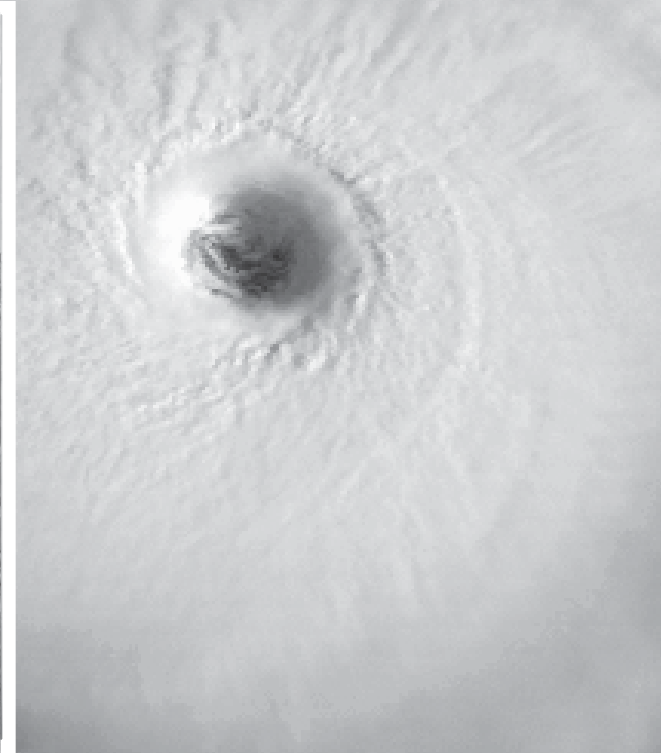
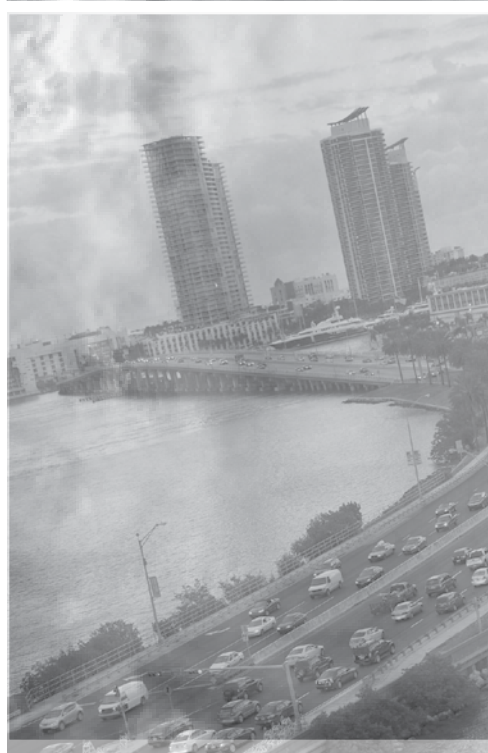
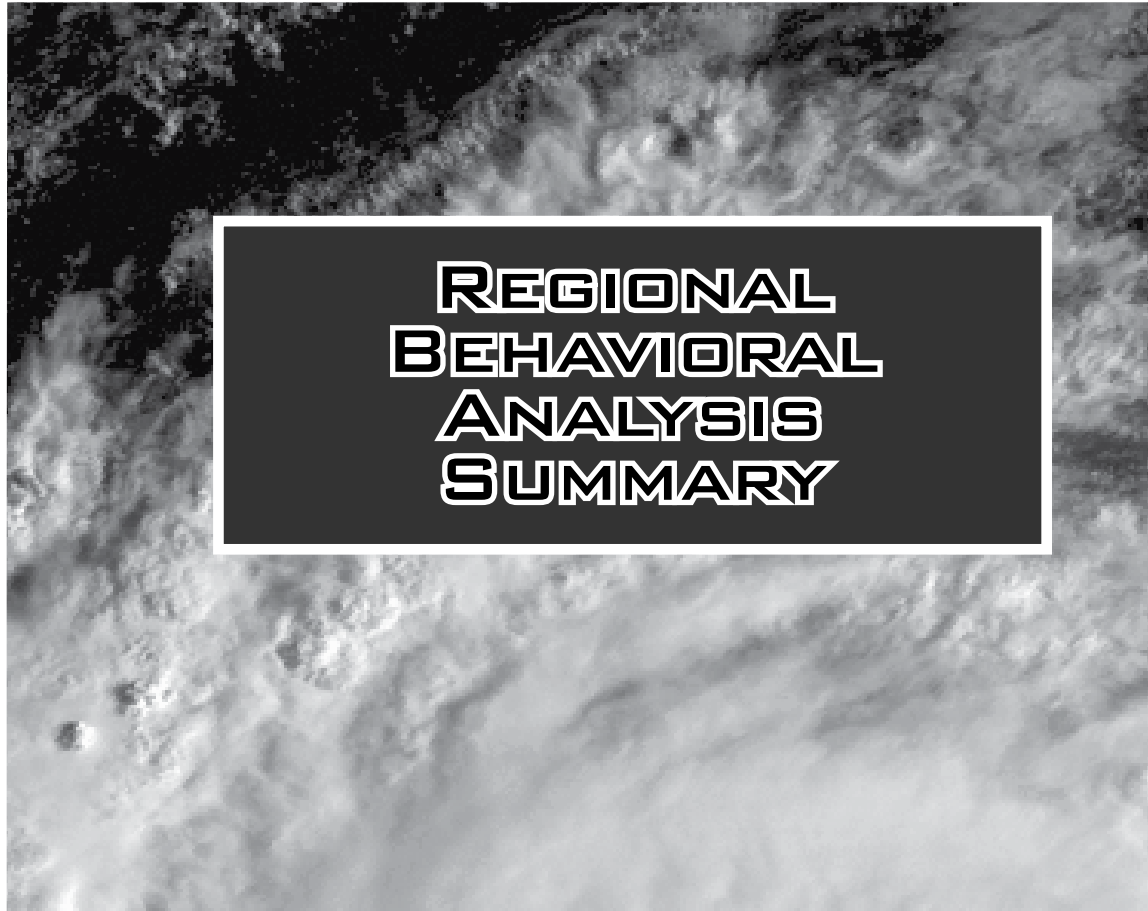




FLORIDA STATEWIDE REGIONAL EVACUATION STUDY PROGRAM





Volume 1-11
South Florida Region
Technical Data Report

Chapter III
Regional Behavioral Analysis



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CHAPTER III

REGIONAL BEHAVIORAL ANALYSIS SUMMARY

A. Background

For planners and emergency managers, one of the most elusive components of evacuation planning is anticipation of the behavior of our population. The behavioral analysis is one of the most important tasks in preparing hurricane evacuation plans. It includes the development of the necessary assumptions regarding the manner in which evacuees in and around the threatened area will react to the hurricane threat. Behavioral assumptions based on professional analysis of survey results are the final output of the behavioral component of this study. These assumptions regarding human behavior in an emergency situation become a critical tool in shelter planning, transportation modeling, and evacuation decision-making and public information efforts.



The public responses having the greatest impact upon an evacuation are listed below. These tendencies and choices of potential evacuees must be quantified in the behavioral analysis:

1. **Evacuation Rates** – The percentage of population in evacuated and non-evacuated areas that will evacuate during a threat;
2. **Evacuation Timing** – When the evacuation population would leave their residences in response to a hurricane warning, watch, a given evacuation order or recommendation, and landfall;
3. **Vehicle Use** – The number of vehicles that evacuating households would use for evacuation;
4. **Type of Refuge** – The percentage of evacuees that will seek public shelter and other types of refuge such as the homes of friends and relatives, hotel/motels and other locations such as churches, workplaces, and second homes;
5. **Evacuation Destinations** – The location an evacuee travels to in the event of an evacuation. These destinations can include public shelters, homes of friends/relatives, hotels/motels, and destinations out of the region;
6. **Response by Vacationers** – The evacuation response by vacationers, including recreational vehicle (RV) park visitors, encompassing evacuation rate, timing, public shelter use, and vehicle use.

Final behavioral assumptions for each county in the region are included near the end of this summary. Further discussion and a detailed explanation of the analysis used to derive primary behavioral assumptions are included in Volume 2 of this study.

B. Methodology

1. Survey Methodology

The behavioral analysis for the Statewide Regional Evacuation Study Program (SRESP) is based on new behavioral data compiled from telephone responses to a survey instrument developed for the study by each regional planning council, with input from local emergency managers. The wording of survey questions was further refined by Dr. Earl J. Baker of Hazards Management Group, Inc. Kerr & Downs Research, Inc. administered the survey instrument via random telephone interviews and assembled the results for each region as Volume 3 of the Statewide Regional Evacuation Study Program. Volume 3 – Regional Behavioral Survey Report constitutes a compiled and complete listing of survey results and regional findings from the unprecedented 2007-2008 survey of Florida residents. Further analysis and planning assumptions were developed from the survey results by Hazards Management Group (see Volume 2 – Regional Behavioral Analysis).

The primary aim of the survey was to provide data to assist in deriving evacuation related behavioral assumptions for transportation and shelter analyses. The main focus of the survey was hurricane evacuation, but questions were also asked about evacuation due to freshwater flooding, wildfires, and hazardous material accidents. The survey instrument included questions that are important in developing accurate behavioral assumptions for transportation and shelter planning. These included questions asked of all Florida survey participants, but also incorporated questions deemed useful by the regional planning council and county emergency management officials. Meetings were held with county and regional planning council staff to discuss the questionnaire and related survey issues.

In each coastal county of the state approximately 400 telephone interviews were conducted. The interviews were allocated between risk areas and non-surge areas in the respective counties. The aggregation of evacuation zones and allocations of interviews among the evacuation zones were determined after input from county and regional representatives and varied among counties and regions. Respondents to the survey were also selected in order to reflect aggregations of evacuation zones currently used operationally and in public information materials by counties, and to provide appropriate distributions of data that would be necessary to derive behavioral projections as required by the Statewide Regional Evacuation Study Program. In order to ensure that respondents resided in the evacuation zones of interest, addresses were randomly selected first and then matched with telephone numbers. Only residences with land-line telephones were called, as sampling was conducted by address. In non-coastal counties, 150 interviews were conducted

Kerr & Downs Research conducted interviews with 1,200 residents of the South Florida region, 400 in each county. In Broward and Miami-Dade, the 400 interviews were allocated among evacuation zones after consultation with county emergency management officials in each county. In Monroe County the 400 interviews were apportioned geographically within the Keys, after consultation with county emergency management officials. Sample sizes, also broken down according to whether the respondent lived in a site-built home or a mobile home (including manufactured homes), are shown in Table III-1.

Table III-1
Sample Sizes for Counties in the South Florida Region

	Site-Built Homes	Mobile Homes	Not Determined	Total Homes
Broward Cat 1-2	150	0		150
Broward Cat 3-5	98	2		100
Broward Non-surge	145	4	1	150
Miami-Dade Cat 1	147	1	2	150
Miami-Dade Cat 2-3	99	1		100
Miami-Dade Cat 4-5*	49	1		50
Miami-Dade Non-surge	99	1		100
Monroe - Key West	90	5	5	100
Monroe - Lower Keys	93	6	1	100
Monroe - Middle Keys	79	17	4	100
Monroe - Upper Keys	81	16	3	100
TOTAL	1,130	54	16	1,200

*Subset of Cat 4-5 storms with unusual attributes

Some questions in the survey were asked of only a portion of the sample. For example, only respondents who were living in the region in 2005 were asked about their response in Wilma. Only those who left their homes to go someplace safer in Wilma were asked where they went when they left their homes. Therefore, for certain questions, sample sizes were smaller than the figures shown in Table III-1.

Other surveys with the public have been conducted in the region with respect to hurricane evacuation, both in earlier hurricane evacuation planning studies and in evacuation studies following particular hurricanes. Those studies were consulted to supplement the data collected in the 2007-2008 SRESP survey.

For hazards other than hurricanes, sample sizes were smaller. In the South Florida Region, a little over a fourth of the respondents were asked about wildfires (368), freshwater flooding (325), and hazardous material accidents (327). In Miami-Dade and Monroe Counties, within the emergency planning zone for the Turkey Point nuclear power plant, 179 respondents were asked about nuclear power plants.

a. Storm Events

The behavioral survey for the Statewide Regional Evacuation Study Program focused primarily on the storm events of 2004-2005. Due to the varied impact areas from the storm events, each of the 11 regional planning councils identified the appropriate storm events on which the survey for their region would be based. Surveys in the South Florida Region included experiences gained from the following storms.

- Andrew (1992) – Miami-Dade
- Georges (1998) – Monroe
- Frances (2004) – Broward and Miami-Dade
- Ivan (2004) – Monroe

- Jeanne (2004) – Broward
- Wilma (2005) – Broward, Miami-Dade and Monroe

A brief summary of each storm is included to provide context for the responses to the survey.

Hurricane Andrew¹ struck the east coast near the City of Homestead, Miami-Dade County, on August 24, 1992. Only two other hurricanes in history, both category 5 storms – the Labor Day storm of 1935 and Camille in 1969 – were stronger than Hurricane Andrew when they made landfall in the United States. It struck South Florida with a storm surge of over 16 feet and winds that gusted over 175 mph. Evacuation orders were issued on August 23 at 6:00 a.m. in Monroe County, 8:00 a.m. in Miami-Dade County, 7:00 a.m. in Broward County, and 3:00 p.m. in Palm Beach County. An estimated three quarters of a million people evacuated dwelling units in South Florida, and over 82,000 sought public shelter, 43,000 in Miami-Dade County alone. The scale of the disaster was enormous and the massive recovery that ultimately ensued was of epic proportions. In Miami-Dade County, which took the brunt of the storm, 14 deaths were directly caused by Andrew. Of these, very few were from drowning, a testament to the successful evacuation carried out by local emergency management officials. The damages were staggering, surpassing \$50 billion, affecting emergency management policies and procedures, the insurance industry and land development regulations (including the statewide building code).

Hurricane Georges² made its way into the Florida Straits early on September 25, 2004, after making landfall over Hispaniola and Cuba. Around 3:30 p.m. that day, Georges made landfall near Key West, before moving towards the Gulf Coast. Storm surge was estimated at 4-6 feet in the Florida Keys. Although Georges caused 602 direct deaths overall, only one was in the U.S. In the Florida Keys 1,536 homes were damaged, of which 173 were completely destroyed, many of which were mobile homes. Monroe County ordered a tourist evacuation at 7:00 a.m. on September 22, followed at 4:00 p.m. that same day by a mandatory mobile home evacuation. A full evacuation for the population in the Lower Keys, from the 7-mile bridge south, was ordered the following day at 7:00 a.m., followed by mandatory evacuation orders for the Middle Keys beginning at 11:00 a.m. and the Upper Keys beginning at 4:00 p.m. Monroe County Emergency Management estimates that from 43-46% of the population participated in the evacuation.

¹ This description is drawn largely from the *Hurricane Andrew Assessment: Review of Hurricane Evacuation Studies Utilization and Information Dissemination* (January 1993), prepared by Post, Buckley, Schuh and Jernigan, Inc., for the U.S. Army Corps of Engineers and the Federal Emergency Management Agency, <http://csc.noaa.gov/hes/postStorm.html#andrew>.

² This description is compiled from Monroe County directives and from information contained in John L. Guiney, *Preliminary Report: Hurricane Georges, 15 September – 01 October 1998*, National Oceanic and Atmospheric Administration, National Hurricane Center, 5 January, 1999, www.nhc.noaa.gov/1998georges.html.

Hurricane Frances³ took a direct path along the northern Caribbean Islands and came ashore over the southern end of Hutchinson Island, near Stuart, Florida, as a category 2 hurricane, on September 5, 2004. Frances gradually weakened as it moved slowly west-northwestward across the Florida Peninsula, and became a tropical storm just before emerging into the northeastern Gulf of Mexico near New Port Richey early on September 6. Hurricane-force winds from Frances affected only the northern parts of the South Florida Region. Frances produced notable storm surges along both the Atlantic and Gulf coasts of Florida. The highest measured storm surge was 5.89 feet above mean sea level on the Florida east coast at the St. Lucie Lock. The National Weather Service Melbourne Weather Forecast Office (WFO) estimated storm surge at 8 feet near Vero Beach and 6 feet around Cocoa Beach. Lesser storm surge values were estimated elsewhere along the Florida east coast, while storm surges of 1-2 feet above normal tide levels were reported as far north as the Georgia coast. Along the Gulf coast, a storm tide of 6 feet was estimated in Pinellas County, Florida, while storm tides of 3-5 feet were estimated in the Florida Big Bend area. Frances was directly responsible for seven deaths in the United States, five of which in Florida.

Hurricane Ivan⁴ passed Grenada into the southeastern Caribbean Sea as a category 3 storm on September 8, 2004. As it moved on a west-northwest track across the Caribbean and into the east-central Gulf of Mexico, it strengthened and weakened several times, reaching category 5 strength on three occasions. Ivan made landfall as a major hurricane with sustained winds of near 120 mph on September 16, 2004, just west of Gulf Shores, Alabama. Ivan weakened as it moved inland, producing over 100 tornadoes and heavy rains across much of the southeastern United States, before merging with a frontal system on September 18. The extra tropical remnant low of Ivan split off from the frontal system and drifted southward in the western Atlantic for several days, crossed southern Florida, and re-entered the Gulf of Mexico on September 21. Ivan weakened before it made its final landfall in southwestern Louisiana as a tropical depression on the 24th. Surge heights of 10-15 feet occurred along the Gulf coast during Ivan's first U.S. landfall. Peak rainfall amounts in the Caribbean and United States were generally 10-15 inches. The death toll from Ivan reached 92, 25 of which in the United States. Monroe County ordered a tourist evacuation at 8:00 a.m. on September 9, followed at 5:00 p.m. that same day by a mandatory mobile home evacuation. A mandatory evacuation for the full population of Monroe County was ordered the following day at 5:00 a.m. and lifted at 5:00 a.m. on September 13. Monroe County Emergency Management estimates that 55% of the population participated in the evacuation. The Florida Keys and the rest of South Florida were spared any significant impacts from Hurricane Ivan.

³ This description is compiled from information contained in John L. Beven II, *Tropical Cyclone Report: Hurricane Frances, 25 August - 8 September 2004*, National Oceanic and Atmospheric Administration, National Hurricane Center, 17 December, 2004, www.nhc.noaa.gov/2004frances.shtml?.

⁴ This description is compiled from Monroe County directives and from information contained in Stacy R. Stewart, *Tropical Cyclone Report: Hurricane Ivan, 2-24 September 2004*, National Oceanic and Atmospheric Administration, National Hurricane Center, 16 December 2004, www.nhc.noaa.gov/2004ivan.shtml?.

Hurricane Jeanne⁵ was the third hurricane of the 2004 season to affect the region. It made landfall at the southern end of Hutchinson Island, just east of Stuart, on September 26, as a category 3 storm. Jeanne and Frances followed similar paths across the state. A storm surge of 3.8 feet above normal astronomical tide levels was measured at Trident Pier at Port Canaveral, Florida, about an hour after landfall. Storm surge flooding of up to 6 feet above normal tides likely occurred along the Florida east coast from the vicinity of Melbourne southward to Ft. Pierce. On the Florida west coast, a negative storm surge of about 4.5 feet below normal tides was measured at Cedar Key when winds were blowing offshore. This was followed by a positive surge of about 3.5 feet above normal when winds became onshore. Three direct deaths were registered in Florida, with estimates of 3,000 or more deaths in Haiti.

Hurricane Wilma⁶ made landfall in southwestern Florida, near Cape Romano, on October 24, 2005. Maximum sustained winds were estimated to be near 105 knots (category 3 intensity) at landfall. Moving at a forward speed of 20-25 knots, the hurricane crossed the southern Florida peninsula in 4.5 hours, with the center emerging into the Atlantic just southeast of Jupiter. Maximum winds had decreased to near 95 knots (category 2) during the crossing of Florida. Most of the southeastern Florida peninsula experienced at least category 1 hurricane conditions, and some parts of northern Miami-Dade County, Broward County and Palm Beach County likely had category 2 hurricane conditions, including wind gusts to near 100 knots. A storm surge of 4-8 feet was reported from coastal Collier County. It is likely, however, that higher storm surges occurred over uninhabited areas of southwestern Florida to the south of where Wilma made landfall. Storm surges of 4-5 feet were observed over much of the lower and middle Florida Keys, locally to near 7 feet. However, a storm surge of near 9 feet was estimated visually in the Marathon area. Storm surges were generally in the 4-5 feet range over the Upper Keys. This resulted in considerable flooding over substantial portions of the Keys. Monroe County estimates that there was widespread flood damage to over 6,000 dwelling units in the unincorporated county. Relatively minor storm surge flooding occurred on the Biscayne Bay shoreline of Dade County. Monroe County ordered a general evacuation on October 22 starting at 12:00 noon. Monroe County Emergency Management estimates that less than 10% of the population participated in the evacuation.

b. Regional Characteristics

South Florida faces many challenges in evacuation as a result of our specific geographic and demographic characteristics. The region has a large, densely populated coast along the barrier island chain in Broward and Miami-Dade Counties. The Florida Keys, the long chain of islands that extends to Key West, are linked together by a single highway, and joined to the mainland by US 1 and Card Sound Road. The entire Keys must be

⁵ This description is compiled from information contained in Miles B. Lawrence and Hugh D. Cobb, *Tropical Cyclone Report: Hurricane Jeanne, 13-28 September 2004*, National Oceanic and Atmospheric Administration, National Hurricane Center, 7 January 2005, www.nhc.noaa.gov/2004jeanne.shtml?

⁶ This description is compiled from Monroe County directives and from information contained in Richard J. Pasch, Eric S. Blake, Hugh D. Cobb III, and David P. Roberts, *Tropical Cyclone Report: Hurricane Wilma, 15-25 October 2005*, National Oceanic and Atmospheric Administration, National Hurricane Center, 12 January 2006, www.nhc.noaa.gov/ms-word/TCR-AL252005_Wilma.doc.

evacuated to the mainland for storms of category 3 or higher, and there is a significant mobile home population in the Keys that must be evacuated for every approaching storm. A significant part of our population is elderly, which requires us to prepare for increased demand for special needs shelters and health care support. The significant presence of tourists in South Florida, even during hurricane season, introduces the need for additional preparations for evacuation and sheltering. Fortunately, inland areas are available in both Miami-Dade and Broward Counties that are suitable for sheltering populations that evacuate from surge zones along the coastal areas, making it possible to avoid out-of-county evacuations for most storms.

2. Deriving Behavioral Assumptions

Since each evacuation scenario is different and entirely unique, behavioral analysis for evacuation is predictive. The final products of behavioral analyses are basic assumptions that form the best available predictive information regarding likely human behavior. Regardless of how detailed, formal, or quantitative an evacuation plan appears, it contains assumptions about behaviors such as those discussed throughout this study. Every time a clearance time is calculated to determine the length of time required to complete an evacuation under a defined scenario, the model simulations include quantitative assumptions regarding behavioral factors. Behavioral assumptions are also employed in an effort to predict the needed capacity of shelters to house an unknown number of residents that will evacuate to a public shelter. Behavioral assumptions will change over time based on the level of public education regarding evacuation or the level of evacuation experience of a population. The issue is not whether such assumptions are or should be made, but what the assumptions should be.

There is no simple one-rule-fits-all technique for deriving behavioral assumptions for planning. The best solution is to employ the best available mix of indicators, relying most heavily on the best information available for each behavior and scenario in question. A detailed listing and discussion of behavioral assumptions is included in Volume 2 of this Statewide Regional Evacuation Study Program series. However, a few of the most fundamental and critical assumptions are included at the end of this summary.

C. Key Survey Findings for the South Florida Region

1. Information and Awareness

Over four out of five South Florida residents (81%) have access to the Internet. One in three of these individuals (32%) reported visiting their county's website to search for information about hurricanes – this translates to 26% of all residents in the region. Two out of three residents (65%) in South Florida maintain they have seen a map of their county showing areas that need to evacuate in case of hurricanes.

Just over half of the residents (53%) in South Florida believe they live in a surge evacuation zone. The accuracy of knowledge about one's evacuation zone is shown below:

Evacuation Zone where Respondent Lives	Correct	Incorrect	Don't Know / Not Sure
Category 1	72%	12%	17%
Category 2	41%	20%	39%
Category 3	20%	30%	50%
Category 4	23%	32%	45%
Category 5	23%	32%	45%
Non-Surge	0%	24%	76%

A majority of the residents of evacuation zones for a category 1 storm reports accurately the evacuation zone where they live. For all other categories of storm, the majority of South Florida residents do not accurately report the zone where they live. This finding indicates a lack of knowledge or understanding of risk, the relationship of storm surge and evacuation zones, and illustrates the need for more effective public information.

2. Evacuation Intent

Percentages of citizens who say they will follow mandatory evacuation notices vary depending on the strength of the storm. It makes sense that compliance with orders for evacuation increases linearly as hurricanes strengthen from category 1 or 2 to 3 to 5. It should be noted that, historically, respondents' intent to evacuate is consistently higher than actual evacuation rates.

Storm	Evacuated	Destination			
		Neighborhood	County	Elsewhere in Florida	Outside Florida
Andrew	34%	4%	16%	11%	2%
Georges	38%	1%	6%	29%	2%
Ivan	28%	<1%	3%	21%	3%
Frances	14%	3%	4%	7%	1%
Jeanne	10%	0%	4%	4%	2%
Wilma	15%	1%	3%	10%	1%

Source: Kerr & Downs Research, *Behavioral Analysis: South Florida Regional Report* (p. 8)

Significant percentages of residents say they intend to evacuate their homes even when the evacuation notice does not apply directly to them. The term "shadow evacuation" applies to those residents of site-built homes who live outside of the storm surge evacuation zones and evacuate without having been ordered.

Table III-4 reveals that non-surge vulnerable evacuees could represent a significant proportion of the overall evacuation population and will contribute to potential evacuation route congestion, fuel shortages and shelter demand.

Evacuation Zone	Evacuation Notice for Zones 1 and 2	Evacuation Notice for Zones 1, 2 and 3	Evacuation Notice for Zones 1, 2, 3, 4 and 5
South Florida	57%	79%	93%
Category 1	58%	71%	90%
Category 2	77%	89%	96%
Category 3	65%	90%	98%
Category 4	60%	79%	96%
Category 5	60%	79%	96%
Non-Surge	52%	83%	92%

Source: Kerr & Downs Research, *Behavioral Analysis: South Florida Regional Report* (pp. 40-42).

3. Evacuation Destination

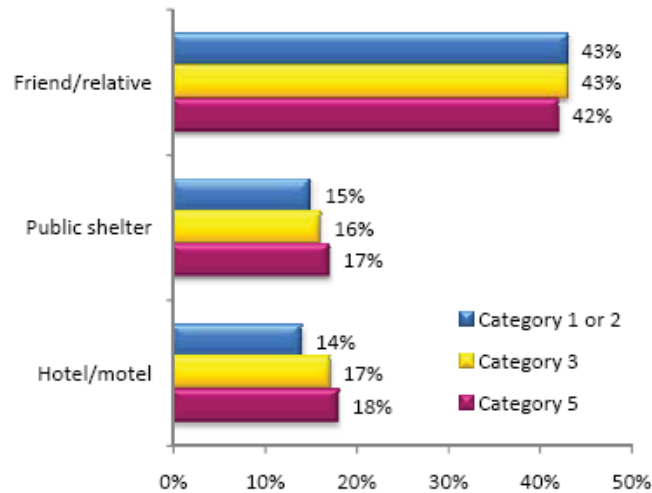
The responses to the survey should be understood in the context of official policies in the region that are specific to the three counties:

- Monroe County – For storms of category 3 or higher, the County issues a mandatory evacuation order for 100% of the population in the Florida Keys that is within the projected cone of impact.
- Miami-Dade County – Residents are encouraged to find shelter within the County. Those within coastal surge zones (A, B and C) are ordered to evacuate to areas of safety elsewhere in the County in accordance with the characteristics of the storm.
- Broward County – Residents are encouraged to find shelter within the County. Those within coastal surge zones (A and B) are ordered to evacuate to areas of safety elsewhere in the County in accordance with the characteristics of the storm.

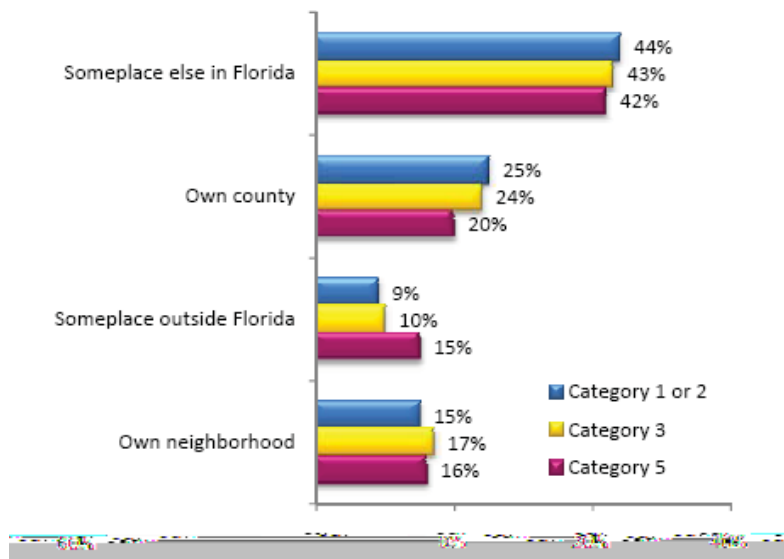
Regardless of the hurricane strength, most residents of the South Florida Region intend to go to the homes of friends or relatives if they evacuate. Behavioral survey results indicated that 42-43% of evacuees intend to find safety in the households of friends and family. Another 14-18% of respondents indicated they would seek hotel/motel accommodations and 15-17% indicated they would seek public shelter. Minor changes in evacuation destinations occur as hurricanes strengthen in the hypothetical scenarios.

Statewide, most residents intend to evacuate to other places in Florida regardless of hurricane strength. Almost two-thirds of the residents in site-built homes in coastal counties said they would go out of county when evacuating, compared to half of those in non-coastal counties although most would remain in the region. Fewer mobile home evacuees said they would go out of county. The percentages of residents who intend to evacuate outside Florida increase as hurricanes strengthen to category 5. Most residents who intend to evacuate outside Florida will go to Georgia. Specific information regarding evacuation destinations of South Florida residents are shown in the following two figures.

**Figure III-1
Evacuation Destinations by Type – South Florida**



**Figure III-2
Evacuation Destinations by Location – South Florida**



4. Obstacles to Evacuation

In order to determine why residents who are ordered to evacuate indicate that they will not, questions designed to identify any potential obstacles to evacuation were posed.

Seven percent of South Florida households include an individual who requires assistance during evacuation. Over half of these households have an individual who is disabled, has a medical condition or requires some other type of special assistance beyond transportation. Almost half of these households (3% of all households) require transportation assistance,

and one in eight needs the assistance of an outside agency. Only one in four (28%) of the households that require special assistance have registered with their county as needing special assistance.

The proportion of households that include an individual requiring assistance during evacuation is highest in Broward County (9%), and 7% of all households have a person with special needs. The special needs population rises to 9% in the category 1 and 2 zones of Broward County. In Miami-Dade County, the special needs population is smaller (3% of all households). However, with 14% of households having no vehicle, about 4% of all households need transportation assistance – this rises to 7% of the households within Miami-Dade County surge-zones. In Monroe County, only 1% of all households include an individual requiring assistance during evacuation.

Approximately one in nine households (11%) claims there are obstacles beyond transportation and disabilities/medical needs that create obstacles to evacuating. In those households, pets (30%), traffic (20%), job (13%) and road obstructions (11%) are cited as the most critical obstacles to evacuation other than lack of transportation or medical/special needs. Residents in non-surge zones are more likely to cite job concerns (22%) as an obstacle, especially in Broward County (36%).

Over one in ten households (11%) claims that there are obstacles beyond transportation and disabilities/medical needs that create obstacles to evacuating. Residents living in a category 1 evacuation zone (13%) are more likely to believe there are obstacles to evacuation other than lack of transportation or special medical needs. Pets (30%), traffic (20%), and jobs (13%) are cited as the most critical obstacles to evacuation other than lack of transportation or medical/special needs. Residents living in non-surge zones (22%) are more likely to think jobs will be a problem. Only 7% of households in the South Florida region include one or more individuals who will require assistance in the event of an evacuation. This percentage is highest within the households in category 2 evacuation zone (9%). Percentages of residents needing assistance in order to evacuate are highest in Broward County (9%) and lowest in Monroe County (4%).

Monroe County residents (13%) are more likely to think obstacles other than transportation and medical/special needs may keep them from evacuating. Pets are listed more often by Miami-Dade County residents (38%), while Broward County residents (17%) are more likely to list jobs as an impediment to evacuation.

Two in five residents (38%) in the South Florida region have pets: 87% of these residents plan to take their pets with them if they evacuate. Most residents with pets (85%) are aware that public shelters will not accept pets inside, and 5% of these residents claim they will not evacuate because of this.

Only 12% of South Florida region households that need hurricane assistance during hurricane evacuation (1% of all households in the region) need an outside agency to lend transportation or medical assistance. Most households that need assistance during evacuation will either provide that assistance within their household (43%) or depend on a friend or relative (38%) to provide this assistance. Sample sizes within the evacuation zones and within counties are fairly small and should be interpreted with caution.

Evacuation Zone	Number	Yes	No	Not Sure
South Florida Region	1,200	7%	92%	1%
Category 1	625	7%	92%	1%
Category 2	125	9%	90%	1%
Category 3	83	7%	92%	0%
Category 4	58	8%	91%	1%
Category 5	59	8%	91%	1%
Non-Surge	250	5%	94%	1%

Source: Kerr & Downs Research, *Behavioral Analysis: South Florida Regional Report* (p. 71)

5. Evacuation Scenarios

Evacuation behavior can be affected by a variety of external factors as illustrated throughout the behavioral survey results. Several of the most significant factors and likely behavioral responses are discussed in this section.

a. Storm Characteristics

(1) Storm Severity

The 2007-2008 behavioral survey results for the South Florida Region consistently show a marked difference in responses associated with hypothetical severe storms (category 4 and category 5). Storm severity also plays a significant role in evacuation destination, especially with regard to out-of-county travel. Conclusions derived from Hurricanes Charley, Frances and Jeanne participation rates cannot accurately predict the evacuation scenario for a large, highly destructive major storm. In Florida, evacuation during Hurricane Floyd is one of the best examples of a multi-regional, multi-state evacuation caused by a large hurricane. The setting for Hurricane Floyd in 1999 should be taken into account when attempting to understand the reaction of the population. Floyd was a strong category 4 storm that had moved on a path directly toward South Florida for several days. The storm was ominous, but forecasters guardedly predicted that Floyd would veer off into the Atlantic Ocean and miss Florida. The storm continued to advance with huge press coverage and did not turn until finally, at the last safe distance, the storm altered its course and skirted the State. Floyd did, however, landfall in North Carolina as a category 2 storm, causing major damage along the Eastern Seaboard and initiating what Time Magazine described as the largest evacuation in history. The point here is to give an idea of how public response can be affected by an extreme storm.

Evacuation rates in non-coastal counties during Floyd ranged from 12% in the East Central Florida region to 49% in the Charleston, SC region. The average non-coastal county evacuation rate for all 11 regions studied was about 24%. Keep in mind that Floyd was a major storm and every storm is different. However, because of the

scale of the Floyd evacuation, the chance of reoccurrence must be recognized. Results for coastal and non-coastal county evacuation need to be continually evaluated and validated by behavioral studies from other storms.

In sum, the Hurricane Floyd Assessment clearly showed that, in a major storm, people will get in their car and leave their home county. In fact, the 7,000 surveys from the Hurricane Floyd Assessment inferred that 75% of the nearly 3 million evacuees left their county. As stated throughout this study, every storm presents a unique and different scenario. However, storm severity has consistently been shown to be a significant factor in making the decision to evacuate. Multi-region clearance times are provided in Volume 4 – Regional Transportation Analysis.

(2) Landfalling, Paralleling and Exiting Storm Paths

Storm path can have a significant effect on any evacuation scenario especially with respect to out-of-county evacuation destinations. A comparison of these three storm path scenarios serves as a reminder that every storm is different. Therefore, studies such as this one cannot predict operational decision making. However, a general discussion of potential scenarios can provide useful information to emergency managers for decision making.

- (a). Landfalling storms are storms that impact the coastline directly. Generally, landfalling storms precipitate the highest surge values and most destructive winds. With regard to evacuation, landfalling storms allow for more alternative evacuation destinations. For example, a storm landfalling in the Broward County would allow for evacuating populations to find safe destinations to the north or south of the storm path.
- (b). Paralleling storms, like the name suggests, typically travel along the coastline. On the Gulf Coast of Florida paralleling storms are potentially more destructive than on the Atlantic coast due to the counterclockwise spin of a tropical cyclone. Evacuation patterns are typically to the north and away from the storm path.
- (c) Exiting storms, as the name also suggests are storms that have made landfall and, after having travelled across land, are heading back to sea. In Florida, that typically means across the peninsula. Relative surge values and wind speeds are typically lower for exiting storms. However, Hurricanes Frances and Jeanne in 2004 demonstrated that evacuation of vulnerable areas during an exiting storm is often warranted due to the unpredictable nature of storm events. Each of the two storms created a different scenario with unique characteristics. Therefore, operational decisions cannot be made in advance. Discussion of storm scenarios only provides a theoretical frame of reference.

(3) Evacuation Timing

The timeframe in which people respond to an evacuation order varies. The terms long response and short response refer to the time it takes for evacuees to mobilize

following an evacuation notice. Evacuation studies typically express the temporal nature of evacuation response in a “response curve” that is derived from response curves documented in actual evacuation. Traffic modelers, in turn, load the response curve into the model to calculate evacuating traffic counts and predict potentials for traffic congestion during a future evacuation event.

The most significant factor affecting a long or short response is the urgency of the evacuation order. Response curves are also affected by the media. If a storm changes course unexpectedly or intensifies it usually becomes necessary to hasten evacuation. Urgency is sometimes inherent due to the relatively inaccurate science of hurricane forecasting.

b. Phased Evacuation

In urban areas or in areas with large at-risk populations, phased evacuation is an operational tool to allow for a more orderly evacuation. In this scenario, specific areas are given a time window in which to evacuate based on the capacity of the roadway to accommodate the expected flow. This also allows more vulnerable populations to clear bridges and causeways before mainland evacuations are ordered. Phased evacuation is commonly used in the Florida Keys due to the roadway characteristics that link this densely populated string of islands. The effectiveness of phased evacuation relies on accurate behavioral assumptions.

c. Reverse Lane Flow

Reverse lane flow is an evacuation scenario where authorities change the direction of highway lanes to direct all lanes to flow in the same direction. The purpose is to hasten the evacuation of people during a major disaster. When a major hurricane is expected to make landfall, the Highway Patrol will implement reverse lane flow upon an Executive Order from the Governor.

Currently, only a few highway segments are designated for potential reverse lane flow operations in the state:

- I-10 West from Jacksonville;
- I-4 East from Tampa;
- I-75 North from Tampa;
- State Road 528 West out of Brevard County;
- Florida Turnpike North from Ft. Pierce;
- Alligator Alley (I-75) West from Ft. Lauderdale;
- Alligator Alley (I-75) East from Naples;
- and the new I-75 Shoulder Plan in Charlotte County.

The listed highway segments relate to the likely evacuation routes that a significant number of residents living in Florida’s largest metropolitan areas would travel in an evacuation scenario.

In situations where evacuation timing is critical and a few additional hours are needed for evacuation, reverse lane flow will speed up the evacuation of residents and tourists.

However, reverse lane flow operations are counter-intuitive to the driving public and are only proposed to be implemented during daylight hours. Substantial numbers of public safety man-hours are needed to implement the traffic redirection at each interchange. Yet for all the preparation and man-hour resources needed for implementation, modeling efforts predict only a 33% increase in roadway capacity. Therefore, the applicability of reverse lane flow is limited to specific scenarios where the Governor recognizes the urgency for a temporary increase in evacuation route capacity.

6. Evacuation Behavior for Other Hazards

The behavioral survey administered for the Statewide Regional Evacuation Study Program included several questions regarding other disasters that may precipitate evacuation orders. Survey respondents were asked questions about their awareness of vulnerability and willingness to follow evacuation orders if issued. The following behavioral information is gathered from Volume 3 - Behavioral Survey Report.

Survey findings included here regarding other evacuation related hazards represent an initial investigation into potential behaviors associated with the hazards examined below. These findings have not been validated through comparison and correlation with similar studies. Therefore, these findings should be considered a starting point for future investigations and analysis.

a. Wildfire

The following questions were part of the survey. Responses and further discussion are below the question.

(1) Do you believe that your home might ever be threatened by a wildfire?

Over one in ten residents (11%) in the South Florida region believe that their area may, at some point, be threatened by a wildfire. This feeling is less prevalent in non-surge zones (10%) and most prevalent in a category 2 evacuation zone (16%). Results do not vary greatly across counties, with only 2 percentage points at most separating all counties in the South Florida region.

(2) If a wildfire threatened your community and public safety officials ordered you to evacuate, would you?

Nearly nine out of ten residents (87%) in the South Florida region claim they intend to evacuate if ordered to do so by public safety officials because of wildfire threats. Intent to evacuate if ordered to do so is lowest in a category 1 evacuation zone (77%) and highest in a category 3 evacuation zone and non-surge zones (91%). Intent to evacuate varies across counties as 74% of Monroe County residents say they intend to evacuate because of wildfires if ordered to do so by public safety officials, while 90% of Broward and Miami-Dade counties' residents intend to evacuate.

(3) Where would you go if you evacuated because of a wildfire?

One in five residents (20%) intends to go to public shelters if there is a need to evacuate because of wildfires. A plurality of residents (44%) intends to evacuate to friends and relatives, while over one in ten (14%) plans to go to a hotel or motel. Non-surge zone residents (24%) are more likely to go to a public shelter; while residents in category 2 evacuation zone (70%) are more likely to go to friends or relatives. Responses to this question vary widely across counties. For example, 25% of Miami-Dade County residents say they intend to evacuate to a public shelter, while fewer Monroe County residents (1%) intend to do so. One in five Monroe County residents (18%) plans to seek shelter in a hotel or motel, while only 11% of Broward County residents plan to do so.

(4) Since you've been living in this location, have you ever evacuated your home because of a wildfire?

No residents in the South Florida region say they have experienced a wildfire while living in this area.

b. Freshwater Flooding

Freshwater flooding in the South Florida Region can occur for a variety of reasons including riverine flooding and seasonal flooding from rainfall events and dam (gate) failures. Please refer to the Hazards Analysis of this Technical Data Report for specific description of vulnerabilities. The questions below do not refer to any specific flooding scenario or situation.

(1) Do you believe that your home might ever be threatened by freshwater flooding?

Not quite one in four residents (23%) of the South Florida region say their home might be threatened by freshwater flooding at some point. Residents in a category 3 evacuation zone (29%) and non-surge zones (30%) are more likely to make this claim. Broward County (26%) and Miami-Dade County (25%) residents are more likely to claim their homes might eventually be threatened by freshwater flooding, while comparatively few Monroe County residents (12%) make this claim.

(2) If freshwater flooding threatened your community and public safety officials ordered you to evacuate, would you?

Nearly three in four residents (73%) in South Florida region maintain they will evacuate their homes if ordered to do so by public safety officials because of freshwater flooding. This percentage is considerably lower than the 87% of residents who claim they will evacuate because of wildfires. Residents living in category 2 and 3 evacuation zones (87%) are more likely to say they intend to evacuate for freshwater flooding if ordered to do so by public officials. Broward County residents (84%) are more likely to intend to evacuate because of freshwater

flooding. Only 30% of Monroe County residents say they will evacuate if ordered to do so because of freshwater flooding.

(3) Where would you go if you evacuated because of freshwater flooding?

A plurality of residents (34%) intends to evacuate to friends or relatives if ordered to evacuate by public officials as a result of freshwater flooding. Residents living in a category 3 evacuation zone (50%) are more likely to evacuate to friends and relatives. One in six residents (15%) maintains they will go to public shelters, while slightly more (17%) will go to hotels or motels. Residents of Miami-Dade County (22%) are more likely to seek out public shelters, while Broward County residents (24%) are more likely to evacuate to hotels or motels.

(4) Since you've been living in this location, have you ever evacuated your home because of freshwater flooding?

Few residents of the South Florida region (1%) indicate they have experienced freshwater flooding while living in this area. Results do not vary greatly across evacuation zones as only 2 percentage points at most separate all zones in the South Florida region. Residents cited the following years when asked in which year freshwater flooding occurred:

- 1991
- 2005

Most residents sought shelter with friends and relatives during that event. Results do not vary greatly across counties with only 2 percentage points at most separating all counties in the South Florida region.

c. Hazardous Materials Spill

(1) Do you believe that your home might ever be threatened by a hazardous material accident?

Relatively few South Florida region residents (17%) believe they will be threatened by a hazardous material accident. Concern for this type of accident peaks in category 1, 4 and 5 evacuation zones (18%) and is lowest in the category 2 evacuation zone (11%). Belief of future threats from a hazardous material accident is highest in Miami-Dade County (21%) and lowest in Broward County (12%).

(2) If a hazardous material accident threatened your community and public safety officials ordered you to evacuate, would you?

While few residents (17%) believe that they are threatened by a future hazardous material accident, a high percentage (87%) say they intend to evacuate their homes if public safety officials ask them to do so in response to this type of accident. Residents living in the category 1 evacuation zone (83%) are least likely to evacuate, while all residents living in non-surge zones say they intend to evacuate if told to do so. Intention to evacuate in response to hazardous material accidents if told to do

so by public safety officials peaks in Miami-Dade County (88%) and is lowest in Monroe County (84%).

(3) Where would you go if you evacuated because of a hazardous material accident?

Only 8% of residents in the South Florida region say they intend to go to a public shelter if they evacuate from a hazardous material accident. A majority of residents (54%) intends to go to friends or relatives. One in ten (14%) intends to evacuate to a hotel or motel. Residents living in non-surge zones (88%) are more likely to go to friends and relatives. Residents living in category 4 and 5 evacuation zones (13%) are comparatively more likely to seek safety at public shelters. Miami-Dade County residents (59%) are more likely to go to friends and relatives, while Broward County residents (22%) are more likely to seek safety at hotels and motels.

(4) Since you've been living in this location, have you ever evacuated your home because of a hazardous material accident?

Only one percent of residents in the South Florida region say they have experienced a hazardous material accident in the region.

(5) Suppose there was a hazardous material accident but public safety officials advised you to close your windows and doors, turn off your air conditioner, and stay indoors rather than trying to evacuate. Would you stay indoors rather than trying to evacuate?

Four out of five residents (78%) in the South Florida region claim they would follow public safety officials' instructions to stay indoors rather than trying to evacuate. Residents living in category 4 and 5 evacuation zones (91%) are more likely to follow public safety officials' directives on this issue. Willingness to stay indoors following a hazardous material accident is highest in Broward County (83%) and lowest in Miami-Dade County (74%).

d. Nuclear Power Plant Incident

(1) Do you believe that your home might ever be threatened by radiation released as a result of an accident at the Turkey Point Nuclear Power Plant?

Not quite half of the residents (44%) living in Miami-Dade and Monroe counties believe their homes may at some point be threatened by radiation released as a result of an accident at the Turkey Point nuclear power plant. Concern for this type of disaster is highest among residents living in the category 1 evacuation zone (47%). Monroe County residents (47%) are more concerned than Miami-Dade County (41%) residents about their homes being threatened from radiation being released as a result of an accident at the Turkey Point nuclear power plant.

- (2) If an accident at Turkey Point nuclear power plant threatened your community and public safety officials ordered you to evacuate, would you?**

A very high percentage of residents (87%) will evacuate if ordered to do so if an accident at Turkey Point nuclear power plant threatened the community. Residents in category 2 and 3 evacuation zones (97%) and all non-surge zones are more likely to evacuate under these circumstances. Miami-Dade County residents (91%) are more likely to evacuate than are Monroe County residents (81%).

- (3) Where would you go if you DID evacuate because of an accident at Turkey Point nuclear power plant?**

A plurality of residents (41%) in Miami-Dade and Monroe counties intends to go to friends and relatives in the event of a nuclear accident at Turkey Point nuclear power plant. Residents living in category 2 and 3 evacuation zones (40%) are more likely to go to hotels or motels. Only 5% of the region's residents intend to go to a public shelter; incidence of taking this action is much greater in Miami-Dade County (6%) than in Monroe County (2%).

- (4) Are you located within the 10-mile emergency planning zone for Turkey Point nuclear power plant?**

One in ten residents (8%) in Miami-Dade and Monroe counties believes they live within a 10-mile emergency planning zone of the Turkey Point nuclear power plant.

- (5) Do you have a brochure or other information telling you what you should do in case of an accident at Turkey Point nuclear power plant?**

One in six residents (16%) in Miami-Dade and Monroe counties has brochures or some type of information telling them what to do in the event of an accident at Turkey Point nuclear power plant.

- (6) Suppose there was an accident at Turkey Point nuclear power plant but public safety officials advised you to close your windows and doors, turn off your air conditioner, and stay indoors rather than trying to evacuate. Would you stay indoors rather than trying to evacuate?**

Eight out of ten residents (79%) are willing to follow public safety officials' directives to stay indoors in the event of an accident at Turkey Point nuclear power plant. Residents in category 2 and 3 evacuation zones (96%) and all non-surge zone residents are more willing to stay put as directed. Intent to follow public safety officials' directives to stay indoors in the event of an accident at Turkey Point nuclear power plant only varies by two percentage points between residents in Miami-Dade and Monroe counties.

D. Use of Survey Findings

Responses to individual survey questions alone are not usually good indicators of how residents will respond in actual threats. A mix of the following indicators was used in deriving behavioral assumptions to use in planning:

- Intended responses
- Responses in past threats
- Responses in past threats in other locations
- Factors usually correlated with actual response

1. Intended Responses

Some of the survey questions asked respondents what they would do in certain situations – whether they would evacuate, where they would go, and so forth. Answers to those questions constitute intended responses and they provide a very straightforward indicator of behavior. Unfortunately, intended responses often do not match actual responses. That is, people often don't do what they said they would do. In some cases there are statistical adjustments to intended responses that result in much closer matches to actual behavior. For example, in most locations actual use of public shelters is only about half the level indicated by intended response surveys.

2. Actual Responses

A number of survey questions asked interviewees how they responded in past hurricane threats. Depending on their county, South Florida survey participants were asked about their evacuation behavior in three of the following hurricanes: Andrew, Frances, Georges, Ivan, Jeanne, and Wilma. Earlier surveys have documented responses in those same hurricanes, as well as others such as Floyd and Michelle. Responses in past threats can be good predictors of future response, but only if the past threats are similar to future threats, both with respect to the storm characteristics and actions taken by public officials. In most locations in the South Florida Region, past threats from most hurricanes asked about in the survey did not generate evacuations as large as those that could occur in future storms. Therefore, evacuation participation rates observed in those storms are not necessarily the best indicators of what it is reasonable to plan for in future threats. For other behaviors such as type of refuge and destination, past responses can be compared for consistency from one evacuation to another and can be used as a comparison with intended responses.

3. Past Response in Other Locations

Although all places are different, responses and patterns observed in one set of locations are often good indicators of what can occur elsewhere, when conditions are similar. This is particularly useful when planning for threats for which there is no reliable response data for similar threats for the region. As part of the SRESP, twelve different hurricane threats were asked about in one county or another. In addition, public response has been documented in many other hurricane threats both in and out of Florida, some of which are relevant to planning in the South Florida region. For example, in the great majority of evacuations

fewer than 15% of evacuees leave on their own, prior to an evacuation notice being issued by public officials. Due to the consistency of that finding, it is reasonable to apply it to the South Florida counties.

4. Statistical Predictors

Data from other hurricane evacuation surveys like those described above have been analyzed statistically to identify factors that have been correlated with evacuation behavior. Certain variables have been found to predict actual response better than others. For example, perceived vulnerability, actual vulnerability (e.g., evacuation zone), housing type, and hearing evacuation orders are all good predictors of whether residents will evacuate. The SRESP survey measured perceived vulnerability, evacuation zone, housing type, and expectation of being told to evacuate, and those factors were combined to provide an indication of whether interviewees would evacuate in certain storm threats, from certain locations, and from certain types of housing. Other variables were used to provide an indication of other evacuation behaviors.

5. Combining Information

There is no simple one-rule-fits-all technique for using the above information in deriving behavioral assumptions for planning. The best solution is to employ the best available mix of indicators, relying most heavily on the best information available for each behavior and scenario in question, for a particular county and storm threat. When good, reliable actual response information was available for a certain storm threat scenario, it was relied on more than other types of information. When actual response information was lacking, a combination of intended response, trends from other locations, and application of predictor variables was used.

6. Sample Size Considerations

SRESP survey statistics were derived from the sample described previously (section I.A. above). The sample provides an estimate of values for the population of people from which the sample was drawn. For example, a sample of Miami-Dade County residents was interviewed for the purpose of estimating how the larger population of Miami-Dade County residents would respond to the same questions.

The sampling plan used in the SRESP survey was designed to provide statistically useful county-level data, given budgetary constraints. However, sample estimates become less reliable statistically when the responses are disaggregated, as they were in the analyses conducted as part of the SRESP. When responses are broken down by evacuation zone within a county and then by housing type, population-level differences among zones and between housing types are not always as large as they might appear in the sample. This is because sampling error increases when sample size decreases. Therefore, differences in the sample might not be large enough to support a conclusion that similar differences exist in the population from which the sample was selected, due to sampling error.

Aggregating results across counties helps overcome zonal and housing disaggregation problems. However, county variations – if they exist – are masked when results are

aggregated at the regional level. The analysis looked at survey results at both the county and regional levels, relying on county-level data to the extent that sample sizes justified that level of analysis, but relying more on regional data when county-level sample sizes were too small.

This is especially true for actual response data. Many SRESP respondents were not living in their current county when past storm threats occurred, so they were not asked about their response in those storms. If a resident was living in the area at the time but didn't evacuate, that person couldn't be asked where he or she went (e.g., public shelter, out-of-county). Therefore, for certain actual response questions, regional statistics were more meaningful than county statistics.

E. Planning Assumptions

Specific planning assumptions for residents are shown in the following tables. Appearing below each set of tables, there is a brief description of the content of the table. For a more in-depth analysis of the planning assumptions, refer to Volume 2 – Regional Behavioral Analysis.

For each county there are 14 tables:

1. Evacuation rate for site-built homes
2. Out-of-county trip rates for site-built homes
3. Percent of available vehicles to be used by site-built homes
4. Public shelter use rates for site-built homes
5. Friend and relative use rates for site-built homes
6. Hotel and motel use rates for site-built homes
7. Other refuge use rates for site-built homes
8. Evacuation rate for site-built homes
9. Out-of-county trip rates for mobile and manufactured homes
10. Percent of available vehicles to be used by mobile and manufactured homes
11. Public shelter use rates for mobile and manufactured homes
12. Friend and relative use rates for mobile and manufactured homes
13. Hotel and motel use rates for mobile and manufactured homes
14. Other refuge use rates for mobile and manufactured homes

In each table for each county there are planning assumptions for six evacuation zones:

1. Areas needing to evacuate due to storm surge flooding from category 1 hurricanes
2. Areas needing to evacuate due to storm surge flooding from category 2 hurricanes
3. Areas needing to evacuate due to storm surge flooding from category 3 hurricanes
4. Areas needing to evacuate due to storm surge flooding from category 4 hurricanes
5. Areas needing to evacuate due to storm surge flooding from category 5 hurricanes
6. Areas not needing to evacuate due to storm surge flooding from hurricanes

Zones were defined relative to zones currently used by each county. In instances where counties currently aggregate zones the planning assumptions were interpolated for intermediate zones. For example, if a county used zones 1-2, 3, and 4-5, trends across those zones were used to specify assumptions for zones 1, 2, 3, 4, and 5.

1. Evacuation Rates

Evacuation rates refer to the percentage of people who will leave their homes to go someplace safer during a hurricane threat. This is a critical variable for planning because it drives the number of vehicles on the roadways during an evacuation. Responses will vary even for hurricanes of the same intensity, depending on how great the threat appears to be to one's specific location, as well as other factors. Evacuation rates on the periphery of warning areas tend to be lower than in areas closest to the projected path of a threatening storm. A strong category 4 hurricane that has maintained its intensity for a day or more prior to landfall will elicit greater response than one that intensifies from a 2 to a 4 just six hours prior to landfall or one that weakens from a 4 to a 2 twelve hours prior to landfall. Both media attention and actions by public officials will vary from one strong category 4 hurricane to another due to similar considerations. A large category 4 storm will receive greater attention from media and officials than a small category 4 storm (e.g., Floyd, "Andrew's Big Brother"). Actions by public officials have a great impact on evacuation rate. People are much more likely to evacuate, especially in strong storms, when they believe they have been ordered to evacuate than when they believe they have received a recommendation to evacuate or haven't been told at all whether they should evacuate. A problem is that many people (often 30% in category 1 evacuation zones) fail to hear, comprehend, or believe that evacuation orders apply to them. The methods and aggressiveness used to disseminate evacuation notices affect evacuation rates.

The planning assumptions for evacuation rates are the *maximum probable rates*. They assume that a threatening storm of a given category poses its greatest threat to each county. That is,

1. The storm's forecast track is over the county early and throughout at least a full day of the threat.
2. The storm has been at the specified intensity for at least a day of the threat and remains at that intensity until landfall.
3. The storm makes landfall in the county.

These conditions aren't met very often, and recent threats in the South Florida region have not generated evacuation rates as high as those in some of the planning assumptions. In fact in the 12 storms asked about in one county or another as part of the SRESP, the highest evacuation rates observed for site-built homes in the category 1 evacuation zone in any county was 80% (Santa Rosa in Ivan and Nassau in Floyd). But evacuation rates over 90% have been documented in other threats (e.g., Escambia in Frederic, parts of Pinellas in Elena, most of coastal Georgia and southern South Carolina in Floyd, and Galveston, Texas in Rita).

Applying the county planning assumptions to the entire region overstates evacuation rates for the region, because not every county in the region will meet the conditions. However, one doesn't know in advance the county to which they will apply, if any.

The planning assumptions assume that officials issue mandatory evacuation orders for surge-related evacuation zones for hurricanes of corresponding intensities (e.g., everyone in the category 1 evacuation zone is ordered to evacuate in a category 1 hurricane). It also

assumes that all mobile homes and residents of manufactured housing are ordered to evacuate for hurricanes of all intensities.

The planning assumptions include shadow evacuation – people leaving from areas and structures not ordered by officials to evacuate. These assumptions can add substantially to the total number of people evacuating and generating shelter demand, but the phenomenon exists, particularly when conditions such as those enumerated above apply (storm is forecast for an extended period to strike the county, maintains its intensity, and makes landfall in the county). One reason that shadow evacuation occurs is that many people have misconceptions about their vulnerability.

2. Out-of-County Trips

Many evacuees go farther than necessary to reach safety, and the planning assumptions indicate the percentage of evacuees who will go to destinations outside their own county. The Survey Data Report lists the actual destination (i.e., city) where intended evacuees said they would go and where actual evacuees have gone in the past, if they said they would go or went beyond their own neighborhoods. Going out-of-county can increase evacuation clearance times but has occurred in the past and will in the future until officials are more successful at dissuading evacuees from doing so. Very few out-of-county evacuees seek refuge in public shelters. The great majority go to the homes of friends and relatives or to hotels and motels. Because evacuation rates were low in recent storms, out-of-county trip rates are based on the minority of residents who evacuated and might not be the same if evacuation rates had been greater.

3. Type of Refuge

There are separate tables for the percentage of evacuees who will go to public shelters, the homes of friends and relatives, hotels and motels, and other types of refuge (such as churches, workplaces, and second homes). Survey respondents tend to overstate their likelihood of using public shelters and understate their likelihood of going to the homes of friends and relatives. Actual refuge use is the best indicator, but in the South Florida region there have been too few evacuees in recent hurricane threats included in the survey to provide highly-reliable estimates at the county level for future planning. Planning assumptions for the counties reflect a reduced value of the intended public shelter use figures unless actual response values were consistent with the intended behavior. The ability of evacuees to actually go to their intended refuge or to the places they have gone in the past will depend of the availability of those refuges in future threats.

4. Percent of Available Vehicles

Many evacuating households tend to take only a portion of the vehicles available to them, mainly to avoid separating the family more than necessary. The planning assumptions indicate the percentage of vehicles available to households that will be used in an evacuation. The Survey Data Report includes the number of vehicles available to evacuating households and the number they would take. The percent-of-available figures are derived from those data. Although planners could use the number of vehicles per household from the SRESP survey and reported in the Survey Data Report, census data

should provide better statistical estimates of the number of vehicles available to households, to which the percent-of-available multipliers can be applied. The SRESP survey asked only about intended vehicle use, but a large number of post-storm surveys have asked about actual vehicle use, and the intended use figures tend to match the actual use figures well.

5. Evacuation Timing

Not all evacuees leave at the same time. Some leave before public officials issue evacuation notices, some leave very soon following issuance of evacuation notices, and some wait until shortly before they expect the threatening storm to arrive.

a. Evidence from Past Evacuations

Many surveys documenting response following hurricane evacuations have asked evacuees to indicate the time and date when they departed their homes. The responses have been graphed to depict cumulative evacuation curves. The curves show how the evacuation (on the y-axis) grew over time (on the x-axis), typically with a few people leaving early and then increasing to the point at which 100% of the evacuees had eventually departed. The curves indicate when vehicles enter the evacuation network as evacuating vehicles, not when they reached their destinations or when they made other trips in the network prior to evacuating.

In general a graph of when evacuees depart often looks like the letter "S." In some evacuations the "S" is compressed laterally (i.e., over time) to appear thin and upright. Those curves occur when all departures occur in a relatively short period of time. They usually happen when evacuation notices were not issued early enough due to an unexpected change in a storm's track, forward speed, or intensity. By the time evacuation notices are issued, little time remains before anticipated landfall, so evacuees leave with a sense of urgency corresponding to the threat. This would be referred to as a relatively "fast" or "quick" response.

In other evacuations the "S" is stretched laterally and covers more of the length of the line on which it appears, with departures being distributed over a longer length of time. It looks "flatter." In those cases evacuation notices were issued well in advance of anticipated landfall of the storm, and residents were aware that they had the luxury of waiting longer before departing if they choose to do so. Some evacuees do wait longer before leaving, but not all do. Departures are distributed over a longer period of time than in the first example. This might be referred to as a "slow" response.

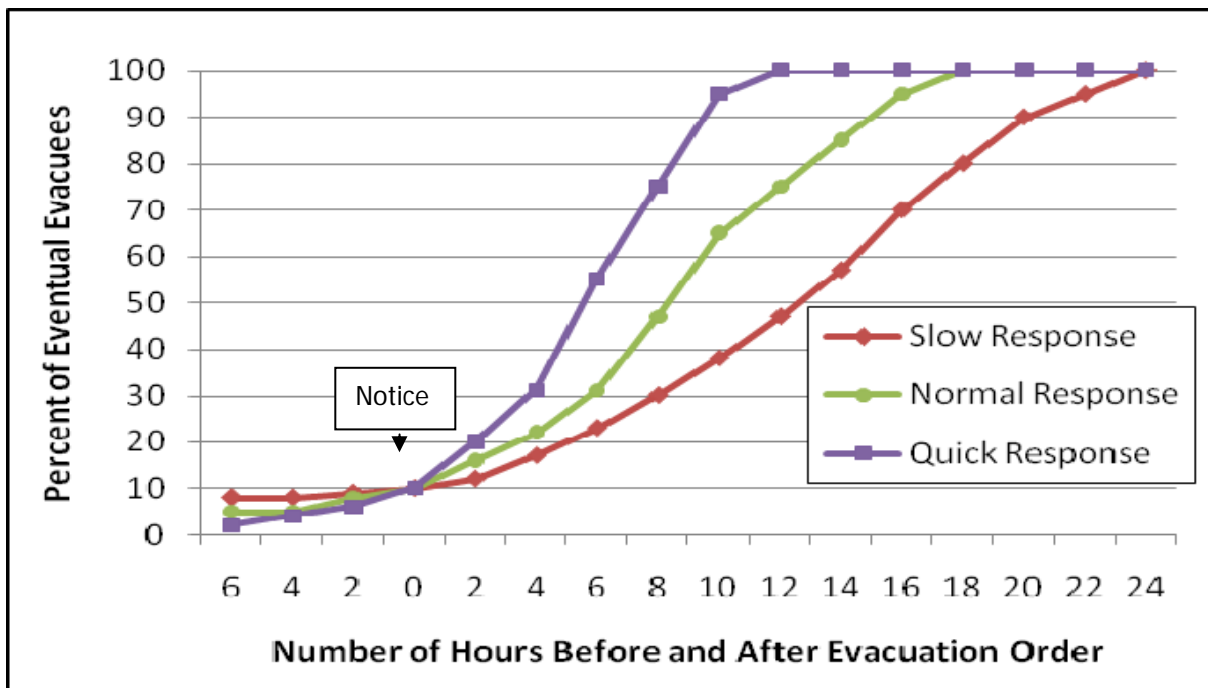
There are also evacuation timing curves that fall between those two, resulting in an "S" that is less compressed than the first, but less stretched than the second. This sort of evacuation results when evacuation notices are issued earlier than in the first example, but not as early as in the second case.

In all three scenarios evacuees collectively take as much time as they believe is available to them. Perceptions about the urgency of the evacuation account for variations in whether the evacuation is "quick," "slow," or in between ("normal").

b. Response Curves for Planning

The three evacuation timing scenarios described above are depicted graphically in Figure III-3, reflecting the three versions of the letter “S.” The slowest of the three curves assumes that evacuation notices were issued at least 24 hours before landfall. The fastest of the three assumes that evacuation notices were issued just 12 hours prior to the anticipated onset of hurricane conditions.

**Figure III-3
Response Curves for Evacuation Planning**



c. Variations in the Curves

The haste in which evacuees depart is mainly a function of the perceived urgency of leaving sooner rather than later. Variations from storm to storm are usually a function of forecasts. If a forecast changes to indicate that landfall will occur sooner than previously anticipated, more people will started leaving. If intensity of a storm increases, indicating that additional areas of a community need to evacuate, departures from those areas will increase. These changes influence public response primarily through evacuation notices and instructions provided by local officials. Officials can significantly affect the distribution of departures by when they issue evacuation notices and how they word the notices and related announcements.

In each threat scenario occupants of less vulnerable areas (e.g., inland) will tend to wait longer to evacuate than those living in more hazardous locations (e.g., beaches).

Variation in the curves is a function of variation in the perceived urgency of evacuating promptly, not demographics.

People prefer not to evacuate at night but will do so if necessary. Examples are Eloise, Elena, and Opal. Relatively few people leave prior to the issuance of evacuation notices by officials. People are willing to leave before watches and warnings are posted by the National Hurricane Center if asked to do so by local officials.

d. Examples of Actual Response Curves

Respondents to the SRESP survey were not asked when they departed in past evacuations because too much time had passed between the evacuations and the interviews to trust the accuracy of recollections. The questions would also have made the interviews unacceptably lengthy. There are ample actual response curves that have been documented in other surveys.

(1) Two-day Evacuations

If officials issue evacuation notices more than 24 hours prior to anticipated landfall, evacuation departures will be distributed over a period longer than 24 hours. Some evacuees will leave shortly after the evacuation notice during daylight hours, then departures will essentially stop on the evening of the first day, and then resume on the morning of the second day.

Most of the recent evacuations in Florida and elsewhere have taken place over a period of more than 24 hours. This has been the result of evacuation notices having been issued more than 24 hours prior to arrival of the storms. Curves were constructed for 11 different coastal regions in Floyd, for example, including four regions in Florida, and all 11 curves were distributed over more than a 24-hour period. All four of the 2004 major hurricanes in Florida (Charley, Frances, Ivan, and Jeanne) had evacuations that covered more than 24 hours. Evacuation departures in Katrina in Mississippi and Louisiana and in Rita in Texas in 2005 occurred over a period of two days or more. The same was true of Bertha and Fran in South Carolina in 1996, Georges in Florida in 1998, Lili in Texas and Louisiana in 2002, and Isabel in Virginia and Maryland in 2003.

(2) One-day Evacuations

The prevalence of two-evacuations stems from good forecasts and a precautionary approach by public safety officials, particularly in stronger storms. If the National Hurricane Center goes forward with plans to extend the lead times for Hurricane Watches and Warnings by 12 hours, early issuance of evacuation notices will probably continue.

However, good early forecasts won't always be the case, or for other reasons evacuations notices won't be issued early enough to afford the luxury of having two days in which to evacuate. In those instances evacuations in certain areas will need to be rushed to completion following issuance of evacuation notices, and the

duration of evacuations will be less than two days. If the goal of clearance time calculations is to estimate the minimum amount of time necessary to complete an evacuation safely, response curves of shorter duration than two days should be assumed.

The quickest of the one-day curves assumes that all evacuees depart within 12 hours of an evacuation notice being issued, with just 10% having left prior to the evacuation notice. Examples of approximately 12-hour response curves are Broward and Miami-Dade Counties in Andrew in 1992, Pinellas County in Elena in 1985, and Escambia County in Frederic in 1979. Storms in which evacuation departures were distributed over a 12 to 18 hour period include David in Miami-Dade in 1979 and Opal in northwest Florida in 1995. Eloise in northwest Florida in 1975 is a rare example of evacuation departures occurring over a period of just six hours, but in some locations as little as 45% of the public evacuated.

F. Planning Assumptions for Vacationers

Compared to residents, there is relatively little data documenting how vacationers respond to hurricane threats, and no SRES survey was conducted with vacationers to ascertain their intentions. Recommendations for behavioral assumptions for tourists are derived from intended-response survey findings with visitors to other locations and from existing data on how vacationers have responded in other locations, including the Carolinas.

1. Evacuation Rates

There is no evidence that vacationers are reluctant to evacuate when a hurricane interrupts their visit to a coastal community. Based on observations of vacationer behavior in other locations and surveys in other locations concerning intended responses, it is reasonable to assume that 90% to 95% of vacationers will evacuate their accommodations *if evacuation orders are issued*.

2. Type of Refuge

Officials sometimes report a large number of vacationers in public shelters, but they represent a very small percentage of the total visitor population. Fewer than 5% of the evacuating vacationers will go to public shelters. Between 25% and 50% will seek inland hotels and motels. The remainder will return home or stay with friends and relatives in Florida, although the number returning home will depend on the distances traveled by tourists from home. Those most likely to return home live within a one-day drive of where they vacation.

3. Destinations

Up to 5% of tourist evacuees will stay within the county where their vacation accommodations were located or go to a nearby county to use a public shelter. At least half will go elsewhere in Florida to continue their vacation or wait out the storm. Up to half will return home, if they live within a one-day drive.

4. Vehicle Use

The great majority of tourists have a vehicle available to them when on vacation, often their own. Virtually all of the vehicles will be used in evacuating, either to other tourist destinations, home, or airports.

5. Evacuation Timing

Tourists leave at least as early as residents. The same curves used for residents should be used for tourists, unless officials order vacationers to evacuate earlier.

G. Planning Assumption Tables

Planning assumptions for evacuation behavior form the final product of behavioral analysis and are subsequently used as inputs for the transportation modeling effort. Reasonable and accurate assumptions are an important element of any modeling process. Planning assumptions for the Statewide Regional Evacuation Study Program are derived using professional analysis of statewide survey results with a cross comparison of previous behavioral analyses. A more complete explanation of the methodology used to derive planning assumptions can be found in Volume 2. A set of planning assumptions for each of the counties in the South Florida Region is listed in Appendix IIIA, IIIB and IIIC.

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