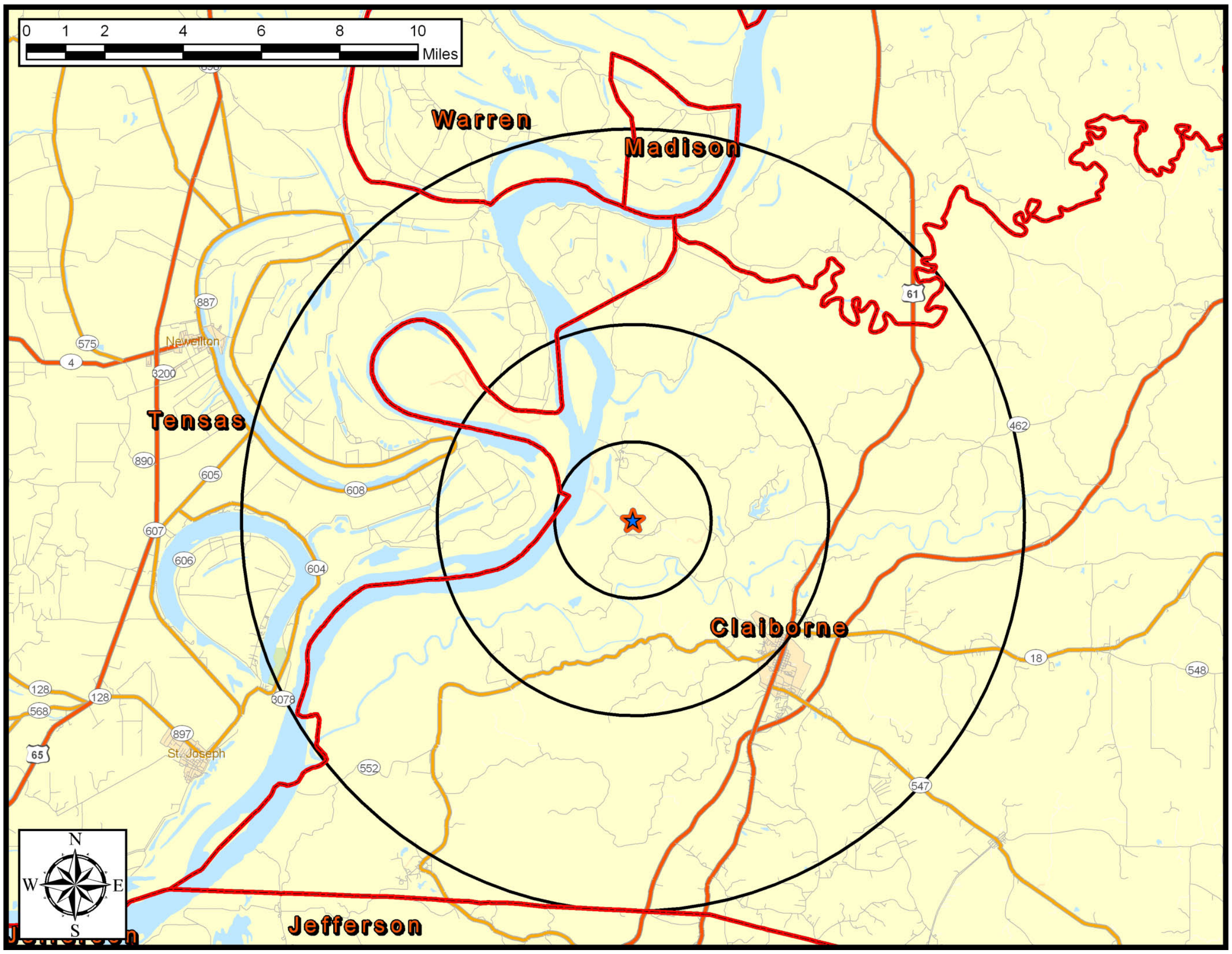
KLD ASSOCIATES, INC.

Grand Gulf Nuclear Station
Development of Evacuation Time Estimates



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September, 2007 **Final Report** **KLD TR-404**

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES (Cont'd)

EXECUTIVE SUMMARY

This report describes the analyses undertaken and the results obtained by a study to develop Evacuation Time Estimates (ETE) for the Grand Gulf Nuclear Station (GGNS) located in Claiborne County, Mississippi. Evacuation time estimates are part of the required planning basis and provide GGNS and State and local governments with site-specific information needed for Protective Action decision-making.

In the performance of this effort, all available prior documentation relevant to Evacuation Time Estimates was reviewed. Other guidance is provided by documents published by Federal Government agencies. Most important of these are:

- 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.

Overview of Project Activities

This project began in August, 2006 and extended over a period of 5 months. The major activities performed are briefly described in chronological sequence:

- Attended "kick-off" meetings with Entergy personnel, representatives from Enercon Services and emergency management personnel representing state and local governments.
- Reviewed prior ETE reports prepared for GGNS and accessed U.S. Census Bureau data files for the year 2000. Studied Geographical Information Systems

(GIS) maps of the area in the vicinity of GGNS, 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” area extending 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 instrument was reviewed and modified by State and county personnel prior to the survey.
- Data collection forms (provided at the kickoff meeting) were returned with data pertaining to employment, transients, and special facilities in each county and in each parish.
- 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 16 Emergency Response Planning Areas (ERPA). These ERPA are then grouped within circular areas or “keyhole” configurations (circles plus radial sectors) that define a total of 9 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). Two special event scenarios were considered; a football game at Alcorn State University during construction of the new unit at GGNS and construction of the new unit at GGNS with no football game.
- The Planning Basis for the calculation of ETE is:

- A rapidly escalating accident at GGNS that quickly assumes the status of General Emergency such that the Advisory to Evacuate is virtually coincident with the siren alert.
- While an unlikely accident scenario, this planning basis will yield ETE, measured as the elapsed time from the Advisory to Evacuate until the last vehicle 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 specified reception centers 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 county and parish evacuation plans. Those in special facilities will likewise be evacuated with public transit: bus, van, or ambulance, as required. Separate ETE are calculated for the transit-dependent evacuees and for those evacuated from special facilities.

Computation of ETE

A total of 108 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 9 Evacuation Regions to completely evacuate from that Region, under the circumstances defined for one of the 12 Evacuation Scenarios (9 x 12 = 108). 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 a portion of the population within the EPZ but outside the impacted region, will elect to "voluntarily" evacuate. In addition, a portion of the population in the "Shadow" region beyond the EPZ that extends a distance of 15 miles from GGNS, 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.

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 procedures.
- The evacuation trips are generated at locations called "zonal centroids" located within the EPZ. 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 computer models compute the routing patterns for evacuating vehicles that are compliant with federal guidelines (outbound relative to the location of GGNS), then simulate 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 50 percent, 90 percent, 95

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.

Traffic Management

This study includes the development of a comprehensive traffic management plan designed to expedite the evacuation of people from within an impacted region. This plan was reviewed with State and local law enforcement personnel.

The plan is documented in the form of detailed schematics specifying: (1) the directions of evacuation travel to be facilitated, and other traffic movements to be discouraged; (2) the traffic control personnel and equipment needed (cones, barricades) and their deployment; (3) the locations of these “Traffic Control Points” (TCP); (4) the priority assigned to each traffic control point indicating its relative importance and how soon it should be manned relative to others; and (5) the number of traffic control personnel required.

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 3-1 displays a map of the GGNS site showing the layout of the 16 ERPA that comprise, in aggregate, the Emergency Planning Zone (EPZ).
- Table 3-1 presents the estimates of permanent resident population in each ERPA based on the 2000 Census data. Extrapolation to the year 2007 reflects population growth rates in each county and parish derived from census data.
- Table 6-1 defines each of the 9 Evacuation Regions in terms of their respective groups of ERPA.

- Table 6-2 lists the 12 Evacuation Scenarios.
- Tables 7-1C and 7-1D are compilations of Evacuation Time Estimates (ETE). These data are the times needed to *clear the indicated regions* of 95 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.
- Table 8-5A presents ETE for the schoolchildren in good weather.
- Table 8-6 presents ETE for the transit-dependent population.

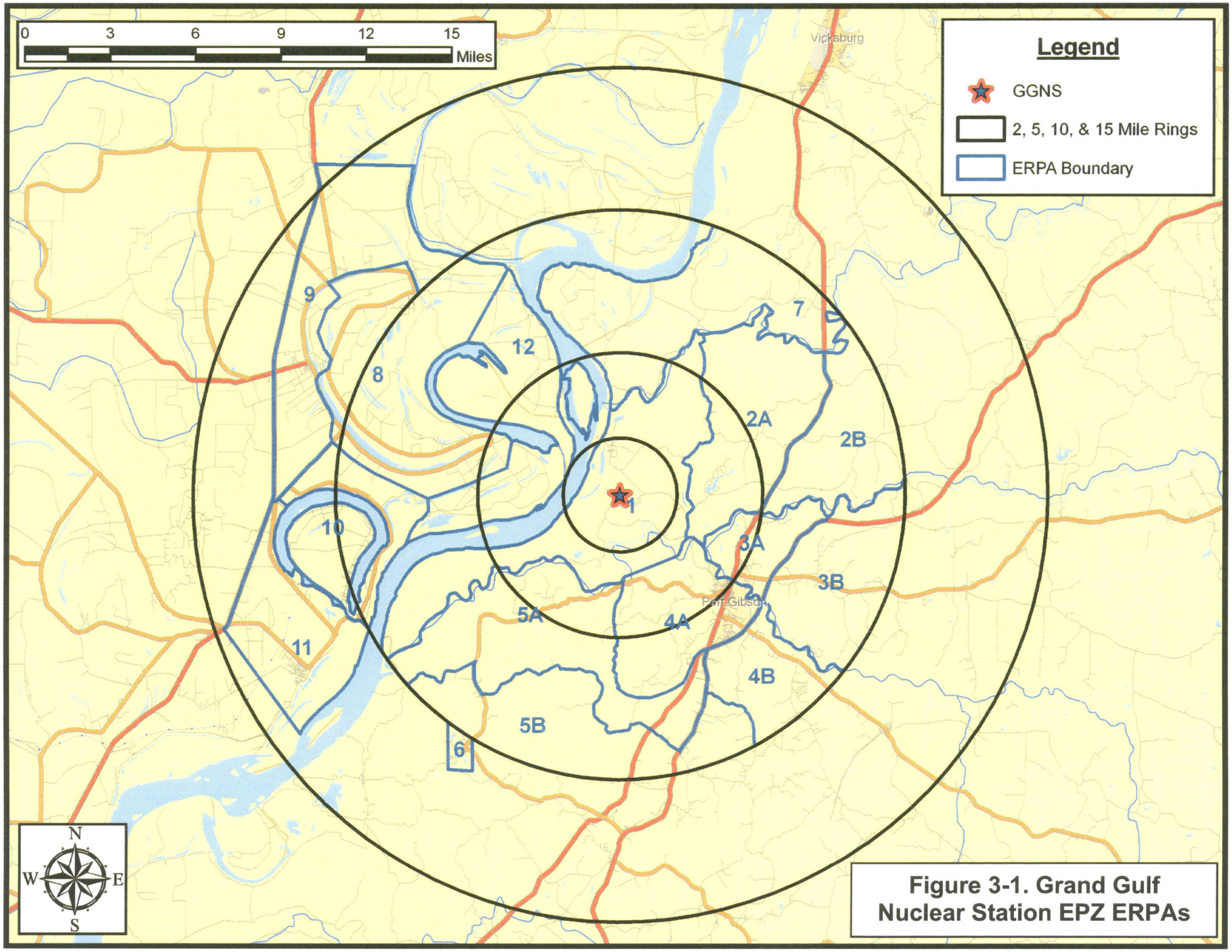

Figure 3-1. Grand Gulf Nuclear Station EPZ ERPAs

Table 3-1. EPZ Permanent Resident Population		
ERPA	**2000 Population**	**2007 Population**
1	104	100
2A	356	342
2B	150	144
3A	983	946
3B	506	487
4A	2,892	2,778
4B	564	541
5A	163	156
5B	396	381
6	2,057	2,258
7	3	3
8	163	148
9	1,892	1,708
10	431	388
11	1,530	1,381
12	0	0
TOTAL	**12,190**	**11,761**
% Change in Population		**- 3.5%**

Table 6-1. Definition of Evacuation Regions		
Region	**Description**	**ERPA**
R1	2-mile, 360º	1
R2	5-mile, 360º	1,2A,3A,4A,5A
R3	Entire EPZ	All
2-mile Ring and Sector to 5-miles		
R4	2-mile ring + wind to 5-miles, 90º NE	1,2A
R5	2-mile ring + wind to 5-miles, 90º SE	1,3A,4A,5A
Refer to R1	2-mile ring + wind to 5-miles, 90º NW	1
Refer to R1	2-mile ring + wind to 5-miles, 90º SW	1
5-mile Ring and Sector to 10-miles (to EPZ boundary)		
R6	5-mile ring + wind to 10-miles, 90º NE	1,2A,2B,3A,4A,5A,7
R7	5-mile ring + wind to 10-miles, 90º SE	1,2A,3A,3B,4A,4B,5A,5B,6
R8	5-mile ring + wind to 10-miles, 90º NW	1,2A,3A,4A,5A,7,8,9,12
R9	5-mile ring + wind to 10-miles, 90º SW	1,2A,3A,4A,5A,5B,6,10,11

Table 6-2. Evacuation Scenario Definitions					
Scenario	**Season**	**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	Alcorn State Football + New Plant Construction
12	Winter	Midweek	Midday	Good	New Plant Construction

Note: Schools are assumed to be in session for the Winter season (midweek, midday).

Table 7-1C. Time To Clear The Indicated Area of 95 Percent of the Affected Population

	Summer		Summer		Summer		Winter		Winter		Winter		Winter	Winter
	Midweek		Weekend		Midweek Weekend		Midweek		Weekend		Midweek Weekend		Weekend	Midweek
Scenario	(1)	(2)	(3)	(4)	(5)	Scenario	(6)	(7)	(8)	(9)	(10)	Scenario	(11)	(12)
	Midday		Midday		Evening		Midday		Midday		Evening		Midday	Midday
Region (ERPA)	Good Weather	Rain	Good Weather	Rain	Good Weather	Region (ERPA)	Good Weather	Rain	Good Weather	Rain	Good Weather	Region (ERPA)	Alcorn Football + New Plant Constuction	New Plant Constuction
Entire 2-Mile Region, 5-Mile Region, and EPZ														
R01 (1)	1 50	1 50	1 40	1 40	1 50	R01 (1)	1 50	1 50	1 40	1 40	1 50	R01 (1)	2 30	2 30
R02 (1,2A,3A,4A,5A)	2 40	2 40	2 00	2 00	2 10	R02 (1,2A,3A,4A,5A)	2 40	2 40	2 00	2 00	2 10	R02 (1,2A,3A,4A,5A)	2 50	2 50
R03 (All)	2 50	2 50	2 10	2 10	2 20	R03 (All)	2 50	2 50	2 10	2 10	2 20	R03 (All)	3 50	2 55
2 Mile Ring + Wind to 5 Miles														
R04 - Wind to NE (1, 2A)	2 00	2 00	1 45	1 45	1 50	R04 - Wind to NE (1, 2A)	2 00	2 00	1 45	1 45	1 50	R04 - Wind to NE (1, 2A)	2 50	2 50
R05 - Wind to SE (1,3A,4A,5A)	2 40	2 40	1 50	1 50	2 00	R05 - Wind to SE (1,3A,4A,5A)	2 40	2 40	1 50	1 50	2 10	R05 - Wind to SE (1,3A,4A,5A)	2 30	2 30
Wind to NW - Same as R1 (1)	1 50	1 50	1 40	1 40	1 50	Wind to NW - Same as R1 (1)	1 50	1 50	1 40	1 40	1 50	Wind to NW - Same as R1 (1)	2 30	2 30
Wind to SW - Same as R1 (1)	1 50	1 50	1 40	1 40	1 50	Wind to SW - Same as R1 (1)	1 50	1 50	1 40	1 40	1 50	Wind to SW - Same as R1 (1)	2 30	2 30
5 Mile Ring + Wind to EPZ Boundary														
R06 - Wind to NE (1,2A,2B,3A,4A,5A,7)	2 40	2 40	2 00	2 00	2 10	R06 - Wind to NE (1,2A,2B,3A,4A,5A,7)	2 50	2 50	2 00	2 00	2 10	R06 - Wind to NE (1,2A,2B,3A,4A,5A,7)	2 55	2 55
R07 - Wind to SE (1,2A,3A,3B,4A,4B,5A,5B,6)	2 50	2 50	2 10	2 10	2 20	R07 - Wind to SE (1,2A,3A,3B,4A,4B,5A,5B,6)	2 50	2 50	2 10	2 10	2 20	R07 - Wind to SE (1,2A,3A,3B,4A,4B,5A,5B,6)	3 50	2 50
R08 - Wind to NW (1,2A,3A,4A,5A,7,8,9,12)	2 40	2 40	2 00	2 00	2 10	R08 - Wind to NW (1,2A,3A,4A,5A,7,8,9,12)	2 40	2 40	2 00	2 00	2 10	R08 - Wind to NW (1,2A,3A,4A,5A,7,8,9,12)	2 50	2 50
R09 - Wind to SW (1,2A,3A,4A,5A,5B,6,10,11)	2 50	2 50	2 10	2 10	2 10	R09 - Wind to SW (1,2A,3A,4A,5A,5B,6,10,11)	2 50	2 50	2 10	2 10	2 10	R09 - Wind to SW (1,2A,3A,4A,5A,5B,6,10,11)	3 50	2 50

Table 7-1D. Time To Clear The Indicated Area of 100 Percent of the Affected Population

Scenario	Summer Midweek		Summer Weekend		Summer Midweek Weekend	Scenario	Winter Midweek		Winter Weekend		Winter Midweek Weekend	Scenario	Winter Weekend	Winter Midweek
	(1)	(2)	(3)	(4)	(5)		(6)	(7)	(8)	(9)	(10)		(11)	(12)
	Midday		Midday		Evening		Midday		Midday		Evening		Midday	Midday
Region (ERPA)	Good Weather	Rain	Good Weather	Rain	Good Weather	Region (ERPA)	Good Weather	Rain	Good Weather	Rain	Good Weather	Region (ERPA)	Alcorn Football + New Plant Constuction	New Plant Constuction
Entire 2-Mile Region, 5-Mile Region, and EPZ														
R01 (1)	2 50	3 00	2 20	2 20	2 20	R01 (1)	2 50	2 50	2 20	2 20	2 20	R01 (1)	2 50	2 50
R02 (1,2A,3A,4A,5A)	4 00	4 00	3 50	3 50	3 50	R02 (1,2A,3A,4A,5A)	4 00	4 00	3 50	3 50	3 50	R02 (1,2A,3A,4A,5A)	4 00	4 00
R03 (All)	4 10	4 10	4 00	4 00	4 00	R03 (All)	4 00	4 10	4 00	4 00	4 00	R03 (All)	4 10	4 00
2 Mile Ring + Wind to 5 Miles														
R04 - Wind to NE (1, 2A)	4 00	4 00	3 50	3 50	3 50	R04 - Wind to NE (1, 2A)	4 00	4 00	3 50	3 50	3 50	R04 - Wind to NE (1, 2A)	4 00	4 00
R05 - Wind to SE (1,3A,4A,5A)	4 00	4 00	3 50	3 50	3 50	R05 - Wind to SE (1,3A,4A,5A)	4 00	4 00	3 50	3 50	3 50	R05 - Wind to SE (1,3A,4A,5A)	4 00	4 00
Wind to NW - Same as R1 (1)	2 50	3 00	2 20	2 20	2 20	Wind to NW - Same as R1 (1)	2 50	2 50	2 20	2 20	2 20	Wind to NW - Same as R1 (1)	2 50	2 50
Wind to SW - Same as R1 (1)	2 50	3 00	2 20	2 20	2 20	Wind to SW - Same as R1 (1)	2 50	2 50	2 20	2 20	2 20	Wind to SW - Same as R1 (1)	2 50	2 50
5 Mile Ring + Wind to EPZ Boundary														
R06 - Wind to NE (1,2A,2B,3A,4A,5A,7)	4 00	4 00	3 50	3 50	3 50	R06 - Wind to NE (1,2A,2B,3A,4A,5A,7)	4 00	4 00	3 50	3 50	3 50	R06 - Wind to NE (1,2A,2B,3A,4A,5A,7)	4 00	4 00
R07 - Wind to SE (1,2A,3A,3B,4A,4B,5A,5B,6)	4 00	4 00	4 00	4 00	3 50	R07 - Wind to SE (1,2A,3A,3B,4A,4B,5A,5B,6)	4 00	4 00	3 50	4 00	3 50	R07 - Wind to SE (1,2A,3A,3B,4A,4B,5A,5B,6)	4 10	4 00
R08 - Wind to NW (1,2A,3A,4A,5A,7,8,9,12)	4 00	4 00	3 50	3 50	3 50	R08 - Wind to NW (1,2A,3A,4A,5A,7,8,9,12)	4 00	4 00	3 50	3 50	3 50	R08 - Wind to NW (1,2A,3A,4A,5A,7,8,9,12)	4 00	4 00
R09 - Wind to SW (1,2A,3A,4A,5A,5B,6,10,11)	4 10	4 10	3 50	3 50	4 00	R09 - Wind to SW (1,2A,3A,4A,5A,5B,6,10,11)	4 00	4 00	3 50	3 50	4 00	R09 - Wind to SW (1,2A,3A,4A,5A,5B,6,10,11)	4 10	4 00

Table 8-5A. School Evacuation Time Estimates - Good Weather											
School	Driver Mobilization Time(min)	Travel Time from Depot (min)	Loading Time (min)	Dist. to EPZ Boundary (mi.)		Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bndry to R.C.		Travel Time EPZ Bdry to RC (min)	ETE to R.C. (hr:min)
				Major Road	Local Road			Major Road	Local Road		
Claiborne County Schools											
A.W. Watson Elementary School	90	30	5	4.2	2.8	11	2:20	38.1	0.7	48	3:05
Chamberlain-Hunt Academy	90	30	5	3.9	0.8	7	2:15	41.1	0.7	51	3:05
Claiborne Educational Foundation	90	30	5	3.9	0.6	6	2:15	41.1	0.7	51	3:05
Port Gibson High	90	30	5	4.2	2.2	10	2:15	38.1	0.7	48	3:05
Port Gibson Middle School	90	30	5	3.9	1.0	7	2:15	41.1	0.7	51	3:05
Reachout Foundation	90	30	5	2.6	0.3	4	2:10	38.1	0.7	48	3:00
						Average ETE:	**2:15**		**Average:**	**50**	**3:04**
Tensas Parish Schools											
Davidson High School	90	30	5	3.1	0.2	5	2:10	27.6	0	34	2:45
Newellton Christian Academy	90	30	5	7.5	1.3	12	2:20	17.2	0	21	2:40
Newellton Elementary	90	30	5	7.5	0.8	11	2:20	17.2	0	21	2:40
Tensas Academy	90	30	5	3.1	0.2	5	2:10	27.6	0	34	2:45
Tensas Charter School	90	30	5	7.5	0.8	11	2:20	17.2	0	21	2:40
Tensas Elementary	90	30	5	2.4	0.2	4	2:10	27.6	0	34	2:45
Tensas High School	90	30	5	2.5	0.2	4	2:10	27.6	0	34	2:45
						Average ETE:	**2:14**		**Average:**	**28**	**2:42**

Table 8-6. Transit-Dependent Evacuation Time Estimates												
GOOD WEATHER												
	Single Wave					**Second Wave**						
County/ Parish	**Mobilization (min)**	**Travel time to EPZ (min)**	**Route Travel Time (min)**	**Pickup Time (min)**	**ETE (hr:min)**	**Arrive at RC (min)**	**Unload (min)**	**Driver Rest (min)**	**Return to EPZ (min)**	**Route Travel Time (min)**	**Pickup Time (min)**	**ETE (hr:min)**
Claiborne	90	30	20	15	**2:35**	185	5	15	50	20	15	**4:50**
Tensas	90	30	20	15	**2:35**	165	5	15	30	20	15	**4:10**
RAIN												
Claiborne	90	35	23	20	**2:50**	210	10	15	55	23	20	**5:35**
Tensas	90	35	23	20	**2:50**	185	10	15	35	23	20	**4:50**

NOTE: The second wave of transit bus trips are only required if there are not sufficient buses to evacuate everyone in the first wave. If bus resources are sufficient, the one-wave ETE should be used.

1. INTRODUCTION

This report describes the analyses undertaken and the results obtained by a study to update the existing Evacuation Time Estimates (ETE) for the Grand Gulf Nuclear Station (GGNS), located in Claiborne County, Mississippi. Evacuation time estimates provide State and local governments with site-specific information needed for Protective Action decision-making.

In the performance of this effort, all available prior documentation relevant to Evacuation Time Estimates was reviewed.

Other guidance is provided by documents published by Federal Government agencies. Most important of these are:

- Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants, US Nuclear Regulatory Commission (NUREG) and Federal Emergency Management Association, NUREG 0654/FEMA-REP-1, Rev. 1, November 1980.

- Analysis of Techniques for Estimating Evacuation Times for Emergency Planning Zones, US Nuclear Regulatory Commission/Contractor Report, NUREG/CR-1745, November 1980.

- State of the Art in Evacuation Time Estimate Studies for Nuclear Power Plants, NUREG/CR-4831, March 1992.

- Development of Evacuation Time Estimates for Nuclear Power Plants, NUREG/CR-6863, January 2005.

We wish to express our appreciation to all the directors and staff members of the Port Gibson/Claiborne County Civil Defense Office and the Tensas Office of Emergency

Preparedness, emergency management agencies and local and state law enforcement agencies, who provided valued guidance and contributed information contained in this report.

1.1 Overview of the ETE Update Process

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

1. Information Gathering:
    - Defined the scope of work in discussion with representatives of Enercon Services and Entergy.
    - Reviewed existing reports describing past evacuation studies.
    - Attended meetings with emergency planners from Claiborne County and Tensas Parish to identify issues to be addressed and resources available.
    - Conducted a detailed field survey of the EPZ highway system and of area traffic conditions.
    - Obtained demographic data from census and state agencies.
    - Conducted a random sample telephone survey of EPZ residents.
    - Conducted a data collection effort to identify and describe schools, special facilities, major employers, transportation providers, and other important sources of 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, trip generation distribution and in highway capacities, associated with different seasons, day of week, time of day and weather conditions.

4. Defined a traffic management strategy. Traffic control is applied at specified Traffic Control Points (TCP) located within the Emergency Planning Zone (EPZ). Local and state police personnel should review all traffic control plans.

5. Defined Evacuation Areas or Regions. The EPZ is partitioned into Emergency Response Planning Areas (ERPAs). These existing ERPA were accepted as the basis for the ETE analysis presented herein. “Regions” are groups of contiguous ERPA for which ETE are calculated. The configurations of these Regions depend upon 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 required by NUREG 0654.

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 IDYNEV system.

   - Estimated the traffic demand, based on the available information derived from Census data, from prior studies, from data provided by local and state agencies and from the telephone survey.

   - Applied the procedures specified in the 2000 Highway Capacity Manual[1] (HCM) to the data acquired during the field survey, to

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[1] Highway Capacity Manual (HCM 2000), Transportation Research Board, National Research Council, 2000.

estimate the capacity of all highway segments comprising the evacuation routes.

- Developed the link-node representation of the evacuation network, which is used as the basis for the computer analysis that calculates the Evacuation Time Estimates (ETE).
- Calculated the evacuating traffic demands for each Region and for each Evacuation Scenario.
- Represented the traffic management strategy.
- Specified the candidate destinations of evacuation travel consistent with outbound movement relative to the location of the GGNS.
- Prepared the input stream for the IDYNEV System.
- Executed the IDYNEV models to provide the estimates of evacuation routing and Evacuation Time Estimates (ETE).

8. Generated a complete set of ETE for all specified Regions and Evacuation Scenarios.
9. Documented ETE in formats responsive to NUREG 0654.
10. Calculated the ETE for all transit activities including those for special facilities (schools, health-related facilities, etc.) and for the transit-dependent.

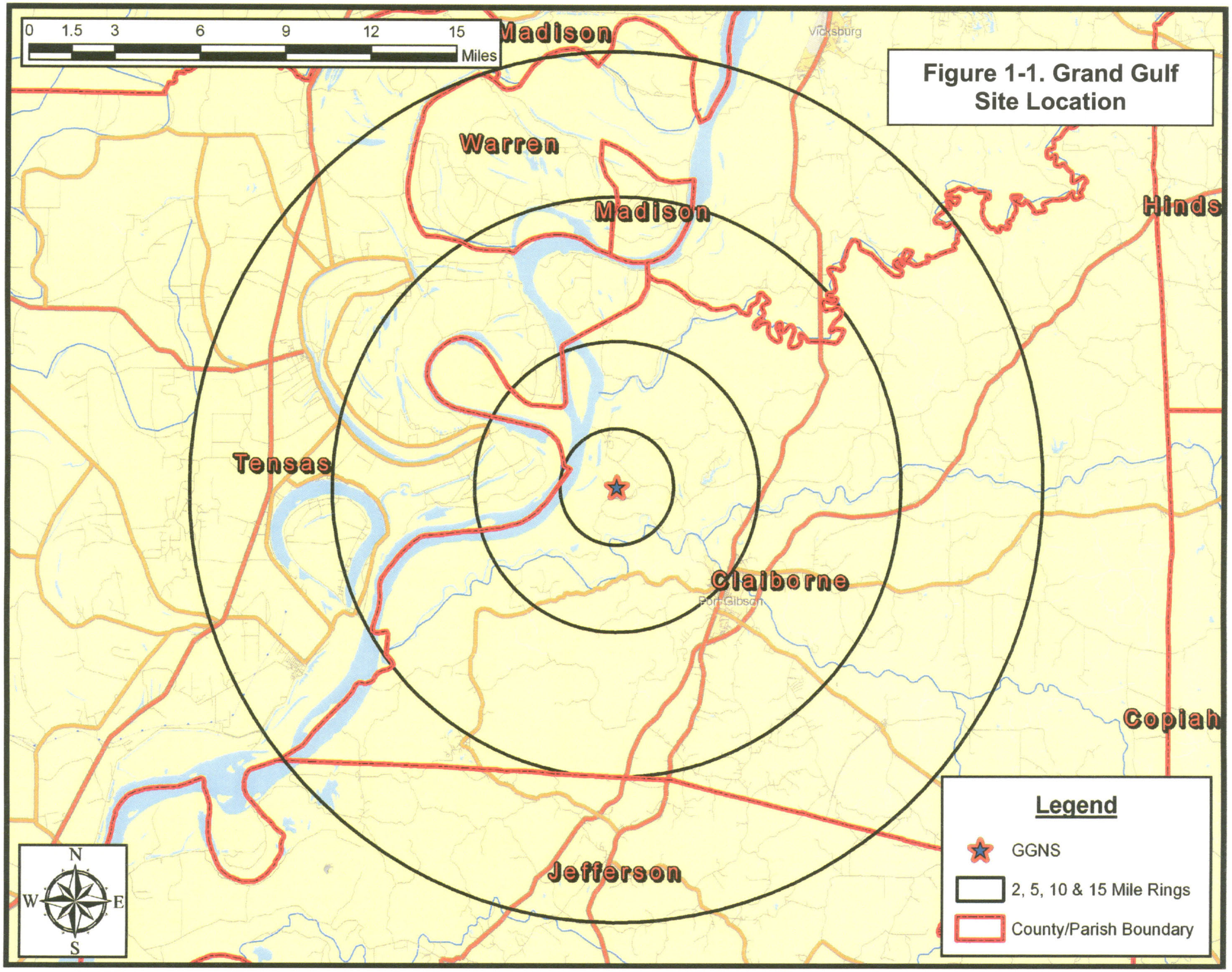
Steps 4 through 9 are iterated as described in Appendix D.

1.2 The Grand Gulf Nuclear Station Site Location

The Grand Gulf Nuclear Station is located 1.5 miles east of the Mississippi River and 5 miles northwest of Port Gibson, Mississippi. The Emergency Planning Zone (EPZ) consists of

1. Part of Claiborne County, Mississippi on the east side of the Mississippi River;
2. Part of Tensas Parish, Louisiana on the west side of the river; and
3. Part of Warren County, Mississippi - only a small portion of the county is inside the EPZ and the area is not populated.

Figure 1-1 displays the area surrounding the Grand Gulf Nuclear Station. This map identifies the communities in the area and the major roads.



0
1.5
3
6
9
12
15
Miles
Figure 1-1. Grand Gulf Site Location
Madison
Vicksburg
Warren
Madison
Hinds
Tensas
Claiborne
Port Gibson
Copiah
Jefferson
N
W
E
S
Legend
GGNS
2, 5, 10 & 15 Mile Rings
County/Parish Boundary

1.3 Preliminary Activities

Since this plan constitutes an update of an existing document, it was necessary to review the prior process and findings. These activities are described below.

Literature Review

KLD Associates was provided with copies of documents describing past studies and analyses leading to the development of emergency plans and of the GGNS ETE. We also obtained supporting documents from a variety of sources, which contained information needed to form the database used for conducting evacuation analyses.

Field Surveys of the Highway Network

KLD personnel drove the entire highway system within the EPZ and for some distance outside. The characteristics of each section of highway were recorded. These characteristics include:

- Number of lanes
- Pavement Width
- Shoulder type & width
- Intersection configuration
- Lane channelization
- Geometrics: Curves, grades
- Posted speed
- Actual free speed
- Abutting land use
- Control devices
- Interchange geometries
- Unusual characteristics: Narrow bridges, sharp curves, poor pavement, flood warning signs, inadequate delineations, etc.

The data were then transcribed; this information was referenced while preparing the input stream for the IDYNEV System. In addition, sketches were made at key highway locations.

Telephone Survey

A telephone survey was undertaken 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 during an evacuation and to estimate elements of the mobilization process. This database was also referenced to estimate the number of transit-dependent residents.

Developing 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.

Highway capacity was estimated for each highway segment based on the field surveys and on the principles specified in the 2000 Highway Capacity Manual (HCM). The link-node representation of the physical highway network was developed using Geographic Information System (GIS) mapping software and the observations obtained from the field survey. This network representation of "links" and "nodes" is shown in Figure 1-2.

Analytical Tools

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

PCDYNEV consists of three submodels:

- A macroscopic traffic simulation model (for details, see Appendix C).
- An intersection capacity model (for details, see Highway Research Record No. 772, Transportation Research Board, 1980, papers by Lieberman and McShane & Lieberman).
- A dynamic, node-centric routing model that adjusts the "base" routing in the event of an imbalance in the levels of congestion on the outbound links.

Another model of the IDYNEV System is the TRAD (Traffic Assignment and Distribution) model. This model integrates an equilibrium assignment model with a trip distribution algorithm to compute origin-destination volumes and paths of travel designed to minimize travel time. For details, see Appendix B.

Still another software product developed by KLD, named UNITES (UNIfied Transportation Engineering System) was used to expedite data entry.

The procedure for applying the IDYNEV System within the framework of developing an update to an ETE is outlined in Appendix D. Appendix A is a glossary of terms.

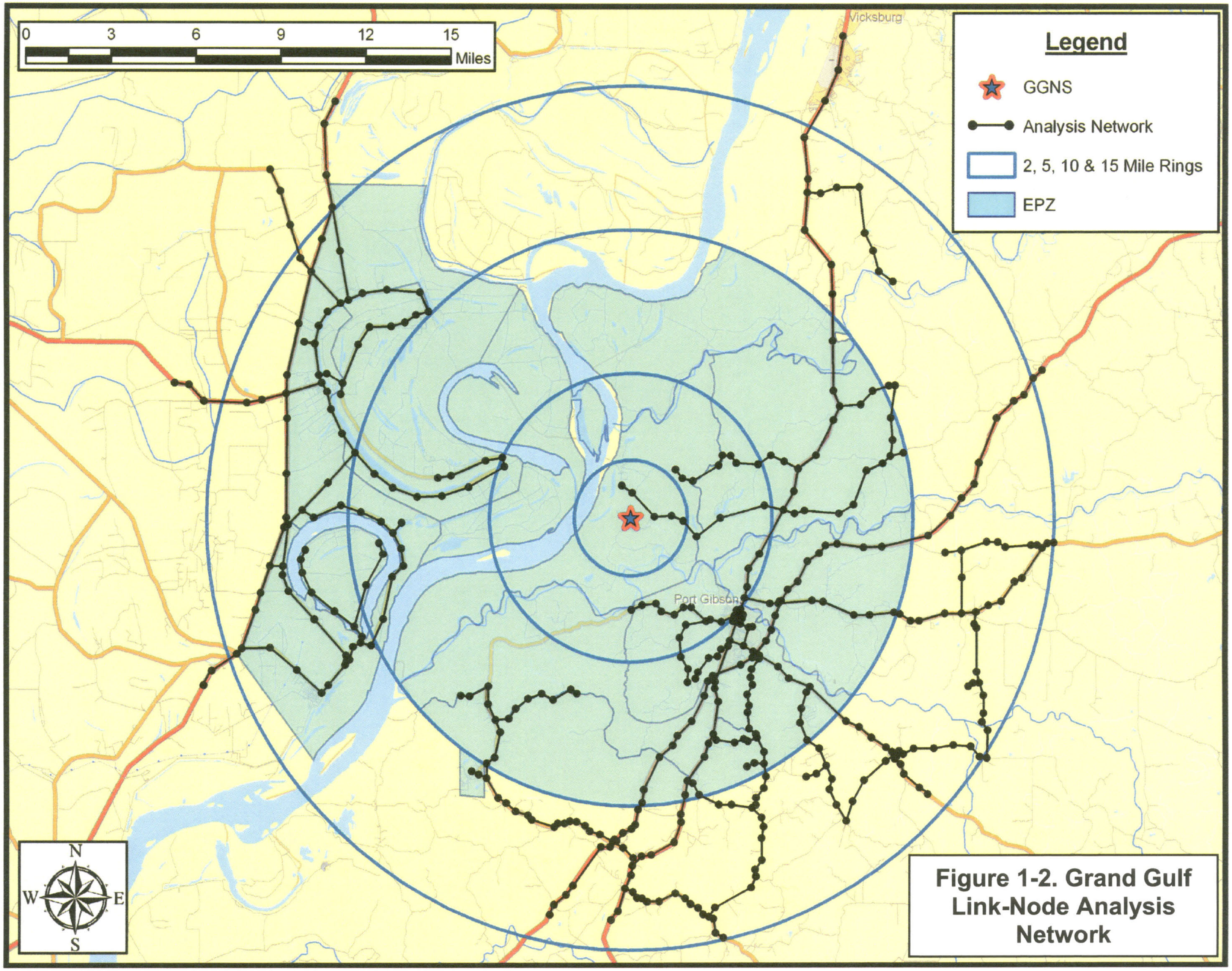


Figure 1-2. Grand Gulf Link-Node Analysis Network

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 GGNS 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 GGNS.

A set of candidate destination nodes on the periphery of the EPZ is specified for each traffic origin (or centroid) within the EPZ. The TRAD model produces output that identifies the "best" traffic routing, subject to the design conditions outlined above. In addition to this information, rough estimates of travel time are provided, together with turn-movement data required by the PCDYNEV simulation model.

The simulation model is then executed to provide 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 expedite the movement of vehicles.

As outlined in Appendix D, this procedure consists of an iterative design-analysis-redesign sequence of activities. If properly done, this procedure converges to yield an evacuation plan which best services the evacuating public.

1.4 Comparison with Prior ETE Study

Table 1-1 presents a comparison of the present ETE study with the 1986 ETE Study and the assessment of the 1986 study performed by Black Diamond Consultants, Inc in 2003.. 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:

- An increase in the number of evacuating vehicles per household.
- Voluntary and shadow evacuation are considered.
- Trip Generation times are based on the results of a telephone survey of EPZ residents.
- Alcorn State University students evacuate by auto. Auto occupancy of 1.06 students/vehicle is used in the current study, compared with 3.00 students/vehicle used in the previous study.
- Grand Gulf Nuclear Station employees evacuate by auto. Auto occupancy of 1.06 employees/vehicle is used in the current study, compared with 2.00 employees/vehicle in the previous study.

Table 1-1. ETE Study Comparisons

Topic	Treatment	
	Previous ETE Study	Current ETE Study
Resident Population Basis	LandView Software using 2000 US Census blocks. Alcorn State students living on campus treated separately. Population = 9,846 Alcorn State = 2,000 Total = 11,846	ArcGIS Software using 2000 US Census blocks; population extrapolated to 2007. Population = 11,761
Resident Population Vehicle Occupancy	1 vehicle/household.	2.71 persons/household, 1.46 evacuating vehicles/household yielding: 1.86 persons/auto
Employee Population	GGNS identified as the only major employer, 2 people/vehicle; 1 person/vehicle for all other employers; 3 people/vehicle for Alcorn State.	Data request forms sent to major employers. Census journey to work data files for Mississippi and Louisiana identified the proportion of employees who commute into the EPZ relative to the total number of employees. These proportions were applied to total employment from the data request forms. Students commuting to Alcorn State University treated as employees due to similar travel patterns. 1.06 employees/vehicle based on phone survey results.
Voluntary evacuation from within EPZ in areas outside region to be evacuated	Not considered.	50 percent of population within the circular portion of the region; 35 percent, in annular ring between the circle and the EPZ boundary. (See Figure 2-1)
Shadow Evacuation	Not considered.	30% of people outside of the EPZ within the shadow area. (See Figure 7-2)
Network Size	100 links; 91 nodes.	493 Links; 389 Nodes.

Table 1-1. ETE Study Comparisons		
Topic	**Treatment**	
	Previous ETE Study	**Current ETE Study**
Roadway Geometric Data	Field surveys conducted in 2003. HCM not referenced.	Field surveys conducted in 2006. Major intersections were video archived. Road capacities based on 2000 HCM.
School Evacuation	Direct evacuation.	Direct evacuation to designated Reception Center.
Transit Dependent Population	Defined as non-auto owning population.	Defined as households with 0 vehicles + households with 1 vehicle with commuters who do not return home + households with 2 vehicles with commuters who do not return home. (See Section 8.1)
Ridesharing	No percentage given.	50 percent of transit dependent persons will ride out with a neighbor of friend.
Trip Generation for Evacuation	Residents and transients assumed to take between 15 and 75 minutes. Employees assumed to take between 15 and 60 minutes.	Based on residential telephone survey of specific pre-trip mobilization activities: Residents with commuters returning leave between 30 and 240 minutes. Residents without commuters returning leave between 15 and 180 minutes. Employees and transients leave between 15 and 120 minutes. All times measured from the Advisory to Evacuate for all above.
Traffic and Access Control	Traffic Control used in all scenarios to facilitate the flow of traffic outbound relative to GGNS.	Traffic and Access Control used in all scenarios to facilitate the flow of traffic outbound relative to GGNS.

Table 1-1. ETE Study Comparisons		
Topic	**Treatment**	
	Previous ETE Study	**Current ETE Study**
Weather	Normal or Adverse. The capacity of each link in the network is reduced by 25% for adverse 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.[1]
Modeling	NETVAC model.	IDYNEV System: TRAD and PCDYNEV.
Special Events	None considered.	Two cases considered: football game at Alcorn State University and the new plant construction phase.
Evacuation Regions	8 "Cases", 1 – 360° sector to 2 miles, 2 - 90° sectors to 5 miles, 4 - 90° sectors to 10 miles and 1 360° sector to 10 miles (i.e. EPZ boundary).	1 additional Region, 360° sector to 5 miles.
Evacuation Time Estimates Reporting	"Maximum" ETE reported for each Case and Scenario.	ETE reported for 50, 90, 95, and 100th percentile population. Results presented by Region and Scenario.
Evacuation Time Estimates for the entire EPZ.	Full EPZ – Weekday: Good weather = 2:25 Full EPZ – Weekend: Good weather =2:25	Winter midweek midday Good weather = 4:00 Summer midweek midday Good weather = 4:10

[1] Agarwal, M. et. Al. Impacts of Weater on Urban Freeway Traffic Flow Characteristics and Facility Capacity, Proceedings of the 2005 Mid-Continent Transportation Research Symposium, August, 2005.

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 2000 data, projected to year 2007. County-specific projections are based upon growth rates estimated by comparing the 2000 census data and 2004 census estimates. Estimates of employees who commute into the EPZ to work are based upon the state Journey to Work Database (database for both Louisiana and Mississippi were used) applied to the employment data obtained from county emergency management officials.
2. Population estimates at special facilities are based on available data from county emergency management offices.
3. Roadway capacity estimates are based on field surveys and the application of Highway Capacity Manual 2000[1].
4. Population mobilization times are based on a statistical analysis of data acquired from the telephone survey.
5. The relationship between resident population and evacuating vehicles is developed from the telephone survey. Values of 2.71 persons per household and 1.46 evacuating vehicles per household are used.
6. The relationship between persons and vehicles for special facilities is as follows:
    a. Parks/Recreational: 1 vehicle per family
    b. Hunting/Fishing Camps: 1.5 persons/vehicle
    c. Employees: 1.06 employees per vehicle (telephone survey results)

[1] Highway Capacity Manual (HCM2000), Transportation Research Board, National Research Council, 2000.

7. Evacuation Time Estimates (ETE) are presented for the evacuation of the 100th percentile of population for each Region and for each Scenario, and for the 2-mile, 5-mile and 10-mile distances. ETEs are presented in tabular format and graphically showing the values of ETE associated with the 50th, 90th and 95th percentiles of population. A Region is defined as a group of zones that is issued the Advisory to Evacuate.

2.2 Study Methodological Assumptions

1. The Evacuation Time is defined as the elapsed time from the moment the Advisory to Evacuate is issued to a specific Region of the EPZ, to the time that Region is clear of people.
2. The ETEs are computed and presented in a format compliant with NUREG 0654, CR-1745 and CR-4831. The ETE for each evacuation area ("Region" comprised of included ERPA) is presented in both statistical and graphical formats.
3. Evacuation movements (paths of travel) are generally outbound relative to the power station to the extent permitted by the highway network, as computed by the computer models. All available evacuation routes are used in the analysis.
4. Regions are defined by the underlying "keyhole" or circular configurations as specified in NUREG 0654. These Regions, as defined, display irregular boundaries reflecting the geography of the zones included within these underlying configurations.
5. Voluntary evacuation is considered as indicated in the accompanying Figure 2-1. Within the circle defined by the distance to be evacuated but outside the Evacuation Region, 50 percent of the people not advised to evacuate are assumed to evacuate within the same time-frame. In the annular area between the circle defined by the extent of the Evacuation Region and the EPZ boundary, it is assumed that 35 percent of people will

voluntarily evacuate. In the area between the EPZ boundary and a 15-mile annular area centered at the plant (the “shadow region”), it is assumed that 30 percent of the people will evacuate voluntarily. Sensitivity studies explore the effect on ETE, of increasing the percentage of voluntary evacuees in this area. (Appendix I)

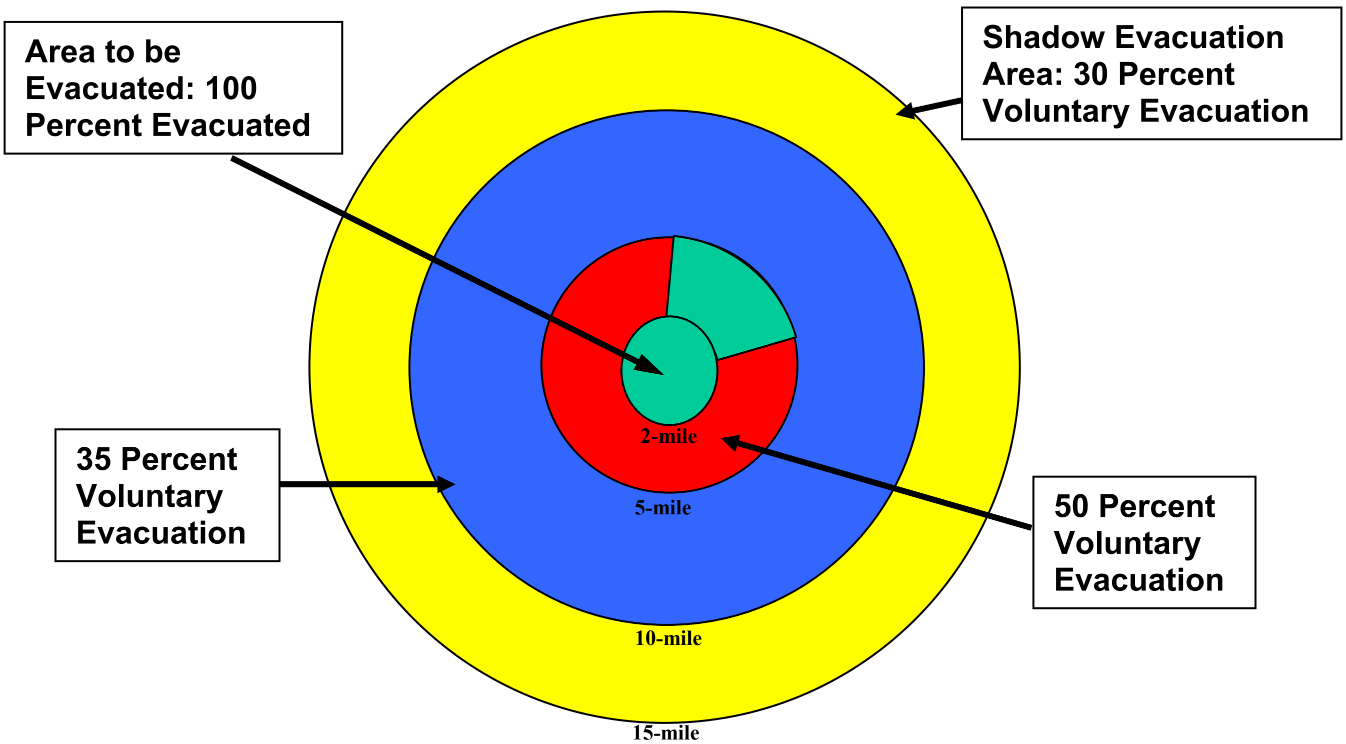


Figure 2-1. Voluntary Evacuation Methodology

The basis for our assumptions is testimony proffered by Dennis Miletti, a professor at Colorado State University, and one of the nations top disaster response experts, at Atomic Safety and Licensing Board (ASLB) hearings, which were deemed acceptable. There are limited data pertaining to nuclear evacuations in the United States. The numbers we use for voluntary evacuation are Professor Miletti’s best estimates based on his years of experience in evacuation planning and preparedness.

6. A total of 12 "Scenarios" representing different seasons, time of day, day of week and weather are considered. Two special event scenarios are studied: A football game at Alcorn State University, and the construction period of the new nuclear plant. These Scenarios are tabulated below:

Scenarios	Season	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	Alcorn State Football Game + New Plant Construction
12	Winter	Midweek	Midday	Good	New Plant Construction

7. The models of the IDYNEV System represent the state of the art, and have been recognized as such by Atomic Safety & Licensing Board (ASLB) in past hearings. (Sources: Atomic Safety & Licensing Board Hearings on Seabrook and Shoreham; Urbanik[2]).

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 coincident with the siren notification.

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

b. Mobilization of the general population will commence within 10 minutes after siren notification.

c. ETE are measured relative to Advisory to Evacuate.

2. It is assumed that everyone within the group of ERPA forming a Region that is issued an Advisory to Evacuate will, in fact, respond in general accord with the planned routes.

3. It is further assumed that:

   a. Schools will be evacuated prior to notification of the general public.

   b. 39 percent of households in the EPZ will await the return of a commuter before beginning their evacuation trip, based on the telephone survey results.

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. 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. It is assumed that drivers will act rationally, travel in the directions identified in the plan, and obey all control devices and traffic guides.

6. Traffic Control Points (TCP) outside the EPZ should be established to facilitate evacuation flow to the Reception Centers.

7. Buses will be used to transport those without access to private vehicles:

   a. If schools are in session, transport (buses) will evacuate students before the issuance of an advisory to evacuate to the general public, directly to the assigned Reception Centers.

   b. Medical facilities are required to have a detailed evacuation plan and to provide adequate transportation for all residents. Buses needed to evacuate special facilities are provided through private contracting.

c. Schoolchildren, if school is in session, are given priority in assigning transit vehicles.

d. Bus mobilization time is considered in ETE calculations.

e. Analysis of the number of required "waves" of transit-dependent evacuation vehicles, is presented.

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] which cites previous evacuation experience.

9. One type of adverse weather scenario is considered. Rain may occur for either winter or summer scenarios. In the case of rain, it is assumed that the rain begins at about the same time as the evacuation advisory is issued. No weather-related reduction in the number of transients who may be present in the EPZ is assumed.

   Adverse weather scenarios affect roadway capacity, free flow highway speeds and the time required to mobilize the general population. The factors assumed for the ETE study are:

Scenario	Highway Capacity*	Free Flow Speed*	Mobilization Time
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] 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).

10. School buses used to transport students are assumed to transport 70 children per bus for elementary schools, and 50 children per bus for middle and high schools. Transit buses used to transport the transit-dependent general population are assumed to transport 30 people per bus.

11. The Natchez-Trace Parkway will be reserved for the movement of emergency vehicles and will not serve as an evacuation route for the general public, with the exception of a football game at Alcorn State University. During football games, evacuees will be permitted to access Natchez-Trace Parkway southbound from Route 552 to alleviate congestion.

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 Emergency Planning Zone (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 2000 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. Simply using parking lot capacities will tend to overestimate the number of transients and can lead to ETE that are too conservative.

Analysis of the population characteristics of the Grand Gulf Nuclear Station (GGNS) 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 ERPA and by polar coordinate representation (population rose). The GGNS EPZ has been subdivided into 16 ERPA. These ERPA are shown in Figure 3-1.

Permanent Residents

The primary source for estimating permanent population is the latest U.S. Census data. The average household size (2.71 persons/household) and the number of evacuating vehicles per household (1.46 vehicles/household) were adapted from the telephone survey results.

Comparing census estimates available for the year 2005, with that for 2000, it is possible to estimate the rate of population change over time and to project the year 2000 resident population to a 2007 base year. The rate of population change was found for Claiborne County and Tensas Parish and applied to project population growth over the most recent 7-year period. Table 3-1 shows that the EPZ population has decreased about 3.5 percent over the last 7 years.

Permanent resident population and vehicle estimates for 2007 are presented in Table 3-2. Figures 3-2 and 3-3 present the permanent resident population and permanent resident vehicle estimates by sector and distance from the GGNS. This “rose” was constructed using GIS software.

<u>Special Events</u>

The construction year for the new unit at GGNS is estimated at 2015. Comparison of the 2000 Census data and the 2006 Census estimates for Claiborne County and Tensas Parish indicate that population is decreasing. We used the same population for permanent residents in the EPZ and in the shadow area for the Construction scenarios (Scenarios 11 and 12) as a conservative approach, rather than diminishing the population based on recent population trends. Enercon Services estimates the construction workforce as 3,100 employees. The telephone survey results (1.06 employees/vehicle) indicate there is some carpooling in the EPZ. Using this factor, we estimate the construction traffic as 2,925 vehicles. We did not consider any roadway improvements for the construction scenario.

The Alcorn State University homepage for athletics indicates that Jack Spinks Stadium seats 22,500 fans. We have assumed that 3,500 of these fans are the students, thus the additional population for the football scenario (Scenario 11) is 19,000 people. We assume that fans travel to the game as a family. Using the average household size of 2.71 people and 1 vehicle per family, the additional vehicle demand for the football game is 7,000 vehicles. All vehicles have been loaded eastbound on to Route 552 so as to not route them closer to the plant. Although the Natchez-Trace Parkway is reserved for emergency vehicles in the event of an evacuation, we are allowing traffic from the football game to access the parkway southbound as they are already out of the EPZ when Route 552 and the parkway intersect.

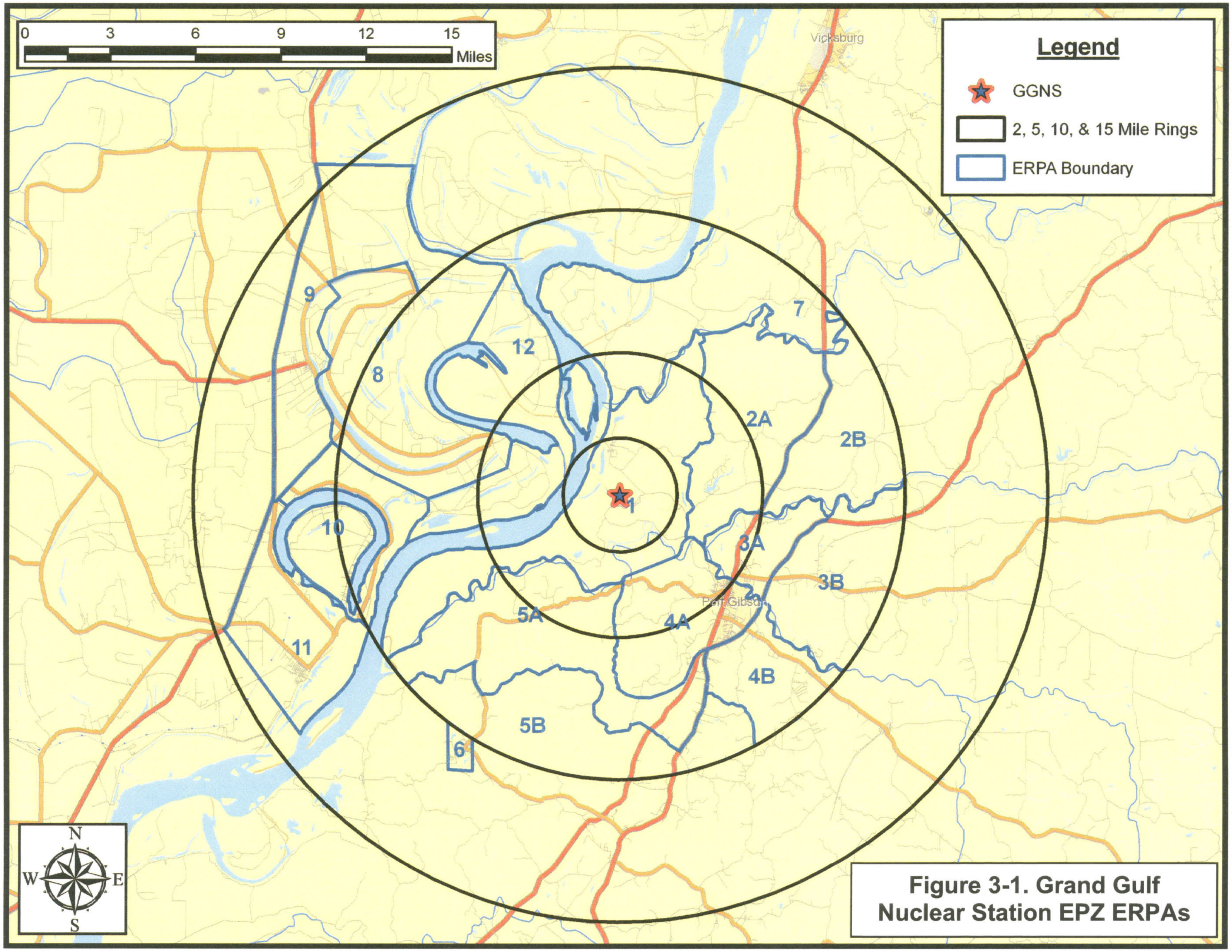
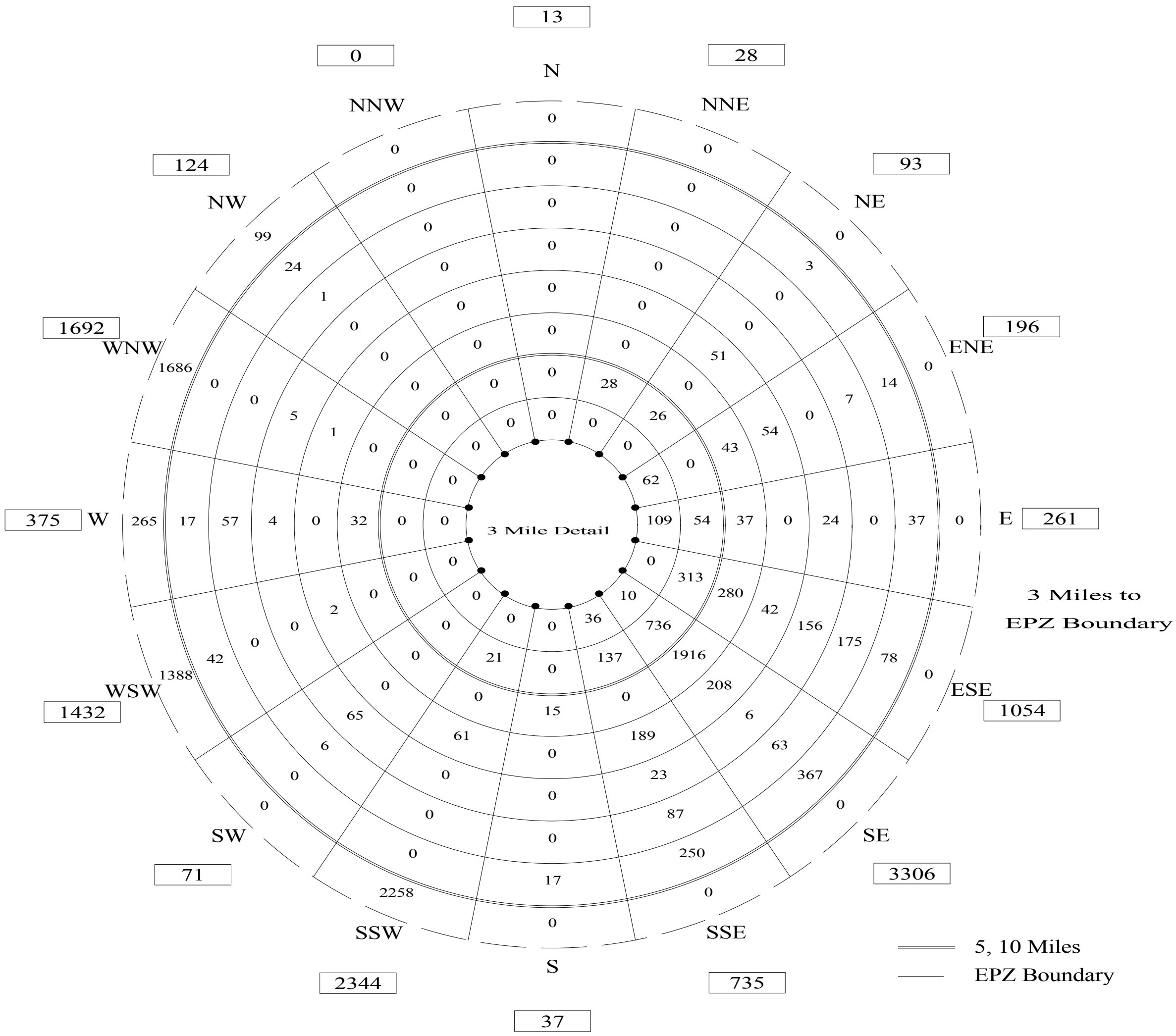


Figure 3-1. Grand Gulf Nuclear Station EPZ ERPAs

Table 3-1. EPZ Permanent Resident Population		
ERPA	**2000 Population**	**2007 Population**
1	104	100
2A	356	342
2B	150	144
3A	983	946
3B	506	487
4A	2,892	2,778
4B	564	541
5A	163	156
5B	396	381
6	2,057	2,258
7	3	3
8	163	148
9	1,892	1,708
10	431	388
11	1,530	1,381
12	0	0
TOTAL	**12,190**	**11,761**
% Change in Population		**- 3.5%**

Table 3-2. Permanent Resident Population and Vehicles by ERPA		
ERPA	**2007 Population**	**Vehicles**
1	100	57
2A	342	190
2B	144	80
3A	946	513
3B	487	265
4A	2,778	1,505
4B	541	296
5A	156	88
5B	381	209
6	2,258	2,032
7	3	2
8	148	84
9	1,708	929
10	388	214
11	1,381	748
12	0	0
TOTAL	**11,761**	**7,212**



Resident Population			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	0	0-1	0
1-2	65	0-2	65
2-3	9	0-3	74
3-4	217	0-4	291
4-5	1315	0-5	1606
5-6	2323	0-6	3929
6-7	608	0-7	4537
7-8	283	0-8	4820
8-9	396	0-9	5216
9-10	849	0-10	6065
10-EPZ	5696	0-EPZ	11761

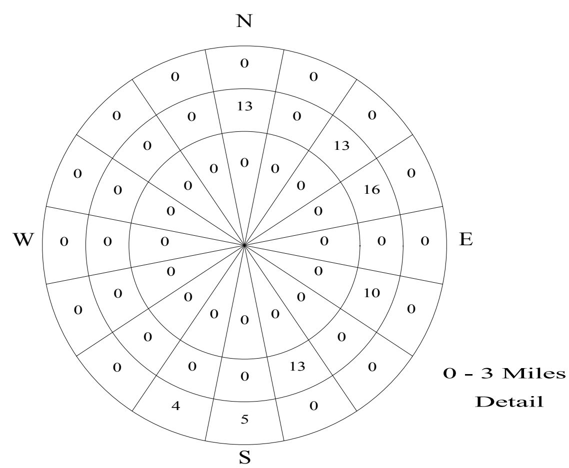
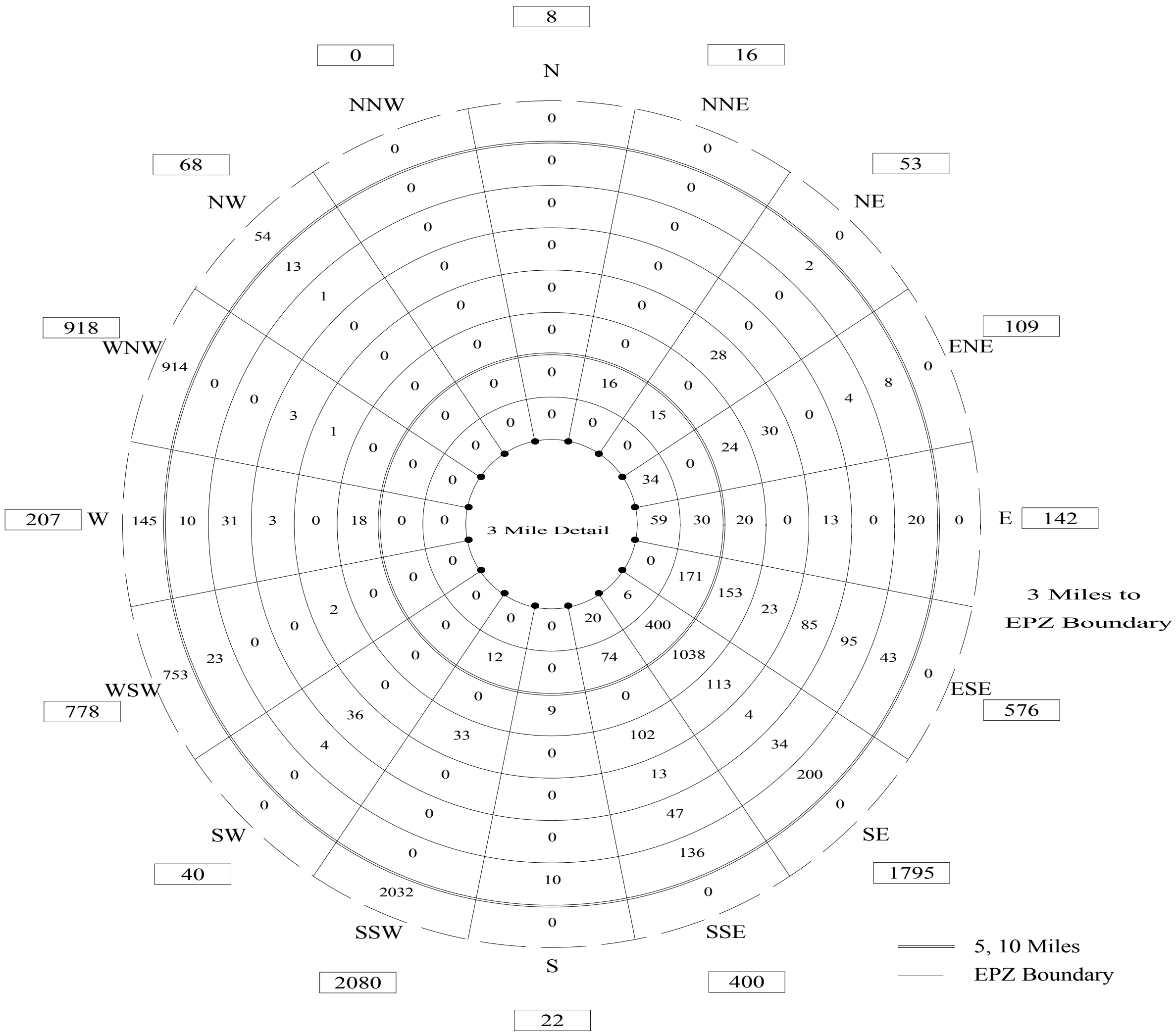


Figure 3-2. Permanent Residents by Sector



Resident Vehicles			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	0	0-1	0
1-2	39	0-2	39
2-3	6	0-3	45
3-4	119	0-4	164
4-5	718	0-5	882
5-6	1262	0-6	2144
6-7	332	0-7	2476
7-8	157	0-8	2633
8-9	216	0-9	2849
9-10	465	0-10	3314
10-EPZ	3898	0-EPZ	7212

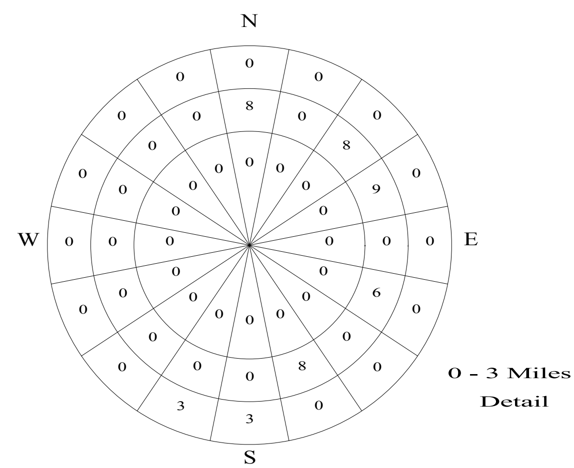


Figure 3-3. Permanent Resident Vehicles by Sector

Transient Population

Transient population groups are defined as those people who are not permanent residents and 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 Grand Gulf EPZ has a number of areas that attract transients, including:

- Grand Gulf Military Park – Historic Landmark
- Lake Bruin State Park – Camping and Recreation
- Warner-Tully YMCA Camp – Children's Summer Camp
- Lake Claiborne Inc. – Private Lake Community
- Hunting and Fishing Camps – 64 total in the EPZ
- Riverboat Cruises

Estimates of the yearly attendance at these transient facilities were provided by Enercon Services, Inc. These yearly attendance figures were divided amongst the 52 weeks of the year. It is assumed that 75% of the weekly attendance is during the peak day. Internet searches were also used to obtain more detailed information about these facilities. The average household size of 2.71 persons per household was applied to the transient facilities to estimate the number of visiting families. One evacuating vehicle per transient family was assumed. The following are estimates of transient population of each of these groups:

Grand Gulf Military Park

The park is a 400-acre landmark commemorating the former town of Grand Gulf and the Civil War battle that took place there; it is identified on the National Register of Historic Places. The park is located 8 miles northwest of Port Gibson, Mississippi in Claiborne County. The park includes Fort Cobun, Fort Wade, historical museums, campground, picnic areas, and other recreational features. The park attracted 90,817 visitors from July, 2004 to June, 2005. The peak transient population at Grand Gulf Military Park is estimated at 1,310 people per day, evacuating in 483 vehicles.

Lake Bruin State Park

Lake Bruin is an oxbow lake that was once part of the Mississippi River. Located in Tensas Parish, Louisiana – it offers fishing, camping, boating, swimming and picnicking. The over 3,000 acres of water surface provide for boating, fishing, and water sports. A beach area is reserved for swimming. There are 25 camp sites with electrical and plumbing hookups. The yearly attendance at the park is 36,000 people. The peak day attendance is estimated at 350 persons, evacuating in 128 vehicles.

Warner-Tully YMCA Camp

Warner Tully is a children's camp with week long sessions throughout June and July each summer. The camp offers swimming, canoeing, riflery, and other activities. There are a total of nine cabins at the camp with 10 campers and 2 counselors per cabin. Campers are dropped off at the beginning of the week by their parents. It is assumed that school buses will be used to evacuate the camp children in the event of an emergency. Assuming bus occupancy of 50 children, 2 buses will be needed to evacuate the camp children. A bus is counted as 2 passenger car equivalents due to its large size and sluggish acceleration characteristics, resulting in 4 evacuating vehicles for the camp.

Lake Claiborne Inc.

Lake Claiborne Inc. is a private community located in Claiborne County, Mississippi. There are a total of 450 members, 51 of which are permanent residents residing in the community year round. The remaining 399 members are considered transients who most likely stay in the community during the peak seasons. Lake Claiborne offers facilities for boating and fishing. The peak day attendance is estimated at 399 people, evacuating in 147 vehicles.

Hunting and Fishing Camps

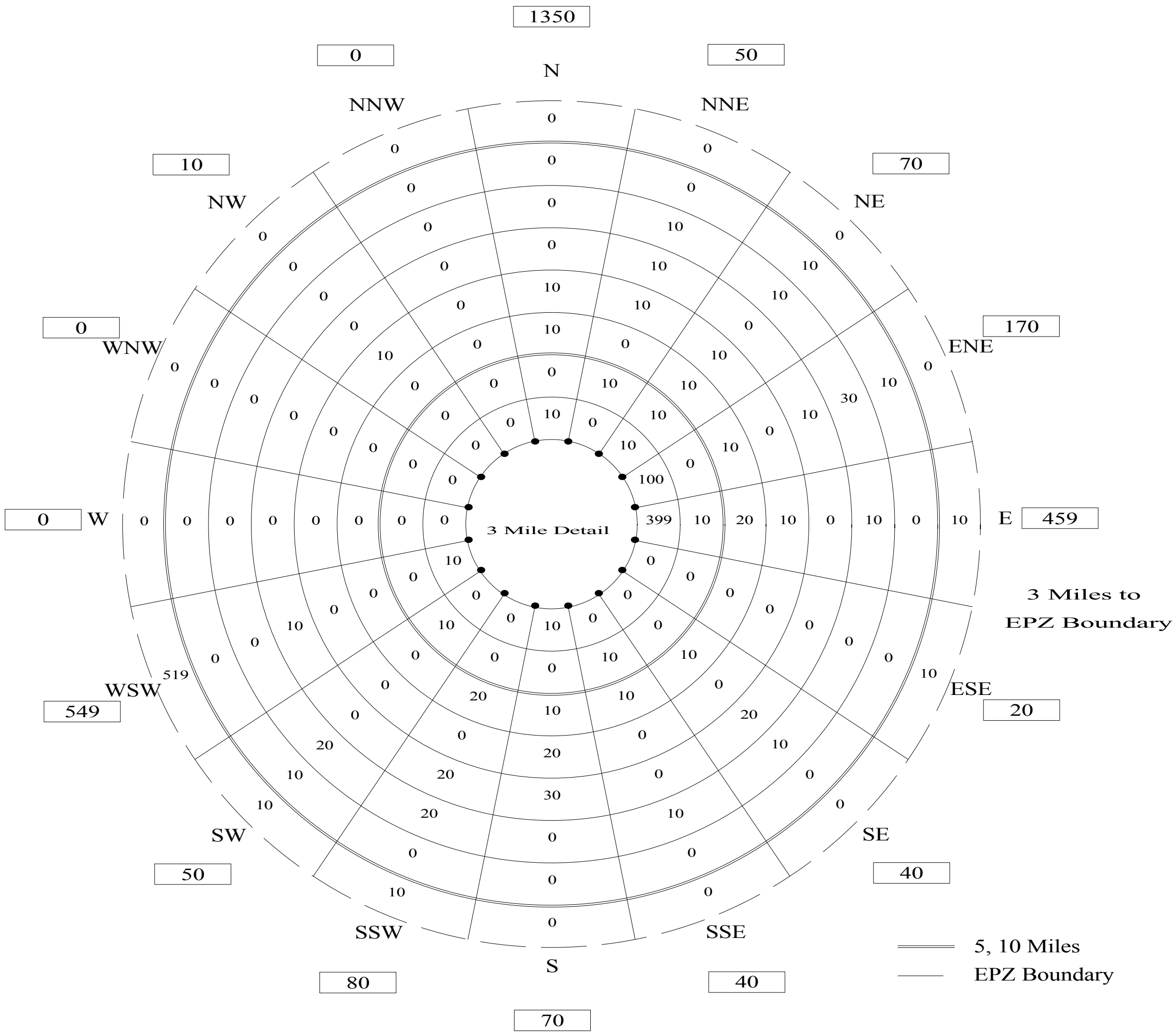
Claiborne County attracts many white-tail deer hunters during the hunting season. As such, there are 64 hunting/fishing camps located in Claiborne County within the EPZ boundary. Appendix E lists these facilities and maps their locations. An estimated 8-10 hunters was assumed at each of the camps in the 2003 ETE update for GGNS; 10 hunters per camp are assumed for this ETE study. Significant car pooling is assumed for the hunting camps due to the social nature of the activity. As such, 1.5 persons/vehicle is assumed for the hunting camps resulting in 7 evacuating vehicles per camp. A total of 640 hunters evacuating in 448 vehicles is assumed for the opening day of hunting season (peak hunting population).

Table 3-3 shows the transient population and the number of transient vehicles in the EPZ. Figures 3-4 and 3-5 present the transient population and transient vehicle estimates by sector and distance from the GGNS.

Riverboat Cruises

Three old fashioned steamboats traverse the Mississippi River within the GGNS EPZ – the Delta Queen, the Mississippi Queen, and the American Queen. The boats do not load in the EPZ. They cruise at an average speed of 10 knots/hr which would easily enable them to traverse the EPZ in under an hour. The passengers on these boats are not considered in the transient estimates for this study.

Table 3-3. Summary of Transient Population and Transient Vehicles					
Facility	**ERPA**	**Yearly Attendance**	**Weekly Attendance**	**Peak Day Attendance**	**Peak Vehicles**
Grand Gulf Military Park	1	90,817	1,746	1,310	483
Lake Claiborne	2A	450 members, 51 permanent residents		399	147
Warner-Tully YMCA	2A	9 cabins, 10 campers per cabin (June & July)		90	4
Hunting/Fishing Camps	64 Camps total - all located in Claiborne County			10	7
Lake Bruin State Park	10	36,000	692	519	192



Transient Population			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	0	0-1	0
1-2	1350	0-2	1350
2-3	40	0-3	1390
3-4	539	0-4	1929
4-5	50	0-5	1979
5-6	100	0-6	2079
6-7	70	0-7	2149
7-8	100	0-8	2249
8-9	120	0-9	2369
9-10	30	0-10	2399
10-EPZ	559	0-EPZ	2958

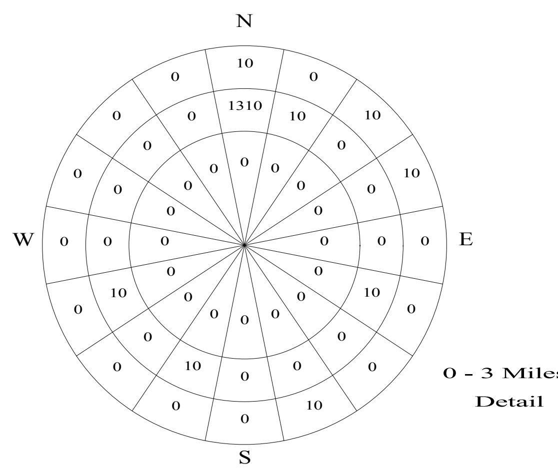
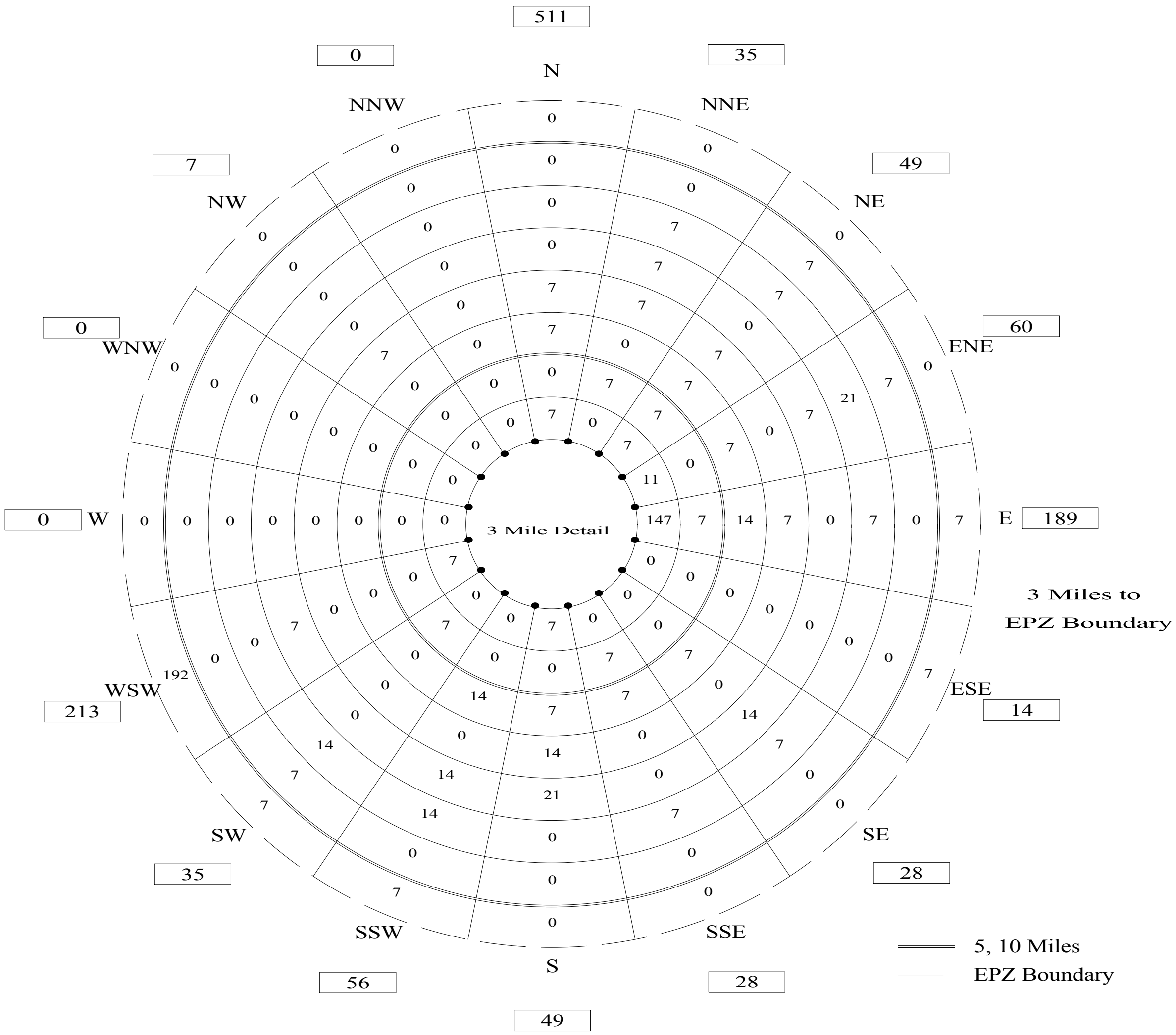


Figure 3-4. Transient Population by Sector



Transient Vehicles			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	0	0-1	0
1-2	511	0-2	511
2-3	28	0-3	539
3-4	186	0-4	725
4-5	35	0-5	760
5-6	70	0-6	830
6-7	49	0-7	879
7-8	70	0-8	949
8-9	84	0-9	1033
9-10	21	0-10	1054
10-EPZ	220	0-EPZ	1274

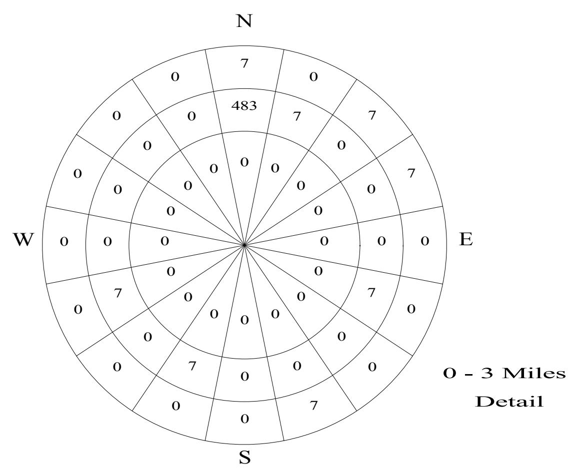


Figure 3-5. Transient Vehicles by Sector

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 on those commuting employees who will evacuate along with the permanent resident population.

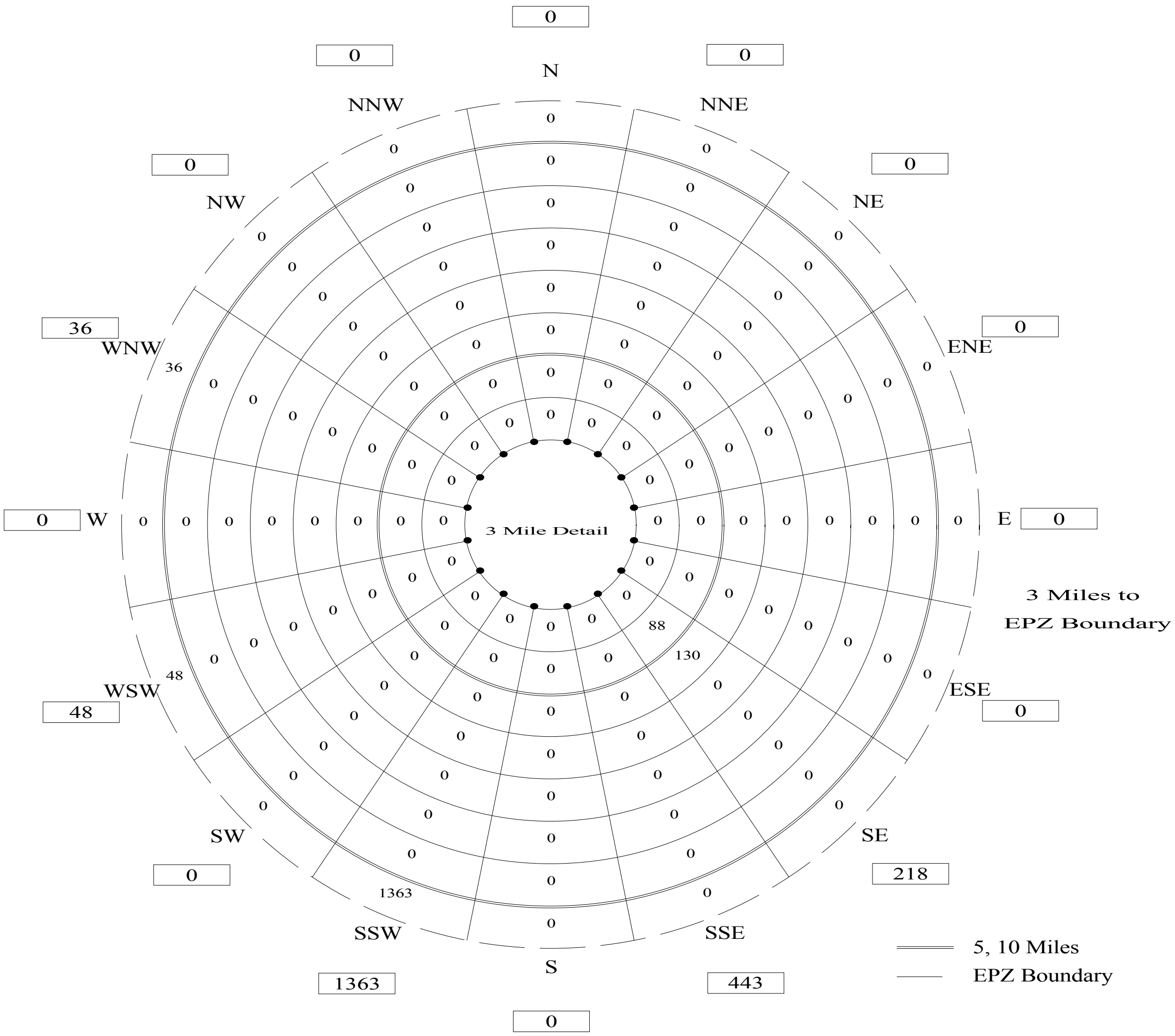
To represent the number of persons that work in the EPZ but live outside the EPZ, year 2000 journey-to-work data were used for Louisiana and Mississippi. These data define the number of persons working in a specified location (municipality) by their place of residence (origin municipality). The data indicate that, on average, 50 percent of workers in Tensas Parish come from outside the parish and 59 percent of the workers in Claiborne County are commute to work from outside the county. Data request forms were sent to emergency planning officials in Tensas and Claiborne. These completed forms were used to estimate the number of employees within the EPZ.

Students commuting to Alcorn State University are treated as employees due to similar travel patterns, arriving in the morning and leaving in the evening. The 2003 ETE study estimated 3,100 students at the university, 1,100 of which commute to the campus. 2006 estimates of enrollment are 3,500 students, based on the University website. Applying the percentage of commuting students from 2003, an estimated 1,242 students commute to the campus. The remaining students are counted as permanent residents in the Census data. We assume that those students living on campus have their own vehicles and will evacuate using those vehicles.

An occupancy of 1.06 persons per employee-vehicle obtained from the telephone survey, was used to determine the number of evacuating employee vehicles.

Table 3-4 presents non-EPZ Resident employee and vehicle estimates by ERPA. Figures 3-6 and 3-7 present these data by sector.

Table 3-4. Summary of Non-EPZ Employees and Employee Vehicles						
Facility	**County**	**ERPA**	**Total Employees**	**Max Shift Employees**	**Non-EPZ Employees**	**Employee Vehicles**
GGNS Workforce	Claiborne	1	750	750	443	418
Claiborne County Hospital	Claiborne	4A	35	35	21	20
Port Gibson High School Faculty	Claiborne	4A	60	60	35	33
Port Gibson Middle School Faculty	Claiborne	4A	47	47	28	26
Watson Elementary School Faculty	Claiborne	4A	89	89	53	50
Chamberlain-Hunt Academy Faculty	Claiborne	4A	58	58	34	32
Claiborne Educational Foundation Faculty	Claiborne	4A	9	9	5	5
Alcorn State University Faculty	Claiborne	6	205	205	121	114
Alcorn State University Commuting Students	Claiborne	6	1,242	1,242	1,242	1,172
Piggly Wiggly	Claiborne	4A	25	25	15	14
M&M Superstore	Claiborne	4A	16	12	7	7
Claiborne County Nursing Home	Claiborne	3A	82	34	20	19
Tensas Elementary School Faculty	Tensas	11	52	52	26	25
Davidson High School Faculty	Tensas	11	18	18	9	8
Tensas Academy Faculty	Tensas	11	26	26	13	12
Newellton High School Faculty	Tensas	9	30	30	15	14
Tensas Charter School Faculty	Tensas	9	6	6	3	3
J.B. Evans Correctional Center	Tensas	9	15	15	8	8
Tensas Care & Rehab Center	Tensas	9	68	20	10	9
TOTALS:			**2,833**	**2,733**	**2,108**	**1,989**



Employees			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	443	0-1	443
1-2	0	0-2	443
2-3	0	0-3	443
3-4	0	0-4	443
4-5	88	0-5	531
5-6	130	0-6	661
6-7	0	0-7	661
7-8	0	0-8	661
8-9	0	0-9	661
9-10	0	0-10	661
10-EPZ	1447	0-EPZ	2108

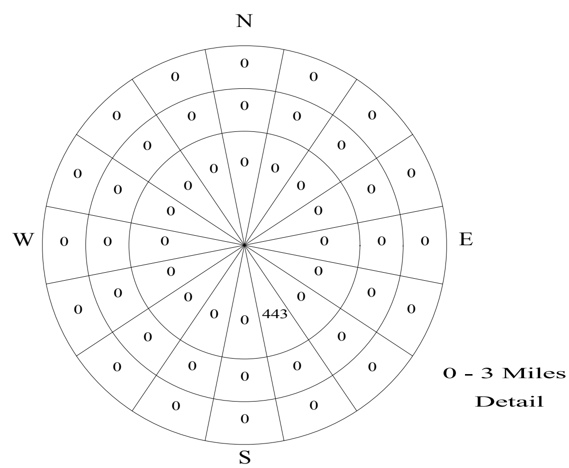
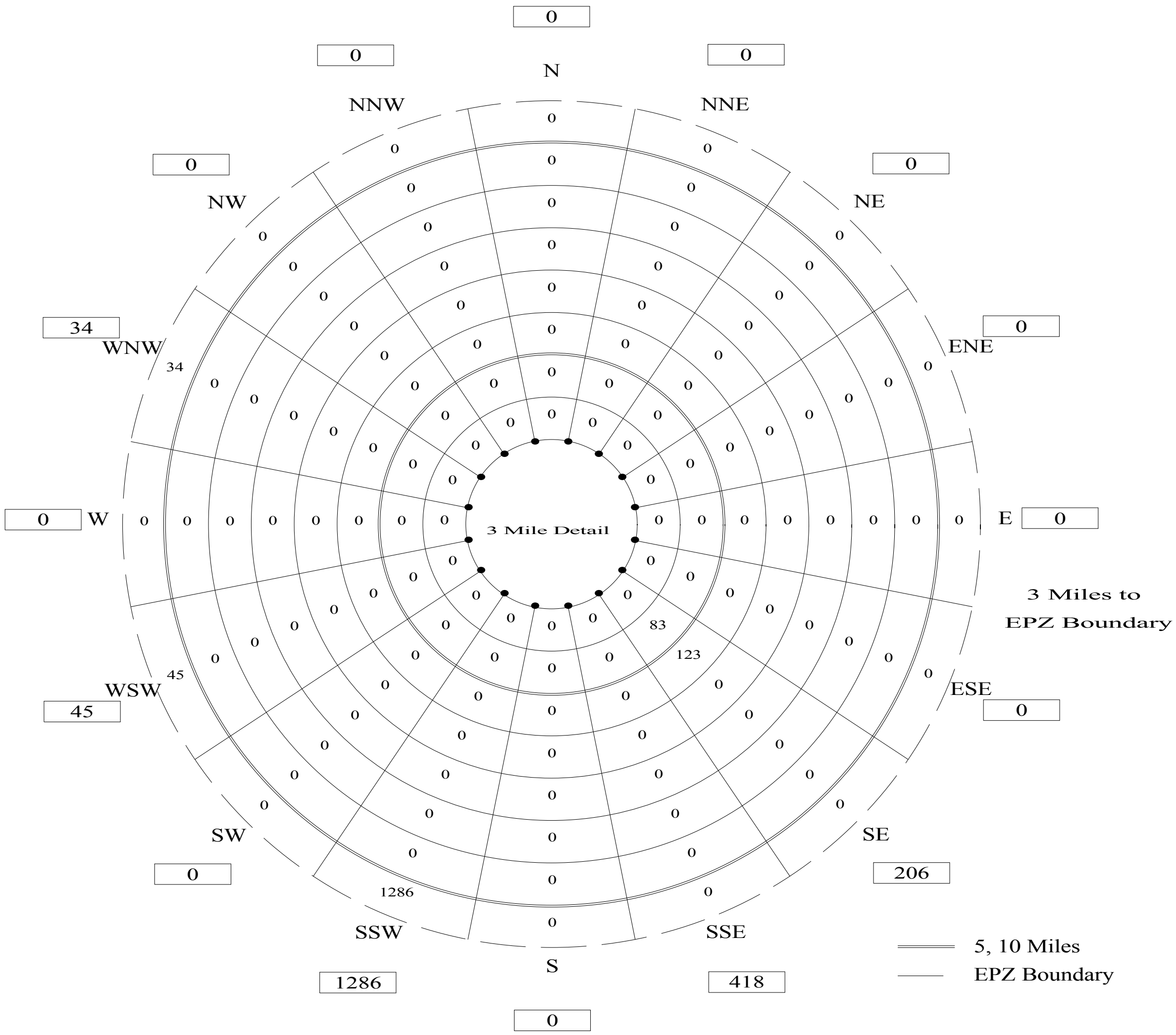


Figure 3-6. Employee Population by Sector



Employee Vehicles			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	418	0-1	418
1-2	0	0-2	418
2-3	0	0-3	418
3-4	0	0-4	418
4-5	83	0-5	501
5-6	123	0-6	624
6-7	0	0-7	624
7-8	0	0-8	624
8-9	0	0-9	624
9-10	0	0-10	624
10-EPZ	1365	0-EPZ	1989

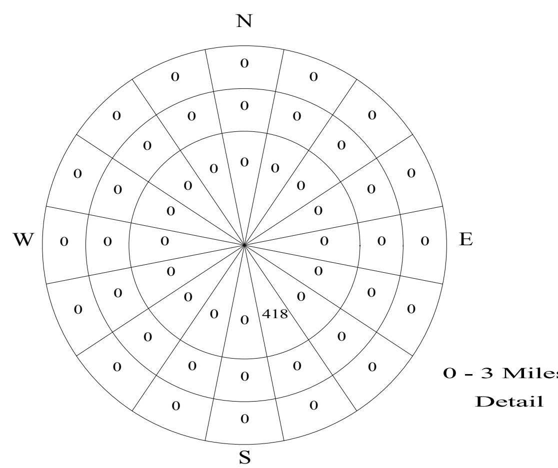


Figure 3-7. Employee Vehicles by Sector

Medical Facilities

Data request forms were completed for each of the medical facilities within the GGNS EPZ. Chapter 8 details the evacuation of medical facilities and their patients. The number and type of evacuating vehicles that need to be provided depends on the patients' state of health. Buses can transport up to 40 people; vans, up to 12 people; ambulances, up to 2 people (patients).

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 US routes – Route 61 in Mississippi and Route 65 in Louisiana, which are the primary routes through the EPZ. We assume that 300 vehicles per lane load northbound and southbound on Route 65 and Route 61; Route 65 is a single lane northbound and southbound while Route 61 is 2 lanes in each direction. It is assumed that this traffic will continue to enter the EPZ during the first 60 minutes following the Advisory to Evacuate. This produces an estimate of 1,800 vehicles entering the EPZ as external-external trips during this period.

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. (From the 2000 Highway Capacity Manual)

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.

Because of the effect of weather on the capacity of a roadway, it is necessary to adjust capacity figures to represent the prevailing conditions during inclement weather. Based on limited empirical data, weather conditions such as heavy 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.

Given the rural character of the EPZ and the availability of well-maintained highways, congestion arising from evacuation is not likely to be significant except in certain areas. 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.

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 Traffic Management Plan identifies these locations (called Traffic Control Points, TCP) and the management procedures applied.

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

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

where:

Qcap,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_m	=	The mean duration of GREEN time servicing vehicles that are executing movement, *m*, for each signal cycle; seconds
L	=	The mean "lost time" for each signal phase servicing movement, m; seconds
C	=	The duration of each signal cycle; seconds
P_m	=	The 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, 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,

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

where

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

The estimation of h_m for specified values of $h_{sat}, F_1, F_2, ...$ is undertaken within the PCDYNEV simulation model and within the TRAD model by a mathematical model[1]. The resulting values for h_m always satisfy the condition:

$$h_m \geq h_{sat}$$

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 Highway Capacity Manual.

1 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.

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. Figure 4-1 describes this relationship.

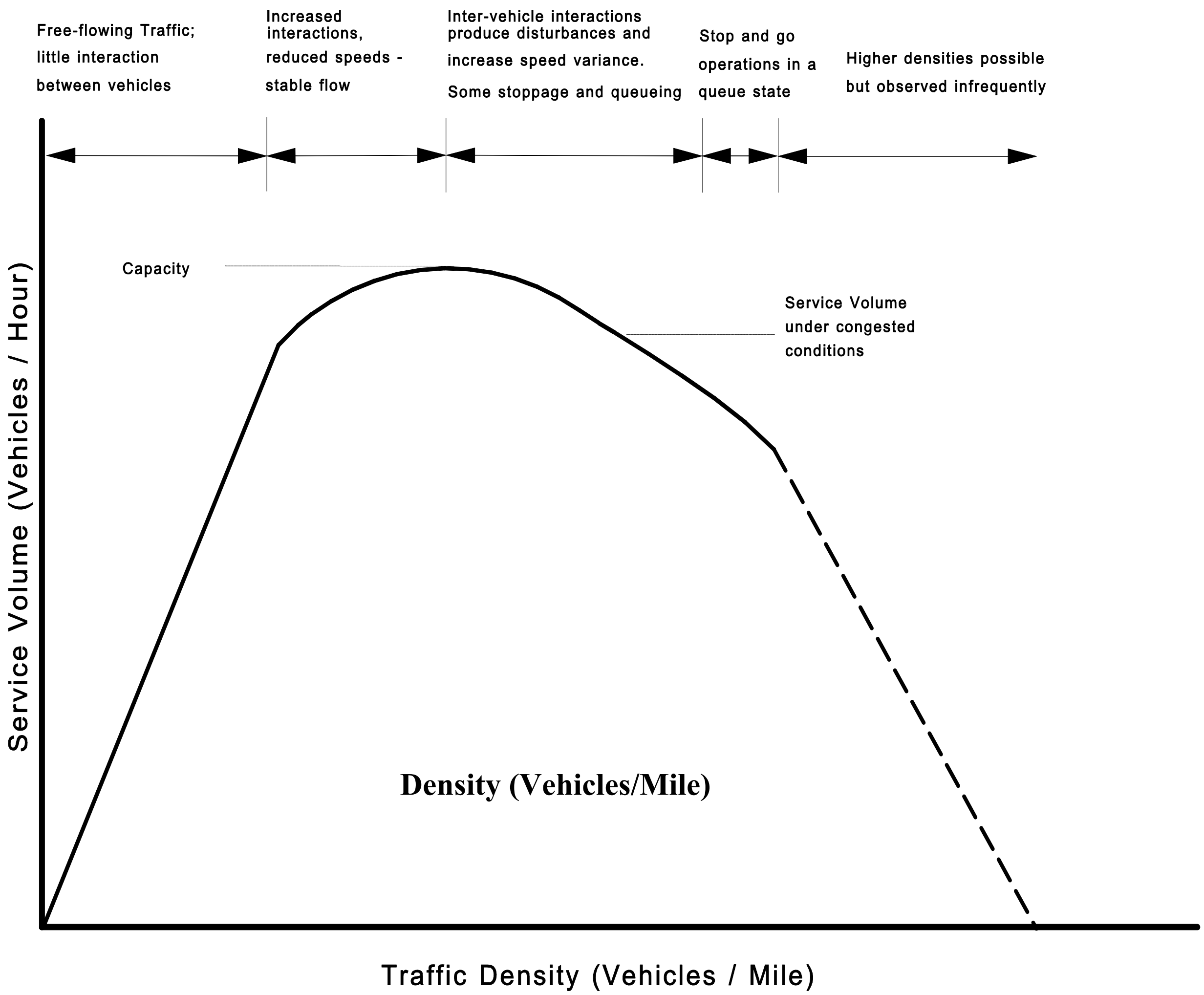


Figure 4-1. Fundamental Relationship Between Volume and Density

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; this 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. 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:

$$V_F = R \times \text{Capacity}$$

where R = Reduction factor which is less than unity.

Based on empirical data collected on freeways, we have employed a value of R=0.85. It is important to mention that some investigators, on analyzing data collected on freeways, conclude that little reduction in capacity occurs even when traffic is operating at Level of Service, *F*. While there is conflicting evidence on this subject, we adopt a conservative approach and use a value of capacity, V_F, that is applied during LOS F conditions; V_F, is lower than the specified capacity.

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.

The procedure used here was to estimate "section" capacity, V_E, based on observations made traveling over each section of the evacuation network, by the posted speed limits and travel behavior of other motorists. It was then determined 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.

Application to the Grand Gulf Nuclear Power Station EPZ

As part of the development of the GGNS EPZ traffic network, an estimate of roadway capacity is required. The source material for the capacity estimates presented herein is contained in:

2000 Highway Capacity Manual (HCM)
Transportation Research Board
National Research Council
Washington, D.C.

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

- Two-lane roads: Local, State
- Multi-lane Highways (at-grade)
- Freeways (Natchez-Trace Parkway)

Each of these classifications will be discussed.

Two-Lane Roads

Ref: HCM Chapter 20

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 evacuation 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 city limits.

Multi-Lane Highway

Ref: HCM Chapter 21

Exhibit 21-23 (in the HCM) presents a set of curves that indicates a per-lane capacity of approximately 2100 pc/h, for free-speeds of 55-60 mph. 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.

Freeways

Ref: HCM Chapters 22-25

Chapter 22 of the HCM describes a procedure for integrating the results obtained in Chapters 23, 24 and 25, which compute capacity and LOS for freeway components. The discussion also references Chapter 31, which presents a discussion on simulation models. The simulation model, PC-DYNEV, automatically performs this integration process.

Chapter 23 of the HCM presents procedures for estimating capacity and LOS for A Basic Freeway Segments". Exhibit 23-3 of the HCM2000 presents capacity vs. free speed estimates.

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

The inputs to the simulation model are highway geometrics, and free-speeds and capacity based on field observations. The simulation logic calculates actual time-varying speeds based on demand: capacity relationships.

Chapter 24 of the HCM presents procedures for estimating capacity, speed, density and LOS. The simulation model contains logic that relates speed to demand volume: capacity ratio. The value of capacity that is obtained from Exhibit 24-8 (of the HCM2000), depends on the "Type" and geometrics of the weaving segment and on the "Volume Ratio" (ratio of weaving volume to total volume).

Chapter 25 of the HCM presents procedures for estimating capacities of ramps and of "merge" areas. The capacity of a merge area "is determined primarily by the capacity of the downstream freeway segment". Values of this merge area capacity are presented in Exhibit 25-7 of the HCM2000, and depend on the number of freeway lanes and on the freeway free speed. The KLD simulation model logic simulates the merging operations of the ramp and freeway traffic. 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).

Intersections

Ref: HCM Chapters 16, 17

Procedures for estimating capacity and LOS for approaches to intersections are presented in Chapters 16 (signalized intersections) and 17 (un-signalized intersections). These are the two longest chapters in the HCM 2000, reflecting the complexity of these procedures. The simulation logic is likewise complex, but different; as stated on page 31-21 of the HCM2000:

> *"Assumptions and complex theories are used in the simulation model to represent the real-world dynamic traffic environment."*

5. ESTIMATION OF TRIP GENERATION TIME

NRC guidelines (see NUREG 0654, Appendix 4) 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 adapted telephone survey. We define the sum of these distributions of elapsed times as the Trip Generation Time Distribution.

Background

An accident at a nuclear power station is characterized by the following Emergency Action 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 accord with Federal Regulations, that a rapidly escalating accident will be considered in calculating the Trip Generation Time. We will assume:

a. The Advisory to Evacuate will be announced coincident with the emergency notification.

b. Mobilization of the general population will commence up to 10 minutes after the alert notification.

c. Evacuation Time Estimates (ETEs) are measured relative to the Advisory to Evacuate.

d. Schools will begin evacuating prior to the Advisory to Evacuate.

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

- Establish a temporal framework for estimating the Trip Generation distribution in the format recommended in Appendix 4 of NUREG 0654.
- Identify temporal points of reference that uniquely define "Clear Time" and Evacuation Time Estimates (ETE).

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

For example, suppose one hour will elapse 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 Emergency Planning Zone (EPZ) will be lower when the Advisory to Evacuate is announced, than at the time of the General Emergency. Thus, the time needed to evacuate the EPZ, after the Advisory to Evacuate will be less than the estimates presented in this report.

The notification process consists of two events:

- Transmitting information (e.g. using sirens, tone alerts, EAS broadcasts, loud speakers).
- Receiving and correctly interpreting the information that is transmitted.

The peak permanent resident population within the EPZ approximates 11,750 persons who are deployed over an area of approximately 314 square miles and 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 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 that 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 NUREG 0654, 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 ETEs may be obtained.

For example, people at home or at work within the EPZ will be notified by siren, and/or tone alert and/or radio. 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.

Generally, the information required can be obtained from a telephone survey of EPZ residents. Such a survey was conducted. Appendix F presents the 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 elsewhere to the development of the Grand Gulf Nuclear Plant ETE.

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-accident condition
2	Awareness of accident situation
3	Depart place of work to return home
4	Arrive home
5	Leave to evacuate the area

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	Public receives notification information	1
2 → 3	Prepare to leave work	2
2,3 → 4	Travel home	3
2,4 → 5	Prepare to leave for evacuation trip	4

These relationships are shown graphically in Figure 5-1.

An employee who lives outside the EPZ will follow sequence (e) of Figure 5-1; a resident of the EPZ who is at work, and will return home before beginning the evacuation trip will follow sequence (c) of Figure 5-1. Note that event 5, "Leave to evacuate the area," is conditional either on event 2 or on event 4. That is, activity 2 → 5 by a resident at home can be undertaken in parallel with activities 2 → 3, 3 → 4 and 4 → 5 by a commuter returning to that home, as shown in Figure 5-1 (a) and (c). Specifically, one adult member of a household can prepare to leave home (i.e. secure the home, pack clothing, etc.), while others are traveling home from work. In this instance, the household members would be able to evacuate sooner than if such trip preparation were deferred until all household members had returned home. For this study, we adopt the conservative posture that all activities will occur in 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.

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 we are operating on distributions – not scalar numbers).

Time Distribution No. 1, Notification Process: Activity 1 → 2

It is reasonable to expect that 85 percent of those within the EPZ will be aware of the accident within 30 minutes with the remainder notified within the following 20 minutes. The notification distribution is given below:

Distribution No. 1, Notification Time: Activity 1 → 2

Table 5-2. Time Distribution for Notifying the Public

Elapsed Time (Minutes)	Percent of Population Notified
0	0
5	7
10	13
15	26
20	46
25	65
30	85
35	90
40	95
45	98
50	100

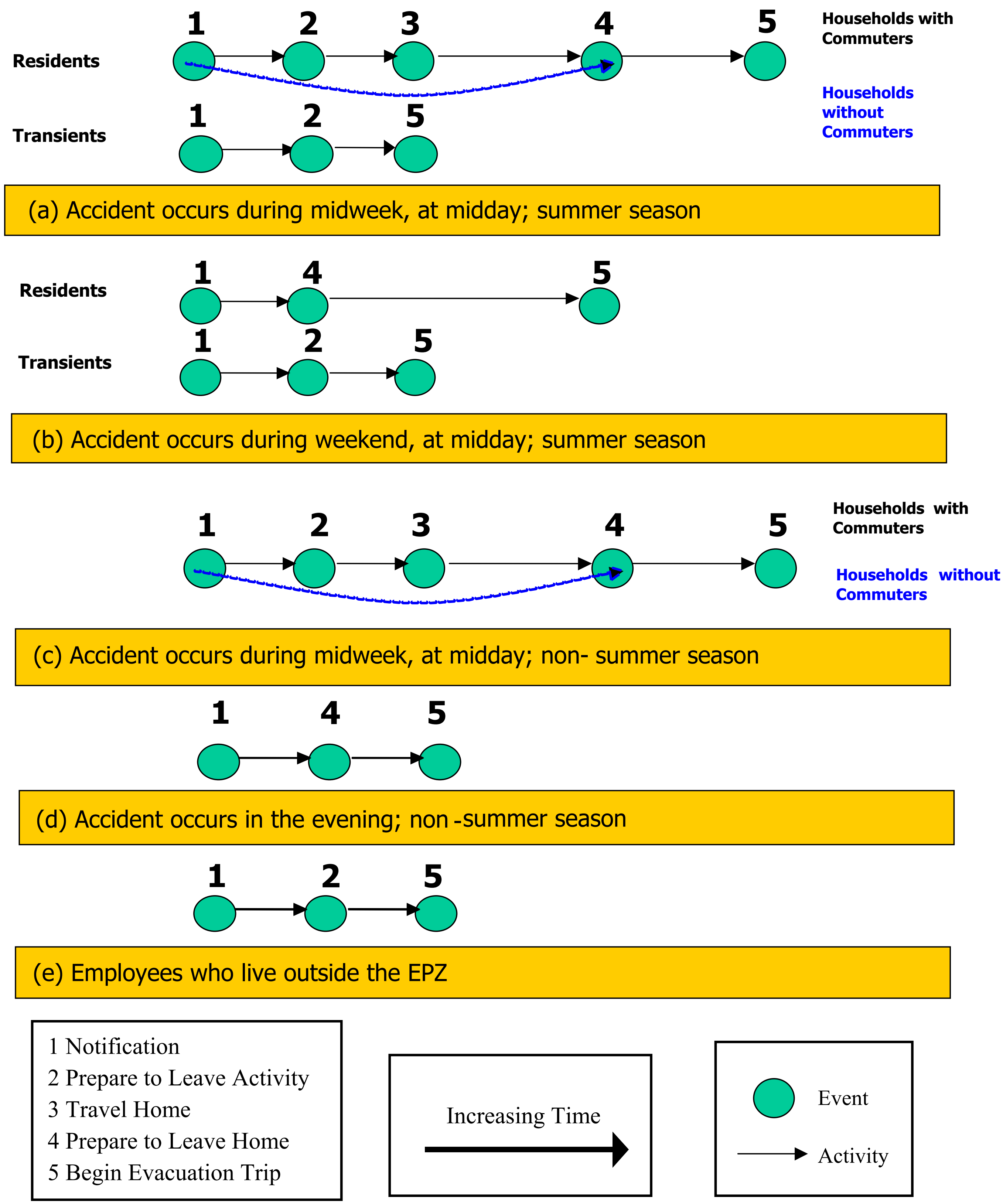


Figure 5-1. Events and Activities Preceding the Evacuation Trip

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 would require additional time to secure their facility. The distribution of Activity 2 → 3 reflects data obtained by the telephone survey. This distribution is plotted in Figure 5-2 and listed below.

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

Elapsed Time (Minutes)	Cumulative Percent Employees Leaving Work
0	0
5	21
10	36
15	49
20	57
25	64
30	72
35	76
40	80
45	84
50	87
55	90
60	93
65	94
70	95
75	96
80	97
85	98
90	99
95	100

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

Distribution No. 3, Travel Home: Activity 3 → 4

These data are provided directly by the telephone survey. This distribution is plotted in Figure 5-2 and listed below.

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

Elapsed Time (Minutes)	Cumulative Percent Returning Home
0	0
5	16
10	34
15	50
20	59
25	65
30	73
35	79
40	83
45	87
50	90
55	93
60	96
65	97
70	98
75	99
80	100

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

Distribution No. 4, Prepare to Leave Home: Activity 2,4 → 5

These data are provided directly by the telephone survey. This distribution is plotted in Figure 5-2 and listed below.

Table 5-5. Time Distribution of Population Ready to Evacuate

Elapsed Time (Minutes)	Cumulative Percent Ready to Evacuate
0	0
5	10
10	21
15	32
20	43
25	54
30	62
35	68
40	71
45	74
50	78
55	81
60	85
65	88
70	89
75	91
80	91
85	92
90	92
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100	93
105	93
110	94
115	94
120	95
125	96
130	97
135	98
140	99
145	100

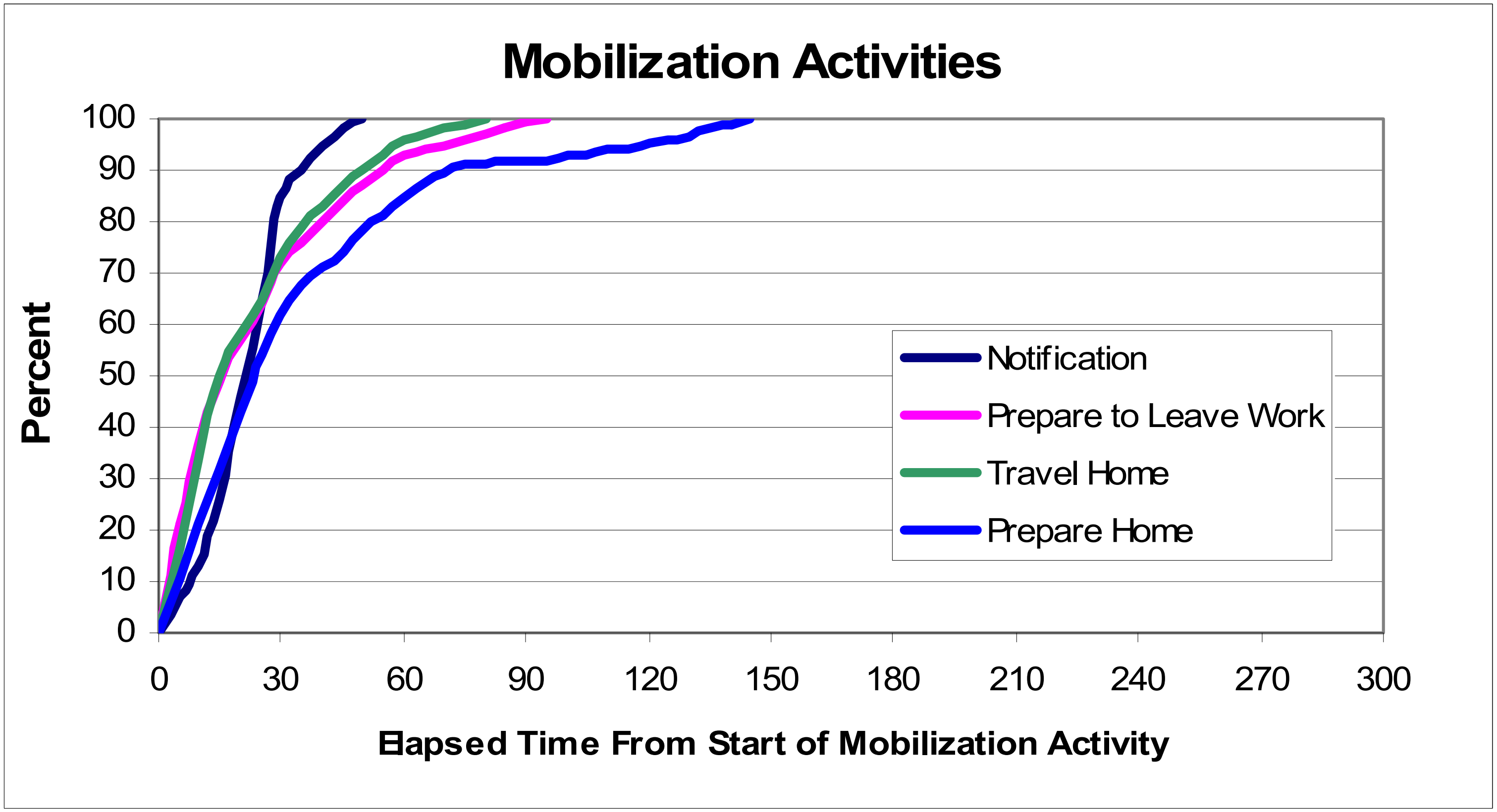


Figure 5-2. Evacuation Mobilization Activities

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. We assume 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 → 4) must precede Activity 4 → 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. Mapping Distributions to Events

Apply "Summing" Algorithm To:		
Distributions 1 and 2	To Obtain Distribution A	That defines Event. 3
Distributions A and 3	To Obtain Distribution B	That defines Event. 4
Distributions B and 4	To Obtain Distribution C	That defines Event. 5
Distributions 1 and 4	To Obtain Distribution D	That defines Event. 5

Distributions A through D are described below; distributions A, C, and D are shown in Figure 5-3:

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.
C	Time distribution of residents with commuters leaving home to begin the evacuation trip.
D	Time distribution of residents without commuters returning home to begin the evacuation trip.

Figure 5-3 presents the combined trip generation distributions designated A, C, and D. These distributions are presented on the same time scale. The PCDYNEV simulation model is designed to accept varying rates of vehicle trip generation for each origin centroid, expressed in the form of histograms.

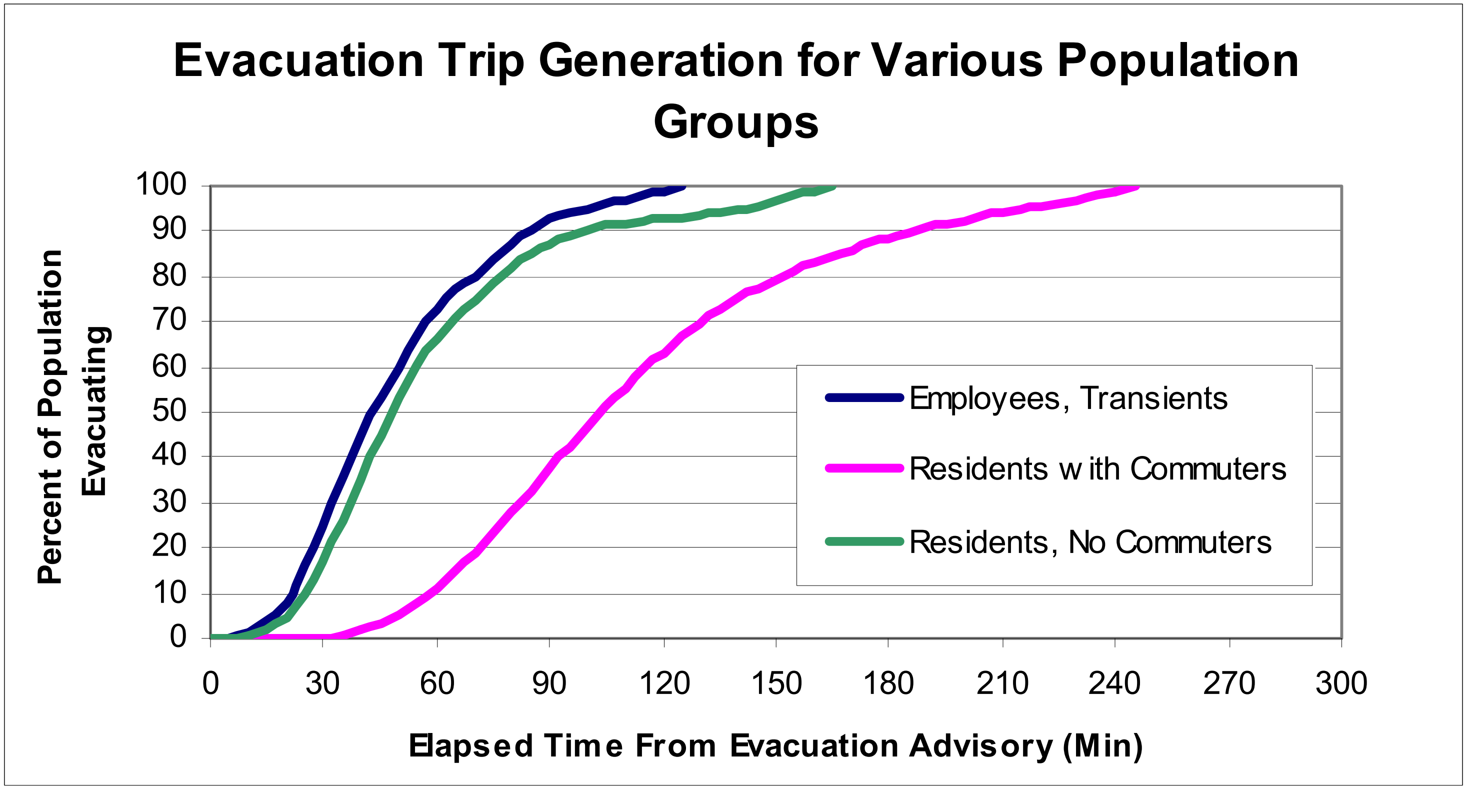


Figure 5-3. Comparison of Trip Generation Distributions

Table 5-8. Trip Generation for the EPZ Population					
Time Period	Duration (Min)	Percent of Total Trips Generated Within Indicated Time Period			
		Residents With Commuters (Distribution C)	Residents Without Commuters (Distribution D)	Employees (Distribution A)	Transients (Distribution A)
1	15	0	4	5	5
2	15	0	16	22	22
3	30	11	47	46	46
4	30	27	21	19	19
5	30	26	4	8	8
6	30	15	5	0	0
7	30	10	3	0	0
8	30	5	0	0	0
9	30	6	0	0	0
10	600	0	0	0	0

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 evacuation ERPAs, 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 9 Regions were defined which encompass all the groupings of ERPAs considered. These Regions are defined in Table 6-1. The ERPA configurations are identified in Figure 6-1. Each keyhole sector-based area consists of a central circle centered at the Grand Gulf Nuclear Station (GGNS), and an adjoining quadrant with a central angle of 90 degrees. These sectors extend to a distance of 5 miles from GGNS (Region R2, and Regions R4 to R5), or 10 miles (Region R3, Regions R6 to R9).

A total of 12 Scenarios were evaluated for all Regions. Thus, there are a total of 12x9=108 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 assumed to evacuate for each scenario. Table 6-4 presents the vehicle counts for each scenario.

Table 6-1. Definition of Evacuation Regions		
Region	**Description**	**ERPA**
R1	2-mile, 360º	1
R2	5-mile, 360º	1,2A,3A,4A,5A
R3	Entire EPZ	All
2-mile Ring and Sector to 5-miles		
R4	2-mile ring + wind to 5-miles, 90º NE	1,2A
R5	2-mile ring + wind to 5-miles, 90º SE	1,3A,4A,5A
Refer to R1	2-mile ring + wind to 5-miles, 90º NW	1
Refer to R1	2-mile ring + wind to 5-miles, 90º SW	1
5-mile Ring and Sector to 10-miles (to EPZ boundary)		
R6	5-mile ring + wind to 10-miles, 90º NE	1,2A,2B,3A,4A,5A,7
R7	5-mile ring + wind to 10-miles, 90º SE	1,2A,3A,3B,4A,4B,5A,5B,6
R8	5-mile ring + wind to 10-miles, 90º NW	1,2A,3A,4A,5A,7,8,9,12
R9	5-mile ring + wind to 10-miles, 90º SW	1,2A,3A,4A,5A,5B,6,10,11

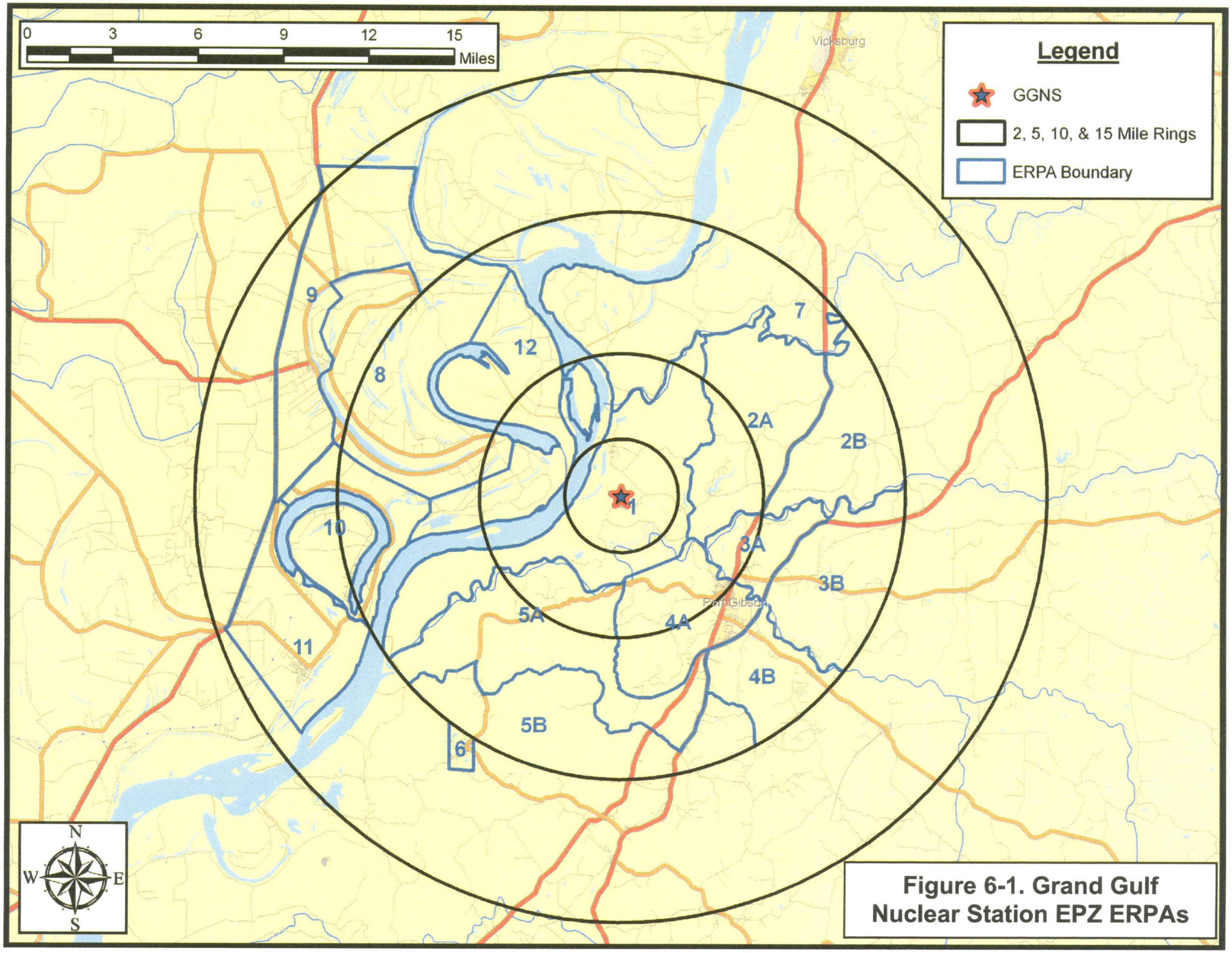


Figure 6-1. Grand Gulf Nuclear Station EPZ ERPAs

Table 6-2. Evacuation Scenario Definitions					
Scenario	**Season**	**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	Alcorn State Football + New Plant Construction
12	Winter	Midweek	Midday	Good	New Plant Construction

Note: Schools are assumed to be in session for the Winter season (midweek, midday).

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

Scenarios	Residents With Commuters in Household	Residents With No Commuters in Household	Employees	Transients	Shadow	Special Events	School Buses	Transit Buses	External Through Traffic
1	62%	38%	96%	50%	38%	0%	10%	100%	100%
2	62%	38%	96%	50%	38%	0%	10%	100%	100%
3	10%	90%	48%	100%	34%	0%	0%	100%	100%
4	10%	90%	48%	100%	34%	0%	0%	100%	100%
5	10%	90%	10%	25%	31%	0%	0%	100%	60%
6	62%	38%	100%	15%	38%	0%	100%	100%	100%
7	62%	38%	100%	15%	38%	0%	100%	100%	100%
8	10%	90%	48%	25%	34%	0%	0%	100%	100%
9	10%	90%	48%	25%	34%	0%	0%	100%	100%
10	10%	90%	10%	10%	31%	0%	0%	100%	60%
11	10%	90%	48%	25%	34%	100%	0%	100%	100%
12	62%	38%	96%	50%	38%	100%	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 of 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 30% relocation of shadow residents along with a proportional percentage of shadow employees. The percentage of shadow employees is computed using the scenario-specific ratio of EPZ employees to residents. We assume that employment in the shadow is similar to that in the EPZ.
Shadow % = 30% × [1 + (sum of employees for scenario ÷ sum of residents for scenario)]

Special Events.. Additional vehicles in the Alcorn State University area associated with a football weekend and in the area of the Grand Gulf Nuclear Station during the construction phase of the new unit.

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 local highways and major arterial roads at the start of the evacuation. This traffic is stopped by access control approximately 1-2 hours after the evacuation begins.

Table 6-4. Vehicle Estimates for Various Combinations of Regions and Scenarios

Scenarios	Residents with Commuters	Residents without Commuters	Employees	Transients	Shadow	Special Events	School Buses	Transit Buses	External Traffic	Total Scenario Vehicles
1	4,458	2,754	1,909	637	934	-	12	38	1,800	12,542
2	4,458	2,754	1,909	637	934	-	12	38	1,800	12,542
3	446	6,766	935	1,274	835	-	-	38	1,800	12,116
4	446	6,766	935	1,274	835	-	-	38	1,800	12,116
5	446	6,766	199	510	759	-	-	38	1,080	9,607
6	4,458	2,754	1,989	408	943	-	124	38	1,800	12,297
7	4,458	2,754	1,989	293	943	-	124	38	1,800	12,297
8	4,458	2,754	1,989	153	943	-	-	38	1,800	11,161
9	446	6,766	935	510	835	-	-	38	1,800	11,161
10	446	6,766	199	255	759	-	-	38	1,080	9,415
11	446*	6,766*	935	510	835*	9,925	-	38	1,800	21,086
12	4,458*	2,754*	1,989	408	943*	2,925	12	38	1,800	15,467

*The projected construction year is 2015. Based on discussion with Enercon Services, the permanent resident population and shadow population have not been extrapolated to 2007. Comparison of the 2000 Census and 2006 Census estimates indicate that population is actually decreasing within the EPZ (See Table 3-1); however, the 2007 population estimates have been maintained for 2015 as a conservative basis.

7. GENERAL POPULATION EVACUATION TIME ESTIMATES (ETE)

This section presents the current results of the computer analyses using the IDYNEV System described in Appendices B, C and D. These results cover 9 regions within the GGNS EPZ and the 12 Evacuation Scenarios discussed in Section 6.

The ETE for all Evacuation Cases are presented in Tables 7-1A through 7-1D. **These tables present the estimated times to clear the indicated population percentages from the Evacuation Regions for all Evacuation Scenarios.** The tabulated values of ETE are obtained by interpolating the PC-DYNEV simulation model outputs which are generated at 10-minute intervals, then rounding these data to the nearest 5 minutes.

7.1 Voluntary Evacuation and Shadow Evacuation

We define "voluntary evacuees" as people who are within the EPZ in ERPAs for which an Advisory to Evacuate *has not* been issued, yet who nevertheless elect to evacuate. We define "shadow evacuation" as the movement of people from areas *outside* the EPZ for whom no protective action recommendation has been issued. Both voluntary and shadow evacuation are assumed to take place over the same time frame as the evacuation from within the impacted Evacuation Region.

The ETE for GGNS addresses the issue of voluntary evacuees in the manner shown in Figure 7-1. Within the circle defined by the farthest radial distance of the Evacuation Region, 50 percent of those people located in ERPAs not advised to evacuate, are assumed to do so. Within the annular ring extending from the furthest distance of the Evacuation Region (if less than 10 miles), to the EPZ boundary, it is assumed that 35 percent of the people located there will elect to evacuate.

Figure 7-2 presents the area identified as the Shadow Evacuation Region. This region extends radially from the boundary of the EPZ to a distance of 15 miles.

Traffic generated within this Shadow Evacuation Region, traveling away from the GGNS location, has a potential for impeding evacuating vehicles from within the Evacuation Region. We assume that the traffic volumes emitted within the Shadow Evacuation Region correspond to 30 percent of the residents there plus a proportionate number of employees in that region. **All ETE calculations include this shadow traffic movement.**

7.2 Patterns of Traffic Congestion During Evacuation

Figures 7-3 through 7-5 illustrate the patterns of traffic congestion that arise for the case when the entire EPZ (Region R3) is advised to evacuate during the winter, weekend, midday period under good weather conditions. It is further assumed that an Alcorn State football game and new plant construction are in progress (Evacuation Scenario 11). This scenario was chosen because these "special events" cause localized traffic congestion in the EPZ. Traffic congestion present during Scenarios 1 through 10 is a local effect that does not last long; congestion does not significantly effect the duration of the ETE.

Traffic congestion, as the term is used here, is defined as Level of Service (LOS) F. LOS F is defined as follows (2000 HCM):

> Level of Service F is used to define forced or breakdown flow. This condition exists wherever the amount of traffic approaching a point exceeds the amount that can traverse the point. Queues form behind such locations. Operations within the queue are characterized by stop-and-go waves, and they are extremely unstable. Vehicles may progress at reasonable speeds for several hundred feet or more, then be required to stop in a cyclic fashion. Level of Service F is used to describe the operating conditions within the queue, as well as the point of the breakdown. It should be noted, however, that in many cases operating conditions of vehicles or pedestrians discharged from the queue may be

quite good. Nevertheless, it is the point at which arrival flow exceeds discharge flow, which causes the queue to form, and Level of Service F is an appropriate designation for such points.

This definition is general and conceptual in nature, and applies primarily to uninterrupted flow. Levels of Service for interrupted flow facilities vary widely in terms of both the user's perception of service quality and the operational variables used to describe them.

All highway "links" which experience LOS F are delineated in these Figures by a red line; all others are lightly indicated. Congestion develops rapidly around concentrations of population and traffic bottlenecks. Two areas in the EPZ are congested by 30 minutes (Figure 7-3) after the evacuation advisory including:

- Eastbound approaches to US Route 61 from Route 552 (Alcorn State traffic)
- Eastbound approaches to US Route 61 from Grand Gulf Rd (Plant employees, construction workers, and Grand Gulf Military Park traffic)

Figure 7-4 presents the congestion pattern one hour after the Advisory to Evacuate. Major areas of congestion in the EPZ are:

- Eastbound approaches to US Route 61 from Route 552 (Alcorn State traffic)
- Eastbound approaches to US Route 61 from Grand Gulf Rd (Plant employees, construction workers, and Grand Gulf Military Park traffic)
- Some local congestion is present outside of the EPZ boundary where evacuation routes merge.

Figure 7-5 presents congestion levels at 3 hours after the start of evacuation. This figure shows the congestion arising from the presence of plant construction workers has dissipated. However, there is still congestion caused by traffic exiting Alcorn State.

The absence of congestion on network links implies that traffic demand there has decreased below the roadway capacity for a period of time sufficient to dissipate any traffic queues. It does not imply that traffic has completely cleared from these roadway sections.

7.3 Evacuation Rates

Evacuation is a continuous process, as implied by Figures 7-3 through 7-5. Another format for displaying the dynamics of evacuation is depicted in Figure 7-6. This plot indicates the rate at which traffic flows out of the indicated areas for the case of an evacuation of the full 10-mile Region R3 (i.e., entire EPZ) under the indicated conditions. Appendix J presents these plots for all Evacuation Scenarios for Region R3.

As indicated in Figure 7-6, there is typically a long "tail" to these distributions. Vehicles evacuate an area slowly at the beginning, as people respond to the Advisory to Evacuate 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 the real world, this ideal is generally unattainable reflecting the variation in population density and in highway capacity over the EPZ.

7.4 Guidance on Using ETE Tables

Tables 7-1A through 7-1D present the ETE values for all 9 Evacuation Regions and all 12 Evacuation Scenarios. They are organized as follows:

Table	Contents
7-1A	ETE represents the elapsed time required for 50 percent of the population within a Region, to evacuate from that Region.
7-1B	ETE represents the elapsed time required for 90 percent of the population within a Region, to evacuate from that Region.
7-1C	ETE represents the elapsed time required for 95 percent of the population within a Region, to evacuate from that Region.
7-1D	ETE represents the elapsed time required for 100 percent of the population within a Region, to evacuate from that Region.

The user first determines the percentile of population for which the ETE is sought. The applicable value of ETE within the chosen Table may then be identified using the following procedure:

1. Identify the applicable **Scenario**:
   - The Season
     - Summer
     - Winter (also Autumn and Spring)
   - The Day of Week
     - Midweek
     - Weekend
   - The Time of Day
     - Midday
     - Evening
   - Weather Condition
     - Good Weather

- Rain
- Special Event (if any)
  - Alcorn State Football + New Plant Construction
  - New Plant Construction (Alone)

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 Tables 7-1A through 7-1D. For these conditions, Scenario (4) applies.
- The conditions of a winter evening (either midweek or weekend) and rain are not explicitly identified in Tables 7-1A through 7-1D. For these conditions, Scenarios (9) for rain apply.
- The seasons are defined as follows:
  - Summer implies that public schools are *not* in session.
  - Winter, Spring and Autumn imply that public schools *are* in session.
- Time of Day: Midday implies the time over which most commuters are at work.

2. With the Scenario identified, now identify the **Evacuation Region**:

- Determine the projected azimuth direction of the plume (coincident with the wind direction). Determine which quadrant this plume direction lies in – NE, SE, NW, or SW.
- Determine the distance that the Evacuation Region will extend from GGNS. The applicable distances and their associated candidate Regions are given below:
  - 2 Miles (Region R1)
  - 5 Miles (Regions R2, R4, and R5)
  - to EPZ Boundary (Regions R3 and R6-R9)
- Enter Table 7-2 and identify the applicable group of candidate Regions based on the distance that the selected Region extends from GGNS.

Select the Evacuation Region identifier in that row from the first column of the Table.

3. Determine the **ETE for the Scenario** identified in Step 1 and the Region identified in Step 2, 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 determined 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.

<u>Example</u>

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

- Sunday, August 10th at 4:00 AM.
- It is raining.
- Wind direction is *to* the northeast (NE).
- Wind speed is such that the distance to be evacuated is judged to be 10 miles (to EPZ boundary).
- The desired ETE is that value needed to evacuate 95 percent of the population from within the impacted Region.

Table 7-1C is applicable because the 95-percentile population is desired. Proceed as follows:

1. Identify the Scenario as summer, weekend, evening and raining. Entering Table 7-1C, 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. Since the wind direction is to the northeast (NE) and the evacuation distance extends to 10-miles (or EPZ boundary), enter Table 7-2 and locate the group entitled “5 Mile Ring and Sector to 10-miles (to EPZ Boundary)”. Under “DESCRIPTION”, identify the NE (northeast) azimuth (wind direction) and read REGION R6 in the first column of that row.

3. Enter Table 7-1C to locate the data cell containing the value of ETE for Scenario 4 and Region 6. This data cell is in column (4) and in the row for Region R6; it contains the ETE value of **2:00**.

Table 7-1A. Time To Clear The Indicated Area of 50 Percent of the Affected Population

	Summer		Summer		Summer		Winter		Winter		Winter		Winter	Winter
	Midweek		Weekend		Midweek Weekend		Midweek		Weekend		Midweek Weekend		Weekend	Midweek
Scenario	(1)	(2)	(3)	(4)	(5)	Scenario	(6)	(7)	(8)	(9)	(10)	Scenario	(11)	(12)
	Midday		Midday		Evening		Midday		Midday		Evening		Midday	Midday
Region (ERPA)	Good Weather	Rain	Good Weather	Rain	Good Weather	Region (ERPA)	Good Weather	Rain	Good Weather	Rain	Good Weather	Region (ERPA)	Alcorn Football + New Plant Constuction	New Plant Constuction
Entire 2-Mile Region, 5-Mile Region, and EPZ														
R01 (1)	0 50	0 50	0 50	0 50	0 50	R01 (1)	0 50	0 50	0 50	0 50	0 50	R01 (1)	1 20	1 20
R02 (1,2A,3A,4A,5A)	1 05	1 05	0 55	0 55	0 55	R02 (1,2A,3A,4A,5A)	1 10	1 10	0 55	0 55	0 55	R02 (1,2A,3A,4A,5A)	1 20	1 20
R03 (All)	1 10	1 10	0 60	0 60	0 55	R03 (All)	1 10	1 10	0 60	0 60	0 60	R03 (All)	1 25	1 25
2 Mile Ring + Wind to 5 Miles														
R04 - Wind to NE (1, 2A)	0 60	1 00	0 55	0 55	0 55	R04 - Wind to NE (1, 2A)	1 00	1 00	0 55	0 55	0 55	R04 - Wind to NE (1, 2A)	1 20	1 25
R05 - Wind to SE (1,3A,4A,5A)	1 05	1 05	0 55	0 55	0 55	R05 - Wind to SE (1,3A,4A,5A)	1 05	1 05	0 55	0 55	0 55	R05 - Wind to SE (1,3A,4A,5A)	1 20	1 20
Wind to NW - Same as R1 (1)	0 50	0 50	0 50	0 50	0 50	Wind to NW - Same as R1 (1)	0 50	0 50	0 50	0 50	0 50	Wind to NW - Same as R1 (1)	1 20	1 20
Wind to SW - Same as R1 (1)	0 50	0 50	0 50	0 50	0 50	Wind to SW - Same as R1 (1)	0 50	0 50	0 50	0 50	0 50	Wind to SW - Same as R1 (1)	1 20	1 20
5 Mile Ring + Wind to EPZ Boundary														
R06 - Wind to NE (1,2A,2B,3A,4A,5A,7)	1 05	1 05	0 55	0 55	0 55	R06 - Wind to NE (1,2A,2B,3A,4A,5A,7)	1 10	1 10	0 55	0 55	0 55	R06 - Wind to NE (1,2A,2B,3A,4A,5A,7)	1 20	1 20
R07 - Wind to SE (1,2A,3A,3B,4A,4B,5A,5B,6)	1 05	1 10	0 55	0 55	0 55	R07 - Wind to SE (1,2A,3A,3B,4A,4B,5A,5B,6)	1 10	1 10	0 55	0 55	0 55	R07 - Wind to SE (1,2A,3A,3B,4A,4B,5A,5B,6)	1 25	1 20
R08 - Wind to NW (1,2A,3A,4A,5A,7,8,9,12)	1 05	1 05	0 55	0 55	0 55	R08 - Wind to NW (1,2A,3A,4A,5A,7,8,9,12)	1 10	1 10	0 55	0 55	0 55	R08 - Wind to NW (1,2A,3A,4A,5A,7,8,9,12)	1 20	1 20
R09 - Wind to SW (1,2A,3A,4A,5A,5B,6,10,11)	1 05	1 05	0 55	0 55	0 55	R09 - Wind to SW (1,2A,3A,4A,5A,5B,6,10,11)	1 10	1 10	0 55	0 55	0 55	R09 - Wind to SW (1,2A,3A,4A,5A,5B,6,10,11)	1 20	1 20

Table 7-1B. Time To Clear The Indicated Area of 90 Percent of the Affected Population														
	Summer		Summer		Summer		Winter		Winter		Winter		Winter	Winter
	Midweek		Weekend		Midweek Weekend		Midweek		Weekend		Midweek Weekend		Weekend	Midweek
Scenario	(1)	(2)	(3)	(4)	(5)	Scenario	(6)	(7)	(8)	(9)	(10)	Scenario	(11)	(12)
	Midday		Midday		Evening		Midday		Midday		Evening		Midday	Midday
Region (ERPA)	Good Weather	Rain	Good Weather	Rain	Good Weather	Region (ERPA)	Good Weather	Rain	Good Weather	Rain	Good Weather	Region (ERPA)	Alcorn Football + New Plant Constuction	New Plant Constuction
Entire 2-Mile Region, 5-Mile Region, and EPZ														
R01 (1)	1 35	1 35	1 30	1 30	1 30	R01 (1)	1 40	1 40	1 30	1 30	1 30	R01 (1)	2 25	2 25
R02 (1,2A,3A,4A,5A)	2 10	2 10	1 40	1 40	1 40	R02 (1,2A,3A,4A,5A)	2 10	2 10	1 40	1 40	1 40	R02 (1,2A,3A,4A,5A)	2 40	2 40
R03 (All)	2 20	2 20	1 50	1 50	1 50	R03 (All)	2 20	2 20	1 50	1 50	1 50	R03 (All)	3 20	2 40
2 Mile Ring + Wind to 5 Miles														
R04 - Wind to NE (1, 2A)	1 45	1 45	1 35	1 40	1 40	R04 - Wind to NE (1, 2A)	1 45	1 45	1 35	1 40	1 40	R04 - Wind to NE (1, 2A)	2 40	2 40
R05 - Wind to SE (1,3A,4A,5A)	2 00	2 00	1 40	1 40	1 40	R05 - Wind to SE (1,3A,4A,5A)	2 10	2 10	1 40	1 40	1 40	R05 - Wind to SE (1,3A,4A,5A)	2 25	2 25
Wind to NW - Same as R1 (1)	1 35	1 35	1 30	1 30	1 30	Wind to NW - Same as R1 (1)	1 40	1 40	1 30	1 30	1 30	Wind to NW - Same as R1 (1)	2 25	2 25
Wind to SW - Same as R1 (1)	1 35	1 35	1 30	1 30	1 30	Wind to SW - Same as R1 (1)	1 40	1 40	1 30	1 30	1 30	Wind to SW - Same as R1 (1)	2 25	2 25
5 Mile Ring + Wind to EPZ Boundary														
R06 - Wind to NE (1,2A,2B,3A,4A,5A,7)	2 10	2 10	1 40	1 40	1 40	R06 - Wind to NE (1,2A,2B,3A,4A,5A,7)	2 10	2 10	1 40	1 40	1 40	R06 - Wind to NE (1,2A,2B,3A,4A,5A,7)	2 40	2 40
R07 - Wind to SE (1,2A,3A,3B,4A,4B,5A,5B,6)	2 20	2 20	1 40	1 40	1 50	R07 - Wind to SE (1,2A,3A,3B,4A,4B,5A,5B,6)	2 20	2 20	1 40	1 45	1 50	R07 - Wind to SE (1,2A,3A,3B,4A,4B,5A,5B,6)	3 20	2 40
R08 - Wind to NW (1,2A,3A,4A,5A,7,8,9,12)	2 10	2 10	1 40	1 45	1 40	R08 - Wind to NW (1,2A,3A,4A,5A,7,8,9,12)	2 10	2 10	1 40	1 45	1 40	R08 - Wind to NW (1,2A,3A,4A,5A,7,8,9,12)	2 40	2 40
R09 - Wind to SW (1,2A,3A,4A,5A,5B,6,10,11)	2 10	2 10	1 50	1 50	1 50	R09 - Wind to SW (1,2A,3A,4A,5A,5B,6,10,11)	2 20	2 20	1 50	1 50	1 50	R09 - Wind to SW (1,2A,3A,4A,5A,5B,6,10,11)	3 20	2 40

Table 7-1C. Time To Clear The Indicated Area of 95 Percent of the Affected Population

	Summer		Summer		Summer		Winter		Winter		Winter		Winter	Winter
	Midweek		Weekend		Midweek Weekend		Midweek		Weekend		Midweek Weekend		Weekend	Midweek
Scenario	(1)	(2)	(3)	(4)	(5)	Scenario	(6)	(7)	(8)	(9)	(10)	Scenario	(11)	(12)
	Midday		Midday		Evening		Midday		Midday		Evening		Midday	Midday
Region (ERPA)	Good Weather	Rain	Good Weather	Rain	Good Weather	Region (ERPA)	Good Weather	Rain	Good Weather	Rain	Good Weather	Region (ERPA)	Alcorn Football + New Plant Constuction	New Plant Constuction
Entire 2-Mile Region, 5-Mile Region, and EPZ														
R01 (1)	1 50	1 50	1 40	1 40	1 50	R01 (1)	1 50	1 50	1 40	1 40	1 50	R01 (1)	2 30	2 30
R02 (1,2A,3A,4A,5A)	2 40	2 40	2 00	2 00	2 10	R02 (1,2A,3A,4A,5A)	2 40	2 40	2 00	2 00	2 10	R02 (1,2A,3A,4A,5A)	2 50	2 50
R03 (All)	2 50	2 50	2 10	2 10	2 20	R03 (All)	2 50	2 50	2 10	2 10	2 20	R03 (All)	3 50	2 55
2 Mile Ring + Wind to 5 Miles														
R04 - Wind to NE (1, 2A)	2 00	2 00	1 45	1 45	1 50	R04 - Wind to NE (1, 2A)	2 00	2 00	1 45	1 45	1 50	R04 - Wind to NE (1, 2A)	2 50	2 50
R05 - Wind to SE (1,3A,4A,5A)	2 40	2 40	1 50	1 50	2 00	R05 - Wind to SE (1,3A,4A,5A)	2 40	2 40	1 50	1 50	2 10	R05 - Wind to SE (1,3A,4A,5A)	2 30	2 30
Wind to NW - Same as R1 (1)	1 50	1 50	1 40	1 40	1 50	Wind to NW - Same as R1 (1)	1 50	1 50	1 40	1 40	1 50	Wind to NW - Same as R1 (1)	2 30	2 30
Wind to SW - Same as R1 (1)	1 50	1 50	1 40	1 40	1 50	Wind to SW - Same as R1 (1)	1 50	1 50	1 40	1 40	1 50	Wind to SW - Same as R1 (1)	2 30	2 30
5 Mile Ring + Wind to EPZ Boundary														
R06 - Wind to NE (1,2A,2B,3A,4A,5A,7)	2 40	2 40	2 00	2 00	2 10	R06 - Wind to NE (1,2A,2B,3A,4A,5A,7)	2 50	2 50	2 00	2 00	2 10	R06 - Wind to NE (1,2A,2B,3A,4A,5A,7)	2 55	2 55
R07 - Wind to SE (1,2A,3A,3B,4A,4B,5A,5B,6)	2 50	2 50	2 10	2 10	2 20	R07 - Wind to SE (1,2A,3A,3B,4A,4B,5A,5B,6)	2 50	2 50	2 10	2 10	2 20	R07 - Wind to SE (1,2A,3A,3B,4A,4B,5A,5B,6)	3 50	2 50
R08 - Wind to NW (1,2A,3A,4A,5A,7,8,9,12)	2 40	2 40	2 00	2 00	2 10	R08 - Wind to NW (1,2A,3A,4A,5A,7,8,9,12)	2 40	2 40	2 00	2 00	2 10	R08 - Wind to NW (1,2A,3A,4A,5A,7,8,9,12)	2 50	2 50
R09 - Wind to SW (1,2A,3A,4A,5A,5B,6,10,11)	2 50	2 50	2 10	2 10	2 10	R09 - Wind to SW (1,2A,3A,4A,5A,5B,6,10,11)	2 50	2 50	2 10	2 10	2 10	R09 - Wind to SW (1,2A,3A,4A,5A,5B,6,10,11)	3 50	2 50

Table 7-1D. Time To Clear The Indicated Area of 100 Percent of the Affected Population															
	Summer		Summer		Summer		Winter		Winter		Winter		Winter	Winter
	Midweek		Weekend		Midweek Weekend		Midweek		Weekend		Midweek Weekend		Weekend	Midweek
Scenario	(1)	(2)	(3)	(4)	(5)	Scenario	(6)	(7)	(8)	(9)	(10)	Scenario	(11)	(12)
	Midday		Midday		Evening		Midday		Midday		Evening		Midday	Midday
Region (ERPA)	Good Weather	Rain	Good Weather	Rain	Good Weather	Region (ERPA)	Good Weather	Rain	Good Weather	Rain	Good Weather	Region (ERPA)	Alcorn Football + New Plant Constuction	New Plant Constuction
Entire 2-Mile Region, 5-Mile Region, and EPZ														
R01 (1)	2 50	3 00	2 20	2 20	2 20	R01 (1)	2 50	2 50	2 20	2 20	2 20	R01 (1)	2 50	2 50
R02 (1,2A,3A,4A,5A)	4 00	4 00	3 50	3 50	3 50	R02 (1,2A,3A,4A,5A)	4 00	4 00	3 50	3 50	3 50	R02 (1,2A,3A,4A,5A)	4 00	4 00
R03 (All)	4 10	4 10	4 00	4 00	4 00	R03 (All)	4 00	4 10	4 00	4 00	4 00	R03 (All)	4 10	4 00
2 Mile Ring + Wind to 5 Miles														
R04 - Wind to NE (1, 2A)	4 00	4 00	3 50	3 50	3 50	R04 - Wind to NE (1, 2A)	4 00	4 00	3 50	3 50	3 50	R04 - Wind to NE (1, 2A)	4 00	4 00
R05 - Wind to SE (1,3A,4A,5A)	4 00	4 00	3 50	3 50	3 50	R05 - Wind to SE (1,3A,4A,5A)	4 00	4 00	3 50	3 50	3 50	R05 - Wind to SE (1,3A,4A,5A)	4 00	4 00
Wind to NW - Same as R1 (1)	2 50	3 00	2 20	2 20	2 20	Wind to NW - Same as R1 (1)	2 50	2 50	2 20	2 20	2 20	Wind to NW - Same as R1 (1)	2 50	2 50
Wind to SW - Same as R1 (1)	2 50	3 00	2 20	2 20	2 20	Wind to SW - Same as R1 (1)	2 50	2 50	2 20	2 20	2 20	Wind to SW - Same as R1 (1)	2 50	2 50
5 Mile Ring + Wind to EPZ Boundary														
R06 - Wind to NE (1,2A,2B,3A,4A,5A,7)	4 00	4 00	3 50	3 50	3 50	R06 - Wind to NE (1,2A,2B,3A,4A,5A,7)	4 00	4 00	3 50	3 50	3 50	R06 - Wind to NE (1,2A,2B,3A,4A,5A,7)	4 00	4 00
R07 - Wind to SE (1,2A,3A,3B,4A,4B,5A,5B,6)	4 00	4 00	4 00	4 00	3 50	R07 - Wind to SE (1,2A,3A,3B,4A,4B,5A,5B,6)	4 00	4 00	3 50	4 00	3 50	R07 - Wind to SE (1,2A,3A,3B,4A,4B,5A,5B,6)	4 10	4 00
R08 - Wind to NW (1,2A,3A,4A,5A,7,8,9,12)	4 00	4 00	3 50	3 50	3 50	R08 - Wind to NW (1,2A,3A,4A,5A,7,8,9,12)	4 00	4 00	3 50	3 50	3 50	R08 - Wind to NW (1,2A,3A,4A,5A,7,8,9,12)	4 00	4 00
R09 - Wind to SW (1,2A,3A,4A,5A,5B,6,10,11)	4 10	4 10	3 50	3 50	4 00	R09 - Wind to SW (1,2A,3A,4A,5A,5B,6,10,11)	4 00	4 00	3 50	3 50	4 00	R09 - Wind to SW (1,2A,3A,4A,5A,5B,6,10,11)	4 10	4 00

Table 7-2. Definition of Evacuation Regions		
Region	**Description**	**ERPA**
R1	2-mile, 360º	1
R2	5-mile, 360º	1,2A,3A,4A,5A
R3	Entire EPZ	All
2-mile Ring and Sector to 5-miles		
R4	2-mile ring + wind to 5-miles, 90º NE	1,2A
R5	2-mile ring + wind to 5-miles, 90º SE	1,3A,4A,5A
Refer to R1	2-mile ring + wind to 5-miles, 90º NW	1
Refer to R1	2-mile ring + wind to 5-miles, 90º SW	1
5-mile Ring and Sector to 10-miles (to EPZ boundary)		
R6	5-mile ring + wind to 10-miles, 90º NE	1,2A,2B,3A,4A,5A,7
R7	5-mile ring + wind to 10-miles, 90º SE	1,2A,3A,3B,4A,4B,5A,5B,6
R8	5-mile ring + wind to 10-miles, 90º NW	1,2A,3A,4A,5A,7,8,9,12
R9	5-mile ring + wind to 10-miles, 90º SW	1,2A,3A,4A,5A,5B,6,10,11

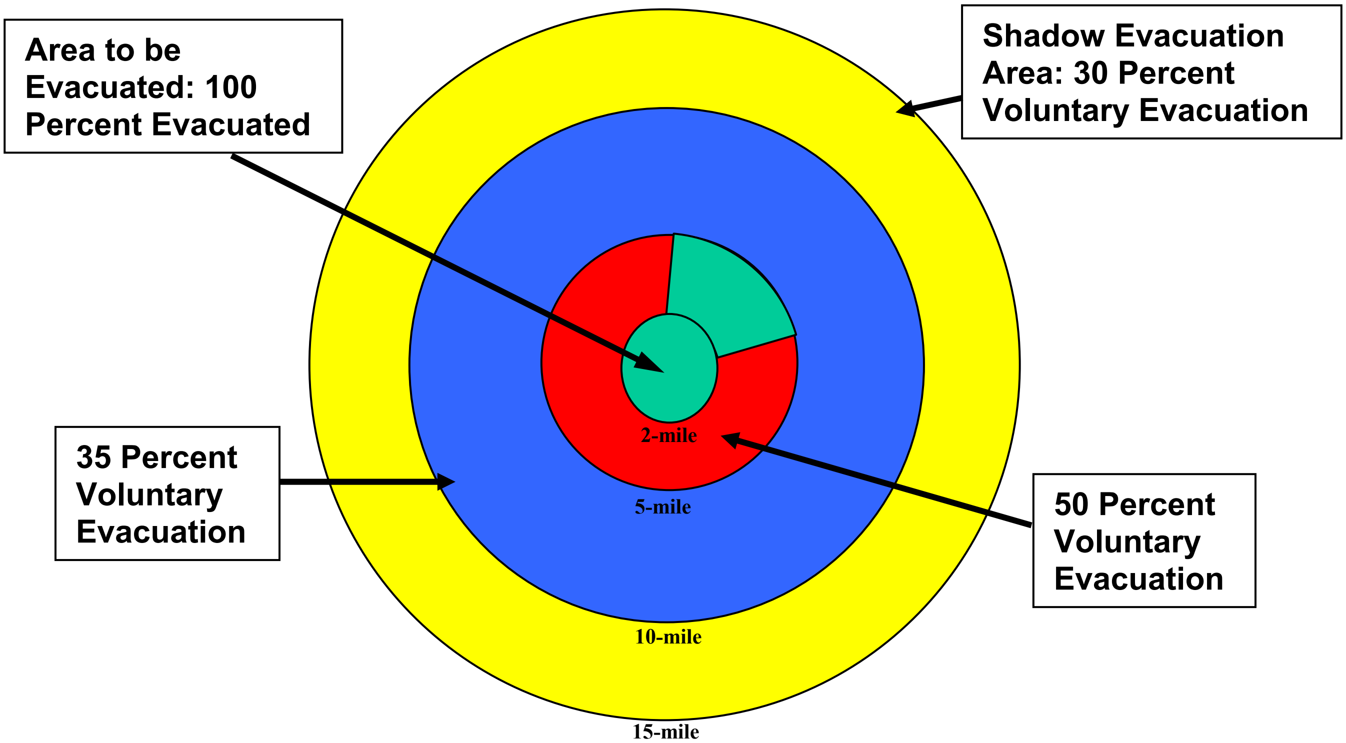


Figure 7-1. Voluntary Evacuation Methodology

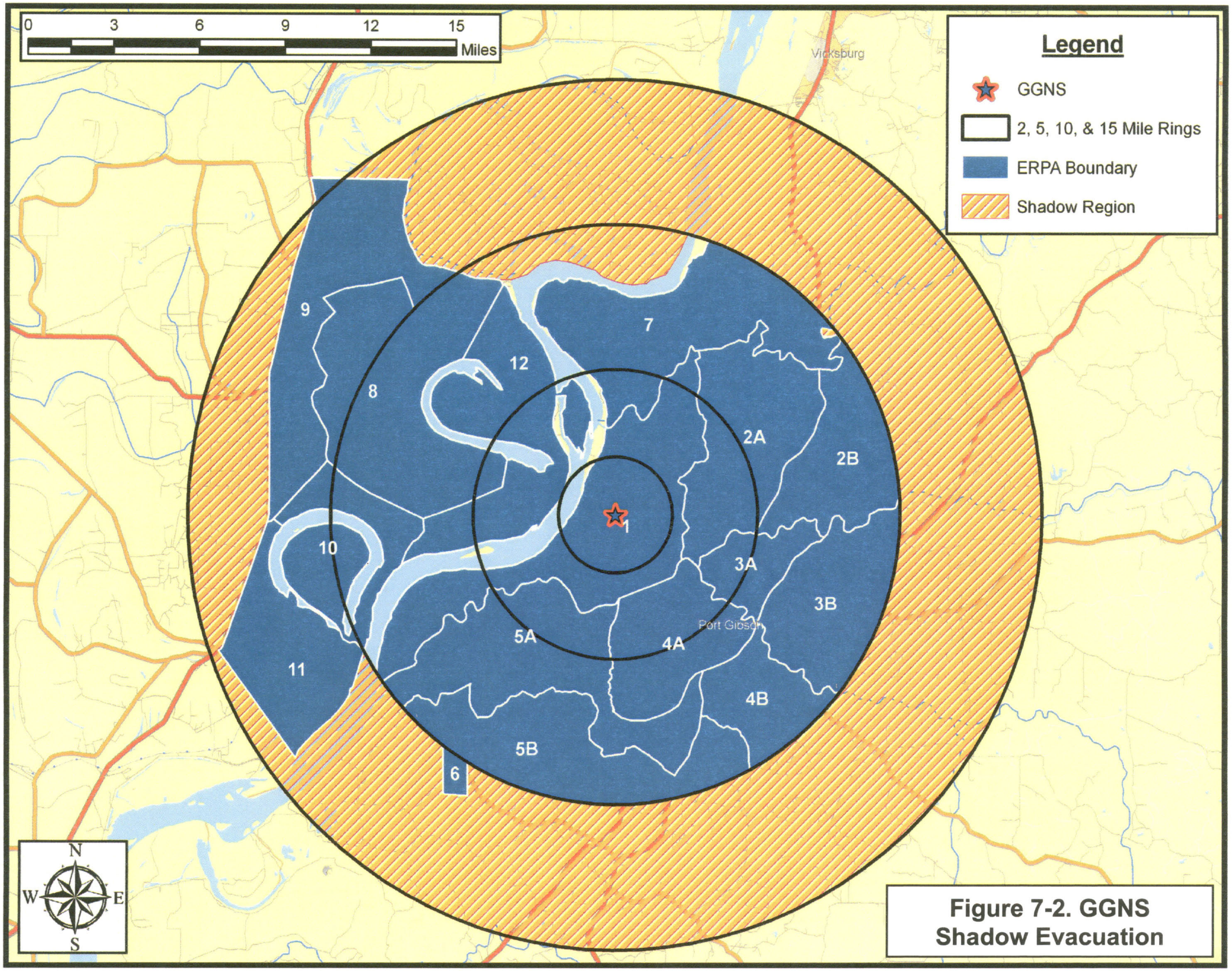


Figure 7-2. GGNS Shadow Evacuation

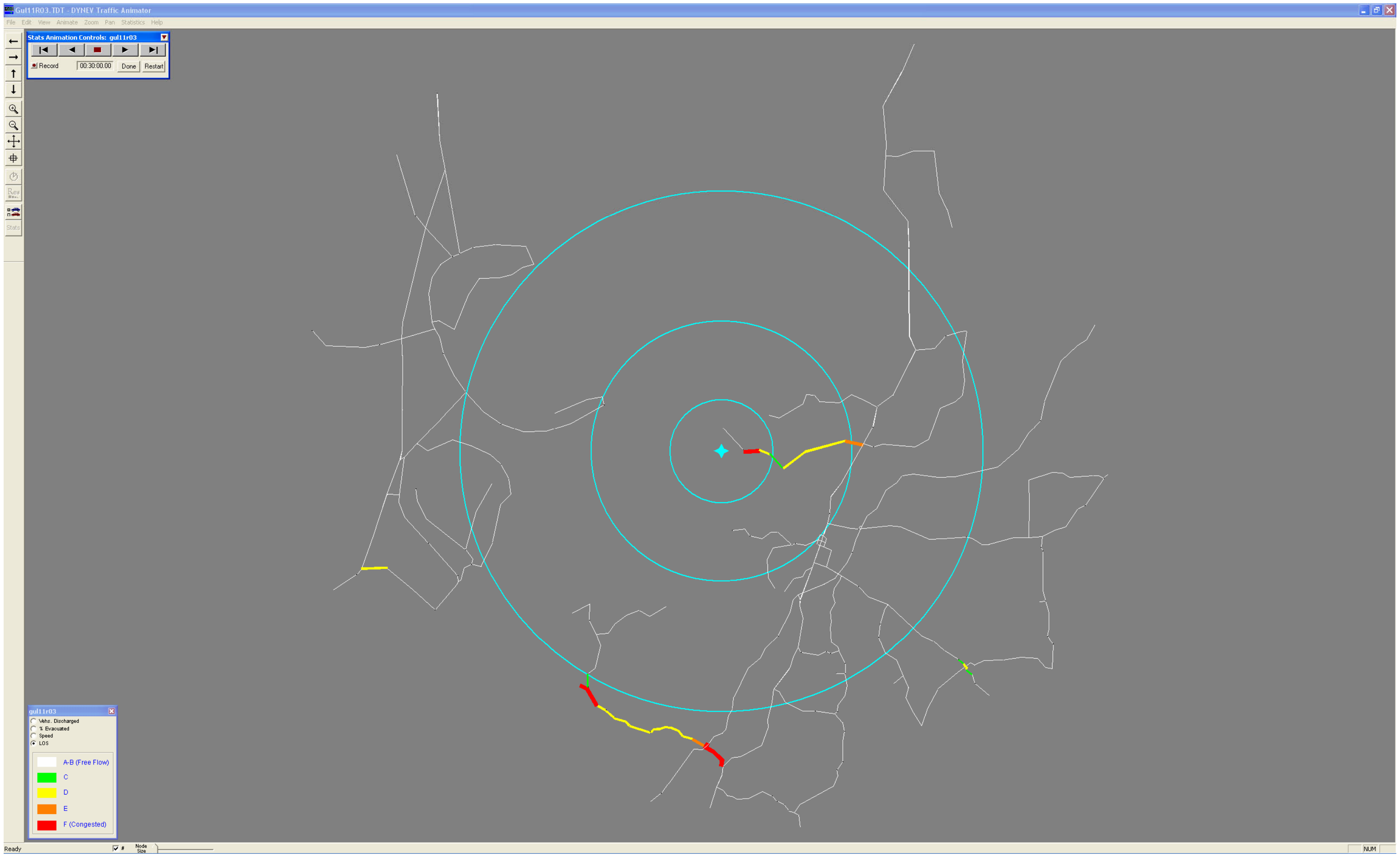


Figure 7-3. Areas of Traffic Congestion

30 Minutes after the Advisory to Evacuate

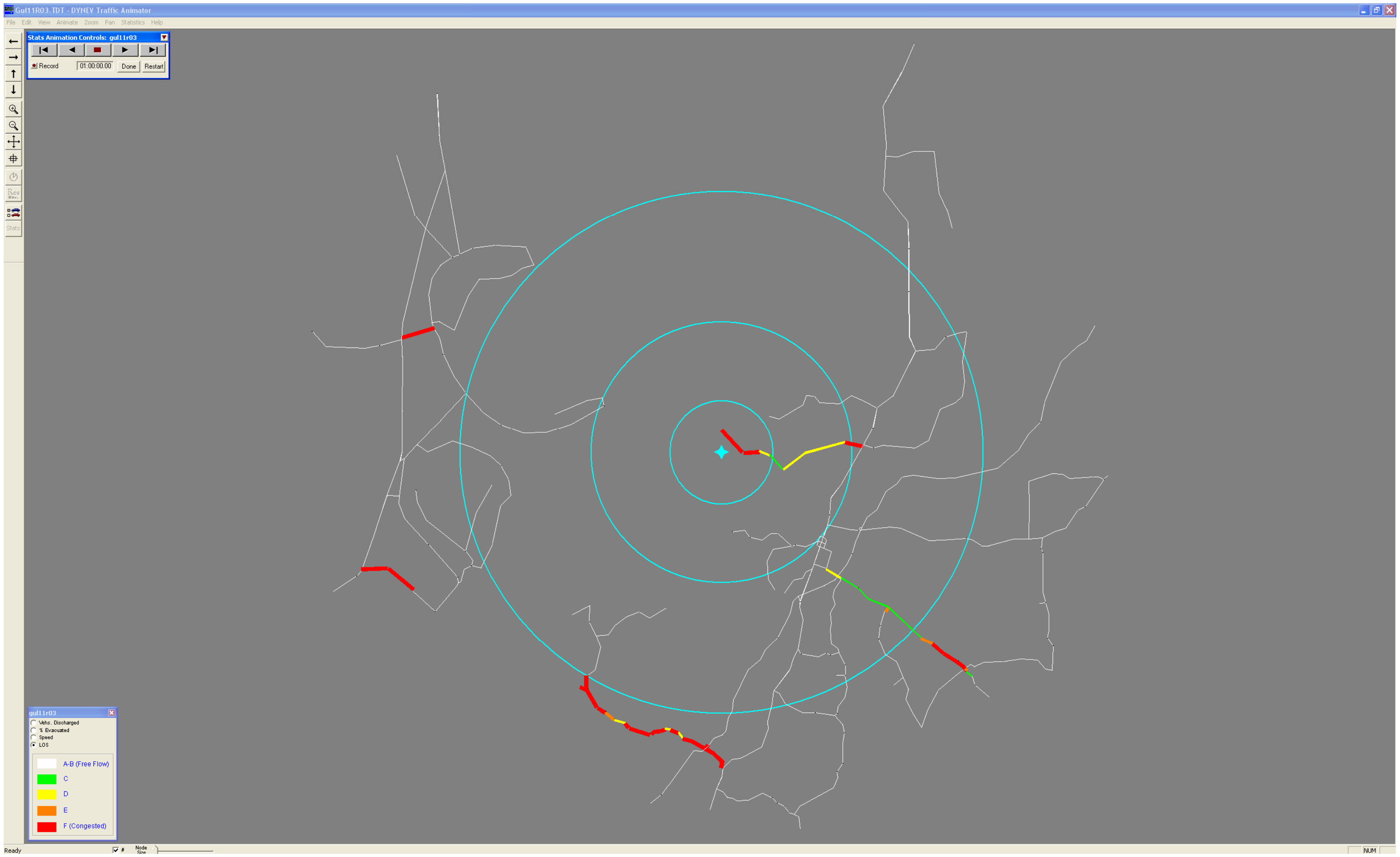


Figure 7-4. Areas of Traffic Congestion

1 Hour after the Advisory to Evacuate

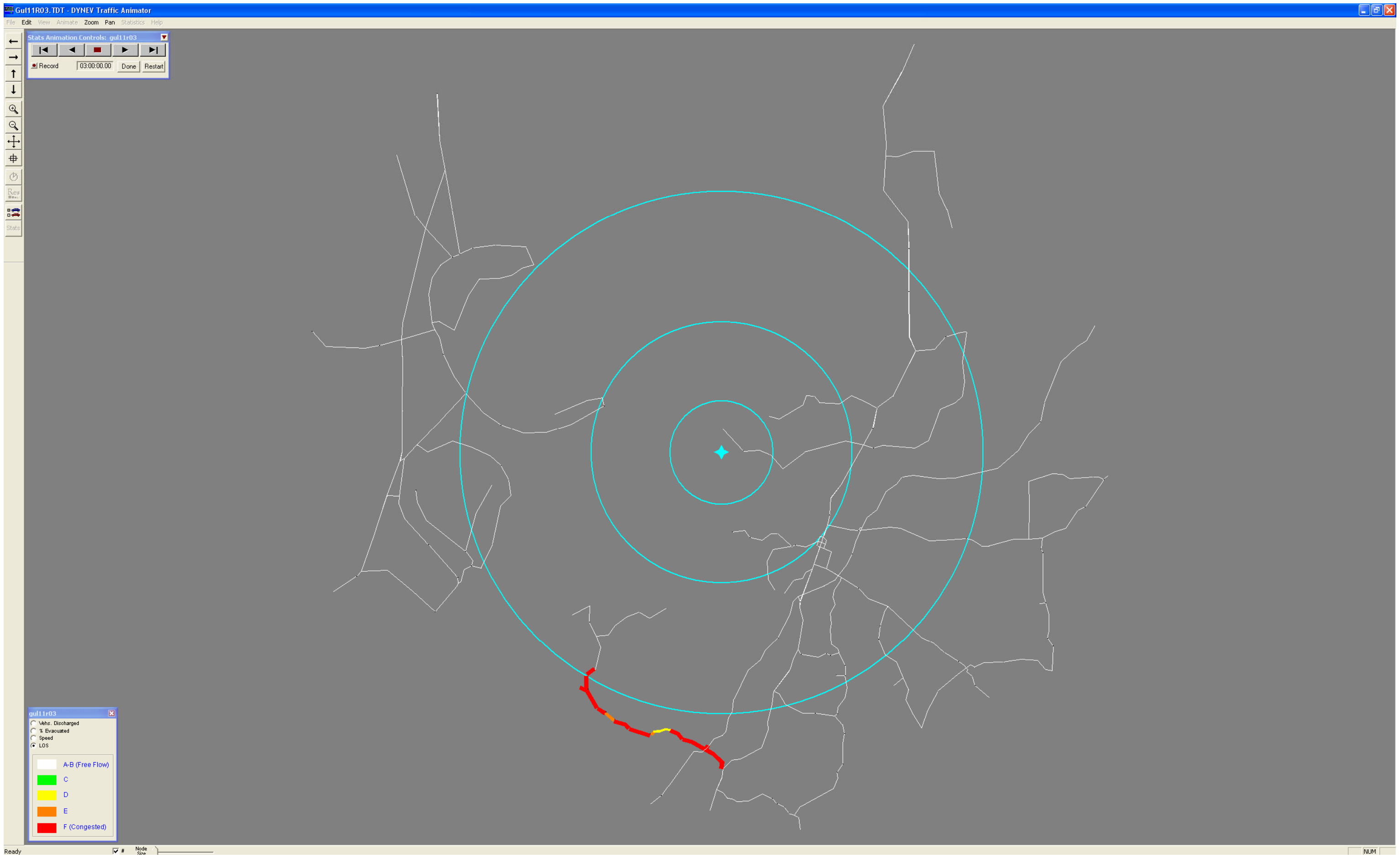


Figure 7-5. Areas of Traffic Congestion

3 Hours after the Advisory to Evacuate

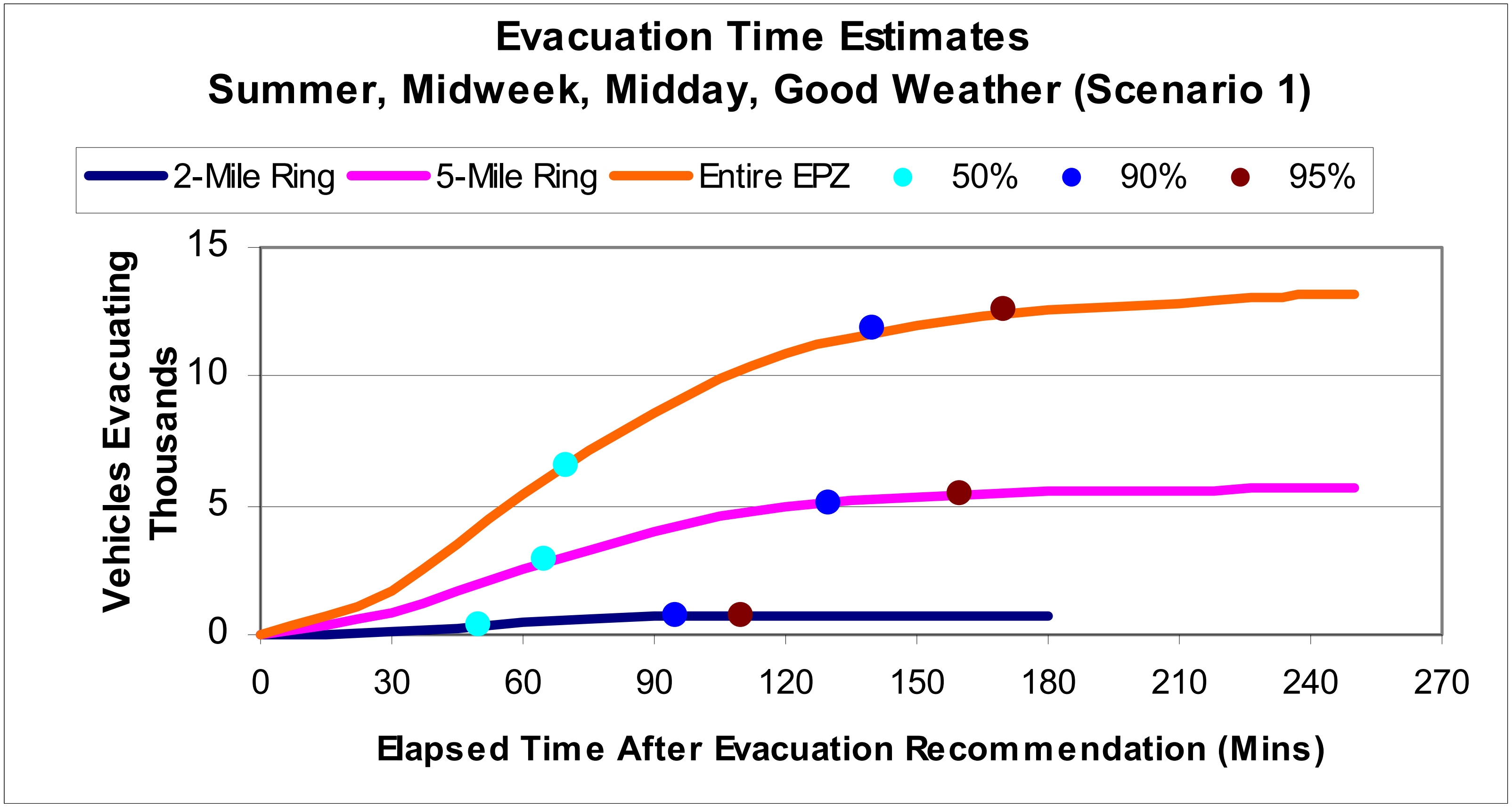


Figure 7-6. Evacuation Time Estimates for GGNS Summer, Midweek, Midday, Good Weather
Evacuation of Region R3 (Entire EPZ)

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 (buses). The demand for transit service reflects the needs of two population groups: (1) residents, employees and transients with no vehicles available; and (2) residents of special facilities such as schools, health-support facilities, institutions and child-care facilities.

These transit vehicles merge into and become a part of the general evacuation traffic environment 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 experience at other rural plants, it is estimated that bus mobilization time will average approximately 90 minutes extending from the Advisory to Evacuate to the time when buses are dispatched from their respective depots.

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 family members is universally prevalent during emergencies and should be anticipated in the planning process. Many emergency plans, however, call for parents to pick up children at host schools or reception centers to speed the evacuation of the schoolchildren in the event that buses need to return to the EPZ and evacuate transit dependents. We provide estimates of buses under the assumption that no children will be picked up at school by their parents as an upper bound estimate of the transit vehicles needed.

The procedure is:

- Estimate demand for transit service
- Estimate time to perform all transit functions
- Estimate route travel times to the EPZ boundary and to the school 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 ordered.

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, we will not reduce our estimates of transit vehicles since it would add to the complexity of the implementation procedures.
- 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.**

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 (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.

Table 8-1 indicates that transportation must be provided for 580 people. Therefore, a total of 19 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 Grand Gulf EPZ:

$$P = 3500 \times (0.105 \times 2.29 + 0.323 \times (2.21 - 1) \times 0.61 \times 0.33 + 0.355 \times (2.85 - 2) \times (0.61 \times 0.33)^2) = 3500 \times 0.331 = 1161$$
$$B = (0.5 \times P) \div 30 = 19$$

The telephone survey conducted in the EPZ collects all the relevant information to estimate the total population requiring public transit or ride-share. These calculations are explained as follows:

1. Households with No Vehicles: The average size of a household without access to a vehicle is 2.29. 10.5% of all the households in the EPZ do not have any vehicles. All the members of these households (HH) will evacuate by public transit or ride-share. The term 3500(total households) x 0.105 x 2.29, accounts for these people.

2. Households with One Vehicle: The average size of a household with only one vehicle is 2.21. If a household commuter is using the car, the number of people who are at home is 2.21-1 = 1.21. There are 32.3% households in the EPZ with one vehicle. 61% of the households in the EPZ have at least one commuter; the commuter in 33% of these households, on average, will not

return home. The number of HH where the commuter will not return home is equal to (3500 x 0.323 x 0.61 x 0.33). The number of persons in these households who will evacuate by public transit or ride-share is equal to the product of this number of households and the average household size of 1.21.

3. Households with Two Vehicles: The average size of a household with two vehicles is 2.85. If both available vehicles are used by non-returning commuters, the number of people who are at home is 2.85 – 2 = 0.85. There are 35.5% households in the EPZ with 2 vehicles. Hence, the number of HH where neither commuter will return home is equal to 3500 x 0.355 x $(0.61 \times 0.33)^2$. The number of persons in these households who will evacuate by public transit or ride-share is equal to the product of this number of households and the average household size of 0.85.

4. Households with 3 or More Vehicles: Households with 3 or more vehicles are assumed to have no need for transit vehicles.

5. The total number of persons requiring public transit is the sum of such people in HH as described in items 1, 2, and 3.

6. 50% of the estimated number of persons require public transit, while others ride-share with neighbors. Knowing the capacity of a transit bus (30 adults/bus), the total number of buses can be estimated as: $(0.5 \times P) \div 30$.

8.2 School Population – Transit Demand

Table 8-2 presents the school population and transportation requirements (based on data gathered during the 2006 school year) for the direct evacuation of all schools within the EPZ. The column in Table 8-2 entitled “Bus Runs 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.
- Bus capacity, expressed in students per bus, is set to 70 for primary schools and 50 for middle and high schools.
- Those staff members who do not accompany the students will evacuate in their private vehicles.
- No allowance is made for student absenteeism which is in the neighborhood of 3 percent, daily.

We recommend that the Claiborne County and Tensas Parish introduce procedures whereby the schools are contacted prior to the dispatch of buses from the depot (approximately 90 minutes after the Advisory to Evacuate), 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. 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. Those students not picked up by their parents prior to the arrival of the buses, will be transported to these centers where they will be subsequently retrieved by their respective families.

8.3 Special Facility Demand

Table 8-4 presents the census of special facilities in the EPZ as of December, 2006. Approximately 119 people have been identified as living in, or being treated in, these facilities. This census also indicates the number of wheelchair-bound people and the number of bed-ridden people. The transportation requirements for this group are also presented. The number of ambulance runs is determined by assuming that 2 patients can be accommodated per ambulance trip; the number of wheelchair van runs assumes 4 wheelchairs per trip; and the number of bus runs estimated assumes 30 ambulatory patients per trip. Wheelchair buses and vans are often scarce; however, regular buses can be used to transport wheelchair bound patients. Patients would occupy the front portion of the bus and their wheelchairs would be folded and stacked in the back of the bus. Staff at the medical facility would assist the patients in boarding the buses.

8.4 Evacuation Time Estimates for Transit-Dependent People

EPZ bus resources are assigned to evacuating schoolchildren 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 will be calculated for both a one wave transit evacuation and for two waves (Table 8-6). Of course, if the impacted Evacuation Region is other than R3 (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 bus 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)

Mobilization is the elapsed time from the Advisory to Evacuate until the time the buses are dispatched from their respective depots. It is assumed that for a rapidly escalating radiological emergency with no observable indication before the fact, drivers would likely require 90 minutes to be contacted, to travel to the depot, be briefed, and to begin traveling to the transit-dependent facilities. Mobilization time is slightly longer – 100 minutes – when raining.

Activity: Travel to Facility (B→C)

It is assumed that buses will be traveling from nearby cities (Vicksburg, Tallulah, Natchez) and will require approximately 30 minutes to travel from the depot to the facility in good weather, and 35 minutes in rain.

Activity: Board Passengers (C→D)

Studies have shown that passengers can board a bus at headways of 2-4 seconds (Ref. HCM2000 Page 27-27). Therefore, the total dwell time to service passengers boarding a bus to capacity at a single stop (e.g., at a school) is about 5 minutes. A loading time of 10 minutes will be used for rain scenarios. For multiple stops along a pick-up route we must allow for the additional delay associated with stopping and starting at each pick-up point. This additional delay to service passengers expands this estimate of boarding time to 15 minutes in good weather, and 20 minutes in rain.

Activity: Travel to EPZ Boundary (D→E)

School Evacuation

The distance from a school to the EPZ boundary is measured using Geographical Information Systems (GIS) software along the most likely route out of the EPZ. The measurements are divided between those distances traveled on local roads and those distances traveled on major routes. We will conservatively assert that bus travel speeds are 30 mph on local roads, and 50 mph on major routes such as US Route 61 in Mississippi and US Route 65 in Louisiana.

Travel speeds are reduced by 10 percent for rain scenarios. Tables 8-5A (good weather) and 8-5B (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 School Reception Center. The evacuation time out of the EPZ can be computed as the sum of travel times associated with Activities A→B, B→C, C→D, and D→E (For example: 90 min. + 30 + 5 + 11 = 2:20 for Newellton Elementary School, 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 indicated in Table 5-8, more than 90 percent of the evacuees will complete their mobilization when the first buses will begin their routes, 90 minutes after the Advisory to Evacuate.

Those buses servicing the transit-dependent evacuees will first travel along their pick-up routes, then proceed out of the EPZ. Buses will travel along Route 61, Route 18, and Route 547 in Mississippi, and Route 65, Route 4, and Route 128 in Louisiana as most of the population lives in the vicinity of these routes. Pickup points will be in the Towns of Port Gibson, Newellton, and Saint Joseph. Figure 8-2 depicts proposed bus pick-up routes. The travel distance along the respective pick-up routes within the Region was measured using GIS software. The average length of the routes from entrance into the EPZ until departure is 13 miles. Most of the evacuation traffic will have dissipated when the transit dependent buses begin their routes. As such, the associated travel times are computed assuming an average speed of 40 mph.

Table 8-6 presents the transit-dependent population evacuation time estimates obtained using the above procedures. For example, the ETE is computed as 90 + 30 + 15 + 20 = 2:35 hours for good weather. Here, 20 minutes is the time to travel 13 miles at 40 mph. The ETE for a second wave (discussed below) is presented in the event there is a shortfall of available buses or bus drivers.

Activity: Travel to School Reception Centers (E→F)

The distances from the EPZ boundary to the school reception centers are measured using Geographical Information Systems (GIS) software along the most likely route from the EPZ to the reception center. 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 public. Bus speeds of 30 mph on local roads and 50 mph on major routes will also be applied for this activity.

Activity: Passengers Leave Bus (F→G)

A bus can empty within 5 minutes.

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

The buses assigned to return to the EPZ to perform a "second wave" evacuation of transit-dependent evacuees will be those that evacuated the schoolchildren. These buses are assigned since they will be the first buses to complete their evacuation service and are therefore the first to be available for the second wave. The passengers leave the bus, and the bus then travels to its route and proceeds to pick up transit-dependent evacuees along the route. The travel time back to the EPZ is calculated using distances estimated from GIS and the assumed bus travel speeds.

The transit dependent ETE are estimated separately for Claiborne County and Tensas Parish. The following ETE computation for Claiborne County is provided as an example:

- Bus arrives at reception center at 3:05, on average, in good weather (Table 8-5A).
- Bus discharges passengers (5 minutes) and driver takes a 15-minute rest: 20 minutes.
- Bus returns to EPZ: 50 minutes, on average (Table 8-5A).
- Bus completes pick-ups along route and departs EPZ: 15 minutes + (13 miles @ 40 mph) = 35 minutes.
- Bus exits EPZ at time 3:05 + 0:20 + 0:50 + 0:35 = 4:50 after the Advisory to Evacuate.

The ETE for the completion of the second wave are given in Table 8-6.

Evacuation of Ambulatory Persons from Special Facilities

The bus operations for this group are similar to those for school evacuation except:

- These buses will leave the depots later, approximately 2 hours after the Advisory to Evacuate.
- The passenger loading time will be longer at approximately 30 minutes to account for the time to move patients from inside the facility to the vehicles.

The time that these buses will leave these special facilities to begin their respective evacuation trips out of the EPZ is calculated as follows:

- Bus leaves depot at 2:00 (2:15 for rain).
- Bus travels to facility, 30 minutes (35 for rain).
- Passengers board bus, 30 minutes (35 for rain).

Thus, the bus will leave the facility at 3:00 after the Advisory to Evacuate. These buses will travel out of the EPZ at the assumed speeds of 30 mph for local roads and 50 mph for major routes. As was done for the schools, the distance from the facility to the EPZ boundary is measured using GIS and the travel time is found using the bus travel speeds. For example, the travel time for Claiborne County Hospital to the EPZ boundary will be 6 minutes and the resulting ETE will be three hours and 10 minutes (rounded up to the nearest 5 minutes). The ETE to evacuate ambulatory residents from special facilities are presented in Table 8-7.

<u>Emergency Medical Services (EMS) Vehicles</u>

The previous discussion focused on transit operations for ambulatory and wheelchair-bound persons within the Region. It is also necessary to provide transit services to non-ambulatory persons who do not -- or cannot -- have access to private vehicles. As shown in Table 8-4, a total of 9 ambulance trips are anticipated for an evacuation of the entire EPZ. A single wave of service is assumed. Additional ambulances are assumed to travel from the major cities to the north (Tallulah and Vicksburg) if the available resources within the EPZ are not sufficient.

It is reasonable to expect that the response times of EMS vehicles should be less than for the buses dispatched to evacuate special facilities. We will conservatively estimate the same ETE for these EMS vehicles as for the vehicles evacuating ambulatory evacuees from special facilities. This approach takes into account that a somewhat longer vehicle loading time for these passengers, relative to that for the ambulatory evacuees, will balance the earlier arrival times of these vehicles at the facilities. Therefore, the ETE for EMS vehicles to leave the EPZ are the same as for the vehicles evacuating ambulatory evacuees from special facilities; see Table 8-7.

J.B. Evans Correctional Center

The J.B. Evans Correctional Center (JBECC) is located in ERPA 9 near the northwest boundary of the EPZ, nearly 12 miles from the power station. Given its location, it is most likely that the JBECC would be “locked down” during a radiological accident, with all occupants taking shelter.

In the unlikely event that an evacuation of the facility is ordered, it will be necessary to assign transit vehicles to provide transportation. The need for security will largely dictate the number of buses required to transport the [up to] 400 inmates accompanied by 14 employees, a distance of about 190 miles to the host facility in Lafayette, LA.

Single Wave

It is conservatively assumed that each bus will be occupied by inmates at a 50-60% load factor. This translates into about 25-30 inmates per bus plus the driver and at least one employee. Thus 14 buses, each with a capacity of 55 seats are required. The buses may be assembled at JBECC from several sources:

- Buses previously used to evacuate schoolchildren
- Additional buses from neighboring communities outside of the EPZ
- Buses provided by Louisiana Correctional Services from Lafayette.

From the first two sources, it is reasonable to estimate the arrival of these buses at 3 hours after the Advisory to Evacuate. This estimate reflects the 2:20 required to evacuate schoolchildren, followed by travel to JBECC or the time needed to mobilize other buses and for these to travel to JBECC.

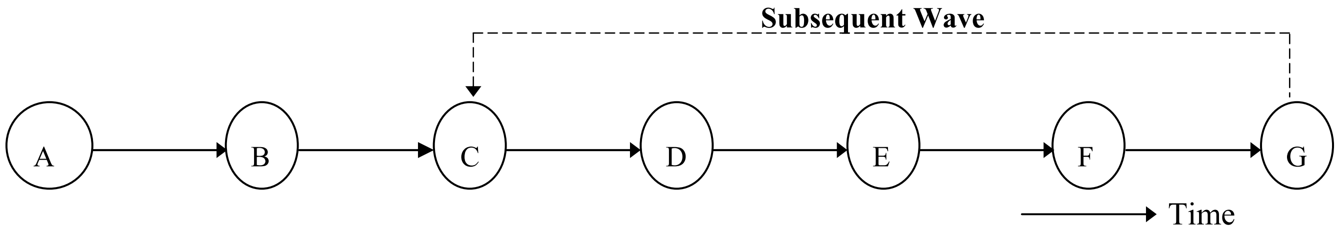
To maintain security, it is expected that these buses will evacuate in a single group (or convoy) with an escort of law enforcement vehicles. It is estimated that each bus can be boarded by 25-30 inmates and secured in 10 minutes. Assuming 3 buses can be loaded in parallel, consistent with the need to maintain order and security and that all buses will be loaded before departure, then 14/3, or 5 waves of buses at 10 minutes requires a total of 50 minutes to mobilize the inmates.

Add 10 minutes to travel out of the EPZ. Then the total ETE for JBECC is:

Mobilize the buses:	3:00
Board the Inmates:	0:50
Travel out of EPZ:	0:10
ETE	**4:00**

If buses must be dispatched from Lafayette, the ETE would be:

Mobilize the buses in Lafayette:	0:30
Travel to JBECC:	4:00
Board Inmates, Travel out of EPZ:	1:00
ETE	**5:30**



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 School Reception Center
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 School Reception Center Outside the EPZ.
F→G	Passengers Leave Bus; Driver Takes a Break

Figure 8-1. Chronology of Transit Evacuation Operations

Table 8-1. Transit Population Estimates

Facility Name	2007 Population	Survey Average Household Size With Indicated No. of Vehicles			Estimated Number of Households	Survey Percent Households With			Survey Percent Households With Commuters	Survey Percent Households With Non-Returning Commuters	Total People Requiring Transport	Estimated Ridesharing Percentage	People Requiring Public Transit	Percent of Population Requiring Public Transit
		0	1	2		0 Veh-icle	1 Veh-icle	2 Veh-icle						
Grand Gulf	11,761	2.29	2.21	2.85	3,500	10.5%	32.3%	35.5%	61%	33%	1,161	50%	581	4.9%

Table 8-2. School Population Demand Estimates							
ERPA	**Distance (miles)**	**Direction**	**School Name**	**Municipality**	**Enroll-ment**	**Staff**	**Bus Runs Req'd**
Claiborne County Schools							
2B	7.5	ESE	Reachout Foundation	Port Gibson	10	3	1
4A	4.2	SE	A.W. Watson Elementary School	Port Gibson	889	89	13
4A	5.5	SE	Chamberlain-Hunt Academy	Port Gibson	101	58	3
4A	5.7	SE	Claiborne Educational Foundation	Port Gibson	36	9	1
4A	5.2	SE	Port Gibson High School	Port Gibson	578	60	12
4A	5.4	SE	Port Gibson Middle School	Port Gibson	431	47	9
				Tensas Parish Totals:	2,045	266	39
Tensas Parish Schools							
9	11.9	WNW	Newellton Christian Academy	Newellton	36	6	1
9	12.3	WNW	Newellton Elementary	Newellton	225	52	4
9	12.2	WNW	Tensas Charter School	Newellton	33	6	1
11	12.6	WSW	Davidson High School	Saint Joseph	190	18	4
11	12.6	WSW	Tensas Academy	Saint Joseph	194	26	4
11	12.9	WSW	Tensas Elementary	Saint Joseph	202	13	3
11	12.8	WSW	Tensas High School	Saint Joseph	225	35	5
				Tensas Parish Totals:	1,105	156	22
				EPZ Totals:	**3,150**	**422**	**61**

* It is assumed that students attending colleges will have their own transportation

Table 8-3. School Reception Centers				
School	**Reception Center**	**Address**	**Municipality**	**State**
All Claiborne County Schools	Hazlehurst High School	101 S Haley St	Hazlehurst	MS
Tensas Academy	Ferriday High School	801 E Wallace Blvd	Ferriday	LA
Tensas Elementary				
Davidson High School				
Newellton Elementary	Tallulah High School	600 Bayou Dr	Tallulah	LA
Newellton High School				
Newellton Christian Academy				

Table 8-4. Special Facility Transit Demand												
ERPA	Distance (miles)	Dir-ection	Facility Name	Municipality	Cap-acity	Current Census	Ambu-latory	Wheel-chair Bound	Bed-ridden	Ambu-lance Runs	Wheel-chair Bus Runs	Bus Runs
Claiborne County												
4A	5.5	SE	Claiborne County Hospital	Port Gibson	32	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4A	4.9	SE	Claiborne County Nursing Center	Port Gibson	77	64	15	38	11	6	10	1
				Claiborne County Totals:	109	64	15	38	11	6	10	1
Tensas Parish												
9	12.4	WNW	Franklin Medical Rural Health Clinic	Newellton	N/A	N/A	3	6	N/A	N/A	2	1
9	12.7	WNW	Tensas Care & Rehabilitation Center	Newellton	102	55	25	24	6	3	6	1
11	12.4	WSW	St. Joseph Rural Health Clinic	Saint Joseph	Outpatient Healthcare facility							
11	12.7	WSW	Tensas Community Health Center	Saint Joseph	Outpatient Healthcare facility							
11	12.8	WSW	Tensas Parish Health Unit	Saint Joseph	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
				Tensas Parish Totals:	102	55	28	30	6	3	8	2
				EPZ Totals:	**211**	**119**	**43**	**68**	**17**	**9**	**18**	**3**

N/A = Not Available

Table 8-5A. School Evacuation Time Estimates - Good Weather

School	Driver Mobilization Time(min)	Travel Time from Depot (min)	Loading Time (min)	Dist. to EPZ Boundary (mi.)		Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bndry to R.C.		Travel Time EPZ Bdry to RC (min)	ETE to R.C. (hr:min)
				Major Road	Local Road			Major Road	Local Road		
Claiborne County Schools											
A.W. Watson Elementary School	90	30	5	4.2	2.8	11	2:20	38.1	0.7	48	3:05
Chamberlain-Hunt Academy	90	30	5	3.9	0.8	7	2:15	41.1	0.7	51	3:05
Claiborne Educational Foundation	90	30	5	3.9	0.6	6	2:15	41.1	0.7	51	3:05
Port Gibson High	90	30	5	4.2	2.2	10	2:15	38.1	0.7	48	3:05
Port Gibson Middle School	90	30	5	3.9	1.0	7	2:15	41.1	0.7	51	3:05
Reachout Foundation	90	30	5	2.6	0.3	4	2:10	38.1	0.7	48	3:00
						Average ETE:	**2:15**		**Average:**	**50**	**3:04**
Tensas Parish Schools											
Davidson High School	90	30	5	3.1	0.2	5	2:10	27.6	0	34	2:45
Newellton Christian Academy	90	30	5	7.5	1.3	12	2:20	17.2	0	21	2:40
Newellton Elementary	90	30	5	7.5	0.8	11	2:20	17.2	0	21	2:40
Tensas Academy	90	30	5	3.1	0.2	5	2:10	27.6	0	34	2:45
Tensas Charter School	90	30	5	7.5	0.8	11	2:20	17.2	0	21	2:40
Tensas Elementary	90	30	5	2.4	0.2	4	2:10	27.6	0	34	2:45
Tensas High School	90	30	5	2.5	0.2	4	2:10	27.6	0	34	2:45
						Average ETE:	**2:14**		**Average:**	**28**	**2:42**

Table 8-5B. School Evacuation Time Estimates - Rain												
School	Driver Mobilization Time(min)	Travel Time from Depot (min)	Loading Time (min)	Dist. to EPZ Boundary (mi.)		Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bndry to R.C.		Travel Time EPZ Bdry to RC (min)	ETE to R.C. (hr:min)
				Major Road	Local Road			Major Road	Local Road		
Claiborne County Schools											
A.W. Watson Elementary School	100	35	10	4.2	2.8	12	2:40	38.1	0.7	53	3:30
Chamberlain-Hunt Academy	100	35	10	3.9	0.8	7	2:35	41.1	0.7	57	3:30
Claiborne Educational Foundation	100	35	10	3.9	0.6	7	2:35	41.1	0.7	57	3:30
Port Gibson High	100	35	10	4.2	2.2	11	2:40	38.1	0.7	53	3:30
Port Gibson Middle School	100	35	10	3.9	1.0	8	2:35	41.1	0.7	57	3:30
Reachout Foundation	100	35	10	2.6	0.3	5	2:30	38.1	0.7	53	3:25
						Average ETE:	**2:35**		**Average:**	**55**	**3:29**
Tensas Parish Schools											
Davidson High School	100	35	10	3.1	0.2	5	2:30	27.6	0	37	3:10
Newellton Christian Academy	100	35	10	7.5	1.3	13	2:40	17.2	0	23	3:05
Newellton Elementary	100	35	10	7.5	0.8	12	2:40	17.2	0	23	3:00
Tensas Academy	100	35	10	3.1	0.2	5	2:30	27.6	0	37	3:10
Tensas Charter School	100	35	10	7.5	0.8	12	2:40	17.2	0	23	3:00
Tensas Elementary	100	35	10	2.4	0.2	4	2:30	27.6	0	37	3:10
Tensas High School	100	35	10	2.5	0.2	4	2:30	27.6	0	37	3:10
						Average ETE:	**2:34**		**Average:**	**31**	**3:06**

Table 8-6. Transit-Dependent Evacuation Time Estimates													
GOOD WEATHER													
County/ Parish	**Single Wave**					**Second Wave**							
	Mobilization (min)	**Travel time to EPZ (min)**	**Route Travel Time (min)**	**Pickup Time (min)**	**ETE (hr:min)**	**Arrive at RC (min)**	**Unload (min)**	**Driver Rest (min)**	**Return to EPZ (min)**	**Route Travel Time (min)**	**Pickup Time (min)**	**ETE (hr:min)**
Claiborne	90	30	20	15	**2:35**	185	5	15	50	20	15	**4:50**
Tensas	90	30	20	15	**2:35**	165	5	15	30	20	15	**4:10**
RAIN												
Claiborne	90	35	23	20	**2:50**	210	10	15	55	23	20	**5:35**
Tensas	90	35	23	20	**2:50**	185	10	15	35	23	20	**4:50**

NOTE: The second wave of transit bus trips are only required if there are not sufficient buses to evacuate everyone in the first wave. If bus resources are sufficient, the one-wave ETE should be used.

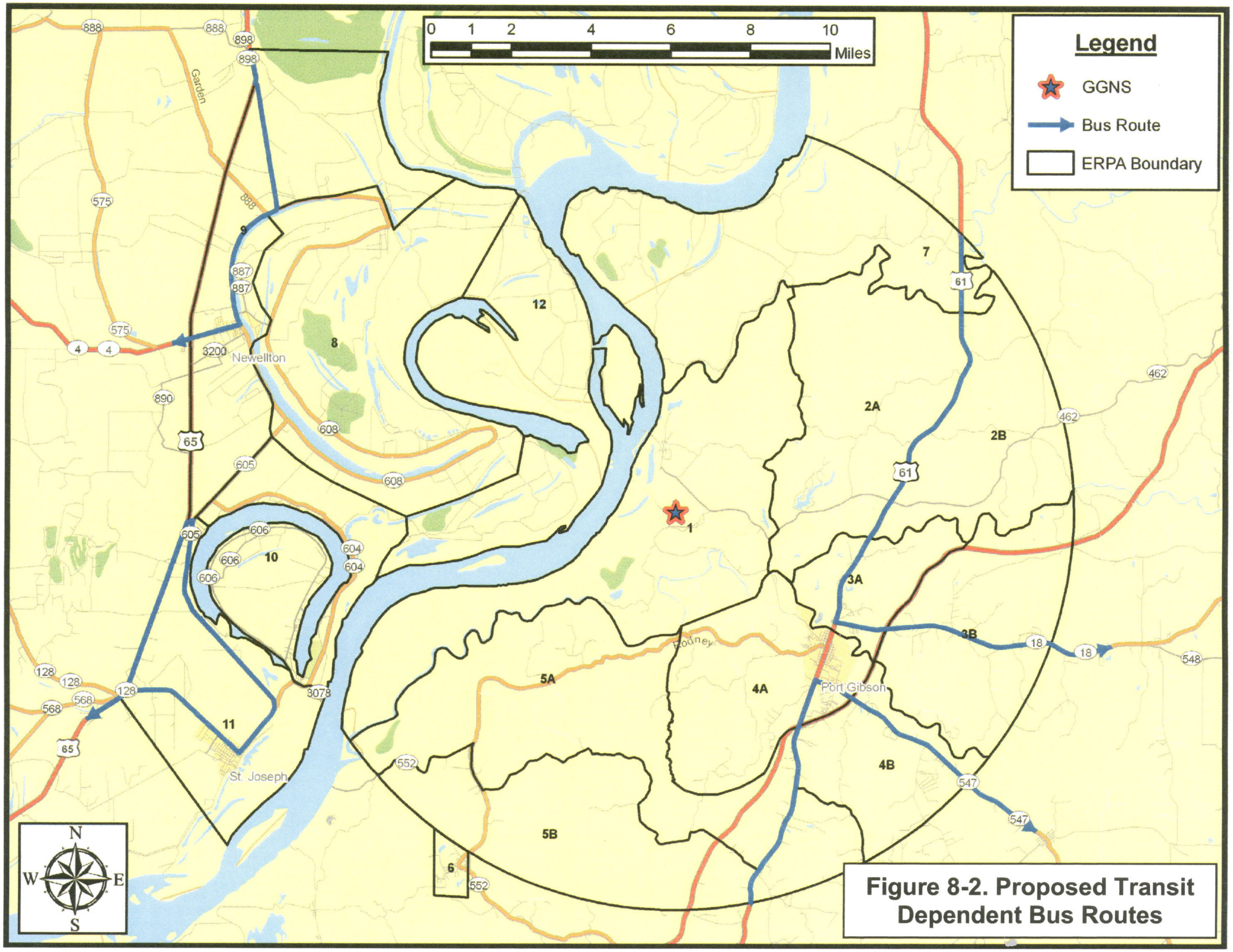

0 1 2 4 6 8 10
Miles
Legend
GGNS
Bus Route
ERPA Boundary
Figure 8-2. Proposed Transit Dependent Bus Routes
Newellton
St. Joseph
Port Gibson
Rodney
Garden
1
2A
2B
3A
3B
4A
4B
5A
5B
6
7
8
9
10
11
12
N
S
E
W

Table 8-7A. Evacuation Time Estimates for Ambulatory Evacuees from Special Facilities Good Weather							
Facility	Driver Mobilization Time(min)	Travel Time from Depot (min)	Loading Time (min)	Dist. to EPZ Boundary (mi.) Major Road	Dist. to EPZ Boundary (mi.) Local Road	Travel Time to EPZ Bdry (min)	ETE (hr:min)
Claiborne County Special Facilities							
Claiborne County Hospital	120	30	30	6.0	0	8	**3:10**
Claiborne County Nursing Center	120	30	30	7.6	0	10	**3:10**
Tensas Parish Special Facilities							
Franklin Medical Rural Health Clinic	120	30	30	0	0.6	2	**3:05**
St. Joseph Rural Healthcare Center	120	30	30	0.2	3.6	8	**3:10**
Tensas Care & Rehabilitation Center	120	30	30	0	0.3	1	**3:05**
Tensas Community Health Center	120	30	30	0.2	3.8	8	**3:10**
Tensas Parish Health Unit	120	30	30	0.2	3.8	8	**3:10**

Table 8-7B. Evacuation Time Estimates for Ambulatory Evacuees from Special Facilities Rain							
Facility	Driver Mobilization Time(min)	Travel Time from Depot (min)	Loading Time (min)	Dist. to EPZ Boundary (mi.) Major Road	Dist. to EPZ Boundary (mi.) Local Road	Travel Time to EPZ Bdry (min)	ETE (hr:min)
Claiborne County Special Facilities							
Claiborne County Hospital	135	35	35	6.0	0	8	**3:35**
Claiborne County Nursing Center	135	35	35	7.6	0	11	**3:40**
Tensas Parish Special Facilities							
Franklin Medical Rural Health Clinic	135	35	35	0	0.6	2	**3:30**
St. Joseph Rural Healthcare Center	135	35	35	0.2	3.6	9	**3:35**
Tensas Care & Rehabilitation Center	135	35	35	0	0.3	1	**3:30**
Tensas Community Health Center	135	35	35	0.2	3.8	9	**3:35**
Tensas Parish Health Unit	135	35	35	0.2	3.8	9	**3:35**

9. TRAFFIC MANAGEMENT STRATEGY

This section presents the current 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.
- Equipment to assist these personnel in the performance of their tasks:
  - Traffic Barriers
  - Traffic Cones
  - Signs
- A plan that defines all necessary details and is documented in a format that is readily understood.

The functions to be performed in the field are:

1. Facilitate evacuating traffic movements that serve to expedite travel out of the EPZ along routes that the analysis has found to be most effective.
2. Discourage traffic movements that permit evacuating vehicles to travel in a direction which takes them significantly closer to the power station, or which interferes with the efficient flow of other evacuees.

We employ the terms "facilitate" and "discourage" 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 preliminary to evacuating.

- An evacuating driver may be taking a detour from the evacuation route in order to pick up a relative.
- 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 strategy is the outcome of the following process:

1. A field survey of these critical locations.

   The schematics of Appendix G are based on data collected during field surveys and upon large-scale maps.
2. Consultation with emergency management and enforcement personnel.

   Trained personnel who are experienced in controlling traffic and who are familiar with the likely traffic patterns should review these control tactics.
3. Prioritization of TCPs.

   Application of traffic control at some TCPs will have a more pronounced influence on expediting traffic movements. Thus, during the mobilization of personnel to respond to the emergency situation, those TCPs, which are assigned a higher priority, will be manned earlier.

   This setting of priorities should be undertaken with the concurrence of emergency management and law enforcement personnel. These priorities should be compatible with the availability of local manpower resources.

In each schematic that appears in Appendix G, the control tactic at each TCP is presented.

10. EVACUATION ROUTES

Evacuation routes are composed of two distinct components:

- Routing from an ERPA being evacuated to the boundary of the Evacuation Region and thence out of the Emergency Planning Zone (EPZ).
- Routing of evacuees from the EPZ boundary to the reception centers.

Evacuees should be routed within the EPZ in such a way as to *minimize their exposure to risk*. This primary requirement is met by routing traffic to move away from the location of the Grand Gulf Nuclear Station, to the extent practicable, and by delineating evacuation routes that expedite the movement of evacuating vehicles. This latter objective is addressed by developing evacuation routes to achieve a balancing of traffic demand relative to the available highway capacity to the extent possible, subject to satisfying the primary requirement noted above. This is achieved by carefully specifying candidate destinations for all origin centroids where evacuation trips are generated, and applying the TRAD model effectively. See Appendices A-D for further discussion.

The routing of evacuees from the EPZ boundary to the reception centers should be responsive to several considerations:

- Minimize the amount of travel outside the EPZ, from the points where these routes cross the EPZ boundary, to the reception centers.
- Relate the anticipated volume of traffic destined to the reception center, to the capacity of the reception center facility.

Figure 10-1 presents a map showing the general population reception centers. The major evacuation routes for the four quadrants of the EPZ are presented in Figures 10-2 through 10-5.

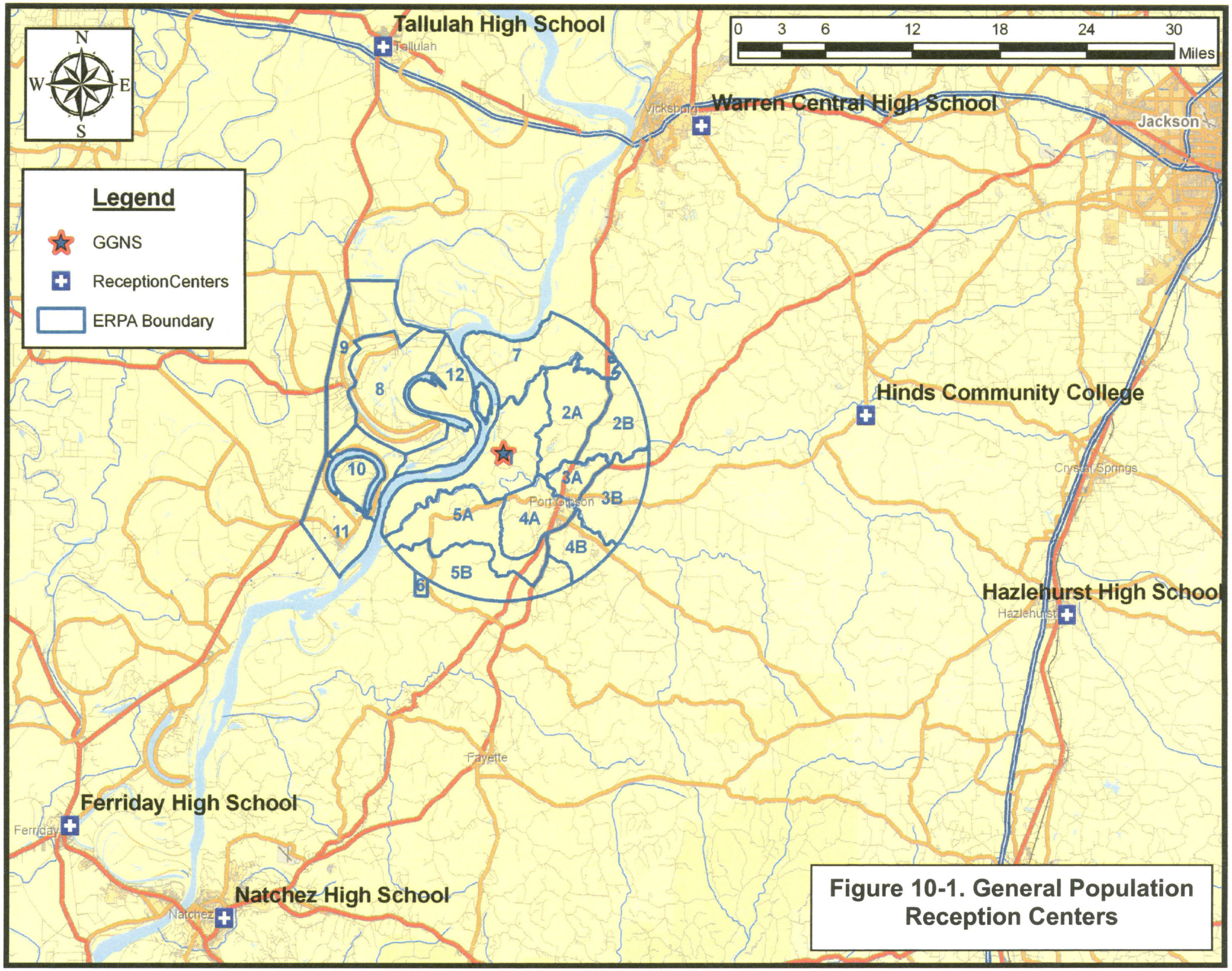


Figure 10-1. General Population Reception Centers

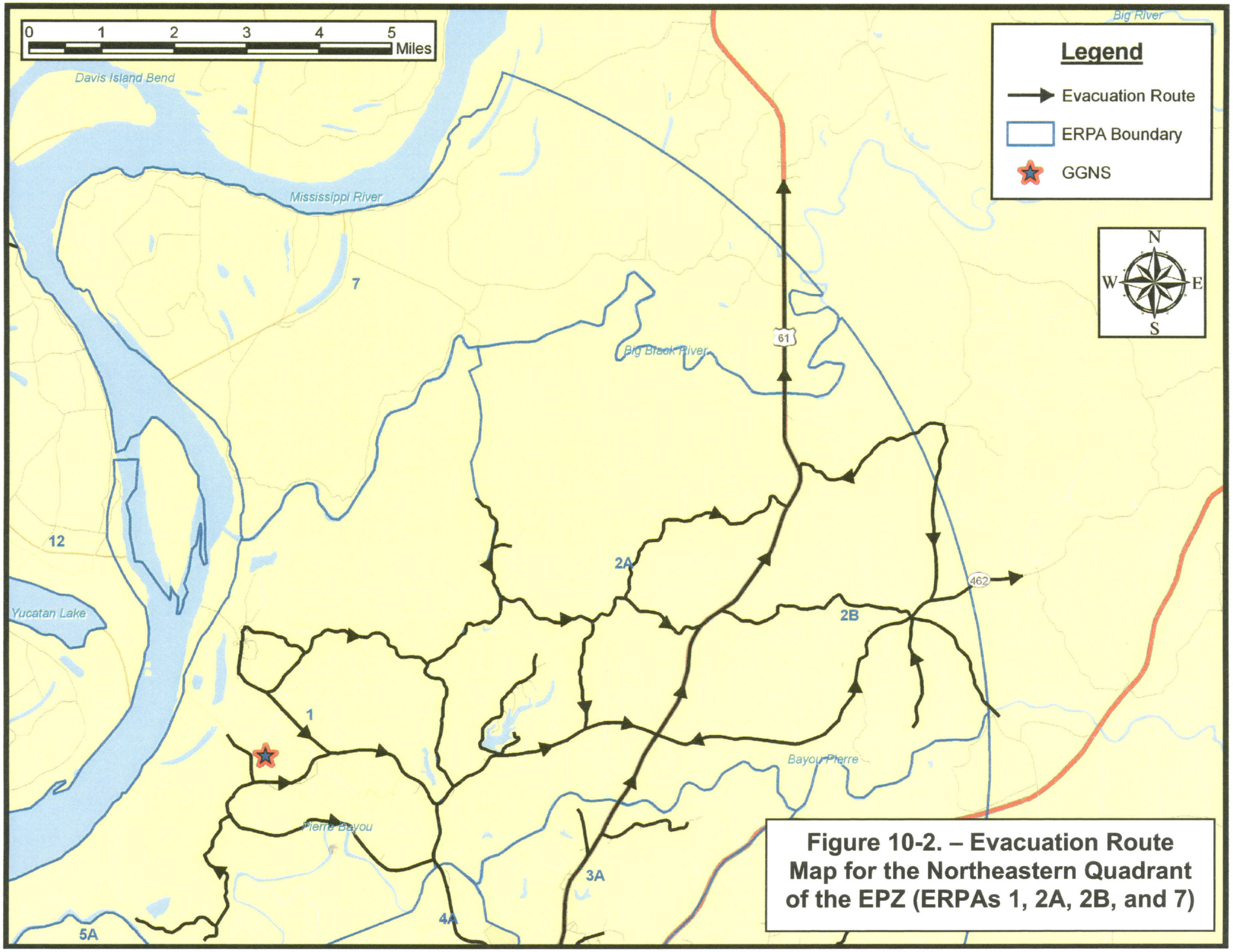


Figure 10-2. – Evacuation Route Map for the Northeastern Quadrant of the EPZ (ERPAs 1, 2A, 2B, and 7)

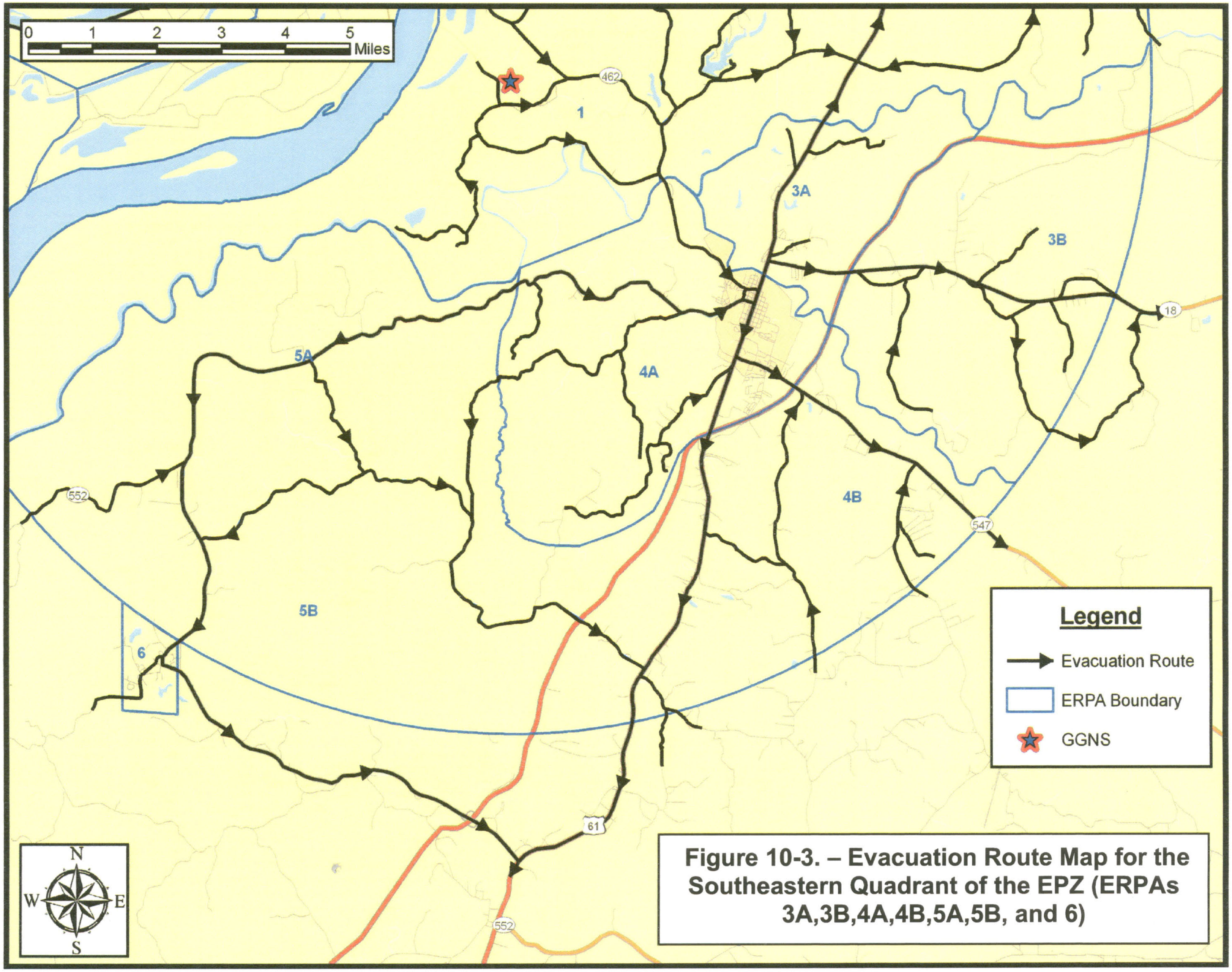


Figure 10-3. – Evacuation Route Map for the Southeastern Quadrant of the EPZ (ERPAs 3A,3B,4A,4B,5A,5B, and 6)

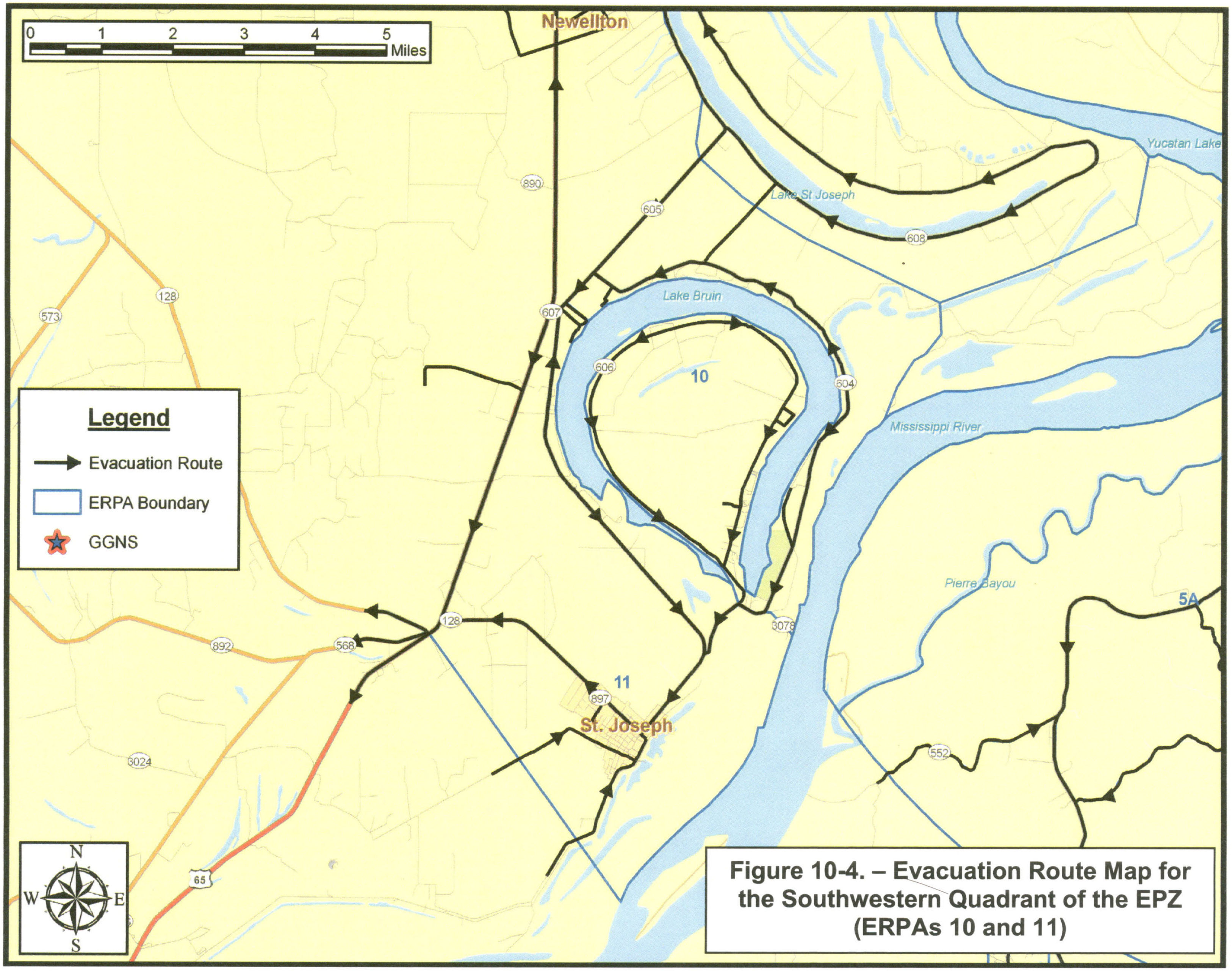


Figure 10-4. – Evacuation Route Map for the Southwestern Quadrant of the EPZ (ERPAs 10 and 11)

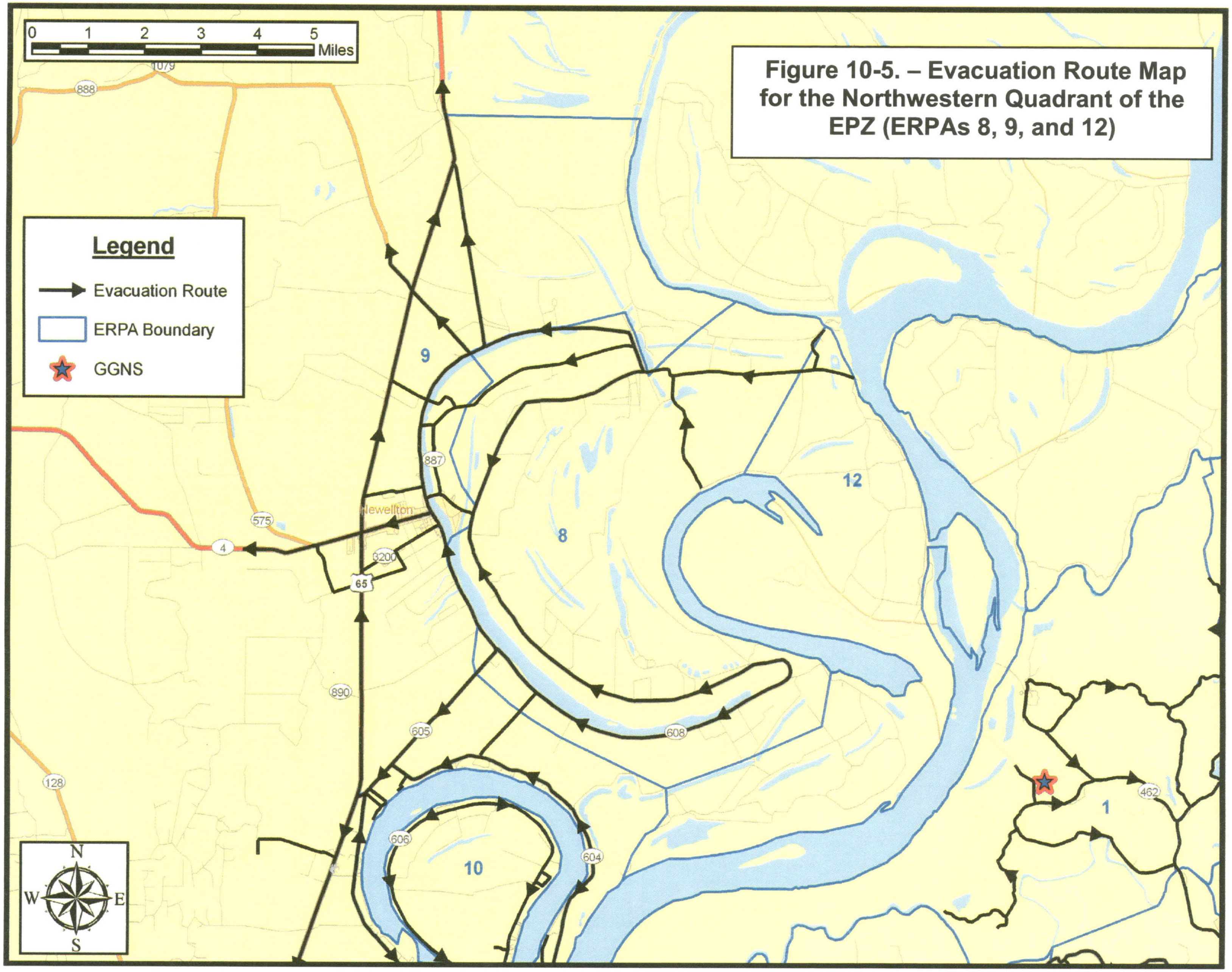


Figure 10-5. – Evacuation Route Map for the Northwestern Quadrant of the EPZ (ERPAs 8, 9, and 12)
0 1 2 3 4 5 Miles
Legend
Evacuation Route
ERPA Boundary
GGNS
N
W
E
S
1079
888
9
8
12
10
1
887
Newellton
575
4
3200
65
890
605
608
606
604
462
128

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.
4. Cellular phone calls 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 towns to support a communication 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 exhausting 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. Tow trucks may 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.

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. Although Claiborne County and Tensas Parish may use their own procedures for confirmation, we suggest an alternative or complementary approach.

The procedure we suggest 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. We believe 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 after the mobilization activities are completed. 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 8-1/2 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 ERPAs), then the confirmation process will extend over a time frame of about 85 minutes. Thus, the confirmation should be completed well 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 auto dialing equipment can significantly reduce the manpower requirements and the time required to undertake this type of confirmation survey.

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.

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, p 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.) = 4,000
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,

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

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

Finite population correction:

$$n_F = \frac{nN}{n + N - 1} = 286$$

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 = 205.

Est. Person Hours to complete 300 telephone calls

Assume: Time to dial using touch-tone (random selection of listed numbers): 30 seconds
Time for 8 rings (no answer): 48 seconds
Time for 4 rings plus short conversation: 60 sec.
Interval between calls: 20 sec.

Person Hours: 300[30+20+0.8(48)+0.2(60)]/3600 = 8.4

APPENDIX A

Glossary of Traffic Engineering Terms

APPENDIX A: GLOSSARY OF TRAFFIC ENGINEERING TERMS

Term	Definition
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 area, 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.
Network	A graphical representation of the geometric topology of a physical roadway system, which is comprised of directional links and nodes.
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.
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.

Term	Definition
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 of 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

Traffic Assignment Model

APPENDIX B: TRAFFIC ASSIGNMENT MODEL

This section describes the integrated trip assignment and distribution model named TRAD that is expressly designed for use in analyzing evacuation scenarios. This model employs equilibrium traffic assignment principles and is one of the models of the I-DYNEV System.

To apply TRAD, the analyst must specify the highway network, link capacity information, the volume of traffic generated at all origin centroids, a set of accessible candidate destination nodes on the periphery of the EPZ for each origin, and the capacity (i.e., "attraction") of each destination node. TRAD calculates the optimal trip distribution and the optimal trip assignment (i.e., routing) of the traffic generated at each origin node, traveling to the associated set of candidate destination nodes, so as to minimize evacuee travel times.

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" route. The model is designed to identify these "best" routes in a manner that distributes vehicles from origins to destinations and routes them over the highway network, in a consistent and optimal manner.

The approach we adopt is to extend the basic equilibrium assignment methodology to embrace the distribution process, as well. That is, the selection of destination nodes by travelers from each origin node, and the selection of the connecting paths of travel, are both determined by the integrated model. This determination is subject to specified capacity constraints, so as to satisfy the stated objective function. This objective function is the statement of the User Optimization Principle by Wardrop (**Wardrop, J.G.**, ***Some***

Theoretical Aspects of Road Traffic Research, Proc.Instn.Civ.Engrs. Part II 1(2), 325-362, 1952).

To accomplish this integration, we leave the equilibrium assignment model intact, changing only the form of the objective function. It will also be necessary to create a "fictional" augmentation of the highway network. This augmentation will consist of Pseudo-Links and Pseudo-Nodes, so configured as to embed an equilibrium Distribution Model within the fabric of the Assignment Model.

<u>Specification of TRAD Model Inputs</u>

The user must specify, for each origin node, the average hourly traffic volume generated, as well as a set of candidate accessible destinations. A destination is “accessible” to traffic originating at an origin node if there is at least one path connecting the origin to the destination node. There must be at least one destination node specified for each origin centroid. The number of trips generated at the origin node, which are distributed to each specified, accessible destination node within this set, is determined by the model in a way as to satisfy the network-wide objective function (Wardrop's Principle).

The user must also specify the total number of trips which can be accommodated by each destination node. This value reflects the capacities of the road(s) immediately servicing the destination node. We call this number of trips, the "attraction" of the destination node, consistent with conventional practice. Clearly, we require that the total number of trips traveling to a destination, j, from <u>all</u> origin nodes, i, cannot exceed the attraction of destination node, j. By summing over all destination nodes, this constraint also states that the total trips generated at all origin nodes must not exceed the total capacity to accommodate these trips at all of the specified destinations.

In summary, the user must specify the total trips generated at each of the origin nodes, the maximum number of trips that can be accommodated by each of the specified destination nodes and the highway network attributes which include the traffic control tactics. The TRAD model includes a function which expresses travel time on each network link in terms of traffic volume and link capacity. This function drives the underlying trip distribution and trip assignment decision-making process. Thus, the TRAD satisfies the objectives of evacuees to select destination nodes and travel paths to minimize evacuation travel time. As such, this integrated model is classified as a behavioral model.

At the outset, it may appear that we have an intractable problem:

- If TRAD retains the basic assignment algorithm, it must be provided a Trip Table as input.
- On the other hand, if the distribution model is embedded within the assignment model, rather than preceding it, a Trip Table is not available as input.

The resolution of this problem is as follows:

1. We construct an "augmentation" network that allows the user to specify only the volume for each origin node. The allocation of trips from the origin node to each candidate destination node, is not specified and will be determined internally by the model.
2. We construct pseudo-links which enforce the specified values of attraction, A_j, for all destination nodes, j, by suitably calibrating the relationship of the travel time vs. volume and capacity.

This augmented network is comprised of three subnetworks:

1. The highway subnetwork, which consists of "Class I" Links and Nodes.
2. A subnetwork of "Class II" Pseudo-Links which acts as an interface between

the highway subnetwork and the network augmentation.

3. The subnetwork of "Class III" Pseudo-Links and Nodes which comprises the network augmentation described above.

The need for these Class II links will become clear later. The classifications are described below:

<u>Class I Links and Nodes</u>

These links and nodes represent the physical highway network: sections of highway and intersections. Trips generated at each Origin [Centroid] Node are assigned to a specified Class I link via a "connector" link. These connector links are transparent to the user and offer no impedance to the traveler; they represent the aggregation of local streets which service the centroidal generated trips and feed them onto the highway network. The real-world destination nodes are part of this network. The immediate approaches to these destination nodes are Class I links.

<u>Class II Links</u>

These pseudo-links are constructed so as to connect each specified destination node with its Class III Pseudo-Node (P-N) counterpart on a one-to-one basis. The capacities of these Class II links are set equal to the capacities at their respective destination nodes.

<u>Class III Links and Nodes</u>

Class III links and nodes form the augmentation to the basic network. These Pseudo-Links provide paths from the Class II links servicing traffic traveling from the specified [real] destination nodes, to the Super-Nodes which represent the user-specified set of destination nodes associated with each origin node.

Each Class of links provides a different function:

- Class I links represent the physical highway network. As such, each link has a finite capacity, a finite length and an estimated travel time for free-flowing vehicles. The nodes generally represent intersections, interchanges and, possibly, changes in link geometry. The topology of the Class I network represents that of the physical highway system.
- The Class II links represent the interface between the real highway subnetwork and the augmentation subnetwork. These pseudo-links are needed to represent the specified "attractions" of each destination node, i.e., the maximum number of vehicles that can be accommodated by each destination node. Instead of explicitly assigning a capacity limitation to the destination nodes, we assign this capacity limitation of the Class II Pseudo-Links. This approach is much more suitable, computationally.
- The topology of the network augmentation (i.e., Class III Links and Nodes) is designed so that all traffic from an origin node can only travel to the single “Super-Node” by flowing through its set of real destination nodes, thence along the links of the augmented network.

The Class II Pseudo-Links and the network augmentation of Class III Pseudo-Nodes and Links represent logical constructs of fictitious links created internally by the model, that allows the user to specify the identity of all destination nodes in each origin-based set, without specifying the distribution of traffic volumes from the origin to each destination node in that set.

Calculation of Capacities and Impedances

Each class of links exhibits different properties. Specifically, the relationship between travel impedance (which is expressed in terms of travel time) and both volume and capacity will differ:

- For Class I links, the capacity represents the physical limitation of the highway sections. Travel impedance is functionally expressed by relating travel time with respect to the traffic volume-link capacity relationship.
- For Class II links, link capacity represents the maximum number of vehicles that can be accommodated at the [real] destination nodes that form the upstream nodes of each Class II link. Since Class II links are Pseudo-Links, there should be virtually no difference in impedance to traffic along Class II links when the assigned traffic volume on these links is below their respective capacities. That is, the assignment of traffic should not be influenced by differences in travel impedance on those Class II links where the assigned volumes do not exceed their respective capacities.
- For Class III links, both capacity and impedance have no meaning. Since the Class II links limit the number of vehicles entering the Class III subnetwork at all entry points (i.e., at the Class II Pseudo-Nodes) and since all these links are Pseudo-Links, it follows that the Class III network is, by definition, an uncapacitated network.

Specification of the Objective Function

It is computationally convenient to be able to specify a single impedance (or "cost") function relating the travel time on a link, to its capacity and assigned traffic volume, for all classes of links. To achieve this, we will adopt the following form based on the original "BPR

Formula[1]":

$$T = T_o\{\alpha[1+a_1(\frac{v}{c})^{b_1}]+\beta[1+a_2(\frac{v}{c})^{b_2}]\}+I$$

Where, as for the present traffic assignment model in TRAD,

T	=	Link travel time, sec.
T_o	=	Unimpeded link travel time, sec.
V	=	Traffic volume on the link, veh/hr
C	=	Link capacity, veh/hr
a_i,b_i	=	Calibration parameters
α, ß	=	Coefficients defined below
I	=	Impedance term, expressed in seconds, which could represent turning penalties or any other factor which is justified in the user's opinion

The assignment of coefficients varies according to the Class in which a link belongs:

Class	α	ß	T_o
I	1	0	L/U_f
II	0	1	W
III	0	0	1

Here, L is a highway link length and U_f is the free-flow speed of traffic on a highway link. The values of a_1 and b_1, which are applicable only for Class I links, are based on experimental data:

$a_1 = 0.8$ $b_1 = 5.0$

The values of a_2 and b_2, which are applicable for each Class II links, are based upon the absolute requirement that the upstream destination node can service no more traffic than

1 Bureau of Public Roads (1964). Traffic Assignment Manual. U.S. Dept. of Commerce, Urban Planning Division, Washington D.C.

the user-specified value of the maximum "attraction". In addition, these parameters must be chosen so that these Pseudo-Links all offer the same impedance to traffic when their assigned volumes are less than their respective specified maximum attractions.

The weighting factor, W, is computed internally by the software.

Of course, it is still possible for the assignment algorithm within TRAD to distribute more traffic to a destination node than that node can accommodate. For emergency planning purposes, this is a desirable model feature. Such a result will be flagged by the model to alert the user to the fact that some factor is strongly motivating travelers to move to that destination node, despite its capacity limitations. This factor can take many forms: inadequate highway capacity to other destinations, improper specification of candidate destinations for some of the origins, or some other design inadequacy. The planner can respond by modifying the control tactics, changing the origin-destination distribution patter, providing more capacity at the overloaded destinations, etc.

APPENDIX C

Traffic Simulation Model: PCDYNEV

APPENDIX C: TRAFFIC SIMULATION MODEL: PCDYNEV

A model, named PC-DYNEV, is an adaptation of the TRAFLO Level II simulation model, developed by KLD for the Federal Highway Administration (FHWA). Extensions in scope were introduced to expand the model's domain of application to include all types of highway facilities, to represent the evacuation traffic environment and to increase its computational efficiency. This model produces the extensive set of output Measures of Effectiveness (MOE) shown in Table C-1.

The traffic stream is described internally in the form of statistical flow profiles. These profiles, expressed internally as statistical histograms, describe the platoon structure of the traffic stream on each network link. The simulation logic identifies five types of histograms:

- The ENTRY histogram which describes the platoon flow at the upstream end of the subject link. This histogram is simply an aggregation of the appropriate OUTPUT turn-movement-specific histograms of all feeder links.
- The INPUT histograms which describe the platoon flow pattern arriving at the stop line. These are obtained by first disaggregating the ENTRY histogram into turn-movement-specific component ENTRY histograms. Each such component is modified to account for the platoon dispersion which results as traffic traverses the link. The resulting INPUT histograms reflect the specified turn percentages for the subject link.
- The SERVICE histogram which describes the service rates for each turn movement. These service rates reflect the type of control device servicing traffic on this approach; if it is a signal, then this histogram reflects the specified movement-specific signal phasing. A separate model estimates service rates for each turn movement, given that the control is GO.

These data are provided for each network link and are also aggregated over the entire network.

- The QUEUE histogram that describe the time-varying ebb and growth of the queue formation at the stop line. These histograms are derived from the interaction of the respective IN histograms with the SERVICE histograms.
- The OUT histograms that describe the pattern of traffic discharging from the subject link. Each of the IN histograms is transformed into an OUT histogram by the control applied to the subject link. Each of these OUT histograms is added into the (aggregate) ENTRY histogram of its receiving link. This approach provides the model with the ability to identify the characteristics of each turn-movement-specific component of the traffic stream. Each component is serviced at a different saturation flow rate as is the case in the real world. The logic recognizes when one component of the traffic flow encounters saturation conditions even if the others do not.

Algorithms provide estimates of delay and stops reflecting the interaction of the IN histograms with the SERVICE histograms. The logic also provides for properly treating spillback conditions reflecting queues extending from its host link, into its upstream feeder links.

A valuable feature is the ability to internally generate functions that relate mean speed to density on each link, given user-specified estimates of free-flow speed and saturation service rates for each link. Such relationships are essential in order to simulate traffic operations on freeways and rural roads, where signal control does not exist or where its effect is not the dominant factor in impeding traffic flow.

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

- Topology of the roadway system
- Geometrics of each roadway component
- Channelization of traffic on each roadway component
- Motorist behavior that, in aggregate, determines the operational performance of vehicles in the system
- Specification of the traffic control devices and their operational characteristics
- Traffic volumes entering and leaving the roadway system
- Traffic composition.

To provide an efficient framework for defining these specifications, the physical environment is represented as a network. The unidirectional links of the network generally represent roadway components: either urban streets or freeway segments. The nodes of the network generally represent urban intersections or points along the freeway where a geometric property changes (e.g. a lane drop, change in grade or ramp).

Figure C-1 is an example of a small network representation. The freeway is defined by the sequence of links, (20,21), (21,22), (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. Measures of Effectiveness Output by PCDYNEV	
Measure	**Units**
Travel	Vehicle-Miles and Vehicle-Trips
Moving Time	Vehicle-Minutes
Delay Time	Vehicle-Minutes
Total Travel Time	Vehicle-Minutes
Efficiency: Moving Time/Total Travel Time	Percent
Mean Travel Time per Vehicle	Seconds
Mean Delay per Vehicle	Seconds
Mean Delay per Vehicle-Mile	Seconds/Mile
Mean Speed	Miles/Hour
Mean Occupancy	Vehicles
Mean Saturation	Percent
Vehicle Stops	Percent

Table C-2. Input Requirements for the PCDYNEV Model

GEOMETRICS

- Links defined by upstream downstream node numbers
- Links lengths
- Number of lanes (up to 6)
- Turn pockets
- Grade
- Network topology defined in terms of target nodes for each receiving link

TRAFFIC VOLUMES

- On all entry links and sink/source nodes stratified by vehicle type: auto, car pool, bus, truck
- Link-specific turn movements

TRAFFIC CONTROL SPECIFICATIONS

- Traffic signals: link-specific, turn movement specific
- Signal control treated as fixed time
- 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 OPERATIONS CHARACTERISTICS

- Drivers (vehicle-specific) response mechanisms: free-flow speed, aggressiveness, discharge headway
- Link-specific mean speed for free-flowing (unimpeded) traffic
- Vehicle-type operational characteristics: acceleration, deceleration
- Such factors as bus route designation, bus station location, dwell time, headway, etc.

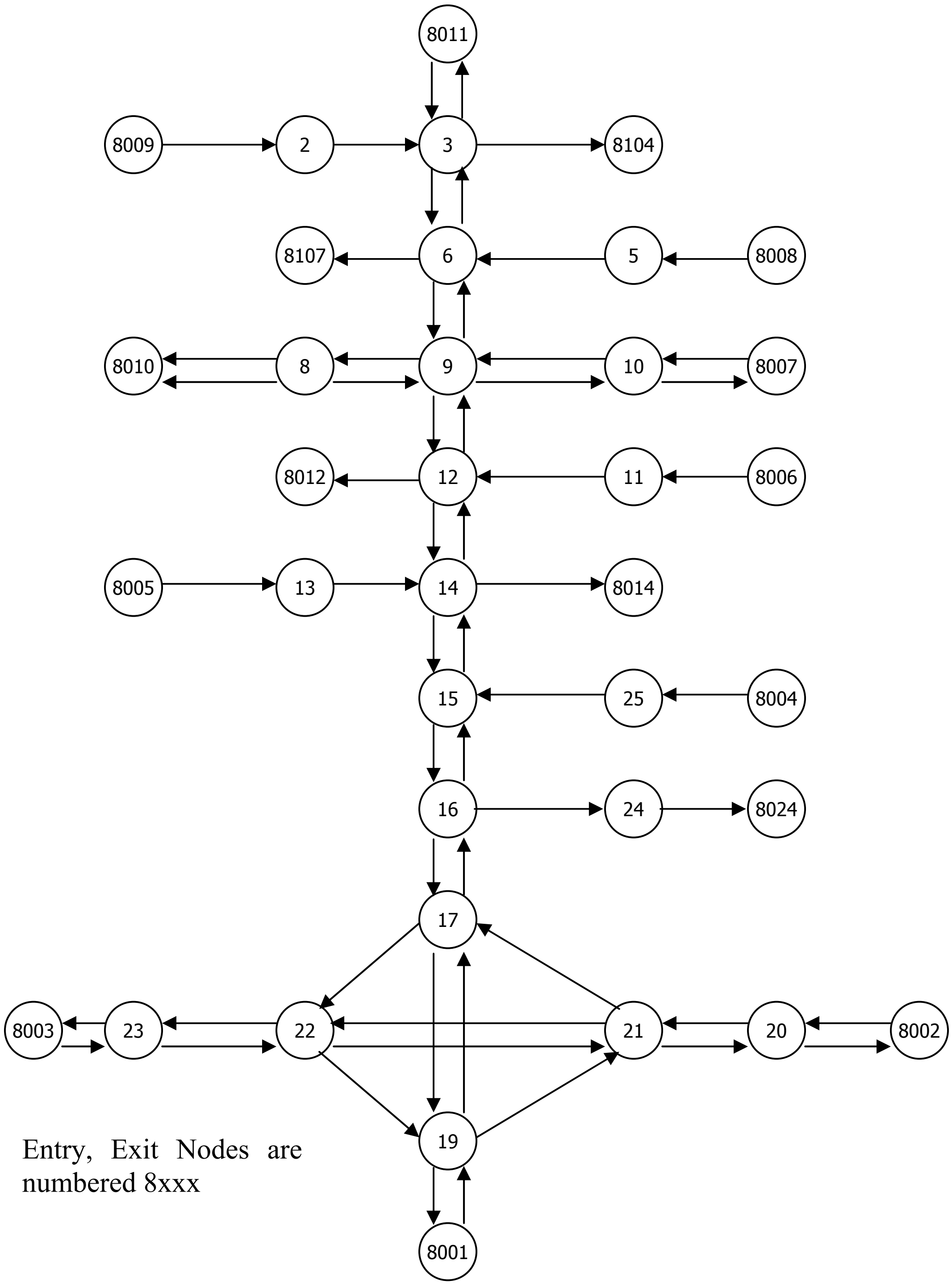


Figure C-1: Representative Analysis Network

APPENDIX D

Detailed Description of Study Procedure

APPENDIX D: DETAILED DESCRIPTION OF STUDY PROCEDURE

This appendix describes the activities that were performed to compute accurate Evacuation Time Estimates (ETE). 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 this flow diagram.

Step 1.

The first activity is to obtain data defining the spatial distribution and demographic characteristics of the population within the Emergency Planning Zone (EPZ). These data were obtained from U.S. Census files and from results adapted from a telephone survey conducted within the EPZ. Transient data and employee data were obtained through data collection forms submitted by County Emergency Management Offices..

Step 2.

The next activity is to examine large-scale maps of the EPZ in both hard-copy form and using Geographical Information System (GIS) software. These maps were used to identify the analysis highway network and the access roads from each residential development to the adjoining elements of this network. This information is used to plan a field survey of the highway system and later, to assign generated evacuation trips to the correct destinations at the periphery of the EPZ.

Step 3.

The next step is to conduct a physical survey of the roadway system. The purpose of this survey is to determine the geometric properties of the highway elements, 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 and to make the necessary observations needed to estimate realistic values of roadway capacity.

Step 4.

With this information, develop the evacuation network representation of the physical roadway system.

Step 5.

With the network drawn, proceed to estimate the capacities of each link and to locate the origin centroids where trips would be generated during the evacuation process.

Step 6.

With this information at hand, the data were entered into the computer to create the input stream for the TRaffic Assignment and Distribution (TRAD) model. This model was designed to be compatible with the PCDYNEV traffic simulation model used later in the project; the input stream required for one model is entirely compatible with the input stream required by the other. Using a software system developed by KLD named UNITES, the data entry activity is performed interactively directly on the computer.

Step 7.

The TRAD model contains software that performs diagnostic testing of the input stream. These assist the user in identifying and correcting errors in the input stream.

Step 8.

After creating the input stream, execute the TRAD model to compute evacuating traffic routing patterns consistent with the guidelines of NUREG 0654, Appendix 4. The TRAD model also provides estimates of traffic loading on each highway link as well as rough estimates of operational performance.

Step 9.

Critically examine the statistics produced by the TRAD 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 result.

Essentially, the approach is to identify those "hot spots" 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 improper routing, as a shortfall of capacity, or as a quantitative error in the way the physical system was represented in the input stream. This examination leads to one of two conclusions:

- The results are as satisfactory as could be expected at this stage of the analysis process; or
- The input stream must be modified accordingly.

This decision requires, of course, the application of the user's judgment based upon the results obtained in previous applications of the TRAD model and a comparison of the results of this last case with the previous ones. If the results are satisfactory in the opinion of the user, then the process continues with Step 12. Otherwise, proceed to Step 10.

Step 10.

There are many "treatments" available to the user in resolving such problems. These treatments range from decisions to reroute the traffic by 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 or changing the trip table. Such "treatments" take the form of modifications to the original input stream.

Step 11.

As noted above, the changes to the input stream must be implemented to reflect the modifications undertaken in Step 10. At the completion of this activity, the process returns to Step 8 where the TRAD model is again executed.

Step 12.

The output of the TRAD model includes the computed turn movements for each link. These data are required – and – accessed by the PCDYNEV simulation model. This step completes the specification of the PCDYNEV input stream.

Step 13.

After the PCDYNEV input stream has been debugged, the simulation model is executed to provide detailed estimates, expressed as statistical Measures of Effectiveness (MOE), which describe the detailed performance of traffic operations on each link of the network.

Step 14.

In this step, the detailed output of the simulation model is examined to identify whether problems exist on the network. The results of the simulation model are extremely detailed and far more accurately describe traffic operations than those provided by the TRAD model. Thus, it is possible to identify the cause of any problems by carefully studying the output.

Again, one can implement corrective treatments designed to expedite the flow of traffic on the network in the event that the results are considered to be less efficient than is possible to achieve. If input changes are needed, the analysis process proceeds to Step 15. On the other hand, if the results are satisfactory, then one can decide whether to return to Step 8 to again execute the TRAD model and repeat the whole process, or to accept the simulation results. If there were no changes indicated by the activities of Step 14, because the results were satisfactory, we can then proceed to document them in Step 17. Otherwise, return to Step 8 to determine the effects of the changes implemented in Step 14 on the optimal routing patterns over the network. This determination can be ascertained by executing the TRAD model.

Step 15.

This activity implements the changes in control treatments or in the assignment of destinations associated with one or more origins in order to improve the representation of traffic flow over the network. These treatments can also include the consideration of adding roadway segments to the existing analysis network to improve the representation of the physical system.

Step 16.

Once the treatments have been identified, it is necessary to modify the simulation model input stream accordingly. At the completion of this effort, the procedure returns to Step 13 to execute the simulation model again.

Step 17.

The simulation results are analyzed, tabulated and graphed. The results are then documented, as required.

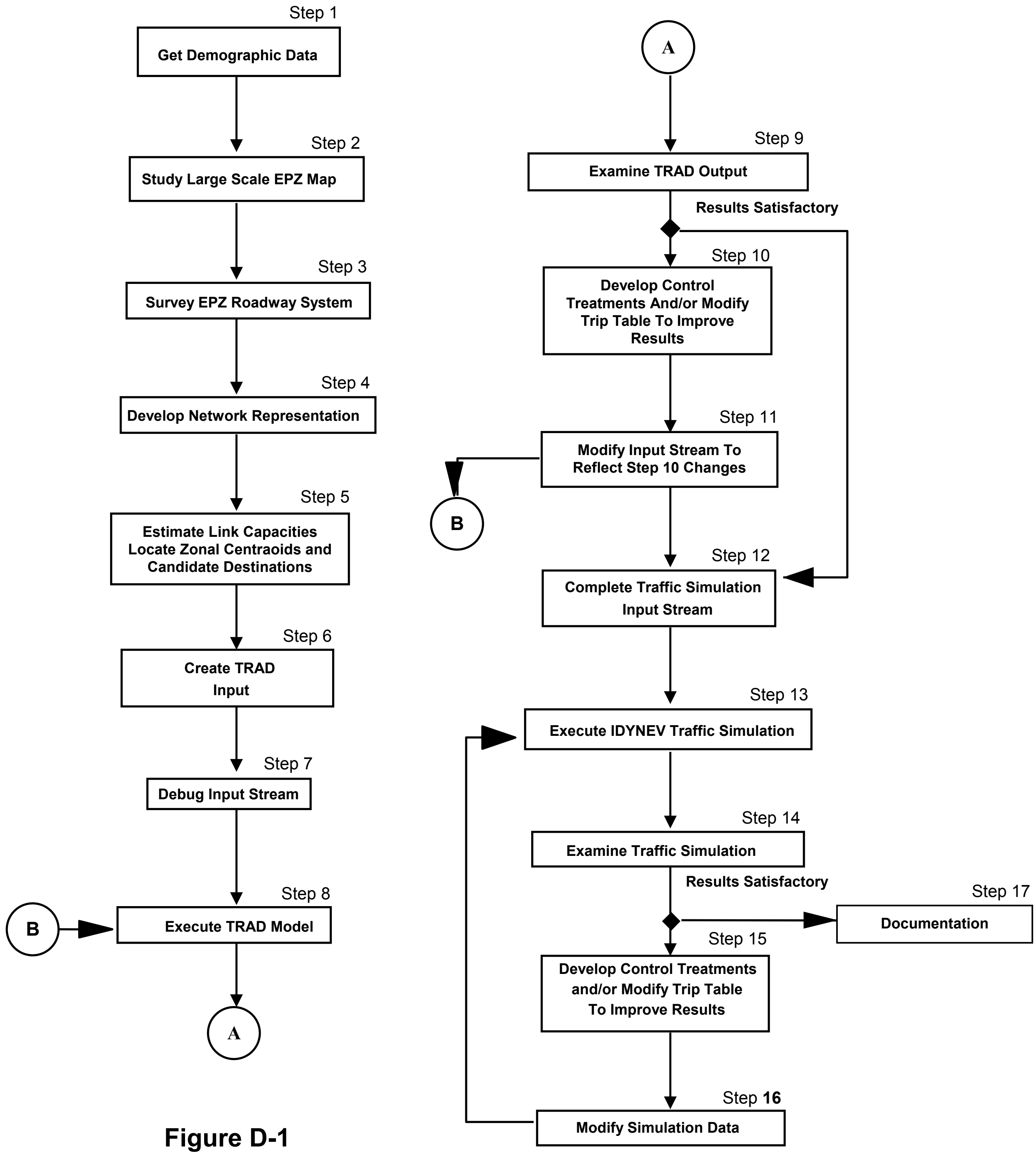


Figure D-1

Flow Diagram of Activities

APPENDIX E

Special Facility Data

APPENDIX E: SPECIAL FACILITY DATA

The following tables list population information, as of December 2006, for the special facilities that are in the Grand Gulf Nuclear Station EPZ. The facilities include schools, day care centers, hospitals and other medical facilities, correctional institutions, and major employers. The transient population tables include listings for state parks, county parks, hotels and motels, and other recreational areas. Each table is grouped by county and parish. The location of the facility is defined by its distance (in miles) and compass direction relative to the Grand Gulf Nuclear Station.

Grand Gulf EPZ: Correctional Facilities (As of December 2006)								
ERPA	**Distance (miles)**	**Dir-ection**	**Name**	**Street Address**	**Municipality**	**Phone**	**Capacity**	**Current Census**
Claiborne County								
4A	4.9	SE	Claiborne County Sheriff Dept	Main Street & Olive St	Port Gibson	601-437-5161	25	22
4A	5.1	SE	Port Gibson Police Dept	800 Farmer Street	Port Gibson	601-437-5101	6	N.A.
						Sub-total	31	22
Tensas Parish								
9	11.8	WNW	J.B. Evans Correctional Center	Routh St & Burnside St	Newellton	318-467-3355	400	365
						Sub-total	400	365
						Overall Total	**431**	**387**

N.A. = Not Available

Grand Gulf EPZ: State Parks & Overnight Camps (As of December 2006)								
ERPA	**Distance (miles)**	**Dir-ection**	**Facility Name**	**Street Address**	**Municipality**	**Phone**	**Persons**	**Total Vehicles**
Claiborne County								
1	1.2	NNW	Grand Gulf Military Park	12006 Grand Gulf Road	Port Gibson	601-437-5911	20	20
						Sub-total	20	20
Tensas Parish								
10	10.1	WSW	Lake Bruin State Park	State Highway 604 & Robertson	Saint Joseph	318-766-3530	25	25
						Sub-total	25	25
						Overall Total	**45**	**45**

Grand Gulf EPZ: Day Care Centers (As of December 2006)								
ERPA	**Distance (miles)**	**Dir-ection**	**Name**	**Street Address**	**Municipality**	**Phone**	**Enrollment**	**Empl-oyees**
				Claiborne County				
3A	4.9	SE	Loving Arms Daycare & Pre-School	Elm St & Northside Sub Rd	Port Gibson	601-437-8262	48	9
4A	5.2	SE	All God's Children Pre-School & Nursery	509 Walnut Street	Port Gibson	601-437-3588	17	3
4A	4.9	SE	Child Day Care Kindergarten	301 Market Street	Port Gibson	601-437-5144	7	3
4A	5.3	SE	Claiborne County Vo-Tech	College St & Jackson St	Port Gibson	601-437-3800	7	2
4A	5.4	SE	Concerned Citizens Daycare	1402 College Street	Port Gibson	601-437-3677	19	4
4A	5.1	SE	Heavenly Angels Daycare	Church St & Orange St	Port Gibson	601-437-3200	10	5
4A	5.2	SE	Little Kids College	904 Farmer Street	Port Gibson	601-437-5715	24	4
4A	5.6	SE	Little Kids University	Rte 61 & Sunset Hill Rd	Port Gibson	601-437-8576	28	6
4A	4.6	SE	Richardson Headstart	Osage St & Oil Mill Rd	Port Gibson	601-437-4094	190	51
4B	9.1	SE	Amazing Grace Day Care	Tillman Rd & Moore Rd	Port Gibson	601-437-4010	21	7
5A	6.3	SSE	Brite Minds Inc	Rte 61 & Bridgewell Ln	Port Gibson	601-437-5353	5	2
5A	6.3	SSE	Open Arms Christian Center	Rte 61 & Bridgewell Ln	Port Gibson	601-437-8506	7	2
						Sub-total	383	98
				Tensas Parish				
11	12.6	WSW	Little Green Nursery	Pauline Street & State Highway 128	Saint Joseph	318-766-3380	12	2
11	12.6	WSW	Right Start Child Care	12th St & State Highway 128	Saint Joseph	318-766-7764	25	3
						Sub-total	37	5
						Overall Total	**420**	**103**

Grand Gulf EPZ: Hotels / Motels (As of December 2006)								
ERPA	**Distance (miles)**	**Dir-ection**	**Facility Name**	**Street Address**	**Municipality**	**Phone**	**Persons**	**Vehicles**
Claiborne County								
2A	5.4	SE	Grand Gulf Inn	Rte 61 & Grand Gulf Rd	Port Gibson	601-437-8811	88	44
						Sub-tota		
Tensas Parish								
10	10.1	WSW	Lake Bruin Motel & Grill	State Highway 604 & Robertson	Saint Joseph	318-766-6007	44	11
11	12.1	WSW	Shilo Lake Bruin Resort	State Highway 605 & Washam Rd	Saint Joseph	318-766-3334	525	105
						Sub-total		
						Overall Total	**657**	**160**

Grand Gulf EPZ: Major Employers (As of December 2006)							
ERPA	**Distance (miles)**	**Direction**	**Facility Name**	**Street Address**	**Municipality**	**Phone**	**Employees**
Claiborne County							
4A	5.1	SE	M&M Superstore	Church Street & Orange St	Port Gibson	601-437-4191	12
4A	4.9	SE	Piggly Wiggly	Main Street & Orange St	Port Gibson	601-437-4205	25
						Sub-total	37
Tensas Parish							
9	11.8	WNW	J.B. Evans Correctional Center	Routh St & Burnside St	Newellton	318-467-3355	15
11	12.8	WSW	Tensas Parish School Board	Plank Rd & State Highway 897	Saint Joseph	318-766-3269	15
						Sub-total	30
						Overall Total	**67**

Grand Gulf EPZ: Medical Facilities & Nursing Homes (As of December 2006)								
ERPA	**Distance (miles)**	**Dir-ection**	**Facility Name**	**Street Address**	**Municipality**	**Phone**	**Capacity**	**Employees**
Claiborne County								
4A	5.5	SE	Claiborne County Hospital	123 McComb Ave	Port Gibson	601-437-5141	32	53
4A	4.9	SE	Claiborne County Nursing Center	Old 61 & Rte 61	Port Gibson	601-437-8737	77	82
						Sub-total	109	135
Tensas Parish								
9	12.4	WNW	Franklin Medical Rural Helath Clinic	Verona Ln & Depot St	Newellton	318-467-9949	N.A.	7
9	12.7	WNW	Tensas Care & Rehabilitation Center	901 Verona Ln	Newellton	318-467-5117	102	68
11	12.4	WSW	St. Joseph Rural Healthcare Center	State Highway 605 & North St	Saint Joseph	318-766-8506	N.A.	7
11	12.7	WSW	Tensas Community Health Center	402 Levee St	Saint Joseph	318-766-1967	N.A.	8
11	12.8	WSW	Tensas Parish Health Unit	402 Levee Street	Saint Joseph	318-766-3513	N.A.	2
						Sub-total	102	92
						Overall Total	**211**	**227**

N.A. = Not Available

Grand Gulf EPZ: Schools (As of December 2006)								
ERPA	**Distance (miles)**	**Dir-ection**	**School Name**	**Street Address**	**Municipality**	**Phone**	**Enrollment**	**Staff**
Claiborne County								
2B	7.5	ESE	Reachout Foundation	Romola Road & Bucks Dr	Port Gibson	601-437-9600	10	3
4A	4.2	SE	A.W. Watson Elementary School	Oil Mill Rd	Port Gibson	601-437-5070	889	89
4A	5.5	SE	Chamberlain-Hunt Academy	124 McComb Avenue	Port Gibson	601-437-4291	101	58
4A	5.7	SE	Claiborne Educational Foundation	Horton Drive & Lum Ln	Port Gibson	601-437-4097	36	9
4A	5.2	SE	Port Gibson High	College St & Jackson St	Port Gibson	601-437-4190	578	60
4A	5.4	SE	Port Gibson Middle School	Ramsey Drive & Church St	Port Gibson	601-437-4251	431	47
						Sub-total	2045	266
Tensas Parish								
9	11.9	WNW	Newellton Christian Academy	Verona St & Main St	Newellton	318-467-5755	36	6
9	12.3	WNW	Newellton Elementary	500 Verona Street	Newellton	318-467-5109	225	52
9	12.2	WNW	Tensas Charter School	306 Lombardo St	Newellton	318-467-5538	33	6
11	12.6	WSW	Davidson High School	Plank Rd & 8th St	Saint Joseph	318-766-3585	190	18
11	12.6	WSW	Tensas Academy	418 HWY 128	Saint Joseph	318-766-4384	194	26
11	12.9	WSW	Tensas Elementary	Plank Rd & Woodland Ave	Saint Joseph	318-766-3346	202	13
11	12.8	WSW	Tensas High School	Plank Rd & Martha St	Saint Joseph	318-766-3585	225	35
						Sub-total	1105	156
						Overall Total	**3150**	**422**

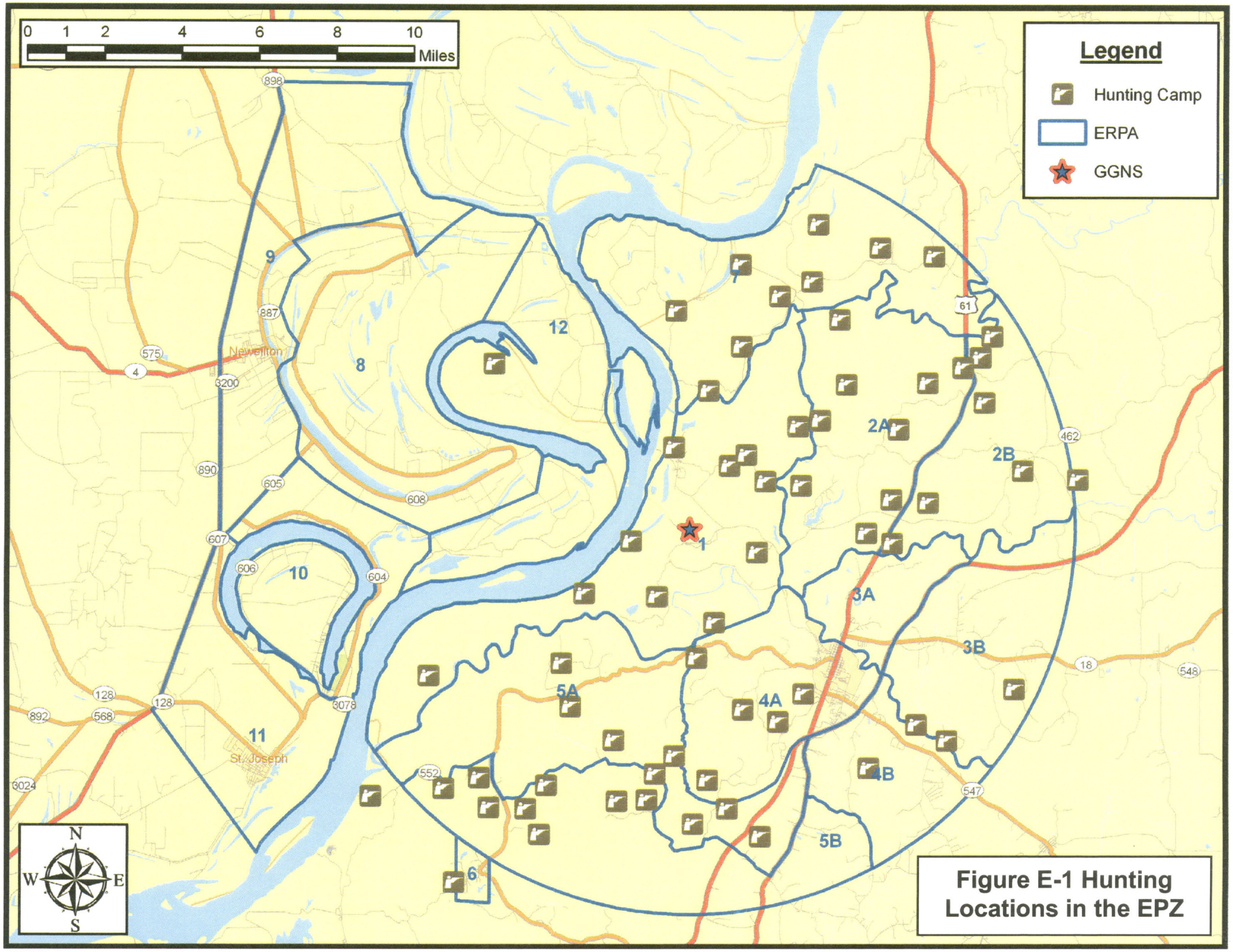


Figure E-1 Hunting Locations in the EPZ

APPENDIX F

Telephone Survey

APPENDIX F: TELEPHONE SURVEY

1. INTRODUCTION

The development of evacuation time estimates for the Emergency Planning Zone (EPZ) of the Grand Gulf nuclear power station requires the identification of travel patterns, car ownership and household size of the population within the EPZ. Demographic information is 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 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 a telephone survey. 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 …?”)

2. SURVEY INSTRUMENT AND SAMPLING PLAN

Attachment A presents the final survey instrument. A draft of the instrument was submitted for comment. Comments were received and the survey instrument was modified.

Following the completion of the instrument, a sampling plan was developed. A sample size of approximately 500 completed survey forms yields results with an acceptable sampling error. The sample must be drawn from the EPZ population. Consequently, a list of EPZ zip codes was developed. This list is shown in Table F-1. Along with each zip code, an estimate of the population in each area was determined. The proportional number of the desired completed survey interviews for each area was identified, as shown in Table F-1.

The completed survey adhered to the sampling plan.

Table F-1. Survey Sampling Plan			
Grand Gulf Telephone Survey			
Sampling Plan			
Zip Code	**Population (2004)**	**Households**	**Required Sample**
Mississippi 39150	9,145	3,362	368
Louisiana 71357	3,294	1,211	132
Totals:	12,439	4,573	500
Average Household Size		**2.72**	
Total Sample Required		**500**	

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.

Household Demographic Results

Household Size

Figure F-1 presents the distribution of household size within the EPZ. The average household contains 2.71 people. The estimated household size (2.72 persons) used to determine the survey sample (Table F-1) was drawn from Census data. The close agreement between the average household size obtained from the survey and the Census value is an indication of the reliability of the survey.

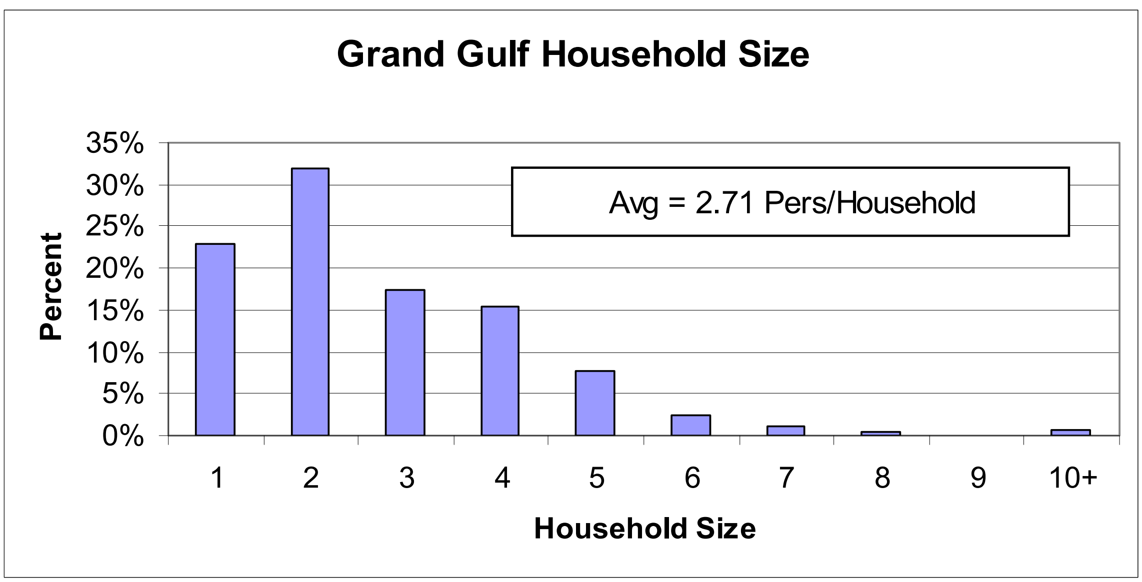


Figure F-1. Household Size in the EPZ

Automobile Ownership

The average number of automobiles per household in the EPZ is 1.77. It should be noted that approximately 10.5 percent of households do not have access to an automobile. The distribution of automobile ownership by household is presented in Figure F-2. Figures F-3 and F-4 present the automobile availability by household size. As expected, nearly all households of two or more people have access to at least one vehicle.

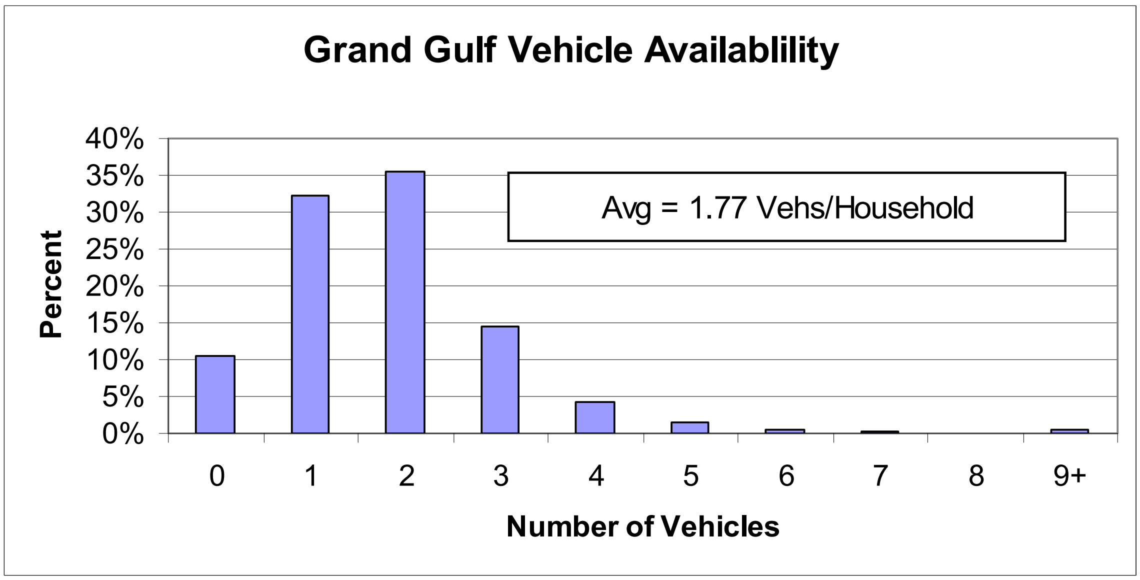


Figure F-2. Household Vehicle Availability

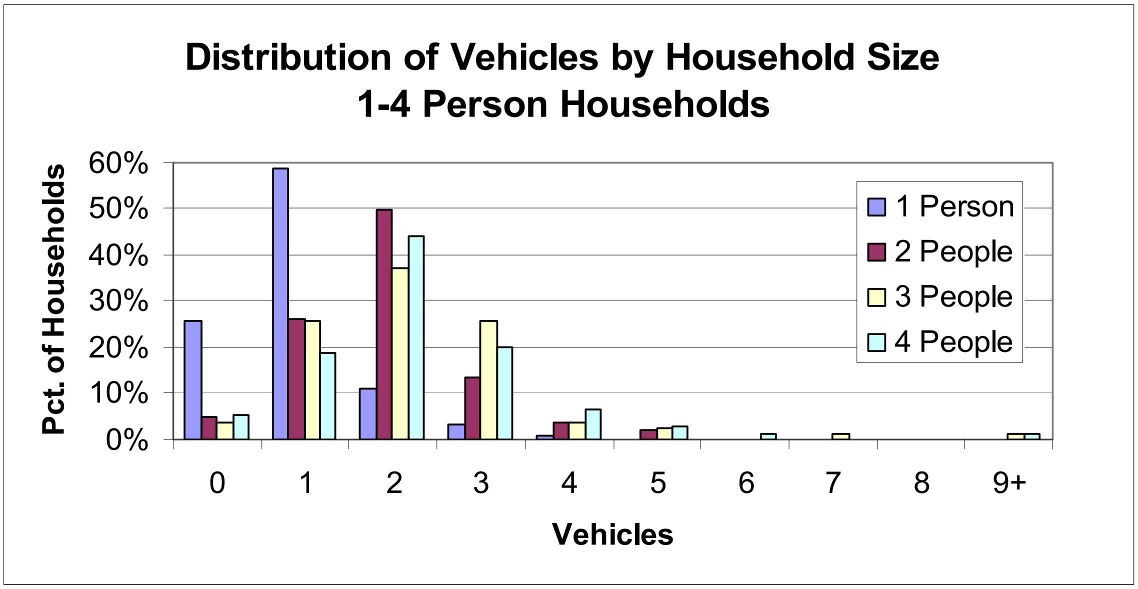


Figure F-3. Vehicle Availability – 1 to 4 Person Households

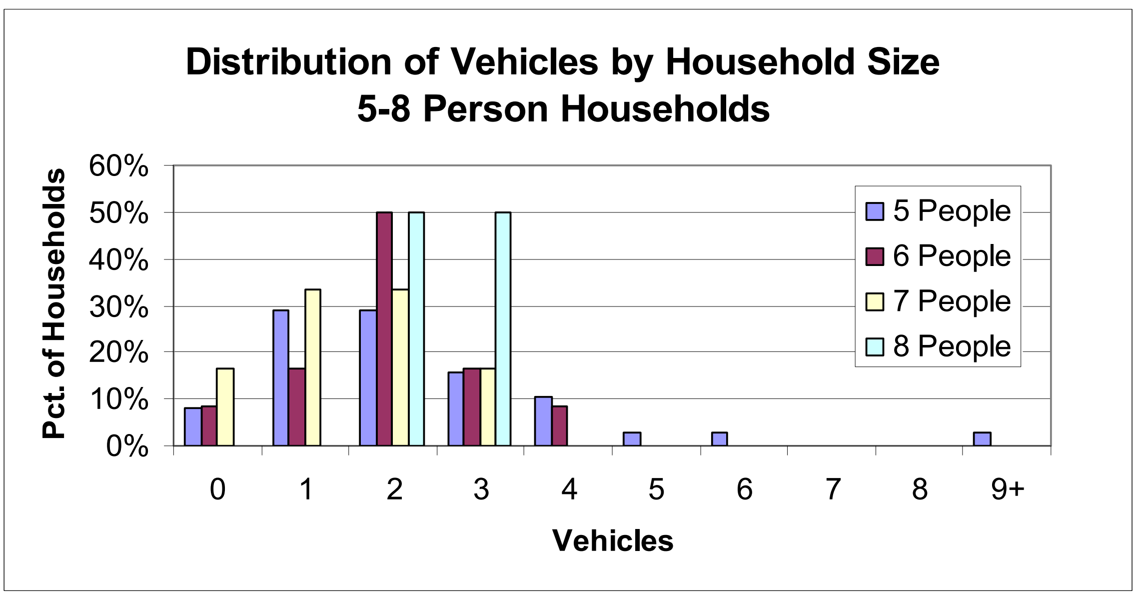


Figure F-4. Vehicle Availability – 5 to 8 Person Households

Schoolchildren

The average number of schoolchildren per household identified by the survey is 0.92 children per household. Figure F-5 presents the distribution of schoolchildren.

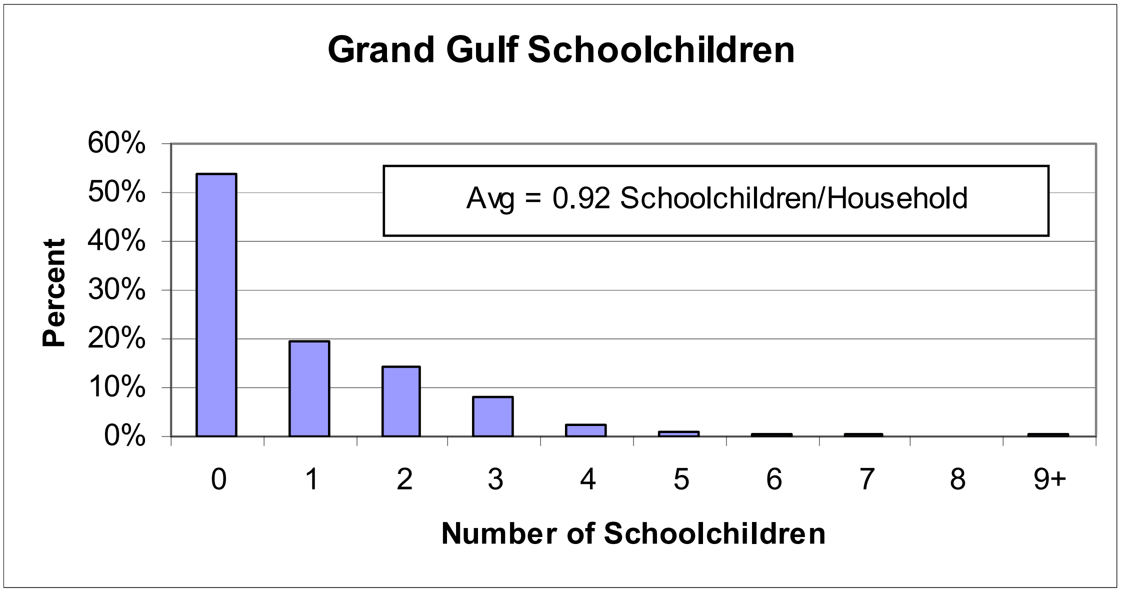


Figure F-5. Schoolchildren in Households

Commuters

Figure F-6 presents the distribution of the number of commuters (people who travel to work or school) in each household. The data shows an average of 1.04 commuters in each household in the EPZ.

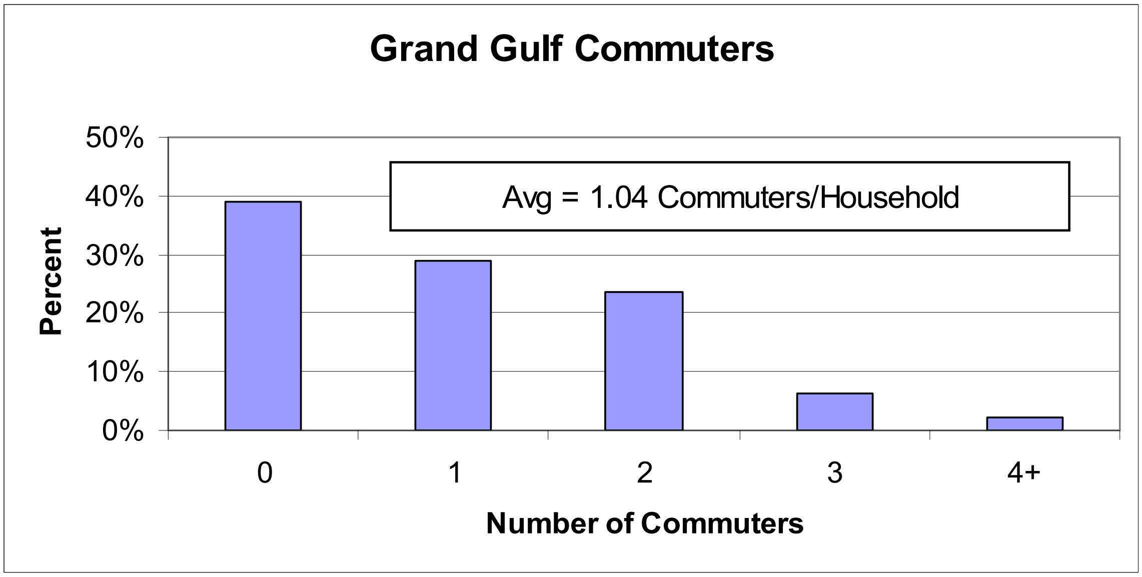


Figure F-6. Commuters in Households in the EPZ

Commuter Travel Modes

Figure F-7 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 or school.

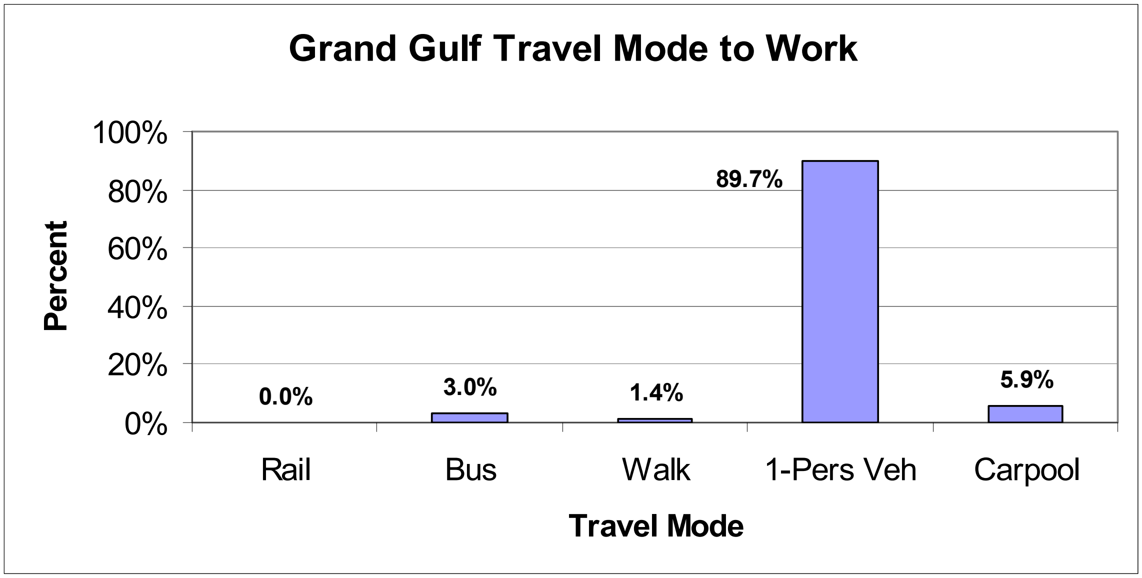


Figure F-7. Modes of Travel in the EPZ

Evacuation Response

Several questions were asked which gauge the population response to an emergency. The first of these asked was "How many of the vehicles that are usually available to the household would your family use during an evacuation?" The response is shown in Figure F-8. On average, 1.46 vehicles per household would be used for evacuation purposes. This result is important. The previous ETE analysis assumed that households would evacuate using one vehicle per household. Application of the survey results would indicate that an evacuation would involve approximately 46% more vehicles than previously assumed.

The second evacuation response question asked was "When the commuters are away from home, is there a vehicle at home that is available for evacuation during any emergency?" Of the survey participants who responded, 56 percent said that there was another vehicle available to evacuate, while 44 percent answered that there would be no vehicle available for evacuation.

The third evacuation response question was "Would your family await the return of other family members prior to evacuating the area?" Of the survey participants who responded, 67 percent said they would await the return of other family members before evacuating and 33 percent indicated that they would not await the return of other family members.

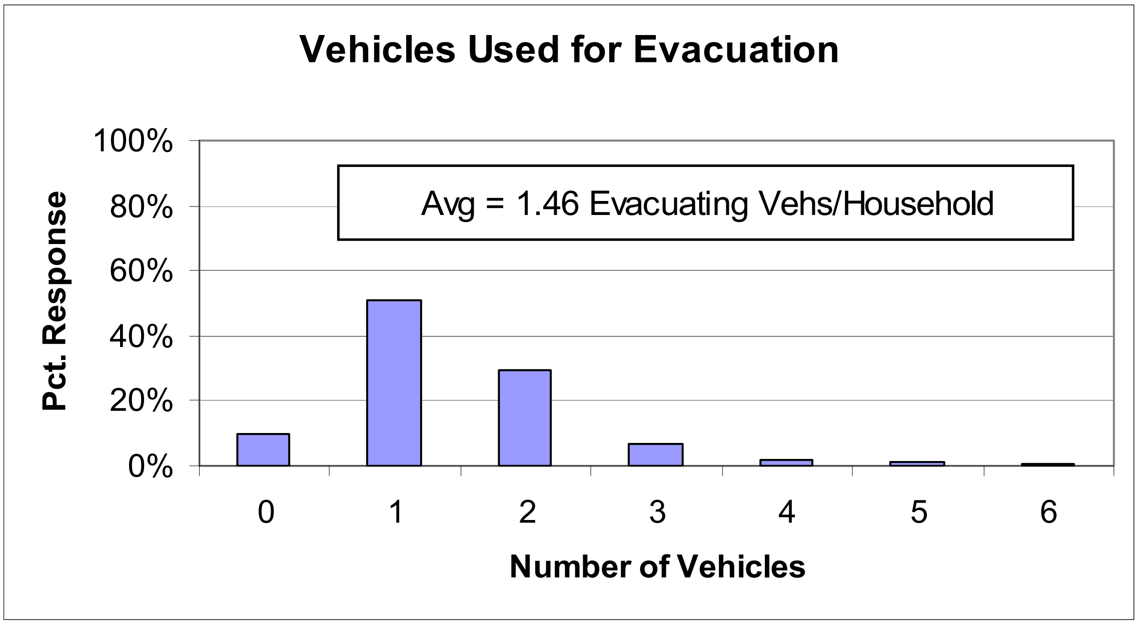


Figure F-8. Number of Vehicles Used for Evacuation

Time Distribution Results

The survey asked four 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.

How long does it take the commuter to complete preparation for leaving work?

Figure 9 presents the cumulative distribution. In all cases, the activity is completed by about 120 minutes. Fifty percent of workers can leave work within 15 minutes.

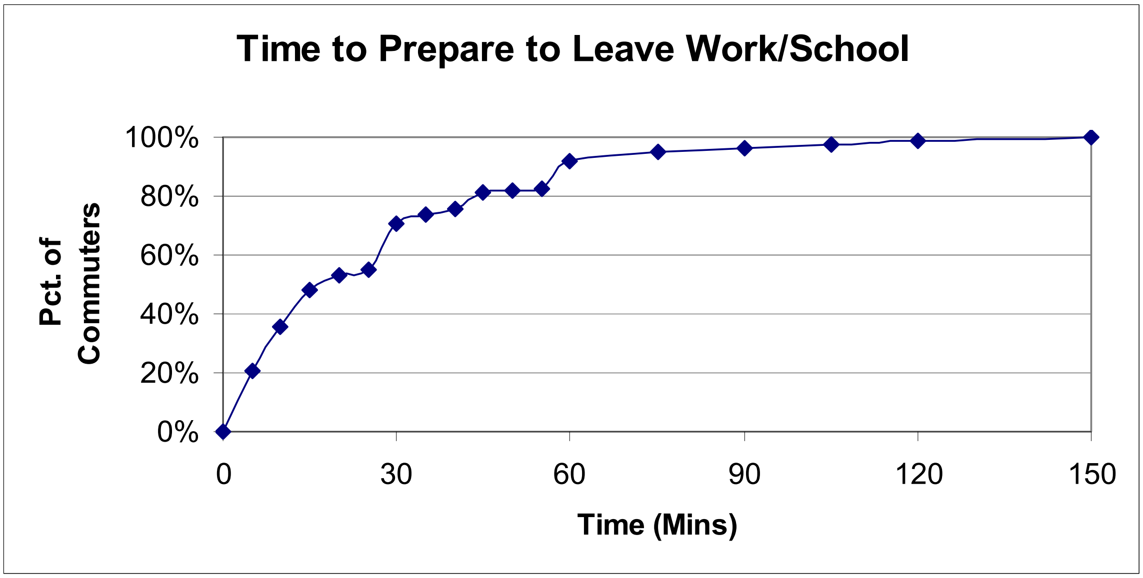


Figure F-9. Time Required to Prepare to Leave Work

How long would it take the commuter to travel home?

Figure F-10 presents the work to home travel time for commuters. Over 80 percent of commuters can arrive home within about 40 minutes of leaving work; nearly all within an hour and a half.

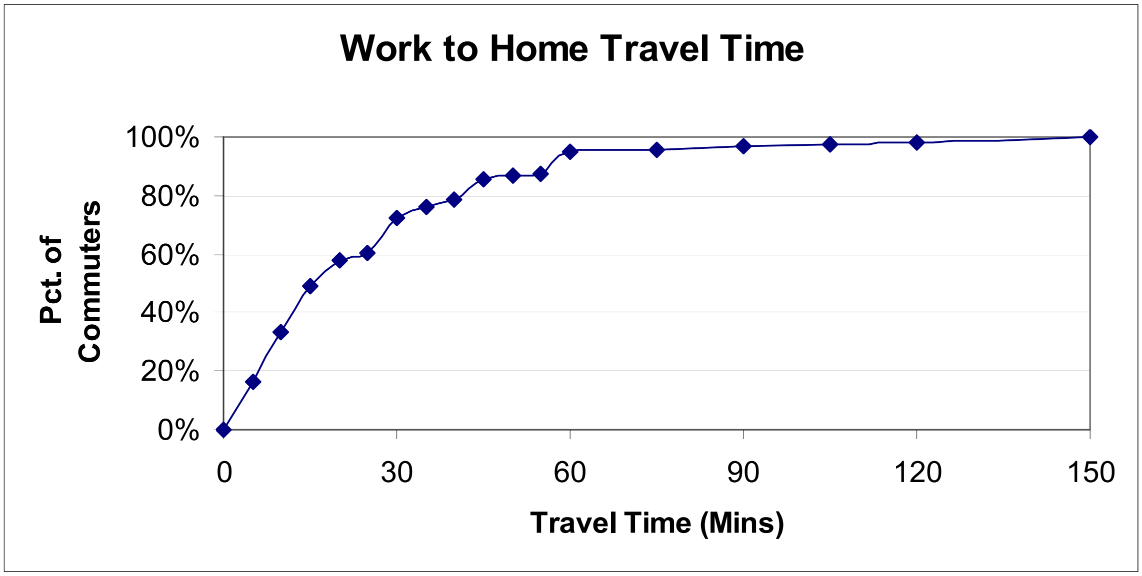


Figure F-10. Work to Home Travel Time

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 the home prior to 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." Over 90 percent of households can be ready to leave home within an hour and a half; the remaining households require up to an additional four and a half hours.

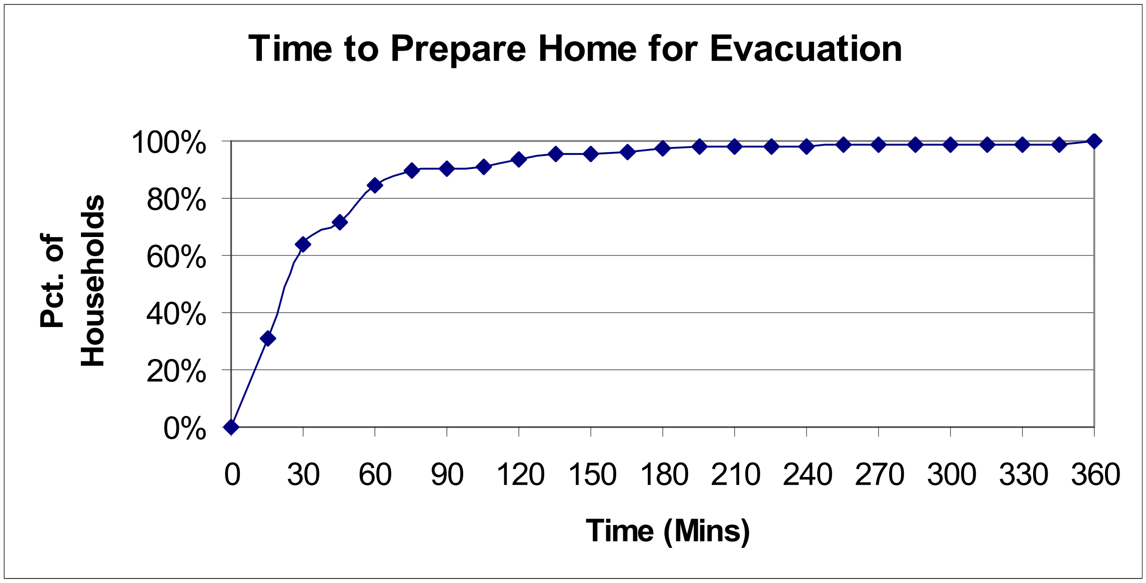


Figure F-11. Time to Prepare Home for Evacuation

4. CONCLUSIONS

The telephone survey provides valuable, relevant data that are used to quantify "mobilization time" which can influence evacuation time estimates.

ATTACHMENT A

Telephone Survey Instrument

Survey Instrument

Preamble # 1 – Used for Mississippi Zip Code (39150) Calls

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 information obtained will be used in a traffic engineering study and in connection with an update of the county's emergency response plans. Your participation in this survey will greatly enhance the county's emergency preparedness program.

Preamble # 2 – Used for Louisiana Zip Code (71357) Calls

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 information obtained will be used in a traffic engineering study and in connection with an update of your parish's emergency response plans. Your participation in this survey will greatly enhance the parish's emergency preparedness program.

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

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	**COL.42**
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.43	**COL.44**
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.45	**COL.46**
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.47	**COL.48**
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

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. If time permits, 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. If time permits, 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

Thank you very much. ______________________________________
(TELEPHONE NUMBER CALLED)

Closing # 1 – Used for Mississippi Zip Code (39150) Calls

For additional information, contact your County Civil Defense Office

Closing # 2 - Used for Louisiana Zip Code (71357) Calls

For additional information, contact your Parish Office of Homeland Security and Emergency Preparedness

APPENDIX G

Traffic Control

APPENDIX G: TRAFFIC CONTROL

This appendix presents the traffic control tactics implemented in developing evacuation time estimates for the Grand Gulf Nuclear Station.

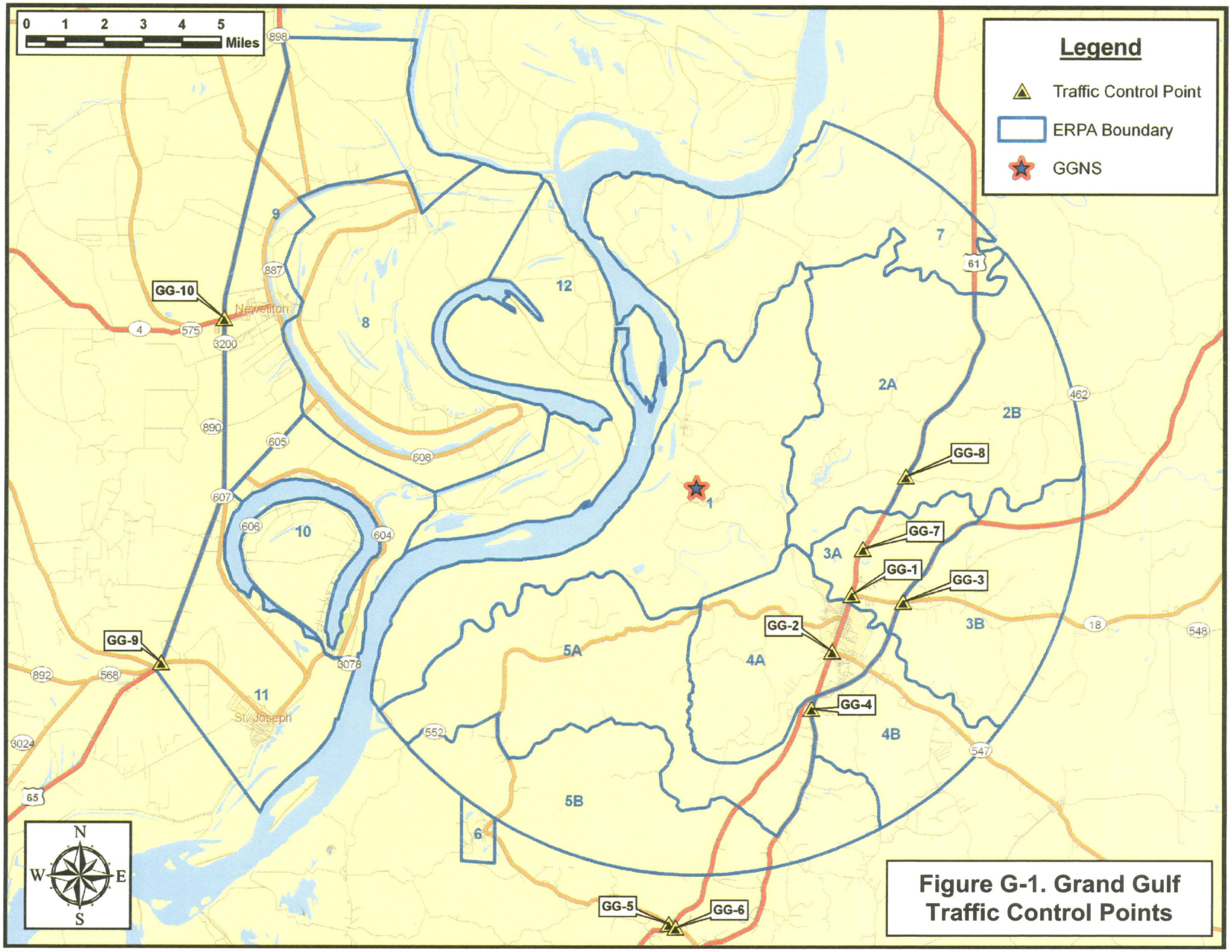


Figure G-1. Grand Gulf Traffic Control Points

Table G-1. GGNS Traffic Control Point Summary						
Claiborne County Traffic Control Points						
TCP ID	**Location**	**Town**	**Priority**	**No. of Guides**	**No. of Cones**	**No. of Barricades**
GG-1	US Hwy 61 & State Hwy 18	Port Gibson	2	1	9	0
GG-2	US Hwy 61 & State Hwy 547	Port Gibson	2	1	6	0
GG-3	State Hwy 18 & Natchez-Trace Pkwy	Port Gibson	3	1	3	0
GG-4	US Hwy 61 & Natchez-Trace Pkwy	Port Gibson	2	2	6	0
GG-5	State Hwy 552 & Natchez-Trace Pkwy Southbound	Clifton	1	1	6	0
GG-6	State Hwy 552 & Natchez-Trace Pkwy Northbound	Clifton	2	1	12	0
GG-7	US Hwy 61 northbound widening to 2 lanes	Port Gibson	1	1	0	20
GG-8	US Hwy 61 & State Hwy 462	Port Gibson	1	3	3	20
Claiborne Total Manpower/Equipment Needed:				11	45	40
Tensas Parish Traffic Control Points						
GG-9	US Hwy 65 & State Hwy 128	Saint Joseph	3	1	6	0
GG-10	US Hwy 65 & State Hwy 4	Newellton	2	1	3	0
Tensas Total Manpower/Equipment Needed:				2	9	0
EPZ Total Manpower/Equipment Needed:				13	54	40

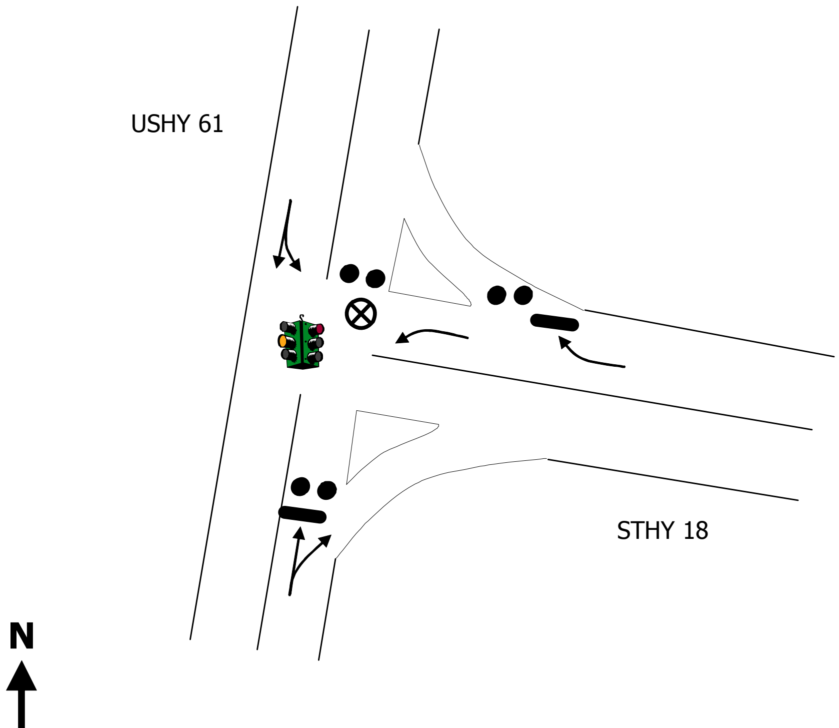
TCP

TOWN: PORT GIBSON

LOCATION: U.S. Highway 61 & State Highway 18

TCP ID: GG – 1

ERPA: 3A



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

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 USHY 61.
2. Facilitate southbound movement on USHY 61.
3. Facilitate eastbound movement on STHY 18.

MANPOWER/EQUIPMENT

1 Traffic Guide
9 Traffic Cones

LOCATION PRIORITY

2

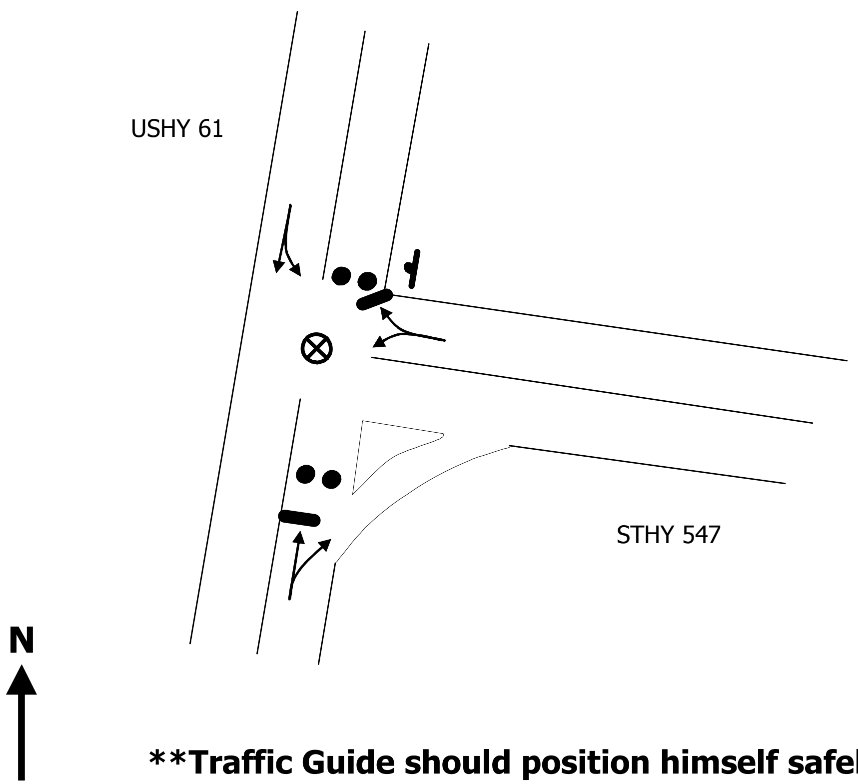
TCP

TOWN: PORT GIBSON

LOCATION: U.S. Highway 61 & State Highway 547

TCP ID: GG – 2

ERPA: 4A



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

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 USHY 61.
2. Facilitate southbound movement on USHY 61.
3. Facilitate eastbound movement on STHY 547

MANPOWER/EQUIPMENT

1 Traffic Guide
6 Traffic Cones

LOCATION PRIORITY

2

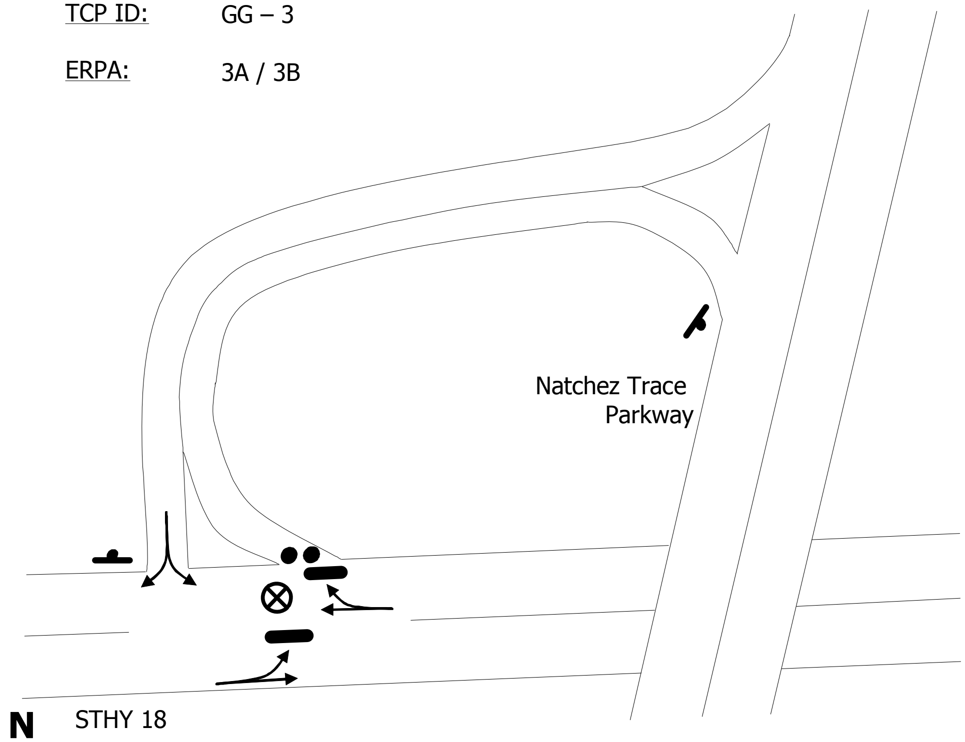
TCP

TOWN: PORT GIBSON

LOCATION: State Highway 18 & Natchez Trace Parkway

TCP ID: GG – 3

ERPA: 3A / 3B



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

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 entrance onto Natchez Trace Parkway. **Parkway is reserved for emergency vehicles.**
2. Facilitate eastbound movement on STHY 18

MANPOWER/EQUIPMENT

1	Traffic Guide
3	Traffic Cones

LOCATION PRIORITY

3

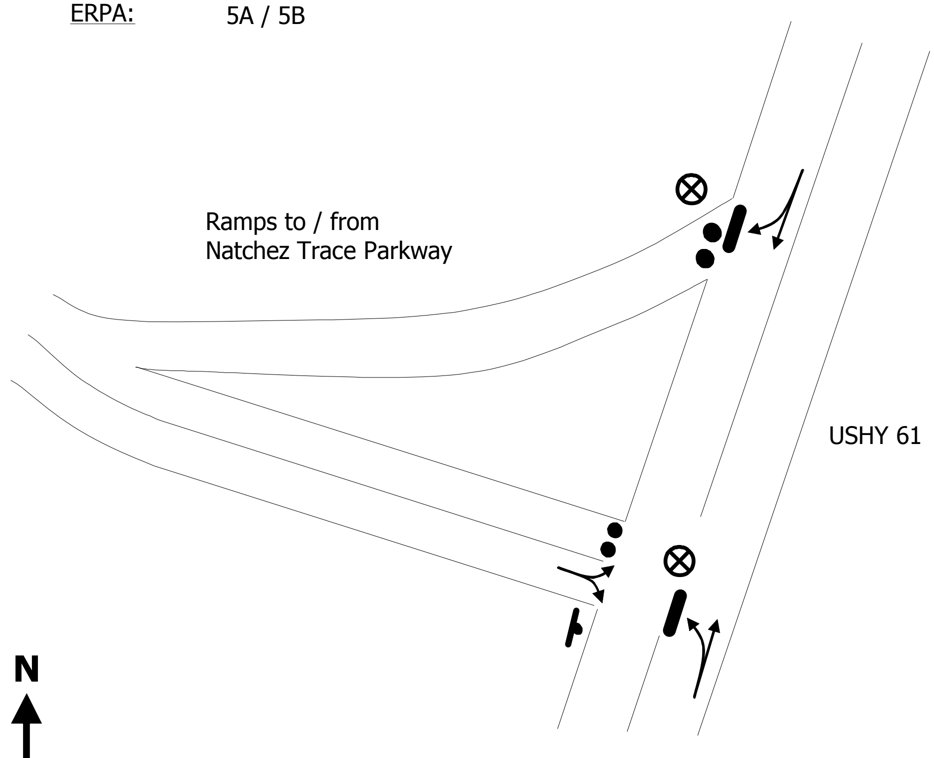
TCP

TOWN: PORT GIBSON

LOCATION: U.S. Highway 61 & Natchez Trace Parkway

TCP ID: GG – 4

ERPA: 5A / 5B



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

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 entrance onto Natchez Trace Parkway. **Parkway is reserved for emergency vehicles.**
2. Facilitate southbound movement on USHY 61

MANPOWER/EQUIPMENT

2 Traffic Guides
6 Traffic Cones

LOCATION PRIORITY

2

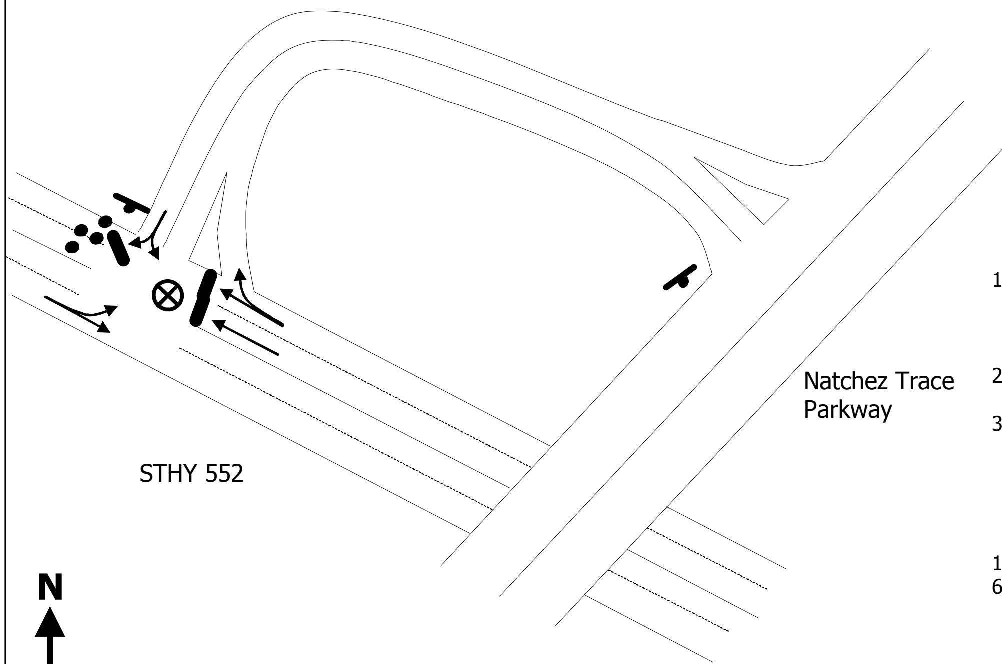
TCP

TOWN: CLIFTON

LOCATION: State Highway 552 & Natchez Trace Parkway

TCP ID: GG – 5

ERPA: SHADOW



N

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

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. Facilitate access to Natchez Trace Parkway southbound to facilitate evacuation of Alcorn State University.
2. Facilitate eastbound movement on STHY 552.
3. Discourage westbound movement on STHY 552

MANPOWER/EQUIPMENT

1 Traffic Guide
6 Traffic Cones

LOCATION PRIORITY

1

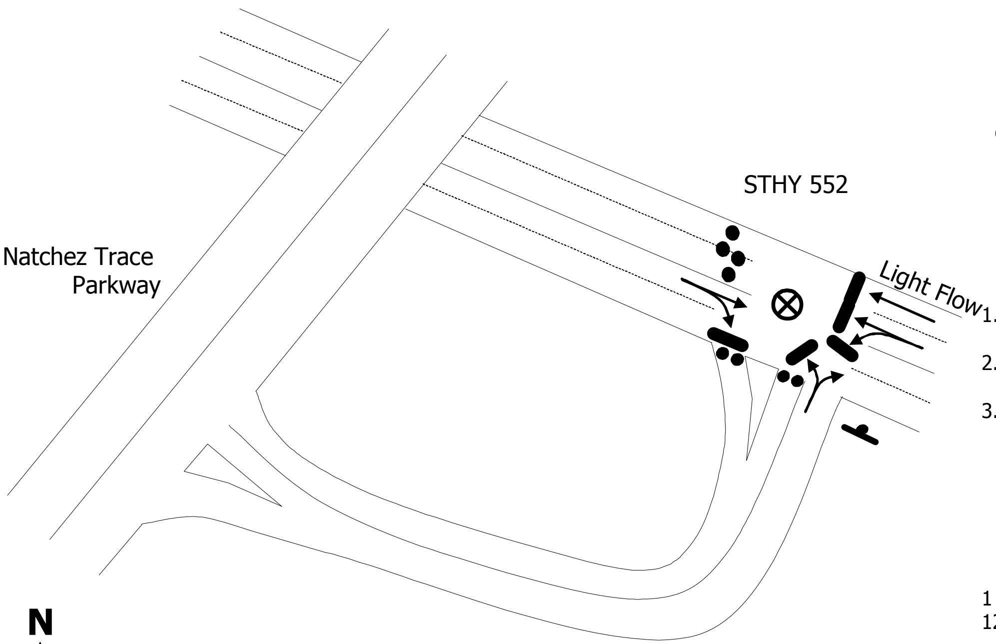
TCP

TOWN: CLIFTON

LOCATION: State Highway 552 & Natchez Trace Parkway

TCP ID: GG – 6

ERPA: SHADOW



N

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

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 access to Natchez Trace Parkway northbound.
2. Facilitate eastbound movement on STHY 552
3. Discourage westbound movement on STHY 552

MANPOWER/EQUIPMENT

1 Traffic Guide
12 Traffic Cones

LOCATION PRIORITY

2

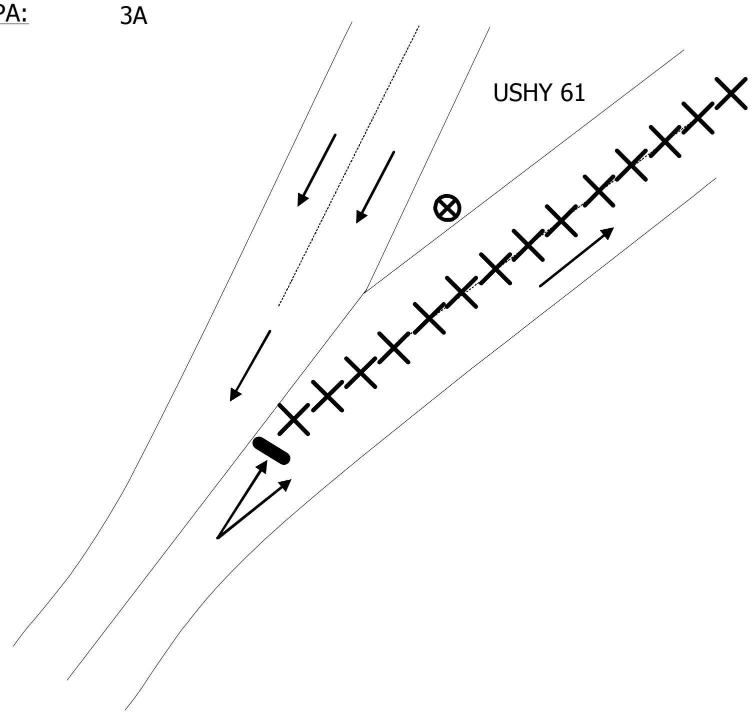
TCP

TOWN: PORT GIBSON

LOCATION: U.S. Highway 61 (1.3 miles N of STHY 18)

TCP ID: GG – 7

ERPA: 3A



N

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

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. Barricade left lane of USHY 61 northbound. Lane is reserved for GGNS evacuees farther north (See TCP GG-8).
2. Facilitate southbound movement on USHY 61.

MANPOWER/EQUIPMENT

1	Traffic Guide
20	Traffic Barricades

LOCATION PRIORITY

1

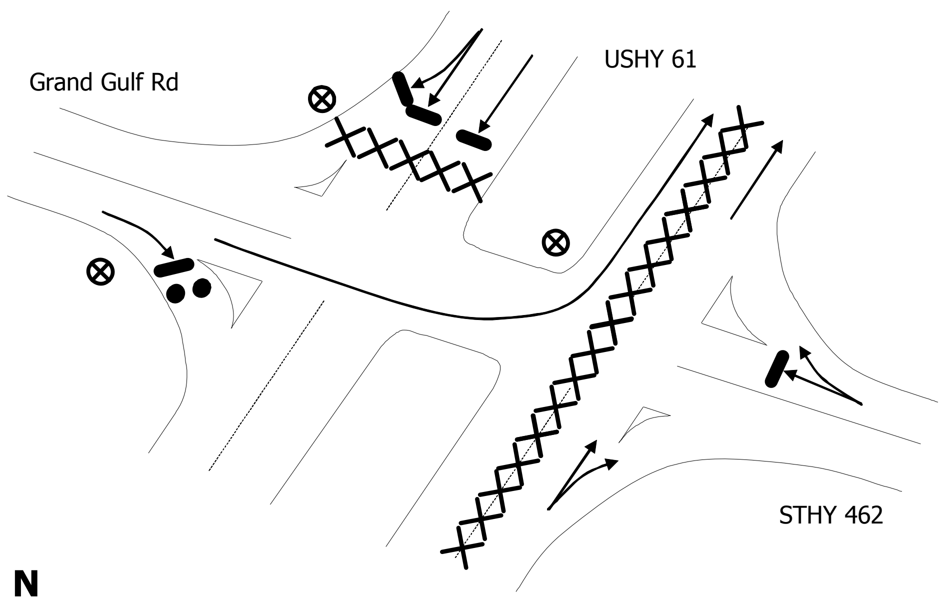
TCP

TOWN: PORT GIBSON

LOCATION: U.S. Highway 61 & State Highway 462

TCP ID: GG – 8

ERPA: 2A / 2B



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

Key

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

ACTIONS TO BE TAKEN

1. Discourage southbound movement on USHY 61.
2. Discourage westbound movement on Grand Gulf Rd.
3. Facilitate northbound movement on STHY 462, reserve left lane for evacuees from GGNS.

MANPOWER/EQUIPMENT

3	Traffic Guides
3	Traffic Cones
20	Traffic Barricades

LOCATION PRIORITY

1

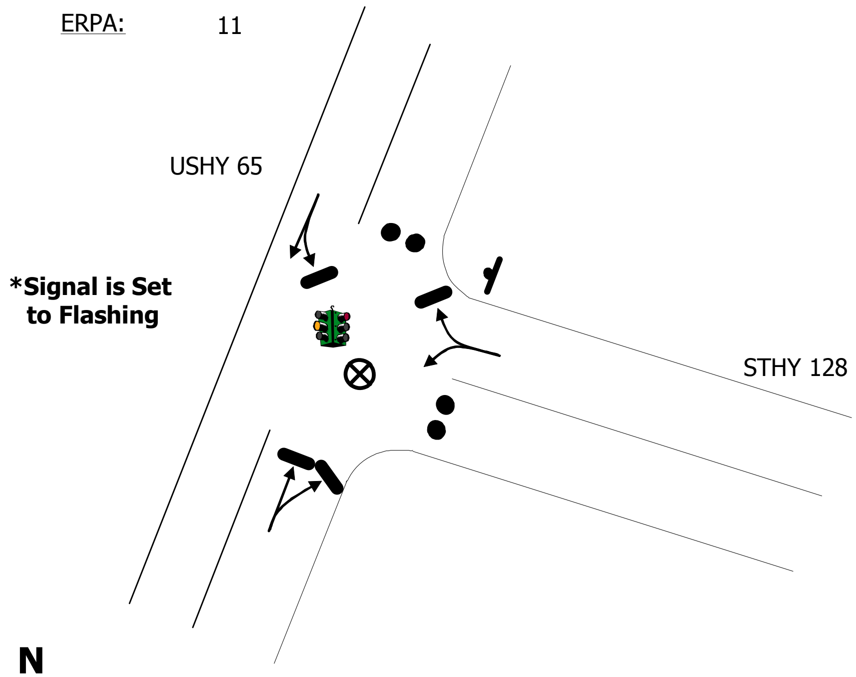
TCP

TOWN: SAINT JOSEPH

LOCATION: U.S. Highway 65 & State Highway 128

TCP ID: GG – 9

ERPA: 11



N

Traffic Guide should position himself safely

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 USHY 65.
2. Discourage eastbound movement on STHY 128.
3. Facilitate southbound movement on USHY 65.

MANPOWER/EQUIPMENT

1 Traffic Guide
6 Traffic Cones

LOCATION PRIORITY

3

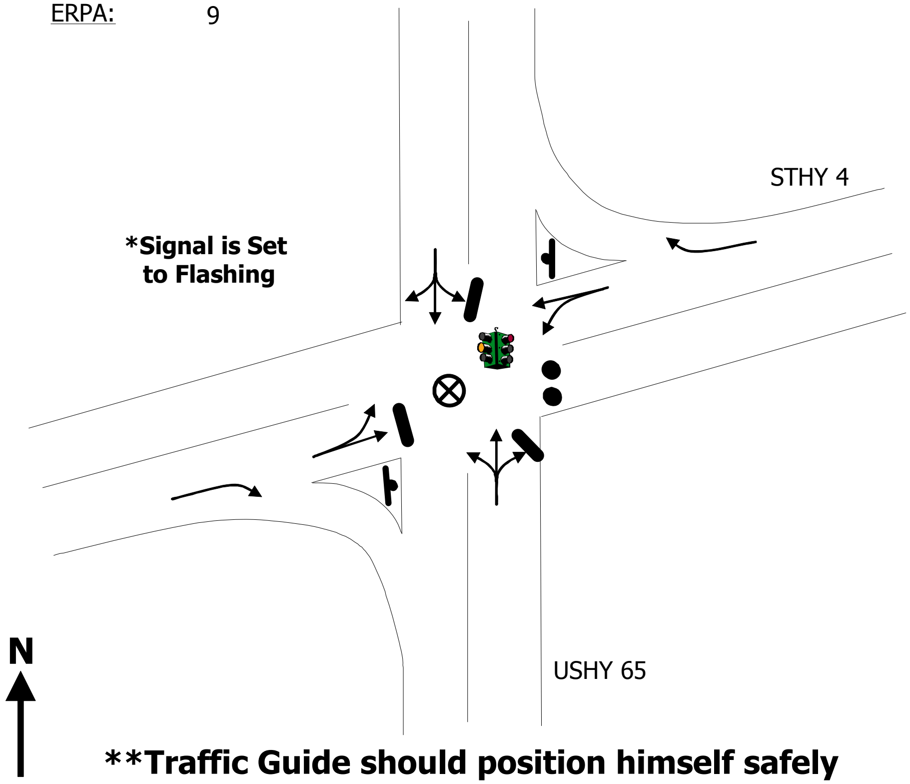
TCP

TOWN: NEWELLTON

LOCATION: U.S. Highway 65 & State Highway 4

TCP ID: GG – 10

ERPA: 9



**Traffic Guide should position himself safely

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 Eastbound movement on State Highway 4.
2. Facilitate westbound movement on State Highway 4
3. Facilitate north/south bound movement on U.S. Highway 65.

MANPOWER/EQUIPMENT

1	Traffic Guide
3	Traffic Cones

LOCATION PRIORITY

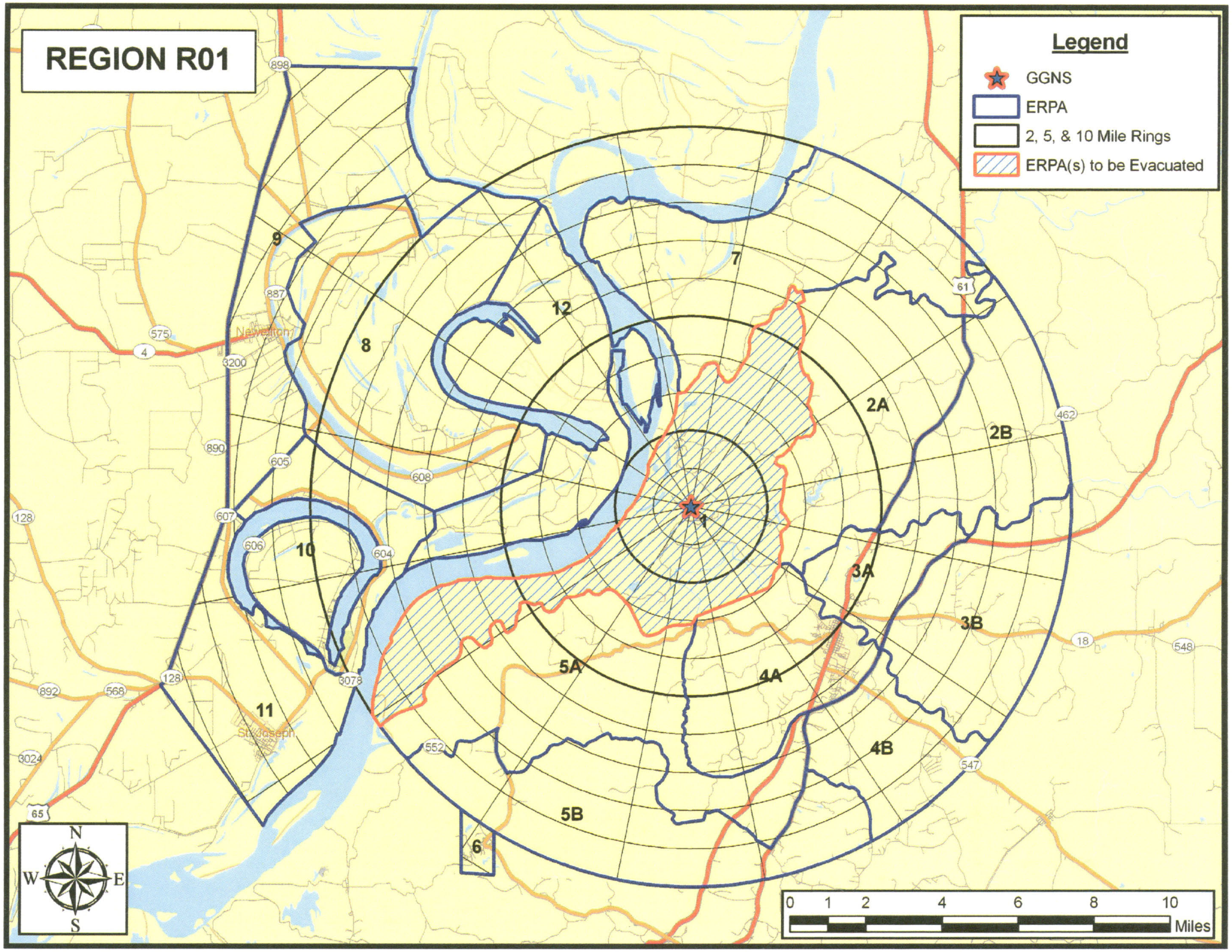
2

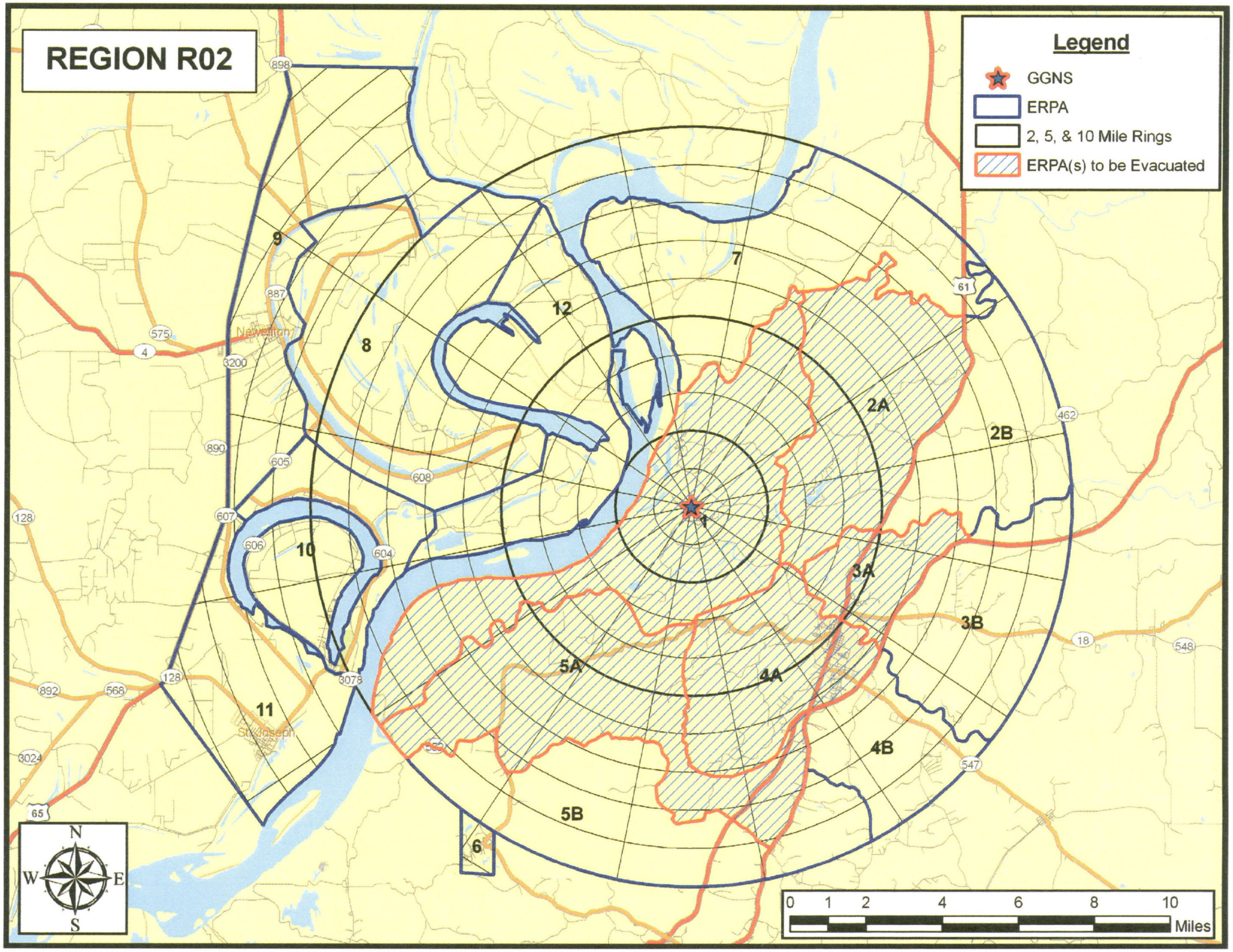
APPENDIX H

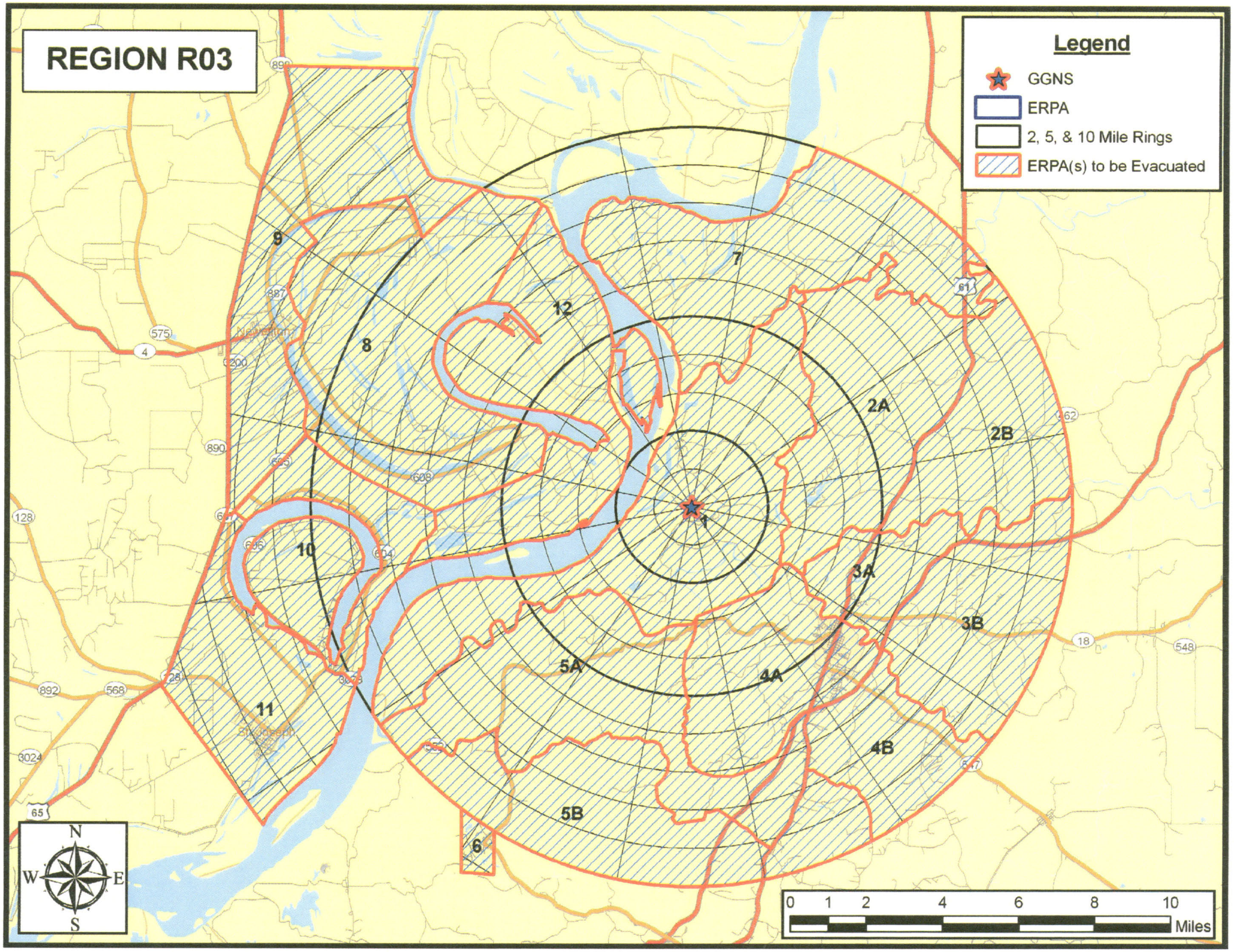
Evacuation Region Maps

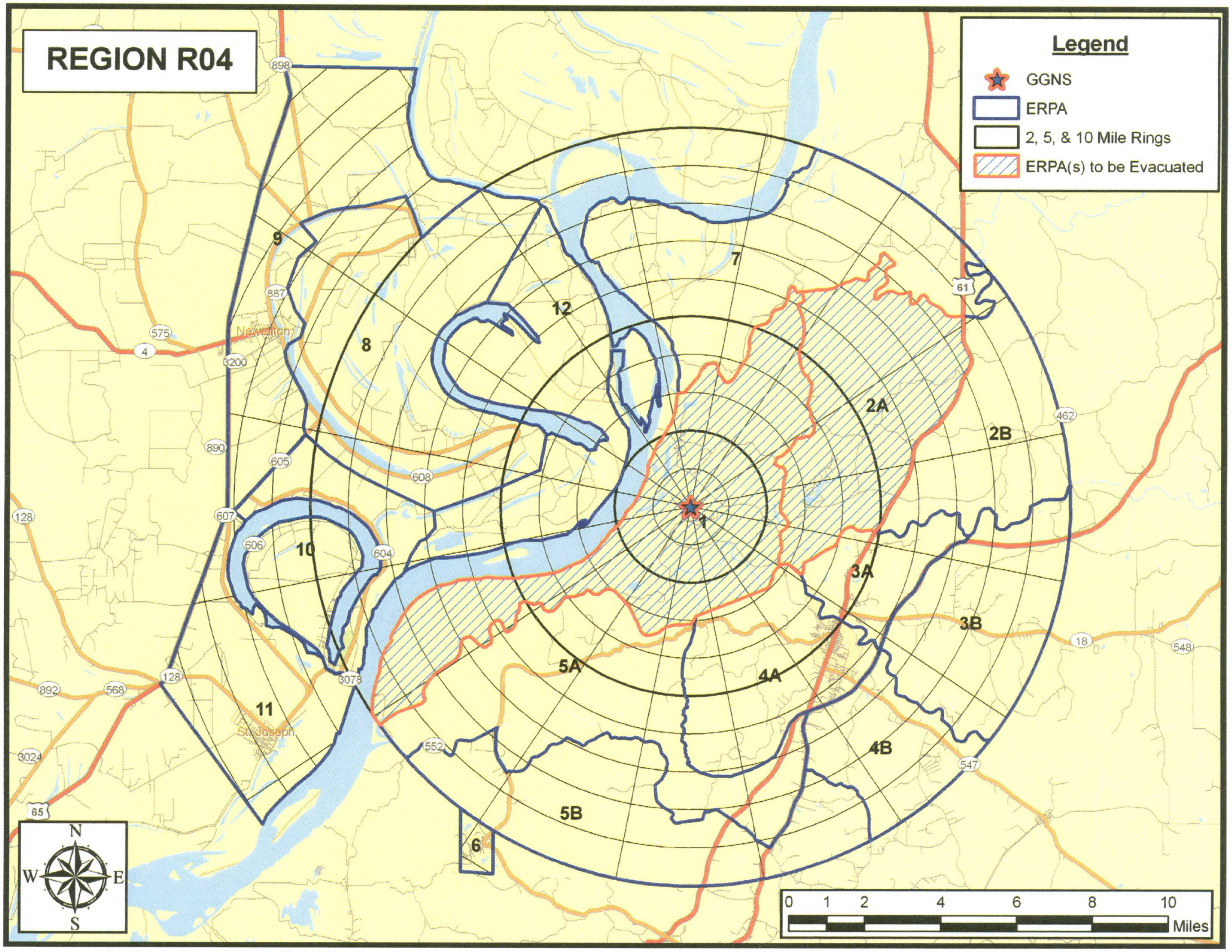
APPENDIX H: EVACUATION REGION MAPS

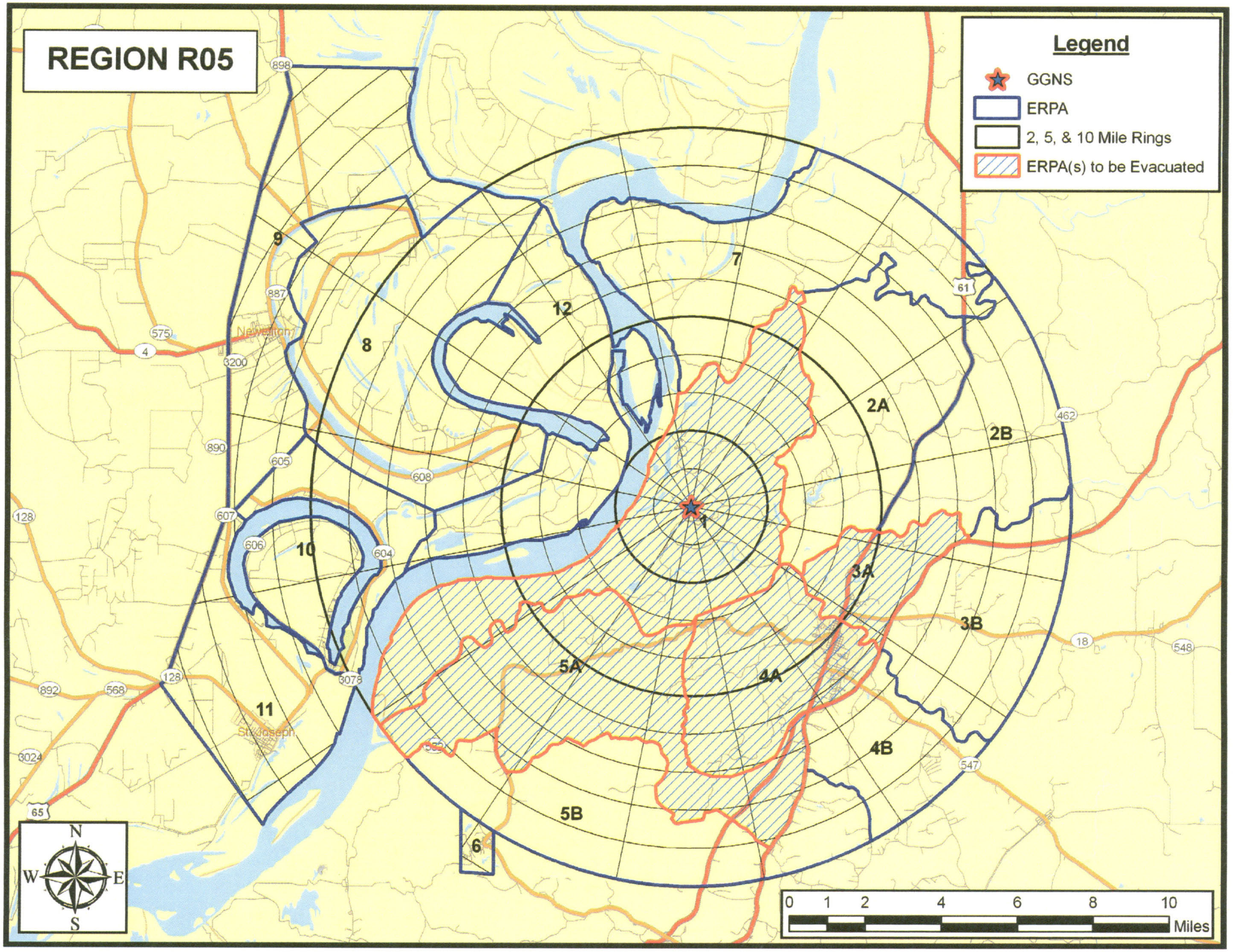
This appendix presents maps of all Evacuation Regions.


REGION R01
Legend
GGNS
ERPA
2, 5, & 10 Mile Rings
ERPA(s) to be Evacuated
1
2A
2B
3A
3B
4A
4B
5A
5B
6
7
8
9
10
11
12
Newellton
St. Joseph
0 1 2 4 6 8 10
Miles
N
S
E
W

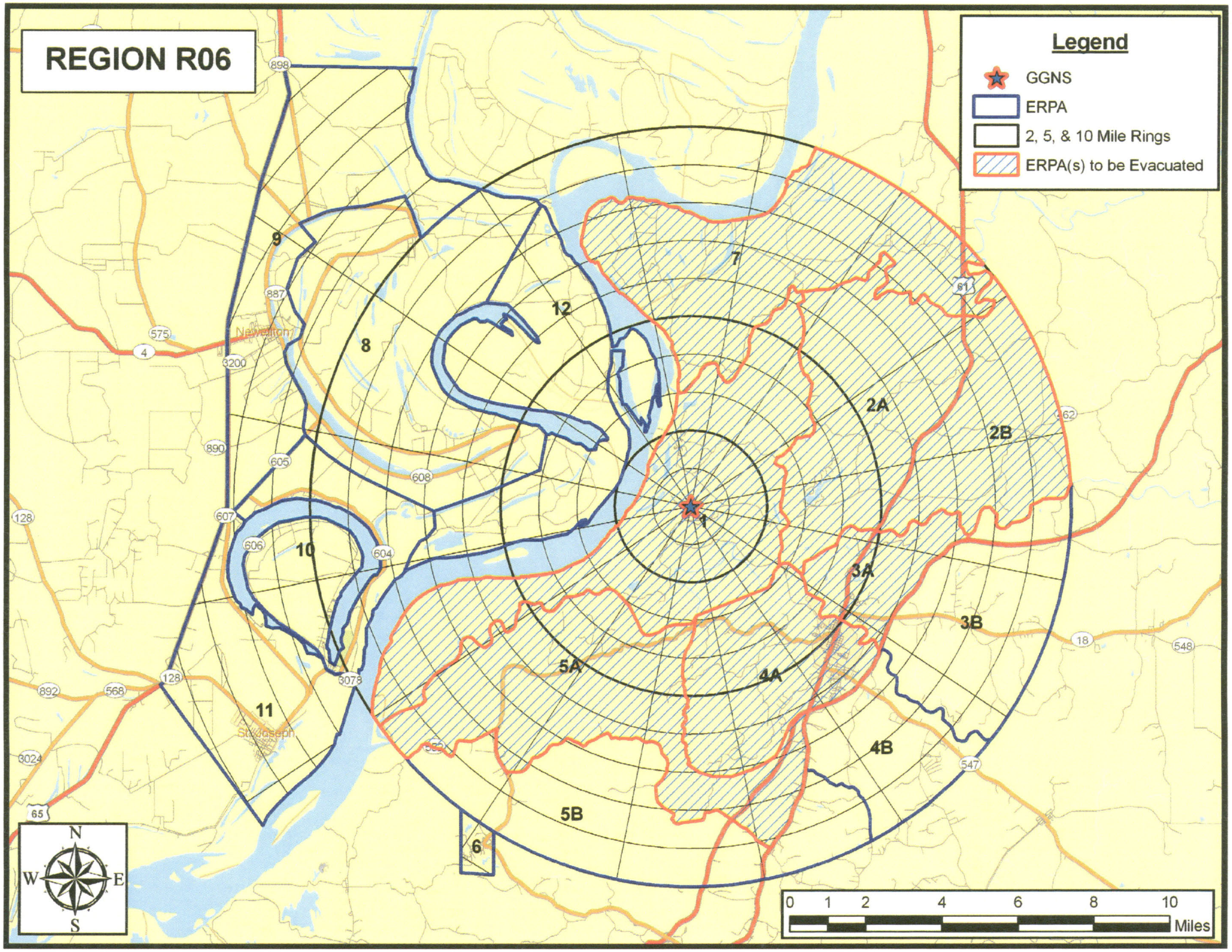

REGION R02
Legend
GGNS
ERPA
2, 5, & 10 Mile Rings
ERPA(s) to be Evacuated
1
2A
2B
3A
3B
4A
4B
5A
5B
6
7
8
9
10
11
12
Newellton
St. Joseph
0 1 2 4 6 8 10
Miles
N
S
E
W

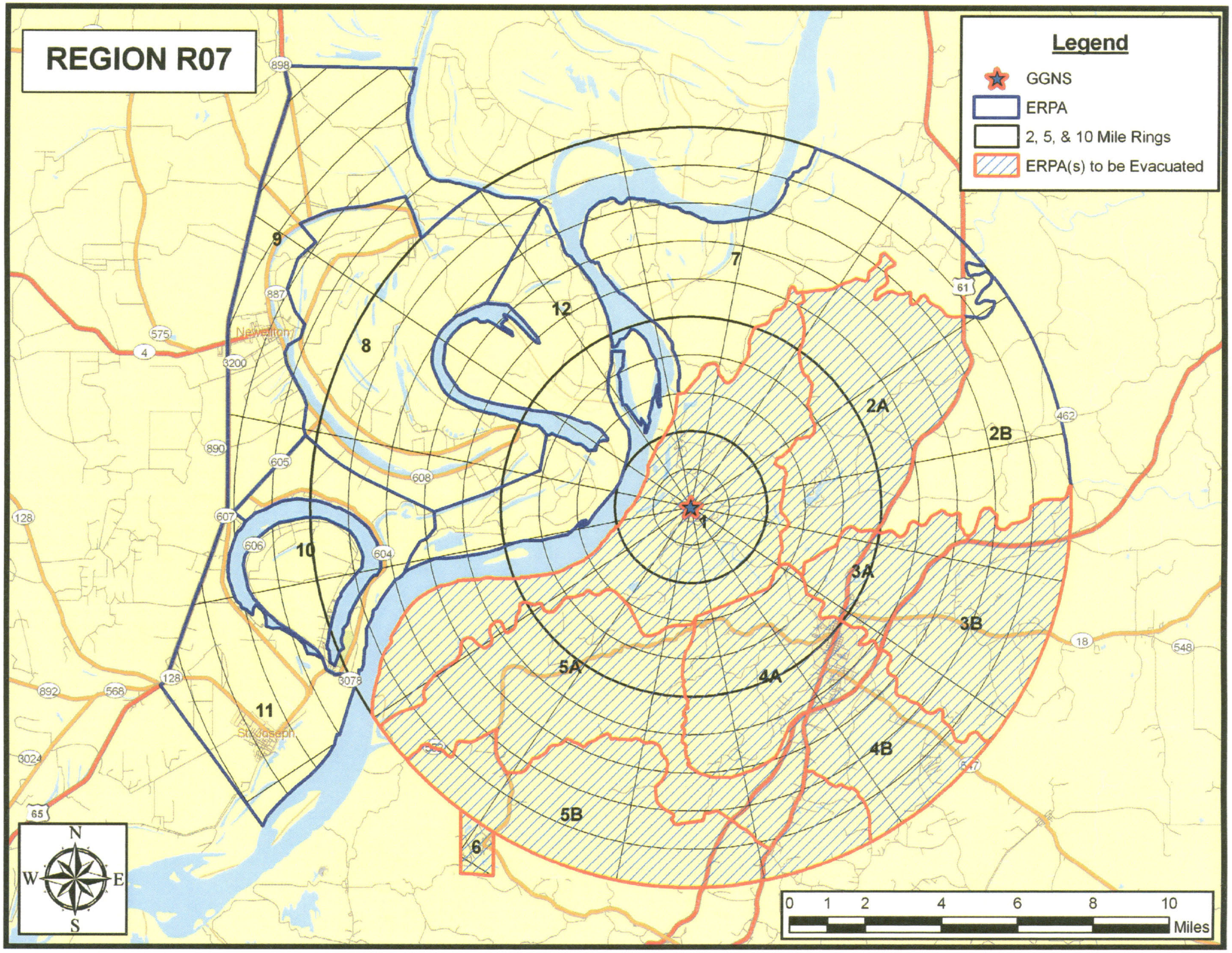

REGION R03
Legend
GGNS
ERPA
2, 5, & 10 Mile Rings
ERPA(s) to be Evacuated
1
2A
2B
3A
3B
4A
4B
5A
5B
6
7
8
9
10
11
12
N
S
E
W
0 1 2 4 6 8 10
Miles

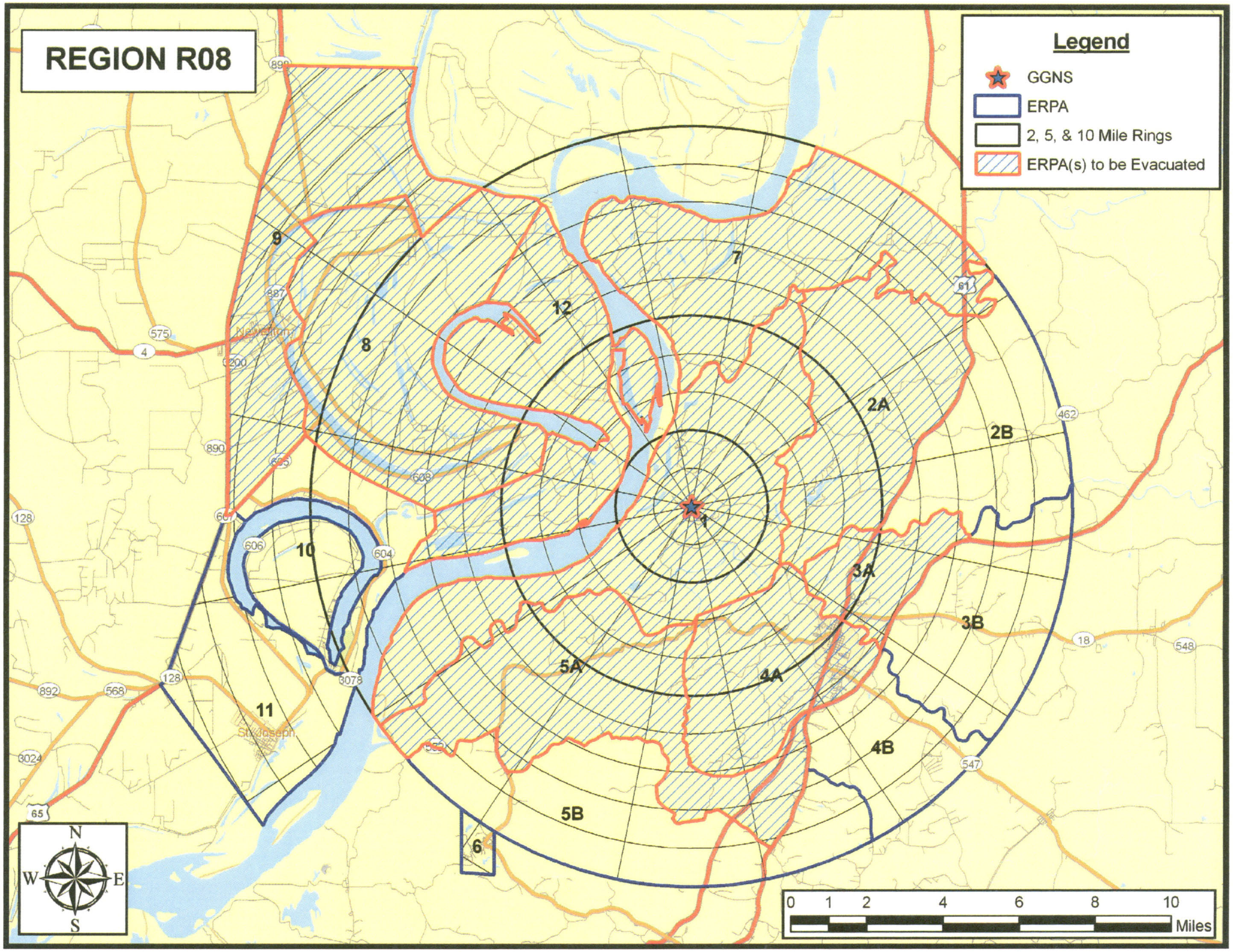

REGION R04
Legend
GGNS
ERPA
2, 5, & 10 Mile Rings
ERPA(s) to be Evacuated
1
2A
2B
3A
3B
4A
4B
5A
5B
6
7
8
9
10
11
12
Newellton
St. Joseph
0 1 2 4 6 8 10
Miles
N
S
E
W

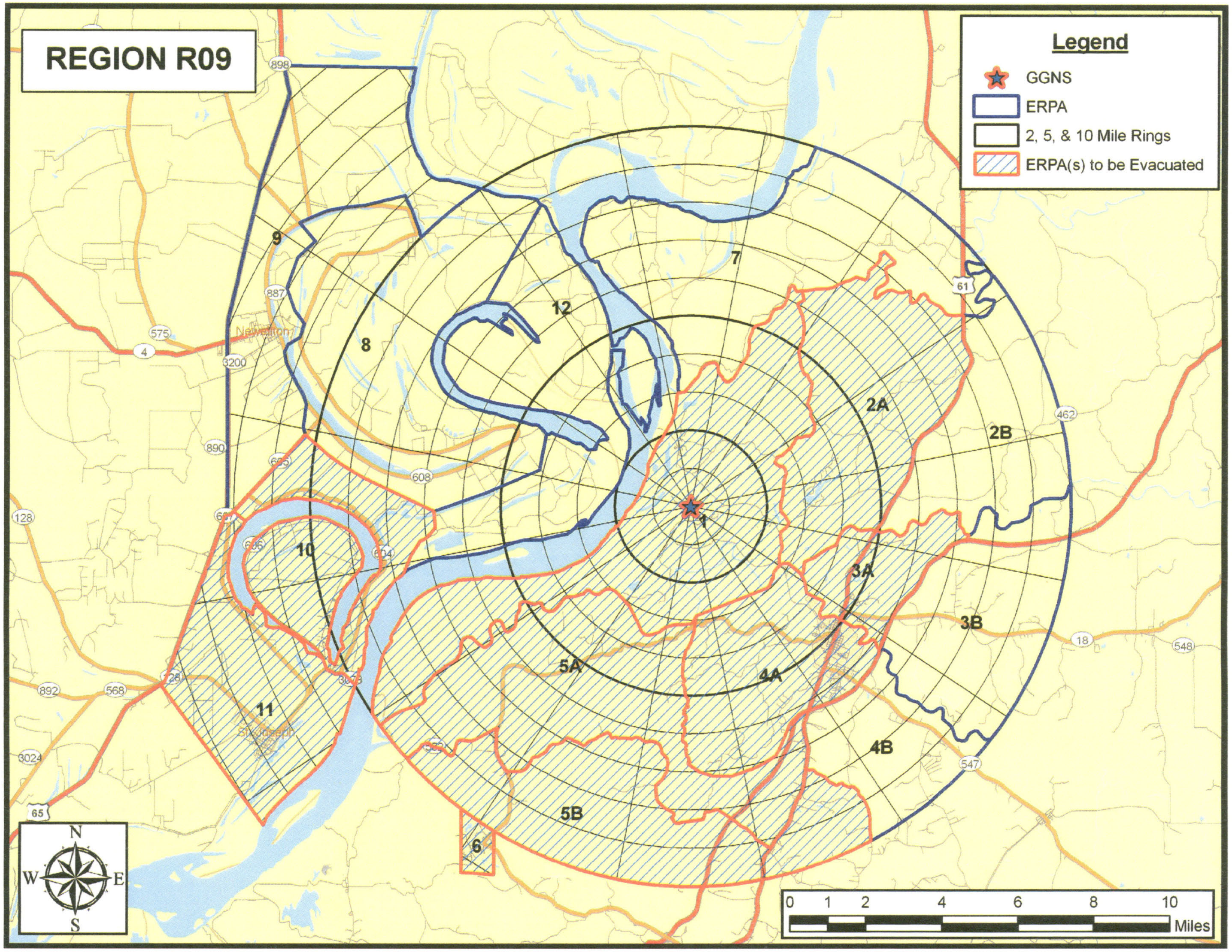


REGION R05
Legend
GGNS
ERPA
2, 5, & 10 Mile Rings
ERPA(s) to be Evacuated
1
2A
2B
3A
3B
4A
4B
5A
5B
6
7
8
9
10
11
12
N
S
E
W
0 1 2 4 6 8 10
Miles


REGION R06
Legend
GGNS
ERPA
2, 5, & 10 Mile Rings
ERPA(s) to be Evacuated
1
2A
2B
3A
3B
4A
4B
5A
5B
6
7
8
9
10
11
12
N
S
E
W
0 1 2 4 6 8 10
Miles


REGION R07
Legend
GGNS
ERPA
2, 5, & 10 Mile Rings
ERPA(s) to be Evacuated
Newellton
St. Joseph
1
2A
2B
3A
3B
4A
4B
5A
5B
6
7
8
9
10
11
12
0 1 2 4 6 8 10
Miles
N
S
E
W


REGION R08
Legend
GGNS
ERPA
2, 5, & 10 Mile Rings
ERPA(s) to be Evacuated
1
2A
2B
3A
3B
4A
4B
5A
5B
6
7
8
9
10
11
12
0 1 2 4 6 8 10
Miles
N
S
E
W


REGION R09
Legend
GGNS
ERPA
2, 5, & 10 Mile Rings
ERPA(s) to be Evacuated
1
2A
2B
3A
3B
4A
4B
5A
5B
6
7
8
9
10
11
12
Newellton
0 1 2 4 6 8 10
Miles
N
S
E
W

APPENDIX I

Evacuation Sensitivity Studies

APPENDIX I: EVACUATION SENSITIVITY STUDIES

A sensitivity study was performed to determine whether changes in the estimated trip generation time has an effect upon the evacuation time estimate for the entire EPZ. The case considered was Scenario 1, Region 3; a summer, midweek, midday, good weather evacuation for the entire EPZ. Table I-1 presents the results of this study.

Table I-1. Evacuation Time Estimates for Trip Generation Sensitivity Study

	Evacuation Time Estimate		
Trip Generation Period	**2-Mile Region**	**5-Mile Region**	**Entire EPZ**
2 Hours	2:00	2:10	2:30
4 Hours	2:50	4:00	4:10

The results confirm the importance of accurately estimating the trip generation times. The evacuation time estimates closely mirror the values for the time the last evacuation trip is generated. The reason for this is the lack of significant traffic congestion during an evacuation. The results indicate that programs to educate the public and encourage them toward faster responses for a radiological emergency can considerably enhance the county and parish emergency planning programs.

A sensitivity study was conducted to determine the effects on Evacuation Time Estimates (ETE) of changes in the percentage of people who decide to relocate from the Shadow Region. The movement of people in the shadow region has a potential to impede vehicles evacuating from an Evacuation Region within the EPZ.

Table I-2 presents the evacuation time estimates for each of these cases. The ETE for the 2 mile, 5 mile and the entire EPZ remain unchanged as the percentage of people who decide to relocate from areas within the shadow region increase from 15% to 60%. The population density in the shadow region is such that the movement of people in this area has no effect on ETE.

Table I-2. Evacuation Time Estimates for Shadow Sensitivity Study

	Evacuation Time Estimate		
Percent Shadow Evacuation	**2-Mile Region**	**5-Mile Region**	**Entire EPZ**
15	3:00	4:00	4:10
30	2:50	4:00	4:10
60	3:00	4:00	4:10

APPENDIX J

Evacuation Time Estimates for All Evacuation Regions and Scenarios

And

Evacuation Time Graphs for Region R3, for all Scenarios

APPENDIX J: EVACUATION TIME ESTIMATES FOR ALL EVACUATION REGIONS AND SCENARIOS

AND

EVACUATION TIME GRAPHS FOR REGION R3, FOR ALL SCENARIOS

This appendix presents the ETE Results for all 9 Regions and all 12 Scenarios (Tables J-1A through J-1D).

Plots of Evacuating Vehicles vs. Elapsed Time leaving the 2-mile and 5-mile circular areas around GGNS and the entire EPZ for Region R3, for all 14 scenarios. Each plot has points indicating the evacuation times corresponding to the 50th, 90th, and 95th percentiles of evacuated population.

J.1 Guidance on Using ETE Tables

Tables J-1A through J-1D present the ETE values for all 9 Evacuation Regions and all 12 Evacuation Scenarios. They are organized as follows:

Table	Contents
J-1A	ETE represents the elapsed time required for 50 percent of the population within a Region, to evacuate from that Region.
J-1B	ETE represents the elapsed time required for 90 percent of the population within a Region, to evacuate from that Region.
J-1C	ETE represents the elapsed time required for 95 percent of the population within a Region, to evacuate from that Region.
J-1D	ETE represents the elapsed time required for 100 percent of the population within a Region, to evacuate from that Region.

The user first determines the percentile of population for which the ETE is sought. The applicable value of ETE within the chosen Table may then be identified using the following procedure:

1. Identify the applicable **Scenario**:
   - The Season
     1. Summer
     2. Winter (also Autumn and Spring)
   - The Day of Week
     3. Midweek
     4. Weekend
   - The Time of Day
     5. Midday
     6. Evening
   - Weather Condition
     7. Good Weather
     8. Rain
   - Special Event (if any)
     9. Alcorn State Football + New Plant Construction
     10. New Plant Construction (Alone)

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 Tables J-1A through J-1D. For these conditions, Scenario (4) applies.
- The conditions of a winter evening (either midweek or weekend) and rain are not explicitly identified in Tables J-1A through J-1D. For these conditions, Scenarios (9) for rain apply.
- The seasons are defined as follows:

    - Summer implies that public schools are *not* in session.
    - Winter, Spring and Autumn imply that public schools *are* in session.
- Time of Day: Midday implies the time over which most commuters are at work.

2. With the Scenario identified, now identify the **Evacuation Region**:
    - Determine the projected azimuth direction of the plume (coincident with the wind direction). Determine which quadrant this plume direction lies in – NE, SE, NW, or SW.
    - Determine the distance that the Evacuation Region will extend from GGNS. The applicable distances and their associated candidate Regions are given below:
        - 2 Miles (Region R1)
        - 5 Miles (Regions R2, R4, and R5)
        - to EPZ Boundary (Regions R3 and R6-R9)
    - Enter Table 7-2 and identify the applicable group of candidate Regions based on the distance that the selected Region extends from GGNS. Select the Evacuation Region identifier in that row from the first column of the Table.

3. Determine the **ETE for the Scenario** identified in Step 1 and the Region identified in Step 2, 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 determined 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 *to* the northeast (NE).
- Wind speed is such that the distance to be evacuated is judged to be 10 miles (to EPZ boundary).
- The desired ETE is that value needed to evacuate 95 percent of the population from within the impacted Region.

Table 7-1C is applicable because the 95-percentile population is desired. Proceed as follows:

1. Identify the Scenario as summer, weekend, evening and raining. Entering Table 7-1C, 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. Since the wind direction is to the northeast (NE) and the evacuation distance extends to 10-miles (or EPZ boundary), enter Table 7-2 and locate the group entitled “5 Mile Ring and Sector to 10-miles (to EPZ Boundary)”. Under “DESCRIPTION”, identify the NE (northeast) azimuth (wind direction) and read REGION R6 in the first column of that row.

3. Enter Table 7-1C to locate the data cell containing the value of ETE for Scenario 4 and Region 6. This data cell is in column (4) and in the row for Region R6; it contains the ETE value of **2:00**.

Table J-1A. Time To Clear The Indicated Area of 50 Percent of the Affected Population

	Summer		Summer		Summer		Winter		Winter		Winter		Winter	Winter
	Midweek		Weekend		Midweek Weekend		Midweek		Weekend		Midweek Weekend		Weekend	Midweek
Scenario	(1)	(2)	(3)	(4)	(5)	Scenario	(6)	(7)	(8)	(9)	(10)	Scenario	(11)	(12)
	Midday		Midday		Evening		Midday		Midday		Evening		Midday	Midday
Region (ERPA)	Good Weather	Rain	Good Weather	Rain	Good Weather	Region (ERPA)	Good Weather	Rain	Good Weather	Rain	Good Weather	Region (ERPA)	Alcorn Football + New Plant Constuction	New Plant Constuction
Entire 2-Mile Region, 5-Mile Region, and EPZ														
R01 (1)	0 50	0 50	0 50	0 50	0 50	R01 (1)	0 50	0 50	0 50	0 50	0 50	R01 (1)	1 20	1 20
R02 (1,2A,3A,4A,5A)	1 05	1 05	0 55	0 55	0 55	R02 (1,2A,3A,4A,5A)	1 10	1 10	0 55	0 55	0 55	R02 (1,2A,3A,4A,5A)	1 20	1 20
R03 (All)	1 10	1 10	0 60	0 60	0 55	R03 (All)	1 10	1 10	0 60	0 60	0 60	R03 (All)	1 25	1 25
2 Mile Ring + Wind to 5 Miles														
R04 - Wind to NE (1, 2A)	0 60	1 00	0 55	0 55	0 55	R04 - Wind to NE (1, 2A)	1 00	1 00	0 55	0 55	0 55	R04 - Wind to NE (1, 2A)	1 20	1 25
R05 - Wind to SE (1,3A,4A,5A)	1 05	1 05	0 55	0 55	0 55	R05 - Wind to SE (1,3A,4A,5A)	1 05	1 05	0 55	0 55	0 55	R05 - Wind to SE (1,3A,4A,5A)	1 20	1 20
Wind to NW - Same as R1 (1)	0 50	0 50	0 50	0 50	0 50	Wind to NW - Same as R1 (1)	0 50	0 50	0 50	0 50	0 50	Wind to NW - Same as R1 (1)	1 20	1 20
Wind to SW - Same as R1 (1)	0 50	0 50	0 50	0 50	0 50	Wind to SW - Same as R1 (1)	0 50	0 50	0 50	0 50	0 50	Wind to SW - Same as R1 (1)	1 20	1 20
5 Mile Ring + Wind to EPZ Boundary														
R06 - Wind to NE (1,2A,2B,3A,4A,5A,7)	1 05	1 05	0 55	0 55	0 55	R06 - Wind to NE (1,2A,2B,3A,4A,5A,7)	1 10	1 10	0 55	0 55	0 55	R06 - Wind to NE (1,2A,2B,3A,4A,5A,7)	1 20	1 20
R07 - Wind to SE (1,2A,3A,3B,4A,4B,5A,5B,6)	1 05	1 10	0 55	0 55	0 55	R07 - Wind to SE (1,2A,3A,3B,4A,4B,5A,5B,6)	1 10	1 10	0 55	0 55	0 55	R07 - Wind to SE (1,2A,3A,3B,4A,4B,5A,5B,6)	1 25	1 20
R08 - Wind to NW (1,2A,3A,4A,5A,7,8,9,12)	1 05	1 05	0 55	0 55	0 55	R08 - Wind to NW (1,2A,3A,4A,5A,7,8,9,12)	1 10	1 10	0 55	0 55	0 55	R08 - Wind to NW (1,2A,3A,4A,5A,7,8,9,12)	1 20	1 20
R09 - Wind to SW (1,2A,3A,4A,5A,5B,6,10,11)	1 05	1 05	0 55	0 55	0 55	R09 - Wind to SW (1,2A,3A,4A,5A,5B,6,10,11)	1 10	1 10	0 55	0 55	0 55	R09 - Wind to SW (1,2A,3A,4A,5A,5B,6,10,11)	1 20	1 20

Table J-1B. Time To Clear The Indicated Area of 90 Percent of the Affected Population

	Summer		Summer		Summer		Winter		Winter		Winter		Winter	Winter
	Midweek		Weekend		Midweek Weekend		Midweek		Weekend		Midweek Weekend		Weekend	Midweek
Scenario	(1)	(2)	(3)	(4)	(5)	Scenario	(6)	(7)	(8)	(9)	(10)	Scenario	(11)	(12)
	Midday		Midday		Evening		Midday		Midday		Evening		Midday	Midday
Region (ERPA)	Good Weather	Rain	Good Weather	Rain	Good Weather	Region (ERPA)	Good Weather	Rain	Good Weather	Rain	Good Weather	Region (ERPA)	Alcorn Football + New Plant Constuction	New Plant Constuction
Entire 2-Mile Region, 5-Mile Region, and EPZ														
R01 (1)	1 35	1 35	1 30	1 30	1 30	R01 (1)	1 40	1 40	1 30	1 30	1 30	R01 (1)	2 25	2 25
R02 (1,2A,3A,4A,5A)	2 10	2 10	1 40	1 40	1 40	R02 (1,2A,3A,4A,5A)	2 10	2 10	1 40	1 40	1 40	R02 (1,2A,3A,4A,5A)	2 40	2 40
R03 (All)	2 20	2 20	1 50	1 50	1 50	R03 (All)	2 20	2 20	1 50	1 50	1 50	R03 (All)	3 20	2 40
2 Mile Ring + Wind to 5 Miles														
R04 - Wind to NE (1, 2A)	1 45	1 45	1 35	1 40	1 40	R04 - Wind to NE (1, 2A)	1 45	1 45	1 35	1 40	1 40	R04 - Wind to NE (1, 2A)	2 40	2 40
R05 - Wind to SE (1,3A,4A,5A)	2 00	2 00	1 40	1 40	1 40	R05 - Wind to SE (1,3A,4A,5A)	2 10	2 10	1 40	1 40	1 40	R05 - Wind to SE (1,3A,4A,5A)	2 25	2 25
Wind to NW - Same as R1 (1)	1 35	1 35	1 30	1 30	1 30	Wind to NW - Same as R1 (1)	1 40	1 40	1 30	1 30	1 30	Wind to NW - Same as R1 (1)	2 25	2 25
Wind to SW - Same as R1 (1)	1 35	1 35	1 30	1 30	1 30	Wind to SW - Same as R1 (1)	1 40	1 40	1 30	1 30	1 30	Wind to SW - Same as R1 (1)	2 25	2 25
5 Mile Ring + Wind to EPZ Boundary														
R06 - Wind to NE (1,2A,2B,3A,4A,5A,7)	2 10	2 10	1 40	1 40	1 40	R06 - Wind to NE (1,2A,2B,3A,4A,5A,7)	2 10	2 10	1 40	1 40	1 40	R06 - Wind to NE (1,2A,2B,3A,4A,5A,7)	2 40	2 40
R07 - Wind to SE (1,2A,3A,3B,4A,4B,5A,5B,6)	2 20	2 20	1 40	1 40	1 50	R07 - Wind to SE (1,2A,3A,3B,4A,4B,5A,5B,6)	2 20	2 20	1 40	1 45	1 50	R07 - Wind to SE (1,2A,3A,3B,4A,4B,5A,5B,6)	3 20	2 40
R08 - Wind to NW (1,2A,3A,4A,5A,7,8,9,12)	2 10	2 10	1 40	1 45	1 40	R08 - Wind to NW (1,2A,3A,4A,5A,7,8,9,12)	2 10	2 10	1 40	1 45	1 40	R08 - Wind to NW (1,2A,3A,4A,5A,7,8,9,12)	2 40	2 40
R09 - Wind to SW (1,2A,3A,4A,5A,5B,6,10,11)	2 10	2 10	1 50	1 50	1 50	R09 - Wind to SW (1,2A,3A,4A,5A,5B,6,10,11)	2 20	2 20	1 50	1 50	1 50	R09 - Wind to SW (1,2A,3A,4A,5A,5B,6,10,11)	3 20	2 40

Table J-1C. Time To Clear The Indicated Area of 95 Percent of the Affected Population

	Summer		Summer		Summer		Winter		Winter		Winter		Winter	Winter
	Midweek		Weekend		Midweek Weekend		Midweek		Weekend		Midweek Weekend		Weekend	Midweek
Scenario	(1)	(2)	(3)	(4)	(5)	Scenario	(6)	(7)	(8)	(9)	(10)	Scenario	(11)	(12)
	Midday		Midday		Evening		Midday		Midday		Evening		Midday	Midday
Region (ERPA)	Good Weather	Rain	Good Weather	Rain	Good Weather	Region (ERPA)	Good Weather	Rain	Good Weather	Rain	Good Weather	Region (ERPA)	Alcorn Football + New Plant Constuction	New Plant Constuction
Entire 2-Mile Region, 5-Mile Region, and EPZ														
R01 (1)	1 50	1 50	1 40	1 40	1 50	R01 (1)	1 50	1 50	1 40	1 40	1 50	R01 (1)	2 30	2 30
R02 (1,2A,3A,4A,5A)	2 40	2 40	2 00	2 00	2 10	R02 (1,2A,3A,4A,5A)	2 40	2 40	2 00	2 00	2 10	R02 (1,2A,3A,4A,5A)	2 50	2 50
R03 (All)	2 50	2 50	2 10	2 10	2 20	R03 (All)	2 50	2 50	2 10	2 10	2 20	R03 (All)	3 50	2 55
2 Mile Ring + Wind to 5 Miles														
R04 - Wind to NE (1, 2A)	2 00	2 00	1 45	1 45	1 50	R04 - Wind to NE (1, 2A)	2 00	2 00	1 45	1 45	1 50	R04 - Wind to NE (1, 2A)	2 50	2 50
R05 - Wind to SE (1,3A,4A,5A)	2 40	2 40	1 50	1 50	2 00	R05 - Wind to SE (1,3A,4A,5A)	2 40	2 40	1 50	1 50	2 10	R05 - Wind to SE (1,3A,4A,5A)	2 30	2 30
Wind to NW - Same as R1 (1)	1 50	1 50	1 40	1 40	1 50	Wind to NW - Same as R1 (1)	1 50	1 50	1 40	1 40	1 50	Wind to NW - Same as R1 (1)	2 30	2 30
Wind to SW - Same as R1 (1)	1 50	1 50	1 40	1 40	1 50	Wind to SW - Same as R1 (1)	1 50	1 50	1 40	1 40	1 50	Wind to SW - Same as R1 (1)	2 30	2 30
5 Mile Ring + Wind to EPZ Boundary														
R06 - Wind to NE (1,2A,2B,3A,4A,5A,7)	2 40	2 40	2 00	2 00	2 10	R06 - Wind to NE (1,2A,2B,3A,4A,5A,7)	2 50	2 50	2 00	2 00	2 10	R06 - Wind to NE (1,2A,2B,3A,4A,5A,7)	2 55	2 55
R07 - Wind to SE (1,2A,3A,3B,4A,4B,5A,5B,6)	2 50	2 50	2 10	2 10	2 20	R07 - Wind to SE (1,2A,3A,3B,4A,4B,5A,5B,6)	2 50	2 50	2 10	2 10	2 20	R07 - Wind to SE (1,2A,3A,3B,4A,4B,5A,5B,6)	3 50	2 50
R08 - Wind to NW (1,2A,3A,4A,5A,7,8,9,12)	2 40	2 40	2 00	2 00	2 10	R08 - Wind to NW (1,2A,3A,4A,5A,7,8,9,12)	2 40	2 40	2 00	2 00	2 10	R08 - Wind to NW (1,2A,3A,4A,5A,7,8,9,12)	2 50	2 50
R09 - Wind to SW (1,2A,3A,4A,5A,5B,6,10,11)	2 50	2 50	2 10	2 10	2 10	R09 - Wind to SW (1,2A,3A,4A,5A,5B,6,10,11)	2 50	2 50	2 10	2 10	2 10	R09 - Wind to SW (1,2A,3A,4A,5A,5B,6,10,11)	3 50	2 50

Table J-1D. Time To Clear The Indicated Area of 100 Percent of the Affected Population														
	Summer		Summer		Summer		Winter		Winter		Winter		Winter	Winter
	Midweek		Weekend		Midweek Weekend		Midweek		Weekend		Midweek Weekend		Weekend	Midweek
Scenario	(1)	(2)	(3)	(4)	(5)	Scenario	(6)	(7)	(8)	(9)	(10)	Scenario	(11)	(12)
	Midday		Midday		Evening		Midday		Midday		Evening		Midday	Midday
Region (ERPA)	Good Weather	Rain	Good Weather	Rain	Good Weather	Region (ERPA)	Good Weather	Rain	Good Weather	Rain	Good Weather	Region (ERPA)	Alcorn Football + New Plant Constuction	New Plant Constuction
Entire 2-Mile Region, 5-Mile Region, and EPZ														
R01 (1)	2 50	3 00	2 20	2 20	2 20	R01 (1)	2 50	2 50	2 20	2 20	2 20	R01 (1)	2 50	2 50
R02 (1,2A,3A,4A,5A)	4 00	4 00	3 50	3 50	3 50	R02 (1,2A,3A,4A,5A)	4 00	4 00	3 50	3 50	3 50	R02 (1,2A,3A,4A,5A)	4 00	4 00
R03 (All)	4 10	4 10	4 00	4 00	4 00	R03 (All)	4 00	4 10	4 00	4 00	4 00	R03 (All)	4 10	4 00
2 Mile Ring + Wind to 5 Miles														
R04 - Wind to NE (1, 2A)	4 00	4 00	3 50	3 50	3 50	R04 - Wind to NE (1, 2A)	4 00	4 00	3 50	3 50	3 50	R04 - Wind to NE (1, 2A)	4 00	4 00
R05 - Wind to SE (1,3A,4A,5A)	4 00	4 00	3 50	3 50	3 50	R05 - Wind to SE (1,3A,4A,5A)	4 00	4 00	3 50	3 50	3 50	R05 - Wind to SE (1,3A,4A,5A)	4 00	4 00
Wind to NW - Same as R1 (1)	2 50	3 00	2 20	2 20	2 20	Wind to NW - Same as R1 (1)	2 50	2 50	2 20	2 20	2 20	Wind to NW - Same as R1 (1)	2 50	2 50
Wind to SW - Same as R1 (1)	2 50	3 00	2 20	2 20	2 20	Wind to SW - Same as R1 (1)	2 50	2 50	2 20	2 20	2 20	Wind to SW - Same as R1 (1)	2 50	2 50
5 Mile Ring + Wind to EPZ Boundary														
R06 - Wind to NE (1,2A,2B,3A,4A,5A,7)	4 00	4 00	3 50	3 50	3 50	R06 - Wind to NE (1,2A,2B,3A,4A,5A,7)	4 00	4 00	3 50	3 50	3 50	R06 - Wind to NE (1,2A,2B,3A,4A,5A,7)	4 00	4 00
R07 - Wind to SE (1,2A,3A,3B,4A,4B,5A,5B,6)	4 00	4 00	4 00	4 00	3 50	R07 - Wind to SE (1,2A,3A,3B,4A,4B,5A,5B,6)	4 00	4 00	3 50	4 00	3 50	R07 - Wind to SE (1,2A,3A,3B,4A,4B,5A,5B,6)	4 10	4 00
R08 - Wind to NW (1,2A,3A,4A,5A,7,8,9,12)	4 00	4 00	3 50	3 50	3 50	R08 - Wind to NW (1,2A,3A,4A,5A,7,8,9,12)	4 00	4 00	3 50	3 50	3 50	R08 - Wind to NW (1,2A,3A,4A,5A,7,8,9,12)	4 00	4 00
R09 - Wind to SW (1,2A,3A,4A,5A,5B,6,10,11)	4 10	4 10	3 50	3 50	4 00	R09 - Wind to SW (1,2A,3A,4A,5A,5B,6,10,11)	4 00	4 00	3 50	3 50	4 00	R09 - Wind to SW (1,2A,3A,4A,5A,5B,6,10,11)	4 10	4 00

Table J-2. Definition of Evacuation Regions		
Region	**Description**	**ERPA**
R1	2-mile, 360º	1
R2	5-mile, 360º	1,2A,3A,4A,5A
R3	Entire EPZ	All
2-mile Ring and Sector to 5-miles		
R4	2-mile ring + wind to 5-miles, 90º NE	1,2A
R5	2-mile ring + wind to 5-miles, 90º SE	1,3A,4A,5A
Refer to R1	2-mile ring + wind to 5-miles, 90º NW	1
Refer to R1	2-mile ring + wind to 5-miles, 90º SW	1
5-mile Ring and Sector to 10-miles (to EPZ boundary)		
R6	5-mile ring + wind to 10-miles, 90º NE	1,2A,2B,3A,4A,5A,7
R7	5-mile ring + wind to 10-miles, 90º SE	1,2A,3A,3B,4A,4B,5A,5B,6
R8	5-mile ring + wind to 10-miles, 90º NW	1,2A,3A,4A,5A,7,8,9,12
R9	5-mile ring + wind to 10-miles, 90º SW	1,2A,3A,4A,5A,5B,6,10,11

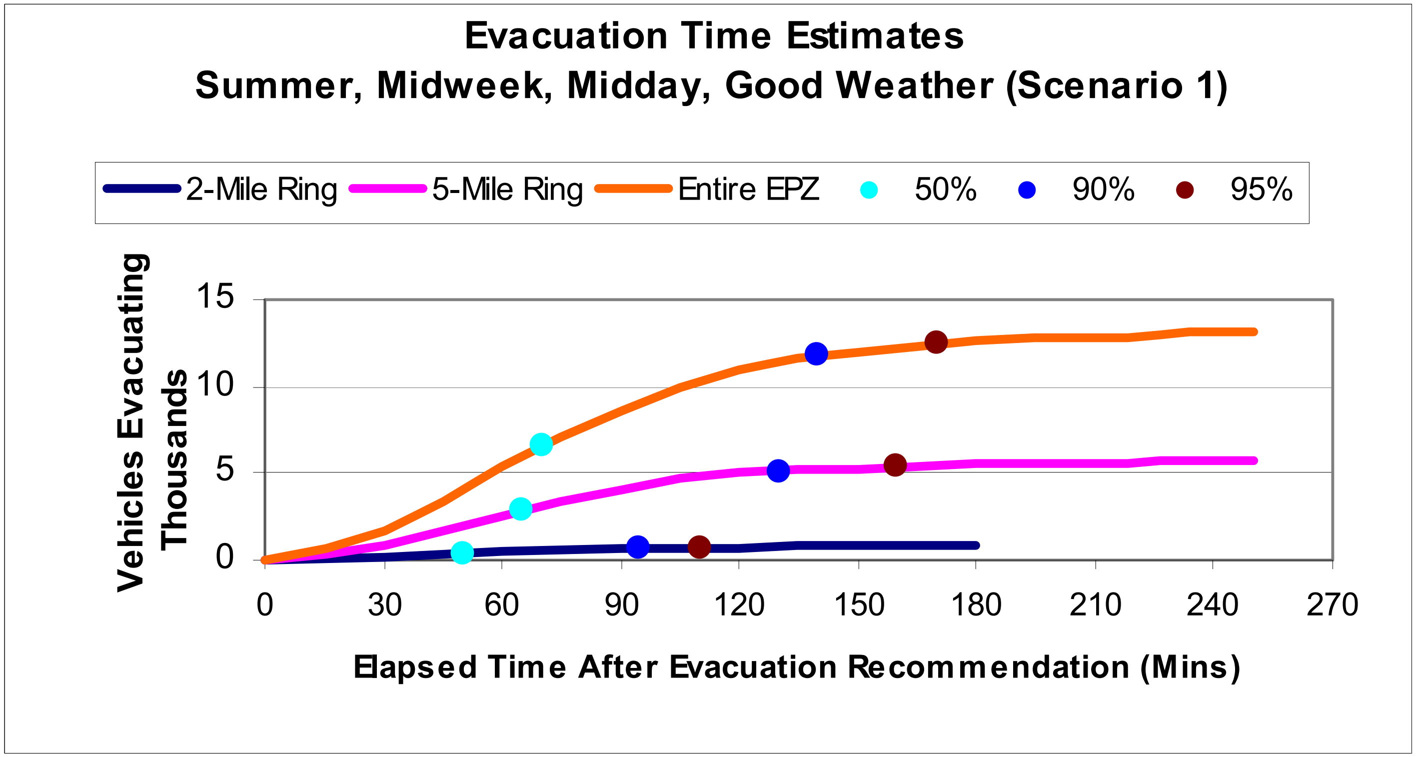


Figure J-1. Evacuation Time Estimates – Scenario 1 for Region R3 (Entire EPZ)

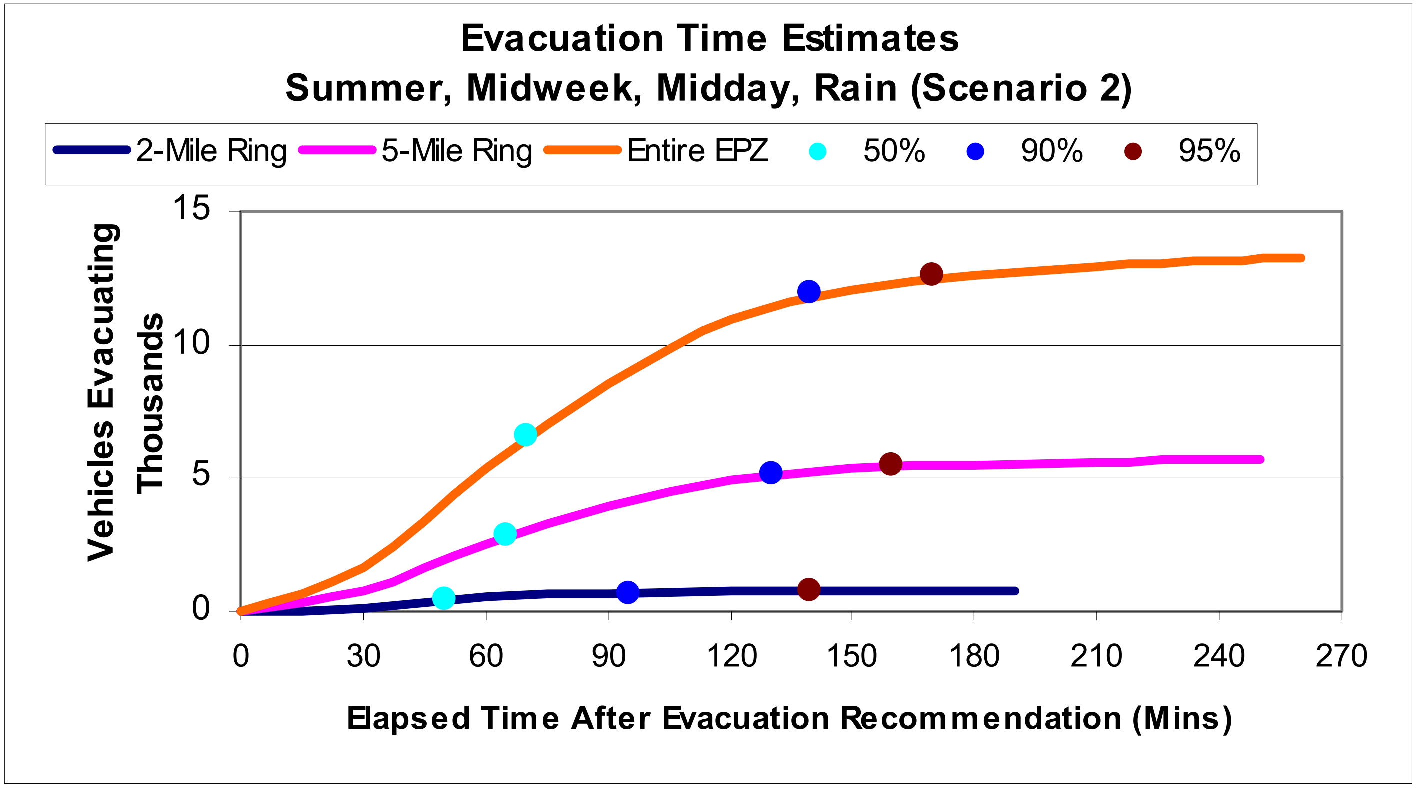


Figure J-2. Evacuation Time Estimates – Scenario 2 for Region R3 (Entire EPZ)

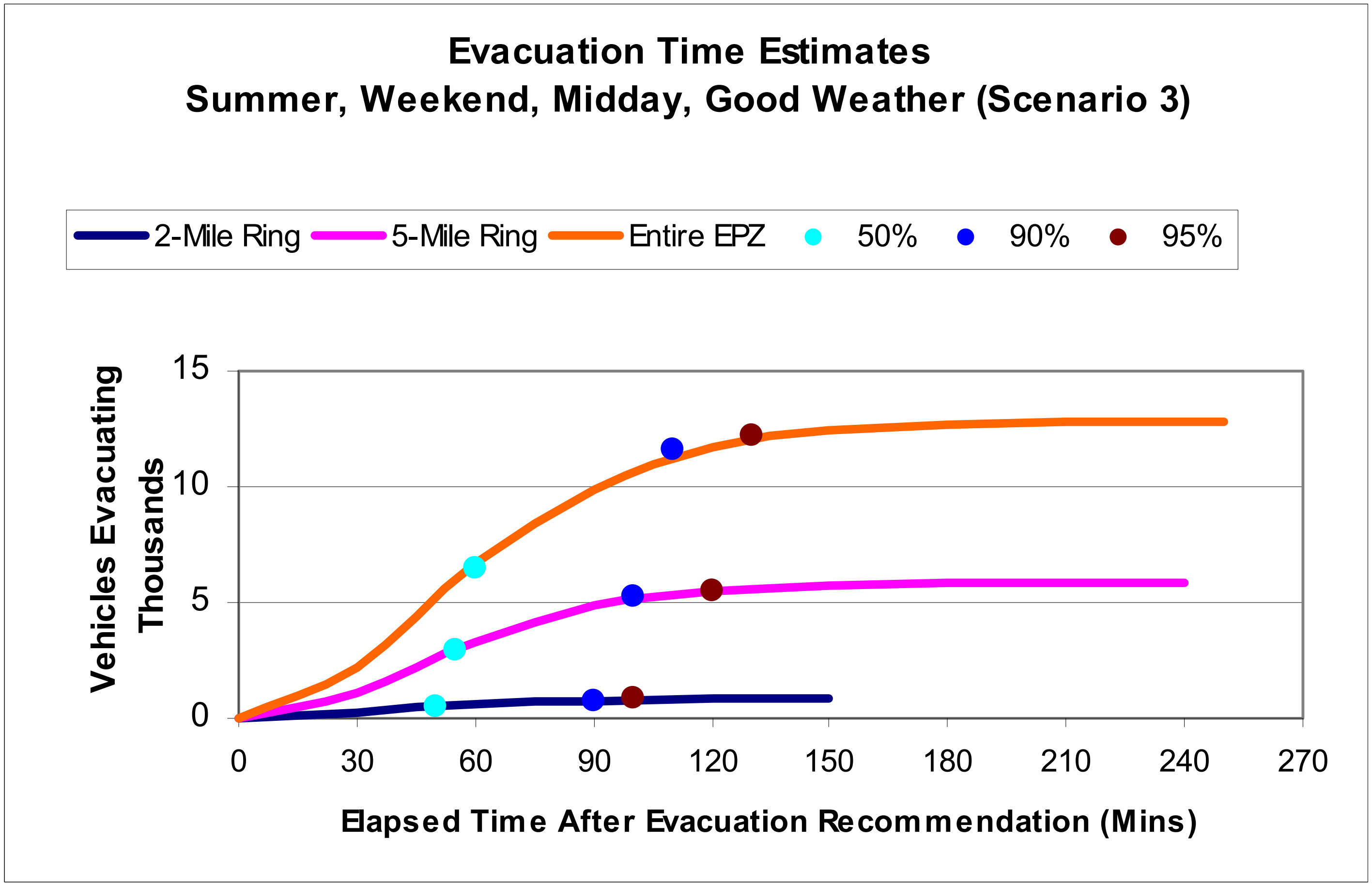


Figure J-3. Evacuation Time Estimates – Scenario 3 for Region R3 (Entire EPZ)

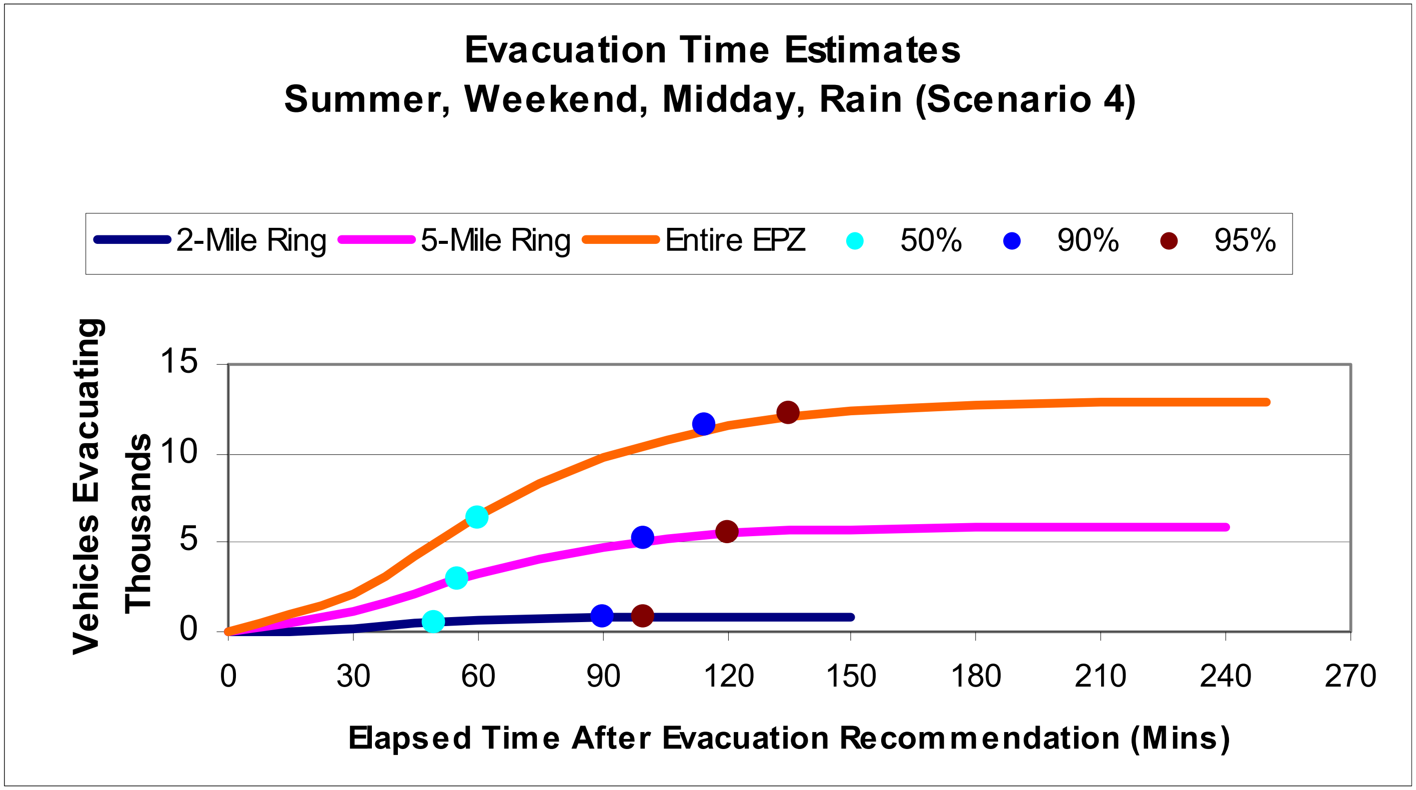


Figure J-4. Evacuation Time Estimates – Scenario 4 for Region R3 (Entire EPZ)

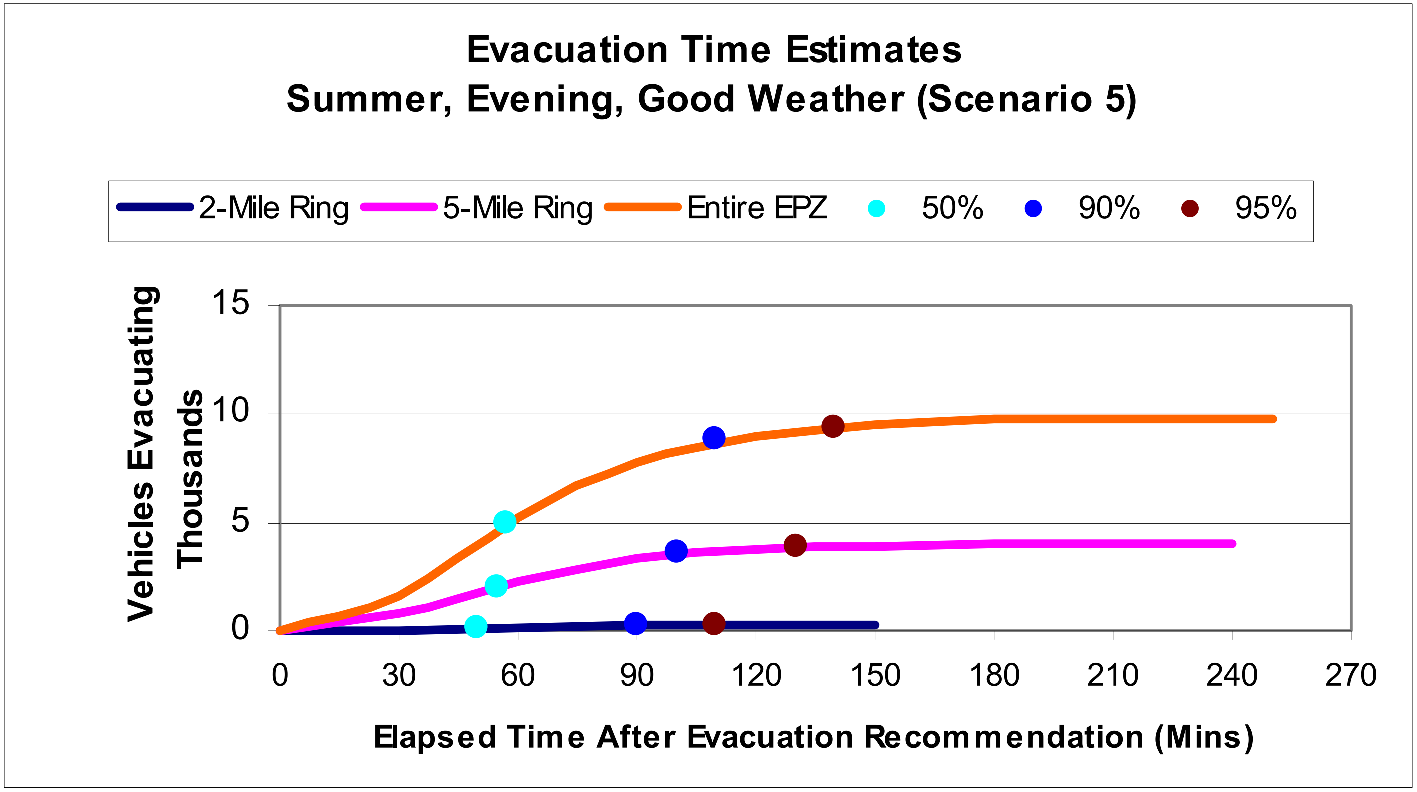


Figure J-5. Evacuation Time Estimates – Scenario 5 for Region R3 (Entire EPZ)

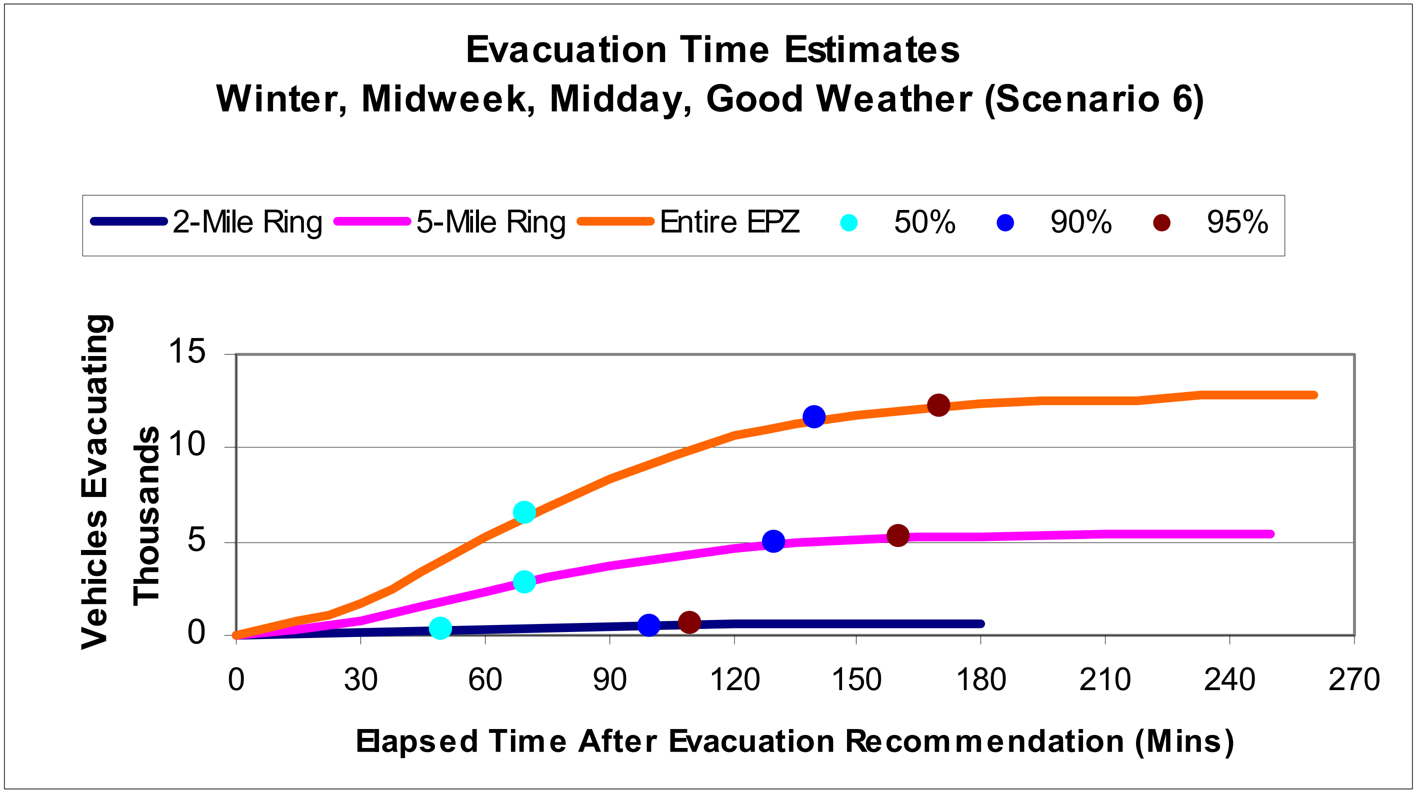


Figure J-6. Evacuation Time Estimates – Scenario 6 for Region R3 (Entire EPZ)

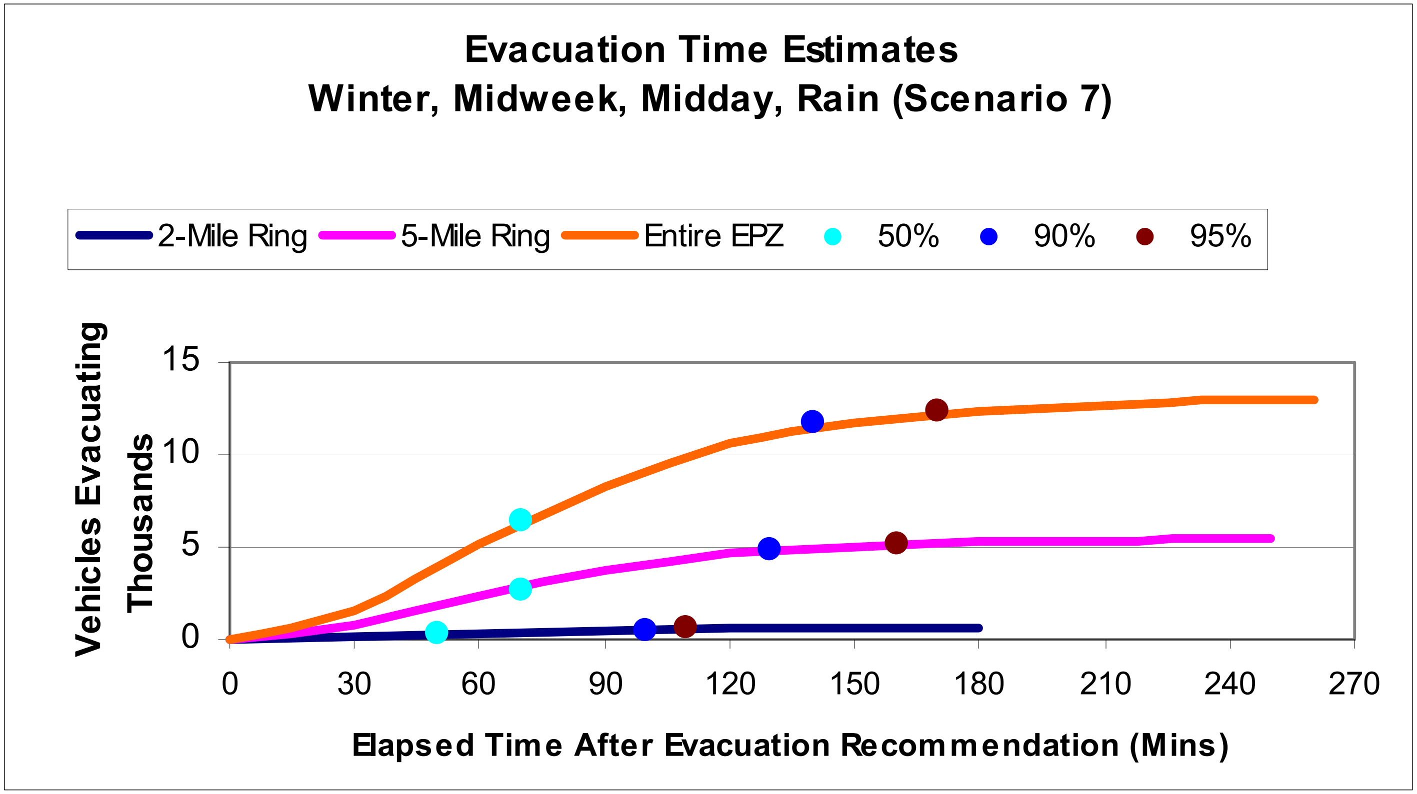


Figure J-7. Evacuation Time Estimates – Scenario 7 for Region R3 (Entire EPZ)

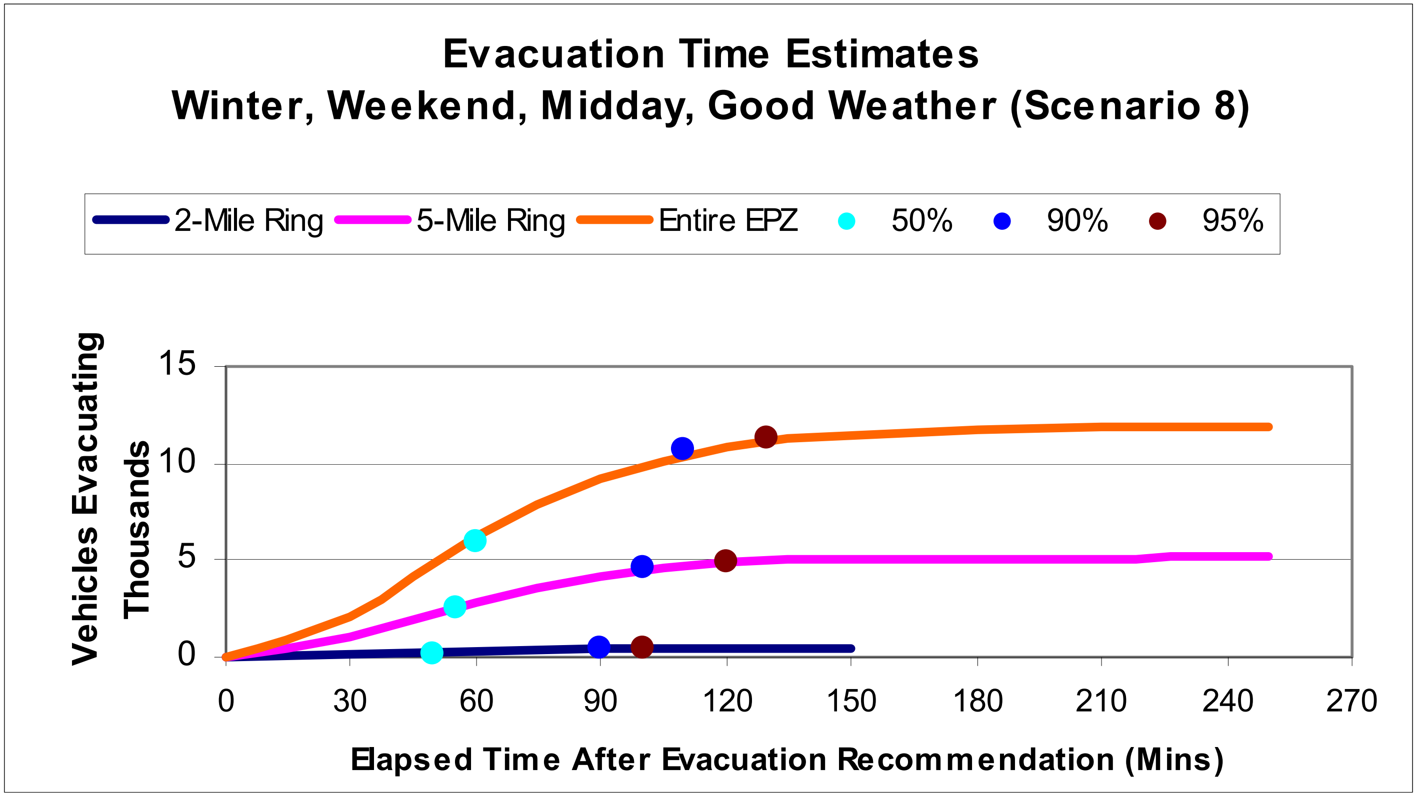


Figure J-8. Evacuation Time Estimates – Scenario 8 for Region R3 (Entire EPZ)

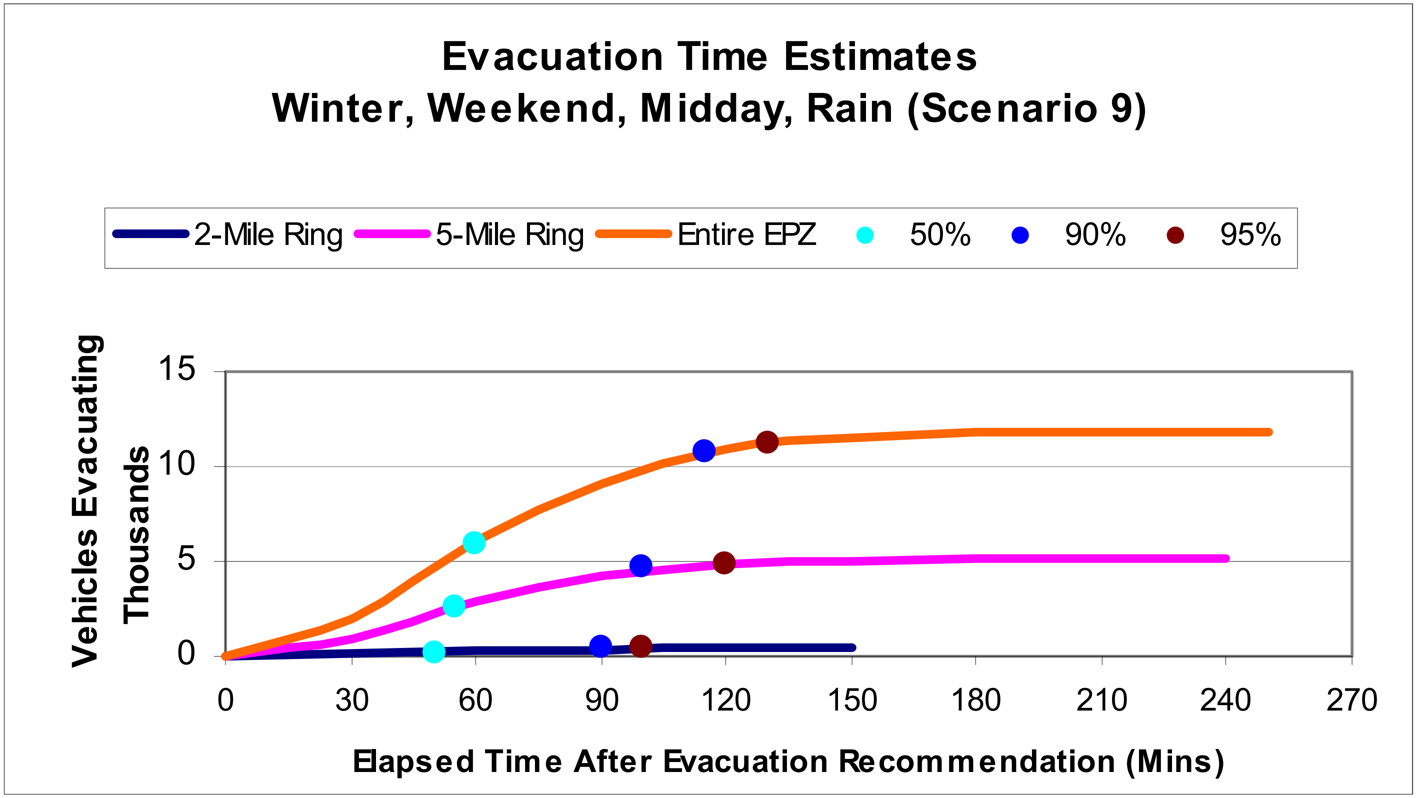


Figure J-9. Evacuation Time Estimates – Scenario 9 for Region R3 (Entire EPZ)

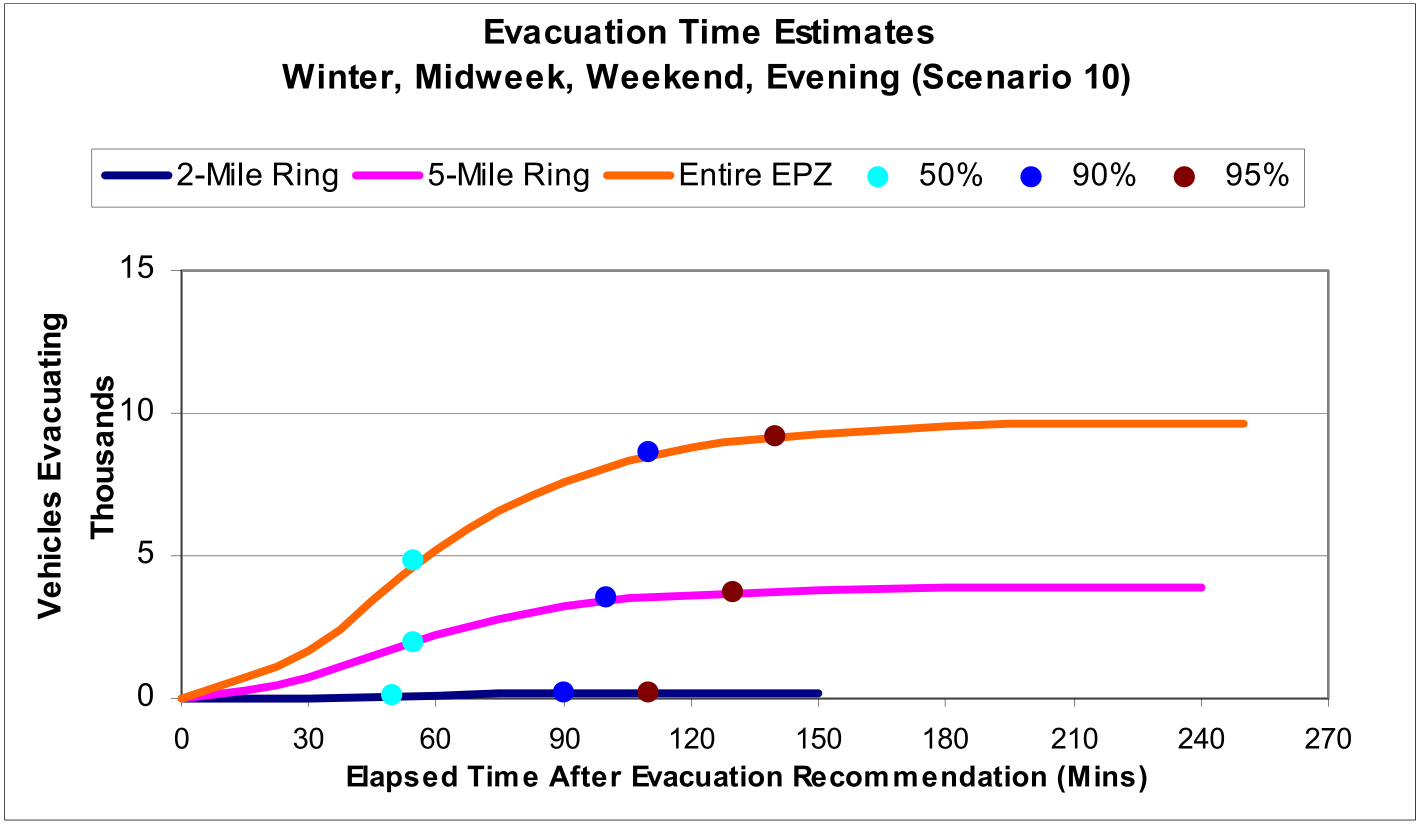


Figure J-10. Evacuation Time Estimates – Scenario 10 for Region R3 (Entire EPZ)

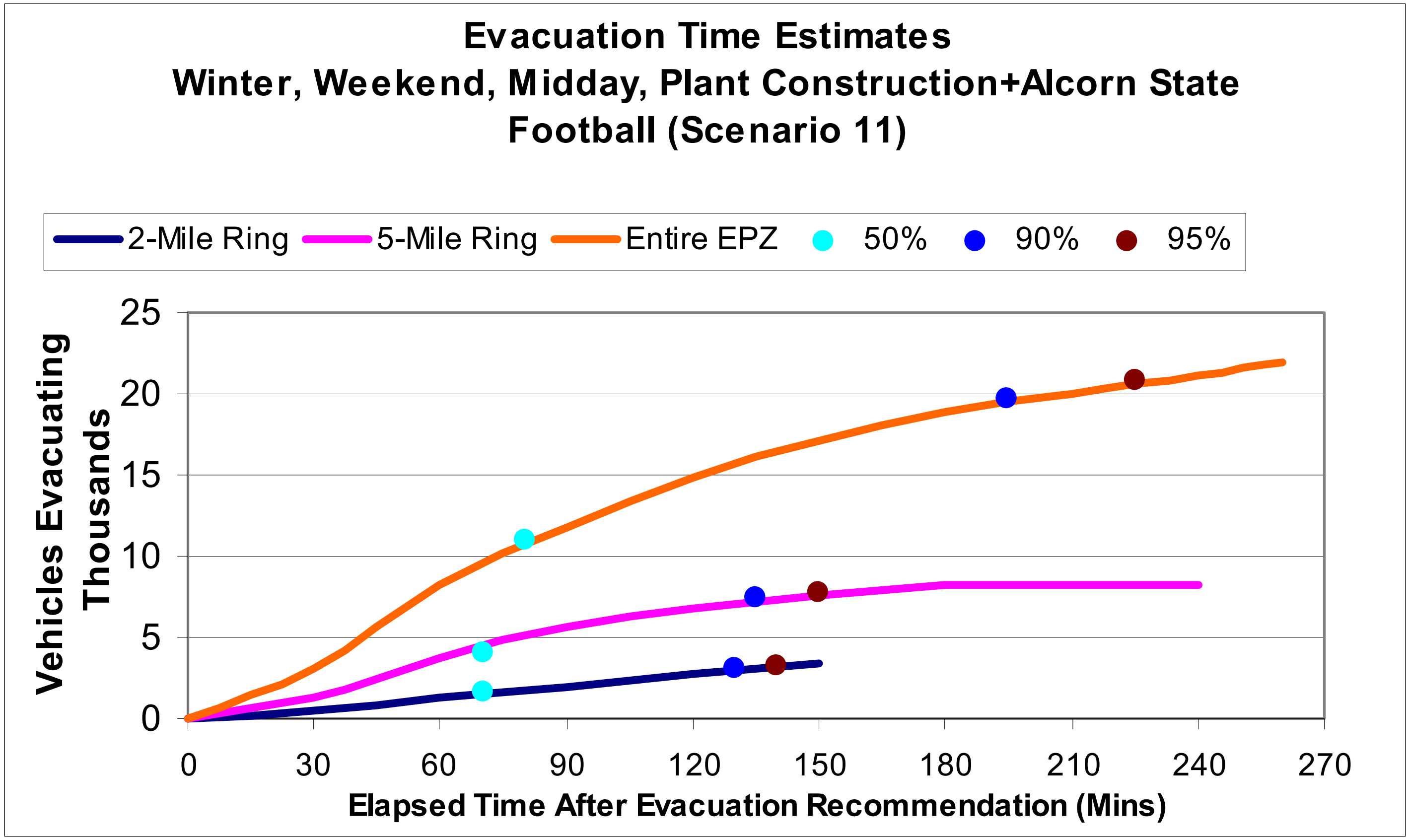


Figure J-11. Evacuation Time Estimates – Scenario 11 for Region R3 (Entire EPZ)

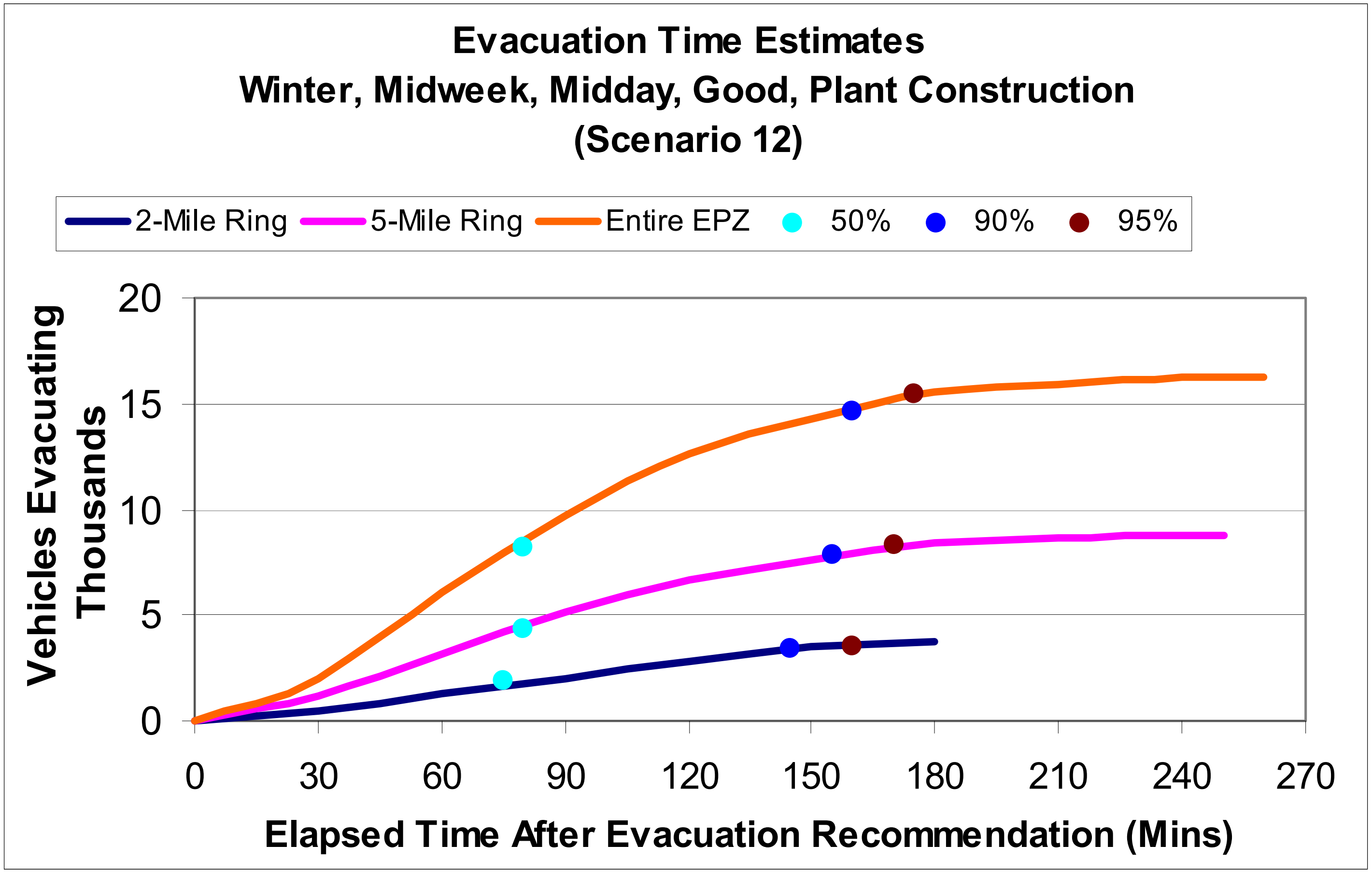


Figure J-12. Evacuation Time Estimates – Scenario 12 for Region R3 (Entire EPZ)

APPENDIX K

Evacuation Roadway Network Characteristics

Upstream Node Number	Downstream Node Number	Length (Miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
1	273	71	1	1714	50
2	391	131	2	2000	65
2	8	153	2	2000	65
3	43	39	1	2000	45
3	101	91	1	1714	45
3	16	41	1	1500	35
4	5	117	2	2000	65
5	6	147	2	2000	65
5	4	117	2	2000	65
6	5	147	2	2000	65
6	7	144	2	2000	65
7	6	144	2	2000	65
7	391	48	2	2000	65
8	45	103	2	2000	65
8	2	153	2	2000	65
9	44	172	2	2000	65
9	10	59	2	2000	65
10	11	53	2	2000	65
10	9	59	2	2000	65
11	10	53	2	2000	65
11	12	137	2	2000	65
12	13	77	2	2000	65
12	11	137	2	2000	65
13	14	79	2	2000	65
13	12	77	2	2000	65
14	13	79	2	2000	65
14	41	74	2	2000	65
15	42	63	1	2000	45
15	41	175	1	2000	65
16	165	7	2	1500	35
16	3	41	1	1500	35
17	165	21	2	1500	35
17	18	19	2	1500	35
18	17	19	2	1500	35
18	19	69	2	1500	35
19	110	52	1	1714	40
19	380	20	1	2000	45

Upstream Node Number	Downstream Node Number	Length (Miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
19	18	69	2	1500	35
20	21	23	1	1500	25
20	380	133	1	2000	45
20	22	23	1	2000	55
21	89	26	1	2000	60
22	23	47	1	2000	55
22	20	23	1	2000	55
23	24	115	1	2000	60
23	22	47	1	2000	55
24	23	115	1	2000	55
24	25	37	2	2000	60
25	26	48	2	2000	60
25	24	37	2	2000	60
26	27	103	2	2000	60
26	25	48	2	2000	60
27	28	50	2	2000	60
27	26	103	2	2000	60
28	27	50	2	2000	60
28	29	69	2	2000	60
29	28	69	2	2000	60
29	30	28	2	2000	60
30	29	28	2	2000	60
30	31	74	2	2000	60
31	30	74	2	2000	60
31	32	93	2	2000	60
32	31	93	2	2000	60
32	33	34	2	2000	60
33	32	34	2	2000	60
33	35	46	2	2000	60
34	35	27	1	1714	40
35	36	33	2	2000	60
35	33	46	2	2000	60
36	37	52	2	2000	60
36	35	33	2	2000	60
37	36	52	2	2000	60
37	38	30	1	1714	50
37	40	83	2	2000	60

Upstream Node Number	Downstream Node Number	Length (Miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
38	39	24	1	1714	50
39	338	19	1	1714	50
40	37	83	2	2000	60
41	15	175	1	2000	45
41	14	74	2	2000	65
42	43	65	1	2000	45
42	15	63	1	2000	45
43	3	39	1	2000	45
43	42	65	1	2000	45
44	45	164	2	2000	65
44	9	172	2	2000	65
45	44	164	2	2000	65
45	8	103	2	2000	65
47	34	51	2	2000	55
48	49	11	1	1500	25
48	47	42	2	2000	55
49	50	9	1	1500	25
50	51	31	1	2000	60
51	52	32	1	2000	60
52	53	167	1	2000	60
53	54	41	1	2000	60
54	55	55	1	2000	60
56	48	51	2	2000	55
57	56	38	2	2000	55
58	57	26	2	2000	55
59	58	34	2	2000	55
60	59	23	2	2000	55
61	60	21	2	2000	55
62	61	24	2	2000	55
63	62	17	2	2000	55
64	63	82	2	2000	55
65	64	21	2	2000	55
66	65	46	2	2000	55
67	66	45	2	2000	55
68	67	33	2	2000	55
69	68	80	2	2000	55
70	69	31	2	2000	55

Upstream Node Number	Downstream Node Number	Length (Miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
71	75	62	1	1200	40
72	76	47	1	1200	40
73	71	75	1	1200	40
74	72	47	1	1200	40
75	72	60	1	1200	40
76	77	90	1	1200	40
77	78	34	1	1200	45
78	69	50	1	1714	55
79	163	20	1	1500	35
79	17	14	1	1500	35
79	164	20	1	1500	35
80	79	51	1	1500	30
81	80	40	1	1200	40
82	81	15	1	1200	40
83	82	73	1	1200	40
84	83	27	1	1200	40
85	84	42	1	1200	40
86	85	48	1	1200	40
87	86	34	1	1200	40
88	87	49	1	1200	40
89	90	52	1	2000	60
90	91	99	1	2000	60
91	92	71	1	2000	60
92	93	38	1	2000	60
93	94	62	1	2000	60
94	95	126	1	2000	60
95	96	45	1	2000	60
96	97	28	1	2000	60
97	98	54	1	2000	60
98	99	20	1	2000	60
99	100	33	1	2000	60
100	50	35	1	2000	60
101	102	30	1	1714	45
102	105	121	1	1714	60
102	103	10	1	1500	25
103	104	6	1	1500	25
104	128	56	1	2000	60

Upstream Node Number	Downstream Node Number	Length (Miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
104	111	45	1	2000	60
105	106	39	1	1714	60
106	133	119	1	1714	60
107	162	14	1	1500	35
107	17	15	1	1500	35
108	18	16	1	1500	35
108	107	20	1	1500	35
109	110	66	1	1714	40
109	108	32	1	1500	35
110	173	40	1	1714	40
111	112	46	1	2000	60
112	113	77	1	2000	60
113	114	50	1	2000	60
114	115	35	1	2000	60
115	116	42	1	2000	60
116	117	95	1	2000	60
117	118	64	1	2000	60
118	119	168	1	2000	60
119	120	105	1	2000	60
120	121	73	1	2000	60
121	122	66	1	2000	60
122	123	74	1	2000	60
123	124	168	1	2000	60
124	125	85	1	2000	60
125	126	41	1	2000	60
126	127	66	1	2000	60
128	129	51	1	2000	60
129	130	43	1	2000	60
130	131	75	1	2000	60
131	132	48	1	2000	60
132	21	106	1	2000	60
133	134	55	1	1714	60
134	135	87	1	1714	60
135	136	21	1	1714	60
136	137	45	1	1714	60
137	138	31	1	1714	60
138	205	95	1	1714	60

Upstream Node Number	Downstream Node Number	Length (Miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
139	140	51	1	1714	60
140	141	49	1	1714	60
141	142	47	1	1714	60
142	143	83	1	1714	60
143	144	29	1	1714	60
144	145	126	1	1714	60
145	172	24	1	1714	60
146	13	57	1	900	30
147	41	69	1	1714	50
148	147	161	1	1714	50
149	148	106	1	1714	50
150	153	45	1	1714	50
151	150	61	1	1714	50
152	151	114	1	1714	50
153	149	72	1	1714	50
154	146	51	1	900	30
155	154	55	1	900	30
156	155	77	1	900	30
157	156	33	1	900	30
158	157	29	1	900	30
159	158	37	1	900	30
160	159	106	1	900	30
161	160	39	1	900	30
162	165	17	1	1500	35
163	165	13	1	1500	35
164	18	12	1	1500	35
165	16	7	2	1500	35
165	17	21	2	1500	35
166	145	20	1	1714	40
167	166	22	1	1714	40
168	167	91	1	1714	40
169	168	32	1	1714	40
170	169	39	1	1714	40
171	170	94	1	1714	40
171	206	94	1	1714	40
173	311	25	1	1714	40
174	175	56	1	1714	55

Upstream Node Number	Downstream Node Number	Length (Miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
175	176	80	1	1714	55
176	177	175	1	1714	55
177	178	50	1	1714	55
178	179	57	1	1714	55
179	180	62	1	1714	55
180	181	26	1	1500	35
181	182	13	1	1500	25
182	191	10	1	1500	25
183	182	21	1	1500	25
184	183	18	1	1500	25
185	184	42	1	1714	45
186	185	72	1	1714	45
187	186	69	1	1714	45
188	187	63	1	1714	45
189	188	47	1	1714	45
190	189	26	1	1714	45
191	192	10	1	1500	25
192	193	26	1	1714	40
193	194	36	1	1714	55
194	195	73	1	1714	55
196	202	39	1	1714	50
196	198	46	1	1714	50
197	196	22	1	1714	40
198	199	63	1	1714	50
199	200	31	1	1714	50
200	201	36	1	1714	50
201	190	96	1	1714	50
202	203	153	1	1714	50
203	204	15	1	1714	50
204	140	42	1	1714	40
205	139	59	1	1714	60
206	139	125	1	1714	40
207	41	42	1	1500	40
208	207	36	1	1500	40
209	208	123	1	1500	40
210	209	61	1	1500	40
211	210	127	1	1500	40

Upstream Node Number	Downstream Node Number	Length (Miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
212	211	62	1	1500	40
213	214	56	1	1500	40
213	212	37	1	1500	40
214	215	77	1	1500	40
215	216	114	1	1500	40
216	217	22	1	1500	40
217	218	60	1	1500	40
218	219	63	1	1500	40
219	10	74	1	1500	40
220	223	178	1	2000	60
221	233	186	1	2000	60
221	234	120	1	2000	60
222	234	116	1	2000	60
222	223	115	1	2000	60
223	220	178	1	2000	60
223	222	115	1	2000	60
224	233	184	1	2000	60
224	225	63	1	2000	60
225	224	63	1	2000	60
225	232	87	1	2000	60
225	238	88	1	1714	50
226	227	35	1	2000	60
226	231	157	1	2000	60
227	226	35	1	2000	60
227	235	142	1	2000	60
228	236	142	1	2000	60
228	229	26	1	2000	60
229	230	106	1	2000	60
229	228	26	1	2000	60
230	229	106	1	2000	60
231	232	186	1	2000	60
231	226	157	1	2000	60
232	231	186	1	2000	60
232	225	87	1	2000	60
233	221	186	1	2000	60
233	224	184	1	2000	60
234	221	120	1	2000	60

Upstream Node Number	Downstream Node Number	Length (Miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
234	222	116	1	2000	60
235	227	142	1	2000	60
235	286	46	1	1714	40
235	290	99	1	2000	60
236	290	62	1	2000	60
236	228	142	1	2000	60
237	225	130	1	1500	35
238	239	55	1	1714	50
239	240	151	1	1714	50
240	241	79	1	1714	50
242	243	30	1	1714	50
242	244	173	1	1714	50
243	221	150	1	1714	40
244	222	155	1	1714	50
245	242	55	1	1714	50
246	245	87	1	1714	50
247	246	117	1	1714	50
248	247	74	1	1714	50
249	248	46	1	1714	50
250	249	47	1	1714	50
251	250	51	1	1714	50
252	251	77	1	1714	50
253	252	72	1	1714	50
254	255	66	1	1714	50
254	253	145	1	1714	50
255	256	28	1	1714	50
256	237	29	1	1500	30
257	258	133	1	1500	50
258	259	60	1	1500	50
259	260	32	1	1500	50
260	261	145	1	1500	50
261	262	100	1	1500	50
262	263	87	1	1500	50
263	264	92	1	1500	50
264	265	80	1	1500	50
265	266	102	1	1500	50
266	274	141	1	1714	50

Upstream Node Number	Downstream Node Number	Length (Miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
266	275	80	1	1714	40
267	243	55	1	1714	50
268	267	58	1	1714	50
269	268	63	1	1714	50
269	256	110	1	1714	30
270	221	62	1	1714	40
271	270	121	1	1714	40
272	271	122	1	1714	40
273	227	17	1	1714	40
274	1	131	1	1714	50
275	277	93	1	1714	40
276	237	36	1	1500	30
277	276	62	1	1714	40
278	279	31	1	1714	45
279	280	47	1	1714	45
280	281	13	1	1714	45
281	283	12	1	1714	60
282	281	22	1	1714	60
283	310	93	1	1714	60
284	291	118	1	1714	30
285	278	39	1	1714	45
286	273	144	1	1714	50
286	287	30	1	1714	50
287	288	61	1	1714	50
288	289	134	1	1714	50
289	282	168	1	1714	50
290	236	62	1	2000	60
290	235	99	1	2000	60
291	292	123	1	1714	50
292	228	100	1	1714	50
293	1	48	1	1714	45
294	295	57	1	1714	45
294	298	62	1	1714	45
295	296	79	1	1714	45
296	297	74	1	1714	45
297	293	106	1	1714	45
298	299	61	1	1714	45

Upstream Node Number	Downstream Node Number	Length (Miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
299	300	55	1	1714	45
300	301	150	1	1714	45
301	285	101	1	1714	45
302	303	122	1	1714	40
303	304	150	1	1714	40
304	305	46	1	1714	40
305	278	20	1	1714	40
306	304	88	1	1714	40
307	306	104	1	1714	40
308	307	76	1	1714	40
309	308	45	1	1714	40
310	284	35	1	1714	30
311	174	78	1	1714	55
312	311	11	1	1500	40
313	312	46	1	1500	40
314	313	28	1	1500	40
315	314	27	1	1500	40
316	315	38	1	1500	40
317	316	39	1	1500	40
318	317	24	1	1500	40
319	318	56	1	1500	40
320	319	31	1	1500	40
321	320	13	1	1500	40
321	353	34	1	1200	40
322	321	56	1	1500	40
323	322	40	1	1500	40
323	324	44	1	1500	40
324	325	41	1	1500	40
325	326	44	1	1500	40
326	327	25	1	1500	40
327	328	15	1	1500	40
328	348	74	1	1500	40
328	329	47	1	1500	40
329	330	32	1	1500	40
330	331	40	1	1500	40
331	332	77	1	1500	40
332	333	39	1	1500	40

Upstream Node Number	Downstream Node Number	Length (Miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
333	334	24	1	1500	40
334	335	42	1	1500	40
335	336	146	1	1500	40
336	337	38	1	1500	40
337	346	17	1	1714	50
338	339	19	1	1714	50
339	340	43	1	1714	50
340	341	64	1	1714	50
341	342	40	1	1714	50
342	343	27	1	1714	50
343	344	30	1	1714	50
344	345	28	1	1714	50
345	337	22	1	1714	50
346	347	50	1	1714	50
348	349	46	1	1500	40
349	350	77	1	1500	40
350	351	47	1	1500	40
351	27	21	1	1500	40
352	323	34	1	1500	40
353	354	18	1	1200	40
354	355	35	1	1200	40
355	356	65	1	1200	40
356	24	23	1	1200	40
357	358	101	1	1500	40
358	182	38	1	1500	25
359	357	84	1	1500	40
360	359	71	1	1500	40
361	360	66	1	1500	40
362	361	59	1	1500	40
363	362	37	1	1500	40
364	365	51	1	1500	40
365	370	66	1	1500	40
366	176	23	1	1500	40
367	364	64	1	1500	40
367	363	51	1	1500	40
368	367	45	1	1500	40
369	366	59	1	1500	40

Upstream Node Number	Downstream Node Number	Length (Miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
370	369	50	1	1500	40
371	74	43	1	1200	40
372	371	56	1	1200	40
373	372	51	1	1200	40
374	373	46	1	1200	40
375	374	73	1	1200	40
376	82	73	1	1200	40
377	376	50	1	1200	40
378	377	68	1	1200	40
379	378	49	1	1200	40
380	19	20	1	2000	45
380	20	133	1	2000	55
381	380	27	1	1200	40
382	381	28	1	1200	40
383	382	32	1	1200	40
384	383	63	1	1200	40
385	389	79	1	1500	40
386	385	161	1	1500	40
387	386	68	1	1500	40
388	387	75	1	1500	40
389	390	62	1	1500	40
390	391	47	1	1200	40
391	2	131	2	2000	65
391	7	48	2	2000	65

APPENDIX L

Emergency Response Planning Area (ERPA) Boundaries

APPENDIX L: EMERGENCY RESPONSE PLANNING AREA (ERPA) BOUNDARIES

ERPA 1

Defined as the area including the Grand Gulf Nuclear Station. It is bounded by the Mississippi River on the east, the Bayou Pierre and 3-mile radius on the south, local roads on the east and the Big Black River on the north.

ERPA 2A

Defined as the area bounded by the Big Black River on the north, local roads on the east, the Bayou Pierre on the south and Route 61 on the east.

ERPA 2B

Defined as the area just east of Area 2A with Route 61 serving as the western boundary, Bayou Pierre as its southern boundary, and the 10-mile radius as its eastern boundary. The Big Black River is to the north of the area.

ERPA 3A

Defined as the area to the south of Bayou Pierre with local roads to the east and Little Bayou Pierre to the south and west.

ERPA 3B

Defined as the area bounded on the north by the Bayou Pierre, on the west by local roads, on the south by Little Bayou Pierre and on the east by the 10-mile radius.

ERPA 4A

Defined as the area including the town of Port Gibson. The 3-mile radius is to the north, Widows Creek to the west, local roads to the south and the Little Bayou Pierre to the east.

ERPA 4B

Defined as the area southwest of the Little Bayou Pierre, north-west of the 10-mile radius, and east of Route 61 and local roads.

ERPA 5A

Defined as the area to the south of the Grand Gulf site and bounded by the Bayou Pierre to the north and east, Widows Creek and Route 61 to the east and local roads to the south.

ERPA 5B

Defined as the area just south of Area 5A with Route 61 and local roads to the north, and the 10-mile radius serving as the southern boundary.

ERPA 6

Defined as the area located south of the 10-mile radius including Alcorn University.

ERPA 7

Defined as the area north of Grand Gulf site bounded by the Big Black River, the Mississippi River, and the 10-mile radius.

ERPA 8

Defined as the area in Tensas Parish, Louisiana, bounded on the north by the EPZ boundary, by the area just west and south of Lake Joseph and by the Mississippi River on the east.

ERPA 9

Defined as the area just west of Area 8 and includes the town of Newellton. It is bounded on the west by Route 65 and on the north by the EPZ boundary.

ERPA 10

Defined as the area just south of Areas 8 & 9. It is bounded on the east and south by the Mississippi River and on the south and west by the western portion of Lake Bruin.

ERPA 11

Defined as the area including the town of St. Joseph. It has Lake Bruin as its northern boundary, the Mississippi River to the east and the EPZ boundary to the south and west.