# Volume 1-10
# Treasure Coast Region
# Technical Data Report

## CHAPTER VI

## Regional Transportation Analysis
## 2016 Update

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# Chapter VI
# Regional Evacuation Transportation Analysis

The evacuation transportation analysis discussed in this Chapter and in Volume IV 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 most effective and efficient manner 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, facilitate knowledge sharing between state, regional, county, and local partners. To achieve this objective, it is important for Florida's eleven 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 Regional Planning Councils.

## B. Study Area

This 2015 study includes significant updates and revisions in comparison to the 2010 SRESP initial data release for the Treasure Coast Region. The study area for this analysis includes the four counties of the Treasure Coast Regional Planning Council (TCRPC) region (Indian River, Martin, Palm Beach, and St. Lucie Counties). 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 TCRPC Region. 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 (FDEM), Department of Transportation, Economic Opportunity (formerly the Department of Community Affairs), and local county emergency management teams with CDM Smith serving as the transportation consultant. From 2008 to 2010, CDM Smith conducted a series of four regional meetings at the local level 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 in the Treasure Coast Region.

During the development of this Study update, completed in 2015, three meetings were held at the local and regional level to receive updated input from local county emergency management and the regional planning council. In addition, several conference calls and one webinar were also conducted as were necessary to clarify direction from the region's emergency management officials. The three meetings held in the Treasure Coast region included the following:

**Initial Regional Meeting: Operational Scenario Development**
The first regional meeting for the Treasure Coast region was held on April 2, 2015 at 10:00 AM. The purpose of the scenario development update meeting was to review the Treasure Coast region demographic updated data and discuss the operational scenarios to be evaluated for emergency management purposes in the upcoming modeling.

**2nd Regional Meeting: Transportation Analysis Update Meeting**
The second regional meeting for the Treasure Coast region was held on August 26, 2015 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 report.

**3rd Regional Meeting: Transportation Analysis Update Meeting**
The third and final regional meeting for the Treasure Coast region was held on September 16, 2015 at 1:30 PM. The purpose of the transportation analysis meeting was to review the revised draft results of the transportation analysis and receive any additional feedback on the draft final report.

# D. Study Comparisons

It is important to note that this study (2015) contains significant updates and revisions in comparison to the 2010 SRESP study for the Treasure Coast Regional Planning Council (TCRPC) region. These revisions include updates to population projections based on the 2010 census, new evacuation zones based on updated topography data, modifications to the roadway network due to recently completed and planned construction projects, and changes to the location and size of available shelters. These revisions have significant impacts on evacuating vehicle behavior for the region and caused changes to the calculated clearance times in each county. These updates and revisions make comparisons to the previous 2010 study difficult.

# E. 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 Region Evacuation Transportation Analysis is identical to the methodology used for all eleven Regional Planning Councils and is summarized in the following sections. Each portion of the methodology is explained in greater detail in Volume 4: Evacuation Transportation Analysis.

## 1. Behavioral Assumptions

In 2008, the SRESP commissioned a survey of Florida residents in each county. 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.

## 2. 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 contains 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 8,829 zones within the State of Florida and 627 located outside the State. This number provides sufficient detail to accurately accommodate the assignment of evacuation trips onto an evacuation network.

## 3. 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.

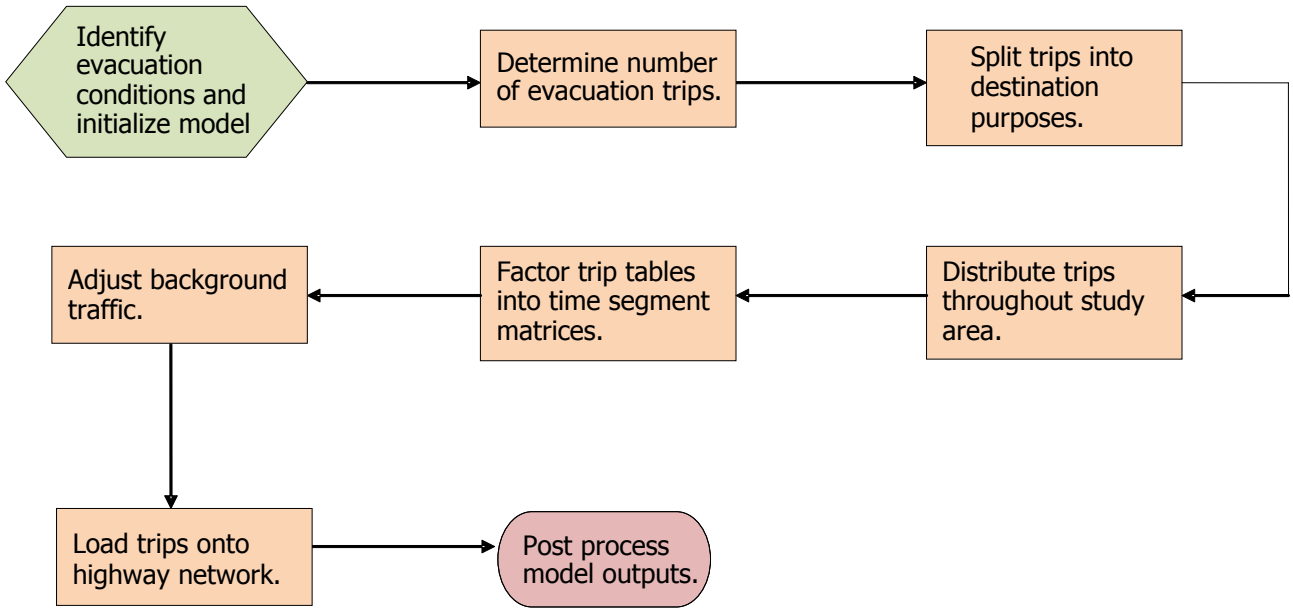
The second group of traffic is known as background traffic. Background traffic, as its name implies, is not the primary focus of an evacuation transportation analysis and is accounted for primarily to impede the movement of evacuation trips through the network. These trips represent individuals going about their daily business not engaged in 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.

## 4. 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 VI-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 VI-1 - General Model Flow**




## 5. 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.

## 6. 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, use of survey rates, 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.

# F. 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:

## 1. 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 TCRPC 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 (the latest model available) was used as a basis for developing the regional model network, while the evacuation routes were obtained from the TCRPC. The TCRPC 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 2010 conditions and is referred to as the base model network. **Figure VI-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, Transportation Supplemental Data Support 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.

## 2. 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 VI-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.

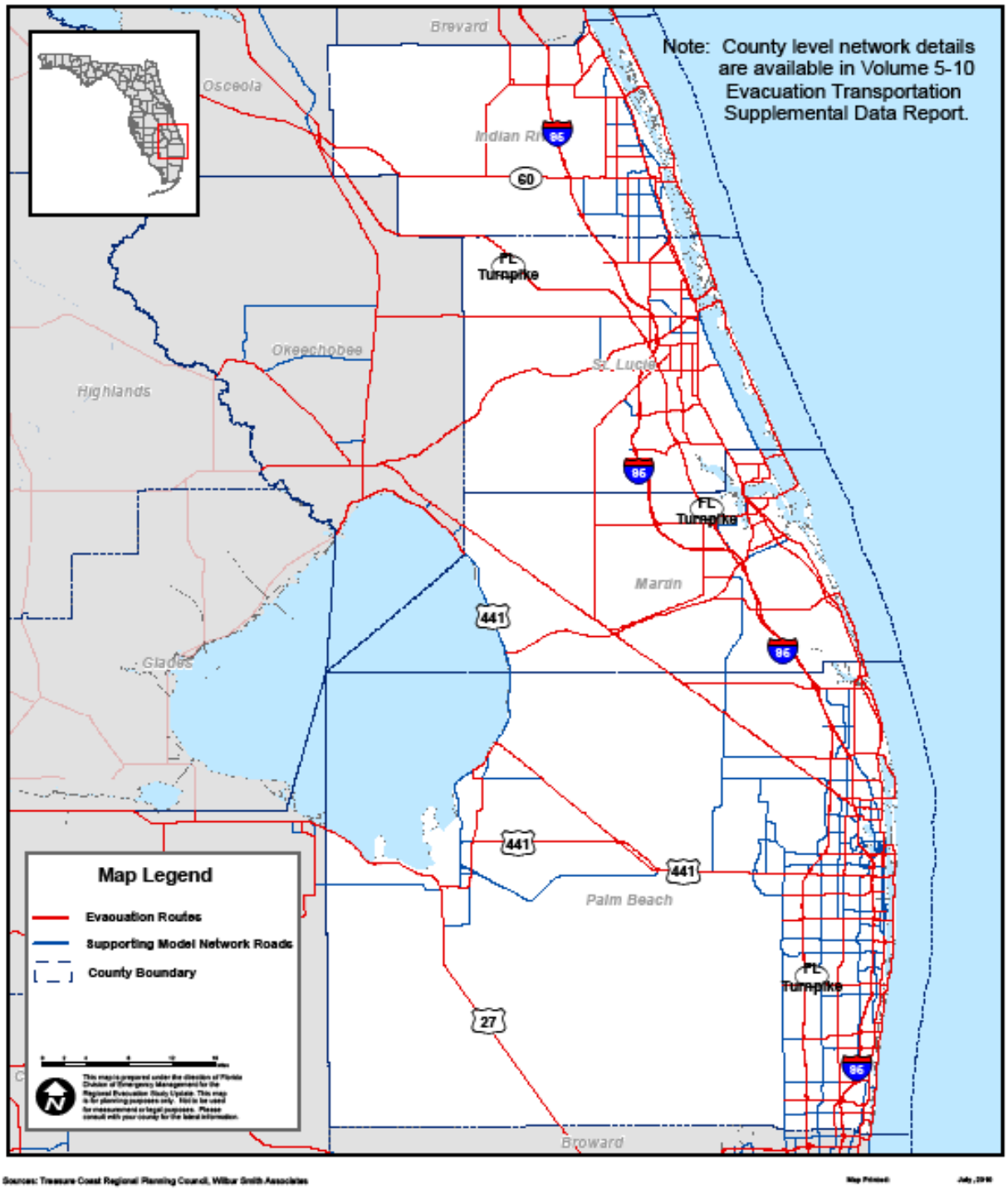
## 3. Regional Demographic Characteristics

Demographic data were developed for the following years: 2010, 2015, and 2020. A snapshot of the key demographic data for each county in the TCRPC region for 2010,

2015 and 2020 is summarized in **Table VI-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 VI-2**

**Treasure Coast Regional Model Network**

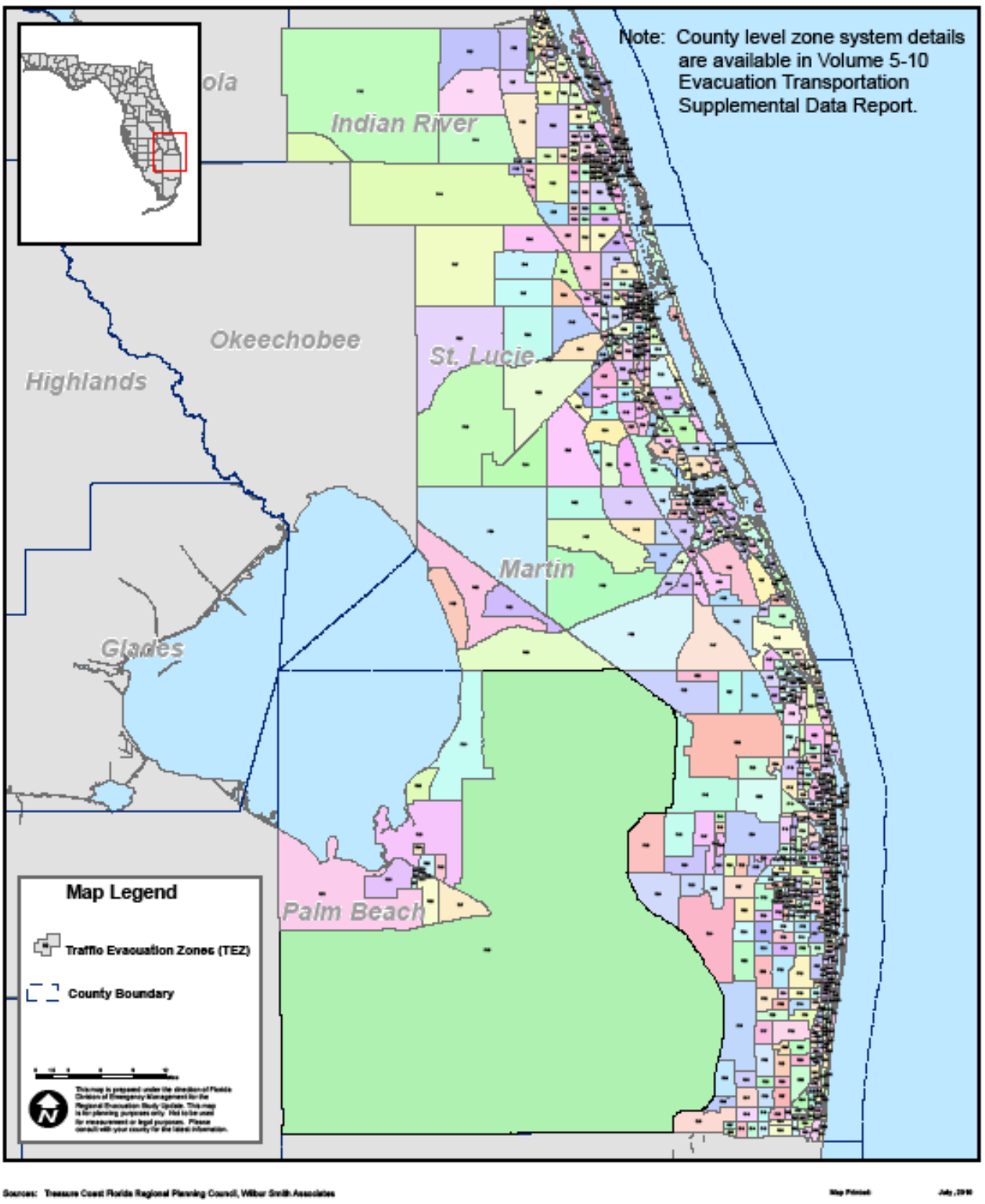



Sources: Treasure Coast Regional Planning Council, Wilbur Smith Associates

**Figure VI-3**

**FIGURE VI-3**

Treasure Coast Regional Model Transportation Evacuation (TEZ) Zone System




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

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 300,000 people by 2020. Indian River and Martin Counties have the smallest populations in the region; however, both are expected to reach more than 150,000 in 2020. 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.

**Table VI-1 – Treasure Coast Demographic Characteristic Summary**

| County | Characteristic | Year | | |
|---|---|---|---|---|
| | | 2010 | 2015 | 2020 |
| Indian River | Occupied site-built homes | 55,843 | 60,092 | 64,629 |
| | Population in site-built homes | 127,987 | 140,442 | 151,295 |
| | Occupied mobile homes | 4,333 | 3,687 | 3,688 |
| | Population in mobile home | 8,247 | 6,600 | 6,599 |
| | Hotel/motel units | 3,185 | 3,186 | 3,193 |
| Martin | Occupied site-built homes | 58,006 | 58,497 | 62,078 |
| | Population in site-built homes | 130,718 | 133,773 | 142,076 |
| | Occupied mobile homes | 5,893 | 5,658 | 5,667 |
| | Population in mobile home | 11,667 | 12,166 | 12,226 |
| | Hotel/motel units | 1,834 | 1,871 | 1,911 |
| Palm Beach | Occupied site-built homes | 528,454 | 541,996 | 568,236 |
| | Population in site-built homes | 1,258,185 | 1,322,482 | 1,385,399 |
| | Occupied mobile homes | 15,773 | 15,545 | 15,641 |
| | Population in mobile home | 41,977 | 42,233 | 42,109 |
| | Hotel/motel units | 19,459 | 19,609 | 19,738 |
| St. Lucie | Occupied site-built homes | 99,859 | 111,869 | 125,955 |
| | Population in site-built homes | 259,443 | 296,809 | 333,204 |
| | Occupied mobile homes | 8,664 | 8,064 | 8,052 |
| | Population in mobile home | 15,293 | 14,354 | 14,354 |
| | Hotel/motel units | 2,889 | 3,826 | 4,746 |

*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.*

## 4. Zone System and Highway Network

To correspond to the three different sets of demographic data, three model networks were ultimately developed. The Base 2010 network and two future year networks to correspond to the 2015 demographic and 2020 demographic data. The 2010 base model network was updated to reflect roadway capacity improvement projects completed between 2011 and 2015 to create the 2015 network. The 2015 network was then updated

to reflect planned roadway capacity improvement projects expected to be implemented between 2016 and 2020 to create the 2020 network. The planned roadway improvements that were added to the network generally include only capacity improvement projects such as additional through lanes. **Table VI-2** identifies capacity improvement projects completed between 2011 and 2015 that were included in the 2015 network. Likewise, **Table VI-3** identifies capacity improvement projects planned for implementation between 2016 and 2020. The tables identify each roadway that will be improved as well as the extent of the improvement.

It is important to note that **Tables VI-2 and VI-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 VI-2 – Treasure Coast Roadway Improvements, 2011–2015

| County | Roadway | From | To | # 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 | 82nd Ave (CR 609) | 6 |
| | SR 60 | MP 14.634 | W of I-95/MP 22.5 | 4 |
| | 66th Ave | Oslo Road | SR 60 | 2 |
| | 66th Ave | SR 60 | 49th St | 4 |
| | 53rd St | 58th Ave | US 1 | 4 |
| Martin | SR 76 | SW Jack James Dr. | SW Lost River Road | 6 |
| | SR 710 (BRIDGE #890016) | | | 4 |
| | SR 9/I-95 at SR 76/Kanner Hwy | | | N/A |
| | SR 710 | MP 2.0 | W of SW Fox Brown Rd | 4 |
| Palm Beach | Turnpike | SR 802 | SR 704 | 8 |
| | I-95 | Broward Co. line | Linton Blvd | 10 |
| | Atlantic Ave | Turnpike | Jog Rd. | 6 |
| | Okeechobee Blvd | Australian Blvd | Tamarind Ave | 8 |
| | SR 80 | W of SR 7 | W of Turnpike | 6 |
| | SR 80 | W of Haverhill | W of Congress Ave | 6 |
| | SR 710 | Military Trl | Australian Ave | 4 |
| | SR 710 | Palm Beach/Martin County Lines | W of Pratt Whitney | 4 |
| | Atlantic Ave/Turnpike Interchange at (SR 806/SR 91/MP 81) | | | N/A |
| | I-95 (SR 9) | N of Palm Beach Lakes | N of Blue Heron Blvd | 8 |
| | Turnpike | Lantana Toll Plaza | Okeechobee Blvd | 8 |

| | | | | |
|---|---|---|---|---|
| | SR 710/Turnpike Interchange (MP 106) | | | N/A |
| | Jog Road | N of SR 710 | Northlake Blvd | 4 |
| | SR7 Extension | Okeechobee Blvd | 60th Street | 2 |
| | 60th Street | SR 7 Extension | Royal Palm Beach Blvd | 3 |
| | Lyons Road | Atlantic Avenue | Boynton Beach Blvd | 2 |
| | Seminole Pratt Whitney Rd | SR 80 | Sycamore | 4 |
| St Lucie | SR 70 | Okeechobee Co. line | MP 10.216 | 4 |
| | SR 70 | Kings Hwy | Jenkins Rd | 8 |
| | I-95 | SR 70 | Indian River Co. 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 completed between 2011 and 2015 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 2010.*

### Table VI-3 - Treasure Coast Planned Roadway Improvements, 2016–2020

| County | Roadway | From | To | Number of Lanes |
|---|---|---|---|---|
| **Indian River** | US 1 | Oslo Rd | Highlands Drive | 6 |
| | I-95 (SR 9) | St. Lucie Co. Line | Brevard County Line | 6 |
| | 37th St | Indian River Blvd | US 1 | 4 |
| **Martin** | SR 710 | SR 76 | Palm Beach/Martin Co. Lines | 4 |
| **Palm Beach** | Seminole Pratt Whitney Rd | Sycamore Dr | Northlake Blvd | 4 |
| | Northlake Blvd | Seminole Pratt Whitney | Coconut Blvd | 4 |
| | SR 710 | Australian Ave | Old Dixie Hwy | 4 |
| **St Lucie** | SR-9/I-95 at St. Lucie West Blvd | | | N/A |
| | SR 713 (Kings Hwy) | 500' S of SR 70 | N of Picos Rd | 4 |
| | Midway Road Phase 1 | 25th Street | Selvitz Rd | 4 |
| | Midway Road Phase 2 | Selvitz Road | I-95 | 4 |

*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 2016 and 2020 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.*

## 5. 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 VI-4** through **Figure VI-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 2-10, Regional Behavioral Analysis were modified to fit the evacuation zones created by Indian River and Martin Counties. The original rates were based on a five zone system, however Palm Beach now uses four (4) zones and St. Lucie County uses three zones; however, Indian River utilizes four (4) zones, and Martin, three (3) zones. The evacuation zone systems for those counties are listed below:

- Indian River – 4 zones: Zone A, Zone B, Zone C, Zone D/E;
- Martin – 3 zones: Zone A/B, Zone C/D, Zone E.
- Palm Beach – 4 zones: Zone A/B, Zone C, Zone D and Zone E
- St. Lucie – 5 zones : Zone A, Zone B, Zone C, Zone D, Zone E

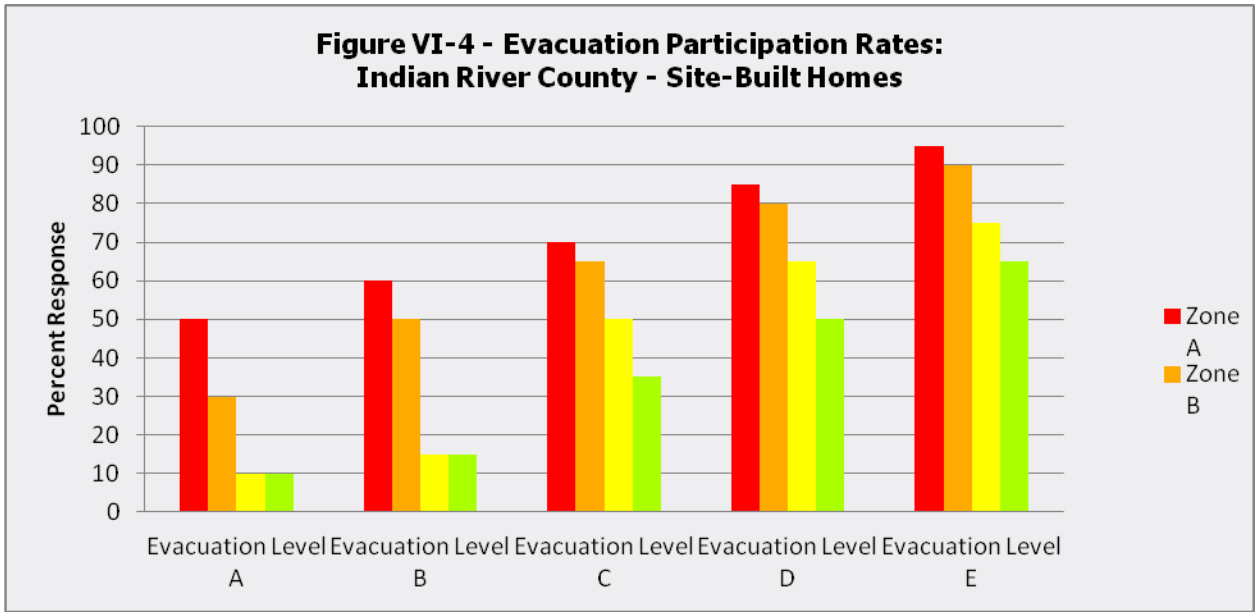


**Figure VI-5 – Evacuation Participation Rates: Indian River County – Mobile Homes**

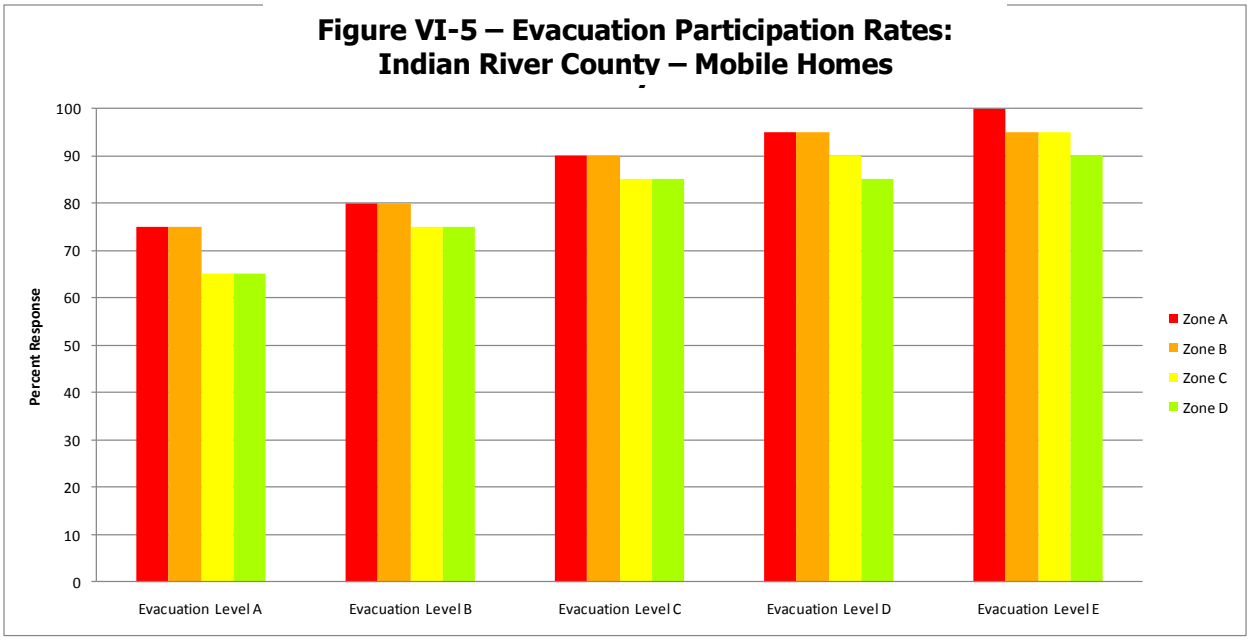



**Figure VI-6 – Evacuation Participation Rates: Martin County – Site-Built Homes**

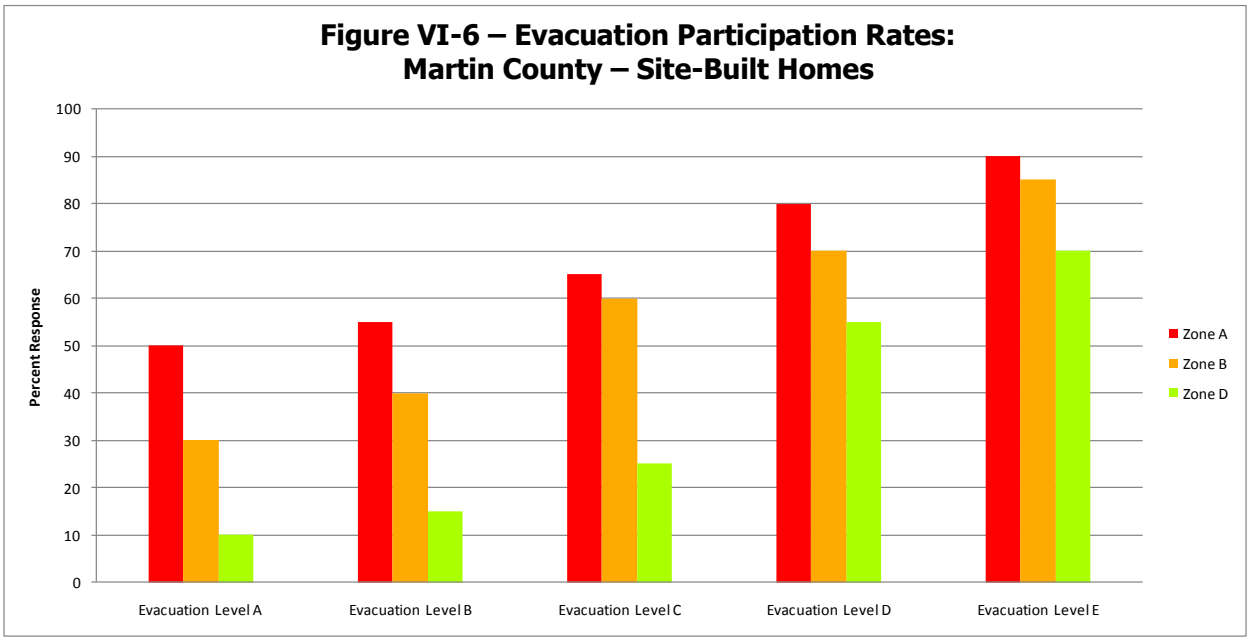


**Figure VI-7 – Evacuation Participation Rates: Martin County – Mobile Homes**

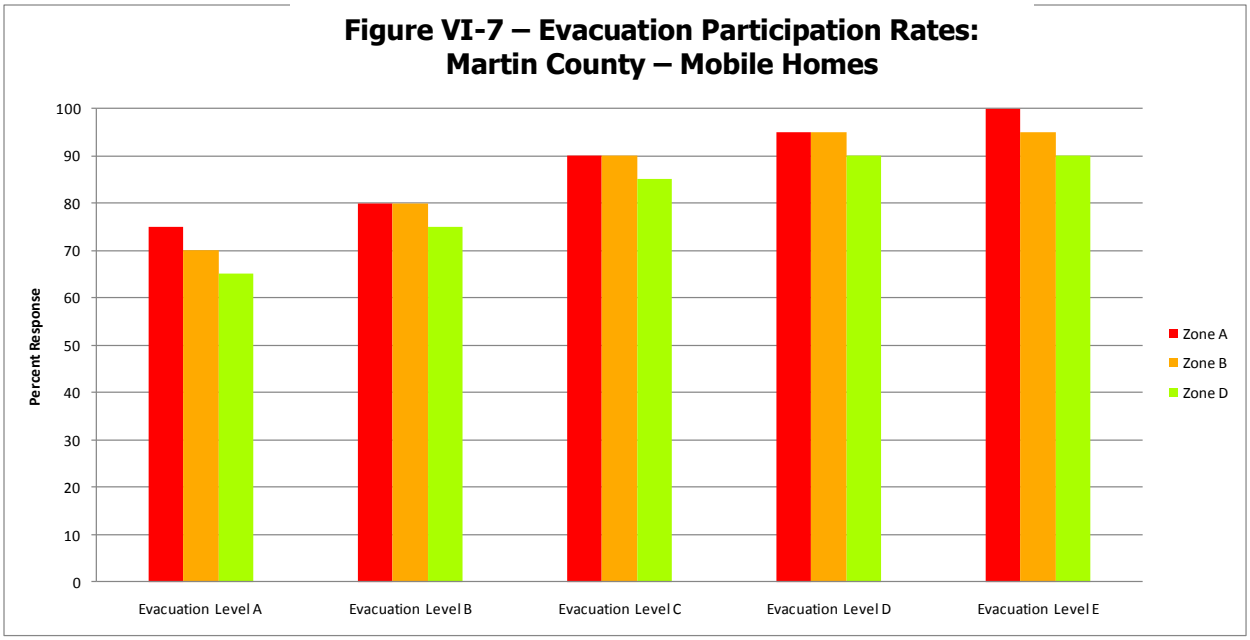
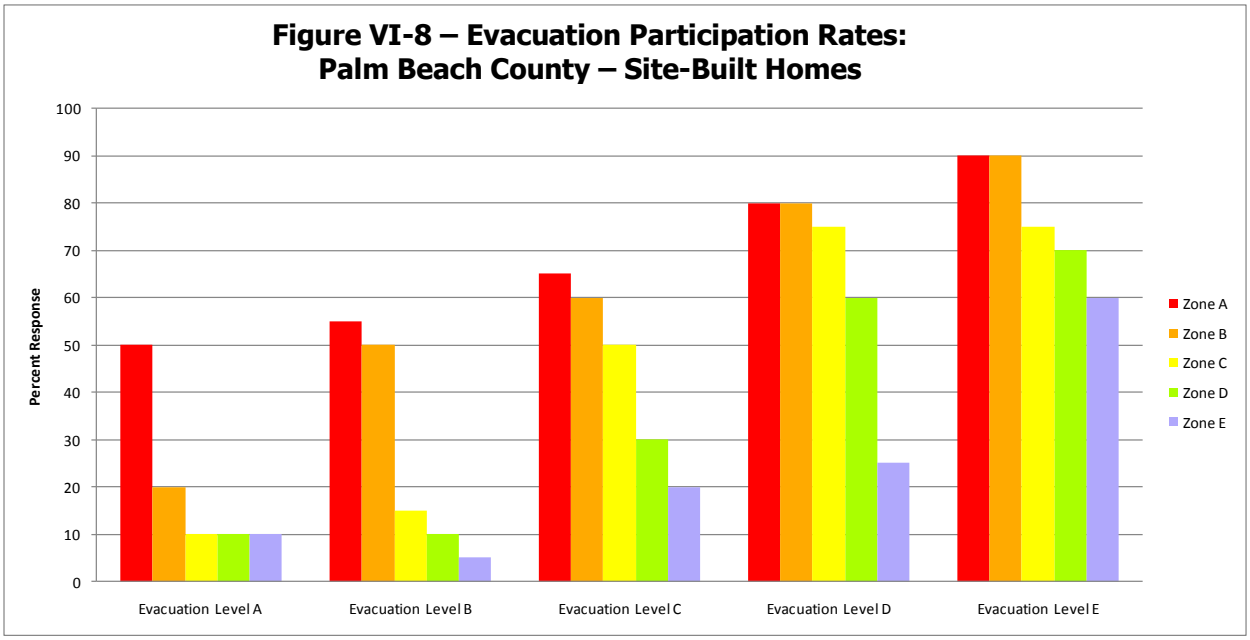



**Figure VI-8 – Evacuation Participation Rates: Palm Beach County – Site-Built Homes**



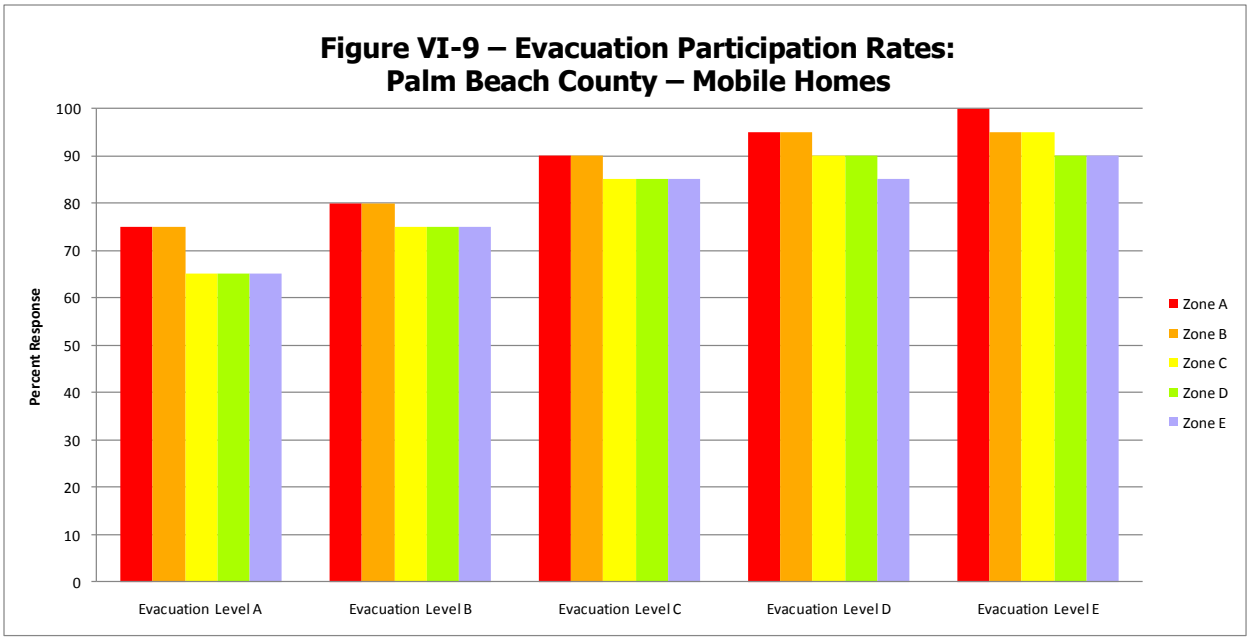


Figure VI-9 – Evacuation Participation Rates:
Palm Beach County – Mobile Homes
Percent Response
100
90
80
70
60
50
40
30
20
10
0
Evacuation Level A
Evacuation Level B
Evacuation Level C
Evacuation Level D
Evacuation Level E
Zone A
Zone B
Zone C
Zone D
Zone E

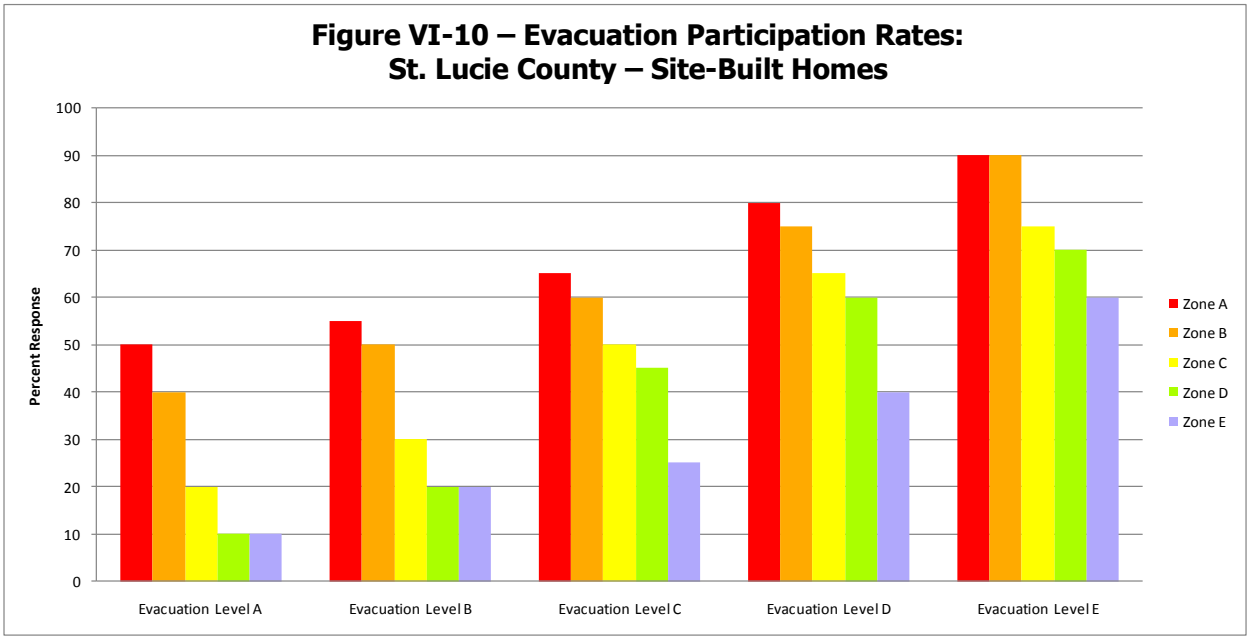
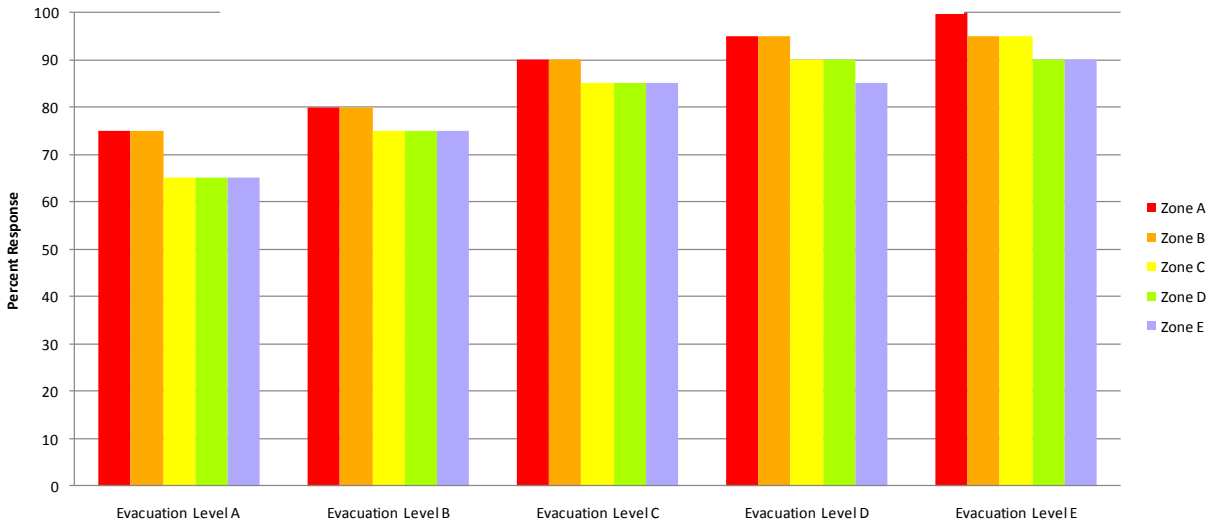


Figure VI-10 – Evacuation Participation Rates:
St. Lucie County – Site-Built Homes
Percent Response
100
90
80
70
60
50
40
30
20
10
0
Evacuation Level A
Evacuation Level B
Evacuation Level C
Evacuation Level D
Evacuation Level E
Zone A
Zone B
Zone C
Zone D
Zone E

**Figure VI-11 – Evacuation Participation Rates: Indian River County – Site-Built Homes**




### 6. 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 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. Active shelters change each year and the list displayed in the table shows those active for 2015.

### 7. 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, Evacuation Transportation Supplemental Data Report.

## G. TIME User Interface

CDM Smith developed the Transportation Interface for Modeling Evacuations (TIME) to make it easier for TCRPC 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.

## H. 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 2015 is identified in **Table VI-4**, summarized by evacuation zone and split between site-built homes and mobile/manufactured homes. Vulnerable population for 2020 is summarized in **Table VI-5**.

**Table VI-4 – 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 | 15,524 | 16,288 | 1,704 | 2,539 | |
| Mobile/Manuf. Homes | 148 | 1,072 | 34 | 296 | |
| TOTAL | 15,672 | 17,360 | 1,738 | 2,835 | |
| **Martin County** | | | | | |
| Site-built Homes | 10,587 | | 11,756 | | 23,438 |
| Mobile/Manuf. Homes | 133 | | 282 | | 1,138 |
| TOTAL | 10,720 | | 12,038 | | 24,576 |
| **Palm Beach County** | | | | | |
| Site-built Homes | 65,646 | | 55,186 | 35,036 | 46,910 |
| Mobile/Manuf. Homes | 913 | | 730 | 616 | 816 |
| TOTAL | 66,559 | | 55,917 | 35,652 | 47,726 |
| **St. Lucie County** | | | | | |
| Site-built Homes | 20,831 | | | 11,103 | |
| Mobile/Manuf. Homes | 1,245 | | | 222 | |

| | | |
|---|---|---|
| TOTAL | 22,076 | 11,325 |

*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.*

## Table VI-5 – Vulnerable Population in the Treasure Coast Region for 2020

| | Evacuation Zone A | Evacuation Zone B | Evacuation Zone C | Evacuation Zone D | Evacuation Zone E |
|---|---|---|---|---|---|
| **Indian River County*** | | | | | |
| Site-built Homes | 16,210 | 17,452 | 1,865 | 2,682 | |
| Mobile/Manuf. Homes | 148 | 1,072 | 34 | 296 | |
| TOTAL | 16,358 | 18,524 | 1,899 | 2,978 | |
| **Martin County** | | | | | |
| Site-built Homes | 10,993 | | 12,605 | | 26,733 |
| Mobile/Manuf. Homes | 133 | | 282 | | 1,138 |
| TOTAL | 11,126 | | 12,887 | | 27,871 |
| **Palm Beach County** | | | | | |
| Site-built Homes | 68,463 | | 58,493 | 36,225 | 49,013 |
| Mobile/Manuf. Homes | 913 | | 730 | 616 | 816 |
| TOTAL | 69,376 | | 59,223 | 36,841 | 49,829 |
| **St. Lucie County** | | | | | |
| Site-built Homes | 23,245 | | | 11,954 | |
| Mobile/Manuf. Homes | 1,245 | | | 222 | |
| TOTAL | 24,490 | | | 12,176 | |

*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.*

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 VI-6** for 2015 and in **Table VI-7** for 2020.

The vulnerable shadow population is provided in **Table VI-8** for both 2015 and 2020. 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 VI-6 – 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 | 8,627 | 9,601 | 958 | 1,574 | |
| To Hotel/ Motel | 3,903 | 4,233 | 431 | 679 | |
| To Public Shelter | 794 | 943 | 140 | 239 | |
| To Other Destination | 2,348 | 2,583 | 209 | 343 | |

| | | | | |
|---|---|---|---|---|
| **Martin County** | | | | |
| To Friends and Family | 6,968 | 7,825 | | 17,274 |
| To Hotel/ Motel | 1,601 | 1,792 | | 3,929 |
| To Public Shelter | 334 | 504 | | 1,408 |
| To Other Destination | 1,817 | 1,918 | | 3,964 |
| **Palm Beach County** | | | | |
| To Friends and Family | 39,935 | 33,550 | 21,391 | 28,636 |
| To Hotel/ Motel | 16,548 | 13,906 | 8,851 | 11,850 |
| To Public Shelter | 3,392 | 2,847 | 1,826 | 2,443 |
| To Other Destination | 6,683 | 5,614 | 3,584 | 4,797 |
| **St. Lucie County** | | | | |
| To Friends and Family | 13,183 | | 6,784 | |
| To Hotel/ Motel | 3,498 | | 1,732 | |
| To Public Shelter | 1,974 | | 1,350 | |
| To Other Destination | 3,420 | | 1,459 | |

*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.*

## Table VI-7 – Vulnerable Population by Destination for 2020

| | Evacuation Zone A | Evacuation Zone B | Evacuation Zone C | Evacuation Zone D | Evacuation Zone E |
|---|---|---|---|---|---|
| **Indian River County*** | | | | | |
| To Friends and Family | 9,004 | 10,241 | 1,046 | 1,653 | |
| To Hotel/ Motel | 4,075 | 4,524 | 471 | 715 | |
| To Public Shelter | 828 | 1,001 | 153 | 250 | |
| To Other Destination | 2,451 | 2,757 | 228 | 360 | |
| **Martin County** | | | | | |
| To Friends and Family | 7,232 | | 8,377 | | 18,116 |
| To Hotel/ Motel | 1,662 | | 1,919 | | 4,124 |
| To Public Shelter | 346 | | 538 | | 1,473 |
| To Other Destination | 1,886 | | 2,054 | | 4,158 |
| **Palm Beach County** | | | | | |
| To Friends and Family | 41,626 | | 35,534 | 22,105 | 29,897 |
| To Hotel/ Motel | 17,253 | | 14,733 | 9,149 | 12,376 |
| To Public Shelter | 3,533 | | 3,012 | 1,855 | 2,549 |
| To Other Destination | 6,965 | | 5,944 | 3,703 | 5,007 |
| **St. Lucie County** | | | | | |
| To Friends and Family | 14,632 | | | 7,295 | |
| To Hotel/ Motel | 3,860 | | | 1,860 | |
| To Public Shelter | 2,192 | | | 1,452 | |
| To Other Destination | 3,806 | | | 1,570 | |

*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.*

## Table VI-8 – Vulnerable Shadow Evacuation Population

| | Evacuation Level A | Evacuation Level B | Evacuation Level C | Evacuation Level D | Evacuation Level E |
|---|---|---|---|---|---|
| **2015** | | | | | |
| Indian River County | 17,829 | 17,647 | 17,901 | 27,223 | 32,439 |
| Martin County | 21,549 | 27,714 | 26,371 | 37,523 | 33,566 |
| Palm Beach County | 132,638 | 116,563 | 180,799 | 228,220 | 272,338 |
| St. Lucie County | 28,982 | 43,332 | 44,999 | 67,385 | 80,624 |
| **2020** | | | | | |
| Indian River County | 18,739 | 18,677 | 19,948 | 29,105 | 34,760 |
| Martin County | 22,155 | 28,712 | 27,267 | 39,118 | 35,071 |
| Palm Beach County | 136,691 | 119,879 | 186,583 | 236,398 | 282,748 |
| St. Lucie County | 30,786 | 46,879 | 48,676 | 74,088 | 88,983 |

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

# I. 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:

### 1. 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 TCRPC 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 VI-9**; and,

### 2. 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 VI-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 TCRPC to continue testing combinations of options and provide additional information to emergency managers.

# J. 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, Regional Population and Vulnerability Analysis. 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 VI-9 – Base Scenarios

| | Scenario 1 Level A 2015 | Scenario 2 Level B 2015 | Scenario 3 Level C 2015 | Scenario 4 Level D 2015 | Scenario 5 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<br>Martin<br>Palm Beach<br>St. Lucie<br>Broward<br>Brevard | Indian River<br>Martin<br>Palm Beach<br>St. Lucie<br>Broward<br>Brevard | Indian River<br>Martin<br>Palm Beach<br>St. Lucie<br>Broward<br>Brevard | Indian River<br>Martin<br>Palm Beach<br>St. Lucie<br>Broward<br>Brevard | Indian River<br>Martin<br>Palm Beach<br>St. Lucie<br>Broward<br>Brevard |
| | **Scenario 6 Level A 2020** | **Scenario 7 Level B 2020** | **Scenario 8 Level C 2020** | **Scenario 9 Level D 2020** | **Scenario 10 Level E 2020** |
| **Demographic Data** | 2020 | 2020 | 2020 | 2020 | 2020 |
| **Highway Network** | 2020 | 2020 | 2020 | 2020 | 2020 |
| **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<br>Martin<br>Palm Beach<br>St. Lucie<br>Broward<br>Brevard | Indian River<br>Martin<br>Palm Beach<br>St. Lucie<br>Broward<br>Brevard | Indian River<br>Martin<br>Palm Beach<br>St. Lucie<br>Broward<br>Brevard | Indian River<br>Martin<br>Palm Beach<br>St. Lucie<br>Broward<br>Brevard | Indian River<br>Martin<br>Palm Beach<br>St. Lucie<br>Broward<br>Brevard |

## Table VI-10 – Operational Scenarios

| | Scenario 1 Level A 2015 | Scenario 2 Level B 2015 | Scenario 3 Level C 2015 | Scenario 4 Level D 2015 | Scenario 5 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<br>Martin<br>Palm Beach<br>St. Lucie<br>Broward<br>Brevard | Indian River<br>Martin<br>Palm Beach<br>St. Lucie<br>Broward<br>Brevard | Indian River<br>Martin<br>Palm Beach<br>St. Lucie<br>Broward<br>Brevard | Indian River<br>Martin<br>Palm Beach<br>St. Lucie<br>Broward<br>Brevard | Indian River<br>Martin<br>Palm Beach<br>St. Lucie<br>Broward<br>Brevard |
| | **Scenario 6 Level A 2020** | **Scenario 7 Level B 2020** | **Scenario 8 Level C 2020** | **Scenario 9 Level D 2020** | **Scenario 10 Level E 2020** |
| **Demographic Data** | 2020 | 2020 | 2020 | 2020 | 2020 |
| **Highway Network** | 2020 | 2020 | 2020 | 2020 | 2020 |
| **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<br>Martin<br>Palm Beach<br>St. Lucie<br>Broward<br>Brevard | Indian River<br>Martin<br>Palm Beach<br>St. Lucie<br>Broward<br>Brevard | Indian River<br>Martin<br>Palm Beach<br>St. Lucie<br>Broward<br>Brevard | Indian River<br>Martin<br>Palm Beach<br>St. Lucie<br>Broward<br>Brevard | Indian River<br>Martin<br>Palm Beach<br>St. Lucie<br>Broward<br>Brevard |

## 1. 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.

## 2. 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.

## 3. 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.

## 4. 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 TCRPC is clear;
- All out of county trips exit the TCRPC region, 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 TCRPC region, 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 VI-11** and **VI-12**, while clearance times for each of the operational scenarios are summarized in **Table VI-13** and **Table VI-14.** Clearance time includes several components, including the mobilization time for the evacuating population to prepare for an evacuation (pack supplies and personal belongings, load their vehicle, etc.), the actual time spent traveling on the roadway

network, and the delay time caused by traffic congestion.

## 5. Base Scenarios

In-county clearance times for the 2015 base scenarios range from 12.5 hours to 35.5 hours, depending upon the evacuation level. Palm Beach County has the highest in-county clearance time of 35.5 hours for the level E scenario. Clearance time to shelter shows a similar pattern, with clearance times ranging from 11 to 35.5 hours.

In 2020, in-county clearance times for the base scenarios vary between 12 hours for the evacuation level A scenarios and 30.5 hours for Indian River County for the evacuation level E scenario. This shows a slight reduction in clearance time from 2010 due to the completion of several roadway improvement projects throughout the region. Clearance Time to Shelter shows a similar pattern, with clearance times for the base scenarios ranging from 11 hours for the evacuation level A scenarios to 25.5 hours for Palm Beach County for evacuation level E scenario in 2020.

Out of county clearance times for the 2015 base scenarios range from 14 to 35.5 hours, while in 2015 they range from 14 hours for the base evacuation level A scenario to 31.5 hours in Indian River County for the evacuation level E scenario in 2020. Regional clearance time for the four county TCRPC region ranges from 14.5 hours to 35.5 hours.

## 6. Operational Scenarios

In-county clearance times for the 2015 operational scenarios range from 5.5 hours to 40.5 hours depending upon the scenario. Clearance Time to Shelter are significantly lower, with clearance times for the operational scenarios ranging from 0 hours to 19.5 hours depending upon the county and the scenario.

In 2015, in-county clearance times for the operational scenarios vary from 0 hours to 38.5 hours for the level B evacuation in Palm Beach County. The 2010 level B evacuation includes vehicle trips evacuating from as far south as Monroe County and the Florida Keys, which causes a large northbound evacuation through Palm Beach County. Clearance Time to Shelter is significantly lower, with clearance times for the base scenarios ranging from 0 hours to 19.0 hours depending upon the scenario.

Out of county clearance times for the 2015 operational scenarios range from 7 hours to 41.5 hours for the evacuation level C scenario, which includes Monroe County evacuations. Out of county clearance times are similar for all counties in 2015 to between 10.5 and 40 hours depending upon the scenario. Regional clearance time for the four county TCRPC region ranges from 8 hours to 41.5 hours in 2015. This time increases to between 11 and 40 hours in 2015.

## Table VI-11 – 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 | 12.5 | 14.0 | 20.0 |
| Martin | 12.5 | 12.5 | 13.0 | 14.0 | 18.0 |
| Palm Beach | 13.0 | 13.0 | 15.5 | 18.0 | 24.0 |
| St. Lucie | 12.5 | 12.5 | 13.0 | 14.0 | 19.5 |
| **In-County Clearance Time** | | | | | |
| Indian River | 12.5 | 12.5 | 18.0 | 24.0 | 33.5 |
| Martin | 13.5 | 13.5 | 16.0 | 20.5 | 27.5 |
| Palm Beach | 13.5 | 13.5 | 15.5 | 20.0 | 25.0 |
| St. Lucie | 13.5 | 14.0 | 18.0 | 23.0 | 32.5 |
| **Out of County Clearance Time** | | | | | |
| Indian River | 15.0 | 16.0 | 19.0 | 24.5 | 35.5 |
| Martin | 14.0 | 15.0 | 17.5 | 22.0 | 30.5 |
| Palm Beach | 15.0 | 16.0 | 16.5 | 21.5 | 31.0 |
| St. Lucie | 14.5 | 15.0 | 18.5 | 24.0 | 33.5 |
| **Regional Clearance Time** | | | | | |
| Treasure Coast | 15.0 | 16.0 | 19.0 | 24.5 | 35.5 |

## Table VI-12 – 2020 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 | 12.5 | 14.5 | 20.0 |
| Martin | 12.5 | 12.5 | 12.5 | 13.5 | 19.5 |
| Palm Beach | 13.0 | 13.5 | 16.5 | 19.0 | 26.5 |
| St. Lucie | 12.5 | 13.0 | 13.5 | 15.0 | 17.5 |
| **In-County Clearance Time** | | | | | |
| Indian River | 12.5 | 12.5 | 12.5 | 25.0 | 33.5 |
| Martin | 13.5 | 12.5 | 16.5 | 21.5 | 27.5 |
| Palm Beach | 13.5 | 13.5 | 16.5 | 21.0 | 26.5 |
| St. Lucie | 13.5 | 14.5 | 19.5 | 25.0 | 32.5 |
| **Out of County Clearance Time** | | | | | |
| Indian River | 15.0 | 16.5 | 19.5 | 26.0 | 37.0 |
| Martin | 14.5 | 14.5 | 18.5 | 23.0 | 30.5 |
| Palm Beach | 15.0 | 15.5 | 17.0 | 23.5 | 27.5 |
| St. Lucie | 14.5 | 15.0 | 19.5 | 25.0 | 33.0 |
| **Regional Clearance Time** | | | | | |
| Treasure Coast | 15.0 | 16.5 | 19.5 | 26.0 | 37.0 |

## Table VI-13 – 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 | 7.0 | 9.0 | 11.5 | 17.5 |
| Martin | 6.5 | 6.5 | 6.5 | 10.0 | 13.5 |
| Palm Beach | 7.0 | 7.5 | 11.0 | 16.0 | 23.5 |
| St. Lucie | 6.5 | 7.0 | 9.0 | 11.0 | 14.5 |
| **In-County Clearance Time** | | | | | |
| Indian River | 6.5 | 9.5 | 9.5 | 20.0 | 24.5 |
| Martin | 7.5 | 8.0 | 11.0 | 17.0 | 22.0 |
| Palm Beach | 7.5 | 7.5 | 11.0 | 16.0 | 23.5 |
| St. Lucie | 8.5 | 9.5 | 12.5 | 19.5 | 24.5 |
| **Out of County Clearance Time** | | | | | |
| Indian River | 10.0 | 12.5 | 16.0 | 22.5 | 31.0 |
| Martin | 8.0 | 9.0 | 12.0 | 18.5 | 25.5 |
| Palm Beach | 9.0 | 9.0 | 11.5 | 17.0 | 29.5 |
| St. Lucie | 9.0 | 10.5 | 14.5 | 20.0 | 26.0 |
| **Regional Clearance Time** | | | | | |
| Treasure Coast | 10.0 | 12.5 | 16.0 | 22.0 | 31.0 |

## Table VI-14 – 2020 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 | 7.5 | 9.5 | 12.5 | 18.5 |
| Martin | 6.5 | 6.5 | 7.0 | 10.5 | 14.5 |
| Palm Beach | 7.0 | 7.5 | 11.5 | 17.0 | 32.0 |
| St. Lucie | 6.5 | 7.0 | 8.5 | 11.5 | 14.5 |
| **In-County Clearance Time** | | | | | |
| Indian River | 6.5 | 7.5 | 9.5 | 21.0 | 26.5 |
| Martin | 7.0 | 8.0 | 11.5 | 18.0 | 23.0 |
| Palm Beach | 7.5 | 8.0 | 11.5 | 17.5 | 32.0 |
| St. Lucie | 9.0 | 10.5 | 13.0 | 20.5 | 26.0 |
| **Out of County Clearance Time** | | | | | |
| Indian River | 10.5 | 12.5 | 17.0 | 23.5 | 35.0 |
| Martin | 8.5 | 9.5 | 13.0 | 20.0 | 29.5 |
| Palm Beach | 9.0 | 9.0 | 12.0 | 18.0 | 33.0 |
| St. Lucie | 9.5 | 11.0 | 14.5 | 21.0 | 30.0 |
| **Regional Clearance Time** | | | | | |
| Treasure Coast | 10.5 | 12.5 | 17.0 | 23.5 | 35.0 |

## K. 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 2015 is identified in **Table VI-15** and for 2020 in **Table VI-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 VI-15 – 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 | 26,801 | 38,009 | 33,266 | 31,752 | 23,677 |
| 18-Hour | 33,501 | 50,678 | 49,899 | 47,629 | 35,515 |
| 24-Hour | | | 52,671 | 63,505 | 47,354 |
| 36-Hour | | | | 64,828 | 70,044 |
| **Estimated Evacuating Population Clearing Martin County** | | | | | |
| 12-Hour | 27,659 | 30,747 | 33,689 | 32,881 | 32,616 |
| 18-Hour | 32,269 | 38,434 | 49,130 | 49,322 | 48,925 |
| 24-Hour | | | | 60,282 | 65,233 |
| 36-Hour | | | | | 82,900 |
| **Estimated Evacuating Population Clearing Palm Beach County** | | | | | |
| 12-Hour | 106,110 | 137,342 | 220,564 | 215,636 | 185,107 |
| 18-Hour | 132,638 | 183,122 | 303,275 | 323,454 | 277,660 |
| 24-Hour | | | | 386,348 | 370,213 |
| 36-Hour | | | | | 478,192 |
| **Estimated Evacuating Population Clearing St. Lucie County** | | | | | |
| 12-Hour | 42,255 | 52,326 | 43,508 | 50,393 | 40,845 |
| 18-Hour | 51,058 | 65,408 | 65,262 | 75,590 | 61,267 |
| 24-Hour | | | 67,075 | 100,786 | 81,690 |
| 36-Hour | | | | | 114,025 |

*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 VI-16 – Maximum Evacuating Population by Time Interval for 2020

| | Evacuation Level A | Evacuation Level B | Evacuation Level C | Evacuation Level D | Evacuation Level E |
|---|---|---|---|---|---|
| **Estimated Evacuating Population Clearing Indian River County** | | | | | |
| 12-Hour | 28,077 | 38,951 | 34,294 | 31,783 | 24,168 |
| 18-Hour | 35,096 | 53,558 | 51,441 | 47,674 | 36,252 |
| 24-Hour | | | 55,728 | 63,566 | 48,336 |
| 36-Hour | | | | 68,863 | 74,518 |
| **Estimated Evacuating Population Clearing Martin County** | | | | | |
| 12-Hour | 27,543 | 32,969 | 33,263 | 32,938 | 34,212 |
| 18-Hour | 33,281 | 39,838 | 49,895 | 49,408 | 51,318 |
| 24-Hour | | | 51,281 | 63,132 | 68,424 |
| 36-Hour | | | | | 86,956 |
| **Estimated Evacuating Population Clearing Palm Beach County** | | | | | |
| 12-Hour | 109,353 | 146,520 | 222,481 | 205,194 | 217,317 |
| 18-Hour | 136,691 | 189,255 | 315,182 | 307,791 | 325,975 |
| 24-Hour | | | | 401,838 | 434,633 |
| 36-Hour | | | | | 498,017 |

| Estimated Evacuating Population Clearing St. Lucie County | | | | | |
|---|---|---|---|---|---|
| 12-Hour | 45,746 | 57,095 | 45,025 | 53,162 | 45,691 |
| 18-Hour | 55,276 | 71,369 | 67,538 | 79,743 | 68,536 |
| 24-Hour | | | 73,166 | 106,324 | 91,381 |
| 36-Hour | | | | 110,754 | 125,649 |

*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. 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;

- 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.

## M. 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 play a major role even when evacuations occur in other parts of the State, especially with South Florida and Monroe County storm events. For example, for the operational scenarios including evacuations of the Florida Keys, out of county clearance times for TCRPC counties were significantly higher due to a large influx of evacuees from other counties. TCRPC counties should continue their coordination efforts with the State on public information campaigns to clearly define those that are vulnerable and should evacuate verses 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, Evacuation Transportation Supplemental Data Report) 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.

## Table VI-17 – 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** | | | | | |
| Site-built | 14,224 | 22,192 | 23,210 | 28,485 | 30,731 |
| Mobile/Manuf. | 3,613 | 3,613 | 3,613 | 3,613 | 3,613 |
| Tourists | 568 | 786 | 809 | 860 | 860 |
| TOTAL | 18,405 | 26,591 | 27,632 | 32,958 | 35,204 |
| **Martin** | | | | | |
| Site-built | 9,897 | 12,896 | 18,182 | 23,594 | 34,133 |
| Mobile/Manuf. | 8,256 | 8,256 | 8,256 | 8,256 | 8,256 |
| Tourists | 574 | 574 | 575 | 575 | 904 |
| TOTAL | 18,727 | 21,726 | 27,013 | 32,425 | 43,293 |
| **Palm Beach** | | | | | |
| Site-built | 47,219 | 74,050 | 135,120 | 177,197 | 222,776 |
| Mobile/Manuf. | 18,863 | 18,863 | 18,863 | 18,8631 | 18,863 |
| Tourists | 0 | 3,309 | 5,395 | 5,486 | 5,839 |
| TOTAL | 66,082 | 96,222 | 159,378 | 201,546 | 247,478 |
| **St. Lucie** | | | | | |
| Site-built | 17,926 | 25,045 | 25,883 | 42,636 | 49,197 |
| Mobile/Manuf. | 10,023 | 10,023 | 10,023 | 10,023 | 10,023 |
| Tourists | 956 | 956 | 956 | 962 | 962 |
| TOTAL | 28,905 | 36,024 | 36,862 | 53,621 | 60,182 |

**Table VI-18 – Evacuating Vehicles by Base Scenario for 2020**

| | 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 | 14,977 | 23,527 | 24,637 | 30,382 | 32,840 |
| Mobile/Manuf. Homes | 3,612 | 3,612 | 3,612 | 3,612 | 3,612 |
| Tourists | 602 | 833 | 862 | 916 | 916 |
| TOTAL | 19,191 | 27,972 | 29,111 | 34,910 | 37,368 |
| **Martin County** | | | | | |
| Site-built Homes | 10,390 | 13,584 | 19,243 | 25,003 | 36,116 |
| Mobile/Manuf. Homes | 8,176 | 8,176 | 8,176 | 8,176 | 8,176 |
| Tourists | 580 | 580 | 582 | 582 | 917 |
| TOTAL | 19,146 | 22,340 | 28,001 | 33,761 | 45,209 |
| **Palm Beach County** | | | | | |
| Site-built Homes | 49,975 | 78,388 | 143,220 | 187,612 | 235,836 |
| Mobile/Manuf. Homes | 18,975 | 18,975 | 18,975 | 18,975 | 18,975 |
| Tourists | 0 | 3,396 | 5,314 | 5,405 | 5,825 |
| TOTAL | 68,950 | 100,759 | 167,509 | 211,992 | 260,636 |
| **St. Lucie County** | | | | | |
| Site-built Homes | 20,591 | 28,630 | 29,528 | 48,301 | 55,741 |
| Mobile/Manuf. Homes | 9,357 | 9,357 | 9,357 | 9,357 | 9,357 |
| Tourists | 984 | 984 | 984 | 990 | 990 |
| TOTAL | 30,932 | 38,971 | 39,869 | 58,648 | 66,088 |