400 acres, or one quarter (25.4%) of land in St. Lucie County is forested. Locations where these forested lands and homes or businesses intermingle create potential risk areas for wildland fire. Less urbanized communities and areas within the County are more vulnerable to wildland fire than the more developed communities. The City of Port St. Lucie, the Lakewood Park Area, and western St. Lucie County have a higher risk from wildland fires than other locations within the County.

4.1.6.3 Risk Assessment

The City of Port St. Lucie and the unincorporated areas north and west of Fort Pierce are particularly vulnerable to wildland fire at the Wildland/Urban Interface Zone. In the spring of 1999, three days of wildland fires destroyed a total of 54 homes in Port St. Lucie and damaged an additional 76. Total estimated damages to the 130 structures were $5,066,776, with uninsured losses estimated at more than $1 million. Direct expenses incurred by St. Lucie County in fighting these fires were $795,556, and additional $40,597 were incurred by Martin and Palm Beach counties as they helped St. Lucie.

Less urbanized communities and areas within the County are more vulnerable to wildland fire than the more developed communities. Large areas in the western part of the County and many isolated unincorporated pockets of residential development are quite vulnerable to wildland fire in St. Lucie County. The City of Port St. Lucie, the Lakewood Park area, and virtually all of St. Lucie County's unincorporated areas have a high vulnerability to wildland fire during the dry season each year. The problems in the City of Port St. Lucie and in the unincorporated pockets of development such as Lakewood Park arise from the following conditions:

- An extensive canopy of slash pine (*Pinus elliotii*), and in some areas sand pines (*Pinus clausa*); and
- Numerous undeveloped lots interspersed with residences.

Upland pine communities in south Florida are adapted for periodic episodes of fire and burn very easily. They also generate large quantities of flammable leaf litter and other combustible by-products, which catch fire easily and generate a very hot, if short-lived, fire. Clearing of vacant lots, periodic removal of accumulated leaf litter, maintained fire breaks, and controlled burns in the undeveloped or rangeland areas of the County are the best mitigative measures that can be applied for this hazard.

The risk assessment data for wildland fires for St. Lucie County are based on the MEMPHIS risk assessment model. **Table 4.22** displays the wildland fire exposure for structures in St. Lucie County.

Table 4.22. Wildland fire exposure, St. Lucie County, 2004.

Risk Level	Number of Structures	Value of Structures	Population
Low	66,097	$5,332,901,376	155,651
Medium	8,241	$806,260,928	13,283
High	10,887	$1,032,030,528	23,761

Source: Florida Department of Community Affairs, 2004a.

4.1.7 Muck Fires

4.1.7.1 Hazard Identification

A muck fire is a fire that consumes all the organic material of the forest floor and also burns into the underlying soil. It differs from a surface fire by being invulnerable to wind. If the fire gets deep into the ground, it could smolder for several years. In a surface fire, the flames are visible and burning is accelerated by wind, whereas in a muck fire, wind is not generally a serious factor (Canadian Soil Information System, 1996). Another extraordinary fact about muck fires has to do with their release of carbon dioxide. A peat bog that is on fire can release more carbon dioxide into the atmosphere than all the power stations and car engines emit in Western Europe in one year (Pearce, 1997). This type of fire could have a significant impact on global warming.

Historic Events. Muck fires are not a frequent threat to Florida. However, during a drought in the 1980's, fires in the Everglades consumed the rich, dried out muck that had once been the bottom of the swamp. These fires burned deep into the ground and required alternative firefighting techniques. Muck fires occur very infrequently in St. Lucie County, and the only areas where this hazard might produce impacts are in the western and southern portions of the County. At the present time, muck fires are not considered a significant threat.

4.1.8 Extreme Temperatures

4.1.8.1 Freezing Temperatures

Hazard Identification. According to the Department of Agriculture and Consumer Services, a moderate freeze may be expected every 1 to 2 years. Severe freezes may be expected on an average of once every 15 to 20 years. Freezes pose a major hazard to the agriculture industry in St. Lucie County on a recurring basis, and are a significant threat to the economic vitality of the State's vital agriculture industry. Agricultural lands represent nearly one-half of all land in St. Lucie County (University of Florida, 2001a). St. Lucie County has experienced seven significant freezes between 1970 and the present.

Historic Events. Florida has experienced a number of severe or disastrous freezes, where the majority of the winter crops are lost. The lowest temperature ever recorded in the state of Florida is -2º F (NCDC, 1998b). Since December 1889, there have been at least 22 recorded severe freezes; the most recent being in 1996, when a Presidential Disaster Declaration was issued for crop losses exceeding $90 billion. During this event, there was extensive loss of citrus trees, and the majority has not been replanted. Freezes in January of 1977 had severe impacts on agriculture around the state. A United States Department of Agriculture report indicated the following crop loss: citrus, 35%; vegetables, 95% to 100%; commercial flowers, 50% to 75%; permanent pasture land, 50%; and sugar cane, 40%. In addition, there was a severe loss to the tropical fish industry. It is estimated the freeze cost the Florida economy $2 billion in 1977 dollars (NWS, 1999a).

4.1.8.2 Extreme Heat

Hazard Identification. Temperatures that remain 10º or more above the average high temperature for a region and last for several weeks are defined as extreme heat

(FEMA, 2003a). Humid conditions, which add to the discomfort of high temperatures, occur when an area of high atmospheric pressure traps hazy, damp air near the ground.

Human bodies dissipate heat in one of three ways: by varying the rate and depth of blood circulation; by losing water through the skin and sweat glands; and by panting. As the blood is heated to above 98.6º, the heart begins to pump more blood, blood vessels dilate to accommodate the increased flow, and bundles of tiny capillaries penetrating through the upper layers of skin are put into operation. The body's blood is circulated closer to the surface, and excess heat is released into the cooler atmosphere. At the same time, water diffuses through the skin as perspiration. The skin handles about 90% of the body's heat dissipating function.

Heat disorders generally have to do with a reduction or collapse of the body's ability to cool itself by circulatory changes and sweating, or a chemical (salt) imbalance caused by too much sweating. When the body cannot cool itself, or when it cannot compensate for fluids and salt lost through perspiration, the temperature of the body's inner core begins to rise, and heat-related illness may develop. Studies indicate that, other things being equal, the severity of heat disorders tends to increase with age. Heat cramps in a 17-year old may be heat exhaustion in a 40-year old, and heat stroke in a person over 60.

When the temperature gets extremely high, the NWS has increased its efforts to alert the general public as well as the appropriate authorities by issuing Special Weather Statements. Residents should heed these warnings to prevent heat-related medical complications. As a result of the latest research findings, the NWS has devised the "Heat Index" (HI). The HI, given in degrees Fahrenheit, is an accurate measure of how hot it really feels when relative humidity is added to the actual air temperature. The NWS will initiate alert procedures when the HI is expected to exceed 105º F for at least two consecutive days. Possible heat disorders related to the corresponding HIs are listed below.

- HI of 130ºF or higher – Heatstroke/sunstroke with exposure for people in higher risk groups
- HI of 105ºF-130ºF – Sunstroke, heat cramps, and heat exhaustion likely and heatstroke possible with prolonged physical activity
- HI of 90ºF-105ºF – Sunstroke, heat cramps with prolonged exposure
- HI of 80ºF-90ºF – Fatigue possible with prolonged exposure and physical activity (NWS, 1999b)

Historic Events. The highest temperature ever recorded in the state was on June 29, 1931 at 103º F in Monticello at an elevation of 207 feet. (NCDC, 1998a). In a normal year, approximately 175 Americans die from extreme heat. However, in 1995, the death toll was 1,021 (NWS, 1997).

4.1.8.3 Vulnerability Assessment

Extreme temperature events can have the following potential impacts within a community:

- Electric power outage;
- Human health and safety;
- Psychological hardship;
- Economic disruption;

- Agricultural/fisheries damage; and
- Damage to critical environmental resources.

Temperature extremes, both freezes and periods of excessive heat impact communities with a larger population of older people to a greater extent than those with younger populations. According to the 2000 Census, 34% of residents in St. Lucie County are over the age of 60. Freezing conditions primarily affect agriculture and homeless indigents. When conditions are predicted to be below freezing, shelters are opened. As stated earlier, over 60% of land in St. Lucie County is currently designated as agricultural land. A survey of the County's homeless population was conducted in 2002 indicating that there are approximately 490 homeless individuals within the County (Florida Department of Children and Families, 2003). Inland communities away from the moderating influence of the ocean or the estuary are more vulnerable to temperature extremes as are areas with significant agricultural assets. According to the FDCA, between 1979 and 1998, there have been 230 extreme temperature-related deaths in the state. This number is greater than the number of deaths caused by hurricanes and tornadoes combined. The west County area is considered to have a high risk for losses associated with extreme temperatures, especially freezes, due to the prominence of agricultural land uses in that area.

4.1.8.4 Risk Assessment

At the time of publication, data were not available to determine potential loss in St. Lucie County due to extreme temperatures.

4.1.9 Erosion

4.1.9.1 Soil Erosion

Hazard Identification. Soil erosion is the deterioration of soil by the physical movement of soil particles from a given site. Wind, water, animals, and the use of tools by man may all be reasons for erosion. The two most powerful erosion agents are wind and water, but in most cases, these are damaging only after man, animals, insects, diseases, or fire have removed or depleted natural vegetation. Accelerated erosion caused by human activity is the most serious form of soil erosion, and can occur so rapidly that surface soil may sometimes be blown or washed away down to the bedrock.

Undisturbed by man, soil is usually covered by shrubs and trees, dead and decaying leaves, or a thick mat of grass. Whatever the vegetation, it protects the soil when rain falls or wind blows. Root systems of plants hold soil together. Even in drought, the roots of native grasses, which extend several feet into the ground, help tie down the soil and keep it from blowing away. With its covering of vegetation stripped away, soil is vulnerable to damage. Whether through cultivation, grazing, deforestation, burning, or bulldozing, once the soil is bare to the erosive action of wind and water, the slow rate of natural erosion is greatly increased. Losses of soil take place much faster than new soil can be created. With the destruction of soil structure, eroded land is even more susceptible to erosion.

The occurrence of erosion has greatly increased, generally at a rate at which soils cannot be sustained by natural soil regeneration. This is because of the activities of modern development and population growth, particularly agricultural intensification. It also is in the field of agriculture that most efforts have been made to conserve soils, with mixed success (Union of International Associations, 1999).

Particles scattered by erosion also can cause problems elsewhere. Stormwater drainage systems, both natural and mechanical, are frequently clogged by loose sediment. If drainage systems are not cleared of uncontrolled sediment on a regular basis, they lose function.

4.1.9.2 Beach Erosion

Hazard Identification. Wind, waves, and long shore currents are the driving forces behind coastal erosion. This removal and deposition of sand permanently changes beach shape and structure (Sea Grant Haznet, 1998). Most beaches, if left alone to natural processes, experience natural shoreline retreat. As houses, highways, seawalls, and other structures are constructed on or close to the beach, the natural shoreline retreat processes are interrupted. The beach jams up against these man-made obstacles and narrows considerably as the built-up structures prevent the beach from moving naturally inland. When buildings are constructed close to the shoreline, coastal property soon becomes threatened by erosion. The need for shore protection often results in "hardening" the coast with a structure such as a seawall or revetment.

A seawall is a large concrete wall designed to protect buildings or other man-made structures from beach erosion. A revetment is a cheaper option constructed with "rip rap" such as large boulders, concrete rubble, or even old tires. Although these structures may serve to protect beachfront property for a while, the resulting disruption of the natural coastal processes has serious consequences for all beaches in the area. Seawalls inhibit the natural ability of the beach to adjust its slope to the ever-changing ocean wave conditions. Large waves wash up against the seawall and rebound back out to sea carrying large quantities of beach sand with them. With each storm, the beach narrows, sand is lost to deeper water, and the long shore current scours the base of the wall. Eventually large waves impact the seawall with such force that a bigger structure becomes necessary to continue to resist the forces of the ocean (Pilkey and Dixon, 1996).

According to the Coastal Management Element of the County's Comprehensive Plan, there have been several beach restoration projects in St. Lucie County, the first of which was a Federal project undertaken in 1971, followed by a second in 1983. Between 1971 and 1990, 1.2 million yd^3 of material was replaced 1.3 miles south of the Inlet. The average projected erosion rate for the 10,000 feet of shoreline south of the inlet is 4.3 feet annually, while the average projected accretion rate for the 10,000 feet of shoreline north of the inlet is 5.4 feet per year.

4.1.9.3 Vulnerability Assessment

Erosion can have the following potential impacts within a community:

- Soil/beach erosion;
- Navigable waterway impairment;
- Economic disruption;
- Damage to critical environmental resources; and
- Stormwater drainage impairment.

St. Lucie County's vulnerability to soil collapse and beach erosion is moderate along its entire coastline. The most significant area of beach erosion in the County is along Fort Pierce Beach, immediately south of the Fort Pierce Inlet. This area has just been the subject of a major beach renourishment project sponsored jointly by the County and U.S. Army Corps of Engineers. Other beachfront communities report low to moderate erosion problems. Erosion also is a potential vulnerability for the communities located on both the Indian River and the North Fork of the St. Lucie River, and along many of the various canals in the eastern part of the County.

4.1.9.4 Risk Assessment

FDEP updated a statewide assessment of beach erosion in 2002. In that assessment, FDEP defined the "critical erosion area" as a segment of shoreline where natural processes or human activity have caused or contributed to erosion and recession of the beach or dune system to such a degree that upland development, recreation interests, wildlife habitat, or important cultural resources are threatened or lost.

Figure 4.8 shows the two critical erosion areas (5.6 miles) and one non-critical erosion area (2.8 miles) in St. Lucie County. The critical erosion area (R34 - R46) extends south from the Fort Pierce Inlet threatening recreation and development interests. Most of this area is a State and Federal beach restoration project. Further south along central Hutchinson Island is a 2.8-mile stretch of non-critical eroding shoreline (R65 - R80), which lacks any current threats. The south 3.4 miles of the County shoreline (R98 - R115 +1,000) are now designated critical with development interests threatened (FDEP, 2004).

Historically, St. Lucie County has experienced beach erosion along its Atlantic coastline, with much of it concentrated in the South Beach area, which is located immediately south of the Ft. Pierce Inlet. **Table 4.23** clearly shows that there have been multiple attempts to nourish the beach. In a recent study, the 2004 Hurricane Recovery Plan for Florida's Beach and Dune System, completed by the Florida Department of Environmental Protection, the Department recommends that shore protection and dune restoration projects are warranted and that it would take an approximate cost of $6,350,000 to restore the eroded beaches.

Table 4.23. Nourishment effects.

Ft. Pierce South Beach					
Year	Purpose	Cubic Yards	Length (ft)	Actual Cost	2003 Cost
1971	Storm & Erosion	718,000	6,864	621,288	2,649,021
1974	Navigation	36,000	Not provided	68,441	228,396
1978	Navigation	49,800	6,864	315,591	766,354
1980	Storm & Erosion	426,000	Not provided	1,428,000	2,973,787
1983	Storm & Erosion	346,000	6,864	1,559,431	2,585,372
1987	Navigation	29,800	6,864	259,561	397,118
1989	Navigation	47,800	6,864	394,400	576,089
1990	Navigation	55,700	6,864	236,017	336,219
1994	Navigation	7,190	Not provided	33,915	42,275
1995	Navigation	166,650	Not provided	808,981	996,772
1999		908,000	6,864	6,200,000	6,897,871

Source: Duke University Program for the Study of Developed Shorelines, 2003.

INSERT FIGURE 4.8

4.1.10 Drought

4.1.10.1 Hazard Identification

Drought is a normal, recurrent feature of climate, although many perceive it as a rare and random event. In fact, each year some part of the U.S. has severe or extreme drought. Although it has many definitions, drought originates from a deficiency of precipitation over an extended period of time, usually a season or more (National Drought Mitigation Center, 2003). It produces a complex web of impacts that spans many sectors of the economy and reaches well beyond the area producing physical drought. This complexity exists because water is essential to our ability to produce goods and provide services (National Drought Mitigation Center, 2003).

A few examples of direct impacts of drought are reduced crop, rangeland, and forest productivity; increased fire hazard; reduced water levels; increased livestock and wildlife mortality rates; and damage to wildlife and fish habitat. Social impacts include public safety, health, conflicts between water users, reduced quality of life, and inequities in the distribution of impacts and disaster relief. Income loss is another indicator used in assessing the impacts of drought; reduced income for farmers has a ripple effect throughout the region's economy (National Drought Mitigation Center, 2003).

The web of impacts is so diffuse that it is very difficult to come up with financial estimates of damages. However, the FEMA estimates $6 to $8 billion in losses as the annual average (FEMA, 1995). The worst drought in recent history occurred in 1987-1989, and the NCDC reports the estimated cost as $40 billion (National Drought Mitigation Center, 2003).

In St. Lucie County, the primary sources of water are watershed areas, Lake Okeechobee, and the County's wellfields. Excess water from an interconnected series of lakes, rivers, canals, and marshes flows either north to the St. Johns River or east to the Indian River Lagoon (Indian River County Department of Emergency Services, 1998). When this cycle is disrupted by periods of drought, one of the potentially most damaging effects is substantial crop loss in the western agricultural areas of the County. In addition to obvious losses in yields in both crop and livestock production, drought in St. Lucie County is associated with increases in insect infestations, plant disease, and wind erosion. In addition, the incidence of forest fires increases substantially during extended droughts, which in turn places both human and wildlife populations at higher levels of risk.

The South Florida and St. Johns River Water Management Districts and County staff manage the County's water resources. Complementing the District's water management efforts during periods of critical water shortage, a countywide, uniform, forceful, contingency plan is in place to effectively restrict the use of water.

Rainfall patterns vary greatly both seasonally and annually in Florida. Therefore, periods of low rainfall are a common occurrence but still may have significant impacts. This especially can be the case if there are several periods of low rainfall in the same year or series of years, as seen in **Figure 4.9**. Based on daily rainfall records from the Indian River Research and Education Center at Fort Pierce from 1953-2002, periods of 3 weeks or more with cumulative rainfall of less than 0.25, 0.50, and 1.0 inches were identified by researchers from the University of Florida. There have been seven occurrences since 1953 where there were periods of 6 or more weeks with less than 0.25 inch of cumulative rainfall and

33 periods of 4 or more weeks with less than 0.25 inch. There also have been 34 periods of 4 or more weeks with less than 0.50 inch of rain and 52 periods with less than 1.0 inch. These periods of drought frequently coincided with the season of late March to mid-October, when citrus crops require intense irrigation. There were 26 occurences of drought for 5 weeks or more during this season (Boman and Shukla, 2004).

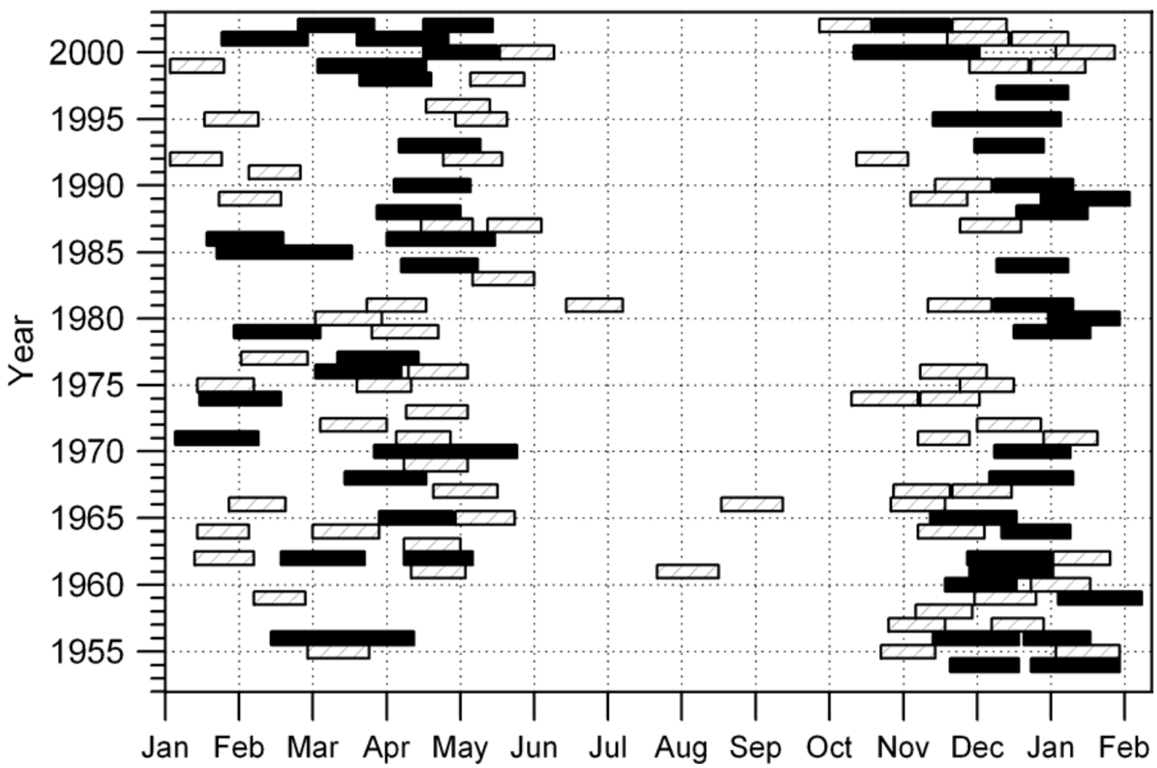


Figure 4.9. Periods of 3 to 4 weeks (hatched bars) or more than 4 weeks (solid bars) for 1953-2002 with less than 0.25 inch of cumulative rainfall (data from the Indian River Research and Education Center as reported in Boman and Shukla, 2004).

4.1.10.2 Vulnerability Assessment

Drought can have the following potential impacts within a community:

- Economic disruption;
- Agricultural/fisheries damage;
- Damage to critical environmental resources; and
- Fire.

St. Lucie County overall has a moderate vulnerability to the impacts from drought due to the County's large agricultural land use. The western area of the County is most vulnerable to the impacts of drought because this area is extensively involved in farming and ranching. The urbanized communities along the County's coast are less vulnerable due to their location and non-agricultural economic base. Potential impacts to St. Lucie County's potable water supply during drought conditions appear to be slight at this time.

4.1.10.3 Risk Assessment

At the time of publication, no model was available to determine the potential loss associated with drought in St. Lucie County. The best datum available to determine potential loss is the market value of farms in St. Lucie County, which in 1997 totaled $1.1 million.

4.1.11 Seismic Hazards

4.1.11.1 Dam/Levee Failure

Hazard Identification. Dam/levee failure poses a minor threat to population and property in St. Lucie County. All dams and levees are earthen structures and are State, regional, local, or privately controlled. The most significant risk related to dam/levee failure is flooding due to substantial rainfall and its eastward migration to final discharge in the Indian River Lagoon. Structural and non-structural techniques to slow and contain this runoff incorporate several drainage systems. Rainfall in excess of designed capacities could cause erosion of constructed drainage facilities and flooding of many areas including primary roadway evacuation routes (Indian River County Department of Emergency Services, 1998). According to the National Inventory of Dams, there are 6 dams in St. Lucie County (Structure 97, Control Structure 3, Control Structure 2, Structure 99, Structure 50, and Control Structure 1 [USACE, 1999]).

4.1.11.2 Earthquakes

Hazard Identification. Although Florida is not usually considered to be a state subject to earthquakes, several minor shocks have occurred over time, but only one caused any damage (USDOI, USGS, 2004).

Historic Events.

- In January 1879, an earthquake occurred near St. Augustine that is reported to have knocked plaster from walls and articles from shelves. Similar effects were reported in Daytona Beach. The earthquake was felt in Tampa, throughout central Florida, and in Savannah, Georgia as well (USDOI, USGS, 2004).
- In January 1880, another earthquake occurred, this time with Cuba as the focal point. Shock waves were sent as far north as the town of Key West (USDOI, USGS, 2004).
- In August 1886, Charleston, South Carolina was the center of a shock that was felt throughout northern Florida. It rang church bells in St. Augustine and severely jolted other towns along sections of Florida’s east coast. Jacksonville residents felt many of the strong aftershocks that occurred in September, October, and November 1886 (USDOI, USGS, 2004).
- In June 1893, Jacksonville experienced a minor shock that lasted about 10 seconds. Another earthquake occurred in October 1893, which also did not cause any damage (USDOI, USGS, 2004).

- In November 1948, doors and windows rattled in Captiva Island, west of Ft. Myers. It was reportedly accompanied by sounds like distant heavy explosions (USDOI, USGS, 2004).
- In November 1952, a slight tremor was felt in Quincy, a town located 20 miles northwest of Tallahassee. Windows and doors rattled, but no damage was reported (USDOI, USGS, 2004).

4.1.11.3 Sinkholes and Subsidence

Hazard Identification. Sinkholes are a common feature of Florida's landscape. They are only one of many kinds of karst landforms, which include caves, disappearing streams, springs, and underground drainage systems, all of which occur in Florida. Karst is a generic term that refers to the characteristic terrain produced by erosional processes associated with the chemical weathering and dissolution of limestone or dolomite, the two most common carbonate rocks in Florida. Dissolution of carbonate rocks begins when they are exposed to acidic water. Most rainwater is slightly acidic and usually becomes more acidic as it moves through decaying plant debris. Limestones in Florida are porous, allowing the acidic water to percolate through them, dissolving some limestone and carrying it away in solution. Over time, this persistent erosion process has created extensive underground voids and drainage systems in much of the carbonate rocks throughout the state. Collapse of overlying sediments into the underground cavities produces sinkholes (Florida Geological Survey, 1998).

4.1.11.4 Vulnerability Assessment

Seismic events can have the following potential impacts within a community:

- Surface and air transportation disruption; and
- Toxic releases.

There are areas in western St. Lucie County where canal bank failures could cause or exacerbate flooding during heavy rain events or storms. This problem is, however, more related to soil erosion than to actual levee failure. There has never been any seismic activity, soil failures, or sinkhole activity in St. Lucie County. While these hazards may exist, County vulnerability to them at this time must be considered very low.

4.1.11.5 Risk Assessment

The USDOI, USGS and the Florida Department of Natural Resources Bureau of Geology have created a map illustrating sinkhole type, development, and distribution for the state of Florida. Sinkhole risk is categorized using four categories. According to this map, St. Lucie County lies in Area II, which is classified as having coverage between 30 and 200 feet thick, consisting of incohesive and permeable sand. Sinkholes are few, shallow, of small diameter, and develop gradually. Cover-subsidence sinkholes dominate in this area.

According to the MEMPHIS risk assessment model, all structures in St. Lucie County fall into the very low risk category for sinkholes.

4.1.12 Agricultural Pests and Diseases

Florida is among the top three agriculture-producing states in the nation. Agriculture generates farm cash receipts of nearly $6 billion annually, of which citrus and vegetable crops contribute more than 40%. The industry is susceptible to many hazards including freezes, droughts, and exotic pests or diseases. Agricultural crops are grown throughout the state, and every region is vulnerable to the effects of an exotic pest or disease infestation. As a result, Florida uses the second highest volume of pesticides in the nation.

Agriculture and citrus production play a key role in the St. Lucie County economy; 52% of the County is farmland. The main threats to the St. Lucie County agriculture industry are 1) citrus canker; 2) Mediterranean fruit fly (Medfly); 3) sugarcane pests; and 4) Tomato Yellow Leaf Curl Virus (TYLCV).

4.1.12.1 Citrus Canker

Citrus canker has been found in Dade County, and the potential for its spread to other counties is high. Citrus canker is a bacterial disease of citrus that causes premature leaf and fruit drop. It affects all types of citrus, including oranges, sour oranges, grapefruit, tangerines, lemons, and limes. Symptoms found on leaves and fruit are brown, raised lesions surrounded by an oily, water-soaked area and a yellow ring or halo (Florida Department of Agriculture and Consumer Services, 1998a).

There is no known chemical compound that will destroy the citrus canker bacteria. In order to eradicate the disease, infected trees must be cut down and disposed of properly. It is a highly contagious disease that can be spread rapidly by windborne rain, lawnmowers and other landscaping equipment, animals and birds, people carrying the infection on their hands or clothing, and moving infected or exposed plants or plant parts (Florida Department of Agriculture and Consumer Services, 1998b).

4.1.12.2 Mediterranean fruit fly (Medfly)

Another threat to St. Lucie County's agriculture industry is the Medfly. It is one of the world's most destructive pests and infests more than 250 different plants that are important for U.S. food producers, homeowners, and wildlife. It is considered the greatest pest threat to Florida's $1.5 billion citrus crop, as well as endangering many other economically significant crops (Florida Department of Agriculture and Consumer Services, 1998d). For example, a Medfly outbreak in 1997 cost an estimated $32 million to eradicate in Manatee, Marion, Orange, Polk, and Sarasota counties (USDA, 1999). If a long-term or widespread Medfly infestation were to occur, Florida growers would not be permitted to ship numerous fruit and vegetable crops to many foreign and domestic markets. The movement of fruits and vegetables, even within the state, would be disrupted, which could lead to higher prices in the supermarket. Costly post-harvest treatment of fruits and vegetables to meet quarantine restrictions of domestic and foreign markets would also be required. If the Medfly is not eradicated in Florida, ongoing pesticide treatments by homeowners and commercial growers will be necessary.

Adult Med flies are up to ¼" long, black with yellow abdomens, and have yellow marks on their thoraxes. Their wings are banded with yellow. The female Med fly damages produce by laying eggs in the host fruit or vegetable. The resulting larvae feed on the pulp, rendering the produce unfit for human consumption. In addition to citrus, med flies will feed on hundreds of other commercial and backyard fruit and vegetable crops.

Because med flies are not strong fliers, the pest is spread by the transport of larval-infested fruit. The major threats come from travelers, the U.S. mail, and commercial fruit smugglers. Several steps have been taken to prevent new infestations. State and federal officials are working with postal authorities to develop ways to inspect packages suspected of carrying infested fruit. In addition, public education efforts carrying the message “Don’t Spread Med” are being expanded (Florida Department of Agriculture and Consumer Services, 1998d).

4.1.12.3 Sugarcane Pests

Changes in sugarcane agriculture, including new diseases and insect pests, have seriously impacted the quality of cane and juice delivered to the mill for processing. These changing developments affect the level of sucrose, purity, fiber, and color of cane resulting in a loss of sugar and decrease in the quantity and quality of sugar produced (Legendre et al., 1998).

4.1.12.4 TYLCV

The TYLCV is believed to have entered the state in Dade County sometime in early 1997 (Florida Department of Agriculture and Consumer Services, 1999). Symptoms vary among tomato types, but in general, leaves produced shortly after infection are reduced in size, distorted, cupped inward or downward, and have a yellow mottle. Fewer than 1 in 10 flowers will produce fruit after TYLCV infection, severely reducing yields.

The virus is transmitted by adult silverleaf whiteflies. Although frequent applications of pesticides help to decrease whitefly populations and suppress the spread of TYLCV, virus management through whitefly control is not possible in years where whitefly populations are high. Fortunately, the virus is not transmitted through seed or casual contact with infected plants.

4.1.12.5 Vulnerability Assessment

Agricultural pests and diseases can have the following potential impacts within a community:

- Human health and safety;
- Psychological hardship
- Economic disruption;
- Agricultural/fisheries damage; and
- Damage to critical environmental resources.

Agricultural pests and diseases are more significant hazards in those areas of the County where agriculture is a more significant element in the economic base. In 2001, St. Lucie County produced 98,899,000 boxes of citrus. The State of Florida has the second highest tomato sales, bringing in $392 million in 1999 (University of Florida, 2001a). The western portion of St. Lucie County is a major ranching and citrus area, and there are numerous nurseries and smaller agriculture-related businesses located through the County.

Overall, the County's vulnerability to agricultural pests and diseases is considered to be moderate except in the western portions of the County where it is considered to be high.

4.1.12.6 Risk Assessment

At the time of publication, no model was available to determine the potential loss associated with agricultural pests and diseases in St. Lucie County. The best datum available to determine potential loss is the market value of farms in St. Lucie County, which in 1997 totaled $1.1 million.

4.1.13 Epidemics

4.1.13.1 Hazard Identification

Infectious diseases emerging throughout history have included some of the most feared plagues of the past. New infections continue to emerge today, while many of the old plagues are still with us. As demonstrated by influenza epidemics, under suitable circumstances, a new infection first appearing anywhere in the world could travel across entire continents within days or weeks (Morse, 1995). Due to the potential of complex health and medical conditions that can threaten the general population, Florida's vulnerability to an epidemic is continually being monitored. With millions of tourists arriving and departing the state annually, disease and disease exposure (airborne, vector, and ingestion) are constantly evaluated and analyzed.

Primarily as a result of the entrance of undocumented aliens into south Florida, and the large number of small wildlife, previously controlled or eradicated diseases have surfaced. Health officials closely monitor this potential threat to the public health. The emphasis upon preventive medical measures such as school inoculation, pet licensing, rodent/insect eradication, water purification, sanitary waste disposal, health inspections, and public health education mitigates this potential disaster.

Another potential threat to south Florida's population is food contamination. Frequent news stories document that *E. coli* and botulism breakouts throughout the country are not that uncommon. In 1997, millions of pounds of possibly contaminated beef from Arkansas-based Hudson Foods Company were seized by the Department of Agriculture and destroyed.

The County addresses Anthrax and west Nile issues through the Health Department and mosquito control.

4.1.13.2 Vulnerability Assessment

Epidemics can have the following potential impacts within a community:

- Human Health & Safety;
- Psychological Hardship;
- Economic Disruption;
- Disruption of Community Services; and
- Agricultural/Fisheries Damages.

Florida is more vulnerable than many other states to possible outbreaks of infectious diseases due to the large number of international and U.S. tourists it attracts. The number of illegal aliens reaching U.S. shores also increases vulnerability to disease hazards. St. Lucie County's vulnerability to epidemic outbreaks, while higher than some other Florida counties due to its large immigrant population, is still considered only moderate. Medical facilities are adequate for current needs, but would be stressed if forced to deal with a major disease outbreak.

4.1.13.3 Risk Assessment

At the time of publication, no model was available to determine the potential loss associated with epidemics in St. Lucie County.

4.2 TECHNOLOGICAL HAZARDS

This subsection will now identify those hazards in St. Lucie County identified as being technological hazards.

4.2.1 Radiological Accidents

4.2.1.1 Hazard Identification

While an actual release of radioactive material is extremely unlikely and the immediate threat to life extremely low, vulnerability to a nuclear plant disaster could consist of long range health effects with temporary and permanent displacement of population from affected areas. The potential danger from an accident at a nuclear power plant is exposure to radiation. This exposure could come from the release of radioactive material from the plant into the environment, usually characterized by a plume (cloudlike) formation. The area the radioactive release may affect is determined by the amount released from the plant, wind direction and speed, and weather conditions (e.g., rain), which would quickly drive the radioactive material into the ground, hence causing increased deposition of radionuclides.

Thirty of the 67 counties in the State of Florida are involved in preparedness planning for a commercial nuclear power plant emergency. Emergency Planning Zones (EPZs) have been designated for each power plant to enhance planning efforts for an emergency. An EPZ is comprised of two zones, the 10-mile plume exposure zone and the 50-mile ingestion exposure zone (Nuclear Energy Institute, 2004). Specific coordinating procedures for response to a General Emergency at a nuclear power plant have been prepared in the form of Standard Operating Procedures. These include Emergency Classification Levels, which assist in notifying the public if a problem occurs at a plant. They are defined by four categories (FEMA, 2004):

- Notification of Unusual Event - The event poses no threat to plant employees, but emergency officials are notified. No action by the public is necessary.
- Alert - An event has occurred that could reduce the plant's level of safety, but back-up systems still work. Emergency agencies are notified and kept informed, but no action by the public is necessary.
- Site Area Emergency - The event involves major problems with the plant's safety and has progressed to the point that a release of some radioactivity into the air or water is possible, but is not expected to exceed EPA Protective Action Guidelines (PAGs). Thus, no action by the public is necessary.

- General Emergency - The event has caused a loss of safety systems. If such an event occurs, radiation could be released that would penetrate the site boundary. State and local authorities will take action to protect the residents living near the plant. The alert and notification system will be sounded. People in the affected areas could be advised to evacuate, or in some situations, to shelter in place. When the sirens are sounded, radio and television alerts will have site-specific information and instructions.

The St. Lucie nuclear power generation plant is located 12 miles southeast of the City of Fort Pierce on Hutchinson Island in St. Lucie County. The facility contains two reactors and is owned and operated by the Florida Power & Light Company. Counties within the 50-mile EPZ include all or portions of St. Lucie, Martin, Glades, Osceola, Okeechobee, Brevard, Highlands, Palm Beach, and Indian River.

The Florida Power & Light St. Lucie Nuclear Power Plant is located on south Hutchinson Island, and all of St. Lucie County falls within the 50-mile radius EPZ for that plant. This means that virtually all of St. Lucie County is extremely vulnerable to a nuclear power plant accident. Fortunately, the frequency with which nuclear power plant accidents occur is very low, and the overall risk to the citizens of St. Lucie County is therefore considered low.

4.2.1.2 Vulnerability Assessment

Nuclear emergency is perhaps the single hazard facing St. Lucie County that has received massive emergency management attention at all levels of government. Emergency management planning and regulation relative to nuclear power plant accidents exists at the Federal, State, local, and corporate levels. Drills are held routinely, and the Nuclear Regulatory Commission as well as several other Federal agencies require extensive documentation. Contingency planning for nuclear accidents at the plant itself appears to be well in hand. Of more risk to the citizens of St. Lucie County is the transport of fissionable material to and from the plant. Such material transfers are handled with a great deal of care, and there has never been a significant accident during such transfers. Again, while St. Lucie County's vulnerability to such accidents is high, the risk that this hazard will produce an impact within the community appears to be low.

Radiological accidents can have the following potential impacts on a community:

- Electric power outage;
- Surface and air transportation disruption;
- Telecommunications system outage;
- Human and health safety;
- Psychological hardship;
- Economic disruption;
- Disruption of community services;
- Damage to critical environmental resources; and
- Toxic releases.

4.2.1.3 Risk Assessment

At the time of publication, no data were available to determine the potential loss associated with a radiological accident in St. Lucie County.

4.2.2 Power Failures (Outages)

4.2.2.1 Hazard Identification

Power failure can result from a variety of related causes, including sagging lines due to hot weather, flashovers from transmission lines to nearby trees, and incorrect relay settings. According to the electric utility industry's trade association, the potential for such disturbances is expected to increase with the profound changes now sweeping the electric utility industry.

To address times when generating capacity is tight, or falls below consumer demand due to State or local emergencies, the Florida Electrical Emergency Contingency Plan was developed. Alerts have been created to give early warning of potential electricity shortfalls and bring utilities, emergency management officials, and the general public to a state of preparedness. The Contingency Plan has four stages (Florida Reliability Coordinating Council, 2004):

- Generating Capacity Advisory - A Generating Capacity Advisory is primarily for information purposes. It starts utility tracking activities, and it initiates inter-utility and inter-agency communication. No action by the public is required. General information may be distributed to consumers to forewarn them of conditions if necessary.
- Generating Capacity Alert - A Generating Capacity Alert starts actions to increase reserves. Available emergency supply options will be explored. When reserves fall below the size of the largest generating unit in the state, loss of that size unit to an unexpected mechanical failure could lead to blackouts somewhere since insufficient backup is available.
- Generating Capacity Emergency - A Generating Capacity Emergency occurs when blackouts are inevitable somewhere in Florida. Every available means of balancing supply and demand will be exhausted. Rolling blackouts, manually activated by utilities, are a last resort to avoid system overload and possible equipment damage. Frequent status reports are provided to agencies and the media. The Division of Emergency Management will consider using the Emergency Broadcast System to inform citizens of events and to direct them to available shelters if conditions warrant. Recognizing the consequences of a loss of electricity, individual utility emergency plans include provisions for special facilities critical to the safety and welfare of citizens.
- System Load Restoration - System Load Restoration is instituted when rolling blackouts have been terminated and power supply is adequate. It is the recovery stage, and efforts are made to provide frequent system status reports.

Historic Events. In the U.S., from July 2 to August 10, 1996, the Western States Utility Power Grid reported widespread power outages that affected millions of customers in several western states and adjacent areas of Canada and Mexico.

A massive power outage struck the northeast on Thursday, August 14, 2003. Areas affected by the outage included: New York City and Albany, New York; Cleveland and Toledo, Ohio; Detroit and Lansing, Michigan; parts of New Jersey and Connecticut; as well as Toronto and Ontario, Canada. The most extensive power failure in history, it shut down 10 major airports, 9 power plants, affected 50 million people, and led to a declared State of Emergency in New York City. The Ford Motor Company lost production capability at 21 of its facilities. Two deaths and 71 fires were attributed to the outage in New York City alone (Gellman and Milbank, 2003). The preliminary economic impacts of this event are large. It is estimated that the power failure cost approximately $1 billion including $800 million in unsold goods and services and $250 million in spoiled food.

4.2.2.2 Vulnerability Assessment

Power failures have the same potential impacts in all St. Lucie County communities. The vulnerability of all communities to power failures is considered low. The power grid throughout St. Lucie County is diversified, and there are no single choke points or distribution nodes whose failure would disrupt power distribution to the entire community.

Power failure can have the following potential impacts on a community:

- Electric power outage;
- Surface and air transportation distribution;
- Potable water system loss or disruption;
- Sewer system outage;
- Telecommunications system outage;
- Human and health safety;
- Psychological hardship;
- Economic disruption; and
- Disruption of community services.

4.2.2.3 Risk Assessment

At the time of publication, no model was available to determine the potential loss associated with power failure in St. Lucie County.

4.2.3 Hazardous Materials Accidents

4.2.3.1 Hazard Identification

Hazardous materials accidents can occur anywhere there is a road, rail line, pipeline, or fixed facility storing hazardous materials. Virtually the entire state is at risk to an unpredictable accident of some type. Most accidents are small spills and leaks, but some result in injuries, property damage, environmental contamination, and other consequences. These materials can be poisonous, corrosive, flammable, radioactive, or pose other hazards and are regulated by the Department of Transportation. However, out of approximately

1,663 hazardous materials incidents reported statewide in 1997, no known fatalities were reported, less than 4% resulted in injuries, and less than 6% resulted in evacuation.

Emergencies involving hazardous materials can be expected to range from a minor accident with no off-site effects to a major accident that may result in an off-site release of hazardous or toxic materials. The overall objective of chemical emergency response planning and preparedness is to minimize exposure for a wide range of accidents that could produce off-site levels of contamination in excess of Levels of Concern established by the EPA. Minimizing this exposure will reduce the consequences of an emergency to people in the area near to facilities that manufacture, store, or process hazardous materials (Treasure Coast Regional Planning Council, 1998).

A large volume of hazardous materials is transported to and through the County by railroad and highway, air, water, and pipeline daily. Within St. Lucie County, there are a number of both public and private fixed facilities that produce or use hazardous materials. Coordinating procedures for hazardous material response are found within the County's Emergency Plan for Hazardous Materials.

In addition to the County's Emergency Plan for Hazardous Materials, Local Emergency Planning Committee officials have prepared a plan for use in responding to and recovering from a release of hazardous or toxic materials. This plan addresses the range of potential emergency situations and the appropriate measures to be implemented to minimize exposure through inhalation, ingestion, or direct exposure (Treasure Coast Regional Planning Council, 1998).

Mishandling and improper disposal or storage of medical wastes and low-level radioactive products from medical use also are a hazard to St. Lucie County. For example, a few years ago an incident occurred in New Jersey where improper disposal of medical wastes resulted in some of the used products ending up on Atlantic Ocean beaches.

Historical Events. In September of 1999, a sewage spill released 8,500,000 gallons of sewage into the Indian River Lagoon. In July of 2000, a fertilizer fire at the Lykes Manufacturing Plant created a chemical fire. In October of 2001, the Health Department organized and coordinated the County's response to potential anthrax incidents. The estimated cost of response for the department is estimated at $46,481.

4.2.3.2 Vulnerability Assessment

Hazardous materials events can have the following potential impacts within a community:

- Surface and air transportation disruption;
- Human health and safety;
- Psychological hardship;
- Economic disruption;
- Disruption of community services;
- Fire; and
- Toxic releases.

A community's vulnerability to hazardous materials accidents depends on three factors. These are:

1) The major transportation routes that pass through the community;
2) The hazardous material generators located in or near the community; and
3) The resources in terms of people and property are in an area of possible impact from a hazardous materials release.

Overall, unincorporated St. Lucie County has a low vulnerability to impacts from hazardous materials releases. There are relatively few major generators within the County, and those that do exist are generally away from major population centers.

Specific areas with higher vulnerability for hazardous materials accidents are along the transportation network (both highway and rail) that pass through the County. The jurisdictions of Fort Pierce and St. Lucie Village are extremely vulnerable to toxic material spills and releases from transportation system accidents, primarily rail accidents, as is the unincorporated area along South Indian River Drive. The Florida East Coast Rail Road runs through downtown Fort Pierce and directly adjacent to South Indian River Drive and St. Lucie Village. Toxic material spills have occurred along the rail line, and given the right set of circumstances, such releases could produce significant detrimental effects on life and property.

Because of its location relative to the St. Lucie nuclear power plant, all of St. Lucie County has a high vulnerability to a nuclear power plant accident or nuclear materials release. While the County's level of vulnerability is high, the frequency with which nuclear power plant accidents occur is very low, and the overall risk to the citizens of St. Lucie County is therefore considered low. Nuclear emergency is perhaps the single hazard facing St. Lucie County, which has received massive emergency management attention at all levels of government. Emergency management planning and regulation relative to nuclear power plant accidents exists at all levels, Federal, State, local, and corporate. This hazard has not been extensively addressed in St. Lucie County.

4.2.3.3 Risk Assessment

At the time of publication, no model was available to determine the potential loss associated with hazardous materials accidents in St. Lucie County.

4.2.4 Transportation System Accidents

4.2.4.1 Hazard Identification

Florida has a large transportation network consisting of major highways, airports, marine ports, and passenger railroads. The heavily populated areas of St. Lucie County are particularly vulnerable to serious accidents, which are capable of producing mass casualties. With the linear configuration of several major highways in St. Lucie County, such as interstate highways and the Florida Turnpike, major transportation accidents could occur in a relatively rural area, severely stressing the capabilities of local resources to respond effectively. A recent notorious example is the crash in the Everglades of ValuJet Flight 597 on May 11, 1996, which resulted in 109 fatalities and cost of millions of dollars, severely taxing the financial and public safety resources of Dade County. Similarly, a major transportation accident could involve a large number of tourists and visitors from other countries, given Florida's popularity as a vacation destination, further complicating the emergency response to such an event.

As a major industrial nation, the U.S. produces, distributes, and consumes large quantities of oil. Petroleum-based oil is used as a major power source to fuel factories and various modes of transportation, and in many everyday products, such as plastics, nylon, paints, tires, cosmetics, and detergents (EPA, 1998). At every point in the production, distribution, and consumption process, oil is stored in tanks. With billions of gallons of oil being stored throughout the country, the potential for an oil spill is significant, and the effects of spilled oil can pose serious threats to the environment.

In addition to petroleum-based oil, the U.S. consumes millions of gallons of non-petroleum oils, such as silicone and mineral-based oils and animal and vegetable oils. Like petroleum products, these non-petroleum oils are often stored in tanks that have the potential to spill, causing environmental damages that are just as serious as those caused by petroleum-based oils. To address the potential environmental threat posed by petroleum and non-petroleum oils, the EPA has established a program designed to prevent oil spills. The program has reduced the number of spills to less than 1% of the total volume handled each year (EPA, 1998).

St. Lucie County has about 22 miles of Atlantic Ocean coastline that is subject to contamination caused by an oil spill. By Executive Order, the responsibility for preparing response plans for coastal oil spills is designated to the DEP, Division of Florida Marine Patrol (Indian River County Department of Emergency Services, 1998). The Florida Coastal Pollutant Spill Plan has been prepared to coordinate response procedures and recovery efforts after a spill. There are two active oil field regions in Florida: in Escambia and Santa Rosa counties in the Panhandle, and Collier, Dade, Hendry, and Lee counties in southwest Florida.

4.2.4.2 Vulnerability Assessment

Transportation system accidents can have the following potential impacts within a community:

- Surface and air transportation disruption;
- Navigable waterway impairment;
- Human health and safety;
- Economic disruption;
- Disruption of community services; and
- Fire.

There are no longer any commercial airlines flying into the St. Lucie Municipal Airport, but the airport is a major general aviation facility for the region. There are two large flight schools, a number of commercial aircraft construction and maintenance operations, and a considerable amount of private and charter air traffic. The airport is located directly to the north of the City of Fort Pierce, and the runway approaches pass directly over St. Lucie Village. Aviation is an important element of the economy in St. Lucie County, and this activity raises the County's vulnerability to aviation associated accidents.

Vulnerability to transportation system accidents is also associated with the highway and rail systems that run through the County. Individual community and population center vulnerabilities to this hazard are entirely dependent upon location. The City of Fort Pierce is the County's major transportation hub, with rail yards, trucking centers, and a port. Transportation accidents have created blockages of highways within the City. Due to their locations along the rail line, both St. Lucie Village and unincorporated South Indian River Drive have higher vulnerabilities to rail system accidents. St. Lucie Village also is more vulnerable to plane crashes due to its location relative to the St. Lucie airport. The western, unincorporated portion of the County and City of Port St. Lucie has higher vulnerability to major highway accidents due to the presence of I-95 and the Florida Turnpike.

The Port of Fort Pierce is located within the Indian River Lagoon, a designated National Estuary under the EPA's National Estuary Program (Section 320 - 33 USC 1330) of the Clean Water Act. As such, this Port is by definition located within an environmentally sensitive area. Spills of any type in such areas are of more significance due to the sensitive nature of the environmental resources seen there.

4.2.4.3 Risk Assessment

At the time of publication, data were not available to determine the potential loss in St. Lucie County due to transportation system accidents.

4.2.5 Wellfield Contaminations

4.2.5.1 Hazard Identification

The development of wellfield protection programs is a major preventative approach for the protection of community drinking water supplies. Wellfield protection is a means of safeguarding public water supply wells by preventing contaminants from entering the area that contributes water to the well or wellfield over a period of time. Management plans are developed for the wellfield protection area that include inventorying potential sources of ground water contamination, monitoring for the presence of specific contaminants, and managing existing and proposed land and water uses that pose a threat to ground water quality.

Ground water is an essential natural resource. It is a source of drinking water for more than half of the U.S. population and more than 95% of the rural population (Browning, 1998). In addition, ground water is a support system for sensitive ecosystems, such as wetlands or wildlife habitats.

Between 1971 and 1985, there were 245 ground water related outbreaks of disease, resulting in more than 52,000 individuals being affected by associated illnesses (Browning, 1998). While most of these diseases were short-term digestive disorders caused by bacteria and viruses, hazardous chemicals found in wells nationwide also pose risks to public health.

The 1986 Amendments to the Federal Safe Drinking Water Act require states to implement wellfield protection programs for public water wells. Prevention strategies include maintaining isolation distances from potential contamination sources, reporting to the state violations of the isolation distance, and asking a local governmental unit to regulate these sources.

Cleaning up contaminated ground water can be technically difficult, extremely expensive, and sometimes simply cannot be done. Contaminated ground water also affects the community by discouraging new businesses or residents from locating in that community.

4.2.5.2 Vulnerability Assessment

Wellfield contamination can have the following potential impacts within a community:

- Potable water system loss or disruption;
- Sewer system outage;
- Human health and safety;
- Psychological hardship;
- Economic disruption; and
- Disruption of community services.

St. Lucie County's Conservation Element of the Comprehensive Growth Management Plan contains a policy regarding wellfield protection. The policy (8.1.5.1) outlines the following standards for wellfield protection within the County:

1) Assure adequate and safe water supplies to present and future citizens of the County;
2) Comply with Federal and State regulations in the best interests of the County and its future growth and development;
3) Avoid crisis water supply situations through careful groundwater resources planning and conservation;
4) Identify and protect the functions of public wellfield areas, including recharge of those areas, and provide incentives to keep the present and future public well fields compatible with the needs expressed in 1) above;
5) Ensure that new development is compatible with existing local and regional water supply capabilities; and
6) Protect present and future public well fields against depletion and contamination through appropriate regulation, incentives, and cooperative agreements.

Section 6.03.00 of the St. Lucie County Land Development Code also outlines requirements for protecting wellfields within the County. Wellfield contamination has not been a major problem for most of St. Lucie County. There is some potential exposure to this hazard in the eastern portion of the County, but overall the County vulnerability to this hazard is considered low.

4.2.5.3 Risk Assessment

At the time of publication, no data were available to determine the potential loss associated with wellfield contamination in St. Lucie County.

4.2.6 Communications Failures

4.2.6.1 Hazard Identification

As society emerges from industrial production into the age of information, we are seeing new kinds of technological accidents/disasters. Recently, a communications failure occurred that was the worst in 37 years of satellite service. Some major problems with the telecommunications satellite Galaxy IV drastically affected 120 companies in the paging industry (Rubin, 1998). Radio and other forms of news broadcasts also were affected. The pager failure not only affected personal and business communications, but emergency managers and medical personnel as well.

4.2.6.2 Vulnerability Assessment

Communications failures can have the following potential impacts within a community:

- Telecommunications system outage;
- Economic disruption; and
- Disruption of community services.

Communications failures have a greater potential to produce adverse economic impacts in business-based rather than retirement or residential communities. On the other hand, communications system failures in residential and retirement communities may put more human lives at risk. St. Lucie County's vulnerability to communications systems failures is generally considered moderate. The City of Fort Pierce and U.S. Highway 1 corridor throughout the County have higher vulnerabilities to this hazard. Fort Pierce is the center of government and business within the County, and there is an extensive concentration of business activity along the U.S. Highway 1 corridor throughout the County. Other concentrations of business and financial activity include Port St. Lucie Boulevard in the City of Port St. Lucie, and certain areas of Prima Vista Boulevard, also in the City of Port St. Lucie. Basically, St. Lucie County's vulnerability to this hazard is no greater or less than most other Florida coastal counties.

4.2.6.3 Risk Assessment

At the time of publication, no data were available to determine the potential loss in St. Lucie County due to communications failure.

4.2.7 Military Ordnance

4.2.7.1 Hazard Identification

Unexploded military ordnance is a hazard unique to St. Lucie and Indian River counties. The former Fort Pierce Naval Amphibious Training Base was established in 1942, and its training exercises were conducted on outlying areas of North and South Hutchinson Islands. Training at the base included testing of bombs, rockets, and mines. Several explosive devices left over from these training missions have been found along the shores of Vero Beach and Fort Pierce. Public exposure to unexploded ordnance could occur primarily as a result of three types of activities: earth moving (building construction, pool construction, and major landscaping), recreational diving, and use of beach areas.

Unexploded ordnance also may wash ashore or be exposed after storms (Indian River County Department of Emergency Services, 1998). Prior clean up operations have been coordinated by the U.S. Army Corps of Engineers (Jacksonville office) with the full cooperation of the St. Lucie County Department of Emergency Management.

4.2.7.2 Vulnerability Assessment

Unexploded military ordnance can have the following potential impacts within a community:

- Human and health safety;
- Psychological hardship;
- Damage to critical environmental resources; and
- Toxic releases.

There is some exposure to risk from unexploded military ordnance along St. Lucie County beaches, but the overall vulnerability of County residents to this hazard is very low. The communities most vulnerable to this hazard are those immediately north of the Fort Pierce Inlet on Hutchinson Island. While old military ordnance does occasionally surface along these beaches, there has never been a case where the ordnance was still live.

4.2.7.3 Risk Assessment

At the time of publication, no data were available to determine the potential loss in St. Lucie County due to unexploded military ordnance.

4.3 SOCIETAL HAZARDS

This subsection will now identify those hazards in St. Lucie County identified as being societal hazards.

4.3.1 Terrorism and Sabotage

4.3.1.1 Terrorism

Terrorist attacks may take the form of induced dam or levee failures, the use of hazardous materials to injure or kill, or the use of biological weapons to create an epidemic. While there have not been any successful acts of terrorism committed in Florida in recent years, it is recognized that the state has many critical and high-profile facilities, high concentration of population, and other potentially attractive venues for terrorist activity that are inherently vulnerable to a variety of terrorist methods. Governmental/political, transportation, commercial, infrastructure, cultural, academic, research, military, athletic, and other activities and facilities constitute ideal targets for terrorist attacks, which may cause catastrophic levels of property and environmental damage, injury, and loss of life. Furthermore, a variety of extremist groups are known to operate within Florida, and potential terrorist attacks have been investigated and averted in recent years (Indian River County Department of Emergency Services, 2002).

Acts of terrorism are capable of creating disasters, which threaten the safety of a large number of citizens. The U.S. has been relatively untouched by the storm of terrorist activities experienced in other parts of the world; however, in recent years, an increasing incidence of terrorism has been recorded in this nation.

The Federal government has recognized that the U.S. has entered the post-Cold War era. As a result, Federal planning guidelines regarding military threats are in transition. However, nuclear weapons continue to be a serious planning concern especially in areas surrounding military installations (Indian River County Department of Emergency Services, 1998). Those involved with the emergency management of government monitor the influx of undocumented aliens into south Florida from areas unfriendly to the interest of the U.S.

Historical Events. On September 11, 2001, terrorists attacked the World Trade Center in New York City and the Pentagon in Washington, DC, crashing hijacked commercial airplanes into the structures. All told, approximately 3,000 civilians and emergency response personnel perished in the attack. The long-term economic and psychological impacts of this event are astounding. New York City alone experienced capital losses totaling $34 million. The attack on the World Trade Center resulted in a loss of 12.5 million ft^2 of office space and damaged 7.7 million more. The insured losses associated with the event totaled $52 million. The City estimates that 125,300 jobs were lost because of the attack (National Conference of State Legislatures, 2003). The September 11th attacks also had local connections to Indian River County as some of the New York City terrorists received flight training at the Vero Beach Municipal Airport.

4.3.1.2 Computer Accidents and Sabotage

The President's Commission on Critical Infrastructure Protection (PCCIP) recently reported that there is increasing threat that the U.S. could suffer something similar to an "Electronic Pearl Harbor" (Rubin, 1998). Networked information systems present new security challenges in addition to the benefits they offer. Long-term power outages could cause massive computer outages, with severe economic impacts such as loss of sales, credit checking, banking transactions, and ability to communicate and exchange information and data. "Today, the right command sent over a network to a power generating station's control computer could be just as effective as a backpack full of explosives, and the perpetrator would be harder to identify and apprehend," states the PCCIP's report.

With the growth of a computer-literate population, increasing numbers of people possess the skills necessary to attempt such an attack. The resources to conduct a cyber attack are now easily accessible everywhere. A personal computer and an Internet service provider anywhere in the world are enough to cause a great deal of harm. Threats include (Rubin, 1998):

- Human error;
- Insider use of authorized access for unauthorized disruptive purposes;
- Recreational hackers - with or without hostile intent;
- Criminal activity - for financial gain, to steal information or services, or organized crime;
- Industrial espionage;

- Terrorism - including various disruptive operations; and
- National intelligence - information warfare, intended disruption of military operations.

The effects of such activities may take the form of disruption of air traffic controls, train switches, banking transfers, police investigations, commercial transactions, defense plans, power line controls, and other essential functions. As the Internet becomes more and more important, the loss of its services, whether by accident or intent, becomes a greater hardship for those relying on this new form of communication. Computer failures could affect emergency communications as well as routine civilian applications, such as telephone service, brokerage transactions, credit card payments, Social Security payments, pharmacy transactions, airline schedules, etc.

4.3.1.3 Vulnerability Assessment

Terrorism and sabotage events can have the following potential impacts within a community:

- Electric power outage;
- Surface and air transportation disruption;
- Potable water system loss or disruption;
- Telecommunications system outage;
- Human health and safety;
- Psychological hardship;
- Economic disruption;
- Damage to critical environmental resources;
- Damage to identified historical resources;
- Fire; and
- Toxic releases.

The possibilities for terrorism and sabotage in St. Lucie County are limited, and the County's vulnerability to this hazard is low. The City of Fort Pierce has a slightly higher vulnerability to terrorism as it is the center of government and also because of the role played by aviation in the local economy, but this vulnerability is still considered low.

4.3.1.4 Risk Assessment

At the time of publication, no data were available to determine the potential loss in St. Lucie County due to terrorism.

4.3.2 Civil Disturbance

4.3.2.1 Hazard Identification

As in any other area, St. Lucie County is subject to civil disturbances in the form of riots, mob violence, and a breakdown of law and order in a focalized area. Communities with racial mixtures, gang violence, and drug trafficking are increasingly aware of the need to plan for civil disturbance emergencies (Indian River County Department of Emergency Services, 1998). Although they can occur at any time, civil disturbances are often preceded by periods of increased tension caused by questionable social and/or political events such as controversial jury trials or law enforcement actions. Police services are responsible for the restoration of law and order in any area of the County.

4.3.2.2 Vulnerability Assessment

Civil disturbance can have the following potential impacts within a community:

- Surface and air transportation disruption;
- Human health and safety;
- Psychological hardship;
- Economic disruption;
- Disruption of community services; and
- Damage to identified historical resources.

The overall potential for civil disturbance in St. Lucie County is considered low. The City of Fort Pierce, however has a relatively high vulnerability to this hazard. There has been significant civil unrest in certain areas of this City in the past, and a significant potential for such unrest remains. Recently (within the last 3 years), the potential for civil disturbance appears to have been reduced as a result of community-based police activities.

4.3.2.3 Risk Assessment

At the time of publication, no data were available to determine the potential loss in St. Lucie County due to civil unrest.

4.3.3 Immigration Crises

4.3.3.1 Hazard Identification

Florida's location as the nearest U.S. landmass bordering the Caribbean basin makes it a chosen point of entry for many migrants attempting to enter the country illegally. A mass arrival of illegal immigrants to a community could be disruptive to the routine functioning of the impacted community, resulting in significant expenditures related to the situation. An example of this threat occurred in 1994, when the state responded to two mass migration incidents. In May 1994, there was an unexpected migration of approximately 100 Haitian refugees; while in August 1994, there was an influx of 700 Cubans. These events are typically preceded by periods of increasing tension abroad, which can be detected and monitored. Enforcement of immigration laws is a Federal government responsibility. However, it is anticipated that joint jurisdictional support of any operation will be required from the State and local governments.

The Atlantic shore of St. Lucie County is the frequent scene of the arrival of undocumented aliens, usually Haitian or Cuban (Indian River County Emergency Management Division, 2002). The County has both the history and the potential for the unannounced arrival of a large number of aliens. Until relieved of the responsibility by the State and Federal governments, St. Lucie County must be capable of providing mass refugee care to include shelter, food, water, transportation, medical, police protection, and other social services.

4.3.3.2 Vulnerability Assessment

Immigration crises can have the following potential impacts within a community:

- Human health and safety;
- Psychological hardship;
- Economic disruption; and
- Disruption of community services.

Reviewing the data on past illegal immigration and mass population movements such as the Haitian influx and Cuban raft incidents of the 1980s indicates that illegal immigration has never reached a crisis state for the local authorities in St. Lucie County. St. Lucie County's vulnerability to this hazard is moderate, however, due to demographic features. The City of Fort Pierce has a slightly higher vulnerability to illegal immigration impacts due to its large population of Latin American and Caribbean immigrants.

4.3.3.3 Risk Assessment

At the time of publication, no data were available to determine the potential loss in St. Lucie County due to immigration crises.

4.3.4 Societal Alienation

4.3.4.1 Hazard Identification

The term "societal alienation" as used here applies to a variety of social problems including homelessness, behavioral problems, and mental health issues. St. Lucie County is a relatively poor County by Florida east coast standards, and many of its citizens are more vulnerable to these types of societal alienation problems than the citizens of neighboring, more affluent jurisdictions.

4.3.4.2 Vulnerability Assessment

St. Lucie County has a higher vulnerability to the complex of problems caused by "societal alienation" than more affluent counties along Florida's east coast. If crime rate is used as an indicator, St. Lucie County's vulnerability in these areas has been reduced over the last few years. This reduction may be attributed to some social programs and grants.

Social alienation can have the following impacts on a community:

- Human health and safety; and
- Psychological hardship.

4.3.4.3 Risk Assessment

At the time of publication, no data were available to determine the potential loss in St. Lucie County due to societal alienation.

4.3.5 Substance Abuse

4.3.5.1 Hazard Identification

Substance abuse as described here includes drug and alcohol problems, as well as child, spouse, and elder person abuse. Again, the relatively lower household income of St. Lucie County citizens renders them more vulnerable to these societal hazards than some of their more affluent neighbors. The social net in terms of both public and private financial reserves is thin here, and any additional stress rapidly exacerbates societal problems.

4.3.5.2 Vulnerability Assessment

Traditionally St. Lucie County has had a high vulnerability to both drug and alcohol abuse and the associated social problems of spouse and child abuse. Again, based on police records, it appears that progress is being made in improving this situation, but the County margin for this hazard is still thin, and vulnerability remains high even though the frequency of occurrence has been reduced.

Substance abuse can have the following impacts on a community:

- Human health and safety; and
- Psychological hardship.

4.3.5.3 Risk Assessment

At the time of publication, no data were available to determine the potential loss in St. Lucie County due to substance abuse.

4.3.6 Economic Collapse (Recession/Depression)

4.3.6.1 Hazard Identification

St. Lucie County has three main sources of income and employment: agriculture, tourism, and construction. These industries are notoriously susceptible to the vagaries of the national and international economic situation. There is no manufacturing and very little service industry economic base, and while St. Lucie County does have its share of retired citizens, these individuals tend to be living on fixed incomes without large personal retirement plans. All these socioeconomic and demographic features combine to make St. Lucie County particularly vulnerable to the effects of economic downturn.

4.3.6.2 Vulnerability Assessment

St. Lucie County is more vulnerable to the impacts of economic fluctuations than many counties in south Florida because it is dependent on a relatively narrow economic base. Some of the economic base's key components such as agriculture, tourism, and construction are heavily impacted by economic downturns. Unfortunately, recognizing a problem and being able to correct it are two very different things. There is very little St. Lucie County can do to control national or global economic fluctuation. The most effective steps the County can take to harden itself against the effects of recession or depression are to continue its efforts to diversify the economic base as much as possible. Long-term planning in the area of public health and safety should take into consideration that an economic downturn will exacerbate all of the social and societal problems faced by the County. Police and social service agencies need to be prepared for this eventuality.

Social alienation can have the following impacts on a community:

- Human health and safety;
- Psychological hardship;
- Economic disruption; and
- Disruption of community services.

4.3.6.3 Risk Assessment

At the time of publication, no data were available to determine the potential loss in St. Lucie County due to economic collapse.

4.4 HAZARDS SUMMARY

St. Lucie County's proximity to water and large population concentrations contribute to the heightened potential for property and content damage, loss of life, community and emergency service disruption, and economic losses due to flooding and storm surge. Another key vulnerability factor making St. Lucie County at risk to wildland fire is the current pattern of "patchwork" development. This development pattern leaves undeveloped parcels scattered throughout developments creating the opportunity for fire to move throughout a neighborhood.

St. Lucie County is a large and diversified County and while all County residents are exposed to some degree to the hazards identified in **Table 4.24**, geographic location as well as other factors greatly affects individual vulnerabilities to specific hazards. While there are only three incorporated jurisdictions in St. Lucie County, there are several geographically distinct urbanized population centers, and their relative vulnerabilities also have been indicated in **Table 4.24**.

Table 4.25 summarizes St. Lucie County's risk or potential for loss relative to each of the hazards identified.

Table 4.24. St. Lucie County hazard vulnerability by incorporated jurisdiction and population centers.

Hazard Category	Incorporated Jurisdictions			Unincorporated Population Centers						
	St. Lucie Village	City of Fort Pierce	City of Port St. Lucie	Unincorporated Hutchinson Island	South Indian River Drive	North Beach Area	White City Area	Lakewood Park Area	West County Area	Overall County Vulnerability
Natural Disasters										
Floods	●	●	●	●	_	●	●	●	●	●
Hurricane/tropical storm	●	●	●	●	●	●	●	●	●	●
Tornado	Θ	_	Θ	Θ	Θ	_	Θ	_	Θ	Θ
Severe thunderstorm/lightning	_	●	●	_	_	_	_	_	Θ	_
Drought	Θ	Θ	Θ	Θ	Θ	Θ	Θ	Θ	_	_
Temperature extremes	Θ	_	Θ	Θ	Θ	Θ	_	_	●	_
Agricultural pests and disease	Θ	Θ	Θ	Θ	Θ	Θ	_	_	●	_
Wildland/Urban Interface Zone	_	_	●	Θ	_	Θ	_	●	●	_

● = High, _ = Moderate, Θ = Low, ○ = Very Low

Table 4.24. (Continued).

Hazard Category	Incorporated Jurisdictions			Unincorporated Population Centers						
	St. Lucie Village	City of Fort Pierce	City of Port St. Lucie	Unincorporated Hutchinson Island	South Indian River Drive	North Beach Area	White City Area	Lakewood Park Area	West County Area	Overall County Vulnerability
Muck fires	○	○	○	○	○	○	○	○	○	○
Soil/beach erosion	Θ	●	Θ	_	_	_	○	○	○	_
Epidemic	Θ	_	_	Θ	_	Θ	_	_	○	_
Seismic hazards	○	○	○	○	○	○	○	○	○	○
Technological Hazards										
Hazardous materials accident	_	●	_	○	Θ	○	Θ	Θ	_	Θ
Radiological accidents including nuclear power plant accidents	●	●	●	●	●	●	●	●	●	●
Communications failure	Θ	_	_	Θ	Θ	Θ	Θ	Θ	○	Θ
Transportation system accidents	●	●	_	○	_	○	Θ	Θ	Θ	Θ

● = High, _ = Moderate, Θ = Low, ○ = Very Low

Table 4.24. (Continued).

Hazard Category	Incorporated Jurisdictions			Unincorporated Population Centers						
	St. Lucie Village	City of Fort Pierce	City of Port St. Lucie	Unincorporated Hutchinson Island	South Indian River Drive	North Beach Area	White City Area	Lakewood Park Area	West County Area	Overall County Vulnerability
Wellfield contamination	Θ	_	Θ	Θ	Θ	Θ	Θ	Θ	○	Θ
Power failure (outages)	_	_	_	Θ	Θ	Θ	Θ	Θ	○	Θ
Unexploded military ordnance	○	Θ	○	Θ	○	_	○	○	○	○
Societal Hazards										
Civil disturbance	○	_	Θ	○	○	○	Θ	Θ	○	○
Terrorism and sabotage	○	Θ	Θ	○	○	○	○	○	○	○
Immigration crisis	○	_	Θ	○	○	○	○	○	○	○

● = High, _ = Moderate, Θ = Low, ○ = Very Low

Table 4.24. (Continued).

Hazard Category	Incorporated Jurisdictions			Unincorporated Population Centers						
	St. Lucie Village	City of Fort Pierce	City of Port St. Lucie	Unincorporated Hutchinson Island	South Indian River Drive	North Beach Area	White City Area	Lakewood Park Area	West County Area	Overall County Vulnerability
Societal alienation	Θ	_	_	Θ	○	Θ	Θ	Θ	Θ	Θ
Abuse	Θ	_	_	Θ	_	Θ	Θ	Θ	Θ	Θ
Economic collapse	_	○	_	_	_	Θ	_	_	_	_

● = High, _ = Moderate, Θ = Low, ○ = Very Low

Table 4.25. Risk assessment and hazard evaluation for St. Lucie County.

Hazard Category	Hazard Evaluation			
	Frequency	Vulnerability	Exposure	Risk (Potential for Loss)
Natural Hazards				
Floods	Flooding significant enough to damage property occurs regularly in St. Lucie County. This is particularly true in unincorporated areas and in the City of Fort Pierce.	Countywide vulnerability is high but area specific.	Property damage along the coast of St. Lucie County occurs most often in the late winter or early spring and is associated with winter storms and northeasters. Flooding in the inland portions of the County occurs most often in the fall and is often associated with tropical depressions and tropical storms. Incidences of flooding in specific areas of St. Lucie County seem to be on the increase. Total flooding exposure based on data from the Mapping for Emergency Management, Parallel Hazard Information System (MEMPHIS) database is $1,440,244,876	Frequency = High Vulnerability = High Exposure = High Risk = High
Hurricanes/Tropical Storms				
Tropical Storms	Pass within 100 nmi of St. Lucie County once or twice every year.	High from rain-associated flooding damages; relatively low from wind damage.	The major causes of damage associated with tropical storms are heavy rain and flooding. Many communities within St. Lucie County have particularly high vulnerabilities to flooding associated with these storms. Total tropical storm exposure for St. Lucie County based on 1999 The Arbiter of Storms (TAOS) is $615,451,161	Frequency = High Vulnerability = High Exposure = Moderate Risk = High

Table 4.25. (Continued).

Hazard Category	Hazard Evaluation			
	Frequency	Vulnerability	Exposure	Risk (Potential for Loss)
Category 1 Hurricanes	Pass within 100 nmi of St. Lucie County once every 3.1 years.	High from rain-associated flooding; moderate from wind damage.	The continental shelf off St. Lucie County is beginning to widen. Consequently, St. Lucie County's vulnerability to storm surges from the Atlantic is relatively higher when compared to counties to the south. Total Category 1 hurricane exposure for St. Lucie County based on MEMPHIS is Water: $984,876,340 Wind: Light Damage - $7,171,248,640	Frequency = High Vulnerability = High Exposure = High Risk = High
Category 2 Hurricanes	Pass within 100 nmi of St. Lucie County once every 5.3 years.	High from rain-associated flooding; significant from wind damage.	Winds in Category 2 storms range from 96 to 110 mph. Significant damage is possible in older wood frame residential construction. Total Category 2 hurricane exposure for St. Lucie County based on MEMPHIS is Water: $1,168,017,648 Wind: Light Damage - $6,931,181,056 Moderate Damage - $240,065,024	Frequency = High Vulnerability = High Exposure = High Risk = High

Table 4.25. (Continued).

Hazard Category	Hazard Evaluation			
	Frequency	Vulnerability	Exposure	Risk (Potential for Loss)
Category 3 Hurricanes	Pass within 100 nmi of St. Lucie County once every 11.5 years.	Very high from rain-associated flooding coupled with storm surge; major from wind damage.	Winds in Category 3 storms range from 111 to 130 mph. These winds can do major damage to most residential construction. Total Category 3 hurricane exposure for St. Lucie County based on MEMPHIS is Water: $2,307,808,640 Wind: Light Damage - $348,841,952 Moderate Damage - $6,822,398,464	Frequency = Moderate Vulnerability = High Exposure = High Risk = High
Category 4 Hurricanes	Pass within 100 nmi of St. Lucie County once every 202 years.	Very high from rain-associated flooding coupled with storm surge; massive from wind damage.	Sustained winds in a Category 4 hurricane range from 131 to 155 mph. There are very few commercial structures in St. Lucie County engineered to withstand such winds. Total Category 4 hurricane exposure for St. Lucie County based on MEMPHIS is Water: $3,459,213,248 Wind: Moderate Damage - $749,148,928 Heavy Damage - $4,804,990,464 Severe Damage - $1,617,078,144	Frequency = Low Vulnerability = High Exposure = High Risk = Moderate

Table 4.25. (Continued).

Hazard Category	Hazard Evaluation			
	Frequency	Vulnerability	Exposure	Risk (Potential for Loss)
Category 5 Hurricanes	Pass within 100 nmi of St. Lucie County once every 1,500 years.	High from rain-associated flooding; catastrophic in terms of wind damage.	Sustained winds in a Category 5 hurricane range upward from 155 mph. Very few structures can withstand these winds. Massive flooding may occur in the western part of the County resulting from the storm surge in Lake Okeechobee. Total Category 5 hurricane exposure for St. Lucie County based on MEMPHIS is Water: $4,649,864,832 Wind: Heavy Damage - $301,612,704 Severe Damage - $2,758,868,992 Destroyed - $4,110,738,944	Frequency = Low Vulnerability = High Exposure = High Risk = Low
Tornadoes	Between 1950 and 1998, there were 135 tornadoes, waterspouts, and funnel clouds reported from the Treasure Coast area. Of these, 91 touched down on land and were officially classified as tornadoes (1.90 tornadoes per year). In tornado prone southeast Florida, the odds of a tornado striking any specific location are once every 250 years.	During the 48 years from 1950 to 1998, 73 people have been killed by tornadoes (1.52 deaths per year). Total property damage by tornadoes over this same time period has been estimated at $21 million or approximately $440,000 per year. Since 1953, tornadoes in St. Lucie County have caused a total of $43 million in property damage (2 deaths and 26 injured).	Tornadoes are rated from 0 to 5 based on their path length and mean width (Fujita-Pearson Scale). F0 tornados cause light damage, and F5 tornadoes cause incredible or catastrophic damage. Of the 91 tornadoes recorded from the Treasure Coast area between 1950 and 1998, 54 were classified as F0 (59%), 28 (31%) were classified as F1, 8 (9%) were classified as F2, and 1 (1%) was classified as an F3 tornado.	Frequency = Moderate Vulnerability = Moderate Exposure = Low Risk = Low

Table 4.25. (Continued).

Hazard Category	Hazard Evaluation			
	Frequency	Vulnerability	Exposure	Risk (Potential for Loss)
Severe Thunderstorms and Lightning	Since October 1975 and 2003, 31 severe thunder and lightning storms were reported in St. Lucie County (St. Lucie County averages greater than 70.4 days with thunderstorms per year).	Since 1994, these storms resulted in 4 injuries (from lightning), and a total of $246,000 in reported property damage (also from lightning). This represents an average of $2,500 in damages per month.	Thunderstorms with strong wind, downbursts, hail, and lightning are very common on Florida's southeast coast. Property losses due to lightning are poorly documented. We estimate that the actual property damage from lightning is closer to $390,000 or $32,500 per month based on statewide insurance claims.	Frequency = High Vulnerability = Moderate Exposure = Moderate Risk = Moderate
Drought	Every year, some portion of the U.S. endures drought conditions. Florida recently has experienced drought conditions annually in the spring and early summer.	St. Lucie County's vulnerability to drought-related damage and economic loss can occur in many areas. Direct impacts include reduced crop yield, increased fire hazard, reduced water levels, increased livestock and wildlife mortality rates, and damage to wildlife and fish habitat. Social impacts include public safety, health, conflicts between water users, and general reduction in the quality of life.	St. Lucie County's most direct exposure to drought is the economic loss endured by its agricultural community. The average annual market value of agricultural products from St. Lucie County is approximately $625 million.	Frequency = High Vulnerability = Moderate Exposure = High Risk = Moderate

Table 4.25. (Continued).

Hazard Category	Hazard Evaluation			
	Frequency	Vulnerability	Exposure	Risk (Potential for Loss)
Temperature Extremes	Between 1970 and 1999, seven significant freezes have affected St. Lucie County. Prolonged periods of extremely high temperatures are relatively rare in St. Lucie County; however, due to the consistently high humidity, the local “heat index” is often significantly above the actual temperature during the summer months.	St. Lucie County as a whole has a high economic vulnerability to freezing temperatures. The most significant area of impact is the commercial agricultural segment of the community, but countywide cold-sensitive ornamental landscaping also leaves many entities, public and private, open for significant economic loss. While the frequency of “heat waves” is low, the frequency of heat indexes within the range of causing health problems is moderate to high during the summer months.	While the loss of life from either extreme low or high temperatures in St. Lucie County is not great compared to national statistics, St. Lucie County does have a significant economic exposure to low temperatures in both the public and private sectors. The average annual market value of agricultural products for St. Lucie County is approximately $625 million.	Frequency = Moderate Vulnerability = Moderate Exposure = Moderate Risk = Moderate
Agricultural Pests and Diseases	To date, infestations of agricultural plant diseases in St. Lucie County have been rare. Livestock diseases and wild animal vector diseases such as rabies continue to be a problem.	St. Lucie County is highly vulnerable to agricultural diseases and pests due to its location and the amount of traffic that passes through it.	Exposure to agricultural pests, particularly livestock diseases, is high in terms of the County’s agricultural community. The average annual market value of agricultural products for St. Lucie County is approximately $625 million.	Frequency = Moderate Vulnerability = Moderate Exposure = High Risk = Moderate

Table 4.25. (Continued).

Hazard Category	Hazard Evaluation			
	Frequency	Vulnerability	Exposure	Risk (Potential for Loss)
Wildland/Urban Interface Zone	Wildland fires have become a common annual occurrence in wooded areas during Florida's dry season.	Wildfire is a significant and frequent hazard in specific areas of St. Lucie County. Vulnerability varies extensively with location.	Exposure to wildland fire varies greatly across St. Lucie County. While exposure is relatively low along the County's urbanized coastline, it is quite high in some of the landlocked interior communities. A wildland fire in Port St. Lucie in April 1999, caused an estimated $10 million in damage. Mitigation projects addressing this issue need to be evaluated on a case by case basis. Wildland fire exposure in St. Lucie County based on the MEMPHIS is as follows: Low Risk: $5,332,901,376 Medium Risk: $806,260,928 High Risk: $1,032,030,528	Frequency = Moderate Vulnerability = Moderate Exposure = Moderate Risk = Moderate
Muck Fires	Muck fires are not a frequent threat to St. Lucie County. They occur during periods of extreme drought, when the swamp muck becomes dried out and is ignited. Once ignited, these fires burn deep within the muck and are extremely difficult to extinguish.	Areas with the highest vulnerability to this hazard are on the western side of the County.	There have been no significant muck fires in St. Lucie County in the last 30 years, and this hazard is considered to be a limited danger. There were significant muck fires in the Everglades in the 1980's. Because the fires are so difficult to extinguish, they become significant air quality problems. Specific mitigation projects must be evaluated based on location and potential danger.	Frequency = Low Vulnerability = Low Exposure = Low Risk = Low

Table 4.25. (Continued).

Hazard Category	Hazard Evaluation			
	Frequency	Vulnerability	Exposure	Risk (Potential for Loss)
Soil/Beach Erosion	Beach erosion constantly occurs along St. Lucie County's coastline. In some areas, specific structures are threatened. Other specific sites where erosion is a persistent problem are along stormwater drainage points into the Intracoastal Waterway and along canals.	All the coastal communities have high vulnerability relative to beach erosion. Public and private cooperation is required to address beach erosion problems. Potential long-term mitigation will focus on overall sand budgets and sand transport rates. Mitigation projects in this area should be evaluated carefully by experienced coastal engineers. The erosion vulnerability is associated with stormwater outfalls and canals is limited and site-specific in nature.	Some specific locations have a higher "immediate exposure" than others. Overall, St. Lucie County's exposure to direct economic losses from erosion is moderate. Within the City of Fort Pierce, this exposure is high. Stormwater drainage outfall and canal bank stabilization projects should be evaluated based on site specifics.	Frequency = High Vulnerability = Moderate Exposure = Moderate Risk = Moderate
Epidemic	There has never been an outbreak of a serious disease epidemic in St. Lucie County. Annual occurrences of flu and periodic outbreaks of so-called children's diseases have not reached epidemic proportions.	St. Lucie County's vulnerability to disease outbreak is higher than many areas of the nation simply because of the amount of tourist traffic that passes through the County.	Due to the large number of retired and elderly people living in St. Lucie County, the countywide exposure to serious impacts from disease outbreaks must be considered moderate.	Frequency = Low Vulnerability = Moderate Exposure = Moderate Risk = Low

Table 4.25. (Continued).

Hazard Category	Hazard Evaluation			
	Frequency	Vulnerability	Exposure	Risk (Potential for Loss)
Seismic Hazards (Sinkhole/Soil Failure)	Sinkholes are not considered to be a significant hazard in St. Lucie County. Soil failure or collapse is rare in St. Lucie County and is generally related to some other natural hazard, such as canal bank or levee failure during a period of flooding.	Countywide vulnerability to this type of hazard is low; however, areas that might be affected by dam or levee failure need to be evaluated carefully.	Overall, the community exposure to these types of hazards is low other than in specific locations and under specific circumstances. Sinkhole exposure according to the MEMPHIS data places all of St. Lucie County in the very low risk category.	Frequency = Low Vulnerability = Low Exposure = Low Risk = Low
Technological				
Hazardous Materials Accident	The frequency with which hazardous materials incidents occur in St. Lucie County is essentially the same as for other counties located along the major Florida east coast transportation corridor. Minor spills occur with a moderate frequency. St. Lucie County has some 305 reported (Section 302) hazardous material sites, some of which are located in urban areas. To date, the frequency of releases from these facilities have been low compared to the number of releases from transportation accidents.	Countywide, St. Lucie County has a low vulnerability with respect to hazardous materials releases. Some areas such as The City of Fort Pierce has moderate vulnerability to this hazard due to specific circumstances.	Countywide, the exposure relative to a site-specific hazardous materials release is low.	Frequency = Moderate Vulnerability = Low Exposure = Low Risk = Moderate

Table 4.25. (Continued).

Hazard Category	Hazard Evaluation			
	Frequency	Vulnerability	Exposure	Risk (Potential for Loss)
Radiological Accidents Including Nuclear Power Plant Accidents	To date, the frequency of radiological accidents and releases has been very low.	St. Lucie County is highly vulnerable to radiological accidents due to its location with respect to the St. Lucie Nuclear Power Plant.	Countywide, the exposure to a nuclear power plant accident must be considered high while exposure to other types of radioactive materials releases is considered low.	Frequency = Very Low Vulnerability = High Exposure = High Risk = Low
Communications Failure	Major communications failures have occurred infrequently in St. Lucie County to date.	St. Lucie County as a whole has a relatively low vulnerability to communications system breakdown. In some areas, such as the Cities of Fort Pierce and Port St. Lucie, this vulnerability is higher.	St. Lucie County's exposure in the event of a major communications system failure is relatively low due to its agricultural economic base.	Frequency = Low Vulnerability = Low Exposure = Low Risk = Low
Transportation System Accidents	St. Lucie County has major rail lines, north-south highway corridors, and an airport. Ground transportation accidents occur relatively frequently. Major transportation accidents such as rail and plane crashes have been rare to date.	The concentration of transportation industries and activities in the eastern portion of the County along the sand ridge, has made the City of Fort Pierce and St. Lucie Village particularly vulnerable to transportation accidents.	Countywide exposure is low, but is considered high in specific locations.	Frequency = Low Vulnerability = Low Exposure = Low (Countywide) Risk = Low

Table 4.25. (Continued).

Hazard Category	Hazard Evaluation			
	Frequency	Vulnerability	Exposure	Risk (Potential for Loss)
Wellfield Contamination	St. Lucie County maintains a program designed to monitor this risk. To date, instances of wellfield contamination in St. Lucie County have been rare.	The eastern part of the County along the coastline is more vulnerable to this hazard. This is the area with the greatest population and the most industrialization. During times of drought, this area also is vulnerable to wellfield contamination from salt water intrusion.	Exposure in terms of property value is moderate with regard to this hazard.	Frequency = Low Vulnerability = Low Exposure = Moderate Risk = Low
Power Failure (Outages)	Business and industry in St. Lucie County are affected regularly by power fluctuation and short-term power outages. Major, long-term outages are rare.	All modern societies are highly vulnerable to prolonged power failures. Even power failures of 12 to 24 hours would have significant impacts on both the County's economy and on human health and safety.	Short-term power loss has a significant, but hard to quantify economic impact in terms of equipment damage and lost productivity. Prolonged power failures lasting days or weeks would be a major disaster for St. Lucie County both economically and in terms of human health and safety.	Frequency = Low for major power disruptions Vulnerability = Moderate Exposure = High Risk = Moderate
Unexploded Military Ordnance	Old military ordnance has turned up on the beaches on St. Lucie County, but this occurs very infrequently.	Very low countywide.	Very low.	Frequency = Low Vulnerability = Very Low Exposure = Very Low Risk = Low
Societal				
Civil Disturbance	There have been incidents on civil disturbances in St. Lucie County. Minor civil disturbances occur with moderate frequency in specific jurisdictions.	Overall vulnerability to civil disturbance in St. Lucie County is low; however, there are specific areas and jurisdictions that are moderately if not highly vulnerable to this hazard.	Exposure in terms of dollars to the effects of civil disturbances must be considered low within the overall perspective of the County. Exposure in terms of human health and safety is moderate.	Frequency = Low Vulnerability = Low (Countywide) Exposure = Moderate Risk = Low

Table 4.25. (Continued).

Hazard Category	Hazard Evaluation			
	Frequency	Vulnerability	Exposure	Risk (Potential for Loss)
Terrorism and Sabotage	Other than random "hate crimes," there have never been any significant acts of terrorism or sabotage in St. Lucie County.	St. Lucie County has a low vulnerability for acts of terrorism and sabotage.	St. Lucie County's exposure to this hazard must be considered very low. There are several climatological, geographic, and infrastructural aspects to St. Lucie County that reduce its attractiveness to large scale acts of terrorism.	Frequency = Low Vulnerability = Low Exposure = Low Risk = Low
Immigration Crisis	Illegal immigration has, and continues to impact St. Lucie County. While major immigration crises are rare, St. Lucie County has been affected by most of those that have occurred.	Because of its demographics and large agricultural industry, St. Lucie County has a moderate vulnerability to immigration crises arising from anywhere in the Caribbean, Latin America, or South America.	Exposure in terms of dollars from an immigration crisis would result mainly from the stress on local police and health services. Exposure in terms of human health and safety would result from the possible introduction of diseases and stress on the existing health care network.	Frequency = Moderate over the last decade Vulnerability = Moderate Exposure = Moderate Risk = Moderate
Societal Alienation	St. Lucie County has a larger population of the disenfranchise than many of its neighbors. Reported frequencies of social alienation may be higher in this area.	St. Lucie County is more vulnerable to this problem due to the relatively lower income levels of many of its citizens.	Exposure in terms of property to this hazard is low. Alienation affects lives not property.	Frequency = Moderate Vulnerability = Moderate Exposure = Low Risk = Low for property, moderate for social problems
Substance Abuse	Substance abuse in St. Lucie County may be higher than many of its more affluent neighbors, but it is equally possible this may just be a more hidden problem in other jurisdictions.	St. Lucie County is highly vulnerable to this social problem primarily because it has fewer resources to deal with the problem.	Exposure in terms of lives and property is considered moderate in terms of this social problem.	Frequency = Moderate Vulnerability = High Exposure = Moderate Risk = Moderate

Table 4.25. (Continued).

Hazard Category	Hazard Evaluation			
	Frequency	Vulnerability	Exposure	Risk (Potential for Loss)
Economic Collapse	Economic fluctuation happens at greater frequencies in the St. Lucie County economy because it is dependent on a relatively narrow base.	St. Lucie County's vulnerability to this modern hazard is high because the majority of its citizens have relative little economic reserve.	Exposure to this hazard is no higher in St. Lucie County than in other southeastern Florida counties, but this exposure must be considered significant.	Frequency = Moderate Vulnerability = High Exposure = High Risk = Moderate