



Volume 1-8

Tampa Bay Region Technical Data Report

CHAPTER VI

EVACUATION TRANSPORTATION ANALYSIS



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TABLE OF CONTENTS

A.	Background and Purpose.....	5
B.	Study Area	5
C.	Input and Coordination	6
D.	Evacuation Modeling Methodology and Framework	6
E.	Regional Model Implementation	9
F.	TIME User Interface	21
G.	Vulnerable Population.....	21
H.	Evacuation Model Scenarios.....	26
I.	Clearance Time Results	26
J.	Maximum Evacuating Population Clearances.....	33
K.	Sensitivity Analysis	33
L.	Summary and Conclusions	36

LIST OF TABLES

Table VI-1	Tampa Bay Demographic Characteristic Summary	13
Table VI-2	Tampa Bay Region Roadway Improvements, 2006-2010	15
Table VI-3	Tampa Bay Planned Roadway Improvements, 2011-2015	16
Table VI-4	Vulnerable Population in the Tampa Bay Region for 2010.....	22
Table VI-5	Vulnerable Population in the Tampa Bay Region for 2015.....	23
Table VI-6	Vulnerable Population by Destination for 2010	24
Table VI-7	Vulnerable Population by Destination for 2015	25
Table VI-8	Vulnerable Shadow Evacuation Population	25
Table VI-9	Base Scenarios.....	27
Table VI-10	Operational Scenarios	28
Table VI-11	2010 Clearance Times for Base Scenario	31
Table VI-12	2015 Clearance Times for Base Scenario	31
Table VI-13	2010 Clearance Times for Operational Scenarios.....	32
Table VI-14	2015 Clearance Times for Operational Scenarios.....	32
Table VI-15	Maximum Evacuating Population by Time Interval for 2010.....	34
Table VI-16	Maximum Evacuating Population by Time Interval for 2015.....	35

LIST OF FIGURES

Figure VI-1	General Model Flow	8
Figure VI-2	Tampa Bay Regional Model Network	11
Figure VI-3	Tampa Bay Regional Model Traffic Evacuation Zone Map	12
Figure VI-4	Evacuation Participation Rates: Hillsborough County - Site-Built Homes	17
Figure VI-5	Evacuation Participation Rates: Hillsborough County - Mobile Homes	17
Figure VI-6	Evacuation Participation Rates: Manatee County - Site Built Homes	18

Figure VI-7	Evacuation Participation Rates: Manatee County - Mobile Homes	18
Figure VI-8	Evacuation Participation Rates: Pasco County - Site Built Homes	19
Figure VI-9	Evacuation Participation Rates: Pasco County - Mobile Homes	19
Figure VI-10	Evacuation Participation Rates: Pinellas County - Site Built Homes	20
Figure VI-11	Evacuation Participation Rates: Pinellas County - Mobile Homes	20

CHAPTER VI

EVACUATION

TRANSPORTATION ANALYSIS



The evacuation transportation analysis discussed in this chapter 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) as in the 2006 Tampa Bay Study Update. 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 Tampa Bay 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 Tampa Bay region. While the impact of other regions is included in the Tampa Bay 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 Tampa Bay 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 Tampa Bay 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.

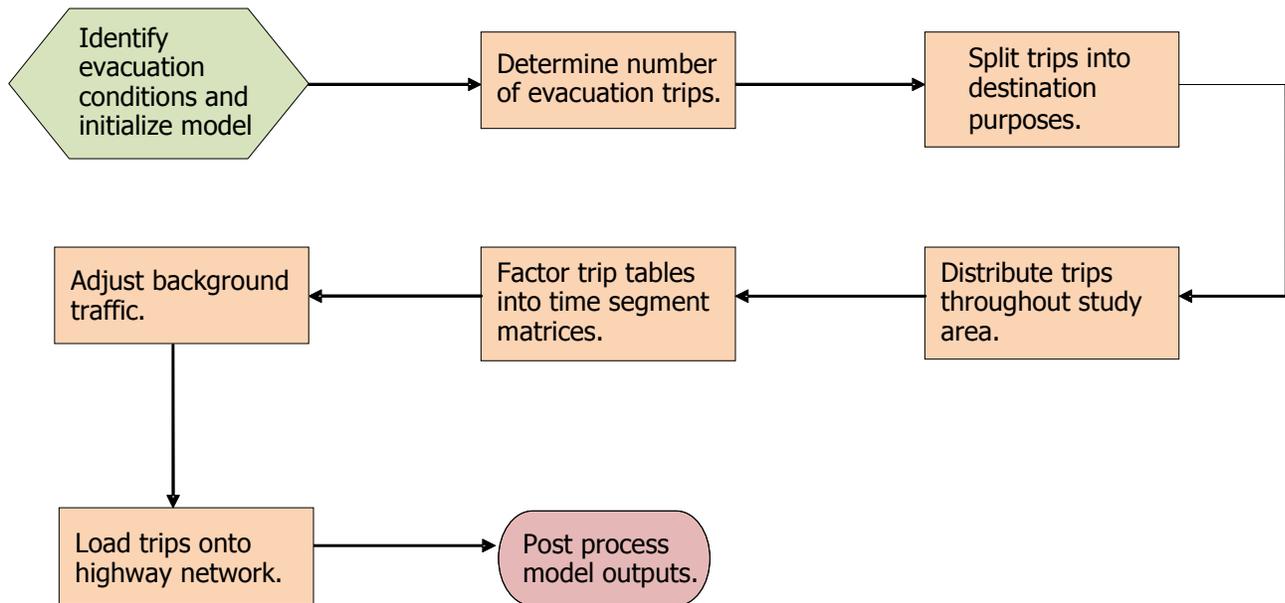
- **Background Traffic** - The traffic that consumes the roadway capacity of a transportation system during an evacuation can be divided into two groups. The first group is the evacuation traffic itself. Once the evacuation demand is determined, this information is converted into a number of vehicles 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 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



- **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 Tampa Bay 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 Tampa Bay 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 VI-2** identifies the model network and evacuation routes for the TBRPC. County level details of the regional model network are provided in the Volume 5-8 report. The regional model network for the Tampa Bay region includes key roadways within the four county region, including I-4, I-75, I-275, US 301, US 19, SR 39, SR 64, SR 70, SR 52, and SR 54.
- **Regional Zone System** - The regional zone system is based on Traffic Evacuation Zones (TEZ) and contains the regional demographic information, which includes housing and population data that is essential to modeling evacuation traffic. There are 1,673 TEZs located within the four county Tampa Bay region, as illustrated in **Figure VI-3**. In the Tampa Bay region, Pinellas County has the largest number of TEZs with 631, with Hillsborough following 505 TEZs. Manatee and Pasco Counties have the lowest number of TEZs within the RPC 332 and 205 zones, respectively. The larger numbers of TEZs generally reflect counties with dense urban structure and 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 Tampa Bay RPC for 2006, 2010 and 2015 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

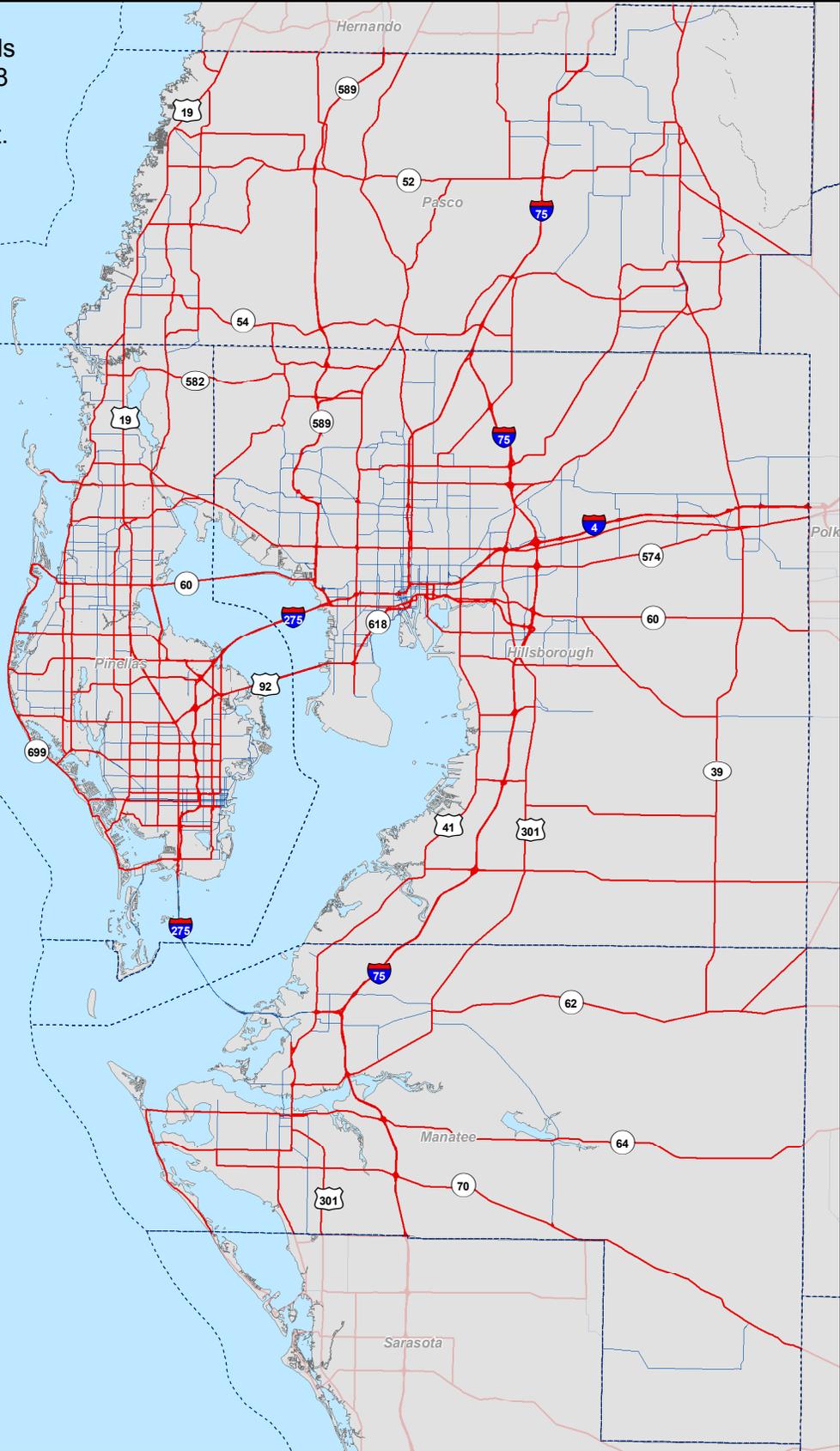
home category includes RVs and boats and the permanent population in those housing options. The demographic characteristics summary also includes hotels and motels because many of these units are in vulnerable areas, and the proportion of seasonal units and hotel/motel units that are occupied at any point in time will have an important impact on the total population that may participate in an evacuation.



Figure VI-2 Tampa Bay Regional Model Network



Note: County level network details are available in Volume 5-8 Evacuation Transportation Supplemental Data Report.



Map Legend

- Evacuation Routes
- Supporting Model Network Roads
- - - County Boundary

0 1.5 3 6 9 12 Miles

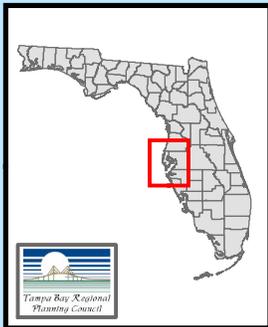
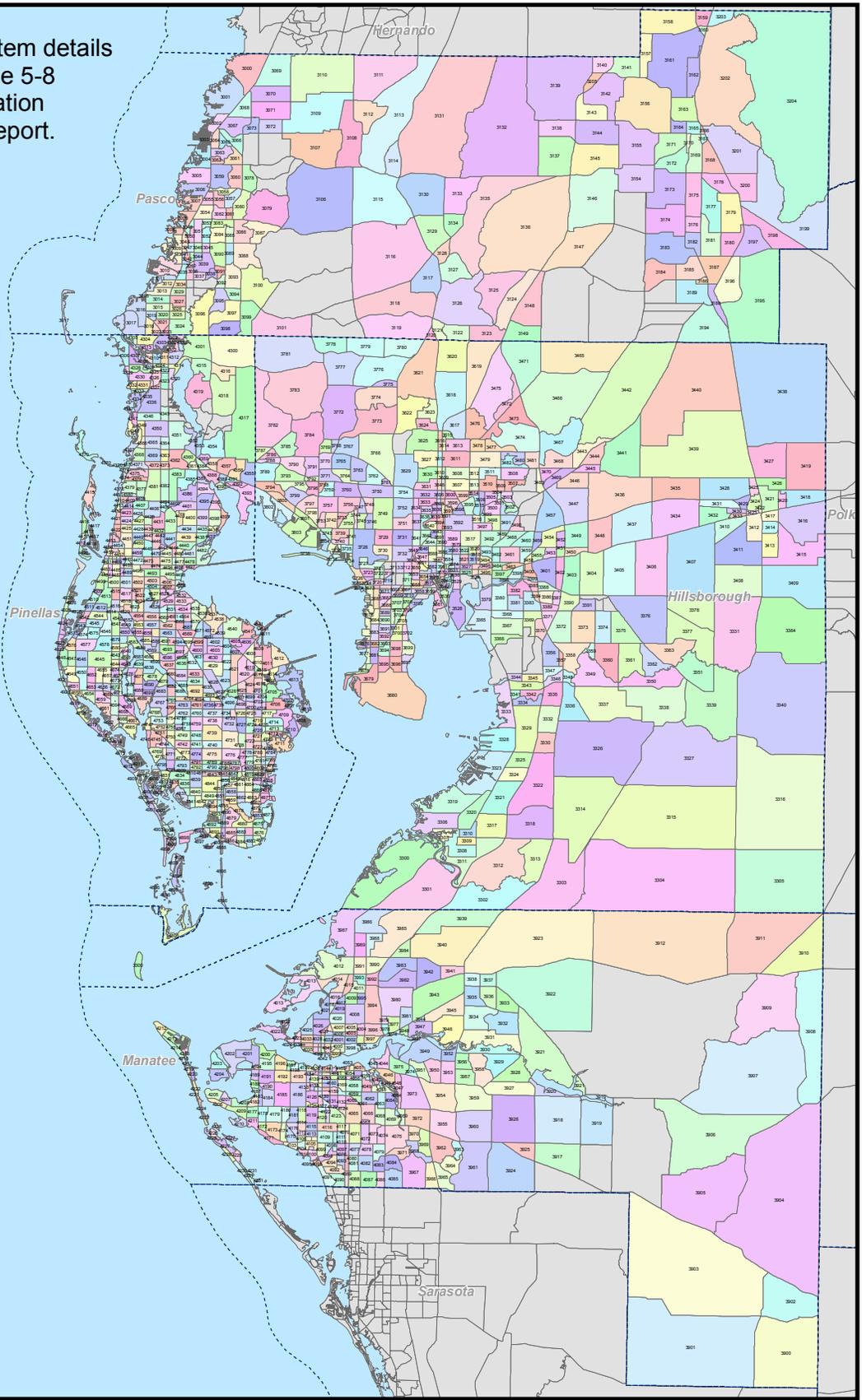
This map is prepared under the direction of Florida Division of Emergency Management for the Regional Evacuation Study Update. This map is for planning purposes only. Not to be used for measurement or legal purposes. Please consult with your county for the latest information.



Figure VI-3 Tampa Bay Regional Model Transportation Evacuation Zone System (TEZ)



Note: County level zone system details are available in Volume 5-8 Evacuation Transportation Supplemental Data Report.



Map Legend

- Traffic Evacuation Zones (TEZ)
- County Boundary

0 1.5 3 6 9 12 Miles

This map is prepared under the direction of Florida Division of Emergency Management for the Regional Evacuation Study Update. This map is for planning purposes only. Not to be used for measurement or legal purposes. Please consult with your county for the latest information.

Hillsborough County has the largest population in the region during all three time periods. The county is expected to reach over 1.4 million people by 2015. Pinellas County has the second largest population in the region, and this county is far more densely populated than the other counties, including Hillsborough. This is very significant in the behavior of the evacuation transportation model because most of the population in Pinellas lives close to a coastline and in an evacuation zone. Both Manatee and Pasco Counties are forecasted to experience an almost 25% increase in population between 2006 and 2015; conversely, Pinellas County is expected to have a nominal 5% increase.

Table VI-1 Tampa Bay Demographic Characteristic Summary

County	Characteristic	Year		
		2006	2010	2015
Hillsborough	Occupied site-built homes	458,437	490,495	530,827
	Population in site-built homes	1,150,539	1,236,201	1,343,269
	Occupied mobile homes	23,888	23,888	23,888
	Population in mobile home	65,318	65,318	65,318
	Hotel/motel units	20,282	24,729	30,290
Manatee County	Occupied site-built homes	124,492	136,714	124,391
	Population in site-built homes	322,752	353,968	402,831
	Occupied mobile homes	14,066	14,066	14,066
	Population in mobile home	24,538	24,538	24,538
	Hotel/motel units	9,352	11,651	14,545
Pasco County	Occupied site-built homes	177,582	194,845	218,489
	Population in site-built homes	417,787	461,989	517,249
	Occupied mobile homes	32,245	32,245	32,245
	Population in mobile home	68,251	68,251	68,251
	Hotel/motel units	2,992	4,211	5,736
Pinellas County	Occupied site-built homes	425,852	433,346	443,296
	Population in site-built homes	922,734	944,342	971,631
	Occupied mobile homes	27,053	27,005	27,005
	Population in mobile home	44,477	44,349	44,349
	Hotel/motel units	19,025	19,025	19,025

Source: Tampa Bay Regional Planning Council

- **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 VI-2** identifies capacity improvement projects completed between 2006 and 2010 that were included in the 2010 network. Likewise, **Table VI-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 Hillsborough County, US 301 from Balm Road to SR 674 will be widened to 8 lanes.

It is important to note that Tables IV-2 and IV-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 Tampa Bay Region, all four counties within the region have evacuation zones corresponding to five 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 5-8.

A review of the evacuation rates for the Tampa Bay 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 VI-4 through Figure VI-11.

- **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 144 shelters, including 54 in Hillsborough County, 29 in Manatee County, 30 in Pasco County, and 31 in Pinellas County, all of which are classified as primary shelters. All together, the 144 shelters located within the four county region can host more than 170,000 persons during an evacuation event.

Table VI-2 Tampa Bay Region Roadway Improvements, 2006-2010

County	Roadway	From	To	Number of Lanes
Hillsborough	SR 618	SR 45	I-75	8/10
	N 21st St/N 22nd St	SR 60	I-4	6
	SR 45/US 41	Maritime Blvd	SR 60	6
	Manhattan Ave	Gandy Blvd	Kensington Ave	4
	CR 585A	Hillsborough Ave	SR 582	4
	Race Track Road	Hillsborough Ave	Douglas Rd	6
	SR 676	W of US 41	E of US 301	4
	Park Rd	I-4 (SR 400)	Sam Allen Rd	4
	I-4	I-275	50th St	8
	Boyette Rd	US 301	Allen Wood Dr	6
Manatee	US 301	Erie Rd/Old Tampa Rd	CR 675	4
	SR 64	I-75	Heritage Green Way	6
	SR 64	Heritage Green Way	Lakewood Ranch Blvd	6
	SR 64	Lakewood Ranch Blvd	Lorraine Rd	4
	SR 70	I-75	Lorraine Rd	6
Pasco	Ridge Rd	Little Rd	Moon Lake Rd	4
	SR 52	Moon Lake Rd	Suncoast Parkway	4
	SR 54	Magnolia	SR 581	4
	SR 54	CR 581	E of CR 577	6
	CR 581	County Line	SR 54	6
	C.R. 578 N County Line	US 19	East Rd	4
	US 41 (SR 45)	Tower Rd	Ridge Rd/Connerton Bld	4
	CR 1/ Little Rd	SR 54/ Gunn Hwy	Old County Road 54	6
Pinellas	Bryan Dairy Rd	72nd St	US 19	6
	US 19 (SR 55)	N of 49th St N	N of 126th Ave N	10 *
	SR 688 (Ulmerton Rd)	Indian Rocks Rd	W of 113th St	6
	CR 1/Keene Rd	SR 60	CR 576 (Sunset Pt. Rd)	4
	CR 880 (Klosterman Rd)	Pinellas Ave	US 19	4

Sources: FDOT SIS First Five Year Plan, FDOT SIS Second Five Year Plan, Tampa Bay 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.

* 10 lanes includes 6 partially controlled lanes w/ 4-lane service roads

Table VI-3 Tampa Bay Planned Roadway Improvements, 2011-2015

County	Roadway	From	To	Number of Lanes
Hillsborough	Lutz Lake Fern Rd	Suncoast Parkway	Dale Mabry Highway	4
	US 301	Balm Rd	SR 674	8
	Bruce B. Downs Blvd	Pebble Creek Dr	Pasco County	6
	SR 574	W of Highview	E of Parsons Ave	4
	SR 589 (Veteran's Expy)	Memorial Hwy	S of Gunn Hwy	6
	I-4/Selmon Expressway	S of Selmon Expresswy	7th Ave	4
	I-4/Selmon Expressway	7th Ave	I-4	4
	I-275 (SR 93)	Himes Ave	Hillsborough River	8
	I-275 (SR 93)	SR 60 (Memorial Hwy)	Himes Ave	8
	I-275 (SR 93)	Howard Frankland	Himes Ave	8
	I-75	S of Fowler Ave	N of CR-581	8
Manatee	None	N/A	N/A	N/A
Pasco	Clinton Ave.	Ft. King Hwy	U.S.301	4
Pinellas	Keystone Rd	US 19	East Lake Rd	4
	Bryan Dairy Rd	Starkey Rd	72nd St	6
	US 19 (SR 55)	N of Whitney Rd	S of Seville Rd	10 *
	US 19 (SR 55)	S of Seville Blvd	N of SR 60	10 *
	SR 688 (Ulmerton Rd)	W of 38th ST	W of I-275	6
	SR 688 (Ulmerton Rd)	E of 119th ST	W of Seminole Bypass	6
	SR 688 (Ulmerton Rd)	E of Wild Acres Road	El Centro Ranchero	6
	SR 688 (Ulmerton Rd)	El Centro Ranchero	W of US 19	6
	Starkey Rd	84th Lane	Tyrone Blvd	6
	Gandy Blvd	9th Street North	28th St (Ext)	6
	Starkey Rd	84th Lane	Bryan Dairy Rd	6

Sources: FDOT SIS First Five Year Plan, FDOT SIS Second Five Year Plan, Tampa Bay 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.

* 10 lanes includes 6 partially controlled lanes w/ 4-lane service roads

Figure VI-4 Evacuation Participation Rates: Hillsborough County - Site-Built Homes

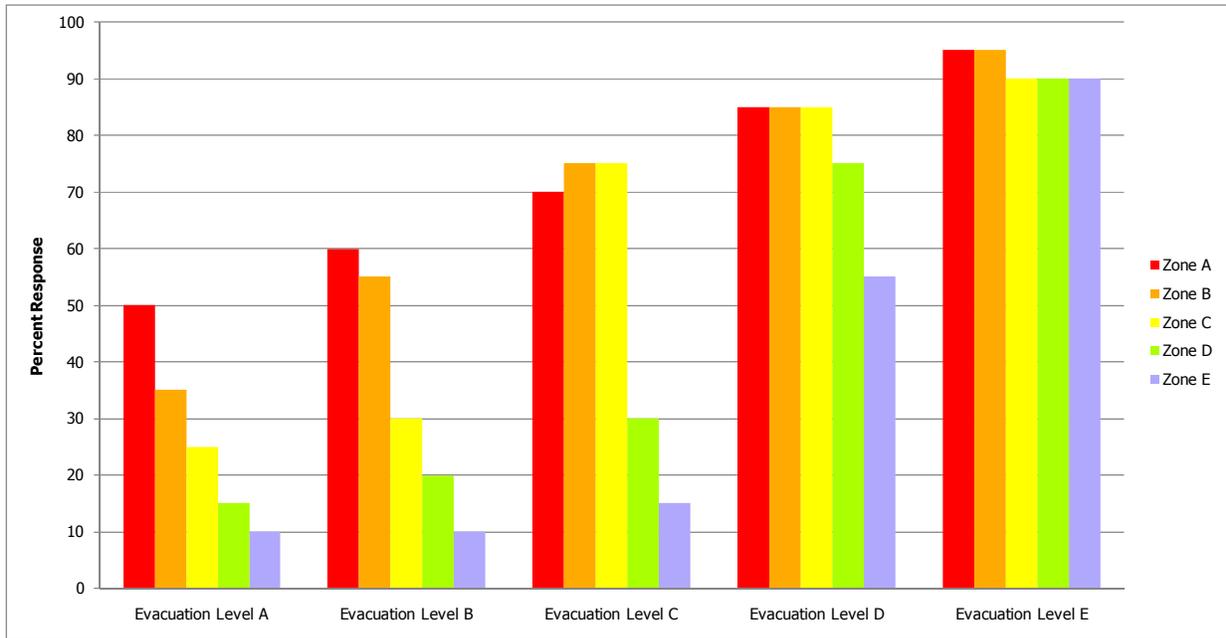


Figure VI-5 Evacuation Participation Rates: Hillsborough County - Mobile Homes

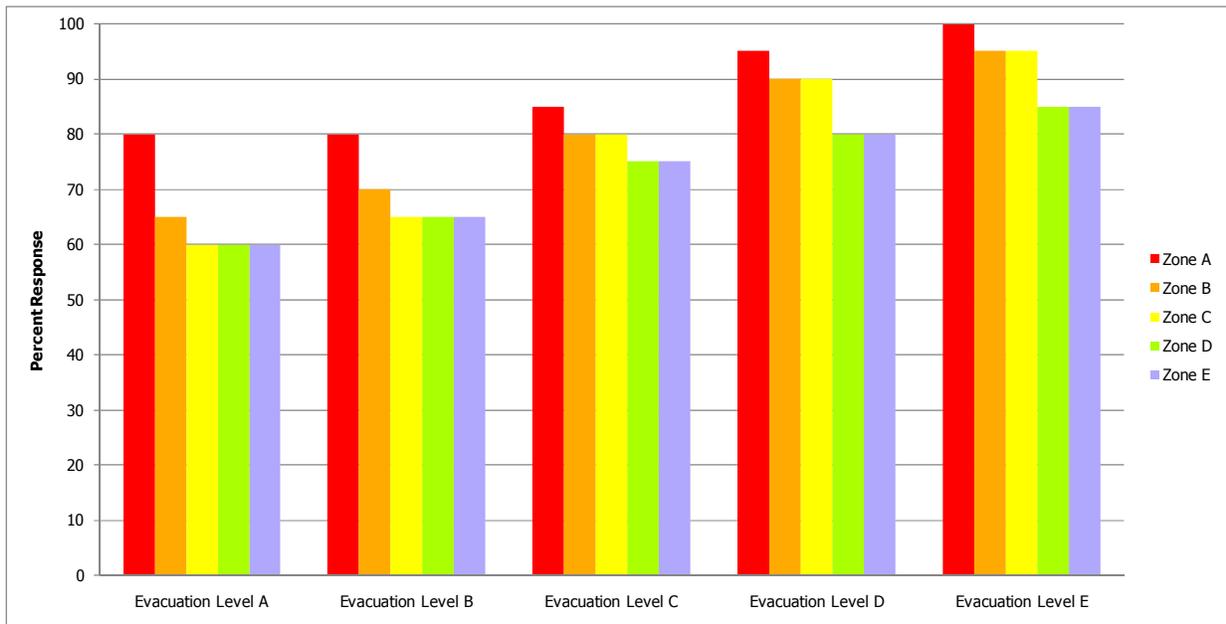


Figure VI-6 Evacuation Participation Rates: Manatee County - Site Built Homes

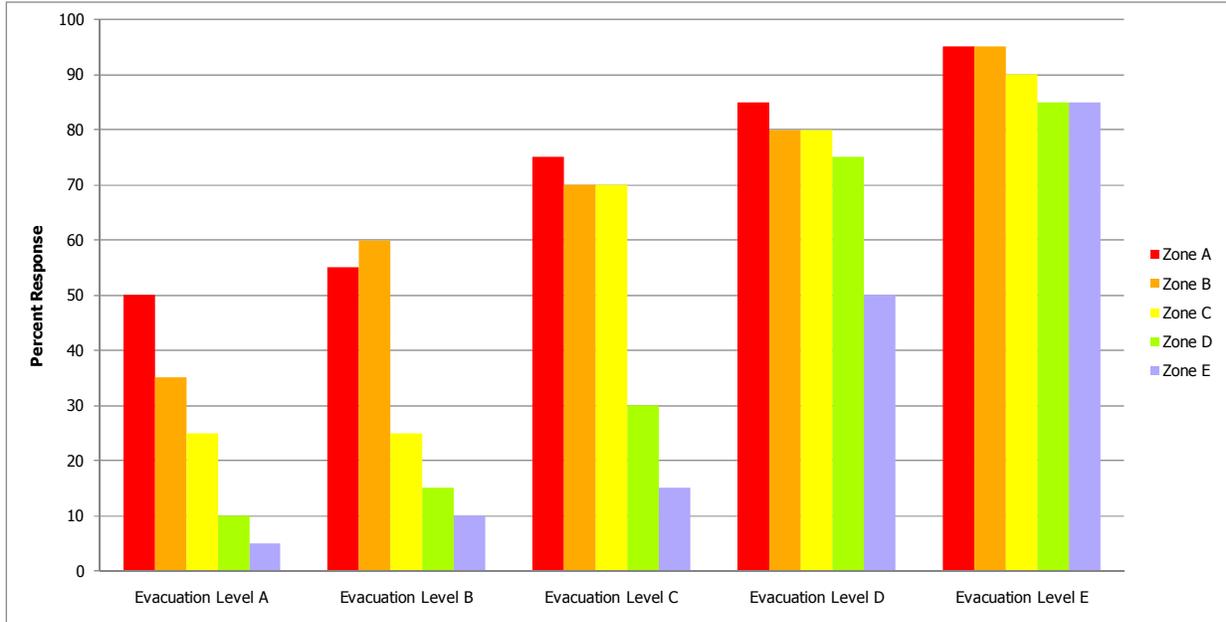


Figure VI-7 Evacuation Participation Rates: Manatee County - Mobile Homes

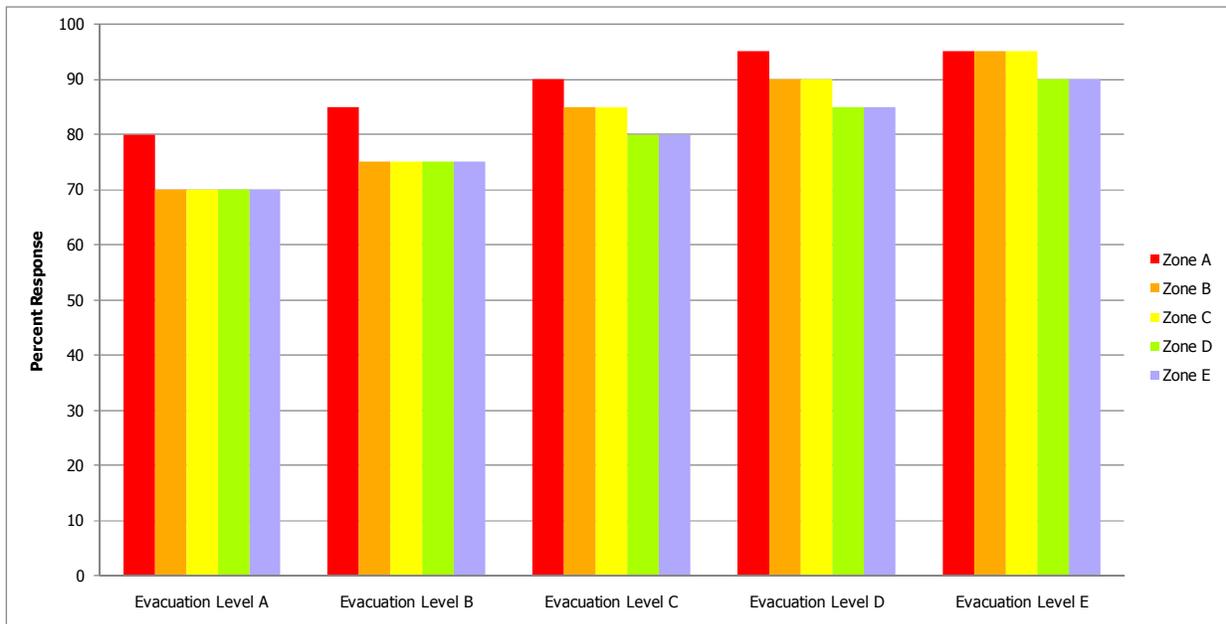


Figure VI-8 Evacuation Participation Rates: Pasco County - Site Built Homes

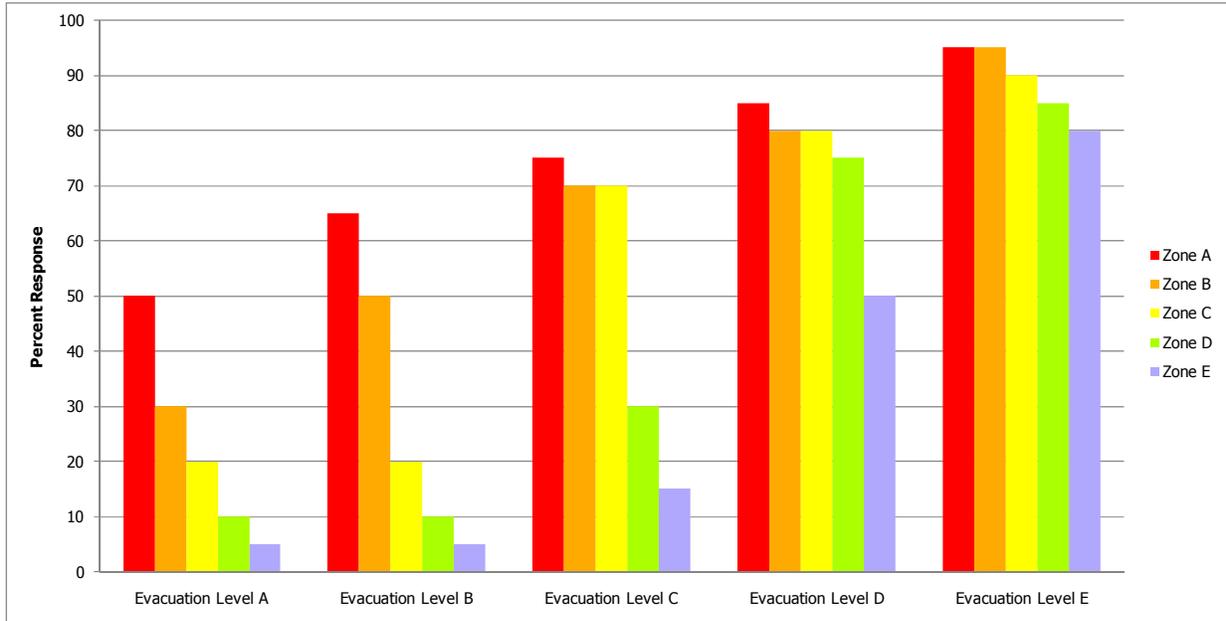


Figure VI-9 Evacuation Participation Rates: Pasco County - Mobile Homes

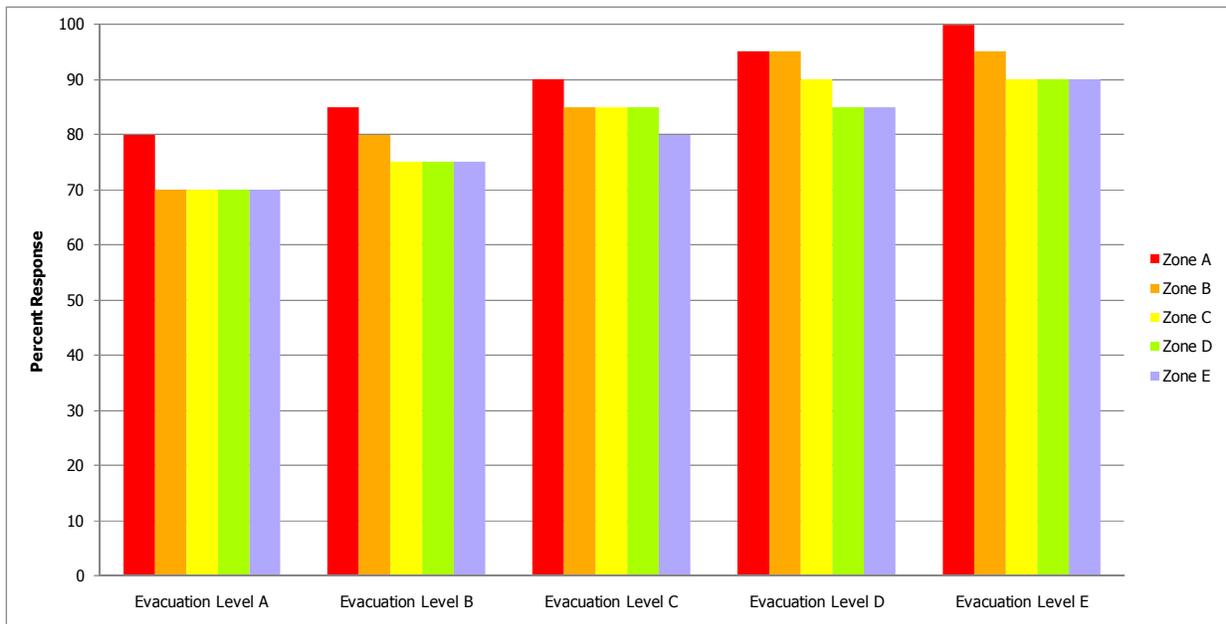


Figure VI-10 Evacuation Participation Rates: Pinellas County - Site Built Homes

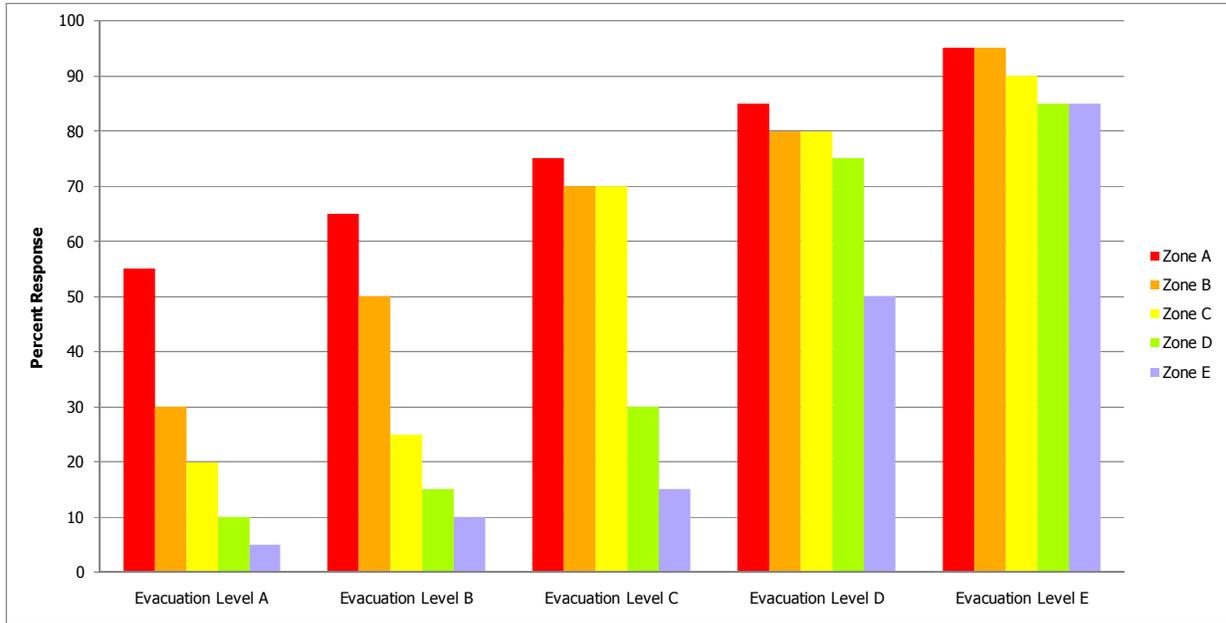
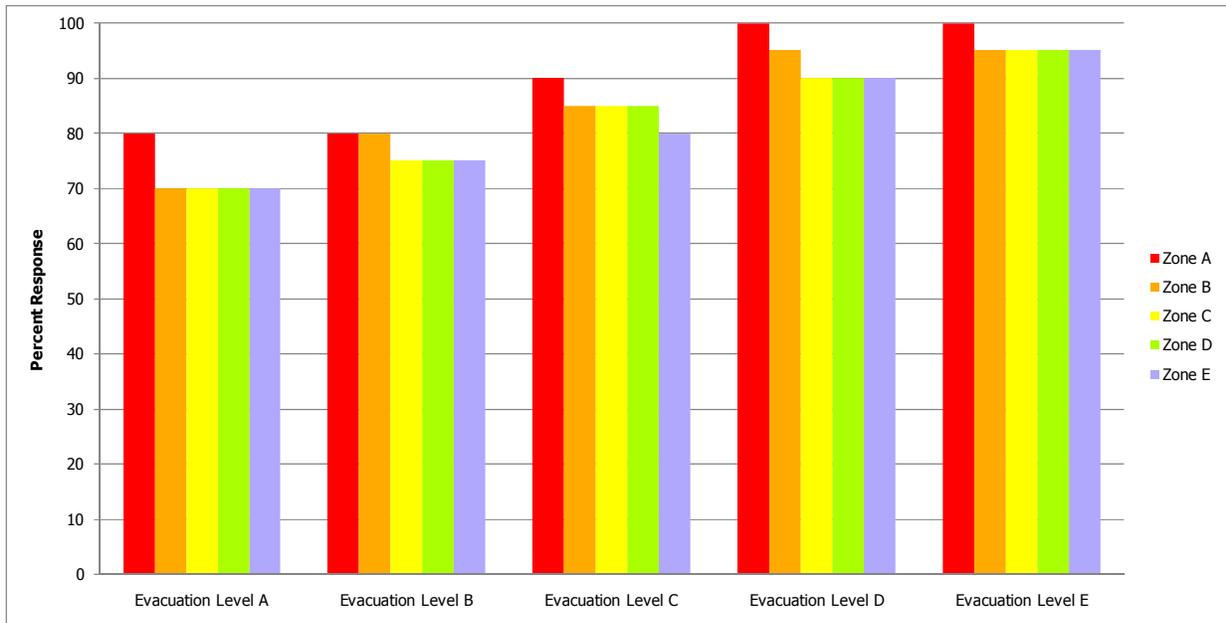


Figure VI-11 Evacuation Participation Rates: Pinellas County - Mobile Homes

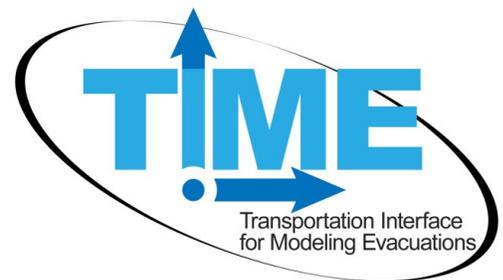


- **Evacuation Zones** - The final input variable that is needed to complete the transportation evacuation model is the delineation of evacuation zones for all coastal counties. Local county emergency managers have the responsibility of identifying and defining evacuation zones for their county. All four counties within the Tampa Bay 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 5-8.

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 Tampa Bay Region for 2010 is identified in

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

Table VI-4 Vulnerable Population in the Tampa Bay Region for 2010

	Evacuation Zone A	Evacuation Zone B	Evacuation Zone C	Evacuation Zone D	Evacuation Zone E
Hillsborough County					
Site-built Homes	81,698	106,164	59,233	65,805	66,996
Mobile/Manuf. Homes	3,677	2,599	1,883	3,065	3,989
TOTAL	85,375	108,763	61,116	68,870	70,985
Manatee County					
Site-built Homes	39,227	23,434	28,902	60,097	85,350
Mobile/Manuf. Homes	3,270	2,668	2,043	4,577	4,735
TOTAL	42,497	26,102	30,945	64,674	90,085
Pasco County					
Site-built Homes	40,286	47,938	62,409	29,734	21,788
Mobile/Manuf. Homes	4,636	4,462	5,301	3,737	2,452
TOTAL	44,922	52,400	67,710	33,471	24,240
Pinellas County					
Site-built Homes	153,436	130,087	124,181	94,025	51,953
Mobile/Manuf. Homes	2,789	6,407	8,335	8,814	1,561
TOTAL	156,225	136,494	132,516	102,839	53,514

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 Tampa Bay Region for 2015

	Evacuation Zone A	Evacuation Zone B	Evacuation Zone C	Evacuation Zone D	Evacuation Zone E
Hillsborough County					
Site-built Homes	89,414	115,711	65,565	70,976	72,318
Mobile/Manuf. Homes	3,677	2,599	1,883	3,065	3,989
TOTAL	93,091	118,310	67,448	74,041	76,307
Manatee County					
Site-built Homes	42,313	26,111	32,251	66,237	94,343
Mobile/Manuf. Homes	3,270	2,668	2,043	4,577	4,735
TOTAL	45,583	28,779	34,294	70,814	99,078
Pasco County					
Site-built Homes	41,462	49,089	64,442	31,053	22,732
Mobile/Manuf. Homes	4,636	4,462	5,301	3,737	2,452
TOTAL	46,098	53,551	69,743	34,790	25,184
Pinellas County					
Site-built Homes	158,203	134,163	128,913	98,345	53,371
Mobile/Manuf. Homes	2,789	6,407	8,335	8,814	1,561
TOTAL	160,992	140,570	137,248	107,159	54,932

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 Tampa Bay Region are identified in **Table VI-6** for 2010 and in **Table VI-7** for 2015.

The vulnerable shadow population is provided in **Table VI-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 VI-6 Vulnerable Population by Destination for 2010

	Evacuation Zone A	Evacuation Zone B	Evacuation Zone C	Evacuation Zone D	Evacuation Zone E
Hillsborough County					
To Friends and Family	55,494	70,696	39,725	44,765	46,140
To Hotel/ Motel	16,891	21,623	12,129	10,177	10,448
To Public Shelter	4,453	5,568	3,150	7,040	7,298
To Other Destination	8,538	10,876	6,112	6,887	7,098
Manatee County					
To Friends and Family	25,662	15,795	18,670	39,033	54,288
To Hotel/ Motel	8,336	3,915	4,642	9,701	13,513
To Public Shelter	2,288	2,195	2,557	6,467	9,008
To Other Destination	6,211	4,197	5,077	9,472	13,276
Pasco County					
To Friends and Family	28,504	31,217	40,361	18,222	13,209
To Hotel/ Motel	10,767	10,257	13,277	6,507	4,725
To Public Shelter	2,710	2,843	6,771	3,534	2,547
To Other Destination	2,941	8,083	7,301	5,207	3,759
Pinellas County					
To Friends and Family	109,079	88,401	85,719	66,405	34,706
To Hotel/ Motel	23,573	27,299	26,503	15,867	8,105
To Public Shelter	7,951	7,145	7,043	8,403	4,312
To Other Destination	15,623	13,649	13,252	12,164	6,390

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 2015

	Evacuation Zone A	Evacuation Zone B	Evacuation Zone C	Evacuation Zone D	Evacuation Zone E
Hillsborough County					
To Friends and Family	60,509	76,901	43,841	48,127	49,600
To Hotel/ Motel	18,434	23,532	13,396	10,953	11,247
To Public Shelter	4,838	6,045	3,467	7,557	7,830
To Other Destination	9,309	11,831	6,745	7,404	7,631
Manatee County					
To Friends and Family	27,513	17,401	20,679	42,718	59,683
To Hotel/ Motel	8,953	4,317	5,144	10,622	14,862
To Public Shelter	2,443	2,409	2,825	7,081	9,908
To Other Destination	6,674	4,652	5,646	10,393	14,625
Pasco County					
To Friends and Family	29,268	31,908	41,581	18,947	13,729
To Hotel/ Motel	11,061	10,487	13,684	6,771	4,914
To Public Shelter	2,768	2,901	6,974	3,666	2,641
To Other Destination	3,000	8,256	7,504	5,405	3,900
Pinellas County					
To Friends and Family	112,416	91,050	88,795	69,212	35,628
To Hotel/ Motel	24,288	28,114	27,450	16,514	8,318
To Public Shelter	8,189	7,349	7,279	8,749	4,426
To Other Destination	16,099	14,057	13,725	12,683	6,561

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
2010					
Hillsborough County	181,791	155,023	194,153	201,338	248,834
Manatee County	62,512	66,950	81,530	92,286	58,982
Pasco County	108,755	90,645	94,893	89,870	89,530
Pinellas County	156,002	129,276	130,801	113,936	126,882
2015					
Hillsborough County	193,691	164,826	207,741	215,901	268,265
Manatee County	68,344	74,513	92,216	105,217	70,989
Pasco County	112,233	93,794	100,439	95,365	96,988
Pinellas County	159,116	131,700	133,169	115,486	128,512

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 Tampa Bay region are identified in **Table VI-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 Tampa Bay 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 Tampa Bay 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 Tampa Bay 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 VI-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	Hillsborough Manatee Pasco Pinellas Sarasota Hernando	Hillsborough Manatee Pasco Pinellas Sarasota Hernando	Hillsborough Manatee Pasco Pinellas Sarasota Hernando	Hillsborough Manatee Pasco Pinellas Sarasota Hernando	Hillsborough Manatee Pasco Pinellas Sarasota Hernando
	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	Hillsborough Manatee Pasco Pinellas Sarasota Hernando	Hillsborough Manatee Pasco Pinellas Sarasota Hernando	Hillsborough Manatee Pasco Pinellas Sarasota Hernando	Hillsborough Manatee Pasco Pinellas Sarasota Hernando	Hillsborough Manatee Pasco Pinellas Sarasota Hernando

Table VI-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 and Skyway Bridge closes at hour 18	2010 and Skyway Bridge closes at hour 18
One-Way Operations	None	None	None	None	None
University Population	Summer	Summer	Summer	Summer	Summer
Tourist Rate	Default	Default	Default	Default	Default
Shelters Open	Primary	Primary	Primary	Primary	Primary
Response Curve	9-hour	12-hour	18-hour	24-hour except Citrus & Hernando 18-hour	24-hour except Citrus & Hernando 18-hour
Evacuation Phasing	None	None	None	Yes – Citrus & Hernando start in hour 6	Yes – Citrus & Hernando start in hour 6
Behavioral Response	Planning	Planning	Planning	Planning	Planning
Evacuation Zone	A	B	C	D	E
Counties Evacuating	Hillsborough Manatee Pasco Pinellas Sarasota Hernando Charlotte	Hillsborough Manatee Pasco Pinellas Sarasota Hernando Charlotte	Hillsborough Manatee Pasco Pinellas Sarasota Hernando Charlotte	Hillsborough Manatee Pasco Pinellas Sarasota Hernando Charlotte Citrus	Hillsborough Manatee Pasco Pinellas Sarasota Hernando Charlotte Citrus
	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 and Skyway Bridge closes at hour 18	2015 and Skyway Bridge closes at hour 18
One-Way Operations	None	None	None	Yes, I-4 & I-75	Yes, I-4 & I-75
University Population	Summer	Summer	Summer	Summer	Summer
Tourist Rate	Default	Default	Default	Default	Default
Shelters Open	Primary	Primary	Primary	Primary	Primary
Response Curve	9-hour	12-hour	18-hour	24-hour except Citrus & Hernando 18-hour	24-hour except Citrus & Hernando 18-hour
Evacuation Phasing	None	None	None	Yes – Citrus & Hernando start in hour 6	Yes – Citrus & Hernando start in hour 6
Behavioral Response	Planning	Planning	Planning	Planning	Planning
Evacuation Zone	A	B	C	D	E
Counties Evacuating	Hillsborough Manatee Pasco Pinellas Sarasota Hernando Charlotte	Hillsborough Manatee Pasco Pinellas Sarasota Hernando Charlotte	Hillsborough Manatee Pasco Pinellas Sarasota Hernando Charlotte Polk	Hillsborough Manatee Pasco Pinellas Sarasota Hernando Charlotte Citrus	Hillsborough Manatee Pasco Pinellas Sarasota Hernando Charlotte Citrus

- **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 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 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 13 hours to 60 hours, depending upon the evacuation level. Pasco County has the highest in-county clearance time of 60 hours for the level E scenario due to the influence of trips evacuating from other counties within the region. Clearance time to shelter shows a similar pattern, with clearance times ranging from 13 to 60 hours.

In 2015, in-county clearance times for the base scenarios vary between 13 hours for the evacuation level A scenarios and 58.5 hours for Pasco County for the evacuation level D 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 13 hours for the evacuation level A scenarios to 58.5 hours for Pasco County for evacuation level D scenario in 2015.

Out of county clearance times for the 2010 base scenarios range from 14 to 60.5 hours, while in 2015 they range from 14 hours for the base evacuation level A scenario to 57.5 hours in Pasco County for the evacuation level E scenario in 2015. Again, the slight drop in clearance time in 2015 is due to the completion of roadway improvement projects. Regional clearance time for the four county TBRPC region ranges from 16.5 hours to 60.5 hours.

Operational Scenarios

In-county clearance times for the 2010 operational scenarios range from 11 hours to 59.5 hours depending upon the scenario. Clearance Time to Shelter shows a similar pattern, with clearance times for the operational scenarios ranging from 10 hours to 59 hours depending upon the county and the scenario.

In 2015, in-county clearance times for the operational scenarios vary from 11 hours to 78.5 hours for the level E evacuation in Pasco County. The 2015 level E evacuation includes vehicle trips evacuating from as far south as Charlotte County, which causes a large northbound evacuation through Pasco County. Clearance Time to Shelter shows a similar pattern, with clearance times for the base scenarios ranging from 10 hours to 78.5 hours depending upon the scenario.

Out of county clearance times for the 2010 operational scenarios range from 11 hours to 60 hours for the evacuation level E scenario. The 9-hour response curve for the level A evacuation helps in reducing the clearance time from the base scenario. Out of county clearance times increase for all counties in 2015 to between 11 and 78 hours depending upon the scenario. Regional clearance time for the four county TBRPC region ranges from 13 hours to 60 hours in 2010. This time increases to between 12 and 78 hours in 2015.

Table VI-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					
Hillsborough	15.5	22.0	29.5	39.0	59.5
Manatee	12.5	12.5	17.0	20.5	34.0
Pasco	14.0	18.0	33.5	49.5	60.0
Pinellas	13.0	13.0	18.5	22.5	41.0
In-County Clearance Time					
Hillsborough	15.5	22.0	29.5	39.0	59.5
Manatee	13.5	14.0	19.0	33.0	40.0
Pasco	14.0	18.0	33.5	49.5	60.0
Pinellas	13.0	13.5	18.5	24.0	43.0
Out of County Clearance Time					
Hillsborough	16.5	23.0	29.5	47.0	59.5
Manatee	14.5	14.5	19.5	33.0	45.5
Pasco	17.0	22.0	36.0	54.5	60.5
Pinellas	14.0	13.5	18.5	24.0	43.0
Regional Clearance Time					
Tampa Bay Region	16.5	23.0	36.0	54.5	60.5

Table VI-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					
Hillsborough	14.5	22.0	29.5	41.0	54.5
Manatee	13.0	13.0	19.5	22.5	44.5
Pasco	13.5	20.5	40.5	58.5	54.0
Pinellas	13.0	13.0	20.0	29.0	50.5
In-County Clearance Time					
Hillsborough	14.5	22.0	29.5	41.0	54.5
Manatee	14.0	15.0	24.0	36.5	51.5
Pasco	13.5	20.5	40.5	58.5	54.0
Pinellas	13.5	14.0	20.0	29.0	50.5
Out of County Clearance Time					
Hillsborough	15.5	22.5	29.0	40.5	55.0
Manatee	14.5	15.0	24.0	36.0	51.5
Pasco	16.5	22.5	40.5	58.5	57.5
Pinellas	14.0	14.0	19.5	28.0	50.5
Regional Clearance Time					
Tampa Bay Region	16.5	22.5	40.5	58.5	57.5

Table VI-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					
Hillsborough	13.0	15.0	22.0	29.5	59.0
Manatee	10.0	13.0	19.0	28.0	53.0
Pasco	11.0	13.5	21.0	33.5	58.0
Pinellas	10.0	13.0	19.0	25.0	33.5
In-County Clearance Time					
Hillsborough	13.0	15.0	22.0	29.5	59.0
Manatee	11.0	14.0	20.0	29.5	53.0
Pasco	11.0	13.5	21.0	33.5	58.0
Pinellas	11.5	14.0	20.5	29.0	58.5
Out of County Clearance Time					
Hillsborough	13.0	15.5	22.0	29.0	59.0
Manatee	11.0	14.0	20.0	27.5	52.5
Pasco	11.5	14.5	21.0	34.0	60.0
Pinellas	11.5	13.5	20.0	28.5	58.0
Regional Clearance Time					
Tampa Bay Region	13.0	15.5	22.0	34.0	60.0

Table VI-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					
Hillsborough	12.0	15.5	26.0	38.0	78.0
Manatee	10.0	13.0	19.0	27.0	69.5
Pasco	12.0	13.5	23.5	40.5	78.5
Pinellas	10.0	13.0	19.5	25.5	71.0
In-County Clearance Time					
Hillsborough	12.0	15.5	26.0	38.0	78.0
Manatee	11.0	14.0	20.0	33.5	73.5
Pasco	12.0	14.5	23.5	40.5	78.5
Pinellas	11.0	14.0	20.0	31.0	72.0
Out of County Clearance Time					
Hillsborough	12.0	15.5	25.5	38.0	78.0
Manatee	11.0	14.0	20.0	33.0	75.0
Pasco	11.5	14.5	26.0	37.0	78.0
Pinellas	10.5	14.0	20.0	31.0	72.0
Regional Clearance Time					
Tampa Bay Region	12.0	15.5	26.0	38.0	78.0

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 VI-15** and for 2015 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 2010

	Evacuation Level A	Evacuation Level B	Evacuation Level C	Evacuation Level D	Evacuation Level E
Estimated Evacuating Population Clearing Hillsborough County					
12-Hour	194,303	182,151	182,810	134,161	129,871
18-Hour	267,166	273,227	365,619	201,241	194,806
24-Hour		349,123	274,214	268,321	259,742
36-Hour			449,407	402,482	389,613
Estimated Evacuating Population Clearing Manatee County					
12-Hour	86,904	112,178	111,430	93,274	82,625
18-Hour	105,009	135,549	167,145	84,717	93,209
24-Hour			181,074	112,956	124,278
36-Hour				256,504	186,418
Estimated Evacuating Population Clearing Pasco County					
12-Hour	108,478	102,527	86,642	63,495	61,938
18-Hour	153,677	153,791	129,963	95,242	92,908
24-Hour		187,967	173,283	126,990	123,877
36-Hour			259,925	190,485	185,815
Estimated Evacuating Population Clearing Pinellas County					
12-Hour	267,623	374,828	360,672	321,005	197,713
18-Hour	312,227	421,681	541,008	481,508	296,569
24-Hour			556,036	642,010	395,425
36-Hour					593,138

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 2015

	Evacuation Level A	Evacuation Level B	Evacuation Level C	Evacuation Level D	Evacuation Level E
Estimated Evacuating Population Clearing Hillsborough County					
12-Hour	222,025	200,654	201,348	168,531	152,174
18-Hour	286,782	300,982	302,021	252,796	228,260
24-Hour		376,227	486,590	337,061	304,347
36-Hour				505,592	456,521
Estimated Evacuating Population Clearing Manatee County					
12-Hour	94,284	119,100	100,436	94,896	81,446
18-Hour	113,927	148,875	150,654	142,344	122,168
24-Hour			200,872	189,791	162,891
36-Hour				284,687	244,337
Estimated Evacuating Population Clearing Pasco County					
12-Hour	115,150	103,170	79,950	61,446	68,109
18-Hour	158,331	154,754	119,925	92,168	102,163
24-Hour		193,443	159,900	122,891	136,217
36-Hour			239,850	184,337	204,326
Estimated Evacuating Population Clearing Pinellas County					
12-Hour	274,378	371,367	351,987	283,481	173,326
18-Hour	320,108	433,262	527,981	425,221	259,989
24-Hour			571,979	566,961	346,652
36-Hour				661,455	519,978

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 Tampa Bay 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 TBRPC region include I-75, I-275, and I-4. For large storm events, such as level D and E evacuations, other State facilities also play an important role in evacuations, such as SR 52 and 54 in Pasco County, SR 60 in Pinellas County, and SR 64 in Manatee County. Outside the region, the Turnpike/I-75 interchange in Sumter County is clearly an issue in all evacuation scenarios;
- During the level A and B evacuation scenarios, the roadway segments with the highest vehicle queues are primarily concentrated along the major Interstate and State Highway system. During these levels of evacuation, State and County officials should coordinate personnel resources to provide sufficient traffic control at interchanges and major intersections along these routes;
- In contrast, for the higher level C, D, and E evacuation scenarios, many other roadway facilities, both within and outside of the region, will require personnel resources for sufficient traffic control at interchanges and major intersections;
- The TBRPC counties, in coordination with the State, should continue public information campaigns to clearly define those that are vulnerable and should evacuate verses those who choose to evacuate on their own. During large storm events in the operational scenarios, evacuations by the vulnerable population in the four TBRPC Counties are impacted by shadow evacuations occurring in other parts of the counties and in areas outside the TBPRC region;
- The Florida Department of Transportation should continue to work with local counties on implementing intelligent transportation system (ITS) technology, which will provide enhanced monitoring and notification systems to provide evacuating traffic with up to date information regarding expected travel times and alternate routes;
- A comparison of the 2010 and 2015 base scenarios clearly indicate that the roadway improvement projects planned for implementation between 2011 and 2015 have an impact in reducing evacuation clearance times. Despite the increased population levels in 2015 within the TBRPC region, clearance times were generally stable between the 2010 and 2015 time periods. The roadway improvement projects were effective in keeping clearance times constant. FDOT, MPOs within the region, and county governments should continue funding roadway improvement projects within the region;

- The State can use the data and information provided in this report (specifically the evacuating vehicle maps in Volume 5-8) 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 Tampa Bay 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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