Florida Statewide Regional Evacuation Study Program

Evacuation Transportation Analysis

Volume 4-10

Florida Division of Emergency Management

Treasure Coast Regional Planning Council

Treasure Coast Region

Includes Hurricane Evacuation Study

Statewide Regional Evacuation Study Program

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EVACUATION TRANSPORTATION ANALYSIS

VOLUME 4-10

TREASURE COAST REGION

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Treasure Coast Regional Planning Council
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November 2010

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TABLE OF CONTENTS

Page

Executive Summary ES-1
A. Background and Purpose ES-1
B. Study Area ES-1
C. Input and Coordination ES-2
D. Evacuation Modeling Methodology and Framework ES-2
E. Regional Model Implementation ES-5
F. TIME User Interface ES-16
G. Vulnerable Population ES-16
H. Evacuation Model Scenarios ES-21
I. Clearance Time Results ES-21
J. Maximum Evacuating Population Clearances ES-28
K. Sensitivity Analysis ES-28
L. Summary and Conclusions ES-31

Chapter I – Introduction I-1
A. Background and Purpose I-1
B. Study Area I-1
C. Input and Coordination I-3

Chapter II – Evacuation Modeling Methodology and Framework II-1
A. Behavioral Assumptions II-1
B. Zone System and Highway Network II-3
C. Background Traffic II-6
D. Evacuation Traffic II-8
E. Dynamic Traffic Assignment II-12
F. Prototype Model Development II-13

Chapter III – Regional Model Implementation III-1
A. Regional Model Network III-1
B. Regional Zone System III-1
C. Regional Demographic Characteristics III-4
D. Planned Roadway Improvements III-7
E. Behavioral Assumptions III-10
F. Shelters III-15
G. Evacuation Zones III-15
H. TIME User Interface III-15

Chapter IV – Transportation Analysis IV-1
A. Vulnerable Population IV-1
B. Clearance Time Definitions IV-6
C. Evacuation Model Scenarios IV-7
D. Base Scenarios IV-7

Page

E. Base Scenario Results IV-10
F. Operational Scenarios IV-35
G. Operational Scenario Results IV-37
H. Maximum Evacuating Population Clearances IV-62
I. Sensitivity Analysis IV-62
J. Summary and Conclusions IV-65

LIST OF FIGURES

Page

Figure ES-1 – General Model Flow ES-4
Figure ES-2 – Treasure Coast Regional Model Network ES-6
Figure ES-3 – Treasure Coast Regional Model Transportation Evacuation Zone System (TEZ)ES-7
Figure ES-4 – Evacuating Participation Rates: Indian River County – Site-Built Homes ES-12
Figure ES-5 – Evacuating Participation Rates: Indian River County – Mobile Homes.....ES-12
Figure ES-6 – Evacuating Participation Rates: Martin County – Site-Built Homes ES-13
Figure ES-7 – Evacuating Participation Rates: Martin County – Mobile Homes ES-13
Figure ES-8 – Evacuating Participation Rates: Palm Beach County – Site-Built Homes.....ES-14
Figure ES-9 – Evacuating Participation Rates: Palm Beach County – Mobile Homes ES-14
Figure ES-10 – Evacuating Participation Rates: St. Lucie County – Site-Built Homes ES-15
Figure ES-11 – Evacuating Participation Rates: St. Lucie County – Mobile Homes ES-15
Figure I-1 – Treasure Coast Regional Planning Council Counties.....I-2
Figure II-1 – Nine Hour Response Curve.....II-2
Figure II-2 – Percent of Available Capacity for Coastal Counties II-7
Figure II-3 – Percent of Available Capacity for Other Counties II-8
Figure II-4 – General Model Flow II-9
Figure III-1 – Treasure Coast Regional Model Area..... III-2
Figure III-2 – Treasure Coast Regional Model Network III-3
Figure III-3 – Treasure Coast Regional Model Transportation Evacuation Zone System (TEZ)III-5
Figure III-4 – Evacuating Participation Rates: Indian River County – Site-Built Homes III-11
Figure III-5 – Evacuating Participation Rates: Indian River County – Mobile Homes.....III-11
Figure III-6 – Evacuating Participation Rates: Martin County – Site-Built Homes III-12
Figure III-7 – Evacuating Participation Rates: Martin County – Mobile Homes III-12
Figure III-8 – Evacuating Participation Rates: Palm Beach County – Site-Built Homes.....III-13
Figure III-9 – Evacuating Participation Rates: Palm Beach County – Mobile Homes III-13
Figure III-10 – Evacuating Participation Rates: St. Lucie County – Site-Built Homes III-14
Figure III-11 – Evacuating Participation Rates: St. Lucie County – Mobile Homes III-14
Figure III-12 – Treasure Coast Regional Evacuation Zones III-16
Figure IV-1 – Critical Roadway Segments with Excessive Vehicle Queues for 2010 Base Scenario Evacuation Level A IV-17
Figure IV-2 – Critical Roadway Segments with Excessive Vehicle Queues for 2010 Base Scenario Evacuation Level B IV-18
Figure IV-3 – Critical Roadway Segments with Excessive Vehicle Queues for 2010 Base Scenario Evacuation Level C IV-19
Figure IV-4 – Critical Roadway Segments with Excessive Vehicle Queues for 2010 Base Scenario Evacuation Level D IV-20
Figure IV-5 – Critical Roadway Segments with Excessive Vehicle Queues for 2010 Base Scenario Evacuation Level E IV-21
Figure IV-6 – Critical Roadway Segments with Excessive Vehicle Queues for 2015 Base Scenario Evacuation Level A IV-22

Page

Figure IV-7 – Critical Roadway Segments with Excessive Vehicle Queues for 2015 Base Scenario Evacuation Level B IV-23
Figure IV- 8 – Critical Roadway Segments with Excessive Vehicle Queues for 2015 Base Scenario Evacuation Level C IV-24
Figure IV-9 – Critical Roadway Segments with Excessive Vehicle Queues for 2015 Base Scenario Evacuation Level D IV-25
Figure IV-10 – Critical Roadway Segments with Excessive Vehicle Queues for 2015 Base Scenario Evacuation Level E IV-26
Figure IV-11 – Clearance Time to Shelter Base Scenarios IV-33
Figure IV-12 – In-County Clearance Times Base Scenarios IV-33
Figure IV-13 – Out of County Clearance Times Base Scenarios IV-34
Figure IV-14 – Critical Roadway Segments with Excessive Vehicle Queues for 2010 Operational Scenario Evacuation Level A IV-44
Figure IV-15 – Critical Roadway Segments with Excessive Vehicle Queues for 2010 Operational Scenario Evacuation Level B IV-45
Figure IV-16 – Critical Roadway Segments with Excessive Vehicle Queues for 2010 Operational Scenario Evacuation Level C IV-46
Figure IV-17 – Critical Roadway Segments with Excessive Vehicle Queues for 2010 Operational Scenario Evacuation Level D IV-47
Figure IV-18 – Critical Roadway Segments with Excessive Vehicle Queues for 2010 Operational Scenario Evacuation Level E IV-48
Figure IV-19 – Critical Roadway Segments with Excessive Vehicle Queues for 2015 Operational Scenario Evacuation Level A IV-49
Figure IV-20 – Critical Roadway Segments with Excessive Vehicle Queues for 2015 Operational Scenario Evacuation Level B IV-50
Figure IV-21 – Critical Roadway Segments with Excessive Vehicle Queues for 2015 Operational Scenario Evacuation Level C IV-51
Figure IV-22 – Critical Roadway Segments with Excessive Vehicle Queues for 2015 Operational Scenario Evacuation Level D IV-52
Figure IV-23 – Critical Roadway Segments with Excessive Vehicle Queues for 2015 Operational Scenario Evacuation Level E IV-53
Figure IV-24 – Clearance Time to Shelter Operational Scenarios IV-60
Figure IV-25 – In-County Clearance Times Operational Scenarios IV-60
Figure IV-26 – Out of County Clearance Times Operational Scenarios IV-61

LIST OF TABLES

Page

Table ES-1 – Treasure Coast Demographic Characteristic Summary ES-8
Table ES-2 – Treasure Coast Region Roadway Improvements, 2006 – 2010 .....ES-10
Table ES-3 – Treasure Coast Region Roadway Improvements, 2011 – 2015 .....ES-11
Table ES-4 – Vulnerable Population in the Treasure Coast Region for 2010.....ES-17
Table ES-5 – Vulnerable Population in the Treasure Coast Region for 2015.....ES-18
Table ES-6 – Vulnerable Population by Destination for 2010 .....ES-19
Table ES-7 – Vulnerable Population by Destination for 2015 .....ES-20
Table ES-8 – Vulnerable Shadow Evacuation Population ES-20
Table ES-9 – Base Scenarios.....ES-22
Table ES-10 – Operational Scenarios.....ES-23
Table ES-11 – 2010 Clearance Times for Base Scenario.....ES-26
Table ES-12 – 2015 Clearance Times for Base Scenario.....ES-26
Table ES-13 – 2010 Clearance Times for Operational Scenarios ES-27
Table ES-14 – 2015 Clearance Times for Operational Scenarios ES-27
Table ES-15 – Maximum Evacuating Population by Time Interval for 2010.....ES-29
Table ES-16 – Maximum Evacuating Population by Time Interval for 2015.....ES-30
Table II-1 – Out of County Trip Destinations by Region II-11
Table III-1 – Treasure Coast Demographic Characteristics Summary III-6
Table III-2 – Treasure Coast Region Roadway Improvements, 2006 - 2010 ..... III-8
Table III-3 – Treasure Coast Planned Roadway Improvements, 2011-2015 ..... III-9
Table IV-1 – Vulnerable Population in the Treasure Coast Region for 2010 .....IV-2
Table IV-2 – Vulnerable Population in the Treasure Coast Region for 2015 .....IV-3
Table IV-3 – Vulnerable Population by Destination for 2010.....IV-4
Table IV-4 – Vulnerable Population by Destination for 2015.....IV-5
Table IV-5 – Vulnerable Shadow Evacuation Population.....IV-5
Table IV-6 – Base Scenarios IV-9
Table IV-7 – Evacuating Population by Base Scenario for 2010 .....IV-11
Table IV-8 – Evacuating Population by Base Scenario for 2015 .....IV-12
Table IV-9 – Evacuating Vehicles by Base Scenario for 2010.....IV-13
Table IV-10 – Evacuating Vehicles by Base Scenario for 2015 .....IV-14
Table IV-11 – Shelter Demand by Base Scenario.....IV-15
Table IV-12 – Total Evacuating Vehicles for Base Scenarios IV-16
Table IV-13 – Evacuating Vehicles Leaving Each County by Evacuation Route
for the 2010 Base Scenario.....IV-27
Table IV-14 – Evacuating Vehicles Leaving Each County by Evacuation Route
for the 2015 Base Scenario.....IV-28
Table IV-15 – Evacuating Vehicles Entering Each County by Evacuation Route
for the 2010 Base Scenario.....IV-29
Table IV-16 –Evacuating Vehicles Entering Each County by Evacuation Route for the
2015 Base Scenario IV-30

Page

Table IV-17 – 2010 Clearance Times for Base Scenario IV-32
Table IV-18 – 2015 Clearance Times for Base Scenario IV-32
Table IV-19 – Operational Scenarios IV-36
Table IV-20 – Evacuating Population by Operational Scenario for 2010..... IV-38
Table IV-21 – Evacuating Population by Operational Scenario for 2015..... IV-39
Table IV-22 – Evacuating Vehicles by Operational Scenario for 2010 ..... IV-40
Table IV-23 – Evacuating Vehicles by Operational Scenario for 2015 ..... IV-41
Table IV-24 – Shelter Demand by Operational Scenario IV-42
Table IV-25 – Total Evacuating Vehicles for Operational Scenarios IV-43
Table IV 26 – Evacuating Vehicles Leaving Each County by Evacuation Route
for the 2010 Operational Scenarios IV-54
Table IV-27 – Evacuating Vehicles Leaving Each County by Evacuation Route
for the 2015 Operational Scenarios IV-55
Table IV-28 – Evacuating Vehicles Entering Each County by Evacuation Route
for the 2010 Operational Scenarios IV-56
Table IV-29 – Evacuating Vehicles Entering Each County by Evacuation Route
for the 2015 Operational Scenarios IV-57
Table IV-30 – 2010 Clearance Times for Operational Scenarios IV-59
Table IV-31 – 2015 Clearance Times for Operational Scenarios IV-59
Table IV-32 – Maximum Evacuating Population by Time Interval for 2010 ..... IV-63
Table IV-33 – Maximum Evacuating Population by Time Interval for 2015 ..... IV-64

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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 four county Treasure Coast 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 Treasure Coast region. While the impact of other regions is included in the Treasure Coast analysis, it is important to note that the results of the transportation analysis presented in this document are only reported for the four counties included in the Treasure Coast 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 Treasure Coast RPC Evacuation Transportation Analysis is identical to the methodology used for all eleven Regional Planning Councils and includes the following components:

- **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.

- **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.

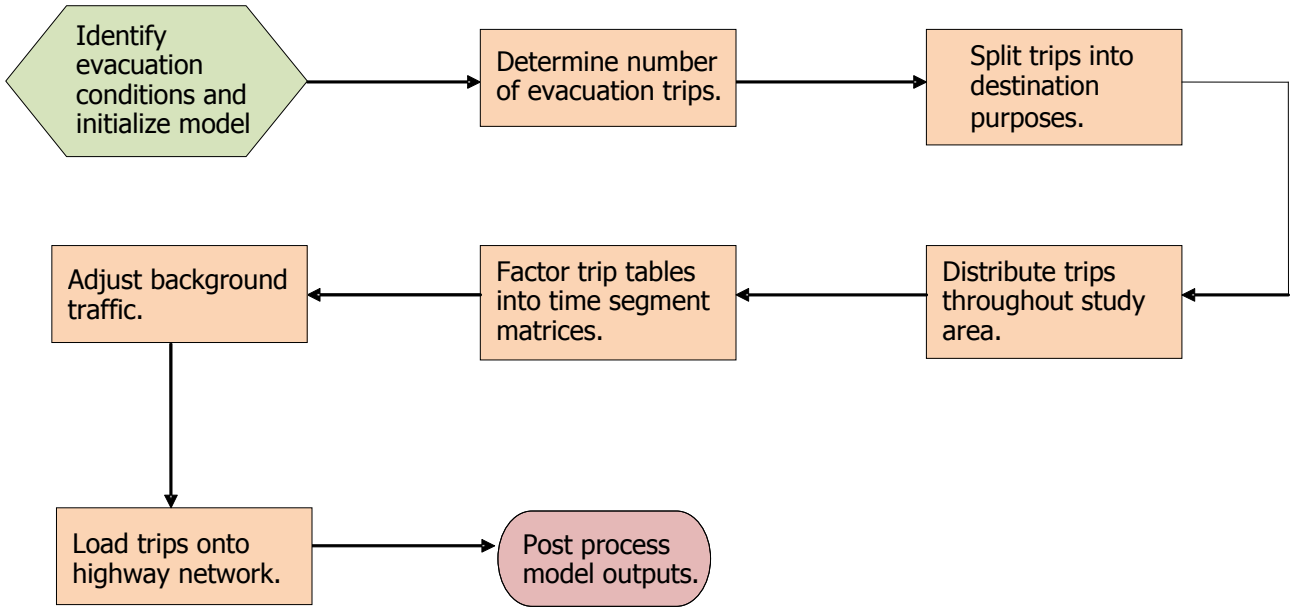
- **Background Traffic** - The traffic that consumes the roadway capacity of a transportation system during an evacuation can be divided into two groups. The first group is the evacuation traffic itself. Once the evacuation demand is determined, this information is converted into a number of vehicles 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 Treasure Coast Region used a series of input data provided by the RPC, including the following:

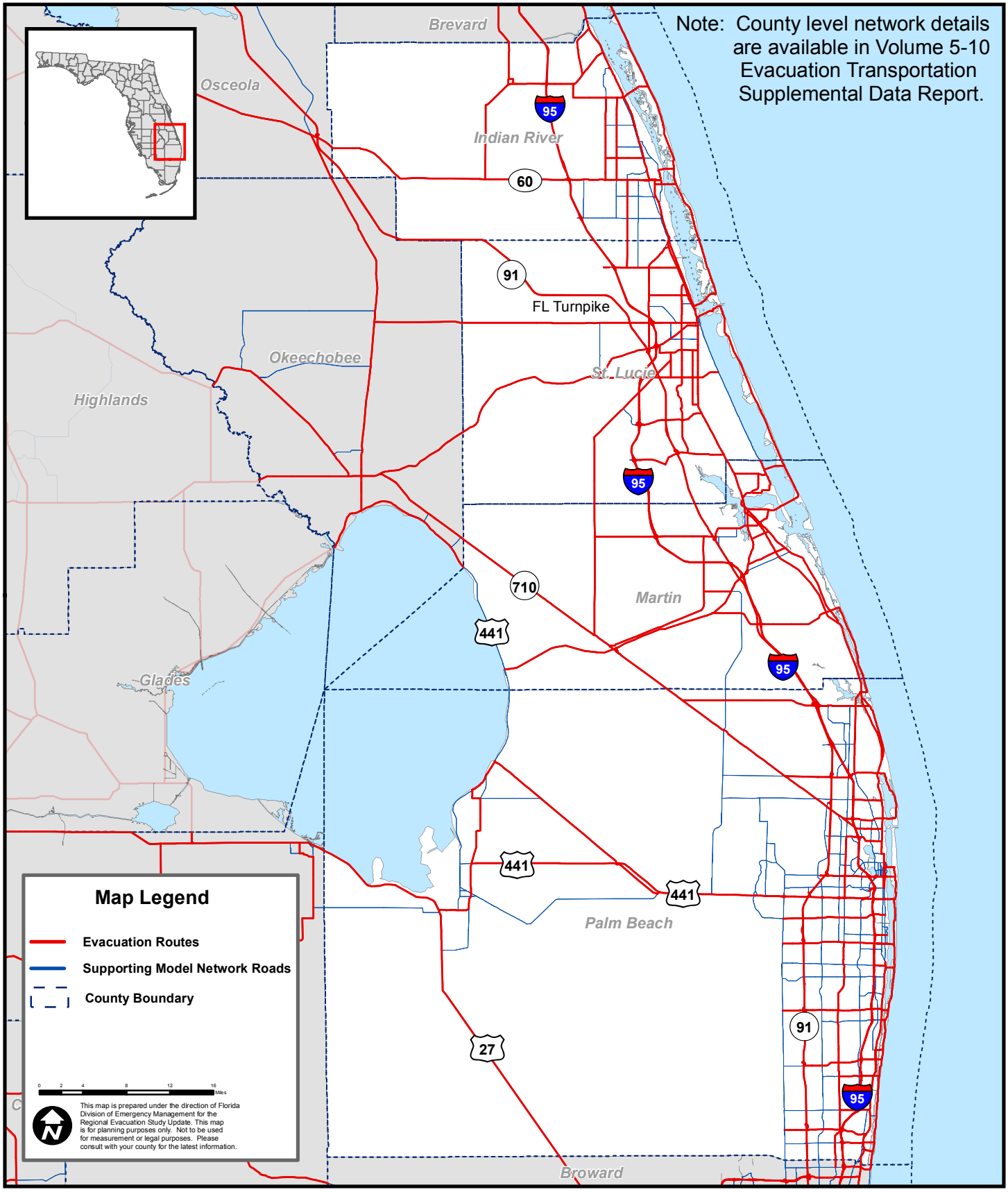
- **Regional Model Network** - The regional model network consists of the RPC designated evacuation routes as well as a supporting roadway network that facilitates movement of evacuation traffic. The 2005 Florida Department of Transportation (FDOT) Statewide Model Network was used as a basis for developing the regional model network, while the evacuation routes were obtained from the Treasure Coast RPC. The RPC relied on the emergency managers of its constituent counties to provide it with information on which roads were to be included as evacuation routes. 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 TCRPC. County level details of the regional model network are provided in the Volume 5-10 report. The regional model network for the Treasure Coast region includes key roadways within the four county region, including I-95, Florida's Turnpike, US 1, US 441, US 27, US 98, SR 60, SR 70, SR A1A, SR 76, SR 710, and SR 80.

- **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 752 zones located within the four county Treasure Coast region, as illustrated in **Figure ES-3**. In the Treasure Coast region, Palm Beach County has the largest number of TEZs with 382, and St. Lucie County follows with 157 TEZs. Indian River and Martin Counties have the lowest number of TEZs in the RPC with 117 and 96 zones, respectively. The larger number of TEZs generally reflects counties with denser urban structure and/or higher population densities.

- **Regional Demographic Characteristics** - Demographic data were developed for the following years: 2006, 2010, and 2015. A snapshot of the key demographic data for each county in the Treasure Coast 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.

Figure ES-2

Treasure Coast Regional Model Network

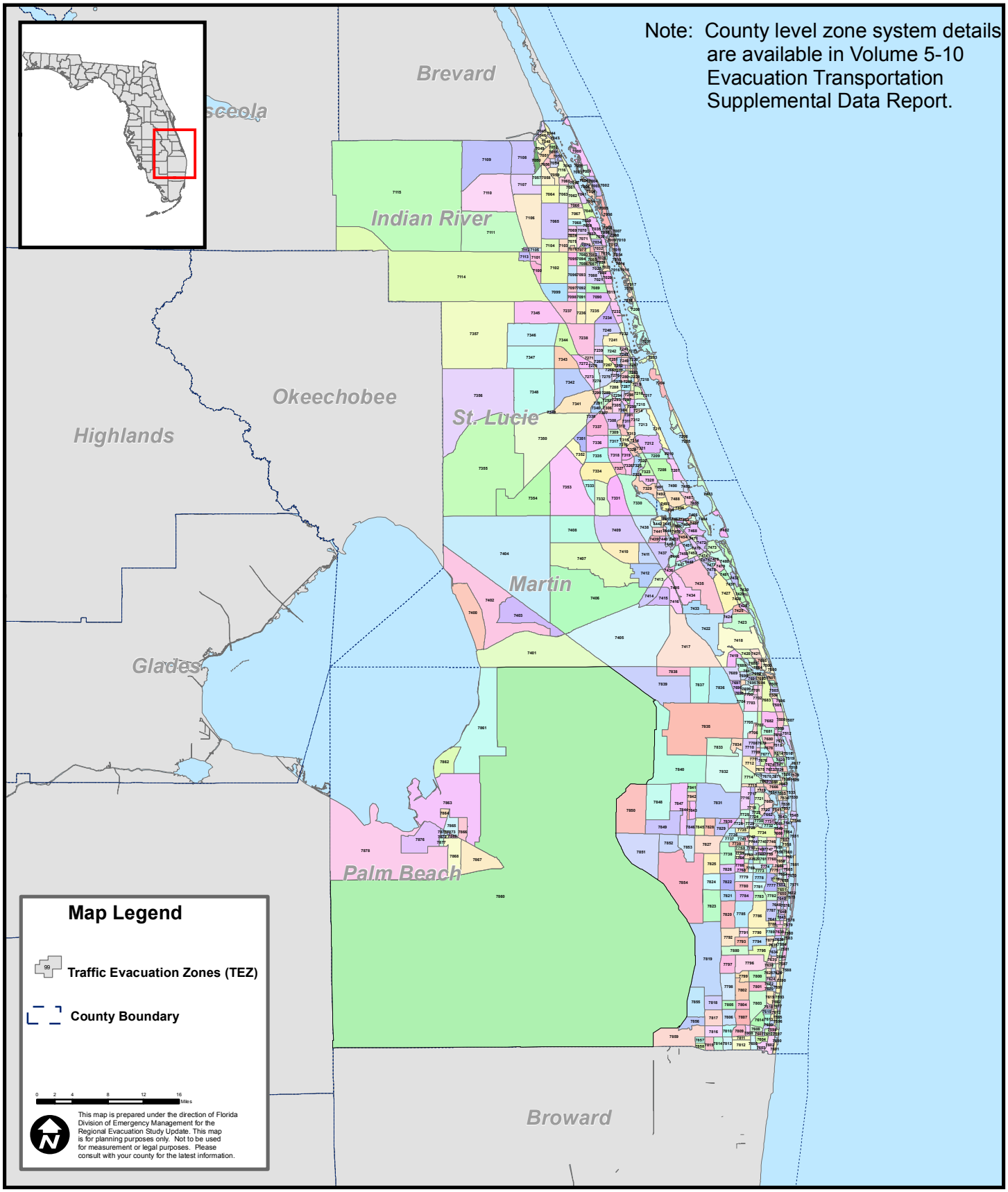


Sources: Treasure Coast Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure ES-3

Treasure Coast Regional Model Transportation Evacuation (TEZ) Zone System



Sources: Treasure Coast Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Palm Beach County has the largest population in the region during all three time periods. The county is expected to reach over 1.3 million people by 2015. St. Lucie County has the second largest population in the region and is forecasted to have more that 330,000 people by 2015. Indian River County has the smallest population in the region and is expected to reach more than 150,000 in 2015. Although Palm Beach County shows the largest absolute growth between 2006 and 2015, the county will experience the smallest percentage of change in population. St. Lucie County is predicted to experience the largest percentage of change at 33%.

Table ES-1 – Treasure Coast Demographic Characteristic Summary

County	Characteristic	Year		
		2006	2010	2015
Indian River	Occupied site-built homes	54,270	57,972	62,586
	Population in site-built homes	121,023	129,279	139,564
	Occupied mobile homes	6,500	6,500	6,500
	Population in mobile home	13,546	13,546	13,546
	Hotel/motel units	2,235	2,235	2,310
Martin	Occupied site-built homes	57,028	60,400	65,402
	Population in site-built homes	126,031	133,488	144,539
	Occupied mobile homes	7,009	7,009	7,009
	Population in mobile home	12,879	12,879	12,879
	Hotel/motel units	1,335	1,335	1,335
Palm Beach	Occupied site-built homes	521,288	540,518	584,453
	Population in site-built homes	1,224,572	1,269,753	1,372,899
	Occupied mobile homes	18,609	19,294	20,854
	Population in mobile home	41,375	42,908	46,390
	Hotel/motel units	23,023	23,023	23,023
St. Lucie	Occupied site-built homes	80,965	93,492	107,037
	Population in site-built homes	231,995	269,736	313,422
	Occupied mobile homes	10,115	10,115	10,115
	Population in mobile home	17,312	17,312	17,312
	Hotel/motel units	3,726	3,726	3,726

Source: Treasure Coast Regional Planning Council (Indian River, Martin, and St. Lucie Counties) and Wilbur Smith Associates (Palm Beach County). Demographic data for Palm Beach County used in the transportation analysis was derived independently to conform to model TEZ boundaries and may vary from demographic data presented in other sections of the Treasure Coast Statewide Regional Evacuation Study.

- **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 Indian River County, US 1 from the Oslo Rd to Highlands Drive 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 Treasure Coast Region, all four of the counties within the region have evacuation zones corresponding to categories of storm surge. Evacuation rates for site-built homes and mobile/manufactured homes are provided by county and summarized in **Figure ES-4** through **Figure ES-11**. 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 5-10.

  Please note that the original behavioral response rates provided by SRESP in Volume 2 were modified to fit the evacuation zones created by Indian River County. The original rates were based on a five zone system, such as in Palm Beach, Martin, and St. Lucie Counties; however, Indian River utilizes four zones – Zone A, Zone B, Zone C, Zone D/E.

- **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 four county region there are a total of 78 shelters, including 14 in Indian River County, 14 in Martin County, 30 in Palm Beach County, and 20 in St. Lucie County, all of which are classified as primary shelters. All together, the 78 shelters located within the four county region can host more than 73,000 persons during an evacuation event. Detailed lists of the available public shelters by county are included in Volume 5-10.

Table ES-2 – Treasure Coast Roadway Improvements, 2006 – 2010

County	Roadway	From	To	Number of Lanes
Indian River	SR 60	Osceola County line	I-95	4
	CR 512	I-95	Roseland Road	4
	Oslo Road	US 1	27th Avenue	4
Martin	SR 714	CR A1A	SR A1A	4
	CR A1A (Dixie Hwy)	Indian St	Monterey Rd	4
Palm Beach	Seminole Pratt Whitney Rd	SR 80	Sycamore Dr	4
	SR 710	Military Trail	Congress Ave	4
	SR 809	SR 704	SR 702	6
	SR 80	US 441	SR 807	8
	Turnpike	Lantana Toll Plaza	Lake Worth Rd	8
	I-95	N of SR 80	N of Congress Ave	10
	SR 811	Broward County line	SW 18th St	4
	Atlantic Ave	Lyons Rd.	Starkey Rd.	6
	Beeline Hwy	Martin County Line	Seminole Pratt Whitney	4
	Jog Rd.	Roebuck Rd.	45th Street	4
	Jog Rd.	Beeline Hwy	Turnpike	4
St Lucie	SR 70	McCarty Rd	Header Canal Rd	4
	US 41	NE Riomar Dr	W Midway Rd	6

Sources: FDOT SIS First Five Year Plan, FDOT SIS Second Five Year Plan, Treasure Coast 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.

Table ES-3 - Treasure Coast Planned Roadway Improvements, 2011–2015

County	Roadway	From	To	Number of Lanes
Indian River	58th Ave	53rd St	49th St	4
	43rd Ave	26th St	16th St	4
	17th St	Old Dixie Hwy	6th Ave	4
	Aviation Blvd	26th St	16th St	4
	Oslo Road	58th Ave	29th Ave	4
	US 1	Oslo Rd	Indian River Blvd	6
	SR 60	I-95	66th Ave	6
	US 1	Oslo Rd	Highlands Drive	6
Martin	SR 710	SR 76	SW Citrus Blvd	4
	SR 76	SW Jack James Drive	SW Lost River Road	6
Palm Beach	Seminole Pratt Whitney Rd	Sycamore Dr.	Beeline Hwy	4
	SR 710	Congress Ave	Old Dixie Hwy	4
	Palmetto Park Rd	W of Military Trail	I-95	8
	Turnpike	SR 802	SR 704	8
	I-95	Broward County line	Linton Blvd	10
	Atlantic Ave	Turnpike	Jog Rd.	6
	Beeline Hwy	PGA Blvd.	Congress Ave	6
	Northlake Blvd.	Seminole Pratt Whitney	Coconut Blvd.	4
	Okeechobee Blvd.	Australian Blvd.	Tamarind Ave	8
	Palmetto Park Rd	Lyons Rd.	W of Military Trail	8
St Lucie	SR 70	Okeechobee County line	MP 10.216	4
	SR 70	Kings Hwy	Jenkins Rd	6
	I-95	SR 70	Indian River County line	8

Sources: FDOT SIS First Five Year Plan, FDOT SIS Second Five Year Plan, Treasure Coast 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.

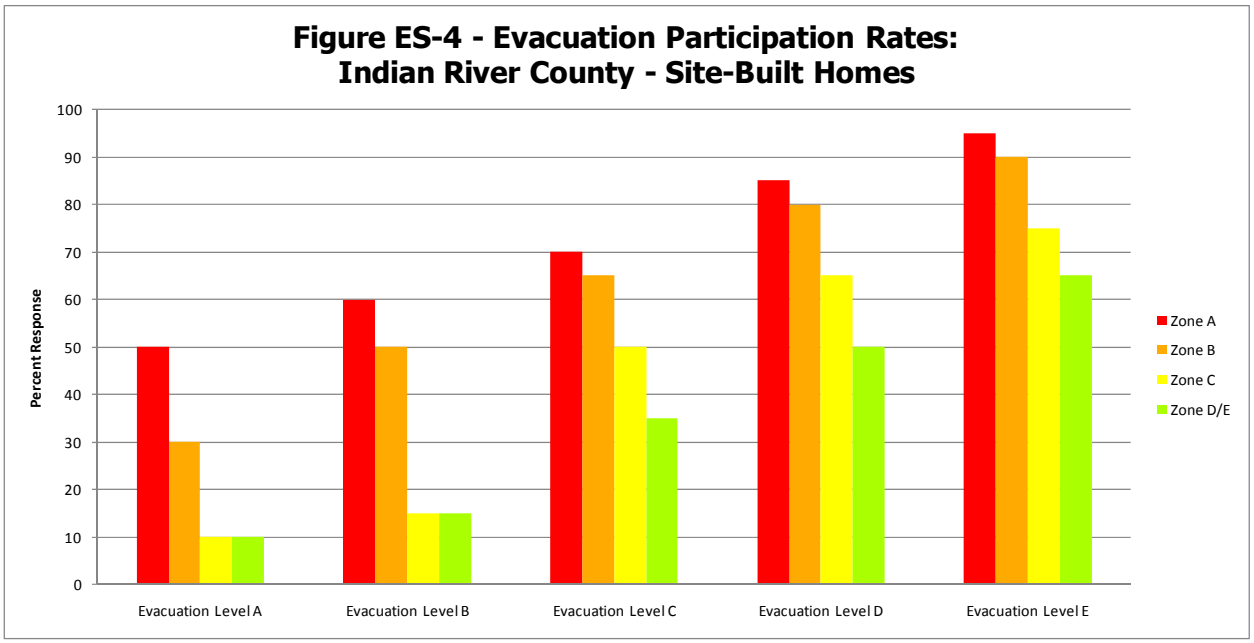


Figure ES-4 - Evacuation Participation Rates:
Indian River County - Site-Built Homes
Percent Response
100
90
80
70
60
50
40
30
20
10
0
Evacuation Level A
Evacuation Level B
Evacuation Level C
Evacuation Level D
Evacuation Level E
Zone A
Zone B
Zone C
Zone D/E

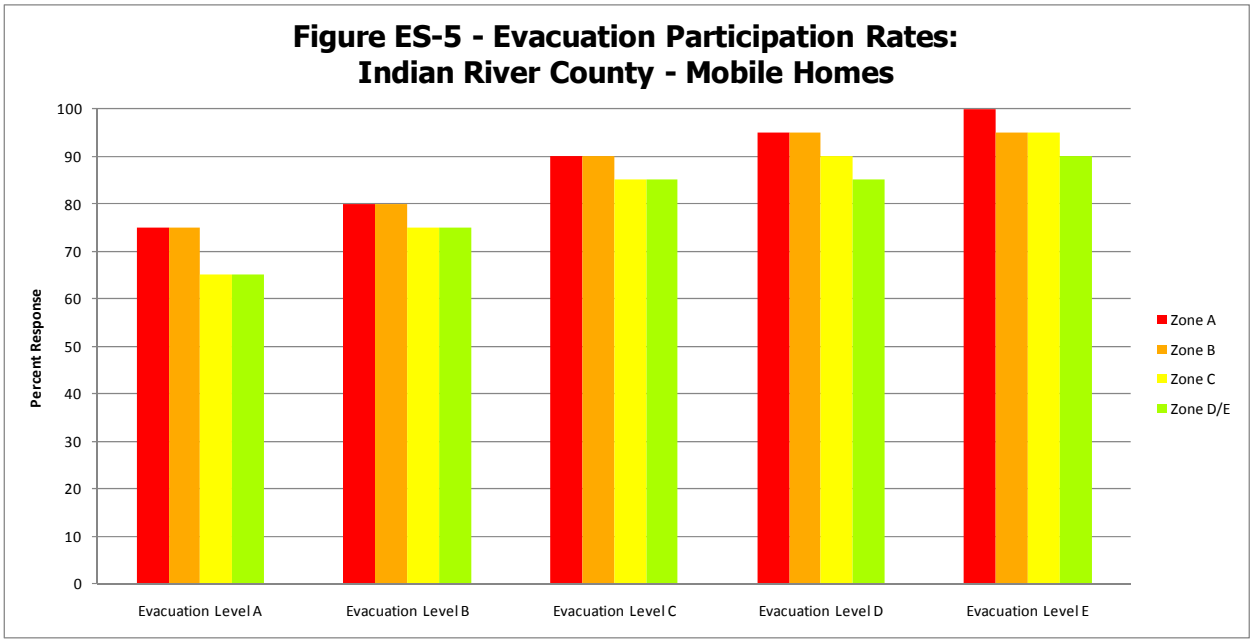


Figure ES-5 - Evacuation Participation Rates:
Indian River County - Mobile Homes
Percent Response
100
90
80
70
60
50
40
30
20
10
0
Evacuation Level A
Evacuation Level B
Evacuation Level C
Evacuation Level D
Evacuation Level E
Zone A
Zone B
Zone C
Zone D/E

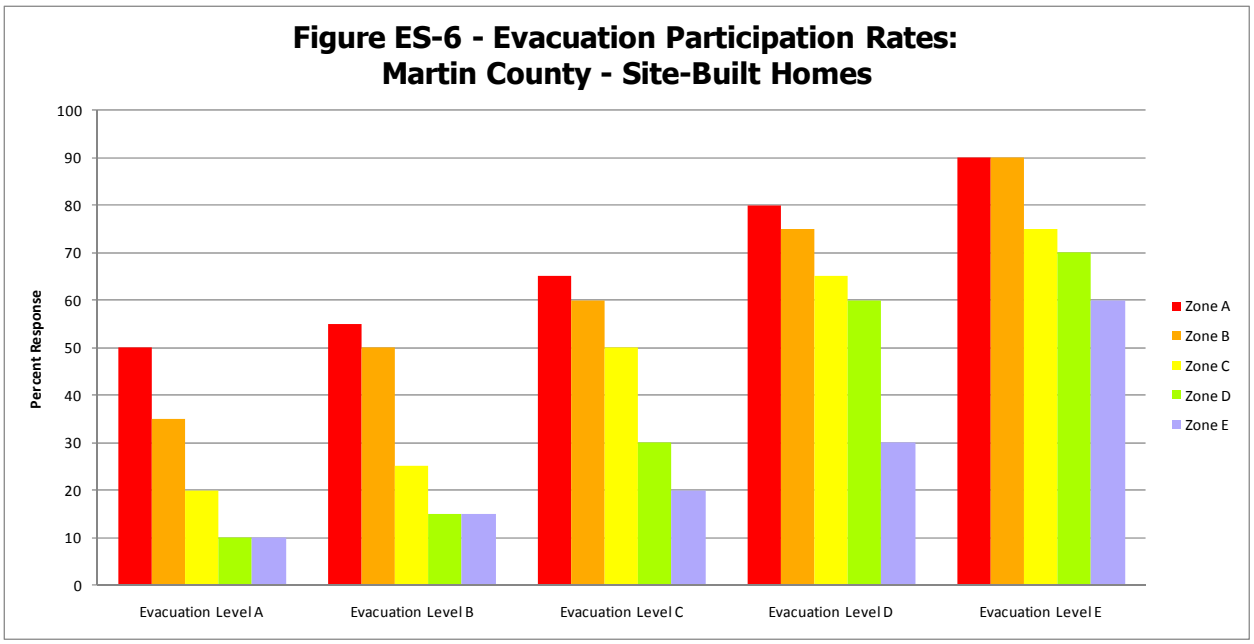


Figure ES-6 - Evacuation Participation Rates:
Martin County - Site-Built Homes
Percent Response
100
90
80
70
60
50
40
30
20
10
0
Evacuation Level A
Evacuation Level B
Evacuation Level C
Evacuation Level D
Evacuation Level E
Zone A
Zone B
Zone C
Zone D
Zone E

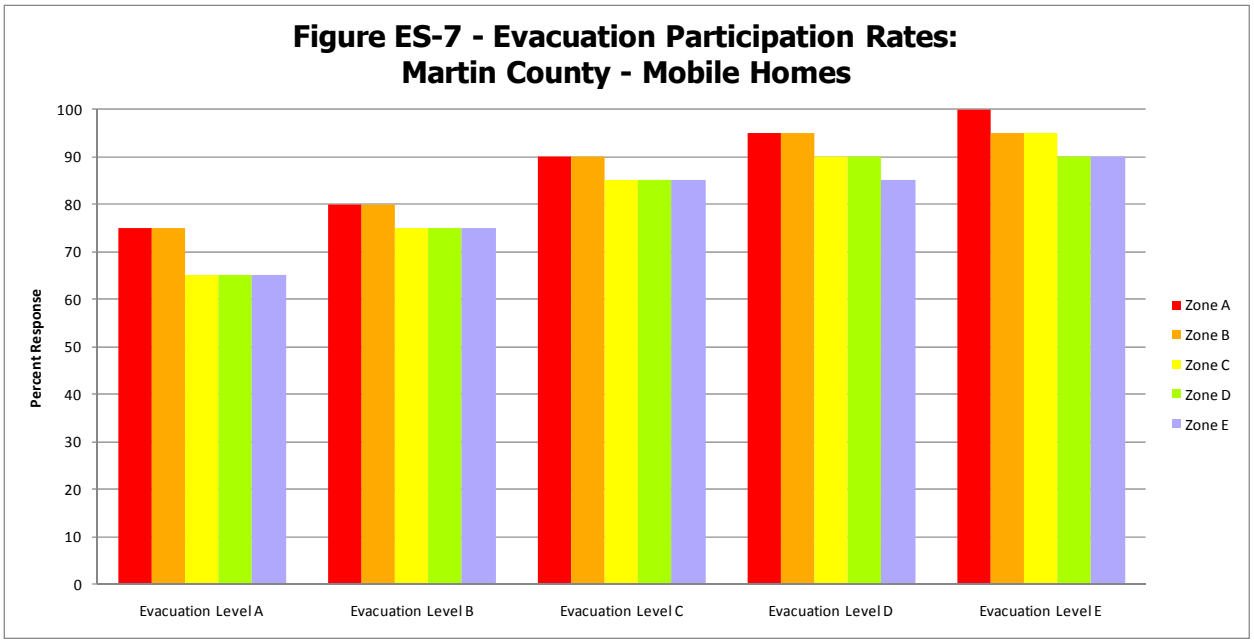


Figure ES-7 - Evacuation Participation Rates:
Martin County - Mobile Homes
Percent Response
100
90
80
70
60
50
40
30
20
10
0
Evacuation Level A
Evacuation Level B
Evacuation Level C
Evacuation Level D
Evacuation Level E
Zone A
Zone B
Zone C
Zone D
Zone E

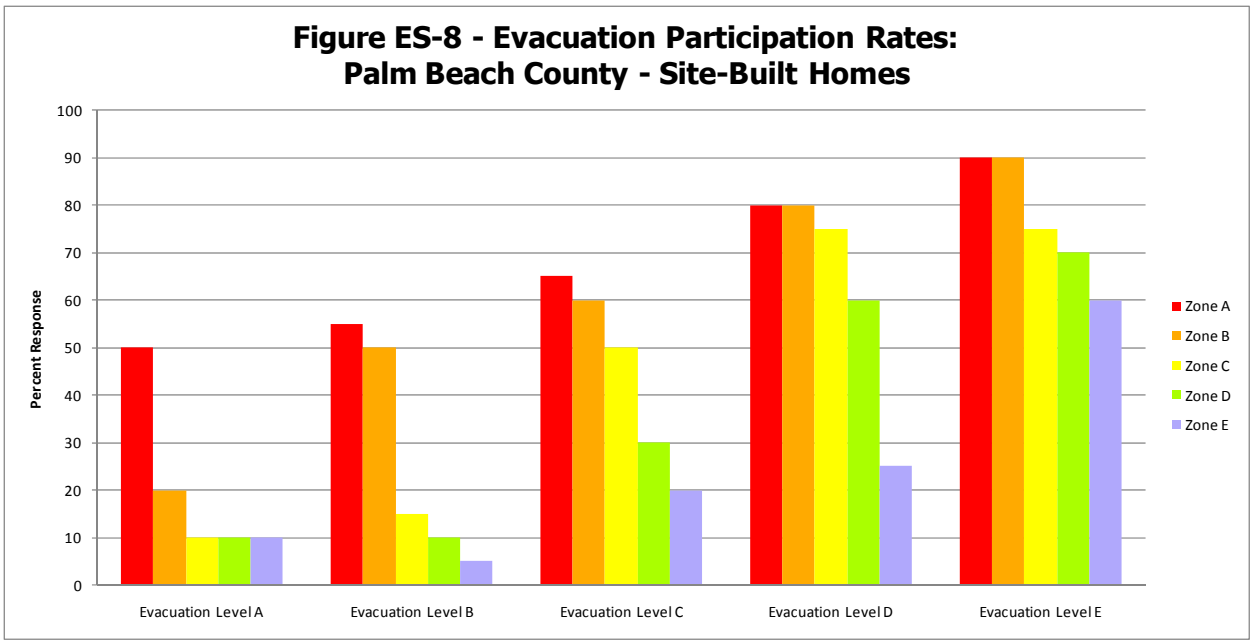


Figure ES-8 - Evacuation Participation Rates:
Palm Beach County - Site-Built Homes
Percent Response
100
90
80
70
60
50
40
30
20
10
0
Evacuation Level A
Evacuation Level B
Evacuation Level C
Evacuation Level D
Evacuation Level E
Zone A
Zone B
Zone C
Zone D
Zone E

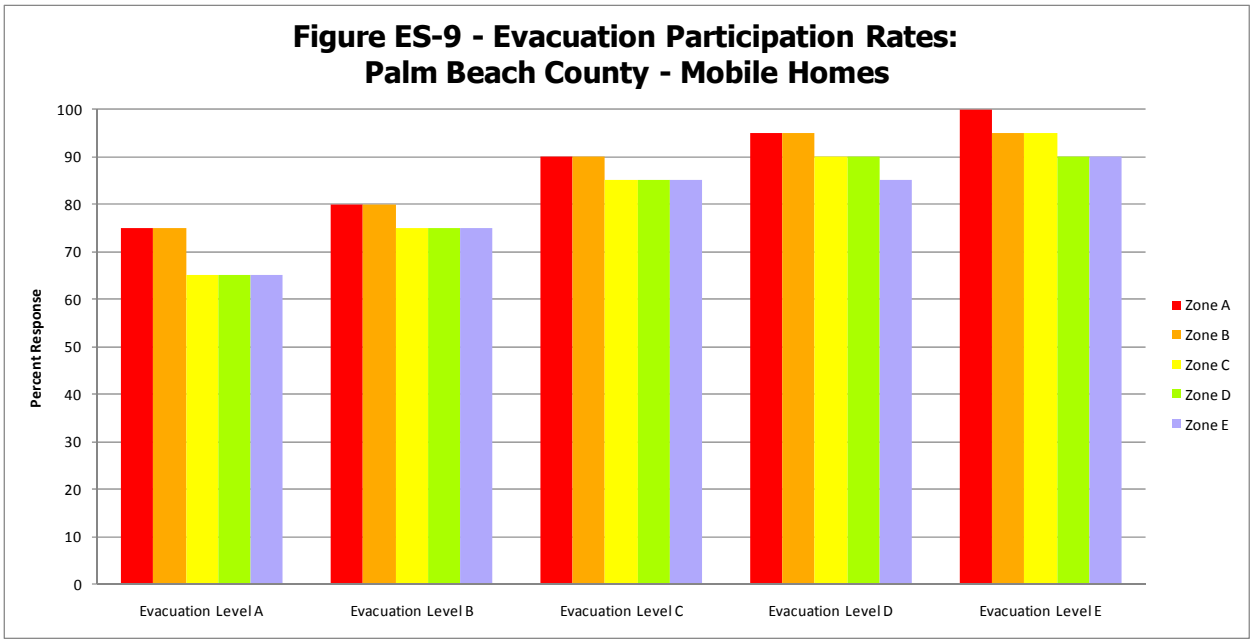


Figure ES-9 - Evacuation Participation Rates:
Palm Beach County - Mobile Homes
Percent Response
100
90
80
70
60
50
40
30
20
10
0
Evacuation Level A
Evacuation Level B
Evacuation Level C
Evacuation Level D
Evacuation Level E
Zone A
Zone B
Zone C
Zone D
Zone E

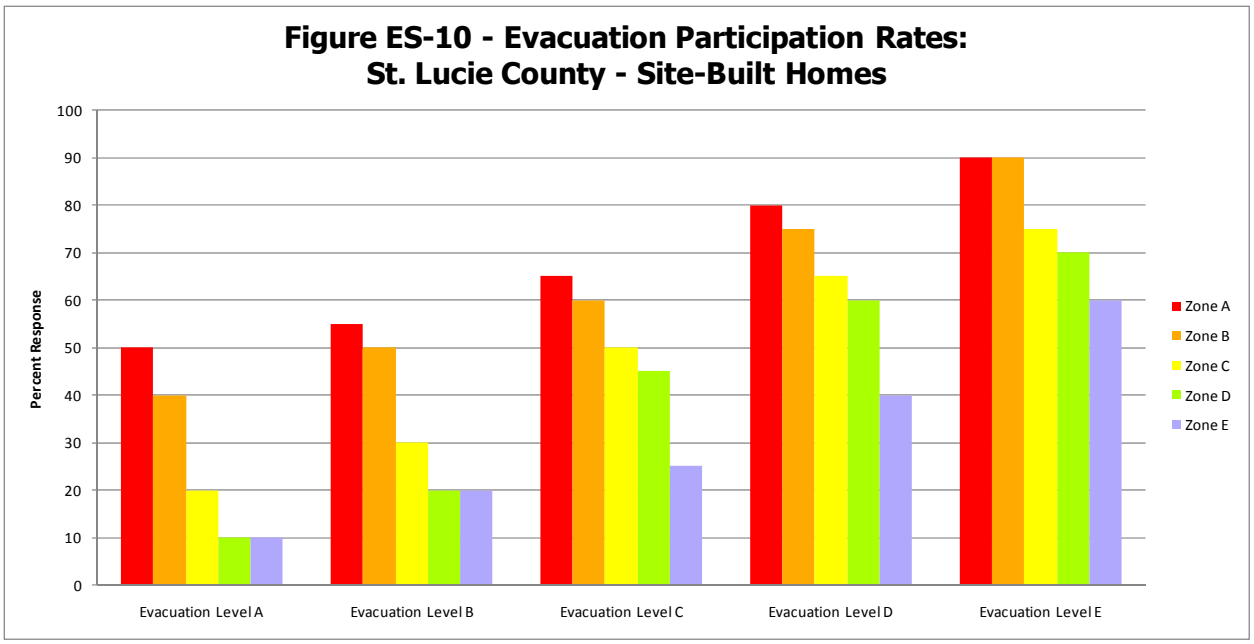


Figure ES-10 - Evacuation Participation Rates:
St. Lucie County - Site-Built Homes
Percent Response
100
90
80
70
60
50
40
30
20
10
0
Evacuation Level A
Evacuation Level B
Evacuation Level C
Evacuation Level D
Evacuation Level E
Zone A
Zone B
Zone C
Zone D
Zone E

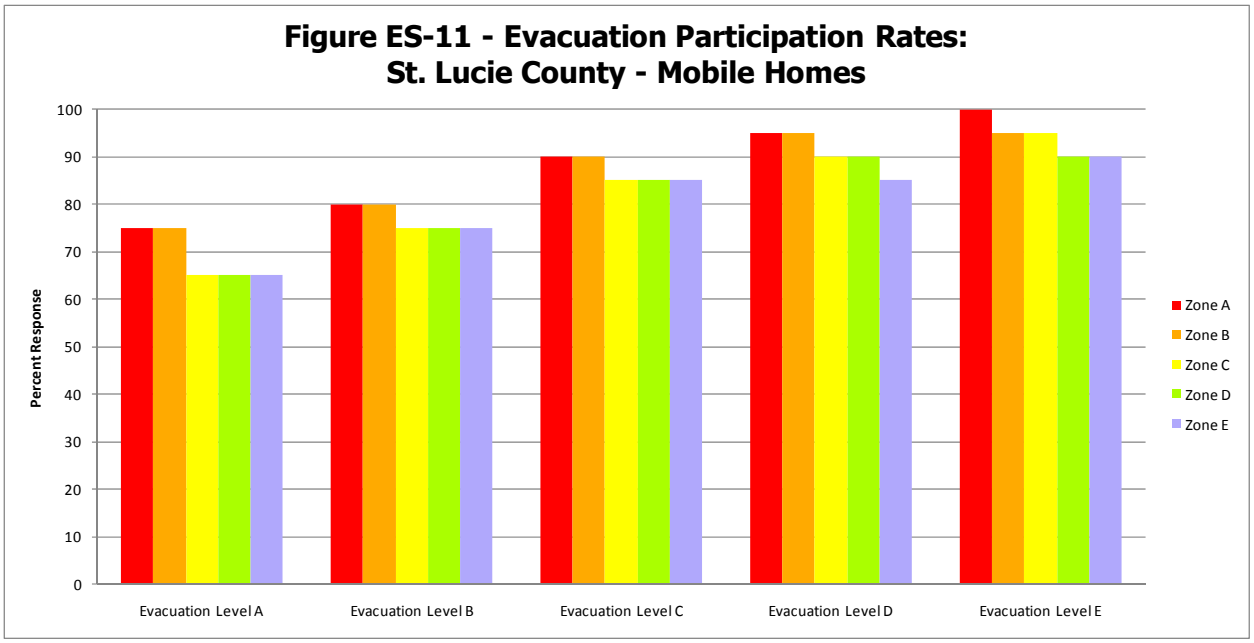


Figure ES-11 - Evacuation Participation Rates:
St. Lucie County - Mobile Homes
Percent Response
100
90
80
70
60
50
40
30
20
10
0
Evacuation Level A
Evacuation Level B
Evacuation Level C
Evacuation Level D
Evacuation Level E
Zone A
Zone B
Zone C
Zone D
Zone E

- **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. All four counties within the Treasure Coast region have updated and established their evacuation zones based on the results of the new data and information collected as part of the SRESP. County level evacuation zones are included in Volume 5-10.

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 Treasure Coast 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 Treasure Coast Region for 2010

	Evacuation Zone A	Evacuation Zone B	Evacuation Zone C	Evacuation Zone D	Evacuation Zone E
Indian River County*					
Site-built Homes	18,125	19,208	907	2,547	
Mobile/Manuf. Homes	10	1,550	0	533	
TOTAL	18,135	20,758	907	3,081	
Martin County					
Site-built Homes	6,632	2,182	6,186	8,153	23,438
Mobile/Manuf. Homes	335	60	184	154	1,422
TOTAL	6,966	2,242	6,370	8,308	24,861
Palm Beach County					
Site-built Homes	73,968	9,039	22,530	26,358	41,615
Mobile/Manuf. Homes	2,112	195	540	468	723
TOTAL	76,080	9,234	23,070	26,826	42,338
St. Lucie County					
Site-built Homes	6,942	2,241	2,710	1,447	1,775
Mobile/Manuf. Homes	1,759	307	286	75	104
TOTAL	8,701	2,548	2,996	1,522	1,879

Note: Vulnerable population determined using SRESP behavioral 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 B does not include vulnerable population listed for Evacuation Zone A.
**Indian River County has a combined D/E zone.*

Table ES-5 – Vulnerable Population in the Treasure Coast Region for 2015

	Evacuation Zone A	Evacuation Zone B	Evacuation Zone C	Evacuation Zone D	Evacuation Zone E
Indian River County*					
Site-built Homes	19,566	20,736	979	2,749	
Mobile/Manuf. Homes	10	1,550	0	533	
TOTAL	19,576	22,286	979	3,283	
Martin County					
Site-built Homes	6,935	2,277	6,412	8,439	24,427
Mobile/Manuf. Homes	335	60	184	154	1,422
TOTAL	7,270	2,337	6,596	8,593	25,850
Palm Beach County					
Site-built Homes	79,978	9,773	24,360	28,499	44,996
Mobile/Manuf. Homes	2,282	210	583	506	781
TOTAL	82,261	9,983	24,943	29,005	45,777
St. Lucie County					
Site-built Homes	7,244	2,329	2,862	1,521	1,874
Mobile/Manuf. Homes	1,759	307	286	75	104
TOTAL	9,003	2,635	3,148	1,596	1,978

Note: Vulnerable population determined using SRESP behavioral 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 B does not include vulnerable population listed for Evacuation Zone A.
**Indian River County has a combined D/E zone.*

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 Treasure Coast 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
Indian River County*					
To Friends and Family	9,975	11,495	499	1,721	
To Hotel/ Motel	4,533	5,035	227	717	
To Public Shelter	907	1,146	73	268	
To Other Destination	2,720	3,083	109	375	
Martin County					
To Friends and Family	4,528	1,457	4,140	5,400	16,159
To Hotel/ Motel	1,028	333	946	1,238	3,658
To Public Shelter	239	73	208	426	1,343
To Other Destination	1,171	379	1,076	1,243	3,701
Palm Beach County					
To Friends and Family	45,648	5,540	13,842	16,095	25,403
To Hotel/ Motel	18,809	2,289	5,714	6,660	10,512
To Public Shelter	3,952	475	1,191	1,374	2,167
To Other Destination	7,671	929	2,323	2,697	4,255
St. Lucie County					
To Friends and Family	5,133	1,513	1,783	910	1,122
To Hotel/ Motel	1,569	428	492	240	297
To Public Shelter	696	204	348	180	221
To Other Destination	1,303	402	372	193	238

Note: Vulnerable population destinations determined using SRESP behavioral 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 B does not include vulnerable population listed for Evacuation Zone A.
**Indian River County has a combined D/E zone.*

Table ES-7 – Vulnerable Population by Destination for 2015

	Evacuation Zone A	Evacuation Zone B	Evacuation Zone C	Evacuation Zone D	Evacuation Zone E
Indian River County*					
To Friends and Family	10,767	12,335	539	1,832	
To Hotel/ Motel	4,893	5,417	245	767	
To Public Shelter	980	1,223	78	284	
To Other Destination	2,936	3,312	118	399	
Martin County					
To Friends and Family	4,725	1,519	4,287	5,586	16,802
To Hotel/ Motel	1,074	348	980	1,281	3,806
To Public Shelter	248	76	214	440	1,392
To Other Destination	1,223	395	1,114	1,286	3,849
Palm Beach County					
To Friends and Family	49,356	5,990	14,966	17,403	27,466
To Hotel/ Motel	20,337	2,475	6,177	7,201	11,366
To Public Shelter	4,273	514	1,288	1,486	2,344
To Other Destination	8,295	1,005	2,512	2,916	4,601
St. Lucie County					
To Friends and Family	5,314	1,566	1,874	954	1,182
To Hotel/ Motel	1,614	441	515	251	312
To Public Shelter	720	211	366	188	233
To Other Destination	1,355	417	392	203	251

Table ES-8 – Vulnerable Shadow Evacuation Population

	Evacuation Level A	Evacuation Level B	Evacuation Level C	Evacuation Level D	Evacuation Level E
2010					
Indian River County	24,990	22,875	23,296	30,839	35,268
Martin County	22,950	29,028	29,697	39,600	36,918
Palm Beach County	110,854	108,368	172,042	221,435	267,138
St. Lucie County	30,029	42,643	41,996	67,001	79,289
2015					
Indian River County	25,807	23,585	24,037	32,214	36,995
Martin County	23,694	30,345	31,056	42,037	39,598
Palm Beach County	119,508	116,779	185,530	238,869	288,141
St. Lucie County	32,256	47,013	46,343	75,618	90,010

Note: Vulnerable shadow population determined using SRESP behavioral data and county provided evacuation zones.

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 Treasure Coast 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 Treasure Coast 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 Treasure Coast 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 ten operational scenarios were modeled for the Treasure Coast 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	Indian River Martin Palm Beach St. Lucie Broward Brevard	Indian River Martin Palm Beach St. Lucie Broward Brevard	Indian River Martin Palm Beach St. Lucie Broward Brevard	Indian River Martin Palm Beach St. Lucie Broward Brevard	Indian River Martin Palm Beach St. Lucie Broward Brevard
	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	Indian River Martin Palm Beach St. Lucie Broward Brevard	Indian River Martin Palm Beach St. Lucie Broward Brevard	Indian River Martin Palm Beach St. Lucie Broward Brevard	Indian River Martin Palm Beach St. Lucie Broward Brevard	Indian River Martin Palm Beach St. Lucie Broward Brevard

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	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	6-hour	6-hour	6-hour	9-hour	9-hour
Evacuation Phasing	None	None	None	None	None
Behavioral Response	Planning	Planning	Planning	Planning	Planning
Evacuation Level	A	B	C	D	E
Counties Evacuating	Indian River Martin Palm Beach St. Lucie Broward Brevard	Indian River Martin Palm Beach St. Lucie Broward Brevard	Indian River Martin Palm Beach St. Lucie Broward Brevard	Indian River Martin Palm Beach St. Lucie Broward Brevard	Indian River Martin Palm Beach St. Lucie Broward Brevard
	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	6-hour	6-hour	6-hour	9-hour	9-hour
Evacuation Phasing	None	None	None	None	None
Behavioral Response	Planning	Planning	Planning	Planning	Planning
Evacuation Level	A	B	C	D	E
Counties Evacuating	Indian River Martin Palm Beach St. Lucie Broward Brevard	Indian River Martin Palm Beach St. Lucie Broward Brevard	Indian River Martin Palm Beach St. Lucie Broward Brevard	Indian River Martin Palm Beach St. Lucie Broward Brevard	Indian River Martin Palm Beach St. Lucie Broward Brevard

- **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.

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

Base Scenarios

In-county clearance times for the 2010 base scenarios range from 12.5 hours to 27 hours, depending upon the evacuation level. Indian River County has the highest in-county clearance time of 27 hours for the level E scenario. Clearance times to shelter range from 12.5 to 25.5 hours.

In 2015, in-county clearance times for the base scenarios vary between 12.5 hours for the evacuation level A scenarios and 37.5 hours for Indian River County for the evacuation level E scenario. Clearance time to shelter shows a similar pattern, with clearance times for the base scenarios ranging from 12.5 hours for the evacuation level A scenarios to 23.5 hours for Palm Beach County for evacuation level E scenario in 2015.

Out of county clearance times for the 2010 base scenarios range from 14 to 28 hours, while in 2015 they range from 14 hours for the base evacuation level A scenario to 41 hours in Indian River County for the evacuation level E scenario in 2015. Regional clearance time for the four county TCRPC region ranges from 14.5 hours to 41 hours.

Operational Scenarios

In-county clearance times for the 2010 operational scenarios range from 7 hours to 31.5 hours depending upon the scenario. Clearance times to shelter for the operational scenarios range from 6.5 hours to 28.5 hours depending upon the county and the scenario.

In 2015, in-county clearance times for the operational scenarios vary from 7 hours to 31 hours for the level E evacuation in Palm Beach County. Clearance times to shelter for the 2015 operational scenarios range from 6 hours to 20.5 hours depending upon the scenario.

Out of county clearance times for the 2010 operational scenarios range from 8 hours to 32 hours for the evacuation level E scenario. Out of county clearance times are similar for all counties in 2015 and fall between 8 and 31 hours depending upon the scenario. Regional clearance time for the four county TCRPC region ranges from 9 hours to 32 hours in 2010 and from 9 to 31 hours in 2015.

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					
Indian River	12.5	12.5	14.0	13.0	18.0
Martin	12.5	12.5	12.5	13.5	15.5
Palm Beach	13.5	13.0	13.5	16.0	25.5
St. Lucie	12.5	12.5	13.0	16.0	18.0
In-County Clearance Time					
Indian River	12.5	13.0	15.0	18.5	27.0
Martin	13.5	14.0	14.0	15.5	23.0
Palm Beach	14.5	14.5	14.5	17.5	26.5
St. Lucie	13.0	13.5	14.0	17.5	25.0
Out of County Clearance Time					
Indian River	14.5	14.5	16.0	19.5	28.0
Martin	14.0	14.0	14.0	16.0	23.0
Palm Beach	14.5	14.5	14.5	17.5	26.5
St. Lucie	14.0	14.5	14.5	18.5	25.0
Regional Clearance Time					
Treasure Coast	14.5	14.5	16.0	19.5	28.0

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					
Indian River	12.5	12.5	13.0	15.5	19.0
Martin	12.5	12.5	12.5	14.0	17.0
Palm Beach	13.5	13.5	13.5	16.0	23.5
St. Lucie	12.5	12.5	13.5	14.0	16.5
In-County Clearance Time					
Indian River	12.5	14.0	15.0	17.5	37.5
Martin	13.5	13.5	14.0	16.0	23.0
Palm Beach	14.0	14.0	14.0	17.0	26.5
St. Lucie	13.0	14.0	14.0	16.0	31.0
Out of County Clearance Time					
Indian River	14.5	15.0	16.0	19.5	41.0
Martin	14.0	14.0	14.0	16.0	23.0
Palm Beach	14.5	14.0	14.5	17.0	26.5
St. Lucie	14.5	14.5	14.5	16.5	34.0
Regional Clearance Time					
Treasure Coast	14.5	15.0	16.0	19.5	41.0

Table ES-13 – 2010 Clearance Times for Operational Scenarios

	Evacuation Level A Operational Scenario	Evacuation Level B Operational Scenario	Evacuation Level C Operational Scenario	Evacuation Level D Operational Scenario	Evacuation Level E Operational Scenario
Clearance Time to Shelter					
Indian River	6.5	6.5	7.0	10.5	13.0
Martin	6.5	6.5	7.5	11.0	14.5
Palm Beach	7.0	7.0	8.5	13.0	28.5
St. Lucie	6.5	6.5	6.5	12.0	12.0
In-County Clearance Time					
Indian River	7.5	9.5	12.5	16.5	26.5
Martin	7.5	7.5	8.0	12.5	26.5
Palm Beach	8.0	8.0	10.0	16.0	31.5
St. Lucie	7.0	8.0	10.5	15.5	25.0
Out of County Clearance Time					
Indian River	9.0	9.5	13.5	20.0	26.5
Martin	8.0	8.0	8.0	12.5	26.5
Palm Beach	8.0	8.0	10.0	16.0	32.0
St. Lucie	8.5	8.5	11.5	17.0	25.0
Regional Clearance Time					
Treasure Coast	9.0	9.5	13.5	20.0	32.0

Table ES-14 – 2015 Clearance Times for Operational Scenarios

	Evacuation Level A Operational Scenario	Evacuation Level B Operational Scenario	Evacuation Level C Operational Scenario	Evacuation Level D Operational Scenario	Evacuation Level E Operational Scenario
Clearance Time to Shelter					
Indian River	6.5	6.5	7.0	11.0	12.0
Martin	6.5	7.0	7.5	11.5	14.5
Palm Beach	7.5	7.5	10.5	21.0	20.5
St. Lucie	6.0	6.5	6.5	12.0	16.0
In-County Clearance Time					
Indian River	8.0	9.5	12.5	19.5	27.5
Martin	7.5	7.5	8.5	13.0	20.5
Palm Beach	8.0	8.0	11.0	21.5	31.0
St. Lucie	7.0	8.0	11.5	16.5	26.0
Out of County Clearance Time					
Indian River	9.0	10.5	13.0	19.5	27.5
Martin	8.0	7.5	8.5	13.0	21.0
Palm Beach	8.5	8.5	11.0	21.5	31.0
St. Lucie	8.0	8.5	12.0	17.5	26.0
Regional Clearance Time					
Treasure Coast	9.0	10.5	13.0	21.5	31.0

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 Indian River County					
12-Hour	35,690	51,118	47,322	45,366	33,492
18-Hour	43,125	61,768	63,096	68,049	50,239
24-Hour				73,720	66,985
36-Hour					78,149
Estimated Evacuating Population Clearing Martin County					
12-Hour	25,642	32,774	38,807	47,615	44,695
18-Hour	29,916	38,236	45,275	63,486	67,042
24-Hour					85,665
36-Hour					
Estimated Evacuating Population Clearing Palm Beach County					
12-Hour	154,704	160,289	232,077	244,557	201,367
18-Hour	186,934	193,682	280,426	356,645	302,051
24-Hour					402,734
36-Hour					444,686
Estimated Evacuating Population Clearing St. Lucie County					
12-Hour	33,197	44,600	46,544	53,687	46,529
18-Hour	38,730	53,892	56,241	80,531	69,793
24-Hour				82,768	93,058
36-Hour					96,935

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.

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 Indian River County					
12-Hour	37,558	52,358	50,159	48,208	24,328
18-Hour	45,383	65,447	66,878	72,312	36,491
24-Hour				78,338	48,655
36-Hour					72,983
Estimated Evacuating Population Clearing Martin County					
12-Hour	26,541	34,245	40,508	50,125	47,084
18-Hour	30,964	39,952	47,259	66,833	70,626
24-Hour					90,244
36-Hour					
Estimated Evacuating Population Clearing Palm Beach County					
12-Hour	166,981	179,163	250,524	271,808	217,408
18-Hour	201,769	209,023	302,717	385,061	326,112
24-Hour					434,817
36-Hour					480,110
Estimated Evacuating Population Clearing St. Lucie County					
12-Hour	34,145	48,539	50,590	66,909	38,248
18-Hour	41,259	58,651	61,129	92,000	57,372
24-Hour					76,496
36-Hour					108,370

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.

- 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 Treasure Coast 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 20 different scenarios (10 base and 10 operational), several conclusions could be reached regarding the transportation analysis, including the following:

- Critical transportation facilities within the TCRPC region include I-95, the Turnpike, SR 60, and portions of US 441 and SR 710 for all evacuation scenarios. For large storm events, such as level D and E evacuations, other State facilities also play an important role in evacuations, such as SR 76 in Martin County and SR 68 in St. Lucie 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;

- TCRPC counties should continue their coordination efforts with the State on public information campaigns to clearly define those that are vulnerable and should evacuate versus those who choose to evacuate on their own.

- 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 5-10) 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 Treasure Coast 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.

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.

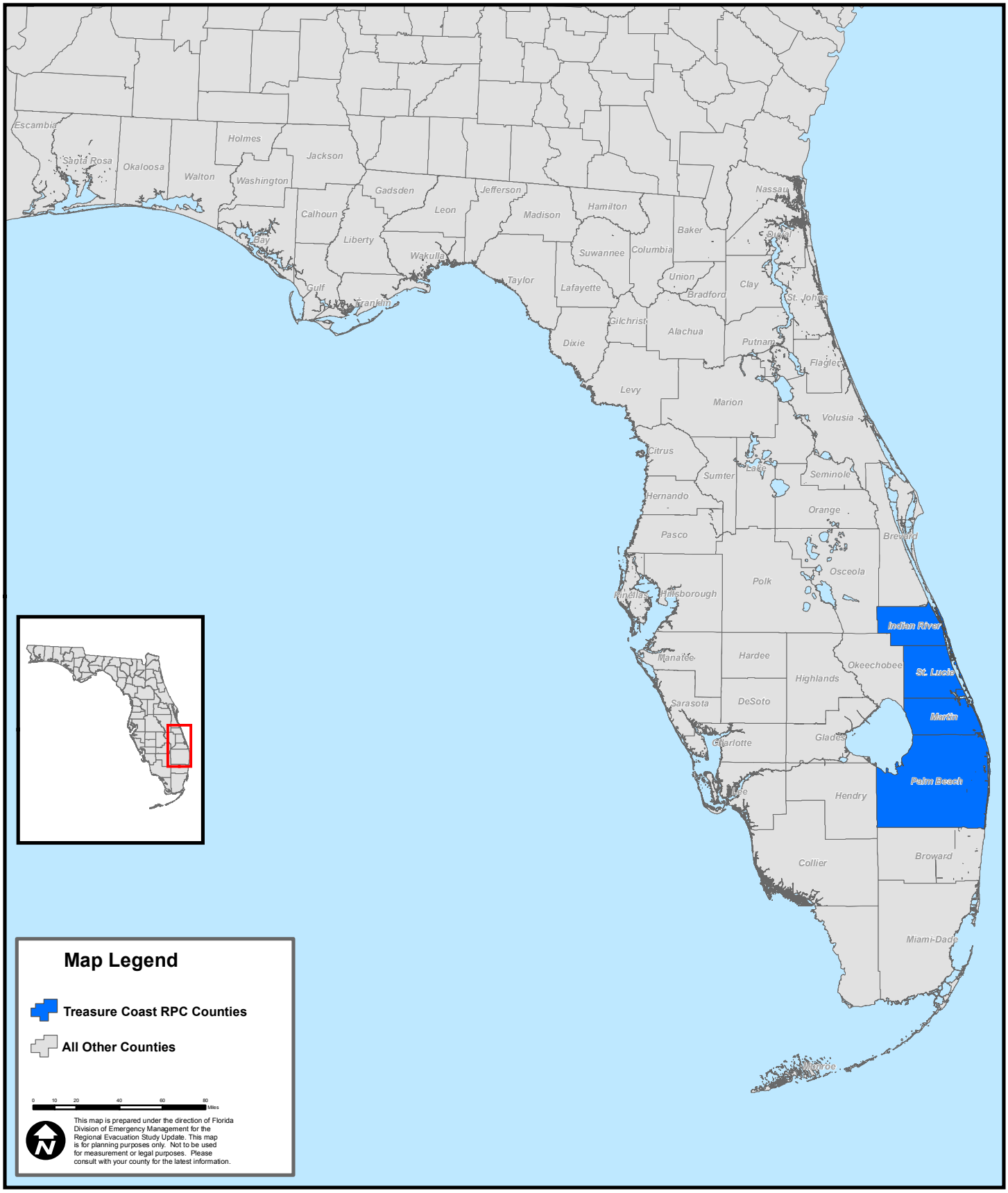
One of the objectives of the SRESP is to create consistent and integrated regional evacuation data and mapping, and by doing so, to facilitate knowledge sharing between state, regional, county, and local partners. To achieve this objective, it is important for all Regional Planning Councils to adopt 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 four county Treasure Coast 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 Treasure Coast region. While the impact of other regions is included in the Treasure Coast analysis, it is important to note that the results of the transportation analysis presented in this document are only reported for the four counties included in the Treasure Coast RPC. Transportation analysis results for other regions and counties are reported in the corresponding Volume 4 report for those regions.

Figure I-1

Treasure Coast Regional Planning Council



Sources: Treasure Coast Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 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 Treasure Coast region included the following:

Regional Meeting No. 1 – Model Development Meeting
The first regional meeting for the Treasure Coast region was held on October 8, 2008 at 10 AM. 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 Treasure Coast region was held on March 31, 2009 at 9:30 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 Treasure Coast regional model.

Regional Meeting No. 3 – Scenario Development Meeting
The third regional meeting for the Treasure Coast region was held on October 22, 2009 at 10 AM. The purpose of the scenario development meeting was to discuss the final evacuation methodology and framework, review the Treasure Coast 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 Treasure Coast region was held on September 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 Treasure Coast RPC Evacuation Transportation Analysis is identical to the methodology used for all eleven Regional Planning Councils and is summarized in the following sections.

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.

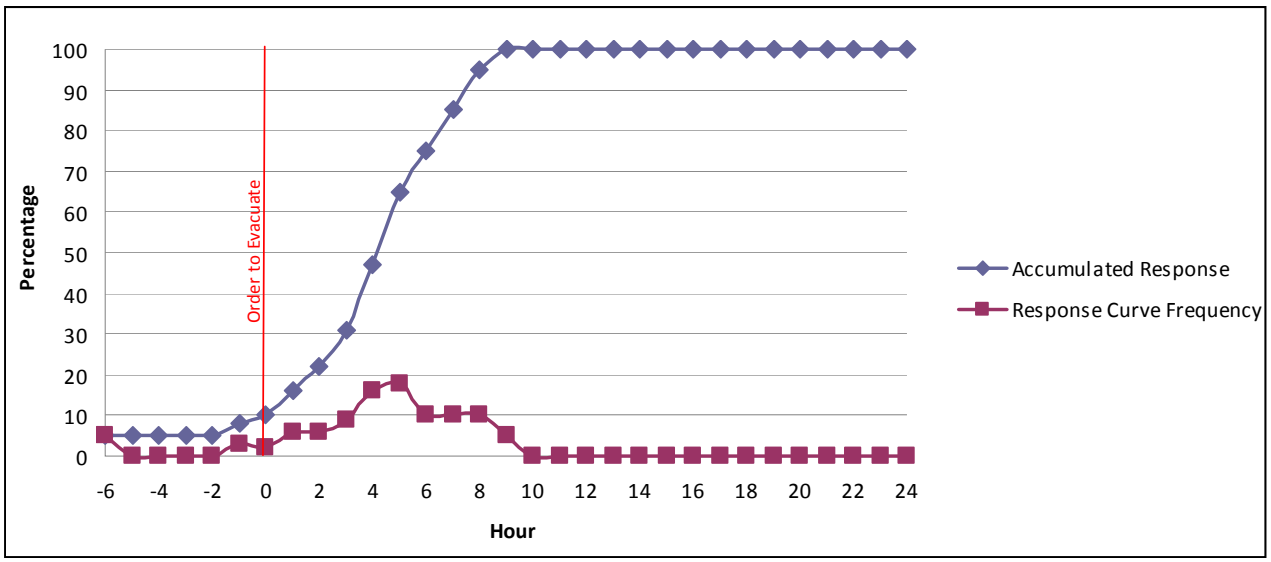
When will they leave?

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; and,
- 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.

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

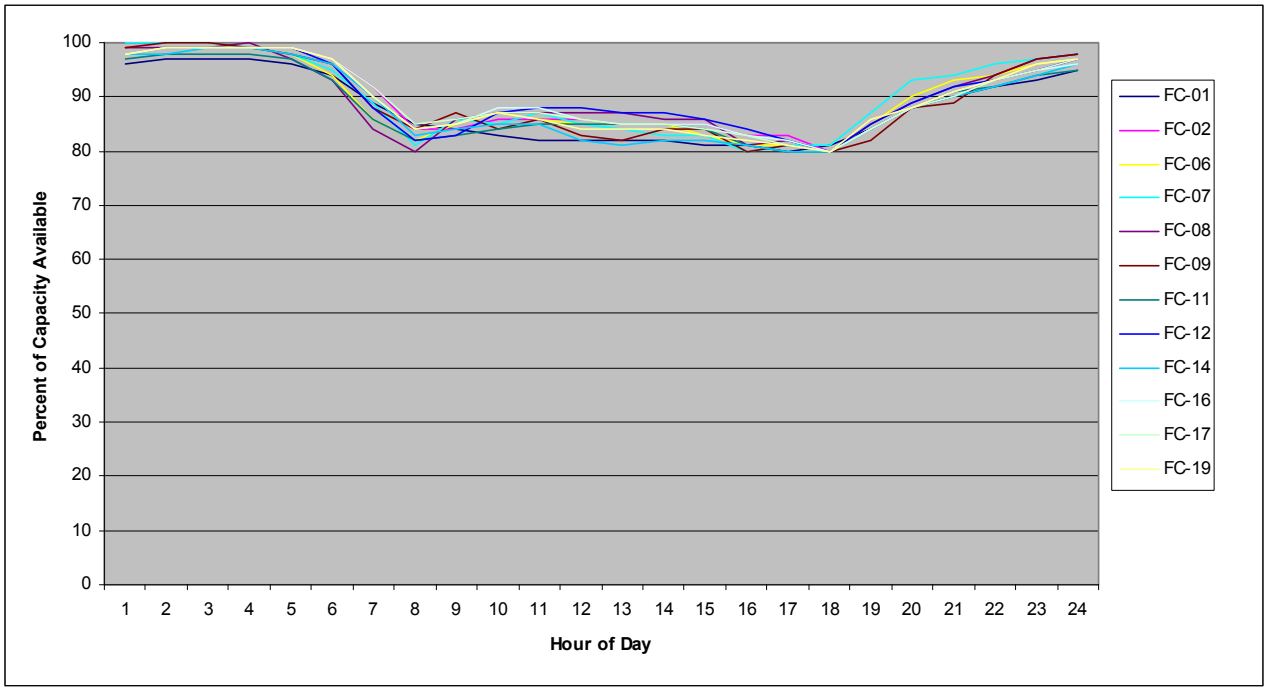
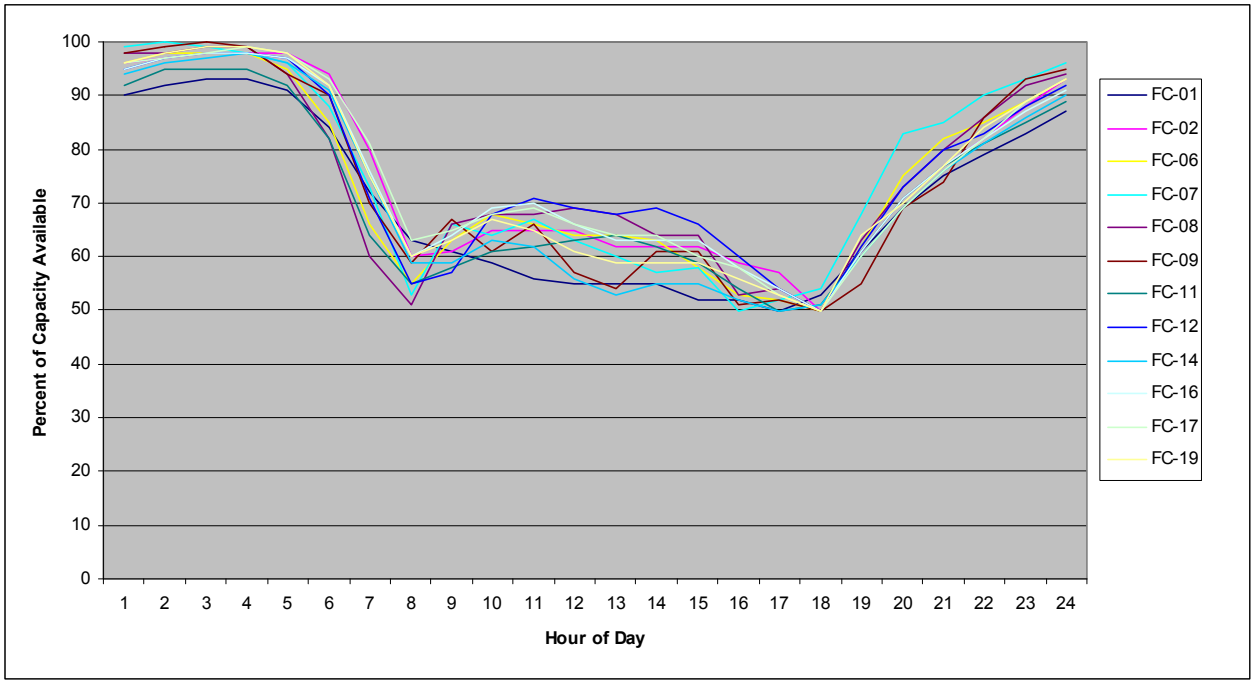


Figure II-3 – Percent of Available Capacity for Other Counties

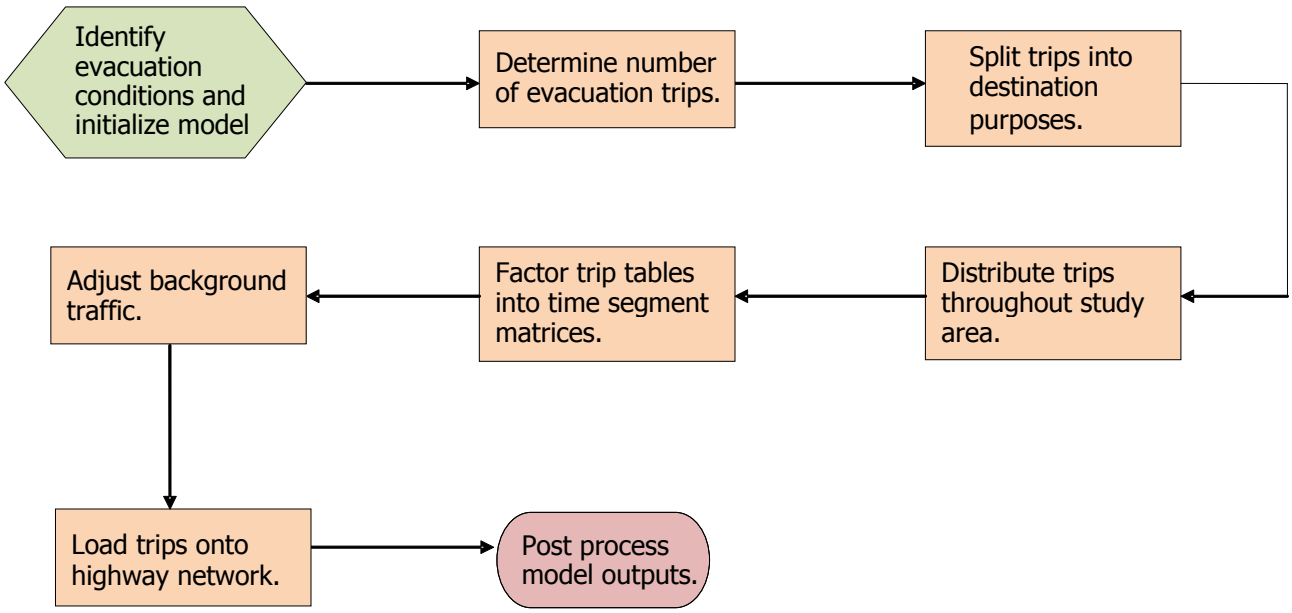


D. Evacuation Traffic

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.

<u>In County Balancing</u> - 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.

<u>Out of County Balancing</u> - 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 Treasure Coast Region, the regional model network includes the four counties within the RPC plus nine 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 Treasure Coast Region. It is important to note that the input data discussed in this chapter is included only for the counties within the Treasure Coast RPC, as these are the counties that the Treasure Coast RPC has direct responsibility for the data. Data for the adjacent counties included in the Treasure Coast 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

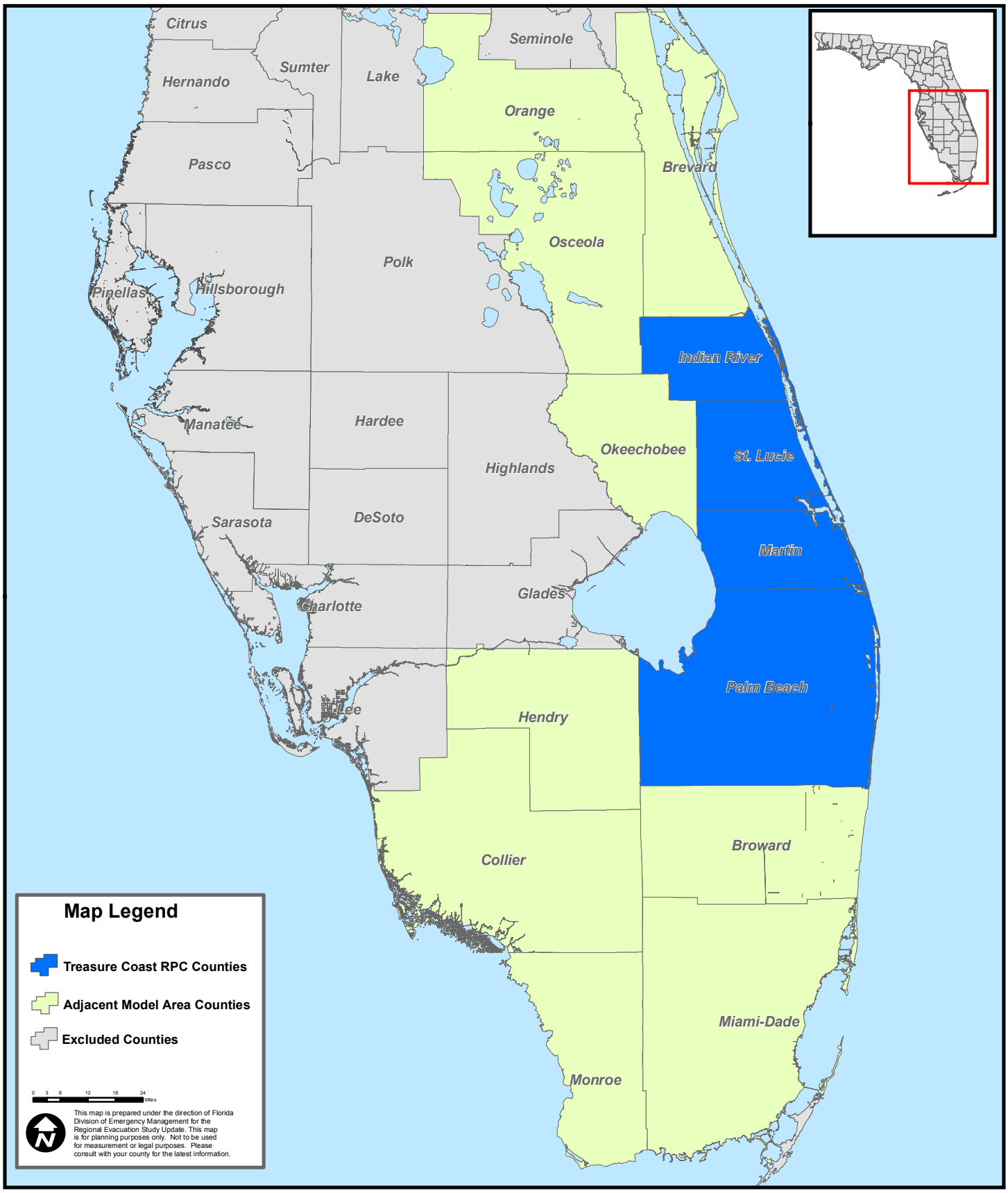
The road network is a key component of the evacuation model. The roadway variables in the network include area type, functional class, number of through lanes, capacity, speed, and several others. The regional model network consists of the RPC designated evacuation routes as well as a supporting roadway 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 Treasure Coast RPC. The RPC relied on the emergency managers of its constituent counties to provide it with information on which roads were to be included as evacuation routes. 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 TCRPC. County level details of the regional model network are provided in the Volume 5 report. The regional model network for the Treasure Coast region includes key roadways within the four county region, including I-95, Florida's Turnpike, US 1, US 441, US 27, US 98, SR 60, SR 70, SR A1A, SR 76, SR 710, and SR 80 .

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 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

Figure III-1

Treasure Coast Regional Model Area

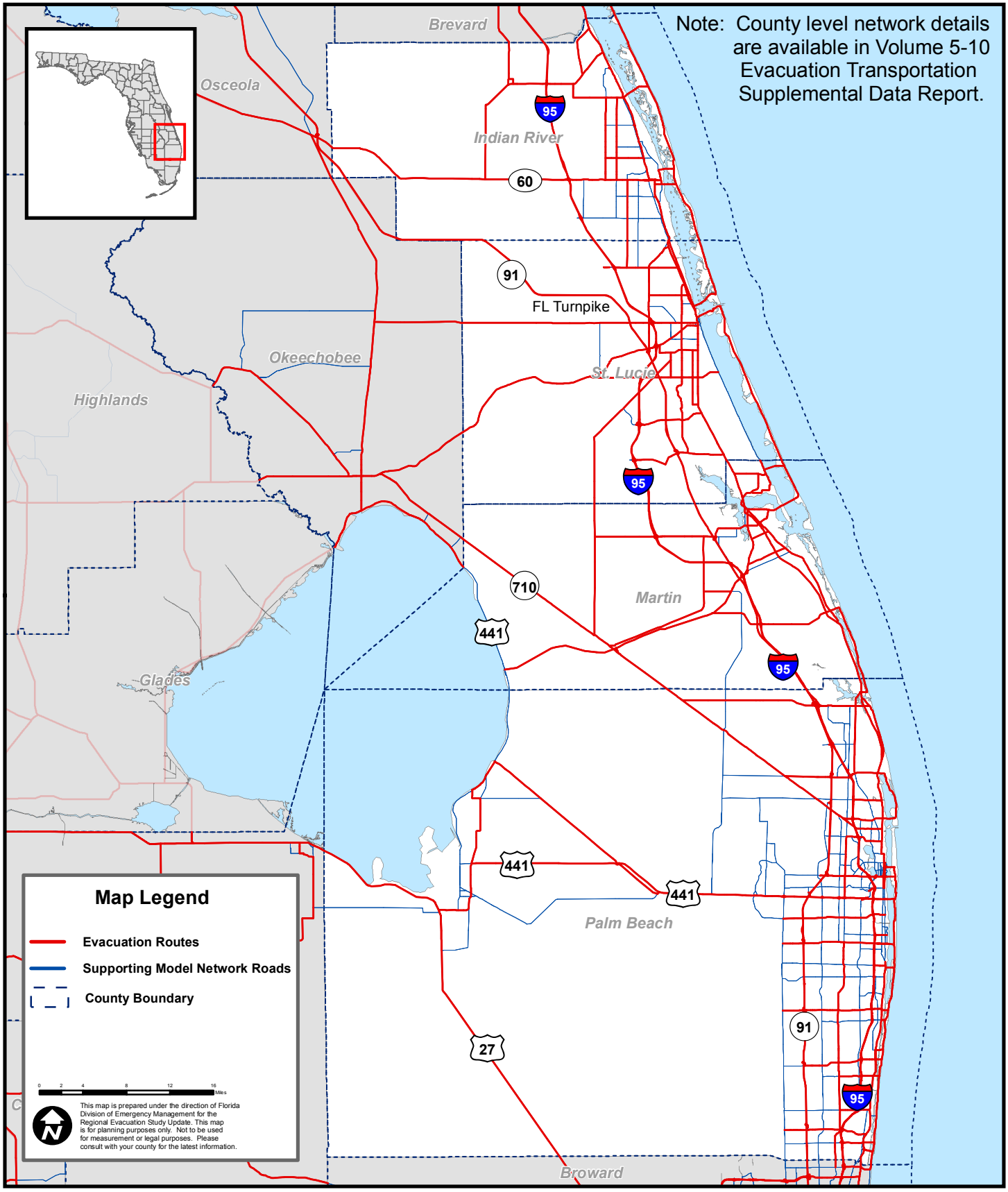


Sources: Treasure Coast Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure III-2

Treasure Coast Regional Model Network



Sources: Treasure Coast Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

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, 752 of the zones are located within the four county Treasure Coast region, as illustrated in **Figure III-3**. In the Treasure Coast region, Palm Beach County has the largest number of TEZs with 382, and St. Lucie County follows with 157 TEZs. Indian River and Martin Counties have the lowest number of TEZs in the RPC with 117 and 96 zones, respectively. The larger number of TEZs generally reflects counties with denser urban structure and/or 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. The demographic data were developed for the following years: 2006, 2010, and 2015.

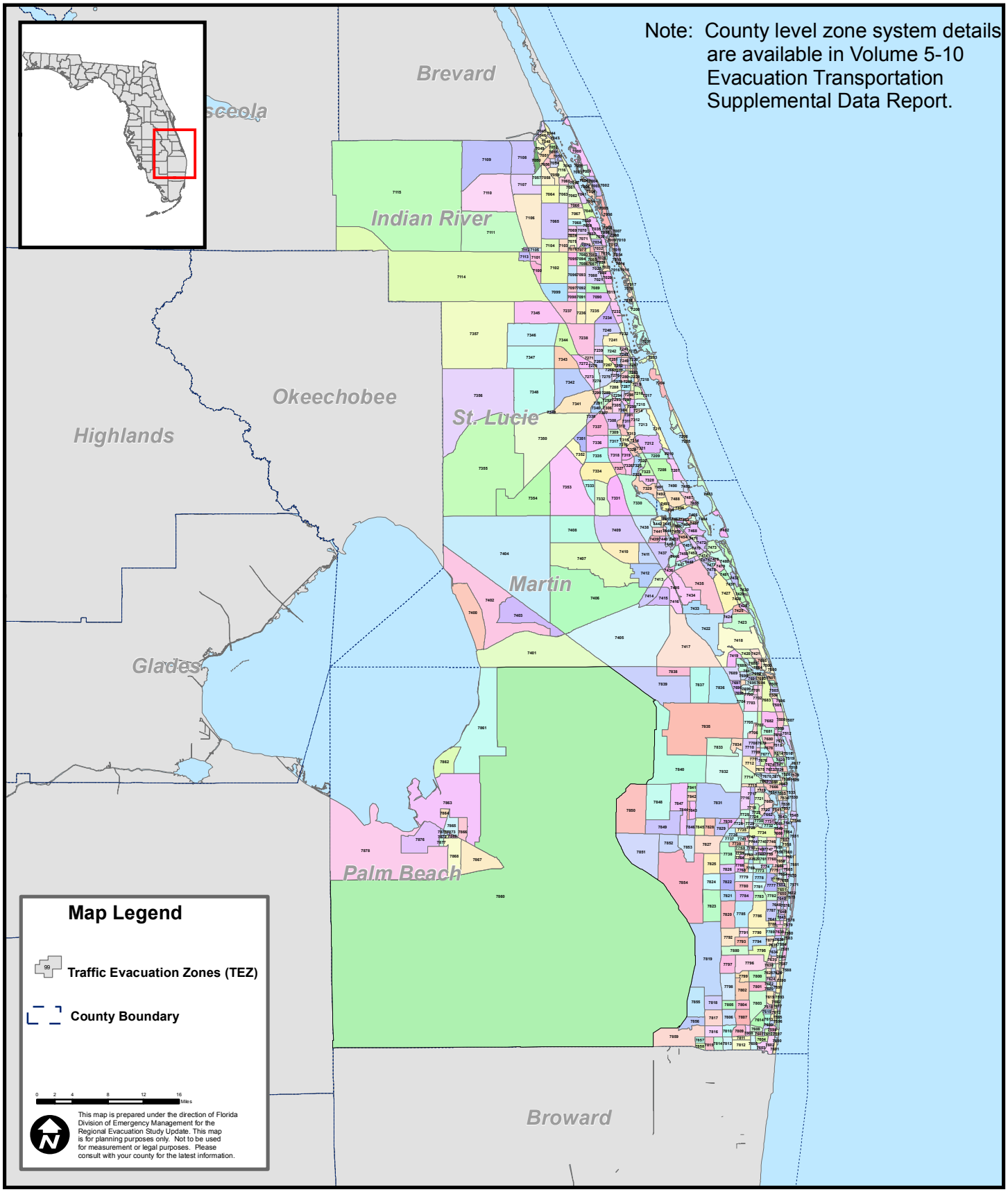
A snapshot of the key demographic data for each county in the Treasure Coast RPC for 2006, 2010 and 2015 is summarized in **Table III-1**. The tables list the number of occupied dwelling units for site built homes, the permanent population in site-built homes, as well as the number of occupied dwelling 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 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.

Palm Beach County has the largest population in the region during all three time periods. The county is expected to reach over 1.3 million people by 2015. St. Lucie County has the second largest population in the region and is forecasted to have more that 330,000 people by 2015. Indian River County has the smallest population in the region and is expected to reach more than 150,000 in 2015. Although Palm Beach County shows the largest absolute growth between 2006 and 2015, the county will experience the smallest percentage of change in population. St. Lucie County is predicted to experience the largest percentage of change at 33%.

With the exception of Palm Beach County, the RPC kept the number of mobile homes and population in mobile homes static for each of the time horizons. Palm Beach County has the highest number of mobile homes followed by St. Lucie. Indian River County has the lowest number of mobile homes at 6,500. For the entire region, mobile homes make up about 5% of all occupied homes.

Figure III-3

Treasure Coast Regional Model Transportation Evacuation (TEZ) Zone System



Sources: Treasure Coast Florida Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Table III-1 - Treasure Coast Demographic Characteristic Summary

County	Characteristic	Year		
		2006	2010	2015
Indian River	Occupied site-built homes	54,270	57,972	62,586
	Population in site-built homes	121,023	129,279	139,564
	Occupied mobile homes	6,500	6,500	6,500
	Population in mobile home	13,546	13,546	13,546
	Hotel/motel units	2,235	2,235	2,310
Martin	Occupied site-built homes	57,028	60,400	65,402
	Population in site-built homes	126,031	133,488	144,539
	Occupied mobile homes	7,009	7,009	7,009
	Population in mobile home	12,879	12,879	12,879
	Hotel/motel units	1,335	1,335	1,335
Palm Beach	Occupied site-built homes	521,288	540,518	584,453
	Population in site-built homes	1,224,572	1,269,753	1,372,899
	Occupied mobile homes	18,609	19,294	20,854
	Population in mobile home	41,375	42,908	46,390
	Hotel/motel units	23,023	23,023	23,023
St. Lucie	Occupied site-built homes	80,965	93,492	107,037
	Population in site-built homes	231,995	269,736	313,422
	Occupied mobile homes	10,115	10,115	10,115
	Population in mobile home	17,312	17,312	17,312
	Hotel/motel units	3,726	3,726	3,726

Source: Treasure Coast Regional Planning Council (Indian River, Martin, and St. Lucie Counties) and Wilbur Smith Associates (Palm Beach County). Demographic data for Palm Beach County used in the transportation analysis was derived independently to conform to model TEZ boundaries and may vary from demographic data presented in other sections of the Treasure Coast Statewide Regional Evacuation Study.

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 Indian River County, US 1 from the Oslo Rd to Highlands Drive 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 - Treasure Coast Region Roadway Improvements, 2006 – 2010

County	Roadway	From	To	Number of Lanes
Indian River	SR 60	Osceola County line	I-95	4
	CR 512	I-95	Roseland Road	4
	Oslo Road	US 1	27th Avenue	4
Martin	SR 714	CR A1A	SR A1A	4
	CR A1A (Dixie Hwy)	Indian St	Monterey Rd	4
Palm Beach	Seminole Pratt Whitney Rd	SR 80	Sycamore Dr	4
	SR 710	Military Trail	Congress Ave	4
	SR 809	SR 704	SR 702	6
	SR 80	US 441	SR 807	8
	Turnpike	Lantana Toll Plaza	Lake Worth Rd	8
	I-95	N of SR 80	N of Congress Ave	10
	SR 811	Broward County line	SW 18th St	4
	Atlantic Ave	Lyons Rd.	Starkey Rd.	6
	Beeline Hwy	Martin County Line	Seminole Pratt Whitney	4
	Jog Rd.	Roebuck Rd.	45th Street	4
	Jog Rd.	Beeline Hwy	Turnpike	4
St Lucie	SR 70	McCarty Rd	Header Canal Rd	4
	US 41	NE Riomar Dr	W Midway Rd	6

Sources: FDOT SIS First Five Year Plan, FDOT SIS Second Five Year Plan, Treasure Coast 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.

Table III-3 - Treasure Coast Planned Roadway Improvements, 2011–2015

County	Roadway	From	To	Number of Lanes
Indian River	58th Ave	53rd St	49th St	4
	43rd Ave	26th St	16th St	4
	17th St	Old Dixie Hwy	6th Ave	4
	Aviation Blvd	26th St	16th St	4
	Oslo Road	58th Ave	29th Ave	4
	US 1	Oslo Rd	Indian River Blvd	6
	SR 60	I-95	66th Ave	6
	US 1	Oslo Rd	Highlands Drive	6
Martin	SR 710	SR 76	SW Citrus Blvd	4
	SR 76	SW Jack James Drive	SW Lost River Road	6
Palm Beach	Seminole Pratt Whitney Rd	Sycamore Dr.	Beeline Hwy	4
	SR 710	Congress Ave	Old Dixie Hwy	4
	Palmetto Park Rd	W of Military Trail	I-95	8
	Turnpike	SR 802	SR 704	8
	I-95	Broward County line	Linton Blvd	10
	Atlantic Ave	Turnpike	Jog Rd.	6
	Beeline Hwy	PGA Blvd.	Congress Ave	6
	Northlake Blvd.	Seminole Pratt Whitney	Coconut Blvd.	4
	Okeechobee Blvd.	Australian Blvd.	Tamarind Ave	8
	Palmetto Park Rd	Lyons Rd.	W of Military Trail	8
St Lucie	SR 70	Okeechobee County line	MP 10.216	4
	SR 70	Kings Hwy	Jenkins Rd	6
	I-95	SR 70	Indian River County line	8

Sources: FDOT SIS First Five Year Plan, FDOT SIS Second Five Year Plan, Treasure Coast 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.

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. For the Treasure Coast Region, all four counties within the region have evacuation zones corresponding to different categories of storm surge. Evacuation rates for site-built homes and mobile/manufactured homes are provided by county and summarized in **Figure III-4** through **Figure III-11**. 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 5-10.

A review of the evacuation rates for the Treasure Coast 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 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-11.

For example, if an evacuation order was issued for Indian River County for persons living in evacuation zone A, the county could expect a 50 percent participation rate from persons living in site-built homes in evacuation zone A (Figure III-4) and a 75 percent participation rate from persons living in mobile/manufactured homes in evacuation zone A (Figure III-5). In addition, Indian River County can expect shadow evacuations to occur for persons living in site-built homes at a rate of 30 percent from evacuation zone B, 10 percent from evacuation zone C, and 10 percent for evacuation zone D, which also includes zone E (Figure III-4). Likewise, for persons living in mobile/manufactured homes, Indian River County can expect shadow evacuations to occur at a rate of 75 percent from evacuation zone B, and 65 percent each from evacuation zones C and D/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 Indian River County. The original rates were based on a five zone system, such as in Palm Beach, Martin, and St. Lucie Counties; however, Indian River utilizes four zones – Zone A, Zone B, Zone C, Zone D/E.

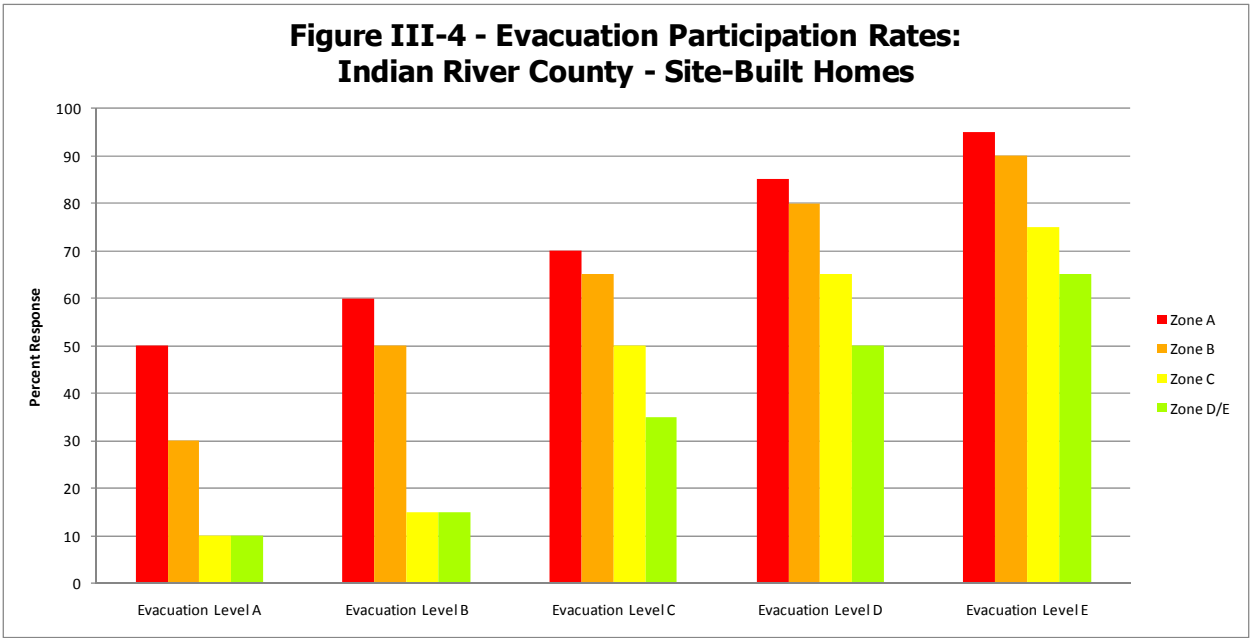


Figure III-4 - Evacuation Participation Rates:
Indian River County - Site-Built Homes
Percent Response
100
90
80
70
60
50
40
30
20
10
0
Evacuation Level A
Evacuation Level B
Evacuation Level C
Evacuation Level D
Evacuation Level E
Zone A
Zone B
Zone C
Zone D/E

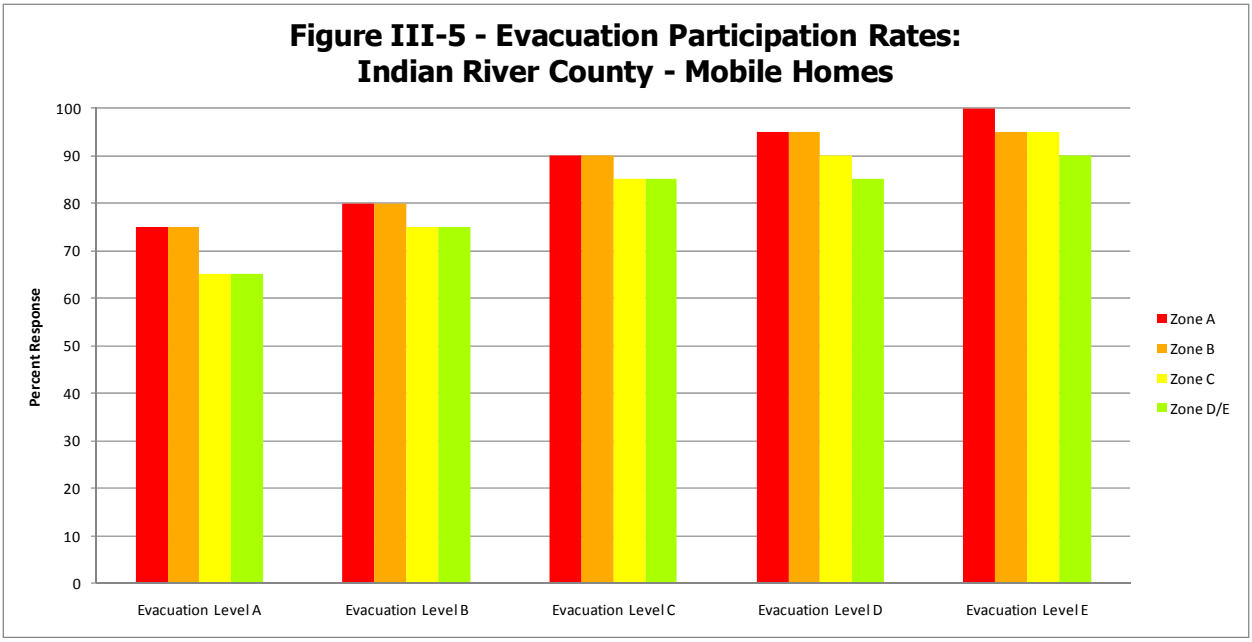


Figure III-5 - Evacuation Participation Rates:
Indian River County - Mobile Homes
Percent Response
100
90
80
70
60
50
40
30
20
10
0
Evacuation Level A
Evacuation Level B
Evacuation Level C
Evacuation Level D
Evacuation Level E
Zone A
Zone B
Zone C
Zone D/E

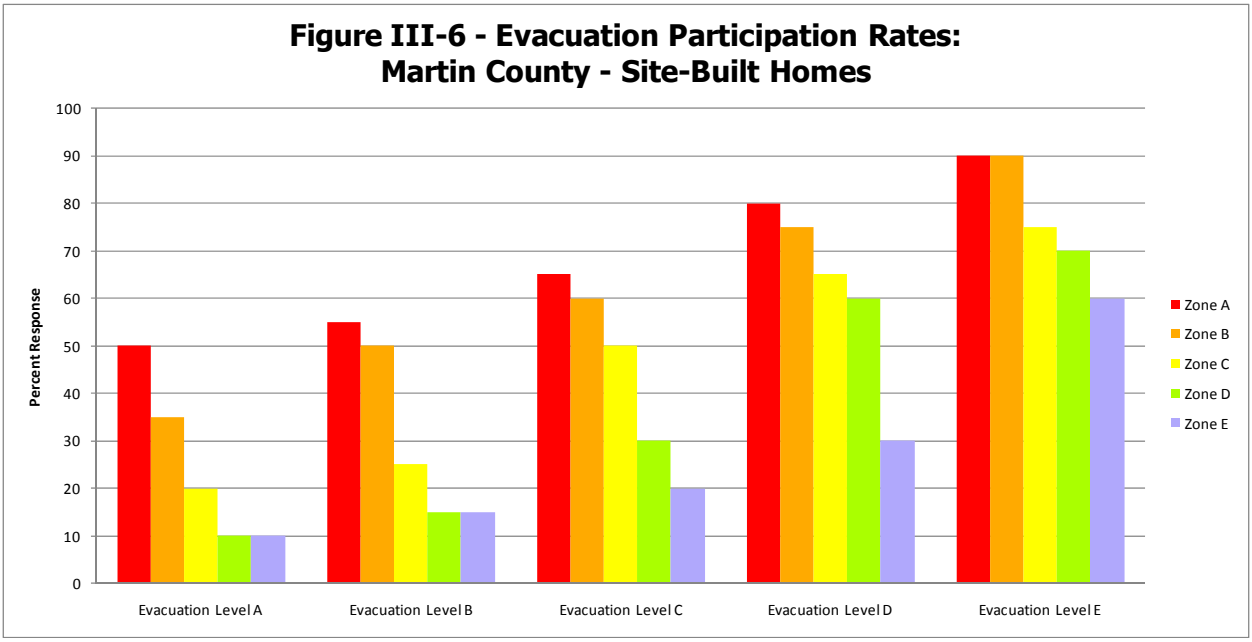


Figure III-6 - Evacuation Participation Rates:
Martin County - Site-Built Homes
Percent Response
100
90
80
70
60
50
40
30
20
10
0
Evacuation Level A
Evacuation Level B
Evacuation Level C
Evacuation Level D
Evacuation Level E
Zone A
Zone B
Zone C
Zone D
Zone E

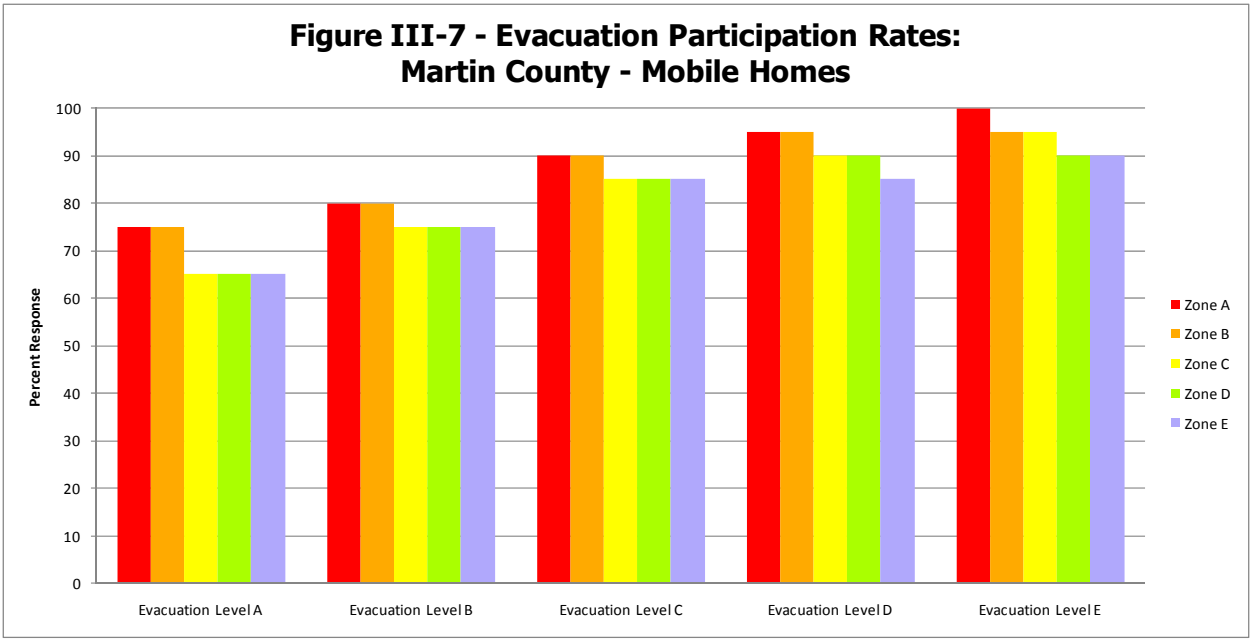


Figure III-7 - Evacuation Participation Rates:
Martin County - Mobile Homes
Percent Response
100
90
80
70
60
50
40
30
20
10
0
Evacuation Level A
Evacuation Level B
Evacuation Level C
Evacuation Level D
Evacuation Level E
Zone A
Zone B
Zone C
Zone D
Zone E

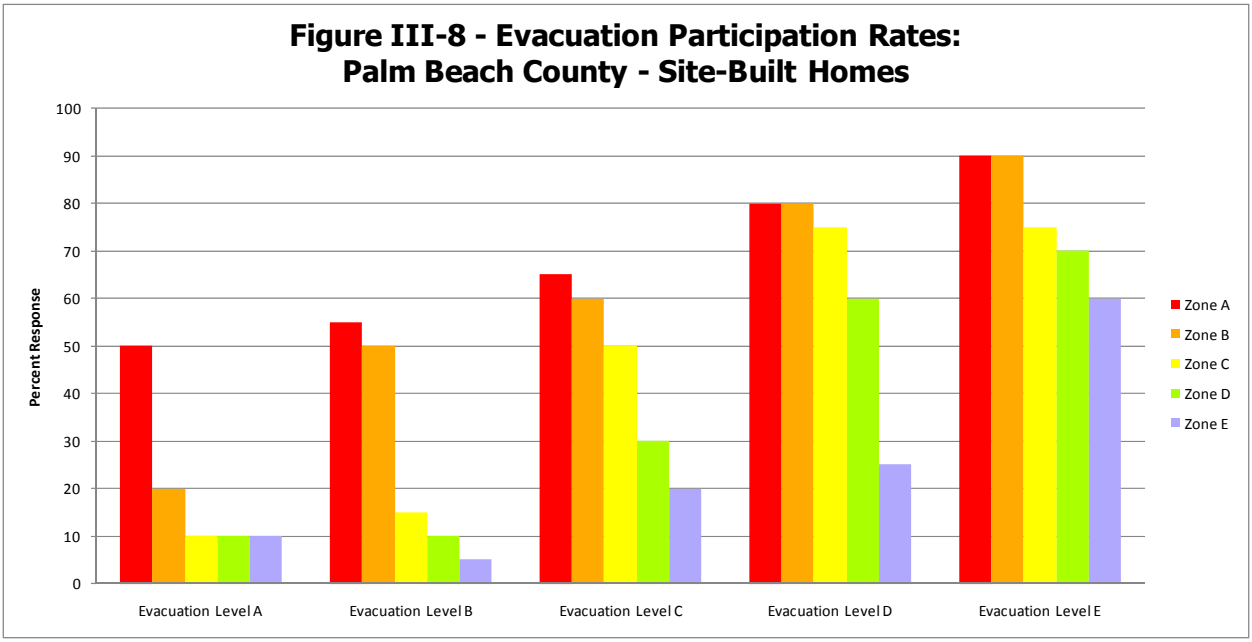


Figure III-8 - Evacuation Participation Rates:
Palm Beach County - Site-Built Homes
Percent Response
100
90
80
70
60
50
40
30
20
10
0
Evacuation Level A
Evacuation Level B
Evacuation Level C
Evacuation Level D
Evacuation Level E
Zone A
Zone B
Zone C
Zone D
Zone E

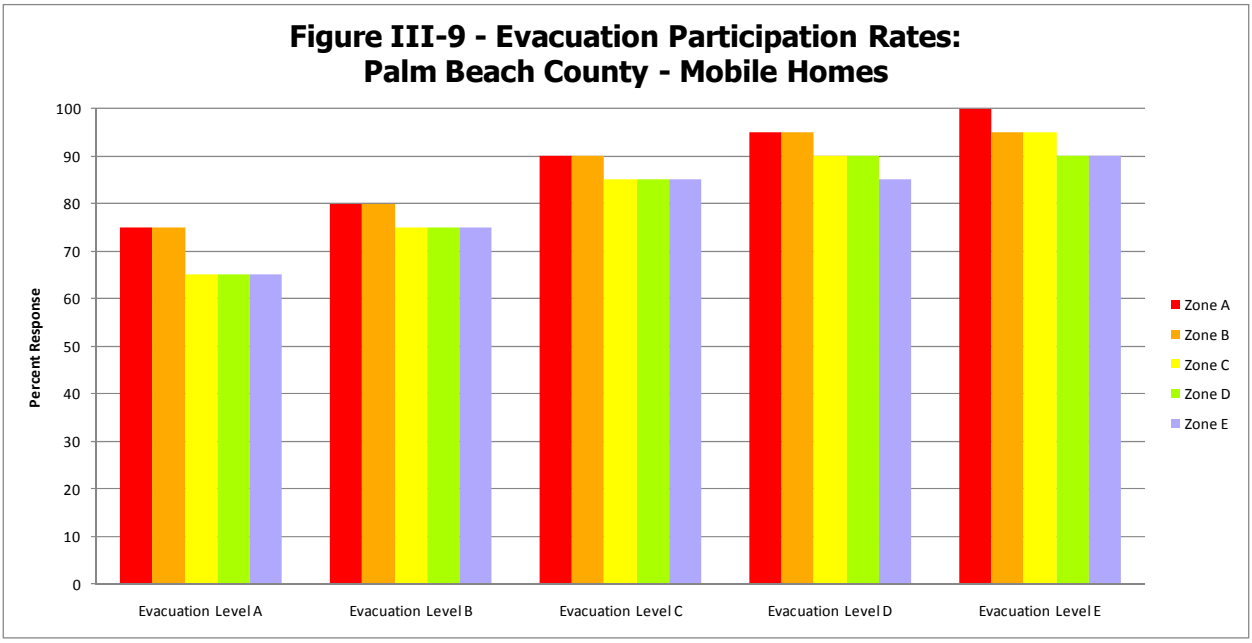


Figure III-9 - Evacuation Participation Rates:
Palm Beach County - Mobile Homes
Percent Response
100
90
80
70
60
50
40
30
20
10
0
Evacuation Level A
Evacuation Level B
Evacuation Level C
Evacuation Level D
Evacuation Level E
Zone A
Zone B
Zone C
Zone D
Zone E

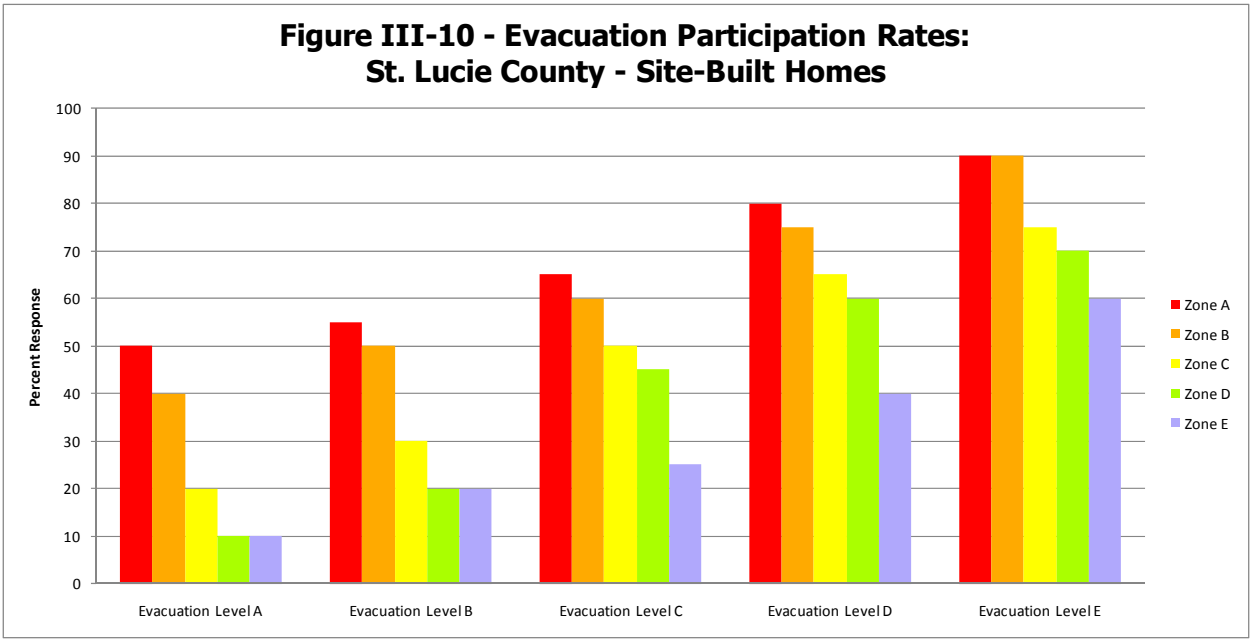


Figure III-10 - Evacuation Participation Rates:
St. Lucie County - Site-Built Homes
Percent Response
100
90
80
70
60
50
40
30
20
10
0
Evacuation Level A
Evacuation Level B
Evacuation Level C
Evacuation Level D
Evacuation Level E
Zone A
Zone B
Zone C
Zone D
Zone E

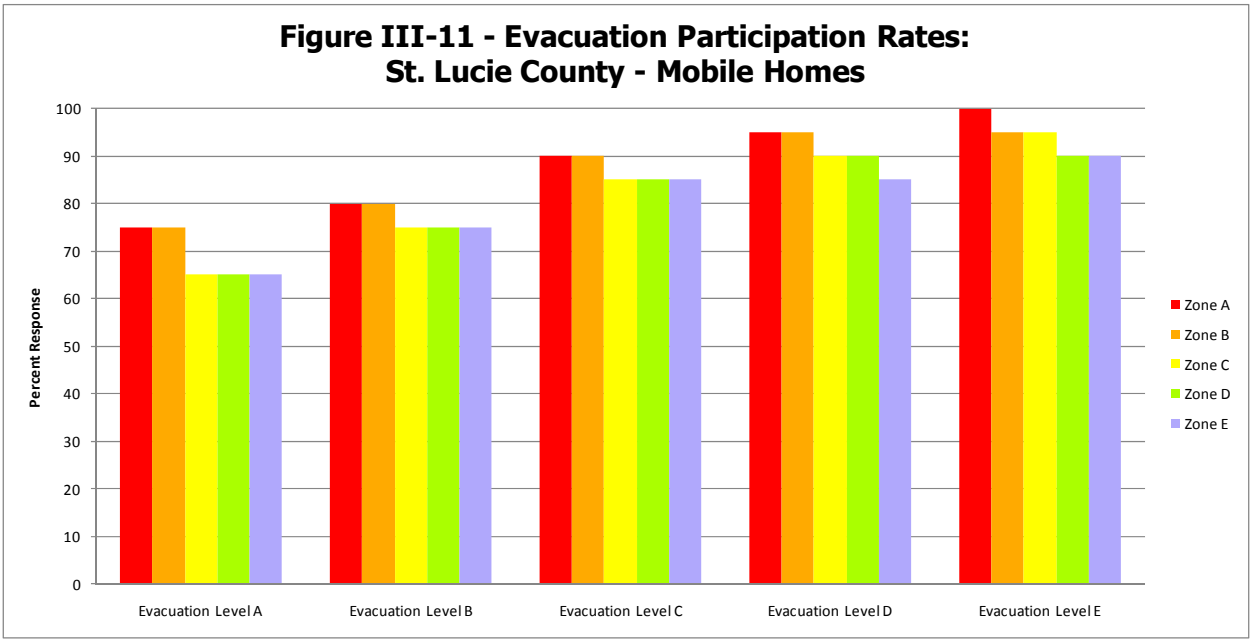


Figure III-11 - Evacuation Participation Rates:
St. Lucie County - Mobile Homes
Percent Response
100
90
80
70
60
50
40
30
20
10
0
Evacuation Level A
Evacuation Level B
Evacuation Level C
Evacuation Level D
Evacuation Level E
Zone A
Zone B
Zone C
Zone D
Zone E

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 Treasure Coast 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 four county region there are a total of 78 shelters, including 14 in Indian River County, 14 in Martin County, 30 in Palm Beach County, and 20 in St. Lucie County, all of which are classified as primary shelters. All together, the 78 shelters located within the four county region can host more than 73,000 persons during an evacuation event. Detailed lists of the available public shelters by county are included in Volume 5-10.

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. All four counties within the Treasure Coast region have updated and established their evacuation zones based on the results of the new data and information collected as part of the SRESP. Evacuation zones for the Treasure Coast Region are illustrated in **Figure III-12**. County level evacuation zones are included in Volume 5-10.

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.

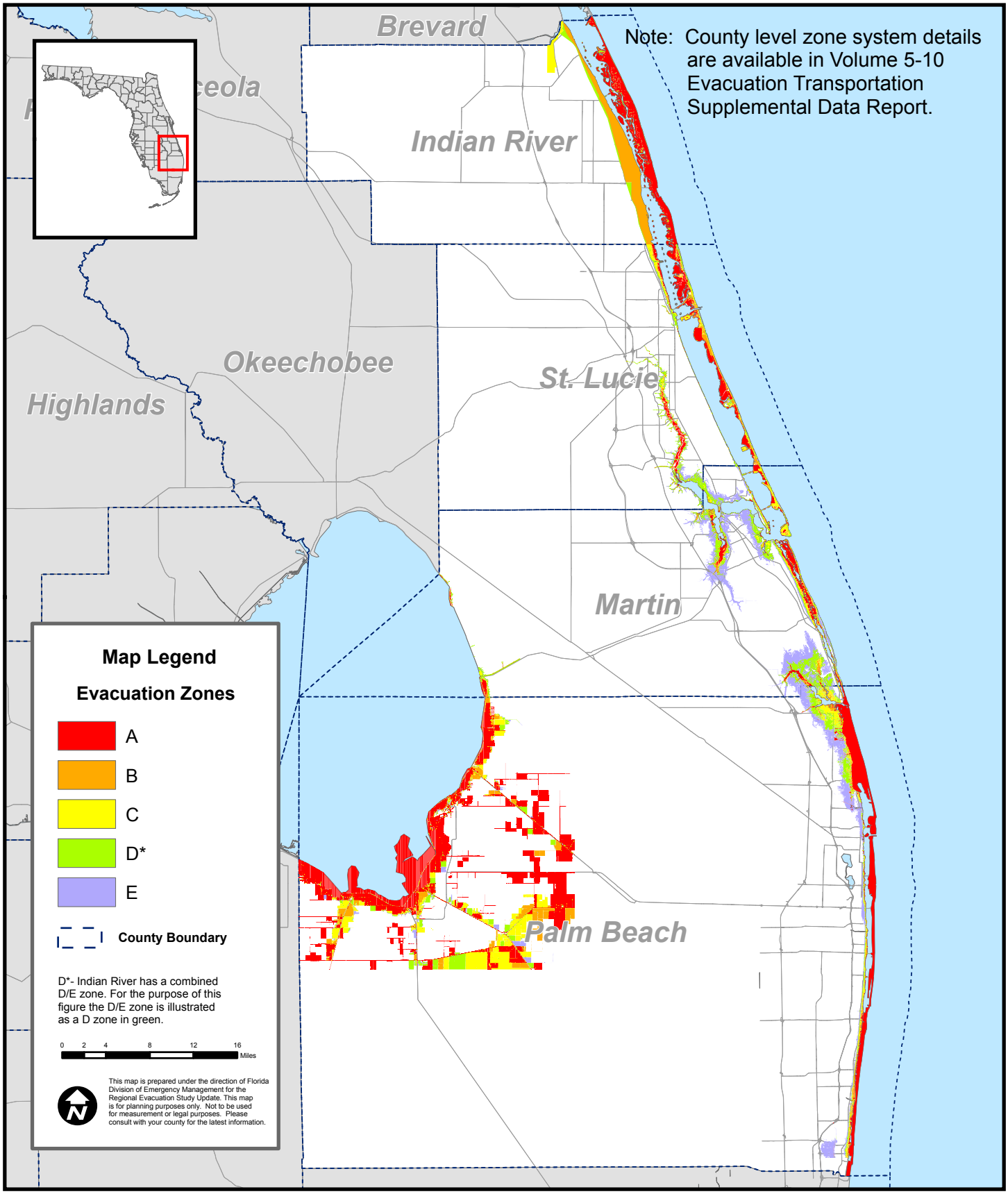
The evacuation model variables include a set of distinguishing characteristics that could apply to evacuation scenarios as selection criteria. These following variables may be selected using the TIME interface and allow the user to retrieve the best results from various evacuation alternatives:

- **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-12

Treasure Coast Regional Evacuation Zones



Sources: Treasure Coast 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 the user to take into account the FDOT one-way evacuation operations plans for major facilities, including Florida's Turnpike, the Beachline Expressway (SR 528), and I-75.

- **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. 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 Treasure Coast's model network and include both coastal and inland counties. The coastal counties include Brevard, Indian River, St. Lucie, Martin, Palm Beach, Broward, Miami-Dade, Monroe, and Collier Counties. The inland counties are Orange, Osceola, Okeechobee, and Hendry 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 Treasure Coast 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 Treasure Coast Region varies by evacuation zone by county. Palm Beach County, for example, has more than 65,000 additional vulnerable residents in evacuation zone B than in evacuation zone A in 2010. Palm Beach County has by far the largest vulnerable population in the region in 2010, with more than 177,000 people in all five evacuation zones combined. In all 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 Treasure Coast Region are identified in **Table IV-3** for 2010 and in **Table IV-4** for 2015.

In all cases in the Treasure Coast Region, the vulnerable population is far more likely to stay with friends and family during an evacuation. This is followed by hotel/motel and other locations. In all cases, public shelter destinations are identified as the least likely destination of the vulnerable population 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 four county region ranges from 188,000 to 418,000 persons for 2010, depending upon the evacuation level. For 2015, the range increases to between 200,000 and 454,000 persons.

Table IV-1 – Vulnerable Population in the Treasure Coast Region for 2010

	Evacuation Zone A	Evacuation Zone B	Evacuation Zone C	Evacuation Zone D	Evacuation Zone E
Indian River County*					
Site-built Homes	18,125	19,208	907	2,547	
Mobile/Manuf. Homes	10	1,550	0	533	
TOTAL	18,135	20,758	907	3,081	
Martin County					
Site-built Homes	6,632	2,182	6,186	8,153	23,438
Mobile/Manuf. Homes	335	60	184	154	1,422
TOTAL	6,966	2,242	6,370	8,308	24,861
Palm Beach County					
Site-built Homes	73,968	9,039	22,530	26,358	41,615
Mobile/Manuf. Homes	2,112	195	540	468	723
TOTAL	76,080	9,234	23,070	26,826	42,338
St. Lucie County					
Site-built Homes	6,942	2,241	2,710	1,447	1,775
Mobile/Manuf. Homes	1,759	307	286	75	104
TOTAL	8,701	2,548	2,996	1,522	1,879

Note: Vulnerable population determined using SRESP behavioral 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 B does not include vulnerable population listed for Evacuation Zone A.
**Indian River County has a combined D/E zone.*

Table IV-2 – Vulnerable Population in the Treasure Coast Region for 2015

	Evacuation Zone A	Evacuation Zone B	Evacuation Zone C	Evacuation Zone D	Evacuation Zone E
Indian River County*					
Site-built Homes	19,566	20,736	979	2,749	
Mobile/Manuf. Homes	10	1,550	0	533	
TOTAL	19,576	22,286	979	3,283	
Martin County					
Site-built Homes	6,935	2,277	6,412	8,439	24,427
Mobile/Manuf. Homes	335	60	184	154	1,422
TOTAL	7,270	2,337	6,596	8,593	25,850
Palm Beach County					
Site-built Homes	79,978	9,773	24,360	28,499	44,996
Mobile/Manuf. Homes	2,282	210	583	506	781
TOTAL	82,261	9,983	24,943	29,005	45,777
St. Lucie County					
Site-built Homes	7,244	2,329	2,862	1,521	1,874
Mobile/Manuf. Homes	1,759	307	286	75	104
TOTAL	9,003	2,635	3,148	1,596	1,978

Note: Vulnerable population determined using SRESP behavioral 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 B does not include vulnerable population listed for Evacuation Zone A.
**Indian River County has a combined D/E zone.*

Table IV-3 – Vulnerable Population by Destination for 2010

	Evacuation Zone A	Evacuation Zone B	Evacuation Zone C	Evacuation Zone D	Evacuation Zone E
Indian River County*					
To Friends and Family	9,975	11,495	499	1,721	
To Hotel/ Motel	4,533	5,035	227	717	
To Public Shelter	907	1,146	73	268	
To Other Destination	2,720	3,083	109	375	
Martin County					
To Friends and Family	4,528	1,457	4,140	5,400	16,159
To Hotel/ Motel	1,028	333	946	1,238	3,658
To Public Shelter	239	73	208	426	1,343
To Other Destination	1,171	379	1,076	1,243	3,701
Palm Beach County					
To Friends and Family	45,648	5,540	13,842	16,095	25,403
To Hotel/ Motel	18,809	2,289	5,714	6,660	10,512
To Public Shelter	3,952	475	1,191	1,374	2,167
To Other Destination	7,671	929	2,323	2,697	4,255
St. Lucie County					
To Friends and Family	5,133	1,513	1,783	910	1,122
To Hotel/ Motel	1,569	428	492	240	297
To Public Shelter	696	204	348	180	221
To Other Destination	1,303	402	372	193	238

Note: Vulnerable population destinations determined using SRESP behavioral 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 B does not include vulnerable population listed for Evacuation Zone A.
**Indian River County has a combined D/E zone.*

Table IV-4 – Vulnerable Population by Destination for 2015

	Evacuation Zone A	Evacuation Zone B	Evacuation Zone C	Evacuation Zone D	Evacuation Zone E
Indian River County*					
To Friends and Family	10,767	12,335	539	1,832	
To Hotel/ Motel	4,893	5,417	245	767	
To Public Shelter	980	1,223	78	284	
To Other Destination	2,936	3,312	118	399	
Martin County					
To Friends and Family	4,725	1,519	4,287	5,586	16,802
To Hotel/ Motel	1,074	348	980	1,281	3,806
To Public Shelter	248	76	214	440	1,392
To Other Destination	1,223	395	1,114	1,286	3,849
Palm Beach County					
To Friends and Family	49,356	5,990	14,966	17,403	27,466
To Hotel/ Motel	20,337	2,475	6,177	7,201	11,366
To Public Shelter	4,273	514	1,288	1,486	2,344
To Other Destination	8,295	1,005	2,512	2,916	4,601
St. Lucie County					
To Friends and Family	5,314	1,566	1,874	954	1,182
To Hotel/ Motel	1,614	441	515	251	312
To Public Shelter	720	211	366	188	233
To Other Destination	1,355	417	392	203	251

Note: Vulnerable population destinations determined using SRESP behavioral 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 B does not include vulnerable population listed for Evacuation Zone A.
**Indian River County has a combined D/E zone.*

Table IV-5 – Vulnerable Shadow Evacuation Population

	Evacuation Level A	Evacuation Level B	Evacuation Level C	Evacuation Level D	Evacuation Level E
2010					
Indian River County	24,990	22,875	23,296	30,839	35,268
Martin County	22,950	29,028	29,697	39,600	36,918
Palm Beach County	110,854	108,368	172,042	221,435	267,138
St. Lucie County	30,029	42,643	41,996	67,001	79,289
2015					
Indian River County	25,807	23,585	24,037	32,214	36,995
Martin County	23,694	30,345	31,056	42,037	39,598
Palm Beach County	119,508	116,779	185,530	238,869	288,141
St. Lucie County	32,256	47,013	46,343	75,618	90,010

Note: Vulnerable shadow population determined using SRESP behavioral data and county provided evacuation zones.

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 Treasure Coast 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** - 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 the following:
  - 100% response in evacuation zones for both mobile homes and site built homes for the counties in the RPC, plus one coastal county on either side of the region (includes Indian River, Martin, Palm Beach, St. Lucie, Broward, and Brevard Counties);
  - 100% response for mobile homes in inland areas for the counties in the RPC, plus one coastal county on either side of the region;
  - Planning Assumption response (shadow evacuation) for site built homes in inland areas for the counties in the RPC plus one coastal county on either side of the region; and,
  - For the remaining counties in the Treasure Coast 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	Indian River Martin Palm Beach St. Lucie Broward Brevard	Indian River Martin Palm Beach St. Lucie Broward Brevard	Indian River Martin Palm Beach St. Lucie Broward Brevard	Indian River Martin Palm Beach St. Lucie Broward Brevard	Indian River Martin Palm Beach St. Lucie Broward Brevard
	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	Indian River Martin Palm Beach St. Lucie Broward Brevard	Indian River Martin Palm Beach St. Lucie Broward Brevard	Indian River Martin Palm Beach St. Lucie Broward Brevard	Indian River Martin Palm Beach St. Lucie Broward Brevard	Indian River Martin Palm Beach St. Lucie Broward Brevard

E. Base Scenario Results

Each of the ten base scenarios were modeled for the Treasure Coast 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 four county region, total evacuating population ranges from more than 298,700 persons for a base scenario level A evacuation to more than 705,000 persons for a base scenario level E evacuation in 2010. By 2015, this range increases within the four counties to more than 319,000 persons for a base scenario level A evacuation and more than 761,000 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 four county region for the base scenarios also varies by evacuation level. A total of more than 159,500 vehicles evacuate from the four county RPC for a base scenario level A evacuation in 2010, and this number increases to more than 361,500 evacuating vehicles from the four 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 170,500 vehicles for a base scenario level A evacuation and nearly 390,000 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 four county region ranges from more than 23,500 persons for the base scenario level A evacuation in 2010 to almost 54,000 persons for the base scenario level E evacuation. By 2015, the public shelter demand is expected to increase to more than 25,000 persons for the level A evacuation and more than 58,000 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
Indian River County					
Site-built Homes	28,698	46,770	48,049	58,561	62,990
Mobile/Manuf. Homes	13,529	13,529	13,529	13,529	13,529
Tourists	898	1,469	1,518	1,630	1,630
TOTAL	43,125	61,768	63,096	73,720	78,149
Martin County					
Site-built Homes	16,802	25,122	32,161	50,236	71,648
Mobile/Manuf. Homes	12,868	12,868	12,868	12,868	12,868
Tourists	246	246	246	382	1,149
TOTAL	29,916	38,236	45,275	63,486	85,665
Palm Beach County					
Site-built Homes	139,758	146,029	231,609	307,054	393,170
Mobile/Manuf. Homes	42,904	42,904	42,904	42,904	42,904
Tourists	4,272	4,749	5,913	6,687	8,612
TOTAL	186,934	193,682	280,426	356,645	444,686
St. Lucie County					
Site-built Homes	21,432	36,103	38,452	64,979	78,777
Mobile/Manuf. Homes	17,241	17,241	17,241	17,241	17,241
Tourists	57	548	548	548	917
TOTAL	38,730	53,892	56,241	82,768	96,935

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
Indian River County					
Site-built Homes	30,956	50,449	51,831	63,179	67,960
Mobile/Manuf. Homes	13,529	13,529	13,529	13,529	13,529
Tourists	898	1,469	1,518	1,630	1,630
TOTAL	45,383	65,447	66,878	78,338	83,119
Martin County					
Site-built Homes	17,850	26,838	34,145	53,583	76,227
Mobile/Manuf. Homes	12,868	12,868	12,868	12,868	12,868
Tourists	246	246	246	382	1,149
TOTAL	30,964	39,952	47,259	66,833	90,244
Palm Beach County					
Site-built Homes	151,123	157,900	250,430	332,000	425,124
Mobile/Manuf. Homes	46,374	46,374	46,374	46,374	46,374
Tourists	4,272	4,749	5,913	6,687	8,612
TOTAL	201,769	209,023	302,717	385,061	480,110
St. Lucie County					
Site-built Homes	23,961	40,862	43,340	74,211	90,212
Mobile/Manuf. Homes	17,241	17,241	17,241	17,241	17,241
Tourists	57	548	548	548	917
TOTAL	41,259	58,651	61,129	92,000	108,370

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
Indian River County					
Site-built Homes	15,598	24,265	24,987	30,295	32,537
Mobile/Manuf. Homes	5,597	5,597	5,597	5,597	5,597
Tourists	499	817	844	906	906
TOTAL	21,694	30,679	31,428	36,798	39,040
Martin County					
Site-built Homes	8,960	13,266	16,931	26,295	37,049
Mobile/Manuf. Homes	7,803	7,803	7,803	7,803	7,803
Tourists	164	164	164	255	765
TOTAL	16,927	21,233	24,898	34,353	45,617
Palm Beach County					
Site-built Homes	75,450	78,978	121,330	158,449	200,782
Mobile/Manuf. Homes	22,359	22,359	22,359	22,359	22,359
Tourists	2,848	3,165	3,940	4,456	5,741
TOTAL	100,657	104,502	147,629	185,264	228,882
St. Lucie County					
Site-built Homes	10,675	17,617	18,930	31,192	37,602
Mobile/Manuf. Homes	9,846	9,846	9,846	9,846	9,846
Tourists	38	365	365	365	611
TOTAL	20,559	27,828	29,141	41,403	48,059

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
Indian River County					
Site-built Homes	16,826	26,175	26,954	32,685	35,104
Mobile/Manuf. Homes	5,597	5,597	5,597	5,597	5,597
Tourists	499	817	844	906	906
TOTAL	22,922	32,589	33,395	39,188	41,607
Martin County					
Site-built Homes	9,512	14,164	17,964	28,031	39,410
Mobile/Manuf. Homes	7,803	7,803	7,803	7,803	7,803
Tourists	164	164	164	255	765
TOTAL	17,479	22,131	25,931	36,089	47,978
Palm Beach County					
Site-built Homes	81,574	85,388	131,176	171,308	217,079
Mobile/Manuf. Homes	24,181	24,181	24,181	24,181	24,181
Tourists	2,848	3,165	3,940	4,456	5,741
TOTAL	108,603	112,734	159,297	199,945	247,001
St. Lucie County					
Site-built Homes	11,848	19,798	21,182	35,396	42,798
Mobile/Manuf. Homes	9,846	9,846	9,846	9,846	9,846
Tourists	38	365	365	365	611
TOTAL	21,732	30,009	31,393	45,607	53,255

Table IV-11 – Shelter Demand by 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
2010					
Indian River	2,951	3,996	4,107	5,063	5,478
Martin	2,640	3,245	3,491	4,847	6,131
Palm Beach	14,648	15,004	21,425	27,336	33,803
St. Lucie	3,293	4,592	4,884	7,174	8,405
2015					
Indian River	3,082	4,209	4,325	5,358	5,805
Martin	2,708	3,369	3,626	5,097	6,464
Palm Beach	15,816	16,199	23,134	29,520	36,504
St. Lucie	3,504	4,989	5,297	7,949	9,365

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.

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 four counties within the RPC, for a total of six 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	371,376	408,831	513,812	668,393	873,099
2015	392,946	434,009	546,083	712,363	932,571

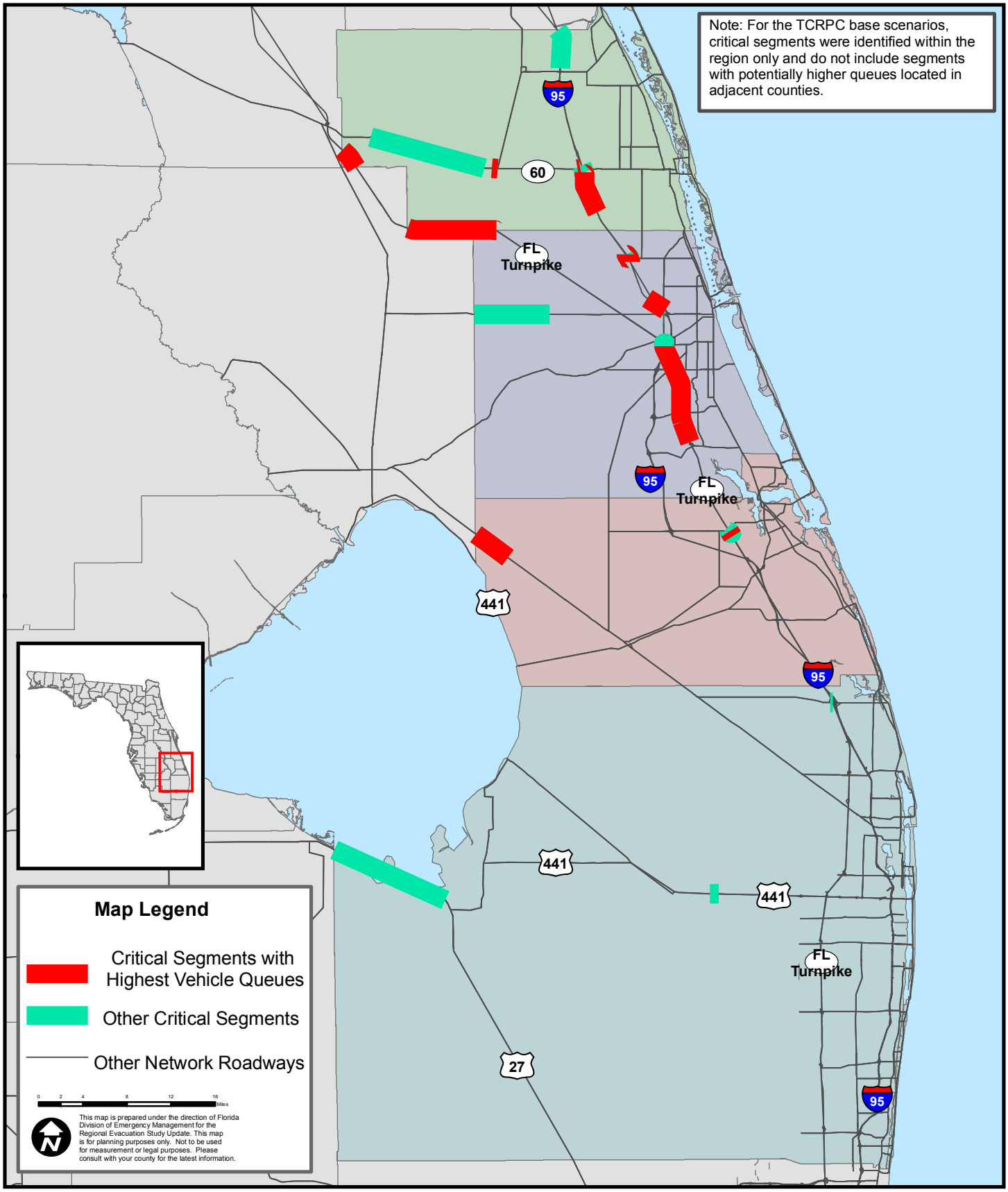
The identification of critical roadways in the evacuation network is also important to assist emergency managers with identifying roadways that have the greatest impact on clearance times. Critical roadways were identified by reviewing roadways in the model network that have the highest vehicle queues 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 Treasure Coast 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 I-95, the Turnpike, SR 60, and portions of US 441 and SR 710 are critical facilities for all evacuation scenarios. During the level A evacuation scenarios, the roadway segments with the highest vehicle queues are primarily located outside the western edge of the four county region, with the exception of I-95 and SR 60 in Indian River County. In contrast, for the level D and E evacuation scenarios, the roadway segments with the highest vehicle queues include other regional roadways, including SR 76 in Martin County and SR 68 in St. Lucie County.

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 Treasure Coast Region for each base scenario are included in Volume 5-10. 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 generally follow the same pattern as the critical segment figures, as locations with higher queues generally have higher traffic volumes.

Figure IV-1

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

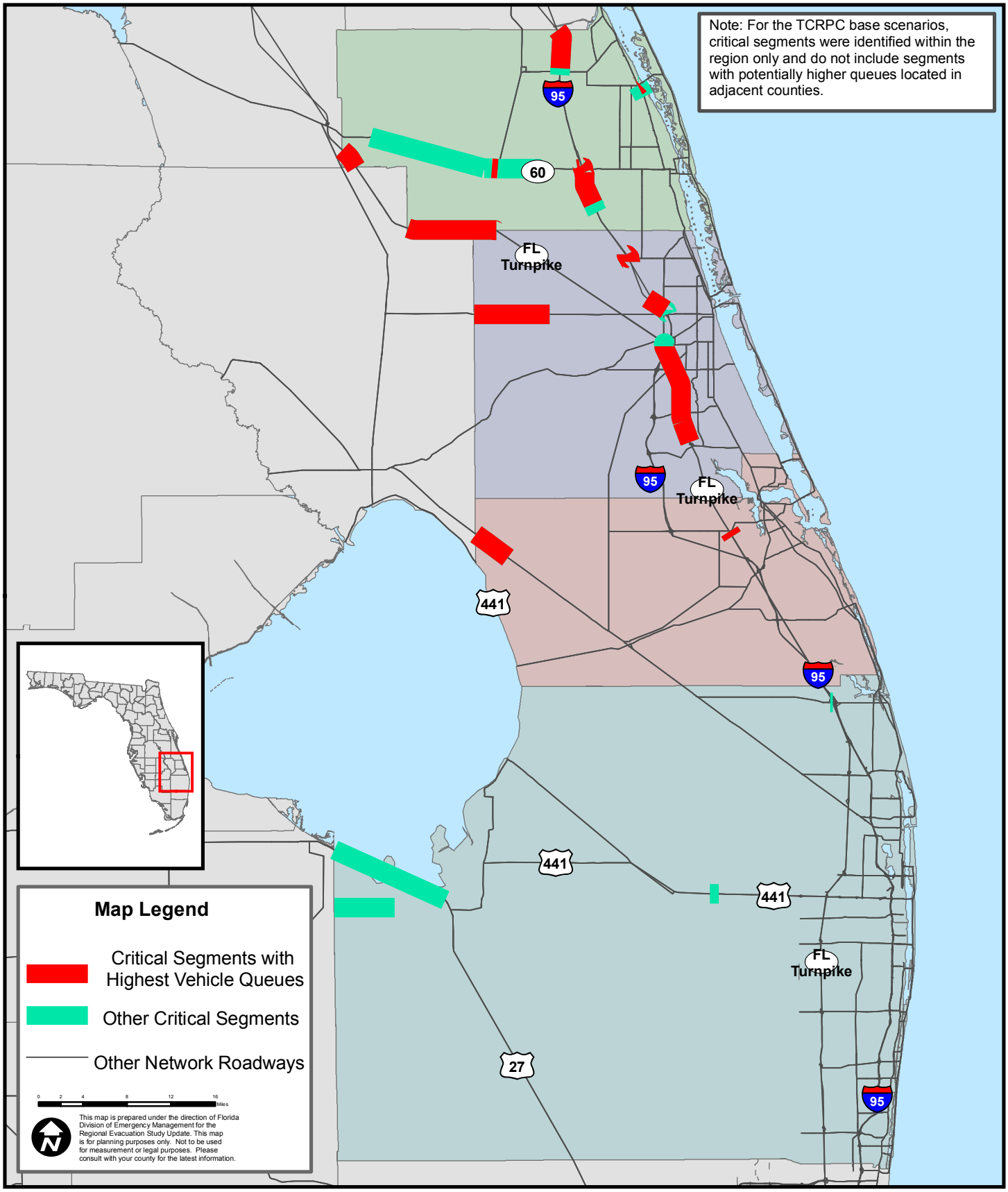


Sources: Treasure Coast Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-2

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

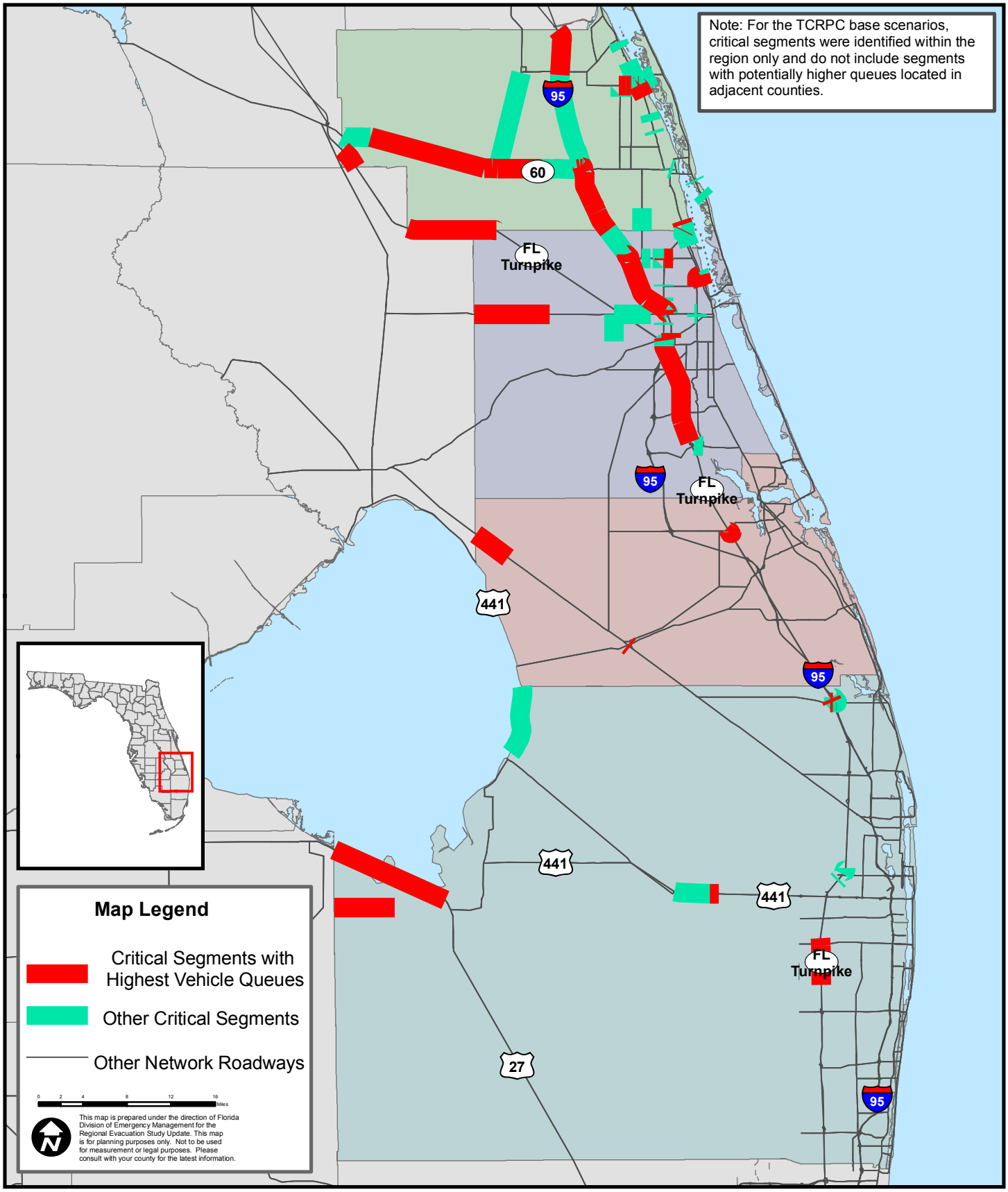


Sources: Treasure Coast Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-3

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

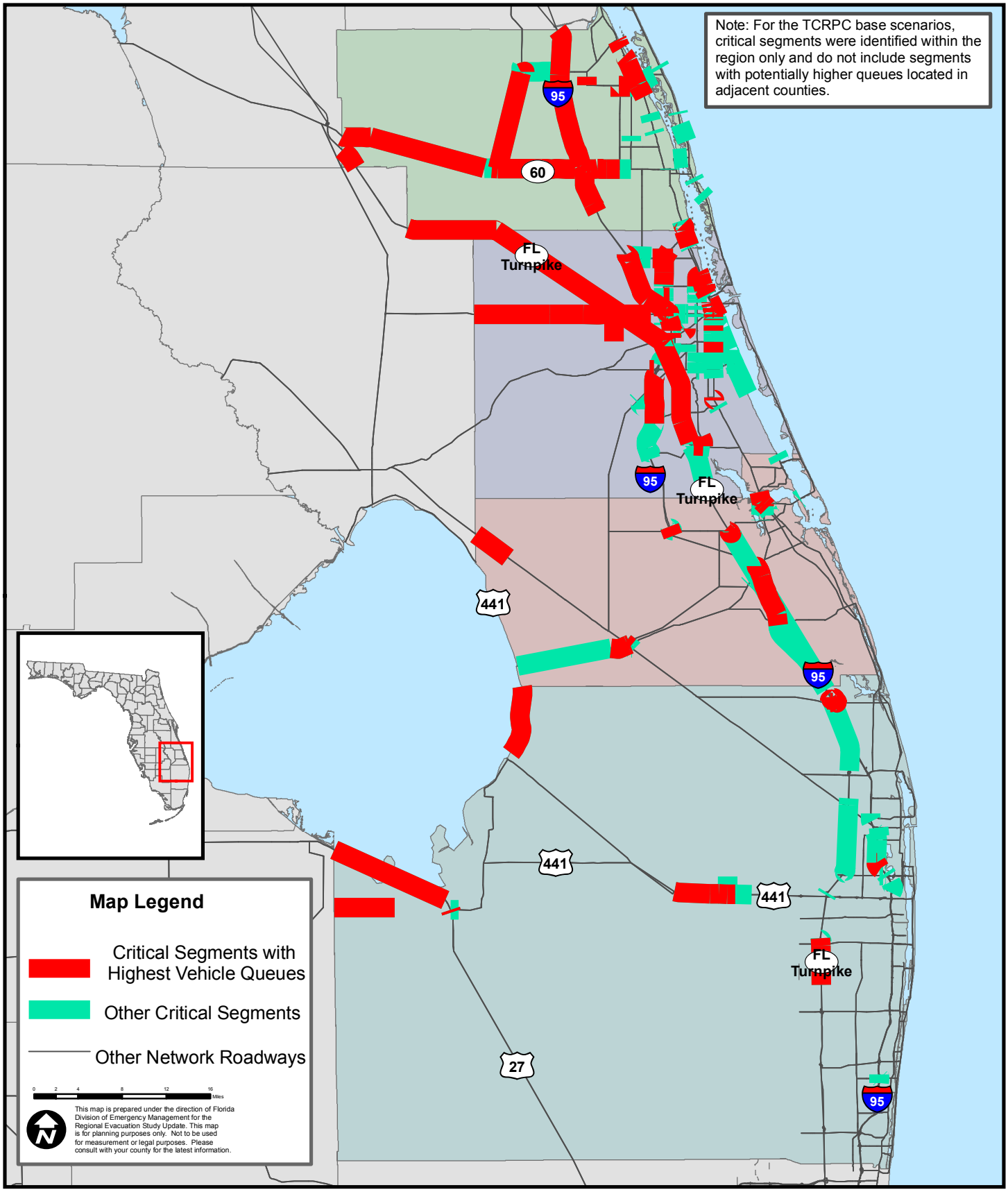


Sources: Treasure Coast Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-4

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

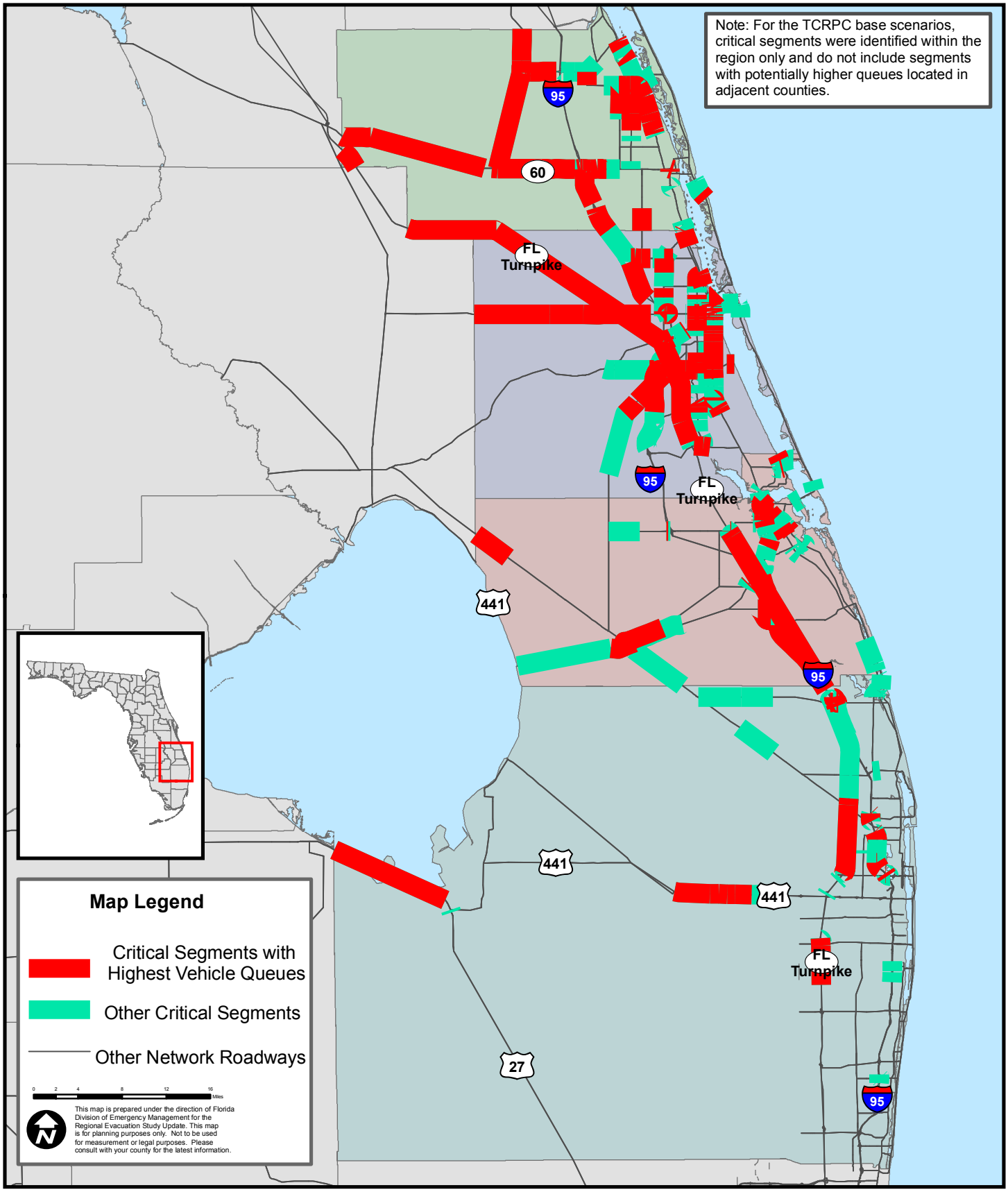


Sources: Treasure Coast Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-5

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

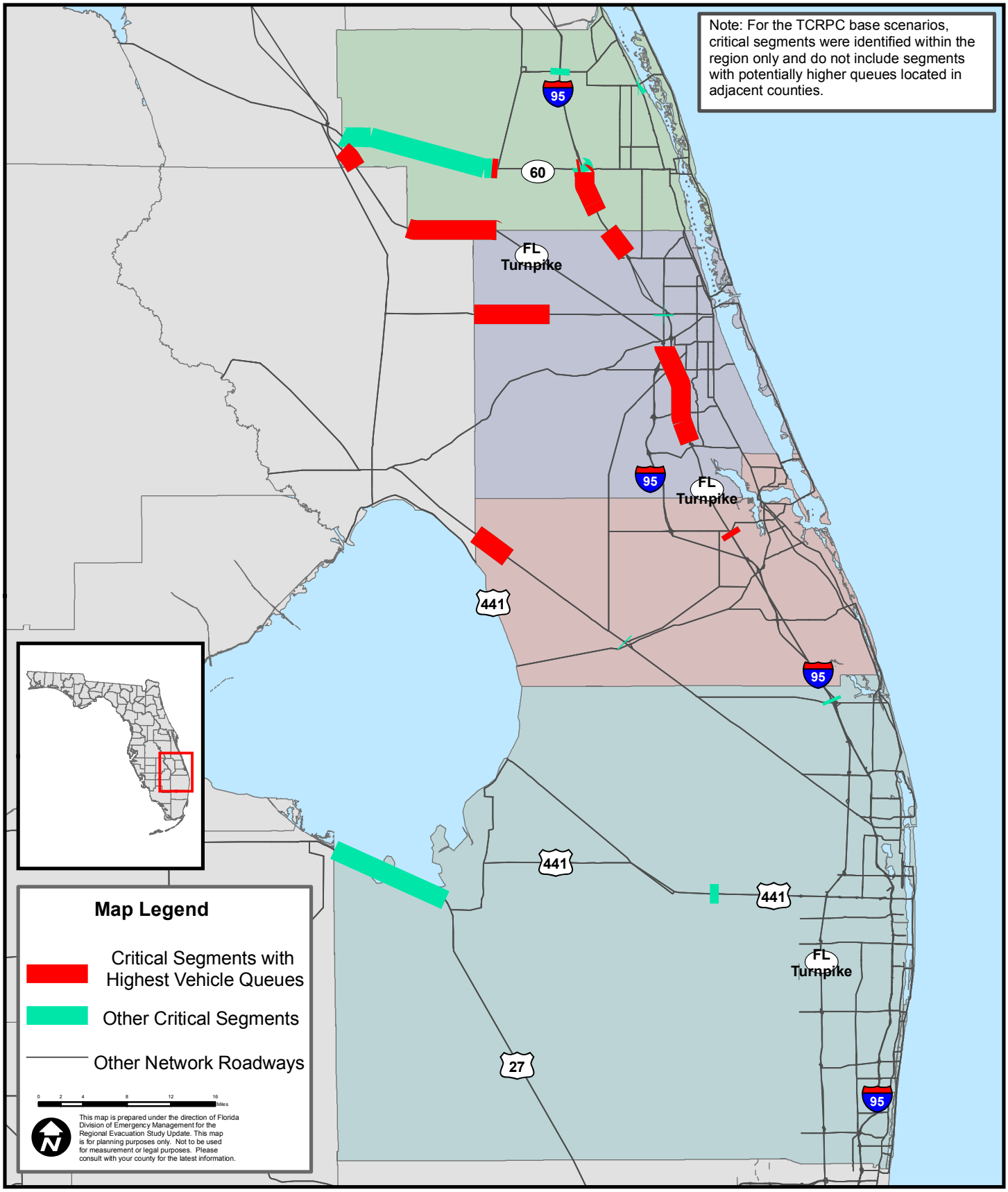


Sources: Treasure Coast Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-6

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

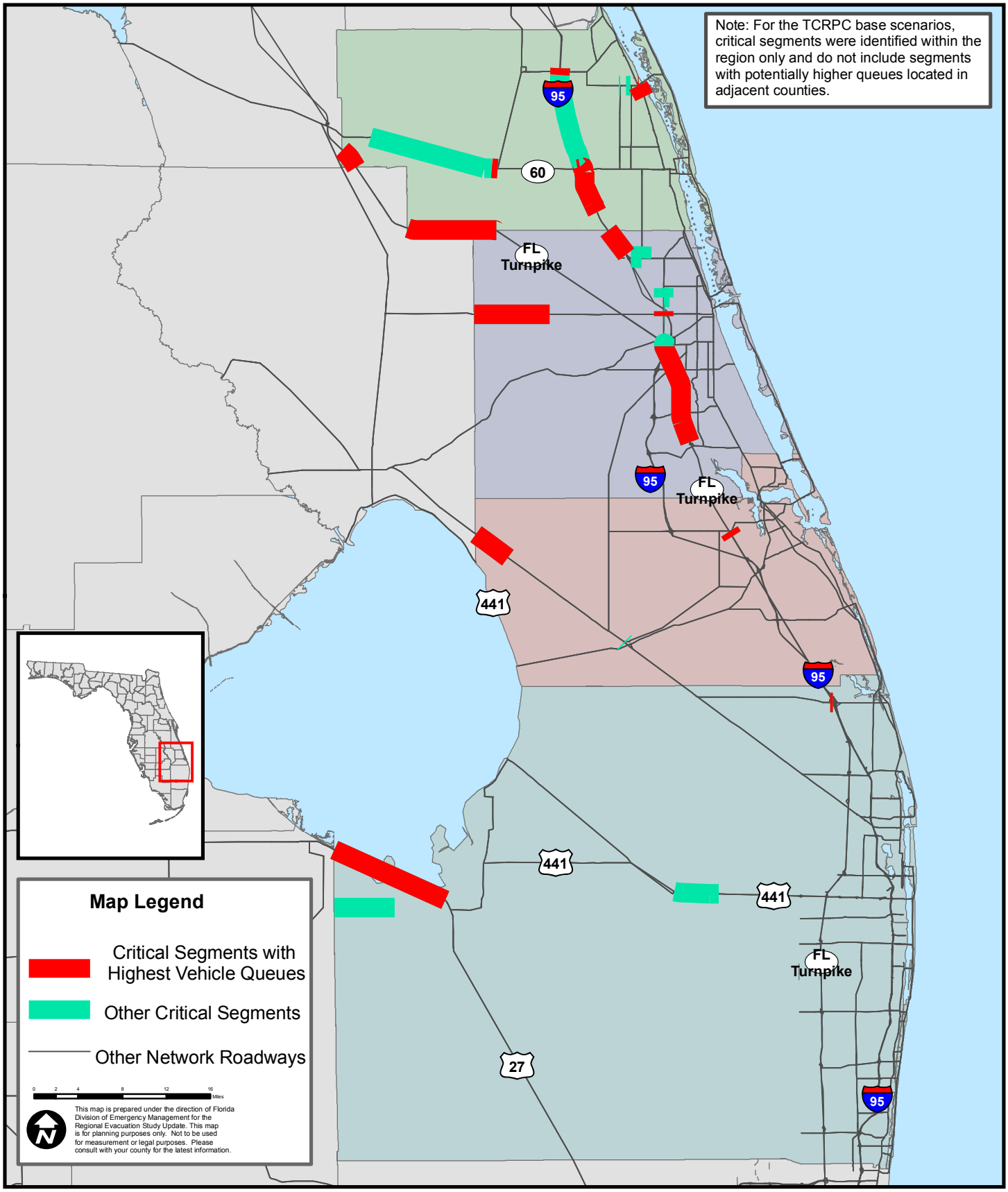


Sources: Treasure Coast Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-7

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

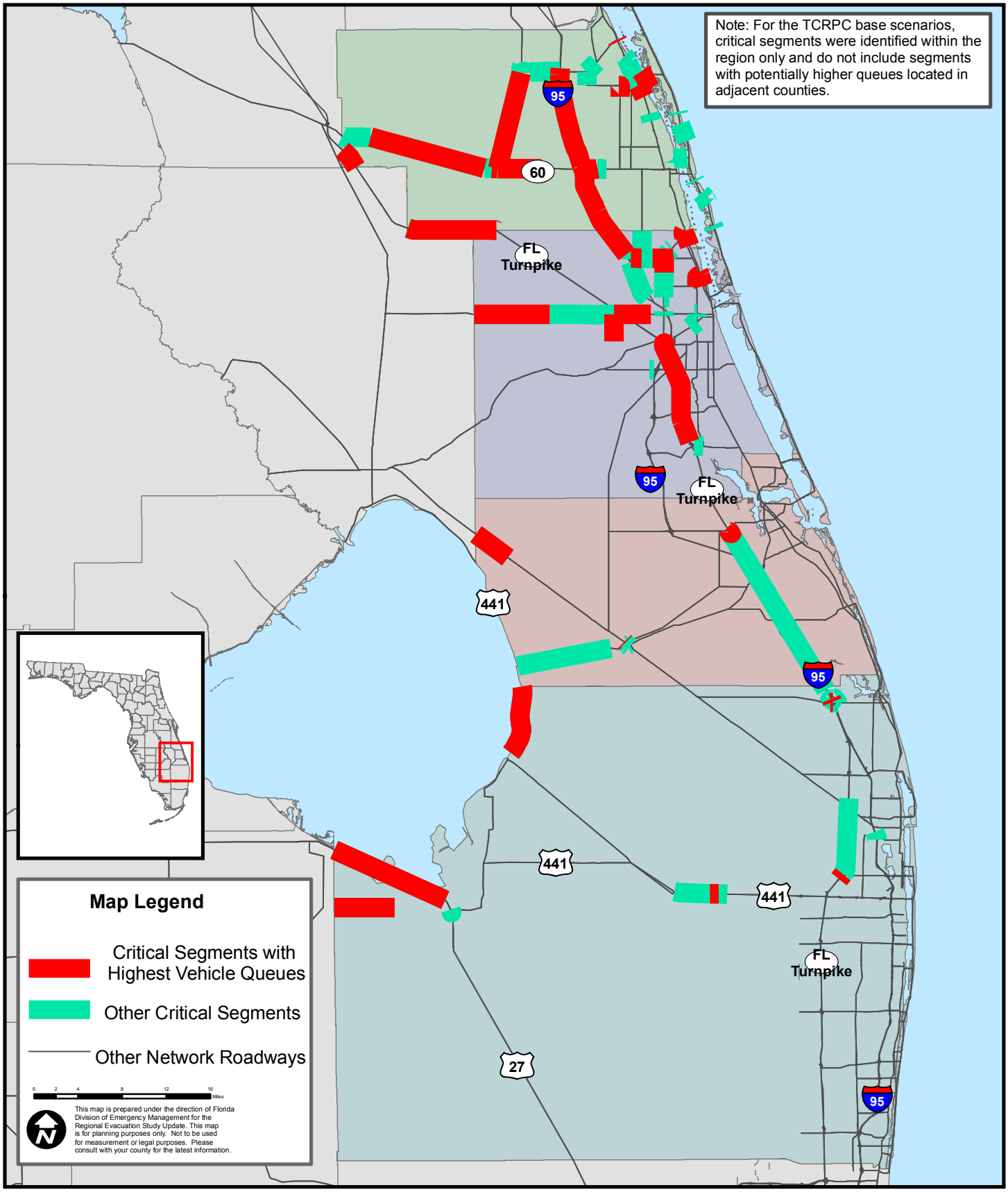


Sources: Treasure Coast Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-8

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

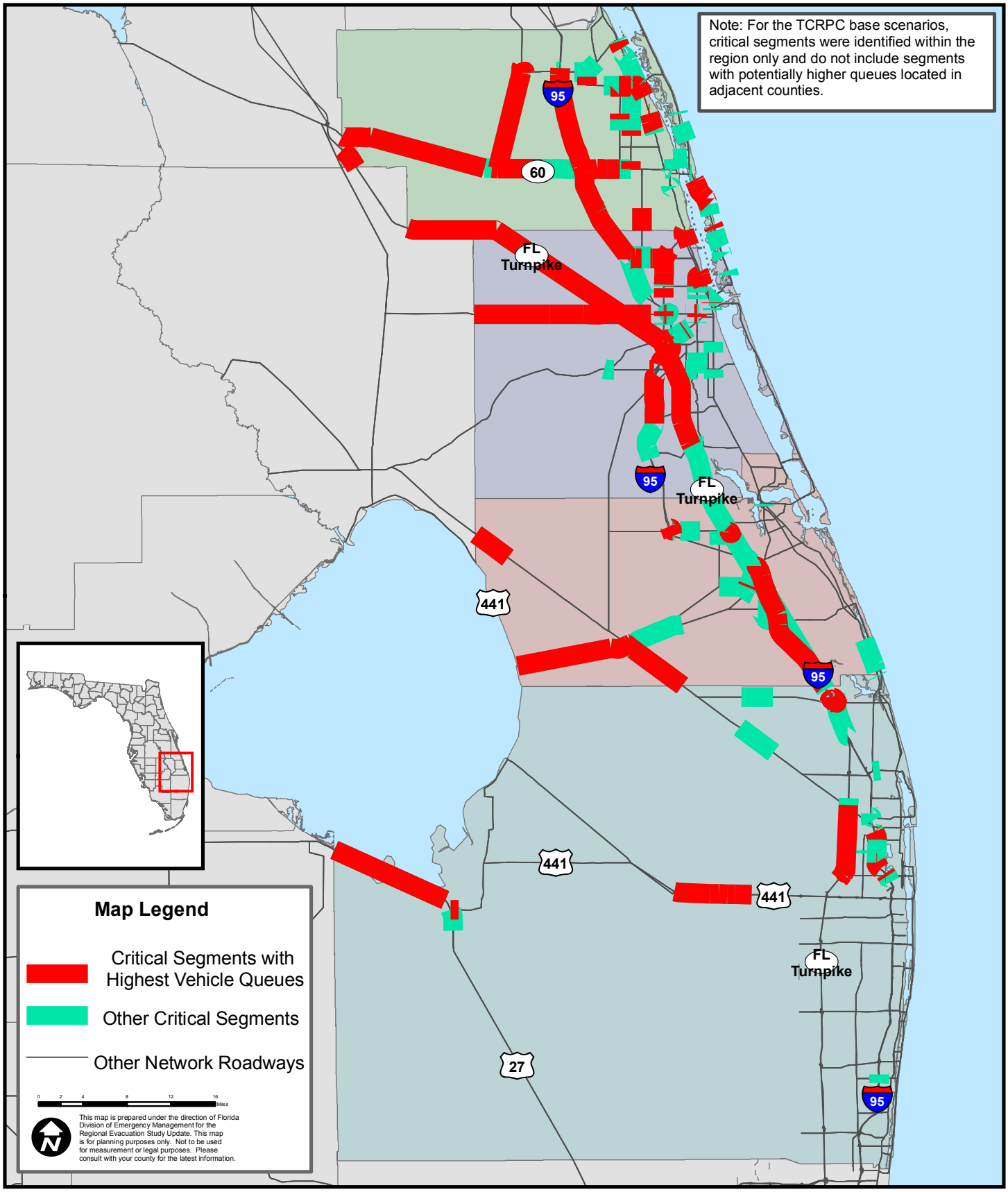


Sources: Treasure Coast Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-9

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

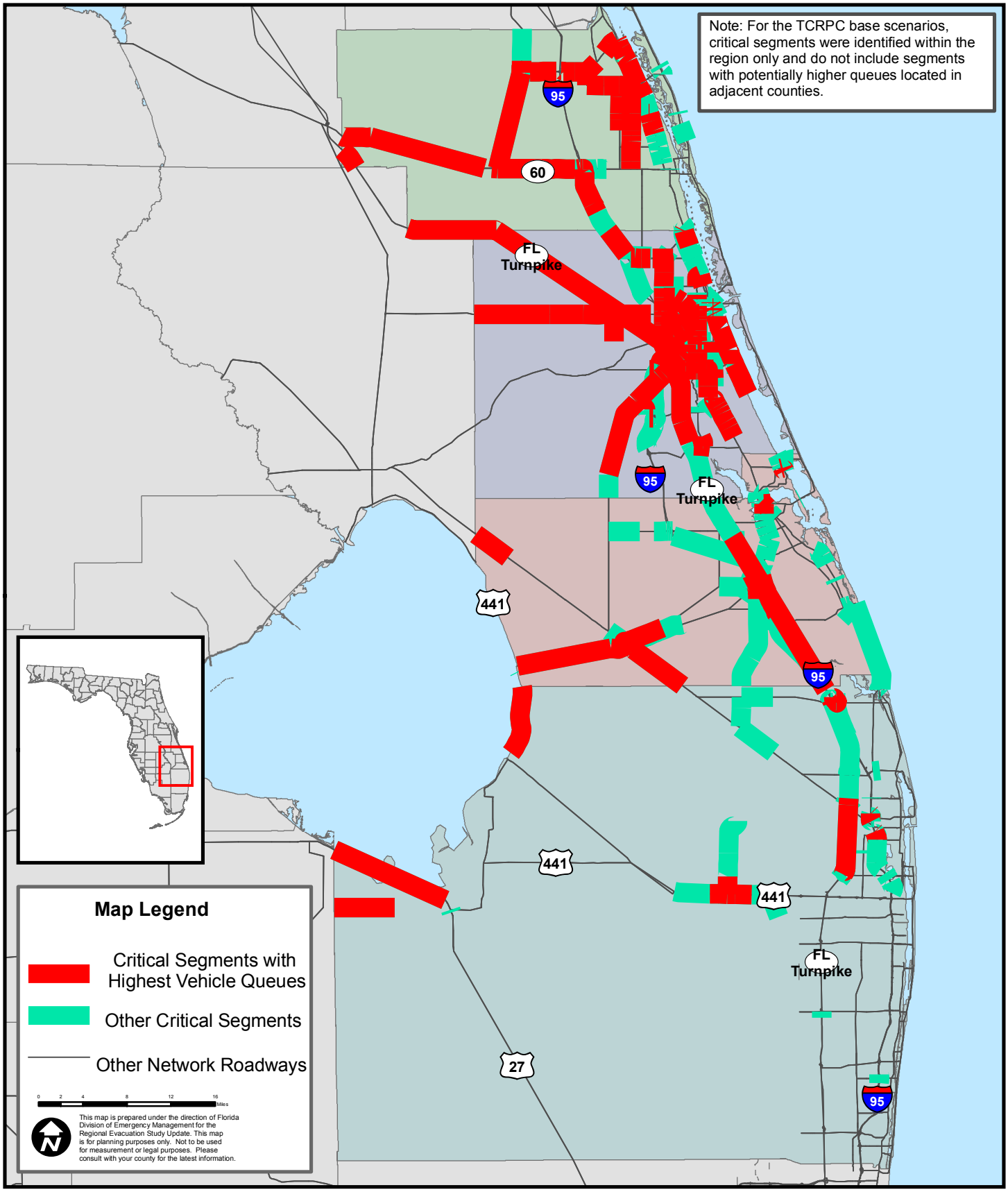


Sources: Treasure Coast Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-10

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



Sources: Treasure Coast 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 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
Indian River County					
FL Turnpike NB	21,600	21,700	22,300	27,700	38,300
SR 60 Westbound	8,100	9,300	13,700	19,100	24,400
I-95 Northbound	26,300	29,900	35,900	50,700	59,100
US 1 Northbound	200	2,200	7,800	11,700	14,800
I-95 Southbound	2,800	3,500	3,700	4,700	6,600
Martin County					
SR 710 Northbound	4,200	3,500	3,500	4,000	3,200
I-95 Northbound	15,600	15,200	32,200	44,800	50,800
FL Turnpike NB	30,300	30,200	30,200	35,900	36,200
US 1 Northbound	2,700	4,000	6,200	13,400	24,600
I-95 Southbound	2,200	2,800	3,800	5,700	10,000
FL Turnpike SB	6,200	7,800	8,500	10,500	9,700
Palm Beach County					
US 1 Northbound	100	100	800	6,000	1,100
FL Turnpike NB	27,100	26,800	28,200	34,000	35,200
I-95 Northbound	16,800	16,500	32,600	46,100	58,000
SR 710 Northbound	5,200	5,000	8,100	11,200	10,700
US 27 Westbound	6,400	7,200	9,900	13,200	16,300
FL Turnpike SB	5,600	7,300	9,800	11,700	17,700
I-95 Southbound	6,200	7,300	9,800	11,400	15,900
St. Lucie County					
SR 70 Westbound	1,600	2,300	2,000	2,800	3,300
FL Turnpike NB	21,600	21,800	22,300	27,700	38,300
I-95 Northbound	26,300	28,400	32,600	42,400	36,800
US 1 Northbound	2,000	2,700	8,400	15,400	22,300
FL Turnpike SB	6,000	7,600	8,300	9,600	7,600
I-95 Southbound	500	900	1,600	3,500	7,200

Table IV-14 – Evacuating Vehicles Leaving Each County by Evacuation Route for the 2015 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
Indian River County					
FL Turnpike NB	22,000	21,200	23,800	34,300	41,000
SR 60 Westbound	8,800	9,300	14,400	17,900	26,300
I-95 Northbound	27,400	31,200	38,600	53,700	51,900
US 1 Northbound	400	4,100	7,200	12,100	22,900
I-95 Southbound	3,000	3,600	31,900	4,800	7,200
Martin County					
SR 710 Northbound	3,800	3,100	3,500	3,500	4,700
I-95 Northbound	17,000	18,000	33,000	52,400	51,600
FL Turnpike NB	31,100	29,400	33,700	35,300	41,200
US 1 Northbound	2,900	4,500	6,000	13,400	26,200
I-95 Southbound	2,400	2,900	4,200	6,700	11,500
FL Turnpike SB	6,500	8,100	8,900	10,400	9,400
Palm Beach County					
US 1 Northbound	100	200	1,500	8,000	10,400
FL Turnpike NB	27,800	26,100	30,800	33,000	40,500
I-95 Northbound	18,300	18,900	33,100	48,500	60,700
SR 710 Northbound	5,400	5,400	8,600	10,900	12,700
US 27 Westbound	6,900	7,700	10,500	15,800	18,900
FL Turnpike SB	6,300	8,400	10,800	13,200	19,300
I-95 Southbound	9,800	8,000	10,600	13,100	16,000
St. Lucie County					
SR 70 Westbound	1,700	2,300	2,200	3,200	3,600
FL Turnpike NB	22,000	21,200	23,800	34,600	41,000
I-95 Northbound	27,500	27,100	31,900	42,800	27,000
US 1 Northbound	1,500	4,800	10,000	13,500	24,700
FL Turnpike SB	6,400	8,100	8,500	9,800	7,300
I-95 Southbound	600	1,100	2,000	4,400	9,300

Table IV-15 – Evacuating Vehicles Entering Each County by Evacuation Route for the 2010 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
Indian River County					
FL Turnpike NB	21,600	21,800	22,300	27,700	38,300
I-95 Northbound	26,300	28,400	32,600	42,400	36,800
US 1 Northbound	2,000	2,700	8,400	15,400	22,300
Martin County					
US 1 Northbound	100	100	800	6,000	1,100
FL Turnpike NB	27,100	26,800	28,200	34,000	35,200
I-95 Northbound	16,800	16,500	32,600	46,100	58,000
SR 710 Northbound	5,200	5,000	8,100	11,200	10,700
FL Turnpike SB	6,000	7,600	8,300	9,600	7,600
I-95 Southbound	500	900	1,600	3,500	7,200
Palm Beach County					
I-95 Southbound	2,200	2,800	3,800	5,700	10,000
FL Turnpike SB	6,200	7,800	8,500	10,500	9,700
US 27 Northbound	4,000	4,400	6,500	8,900	12,900
I-95 Northbound	6,200	6,300	12,000	21,900	26,500
FL Turnpike NB	16,100	16,600	20,100	26,600	36,600
St. Lucie County					
I-95 Southbound	2,800	3,500	3,700	4,700	6,600
I-95 Northbound	15,600	15,200	32,200	44,800	50,800
FL Turnpike NB	30,300	30,200	30,200	35,900	36,200
US 1 Northbound	2,700	4,000	6,200	13,400	24,600

Table IV-16 – Evacuating Vehicles Entering Each County by Evacuation Route for the 2015 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
Indian River County					
FL Turnpike NB	22,000	21,200	23,800	34,600	41,000
I-95 Northbound	27,500	27,100	31,900	42,800	27,000
US 1 Northbound	1,500	4,800	10,000	13,500	24,700
Martin County					
US 1 Northbound	100	200	1,500	8,000	10,400
FL Turnpike NB	27,800	26,100	30,800	33,000	40,500
I-95 Northbound	18,300	18,900	33,100	48,500	60,700
SR 710 Northbound	5,400	5,400	8,600	10,900	12,700
FL Turnpike SB	6,400	8,100	8,500	9,800	7,300
I-95 Southbound	600	1,100	2,000	4,400	9,300
Palm Beach County					
I-95 Southbound	2,400	2,900	4,200	6,700	11,500
FL Turnpike SB	6,500	8,200	8,900	10,400	9,400
US 27 Northbound	4,300	4,900	6,900	9,700	13,200
I-95 Northbound	6,300	7,200	12,800	20,600	24,900
FL Turnpike NB	16,800	16,500	20,700	30,400	38,600
St. Lucie County					
I-95 Southbound	3,000	3,600	31,900	4,800	7,200
I-95 Northbound	18,300	18,000	33,000	52,400	51,600
FL Turnpike NB	31,100	29,400	33,700	35,300	41,200
US 1 Northbound	2,900	4,500	6,000	13,400	26,200

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 2010 base scenarios range from 12.5 hours to 27 hours, depending upon the evacuation level. Indian River County has the highest in-county clearance time of 27 hours for the level E scenario. Clearance times to shelter range from 12.5 to 25.5 hours.

In 2015, in-county clearance times for the base scenarios vary between 12.5 hours for the evacuation level A scenarios and 37.5 hours for Indian River County for the evacuation level E scenario. Clearance time to shelter shows a similar pattern, with clearance times for the base scenarios ranging from 12.5 hours for the evacuation level A scenarios to 23.5 hours for Palm Beach County for evacuation level E scenario in 2015.

Out of county clearance times for the 2010 base scenarios range from 14 to 28 hours, while in 2015 they range from 14 hours for the base evacuation level A scenario to 41 hours in Indian River County for the evacuation level E scenario in 2015. Regional clearance time for the four county TCRPC region ranges from 14.5 hours to 41 hours.

Table IV-17 – 2010 Clearance Times 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
Clearance Time to Shelter					
Indian River	12.5	12.5	14.0	13.0	18.0
Martin	12.5	12.5	12.5	13.5	15.5
Palm Beach	13.5	13.0	13.5	16.0	25.5
St. Lucie	12.5	12.5	13.0	16.0	18.0
In-County Clearance Time					
Indian River	12.5	13.0	15.0	18.5	27.0
Martin	13.5	14.0	14.0	15.5	23.0
Palm Beach	14.5	14.5	14.5	17.5	26.5
St. Lucie	13.0	13.5	14.0	17.5	25.0
Out of County Clearance Time					
Indian River	14.5	14.5	16.0	19.5	28.0
Martin	14.0	14.0	14.0	16.0	23.0
Palm Beach	14.5	14.5	14.5	17.5	26.5
St. Lucie	14.0	14.5	14.5	18.5	25.0
Regional Clearance Time					
Treasure Coast	14.5	14.5	16.0	19.5	28.0

Table IV-18 – 2015 Clearance Times 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
Clearance Time to Shelter					
Indian River	12.5	12.5	13.0	15.5	19.0
Martin	12.5	12.5	12.5	14.0	17.0
Palm Beach	13.5	13.5	13.5	16.0	23.5
St. Lucie	12.5	12.5	13.5	14.0	16.5
In-County Clearance Time					
Indian River	12.5	14.0	15.0	17.5	37.5
Martin	13.5	13.5	14.0	16.0	23.0
Palm Beach	14.0	14.0	14.0	17.0	26.5
St. Lucie	13.0	14.0	14.0	16.0	31.0
Out of County Clearance Time					
Indian River	14.5	15.0	16.0	19.5	41.0
Martin	14.0	14.0	14.0	16.0	23.0
Palm Beach	14.5	14.0	14.5	17.0	26.5
St. Lucie	14.5	14.5	14.5	16.5	34.0
Regional Clearance Time					
Treasure Coast	14.5	15.0	16.0	19.5	41.0

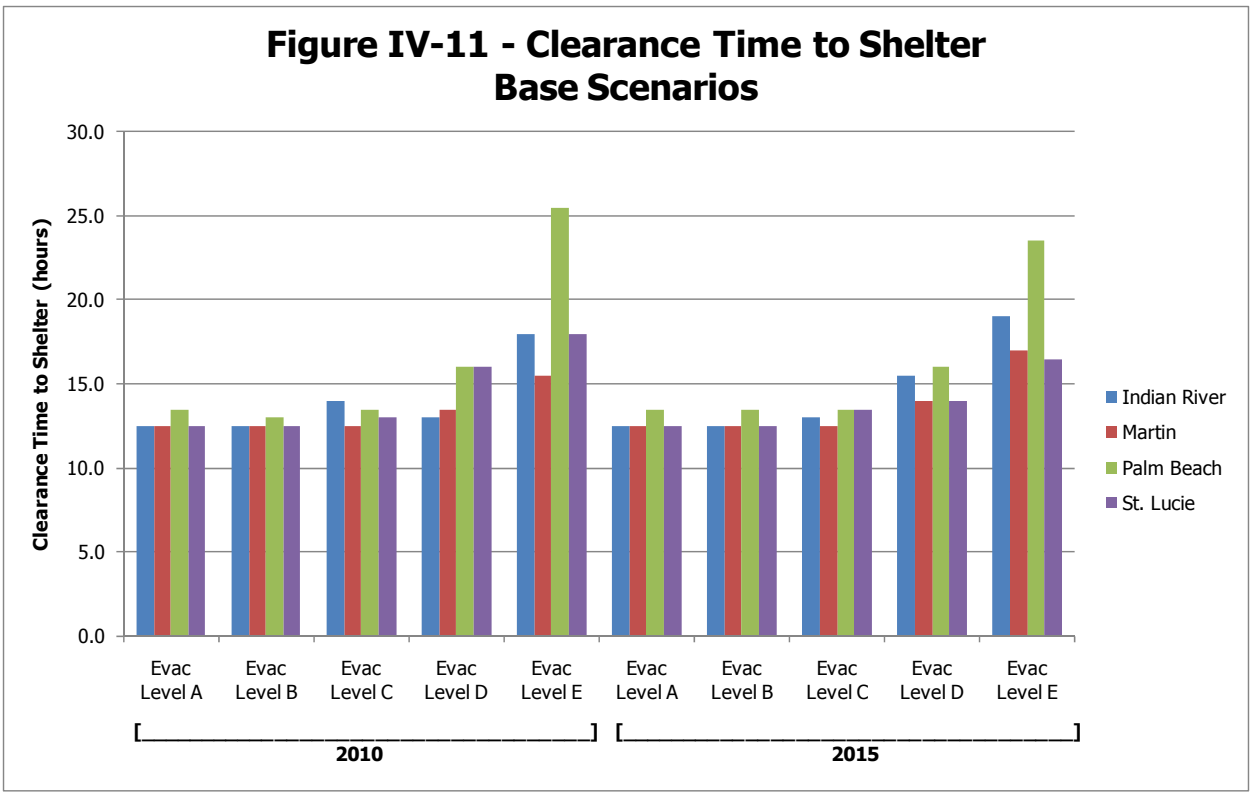


Figure IV-11 - Clearance Time to Shelter
Base Scenarios
Clearance Time to Shelter (hours)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Evac Level A
Evac Level B
Evac Level C
Evac Level D
Evac Level E
Evac Level A
Evac Level B
Evac Level C
Evac Level D
Evac Level E
2010
2015
Indian River
Martin
Palm Beach
St. Lucie

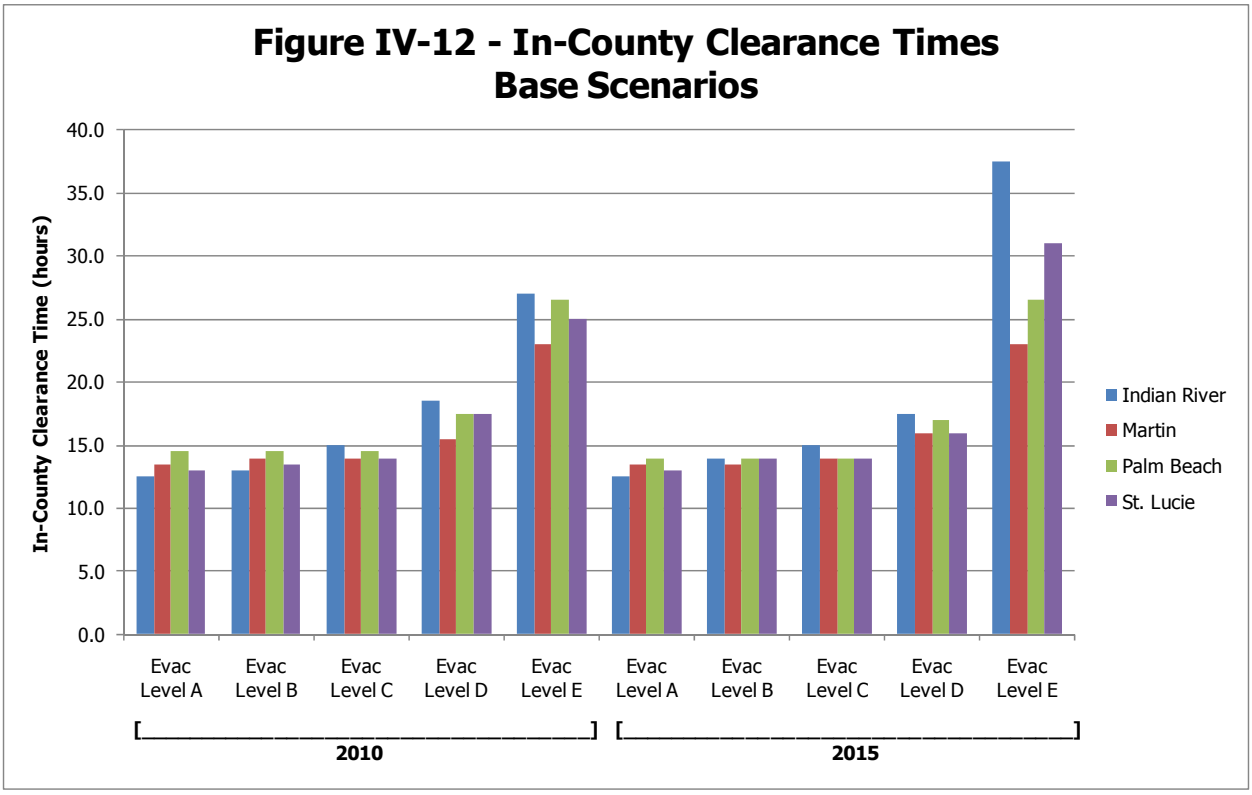


Figure IV-12 - In-County Clearance Times
Base Scenarios
In-County Clearance Time (hours)
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Evac Level A
Evac Level B
Evac Level C
Evac Level D
Evac Level E
Evac Level A
Evac Level B
Evac Level C
Evac Level D
Evac Level E
2010
2015
Indian River
Martin
Palm Beach
St. Lucie

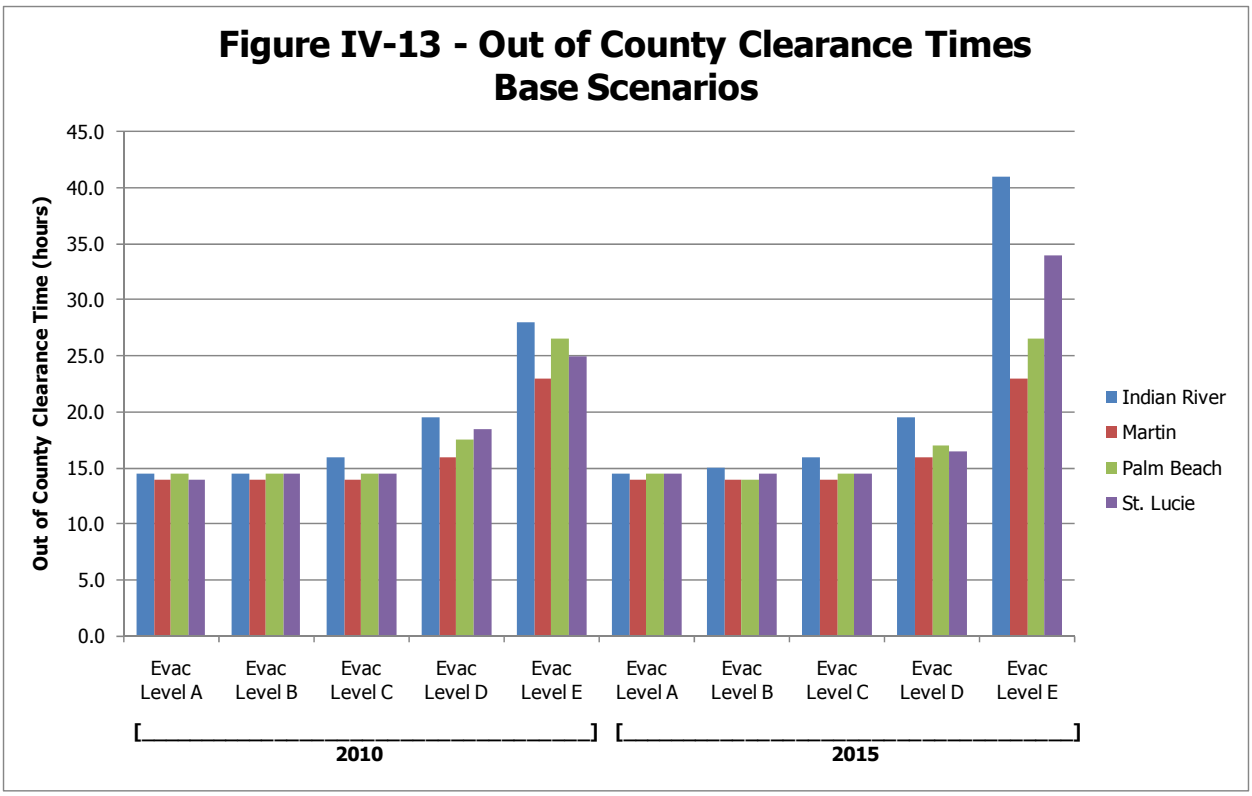


Figure IV-13 - Out of County Clearance Times
Base Scenarios
Out of County Clearance Time (hours)
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Evac Level A
Evac Level B
Evac Level C
Evac Level D
Evac Level E
Evac Level A
Evac Level B
Evac Level C
Evac Level D
Evac Level E
2010
2015
Indian River
Martin
Palm Beach
St. Lucie

F. Operational Scenarios

The transportation analysis also included ten region wide operational scenarios selected by the county emergency managers and RPC staff for the Treasure Coast 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 ten operational scenarios can be different for each scenario.

The ten operational scenarios selected for analysis in the Treasure Coast Region are illustrated in **Table IV-19**. All ten operational scenarios used the planning assumptions rates, along with the fall/spring session university population. In addition, the scenarios used two different response curves, with the level A, B, and C evacuations using a 6-hour response curve, and the level D and E evacuations using a 9-hour response curve. The operational scenarios included the same counties as the base scenarios: Broward, Palm Beach, Martin, St. Lucie, Indian River, and Brevard Counties.

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	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	6-hour	6-hour	6-hour	9-hour	9-hour
Evacuation Phasing	None	None	None	None	None
Behavioral Response	Planning	Planning	Planning	Planning	Planning
Evacuation Level	A	B	C	D	E
Counties Evacuating	Indian River Martin Palm Beach St. Lucie Broward Brevard	Indian River Martin Palm Beach St. Lucie Broward Brevard	Indian River Martin Palm Beach St. Lucie Broward Brevard	Indian River Martin Palm Beach St. Lucie Broward Brevard	Indian River Martin Palm Beach St. Lucie Broward Brevard
	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	6-hour	6-hour	6-hour	9-hour	9-hour
Evacuation Phasing	None	None	None	None	None
Behavioral Response	Planning	Planning	Planning	Planning	Planning
Evacuation Level	A	B	C	D	E
Counties Evacuating	Indian River Martin Palm Beach St. Lucie Broward Brevard	Indian River Martin Palm Beach St. Lucie Broward Brevard	Indian River Martin Palm Beach St. Lucie Broward Brevard	Indian River Martin Palm Beach St. Lucie Broward Brevard	Indian River Martin Palm Beach St. Lucie Broward Brevard

G. Operational Scenario Results

Each of the ten operational scenarios were modeled for the Treasure Coast 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 four 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 four county region, total evacuating population ranges from just over 212,000 persons for the operational scenario level A evacuation to almost 628,000 persons for the operational scenario level E evacuation in 2010. By 2015, this range increases within the four counties to more than 227,500 persons for the operational scenario level A evacuation and more than 689,500 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 four county region for the operational scenarios also varies by evacuation level. A total of more than 111,000 vehicles evacuate from the four county RPC for the operational scenario level A evacuation in 2010, and this number increases to nearly 326,000 evacuating vehicles from the four county region for the operational scenario level E evacuation in 2010. By 2015, the number of evacuating vehicles is expected to increase to over 119,335 vehicles for the operational scenario level A evacuation and nearly 352,000 evacuating vehicles for the operational scenario level E evacuation.

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 four county region ranges from more than 17,000 persons for the operational scenario level A evacuation in 2010 to more than 49,500 persons for the operational scenario level E evacuation. By 2015, the public shelter demand is expected to increase to more than 18,000 persons for the level A evacuation and more than 53,500 persons for the level E evacuation.

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

	Evacuation Level A Operational Scenario	Evacuation Level B Operational Scenario	Evacuation Level C Operational Scenario	Evacuation Level D Operational Scenario	Evacuation Level E Operational Scenario
Indian River County					
Site-built Homes	19,623	29,888	35,416	50,400	59,040
Mobile/Manuf. Homes	8,378	9,653	11,006	11,656	12,255
Tourists	898	1,469	1,518	1,630	1,630
TOTAL	28,899	41,010	47,940	63,686	72,925
Martin County					
Site-built Homes	13,487	21,047	25,871	42,935	57,400
Mobile/Manuf. Homes	7,868	9,135	10,422	10,994	11,627
Tourists	246	246	246	382	1,149
TOTAL	21,601	30,428	36,539	54,311	70,176
Palm Beach County					
Site-built Homes	102,754	108,210	190,817	274,249	354,651
Mobile/Manuf. Homes	26,176	30,351	34,641	36,750	38,862
Tourists	4,272	4,749	5,913	6,687	8,612
TOTAL	133,202	143,310	231,371	317,686	402,125
St. Lucie County					
Site-built Homes	17,963	31,860	33,771	61,503	76,037
Mobile/Manuf. Homes	10,677	12,298	14,022	14,879	15,722
Tourists	57	548	548	548	917
TOTAL	28,697	44,706	48,341	76,930	92,676

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

	Evacuation Level A Operational Scenario	Evacuation Level B Operational Scenario	Evacuation Level C Operational Scenario	Evacuation Level D Operational Scenario	Evacuation Level E Operational Scenario
Indian River County					
Site-built Homes	21,167	32,243	38,205	54,375	63,699
Mobile/Manuf. Homes	8,378	9,653	11,006	11,656	12,255
Tourists	898	1,469	1,518	1,630	1,630
TOTAL	30,443	43,365	50,729	67,661	77,584
Martin County					
Site-built Homes	14,381	22,575	27,592	45,997	61,390
Mobile/Manuf. Homes	7,868	9,135	10,422	10,994	11,627
Tourists	246	246	246	382	1,149
TOTAL	22,495	31,956	38,260	57,373	74,166
Palm Beach County					
Site-built Homes	111,109	117,006	206,326	296,537	383,479
Mobile/Manuf. Homes	28,292	32,805	37,442	39,722	42,005
Tourists	4,272	4,749	5,913	6,687	8,612
TOTAL	143,673	154,560	249,681	342,946	434,096
St. Lucie County					
Site-built Homes	20,341	36,439	38,442	70,570	87,333
Mobile/Manuf. Homes	10,677	12,298	14,022	14,879	15,722
Tourists	57	548	548	548	917
TOTAL	31,075	49,285	53,012	85,997	103,972

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

	Evacuation Level A Operational Scenario	Evacuation Level B Operational Scenario	Evacuation Level C Operational Scenario	Evacuation Level D Operational Scenario	Evacuation Level E Operational Scenario
Indian River County					
Site-built Homes	10,368	15,557	18,407	26,089	30,527
Mobile/Manuf. Homes	3,501	4,018	4,578	4,844	5,081
Tourists	499	817	844	906	906
TOTAL	14,368	20,392	23,829	31,839	36,514
Martin County					
Site-built Homes	7,101	11,012	13,542	22,399	29,789
Mobile/Manuf. Homes	4,764	5,533	6,314	6,664	7,048
Tourists	164	164	164	255	765
TOTAL	12,029	16,709	20,020	29,318	37,602
Palm Beach County					
Site-built Homes	53,713	56,910	98,173	140,180	180,178
Mobile/Manuf. Homes	13,632	15,812	18,048	19,143	20,243
Tourists	2,848	3,165	3,940	4,456	5,741
TOTAL	70,193	75,887	120,161	163,779	206,162
St. Lucie County					
Site-built Homes	8,755	15,242	16,309	29,247	36,086
Mobile/Manuf. Homes	6,107	7,029	8,014	8,503	8,984
Tourists	38	365	365	365	611
TOTAL	14,900	22,636	24,688	38,115	45,681

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

	Evacuation Level A Operational Scenario	Evacuation Level B Operational Scenario	Evacuation Level C Operational Scenario	Evacuation Level D Operational Scenario	Evacuation Level E Operational Scenario
Indian River County					
Site-built Homes	11,185	16,783	19,857	28,147	32,936
Mobile/Manuf. Homes	3,501	4,018	4,578	4,844	5,081
Tourists	499	817	844	906	906
TOTAL	15,185	21,618	25,279	33,897	38,923
Martin County					
Site-built Homes	7,568	11,807	14,436	23,987	31,854
Mobile/Manuf. Homes	4,764	5,533	6,314	6,664	7,048
Tourists	164	164	164	255	765
TOTAL	12,496	17,504	20,914	30,906	39,667
Palm Beach County					
Site-built Homes	58,073	61,530	106,143	151,559	194,806
Mobile/Manuf. Homes	14,743	17,100	19,518	20,703	21,893
Tourists	2,848	3,165	3,940	4,456	5,741
TOTAL	75,664	81,795	129,601	176,718	222,440
St. Lucie County					
Site-built Homes	9,845	17,324	18,441	33,359	41,206
Mobile/Manuf. Homes	6,107	7,029	8,014	8,503	8,984
Tourists	38	365	365	365	611
TOTAL	15,990	24,718	26,820	42,227	50,801

Table IV-24 – Shelter Demand by Operational Scenario

	Evacuation Level A Operational Scenario	Evacuation Level B Operational Scenario	Evacuation Level C Operational Scenario	Evacuation Level D Operational Scenario	Evacuation Level E Operational Scenario
2010					
Indian River	2,002	2,842	3,254	4,460	5,145
Martin	1,861	2,616	2,973	4,314	5,339
Palm Beach	10,700	11,509	18,324	24,931	31,428
St. Lucie	2,455	3,824	4,168	6,623	7,979
2015					
Indian River	2,096	2,990	3,426	4,721	5,456
Martin	1,926	2,734	3,101	4,553	5,648
Palm Beach	11,548	12,421	19,784	26,923	33,936
St. Lucie	2,653	4,207	4,560	7,382	8,923

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.

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 the two coastal counties on either side of the RPC, in addition to the four counties within the RPC, for a total of six evacuating counties, as identified in Table IV-19.

Table IV-25 – Total Evacuating Vehicles for Operational Scenarios

	Evacuation Level A Operational Scenario	Evacuation Level B Operational Scenario	Evacuation Level C Operational Scenario	Evacuation Level D Operational Scenario	Evacuation Level E Operational Scenario
2010	268,614	317,434	417,723	597,372	801,232
2015	284,561	337,319	444,435	637,015	856,421

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 Treasure Coast Region are identified in **Figures IV-14** through **IV-23** for each of the operational scenarios for 2010 and 2015.

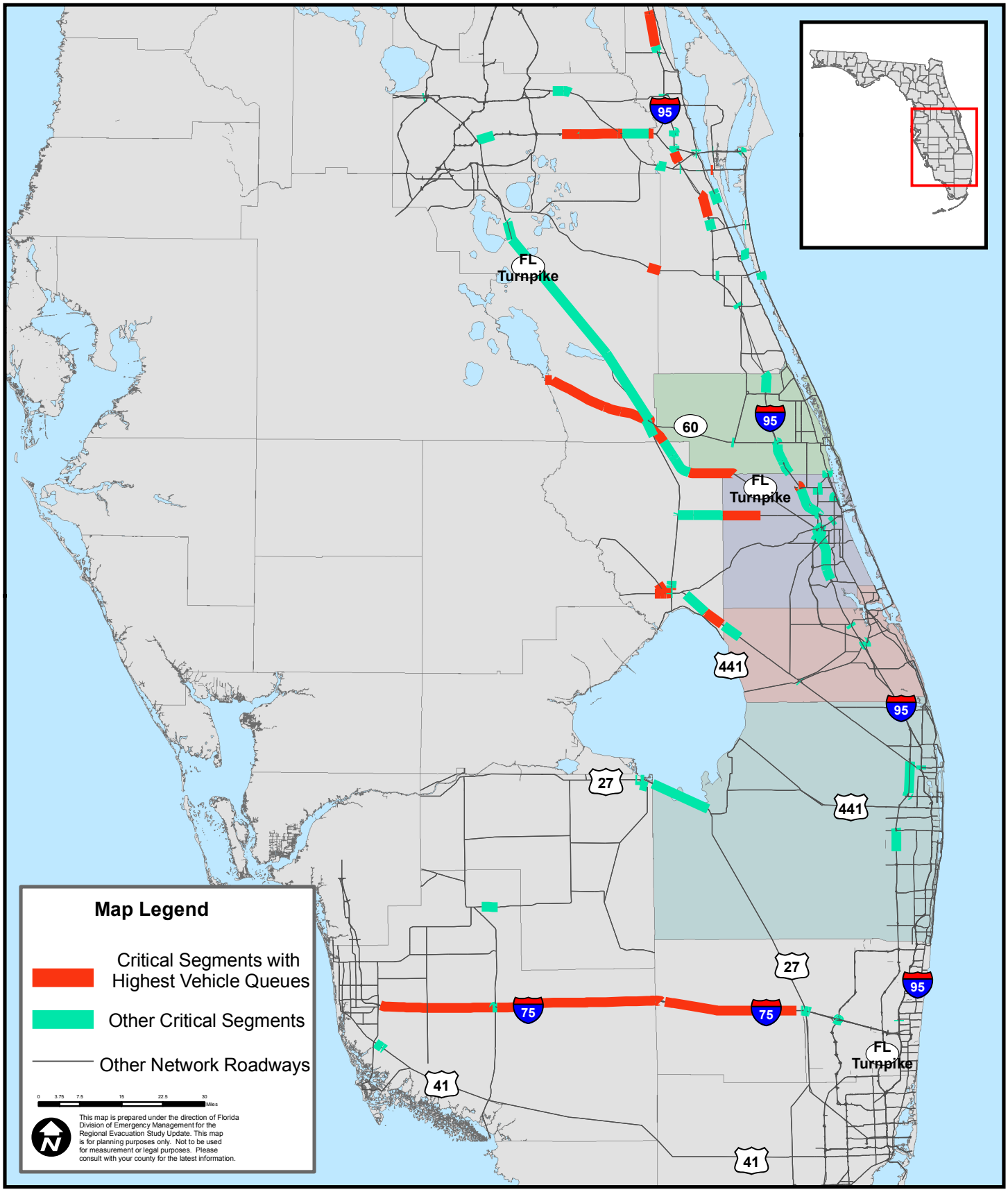
I-95, the Turnpike, and portions of US 441 and SR 60 are critical facilities for the operational scenarios as well. Similar to the base scenarios, during the level A evacuation scenarios the roadway segments with the highest vehicle queues are primarily located outside of the four county region, with the exception of I-95.

Evacuating vehicles exiting each county by major evacuation route are identified in **Table IV-26** for 2010 and **Table IV-27** for 2015. In addition, evacuating vehicles entering each county by major evacuation route are identified in **Table IV-28** for 2010 and **Table IV-29** for 2015. Detailed volume figures for all evacuation routes in the Treasure Coast Region for each operational scenario are included in Volume 5-10.

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 Evacuation Level A

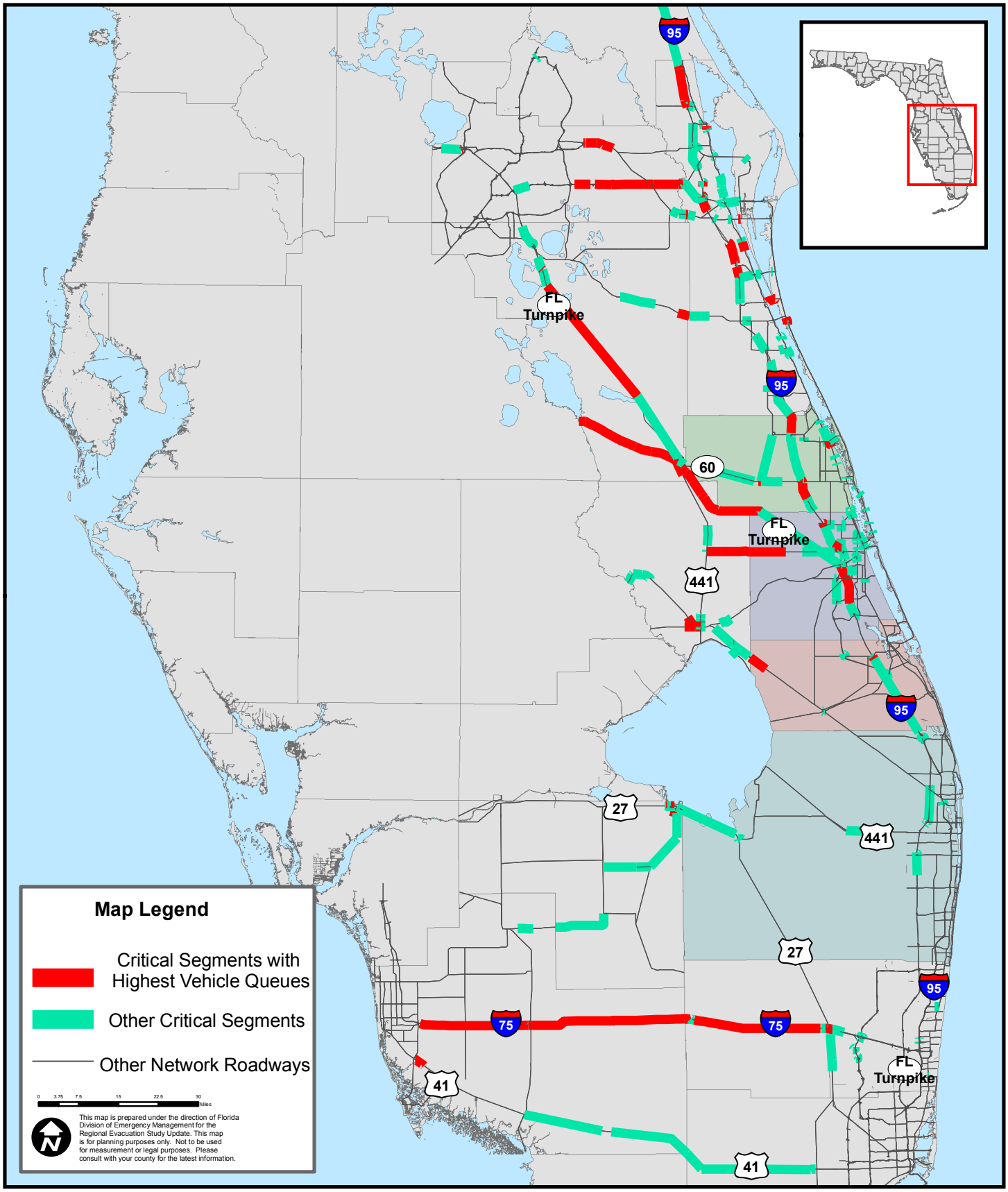


Sources: Treasure Coast Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-15

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

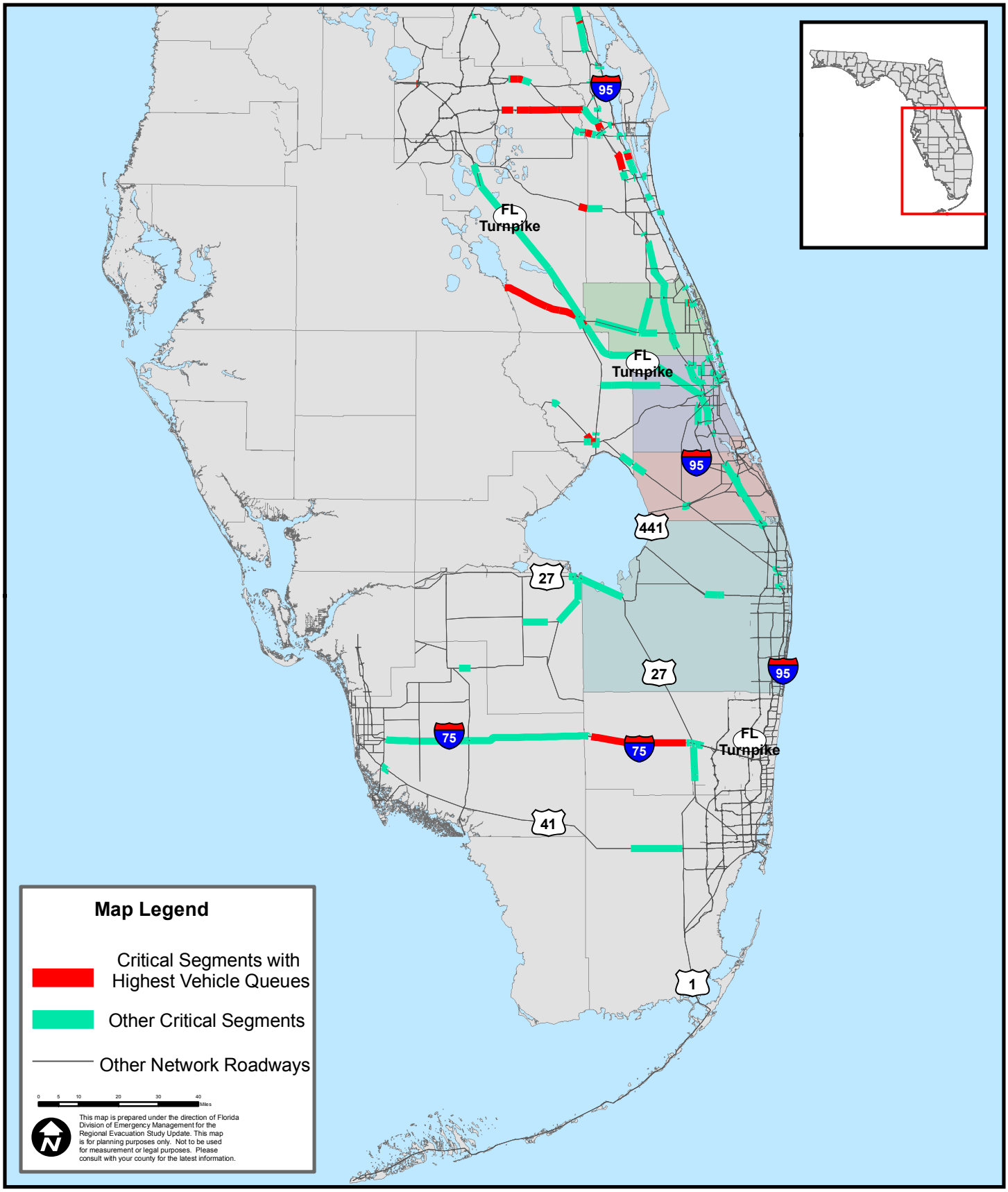


Sources: Treasure Coast Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-16

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

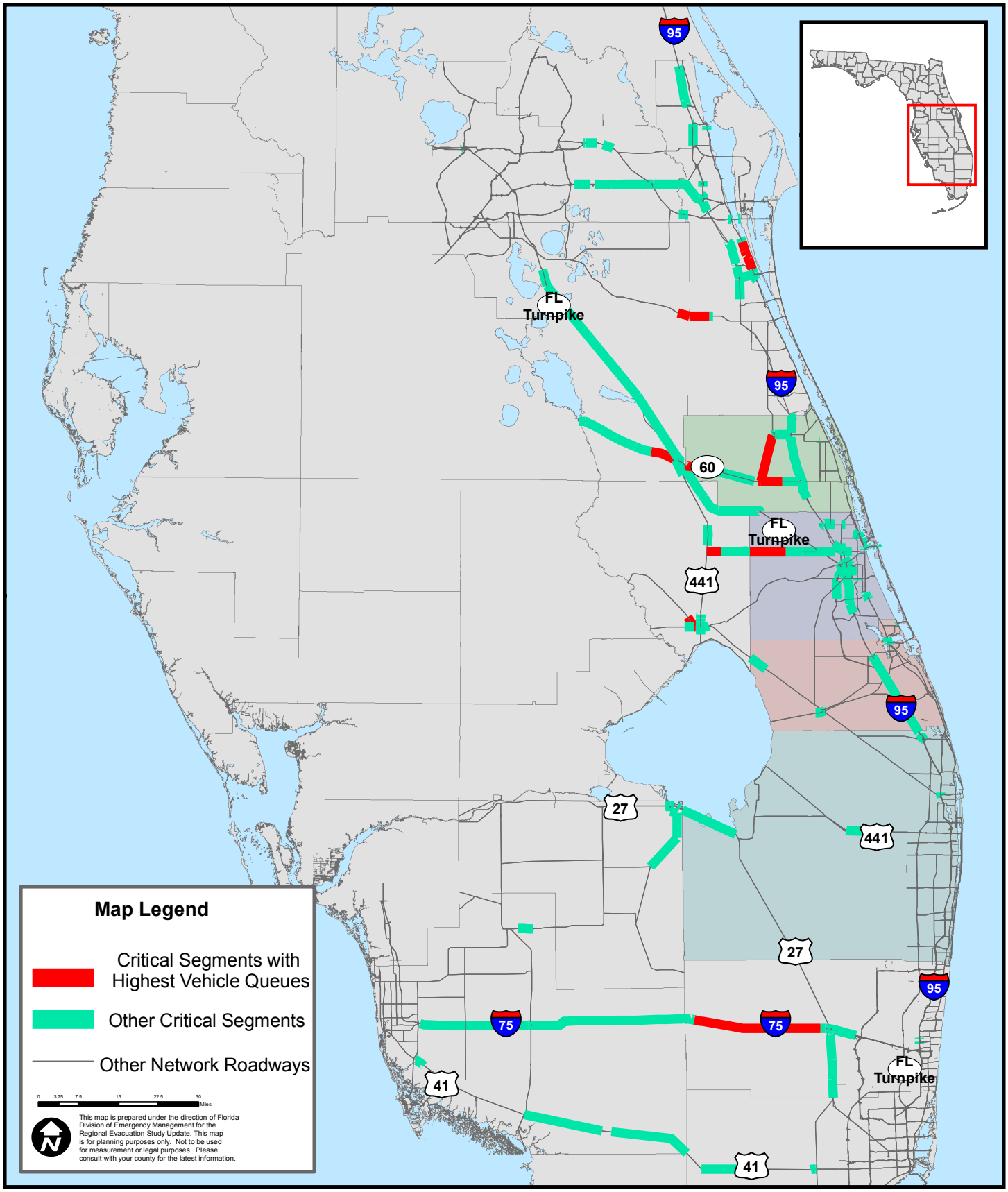


Sources: Treasure Coast Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-17

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

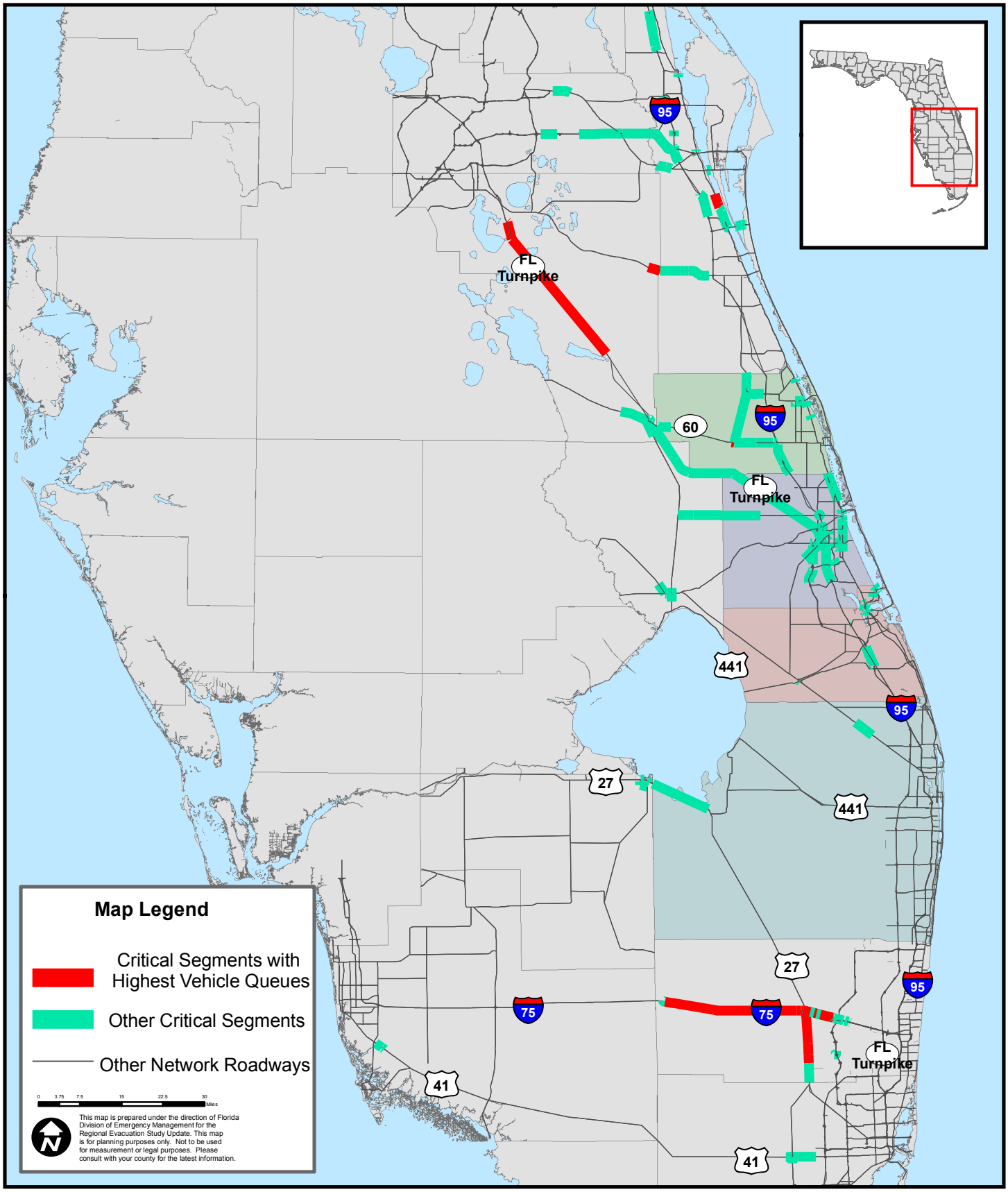


Sources: Treasure Coast Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-18

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

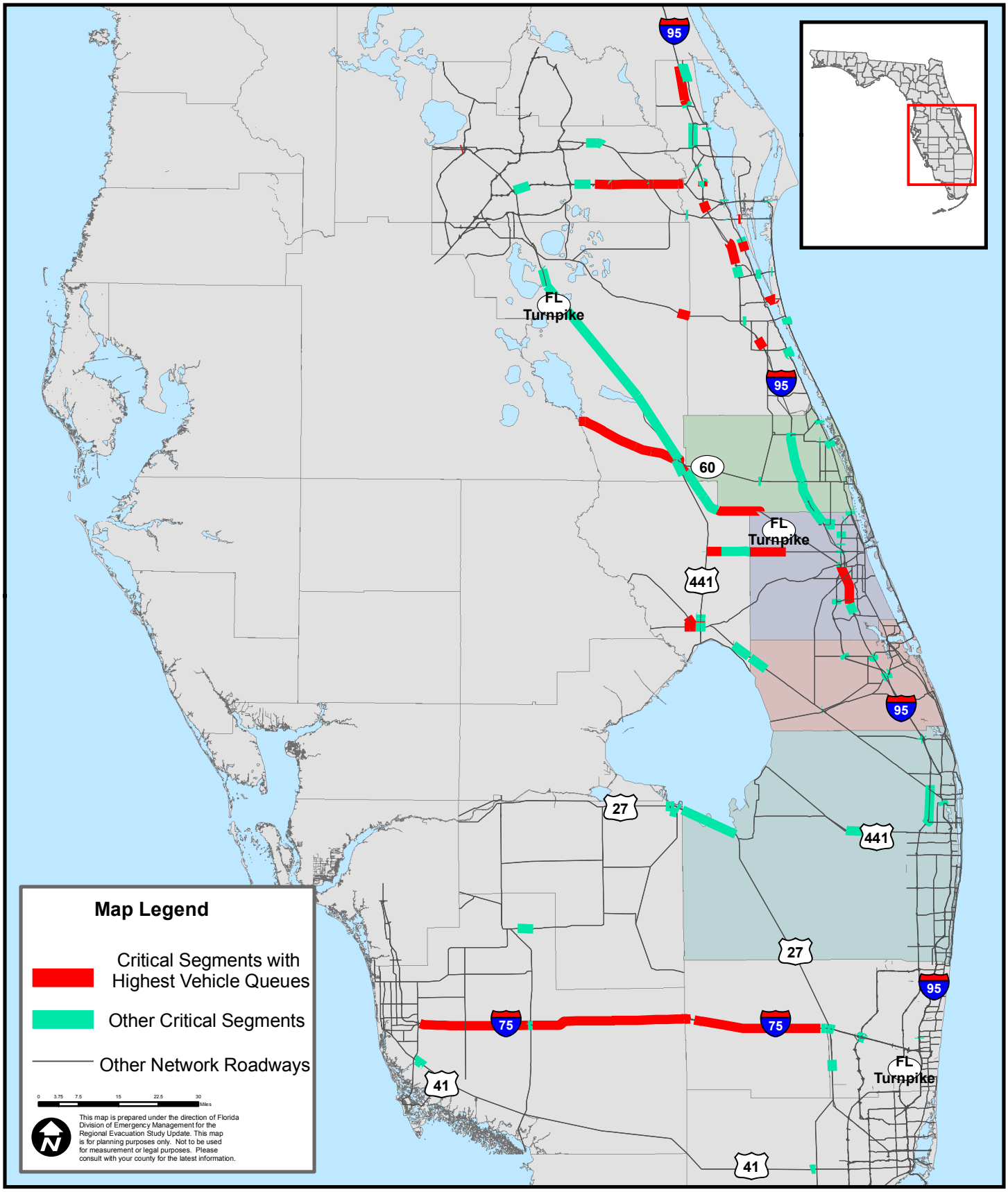


Sources: Treasure Coast Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-19

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

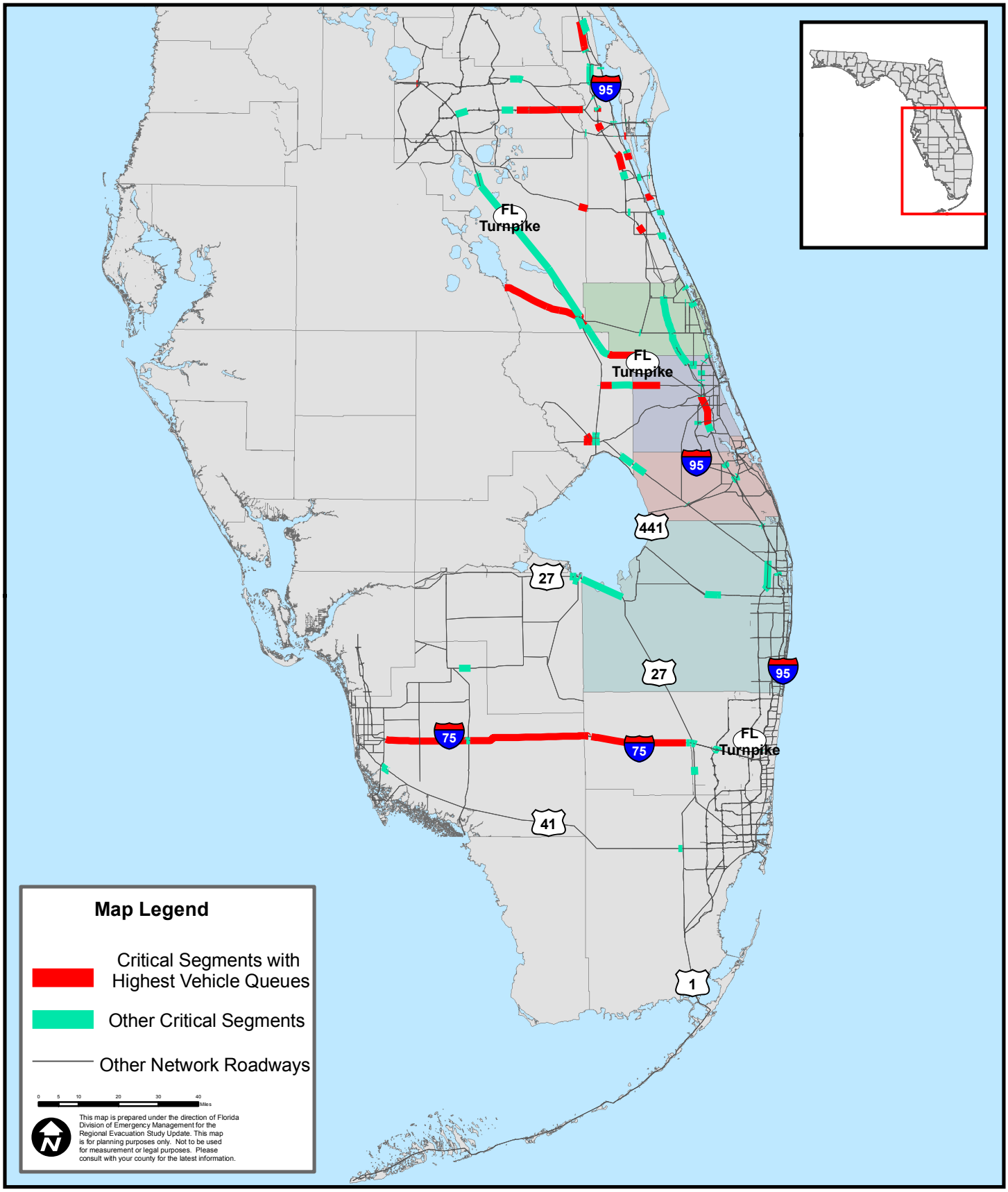


Sources: Treasure Coast Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-20

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

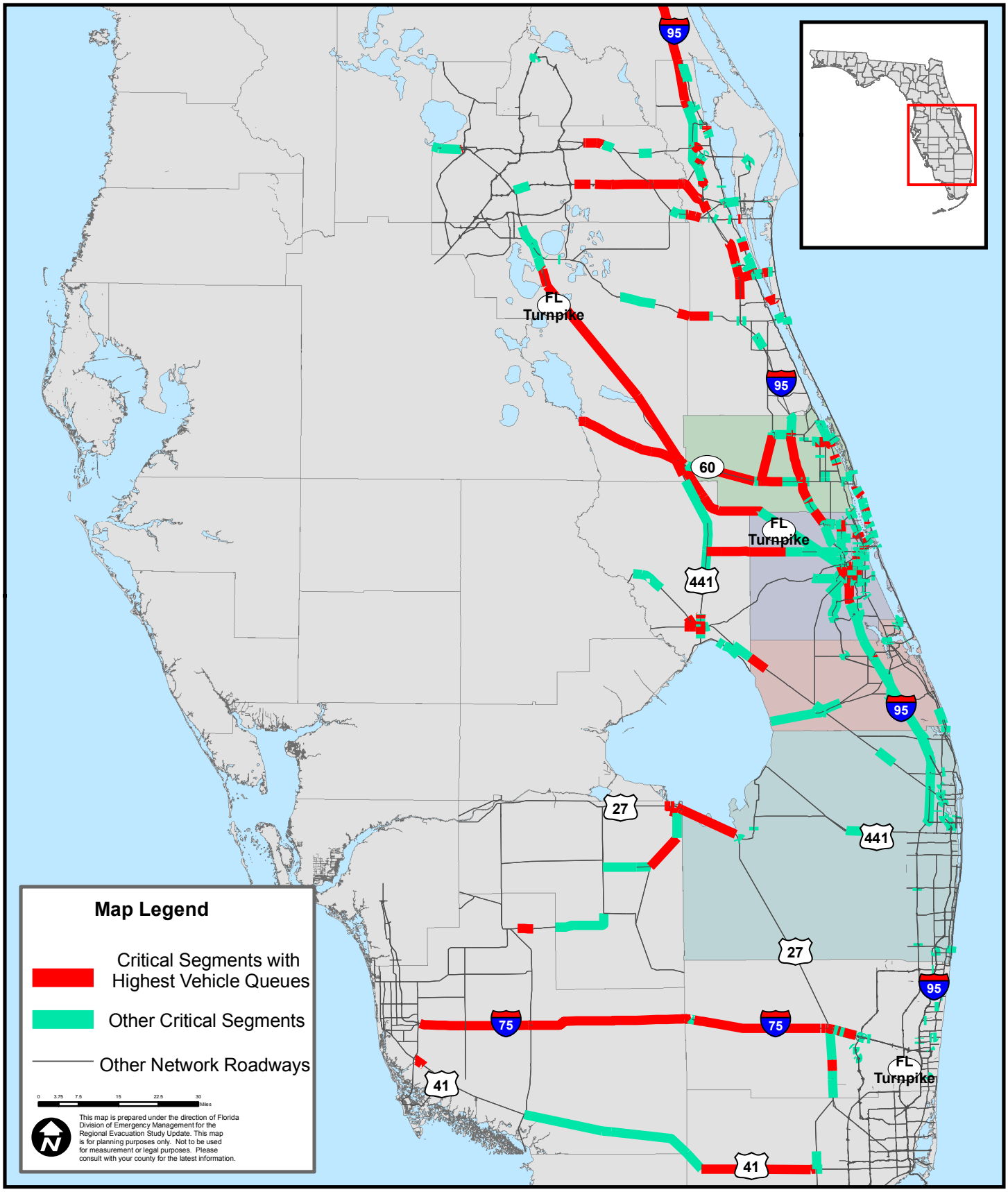


Sources: Treasure Coast Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-21

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

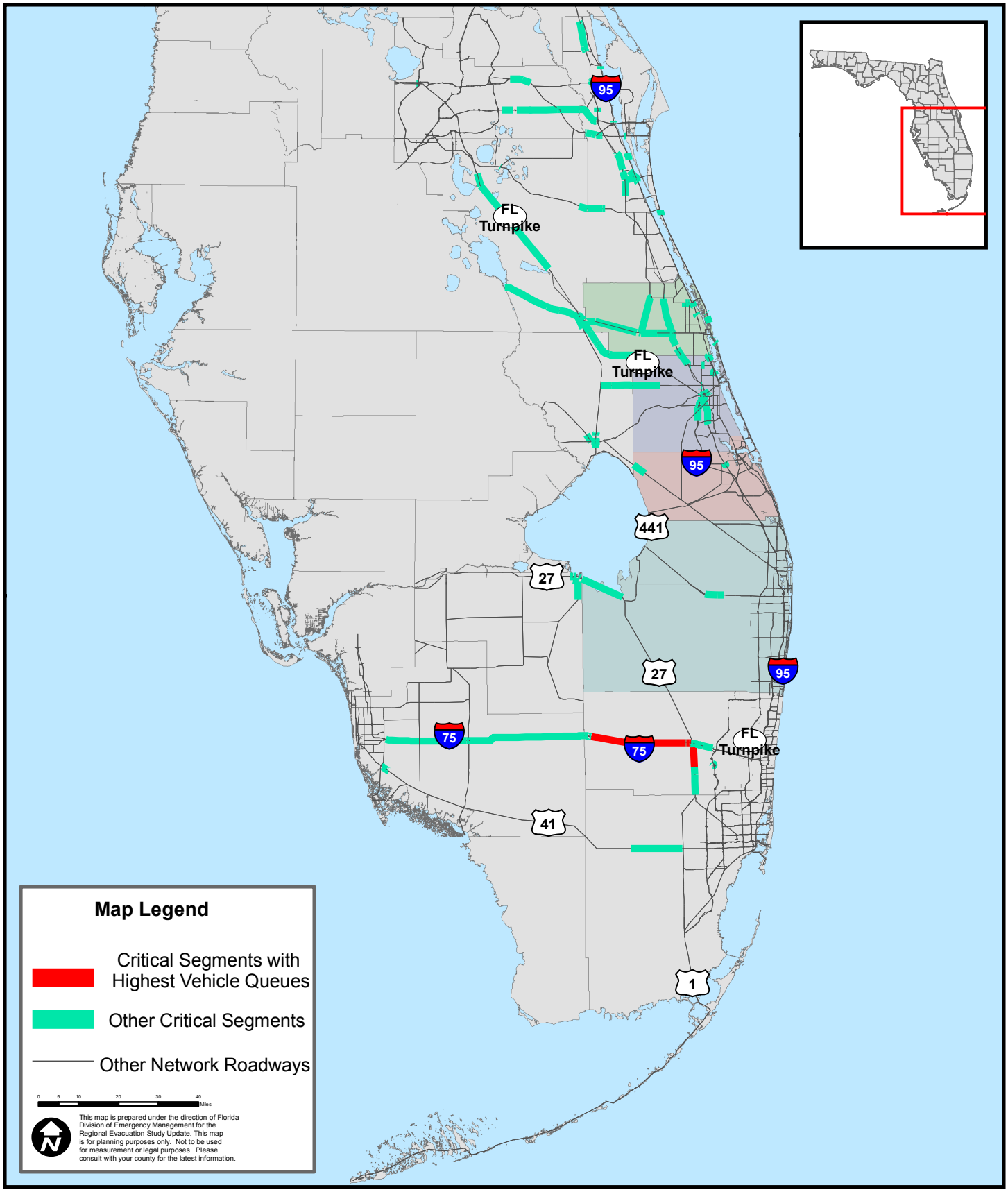


Sources: Treasure Coast Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-22

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

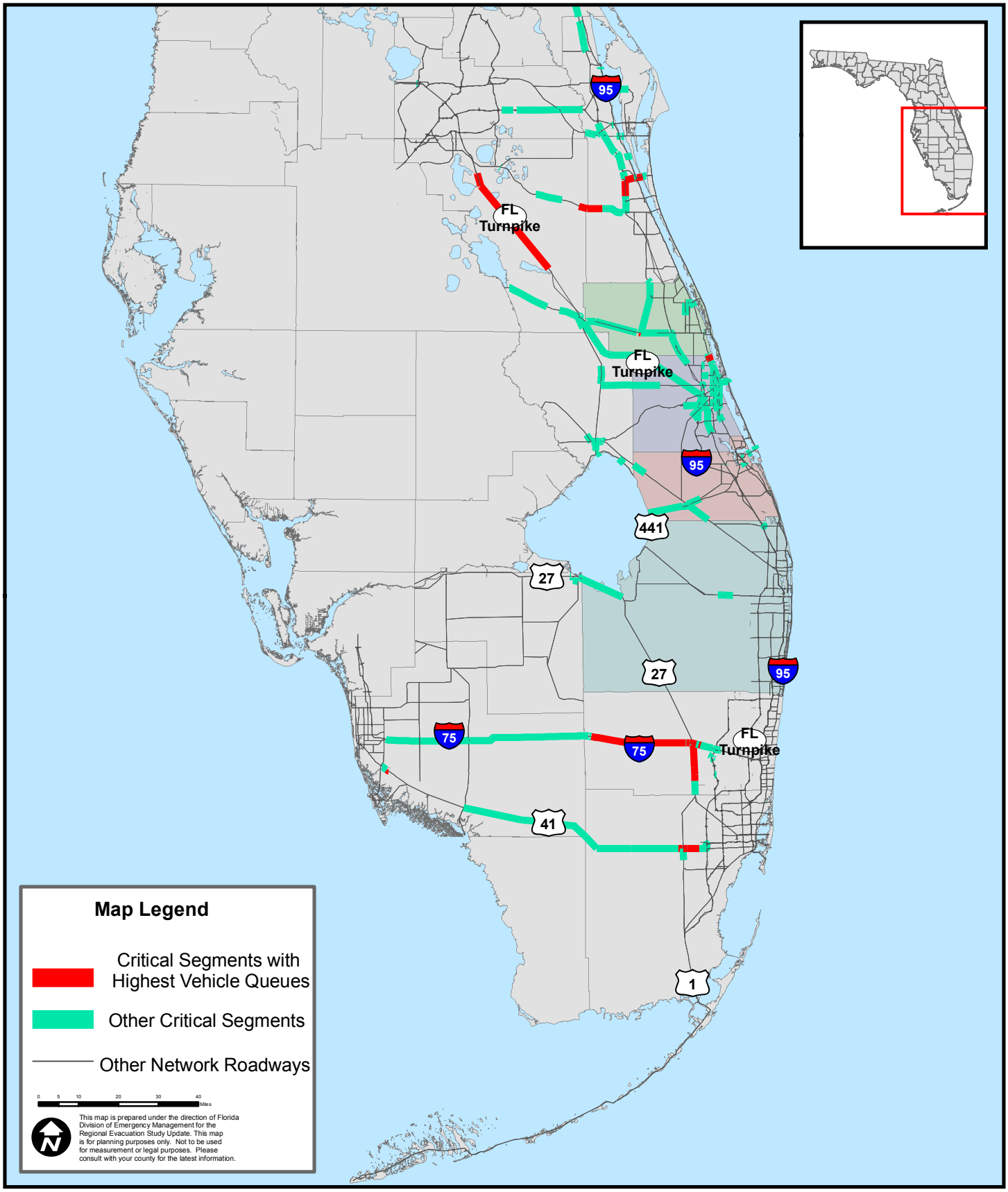


Sources: Treasure Coast Regional Planning Council, Wilbur Smith Associates

Map Printed: November, 2010

Figure IV-23

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



Sources: Treasure Coast 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

	Evacuation Level A Operational Scenario	Evacuation Level B Operational Scenario	Evacuation Level C Operational Scenario	Evacuation Level D Operational Scenario	Evacuation Level E Operational Scenario
Indian River County					
FL Turnpike NB	12,700	14,100	16,100	22,000	36,400
SR 60 Westbound	6,100	7,400	10,000	20,800	25,700
I-95 Northbound	16,900	19,400	28,800	44,200	42,800
US 1 Northbound	3,000	5,300	8,400	11,200	19,400
I-95 Southbound	1,800	2,200	2,900	4,200	6,400
Martin County					
SR 710 Northbound	2,400	2,100	2,200	2,800	3,200
I-95 Northbound	16,900	17,200	27,200	35,900	48,700
FL Turnpike NB	16,300	16,900	20,300	32,400	31,300
US 1 Northbound	1,800	4,400	7,200	13,400	17,700
I-95 Southbound	1,500	2,900	4,400	6,100	10,100
FL Turnpike SB	4,100	4,700	5,400	8,300	8,300
Palm Beach County					
US 1 Northbound	0	100	300	700	1,800
FL Turnpike NB	15,000	15,500	18,900	30,200	28,500
I-95 Northbound	16,400	17,300	27,300	38,500	51,600
SR 710 Northbound	3,800	4,300	5,600	8,600	7,900
US 27 Westbound	4,400	5,700	8,100	11,300	14,000
FL Turnpike SB	3,400	4,500	6,700	10,200	15,800
I-95 Southbound	3,800	4,500	6,500	9,900	14,200
St. Lucie County					
SR 70 Westbound	1,100	1,600	1,700	2,600	3,200
FL Turnpike NB	12,700	14,100	16,100	22,000	36,400
I-95 Northbound	16,500	17,700	25,100	39,600	31,900
US 1 Northbound	3,900	4,600	7,700	12,400	23,000
FL Turnpike SB	4,000	4,600	4,600	6,900	6,400
I-95 Southbound	400	1,500	3,400	4,700	7,000

Table IV-27 – Evacuating Vehicles Leaving Each County by Evacuation Route for the 2015 Operational Scenarios

	Evacuation Level A Operational Scenario	Evacuation Level B Operational Scenario	Evacuation Level C Operational Scenario	Evacuation Level D Operational Scenario	Evacuation Level E Operational Scenario
Indian River County					
FL Turnpike NB	12,800	14,600	16,800	23,600	38,400
SR 60 Westbound	6,200	8,200	11,500	19,100	25,700
I-95 Northbound	18,100	21,400	31,800	47,600	47,400
US 1 Northbound	4,200	5,400	9,000	14,000	18,800
I-95 Southbound	1,800	2,300	3,300	4,300	6,200
Martin County					
SR 710 Northbound	1,900	2,100	2,400	3,000	3,900
I-95 Northbound	18,300	19,600	27,200	40,700	52,600
FL Turnpike NB	16,900	17,000	21,300	31,500	27,500
US 1 Northbound	1,900	3,900	7,600	13,300	21,900
I-95 Southbound	1,700	3,300	5,400	7,000	10,700
FL Turnpike SB	4,300	4,800	5,000	8,600	9,000
Palm Beach County					
US 1 Northbound	200	300	5,000	9,000	11,700
FL Turnpike NB	15,800	15,300	19,900	28,300	31,500
I-95 Northbound	17,400	19,300	27,700	42,400	55,000
SR 710 Northbound	4,000	4,900	5,200	7,000	8,700
US 27 Westbound	5,000	6,300	8,600	12,600	15,500
FL Turnpike SB	3,800	5,000	7,800	13,000	19,400
I-95 Southbound	4,200	3,000	7,900	11,500	14,800
St. Lucie County					
SR 70 Westbound	1,100	1,800	1,800	2,600	3,700
FL Turnpike NB	12,800	14,600	16,800	23,600	38,400
I-95 Northbound	15,700	18,200	25,200	39,900	27,600
US 1 Northbound	4,300	5,100	9,300	12,600	32,100
FL Turnpike SB	4,200	4,600	4,300	7,000	5,100
I-95 Southbound	500	2,000	4,200	5,800	8,600

Table IV-28 – Evacuating Vehicles Entering Each County by Evacuation Route for the 2010 Operational Scenarios

	Evacuation Level A Operational Scenario	Evacuation Level B Operational Scenario	Evacuation Level C Operational Scenario	Evacuation Level D Operational Scenario	Evacuation Level E Operational Scenario
Indian River County					
FL Turnpike NB	12,700	14,100	16,100	22,000	36,400
I-95 Northbound	16,500	17,700	25,100	39,600	31,900
US 1 Northbound	3,900	4,600	7,700	12,400	23,000
Martin County					
US 1 Northbound	0	100	300	700	1,800
FL Turnpike NB	15,000	15,500	18,900	30,200	28,500
I-95 Northbound	16,400	17,300	27,300	38,500	51,600
SR 710 Northbound	3,800	4,300	5,600	8,600	7,900
FL Turnpike SB	4,000	4,600	4,600	6,900	6,400
I-95 Southbound	400	1,500	3,400	4,700	7,000
Palm Beach County					
I-95 Southbound	1,500	2,900	4,400	6,100	10,100
FL Turnpike SB	4,100	4,700	5,400	8,300	8,300
US 27 Northbound	3,400	4,000	5,600	8,000	10,400
I-95 Northbound	6,400	7,600	11,300	18,800	20,800
FL Turnpike NB	10,600	11,100	13,200	23,500	32,000
St. Lucie County					
I-95 Southbound	1,800	2,200	2,900	4,200	6,400
I-95 Northbound	16,900	17,200	27,200	35,900	48,700
FL Turnpike NB	16,300	16,900	20,300	32,400	31,300
US 1 Northbound	1,800	4,400	7,200	13,400	17,700

Table IV-29 – Evacuating Vehicles Entering Each County by Evacuation Route for the 2015 Operational Scenarios

	Evacuation Level A Operational Scenario	Evacuation Level B Operational Scenario	Evacuation Level C Operational Scenario	Evacuation Level D Operational Scenario	Evacuation Level E Operational Scenario
Indian River County					
FL Turnpike NB	12,800	14,600	16,800	23,600	38,400
I-95 Northbound	15,700	18,200	25,200	39,900	27,600
US 1 Northbound	4,300	5,100	9,300	12,600	32,100
Martin County					
US 1 Northbound	200	300	5,000	9,000	11,700
FL Turnpike NB	15,800	15,300	19,900	28,300	31,500
I-95 Northbound	17,400	19,300	27,700	42,400	55,000
SR 710 Northbound	4,000	4,900	5,200	7,000	8,700
FL Turnpike SB	4,200	4,600	4,300	7,000	5,100
I-95 Southbound	500	2,000	4,200	5,800	8,600
Palm Beach County					
I-95 Southbound	1,700	3,300	5,400	7,000	10,700
FL Turnpike SB	4,300	4,800	5,000	8,600	9,000
US 27 Northbound	3,700	4,100	5,800	8,300	11,100
I-95 Northbound	6,300	7,500	10,100	16,700	20,700
FL Turnpike NB	11,300	12,000	15,400	27,000	33,800
St. Lucie County					
I-95 Southbound	1,800	2,300	3,300	4,300	6,200
I-95 Northbound	18,300	19,600	27,200	40,700	52,600
FL Turnpike NB	16,900	17,000	21,300	31,500	27,500
US 1 Northbound	1,900	3,900	7,600	13,300	21,900

Clearance Times

Clearance times for each of the operational scenarios are summarized in **Table IV-30** and **IV-31**, as well as **Figures IV-24, IV-25,** and **IV-26**. 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 7 hours to 31.5 hours depending upon the scenario. Clearance times to shelter for the operational scenarios range from 6.5 hours to 28.5 hours depending upon the county and the scenario.

In 2015, in-county clearance times for the operational scenarios vary from 7 hours to 31 hours for the level E evacuation in Palm Beach County. Clearance times to shelter for the 2015 operational scenarios range from 6 hours to 20.5 hours depending upon the scenario.

Out of county clearance times for the 2010 operational scenarios range from 8 hours to 32 hours for the evacuation level E scenario. Out of county clearance times are similar for all counties in 2015 and fall between 8 and 31 hours depending upon the scenario. Regional clearance time for the four county TCRPC region ranges from 9 hours to 32 hours in 2010 and from 9 to 31 hours in 2015.

Table IV-30 – 2010 Clearance Times for Operational Scenarios

	Evacuation Level A Operational Scenario	Evacuation Level B Operational Scenario	Evacuation Level C Operational Scenario	Evacuation Level D Operational Scenario	Evacuation Level E Operational Scenario
Clearance Time to Shelter					
Indian River	6.5	6.5	7.0	10.5	13.0
Martin	6.5	6.5	7.5	11.0	14.5
Palm Beach	7.0	7.0	8.5	13.0	28.5
St. Lucie	6.5	6.5	6.5	12.0	12.0
In-County Clearance Time					
Indian River	7.5	9.5	12.5	16.5	26.5
Martin	7.5	7.5	8.0	12.5	26.5
Palm Beach	8.0	8.0	10.0	16.0	31.5
St. Lucie	7.0	8.0	10.5	15.5	25.0
Out of County Clearance Time					
Indian River	9.0	9.5	13.5	20.0	26.5
Martin	8.0	8.0	8.0	12.5	26.5
Palm Beach	8.0	8.0	10.0	16.0	32.0
St. Lucie	8.5	8.5	11.5	17.0	25.0
Regional Clearance Time					
Treasure Coast	9.0	9.5	13.5	20.0	32.0

Table IV-31 – 2015 Clearance Times for Operational Scenarios

	Evacuation Level A Operational Scenario	Evacuation Level B Operational Scenario	Evacuation Level C Operational Scenario	Evacuation Level D Operational Scenario	Evacuation Level E Operational Scenario
Clearance Time to Shelter					
Indian River	6.5	6.5	7.0	11.0	12.0
Martin	6.5	7.0	7.5	11.5	14.5
Palm Beach	7.5	7.5	10.5	21.0	20.5
St. Lucie	6.0	6.5	6.5	12.0	16.0
In-County Clearance Time					
Indian River	8.0	9.5	12.5	19.5	27.5
Martin	7.5	7.5	8.5	13.0	20.5
Palm Beach	8.0	8.0	11.0	21.5	31.0
St. Lucie	7.0	8.0	11.5	16.5	26.0
Out of County Clearance Time					
Indian River	9.0	10.5	13.0	19.5	27.5
Martin	8.0	7.5	8.5	13.0	21.0
Palm Beach	8.5	8.5	11.0	21.5	31.0
St. Lucie	8.0	8.5	12.0	17.5	26.0
Regional Clearance Time					
Treasure Coast	9.0	10.5	13.0	21.5	31.0

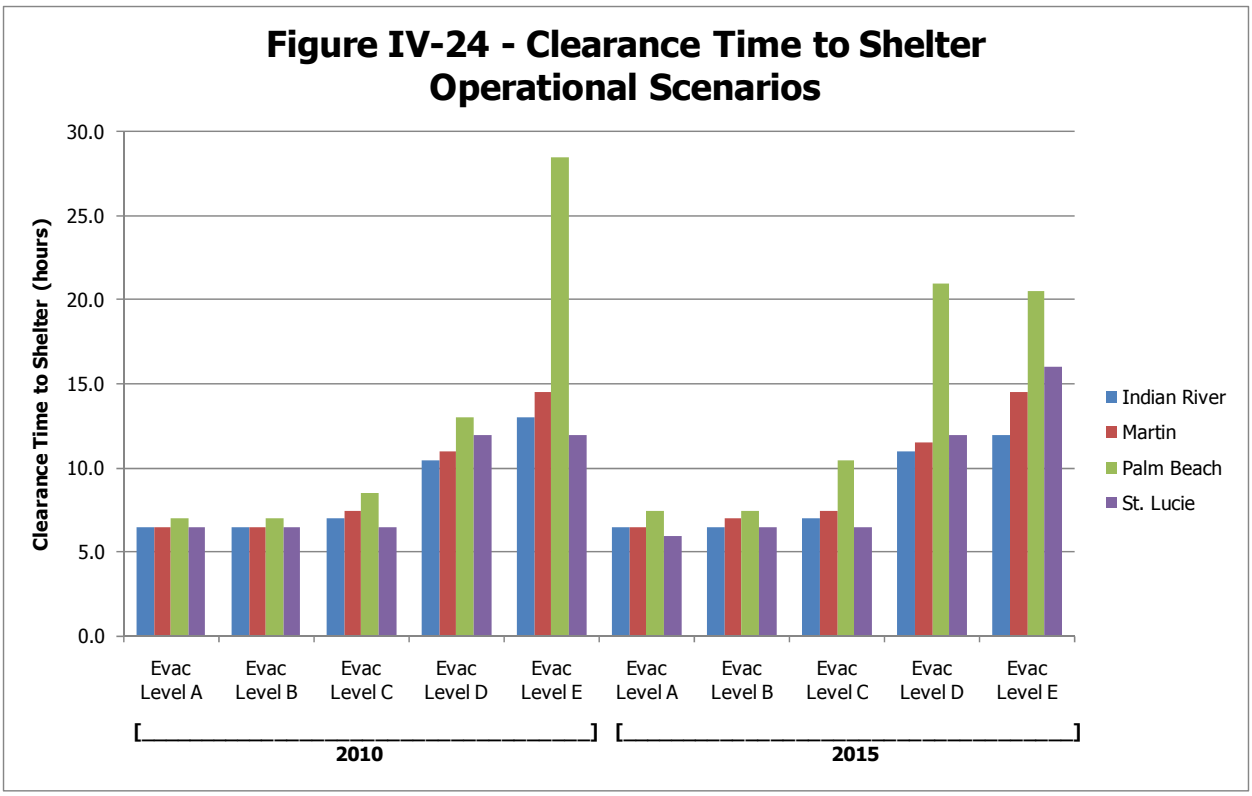


Figure IV-24 - Clearance Time to Shelter
Operational Scenarios
Clearance Time to Shelter (hours)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Evac Level A
Evac Level B
Evac Level C
Evac Level D
Evac Level E
Evac Level A
Evac Level B
Evac Level C
Evac Level D
Evac Level E
2010
2015
Indian River
Martin
Palm Beach
St. Lucie

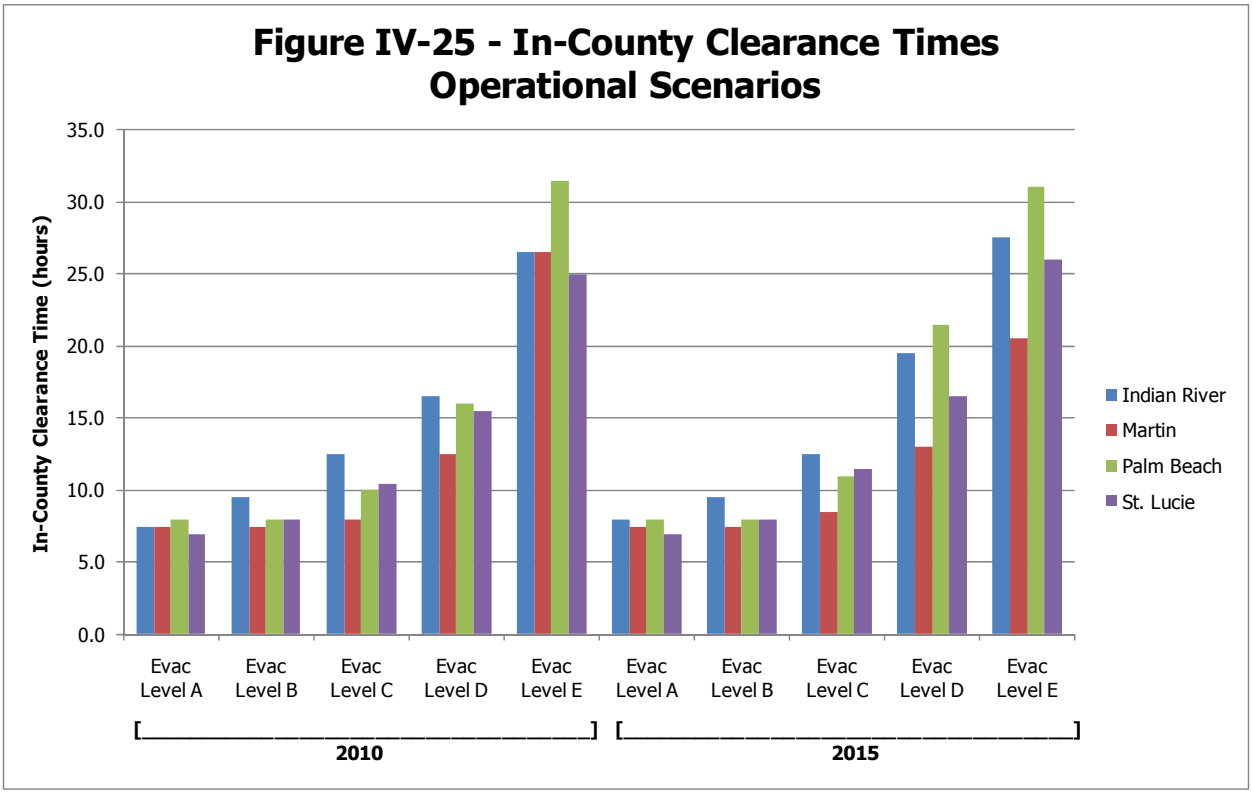


Figure IV-25 - In-County Clearance Times
Operational Scenarios
In-County Clearance Time (hours)
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Evac Level A
Evac Level B
Evac Level C
Evac Level D
Evac Level E
Evac Level A
Evac Level B
Evac Level C
Evac Level D
Evac Level E
2010
2015
Indian River
Martin
Palm Beach
St. Lucie

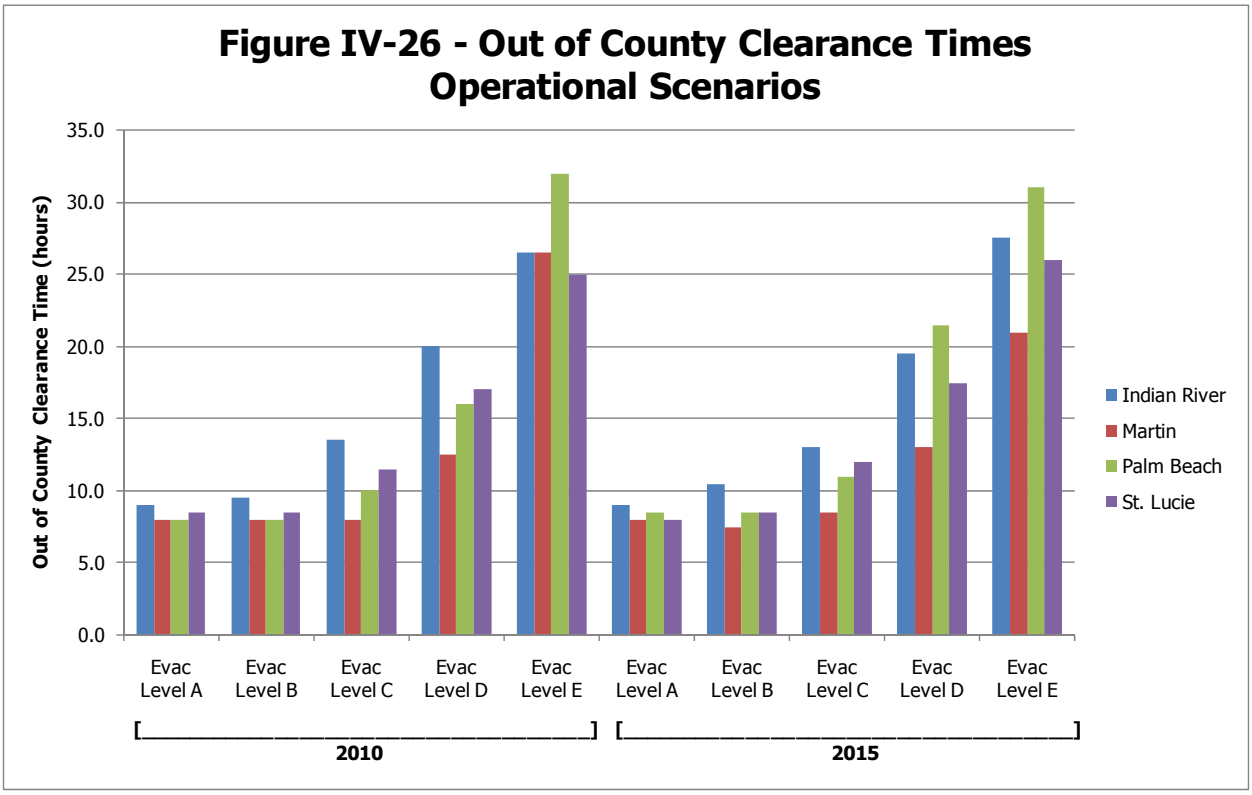


Figure IV-26 - Out of County Clearance Times
Operational Scenarios
Out of County Clearance Time (hours)
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Evac Level A
Evac Level B
Evac Level C
Evac Level D
Evac Level E
Evac Level A
Evac Level B
Evac Level C
Evac Level D
Evac Level E
2010
2015
Indian River
Martin
Palm Beach
St. Lucie

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-31** and for 2015 in **Table IV-32**.

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-32 – 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 Indian River County					
12-Hour	35,690	51,118	47,322	45,366	33,492
18-Hour	43,125	61,768	63,096	68,049	50,239
24-Hour				73,720	66,985
36-Hour					78,149
Estimated Evacuating Population Clearing Martin County					
12-Hour	25,642	32,774	38,807	47,615	44,695
18-Hour	29,916	38,236	45,275	63,486	67,042
24-Hour					85,665
36-Hour					
Estimated Evacuating Population Clearing Palm Beach County					
12-Hour	154,704	160,289	232,077	244,557	201,367
18-Hour	186,934	193,682	280,426	356,645	302,051
24-Hour					402,734
36-Hour					444,686
Estimated Evacuating Population Clearing St. Lucie County					
12-Hour	33,197	44,600	46,544	53,687	46,529
18-Hour	38,730	53,892	56,241	80,531	69,793
24-Hour				82,768	93,058
36-Hour					96,935

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.

Table IV-33 – 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 Indian River County					
12-Hour	37,558	52,358	50,159	48,208	24,328
18-Hour	45,383	65,447	66,878	72,312	36,491
24-Hour				78,338	48,655
36-Hour					72,983
Estimated Evacuating Population Clearing Martin County					
12-Hour	26,541	34,245	40,508	50,125	47,084
18-Hour	30,964	39,952	47,259	66,833	70,626
24-Hour					90,244
36-Hour					
Estimated Evacuating Population Clearing Palm Beach County					
12-Hour	166,981	179,163	250,524	271,808	217,408
18-Hour	201,769	209,023	302,717	385,061	326,112
24-Hour					434,817
36-Hour					480,110
Estimated Evacuating Population Clearing St. Lucie County					
12-Hour	34,145	48,539	50,590	66,909	38,248
18-Hour	41,259	58,651	61,129	92,000	57,372
24-Hour					76,496
36-Hour					108,370

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.

- 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 Treasure Coast 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 20 different scenarios (10 base and 10 operational), several conclusions could be reached regarding the transportation analysis, including the following:

- Critical transportation facilities within the TCRPC region include I-95, the Turnpike, SR 60, and portions of US 441 and SR 710 for all evacuation scenarios. For large storm events, such as level D and E evacuations, other State facilities also play an important role in evacuations, such as SR 76 in Martin County and SR 68 in St. Lucie 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;

- TCRPC counties should continue their coordination efforts with the State on public information campaigns to clearly define those that are vulnerable and should evacuate versus those who choose to evacuate on their own.

- 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 5-10) 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 Treasure Coast 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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