Coastal Bend Study Area Hurricane Evacuation Study Transportation Analysis Report

Prepared by

Texas A&M Transportation Institute
and
Texas A&M Hazard Reduction & Recovery Center

The Texas A&M University System

May 2020

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Date: March 23, 2020

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ACKNOWLEDGEMENT

This project was sponsored by the United States Department of Defense. The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the position or policy of the government, and no official endorsement should be inferred.

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EXECUTIVE SUMMARY

The main purpose of the transportation analysis component of the Coastal Bend region Hurricane Evacuation Study (HES) was to produce estimates of the length of time needed to evacuate ahead of a hurricane. The length of time needed to evacuate is also referred to as "clearance time." Since there is no single type of storm or storm threat, the clearance time was estimated for many different types of storm threats and related evacuations, which were called "scenarios." The scenarios were created based on results from a survey of Coastal Bend residents regarding Hurricane Harvey evacuations combined with input and review from state and local emergency management and resource agencies. **The clearance time analysis represents the estimated number of hours for residents and seasonal visitors in Aransas, Calhoun, Kenedy, Kleberg, Nueces, Refugio, San Patricio, and Victoria Counties to clear the area bounded by these counties**.

The scenarios represent different assumptions of factors that have the most influence on the evacuation clearance time. The scenarios reflect many different evacuation possibilities. For the Coastal Bend HES, the scenarios contained ranges of assumptions on:

- Proportion of population evacuating.
- How soon evacuees start to leave after an evacuation is called.
- Presence of evaculane and contraflow on Interstate Highway 37 (IH 37).

A total of 63 different scenarios were developed—with assistance from state and local representatives—that contained different combinations of values of the above assumptions as well as other less influential, but important, data inputs. Table E-1 presents a generalized summary of these scenarios and the estimated clearance times. The evaculane and contraflow clearance times reflect operation of those treatments on IH 37 only.

Table E-1. Summary of Evacuation Scenarios and Clearance Times

Percent of Population Evacuating From				Means This Many Persons Evacuating	Will Take This Long to Clear The 8-County Coastal Bend Study Area* (hours)		
"A" Zones	"B" Zones	"C" Zones	Outside Evacuation Zone		No Evaculane or Contraflow	Evaculane	Evaculane & Contraflow
75%	50%	40%	45%	377,000	45	42	40
90%	65%	55%	60%	479,000	58	50	45
100%	100%	100%	100%	681,500	80	70	60

*Reflects total time for all evacuees in private vehicles to depart the 8-county project study area. DOES NOT REFLECT TIME TO FINAL DESTINATION

The clearance time estimate for the 100% participation scenario shown in Table E-1 should be viewed as a worst-case scenario in terms of the number of hours of time needed to clear the coastal counties in the event of a coastal storm threat.

BACKGROUND

Purpose

The purpose of the transportation analysis portion of the Coastal Bend Hurricane Evacuation Study (HES) was to provide estimates of time needed to evacuate residents of the Coastal Bend study area (Aransas, Calhoun, Kleberg, Kenedy, Nueces, Refugio, San Patricio, and Victoria Counties) evacuation zones under a variety of evacuation scenarios. The clearance time estimates are inputs to the state and local storm planning efforts directed toward formalization of evacuation protocols. As such, the clearance times should make use of procedures that (a) reflect the state of the practice in evacuation scenario clearance time estimation; (b) are based on latest available local population, population characteristics, and evacuation behavior data; and (c) reflect storm impact/evacuation scenarios that state, regional, and local planners believe represent likely evacuation events.

Relationship to Other Study Components

The transportation analysis is one of the four major components of the Coastal Bend HES. The other components are the evacuation zone development, evacuation behavioral analysis, and vulnerability analysis portions of the study. The clearance time estimation aspect of the transportation analysis brings together results from the evacuation zone development, evacuation behavioral analysis, and vulnerability analysis. The evacuation zone development process defined the geographic areas that are subject to calls for evacuation and thus represented the areas for which clearance time analysis was performed. The survey of Coastal Bend residents regarding Hurricane Harvey evacuation decisions and the associated behavioral analysis provided many of the behavioral response assumptions of the various evacuation scenarios for which clearance time analyses were performed. Data analysis conducted either as part of the vulnerability analysis or used directly in the vulnerability analysis was also used in part in the development of evacuation scenario inputs and/or assumptions.

Evacuation Zone Development

The updated evacuation zone boundaries defined as part of the HES comprised the areas for which clearance times were estimated. Each evacuation zone was separately identified in FEMA's Real-Time Evacuation Planning Model (RtePM) clearance time estimation software to facilitate creation of multiple evacuation scenarios under which a range of evacuation response input assumptions were defined.

Behavioral Analysis

The behavioral analysis component of the HES included a survey of Coastal Bend residents regarding evacuation responses in advance of the landfall of Hurricane Harvey in August 2017. Survey responses regarding the decision to evacuate or not, the timing of evacuation, and the nature of departure in terms of number of people and vehicles as well as evacuation destination were used to create initial evacuation scenarios and to guide discussion with state, regional, and local stakeholders regarding variations in such inputs to form the final evacuation scenarios that were used in the clearance time estimation portion of the transportation analysis.

Vulnerability Analysis

The vulnerability analysis process provided estimates of household, seasonal, and at-risk populations that served as input population data for which clearance time estimates were modeled.

CLEARANCE TIME MODELING

Introduction and Background

Given the variety of circumstances under which evacuations may occur, the clearance time estimation portion of the transportation analysis involved the modeling of multiple evacuation scenarios. In this way, the results of the scenario modeling would offer a range of clearance times given different evacuation circumstances.

The clearance time estimation process brought together population and population-related characteristics as well as the roadway system of the defined evacuation zones and immediate surrounding areas with both localized and generalized behavioral characteristics to estimate a clearance time for different combinations of these inputs. Using information from the evacuation survey of the behavioral analysis component and the vulnerability analysis component, the study team established input data for the following RtePM data items:

1. Evacuation zones.
2. Behavioral data that include:
    a. Evacuation response rate.
    b. Percent of population using private vehicles.
    c. Percent of evacuating pedestrians.
    d. Persons per vehicle.
    e. Percent of vehicles towing another vehicle.
    f. Percent of evacuating population using shelters.
    g. Percent of population using transit.
    h. Expected response time for evacuation and evacuation start time.
    i. Destinations of evacuating population.
3. Roadway data including:
    a. Base evacuation roadway network.
    b. Selection of destination points and weight assigned to each destination point based on proportion of evacuating population destined for that location.
    c. Modification of selected roadway network to reflect evaculane as a stand-alone roadway operations enhancement and contraflow along with evaculane. Specifically,

this entailed modification to free-flow speed, number of lanes, and use of shoulder setting in the RtePM roadway network.

d. Addition of new roads as may be needed to provide connecting ramps for representation of contraflow operations.

4. Seasonal population.
5. Global variables that included level of background traffic and incident level.

Some of the data items used in the clearance time analysis were applied across all applications of RtePM (defined as global inputs in the next section), while others were varied to represent different evacuation scenarios. The variations of these values are listed under the Evacuation Scenario Development portion of this report section.

Even though most of the evacuation traffic uses freeway segments to evacuate the area, it is possible that heavy rains ahead of the need for evacuation might result in some of the base roadway network being inaccessible. The clearance time modeling assumed no impacts to the roadway system due to inland rainfall prior to initiation of evacuation.

The goal of the transportation analysis portion of the HES was to develop estimated clearance times to a point of safety, which was an area defined by the extent of the geographic area for which the HES was being performed. As such, the destination specifications used in the clearance time estimation were the locations where a roadway exited the multi-county region. No estimates of travel time by evacuees to final destination (e.g., San Antonio, Laredo, Austin, Houston, etc.) were developed by this study.

Global Inputs

Among the global inputs to the clearance time estimation process were the evacuation zones, evacuation zone populations, some behavioral data, the base evacuation network, and shelter information.

Evacuation Zones

Using RtePM's graphic interface, evacuation zones were defined based on the RtePM geographic units, which are census block groups, to match, as closely as block group boundaries allowed, the newly defined evacuation zones for the eight counties in the study area, as shown in Figure 1.

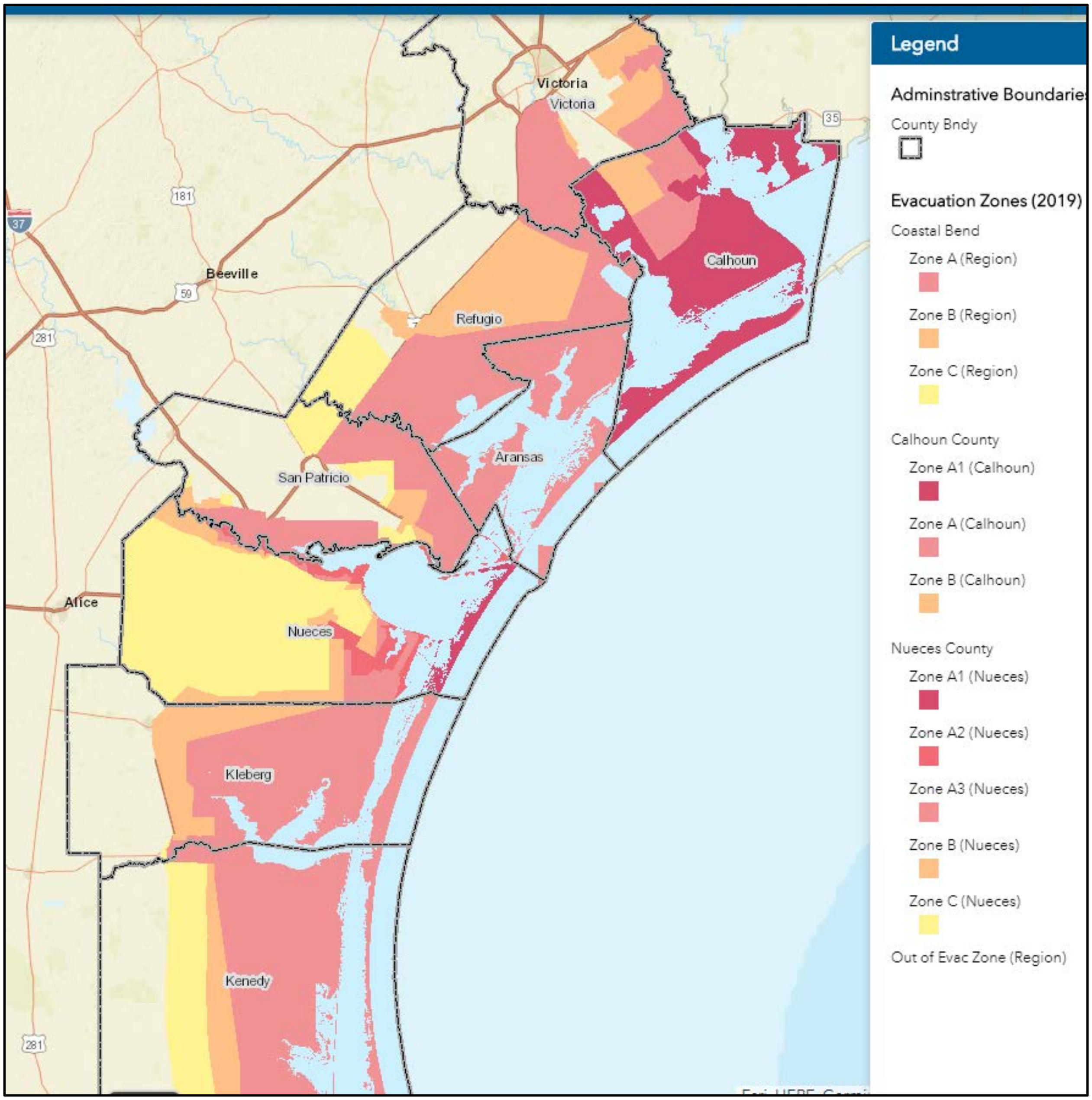

Figure 1. Coastal Bend Study Area Evacuation Zones

The areas within the study area counties but outside the evacuation zones proper were also included in clearance time estimation. These areas were included to represent populations that may evacuate along with populations within the designated evacuation zones—also referred to as the "shadow" evacuation population. For the Coastal Bend HES, shadow evacuation zones included all areas within the eight counties that were not part of the evacuation zones.

Using household population data developed for use in the HES vulnerability analysis, the RtePM estimate of population of each of the evacuation zones was adjusted within RtePM to match the population total developed for and used in the vulnerability analysis. Table 1 presents the resident populations of the evacuation zones based upon data collected for the vulnerability analysis.

Table 1. Evacuation Zone Resident Populations

Evacuation Zone	Calhoun County	Nueces County	Remaining HES Counties	HES Region
A1	15,640	12,942	—	28,582
A2	—	59,968	—	59,968
A3	—	40,821	—	40,821
A	—	—	61,319	61,319
B	—	—	88,844	88,844
C	—	—	191,403	191,403
Total	15,640	113,731	341,566	470,937

Behavioral Inputs

The negative impact of Hurricane Harvey presented an opportunity that benefited the Coastal Bend HES by offering the uncommon but highly positive ability to bring data from actual evacuation behavior into an analysis of evacuation clearance times. Rather than rely on typical hypothetical responses to an evacuation, Harvey offered the chance to survey residents who dealt with the decision to evacuate and the experiences of evacuating among those who chose to evacuate. The survey component of the behavioral analysis involved a survey of residents regarding various aspects of the response to Hurricane Harvey. The reporting of the survey data included a compilation of data on evacuation characteristics that are key clearance time modeling inputs. These data were used to supplant default values available in RtePM because it was felt that the clearance time analysis would benefit from locally based inputs.

Table 2 presents RtePM behavioral inputs that were derived from the survey of Coastal Bend residents and applied universally across all evacuation scenarios.

Table 2. Behavioral Data Input Derived from Behavioral Survey

Input Data Item	Evacuation Zone			Outside Evacuation Zone
	A*	B	C	
Percent of evacuating pedestrians	0%	0%	0%	0%
Percent of population using private vehicles	95%	95%	95%	95%
Percent of population using transit	5%	5%	5%	5%
Persons per vehicle	2.0	2.0	2.0	2.0
Percent of vehicles towing another vehicle	15%	10%	7%	4%

*Includes A-1, A-2, and A-3 zones where they exist.

Table 3 presents the RtePM behavior inputs regarding the distribution of evacuation departures of the study area among the major roadways leading out of the study area. The endpoint roadways and distribution of demand among the endpoints automatically selected by RtePM were adjusted to reflect 1) status as a designated evacuation route by the Texas Department of Transportation (TxDOT), 2) results of the behavior survey and 3) input from regional and local project stakeholders. This adjustment was performed so that the clearance time results would reflect observed and known choices on location and scope of traffic exiting the study area during an evacuation event

Table 3. Study Area Roadway Endpoint Distribution of Demand

Endpoint Roadway	Share of Evacuation Demand
SH 285	2%
SH 35	5%
US 59	8%
FM 665	5%
IH 37	35%
US 77	5%
US 183	3%
FM 624	2%
US 181	15%
E Highway 44	10%
SH 141	5%
US 87/Broadway	5%

Level of Background Traffic

In the context of clearance time analysis within RtePM, background traffic represents non-evacuation-related traffic that occurs on the roadway systems on a typical day. Although the level of background traffic does not substantially affect resulting clearance time, the level of background traffic was set to the "high" option within RtePM to provide the most conservative level of clearance time.

Level of Incidents

The level of traffic incidents, like background traffic, is used within RtePM to affect the clearance time estimates. As with background traffic, the level of traffic incidents does not substantially affect resulting clearance time. To produce clearance time estimates to support the most conservative approach to evacuation timing, the level of traffic incidents was set to the "high" option within RtePM.

Roadway Data

The RtePM graphic interface uses HERE's roadway data as a default choice for selecting a roadway network for evacuation. The portions of the roadway network used in the clearance time modeling are automatically selected following definition of the evacuation zones either by freehand drawing of a polygon or importing polygon geography. It is noteworthy that once a base evacuation roadway network has been automatically selected, it is possible to manually add or delete a roadway segment from the evacuation network. However, roadways that cross the evacuation area boundary cannot be added to the network. For the Coastal Bend HES, the study team reviewed the base evacuation roadway network selected by RtePM for content and consistency with known roadway coverage and found it to be acceptably accurate. The base roadway network for the Coastal Bend HES is shown in Figure 2.

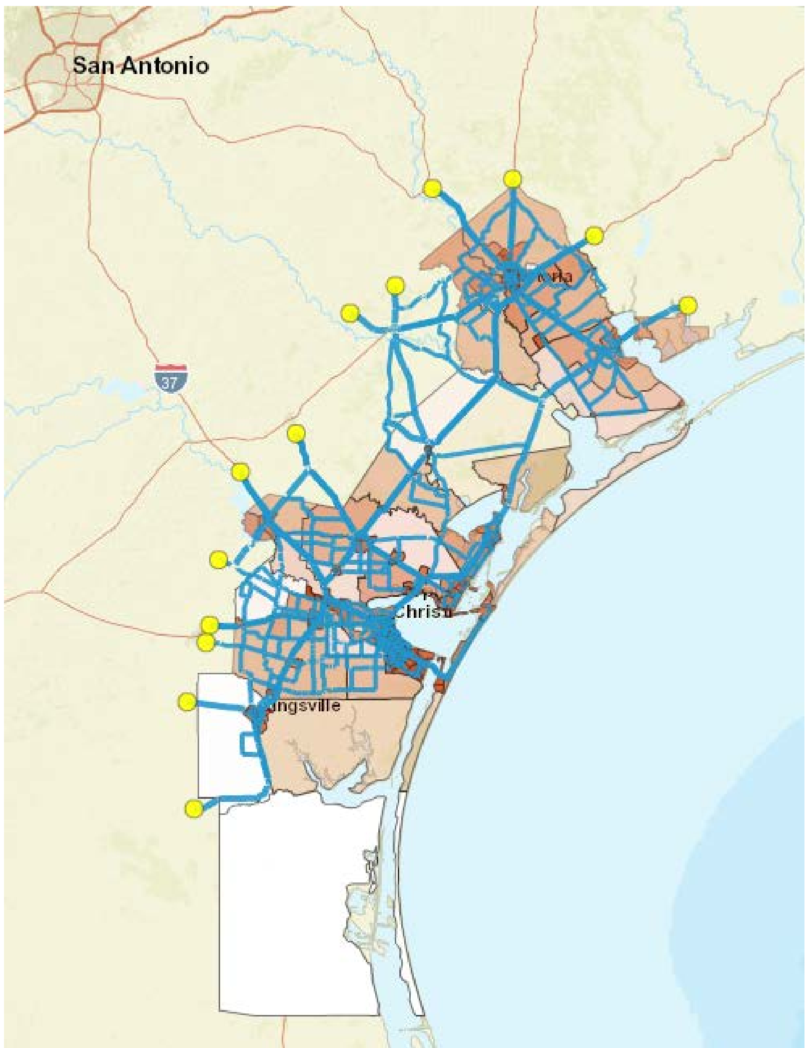

Figure 2. Base Roadway Network for Coastal Bend HES

Shelter Data

For the Coastal Bend HES, no shelters were added to the RtePM model. The available shelter capacity in the area was not considered large enough to make a significant difference in clearance time calculations. The study team understood that the majority of available shelters in the evacuation area would be used as temporary places to gather special needs evacuees and might be used by the non-evacuating population as shelters of last resort.

Scenario-Specific Inputs

Among the scenario-specific inputs were a set of behavioral data, changes to roadway data to reflect evaculane and contraflow operations on IH 37, use of seasonal populations, and global variables such as level of background traffic and incidents during evacuation.

Behavioral Data

Behavioral data inputs that varied by scenario included:

1. Evacuation response rate.
2. Evacuation response time.
3. Evacuation start time.

Evacuation Response Rate

The evacuation response rate represents the proportion of residents who participate in an evacuation. The response rate is varied among evacuations zones to reflect changes in level of participation corresponding to level of exposure and perceived life-safety threat due to storm surge. Results from the behavior survey conducted as part of the HES behavioral analysis were used in the definition of scenarios directly and were varied to create scenarios of different levels of participation.

Evacuation Response Time

Evacuation response time, in the context of the transportation analysis, represents the time lapse between the advisement or ordering of an evacuation and the point at which all those participating in the evacuation have departed their evacuation trip origin point. The length of the response time affects that rate at which evacuation demand enters the roadway system and many times heavily influences the clearance time outcome. The response time is varied to create scenario variations. Results from the behavior survey conducted as part of the HES behavioral analysis were used to inform the decision-making on the response time variations to use in the creation of scenarios.

Evacuation Start Time

Evacuation start time defines the time of day at which evacuation travel begins. The start time is commonly defined with the assumption that hurricane-oriented evacuations are not immediate in nature and allow evacuees to engage in preparation for evacuation and then departure early in the daylight hours. The start time is also somewhat tied to evacuation response time in that response times of 24 hours or less assume most evacuees will travel during daylight hours.

Roadway Data

RtePM allows represented roadway networks to be modified to reflect evaculane (shoulder) or contraflow operations. For the Coastal Bend HES study, the study team used evaculane and contraflow plans from the Department of Public Safety and TxDOT to represent the evaculane and contraflow operations on IH 37 among the evacuation scenarios.

Seasonal Population

Seasonal population represents the population residing in seasonal housing units (i.e., hotels, motels, condos) or in mobile housing units (recreational vehicles, travel trailers, mobile homes) during an evacuation event. Estimates of the population in these two components of seasonal population are based upon counts of seasonal housing and mobile units developed with state and local data sources along with detailed review of aerial imagery. These estimates of seasonal units were reviewed by local project stakeholders who provided additional supplemental data that were included in the final estimates of seasonal units.

Seasonal population is included in the estimation of total population in the study area so that evacuation population includes resident and seasonal populations. Seasonal population for each evacuation zone was included among the scenario inputs. As with resident population, participation rates among seasonal population were varied as part of the evacuation scenario definition. Table 4 presents the estimate of total seasonal population among the evacuation zones as revised as part of this study. The proportion of this population deemed to participate in an evacuation was varied as part of evacuation scenario development.

Table 4. Seasonal Population Estimate

Evacuation Zone/Area			Outside Evacuation Zone		Study Area Total
A	B	C	San Patricio and Victoria Counties	Refugio and Kleberg Counties	
58,900	7,100	13,300	8,300	500	88,100

EVACUATION SCENARIO DEVELOPMENT

Theoretically speaking, the variety of scenarios analyzed was limited only to the variations of input data values available either in RtePM or via local data. Practically speaking, there was a need to limit the scenarios so that (a) each reflected local- and state-level stakeholder interests, (b) they were focused on variables to which RtePM exhibited sensitivity, and (c) they were not so numerous as to result in an inability of the team to effectively communicate results or for the team and project stakeholders to draw meaningful conclusions.

Based on past RtePM assessments by the study team, the important RtePM input variables for consideration in the development of scenarios were known. Therefore, the scenario development process relied upon the past RtePM assessments as well as local and regional project stakeholder input to develop all of the scenarios for which clearance time modeling was performed.

Scenario Development Process

To facilitate the development of scenarios with input from regional and local project stakeholders, the study team constructed a simplified set of scenarios and performed a streamlined clearance time analysis on those scenarios. Since the preliminary scenarios were meant to be illustrative in nature and facilitate discussion and decision-making on full scenarios, the preliminary scenarios did not include representation of seasonal populations and lacked specific inputs on roadway endpoint distributions. The scenarios were constructed to provide regional and local project stakeholders with a sense of the orders of magnitude of clearance times relative to the overall level of participation and response time.

The results of the clearance time analysis of the preliminary scenarios were presented to regional and local stakeholders for review and discussion. The assumptions regarding participation rates and response times that characterized the preliminary scenarios were discussed and decisions made regarding the assumptions regional and local stakeholders wished to include in the final set of scenarios. In addition, scenario assumptions regarding treatment of seasonal populations and destination roadway endpoints and agreement on the use of results from the behavioral survey with respect to inputs on the level of use of private vehicles, prevalence of towing, and evacuation of persons per vehicle were established through discussion with regional and local stakeholders.

Evacuation Scenarios

The scenario development process yielded three groups of scenarios with respect to evacuation participation, as shown in Table 5. The first group, named the "Recent Experience" group, was based upon the evacuation participation levels reported in the survey of Coastal Bend residents' response to Hurricane Harvey in 2017 as part of the behavioral analysis. The second group of scenarios that was created reflected the desire to see participation levels moderately higher than those observed for Hurricane Harvey. This group of scenarios was termed "Recent Experience Plus." The third set of scenarios was developed to gain a sense of clearance times in the extremely unlikely circumstance of 100% of the population from the entire region participating in an evacuation. This group of evacuation scenarios, termed "Maximum Evacuation" group and developed for application with the clearance time analysis tool RtePM, reflected the desires of regional and local emergency managers with respect to establishing clearance times for evacuations of varying degrees of magnitude.

Table 5. Scenario Groups—Evacuation Participation and Population

Scenario Group	Population	Evacuation Zone/Area				Persons Evacuating
		A	B	C	Outside Evacuation Zone	
Recent Experience	% Resident Pop % Seasonal Pop	75% 75%	51% 51%	40% 40%	44% 44%	377,000
Recent Experience Plus	% Resident Pop % Seasonal Pop	90% 90%	66% 66%	55% 55%	59% 59%	479,200
Maximum Evacuation	% Resident Pop % Seasonal Pop	100% 100%	100% 100%	100% 100%	100% 100%	681,400

Application of the global variables (i.e., applying to all scenarios) dealing with the proportion of the population evacuating by private vehicle and the average number of persons per vehicle yielded persons evacuating by private vehicle and evacuating vehicle estimates, as shown in Table 6.

Table 6. Persons Evacuating in Private Vehicles and Vehicles Evacuating

Scenario Group	Persons Evacuating in Private Vehicles	Vehicles
Recent Experience	357,700	179,000
Recent Experience Plus	454,800	227,500
Maximum Evacuation	646,900	323,600

The variation sets of these scenario groups were created using the following inputs.

- Response time (2 days, 24 hours, and 5 hours).
- IH 37 evaculane: not-operational/operational.
- IH 37 contraflow: not-operational/operational in conjunction with evaculane.

Scenario Group 1—Recent Experience

The study team, with input from regional and local project stakeholders, developed nine variations of scenarios in which the evacuation participation rate mirrors that seen in the Coastal Bend evacuation behavior survey. These scenarios are shown in Table 7.

Table 7. Recent Experience Scenario Group

Scenario Group	Evaculane	Contraflow	Response Time
Recent Experience	No	No	2 days 24 hours 5 hours
	Yes	No	2 days 24 hours 5 hours
	Yes	Yes	2 days 24 hours 5 hours

Scenario Group 2—Recent Experience Plus

The study team, with input from regional and local project stakeholders, identified nine variations of scenarios for the Recent Experience Plus group. These scenarios are shown in Table 8.

Table 8. Recent Experience Plus Scenario Group

Scenario Group	Evaculane	Contraflow	Response Time
Recent Experience Plus	No	No	2 days 24 hours 5 hours
	Yes	No	2 days 24 hours 5 hours
	Yes	Yes	2 days 24 hours 5 hours

Scenario Group 3—Maximum Evacuation

The study team, with input from regional and local project stakeholders, identified nine variations of scenarios for the Maximum Evacuation group. These scenarios are shown in Table 9.

Table 9. Maximum Evacuation Scenario Group

Scenario Group	Evaculane	Contraflow	Response Time
Maximum Evacuation	No	No	2 days 24 hours 5 hours
	Yes	No	2 days 24 hours 5 hours
	Yes	Yes	2 days 24 hours 5 hours

All 2-day scenario variations assumed the division of evacuation response, as shown in Table 10. These 2-day scenarios assumed 4:00 a.m. as the evacuation start time and midnight as the evacuation end time on each day, resulting in a total response time of 44 hours over the 2-day period. For the 5-hour and 24-hour response times, an evacuation start time of 8:00 a.m. was used. The choice of start time will affect clearance times in a minor way since presence of background traffic varies throughout the day to mimic normal traffic patterns.

Table 10. Evacuation Response Rate—2-Day Scenarios

	All Areas
Day 1	65%
Day 2	35%

Clearance Time Results

The clearance times for each scenario group, resulting from application of RtePM, are presented below.

Recent Experience

Using RtePM, the study team calculated clearance times for the nine scenarios that made up the Recent Experience scenario group. The clearance time results for the nine scenarios are shown in Figure 3.

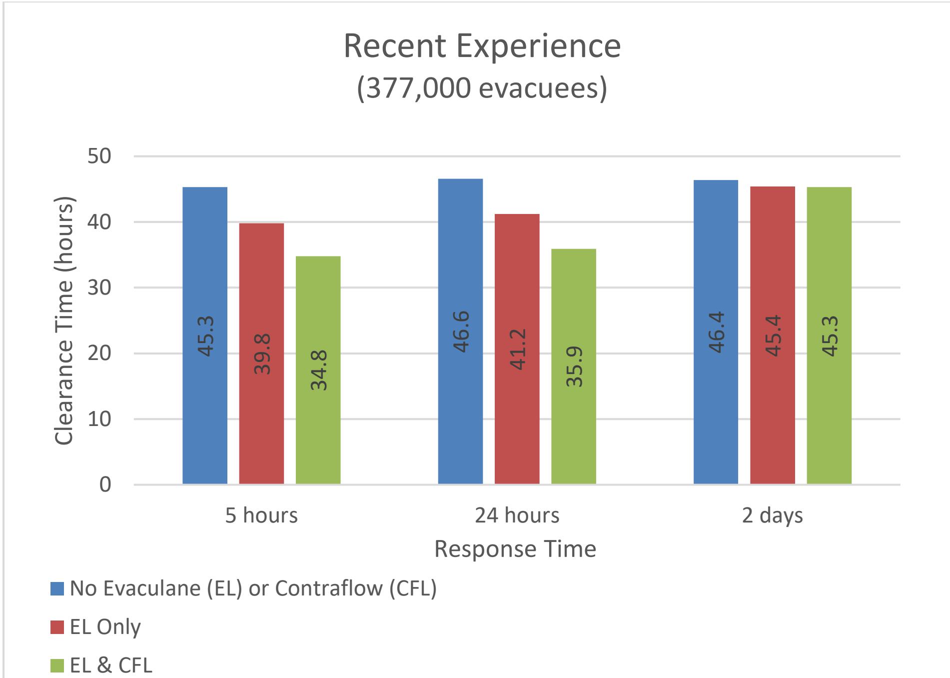

Figure 3. Clearance Time—Recent Experience Scenario Group

The results show that operations of evaculane on IH 37 alone as well as both evaculane and contraflow on IH 37 substantially reduce clearance time for all response times for the 5-hour and 24-hour response times. The relatively limited impact of evaculane and contraflow for the 2-day response time suggests that evaculane and contraflow have little effect on clearance time when not much more than 50% of the total population of the Coastal Bend region (375,000 of 681,000) enter the roadway system over a 2-day period.

Recent Experience Plus

Using RtePM, the study team produced clearance time estimates for the nine scenarios that represent evacuation participation rates that are higher than recent experience but less than full participation. Figure 4 presents the results from this scenario group.

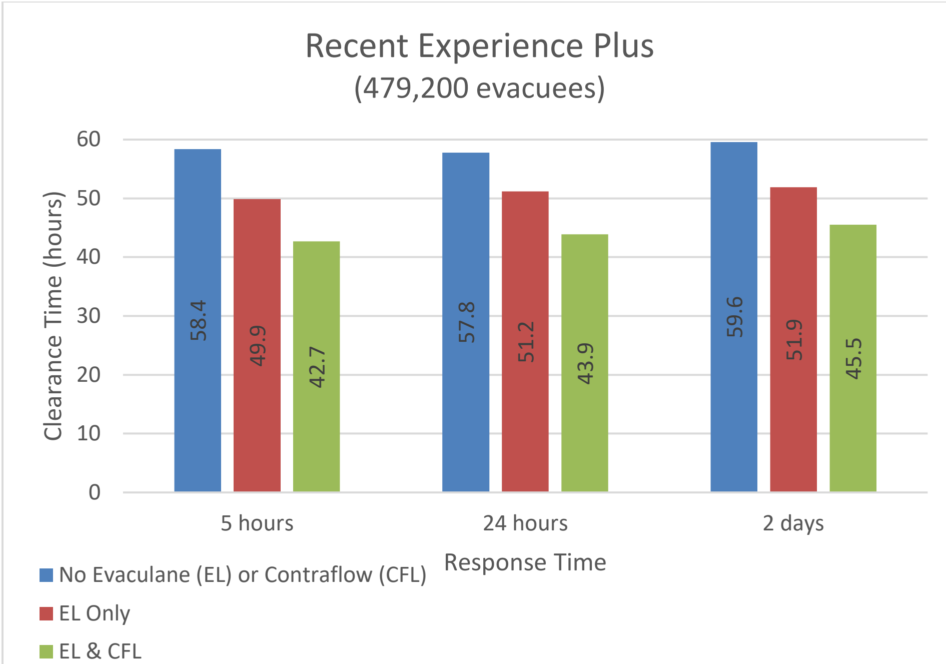

Figure 4. Clearance Time—Recent Experience Plus Scenario Group

As with the Recent Experience scenario group and as would be expected, implementation of evaculane on IH 37 reduces clearance time, and implementation of both contraflow and evaculane on IH 37 reduces clearance time even further, for the 5-hour and 24-hour response time variations. These results also indicate that even for the multi-day response time variation, evaculane and contraflow on IH 37 do substantially reduce clearance time. This is likely due to the higher level of evacuation population in this scenario group compared to the Recent Experience scenario group.

Maximum Evacuation

Using RtePM, the study team produced clearance time estimates for the nine scenarios that represent 100% participation rates by residents and seasonal visitors to the Coastal Bend study area. Figure 5 presents the results from this scenario group.

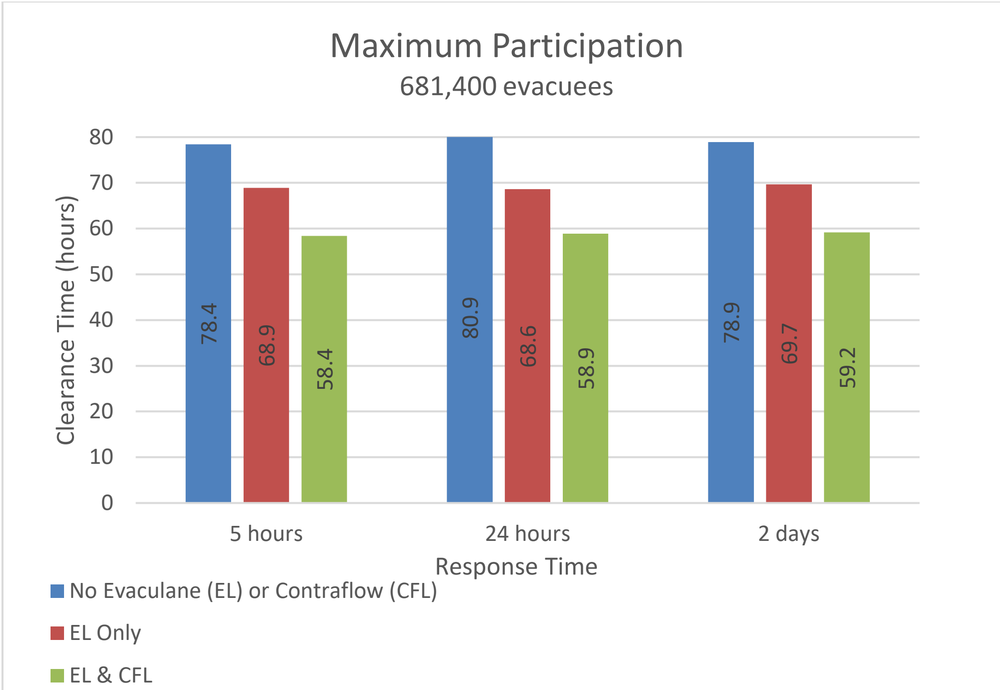

Figure 5. Clearance Time—Maximum Participation Scenario Group

As with the Recent Experience Plus scenario group, the implementation of evaculane and contraflow on IH 37 substantially reduce clearance time for all response time variations. This further illustrates the need and benefit of implementing evacuation/contraflow on IH 37 as the expected number of evacuating population increases.

Roadway-Related Results

A look at the clearance time results suggests that at all participation levels evaluated, response time seems to have little effect on the clearance time when no evaculane or contraflow is present. This suggests that, at least for evacuating populations of 375,000 or more, clearance time is not affected by the provision of additional lead time (i.e., response time—time between call and when last evacuees start their evacuation trip). This is not meant to imply that additional lead time is not important, just that additional lead time does not shorten the time for evacuees to reach a location of safety outside an area expected to be impacted by storm surge. Figure 6 presents the clearance times for the no evaculane and no evaculane/contraflow variations for all three scenario groups and shows the lack of variation of clearance time among a scenario group.

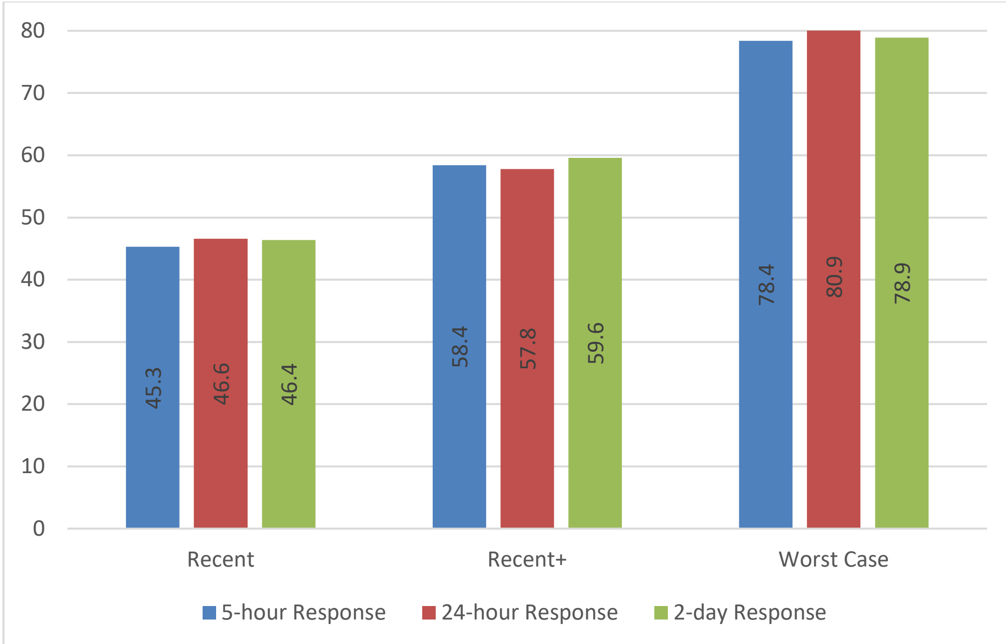

Figure 6. Clearance Time—No Evaculane and/or Contraflow

The other major takeaway from the results is that the clearance time modeling shows that the operation of evaculane alone on IH 37 as well as evaculane along with contraflow on IH 37 substantially reduces clearance time. Table 11 presents the reduction of clearance time relative to the no evaculane/contraflow scenario variations.

Table 11. Reduction in Clearance Time Relative to No Evaculane and No Evaculane and Contraflow

Participation Level	Response Time	IH 37 Evaculane Only		IH 37 Evaculane & Contraflow	
		Hours	Percent	Hours	Percent
Recent	5 hours	5.5	12.1%	10.5	23.2%
	24 hours	5.4	11.6%	10.7	23.0%
	2 days	1.0	2.2%	1.1	2.4%
Recent Experience Plus	5 hours	8.5	14.6%	15.7	26.9%
	24 hours	6.6	11.4%	13.9	24.0%
	2 days	7.7	12.9%	14.1	23.7%
Maximum Participation	5 hours	9.5	12.1%	20.0	25.5%
	24 hours	12.3	15.2%	22.0	27.2%
	2 days	9.2	11.7%	19.7	25.0%

As would be expected, the implementation of additional evacuation traffic capacity on a roadway increases the amount of traffic on that roadway. For the Coastal Bend study, the scenario variations that include evaculane alone on IH 37 and evaculane plus contraflow on IH 37 result in IH 37 becoming a more highly used route out of the study area. Table 12 presents the change in expected traffic volume compared to the no evaculane and no contraflow scenario variation. The data confirm that the evacuation volume on IH 37 increases substantially in conjunction with the increased capacity provided by evaculane and contraflow. The provision of these operational enhancements results in IH 37 becoming a more attractive route for evacuating vehicles within the RtePM traffic assignment process. The increase in expected traffic volume on IH 37 results in a decrease in expected traffic volume on other departure routes. These values represent the total traffic at the point where the exiting roadway crosses the Coastal Bend study area boundary (i.e., the county line).

Table 12. Change in Traffic Volume on Exiting Roadways

Roadway	Percent Change in Traffic Volume*	
	IH 37 Evaculane	IH 37 Evaculane & Contraflow
IH 37	23%	44%
SH 285	−16%	−30%
SH 35	−10%	−23%
US 59	−15%	−28%
FM 665	−14%	−26%
US 77	−15%	−28%
US 183	−14%	−31%
FM 624	−18%	−25%
US 181	−15%	−29%
E Highway 44	−15%	−28%
TX 141	−12%	−25%
US 87/Broadway	−15%	−33%

*Compared to no evaculane and no contraflow on IH 37.

Note: Average of response times for max participation scenario.

Although RtePM is not meant for operational analysis of roadways, it does provide tabular and visual reporting of congestion (i.e., delay) by road section. Figure 7 and Figure 8 present images of roadway performance for 1-hour segments of time within a multi-hour evacuation clearance analysis. These figures come from the Recent Experience Plus scenario group.

Figure 7 shows the state of the roadways in the 6th hour of evacuation event from the Recent Experience Plus scenario group with a 5-hour response time and no evaculane or contraflow. Congestion on the roadway segments represented in RtePM is indicated by a change in color from green to yellow and then to red based on the level of congestion.

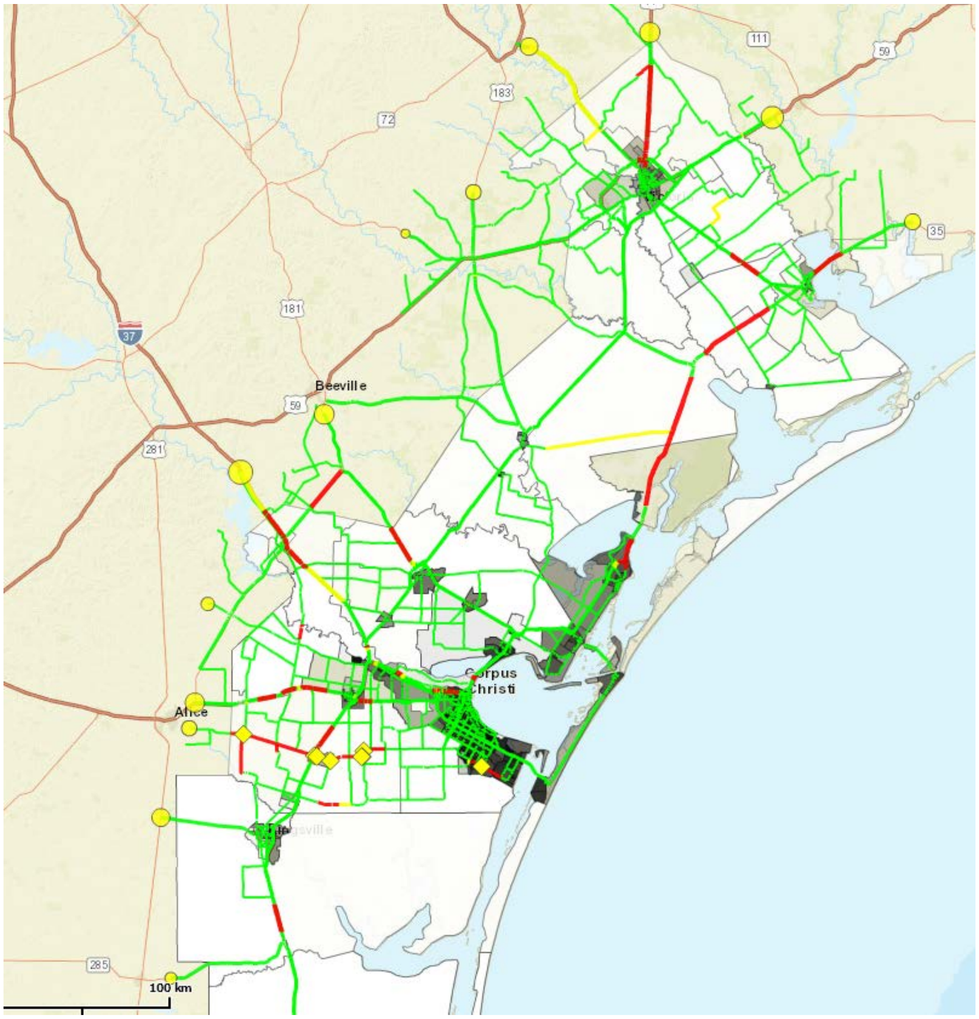

Figure 7. Roadway Status: Recent Experience Plus 5-Hour Response—Hour 6

Figure 8 presents the state of the roadways in the 12th hour of evacuation event from the Recent Experience Plus scenario group with a 5-hour response time and no evaculane or contraflow. As the figure indicates, roadway congestion has increased.

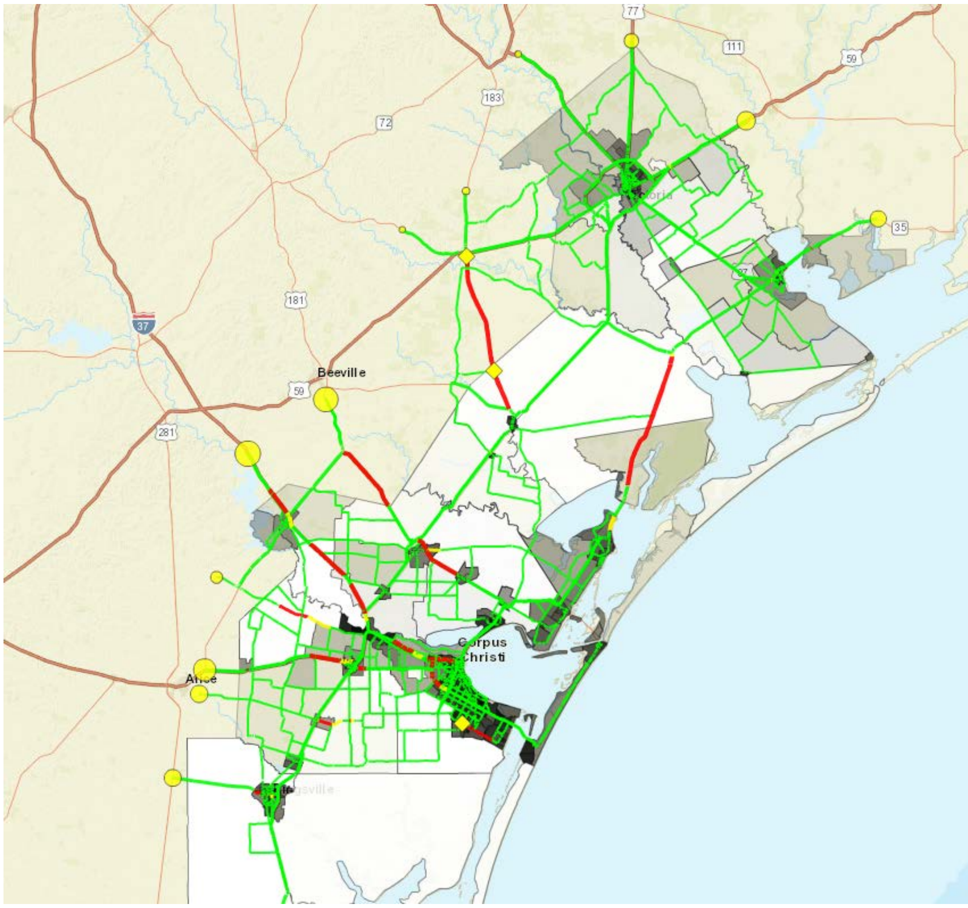

Figure 8. Roadway Status: Recent Experience Plus 5-Hour Response—Hour 12

Although congestion does appear (as indicated by segments colored red and yellow), none of the roadway segments were found to be continuously congested during the evacuation response time for any of the scenarios. The most prominent areas of congestion are along road segments outside the populated core of the study area near or connected to the roadway system endpoints of the study area.

SUMMARY

The modeling of clearance times as part of the transportation analysis estimated that evacuating a population at a size similar to what was seen in response to Hurricane Harvey (i.e., slightly more than half of the resident and common seasonal populations) from the area comprised of Aransas, Calhoun, Kleberg, Kenedy, Nueces, Refugio, San Patricio, and Victoria Counties would require a minimum time of 36 hours and could stretch to almost 48 hours depending on the pace at which evacuees begin the evacuation journey from their homes.

Clearance time analysis of an evacuation event involving levels of evacuation in between Harvey levels but less than 100% evacuation would require slightly less than 60 hours for evacuees to clear the area. Implementation of evaculane alone on IH 37 would reduce that time by slightly less than

10 hours, while implementation of evaculane along with contraflow on IH 37 would reduce clearance time by roughly 15 hours.

Based on the clearance time modeling, a worst-case evacuation event that involved all resident and common seasonal populations departing the eight-county area would require roughly 80 hours. Implementation of evaculane on IH 37 could reduce that time by roughly 10 hours, and implementation of evaculane plus contraflow on IH 37 could reduce that time by roughly 20 hours.