Florida Statewide Regional Evacuation Study Program

Evacuation Transportation Analysis

Volume 4-11

Florida Division of Emergency Management

South Florida Regional Planning Council

South Florida Region

Includes Hurricane Evacuation Study

Statewide Regional Evacuation Study Program

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Volume 4-11

South Florida Region

Evacuation Transportation Analysis

Prepared by

WILBUR SMITH ASSOCIATES

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EVACUATION TRANSPORTATION ANALYSIS

VOLUME 4-11

SOUTH FLORIDA REGION

Prepared for:

South Florida Regional Planning Council
Florida Division of Emergency Management

Prepared by:

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ASSOCIATES

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EXECUTIVE SUMMARY

The evacuation transportation analysis discussed in this volume documents the methodology, analysis, and results of the transportation component of the Statewide Regional Evacuation Study Program (SRESP). Among the many analyses required for the SRESP study, transportation analysis is probably one of the most important components in the process. By bringing together storm intensity, transportation network, shelters, and evacuation population, transportation analysis explicitly links people's behavioral responses to the regional evacuation infrastructure and helps formulate effective and responsive evacuation policy options. Due to the complex calculations involved and numerous evacuation scenarios that need to be evaluated, the best way to conduct the transportation analysis is through the use of computerized transportation simulation programs, or transportation models.

A. Background and Purpose

Over the years, different planning agencies have used different modeling approaches with varying degrees of complexity and mixed success. Some have used full-blown conventional transportation models such as the standard Florida model FSUTMS; others have used a combination of a simplified conventional model and a spreadsheet program, such as the Abbreviated Transportation Model (ATM). These models have different data requirements, use different behavioral assumptions, employ different traffic assignment algorithms, and produce traffic analysis results with different levels of detail and accuracy. These differences make it difficult for planning agencies to share information and data with each other. They also may produce undesirable conditions for staff training and knowledge sharing.

One of the objectives of the SRESP is to create consistent and integrated regional evacuation data and mapping, and by doing so, to facilitate knowledge sharing between state, regional, county, and local partners. To achieve this objective, it is important for all Regional Planning Councils to adopt the same data format and to use the same modeling methodologies for their transportation analyses. The primary purpose of the transportation component of the SRESP is to develop a unified evacuation transportation modeling framework that can be implemented with the data collected by the Regional Planning Councils.

B. Study Area

The study area for this analysis includes the three county South Florida Regional Planning Council area. The transportation modeling methodology includes some processes that are performed at the statewide level, in order to determine the impacts of evacuations from other regions impacting the evacuation clearance times in the South Florida region. While the impact of other regions is included in the South Florida analysis, it is important to note that the results of the transportation analysis presented in this document are only reported for the three counties included in the South Florida RPC. Transportation analysis results for other regions and counties are reported in the corresponding Volume 4 report for those regions.

C. Input and Coordination

The development of the transportation methodology and framework required coordination and input from all eleven regional planning councils in Florida, along with the Division of Emergency Management, Department of Transportation, Department of Community Affairs, and local county emergency management teams. At the statewide level, the transportation consultant, Wilbur Smith Associates, participated in SRESP Work Group Meetings which were typically held on a monthly basis to discuss the development of the transportation methodology and receive feedback and input from the State agencies and RPCs.

At the local and regional level, Wilbur Smith Associates conducted a series of four regional meetings to coordinate with and receive input from local county emergency management, the regional planning council, local transportation planning agencies and groups, as well as other interested agencies.

D. Evacuation Modeling Methodology and Framework

The evacuation modeling methodology and framework was developed during 2008 and 2009 in coordination with all eleven Regional Planning Councils and the Division of Emergency Management. The methodology used in the South Florida RPC Evacuation Transportation Analysis is identical to the methodology used for all eleven Regional Planning Councils and includes the following components[1]:

- **Behavioral Assumptions** – In 2008, the Statewide Regional Evacuation Study Program (SRESP) commissioned a survey of Florida residents. The purpose of this survey was to develop an understanding of the behavior of individuals when faced with the prospect of an impending evacuation. These data were used to develop a set of "planning assumptions" that describe the way people respond to an order to evacuate and are an important input to the SRESP Evacuation Model. The behavioral data provides insights into how people respond to the changing conditions leading up to and during an evacuation. The primary application of the survey data was to help anticipate how people would respond with respect to five behaviors:

    - How many people would evacuate?
    - When they would leave?
    - What type of refuge they would seek?
    - Where they would travel for refuge?
    - How many vehicles would they use?

    These evacuation behaviors are distinguished based on several descriptive variables as listed below:

    - Type of dwelling unit (site-built home versus mobile home);
    - The evacuation zone in which the evacuee reside; and,
    - The intensity of the evacuation that has been ordered.

[1] Modifications to model flow rates (lane capacities) in Monroe County were made to the South Florida RPC model in accordance with the "maximum sustainable traffic flow rates per functional evacuation lane" identified in correspondence from the Florida Department of Transportation, District 6, to the Florida Department of Community Affairs. These flow rates are different than model flow rates used throughout the rest of Florida to accommodate the unique roadway characteristics of Monroe County.

- **Zone System and Highway Network** - The SRESP evacuation model relies upon data that covers the entire State of Florida as well as areas covering the States of Georgia, Alabama, Mississippi, South Carolina, North Carolina, and Tennessee. While the primary focus of the model is with evacuation behavior within Florida, areas outside of the state had to be considered in order to allow a more precise routing of evacuation traffic. This allows the model to measure the flow of traffic across the state line if needed. The data included in this system contain the demographic information crucial to modeling evacuation traffic. The demographic information is labeled as "small area data". These data provide population and dwelling unit information that will identify where the individuals in the region reside. The planning assumptions developed from the behavioral analysis conducted for this study were applied to these demographic data. The result is a set of evacuation trips generated by the evacuation model. The number of these trips will vary depending on the hazard conditions that prompt the evacuation. Small area data geographies were aggregated into larger units known as Traffic Evacuation Zones (TEZ). These TEZ form the basic unit of analysis in the evacuation model. The final TEZ system for the State of Florida has 17,328 zones. This number provides sufficient detail to accurately accommodate the assignment of evacuation trips onto an evacuation network.

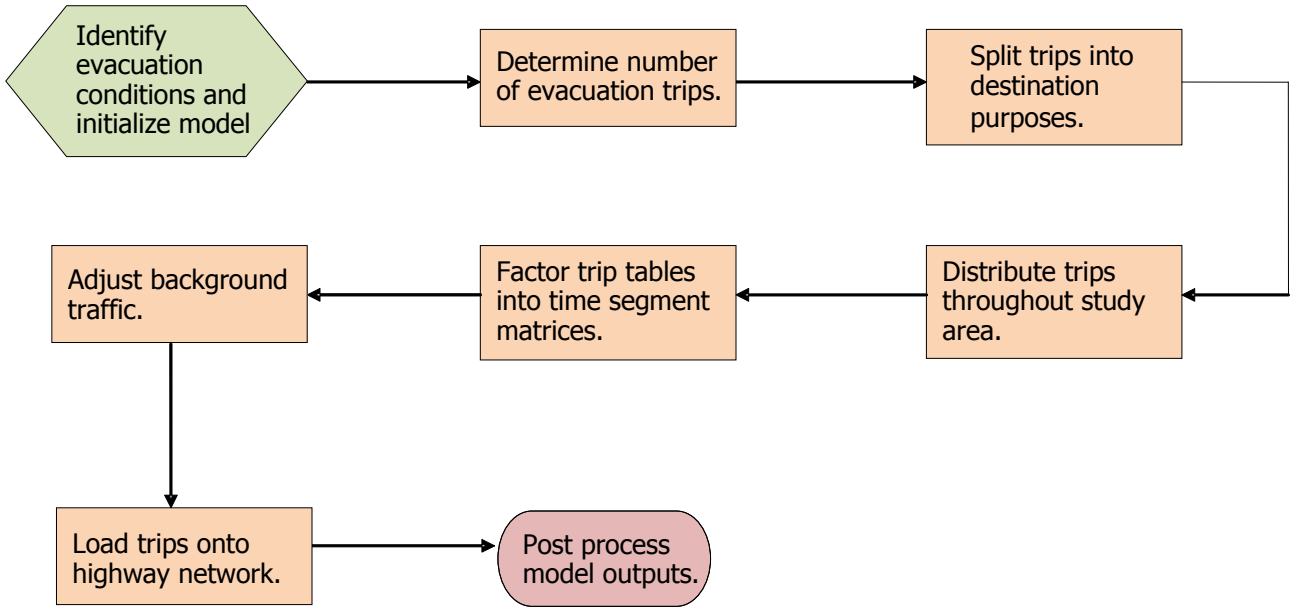
- **Background Traffic** - The traffic that consumes the roadway capacity of a transportation system during an evacuation can be divided into two groups. The first group is the evacuation traffic itself. Once the evacuation demand is determined, this information is converted into a number of vehicles evacuating over time. These evacuation trips are then placed on a representation of the highway network by a model. The model determines the speed at which these trips can move and proceeds to move the evacuation trips accordingly. The result is a set of clearance times.

  The second group of traffic is known as background traffic. Background traffic, as its name implies, is not the primary focus of an evacuation transportation analysis and is accounted for primarily to impede the movement of evacuation trips through the network. These trips represent individuals going about their daily business mostly unconcerned with the evacuation event. For the most part, background traffic represents trips that are relatively insensitive to an order to evacuate and are thus said to be occurring in the "background." Even though background traffic is relatively insensitive to evacuation orders, it is important to account for background traffic since it can have a dramatic impact on available roadway capacity. This in turn can severely affect evacuation clearance times.

- **Evacuation Traffic** - The model flow for the evacuation model is divided into a total of eight modeling steps. The following eight steps are represented graphically in the flowchart in Figure ES-1:

  1. Identify evacuation conditions and initialize model;
  2. Determine number of evacuation trips;
  3. Split trips into destination purposes;
  4. Distribute trips throughout study area;
  5. Factor trip tables into time segment matrices;
  6. Adjust background traffic;
  7. Load trips onto highway network; and,
  8. Post process model outputs.

Figure ES-1 - General Model Flow



- **Dynamic Traffic Assignment** - Dynamic traffic assignment (DTA) was utilized in the evacuation methodology because it is sensitive to individual time increments. DTA works by assigning a certain number of vehicles to the highway network in a given interval of time. The model then tracks the progress of these trips through the network over the interval. Another set of vehicles is assigned during the following time interval. The model then tracks the progress of these trips through the network along with the progress of the trips loaded in the previous time interval. As vehicles begin to arrive at the same segments of roadway, they interact with one another to create congestion. When vehicles that were loaded to the network in subsequent intervals of time arrive at the congested links, they contribute to the congestion as well. This results in a slowing down of the traffic and eventually spill-backs and queuing delays. It is this time dependent feature of DTA that makes it well suited to evacuation modeling. By dynamically adjusting the travel times and speeds of the vehicles moving through the network as they respond to congestion the model is able to do the following:

    - The evacuation model is able to estimate the critical clearance time statistics needed for this study;
    - The model takes into account the impact of compounded congestion from multiple congestion points;
    - The model is able to adjust the routing of traffic throughout the network as a function of congestion as it occurs throughout the evacuation; and,
    - The model is capable of adjusting its capacities from time segment to time segment, making it possible to represent such phenomena as reverse lane operations and background traffic.

- **Prototype Model Development** - Wilbur Smith Associates developed a prototype model to test the modeling methodology used to calculate evacuation clearance times. The prototype model demonstrated the viability of the methodology developed for this

study. This included the use of dynamic traffic assignment, background traffic curves, regional sub-area trip balancing, the use of survey rates, the use of 100% participation rates, response curves, and county-by-county phasing of evacuations. The prototype model served as the backbone for all regional evacuation models that have been developed for this study. The models implemented for each RPC use a structure similar to the prototype with identical methodology.

E. Regional Model Implementation

The regional model developed for the South Florida Region used a series of input data provided by the RPC, including the following:

- **Regional Model Network** - The regional model network consists of the RPC designated evacuation routes as well as a supporting roadway network that facilitates movement of evacuation traffic. The 2005 Florida Department of Transportation (FDOT) Statewide Model Network was used as a basis for developing the regional model network, while the evacuation routes were obtained from the South Florida RPC. The RPC received input from the emergency managers of its constituent counties on roads designated as evacuation routes. Policy in both Miami-Dade County and Broward County encourages in-county evacuations, away from surge areas to the inland portions of the county, not out of county. As a result, some inter-county connectors had to be added in order to compose the regional evacuation network that was developed for the study.

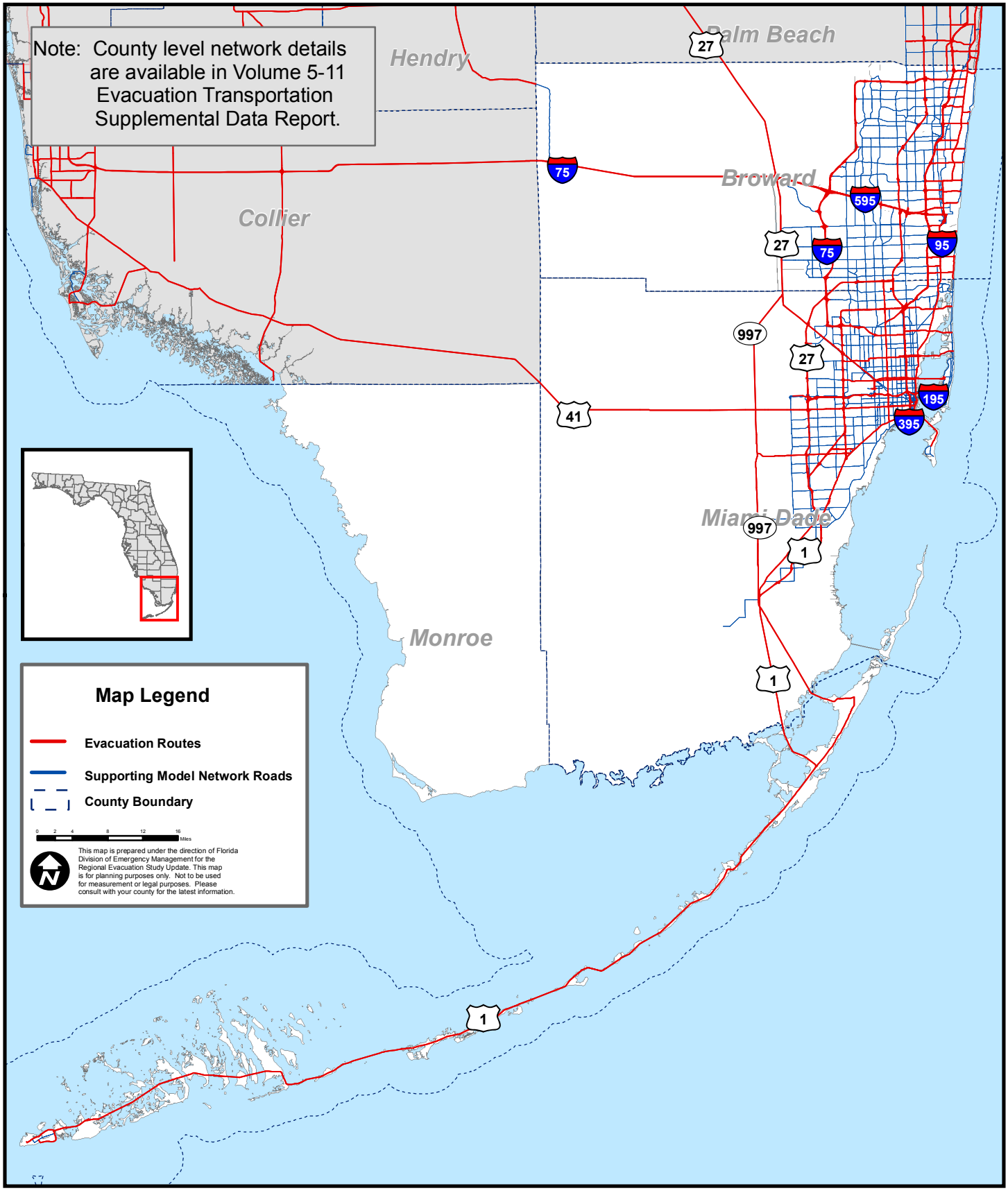
  Lane capacities for the segments of US 1 in Monroe County were defined in accordance with the "maximum sustainable traffic flow rates per functional evacuation lane" identified in correspondence from the Florida Department of Transportation, District 6, to the Florida Department of Community Affairs. FDOT District 6 has identified potential changes in the number of functional evacuation lanes on US 1 as a result of the incorporation of completed and planned shoulder improvements within Monroe County through 2015. Study parameters do not provide for the additional scenarios required to analyze the possibility of utilizing additional lanes in an evacuation. However, through the TIME interface and the regional model for South Florida, additional analysis can be conducted on these resources in the future as part of the detailed planning process.

  The resulting model network was updated to 2006 conditions and is referred to as the base model network. **Figure ES-2** identifies the model network and evacuation routes for the SFRPC. County level details of the regional model network are provided in the Volume 5-11 report. The regional model network for the South Florida region includes key roadways within the three county region, including I-75, I-95, I-195, I-395, Florida's Turnpike, US 1, US 27, US 41, US 441, SR 826, SR 836, SR 869, SR 924, and SR 997.

- **Regional Zone System** - The regional zone system is based on Traffic Evacuation Zones (TEZ) and contains the regional demographic information, which includes housing and population data that is essential to modeling evacuation traffic. There are 1,051 TEZs located within the three county South Florida region, as illustrated in **Figure ES-3**. In the South Florida region, Miami-Dade County has the largest number of TEZs with 632, and Broward County follows with 379 TEZs. Monroe County contains 40 TEZS and has the lowest number of TEZs within the RPC. The larger number of TEZs generally reflects counties with dense urban structure and higher population densities.

Figure ES-2

South Florida Regional Model Network

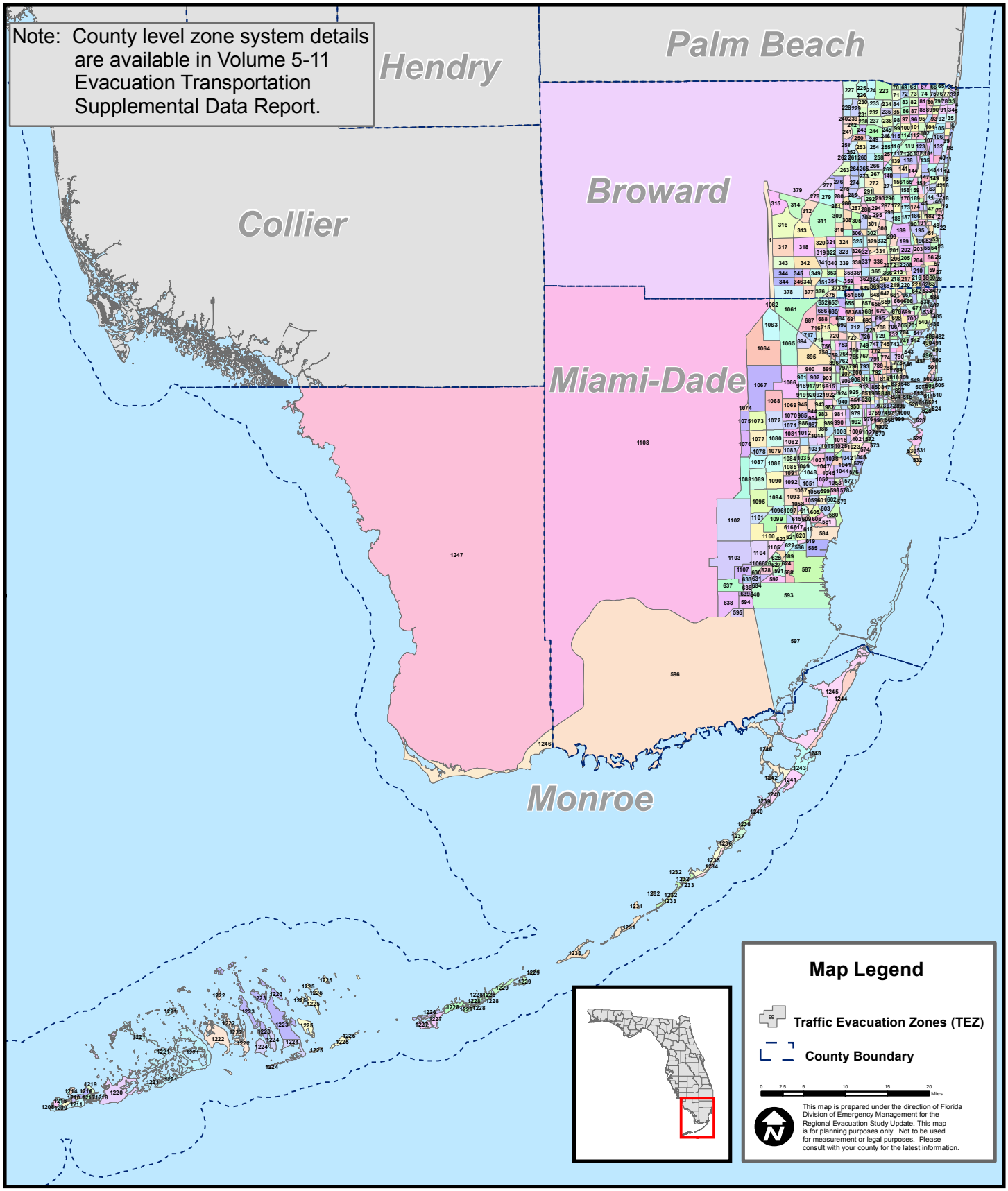


Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: July, 2010

Figure ES-3

South Florida Regional Model Transportation Evacuation (TEZ) Zone System



Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

- **Regional Demographic Characteristics** - Demographic data were developed for census block groups for Monroe County and for traffic analysis zones for Broward County and Miami-Dade County. Estimates for 2006 and projections for 2010 and 2015 were prepared in each county with the aid of local planners – see the county appendices to Chapter I, Volume 1-11 for a detailed discussion of the approach used in each county. The projections for 2010 and 2015 were developed prior to the 2010 Census. It is likely that differences will be observed once the results of the 2010 Census are released, in early 2011. The regional model was designed to allow for demographic data updates, so it will be possible to conduct an update in the transportation analysis to reflect more current estimates and new projections that are expected to follow from the release of the 2010 Census.

  A snapshot of the key demographic data for each county in the South Florida RPC for 2006, 2010 and 2015 is summarized in **Table ES-1**. The tables list the number of occupied dwelling units for site-built homes, the permanent population in site-built homes, as well as the number of occupied dwelling units for mobile homes and the permanent population in mobile homes. The mobile home category includes RVs and boats and the permanent population in those housing options. The demographic characteristics summary also includes hotels and motels because many of these units are in vulnerable areas, and the proportion of seasonal units and hotel/motel units that are occupied at any point in time will have an important impact on the total population that may participate in an evacuation.

Table ES-1 - South Florida Demographic Characteristic Summary

County	Characteristic	Year		
		2006	2010	2015
Broward	Occupied site-built homes	659,884	662,756	690,339
	Population in site-built homes	1,686,387	1,718,826	1,819,299
	Occupied mobile homes	16,762	13,074	13,840
	Population in mobile home	38,896	30,402	32,591
	Hotel/motel units	36,621	38,501	40,013
Miami-Dade	Occupied site-built homes	828,538	855,225	892,978
	Population in site-built homes	2,342,429	2,428,951	2,549,893
	Occupied mobile homes	11,429	11,492	11,639
	Population in mobile home	34,986	35,116	35,478
	Hotel/motel units	46,116	46,116	46,116
Monroe	Occupied site-built homes	30,595	32,213	34,067
	Population in site-built homes	68,585	72,946	77,221
	Occupied mobile homes	6,833	5,807	5,781
	Population in mobile home	14,496	12,179	12,130
	Hotel/motel units	13,086	13,665	13,665

Source: South Florida Regional Planning Council. See discussion on page ES-6 for more information on the source of the small area data.

Miami-Dade County has the largest population in the region during all three time periods. The county is expected to reach over 2.5 million people by 2015. Broward County has the second largest population in the region, and is forecasted to have more than 1.8 million people by 2015. Monroe County, the most vulnerable of the three counties, has the fewest number of people in the South Florida region and is expected to grow very little throughout the time period.

- **Planned Roadway Improvements** - To correspond to the three different sets of demographic data, three model networks were ultimately developed. The base 2006 network and two future year networks to correspond to the 2010 demographic data and the 2015 demographic data. The 2006 base model network was updated to reflect roadway capacity improvement projects completed between 2006 and 2010 to create the 2010 network. The 2010 network was then updated to reflect planned roadway capacity improvement projects expected to be implemented between 2011 and 2015 to create the 2015 network.

  The planned roadway improvements that were added to the network generally include only capacity improvement projects such as additional through lanes. **Table ES-2** identifies capacity improvement projects completed between 2006 and 2010 that were included in the 2010 network. Likewise, **Table ES-3** identifies capacity improvement projects planned for implementation between 2011 and 2015. The tables identify each roadway that will be improved as well as the extent of the improvement. For example, by the end of 2015 in Broward County, SR 7 from Hallandale Beach Blvd to Fillmore St will be widened to 6 lanes.

  It is important to note that Tables ES-2 and ES-3 are not intended to be all inclusive of every transportation improvement project completed within the region. The tables only identify key capacity improvement projects that impact the evacuation model network and are anticipated to have an impact on evacuation clearance times.

- **Behavioral Assumptions** - For the South Florida Region, evacuation rates for site-built homes and mobile/manufactured homes are provided by county and summarized in **Figure ES-4** through **Figure ES-9**. Other rates, such as out of county trip rates, vehicle use rates, public shelter use rates, friend/relative refuge use rates, hotel/motel refuge use rates, and other refuge use rates, are detailed by county, storm threat, and evacuation zone in Volume 5-11.

  A review of the evacuation rates for the South Florida region illustrates that evacuation participation rates increase as the evacuation level increases, and participation rates for persons living in mobile/manufactured homes are generally higher than for persons living in site-built homes. It should be noted that in Broward and Miami-Dade Counties a certain percentage of the population evacuates, even when they are not living in an area that is ordered to evacuate. These people are commonly referred to as shadow evacuees. Shadow evacuation rates are also included in Figure ES-4 through Figure ES-7.

Table ES-2 - South Florida Region Roadway Improvements, 2006 – 2010

County	Roadway	From	To	Number of Lanes
Broward	Griffin Rd	SR 823 (Flamingo Rd)	W of I-75	4
	Bailey Rd	SR 7	NW 64th Ave	4
	Pine Island Rd	Oakland Park Blvd	Commercial Blvd	6
	Sunrise Blvd	Pine Island	Hiatus Rd	6
	SR 7	Dade County Line	Hallandale Beach Blvd	6
	Turnpike	Peters Rd	Sunrise Blvd	8
	Turnpike	Sunrise Blvd	Atlantic Blvd	8
	Andrews Ave Extn	Pompano Park Pl	S of Atlantic Blvd	4
	Davie Rd Extn	NW 72nd Ave	Stirling Rd	1/2
	Dixie Hwy	Hillsboro Blvd	Palm Beach County line	4
	Hiatus Rd	Sunrise Blvd	Oakland Park Blvd	4
	Palm Ave	Stirling Rd	Griffin Rd	4
	Pembroke Rd	SW 160th Ave	SW 136th Ave	4
	Wiles Rd	Lyons Rd	Powerline Rd	4
Miami-Dade	SR 934	Turnpike	NW 87th St	4
	SW 328th St	SW 152nd Ave	SW 137th Ave	4
	SR 997/Krome Ave	N of SW 8th St	MP 2.754	4
	SR 997/Krome Ave	US 1	Lucy St	4
	SW 117th Ave	SW 184th St	SW 152nd St	4
	SR 934	SR 826	SR 823	6
	SR 823/NW 57th Ave	Okeechobee Rd	W 23rd St	6
	SR 826	SR 878	SR 874	8
	SR 826	SR 836	US 27	10
	SW 192nd St	SW 197th Ave`	SW 177th Ave	4
	I-95	I-395	Golden Glades	12

Sources: FDOT SIS First Five Year Plan, FDOT SIS Second Five Year Plan, South Florida Regional Planning Council

Note: Projects included in this table are roadway improvement projects completed between 2006 and 2010 on roadways that are included in the regional transportation model network. Only projects which added roadway capacity, such as additional through lanes, were included. The list is not intended to be all inclusive of every transportation improvement project completed within the region. A list of historical projects completed during the last five years was included in this report because the base regional network developed for the study, along with the base demographic data, is for the year 2006.

Note regarding Monroe County: Lane capacities for the segments of US 1 in Monroe County were defined in accordance with the "maximum sustainable traffic flow rates per functional evacuation lane" identified in correspondence from the Florida Department of Transportation, District 6, to the Florida Department of Community Affairs. FDOT District 6 has identified potential changes in the number of functional evacuation lanes on US 1 as a result of the incorporation of completed and planned shoulder improvements within Monroe County through 2015. Study parameters do not provide for the additional scenarios required to analyze the possibility of utilizing additional lanes in an evacuation. However, through the TIME interface and the regional model for South Florida, additional analysis can be conducted on these resources in the future as part of the detailed planning process.

Table ES-3 - South Florida Planned Roadway Improvements, 2011–2015

County	Roadway	From	To	Number of Lanes
Broward	SR 7	Hallandale Beach Blvd	Fillmore St	6
	Turnpike	Atlantic Blvd	Sawgrass Expy	8
	Turnpike	Homestead Ext-Turnpike (HEFT)	Griffin Rd	8
	I-595/P3/CEI	I-75	W of I-95	10
	I-95	East Sample Rd	Palm Beach County line	10
	Andrews Ave Extn	NW 18th St	Copans Rd	4
	Pine Island Rd	I-595	Nova Dr	6
Miami-Dade/ Broward	I-95	Golden Glades	I-595	12
Miami-Dade	SR 997/Krome Ave	SW 136th St	SR 90/SW 8th St	4
	SR 823/NW 57th Ave	W 46th St/103rd St	TO W 53rd St	6
	NW 25th St	NW 89th Ct	NW 67th Ave	6
	SR 821 (HEFT)	S of SW 117th Ave	S of Kendall Dr	12

Sources: FDOT SIS First Five Year Plan, FDOT SIS Second Five Year Plan, South Florida Regional Planning Council

Note: Projects included in this table are roadway improvement projects planned for completion between 2011 and 2015 on roadways that are included in the regional transportation model network. Only projects which are planned to add roadway capacity, such as additional through lanes, were included. The list is not intended to be all inclusive of every transportation improvement project planned for completion within the region.

Note regarding Monroe County: Lane capacities for the segments of US 1 in Monroe County were defined in accordance with the "maximum sustainable traffic flow rates per functional evacuation lane" identified in correspondence from the Florida Department of Transportation, District 6, to the Florida Department of Community Affairs. FDOT District 6 has identified potential changes in the number of functional evacuation lanes on US 1 as a result of the incorporation of completed and planned shoulder improvements within Monroe County through 2015. Study parameters do not provide for the additional scenarios required to analyze the possibility of utilizing additional lanes in an evacuation. However, through the TIME interface and the regional model for South Florida, additional analysis can be conducted on these resources in the future as part of the detailed planning process.

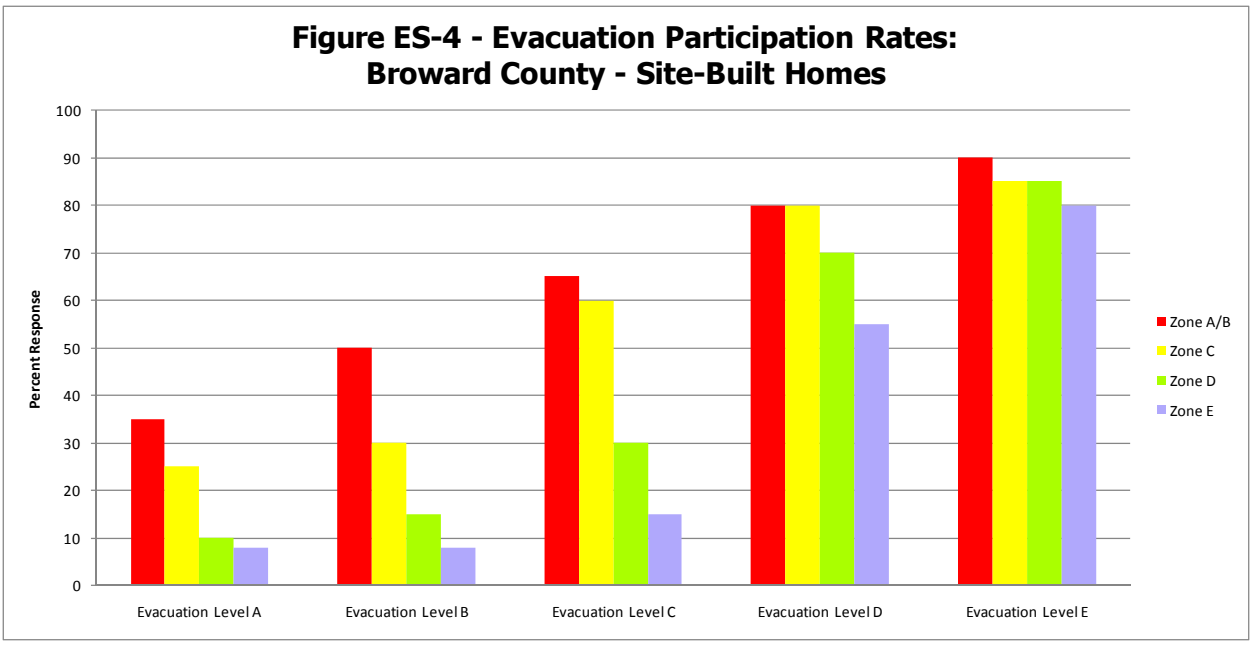


Figure ES-4 - Evacuation Participation Rates:
Broward County - Site-Built Homes
Percent Response
100
90
80
70
60
50
40
30
20
10
0
Evacuation Level A
Evacuation Level B
Evacuation Level C
Evacuation Level D
Evacuation Level E
Zone A/B
Zone C
Zone D
Zone E

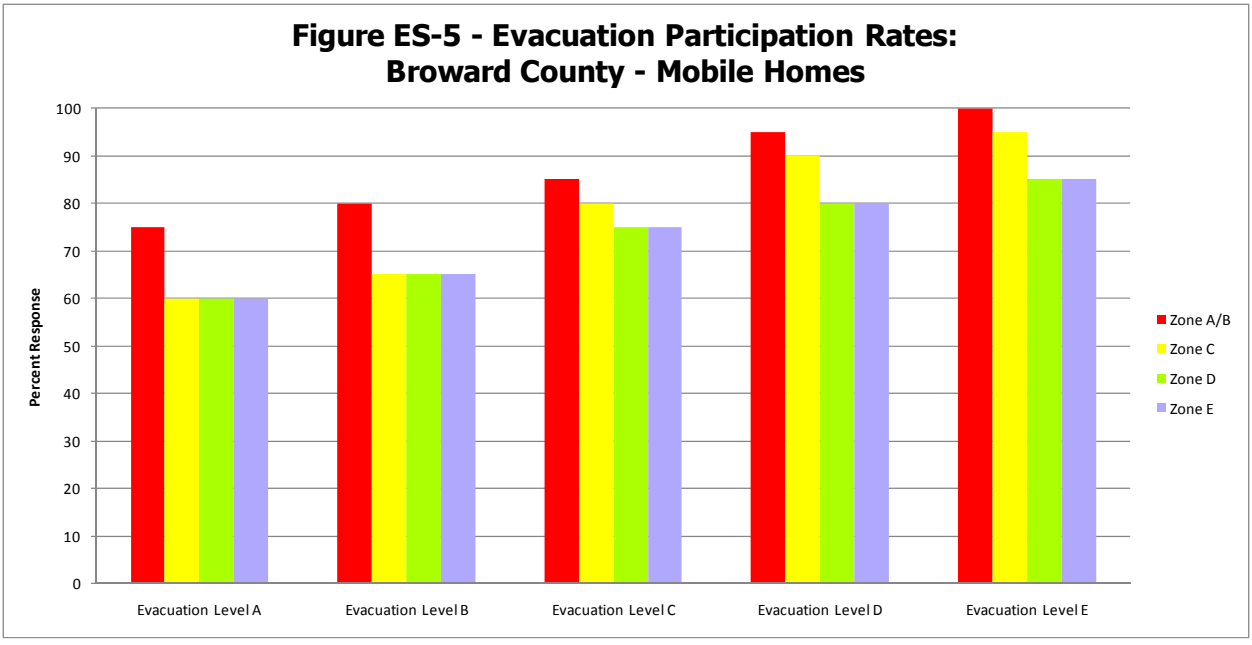


Figure ES-5 - Evacuation Participation Rates:
Broward County - Mobile Homes
Percent Response
100
90
80
70
60
50
40
30
20
10
0
Evacuation Level A
Evacuation Level B
Evacuation Level C
Evacuation Level D
Evacuation Level E
Zone A/B
Zone C
Zone D
Zone E

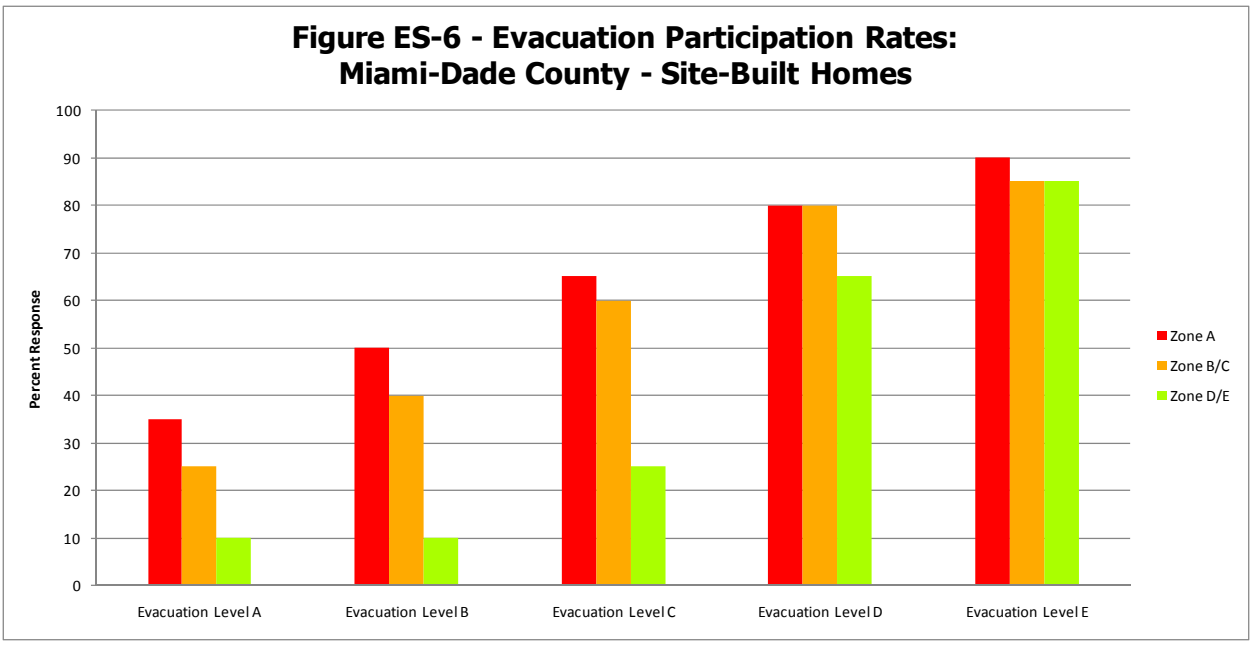


Figure ES-6 - Evacuation Participation Rates:
Miami-Dade County - Site-Built Homes
Percent Response
100
90
80
70
60
50
40
30
20
10
0
Evacuation Level A
Evacuation Level B
Evacuation Level C
Evacuation Level D
Evacuation Level E
Zone A
Zone B/C
Zone D/E

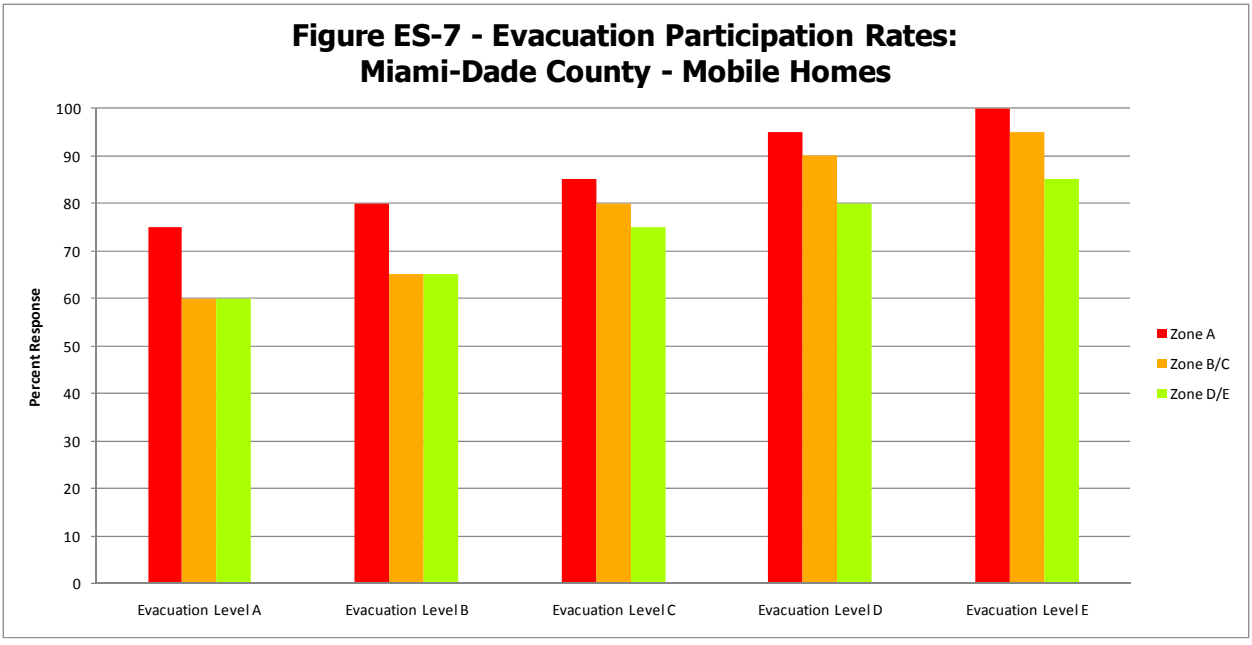


Figure ES-7 - Evacuation Participation Rates:
Miami-Dade County - Mobile Homes
Percent Response
100
90
80
70
60
50
40
30
20
10
0
Evacuation Level A
Evacuation Level B
Evacuation Level C
Evacuation Level D
Evacuation Level E
Zone A
Zone B/C
Zone D/E

Figure ES-8 - Evacuation Participation Rates: Monroe County - Site-Built Homes

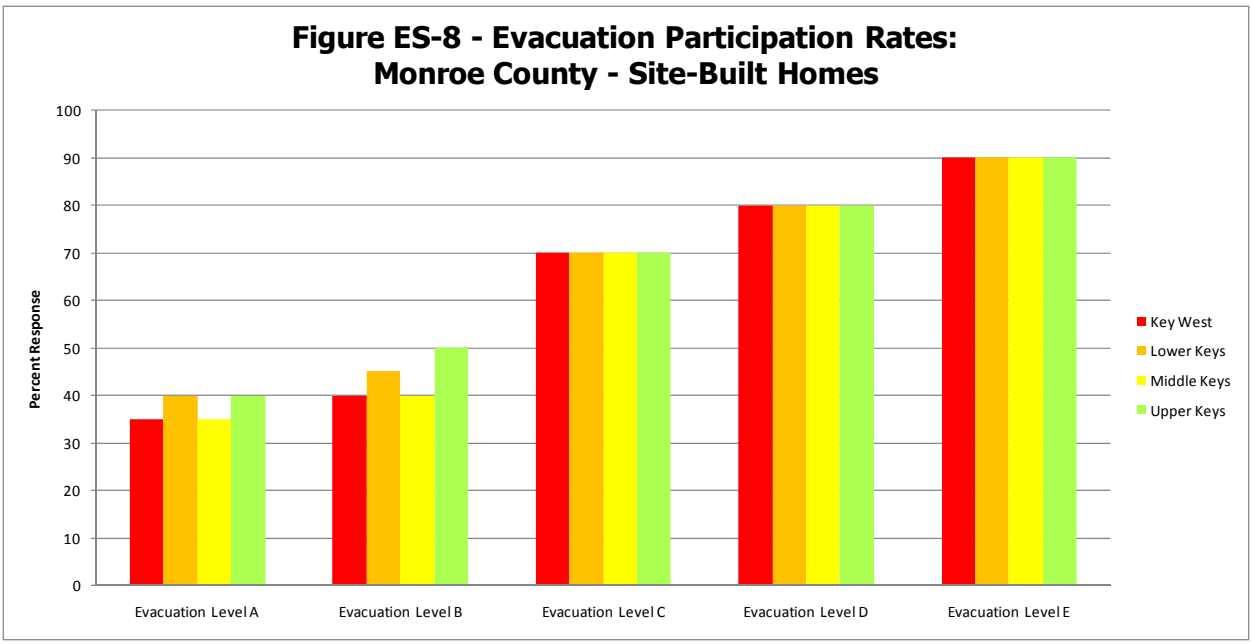
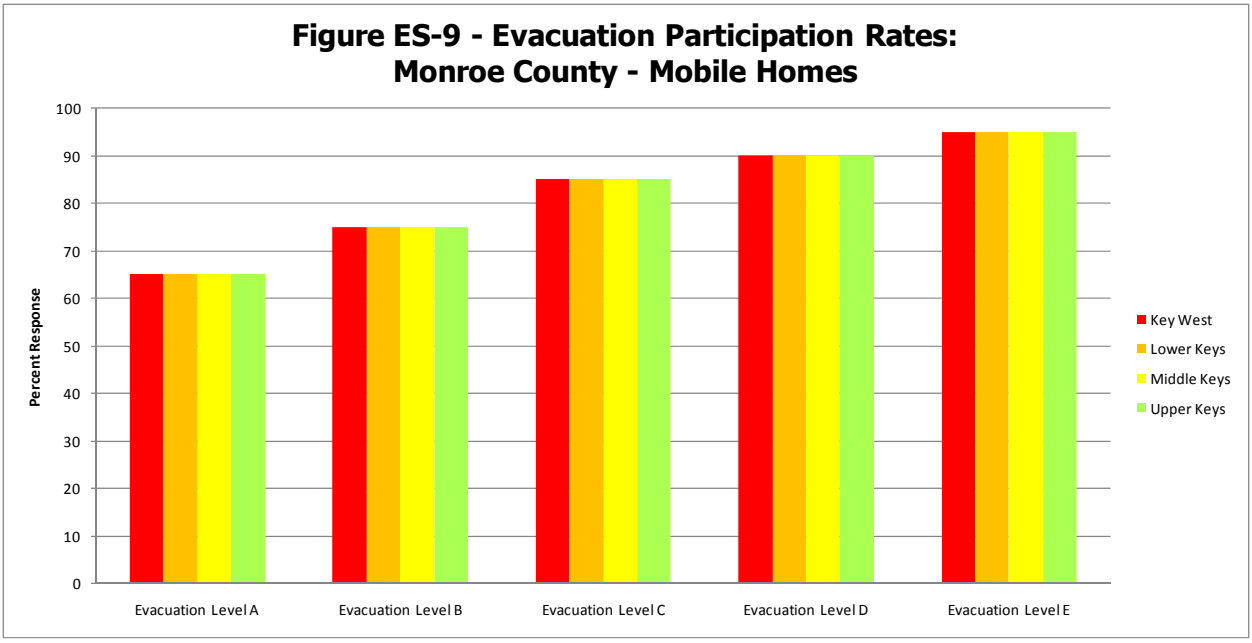


Figure ES-9 - Evacuation Participation Rates: Monroe County - Mobile Homes



Please note that the original behavioral response rates provided by SRESP in Volume 2 were modified to fit the evacuation zones created by Broward and Miami-Dade Counties. The original rates were based on a five zone system; however, the evacuation zones for those counties range from three to four zones depending upon the county. The evacuation zone systems for Broward and Miami-Dade are listed below:

- Broward – 4 zones (for SRESP): Zone A/B, Zone C, Zone D, Zone E;
- Miami-Dade – 3 zones: Zone A, Zone B/C, Zone D/E.

In addition, Monroe County's evacuation zones are not based on storm surge, but are apportioned geographically by sub-regions of the county: Key West, Lower Keys, Middle Keys, and Upper Keys.

- **Shelters** - In order for the transportation model to accurately assign public shelter trips to the correct location, a complete list of available public shelters needs to be available. The shelters were categorized as either primary or other, with primary indicating that the shelter is compliant with American Red Cross standards for a shelter and other indicating all other shelters. In the three county region there are a total of 110 shelters, including 40 in Broward County, 66 in Miami-Dade County, and 4 in Monroe County. All together, the 110 shelters located within the three county region can host more than 150,000 persons during an evacuation event.

- **Evacuation Zones** - The final input variable that is needed to complete the transportation evacuation model is the delineation of evacuation zones for all coastal counties. Local county emergency managers have the responsibility of identifying and defining evacuation zones for their county. County level evacuation zones are included in Volume 5-11.

F. TIME User Interface

Wilbur Smith Associates developed the Transportation Interface for Modeling Evacuations (TIME) to make it easier for RPC staff and transportation planners to use the model and implement the evacuation methodology. The TIME interface is based on an ArcGIS platform and is essentially a condensed transportation model, which provides a user friendly means of modifying input variables that would change the clearance times for various evacuation scenarios.

The evacuation model variables include a set of distinguishing characteristics that could apply to evacuation scenarios as selection criteria. These following variables may be selected using the TIME interface and allow the user to retrieve the best results from various evacuation alternatives:

- Analysis time period;
- Highway network;
- Behavioral response;
- One-way evacuation operations;
- University population;
- Tourist occupancy rates;
- Shelters;

- Counties evacuating;
- Evacuation level;
- Response curve hours; and,
- Evacuation Phasing.

G. Vulnerable Population

Using a combination of the demographic data, behavioral assumptions, and evacuation zones, the vulnerable population in each county could be determined by evacuation level. For the purposes of the transportation analysis, the vulnerable population, or population-at-risk, is defined as the total population living within the county designated evacuation zones for each evacuation level. This population is living in an area that is at risk for severe flooding during a storm event. The vulnerable population for the South Florida Region for 2010 is identified in **Table ES-4**, summarized by evacuation zone and split between site-built homes and mobile/manufactured homes. Vulnerable population for 2015 is summarized in **Table ES-5**.

Table ES-4 – Vulnerable Population in the South Florida Region for 2010

	Evacuation Zone A	Evacuation Zone B	Evacuation Zone C	Evacuation Zone D	Evacuation Zone E
Broward County*					
Site-built Homes	46,214		96,953	45,172	103,939
Mobile/Manuf. Homes	0		191	407	623
TOTAL	46,214		97,144	45,579	104,562
Miami-Dade County*					
Site-built Homes	148,487	153,512		144,869	
Mobile/Manuf. Homes	0	1,917		6,467	
TOTAL	148,487	155,430		151,335	
Monroe County*					
Site-built Homes	72,946				
Mobile/Manuf. Homes	12,179				
TOTAL	85,125				

Note: Vulnerable population determined using SRESP small area data and county provided evacuation zones. Vulnerable population numbers are not inclusive, meaning population numbers listed for a higher zone are not included in the lower zone. For example, vulnerable population listed for Evacuation Zone D does not include vulnerable population listed for Evacuation Zone C. See section E for the source of the small area data.
**Note: For the purposes of this study, Broward County has a combined A/B zone, Miami-Dade County has combined B/C and D/E zones, and all of Monroe County is considered vulnerable.*

Table ES-5 – Vulnerable Population in the South Florida Region for 2015

	Evacuation Zone A	Evacuation Zone B	Evacuation Zone C	Evacuation Zone D	Evacuation Zone E
Broward County*					
Site-built Homes	49,121		102,701	48,840	109,787
Mobile/Manuf. Homes	0		206	440	671
TOTAL	49,121		102,907	49,280	110,458
Miami-Dade County*					
Site-built Homes	153,588	174,226		163,929	
Mobile/Manuf. Homes	0	1,958		6,574	
TOTAL	153,588	176,184		170,503	
Monroe County*					
Site-built Homes	77,221				
Mobile/Manuf. Homes	12,130				
TOTAL	89,351				

Note: Vulnerable population determined using SRESP small area data and county provided evacuation zones. Vulnerable population numbers are not inclusive, meaning population numbers listed for a higher zone are not included in the lower zone. For example, vulnerable population listed for Evacuation Zone D does not include vulnerable population listed for Evacuation Zone C. See section E for the source of the small area data.
**Note: For the purposes of this study, Broward County has a combined A/B zone, Miami-Dade County has combined B/C and D/E zones, and all of Monroe County is considered vulnerable.*

In addition, based again on the demographic data, behavioral assumptions, and evacuation zones, the planned destinations of vulnerable population in each county could be determined by evacuation level. Destinations include friends and family, hotel/motel, public shelter, and other locations. Vulnerable population destinations for the South Florida Region are identified in **Table ES-6** for 2010 and in **Table ES-7** for 2015.

The vulnerable shadow population is provided in **Table ES-8** for both 2010 and 2015. The vulnerable shadow population was determined using the behavioral assumptions for evacuating shadow population and is based on evacuation level (storm category), not evacuation zone.

Table ES-6 – Vulnerable Population by Destination for 2010

	Evacuation Zone A	Evacuation Zone B	Evacuation Zone C	Evacuation Zone D	Evacuation Zone E
Broward County*					
To Friends and Family	34,660		72,839	34,144	78,359
To Hotel/ Motel	6,932		14,572	6,837	15,684
To Public Shelter	924		4,867	2,299	5,259
To Other Destination	3,697		4,867	2,299	5,259
Miami-Dade County*					
To Friends and Family	96,516	101,029		98,368	
To Hotel/ Motel	29,697	30,894		29,620	
To Public Shelter	7,424	7,867		15,134	
To Other Destination	14,849	15,639		8,213	
Monroe County*					
To Friends and Family	48,593				
To Hotel/ Motel	20,168				
To Public Shelter	2,073				
To Other Destination	14,292				

Note: Vulnerable population destinations determined using SRESP small area data and county provided evacuation zones. Vulnerable population numbers are not inclusive, meaning population numbers listed for a higher zone are not included in the lower zone. For example, vulnerable population listed for Evacuation Zone D does not include vulnerable population listed for Evacuation Zone C. See section E for the source of the small area data.
**Note: For the purposes of this study, Broward County has a combined A/B zone, Miami-Dade County has combined B/C and D/E zones, and all of Monroe County is considered vulnerable.*

Table ES-7 – Vulnerable Population by Destination for 2015

	Evacuation Zone A	Evacuation Zone B	Evacuation Zone C	Evacuation Zone D	Evacuation Zone E
Broward County*					
To Friends and Family	36,841		77,160	36,916	82,776
To Hotel/ Motel	7,368		15,436	7,392	16,569
To Public Shelter	982		5,156	2,486	5,556
To Other Destination	3,930		5,156	2,486	5,556
Miami-Dade County*					
To Friends and Family	99,832	114,519		110,827	
To Hotel/ Motel	30,718	35,041		33,443	
To Public Shelter	7,680	8,907		17,050	
To Other Destination	15,359	17,716		9,183	
Monroe County*					
To Friends and Family	51,055				
To Hotel/ Motel	21,165				
To Public Shelter	2,157				
To Other Destination	14,976				

Note: Vulnerable population destinations determined using SRESP small area data and county provided evacuation zones. Vulnerable population numbers are not inclusive, meaning population numbers listed for a higher zone are not included in the lower zone. For example, vulnerable population listed for Evacuation Zone D does not include vulnerable population listed for Evacuation Zone C. See section E for the source of the small area data.
**Note: For the purposes of this study, Broward County has a combined A/B zone, Miami-Dade County has combined B/C and D/E zones, and all of Monroe County is considered vulnerable.*

Table ES-8 – Vulnerable Shadow Evacuation Population

	Evacuation Level A	Evacuation Level B	Evacuation Level C	Evacuation Level D	Evacuation Level E
2010					
Broward County	160,714	167,817	156,617	257,809	345,043
Miami-Dade County	206,603	172,306	194,056	251,893	450,305
Monroe County	0	0	0	0	0
2015					
Broward County	169,295	176,880	165,025	271,484	363,604
Miami-Dade County	217,855	178,334	202,928	259,579	465,523
Monroe County	0	0	0	0	0

Note: Vulnerable shadow population determined using SRESP behavioral data and county provided evacuation zones. See section E for the source of the small area data.

H. Evacuation Model Scenarios

There are literally thousands of possible combinations of variables that can be applied using the evacuation transportation model, which will result in thousands of possible outcomes. For the purposes of this analysis, two distinct sets of analyses were conducted using the SRESP evacuation transportation model, including one set of analysis for growth management purposes and one set of analysis for emergency management purposes. The two sets of analysis include the following:

- **Base Scenarios** – The base scenarios were developed to estimate a series of worst case scenarios and are identical for all eleven RPCs across the State. These scenarios assume 100 percent of the vulnerable population evacuates and includes impacts from counties outside of the RPC area. These scenarios are generally designed for growth management purposes, in order to ensure that all residents that choose to evacuate during an event are able to do so. The base scenarios for the South Florida region are identified in **Table ES-9**; and,

- **Operational Scenarios** – The operational scenarios were developed by the RPCs in coordination with local county emergency managers and are designed to provide important information to emergency management personnel to plan for different storm events. These scenarios are different from region to region and vary for each evacuation level. The operational scenarios for the South Florida region are identified in **Table ES-10**.

Because of the numerous possible combinations of variables that can be applied in the model, the evacuation transportation model is available for use through the South Florida RPC to continue testing combinations of options and provide additional information to emergency managers.

I. Clearance Time Results

Each of the ten base scenarios and twenty-one operational scenarios were modeled for the South Florida Region using the regional evacuation model. Results were derived from the model to summarize the evacuating population, evacuating vehicles, clearance times, and critical congested roadways. Detailed results are discussed in Chapter IV. Clearance times are presented in this executive summary, since the determination of clearance time is one of the most important outcomes from the evacuation transportation analysis.

Calculated clearance times are used by county emergency managers as one input to determine when to recommend an evacuation order. This calculation can include the population-at-risk, shadow evacuees, as well as evacuees from other counties anticipated to pass through the county. Clearance time is developed to include the time required for evacuees to secure their homes and prepare to leave, the time spent by all vehicles traveling along the evacuation route network, and the additional time spent on the road caused by traffic and road congestion. Clearance time does not relate to the time any one vehicle spends traveling along the evacuation route network, nor does it guarantee vehicles will safely reach their destination once outside the County. The four clearance times that are calculated as part of the evacuation transportation analysis include the following:

Table ES-9 – Base Scenarios

	Scenario 1 Level A 2010	Scenario 2 Level B 2010	Scenario 3 Level C 2010	Scenario 4 Level D 2010	Scenario 5 Level E 2010
Demographic Data	2010	2010	2010	2010	2010
Highway Network	2010	2010	2010	2010	2010
One-Way Operations	None	None	None	None	None
University Population	Fall/Spring	Fall/Spring	Fall/Spring	Fall/Spring	Fall/Spring
Tourist Rate	Default	Default	Default	Default	Default
Shelters Open	Primary	Primary	Primary	Primary	Primary
Response Curve	12-hour	12-hour	12-hour	12-hour	12-hour
Evacuation Phasing	None	None	None	None	None
Behavioral Response	100%	100%	100%	100%	100%
Evacuation Zone	A	B	C	D	E
Counties Evacuating	Broward Miami-Dade Monroe Palm Beach Collier	Broward Miami-Dade Monroe Palm Beach Collier	Broward Miami-Dade Monroe Palm Beach Collier	Broward Miami-Dade Monroe Palm Beach Collier	Broward Miami-Dade Monroe Palm Beach Collier
	Scenario 6 Level A 2015	**Scenario 7 Level B 2015**	**Scenario 8 Level C 2015**	**Scenario 9 Level D 2015**	**Scenario 10 Level E 2015**
Demographic Data	2015	2015	2015	2015	2015
Highway Network	2015	2015	2015	2015	2015
One-Way Operations	None	None	None	None	None
University Population	Fall/Spring	Fall/Spring	Fall/Spring	Fall/Spring	Fall/Spring
Tourist Rate	Default	Default	Default	Default	Default
Shelters Open	Primary	Primary	Primary	Primary	Primary
Response Curve	12-hour	12-hour	12-hour	12-hour	12-hour
Evacuation Phasing	None	None	None	None	None
Behavioral Response	100%	100%	100%	100%	100%
Evacuation Zone	A	B	C	D	E
Counties Evacuating	Broward Miami-Dade Monroe Palm Beach Collier	Broward Miami-Dade Monroe Palm Beach Collier	Broward Miami-Dade Monroe Palm Beach Collier	Broward Miami-Dade Monroe Palm Beach Collier	Broward Miami-Dade Monroe Palm Beach Collier

Table ES-10 – Operational Scenarios

Table ES-10 – Operational Scenarios

	Scenario 1 Level A 2010	Scenario 2 Level B 2010	Scenario 3 Level C 2010	Scenario 4 Level D 2010	Scenario 5 Level E 2010
Demographic Data	2010	2010	2010	2010	2010
Highway Network	2010	2010	2010	2010	2010
One-Way Operations	None	None	None	None	None
University Population	Default	Default	Default	Default	Default
Tourist Rate	Default	Default	Default	Default	Default
Shelters Open	Primary	Primary	Primary	Primary/Other	Primary/Other
Response Curve	9-hour	12-hour	9-hour	12-hour	12-hour
Evacuation Phasing	Miami-Dade and Broward 24 hours after Monroe	Miami-Dade and Broward 24 hours after Monroe	Miami-Dade and Broward 24 hours after Monroe	Miami-Dade, Broward, and Palm Beach 24 hours after Monroe	Miami-Dade, Broward, and Palm Beach 24 hours after Monroe and Collier
Behavioral Response	Planning	Planning	Planning	Planning	Planning
Evacuation Zone	A	B	C	D	E
Counties Evacuating	Monroe Miami-Dade Broward	Monroe Miami-Dade Broward	Monroe Miami-Dade Broward	Monroe Miami-Dade Broward Palm Beach	Monroe Miami-Dade Broward Palm Beach Collier

	Scenario 6 Level A 2010	Scenario 7 Level B 2010	Scenario 8a Level C 2010	Scenario 8b Level C 2010	Scenario 9 Level D 2010	Scenario 10 Level E 2010
Demographic Data	2010	2010	2010	2010	2010	2010
Highway Network	2010	2010	2010	2010	2010	2010
One-Way Operations	None	None	None	None	None	None
University Population	Default	Default	Default	Default	Default	Default
Tourist Rate	Default	Default	Default	Default	Default	Default
Shelters Open	Primary	Primary	Primary	Primary	Primary/Other	Primary/Other
Response Curve	9-hour	9-hour	12-hour	12-hour	9-hour	9-hour
Evacuation Phasing	None	None	None	None	None	None
Behavioral Response	Planning	Planning	Planning	100%	Planning	Planning
Evacuation Zone	A	B	C	C	D	E
Counties Evacuating	Monroe Miami-Dade	Broward	Monroe	Monroe	Miami-Dade	Broward

	Scenario 11 Level A 2015	Scenario 12 Level B 2015	Scenario 13 Level C 2015	Scenario 14 Level D 2015	Scenario 15 Level E 2015
Demographic Data	2015	2015	2015	2015	2015
Highway Network	2015	2015	2015	2015	2015
One-Way Operations	None	None	None	Turnpike	Turnpike & I-75
University Population	Default	Default	Default	Default	Default
Tourist Rate	Default	Default	Default	Default	Default
Shelters Open	Primary	Primary	Primary	Primary/Other	Primary/Other
Response Curve	9-hour	12-hour	12-hour	9-hour	12-hour
Evacuation Phasing	None	None	Miami-Dade and Broward 24 hours after Monroe	None	None
Behavioral Response	Planning	Planning	Planning	Planning	Planning
Evacuation Zone	A	B	C	D	E
Counties Evacuating	Monroe Miami-Dade Broward	Monroe Miami-Dade Broward	Monroe Miami-Dade Broward	Monroe Miami-Dade Broward Palm Beach	Monroe Miami-Dade Broward Palm Beach Collier

Table ES-10 – Operational Scenarios

	Scenario 16 Level A 2015	Scenario 17 Level B 2015	Scenario 18 Level C 2015	Scenario 19 Level D 2015	Scenario 20 Level E 2015
Demographic Data	2015	2015	2015	2015	2015
Highway Network	2015	2015	2015	2015	2015
One-Way Operations	None	None	None	None	None
University Population	Default	Default	Default	Default	Default
Tourist Rate	Default	Default	Default	Default	Default
Shelters Open	Primary	Primary	Primary/Other	Primary/Other	Primary/Other
Response Curve	12-hour	9-hour	12-hour	18-hour	12-hour
Evacuation Phasing	None	None	None	None	None
Behavioral Response	Planning	Planning	Planning	Planning	Planning
Evacuation Zone	A	B	C	D	E
Counties Evacuating	Monroe Miami-Dade	Broward Miami-Dade	Broward	Monroe	Miami-Dade

- **Clearance Time to Shelter** - The time necessary to safely evacuate vulnerable residents and visitors to a "point of safety" within the county based on a specific hazard, behavioral assumptions and evacuation scenario. Calculated from the point in time when the evacuation order is given to the point in time when the last vehicle reaches a point of safety within the county. Key points to remember for clearance time to shelter include:
  - All in-county trips reach their destination within the county; and,
  - This definition does not include any out of county trips.

- **In-County Clearance Time** - The time required from the point an evacuation order is given until the last evacuee can either leave the evacuation zone or arrive at safe shelter within the county. This does not include those evacuees leaving the county on their own. Key points to remember for in-county clearance time include:
  - All in-county trips reach their destination within the county;
  - All out of county trips exit the evacuation zone, but may still be located in the county; and,
  - This definition does not include out-of-county pass-through trips from adjacent counties, unless they evacuate through an evacuation zone.

- **Out of County Clearance Time** - The time necessary to safely evacuate vulnerable residents and visitors to a "point of safety" within the county based on a specific hazard, behavioral assumptions and evacuation scenario. Calculated from the point an evacuation order is given to the point in time when the last vehicle assigned an external destination exits the county. Key points to remember for out of county clearance time include:
  - The roadway network within the county is clear;
  - All out of county trips exit the county, including out of county pass-through trips from adjacent counties; and,
  - All in-county trips reach their destination.

- **Regional Clearance Time** - The time necessary to safely evacuate vulnerable residents and visitors to a "point of safety" within the (RPC) region based on a specific hazard, behavioral assumptions and evacuation scenario. Calculated from last vehicle assigned an external destination exits the region. Key points to remember for regional clearance time include:
  - The roadway network within the RPC is clear;
  - All out of county trips exit the RPC, including out of county pass-through trips from adjacent counties;
  - All in-county trips reach their destination; and,
  - Regional clearance time is equal to the largest out of county clearance time for a given scenario for any of the counties within the RPC, since the out of county clearance time includes out of county pass through trips from adjacent counties.

Clearance times for each of the base scenarios are summarized in **Table ES-11** and **ES-12**, while clearance times for each of the operational scenarios are summarized in **Table ES-13** and **Table ES-14.**

Base Scenarios

In-county clearance times for the base scenarios range from 12.5 hours for the evacuation level A scenarios to 31 hours for evacuation level E scenarios in 2010. Clearance Time to Shelter shows a similar pattern, with clearance times for the base scenarios ranging from 3 hours for Monroe County in the evacuation level A scenarios to 30 hours for Broward County for evacuation level E scenario in 2010. In-county clearance times generally remain close to the selected response curve for lower level evacuation scenarios, such as the 12 hour curves for the level A, B, and C base scenarios. Clearance times are generally not less than the response curve unless in county or to shelter population numbers are very low, such as in the Key West area of Monroe County.

In 2015, in-county clearance times for the base scenarios range from 12.5 hours for the evacuation level A scenarios to 45 hours for Broward County for the evacuation level E scenario. Clearance Time to Shelter shows a similar pattern, with clearance times for the base scenarios ranging from 4 hours for the Monroe County evacuation level A scenario to 45 hours for Broward County for evacuation level E scenario in 2015. In county clearance times for Miami-Dade County in level B or higher scenarios are typically equal to or above Monroe County out of county clearance times. By definition, in county clearance time includes out of county trips from other counties that pass through evacuation zones in the evacuating county. Miami-Dade County has a combined B/C evacuation zone where US 1 enters from Monroe County, so in county clearance time for Miami-Dade in all level B or higher base scenarios will reflect the out of county clearance time for Monroe County.

In-county clearance time for Broward County increases significantly for the level E scenario from 2010 to 2015 due to significant capacity issues on I-95 in Palm Beach County near the Okeechobee Boulevard interchange. While this capacity issue affects all scenarios, the 30,000 additional evacuating vehicles between the 2010 and 2015 level E scenario cause the queuing and spillback from Palm Beach County to more significantly impact the in-county and shelter evacuating vehicles in Broward County in 2015 than in 2010.

Out of county clearance times for the base scenarios range from 24 hours for the base evacuation level A scenario to 39.5 hours in Broward County for the evacuation level E scenario. Out of county clearance times range from 24.5 hours for the base evacuation level A scenario to 46 hours in Broward County in 2015.

Regional clearance time for the three county SFRPC region ranges from 26 hours to 39.5 hours in 2010 and from 26.5 to 46 hours in 2015.

Operational Scenarios

In-county clearance times for the 2010 operational scenarios range from 5.5 hours to 47 hours depending upon the scenario. Clearance Time to Shelter for the 2010 operational scenarios range from 4.5 hours to 23.5 hours depending upon the county and the scenario. In-county clearance times for Broward County remain close to the selected response curve for lower level evacuation scenarios, such as 9.5 hours for scenario 1, 12.5 hours for scenario 2, and 9.5 hours for scenario 3. These three scenarios use different response curves (9 hour curves for scenarios

Table ES-11 – 2010 Clearance Times for Base Scenario

	Evacuation Level A Base Scenario	Evacuation Level B Base Scenario	Evacuation Level C Base Scenario	Evacuation Level D Base Scenario	Evacuation Level E Base Scenario
Clearance Time to Shelter					
Monroe – Key West	3.0	2.5	N/A	N/A	N/A
Monroe – Lower Keys	N/A	N/A	N/A	N/A	N/A
Monroe – Middle Keys	N/A	N/A	N/A	N/A	N/A
Monroe – Upper Keys	N/A	N/A	N/A	N/A	N/A
Monroe – Total	3.0	2.5	N/A	N/A	N/A
Miami-Dade County	13.0	13.0	13.0	13.0	13.5
Broward County	12.5	12.5	13.0	19.0	30.0
In-County Clearance Time					
Monroe – Key West	12.5	12.5	15.5	15.5	15.5
Monroe – Lower Keys	17.5	18.5	22.5	22.5	22.5
Monroe – Middle Keys	22.0	23.0	27.5	27.5	27.5
Monroe – Upper Keys	24.0	26.0	31.0	31.0	31.0
Monroe – Total	24.0	26.0	31.0	31.0	31.0
Miami-Dade County	13.0	26.5	31.0	31.0	31.0
Broward County	12.5	12.5	13.5	20.0	31.0
Out of County Clearance Time					
Monroe – Key West	12.5	12.5	15.0	15.0	15.0
Monroe – Lower Keys	17.0	18.0	22.0	22.0	22.0
Monroe – Middle Keys	21.5	22.5	27.0	27.0	27.0
Monroe – Upper Keys	24.0	25.5	30.5	30.5	30.5
Monroe – Total	24.0	25.5	30.5	30.5	30.5
Miami-Dade County	25.5	27.0	31.5	31.5	32.0
Broward County	26.0	27.5	32.0	32.0	39.5
Regional Clearance Time					
South Florida Region	26.0	27.5	32.0	32.0	39.5

Note: In-county clearance times are generally not less than the response curve unless in county or to shelter population numbers are very low. The base scenarios use a 12 hour response curve.. Also, in county clearance times for Miami-Dade County are typically equal to or above Monroe County out of county clearance times for all level B or higher scenarios that include Monroe County evacuating. By definition, in county clearance time includes out of county trips from other counties that pass through evacuation zones in the evacuating county, including Miami-Dade's combined B/C evacuation zone located where US 1 enters from Monroe County.

Table ES-12 – 2015 Clearance Times for Base Scenario

	Evacuation Level A Base Scenario	Evacuation Level B Base Scenario	Evacuation Level C Base Scenario	Evacuation Level D Base Scenario	Evacuation Level E Base Scenario
Clearance Time to Shelter					
Monroe – Key West	4.0	3.0	N/A	N/A	N/A
Monroe – Lower Keys	N/A	N/A	N/A	N/A	N/A
Monroe – Middle Keys	N/A	N/A	N/A	N/A	N/A
Monroe – Upper Keys	N/A	N/A	N/A	N/A	N/A
Monroe – Total	4.0	3.0	N/A	N/A	N/A
Miami-Dade County	13.0	13.0	13.0	13.0	14.5
Broward County	12.5	12.5	13.0	21.0	45.0
In-County Clearance Time					
Monroe – Key West	12.5	12.5	16.5	16.5	16.5
Monroe – Lower Keys	17.5	18.5	24.0	24.0	24.0
Monroe – Middle Keys	22.5	23.5	29.0	29.0	29.0
Monroe – Upper Keys	25.0	27.0	32.5	32.5	32.5
Monroe – Total	25.0	27.0	32.5	32.5	32.5
Miami-Dade County	13.0	27.0	32.5	32.5	32.5
Broward County	12.5	12.5	13.0	21.0	45.0
Out of County Clearance Time					
Monroe – Key West	12.5	12.5	16.0	16.0	16.0
Monroe – Lower Keys	17.0	18.0	23.5	23.5	23.5
Monroe – Middle Keys	22.0	23.0	28.5	28.5	28.5
Monroe – Upper Keys	24.5	26.5	32.0	32.0	32.0
Monroe – Total	24.5	26.5	32.0	32.0	32.0
Miami-Dade County	26.0	27.5	33.0	33.0	35.0
Broward County	26.5	28.0	33.5	33.5	46.0
Regional Clearance Time					
South Florida Region	26.5	28.0	33.5	33.5	46.0

Note: In-county clearance times are generally not less than the response curve unless in county or to shelter population numbers are very low. The base scenarios use a 12 hour response curve.. Also, in county clearance times for Miami-Dade County are typically equal to or above Monroe County out of county clearance times for all level B or higher scenarios that include Monroe County evacuating. By definition, in county clearance time includes out of county trips from other counties that pass through evacuation zones in the evacuating county, including Miami-Dade's combined B/C evacuation zone located where US 1 enters from Monroe County.

Table ES-13 – 2010 Clearance Times for Operational Scenarios

	Scenario 1 Evacuation Level A	Scenario 2 Evacuation Level B	Scenario 3 Evacuation Level C	Scenario 4 Evacuation Level D	Scenario 5 Evacuation Level E
Clearance Time to Shelter					
Monroe – Key West	5.5	4.5	N/A	N/A	N/A
Monroe – Lower Keys	N/A	N/A	N/A	N/A	N/A
Monroe – Middle Keys	N/A	N/A	N/A	N/A	N/A
Monroe – Upper Keys	N/A	N/A	N/A	N/A	N/A
Monroe – Total	5.5	4.5	N/A	N/A	N/A
Miami-Dade County	9.5	13.0	10.0	13.0	23.5
Broward County	9.5	12.5	9.5	20.5	23.5
In-County Clearance Time					
Monroe – Key West	9.5	12.5	10.0	13.0	13.5
Monroe – Lower Keys	16.0	17.5	16.5	19.0	21.0
Monroe – Middle Keys	19.5	22.0	20.0	22.5	25.0
Monroe – Upper Keys	22.5	25.0	22.5	25.5	28.0
Monroe – Total	22.5	25.0	22.5	25.5	28.0
Miami-Dade County	9.5	36.5	33.5	36.5	47.0
Broward County	9.5	12.5	9.5	20.5	42.0
Out of County Clearance Time					
Monroe – Key West	9.5	12.5	9.5	12.5	13.0
Monroe – Lower Keys	15.5	17.0	16.0	18.5	20.5
Monroe – Middle Keys	19.5	21.5	19.5	22.0	24.5
Monroe – Upper Keys	22.5	24.5	22.0	25.0	27.5
Monroe – Total	22.5	24.5	22.0	25.0	27.5
Miami-Dade County	34.0	37.0	34.0	40.5	49.5
Broward County	34.5	36.5	45.5	65.0	46.5
Regional Clearance Time					
South Florida	35.5	38.0	46.5	66.5	49.5

Notes: For scenarios 1, 2, 3, 4, and 5, regional clearance time is larger than the highest out of county clearance time from any of the counties in the region due to the 24 hour phasing used as part of the scenario.

In-county clearance times are generally not less than the response curve unless in county or to shelter population numbers are very low. In-county clearance time for Broward County in scenarios 1, 2, and 3 illustrate this, as these scenarios used a 9 hour, 12 hour, and 9 hour response curve, respectively.

In county clearance times for Miami-Dade County are typically equal to or above Monroe County out of county clearance times for scenarios that include Monroe County evacuating. By definition, in county clearance time includes out of county trips from other counties that pass through evacuation zones in the evacuating county, including Miami-Dade's combined B/C evacuation zone located where US 1 enters from Monroe County.

Out of county clearance time for Broward County in Scenario 4 is significantly larger than the out of county clearance time for Broward County in Scenario 5 due to the phasing used on Scenario 5, where Collier and Monroe Counties evacuate 24 hours prior to the remaining counties.

Table ES-13 – 2010 Clearance Times for Operational Scenarios (continued)

	Scenario 6 Evacuation Level A	Scenario 7 Evacuation Level B	Scenario 8a Evacuation Level C	Scenario 8b Evacuation Level C	Scenario 9 Evacuation Level D	Scenario 10 Evacuation Level E
Clearance Time to Shelter						
Monroe – Key West	5.0	N/A	N/A	N/A	N/A	N/A
Monroe – Lower Keys	N/A	N/A	N/A	N/A	N/A	N/A
Monroe – Middle Keys	N/A	N/A	N/A	N/A	N/A	N/A
Monroe – Upper Keys	N/A	N/A	N/A	N/A	N/A	N/A
Monroe – Total	5.0	N/A	N/A	N/A	N/A	N/A
Miami-Dade County	9.5	N/A	N/A	N/A	10.0	N/A
Broward County	N/A	9.5	N/A	N/A	N/A	9.5
In-County Clearance Time						
Monroe – Key West	9.5	N/A	12.5	15.0	N/A	N/A
Monroe – Lower Keys	16.0	N/A	16.5	22.0	N/A	N/A
Monroe – Middle Keys	19.5	N/A	20.0	27.0	N/A	N/A
Monroe – Upper Keys	22.5	N/A	22.5	30.5	N/A	N/A
Monroe – Total	22.5	N/A	22.5	30.5	N/A	N/A
Miami-Dade County	9.5	N/A	N/A	N/A	10.0	N/A
Broward County	5.5	9.5	N/A	N/A	N/A	9.5
Out of County Clearance Time						
Monroe – Key West	9.5	N/A	12.5	15.0	N/A	N/A
Monroe – Lower Keys	15.5	N/A	16.5	22.0	N/A	N/A
Monroe – Middle Keys	19.5	N/A	20.0	27.0	N/A	N/A
Monroe – Upper Keys	22.5	N/A	22.5	30.5	N/A	N/A
Monroe – Total	22.5	N/A	22.5	30.5	N/A	N/A
Miami-Dade County	23.5	9.5	23.5	31.5	10.5	11.0
Broward County	24.0	10.0	22.5	30.5	13.0	24.0
Regional Clearance Time						
South Florida	24.0	10.0	23.5	31.5	13.0	24.0

Table ES-14 – 2015 Clearance Times for Operational Scenarios

	Scenario 11 Evacuation Level A	Scenario 12 Evacuation Level B	Scenario 13 Evacuation Level C	Scenario 14 Evacuation Level D	Scenario 15 Evacuation Level E
Clearance Time to Shelter					
Monroe – Key West	5.5	4.0	N/A	N/A	N/A
Monroe – Lower Keys	N/A	N/A	N/A	N/A	N/A
Monroe – Middle Keys	N/A	N/A	N/A	N/A	N/A
Monroe – Upper Keys	N/A	N/A	N/A	N/A	N/A
Monroe – Total	5.5	4.0	N/A	N/A	N/A
Miami-Dade County	10.0	13.0	13.0	10.0	13.0
Broward County	9.5	12.5	12.5	22.5	46.0
In-County Clearance Time					
Monroe – Key West	10.0	12.5	13.0	12.0	14.5
Monroe – Lower Keys	16.5	18.0	17.5	19.5	22.0
Monroe – Middle Keys	20.0	22.5	21.0	23.5	26.0
Monroe – Upper Keys	23.0	26.0	24.0	26.0	29.5
Monroe – Total	23.0	26.0	24.0	26.0	29.5
Miami-Dade County	10.0	26.0	36.5	26.5	29.5
Broward County	9.5	12.5	12.5	22.5	47.0
Out of County Clearance Time					
Monroe – Key West	10.0	12.5	12.5	11.5	14.0
Monroe – Lower Keys	16.0	17.5	17.0	19.0	21.5
Monroe – Middle Keys	20.0	22.0	20.5	23.0	25.5
Monroe – Upper Keys	23.0	25.5	23.5	25.5	29.0
Monroe – Total	23.0	25.5	23.5	25.5	29.0
Miami-Dade County	24.0	26.5	37.0	27.0	44.5
Broward County	24.5	27.0	43.0	46.5	47.0
Regional Clearance Time					
South Florida	24.5	27.0	44.5	46.5	47.0

Notes: For scenario 13, regional clearance time is larger than the highest out of county clearance time from any of the counties in the region due to the 24 hour phasing used as part of the scenario.

In-county clearance times are generally not less than the response curve unless in county or to shelter population numbers are very low. In-county clearance time for Broward County in scenarios 11, 12, and 13 illustrate this, as these scenarios used a 9 hour, 12 hour, and 12 hour response curve, respectively.

In county clearance times for Miami-Dade County are typically equal to or above Monroe County out of county clearance times for scenarios that include Monroe County evacuating. By definition, in county clearance time includes out of county trips from other counties that pass through evacuation zones in the evacuating county, including Miami-Dade's combined B/C evacuation zone located where US 1 enters from Monroe County.

Table ES-14 – 2015 Clearance Times for Operational Scenarios (continued)

	Scenario 16 Evacuation Level A	Scenario 17 Evacuation Level B	Scenario 18 Evacuation Level C	Scenario 19 Evacuation Level D	Scenario 20 Evacuation Level E
Clearance Time to Shelter					
Monroe – Key West	4.0	N/A	N/A	N/A	N/A
Monroe – Lower Keys	N/A	N/A	N/A	N/A	N/A
Monroe – Middle Keys	N/A	N/A	N/A	N/A	N/A
Monroe – Upper Keys	N/A	N/A	N/A	N/A	N/A
Monroe – Total	4.0	N/A	N/A	N/A	N/A
Miami-Dade County	13.0	10.0	N/A	N/A	13.0
Broward County	N/A	9.5	12.5	N/A	N/A
In-County Clearance Time					
Monroe – Key West	12.5	N/A	N/A	19.0	N/A
Monroe – Lower Keys	17.0	N/A	N/A	20.5	N/A
Monroe – Middle Keys	21.0	N/A	N/A	24.0	N/A
Monroe – Upper Keys	24.0	N/A	N/A	27.0	N/A
Monroe – Total	24.0	N/A	N/A	27.0	N/A
Miami-Dade County	13.0	10.5	N/A	N/A	13.5
Broward County	N/A	9.5	12.5	N/A	N/A
Out of County Clearance Time					
Monroe – Key West	12.5	8.5	N/A	18.5	N/A
Monroe – Lower Keys	16.5	9.5	N/A	20.0	N/A
Monroe – Middle Keys	20.5	9.5	N/A	23.5	N/A
Monroe – Upper Keys	23.5	10.0	N/A	26.5	N/A
Monroe – Total	23.5	10.0	N/A	26.5	N/A
Miami-Dade County	24.5	10.5	12.5	27.5	13.5
Broward County	25.0	25.5	13.0	26.5	17.0
Regional Clearance Time					
South Florida	25.0	25.5	13.0	27.5	17.0

1 and 3 and a 12 hour curve for scenario 2). Clearance times are generally not less than the response curve unless in county or to shelter population numbers are very low.

In 2015, in-county clearance times for the operational scenarios vary from 9.5 hours to 47 hours for the level E evacuation in Broward County. Clearance Time to Shelter shows a similar pattern, with clearance times for the base scenarios ranging from 5.5 hours to 46 hours depending upon the scenario. In county clearance times for Miami-Dade County are typically equal to or above Monroe County out of county clearance times for scenarios that include Monroe County evacuating. By definition, in county clearance time includes out of county trips from other counties that pass through evacuation zones in the evacuating county. Miami-Dade County has a combined B/C evacuation zone where US 1 enters from Monroe County, so in county clearance time for Miami-Dade in all level B or higher evacuations that also include a Monroe County evacuation will reflect the out of county clearance time for Monroe County.

Out of county clearance times for the 2010 operational scenarios range from 9.5 hours to 65 hours for Scenario 4. The out of county clearance time for Scenario 4 is significantly larger than the out of county clearance time for Scenario 5 even though the number of evacuating vehicles is less for Scenario 4. The lower time for Scenario 5 is due to the phasing used on the scenario, where Collier and Monroe Counties evacuate 24 hours prior to the remaining counties. When westbound evacuating traffic from Broward County arrives in Collier County, most of Collier County is clear of traffic and better able to accommodate evacuating traffic. In Scenario 4, only Monroe County evacuates 24 hours prior to the remaining counties, and Collier County does not evacuate and is operating under normal background traffic conditions. The background traffic in Collier County creates significant issues for westbound Broward County evacuating traffic and causes the out of county clearance time to increase nearly 20 hours. Out of county clearance times range from 10 to 47 in 2015 depending upon the scenario.

Regional clearance time for the three county SFRPC region ranges from 10 hours to 66.5 hours in 2010. This time ranges from 13 to 47 hours in 2015. It is important to note that for six of the operational scenarios (scenarios 1, 2, 3, 4, 5, and 13) regional clearance time is larger than the highest out of county clearance time from any of the counties in the region. This is due to the 24 hour phasing used as part of the scenario, where one or more counties evacuate 24 hours prior to the remaining counties. The regional clearance time begins calculating when the first county orders its evacuation, while the out of county clearance time does not begin for each county until the first evacuating vehicle enters the roadway network within the county.

J. Maximum Evacuating Population Clearances

From an emergency management standpoint, it is important to get an understanding of the maximum proportion of the evacuating population that can be expected to evacuate at various time intervals during an evacuation. Should storm conditions change during an evacuation, emergency managers will need to be able to estimate what portion of the evacuating population is estimated to still remain within the county trying to evacuate.

Using the base scenarios, which assume 100% of the vulnerable population is evacuating, along with shadow evacuations and evacuations from adjacent counties, an estimate was made of the evacuating population actually able to evacuate out of each county by the time intervals of 12, 18, 24, and 36 hours. The estimated maximum evacuating population by time interval for 2010 is identified in **Table ES-15** and for 2015 in **Table ES-16**.

It is important to note that these estimates take into account many variables, including roadway capacity, in-county evacuating trips, out of county evacuating trips, evacuating trips from other counties, and background traffic that is impeding the evacuation trips. For this reason, the maximum evacuation population by time interval will vary slightly between evacuation level and either increase or decrease from one evacuation level to the next.

K. Sensitivity Analysis

As discussed previously, there are literally thousands of possible combinations of variables that can be applied using the evacuation transportation model, which will result in thousands of possible outcomes. As part of the analysis process, a sensitivity analysis was conducted using the prototype model to evaluate the effect of different response curves on the calculated evacuation clearance times. Calculated clearance times will never be lower than the designated response time, since some evacuating residents will wait to evacuate until near the end of the response time window. For example, using a 12-hour response curve in the analysis means that all residents will begin their evacuation process within 12-hours, and some residents will choose to wait and begin evacuating more than 11.5 hours from when the evacuation was ordered. This will generate a clearance time of more than 12 hours.

The sensitivity analysis identified that clearance times will vary by scenario and by any of the numerous parameters that can be chosen in a particular scenario model run (demographics, student population, tourist population, different counties that are evacuating, response curve, phasing, shadow evacuations, etc.). A few general rules of thumb did emerge from the sensitivity analysis that can provide some guidance to the region regarding the sensitivity of the response curve to the calculated clearance times:

- For low evacuation levels A and B, clearance time will vary by as much as 40 percent depending on the response curve. Low evacuation levels A and B have fewer evacuating vehicles that can be accommodated more easily on the transportation network. In most cases, clearance times typically exceed the response curve by one to two hours. Thus, a 12 hour response curve may yield a clearance time of 13 or 14 hours while an 18 hour response curve may yield a clearance time of 19 or 20 hours. This leads to a higher level of variability than larger evacuations;

Table ES-15 – Maximum Evacuating Population by Time Interval for 2010

	Evacuation Level A	Evacuation Level B	Evacuation Level C	Evacuation Level D	Evacuation Level E
Estimated Evacuating Population Clearing Monroe County					
12-Hour	36,195	36,205	28,669	28,669	28,669
18-Hour	54,293	54,308	43,004	43,004	43,004
24-Hour	72,390	72,410	57,339	57,339	57,339
36-Hour		76,936	72,868	72,868	72,868
Estimated Evacuating Population Clearing Miami-Dade County					
12-Hour	167,101	211,655	189,704	269,389	339,584
18-Hour	250,652	317,482	284,556	404,083	509,376
24-Hour	334,202	423,309	379,408	538,777	679,168
36-Hour	355,090	476,223	497,973	707,145	905,557
Estimated Evacuating Population Clearing Broward County					
12-Hour	95,505	93,395	112,491	167,530	193,987
18-Hour	143,258	140,093	168,736	251,295	290,981
24-Hour	191,010	186,791	224,981	335,060	387,975
36-Hour	206,928	214,031	299,975	446,746	581,962

Note: These estimates take into account many variables, including roadway capacity, in-county evacuating trips, out of county evacuating trips, evacuating trips from other counties, and background traffic that is impeding the evacuation trips. For this reason, the maximum evacuation population by time interval will vary between evacuation level and either increase or decrease from one evacuation level to the next. See section E for the source of the small area data.

Table ES-16 – Maximum Evacuating Population by Time Interval for 2015

	Evacuation Level A	Evacuation Level B	Evacuation Level C	Evacuation Level D	Evacuation Level E
Estimated Evacuating Population Clearing Monroe County					
12-Hour	36,219	35,669	28,928	28,928	28,928
18-Hour	54,328	53,504	43,392	43,392	43,392
24-Hour	72,438	71,339	57,857	57,857	57,857
36-Hour	73,947	78,770	77,142	77,142	77,142
Estimated Evacuating Population Clearing Miami-Dade County					
12-Hour	171,435	221,719	193,709	276,311	331,131
18-Hour	257,153	332,578	290,564	414,466	496,696
24-Hour	342,870	443,438	387,418	552,621	662,261
36-Hour	371,443	508,106	532,700	759,854	965,798
Estimated Evacuating Population Clearing Broward County					
12-Hour	98,905	96,858	113,571	169,358	176,183
18-Hour	148,358	145,286	170,357	254,037	264,275
24-Hour	197,811	193,715	227,142	338,717	352,367
36-Hour	218,416	226,001	317,053	472,792	528,550

Note: These estimates take into account many variables, including roadway capacity, in-county evacuating trips, out of county evacuating trips, evacuating trips from other counties, and background traffic that is impeding the evacuation trips. For this reason, the maximum evacuation population by time interval will vary between evacuation level and either increase or decrease from one evacuation level to the next. See section E for the source of the small area data.

- For mid-level evacuations such as C and sometimes D, clearance time varied by as much as 25 percent during the sensitivity analysis. The number of evacuating vehicles is considerably higher than for levels A and B, and lower response curves tend to load the transportation network faster than longer response curves. The variability in clearance times is less in these cases than for low evacuation levels; and,

- For high-level evacuations such as some level D evacuations and all E evacuations, clearance time variability is reduced to about 10 to 15 percent. Large evacuations involve large numbers of evacuating vehicles, and the sensitivity test identified that clearance times are not as dependent on the response curve as lower level evacuations since it takes a significant amount of time to evacuate a large number of vehicles.

The counties within the South Florida Region are encouraged to test additional scenarios beyond what has been provided in this study. Each model run will provide additional information for the region to use in determining when to order an evacuation. Due to advancements in computer technology and the nature of the developed transportation evacuation methodology, this study includes a more detailed and time consuming analysis process than used in previous years studies. Counties interested in testing various response curves for each scenario can easily do so using the TIME interface to calculate clearance times for different response curves.

L. Summary and Conclusions

Through a review of the results of the 31 different scenarios (10 base and 21 operational), several conclusions could be reached regarding the transportation analysis, including the following:

- Critical transportation facilities within the SFRPC region include US 1, I-95, I-75, I-595, I-395, and the Turnpike. For large storm events, such as level D and E evacuations, other State facilities also play an important role in evacuations, such as US 41 in Miami-Dade County and US 27 in Broward County;

- During the level A and B evacuation scenarios, the roadway segments with the highest vehicle queues are primarily concentrated along the major Interstate and State Highway system. During these levels of evacuation, State and County officials should coordinate personnel resources to provide sufficient traffic control at interchanges and major intersections along these routes;

- In contrast, for the higher level C, D, and E evacuation scenarios, many other roadway facilities, both within and outside of the region, will require personnel resources for sufficient traffic control at interchanges and major intersections;

- The SFRPC counties, in coordination with the State, should continue public information campaigns to clearly define those that are vulnerable and should evacuate verses those who choose to evacuate on their own. During large storm events in the operational scenarios, evacuations by the vulnerable population in the three SFRPC Counties are impacted by shadow evacuations occurring in other parts of the counties and in areas outside the SFPRC region;

- The Florida Department of Transportation should continue to work with local counties on

implementing intelligent transportation system (ITS) technology, which will provide enhanced monitoring and notification systems to provide evacuating traffic with up to date information regarding expected travel times and alternate routes;

- The State can use the data and information provided in this report (specifically the evacuating vehicle maps in Volume 5-11) to estimate fuel and supply requirements along major evacuation routes to aid motorists during the evacuation process;

- For major evacuation routes that have signalized traffic control at major intersections, traffic signal timing patterns should be adjusted during the evacuation process to provide maximum green time for evacuating vehicles in the predominate north and west directions; and,

- The counties within the South Florida Region are encouraged to test additional transportation scenarios beyond what has been provided in this study. Each model run will provide additional information for the region to use in planning for an evacuation. Counties interested in testing various response curves for each scenario can easily do so using the TIME interface to calculate clearance times for different evacuation conditions, such as different evacuation levels, different behavioral response assumptions, and different response curves.

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CHAPTER I
INTRODUCTION

The evacuation transportation analysis discussed in this volume documents the methodology, analysis, and results of the transportation component of the Statewide Regional Evacuation Study Program (SRESP). Among the many analyses required for the SRESP study, transportation analysis is probably one of the most important components in the process. By bringing together storm intensity, transportation network, shelters, and evacuation population, transportation analysis explicitly links people's behavioral responses to the regional evacuation infrastructure and helps formulate effective and responsive evacuation policy options. Due to the complex calculations involved and numerous evacuation scenarios that need to be evaluated, the best way to conduct the transportation analysis is through the use of computerized transportation simulation programs, or transportation models.

A. Background and Purpose

Over the years, different planning agencies have used different modeling approaches with varying degrees of complexity and mixed success. Some have used full-blown conventional transportation models such as the standard Florida model FSUTMS; others have used a combination of a simplified conventional model and a spreadsheet program, such as the Abbreviated Transportation Model (ATM). These models have different data requirements, use different behavioral assumptions, employ different traffic assignment algorithms, and produce traffic analysis results with different levels of detail and accuracy. These differences make it difficult for planning agencies to share information and data with each other. They also may produce undesirable conditions for staff training and knowledge sharing.

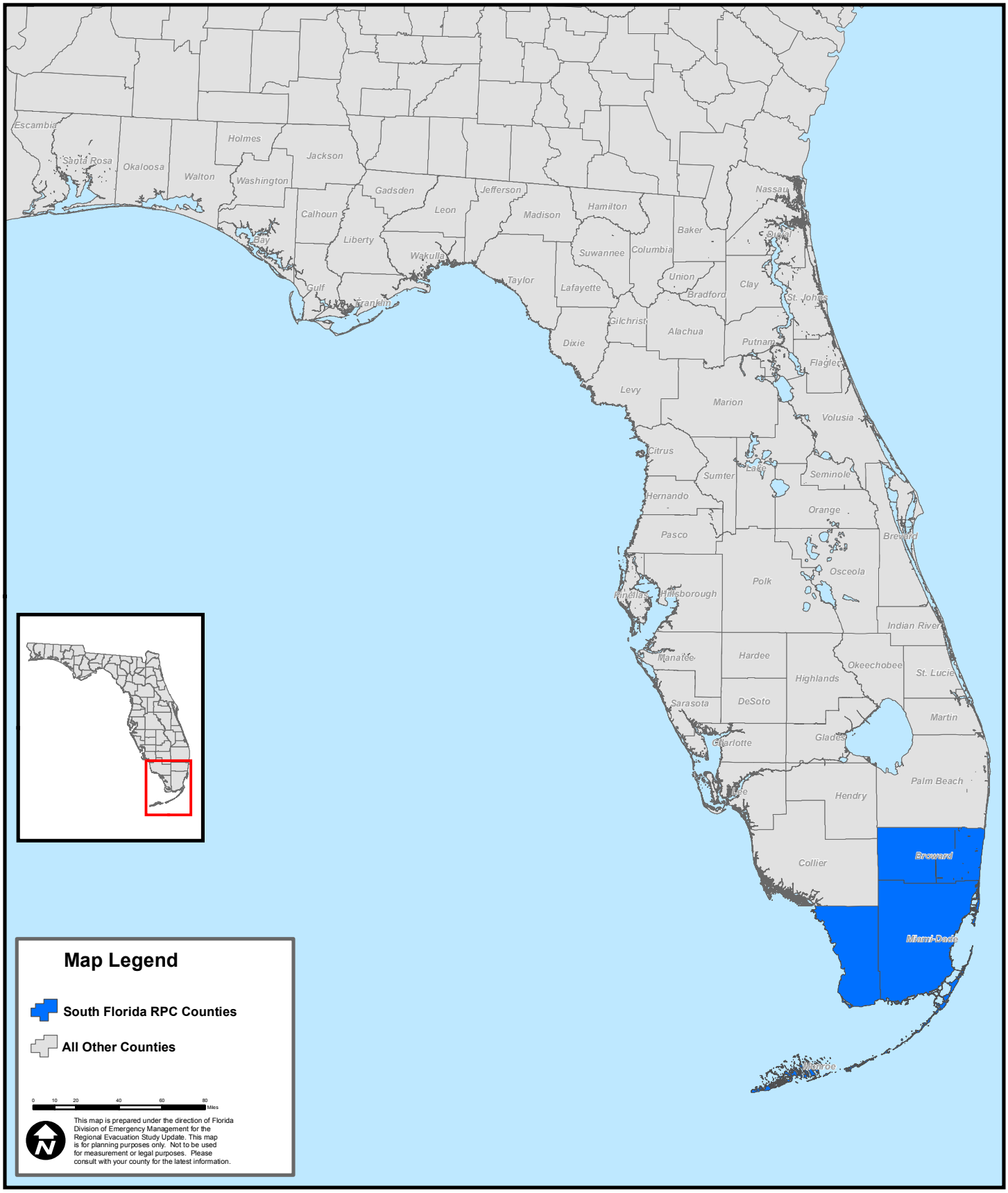
One of the objectives of the SRESP is to create consistent and integrated regional evacuation data and mapping, and by doing so, to facilitate knowledge sharing between state, regional, county, and local partners. To achieve this objective, it is important for all Regional Planning Councils to adopt the same data format and to use the same modeling methodologies for their transportation analyses. The primary purpose of the transportation component of the SRESP is to develop a unified evacuation transportation modeling framework that can be implemented with the data collected by the Regional Planning Councils.

B. Study Area

The study area for this analysis includes the three county South Florida Regional Planning Council area, as illustrated in **Figure I-1**. The transportation modeling methodology includes some processes that are performed at the statewide level, in order to determine the impacts of evacuations from other regions impacting the evacuation clearance times in the South Florida region. While the impact of other regions is included in the South Florida analysis, it is important to note that the results of the transportation analysis presented in this document are only reported for the three counties included in the South Florida RPC. Transportation analysis results for other regions and counties are reported in the corresponding Volume 4 report for those regions.

Figure I-1

South Florida Regional Planning Council



Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: July, 2010

C. Input and Coordination

The development of the transportation methodology and framework required coordination and input from all eleven regional planning councils in Florida, along with the Division of Emergency Management, Department of Transportation, Department of Community Affairs, and local county emergency management teams. At the statewide level, the transportation consultant, Wilbur Smith Associates, participated in SRESP Work Group Meetings which were typically held on a monthly basis to discuss the development of the transportation methodology and receive feedback and input from the State agencies and RPCs.

At the local and regional level, Wilbur Smith Associates conducted a series of four regional meetings to coordinate with and receive input from local county emergency management, the regional planning council, local transportation planning agencies and groups, as well as other interested agencies. The four meetings held in the South Florida region included the following:

Regional Meeting No. 1 – Model Development Meeting
The first regional meeting for the South Florida region was held on October 29, 2008 at 1:00 PM. The purpose of the model development meeting was to introduce the transportation model development process. Feedback received through this process was used and incorporated into the development of the evacuation transportation methodology and framework.

Regional Meeting No. 2 – Model Implementation Meeting
The second regional meeting for the South Florida region was held on April 1, 2009 at 10:00 AM. The purpose of the model implementation meeting was to discuss the evacuation modeling methodology, present the evacuation networks and small area data summaries, and obtain input from local county emergency management staff regarding county level traffic management plans, model input assumptions, and the geographic extents of the regional model. Feedback received through this process was used and incorporated into the development of the South Florida regional model.

Regional Meeting No. 3 – Scenario Development Meeting
The third regional meeting for the South Florida region was held on October 15, 2009 at 10:00 AM. The purpose of the scenario development meetings was to discuss the final evacuation methodology and framework, review the South Florida regional model network, discuss the base scenarios for the region for growth management purposes, and discuss and receive input on the operational scenarios to be evaluated for emergency management purposes.

Regional Meeting No. 4 – Transportation Analysis Meeting
The fourth and final regional meeting for the South Florida region was held on November 23, 2010 at 10:00 AM. The purpose of the transportation analysis meeting was to review the draft results of the transportation analysis and receive feedback on the draft final report.

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CHAPTER II
EVACUATION MODELING METHODOLOGY AND FRAMEWORK

The evacuation modeling methodology and framework was developed during 2008 and 2009 in coordination with all eleven Regional Planning Councils and the Division of Emergency Management. The methodology used in the South Florida RPC Evacuation Transportation Analysis is identical to the methodology used for all eleven Regional Planning Councils and is summarized in the following sections[1].

A. Behavioral Assumptions

In 2008, the Statewide Regional Evacuation Study Program (SRESP) commissioned a survey of Florida residents. The purpose of this survey was to develop an understanding of the behavior of individuals when faced with the prospect of an impending evacuation. These data were used to develop a set of "planning assumptions" that describe the way people respond to an order to evacuate and are an important input to the SRESP Evacuation Model. The behavioral data provides insights into how people respond to the changing conditions leading up to and during an evacuation.

The primary application of the survey data was to help anticipate how people would respond with respect to five behaviors:

- How many people would evacuate?
- When they would leave?
- What type of refuge they would seek?
- Where they would travel for refuge?
- How many vehicles would they use?

These evacuation behaviors are distinguished based on several descriptive variables as listed below:

- Type of dwelling unit (site-built home versus mobile home);
- The evacuation zone in which the evacuee reside; and,
- The intensity of the evacuation that has been ordered.

How many people?

The evacuation rate indicates the percent of residents who will leave their homes to go some place safer in each storm threat scenario. The evacuation rates are based on the following assumptions: that the storm track passes very close to the area being evacuated; and officials order evacuation for surge evacuation zones corresponding to storm category. Under the 100 percent response scenario, this rate will default to 100 percent.

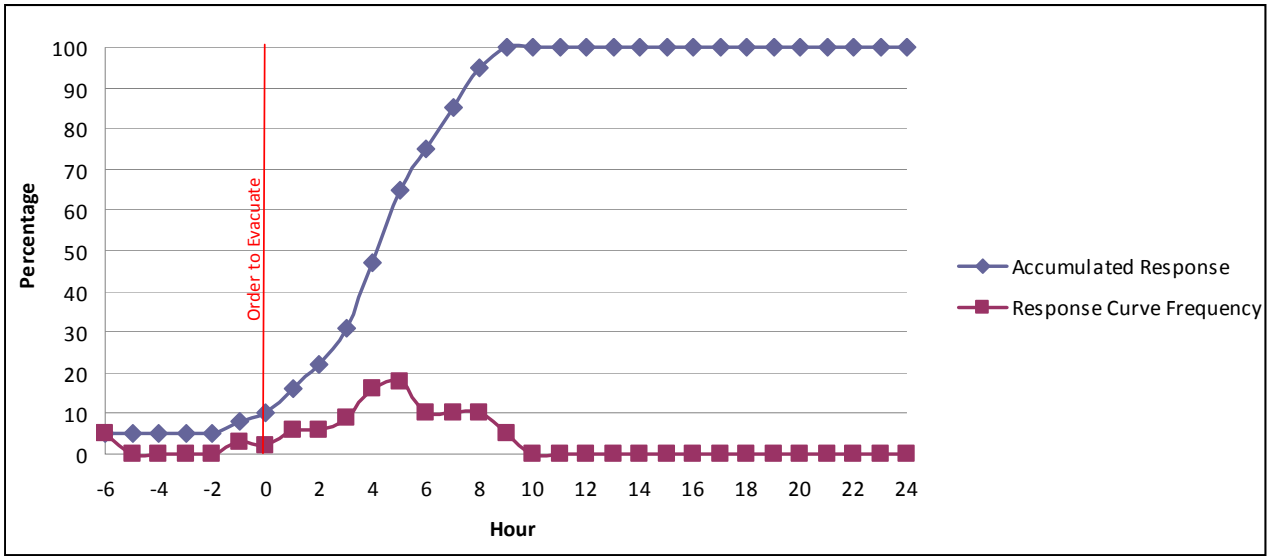
[1] Modifications to model flow rates (lane capacities) in Monroe County were made to the South Florida RPC model in accordance with the "maximum sustainable traffic flow rates per functional evacuation lane" identified in correspondence from the Florida Department of Transportation, District 6, to the Florida Department of Community Affairs. These flow rates are different than model flow rates used throughout the rest of Florida to accommodate the unique roadway characteristics of Monroe County.

When will they leave?

Consistent with behavior observed in past evacuations, evacuees do not begin their journey toward safety all at the same time. Rather, evacuees each begin their trips at different times based on their unique characteristics and constraints. Some individuals will prefer to evacuate soon after an order is given. Others may need to spend time securing personal property or seeing to the welfare of their relatives before they feel comfortable evacuating. Yet others will underestimate the threat posed to them by an oncoming storm and may not evacuate until very late. A set of evacuation response curves show the proportion of evacuation by increment of time for evacuation orders that were issued.

Each curve represents a different assumption on the amount of time it will take for an evacuating population to fully mobilize. The curves reflect the sense of urgency with which the population perceives the impending evacuation. Faster curves represent more urgent circumstances and slower curves represent less urgent circumstances. These curves are used by the model to divide the total number of evacuating trips into segments representing each hour that evacuating trips begin their journey. For example, a nine hour curve will place a certain number of evacuating trips in the first segment. These trips will represent those evacuees leaving in the first hour of an evacuation. The curve will then place another number of trips in the second segment representing the number of people leaving in the second hour of an evacuation. This process continues until all evacuees have begun their journey, which in a nine hour curve occurs during the ninth segment. All of the curves developed for the SRESP assume that some portion of the evacuating population leave before an order to evacuate is given. Typically, this is ten percent of the evacuating population. The nine hour response curve used in the model is depicted in **Figure II-1**. Response curves are available in the model to evaluate six, nine, twelve, eighteen, twenty-four, and thirty-six hour responses.

Figure II-1 – Nine Hour Response Curve



What type of refuge would be sought?
The survey data identified four types of refuge sought by evacuees. Specific rates were developed that identified the number of evacuees seeking shelter at each of these following different types of refuge:

- Friends and family;
- Hotel or motel;
- Public shelter; and,
- Other types of refuge not covered elsewhere in the list including, but not limited to, office space, churches, civic organization halls, and club houses.

Where will they travel?
The behavior survey distinguishes between trips that leave the county where an evacuation journey begins and trips that stay within the county. The out-of-county trip rate indicates the percent of evacuees who will seek refuge outside their county of residence. The in-county trip rate will determine how many of the evacuating trips are destined to remain within the county.

How many vehicles are used?
The vehicle use rate indicates the percentage of vehicles available to the evacuating household(s) that will be used in evacuation in each storm threat scenario. This rate ultimately determines the number of vehicles on the highways during an evacuation.

B. Zone System and Highway Network

The SRESP evacuation model relies upon data that covers the entire State of Florida as well as areas covering the States of Georgia, Alabama, Mississippi, South Carolina, North Carolina, and Tennessee. While the primary focus of the model is with evacuation behavior within Florida, areas outside of the state had to be considered in order to allow a more precise routing of evacuation traffic. This allows the model to measure the flow of traffic across the state line if needed.

Zone System
The data included in this system contain the demographic information crucial to modeling evacuation traffic. The demographic information is labeled as “small area data”. These data provide population and dwelling unit information that will identify where the individuals in the region reside. The planning assumptions developed from the behavioral analysis conducted for this study were applied to these demographic data. The result is a set of evacuation trips generated by the evacuation model. The number of these trips will vary depending on the hazard conditions that prompt the evacuation.

The RPC developed their small area data by consulting either MPO or FDOT model Traffic Analysis Zone (TAZ) data or Census 2000 geography. In some cases, demographic data were developed at the parcel level. Data were developed for the following years: 2006, 2010, and 2015.

Traffic Evacuation Zones (TEZ)
Small area data geographies were aggregated into larger units known as Traffic Evacuation Zones (TEZ). These TEZ form the basic unit of analysis in the evacuation model similar to how traffic analysis zones form the basic unit of analysis in a standard travel demand model. The TEZ system was developed so that the small area geographies will nest completely within one

TEZ or another. This eliminates any potential for split data and will ensure that data in the TEZ system can always be updated with relative ease.

The final TEZ system for the State of Florida has 17,328 zones. This number provides sufficient detail to accurately accommodate the assignment of evacuation trips onto an evacuation network. Furthermore, additional roadway segments have been included in the model's highway network to facilitate the movement of evacuation trips onto and off of the evacuation network. Each TEZ has a unique identification number that will be used by the model to connect evacuation trip generation to the evacuation highway network.

Highway Network

A highway network is used to represent the roads that evacuees travel along as they journey toward safety. Various datasets were used to develop the highway network database as follows:

- Florida Statewide Model Network – The 2005 base year statewide model was used as a basis for developing the evacuation model. The statewide model was obtained from the Florida Department of Transportation (FDOT) Systems Planning Office;

- Evacuation Routes – Evacuation routes in each Regional Planning Council (RPC) area were obtained from the RPCs themselves. The RPCs relied on their constituent counties to provide them with information on which roads were to be included as evacuation routes;

- Florida Highway Data Software (FHD) – The 2006 Florida Highway Data software was obtained from FDOT. This software was used to view and query data extracted from the Roadway Characteristics Inventory (RCI) which includes number of lanes, facility types, speed limits, etc.;

- FDOT Quality/Level of Service Handbook – The 2002 FDOT Quality/Level of Service Handbook (QLOS) and the 2007 LOS Issue Papers (2002 FDOT QLOS addendum) were obtained from the FDOT Systems Planning Office website. The QLOS handbook and the LOS tables were used to establish roadway capacities for evacuation purposes; and,

- Microsoft and Google aerials and maps – These aerial maps were used to identify and clarify roadway alignments. Whenever questions concerning the existence of particular facilities, their characteristics, or their alignments arose, aerials were referenced.

Changes to the Florida Statewide Model Network

Some modifications to the Florida Statewide Model network were necessary in order to make the data usable for evacuation modeling purposes:

- The original database, which was coded for a 2005 base year, was updated to 2006 conditions to correspond to the SRESP base year;
- Additional facilities had to be added to the network to accommodate evacuation traffic behavior;
- Many attributes from the original data set were removed and new ones were added specifically tailored for trip activity for evacuation modeling purposes;
- Based on RPC input, any missing facilities instrumental for evacuations were coded into

the highway network database;
- The highway network database was extensively reviewed for the correct coding of one-way links;
- The 2006 FHD software was used to verify the highway network database number of lanes for the state roads, US highways, and major county roads. For other roads Microsoft and Google aerial maps were used;
- The area type and facility type attributes for each roadway segment were verified for their consistency with existing conditions;
- The network attributes were modified to the specific needs of evacuation modeling and reporting purposes. The evacuation routes designated by the RPC were flagged for reporting purposes. The County name attribute and the RPC number attributes were checked and modified accordingly;
- Due to the unique characteristics of the Florida Keys, additional modifications were made to US 1 and the roadway network in Monroe County. Roadway capacities were modified to conform to FDOT District 6 recommendations for roadway capacity.
- The 2010 and 2015 roadway networks were created using the 2006 network and adding capacity improvement projects that were completed by 2010 (for the 2010 network) and planned to be completed by 2015 (for the 2015 network). Planned projects for the 2015 network were obtained from the FDOT five year work program as of April 2010 and are discussed in more detail in Chapter III.

Capacities

Network capacities for the evacuation model are based on facility type and area type. The network facility type classification and the area type classification were retained from the existing Florida Statewide Model highway network database.

FDOT's 2002 Quality/Level of Service (QLOS) generalized level of service volume tables were used for estimating the link capacity for each combination of functional class and area type. The generalized level of service volume tables were generated from conceptual planning software which is based on the 2000 edition of the Highway Capacity Manual (HCM). Using statewide default values for each of these roadway characteristics, the generalized LOS volume tables were developed from the conceptual planning software.

The peak hour volume represents the most critical period for traffic operations and has the highest capacity requirements. Many urban routes are filled to capacity during each peak hour, and variation is therefore severely constrained. The peak hour directional volumes at LOS E, closely represent the maximum volume (capacity) that can be accommodated through a given roadway. In some cases the Peak Hour Two-Way LOS tables do not show the maximum services volumes at the LOS E. For example, the four-lane Class I arterial service volumes are only shown from LOS A to LOS D, This indicates that the maximum volume thresholds (capacity) are reached at LOS D and these volumes represent the capacity of the roadway.

A lookup table was created with facility type, area type, number of lanes, and capacities by comparing model network characteristics to the roadway characteristics in the QLOS manual. The lookup table is shown in **the Transportation Supplemental Data Report**. The capacity attribute in the network was automatically assigned for any given link with a specific facility type, area type and number of lanes during the network preparation process.

Speeds
The existing highway network database link speeds were verified for their reasonableness and their suitability for evacuation modeling purpose. The speed values of the existing statewide model database were reasonable and therefore retained in for evacuation modeling.

Roadway Attributes
The roadway attributes contain the highway characteristics for each link in the highway network. Some of the attributes like DISTANCE, FTYPE, ATYPE, etc., were retained from the highway network database and other attributes like DENSITY and EVAC_RTE are specific to the evacuation modeling and were included in the network.

Reverse Lane Operations
Additional changes were also made in order to accommodate reverse lane operations in an evacuation scenario. Most of the facilities that would be subject to a reverse lane operations scenario were coded as a pair of one-way links. Additional attributes were added to the network in order to allow for the correct calculation of capacity in the reverse lane direction. The configurations of reverse lane facilities reflect the reverse lane operations plans established by the State.

C. Background Traffic

The traffic that consumes the roadway capacity of a transportation system during an evacuation can be divided into two groups. The first group is the evacuation traffic itself. Once the evacuation demand is determined, this information is converted into a number of vehicles evacuating over time. These evacuation trips are then placed on a representation of the highway network by a model. The model determines the speed at which these trips can move and proceeds to move the evacuation trips accordingly. The result is a set of clearance times.

The second group of traffic is known as background traffic. Background traffic, as its name implies, is not the primary focus of an evacuation transportation analysis and is accounted for primarily to impede the movement of evacuation trips through the network. These trips represent individuals going about their daily business mostly unconcerned with the evacuation event. For the most part, background traffic represents trips that are relatively insensitive to an order to evacuate and are thus said to be occurring in the “background.” Even though background traffic is relatively insensitive to evacuation orders, it is important to account for background traffic since it can have a dramatic impact on available roadway capacity. This in turn can severely affect evacuation clearance times.

Methodology used to Account for Background Traffic
There are two dynamics at work when evacuation traffic and background traffic interact with one another. The first is the effect of background traffic displacing evacuation traffic as background traffic attempts to use the same roads as the evacuation traffic. The second is the effect of evacuation traffic displacing background traffic. As vehicles move along the network and try to get onto certain roads they leave less room for other vehicles to use those same roads. As background traffic builds up there is less room for evacuation traffic to move, and vice versa. While the effect that evacuation traffic has on background traffic may be of some interest to those who are concerned with disruptions in daily trip making behavior during an evacuation event, for the purposes of this study we are much more interested in the effect that background traffic has on evacuation clearance times.

The effect that background traffic has on evacuation traffic can be stated in terms of available capacity. The more background traffic there is on a segment of road, the less capacity is available for evacuation traffic to use. Following this logic, it becomes apparent that by causing the available capacity to fluctuate throughout the evacuation event, one is able to sufficiently account for the impact of background traffic. FDOT's Florida Traffic Information DVD was used to develop average peaking characteristics for various functional classes of roadways throughout the state. These characteristics were analyzed to determine how much capacity is available throughout a given day during an evacuation.

Two sets of curves were developed, one for coastal evacuating counties that represent lower background traffic and one for all other counties representing greater background traffic. The model then adjusts capacities up and down consistent with these curves as it simulates the evacuation.

Figure II-2 illustrates the set of curves showing the percentage of available capacity throughout a 24 hour period for a coastal evacuating county after the model accounts for background traffic. **Figure II-3** illustrates the set of curves showing the percentage of available capacity throughout a 24 hour period for all other counties after the model accounts for background traffic.

Figure II-2 – Percent of Available Capacity for Coastal Counties

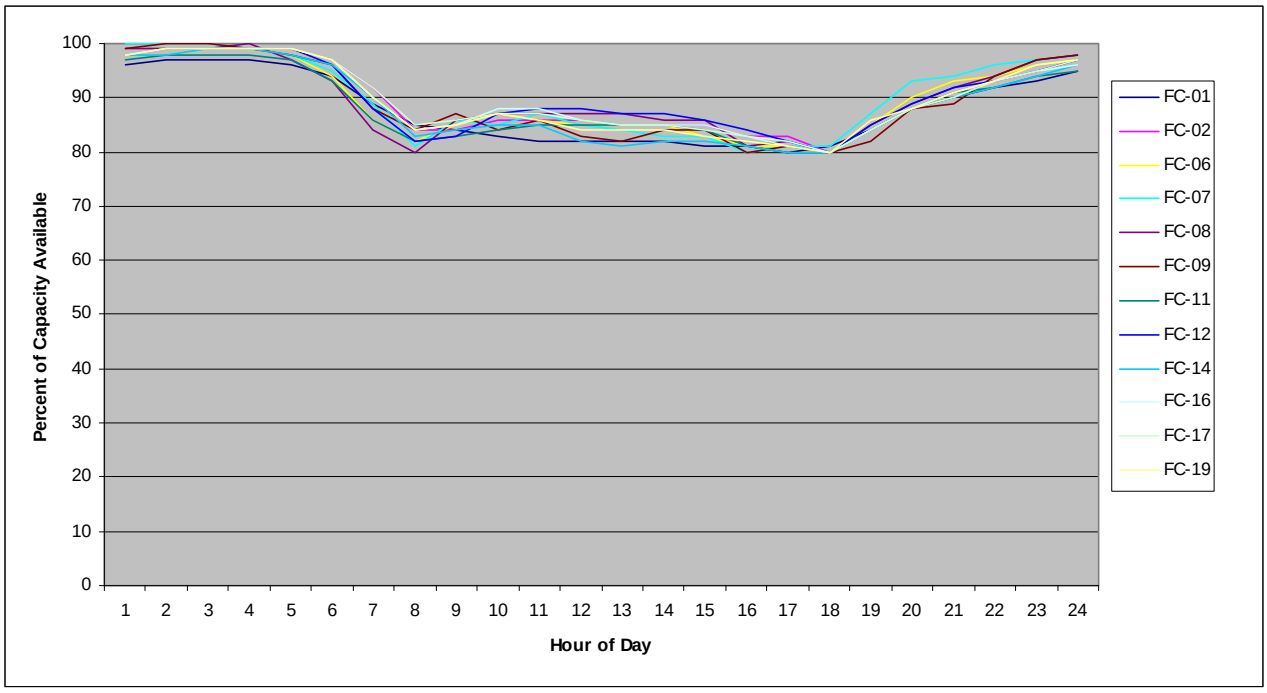
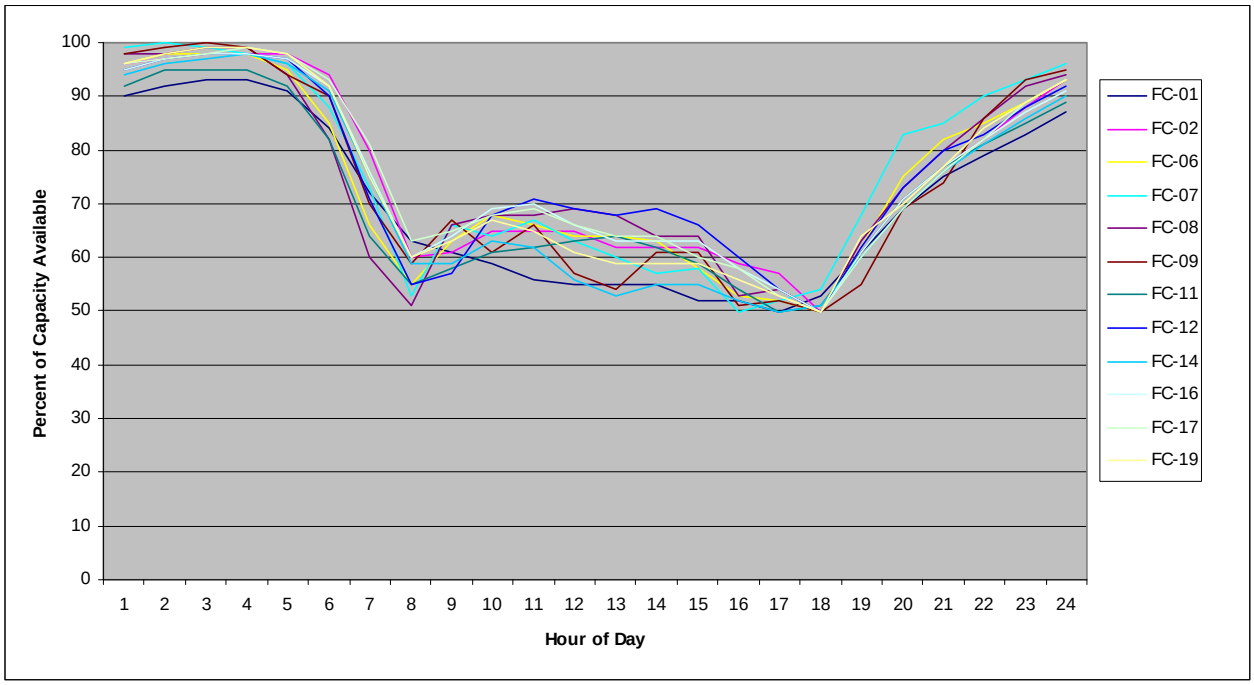


Figure II-3 – Percent of Available Capacity for Other Counties

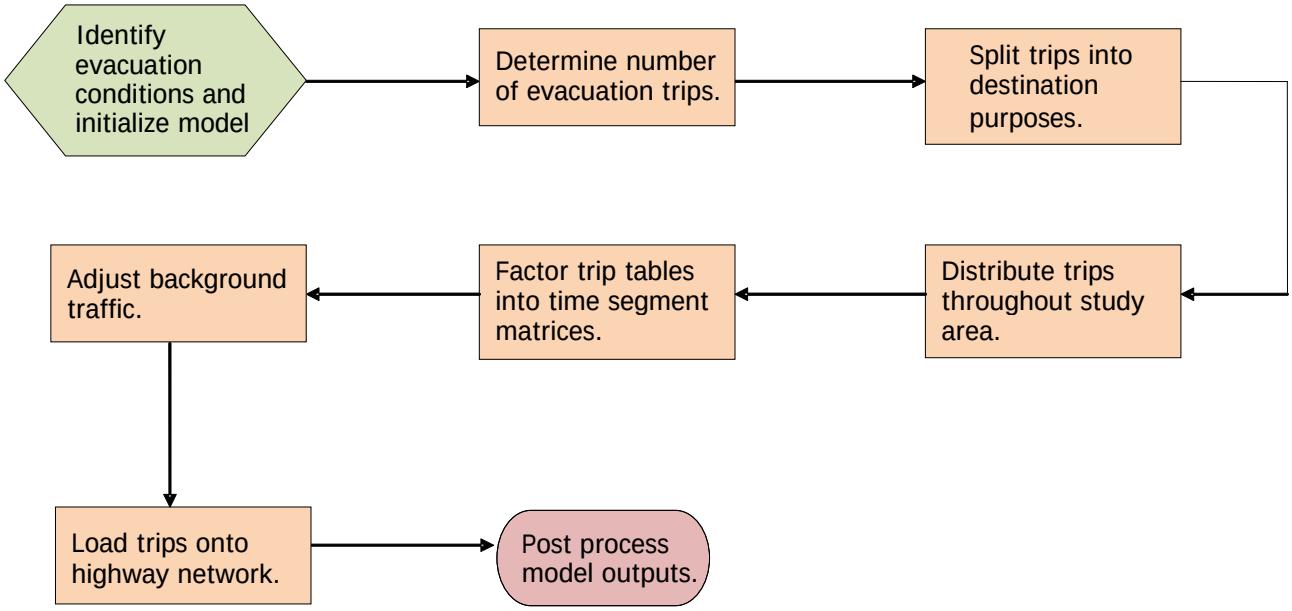


D. Evacuation Traffic

The model flow for the evacuation model is divided into a total of eight modeling steps. The following eight steps are represented graphically in the flowchart in **Figure II-4**:

1. Identify evacuation conditions and initialize model;
2. Determine number of evacuation trips;
3. Split trips into destination purposes;
4. Distribute trips throughout study area;
5. Factor trip tables into time segment matrices;
6. Adjust background traffic;
7. Load trips onto highway network; and,
8. Post process model outputs.

Figure II-4 - General Model Flow



Initializing the Model

At the beginning of the model flow, the model will need to determine the hazard conditions representing the particular scenario that will be analyzed. This will allow the model to accurately identify the areas that will be subject to evacuation and to determine the intensity of the evacuation event. This process will then establish the appropriate rates that will be used to determine the number of evacuation trips that will be generated.

Number of Evacuating Trips

After the model has finished initializing it will begin to calculate the number of evacuation trips that are generated. Estimating an appropriate number of trips is essential to ensuring that the behavior expressed on the highway network during trip assignment is reflective of likely conditions during a real world evacuation event.

The planning assumptions developed by the behavioral analysis were translated into a master rates file that can be referenced by the model in order to determine the number of evacuation trips that a particular scenario can be expected to generate.

Production Ends

Every trip has two ends. One end represents where a trip begins its journey and is typically referred to as the production end. The other end represents where a trip finishes its journey and is typically referred to as the attraction end. The calculation of the production end of each evacuation trip in the model is driven by the master rates file mentioned above.

Attraction Ends

The other end of an evacuation trip, the attraction end, is calculated using a much more simplified methodology. Public shelters have clearly defined capacities. For hotels and motels, each room will be designated as an attraction. Trips destined to shelter with friends and family

or in other unspecified destinations will have an attraction generated at each non-evacuating household in the model. This will ensure that these trips are evenly distributed around the area with some clumping occurring in highly residential areas.

Splitting Trips into Destination Purposes

Once the number of evacuation trips has been determined it will be necessary to divide the trips into various trip purposes. These purposes are based on the type of destination that an evacuee is headed to and the relative location of that destination. There are four types of destinations and two relative locations for a total of eight trip purposes, as identified below:

- Friends & Family – In County;
- Public Shelter – In County;
- Hotel/Motel – In County;
- Other – In County;
- Friends & Family – Out of County;
- Public Shelter – Out of County;
- Hotel/Motel – Out of County; and,
- Other – Out of County.

The same behavioral analysis that establishes the evacuation and vehicle use rates used to determine the number of evacuation trips that are being generated by the model is also a source of data for determining the various destinations where these evacuation trips are heading.

Trip End Balancing

Once the model has finished splitting the trip ends into their respective purposes, it will commence the process of balancing trip ends. The balancing of trip ends is critical so that the trip distribution process which is to follow this step will be able to tie every trip production to every trip attraction. A surplus or deficit of one trip end or the other may cause complications in the evacuation model that can lead to overestimating the model, underestimating the model, or aborting the model process.

In County Balancing - The trip balancing procedure begins by considering each purpose individually. If the trip purpose under consideration is an In County purpose the model compares the number of productions to the number of attractions. If the number of attractions is greater than the number of productions, the model will simply apply a universal adjustment of all attraction trip ends in the county down to the number of productions. The end result should be an equal number of In County productions and attractions.

If, on the other hand, the productions should exceed attractions the excess productions are shifted over to the corresponding Out of County purposes. For example, if the model estimates using the behavioral planning assumptions that there will be 3,000 evacuees destined In County to Hotel/Motel destinations, but there are only 2,500 Hotel/Motel attraction ends available in the county, the excess 500 trips will become Out of County Hotel/Motel trips.

Out of County Balancing - If the purpose under consideration is an Out of County purpose the model will balance the attractions regionally. Using data derived from the behavioral study, a certain percentage of each out of county trip will be destined to a particular region. If a

particular region is prohibited by the model from receiving evacuation trips, the model will reallocate the portion of evacuation trips originally destined for that regional equally among all other regions. **Table II-1** identifies the percentages of out of county trips destined from each region and to each region. When the model has finished balancing the evacuation productions and attractions, the model will then proceed with trip distribution.

Table II-1 – Out of County Trip Destinations by Region

To / From	Apalachee	Central	East Central	North Central	Northeast	South	Southwest	Tampa Bay	Treasure Coast	West	Withla-coochie	Out-of-State
Apalachee	31.2%	0.1%	1.1%	2.3%	2.1%	0.0%	0.1%	0.7%	0.3%	3.5%	0.8%	57.8%
Central	5.9%	9.8%	13.0%	4.4%	4.7%	0.0%	4.2%	5.9%	5.4%	0.7%	1.7%	44.2%
East Central	2.5%	1.7%	27.1%	5.4%	5.9%	1.5%	2.6%	6.7%	0.8%	1.4%	3.1%	41.2%
North Central	5.2%	0.7%	3.6%	15.2%	6.3%	0.3%	0.3%	3.1%	0.2%	1.3%	2.0%	61.8%
Northeast	3.7%	0.7%	4.2%	6.6%	10.3%	0.6%	0.6%	1.8%	0.2%	1.9%	2.0%	67.4%
South	2.0%	3.4%	20.9%	2.1%	3.4%	24.5%	5.7%	2.1%	9.0%	0.5%	3.1%	23.4%
Southwest	1.4%	5.2%	15.9%	3.9%	3.3%	4.6%	11.0%	8.4%	3.2%	0.8%	5.4%	37.0%
Tampa Bay	3.2%	3.7%	14.1%	2.8%	4.5%	2.2%	1.3%	15.7%	2.0%	0.5%	7.3%	42.6%
Treasure Coast	2.8%	1.5%	22.8%	3.0%	4.4%	4.5%	4.0%	9.4%	11.5%	0.2%	2.0%	34.0%
West	6.3%	0.2%	2.1%	0.9%	3.5%	0.4%	0.1%	0.3%	0.3%	8.7%	0.8%	76.4%
Withla-coochee	2.4%	1.7%	12.4%	7.4%	3.3%	1.0%	0.7%	6.5%	0.5%	1.2%	15.0%	48.0%

Source: Derived from SRESP Behavioral Data and Planning Assumptions

Trip Distribution

After the model has determined how many evacuation trips there will be in a given scenario, split those trips into purposes, and balanced the trip ends for those purposes, it will be necessary for the model to perform a trip distribution. The trip distribution step in the model connects each production end to a unique attraction end. The end result is a trip table containing origins and destinations for each trip in the model. Typically, origin zones are referred to by the letter I and destination zones are referred to by the letter J. An Origin-Destination matrix, also known as an OD matrix, is one of the principal inputs into trip assignment. This matrix tells the model where each trip is coming from and where it is going to.

The trip distribution process begins by looping through each trip purpose and determining whether the purpose is In County or Out of County. In County trips are restricted to destination TEZs within the same county as the trip origin. Out of County trips are restricted to TEZs not in the same county as the trip origin. The trip distribution is conducted using a gravity model that relies on distances as the chief measure of impedance.

Time Segmentation

The final step of the model prior to initiating the trip assignment sequence is to segment the trip table into discreet time periods. This segmentation determines at what point in time each trip begins its evacuation. The model is set up to process a set of evacuation response curves with a period resolution of one-half hour. The model uses a set of factors developed from the behavioral response curves to divide the evacuation trip tables into the different segments.

The model makes the following assumptions. Due to limitations in the model, these assumptions cannot be adjusted. The analyst should keep these assumptions in mind when using results developed by the model:

- All evacuations begin when an order to evacuate has been issued;
- All evacuations begin during the first hour of daylight, approximately 7:00 AM;
- All evacuations begin during an average weekday;
- Some portion of evacuation trips, typically ten percent, leaves prior to the beginning of an evacuation; and,
- Those evacuation trips that leave prior to the beginning of an evacuation leave no later than the previous evening and have already cleared the network by the time an evacuation order is given.

E. Dynamic Traffic Assignment

Dynamic traffic assignment (DTA) was utilized because it is sensitive to individual time increments. DTA works by assigning a certain number of vehicles to the highway network in a given interval of time. The model then tracks the progress of these trips through the network over the interval. Another set of vehicles is assigned during the following time interval. The model then tracks the progress of these trips through the network along with the progress of the trips loaded in the previous time interval. As vehicles begin to arrive at the same segments of roadway, they interact with one another to create congestion. When vehicles that were loaded to the network in subsequent intervals of time arrive at the congested links, they contribute to the congestion as well. This results in a slowing down of the traffic and eventually spill-backs and queuing delays.

It is this time dependent feature of DTA that makes it well suited to evacuation modeling. By dynamically adjusting the travel times and speeds of the vehicles moving through the network as they respond to congestion the model is able to do the following:

- The evacuation model is able to estimate the critical clearance time statistics needed for this study;
- The model takes into account the impact of compounded congestion from multiple congestion points;
- The model is able to adjust the routing of traffic throughout the network as a function of congestion as it occurs throughout the evacuation; and,
- The model is capable of adjusting its capacities from time segment to time segment, making it possible to represent such phenomena as reverse lane operations and background traffic.

Parameters of the Evacuation Assignment

The DTA for the evacuation model makes use of certain parameters which dictate how the assignment will function. The parameters that were established are:

- **Capacity -** The SRESP evacuation model uses hourly lane capacities derived from the Florida Department of Transportation Quality/Level-of-Service Handbook. These capacities are initially set to represent Level-of-Service E conditions. These capacities are then further increased by an additional 20 percent for freeway links and 10 percent for non-freeway links. These increases in capacity are meant to reflect high volume usage typically found during an evacuation, optimal green timing of traffic signals and traffic control typically controlled during an evacuation by law enforcement personnel, and the use of shoulder and emergency lanes;

- **Storage -** Storage determines how many vehicles can remain standing on a length of roadway at any moment in time. The evacuation model assumes that storage is set to 250 vehicles per lane per mile. This assumes approximately 21 feet of space are "occupied" by any given vehicle. Given the mix of vehicles on a roadway network (including compacts, SUVs, trailers, and trucks) this spacing appears to be reasonable for stand-still traffic;

- **Time Intervals -** In order to properly implement a DTA model, the assignment process needs to be segmented according to a set of time intervals. Half-hour intervals provide sufficient detail to satisfy the planning needs of both emergency management and growth management concerns. The model calculates vehicle assignments over 192 such intervals for a 96 hour model period. This is sufficient to capture all evacuation activity during an event and allows sufficient time for the evacuation traffic to clear at both the county and regional level; and,

- **One-Way Evacuation Operation -** The State of Florida has recently published a series of one-way evacuation operation plans for major corridors throughout the state. The intention of these plans is to fully maximize the available capacity on a freeway by using all lanes to move evacuees away from danger. The model will emulate one-way operations by simultaneously increasing the capacity of links headed away from the threatened area and eliminating the capacity of links headed toward the threatened area. The capacity of links headed away from the threatened area will increase by 66 percent, which is consistent with capacity increases used by Florida's Turnpike Enterprise. Past experience of reverse lane operations have shown that capacities do not double, as is commonly assumed, but increase by a lower percentage of about two thirds.

F. Prototype Model Development

Wilbur Smith Associates developed the prototype model to test the modeling methodology used to calculate evacuation clearance times. The prototype model demonstrated the viability of the methodology developed for this study. This included the use of dynamic traffic assignment, background traffic curves, regional sub-area trip balancing, the use of survey rates, the use of 100% participation rates, response curves, and county-by-county phasing of evacuations.

The prototype model served as the backbone for all regional evacuation models that have been developed for this study. The models implemented for each RPC use a structure similar to the prototype with identical methodology.

The SRESP evacuation model relies upon data that covers the entire State of Florida as well as areas covering the States of Georgia, Alabama, Mississippi, South Carolina, North Carolina, and Tennessee. While the primary focus of the model is with evacuation behavior within Florida, areas outside of the state had to be considered in order to allow a more precise routing of evacuation traffic. This allows the model to measure the flow of traffic across the state line if needed.

CHAPTER III
REGIONAL MODEL IMPLEMENTATION

The evacuation transportation model discussed in Chapter II includes several components that are completed using a statewide dataset (determine number of evacuation trips, split trips into destination purposes, and distribute trips throughout state) and several components that can only be completed at the regional level (factor trip tables into time segment matrices, adjust background traffic, and load trips onto the highway network) due to computer run time limitations with the model software. Thus, for the regional level steps, each RPC throughout the State needed to decide on a regional model network to complete the analysis in their region. For the South Florida Region, the regional model network includes the three counties within the RPC plus ten other counties surrounding the region, as illustrated in **Figure III-1**.

This chapter discusses the input data used in evaluating evacuation transportation conditions for the South Florida Region. It is important to note that the input data discussed in this chapter is included only for the counties within the South Florida RPC, as these are the counties that the South Florida RPC has direct responsibility for the data. Data for the adjacent counties included in the South Florida Regional model were provided by the corresponding RPC in which the counties belong. The model data for these counties is discussed in the corresponding Volume 4 report for those respective RPCs.

A. Regional Model Network

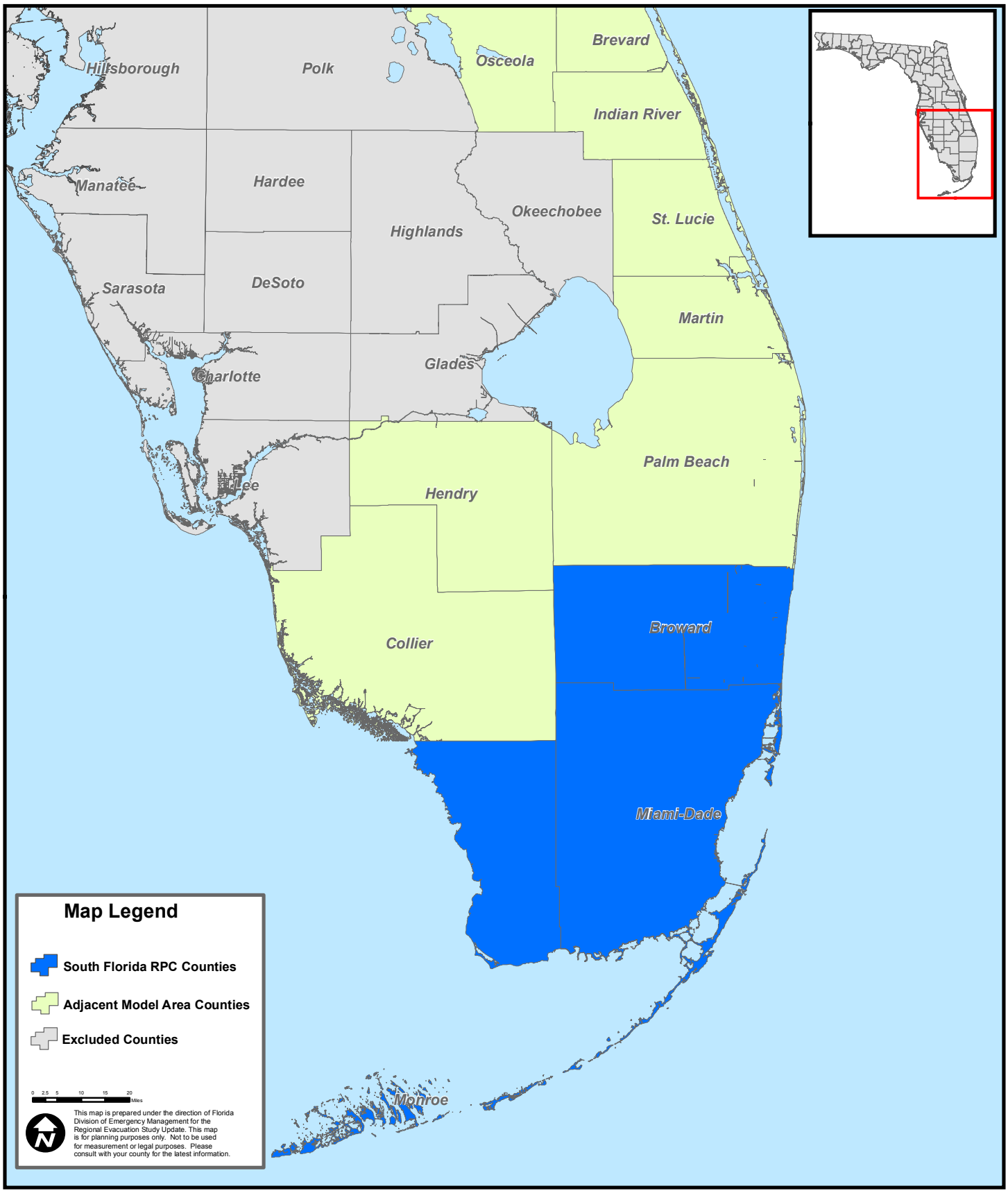
The road network is a key component of the evacuation model. The roadway variables in the network include area type, functional class, number of through lanes, capacity, speed, and several others. The regional model network consists of the RPC designated evacuation routes as well as a supporting roadway network that facilitates movement of evacuation traffic. The 2005 Florida Department of Transportation (FDOT) Statewide Model Network was used as a basis for developing the regional model network, while the evacuation routes were obtained from the South Florida RPC. The RPC received input from the emergency managers of its constituent counties on roads designated as evacuation routes. Policy in both Miami-Dade County and Broward County encourages in-county evacuations, away from surge areas to the inland portions of the county, not out of county. As a result, some inter-county connectors had to be added in order to compose the regional evacuation network that was developed for the study. The resulting model network was updated to 2006 conditions and is referred to as the base model network. **Figure III-2** identifies the model network and evacuation routes for the SFRPC. County level details of the regional model network are provided in the Volume 5-11 report. The regional model network for the South Florida region includes key roadways within the three county region, including I-75, I-95, I-195, I-395, Florida's Turnpike, US 1, US 27, US 41, US 441, SR 826, SR 836, SR 869, SR 924, and SR 997.

B. Regional Zone System

The regional zone system is based on Traffic Evacuation Zones (TEZ) and contains the regional demographic information, which includes housing and population data that is essential to modeling evacuation traffic, as discussed in Chapter II. The regional demographic

Figure III-1

South Florida Regional Model Area

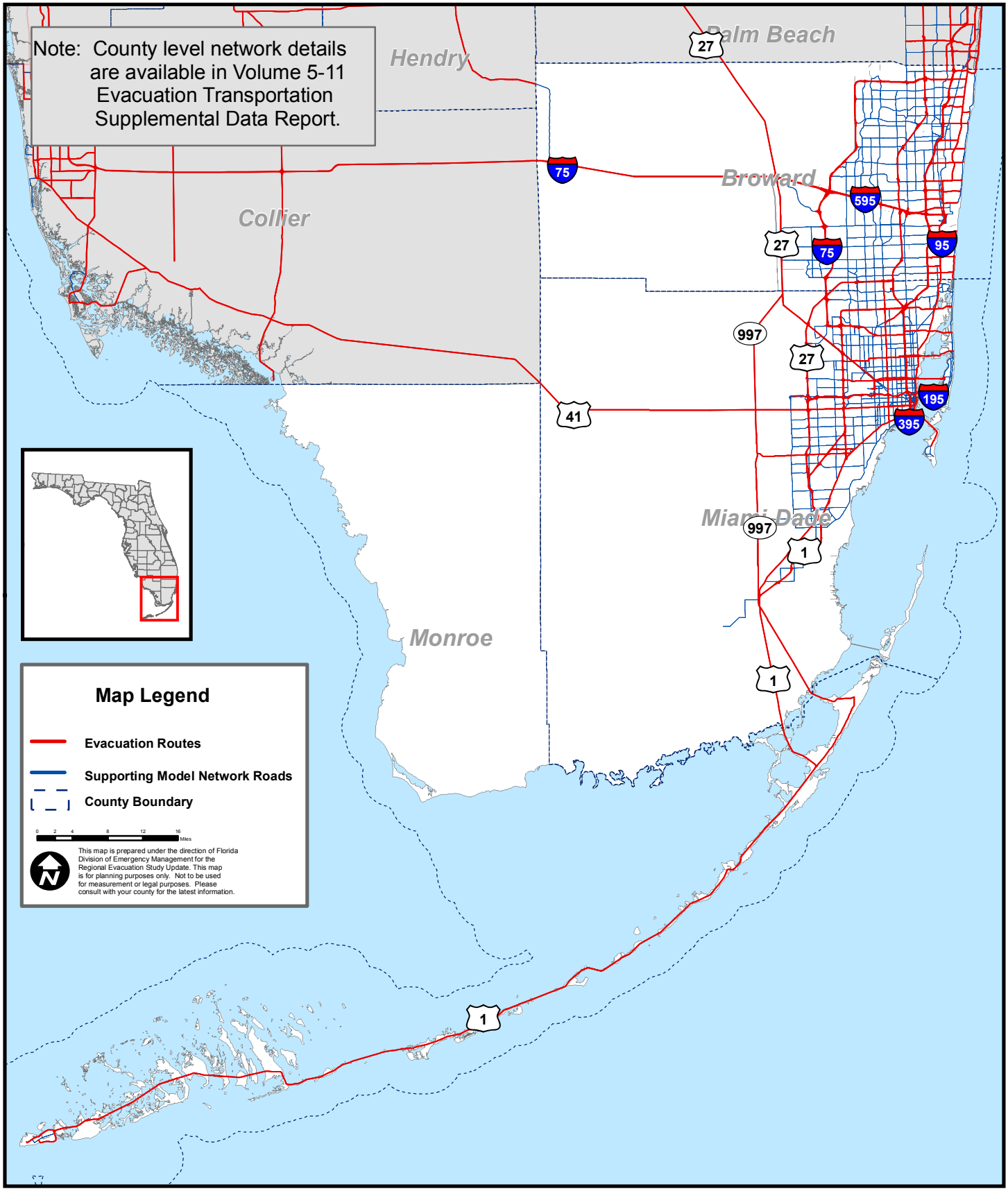


Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: May, 2010

Figure III-2

South Florida Regional Model Network



Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: July, 2010

characteristics identify where the individuals in the region reside, as well as where the vulnerable populations are located. The TEZs are aggregations of the smaller small area data geographies provided by the RPC. Each traffic evacuation zone has a unique identification number that is used by the model to connect evacuation trip generation to the evacuation highway network. There is a buffer in zone numbering between counties to allow for future growth in each county.

The final TEZ system for the State of Florida has 17,328 zones. Of the total number of zones in Florida, 1,051 of the zones are located within the three county South Florida region, as illustrated in **Figure III-3**. In the South Florida region, Miami-Dade County has the largest number of TEZs with 632, and Broward County follows with 379 TEZs. Monroe County contains 40 TEZS and has the lowest number of TEZs within the RPC. The larger number of TEZs generally reflects counties with dense urban structure and higher population densities.

C. Regional Demographic Characteristics

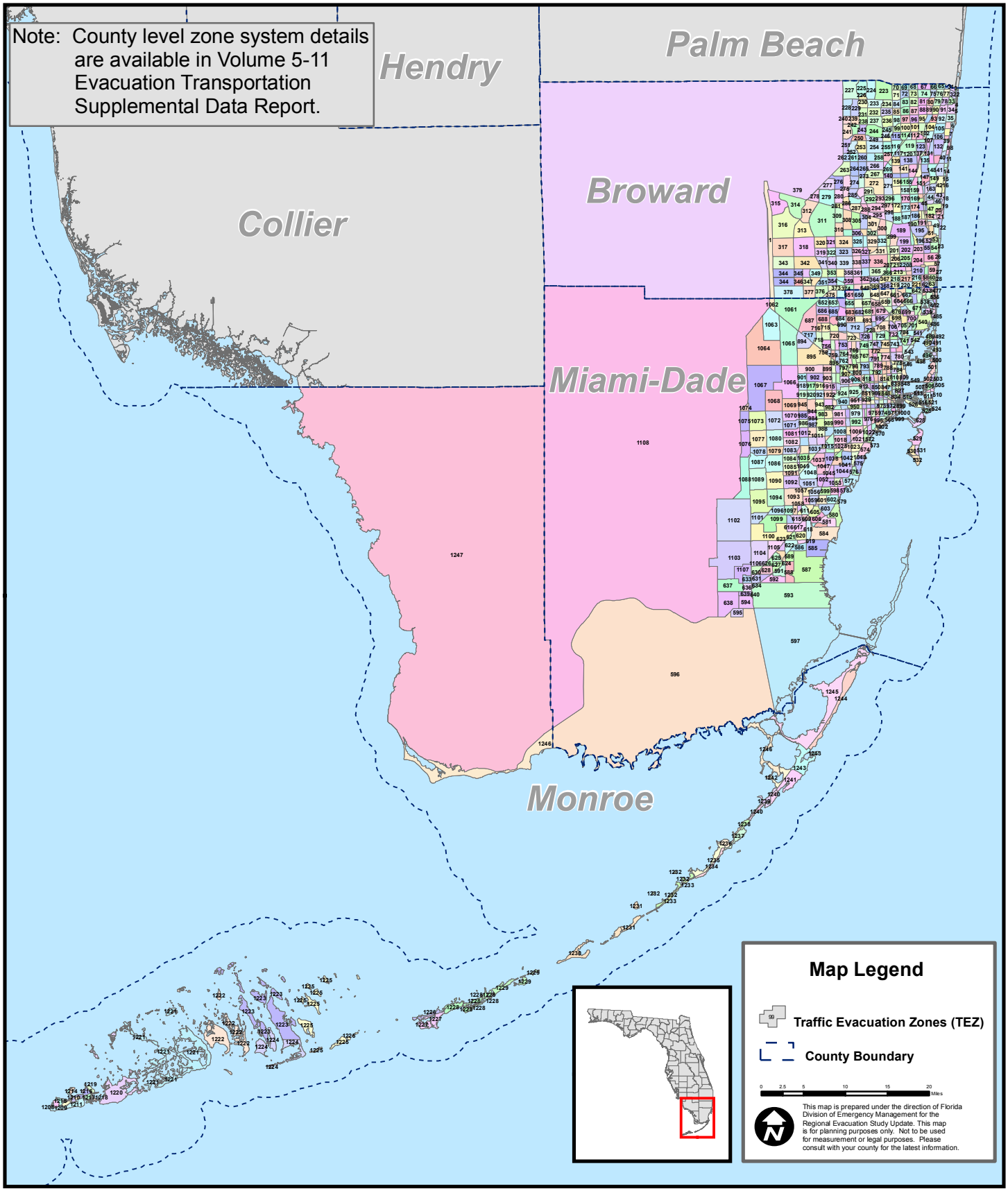
As discussed in Chapter II, the evacuation model uses the demographic information as input for generating a set of evacuation trips. Demographic data were developed for census block groups for Monroe County and for traffic analysis zones for Broward County and Miami-Dade County. Estimates for 2006 and projections for 2010 and 2015 were prepared in each county with the aid of local planners – see the county appendices to Chapter I, Volume 1-11 for a detailed discussion of the approach used in each county. The projections for 2010 and 2015 were developed prior to the 2010 Census. It is likely that differences will be observed once the results of the 2010 Census are released, in early 2011. The regional model was designed to allow for demographic data updates, so it will be possible to conduct an update in the transportation analysis to reflect more current estimates and new projections that are expected to follow from the release of the 2010 Census.

A snapshot of the key demographic data for each county in the South Florida RPC for 2006, 2010 and 2015 is summarized in **Table III-1**. The tables list the number of occupied dwelling units for site-built homes, the permanent population in site-built homes, as well as the number of occupied dwelling units for mobile homes and the permanent population in mobile homes. The mobile home category includes RVs and boats and the permanent population in those housing options. The demographic characteristics summary also includes hotels and motels because many of these units are in or near vulnerable areas, and the proportion of seasonal units and hotel/motel units that are occupied at any point in time will have an important impact on the total population that may participate in an evacuation. Detailed demographic data for each individual TEZ within the region is included in Volume 5-11.

Miami-Dade County has the largest population in the region during all three time periods. The county is expected to reach over 2.5 million people by 2015. Broward County has the second largest population in the region, and is forecasted to have more than 1.8 million people by 2015. Monroe County, the most vulnerable of the three counties, has the fewest number of people in the South Florida region and is expected to grow very little throughout the time period. Generally, mobile homes make up a fairly small component of the housing stock in South Florida region. In 2010 and 2015, mobile homes comprise only about two percent of the occupied homes in Broward and Miami-Dade. Monroe County is an exception; occupied mobile homes make up about fifteen percent of all occupied units in the county.

Figure III-3

South Florida Regional Model Transportation Evacuation (TEZ) Zone System



Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Table III-1 - South Florida Demographic Characteristic Summary

County	Characteristic	Year		
		2006	2010	2015
Broward	Occupied site-built homes	659,884	662,756	690,339
	Population in site-built homes	1,686,387	1,718,826	1,819,299
	Occupied mobile homes	16,762	13,074	13,840
	Population in mobile home	38,896	30,402	32,591
	Hotel/motel units	36,621	38,501	40,013
Miami-Dade	Occupied site-built homes	828,538	855,225	892,978
	Population in site-built homes	2,342,429	2,428,951	2,549,893
	Occupied mobile homes	11,429	11,492	11,639
	Population in mobile home	34,986	35,116	35,478
	Hotel/motel units	46,116	46,116	46,116
Monroe	Occupied site-built homes	30,595	32,213	34,067
	Population in site-built homes	68,585	72,946	77,221
	Occupied mobile homes	6,833	5,807	5,781
	Population in mobile home	14,496	12,179	12,130
	Hotel/motel units	13,086	13,665	13,665

Source: South Florida Regional Planning Council. See Section C discussion for more information on the source of the small area data.

D. Planned Roadway Improvements

To correspond to the three different sets of demographic data, three model networks were ultimately developed. The base 2006 network, discussed in section A, and two future year networks to correspond to the 2010 demographic data and the 2015 demographic data. The 2006 base model network was updated to reflect roadway capacity improvement projects completed between 2006 and 2010 to create the 2010 network. The 2010 network was then updated to reflect planned roadway capacity improvement projects expected to be implemented between 2011 and 2015 to create the 2015 network.

The planned roadway improvements that were added to the network generally include only capacity improvement projects such as additional through lanes. **Table III-2** identifies capacity improvement projects completed between 2006 and 2010 that were included in the 2010 network. Likewise, **Table III-3** identifies capacity improvement projects planned for implementation between 2011 and 2015. The tables identify each roadway that will be improved as well as the extent of the improvement. For example, by the end of 2015 in Broward County, SR 7 from Hallandale Beach Blvd to Fillmore St will be widened to 6 lanes.

It is important to note that Tables III-2 and III-3 are not intended to be all inclusive of every transportation improvement project completed within the region. The tables only identify key capacity improvement projects that impact the evacuation model network and are anticipated to have an impact on evacuation clearance times.

Table III-2 - South Florida Region Roadway Improvements, 2006 – 2010

County	Roadway	From	To	Number of Lanes
Broward	Griffin Rd	SR 823 (Flamingo Rd)	W of I-75	4
	Bailey Rd	SR 7	NW 64th Ave	4
	Pine Island Rd	Oakland Park Blvd	Commercial Blvd	6
	Sunrise Blvd	Pine Island	Hiatus Rd	6
	SR 7	Dade County Line	Hallandale Beach Blvd	6
	Turnpike	Peters Rd	Sunrise Blvd	8
	Turnpike	Sunrise Blvd	Atlantic Blvd	8
	Andrews Ave Extn	Pompano Park Pl	S of Atlantic Blvd	4
	Davie Rd Extension	NW 72nd Ave	Stirling Rd	4
	Dixie Hwy	Hillsboro Blvd	Palm Beach C. Line	4
	Hiatus Rd	Sunrise Blvd	Oakland Park Blvd	4
	Palm Ave	Stirling Rd	Griffin Rd	4
	Pembroke Rd	SW 160th Ave	SW 136th Ave	4
	Wiles Rd	Lyons Rd	Powerline Rd	4
Miami-Dade	SR 934	Turnpike	NW 87th St	4
	SW 328th St	SW 152nd Ave	SW 137th Ave	4
	SR 997/Krome Ave	N of SW 8th St	MP 2.754	4
	SR 997/Krome Ave	US 1	Lucy St	4
	SW 117th Ave	SW 184th St	SW 152nd St	4
	SR 934	SR 826	SR 823	6
	SR 823/NW 57th Ave	Okeechobee Rd	W 23rd St	6
	SR 826	SR 878	SR 874	8
	SR 826	SR 836	US 27	10
	SW 192nd St	SW 197th Ave`	SW 177th Ave	4
	I-95	I-395	Golden Glades	12

Sources: FDOT SIS First Five Year Plan, FDOT SIS Second Five Year Plan, South Florida Regional Planning Council

Note: Projects included in this table are roadway improvement projects completed between 2006 and 2010 on roadways that are included in the regional transportation model network. Only projects which added roadway capacity, such as additional through lanes, were included. The list is not intended to be all inclusive of every transportation improvement project completed within the region. A list of historical projects completed during the last five years was included in this report because the base regional network developed for the study, along with the base demographic data, is for the year 2006.

Note regarding Monroe County: Lane capacities for the segments of US 1 in Monroe County were defined in accordance with the "maximum sustainable traffic flow rates per functional evacuation lane" identified in correspondence from the Florida Department of Transportation, District 6, to the Florida Department of Community Affairs. FDOT District 6 has identified potential changes in the number of functional evacuation lanes on US 1 as a result of the incorporation of completed and planned shoulder improvements within Monroe County through 2015. Study parameters do not provide for the additional scenarios required to analyze the possibility of utilizing additional lanes in an evacuation. However, through the TIME interface and the regional model for South Florida, additional analysis can be conducted on these resources in the future as part of the detailed planning process.

Table III-3 - South Florida Planned Roadway Improvements, 2011–2015

County	Roadway	From	To	Number of Lanes
Broward	SR 7	Hallandale Beach Blvd	Fillmore St	6
	Turnpike	Atlantic Blvd	Sawgrass Expy	8
	Turnpike	Homestead Ext-Turnpike (HEFT)	Griffin Rd	8
	I-595/P3/CEI	I-75	W of I-95	10
	I-95	East Sample Rd	Palm Beach County line	10
	Andrews Ave Extn	NW 18th St	Copans Rd	4
	Pine Island Rd	I-595	Nova Dr	6
Miami-Dade/ Broward	I-95	Golden Glades	I-595	12
Miami-Dade	SR 997/Krome Ave	SW 136th St	SR 90/SW 8th St	4
	SR 823/NW 57th Ave	W 46th St/103rd St	TO W 53rd St	6
	NW 25th St	NW 89th Ct	NW 67th Ave	6
	SR 821 (HEFT)	S of SW 117th Ave	S of Kendall Dr	12

Sources: FDOT SIS First Five Year Plan, FDOT SIS Second Five Year Plan, South Florida Regional Planning Council

Note: Projects included in this table are roadway improvement projects planned for completion between 2011 and 2015 on roadways that are included in the regional transportation model network. Only projects which are planned to add roadway capacity, such as additional through lanes, were included. The list is not intended to be all inclusive of every transportation improvement project planned for completion within the region.

Note regarding Monroe County: Lane capacities for the segments of US 1 in Monroe County were defined in accordance with the "maximum sustainable traffic flow rates per functional evacuation lane" identified in correspondence from the Florida Department of Transportation, District 6, to the Florida Department of Community Affairs. FDOT District 6 has identified potential changes in the number of functional evacuation lanes on US 1 as a result of the incorporation of completed and planned shoulder improvements within Monroe County through 2015. Study parameters do not provide for the additional scenarios required to analyze the possibility of utilizing additional lanes in an evacuation. However, through the TIME interface and the regional model for South Florida, additional analysis can be conducted on these resources in the future as part of the detailed planning process.

E. Behavioral Assumptions

The behavioral assumptions provide important information on the way people respond to an evacuation order and are an important input to the SRESP transportation evacuation model. Evacuation rates for site-built homes and mobile/manufactured homes are provided by county and summarized in **Figure III-4** through **Figure III-9**. Other rates, such as out of county trip rates, vehicle use rates, public shelter use rates, friend/relative refuge use rates, hotel/motel refuge use rates, and other refuge use rates, are detailed by county, storm threat, and evacuation zone in Volume 5-11.

A review of the evacuation rates for the South Florida region illustrates that evacuation participation rates increase as the evacuation level increases, and participation rates for persons living in mobile/manufactured homes are generally higher than for persons living in site-built homes. It should be noted that in Broward and Miami-Dade Counties a certain percentage of the population evacuates, even when they are not living in an area that is ordered to evacuate. These people are commonly referred to as shadow evacuees. Shadow evacuation rates are also included in Figure III-4 through Figure III-7.

For example, if an evacuation order was issued for Broward County for persons living in evacuation zone A/B, the county could expect a 35 percent participation rate from persons living in site-built homes in evacuation zone A/B (Figure III-4) and an 75 percent participation rate from persons living in mobile/manufactured homes in evacuation zone A/B (Figure III-5). In addition, Broward County can expect shadow evacuations to occur for persons living in site-built homes at a rate 25 percent from evacuation zone C, 10 percent from evacuation zone D, and 8 percent from evacuation zone E (Figure III-4). Likewise, for persons living in mobile/manufactured homes, Broward County can expect shadow evacuations to occur at a rate of 60 percent each from evacuation zones C, D, and E (Figure III-5).

Please note that the original behavioral response rates provided by SRESP in Volume 2 were modified to fit the evacuation zones created by Broward and Miami-Dade Counties. The original rates were based on a five zone system; however, the evacuation zones for those counties range from three to four zones depending upon the county. The evacuation zone systems for Broward and Miami-Dade are listed below:

- Broward – 4 zones (for SRESP): Zone A/B, Zone C, Zone D, Zone E;
- Miami-Dade – 3 zones: Zone A, Zone B/C, Zone D/E.

In addition, Monroe County's evacuation zones are not based on storm surge, but are apportioned geographically by sub-regions of the county: Key West, Lower Keys, Middle Keys, and Upper Keys.

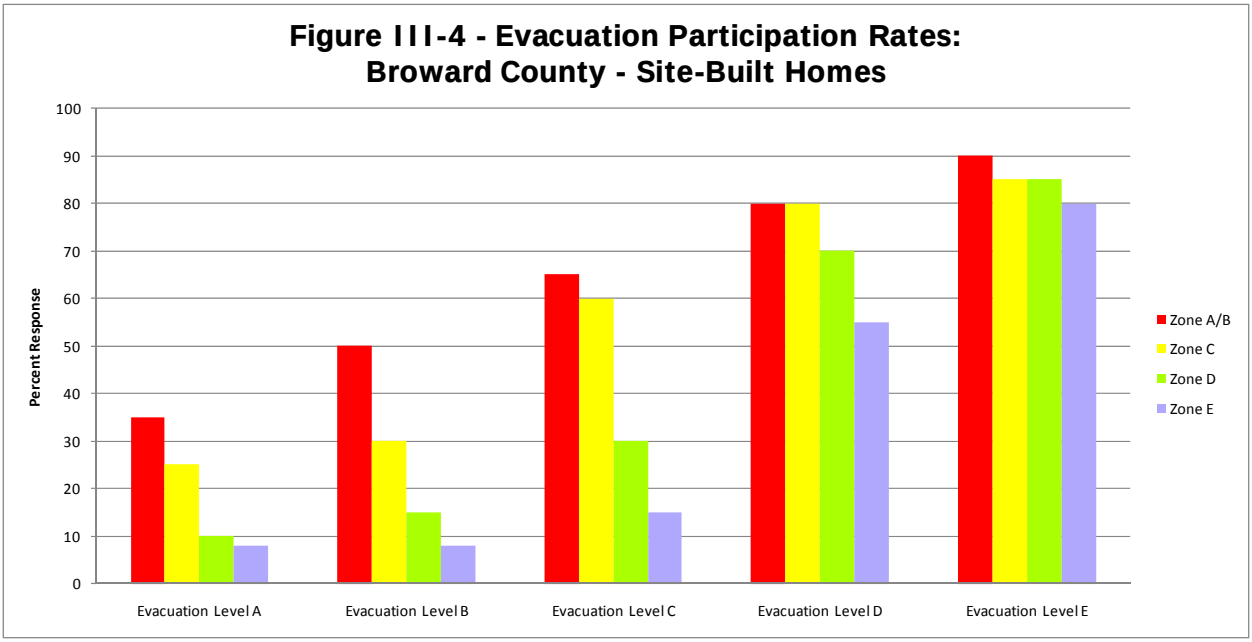


Figure III-4 - Evacuation Participation Rates:
Broward County - Site-Built Homes
Percent Response
100
90
80
70
60
50
40
30
20
10
0
Evacuation Level A
Evacuation Level B
Evacuation Level C
Evacuation Level D
Evacuation Level E
Zone A/B
Zone C
Zone D
Zone E

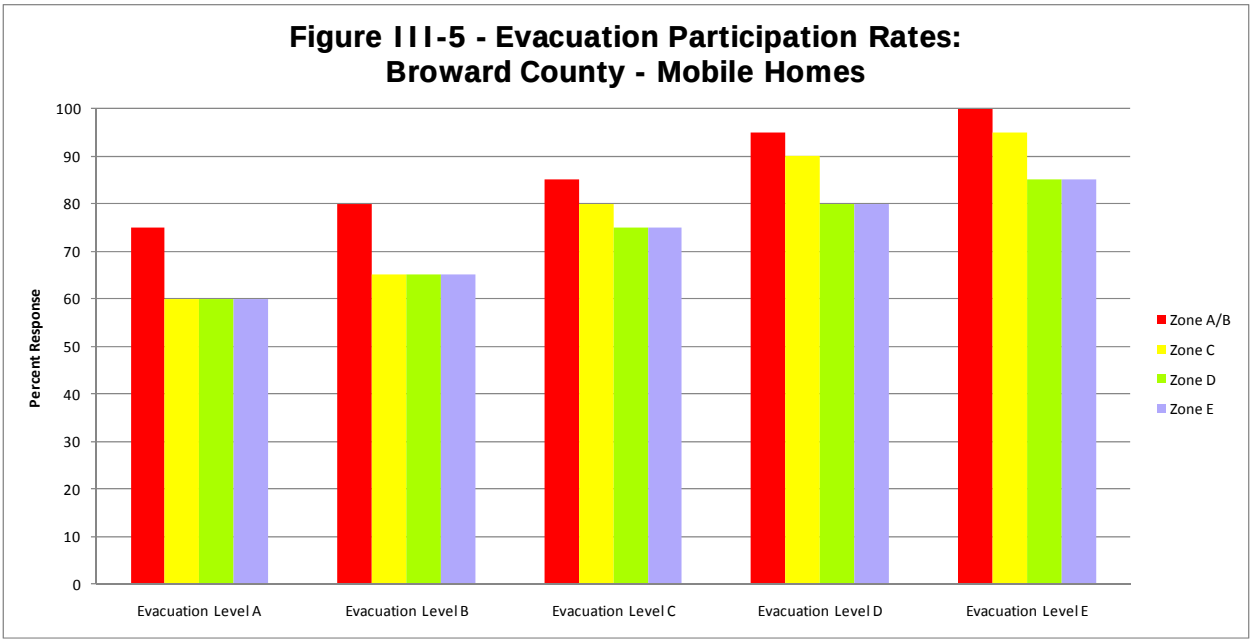


Figure III-5 - Evacuation Participation Rates:
Broward County - Mobile Homes
Percent Response
100
90
80
70
60
50
40
30
20
10
0
Evacuation Level A
Evacuation Level B
Evacuation Level C
Evacuation Level D
Evacuation Level E
Zone A/B
Zone C
Zone D
Zone E

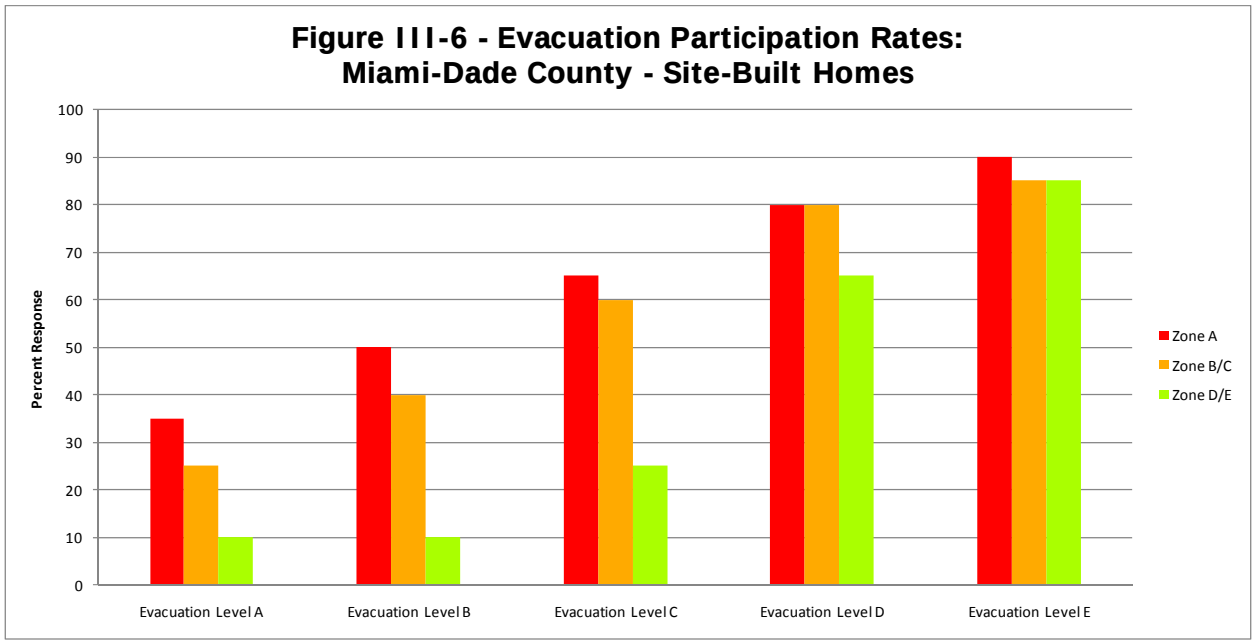


Figure III-6 - Evacuation Participation Rates:
Miami-Dade County - Site-Built Homes
Percent Response
100
90
80
70
60
50
40
30
20
10
0
Evacuation Level A
Evacuation Level B
Evacuation Level C
Evacuation Level D
Evacuation Level E
Zone A
Zone B/C
Zone D/E

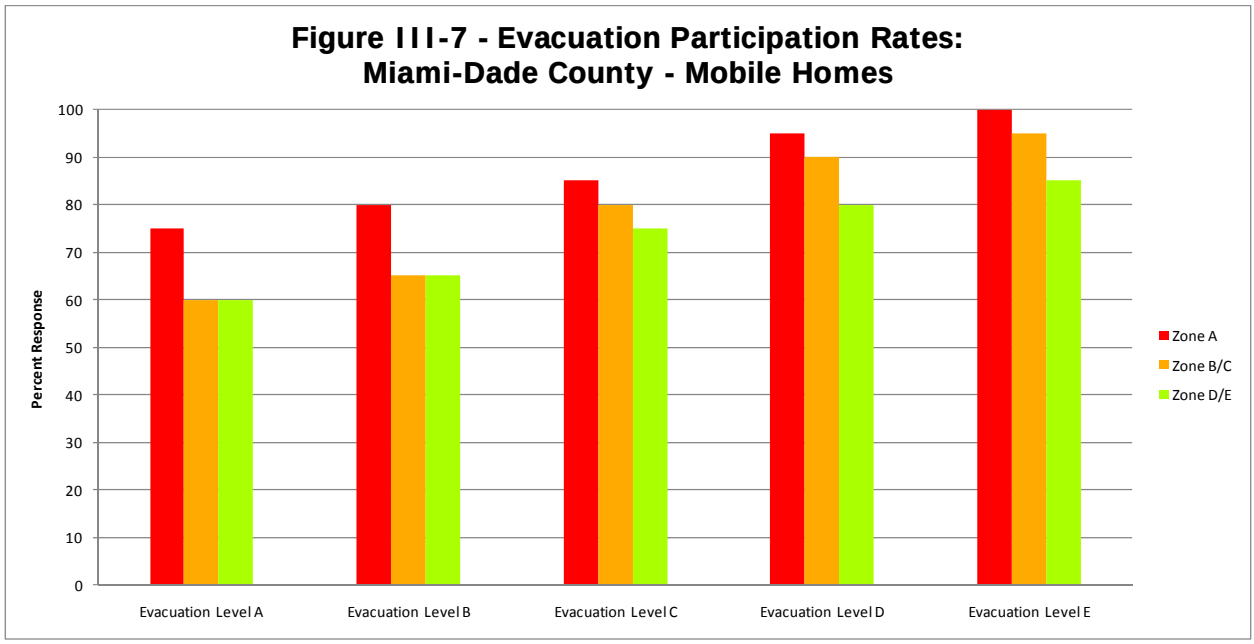


Figure III-7 - Evacuation Participation Rates:
Miami-Dade County - Mobile Homes
Percent Response
100
90
80
70
60
50
40
30
20
10
0
Evacuation Level A
Evacuation Level B
Evacuation Level C
Evacuation Level D
Evacuation Level E
Zone A
Zone B/C
Zone D/E

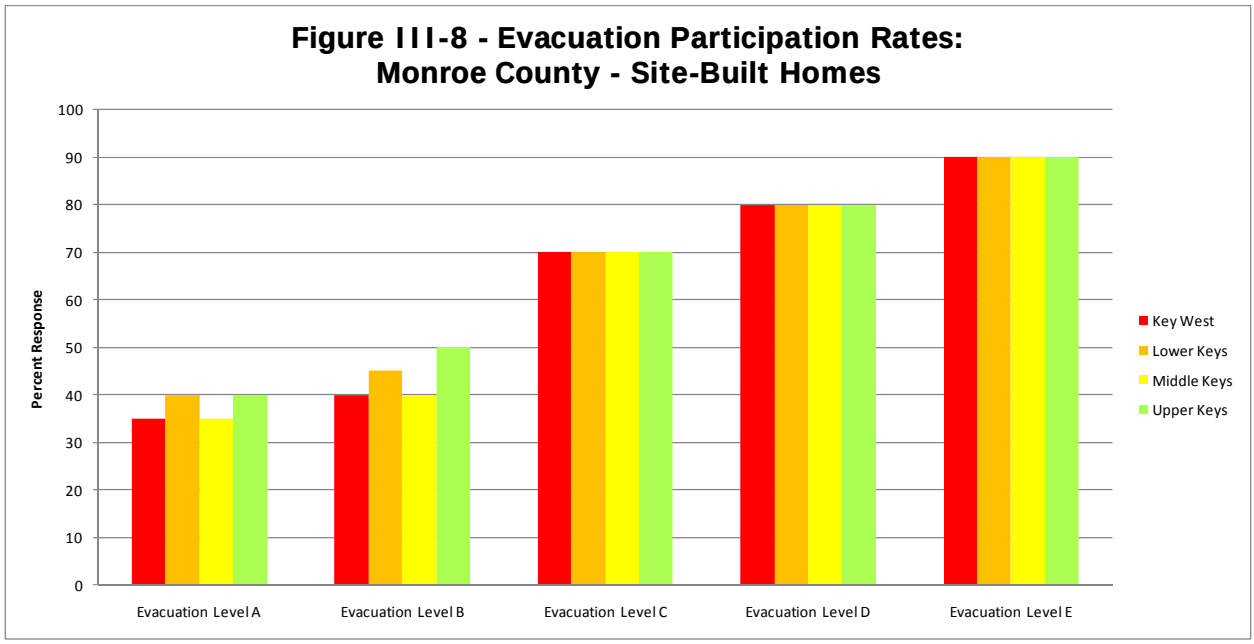


Figure III-8 - Evacuation Participation Rates:
Monroe County - Site-Built Homes
Percent Response
100
90
80
70
60
50
40
30
20
10
0
Evacuation Level A
Evacuation Level B
Evacuation Level C
Evacuation Level D
Evacuation Level E
Key West
Lower Keys
Middle Keys
Upper Keys

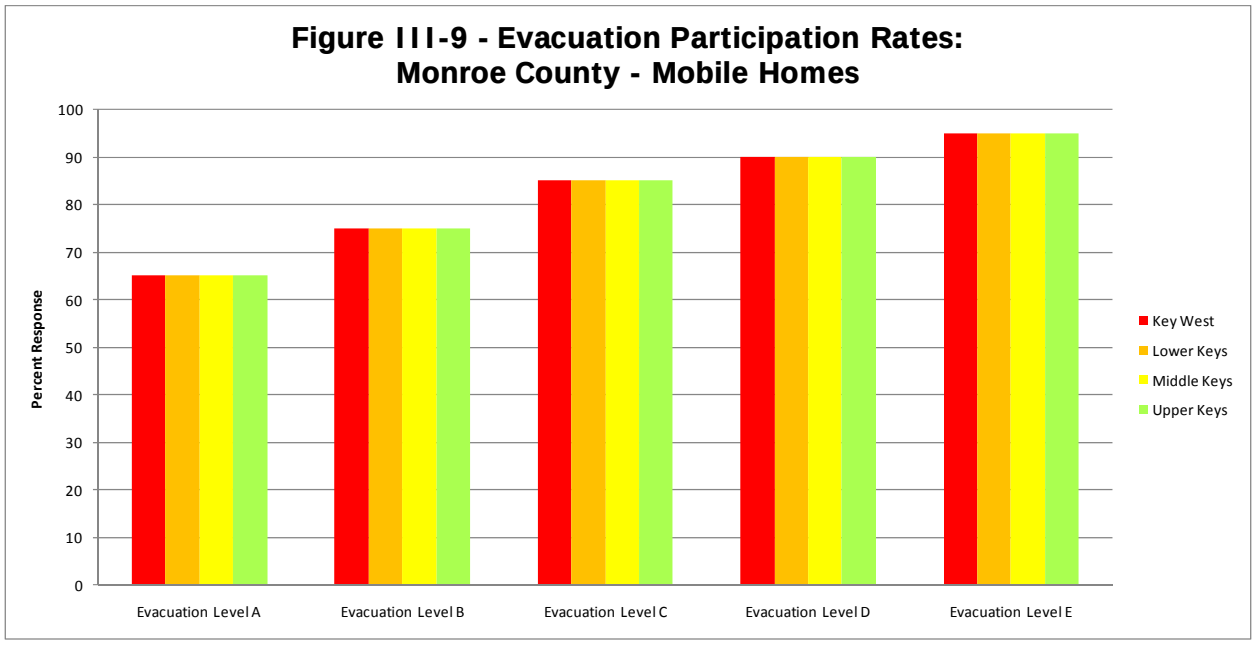


Figure III-9 - Evacuation Participation Rates:
Monroe County - Mobile Homes
Percent Response
100
90
80
70
60
50
40
30
20
10
0
Evacuation Level A
Evacuation Level B
Evacuation Level C
Evacuation Level D
Evacuation Level E
Key West
Lower Keys
Middle Keys
Upper Keys

F. Shelters

In order for the transportation model to accurately assign public shelter trips to the correct location, a complete list of available public shelters needs to be available. The South Florida RPC compiled the list of available public shelters using information provided by the local county emergency managers. The shelters were categorized as either primary or other, with primary indicating that the shelter is compliant with American Red Cross standards for a shelter and other indicating all other shelters.

In the three county region there are a total of 110 shelters, including 40 in Broward County, 66 in Miami-Dade County, and 4 in Monroe County. All together, the 110 shelters located within the three county region can host more than 150,000 persons during an evacuation event. Detailed lists of the available public shelters by county are included in Volume 5-11.

G. Evacuation Zones

The final input variable that is needed to complete the transportation evacuation model is the delineation of evacuation zones for all coastal counties. Local county emergency managers have the responsibility of identifying and defining evacuation zones for their county. Evacuation zones for the South Florida Region are illustrated in **Figure III-10**. County level evacuation zones are included in Volume 5-11.

H. TIME User Interface

Wilbur Smith Associates developed the Transportation Interface for Modeling Evacuations (TIME) to make it easier for RPC staff and transportation planners to use the model and implement the evacuation methodology. The TIME interface is based on an ArcGIS platform and is essentially a condensed transportation model, which provides a user friendly means of modifying input variables that would change the clearance times for various evacuation scenarios.

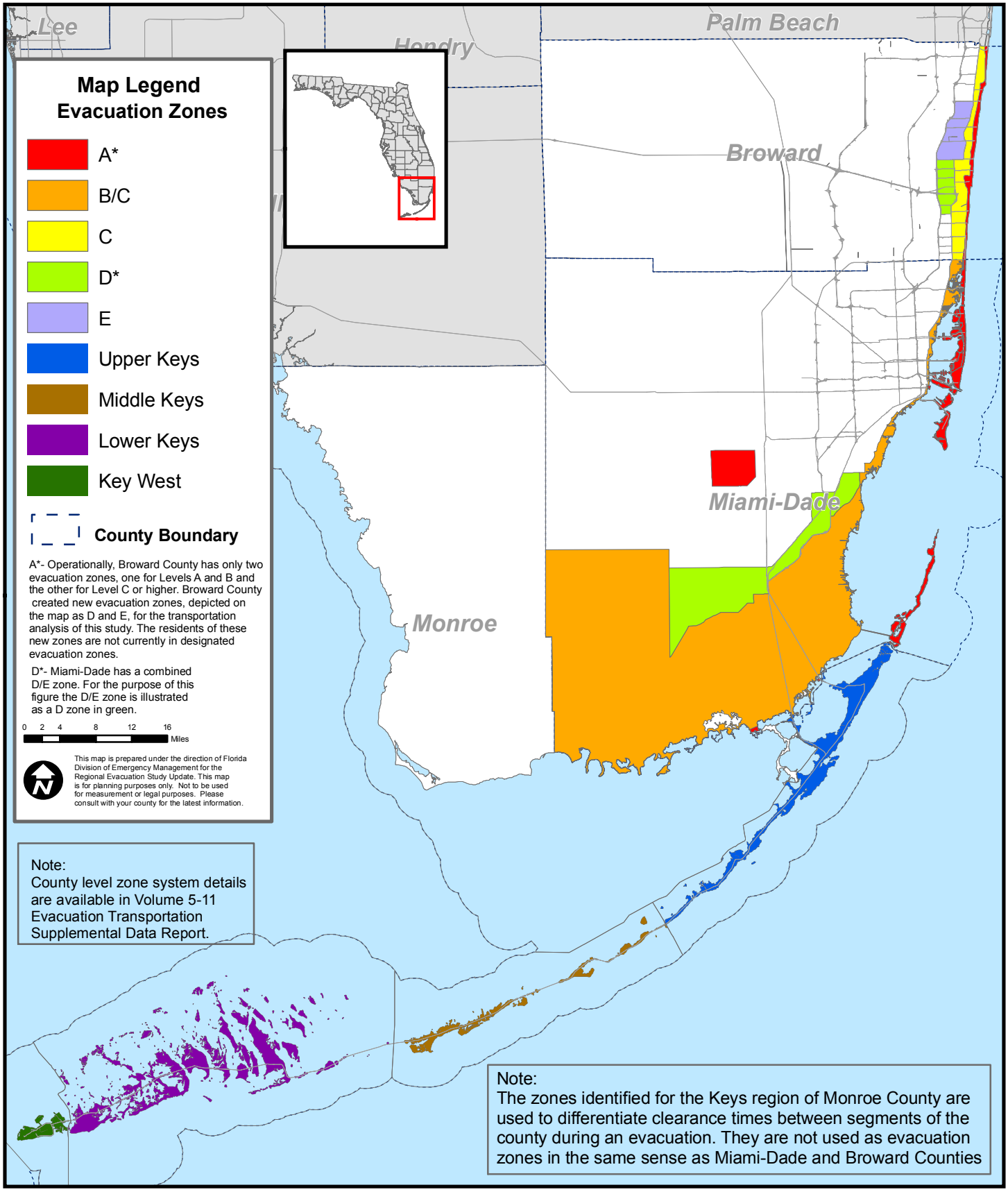
The evacuation model variables include a set of distinguishing characteristics that could apply to evacuation scenarios as selection criteria. These following variables may be selected using the TIME interface and allow the user to retrieve the best results from various evacuation alternatives:

- **Analysis time period -** The first input variable is the evacuation analysis time period. The time period selections include 2006, 2010 and 2015. The time period determines which set of demographic data and which version of the model network will be used.

- **Highway network -** Once the time period is selected, the user must pick either the default highway network or a modified network. The default includes the network corresponding to the selected time period and also incorporates planned highway improvement projects from the Florida Department of Transportation Work Program. In the case that there are any new projects or changes need to be taken into account, the

Figure III-10

South Florida Regional Evacuation Zones



Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

modified network would be chosen. These changes could include possible road or bridge closures because of storm conditions or any managed traffic diversions or traffic control measures.

- **Behavioral response -** The next variable is behavioral response, which is a set of "planning assumptions" that describe the way people respond to an order to evacuate and are an important input to the SRESP Evacuation Model. A user may choose 100% or the survey response. The 100% response indicates that 100% of people in evacuation zones will evacuate, while the survey response uses the percentage of people from the behavioral planning assumptions corresponding to the evacuation level for each county.

- **One-way evacuation operations -** Another variable for consideration is whether to allow one-way evacuation operations or not. One-way evacuation operations allow take into account the FDOT one-way evacuation operations plans for major facilities, including I-75, and Florida's Turnpike.

- **University population -** The model permits the user to incorporate the population in university housing since this data is not included in the regular population numbers. The default assumption is that the region's universities are at the maximum housing capacity housing during the Fall/Spring semester. The other options available are the summer university population, which is generally much less than the fall or spring, and an option for no school in session.

- **Tourist occupancy rates -** The RPC has the option to choose the default rates or to modify those rates based on any special circumstance they may have for tourist rates since there are different tourist seasons, sectors and special events. For example, the South Florida RPC may want to take into account additional traffic that would be generated by visitors for a large sporting event. If modified rates are desired, then the user may select no tourist occupancy or modify the rates on a county by county basis.

- **Shelters -** When choosing which shelters are open to the public during an evacuation event, the user may select either primary shelters or other shelters, both primary and other shelters, and/or modified. In many situations, the shelters category may need to be modified because of availability or capacity changes.

- **Counties evacuating -** The evacuating counties are the counties within the geographic extent of South Florida's model network and include both coastal and inland counties. The coastal counties include Broward, Miami-Dade, Monroe, Palm Beach, Martin, St. Lucie, Indian River, Brevard, and Collier Counties. The inland counties are Hendry, Okeechobee, Osceola, and Orange Counties. The user has the opportunity to pick which of the counties in the network actually evacuate.

- **Evacuation level -** Once the evacuating counties are chosen, the evacuation level is designated. The evacuation levels range from A to E and represent the evacuation zones that are ordered to evacuate. The user may also select "none", which assumes that no evacuations are made within the selected county; only regular background traffic will occur.

- **Response curve hours –** The user must define which evacuation response curve will be applied to each evacuating county in the area. The evacuation response curves show the proportion of evacuation by increment of time for evacuation orders that were issued. There are six different curves to from which to choose: a 6-hour curve, 9-hour curve, 12-hour curve, 18-hour curve, 24-hour curve, and a 36-hour curve. The faster curves represent more urgent circumstances and slower curves represent less urgent circumstances.

- **Evacuation Phasing –** The phase selection indicates when an evacuation would begin in a given county. There are ten different options beginning in hour 1 and extending to hour 27. After hour 3, the other phasing options follow in 3 hour increments.

CHAPTER IV
TRANSPORTATION ANALYSIS

The transportation analysis brings together key factors such as evacuation level, transportation network, shelters, and evacuation population, and explicitly links people's behavioral responses to the regional evacuation infrastructure. The results of this analysis help to formulate effective and responsive evacuation policy options. Two distinct sets of analyses were conducted using the SRESP evacuation transportation model, including one set of analysis for growth management purposes and one set of analysis for emergency management purposes. The results of this analysis are discussed in this chapter.

A. Vulnerable Population

Using a combination of the demographic data, behavioral assumptions, and evacuation zones, the vulnerable population in each county could be determined by evacuation level. For the purposes of the transportation analysis, the vulnerable population, or population-at-risk, is defined as the total population living within the county designated evacuation zones for each evacuation level. This population is living in an area that is at risk for severe flooding during a storm event. The vulnerable population for the South Florida Region for 2010 is identified in **Table IV-1**, summarized by evacuation zone and split between site-built homes and mobile/manufactured homes. Vulnerable population for 2015 is summarized in **Table IV-2**.

The vulnerable population in the South Florida Region includes Broward, Miami-Dade, and Monroe Counties. The vulnerable population varies by evacuation zone. Broward County, for example, has more than 46,000 vulnerable residents in evacuation zone A and just more that 97,000 vulnerable residents in evacuation zone B in 2010. In each of the counties in the region, the vulnerable population living in site-built homes far exceeds the vulnerable population living in mobile/manufactured homes.

In addition, based again on the demographic data, behavioral assumptions, and evacuation zones, the planned destinations of vulnerable population in each county could be determined by evacuation level. Destinations include friends and family, hotel/motel, public shelter, and other locations. Vulnerable population destinations for the South Florida Region are identified in **Table IV-3** for 2010 and in **Table IV-4** for 2015.

In Broward, Miami-Dade and Monroe Counties, the vulnerable population is far more likely to stay with friends and family during an evacuation. This is followed by hotel/motel as the second choice and other locations as the third. In all cases, public shelter destinations are identified as the least likely destination during an evacuation event.

The vulnerable shadow population is provided in **Table IV-5** for both 2010 and 2015. The vulnerable shadow population was determined using the behavioral assumptions for evacuating shadow population and is based on evacuation level (storm category), not evacuation zone. Vulnerable shadow population for the three county region ranges from 367,300 to nearly 795,400 persons for 2010, depending upon the evacuation level. For 2015, the range increases to between 387,100 and 829,200 persons. It should be noted that Monroe County does not have a vulnerable shadow population, since 100 percent of the county is considered vulnerable.

Table IV-1 – Vulnerable Population in the South Florida Region for 2010

	Evacuation Zone A	Evacuation Zone B	Evacuation Zone C	Evacuation Zone D	Evacuation Zone E
Broward County*					
Site-built Homes	46,214		96,953	45,172	103,939
Mobile/Manuf. Homes	0		191	407	623
TOTAL	46,214		97,144	45,579	104,562
Miami-Dade County*					
Site-built Homes	148,487	153,512		144,869	
Mobile/Manuf. Homes	0	1,917		6,467	
TOTAL	148,487	155,430		151,335	
Monroe County*					
Site-built Homes	72,946				
Mobile/Manuf. Homes	12,179				
TOTAL	85,125				

*Note: Vulnerable population determined using SRESP small area data and county provided evacuation zones. Vulnerable population numbers are not inclusive, meaning population numbers listed for a higher zone are not included in the lower zone. For example, vulnerable population listed for Evacuation Zone D does not include vulnerable population listed for Evacuation Zone C. See Chapter III, Section C for the source of the small area data. *Note: For the purposes of this study, Broward County has a combined A/B zone, Miami-Dade County has combined B/C and D/E zones, and all of Monroe County is considered vulnerable.*

Table IV-2 – Vulnerable Population in the South Florida Region for 2015

	Evacuation Zone A	Evacuation Zone B	Evacuation Zone C	Evacuation Zone D	Evacuation Zone E
Broward County*					
Site-built Homes	49,121		102,701	48,840	109,787
Mobile/Manuf. Homes	0		206	440	671
TOTAL	49,121		102,907	49,280	110,458
Miami-Dade County*					
Site-built Homes	153,588	174,226		163,929	
Mobile/Manuf. Homes	0	1,958		6,574	
TOTAL	153,588	176,184		170,503	
Monroe County*					
Site-built Homes	77,221				
Mobile/Manuf. Homes	12,130				
TOTAL	89,351				

*Note: Vulnerable population determined using SRESP small area data and county provided evacuation zones. Vulnerable population numbers are not inclusive, meaning population numbers listed for a higher zone are not included in the lower zone. For example, vulnerable population listed for Evacuation Zone D does not include vulnerable population listed for Evacuation Zone C. See Chapter III, Section C for the source of the small area data. *Note: For the purposes of this study, Broward County has a combined A/B zone, Miami-Dade County has combined B/C and D/E zones, and all of Monroe County is considered vulnerable.*

Table IV-3 – Vulnerable Population by Destination for 2010

	Evacuation Zone A	Evacuation Zone B	Evacuation Zone C	Evacuation Zone D	Evacuation Zone E
Broward County*					
To Friends and Family	34,660		72,839	34,144	78,359
To Hotel/ Motel	6,932		14,572	6,837	15,684
To Public Shelter	924		4,867	2,299	5,259
To Other Destination	3,697		4,867	2,299	5,259
Miami-Dade County*					
To Friends and Family	96,516	101,029		98,368	
To Hotel/ Motel	29,697	30,894		29,620	
To Public Shelter	7,424	7,867		15,134	
To Other Destination	14,849	15,639		8,213	
Monroe County*					
To Friends and Family	48,593				
To Hotel/ Motel	20,168				
To Public Shelter	2,073				
To Other Destination	14,292				

*Note: Vulnerable population destinations determined using SRESP small area data and county provided evacuation zones. Vulnerable population numbers are not inclusive, meaning population numbers listed for a higher zone are not included in the lower zone. For example, vulnerable population listed for Evacuation Zone D does not include vulnerable population listed for Evacuation Zone C. See Chapter III, Section C for the source of the small area data. *Note: For the purposes of this study, Broward County has a combined A/B zone, Miami-Dade County has combined B/C and D/E zones, and all of Monroe County is considered vulnerable.*

Table IV-4 – Vulnerable Population by Destination for 2015

	Evacuation Zone A	Evacuation Zone B	Evacuation Zone C	Evacuation Zone D	Evacuation Zone E
Broward County*					
To Friends and Family	36,841		77,160	36,916	82,776
To Hotel/ Motel	7,368		15,436	7,392	16,569
To Public Shelter	982		5,156	2,486	5,556
To Other Destination	3,930		5,156	2,486	5,556
Miami-Dade County*					
To Friends and Family	99,832	114,519		110,827	
To Hotel/ Motel	30,718	35,041		33,443	
To Public Shelter	7,680	8,907		17,050	
To Other Destination	15,359	17,716		9,183	
Monroe County*					
To Friends and Family	51,055				
To Hotel/ Motel	21,165				
To Public Shelter	2,157				
To Other Destination	14,976				

*Note: Vulnerable population destinations determined using SRESP small area data and county provided evacuation zones. Vulnerable population numbers are not inclusive, meaning population numbers listed for a higher zone are not included in the lower zone. For example, vulnerable population listed for Evacuation Zone D does not include vulnerable population listed for Evacuation Zone C. See Chapter III, Section C for the source of the small area data. *Note: For the purposes of this study, Broward County has a combined A/B zone, Miami-Dade County has combined B/C and D/E zones, and all of Monroe County is considered vulnerable.*

Table IV-5 – Vulnerable Shadow Evacuation Population

	Evacuation Level A	Evacuation Level B	Evacuation Level C	Evacuation Level D	Evacuation Level E
2010					
Broward County	160,714	167,817	156,617	257,809	345,043
Miami-Dade County	206,603	172,306	194,056	251,893	450,305
Monroe County	0	0	0	0	0
2015					
Broward County	169,295	176,880	165,025	271,484	363,604
Miami-Dade County	217,855	178,334	202,928	259,579	465,523
Monroe County	0	0	0	0	0

Note: Vulnerable shadow population determined using SRESP behavioral data and county provided evacuation zones. See Chapter III, Section C for the source of the small area data.

B. Clearance Time Definitions

The determination of clearance time is one of the most important outcomes from the evacuation transportation analysis. Calculated clearance times are used by county emergency managers as one input to determine when to recommend an evacuation order. This calculation can include the population-at-risk, shadow evacuees, as well as evacuees from other counties anticipated to pass through the county. Clearance time is developed to include the time required for evacuees to secure their homes and prepare to leave, the time spent by all vehicles traveling along the evacuation route network, and the additional time spent on the road caused by traffic and road congestion. Clearance time does not relate to the time any one vehicle spends traveling along the evacuation route network, nor does it guarantee vehicles will safely reach their destination once outside the County. The four clearance times that are calculated as part of the evacuation transportation analysis include the following:

- **Clearance Time to Shelter** - The time necessary to safely evacuate vulnerable residents and visitors to a "point of safety" within the county based on a specific hazard, behavioral assumptions and evacuation scenario. Calculated from the point in time when the evacuation order is given to the point in time when the last vehicle reaches a point of safety within the county. Key points to remember for clearance time to shelter include:
  - All in-county trips reach their destination within the county; and,
  - This definition does not include any out of county trips.

- **In-County Clearance Time** - The time required from the point an evacuation order is given until the last evacuee can either leave the evacuation zone or arrive at safe shelter within the county. This does not include those evacuees leaving the county on their own. Key points to remember for in-county clearance time include:
  - All in-county trips reach their destination within the county;
  - All out of county trips exit the evacuation zone, but may still be located in the county; and,
  - This definition does not include out-of-county pass-through trips from adjacent counties, unless they evacuate through an evacuation zone.

- **Out of County Clearance Time** - The time necessary to safely evacuate vulnerable residents and visitors to a "point of safety" within the county based on a specific hazard, behavioral assumptions and evacuation scenario. Calculated from the point an evacuation order is given to the point in time when the last vehicle assigned an external destination exits the county. Key points to remember for out of county clearance time include:
  - The roadway network within the county is clear;
  - All out of county trips exit the county, including out of county pass-through trips from adjacent counties; and,
  - All in-county trips reach their destination.

- **Regional Clearance Time** - The time necessary to safely evacuate vulnerable residents and visitors to a "point of safety" within the (RPC) region based on a specific hazard, behavioral assumptions and evacuation scenario. Calculated from last vehicle assigned an external destination exits the region. Key points to remember for regional clearance time include:

- The roadway network within the RPC is clear;
- All out of county trips exit the RPC, including out of county pass-through trips from adjacent counties;
- All in-county trips reach their destination; and,
- Regional clearance time is equal to the largest out of county clearance time for a given scenario for any of the counties within the RPC, since the out of county clearance time includes out of county pass through trips from adjacent counties.

C. Evacuation Model Scenarios

There are literally thousands of possible combinations of variables that can be applied using the evacuation transportation model, which will result in thousands of possible outcomes. For the purposes of this analysis, two distinct sets of analyses were conducted using the SRESP evacuation transportation model, including one set of analysis for growth management purposes and one set of analysis for emergency management purposes. The two sets of analysis include the following:

- **Base Scenarios** – The base scenarios were developed to estimate a series of worst case scenarios and are identical for all eleven RPCs across the State. These scenarios assume 100 percent of the vulnerable population evacuates and includes impacts from counties outside of the RPC area. These scenarios are generally designed for growth management purposes, in order to ensure that all residents that choose to evacuate during an event are able to do so; and,

- **Operational Scenarios** – The operational scenarios were developed by the RPCs in coordination with local county emergency managers and are designed to provide important information to emergency management personnel to plan for different storm events. These scenarios are different from region to region and vary for each evacuation level.

Because of the numerous possible combinations of variables that can be applied in the model, the evacuation transportation model is available for use through the South Florida RPC to continue testing combinations of options and provide additional information to emergency managers.

D. Base Scenarios

A total of ten base scenarios were developed through discussions with the SRESP Statewide Work Group and are identical for all eleven RPCs. The SRESP requires a consistent set of base scenarios that will be used by all regions across the State to provide a consistent background between regions. The base scenarios also allow the results to be used consistently from region to region for other purposes, such as growth management. The ten base scenarios were developed to include the following assumptions:

- **Analysis Time Period** – Five scenarios for the 2010 time period and five scenarios for the 2015 time period. The five scenarios for each time period include one for each of the five evacuation levels, A, B, C, D, and E;

- **Highway Network** – The five 2010 scenarios use the 2010 network and the five 2015 scenarios use the 2015 network, which includes planned roadway capacity improvement

projects expected to be implemented by 2015;

- **One-Way Evacuation Operations** – The base scenarios do not include implementation of any one-way evacuation operations;

- **University Population** – The base scenarios use the fall/spring semester data to estimate evacuation trips by the student population. This data was provided by each RPC as part of the demographic small area data;

- **Tourist Occupancy Rates** – The base scenarios use the default hotel/motel occupancy rates to estimate tourist evacuation trips. This data was provided by each RPC as part of the demographic small area data;

- **Shelters** – The base scenarios assume all designated primary shelters within each county in the model network are open. The base scenarios do not include shelters that are designated as other shelters, only primary shelters;

- **Response Curve** – The 12-hour response curve is used for all ten base scenarios;

- **Evacuation Phasing** - All counties that are evacuating begin at same time, within 1 hour of the evacuation order being given;

- **Behavioral Response** – The base scenarios include the counties in the RPC plus one coastal county on either side of the RPC region (includes Broward, Miami-Dade, Monroe, Palm Beach, and Collier Counties). For all five evacuation levels (A, B, C, D, or E) in both the 2010 and 2015 time periods, the behavioral response for the base scenarios includes slightly different assumptions for Monroe County than the other counties included in the scenarios. For Monroe County, the following behavioral response was assumed:
  - For base scenarios with evacuation levels A and B, 100% response from mobile homes and 100% response from tourists are assumed, plus the planning assumption response rates for site-built homes;
  - For base scenarios with evacuation levels C, D, and E, tourists are assumed to evacuate 48 hours before landfall and mobile homes are assumed to evacuate 36 hours before landfall. Thus, during the base scenarios for evacuation levels C, D, and E, tourists and mobile homes are assumed to have already completed evacuations and these scenarios only include 100% of all site-built homes;

  For the remaining counties included in the base scenarios (Broward, Miami-Dade, Palm Beach, and Collier Counties)
  - 100% response in evacuation zones for both mobile homes and site-built homes;
  - 100% response for mobile homes in inland areas;
  - Planning Assumption response (shadow evacuation) for site-built homes in inland areas; and,
  - For the remaining counties in the South Florida model network, no evacuations are assumed, including shadow evacuations.

The ten base scenarios are summarized in **Table IV-6**.

Table IV-6 – Base Scenarios

	Scenario 1 Level A 2010	Scenario 2 Level B 2010	Scenario 3 Level C 2010	Scenario 4 Level D 2010	Scenario 5 Level E 2010
Demographic Data	2010	2010	2010	2010	2010
Highway Network	2010	2010	2010	2010	2010
One-Way Operations	None	None	None	None	None
University Population	Fall/Spring	Fall/Spring	Fall/Spring	Fall/Spring	Fall/Spring
Tourist Rate	Default	Default	Default	Default	Default
Shelters Open	Primary	Primary	Primary	Primary	Primary
Response Curve	12-hour	12-hour	12-hour	12-hour	12-hour
Evacuation Phasing	None	None	None	None	None
Behavioral Response	100%	100%	100%	100%	100%
Evacuation Zone	A	B	C	D	E
Counties Evacuating	Broward Miami-Dade Monroe Palm Beach Collier	Broward Miami-Dade Monroe Palm Beach Collier	Broward Miami-Dade Monroe Palm Beach Collier	Broward Miami-Dade Monroe Palm Beach Collier	Broward Miami-Dade Monroe Palm Beach Collier
	Scenario 6 Level A 2015	**Scenario 7 Level B 2015**	**Scenario 8 Level C 2015**	**Scenario 9 Level D 2015**	**Scenario 10 Level E 2015**
Demographic Data	2015	2015	2015	2015	2015
Highway Network	2015	2015	2015	2015	2015
One-Way Operations	None	None	None	None	None
University Population	Fall/Spring	Fall/Spring	Fall/Spring	Fall/Spring	Fall/Spring
Tourist Rate	Default	Default	Default	Default	Default
Shelters Open	Primary	Primary	Primary	Primary	Primary
Response Curve	12-hour	12-hour	12-hour	12-hour	12-hour
Evacuation Phasing	None	None	None	None	None
Behavioral Response	100%	100%	100%	100%	100%
Evacuation Zone	A	B	C	D	E
Counties Evacuating	Broward Miami-Dade Monroe Palm Beach Collier	Broward Miami-Dade Monroe Palm Beach Collier	Broward Miami-Dade Monroe Palm Beach Collier	Broward Miami-Dade Monroe Palm Beach Collier	Broward Miami-Dade Monroe Palm Beach Collier

E. Base Scenario Results

Each of the ten base scenarios were modeled for the South Florida Region using the regional evacuation model. Results were derived from the model to summarize the evacuating population, evacuating vehicles, clearance times, and critical congested roadways. Each of these results are discussed in the following sections.

Evacuating Population

It is important to determine the evacuating population for each of the base scenarios in order to understand the magnitude of the evacuation effort, including estimated population that is evacuating and the county level shelter demand. Evacuating population for the base scenarios is summarized by county for 2010 in **Table IV-7** and for 2015 in **Table IV-8**.

Within the three county region, total evacuating population ranges from more than 634,400 persons for a base scenario level A evacuation to more than 1.6 million persons for a base scenario level E evacuation in 2010. By 2015, this range increases within the three counties to more than 663,800 persons for a base scenario level A evacuation and more than 1.7 million persons for a base scenario level E evacuation.

Evacuating Vehicles

From a transportation standpoint, the number of evacuating vehicles is more important than the evacuating population. Evacuating vehicles for the base scenarios is summarized by county for 2010 in **Table IV-9** and for 2015 in **Table IV-10**.

The total number of evacuating vehicles within the three county region for the base scenarios also varies by evacuation level. A total of more than 317,800 vehicles evacuate from the three county RPC for a base scenario level A evacuation in 2010, and this number increases to more than 754,700 evacuating vehicles from the three county region for a base scenario level E evacuation in 2010. By 2015, the number of evacuating vehicles is expected to increase to more than 323,500 vehicles for a base scenario level A evacuation and more than 782,800 evacuating vehicles for a base scenario level E evacuation.

Shelter Demand

Shelter demand is another critical piece of the evacuating population, and shelter demand estimates by county are summarized for each of the base scenarios in **Table IV-11**. Shelter demand is the population in each county who will seek public shelter during their evacuation, either at an in-county shelter or an out of county shelter.

Public shelter demand in the three county region ranges from more than 34,600 persons for the base scenario level A evacuation in 2010 to more than 91,900 persons for the base scenario level E evacuation. By 2015, the public shelter demand is expected to increase to more than 35,300 persons for the level A evacuation and nearly 95,600 persons for the level E evacuation.

Table IV-7 – Evacuating Population by Base Scenario for 2010

	Evacuation Level A Base Scenario	Evacuation Level B Base Scenario	Evacuation Level C Base Scenario	Evacuation Level D Base Scenario	Evacuation Level E Base Scenario
Monroe County – Key West					
Site-built Homes	10,576	12,086	30,216	30,216	30,216
Mobile/Manuf. Homes	3,116	3,116	0	0	0
Tourists	15,709	15,709	0	0	0
TOTAL	29,401	30,911	30,216	30,216	30,216
Monroe County – Lower Keys					
Site-built Homes	5,322	5,987	13,305	13,305	13,305
Mobile/Manuf. Homes	2,427	2,427	0	0	0
Tourists	1,328	1,328	0	0	0
TOTAL	9,077	9,742	13,305	13,305	13,305
Monroe County – Middle Keys					
Site-built Homes	3,951	4,516	11,290	11,290	11,290
Mobile/Manuf. Homes	2,492	2,492	0	0	0
Tourists	7,229	7,229	0	0	0
TOTAL	13,672	14,237	11,290	11,290	11,290
Monroe County – Upper Keys					
Site-built Homes	7,223	9,029	18,057	18,057	18,057
Mobile/Manuf. Homes	4,173	4,173	0	0	0
Tourists	8,844	8,844	0	0	0
TOTAL	20,240	22,046	18,057	18,057	18,057
Monroe County – Total					
Site-built Homes	27,072	31,618	72,868	72,868	72,868
Mobile/Manuf. Homes	12,208	12,208	0	0	0
Tourists	33,110	33,110	0	0	0
TOTAL	72,390	76,936	72,868	72,868	72,868
Miami-Dade County					
Site-built Homes	300,447	415,538	437,288	645,248	843,660
Mobile/Manuf. Homes	35,087	35,087	35,087	35,087	35,087
Tourists	19,556	25,598	25,598	26,810	26,810
TOTAL	355,090	476,223	497,973	707,145	905,557
Broward County					
Site-built Homes	154,717	161,820	243,699	388,274	577,770
Mobile/Manuf. Homes	30,402	30,402	30,402	30,402	30,402
Tourists	21,809	21,809	25,874	28,070	30,370
TOTAL	206,928	214,031	299,975	446,746	638,542

See Chapter III, Section C for the source of the small area data.

Table IV-8 – Evacuating Population by Base Scenario for 2015

	Evacuation Level A Base Scenario	Evacuation Level B Base Scenario	Evacuation Level C Base Scenario	Evacuation Level D Base Scenario	Evacuation Level E Base Scenario
Monroe County – Key West					
Site-built Homes	11,024	12,599	31,498	31,498	31,498
Mobile/Manuf. Homes	3,130	3,130	0	0	0
Tourists	15,709	15,709	0	0	0
TOTAL	29,863	31,438	31,498	31,498	31,498
Monroe County – Lower Keys					
Site-built Homes	5,784	6,507	14,460	14,460	14,460
Mobile/Manuf. Homes	2,398	2,398	0	0	0
Tourists	1,328	1,328	0	0	0
TOTAL	9,510	10,233	14,460	14,460	14,460
Monroe County – Middle Keys					
Site-built Homes	4,159	4,754	11,884	11,884	11,884
Mobile/Manuf. Homes	2,486	2,486	0	0	0
Tourists	7,229	7,229	0	0	0
TOTAL	13,874	14,469	11,884	11,884	11,884
Monroe County – Upper Keys					
Site-built Homes	7,720	9,650	19,300	19,300	19,300
Mobile/Manuf. Homes	4,136	4,136	0	0	0
Tourists	8,844	8,844	0	0	0
TOTAL	20,700	22,630	19,300	19,300	19,300
Monroe County – Total					
Site-built Homes	28,687	33,510	77,142	77,142	77,142
Mobile/Manuf. Homes	12,150	12,150	0	0	0
Tourists	33,110	33,110	0	0	0
TOTAL	73,947	78,770	77,142	77,142	77,142
Miami-Dade County					
Site-built Homes	316,445	447,066	471,660	697,602	903,546
Mobile/Manuf. Homes	35,442	35,442	35,442	35,442	35,442
Tourists	19,556	25,598	25,598	26,810	26,810
TOTAL	371,443	508,106	532,700	759,854	965,798
Broward County					
Site-built Homes	164,032	171,617	258,604	412,147	612,425
Mobile/Manuf. Homes	32,575	32,575	32,575	32,575	32,575
Tourists	21,809	21,809	25,874	28,070	30,370
TOTAL	218,416	226,001	317,053	472,792	675,370

See Chapter III, Section C for the source of the small area data.

Table IV-9 – Evacuating Vehicles by Base Scenario for 2010

	Evacuation Level A Base Scenario	Evacuation Level B Base Scenario	Evacuation Level C Base Scenario	Evacuation Level D Base Scenario	Evacuation Level E Base Scenario
Monroe County – Key West					
Site-built Homes	5,599	6,399	15,997	15,997	15,997
Mobile/Manuf. Homes	1,557	1,557	0	0	0
Tourists	5,236	5,236	0	0	0
TOTAL	12,392	13,192	15,997	15,997	15,997
Monroe County – Lower Keys					
Site-built Homes	2,999	3,373	7,497	7,497	7,497
Mobile/Manuf. Homes	1,515	1,515	0	0	0
Tourists	443	443	0	0	0
TOTAL	4,957	5,331	7,497	7,497	7,497
Monroe County – Middle Keys					
Site-built Homes	2,316	2,646	6,616	6,616	6,616
Mobile/Manuf. Homes	1,488	1,488	0	0	0
Tourists	2,410	2,410	0	0	0
TOTAL	6,214	6,544	6,616	6,616	6,616
Monroe County – Upper Keys					
Site-built Homes	4,796	5,995	11,990	11,990	11,990
Mobile/Manuf. Homes	2,928	2,928	0	0	0
Tourists	2,948	2,948	0	0	0
TOTAL	10,672	11,871	11,990	11,990	11,990
Monroe County – Total					
Site-built Homes	15,710	18,413	42,100	42,100	42,100
Mobile/Manuf. Homes	7,488	7,488	0	0	0
Tourists	11,037	11,037	0	0	0
TOTAL	34,235	36,938	42,100	42,100	42,100
Miami-Dade County					
Site-built Homes	152,535	201,117	210,628	300,695	385,725
Mobile/Manuf. Homes	15,300	15,300	15,300	15,300	15,300
Tourists	13,396	17,535	17,535	18,363	18,363
TOTAL	181,231	233,952	243,463	334,358	419,388
Broward County					
Site-built Homes	73,185	76,514	116,659	177,212	258,340
Mobile/Manuf. Homes	14,630	14,630	14,630	14,630	14,630
Tourists	14,539	14,539	17,247	18,710	20,243
TOTAL	102,354	105,683	148,536	210,552	293,213

See Chapter III, Section C for the source of the small area data.

Table IV-10 – Evacuating Vehicles by Base Scenario for 2015

	Evacuation Level A Base Scenario	Evacuation Level B Base Scenario	Evacuation Level C Base Scenario	Evacuation Level D Base Scenario	Evacuation Level E Base Scenario
Monroe County – Key West					
Site-built Homes	5,829	6,661	16,653	16,653	16,653
Mobile/Manuf. Homes	1,563	1,563	0	0	0
Tourists	5,236	5,236	0	0	0
TOTAL	12,628	13,460	16,653	16,653	16,653
Monroe County – Lower Keys					
Site-built Homes	3,266	3,675	8,166	8,166	8,166
Mobile/Manuf. Homes	1,500	1,500	0	0	0
Tourists	443	443	0	0	0
TOTAL	5,209	5,618	8,166	8,166	8,166
Monroe County – Middle Keys					
Site-built Homes	2,436	2,785	6,961	6,961	6,961
Mobile/Manuf. Homes	1,484	1,484	0	0	0
Tourists	2,410	2,410	0	0	0
TOTAL	6,330	6,679	6,961	6,961	6,961
Monroe County – Upper Keys					
Site-built Homes	5,122	6,403	12,806	12,806	12,806
Mobile/Manuf. Homes	2,896	2,896	0	0	0
Tourists	2,948	2,948	0	0	0
TOTAL	10,966	12,247	12,806	12,806	12,806
Monroe County – Total					
Site-built Homes	16,653	19,524	44,586	44,586	44,586
Mobile/Manuf. Homes	7,443	7,443	0	0	0
Tourists	11,037	11,037	0	0	0
TOTAL	35,133	38,004	44,586	44,586	44,586
Miami-Dade County					
Site-built Homes	153,029	204,207	214,728	311,145	398,778
Mobile/Manuf. Homes	15,524	15,524	15,524	15,524	15,524
Tourists	13,396	17,535	17,535	18,363	18,363
TOTAL	181,949	237,266	247,787	345,032	432,665
Broward County					
Site-built Homes	76,444	79,932	121,782	185,244	269,840
Mobile/Manuf. Homes	15,475	15,475	15,475	15,475	15,475
Tourists	14,539	14,539	17,247	18,710	20,243
TOTAL	106,458	109,946	154,504	219,429	305,558

See Chapter III, Section C for the source of the small area data.

Table IV-11 – Shelter Demand by Base Scenario

	Evacuation Level A	Evacuation Level B	Evacuation Level C	Evacuation Level D	Evacuation Level E
2010					
Monroe – Key West	860	890	592	1,480	1,480
Monroe – Lower Keys	294	307	278	694	694
Monroe – Middle Keys	457	470	244	244	244
Monroe – Upper Keys	736	779	444	444	444
Monroe – Total	2,348	2,446	1,558	2,862	2,862
Miami-Dade County	22,762	27,659	29,419	46,163	61,894
Broward County	9,502	9,809	13,786	19,529	27,184
2015					
Monroe – Key West	870	901	616	1,541	1,541
Monroe – Lower Keys	302	318	302	755	755
Monroe – Middle Keys	463	475	257	257	257
Monroe – Upper Keys	744	792	474	474	474
Monroe – Total	2,377	2,486	1,648	3,027	3,027
Miami-Dade County	23,033	28,170	30,116	48,035	64,247
Broward County	9,894	10,216	14,350	20,365	28,338

Note: Shelter demand is the population in each county who will seek public shelter during their evacuation, either at an in-county shelter or an out of county shelter. See Chapter III, Section C for the source of the small area data.

Congested Roadways

Another important component of the transportation analysis is the identification of critical roadway segments for evacuation traffic. This analysis includes a review of vehicle flows during the evacuation period, along with excessive vehicle queues. A summary of the total number of evacuating vehicles for each of the base scenarios is presented in **Table IV-12**. It is important to note that the total number of evacuating vehicles in the table below includes vehicles evacuating from the two coastal counties on either side of the RPC, in addition to the three counties within the RPC, for a total of five evacuating counties.

Table IV-12 – Total Evacuating Vehicles for Base Scenarios

	Evacuation Level A Base Scenario	Evacuation Level B Base Scenario	Evacuation Level C Base Scenario	Evacuation Level D Base Scenario	Evacuation Level E Base Scenario
2010	494,972	608,312	740,299	934,203	1,145,954
2015	505,576	608,713	746,749	954,121	1,175,321

The identification of critical roadways in the evacuation network is also important to assist emergency managers with identifying roadways that have the greatest impact on clearance times. Critical roadways were identified by reviewing roadways in the model network that have the highest vehicle queues for extended periods of time during an evacuation. Due to the nature of a major evacuation in general, nearly all roadway facilities will have extended vehicle queues at some point during the evacuation process. The point of this analysis is to identify those roadway facilities that have vehicle queues for the longest time periods during each of the evacuation scenarios. Critical roadway segments for the South Florida Region are identified in **Figures IV-1** through **IV-10** for each of the base scenarios for 2010 and 2015.

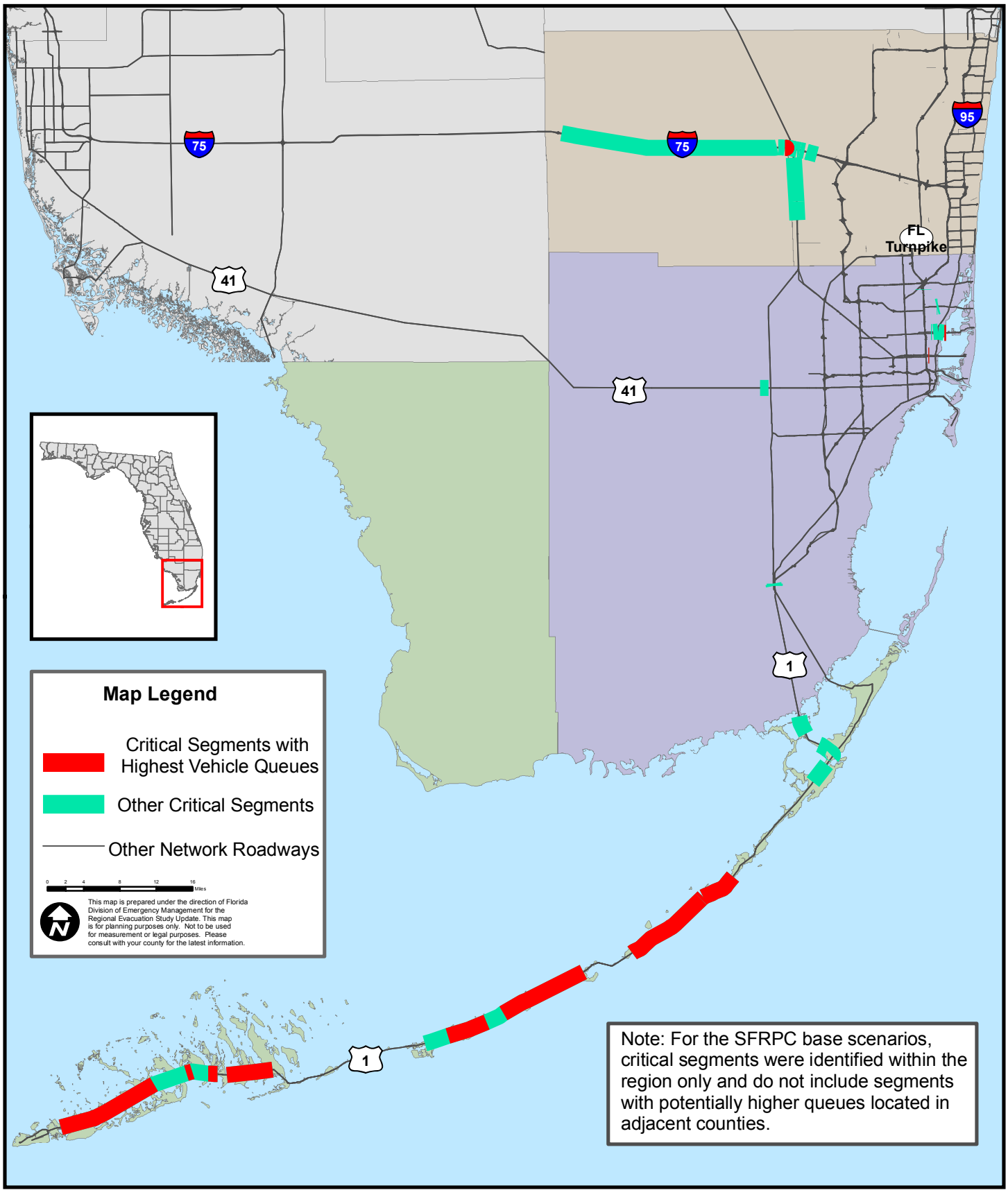
Through a review of the critical roadway segment figures, it is clear that US 1, I-95, I-75, the Turnpike, and numerous other roadways are critical facilities for all evacuation scenarios. During the level A evacuation scenarios, the roadway segments with the highest vehicle queues are primarily concentrated along the major Interstate and State Highway system. In contrast, for the level E evacuation scenarios, the roadway segments with the highest vehicle queues include other roadways both within and outside the region.

In addition to the identification of critical roadway segments, the total number of evacuating vehicles entering and exiting each county by evacuation scenario was also determined. Evacuating vehicles exiting each county by major evacuation route are identified in **Table IV-13** for 2010 and **Table IV-14** for 2015. In addition, evacuating vehicles entering each county by major evacuation route are identified in **Table IV-15** for 2010 and **Table IV-16** for 2015. Detailed volume figures for all evacuation routes in the South Florida Region for each base scenario are included in Volume 5-11.

The number of vehicles entering and exiting each county during an evacuation varies widely depending upon the scenario, roadway, and county. As expected, major interstates and state highways generally carry larger volumes of evacuating traffic. The vehicle flows into and out of each county also generally follow the same pattern as the critical segment figures, as locations with higher queues and congestion generally have higher traffic volumes.

Figure IV-1

Critical Roadway Segments with Excessive Vehicle Queues for 2010 Base Scenario Evacuation Level A

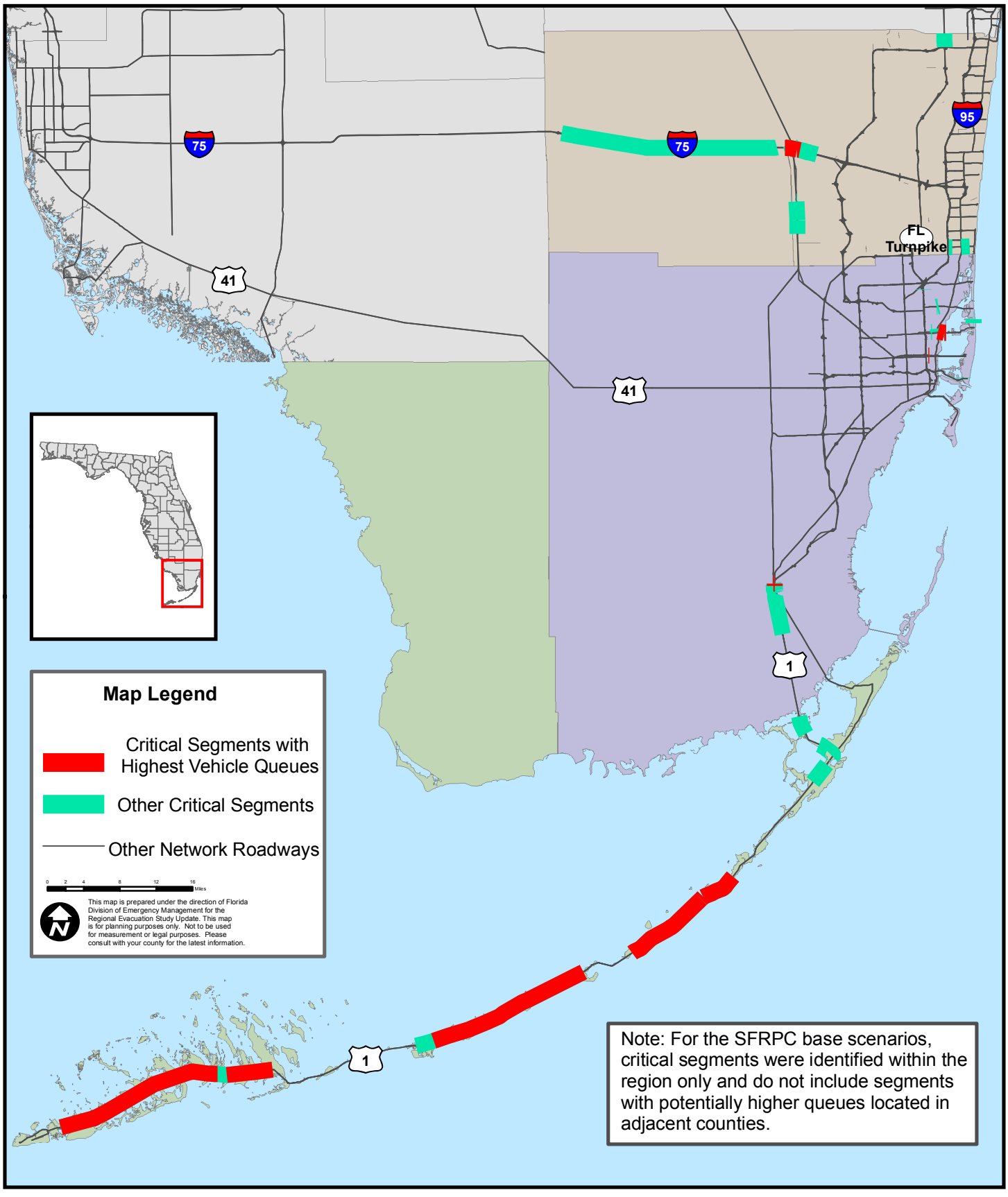


Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-2

Critical Roadway Segments with Excessive Vehicle Queues for 2010 Base Scenario Evacuation Level B

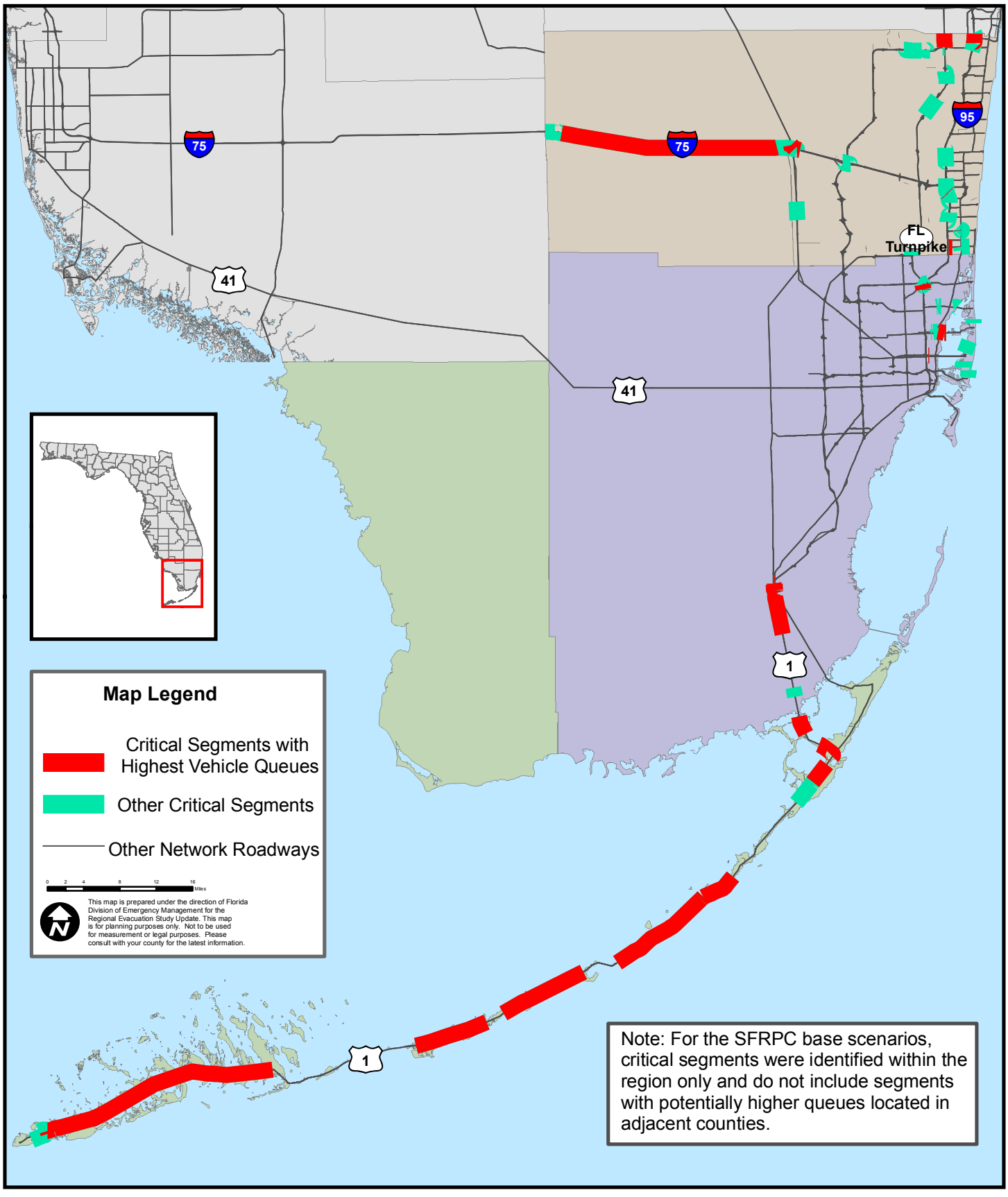


Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-3

Critical Roadway Segments with Excessive Vehicle Queues for 2010 Base Scenario Evacuation Level C

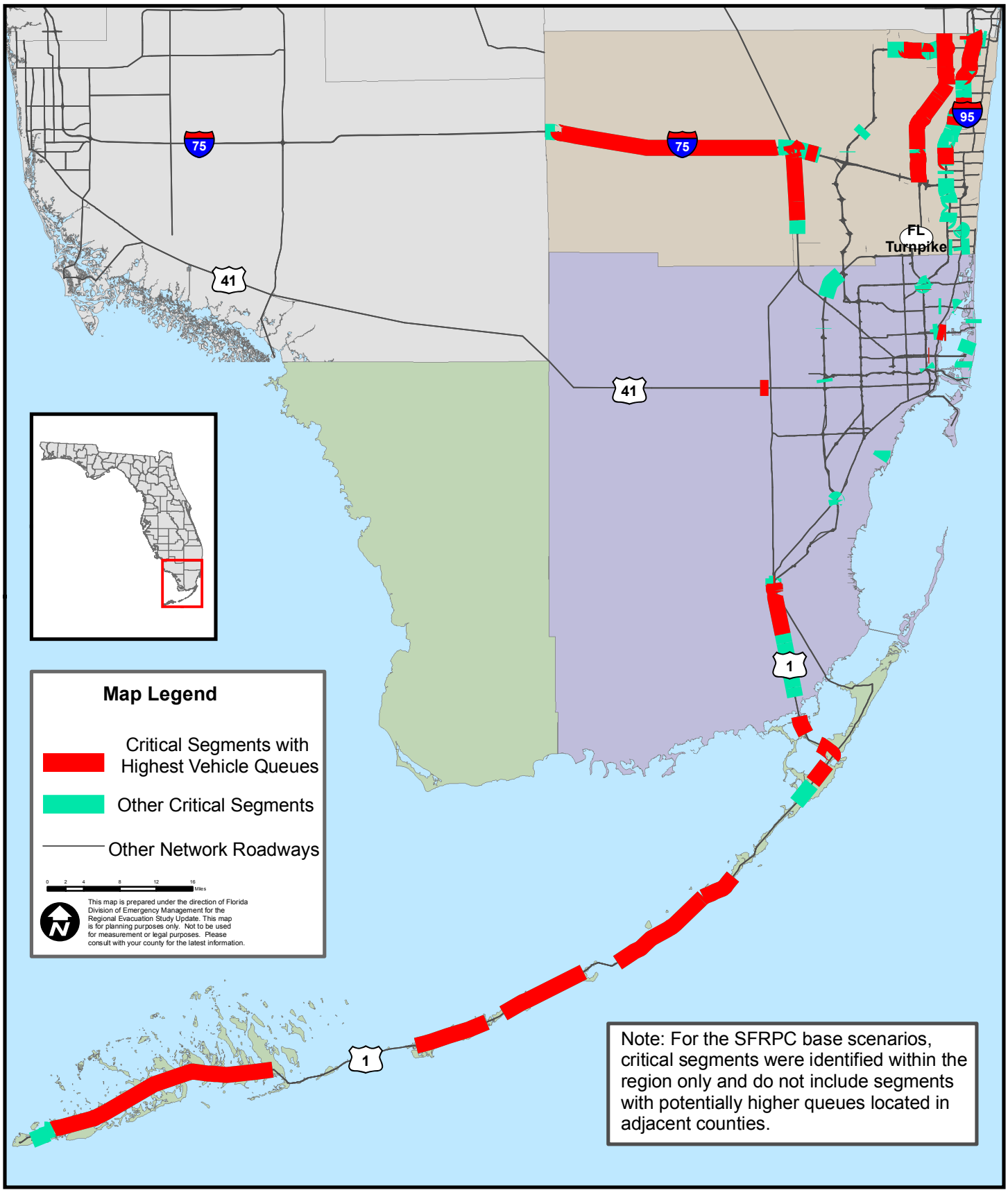


Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-4

Critical Roadway Segments with Excessive Vehicle Queues for 2010 Base Scenario Evacuation Level D

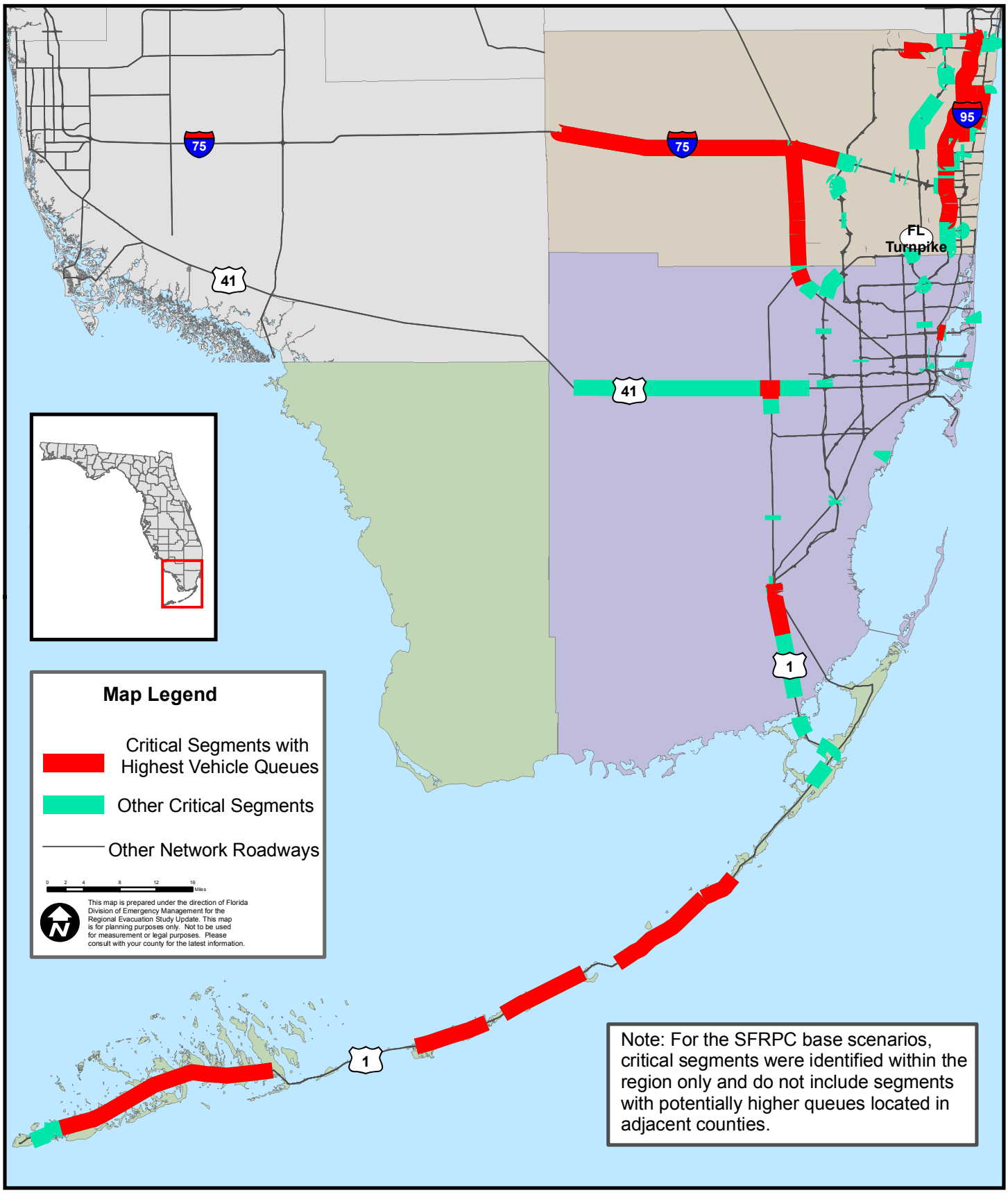


Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-5

Critical Roadway Segments with Excessive Vehicle Queues for 2010 Base Scenario Evacuation Level E

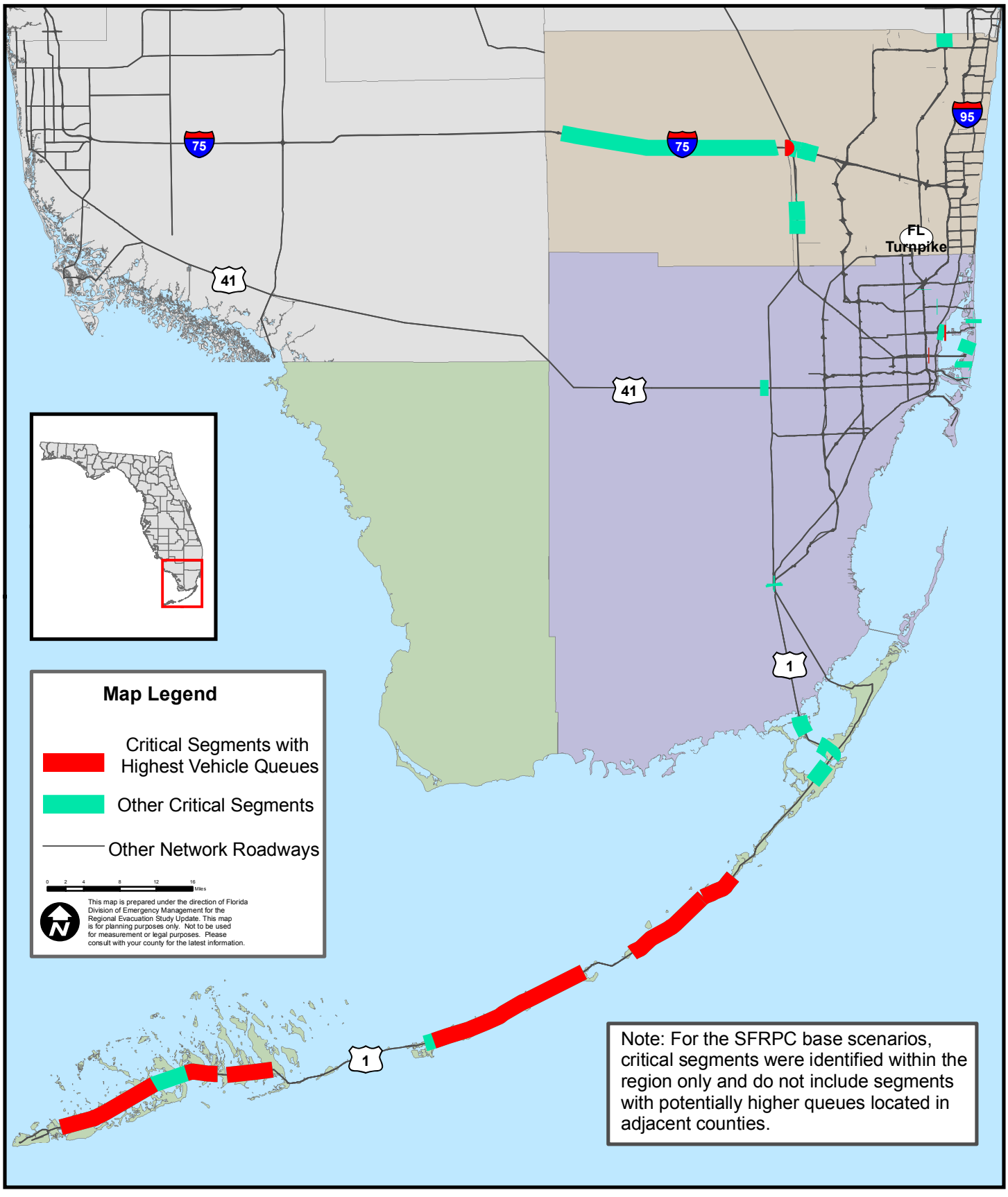


Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-6

Critical Roadway Segments with Excessive Vehicle Queues for 2015 Base Scenario Evacuation Level A

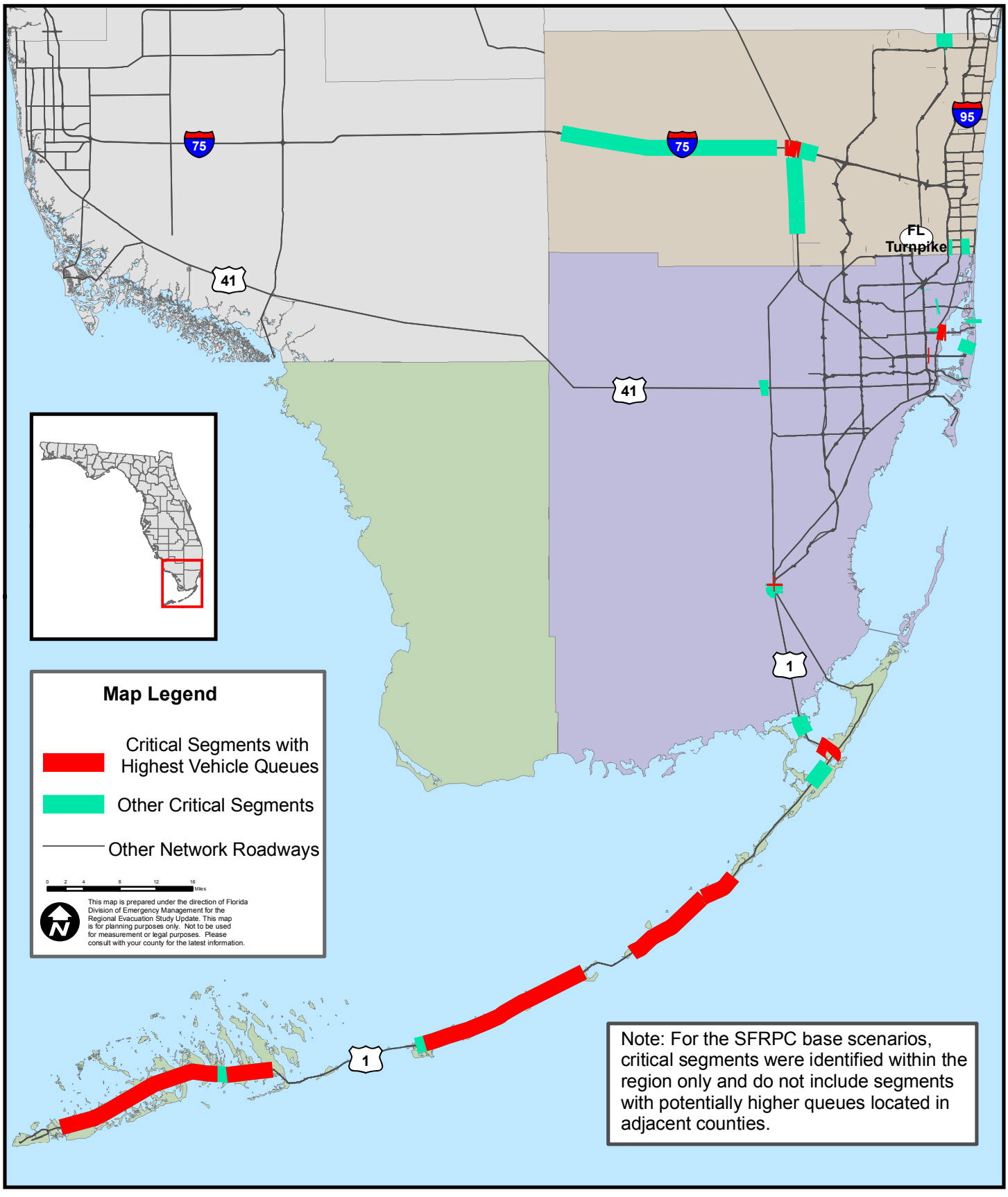


Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-7

Critical Roadway Segments with Excessive Vehicle Queues for 2015 Base Scenario Evacuation Level B

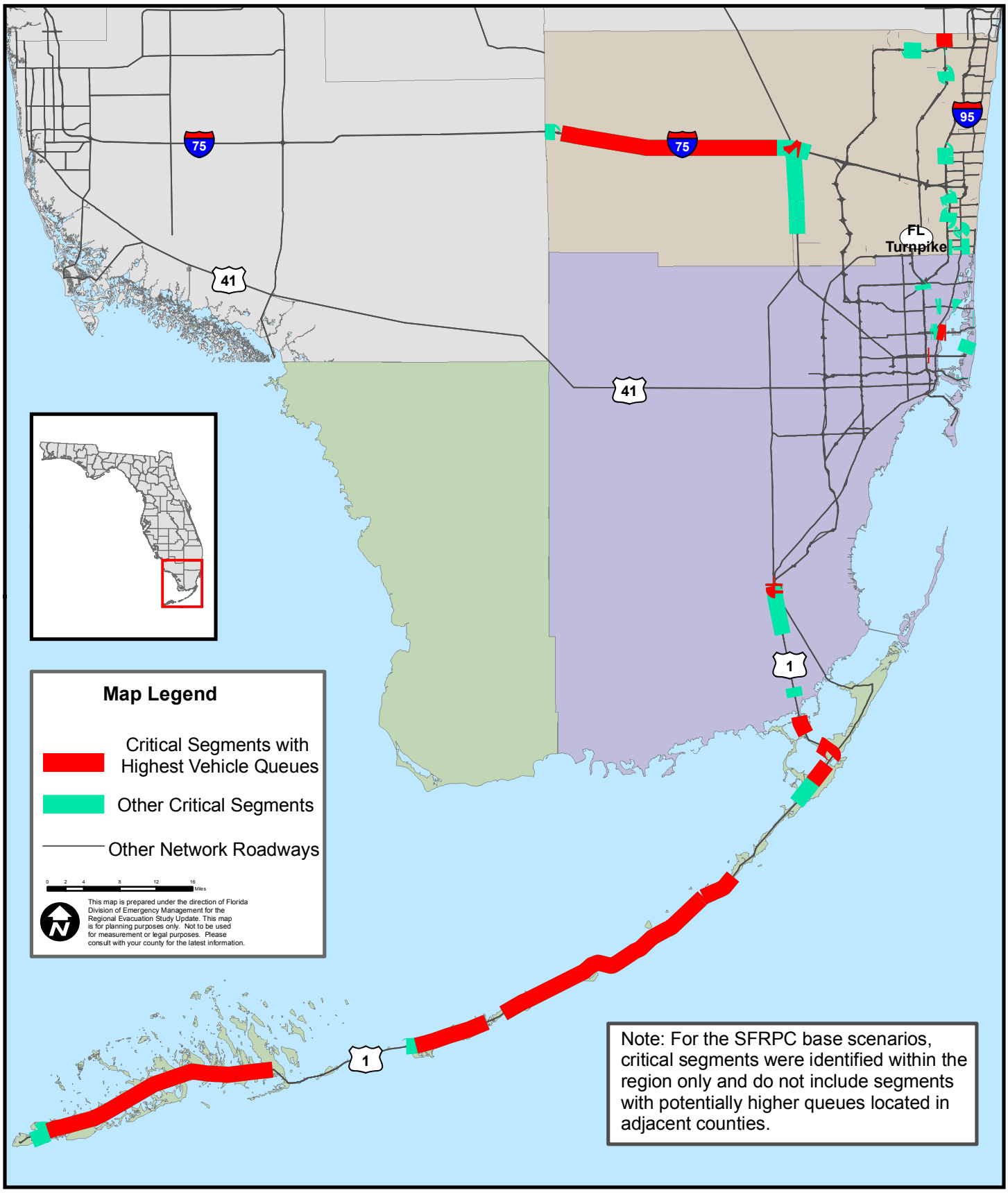


Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-8

Critical Roadway Segments with Excessive Vehicle Queues for 2015 Base Scenario Evacuation Level C

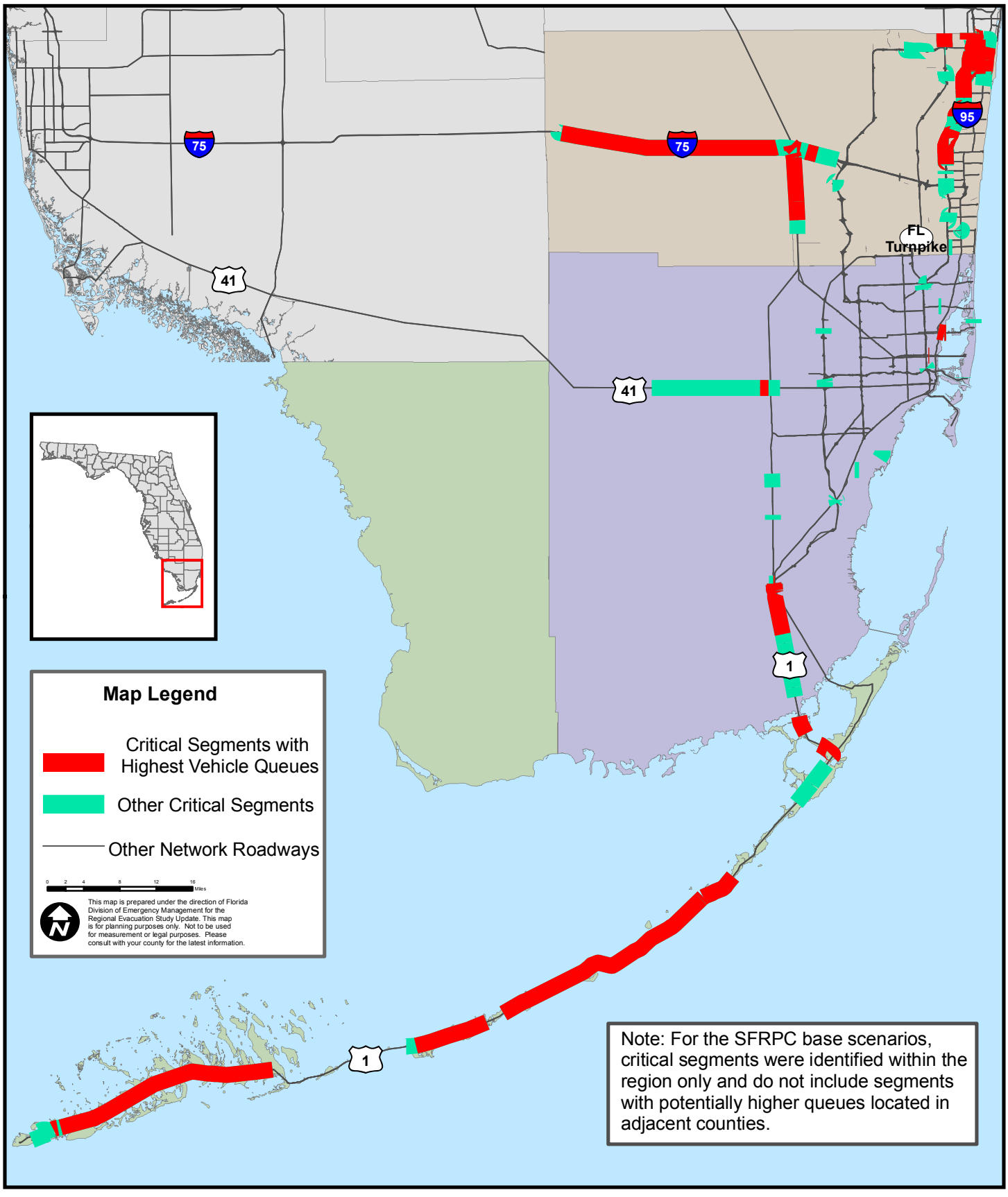


Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-9

Critical Roadway Segments with Excessive Vehicle Queues for 2015 Base Scenario Evacuation Level D

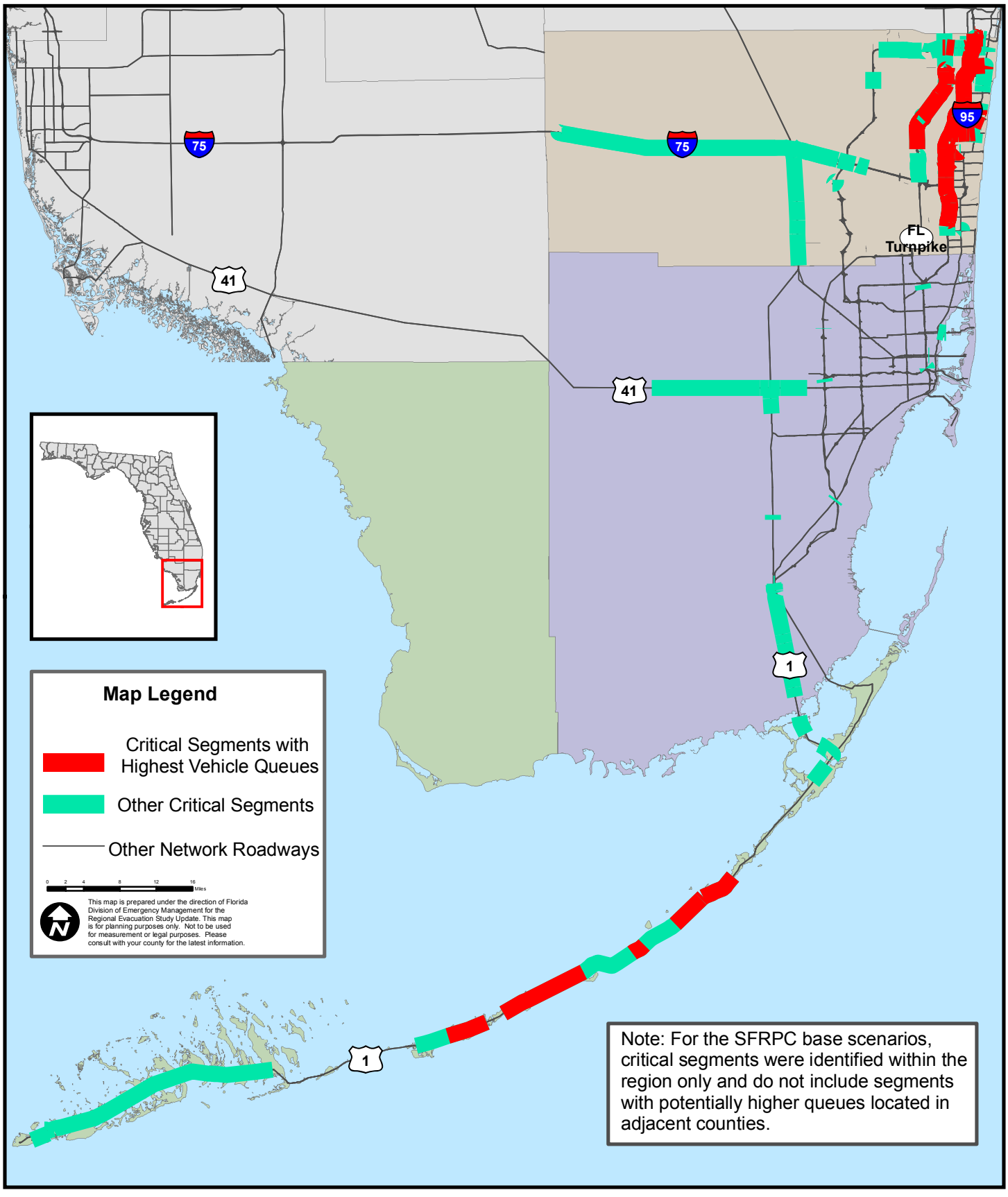


Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-10

Critical Roadway Segments with Excessive Vehicle Queues for 2015 Base Scenario Evacuation Level E



Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Table IV-13 – Evacuating Vehicles Leaving Each County by Evacuation Route for the 2010 Base Scenario

	Evacuation Level A Base Scenario	Evacuation Level B Base Scenario	Evacuation Level C Base Scenario	Evacuation Level D Base Scenario	Evacuation Level E Base Scenario
Monroe County					
US 1 Northbound	30,000	32,500	37,700	37,700	37,600
Miami-Dade County					
US 41 Westbound	300	6,200	4,200	16,400	21,500
US 27 Northbound	3,700	5,600	4,800	7,700	8,700
I-75 Northbound	16,000	21,100	28,500	36,400	56,700
FL 821 Northbound	17,000	20,600	24,900	30,300	28,700
Turnpike Northbnd	28,400	32,700	36,700	37,200	39,900
I-95 Northbound	13,300	21,200	20,600	27,900	34,800
US 1 Northbound	2,500	7,900	7,900	8,100	8,700
Broward County					
US 1 Southbound	400	100	100	200	300
I-95 Southbound	8,200	8,300	12,200	13,800	17,000
Turnpike Southbnd	1,700	1,700	2,300	3,200	5,700
FL 821 Southbound	2,500	2,700	3,600	5,600	8,900
I-75 Southbound	1,800	2,200	3,100	3,700	5,600
US 27 Southbound	0	100	100	0	100
I-75 Westbound	39,900	39,100	28,700	14,100	21,200
US 27 Northbound	12,800	17,200	19,700	24,800	33,100
Turnpike Northbnd	43,900	52,100	64,000	53,200	73,900
I-95 Northbound	23,700	31,500	35,500	49,900	53,800
US 1 Northbound	1,200	2,500	8,000	14,500	18,900

Table IV-14 – Evacuating Vehicles Leaving Each County by Evacuation Route for the 2015 Base Scenario

	Evacuation Level A Base Scenario	Evacuation Level B Base Scenario	Evacuation Level C Base Scenario	Evacuation Level D Base Scenario	Evacuation Level E Base Scenario
Monroe County					
US 1 Northbound	30,800	33,400	39,900	39,900	39,900
Miami-Dade County					
US 41 Westbound	6,900	7,000	6,800	13,300	19,400
US 27 Northbound	4,600	6,000	6,300	9,100	10,100
I-75 Northbound	15,700	21,900	28,300	44,000	67,500
FL 821 Northbound	18,100	22,600	27,000	31,300	25,300
Turnpike Northbnd	28,800	34,800	39,300	42,600	46,500
I-95 Northbound	12,000	18,800	16,800	25,300	30,300
US 1 Northbound	2,200	7,600	7,400	8,000	8,400
Broward County					
US 1 Southbound	400	100	100	200	300
I-95 Southbound	8,300	8,300	12,000	14,400	18,000
Turnpike Southbnd	1,800	1,700	2,200	3,200	6,100
FL 821 Southbound	2,600	2,700	4,000	5,300	9,400
I-75 Southbound	1,700	1,900	2,700	3,600	5,000
US 27 Southbound	0	100	100	0	100
I-75 Westbound	41,100	39,600	35,300	34,200	43,400
US 27 Northbound	12,300	15,000	20,900	23,600	30,200
Turnpike Northbnd	46,600	54,900	61,600	65,900	70,600
I-95 Northbound	23,700	24,100	32,500	49,400	44,400
US 1 Northbound	400	3,900	6,700	14,600	22,800

Table IV-15 – Evacuating Vehicles Entering Each County by Evacuation Route for the 2010 Base Scenario

	Evacuation Level A Base Scenario	Evacuation Level B Base Scenario	Evacuation Level C Base Scenario	Evacuation Level D Base Scenario	Evacuation Level E Base Scenario
Miami-Dade County					
US 1 Southbound	400	100	100	200	300
I-95 Southbound	8,200	8,300	12,200	13,800	17,000
Turnpike Southbnd	1,700	1,700	2,300	3,200	5,700
FL 821 Southbound	2,500	2,700	3,600	5,600	8,900
I-75 Southbound	1,800	2,200	3,100	3,700	5,600
US 27 Southbound	0	100	100	0	100
US 1 Northbound	30,000	32,500	37,700	37,700	37,600
Broward County					
US 1 Southbound	200	100	100	300	700
I-95 Southbound	2,600	1,600	1,900	2,700	3,100
Turnpike Southbnd	1,400	1,000	1,300	1,700	2,300
US 27 Southbound	100	100	100	100	100
US 27 Northbound	3,700	5,600	4,800	7,700	8,700
I-75 Northbound	16,000	21,100	28,500	36,400	56,700
FL 821 Northbound	17,000	20,600	24,900	30,300	28,700
Turnpike Northbnd	28,400	32,700	36,700	37,200	39,900
I-95 Northbound	13,300	21,200	20,600	27,900	34,800
US 1 Northbound	2,500	7,900	7,900	8,100	8,700

Table IV-16 – Evacuating Vehicles Entering Each County by Evacuation Route for the 2015 Base Scenario

	Evacuation Level A Base Scenario	Evacuation Level B Base Scenario	Evacuation Level C Base Scenario	Evacuation Level D Base Scenario	Evacuation Level E Base Scenario
Miami-Dade County					
US 1 Southbound	400	100	100	200	300
I-95 Southbound	8,300	8,300	12,000	14,400	18,000
Turnpike Southbnd	1,800	1,700	2,200	3,200	6,100
FL 821 Southbound	2,600	2,700	4,000	5,300	9,400
I-75 Southbound	1,700	1,900	2,700	3,600	5,000
US 27 Southbound	0	100	100	0	100
US 1 Northbound	30,800	33,400	39,900	39,900	39,900
Broward County					
US 1 Southbound	100	1,200	100	300	800
I-95 Southbound	2,700	1,700	2,200	2,800	3,400
Turnpike Southbnd	1,500	900	1,500	2,000	2,300
US 27 Southbound	100	100	100	100	200
US 27 Northbound	4,600	6,000	6,300	9,100	10,100
I-75 Northbound	15,700	21,900	28,300	44,000	67,500
FL 821 Northbound	18,100	22,600	27,000	31,300	25,300
Turnpike Northbnd	28,800	34,800	39,300	42,600	46,500
I-95 Northbound	12,000	18,800	16,800	25,300	30,300
US 1 Northbound	2,200	7,600	7,400	8,000	8,400

Clearance Times

Calculated clearance times are used by county emergency managers as one input to determine when to recommend an evacuation order. Clearance times for each of the base scenarios are summarized in **Table IV-17** and **IV-18**, as well as **Figures IV-11, IV-12,** and **IV-13**. Clearance time includes several components, including the mobilization time for the evacuating population to prepare for an evacuation (pack supplies and personal belongs, load their vehicle, etc.), the actual time spent traveling on the roadway network, and the delay time caused by traffic congestion.

In-county clearance times for the base scenarios range from 12.5 hours for the evacuation level A scenarios to 31 hours for evacuation level E scenarios in 2010. Clearance Time to Shelter shows a similar pattern, with clearance times for the base scenarios ranging from 3 hours for Monroe County in the evacuation level A scenarios to 30 hours for Broward County for evacuation level E scenario in 2010. In-county clearance times generally remain close to the selected response curve for lower level evacuation scenarios, such as the 12 hour curves for the level A, B, and C base scenarios. Clearance times are generally not less than the response curve unless in county or to shelter population numbers are very low, such as in the Key West area of Monroe County.

In 2015, in-county clearance times for the base scenarios range from 12.5 hours for the evacuation level A scenarios to 45 hours for Broward County for the evacuation level E scenario. Clearance Time to Shelter shows a similar pattern, with clearance times for the base scenarios ranging from 4 hours for the Monroe County evacuation level A scenario to 45 hours for Broward County for evacuation level E scenario in 2015. In county clearance times for Miami-Dade County in level B or higher scenarios are typically equal to or above Monroe County out of county clearance times. By definition, in county clearance time includes out of county trips from other counties that pass through evacuation zones in the evacuating county. Miami-Dade County has a combined B/C evacuation zone where US 1 enters from Monroe County, so in county clearance time for Miami-Dade in all level B or higher base scenarios will reflect the out of county clearance time for Monroe County.

In-county clearance time for Broward County increases significantly for the level E scenario from 2010 to 2015 due to significant capacity issues on I-95 in Palm Beach County near the Okeechobee Boulevard interchange. While this capacity issue affects all scenarios, the 30,000 additional evacuating vehicles between the 2010 and 2015 level E scenario cause the queuing and spillback from Palm Beach County to more significantly impact the in-county and shelter evacuating vehicles in Broward County in 2015 than in 2010.

Out of county clearance times for the base scenarios range from 24 hours for the base evacuation level A scenario to 39.5 hours in Broward County for the evacuation level E scenario. Out of county clearance times range from 24.5 hours for the base evacuation level A scenario to 46 hours in Broward County in 2015.

Regional clearance time for the three county SFRPC region ranges from 26 hours to 39.5 hours in 2010 and from 26.5 to 46 hours in 2015.

Table IV-17 – 2010 Clearance Times for Base Scenario

	Evacuation Level A Base Scenario	Evacuation Level B Base Scenario	Evacuation Level C Base Scenario	Evacuation Level D Base Scenario	Evacuation Level E Base Scenario
Clearance Time to Shelter					
Monroe – Key West	3.0	2.5	N/A	N/A	N/A
Monroe – Lower Keys	N/A	N/A	N/A	N/A	N/A
Monroe – Middle Keys	N/A	N/A	N/A	N/A	N/A
Monroe – Upper Keys	N/A	N/A	N/A	N/A	N/A
Monroe – Total	3.0	2.5	N/A	N/A	N/A
Miami-Dade County	13.0	13.0	13.0	13.0	13.5
Broward County	12.5	12.5	13.0	19.0	30.0
In-County Clearance Time					
Monroe – Key West	12.5	12.5	15.5	15.5	15.5
Monroe – Lower Keys	17.5	18.5	22.5	22.5	22.5
Monroe – Middle Keys	22.0	23.0	27.5	27.5	27.5
Monroe – Upper Keys	24.0	26.0	31.0	31.0	31.0
Monroe – Total	24.0	26.0	31.0	31.0	31.0
Miami-Dade County	13.0	26.5	31.0	31.0	31.0
Broward County	12.5	12.5	13.5	20.0	31.0
Out of County Clearance Time					
Monroe – Key West	12.5	12.5	15.0	15.0	15.0
Monroe – Lower Keys	17.0	18.0	22.0	22.0	22.0
Monroe – Middle Keys	21.5	22.5	27.0	27.0	27.0
Monroe – Upper Keys	24.0	25.5	30.5	30.5	30.5
Monroe – Total	24.0	25.5	30.5	30.5	30.5
Miami-Dade County	25.5	27.0	31.5	31.5	32.0
Broward County	26.0	27.5	32.0	32.0	39.5
Regional Clearance Time					
South Florida Region	26.0	27.5	32.0	32.0	39.5

Note: In-county clearance times are generally not less than the response curve unless in county or to shelter population numbers are very low. The base scenarios use a 12 hour response curve.. Also, in county clearance times for Miami-Dade County are typically equal to or above Monroe County out of county clearance times for all level B or higher scenarios that include Monroe County evacuating. By definition, in county clearance time includes out of county trips from other counties that pass through evacuation zones in the evacuating county, including Miami-Dade's combined B/C evacuation zone located where US 1 enters from Monroe County.

Table IV-18 – 2015 Clearance Times for Base Scenario

	Evacuation Level A Base Scenario	Evacuation Level B Base Scenario	Evacuation Level C Base Scenario	Evacuation Level D Base Scenario	Evacuation Level E Base Scenario
Clearance Time to Shelter					
Monroe – Key West	4.0	3.0	N/A	N/A	N/A
Monroe – Lower Keys	N/A	N/A	N/A	N/A	N/A
Monroe – Middle Keys	N/A	N/A	N/A	N/A	N/A
Monroe – Upper Keys	N/A	N/A	N/A	N/A	N/A
Monroe – Total	4.0	3.0	N/A	N/A	N/A
Miami-Dade County	13.0	13.0	13.0	13.0	14.5
Broward County	12.5	12.5	13.0	21.0	45.0
In-County Clearance Time					
Monroe – Key West	12.5	12.5	16.5	16.5	16.5
Monroe – Lower Keys	17.5	18.5	24.0	24.0	24.0
Monroe – Middle Keys	22.5	23.5	29.0	29.0	29.0
Monroe – Upper Keys	25.0	27.0	32.5	32.5	32.5
Monroe – Total	25.0	27.0	32.5	32.5	32.5
Miami-Dade County	13.0	27.0	32.5	32.5	32.5
Broward County	12.5	12.5	13.0	21.0	45.0
Out of County Clearance Time					
Monroe – Key West	12.5	12.5	16.0	16.0	16.0
Monroe – Lower Keys	17.0	18.0	23.5	23.5	23.5
Monroe – Middle Keys	22.0	23.0	28.5	28.5	28.5
Monroe – Upper Keys	24.5	26.5	32.0	32.0	32.0
Monroe – Total	24.5	26.5	32.0	32.0	32.0
Miami-Dade County	26.0	27.5	33.0	33.0	35.0
Broward County	26.5	28.0	33.5	33.5	46.0
Regional Clearance Time					
South Florida Region	26.5	28.0	33.5	33.5	46.0

Note: In-county clearance times are generally not less than the response curve unless in county or to shelter population numbers are very low. The base scenarios use a 12 hour response curve.. Also, in county clearance times for Miami-Dade County are typically equal to or above Monroe County out of county clearance times for all level B or higher scenarios that include Monroe County evacuating. By definition, in county clearance time includes out of county trips from other counties that pass through evacuation zones in the evacuating county, including Miami-Dade's combined B/C evacuation zone located where US 1 enters from Monroe County.

Figure IV-11 - Clearance Time to Shelter Base Scenarios

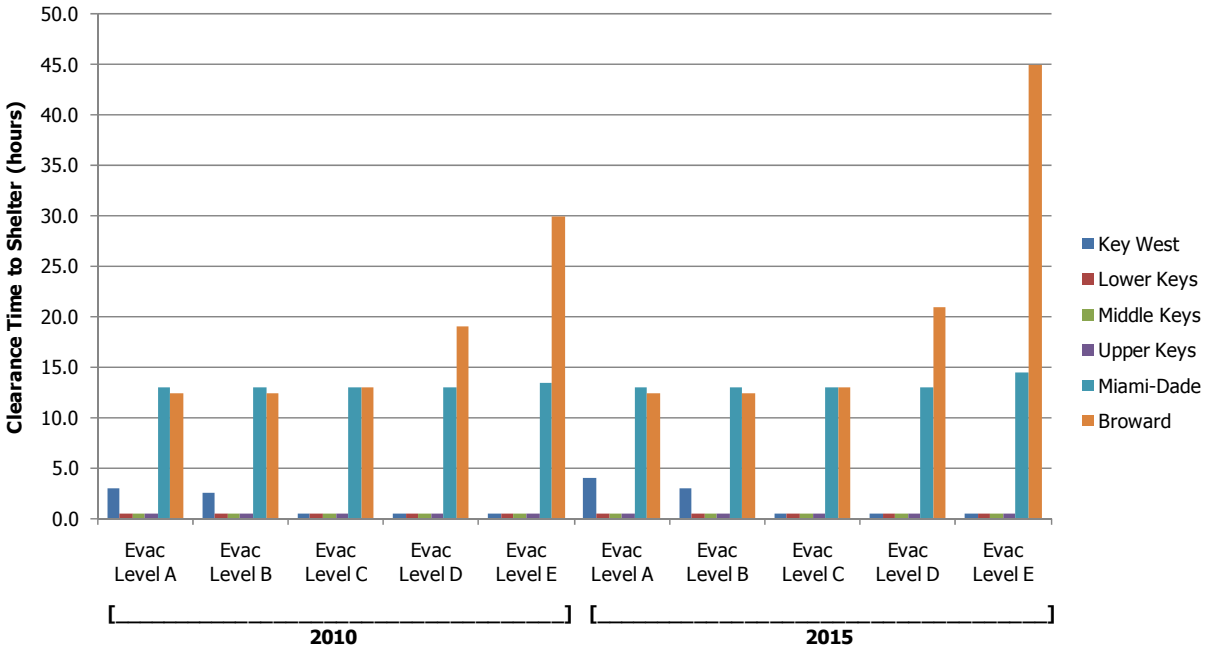


Figure IV-12 - In-County Clearance Times Base Scenarios

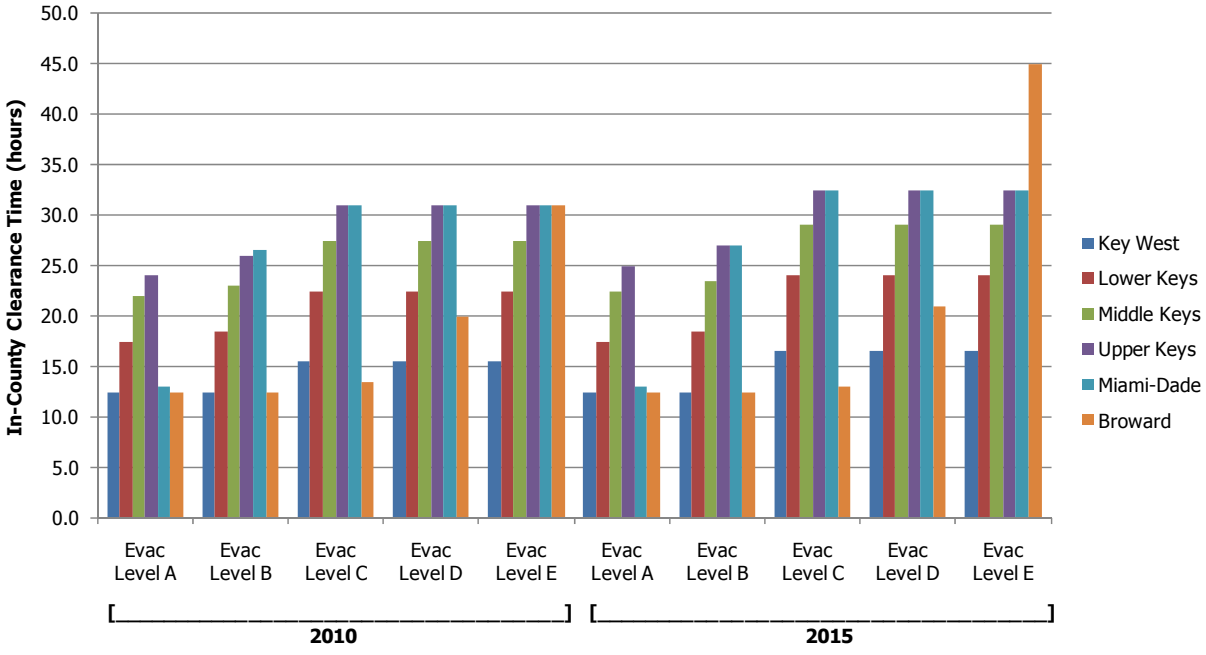
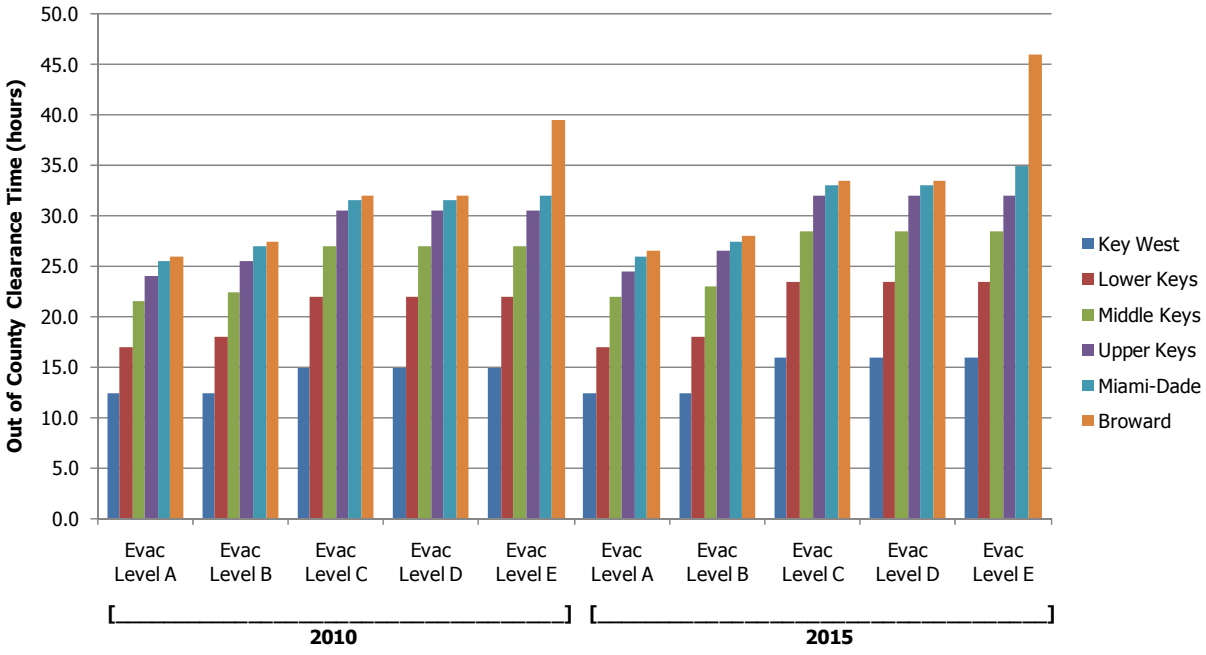


Figure IV-13 - Out of County Clearance Times
Base Scenarios



F. Operational Scenarios

The transportation analysis also included 21 region wide operational scenarios selected by the county emergency managers and RPC staff for the South Florida Region. While the base scenarios required that the basic assumptions were consistent between scenarios except for the year and the evacuation level, this is not the case for the operational scenarios. The only requirement for each region is that two operational scenarios are developed for each evacuation level (two for Level A, two for Level B, etc.). Otherwise, the assumptions and characteristics between the 21 operational scenarios can be different for each scenario.

The 21 operational scenarios selected for analysis in the South Florida Region are illustrated in **Table IV-19**. All 21 operational scenarios used the default tourist and university population rates. Response curves ranged from 9 hours to 12 hours depending upon the scenario. Because of the unique characteristics of the South Florida region, the operational scenarios include a wide variety of evacuations, including both single county evacuations and multi-county evacuations.

The operational scenarios generally did not test phased evacuations, with the exception of scenarios 1 through 5 and 13. These scenarios assumed Monroe County would order their evacuation 24 hours prior to the other counties in the scenario, such as Miami-Dade or Broward.

One-way evacuation operations were tested with two of the operational scenarios and all operational scenarios used the default roadway network. Scenario 14 tested one-way operations on the Turnpike (from Lantana north) and Scenario 15 tested one-way operations on both the Turnpike and I-75 (from US 27 west on Alligator Alley). It is important to note that one-way operations are only used during daylight hours and were modeled only during the first 12 hours of an evacuation. In addition, primary shelters were open in all scenarios, with other shelters also open as part of the level D and E evacuation scenarios.

Table IV-19 – Operational Scenarios

	Scenario 1 Level A 2010	Scenario 2 Level B 2010	Scenario 3 Level C 2010	Scenario 4 Level D 2010	Scenario 5 Level E 2010
Demographic Data	2010	2010	2010	2010	2010
Highway Network	2010	2010	2010	2010	2010
One-Way Operations	None	None	None	None	None
University Population	Default	Default	Default	Default	Default
Tourist Rate	Default	Default	Default	Default	Default
Shelters Open	Primary	Primary	Primary	Primary/Other	Primary/Other
Response Curve	9-hour	12-hour	9-hour	12-hour	12-hour
Evacuation Phasing	Miami-Dade and Broward 24 hours after Monroe	Miami-Dade and Broward 24 hours after Monroe	Miami-Dade and Broward 24 hours after Monroe	Miami-Dade, Broward, and Palm Beach 24 hours after Monroe	Miami-Dade, Broward, and Palm Beach 24 hours after Monroe and Collier
Behavioral Response	Planning	Planning	Planning	Planning	Planning
Evacuation Zone	A	B	C	D	E
Counties Evacuating	Monroe Miami-Dade Broward	Monroe Miami-Dade Broward	Monroe Miami-Dade Broward	Monroe Miami-Dade Broward Palm Beach	Monroe Miami-Dade Broward Palm Beach Collier

	Scenario 6 Level A 2010	Scenario 7 Level B 2010	Scenario 8a Level C 2010	Scenario 8b Level C 2010	Scenario 9 Level D 2010	Scenario 10 Level E 2010
Demographic Data	2010	2010	2010	2010	2010	2010
Highway Network	2010	2010	2010	2010	2010	2010
One-Way Operations	None	None	None	None	None	None
University Population	Default	Default	Default	Default	Default	Default
Tourist Rate	Default	Default	Default	Default	Default	Default
Shelters Open	Primary	Primary	Primary	Primary	Primary/Other	Primary/Other
Response Curve	9-hour	9-hour	12-hour	12-hour	9-hour	9-hour
Evacuation Phasing	None	None	None	None	None	None
Behavioral Response	Planning	Planning	Planning	100%	Planning	Planning
Evacuation Zone	A	B	C	C	D	E
Counties Evacuating	Monroe Miami-Dade	Broward	Monroe	Monroe	Miami-Dade	Broward

	Scenario 11 Level A 2015	Scenario 12 Level B 2015	Scenario 13 Level C 2015	Scenario 14 Level D 2015	Scenario 15 Level E 2015
Demographic Data	2015	2015	2015	2015	2015
Highway Network	2015	2015	2015	2015	2015
One-Way Operations	None	None	None	Turnpike	Turnpike & I-75
University Population	Default	Default	Default	Default	Default
Tourist Rate	Default	Default	Default	Default	Default
Shelters Open	Primary	Primary	Primary	Primary/Other	Primary/Other
Response Curve	9-hour	12-hour	12-hour	9-hour	12-hour
Evacuation Phasing	None	None	Miami-Dade and Broward 24 hours after Monroe	None	None
Behavioral Response	Planning	Planning	Planning	Planning	Planning
Evacuation Zone	A	B	C	D	E
Counties Evacuating	Monroe Miami-Dade Broward	Monroe Miami-Dade Broward	Monroe Miami-Dade Broward	Monroe Miami-Dade Broward Palm Beach	Monroe Miami-Dade Broward Palm Beach Collier

Table IV-19 – Operational Scenarios

	Scenario 16 Level A 2015	Scenario 17 Level B 2015	Scenario 18 Level C 2015	Scenario 19 Level D 2015	Scenario 20 Level E 2015
Demographic Data	2015	2015	2015	2015	2015
Highway Network	2015	2015	2015	2015	2015
One-Way Operations	None	None	None	None	None
University Population	Default	Default	Default	Default	Default
Tourist Rate	Default	Default	Default	Default	Default
Shelters Open	Primary	Primary	Primary/Other	Primary/Other	Primary/Other
Response Curve	12-hour	9-hour	12-hour	18-hour	12-hour
Evacuation Phasing	None	None	None	None	None
Behavioral Response	Planning	Planning	Planning	Planning	Planning
Evacuation Zone	A	B	C	D	E
Counties Evacuating	Monroe Miami-Dade	Broward Miami-Dade	Broward	Monroe	Miami-Dade

G. Operational Scenario Results

Each of the 21 operational scenarios were modeled for the South Florida Region using the regional evacuation model. Results were derived from the model to summarize the evacuating population, evacuating vehicles, clearance times, and critical congested roadways. The results are discussed in the following sections.

Evacuating Population

Similar to the base scenarios, the evacuating population was estimated for the three county region. Evacuating population for the operational scenarios is summarized by county for 2010 in **Table IV-20** and for 2015 in **Table IV-21**.

Within the three county region, total evacuating population ranges from nearly 51,000 persons for a single Monroe County evacuation to nearly 1.5 million persons for the operational scenario level E multi-county evacuation in 2010. By 2015, total evacuating population ranges from nearly 61,700 persons for a single county evacuation to nearly 1.6 million persons for the operational scenario level E evacuation.

Evacuating Vehicles

From a transportation standpoint, the number of evacuating vehicles is more important than the evacuating population. Evacuating vehicles for the operational scenarios are summarized by county for 2010 in **Table IV-22** and for 2015 in **Table IV-23**.

The total number of evacuating vehicles within the three county region for the operational scenarios also varies by evacuation level. On the low end, a total of more than 29,500 vehicles evacuate during the level C Monroe County only evacuation (Scenario 8). On the high end, a total of more than 720,800 evacuating vehicles are estimated for Scenario 15, which is a multi-county level E scenario.

Shelter Demand

Shelter demand estimates by county are summarized for each of the operational scenarios in **Table IV-24**. Shelter demand is the population in each county who will seek public shelter during their evacuation, either at an in-county shelter or an out of county shelter.

Public shelter demand in the three county region ranges from only 1,100 persons to more than 85,300 persons depending upon the scenario. By 2015, the public shelter demand is expected to increase to a range of between 2,400 and 91,300 persons, depending upon the scenario.

Table IV-20 – Evacuating Population by Operational Scenario for 2010

	Scenario 1 Evacuation Level A	Scenario 2 Evacuation Level B	Scenario 3 Evacuation Level C	Scenario 4 Evacuation Level D	Scenario 5 Evacuation Level E
Monroe County – Key West					
Site-built Homes	10,576	12,086	21,151	24,173	27,194
Mobile/Manuf. Homes	2,025	2,337	0	0	0
Tourists	15,709	15,709	0	0	0
TOTAL	28,310	30,132	21,151	24,173	27,194
Monroe County – Lower Keys					
Site-built Homes	5,322	5,987	9,313	10,644	11,974
Mobile/Manuf. Homes	1,577	1,820	0	0	0
Tourists	1,328	1,328	0	0	0
TOTAL	8,227	9,135	9,313	10,644	11,974
Monroe County – Middle Keys					
Site-built Homes	3,951	4,516	7,903	9,032	10,161
Mobile/Manuf. Homes	1,620	1,869	0	0	0
Tourists	7,229	7,229	0	0	0
TOTAL	12,800	13,614	7,903	9,032	10,161
Monroe County – Upper Keys					
Site-built Homes	7,223	9,029	12,640	14,446	16,252
Mobile/Manuf. Homes	2,712	3,130	0	0	0
Tourists	8,844	8,844	0	0	0
TOTAL	18,779	21,003	12,640	14,446	16,252
Monroe County – Total					
Site-built Homes	27,072	31,618	51,007	58,295	65,581
Mobile/Manuf. Homes	7,934	9,156	0	0	0
Tourists	33,110	33,110	0	0	0
TOTAL	68,116	73,884	51,007	58,295	65,581
Miami-Dade County					
Site-built Homes	204,002	249,277	323,975	534,130	784,054
Mobile/Manuf. Homes	18,381	21,471	23,740	26,926	28,680
Tourists	19,556	25,598	25,598	26,810	26,810
TOTAL	241,939	296,346	373,313	587,866	839,544
Broward County					
Site-built Homes	124,614	138,664	188,735	346,081	531,026
Mobile/Manuf. Homes	15,323	18,302	19,893	22,882	24,402
Tourists	21,809	21,809	25,874	28,070	30,370
TOTAL	161,746	178,775	234,502	397,033	585,798

See Chapter III, Section C for the source of the small area data.

Table IV-20 – Evacuating Population by Operational Scenario for 2010 (cont.)

	Scenario 6 Evacuation Level A	Scenario 7 Evacuation Level B	Scenario 8a Evacuation Level C	Scenario 8b Evacuation Level C	Scenario 9 Evacuation Level D	Scenario 10 Evacuation Level E
Monroe County – Key West						
Site-built Homes	10,576	0	21,151	30,216	0	0
Mobile/Manuf. Homes	2,025	0	0	0	0	0
Tourists	15,709	0	0	0	0	0
TOTAL	28,310	0	21,151	30,216	0	0
Monroe County – Lower Keys						
Site-built Homes	5,322	0	9,313	13,305	0	0
Mobile/Manuf. Homes	1,577	0	0	0	0	0
Tourists	1,328	0	0	0	0	0
TOTAL	8,227	0	9,313	13,305	0	0
Monroe County – Middle Keys						
Site-built Homes	3,951	0	7,903	11,290	0	0
Mobile/Manuf. Homes	1,620	0	0	0	0	0
Tourists	7,229	0	0	0	0	0
TOTAL	12,800	0	7,903	11,290	0	0
Monroe County – Upper Keys						
Site-built Homes	7,223	0	12,640	18,057	0	0
Mobile/Manuf. Homes	2,712	0	0	0	0	0
Tourists	8,844	0	0	0	0	0
TOTAL	18,779	0	12,640	18,057	0	0
Monroe County – Total						
Site-built Homes	27,072	0	51,007	72,868	0	0
Mobile/Manuf. Homes	7,934	0	0	0	0	0
Tourists	33,110	0	0	0	0	0
TOTAL	68,116	0	51,007	72,868	0	0
Miami-Dade County						
Site-built Homes	204,002	0	0	0	534,130	0
Mobile/Manuf. Homes	18,381	0	0	0	26,926	0
Tourists	19,556	0	0	0	26,810	0
TOTAL	241,939	0	0	0	587,866	0
Broward County						
Site-built Homes	0	138,664	0	0	0	531,026
Mobile/Manuf. Homes	0	18,302	0	0	0	24,402
Tourists	0	21,809	0	0	0	30,370
TOTAL	0	178,775	0	0	0	585,798

See Chapter III, Section C for the source of the small area data.

Table IV-21 – Evacuating Population by Operational Scenario for 2015

	Scenario 11 Evacuation Level A	Scenario 12 Evacuation Level B	Scenario 13 Evacuation Level C	Scenario 14 Evacuation Level D	Scenario 15 Evacuation Level E
Monroe County – Key West					
Site-built Homes	11,024	12,599	22,048	25,198	28,348
Mobile/Manuf. Homes	2,034	2,347	0	0	0
Tourists	15,709	15,709	0	0	0
TOTAL	28,767	30,655	22,048	25,198	28,348
Monroe County – Lower Keys					
Site-built Homes	5,784	6,507	10,122	11,568	13,014
Mobile/Manuf. Homes	1,558	1,798	0	0	0
Tourists	1,328	1,328	0	0	0
TOTAL	8,670	9,633	10,122	11,568	13,014
Monroe County – Middle Keys					
Site-built Homes	4,159	4,754	8,319	9,507	10,696
Mobile/Manuf. Homes	1,616	1,865	0	0	0
Tourists	7,229	7,229	0	0	0
TOTAL	13,004	13,848	8,319	9,507	10,696
Monroe County – Upper Keys					
Site-built Homes	7,720	9,650	13,510	15,440	17,370
Mobile/Manuf. Homes	2,688	3,102	0	0	0
Tourists	8,844	8,844	0	0	0
TOTAL	19,252	21,596	13,510	15,440	17,370
Monroe County – Total					
Site-built Homes	28,687	33,510	53,999	61,713	69,428
Mobile/Manuf. Homes	7,896	9,112	0	0	0
Tourists	33,110	33,110	0	0	0
TOTAL	69,693	75,732	53,999	61,713	69,428
Miami-Dade County					
Site-built Homes	216,646	265,801	348,258	574,676	837,474
Mobile/Manuf. Homes	18,573	21,692	23,988	27,204	28,976
Tourists	19,556	25,598	25,598	26,810	26,810
TOTAL	254,775	313,091	397,844	628,690	893,260
Broward County					
Site-built Homes	132,051	147,017	200,253	367,079	562,816
Mobile/Manuf. Homes	16,419	19,611	21,316	24,518	26,147
Tourists	21,809	21,809	25,874	28,070	30,370
TOTAL	170,279	188,437	247,443	419,667	619,333

See Chapter III, Section C for the source of the small area data.

Table IV-21 – Evacuating Population by Operational Scenario for 2015 (cont.)

	Scenario 16 Evacuation Level A	Scenario 17 Evacuation Level B	Scenario 18 Evacuation Level C	Scenario 19 Evacuation Level D	Scenario 20 Evacuation Level E
Monroe County – Key West					
Site-built Homes	11,024	0	0	25,198	0
Mobile/Manuf. Homes	2,034	0	0	0	0
Tourists	15,709	0	0	0	0
TOTAL	28,767	0	0	25,198	0
Monroe County – Lower Keys					
Site-built Homes	5,784	0	0	11,568	0
Mobile/Manuf. Homes	1,558	0	0	0	0
Tourists	1,328	0	0	0	0
TOTAL	8,670	0	0	11,568	0
Monroe County – Middle Keys					
Site-built Homes	4,159	0	0	9,507	0
Mobile/Manuf. Homes	1,616	0	0	0	0
Tourists	7,229	0	0	0	0
TOTAL	13,004	0	0	9,507	0
Monroe County – Upper Keys					
Site-built Homes	7,720	0	0	15,440	0
Mobile/Manuf. Homes	2,688	0	0	0	0
Tourists	8,844	0	0	0	0
TOTAL	19,252	0	0	15,440	0
Monroe County – Total					
Site-built Homes	28,687	0	0	61,713	0
Mobile/Manuf. Homes	7,896	0	0	0	0
Tourists	33,110	0	0	0	0
TOTAL	69,693	0	0	61,713	0
Miami-Dade County					
Site-built Homes	216,646	447,066	0	0	837,474
Mobile/Manuf. Homes	18,573	35,442	0	0	28,976
Tourists	19,556	25,598	0	0	26,810
TOTAL	254,775	508,106	0	0	893,260
Broward County					
Site-built Homes	0	171,617	200,253	0	0
Mobile/Manuf. Homes	0	32,575	21,316	0	0
Tourists	0	21,809	25,874	0	0
TOTAL	0	226,001	247,443	0	0

See Chapter III, Section C for the source of the small area data.

Table IV-22 – Evacuating Vehicles by Operational Scenario for 2010

	Scenario 1 Evacuation Level A	Scenario 2 Evacuation Level B	Scenario 3 Evacuation Level C	Scenario 4 Evacuation Level D	Scenario 5 Evacuation Level E
Monroe County – Key West					
Site-built Homes	5,599	6,399	11,198	12,798	14,398
Mobile/Manuf. Homes	1,012	1,167	0	0	0
Tourists	5,236	5,236	0	0	0
TOTAL	11,847	12,802	11,198	12,798	14,398
Monroe County – Lower Keys					
Site-built Homes	2,999	3,373	5,248	5,997	6,747
Mobile/Manuf. Homes	985	1,136	0	0	0
Tourists	443	443	0	0	0
TOTAL	4,427	4,952	5,248	5,997	6,747
Monroe County – Middle Keys					
Site-built Homes	2,316	2,646	4,631	5,293	5,954
Mobile/Manuf. Homes	967	1,116	0	0	0
Tourists	2,410	2,410	0	0	0
TOTAL	5,693	6,172	4,631	5,293	5,954
Monroe County – Upper Keys					
Site-built Homes	4,796	5,995	8,393	9,592	10,791
Mobile/Manuf. Homes	1,903	2,196	0	0	0
Tourists	2,948	2,948	0	0	0
TOTAL	9,647	11,139	8,393	9,592	10,791
Monroe County – Total					
Site-built Homes	15,710	18,413	29,470	33,680	37,890
Mobile/Manuf. Homes	4,867	5,615	0	0	0
Tourists	11,037	11,037	0	0	0
TOTAL	31,614	35,065	29,470	33,680	37,890
Miami-Dade County					
Site-built Homes	95,670	118,509	154,097	248,052	357,750
Mobile/Manuf. Homes	8,046	9,378	10,389	11,770	12,535
Tourists	13,396	17,535	17,535	18,363	18,363
TOTAL	117,112	145,422	182,021	278,185	388,648
Broward County					
Site-built Homes	56,898	63,985	88,225	157,147	236,930
Mobile/Manuf. Homes	7,371	8,806	9,570	11,010	11,742
Tourists	14,539	14,539	17,247	18,710	20,243
TOTAL	78,808	87,330	115,042	186,867	268,915

See Chapter III, Section C for the source of the small area data.

Table IV-22 – Evacuating Vehicles by Operational Scenario for 2010 (cont.)

	Scenario 6 Evacuation Level A	Scenario 7 Evacuation Level B	Scenario 8a Evacuation Level C	Scenario 8b Evacuation Level C	Scenario 9 Evacuation Level D	Scenario 10 Evacuation Level E
Monroe County – Key West						
Site-built Homes	5,599	0	11,198	15,997	0	0
Mobile/Manuf. Homes	1,012	0	0	0	0	0
Tourists	5,236	0	0	0	0	0
TOTAL	11,847	0	11,198	11,198	0	0
Monroe County – Lower Keys						
Site-built Homes	2,999	0	5,248	7,497	0	0
Mobile/Manuf. Homes	985	0	0	0	0	0
Tourists	443	0	0	0	0	0
TOTAL	4,427	0	5,248	5,248	0	0
Monroe County – Middle Keys						
Site-built Homes	2,316	0	4,631	6,616	0	0
Mobile/Manuf. Homes	967	0	0	0	0	0
Tourists	2,410	0	0	0	0	0
TOTAL	5,693	0	4,631	6,616	0	0
Monroe County – Upper Keys						
Site-built Homes	4,796	0	8,393	11,990	0	0
Mobile/Manuf. Homes	1,903	0	0	0	0	0
Tourists	2,948	0	0	0	0	0
TOTAL	9,647	0	8,393	11,990	0	0
Monroe County – Total						
Site-built Homes	15,710	0	29,470	42,100	0	0
Mobile/Manuf. Homes	4,867	0	0	0	0	0
Tourists	11,037	0	0	0	0	0
TOTAL	31,614	0	29,470	42,100	0	0
Miami-Dade County						
Site-built Homes	95,670	0	0	0	248,052	0
Mobile/Manuf. Homes	8,046	0	0	0	11,770	0
Tourists	13,396	0	0	0	18,363	0
TOTAL	117,112	0	0	0	278,185	0
Broward County						
Site-built Homes	0	63,985	0	0	0	236,930
Mobile/Manuf. Homes	0	8,806	0	0	0	11,742
Tourists	0	14,539	0	0	0	20,243
TOTAL	0	87,330	0	0	0	268,915

See Chapter III, Section C for the source of the small area data.

Table IV-23 – Evacuating Vehicles by Operational Scenario for 2015

	Scenario 11 Evacuation Level A	Scenario 12 Evacuation Level B	Scenario 13 Evacuation Level C	Scenario 14 Evacuation Level D	Scenario 15 Evacuation Level E
Monroe County – Key West					
Site-built Homes	5,829	6,661	11,657	13,322	14,988
Mobile/Manuf. Homes	1,016	1,172	0	0	0
Tourists	5,236	5,236	0	0	0
TOTAL	12,081	13,069	11,657	13,322	14,988
Monroe County – Lower Keys					
Site-built Homes	3,266	3,675	5,716	6,533	7,349
Mobile/Manuf. Homes	975	1,125	0	0	0
Tourists	443	443	0	0	0
TOTAL	4,684	5,243	5,716	6,533	7,349
Monroe County – Middle Keys					
Site-built Homes	2,436	2,785	4,873	5,569	6,265
Mobile/Manuf. Homes	965	1,113	0	0	0
Tourists	2,410	2,410	0	0	0
TOTAL	5,811	6,308	4,873	5,569	6,265
Monroe County – Upper Keys					
Site-built Homes	5,122	6,403	8,964	10,245	11,526
Mobile/Manuf. Homes	1,883	2,172	0	0	0
Tourists	2,948	2,948	0	0	0
TOTAL	9,953	11,523	8,964	10,245	11,526
Monroe County – Total					
Site-built Homes	16,653	19,524	31,210	35,669	40,128
Mobile/Manuf. Homes	4,839	5,582	0	0	0
Tourists	11,037	11,037	0	0	0
TOTAL	32,529	36,143	31,210	35,669	40,128
Miami-Dade County					
Site-built Homes	97,688	120,695	157,633	255,922	369,508
Mobile/Manuf. Homes	8,158	9,512	10,535	11,938	12,714
Tourists	13,396	17,535	17,535	18,363	18,363
TOTAL	119,242	147,742	185,703	286,223	400,585
Broward County					
Site-built Homes	59,395	66,818	92,142	164,181	247,464
Mobile/Manuf. Homes	7,797	9,315	10,123	11,646	12,420
Tourists	14,539	14,539	17,247	18,710	20,243
TOTAL	81,731	90,672	119,512	194,537	280,127

See Chapter III, Section C for the source of the small area data.

Table IV-23 – Evacuating Vehicles by Operational Scenario for 2015 (cont.)

	Scenario 16 Evacuation Level A	Scenario 17 Evacuation Level B	Scenario 18 Evacuation Level C	Scenario 19 Evacuation Level D	Scenario 20 Evacuation Level E
Monroe County – Key West					
Site-built Homes	5,829	0	0	13,322	0
Mobile/Manuf. Homes	1,016	0	0	0	0
Tourists	5,236	0	0	0	0
TOTAL	12,081	0	0	13,322	0
Monroe County – Lower Keys					
Site-built Homes	3,266	0	0	6,533	0
Mobile/Manuf. Homes	975	0	0	0	0
Tourists	443	0	0	0	0
TOTAL	4,684	0	0	6,533	0
Monroe County – Middle Keys					
Site-built Homes	2,436	0	0	5,569	0
Mobile/Manuf. Homes	965	0	0	0	0
Tourists	2,410	0	0	0	0
TOTAL	5,811	0	0	5,569	0
Monroe County – Upper Keys					
Site-built Homes	5,122	0	0	10,245	0
Mobile/Manuf. Homes	1,883	0	0	0	0
Tourists	2,948	0	0	0	0
TOTAL	9,953	0	0	10,245	0
Monroe County – Total					
Site-built Homes	16,653	0	0	35,669	0
Mobile/Manuf. Homes	4,839	0	0	0	0
Tourists	11,037	0	0	0	0
TOTAL	32,529	0	0	35,669	0
Miami-Dade County					
Site-built Homes	97,688	204,207	0	0	369,508
Mobile/Manuf. Homes	8,158	15,524	0	0	12,714
Tourists	13,396	17,535	0	0	18,363
TOTAL	119,242	237,266	0	0	400,585
Broward County					
Site-built Homes	0	79,932	92,142	0	0
Mobile/Manuf. Homes	0	15,475	10,123	0	0
Tourists	0	14,539	17,247	0	0
TOTAL	0	109,946	119,512	0	0

See Chapter III, Section C for the source of the small area data.

Table IV-24 – Shelter Demand by Operational Scenario

	Scenario 1 Evacuation Level A	Scenario 2 Evacuation Level B	Scenario 3 Evacuation Level C	Scenario 4 Evacuation Level D	Scenario 5 Evacuation Level E
2010					
Monroe – Key West	810	855	414	1,184	1,332
Monroe – Lower Keys	246	272	194	555	623
Monroe – Middle Keys	409	437	172	196	220
Monroe – Upper Keys	640	712	311	355	400
Monroe – Total	2,105	2,276	1,092	2,290	2,575
Miami-Dade County	16,162	18,924	23,282	38,587	57,916
Broward County	7,555	8,268	10,706	17,281	24,809

	Scenario 6 Evacuation Level A	Scenario 7 Evacuation Level B	Scenario 8a Evacuation Level C	Scenario 8b Evacuation Level C	Scenario 9 Evacuation Level D	Scenario 10 Evacuation Level E
2010						
Monroe – Key West	810	0	414	592	0	0
Monroe – Lower Keys	246	0	194	278	0	0
Monroe – Middle Keys	409	0	172	244	0	0
Monroe – Upper Keys	640	0	311	444	0	0
Monroe – Total	2,105	0	1,092	1,558	0	0
Miami-Dade County	16,162	0	0	0	38,587	0
Broward County	0	8,268	0	0	0	24,809

	Scenario 11 Evacuation Level A	Scenario 12 Evacuation Level B	Scenario 13 Evacuation Level C	Scenario 14 Evacuation Level D	Scenario 15 Evacuation Level E
2015					
Monroe – Key West	820	864	431	1,232	1,386
Monroe – Lower Keys	255	283	211	605	679
Monroe – Middle Keys	414	440	179	205	231
Monroe – Upper Keys	651	725	331	379	427
Monroe – Total	2,140	2,313	1,153	2,422	2,723
Miami-Dade County	16,550	19,333	23,913	39,993	60,045
Broward County	7,842	8,593	11,130	17,997	25,848

	Scenario 16 Evacuation Level A	Scenario 17 Evacuation Level B	Scenario 18 Evacuation Level C	Scenario 19 Evacuation Level D	Scenario 20 Evacuation Level E
2015					
Monroe – Key West	820	0	0	1,232	0
Monroe – Lower Keys	255	0	0	605	0
Monroe – Middle Keys	414	0	0	205	0
Monroe – Upper Keys	651	0	0	379	0
Monroe – Total	2,140	0	0	2,422	0
Miami-Dade County	16,550	28,170	0	0	60,045
Broward County	0	10,216	11,130	0	0

Note: Shelter demand is the population in each county who will seek public shelter during their evacuation, either at an in-county shelter or an out of county shelter. See Chapter III, Section C for the source of the small area data.

Congested Roadways

A summary of the total number of evacuating vehicles for each of the operational scenarios is presented in **Table IV-25**. It is important to note that the total number of evacuating vehicles in the table below includes vehicles evacuating from all of the counties included in the operational scenario, as identified in Table IV-19. The number of counties varies by scenario, from one county evacuating to 5 counties evacuating.

Table IV-25 – Total Evacuating Vehicles for Operational Scenarios

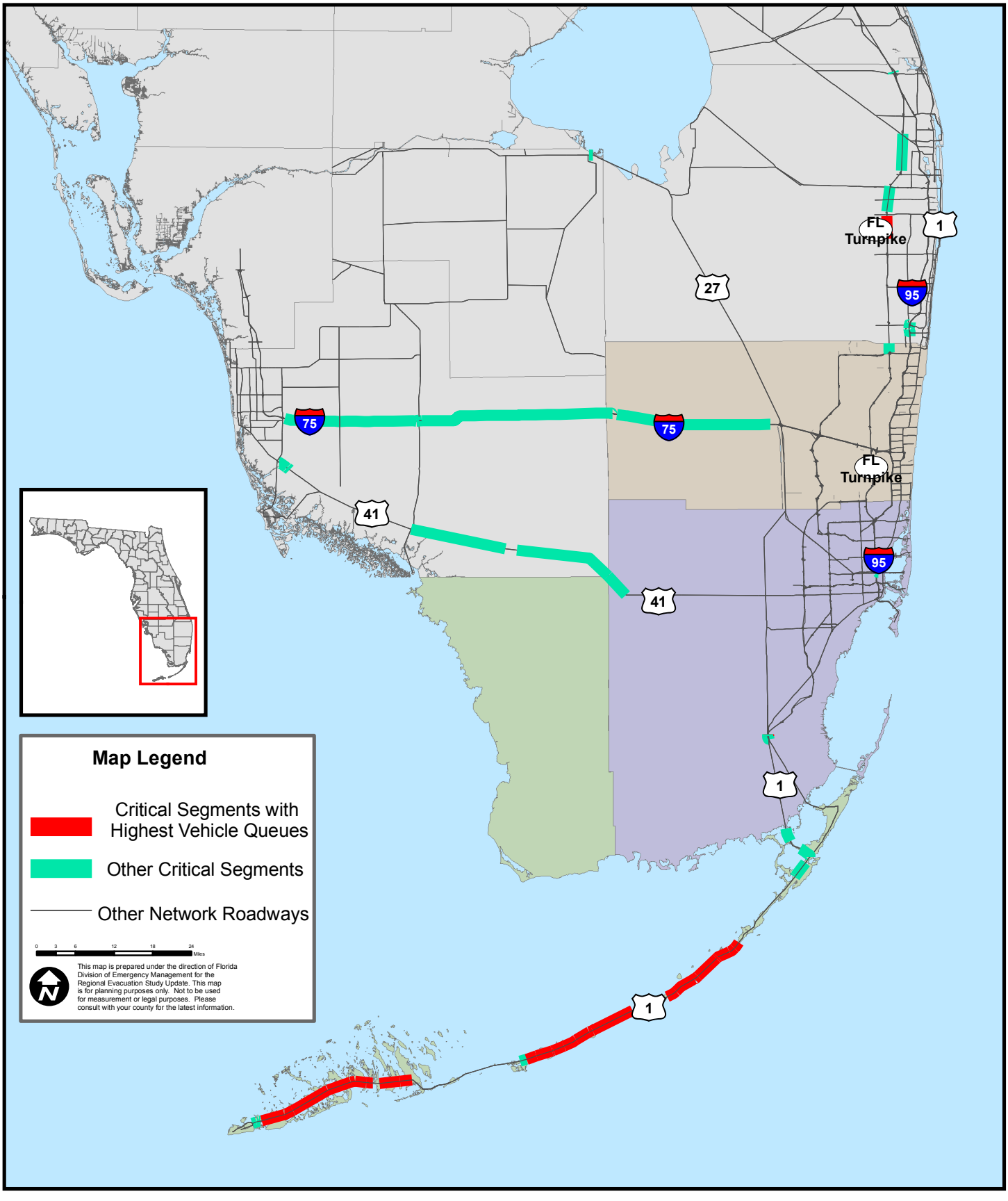
	Scenario 1 Evacuation Level A	**Scenario 2 Evacuation Level B**	**Scenario 3 Evacuation Level C**	**Scenario 4 Evacuation Level D**	**Scenario 5 Evacuation Level E**	
2010	227,536	267,823	326,553	662,535	1,038,339	
	Scenario 6 Evacuation Level A	**Scenario 7 Evacuation Level B**	**Scenario 8a Evacuation Level C**	**Scenario 8b Evacuation Level C**	**Scenario 9 Evacuation Level D**	**Scenario 10 Evacuation Level E**
2010	148,729	87,330	29,492	42,133	278,185	268,915
	Scenario 11 Evacuation Level A	**Scenario 12 Evacuation Level B**	**Scenario 13 Evacuation Level C**	**Scenario 14 Evacuation Level D**	**Scenario 15 Evacuation Level E**	
2015	233,507	274,563	336,447	693,176	1,065,885	
	Scenario 16 Evacuation Level A	**Scenario 17 Evacuation Level B**	**Scenario 18 Evacuation Level C**	**Scenario 19 Evacuation Level D**	**Scenario 20 Evacuation Level E**	
2015	151,777	347,211	119,512	35,697	400,585	

Similar to the base scenarios, critical roadways were identified by reviewing roadways in the model network that have the highest vehicle queues for extended periods of time during an evacuation. Due to the nature of a major evacuation in general, nearly all roadway facilities will have extended vehicle queues at some point during the evacuation process. The point of this analysis is to identify those roadway facilities that have vehicle queues for the longest time periods during each of the evacuation scenarios. Critical roadway segments for the South Florida region are identified in **Figures IV-14** through **IV-33** for each of the operational scenarios for 2010 and 2015. US 1, I-95, I-75, the Turnpike, and numerous other roadways are critical facilities for all evacuation scenarios. Critical segments do vary by scenario, however, as the location of the evacuation event determines which portions of the region experience congestion and queuing.

In addition to the identification of critical roadway segments, the total number of evacuating vehicles entering and exiting each county by evacuation scenario was also determined. Evacuating vehicles exiting each county by major evacuation route are identified in **Tables IV-26** and **IV-27** for 2010 and **Tables IV-28** and **IV-29** for 2015. In addition, evacuating vehicles entering each county by major evacuation route are identified in **Tables IV-30** and **IV-31** for 2010 and **Tables IV-32** and **IV-33** for 2015. Detailed volume figures for all evacuation routes in the South Florida Region for each operational scenario are included in Volume 5-11. The number of vehicles entering and exiting each county during an evacuation varies widely depending upon the scenario, roadway, and county. As expected, major interstates and state highways generally carry larger volumes of evacuating traffic. The vehicle flows into and out of each county also generally follow the same pattern as the critical segment figures, as locations with higher queues and congestion generally have higher traffic volumes.

Figure IV-14

Critical Roadway Segments with Excessive Vehicle Queues for 2010 Operational Scenario 1 Evacuation Level A

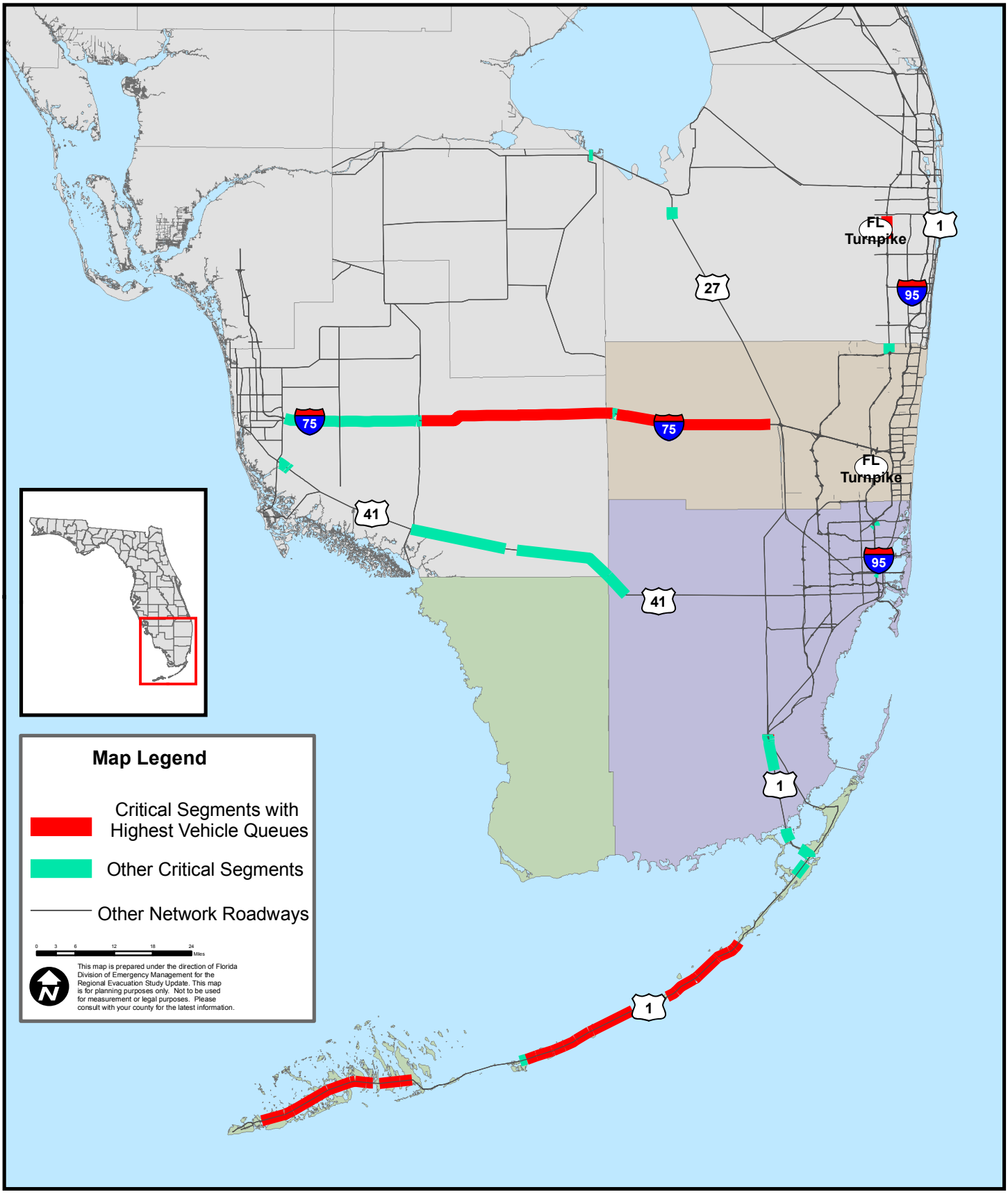


Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-15

Critical Roadway Segments with Excessive Vehicle Queues for 2010 Operational Scenario 2 Evacuation Level B

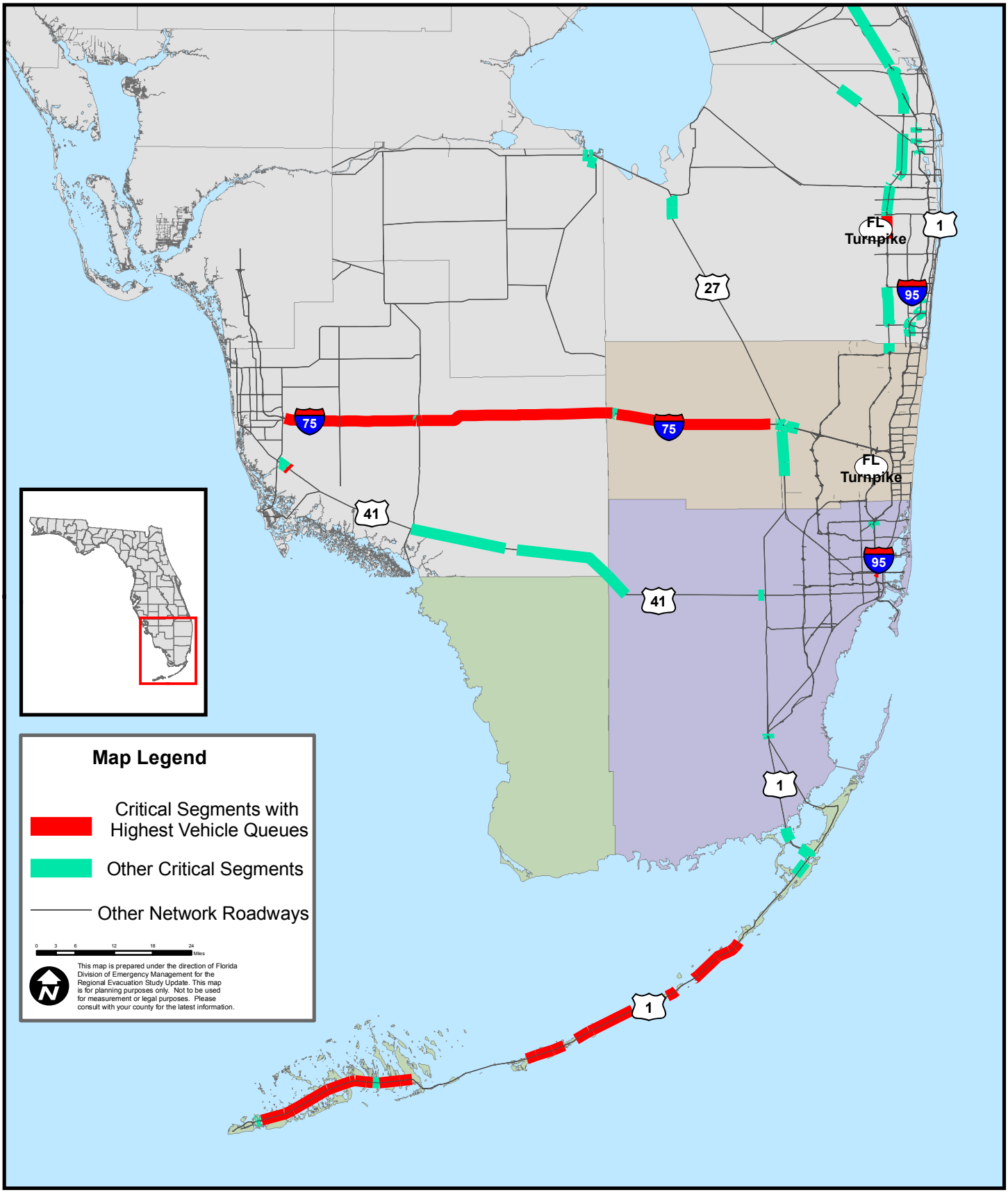


Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-16

Critical Roadway Segments with Excessive Vehicle Queues for 2010 Operational Scenario 3 Evacuation Level C

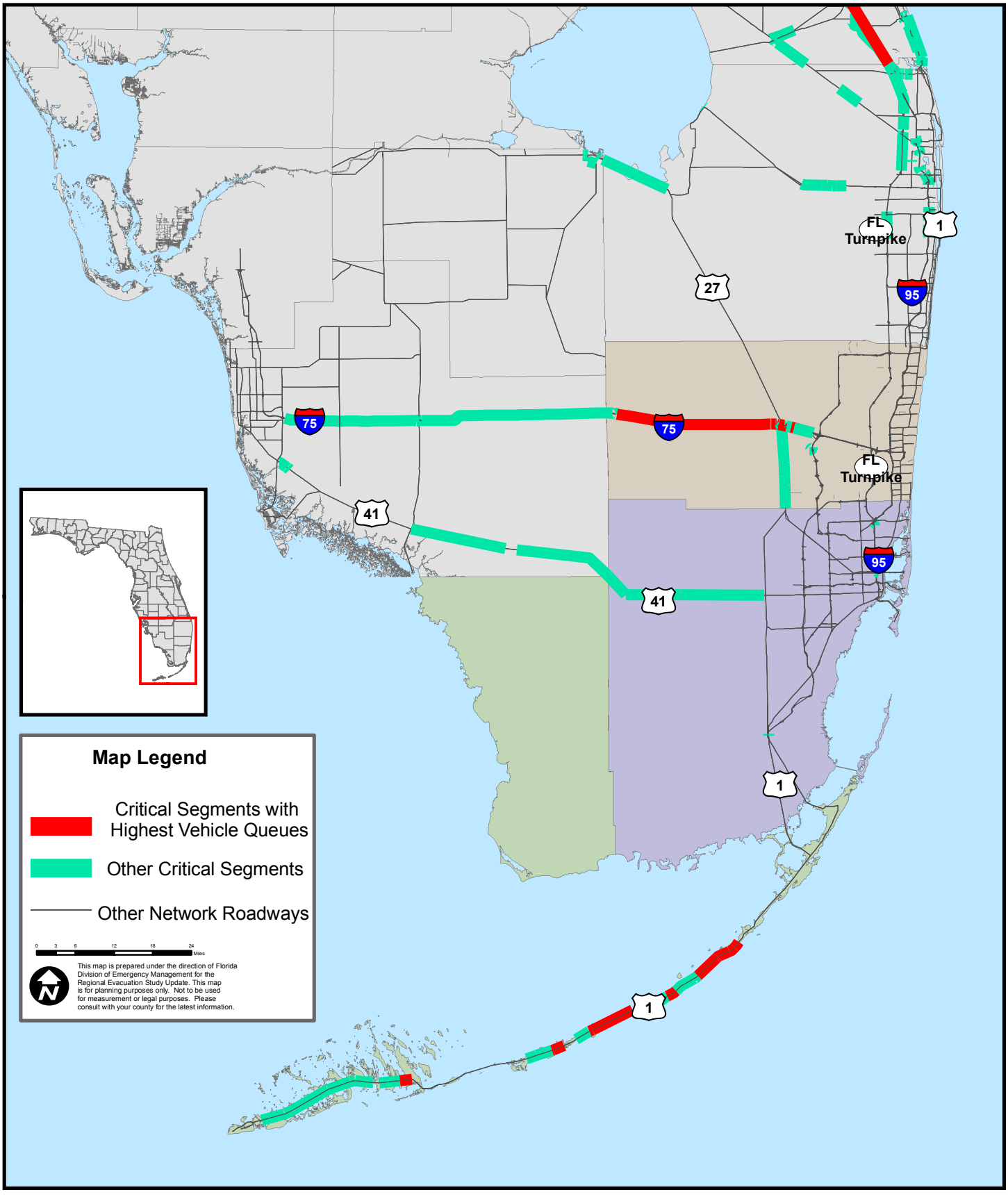


Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-17

Critical Roadway Segments with Excessive Vehicle Queues for 2010 Operational Scenario 4 Evacuation Level D

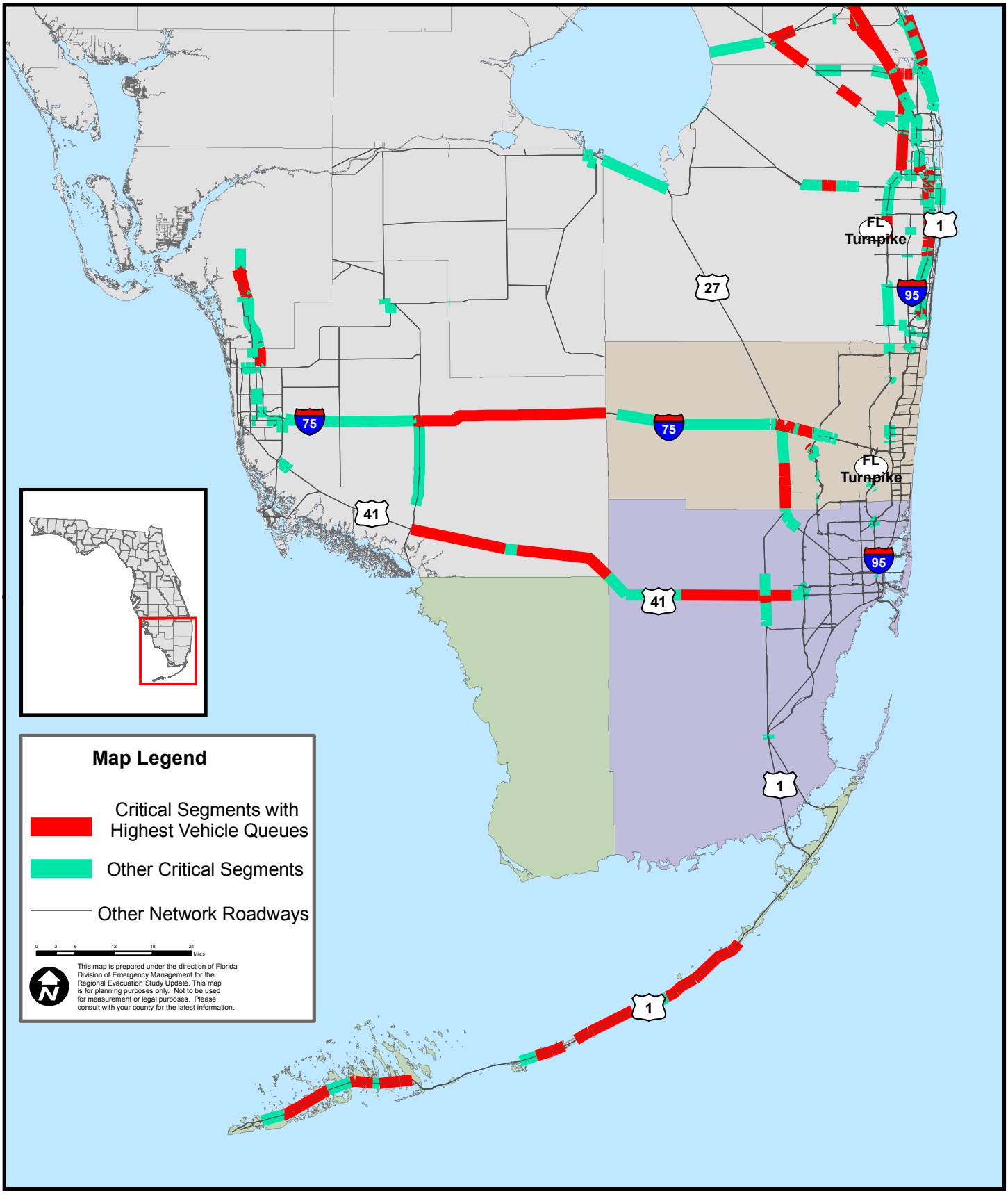


Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-18

Critical Roadway Segments with Excessive Vehicle Queues for 2010 Operational Scenario 5 Evacuation Level E

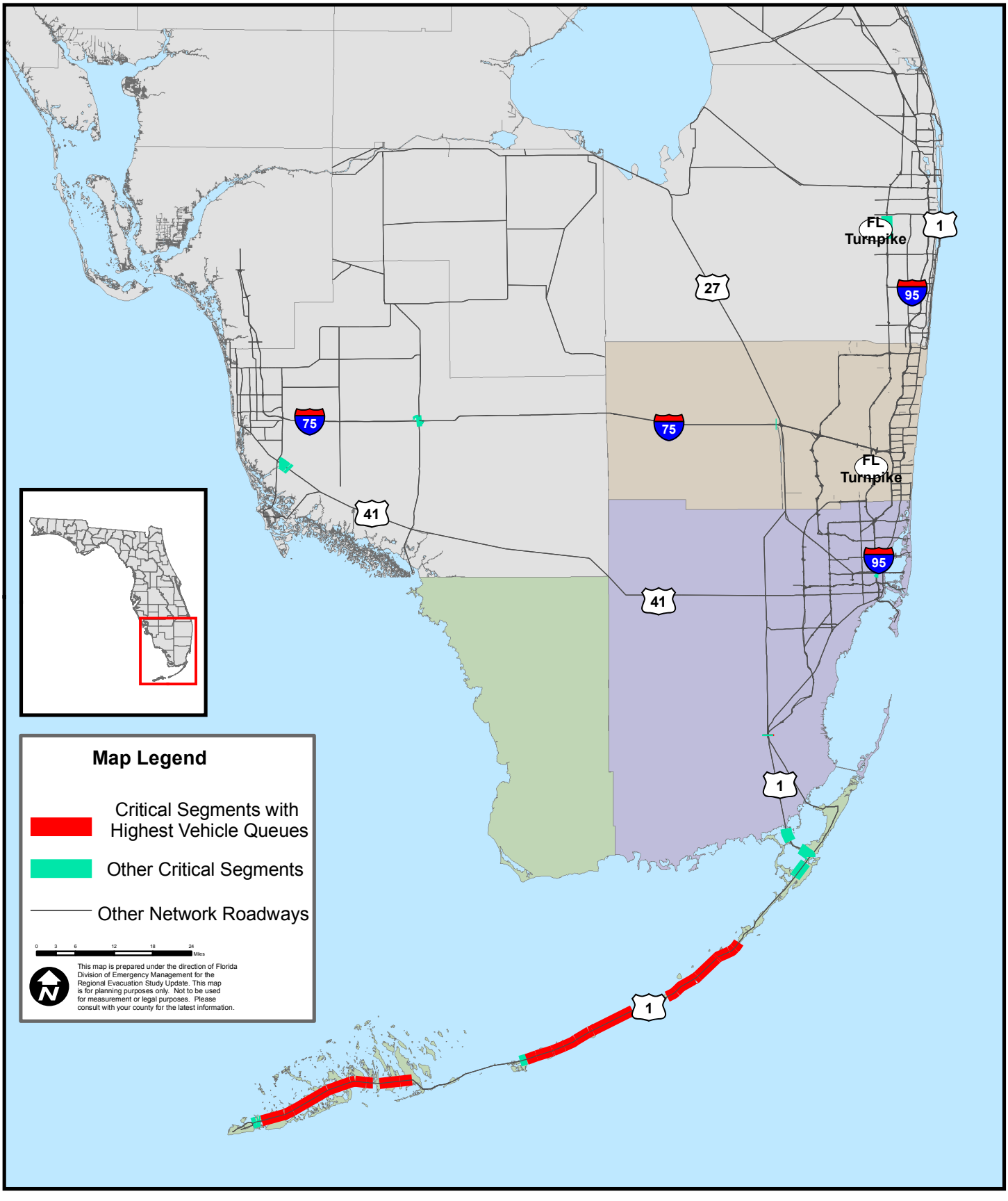


Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-19

Critical Roadway Segments with Excessive Vehicle Queues for 2010 Operational Scenario 6 Evacuation Level A

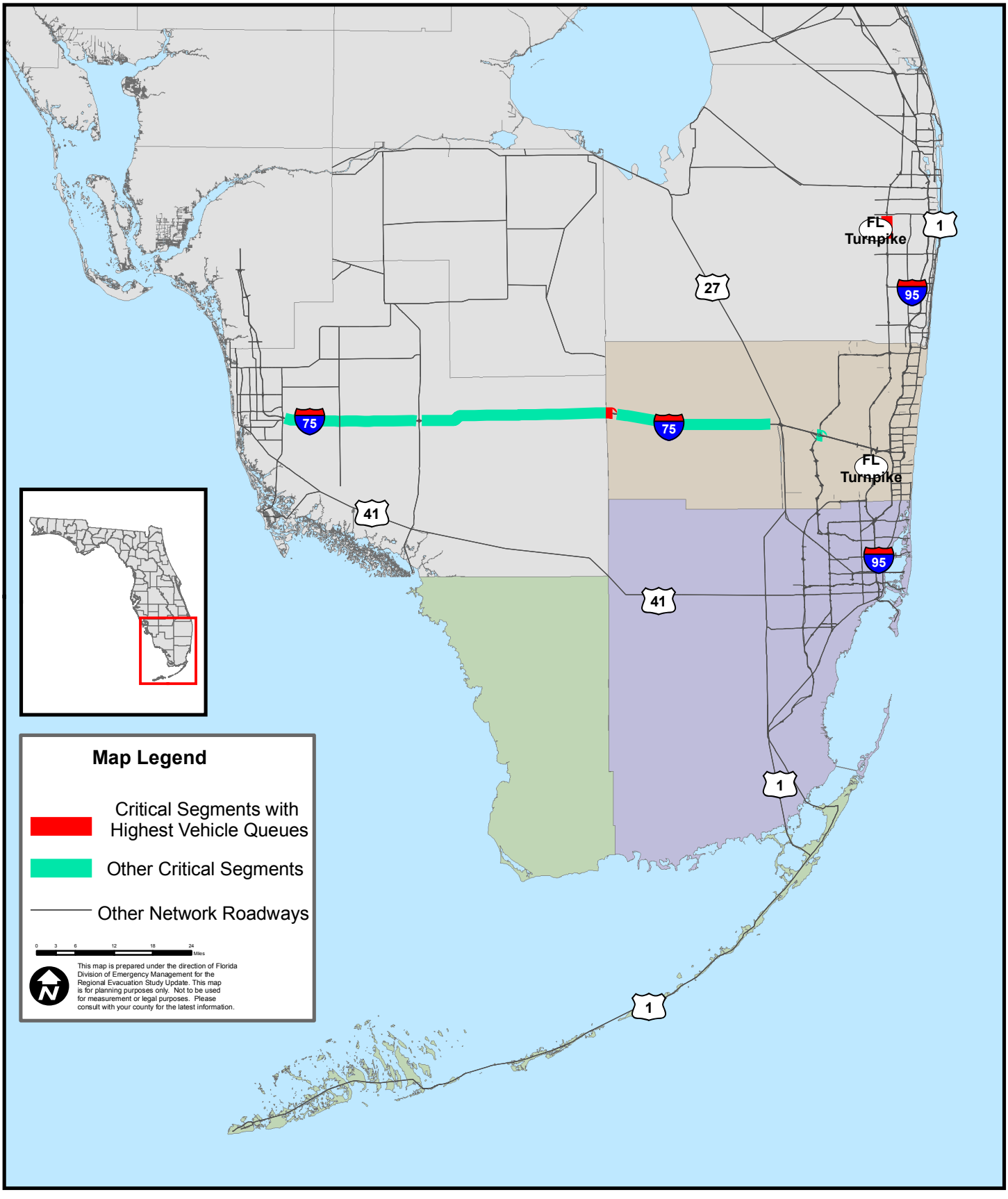


Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-20

Critical Roadway Segments with Excessive Vehicle Queues for 2010 Operational Scenario 7 Evacuation Level B

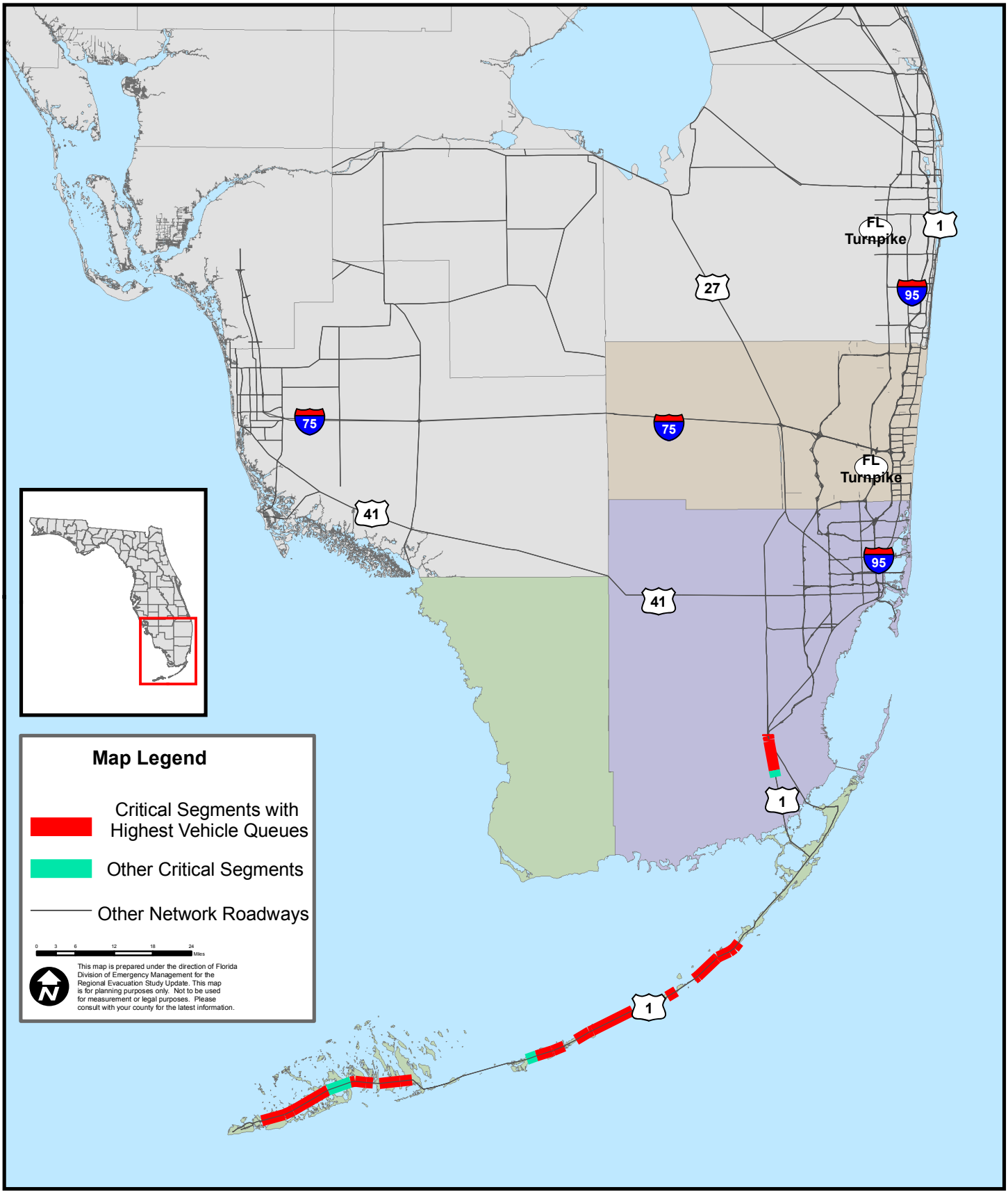


Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-21

Critical Roadway Segments with Excessive Vehicle Queues for 2010 Operational Scenario 8-A Evacuation Level C

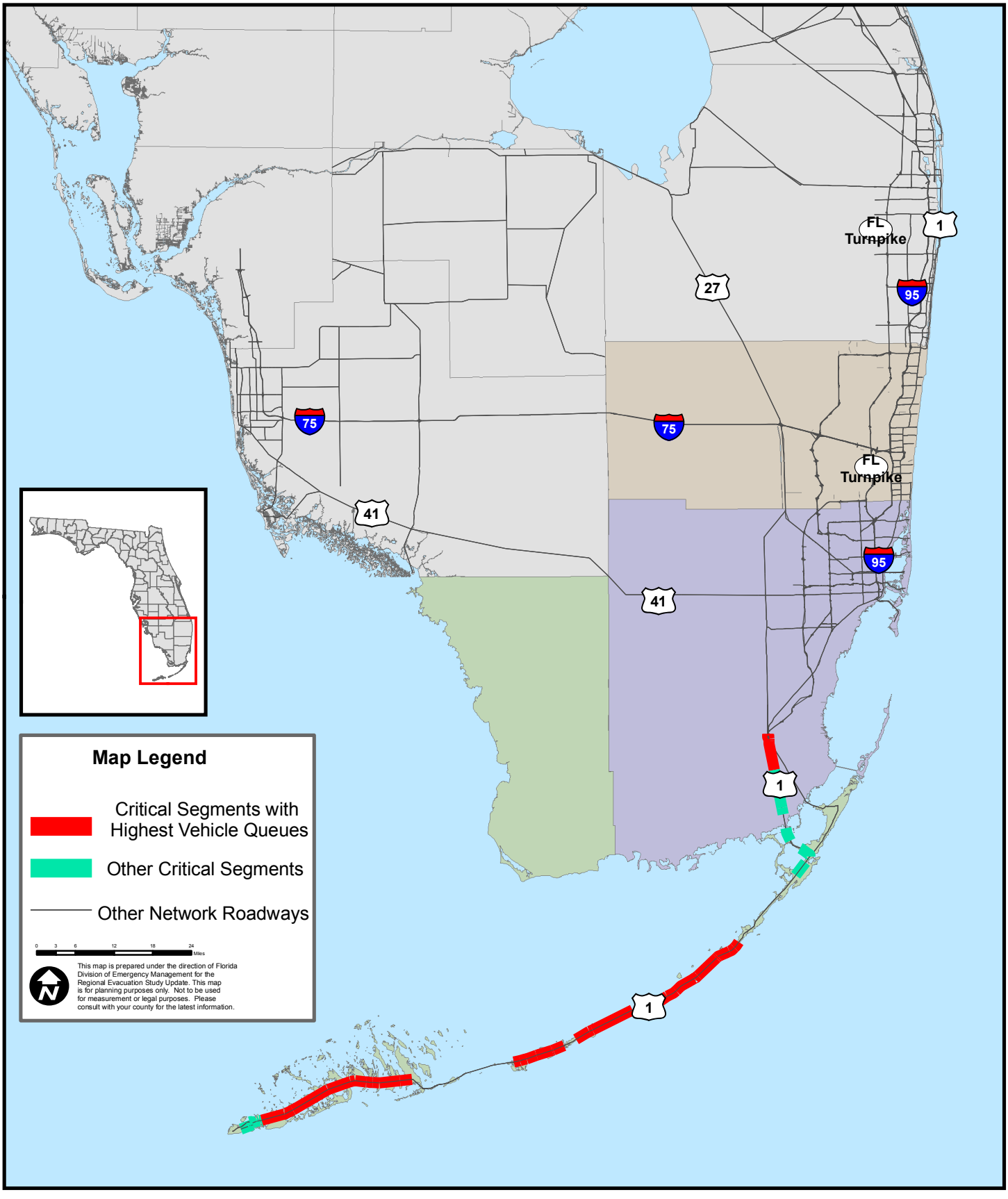


Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-22

Critical Roadway Segments with Excessive Vehicle Queues for 2010 Operational Scenario 8-B Evacuation Level C

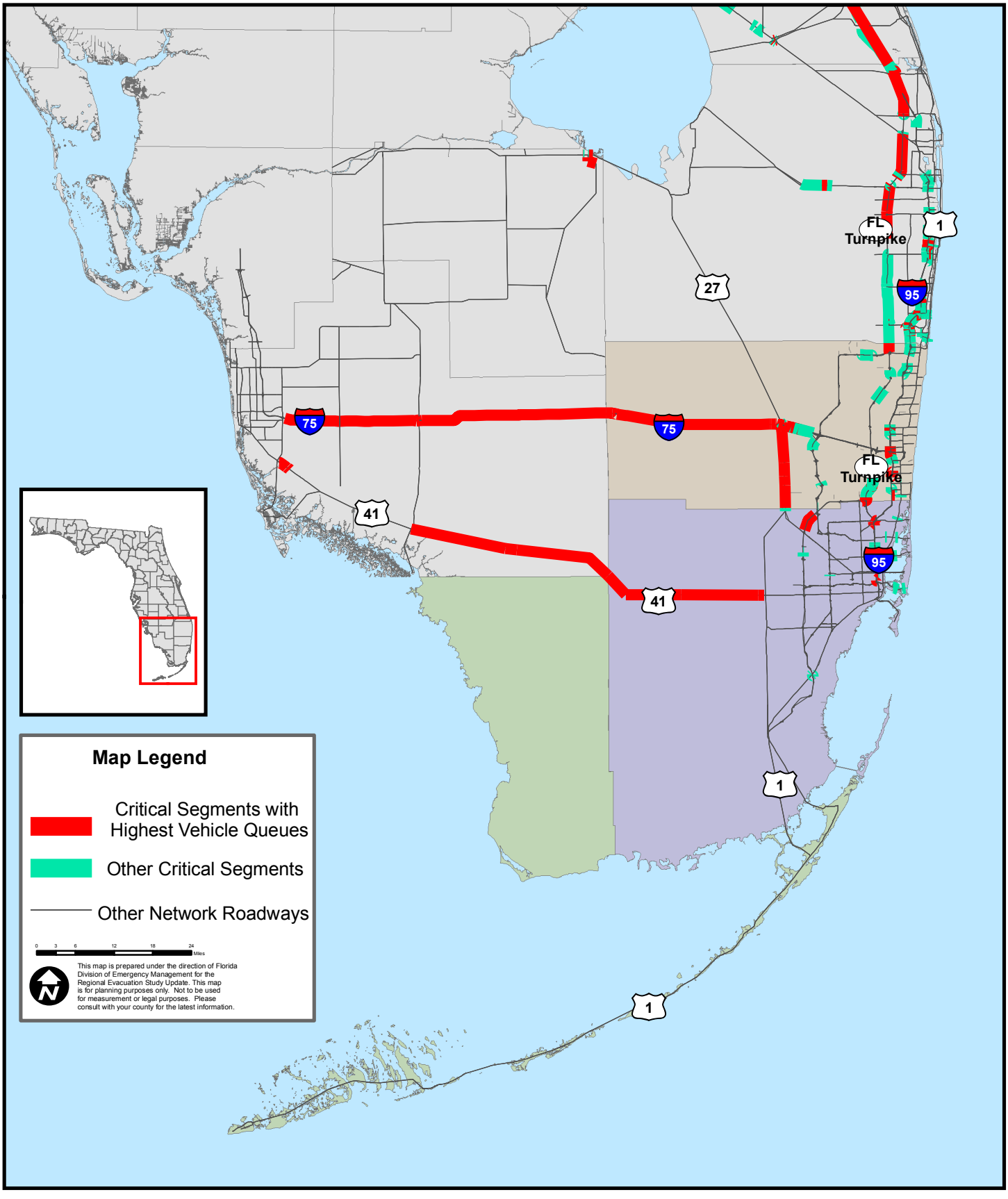


Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-23

Critical Roadway Segments with Excessive Vehicle Queues for 2010 Operational Scenario 9 Evacuation Level D

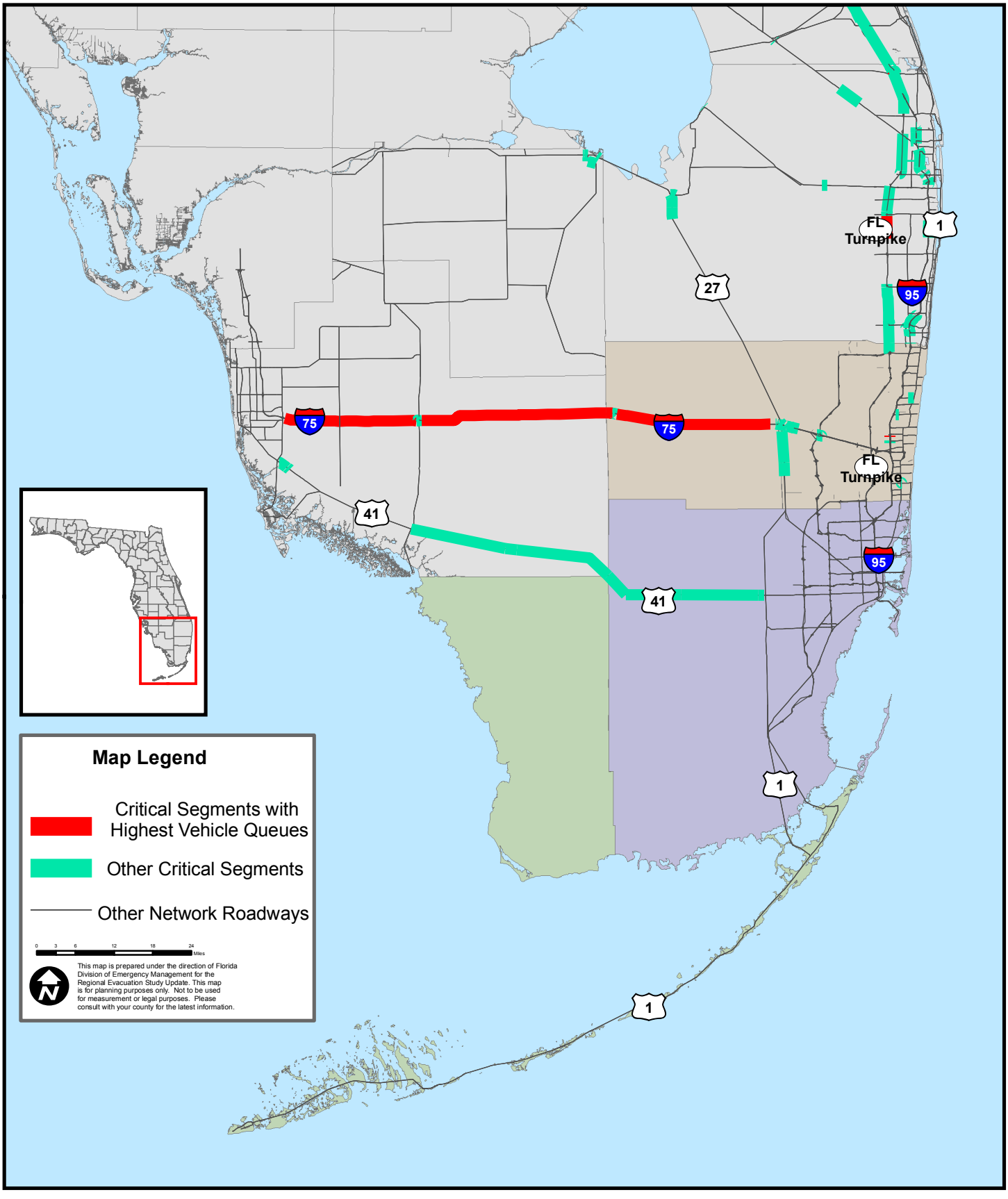


Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-24

Critical Roadway Segments with Excessive Vehicle Queues for 2010 Operational Scenario 10 Evacuation Level E

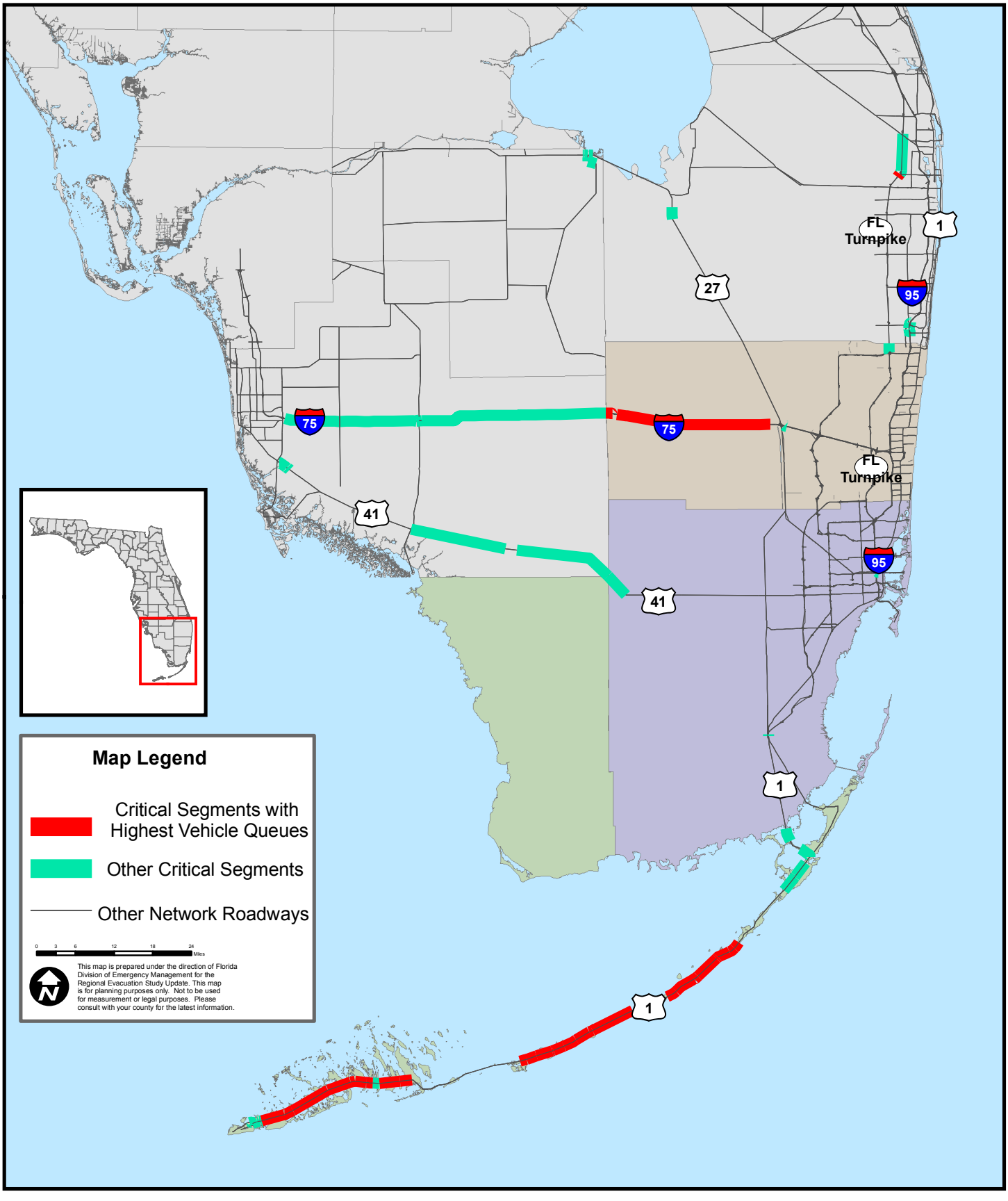


Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-25

Critical Roadway Segments with Excessive Vehicle Queues for 2015 Operational Scenario 11 Evacuation Level A

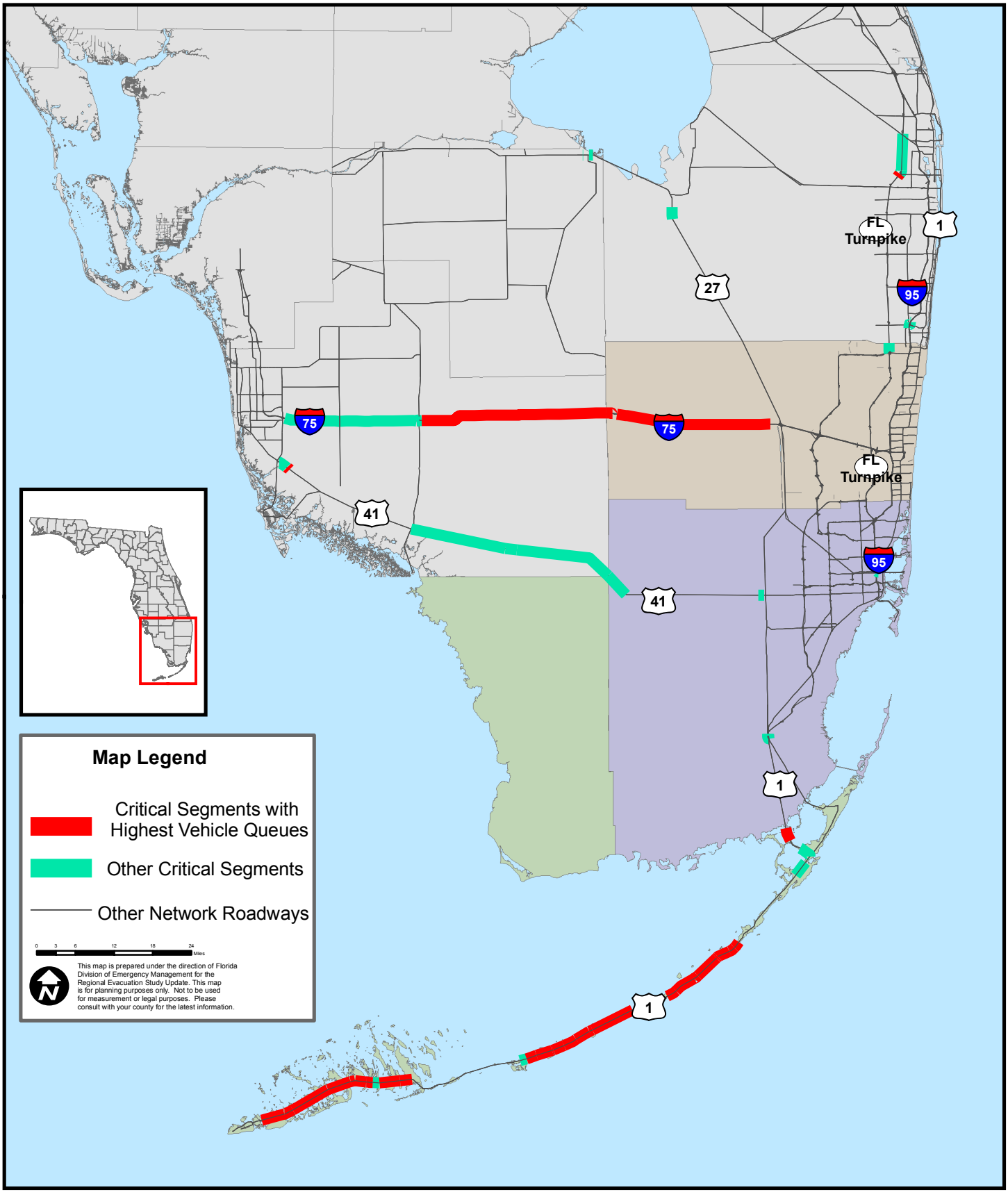


Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-26

Critical Roadway Segments with Excessive Vehicle Queues for 2015 Operational Scenario 12 Evacuation Level B

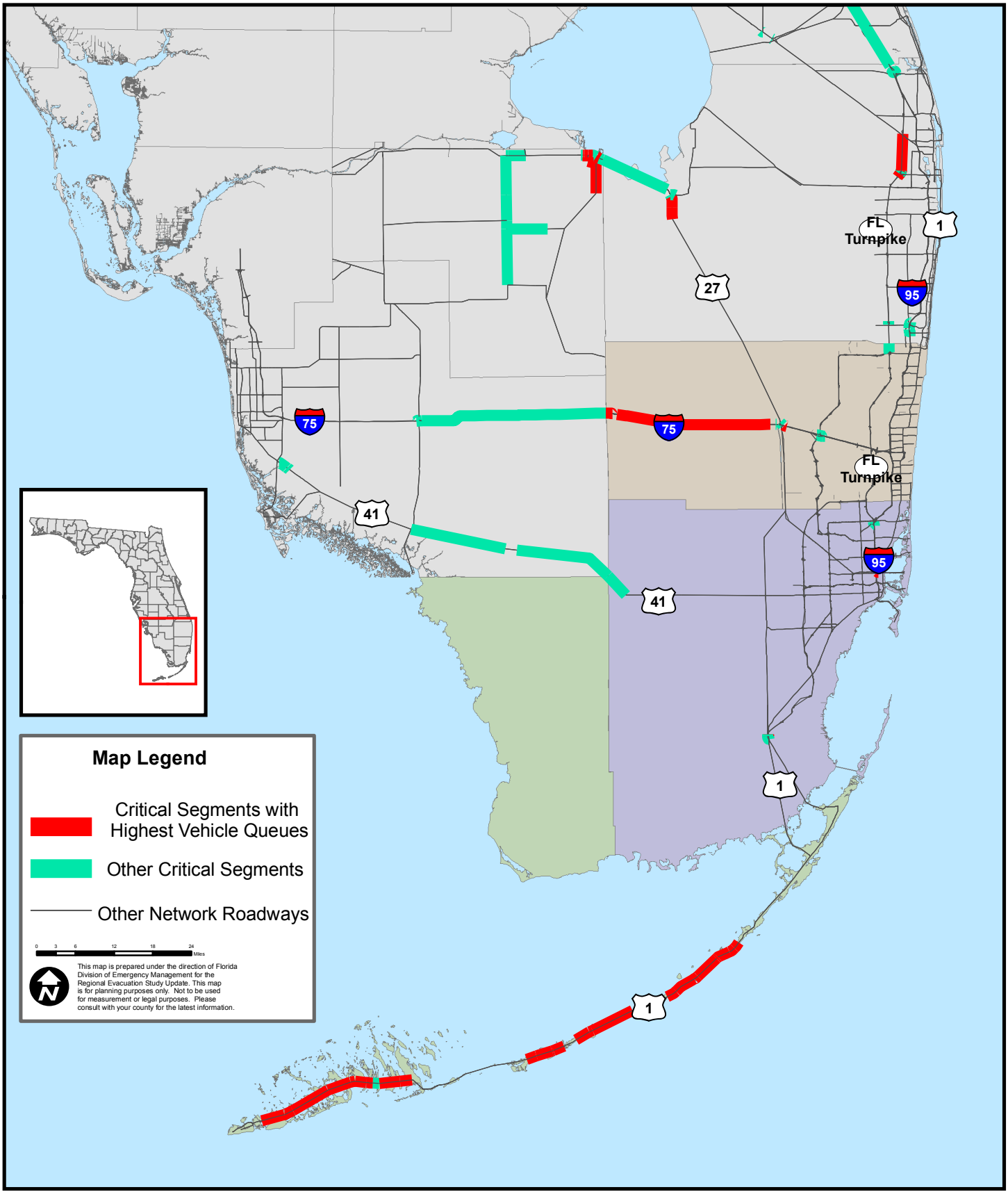


Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-27

Critical Roadway Segments with Excessive Vehicle Queues for 2015 Operational Scenario 13 Evacuation Level C

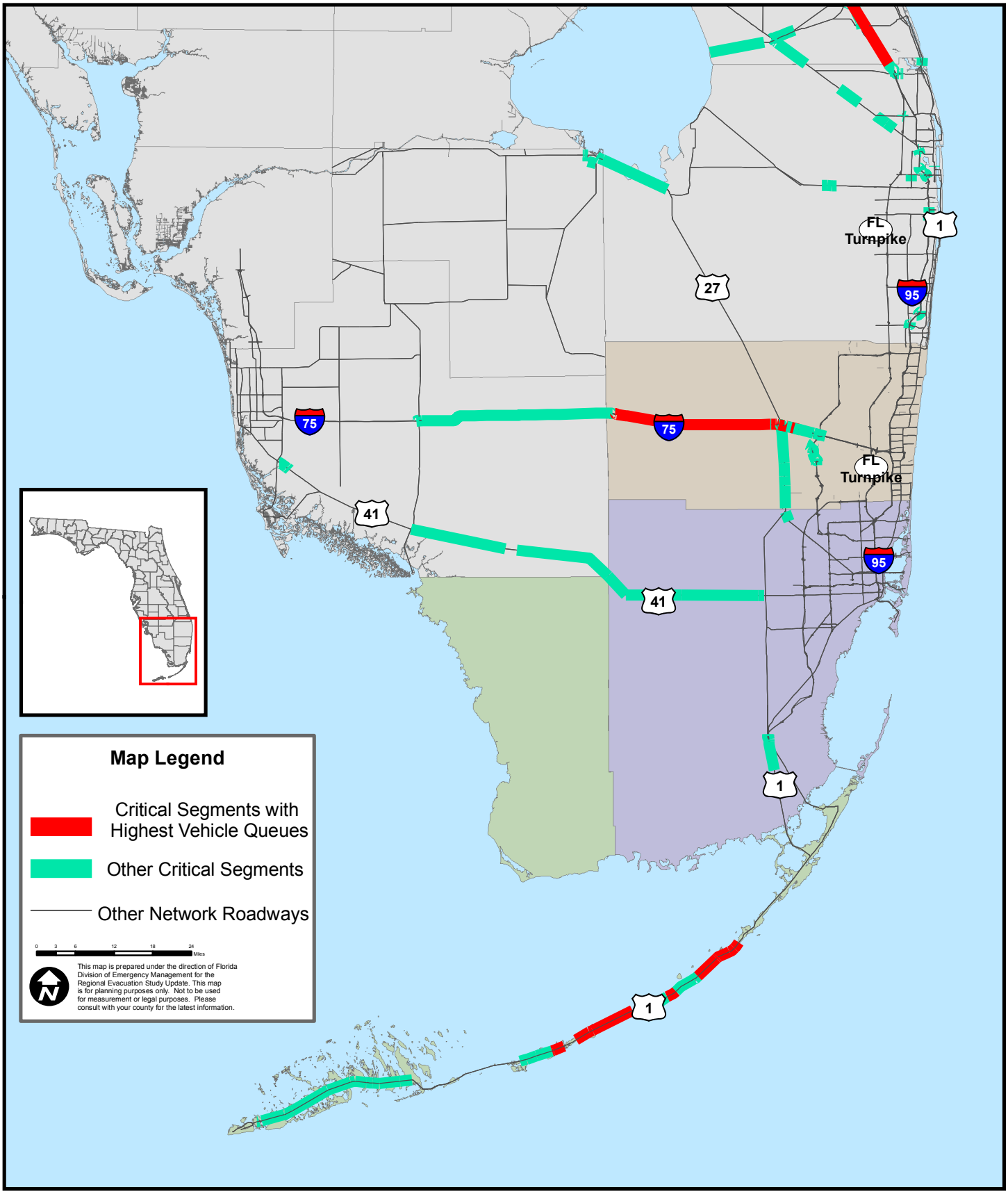


Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-28

Critical Roadway Segments with Excessive Vehicle Queues for 2015 Operational Scenario 14 Evacuation Level D

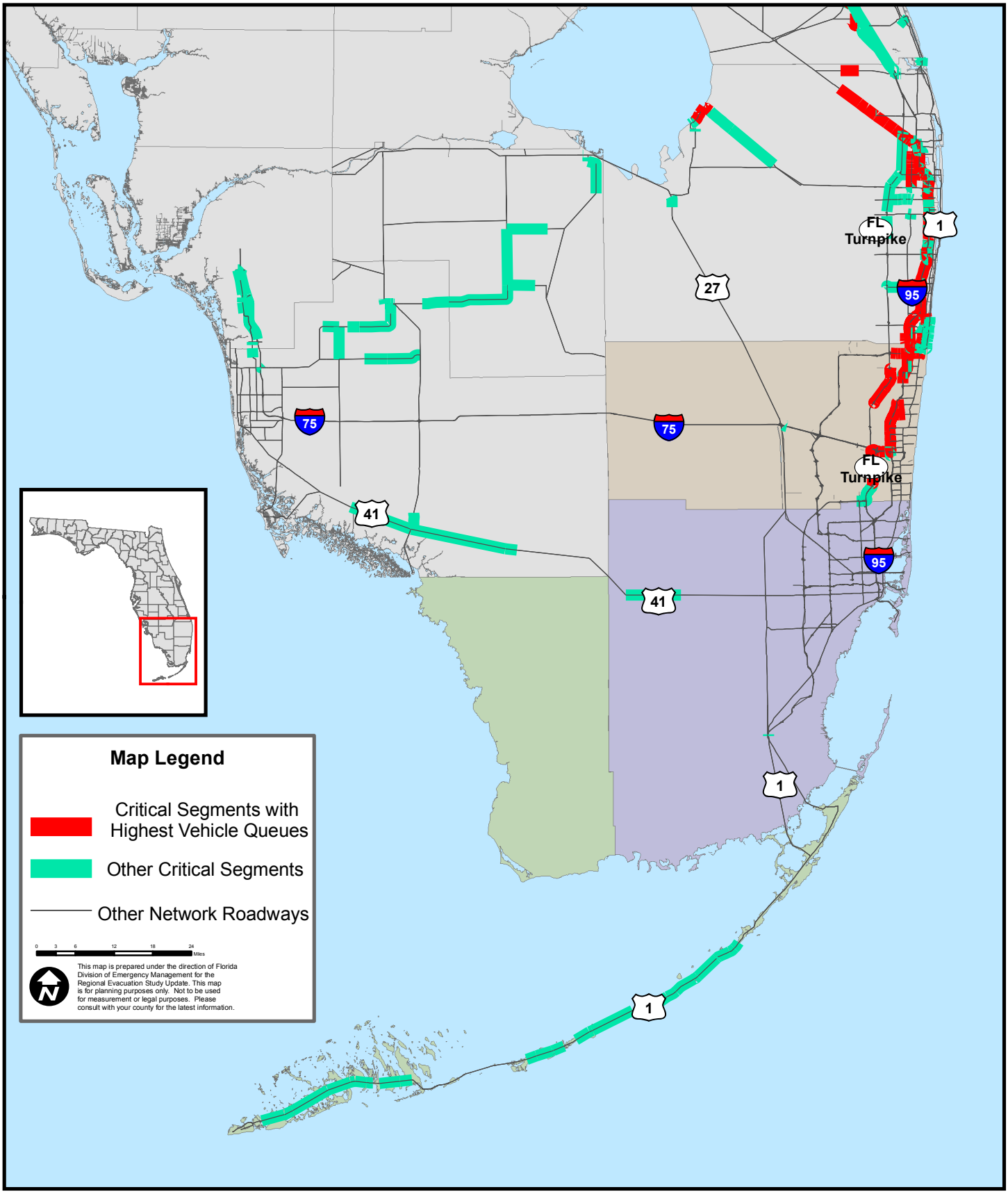


Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-29

Critical Roadway Segments with Excessive Vehicle Queues for 2015 Operational Scenario 15 Evacuation Level E

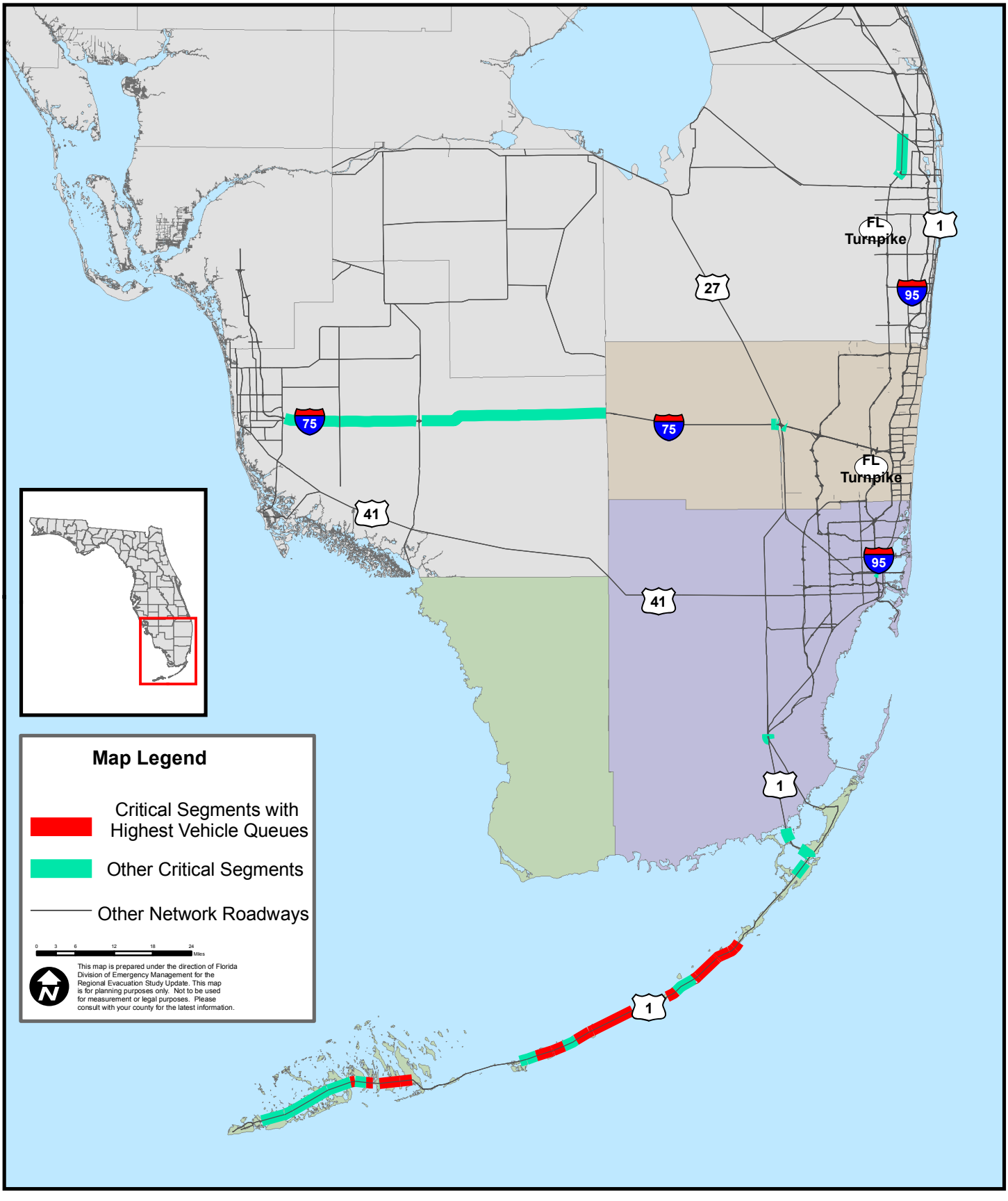


Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-30

Critical Roadway Segments with Excessive Vehicle Queues for 2015 Operational Scenario 16 Evacuation Level A

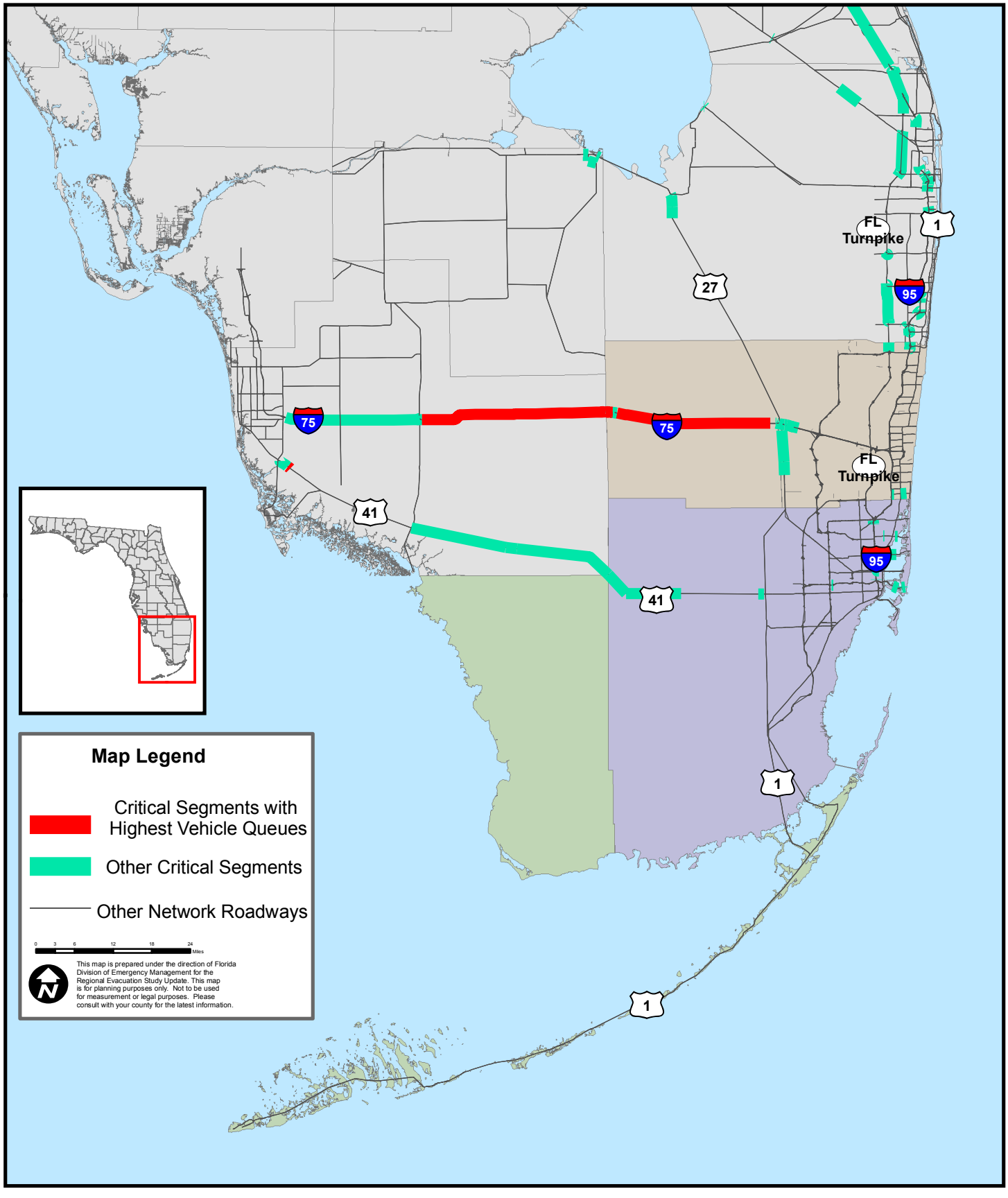


Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-31

Critical Roadway Segments with Excessive Vehicle Queues for 2015 Operational Scenario 17 Evacuation Level B

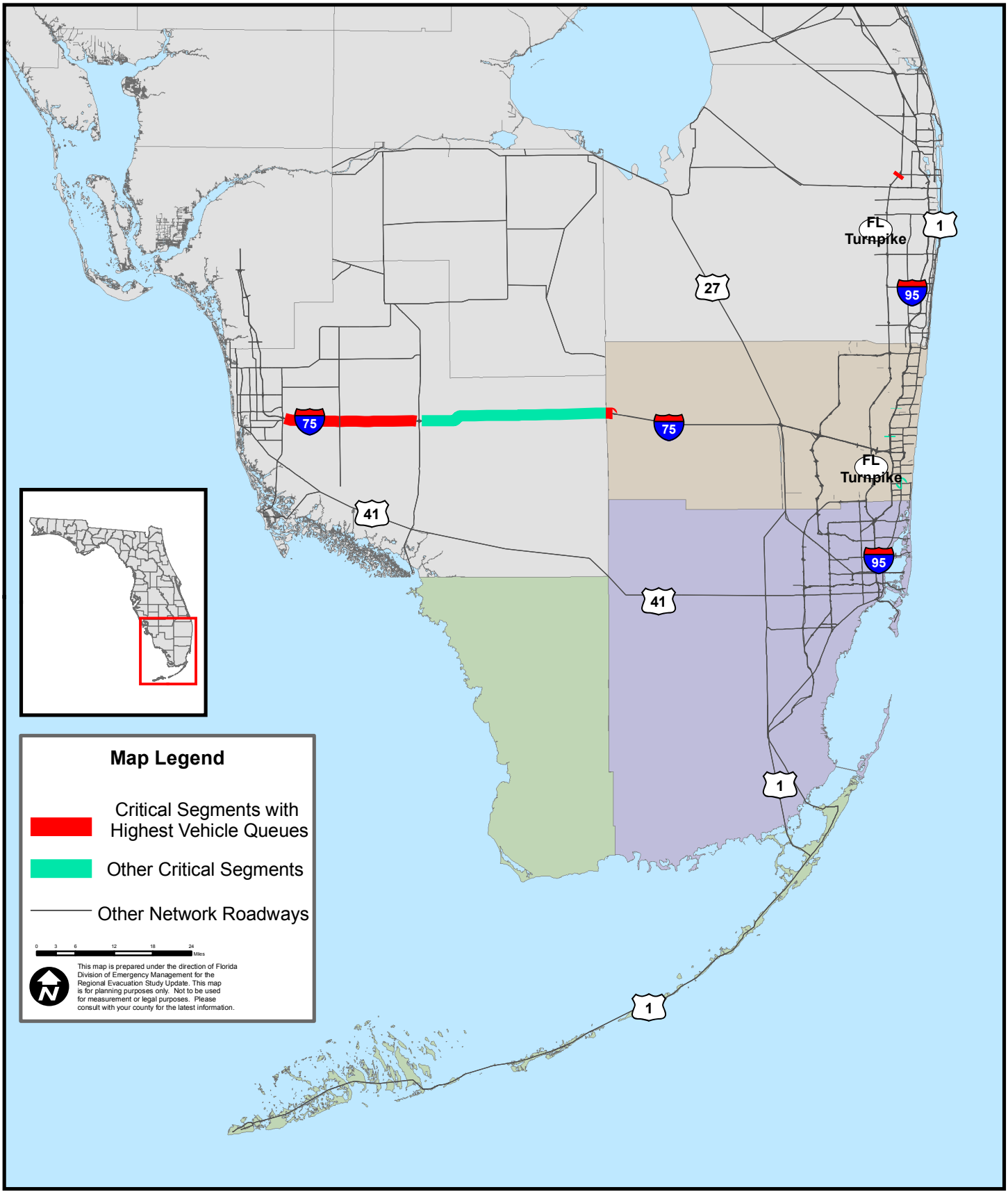


Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: October, 2010

Figure IV-32

Critical Roadway Segments with Excessive Vehicle Queues for 2015 Operational Scenario 18 Evacuation Level C

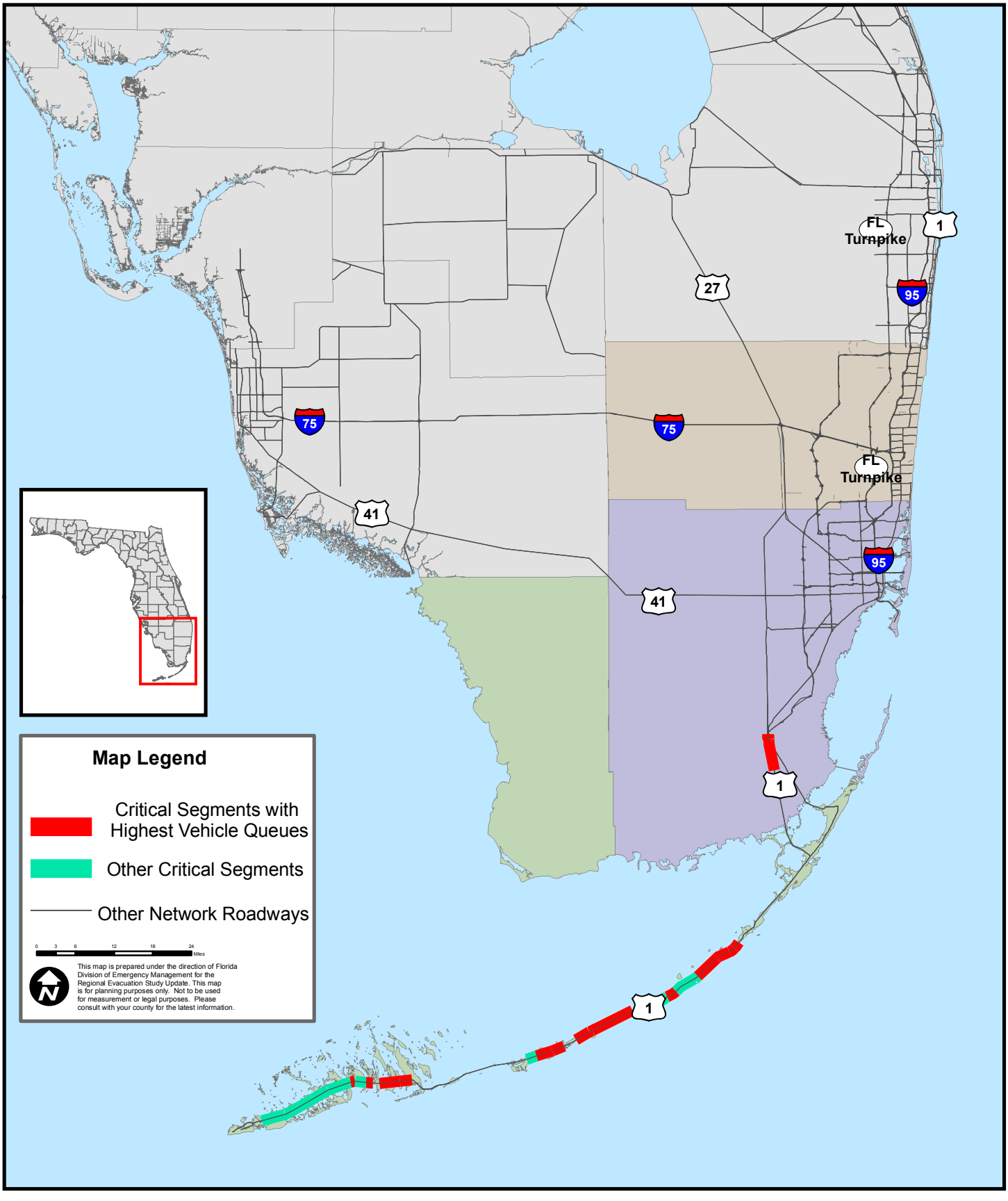


Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-33

Critical Roadway Segments with Excessive Vehicle Queues for 2015 Operational Scenario 19 Evacuation Level D

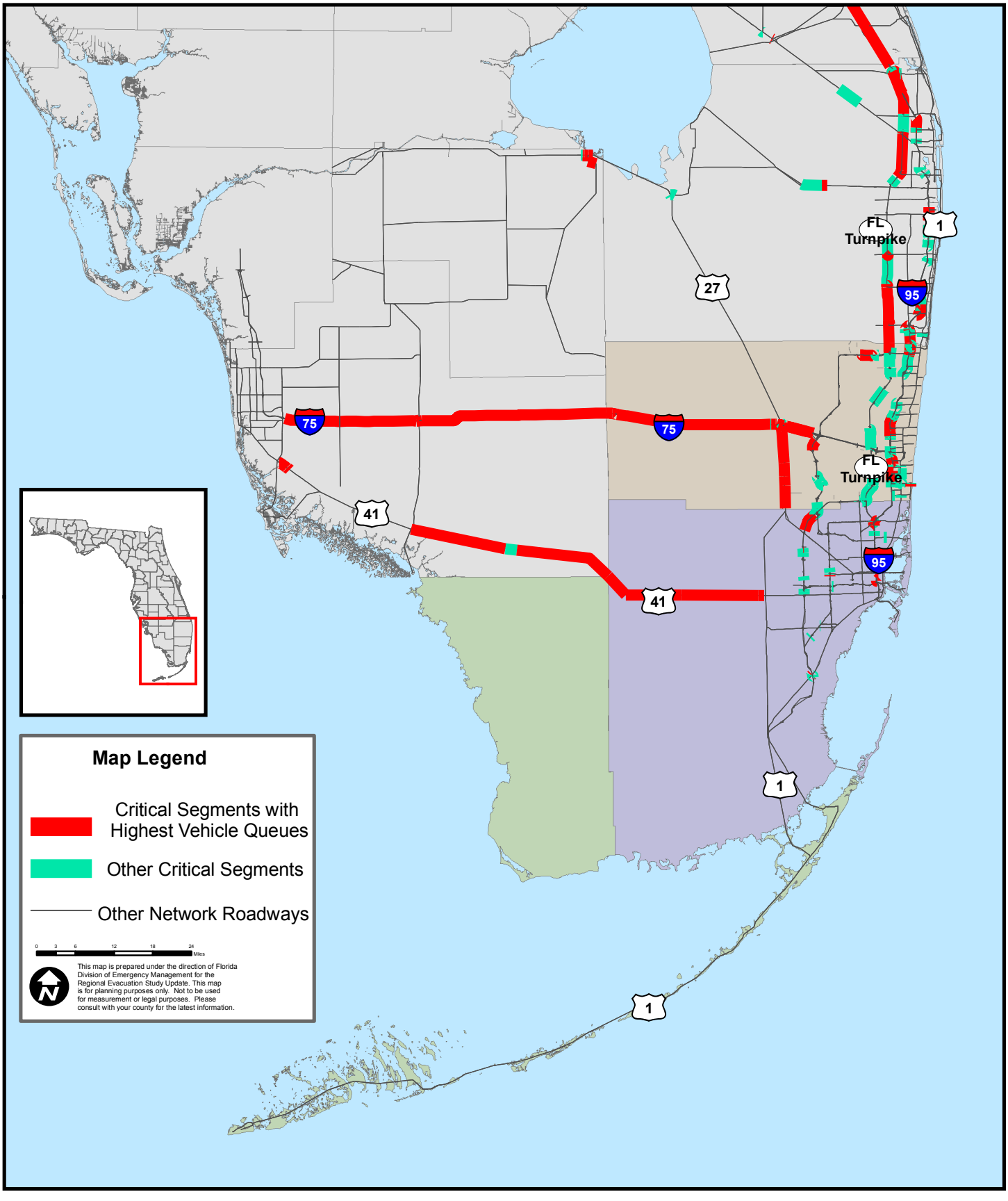


Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: October, 2010

Figure IV-34

Critical Roadway Segments with Excessive Vehicle Queues for 2015 Operational Scenario 20 Evacuation Level E



Sources: South Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Table IV-26 – Evacuating Vehicles Leaving Each County by Evacuation Route for the 2010 Operational Scenarios 1 through 5

	Evacuation Level A Operational Scenario 1	Evacuation Level B Operational Scenario 2	Evacuation Level C Operational Scenario 3	Evacuation Level D Operational Scenario 4	Evacuation Level E Operational Scenario 5
Monroe County					
US 1 Northbound	27,700	30,700	26,300	30,100	33,900
Miami-Dade County					
US 41 Westbound	4,000	4,400	5,100	11,400	22,100
US 27 Northbound	0	0	2,900	7,000	8,700
I-75 Northbound	15,800	17,600	23,900	31,200	32,800
FL 821 Northbound	16,000	18,600	16,600	29,200	37,100
Turnpike Northbnd	19,700	27,100	27,400	32,800	38,200
I-95 Northbound	7,900	9,800	10,400	18,100	31,400
US 1 Northbound	1,900	3,700	4,700	6,000	6,800
Broward County					
US 1 Southbound	300	100	100	100	200
I-95 Southbound	5,500	6,000	9,100	14,200	15,700
Turnpike Southbnd	1,100	1,100	1,300	3,400	5,100
FL 821 Southbound	1,500	1,700	2,600	5,300	7,900
I-75 Southbound	1,200	1,200	1,400	2,100	4,000
US 27 Southbound	0	0	0	0	0
I-75 Westbound	26,000	31,300	34,500	56,300	69,700
US 27 Northbound	7,900	9,300	12,000	21,700	21,800
Turnpike Northbnd	30,300	36,600	34,400	57,900	99,300
I-95 Northbound	15,300	18,200	20,700	33,300	37,500
US 1 Northbound	800	1,100	3,700	3,500	12,000

Table IV-27 – Evacuating Vehicles Leaving Each County by Evacuation Route for the 2010 Operational Scenarios 6 through 10

	Evacuation Level A Operational Scenario 6	Evacuation Level B Operational Scenario 7	Evacuation Level C Operational Scenario 8a	Evacuation Level C Operational Scenario 8b	Evacuation Level D Operational Scenario 9	Evacuation Level E Operational Scenario 10
Monroe County						
US 1 Northbound	27,600	0	26,000	37,700	0	0
Miami-Dade County						
US 41 Westbound	2,800	0	0	100	6,100	4,100
US 27 Northbound	900	0	0	0	4,500	0
I-75 Northbound	12,600	0	10,500	15,200	30,300	0
FL 821 Northbound	12,800	0	11,600	16,500	9,600	0
Turnpike Northbnd	20,400	0	0	0	26,300	0
I-95 Northbound	6,700	0	300	400	23,200	100
US 1 Northbound	1,800	0	0	0	7,100	0
Broward County						
US 1 Southbound	0	100	0	0	0	500
I-95 Southbound	0	3,300	0	0	100	12,200
Turnpike Southbnd	0	600	0	0	0	3,100
FL 821 Southbound	100	1,000	0	0	100	7,000
I-75 Southbound	0	700	0	0	0	3,700
US 27 Southbound	0	0	0	0	0	100
I-75 Westbound	19,300	13,900	7,900	11,300	25,400	29,100
US 27 Northbound	5,100	2,700	1,600	2,300	7,600	10,600
Turnpike Northbnd	21,700	13,900	9,700	13,700	25,000	26,300
I-95 Northbound	7,900	5,800	500	800	18,700	22,100
US 1 Northbound	0	0	0	0	5,100	5,000

Table IV-28 – Evacuating Vehicles Leaving Each County by Evacuation Route for the 2015 Operational Scenarios 11 through 15

	Evacuation Level A Operational Scenario 11	Evacuation Level B Operational Scenario 12	Evacuation Level C Operational Scenario 13	Evacuation Level D Operational Scenario 14	Evacuation Level E Operational Scenario 15
Monroe County					
US 1 Northbound	28,500	31,800	27,800	31,900	35,900
Miami-Dade County					
US 41 Westbound	5,800	7,100	4,400	13,200	16,300
US 27 Northbound	400	0	1,000	7,400	11,100
I-75 Northbound	14,900	15,800	21,600	29,200	73,600
FL 821 Northbound	16,200	19,000	19,600	29,000	24,700
Turnpike Northbnd	20,000	26,800	31,600	38,900	47,700
I-95 Northbound	7,500	10,600	11,000	18,900	26,200
US 1 Northbound	1,800	3,500	4,900	6,000	6,900
Broward County					
US 1 Southbound	300	100	100	100	300
I-95 Southbound	5,400	6,100	9,200	14,200	16,000
Turnpike Southbnd	1,000	1,000	1,300	0	0
FL 821 Southbound	1,700	1,800	2,700	5,100	5,700
I-75 Southbound	1,200	1,200	1,400	1,800	0
US 27 Southbound	0	0	0	0	0
I-75 Westbound	23,900	28,000	21,000	48,200	35,500
US 27 Northbound	9,000	10,100	22,600	17,000	23,000
Turnpike Northbnd	28,500	35,400	40,700	52,200	73,700
I-95 Northbound	16,600	19,300	21,600	24,400	49,800
US 1 Northbound	1,400	1,500	2,400	8,100	14,200

Table IV-29 – Evacuating Vehicles Leaving Each County by Evacuation Route for the 2015 Operational Scenarios 16 through 20

	Evacuation Level A Operational Scenario 16	Evacuation Level B Operational Scenario 17	Evacuation Level C Operational Scenario 18	Evacuation Level D Operational Scenario 19	Evacuation Level E Operational Scenario 20
Monroe County					
US 1 Northbound	0	0	0	0	0
Miami-Dade County					
US 41 Westbound	100	4,100	0	0	8,300
US 27 Northbound	14,800	17,700	0	12,700	7,000
I-75 Northbound	13,600	6,900	0	14,100	42,500
FL 821 Northbound	23,900	31,700	0	0	15,900
Turnpike Northbnd	5,300	19,000	0	300	33,000
I-95 Northbound	1,800	7,500	0	0	29,900
US 1 Northbound	0	0	0	0	7,900
Broward County					
US 1 Southbound	0	9,400	200	0	0
I-95 Southbound	0	1,800	5,100	0	0
Turnpike Southbnd	100	3,500	800	0	0
FL 821 Southbound	0	2,000	1,700	0	200
I-75 Southbound	0	0	800	0	0
US 27 Southbound	21,900	30,100	0	9,500	0
I-75 Westbound	4,900	11,300	18,500	1,900	33,800
US 27 Northbound	24,700	24,200	3,900	11,700	9,500
Turnpike Northbnd	5,200	23,800	19,300	700	40,600
I-95 Northbound	0	4,500	7,900	0	26,600
US 1 Northbound	0	2,900	100	0	5,000

Table IV-30 – Evacuating Vehicles Entering Each County by Evacuation Route for the 2010 Operational Scenarios 1 through 5

	Evacuation Level A Operational Scenario 1	Evacuation Level B Operational Scenario 2	Evacuation Level C Operational Scenario 3	Evacuation Level D Operational Scenario 4	Evacuation Level E Operational Scenario 5
Miami-Dade County					
US 1 Southbound	300	100	100	100	200
I-95 Southbound	5,500	6,000	9,100	14,200	15,700
Turnpike Southbnd	1,100	1,100	1,300	3,400	5,100
FL 821 Southbound	1,500	1,700	2,600	5,300	7,900
I-75 Southbound	1,200	1,200	1,400	2,100	4,000
US 27 Southbound	0	0	0	0	0
US 1 Northbound	27,700	30,700	26,300	30,100	33,900
Broward County					
US 1 Southbound	0	1,100	0	200	500
I-95 Southbound	0	0	0	3,400	4,900
Turnpike Southbnd	0	0	0	2,400	2,800
US 27 Southbound	0	0	0	100	100
US 27 Northbound	0	0	2,900	7,000	8,700
I-75 Northbound	15,800	17,600	23,900	31,200	32,800
FL 821 Northbound	16,000	18,600	16,600	29,200	37,100
Turnpike Northbnd	19,700	27,100	27,400	32,800	38,200
I-95 Northbound	7,900	9,800	10,400	18,100	31,400
US 1 Northbound	1,900	3,700	4,700	6,000	6,800

Table IV-31 – Evacuating Vehicles Entering Each County by Evacuation Route for the 2010 Operational Scenarios 6 through 10

	Evacuation Level A Operational Scenario 6	Evacuation Level B Operational Scenario 7	Evacuation Level C Operational Scenario 8a	Evacuation Level C Operational Scenario 8b	Evacuation Level D Operational Scenario 9	Evacuation Level E Operational Scenario 10
Miami-Dade County						
US 1 Southbound	0	100	0	0	0	0
I-95 Southbound	0	3,300	0	0	0	0
Turnpike Southbnd	0	600	0	0	0	0
FL 821 Southbound	100	1,000	0	0	0	0
I-75 Southbound	0	700	0	0	0	0
US 27 Southbound	0	0	0	0	0	0
US 1 Northbound	27,600	200	26,300	37,700	0	0
Broward County						
US 1 Southbound	0	0	0	0	0	0
I-95 Southbound	0	0	0	0	0	0
Turnpike Southbnd	0	0	0	0	0	0
US 27 Southbound	0	0	0	0	0	0
US 27 Northbound	900	0	0	0	4,500	4,500
I-75 Northbound	12,600	0	10,500	15,200	30,300	30,300
FL 821 Northbound	12,800	0	11,600	16,500	9,600	9,600
Turnpike Northbnd	20,400	0	0	0	26,300	26,300
I-95 Northbound	6,700	0	300	400	23,200	23,200
US 1 Northbound	1,800	0	0	0	7,100	7,100

Table IV-32 – Evacuating Vehicles Entering Each County by Evacuation Route for the 2015 Operational Scenarios 11 through 15

	Evacuation Level A Operational Scenario 11	Evacuation Level B Operational Scenario 12	Evacuation Level C Operational Scenario 13	Evacuation Level D Operational Scenario 14	Evacuation Level E Operational Scenario 15
Miami-Dade County					
US 1 Southbound	300	100	100	100	300
I-95 Southbound	5,400	6,100	9,200	14,200	16,000
Turnpike Southbnd	1,000	1,000	1,300	0	0
FL 821 Southbound	1,700	1,800	2,700	5,100	5,700
I-75 Southbound	1,200	1,200	1,400	1,800	0
US 27 Southbound	0	0	0	0	0
US 1 Northbound	28,500	31,800	27,800	31,900	35,900
Broward County					
US 1 Southbound	0	0	0	300	500
I-95 Southbound	0	0	0	3,300	4,600
Turnpike Southbnd	0	0	0	0	0
US 27 Southbound	0	0	0	100	800
US 27 Northbound	400	0	1,000	7,400	11,100
I-75 Northbound	14,900	15,800	21,600	29,200	73,600
FL 821 Northbound	16,200	19,000	19,600	29,000	24,700
Turnpike Northbnd	20,000	26,800	31,600	38,900	47,700
I-95 Northbound	7,500	10,600	11,000	18,900	26,200
US 1 Northbound	1,800	3,500	4,900	6,000	6,900

Table IV-33 – Evacuating Vehicles Entering Each County by Evacuation Route for the 2015 Operational Scenarios 16 through 20

	Evacuation Level A Operational Scenario 16	Evacuation Level B Operational Scenario 17	Evacuation Level C Operational Scenario 18	Evacuation Level D Operational Scenario 19	Evacuation Level E Operational Scenario 20
Miami-Dade County					
US 1 Southbound	0	100	200	0	0
I-95 Southbound	0	9,400	5,100	0	0
Turnpike Southbnd	0	1,800	800	0	0
FL 821 Southbound	100	3,500	1,700	0	0
I-75 Southbound	0	2,000	800	0	0
US 27 Southbound	0	0	0	0	0
US 1 Northbound	28,500	0	0	31,900	0
Broward County					
US 1 Southbound	0	0	0	0	0
I-95 Southbound	0	0	0	0	0
Turnpike Southbnd	0	0	0	0	0
US 27 Southbound	0	0	0	0	0
US 27 Northbound	100	4,100	0	0	7,000
I-75 Northbound	14,800	17,700	0	12,700	42,500
FL 821 Northbound	13,600	6,900	0	14,100	15,900
Turnpike Northbnd	23,900	31,700	0	0	33,000
I-95 Northbound	5,300	19,000	0	300	29,900
US 1 Northbound	1,800	7,500	0	0	7,900

Clearance Times

Clearance times for each of the operational scenarios are summarized in **Table IV-34** and **IV-35**, as well as **Figures IV-35, IV-36, IV-37, IV-38, IV-39** and **IV-40**. Clearance time includes several components, including the mobilization time for the evacuating population to prepare for an evacuation (pack supplies and personal belongs, load their vehicle, etc.), the actual time spent traveling on the roadway network, and the delay time caused by traffic congestion.

In-county clearance times for the 2010 operational scenarios range from 5.5 hours to 47 hours depending upon the scenario. Clearance Time to Shelter for the 2010 operational scenarios range from 4.5 hours to 23.5 hours depending upon the county and the scenario. In-county clearance times for Broward County remain close to the selected response curve for lower level evacuation scenarios, such as 9.5 hours for scenario 1, 12.5 hours for scenario 2, and 9.5 hours for scenario 3. These three scenarios use different response curves (9 hour curves for scenarios 1 and 3 and a 12 hour curve for scenario 2). Clearance times are generally not less than the response curve unless in county or to shelter population numbers are very low.

In 2015, in-county clearance times for the operational scenarios vary from 9.5 hours to 47 hours for the level E evacuation in Broward County. Clearance Time to Shelter shows a similar pattern, with clearance times for the base scenarios ranging from 5.5 hours to 46 hours depending upon the scenario. In county clearance times for Miami-Dade County are typically equal to or above Monroe County out of county clearance times for scenarios that include Monroe County evacuating. By definition, in county clearance time includes out of county trips from other counties that pass through evacuation zones in the evacuating county. Miami-Dade County has a combined B/C evacuation zone where US 1 enters from Monroe County, so in county clearance time for Miami-Dade in all level B or higher evacuations that also include a Monroe County evacuation will reflect the out of county clearance time for Monroe County.

Out of county clearance times for the 2010 operational scenarios range from 9.5 hours to 65 hours for Scenario 4. The out of county clearance time for Scenario 4 is significantly larger than the out of county clearance time for Scenario 5 even though the number of evacuating vehicles is less for Scenario 4. The lower time for Scenario 5 is due to the phasing used on the scenario, where Collier and Monroe Counties evacuate 24 hours prior to the remaining counties. When westbound evacuating traffic from Broward County arrives in Collier County, most of Collier County is clear of traffic and better able to accommodate evacuating traffic. In Scenario 4, only Monroe County evacuates 24 hours prior to the remaining counties, and Collier County does not evacuate and is operating under normal background traffic conditions. The background traffic in Collier County creates significant issues for westbound Broward County evacuating traffic and causes the out of county clearance time to increase nearly 20 hours. Out of county clearance times range from 10 to 47 in 2015 depending upon the scenario.

Regional clearance time for the three county SFRPC region ranges from 10 hours to 66.5 hours in 2010. This time ranges from 13 to 47 hours in 2015. It is important to note that for six of the operational scenarios (scenarios 1, 2, 3, 4, 5, and 13) regional clearance time is larger than the highest out of county clearance time from any of the counties in the region. This is due to the 24 hour phasing used as part of the scenario, where one or more counties evacuate 24 hours prior to the remaining counties. The regional clearance time begins calculating when the first county orders its evacuation, while the out of county clearance time does not begin for each county until the first evacuating vehicle enters the roadway network within the county.

Table IV-34 – 2010 Clearance Times for Operational Scenarios

	Scenario 1 Evacuation Level A	Scenario 2 Evacuation Level B	Scenario 3 Evacuation Level C	Scenario 4 Evacuation Level D	Scenario 5 Evacuation Level E
Clearance Time to Shelter					
Monroe – Key West	5.5	4.5	N/A	N/A	N/A
Monroe – Lower Keys	N/A	N/A	N/A	N/A	N/A
Monroe – Middle Keys	N/A	N/A	N/A	N/A	N/A
Monroe – Upper Keys	N/A	N/A	N/A	N/A	N/A
Monroe – Total	5.5	4.5	N/A	N/A	N/A
Miami-Dade County	9.5	13.0	10.0	13.0	23.5
Broward County	9.5	12.5	9.5	20.5	23.5
In-County Clearance Time					
Monroe – Key West	9.5	12.5	10.0	13.0	13.5
Monroe – Lower Keys	16.0	17.5	16.5	19.0	21.0
Monroe – Middle Keys	19.5	22.0	20.0	22.5	25.0
Monroe – Upper Keys	22.5	25.0	22.5	25.5	28.0
Monroe – Total	22.5	25.0	22.5	25.5	28.0
Miami-Dade County	9.5	36.5	33.5	36.5	47.0
Broward County	9.5	12.5	9.5	20.5	42.0
Out of County Clearance Time					
Monroe – Key West	9.5	12.5	9.5	12.5	13.0
Monroe – Lower Keys	15.5	17.0	16.0	18.5	20.5
Monroe – Middle Keys	19.5	21.5	19.5	22.0	24.5
Monroe – Upper Keys	22.5	24.5	22.0	25.0	27.5
Monroe – Total	22.5	24.5	22.0	25.0	27.5
Miami-Dade County	34.0	37.0	34.0	40.5	49.5
Broward County	34.5	36.5	45.5	65.0	46.5
Regional Clearance Time					
South Florida	35.5	38.0	46.5	66.5	49.5

Notes: For scenarios 1, 2, 3, 4, and 5, regional clearance time is larger than the highest out of county clearance time from any of the counties in the region due to the 24 hour phasing used as part of the scenario.

In-county clearance times are generally not less than the response curve unless in county or to shelter population numbers are very low. In-county clearance time for Broward County in scenarios 1, 2, and 3 illustrate this, as these scenarios used a 9 hour, 12 hour, and 9 hour response curve, respectively.

In county clearance times for Miami-Dade County are typically equal to or above Monroe County out of county clearance times for scenarios that include Monroe County evacuating. By definition, in county clearance time includes out of county trips from other counties that pass through evacuation zones in the evacuating county, including Miami-Dade's combined B/C evacuation zone located where US 1 enters from Monroe County.

Out of county clearance time for Broward County in Scenario 4 is significantly larger than the out of county clearance time for Broward County in Scenario 5 due to the phasing used on Scenario 5, where Collier and Monroe Counties evacuate 24 hours prior to the remaining counties.

Table IV-34 – 2010 Clearance Times for Operational Scenarios (continued)

	Scenario 6 Evacuation Level A	Scenario 7 Evacuation Level B	Scenario 8a Evacuation Level C	Scenario 8b Evacuation Level C	Scenario 9 Evacuation Level D	Scenario 10 Evacuation Level E
Clearance Time to Shelter						
Monroe – Key West	5.0	N/A	N/A	N/A	N/A	N/A
Monroe – Lower Keys	N/A	N/A	N/A	N/A	N/A	N/A
Monroe – Middle Keys	N/A	N/A	N/A	N/A	N/A	N/A
Monroe – Upper Keys	N/A	N/A	N/A	N/A	N/A	N/A
Monroe – Total	5.0	N/A	N/A	N/A	N/A	N/A
Miami-Dade County	9.5	N/A	N/A	N/A	10.0	N/A
Broward County	N/A	9.5	N/A	N/A	N/A	9.5
In-County Clearance Time						
Monroe – Key West	9.5	N/A	12.5	15.0	N/A	N/A
Monroe – Lower Keys	16.0	N/A	16.5	22.0	N/A	N/A
Monroe – Middle Keys	19.5	N/A	20.0	27.0	N/A	N/A
Monroe – Upper Keys	22.5	N/A	22.5	30.5	N/A	N/A
Monroe – Total	22.5	N/A	22.5	30.5	N/A	N/A
Miami-Dade County	9.5	N/A	N/A	N/A	10.0	N/A
Broward County	5.5	9.5	N/A	N/A	N/A	9.5
Out of County Clearance Time						
Monroe – Key West	9.5	N/A	12.5	15.0	N/A	N/A
Monroe – Lower Keys	15.5	N/A	16.5	22.0	N/A	N/A
Monroe – Middle Keys	19.5	N/A	20.0	27.0	N/A	N/A
Monroe – Upper Keys	22.5	N/A	22.5	30.5	N/A	N/A
Monroe – Total	22.5	N/A	22.5	30.5	N/A	N/A
Miami-Dade County	23.5	9.5	23.5	31.5	10.5	11.0
Broward County	24.0	10.0	22.5	30.5	13.0	24.0
Regional Clearance Time						
South Florida	24.0	10.0	23.5	31.5	13.0	24.0

Table IV-35 – 2015 Clearance Times for Operational Scenarios

	Scenario 11 Evacuation Level A	Scenario 12 Evacuation Level B	Scenario 13 Evacuation Level C	Scenario 14 Evacuation Level D	Scenario 15 Evacuation Level E
Clearance Time to Shelter					
Monroe – Key West	5.5	4.0	N/A	N/A	N/A
Monroe – Lower Keys	N/A	N/A	N/A	N/A	N/A
Monroe – Middle Keys	N/A	N/A	N/A	N/A	N/A
Monroe – Upper Keys	N/A	N/A	N/A	N/A	N/A
Monroe – Total	5.5	4.0	N/A	N/A	N/A
Miami-Dade County	10.0	13.0	13.0	10.0	13.0
Broward County	9.5	12.5	12.5	22.5	46.0
In-County Clearance Time					
Monroe – Key West	10.0	12.5	13.0	12.0	14.5
Monroe – Lower Keys	16.5	18.0	17.5	19.5	22.0
Monroe – Middle Keys	20.0	22.5	21.0	23.5	26.0
Monroe – Upper Keys	23.0	26.0	24.0	26.0	29.5
Monroe – Total	23.0	26.0	24.0	26.0	29.5
Miami-Dade County	10.0	26.0	36.5	26.5	29.5
Broward County	9.5	12.5	12.5	22.5	47.0
Out of County Clearance Time					
Monroe – Key West	10.0	12.5	12.5	11.5	14.0
Monroe – Lower Keys	16.0	17.5	17.0	19.0	21.5
Monroe – Middle Keys	20.0	22.0	20.5	23.0	25.5
Monroe – Upper Keys	23.0	25.5	23.5	25.5	29.0
Monroe – Total	23.0	25.5	23.5	25.5	29.0
Miami-Dade County	24.0	26.5	37.0	27.0	44.5
Broward County	24.5	27.0	43.0	46.5	47.0
Regional Clearance Time					
South Florida	24.5	27.0	44.5	46.5	47.0

Notes: For scenario 13, regional clearance time is larger than the highest out of county clearance time from any of the counties in the region due to the 24 hour phasing used as part of the scenario.

In-county clearance times are generally not less than the response curve unless in county or to shelter population numbers are very low. In-county clearance time for Broward County in scenarios 11, 12, and 13 illustrate this, as these scenarios used a 9 hour, 12 hour, and 12 hour response curve, respectively.

In county clearance times for Miami-Dade County are typically equal to or above Monroe County out of county clearance times for scenarios that include Monroe County evacuating. By definition, in county clearance time includes out of county trips from other counties that pass through evacuation zones in the evacuating county, including Miami-Dade's combined B/C evacuation zone located where US 1 enters from Monroe County.

Table IV-35 – 2015 Clearance Times for Operational Scenarios (continued)

	Scenario 16 Evacuation Level A	Scenario 17 Evacuation Level B	Scenario 18 Evacuation Level C	Scenario 19 Evacuation Level D	Scenario 20 Evacuation Level E
Clearance Time to Shelter					
Monroe – Key West	4.0	N/A	N/A	N/A	N/A
Monroe – Lower Keys	N/A	N/A	N/A	N/A	N/A
Monroe – Middle Keys	N/A	N/A	N/A	N/A	N/A
Monroe – Upper Keys	N/A	N/A	N/A	N/A	N/A
Monroe – Total	4.0	N/A	N/A	N/A	N/A
Miami-Dade County	13.0	10.0	N/A	N/A	13.0
Broward County	N/A	9.5	12.5	N/A	N/A
In-County Clearance Time					
Monroe – Key West	12.5	N/A	N/A	19.0	N/A
Monroe – Lower Keys	17.0	N/A	N/A	20.5	N/A
Monroe – Middle Keys	21.0	N/A	N/A	24.0	N/A
Monroe – Upper Keys	24.0	N/A	N/A	27.0	N/A
Monroe – Total	24.0	N/A	N/A	27.0	N/A
Miami-Dade County	13.0	10.5	N/A	N/A	13.5
Broward County	N/A	9.5	12.5	N/A	N/A
Out of County Clearance Time					
Monroe – Key West	12.5	8.5	N/A	18.5	N/A
Monroe – Lower Keys	16.5	9.5	N/A	20.0	N/A
Monroe – Middle Keys	20.5	9.5	N/A	23.5	N/A
Monroe – Upper Keys	23.5	10.0	N/A	26.5	N/A
Monroe – Total	23.5	10.0	N/A	26.5	N/A
Miami-Dade County	24.5	10.5	12.5	27.5	13.5
Broward County	25.0	25.5	13.0	26.5	17.0
Regional Clearance Time					
South Florida	25.0	25.5	13.0	27.5	17.0

Figure IV-35 - Clearance Time to Shelter 2010 Operational Scenarios

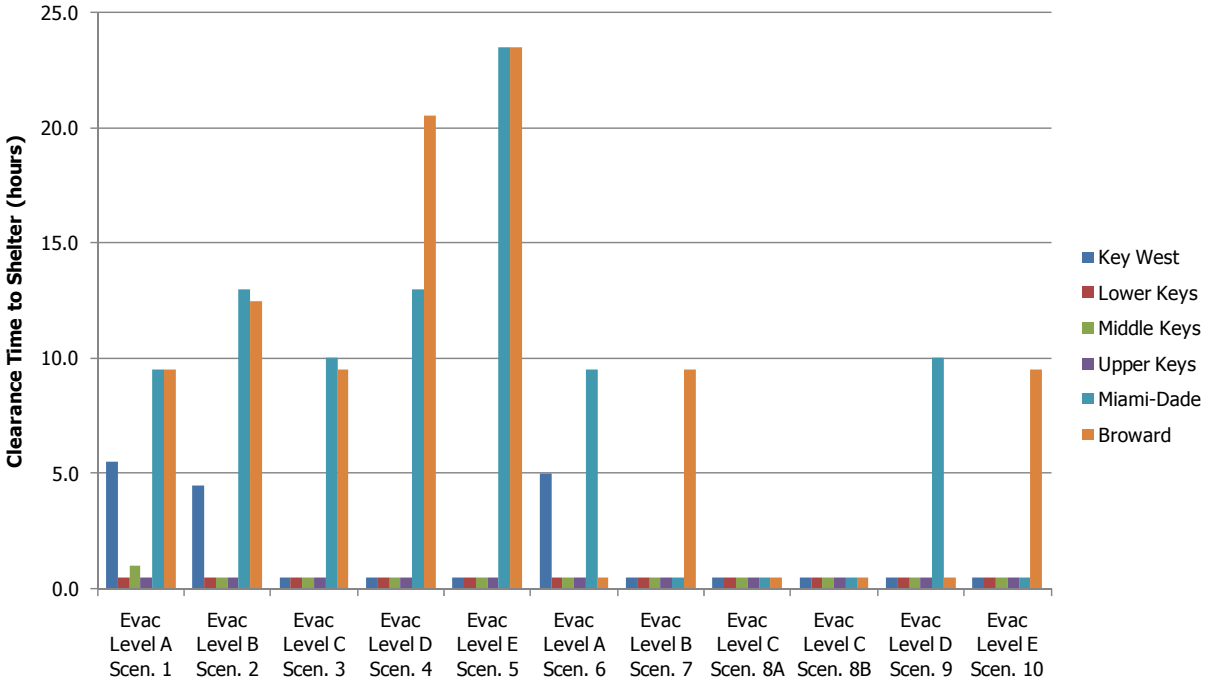


Figure IV-36 - In-County Clearance Times 2010 Operational Scenarios

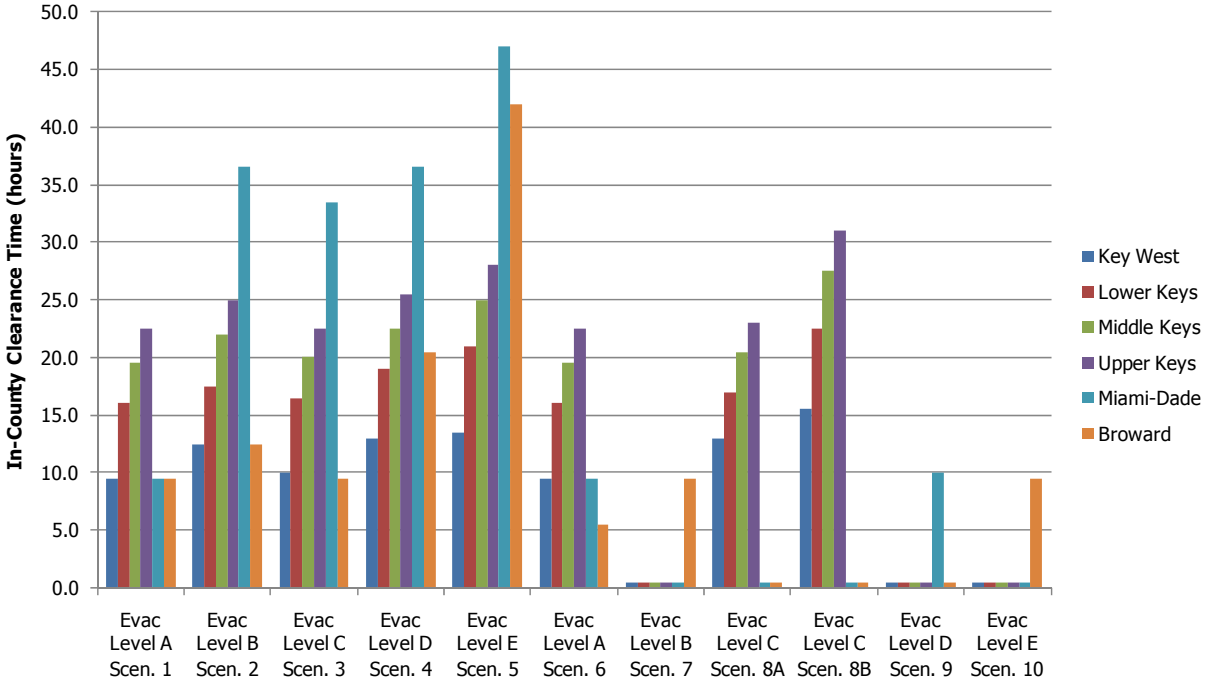


Figure IV-37 - Out of County Clearance Times 2010 Operational Scenarios

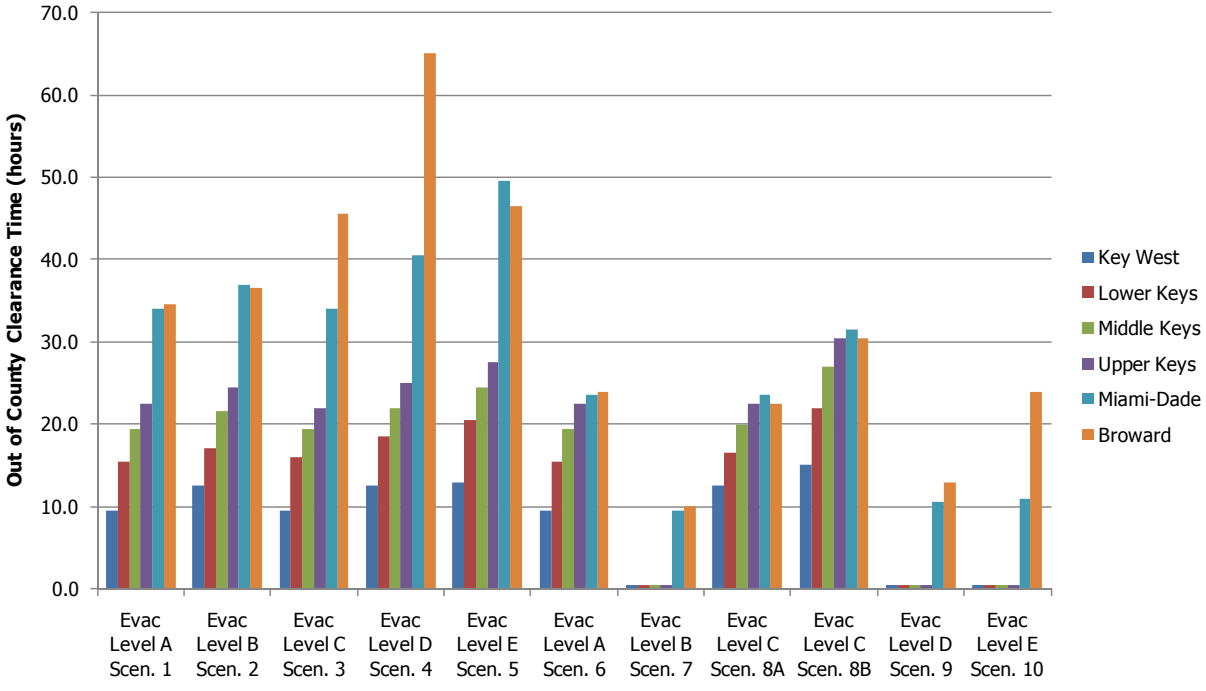


Figure IV-38 - Clearance Time to Shelter 2015 Operational Scenarios

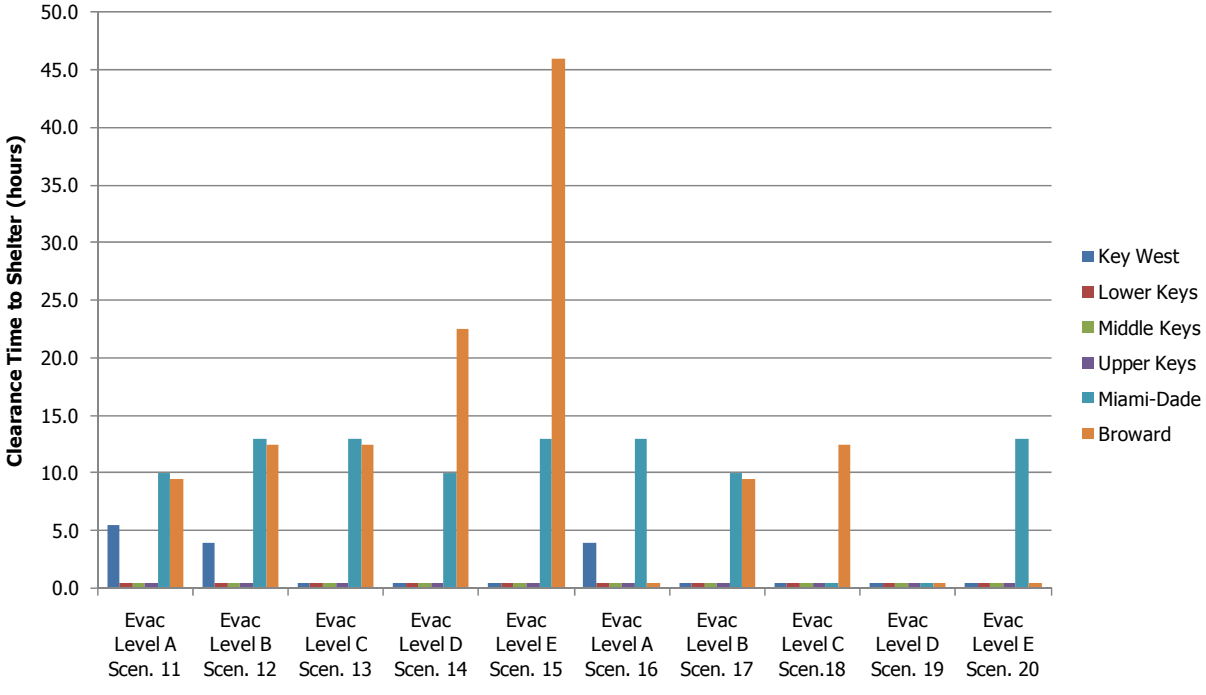


Figure IV-39 - In-County Clearance Times 2015 Operational Scenarios

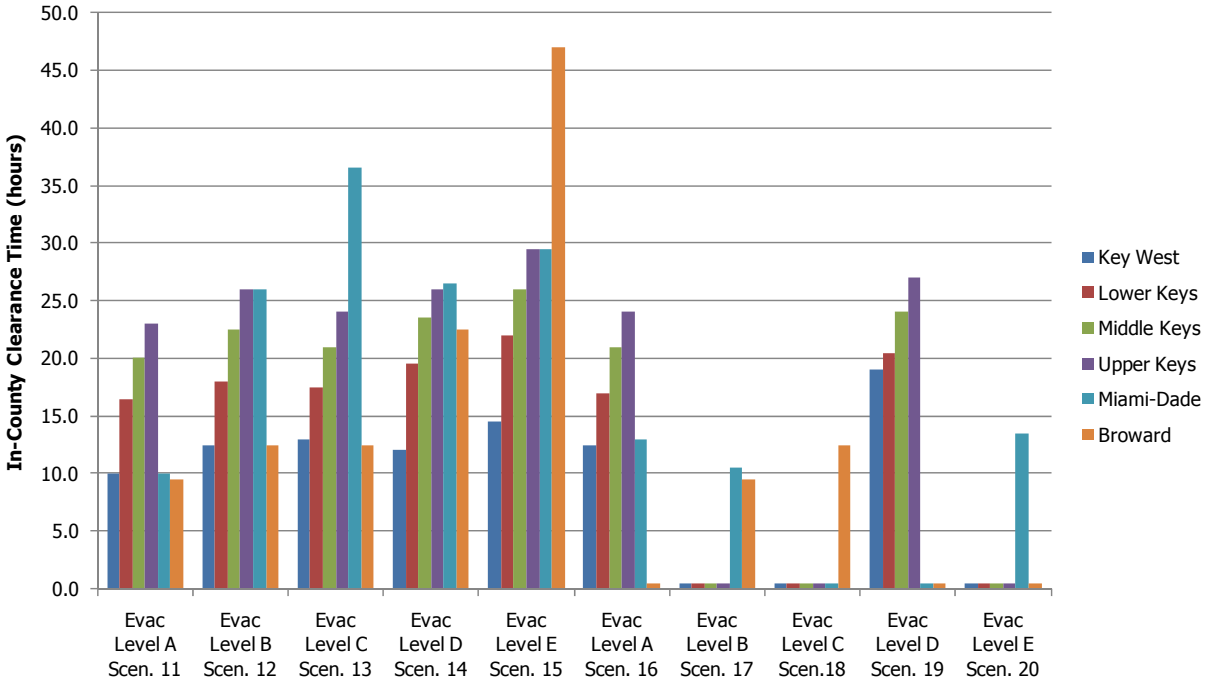
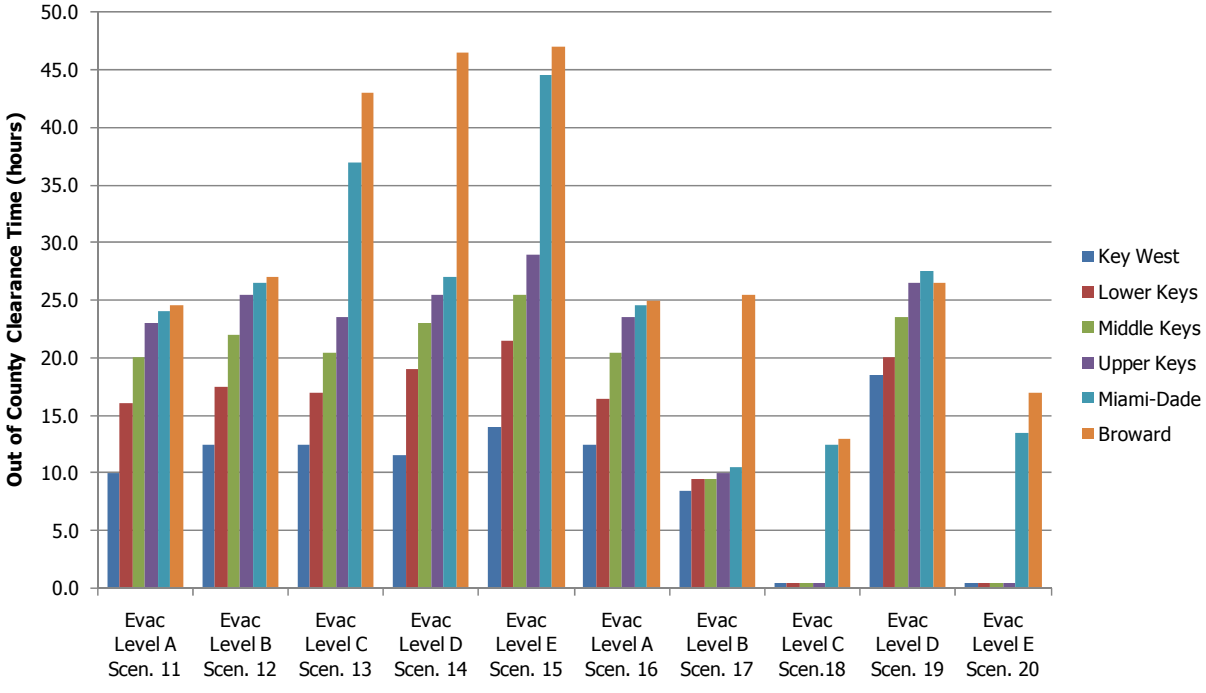


Figure IV-40 - Out of County Clearance Times 2015 Operational Scenarios



H. Maximum Evacuating Population Clearances

From an emergency management standpoint, it is important to get an understanding of the maximum proportion of the evacuating population that can be expected to evacuate at various time intervals during an evacuation. Should storm conditions change during an evacuation, emergency managers will need to be able to estimate what portion of the evacuating population is estimated to still remain within the county trying to evacuate.

Using the base scenarios, which assume 100% of the vulnerable population is evacuating, along with shadow evacuations and evacuations from adjacent counties, an estimate was made of the evacuating population actually able to evacuate out of each county by the time intervals of 12, 18, 24, and 36 hours. The estimated maximum evacuating population by time interval for 2010 is identified in **Table IV-36** and for 2015 in **Table IV-37**.

It is important to note that these estimates take into account many variables, including roadway capacity, in-county evacuating trips, out of county evacuating trips, evacuating trips from other counties, and background traffic that is impeding the evacuation trips. For this reason, the maximum evacuation population by time interval will vary slightly between evacuation level and either increase or decrease from one evacuation level to the next.

I. Sensitivity Analysis

As discussed previously, there are literally thousands of possible combinations of variables that can be applied using the evacuation transportation model, which will result in thousands of possible outcomes. As part of the analysis process, a sensitivity analysis was conducted using the prototype model to evaluate the effect of different response curves on the calculated evacuation clearance times. Calculated clearance times will never be lower than the designated response time, since some evacuating residents will wait to evacuate until near the end of the response time window. For example, using a 12-hour response curve in the analysis means that all residents will begin their evacuation process within 12-hours, and some residents will choose to wait and begin evacuating more than 11.5 hours from when the evacuation was ordered. This will generate a clearance time of more than 12 hours.

The sensitivity analysis identified that clearance times will vary by scenario and by any of the numerous parameters that can be chosen in a particular scenario model run (demographics, student population, tourist population, different counties that are evacuating, response curve, phasing, shadow evacuations, etc.). A few general rules of thumb did emerge from the sensitivity analysis that can provide some guidance to the region regarding the sensitivity of the response curve to the calculated clearance times:

- For low evacuation levels A and B, clearance time will vary by as much as 40 percent depending on the response curve. Low evacuation levels A and B have fewer evacuating vehicles that can be accommodated more easily on the transportation network. In most cases, clearance times typically exceed the response curve by one to two hours. Thus, a 12 hour response curve may yield a clearance time of 13 or 14 hours while an 18 hour response curve may yield a clearance time of 19 or 20 hours. This leads to a higher level of variability than larger evacuations;

Table IV-36 – Maximum Evacuating Population by Time Interval for 2010

	Evacuation Level A	Evacuation Level B	Evacuation Level C	Evacuation Level D	Evacuation Level E
Estimated Evacuating Population Clearing Monroe County					
12-Hour	36,195	36,205	28,669	28,669	28,669
18-Hour	54,293	54,308	43,004	43,004	43,004
24-Hour	72,390	72,410	57,339	57,339	57,339
36-Hour		76,936	72,868	72,868	72,868
Estimated Evacuating Population Clearing Miami-Dade County					
12-Hour	167,101	211,655	189,704	269,389	339,584
18-Hour	250,652	317,482	284,556	404,083	509,376
24-Hour	334,202	423,309	379,408	538,777	679,168
36-Hour	355,090	476,223	497,973	707,145	905,557
Estimated Evacuating Population Clearing Broward County					
12-Hour	95,505	93,395	112,491	167,530	193,987
18-Hour	143,258	140,093	168,736	251,295	290,981
24-Hour	191,010	186,791	224,981	335,060	387,975
36-Hour	206,928	214,031	299,975	446,746	581,962

Note: These estimates take into account many variables, including roadway capacity, in-county evacuating trips, out of county evacuating trips, evacuating trips from other counties, and background traffic that is impeding the evacuation trips. For this reason, the maximum evacuation population by time interval will vary between evacuation level and either increase or decrease from one evacuation level to the next. See Chapter III, Section C for the source of the small area data.

Table IV-37 – Maximum Evacuating Population by Time Interval for 2015

	Evacuation Level A	Evacuation Level B	Evacuation Level C	Evacuation Level D	Evacuation Level E
Estimated Evacuating Population Clearing Monroe County					
12-Hour	36,219	35,669	28,928	28,928	28,928
18-Hour	54,328	53,504	43,392	43,392	43,392
24-Hour	72,438	71,339	57,857	57,857	57,857
36-Hour	73,947	78,770	77,142	77,142	77,142
Estimated Evacuating Population Clearing Miami-Dade County					
12-Hour	171,435	221,719	193,709	276,311	331,131
18-Hour	257,153	332,578	290,564	414,466	496,696
24-Hour	342,870	443,438	387,418	552,621	662,261
36-Hour	371,443	508,106	532,700	759,854	965,798
Estimated Evacuating Population Clearing Broward County					
12-Hour	98,905	96,858	113,571	169,358	176,183
18-Hour	148,358	145,286	170,357	254,037	264,275
24-Hour	197,811	193,715	227,142	338,717	352,367
36-Hour	218,416	226,001	317,053	472,792	528,550

Note: These estimates take into account many variables, including roadway capacity, in-county evacuating trips, out of county evacuating trips, evacuating trips from other counties, and background traffic that is impeding the evacuation trips. For this reason, the maximum evacuation population by time interval will vary between evacuation level and either increase or decrease from one evacuation level to the next. See Chapter III, Section C for the source of the small area data.

- For mid-level evacuations such as C and sometimes D, clearance time varied by as much as 25 percent during the sensitivity analysis. The number of evacuating vehicles is considerably higher than for levels A and B, and lower response curves tend to load the transportation network faster than longer response curves. The variability in clearance times is less in these cases than for low evacuation levels; and,

- For high-level evacuations such as some level D evacuations and all E evacuations, clearance time variability is reduced to about 10 to 15 percent. Large evacuations involve large numbers of evacuating vehicles, and the sensitivity test identified that clearance times are not as dependent on the response curve as lower level evacuations since it takes a significant amount of time to evacuate a large number of vehicles.

The counties within the South Florida Region are encouraged to test additional scenarios beyond what has been provided in this study. Each model run will provide additional information for the region to use in determining when to order an evacuation. Due to advancements in computer technology and the nature of the developed transportation evacuation methodology, this study includes a more detailed and time consuming analysis process than used in previous years studies. Counties interested in testing various response curves for each scenario can easily do so using the TIME interface to calculate clearance times for different response curves.

J. Summary and Conclusions

Through a review of the results of the 31 different scenarios (10 base and 21 operational), several conclusions could be reached regarding the transportation analysis, including the following:

- Critical transportation facilities within the SFRPC region include US 1, I-95, I-75, I-595, I-395, and the Turnpike. For large storm events, such as level D and E evacuations, other State facilities also play an important role in evacuations, such as US 41 in Miami-Dade County and US 27 in Broward County;

- During the level A and B evacuation scenarios, the roadway segments with the highest vehicle queues are primarily concentrated along the major Interstate and State Highway system. During these levels of evacuation, State and County officials should coordinate personnel resources to provide sufficient traffic control at interchanges and major intersections along these routes;

- In contrast, for the higher level C, D, and E evacuation scenarios, many other roadway facilities, both within and outside of the region, will require personnel resources for sufficient traffic control at interchanges and major intersections;

- The SFRPC counties, in coordination with the State, should continue public information campaigns to clearly define those that are vulnerable and should evacuate verses those who choose to evacuate on their own. During large storm events in the operational scenarios, evacuations by the vulnerable population in the three SFRPC Counties are impacted by shadow evacuations occurring in other parts of the counties and in areas outside the SFPRC region;

- The Florida Department of Transportation should continue to work with local counties on implementing intelligent transportation system (ITS) technology, which will provide enhanced monitoring and notification systems to provide evacuating traffic with up to date information regarding expected travel times and alternate routes;

- The State can use the data and information provided in this report (specifically the evacuating vehicle maps in Volume 5-11) to estimate fuel and supply requirements along major evacuation routes to aid motorists during the evacuation process;

- For major evacuation routes that have signalized traffic control at major intersections, traffic signal timing patterns should be adjusted during the evacuation process to provide maximum green time for evacuating vehicles in the predominate north and west directions; and,

- The counties within the South Florida Region are encouraged to test additional transportation scenarios beyond what has been provided in this study. Each model run will provide additional information for the region to use in planning for an evacuation. Counties interested in testing various response curves for each scenario can easily do so using the TIME interface to calculate clearance times for different evacuation conditions, such as different evacuation levels, different behavioral response assumptions, and different response curves.

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