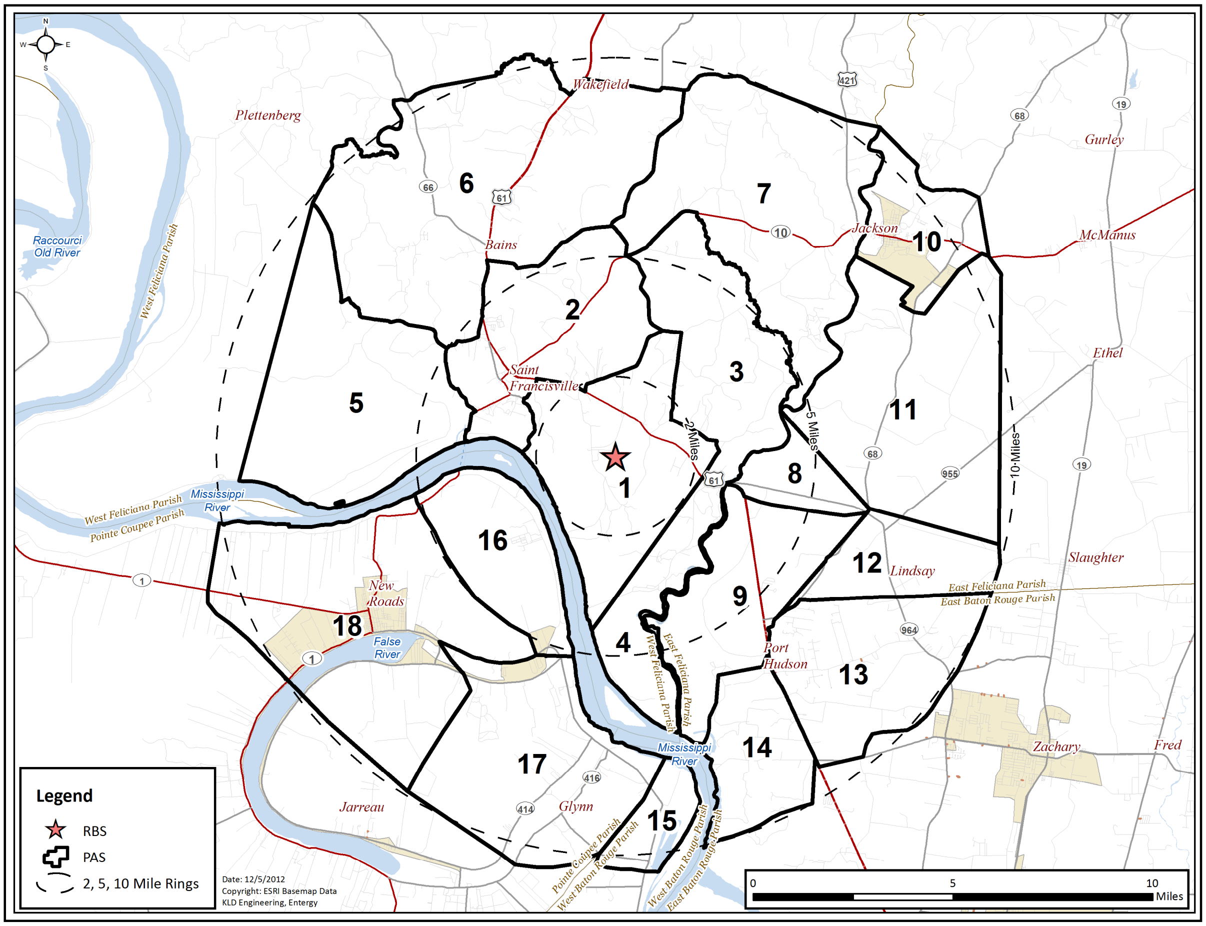
River Bend Station

Development of Evacuation Time Estimates



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EXECUTIVE SUMMARY

This report describes the analyses undertaken and the results obtained by a study to develop Evacuation Time Estimates (ETE) for the River Bend Station (RBS) located in West Feliciana Parish, LA. ETE are part of the required planning basis and provide Entergy and State and local governments with site-specific information needed for Protective Action decision-making.

In the performance of this effort, guidance is provided by documents published by Federal Governmental agencies. Most important of these are:

- Criteria for Development of Evacuation Time Estimate Studies, NUREG/CR-7002, November 2011.
- Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants, NUREG-0654/FEMA-REP-1, Rev. 1, November 1980.
- Development of Evacuation Time Estimates for Nuclear Power Plants, NUREG/CR-6863, January 2005.
- 10CFR50, Appendix E – "Emergency Planning and Preparedness for Production and Utilization Facilities"

Overview of Project Activities

This project began in March 2012and extended over a period of six months. The major activities performed are briefly described in chronological sequence:

- Attended "kick-off" meetings with Energy personnel and emergency management personnel representing state and parish governments.
- Accessed U.S. Census Bureau data files for the year 2010. Studied Geographical Information Systems (GIS) maps of the area in the vicinity of the River Bend Station, then conducted a detailed field survey of the highway network.
- Synthesized this information to create an analysis network representing the highway system topology and capacities within the Emergency Planning Zone (EPZ), plus a Shadow Region covering the region between the EPZ boundary and approximately 15 miles radially from the plant.
- Designed and sponsored a telephone survey of residents within the EPZ to gather focused data needed for this ETE study that were not contained within the census database. The survey used was carried out in 2008; it is still valid since there has not been a significant change in EPZ demographics. The survey instrument had been reviewed and modified by the licensee and offsite response organization (ORO) personnel prior to the survey.
- Data collection was rendered from the River Bend Station Data Resources book. All data was provided for transients and employees.

- The traffic demand and trip-generation rates of evacuating vehicles were estimated from the gathered data. The trip generation rates reflected the estimated mobilization time (i.e., the time required by evacuees to prepare for the evacuation trip) computed using the results of the telephone survey of EPZ residents.
- Following federal guidelines, the EPZ is subdivided into 18 Protective Action Sectors (PAS). These PAS are then grouped within circular areas or "keyhole" configurations (circles plus radial sectors) that define a total of 36 Evacuation Regions.
- The time-varying external circumstances are represented as Evacuation Scenarios, each described in terms of the following factors: (1) Season (Summer, Winter); (2) Day of Week (Midweek, Weekend); (3) Time of Day (Midday, Evening); and (4) Weather (Good, Rain). One special event scenario involving the Mardi Gras celebration on New Roads was considered. One roadway impact scenario was considered wherein a single lane was closed on US 61 southbound for the duration of the evacuation.
- Staged evacuation was considered for those regions wherein the 2 mile radius and sectors downwind to 5 miles were evacuated.
- As per NUREG/CR-7002, the Planning Basis for the calculation of ETE is:
    - A rapidly escalating accident at the River Bend Station that quickly assumes the status of General Emergency such that the Advisory to Evacuate is announced in a timely manner following the siren notification and no early protective actions have been implemented.
    - While an unlikely accident scenario, this planning basis will yield ETE, measured as the elapsed time from the Advisory to Evacuate until the stated percentage of the population exits the impacted Region, that represent "upper bound" estimates. This conservative Planning Basis is applicable for all initiating events.
- If the emergency occurs while schools are in session, the ETE study assumes that the children will be evacuated by bus directly to reception centers or host schools located outside the EPZ. Parents, relatives, and neighbors are advised to not pick up their children at school prior to the arrival of the buses dispatched for that purpose. The ETE for schoolchildren are calculated separately.
- Evacuees who do not have access to a private vehicle will either ride-share with relatives, friends or neighbors, or be evacuated by buses provided as specified in the parish evacuation plans. Those in special facilities will likewise be evacuated with public transit, as needed: bus, van, or ambulance, as required. Separate ETE are calculated for the transit-dependent evacuees, for homebound special needs population, and for those evacuated from special facilities.

<u>Computation of ETE</u>

A total of 432 ETE were computed for the evacuation of the general public. Each ETE quantifies the aggregate evacuation time estimated for the population within one of the 36 Evacuation Regions to evacuate from that Region, under the circumstances defined for one of the 12

Evacuation Scenarios (36 x 12 = 432). Separate ETE are calculated for transit-dependent evacuees, including schoolchildren for applicable scenarios.

Except for Region R03, which is the evacuation of the entire EPZ, only a portion of the people within the EPZ would be advised to evacuate. That is, the Advisory to Evacuate applies only to those people occupying the specified impacted region. It is assumed that 100 percent of the people within the impacted region will evacuate in response to this Advisory. The people occupying the remainder of the EPZ outside the impacted region may be advised to take shelter.

The computation of ETE assumes that 20% of the population within the EPZ, but outside the impacted region, will elect to "voluntarily" evacuate. In addition, 20% of the population in the Shadow Region will also elect to evacuate. These voluntary evacuees could impede those who are evacuating from within the impacted region. The impedance that could be caused by voluntary evacuees is considered in the computation of ETE for the impacted region.

Staged evacuation is considered wherein those people within the 2-mile region evacuate immediately, while those beyond 2 miles, but within the EPZ, shelter-in-place. Once 90% of the 2-mile region is evacuated, those people beyond 2 miles begin to evacuate. As per federal guidance, 20% of people beyond 2 miles will evacuate (non-compliance) even though they are advised to shelter-in-place.

The computational procedure is outlined as follows:

- A link-node representation of the highway network is coded. Each link represents a unidirectional length of highway; each node usually represents an intersection or merge point. The capacity of each link is estimated based on the field survey observations and on established traffic engineering procedures.
- The evacuation trips are generated at locations called "zonal centroids" located within the EPZ and Shadow Region. The trip generation rates vary over time reflecting the mobilization process, and from one location (centroid) to another depending on population density and on whether a centroid is within, or outside, the impacted area.
- The evacuation model computes the routing patterns for evacuating vehicles that are compliant with federal guidelines (outbound relative to the location of the plant), then simulates the traffic flow movements over space and time. This simulation process estimates the rate that traffic flow exits the impacted region.

The ETE statistics provide the elapsed times for 90 percent and 100 percent, respectively, of the population within the impacted region, to evacuate from within the impacted region. These statistics are presented in tabular and graphical formats. The 90th percentile ETE have been identified as the values that should be considered when making protective action decisions because the 100th percentile ETE are prolonged by those relatively few people who take longer to mobilize. This is referred to as the "evacuation tail" in Section 4.0 of NUREG/CR-7002.

The use of a public outreach (information) program to emphasize the need for evacuees to minimize the time needed to prepare to evacuate (secure the home, assemble needed clothes, medicines, etc.) should also be considered.

Traffic Management

This study references the comprehensive traffic management plans provided by the River Bend Station and the State of Louisiana, and identifies critical intersections. One additional TCP is suggested, as detailed in Appendix G.

Selected Results

A compilation of selected information is presented on the following pages in the form of Figures and Tables extracted from the body of the report; these are described below.

- Figure 6-1 displays a map of the RBS EPZ showing the layout of the 18 PAS that comprise, in aggregate, the EPZ.
- Table 3-1 presents the estimates of permanent resident population in each PAS based on the 2010 Census data.
- Table 6-1 defines each of the 36 Evacuation Regions in terms of their respective groups of PAS.
- Table 6-2 lists the Evacuation Scenarios.
- Tables 7-1 and 7-2 are compilations of ETE. These data are the times needed to clear the indicated regions of 90 and 100 percent of the population occupying these regions, respectively. These computed ETE include consideration of mobilization time and of estimated voluntary evacuations from other regions within the EPZ and from the Shadow Region.
- Tables 7-3 and 7-4 presents ETE for the 2-mile region for un-staged and staged evacuations for the 90^{th} and 100^{th} percentiles, respectively.
- Table 8-7 presents ETE for the schoolchildren in good weather.
- Table 8-10 presents ETE for the transit-dependent population in good weather.
- Figure H-8 presents an example of an Evacuation Region (Region R08) to be evacuated under the circumstances defined in Table 6-1. Maps of all regions are provided in Appendix H.

Conclusions

- General population ETE were computed for 432 unique cases – a combination of 36 unique Evacuation Regions and 12 unique Evacuation Scenarios. Table 7-1 and Table 7-2 document these ETE for the 90^{th} and 100^{th} percentiles. These ETE range from 2:10 (hr:min) to 3:10 at the 90^{th} percentile (non-special event cases).
- Inspection of Table 7-1 and Table 7-2 indicates that the ETE for the 100^{th} percentile are significantly longer than those for the 90^{th} percentile. This is the result of the long tail to the trip generation curves as well as congestion within the EPZ. When the system becomes congested, traffic exits the EPZ at rates somewhat below capacity until some evacuation routes have cleared. As more routes clear, the aggregate rate of egress slows since many vehicles have already left the EPZ. Towards the end of the process, relatively few evacuation routes service the remaining demand. See Figures 7-10 through 7-21.

- Inspection of Table 7-3 and Table 7-4 indicates that a staged evacuation provides no benefits to evacuees from within the 2 mile region and unnecessarily delays the evacuation of those beyond 2 miles (compare Regions R02 and R04 through R13 with Regions R26, and R27 through R36, respectively, in Tables 7-1 and 7-2). See Section 7.6 for additional discussion.
- Comparison of Scenarios 8 (winter, weekend, midday, good weather) and 11 (winter, weekend, midday) in Table 7-2 indicates that the special event significantly impacts both the 90th and 100th percentile ETE. See Section 7.5 for additional discussion.
- Comparison of Scenarios 1 and 12 in Table 7-1 indicates that the roadway closure – one lane southbound on US 61 from St. Francisville to SR 64 at the boundary of the EPZ – does not have a significant impact on the 90th percentile ETE. US 61 is a two lane high speed highway through the entire EPZ and even with one lane closed southbound, there is enough capacity on the remaining lane and other outbound roadways, to handle demand.
- Jackson and New Roads are the two most congested areas during an evacuation. The last location in the EPZ to exhibit traffic congestion is Jackson; this is the result of SR 10 being a major evacuation route. All congestion within the EPZ clears by 4 hours and 20 minutes after the Advisory to Evacuate, for the Scenario 6, Region 3 case. See Section 7.3 and Figures 7-3 through 7-9.
- Separate ETE were computed for schools, medical facilities, transit-dependent persons, homebound special needs persons and correctional facilities. The average single-wave ETE for these facilities are within a similar range as the general population ETE at the 90th percentile. See Section 8.
- Table 8-5 indicates that there are sufficient buses and wheelchair buses available to evacuate the transit-dependent population within the EPZ in a single wave. A second-wave ETE for schools and other transit-dependents is not needed. See Sections 8.4 and 8.5.
- The general population ETE at the 90th percentile is relatively insensitive to reductions in the base trip generation time of 4¾ hours due to the moderate traffic congestion within the EPZ. Reducing the trip generation time by 2 hours only reduces the 90th and 100th percentile ETE by 20 and 25 minutes, respectively. See Table M-1.
- The general population ETE is relatively insensitive to the voluntary evacuation of vehicles in the Shadow Region. Only large changes in the percent shadow evacuation have a significant impact (tripling the shadow evacuation percentage increases the 90th percentile ETE by 30 minutes). See Table M-2.
- Population changes of +30% result in ETE changes which meet the criteria for updating ETE between decennial Censuses. See Section M.3.

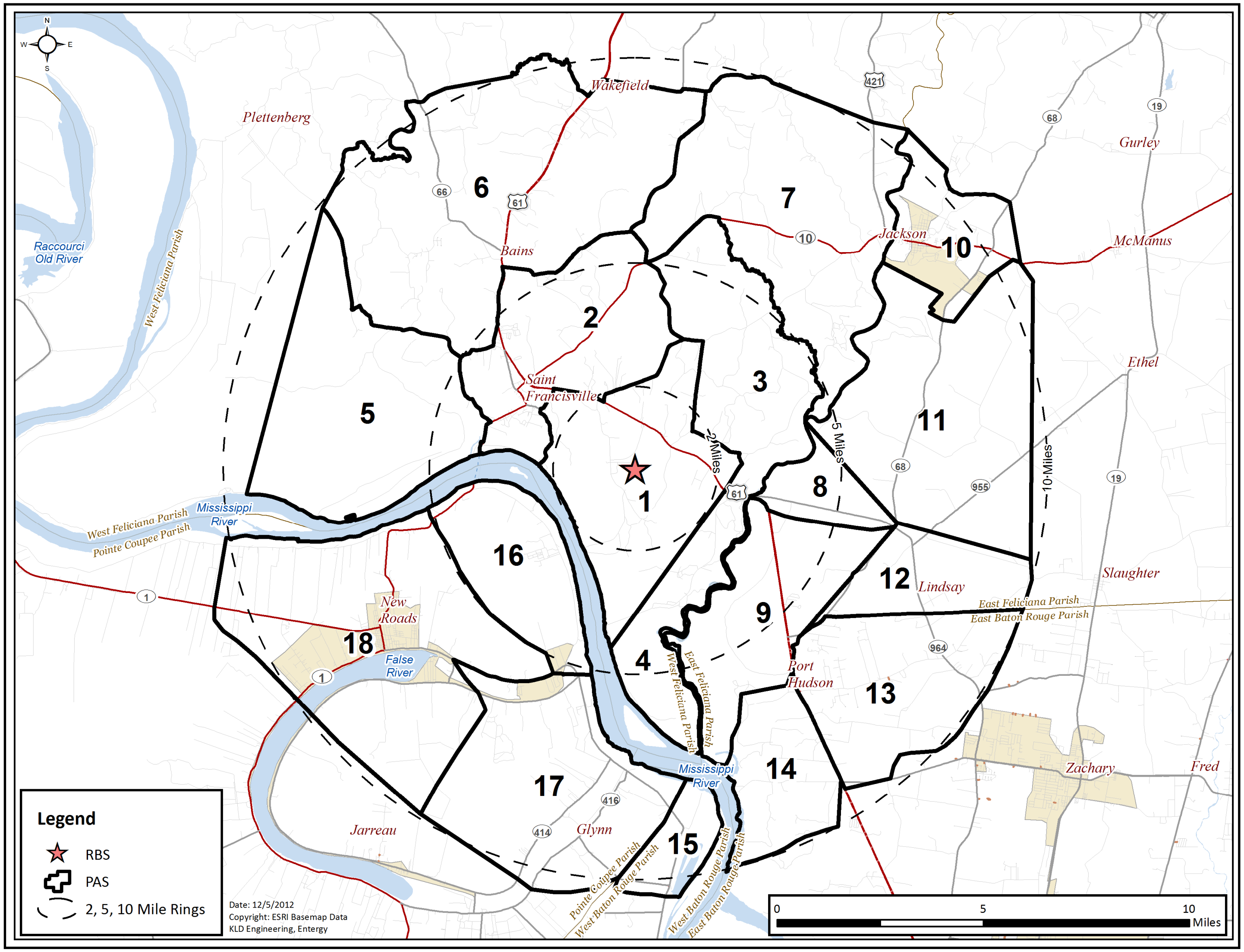

Figure 6-1. RBS EPZ PAS

Table 3-1. EPZ Permanent Resident Population

PAS	2000 Population	2010 Population
1	636	669
2	3,490	3,377
3	324	501
4	105	96
5	21	26
6	2,048	2,184
7	704	901
8	8	15
9	459	310
10	4,151	2,488
11	311	1,803
12	198	393
13	2,040	2,635
14	180	223
15	62	55
16	576	338
17	1,682	1,703
18	8,005	7,875
TOTAL	**25,000**	**25,592**
EPZ Population Growth:		**2.37%**

Table 6-1. Description of Evacuation Regions

Region	Description	PAS																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
R01	2 mile ring	X																	
R02	5-mile ring	X	X	X	X				X	X							X		
R03	Full EPZ	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Evacuate 2 mile ring and 5 miles downwind																			
Region	Wind Direction Toward	PAS																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
R04	N, NNE	X	X	X															
R05	NE	X		X															
R06	ENE	X		X					X										
R07	E, ESE	X		X	X				X	X									
R08	SE, SSE	X			X					X									
R09	S	X			X					X							X		
R10	SSW	X			X												X		
R11	SW, WSW	X															X		
R12	W	X	X			X											X		
R13	WNW, NW, NNW	X	X																
Evacuate 5 mile ring and downwind to EPZ boundary																			
Region	Wind Direction Toward	PAS																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
R14	N, NNE	X	X	X	X	X	X	X	X	X	X						X		
R15	NE, ENE	X	X	X	X	X		X	X	X	X	X					X		
R16	E	X	X	X	X	X		X	X	X	X	X	X	X			X		
R17	ESE	X	X	X	X	X			X	X		X	X	X	X		X		
R18	SE	X	X	X	X	X			X	X			X	X	X	X	X		
R19	SSE	X	X	X	X	X			X	X			X	X	X	X	X	X	
R20	S	X	X	X	X	X			X	X					X	X	X	X	X
R21	SSW	X	X	X	X	X			X	X						X	X	X	X
R22	SW, WSW	X	X	X	X	X			X	X							X	X	X
R23	W	X	X	X	X	X	X		X	X							X		X
R24	WNW, NW	X	X	X	X	X	X		X	X							X		
R25	NNW	X	X	X	X	X	X	X	X	X							X		

Staged Evacuation - 2-Mile Radius Evacuates, then Evacuate Downwind to 5 Miles																			
Region	**Wind Direction Toward**	**PAS**																	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
R26	5 Mile Ring	X	X	X	X				X	X							X		
R27	N, NNE	X	X	X															
R28	NE	X		X															
R29	ENE	X		X					X										
R30	E, ESE	X		X	X				X	X									
R31	SE, SSE	X			X					X									
R32	S	X			X					X							X		
R33	SSW	X			X												X		
R34	SW, WSW	X															X		
R35	W	X	X			X											X		
R36	WNW, NW, NNW	X	X																
Shelter-in-Place until 90% ETE for R01, then Evacuate						**Area(s) Shelter-in-Place**						**Area(s) Evacuate**							

Table 6-2. Evacuation Scenario Definitions

Scenario	Season[1]	Day of Week	Time of Day	Weather	Special
1	Summer	Midweek	Midday	Good	None
2	Summer	Midweek	Midday	Rain	None
3	Summer	Weekend	Midday	Good	None
4	Summer	Weekend	Midday	Rain	None
5	Summer	Midweek, Weekend	Evening	Good	None
6	Winter	Midweek	Midday	Good	None
7	Winter	Midweek	Midday	Rain	None
8	Winter	Weekend	Midday	Good	None
9	Winter	Weekend	Midday	Rain	None
10	Winter	Midweek, Weekend	Evening	Good	None
11	Winter	Weekend	Midday	Good	Mardi Gras Festival in New Roads, LA
12	Summer	Weekend	Midday	Good	Roadway Impact – Lane Closure on US 61 SB

[1] Winter means that school is in session (also applies to spring and autumn). Summer means that school is not in session.

Table 7-1. Time to Clear the Indicated Area of *__90__* Percent of the Affected Population

	Summer		Summer		Summer	Winter		Winter		Winter	Winter	Summer	
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek	
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	**Scenario:**
	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday	
Region	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact	**Region**
Entire 2-Mile Region, 5-Mile Region, and EPZ													
R01	2:15	2:20	2:15	2:20	2:20	2:15	2:15	2:15	2:15	2:20	2:15	2:15	**R01**
R02	2:25	2:30	2:20	2:20	2:20	2:25	2:25	2:15	2:15	2:20	2:15	2:25	**R02**
R03	3:05	3:15	2:50	3:05	2:55	3:10	3:20	2:55	3:15	2:55	4:50	3:10	**R03**
2-Mile Region and Keyhole to 5 Miles													
R04	2:25	2:25	2:15	2:20	2:20	2:25	2:25	2:15	2:15	2:20	2:15	2:25	**R04**
R05	2:20	2:20	2:15	2:20	2:20	2:20	2:20	2:15	2:15	2:20	2:15	2:20	**R05**
R06	2:20	2:20	2:15	2:20	2:20	2:20	2:20	2:15	2:15	2:20	2:15	2:20	**R06**
R07	2:25	2:25	2:20	2:20	2:20	2:20	2:25	2:15	2:20	2:20	2:15	2:25	**R07**
R08	2:20	2:25	2:20	2:25	2:25	2:20	2:20	2:15	2:20	2:20	2:15	2:20	**R08**
R09	2:20	2:25	2:20	2:25	2:25	2:20	2:20	2:15	2:20	2:20	2:15	2:20	**R09**
R10	2:15	2:20	2:15	2:20	2:20	2:15	2:15	2:15	2:15	2:20	2:15	2:15	**R10**
R11	2:15	2:20	2:15	2:20	2:20	2:15	2:20	2:15	2:15	2:20	2:15	2:15	**R11**
R12	2:25	2:25	2:15	2:20	2:20	2:20	2:25	2:10	2:15	2:15	2:10	2:25	**R12**
R13	2:25	2:25	2:15	2:20	2:20	2:20	2:25	2:10	2:15	2:15	2:10	2:25	**R13**
5-Mile Region and Keyhole to EPZ Boundary													
R14	3:20	3:35	3:10	3:30	3:20	3:30	3:50	3:20	3:45	3:20	3:20	3:20	**R14**
R15	3:05	3:15	2:55	3:00	2:55	3:10	3:20	3:00	3:15	2:55	3:00	3:05	**R15**
R16	3:05	3:10	2:50	2:55	2:50	3:10	3:15	2:55	3:10	2:50	2:55	3:05	**R16**
R17	2:30	2:35	2:20	2:20	2:20	2:30	2:30	2:15	2:20	2:20	2:15	2:30	**R17**
R18	2:30	2:30	2:20	2:20	2:20	2:30	2:30	2:15	2:20	2:20	2:15	2:30	**R18**
R19	2:30	2:35	2:20	2:20	2:20	2:30	2:30	2:15	2:20	2:20	2:15	2:30	**R19**
R20	2:35	2:35	2:20	2:20	2:20	2:30	2:35	2:15	2:20	2:20	5:00	2:35	**R20**
R21	2:35	2:35	2:20	2:20	2:20	2:30	2:35	2:15	2:20	2:20	5:00	2:35	**R21**
R22	2:35	2:35	2:20	2:20	2:20	2:30	2:30	2:15	2:20	2:20	5:00	2:35	**R22**
R23	2:35	2:35	2:20	2:25	2:20	2:30	2:40	2:25	2:35	2:20	5:00	2:35	**R23**

	Summer		Summer		Summer	Winter		Winter		Winter	Winter	Summer	
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek	
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	Scenario:
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday	Region
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact	
R24	2:30	2:30	2:20	2:25	2:20	2:30	2:40	2:25	2:40	2:20	2:25	2:30	**R24**
R25	3:05	3:15	2:50	3:05	2:55	3:15	3:20	3:10	3:20	2:55	3:10	3:05	**R25**
Staged Evacuation - 2-Mile Region and Keyhole to 5 Miles													
R26	3:00	3:05	3:00	3:00	3:05	3:00	3:00	3:00	3:00	3:05	3:00	3:00	**R26**
R27	3:05	3:05	3:00	3:00	3:10	3:05	3:05	3:00	3:00	3:05	3:00	3:05	**R27**
R28	2:45	2:45	2:45	2:45	2:45	2:40	2:45	2:40	2:40	2:45	2:40	2:45	**R28**
R29	2:45	2:45	2:45	2:45	2:45	2:40	2:45	2:40	2:40	2:45	2:40	2:45	**R29**
R30	2:45	2:45	2:45	2:45	2:50	2:45	2:45	2:45	2:45	2:45	2:45	2:45	**R30**
R31	2:40	2:40	2:40	2:40	2:45	2:35	2:35	2:35	2:40	2:45	2:35	2:40	**R31**
R32	2:40	2:40	2:40	2:40	2:45	2:40	2:40	2:40	2:40	2:45	2:40	2:40	**R32**
R33	2:35	2:35	2:40	2:40	2:40	2:35	2:35	2:35	2:35	2:40	2:35	2:35	**R33**
R34	2:35	2:35	2:35	2:35	2:40	2:35	2:35	2:35	2:35	2:40	2:35	2:35	**R34**
R35	2:55	3:00	2:55	2:55	3:00	2:55	3:00	2:55	2:55	3:00	2:55	2:55	**R35**
R36	3:00	3:00	2:55	2:55	3:00	2:55	3:00	2:55	2:55	3:00	2:55	3:00	**R36**

Table 7-2. Time to Clear the Indicated Area of *100* Percent of the Affected Population

	Summer		Summer		Summer	Winter		Winter		Winter	Winter	Summer	
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek	
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**Scenario:**
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday	**Region**
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact	
Entire 2-Mile Region, 5-Mile Region, and EPZ													
R01	4:45	4:45	4:45	4:45	4:45	4:45	4:45	4:45	4:45	4:45	4:45	4:45	**R01**
R02	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R02**
R03	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:40	4:55	**R03**
2-Mile Region and Keyhole to 5 Miles													
R04	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R04**
R05	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R05**
R06	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R06**
R07	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R07**
R08	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R08**
R09	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R09**
R10	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R10**
R11	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R11**
R12	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R12**
R13	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R13**
5-Mile Region and Keyhole to EPZ Boundary													
R14	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	**R14**
R15	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	**R15**
R16	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	**R16**
R17	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	**R17**
R18	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	**R18**
R19	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	**R19**
R20	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:40	4:55	**R20**
R21	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:35	4:55	**R21**
R22	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:40	4:55	**R22**
R23	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:35	4:55	**R23**

	Summer		Summer		Summer	Winter		Winter		Winter	Winter	Summer	
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek	
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**Scenario:**
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday	**Region**
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact	
R24	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	**R24**
R25	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	**R25**
Staged Evacuation - 2-Mile Region and Keyhole to 5 Miles													
R26	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R26**
R27	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R27**
R28	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R28**
R29	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R29**
R30	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R30**
R31	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R31**
R32	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R32**
R33	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R33**
R34	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R34**
R35	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R35**
R36	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R36**

Table 7-3. Time to Clear 90 Percent of the 2-Mile Region

	Summer		Summer		Summer	Winter		Winter		Winter	Winter	Summer	
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek	
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	**Scenario:**
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday	**Region**
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact	
Unstaged Evacuation - 2-Mile Region													
R01	2:15	2:20	2:15	2:20	2:20	2:15	2:15	2:15	2:15	2:20	2:15	2:15	**R01**
Unstaged Evacuation - 2-Mile Region and Keyhole to 5-Miles													
R02	2:20	2:25	2:20	2:20	2:25	2:20	2:20	2:15	2:20	2:20	2:15	2:20	**R02**
R04	2:20	2:25	2:20	2:20	2:25	2:20	2:20	2:15	2:20	2:25	2:15	2:20	**R04**
R05	2:20	2:20	2:15	2:20	2:20	2:15	2:20	2:15	2:15	2:20	2:15	2:20	**R05**
R06	2:20	2:20	2:15	2:20	2:20	2:15	2:20	2:15	2:15	2:20	2:15	2:20	**R06**
R07	2:20	2:20	2:15	2:20	2:20	2:15	2:20	2:15	2:15	2:20	2:15	2:20	**R07**
R08	2:15	2:20	2:15	2:20	2:20	2:15	2:15	2:15	2:15	2:20	2:15	2:15	**R08**
R09	2:15	2:20	2:15	2:20	2:20	2:15	2:15	2:15	2:15	2:20	2:15	2:15	**R09**
R10	2:15	2:20	2:15	2:20	2:20	2:15	2:20	2:15	2:15	2:20	2:15	2:15	**R10**
R11	2:15	2:20	2:15	2:20	2:20	2:15	2:15	2:15	2:15	2:20	2:15	2:15	**R11**
R12	2:20	2:25	2:20	2:20	2:25	2:15	2:20	2:15	2:20	2:20	2:15	2:20	**R12**
R13	2:20	2:25	2:20	2:20	2:25	2:20	2:20	2:15	2:20	2:20	2:15	2:20	**R13**
Staged Evacuation 2-Mile Region and Keyhole to 5-Miles													
R26	2:40	2:45	2:45	2:45	2:45	2:40	2:40	2:45	2:45	2:45	2:45	2:40	**R26**
R27	2:40	2:45	2:45	2:45	2:45	2:40	2:40	2:45	2:45	2:45	2:45	2:40	**R27**
R28	2:30	2:35	2:30	2:35	2:40	2:30	2:30	2:30	2:30	2:40	2:30	2:30	**R28**
R29	2:30	2:35	2:30	2:35	2:40	2:30	2:30	2:30	2:30	2:40	2:30	2:30	**R29**
R30	2:30	2:35	2:30	2:35	2:40	2:30	2:30	2:30	2:30	2:40	2:30	2:30	**R30**
R31	2:30	2:30	2:30	2:30	2:35	2:25	2:30	2:25	2:25	2:35	2:25	2:30	**R31**
R32	2:30	2:30	2:30	2:30	2:35	2:25	2:30	2:25	2:25	2:35	2:25	2:30	**R32**
R33	2:30	2:30	2:30	2:30	2:35	2:25	2:30	2:25	2:25	2:35	2:25	2:30	**R33**
R34	2:30	2:30	2:30	2:30	2:35	2:25	2:30	2:25	2:25	2:35	2:25	2:30	**R34**
R35	2:40	2:45	2:45	2:45	2:45	2:40	2:40	2:40	2:40	2:45	2:40	2:40	**R35**
R36	2:40	2:45	2:45	2:45	2:45	2:40	2:40	2:40	2:45	2:45	2:40	2:40	**R36**

Table 7-4. Time to Clear 100 Percent of the 2-Mile Region

	Summer		Summer		Summer	Winter		Winter		Winter	Winter	Summer	
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek	
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	**Scenario:**
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday	**Region**
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact	
Unstaged Evacuation - 2-Mile Region													
R01	4:45	4:45	4:45	4:45	4:45	4:45	4:45	4:45	4:45	4:45	4:45	4:45	**R01**
Unstaged Evacuation - 2-Mile Region and Keyhole to 5-Miles													
R02	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R02**
R04	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R04**
R05	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R05**
R06	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R06**
R07	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R07**
R08	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R08**
R09	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R09**
R10	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R10**
R11	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R11**
R12	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R12**
R13	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R13**
Staged Evacuation -2-Mile Region and Keyhole to 5-Miles													
R26	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R26**
R27	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R27**
R28	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R28**
R29	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R29**
R30	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R30**
R31	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R31**
R32	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R32**
R33	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R33**
R34	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R34**
R35	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R35**
R36	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R36**

Table 8-7. School Evacuation Time Estimates – Good Weather

School	Driver Mobilization Time (min)	Loading Time (min)	Dist. To EPZ Bdry (mi)	Average Speed (mph)	Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bdry to R.C. (mi.)	Travel Time from EPZ Bdry to R.C. (min)	ETE to R.C. (hr:min)
EAST BATON ROUGE, LA									
Port Hudson Career Academy	90	15	2.2	55.0	3	**1:50**	17.3	19	**2:10**
EAST FELICIANA, LA									
Jackson Public Schools	90	15	3.5	9.3	23	**2:10**	33.3	37	**2:45**
Quad Area-Jackson Head Start	90	15	3.2	9.7	20	**2:05**	33.3	37	**2:45**
POINTE COUPEE, LA									
Catholic Schools - New Roads	90	15	1.8	39.7	3	**1:50**	34.1	38	**2:30**
Christian Women Caring for Children	90	15	1.1	34.5	2	**1:50**	41.2	45	**2:35**
False River Academy	90	15	1.3	39.7	2	**1:50**	34.1	38	**2:25**
Kid D Land Daycare & Learning	90	15	1.2	34.5	3	**1:50**	41.2	45	**2:35**
Mae Mae's Playhouse and Preschool	90	15	1.3	34.5	3	**1:50**	41.2	45	**2:35**
New Roads Kiddie College	90	15	3.0	34.0	6	**1:55**	34.1	38	**2:30**
Rosenwald Elementary School	90	15	3.3	35.9	6	**1:55**	34.1	38	**2:30**
Rougon Elementary School*	90	15	0.1	37.3	1	**1:50**	34.1	38	**2:25**
WEST FELICIANA, LA									
Bains Elementary School	90	15	14.0	7.6	111	**3:40**	33.3	37	**4:15**
Bains Lower Elementary	90	15	14.0	7.6	111	**3:40**	33.3	37	**4:15**
Chase Ministries	90	15	15.7	8.2	116	**3:45**	33.3	37	**4:20**
First Step Day Care & Learning Center	90	15	14.6	8.0	110	**3:35**	33.3	37	**4:15**
Grace Preschool	90	15	15.3	8.2	113	**3:40**	33.3	37	**4:15**
In the Beginning Child Development Center	90	15	12.8	7.4	104	**3:30**	33.3	37	**4:10**
West Feliciana High School	90	15	14.4	7.6	122	**3:50**	33.3	37	**4:25**
West Feliciana Middle School	90	15	14.4	7.1	122	**3:50**	33.3	37	**4:25**
Girl Scout Camp Marydale	90	15	24.6	24.5	61	**2:50**	33.3	37	**3:25**
					Maximum for EPZ:	**3:50**		**Maximum:**	**4:25**
					Average for EPZ:	**2:40**		**Average:**	**3:20**

Table 8-10. Transit-Dependent Evacuation Time Estimates – Good Weather

		One-Wave							Two-Wave					
Route Number	Bus Number	Mobilization (min)	Route Length (miles)	Speed (mph)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)	Distance to R. C. (miles)	Travel Time to R. C. (min)	Unload (min)	Driver Rest (min)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)
1	1	120	10.1	52.8	11	30	**2:45**	17.3	23	5	10	48	30	**4:45**
2	2	120	3.3	48.9	4	30	**2:35**	19.5	26	5	10	34	30	**4:25**
	1	135	3.3	50.2	4	30	**2:50**	19.5	26	5	10	34	30	**4:40**
3	1	120	4.9	54.6	5	30	**2:40**	19.5	26	5	10	38	30	**4:30**
4	1	120	14.4	42.2	20	30	**2:55**	17.3	23	5	10	60	30	**5:05**
	1	135	14.4	47.4	18	30	**3:05**	17.3	23	5	10	60	30	**5:15**
5	1	120	7.2	9.2	47	30	**3:20**	33.3	44	5	10	63	30	**5:55**
6	2	120	14.2	8.6	99	30	**4:10**	33.3	44	5	10	83	30	**7:05**
	2	135	14.2	9.6	88	30	**4:15**	33.3	44	5	10	83	30	**7:10**
7	1	120	6.3	54.7	7	30	**2:40**	23.9	32	5	10	47	30	**4:45**
	1	135	6.3	54.5	7	30	**2:55**	23.9	32	5	10	47	30	**5:00**
8	4	120	4.3	33.4	8	30	**2:40**	33.3	44	5	10	58	30	**5:10**
	4	135	4.3	33.1	8	30	**2:55**	33.3	44	5	10	58	30	**5:25**
	2	150	4.3	33.5	8	30	**3:10**	33.3	44	5	10	57	30	**5:40**
9	3	120	3.5	10.8	19	30	**2:50**	33.3	44	5	10	55	30	**5:15**
10	1	120	8.1	5.8	84	30	**3:55**	33.3	44	5	10	66	30	**6:35**
11	2	120	24.6	26.2	56	30	**3:30**	33.3	44	5	10	110	30	**6:50**
	1	135	24.6	26.8	55	30	**3:45**	33.3	44	5	10	110	30	**7:05**
						Maximum ETE:	**4:15**						**Maximum ETE:**	**7:10**
						Average ETE:	**3:10**						**Average ETE:**	**5:35**

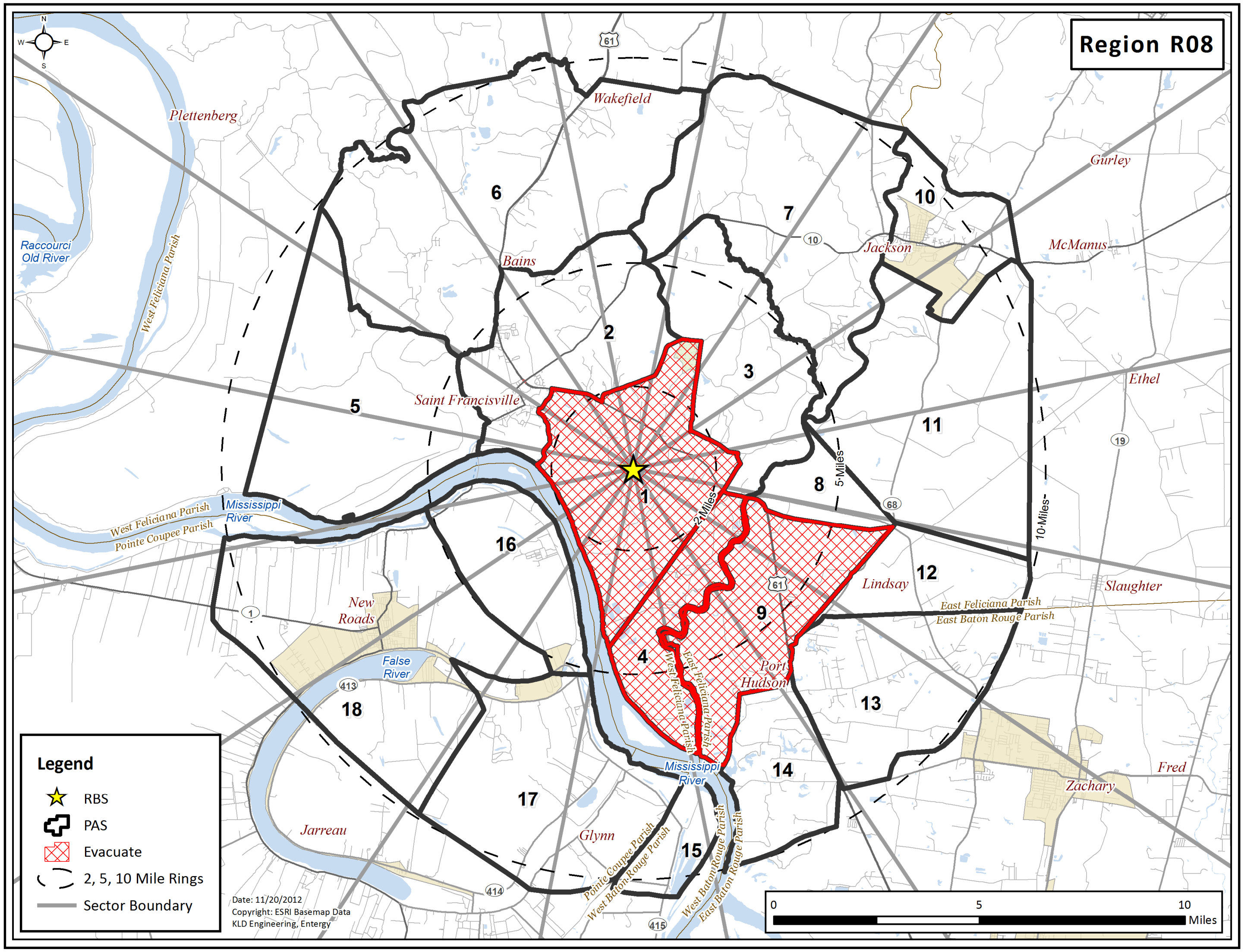

Figure H-8. Region R08

1 INTRODUCTION

This report describes the analyses undertaken and the results obtained by a study to develop Evacuation Time Estimates (ETE) for the River Bend Station (RBS), located in West Feliciana Parish, LA. ETE provide State and local governments with site-specific information needed for Protective Action decision-making.

In the performance of this effort, guidance is provided by documents published by Federal Governmental agencies. Most important of these are:

- Criteria for Development of Evacuation Time Estimate Studies, NUREG/CR-7002, November 2011.
- Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants, NUREG 0654/FEMA REP 1, Rev. 1, November 1980.
- Analysis of Techniques for Estimating Evacuation Times for Emergency Planning Zones, NUREG/CR 1745, November 1980.
- Development of Evacuation Time Estimates for Nuclear Power Plants, NUREG/CR-6863, January 2005.

The work effort reported herein was supported and guided by local stakeholders who contributed suggestions, critiques, and the local knowledge base required. Table 1-1 presents a summary of stakeholders and interactions.

Table 1-1. Stakeholder Interaction

Stakeholder	Nature of Stakeholder Interaction
Entergy emergency planning personnel	Meetings to define data requirements and set up contacts with local government agencies. Obtain RBS Emergency Preparedness Plan, Previous RBS ETE Report
East Feliciana, West Feliciana, West Baton Rouge, East Baton Rouge and Pointe Coupee Parishes	Meetings to define data requirements and set up contacts with local government agencies, Obtain special event data
Louisiana Department of Environmental Quality	Obtain Louisiana Peacetime Radiological Response Plan
Local and State Police Agencies	Obtain existing traffic management plans, obtain special facility data for transients

1.1 Overview of the ETE Process

The following outline presents a brief description of the work effort in chronological sequence:

1. Information Gathering:

a. Defined the scope of work in discussions with representatives from Entergy.

b. Attended meetings with emergency planners from East Feliciana, West Feliciana, West Baton Rouge, East Baton Rouge and Pointe Coupee Parishes, Louisiana Department of Environmental Action, Louisiana Governor's Office of Homeland Security and Emergency Preparedness and state and local police to identify issues to be addressed and resources available.

c. Conducted a detailed field survey of the highway system and of area traffic conditions within the Emergency Planning Zone (EPZ) and Shadow Region.

d. Obtained demographic data from the 2010 census.

e. Reanalyzed previous random telephone sample survey of EPZ residents.

f. Review and tabulated data describing schools, special facilities, major employers, transportation providers, and other important information.

2. Estimated distributions of Trip Generation times representing the time required by various population groups (permanent residents, employees, and transients) to prepare (mobilize) for the evacuation trip. These estimates are primarily based upon the random sample telephone survey.

3. Defined Evacuation Scenarios. These scenarios reflect the variation in demand, in trip generation distribution and in highway capacities, associated with different seasons, day of week, time of day and weather conditions.

4. Reviewed the existing traffic management plan to be implemented by local and state police in the event of an incident at the plant. Traffic control is applied at specified Traffic Control Points (TCP) located within the EPZ.

5. Used existing PAS to define Evacuation Regions. The EPZ is partitioned into 18 PAS along jurisdictional and geographic boundaries. "Regions" are groups of contiguous PAS for which ETE are calculated. The configurations of these Regions reflect wind direction and the radial extent of the impacted area. Each Region, other than those that approximate circular areas, approximates a "key-hole section" within the EPZ as recommended by NUREG/CR-7002.

6. Estimated demand for transit services for persons at "Special Facilities" and for transit-dependent persons at home.

7. Prepared the input streams for the DYNEV II system.

   a. Estimated the evacuation traffic demand, based on the available information derived from Census data, and from data provided by local and state agencies, Entergy and from the telephone survey.

   b. Applied the procedures specified in the 2010 Highway Capacity Manual (HCM[1])

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[1] Highway Capacity Manual (HCM 2010), Transportation Research Board, National Research Council, 2010.

to the data acquired during the field survey, to estimate the capacity of all highway segments comprising the evacuation routes.

   c. Developed the link-node representation of the evacuation network, which is used as the basis for the computer analysis that calculates the ETE.

   d. Calculated the evacuating traffic demand for each Region and for each Scenario.

   e. Specified selected candidate destinations for each “origin” (location of each “source” where evacuation trips are generated over the mobilization time) to support evacuation travel consistent with outbound movement relative to the location of the Entergy.

8. Executed the DYNEV II model to determine optimal evacuation routing and compute ETE for all residents, transients and employees (“general population”) with access to private vehicles. Generated a complete set of ETE for all specified Regions and Scenarios.

9. Documented ETE in formats in accordance with NUREG/CR-7002.

10. Calculated the ETE for all transit activities including those for special facilities (schools, medical facilities, etc.), for the transit-dependent population and for homebound special needs population.

1.2 The River Bend Station Location

The River Bend Station is located along the Mississippi River in West Feliciana Parish, Louisiana. The site is approximately 30 miles northwest of Baton Rouge, LA. The Emergency Planning Zone (EPZ) consists of parts of East Feliciana, West Feliciana, West Baton Rouge, East Baton Rouge and Pointe Coupee Parishes. Figure 1-1 displays the area surrounding the RBS. This map identifies the communities in the area and the major roads.

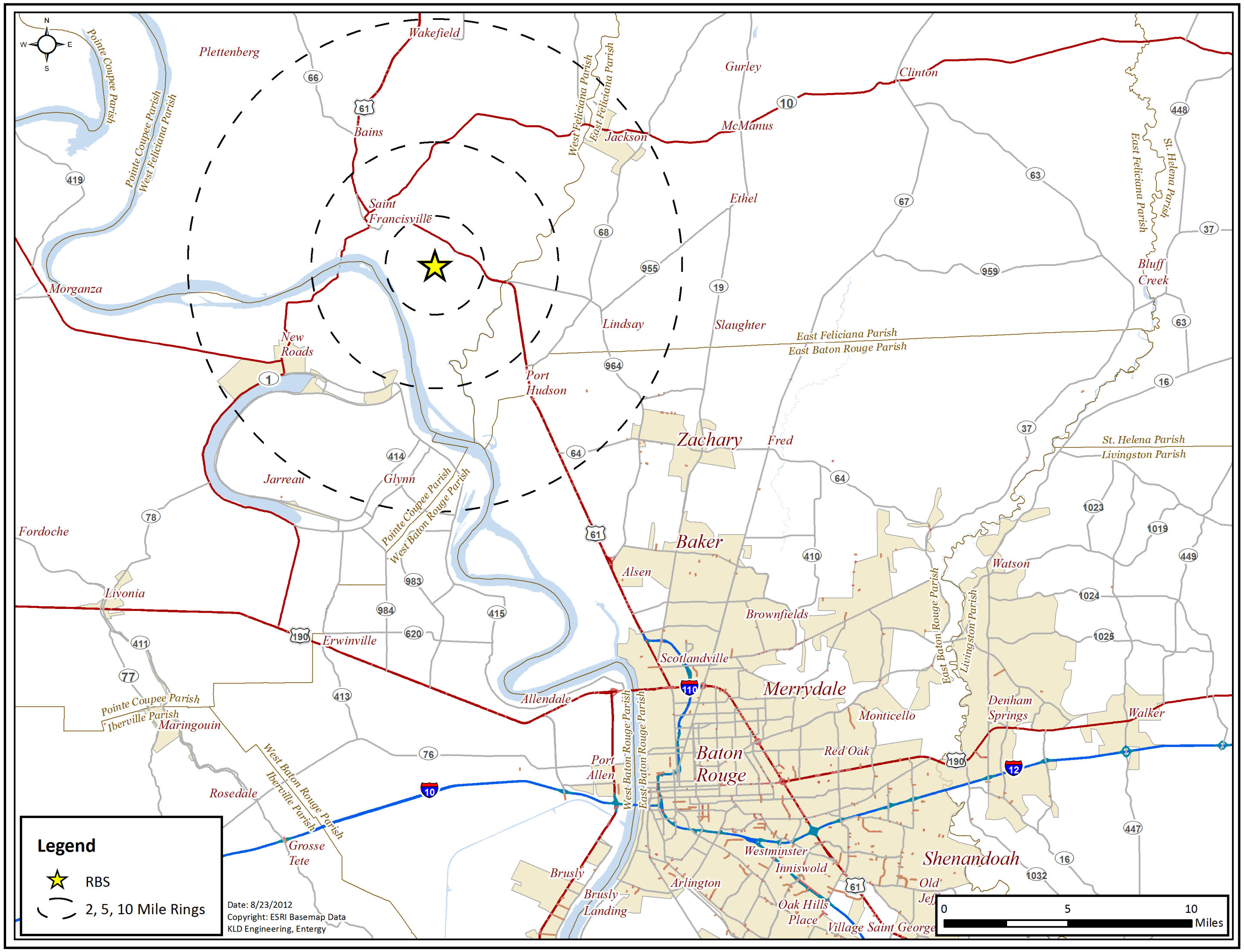


Figure 1-1. RBS Location

1.3 Preliminary Activities

These activities are described below.

Field Surveys of the Highway Network

KLD personnel drove the entire highway system within the EPZ and the Shadow Region which consists of the area between the EPZ boundary and approximately 15 miles radially from the plant. The characteristics of each section of highway were recorded. These characteristics are shown in Table 1-2:

Table 1-2. Highway Characteristics

- Number of lanes
- Lane width
- Shoulder type & width
- Interchange geometries
- Lane channelization & queuing capacity (including turn bays/lanes)
- Geometrics: curves, grades (>4%)
- Posted speed
- Actual free speed
- Abutting land use
- Control devices
- Intersection configuration (including roundabouts where applicable)
- Traffic signal type
- Unusual characteristics: Narrow bridges, sharp curves, poor pavement, flood warning signs, inadequate delineations, toll booths, etc.

Video and audio recording equipment were used to capture a permanent record of the highway infrastructure. No attempt was made to meticulously measure such attributes as lane width and shoulder width; estimates of these measures based on visual observation and recorded images were considered appropriate for the purpose of estimating the capacity of highway sections. For example, Exhibit 15-7 in the HCM indicates that a reduction in lane width from 12 feet (the "base" value) to 10 feet can reduce free flow speed (FFS) by 1.1 mph – not a material difference – for two-lane highways. Exhibit 15-30 in the HCM shows little sensitivity for the estimates of Service Volumes at Level of Service (LOS) E (near capacity), with respect to FFS, for two-lane highways.

The data from the audio and video recordings were used to create detailed geographical information systems (GIS) shapefiles and databases of the roadway characteristics and of the traffic control devices observed during the road survey; this information was referenced while preparing the input stream for the DYNEV II System.

As documented on page 15-5 of the HCM 2010, the capacity of a two-lane highway is 1700 passenger cars per hour in one direction. For freeway sections, a value of 2250 vehicles per hour per lane is assigned, as per Exhibit 11-17 of the HCM 2010. The road survey has identified several segments which are characterized by adverse geometrics on two-lane highways which are reflected in reduced values for both capacity and speed. These estimates are consistent with the service volumes for LOS E presented in HCM Exhibit 15-30. These links may be

identified by reviewing Appendix K. Link capacity is an input to DYNEV II which computes the ETE. Further discussion of roadway capacity is provided in Section 4 of this report.

Traffic signals are either pre-timed (signal timings are fixed over time and do not change with the traffic volume on competing approaches), or are actuated (signal timings vary over time based on the changing traffic volumes on competing approaches). Actuated signals require detectors to provide the traffic data used by the signal controller to adjust the signal timings. These detectors are typically magnetic loops in the roadway, or video cameras mounted on the signal masts and pointed toward the intersection approaches. If detectors were observed on the approaches to a signalized intersection during the road survey, detailed signal timings were not collected as the timings vary with traffic volume. TCPs at locations which have control devices are represented as actuated signals in the DYNEV II system.

If no detectors were observed, the signal control at the intersection was considered pre-timed, and detailed signal timings were gathered for several signal cycles. These signal timings were input to the DYNEV II system used to compute ETE, as per NUREG/CR-7002 guidance.

Figure 1-2 presents the link-node analysis network that was constructed to model the evacuation roadway network in the EPZ and Shadow Region. The directional arrows on the links and the node numbers have been removed from Figure 1-2 to clarify the figure. The detailed figures provided in Appendix K depict the analysis network with directional arrows shown and node numbers provided. The observations made during the field survey were used to calibrate the analysis network.

Telephone Survey

A telephone survey was undertaken 2008 to gather information needed for the evacuation study. Appendix F presents the survey instrument, the procedures used and tabulations of data compiled from the survey returns.

These data were utilized to develop estimates of vehicle occupancy to estimate the number of evacuating vehicles during an evacuation and to estimate elements of the mobilization process. This database was also referenced to estimate the number of transit-dependent residents.

Computing the Evacuation Time Estimates

The overall study procedure is outlined in Appendix D. Demographic data were obtained from several sources, as detailed later in this report. These data were analyzed and converted into vehicle demand data. The vehicle demand was loaded onto appropriate “source” links of the analysis network using GIS mapping software. The DYNEV II system was then used to compute ETE for all Regions and Scenarios.

Analytical Tools

The DYNEV II System that was employed for this study is comprised of several integrated computer models. One of these is the DYNEV (DYnamic Network EVacuation) macroscopic simulation model, a new version of the IDYNEV model that was developed by KLD under contract with the Federal Emergency Management Agency (FEMA).

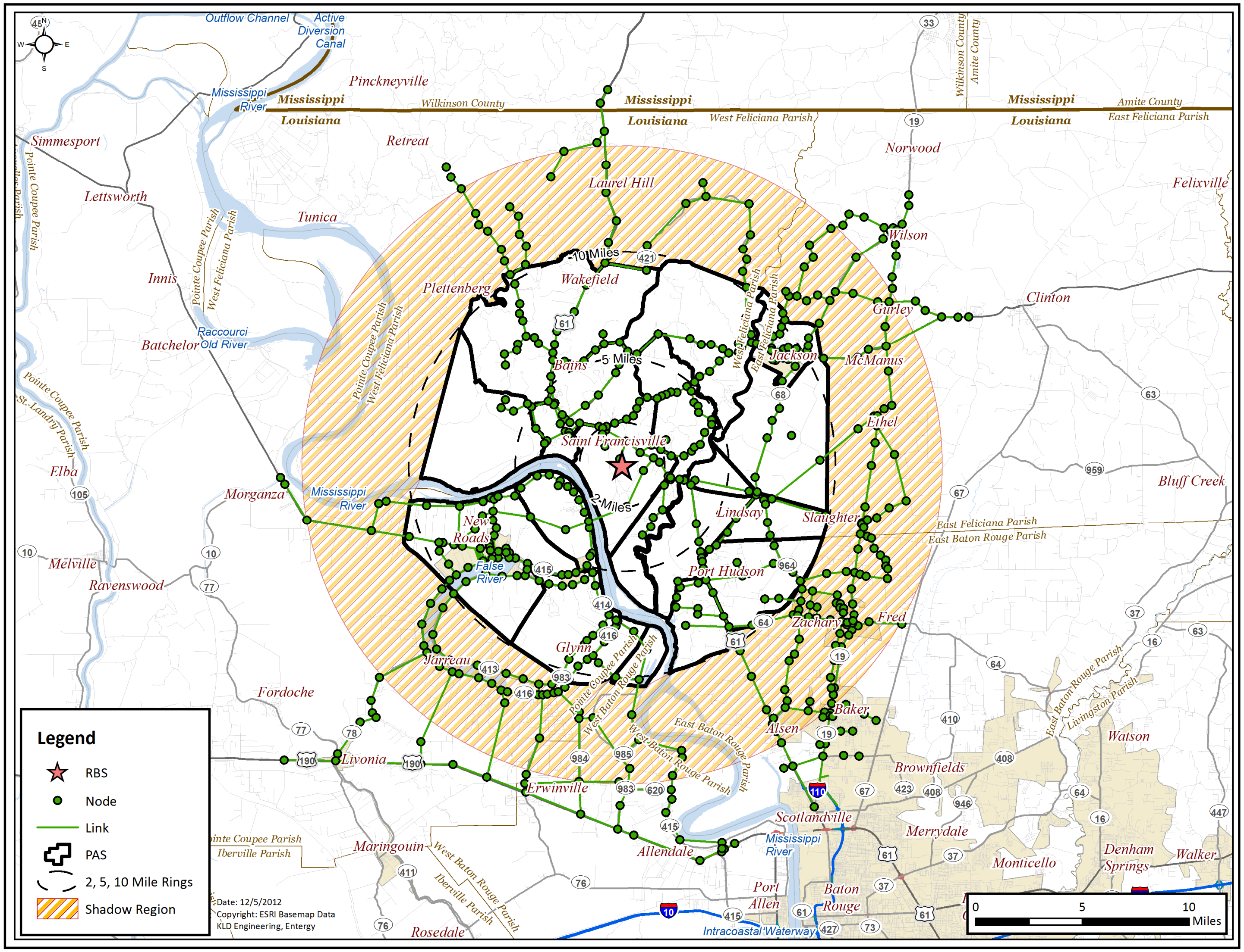


Figure 1-2. RBS Link-Node Analysis Network

DYNEV II consists of four sub-models:

- A macroscopic traffic simulation model (for details, see Appendix C).
- A Trip Distribution (TD), model that assigns a set of candidate destination (D) nodes for each "origin" (O) located within the analysis network, where evacuation trips are "generated" over time. This establishes a set of O-D tables.
- A Dynamic Traffic Assignment (DTA), model which assigns trips to paths of travel (routes) which satisfy the O-D tables, over time. The TD and DTA models are integrated to form the DTRAD (Dynamic Traffic Assignment and Distribution) model, as described in Appendix B.
- A Myopic Traffic Diversion model which diverts traffic to avoid intense, local congestion, if possible.

Another software product developed by KLD, named UNITES (UNIfied Transportation Engineering System) was used to expedite data entry and to automate the production of output tables.

The dynamics of traffic flow over the network are graphically animated using the software product, EVAN (EVacuation ANimator), developed by KLD. EVAN is GIS based, and displays statistics such as LOS, vehicles discharged, average speed, and percent of vehicles evacuated, output by the DYNEV II System. The use of a GIS framework enables the user to zoom in on areas of congestion and query road name, town name and other geographical information.

The procedure for applying the DYNEV II System within the framework of developing ETE is outlined in Appendix D. Appendix A is a glossary of terms.

For the reader interested in an evaluation of the original model, I-DYNEV, the following references are suggested:

- NUREG/CR-4873 – Benchmark Study of the I-DYNEV Evacuation Time Estimate Computer Code
- NUREG/CR-4874 – The Sensitivity of Evacuation Time Estimates to Changes in Input Parameters for the I-DYNEV Computer Code

The evacuation analysis procedures are based upon the need to:

- Route traffic along paths of travel that will expedite their travel from their respective points of origin to points outside the EPZ.
- Restrict movement toward the plant to the extent practicable, and disperse traffic demand so as to avoid focusing demand on a limited number of highways.
- Move traffic in directions that are generally outbound, relative to the location of the RBS.

DYNEV II provides a detailed description of traffic operations on the evacuation network. This description enables the analyst to identify bottlenecks and to develop countermeasures that

are designed to represent the behavioral responses of evacuees. The effects of these countermeasures may then be tested with the model.

1.4 Comparison with Prior ETE Study

Table 1-3 presents a comparison of the present ETE study with the 2008 study. The major factors contributing to the differences between the ETE values obtained in this study and those of the previous study can be summarized as follows:

- Vehicle occupancy and trip-generation rates are based on the results of a telephone survey of EPZ residents.
- Voluntary and shadow evacuations of 20% are considered.
- Highway representation is far more detailed.
- Dynamic evacuation modeling used.

Table 1-3. ETE Study Comparisons

Topic	Previous ETE Study	Current ETE Study
Resident Population Basis	2000 US Census Data; Population = 25,000	ArcGIS Software using 2010 US Census blocks; area ratio method used. Population = 25,592
Resident Population Vehicle Occupancy	2.52 persons/household, 1.53 evacuating vehicles/household yielding: 1.65 persons/vehicle.	2.52 persons/household, 1.53 evacuating vehicles/household yielding: 1.65 persons/vehicle.
Employee Population	Employees treated as separate population group. Employee estimates based on information provided about major employers in EPZ by the Parish emergency management staff and by direct phone calls to major employers. 1.00 employees/vehicle based on phone survey results. Employees = 1,875	Employee estimates based on information provided about major employers in EPZ in the River Bend Resources Data Book, supplemented by information from the U.S. Census Bureau's Longitudinal Employer-Household Dynamics interactive website . 1.00 employees per vehicle based on telephone survey results. Employees = 2,543

Topic	Previous ETE Study	Current ETE Study
Transit-Dependent Population	Estimates based upon U.S. Census data and the results of the telephone survey. A total of 892 people who do not have access to a vehicle, requiring 30 buses to evacuate.	Estimates based upon U.S. Census data and the results of the telephone survey. A total of 926 people who do not have access to a vehicle, requiring 31 buses to evacuate. An additional 8 homebound special needs persons needed special transportation to evacuate all 8 require a wheel chair accessible vehicle.
Transient Population	Transient estimates based on information from parish and local tourism websites and supplemented with telephone calls as well as information provided in the previous report. Transients = 3,616	Transient estimates based upon information provided about transient attractions in EPZ listed in the River Bend Resources Data Book, supplemented by observations of the facilities during the road survey. Transients = 4,389
Special Facilities Population	Special facility population based on information provided by each parish within the EPZ. Special Facility Population = 2,178 Vehicles originating at special facilities = 747	Special facility population of medical and correctional facilities based on information listed in the River Bend Resources Data Book. Current census =2,721 Buses Required = 89 Van required = 1 Wheelchair Bus Required =9 Ambulances Required = 7
School Population	School population based on information provided by each parish within the EPZ. School enrollment = 5,831 Vehicles originating at schools = 109	School population based on information provided by the River Bend Data Resources Book. School (and evacuating day care) enrollment = 6,508 Buses required = 116
Voluntary evacuation from within EPZ in areas outside region to be evacuated	50 percent of population within the circular portion of the region; 35 percent, in annular ring between the circle and the EPZ boundary	20 percent of the population within the EPZ, but not within the Evacuation Region (see Figure 2-1)

Topic	Previous ETE Study	Current ETE Study
Shadow Evacuation	30% of people outside of the EPZ within the shadow area	20% of people outside of the EPZ within the Shadow Region (see Figure 7-2)
Network Size	690 links; 530 nodes	826 links; 597 nodes
Roadway Geometric Data	Field surveys conducted in 2007. Roads and intersections were video archived. Road capacities based on 2000 HCM.	Field surveys conducted in March 2010. Roads and intersections were video archived. Road capacities based on 2010 HCM.
School Evacuation	Direct evacuation to designated Reception Center.	Direct evacuation to designated Reception Center.
Ridesharing	50 percent of transit-dependent persons will evacuate with a neighbor or friend.	50 percent of transit-dependent persons will evacuate with a neighbor or friend.
Trip Generation for Evacuation	Based on residential telephone survey of specific pre-trip mobilization activities: Residents with commuters returning leave between 30 and 330 minutes. Residents without commuters returning leave between 15 and 300 minutes. Employees and transients leave between 15 and 150 minutes. All times measured from the advisory to evacuate.	Based on residential telephone survey of specific pre-trip mobilization activities: Residents with commuters returning leave between 30 and 270 minutes. Residents without commuters returning leave between 5 and 150 minutes. Employees and transients leave between 5 and 105 minutes. All times measured from the Advisory to Evacuate.
Weather	Normal or Rain. The capacity and free flow speed of all links in the network are reduced by 10% in the event of rain.	Normal or Rain. The capacity and free flow speed of all links in the network are reduced by 10% in the event of rain.
Modeling	IDYNEV System: TRAD and PC-DYNEV	DYNEV II System – Version 4.0.15.0
Special Events	Construction of the new RBS Site.	Mardi Gras Celebration in New Roads. Special Event Population = 67,924 additional transients
Evacuation Cases	27 Regions and 11 Scenarios producing 297 unique cases.	36 Regions and 12 Scenarios producing 432 unique cases.

Topic	Previous ETE Study	Current ETE Study
Evacuation Time Estimates Reporting	ETE reported for 50th, 90th, 95th, and 100th percentile population. Results presented by Region and Scenario.	ETE reported for 90th and 100th percentile population. Results presented by Region and Scenario.
Evacuation Time Estimates for the entire EPZ, 90th percentile	Winter Weekday Midday, Good Weather: 3:00 Summer Weekend, Midday, Good Weather: 2:40	Winter Weekday Midday, Good Weather: 3:10 Summer Weekend, Midday, Good Weather: 2:50

2 STUDY ESTIMATES AND ASSUMPTIONS

This section presents the estimates and assumptions utilized in the development of the evacuation time estimates.

2.1 Data Estimates

1. Population estimates are based upon Census 2010 data.
2. Estimates of employees who reside outside the EPZ and commute to work within the EPZ are based upon data obtained from the U.S. Census Bureau, Center for Economic Studies and surveys of major employers in the EPZ.
3. Population estimates at special facilities are based on available data from the River Bend Data Resources Book.
4. Roadway capacity estimates are based on field surveys and the application of the Highway Capacity Manual 2010.
5. Population mobilization times are based on a statistical analysis of data acquired from a random sample telephone survey of EPZ residents (see Section 5 and Appendix F).
6. The relationship between resident population and evacuating vehicles is developed from the telephone survey. Average values of 2.52 persons per household and 1.53 evacuating vehicles per household are used. The relationship between persons and vehicles for transients and employees is as follows:
    a. Employees: 1.03 employees per vehicle (telephone survey results) for all major employers.
    b. Parks: Vehicle occupancy varies based upon data listed in the RBS Data Resources Book.
    c. Special Events: Data provided by the Pointe Coupee Parish for the New Roads Mardi Gras celebration indicates that vehicles on average have 4 people per vehicle is used to estimate the number of vehicles.

2.2 Study Methodological Assumptions

1. ETE are presented for the evacuation of the 90th and 100th percentiles of population for each Region and for each Scenario. The percentile ETE is defined as the elapsed time from the Advisory to Evacuate issued to a specific Region of the EPZ, to the time that Region is clear of the indicated percentile of evacuees. A Region is defined as a group of PAS that is issued an Advisory to Evacuate. A scenario is a combination of circumstances, including time of day, day of week, season, and weather conditions.
2. The ETE are computed and presented in tabular format and graphically, in a format compliant with NUREG/CR-7002.
3. Evacuation movements (paths of travel) are generally outbound relative to the plant to the extent permitted by the highway network. All major evacuation routes are used in the analysis.
4. Regions are defined by the underlying "keyhole" or circular configurations as specified in Section 1.4 of NUREG/CR-7002. These Regions, as defined, display irregular boundaries reflecting the geography of the PAS included within these underlying configurations.
5. As indicated in Figure 2-2 of NUREG/CR-7002, 100% of people within the impacted "keyhole" evacuate. 20% of those people within the EPZ, not within the impacted keyhole, will voluntarily evacuate. 20% of those people within the Shadow Region will voluntarily evacuate. See Figure 2-1 for a graphical representation of these evacuation percentages. Sensitivity studies explore the effect on ETE of increasing the percentage of voluntary evacuees in the Shadow Region (see Appendix M).
6. A total of 12 "Scenarios" representing different temporal variations (season, time of day, day of week) and weather conditions are considered. These Scenarios are outlined in Table 2-1.
7. Scenario 12 considers the closure of a single lane southbound on US 61 from the St. Francisville border to the EPZ boundary at the nearest intersection of SR 964.
8. The models of the I-DYNEV System were recognized as state of the art by the Atomic Safety & Licensing Board (ASLB) in past hearings. (Sources: Atomic Safety & Licensing Board Hearings on Seabrook and Shoreham; Urbanik[1]). The models have continuously been refined and extended since those hearings and were independently validated by a consultant retained by the NRC. The new DYNEV II model incorporates the latest technology in traffic simulation and in dynamic traffic assignment.

[1] Urbanik, T., et. al. Benchmark Study of the I-DYNEV Evacuation Time Estimate Computer Code, NUREG/CR-4873, Nuclear Regulatory Commission, June, 1988.

Table 2-1. Evacuation Scenario Definitions

Scenario	Season[2]	Day of Week	Time of Day	Weather	Special
1	Summer	Midweek	Midday	Good	None
2	Summer	Midweek	Midday	Rain	None
3	Summer	Weekend	Midday	Good	None
4	Summer	Weekend	Midday	Rain	None
5	Summer	Midweek, Weekend	Evening	Good	None
6	Winter	Midweek	Midday	Good	None
7	Winter	Midweek	Midday	Rain	None
8	Winter	Weekend	Midday	Good	None
9	Winter	Weekend	Midday	Rain	None
10	Winter	Midweek, Weekend	Evening	Good	None
11	Winter	Weekend	Midday	Good	Mardi Gras Festival in New Roads, LA
12	Summer	Weekend	Midday	Good	Roadway Impact – Lane Closure on US 61 SB

[2] Winter assumes that school is in session (also applies to spring and autumn). Summer assumes that school is not in session.

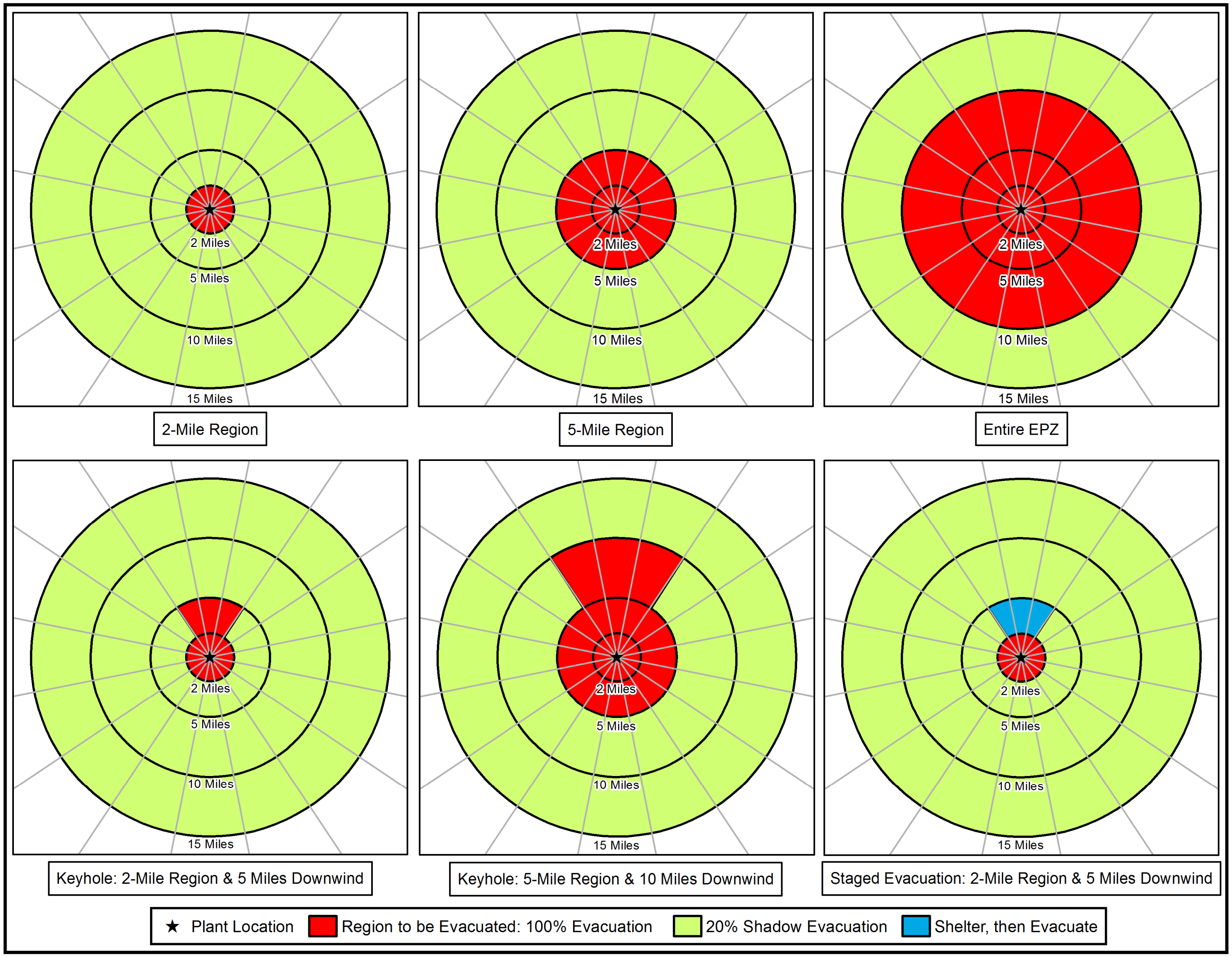


Figure 2-1. Voluntary Evacuation Methodology

2.3 Study Assumptions

1. The Planning Basis Assumption for the calculation of ETE is a rapidly escalating accident that requires evacuation, and includes the following:
    a. Advisory to Evacuate is announced within a timely manner following the siren notification.
    b. Mobilization of the general population will commence within 15 minutes after siren notification.
    c. ETE are measured relative to the Advisory to Evacuate.
2. It is assumed that everyone within the group of PAS forming a Region that is issued an Advisory to Evacuate will, in fact, respond and evacuate in general accord with the planned routes.
3. 59 percent of the households in the EPZ have at least 1 commuter; 64 percent of those households with commuters will await the return of a commuter before beginning their evacuation trip, based on the telephone survey results. Therefore 38 percent (59% x 64% = 38%) of EPZ households will await the return of a commuter, prior to beginning their evacuation trip.
4. The ETE will also include consideration of "through" (External-External) trips during the time that such traffic is permitted to enter the evacuated Region. "Normal" traffic flow is assumed to be present within the EPZ at the start of the emergency.
5. Access Control Points (ACP) will be staffed within approximately 120 minutes following the siren notifications, to divert traffic attempting to enter the EPZ. Earlier activation of ACP locations could delay returning commuters. It is assumed that no through traffic will enter the EPZ after this 120 minute time period.
6. Traffic Control Points (TCP) within the EPZ will be staffed over time, beginning at the Advisory to Evacuate. Their number and location will depend on the Region to be evacuated and resources available. The objectives of these TCP are:
    a. Facilitate the movements of all (mostly evacuating) vehicles at the location.
    b. Discourage inadvertent vehicle movements towards the plant.
    c. Provide assurance and guidance to any traveler who is unsure of the appropriate actions or routing.
    d. Act as local surveillance and communications center.
    e. Provide information to the emergency operations center (EOC) as needed, based on direct observation or on information provided by travelers.

    In calculating ETE, it is assumed that evacuees will drive safely, travel in directions identified in the plan, and obey all control devices and traffic guides.

7. Buses will be used to transport those without access to private vehicles:
    a. If schools are in session, transport (buses) will evacuate students directly to the designated reception center.
    b. If day cares are in session, transportation will be provided by the centers and evacuated to the designated reception center.
    c. Buses, wheelchair vans and ambulances will evacuate patients at medical facilities and at any senior facilities within the EPZ, as needed.
    d. Transit-dependent general population will be evacuated to Reception Centers.
    e. Schoolchildren, if school is in session, are given priority in assigning transit vehicles.
    f. Bus mobilization time is considered in ETE calculations.
    g. Analysis of the number of required round-trips ("waves") of evacuating transit vehicles is presented.
    h. Transport of transit-dependent evacuees from reception centers to congregate care centers is not considered in this study.
8. Provisions are made for evacuating the transit-dependent portion of the general population to reception centers by bus, based on the assumption that some of these people will ride-share with family, neighbors, and friends, thus reducing the demand for buses. We assume that the percentage of people who rideshare is 50 percent. This assumption is based upon reported experience for other emergencies[3], and on guidance in Section 2.2 of NUREG/CR-7002.
9. One type of adverse weather scenario is considered. Rain may occur for either winter or summer scenarios. It is assumed that the rain begins earlier or at about the same time the evacuation advisory is issued. No weather-related reduction in the number of transients who may be present in the EPZ is assumed. It is assumed that roads are passable.

    Adverse weather scenarios affect roadway capacity and the free flow highway speeds. The factors applied for the ETE study are based on recent research on the effects of weather on roadway operations[4]; the factors are shown in Table 2-2.

[3] Institute for Environmental Studies, University of Toronto, THE MISSISSAUGA EVACUATION FINAL REPORT, June 1981. The report indicates that 6,600 people of a transit-dependent population of 8,600 people shared rides with other residents; a ride share rate of 76% (Page 5-10).

[4] Agarwal, M. et. Al. Impacts of Weather on Urban Freeway Traffic Flow Characteristics and Facility Capacity, Proceedings of the 2005 Mid-Continent Transportation Research Symposium, August, 2005. The results of this paper are included as Exhibit 10-15 in the HCM 2010.

10. School buses used to transport students are assumed to transport 60 students per bus for elementary schools and 60 students per bus for middle and high schools, based on data provided in the River Bend Data Resources Book. Transit buses used to transport the transit-dependent general population are assumed to transport 30 people per bus.

Table 2-2. Model Adjustment for Adverse Weather

Scenario	Highway Capacity*	Free Flow Speed*	Mobilization Time for General Population
Rain	90%	90%	No Effect
*Adverse weather capacity and speed values are given as a percentage of good weather conditions. Roads are assumed to be passable.			

3 DEMAND ESTIMATION

The estimates of demand, expressed in terms of people and vehicles, constitute a critical element in developing an evacuation plan. These estimates consist of three components:

1. An estimate of population within the EPZ, stratified into groups (resident, employee, transient).
2. An estimate, for each population group, of mean occupancy per evacuating vehicle. This estimate is used to determine the number of evacuating vehicles.
3. An estimate of potential double-counting of vehicles.

Appendix E presents much of the source material for the population estimates. Our primary source of population data, the 2010 Census, however, is not adequate for directly estimating some transient groups.

Throughout the year, vacationers and tourists enter the EPZ. These non-residents may dwell within the EPZ for a short period (e.g. a few days or one or two weeks), or may enter and leave within one day. Estimates of the size of these population components must be obtained, so that the associated number of evacuating vehicles can be ascertained.

The potential for double-counting people and vehicles must be addressed. For example:

- A resident who works and shops within the EPZ could be counted as a resident, again as an employee and once again as a shopper.
- A visitor who stays at a hotel and spends time at a park, then goes shopping could be counted three times.

Furthermore, the number of vehicles at a location depends on time of day. For example, motel parking lots may be full at dawn and empty at noon. Similarly, parking lots at area parks, which are full at noon, may be almost empty at dawn. Estimating counts of vehicles by simply adding up the capacities of different types of parking facilities will tend to overestimate the number of transients and can lead to ETE that are too conservative.

Analysis of the population characteristics of the River Bend Station EPZ indicates the need to identify three distinct groups:

- Permanent residents - people who are year round residents of the EPZ.
- Transients - people who reside outside of the EPZ who enter the area for a specific purpose (shopping, recreation) and then leave the area.
- Employees - people who reside outside of the EPZ and commute to businesses within the EPZ on a daily basis.

Estimates of the population and number of evacuating vehicles for each of the population groups are presented for each PAS and by polar coordinate representation (population rose). The River Bend Station EPZ is subdivided into 18 PAS. The EPZ is shown in Figure 3-1.

3.1 Permanent Residents

The primary source for estimating permanent population is the latest U.S. Census data. The average household size (2.52 persons/household – See Figure F-1) and the number of evacuating vehicles per household (1.53 vehicles/household – See Figure F-7) were adapted from the telephone survey results.

Population estimates are based upon Census 2010 data. The estimates are created by cutting the census block polygons by the PAS and EPZ boundaries. A ratio of the original area of each census block and the updated area (after cutting) is multiplied by the total block population to estimate what the population is within the EPZ. This methodology assumes that the population is evenly distributed across a census block. Table 3-1 provides the permanent resident population within the EPZ, by PAS based on this methodology.

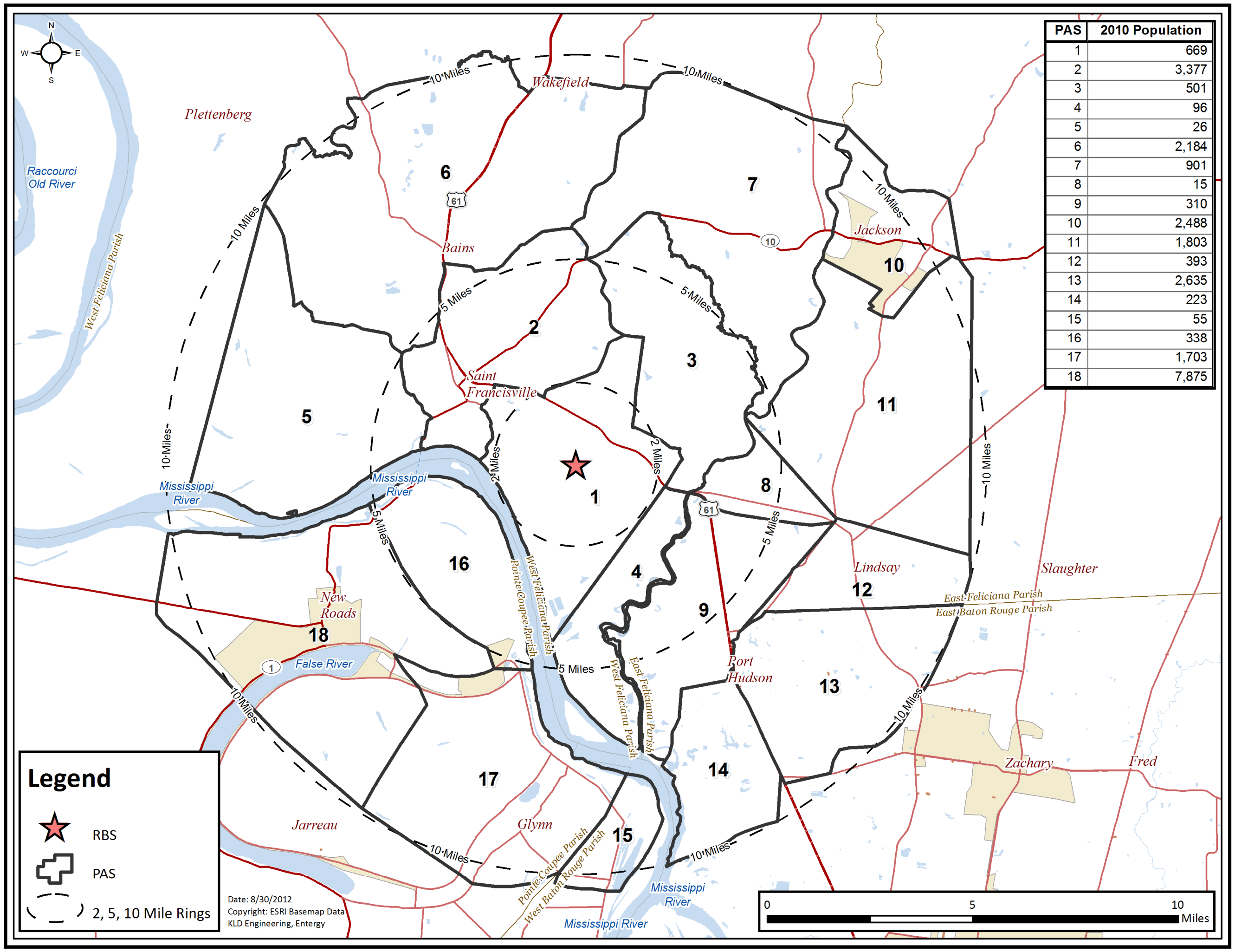
The year 2010 permanent resident population is divided by the average household size and then multiplied by the average number of evacuating vehicles per household in order to estimate number of vehicles. Permanent resident population and vehicle estimates are presented in Table 3-2. Figure 3-2 and Figure 3-3 present the permanent resident population and permanent resident vehicle estimates by sector and distance from the River Bend Station. This "rose" was constructed using GIS software.

It can be argued that this estimate of permanent residents overstates, somewhat, the number of evacuating vehicles, especially during the summer. It is certainly reasonable to assert that some portion of the population would be on vacation during the summer and would travel elsewhere. A rough estimate of this reduction can be obtained as follows:

- Assume 50 percent of all households vacation for a two-week period over the summer.
- Assume these vacations, in aggregate, are uniformly dispersed over 10 weeks, i.e. 10 percent of the population is on vacation during each two-week interval.
- Assume half of these vacationers leave the area.

On this basis, the permanent resident population would be reduced by 5 percent in the summer and by a lesser amount in the off-season. Given the uncertainty in this estimate, we elected to apply no reductions in permanent resident population for the summer scenarios to account for residents who may be out of the area.

Figure 3-1. RBS EPZ



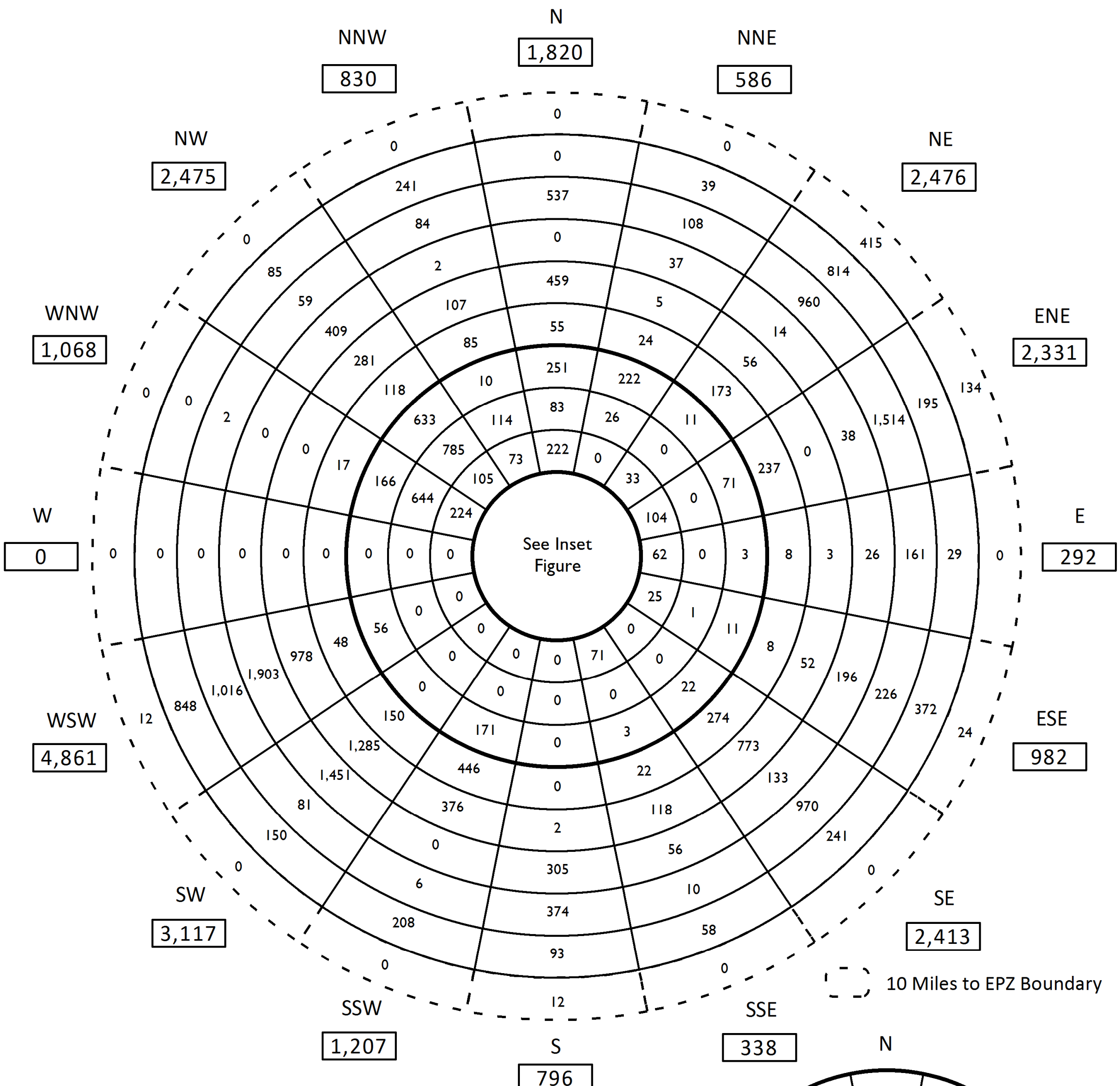
PAS	2010 Population
1	669
2	3,377
3	501
4	96
5	26
6	2,184
7	901
8	15
9	310
10	2,488
11	1,803
12	393
13	2,635
14	223
15	55
16	338
17	1,703
18	7,875

Table 3-1. EPZ Permanent Resident Population

PAS	2000 Population	2010 Population
1	636	669
2	3,490	3,377
3	324	501
4	105	96
5	21	26
6	2,048	2,184
7	704	901
8	8	15
9	459	310
10	4,151	2,488
11	311	1,803
12	198	393
13	2,040	2,635
14	180	223
15	62	55
16	576	338
17	1,682	1,703
18	8,005	7,875
TOTAL	**25,000**	**25,592**
EPZ Population Growth:		**2.37%**

Table 3-2. Permanent Resident Population and Vehicles by PAS

PAS	2010 Population	2010 Resident Vehicles
1	669	405
2	3,377	2,048
3	501	305
4	96	58
5	26	15
6	2,184	1,328
7	901	548
8	15	10
9	310	188
10	2,488	1,507
11	1,803	1,095
12	393	238
13	2,635	1,600
14	223	135
15	55	34
16	338	206
17	1,703	1,036
18	7,875	4,778
TOTAL	**25,592**	**15,534**



Resident Population

Miles	Subtotal by Ring	Cumulative Total
0 - 1	112	112
1 - 2	470	582
2 - 3	919	1,501
3 - 4	1,653	3,154
4 - 5	1,630	4,784
5 - 6	1,665	6,449
6 - 7	4,495	10,944
7 - 8	4,570	15,514
8 - 9	6,108	21,622
9 - 10	3,373	24,995
10 - EPZ	597	25,592
	Total:	25,592

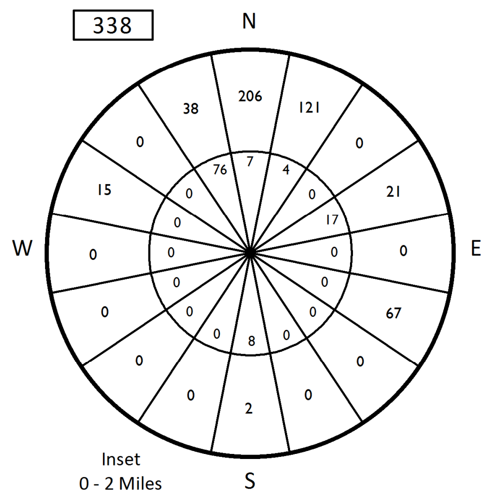
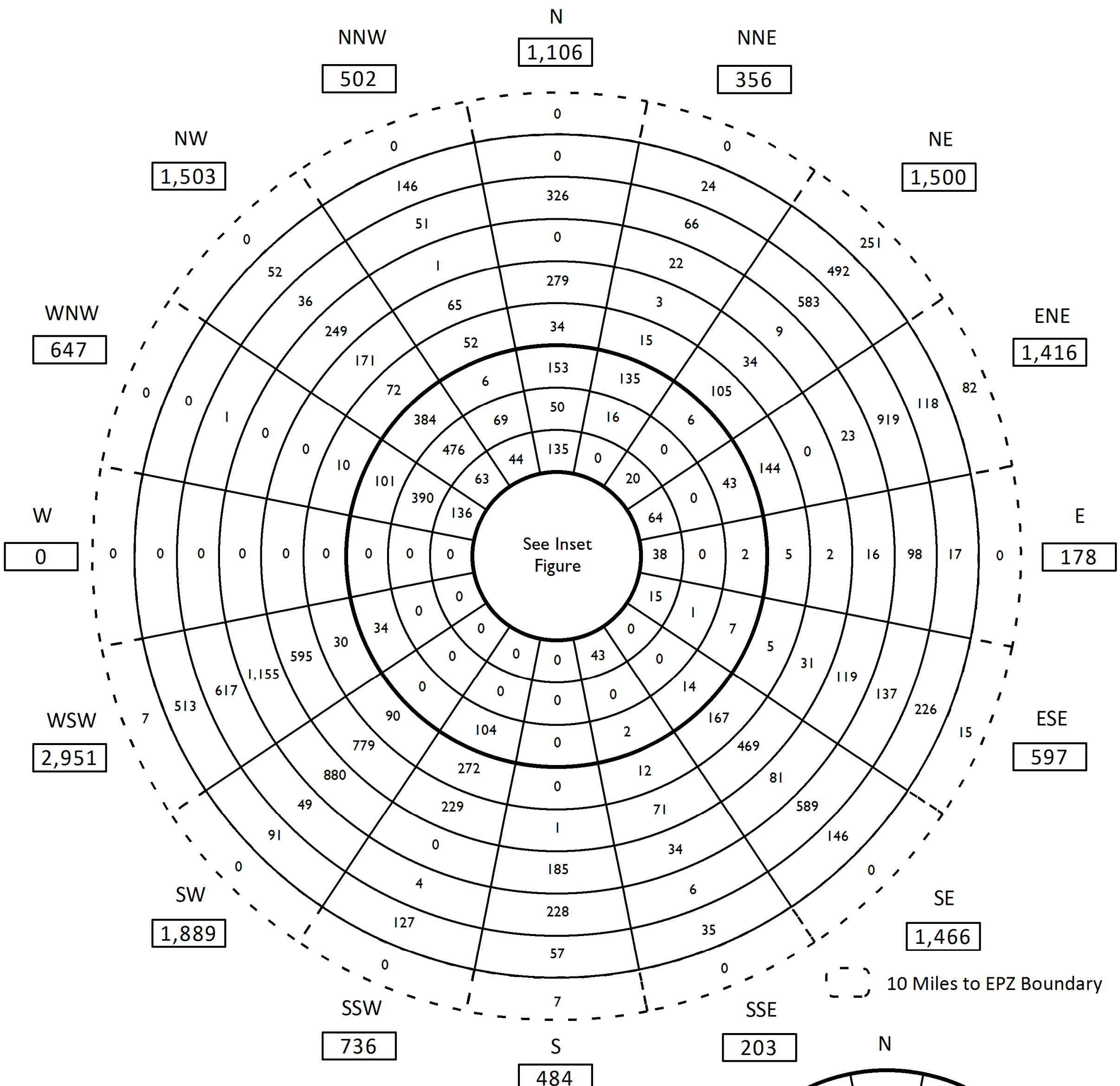


Figure 3-2. Permanent Resident Population by Sector



Resident Vehicles

Miles	Subtotal by Ring	Cumulative Total
0 - 1	67	67
1 - 2	284	351
2 - 3	558	909
3 - 4	1,002	1,911
4 - 5	991	2,902
5 - 6	1,013	3,915
6 - 7	2,729	6,644
7 - 8	2,774	9,418
8 - 9	3,710	13,128
9 - 10	2,044	15,172
10 - EPZ	362	15,534
	Total:	15,534

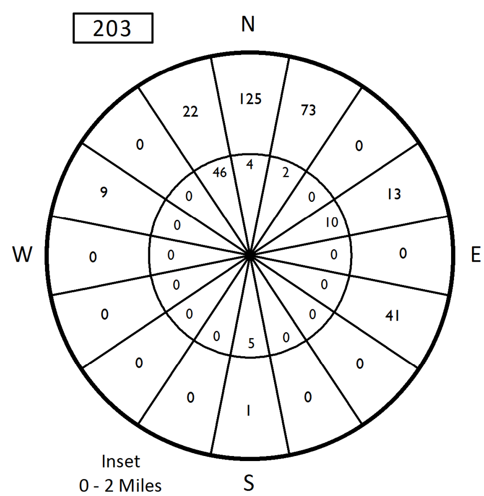


Figure 3-3. Permanent Resident Vehicles by Sector

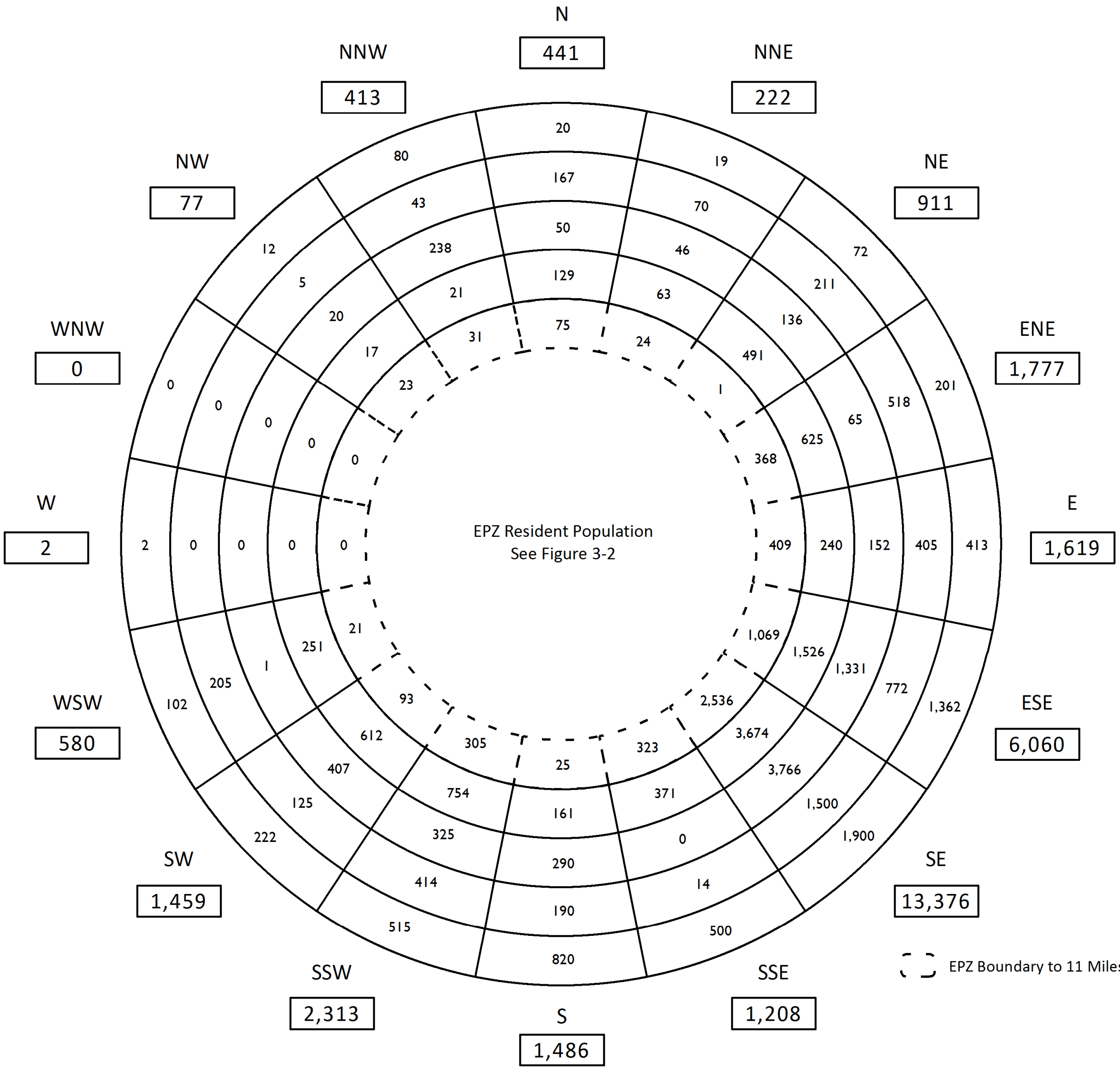
3.2 Shadow Population

A portion of the population living outside the evacuation area extending to 15 miles radially from the River Bend Station (in the Shadow Region) may elect to evacuate without having been instructed to do so. Based upon NUREG/CR-7002 guidance, it is assumed that 20 percent of the permanent resident population, based on U.S. Census Bureau data, in this Shadow Region will elect to evacuate.

Shadow population characteristics (household size, evacuation vehicles per household, mobilization time) are assumed to be the same as that for the EPZ permanent resident population. Table 3-3, Figure 3-4, and Figure 3-5 present estimates of the shadow population and vehicles, by sector.

Table 3-3. Shadow Population and Vehicles by Sector

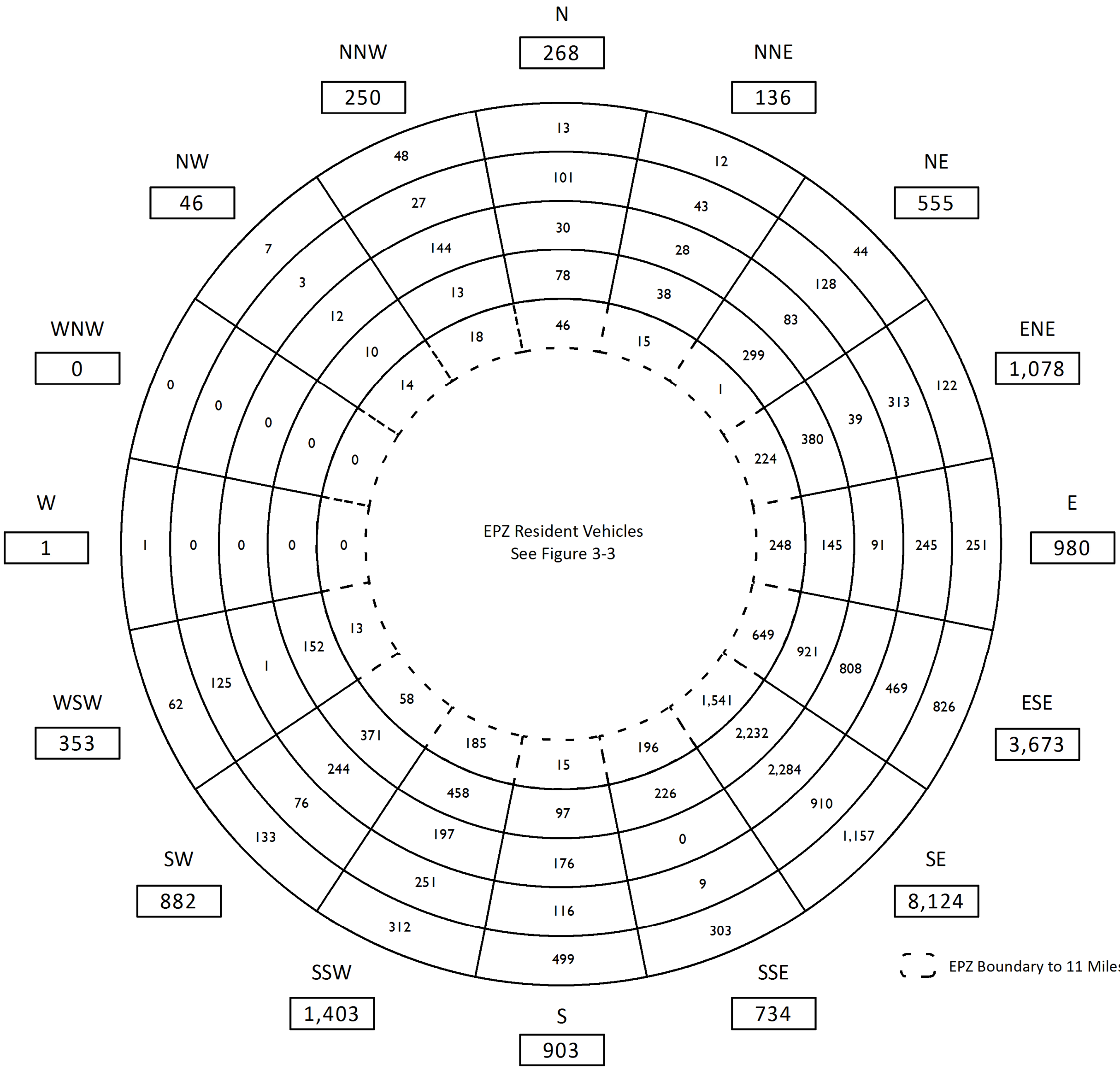
Sector	Population	Evacuating Vehicles
N	441	268
NNE	222	136
NE	911	555
ENE	1,777	1,078
E	1,619	980
ESE	6,060	3,673
SE	13,376	8,124
SSE	1,208	734
S	1,486	903
SSW	2,313	1,403
SW	1,459	882
WSW	580	353
W	2	1
WNW	-	-
NW	77	46
NNW	413	250
TOTAL	**31,944**	**19,386**



Shadow Population

Miles	Subtotal by Ring	Cumulative Total
EPZ - 11	5,303	5,303
11 - 12	8,935	14,238
12 - 13	6,827	21,065
13 - 14	4,639	25,704
14 - 15	6,240	31,944
	Total:	31,944

Figure 3-4. Shadow Population by Sector



Shadow Vehicles

Miles	Subtotal by Ring	Cumulative Total
EPZ - 11	3,223	3,223
11 - 12	5,420	8,643
12 - 13	4,137	12,780
13 - 14	2,816	15,596
14 - 15	3,790	19,386
	Total:	19,386

Figure 3-5. Shadow Vehicles by Sector

3.3 Transient Population

Transient population groups are defined as those people (who are not permanent residents, nor commuting employees) who enter the EPZ for a specific purpose (shopping, recreation). Transients may spend less than one day or stay overnight at camping facilities, hotels and motels. The River Bend Station EPZ has a number of areas and facilities that attract transients, including:

- Lodging Facilities
- Campground & Parks
- Golf Courses
- Historical Sites
- Hunting Camps
- River Cruises – St. Francisville
- Technical Colleges

Transient data is collected and maintained by local Parish and RBS emergency planning personnel and stored in the comprehensive River Bend Station Data Resources Book. This resource book is the source of all data unless otherwise noted. The publish data on the resource book used was March 2012.

There are seven lodging facilities within the EPZ have reported a total of 762 transients in 429 vehicles. These numbers have been assigned to lodging facilities in the EPZ.

There is one campground and one major park area that draws a transient population to the EPZ. A total of 137 transients and 73 vehicles have been assigned to the campground and park area within the EPZ.

There are two golf courses within the EPZ. The Beaver Valley Golf Course was surveyed to determine the number of golfers and vehicles at the facility on a typical peak day, and the number of golfers that travels from outside the area. The second course, False River Golf and Country Club estimates were provided in the RBS Data Resources Book. A total of 141 transients and 77 vehicles are assigned to golf courses within the EPZ.

There are seven historical sites within the EPZ and have reported totals of 2,294 transients in 720 vehicles. These numbers have been assigned for historical sites in the EPZ.

In addition to the RBS Data Resources Book, West Feliciana Parish Sheriff's Department provided an extensive list of hunting camps within the EPZ. The estimated number of transients is 435 and 203 vehicles have been assigned to hunting camps within the EPZ.

Several river cruises dock in St. Francisville and allow patrons to tour local historical sites. The estimated number of transients for these cruises is 400 transients on 7 tour buses or 14 vehicles.

The Louisiana Technical College, a small commuter technical school, has two branch campuses within the RBS EPZ. The campuses report a small number of students, 140 at the Jumonville Campus (PAS 18) and 80 at the Folkes Campus (PAS 10). These students have a similar travel

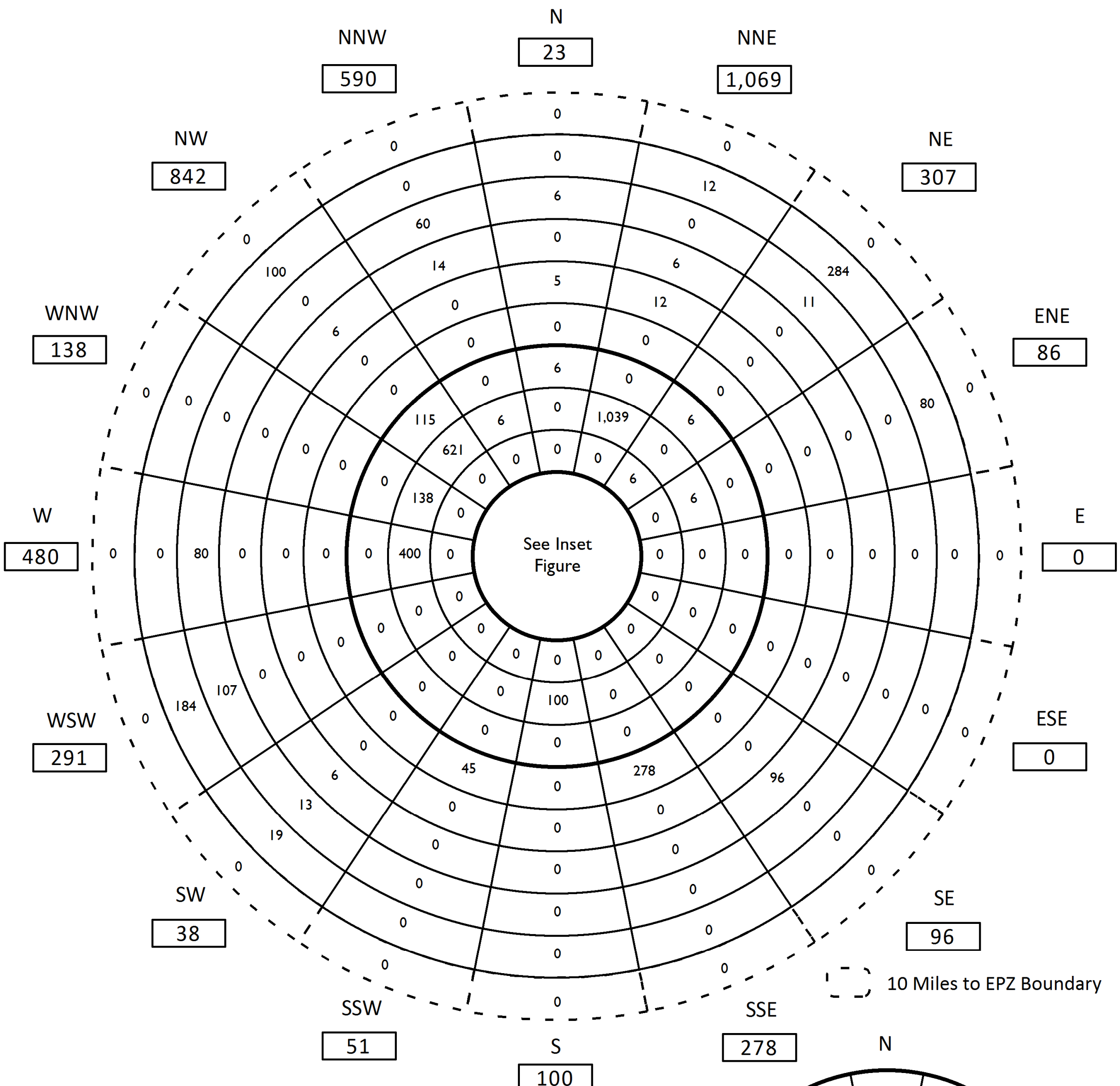
pattern that of commuting transients and have been included with the transients rose diagrams in Figure 3-6 and Figure 3-7 as well as Table 3-4. In Table 3-7 and Table 3-8, they have been allocated their own column and are not double counted within the schools and transients. In Section 8, Table 8-2 the colleges are also listed as schools; no ETE has been provided for them as students have their own transportation. Each student reports having their own vehicle and 220 vehicles have been added to the network.

Appendix E summarizes the transient data that was estimated for the EPZ. Table E-5 presents the number of transients visiting recreational areas, while Table E-6 presents the number of transients at hunting camps. Lodging facilities within the EPZ are presented in Table E-7.

Table 3-4 presents transient population and transient vehicle estimates by PAS. Figure 3-6 and Figure 3-7 present these data by sector and distance from the plant.

Table 3-4. Summary of Transients and Transient Vehicles

PAS	Transients	Transient Vehicles
1	1,667	374
2	1,286	452
3	12	4
4	-	-
5	80	40
6	191	95
7	187	138
8	-	-
9	278	146
10	138	88
11	-	-
12	-	-
13	96	32
14	-	-
15	-	-
16	-	-
17	-	-
18	374	287
TOTAL	**4,389**	**1,736**



Transients

Miles	Subtotal by Ring	Cumulative Total
0 - 1	6	6
1 - 2	516	522
2 - 3	6	528
3 - 4	2,310	2,838
4 - 5	127	2,965
5 - 6	323	3,288
6 - 7	17	3,305
7 - 8	128	3,433
8 - 9	277	3,710
9 - 10	679	4,389
10 - EPZ	0	4,389
	Total:	4,389

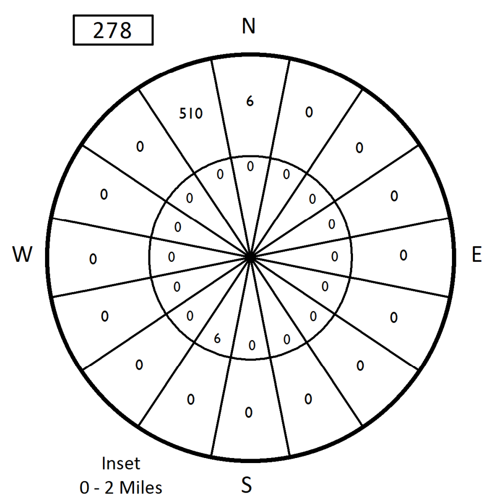
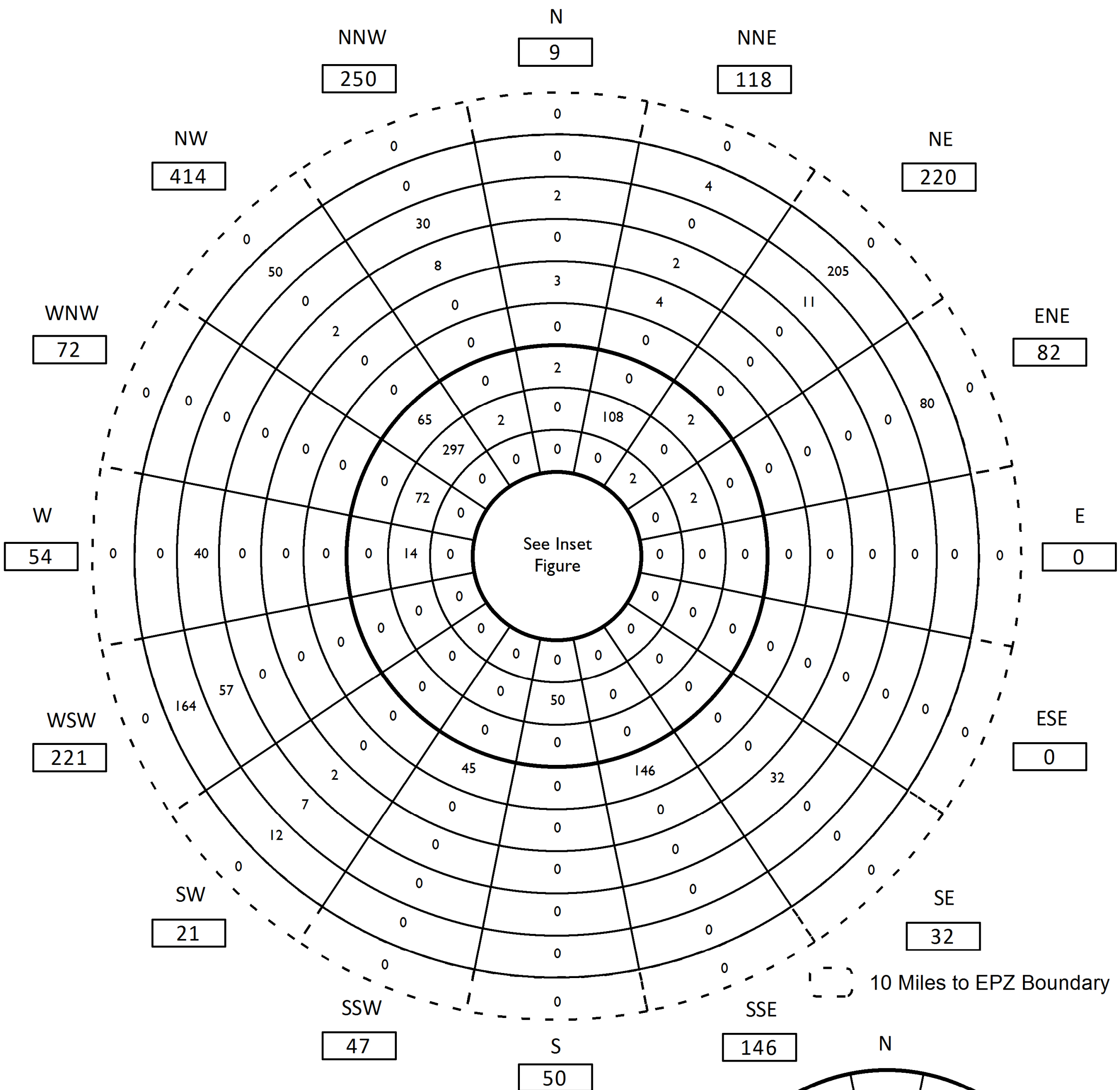


Figure 3-6. Transient Population by Sector



Transient Vehicles

Miles	Subtotal by Ring	Cumulative Total
0 - 1	2	2
1 - 2	212	214
2 - 3	2	216
3 - 4	545	761
4 - 5	69	830
5 - 6	191	1,021
6 - 7	7	1,028
7 - 8	46	1,074
8 - 9	147	1,221
9 - 10	515	1,736
10 - EPZ	0	1,736
	Total:	1,736

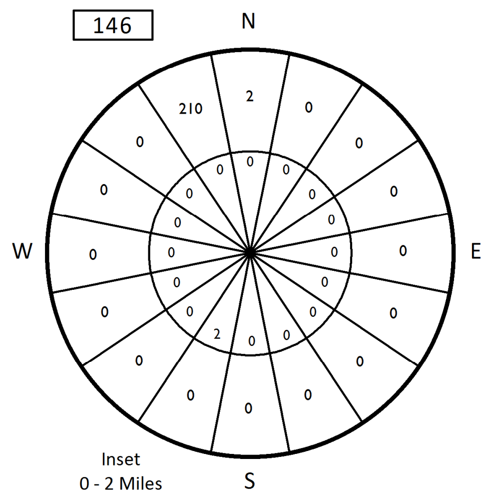


Figure 3-7. Transient Vehicles by Sector

3.4 Employees

Employees who work within the EPZ fall into two categories:

- Those who live and work in the EPZ
- Those who live outside of the EPZ and commute to jobs within the EPZ.

Those of the first category are already counted as part of the permanent resident population. To avoid double counting, we focus only on those employees commuting from outside the EPZ who will evacuate along with the permanent resident population.

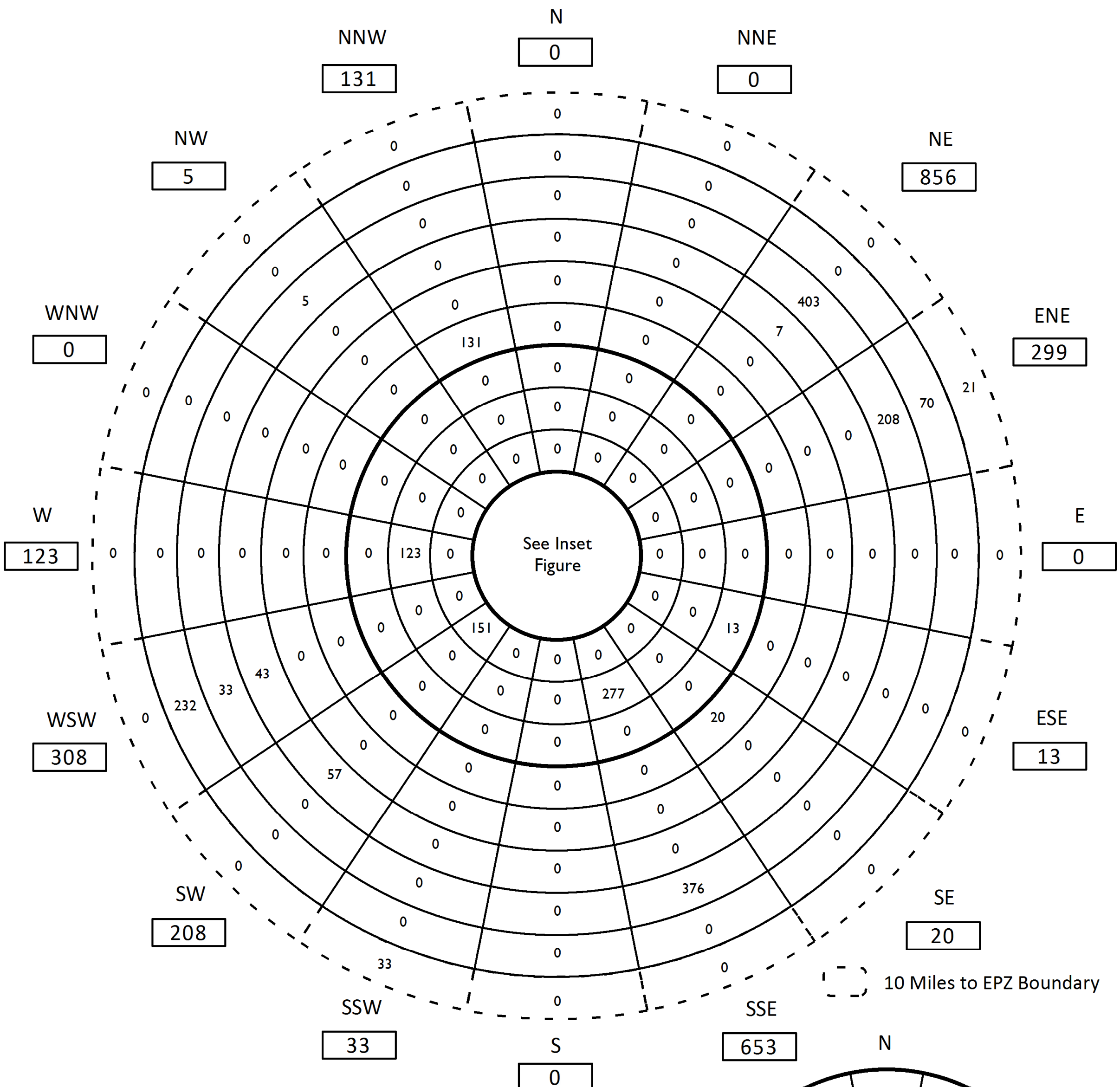
Total number of employees for major employers was also provided in the RBS Data Resources Book. The U.S. Census Bureau's Longitudinal Employer-Household Dynamics interactive website was used to obtain information regarding employees working within the EPZ, but residing outside. It was determined that an average of 66% of Employees working within the EPZ live outside (Non-EPZ factor).

In Table E-4, the Employees (Max Shift) is multiplied by the percent Non-EPZ factor to determine the number of employees who are not residents of the EPZ. A vehicle occupancy of 1.03 employees per vehicle obtained from the telephone survey (See Figure F-6) was used to determine the number of evacuating employee vehicles for all major employers, except the U.S. Army Corps of Engineers whom provided specific vehicle occupancy factors.

Table 3-5 presents non-EPZ Resident employee and vehicle estimates by PAS. Figure 3-8 and Figure 3-9 present these data by sector.

Table 3-5. Summary of Non-EPZ Resident Employees and Employee Vehicles

PAS	Employees	Employee Vehicles
1	446	433
2	254	217
3	-	-
4	277	269
5	-	-
6	5	5
7	14	14
8	13	13
9	20	19
10	487	472
11	208	202
12	-	-
13	-	-
14	376	365
15	-	-
16	151	147
17	33	32
18	365	355
TOTAL	**2,649**	**2,543**



Employees

Miles	Subtotal by Ring	Cumulative Total
0 - 1	446	446
1 - 2	0	446
2 - 3	151	597
3 - 4	400	997
4 - 5	13	1,010
5 - 6	151	1,161
6 - 7	0	1,161
7 - 8	107	1,268
8 - 9	1,025	2,293
9 - 10	302	2,595
10 - EPZ	54	2,649
	Total:	2,649

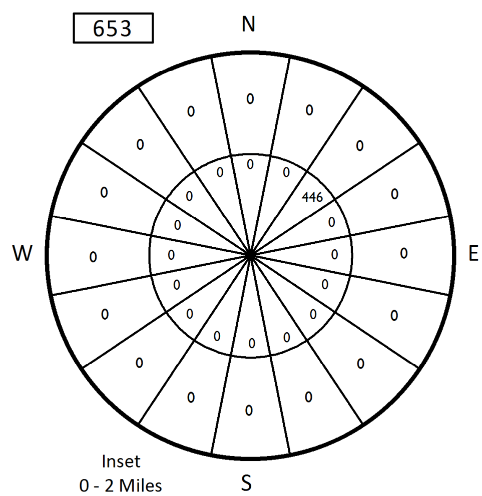
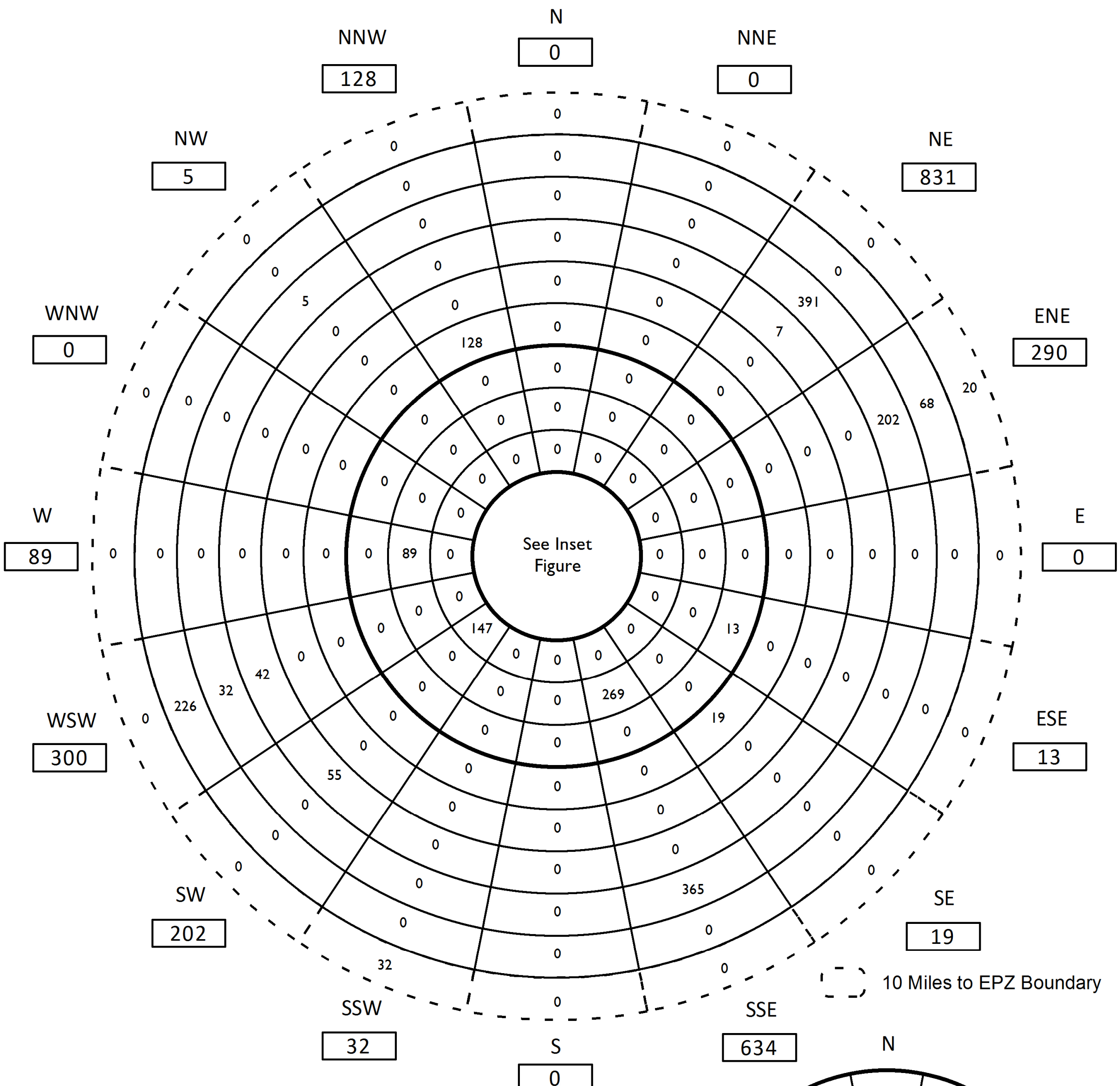


Figure 3-8. Employee Population by Sector



Employee Vehicles

Miles	Subtotal by Ring	Cumulative Total
0 - 1	433	433
1 - 2	0	433
2 - 3	147	580
3 - 4	358	938
4 - 5	13	951
5 - 6	147	1,098
6 - 7	0	1,098
7 - 8	104	1,202
8 - 9	995	2,197
9 - 10	294	2,491
10 - EPZ	52	2,543
	Total:	2,543

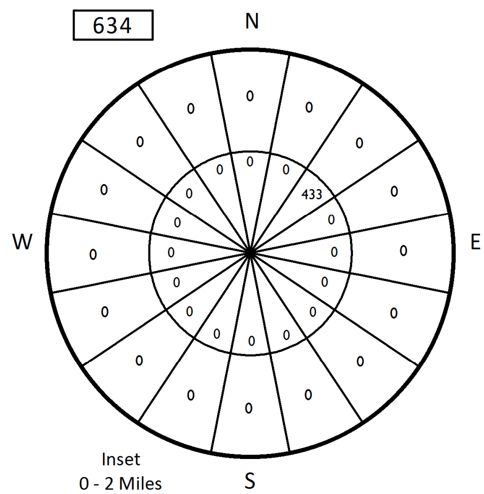


Figure 3-9. Employee Vehicles by Sector

3.5 Medical Facilities

There are ten medical facilities within the EPZ. Data was also provided for each of the medical facilities in the RBS Data Resources Book. Table E-3 in Appendix E summarizes the data gathered. Section 8 details the evacuation of medical facilities and their patients. The number and type of evacuating vehicles that need to be provided depend on the patients' state of health. It is estimated that buses can transport up to 30 people; wheelchair vans, up to 4 people; wheelchair buses up to 15 people; and ambulances, up to 2 people.

3.6 Total Demand in Addition to Permanent Population

Vehicles will be traveling through the EPZ (external-external trips) at the time of an accident. After the Advisory to Evacuate is announced, these through-travelers will also evacuate. These through vehicles are assumed to travel on the major routes traversing the EPZ – US HWY 61, SR 190 and SR 19. It is assumed that this traffic will continue to enter the EPZ during the first 120 minutes following the Advisory to Evacuate.

Average Annual Daily Traffic (AADT) data was obtained from Federal Highway Administration to estimate the number of vehicles per hour on the aforementioned routes. The AADT was multiplied by the K-Factor, which is the proportion of the AADT on a roadway segment or link during the design hour, resulting in the design hour volume (DHV). The design hour is usually the 30^{th} highest hourly traffic volume of the year, measured in vehicles per hour (vph). The DHV is then multiplied by the D-Factor, which is the proportion of the DHV occurring in the peak direction of travel (also known as the directional split). The resulting values are the directional design hourly volumes (DDHV), and are presented in Table 3-6, for each of the routes considered. The DDHV is then multiplied by 2 hours (access control points – ACP – are assumed to be activated at 120 minutes after the advisory to evacuate) to estimate the total number of external vehicles loaded on the analysis network. As indicated, there are 8,240 vehicles entering the EPZ as external-external trips prior to the activation of the ACP and the diversion of this traffic. This number is reduced by 60% for evening scenarios (Scenarios 5 and 10) as discussed in Section 6.

3.7 Special Event

One special event (Scenario 11) is considered for the ETE study – the Mardi Gras Celebration in New Roads, LA. This is a large celebration taking place in down town New Roads on Main Street. Data was obtained from Pointe Coupee Parish, RBS Emergency planning staff and law enforcement personnel for the parish. Approximately 80,000 people attend this celebration which takes place the Saturday before Fat Tuesday. According to Pointe Coupee Parish emergency management personnel, approximately 85% of the 80,000 attendees come from outside the EPZ. The average vehicle occupancy was reported at 4 persons per vehicle. A total of 67,924 people in 16,981 vehicles were incorporated at various parking locations for this special event with in one mile of downtown New Roads. The special event vehicle trips were generated utilizing the same mobilization distributions for transients.

Table 3-6. RBS EPZ External Traffic

Upstream Node	Downstream Node	Road Name	Direction	HPMS[1] AADT	K-Factor[2]	D-Factor[2]	Hourly Volume	External Traffic
8537	537	US-190	Eastbound	18,600	0.116	0.5	1,079	2,158
8641	641	US-190	Westbound	18,600	0.116	0.5	1,079	2,158
8598	598	US-61	Southbound	10,500	0.116	0.5	609	1,218
8153	153	SR-19	Southbound	6,300	0.118	0.5	372	744
							TOTAL:	**6,278**

[1]Highway Performance Monitoring System (HPMS), Federal Highway Administration (FHWA), Washington, D.C., 2012
[2]HCM 2010

3.8 Summary of Demand

A summary of population and vehicle demand is summarized in Table 3-7 and Table 3-8, respectively. This summary includes all population groups described in this section. Additional population groups – transit-dependent, special facility and school population – are described in greater detail in Section 8. A total of 48,954 people and 30,466 vehicles are considered in this study.

Table 3-7. Summary of Population Demand

PAS	Residents	Transit-Dependent	Transients	Employees	Special Facilities	Schools	Technical Colleges	Shadow Population	External Traffic	Total
1	669	24	1,667	446	-	-	-	-	-	2,806
2	3,377	122	1,286	254	59	2,575	-	-	-	7,673
3	501	18	12	-	124	-	-	-	-	655
4	96	3	-	277	-	-	-	-	-	376
5	26	1	80	-	-	-	-	-	-	107
6	2,184	79	191	5	-	263	-	-	-	2,722
7	901	33	187	14	7	-	-	-	-	1,142
8	15	1	-	13	-	-	-	-	-	29
9	310	11	278	20	-	-	-	-	-	619
10	2,488	90	138	487	684	1,008	80	-	-	4,975
11	1,803	65	-	208	1,470	-	-	-	-	3,546
12	393	14	-	-	-	-	-	-	-	407
13	2,635	95	96	-	-	-	-	-	-	2,826
14	223	8	-	376	-	125	-	-	-	732
15	55	2	-	-	-	-	-	-	-	57
16	338	12	-	151	100	-	-	-	-	601
17	1,703	62	-	33	-	406	-	-	-	2,204
18	7,875	286	234	365	277	1,911	140	-	-	10,948
Shadow	-	-	-	-	-	-	-	6,389	-	6,389
Total	**25,592**	**926**	**4,169**	**2,649**	**2,721**	**6,288**	**220**	**6,389**	**0**	**48,954**

NOTE: Shadow Population has been reduced to 20%. Refer to Figure 2-1 for additional information.
NOTE: Special Facilities include both medical facilities and correctional facilities.
NOTE: Technical college campuses are listed in Section 3.3 and also in Table 8-2, but listed separately in this table.

Table 3-8. Summary of Vehicle Demand

PAS	Residents	Transit-Dependent	Transients	Employees	Special Facilities	Schools	Technical Colleges	Shadow Population	External Traffic	Total
1	405	2	374	433	-	-	-	-	-	1,214
2	2,048	8	452	217	4	96	-	-	-	2,825
3	305	2	4	-	10	-	-	-	-	321
4	58	-	-	269	-	-	-	-	-	327
5	15	-	40	-	-	-	-	-	-	55
6	1,328	6	95	5	1	10	-	-	-	1,445
7	548	2	138	14	-	-	-	-	-	702
8	10	-	-	13	-	-	-	-	-	23
9	188	-	146	19	-	-	-	-	-	353
10	1,507	6	88	472	48	38	80	-	-	2,239
11	1,095	4	-	202	98	-	-	-	-	1,399
12	238	2	-	-	-	-	-	-	-	240
13	1,600	6	32	-	-	-	-	-	-	1,638
14	135	-	-	365	-	6	-	-	-	506
15	34	-	-	-	-	-	-	-	-	34
16	206	-	-	147	4	-	-	-	-	357
17	1,036	4	-	32	-	14	-	-	-	1,086
18	4,778	20	147	355	39	68	140	-	-	5,547
Shadow	-	-	-	-	-	-	-	3,877	6,278	10,155
Total	**15,534**	**62**	**1,516**	**2,543**	**204**	**232**	**220**	**3,877**	**6,278**	**30,466**

NOTE: Buses represented as two passenger vehicles. Refer to Section 8 for additional information.
NOTE: Technical college campuses are listed in Section 3.3 and also in Table 8-2, but listed separately in this table.

4 ESTIMATION OF HIGHWAY CAPACITY

The ability of the road network to service vehicle demand is a major factor in determining how rapidly an evacuation can be completed. The capacity of a road is defined as the maximum hourly rate at which persons or vehicles can reasonably be expected to traverse a point or uniform section of a lane of roadway during a given time period under prevailing roadway, traffic and control conditions, as stated in the 2010 Highway Capacity Manual (HCM 2010).

In discussing capacity, different operating conditions have been assigned alphabetical designations, A through F, to reflect the range of traffic operational characteristics. These designations have been termed "Levels of Service" (LOS). For example, LOS A connotes free-flow and high-speed operating conditions; LOS F represents a forced flow condition. LOS E describes traffic operating at or near capacity.

Another concept, closely associated with capacity, is “Service Volume” (SV). Service volume is defined as “The maximum hourly rate at which vehicles, bicycles or persons reasonably can be expected to traverse a point or uniform section of a roadway during an hour under specific assumed conditions while maintaining a designated level of service.” This definition is similar to that for capacity. The major distinction is that values of SV vary from one LOS to another, while capacity is the service volume at the upper bound of LOS E, only.

This distinction is illustrated in Exhibit 11-17 of the HCM 2010. As indicated there, the SV varies with Free Flow Speed (FFS), and LOS. The SV is calculated by the DYNEV II simulation model, based on the specified link attributes, FFS, capacity, control device and traffic demand.

Other factors also influence capacity. These include, but are not limited to:

- Lane width
- Shoulder width
- Pavement condition
- Horizontal and vertical alignment (curvature and grade)
- Percent truck traffic
- Control device (and timing, if it is a signal)
- Weather conditions (rain, fog, wind speed)

These factors are considered during the road survey and in the capacity estimation process; some factors have greater influence on capacity than others. For example, lane and shoulder width have only a limited influence on Base Free Flow Speed (BFFS[1]) according to Exhibit 15-7 of the HCM. Consequently, lane and shoulder widths at the narrowest points were observed during the road survey and these observations were recorded, but no detailed measurements of lane or shoulder width were taken. Horizontal and vertical alignment can influence both FFS and capacity. The estimated FFS were measured using the survey vehicle’s speedometer and observing local traffic, under free flow conditions. Capacity is estimated from the procedures of

[1] A very rough estimate of BFFS might be taken as the posted speed limit plus 10 mph (HCM 2010 Page 15-15)

the 2010 HCM. For example, HCM Exhibit 7-1(b) shows the sensitivity of Service Volume at the upper bound of LOS D to grade (capacity is the Service Volume at the upper bound of LOS E).

As discussed in Section 2.3, it is necessary to adjust capacity figures to represent the prevailing conditions during inclement weather. Based on limited empirical data, weather conditions such as rain reduce the values of free speed and of highway capacity by approximately 10 percent. Over the last decade new studies have been made on the effects of rain on traffic capacity. These studies indicate a range of effects between 5 and 20 percent depending on wind speed and precipitation rates. As indicated in Section 2.3, we employ a reduction in free speed and in highway capacity of 10 percent for rain.

Since congestion arising from evacuation may be significant, estimates of roadway capacity must be determined with great care. Because of its importance, a brief discussion of the major factors that influence highway capacity is presented in this section.

Rural highways generally consist of: (1) one or more uniform sections with limited access (driveways, parking areas) characterized by "uninterrupted" flow; and (2) approaches to at-grade intersections where flow can be "interrupted" by a control device or by turning or crossing traffic at the intersection. Due to these differences, separate estimates of capacity must be made for each section. Often, the approach to the intersection is widened by the addition of one or more lanes (turn pockets or turn bays), to compensate for the lower capacity of the approach due to the factors there that can interrupt the flow of traffic. These additional lanes are recorded during the field survey and later entered as input to the DYNEV II system.

4.1 Capacity Estimations on Approaches to Intersections

At-grade intersections are apt to become the first bottleneck locations under local heavy traffic volume conditions. This characteristic reflects the need to allocate access time to the respective competing traffic streams by exerting some form of control. During evacuation, control at critical intersections will often be provided by traffic control personnel assigned for that purpose, whose directions may supersede traffic control devices. The existing traffic management plans documented in the parish emergency plans are extensive and were adopted without change.

The per-lane capacity of an approach to a signalized intersection can be expressed (simplistically) in the following form:

$$Q_{cap,m} = \left(\frac{3600}{h_m}\right) \times \left(\frac{G-L}{C}\right)_m = \left(\frac{3600}{h_m}\right) \times P_m$$

where:

$Q_{cap,m}$ = Capacity of a single lane of traffic on an approach, which executes

		movement, *m*, upon entering the intersection; vehicles per hour (vph)
h_m	=	Mean queue discharge headway of vehicles on this lane that are executing movement, *m*; seconds per vehicle
G	=	Mean duration of GREEN time servicing vehicles that are executing movement, *m*, for each signal cycle; seconds
L	=	Mean "lost time" for each signal phase servicing movement, *m*; seconds
C	=	Duration of each signal cycle; seconds
P_m	=	Proportion of GREEN time allocated for vehicles executing movement, *m*, from this lane. This value is specified as part of the control treatment.
m	=	The movement executed by vehicles after they enter the intersection: through, left-turn, right-turn, and diagonal.

The turn-movement-specific mean discharge headway h_m, depends in a complex way upon many factors: roadway geometrics, turn percentages, the extent of conflicting traffic streams, the control treatment, and others. A primary factor is the value of "saturation queue discharge headway", h_{sat}, which applies to through vehicles that are not impeded by other conflicting traffic streams. This value, itself, depends upon many factors including motorist behavior. Formally, we can write,

$$h_m = f_m(h_{sat}, F_1, F_2, \dots)$$

where:

h_{sat}	=	Saturation discharge headway for through vehicles; seconds per vehicle
F_1, F_2	=	The various known factors influencing h_m
$f_m(\ )$	=	Complex function relating h_m to the known (or estimated) values of h_{sat}, F_1, F_2, …

The estimation of h_m for specified values of h_{sat}, F_1, F_2, ... is undertaken within the DYNEV II simulation model by a mathematical model[2]. The resulting values for h_m always satisfy the condition:

$$h_m \geq h_{sat}$$

[2] Lieberman, E., "Determining Lateral Deployment of Traffic on an Approach to an Intersection", McShane, W. & Lieberman, E., "Service Rates of Mixed Traffic on the far Left Lane of an Approach". Both papers appear in Transportation Research Record 772, 1980. Lieberman, E., Xin, W., "Macroscopic Traffic Modeling For Large-Scale Evacuation Planning", presented at the TRB 2012 Annual Meeting, January 22-26, 2012

That is, the turn-movement-specific discharge headways are always greater than, or equal to the saturation discharge headway for through vehicles. These headways (or its inverse equivalent, "saturation flow rate"), may be determined by observation or using the procedures of the HCM 2010.

The above discussion is necessarily brief given the scope of this ETE report and the complexity of the subject of intersection capacity. In fact, Chapters 18, 19 and 20 in the HCM 2010 address this topic. The factors, F_1, F_2,…, influencing saturation flow rate are identified in equation (18-5) of the HCM 2010.

The traffic signals within the EPZ and Shadow Region are modeled using representative phasing plans and phase durations obtained as part of the field data collection. Traffic responsive signal installations allow the proportion of green time allocated (P_m) for each approach to each intersection to be determined by the expected traffic volumes on each approach during evacuation circumstances. The amount of green time (G) allocated is subject to maximum and minimum phase duration constraints; 2 seconds of yellow time are indicated for each signal phase and 1 second of all-red time is assigned between signal phases, typically. If a signal is pre-timed, the yellow and all-red times observed during the road survey are used. A lost time (L) of 2.0 seconds is used for each signal phase in the analysis.

4.2 Capacity Estimation along Sections of Highway

The capacity of highway sections -- as distinct from approaches to intersections -- is a function of roadway geometrics, traffic composition (e.g. percent heavy trucks and buses in the traffic stream) and, of course, motorist behavior. There is a fundamental relationship which relates service volume (i.e. the number of vehicles serviced within a uniform highway section in a given time period) to traffic density. The top curve in Figure 4-1 illustrates this relationship.

As indicated, there are two flow regimes: (1) Free Flow (left side of curve); and (2) Forced Flow (right side). In the Free Flow regime, the traffic demand is fully serviced; the service volume increases as demand volume and density increase, until the service volume attains its maximum value, which is the capacity of the highway section. As traffic demand and the resulting highway density increase beyond this "critical" value, the rate at which traffic can be serviced (i.e. the service volume) can actually decline below capacity ("capacity drop"). Therefore, in order to realistically represent traffic performance during congested conditions (i.e. when demand exceeds capacity), it is necessary to estimate the service volume, V_F, under congested conditions.

The value of V_F can be expressed as:

$$V_F = R \times Capacity$$

where:

R = Reduction factor which is less than unity

We have employed a value of R=0.90. The advisability of such a capacity reduction factor is based upon empirical studies that identified a fall-off in the service flow rate when congestion occurs at "bottlenecks" or "choke points" on a freeway system. Zhang and Levinson[3] describe a research program that collected data from a computer-based surveillance system (loop detectors) installed on the Interstate Highway System, at 27 active bottlenecks in the twin cities metro area in Minnesota over a 7-week period. When flow breakdown occurs, queues are formed which discharge at lower flow rates than the maximum capacity prior to observed breakdown. These queue discharge flow (QDF) rates vary from one location to the next and also vary by day of week and time of day based upon local circumstances. The cited reference presents a mean QDF of 2,016 passenger cars per hour per lane (pcphpl). This figure compares with the nominal capacity estimate of 2,250 pcphpl estimated for the ETE and indicated in Appendix K for freeway links. The ratio of these two numbers is 0.896 which translates into a capacity reduction factor of 0.90.

Since the principal objective of evacuation time estimate analyses is to develop a "realistic" estimate of evacuation times, use of the representative value for this capacity reduction factor (R=0.90) is justified. This factor is applied only when flow breaks down, as determined by the simulation model.

Rural roads, like freeways, are classified as "uninterrupted flow" facilities. (This is in contrast with urban street systems which have closely spaced signalized intersections and are classified as "interrupted flow" facilities.) As such, traffic flow along rural roads is subject to the same effects as freeways in the event traffic demand exceeds the nominal capacity, resulting in queuing and lower QDF rates. As a practical matter, rural roads rarely break down at locations away from intersections. Any breakdowns on rural roads are generally experienced at intersections where other model logic applies, or at lane drops which reduce capacity there. Therefore, the application of a factor of 0.90 is appropriate on rural roads, but rarely, if ever, activated.

The estimated value of capacity is based primarily upon the type of facility and on roadway geometrics. Sections of roadway with adverse geometrics are characterized by lower free-flow speeds and lane capacity. Exhibit 15-30 in the Highway Capacity Manual was referenced to estimate saturation flow rates. The impact of narrow lanes and shoulders on free-flow speed and on capacity is not material, particularly when flow is predominantly in one direction as is the case during an evacuation.

The procedure used here was to estimate "section" capacity, V_E, based on observations made traveling over each section of the evacuation network, based on the posted speed limits and travel behavior of other motorists and by reference to the 2010 HCM. The DYNEV II simulation model determines for each highway section, represented as a network link, whether its capacity would be limited by the "section-specific" service volume, V_E, or by the intersection-specific capacity. For each link, the model selects the lower value of capacity.

[3] Lei Zhang and David Levinson, "Some Properties of Flows at Freeway Bottlenecks," Transportation Research Record 1883, 2004.

4.3 Application to the River Bend Station Study Area

As part of the development of the link-node analysis network for the study area, an estimate of roadway capacity is required. The source material for the capacity estimates presented herein is contained in:

> 2010 Highway Capacity Manual (HCM)
> Transportation Research Board
> National Research Council
> Washington, D.C.

The highway system in the study area consists primarily of three categories of roads and, of course, intersections:

- Two-Lane roads: Local, State
- Multi-Lane Highways (at-grade)
- Freeways

Each of these classifications will be discussed.

4.3.1 Two-Lane Roads

Ref: HCM Chapter 15

Two lane roads comprise the majority of highways within the EPZ. The per-lane capacity of a two-lane highway is estimated at 1700 passenger cars per hour (pc/h). This estimate is essentially independent of the directional distribution of traffic volume except that, for extended distances, the two-way capacity will not exceed 3200 pc/h. The HCM procedures then estimate Level of Service (LOS) and Average Travel Speed. The DYNEV II simulation model accepts the specified value of capacity as input and computes average speed based on the time-varying demand: capacity relations.

Based on the field survey and on expected traffic operations associated with evacuation scenarios:

- Most sections of two-lane roads within the EPZ are classified as "Class I", with "level terrain"; some are "rolling terrain".
- "Class II" highways are mostly those within urban and suburban centers.

4.3.2 Multi-Lane Highway

Ref: HCM Chapter 14

Exhibit 14-2 of the HCM 2010 presents a set of curves that indicate a per-lane capacity ranging from approximately 1900 to 2200 pc/h, for free-speeds of 45 to 60 mph, respectively. Based on observation, the multi-lane highways outside of urban areas within the EPZ service traffic with free-speeds in this range. The actual time-varying speeds computed by the simulation model reflect the demand: capacity relationship and the impact of control at intersections. A

conservative estimate of per-lane capacity of 1900 pc/h is adopted for this study for multi-lane highways outside of urban areas, as shown in Appendix K.

4.3.3 Freeways

Ref: HCM Chapters 10, 11, 12, 13

Chapter 10 of the HCM 2010 describes a procedure for integrating the results obtained in Chapters 11, 12 and 13, which compute capacity and LOS for freeway components. Chapter 10 also presents a discussion of simulation models. The DYNEV II simulation model automatically performs this integration process.

Chapter 11 of the HCM 2010 presents procedures for estimating capacity and LOS for “Basic Freeway Segments". Exhibit 11-17 of the HCM 2010 presents capacity vs. free speed estimates, which are provided below.

Free Speed (mph):	55	60	65	70+
Per-Lane Capacity (pc/h):	2250	2300	2350	2400

The inputs to the simulation model are highway geometrics, free-speeds and capacity based on field observations. The simulation logic calculates actual time-varying speeds based on demand: capacity relationships. A conservative estimate of per-lane capacity of 2250 pc/h is adopted for this study for freeways, as shown in Appendix K.

Chapter 12 of the HCM 2010 presents procedures for estimating capacity, speed, density and LOS for freeway weaving sections. The simulation model contains logic that relates speed to demand volume: capacity ratio. The value of capacity obtained from the computational procedures detailed in Chapter 12 depends on the "Type" and geometrics of the weaving segment and on the "Volume Ratio" (ratio of weaving volume to total volume).

Chapter 13 of the HCM 2010 presents procedures for estimating capacities of ramps and of "merge" areas. There are three significant factors to the determination of capacity of a ramp-freeway junction: The capacity of the freeway immediately downstream of an on-ramp or immediately upstream of an off-ramp; the capacity of the ramp roadway; and the maximum flow rate entering the ramp influence area. In most cases, the freeway capacity is the controlling factor. Values of this merge area capacity are presented in Exhibit 13-8 of the HCM 2010, and depend on the number of freeway lanes and on the freeway free speed. Ramp capacity is presented in Exhibit 13-10 and is a function of the ramp free flow speed. The DYNEV II simulation model logic simulates the merging operations of the ramp and freeway traffic in accord with the procedures in Chapter 13 of the HCM 2010. If congestion results from an excess of demand relative to capacity, then the model allocates service appropriately to the two entering traffic streams and produces LOS F conditions (The HCM does not address LOS F explicitly).

4.3.4 Intersections

Ref: HCM Chapters 18, 19, 20, 21

Procedures for estimating capacity and LOS for approaches to intersections are presented in Chapter 18 (signalized intersections), Chapters 19, 20 (un-signalized intersections) and Chapter 21 (roundabouts). The complexity of these computations is indicated by the aggregate length of these chapters. The DYNEV II simulation logic is likewise complex.

The simulation model explicitly models intersections: Stop/yield controlled intersections (both 2-way and all-way) and traffic signal controlled intersections. Where intersections are controlled by fixed time controllers, traffic signal timings are set to reflect average (non-evacuation) traffic conditions. Actuated traffic signal settings respond to the time-varying demands of evacuation traffic to adjust the relative capacities of the competing intersection approaches.

The model is also capable of modeling the presence of manned traffic control. At specific locations where it is advisable or where existing plans call for overriding existing traffic control to implement manned control, the model will use actuated signal timings that reflect the presence of traffic guides. At locations where a special traffic control strategy (continuous left-turns, contra-flow lanes) is used, the strategy is modeled explicitly. Where applicable, the location and type of traffic control for nodes in the evacuation network are noted in Appendix K. The characteristics of the ten highest volume signalized intersections are detailed in Appendix J.

4.4 Simulation and Capacity Estimation

Chapter 6 of the HCM is entitled, "HCM and Alternative Analysis Tools." The chapter discusses the use of alternative tools such as simulation modeling to evaluate the operational performance of highway networks. Among the reasons cited in Chapter 6 to consider using simulation as an alternative analysis tool is:

> *"The system under study involves a group of different facilities or travel modes with mutual interactions invoking several procedural chapters of the HCM. Alternative tools are able to analyze these facilities as a single system."*

This statement succinctly describes the analyses required to determine traffic operations across an area encompassing an EPZ operating under evacuation conditions. The model utilized for this study, DYNEV II, is further described in Appendix C. It is essential to recognize that simulation models do not replicate the methodology and procedures of the HCM – they *replace* these procedures by describing the complex interactions of traffic flow and computing Measures of Effectiveness (MOE) detailing the operational performance of traffic over time and by location. The DYNEV II simulation model includes some HCM 2010 procedures only for the purpose of estimating capacity.

All simulation models must be calibrated properly with field observations that quantify the performance parameters applicable to the analysis network. Two of the most important of

these are: (1) Free flow speed (FFS); and (2) saturation headway, h_{sat}. The first of these is estimated by direct observation during the road survey; the second is estimated using the concepts of the HCM 2010, as described earlier. These parameters are listed in Appendix K, for each network link.

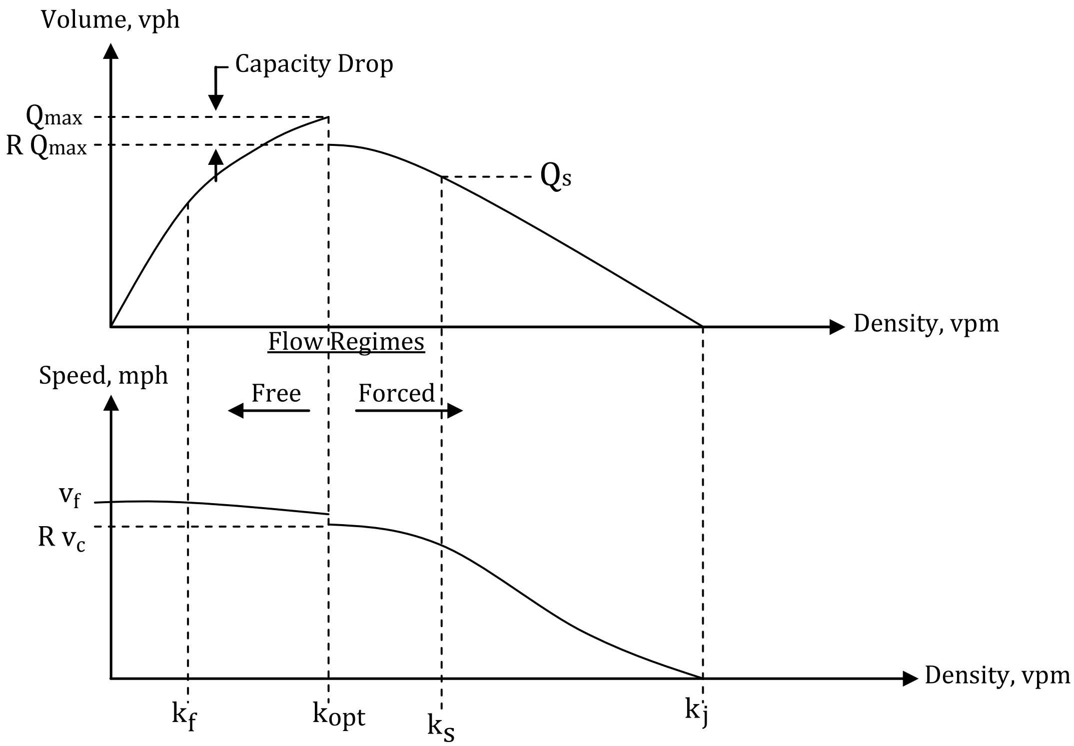


Figure 4-1. Fundamental Diagrams

5 ESTIMATION OF TRIP GENERATION TIME

Federal Government guidelines (see NUREG CR-7002) specify that the planner estimate the distributions of elapsed times associated with mobilization activities undertaken by the public to prepare for the evacuation trip. The elapsed time associated with each activity is represented as a statistical distribution reflecting differences between members of the public. The quantification of these activity-based distributions relies largely on the results of the telephone survey. We define the sum of these distributions of elapsed times as the Trip Generation Time Distribution.

5.1 Background

In general, an accident at a nuclear power plant is characterized by the following Emergency Classification Levels (see Appendix 1 of NUREG 0654 for details):

1. Unusual Event
2. Alert
3. Site Area Emergency
4. General Emergency

At each level, the Federal guidelines specify a set of Actions to be undertaken by the Licensee, and by State and Local offsite authorities. As a Planning Basis, we will adopt a conservative posture, in accordance with Section 1.2 of NUREG/CR-7002, that a rapidly escalating accident will be considered in calculating the Trip Generation Time. We will assume:

1. The Advisory to Evacuate will be announced in a timely manner following the siren notification.
2. Mobilization of the general population will commence within 15 minutes after the siren notification.
3. ETE are measured relative to the Advisory to Evacuate.

We emphasize that the adoption of this planning basis is not a representation that these events will occur within the indicated time frame. Rather, these assumptions are necessary in order to:

1. Establish a temporal framework for estimating the Trip Generation distribution in the format recommended in Section 2.13 of NUREG/CR-6863.
2. Identify temporal points of reference that uniquely define "Clear Time" and ETE.

It is likely that a longer time will elapse between the various classes of an emergency.

For example, suppose one hour elapses from the siren alert to the Advisory to Evacuate. In this case, it is reasonable to expect some degree of spontaneous evacuation by the public during this one-hour period. As a result, the population within the EPZ will be lower when the Advisory to Evacuate is announced, than at the time of the siren alert. In addition, many will engage in preparation activities to evacuate, in anticipation that an Advisory will be broadcast.

Thus, the time needed to complete the mobilization activities and the number of people remaining to evacuate the EPZ after the Advisory to Evacuate, will both be somewhat less than the estimates presented in this report. Consequently, the ETE presented in this report are higher than the actual evacuation time, if this hypothetical situation were to take place.

The notification process consists of two events:

1. Transmitting information using the alert notification systems available within the EPZ (e.g. sirens, tone alerts, EAS broadcasts, and loud speakers).
2. Receiving and correctly interpreting the information that is transmitted.

The population within the EPZ is dispersed over an area of approximately 311 square miles and is engaged in a wide variety of activities. It must be anticipated that some time will elapse between the transmission and receipt of the information advising the public of an accident.

The amount of elapsed time will vary from one individual to the next depending on where that person is, what that person is doing, and related factors. Furthermore, some persons who will be directly involved with the evacuation process may be outside the EPZ at the time the emergency is declared. These people may be commuters, shoppers and other travelers who reside within the EPZ and who will return to join the other household members upon receiving notification of an emergency.

As indicated in Section 2.13 of NUREG/CR-6863, the estimated elapsed times for the receipt of notification can be expressed as a distribution reflecting the different notification times for different people within, and outside, the EPZ. By using time distributions, it is also possible to distinguish between different population groups and different day-of-week and time-of-day scenarios, so that accurate ETE may be computed.

For example, people at home or at work within the EPZ will be notified by siren, and/or tone alert and/or radio (if available). Those well outside the EPZ will be notified by telephone, radio, TV and word-of-mouth, with potentially longer time lags. Furthermore, the spatial distribution of the EPZ population will differ with time of day - families will be united in the evenings, but dispersed during the day. In this respect, weekends will differ from weekdays.

As indicated in Section 4.1 of NUREG/CR-7002, the information required to compute trip generation times is typically obtained from a telephone survey of EPZ residents. Such a survey was conducted in support of this ETE study. Appendix F presents the survey sampling plan, survey instrument, and raw survey results. It is important to note that the shape and duration of the evacuation trip mobilization distribution is important at sites where traffic congestion is not expected to cause the evacuation time estimate to extend in time well beyond the trip generation period. The remaining discussion will focus on the application of the trip generation data obtained from the telephone survey to the development of the ETE documented in this report.

5.2 Fundamental Considerations

The environment leading up to the time that people begin their evacuation trips consists of a sequence of events and activities. Each event (other than the first) occurs at an instant in time and is the outcome of an activity.

Activities are undertaken over a period of time. Activities may be in "series" (i.e. to undertake an activity implies the completion of all preceding events) or may be in parallel (two or more activities may take place over the same period of time). Activities conducted in series are functionally dependent on the completion of prior activities; activities conducted in parallel are functionally independent of one another. The relevant events associated with the public's preparation for evacuation are:

Event Number	Event Description
1	Notification
2	Awareness of Situation
3	Depart Work
4	Arrive Home
5	Depart on Evacuation Trip

Associated with each sequence of events are one or more activities, as outlined below:

Table 5-1. Event Sequence for Evacuation Activities

Event Sequence	Activity	Distribution
1 → 2	Receive Notification	1
2 → 3	Prepare to Leave Work	2
2,3 → 4	Travel Home	3
2,4 → 5	Prepare to Leave to Evacuate	4

These relationships are shown graphically in Figure 5-1.

- An Event is a 'state' that exists at a point in time (e.g., depart work, arrive home)
- An Activity is a 'process' that takes place over some elapsed time (e.g., prepare to leave work, travel home)

As such, a completed Activity changes the 'state' of an individual (e.g. the activity, 'travel home' changes the state from 'depart work' to 'arrive home'). Therefore, an Activity can be described as an 'Event Sequence'; the elapsed times to perform an event sequence vary from one person to the next and are described as statistical distributions on the following pages.

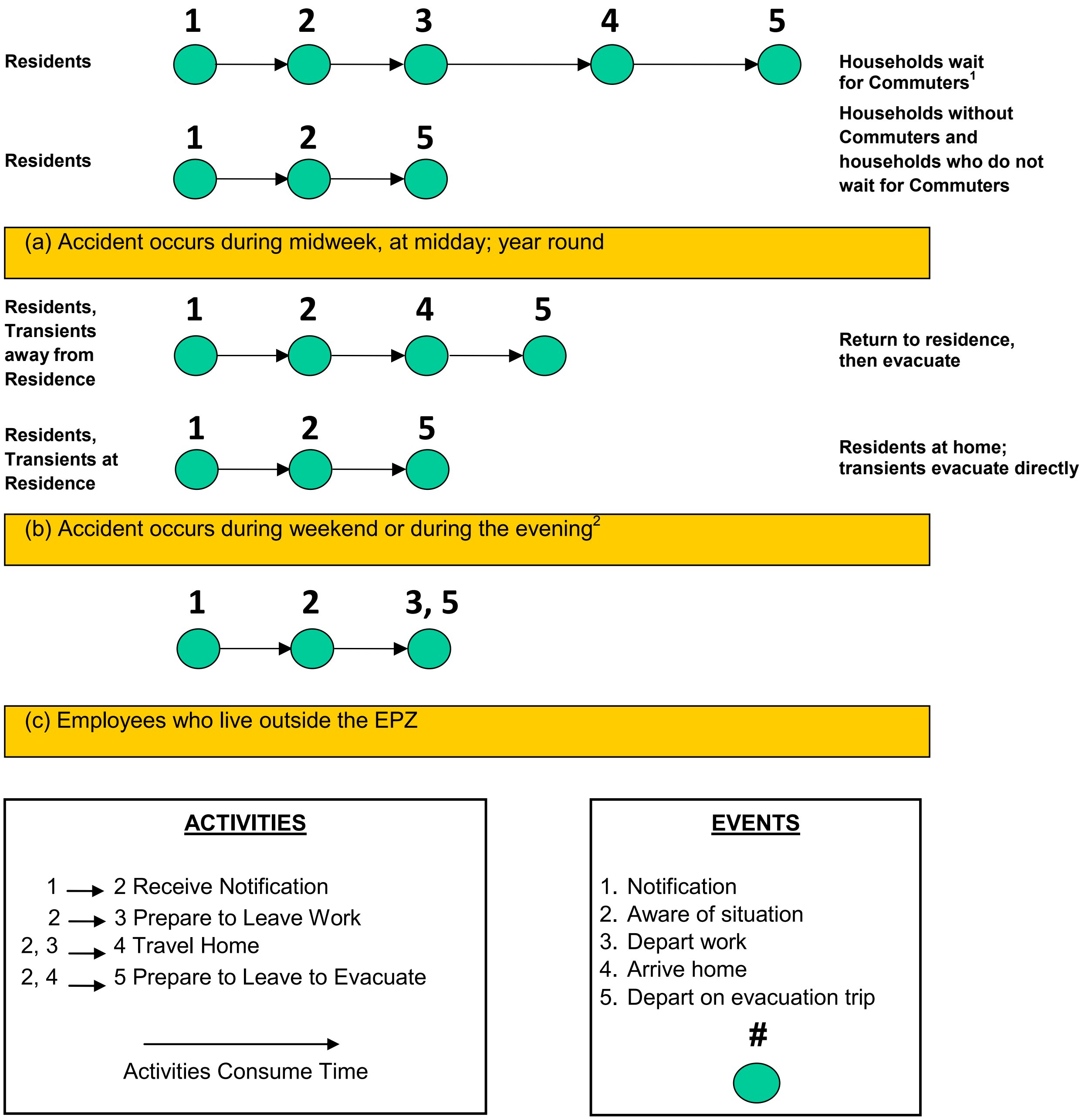
An employee who lives outside the EPZ will follow sequence (c) of Figure 5-1. A household

within the EPZ that has one or more commuters at work, and will await their return before beginning the evacuation trip will follow the first sequence of Figure 5-1(a). A household within the EPZ that has no commuters at work, or that will not await the return of any commuters, will follow the second sequence of Figure 5-1(a), regardless of day of week or time of day.

Households with no commuters on weekends or in the evening/night-time, will follow the applicable sequence in Figure 5-1(b). Transients will always follow one of the sequences of Figure 5-1(b). Some transients away from their residence could elect to evacuate immediately without returning to the residence, as indicated in the second sequence.

It is seen from Figure 5-1, that the Trip Generation time (i.e. the total elapsed time from Event 1 to Event 5) depends on the scenario and will vary from one household to the next. Furthermore, Event 5 depends, in a complicated way, on the time distributions of all activities preceding that event. That is, to estimate the time distribution of Event 5, we must obtain estimates of the time distributions of all preceding events. For this study, we adopt the conservative posture that all activities will occur in sequence.

In some cases, assuming certain events occur strictly sequential (for instance, commuter returning home before beginning preparation to leave) can result in rather ***conservative*** (that is, longer) estimates of mobilization times. It is reasonable to expect that at least some parts of these events will overlap for many households, but that assumption is not made in this study.



[1] Applies for evening and weekends also if commuters are at work.
[2] Applies throughout the year for transients.

Figure 5-1. Events and Activities Preceding the Evacuation Trip

5.3 Estimated Time Distributions of Activities Preceding Event 5

The time distribution of an event is obtained by "summing" the time distributions of all prior contributing activities. (This "summing" process is quite different than an algebraic sum since it is performed on distributions – not scalar numbers).

Time Distribution No. 1, Notification Process: Activity 1 $\rightarrow$ 2

In accordance with the 2012 Federal Emergency Management Agency (FEMA) Radiological Emergency Preparedness Program Manual, 100% of the population is notified within 45 minutes. It is assumed (based on the presence of sirens within the EPZ) that 87 percent of those within the EPZ will be aware of the accident within 30 minutes with the remainder notified within the following 15 minutes. The notification distribution is given below:

Table 5-2. Time Distribution for Notifying the Public

Elapsed Time (Minutes)	Percent of Population Notified
0	0%
5	7%
10	13%
15	27%
20	47%
25	66%
30	87%
35	92%
40	97%
45	100%

Distribution No. 2, Prepare to Leave Work: Activity 2 → 3

It is reasonable to expect that the vast majority of business enterprises within the EPZ will elect to shut down following notification and most employees would leave work quickly. Commuters, who work outside the EPZ could, in all probability, also leave quickly since facilities outside the EPZ would remain open and other personnel would remain. Personnel or farmers responsible for equipment/livestock would require additional time to secure their facility. The distribution of Activity 2 → 3 shown in Table 5-3 reflects data obtained by the telephone survey. This distribution is plotted in Figure 5-2.

Table 5-3. Time Distribution for Employees to Prepare to Leave Work

Elapsed Time (Minutes)	Cumulative Percent Employees Leaving Work	Elapsed Time (Minutes)	Cumulative Percent Employees Leaving Work
0	0%	45	86%
5	33%	50	87%
10	47%	55	88%
15	58%	60	96%
20	65%	75	98%
25	66%	90	99%
30	79%	105	100%
35	80%		
40	81%		

NOTE: The survey data was normalized to distribute the "Don't know" response. That is, the sample was reduced in size to include only those households who responded to this question. The underlying assumption is that the distribution of this activity for the "Don't know" responders, if the event takes place, would be the same as those responders who provided estimates.

Distribution No. 3, Travel Home: Activity 3 $\rightarrow$ 4

These data are provided directly by those households which responded to the telephone survey. This distribution is plotted in Figure 5-2 and listed in Table 5-4.

Table 5-4. Time Distribution for Commuters to Travel Home

Elapsed Time (Minutes)	Cumulative Percent Returning Home	Elapsed Time (Minutes)	Cumulative Percent Returning Home
0	0	45	87%
5	16%	50	89%
10	31%	55	90%
15	40%	60	95%
20	50%	75	97%
25	53%	90	99%
30	68%	105	99%
35	72%	120	100%
40	78%		

NOTE: The survey data was normalized to distribute the "Don't know" response

Distribution No. 4, Prepare to Leave Home: Activity 2, 4 $\rightarrow$ 5

These data are provided directly by those households which responded to the telephone survey. This distribution is plotted in Figure 5-2 and listed in Table 5-5.

Table 5-5. Time Distribution for Population to Prepare to Evacuate

Elapsed Time (Minutes)	Cumulative Percent Ready to Evacuate
0	0%
15	25%
30	56%
45	61%
60	79%
75	86%
90	87%
105	88%
120	94%
135	97%
150	97%
165	97%
180	99%
195	100%

NOTE: The survey data was normalized to distribute the "Don't know" response

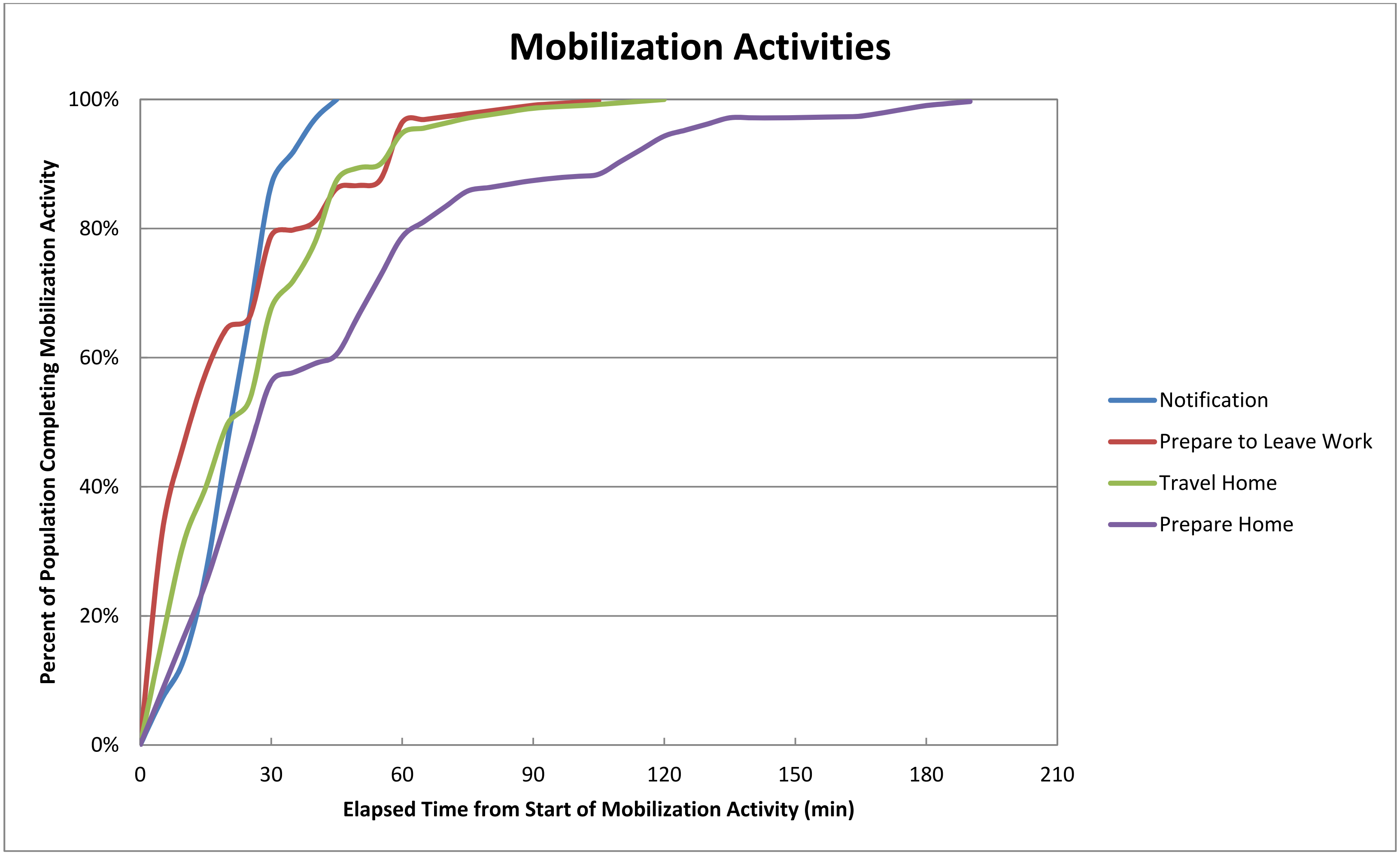


Figure 5-2. Evacuation Mobilization Activities

5.4 Calculation of Trip Generation Time Distribution

The time distributions for each of the mobilization activities presented herein must be combined to form the appropriate Trip Generation Distributions. As discussed above, this study assumes that the stated events take place in sequence such that all preceding events must be completed before the current event can occur. For example, if a household awaits the return of a commuter, the work-to-home trip (Activity 3 $\rightarrow$ 4) must precede Activity 4 $\rightarrow$ 5.

To calculate the time distribution of an event that is dependent on two sequential activities, it is necessary to "sum" the distributions associated with these prior activities. The distribution summing algorithm is applied repeatedly as shown to form the required distribution. As an outcome of this procedure, new time distributions are formed; we assign "letter" designations to these intermediate distributions to describe the procedure. Table 5-6 presents the summing procedure to arrive at each designated distribution.

Table 5-6. Mapping Distributions to Events

Apply "Summing" Algorithm To:	Distribution Obtained	Event Defined
Distributions 1 and 2	Distribution A	Event 3
Distributions A and 3	Distribution B	Event 4
Distributions B and 4	Distribution C	Event 5
Distributions 1 and 4	Distribution D	Event 5

Table 5-7 presents a description of each of the final trip generation distributions achieved after the summing process is completed.

Table 5-7. Description of the Distributions

Distribution	Description
A	Time distribution of commuters departing place of work (Event 3). Also applies to employees who work within the EPZ who live outside, and to Transients within the EPZ.
B	Time distribution of commuters arriving home (Event 4).
C	Time distribution of residents with commuters who return home, leaving home to begin the evacuation trip (Event 5).
D	Time distribution of residents without commuters returning home, leaving home to begin the evacuation trip (Event 5).

5.4.1 Statistical Outliers

As already mentioned, some portion of the survey respondents answer "don't know" to some questions or choose to not respond to a question. The mobilization activity distributions are based upon actual responses. But, it is the nature of surveys that a few numeric responses are inconsistent with the overall pattern of results. An example would be a case in which for 500 responses, almost all of them estimate less than two hours for a given answer, but 3 say "four hours" and 4 say "six or more hours".

These "outliers" must be considered: are they valid responses, or so atypical that they should be dropped from the sample?

In assessing outliers, there are three alternates to consider:

1) Some responses with very long times may be valid, but reflect the reality that the respondent really needs to be classified in a different population subgroup, based upon special needs;

2) Other responses may be unrealistic (6 hours to return home from commuting distance, or 2 days to prepare the home for departure);

3) Some high values are representative and plausible, and one must not cut them as part of the consideration of outliers.

The issue of course is how to make the decision that a given response or set of responses are to be considered "outliers" for the component mobilization activities, using a method that objectively quantifies the process.

There is considerable statistical literature on the identification and treatment of outliers singly or in groups, much of which assumes the data is normally distributed and some of which uses non-parametric methods to avoid that assumption. The literature cites that limited work has been done directly on outliers in sample survey responses.

In establishing the overall mobilization time/trip generation distributions, the following principles

are used:

1) It is recognized that the overall trip generation distributions are conservative estimates, because they assume a household will do the mobilization activities sequentially, with no overlap of activities;

2) The individual mobilization activities (prepare to leave work, travel home, prepare home) are reviewed for outliers, and then the overall trip generation distributions are created (see Figure 5-1, Table 5-6, Table 5-7);

3) Outliers can be eliminated either because the response reflects a special population (e.g. special needs, transit dependent) or lack of realism, because the purpose is to estimate trip generation patterns for personal vehicles;

4) To eliminate outliers,
    a) the mean and standard deviation of the specific activity are estimated from the responses,
    b) the median of the same data is estimated, with its position relative to the mean noted,
    c) the histogram of the data is inspected, and
    d) all values greater than 3.5 standard deviations are flagged for attention, taking special note of whether there are gaps (categories with zero entries) in the histogram display.

    In general, only flagged values more than 4 standard deviations from the mean are allowed to be considered outliers, with gaps in the histogram expected.

    When flagged values are classified as outliers and dropped, steps “a” to “d” are repeated.

5) As a practical matter, even with outliers eliminated by the above, the resultant histogram, viewed as a cumulative distribution, is not a normal distribution. A typical situation that results is shown below in Figure 5-3.

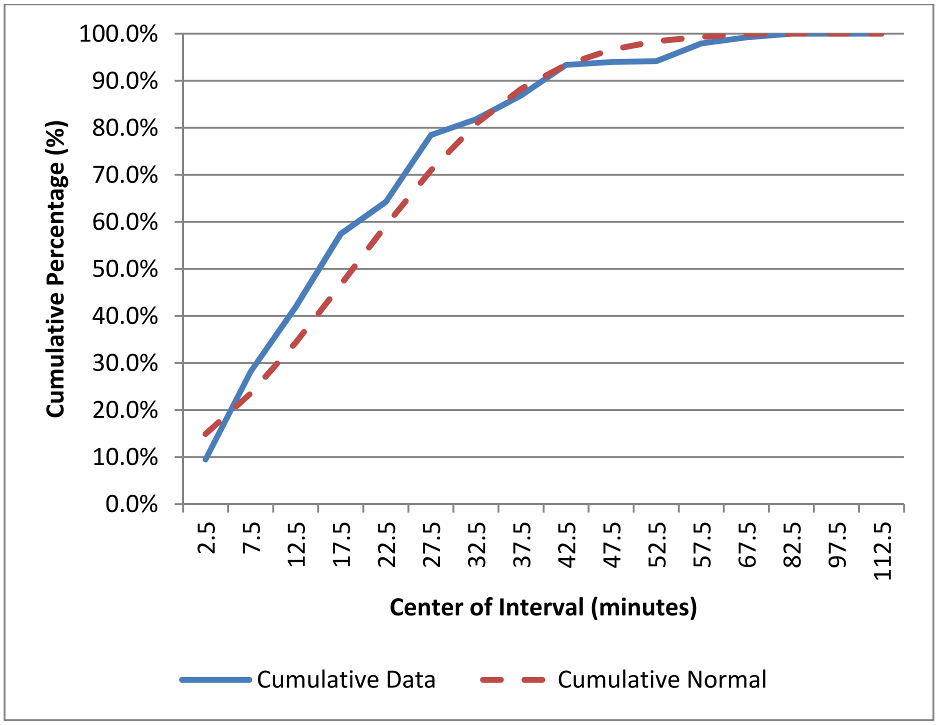


Figure 5-3. Comparison of Data Distribution and Normal Distribution

6) In particular, the cumulative distribution differs from the normal distribution in two key aspects, both very important in loading a network to estimate evacuation times:

- Most of the real data is to the left of the "normal" curve above, indicating that the network loads faster for the first 80-85% of the vehicles, potentially causing more (and earlier) congestion than otherwise modeled;
- The last 10-15% of the real data "tails off" slower than the comparable "normal" curve, indicating that there is significant traffic still loading at later times.

Because these two features are important to preserve, it is the histogram of the data that is used to describe the mobilization activities, not a "normal" curve fit to the data. One could consider other distributions, but using the shape of the *actual* data curve is unambiguous and preserves these important features;

7) With the mobilization activities each modeled according to Steps 1-6, including preserving the features cited in Step 6, the overall (or total) mobilization times are constructed.

This is done by using the data sets and distributions under different scenarios (e.g. commuter returning, no commuter returning). In general, these are additive, using weighting based upon the

probability distributions of each element; Figure 5-4 presents the combined trip generation distributions designated A, C, D. These distributions are presented on the same time scale. (As discussed earlier, the use of strictly additive activities is a conservative approach, because it makes all activities sequential – preparation for departure follows the return of the commuter. In practice, it is reasonable that some of these activities are done in parallel, at least to some extent – for instance, preparation to depart begins by a household member at home while the commuter is still on the road.)

The mobilization distributions that result are used in their tabular/graphical form as direct inputs to later computations that lead to the ETE.

The DYNEV II simulation model is designed to accept varying rates of vehicle trip generation for each origin centroid, expressed in the form of histograms. These histograms, which represent Distributions A, C, D properly displaced with respect to one another, are tabulated in Table 5-8 (Distribution B, Arrive Home, omitted for clarity).

The final time period (15) is 600 minutes long. This time period is added to allow the analysis network to clear, in the event congestion persists beyond the trip generation period. Note that there are no trips generated during this final time period.

5.4.2 Staged Evacuation Trip Generation

As defined in NUREG/CR-7002, staged evacuation consists of the following:

1. PAS comprising the 2 mile region are advised to evacuate immediately
2. PAS comprising regions extending from 2 to 5 miles downwind are advised to shelter in-place while the 2 mile region is cleared
3. As vehicles evacuate the 2 mile region, sheltered people from 2 to 5 miles downwind continue preparation for evacuation
4. The population sheltering in the 2 to 5 mile region are advised to begin evacuating when approximately 90% of those originally within the 2 mile region evacuate across the 2 mile region boundary
5. Non-compliance with the shelter recommendation is the same as the shadow evacuation percentage of 20%

<u>Assumptions</u>

1. The EPZ population in PAS beyond 5 miles will react as does the population in the 2 to 5 mile region; that is they will first shelter, then evacuate after the 90^{th} percentile ETE for the 2 mile region
2. The population in the shadow region beyond the EPZ boundary, extending to approximately 15 miles radially from the plant, will react as they do for all non-staged evacuation scenarios. That is 20% of these households will elect to evacuate with no shelter delay.
3. The transient population will not be expected to stage their evacuation because of the limited sheltering options available to people who may be at parks, on a beach, or at other venues. Also, notifying the transient population of a staged evacuation would prove difficult.
4. Employees will also be assumed to evacuate without first sheltering.

<u>Procedure</u>

1. Trip generation for population groups in the 2 mile region will be as computed based upon the results of the telephone survey and analysis.
2. Trip generation for the population subject to staged evacuation will be formulated as follows:
   a. Identify the 90^{th} percentile evacuation time for the PAS comprising the two mile region. This value, T_{Scen}^{*}, is obtained from simulation results. It will become the time at which the region being sheltered will be told to evacuate for each scenario.
   b. The resultant trip generation curves for staging are then formed as follows:
      i. The non-shelter trip generation curve is followed until a maximum of 20% of the total trips are generated (to account for shelter non-compliance).

ii. No additional trips are generated until time T_{Scen}^*
iii. Following time T_{Scen}^*, the balance of trips are generated:
1. by stepping up and then following the non-shelter trip generation curve (if T_{Scen}^* is $\leq$ max trip generation time) or
2. by stepping up to 100% (if T_{Scen}^* is > max trip generation time)

c. Note: This procedure implies that there may be different staged trip generation distributions for different scenarios. NUREG/CR-7002 uses the statement "approximately 90th percentile" as the time to end staging and begin evacuating. The value of T_{Scen}^* is 2:15 for all scenarios.

3. Staged trip generation distributions are created for the following population groups:
   a. Residents with returning commuters
   b. Residents without returning commuters

Figure 5-5 presents the staged trip generation distributions for both residents with and without returning commuters; the 90th percentile two-mile evacuation time is 135 minutes for good weather. At the 90th percentile evacuation time, 20% of the population (who normally would have completed their mobilization activities for an un-staged evacuation) advised to shelter has nevertheless departed the area. These people do not comply with the shelter advisory. Also included on the plot are the trip generation distributions for these groups as applied to the regions advised to evacuate immediately.

Since the 90th percentile evacuation time occurs before the end of the trip generation time, after the sheltered region is advised to evacuate, the shelter trip generation distribution rises to meet the balance of the non-staged trip generation distribution. Following time T_{Scen}^*, the balance of staged evacuation trips that are ready to depart are released within 15 minutes. After T_{Scen}^*+15, the remainder of evacuation trips are generated in accordance with the unstaged trip generation distribution.

Table 5-9 provides the trip generation histograms for staged evacuation.

5.4.3 Trip Generation for Waterways and Recreational Areas

As indicated in Table 5-2, this study assumes 100% notification in 45 minutes. Table 5-9 indicates that all transients will have mobilized within 1¾ hours. It is assumed that this timeframe is sufficient time for boaters, campers and other transients to return to their vehicles and begin their evacuation trip.

Table 5-8. Trip Generation Histograms for the EPZ Population for Unstaged Evacuation

Time Period	Duration (Min)	Percent of Total Trips Generated Within Indicated Time Period*			
		Employees (Distribution A)	Transients (Distribution A)	Residents with Commuters (Distribution C)	Residents Without Commuters (Distribution D)
1	15	5%	5%	0%	2%
2	15	27%	27%	0%	12%
3	15	31%	31%	3%	24%
4	15	17%	17%	7%	19%
5	15	9%	9%	12%	12%
6	15	7%	7%	13%	12%
7	15	2%	2%	14%	5%
8	15	1%	1%	12%	2%
9	15	1%	1%	10%	3%
10	30	0%	0%	13%	6%
11	30	0%	0%	8%	1%
12	30	0%	0%	4%	2%
13	30	0%	0%	2%	0%
14	30	0%	0%	2%	0%
15	600	0%	0%	0%	0%

NOTE:

- Shadow vehicles are loaded onto the analysis network (Figure 1-2) using Distributions C for good weather.
- Special event vehicles are loaded using Distribution A.

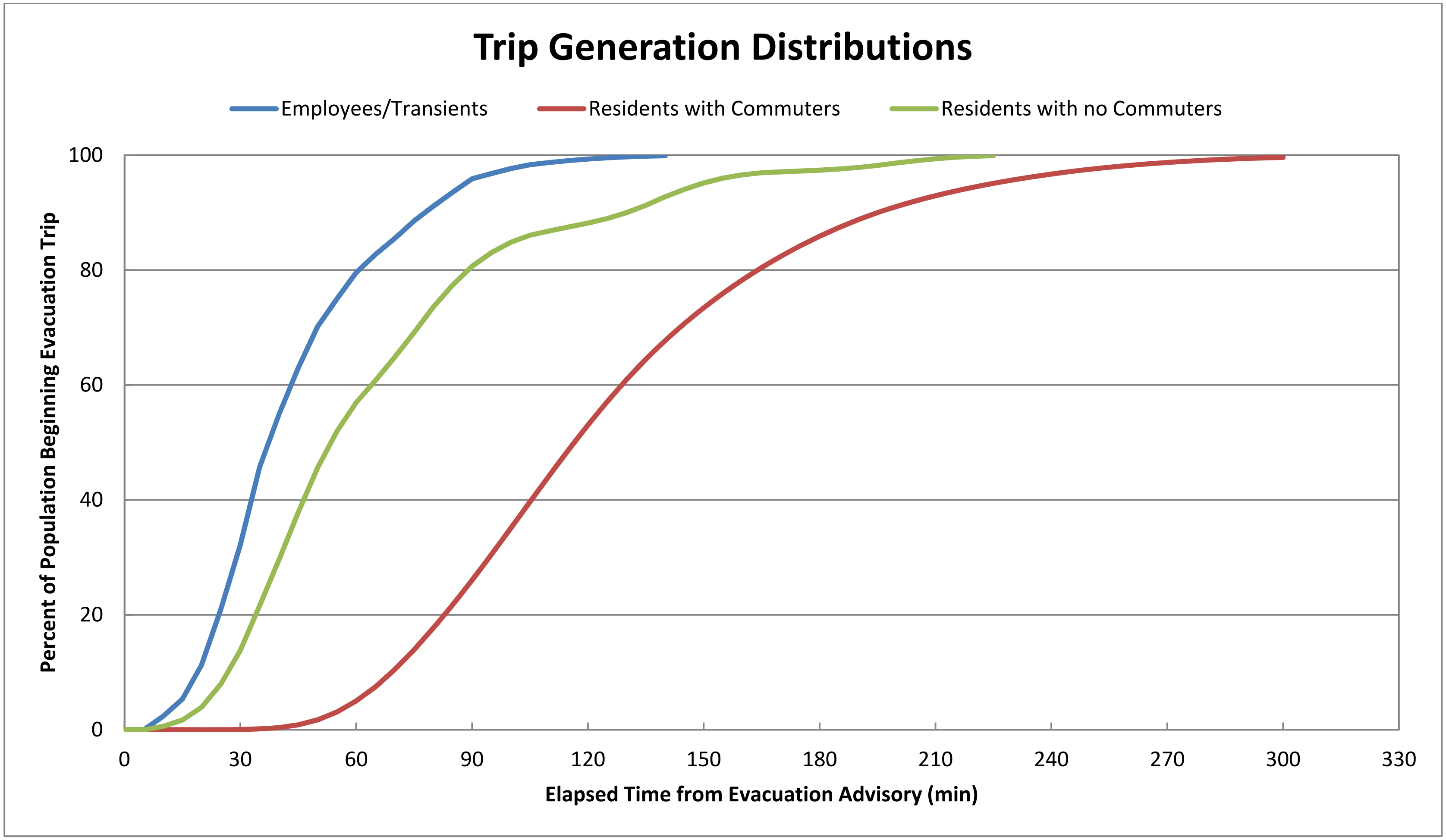


Figure 5-4. Comparison of Trip Generation Distributions

Table 5-9. Trip Generation Histograms for the EPZ Population for Staged Evacuation

Time Period	Duration (Min)	Percent of Total Trips Generated Within Indicated Time Period*	
		Residents with Commuters (Distribution C)	Residents Without Commuters (Distribution D)
1	15	0%	0%
2	15	0%	3%
3	15	1%	5%
4	15	1%	3%
5	15	2%	3%
6	15	3%	2%
7	15	3%	1%
8	15	2%	1%
9	15	2%	0%
10	15	70%	79%
11	30	8%	1%
12	30	4%	2%
13	30	2%	0%
14	30	2%	0%
15	600	0%	0%

*Trip Generation for Employees and Transients (see Table 5-8) is the same for Unstaged and Staged Evacuation.

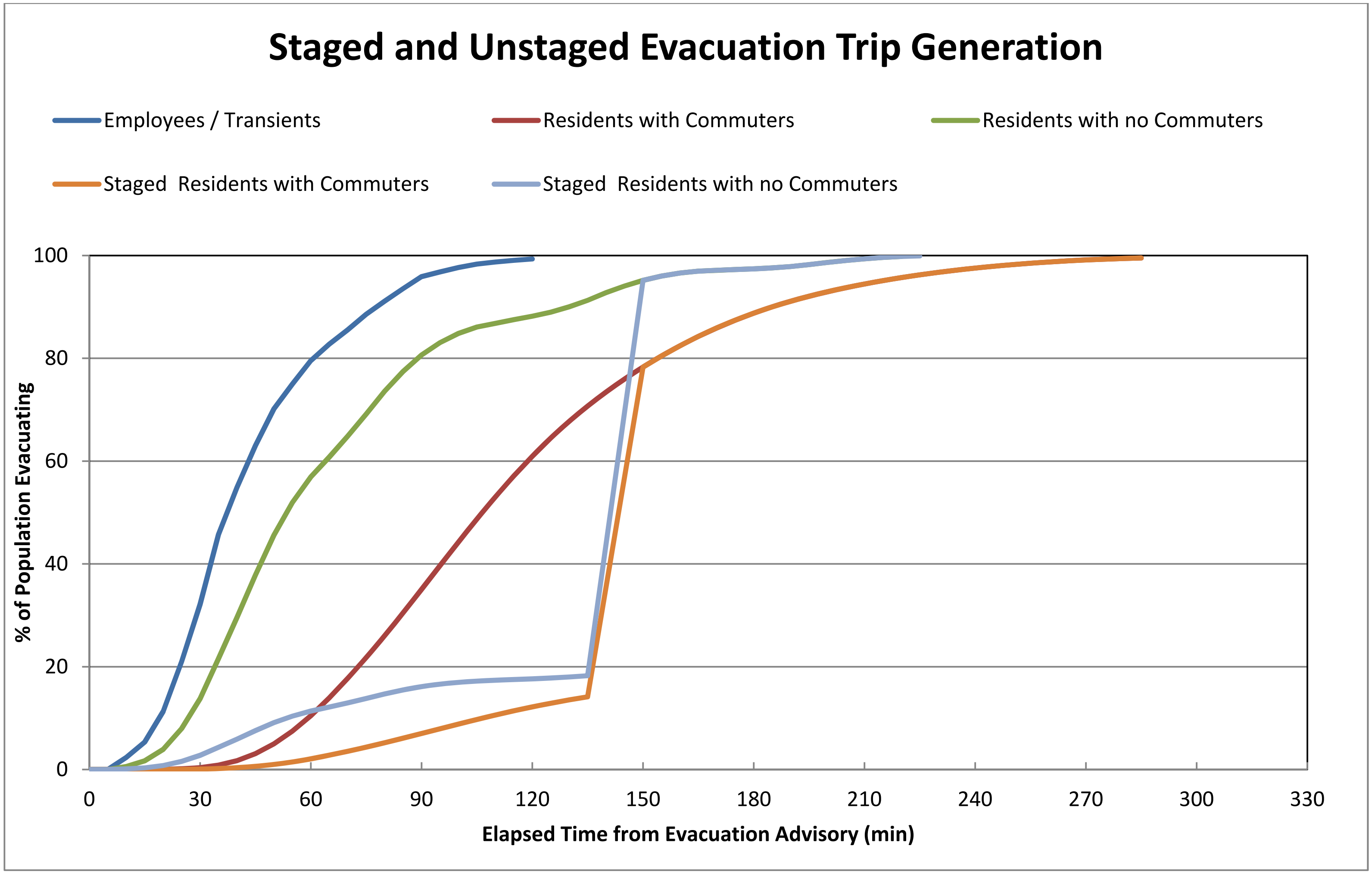


Figure 5-5. Comparison of Staged and Unstaged Trip Generation Distributions in the 2 to 5 Mile Region

6 DEMAND ESTIMATION FOR EVACUATION SCENARIOS

An evacuation "case" defines a combination of Evacuation Region and Evacuation Scenario. The definitions of "Region" and "Scenario" are as follows:

Region A grouping of contiguous evacuating PAS that forms either a "keyhole" sector-based area, or a circular area within the EPZ, that must be evacuated in response to a radiological emergency.

Scenario A combination of circumstances, including time of day, day of week, season, and weather conditions. Scenarios define the number of people in each of the affected population groups and their respective mobilization time distributions.

A total of 36 Regions were defined which encompass all the groupings of PAS considered. These Regions are defined in Table 6-1. The PAS configurations are identified in Figure 6-1. Each keyhole sector-based area consists of a central circle centered at the power plant, and three adjoining sectors, each with a central angle of 22.5 degrees, as per NUREG/CR-7002 guidance. The central sector coincides with the wind direction. These sectors extend to 5 miles from the plant (Regions R04 through R13) or to the EPZ boundary (Regions R14 through R25). Regions R01, R02 and R03 represent evacuations of circular areas with radii of 2, 5 and 10 miles, respectively. Regions R26 through R36 are identical to Regions R02, and R04 through R13, respectively; however, those PAS between 2 miles and 5 miles are staged until 90% of the 2-mile region (Region R01) has evacuated.

A total of 12 Scenarios were evaluated for all Regions. Thus, there are a total of 36x12=432 evacuation cases. Table 6-2 is a description of all Scenarios.

Each combination of region and scenario implies a specific population to be evacuated. Table 6-3 presents the percentage of each population group estimated to evacuate for each scenario. Table 6-4 presents the vehicle counts for each scenario for an evacuation of Region R03 – the entire EPZ.

The vehicle estimates presented in Section 3 are peak values. These peak values are adjusted depending on the scenario and region being considered, using scenario and region specific percentages; the scenario percentages are presented in Table 6-3, while the regional percentages are provided in Table H-1. The percentages presented in Table 6-3 were determined as follows:

The number of residents with commuters during the week (when workforce is at its peak) is equal to the product of 59% (the number of households with at least one commuter) and 64% (the number of households with a commuter that would await the return of the commuter prior to evacuating). See assumption 3 in Section 2.3. It is estimated for weekend and evening scenarios that 10% of households with returning commuters will have a commuter at work during those times.

Employment is assumed to be at its peak during the winter, midweek, midday scenarios. Employment is reduced slightly (96%) for summer, midweek, midday scenarios. This is based on

the estimation that 50% of the employees commuting into the EPZ will be on vacation for a week during the approximate 12 weeks of summer. It is further estimated that those taking vacation will be uniformly dispersed throughout the summer with approximately 4% of employees vacationing each week. It is further estimated that only 10% of the employees are working in the evenings and during the weekends.

Transient activity is estimated to be at its peak during winter weekends and 50% of this peak level during winter weekdays. As shown in Appendix E, there are a significant number of historical sites which draw a large number of people; thus, transient activity is estimated to be high at 100% during the midday hours. Transient activity on summer weekends is estimated to be 15%.

As noted in the shadow footnote to Table 6-3, the shadow percentages are computed using a base of 20% (see assumption 5 in Section 2.2); to include the employees within the shadow region who may choose to evacuate, the voluntary evacuation is multiplied by a scenario-specific proportion of employees to permanent residents in the shadow region. For example, using the values provided in Table 6-4 for Scenario 1, the shadow percentage is computed as follows:

$$20\% \times \left(1 + \frac{2{,}441}{5{,}868 + 9{,}666}\right) = 23\%$$

One special event – Mardi Gras Celebration in New Roads – was considered as Scenario 11. Thus, the special event traffic is 100% evacuated for Scenario 11, and 0% for all other scenarios.

It is estimated that summer school enrollment is approximately 10% of enrollment during the regular school year for summer, midweek, midday scenarios. School is not in session during weekends and evenings, thus no buses for school children are needed under those circumstances. As discussed in Section 7, schools are in session during the winter season, midweek, midday and 100% of buses will be needed under those circumstances. Transit buses for the transit-dependent population are set to 100% for all scenarios as it is assumed that the transit-dependent population is present in the EPZ for all scenarios.

External traffic is estimated to be reduced by 60% during evening scenarios and is 100% for all other scenarios.

Table 6-1. Description of Evacuation Regions

Region	Description	PAS																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
R01	2 mile ring	X																	
R02	5-mile ring	X	X	X	X				X	X							X		
R03	Full EPZ	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Evacuate 2 mile ring and 5 miles downwind																			
Region	**Wind Direction Toward**	**PAS**																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
R04	N, NNE	X	X	X															
R05	NE	X		X															
R06	ENE	X		X					X										
R07	E, ESE	X		X	X				X	X									
R08	SE, SSE	X			X					X									
R09	S	X			X					X							X		
R10	SSW	X			X												X		
R11	SW, WSW	X															X		
R12	W	X	X			X											X		
R13	WNW, NW, NNW	X	X																
Evacuate 5 mile ring and downwind to EPZ boundary																			
Region	**Wind Direction Toward**	**PAS**																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
R14	N, NNE	X	X	X	X	X	X	X	X	X	X						X		
R15	NE, ENE	X	X	X	X	X		X	X	X	X	X					X		
R16	E	X	X	X	X	X		X	X	X	X	X	X	X			X		
R17	ESE	X	X	X	X	X			X	X		X	X	X	X		X		
R18	SE	X	X	X	X	X			X	X			X	X	X	X	X		
R19	SSE	X	X	X	X	X			X	X			X	X	X	X	X	X	
R20	S	X	X	X	X	X			X	X					X	X	X	X	X
R21	SSW	X	X	X	X	X			X	X						X	X	X	X
R22	SW, WSW	X	X	X	X	X			X	X							X	X	X
R23	W	X	X	X	X	X	X		X	X							X		X
R24	WNW, NW	X	X	X	X	X	X		X	X							X		
R25	NNW	X	X	X	X	X	X	X	X	X							X		

Staged Evacuation - 2-Mile Radius Evacuates, then Evacuate Downwind to 5 Miles																			
Region	Wind Direction Toward	PAS																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
R26	5 Mile Ring	X	X	X	X				X	X							X		
R27	N, NNE	X	X	X															
R28	NE	X		X															
R29	ENE	X		X					X										
R30	E, ESE	X		X	X				X	X									
R31	SE, SSE	X			X					X									
R32	S	X			X					X							X		
R33	SSW	X			X												X		
R34	SW, WSW	X															X		
R35	W	X	X			X											X		
R36	WNW, NW, NNW	X	X																

Shelter-in-Place until 90% ETE for R01, then Evacuate | **Area(s) Shelter-in-Place** | **Area(s) Evacuate**

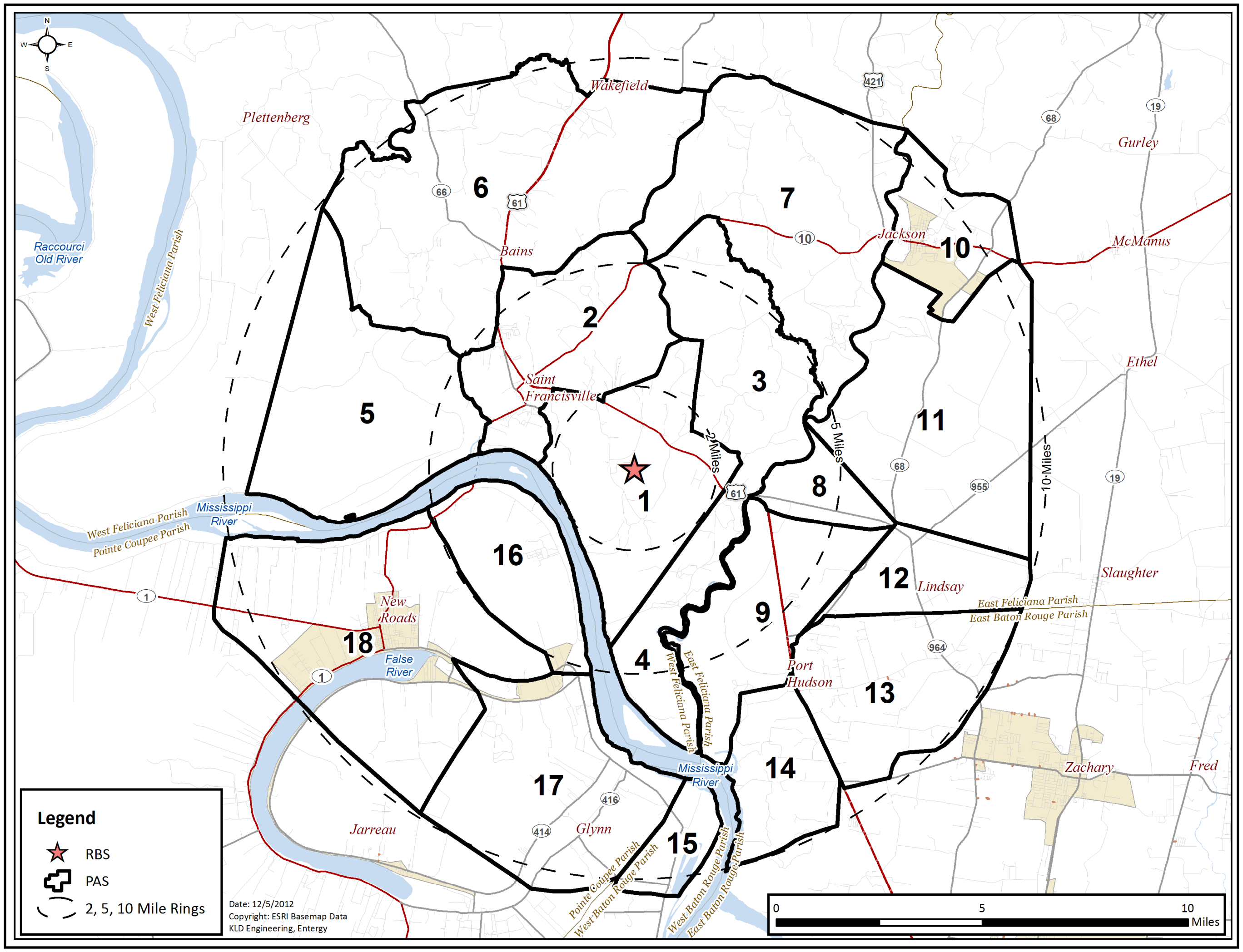


Figure 6-1. RBS EPZ PAS

Table 6-2. Evacuation Scenario Definitions

Scenario	Season[1]	Day of Week	Time of Day	Weather	Special
1	Summer	Midweek	Midday	Good	None
2	Summer	Midweek	Midday	Rain	None
3	Summer	Weekend	Midday	Good	None
4	Summer	Weekend	Midday	Rain	None
5	Summer	Midweek, Weekend	Evening	Good	None
6	Winter	Midweek	Midday	Good	None
7	Winter	Midweek	Midday	Rain	None
8	Winter	Weekend	Midday	Good	None
9	Winter	Weekend	Midday	Rain	None
10	Winter	Midweek, Weekend	Evening	Good	None
11	Winter	Weekend	Midday	Good	Mardi Gras Festival in New Roads, LA
12	Summer	Weekend	Midday	Good	Roadway Impact – Lane Closure on US 61 SB

[1] Winter means that school is in session (also applies to spring and autumn). Summer means that school is not in session.

Table 6-3. Percent of Population Groups Evacuating for Various Scenarios

Scenario	Households With Returning Commuters	Households Without Returning Commuters	Employees	Transients	Shadow	Special Events	School Buses	Transit Buses	External Through Traffic
1	38%	62%	96%	10%	23%	0%	10%	100%	100%
2	38%	62%	96%	10%	23%	0%	10%	100%	100%
3	4%	96%	10%	15%	20%	0%	0%	100%	100%
4	4%	96%	10%	15%	20%	0%	0%	100%	100%
5	4%	96%	10%	5%	20%	0%	0%	100%	40%
6	38%	62%	100%	50%	23%	0%	100%	100%	100%
7	38%	62%	100%	50%	23%	0%	100%	100%	100%
8	4%	96%	10%	100%	20%	0%	0%	100%	100%
9	4%	96%	10%	100%	20%	0%	0%	100%	100%
10	4%	96%	10%	26%	20%	0%	0%	100%	40%
11	4%	96%	10%	100%	20%	100%	0%	100%	100%
12	38%	62%	96%	10%	23%	0%	10%	100%	100%

Resident Households with Commuters ....Households of EPZ residents who await the return of commuters prior to beginning the evacuation trip.
Resident Households with No Commuters ..Households of EPZ residents who do not have commuters or will not await the return of commuters prior to beginning the evacuation trip.
Employees..EPZ employees who live outside the EPZ
Transients ....People who are in the EPZ at the time of an accident for recreational or other (non-employment) purposes.
Shadow...Residents and employees in the shadow region (outside of the EPZ) who will spontaneously decide to relocate during the evacuation. The basis for the values shown is a 20% relocation of shadow residents along with a proportional percentage of shadow employees.
Special Events ....Additional vehicles in the EPZ due to the identified special event.
School and Transit Buses ....Vehicle-equivalents present on the road during evacuation servicing schools and transit-dependent people (1 bus is equivalent to 2 passenger vehicles).
External Through Traffic ....Traffic on interstates/freeways and major arterial roads at the start of the evacuation. This traffic is stopped by access control approximately 2 hours after the evacuation begins.

Table 6-4. Vehicle Estimates by Scenario

Scenario	Households With Returning Commuters	Households Without Returning Commuters	Employees	Transients	Shadow	Special Events	School Buses	Transit Buses	External Through Traffic	Total Scenario Vehicles
1	5,868	9,666	2,441	152	4,486	-	45	167	6,278	29,103
2	5,868	9,666	2,441	152	4,486	-	45	167	6,278	29,103
3	587	14,947	254	227	3,941	-	-	167	6,278	26,401
4	587	14,947	254	227	3,941	-	-	167	6,278	26,401
5	587	14,947	254	76	3,941	-	-	167	2,511	22,483
6	5,868	9,666	2,543	758	4,512	-	452	167	6,278	30,244
7	5,868	9,666	2,543	758	4,512	-	452	167	6,278	30,244
8	587	14,947	254	1,516	3,941	-	-	167	6,278	27,690
9	587	14,947	254	1,516	3,941	-	-	167	6,278	27,690
10	587	14,947	254	394	3,941	-	-	167	2,511	22,801
11	587	14,947	254	1,516	3,941	16,981	-	167	6,278	44,671
12	5,868	9,666	2,441	152	4,486	-	45	167	6,278	29,103

Note: Vehicle estimates are for an evacuation of the entire EPZ (Region R03)

7 GENERAL POPULATION EVACUATION TIME ESTIMATES (ETE)

This section presents the ETE results of the computer analyses using the DYNEV II System described in Appendices B, C and D. These results cover 36 regions within the RBS EPZ and the 12 Evacuation Scenarios discussed in Section 6.

The ETE for all Evacuation Cases are presented in Table 7-1 and Table 7-2. These tables present the estimated times to clear the indicated population percentages from the Evacuation Regions for all Evacuation Scenarios. The ETE of the 2-mile region in both staged and un-staged regions are presented in Table 7-3 and Table 7-4. Table 7-5 defines the Evacuation Regions considered. The tabulated values of ETE are obtained from the DYNEV II System outputs which are generated at 5-minute intervals.

7.1 Voluntary Evacuation and Shadow Evacuation

"Voluntary evacuees" are people within the EPZ in PAS for which an Advisory to Evacuate has not been issued, yet who elect to evacuate. "Shadow evacuation" is the voluntary outward movement of some people from the Shadow Region (outside the EPZ) for whom no protective action recommendation has been issued. Both voluntary and shadow evacuations are assumed to take place over the same time frame as the evacuation from within the impacted Evacuation Region.

The ETE for the RBS EPZ addresses the issue of voluntary evacuees in the manner shown in Figure 7-1. Within the EPZ, 20 percent of people located in PAS outside of the evacuation region who are not advised to evacuate, are assumed to elect to evacuate. Similarly, it is assumed that 20 percent of those people in the Shadow Region will choose to leave the area.

Figure 7-2 presents the area identified as the Shadow Region. This region extends radially from the plant to cover a region between the EPZ boundary and approximately 15 miles. The population and number of evacuating vehicles in the Shadow Region were estimated using the same methodology that was used for permanent residents within the EPZ (see Section 3.1). As discussed in Section 3.2, it is estimated that a total of 31,944 people reside in the Shadow Region; 20 percent of them would evacuate. See Table 6-4 for the number of evacuating vehicles from the Shadow Region.

Traffic generated within this Shadow Region, traveling away from the RBS location, has the potential for impeding evacuating vehicles from within the Evacuation Region. All ETE calculations include this shadow traffic movement.

7.2 Staged Evacuation

As defined in NUREG/CR-7002, staged evacuation consists of the following:

1. PAS comprising the 2 mile region are advised to evacuate immediately.
2. PAS comprising regions extending from 2 to 5 miles downwind are advised to shelter in-place while the two mile region is cleared.

3. As vehicles evacuate the 2 mile region, people from 2 to 5 miles downwind continue preparation for evacuation while they shelter.
4. The population sheltering in the 2 to 5 mile region is advised to evacuate when approximately 90% of the 2 mile region evacuating traffic crosses the 2 mile region boundary.
5. Non-compliance with the shelter recommendation is the same as the shadow evacuation percentage of 20%.

See Section 5.4.2 for additional information on staged evacuation.

7.3 Patterns of Traffic Congestion during Evacuation

Figure 7-3 through Figure 7-9 illustrate the patterns of traffic congestion that arise for the case when the entire EPZ (Region R03) is advised to evacuate during the winter, weekend, midday period under good weather conditions (Scenario 6).

Traffic congestion, as the term is used here, is defined as Level of Service (LOS) F. LOS F is defined as follows (HCM 2010, page 5-5):

> The HCM uses LOS F to define operations that have either broken down (i.e., demand exceeds capacity) or have exceeded a specified service measure value, or combination of service measure values, that most users would consider unsatisfactory. However, particularly for planning applications where different alternatives may be compared, analysts may be interested in knowing just how bad the LOS F condition is. Several measures are available to describe individually, or in combination, the severity of a LOS F condition:
>
> > • *Demand-to-capacity ratios* describe the extent to which capacity is exceeded during the analysis period (e.g., by 1%, 15%, etc.);
> >
> > • *Duration of LOS F* describes how long the condition persists (e.g., 15 min, 1 h, 3 h); and
> >
> > • *Spatial extent measures* describe the areas affected by LOS F conditions. These include measures such as the back of queue, and the identification of the specific intersection approaches or system elements experiencing LOS F conditions.

All highway "links" which experience LOS F are delineated in these figures by a thick red line; all others are lightly indicated. Congestion develops rapidly around concentrations of population and traffic bottlenecks. Figure 7-3 displays the developing congestion within Jackson to the east of RBS just 35 minutes after the Advisory to Evacuate (ATE). Traffic is operating at a LOS of D or better in New Roads.

At one hour after the ATE, Figure 7-4 displays fully-developed congestion in Jackson, which backs up along SR 10 to within 5 miles of the plant. Approach roadways to SR 10 are also at a LOS F. Throughout the EPZ and shadow, there are numerous stop-controlled approaches that are congested and the signal on SR 19 at Port Hudson Pride Road is operating at LOS F due to

heavy demand from both the west and north. The primary evacuation route for PAS 2, 5, 6, 7 and 10, travels along SR 10 through Jackson to the intersection with SR 19. At SR 19 evacuation routing encourages the right turn onto SR 19 to travel southbound towards Baton Rouge and the Reception Centers. To facilitate movements at this intersection, it is suggested that it be made a Traffic Control Point and it is modeled as one in this study (see Appendix G for more details).

At the signalized intersection of SR 78 and SR 1 in the shadow region near the small town of Oscar, traffic is operating at a LOS F on the southbound approach.

At 1:30 after the ATE, as shown in Figure 7-5, the congestion in Jackson along SR 10 is persisting and extends from the boundary of the EPZ to the intersection with Baines Road, at the edge of the 5-mile Region. There is congestion along the approaches to the major evacuation route of US 190 in Pointe Coupee Parish and also along SR 19 in East Baton Rouge Parish, as people evacuate south towards Baton Rouge.

Fully congested conditions remain in the Jackson area 2:40 after the ATE (Figure 7-6). The congestion in New Roads has cleared; however, the stop-controlled approaches of SR-978 and SR 983 to SR 1, in the shadow, have a continual level of service F until they finally clear at 3:10 after the ATE (Figure 7-7).

At 3:35 after the ATE (Figure 7-8), SR 10 through Jackson has begun to clear, but is still operating at a LOS F. A short section of SR 19 in Zachary is also still at LOS F. The area west of the Mississippi River in Point Coupee and West Baton Rouge Parish has cleared and traffic along US 190 is moving freely at LOS A.

Finally, Figure 7-9 displays that by 4:20 after the ATE the last of the evacuating vehicles can move at free-flow speed throughout the EPZ. The lone remnant of congestion is in the Shadow Region to the east, on the approaches to SR-19 from Jackson. All traffic congestion within the network clears by 4:30 after the ATE, which is 15 minutes before the completion of the trip-generation (mobilization) time.

7.4 Evacuation Rates

Evacuation is a continuous process, as implied by Figure 7-10 through Figure 7-21. These figures indicate the rate at which traffic flows out of the indicated areas for the case of an evacuation of the full EPZ (Region R03) under the indicated conditions. One figure is presented for each scenario considered.

As indicated in Figure 7-10, there is typically a long "tail" to these distributions. Vehicles begin to evacuate an area slowly at first, as people respond to the ATE at different rates. Then traffic demand builds rapidly (slopes of curves increase). When the system becomes congested, traffic exits the EPZ at rates somewhat below capacity until some evacuation routes have cleared. As more routes clear, the aggregate rate of egress slows since many vehicles have already left the EPZ. Towards the end of the process, relatively few evacuation routes service the remaining demand.

This decline in aggregate flow rate, towards the end of the process, is characterized by these curves flattening and gradually becoming horizontal. Ideally, it would be desirable to fully saturate all evacuation routes equally so that all will service traffic near capacity levels and all will clear at the same time. For this ideal situation, all curves would retain the same slope until the end – thus minimizing evacuation time. In reality, this ideal is generally unattainable reflecting the spatial variation in population density, mobilization rates and in highway capacity over the EPZ.

7.5 Evacuation Time Estimate (ETE) Results

Table 7-1 and Table 7-2 present the ETE values for all 36 Evacuation Regions and all 12 Evacuation Scenarios. Table 7-3 and Table 7-4 present the ETE values for the 2-Mile region for both staged and un-staged keyhole regions downwind to 5 miles. The tables are organized as follows:

Table	Contents
7-1	ETE represents the elapsed time required for 90 percent of the population within a Region, to evacuate from that Region. All Scenarios are considered, as well as Staged Evacuation scenarios.
7-2	ETE represents the elapsed time required for 100 percent of the population within a Region, to evacuate from that Region. All Scenarios are considered, as well as Staged Evacuation scenarios.
7-3	ETE represents the elapsed time required for 90 percent of the population within the 2-mile Region, to evacuate from that Region with both Concurrent and Staged Evacuations.
7-4	ETE represents the elapsed time required for 100 percent of the population within the 2-mile Region, to evacuate from that Region with both Concurrent and Staged Evacuations.

The animation snapshots described above reflect the ETE statistics for the concurrent (un-staged) evacuation scenarios and regions, which are displayed in Figure 7-3 through Figure 7-9 Most of the congestion is located in subareas 7, 10 and 18 which are beyond the 5-mile area; this is reflected in the ETE statistics:

- The 90th percentile ETE for Regions R01 and R02 (2- and 5-mile areas) are comparable and range between 2:15 (hr:min) and 2:30.
- The 90th percentile ETE for Regions R03 (full EPZ) and R14 – R25 (which extend to the EPZ boundary) can be up to 1 hour longer than the R02 ETE for a non-special event case (up to 1 hour and 30 minutes longer for rain).

The 100th percentile ETE for all Regions and for all Scenarios closely follow the mobilization times. This fact implies that the congestion within the EPZ dissipates prior to the end of mobilization, as is displayed in Figure 7-9.

Comparison of Scenarios 8 and 11 in Table 7-1 indicates that the Special Event – Mardi Gras celebration in New Roads– has a significant impact on the ETE for the 90th percentile. The addition of 16,981 vehicles to the New Roads area increases ETE by up to 2:45 (hr:min) for the regions that include PAS 18. The increase in ETE is due primarily to congestion in downtown New Roads and through the shadow region along SR 1. The 100th percentile ETE for the Special Event Scenario, Region 3, is 6:40 after the ATE, whereas for Scenario 8, the 100th percentile is reflective of mobilization time at 4:55 after the ATE.

Comparison of Scenarios 1 and 12 in Table 7-1 indicates that the roadway closure – one lane southbound on US 61 from St. Francisville to SR 64 at the boundary of the EPZ – does not have a significant impact on the 90th percentile ETE. Although the animation for Scenario 12, Region 3, does show congestion on US 61 that is not evident for the Scenario 1, Region 3 case, the remaining lane on US 61 has enough capacity to handle demand. Evacuation speeds along US 61 are reduced in the lane closure case but at most 5 minutes was added to the ETE.

7.6 Staged Evacuation Results

Table 7-3 and Table 7-4 present a comparison of the ETE compiled for the concurrent (un-staged) and staged evacuation studies. Note that Regions R26 through R36 are the same geographic areas as Regions R02, R04 through R13, respectively.

To determine whether the staged evacuation strategy is worthy of consideration, one must show that the ETE for the 2 Mile region can be reduced without significantly affecting the region between 2 miles and 5 miles. In all cases, as shown in these tables, the ETE for the 2 mile region is 10 to 30 minutes longer than a concurrent evacuation. Staged evacuation provides no benefits to evacuees from within the 2-mile regions and unnecessarily delays the evacuation of those beyond 2 miles.

While failing to provide assistance to evacuees from within 2 miles of the GGNS, staging has a negative impact on the ETE for those evacuating from within the 5-mile area. A comparison of ETE between Regions R26 through R36 with R02 and R04 through R13 reveals that staging can increase the 90th percentile ETE for those in the 2 to 5 mile area by up to 50 minutes (see Table 7-1). This extending of ETE is due to the delay in beginning the evacuation trip, experienced by those who shelter, plus the effect of the trip-generation "spike" (significant volume of traffic beginning the evacuation trip at the same time) that follows their eventual ATE, in creating congestion within the EPZ area beyond 2 miles. The 100th percentile ETE is unchanged by staging.

In summary, the staged evacuation protective action strategy provides no benefits and adversely impacts some evacuees located beyond 2 miles from the RBS.

7.7 Guidance on Using ETE Tables

The user first determines the percentile of population for which the ETE is sought (The NRC guidance calls for the 90th percentile). The applicable value of ETE within the chosen Table may then be identified using the following procedure:

1. Identify the applicable **Scenario**:
   - Season
     - Summer
     - Winter (also Autumn and Spring)
   - Day of Week
     - Midweek
     - Weekend
   - Time of Day
     - Midday
     - Evening
   - Weather Condition
     - Good Weather
     - Rain
   - Special Event
     - Mardi Gras New Roads
     - Road Closure (A lane closure on US 61 SB)
   - Evacuation Staging
     - No, Staged Evacuation is not considered
     - Yes, Staged Evacuation is considered

   While these Scenarios are designed, in aggregate, to represent conditions throughout the year, some further clarification is warranted:

   - The conditions of a summer evening (either midweek or weekend) and rain are not explicitly identified in the Tables. For these conditions, Scenarios (2) and (4) apply.
   - The conditions of a winter evening (either midweek or weekend) and rain are not explicitly identified in the Tables. For these conditions, Scenarios (7) and (10) for rain apply.
   - The seasons are defined as follows:
     - Summer assumes that public schools are not in session.
     - Winter (includes Spring and Autumn) considers that public schools are in session.
   - Time of Day: Midday implies the time over which most commuters are at work or are travelling to/from work.
2. With the desired percentile ETE and Scenario identified, now identify the **Evacuation Region**:
   - Determine the projected azimuth direction of the plume (coincident with the wind direction). This direction is expressed in terms of compass orientation: towards N, NNE, NE, …
   - Determine the distance that the Evacuation Region will extend from the nuclear power plant. The applicable distances and their associated candidate Regions are given below:
     - 2 Miles (Region R01)
     - To 5 Miles (Region R02, R04 through R13)
     - To EPZ Boundary (Regions R03, R14 through R25)

- Enter Table 7-5 and identify the applicable group of candidate Regions based on the distance that the selected Region extends from the RBS. Select the Evacuation Region identifier in that row, based on the azimuth direction of the plume, from the first column of the Table.

3. Determine the **ETE Table** based on the **percentile** selected. Then, for the **Scenario** identified in Step 1 and the **Region** identified in Step 2, proceed as follows:
   - The columns of Table 7-1 are labeled with the Scenario numbers. Identify the proper column in the selected Table using the Scenario number defined in Step 1.
   - Identify the row in this table that provides ETE values for the Region identified in Step 2.
   - The unique data cell defined by the column and row so determined contains the desired value of ETE expressed in Hours:Minutes.

Example

It is desired to identify the ETE for the following conditions:

- Sunday, August 10th at 4:00 AM.
- It is raining.
- Wind direction is toward the north (N).
- Wind speed is such that the distance to be evacuated is judged to be a 5-mile radius and downwind to 10 miles (to EPZ boundary).
- The desired ETE is that value needed to evacuate 90 percent of the population from within the impacted Region.
- A staged evacuation is not desired.

Table 7-1 is applicable because the 90th percentile ETE is desired. Proceed as follows:

1. Identify the Scenario as summer, weekend, evening and raining. Entering Table 7-1, it is seen that there is no match for these descriptors. However, the clarification given above assigns this combination of circumstances to Scenario 4.
2. Enter Table 7-5 and locate the Region described as “Evacuate 5-Mile Radius and Downwind to the EPZ Boundary” for wind direction toward the N (from the S) and read Region R14 in the first column of that row.
3. Enter Table 7-1 to locate the data cell containing the value of ETE for Scenario 4 and Region R14. This data cell is in column (4) and in the row for Region R14; it contains the ETE value of 3:30.

Table 7-1. Time to Clear the Indicated Area of *90* Percent of the Affected Population

	Summer		Summer		Summer	Winter		Winter		Winter	Winter	Summer	
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek	
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	**Scenario:**
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday	**Region**
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact	
Entire 2-Mile Region, 5-Mile Region, and EPZ													
R01	2:15	2:20	2:15	2:20	2:20	2:15	2:15	2:15	2:15	2:20	2:15	2:15	**R01**
R02	2:25	2:30	2:20	2:20	2:20	2:25	2:25	2:15	2:15	2:20	2:15	2:25	**R02**
R03	3:05	3:15	2:50	3:05	2:55	3:10	3:20	2:55	3:15	2:55	4:50	3:10	**R03**
2-Mile Region and Keyhole to 5 Miles													
R04	2:25	2:25	2:15	2:20	2:20	2:25	2:25	2:15	2:15	2:20	2:15	2:25	**R04**
R05	2:20	2:20	2:15	2:20	2:20	2:20	2:20	2:15	2:15	2:20	2:15	2:20	**R05**
R06	2:20	2:20	2:15	2:20	2:20	2:20	2:20	2:15	2:15	2:20	2:15	2:20	**R06**
R07	2:25	2:25	2:20	2:20	2:20	2:20	2:25	2:15	2:20	2:20	2:15	2:25	**R07**
R08	2:20	2:25	2:20	2:25	2:25	2:20	2:20	2:15	2:20	2:20	2:15	2:20	**R08**
R09	2:20	2:25	2:20	2:25	2:25	2:20	2:20	2:15	2:20	2:20	2:15	2:20	**R09**
R10	2:15	2:20	2:15	2:20	2:20	2:15	2:15	2:15	2:15	2:20	2:15	2:15	**R10**
R11	2:15	2:20	2:15	2:20	2:20	2:15	2:20	2:15	2:15	2:20	2:15	2:15	**R11**
R12	2:25	2:25	2:15	2:20	2:20	2:20	2:25	2:10	2:15	2:15	2:10	2:25	**R12**
R13	2:25	2:25	2:15	2:20	2:20	2:20	2:25	2:10	2:15	2:15	2:10	2:25	**R13**
5-Mile Region and Keyhole to EPZ Boundary													
R14	3:20	3:35	3:10	3:30	3:20	3:30	3:50	3:20	3:45	3:20	3:20	3:20	**R14**
R15	3:05	3:15	2:55	3:00	2:55	3:10	3:20	3:00	3:15	2:55	3:00	3:05	**R15**
R16	3:05	3:10	2:50	2:55	2:50	3:10	3:15	2:55	3:10	2:50	2:55	3:05	**R16**
R17	2:30	2:35	2:20	2:20	2:20	2:30	2:30	2:15	2:20	2:20	2:15	2:30	**R17**
R18	2:30	2:30	2:20	2:20	2:20	2:30	2:30	2:15	2:20	2:20	2:15	2:30	**R18**
R19	2:30	2:35	2:20	2:20	2:20	2:30	2:30	2:15	2:20	2:20	2:15	2:30	**R19**
R20	2:35	2:35	2:20	2:20	2:20	2:30	2:35	2:15	2:20	2:20	5:00	2:35	**R20**
R21	2:35	2:35	2:20	2:20	2:20	2:30	2:35	2:15	2:20	2:20	5:00	2:35	**R21**
R22	2:35	2:35	2:20	2:20	2:20	2:30	2:30	2:15	2:20	2:20	5:00	2:35	**R22**
R23	2:35	2:35	2:20	2:25	2:20	2:30	2:40	2:25	2:35	2:20	5:00	2:35	**R23**

	Summer		Summer		Summer	Winter		Winter		Winter	Winter	Summer	
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek	
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**Scenario:**
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday	**Region**
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact	
R24	2:30	2:30	2:20	2:25	2:20	2:30	2:40	2:25	2:40	2:20	2:25	2:30	**R24**
R25	3:05	3:15	2:50	3:05	2:55	3:15	3:20	3:10	3:20	2:55	3:10	3:05	**R25**
Staged Evacuation - 2-Mile Region and Keyhole to 5 Miles													
R26	3:00	3:05	3:00	3:00	3:05	3:00	3:00	3:00	3:00	3:05	3:00	3:00	**R26**
R27	3:05	3:05	3:00	3:00	3:10	3:05	3:05	3:00	3:00	3:05	3:00	3:05	**R27**
R28	2:45	2:45	2:45	2:45	2:45	2:40	2:45	2:40	2:40	2:45	2:40	2:45	**R28**
R29	2:45	2:45	2:45	2:45	2:45	2:40	2:45	2:40	2:40	2:45	2:40	2:45	**R29**
R30	2:45	2:45	2:45	2:45	2:50	2:45	2:45	2:45	2:45	2:45	2:45	2:45	**R30**
R31	2:40	2:40	2:40	2:40	2:45	2:35	2:35	2:35	2:40	2:45	2:35	2:40	**R31**
R32	2:40	2:40	2:40	2:40	2:45	2:40	2:40	2:40	2:40	2:45	2:40	2:40	**R32**
R33	2:35	2:35	2:40	2:40	2:40	2:35	2:35	2:35	2:35	2:40	2:35	2:35	**R33**
R34	2:35	2:35	2:35	2:35	2:40	2:35	2:35	2:35	2:35	2:40	2:35	2:35	**R34**
R35	2:55	3:00	2:55	2:55	3:00	2:55	3:00	2:55	2:55	3:00	2:55	2:55	**R35**
R36	3:00	3:00	2:55	2:55	3:00	2:55	3:00	2:55	2:55	3:00	2:55	3:00	**R36**

Table 7-2. Time to Clear the Indicated Area of *100* Percent of the Affected Population

	Summer		Summer		Summer	Winter		Winter		Winter	Winter	Summer	
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek	
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	**Scenario:**
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday	**Region**
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact	
Entire 2-Mile Region, 5-Mile Region, and EPZ													
R01	4:45	4:45	4:45	4:45	4:45	4:45	4:45	4:45	4:45	4:45	4:45	4:45	**R01**
R02	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R02**
R03	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:40	4:55	**R03**
2-Mile Region and Keyhole to 5 Miles													
R04	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R04**
R05	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R05**
R06	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R06**
R07	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R07**
R08	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R08**
R09	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R09**
R10	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R10**
R11	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R11**
R12	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R12**
R13	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R13**
5-Mile Region and Keyhole to EPZ Boundary													
R14	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	**R14**
R15	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	**R15**
R16	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	**R16**
R17	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	**R17**
R18	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	**R18**
R19	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	**R19**
R20	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:40	4:55	**R20**
R21	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:35	4:55	**R21**
R22	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:40	4:55	**R22**
R23	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	6:35	4:55	**R23**

	Summer		Summer		Summer	Winter		Winter		Winter	Winter	Summer	
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek	
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**Scenario:**
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday	**Region**
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact	
R24	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	**R24**
R25	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	4:55	**R25**
Staged Evacuation - 2-Mile Region and Keyhole to 5 Miles													
R26	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R26**
R27	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R27**
R28	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R28**
R29	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R29**
R30	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R30**
R31	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R31**
R32	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R32**
R33	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R33**
R34	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R34**
R35	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R35**
R36	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R36**

Table 7-3. Time to Clear *__90__* Percent of the 2-Mile Area within the Indicated Region

	Summer		Summer		Summer	Winter		Winter		Winter	Winter	Summer	
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek	
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	Scenario:
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday	Region
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact	
Unstaged Evacuation - 2-Mile Region													
R01	2:15	2:20	2:15	2:20	2:20	2:15	2:15	2:15	2:15	2:20	2:15	2:15	**R01**
Unstaged Evacuation - 2-Mile Region and Keyhole to 5-Miles													
R02	2:20	2:25	2:20	2:20	2:25	2:20	2:20	2:15	2:20	2:20	2:15	2:20	**R02**
R04	2:20	2:25	2:20	2:20	2:25	2:20	2:20	2:15	2:20	2:25	2:15	2:20	**R04**
R05	2:20	2:20	2:15	2:20	2:20	2:15	2:20	2:15	2:15	2:20	2:15	2:20	**R05**
R06	2:20	2:20	2:15	2:20	2:20	2:15	2:20	2:15	2:15	2:20	2:15	2:20	**R06**
R07	2:20	2:20	2:15	2:20	2:20	2:15	2:20	2:15	2:15	2:20	2:15	2:20	**R07**
R08	2:15	2:20	2:15	2:20	2:20	2:15	2:15	2:15	2:15	2:20	2:15	2:15	**R08**
R09	2:15	2:20	2:15	2:20	2:20	2:15	2:15	2:15	2:15	2:20	2:15	2:15	**R09**
R10	2:15	2:20	2:15	2:20	2:20	2:15	2:20	2:15	2:15	2:20	2:15	2:15	**R10**
R11	2:15	2:20	2:15	2:20	2:20	2:15	2:15	2:15	2:15	2:20	2:15	2:15	**R11**
R12	2:20	2:25	2:20	2:20	2:25	2:15	2:20	2:15	2:20	2:20	2:15	2:20	**R12**
R13	2:20	2:25	2:20	2:20	2:25	2:20	2:20	2:15	2:20	2:20	2:15	2:20	**R13**
Staged Evacuation 2-Mile Region and Keyhole to 5-Miles													
R26	2:40	2:45	2:45	2:45	2:45	2:40	2:40	2:45	2:45	2:45	2:45	2:40	**R26**
R27	2:40	2:45	2:45	2:45	2:45	2:40	2:40	2:45	2:45	2:45	2:45	2:40	**R27**
R28	2:30	2:35	2:30	2:35	2:40	2:30	2:30	2:30	2:30	2:40	2:30	2:30	**R28**
R29	2:30	2:35	2:30	2:35	2:40	2:30	2:30	2:30	2:30	2:40	2:30	2:30	**R29**
R30	2:30	2:35	2:30	2:35	2:40	2:30	2:30	2:30	2:30	2:40	2:30	2:30	**R30**
R31	2:30	2:30	2:30	2:30	2:35	2:25	2:30	2:25	2:25	2:35	2:25	2:30	**R31**
R32	2:30	2:30	2:30	2:30	2:35	2:25	2:30	2:25	2:25	2:35	2:25	2:30	**R32**
R33	2:30	2:30	2:30	2:30	2:35	2:25	2:30	2:25	2:25	2:35	2:25	2:30	**R33**
R34	2:30	2:30	2:30	2:30	2:35	2:25	2:30	2:25	2:25	2:35	2:25	2:30	**R34**
R35	2:40	2:45	2:45	2:45	2:45	2:40	2:40	2:40	2:40	2:45	2:40	2:40	**R35**
R36	2:40	2:45	2:45	2:45	2:45	2:40	2:40	2:40	2:45	2:45	2:40	2:40	**R36**

Table 7-4. Time to Clear *100* Percent of the 2-Mile Area within the Indicated Region

	Summer		Summer		Summer	Winter		Winter		Winter	Winter	Summer	
	Midweek		Weekend		Midweek Weekend	Midweek		Weekend		Midweek Weekend	Weekend	Midweek	
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	Scenario:
Region	Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday	Region
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	Special Event	Roadway Impact	
Unstaged Evacuation - 2-Mile Region													
R01	4:45	4:45	4:45	4:45	4:45	4:45	4:45	4:45	4:45	4:45	4:45	4:45	**R01**
Unstaged Evacuation - 2-Mile Region and Keyhole to 5-Miles													
R02	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R02**
R04	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R04**
R05	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R05**
R06	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R06**
R07	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R07**
R08	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R08**
R09	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R09**
R10	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R10**
R11	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R11**
R12	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R12**
R13	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R13**
Staged Evacuation -2-Mile Region and Keyhole to 5-Miles													
R26	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R26**
R27	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R27**
R28	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R28**
R29	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R29**
R30	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R30**
R31	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R31**
R32	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R32**
R33	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R33**
R34	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R34**
R35	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R35**
R36	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	4:50	**R36**

Table 7-5. Description of Evacuation Regions

Region	Description	PAS																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
R01	2 mile ring	X																	
R02	5-mile ring	X	X	X	X				X	X							X		
R03	Full EPZ	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Evacuate 2 mile ring and 5 miles downwind																			
Region	**Wind Direction Toward**	**PAS**																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
R04	N, NNE	X	X	X															
R05	NE	X		X															
R06	ENE	X		X					X										
R07	E, ESE	X		X	X				X	X									
R08	SE, SSE	X			X					X									
R09	S	X			X					X							X		
R10	SSW	X			X												X		
R11	SW, WSW	X															X		
R12	W	X	X			X											X		
R13	WNW, NW, NNW	X	X																
Evacuate 5 mile ring and downwind to EPZ boundary																			
Region	**Wind Direction Toward**	**PAS**																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
R14	N, NNE	X	X	X	X	X	X	X	X	X	X						X		
R15	NE, ENE	X	X	X	X	X	-	X	X	X	X	X					X		
R16	E	X	X	X	X	X		X	X	X	X	X	X	X			X		
R17	ESE	X	X	X	X	X			X	X		X	X	X	X		X		
R18	SE	X	X	X	X	X			X	X			X	X	X	X	X		
R19	SSE	X	X	X	X	X			X	X			X	X	X	X	X	X	
R20	S	X	X	X	X	X			X	X					X	X	X	X	X
R21	SSW	X	X	X	X	X			X	X						X	X	X	X
R22	SW, WSW	X	X	X	X	X			X	X							X	X	X
R23	W	X	X	X	X	X	X		X	X							X		X
R24	WNW, NW	X	X	X	X	X	X		X	X							X		
R25	NNW	X	X	X	X	X	X	X	X	X							X		

Staged Evacuation - 2-Mile Radius Evacuates, then Evacuate Downwind to 5 Miles																			
Region	**Wind Direction Toward**	**PAS**																	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
R26	5 Mile Ring	X	X	X	X				X	X							X		
R27	N, NNE	X	X	X															
R28	NE	X		X															
R29	ENE	X		X					X										
R30	E, ESE	X		X	X				X	X									
R31	SE, SSE	X			X					X									
R32	S	X			X					X							X		
R33	SSW	X			X												X		
R34	SW, WSW	X															X		
R35	W	X	X			X											X		
R36	WNW, NW, NNW	X	X																

Shelter-in-Place until 90% ETE for R01, then Evacuate | **Area(s) Shelter-in-Place** | **Area(s) Evacuate**

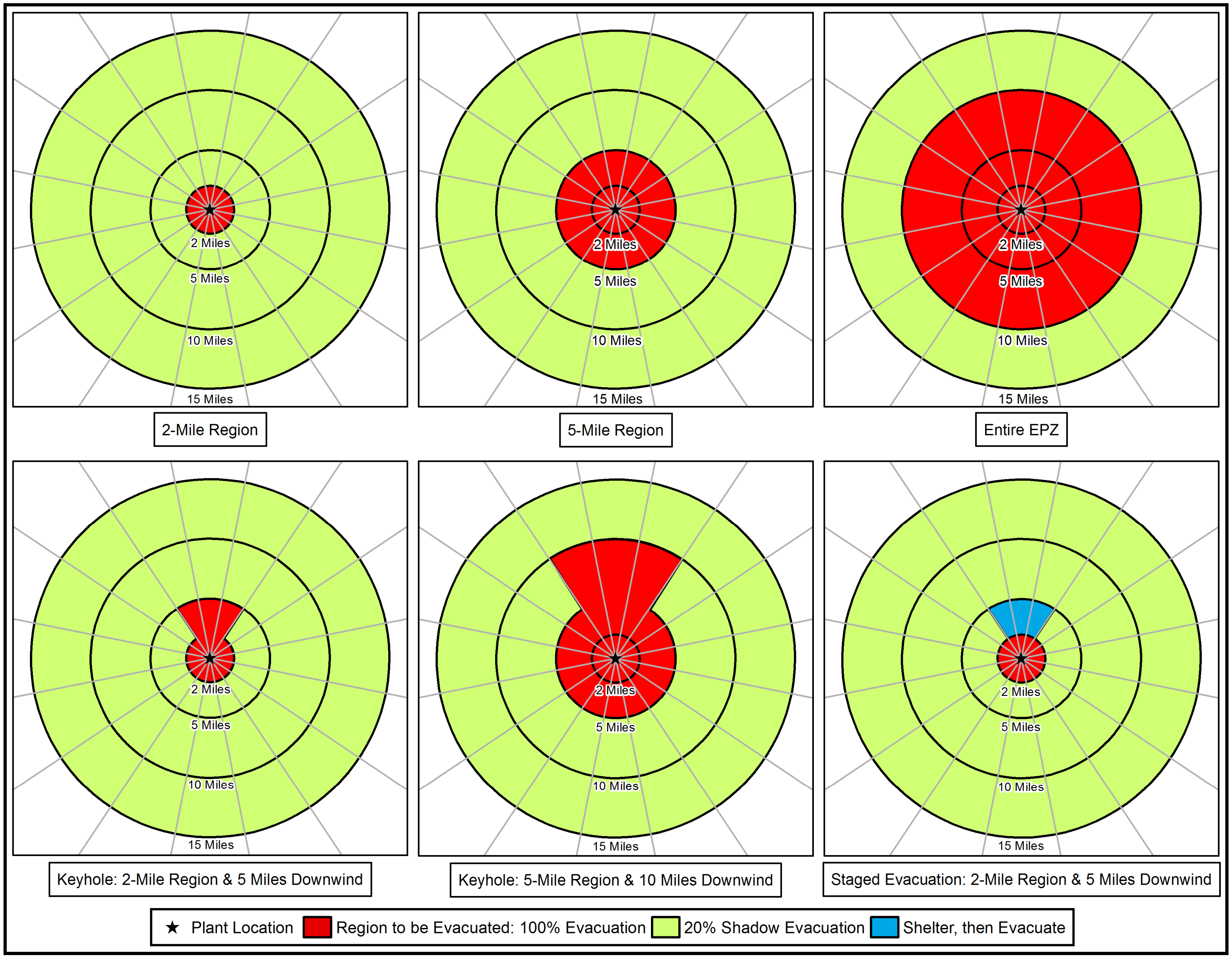


Figure 7-1. Voluntary Evacuation Methodology

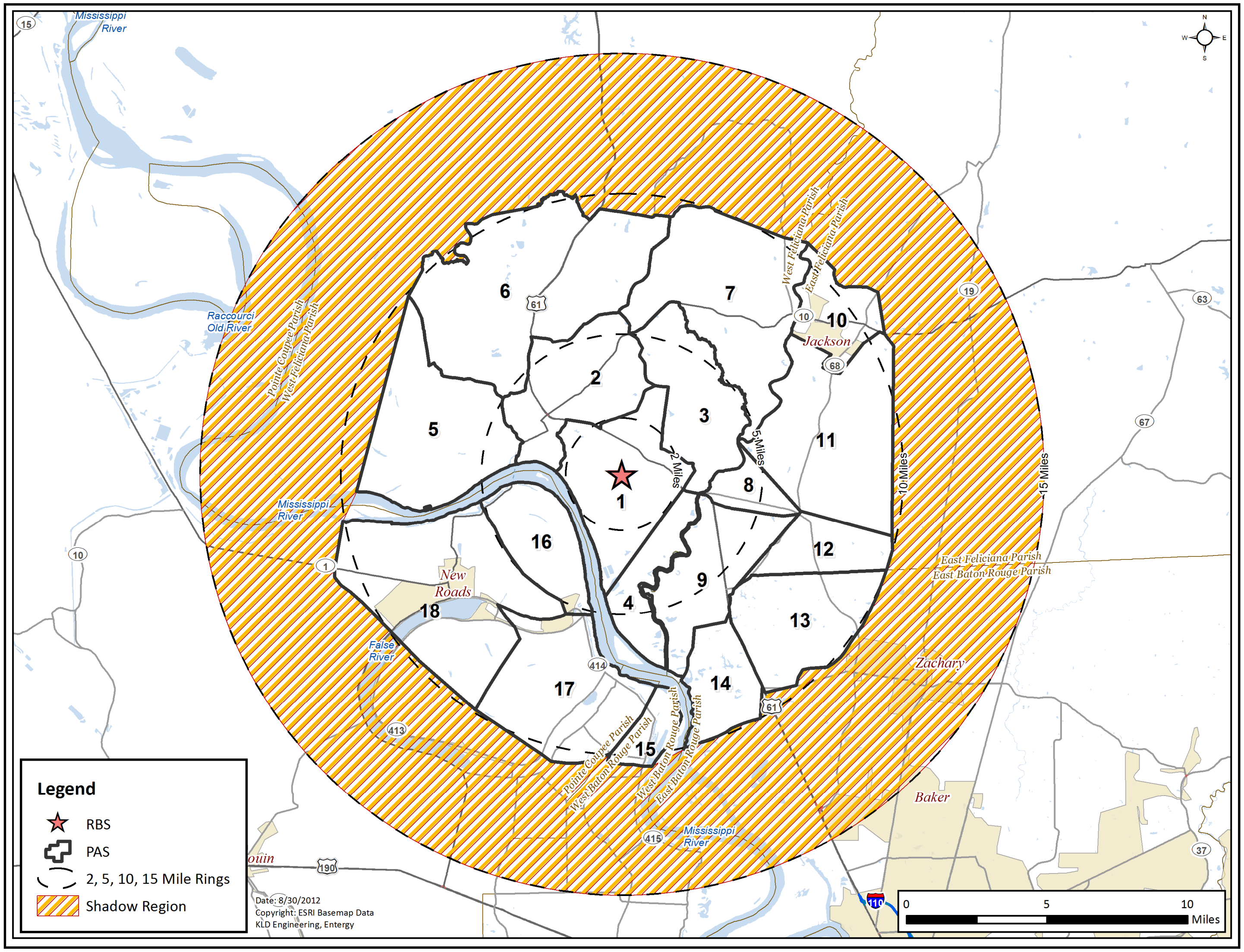


Figure 7-2. RBS Shadow Region

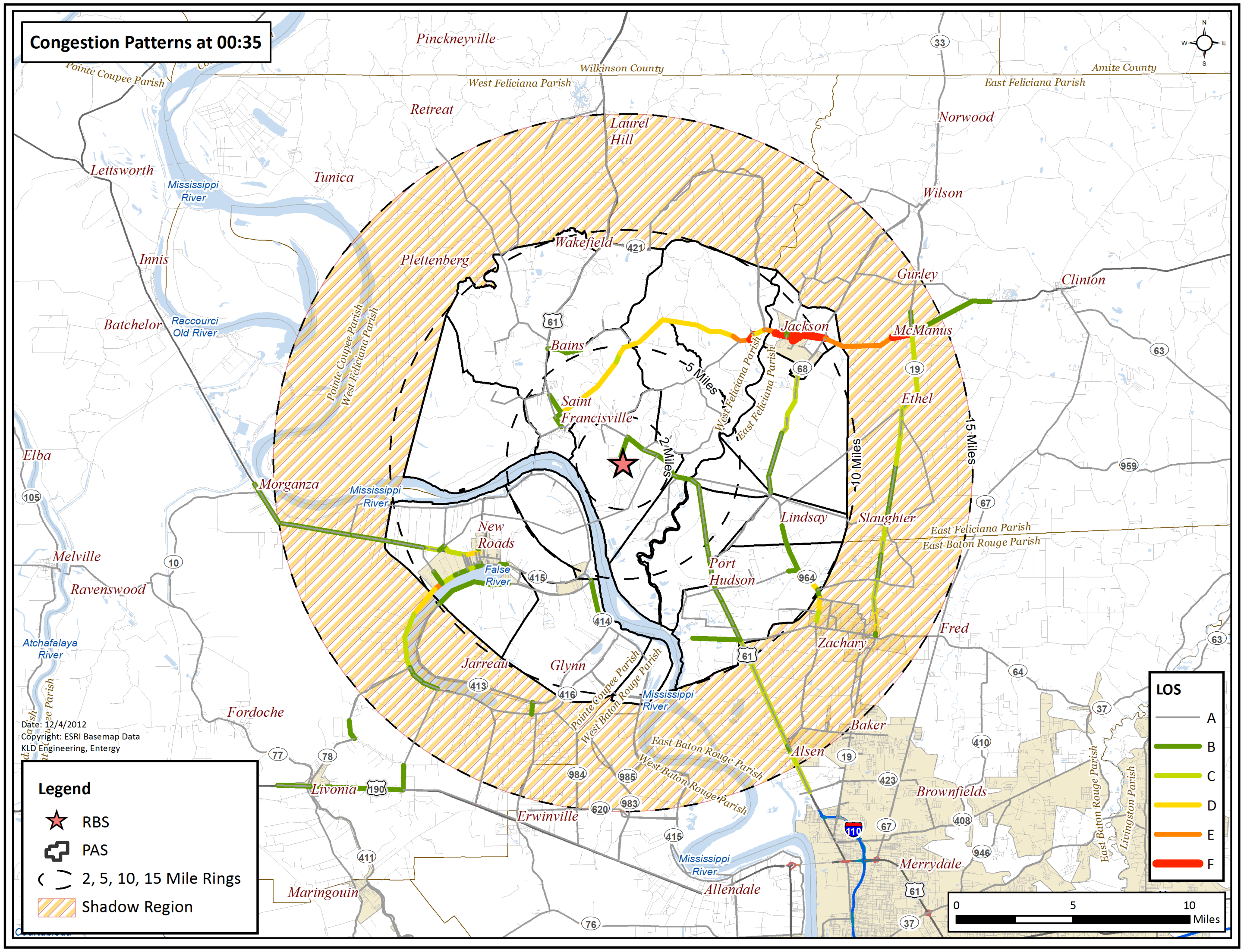


Figure 7-3. Congestion Patterns at 35 Minutes after the Advisory to Evacuate

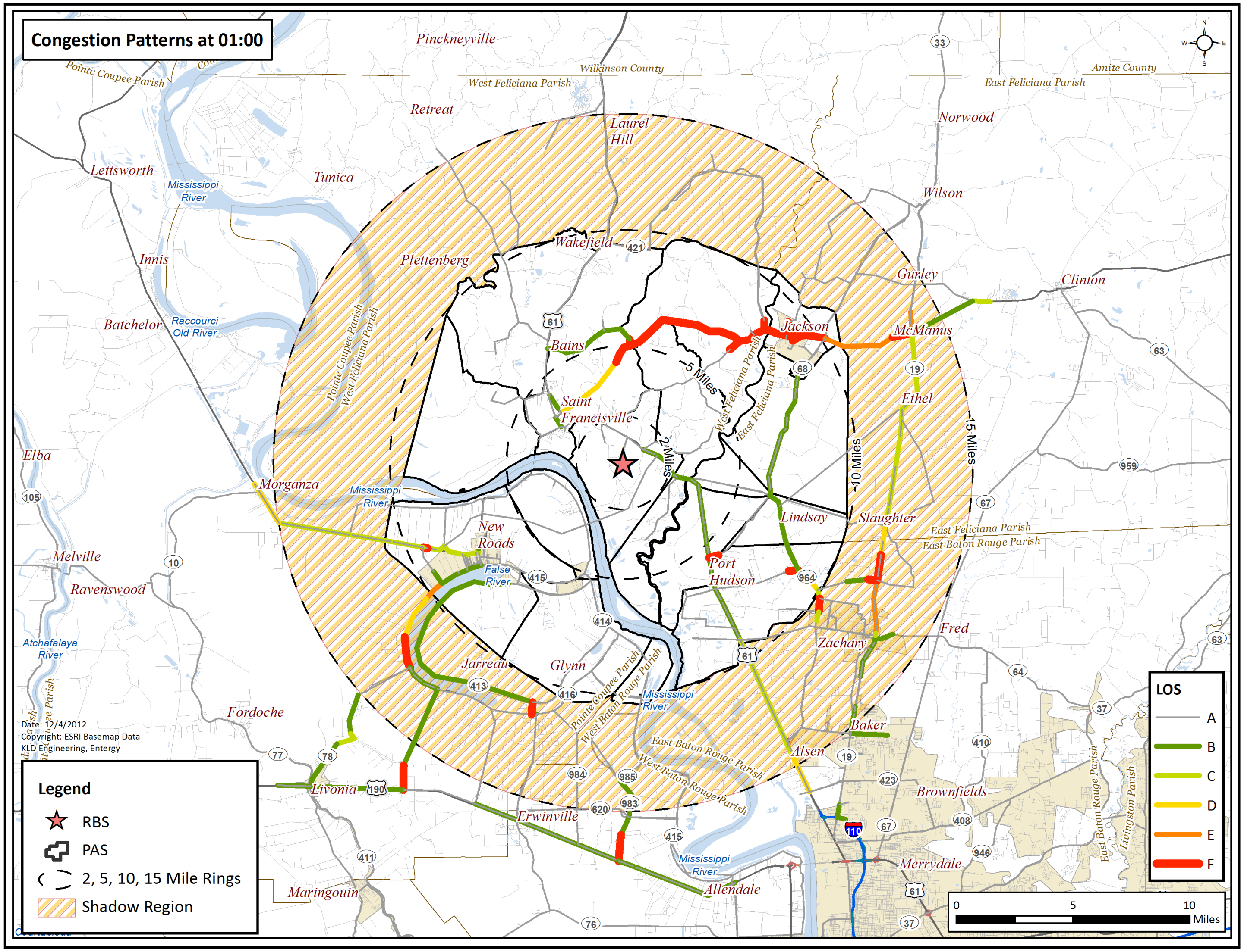


Figure 7-4. Congestion Patterns at 1 Hour after the Advisory to Evacuate

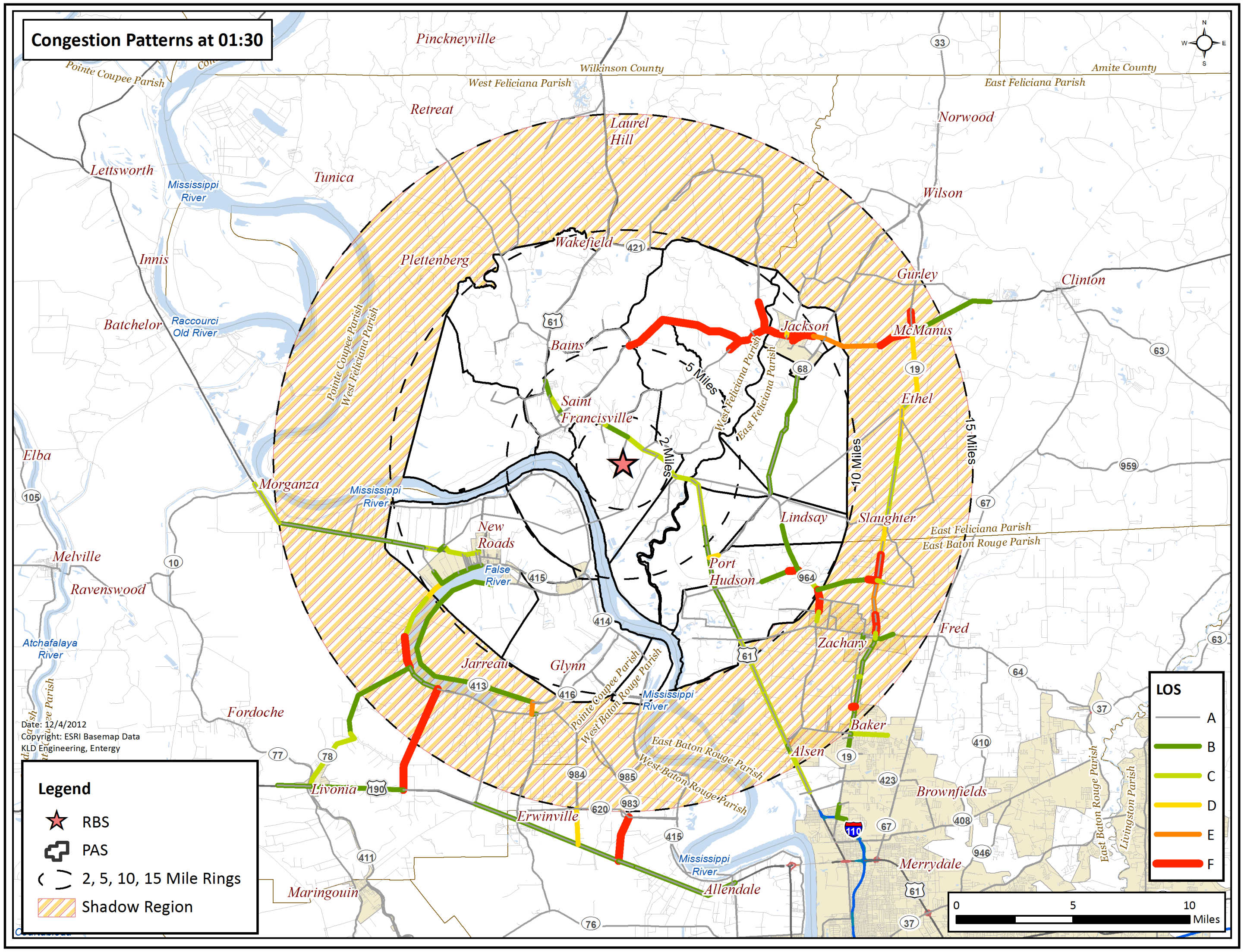


Figure 7-5. Congestion Patterns at 1 Hour, 30 Minutes after the Advisory to Evacuate

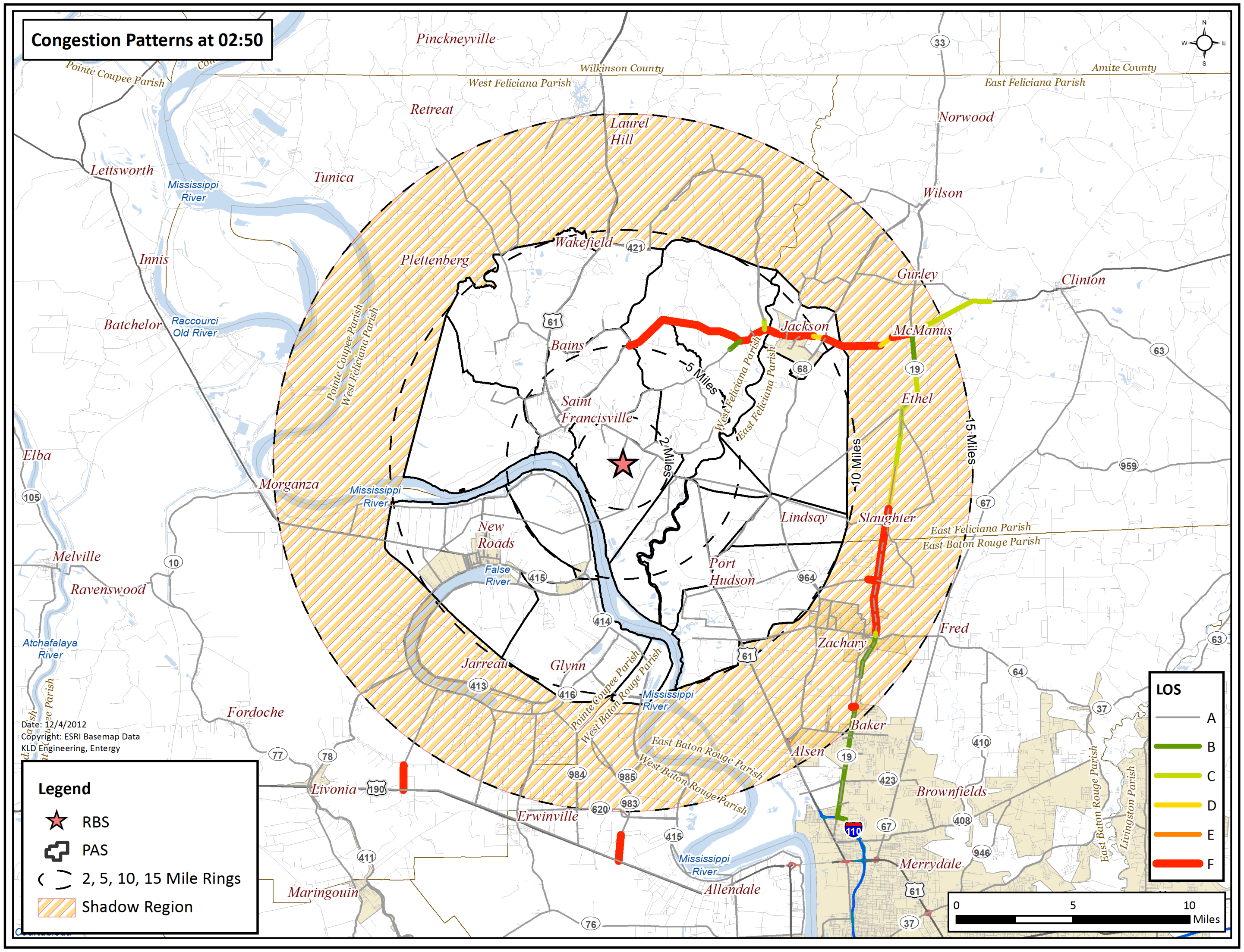


Figure 7-6. Congestion Patterns at 2 Hours, 50 Minutes after the Advisory to Evacuate

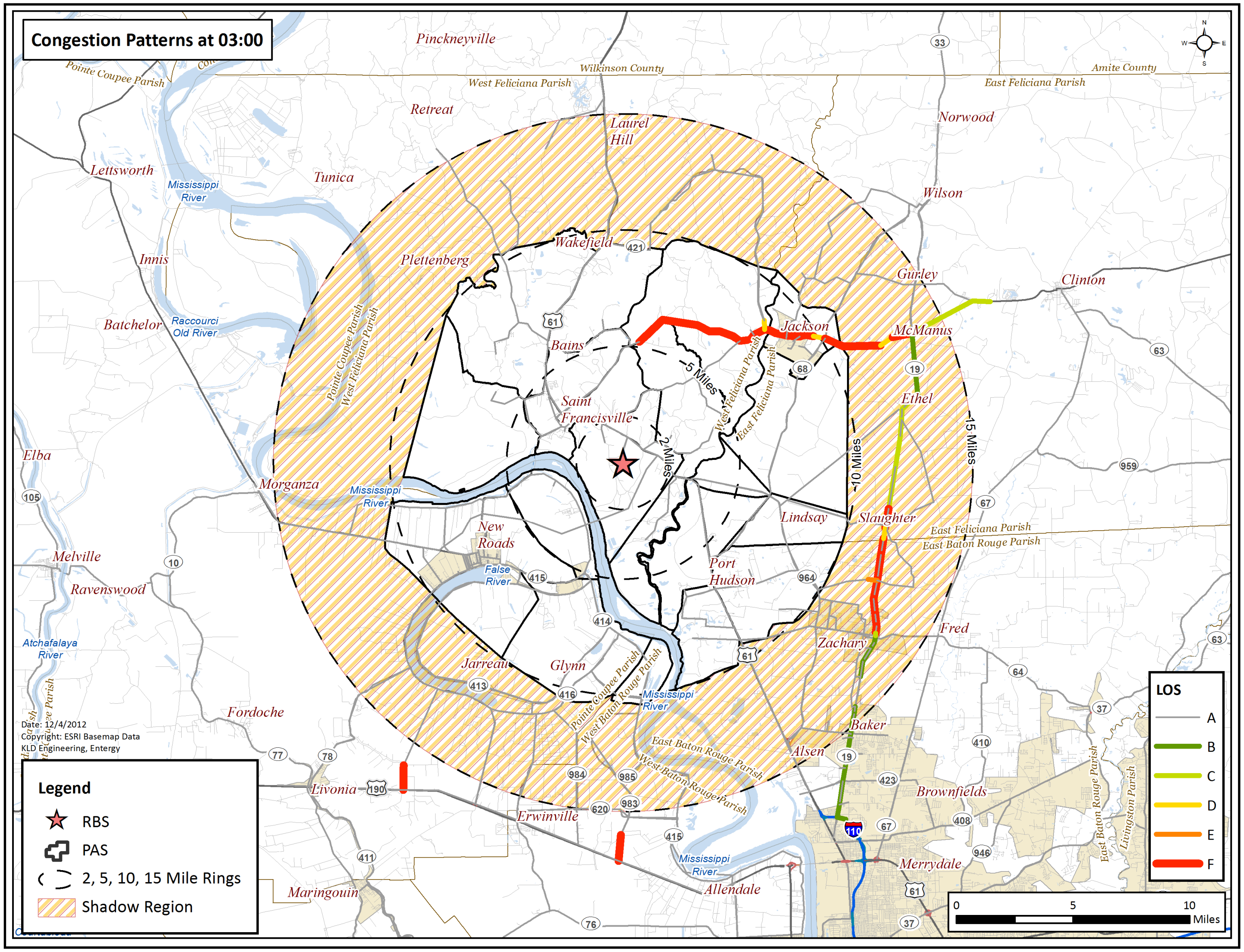


Figure 7-7. Congestion Patterns at 3 Hours after the Advisory to Evacuate

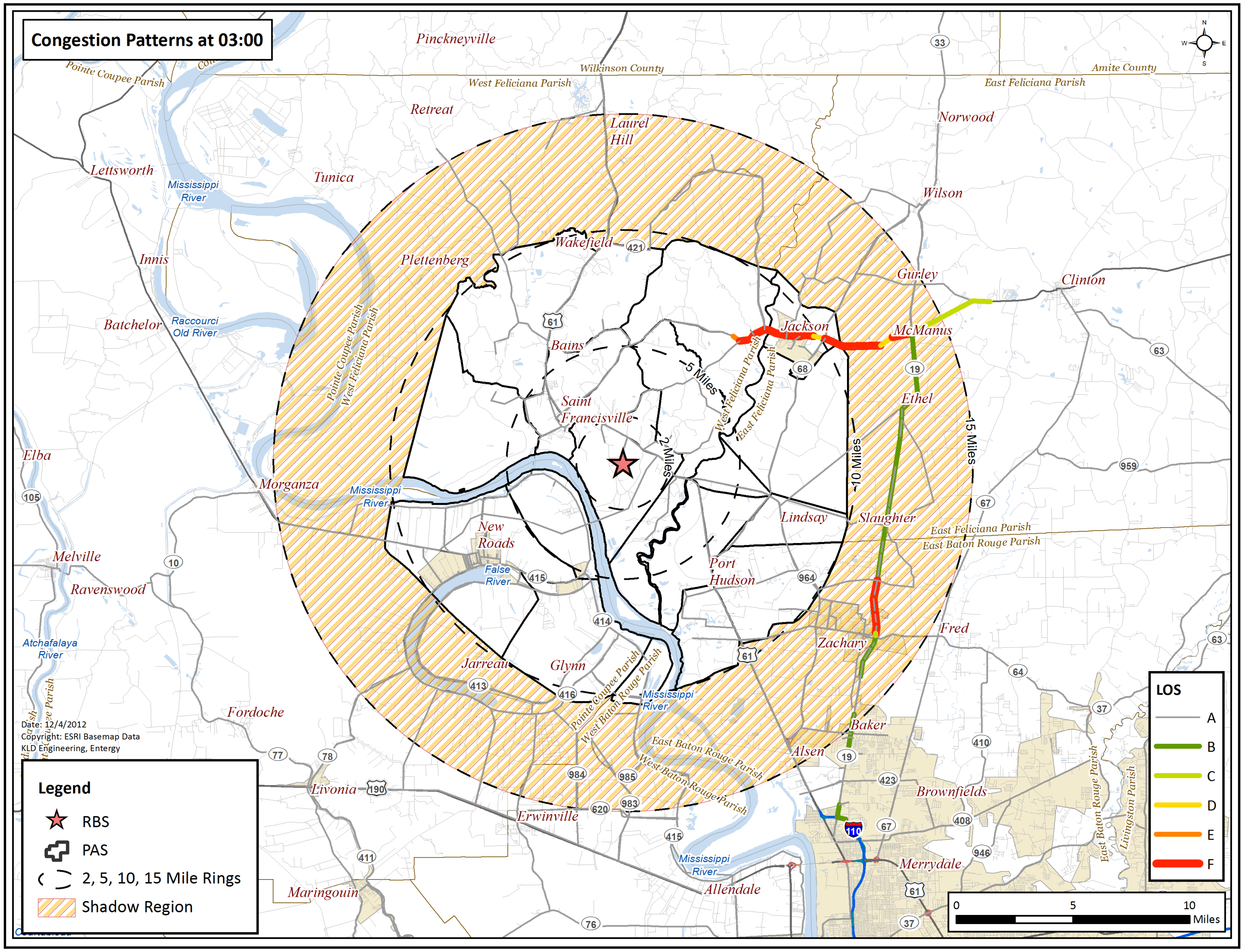


Figure 7-8. Congestion Patterns at 3 Hours, 35 Minutes after the Advisory to Evacuate

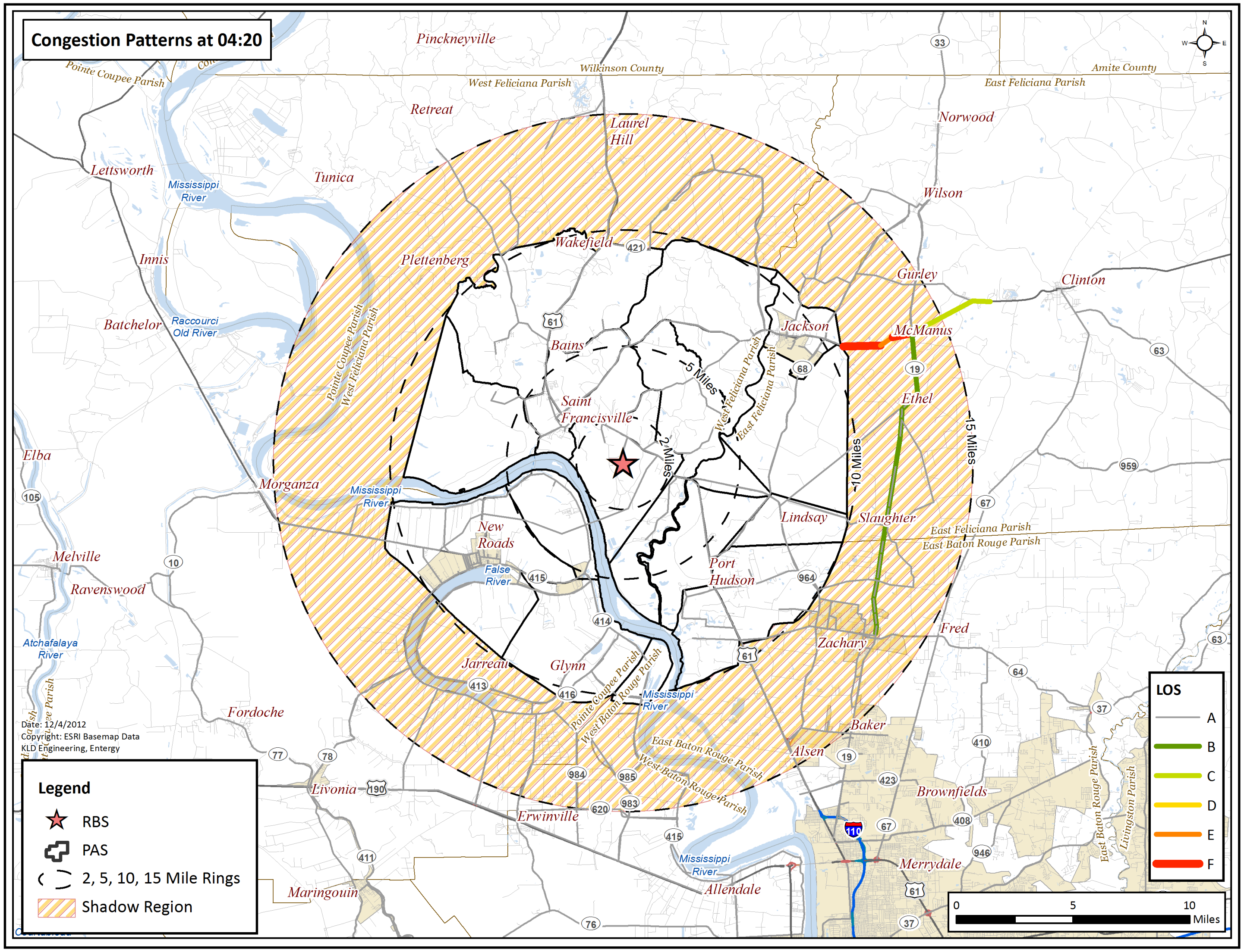


Figure 7-9. Congestion Patterns at 4 Hours, 20 Minutes after the Advisory to Evacuate

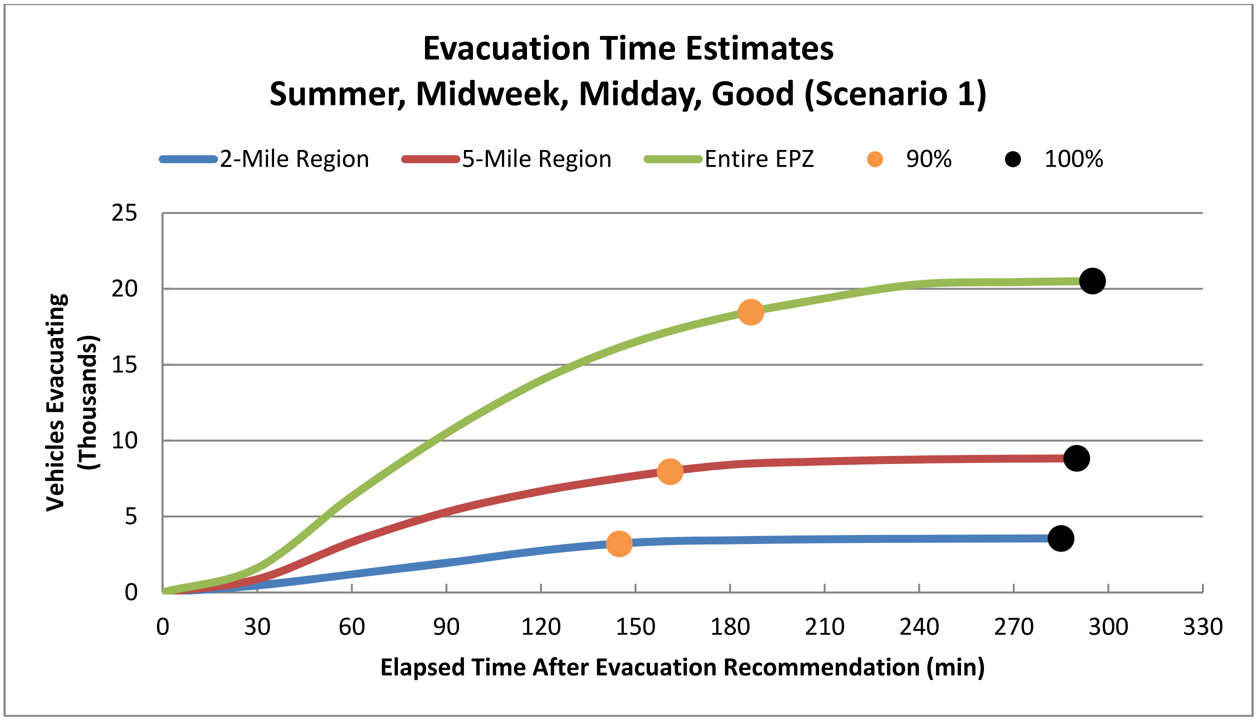


Figure 7-10. Evacuation Time Estimates - Scenario 1 for Region R03

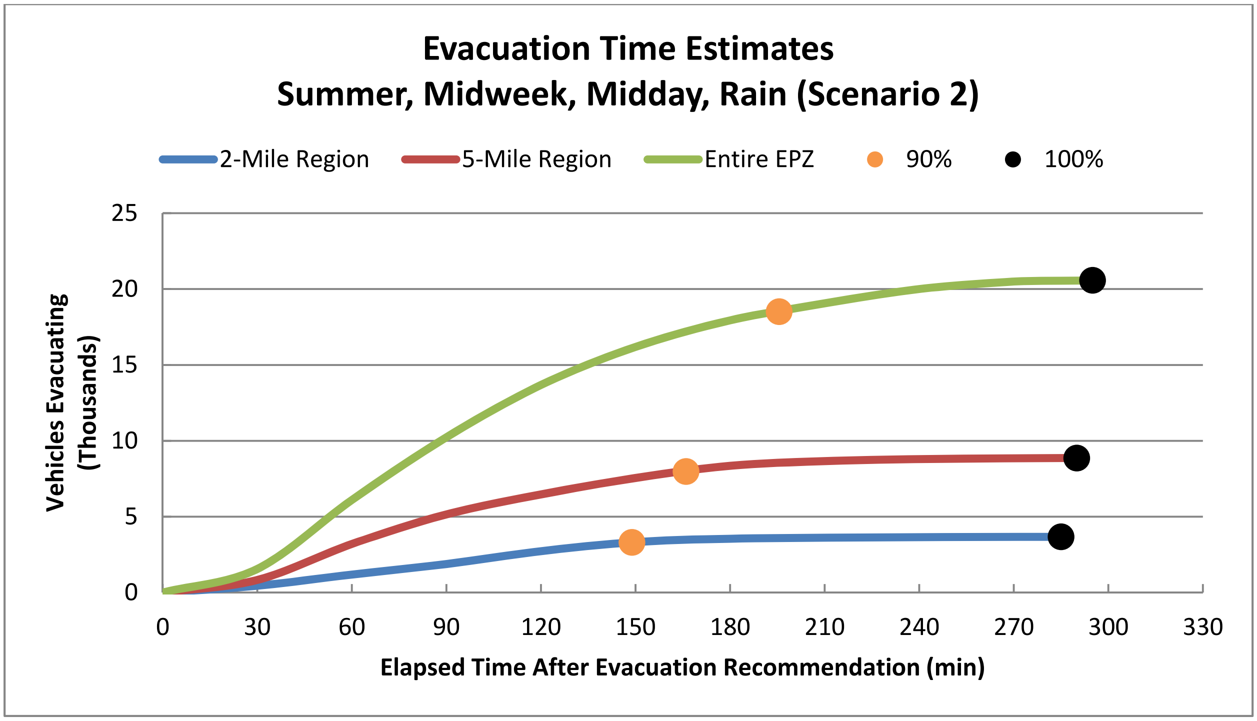


Figure 7-11. Evacuation Time Estimates - Scenario 2 for Region R03

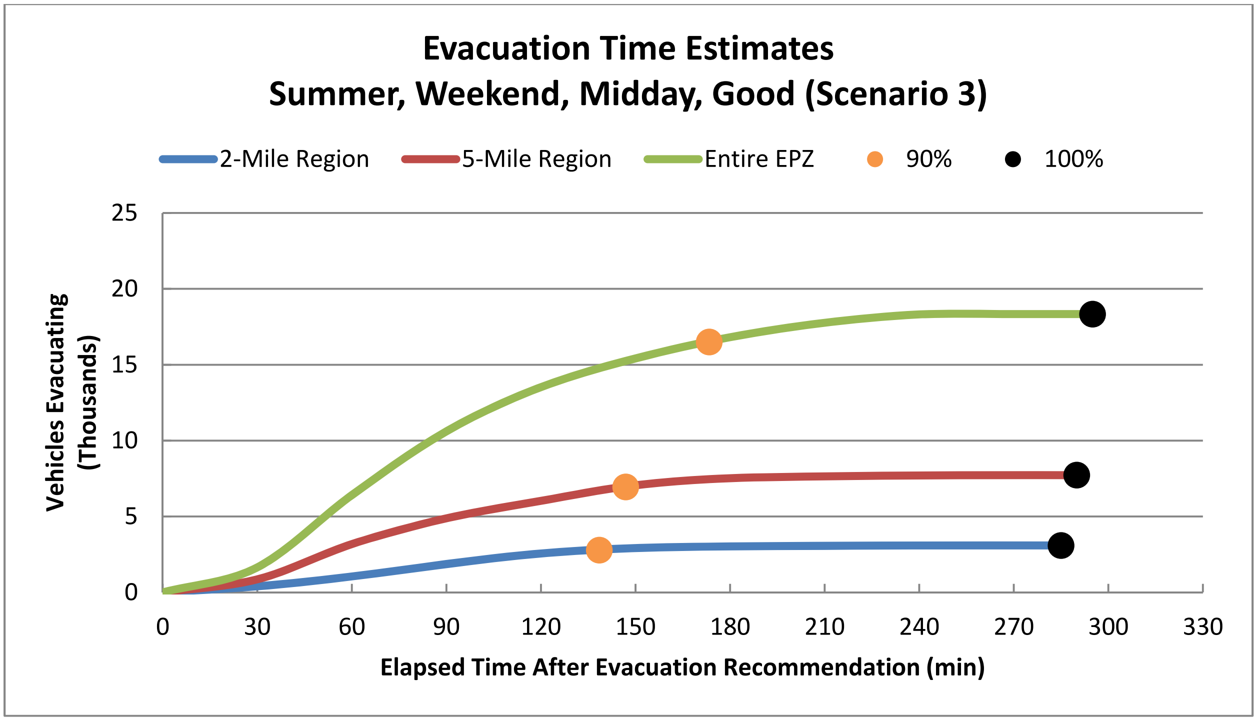


Figure 7-12. Evacuation Time Estimates - Scenario 3 for Region R03

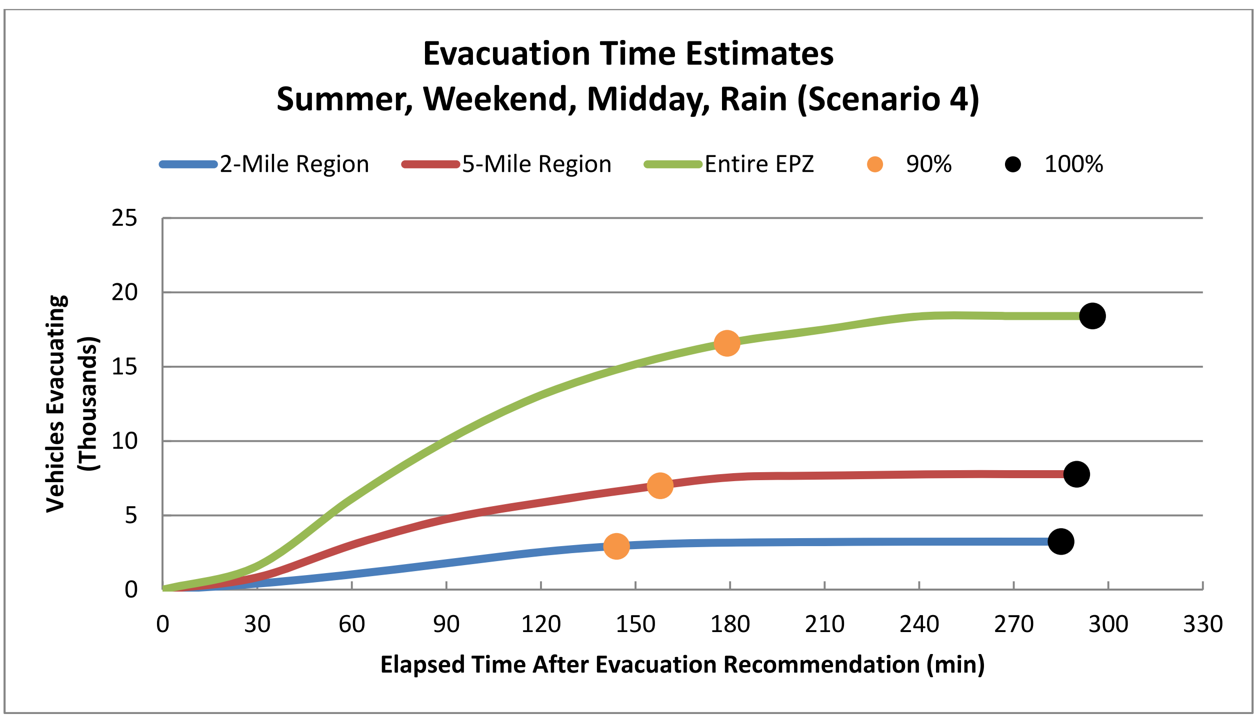


Figure 7-13. Evacuation Time Estimates - Scenario 4 for Region R03

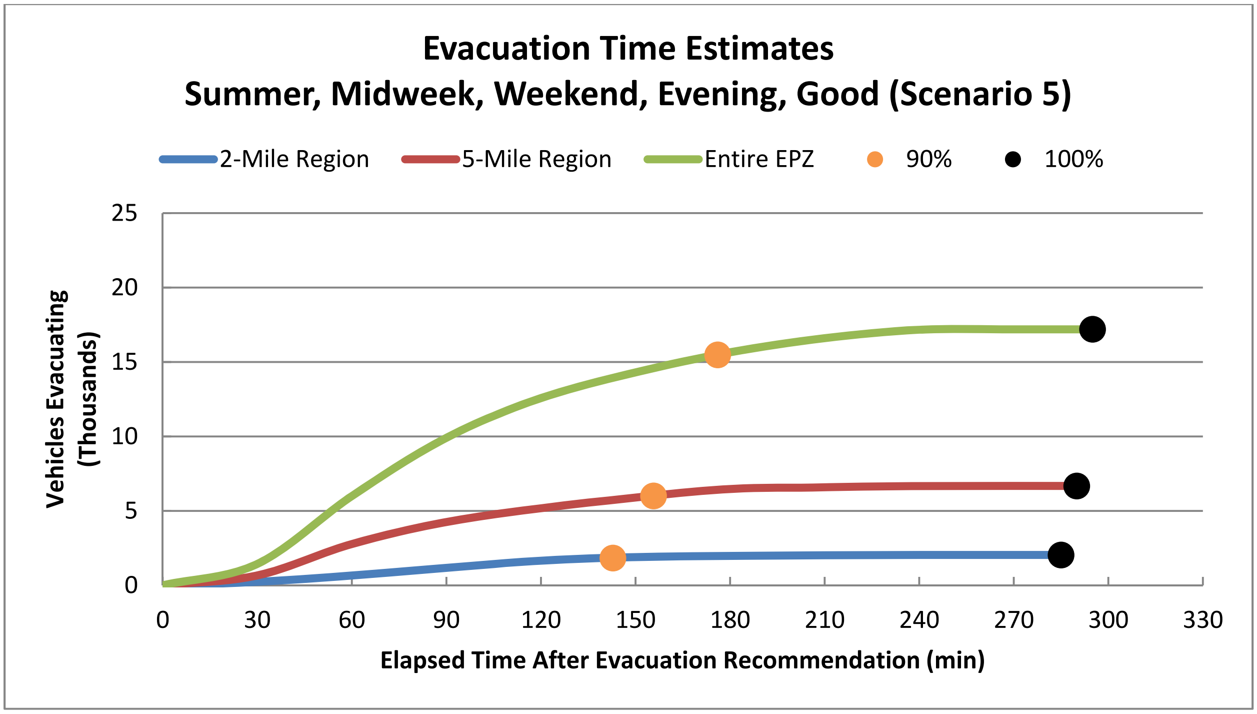


Figure 7-14. Evacuation Time Estimates - Scenario 5 for Region R03

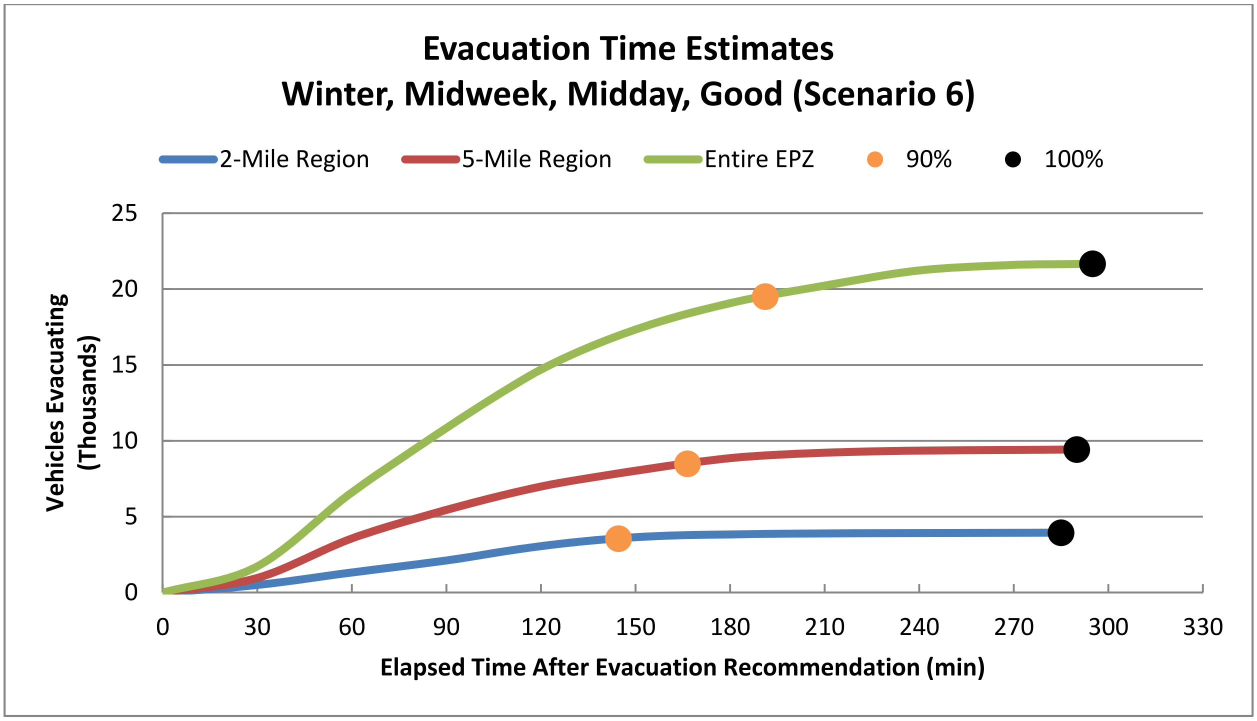


Figure 7-15. Evacuation Time Estimates - Scenario 6 for Region R03

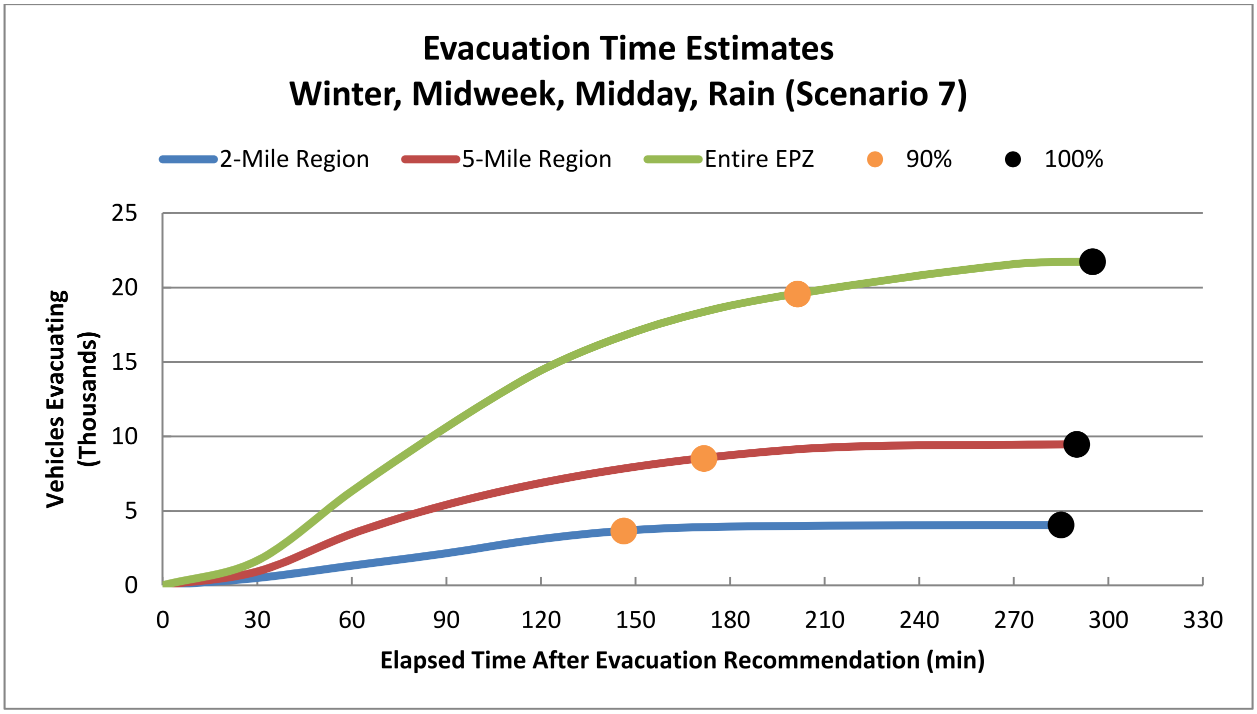


Figure 7-16. Evacuation Time Estimates - Scenario 7 for Region R03

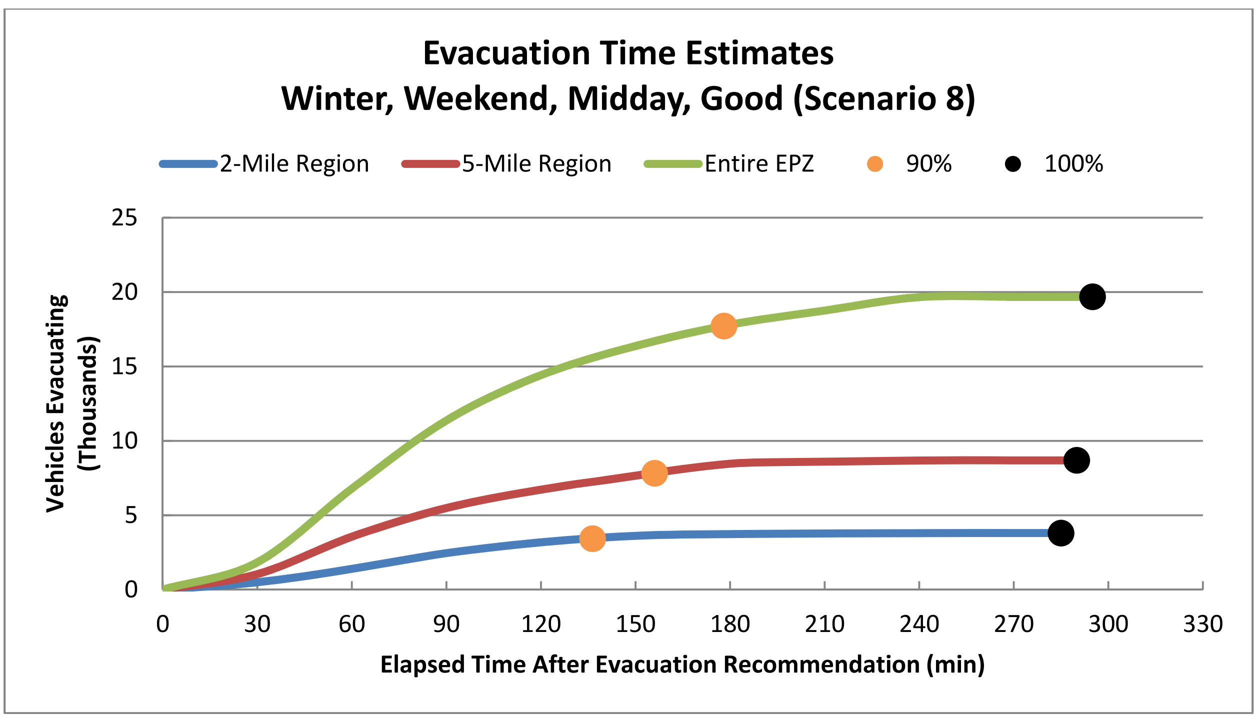


Figure 7-17. Evacuation Time Estimates - Scenario 8 for Region R03

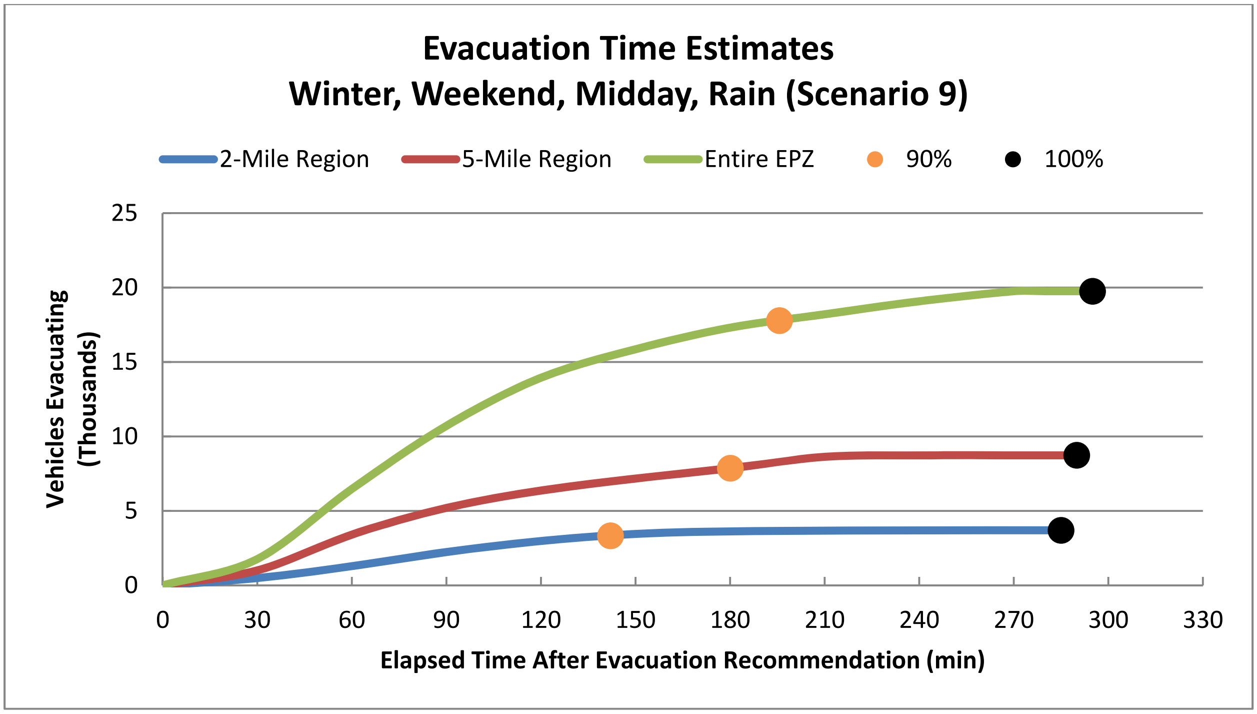


Figure 7-18. Evacuation Time Estimates - Scenario 9 for Region R03

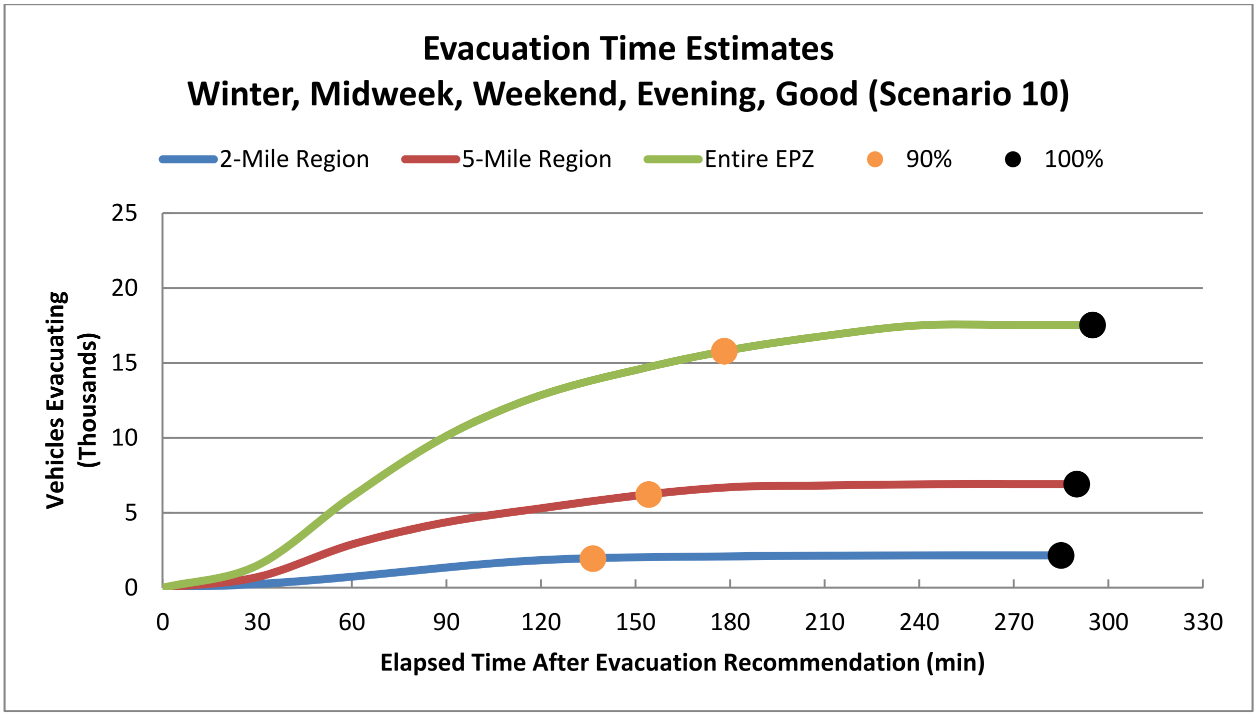


Figure 7-19. Evacuation Time Estimates - Scenario 10 for Region R03

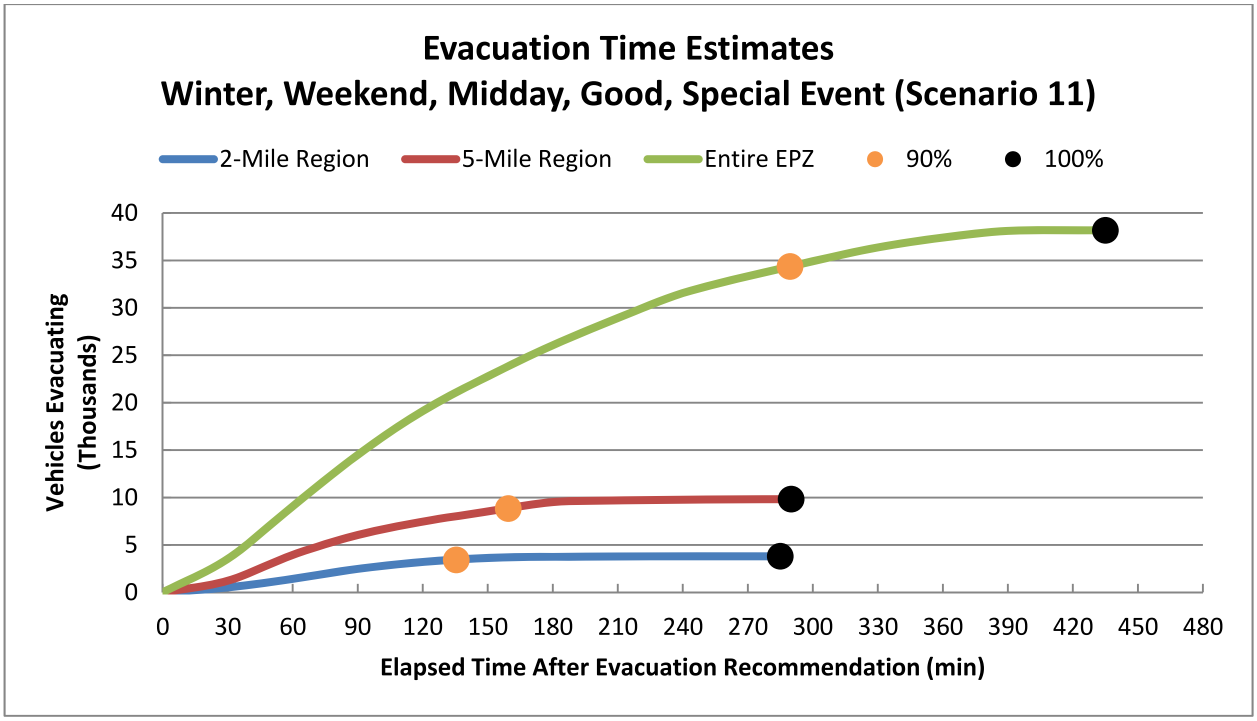


Figure 7-20. Evacuation Time Estimates - Scenario 11 for Region R03

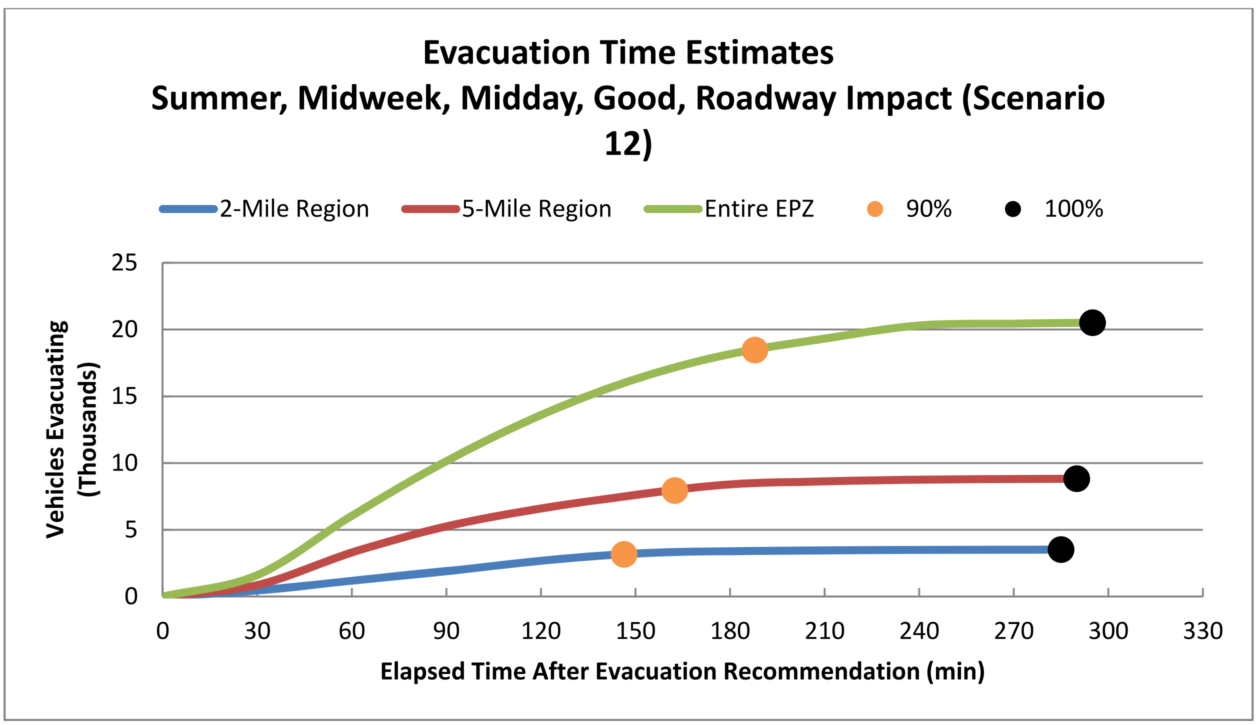


Figure 7-21. Evacuation Time Estimates - Scenario 12 for Region R03

8 TRANSIT-DEPENDENT AND SPECIAL FACILITY EVACUATION TIME ESTIMATES

This section details the analyses applied and the results obtained in the form of evacuation time estimates for transit vehicles. The demand for transit service reflects the needs of three population groups: (1) residents with no vehicles available; (2) residents of special facilities such as schools, medical facilities, and correctional facilities; and (3) homebound special needs population.

These transit vehicles mix with the general evacuation traffic that is comprised mostly of "passenger cars" (pc's). The presence of each transit vehicle in the evacuating traffic stream is represented within the modeling paradigm described in Appendix D as equivalent to two pc's. This equivalence factor represents the longer size and more sluggish operating characteristics of a transit vehicle, relative to those of a pc.

Transit vehicles must be mobilized in preparation for their respective evacuation missions. Specifically:

- Bus drivers must be alerted
- They must travel to the bus depot
- They must be briefed there and assigned to a route or facility

These activities consume time. Based on discussion with the offsite agencies, it is estimated that bus mobilization time will average approximately 90 minutes extending from the Advisory to Evacuate, to the time when buses first arrive at the facility to be evacuated.

During this mobilization period, other mobilization activities are taking place. One of these is the action taken by parents, neighbors, relatives and friends to pick up children from school prior to the arrival of buses, so that they may join their families. Virtually all studies of evacuations have concluded that this "bonding" process of uniting families is universally prevalent during emergencies and should be anticipated in the planning process. The current public information disseminated to residents of the River Bend Station EPZ indicates that schoolchildren will be evacuated to reception centers at emergency action levels of Site Area Emergency or higher, and that parents should pick schoolchildren up at the reception centers. As discussed in Section 2, this study assumes a fast breaking general emergency. Therefore, children are evacuated to the reception centers. Picking up children at school could add to traffic congestion at the schools, delaying the departure of the buses evacuating schoolchildren, which may have to return in a subsequent "wave" to the EPZ to evacuate the transit-dependent population. This report provides estimates of buses under the assumption that no children will be picked up by their parents (in accordance with NUREG/CR-7002), to present an upper bound estimate of buses required. Children at day-care centers will be transported to reception centers by daycares and will be picked up by parents or guardians at the reception center.

The procedure for computing transit-dependent ETE is to:

- Estimate demand for transit service
- Estimate time to perform all transit functions

- Estimate route travel times to the EPZ boundary and to the reception centers

8.1 Transit Dependent People Demand Estimate

The telephone survey (see Appendix F) results were used to estimate the portion of the population requiring transit service:

- Those persons in households that do not have a vehicle available.
- Those persons in households that do have vehicle(s) that would not be available at the time the evacuation is advised.

In the latter group, the vehicle(s) may be used by a commuter(s) who does not return (or is not expected to return) home to evacuate the household.

Table 8-1 presents estimates of transit-dependent people. Note:

- Estimates of persons requiring transit vehicles include schoolchildren. For those evacuation scenarios where children are at school when an evacuation is ordered, separate transportation is provided for the schoolchildren. The actual need for transit vehicles by residents is thereby less than the given estimates. However, estimates of transit vehicles are not reduced when schools are in session.
- It is reasonable and appropriate to consider that many transit-dependent persons will evacuate by ride-sharing with neighbors, friends or family. For example, nearly 80 percent of those who evacuated from Mississauga, Ontario who did not use their own cars, shared a ride with neighbors or friends. Other documents report that approximately 70 percent of transit dependent persons were evacuated via ride sharing. **We will adopt a conservative estimate that 50 percent of transit dependent persons will ride share, in accordance with NUREG/CR-7002.**

The estimated number of bus trips needed to service transit-dependent persons is based on an estimate of average bus occupancy of 30 persons at the conclusion of the bus run. Transit vehicle seating capacities typically equal or exceed 60 children on average (roughly equivalent to 40 adults). If transit vehicle evacuees are two thirds adults and one third children, then the number of "adult seats" taken by 30 persons is 20 + (2/3 x10) = 27. On this basis, the average load factor anticipated is (27/40) x 100 = 68 percent. Thus, if the actual demand for service exceeds the estimates of Table 8-1 by 50 percent, the demand for service can still be accommodated by the available bus seating capacity.

$$\left[20 + \left(\frac{2}{3} \times 10\right)\right] \div 40 \times 1.5 = 1.00$$

Table 8-1 indicates that transportation must be provided for 926 people. Therefore, a total of **31 bus runs** are required to transport this population to reception centers.

To illustrate this estimation procedure, we calculate the number of persons, P, requiring public transit or ride-share, and the number of buses, B, required for the River Bend Station EPZ:

$$P = No.\,of\ HH\ \times \sum_{i=0}^{n} \{(\%\ HH\ with\ i\ vehicles) \times [(Average\ HH\ Size) - i]\} \times A^i C^i$$

Where,

A = Percent of households with commuters

C = Percent of households who will not await the return of a commuter

$$P = 10{,}156 \times [0.068 \times 1.89 + 0.243 \times (1.77 - 1) \times 0.59 \times 0.36 + 0.448 \times (2.69 - 2) \times (0.59 \times 0.36)^2] = 10{,}156 \times 0.0912 = 1{,}851$$

$$B = (0.5 \times P) \div 30 = 31$$

These calculations are explained as follows:

- All members (1.89 avg.) of households (HH) with no vehicles (6.8%) will evacuate by public transit or ride-share. The term 10,156 (number of households) x 0.068 x 1.89, accounts for these people.
- The members of HH with 1 vehicle away (24.3%), who are at home, equal (1.77-1). The number of HH where the commuter will not return home is equal to (10,156 x 0.243 x 0.59 x 0.36), as 59% of EPZ households have a commuter, 36% of which would not return home in the event of an emergency. The number of persons who will evacuate by public transit or ride-share is equal to the product of these two terms.
- The members of HH with 2 vehicles that are away (44.8%), who are at home, equal (2.69 – 2). The number of HH where neither commuter will return home is equal to 10,156 x 0.448 x $(0.59 \times 0.36)^2$. The number of persons who will evacuate by public transit or ride-share is equal to the product of these two terms (the last term is squared to represent the probability that neither commuter will return).
- Households with 3 or more vehicles are assumed to have no need for transit vehicles.
- The total number of persons requiring public transit is the sum of such people in HH with no vehicles, or with 1 or 2 vehicles that are away from home.

The estimate of transit-dependent population in Table 8-1 far exceeds the number of registered transit-dependent persons in the EPZ as provided by the parishes (discussed below in Section 8.5). This is consistent with the findings of NUREG/CR-6953, Volume 2, in that a large majority of the transit-dependent population within the EPZs of U.S. nuclear plants does not register with their local emergency response agency.

8.2 School Population – Transit Demand

Table 8-2 presents the school population and transportation requirements for the direct evacuation of all schools within the EPZ for the 2011-2012 school year. This information was found within the RBS Data Resources Book provided. The column in Table 8-2 entitled "Buses Required" specifies the number of buses required for each school under the following set of assumptions and estimates:

- No students will be picked up by their parents prior to the arrival of the buses.
- While many high school students commute to school using private automobiles (as discussed in Section 2.4 of NUREG/CR-7002), the estimate of buses required for school evacuation do not consider the use of these private vehicles.
- Bus capacity, expressed in students per bus, is set to 60 for all buses as per the RBS Data Resources Book.
- Those staff members who do not accompany the students will evacuate in their private vehicles.
- No allowance is made for student absenteeism, typically 3 percent daily.

It is recommended that the parishes in the EPZ introduce procedures whereby the schools are contacted prior to the dispatch of buses from the depot, to ascertain the current estimate of students to be evacuated. In this way, the number of buses dispatched to the schools will reflect the actual number needed. The need for buses would be reduced by any high school students who have evacuated using private automobiles (if permitted by school authorities). Those buses originally allocated to evacuate schoolchildren that are not needed due to children being picked up by their parents, can be gainfully assigned to service other facilities or those persons who do not have access to private vehicles or to ride-sharing.

Table 8-3 presents a list of the school reception centers for each school in the EPZ. Students will be transported to these reception centers where they will be subsequently retrieved by their respective families. These reception centers also happen to be the same location as the general population reception centers.

8.3 Medical Facility Demand

Table 8-4 presents the census of medical facilities in the EPZ. 1,100 people have been identified as living in, or being treated in, these facilities. The capacity and current census for each facility was provided within the RBS Data Resources Book. This data includes the number of ambulatory, wheelchair-bound and bedridden patients at each facility.

The transportation requirements for the medical facility population are also presented in Table 8-4. The number of ambulance runs is determined by assuming that 2 patients can be accommodated per ambulance trip; the number of wheelchair bus runs assumes 15 wheelchairs per trip and the number of bus runs estimated assumes 30 ambulatory patients per trip.

8.4 Evacuation Time Estimates for Transit Dependent People

EPZ bus resources are assigned to evacuating schoolchildren (if school is in session at the time of the ATE) as the first priority in the event of an emergency. In the event that the allocation of buses dispatched from the depots to the various facilities and to the bus routes is somewhat "inefficient", or if there is a shortfall of available drivers, then there may be a need for some buses to return to the EPZ from the reception center after completing their first evacuation trip, to complete a "second wave" of providing transport service to evacuees. For this reason, the ETE for the transit-dependent population will be calculated for both a one wave transit evacuation and for two waves. Of course, if the impacted Evacuation Region is other than R03 (the entire EPZ), then there will likely be ample transit resources relative to demand in the impacted Region and this discussion of a second wave would likely not apply.

When school evacuation needs are satisfied, subsequent assignments of buses to service the transit-dependent should be sensitive to their mobilization time. Clearly, the buses should be dispatched after people have completed their mobilization activities and are in a position to board the buses when they arrive at the pick-up points.

Evacuation Time Estimates for transit trips were developed using both good weather and adverse weather conditions. Figure 8-1 presents the chronology of events relevant to transit operations. The elapsed time for each activity will now be discussed with reference to Figure 8-1.

Activity: Mobilize Drivers (A→B→C)

Mobilization is the elapsed time from the Advisory to Evacuate until the time the buses arrive at the facility to be evacuated. It is assumed that for a rapidly escalating radiological emergency with no observable indication before the fact, school bus drivers would likely require 90 minutes to be contacted, to travel to the depot, be briefed, and to travel to the transit-dependent facilities. Mobilization time is slightly longer in adverse weather – 100 minutes when raining.

Activity: Board Passengers (C→D)

Based on discussions with offsite agencies, a loading time of 15 minutes (20 minutes for rain) for school buses is used.

For multiple stops along a pick-up route (transit-dependent bus routes) estimation of travel time must allow for the delay associated with stopping and starting at each pick-up point. The time, t, required for a bus to decelerate at a rate, "a", expressed in ft/sec/sec, from a speed, "v", expressed in ft/sec, to a stop, is t = v/a. Assuming the same acceleration rate and final speed following the stop yields a total time, T, to service boarding passengers:

$$T = t + B + t = B + 2t = B + \frac{2v}{a},$$

Where B = Dwell time to service passengers. The total distance, "s" in feet, travelled during the deceleration and acceleration activities is: $s = v^2/a$. If the bus had not stopped to service passengers, but had continued to travel at speed, v, then its travel time over the distance, s,

would be: s/v = v/a. Then the total delay (i.e. pickup time, P) to service passengers is:

$$P = T - \frac{v}{a} = B + \frac{v}{a}$$

Assigning reasonable estimates:

- B = 50 seconds: a generous value for a single passenger, carrying personal items, to board per stop
- v = 25 mph = 37 ft/sec
- a = 4 ft/sec/sec, a moderate average rate

Then, P ≈ 1 minute per stop. Allowing 30 minutes pick-up time per bus run implies 30 stops per run, for good weather. It is assumed that bus acceleration and speed will be less in rain; total loading time is 40 minutes per bus in rain.

Activity: Travel to EPZ Boundary (D→E)

School Evacuation

Transportation resources available were provided by Entergy and the Parishes and are summarized in Table 8-5. Also included in the table are the number of buses needed to evacuate schools, medical facilities, transit-dependent population, homebound special needs (discussed below in Section 8.5) and correctional facilities (discussed below in Section 8.6). These numbers indicate there are sufficient resources available to evacuate everyone in a single wave.

The buses servicing the schools are ready to begin their evacuation trips at 105 minutes after the advisory to evacuate – 90 minutes mobilization time plus 15 minutes loading time – in good weather. The UNITES software discussed in Section 1.3 was used to define bus routes along the most likely path from a school being evacuated to the EPZ boundary, traveling toward the appropriate school reception center. This is done in UNITES by interactively selecting the series of nodes from the school to the EPZ boundary. Each bus route is given an identification number and is written to the DYNEV II input stream. DYNEV computes the route length and outputs the average speed for each 5 minute interval, for each bus route. The specified bus routes are documented in Table 8-6 (refer to the maps of the link-node analysis network in Appendix K for node locations). Data provided by DYNEV during the appropriate timeframe depending on the mobilization and loading times (i.e., 100 to 105 minutes after the advisory to evacuate for good weather) were used to compute the average speed for each route, as follows:

$$Average\ Speed\ \left(\frac{mi.}{hr}\right) = \left[\frac{\sum_{i-1}^{n} length\ of\ link\ i\ (mi)}{\sum_{i-1}^{n} Delay\ on\ link\ i\ (min.) + \frac{length\ of\ link\ i\ (mi.)}{current\ speed\ on\ link\ i\ \left(\frac{mi.}{hr.}\right)} \times \frac{60\ min.}{1\ hr.}}\right] \times \frac{60\ min.}{1\ hr.}$$

The average speed computed (using this methodology) for the buses servicing each of the schools in the EPZ is shown in Table 8-7 through Table 8-8 for school evacuation, and in Table 8-10 through Table 8-11 for the transit vehicles evacuating transit-dependent persons, which are discussed later. The travel time to the EPZ boundary was computed for each bus using the computed average speed and the distance to the EPZ boundary along the most likely route out of the EPZ. The travel time to the EPZ was capped using Louisiana State max bus speed in Table 8-7 and a 10% reduction for rain in Table 8-8 with speeds at 55 mph and 50 mph respectively. For Table 8-10 and Table 8-11 max speeds were also capped at 55 mph and 50 mph for good weather and rain for travel time to the EPZ boundary. The travel time from the EPZ boundary to the Reception Center was computed assuming an average speed of 45 mph, 40 mph for good weather and rain respectively.

Table 8-7 (good weather), Table 8-8 (rain) present the following evacuation time estimates (rounded up to the nearest 5 minutes) for schools in the EPZ: (1) The elapsed time from the Advisory to Evacuate until the bus exits the EPZ; and (2) The elapsed time until the bus reaches the Reception Center. The evacuation time out of the EPZ can be computed as the sum of times associated with Activities A→B→C, C→D, and D→E (For example: 90 min. + 15 + 23 = 2:10 for Jackson Public Schools with good weather). The evacuation time to the School Reception Center is determined by adding the time associated with Activity E→F (discussed below), to this EPZ evacuation time.

Evacuation of Transit-Dependent Population

The buses dispatched from the depots to service the transit-dependent evacuees will be scheduled so that they arrive at their respective routes after their passengers have completed their mobilization. As shown in Figure 5-4 (Residents with no Commuters), approximately 90 percent of the evacuees will complete their mobilization when the buses will begin their routes, 120 minutes after the Advisory to Evacuate. PAS 2 and 18 have high transit-dependent populations and require more buses than any other PAS (Table 8-9). As such, buses are separated into two routes. The start of service on these routes is separated by 15 minute headways, as shown in Table 8-10 and Table 8-11. The use of bus headways ensures that those people who take longer to mobilize will be picked up. Bus mobilization time is 10 minutes longer in rain to account for slower travel speeds and reduced roadway capacity.

Those buses servicing the transit-dependent evacuees will first travel along their pick-up routes,

then proceed out of the EPZ. The 11 bus routes shown graphically in Figure 8-2 and described in Table 8-9 were designed as part of this study to service the major routes through each PAS. It is assumed that residents will walk to and congregate at these pre-designated pick-up locations, and that they can arrive at the stops within the 120 minute bus mobilization time (good weather).

As previously discussed, a pickup time of 30 minutes (good weather) is estimated for 30 individual stops to pick up passengers, with an average of one minute of delay associated with each stop. A longer pickup time of 40 minutes is used for rain.

The travel distance along the respective pick-up routes within the EPZ is estimated using the UNITES software. Bus travel times within the EPZ are computed using average speeds computed by DYNEV, using the aforementioned methodology that was used for school evacuation.

Table 8-10 through Table 8-11 present the transit-dependent population evacuation time estimates for each bus route calculated using the above procedures for good weather and rain, respectively.

For example, the ETE for the bus route servicing PAS 1 is computed as 120 + 11 + 30 = 2:45 for good weather (rounded up to nearest 5 minutes). Here, 11 minutes is the time to travel 10.1 miles at 52.8 mph, the average speed output by the model for this route starting at 120 minutes. The ETE for a second wave (discussed below) is presented in the unlikely event there is a shortfall of available buses or bus drivers, as previously discussed.

Activity: Travel to Reception Centers (E→F)

The distances from the EPZ boundary to the reception centers are measured using GIS software along the most likely route from the EPZ exit point to the reception center. The reception centers are mapped in Figure 10-1. For a one-wave evacuation, this travel time outside the EPZ does not contribute to the ETE. For a two-wave evacuation, the ETE for buses must be considered separately, since it could exceed the ETE for the general population. Assumed bus speeds of 55 mph, 50 mph for good weather and rain respectively, will be applied for this activity for buses servicing the transit-dependent population.

Activity: Passengers Leave Bus (F→G)

A bus can empty within 5 minutes. The driver takes a 10 minute break.

Activity: Bus Returns to Route for Second Wave Evacuation (G→C)

Table 8-5 indicates that the total needs for Transit Dependent population is 31 buses. The parishes collectively can provide 684 buses. There are sufficient resources available to evacuate the transit dependent population in addition to the medical facilities and schools. A second wave is not needed.

Evacuation of Medical Facilities

The evacuation of these facilities is similar to school evacuation except:

- Buses are assigned on the basis of 30 patients to allow for staff to accompany the

patients. Wheelchair buses can accommodate 15 patients, wheelchair vans 4 patients and ambulances can accommodate 2 patients.

- Loading times of 1 minute, 5 minutes, and 15 minutes per patient are assumed for ambulatory patients, wheelchair bound patients, and bedridden patients, respectively.

Table 8-4 indicates that 37 bus runs, 9 wheelchair bus runs and 7 ambulance runs are needed to service all of the medical facilities in the EPZ. According to Table 8-5, the parishes can collectively provide 684 buses, 9 vans, 37 wheel-chair accessible buses, 3 wheelchair accessible vans and 28 ambulances. All transportation resources provided by Entergy and the parishes have been accounted for; there are sufficient transportation resources to evacuate the population of all medical facilities in one wave.

As is done for the schools, it is estimated that mobilization time averages 90 minutes. Specially trained medical support staff (working their regular shift) will be on site to assist in the evacuation of patients. Additional staff (if needed) could be mobilized over this same 90 minute timeframe.

Table 8-12 and Table 8-13 summarize the ETE for medical facilities within the EPZ for good weather and rain. Average speeds output by the model for Scenario 6 (Scenario 7 for rain) Region 3, capped at 55 mph (50 mph for rain), are used to compute travel time to EPZ boundary. The travel time to the EPZ boundary is computed by dividing the distance to the EPZ boundary by the average travel speed. The ETE is the sum of the mobilization time, total passenger loading time, and travel time out of the EPZ. Concurrent loading on multiple buses, wheelchair buses/vans, and ambulances at capacity is assumed such that the maximum loading times for buses, wheelchair buses and ambulances are 30, 75 and 30 minutes, respectively. All ETE are rounded to the nearest 5 minutes. For example, the calculation of ETE for the Feliciana Dialysis Center with 48 ambulatory residents during good weather is:

ETE: 90 + 30 (max. per bus) x 1 + 15 = 135 min. or 2:15 rounded to the nearest 5 minutes.

It is assumed that medical facility population is directly evacuated to appropriate host medical facilities. Relocation of this population to permanent facilities and/or passing through the reception center before arriving at the host facility are not considered in this analysis.

8.5 Special Needs Population

The River Bend Data Resources Book has combined registration for transit-dependent and homebound special needs persons. Based on data provided by this book, there are an estimated 4 homebound special needs people within the West Feliciana Parish portion of the EPZ and 4 people within the Pointe Coupee Parish portion of the EPZ that require transportation assistance to evacuate. These people all require wheelchair accessible vehicles. The RBS Data Resources Book also lists transit dependent population that has registered, but do not require additional resources such as ambulances or wheelchair accessible vehicles. These people have been included within the general transit dependent population discussed in

Section 8.4 .

ETE for Homebound Special Needs Persons

Table 8-14 summarizes the ETE for homebound special needs people. The table is categorized by type of vehicle required and then broken down by weather condition. The table takes into consideration the deployment of multiple vehicles to reduce the number of stops per vehicle. It is conservatively assumed that wheelchair bound special needs households are spaced 3 miles apart. Van speeds approximate 20 mph between households (10% slower in rain). Mobilization times of 90 minutes were used (100 minutes for rain). The last HH is assumed to be 5 miles from the EPZ boundary, and the network-wide average speed, capped at 55 mph (50 mph for rain), after the last pickup is used to compute travel time. ETE is computed by summing mobilization time, loading time at first household, travel to subsequent households, loading time at subsequent households, and travel time to EPZ boundary. All ETE are rounded to the nearest 5 minutes.

For example, assuming no more than one special needs person per HH implies that 8 households need to be serviced. While only 1 buses or 2 wheelchair vans are needed from a capacity perspective, if 4 vehicles are deployed to service these special needs HH, then each would require 2 stops. The following outlines the ETE calculations:

1. Assume 4 wheel chair vans are deployed, each with 2 stops, to service a total of 8 HH.
2. The ETE is calculated as follows:
    a. Vans arrive at the first pickup location: 90 minutes
    b. Load HH members at first pickup: 5 minutes
    c. Travel to subsequent pickup locations: 1 @ 9 minutes = 9 minutes
    d. Load HH members at subsequent pickup locations: 1 @ 5 minutes = 5 minutes
    e. Travel to EPZ boundary: 8 minutes (5 miles @ 39.3 mph).

ETE: 90 + 5 + 9 + 5 + 8 = 2:00 rounded to the nearest 5 minutes

8.6 Correctional Facilities

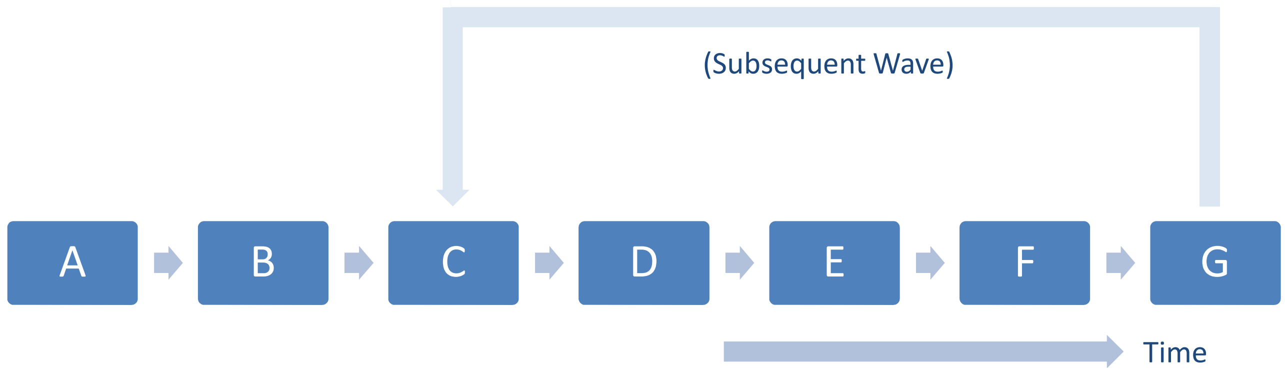
As detailed in Table E-8, there are four correctional facilities within the EPZ – Dixon Correctional Institute, Pointe Coupee Detention Center, West Feliciana Parish Jail and Prison Enterprises Wakefield Plant. The total inmate population at these facilities is 1,621 persons. A total of 52 buses are needed to evacuate these facilities and 1 van for the Wakefield Plant, based on a capacity of 30 inmates per bus. Mobilization time is assumed to be 90 minutes (100 minutes in rain). It is estimated that it takes 60 minutes to load the inmates onto a bus. The detailed evacuation plans for these facilities were not provided. For Point Coupee Detention Center, using GIS software, the shortest route from the facility to the EPZ boundary, traveling away from the plant, is 8.6 miles. The travel time to traverse 8.6 miles is 11 minutes (46.4 mph at 2:30 after the ATE) in good weather, 12 minutes (41.9 mph at 2:40) in rain. All ETE are rounded to the nearest 5 minutes.

Table 8-15. Correctional Facility Evacuation Time Estimates ETE:

Good Weather ETE: 90 + 60 + 11 = 2:45

Rain ETE: 100 + 60 + 12 = 2:55

Table 8-15 provides ETE estimates for each of the correctional facilities.



	Event
A	Advisory to Evacuate
B	Bus Dispatched from Depot
C	Bus Arrives at Facility/Pick-up Route
D	Bus Departs for Reception Center
E	Bus Exits Region
F	Bus Arrives at Reception Center/Host Facility
G	Bus Available for "Second Wave" Evacuation Service
	Activity
A→B	Driver Mobilization
B→C	Travel to Facility or to Pick-up Route
C→D	Passengers Board the Bus
D→E	Bus Travels Towards Region Boundary
E→F	Bus Travels Towards Reception Center Outside the EPZ
F→G	Passengers Leave Bus; Driver Takes a Break

Figure 8-1. Chronology of Transit Evacuation Operations

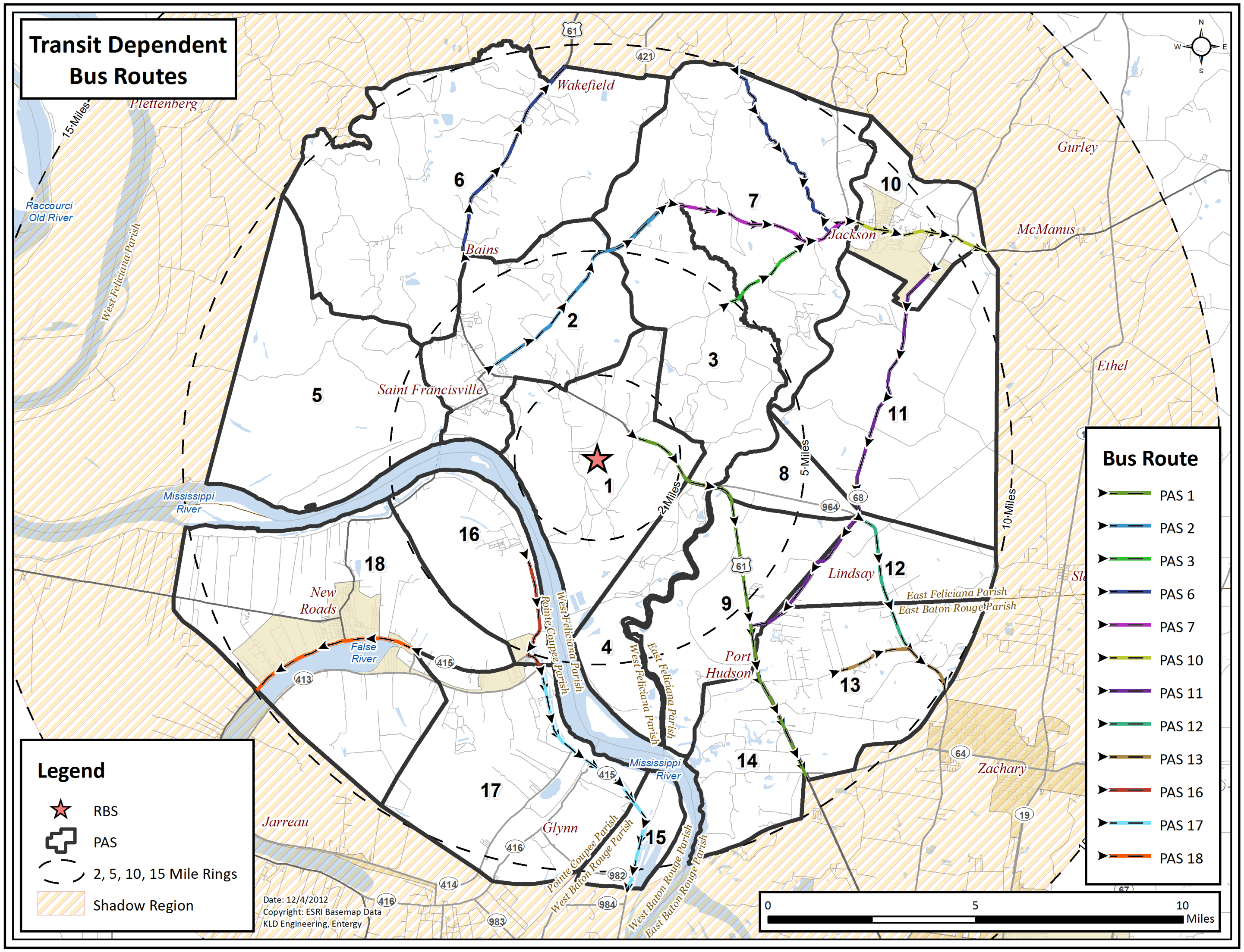


Figure 8-2. Transit-Dependent Bus Routes

Table 8-1. Transit-Dependent Population Estimates

2010 EPZ Population	Survey Average HH Size with Indicated No. of Vehicles			Estimated No. of Households	Survey Percent HH with Indicated No. of Vehicles			Survey Percent HH with Commuters	Survey Percent HH with Non-Returning Commuters	Total People Requiring Transport	Estimated Ridesharing Percentage	People Requiring Public Transit	Percent Population Requiring Public Transit
	0	1	2		0	1	2						
25,592	1.89	1.77	2.69	10,156	6.80%	24.3%	44.8%	59%	36%	1,851	50%	926	3.6%

Table 8-2. School Population Demand Estimates

PAS	School Name	Enrollment	Buses Required
EAST BATON ROUGE, LA			
14	Port Hudson Career Academy	125	3
EAST FELICIANA, LA			
10	Jackson Public Schools	911	17
10	Louisiana Technical College- Folkes Campus[1]	80	0
10	Quad Area-Jackson Head Start	97	2
POINTE COUPEE, LA			
17	Rougon Elementary School	406	7
18	Catholic Schools - New Roads	679	12
18	Christian Women Caring for Children	26	1
18	False River Academy	583	10
18	Kid D Land Daycare & Learning	31	1
18	Louisiana Technical College- Jumonville Campus[1]	140	0
18	Mae Mae's Playhouse and Preschool	60	1
18	New Roads Kiddie College	57	1
18	Rosenwald Elementary School	475	8
WEST FELICIANA, LA			
2	Bains Elementary School	619	11
2	Bains Lower Elementary	534	9
2	Chase Ministries	28	2
2	First Step Day Care & Learning Center	75	2
2	Grace Preschool	35	1
2	In the Beginning Child Development Center	56	2
2	West Feliciana High School	653	11
2	West Feliciana Middle School	575	10
6	Girl Scout Camp Marydale	263	5
	TOTAL:	**6,508**	**116**

[1] Louisiana Technical College does not evacuate by bus. Student vehicles were loaded with schools, but as individual vehicles.

Table 8-3. School Reception Centers

School	Reception Center
EAST BATON ROUGE, LA	
Port Hudson Career Academy	BATON ROUGE RIVER CENTER
EAST FELICIANA, LA	
Jackson Public Schools	BATON ROUGE RIVER CENTER
Louisiana Technical College- Folkes Campus	
Quad Area-Jackson Head Start	
POINTE COUPEE, LA	
Catholic Schools - New Roads	LSU FIELDHOUSE
Christian Women Caring for Children	
False River Academy	
Kid D Land Daycare & Learning	
Louisiana Technical College- Jumonville Campus	
Mae Mae's Playhouse and Preschool	
New Roads Kiddie College	
Rosenwald Elementary School	
Rougon Elementary School	
WEST FELICIANA, LA	
Bains Elementary School	BATON ROUGE RIVER CENTER
Bains Lower Elementary	
Girl Scout Camp Marydale	
Chase Ministries	
First Step Day Care & Learning Center	
Grace Preschool	
In the Beginning Child Development Center	
West Feliciana High School	
West Feliciana Middle School	

Table 8-4. Medical Facility Transit Demand

PAS	Facility Name	Municipality	Current Census	Ambu-latory	Wheel-chair Bound	Bed-ridden	Bus Runs	Wheel-chair Bus Runs	Ambulance
EAST FELICIANA MEDICAL FACILITIES									
10	Feliciana Dialysis Center	Jackson	48	48	0	0	2	0	0
10	East Louisiana State Hospital	Jackson	591	591	0	0	20	0	0
10	Jackson Special Hospital	Jackson	45	45	0	0	2	0	0
		East Feliciana Parish Subtotal:	***684***	***684***	***0***	***0***	***24***	***0***	***0***
POINTE COUPEE MEDICAL FACILITIES									
18	Pointe Coupee Healthcare	New Roads	78	27	48	3	1	4	2
18	Pointe Coupee General Hospital	New Roads	27	14	13	0	1	1	0
18	False River Manor Apartments	New Roads	40	40	0	0	2	0	0
18	Lakeview Manor Nursing Home	New Roads	100	50	40	10	2	3	5
18	New Roads Manor Apartments	New Roads	32	32	0	0	2	0	0
		Pointe Coupee Parish Subtotal:	***277***	***163***	***101***	***13***	***8***	***8***	***7***
WEST FELCIANA MEDICAL FACILITIES									
2	West Feliciana Parish Hospital	St. Francisville	15	15	0	0	1	0	0
3	St. Francisville Country Manor	St. Francisville	124	111	13	0	4	1	0
		West Feliciana Parish Subtotal:	***139***	***126***	***13***	***0***	***5***	***1***	***0***
		TOTAL:	**1,100**	**973**	**114**	**13**	**37**	**9**	**7**

Table 8-5. Summary of Transportation Resources

Transportation Resource	Buses	Vans	Wheelchair Buses	Wheelchair Vans	Ambulances
Resources Available					
West Feliciana EMS	-	-	-	-	3
West Feliciana Parish	27	-	-	-	-
West Baton Rouge Parish	42	-	2	-	-
East Baton Rouge Parish	510	-	30	-	-
East Feliciana Parish	36	-	-	-	-
East Feliciana Parish Council on Aging	-	9	-	3	-
Point Coupee Parish	69	-	5	-	-
Acadian	-	-	-	-	25
TOTAL:	**684**	**9**	**37**	**3**	**28**
Resources Needed					
Schools (Table 8-2):	116	0	0	0	0
Medical Facilities (Table 8-4):	37	0	9	0	7
Transit-Dependent Population (Table 8-10):	31	0	0	0	0
Homebound Special Needs (Section 8.5):	0	0	0	4	0
Correctional Facilities (Section 8.6):	52	1	0	0	0
TOTAL TRANSPORTATION NEEDS:	**236**	**1**	**9**	**4**	**7**

Table 8-6. Bus Route Descriptions

Bus Route Number	Description	Nodes Traversed from Route Start to EPZ Boundary
1	New Roads Facilities on Hospital Rd/HWY 1	500, 378, 380
2	Pointe Coupee Healthcare, Pointe Coupee Hospital	376, 378, 380
3	West Feliciana Parish Hospital	6, 563, 7, 55, 63, 64, 65, 66, 182, 75, 76, 79, 83, 84, 85, 86, 88, 89, 90, 91, 92, 93, 104, 105, 106, 107, 144
4	St. Francisville County Manor	76, 79, 83, 84, 85, 86, 88, 89, 90, 91, 92, 93, 104, 105, 106, 107, 144
5	Jackson Medical Facilities, West Feliciana Dialysis Center	93, 104, 105, 106, 107, 144
6	Quad - Jackson Head Start	94, 93, 104, 105, 106, 107, 144
7	Beginning Child Development Center	63, 64, 65, 66, 182, 75, 76, 79, 83, 84, 85, 86, 88, 89, 90, 91, 92, 93, 104, 105, 106, 107, 144
8	First Step Daycare	492, 7, 55, 63, 64, 65, 66, 182, 75, 76, 79, 83, 84, 85, 86, 88, 89, 90, 91, 92, 93, 104, 105, 106, 107, 144
9	Chase Ministries Grace Preschool	487, 492, 7, 55, 63, 64, 65, 66, 182, 75, 76, 79, 83, 84, 85, 86, 88, 89, 90, 91, 92, 93, 104, 105, 106, 107, 144
10	New Roads Kiddie College	464, 467, 367, 368, 376, 378, 380
11	Catholic Elementary, Middle and High Schools	368, 376, 378, 380
12	Rosenwald Elementary	463, 464, 467, 367, 368, 376, 378, 380
13	Port Hudson Career Academy	216, 217, 218
14	West Feliciana Middle and High Schools, Bains Elementary and Lower Elementary Schools	74, 73, 72, 71, 70, 69, 68, 182, 75, 76, 79, 83, 84, 85, 86, 88, 89, 90, 91, 92, 93, 104, 105, 106, 107, 144
15	Transit Dependent Route PAS 1	2, 134, 133, 131, 605, 130, 129, 206, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218
19	Transit Dependent Route PAS 13	231, 232, 233, 234, 244, 245
20	Transit Dependent Route PAS 12	124, 235, 236, 237, 238, 239, 234, 244, 245, 246
21	Transit Dependent Route PAS 11	117, 116, 109, 107, 144
22	Transit Dependent Route PAS 3	151, 150, 149, 148, 147, 86, 88, 89, 90, 91, 92, 93, 104, 105, 106, 107, 144

Bus Route Number	Description	Nodes Traversed from Route Start to EPZ Boundary
23	Transit Dependent Route PAS 2	7, 55, 63, 64, 65, 66, 182, 75, 76, 79, 83, 84, 85, 86, 88, 89, 90, 91, 92, 93, 104, 105, 106, 107, 144
25	Transit Dependent Route PAS 16	340, 343, 344, 345, 346, 431, 430, 428, 427, 426, 425, 542, 543, 564
26	Transit Dependent Route PAS 17	431, 430, 428, 427, 426, 425, 542, 543, 564
27	Transit Dependent Route PAS 18	357, 358, 661, 366, 367, 368, 376, 378, 380
28	West Feliciana Parish Jail	488, 487, 492, 7, 55, 63, 64, 65, 66, 182, 75, 76, 79, 83, 84, 85, 86, 88, 89, 90, 91, 92, 93, 104, 105, 106, 107, 144
29	Transit Dependent Route PAS 10	91, 92, 93, 104, 105, 106, 107, 144
30	Pointe Coupee Detention Center	336, 337, 338, 339, 340, 343, 344, 345, 346, 431, 430, 428, 427, 426, 425, 424, 423, 422, 421, 420, 419, 418, 416, 415, 414, 413, 412, 504, 526
31	Dixon Correctional Facility	117, 116, 109, 107, 144117, 136, 118, 119, 120, 123, 184, 124, 235, 236, 254, 580
32	Transit Dependent Route PAS 7	76, 79, 83, 84, 85, 86, 88, 89, 90, 91, 92, 93, 104, 105, 106, 107, 144
33	Transit Dependent Route - PAS 6, Girl Scout Camp Marydale	12, 30, 32, 33, 37, 40, 47, 497, 498, 13, 499, 523, 496, 15, 17, 27, 31, 495, 494, 90, 91, 92, 93, 104, 105, 106, 107, 144
36	East Louisiana State Hospital	135, 110, 109, 116, 117, 136, 118, 119, 120, 123, 184, 124, 235, 236, 254, 580

Table 8-7. School Evacuation Time Estimates - Good Weather

School	Driver Mobilization Time (min)	Loading Time (min)	Dist. To EPZ Bdry (mi)	Average Speed (mph)	Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bdry to R.C. (mi.)	Travel Time from EPZ Bdry to R.C. (min)	ETE to R.C. (hr:min)
EAST BATON ROUGE, LA									
Port Hudson Career Academy	90	15	2.2	55.0	3	**1:50**	17.3	19	**2:10**
EAST FELICIANA, LA									
Jackson Public Schools	90	15	3.5	9.3	23	**2:10**	33.3	37	**2:45**
Quad Area-Jackson Head Start	90	15	3.2	9.7	20	**2:05**	33.3	37	**2:45**
POINTE COUPEE, LA									
Catholic Schools - New Roads	90	15	1.8	39.7	3	**1:50**	34.1	38	**2:30**
Christian Women Caring for Children	90	15	1.1	34.5	2	**1:50**	41.2	45	**2:35**
False River Academy	90	15	1.3	39.7	2	**1:50**	34.1	38	**2:25**
Kid D Land Daycare & Learning	90	15	1.2	34.5	3	**1:50**	41.2	45	**2:35**
Mae Mae's Playhouse and Preschool	90	15	1.3	34.5	3	**1:50**	41.2	45	**2:35**
New Roads Kiddie College	90	15	3.0	34.0	6	**1:55**	34.1	38	**2:30**
Rosenwald Elementary School	90	15	3.3	35.9	6	**1:55**	34.1	38	**2:30**
Rougon Elementary School*	90	15	0.1	37.3	1	**1:50**	34.1	38	**2:25**
WEST FELICIANA, LA									
Bains Elementary School	90	15	14.0	7.6	111	**3:40**	33.3	37	**4:15**
Bains Lower Elementary	90	15	14.0	7.6	111	**3:40**	33.3	37	**4:15**
Chase Ministries	90	15	15.7	8.2	116	**3:45**	33.3	37	**4:20**
First Step Day Care & Learning Center	90	15	14.6	8.0	110	**3:35**	33.3	37	**4:15**
Grace Preschool	90	15	15.3	8.2	113	**3:40**	33.3	37	**4:15**
In the Beginning Child Development Center	90	15	12.8	7.4	104	**3:30**	33.3	37	**4:10**
West Feliciana High School	90	15	14.4	7.6	122	**3:50**	33.3	37	**4:25**
West Feliciana Middle School	90	15	14.4	7.1	122	**3:50**	33.3	37	**4:25**
Girl Scout Camp Marydale	90	15	24.6	24.5	61	**2:50**	33.3	37	**3:25**
					Maximum for EPZ:	**3:50**		**Maximum:**	**4:25**
					Average for EPZ:	**2:40**		**Average:**	**3:20**

Table 8-8. School Evacuation Time Estimates - Rain

School	Driver Mobilization Time (min)	Loading Time (min)	Dist. To EPZ Bdry (mi)	Average Speed (mph)	Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bdry to R.C. (mi.)	Travel Time from EPZ Bdry to R.C. (min)	ETE to R.C. (hr:min)
EAST BATON ROUGE, LA									
Port Hudson Career Academy	100	20	2.2	50.0	3	**2:05**	17.3	21	**2:25**
EAST FELICIANA, LA									
Jackson Public Schools	100	20	3.5	9.0	24	**2:25**	33.3	40	**3:05**
Quad Area-Jackson Head Start	100	20	3.2	9.7	20	**2:20**	33.3	40	**3:00**
POINTE COUPEE, LA									
Catholic Schools - New Roads	100	20	1.8	33.7	4	**2:05**	34.1	41	**2:45**
Christian Women Caring for Children	100	20	1.1	35.3	2	**2:05**	41.2	50	**2:55**
False River Academy	100	20	1.3	33.7	3	**2:05**	34.1	41	**2:45**
Kid D Land Daycare & Learning	100	20	1.2	35.3	3	**2:05**	41.2	50	**2:55**
Mae Mae's Playhouse and Preschool	100	20	1.3	35.3	3	**2:05**	41.2	50	**2:55**
New Roads Kiddie College	100	20	3.0	30.6	6	**2:10**	34.1	41	**2:50**
Rosenwald Elementary School	100	20	3.3	32.4	7	**2:10**	34.1	41	**2:50**
Rougon Elementary School	100	20	0.1	32.4	1	**2:05**	34.1	41	**2:45**
WEST FELICIANA, LA									
Bains Elementary School	100	20	14.0	7.1	118	**4:00**	33.3	40	**4:40**
Bains Lower Elementary	100	20	14.0	7.1	118	**4:00**	33.3	40	**4:40**
Chase Ministries	100	20	15.7	7.5	125	**4:05**	33.3	40	**4:45**
First Step Day Care & Learning Center	100	20	14.6	7.4	119	**4:00**	33.3	40	**4:40**
Grace Preschool	100	20	15.3	7.5	122	**4:05**	33.3	40	**4:45**
In the Beginning Child Development Center	100	20	12.8	6.9	112	**3:55**	33.3	40	**4:35**
West Feliciana High School	100	20	14.4	7.1	122	**4:05**	33.3	40	**4:45**
West Feliciana Middle School	100	20	14.4	7.1	122	**4:05**	33.3	40	**4:45**
Girl Scout Camp Marydale	100	20	24.6	21.8	68	**3:10**	33.3	40	**3:50**
					Maximum for EPZ:	**4:05**		**Maximum:**	**4:45**
					Average for EPZ:	**3:00**		**Average:**	**3:40**

Table 8-9. Summary of Transit-Dependent Bus Routes

Route	No. of Buses	Route Description	Length (mi.)
15	1	Servicing Hwy 61 southbound from PAS 1 to the EPZ Boundary.	10.1
19	3	Servicing PAS 13 and western Zachary making stops along SR 946 towards the EPZ boundary.	3.3
20	1	Servicing PAS 12 and the north western portion of Zachary making stops along 964.	4.9
21	2	Servicing PAS 11 southbound on SR 68.	14.2
22	1	Servicing PAS 3 along SR 965 eastbound towards Jackson until the EPZ boundary.	7.2
23	4	Commencing in PAS 2 in St. Francisville making stops along the major evacuation route Hwy 10 towards Jackson.	14.2
26	2	Servicing PAS 17 outside of New Roads, LA making stops along SR 414 and SR 415 towards Baton Rouge.	6.3
27	10	Servicing the town of New Roads (PAS 18) along Hwy 1 southbound.	4.3
29	3	Servicing the town of Jackson along Hwy 10 to the EPZ Boundary.	3.5
32	1	Servicing PAS 7 along Hwy 10 to the EPZ Boundary.	8.1
33	3	Commencing north of St. Francisville in PAS 6 along Hwy 61 northbound to 421 eastbound, then southbound back through Jackson.	24.6
Total:	**31**		

Table 8-10. Transit-Dependent Evacuation Time Estimates - Good Weather

		One-Wave							Two-Wave					
Route Number	Bus Number	Mobilization (min)	Route Length (miles)	Speed (mph)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)	Distance to R. C. (miles)	Travel Time to R. C. (min)	Unload (min)	Driver Rest (min)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)
1	1	120	10.1	52.8	11	30	**2:45**	17.3	23	5	10	48	30	**4:45**
2	2	120	3.3	48.9	4	30	**2:35**	19.5	26	5	10	34	30	**4:25**
	1	135	3.3	50.2	4	30	**2:50**	19.5	26	5	10	34	30	**4:40**
3	1	120	4.9	54.6	5	30	**2:40**	19.5	26	5	10	38	30	**4:30**
4	1	120	14.4	42.2	20	30	**2:55**	17.3	23	5	10	60	30	**5:05**
	1	135	14.4	47.4	18	30	**3:05**	17.3	23	5	10	60	30	**5:15**
5	1	120	7.2	9.2	47	30	**3:20**	33.3	44	5	10	63	30	**5:55**
6	2	120	14.2	8.6	99	30	**4:10**	33.3	44	5	10	83	30	**7:05**
	2	135	14.2	9.6	88	30	**4:15**	33.3	44	5	10	83	30	**7:10**
7	1	120	6.3	54.7	7	30	**2:40**	23.9	32	5	10	47	30	**4:45**
	1	135	6.3	54.5	7	30	**2:55**	23.9	32	5	10	47	30	**5:00**
8	4	120	4.3	33.4	8	30	**2:40**	33.3	44	5	10	58	30	**5:10**
	4	135	4.3	33.1	8	30	**2:55**	33.3	44	5	10	58	30	**5:25**
	2	150	4.3	33.5	8	30	**3:10**	33.3	44	5	10	57	30	**5:40**
9	3	120	3.5	10.8	19	30	**2:50**	33.3	44	5	10	55	30	**5:15**
10	1	120	8.1	5.8	84	30	**3:55**	33.3	44	5	10	66	30	**6:35**
11	2	120	24.6	26.2	56	30	**3:30**	33.3	44	5	10	110	30	**6:50**
	1	135	24.6	26.8	55	30	**3:45**	33.3	44	5	10	110	30	**7:05**
						Maximum ETE:	**4:15**						**Maximum ETE:**	**7:10**
						Average ETE:	**3:10**						**Average ETE:**	**5:35**

Table 8-11. Transit-Dependent Evacuation Time Estimates - Rain

Route Number	Bus Number	One-Wave						Two-Wave							
		Mobilization (min)	Route Length (miles)	Speed (mph)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)	Distance to R. C. (miles)	Travel Time to R. C. (min)	Unload (min)	Driver Rest (min)	Route Travel Time (min)	Pickup Time (min)	ETE (hr:min)
1	1	130	10.1	48.2	13	40	**3:05**	17.3	26	5	10	54	40	**5:20**
2	2	130	3.3	43.8	5	40	**2:55**	19.5	29	5	10	38	40	**5:00**
	1	145	3.3	47.0	4	40	**3:10**	19.5	29	5	10	38	40	**5:15**
3	1	130	4.9	47.9	6	40	**3:00**	19.5	29	5	10	42	40	**5:10**
4	1	130	14.4	41.3	21	40	**3:15**	17.3	26	5	10	67	40	**5:45**
	1	145	14.4	43.8	20	40	**3:25**	17.3	26	5	10	67	40	**5:55**
5	1	130	7.2	7.8	56	40	**3:50**	33.3	50	5	10	71	40	**6:50**
6	2	130	14.2	7.7	111	40	**4:45**	33.3	50	5	10	92	40	**8:05**
	2	145	14.2	8.9	95	40	**4:45**	33.3	50	5	10	92	40	**8:05**
7	1	130	6.3	49.7	8	40	**3:00**	23.9	36	5	10	53	40	**5:25**
	1	145	6.3	49.5	8	40	**3:15**	23.9	36	5	10	53	40	**5:40**
8	4	130	4.3	30.4	8	40	**3:00**	33.3	50	5	10	64	40	**5:50**
	4	145	4.3	30.5	8	40	**3:15**	33.3	50	5	10	64	40	**6:05**
	2	160	4.3	30.5	8	40	**3:30**	33.3	50	5	10	64	40	**6:20**
9	3	130	3.5	10.3	20	40	**3:15**	33.3	50	5	10	61	40	**6:05**
10	1	130	8.1	5.2	94	40	**4:25**	33.3	50	5	10	74	40	**7:25**
11	2	130	24.6	22.7	65	40	**3:55**	33.3	50	5	10	123	40	**7:45**
	1	145	24.6	23.8	62	40	**4:10**	33.3	50	5	10	124	40	**8:00**
						Maximum ETE:	**4:45**						**Maximum ETE:**	**8:05**
						Average ETE:	**3:35**						**Average ETE:**	**6:20**

Table 8-12. Medical Facility Evacuation Time Estimates - Good Weather

Medical Facility	Patient	Mobilization (min)	Loading Rate (min per person)	People	Total Loading Time (min)	Dist. To EPZ Bdry (mi)	Travel Time to EPZ Boundary (min)	ETE (hr:min)
EAST FELICIANA, LA								
Feliciana Dialysis Center	Ambulatory	90	1	48	30	2.9	15	**2:15**
East Louisiana State Hospital	Ambulatory	90	1	591	30	15.2	79	**3:20**
Jackson Special Hospital	Ambulatory	90	1	45	30	2.9	15	**2:15**
POINTE COUPEE, LA								
Pointe Coupee Healthcare	Ambulatory	90	1	27	27	1.2	2	**2:00**
	Wheelchair bound	90	5	48	75	1.2	2	**2:50**
	Bedridden	90	15	3	30	1.2	2	**2:05**
Pointe Coupee General Hospital	Ambulatory	90	1	14	14	0.7	1	**1:45**
	Wheelchair bound	90	5	13	65	0.7	1	**2:40**
False River Manor Apartments	Ambulatory	90	1	40	30	1.0	2	**2:05**
Lakeview Manor Nursing Home	Ambulatory	90	1	50	30	1.0	2	**2:05**
	Wheelchair bound	90	5	40	75	1.0	2	**2:50**
	Bedridden	90	15	10	30	1.0	2	**2:05**
New Roads Manor Apartments	Ambulatory	90	1	32	30	1.5	2	**2:05**
WEST FELICIANA, LA								
West Feliciana Parish Hospital	Ambulatory	90	1	15	15	13.4	105	**3:30**
St. Francisville Country Manor	Ambulatory	90	1	111	30	8.1	84	**3:25**
	Wheelchair bound	90	5	13	65	8.1	59	**3:35**
							Maximum ETE:	**3:35**
							Average ETE:	**2:25**

Table 8-13. Medical Facility Evacuation Time Estimates – Rain

Medical Facility	Patient	Mobilization (min)	Loading Rate (min per person)	People	Total Loading Time (min)	Dist. To EPZ Bdry (mi)	Travel Time to EPZ Boundary (min)	ETE (hr:min)
EAST FELICIANA, LA								
Feliciana Dialysis Center	Ambulatory	100	1	48	30	2.9	14	**2:25**
East Louisiana State Hospital	Ambulatory	100	1	591	30	15.2	89	**3:40**
Jackson Special Hospital	Ambulatory	100	1	45	30	2.9	14	**2:25**
POINTE COUPEE, LA								
Pointe Coupee Healthcare	Ambulatory	100	1	27	27	1.2	2	**2:10**
	Wheelchair bound	100	5	48	75	1.2	2	**3:00**
	Bedridden	100	15	3	30	1.2	2	**2:15**
Pointe Coupee General Hospital	Ambulatory	100	1	14	14	0.7	1	**1:55**
	Wheelchair bound	100	5	13	65	0.7	1	**2:50**
False River Manor Apartments	Ambulatory	100	1	40	30	1.0	2	**2:15**
Lakeview Manor Nursing Home	Ambulatory	100	1	50	30	1.0	2	**2:15**
	Wheelchair bound	100	5	40	75	1.0	2	**3:00**
	Bedridden	100	15	10	30	1.0	2	**2:15**
New Roads Manor Apartments	Ambulatory	100	1	32	30	1.5	3	**2:15**
WEST FELICIANA, LA								
West Feliciana Parish Hospital	Ambulatory	100	1	15	15	13.4	116	**3:55**
St. Francisville Country Manor	Ambulatory	100	1	111	30	8.1	94	**3:45**
	Wheelchair bound	100	5	13	65	8.1	69	**3:55**
							Maximum ETE:	**3:55**
							Average ETE:	**2:40**

Table 8-14. Homebound Special Needs Population Evacuation Time Estimates

Vehicle Type	People Requiring Vehicle	Vehicles deployed	Stops	Weather Conditions	Mobilization Time	Loading Time at 1st Stop	Travel to Subsequent Stops	Total Loading Time at Subsequent Stops	Travel Time to EPZ Boundary	ETE
Wheelchair Vans	8	4	2	Normal	90	5	9	5	8	**2:00**
				Rain	100		10		9	**2:10**

Table 8-15. Correctional Facility Evacuation Time Estimates

Correctional Facility	Weather Conditions	Mobilization (min)	Number of Buses	Loading Rate (min per person)	Number of Inmates	Total Loading Time (min)	Dist. To EPZ Bdry (mi)	Travel Time to EPZ Boundary (min)	ETE (hr:min)
Dixon Correctional Facility	Normal	90	49	2	1,470	60	14.40	18	**2:50**
	Rain	100						20	**3:00**
West Feliciana Parish Jail	Normal	90	1	2	44	60	15.8	76	**3:50**
	Rain	100						89	**4:10**
Pointe Coupee Detention Center	Normal	90	2	2	100	60	8.6	11	**2:45**
	Rain	100						12	**2:55**
								Maximum ETE:	**4:10**
								Average ETE:	**3:15**

The Wakefield Plant using 1 van is not included in this table

9 TRAFFIC MANAGEMENT STRATEGY

This section discusses the suggested traffic control and management strategy that is designed to expedite the movement of evacuating traffic. The resources required to implement this strategy include:

- Personnel with the capabilities of performing the planned control functions of traffic guides (preferably, not necessarily, law enforcement officers).
- Traffic Control Devices to assist these personnel in the performance of their tasks. These devices should comply with the guidance of the Manual of Uniform Traffic Control Devices (MUTCD) published by the Federal Highway Administration (FHWA) of the U.S.D.O.T. All state and most parish transportation agencies have access to the MUTCD, which is available on-line: http://mutcd.fhwa.dot.gov which provides access to the official PDF version.
- A plan that defines all locations, provides necessary details and is documented in a format that is readily understood by those assigned to perform traffic control.

The functions to be performed in the field are:

1. Facilitate evacuating traffic movements that safely expedite travel out of the EPZ.
2. Discourage traffic movements that move evacuating vehicles in a direction which takes them significantly closer to the power plant, or which interferes with the efficient flow of other evacuees.

The terms "facilitate" and "discourage" are employed rather than "enforce" and "prohibit" to indicate the need for flexibility in performing the traffic control function. There are always legitimate reasons for a driver to prefer a direction other than that indicated. For example:

- A driver may be traveling home from work or from another location, to join other family members prior to evacuating.
- An evacuating driver may be travelling to pick up a relative, or other evacuees.
- The driver may be an emergency worker en route to perform an important activity.

The implementation of a plan must also be flexible enough for the application of sound judgment by the traffic guide.

The traffic management plan is the outcome of the following process:

1. The existing TCPs and ACPs identified by the offsite agencies in their existing emergency plans serve as the basis of the traffic management plan, as per NUREG/CR-7002.
2. Computer analysis of the evacuation traffic flow environment.

   This analysis identifies the best routing and those critical intersections that experience pronounced congestion. Any critical intersections that are not identified in the existing offsite plans are suggested as additional TCPs and ACPs
3. A field survey of the highway network within 15 miles of the power plant. The image depicting traffic control at a suggested additional TCP site, which is presented in Appendix G, is based on data collected during field surveys, upon large scale maps, and

on overhead photos.

4. Consultation with emergency management and law enforcement personnel.

   Trained personnel who are experienced in controlling traffic and are aware of the likely evacuation traffic patterns should review the control tactics at the suggested additional TCP.

5. Prioritization of TCPs and ACPs.

   Application of traffic and access control at some TCPs and ACPs will have a more pronounced influence on expediting traffic movements than at other TCPs and ACPs. For example, TCPs controlling traffic originating from areas in close proximity to the power plant could have a more beneficial effect on minimizing potential exposure to radioactivity than those TCPs located far from the power plant. These priorities should be assigned by state/parish emergency management representatives and by law enforcement personnel.

The use of Intelligent Transportation Systems (ITS) technologies (if available) can reduce manpower and equipment needs, while still facilitating the evacuation process. Dynamic Message Signs (DMS) can be placed within the EPZ to provide information to travelers regarding traffic conditions, route selection, and reception center information. DMS can also be placed outside of the EPZ to warn motorists to avoid using routes that may conflict with the flow of evacuees away from the power plant. Highway Advisory Radio (HAR) can be used to broadcast information to evacuees en route through their vehicle stereo systems. Automated Traveler Information Systems (ATIS) can also be used to provide evacuees with information. Internet websites can provide traffic and evacuation route information before the evacuee begins their trip, while on board navigation systems (GPS units), cell phones, and pagers can be used to provide information en route. These are only several examples of how ITS technologies can benefit the evacuation process. Consideration should be given that ITS technologies be used to facilitate the evacuation process, and any additional signage placed should consider evacuation needs.

The ETE analysis treated all controlled intersections that are existing TCP locations in the offsite agency plans as being controlled by actuated signals.

Chapters 2N and 5G, and Part 6 of the 2009 MUTCD are particularly relevant and should be reviewed during emergency response training.

The ETE calculations reflect the assumption that all “external-external” trips are interdicted and diverted after 2 hours have elapsed from the ATE.

All transit vehicles and other responders entering the EPZ to support the evacuation are assumed to be unhindered by personnel manning ACPs and TCPs.

Study Assumptions 5 and 6 in Section 2.3 discuss ACP and TCP staffing schedules and operations.

10 EVACUATION ROUTES

Evacuation routes are comprised of two distinct components:

- Routing from a PAS being evacuated to the boundary of the Evacuation Region and thence out of the EPZ.
- Routing of transit-dependent evacuees from the EPZ boundary to reception centers.

Evacuees will select routes within the EPZ in such a way as to minimize their exposure to risk. This expectation is met by the DYNEV II model routing traffic away from the location of the plant, to the extent practicable. The DTRAD model satisfies this behavior by routing traffic so as to balance traffic demand relative to the available highway capacity to the extent possible. See Appendices B through D for further discussion.

The routing of transit-dependent evacuees from the EPZ boundary to reception centers is designed to minimize the amount of travel outside the EPZ, from the points where these routes cross the EPZ boundary.

Figure 10-1 present a map showing the general population and school reception centers for evacuees. The major evacuation routes for the EPZ are presented in Figure 10-2.

It is assumed that all school evacuees will be taken to the appropriate reception center and subsequently picked up by parents or guardians. Transit-dependent evacuees are transported to one of the reception centers. This study does not consider the transport of evacuees from reception centers to congregate care centers, if the parishes do make the decision to relocate evacuees.

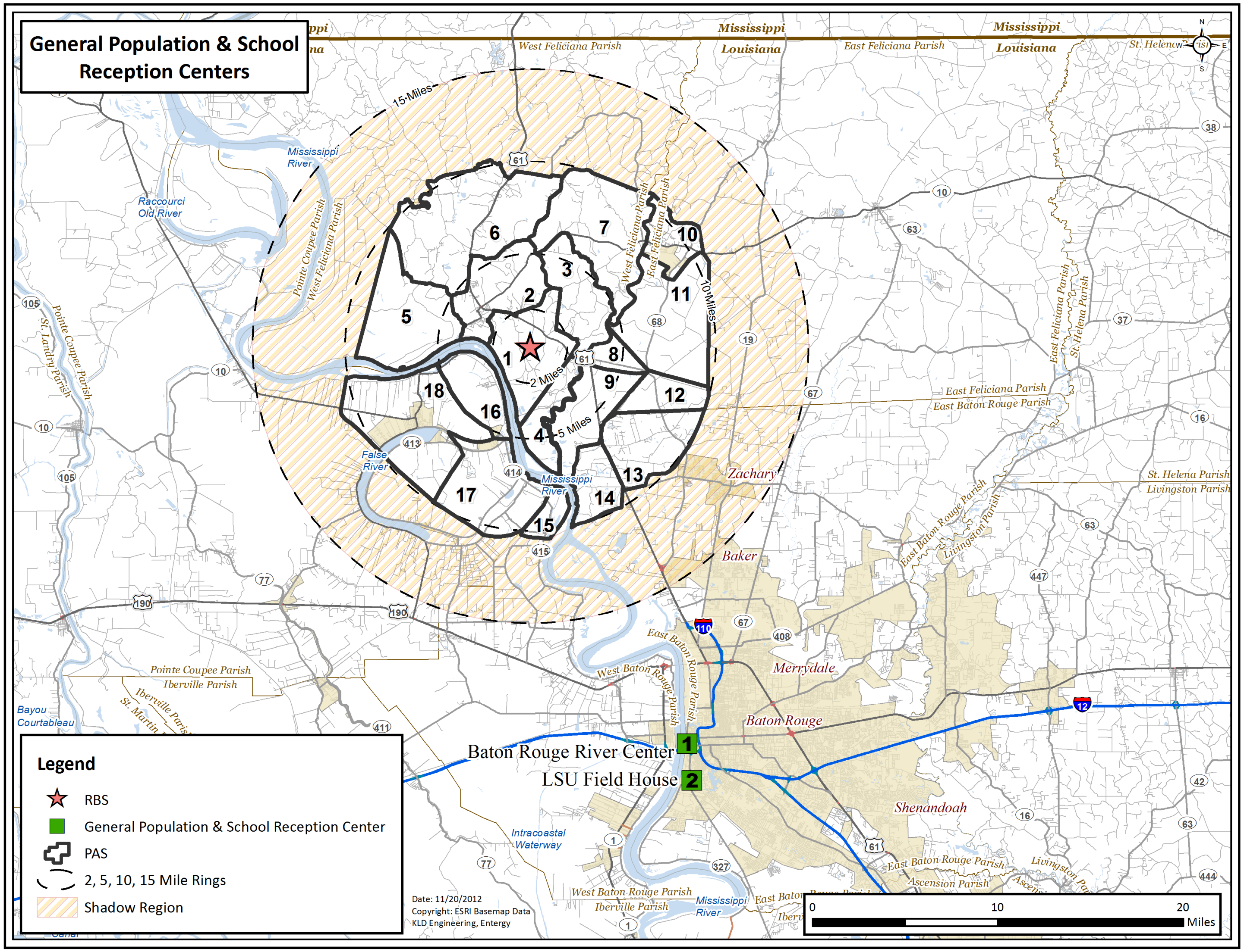


Figure 10-1. General Population and School Reception Centers

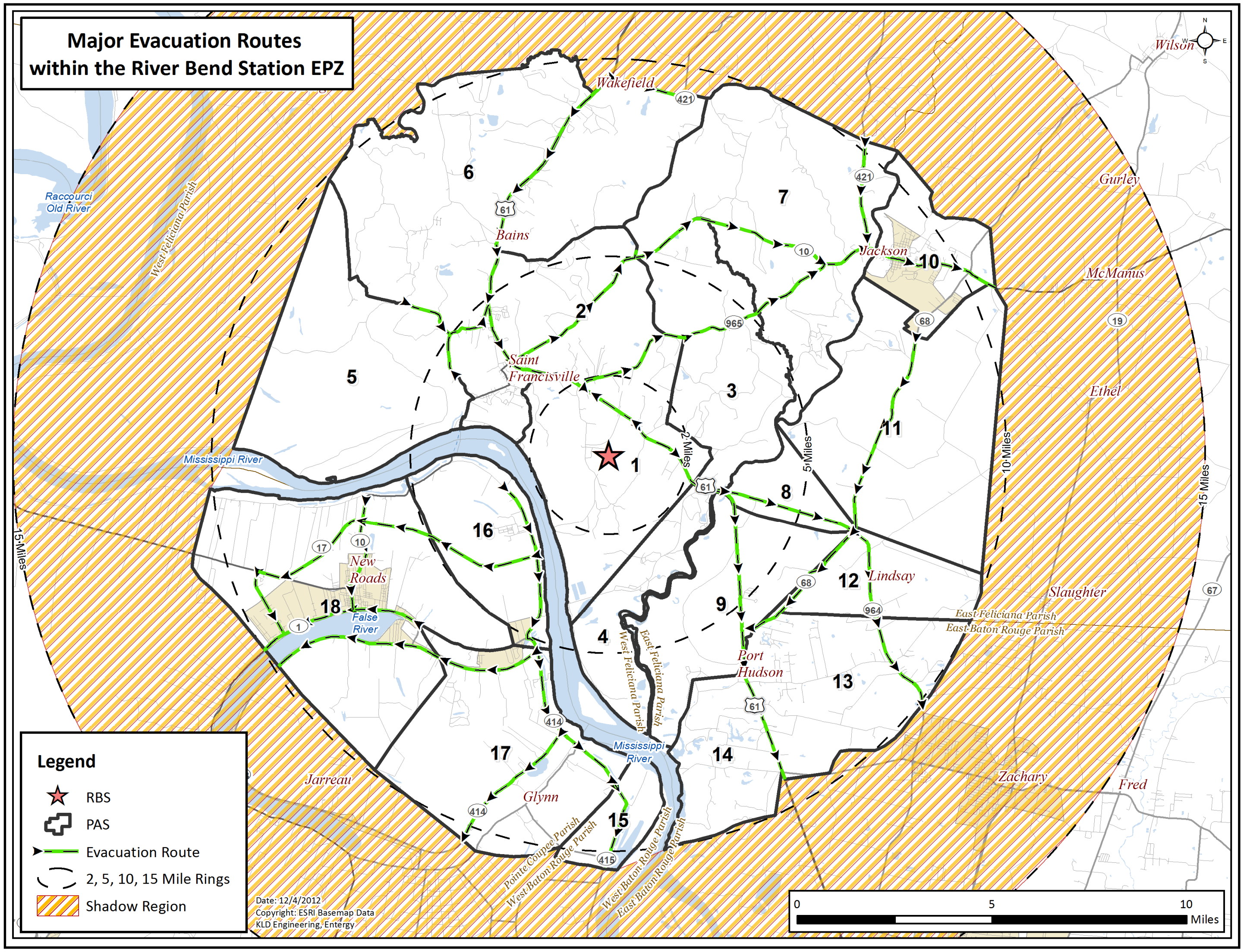


Figure 10-2. RBS Major Evacuation Routes

11 SURVEILLANCE OF EVACUATION OPERATIONS

There is a need for surveillance of traffic operations during the evacuation. There is also a need to clear any blockage of roadways arising from accidents or vehicle disablement. Surveillance can take several forms.

1. Traffic control personnel, located at Traffic Control and Access Control points, provide fixed-point surveillance.
2. Ground patrols may be undertaken along well-defined paths to ensure coverage of those highways that serve as major evacuation routes.
3. Aerial surveillance of evacuation operations may also be conducted using helicopter or fixed-wing aircraft, if available.
4. Cellular phone calls (if cellular coverage exists) from motorists may also provide direct field reports of road blockages.

These concurrent surveillance procedures are designed to provide coverage of the entire EPZ as well as the area around its periphery. It is the responsibility of the Parishes to support an emergency response system that can receive messages from the field and be in a position to respond to any reported problems in a timely manner. This coverage should quickly identify, and expedite the response to any blockage caused by a disabled vehicle.

Tow Vehicles

In a low-speed traffic environment, any vehicle disablement is likely to arise due to a low-speed collision, mechanical failure or the exhaustion of its fuel supply. In any case, the disabled vehicle can be pushed onto the shoulder, thereby restoring traffic flow. Past experience in other emergencies indicates that evacuees who are leaving an area often perform activities such as pushing a disabled vehicle to the side of the road without prompting.

While the need for tow vehicles is expected to be low under the circumstances described above, it is still prudent to be prepared for such a need. Consideration should be given that tow trucks with a supply of gasoline be deployed at strategic locations within, or just outside, the EPZ. These locations should be selected so that:

- They permit access to key, heavily loaded, evacuation routes.
- Responding tow trucks would most likely travel counter-flow relative to evacuating traffic.

Consideration should also be given that the state and local emergency management agencies encourage gas stations to remain open during the evacuation.

12 CONFIRMATION TIME

It is necessary to confirm that the evacuation process is effective in the sense that the public is complying with the Advisory to Evacuate. The Louisiana Peacetime Radiological Response Plan (LPRRP) states:

> "Periodic patrols by law enforcement and/or other emergency personnel will canvas areas to confirm evacuation and remove remaining persons as required."

Should there be insufficient manpower to confirm evacuation using this method discussed above, the following alternative or complementary approach is suggested.

The suggested procedure employs a stratified random sample and a telephone survey. The size of the sample is dependent on the expected number of households that do not comply with the Advisory to Evacuate. It is reasonable to assume, for the purpose of estimating sample size that at least 80 percent of the population within the EPZ will comply with the Advisory to Evacuate. On this basis, an analysis could be undertaken (see Table 12-1) to yield an estimated sample size of approximately 300.

The confirmation process should start at about 3 hours after the Advisory to Evacuate, which is when approximately 95 percent of resident evacuees have completed their mobilization activities (see Table 5-9). At this time, virtually all evacuees will have departed on their respective trips and the local telephone system will be largely free of traffic.

As indicated in Table 12-1, approximately 7½ person hours are needed to complete the telephone survey. If six people are assigned to this task, each dialing a different set of telephone exchanges (e.g., each person can be assigned a different set of three PAS), then the confirmation process will extend over a timeframe of about 75 minutes. Thus, the confirmation should be completed before the evacuated area is cleared. Of course, fewer people would be needed for this survey if the Evacuation Region were only a portion of the EPZ. Use of modern automated computer controlled dialing equipment or other technologies (e.g., reverse 911 or equivalent) can significantly reduce the manpower requirements and the time required to undertake this type of confirmation survey.

If this method is indeed used by the offsite agencies, consideration should be given to maintain a list of telephone numbers within the EPZ in the Emergency Operations Center (EOC) at all times. Such a list could be purchased from vendors and could be periodically updated. As indicated above, the confirmation process should not begin until 3 hours after the Advisory to Evacuate, to ensure that households have had enough time to mobilize. This 3-hour timeframe will enable telephone operators to arrive at their workplace, obtain a call list and prepare to make the necessary phone calls.

Should the number of telephone responses (i.e., people still at home) exceed 20 percent, then the telephone survey should be repeated after an hour's interval until the confirmation process is completed.

Other techniques could also be considered. After traffic volumes decline, the personnel

manning TCPs can be redeployed to travel through residential areas to observe and to confirm evacuation activities.

Table 12-1. Estimated Number of Telephone Calls Required for Confirmation of Evacuation

Problem Definition

Estimate number of phone calls, n, needed to ascertain the proportion, F of households that have not evacuated.

Reference: Burstein, H., Attribute Sampling, McGraw Hill, 1971

Given:

- No. of households plus other facilities, N, within the EPZ (est.) = 10,200
- Est. proportion, F, of households that will not evacuate = 0.20
- Allowable error margin, e: 0.05
- Confidence level, α: 0.95 (implies A = 1.96)

Applying Table 10 of cited reference,

$$p = F + e = 0.25; \;\; q = 1 - p = 0.75$$

$$n = \frac{A^2 pq + e}{e^2} = 308$$

Finite population correction:

$$n_F = \frac{nN}{n + N - 1} = 299$$

Thus, some 300 telephone calls will confirm that approximately 20 percent of the population has not evacuated. If only 10 percent of the population does not comply with the Advisory to Evacuate, then the required sample size, n_F = 212.

Est. Person Hours to complete 300 telephone calls

Assume:

- Time to dial using touch tone (random selection of listed numbers): 30 seconds
- Time for 6 rings (no answer): 36 seconds
- Time for 4 rings plus short conversation: 60 sec.
- Interval between calls: 20 sec.

Person Hours:

$$\frac{300[30 + 0.8(36) + 0.2(60) + 20]}{3600} = 7.6$$

APPENDIX A

Glossary of Traffic Engineering Terms

A. GLOSSARY OF TRAFFIC ENGINEERING TERMS

Table A-1. Glossary of Traffic Engineering Terms

Term	Definition
Analysis Network	A graphical representation of the geometric topology of a physical roadway system, which is comprised of directional links and nodes.
Link	A network link represents a specific, one-directional section of roadway. A link has both physical (length, number of lanes, topology, etc.) and operational (turn movement percentages, service rate, free-flow speed) characteristics.
Measures of Effectiveness	Statistics describing traffic operations on a roadway network.
Node	A network node generally represents an intersection of network links. A node has control characteristics, i.e., the allocation of service time to each approach link.
Origin	A location attached to a network link, within the EPZ or Shadow Region, where trips are generated at a specified rate in vehicles per hour (vph). These trips enter the roadway system to travel to their respective destinations.
Prevailing Roadway and Traffic Conditions	Relates to the physical features of the roadway, the nature (e.g., composition) of traffic on the roadway and the ambient conditions (weather, visibility, pavement conditions, etc.).
Service Rate	Maximum rate at which vehicles, executing a specific turn maneuver, can be discharged from a section of roadway at the prevailing conditions, expressed in vehicles per second (vps) or vehicles per hour (vph).
Service Volume	Maximum number of vehicles which can pass over a section of roadway in one direction during a specified time period with operating conditions at a specified Level of Service (The Service Volume at the upper bound of Level of Service, E, equals Capacity). Service Volume is usually expressed as vehicles per hour (vph).
Signal Cycle Length	The total elapsed time to display all signal indications, in sequence. The cycle length is expressed in seconds.
Signal Interval	A single combination of signal indications. The interval duration is expressed in seconds. A signal phase is comprised of a sequence of signal intervals, usually green, yellow, red.

Term	Definition
Signal Phase	A set of signal indications (and intervals) which services a particular combination of traffic movements on selected approaches to the intersection. The phase duration is expressed in seconds.
Traffic (Trip) Assignment	A process of assigning traffic to paths of travel in such a way as to satisfy all trip objectives (i.e., the desire of each vehicle to travel from a specified origin in the network to a specified destination) and to optimize some stated objective or combination of objectives. In general, the objective is stated in terms of minimizing a generalized "cost". For example, "cost" may be expressed in terms of travel time.
Traffic Density	The number of vehicles that occupy one lane of a roadway section of specified length at a point in time, expressed as vehicles per mile (vpm).
Traffic (Trip) Distribution	A process for determining the destinations of all traffic generated at the origins. The result often takes the form of a Trip Table, which is a matrix of origin-destination traffic volumes.
Traffic Simulation	A computer model designed to replicate the real-world operation of vehicles on a roadway network, so as to provide statistics describing traffic performance. These statistics are called Measures of Effectiveness.
Traffic Volume	The number of vehicles that pass over a section of roadway in one direction, expressed in vehicles per hour (vph). Where applicable, traffic volume may be stratified by turn movement.
Travel Mode	Distinguishes between private auto, bus, rail, pedestrian and air travel modes.
Trip Table or Origin-Destination Matrix	A rectangular matrix or table, whose entries contain the number of trips generated at each specified origin, during a specified time period, that are attracted to (and travel toward) each of its specified destinations. These values are expressed in vehicles per hour (vph) or in vehicles.
Turning Capacity	The capacity associated with that component of the traffic stream which executes a specified turn maneuver from an approach at an intersection.

APPENDIX B

DTRAD: Dynamic Traffic Assignment and Distribution Model

B. DYNAMIC TRAFFIC ASSIGNMENT AND DISTRIBUTION MODEL

This section describes the integrated dynamic trip assignment and distribution model named DTRAD (Dynamic Traffic Assignment and Distribution) that is expressly designed for use in analyzing evacuation scenarios. DTRAD employs logit-based path-choice principles and is one of the models of the DYNEVII System. The DTRAD module implements path-based *Dynamic Traffic Assignment* (DTA) so that time dependent Origin-Destination (OD) trips are "assigned" to routes over the network based on prevailing traffic conditions.

To apply the DYNEV II System, the analyst must specify the highway network, link capacity information, the time-varying volume of traffic generated at all origin centroids and, optionally, a set of accessible candidate destination nodes on the periphery of the EPZ for selected origins. DTRAD calculates the optimal dynamic trip distribution (i.e., trip destinations) and the optimal dynamic trip assignment (i.e., trip routing) of the traffic generated at each origin node traveling to its set of candidate destination nodes, so as to minimize evacuee travel "cost".

Overview of Integrated Distribution and Assignment Model

The underlying premise is that the selection of destinations and routes is intrinsically coupled in an evacuation scenario. That is, people in vehicles seek to travel out of an area of potential risk as rapidly as possible by selecting the "best" routes. The model is designed to identify these "best" routes in a manner that realistically distributes vehicles from origins to destinations and routes them over the highway network, in a consistent and optimal manner, reflecting evacuee behavior.

For each origin, a set of "candidate destination nodes" is selected by the software logic and by the analyst to reflect the desire by evacuees to travel away from the power plant and to access major highways. The specific destination nodes within this set that are selected by travelers and the selection of the connecting paths of travel, are both determined by DTRAD. This determination is made by a logit-based path choice model in DTRAD, so as to minimize the trip "cost", as discussed later.

The traffic loading on the network and the consequent operational traffic environment of the network (density, speed, throughput on each link) vary over time as the evacuation takes place. The DTRAD model, which is interfaced with the DYNEV simulation model, executes a succession of "sessions" wherein it computes the optimal routing and selection of destination nodes for the conditions that exist at that time.

Interfacing the DYNEV Simulation Model with DTRAD

The DYNEV II system reflects NRC guidance that evacuees will seek to travel in a general direction away from the location of the hazardous event. An algorithm was developed to support the DTRAD model in dynamically varying the Trip Table (O-D matrix) over time from one DTRAD session to the next. Another algorithm executes a "mapping" from the specified "geometric" network (link-node analysis network) that represents the physical highway system, to a "path" network that represents the vehicle [turn] movements. DTRAD computations are performed on the "path" network: DYNEV simulation model, on the "geometric" network.

DTRAD Description

DTRAD is the DTA module for the DYNEV II System.

When the road network under study is large, multiple routing options are usually available between trip origins and destinations. The problem of loading traffic demands and propagating them over the network links is called Network Loading and is addressed by DYNEVII using macroscopic traffic simulation modeling. Traffic assignment deals with computing the distribution of the traffic over the road network for given O-D demands and is a model of the route choice of the drivers. Travel demand changes significantly over time, and the road network may have time dependent characteristics, e.g., time-varying signal timing or reduced road capacity because of lane closure, or traffic congestion. To consider these time dependencies, DTA procedures are required.

The DTRAD DTA module represents the dynamic route choice behavior of drivers, using the specification of dynamic origin-destination matrices as flow input. Drivers choose their routes through the network based on the travel cost they experience (as determined by the simulation model). This allows traffic to be distributed over the network according to the time-dependent conditions. The modeling principles of D-TRAD include:

- It is assumed that drivers not only select the best route (i.e., lowest cost path) but some also select less attractive routes. The algorithm implemented by DTRAD archives several “efficient” routes for each O-D pair from which the drivers choose.
- The choice of one route out of a set of possible routes is an outcome of “discrete choice modeling”. Given a set of routes and their generalized costs, the percentages of drivers that choose each route is computed. The most prevalent model for discrete choice modeling is the logit model. DTRAD uses a variant of Path-Size-Logit model (PSL). PSL overcomes the drawback of the traditional multinomial logit model by incorporating an additional deterministic path size correction term to address path overlapping in the random utility expression.
- DTRAD executes the TA algorithm on an abstract network representation called "the path network" which is built from the actual physical link-node analysis network. This execution continues until a stable situation is reached: the volumes and travel times on the edges of the path network do not change significantly from one iteration to the next. The criteria for this convergence are defined by the user.
- Travel “cost” plays a crucial role in route choice. In DTRAD, path cost is a linear summation of the generalized cost of each link that comprises the path. The generalized cost for a link, a, is expressed as

  $$c_a = \alpha t_a + \beta l_a + \gamma s_a ,$$

  where c_a is the generalized cost for link a, and α, β, and γ are cost coefficients for link travel time, distance, and supplemental cost, respectively. Distance and supplemental costs are defined as invariant properties of the network model, while travel time is a dynamic property dictated by prevailing traffic conditions. The DYNEV simulation model

computes travel times on all edges in the network and DTRAD uses that information to constantly update the costs of paths. The route choice decision model in the next simulation iteration uses these updated values to adjust the route choice behavior. This way, traffic demands are dynamically re-assigned based on time dependent conditions. The interaction between the DTRAD traffic assignment and DYNEV II simulation models is depicted in Figure B-1. Each round of interaction is called a Traffic Assignment Session (TA session). A TA session is composed of multiple iterations, marked as loop B in the figure.

- The supplemental cost is based on the "survival distribution" (a variation of the exponential distribution).The Inverse Survival Function is a "cost" term in DTRAD to represent the potential risk of travel toward the plant:

  $s_a = - \beta \ln (p), 0 \leq p \leq l ; \beta > 0$

  $p = \frac{d_n}{d_0}$

  d_n = Distance of node, n, from the plant
  d_0 =Distance from the plant where there is zero risk
  β = Scaling factor

The value of d_o = 15 miles, the outer distance of the shadow region. Note that the supplemental cost, s_a, of link, a, is (high, low), if its downstream node, n, is (near, far from) the power plant.

Network Equilibrium

In 1952, John Wardrop wrote:

> *Under equilibrium conditions traffic arranges itself in congested networks in such a way that no individual trip-maker can reduce his path costs by switching routes.*

The above statement describes the "User Equilibrium" definition, also called the "Selfish Driver Equilibrium". It is a hypothesis that represents a [hopeful] condition that evolves over time as drivers search out alternative routes to identify those routes that minimize their respective "costs". It has been found that this "equilibrium" objective to minimize costs is largely realized by most drivers who routinely take the same trip over the same network at the same time (i.e., commuters). Effectively, such drivers "learn" which routes are best for them over time. Thus, the traffic environment "settles down" to a near-equilibrium state.

Clearly, since an emergency evacuation is a sudden, unique event, it does not constitute a long-term learning experience which can achieve an equilibrium state. Consequently, DTRAD was not designed as an equilibrium solution, but to represent drivers in a new and unfamiliar situation, who respond in a flexible manner to real-time information (either broadcast or observed) in such a way as to minimize their respective costs of travel.

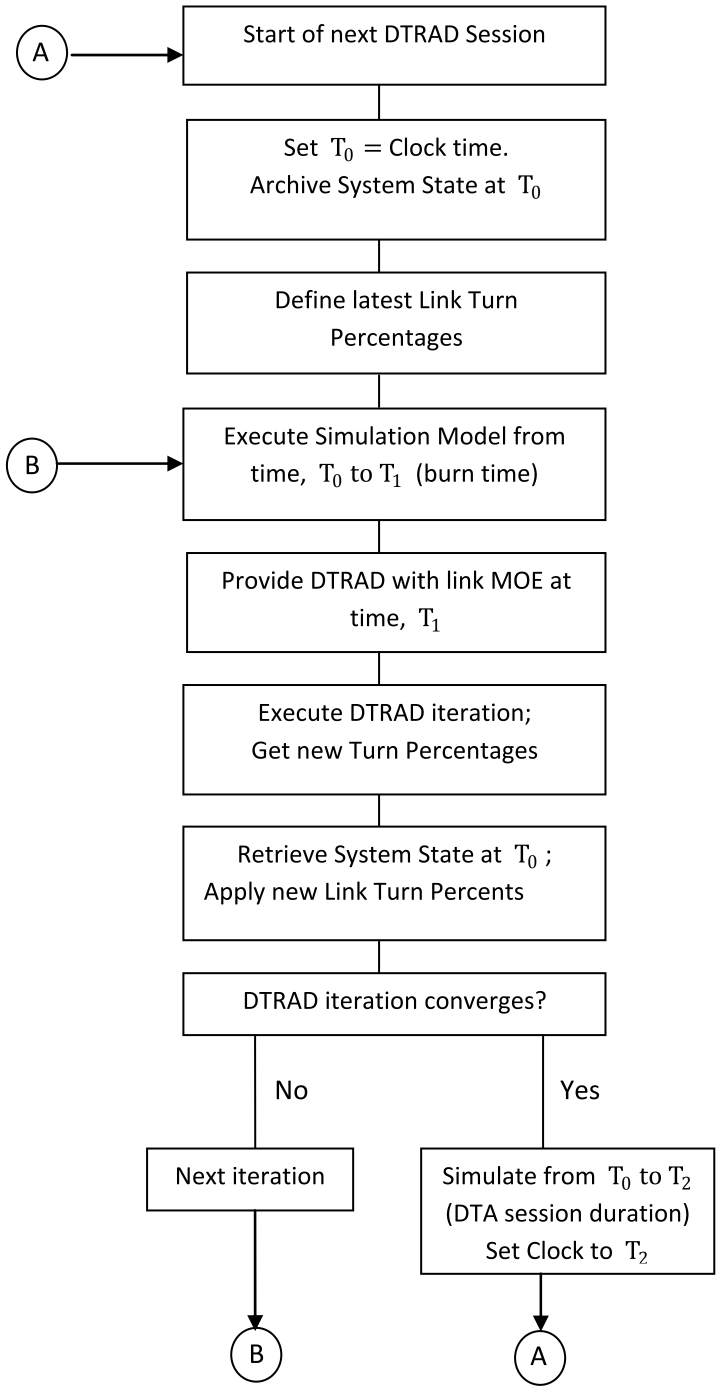


Figure B-1. Flow Diagram of Simulation-DTRAD Interface

APPENDIX C

DYNEV Traffic Simulation Model

C. DYNEV TRAFFIC SIMULATION MODEL

The DYNEV traffic simulation model is a *macroscopic* model that describes the operations of traffic flow in terms of aggregate variables: vehicles, flow rate, mean speed, volume, density, queue length, *on each link*, for each turn movement, during each Time Interval (simulation time step). The model generates trips from "sources" and from Entry Links and introduces them onto the analysis network at rates specified by the analyst based on the mobilization time distributions. The model simulates the movements of all vehicles on all network links over time until the network is empty. At intervals, the model outputs Measures of Effectiveness (MOE) such as those listed in Table C-1.

Model Features Include:

- Explicit consideration is taken of the variation in density over the time step; an iterative procedure is employed to calculate an average density over the simulation time step for the purpose of computing a mean speed for moving vehicles.
- Multiple turn movements can be serviced on one link; a separate algorithm is used to estimate the number of (fractional) lanes assigned to the vehicles performing each turn movement, based, in part, on the turn percentages provided by the DTRAD model.
- At any point in time, traffic flow on a link is subdivided into two classifications: queued and moving vehicles. The number of vehicles in each classification is computed. Vehicle spillback, stratified by turn movement for each network link, is explicitly considered and quantified. The propagation of stopping waves from link to link is computed within each time step of the simulation. There is no "vertical stacking" of queues on a link.
- Any link can accommodate "source flow" from zones via side streets and parking facilities that are not explicitly represented. This flow represents the evacuating trips that are generated at the source.
- The relation between the number of vehicles occupying the link and its storage capacity is monitored every time step for every link and for every turn movement. If the available storage capacity on a link is exceeded by the demand for service, then the simulator applies a "metering" rate to the entering traffic from both the upstream feeders and source node to ensure that the available storage capacity is not exceeded.
- A "path network" that represents the specified traffic movements from each network link is constructed by the model; this path network is utilized by the DTRAD model.
- A two-way interface with DTRAD: (1) provides link travel times; (2) receives data that translates into link turn percentages.
- Provides MOE to animation software, EVAN
- Calculates ETE statistics

All traffic simulation models are data-intensive. Table C-2 outlines the necessary input data elements.

To provide an efficient framework for defining these specifications, the physical highway environment is represented as a network. The unidirectional links of the network represent roadway sections: rural, multi-lane, urban streets or freeways. The nodes of the network generally represent intersections or points along a section where a geometric property changes (e.g. a lane drop, change in grade or free flow speed).

Figure C-1 is an example of a small network representation. The freeway is defined by the sequence of links, (20,21), (21,22), and (22,23). Links (8001, 19) and (3, 8011) are Entry and Exit links, respectively. An arterial extends from node 3 to node 19 and is partially subsumed within a grid network. Note that links (21,22) and (17,19) are grade-separated.

Table C-1. Selected Measures of Effectiveness Output by DYNEV II

Measure	Units	Applies To
Vehicles Discharged	Vehicles	Link, Network, Exit Link
Speed	Miles/Hours (mph)	Link, Network
Density	Vehicles/Mile/Lane	Link
Level of Service	LOS	Link
Content	Vehicles	Network
Travel Time	Vehicle-hours	Network
Evacuated Vehicles	Vehicles	Network, Exit Link
Trip Travel Time	Vehicle-minutes/trip	Network
Capacity Utilization	Percent	Exit Link
Attraction	Percent of total evacuating vehicles	Exit Link
Max Queue	Vehicles	Node, Approach
Time of Max Queue	Hours:minutes	Node, Approach
Route Statistics	Length (mi); Mean Speed (mph); Travel Time (min)	Route
Mean Travel Time	Minutes	Evacuation Trips; Network

Table C-2. Input Requirements for the DYNEV II Model

HIGHWAY NETWORK

- Links defined by upstream and downstream node numbers
- Link lengths
- Number of lanes (up to 9) and channelization
- Turn bays (1 to 3 lanes)
- Destination (exit) nodes
- Network topology defined in terms of downstream nodes for each receiving link
- Node Coordinates (X,Y)
- Nuclear Power Plant Coordinates (X,Y)

GENERATED TRAFFIC VOLUMES

- On all entry links and source nodes (origins), by Time Period

TRAFFIC CONTROL SPECIFICATIONS

- Traffic signals: link-specific, turn movement specific
- Signal control treated as fixed time or actuated
- Location of traffic control points (these are represented as actuated signals)
- Stop and Yield signs
- Right-turn-on-red (RTOR)
- Route diversion specifications
- Turn restrictions
- Lane control (e.g. lane closure, movement-specific)

DRIVER'S AND OPERATIONAL CHARACTERISTICS

- Driver's (vehicle-specific) response mechanisms: free-flow speed, discharge headway
- Bus route designation.

DYNAMIC TRAFFIC ASSIGNMENT

- Candidate destination nodes for each origin (optional)
- Duration of DTA sessions
- Duration of simulation "burn time"
- Desired number of destination nodes per origin

INCIDENTS

- Identify and Schedule of closed lanes
- Identify and Schedule of closed links

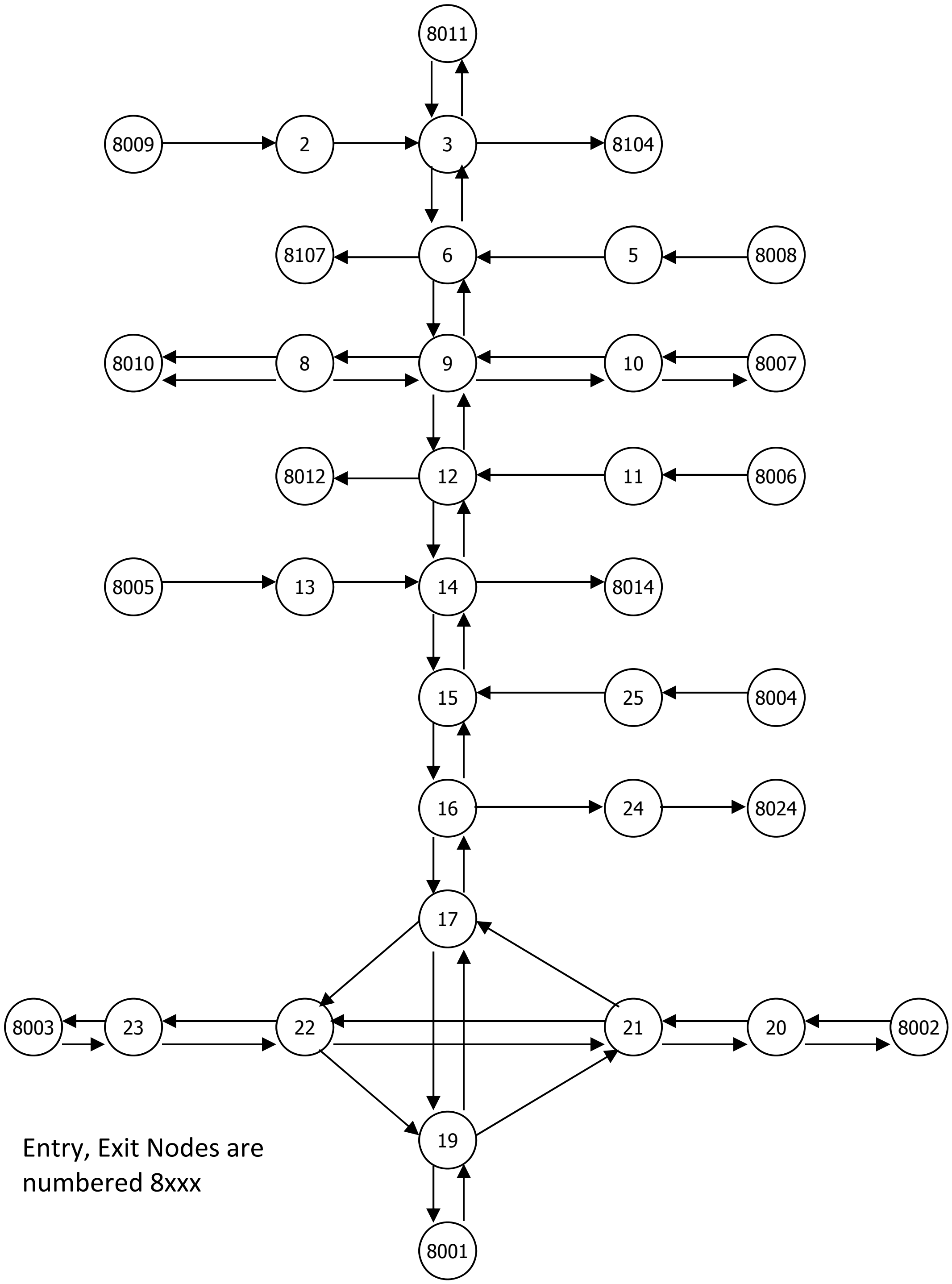


Figure C-1. Representative Analysis Network

C.1 Methodology

C.1.1 The Fundamental Diagram

It is necessary to define the fundamental diagram describing flow-density and speed-density relationships. Rather than "settling for" a triangular representation, a more realistic representation that includes a "capacity drop", (I-R)Q_{max}, at the critical density when flow conditions enter the forced flow regime, is developed and calibrated for each link. This representation, shown in Figure C-2, asserts a constant free speed up to a density, k_f, and then a linear reduction in speed in the range, $k_f \leq k \leq k_c = 45$ vpm, the density at capacity. In the flow-density plane, a quadratic relationship is prescribed in the range, $k_c < k \leq k_s = 95$ vpm which roughly represents the "stop-and-go" condition of severe congestion. The value of flow rate, Q_s, corresponding to k_s, is approximated at $0.7\,RQ_{max}$. A linear relationship between k_s and k_j completes the diagram shown in Figure C-2. Table C-3 is a glossary of terms.

The fundamental diagram is applied to <u>moving</u> traffic on every link. The specified calibration values for each link are: (1) Free speed, v_f ; (2) Capacity, Q_{max} ; (3) Critical density, $k_c = 45$ vpm ; (4) Capacity Drop Factor, R = 0.9 ; (5) Jam density, k_j . Then, $v_c = \frac{Q_{max}}{k_c}$, $k_f = k_c - \frac{(V_f - V_c)\,k_c^2}{Q_{max}}$. Setting $\bar{k} = k - k_c$, then $Q = RQ_{max} - \frac{RQ_{max}}{8333}\bar{k}^2$ for $0 \leq \bar{k} \leq \bar{k}_s = 50$. It can be shown that $Q = (0.98 - 0.0056\,\bar{k})\,RQ_{max}$ for $\bar{k}_s \leq \bar{k} \leq \bar{k}_j$, where $\bar{k}_s = 50$ and $\bar{k}_j = 175$.

C.1.2 The Simulation Model

The simulation model solves a sequence of "unit problems". Each unit problem computes the movement of traffic on a link, for each specified turn movement, over a specified time interval (TI) which serves as the simulation time step for all links. Figure C-3 is a representation of the unit problem in the time-distance plane. Table C-3 is a glossary of terms that are referenced in the following description of the unit problem procedure.

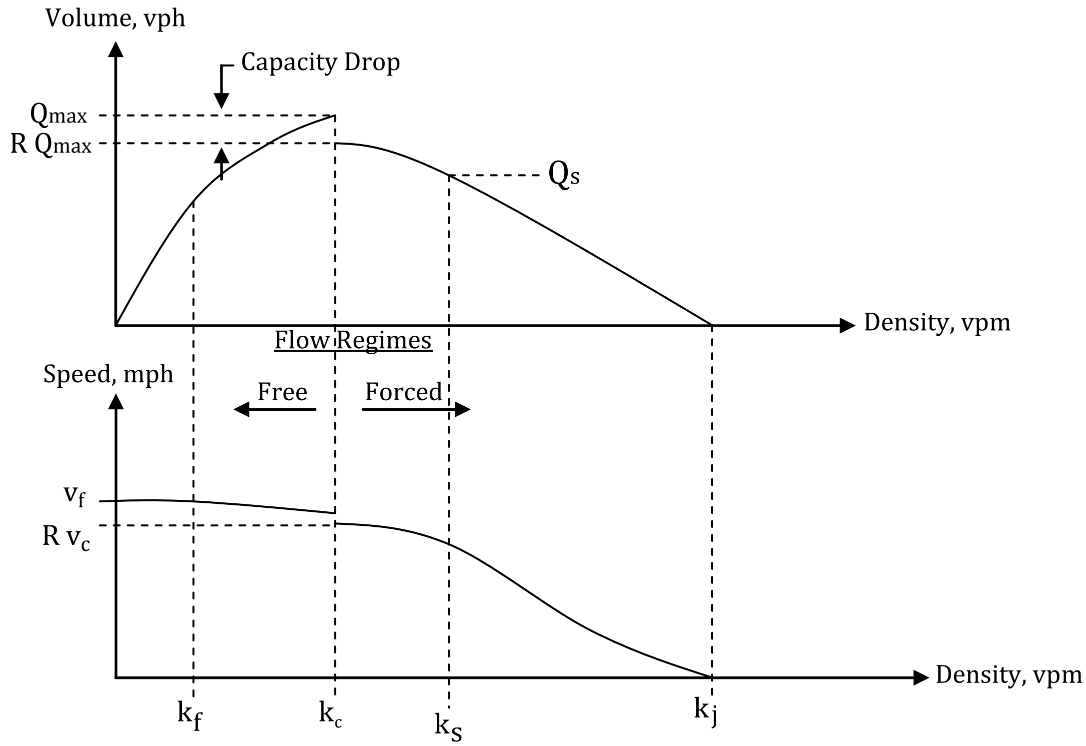


Figure C-2. Fundamental Diagrams

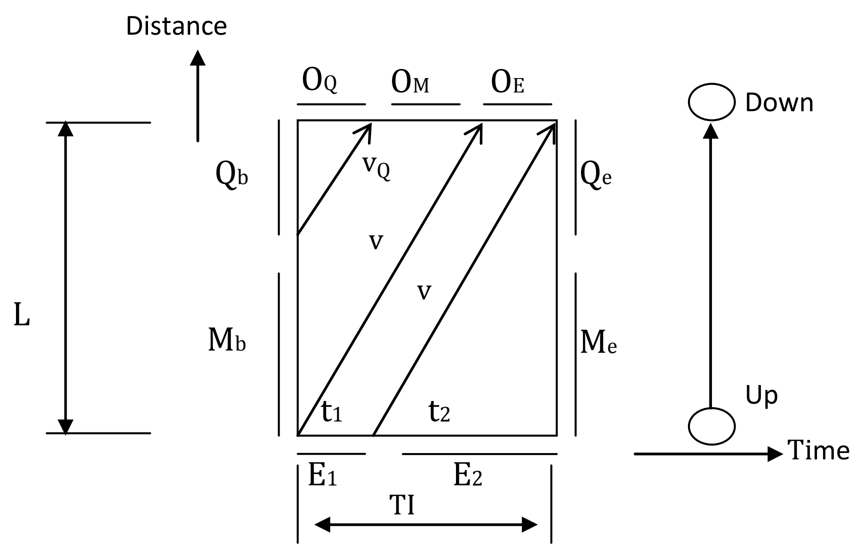


Figure C-3. A UNIT Problem Configuration with $t_1 > 0$

Table C-3. Glossary

Cap	The maximum number of vehicles, of a particular movement, that can discharge from a link within a time interval.
E	The number of vehicles, of a particular movement, that enter the link over the time interval. The portion, E_{TI}, can reach the stop-bar within the TI.
G/C	The green time: cycle time ratio that services the vehicles of a particular turn movement on a link.
h	The mean queue discharge headway, seconds.
k	Density in vehicles per lane per mile.
$\bar{k}$	The average density of moving vehicles of a particular movement over a TI, on a link.
L	The length of the link in feet.
L_b , L_e	The queue length in feet of a particular movement, at the [beginning, end] of a time interval.
LN	The number of lanes, expressed as a floating point number, allocated to service a particular movement on a link.
L_v	The mean effective length of a queued vehicle including the vehicle spacing, feet.
M	Metering factor (Multiplier): 1.
M_b , M_e	The number of moving vehicles on the link, of a particular movement, that are moving at the [beginning, end] of the time interval. These vehicles are assumed to be of equal spacing, over the length of link upstream of the queue.
O	The total number of vehicles of a particular movement that are discharged from a link over a time interval.
O_Q , O_M , O_E	The components of the vehicles of a particular movement that are discharged from a link within a time interval: vehicles that were Queued at the beginning of the TI; vehicles that were Moving within the link at the beginning of the TI; vehicles that Entered the link during the TI.
P_x	The percentage, expressed as a fraction, of the total flow on the link that executes a particular turn movement, x.

Q_b , Q_e	The number of queued vehicles on the link, of a particular turn movement, at the [beginning, end] of the time interval.
Q_{max}	The maximum flow rate that can be serviced by a link for a particular movement in the absence of a control device. It is specified by the analyst as an estimate of link capacity, based upon a field survey, with reference to the HCM.
R	The factor that is applied to the capacity of a link to represent the "capacity drop" when the flow condition moves into the forced flow regime. The lower capacity at that point is equal to RQ_{max} .
RCap	The remaining capacity available to service vehicles of a particular movement after that queue has been completely serviced, within a time interval, expressed as vehicles.
S_x	Service rate for movement x, vehicles per hour (vph).
t_1	Vehicles of a particular turn movement that enter a link over the first t_1 seconds of a time interval, can reach the stop-bar (in the absence of a queue down-stream) within the same time interval.
TI	The time interval, in seconds, which is used as the simulation time step.
v	The mean speed of travel, in feet per second (fps) or miles per hour (mph), of moving vehicles on the link.
v_Q	The mean speed of the last vehicle in a queue that discharges from the link within the TI. This speed differs from the mean speed of moving vehicles, v.
W	The width of the intersection in feet. This is the difference between the link length which extends from stop-bar to stop-bar and the block length.

The formulation and the associated logic presented below are designed to solve the unit problem for each sweep over the network (discussed below), for each turn movement serviced on each link that comprises the evacuation network, and for each TI over the duration of the evacuation.

$\text{Given} = Q_b, M_b, L, TI, E_0, LN, {}^G\!/_C, h, L_v, R_0, L_c, E, M$
$\text{Compute} = O, Q_e, M_e$
$\text{Define} \quad O = O_Q + O_M + O_E \ ; \ E = E_1 + E_2$

1. For the first sweep, s = 1, of this TI, get initial estimates of mean density, k_0, the R – factor, R_0 and entering traffic, E_0, using the values computed for the final sweep of the prior TI. For each subsequent sweep, $s > 1$, calculate $E = \sum_i P_i \ O_i + S$ where P_i, O_i are the relevant turn percentages from feeder link, i, and its total outflow (possibly metered) over this TI; S is the total source flow (possibly metered) during the current TI.
   Set iteration counter, n = 0, $k = k_0$, and $E = E_0$.

2. Calculate $v(k)$ such that $k \leq 130$ using the analytical representations of the fundamental diagram.
   Calculate $\text{Cap} = \frac{Q_{max}(TI)}{3600} \left({}^G\!/_C\right) LN$, in vehicles, this value may be reduced due to metering
   Set $R = 1.0$ if ${}^G\!/_C < 1$ or if $k \leq k_c$; Set $R = 0.9$ only if ${}^G\!/_C = 1$ and $k > k_c$
   Calculate queue length, $\quad L_b = Q_b \frac{L_v}{LN}$

3. Calculate $t_1 = TI - \frac{L}{V}$. If $t_1 \prec 0$, set $t_1 = E_1 = O_E = 0$; Else, $E_1 = E \frac{t_1}{TI}$.

4. Then $E_2 = E - E_1$; $t_2 = TI - t_1$

5. If $Q_b \geq \text{Cap}$, then
   $O_Q = \text{Cap}, O_M = O_E = 0$
   If $t_1 > 0$, then
   $Q'_e = Q_b + M_b + E_1 - \text{Cap}$
   Else
   $Q'_e = Q_b - \text{Cap}$
   End if
   Calculate Q_e and M_e using Algorithm A (below)

6. Else $(Q_b \prec \text{Cap})$
   $O_Q = Q_b, \quad \text{RCap} = \text{Cap} - O_Q$

7. If $M_b \leq \text{RCap}$, then

8. If $t_1 > 0$, $O_M = M_b$, $O_E = \min\left(RCap - M_b, \frac{t_1\ Cap}{TI}\right) \geq 0$

$Q'_e = E_1 - O_E$

If $Q'_e > 0$, then

Calculate Q_e , M_e with Algorithm A

Else

$Q_e = 0$, $M_e = E_2$

End if

Else $(t_1 = 0)$

$O_M = \left(\frac{v(TI) - L_b}{L - L_b}\right) M_b$ and $O_E = 0$

$M_e = M_b - O_M + E$; $Q_e = 0$

End if

9. Else $(M_b > RCap)$

$O_E = 0$

If $t_1 > 0$, then

$O_M = RCap$, $Q'_e = M_b - O_M + E_1$

Calculate Q_e and M_e using Algorithm A

10. Else $(t_1 = 0)$

$M_d = \left[\left(\frac{v(TI) - L_b}{L - L_b}\right) M_b\right]$

If $M_d > RCap$, *then*

$O_M = RCap$

$Q'_e = M_d - O_M$

Apply Algorithm A to calculate Q_e and M_e

Else

$O_M = M_d$

$M_e = M_b - O_M + E$ and $Q_e = 0$

End if

End if

End if

End if

11. Calculate a new estimate of average density, $\bar{k}_n = \frac{1}{4}[k_b + 2\ k_m + k_e]$,

where k_b = density at the beginning of the TI

k_e = density at the end of the TI

k_m = density at the mid-point of the TI

All values of density apply only to the moving vehicles.

If $|\bar{k}_n - \bar{k}_{n-1}| > \epsilon$ and $n < N$

where N = max number of iterations, and ϵ is a convergence criterion, then

12. set $n = n + 1$, and return to step 2 to perform iteration, n, using $k = \bar{k}_n$.
End if

Computation of unit problem is now complete. Check for excessive inflow causing spillback.

13. If $Q_e + M_e > \frac{(L-W)\ LN}{L_v}$, then

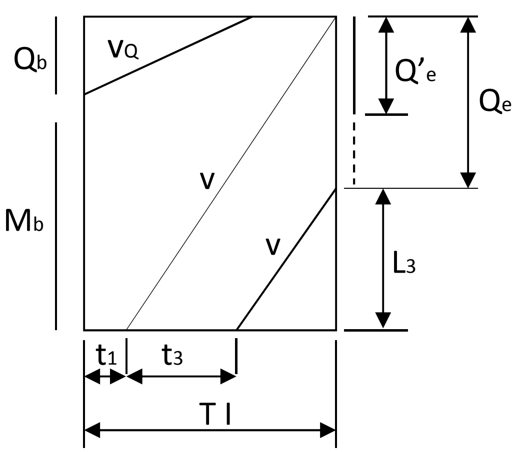
The number of excess vehicles that cause spillback is: $SB = Q_e + M_e - \frac{(L-W) \cdot LN}{L_v}$, where W is the width of the upstream intersection. To prevent spillback, meter the outflow from the feeder approaches and from the source flow, S, during this TI by the amount, SB. That is, set

$$M = 1 - \frac{SB}{(E + S)} \geq 0 \text{, where M is the metering factor (over all movements).}$$

This metering factor is assigned appropriately to all feeder links and to the source flow, to be applied during the next network sweep, discussed later.

Algorithm A

This analysis addresses the flow environment over a TI during which moving vehicles can join a standing or discharging queue. For the case shown, $Q_b \leq Cap$, with $t_1 > 0$ and a queue of length, Q'_e , formed by that portion of M_b and E that reaches the stop-bar within the TI, but could not discharge due to inadequate capacity. That is, $Q_b + M_b + E_1 > Cap$. This queue length, $Q'_e = Q_b + M_b + E_1 - Cap$ can be extended to Q_e by traffic entering the approach during the current TI, traveling at speed, v, and reaching the rear of the queue within the TI. A portion of the entering vehicles, $E_3 = E\,\frac{t_3}{TI}$, will likely join the queue. This analysis calculates t_3 , Q_e and M_e for the input values of L, TI, v, E, t, L_v, LN, Q'_e .



When $t_1 > 0$ and $Q_b \leq Cap$:

Define: $L'_e = Q'_e\,\frac{L_v}{LN}$. From the sketch, $L_3 = v(TI - t_1 - t_3) = L - (Q'_e + E_3)\frac{L_v}{LN}$.

Substituting $E_3 = \frac{t_3}{TI}\,E$ yields: $-vt_3 + \frac{t_3}{TI}\,E\,\frac{L_v}{LN} = L - v(TI - t_1) - L'_e$. Recognizing that the first two terms on the right hand side cancel, solve for t_3 to obtain:

$$t_3 = \frac{L'_e}{\left[v - \frac{E}{TI}\frac{L_v}{LN}\right]} \qquad \text{such that} \quad 0 \le t_3 \le TI - t_1$$

If the denominator, $\left[v - \frac{E}{TI}\frac{L_v}{LN}\right] \le 0, \text{set } t_3 = TI - t_1$.

$$\text{Then, } Q_e = Q'_e + E\,\frac{t_3}{TI} \quad , \qquad M_e = E\left(1 - \frac{t_1 + t_3}{TI}\right)$$

The complete Algorithm A considers all flow scenarios; space limitation precludes its inclusion, here.

C.1.3 Lane Assignment

The "unit problem" is solved for each turn movement on each link. Therefore it is necessary to calculate a value, LN_x , of allocated lanes for each movement, x. If in fact all lanes are specified by, say, arrows painted on the pavement, either as full lanes or as lanes within a turn bay, then the problem is fully defined. If however there remain un-channelized lanes on a link, then an analysis is undertaken to subdivide the number of these physical lanes into turn movement specific virtual lanes, LN_x.

C.2 Implementation

C.2.1 Computational Procedure

The computational procedure for this model is shown in the form of a flow diagram as Figure C-4. As discussed earlier, the simulation model processes traffic flow for each link independently over TI that the analyst specifies; it is usually 60 seconds or longer. The first step is to execute an algorithm to define the sequence in which the network links are processed so that as many links as possible are processed after their feeder links are processed, within the same network sweep. Since a general network will have many closed loops, it is not possible to guarantee that every link processed will have all of its feeder links processed earlier.

The processing then continues as a succession of time steps of duration, TI, until the simulation is completed. Within each time step, the processing performs a series of "sweeps" over all network links; this is necessary to ensure that the traffic flow is synchronous over the entire network. Specifically, the sweep ensures continuity of flow among all the network links; in the context of this model, this means that the values of E, M, and S are all defined for each link such that they represent the synchronous movement of traffic from each link to all of its outbound links. These sweeps also serve to compute the metering rates that control spillback.

Within each sweep, processing solves the "unit problem" for each turn movement on each link. With the turn movement percentages for each link provided by the DTRAD model, an algorithm

allocates the number of lanes to each movement serviced on each link. The timing at a signal, if any, applied at the downstream end of the link, is expressed as a G/C ratio, the signal timing needed to define this ratio is an input requirement for the model. The model also has the capability of representing, with macroscopic fidelity, the actions of actuated signals responding to the time-varying competing demands on the approaches to the intersection.

The solution of the unit problem yields the values of the number of vehicles, O, that discharge from the link over the time interval and the number of vehicles that remain on the link at the end of the time interval as stratified by queued and moving vehicles: $Q_e \text{ and } M_e$. The procedure considers each movement separately (multi-piping). After all network links are processed for a given network sweep, the updated consistent values of entering flows, E; metering rates, M; and source flows, S are defined so as to satisfy the “no spillback” condition. The procedure then performs the unit problem solutions for all network links during the following sweep.

Experience has shown that the system converges (i.e. the values of E, M and S “settle down” for all network links) in just two sweeps if the network is entirely under-saturated or in four sweeps in the presence of extensive congestion with link spillback. (The initial sweep over each link uses the final values of E and M, of the prior TI). At the completion of the final sweep for a TI, the procedure computes and stores all measures of effectiveness for each link and turn movement for output purposes. It then prepares for the following time interval by defining the values of $Q_b \text{ and } M_b$ for the start of the next TI as being those values of $Q_e \text{ and } M_e$ at the end of the prior TI. In this manner, the simulation model processes the traffic flow over time until the end of the run. Note that there is no space-discretization other than the specification of network links.

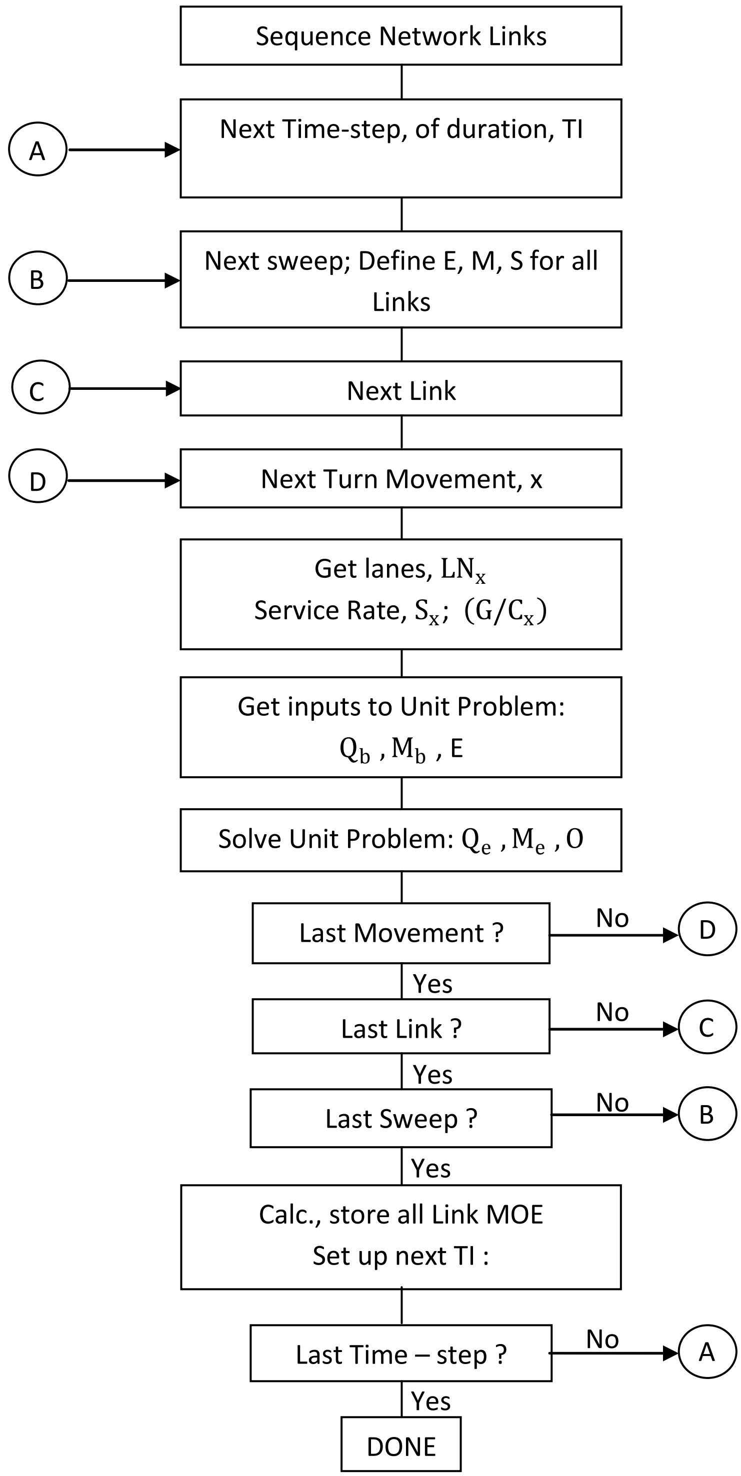


Figure C-4. Flow of Simulation Processing (See Glossary: Table C-3)

C.2.2 Interfacing with Dynamic Traffic Assignment (DTRAD)

The **DYNEV II** system reflects NRC guidance that evacuees will seek to travel in a general direction away from the location of the hazardous event. Thus, an algorithm was developed to identify an appropriate set of destination nodes for each origin based on its location and on the expected direction of travel. This algorithm also supports the DTRAD model in dynamically varying the Trip Table (O-D matrix) over time from one DTRAD session to the next.

Figure B-1 depicts the interaction of the simulation model with the DTRAD model in the **DYNEV II** system. As indicated, **DYNEV II** performs a succession of DTRAD "sessions"; each such session computes the turn link percentages for each link that remain constant for the session duration, $[T_0 , T_2]$, specified by the analyst. The end product is the assignment of traffic volumes from each origin to paths connecting it with its destinations in such a way as to minimize the network-wide cost function. The output of the DTRAD model is a set of updated link turn percentages which represent this assignment of traffic.

As indicated in Figure B-1, the simulation model supports the DTRAD session by providing it with operational link MOE that are needed by the path choice model and included in the DTRAD cost function. These MOE represent the operational state of the network at a time, $T_1 \leq T_2$, which lies within the session duration, $[T_0 , T_2]$. This "burn time", $T_1 - T_0$, is selected by the analyst. For each DTRAD iteration, the simulation model computes the change in network operations over this burn time using the latest set of link turn percentages computed by the DTRAD model. Upon convergence of the DTRAD iterative procedure, the simulation model accepts the latest turn percentages provided by the DTA model, returns to the origin time, T_0 , and executes until it arrives at the end of the DTRAD session duration at time, T_2 **.** At this time the next DTA session is launched and the whole process repeats until the end of the **DYNEV II** run.

Additional details are presented in Appendix B.

APPENDIX D

Detailed Description of Study Procedure

D. DETAILED DESCRIPTION OF STUDY PROCEDURE

This appendix describes the activities that were performed to compute Evacuation Time Estimates. The individual steps of this effort are represented as a flow diagram in Figure D-1. Each numbered step in the description that follows corresponds to the numbered element in the flow diagram.

Step 1

The first activity was to obtain EPZ boundary information and create a GIS base map. The base map extends beyond the Shadow Region which extends approximately 15 miles (radially) from the RBS location. The base map incorporates the local roadway topology, a suitable topographic background and the EPZ boundary.

Step 2

2010 Census block information was obtained in GIS format. This information was used to estimate the resident population within the EPZ and Shadow Region and to define the spatial distribution and demographic characteristics of the population within the study area. The River Bend Station provided their Emergency Resources Databook for use in this study. This two volume resource includes a comprehensive listing of all facilities within the EPZ including transient facility estimates, school enrollment and census population at medical facilities. All data used in the study was sited directly from this resource. Any data missing was supplemented by parish and local municipal sources with the exception of employee data. Any employment data missing was supplemented with the U.S. Census Bureau's Longitudinal Employer-Household Dynamics interactive website data[1].

Step 3

A kickoff meeting was conducted with major stakeholders (state and local emergency managers, on-site and off-site utility emergency managers). The purpose of the kickoff meeting was to present an overview of the work effort, identify key agency personnel, and indicate the data requirements for the study. Specific requests for information were presented to local emergency managers. Unique features of the study area were discussed to identify the local concerns that should be addressed by the ETE study.

Step 4

Next, a physical survey of the roadway system in the study area was conducted to determine the geometric properties of the highway sections, the channelization of lanes on each section of roadway, whether there are any turn restrictions or special treatment of traffic at intersections, the type and functioning of traffic control devices, gathering signal timings for pre-timed traffic signals, and to make the necessary observations needed to estimate realistic values of roadway capacity.

[1] http://lehdmap.did.census.gov/

Step 5

A telephone survey of households within the EPZ was conducted to identify household dynamics, trip generation characteristics, and evacuation-related demographic information of the EPZ population. This information was used to determine important study factors including the average number of evacuating vehicles used by each household, and the time required to perform pre-evacuation mobilization activities.

Step 6

A computerized representation of the physical roadway system, called a link-node analysis network, was developed using the UNITES software developed by KLD. Once the geometry of the network was completed, the network was calibrated using the information gathered during the road survey (Step 4). Estimates of highway capacity for each link and other link-specific characteristics were introduced to the network description. Traffic signal timings were input accordingly. The link-node analysis network was imported into a GIS map. 2010 Census data were overlaid in the map, and origin centroids where trips would be generated during the evacuation process were assigned to appropriate links.

Step 7

The EPZ is subdivided into 18 Protective Action Sectors (PAS). Based on wind direction and speed, Regions (groupings of PAS) that may be advised to evacuate, were developed.

The need for evacuation can occur over a range of time-of-day, day-of-week, seasonal and weather-related conditions. Scenarios were developed to capture the variation in evacuation demand, highway capacity and mobilization time, for different time of day, day of the week, time of year, and weather conditions.

Step 8

The input stream for the DYNEV II model, which integrates the dynamic traffic assignment and distribution model, DTRAD, with the evacuation simulation model, was created for a prototype evacuation case – the evacuation of the entire EPZ for a representative scenario.

Step 9

After creating this input stream, the DYNEV II System was executed on the prototype evacuation case to compute evacuating traffic routing patterns consistent with the appropriate NRC guidelines. DYNEV II contains an extensive suite of data diagnostics which check the completeness and consistency of the input data specified. The analyst reviews all warning and error messages produced by the model and then corrects the database to create an input stream that properly executes to completion.

The model assigns destinations to all origin centroids consistent with a (general) radial evacuation of the EPZ and Shadow Region. The analyst may optionally supplement and/or replace these model-assigned destinations, based on professional judgment, after studying the topology of the analysis highway network. The model produces link and network-wide measures of effectiveness as well as estimates of evacuation time.

Step 10

The results generated by the prototype evacuation case are critically examined. The examination includes observing the animated graphics (using the EVAN software which operates on data produced by DYNEV II) and reviewing the statistics output by the model. This is a labor-intensive activity, requiring the direct participation of skilled engineers who possess the necessary practical experience to interpret the results and to determine the causes of any problems reflected in the results.

Essentially, the approach is to identify those bottlenecks in the network that represent locations where congested conditions are pronounced and to identify the cause of this congestion. This cause can take many forms, either as excess demand due to high rates of trip generation, improper routing, a shortfall of capacity, or as a quantitative flaw in the way the physical system was represented in the input stream. This examination leads to one of two conclusions:

- The results are satisfactory; or
- The input stream must be modified accordingly.

This decision requires, of course, the application of the user's judgment and experience based upon the results obtained in previous applications of the model and a comparison of the results of the latest prototype evacuation case iteration with the previous ones. If the results are satisfactory in the opinion of the user, then the process continues with Step 13. Otherwise, proceed to Step 11.

Step 11

There are many "treatments" available to the user in resolving apparent problems. These treatments range from decisions to reroute the traffic by assigning additional evacuation destinations for one or more sources, imposing turn restrictions where they can produce significant improvements in capacity, changing the control treatment at critical intersections so as to provide improved service for one or more movements, or in prescribing specific treatments for channelizing the flow so as to expedite the movement of traffic along major roadway systems. Such "treatments" take the form of modifications to the original prototype evacuation case input stream. All treatments are designed to improve the representation of evacuation behavior.

Step 12

As noted above, the changes to the input stream must be implemented to reflect the modifications undertaken in Step 11. At the completion of this activity, the process returns to Step 9 where the DYNEV II System is again executed.

Step 13

Evacuation of transit-dependent evacuees and special facilities are included in the evacuation analysis. Fixed routing for transit buses and for school buses, ambulances, and other transit vehicles are introduced into the final prototype evacuation case data set. DYNEV II generates route-specific speeds over time for use in the estimation of evacuation times for the transit

dependent and special facility population groups.

Step 14

The prototype evacuation case was used as the basis for generating all region and scenario-specific evacuation cases to be simulated. This process was automated through the UNITES user interface. For each specific case, the population to be evacuated, the trip generation distributions, the highway capacity and speeds, and other factors are adjusted to produce a customized case-specific data set.

Step 15

All evacuation cases are executed using the DYNEV II System to compute ETE. Once results were available, quality control procedures were used to assure the results were consistent, dynamic routing was reasonable, and traffic congestion/bottlenecks were addressed properly.

Step 16

Once vehicular evacuation results are accepted, average travel speeds for transit and special facility routes were used to compute evacuation time estimates for transit-dependent permanent residents, schools, hospitals, and other special facilities.

Step 17

The simulation results are analyzed, tabulated and graphed. The results were then documented, as required by NUREG/CR-7002.

Step 18

Following the completion of documentation activities, the ETE criteria checklist (see Appendix N) was completed. An appropriate report reference is provided for each criterion provided in the checklist.

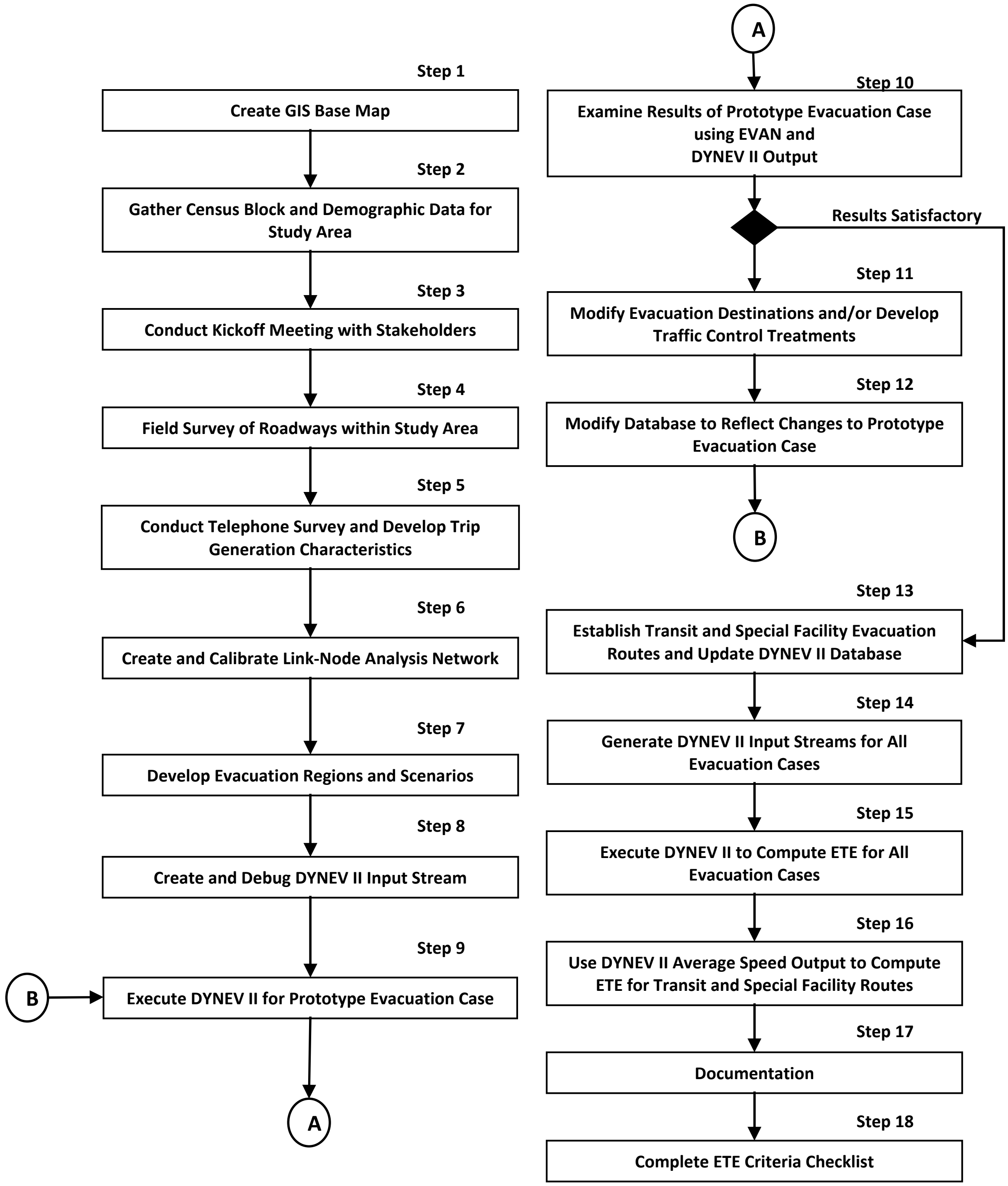


Figure D-1. Flow Diagram of Activities

APPENDIX E

Special Facility Data

E. SPECIAL FACILITY DATA

The following tables list population information, as of March 2012, for special facilities that are located within the River Bend Station EPZ. Special facilities are defined as schools, day care centers, hospitals and other medical care facilities, and correctional facilities. Transient population data is included in the tables for recreational areas and lodging facilities. Employment data is included in the tables for major employers. Each table is grouped by parish. The location of the facility is defined by its straight-line distance (miles) and direction (magnetic bearing) from the center point of the plant. Maps of each school, day care center, recreational area, lodging facility, major employer and correctional facilities are also provided.

Table E-1. Schools within the EPZ

PAS	Distance (miles)	Dire-ction	School Name	Street Address	Municipality	Phone	Enroll-ment	Staff
EAST BATON ROUGE, LA								
14	7.3	SSE	Port Hudson Career Academy	205 West Flonacher Road	Zachary	(225) 658-7381	125	17
						East Baton Rouge Parish Subtotals:	*125*	*17*
EAST FELICIANA, LA								
10	9.9	ENE	Jackson Public Schools	3501 Louisiana 10	Jackson	(225) 634-5933	911	105
10	9.9	ENE	Louisiana Technical College- Folkes Campus	3337 Louisiana 10	Jackson	(225) 634-2636	80	-
						East Feliciana Parish Subtotals:	*991*	*105*
POINTE COUPEE, LA								
17	10.5	SSW	Rougon Elementary School	13258 Louisiana 416	Rougon	(225) 638-8066	406	50
18	7.2	WSW	Rosenwald Elementary School	1100 New Roads Street	New Roads	(225) 638-6341	475	65
18	7.6	SW	Catholic Schools - New Roads	302 Napoleon Street	New Roads	(225) 638-9313	679	85
18	8.8	WSW	False River Academy	201 Major Pkwy	New Roads	(225) 638 3783	583	50
18	9.4	WSW	Louisiana Technical College- Jumonville Campus	605 Hospital Road	New Roads	(225) 634-2636	140	-
						Pointe Coupee Parish Subtotals:	*2,283*	*250*
WEST FELICIANA, LA								
2	5.5	NNW	Bains Elementary School	9792 Bains Road	St. Francisville	(225) 635-3272	619	60
2	5.5	NNW	Bains Lower Elementary	9794 Bains Road	St. Francisville	(225) 635-4696	534	31
2	5.7	NNW	West Feliciana Middle School	9559 Bains Road	St. Francisville	(225) 635-3898	575	73
2	5.8	NNW	West Feliciana High School	8604 Highway 61 North	St. Francisville	(225) 635-4561	653	65
						West Feliciana Parish Subtotals:	*2,381*	*229*
						TOTAL:	**5,780**	**601**

Table E-2. Daycares and Preschools within the EPZ

PAS	Distance (miles)	Dire-ction	School Name	Street Address	Municipality	Phone	Enroll-ment	Staff
EAST FELICIANA, LA								
10	9.0	NE	Quad Area-Jackson Head Start	3531 Cottage Street	Jackson	(225) 634-2813	97	15
						East Feliciana Parish Subtotals:	*97*	*15*
POINTE COUPEE, LA								
18	7.3	WSW	New Roads Kiddie College	1100 New Roads St	New Roads	(800) 433-3243	57	11
18	9.4	WSW	Christian Women Caring for Children	3462 Mary Drive	New Roads	(225) 618-8080	26	6
18	9.4	WSW	Mae Mae's Playhouse and Preschool	3432 Ewing Drive	New Roads	(225) 635-5437	60	14
18	9.5	WSW	Kid D Land Daycare & Learning	3432 Ewing Drive	New Roads	(225) 638-5435	31	4
						Pointe Coupee Parish Subtotals:	*174*	*35*
WEST FELICIANA, LA								
2	3.3	WNW	Grace Preschool	11621 Louisiana Highway 1258	St. Francisville	(225) 635-4065	35	7
2	3.4	WNW	Chase Ministries	9856 Royal Street	St. Francisville	(225) 784-0024	28	8
2	3.6	NW	First Step Day Care & Learning Center	9912 Wilcox St.	St. Francisville	(225) 635-4050	75	8
2	3.8	NNW	In the Beginning Child Development Center	12404 Louisiana 10	St. Francisville	(225) 635-6111	56	17
6	5.9	NNW	Girl Scout Camp Marydale	10317 Marydale Road	St. Francisville	(225) 635-3112	263	-
						West Feliciana Parish Subtotals:	*457*	*40*
						TOTAL:	**728**	**90**

Table E-3. Medical Facilities within the EPZ

PAS	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	Phone	Current Census	Ambu-latory Patients	Wheel-chair Patients	Bed-ridden Patients
EAST FELICIANA PARISH, LA										
10	8.6	NE	Feliciana Dialysis Center	2995 Race Street	Jackson	(225) 634-2733	48	48	0	0
10	8.9	NE	East Louisiana State Hospital	4502 Highway 951	Jackson	(225) 634-0100	591	591	0	0
10	9.3	NE	Jackson Special Hospital	4502 Highway 951	Jackson	(225) 634-0100	45	45	0	0
						East Feliciana Parish Subtotals:	*684*	*684*	*0*	*0*
POINTE COUPEE PARISH, LA										
18	8.7	SW	Pointe Coupee Healthcare	1820 False River Drive	New Roads	(504) 837-3144	78	27	48	3
18	9.2	WSW	Pointe Coupee General Hospital	2202 False River Drive	New Roads	(225) 638-6331	27	14	13	0
18	9.3	WSW	False River Manor Apartments	1102 Hospital Road	New Roads	(225) 638-9080	40	40	0	0
18	9.3	WSW	Lakeview Manor Nursing Home	400 Hospital Road	New Roads	(225) 638-4404	100	50	40	10
18	9.5	WSW	New Roads Manor Apartments	151 Grezaffi Drive	New Roads	(225) 638-4768	32	32	0	0
						Pointe Coupee Parish Subtotals:	*277*	*163*	*101*	*13*
WEST FELICIANA PARISH, LA										
2	2.7	NW	West Feliciana Parish Hospital	5266 Commerce Street	St. Francisville	(225) 635-3811	15	15	0	0
3	6.4	NNE	St. Francisville Country Manor	15243 La Highway 10	St. Francisville	(225) 635-3346	124	111	13	0
						West Feliciana Parish Subtotals:	*139*	*126*	*13*	*0*
						TOTAL:	**1,100**	**973**	**114**	**13**

Table E-4. Major Employers within the EPZ

PAS	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	Phone	Employees (max shift)	Employees (Non EPZ)
EAST BATON ROUGE, LA								
14	8.1	SSE	Amoco Production Co	Louisiana 3113	Zachary	(225) 654-5443	20	13
14	8.1	SSE	Georgia Pacific - Port Hudson	1000 West Mount Pleasant Zachary Road	Zachary	(225) 654-1700	550	363
						East Baton Rouge Parish Subtotals:	*570*	*376*
EAST FELICIANA, LA								
10	8.9	NE	East Louisiana State Hospital	4502 Highway 951	Jackson	(225) 634-0100	600	396
10	9.9	ENE	Jackson Public Schools	3501 Louisiana 10	Jackson	(225) 634-5933	105	70
10	10.2	ENE	Jackson Hardwood	2528 Louisiana 10	Jackson	(225) 634-5443	32	21
11	8.3	ENE	Dixon Correctional Institute	5568 Highway 68	Jackson	(225) 634-1200	315	208
4	3.3	SSE	KPAQ Industries, LLC	2105 Louisiana 964	St. Francisville	(225) 336-2530	420	277
8	4.2	ESE	Williams Gas Pipeline - Transco	2988 Louisiana 964	Jackson	(225) 654-2047	19	13
9	5.1	SE	Colonial Pipeline Co	HWY 61	Jackson	(225) 654-0414	30	20
						East Feliciana Parish Subtotals:	*1,521*	*1,005*
POINTE COUPEE, LA								
16	2.6	SW	Big Cajun No. 2	10431 Cajun II Road	New Roads	(225) 638-3773	229	151
17	10.5	SSW	Rougon Elementary School	13258 Louisiana 416	Rougon	(225) 638-8066	50	33
18	7.2	WSW	Rosenwald Elementary School	1100 New Roads Street	New Roads	(225) 638-6341	65	43
18	7.6	SW	Catholic Elementary, Middle & High Schools	302 Napoleon Street	New Roads	(225) 638-9313	85	57
18	8.8	WSW	False River Academy	201 Major Pkwy	New Roads	(225) 638 3783	50	33
18	9.1	WSW	Wal-Mart	2050 False River Drive	New Roads	(225) 638-8609	50	33
18	9.2	WSW	Pointe Coupee General Hospital	2202 False River Drive	New Roads	(225) 638-6331	170	112
18	9.3	WSW	Lakeview Manor Nursing Home	400 Hospital Road	New Roads	(225) 638-4404	60	40
18	9.7	WSW	Louisiana Generating LLC	112 Telly Street	New Roads	(225) 618-4000	55	36
18	9.7	WSW	Big Cajun No. 1	112 Telly Street	New Roads	(225) 618-4000	16	11
						Pointe Coupee Parish Subtotals:	*830*	*549*

PAS	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	Phone	Employees (max shift)	Employees (Non EPZ)
WEST FELICIANA, LA								
1	0	-	River Bend Station	5485 US HWY 61	St. Francisville	(225) 635-6094	675	446
2	3.5	W	U.S. Army Corps of Engineer's St. Francisville Casting Yard	11374 Ferdinand St.	St. Francisville	(225) 635-3540	186	123
2	5.5	NNW	Bains Elementary School	9792 Bains Road	St. Francisville	(225) 635-3272	60	40
2	5.7	NNW	West Feliciana Middle School	9559 Bains Road	St. Francisville	(225) 635-3898	73	48
2	5.8	NNW	West Feliciana High School	8604 Highway 61 North	St. Francisville	(225) 635-4561	65	43
6	8.1	NW	Lambert Gravel	8190 Tunica Trace	St. Francisville	(225) 635-3251	7	5
7	7.6	NE	Duke Energy/Texas Eastern	LA HWY 10	Jackson	(225) 634-572	10	7
7	8.0	NE	Texas Eastern Transmission	17238 Louisiana 10	St. Francisville	(225) 634-7105	10	7
						West Feliciana Parish Subtotals:	*1,019*	*719*
						TOTAL:	**3,940**	**2,649**

The RBS Databook did not provide a percent outside EPZ figure for employees. The percentage of 66% was applied to all facilities based on the analysis performed using the U.S. Census Bureau’s Longitudinal Employer-Household Dynamics website.

Table E-5. Recreational Attractions within the EPZ

PAS	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	Phone	Transients	Vehicles
EAST BATON ROUGE, LA								
13	SE	8	Beaver Creek Golf Course	1100 E Plains Port Hudson Rd	Zachary	(225) 658-6338	96	32
						East Baton Rouge Parish Subtotals:	*96*	*32*
EAST FELICIANA, LA								
9	SSE	5.9	Port Hudson State Historic Site	236 U.S. Hwy 61	Jackson	(225) 654-3775	278	146
10	NE	9.1	Centenary State Historic Site	3522 College Street	Jackson	N/A	127	77
10	9.9	ENE	Louisiana Technical College-Folkes Campus	3337 Louisiana 10	Jackson	(225) 634-2636	80	80
						East Feliciana Parish Subtotals:	*485*	*303*
POINTE COUPEE, LA								
18	SSW	5.7	False River Golf and Country Club	13875 Patin Dyke Road	Ventress	(225) 638-6309	45	45
18	WSW	8.6	Pointe Coupee Parks & Rec	1200 Major Parkway	New Roads	(225) 618-2141	107	57
18	9.4	WSW	Louisiana Technical College-Jumonville Campus**	605 Hospital Road	New Roads	(225) 634-2636	140	140
						Pointe Coupee Parish Subtotals:	*292*	*242*
WEST FELICIANA, LA								
1	NNW	1.7	Hemingbough	10101 LA Hwy 965	St. Francisville	(225) 635 6617	510	210
1	NNE	3.5	Peaceful Pines RV Park	11907 LA Hwy 965	St. Francisville	(225) 635-4903	30	16
1	NNE	3.5	Audubon State Historic Site	11788 Louisiana 965	St. Francisville	(225) 635-3739	1,009	92
2	WNW	3.3	West Feliciana Historical Society Museum	11757 Ferdinand St	St. Francisville	(225) 635-6330	105	55
2	NW	3.5	Rosedown Plantation	12501 Louisiana Hwy 10	St. Francisville	(225) 635 3332	150	75
2	W	3.5	River Boat Cruises*	N/A	St. Francisville	N/A	400	14
2	NW	4.6	The Myrtles Plantation	7747 US Highway 61	St. Francisville	(225) 635-6277	115	65
						West Feliciana Parish Subtotals:	*2,319*	*527*
						TOTAL:	**3,192**	**1,104**

[1] River Boats use charter buses to transport visitors to local historic sites. The tours use 7 buses which is equivalent to 14 passenger vehicles.

Table E-6. Hunting Clubs within the EPZ

PAS	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	Phone	Transients	Vehicles
POINTE COUPEE, LA								
18	SW	7.5	Evergreen Hunting Club	10635 Island Rd	Ventress	(225) 638-6309	6	2
						Pointe Coupee Parish Subtotals:	*6*	*2*
WEST FELICIANA, LA								
1	SSW	0.64	June Bug Hunting Club	12212 Powell Station Road	St. Francisville	(225) 405-0387	6	2
1	N	1.1	RBS Hunting Club	5485 HWY 61	St. Francisville	N/A	6	2
1	NE	2.2	WFP Laurel Hunting Club, Inc.	5390 Audubon Lane	St. Francisville	N/A	6	2
1	S	3.7	Dugan's Landing	LA Hwy 964	St. Francisville	N/A	100	50
2	NNW	3.8	Red Bug Hunting Club	11988 Louisiana 10	St. Francisville	N/A	6	2
2	N	4.9	Buckhorn Hunting Club	10231 HWY 421	St. Francisville	N/A	6	2
3	ENE	3.9	Big "D" Hunting Club	4660 Louisiana 966	St. Francisville	(225) 235-7619	6	2
3	NE	4.6	Thompson Creek Bluffs Hunting Club	14056 Louisiana 965	St. Francisville	N/A	6	2
5	W	9	West Feliciana Hunting Club	Cat Island Rd	St. Francisville	N/A	80	40
6	N	6.7	Stirling Road Hunting Club	7787 Country Road 345	St. Francisville	N/A	5	3
6	NW	7.4	Delatte Family Hunting Camp	County Road 653	St. Francisville	N/A	6	2
6	NNW	8.6	Bayou Sara Hunting Camp	RT 66 & Solitude Rd	St. Francisville	N/A	60	30
6	N	8.9	Sage Hill Hunting Club	8115 Country Road 322	St. Francisville	(225) 931-4841	6	2
6	NW	9.5	Big Oak, Gainer, High Point Hunting Club	N/A	St. Francisville	N/A	100	50
7	NNE	6.1	Whitetale Hunting Club	Louisiana 10	St. Francisville	N/A	6	2
7	NNE	6.7	Sugarland Hunting Club	16789 Louisiana 10	St. Francisville	N/A	6	2
7	NNE	7.2	Jack's Hunting Club	Curter Rd.	St. Francisville	N/A	6	2
7	NNE	9.9	North Forty Hunting Club	9722 County Road 203	St. Francisville	N/A	6	2
7	NNE	9.9	Club Back Stage	13255 Weaver Rd	St. Francisville	N/A	6	2
						West Feliciana Parish Subtotals:	*429*	*201*
						TOTAL:	**435**	**203**

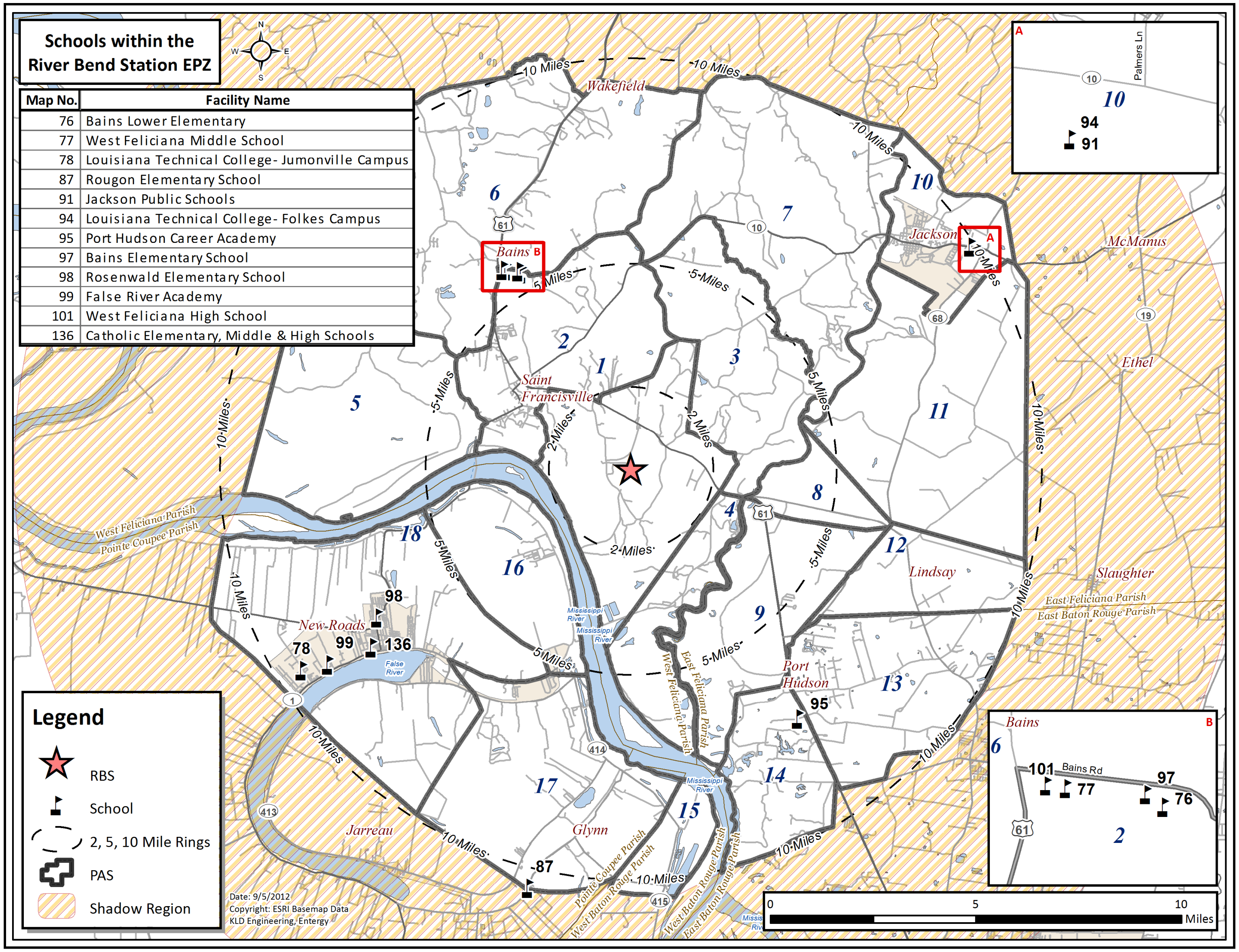
Table E-7. Lodging Facilities within the EPZ

PAS	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	Phone	Transients	Vehicles
EAST FELICIANA, LA								
10	8.9	NE	Old Centenary Inn	1740 Charter Street	Jackson	(225) 634-5050	11	11
						East Feliciana Parish Subtotals:	*11*	*11*
POINTE COUPEE, LA								
18	8.1	SW	Morel's Inn	221 West Main Street	New Roads	(225) 638 7177	13	7
18	9.2	SW	Point Breeze Motel	2111 False River Drive	New Roads	(225) 638 3414	19	12
18	9.4	WSW	Neal's Cypress Inn	675 Hospital Road	New Roads	(225) 638 8084	44	24
						Pointe Coupee Parish Subtotals:	*76*	*43*
WEST FELICIANA, LA								
2	3.1	WNW	St. Francisville Inn	5720 Commerce Street	St. Francisville	(225) 635-6502	13	7
2	3.3	WNW	Magnuson Hotel	7059 US Highway 61	St. Francisville	(225) 635-3831	350	150
2	3.3	NW	Best Western St. Francisville Hotel	6756 US Highway 61	St. Francisville	(225) 635-5851	121	72
2	3.5	NW	Barrow House Bed & Breakfast	9779 Royal Street	St. Francisville	(225) 635-4791	20	10
6	7.2	NNW	The Cottage Plantation	10528 Cottage Lane	St. Francisville	(225) 635-3674	14	8
7	9.9	NE	The Bluffs Country Club & Resort	14233 Sunrise Way	St. Francisville	(225) 634 5222	157	128
						West Feliciana Parish Subtotals:	*675*	*375*
						TOTAL:	**762**	**429**

Table E-8. Correctional Facilities within the EPZ

PAS	Distance (miles)	Dire-ction	Facility Name	Street Address	Municipality	Phone	Capacity
				EAST FELICIANA, LA			
11	8.3	ENE	Dixon Correctional Institute	5568 Highway 68	Jackson	(225) 634-1200	1470
						East Feliciana Parish Subtotals:	*1,470*
				POINTE COUPEE, LA			
16	3.1	WSW	Pointe Coupee Detention Center	10933 Cajun II Road	New Roads	(225) 638-5407	100
						Pointe Coupee Parish Subtotals:	*100*
				WEST FELICIANA, LA			
2	3.4	WNW	West Feliciana Parish Jail	4789 CR-418	St. Francisville	(225) 635-6513	44
6	9.1	N	Prison Enterprises Wakefield Plant	10832 HWY 61	St. Francisville	(225) 342-6633	7
						West Feliciana Parish Subtotals:	*51*
						TOTAL:	**1,621**

Figure E-1. Schools within the EPZ



Map No.	Facility Name
76	Bains Lower Elementary
77	West Feliciana Middle School
78	Louisiana Technical College- Jumonville Campus
87	Rougon Elementary School
91	Jackson Public Schools
94	Louisiana Technical College- Folkes Campus
95	Port Hudson Career Academy
97	Bains Elementary School
98	Rosenwald Elementary School
99	False River Academy
101	West Feliciana High School
136	Catholic Elementary, Middle & High Schools

Figure E-2. Pre-schools and Daycares within the EPZ

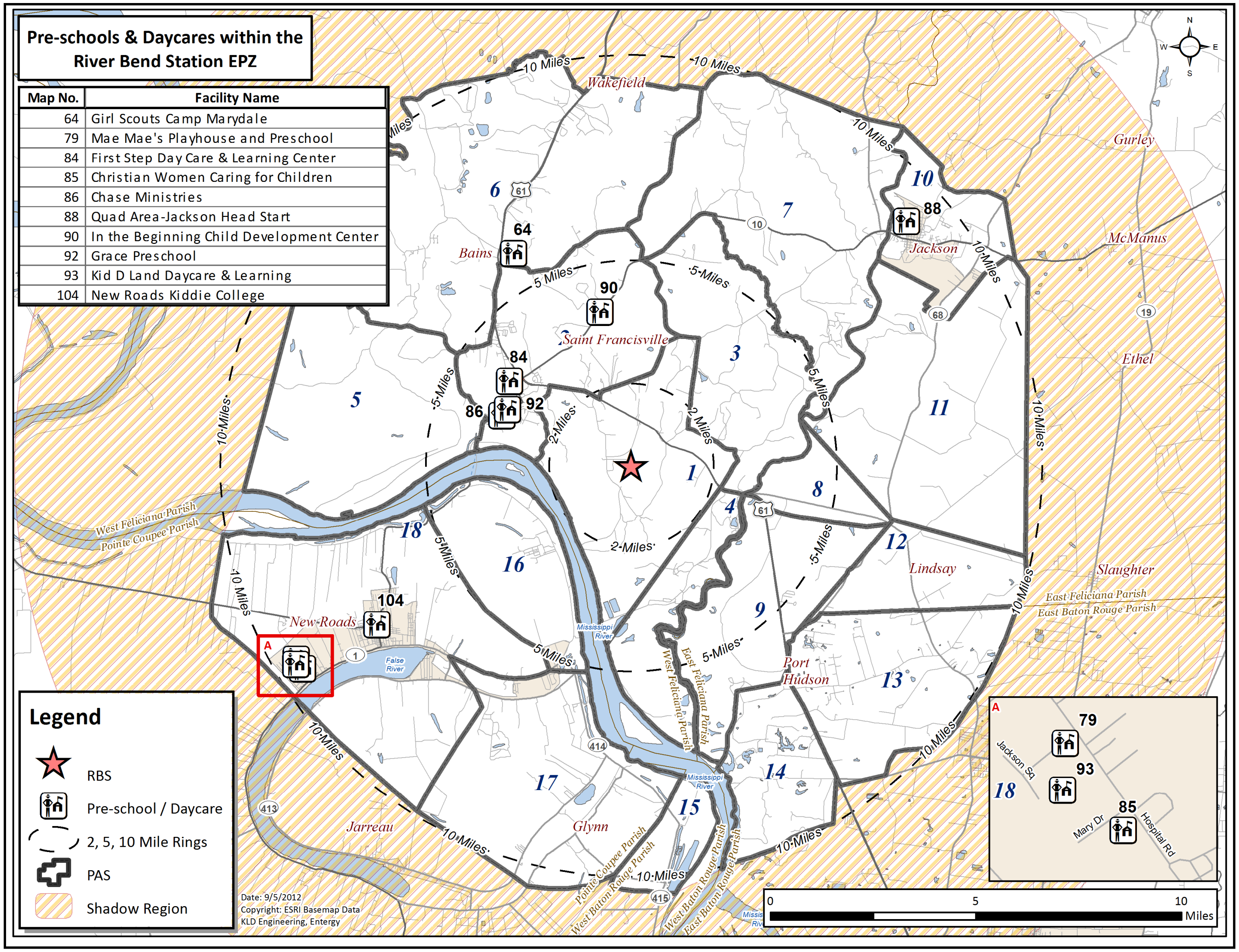
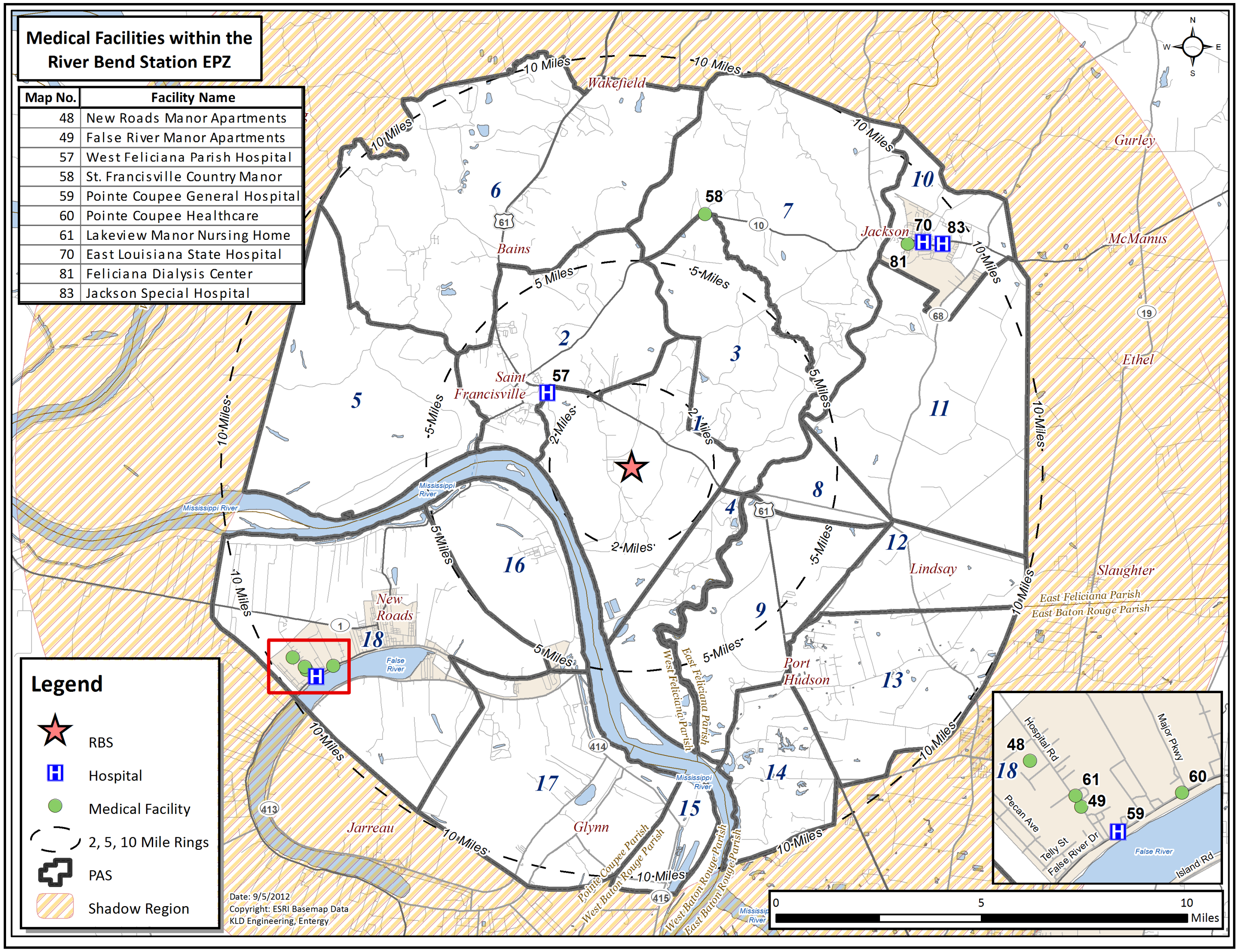


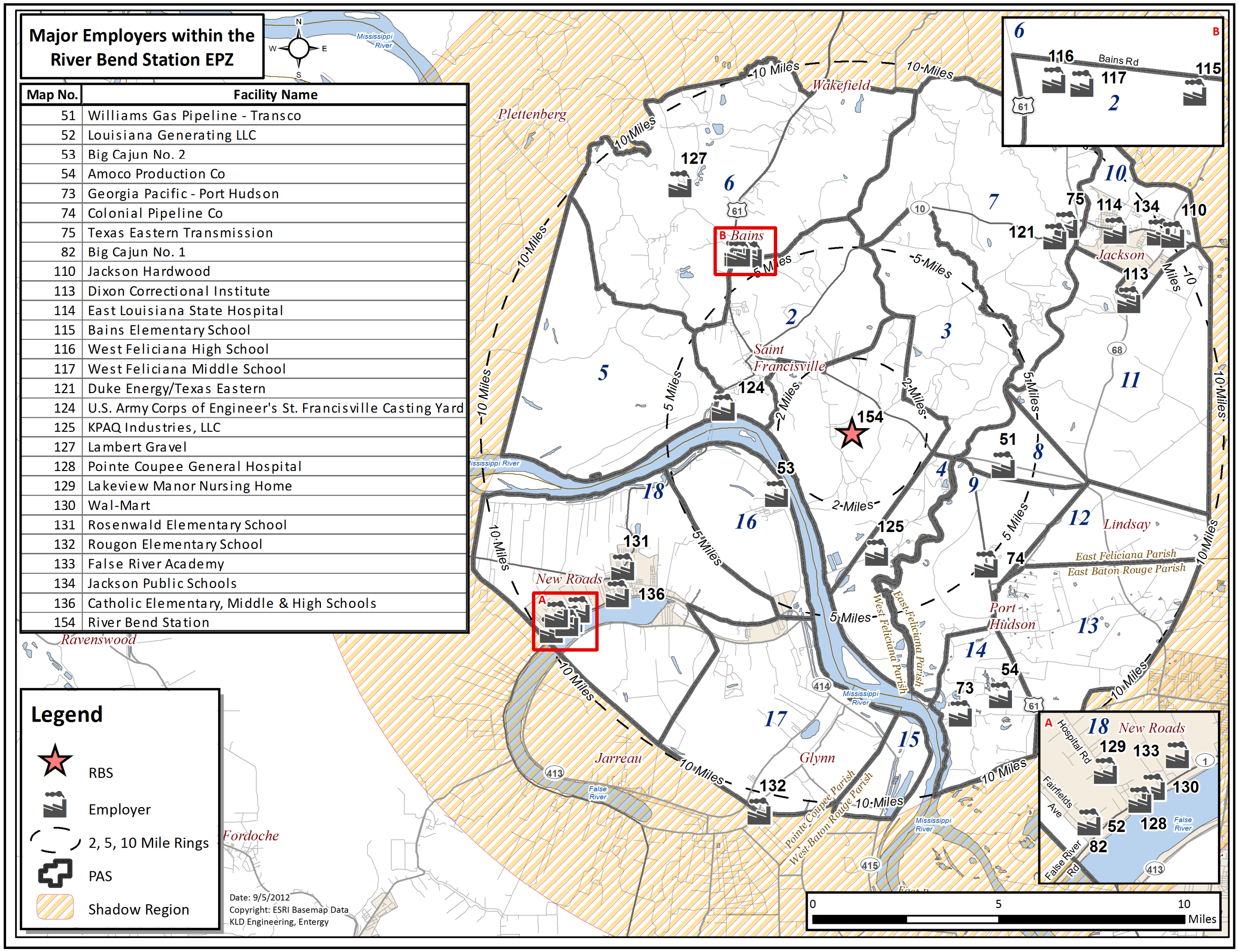
Figure E-3. Medical Facilities within the EPZ



Medical Facilities within the River Bend Station EPZ

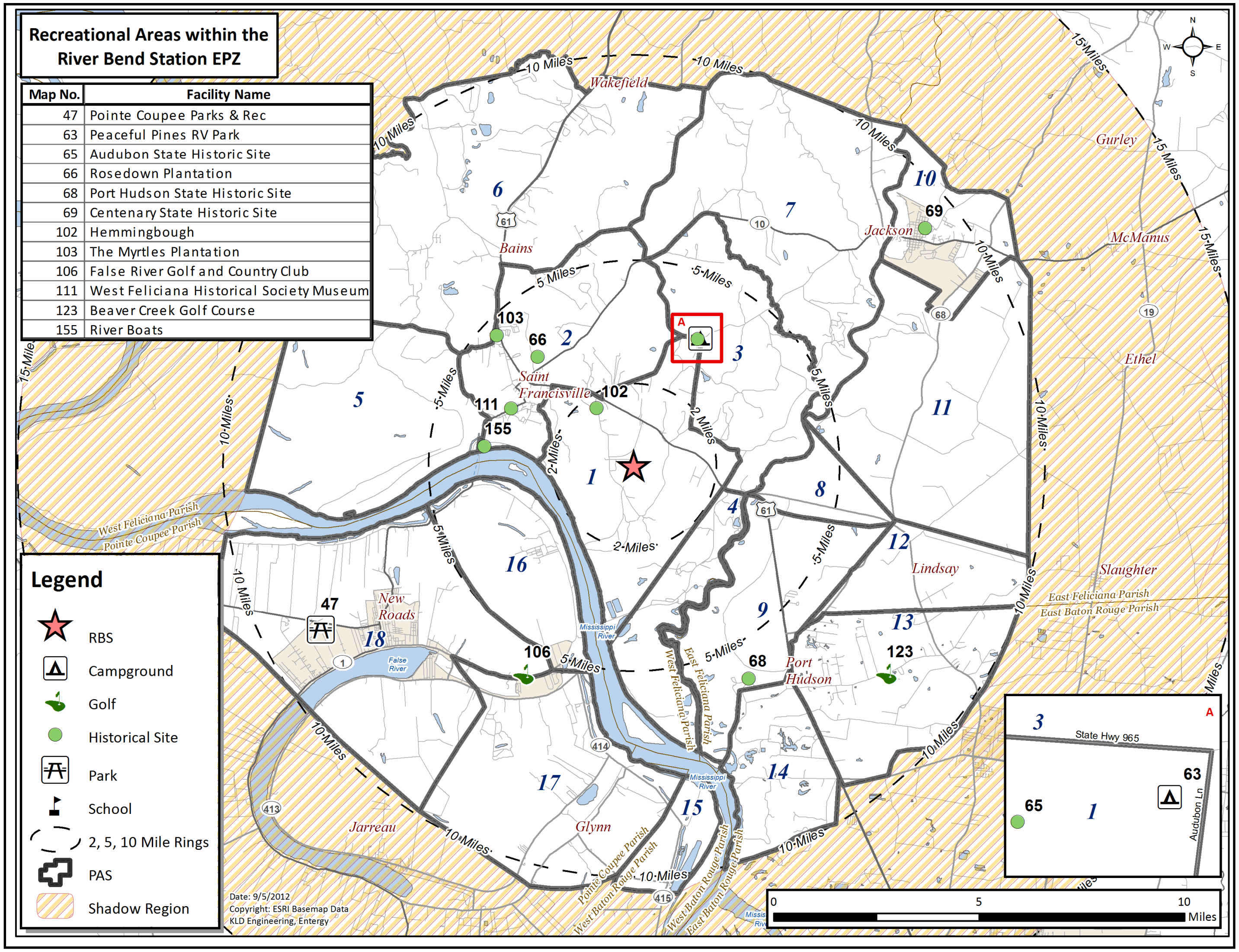
Map No.	Facility Name
48	New Roads Manor Apartments
49	False River Manor Apartments
57	West Feliciana Parish Hospital
58	St. Francisville Country Manor
59	Pointe Coupee General Hospital
60	Pointe Coupee Healthcare
61	Lakeview Manor Nursing Home
70	East Louisiana State Hospital
81	Feliciana Dialysis Center
83	Jackson Special Hospital

Figure E-4. Major Employers within the EPZ



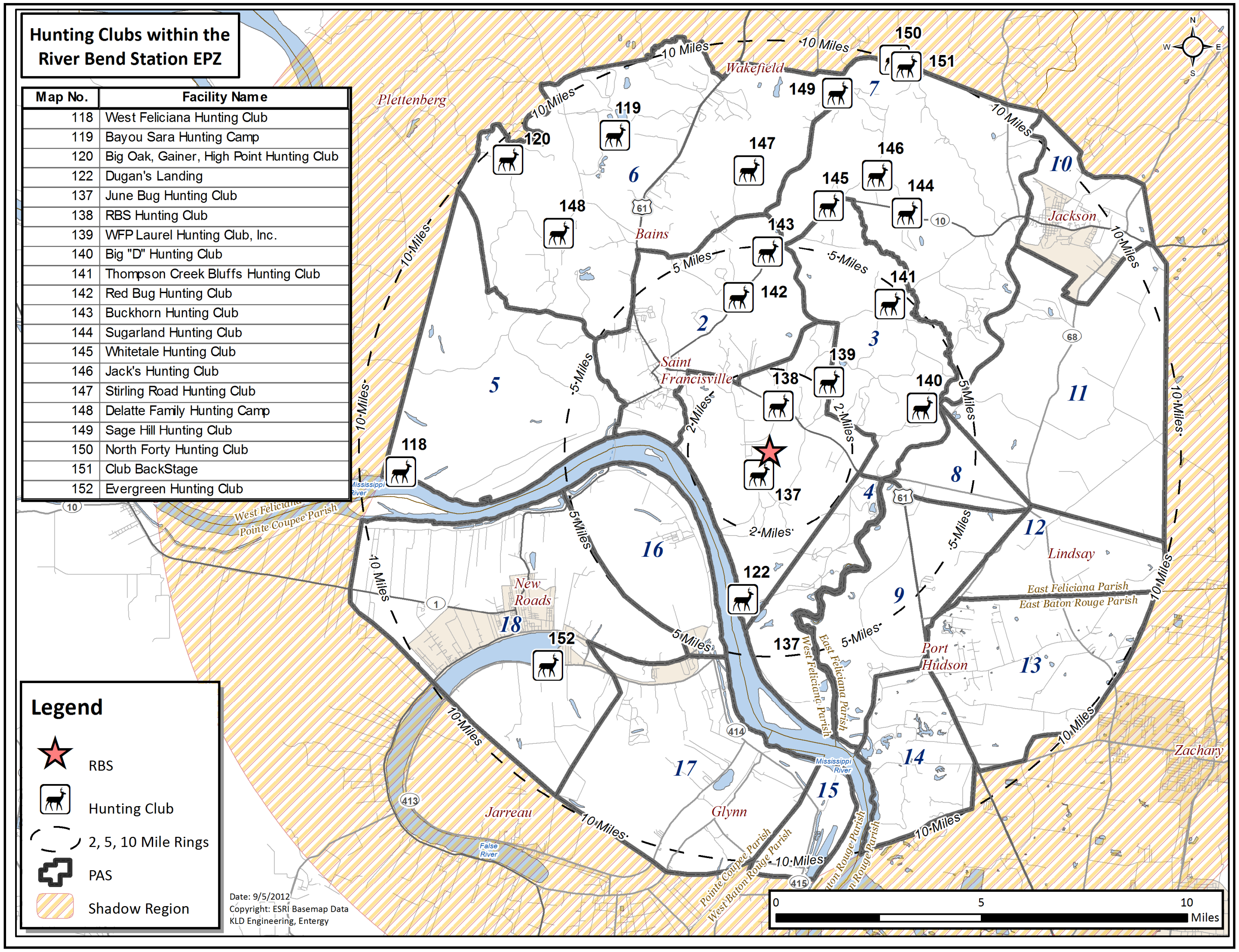
Map No.	Facility Name
51	Williams Gas Pipeline - Transco
52	Louisiana Generating LLC
53	Big Cajun No. 2
54	Amoco Production Co
73	Georgia Pacific - Port Hudson
74	Colonial Pipeline Co
75	Texas Eastern Transmission
82	Big Cajun No. 1
110	Jackson Hardwood
113	Dixon Correctional Institute
114	East Louisiana State Hospital
115	Bains Elementary School
116	West Feliciana High School
117	West Feliciana Middle School
121	Duke Energy/Texas Eastern
124	U.S. Army Corps of Engineer's St. Francisville Casting Yard
125	KPAQ Industries, LLC
127	Lambert Gravel
128	Pointe Coupee General Hospital
129	Lakeview Manor Nursing Home
130	Wal-Mart
131	Rosenwald Elementary School
132	Rougon Elementary School
133	False River Academy
134	Jackson Public Schools
136	Catholic Elementary, Middle & High Schools
154	River Bend Station

Figure E-5. Recreational Areas within the EPZ



Map No.	Facility Name
47	Pointe Coupee Parks & Rec
63	Peaceful Pines RV Park
65	Audubon State Historic Site
66	Rosedown Plantation
68	Port Hudson State Historic Site
69	Centenary State Historic Site
102	Hemmingbough
103	The Myrtles Plantation
106	False River Golf and Country Club
111	West Feliciana Historical Society Museum
123	Beaver Creek Golf Course
155	River Boats

Figure E-6. Hunting Clubs within the EPZ



Hunting Clubs within the River Bend Station EPZ

Map No.	Facility Name
118	West Feliciana Hunting Club
119	Bayou Sara Hunting Camp
120	Big Oak, Gainer, High Point Hunting Club
122	Dugan's Landing
137	June Bug Hunting Club
138	RBS Hunting Club
139	WFP Laurel Hunting Club, Inc.
140	Big "D" Hunting Club
141	Thompson Creek Bluffs Hunting Club
142	Red Bug Hunting Club
143	Buckhorn Hunting Club
144	Sugarland Hunting Club
145	Whitetale Hunting Club
146	Jack's Hunting Club
147	Stirling Road Hunting Club
148	Delatte Family Hunting Camp
149	Sage Hill Hunting Club
150	North Forty Hunting Club
151	Club BackStage
152	Evergreen Hunting Club

Figure E-7. Lodging Facilities within the EPZ

Lodging Facilities within the River Bend Station EPZ

Map No.	Facility Name
50	Old Centenary Inn
71	Best Western St. Francisville Hotel
105	Point Breeze Motel
107	The Bluffs Country Club & Resort
108	Morel's Inn
109	Neal's Cypress Inn
112	The Cottage Plantation
156	Barrow House Bed & Breakfast
157	St. Francisville Inn
158	Magnuson Hotel

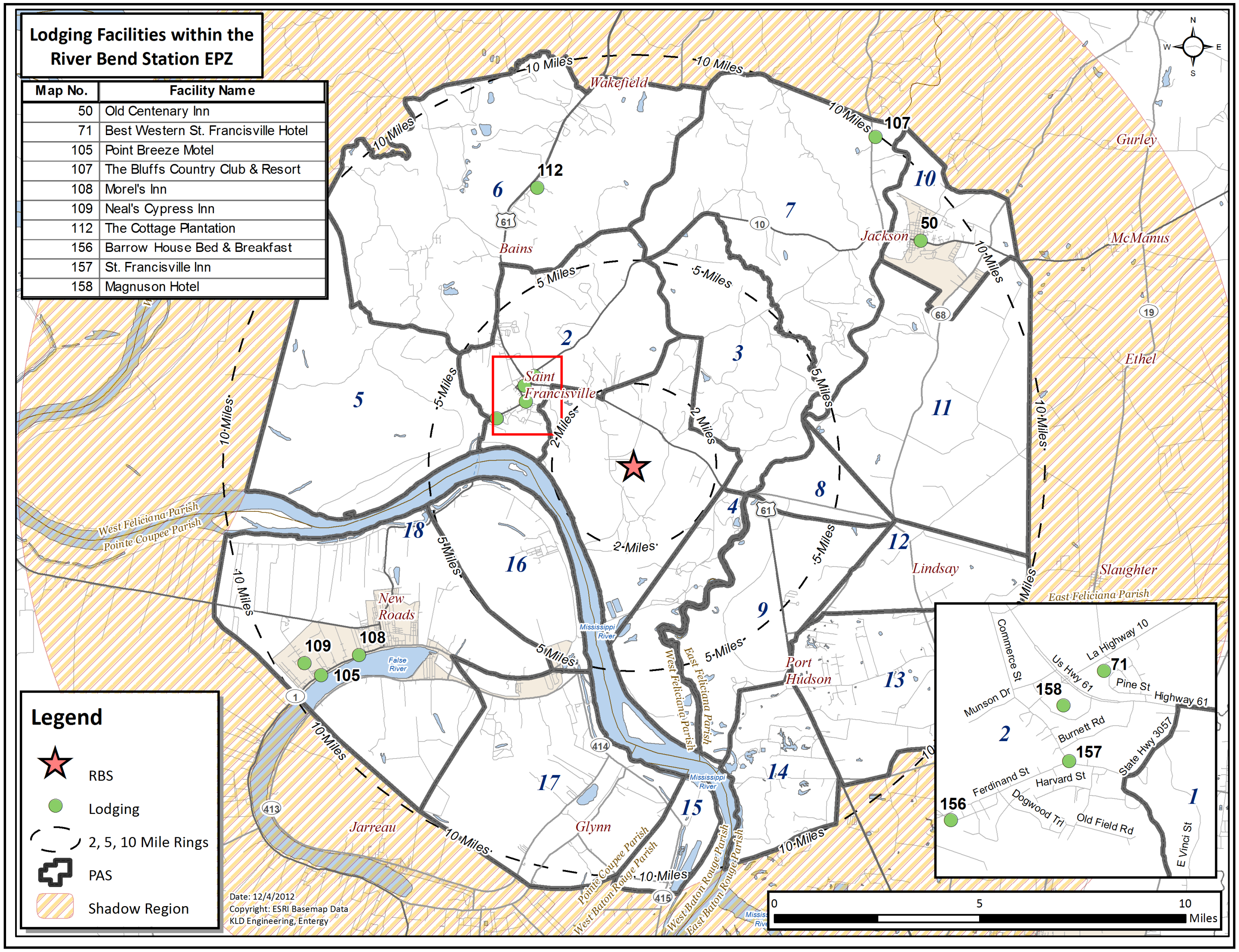
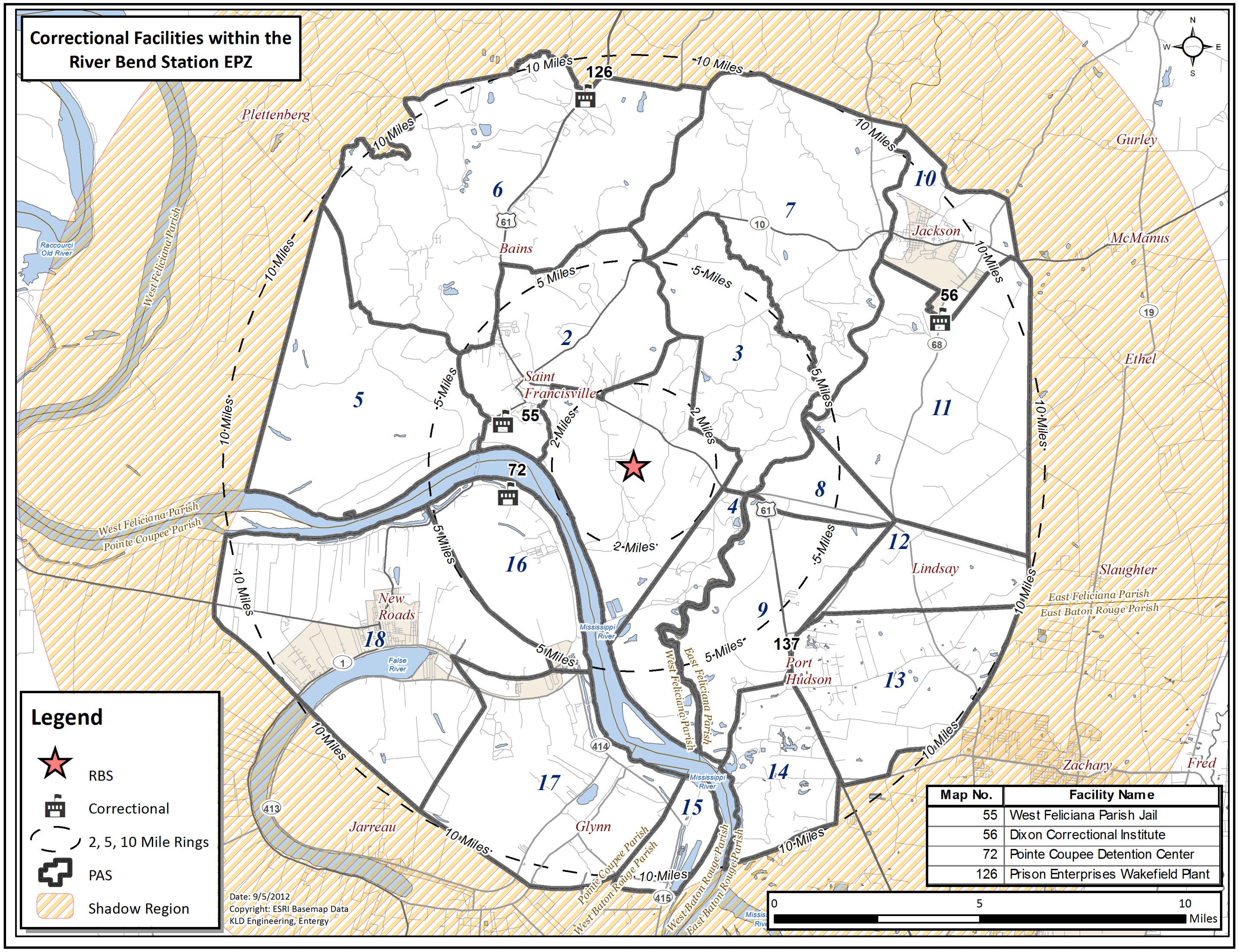


Figure E-8. Correctional Facilities within the EPZ



APPENDIX F

Telephone Survey

F. TELEPHONE SURVEY

F.1 Introduction

The development of evacuation time estimates for the River Bend Station EPZ requires the identification of travel patterns, car ownership and household size of the population within the EPZ. Demographic information can be obtained from Census data. The use of this data has several limitations when applied to emergency planning. First, the Census data do not encompass the range of information needed to identify the time required for preliminary activities (mobilization) that must be undertaken prior to evacuating the area. Secondly, Census data do not contain attitudinal responses needed from the population of the EPZ and consequently may not accurately represent the anticipated behavioral characteristics of the evacuating populace.

These concerns are addressed by conducting a telephone survey of a representative sample of the EPZ population. The survey is designed to elicit information from the public concerning family demographics and estimates of response times to well defined events. The design of the survey includes a limited number of questions of the form "What would you do if …?" and other questions regarding activities with which the respondent is familiar ("How long does it take you to …?")

F.2 Survey Instrument and Sampling Plan

Attachment A presents the final survey instrument used in this study. A draft of the instrument was submitted to stakeholders for comment. Comments were received and the survey instrument was modified accordingly, prior to conducting the survey.

Following the completion of the instrument, a sampling plan was developed. A sample size of approximately 550 **completed** survey forms yields results with a sampling error of ±4.15% at the 95% confidence level. The sample must be drawn from the EPZ population. Consequently, a list of zip codes in the EPZ was developed using GIS software. This list is shown in Table F-1. Along with each zip code, an estimate of the population and number of households in each area was determined by overlaying Census data and the EPZ boundary, again using GIS software. The proportional number of desired completed survey interviews for each area was identified, as shown in Table F-1. Note that the average household size computed in Table F-1 was an estimate for sampling purposes and was not used in the ETE study.

The completed survey adhered to the sampling plan.

Table F-1. RBS Telephone Survey Sampling Plan

Zip Code	Population within EPZ (2000)[1]	Households	Required Sample
70729	62	24	2
70730	211	79	5
70736	512	179	12
70748	5,961	1,509	100
70749	331	146	10
70760	6,989	2,446	162
70773	234	89	6
70775	6,240	2,231	148
70777	109	43	3
70783	2,197	872	58
70791	2,154	696	46
Total	25,000	8,314	550
		Average Household Size:	**3.01**
		Total Sample Required:	**550**

The survey disclosed herein was performed in 2007. The EPZ population has marginally increased by 2.37% (592 people) between the 2000 and 2010 Census (see Section 3.1). In the intervening period, the distribution pattern of population within the EPZ has not changed, nor has the nature of the EPZ. Consequently, the use of 2007 telephone survey sampling plan and results can be justified.

[1]EPZ Population used in 2007 COLA

F.3 Survey Results

The results of the survey fall into two categories. First, the household demographics of the area can be identified. Demographic information includes such factors as household size, automobile ownership, and automobile availability. The distributions of the time to perform certain pre-evacuation activities are the second category of survey results. These data are processed to develop the trip generation distributions used in the evacuation modeling effort, as discussed in Section 5.

A review of the survey instrument reveals that several questions have a “don’t know” (DK) or “refused” entry for a response. It is accepted practice in conducting surveys of this type to accept the answers of a respondent who offers a DK response for a few questions or who refuses to answer a few questions. To address the issue of occasional DK/refused responses from a large sample, the practice is to assume that the distribution of these responses is the same as the underlying distribution of the positive responses. In effect, the DK/refused responses are ignored and the distributions are based upon the positive data that is acquired.

F.3.1 Household Demographic Results

Household Size

Figure F-1 presents the distribution of household size within the EPZ. The average household from the telephone survey contains 2.52 people. The estimated household size (3.01 persons) used to determine the survey sample (Table F-1) was drawn from 2000 Census data. The 2010 Census data indicates there are 25,592 people and 10,156 households. Calculating the average household size based on 2010 Census data results in 2.52 people. The agreement between the average household size obtained from the survey and from the 2010 Census is an indication of the reliability of the survey.

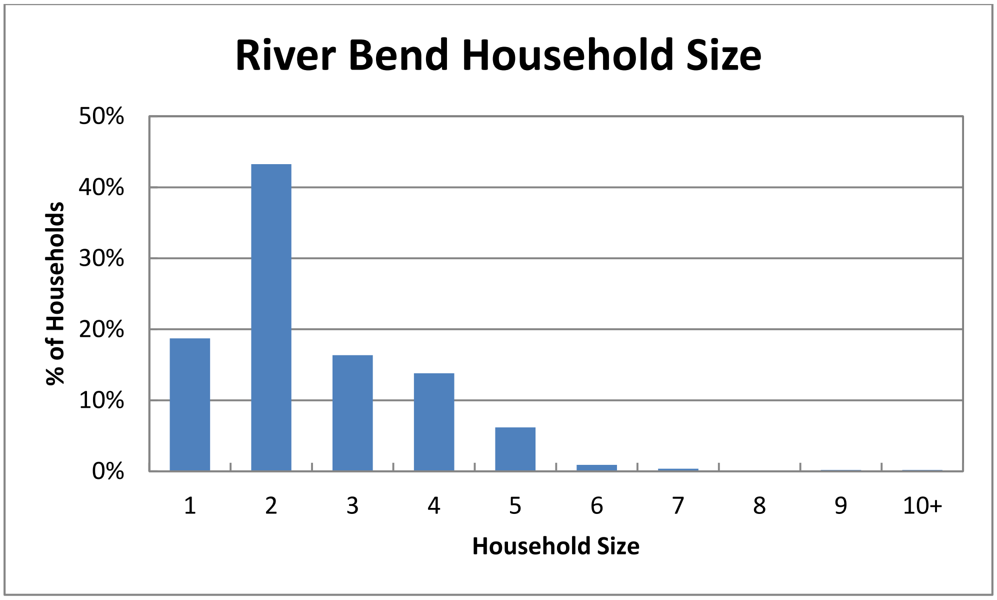


Figure F-1. Household Size in the EPZ

Automobile Ownership

The average number of automobiles available per household in the EPZ is 1.98. It should be noted that approximately 6.75 percent of households do not have access to an automobile. The distribution of automobile ownership is presented in Figure F-2. Figure F-3 and Figure F-4 present the automobile availability by household size. Note that the majority of households without access to a car are single person households. As expected, nearly all households of 2 or more people have access to at least one vehicle.

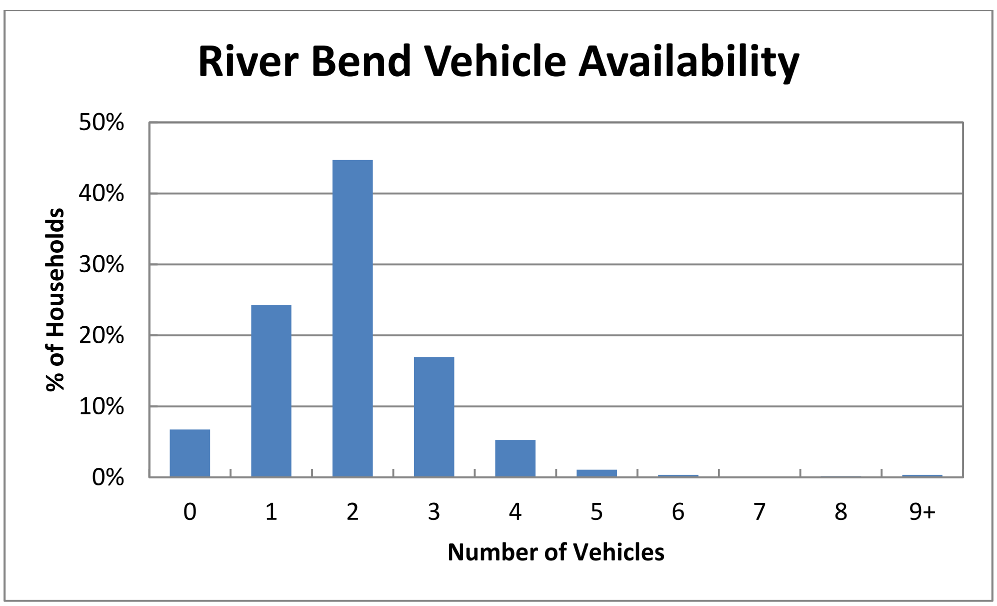


Figure F-2. Household Vehicle Availability

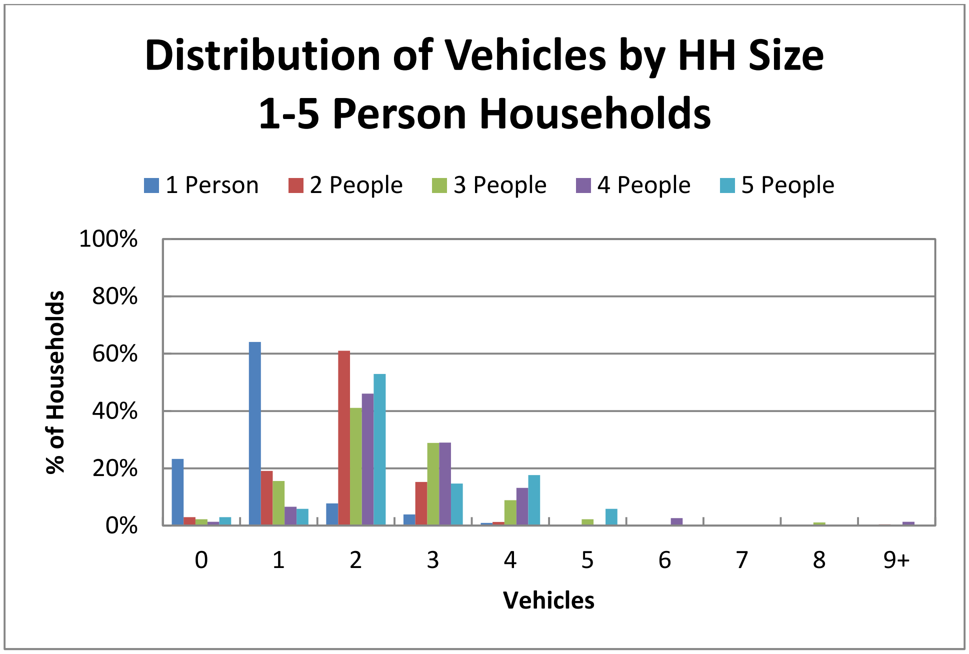


Figure F-3. Vehicle Availability - 1 to 5 Person Households

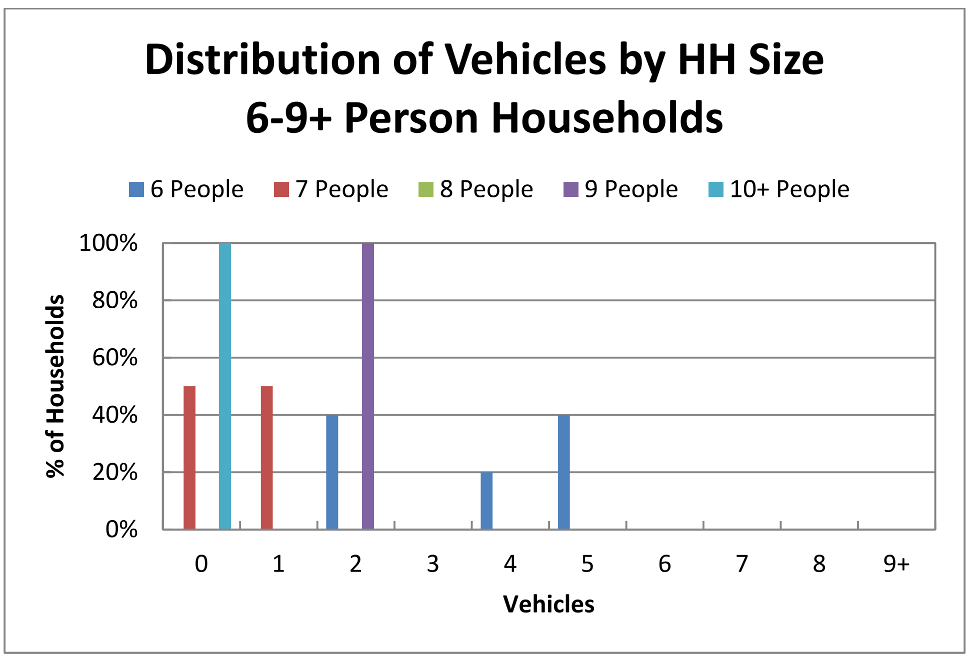


Figure F-4. Vehicle Availability - 6 to 10+ Person Households

Commuters

Figure F-5 presents the distribution of the number of commuters in each household. Commuters are defined as household members who travel to work or college on a daily basis. The data shows an average of 1.00 commuters in each household in the EPZ, and 59% of households have at least one commuter.

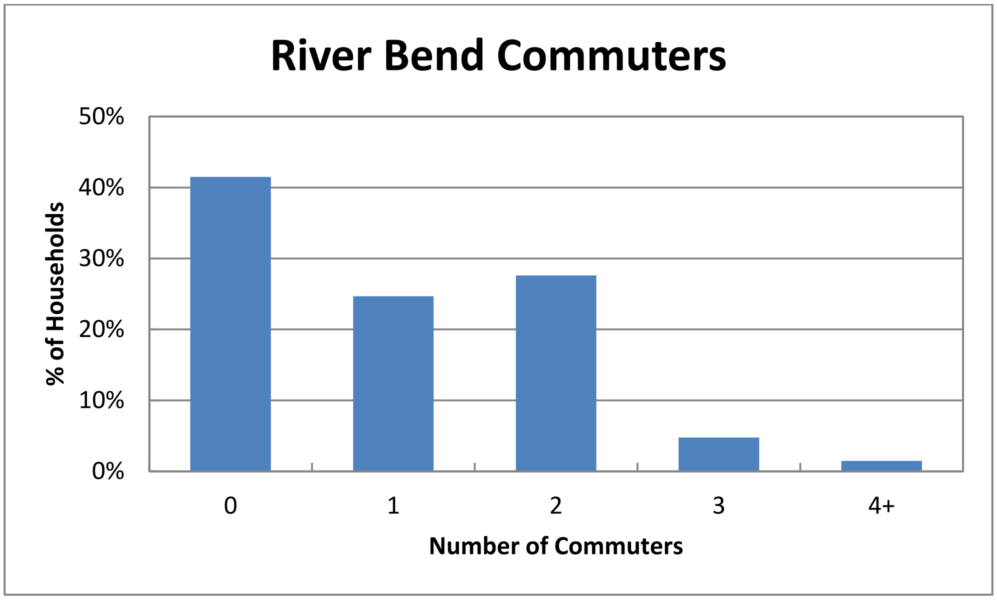


Figure F-5. Commuters in Households in the EPZ

Commuter Travel Modes

Figure F-6 presents the mode of travel that commuters use on a daily basis. The vast majority of commuters use their private automobiles to travel to work. The data shows an average of 1.03 employees per vehicle, assuming 2 people per vehicle – on average – for carpools.

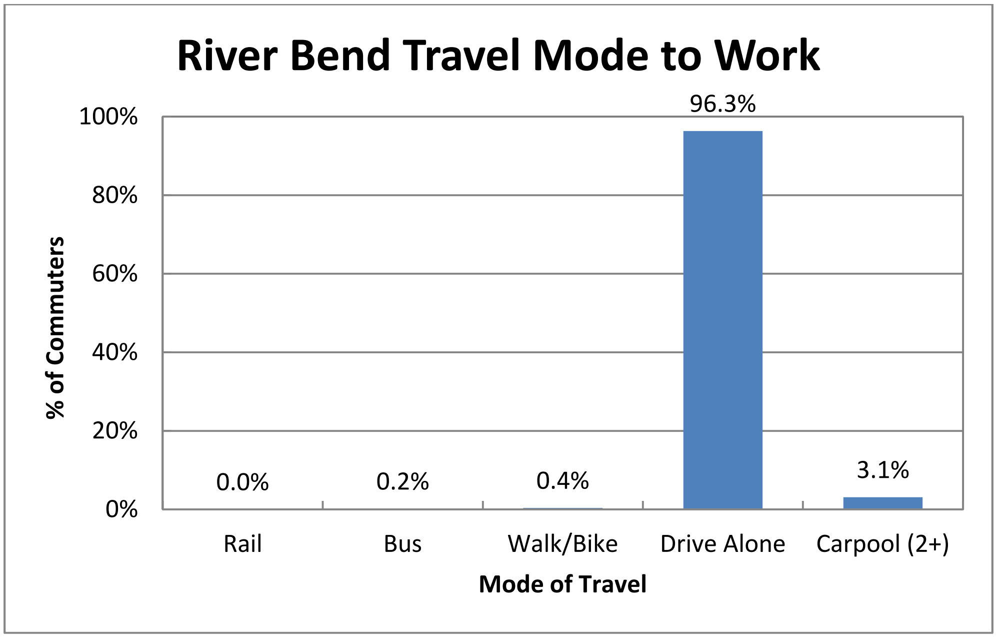


Figure F-6. Modes of Travel in the EPZ

F.3.2 Evacuation Response

Several questions were asked to gauge the population's response to an emergency. These are now discussed:

"How many of the vehicles would your household use during an evacuation?" The response is shown in Figure F-7. On average, evacuating households would use 1.53 vehicles.

"Would your family await the return of other family members prior to evacuating the area?" Of the survey participants who responded, 64 percent said they would await the return of other family members before evacuating and 36 percent indicated that they would not await the return of other family members.

"If you had a household pet, would you take your pet with you if you were asked to evacuate the area?" Based on the responses to the survey, 63 percent of households have a family pet. Of the households with pets, 74 percent of them indicated that they would take their pets with them, as shown in Figure F-8.

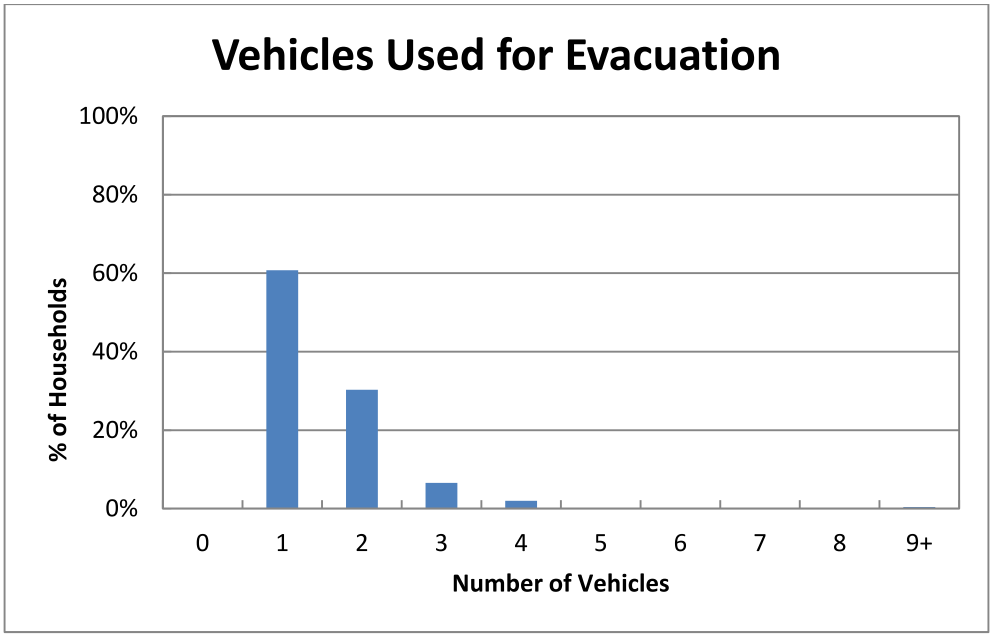


Figure F-7. Number of Vehicles Used for Evacuation

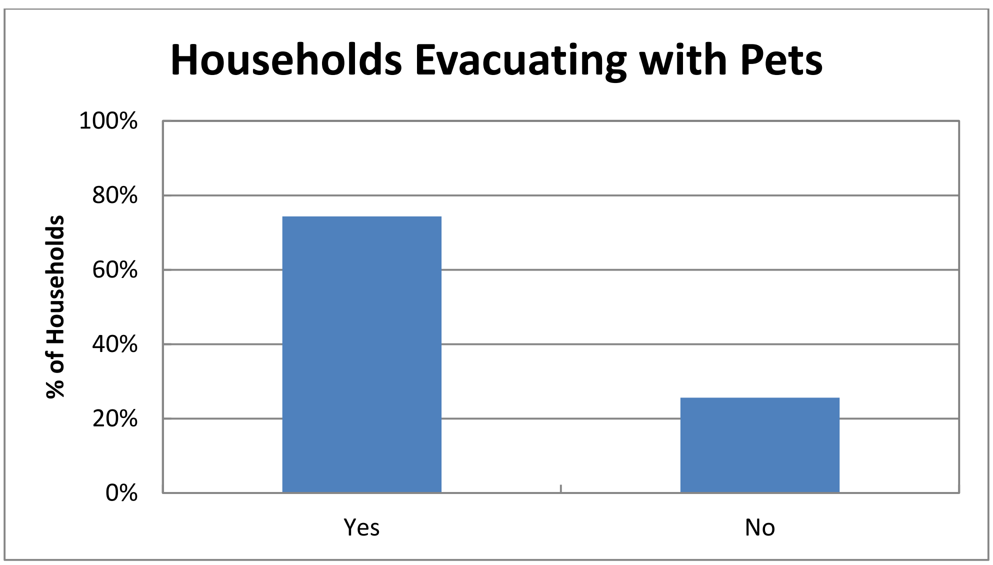


Figure F-8. Households Evacuating with Pets

F.3.3 Time Distribution Results

The survey asked several questions about the amount of time it takes to perform certain pre-evacuation activities. These activities involve actions taken by residents during the course of their day-to-day lives. Thus, the answers fall within the realm of the responder's experience.

The mobilization distributions provided below are the result of having applied the analysis described in Section 5.4.1 on the component activities of the mobilization.

"How long does it take the commuter to complete preparation for leaving work?" Figure F-9 presents the cumulative distribution; in all cases, the activity is completed by about minutes. Eighty-six percent can leave within 45 minutes.

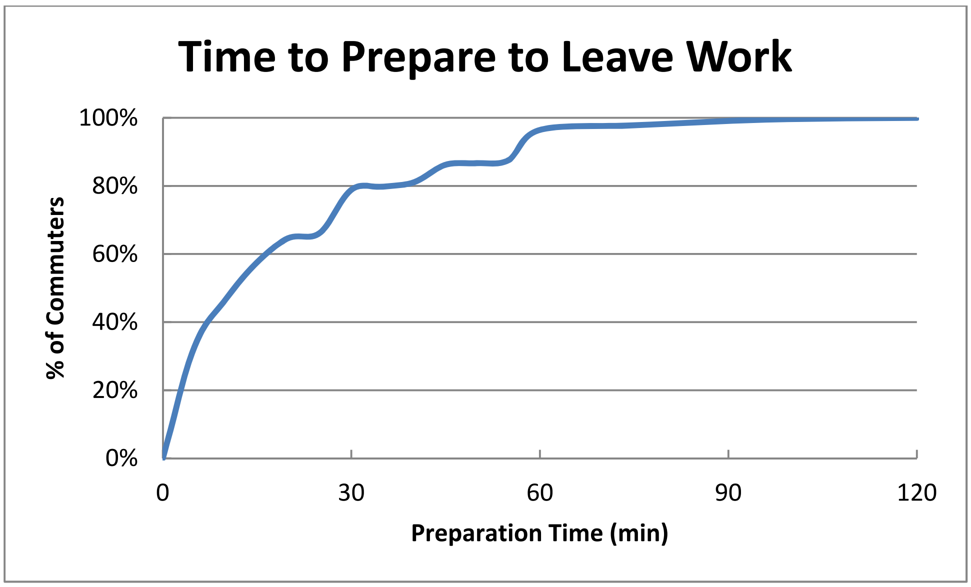


Figure F-9. Time Required to Prepare to Leave Work/School

"How long would it take the commuter to travel home?" Figure F-10 presents the work to home travel time for the EPZ. About 87 percent of commuters can arrive home within about 45 minutes of leaving work; nearly all within 105 minutes.

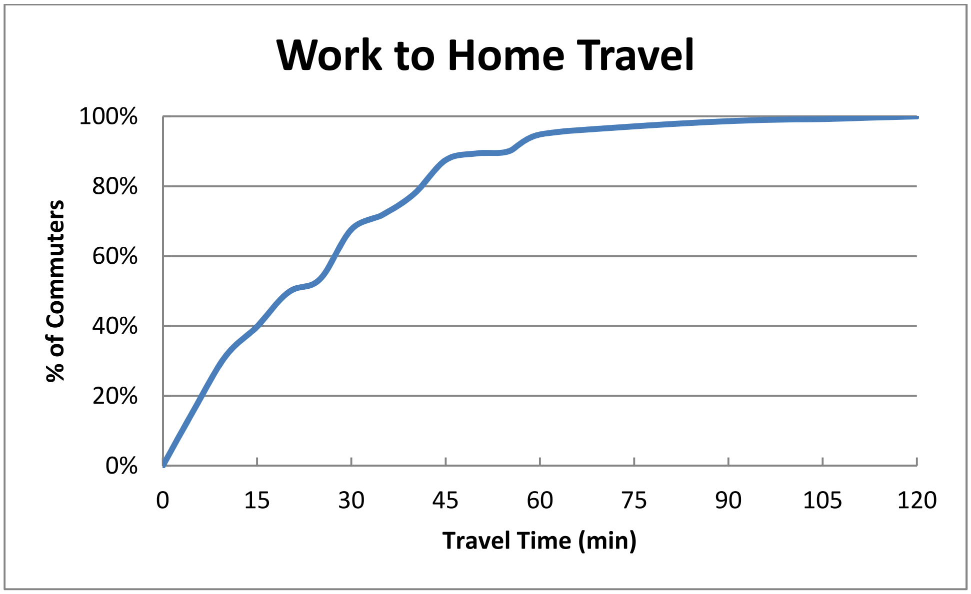


Figure F-10. Work to Home Travel Time

"How long would it take the family to pack clothing, secure the house, and load the car?" Figure F-11 presents the time required to prepare for leaving on an evacuation trip. In many ways this activity mimics a family's preparation for a short holiday or weekend away from home. Hence, the responses represent the experience of the responder in performing similar activities.

The distribution shown in Figure F-11 has a long "tail." About 80 percent of households can be ready to leave home within 60 minutes; the remaining households require up to an additional two hours and a fifteen minutes.

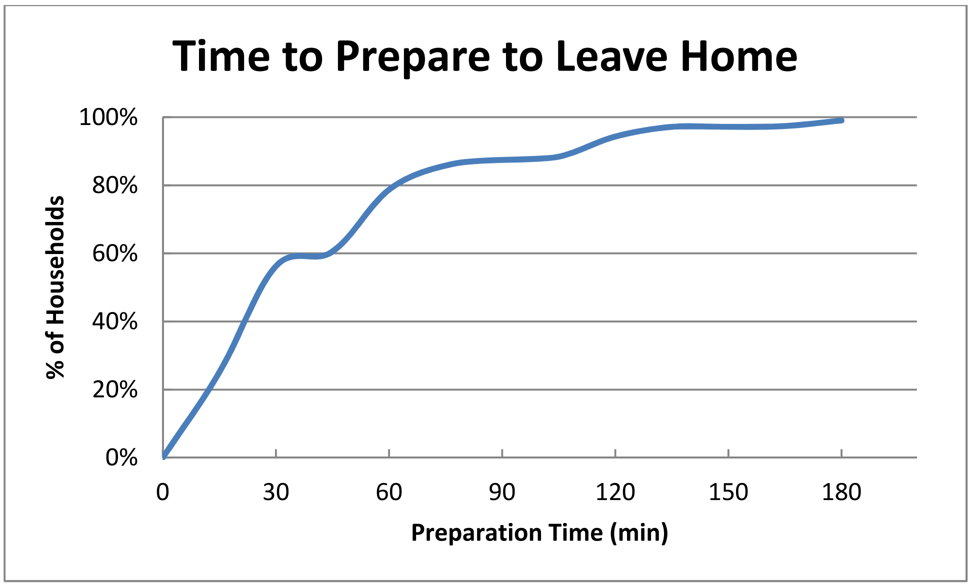


Figure F-11. Time to Prepare Home for Evacuation

F.4 Conclusions

The telephone survey provides valuable, relevant data associated with the EPZ population, which have been used to quantify demographics specific to the EPZ, and "mobilization time" which can influence evacuation time estimates.

ATTACHMENT A

Telephone Survey Instrument

Telephone Survey Instrument

Hello, my name is _______________ and I'm working on a survey being made for [insert marketing firm name] designed to identify local travel patterns in your area. The survey will be used for emergency plans in response to hazards that **are not weather-related**. The information obtained will be used in a traffic engineering study and in connection with an update of the parish's emergency response plans. Your participation in this survey will greatly enhance the parish's emergency preparedness program.

COL.1 Unused
COL.2 Unused
COL.3 Unused
COL.4 Unused
COL.5 Unused

Sex **COL. 8**
1 Male
2 Female

INTERVIEWER: ASK TO SPEAK TO THE HEAD OF HOUSEHOLD OR THE SPOUSE OF THE HEAD OF HOUSEHOLD. (Terminate call if not a residence)

DO NOT ASK:

1A. Record area code. To Be Determined

COL. 9-11

1B. Record exchange number. To Be Determined

COL. 12-14

---

2. What is your home Zip Code **Col. 15-19**

3. In total, how many cars, or other vehicles are usually available to the household? (DO NOT READ ANSWERS.)

COL.20
1 ONE
2 TWO
3 THREE
4 FOUR
5 FIVE
6 SIX
7 SEVEN
8 EIGHT
9 NINE OR MORE
0 ZERO (NONE)
X REFUSED

---

4. How many people usually live in this household? (DO NOT READ ANSWERS.)

COL.21	COL.22
1 ONE	0 TEN
2 TWO	1 ELEVEN
3 THREE	2 TWELVE
4 FOUR	3 THIRTEEN
5 FIVE	4 FOURTEEN
6 SIX	5 FIFTEEN
7 SEVEN	6 SIXTEEN
8 EIGHT	7 SEVENTEEN
9 NINE	8 EIGHTEEN
	9 NINETEEN OR MORE
	X REFUSED

5. How many children living in this household go to local public, private, or parochial schools? (DO NOT READ ANSWERS.)

COL.23
0 ZERO
1 ONE
2 TWO
3 THREE
4 FOUR
5 FIVE
6 SIX
7 SEVEN
8 EIGHT
9 NINE OR MORE
X REFUSED

---

6. How many people in the household commute to a job, or to college, at least 4 times a week?

COL.24		SKIP TO
0	ZERO	Q. 12
1	ONE	Q. 7
2	TWO	Q. 7
3	THREE	Q. 7
4	FOUR OR MORE	Q. 7
5	DON'T KNOW/REFUSED	Q. 12

INTERVIEWER: For each person identified in Question 6, ask Questions 7, 8, 9, and 10.

7. Thinking about commuter #1, how does that person usually travel to work or college? (REPEAT QUESTION FOR EACH COMMUTER.)

	Commuter #1 **COL.25**	Commuter #2 **COL.26**	Commuter #3 **COL.27**	Commuter #4 **COL.28**
Rail	1	1	1	1
Bus	2	2	2	2
Walk/Bicycle	3	3	3	3
Driver Car/Van	4	4	4	4
Park & Ride (Car/Rail, Xpress_bus)	5	5	5	5
Driver Carpool-2 or more people	6	6	6	6
Passenger Carpool-2 or more people	7	7	7	7
Taxi	8	8	8	8
Refused	9	9	9	9

---

8. What is the name of the city, town or community in which Commuter #1 works or attends school? (REPEAT QUESTION FOR EACH COMMUTER.) (FILL IN ANSWER.)

COMMUTER #1			COMMUTER #2			COMMUTER #3			COMMUTER #4		
City/Town		State	City/Town		State	City/Town		State	City/Town		State
COL.29	**COL.30**	**COL.31**	**COL.32**	**COL.33**	**COL.34**	**COL.35**	**COL.36**	**COL.37**	**COL.38**	**COL.39**	**COL.40**
0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6	6	6	6	6

7	7	7	7	7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9	9	9	9	9

9. How long would it take Commuter #1 to travel home from work or college? (REPEAT QUESTION FOR EACH COMMUTER.) (DO NOT READ ANSWERS.)

COMMUTER #1

COL.41
1 5 MINUTES OR LESS
2 6-10 MINUTES
3 11-15 MINUTES
4 16-20 MINUTES
5 21-25 MINUTES
6 26-30 MINUTES
7 31-35 MINUTES
8 36-40 MINUTES
9 41-45 MINUTES

COL.42
1 46-50 MINUTES
2 51-55 MINUTES
3 56 - 1 HOUR
4 OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
5 BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
6 BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
7 BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
8 OVER 2 HOURS (SPECIFY _____)
9
0
X DON'T KNOW/REFUSED

COMMUTER #2

COL.43
1 5 MINUTES OR LESS
2 6-10 MINUTES
3 11-15 MINUTES
4 16-20 MINUTES
5 21-25 MINUTES
6 26-30 MINUTES
7 31-35 MINUTES
8 36-40 MINUTES
9 41-45 MINUTES

COL.44
1 46-50 MINUTES
2 51-55 MINUTES
3 56 - 1 HOUR
4 OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
5 BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
6 BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
7 BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
8 OVER 2 HOURS (SPECIFY _____)
9
0
X DON'T KNOW/REFUSED

COMMUTER #3

COL.45
1 5 MINUTES OR LESS
2 6-10 MINUTES
3 11-15 MINUTES
4 16-20 MINUTES
5 21-25 MINUTES
6 26-30 MINUTES
7 31-35 MINUTES
8 36-40 MINUTES
9 41-45 MINUTES

COL.46
1 46-50 MINUTES
2 51-55 MINUTES
3 56 - 1 HOUR
4 OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES –
5 BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
6 BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
7 BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
8 OVER 2 HOURS (SPECIFY _____)
9
0
X DON'T KNOW/REFUSED

COMMUTER #4

COL.47
1 5 MINUTES OR LESS
2 6-10 MINUTES
3 11-15 MINUTES
4 16-20 MINUTES
5 21-25 MINUTES
6 26-30 MINUTES
7 31-35 MINUTES
8 36-40 MINUTES
9 41-45 MINUTES

COL.48
1 46-50 MINUTES
2 51-55 MINUTES
3 56 - 1 HOUR
4 OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
5 BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
6 BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
7 BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
8 OVER 2 HOURS (SPECIFY _____)
9
0
X DON'T KNOW/REFUSED

10. Approximately how long does it take Commuter #1 to complete preparation for leaving work or college prior to starting the trip home? (REPEAT QUESTION FOR EACH COMMUTER.) (DO NOT READ ANSWERS.)

COMMUTER #1

COL. 49	**COL. 50**
1 5 MINUTES OR LESS	1 46-50 MINUTES
2 6-10 MINUTES	2 51-55 MINUTES
3 11-15 MINUTES	3 56 - 1 HOUR
4 16-20 MINUTES	4 OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
5 21-25 MINUTES	5 BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
6 26-30 MINUTES	6 BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
7 31-35 MINUTES	7 BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
8 36-40 MINUTES	8 OVER 2 HOURS (SPECIFY _____)
9 41-45 MINUTES	9
	0
	X DON'T KNOW/REFUSED

COMMUTER #2

COL. 51	**COL. 52**
1 5 MINUTES OR LESS	1 46-50 MINUTES
2 6-10 MINUTES	2 51-55 MINUTES
3 11-15 MINUTES	3 56 - 1 HOUR
4 16-20 MINUTES	4 OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
5 21-25 MINUTES	5 BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
6 26-30 MINUTES	6 BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
7 31-35 MINUTES	7 BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
8 36-40 MINUTES	8 OVER 2 HOURS (SPECIFY _____)
9 41-45 MINUTES	9
	0
	X DON'T KNOW/REFUSED

COMMUTER #3

COL. 53	**COL. 54**
1 5 MINUTES OR LESS	1 46-50 MINUTES
2 6-10 MINUTES	2 51-55 MINUTES
3 11-15 MINUTES	3 56 - 1 HOUR
4 16-20 MINUTES	4 OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES –
5 21-25 MINUTES	5 BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
6 26-30 MINUTES	6 BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
7 31-35 MINUTES	7 BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
8 36-40 MINUTES	8 OVER 2 HOURS (SPECIFY _____)
9 41-45 MINUTES	9
	0
	X DON'T KNOW/REFUSED

COMMUTER #4

COL. 55	**COL. 56**
1 5 MINUTES OR LESS	1 46-50 MINUTES
2 6-10 MINUTES	2 51-55 MINUTES
3 11-15 MINUTES	3 56 - 1 HOUR
4 16-20 MINUTES	4 OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
5 21-25 MINUTES	5 BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
6 26-30 MINUTES	6 BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
7 31-35 MINUTES	7 BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
8 36-40 MINUTES	8 OVER 2 HOURS (SPECIFY _____)
9 41-45 MINUTES	9
	0
	X DON'T KNOW/REFUSED

---

11. When the commuters are away from home, is there a vehicle at home that is available for evacuation during any emergency?

Col. 57
1 Yes
2 No
3 Don't Know/Refused

12. Would you await the return of family members prior to evacuating the area?

Col. 58
1 Yes
2 No
3 Don't Know/Refused

---

13. How many of the vehicles that are usually available to the household would your family use during an evacuation? (DO NOT READ ANSWERS.)

COL.59
1 ONE
2 TWO
3 THREE
4 FOUR
5 FIVE
6 SIX
7 SEVEN
8 EIGHT
9 NINE OR MORE
0 ZERO (NONE)
X REFUSED

---

14. How long would it take the family to pack clothing, secure the house, load the car, and complete preparations prior to evacuating the area? (DO NOT READ ANSWERS.)

COL.60
1 LESS THAN 15 MINUTES
2 15-30 MINUTES
3 31-45 MINUTES
4 46 MINUTES - 1 HOUR
5 1 HOUR TO 1 HOUR 15 MINUTES
6 1 HOUR 16 MINUTES TO 1 HOUR 30 MINUTES
7 1 HOUR 31 MINUTES TO 1 HOUR 45 MINUTES
8 1 HOUR 46 MINUTES TO 2 HOURS
9 2 HOURS TO 2 HOURS 15 MINUTES
0 2 HOURS 16 MINUTES TO 2 HOURS 30 MINUTES
X 2 HOURS 31 MINUTES TO 2 HOURS 45 MINUTES
Y 2 HOURS 46 MINUTES TO 3 HOURS

COL.61
1 3 HOURS TO 3 HOURS 15 MINUTES
2 3 HOURS 16 MINUTES TO 3 HOURS 30 MINUTES
3 3 HOURS 31 MINUTES TO 3 HOURS 45 MINUTES
4 3 HOURS 46 MINUTES TO 4 HOURS
5 4 HOURS TO 4 HOURS 15 MINUTES
6 4 HOURS 16 MINUTES TO 4 HOURS 30 MINUTES
7 4 HOURS 31 MINUTES TO 4 HOURS 45 MINUTES
8 4 HOURS 46 MINUTES TO 5 HOURS
9 5 HOURS TO 5 HOURS 15 MINUTES
0 5 HOURS 16 MINUTES TO 5 HOURS 30 MINUTES
X 5 HOURS 31 MINUTES TO 5 HOURS 45 MINUTES
Y 5 HOURS 46 MINUTES TO 6 HOURS

COL.62
1 DON'T KNOW

---

15. Would you take household pets with you if you were asked to evacuate the area?

Col. 58
1 Yes
2 No
3 Don't Know/Refused

Thank you very much. ___________________________

(TELEPHONE NUMBER CALLED)

If requested:
For Additional information
Contact your Parish Emergency Management Office

East Baton Rouge OHSEP	389-2100
East Feliciana Parish OHSEP	244-1142
Pointe Coupee Parish OHSEP	694-3737
West Baton Rouge Parish OHSEP	346-1577
West Feliciana Parish OHSEP	635-6428

APPENDIX G

Traffic Management Plan

G. TRAFFIC MANAGEMENT PLAN

NUREG/CR-7002 indicates that the existing TCPs and ACPs identified by the offsite agencies should be used in the evacuation simulation modeling. The traffic and access control plans for the EPZ were provided in the River Bend Data Resources Book.

These plans were reviewed and the TCPs were modeled accordingly.

G.1 Traffic Control Points

As discussed in Section 9, traffic control points at intersections (which are controlled) are modeled as actuated signals. If an intersection has a pre-timed signal, stop, or yield control, and the intersection is identified as a traffic control point, the control type was changed to an actuated signal in the DYNEV II system. Table K-2 provides the control type and node number for those nodes which are controlled. If the existing control was changed due to the point being a Traffic Control Point, the control type is indicated as a TCP in Table K-2.

Figure G-1 maps the TCPs identified in the River Bend Data Resources Book. These TCPS are concentrated in Jackson along SR 10 and New Roads along SR 1, which were identified as the congested areas/roadways in Section 7.3. Theses TCPs would be manned during evacuation by traffic guides who would direct evacuees in the proper direction and facilitate the flow of traffic through the intersection**s**.

As discussed in Section 7.3, the animation of evacuation traffic conditions indicates one critical intersection which would be a bottleneck during evacuation. This critical intersection was cross-checked with the EPZ parish emergency plans and is not currently a TCP. The primary evacuation route for PAS 2, 5, 6, 7 and 10, travels along SR 10 through Jackson to the intersection with SR 19. At SR 19 evacuation routing encourages the right turn onto SR 19 to travel southbound into Baton Rouge. Figure G-2 is an aerial image of the intersection. It is proposed that an officer be placed at this intersection to help facilitate evacuees traveling southbound on SR 19 and eastbound on SR 10. The intersection is a four-way stop which significantly impacts the ETE. A sensitivity study was run without this TCP and resulted in an ETE of 3:35 for Scenario 6 Region 3 at the 90^{th} percentile. All ETE in this study include modeling this TCP, as shown in Table 7-1, the ETE for Scenario 6 Region 3 is 3:10 at the 90^{th} percentile. Figure G-3 provides a potential layout for this TCP. The TCP was recommended to Entergy personnel at the River Bend Station.

G.2 Access Control Points

It is assumed that ACPs will be established within 2 hours of the advisory to evacuate to discourage through travelers from using major through routes which traverse the EPZ. As discussed in Section 3.6, external traffic was only considered on three routes – US 61, US 190 and SR 19 - which traverse the EPZ in this analysis. The generation of these external trips ceased at 2 hours after the advisory to evacuate in the simulation.

According to the States' emergency plans, the access control points in the RBS EPZ will be

manned after the advisory to evacuate has been given by local parish police. It is recommended that ACPs on the eastern and western boundaries of the EPZ along the three aforementioned routes be the top priority in assigning manpower and equipment as they are the major routes traversing the EPZ, which will typically carry the highest volume of through traffic.

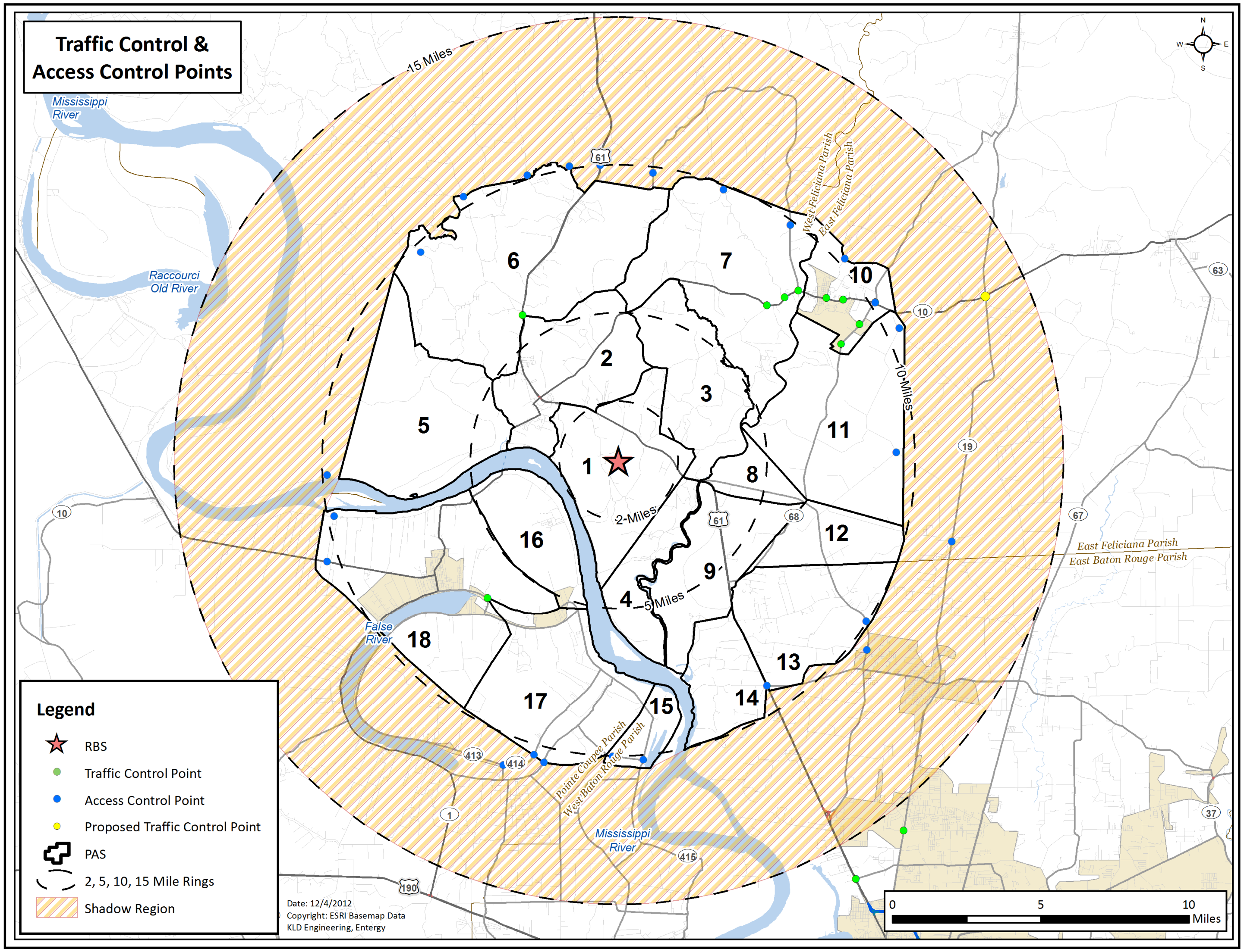
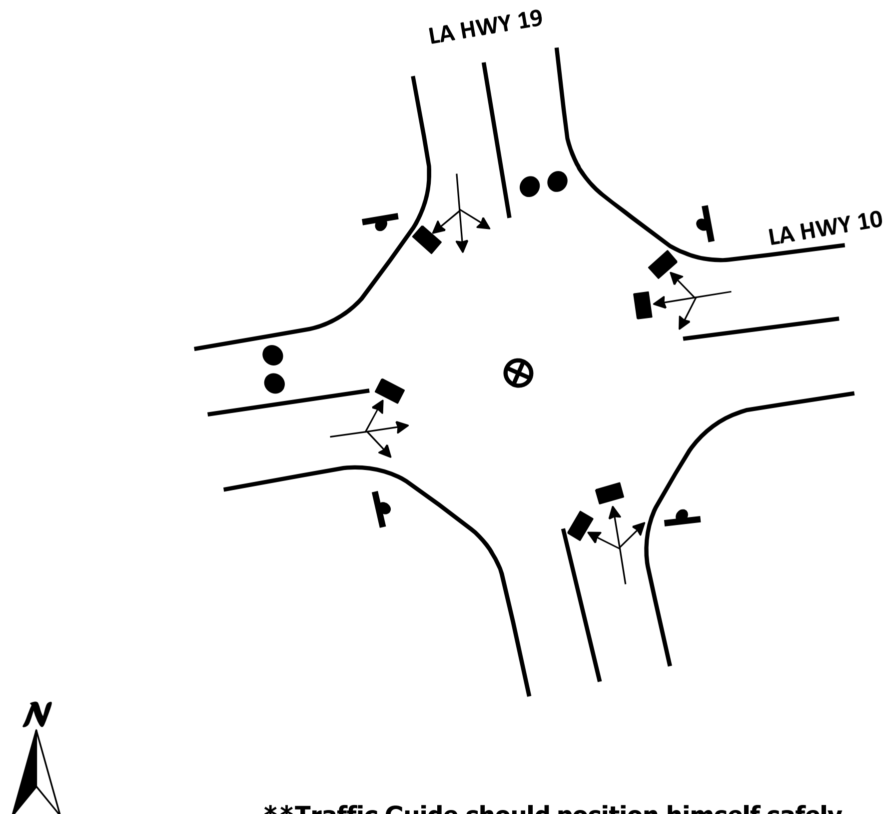


Figure G-1. Traffic Control Points for the RBS Site

Figure G-2. Intersection of State Route 10 and State Route 19

TCP

TOWN: JACKSON
LOCATION: LA HWY 10 & LA HWY 19
TCP ID: SHADOW - 01
PAS: SHADOW REGION



KEY

- MOVEMENT FACILITATED
- MOVEMENT DISCOURAGED/DIVERTED
- TRAFFIC GUIDE
- STOP SIGN
- TRAFFIC BARRICADE (2 ft, 3 ft)
  - 2 PER LANE (LOCAL ROADS AND RAMPS)
  - 4 PER LANE (FREEWAY AND RAMPS)
- TRAFFIC SIGNAL
- TRAFFIC CONES SPACED TO DISCOURAGE TRAFFIC BUT ALLOW PASSAGE (3 PER LANE): 8 ft

ACTIONS TO BE TAKEN

1. Discourage northbound movement on LA Hwy 19.
2. Discourage westbound movement on LA Hwy 10.

MANPOWER/EQUIPMENT ESTIMATE

1 Traffic Guide(s)
6 Traffic Cones

LOCATION PRIORITY

1

****Traffic Guide should position himself safely**

Figure G-3. Proposed Traffic Control Point at intersection of State Route 10 and State Route 19

H EVACUATION REGIONS

This appendix presents the evacuation percentages for each Evacuation Region (Table H-1) and maps of all Evacuation Regions. The percentages presented in Table H-1 are based on the methodology discussed in assumption 5 of Section 2.2 and shown in Figure 2-1.

Note the baseline ETE study assumes 20 percent of households will not comply with the shelter advisory, as per Section 2.5.2 of NUREG/CR-7002.