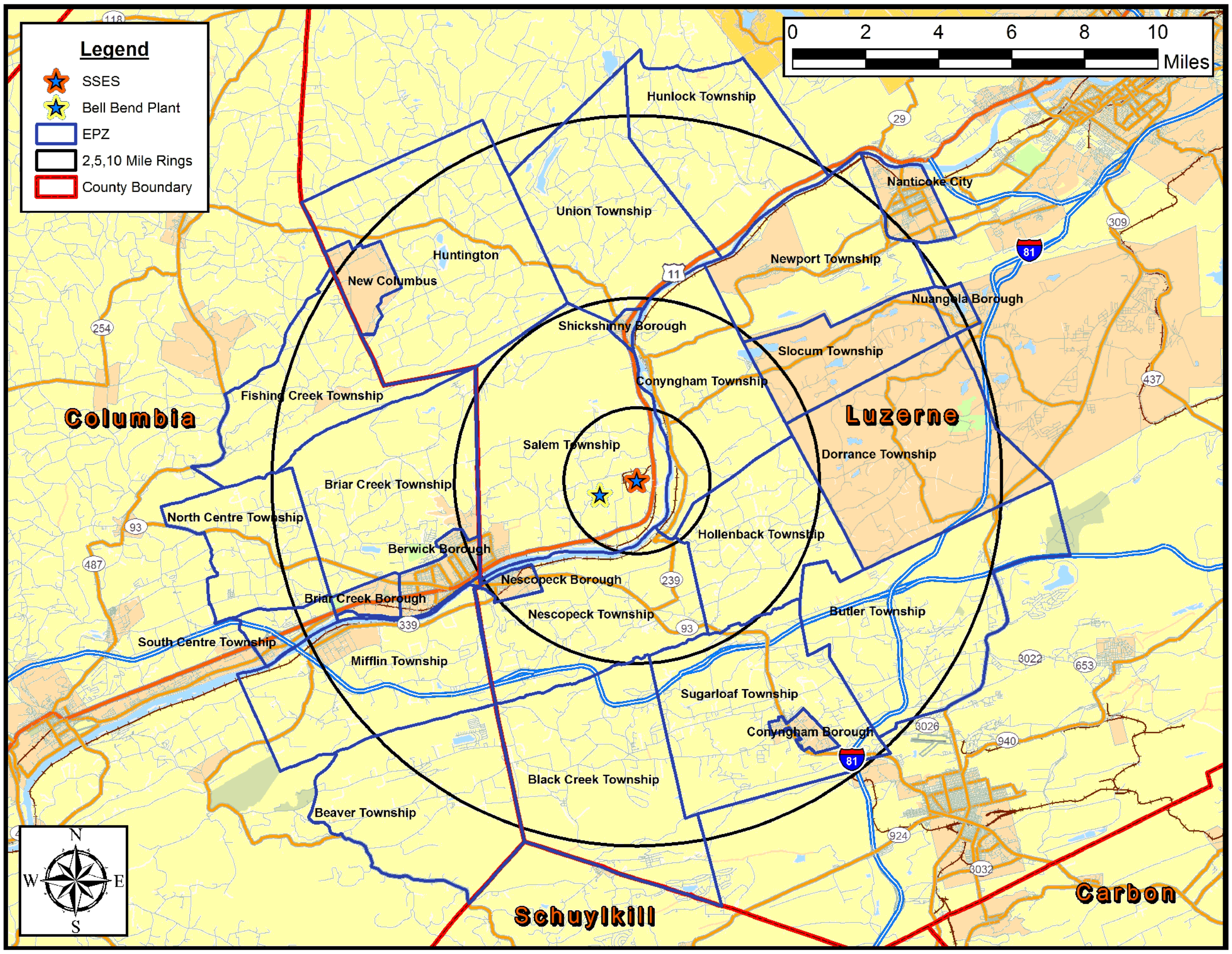
Susquehanna Steam Electric Station (SSES)/Bell Bend Development of Evacuation Time Estimates



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EXECUTIVE SUMMARY

This report describes the analyses undertaken and the results obtained by a study to develop Evacuation Time Estimates (ETE) for the Susquehanna Steam Electric Station (SSES) and the proposed Bell Bend Nuclear Power Plant located in Luzerne County, Pennsylvania. ETE are part of the required planning basis and provide SSES/Bell Bend 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 published by Federal Government agencies and relevant to ETE was reviewed. 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 May, 2008 and extended over a period of 5 months. The major activities performed are briefly described in chronological sequence:

- Attended "kick-off" meetings with PPL, UniStar, and emergency management personnel representing state and local governments.
- Reviewed prior ETE reports prepared for the SSES/Bell Bend.
- Reviewed the existing county and municipal emergency plans.
- Accessed U.S. Census Bureau data files for the year 2000. Studied Geographical Information Systems (GIS) maps of the area in the vicinity of SSES/Bell Bend then conducted a detailed field survey of the highway network.
- Synthesized this information to create an analysis network representing the highway system topology and capacities within the Emergency Planning Zone (EPZ), plus a Shadow Region beyond the EPZ extending to 15 miles from the plant.
- Designed and sponsored a telephone survey of residents within the EPZ to gather focused data needed for this ETE study not contained within the census database. The survey instrument was reviewed and modified by Unistar, PPL and county personnel prior to the survey.
- A data collection survey was conducted to obtain data pertaining to employment,

transients, and special facilities within the EPZ.

- 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 27 emergency response planning area (ERPA) using the existing municipal boundaries. These Municipalities are then grouped within circular areas or “keyhole” configurations (circles plus radial sectors) that define a total of 22 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, Snow). One special event scenario was considered: the construction on Bell Bend site during refueling of SSES in the Year 2015.
- The Planning Basis for the calculation of ETE is:
    - A rapidly escalating accident at SSES/Bell Bend 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 host schools and 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 school children 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 evacuation plans. Those in special facilities will likewise be evacuated with public transit, as needed: bus, van, or ambulance, as required. Separate ETE are calculated for the transit-dependent evacuees and for those evacuated from special facilities.

<u>Computation of ETE</u>

A total of 286 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

22 Evacuation Regions to completely evacuate from that Region, under the circumstances defined for one of the 13 Evacuation Scenarios (22 x 13 = 286). Separate ETE are calculated for transit-dependent evacuees, including school children 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 this region will evacuate in response to this advisory. The people occupying the remainder of the EPZ outside this region may be advised to 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 to a distance of 15 miles from SSES 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 the plant), 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 is also designed to control access into the EPZ after returning commuters have rejoined their families.

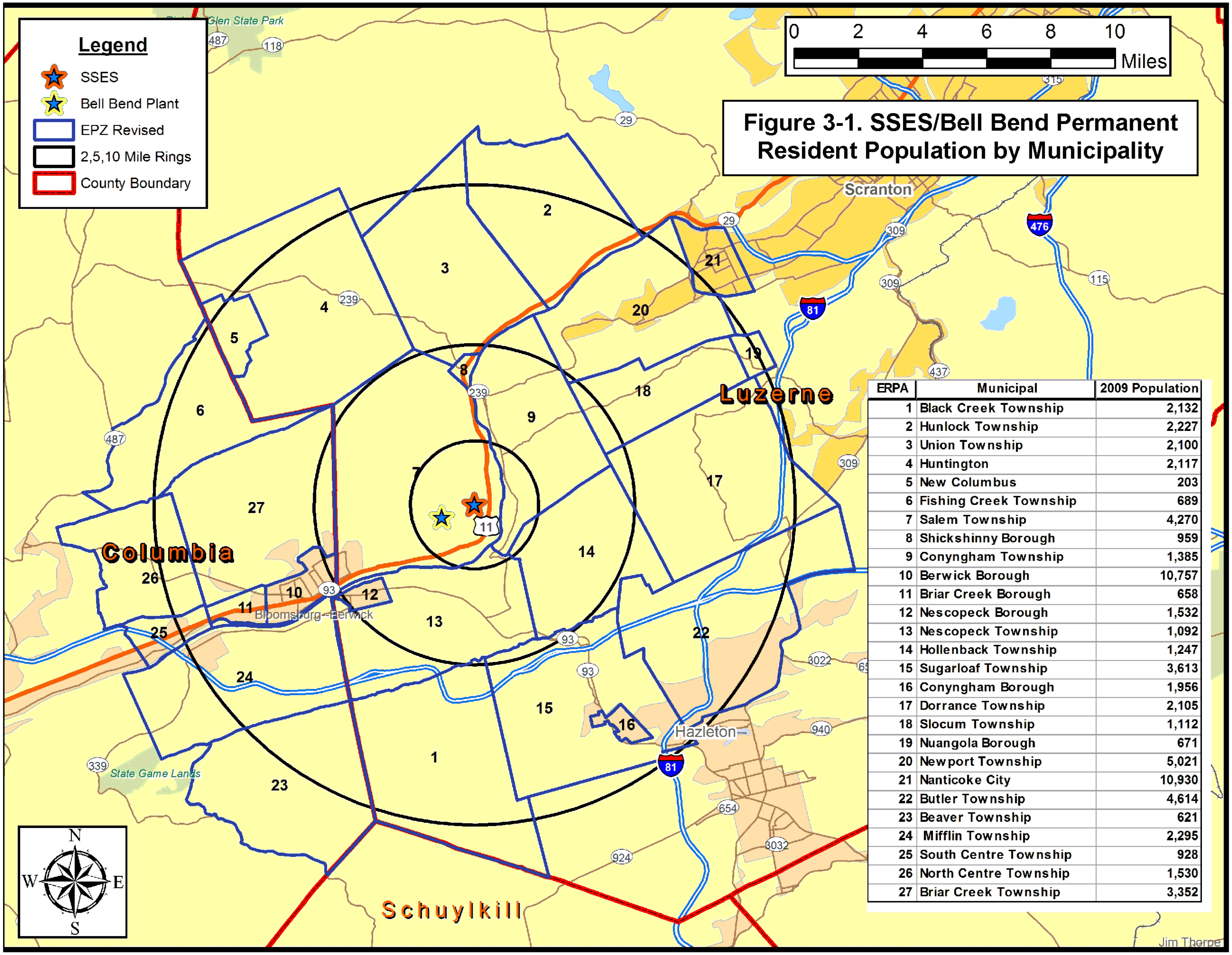
The plan is documented in the form of detailed schematics specifying: (1) the directions of evacuation travel to be facilitated, and other traffic movements to be discouraged; (2) the traffic control personnel and equipment needed (cones, barricades) and their deployment; (3) the locations of these "Traffic 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 SSES/Bell Bend site showing the layout of the 27 Municipalities that comprise, in aggregate, the Emergency Planning Zone (EPZ). The 2009 estimates of permanent resident population within each municipality are also provided.
- Table 3-3 presents the estimates of permanent resident population in each municipality based on the 2000 Census data. Extrapolation to the year 2009 reflects population growth rates in each municipality obtained from the census.
- Table 6-1 defines each of the 22 Evacuation Regions in terms of their respective groups of municipalities.
- Table 6-2 lists the 13 Evacuation Scenarios.
- Tables 7-1C and 7-1D are compilations of 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 8-7A presents ETE for the transit-dependent population in good weather.

Figure 3-1. SSES/Bell Bend Permanent Resident Population by Municipality



ERPA	Municipal	2009 Population
1	Black Creek Township	2,132
2	Hunlock Township	2,227
3	Union Township	2,100
4	Huntington	2,117
5	New Columbus	203
6	Fishing Creek Township	689
7	Salem Township	4,270
8	Shickshinny Borough	959
9	Conyngham Township	1,385
10	Berwick Borough	10,757
11	Briar Creek Borough	658
12	Nescopeck Borough	1,532
13	Nescopeck Township	1,092
14	Hollenback Township	1,247
15	Sugarloaf Township	3,613
16	Conyngham Borough	1,956
17	Dorrance Township	2,105
18	Slocum Township	1,112
19	Nuangola Borough	671
20	Newport Township	5,021
21	Nanticoke City	10,930
22	Butler Township	4,614
23	Beaver Township	621
24	Mifflin Township	2,295
25	South Centre Township	928
26	North Centre Township	1,530
27	Briar Creek Township	3,352

Table 3-2. EPZ Permanent Resident Population		
Municipality	**2000 Population**	**2009 Population**
1	2,132	2,132
2	2,227	2,227
3	2,100	2,100
4	2,117	2,117
5	203	203
6	676	690
7	4,270	4,270
8	959	959
9	1,385	1,385
10	10,552	10,757
11	645	658
12	1,532	1,532
13	1,092	1,092
14	1,247	1,247
15	3,613	3,613
16	1,956	1,956
17	2,105	2,105
18	1,112	1,112
19	671	671
20	5,021	5,021
21	10,930	10,930
22	4,614	4,614
23	609	621
24	2,251	2,295
25	910	928
26	1,501	1,531
27	3,288	3,352
TOTAL	**69,718**	**70,118**
Population Growth:		**0.57%**

Table 6-1. Description of Evacuation Regions

Region	Description	ERPA 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
R01	2 mile ring							x		x																		
R02	5-mile ring							x	x	x			x	x	x													
R03	Full EPZ	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
2-MileRing and 5-Mile Downwind																												
Region	**Description**	**ERPA 1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**
R04	N,NNE,NNW							x	x	x																		
-	NE,W,WNW,NW	**Refer to Region R01**																										
R05	ENE,E,ESE							x		x					x													
R06	SE, SSE							x		x			x	x	x													
R07	S, SSW,SW,WSW							x		x			x	x														
5-Mile Ring and Downwind to EPZ Boundary																												
Region	**Description**	**ERPA 1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**
R08	N		x	x	x	x		x	x	x			x	x	x						x							
R09	NNE		x	x				x	x	x			x	x	x				x		x	x						
R10	NE		x					x	x	x			x	x	x			x	x	x	x	x						
R11	ENE							x	x	x			x	x	x			x	x	x	x	x	x					
R12	E							x	x	x			x	x	x			x	x	x			x					
R13	ESE, SE							x	x	x			x	x	x	x	x	x					x					
R14	SSE	x						x	x	x			x	x	x	x	x						x					
R15	S	x						x	x	x			x	x	x	x	x							x				
R16	SSW	x						x	x	x			x	x	x									x	x			
R17	SW	x						x	x	x	x	x	x	x	x									x	x	x	x	x
R18	WSW						x	x	x	x	x	x	x	x	x									x	x	x	x	x
R19	W				x	x	x	x	x	x	x	x	x	x	x										x	x	x	x
R20	WNW				x	x	x	x	x	x			x	x	x												x	x
R21	NW			x	x	x	x	x	x	x			x	x	x													x
R22	NNW		x	x	x	x		x	x	x			x	x	x													

Table 6-2. Evacuation Scenario Definitions					
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	Midweek	Midday	Snow	None
9	Winter	Weekend	Midday	Good	None
10	Winter	Weekend	Midday	Rain	None
11	Winter	Weekend	Midday	Snow	None
12	Winter	Midweek, Weekend	Evening	Good	None
13	Summer	Midweek	Midday	Good	Bell Bend Construction and SSES Refueling

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		Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend			Midweek Weekend		Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	Scenario:	(6)	(7)	(8)	(9)	(10)	(11)	(12)	Scenario:	(13)
	Midday		Midday		Evening		Midday			Midday			Evening		Midday
Region Wind Toward:	Good Weather	Rain	Good Weather	Rain	Good Weather	Region Wind Toward:	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Region Wind Toward:	Bell Bend Construction and SSES Refueling
Entire 2-Mile Region, 5-Mile Region, and EPZ															
R01 2-Mile Region	3:10	3:10	2:40	2:40	2:40	R01 2-Mile Region	3:00	3:00	4:10	2:40	2:40	3:50	2:40	R01 2-Mile Region	3:10
R02 5-Mile Region	2:40	2:40	2:20	2:20	2:30	R02 5-Mile Region	2:40	2:40	3:40	2:20	2:20	2:50	2:30	R02 5-Mile Region	3:00
R03 Entire EPZ	3:25	3:35	3:15	3:30	3:15	R03 Entire EPZ	3:25	3:35	4:20	3:15	3:20	4:10	3:10	R03 Entire EPZ	3:40
2-Mile Ring and Downwind to 5 Miles															
R04 N,NNE,NNW	3:10	3:10	2:40	2:40	2:40	R04 N,NNE,NNW	3:00	3:00	4:10	2:40	2:40	3:50	2:40	R04 N,NNE,NNW	3:10
R01 NE,W,WNW,NW	See Region R01					R01 NE,W,WNW,NW	See Region R01							R01 NE,W,WNW,NW	See Region R01
R05 ENE,E,ESE	3:00	3:10	2:40	2:40	2:40	R05 ENE,E,ESE	3:00	3:00	4:10	2:40	2:40	3:50	2:40	R05 ENE,E,ESE	3:10
R06 SE,SSE	2:40	2:40	2:20	2:20	2:30	R06 SE,SSE	2:40	2:40	3:40	2:20	2:20	2:50	2:30	R06 SE,SSE	3:00
R07 S, SSW,SW,WSW	2:40	2:40	2:20	2:20	2:30	R07 S, SSW,SW,WSW	2:40	2:40	3:30	2:20	2:20	2:50	2:30	R07 S, SSW,SW,WSW	3:00
5-Mile Ring and Downwind to EPZ Boundary															
R08 N	3:00	3:10	2:40	2:40	2:50	R08 N	3:10	3:10	4:00	2:40	2:40	3:30	2:50	R08 N	3:30
R09 NNE	3:10	3:20	2:50	3:00	3:00	R09 NNE	3:20	3:30	4:10	2:50	3:00	3:50	3:00	R09 NNE	3:20
R10 NE	3:00	3:10	2:40	2:50	2:50	R10 NE	3:10	3:20	4:00	2:40	2:50	3:40	2:50	R10 NE	3:10
R11 ENE	2:50	3:00	2:40	2:50	2:50	R11 ENE	3:00	3:10	3:50	2:40	2:50	3:40	2:50	R11 ENE	3:00
R12 E	2:40	2:40	2:10	2:10	2:20	R12 E	2:40	2:40	3:30	2:10	2:10	2:50	2:30	R12 E	3:00
R13 ESE, SE	2:50	2:50	2:20	2:20	2:30	R13 ESE, SE	2:50	2:50	3:40	2:20	2:20	3:00	2:30	R13 ESE, SE	3:00
R14 SSE	2:50	2:50	2:20	2:20	2:30	R14 SSE	2:50	2:50	3:40	2:20	2:20	3:00	2:30	R14 SSE	3:00
R15 S	2:40	2:40	2:10	2:10	2:30	R15 S	2:40	2:40	3:30	2:10	2:20	2:50	2:30	R15 S	3:00
R16 SSW	3:10	3:10	2:50	3:00	2:50	R16 SSW	3:10	3:10	3:50	2:50	3:00	3:30	2:50	R16 SSW	3:20
R17 SW	3:25	3:35	3:15	3:30	3:10	R17 SW	3:25	3:35	4:20	3:20	3:30	4:10	3:10	R17 SW	3:50
R18 WSW	3:25	3:35	3:15	3:30	3:15	R18 WSW	3:25	3:35	4:20	3:15	3:30	4:10	3:15	R18 WSW	3:50
R19 W	3:20	3:35	3:15	3:30	3:15	R19 W	3:25	3:35	4:20	3:15	3:25	4:10	3:15	R19 W	3:50
R20 WNW	2:50	2:50	2:30	2:30	2:30	R20 WNW	2:50	2:50	4:00	2:30	2:30	3:20	2:30	R20 WNW	3:00
R21 NW	2:50	2:50	2:30	2:30	2:30	R21 NW	2:50	2:50	4:00	2:30	2:30	3:20	2:30	R21 NW	3:00
R22 NNW	3:00	3:00	2:40	2:40	2:50	R22 NNW	3:00	3:10	3:50	2:40	2:40	3:30	2:50	R22 NNW	3:30

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

	Summer		Summer		Summer		Winter			Winter			Winter		Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend			Midweek Weekend		Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	Scenario:	(6)	(7)	(8)	(9)	(10)	(11)	(12)	Scenario:	(13)
	Midday		Midday		Evening		Midday			Midday			Evening		Midday
Region Wind Toward:	Good Weather	Rain	Good Weather	Rain	Good Weather	Region Wind Toward:	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Region Wind Toward:	Bell Bend Construction and SSES Refueling
Entire 2-Mile Region, 5-Mile Region, and EPZ															
R01 2-Mile Region	5:30	5:30	5:00	5:00	5:00	R01 2-Mile Region	5:30	5:30	6:30	5:00	5:00	6:00	5:00	R01 2-Mile Region	5:30
R02 5-Mile Region	5:30	5:30	5:00	5:00	5:00	R02 5-Mile Region	5:30	5:30	6:30	5:00	5:00	6:00	5:00	R02 5-Mile Region	5:30
R03 Entire EPZ	5:40	5:40	5:10	5:20	5:10	R03 Entire EPZ	5:40	5:40	6:40	5:10	5:20	6:20	5:10	R03 Entire EPZ	5:40
2-Mile Ring and Downwind to 5 Miles															
R04 N,NNE,NNW	5:30	5:30	5:00	5:00	5:00	R04 N,NNE,NNW	5:30	5:30	6:30	5:00	5:00	6:00	5:00	R04 N,NNE,NNW	5:30
R01 NE,W,WNW,NW	See Region R01					R01 NE,W,WNW,NW	See Region R01							R01 NE,W,WNW,NW	See Region R01
R05 ENE,E,ESE	5:30	5:30	5:00	5:00	5:00	R05 ENE,E,ESE	5:30	5:30	6:30	5:00	5:00	6:00	5:00	R05 ENE,E,ESE	5:30
R06 SE,SSE	5:30	5:30	5:00	5:00	5:00	R06 SE,SSE	5:30	5:30	6:30	5:00	5:00	6:00	5:00	R06 SE,SSE	5:30
R07 S, SSW,SW,WSW	5:30	5:30	5:00	5:00	5:00	R07 S, SSW,SW,WSW	5:30	5:30	6:30	5:00	5:00	6:00	5:00	R07 S, SSW,SW,WSW	5:30
5-Mile Ring and Downwind to EPZ Boundary															
R08 N	5:30	5:30	5:00	5:00	5:10	R08 N	5:30	5:30	6:30	5:00	5:00	6:10	5:00	R08 N	5:30
R09 NNE	5:30	5:30	5:00	5:00	5:00	R09 NNE	5:30	5:30	6:30	5:00	5:10	6:10	5:00	R09 NNE	5:30
R10 NE	5:30	5:30	5:00	5:10	5:10	R10 NE	5:30	5:30	6:40	5:00	5:10	6:10	5:00	R10 NE	5:30
R11 ENE	5:30	5:30	5:10	5:10	5:10	R11 ENE	5:30	5:30	6:30	5:10	5:10	6:10	5:10	R11 ENE	5:30
R12 E	5:30	5:30	5:10	5:10	5:10	R12 E	5:30	5:30	6:30	5:10	5:10	6:00	5:10	R12 E	5:30
R13 ESE, SE	5:30	5:30	5:10	5:10	5:10	R13 ESE, SE	5:30	5:30	6:40	5:10	5:10	6:10	5:10	R13 ESE, SE	5:30
R14 SSE	5:30	5:30	5:10	5:10	5:10	R14 SSE	5:30	5:30	6:40	5:10	5:10	6:00	5:10	R14 SSE	5:30
R15 S	5:30	5:30	5:00	5:00	5:00	R15 S	5:30	5:30	6:30	5:00	5:00	6:00	5:00	R15 S	5:30
R16 SSW	5:30	5:40	5:10	5:10	5:10	R16 SSW	5:30	5:30	6:40	5:10	5:10	6:10	5:10	R16 SSW	5:30
R17 SW	5:40	5:40	5:10	5:20	5:10	R17 SW	5:40	5:40	6:40	5:10	5:20	6:10	5:10	R17 SW	5:40
R18 WSW	5:40	5:40	5:10	5:10	5:10	R18 WSW	5:40	5:40	6:40	5:10	5:10	6:10	5:10	R18 WSW	5:40
R19 W	5:40	5:40	5:10	5:10	5:10	R19 W	5:40	5:40	6:40	5:10	5:10	6:20	5:10	R19 W	5:40
R20 WNW	5:30	5:30	5:10	5:10	5:10	R20 WNW	5:40	5:40	6:40	5:10	5:10	6:10	5:10	R20 WNW	5:30
R21 NW	5:30	5:30	5:10	5:10	5:10	R21 NW	5:30	5:30	6:40	5:10	5:10	6:10	5:10	R21 NW	5:30
R22 NNW	5:30	5:30	5:00	5:00	5:00	R22 NNW	5:30	5:30	6:30	5:00	5:00	6:00	5:00	R22 NNW	5:30

Table 8-5A. School Evacuation Time Estimates - Good Weather								
School	**Driver Mobilization Time(min)**	**Loading Time (min)**	**Dist. to EPZ Boundary (mi.)**	**Travel Time to EPZ Bdry (min)**	**ETE (hr:min)**	**Dist. EPZ Bndry to H.S. (mi.)**	**Travel Time EPZ Bdry to H.S. (min)**	**ETE to H.S. (hr:min)**
Columbia County								
Beaver Main School	90	5	2.0	3.5	**1:40**	8.0	14.2	**1:55**
Berwick Area Middle School	90	5	7.0	12.4	**1:50**	14.0	24.8	**2:15**
Berwick Senior High School	90	5	7.0	12.4	**1:50**	14.0	24.8	**2:15**
Fourteenth Street Elementary School	90	5	6.5	11.5	**1:50**	18.0	31.9	**2:20**
Heritage Christian Academy	90	5	7.0	12.4	**1:50**	14.0	24.8	**2:15**
Holy Family School	90	5	6.2	11.0	**1:50**	18.0	31.9	**2:20**
Mulberry Street Elementary School	90	5	7.0	12.4	**1:50**	14.0	24.8	**2:15**
Orange Street Elementary School	90	5	5.8	10.3	**1:50**	14.0	24.8	**2:15**
Luzerne County								
Drums Elementary School	90	5	2.0	3.5	**1:40**	8.2	14.5	**1:55**
Garrison Memorial Elementary School	90	5	11.0	19.5	**1:55**	17.0	30.1	**2:25**
GNA Elementary Center	90	5	0.6	1.1	**1:40**	4.0	7.1	**1:45**
Greater Nanticoke High School	90	5	0.6	1.1	**1:40**	4.0	7.1	**1:45**
Hunlock Creek Elementary School	90	5	5.0	8.8	**1:45**	17.0	30.1	**2:15**
Huntington Mills Elementary School	90	5	11.0	19.5	**1:55**	17.0	30.1	**2:25**
J F Kennedy Elementary School	90	5	0.6	1.1	**1:40**	4.0	7.1	**1:45**
K M Smith Elementary School	90	5	0.6	1.1	**1:40**	4.0	7.1	**1:45**
Mulhenberg Christian Academy	90	5	5.0	8.8	**1:45**	17.0	30.1	**2:15**
Nanticoke Middle School	90	5	0.6	1.1	**1:40**	4.0	7.1	**1:45**
Nescopeck Elementary School	90	5	7.3	12.9	**1:50**	14.0	24.8	**2:15**
Northwest Area High School	90	5	11.0	19.5	**1:55**	17.0	30.1	**2:25**
Pope John Paul II School	90	5	0.6	1.1	**1:40**	4.0	7.1	**1:45**
Rice Elementary School	90	5	0.6	1.1	**1:40**	5.5	9.7	**1:50**
Salem Elementary School	90	5	7.0	12.4	**1:50**	14.0	24.8	**2:15**
SIA Tech (Homestead Job Corps Center)	90	5	3.5	6.2	**1:45**	8.2	14.5	**2:00**
Valley Elementary School	90	5	3.0	5.3	**1:45**	8.2	14.5	**1:55**
				Maximum for EPZ:	**1:55**		**Maximum:**	**2:25**

Table 8-6A. Transit Dependent Evacuation Time Estimate - Good Weather				
Mobilization (min)	Loading (min)	Route Travel Time within EPZ (min)	Route Travel Time to Reception Center (min)	ETE (h:min)
90	30	8.8	53.1	3:05

1. INTRODUCTION

This report describes the analyses undertaken and the results obtained in preparing the Evacuation Time Estimates (ETE) for the Susquehanna Steam Electric Station (SSES) and the proposed Bell Bend Nuclear Power Plant (Bell Bend), located in Luzerne County, Pennsylvania. ETE are part of the required planning basis and provide state and local governments with site-specific information needed for Protective Action decision-making.

In the performance of this effort, all available documentation published by Federal Government agencies and relevant to ETE was reviewed. 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 Estimate Studies for Nuclear Power Plants, NUREG/CR-6863, January 2005.

We wish to express our appreciation to UniStar, PPL, all the directors and staff members of the Luzerne County and Columbia County emergency management agencies and local and state law enforcement and planning agencies, who provided valued guidance and contributed information contained in this report.

1.1 Overview of the ETE Determination 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 UniStar and PPL.
    - Attended meetings with emergency planners from the two EPZ counties and from the state to identify issues to be addressed.
    - Conducted a detailed field survey of the EPZ highway system and of area traffic conditions.
    - Obtained demographic data from the census and from state and county 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 evacuation areas or regions. The EPZ is partitioned into areas which serve as a basis for the ETE analysis presented herein. The existing municipal boundaries were used to define these areas. Evacuation “regions” are comprised of contiguous areas for which ETE are calculated. The configuration of these regions reflects the fact that the wind can take any direction and that the radial extent of the impacted area depends on accident-related circumstances. Each region, other than those that approximate circular areas, approximates a “key-hole” configuration within the EPZ as required by NUREG/CR-6863.

5. Estimated demand for transit services for persons at “special facilities” and for transit-dependent persons at home.

6. Defined a traffic management strategy. Traffic control is applied at specified Traffic Control Points (TCP) located within the Emergency Planning Zone (EPZ), and at Access Control Points (ACP) located outside the EPZ.

7. Prepared the input streams for the IDYNEV system.
   - Estimated the traffic demand, based on the available information derived from census data, from data provided by local and state agencies and from the telephone survey.
   - Applied the procedures specified in the 2000 Highway Capacity Manual (HCM[1]) to the data acquired during the field survey, to estimate the capacity of all highway segments comprising the evacuation routes within the EPZ and Shadow Region.
   - Developed the link-node representation of the evacuation network, which is used as the basis for the computer analysis that calculates the ETE.

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

- Calculated the evacuating traffic demands for each evacuation region and for each evacuation scenario. Considered the effects on demand of “voluntary evacuation” and of the “shadow effect”.
- Represented the traffic management strategy if special treatments are to be implemented.
- Specified the candidate destinations of evacuation travel consistent with outbound movement relative to the location of the FNPP.
- Prepared the input stream for the IDYNEV System.
- Executed the IDYNEV models to provide the estimates of evacuation routing and ETE.

8. Generated a complete set of ETE for all specified evacuation regions and scenarios.
9. Documented ETE in formats responsive to the cited NUREG reports.
10. Calculated the ETE for all transit activities including those for special facilities (schools, health-related facilities, etc.) and for the transit-dependent population at home.

Steps 6, 7 and 8 are iterated.

1.2 Location of the SSES and Bell Bend Nuclear Power Plants

SSES and the proposed Bell Bend Nuclear Power Plant are located within Salem Township in Luzerne County approximately one-half mile from the northern shore of the Susquehanna River. The site is approximately 22 miles southeast of the Scranton Wilkes-Barre region. The Emergency Planning Zone (EPZ) consists of parts of two counties: Luzerne County and Columbia County. Figure 1-1 displays the area surrounding SSES/Bell Bend. There are a total of 27 municipalities within the EPZ, some of which are completely within the EPZ.

The EPZ was updated recently. The proposed Bell Bend site is approximately 1 mile west of the existing site at SSES. This led to an extension of the EPZ in the western periphery within Columbia County. The EPZ presented in Figure 1-1, is the latest EPZ.

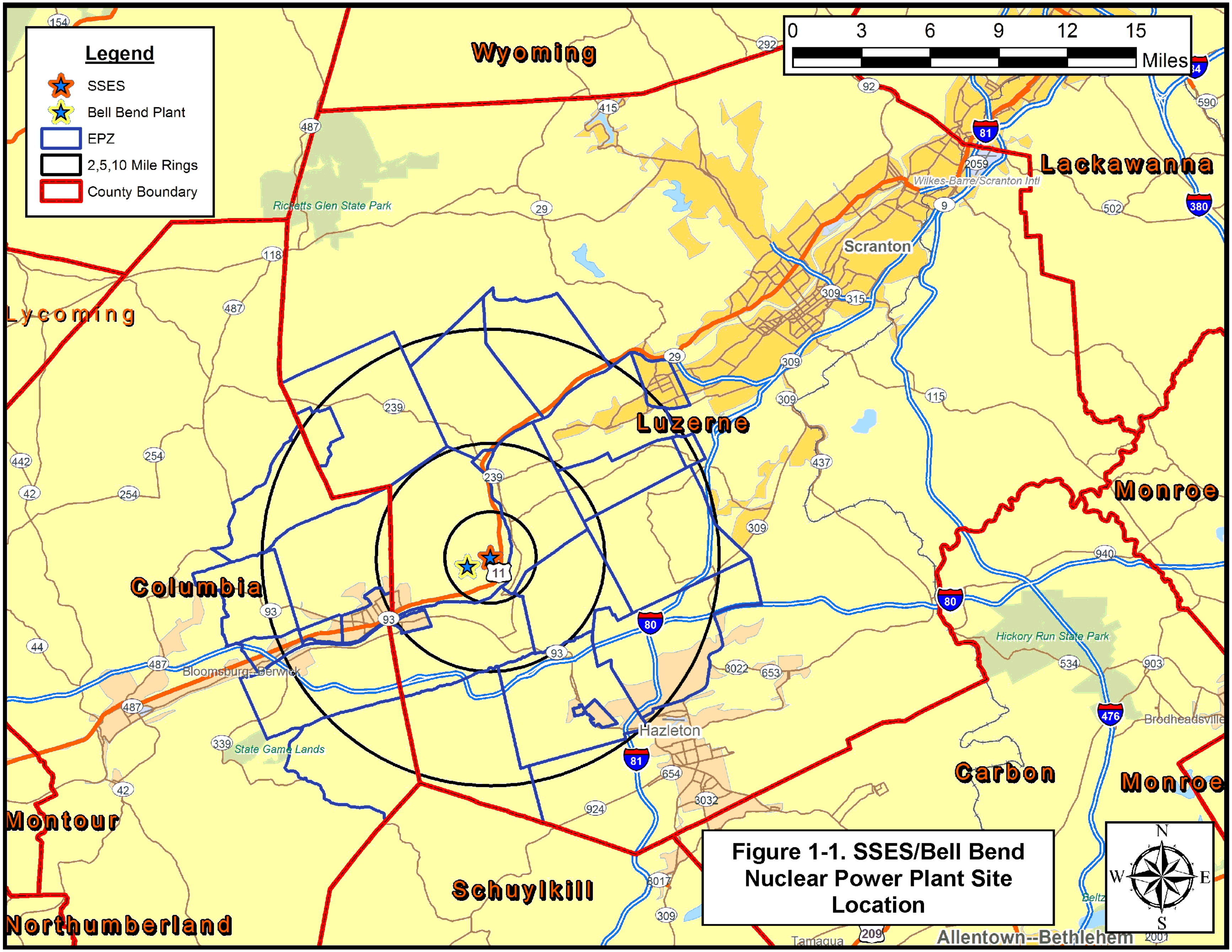


Figure 1-1. SSES/Bell Bend Nuclear Power Plant Site Location

1.3 Preliminary Activities

KLD performed preliminary review activities as 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 ETE. Supporting documents from a variety of sources, which contained information needed to form the database used for conducting evacuation analyses were also provided.

Field Surveys of the Highway Network

KLD personnel drove the entire highway system within the EPZ and for some distance outside. A tablet personal computer equipped with Global Positioning Satellite (GPS) and Geographical Information Systems (GIS) technologies was used during the road survey to acquire and record data. The characteristics of each section of highway were recorded. These characteristics include:

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

Video and audio recording equipment were used to capture a permanent record of the highway infrastructure. No attempt was made to meticulously measure such attributes as lane width and shoulder width; estimates of these measures based on visual observation and recorded images were considered appropriate for the purpose of estimating the capacity of highway sections. For example, Exhibit 20-5 in the Highway Capacity Manual (HCM) indicates that a reduction in lane width from 12 feet (the “base” value) to 10 feet can reduce free flow speed (FFS) by 1.1 mph – not a material difference – for two lane highways. Exhibit 12-15 in the HCM shows no sensitivity for the estimates of Service Volumes at Level of Service (LOS) E (near capacity), with respect to FFS. The topography of the highway (Level, Rolling, Mountainous) is a far more important factor than lane and shoulder width when estimating capacity.

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

As documented on page 20-3 of the HCM2000, the capacity of a two-lane highway is 1700 passenger cars per hour for each direction of travel. For freeway sections, a value of 2250 vehicles per hour per lane is assigned. The road survey has identified several segments which are characterized by adverse geometrics which are reflected in reduced values for both capacity and speed. These estimates reflect the service volumes for LOS E presented in HCM Exhibit 12-15. These links may be identified by reviewing Appendix K. Link capacity is an input to IDYNEV which calculates the ETE. The locations of these sections may be identified by reference to the large-scale map (provided as a separate file) showing the link-node diagram with the nodes identified.

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 and the number of evacuating vehicles, 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 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.

Given the scale of Figure 1-2, it is not feasible to identify the links and nodes to enable the reader to relate to the information presented in Appendix K. Therefore, an annotated map is provided in electronic format which can be printed at a suitable scale, if desired.

Analytical Tools

The IDYNEV System that was employed to compute ETE for this study is comprised of several integrated computer models. One of these is the PC-DYNEV (DYnamic Network

EVacuation) macroscopic simulation model that was developed by KLD under contract with the Federal Emergency Management Agency (FEMA).

IDYNEV 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. Finally, software to display animations of the evacuating traffic environment, named EVAN (Evacuation Animation), was used to assist the analysts during the iterative procedure described above, and to prepare some of the displays in this report.

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

For the reader interested in more details of the model than are provided in Appendices B, C and D, and in Highway Research Record No. 772, the following references are suggested:

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

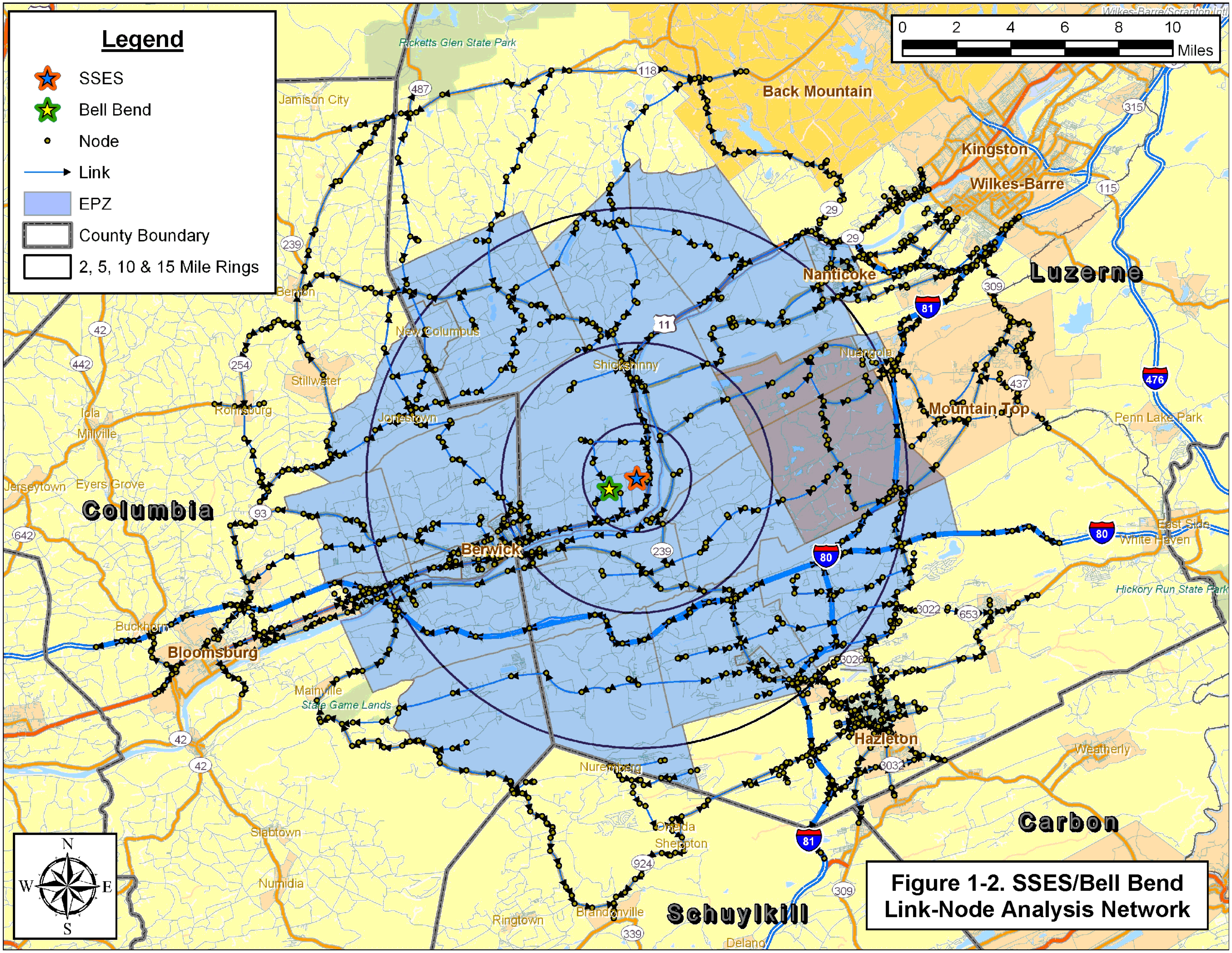


Figure 1-2. SSES/Bell Bend Link-Node Analysis Network

The evacuation analysis procedures are based upon the need to:

- Route traffic along paths that will expedite their travel from their respective points of origin to points outside the EPZ
- Restrict movement toward SSES/Bell Bend 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 SSES/Bell Bend.

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 PC-DYNEV 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 consider the development of countermeasures designed to expedite the movement of vehicles. These are discussed in subsequent sections. The outputs of this model are the volume of traffic, expressed as vehicles/hour, that exit the evacuation region along the various highways (links) that cross the region boundaries. These outputs are exported into a spreadsheet which documents the ETE. Intermediate, detailed results are also produced, at specified time intervals, for each network link. Section 7 presents a further description of this process along with the ETE Tables.

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 earlier ETE study. That study was completed in 1981 by HMM Associates. 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:

- A decrease in permanent resident population.
- Vehicle occupancy and trip-generation rates are based on the results of a telephone survey of EPZ residents.
- Voluntary and shadow evacuations are considered.
- The highway representation is far more detailed. The link-node analysis network extends out to 15 miles from the plant.

Table 1-1. ETE Study Comparisons

Topic	Treatment	
	Previous ETE Study	**Current ETE Study**
Resident Population Basis	ArcGIS Software using 1980 US Census blocks; area ratio method used. Population = 71,511	ArcGIS Software using 2000 US Census blocks; block centroid method used; population extrapolated to 2009 using the 2006 census estimates. Population = 70,118
Resident Population Vehicle Occupancy	3.0 persons per evacuating household based on discussions with emergency management officials.	1.94 persons per evacuating vehicle based on telephone survey results. (1.3 evac. veh./evacuating household; 2.52 persons/household)
Employee Population	Employees treated as separate population group. Employee estimates based on information provided by the counties and direct phone calls to major employers. All employees were counted as part of the evacuating population. 1 employee/vehicle.	Employees treated as separate population group. Employee estimates based on information provided by the counties, by Internet searches, and by direct phone calls to major employers. Using the Journey to Work census data, estimated the percentage of employees residing outside the EPZ. 1.02 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 outer extent of the region; 35 percent of population in annular ring between the outer extent 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)

Table 1-1. ETE Study Comparisons		
Topic	**Treatment**	
	Previous ETE Study	**Current ETE Study**
Network Size	75 Nodes; 135 Links.	1517 Links; 1046 Nodes.
Roadway Geometric Data	Field surveys conducted. Date not provided.	Field surveys conducted in 2008. Major intersections were video archived. GIS shape-files of signal locations and roadway characteristics created during road survey. Road capacities based on 2000 HCM.
School Evacuation	Direct evacuation to designated Reception Center/Host School.	Direct evacuation to designated Reception Center/Host School.
Transit Dependent Population	Transit dependent population estimated using 1970 census data on HH with 0 vehicles	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. Telephone surveys results used to estimate transit dependent population. Verified with the information provided in the county and municipal emergency plans.
Ridesharing	Assumed no ride sharing as a conservative estimate.	50 percent of transit dependent persons will ride with a neighbor or friend.

Table 1-1. ETE Study Comparisons		
Topic	**Treatment**	
	Previous ETE Study	**Current ETE Study**
Trip Generation for Evacuation	Based on discussions with emergency management officials: Residents and Transients leave between 30 minutes, and 2 hours and 30 minutes, with 95% mobilized in 2 hours. Employees leave between 30 minutes and 90 minutes with 90% mobilized within the first 30 minutes. All times measured from the Advisory to Evacuate.	Based on residential telephone survey of specific pre-trip mobilization activities: Residents with commuters returning, leave between 45 minutes and 5 hours and 30 minutes. Residents without commuters returning leave between 15 minutes and 5 hours. Employees and transients leave between 15 minutes and 2 hours. All times measured from the Advisory to Evacuate.
Traffic and Access Control	Not discussed.	Traffic and Access Control used in all scenarios to facilitate the flow of traffic outbound relative to the plant. Detailed schematics provided for each point. These were cross referenced with the detailed traffic control defined in the county and municipal emergency plans.
Modeling	NETVAC3	IDYNEV System: TRAD and PC-DYNEV.
Evacuation Cases	10 Regions, 3 Base Scenarios and 3 Adverse Weather Scenarios. A total of 48 unique cases.	22 Regions (key-hole:central sector in wind direction with adjacent sectors) and 13 Scenarios producing 286 unique cases
Evacuation Time Estimates Reporting	ETE reported 100th percentile population. Results presented by Region and Scenario	ETE reported for 50th, 90th, 95th, and 100th percentile population. Results presented by Region and Scenario.

Table 1-1. ETE Study Comparisons		
Topic	**Treatment**	
	Previous ETE Study	**Current ETE Study**
Evacuation Time Estimates for the entire EPZ, 100th percentile.	Full EPZ – Summer Weekday: Good weather = 6:05 Full EPZ – Summer Weekend: Good weather = 6:00	Full EPZ – Summer Weekday Good weather = 5:40 Full EPZ – Winter Weekday: Good weather = 5:10

2. STUDY ESTIMATES AND ASSUMPTIONS

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

2.1 Data Estimates

1. Population estimates are based upon census 2000 data, projected to year 2009. County-specific projections are based upon growth rates obtained from the census website. Estimates of employees who commute into the EPZ to work are based upon employment data obtained from county economic development websites and from census journey to work files
2. Population estimates at special facilities are based on available data from county emergency management offices and from direct phone calls to the facilities.
3. Roadway capacity estimates are based on field surveys and the application of Highway Capacity Manual 2000 guidance.
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. The average values of 2.52 persons per household and 1.30 evacuating vehicles per household are used.
6. The relationship between persons and vehicles for transients is as follows:
    a. Transients: 2 to 4 persons per vehicle, depending on the facility being visited.
    b. Employees: 1.02 employees per vehicle (telephone survey results)
7. The ETE are presented for the evacuation of the 50^{th}, 90^{th}, 95^{th} and 100^{th} percentiles of population, for each evacuation region and for each scenario. These ETE are presented in tabular and graphical formats. An evacuation region is defined as a group of contiguous emergency response planning areas (ERPA) or municipalities that is issued an advisory to evacuate.
8. The numbers of transit-dependent persons at home and in special facilities are taken from the estimates provided in the radiological emergency plans for each of the municipalities within the EPZ. The number of vehicle-trips required is based upon these estimates and their status (ambulatory, special needs).

2.2 Study Methodological Assumptions

1. The ETE is defined as the elapsed time from the advisory to evacuate issued to persons within a specific evacuation region of the EPZ, to the time that Region is clear of the indicated percentile of people.
2. The ETE are computed and presented in a format compliant with the guidance in the cited NUREG documentation. The ETE for each evacuation area ("region" comprised of included Municipalities) is presented in both statistical and graphical formats.
3. Evacuation movements (paths of travel) are generally outbound relative to the power plant to the extent permitted by the highway network, as computed by the computer models. All available evacuation routes are used in the analysis.
4. Evacuation regions are defined by the underlying "keyhole" or circular configurations as specified in NUREG/CR-6863. These regions, as defined, display irregular boundaries reflecting the geography of the Municipalities included within these underlying configurations.
5. Voluntary evacuation is considered as indicated in the accompanying Figure 2-1. There are basically two "keyhole configurations" that form most evacuation regions: (1) a central circular area of 2-mile radius and a sector with a central angle of 67.5 degrees that extends to a distance of about 5 miles; and (2) a central circular area of 5-mile radius and a sector extending to a distance of 10 miles (actually, to the EPZ boundary). For the first configuration, pictured in Figure 2-1, there exists an area outside the evacuation region but within 5 miles of the power station. It is assumed that 50 percent of the population within this area will elect to "voluntarily" evacuate even though they are advised to shelter. In the remaining area that is outside the evacuation region, but within the EPZ, it is assumed that 35 percent of that population will elect to evacuate.

   For the second configuration (not shown in Figure 2-1), it is assumed that 50 percent of the population within the EPZ, but outside the evacuation region, will elect to voluntarily evacuate. In the area (Shadow Region) between the EPZ boundary and a 15-mile-radiuscircle centered at the plant (the "Shadow Region"), it is assumed that 30 percent of the people there will evacuate voluntarily. Sensitivity studies explored the effect on ETE, of increasing this percentage of voluntary evacuees in the Shadow Region; see Appendix I for the results of this study.
6. A total of 13 "Scenarios" representing different seasons, time of day, day of week and weather are considered. One special event scenario is studied; the peak construction period of the Bell Bend plant during refueling at the SSES site. These scenarios are detailed in Table 2-1.

7. The models of the IDYNEV System were recognized as state of the art by Atomic Safety & Licensing Boards (ASLB) in past hearings. (Sources: Atomic Safety & Licensing Board Hearings on Seabrook and Shoreham; Urbanik[1]). The models have been independently validated by a consultant retained by the NRC and have continuously been refined and extended since those hearings.

Table 2-1. Evacuation Scenario Definitions					
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	Midweek	Midday	Snow	None
9	Winter	Weekend	Midday	Good	None
10	Winter	Weekend	Midday	Rain	None
11	Winter	Weekend	Midday	Snow	None
12	Winter	Midweek, Weekend	Evening	Good	None
13	Summer	Midweek	Midday	Good	Bell Bend Construction and SSES Refueling

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

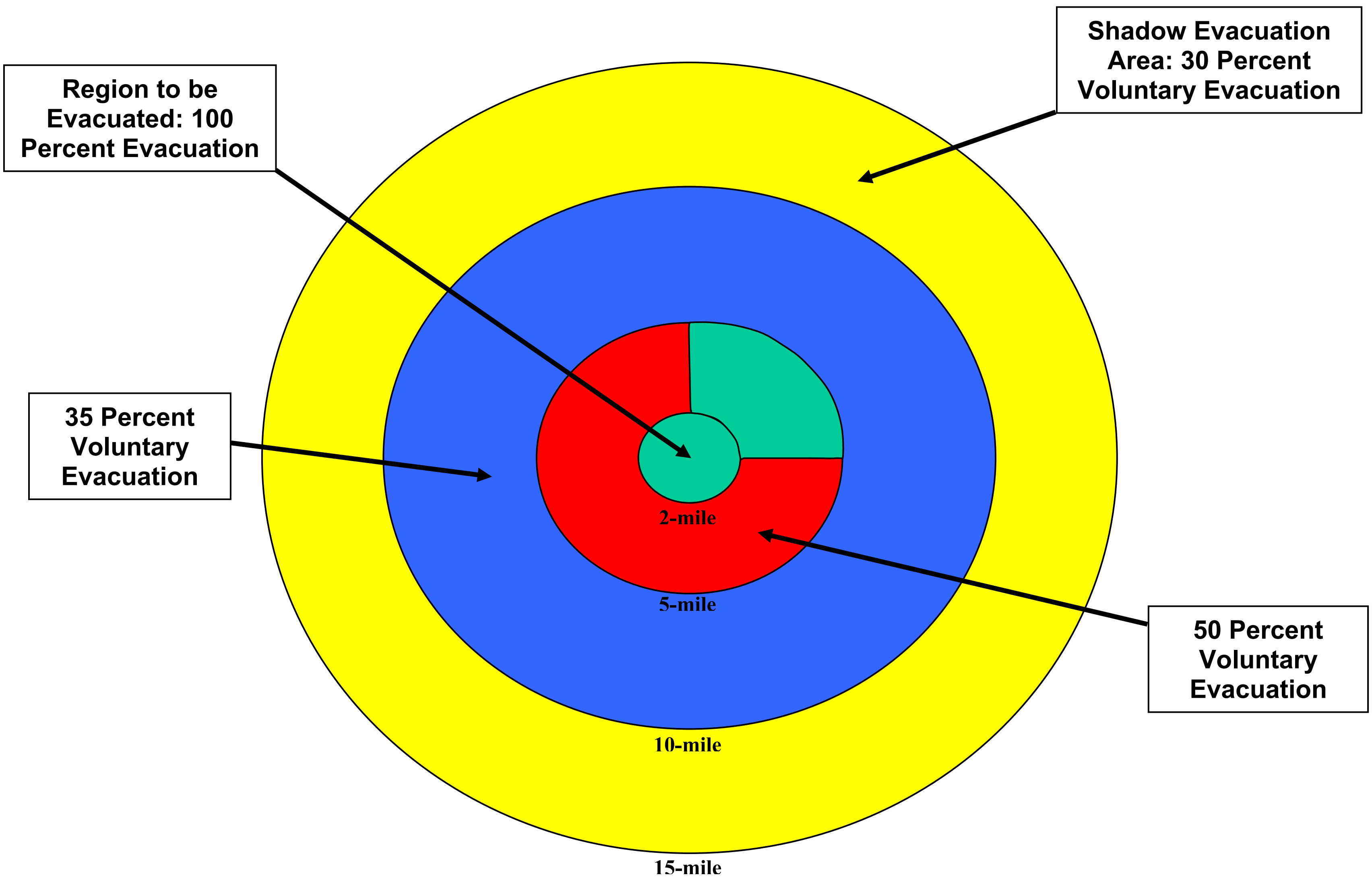


Figure 2-1. Voluntary Evacuation Methodology

2.3 Study Assumptions

1. The Planning Basis assumption for the calculation of ETE is a rapidly escalating accident that requires evacuation, and includes the following:
   a. Advisory to evacuate is announced coincident with the siren notification.
   b. Mobilization of the general population will commence within 10 minutes of the advisory to evacuate.
   c. ETE are measured relative to the 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. Busses will evacuate the schools first (if in session at the time of the accident) before those who are transit-dependent.
   b. 52 percent of households in the EPZ have at least one commuter; 60 percent of those households will await the return of a commuter before beginning their evacuation trip, based on the telephone survey results.
4. The ETE calculations will also include consideration of "through" (external-external) trips during the time that such traffic is permitted to enter the evacuated Region. "Normal" traffic flow is assumed to be present within the EPZ at the start of the emergency.
5. Access Control Points (ACP) will be staffed within approximately 90 minutes of the siren notifications, to divert through traffic attempting to enter the EPZ. Earlier activation of ACP locations could delay returning commuters. It is assumed that no through vehicles will enter the EPZ after this 90 minute mobilization time period.
6. Traffic Control Points (TCP) within the EPZ will be staffed over time, beginning at the advisory to evacuate. Their number and location will depend on the region to be evacuated and personnel resources available. The objectives of these TCP are:
   - Facilitate the movements of all (mostly evacuating) vehicles at the location.
   - Discourage inadvertent vehicle movements toward the power station.
   - Provide assurance and guidance to any traveler who is unsure of the appropriate actions or routing.
   - Act as a local surveillance and communications center. Provide information to the Emergency Operations Center (EOC) as needed, based on direct observation or on information provided by travelers.

   Consistent with these objectives, there is no expectation that the operation of TCPs will materially shorten evacuation times. In calculating ETE, it is assumed that drivers will act rationally, travel in the directions identified in the plan (as documented in the public information material), and obey all control devices and traffic guides. Therefore, the TCP are not expected to enhance or impede the flow of traffic. Consequently, any shortfall of personnel or equipment will not influence the ETE results. Also, the time needed to mobilize personnel or equipment to man these TCP will not influence the ETE results.

7. Buses will be used to transport those without access to private vehicles:
   a. If schools are in session, transport (buses) will evacuate students directly to the assigned Reception Centers and host schools.
   b. Schoolchildren, if school is in session, are given priority in assigning transit vehicles.
   c. Bus mobilization time is considered in ETE calculations.
   d. Analysis of the number of required "waves" of transit vehicles used for evacuation is presented.
8. It is reasonable to assume that 50 percent of transit-dependent people will ride-share with family, neighbors, and friends, thus reducing the demand for buses. This assumption is based upon reported experience for other emergencies[2]. The remaining transit-dependent portion of the general population will be evacuated to reception centers by bus.
9. Two types of adverse weather scenarios are considered. Rain may occur in winter or summer. It is assumed that the rain begins at about the same time the evacuation advisory is issued. Therefore, no weather-related reduction in the number of transients who may be present in the EPZ is assumed.

   Snow may occur in winter scenarios. Transient population reductions are not assumed for snow scenarios. Further, it is assumed that roads are passable and that the appropriate agencies are plowing the roads as they would normally.

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

[2] 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).

Scenario	Highway Capacity*	Free Flow Speed*	Mobilization Time
Rain[3]	90%	90%	No Effect
Snow	80%	80%	Clear driveway before leaving home (Source: Telephone Survey)
*Adverse weather capacity and speed values are given as a percentage of good weather conditions. Roads are assumed to be passable.			

10. School buses used to transport students are assumed to have the capacity 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 an average of 30 people per bus, taking into account that they will be carrying luggage and allowing for some reserve capacity.

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

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. In developing this estimate, it is necessary to distinguish between those who have access to privately owned vehicles (POV) and those who would require transit vehicles be provided. The latter group includes home-based persons and those in "special facilities."

3. An estimate of potential double counting of vehicles.

Appendix E presents much of the source material for the population estimates. The 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 (a few days, or one or two weeks), or may enter and leave within one day. Estimates of the size of this population component 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 within the EPZ could be counted as a resident, again as an employee.
- A visitor who stays at a hotel and spends time at a park, then goes shopping could be counted three times.

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

As outlined above, the population characteristics of the SSES/Bell Bend EPZ can be described as 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 (e.g., hunting, fishing) and then leave the area.
- Commuter-employees - people who reside outside 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 municipality and by polar coordinate representation (population rose). The SSES/Bell Bend EPZ has been subdivided into 27 Municipalities as 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 (2.52 persons/household) and the average number of evacuating vehicles per household (1.3 vehicles/household) were obtained from the telephone survey results.

The rate of population change for each municipality in the study area was obtained by KLD from Census data. These growth rates were applied to Year 2000 Census block point data using Geographical Information Systems (GIS) software to project population within the EPZ and within the shadow region to the Year 2009. Table 3-1 summarizes the rate of population change for each county. The county wide averages suggest that Columbia and Carbon counties are growing at a low rate while Luzerne and Schuylkill counties have lower populations.

Permanent resident population and vehicle estimates for 2009 are presented in Table 3-3. Figures 3-2 and 3-3 present the permanent resident population and permanent resident vehicle estimates by sector and distance from SSES/Bell Bend. This “rose” was constructed using GIS software.

Table 3-1 Population Estimates by County

County	2000 Census	2006 Census Estimate	Annual Growth Rate %
Columbia	64,151	65,014	0.21
Luzerne	319,250	313,020	-0.32*
Carbon	58,802	62,567	0.99
Schuylkill	150,336	147,405	-0.32*

* Using zero growth rates to project population to 2009.

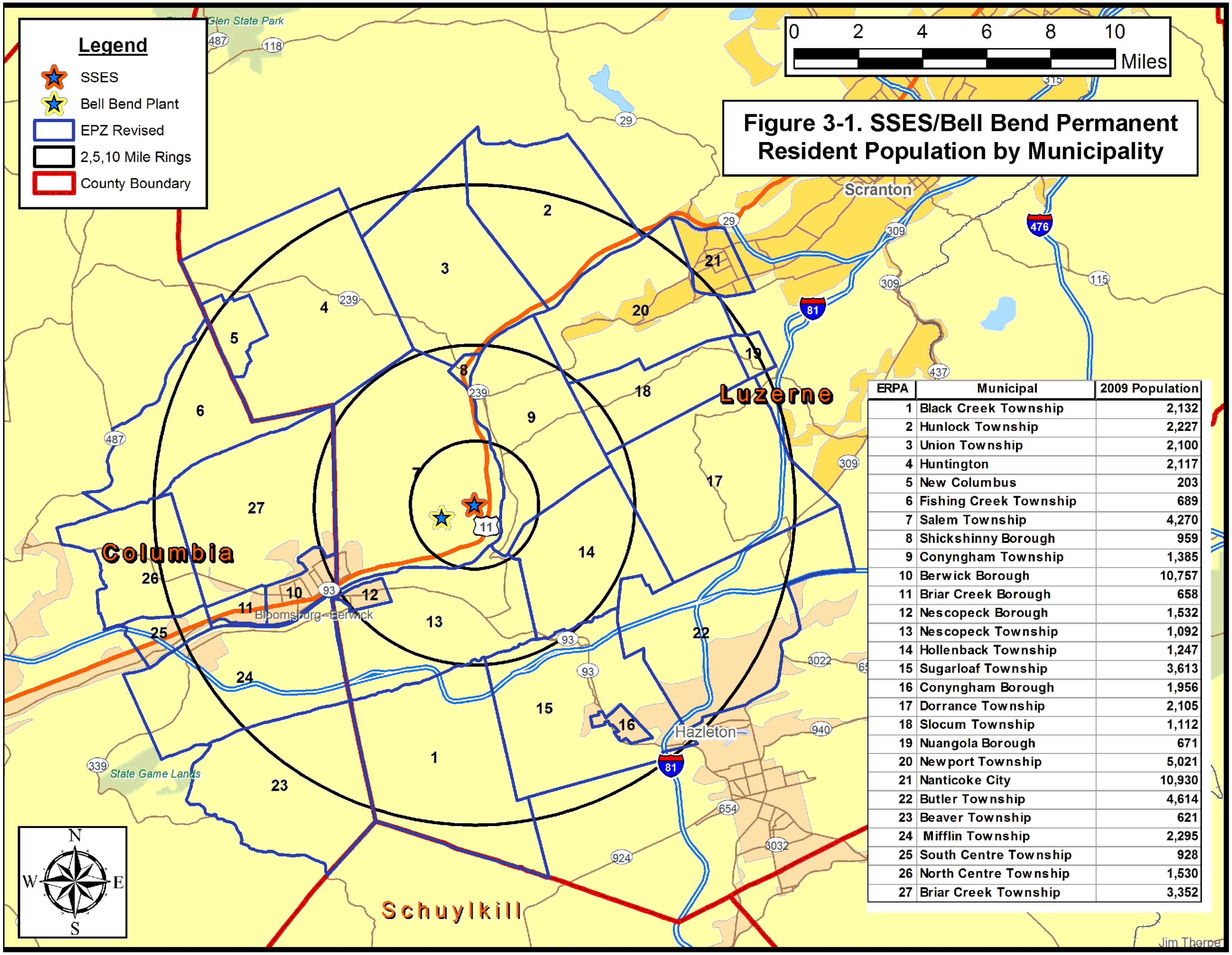
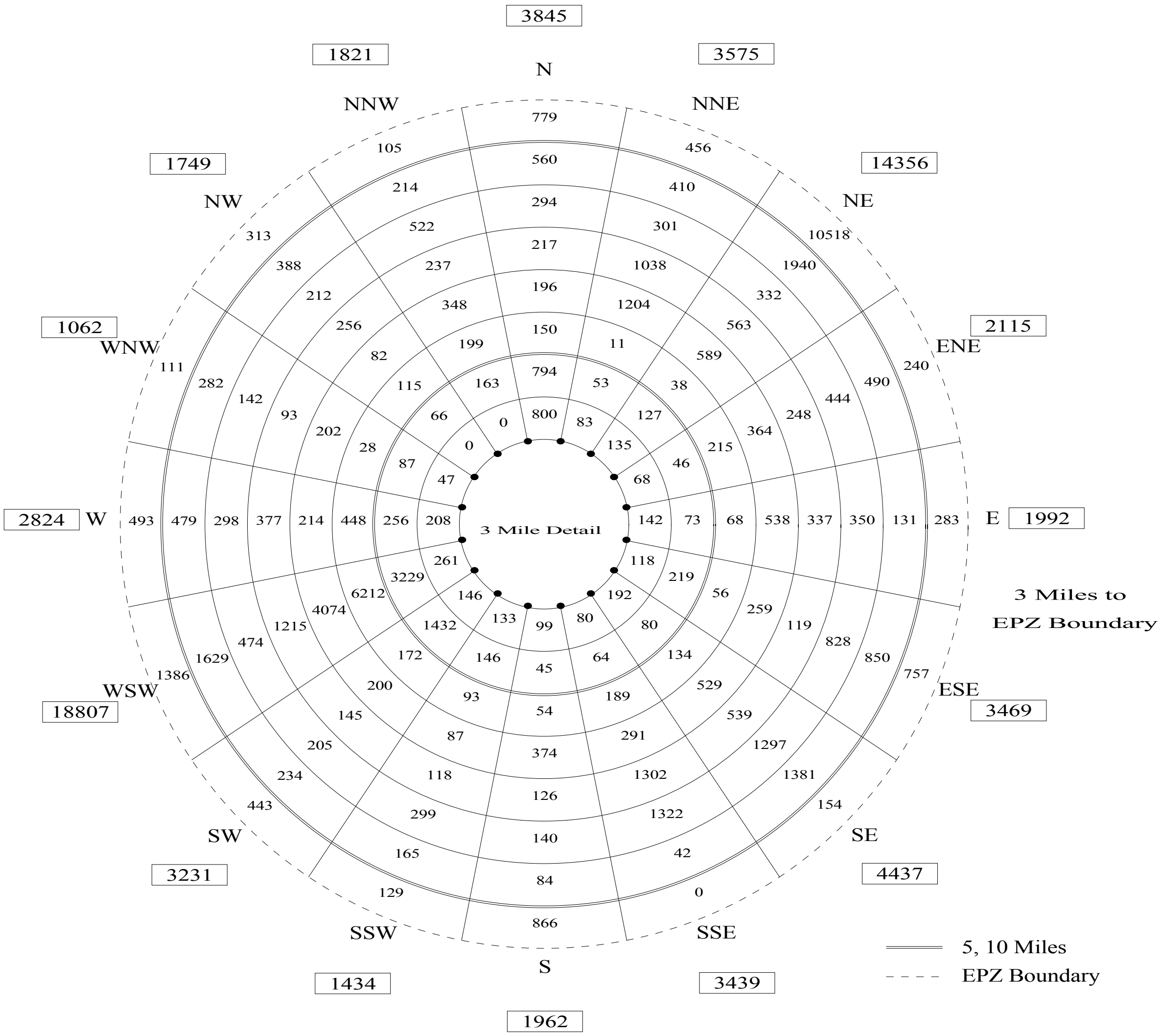


Figure 3-1. SSES/Bell Bend Permanent Resident Population by Municipality

ERPA	Municipal	2009 Population
1	Black Creek Township	2,132
2	Hunlock Township	2,227
3	Union Township	2,100
4	Huntington	2,117
5	New Columbus	203
6	Fishing Creek Township	689
7	Salem Township	4,270
8	Shickshinny Borough	959
9	Conyngham Township	1,385
10	Berwick Borough	10,757
11	Briar Creek Borough	658
12	Nescopeck Borough	1,532
13	Nescopeck Township	1,092
14	Hollenback Township	1,247
15	Sugarloaf Township	3,613
16	Conyngham Borough	1,956
17	Dorrance Township	2,105
18	Slocum Township	1,112
19	Nuangola Borough	671
20	Newport Township	5,021
21	Nanticoke City	10,930
22	Butler Township	4,614
23	Beaver Township	621
24	Mifflin Township	2,295
25	South Centre Township	928
26	North Centre Township	1,530
27	Briar Creek Township	3,352

Table 3-2. EPZ Permanent Resident Population		
Municipality	**2000 Population**	**2009 Population**
1	2,132	2,132
2	2,227	2,227
3	2,100	2,100
4	2,117	2,117
5	203	203
6	676	690
7	4,270	4,270
8	959	959
9	1,385	1,385
10	10,552	10,757
11	645	658
12	1,532	1,532
13	1,092	1,092
14	1,247	1,247
15	3,613	3,613
16	1,956	1,956
17	2,105	2,105
18	1,112	1,112
19	671	671
20	5,021	5,021
21	10,930	10,930
22	4,614	4,614
23	609	621
24	2,251	2,295
25	910	928
26	1,501	1,531
27	3,288	3,352
TOTAL	**69,718**	**70,118**
Population Growth:		**0.57%**

Table 3-3. Permanent Resident Population and Vehicles by Municipality		
Municipality	**2009 Population**	**2009 Vehicles**
1	2,132	1,100
2	2,227	1,149
3	2,100	1,084
4	2,117	1,093
5	203	105
6	690	356
7	4,270	2,203
8	959	495
9	1,385	715
10	10,757	5,550
11	658	340
12	1,532	791
13	1,092	564
14	1,247	644
15	3,613	1,864
16	1,956	1,010
17	2,105	1,086
18	1,112	574
19	671	347
20	5,021	2,591
21	10,930	5,639
22	4,614	2,381
23	621	321
24	2,295	1,184
25	928	479
26	1,531	790
27	3,352	1,730
TOTAL	**70,118**	**36,185**



Resident Population			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	173	0-1	173
1-2	894	0-2	1067
2-3	1224	0-3	2291
3-4	2512	0-4	4803
4-5	6880	0-5	11683
5-6	8182	0-6	19865
6-7	9551	0-7	29416
7-8	6930	0-8	36346
8-9	7460	0-9	43806
9-10	9279	0-10	53085
10-EPZ	17033	0-EPZ	70118

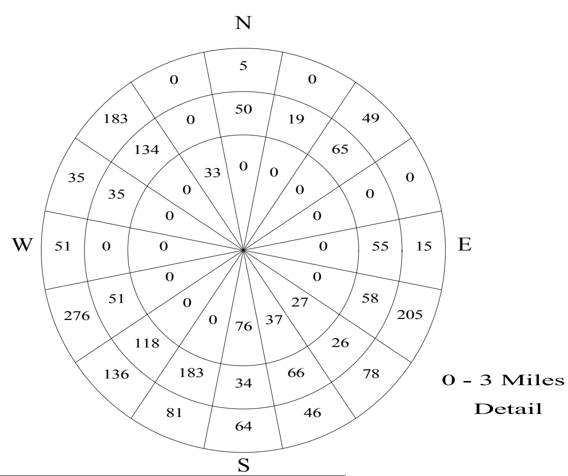
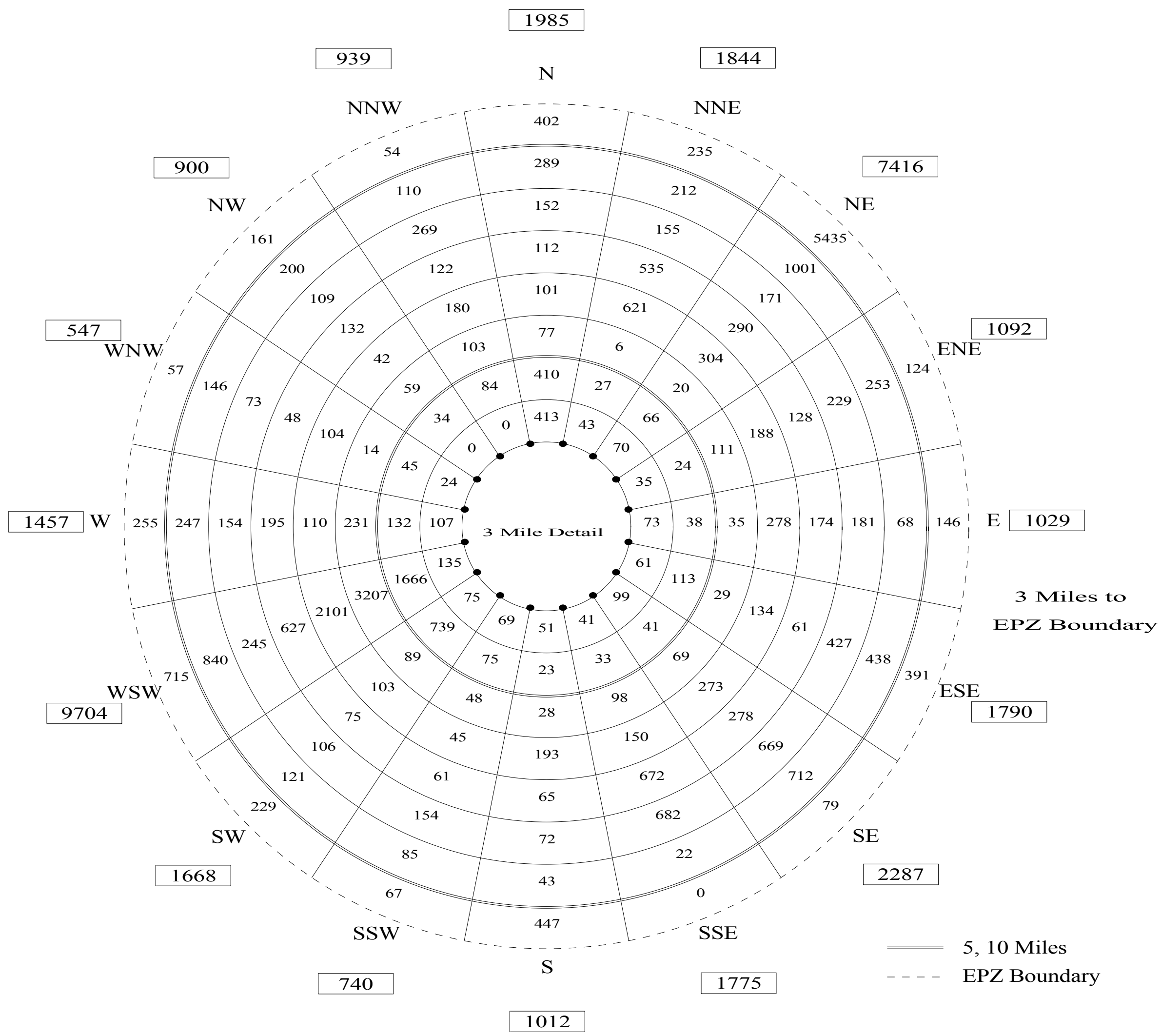


Figure 3-2. Permanent Residents by Sector



Resident Vehicles			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	89	0-1	89
1-2	461	0-2	550
2-3	631	0-3	1181
3-4	1296	0-4	2477
4-5	3550	0-5	6027
5-6	4224	0-6	10251
6-7	4927	0-7	15178
7-8	3575	0-8	18753
8-9	3848	0-9	22601
9-10	4787	0-10	27388
10-EPZ	8797	0-EPZ	36185

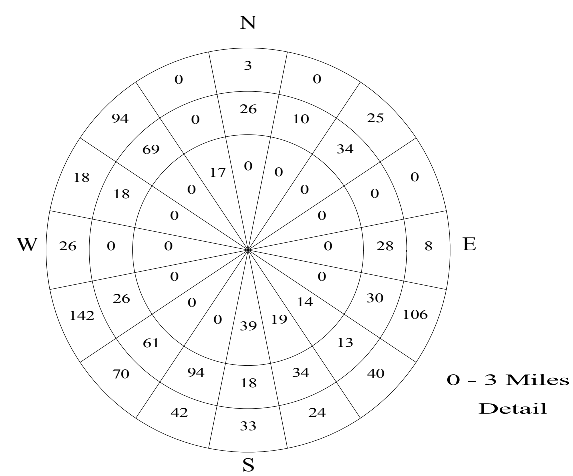


Figure 3-3. Permanent Resident Vehicles by Sector

Transient Population

Transient population groups are defined as those people who are not permanent residents and who enter the EPZ for a specific purpose (hunting, fishing). Transients may spend less than one day or stay overnight or longer at camping facilities, hotels and motels. There are several locations within the SSES/Bell Bend EPZ that attract transients.

1. Fishing

Fishing is popular along the Susquehanna River and lakes within the EPZ. Using the PA State Fishing website three locations within the EPZ were identified: two sites are along the Susquehanna River and the other at Lake Lily.

2. Hunting

The PA state game lands 260 and 55 are within the EPZ. These were identified using the state game lands website.

3. Golf Courses

Three major golf courses were identified within the EPZ. Based on discussions with the golf courses, the report uses an estimated 20 additional people and trips at each course who are non-residents within the EPZ.

4. State Parks

The Nescopeck State park is on the eastern end of the EPZ. Some of the common activities are hiking and fishing. Using aerial imagery of the parking lots, an estimate of 30% non EPZ residents using the facility and assuming 65% peak occupancy, yields an estimated 49 vehicles at this facility.

5. Camp Grounds

Five camp sites were identified within the EPZ. Based on discussions with the camp site management, an average of 1 vehicle with 4 persons per site was estimated, of whom half are from outside the EPZ. Applying peak occupancy of 65% yields a total of 78 campers from outside the EPZ.

6. Hotels/Motels

A total of 11 lodging facilities were identified within the EPZ. Based on a small sample of information, these facilities were estimated to have 80% peak occupancy with 2 persons and 1 vehicle per room.

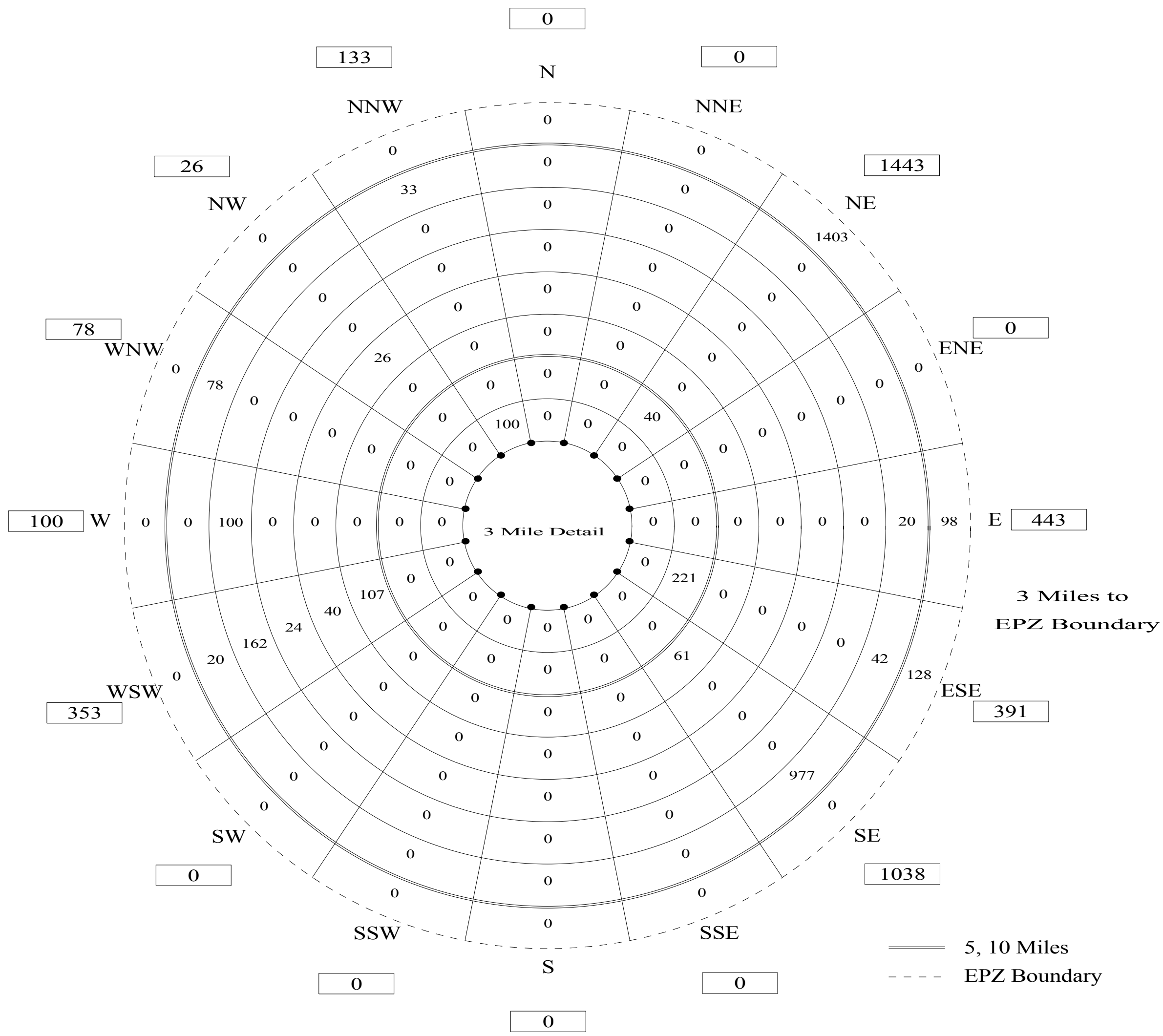
7. Penn State and Luzerne Community College

The Penn State Hazelton campus includes 475 resident students, 977 visiting students. These non-resident students are considered as transients because their departure patterns are similar to other transients. Similarly, 1232 and 100 students, at the Luzerne Community College campuses at Nanticoke and Berwick, respectively, are considered as transients.

There are a total of 4,005 transients in 3,098 vehicles within the SSES/Bell Bend EPZ during peak times. Appendix E presents the supporting data for these estimates, as well as maps of the major transient destinations within the EPZ.

Table 3-4 summarizes the transient population and vehicles by Municipality. Figures 3-4 and 3-5 present transient population and transient vehicle data by sector.

Table 3-4. Transient Population and Vehicles by Municipality		
Municipality	Transients	Transient Vehicles
1	0	0
2	0	0
3	33	9
4	26	7
5	0	0
6	178	120
7	100	100
8	0	0
9	325	82
10	127	114
11	52	26
12	0	0
13	0	0
14	221	56
15	1,038	899
16	0	0
17	20	20
18	40	20
19	0	0
20	0	0
21	1,403	1,403
22	268	135
23	0	0
24	110	55
25	20	20
26	0	0
27	44	32
TOTAL	**4,005**	**3,098**



Transient Population			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	0	0-1	0
1-2	325	0-2	325
2-3	0	0-3	325
3-4	100	0-4	425
4-5	261	0-5	686
5-6	168	0-6	854
6-7	66	0-7	920
7-8	24	0-8	944
8-9	262	0-9	1206
9-10	1170	0-10	2376
10-EPZ	1629	0-EPZ	4005

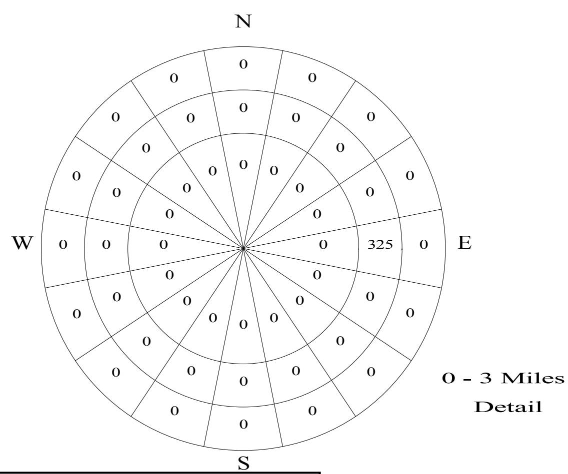
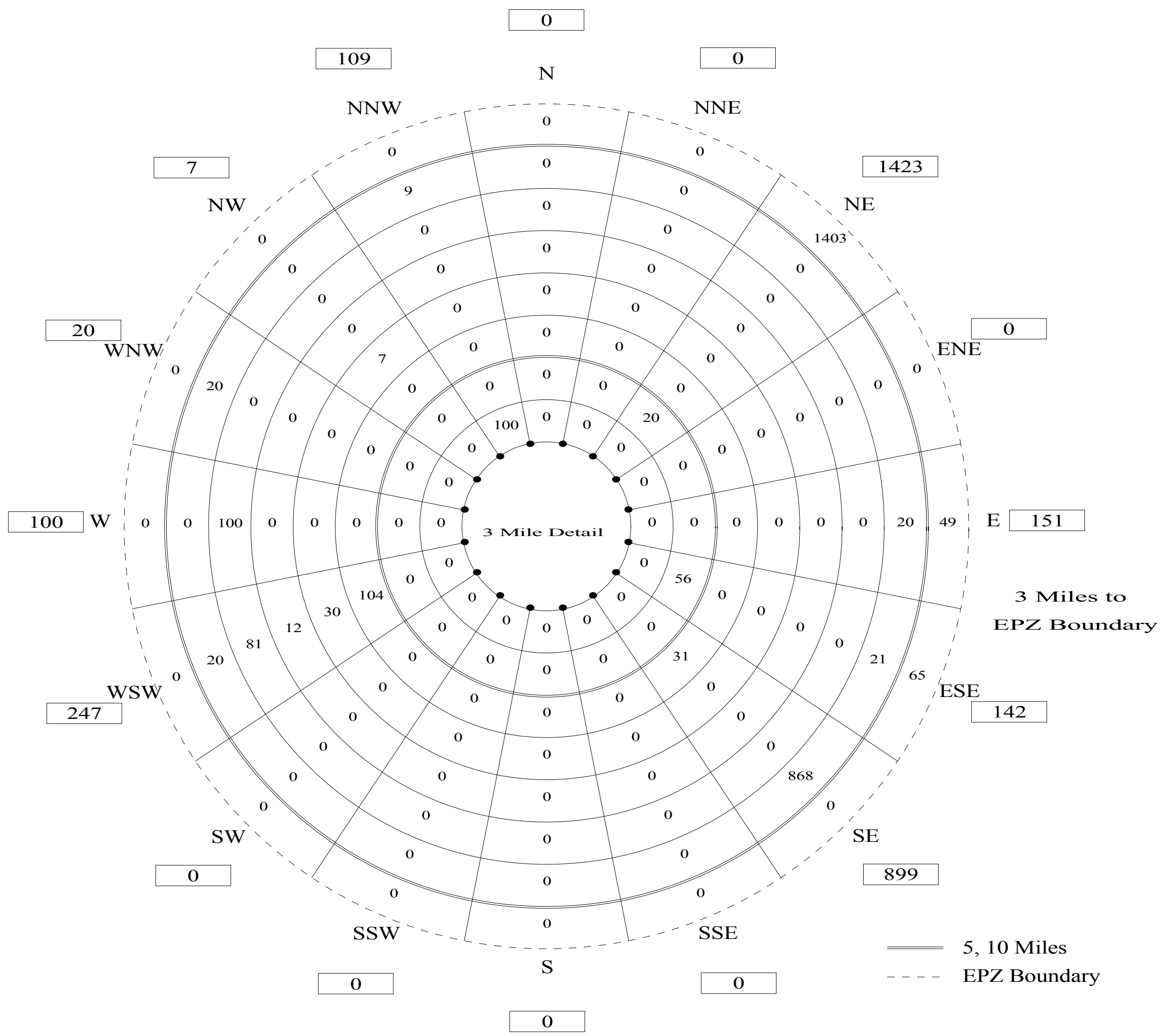
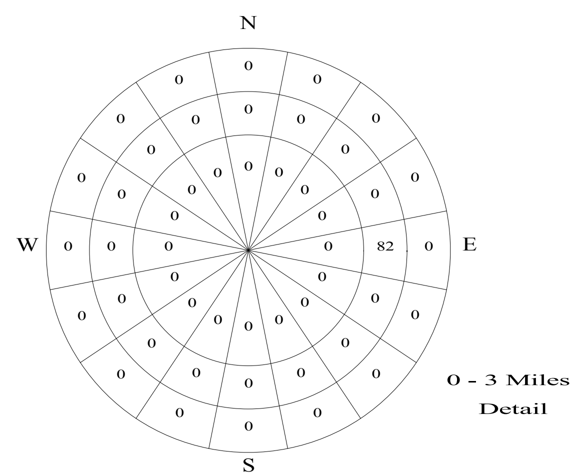


Figure 3-4. Transient Population by Sector





Transient Vehicles			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	0	0-1	0
1-2	82	0-2	82
2-3	0	0-3	82
3-4	100	0-4	182
4-5	76	0-5	258
5-6	135	0-6	393
6-7	37	0-7	430
7-8	12	0-8	442
8-9	181	0-9	623
9-10	958	0-10	1581
10-EPZ	1517	0-EPZ	3098

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

Data for major employers in the EPZ were obtained from internet searches and from direct phone calls to major employers. The locations of these facilities were mapped using GIS software. The GIS map was overlaid with the evacuation analysis network and employees were loaded onto appropriate links.

Appendix E provides the data obtained for major employers within the EPZ as well as a map of the major employers.

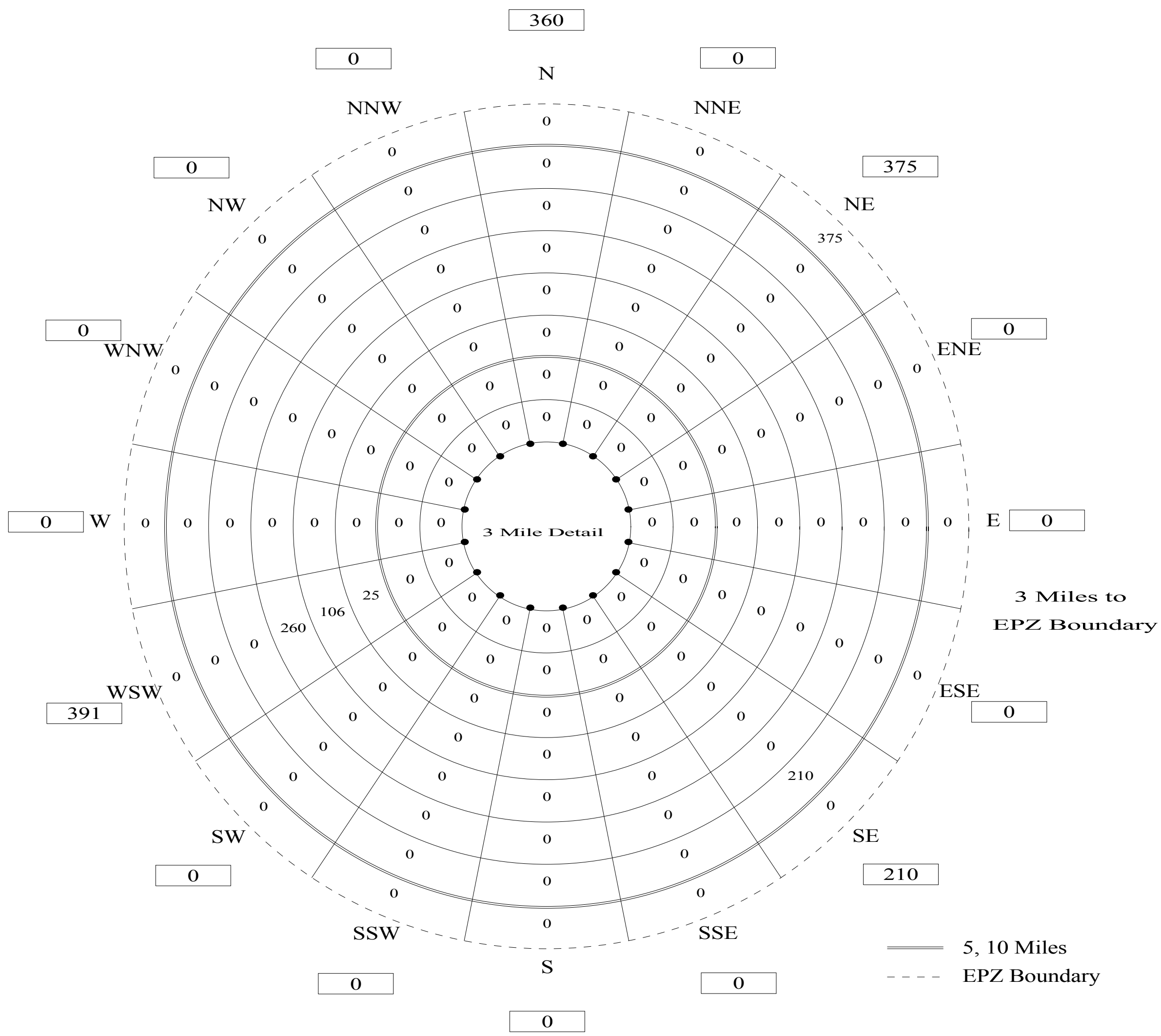
Major employers were asked how many of their employees traveled more than 10 miles to work. This question was used to estimate the percentage of employees that were non-EPZ residents.

There are likely several smaller employment centers within the EPZ, but employees at such facilities are most likely EPZ residents.

Detailed data were provided by PPL for the current site employment at SSES. Using that information, an accurate estimate of the number of employees living outside the EPZ was obtained. For the other major employers, the Journey to Work Census data was used to identify the travel and work patterns within Luzerne and Columbia County. An occupancy of 1.02 persons per employee-vehicle (some carpooling) obtained from the telephone survey, was used to determine the number of evacuating employee vehicles.

There are a total of 1,336 employees commuting into the EPZ on a daily basis. These employees use 1,311 vehicles. Table 3-5 summarizes the employees commuting into the EPZ by municipality. Figures 3-6 and 3-7 present non-EPZ Resident employee data by sector.

Table 3-5. Employees and Vehicles Commuting into the EPZ by Municipality		
Municipality	**Employees**	**Employee Vehicles**
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
6	0	0
7	360	353
8	0	0
9	0	0
10	131	129
11	260	255
12	0	0
13	0	0
14	0	0
15	210	206
16	0	0
17	0	0
18	0	0
19	0	0
20	0	0
21	375	368
22	0	0
23	0	0
24	0	0
25	0	0
26	0	0
27	0	0
TOTAL	**1,336**	**1,311**



Employees			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	360	0-1	360
1-2	0	0-2	360
2-3	0	0-3	360
3-4	0	0-4	360
4-5	0	0-5	360
5-6	25	0-6	385
6-7	106	0-7	491
7-8	260	0-8	751
8-9	0	0-9	751
9-10	210	0-10	961
10-EPZ	375	0-EPZ	1336

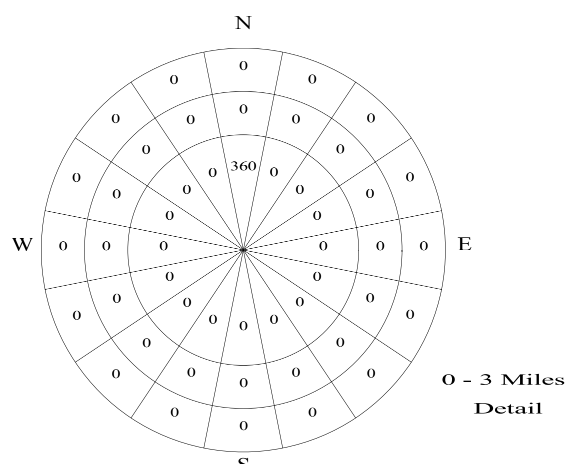
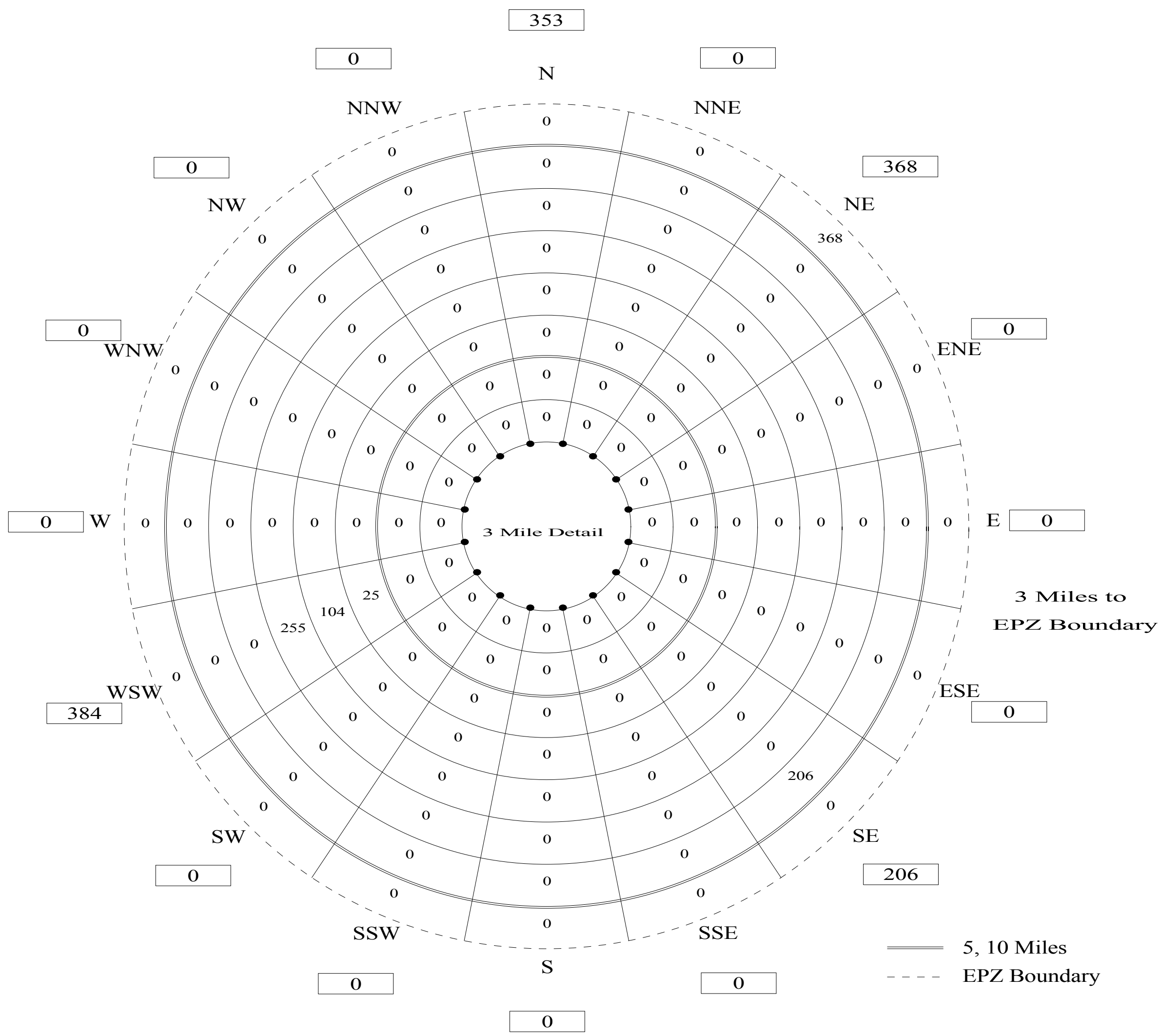


Figure 3-7. Employees by Sector



Employee Vehicles			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	353	0-1	353
1-2	0	0-2	353
2-3	0	0-3	353
3-4	0	0-4	353
4-5	0	0-5	353
5-6	25	0-6	378
6-7	104	0-7	482
7-8	255	0-8	737
8-9	0	0-9	737
9-10	206	0-10	943
10-EPZ	368	0-EPZ	1311

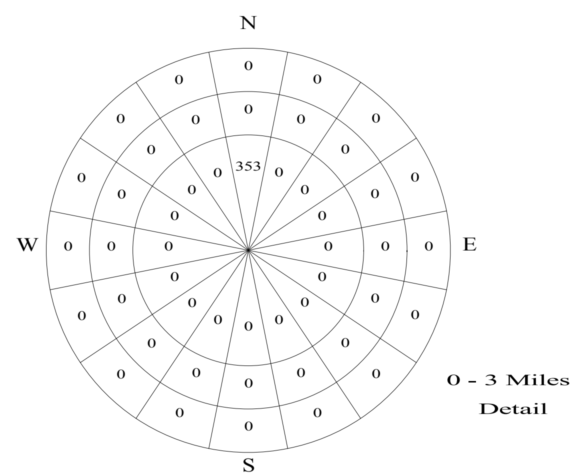


Figure 3-7. Employee Vehicles by Sector

Special Events

Construction

A special event scenario (Scenario 12) represents a typical summer, midweek, midday with construction workers at the proposed Bell Bend site, constructing the new unit when an accident occurs. Based on discussions with UniStar, the peak construction will be in the Year 2015, with a work force of 3,940 construction workers per day. The work force will be assigned to three shifts according to the following percentages: 60, 35, 5. The average occupancy of the construction worker vehicles is expected to be 1.3, yielding 1,819 construction vehicles for the day shift.

.It is also assumed that refueling at SSES will occur for this scenario. The 1,400 additional workers needed for refueling will be split between two shifts. Data collected at the SSES entrance suggests a 70% peak shift is in place which implies a maximum of 980 additional staff on site. Based on the construction schedule, 363 workers related to the operations at the new unit will also be on site. The average vehicle occupancy of 1 worker per vehicle is used to estimate the additional vehicle demand.

A new access road from the Bell Bend site to RT 11 is considered in this study, based on the information provided. It is assumed that a traffic signal is present at this intersection during the construction years. Those workers present for construction of the new unit will use this new site access road, while the refueling workers and the SSES employees will use the present SSES site access road. This construction scenario is expected to add an additional 3054 vehicles (1819+0.7x363+980). Permanent resident population and shadow population are extrapolated to 2015 for this scenario.

Medical Facilities

There are several medical facilities in the EPZ. Chapter 8 details the evacuation time estimate for the patients residing in these facilities. The number and type of evacuating vehicles that need to be provided depends on the state of health of the patients. Buses can transport up to 40 people; vans, up to 12 people; ambulances, up to 2 people (patients).

Pass-Through Demand

Vehicles will be traveling through the EPZ (external-external trips) at the time of an accident. After the advisory to evacuate (ATE) is announced, these through travelers will also evacuate. These through vehicles are assumed to travel on the major pass-through routes in the EPZ (Interstate 80, Interstate 81 and US 11). It is assumed that this traffic will continue to enter the EPZ during the first 90 minutes following the ATE. Using data from the PennDOT traffic reports it is estimated that approximately 8,300 vehicles per hour will enter the EPZ as pass-through demand for the first 90 minutes following the ATE.

4. ESTIMATION OF HIGHWAY CAPACITY

The ability of the road network to service vehicle demand is a major factor in determining how rapidly an evacuation can be completed. The capacity of a road is defined as the maximum hourly rate at which persons or vehicles can reasonably be expected to traverse a point or uniform section of a lane of roadway during a given time period under prevailing roadway, traffic and control conditions as stated in the 2000 Highway Capacity Manual (HCM).

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

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

This distinction is illustrated in Exhibit 12-15 of the HCM. As indicated there, the SV varies with Free Flow Speed (FFS), Terrain and LOS. However, the SV at LOS E (which approximates capacity) varies only with Terrain. This Exhibit was referenced when estimating capacity for two-lane rural highways within the EPZ and Shadow Region; such highways are predominant within the analysis network.

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

- Lane width
- Shoulder width
- Pavement Condition
- Percent Truck Traffic
- Weather conditions (rain, snow, fog, wind speed, ice)

These factors are considered during the road survey and in the capacity estimation process; some factors have greater influence on capacity than others. For example, lane and shoulder width have only a limited influence on free flow speed (FFS) according to Exhibit 20-5 of the HCM. Consequently, lane and shoulder widths at the narrowest points were observed during the road survey and these observations were recorded, but no detailed measurements of lane or shoulder width were taken. The estimated FFS were measured using the survey vehicle’s speedometer and observing local traffic.

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

Given the high population density the borough of Berwick and the City of Nanticoke, and the limited roadways servicing traffic, congestion arising from evacuation is significant in these areas. As such, estimates of roadway capacity must be determined with great care.

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

Capacity Estimation 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 traffic directions may supersede traffic control devices. The Traffic Management Plan identifies these locations (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:

$Q_{cap,m}$	=	Capacity of a single lane of traffic on an approach, which executes movement, *m*, upon entering the intersection; vehicles per hour (vph)
h_m	=	Mean queue discharge headway of vehicles on this lane that are executing movement, *m*; seconds per vehicle
G	=	Mean duration of GREEN time servicing vehicles that are executing movement, *m*, for each signal cycle; seconds

L	=	Mean "lost time" for each signal phase servicing movement, *m*; seconds
C	=	Duration of each signal cycle; seconds
P_m	=	Proportion of GREEN time allocated for vehicles executing movement, *m*, from this lane. This value is specified to IDYNEV as part of the control treatment.
m	=	The movement executed by vehicles after they enter the intersection: through, left-turn, right-turn, and diagonal.

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

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

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 PC-DYNEV 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.

The above discussion is necessarily brief given the scope of this ETE report and the complexity of the subject of intersection capacity. In fact, the two longest chapters in the HCM (16 and 17), each well over 100 pages, address this topic. The factors, F_1, F_2, …, influencing saturation flow rate are indentified in equation (16-4) and Exhibit 16-7 of the

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.

HCM; Exhibit 10-12 identifies the required data and Exhibit 10-7 presents representative values of Service Volume.

Capacity Estimation Along Freeway Sections

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.

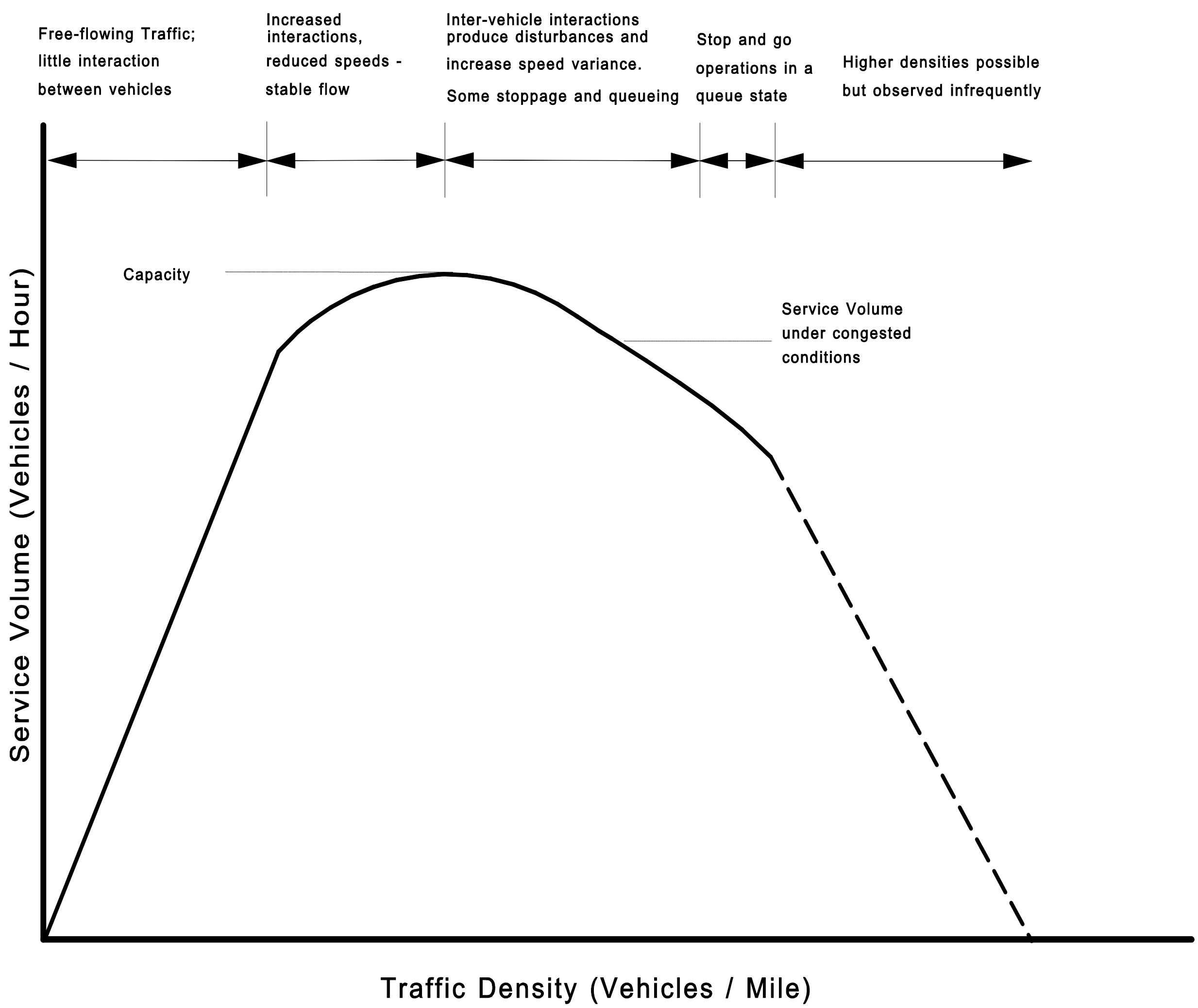


Figure 4-1. Fundamental Relationship Between Volume and Density

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; the service volume increases as demand volume and density increase, until the service volume attains its maximum value, which is the capacity of the highway section. As traffic demand and the resulting highway density increase beyond this "critical" value, the rate at which traffic can be serviced (i.e. the service volume) can actually decline below capacity. Therefore, in order to realistically represent traffic performance during congested conditions (when demand exceeds capacity), it is necessary to estimate the service volume, V_F, under congested (LOS F) 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 service volume, V_F, which is applied during LOS F conditions; V_F, is lower than the specified capacity.

The advisability of such a capacity factor is based upon empirical studies that identified a fall-off in the service flow rate when congestion occurs at “bottlenecks” or “choke points” on a freeway system. Zhang and Levinson[2] describe a research program that collected data from a computer-based surveillance system (loop detectors) installed on the Interstate Highway System, at 27 active bottlenecks in the twin cities metro area in Minnesota over a 7-week period. When flow breakdown occurs, queues are formed which discharge at lower flow rates than the maximum capacity prior to observed breakdown. These queue discharge flow (QDF) rates vary from one location to the next and also vary by day of week and time of day based upon local circumstances. The cited reference presents a mean QDF of 2,016 passenger cars per hour per lane (pcphpl). This figure compares with the nominal capacity estimate of 2,250 pcphpl estimated for the ETE and indicated in Appendix K for freeway links. The ratio of these two numbers is 0.896 which translates into a capacity reduction factor of 0.90. The data collected in the cited reference indicates that the variation of QDF at a location is generally in the range of +/-5% about the average QDF. That is, the lower tail of this distribution would be equivalent to a capacity reduction factor of 0.90 - 0.05 = 0.85 which is the figure adopted.

2 Lei Zhang and David Levinson, “Some Properties of Flows at Freeway Bottlenecks,” Transportation Research Record 1883, 2004.

It is seen that a conservative view is taken in estimating the capacity at bottlenecks when congestion develops (this capacity, of course, is the QDF rate discussed above). One could argue that a more representative value for this capacity reduction factor could be 0.90 as discussed above. Given the emergency conditions, a conservative stance is justified. Therefore, a factor of 0.85 is applied only when flow breaks down, as determined by the simulation model.

Rural roads, like freeways, are classified as “uninterrupted flow” facilities. (This is in contrast with urban street systems which have closely spaced signalized intersections and are classified as “interrupted flow” facilities.) As such, traffic flow along rural roads is subject to the same effects as freeways in the event traffic demand exceeds the nominal capacity, resulting in queuing and lower QDF rates. As a practical matter, rural roads rarely break down at locations away from intersections. The breakdowns on rural roads which are experienced on this network occur at intersections where other model logic applies. Therefore, the application of a factor of 0.85 is appropriate on rural roads but rarely, if ever, activated.

The estimated value of capacity is based primarily upon the type of facility and on roadway geometrics. Sections of roadway with adverse geometrics are characterized by lower free-flow speeds and lane capacity. Table 12-15 in the Highway Capacity Manual was referenced to estimate saturation flow rates. The impact of narrow lanes and shoulders on free-flow speed and on capacity is not material, particularly when flow is predominantly in one direction.

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 and by reference to the 2000 Highway Capacity Manual. 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.

<u>Application to the SSES/Bell Bend Nuclear Power Plant EPZ</u>

As part of the development of the SSES/Bell Bend 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 SSES/Bell Bend EPZ consists primarily of three categories of roads and, of course, intersections:

- Two-lane roads: Local, State
- Multi-lane Highways (at-grade)
- Freeways (Interstate-81, Interstate-84)

Each of these classifications will be discussed.

Two-Lane Roads

Ref: HCM Chapters 12 and 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 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” and some are “mountainous terrain”.
- “Class II” highways are mostly those within city limits.

Multi-Lane Highway

Ref: HCM Chapters 12 and 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-flow 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.

Chapter 12 presents the basic concepts underlying the procedures in Chapters 20 and 21.

Freeways

Ref: HCM Chapters 13, 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 “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, 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 the demand volume: capacity ratio. The value of capacity 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).

Chapter 13 presents basic concepts underlying the procedures in the later chapters.

Intersections

Ref: HCM Chapters 10, 16, 17

Procedures for estimating capacity and LOS for approaches to intersections are presented in Chapters 16 (signalized intersections) and 17 (unsignalized intersections). As previously mentioned, 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."*

Simulation and Capacity Estimation

Chapter 31 of the HCM is entitled, "Simulation and other Models." The lead sentence on the subject of Traffic Simulation Models is:

> Traffic simulation models use numerical techniques on a digital computer to create a description of how traffic behaves over extended periods of time for a given transportation facility or system…by stepping through time and across space, tracking events as the system state unfolds. Traffic simulation models focus on the dynamic of traffic flow.

In general terms, this description applies to the PC-DYNEV model, which is further described in Appendix C. It is essential to recognize that simulation models do not replicate the methodology and procedures of the HCM – they *replace* these procedures by describing the complex interactions of traffic flow and computing Measures of Effectiveness (MOE) detailing the operational performance of traffic over time and by location.

All simulation models must be calibrated properly with field observations that quantify the performance parameters applicable to the analysis network. Two of the most important of these are: (1) Free flow speed (FFS); and (2) saturation headway, h_{sat}. The first of these is estimated by direct observation during the road survey; the second is estimated using the concepts of the HCM, as described earlier. These parameters are listed in Appendix K, for each network link.

5. ESTIMATION OF TRIP GENERATION TIME {PRIVATE }

Federal Government 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 telephone survey (Appendix F). The sum of these activity-based distributions yields the trip generation time distribution.

Background

In general, 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. The planning basis adopts 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.

The adoption of this planning basis is not a representation that these events will occur at the SSES/Bell Bend Nuclear Power Plant within the indicated time frame. Rather, these assumptions are necessary in order to:

- Establish a temporal framework for estimating the trip generation distribution as recommended in Appendix 4 of NUREG 0654.
- Identify temporal points of reference that uniquely define "clear time" and ETE.

It is likely that a longer time will elapse between the various classes of an emergency at SSES/Bell Bend and that the advisory to evacuate is announced somewhat later than the siren alert.

For example, suppose one hour elapses from the declaration of a general emergency (and 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. Under these circumstances, 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, and loud speakers).
- Receiving and correctly interpreting the information that is transmitted.

The peak permanent resident population within the EPZ approximates 74,174 people[1] who are deployed over an area of approximately 367 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 also differ from weekdays.

Fundamental Considerations

[1] This estimate is for a winter midweek scenario and includes 100% of permanent residents, 100% of employees commuting into the EPZ to work, and 68% of transients.

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 activities) 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 or elsewhere, to return home
4	Arrive (or be at) home
5	Begin evacuation trip to leave the area

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

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

*If already at home, this is a null (no-time-consumed) activity.

These relationships are shown graphically in Figure 5-1.

An employee who lives outside the EPZ will follow sequence (d) 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 (a) 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). 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, the conservative posture is 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, the estimate of the time distribution of event 5 depends on the 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).

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

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

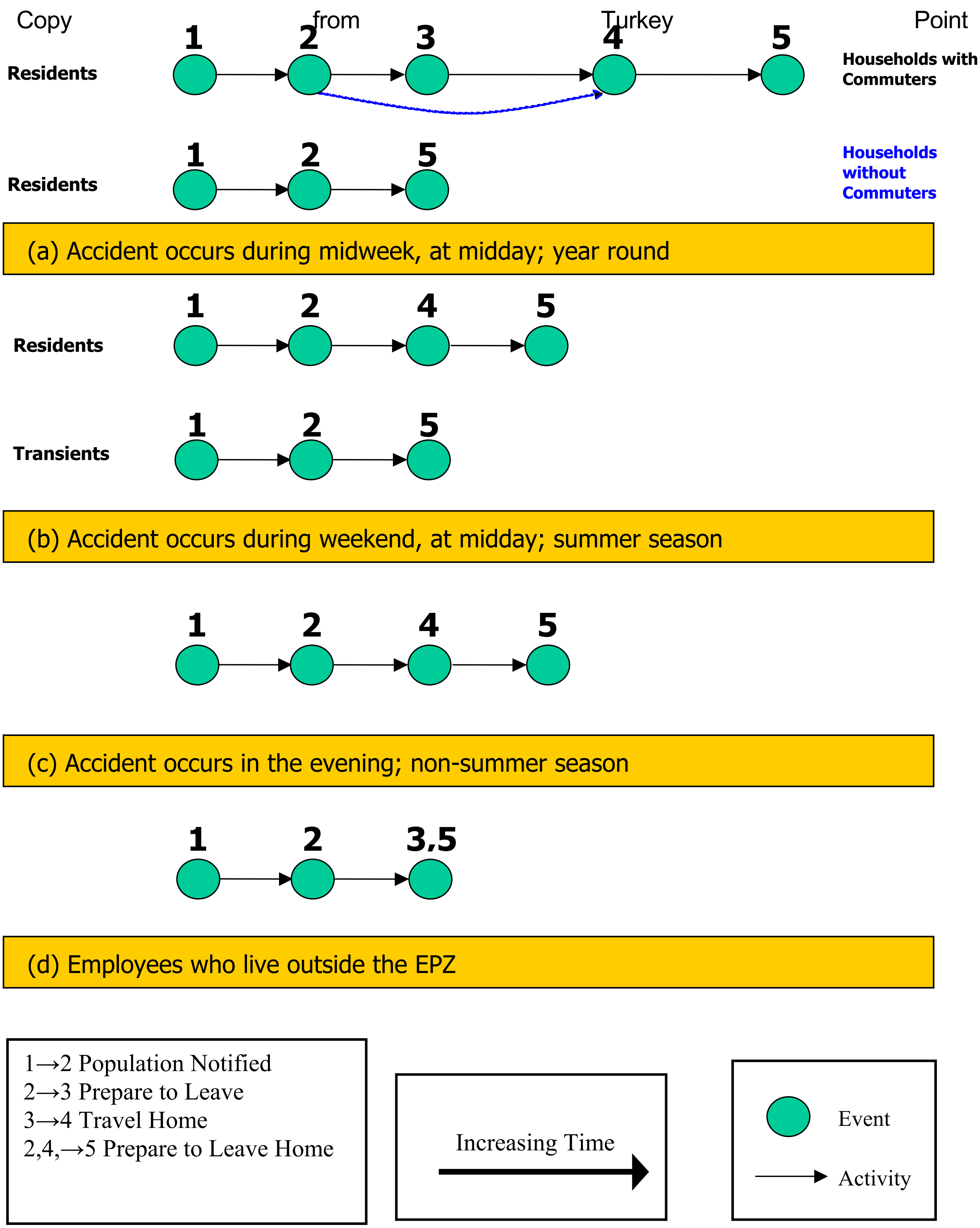


Figure 5-1. Events and Activities Preceding the Evacuation Trip

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 or livestock 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.

Elapsed Time (Minutes)	**Cumulative Percent Employees Leaving Work**
0	0.0%
5	45.6%
10	60.0%
15	67.2%
20	71.4%
25	72.3%
30	83.8%
35	86.9%
40	87.8%
45	91.0%
50	91.5%
55	91.5%
60	97.2%
65	97.6%
70	98.0%
75	98.5%
80	98.7%
85	98.9%
90	99.1%
95	99.4%
100	99.7%
105	100.0%

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

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

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

Elapsed Time (Minutes)	Cumulative Percent Returning Home
0	0.0%
5	14.3%
10	30.8%
15	45.3%
20	61.4%
25	70.2%
30	82.9%
35	86.7%
40	90.2%
45	94.5%
50	95.1%
55	95.3%
60	98.2%
65	98.2%
70	98.2%
75	98.2%
80	98.3%
85	98.4%
90	98.4%
95	98.5%
100	98.6%
105	98.6%
110	99.0%
115	99.3%
120	99.6%
125	99.7%
130	99.7%
135	99.8%
140	99.9%
145	99.9%
150	100.0%

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

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

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

Elapsed Time (Minutes)	Cumulative Pct. Ready to Evacuate
0	0.0%
5	8.5%
10	17.1%
15	25.6%
20	37.0%
25	48.4%
30	59.9%
35	63.2%
40	66.6%
45	70.0%
50	75.4%
55	80.8%
60	86.2%
65	88.4%
70	90.6%
75	92.8%
80	93.2%
85	93.5%
90	93.8%
95	93.8%
100	93.8%
105	93.8%
110	94.8%
115	95.9%
120	96.9%
125	97.1%
130	97.3%
135	97.5%
140	97.5%
145	97.5%
150	97.5%
155	97.5%
160	97.5%
165	97.5%
170	97.7%
175	97.9%
180	98.1%
185	98.3%
190	98.4%
195	98.6%

Elapsed Time (Minutes)	Cumulative Pct. Ready to Evacuate
200	98.6%
205	98.6%
210	98.6%
215	98.6%
220	98.6%
225	98.6%
230	98.7%
235	98.8%
240	98.8%
245	98.8%
250	98.8%
255	98.8%
260	98.9%
265	99.0%
270	99.0%
275	99.0%
280	99.0%
285	99.0%
290	99.2%
295	99.3%
300	99.4%
305	99.5%
310	99.5%
315	99.6%
320	99.6%
325	99.6%
330	99.6%
335	99.6%
340	99.6%
345	99.6%
350	99.7%
355	99.9%
360	100.0%

Snow Clearance Time Distribution

Inclement weather scenarios involving snowfall must address the time lags associated with snow clearance. It is assumed that snow equipment is mobilized and deployed during the snowfall to maintain passable roads. The general consensus is that their efforts are generally successful for all but the most extreme blizzards when the rate of snow accumulation exceeds that of snow clearance over a period of many hours.

Consequently, it is reasonable to assume that the highway system will remain passable – albeit at a lower capacity – under the vast majority of snow conditions. Nevertheless, for the vehicles to gain access to the highway system, it may be necessary for driveways and employee parking lots to be cleared to the extent needed to permit vehicles to gain access to the roadways. These clearance activities take time; this time must be incorporated into the trip generation time distributions. These data are provided by the telephone survey. This distribution is plotted in Figure 5-2 and listed below.

Elapsed Time (Minutes)	Cumulative Pct. Ready to Evacuate
0	0.0%
5	13.2%
10	26.4%
15	39.7%
20	50.4%
25	61.1%
30	71.8%
35	74.6%
40	77.5%
45	80.4%
50	83.0%
55	85.7%
60	88.4%
65	89.6%
70	90.8%
75	92.0%
80	92.6%
85	93.2%
90	93.8%
95	94.3%
100	94.8%

Elapsed Time (Minutes)	Cumulative Pct. Ready to Evacuate
105	95.3%
110	96.0%
115	96.8%
120	97.6%
125	97.8%
130	97.9%
135	98.1%
140	98.1%
145	98.2%
150	98.3%
155	98.3%
160	98.3%
165	98.3%
170	98.6%
175	98.9%
180	99.1%
185	99.4%
190	99.7%
195	100.0%

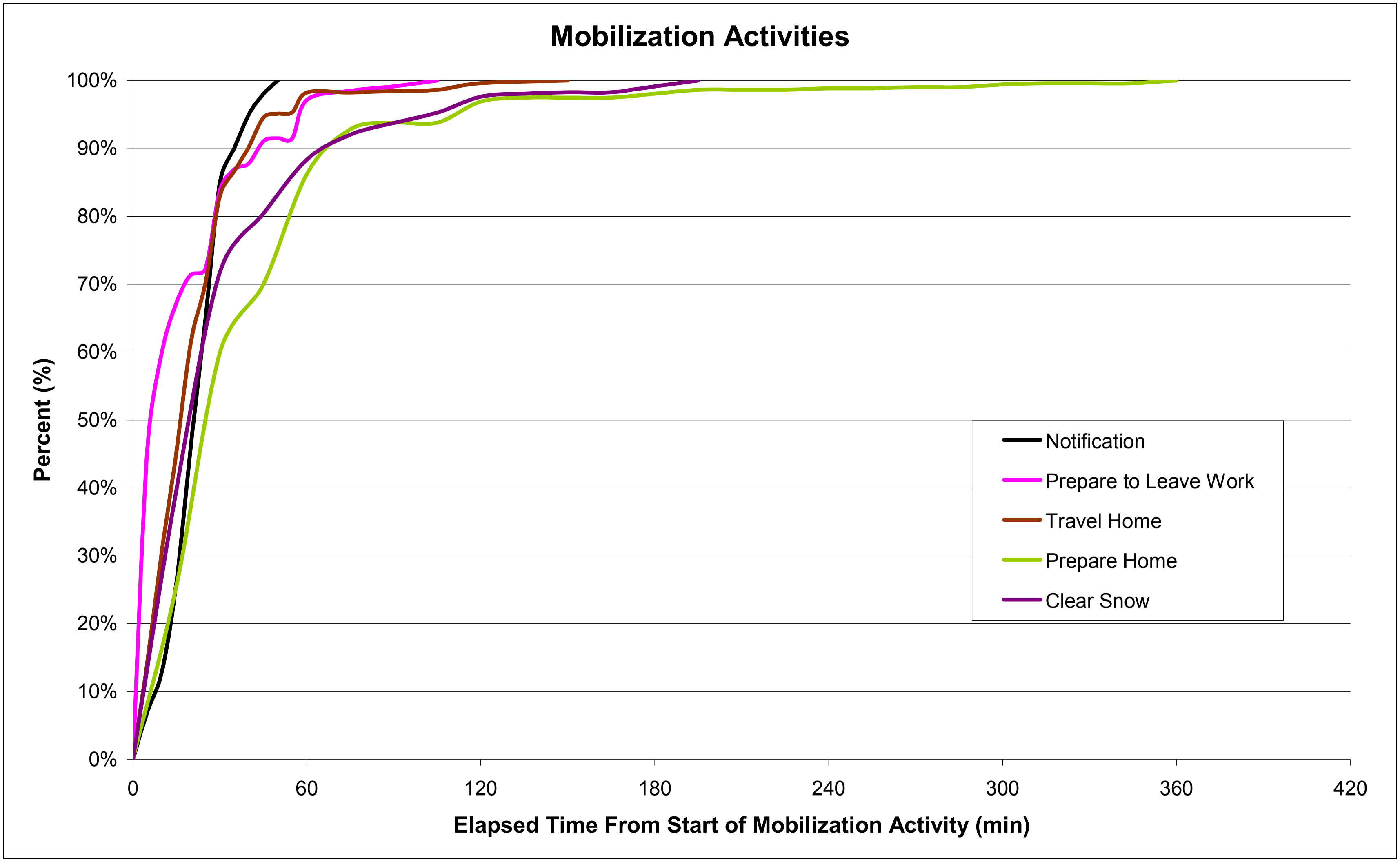


Figure 5-2. Evacuation Mobilization Activities

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. It is assumed 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; "letter" designations are assigned to these intermediate distributions to describe the procedure.

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

Distributions A through F are described below.

Distribution	Description
A	Time distribution of commuters departing place of work (Event 3). Also applies to employees who work within the EPZ but live outside the EPZ, and to Transients within the EPZ.
B	Time distribution of commuters arriving home.
C	Time distribution of residents with commuters who return home, leaving home to begin the evacuation trip.
D	Time distribution of residents with no commuters returning home to begin the evacuation trip.
E	Time distribution of residents with commuters who return home, leaving home to begin the evacuation trip after snow clearance activities.
F	Time distribution of residents with no commuters returning home, leaving to begin the evacuation trip after snow clearance activities.

Figure 5-3 presents the combined trip generation distributions designated A, C, D, E and F. These distributions are presented on the same time scale.

The PC-DYNEV simulation model is designed to accept varying rates of vehicle trip generation for each origin centroid, expressed in the form of histograms. These histograms, which represent Distributions A, C, D, E, and F, properly displaced with respect to one another, are tabulated in Table 5-1 (Distribution B, Arrive Home, omitted for clarity).

The final time period (13) is 600 minutes long. This time period is added to allow the analysis network to clear, in the event congestion persists beyond the trip generation period. Note that there are no trips generated during this final time period.

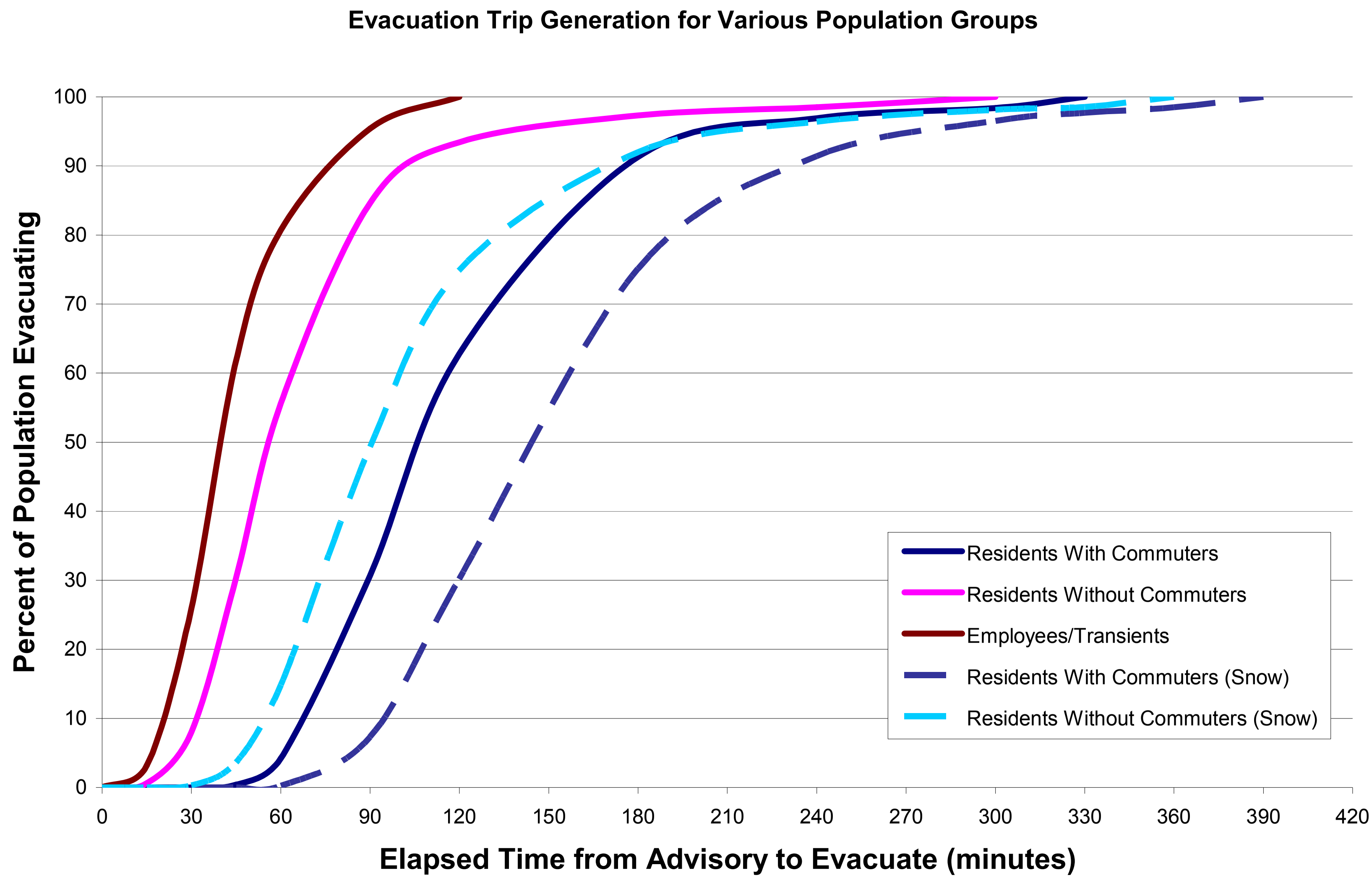


Figure 5-3. Comparison of Trip Generation Distributions

Table 5-1. Trip Generation Time Histograms for the EPZ Population

Time Period	Duration (Min)	Percent of Total Trips Generated Within Indicated Time Period					
		Employees (Distribution A)	Transients (Distribution B)	Residents with Commuters (Distribution C)	Residents Without Commuters (Distribution D)	Residents With Commuters Snow (Distribution E)	Residents Without Commuters Snow (Distribution F)
1	15	3	3	0	1	0	0
2	15	23	23	0	7	0	0
3	15	36	36	0	22	0	3
4	15	19	19	4	25	0	11
5	30	15	15	27	29	7	35
6	30	4	4	32	9	23	26
7	60	0	0	29	4	45	17
8	60	0	0	6	1	16	4
9	60	0	0	1	2	5	2
10	30	0	0	1	0	1	1
11	30	0	0	0	0	1	1
12	30	0	0	0	0	2	0
13	600	0	0	0	0	0	0

6. DEMAND ESTIMATION FOR EVACUATION SCENARIOS{PRIVATE }

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 emergency response planning areas (ERPA) or municipalities 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 and highway operations (calibration).

A total of 22 regions were defined which encompass all the groupings of ERPA 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 circular area centered at the SSES site, and three adjoining sectors, each with a central angle of 22.5 degrees. These sectors extend to a distance of 5 miles from SSES, or to the EPZ boundary

A total of 13 scenarios were evaluated for all regions. Thus, there are
13 x 22 = 286 evacuation cases. Table 6-2 is a description of all Scenarios.

Each combination of region and scenario defines a "case" that implies a specific population to be evacuated. Table 6-3 presents the percent of population groups that evacuate for each scenario, which applies throughout the EPZ. The number of voluntary evacuees varies by evacuation region – not by scenario. Therefore, voluntary evacuees are not included in Table 6-3. Similarly, Table 6-4 presents vehicle estimates for region R03 (the entire EPZ) for all scenarios. These estimates do not include voluntary evacuees for the same reason given above.

Table 6-1 identifies those combinations of ERPA that define each of 22 evacuation regions. For a given region, an empty cell along a row in this table represents an ERPA which is not included within the region, but which contributes voluntary evacuees to the evacuating traffic environment. The number of voluntary evacuees depends on the population within the ERPA and upon the region that is being evacuated.

For example, consider ERPA 6. This ERPA, shown in Figure 6-1, lies between the 5-mile ring and the EPZ boundary to the west. If region R06 were evacuated, then ERPA 6 which is external to R06 (see row for R06 in Table 6-1), would contribute 50% of its population as voluntary evacuees according to Figure 2-1.

Now, if region R06 is advised to evacuate under the conditions of Scenario 1, then the percentages for that scenario that appear in Table 6-3[1] will also apply to the population within ERPA 6. The trip generation distributions (Section 5) for the voluntary evacuees that originate their trips within ERPA 6 are the same as though the ERPA were advised to evacuate; the number of evacuees from that ERPA, however, would be 50% of the total, as explained above.

To summarize, the number of voluntary evacuees in any given evacuation "case" is taken into proper account for each "empty" cell in Table 6-1. The necessary computations to calculate the number of generated trips within each Area are performed by the UNITES software. The output of UNITES, for each case, is the input stream to the IDYNEV system.

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[1] Refer to the columns in Table 6-3 labeled "Residents with Commuters in Household", "Residents with No Commuters in Household", "Employees", and "Transients".

Table 6-1. Description of Evacuation Regions

Region	Description	ERPA																										
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
R01	2 mile ring							x		x																		
R02	5-mile ring							x	x	x			x	x	x													
R03	Full EPZ	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
2-MileRing and 5-Mile Downwind																												
Region	**Description**	**ERPA**																										
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
R04	N,NNE,NNW							x	x	x																		
-	NE,W,WNW,NW	Refer to Region R01																										
R05	ENE,E,ESE							x		x					x													
R06	SE, SSE							x		x			x	x	x													
R07	S, SSW,SW,WSW							x		x			x	x														
5-Mile Ring and Downwind to EPZ Boundary																												
Region	**Description**	**ERPA**																										
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
R08	N		x	x	x	x		x	x	x			x	x	x						x							
R09	NNE		x	x				x	x	x			x	x	x				x		x	x						
R10	NE		x					x	x	x			x	x	x			x	x	x	x	x						
R11	ENE							x	x	x			x	x	x			x	x	x	x	x	x					
R12	E							x	x	x			x	x	x			x	x	x			x					
R13	ESE, SE							x	x	x			x	x	x	x	x	x					x					
R14	SSE	x						x	x	x			x	x	x	x	x						x					
R15	S	x						x	x	x			x	x	x	x	x							x				
R16	SSW	x						x	x	x			x	x	x									x	x			
R17	SW	x						x	x	x	x	x	x	x	x									x	x	x	x	x
R18	WSW						x	x	x	x	x	x	x	x	x									x	x	x	x	x
R19	W				x	x	x	x	x	x	x	x	x	x	x										x	x	x	x
R20	WNW				x	x	x	x	x	x			x	x	x												x	x
R21	NW			x	x	x	x	x	x	x			x	x	x													x
R22	NNW		x	x	x	x		x	x	x			x	x	x													

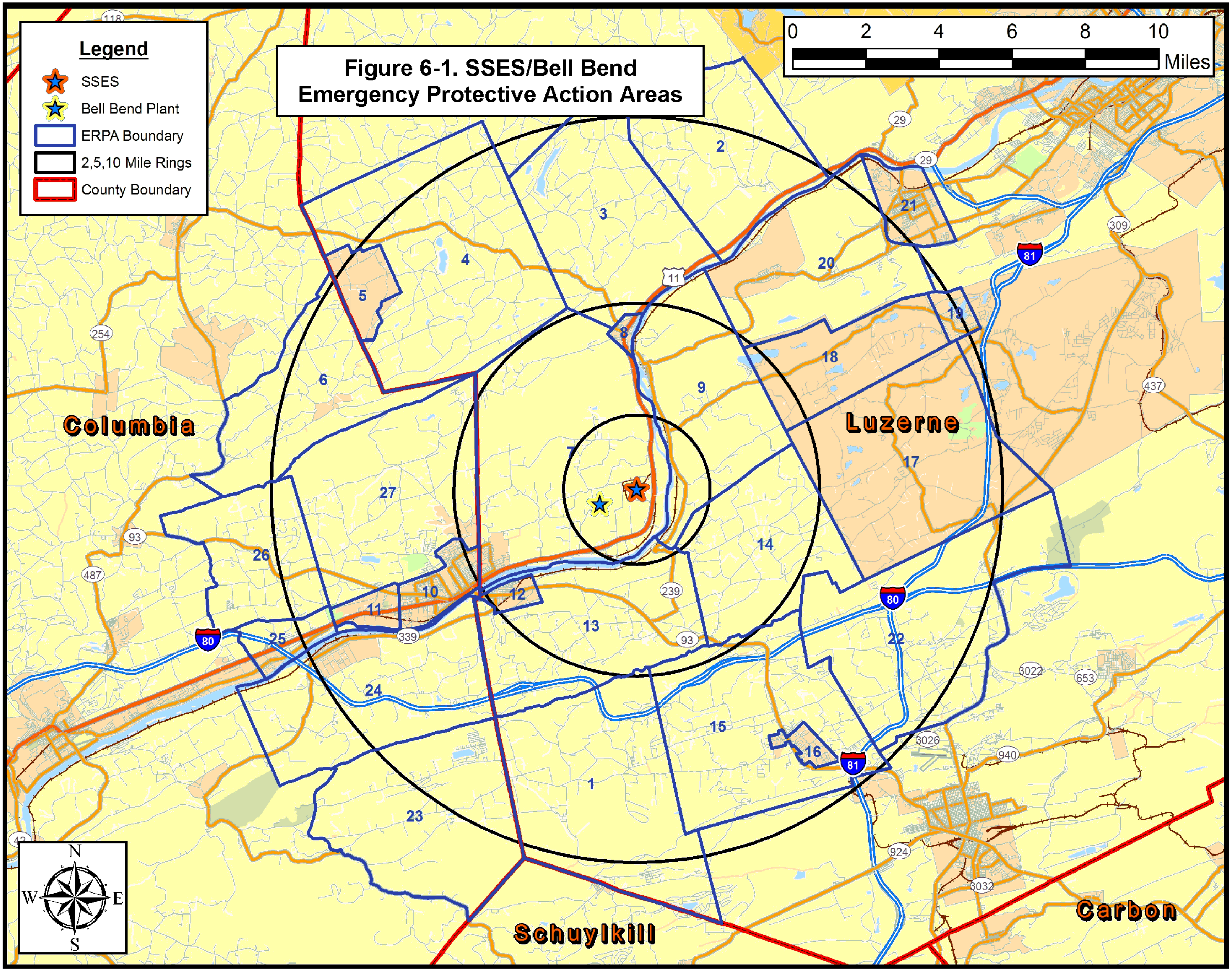


Figure 6-1. SSES/Bell Bend
Emergency Protective Action Areas
Legend
SSES
Bell Bend Plant
ERPA Boundary
2,5,10 Mile Rings
County Boundary
0 2 4 6 8 10
Miles
Columbia
Luzerne
Schuylkill
Carbon
N
W
E
S
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
11
29
80
81
93
239
254
309
339
437
487
653
924
940
3022
3026
3032

Table 6-2. Evacuation Scenario Definitions					
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	Midweek	Midday	Snow	None
9	Winter	Weekend	Midday	Good	None
10	Winter	Weekend	Midday	Rain	None
11	Winter	Weekend	Midday	Snow	None
12	Winter	Midweek, Weekend	Evening	Good	None
13	Summer	Midweek	Midday	Good	Bell Bend Construction and SSES Refueling

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

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

Scenarios	Residents With Commuters in Household	Residents With No Commuters in Household	Employees	Transients	Shadow	Special Event	School Buses	Transit Buses	External Through Traffic
1	52%	48%	96%	11%	31%	0%	10%	100%	100%
2	52%	48%	96%	11%	31%	0%	10%	100%	100%
3	5%	95%	10%	12%	30%	0%	0%	100%	100%
4	5%	95%	10%	12%	30%	0%	0%	100%	100%
5	5%	95%	10%	16%	30%	0%	0%	100%	40%
6	52%	48%	100%	68%	31%	0%	100%	100%	100%
7	52%	48%	100%	68%	31%	0%	100%	100%	100%
8	52%	48%	100%	68%	31%	0%	100%	100%	100%
9	5%	95%	10%	9%	30%	0%	0%	100%	100%
10	5%	95%	10%	9%	30%	0%	0%	100%	100%
11	5%	95%	10%	9%	30%	0%	0%	100%	100%
12	5%	95%	10%	17%	30%	0%	0%	100%	40%
13	52%	48%	96%	11%	31%	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.*

Special Event .... Additional vehicles present at the Bell Bend site during the construction of the new unit and additional vehicles present at the SSES site for refueling in the Year 2015.

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), respectively. School buses for Scenarios 1, 2 and 13 are used to transport those students attending summer school.

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 90 minutes after the evacuation begins.

Table 6-4. Vehicle Estimates by Scenario[2]

Scenarios	Residents with Commuters	Residents without Commuters	Employees	Transients	Shadow	Special Event	School Buses*	Transit Buses*	External Traffic	Total Scenario Vehicles
1	18,821	17,199	1,281	341	14,318	-	38	260	12,482	64,740
2	18,821	17,199	1,281	341	14,318	-	38	260	12,482	64,740
3	1,882	34,138	133	372	13,877	-	-	260	12,482	63,144
4	1,882	34,138	133	372	13,877	-	-	260	12,482	63,144
5	1,882	34,138	133	496	13,877	-	-	260	4,993	55,779
6	18,821	17,199	1,334	2,107	14,338	-	370	260	12,482	66,911
7	18,821	17,199	1,334	2,107	14,338	-	370	260	12,482	66,911
8	18,821	17,199	1,334	2,107	14,338	-	370	260	12,482	66,911
9	1,882	34,138	133	279	13,877	-	-	260	12,482	63,051
10	1,882	34,138	133	279	13,877	-	-	260	12,482	63,051
11	1,882	34,138	133	279	13,877	-	-	260	12,482	63,051
12	1,882	34,138	133	527	13,877	-	-	260	4,993	55,810
13	18,917**	17,293**	1,281	341	14,329**	3,053	38	260	12,482	67,994**

NOTE:
* School Buses and Transit Buses are expressed in vehicle equivalents (1 bus = 2 vehicles). Therefore actual number of buses are 1/2 the value shown.
**Permanent Resident population and Shadow population have been expanded (using county specific growth rates) to the Year 2015 when construction of the Bell Bend unit will be at its peak.

[2] The vehicle estimates presented are for an evacuation of the entire EPZ (Region R03).

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 the 22 Regions within the SSES/Bell Bend Nuclear Power Plant EPZ and the 13 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 from the PC-DYNEV simulation model outputs of vehicles exiting the specified evacuation regions. These outputs are generated at 10-minute intervals, then interpolated to the nearest 5 minutes.

7.1 Voluntary Evacuation and Shadow Evacuation

"Voluntary evacuees" are people who are within the EPZ, in municipalities located outside the evacuation region, for whom an advisory to evacuate *has not* been issued, yet who nevertheless elect to evacuate. The "shadow evacuation" is the movement of people from areas *outside* the EPZ for whom no protective action recommendation has been issued. Both voluntary and shadow evacuations are assumed to take place over the same time frame as the evacuation from within the impacted evacuation region.

The ETE for SSES/Bell Bend address the issue of voluntary evacuees as discussed in Section 2.2 and displayed in Figure 7-1 (same as Figure 2-1). Figure 7-2 presents the area identified as the Shadow Region. This region extends radially from the boundary of the EPZ to a distance of 15 miles from SSES/Bell Bend.

Traffic generated within this shadow region, traveling away from the plant, has the potential for impeding evacuating vehicles from within the evacuation region. It is assumed that traffic volumes emitted within the shadow 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 7-6 illustrate the patterns of traffic congestion that arise for the case when the entire EPZ (Region R03) is advised to evacuate during the summer, midweek midday period under good weather conditions (Scenario 1).

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 at the indicated times are delineated in these Figures by a heavy red line; all others are lightly indicated. Congestion develops in areas with high population density and at traffic bottlenecks. Figures 7-3 through 7-6 present traffic congestion patterns at 1 hour intervals after the advisory to evacuate. Traffic congestion is observed only within the cities of Berwick and Nanticoke. The congestion dissipates within 4 hours from the advisory to evacuate. US 11 within the city of Berwick, Route 29 to Interstate 81, and Kirmar Avenue through the city of Nanticoke are some of the congested links. The delays experienced along these sections are presented in Section 7.5.

7.3 Evacuation Rates

Another format for displaying the dynamics of evacuation is depicted in Figure 7-7. This plot indicates the rate at which traffic flows out of the indicated areas for the case of an evacuation of the entire EPZ (Region R03) under the indicated conditions. Appendix J presents these plots for all evacuation scenarios for region R03.

As indicated in Figure 7-7, 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 within the EPZ.

7.4 Guidance on Using ETE Tables

Tables 7-1A through 7-1D present the ETE values for all 22 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 (schools not in session)
     - Winter (also Autumn and Spring)
   - The Day of Week
     - Midweek (work-day)
     - Weekend, Holiday
   - The Time of Day
     - Midday (work and commuting hours)
     - Evening
   - Weather Condition
     - Good Weather
     - Rain
     - Snow
   - Special Event (if any)
     - Construction of new unit

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, scenario (10) applies. For snow, scenario (11) applies.
- 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 (and column in the Table) identified, now identify the **Evacuation Region**:

- Determine the projected azimuth direction of the plume (coincident with the wind direction). This direction is expressed in terms of compass orientation: *toward* N, NNE, NE…
- Determine the distance that the evacuation region will extend from the nuclear power plant. The applicable distances and their associated regions are given below:
  - 2 Miles (Region R01)
  - 5 Miles (Regions R02, R04 through R07)
  - to EPZ boundary (Regions R03, R08 through R22)
- Enter Table 7-2 and identify the applicable group of candidate regions based on the wind direction and on the distance that the selected region extends from SSES/Bell Bend. 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 Tables 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 *toward* the southwest (SW).
- 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 95th-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. Enter Table 7-2 and locate the group entitled "5-Mile Ring and Downwind to EPZ Boundary". Scan down the second column of that group (with the heading, "Description"), to identify the row with "SW" (southwest azimuth) and read region "R17" 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 R17. This data cell is in the fifth column with the heading for Scenario (4) and in the row for Region R17 SW; it contains the ETE value of **3:30**.

7.5 Discussion of ETE Results

The ETE for the 95% percentile (Table 7-1C) suggests that the 5-Mile ring (R02) has a shorter evacuation time compared to the 2-Mile (R01) and the 10-Mile EPZ (R03). This is attributed to the following:

- Trip mobilization, and
- Congestion within Berwick and Nanticoke.

The smaller population within the 2-mile ring relative to that within the 5-mile ring, and the long tail of the trip mobilization (Section 5), combine to produce a longer time to evacuate 95% of the population within the 2-mile ring, than the time to evacuate 95% of the population within the 5-mile ring.

The average delays (in minutes per vehicle) experienced by evacuees on representative congested links in the network (see Figure 7-3 for locations), at various times during the evacuation, are presented below. These delays are experienced by traffic on the indicated links during the 10 minute period preceding the specified times. For, example, vehicles that travel on link, (748,249) between 1:50 and 2:00 after the advisory to evacuate, experience an average delay of 9.1 minutes. Since this delay approaches the 10 minute sampling period, it indicates that the traffic on this link at this time is experiencing heavy congestion. One hour later, the average delay per vehicle for traffic in this link has declined to 1.7 minutes, indicating that congestion is far less intense. Over the following hour, traffic starts flowing at free-flow speed, with zero delay.

Location	From Node	To Node	Elapsed Time from Advisory to Evacuate			
			1:00	2:00	3:00	4:00
RT 11 in Berwick	199	738	4.7	4.7	4.6	0.0
RT 11 in Berwick	961	962	3.9	5.0	3.2	0.0
RT339 through Mifflin township	748	249	0.0	9.1	1.7	0.0
Main Street in Nanticoke City	284	504	3.9	8.7	4.4	0.0
Kirmar Avenue in Nanticoke City	286	285	0.0	9.3	1.8	0.0
RT 11/RT 29 near Nanticoke City	210	406	0.0	2.8	2.8	0.0

The ETE is not increased with the construction at Bell Bend (compare the ETE for scenarios 1 and 12). The additional traffic from the construction site does produce congestion within the city of Berwick; however, the congestion there disperses within 4 hours. This suggests that the highway network has sufficient capacity to service the additional personnel on site.

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

	Summer		Summer		Summer		Winter			Winter			Winter		Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend			Midweek Weekend		Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	Scenario:	(6)	(7)	(8)	(9)	(10)	(11)	(12)	Scenario:	(13)
	Midday		Midday		Evening		Midday			Midday			Evening		Midday
Region Wind Toward:	Good Weather	Rain	Good Weather	Rain	Good Weather	Region Wind Toward:	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Region Wind Toward:	Bell Bend Construction and SSES Refueling
Entire 2-Mile Region, 5-Mile Region, and EPZ															
R01 2-Mile Region	1:25	1:25	1:15	1:15	1:15	R01 2-Mile Region	1:25	1:25	1:50	1:15	1:15	1:45	1:15	R01 2-Mile Region	1:30
R02 5-Mile Region	1:10	1:10	1:05	1:05	1:05	R02 5-Mile Region	1:10	1:10	1:25	1:05	1:05	1:20	1:05	R02 5-Mile Region	1:15
R03 Entire EPZ	1:30	1:35	1:20	1:25	1:25	R03 Entire EPZ	1:30	1:35	1:55	1:20	1:25	1:45	1:25	R03 Entire EPZ	1:35
2-Mile Ring and Downwind to 5 Miles															
R04 N,NNE,NNW	1:25	1:25	1:10	1:10	1:10	R04 N,NNE,NNW	1:25	1:25	1:55	1:10	1:10	1:45	1:10	R04 N,NNE,NNW	1:35
R01 NE,W,WNW,NW	See Region R01					R01 NE,W,WNW,NW	See Region R01							R01 NE,W,WNW,NW	See Region R01
R05 ENE,E,ESE	1:25	1:25	1:10	1:10	1:10	R05 ENE,E,ESE	1:25	1:25	1:55	1:10	1:10	1:45	1:10	R05 ENE,E,ESE	1:30
R06 SE,SSE	1:10	1:10	1:05	1:05	1:10	R06 SE,SSE	1:10	1:10	1:25	1:05	1:05	1:20	1:10	R06 SE,SSE	1:15
R07 S, SSW,SW,WSW	1:10	1:10	1:05	1:05	1:10	R07 S, SSW,SW,WSW	1:10	1:10	1:25	1:05	1:05	1:20	1:10	R07 S, SSW,SW,WSW	1:15
5-Mile Ring and Downwind to EPZ Boundary															
R08 N	1:20	1:20	1:10	1:10	1:15	R08 N	1:20	1:20	1:40	1:10	1:10	1:30	1:15	R08 N	1:25
R09 NNE	1:25	1:25	1:15	1:15	1:20	R09 NNE	1:25	1:30	1:50	1:15	1:15	1:40	1:20	R09 NNE	1:30
R10 NE	1:15	1:20	1:10	1:10	1:15	R10 NE	1:20	1:20	1:35	1:10	1:10	1:30	1:15	R10 NE	1:20
R11 ENE	1:15	1:15	1:10	1:10	1:15	R11 ENE	1:15	1:20	1:30	1:10	1:10	1:25	1:15	R11 ENE	1:15
R12 E	1:10	1:10	1:05	1:05	1:10	R12 E	1:10	1:10	1:20	1:05	1:05	1:20	1:10	R12 E	1:10
R13 ESE, SE	1:15	1:15	1:05	1:10	1:10	R13 ESE, SE	1:15	1:15	1:30	1:05	1:10	1:25	1:10	R13 ESE, SE	1:15
R14 SSE	1:15	1:15	1:05	1:05	1:10	R14 SSE	1:15	1:15	1:30	1:05	1:05	1:25	1:10	R14 SSE	1:15
R15 S	1:10	1:10	1:05	1:05	1:05	R15 S	1:10	1:10	1:25	1:05	1:05	1:20	1:05	R15 S	1:15
R16 SSW	1:20	1:25	1:10	1:15	1:15	R16 SSW	1:20	1:25	1:40	1:10	1:15	1:35	1:15	R16 SSW	1:25
R17 SW	1:35	1:35	1:20	1:25	1:25	R17 SW	1:35	1:35	1:55	1:20	1:25	1:45	1:25	R17 SW	1:40
R18 WSW	1:35	1:35	1:25	1:25	1:30	R18 WSW	1:35	1:35	2:00	1:25	1:25	1:50	1:30	R18 WSW	1:40
R19 W	1:35	1:35	1:25	1:25	1:25	R19 W	1:35	1:35	2:00	1:25	1:25	1:50	1:25	R19 W	1:40
R20 WNW	1:20	1:20	1:10	1:10	1:15	R20 WNW	1:20	1:20	1:40	1:10	1:10	1:35	1:15	R20 WNW	1:25
R21 NW	1:20	1:20	1:10	1:10	1:10	R21 NW	1:20	1:20	1:40	1:10	1:10	1:30	1:10	R21 NW	1:25
R22 NNW	1:15	1:20	1:05	1:10	1:10	R22 NNW	1:15	1:20	1:35	1:05	1:10	1:30	1:10	R22 NNW	1:25

Table 7-1B. Time To Clear The Indicated Area of 90 Percent of the Affected Population

	Summer		Summer		Summer		Winter			Winter			Winter		Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend			Midweek Weekend		Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	Scenario:	(6)	(7)	(8)	(9)	(10)	(11)	(12)	Scenario:	(13)
	Midday		Midday		Evening		Midday			Midday			Evening		Midday
Region Wind Toward:	Good Weather	Rain	Good Weather	Rain	Good Weather	Region Wind Toward:	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Region Wind Toward:	Bell Bend Construction and SSES Refueling
Entire 2-Mile Region, 5-Mile Region, and EPZ															
R01 2-Mile Region	2:40	2:40	2:20	2:25	2:20	R01 2-Mile Region	2:40	2:40	3:30	2:20	2:25	2:55	2:20	R01 2-Mile Region	2:55
R02 5-Mile Region	2:10	2:10	1:50	1:55	2:10	R02 5-Mile Region	2:10	2:10	2:50	1:50	1:55	2:30	2:10	R02 5-Mile Region	2:40
R03 Entire EPZ	3:00	3:10	2:50	3:00	2:50	R03 Entire EPZ	3:00	3:10	3:50	2:50	3:00	3:40	2:50	R03 Entire EPZ	3:20
2-Mile Ring and Downwind to 5 Miles															
R04 N,NNE,NNW	2:40	2:40	2:20	2:20	2:20	R04 N,NNE,NNW	2:40	2:40	3:30	2:20	2:20	2:55	2:20	R04 N,NNE,NNW	2:55
R01 NE,W,WNW,NW	See Region R01					R01 NE,W,WNW,NW	See Region R01							R01 NE,W,WNW,NW	See Region R01
R05 ENE,E,ESE	2:40	2:40	2:20	2:20	2:20	R05 ENE,E,ESE	2:40	2:40	3:30	2:20	2:20	2:55	2:20	R05 ENE,E,ESE	2:55
R06 SE,SSE	2:10	2:10	1:50	1:55	2:10	R06 SE,SSE	2:10	2:10	2:50	1:50	1:55	2:30	2:10	R06 SE,SSE	2:40
R07 S, SSW,SW,WSW	2:10	2:10	1:50	1:55	2:10	R07 S, SSW,SW,WSW	2:10	2:10	2:50	1:50	1:55	2:30	2:10	R07 S, SSW,SW,WSW	2:40
5-Mile Ring and Downwind to EPZ Boundary															
R08 N	2:40	2:40	2:15	2:20	2:20	R08 N	2:40	2:40	3:30	2:15	2:20	3:00	2:20	R08 N	3:00
R09 NNE	2:50	3:00	2:30	2:40	2:40	R09 NNE	2:55	3:05	3:40	2:30	2:40	3:20	2:40	R09 NNE	3:00
R10 NE	2:40	2:40	2:20	2:30	2:30	R10 NE	2:45	2:50	3:20	2:20	2:30	3:00	2:30	R10 NE	2:50
R11 ENE	2:30	2:30	2:10	2:10	2:20	R11 ENE	2:30	2:40	3:10	2:10	2:10	2:50	2:20	R11 ENE	2:40
R12 E	2:00	2:00	1:50	1:50	2:00	R12 E	2:00	2:05	2:40	1:50	1:50	2:20	2:00	R12 E	2:20
R13 ESE, SE	2:10	2:20	1:55	2:00	2:00	R13 ESE, SE	2:10	2:20	2:55	1:55	2:00	2:30	2:00	R13 ESE, SE	2:30
R14 SSE	2:10	2:20	1:55	1:55	2:00	R14 SSE	2:10	2:20	2:55	1:55	1:55	2:30	2:00	R14 SSE	2:30
R15 S	2:10	2:10	1:50	1:50	2:00	R15 S	2:10	2:10	2:50	1:50	1:50	2:30	2:00	R15 S	2:30
R16 SSW	2:50	2:50	2:30	2:30	2:30	R16 SSW	2:50	2:50	3:20	2:30	2:30	3:00	2:30	R16 SSW	3:00
R17 SW	3:05	3:20	3:00	3:10	3:00	R17 SW	3:10	3:20	4:00	3:00	3:10	3:45	3:00	R17 SW	3:30
R18 WSW	3:05	3:20	3:00	3:10	3:00	R18 WSW	3:10	3:20	4:00	3:00	3:10	3:50	3:00	R18 WSW	3:30
R19 W	3:05	3:15	3:00	3:10	3:00	R19 W	3:05	3:20	4:00	3:00	3:05	3:50	3:00	R19 W	3:30
R20 WNW	2:30	2:30	2:10	2:10	2:15	R20 WNW	2:30	2:30	3:10	2:10	2:10	2:50	2:15	R20 WNW	2:40
R21 NW	2:30	2:30	2:05	2:10	2:10	R21 NW	2:30	2:30	3:10	2:05	2:10	2:50	2:10	R21 NW	2:40
R22 NNW	2:40	2:40	2:10	2:15	2:20	R22 NNW	2:40	2:40	3:20	2:10	2:15	2:50	2:20	R22 NNW	3:00

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

	Summer		Summer		Summer		Winter			Winter			Winter		Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend			Midweek Weekend		Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	Scenario:	(6)	(7)	(8)	(9)	(10)	(11)	(12)	Scenario:	(13)
	Midday		Midday		Evening		Midday			Midday			Evening		Midday
Region Wind Toward:	Good Weather	Rain	Good Weather	Rain	Good Weather	Region Wind Toward:	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Region Wind Toward:	Bell Bend Construction and SSES Refueling
Entire 2-Mile Region, 5-Mile Region, and EPZ															
R01 2-Mile Region	3:10	3:10	2:40	2:40	2:40	R01 2-Mile Region	3:00	3:00	4:10	2:40	2:40	3:50	2:40	R01 2-Mile Region	3:10
R02 5-Mile Region	2:40	2:40	2:20	2:20	2:30	R02 5-Mile Region	2:40	2:40	3:40	2:20	2:20	2:50	2:30	R02 5-Mile Region	3:00
R03 Entire EPZ	3:25	3:35	3:15	3:30	3:15	R03 Entire EPZ	3:25	3:35	4:20	3:15	3:20	4:10	3:10	R03 Entire EPZ	3:40
2-Mile Ring and Downwind to 5 Miles															
R04 N,NNE,NNW	3:10	3:10	2:40	2:40	2:40	R04 N,NNE,NNW	3:00	3:00	4:10	2:40	2:40	3:50	2:40	R04 N,NNE,NNW	3:10
R01 NE,W,WNW,NW	See Region R01					R01 NE,W,WNW,NW	See Region R01							R01 NE,W,WNW,NW	See Region R01
R05 ENE,E,ESE	3:00	3:10	2:40	2:40	2:40	R05 ENE,E,ESE	3:00	3:00	4:10	2:40	2:40	3:50	2:40	R05 ENE,E,ESE	3:10
R06 SE,SSE	2:40	2:40	2:20	2:20	2:30	R06 SE,SSE	2:40	2:40	3:40	2:20	2:20	2:50	2:30	R06 SE,SSE	3:00
R07 S, SSW,SW,WSW	2:40	2:40	2:20	2:20	2:30	R07 S, SSW,SW,WSW	2:40	2:40	3:30	2:20	2:20	2:50	2:30	R07 S, SSW,SW,WSW	3:00
5-Mile Ring and Downwind to EPZ Boundary															
R08 N	3:00	3:10	2:40	2:40	2:50	R08 N	3:10	3:10	4:00	2:40	2:40	3:30	2:50	R08 N	3:30
R09 NNE	3:10	3:20	2:50	3:00	3:00	R09 NNE	3:20	3:30	4:10	2:50	3:00	3:50	3:00	R09 NNE	3:20
R10 NE	3:00	3:10	2:40	2:50	2:50	R10 NE	3:10	3:20	4:00	2:40	2:50	3:40	2:50	R10 NE	3:10
R11 ENE	2:50	3:00	2:40	2:50	2:50	R11 ENE	3:00	3:10	3:50	2:40	2:50	3:40	2:50	R11 ENE	3:00
R12 E	2:40	2:40	2:10	2:10	2:20	R12 E	2:40	2:40	3:30	2:10	2:10	2:50	2:30	R12 E	3:00
R13 ESE, SE	2:50	2:50	2:20	2:20	2:30	R13 ESE, SE	2:50	2:50	3:40	2:20	2:20	3:00	2:30	R13 ESE, SE	3:00
R14 SSE	2:50	2:50	2:20	2:20	2:30	R14 SSE	2:50	2:50	3:40	2:20	2:20	3:00	2:30	R14 SSE	3:00
R15 S	2:40	2:40	2:10	2:10	2:30	R15 S	2:40	2:40	3:30	2:10	2:20	2:50	2:30	R15 S	3:00
R16 SSW	3:10	3:10	2:50	3:00	2:50	R16 SSW	3:10	3:10	3:50	2:50	3:00	3:30	2:50	R16 SSW	3:20
R17 SW	3:25	3:35	3:15	3:30	3:10	R17 SW	3:25	3:35	4:20	3:20	3:30	4:10	3:10	R17 SW	3:50
R18 WSW	3:25	3:35	3:15	3:30	3:15	R18 WSW	3:25	3:35	4:20	3:15	3:30	4:10	3:15	R18 WSW	3:50
R19 W	3:20	3:35	3:15	3:30	3:15	R19 W	3:25	3:35	4:20	3:15	3:25	4:10	3:15	R19 W	3:50
R20 WNW	2:50	2:50	2:30	2:30	2:30	R20 WNW	2:50	2:50	4:00	2:30	2:30	3:20	2:30	R20 WNW	3:00
R21 NW	2:50	2:50	2:30	2:30	2:30	R21 NW	2:50	2:50	4:00	2:30	2:30	3:20	2:30	R21 NW	3:00
R22 NNW	3:00	3:00	2:40	2:40	2:50	R22 NNW	3:00	3:10	3:50	2:40	2:40	3:30	2:50	R22 NNW	3:30

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

	Summer		Summer		Summer		Winter			Winter			Winter		Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend			Midweek Weekend		Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	Scenario:	(6)	(7)	(8)	(9)	(10)	(11)	(12)	Scenario:	(13)
	Midday		Midday		Evening		Midday			Midday			Evening		Midday
Region Wind Toward:	Good Weather	Rain	Good Weather	Rain	Good Weather	Region Wind Toward:	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Region Wind Toward:	Bell Bend Construction and SSES Refueling
Entire 2-Mile Region, 5-Mile Region, and EPZ															
R01 2-Mile Region	5:30	5:30	5:00	5:00	5:00	R01 2-Mile Region	5:30	5:30	6:30	5:00	5:00	6:00	5:00	R01 2-Mile Region	5:30
R02 5-Mile Region	5:30	5:30	5:00	5:00	5:00	R02 5-Mile Region	5:30	5:30	6:30	5:00	5:00	6:00	5:00	R02 5-Mile Region	5:30
R03 Entire EPZ	5:40	5:40	5:10	5:20	5:10	R03 Entire EPZ	5:40	5:40	6:40	5:10	5:20	6:20	5:10	R03 Entire EPZ	5:40
2-Mile Ring and Downwind to 5 Miles															
R04 N,NNE,NNW	5:30	5:30	5:00	5:00	5:00	R04 N,NNE,NNW	5:30	5:30	6:30	5:00	5:00	6:00	5:00	R04 N,NNE,NNW	5:30
R01 NE,W,WNW,NW	See Region R01					R01 NE,W,WNW,NW	See Region R01							R01 NE,W,WNW,NW	See Region R01
R05 ENE,E,ESE	5:30	5:30	5:00	5:00	5:00	R05 ENE,E,ESE	5:30	5:30	6:30	5:00	5:00	6:00	5:00	R05 ENE,E,ESE	5:30
R06 SE,SSE	5:30	5:30	5:00	5:00	5:00	R06 SE,SSE	5:30	5:30	6:30	5:00	5:00	6:00	5:00	R06 SE,SSE	5:30
R07 S, SSW,SW,WSW	5:30	5:30	5:00	5:00	5:00	R07 S, SSW,SW,WSW	5:30	5:30	6:30	5:00	5:00	6:00	5:00	R07 S, SSW,SW,WSW	5:30
5-Mile Ring and Downwind to EPZ Boundary															
R08 N	5:30	5:30	5:00	5:00	5:10	R08 N	5:30	5:30	6:30	5:00	5:00	6:10	5:00	R08 N	5:30
R09 NNE	5:30	5:30	5:00	5:00	5:00	R09 NNE	5:30	5:30	6:30	5:00	5:10	6:10	5:00	R09 NNE	5:30
R10 NE	5:30	5:30	5:00	5:10	5:10	R10 NE	5:30	5:30	6:40	5:00	5:10	6:10	5:00	R10 NE	5:30
R11 ENE	5:30	5:30	5:10	5:10	5:10	R11 ENE	5:30	5:30	6:30	5:10	5:10	6:10	5:10	R11 ENE	5:30
R12 E	5:30	5:30	5:10	5:10	5:10	R12 E	5:30	5:30	6:30	5:10	5:10	6:00	5:10	R12 E	5:30
R13 ESE, SE	5:30	5:30	5:10	5:10	5:10	R13 ESE, SE	5:30	5:30	6:40	5:10	5:10	6:10	5:10	R13 ESE, SE	5:30
R14 SSE	5:30	5:30	5:10	5:10	5:10	R14 SSE	5:30	5:30	6:40	5:10	5:10	6:00	5:10	R14 SSE	5:30
R15 S	5:30	5:30	5:00	5:00	5:00	R15 S	5:30	5:30	6:30	5:00	5:00	6:00	5:00	R15 S	5:30
R16 SSW	5:30	5:40	5:10	5:10	5:10	R16 SSW	5:30	5:30	6:40	5:10	5:10	6:10	5:10	R16 SSW	5:30
R17 SW	5:40	5:40	5:10	5:20	5:10	R17 SW	5:40	5:40	6:40	5:10	5:20	6:10	5:10	R17 SW	5:40
R18 WSW	5:40	5:40	5:10	5:10	5:10	R18 WSW	5:40	5:40	6:40	5:10	5:10	6:10	5:10	R18 WSW	5:40
R19 W	5:40	5:40	5:10	5:10	5:10	R19 W	5:40	5:40	6:40	5:10	5:10	6:20	5:10	R19 W	5:40
R20 WNW	5:30	5:30	5:10	5:10	5:10	R20 WNW	5:40	5:40	6:40	5:10	5:10	6:10	5:10	R20 WNW	5:30
R21 NW	5:30	5:30	5:10	5:10	5:10	R21 NW	5:30	5:30	6:40	5:10	5:10	6:10	5:10	R21 NW	5:30
R22 NNW	5:30	5:30	5:00	5:00	5:00	R22 NNW	5:30	5:30	6:30	5:00	5:00	6:00	5:00	R22 NNW	5:30

Table 7-2. Description of Evacuation Regions

Region	Description	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
		ERPA																										
R01	2 mile ring							x		x																		
R02	5-mile ring							x	x	x			x	x	x													
R03	Full EPZ	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
2-MileRing and 5-Mile Downwind																												
		ERPA																										
Region	Description	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
R04	N,NNE,NNW							x	x	x																		
-	NE,W,WNW,NW	Refer to Region R01																										
R05	ENE,E,ESE							x		x					x													
R06	SE, SSE							x		x			x	x	x													
R07	S, SSW,SW,WSW							x		x			x	x														
5-Mile Ring and Downwind to EPZ Boundary																												
		ERPA																										
Region	Description	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
R08	N		x	x	x	x		x	x	x			x	x	x						x							
R09	NNE		x	x				x	x	x			x	x	x				x		x	x						
R10	NE		x					x	x	x			x	x	x			x	x	x	x	x						
R11	ENE							x	x	x			x	x	x			x	x	x	x	x	x					
R12	E							x	x	x			x	x	x			x	x	x			x					
R13	ESE, SE							x	x	x			x	x	x	x	x	x					x					
R14	SSE	x						x	x	x			x	x	x	x	x						x					
R15	S	x						x	x	x			x	x	x	x	x							x				
R16	SSW	x						x	x	x			x	x	x									x	x			
R17	SW	x						x	x	x	x	x	x	x	x									x	x	x	x	x
R18	WSW						x	x	x	x	x	x	x	x	x									x	x	x	x	x
R19	W				x	x	x	x	x	x	x	x	x	x	x										x	x	x	x
R20	WNW				x	x	x	x	x	x			x	x	x												x	x
R21	NW			x	x	x	x	x	x	x			x	x	x													x
R22	NNW		x	x	x	x		x	x	x			x	x	x													

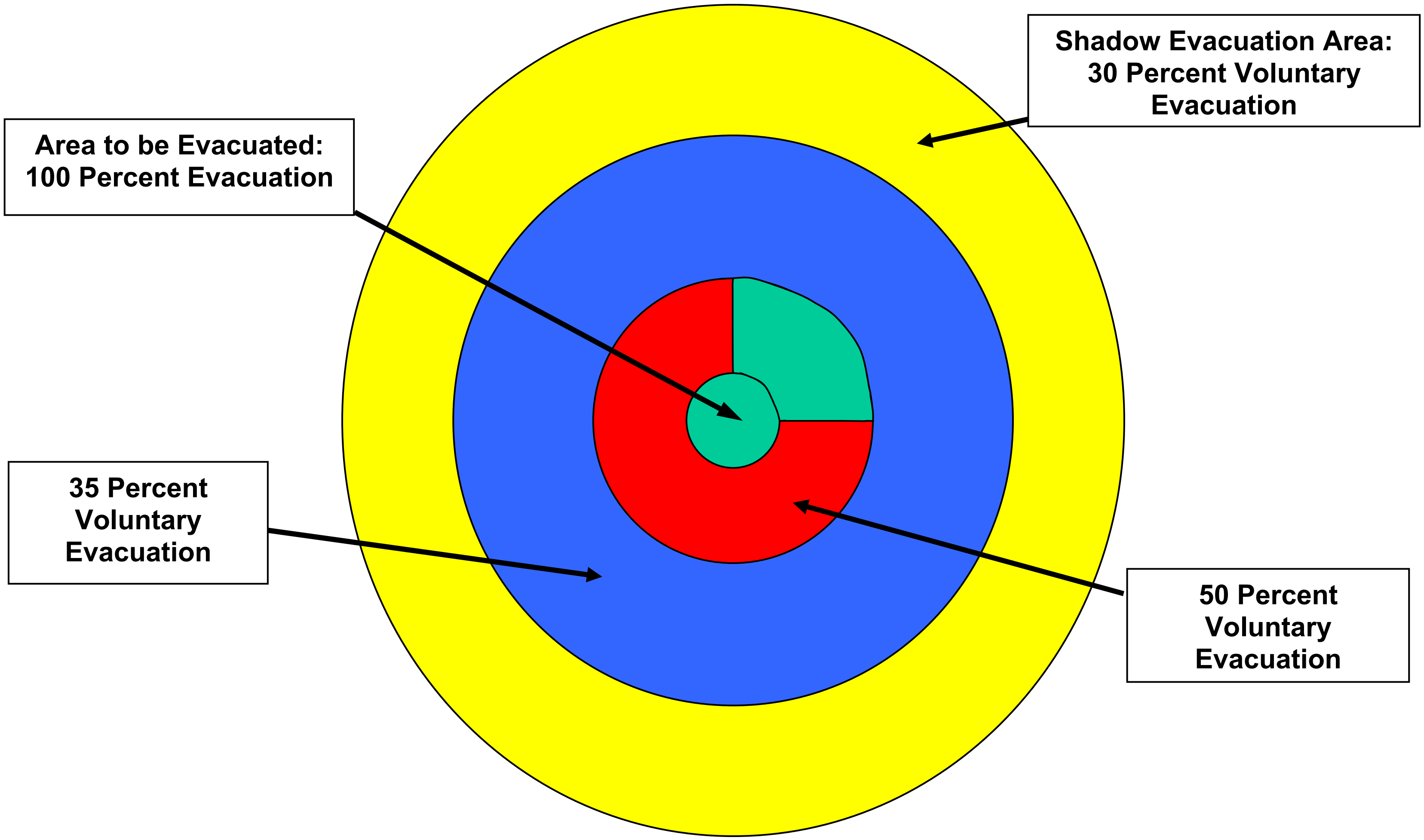


Figure 7-1. Assumed Evacuation Response

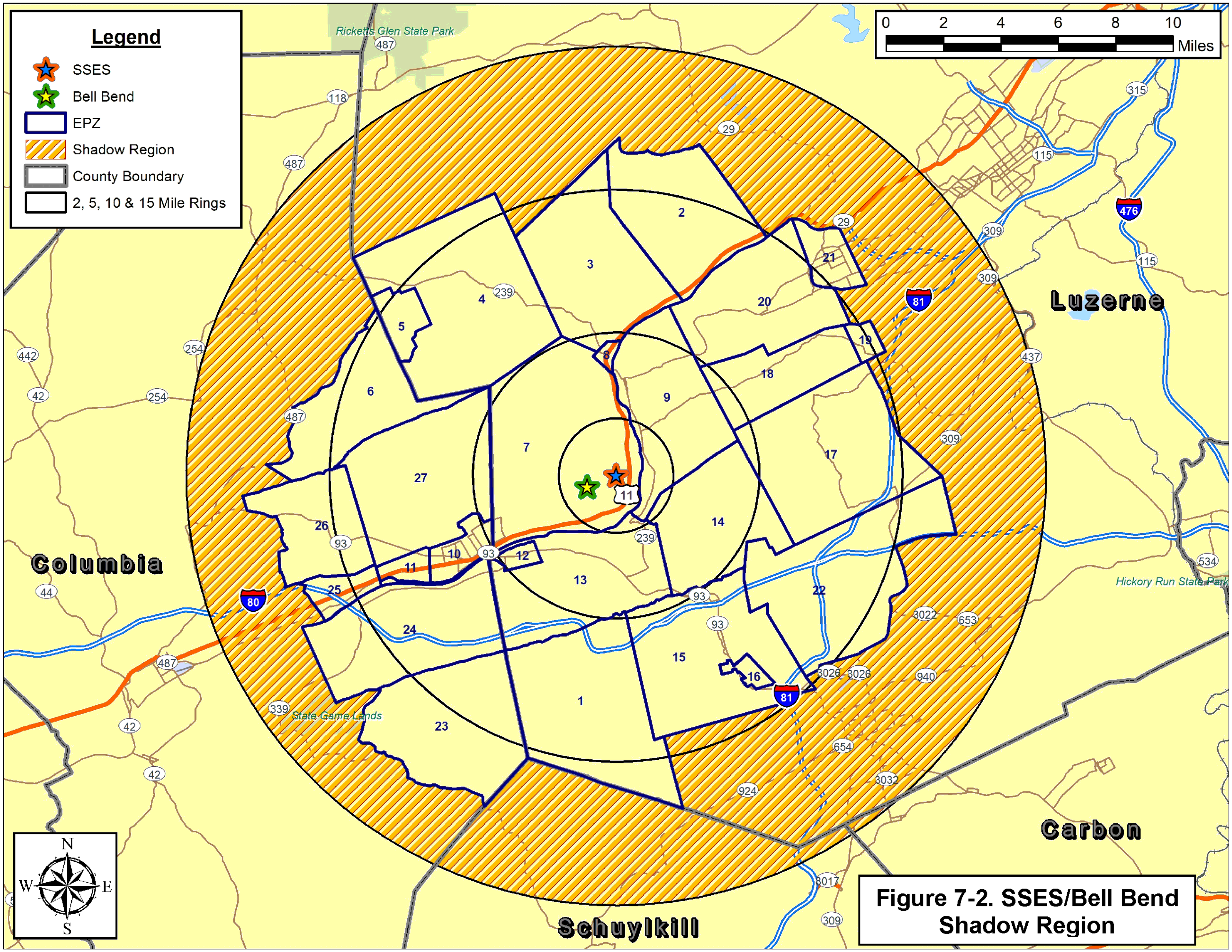


Figure 7-2. SSES/Bell Bend Shadow Region

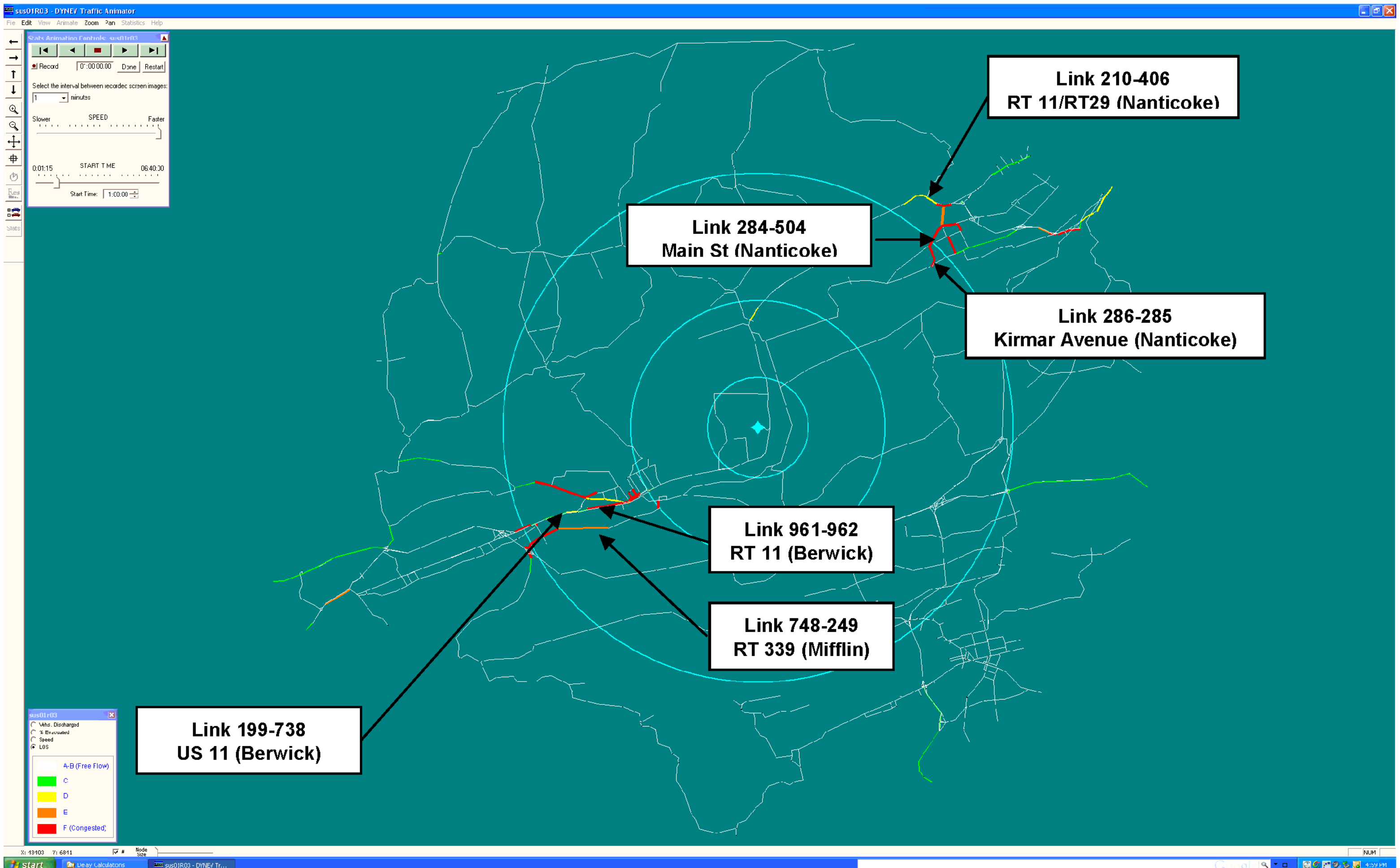


Figure 7-3. Congestion Patterns at 60 Minutes after the Advisory to Evacuate (Scenario 1, Region R03)

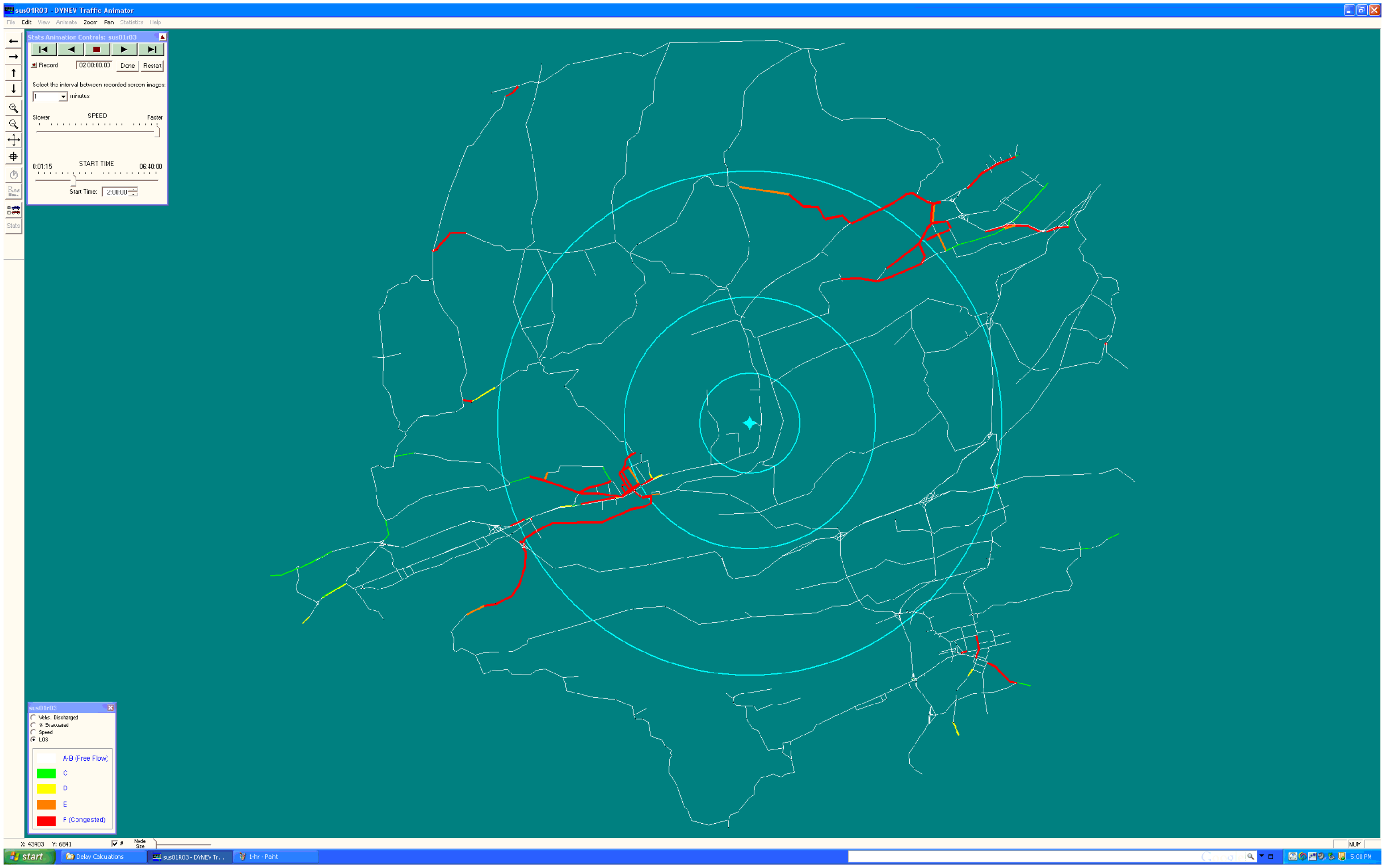


Figure 7-4. Congestion Patterns at 2 Hours after the Advisory to Evacuate (Scenario 1, Region R03)

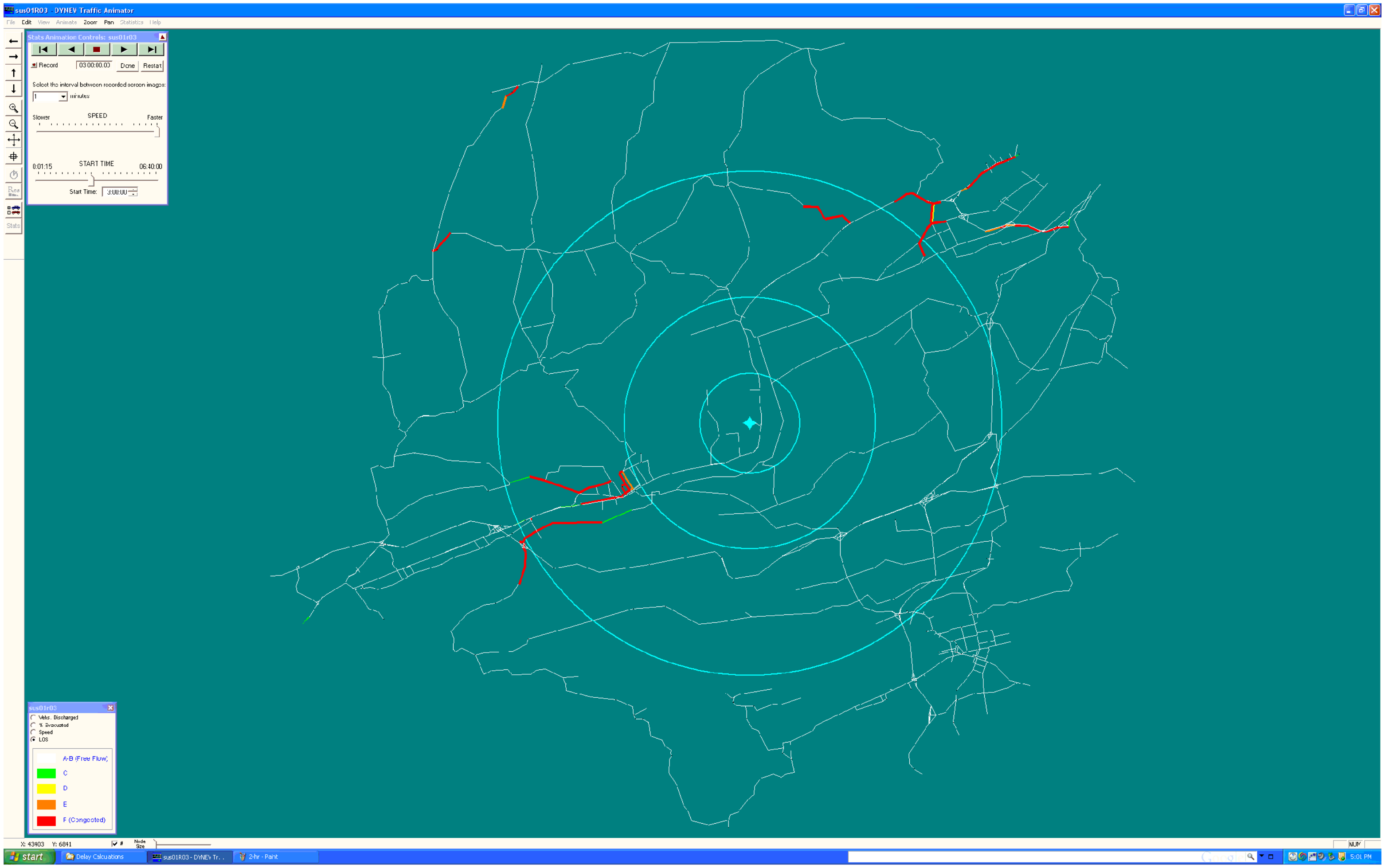


Figure 7-5. Congestion Patterns at 3 Hours after the Advisory to Evacuate (Scenario 1, Region R03)

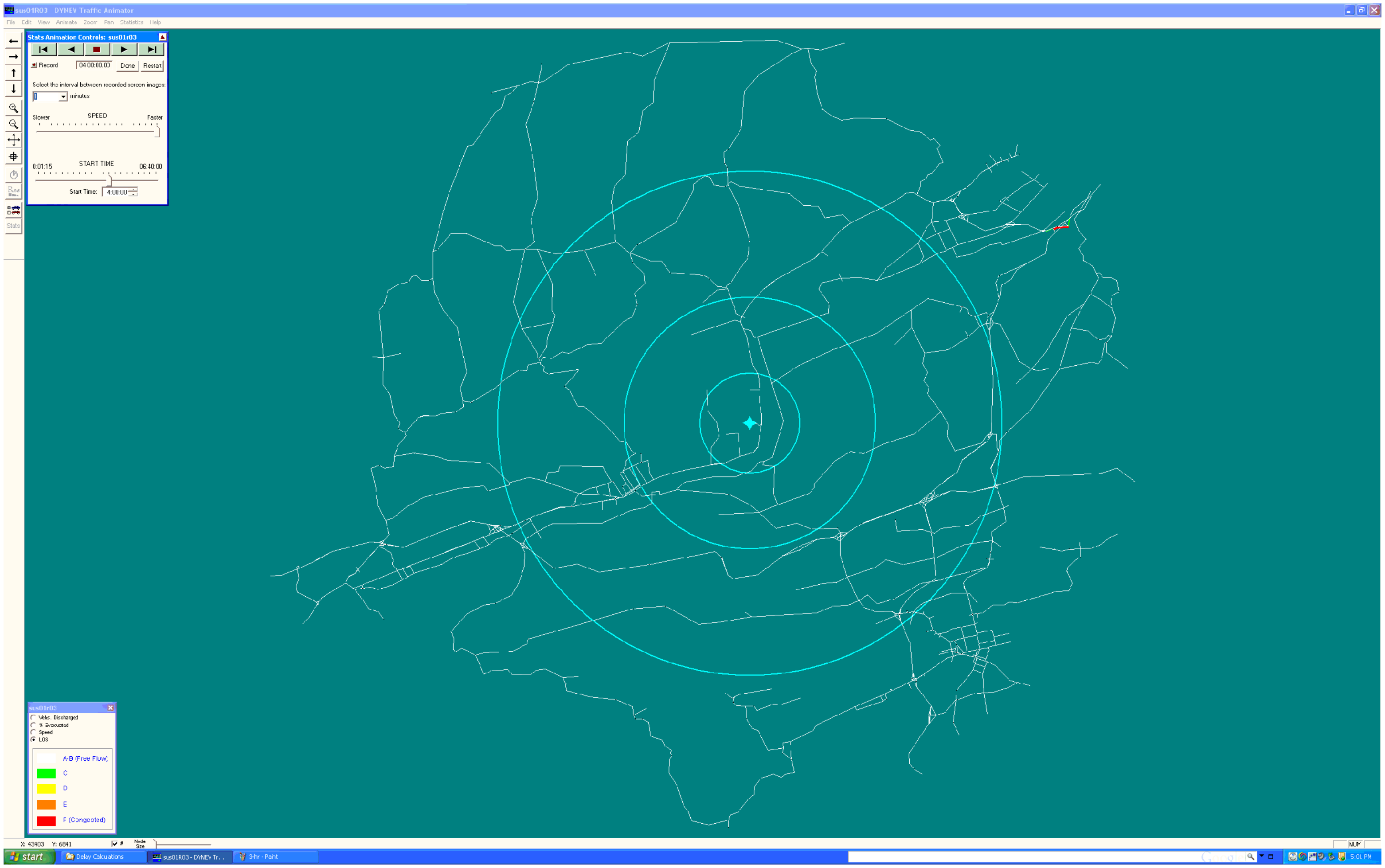


Figure 7-6. Congestion Patterns at 4 Hours after the Advisory to Evacuate (Scenario 1, Region R03)

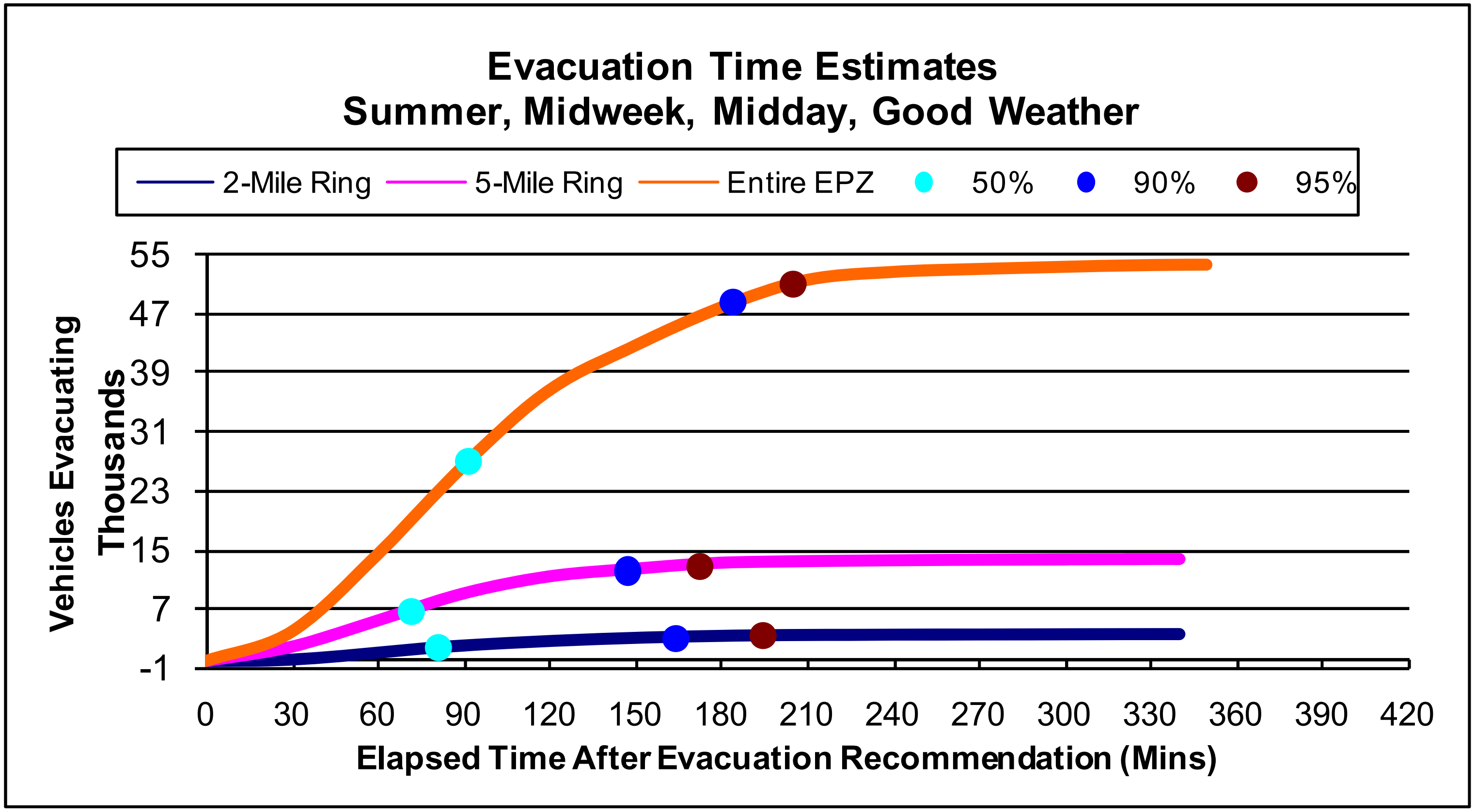


**Figure 7-7. Evacuation Time Estimates for SSES/Bell Bend
Summer, Midweek, Midday, Good Weather
Evacuation of Region R03 (Entire EPZ)**

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 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 larger 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 studies at similar sites, it is estimated that bus mobilization time will be approximately 90 minutes extending from the advisory to evacuate, to the time when buses arrive at their respective assignments for Luzerne and Columbia counties.

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 to speed the evacuation of the school children in the event that buses need to return to the EPZ to evacuate other transit dependent persons. These ETE for transit-based evacuation are developed under the assumption that no children will be picked up at school by their parents; this assumption yields 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 host schools

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 school children. For those evacuation scenarios where children are at school when an evacuation is ordered, separate transportation is provided for the school children. The actual need for transit vehicles by residents under these circumstances is thereby less than the given estimates.
- 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 2,036 people. Therefore, a total of 68 bus runs are required to transport this population to reception centers. The county emergency plans estimate transit dependent population of 5429 for Luzerne County and 2745 for Columbia County. These estimates do not provide the methodology applied to estimate these values and do not appear to consider ride-sharing. Hence, based on the more recent telephone survey results, the transit dependent estimates provided in Table 8-1 are used.

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 SSES/Bell Bend EPZ:

$$P = 27{,}825 \times (0.054 \times 1.68 + 0.293 \times (1.75 - 1) \times 0.52 \times 0.40 + 0.436 \times (2.54 - 2) \times (0.52 \times 0.40)^2)$$

$$P = 27{,}825 * (0..1463) = 4{,}071$$

$$B = (0.5 \times P) \div 30 = 68$$

These calculations are explained as follows:

- All members (1.68.) of households (HH) with no vehicles (5.4%) will evacuate by public transit or ride-share. The term 27,825 (total households) x 0.054 x 1.68, accounts for these people.
- The members of HH with 1 vehicle away (29.3%), who are at home, equal (1.75-1). The number of HH where the commuter will not return home is equal to (27285 x 0.293 x 0.52 x 0.40), given that 52% of the households in the EPZ have at least one commuter, 40% of which will not wait for the commuter to return before evacuating. The number of persons who will evacuate by public transit or ride-share is equal to the product of these two terms.
- The members of HH with 2 vehicles that are away (43.6%), who are at home, equal (2.54 – 2). The number of HH where neither commuter will return home is equal to 27285 x 0.436 x $(0.52 \times 0.40)^2$. The number of persons who will evacuate by public transit or ride-share is equal to the product of these two terms. (The last term is squared to represent the probability that *neither* commuter will return).
- Households with 3 or more vehicles are assumed to have no need for transit vehicles.
- The total number of persons requiring public transit is the sum of such people in HH with no vehicles, or with 1 or 2 vehicles that are away from home.

8.2 School Population – Transit Demand

Table 8-2 presents the school population and transportation requirements for the direct evacuation of all schools within the EPZ. 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 that is in the neighborhood of 3 percent, daily.

We recommend that the counties introduce procedures whereby the schools are contacted prior to the dispatch of buses from the depot, to ascertain the current estimate of students to be evacuated. In this way, the number of buses dispatched to the schools will reflect the actual number needed. Some parents will likely pick up their children at school, although they are asked to pick children up at the host schools. Those buses originally allocated to evacuate school children 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 host schools for the various school districts in the EPZ. Those students not picked up by their parents prior to the arrival of the buses, will be transported to these schools where they will be subsequently retrieved by their respective families.

The estimates of the bus requirements are comparable with the estimates within the county emergency management plans.

8.3 Special Facility Demand

Table 8-4 presents the census of special facilities in the EPZ as of spring 2006. These estimates are derived from the county emergency management plans. Approximately 105 people have been identified as requiring ambulatory assistance. This census also indicates the number of ambulances required.

8.4 Evacuation Time Estimates for Transit-Dependent People

Based on the county emergency management plans, the available bus resources are sufficient in each county to service the school evacuation demand in a “single-wave”, assuming drivers are available for all vehicles. In general, the buses will transport the evacuees to the appropriate host school and be available to return to the EPZ for a second trip to service transit dependent people and other special facilities, if needed.

For each county, transit resources will be assigned to schools as a first priority. When these 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 along the pick-up routes.

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

Activity: Mobilize Drivers (A→B→C)

Mobilization is the elapsed time from the advisory to evacuate until the time the buses have arrived at the facility to be evacuated. Based on studies at other sites, a mobilization time of 90 minutes is assumed. Also, an additional 10 minutes is required under adverse weather conditions to account for slower travel times.

Activity: Board Passengers (C→D)

Studies have shown that passengers can board a bus at headways of 2-3 seconds per passenger (Ref. HCM2000 Exhibit 27-9 and page 27-36). Therefore, the total dwell time to service passengers boarding a bus to capacity at a single stop (e.g., at a school or at a pickup point) is about 5 minutes, allowing for a slower boarding rate for people carrying luggage (50 persons @ 6 seconds). A loading time of 10 minutes will be used for rain scenarios. For multiple stops along a pick-up route, an allowance must be made 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 30 minutes in good weather, and 40 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 toward the designated host school. The travel times to the EPZ boundary are based on evacuation speeds computed by the model (PC-DYNEV). The average speed for an evacuation of the full EPZ (Region 3) under Scenario 6 (winter [school in session], midweek, midday, good weather) conditions, at 90 minutes after the advisory to evacuate, is 33.9 mph, while the average speed for an evacuation of the full EPZ under Scenario 7 conditions (Rain) is 28.4 mph. The travel times to the Host Schools were computed using these average speeds. Based on information provided by county emergency management, there are an adequate number of buses to evacuate the school children in a single wave.

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 host school . The evacuation time out of the EPZ can be computed as the sum of travel times associated with Activities A→B→C, C→D, and D→E (For example: 90 + 5 + 12.4 minutes = 1:50 for Berwick Area Middle School, with good weather). The evacuation time to the host school 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 Section 5, about 90 percent of the evacuees (residents without commuters) 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 travel along their routes picking up those passengers who need transportation, then proceed out of the EPZ.

The county emergency plans have identified the bus staging areas throughout Luzerne County at the Municipal Buildings or key locations within each municipality and at the Bloomsburg fair grounds area within Columbia County with detailed pick up points located within each municipality's plans. To estimate ETE, an average distance of travel for each municipality is estimated using GIS software. Using an average mobilization time of 90 minutes, the average speed output by the PC-DYNEV model at the mobilization time is used to estimate the route travel time – 33.9 mph for the, with good weather; 28.4 mph, with rain. The average distance to the reception centers from the EPZ boundary for both counties is approximately 30 miles. Assuming an internal travel distance of 5 miles within the EPZ, the ETE is calculated as shown in Table 8-6.

It is recommended that the county use bus headways to provide a more robust service by servicing those transit-dependent persons that may need more time to mobilize.

Activity: Travel to Host Schools (E→F)

The distances from the EPZ boundary to the host school are also measured using Geographical Information Systems (GIS) software along the most likely route from the EPZ to the host school. 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. EPZ schools were routed to the appropriate host school depending on the district of the school.

Activity: Passengers Leave Bus (F→G)

Passengers can deboard within 5 minutes (HCM Exhibit 27-9). The bus driver takes a 10 minute break.

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 buses that evacuated the schools. Thus, the mobilization time for the second wave is the average time that buses arrive at the host schools (See Table 8-5). The travel time back to the EPZ is the average of the travel time to the host school from Table 8-5 - 20 minutes for good weather and 25 minutes for rain. The bus then travels its route and picks up transit-dependent evacuees along the route. The average speed output by PC-DYNEV at the time the buses begin the second wave is used to compute the route travel time. Other buses at the host schools may be needed for a second wave evacuation of special facilities as detailed in the following section.

The second wave ETE is computed as follows for good weather:

- Bus arrives at host school at 2:00 in good weather (average of “ETE to H.S (min)” column in Table 8-5A).
- Bus discharges passengers (5 minutes) and driver takes a 10-minute rest: 15 minutes.
- Bus returns to EPZ: 20 minutes (average of travel time to host school in Table 8-5A).
- Bus completes pick-ups along route and departs EPZ: 30 minutes + (5 miles @ 23.6 mph) = approximately 45 minutes.
- Bus exits EPZ at time 2:00+ 0:15 + 0:20+ 0:45 = 3:10 (rounded up to the nearest 5 minutes) after the Advisory to Evacuate.

The ETE for the transit-dependent population do not exceed the ETE for the general population.

<u>Evacuation of Ambulatory Persons from Special Facilities</u>

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

- Buses are assigned on the basis of 30 patients to allow for some staff to accompany the patients and to allow room for walkers, canes, etc.
- The passenger loading time will be longer at approximately one minute per patient to account for the time to move patients from inside the facility to the vehicles and for slow boarding rates.

Based on studies at other facilities, a mobilization time for these buses of 90 minutes is applied. In the event there is a shortfall of transit vehicles for a single wave evacuation, then buses used to evacuate schools will have to return to participate in the evacuation of the special facilities.

Appendix E indicates that the medical facilities are 8.0 miles from the plant, on average. Thus, buses evacuating these facilities will have to travel approximately 2.0 miles to leave the EPZ; estimate the travel distance out of the EPZ as 5 miles. The average travel speed at 90 minutes after the advisory to evacuate is 33.9 mph; thus the travel time out of the

EPZ for buses evacuating special facilities is 9 minutes. The ETE for Bonham nursing home, with 77 ambulatory patients, is provided as an example:

90 + 77 x 1 + 9 = 176 min. or 3:00 rounded up

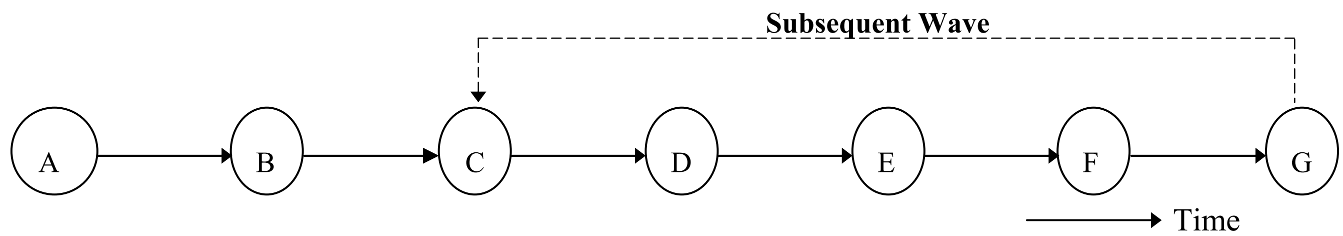
Thus, the ETE for the ambulatory patients at special facilities do not exceed the general population ETE.

Emergency Medical Services (EMS) Vehicles

The previous discussion focused on transit operations for ambulatory persons residing at medical facilities within the Evacuation Region. It is also necessary to provide transit services to non-ambulatory persons who do not – or cannot – have access to private vehicles. Based on the data provided in the county emergency plans, the estimated requirement for ambulances are 36 and 69 in Columbia and Luzerne County, respectively.

It is estimated that at most 60 minutes will be needed to mobilize ambulances and travel to the medical facilities. Loading time is estimated as 10 minutes. As with the buses transporting ambulatory patients, ambulances travel 5 miles, on average, to leave the EPZ. The average speed output by the model at 1 hour for Region 3, Scenario 6 is 33.9 mph; thus, travel time out of the EPZ is 10 minutes.

The ETE for ambulances is: 60 + 10 + 10 = 1:20. The counties indicate that there are sufficient assets to complete the evacuation in a single wave.



Event

A	Advisory to Evacuate
B	Bus Dispatched from Depot
C	Bus Arrives at Facility/Pick-up Route
D	Bus Departs for Host School
E	Bus Exits Region
F	Bus Arrives at Host School
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 Host School Outside the EPZ.
F→G	Passengers Leave Bus; Driver Takes a Break

Figure 8-1. Chronology of Transit Evacuation Operations

Table 8-1. Transit Dependent Population Estimates

Facility Name	2009 EPZ 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 Vehicle	1 Vehicle	2 Vehicle						
SSES/Bell Bend Nuclear Power Plant	70,118	1.68	1.75	2.54	27,825	5.4%	29.3%	43.6%	52%	40%	4,071	50%	2,036	2.9%

Table 8-2A. Luzerne County Schools		
School Name	**Enrollment**	**Bus Runs Required**
Drums Elementary/Middle School	731	11
Garrison Memorial Elementary School	160	3
GNA Educational Center	324	5
GNA Elementary School	443	7
Greater Nanticoke High School	953	20
Hunlock Creek Elementary School	284	5
Huntington Mills Elementary School	308	5
JFK Elementary School	132	2
K M Smith Elementary School	322	5
Keystone Job Corp High School	600	12
Muhlenburg Christian Academy	75	2
Northwest Area High School	668	14
Pope John Paul II Catholic School	320	5
Rice Elementary School	790	12
Salem Elementary School	462	7
The Learning Station School	42	1
Valley Elementary/Middle School	1109	16
Total:		132

Table 8-2B. Columbia County Schools		
School Name	**Enrollment**	**Bus Runs Required**
Beaver Main Elementary School	104	2
Berwick Area Middle School	897	13
Berwick Senior High School	992	20
Fourteenth Street Elementary School	214	4
Heritage Christian Academy	24	1
Holy Family Consolidate	67	1
Mulberry Street Elementary School	88	2
Nescopeck Elementary School	276	4
Orange Street Elementary School	386	6
Total:		53

Table 8-3. Schools and Host Schools	
School	**Host School**
LUZERNE COUNTY	
Drums Elementary/Middle School	McAdoo-Kelayres Elementary School Kelayres, PA
Garrison Memorial Elementary School	Dallas Junior High School Dallas, PA
GNA Educational Center	Hanover Area Senior High School Wilkes Barre, PA
GNA Elementary School	Hanover Area Senior High School Wilkes Barre, PA
Greater Nanticoke High School	Hanover Area Senior High School Wilkes Barre, PA
Hunlock Creek Elementary School	Dallas Junior High School Dallas, PA
Huntington Mills Elementary School	Dallas Junior High School Dallas, PA
JFK Elementary School	Hanover Area Senior High School Wilkes Barre, PA
K M Smith Elementary School	Hanover Area Senior High School Wilkes Barre, PA
Keystone Job Corp High School	McAdoo-Kelayres Elementary School Kelayres, PA*
Muhlenburg Christian Academy	Dallas Junior High School Dallas, PA*
Northwest Area High School	Dallas Junior High School Dallas, PA
Pope John Paul II Catholic School	Hanover Area Senior High School Wilkes Barre, PA
Rice Elementary School	Schools attended until 5 p.m., then to Crestwood Jr.-Sr. High School
Salem Elementary School	Mahoning-Cooper Elementary
The Learning Station School	Hanover Area Senior High School Wilkes Barre, PA*
Valley Elementary School	McAdoo-Kelayres Elementary School Kelayres, PA
COLUMBIA COUNTY	
Beaver Main School	Bloomsburg High School
Berwick Middle School	Danville Middle School
Berwick Senior High School	Danville Senior High School
Fourteenth Street Elementary School	Liberty Valley Elementary
Heritage Christian Academy	Mahoning-Cooper Elementary
Holy Family School	Liberty Valley Elementary
Mulberry Street Elementary School	Danville Elementary
Nescopeck Elementary School	Liberty Valley Elementary
Orange St Elementary School	Danville Middle School

Note: Students and staff at Penn State Hazelton and the Luzerne Community Colleges at Berwick and Nanticoke will evacuate in their private vehicles.

* Not listed in County emergency plans and are directed to the same host school assigned to nearby school.

Table 8-4: Special Facility Transit Demand

Distance (miles)	Direction	Facility Name	Street Address	Municipality	Phone	Capacity	Census	Ambulances Needed	Buses Needed	Vans Needed
LUZERNE COUNTY										
10.3	NE	Mercy Special Care Hospital	128 W Washington St	Nanticoke	(570) 735-5000	67			3	
3.8	E	Johnson Personal Care Home	897 Hobbie Rd	Wapwallopen	(570) 379-3673		18	0	0	2
7.9	S	Zack's Rock Glen Manor	1894 Tomhicken Rd	Rock Glen	(570) 384-4000		35	2	0	2
9.6	NE	Guardian Elder Care Center	147 Old Newport St	Nanticoke	(570) 735-7300		110	11	1	16
9.6	SE	Fritzingertown Senior Living Community	1162 South Old Turnpike Rd	Drums	(570) 788-4178		170	11	2	5
10.3	NW	Bonham Nursing Center	477 Bonnieville Rd	Stillwater	(570) 864-3174		77	0	0	0
10.4	NE	Northeast Counseling	West Washington St	Nanticoke	(570) 735-7590		16	0	0	0
10.4	NE	West Ridge Personal Care Home	541 South Hanover St	Nanticoke	(570) 735-6898		20	1	1	0
	E	Sunny Knoll (Sugarloaf township)	11 Pecora Road	Drums	(570) 788-4448		22	10	0	0
10.5	E	Butler Valley Manor Home	463 N. Hunter Hwy	Drums	(570) 788-4175		37	10	0	5
10.8	NE	Birchwood Nursing Home	395 East Middle Rd	Nanticoke	(570) 735-2973		120	2	1	12
10.9	NE	Villa Personal Care	50 N. Walnut St	Nanticoke	(570) 735-8080		76	0	1	0
COLUMBIA COUNTY										
4.5	W	Berwick Hospital Center	701 E 16th St	Berwick	(570) 759-5000	341			12	
4.5	W	Berwick Retirement Village	801 E 16th St	Berwick	(570) 759-5400		240	2	3	5
					Total	**408**	**941**	**49**	**24**	**47**

Table 8-5A. School Evacuation Time Estimates - Good Weather								
School	**Driver Mobilization Time(min)**	**Loading Time (min)**	**Dist. to EPZ Boundary (mi.)**	**Travel Time to EPZ Bdry (min)**	**ETE (hr:min)**	**Dist. EPZ Bndry to H.S. (mi.)**	**Travel Time EPZ Bdry to H.S. (min)**	**ETE to H.S. (hr:min)**
Columbia County								
Beaver Main School	90	5	2.0	3.5	**1:40**	8.0	14.2	**1:55**
Berwick Area Middle School	90	5	7.0	12.4	**1:50**	14.0	24.8	**2:15**
Berwick Senior High School	90	5	7.0	12.4	**1:50**	14.0	24.8	**2:15**
Fourteenth Street Elementary School	90	5	6.5	11.5	**1:50**	18.0	31.9	**2:20**
Heritage Christian Academy	90	5	7.0	12.4	**1:50**	14.0	24.8	**2:15**
Holy Family School	90	5	6.2	11.0	**1:50**	18.0	31.9	**2:20**
Mulberry Street Elementary School	90	5	7.0	12.4	**1:50**	14.0	24.8	**2:15**
Orange Street Elementary School	90	5	5.8	10.3	**1:50**	14.0	24.8	**2:15**
Luzerne County								
Drums Elementary School	90	5	2.0	3.5	**1:40**	8.2	14.5	**1:55**
Garrison Memorial Elementary School	90	5	11.0	19.5	**1:55**	17.0	30.1	**2:25**
GNA Elementary Center	90	5	0.6	1.1	**1:40**	4.0	7.1	**1:45**
Greater Nanticoke High School	90	5	0.6	1.1	**1:40**	4.0	7.1	**1:45**
Hunlock Creek Elementary School	90	5	5.0	8.8	**1:45**	17.0	30.1	**2:15**
Huntington Mills Elementary School	90	5	11.0	19.5	**1:55**	17.0	30.1	**2:25**
J F Kennedy Elementary School	90	5	0.6	1.1	**1:40**	4.0	7.1	**1:45**
K M Smith Elementary School	90	5	0.6	1.1	**1:40**	4.0	7.1	**1:45**
Mulhenberg Christian Academy	90	5	5.0	8.8	**1:45**	17.0	30.1	**2:15**
Nanticoke Middle School	90	5	0.6	1.1	**1:40**	4.0	7.1	**1:45**
Nescopeck Elementary School	90	5	7.3	12.9	**1:50**	14.0	24.8	**2:15**
Northwest Area High School	90	5	11.0	19.5	**1:55**	17.0	30.1	**2:25**
Pope John Paul II School	90	5	0.6	1.1	**1:40**	4.0	7.1	**1:45**
Rice Elementary School	90	5	0.6	1.1	**1:40**	5.5	9.7	**1:50**
Salem Elementary School	90	5	7.0	12.4	**1:50**	14.0	24.8	**2:15**
SIA Tech (Homestead Job Corps Center)	90	5	3.5	6.2	**1:45**	8.2	14.5	**2:00**
Valley Elementary School	90	5	3.0	5.3	**1:45**	8.2	14.5	**1:55**
				Maximum for EPZ:	**1:55**		**Maximum:**	**2:25**

Table 8-5B. School Evacuation Time Estimates - Rain								
School	Driver Mobilization Time(min)	Loading Time (min)	Dist. to EPZ Boundary (mi.)	Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bndry to H.S. (mi.)	Travel Time EPZ Bdry to H.S. (min)	ETE to H.S. (hr:min)
Columbia County								
Beaver Main School	95	10	2.0	4.2	**1:50**	8.0	16.9	**2:10**
Berwick Area Middle School	95	10	7.0	14.8	**2:00**	14.0	29.6	**2:30**
Berwick Senior High School	95	10	7.0	14.8	**2:00**	14.0	29.6	**2:30**
Fourteenth Street Elementary School	95	10	6.5	13.7	**2:00**	18.0	38.0	**2:40**
Heritage Christian Academy	95	10	7.0	14.8	**2:00**	14.0	29.6	**2:30**
Holy Family School	95	10	6.2	13.1	**2:00**	18.0	38.0	**2:40**
Mulberry Street Elementary School	95	10	7.0	14.8	**2:00**	14.0	29.6	**2:30**
Orange Street Elementary School	95	10	5.8	12.3	**2:00**	14.0	29.6	**2:30**
Luzerne County								
Drums Elementary School	95	10	2.0	4.2	**1:50**	8.2	17.3	**2:10**
Garrison Memorial Elementary School	95	10	11.0	23.2	**2:10**	17.0	35.9	**2:45**
GNA Elementary Center	95	10	0.6	1.3	**1:50**	4.0	8.5	**1:55**
Greater Nanticoke High School	95	10	0.6	1.3	**1:50**	4.0	8.5	**1:55**
Hunlock Creek Elementary School	95	10	5.0	10.6	**2:00**	17.0	35.9	**2:35**
Huntington Mills Elementary School	95	10	11.0	23.2	**2:10**	17.0	35.9	**2:45**
J F Kennedy Elementary School	95	10	0.6	1.3	**1:50**	4.0	8.5	**1:55**
K M Smith Elementary School	95	10	0.6	1.3	**1:50**	4.0	8.5	**1:55**
Mulhenberg Christian Academy	95	10	5.0	10.6	**2:00**	17.0	35.9	**2:35**
Nanticoke Middle School	95	10	0.6	1.3	**1:50**	4.0	8.5	**1:55**
Nescopeck Elementary School	95	10	7.3	15.4	**2:05**	14.0	29.6	**2:30**
Northwest Area High School	95	10	11.0	23.2	**2:10**	17.0	35.9	**2:45**
Pope John Paul II School	95	10	0.6	1.3	**1:50**	4.0	8.5	**1:55**
Rice Elementary School	95	10	0.6	1.3	**1:50**	5.5	11.6	**2:00**
Salem Elementary School	95	10	7.0	14.8	**2:00**	14.0	29.6	**2:30**
SIA Tech (Homestead Job Corps Center)	95	10	3.5	7.4	**1:55**	8.2	17.3	**2:10**
Valley Elementary School	95	10	3.0	6.3	**1:55**	8.2	17.3	**2:10**
				Maximum for EPZ:	**2:10**		**Maximum:**	**2:45**

Table 8-6A. Transit Dependent Evacuation Time Estimate - Good Weather

Mobilization (min)	Loading (min)	Route Travel Time within EPZ (min)	Route Travel Time to Reception Center (min)	ETE (h:min)
90	30	8.8	53.1	3:05

Table 8-6B. Transit Dependent Evacuation Time Estimate - Rain

Mobilization (min)	Loading (min)	Route Travel Time within EPZ (min)	Route Travel Time to Reception Center (min)	ETE (h:min)
90	30	10.6	63.4	3:15

9. TRAFFIC MANAGEMENT STRATEGY {PRIVATE }

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 (preferably, not necessarily, law enforcement officers).
- Traffic Control Devices to assist these personnel in the performance of their tasks. These devices should comply with the guidance of the Manual of Uniform Traffic Control Devices (MUTCD) published by the Federal Highway Administration (FHWA) of the U.S.D.O.T. All state and most county transportation agencies have access to the MUTCD (also available online). Applicable devices include, with reference to the MUTCD:
    - Traffic Barriers: Chapter 6F, section 6F.61, 62 and Figure 6F-4.
    - Traffic Cones: Chapter 3F and section 6F.56.
    - Signs: Chapter 2I
- A plan that defines all necessary details and is documented in a format that is readily understood by those assigned to perform traffic control.

The functions to be performed in the field are:

1. Facilitate evacuating traffic movements that 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 plant, or which interferes with the efficient flow of other evacuees.

The terms "facilitate" and "discourage" are used 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, or other evacuees.
- The driver may be an emergency worker en route to perform an important activity.

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

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

1. A field survey of these critical locations.
   The schematics describing traffic control, which are presented in Appendix G, are based on data collected during field surveys, upon large-scale maps, and on overhead photos.
2. Computer analysis of the evacuation traffic flow environment.
   This analysis identifies the best routing and those locations that experience pronounced congestion.
3. Consultation with emergency management and enforcement personnel.
   Trained personnel who are experienced in controlling traffic and are aware of the likely evacuation traffic patterns should review these control tactics.
4. Prioritization of TCPs.
   Application of traffic control at some TCPs will have a more pronounced influence on expediting traffic movements than at other TCPs. For example, TCPs controlling traffic originating from areas in close proximity to the power plant could have a more beneficial effect on minimizing potential exposure to radioactivity than those TCPs located far from the power plant. Thus, during the mobilization of personnel to respond to the emergency situation, those TCPs which are assigned a higher priority should be manned earlier. These priorities should be reviewed with county emergency management representatives and law enforcement personnel.

The control tactics at the TCPs are presented in schematics that appear in Appendix G.

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

Chapter 2I of the MUTCD presents guidance on emergency management signing. Specifically, the evacuation route sign, EM-1 on page 2I-3, with the word “Hurricane” removed could be installed selectively within the EPZ, if considered advisable by local and state authorities. Similar comments apply to sign EM-3 which identifies TCP locations.
As discussed in Section 2.3, these TCP are not expected to influence the ETE results.

Access control points (ACP) are deployed near the periphery of the EPZ to divert "through" trips. The ETE calculations reflect the assumption that all "external-external" trips are interdicted after 90 minutes have elapsed after the advisory to evacuate (ATE).

All transit trips and other responders entering the EPZ to support the evacuation are assumed to be unhindered by personnel manning TCP.

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

10. EVACUATION ROUTES

Evacuation routes are composed of two distinct components:

- Routing from an emergency response planning area (ERPA) or municipality 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 SSES and Bell Bend sites, 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.

Table 10-1 lists the details for the designated reception centers. Table 10-2 identifies the reception center for each ERPA. Figure 10-1 maps each of the reception centers. An overview of the major evacuation routes for the EPZ is presented in Figure 10-2, while Figures 10-3 and 10-4 show the evacuation routes for Berwick and Nanticoke, respectively. The ETE analysis network is not limited to the primary evacuation routes. All highways other than local streets are represented in the following figures. Some local roads used by traffic to access the primary evacuation routes are included in the analysis network, as shown in Figure 1-2.

Table 10-1. Reception Center Details

Reception Center	EPZ County Serviced	Street Address	City	State	ZIP	County
Big Lots	Luzerne	1010 O'Neill Hwy #1	Dunmore	PA	18512	Lackawanna
Lycoming Mall	Columbia	300 Lycoming Mall Circle #3021	Muncy	PA	17756	Lycoming
Marian High School	Columbia & Luzerne	166 Marian Ave	Tamaqua	PA	18252	Schuylkill
Milton High School	Columbia	700 Mahoning St	Milton	PA	17847	Northumberland
Montandon Elementary School	Columbia & Luzerne	2733 State Route 45	Montandon	PA	17850	Northumberland
Tunkhannock High School	Luzerne	120 W Tioga St	Tunkhannock	PA	18657	Wyoming

Table 10-2. Reception Center Assignments

ERPA	Municipality	County	Reception Center
1	Black Creek Township	Luzerne	Marian High School
2	Hunlock Township	Luzerne	Tunkhannock High School
3	Union Township	Luzerne	Tunkhannock High School
4	Huntington Township	Luzerne	Tunkhannock High School
5	New Columbus Borough	Luzerne	Tunkhannock High School
6	Fishing Creek Township	Columbia	Lycoming Mall
7	Salem Township	Luzerne	Montandon Elementary School
8	Shickshinny Borough	Luzerne	Tunkhannock High School
9	Conyngham Township	Luzerne	Big Lots
10	Berwick Borough	Columbia	Lycoming Mall
11	Briar Creek Borough	Columbia	Lycoming Mall
12	Nescopeck Borough	Luzerne	Montandon Elementary School
13	Nescopeck Township	Luzerne	Montandon Elementary School
14	Hollenback Township	Luzerne	Montandon Elementary School
15	Sugarloaf Township	Luzerne	Marian High School
16	Conyngham Borough	Luzerne	Marian High School
17	Dorrance Township	Luzerne	Big Lots
18	Slocum Township	Luzerne	Big Lots
19	Nuangola Borough	Luzerne	Big Lots
20	Newport Township	Luzerne	Big Lots
21	Nanticoke City	Luzerne	Big Lots
22	Butler Township	Luzerne	Marian High School
23	Beaver Township	Columbia	Marian High School
24	Mifflin Township	Columbia	Montandon Elementary School
25	South Centre Township	Columbia	Montandon Elementary School
26	North Centre Township	Columbia	Milton High School
27	Briar Creek Township	Columbia	Milton High School

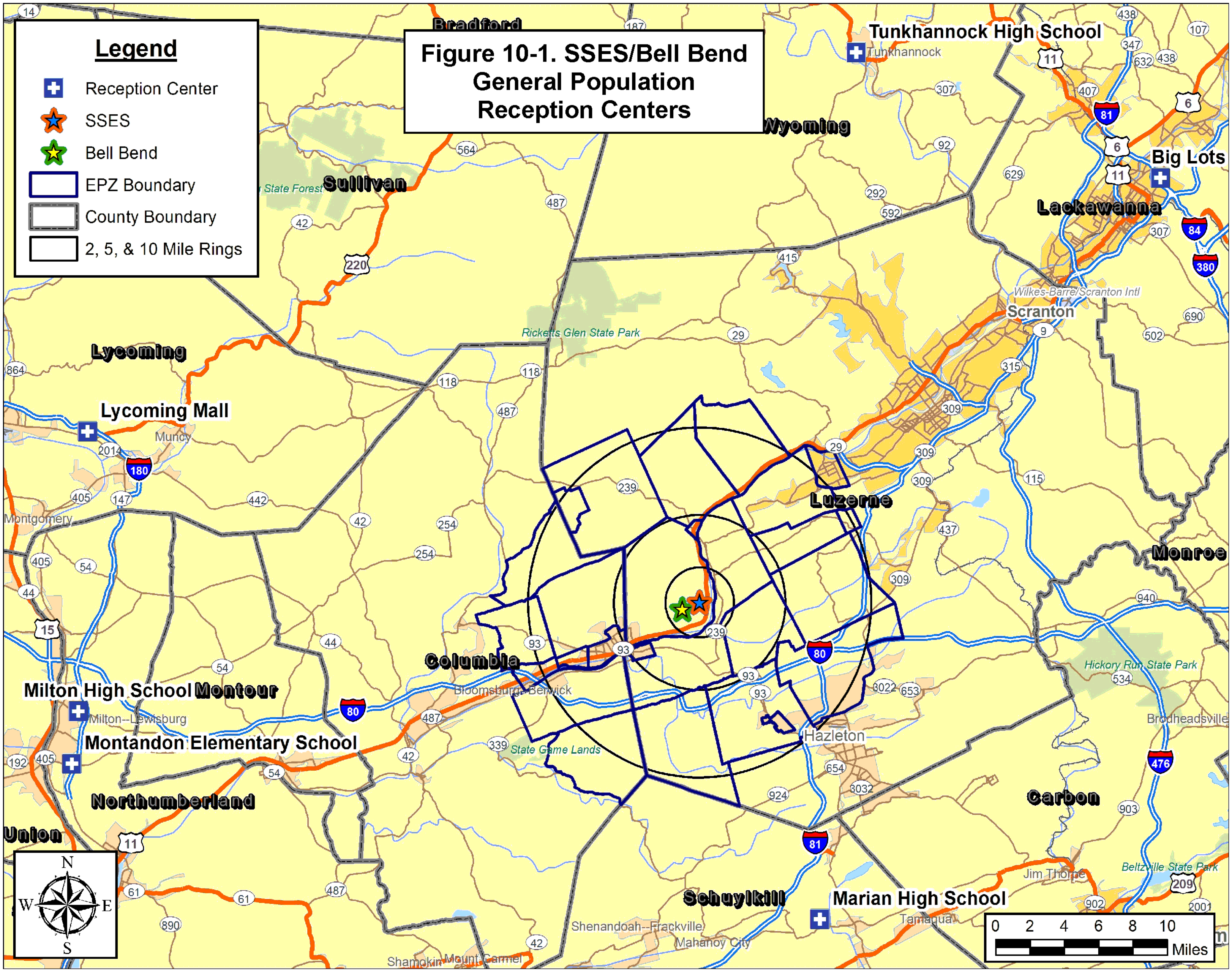


Figure 10-1. SSES/Bell Bend
General Population
Reception Centers
Legend
Reception Center
SSES
Bell Bend
EPZ Boundary
County Boundary
2, 5, & 10 Mile Rings
Tunkhannock High School
Big Lots
Lycoming Mall
Milton High School
Montandon Elementary School
Marian High School
Bradford
Wyoming
Sullivan
Lackawanna
Lycoming
Luzerne
Monroe
Columbia
Montour
Northumberland
Union
Carbon
Schuylkill
Scranton
Hazleton
Bloomsburg-Berwick
Ricketts Glen State Park
Hickory Run State Park
State Game Lands
Beltzville State Park
0 2 4 6 8 10
Miles

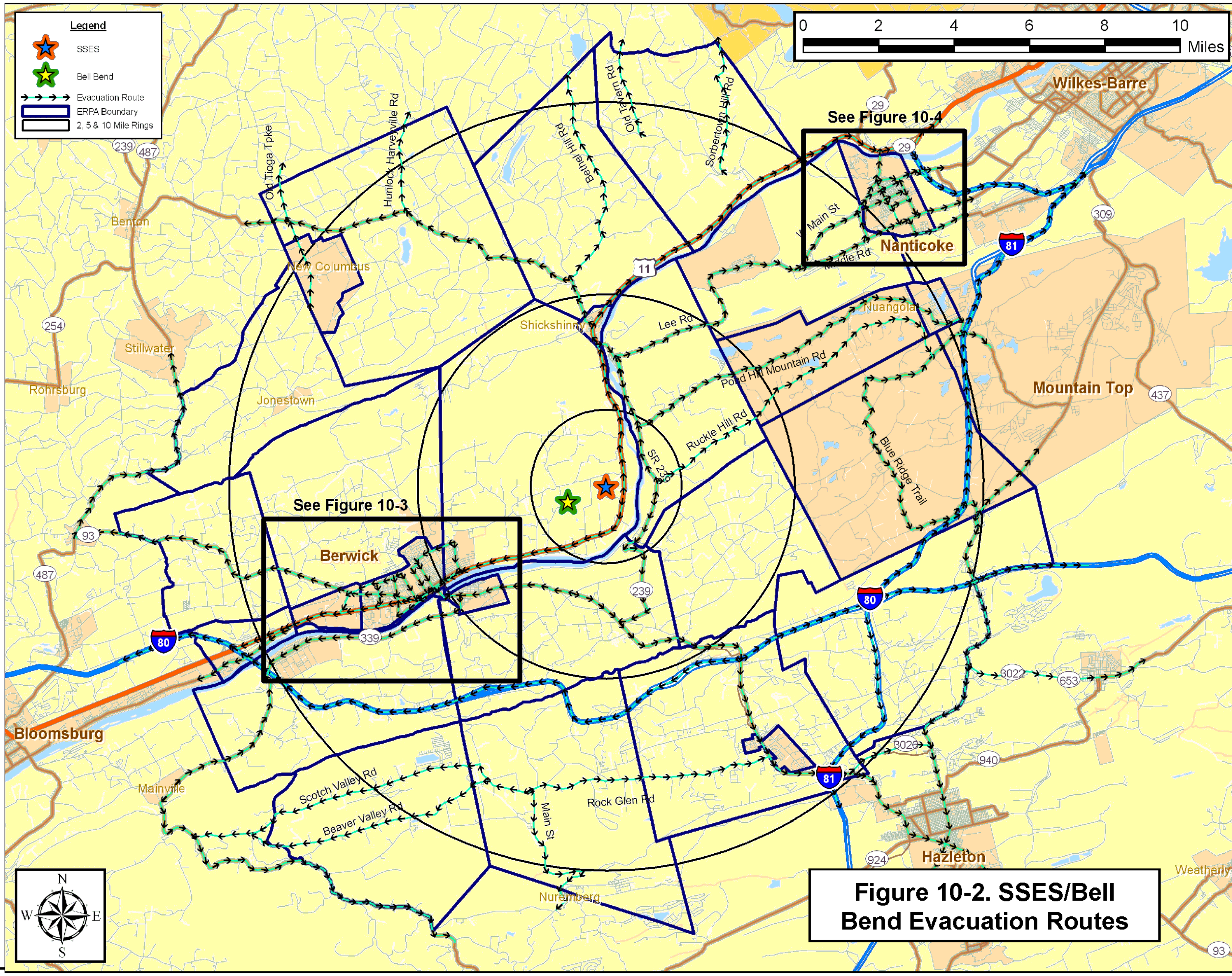


Figure 10-2. SSES/Bell Bend Evacuation Routes

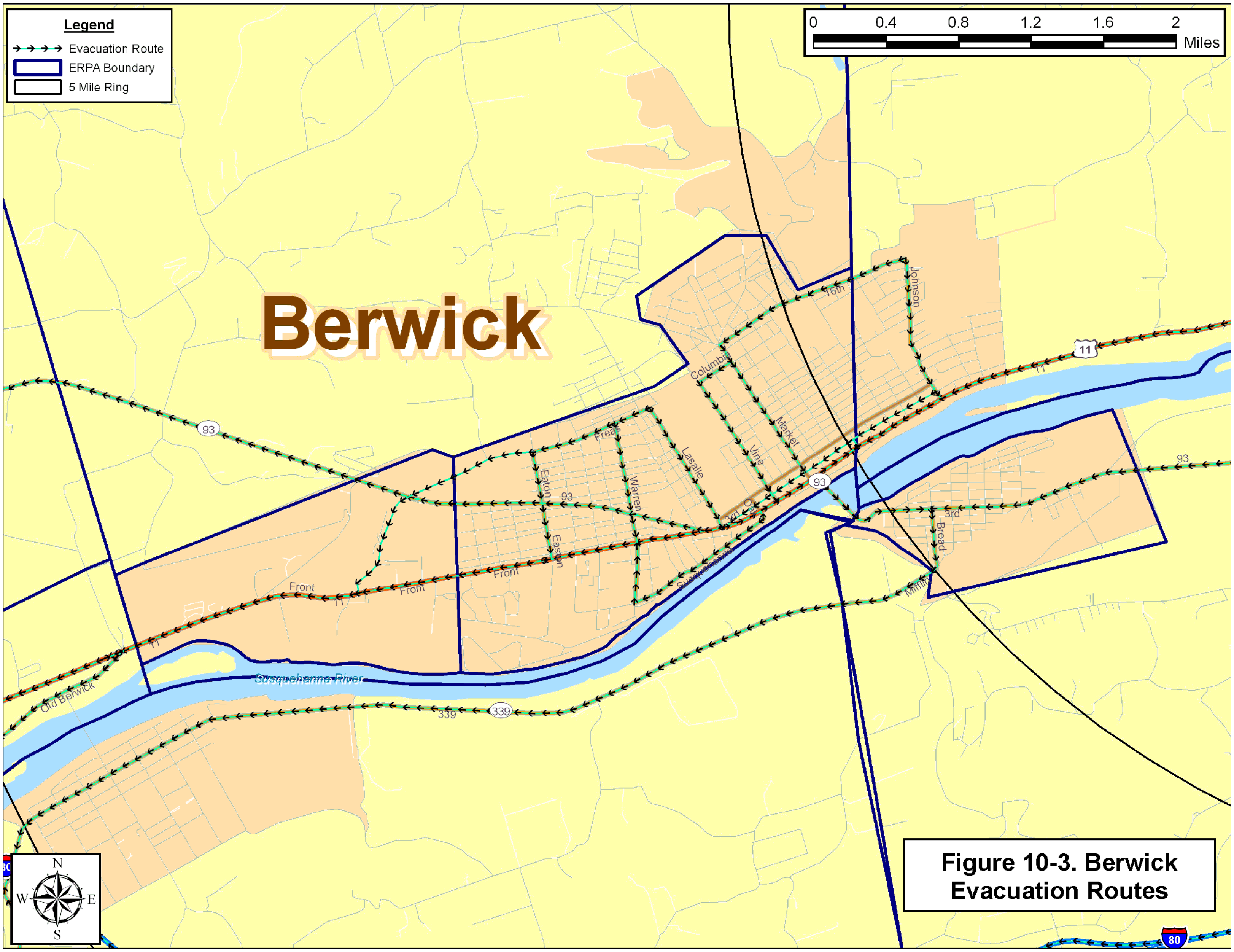


Figure 10-3. Berwick Evacuation Routes

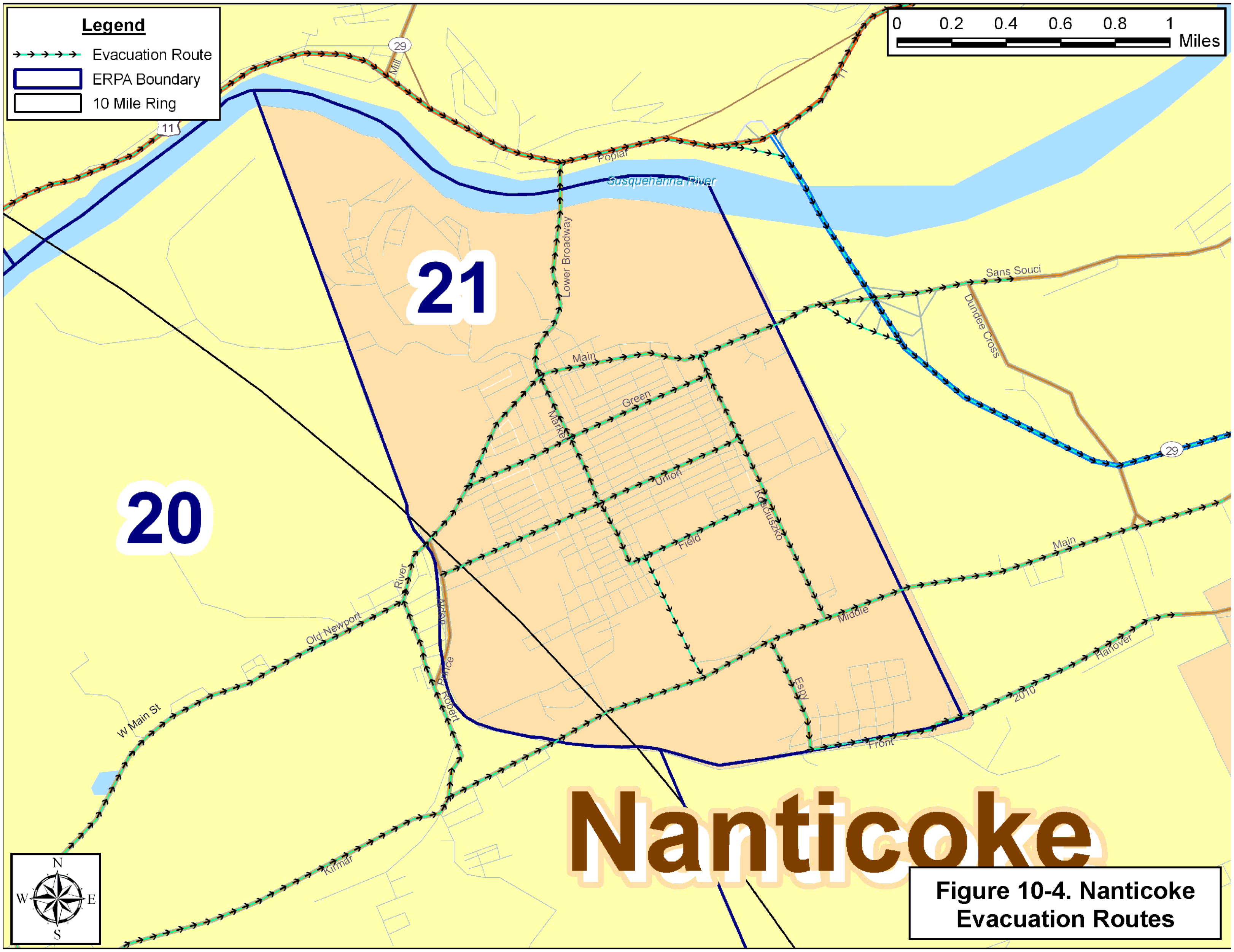


Figure 10-4. Nanticoke Evacuation Routes

11. SURVEILLANCE OF EVACUATION OPERATIONS{PRIVATE }

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 (if cellular coverage exists) from motorists may also provide direct field reports of road blockages.

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

Tow Vehicles

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

While the need for tow vehicles is expected to be low under the circumstances described above, it is still prudent to be prepared for such a need. Tow trucks with a supply of gasoline 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

Guidance in Appendix 4 of NUREG-0654 requires that the time required for confirmation of evacuation be estimated. Although the counties in the EPZ may use their own procedures for confirmation, we suggest an alternative or complementary approach which does not depend on visual observation from a vantage point outside of residences.

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. It is reasonable to assume, for the purpose of estimating sample size that at least 80 percent of the population within the EPZ will comply with the advisory to evacuate. On this basis, an analysis could be undertaken (see Table 12-1) to yield an estimated sample size of approximately 300.

The confirmation process should start at about 3 hours after the advisory to evacuate, which is when 90 percent of evacuees have completed their mobilization activities. At this time, virtually all evacuees will have departed on their respective trips and the local telephone system will be largely free of traffic.

As indicated in Table 12-1, approximately 7½ person hours are needed to complete the telephone survey. If six people are assigned to this task, each dialing a different set of telephone exchanges (e.g., each person can be assigned a different set of Municipalities), then the confirmation process will extend over a time frame of about 75 minutes. Assigning 3 people would require 2½ hours. In either case, the confirmation should be completed before the evacuated area is cleared. Of course, fewer people would be needed for this survey if the evacuation region were only a portion of the EPZ. Use of modern automated computer controlled dialing equipment 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.

The list of resident and business telephone numbers – including cell phone and land lines – should be compiled and archived by local response agencies for this purpose. Such lists can be purchased from vendors at modest cost. For ease of access, this list should be broken down by evacuation region. This approach should be supplemented with other confirmation techniques:

- Patrol cars equipped with loud speakers (route alerting)
- Helicopters or fixed-wing aircraft (if available) equipped with loud speakers

TABLE 12-1
ESTIMATED NUMBER OF TELEPHONE CALLS REQUIRED
FOR CONFIRMATION OF EVACUATION

Problem Definition

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

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

Given:

No. of households plus other facilities, N, within the EPZ (est.) = 27,825
Est. proportion, F, of households that have not evacuated = 0.20
Allowable error margin, e: 0.05
Confidence level, α: 0.95 (implies A = 1.96)

Applying Table 10 of cited reference,

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

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

Finite population correction:

$$n_F = \frac{nN}{n + N - 1} = 305$$

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 = 214.

Est. Person Hours to complete 300 telephone calls

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

Person Hours: 300[30+20+0.8(36)+0.2(60)]/3600 = 7.6

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 connected 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 in time, expressed as vehicles per mile (vpm).
Traffic (Trip) Distribution	A process for determining the destinations of all traffic generated at the origins. The result often takes the form of a Trip Table, which is a matrix of origin-destination traffic volumes.
Traffic Simulation	A computer model designed to replicate the real-world operation of vehicles on a roadway network, so as to provide statistics describing traffic performance. These statistics are called Measures of Effectiveness.
Traffic Volume	The number of vehicles that pass over a section of roadway in one direction, expressed in vehicles per hour (vph). Where applicable, traffic volume may be stratified by turn movement.
Travel Mode	Distinguishes between private auto, bus, rail, pedestrian and air travel modes.
Trip Table or Origin-Destination Matrix	A rectangular matrix or table, whose entries contain the number of trips generated at each specified origin, during a specified time period, that are attracted to (and travel toward) each of its specified destinations. These values are expressed in vehicles per hour (vph) or in vehicles.
Turning Capacity	The capacity associated with that component of the traffic stream which executes a specified turn maneuver from an approach at an intersection.

APPENDIX B

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 IDYNEV 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 their “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 user-equilibrium assignment methodology to embrace the distribution process, as well. Specifically, the analyst assigns a set of candidate destination nodes to each origin node which reflects the general outward-bound direction of travel relative to the location of the power station. The selection of specific 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 highway capacity constraints, so as to satisfy the stated objective function. This objective function is the statement of the User Optimization Principle by Wardrop[1].

To accomplish this integration, we leave the equilibrium assignment model intact, changing the form of the objective function. The model creates a "fictional" augmentation of the “real” highway network. This augmentation consists of Pseudo-Links and Pseudo-Nodes, so configured as to permit the extended network to embed an equilibrium Distribution Model within the fabric of the Assignment Model. Additional discussion may be found in NUREG/CR-4873 (“Benchmark Study of the I-DYNEV Evacuation Time

[1] Wardrop, J.G., 1952. Some Theoretical Aspects of Road Traffic Research, *Proceedings, Institute of Civil Engineers*, Part II, Vol. 1, pp. 325-378.

Estimate Computer Code") and 4874 ("The Sensitivity of Evacuation Time Estimates to Changes in Input Parameters for the I-DYNEV Computer Code").

Specification of TRAD Model Inputs

The analyst 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 that satisfies the network-wide objective function (Wardrop's Principle).

The analyst 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 all 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 analyst 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 model 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 (a matrix defining origin-destination traffic volumes) 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. The model constructs 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 sub-networks:

1. The “real” highway sub-network, which consists of "Class I" Links and Nodes.
2. A sub-network of "Class II" Pseudo-Links which acts as an interface between the highway sub-network and the network augmentation.
3. The sub-network 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:

Class I Links and Nodes

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.

Class II Links

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.

Class III Links and Nodes

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 set of [real] candidate destination nodes, to the Super-Nodes which collect the traffic travelling through the 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 sub-network and the augmentation sub-network. 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 specified 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, which 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[2]":

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

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:

$a_1 = 0.8$ $b_1 = 5.0$

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

The values of a_2 and b_2, which are applicable for each Class II link, are based upon the absolute requirement that the upstream destination node can service no more traffic than 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. (Note that there is no upper-bound constraint in the BPR formula. Of course, when v/c > 1, the exponential terms grow very rapidly, degrading operational performance and discouraging trips from accessing those links.) 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 pattern, providing more capacity at the overloaded destinations, etc.

APPENDIX C

Traffic Simulation Model: PC-DYNEV

APPENDIX C: TRAFFIC SIMULATION MODEL: PC-DYNEV

A model, named PC-DYNEV, is an adaptation of the TRAFLO Level II simulation model[1], 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:

- The QUEUE histograms 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

[1] Lieberman, E. et al. 1980. Macroscopic Simulation for Urban Traffic Management: The TRAFLO Model, Volume 3: Analytical Developments for TRAFLO. Federal Highway Administration Report No. FHWA-RD-80-113.

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), and (22, 23). Links (8001, 19) and (3, 8011) are Entry and Exit links, respectively. An arterial extends from node 3 to node 19 and is partially subsumed within a grid network. Note that links (21, 22) and (17, 19) are grade-separated.

Table C-1. Measures of Effectiveness Output by PC-DYNEV	
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 PC-DYNEV Model

GEOMETRICS

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

TRAFFIC VOLUMES

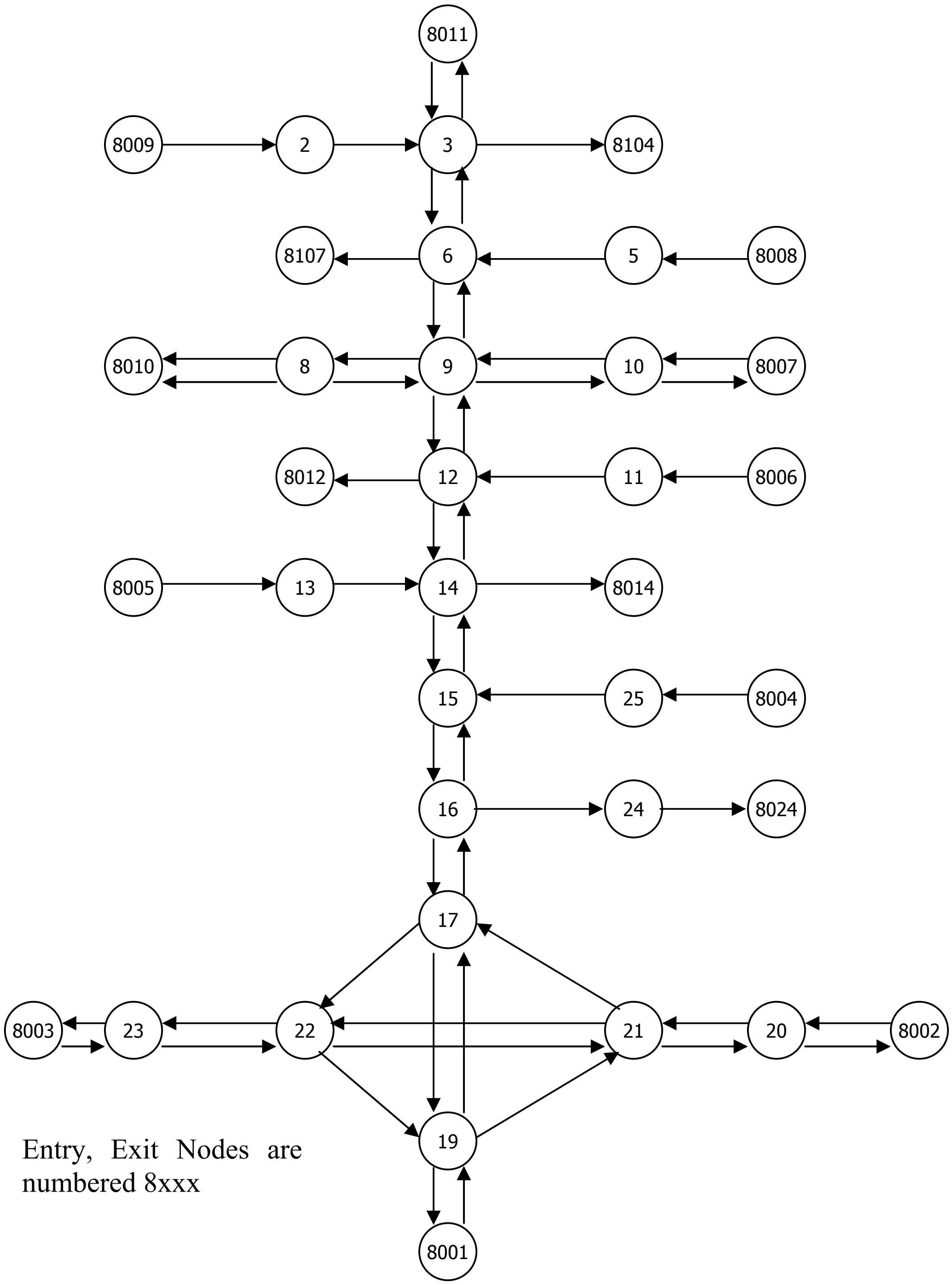
- On all entry links and sink/source nodes stratified by vehicle type: auto, car pool, bus, truck
- Link-specific turn movements

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 OPERATIONAL 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.



Entry, Exit Nodes are numbered 8xxx

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 the results of a telephone survey conducted within the EPZ. Lists of recreational areas and major employers were provided by County Emergency Management Offices. Transient population data and employee data were obtained through phone calls to the facilities listed by the 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 and employment 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. A tablet computer equipped with Global Positioning Satellites (GPS) technology together with video and audio recording equipment are used during the road survey to accurately record the position of traffic control devices and record other roadway data.

Step 4.
With this information, develop the evacuation network representation of the physical roadway system.

Step 5.
With the network created, 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 PC-DYNEV 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 results.

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: excess demand; improper routing; a shortfall of capacity; 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 analyst'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 analyst, 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 PC-DYNEV simulation model. This step completes the specification of the PC-DYNEV input stream.

Step 13.
After the PC-DYNEV 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.

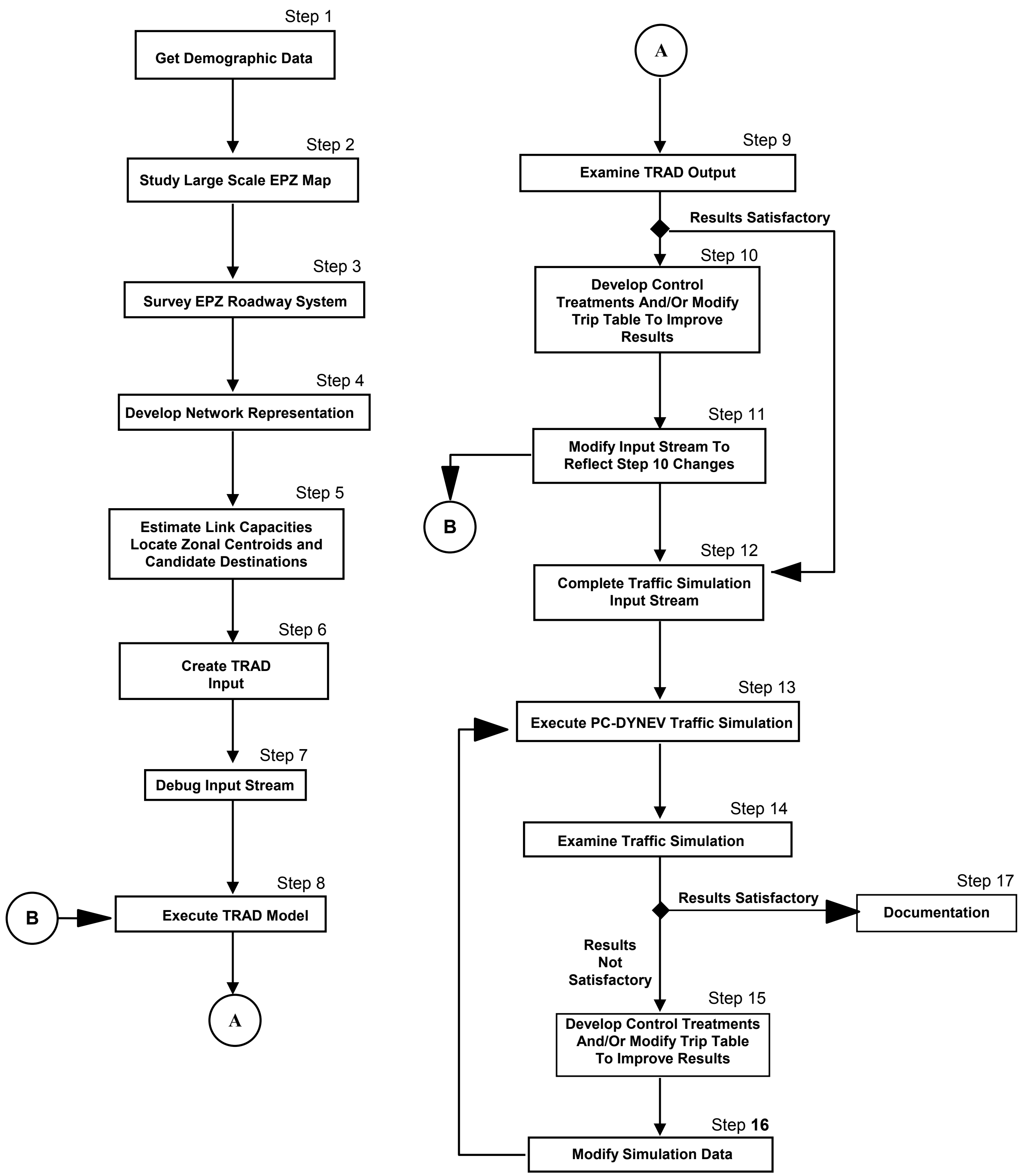


Figure D-1. Flow Diagram of Activities

APPENDIX E

Special Facility Data

APPENDIX E: SPECIAL FACILITY DATA

The following tables list population information for special facilities that are located within the SSES/Bell Bend EPZ. Special facilities are defined as schools, hospitals and other medical care facilities, correctional facilities, and major employers. Transient population data are included in the tables for parks, hotels and motels, hunting, fishing and camp grounds. Each table is grouped by county. The location of the facility is described by its straight-line distance (miles) and direction (magnetic bearing) from the nuclear plant.

SSES EPZ: Schools (Page 1 of 2)							
Distance (miles)	Dir-ection	School Name	Street Address	Municipality	Phone	Student Enrollment	Staff
LUZERNE COUNTY							
4.2	N	Garrison Memorial Elementary School	43 W Vine St	Shickshinny	(570) 542-7001	160	13
4.5	SW	Salem Elementary School	810 E 10th St	Berwick	(570) 759-6400	462	30
6.7	N	Northwest Area High School	243 Thorne Hill Rd	Shickshinny	(570) 542-4126	668	44
7.6	N	Hunlock Creek Elementary School	21 Sunset Lake Rd	Shickshinny	(570) 256-3649	284	19
7.9	SE	Keystone Job Corp High School	P.O.Box 37	Hazleton	(570) 788-0255	600	18
8.0	SE	Valley Elementary/Middle School	79 Rock Glen Rd	Sugarloaf	(570) 788-6044	1109	67
8.3	NW	Huntington Mills Elementary School	417 Shickshinny Lake Rd	Shickshinny	(570) 864-3461	308	18
9.4	SE	Drums Elementary/Middle School	85 S Old Turnpike Rd	Drums	(570) 788-1991	731	39
9.6	NE	K M Smith Elementary School	25 Robert St	Nanticoke	(570) 735-3740	322	16
9.6	SE	Penn State Hazleton	76 University Dr	Hazleton	(570) 450-3000	1232	210
9.8	E	Rice Elementary School	3700 Church Rd	Mountain Top	(570) 868-3161	790	45
9.9	NE	The Learning Station School	133 Alden St	Nanticoke	(570) 735-7998	42	2
9.9	N	Muhlenburg Christian Academy	362 Hunlock-Harveyville Rd	Hunlock Creek	(570) 256-3378	75	15
10.4	NE	Pope John Paul II Catholic School	518 S Hanover St	Nanticoke	(570) 735-7935	320	16
10.7	NE	Luzerne County Community College - Nanticoke	1333 S Prospect St	Nanticoke	(800) 377-5222	1403	375
11.1	NE	GNA Elementary School	601 Kosciuszko St	Nanticoke	(570) 735-1320	443	27
11.1	NE	JFK Elementary School	513 Kosciuszko St	Nanticoke	(570) 735-6450	132	7
11.1	NE	GNA Educational Center	600 E. Union St	Nanticoke	(570) 732-2770	324	18
11.2	NE	Greater Nanticoke High School	425 Kosciuszko St	Nanticoke	(570) 735-7781	953	47
					Sub-total:	**9,405**	**961**

SSES EPZ: Schools (Page 2 of 2)							
COLUMBIA COUNTY							
Distance (miles)	Dir-ection	School Name	Street Address	Municipality	Phone	Student Enrollment	Staff
4.5	SW	Nescopeck Elementary School	315 Dewey St	Nescopeck	(570) 759-6426	276	20
4.6	SW	Berwick Area Middle School	1100 Evergreen Dr	Berwick	(570) 759-6400	897	61
4.7	SW	Berwick Senior High School	1100 Fowler Ave	Berwick	(570) 759-6400	992	74
5.0	SW	Heritage Christian Academy	1112 Butternut St	Berwick	(570) 759-2951	24	5
5.3	SW	Luzerne County Community College - Berwick	107 South Market St	Berwick	(570)759-3900	100	6
5.4	SW	Fourteenth Street Elementary School	1401 N Market St	Berwick	(570) 759-6429	214	16
5.4	SW	Mulberry Street Elementary School	Sixth St and Mulberry St	Berwick	(570)759-4372	88	19
6.0	SW	Holy Family Consolidate	728 Washington St	Berwick	(570) 752-2021	67	9
6.0	SW	Orange Street Elementary School	845 Orange St	Berwick	(570) 759-6422	386	29
12.5	SW	Beaver Main Elementary School	245 Beaver Valley Rd	Bloomsburg	(570) 784 0309	104	18
					Sub-total:	**3,044**	**239**
					Total:	**13,506**	**1,283**

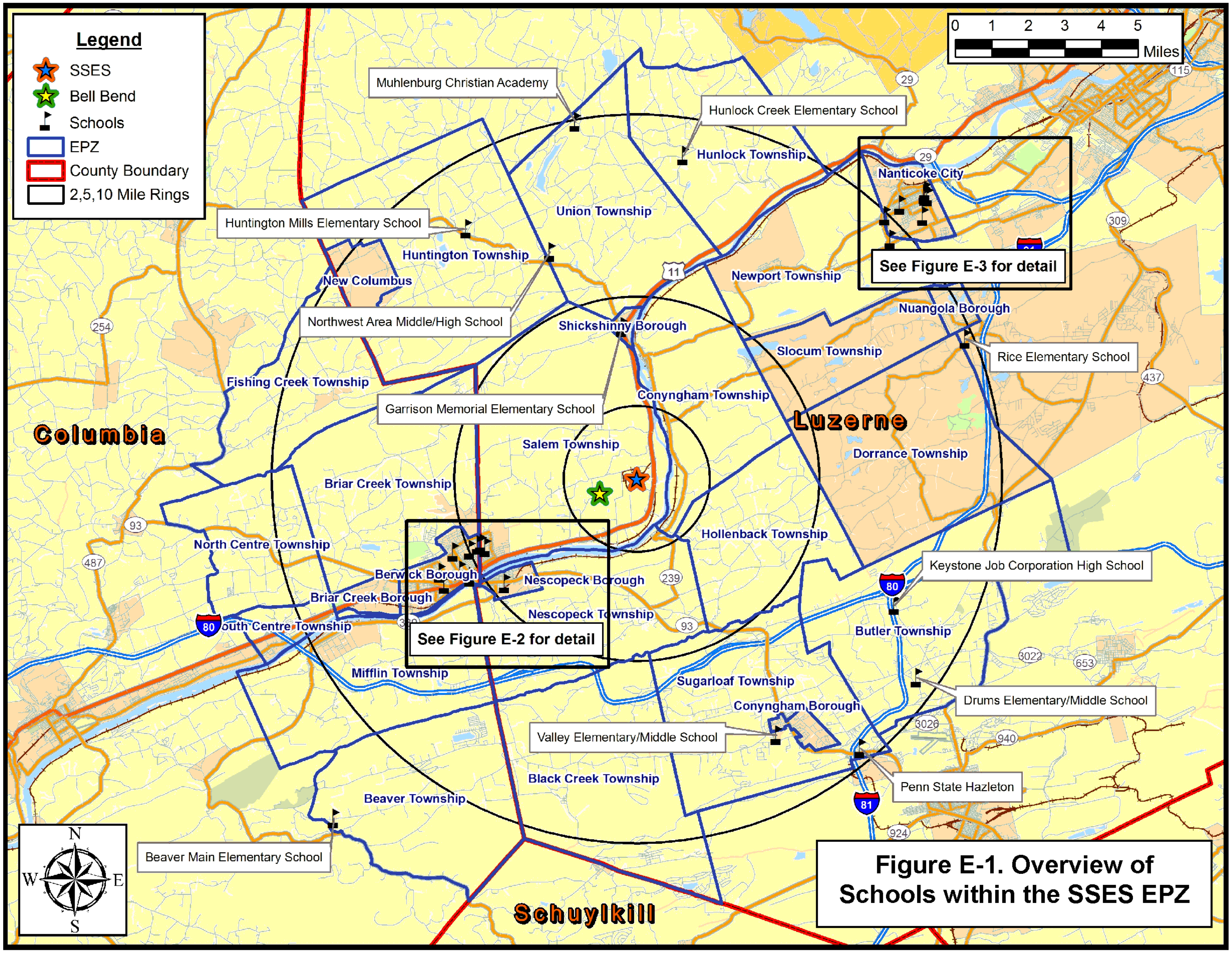
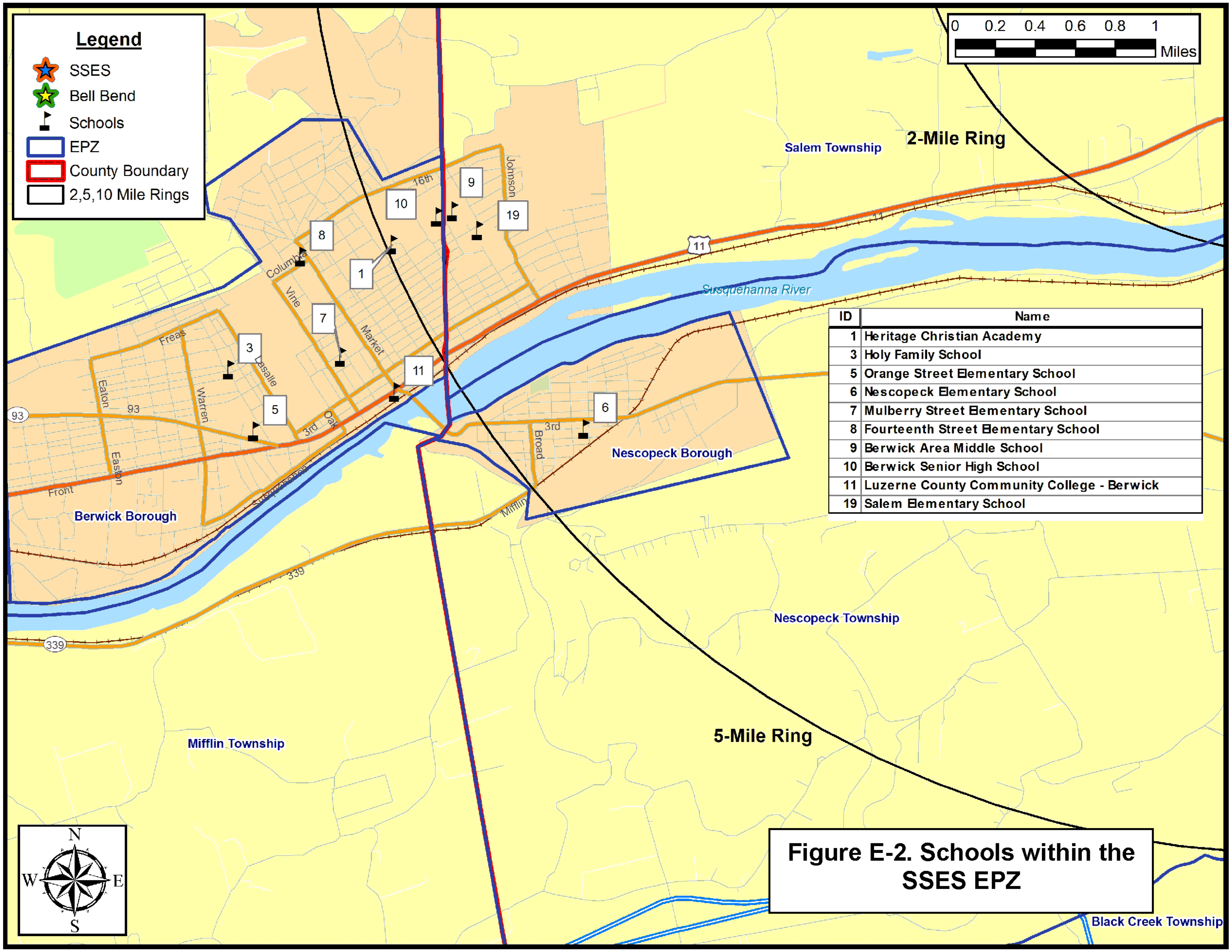


Figure E-1. Overview of Schools within the SSES EPZ



ID	Name
1	Heritage Christian Academy
3	Holy Family School
5	Orange Street Elementary School
6	Nescopeck Elementary School
7	Mulberry Street Elementary School
8	Fourteenth Street Elementary School
9	Berwick Area Middle School
10	Berwick Senior High School
11	Luzerne County Community College - Berwick
19	Salem Elementary School

Figure E-2. Schools within the SSES EPZ

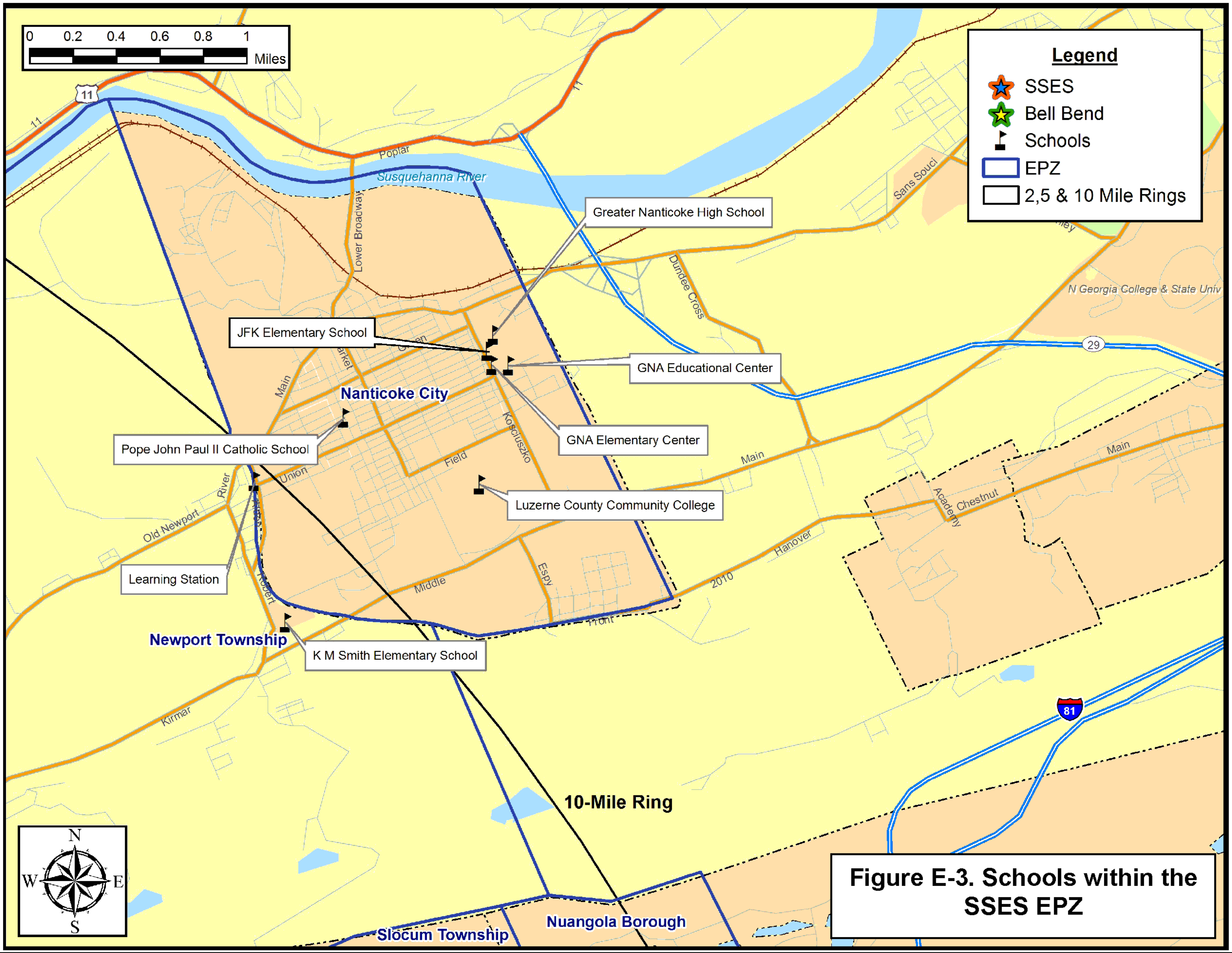


Figure E-3. Schools within the SSES EPZ

SSES EPZ: Major Employers							
Distance (miles)	**Dir-ection**	**Name of Facility**	**Street Address**	**Municipality**	**Phone**	**Total Employees**	**Commuting Employees into EPZ**
LUZERNE COUNTY							
0.0	-	SSES	634 Salem Blvd	Berwick	(866) 832-3312	1247	360
9.6	SE	Penn State Hazelton	76 University Dr	Hazleton	(570) 450-3000	210	210
10.7	NE	Luzerne Community Colle	1333 S Prospect St	Nanticoke	(800) 377-5222	250	200
COLUMBIA COUNTY							
5.7	SW	Deluxe Homes	499 West Third St	Berwick	866-891-7310	105	25
6.1	SW	Wise Foods, Inc.	228 Rasely St	Berwick	(570) 759-4100	450	106
7.1	SW	Berwick Offray	2015 West Front St	Berwick	(570) 752-5934	1100	260
						2,902	**751**

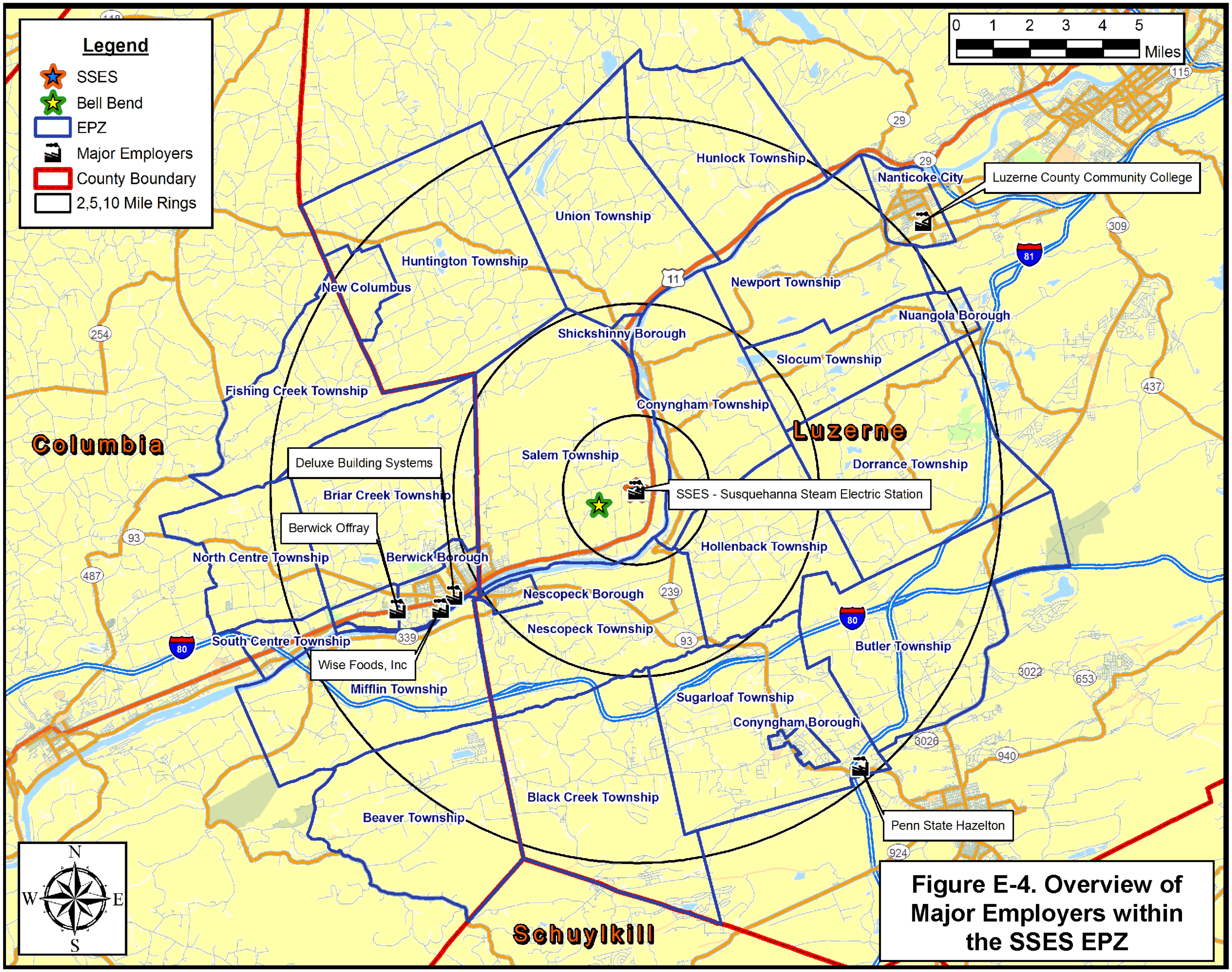


Figure E-4. Overview of Major Employers within the SSES EPZ

SSES: Lodging							
Distance (miles)	Dir-ection	Name of Facility	Street Address	Municipality	Phone	Per-sons	Veh-icles
LUZERNE COUNTY							
5.2	SE	Lookout Motor Lodge	1279 State Route 93	Drums	(570) 788-4131	30	16
5.9	SE	Best Value Inn	1064 State Route 93	Drums	(570) 788-5887	67	34
9.5	SE	Hampton Inn	1 Top of the 80s Rd	Hazleton	(570) 454-3449	197	99
9.8	SE	Fairfield Inn and Suites	1 Woodbine St	Hazleton	(570) 453-0300	91	46
9.9	SE	Forest Hill Inn	3 Forest Hill Rd	Hazleton	(570) 459-2730	64	32
10.0	E	Econo Lodge Hazleton North	10 Woodmere Dr	Drums	(570) 788-4121	67	34
10.1	SE	Holiday Inn Express	1 Corporate Dr	Drums	(877) 863-4780	197	99
10.8	SE	Nesco Manor Hotel	214 N Hunter Hwy	Drums	(570) 788-2452	8	4
COLUMBIA COUNTY							
5.2	W	White Birch Inn B & B	1303 N Market St	Berwick	(570) 759-8251	11	6
8.1	W	Red Maple Inn	7545 Columbia Blvd	Berwick	(570) 752-6220	52	26
8.7	W	Super 8 Motel	450 W 3rd St	Mifflinville	(570) 759-6778	110	55

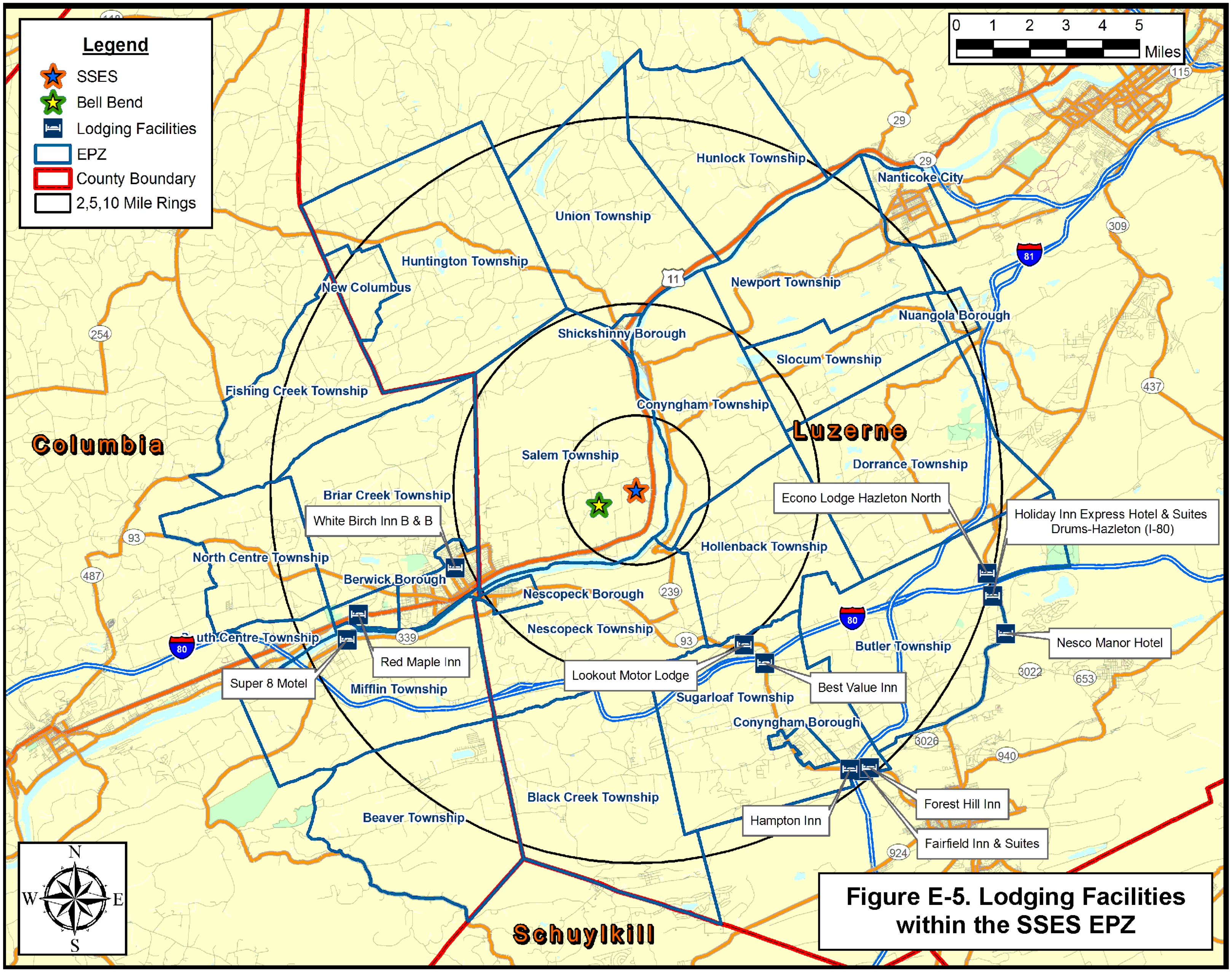


Figure E-5. Lodging Facilities within the SSES EPZ

SSES: CAMPGROUNDS								
Distance (miles)	Dir-ection	Name of Facility	Address	Town	Phone	Available Campsites	Per-sons	Total Vehicles
LUZERNE COUNTY								
1.6	E	Council Cup Campground	212 Ruckle Hill Rd	Wapwallopen	(570) 379-2566	250	325	82
4.3	W	Moyers Grove Campground	309 Moyers Grove Rd	Wapwallopen	(570) 379-3375	170	221	56
6.8	NW	Camp Louise	195 Hawk Rd	Schickshinny	(570) 759-8236	20	26	7
9.3	N	Hidden New Lake Campground	745 Hunlock Harveyville Rd	Schickshinny	(570) 256-7383	25	33	9
COLUMBIA COUNTY								
9.5	NW	Whispering Pines Camping	1557 N Bendertown Rd	Stillwater	(570) 925-6810	60	78	20

SSES: STATE PARKS							
Distance (miles)	Dir-ection	Name of Facility	Address	Town	Phone	Per-sons	Total Vehicles
LUZERNE COUNTY							
11.7	E	Nescopeck State Park	1137 Honey Hole Road	Drums	(570) 403-2006	98	49

SSES: GOLF COURSES							
Distance (miles)	Dir-ection	Name of Facility	Address	Town	Phone	Per-sons	Total Vehicles
LUZERNE COUNTY							
9.0	E	Blue Ridge Trail Golf Club	260 Country Club Drive	Mountain Top	(570) 868-4653	20	20
COLUMBIA COUNTY							
6.5	W	Berwick Golf Club	473 Martzville Road	Berwick	(570) 752-2506	20	20
9.0	W	Rolling Pines Golf Course	355 Golf Course Road	Berwick	(570) 752-1000	20	20

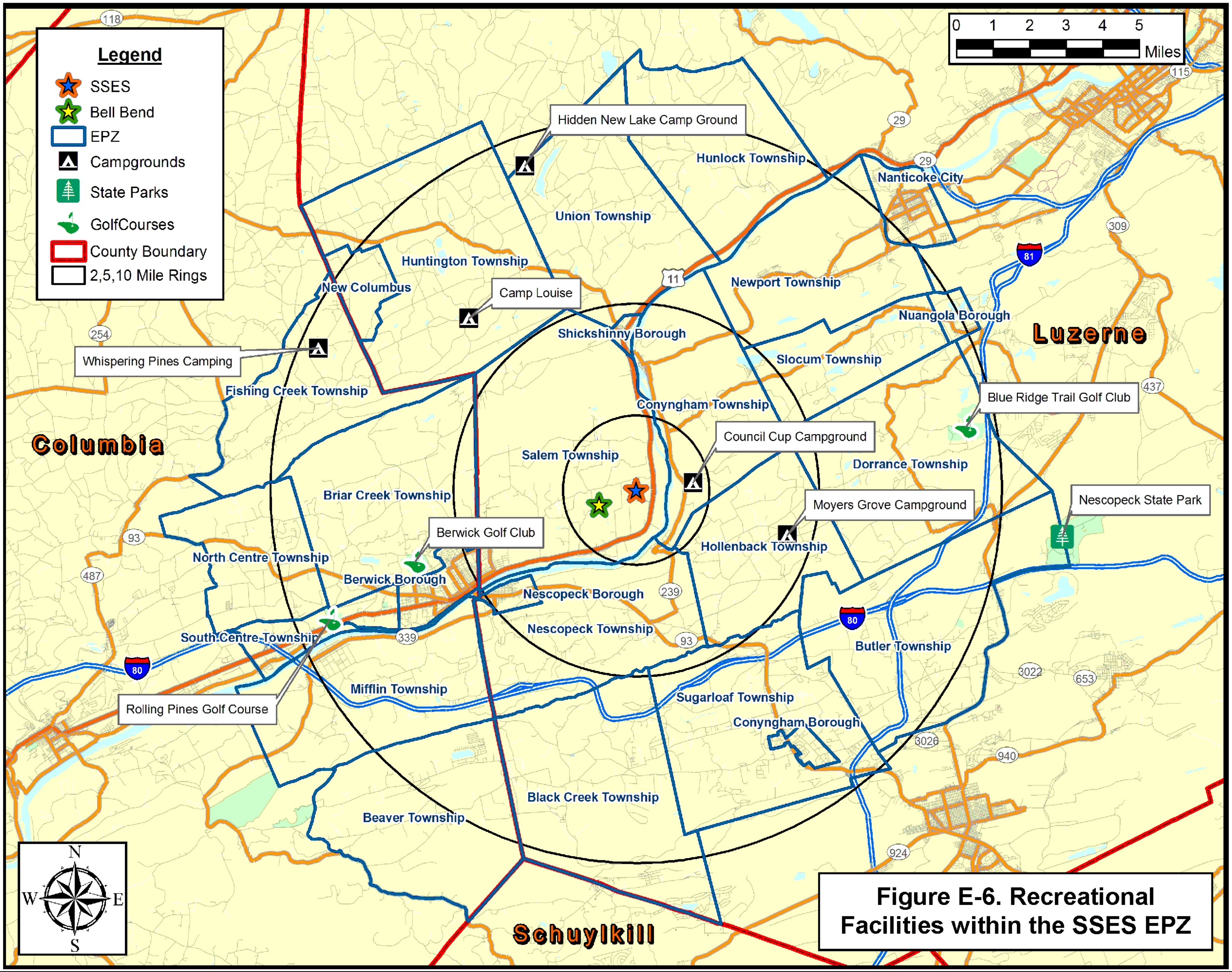


Figure E-6. Recreational Facilities within the SSES EPZ

SSES: HUNTING					
Distance (miles)	**Dir-ection**	**Name of Facility**	**Township**	**Per-sons**	**Total Vehicles**
LUZERNE COUNTY					
3.5	N	State Game Lands 260	Salem	100	100
COLUMBIA COUNTY					
8.4	NW	State Game Lands 55	Fishing Creek	100	100

SSES: FISHING					
Distance (miles)	**Dir-ection**	**Name of Facility**	**Town**	**Per-sons**	**Total Vehicles**
LUZERNE COUNTY					
4.8	NE	Lake Lily	Schickshinny	40	20
COLUMBIA COUNTY					
7.1	W	Susquehanna River, North Branch	Berwick	20	10
7.2	W	Briar Creek Lake	Berwick	24	12

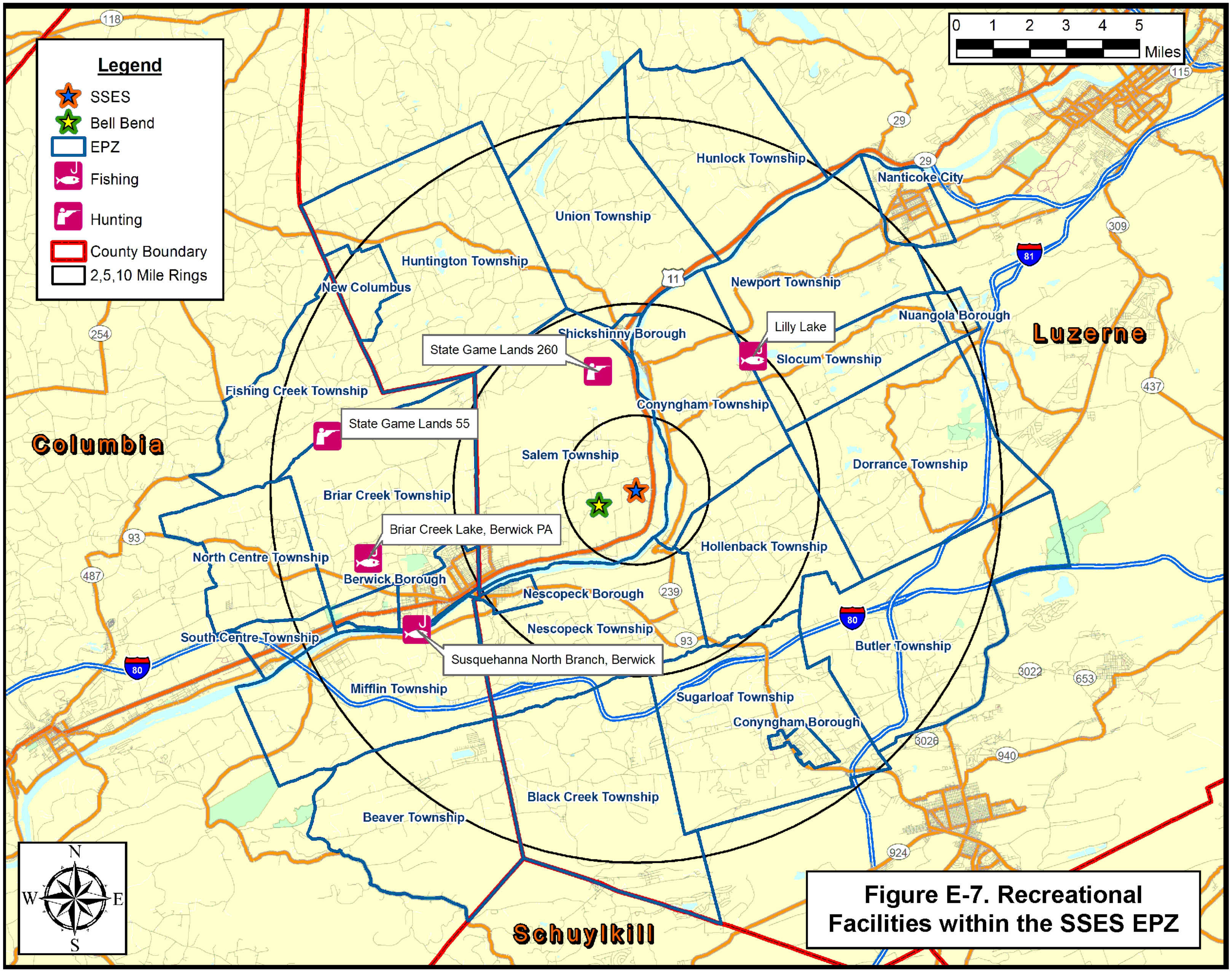


Figure E-7. Recreational Facilities within the SSES EPZ

SSES EPZ: Correctional Facilities

Distance (miles)	Direction	Name of Facility	Address	Town	Phone	Inmates
LUZERNE COUNTY						
7.4	NE	SCI Retreat	660 State Route 11	Hunlock Creek	(570) 735-8754	980

SSES EPZ: Medical Facilities & Nursing Homes										
Distance (miles)	**Direction**	**Facility Name**	**Street Address**	**Municipality**	**Phone**	**Capacity**	**Census**	**Ambulances Needed**	**Buses Needed**	**Vans Needed**
LUZERNE COUNTY										
10.3	NE	Mercy Special Care Hospital	128 W Washington St	Nanticoke	(570) 735-5000	67				
3.8	E	Johnson Personal Care Home	897 Hobbie Rd	Wapwallopen	(570) 379-3673		18	0	0	2
7.9	S	Zack's Rock Glen Manor	1894 Tomhicken Rd	Rock Glen	(570) 384-4000		35	2	0	2
9.6	NE	Guardian Elder Care Center	147 Old Newport St	Nanticoke	(570) 735-7300		110	11	1	16
9.6	SE	Fritzingertown Senior Living Community	1162 South Old Turnpike Rd	Drums	(570) 788-4178		170	11	2	5
10.3	NW	Bonham Nursing Center	477 Bonnieville Rd	Stillwater	(570) 864-3174		77	0	0	0
10.4	NE	Northeast Counseling	West Washington St	Nanticoke	(570) 735-7590		16	0	0	0
10.4	NE	West Ridge Personal Care Home	541 South Hanover St	Nanticoke	(570) 735-6898		20	1	1	0
	E	Sunny Knoll (Sugarloaf township)	11 Pecora Road	Drums	(570) 788-4448		22	10	0	0
10.5	E	Butler Valley Manor Home	463 N. Hunter Hwy	Drums	(570) 788-4175		37	10	0	5
10.8	NE	Birchwood Nursing Home	395 East Middle Rd	Nanticoke	(570) 735-2973		120	2	1	12
10.9	NE	Villa Personal Care	50 N. Walnut St	Nanticoke	(570) 735-8080		76	0	1	0
COLUMBIA COUNTY										
4.5	W	Berwick Hospital Center	701 E 16th St	Berwick	(570) 759-5000	341				
4.5	W	Berwick Retirement Village	801 E 16th St	Berwick	(570) 759-5400		240	2	3	5
5.0	WSW	Outlook Pointe Commons	2050 West Front St	Berwick	(570) 759-3155					
5.0	WSW	Gerringer Boarding Home	39 Village Ln	Berwick	(570) 759-2161					
5.0	WSW	Stulbs Personal Care Home	423 East Fifth St	Berwick	(570) 759-3000					
						408	**941**	**49**	**9**	**47**

Note: Some of the census data is missing. The county emergency plans provided municipality wide estimates instead.

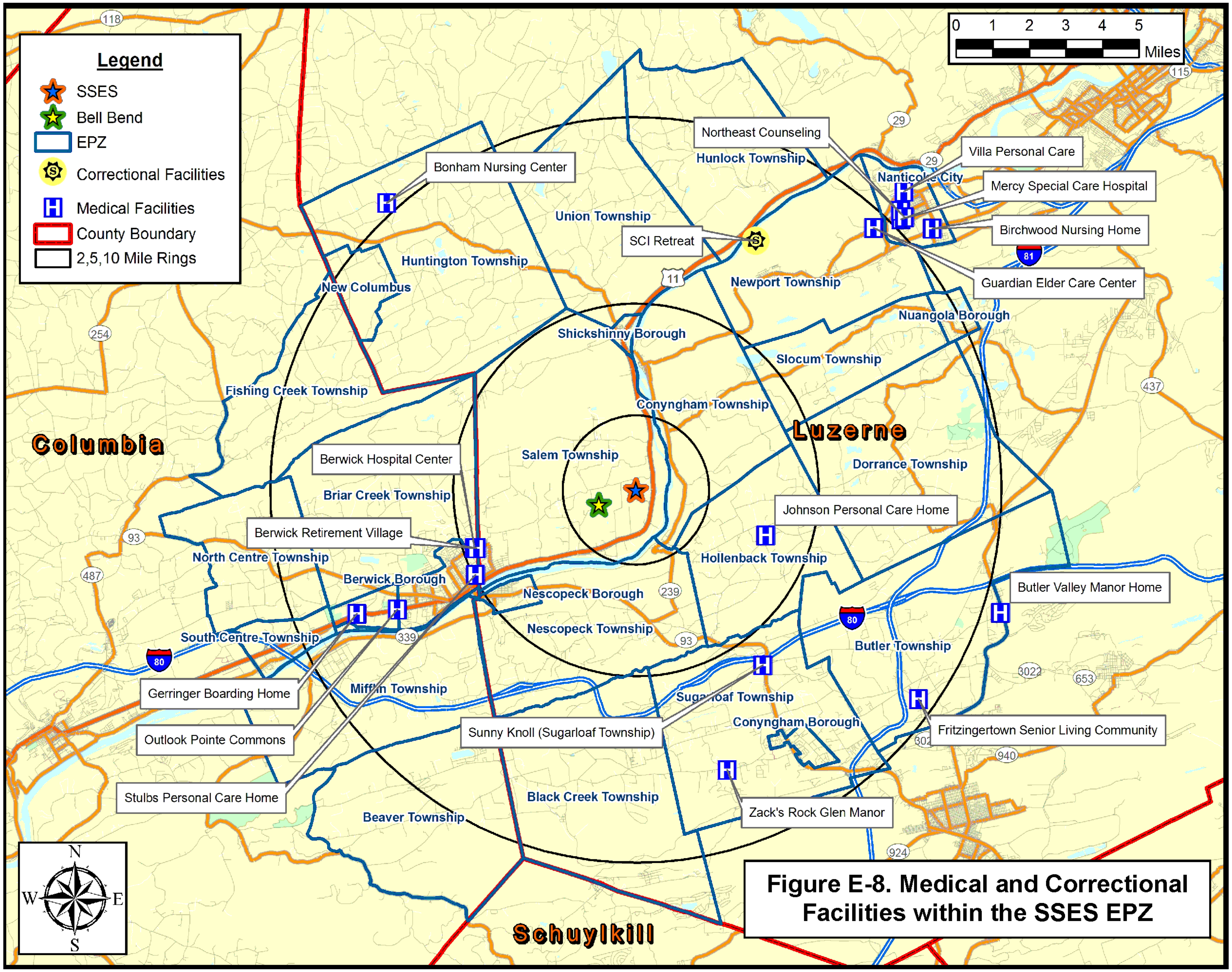


Figure E-8. Medical and Correctional Facilities within the SSES EPZ

APPENDIX F

Telephone Survey

APPENDIX F: TELEPHONE SURVEY

1. INTRODUCTION

The development of evacuation time estimates for the Emergency Planning Zone (EPZ) of the SSES/Bell Bend Nuclear Power Plant 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, the 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 to PPL, UniStar and the EPZ Counties 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 575 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, based on average household size provided by Census data. The proportional number of the desired completed survey interviews for each area was identified, as shown in Table F-1.

Table F-1. Survey Sampling Plan

SSES/Bell Bend Telephone Survey

Sampling Plan

Zip Code	EPZ Population in Zip Code[1] (2000)	Households in EPZ	Required Sample
17814	765	282	6
17815	913	358	8
17859	557	219	5
17878	160	64	1
17985	358	128	3
18202	561	52	1
18219	1348	553	12
18222	4263	1403	30
18246	1672	658	14
18249	4243	1616	34
18603	19696	8145	173
18617	2728	835	18
18621	2167	812	17
18622	130	50	1
18631	1278	535	11
18634	13223	5800	123
18635	3359	1362	29
18655	5217	2057	44
18660	1914	710	15
18707	3919	1466	31
Total	**68,471**	**27,105**	**575**
Average Household Size		**2.5**	
Total Sample Required		**575**	

[1] EPZ population estimate based on SSES EPZ boundary definition

The sampling plan used for the telephone survey presented in Table F-1 was based on the SSES EPZ. This EPZ was updated based on the proposed Bell Bend site. The sample size required by zip code based on this updated EPZ is presented in Table F-2.

Table F-2. Survey Sampling Plan			
SSES/Bell Bend Telephone Survey			
Sampling Plan			
Zip Code	**EPZ Population in Zip Code[2] (2000)**	**Households in EPZ**	**Required Sample**
17814	765	282	6
17815	1893	776	16
17859	546	216	4
17878	170	69	1
17985	358	128	3
18202	561	52	1
18219	1348	553	12
18222	4263	1403	29
18246	1672	658	14
18249	4243	1616	34
18603	19804	8186	170
18617	2728	835	17
18621	2167	812	17
18622	130	50	1
18631	1357	565	12
18634	13223	5800	121
18635	3440	1392	29
18655	5217	2057	43
18660	1914	710	15
18707	3919	1466	30
Total	**69,718**	**27,626**	**575**
Average Household Size		**2.5**	
Total Sample Required		**575**	

Based on the data presented in Table 7-2, the sample size of 575 is sufficient to yield acceptable sampling errors. Also, the sample size by zip code in Table 7-2 closely matches the values in Table 7-1, implying the sufficiency of the conducted telephone survey.

[2] EPZ population estimate based on SSES/Bell Bend EPZ boundary definition

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 2.52 people. The estimated household size (2.5 persons) used to determine the survey sample (Table F-1) was drawn from Census data.

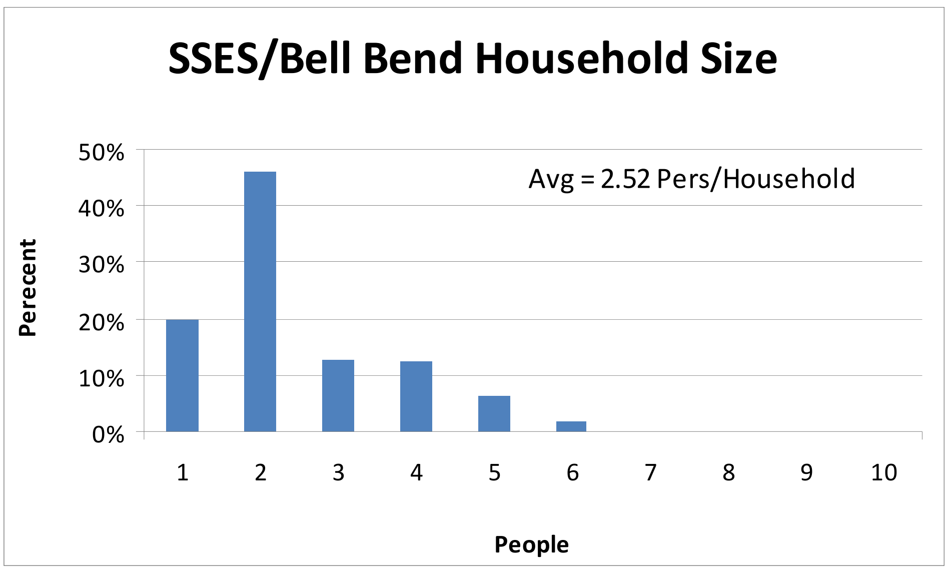


Figure F-1. Household Size in the EPZ

Automobile Ownership

The average number of automobiles per household in the EPZ is 1.91. The distribution of automobile ownership is presented in Figure F-2. Figures F-3 and F-4 present the automobile availability by household size; approximately 5.4 percent of households do not have access to an automobile. The majority of households without access to a car are single person households; nearly all households of 2 or more people have access to at least one vehicle.

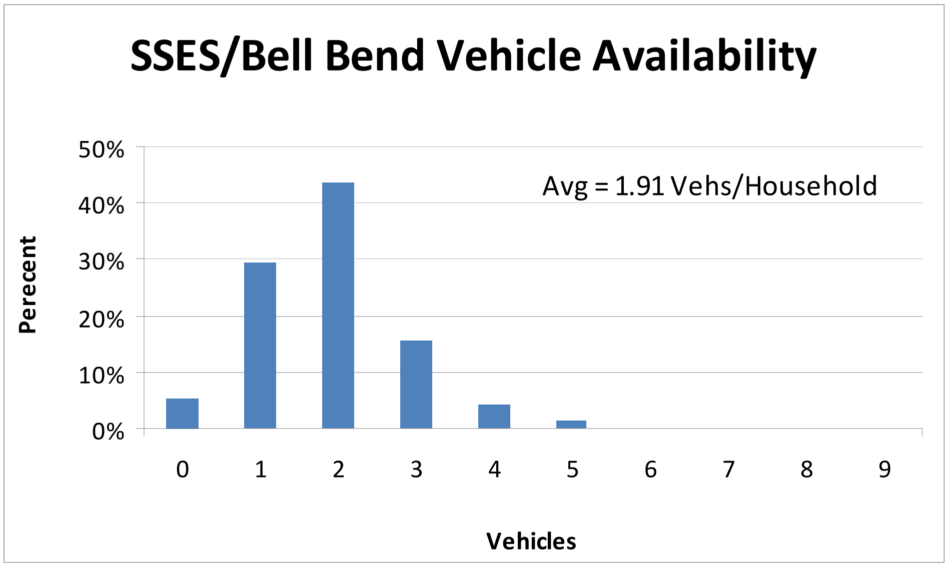


Figure F-2. Household Vehicle Availability

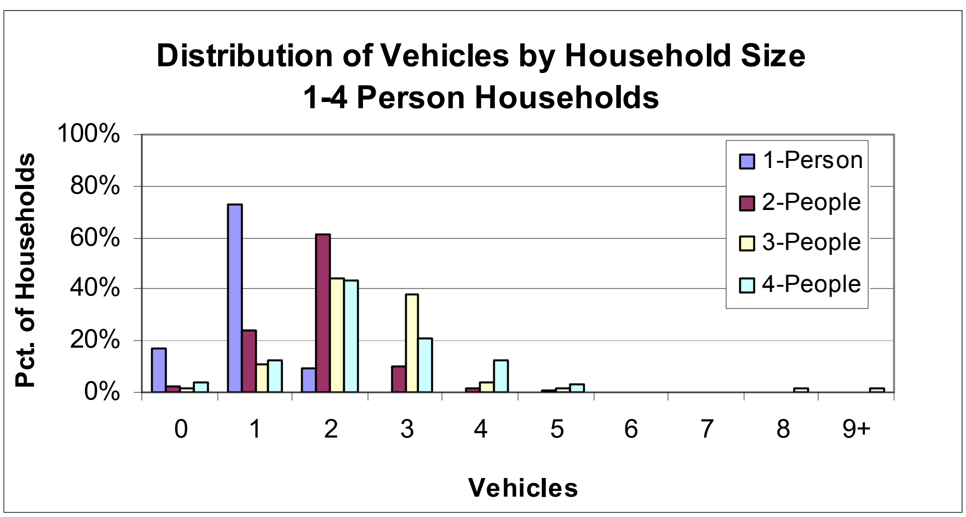


Figure F-3. Vehicle Availability – 1 to 4 Person Households

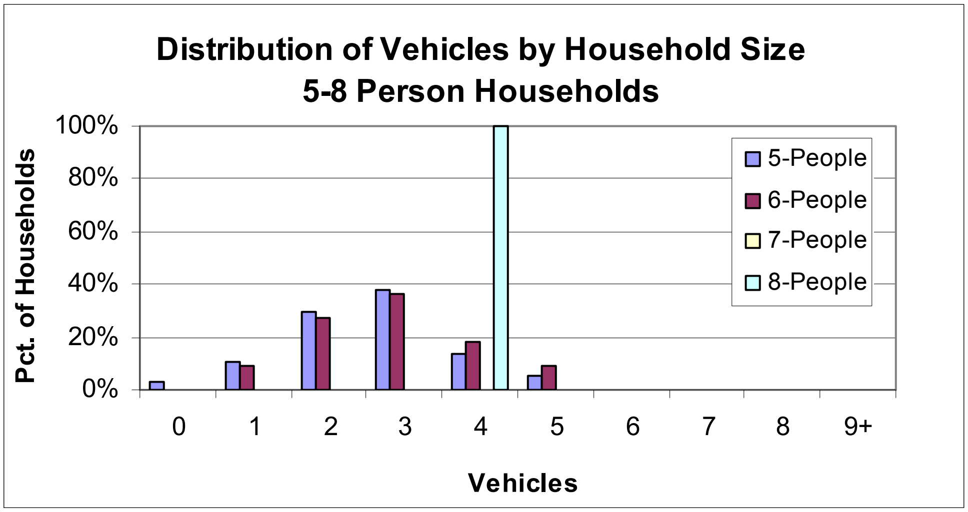


Figure F-4. Vehicle Availability – 5 to 8 Person Households

<u>School Children</u>

The average number of school children per household identified by the survey is 1.47. Figure F-5 presents the distribution of school children.

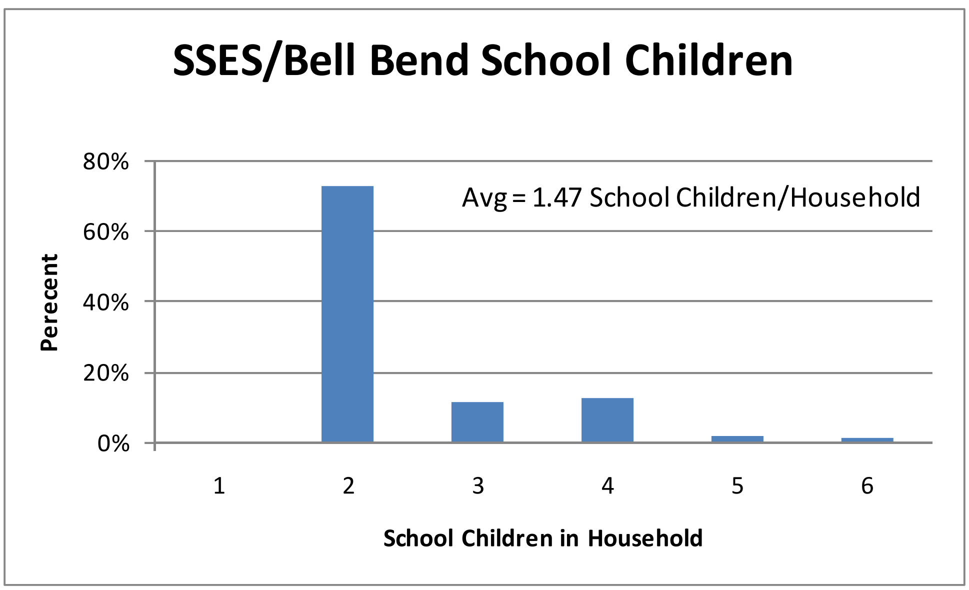


Figure F-5. School Children in Households

<u>Commuters</u>

Figure F-6 presents the distribution of the number of commuters in each household. The data show an average of 0.92 commuters in each household in the EPZ.

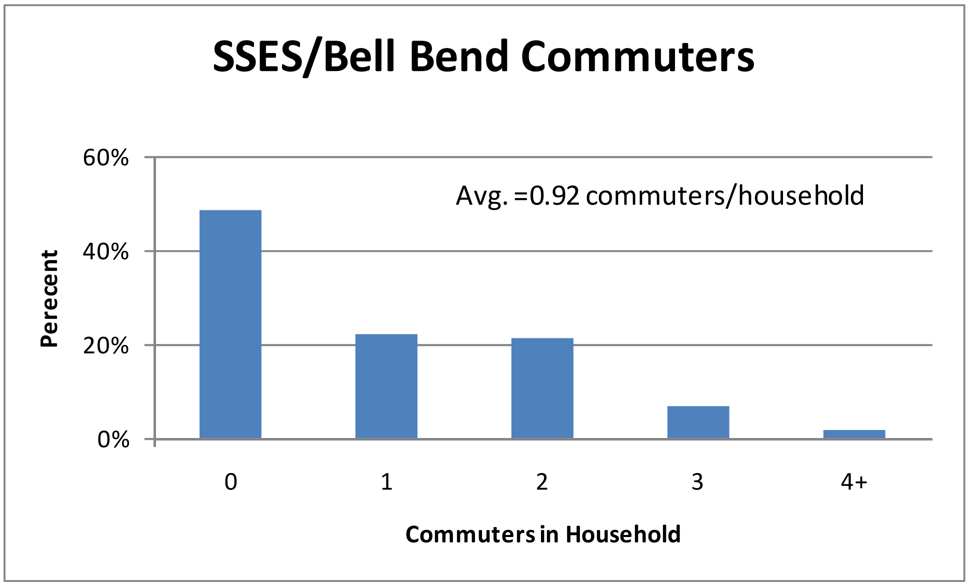


Figure F-6. Commuters in Households in the EPZ

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.

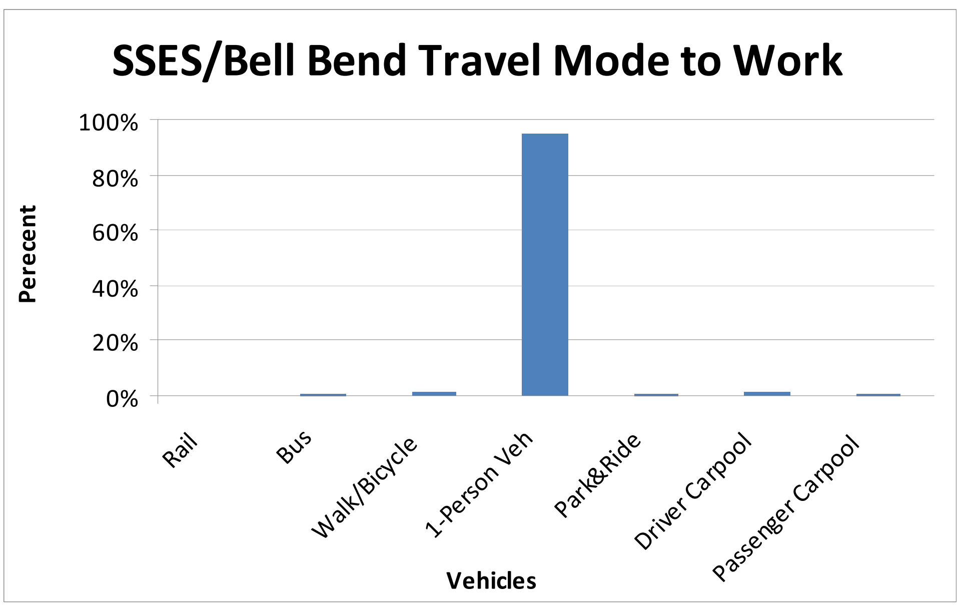


Figure F-7. Modes of Travel to Work by EPZ Residents

Evacuation Response

Several questions were asked which are used to gauge the population's response to an emergency. The first of these asked "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, 1.30 vehicles per household would be used for evacuation purposes.

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, 58 percent said that there was another vehicle available to evacuate, while 42 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, 60 percent said they would await the return of other family members before evacuating and 40 percent indicated that they would not await the return of other family members.

The fourth evacuation response question was "Would you take household pets with you if you were asked to evacuate the area?" As shown in Figure F-9, 54 percent of respondents said they would take their pets; 9 percent would not. The remaining 215 people either did not have a pet, or did not give a definitive answer.

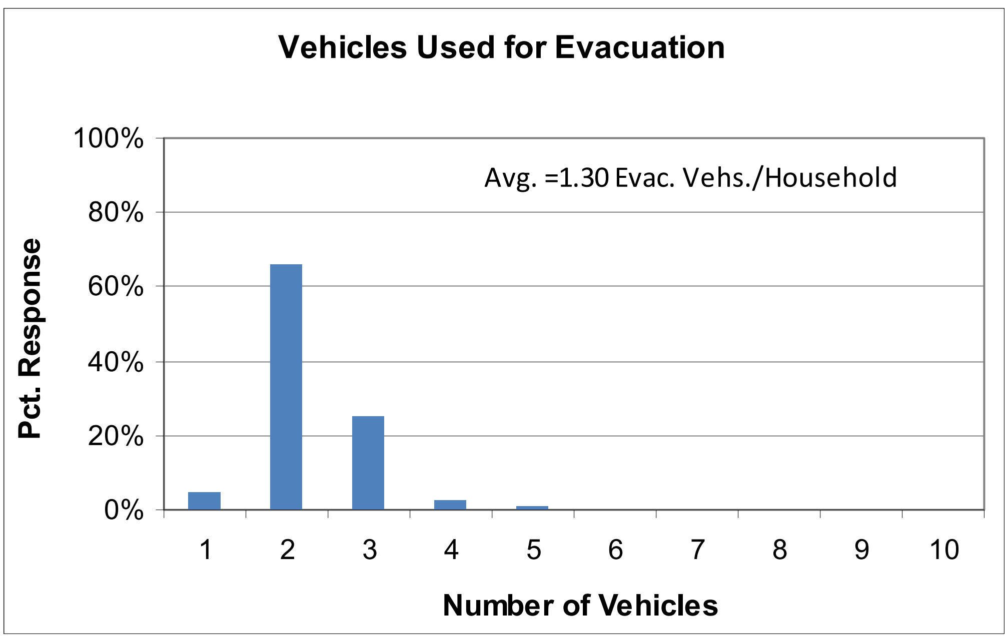


Figure F-8. Number of Vehicles Used for Evacuation

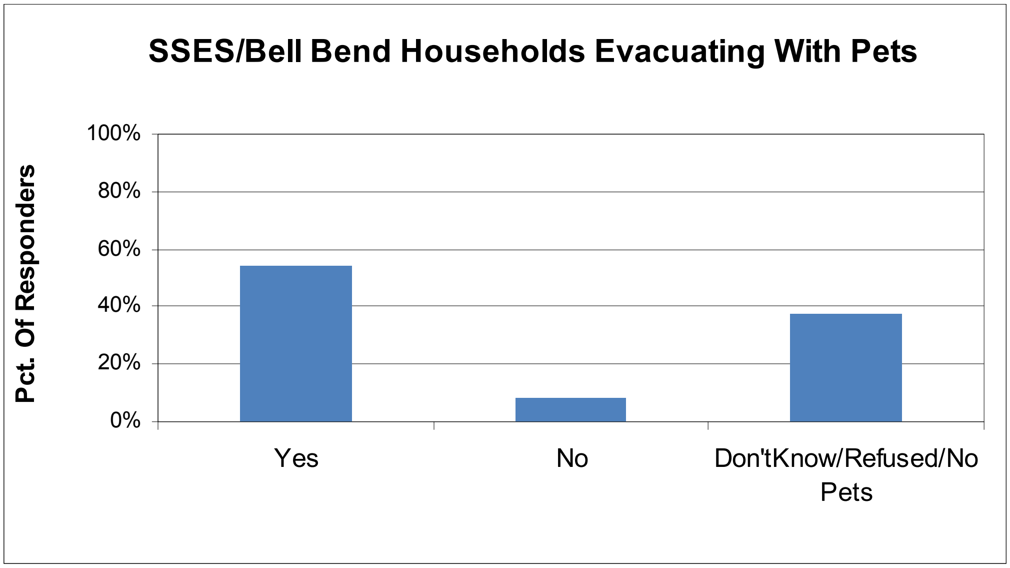


Figure F-9. Households Evacuating With Pets

Time Distribution Results

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

How long does it take the commuter to complete preparation for leaving work? Figure F-10 presents the cumulative distribution. Sixty seven percent can leave within 15 minutes, over 80 percent within 30 minutes and nearly all within one hour

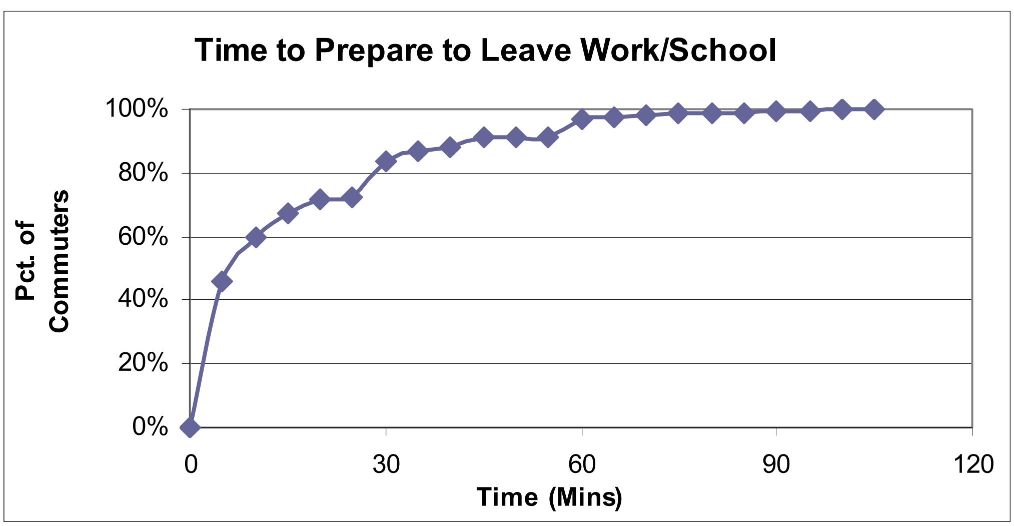


Figure F-10. Time Required to Prepare to Leave Work/School

How long would it take the commuter to travel home?

Figure F-11 presents the work to home travel time. In all cases, over 80 percent of commuters can arrive home within about 30 minutes of leaving work; nearly all within 60 minutes.

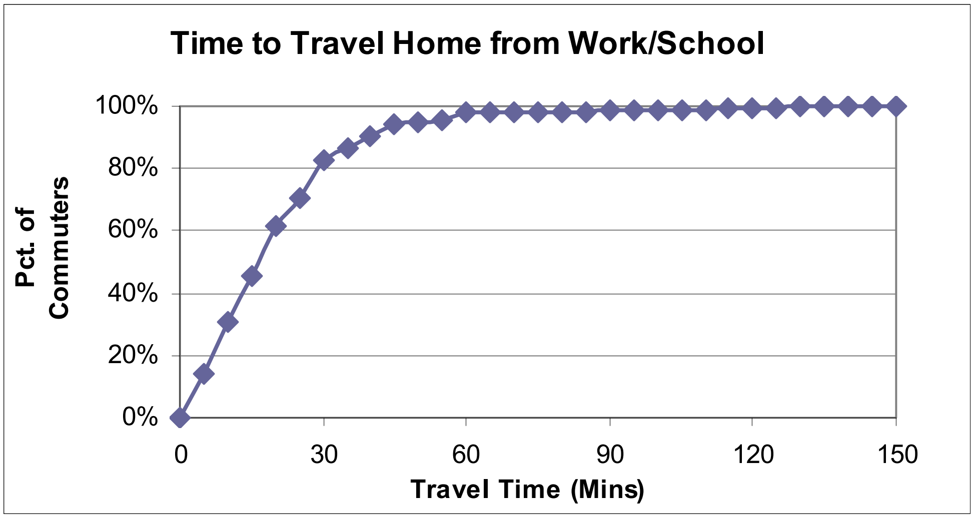


Figure F-11. Work to Home Travel Time

How long would it take the family to pack clothing, secure the house, and load the car?

Figure F-12 presents the time required to prepare for leaving on an evacuation trip. In many ways this activity mimics a family's preparation for a short holiday or weekend away from home. Hence, the responses represent the experience of the responder in performing similar activities.

The distribution shown in Figure F-12 has a long "tail." Nearly 86 percent of households can be ready to leave home within an hour, nearly all within 2 hours.

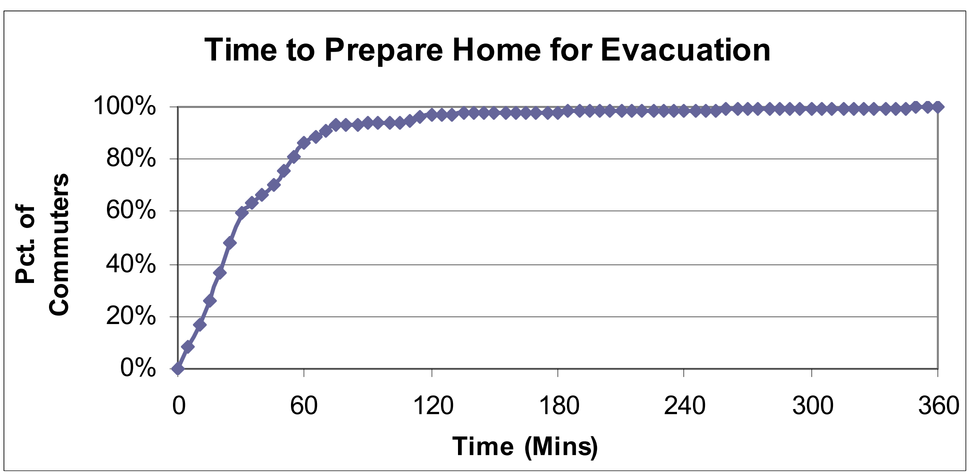


Figure F-12. Time to Prepare Home for Evacuation

How long would it take you to clear 6 to 8 inches of snow?

During adverse, snowy weather conditions an additional activity must be performed before residents can depart on the evacuation trip. Although snow scenarios assume that the roads and highways have been plowed and are passable (albeit at lower speeds and capacities), it would be necessary to clear a private driveway prior to leaving the home so that the vehicle can access the street. Figure F-12 presents these results. The time distribution for clearing the driveway has a long tail; about 88 percent of driveways are passable within 1 hour. However, the last driveway is cleared 3 hours and 15 minutes after the start of this activity.

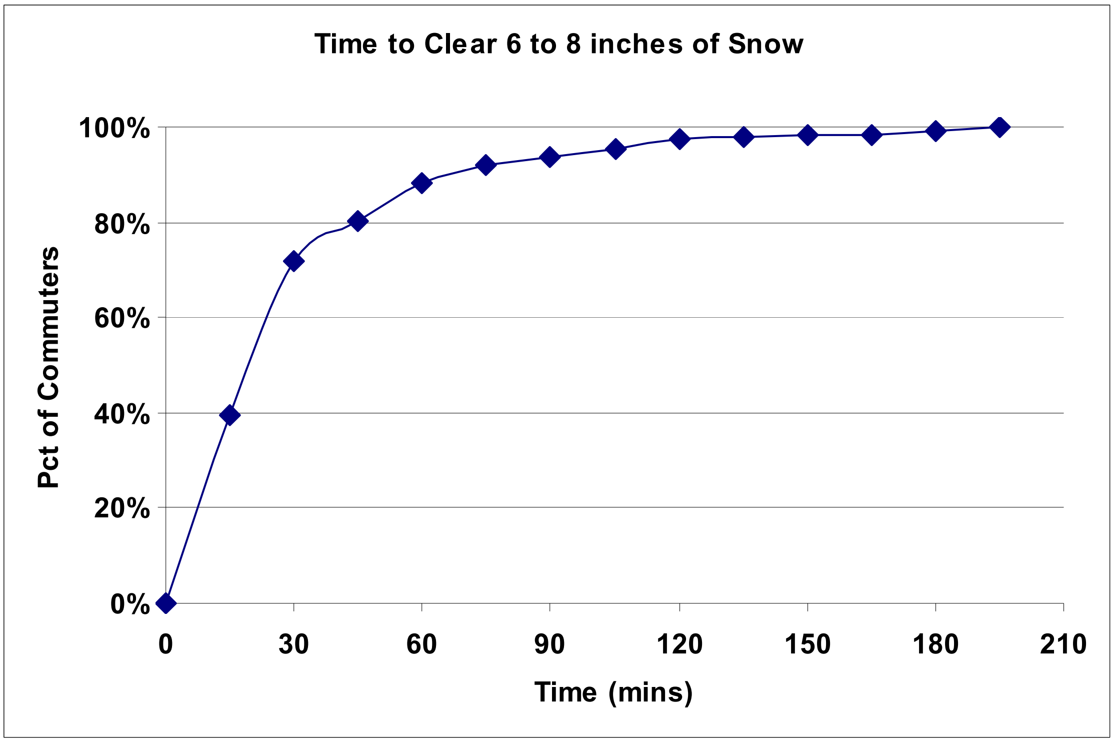


Figure F-12. Time to Clear 6 to 8 Inches of Snow

4. CONCLUSIONS

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

ATTACHMENT A

Telephone Survey Instrument

Survey Instrument

Hello, my name is _______________ and I'm working on a survey being made for [insert marketing firm name] designed to identify local travel patterns in your area. We are conducting the survey to help the county and local municipalities with their evacuation plans for all types of potential events. Your participation in this survey will greatly enhance the county's emergency preparedness program.

COL.1 Unused
COL.2 Unused
COL.3 Unused

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

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

DO NOT ASK:

1A. Record area code. To Be Determined

COL. 9-11

1B. Record exchange number. To Be Determined

COL. 12-14

---

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

---

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

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

---

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

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

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

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

---

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

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

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

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

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

---

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

COMMUTER #1			COMMUTER #2			COMMUTER #3			COMMUTER #4		
City/Town		State	City/Town		State	City/Town		State	City/Town		State
COL.29	**COL.30**	**COL.31**	**COL.32**	**COL.33**	**COL.34**	**COL.35**	**COL.36**	**COL.37**	**COL.38**	**COL.39**	**COL.40**
0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9	9	9	9	9

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

COMMUTER #1

COL.41	**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. Would you await the return of family members prior to evacuating the area?

Col. 58
1 Yes
2 No

3 Don’t Know/Refused

---

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

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

---

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

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

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

COL.62
1 DON'T KNOW

---

15. How long would it take you to clear 6-8" of snow to move the car from the driveway or curb to begin the evacuation trip? Assume the roads are passable. (DO NOT READ RESPONSES.)

COL.63
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.64
1 MORE THAN 3 HOURS
2 DON'T KNOW

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

Col. 65
1 Yes
2 No
3 No Pets
4 Don't Know/Refused

Thank you very much. ___________________________

(TELEPHONE NUMBER CALLED)

If requested:
For Additional information contact:

County	EMA Phone
(In Luzerne County) Luzerne County EMA	570-820-4400
(In Columbia County) PPL	866-832-3312

If there are any questions on who is funding the survey, the response should be:

PPL funded the survey to support and update the evacuation plans of the county and local municipalities. If there are any additional questions please contact PPL at 866-832-3312

ANNEX B

Code of Data Collection Standards With Notes Section
Market Research Association

P.O. Box 230 • Rocky Hill, CT 06067-0230 • 860-257-4008 • Fax: 860-257-3990

Code Approved May 1997

Notes Added September 1999

RESPONSIBILITIES TO RESPONDENTS

Data Collection Companies ...

1. will make factually correct statements to secure cooperation and will honor promises to respondents, whether verbal or written;
2. will not use information to identify respondents without the permission of the respondent, except to those who check the data or are involved in processing the data. If such permission is given, it must be recorded by the interviewer at the time the permission is secured;
3. will respect the respondent's right to withdraw or to refuse to cooperate at any stage of the study and not use any procedure or technique to coerce or imply that cooperation is obligatory;
4. will obtain and document respondent consent when it is known that the name and address or identity of the respondent may be passed to a third party for legal or other purposes, such as audio or video recordings;
5. will obtain permission and document consent of a parent, legal guardian or responsible guardian before interviewing children 12 years old or younger;
6. will give respondents the opportunity to refuse to participate in the research when there is a possibility they may be identifiable even without the use of their name or address (e.g., because of the size of the population being sampled).

Interviewers ...

1. will treat the respondent with respect and not influence him or her through direct or indirect attempts, including the framing of questions and/or a respondent's opinion or attitudes on any issue;
2. will obtain and document permission from a parent, legal guardian or responsible guardian before interviewing children 12 years old or younger. Prior to obtaining permission, the interviewer should divulge the subject matter, length of the interview and other special tasks that will be required.

RESPONSIBILITIES TO CLIENTS

Data Collection Companies ...

1. will ensure that each study is conducted according to the client's exact specifications;
2. will observe confidentiality with all research techniques or methodologies and with information considered confidential or proprietary. Information will not be revealed that could be used to identify clients or respondents without proper authorization;
3. will ensure that companies, their employees and subcontractors involved in data collection take all reasonable precautions so that more than one survey is not conducted in one interview without explicit permission from the Client
4. will report research results accurately and honestly;
5. will not misrepresent themselves as having qualifications, experience, skills or facilities that they do not possess;
6. will refrain from referring to membership in the Marketing Research Association as proof of competence, since the Association does not certify any person's or organization's competency or skill level.

RESPONSIBILITIES TO DATA COLLECTORS

Clients ...

1. will be responsible for providing products and services that are safe and fit or their intended use and disclose/label all product contents;
2. will provide verbal or written instructions;
3. will not ask our members who subcontract research to engage in any activity that is not acceptable as defined in this Code or that is prohibited under any applicable federal, state, local laws, regulations and/or ordinances.

RESPONSIBILITIES TO THE GENERAL PUBLIC AND BUSINESS COMMUNITY

Data Collection Companies ...

1. will not intentionally abuse public confidence in marketing and opinion research;
2. will not represent a non-research activity to be marketing and opinion research, such as:
    - questions whose sole objective is to obtain personal information about respondents, whether for legal, political, private or other purposes,
    - the compilation of lists, registers or data banks of names and addresses for any non-research purposes (e.g., canvassing or fundraising),
    - industrial, commercial or any other form of espionage,
    - the acquisition of information for use by credit rating services or similar organizations,
    - sales or promotional approaches to the respondent,
    - the collection of debts;
3. will make interviewers aware of any special conditions that may be applicable to any minor (18 years old or younger).

These notes are intended to help users of the Code to interpret and apply it in practice. Any questions about how to apply the Code in a specific situation should be addressed to MRA Headquarters.

RESPONSIBILITIES TO RESPONDENTS

Data Collection Companies ...

1. will make factually correct statements to secure cooperation and honor promises to respondents, whether oral or written; *Interviewers will not knowingly provide respondents with information that misrepresents any portion of the interviewing process, such as; length of the interview, scope of task involved, compensation, or intended use of the information collected.*
2. will not use information to identify respondents without the permission of the respondent, except to those who check the data or are involved in processing the data. If such permission is given, it must be recorded by the interviewer at the time the permission is secured; *Respondent information will be linked to data collected only for research purposes such as validation, evaluating data in aggregate based on demographic information, modeling. Providing respondent information is not permissible for any purpose other than legitimate research purposes as mentioned above. If anyone requests respondent identifiable information it will only be provided upon receipt of written declaration of and agreement of some intended use. Such use shall be determined by the provider to qualify as legitimate research use. (i.e. validation, planned recalls, modeling, demographic analysis.) No other use of this information falls within the boundaries of the Code. This applies to all types of respondent sample sources including client supplied lists.*
3. will respect the respondent's right to withdraw or to refuse to cooperate at any stage of the study and not use any procedure or technique to coerce or imply that cooperation is obligatory. *Respondent cooperation is strictly on a voluntary basis. Respondents are entitled to withdraw from an interview at any stage or to refuse to cooperate in a research project. Interviewers should never lead respondents to believe they have no choice in their participation.*
4. will obtain and record respondent consent when it is known that the name and addresses or identity of the respondent may be passed to a third party for legal or other purposes, such as audio or video recordings; *By documenting the respondent's consent for a defined specific use of his/ her name and address we are confirming the respondent realizes we are asking something new of them, i.e., possible participation in another research project.*
5. will obtain permission and document consent of a parent, legal guardian or responsible guardian before interviewing children 12 years old or younger; *Interviewers must take special care when interviewing children or young people. The informed consent of the parent or responsible adult must first be obtained for interviews with children.*
6. will give respondents the opportunity to refuse to participate in the research when there is a possibility they may be identifiable even without the use of their name or address (e.g., because of the size of the population being sampled.) *Respondent cooperation is strictly on a voluntary basis. Respondents are entitled to withdraw from a research project. Company policies and/or interviewer instructions should state the interviewer must give respondents the opportunity to not participate for any reason.*

Interviewers ...

1. will treat the respondent with respect and not influence him or her through direct or indirect attempts, including the framing of questions, a respondent's opinion or attitudes on any issue. *Interviewers cannot ask questions in a way that leads or influences respondents' answers, nor can they provide their own opinions, thoughts or feelings that might bias a respondent and therefore impact the answers they give.*
2. will obtain and document permission of a parent, legal guardian or responsible guardian before interviewing children 12 years old or younger. Prior to obtaining permission, the interviewer should divulge the subject matter, length of interview and other special tasks that will be required. *Interviewers must take special care when interviewing children and young people. The informed consent of the parent or responsible adult must first be obtained for interviews with children. Parents or responsible adults must be told some specifics about the interview process and special tasks, such as audio or video recording, taste testing, respondent fees and special tasks, before permission is obtained.*

RESPONSIBILITIES TO CLIENTS

Data Collection Companies ...

1. will ensure that each study is conducted according to the client's specifications; *Procedures are implemented to conform or verify that client specifications are being followed.*
2. will observe confidentiality with all research techniques or methodologies and with information considered confidential or proprietary. Information will not be revealed that could be used to identify clients or respondents without proper authorization; *Respondent information will be linked to data collected only for research purposes and will not be used for any purpose other than legitimate research. Protect the confidentiality of anything learned about the respondent and/or his or her business.*
3. will ensure that companies, their employees and subcontractors involved in data collection take all reasonable precautions so that no more than one survey is conducted in one interview without explicit permission from the sponsorship company or companies; *Company policies or procedures indicate the practice of conducting more than one survey within an interview is not done without specific permission from the relevant clients.*
4. will report research results accurately and honestly; *Describe how the research was done in enough detail that a skilled researcher could repeat the study; provide data representative of a defined population or activity and enough data to yield projectable results; present the results understandably and fairly, including any results that may seem contradictory or unfavorable.*
5. will not misrepresent themselves as having qualifications, experience, skills or facilities that they do no possess; *If regularly subcontracting data collection, should not infer to clients and prospective clients that they possess this capability "in house"; claim only legitimate academic degrees, clients and other qualifications.*
6. will refrain from referring to membership in the Marketing Research Association as proof of competence, since the Association does not certify any person's or organization's competency or skill level. *MRA does not currently have a certification program for marketing research competency, therefore while members can state their membership in the Association, they cannot claim that this automatically conveys a message of their competency to carry out the marketing research process.*

RESPONSIBILITIES TO DATA COLLECTORS

Clients ...

1. will be responsible for providing products and services that are safe and fit for their intended use and disclose/label all product contents; *It is the client's responsibility to ensure that all test products are in compliance with all safety standards and that all product contents information is provided to the data collectors. Data Collectors should request in writing all pertinent information as well as emergency numbers for respondents and themselves.*
2. will provide oral or written instructions; *To ensure the success of the research, detailed instructions are to be provided prior to the start of any project. These instructions must be written and then confirmed orally for: understanding, ability of the agency to implement and agreement to comply.*
3. will not ask our members who subcontract research to engage in any activity that is not acceptable as defined in this Code or that is prohibited under any applicable federal, state and local laws, regulations and ordinances. *All MRA Members have agreed to comply with the Code as written and thus will not agree to, or ask anyone else to, knowingly violate any of the points of the Code.*

RESPONSIBILITIES TO THE GENERAL PUBLIC AND BUSINESS COMMUNITY

Data Collection Companies ...

1. will not intentionally abuse public confidence in marketing and opinion research; *Marketing research shall be conducted and reported for the sole purpose of providing factual information upon which decisions will be made. At no time is marketing research information to be used to intentionally mislead public opinion. Instances of abuse of public confidence undermine the credibility of our Industry.*
2. will not represent a non-research activity to be marketing and opinion research, such as:
    - questions whose sole objective is to obtain personal information about respondents, whether for legal, political, private or other purposes,
    - the compilation of lists, registers or data banks of names and addresses for any non-research purposes (e.g., canvassing or fundraising),
    - industrial, commercial or any other form of espionage,
    - the acquisition of information for use by credit rating services or similar organizations,
    - sales or promotional approaches to the respondent,

APPENDIX G

Traffic Management

APPENDIX G: TRAFFIC MANAGEMENT

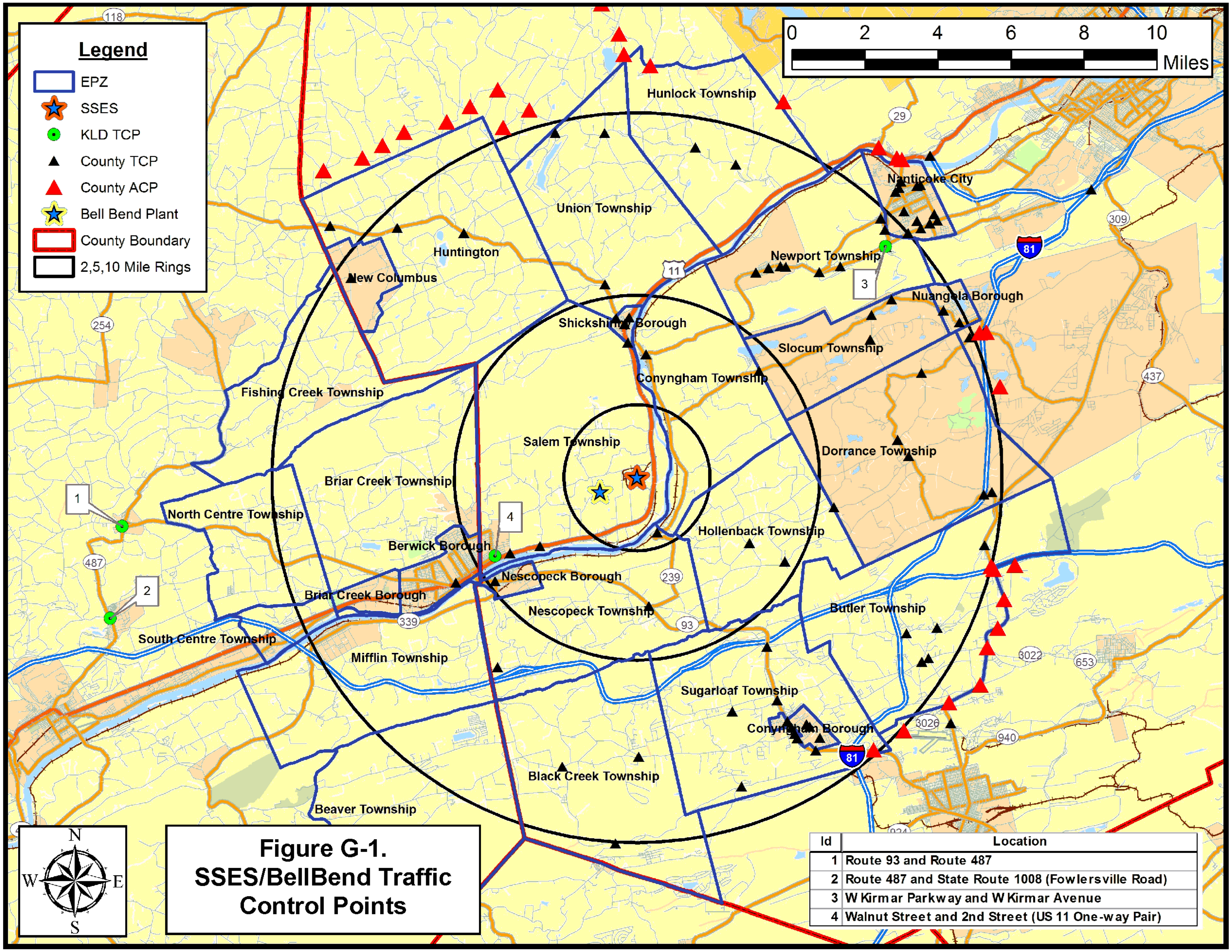
This appendix presents suggested traffic control measures to facilitate the evacuation of the SSES/Bell Bend Nuclear Power Plant EPZ. Pages G-2 through G-7 detail Traffic Control Points (TCP), which are typically intersections within the EPZ; these points are established to facilitate the flow of evacuee traffic from within the EPZ. Table G-1 summarizes the TCP and the manpower and equipment needed to implement traffic control. Figure G-1 provides detailed mapping of the location of each traffic control point.

These intersections were identified based on the simulation of the evacuation flows. The county and local municipal emergency plans had identified 100 TCPs and 36 ACPs, throughout the EPZ. These have also been plotted in Figure G-1.

There are likely to be concerns about manpower and equipment shortages. As such, prioritization of TCP and ACP is established to make the most efficient use of manpower and equipment in the event of an emergency. The use of ITS technologies, as outlined in Section 9, will also aid in overcoming manpower shortages.

With reference to the discussion of Section 2.3, these TCP serve many vital functions, but are not considered in specifying the inputs to the I-DYNEV system used to calculate ETE. Consequently, the results presented in Section 7 and in Appendix J do not reflect the presence of these TCP.

Table G-1 List of Traffic Control Points					
TCP ID	*Municipality*	*Intersection*	*Priority*	*# of Guides*	*# of Cones*
1	Orangeville	Route 93 and Route 487	1	1	2
2	Light Street	Fowlersville Road and Highway 487	1	2	8
3	Nanticoke	Kirmar Parkway, Kirmar Avenue	1	2	8
4	Berwick	Walnut Street and 2nd Street	1	2	6
			Total:	7	24



Id	Location
1	Route 93 and Route 487
2	Route 487 and State Route 1008 (Fowlersville Road)
3	W Kirmar Parkway and W Kirmar Avenue
4	Walnut Street and 2nd Street (US 11 One-way Pair)

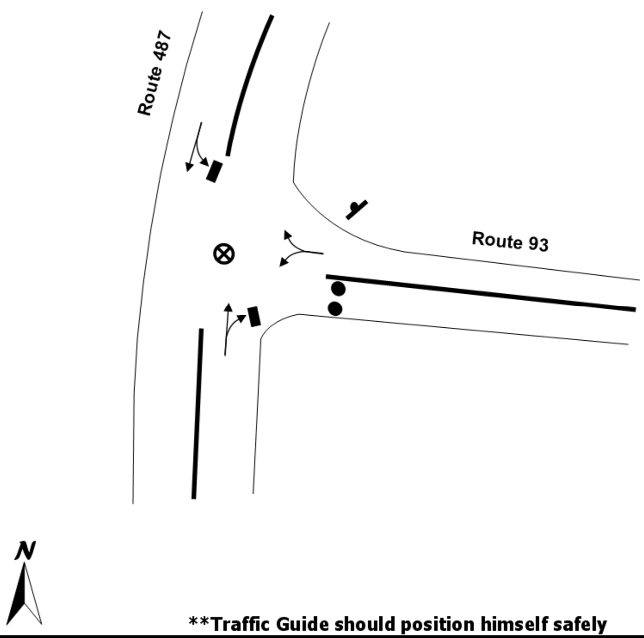
Figure G-1. SSES/BellBend Traffic Control Points

TCP

MUNICIPALITY: Orangeville

LOCATION: Route 93 & Route 487

TCP ID: 1



**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 Route 93

MANPOWER/EQUIPMENT ESTIMATE

1 Traffic Guide(s)
2 Traffic Cones

LOCATION PRIORITY

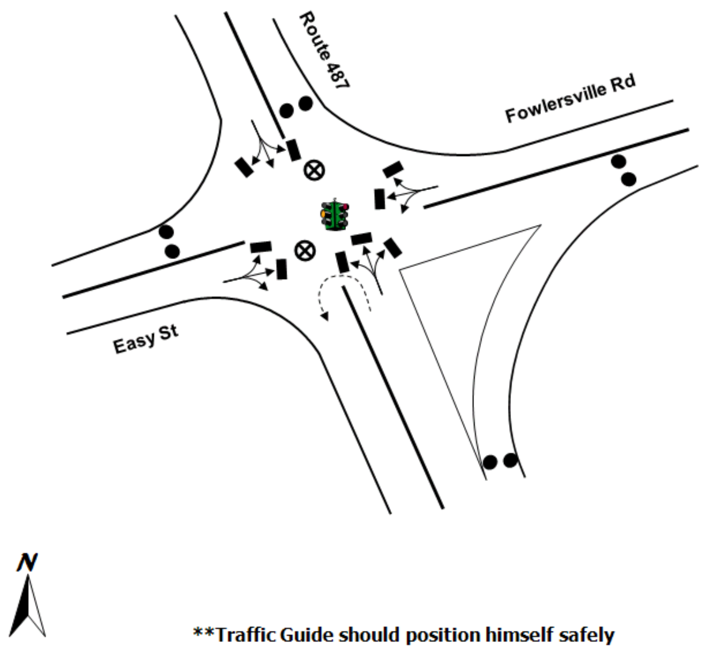
1

TCP

MUNICIPALITY: Light Street

LOCATION: Fowlersville Rd & Route 487

TCP ID: 2



**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 Fowlersville Rd
2. Discourage northbound movement on Route 487
3. U-turn northbound movement on Route 487 to south
4. Discourage westbound movement on Easy St

MANPOWER/EQUIPMENT ESTIMATE

2 Traffic Guide(s)
8 Traffic Cones

LOCATION PRIORITY

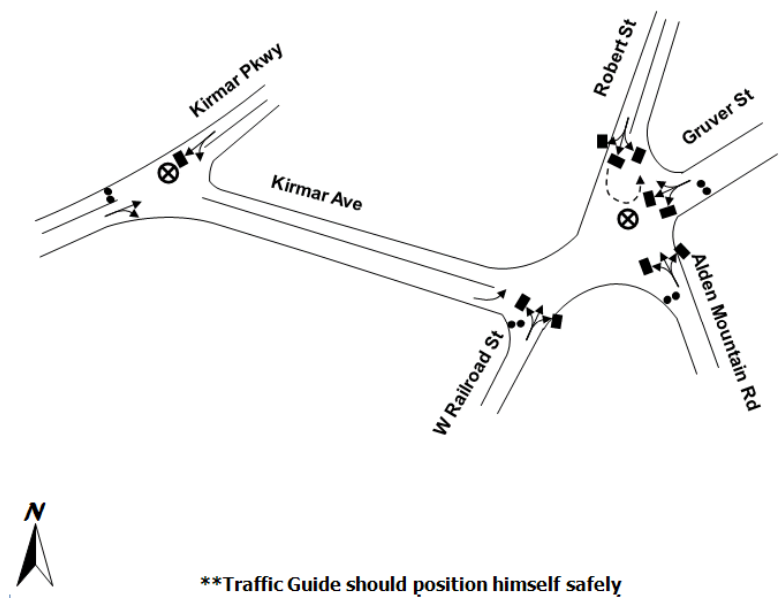
1

TCP

MUNICIPALITY: Nanticoke

LOCATION: Kirmar Pkwy, Kirmar Ave & Robert St

TCP ID: 3



**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 westbound movement on Kirmar Pkwy
2. Discourage southbound movement on W Railroad St
3. Reroute all traffic northbound on Robert St and Kirmar Parkway

MANPOWER/EQUIPMENT ESTIMATE

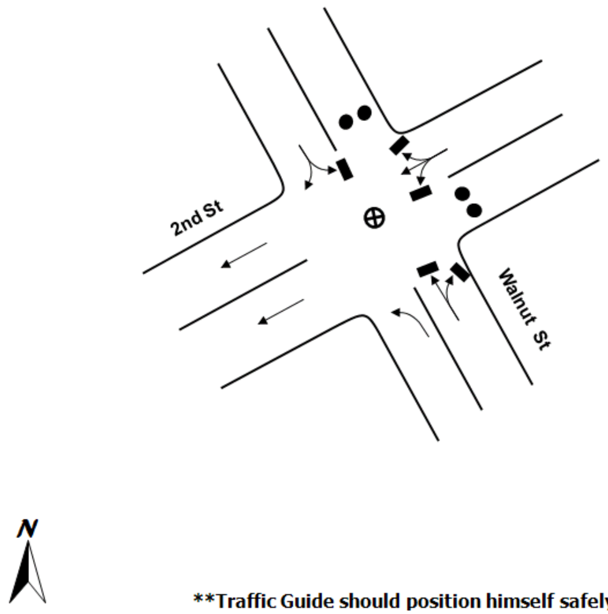
2 Traffic Guide(s)
8 Traffic Cones

LOCATION PRIORITY

1

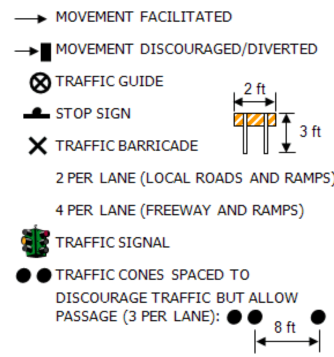
TCP

MUNICIPALITY: Berwick
LOCATION: Walnut St, 2nd St
TCP ID: 4



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

KEY



ACTIONS TO BE TAKEN

1. Detour northbound movement on walnut street towards southwest on 2nd St.
2. Discourage eastbound movement on 2nd St.
3. Discourage southeastbound movement walnut St.

MANPOWER/EQUIPMENT ESTIMATE

2 Traffic Guide(s)
6 Traffic Cones

LOCATION PRIORITY

1

APPENDIX H

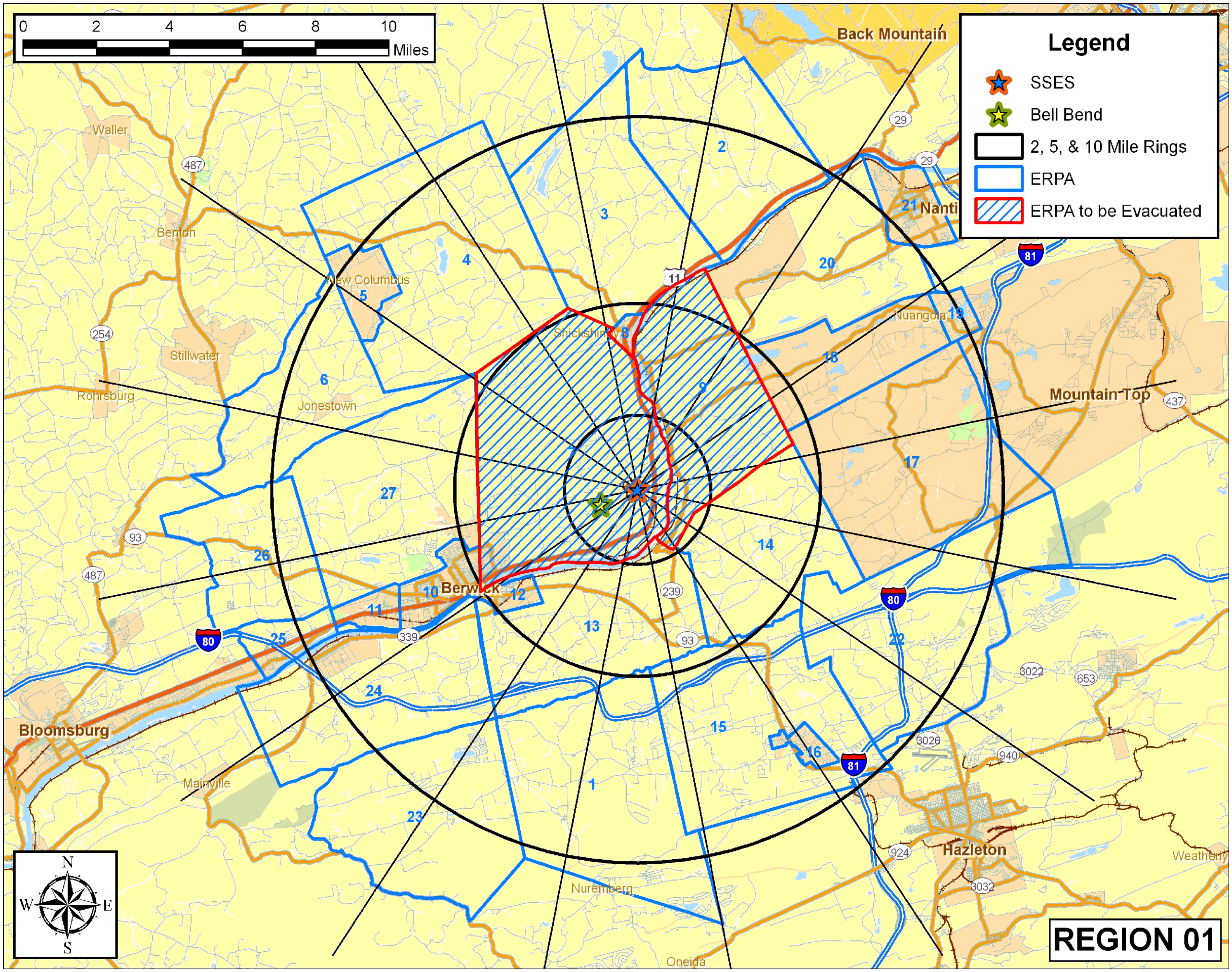
Evacuation Region Maps

APPENDIX H: EVACUATION REGION MAPS

This appendix presents maps of all Evacuation Regions. Table H-1 lists the percentage of population within each emergency response planning area (ERPA) or municipality which evacuates for each of the 22 Regions identified in Section 6.

Table H-1. Percent of ERPA Population Evacuating for Each Region

ERPA	REGION																				
	2-Mile Ring, 5-Mile Ring, Entire EPZ			2-Mile Radius and Downwind to 5-Miles				5-Mile Radius and Downwind to EPZ Boundary													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	35%	35%	100%	35%	35%	35%	35%	50%	50%	50%	50%	50%	50%	100%	100%	100%	100%	50%	50%	50%	50%	50%
2	35%	35%	100%	35%	35%	35%	35%	100%	100%	100%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	100%
3	35%	35%	100%	35%	35%	35%	35%	100%	100%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	100%	100%
4	35%	35%	100%	35%	35%	35%	35%	100%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	100%	100%	100%	100%
5	35%	35%	100%	35%	35%	35%	35%	100%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	100%	100%	100%	100%
6	35%	35%	100%	35%	35%	35%	35%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	100%	100%	100%	100%	50%
7	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
8	35%	100%	100%	100%	50%	50%	50%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
9	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
10	35%	35%	100%	35%	35%	35%	35%	50%	50%	50%	50%	50%	50%	50%	50%	50%	100%	100%	100%	50%	50%	50%
11	35%	35%	100%	35%	35%	35%	35%	50%	50%	50%	50%	50%	50%	50%	50%	50%	100%	100%	100%	50%	50%	50%
12	35%	100%	100%	50%	50%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
13	35%	100%	100%	50%	50%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
14	35%	100%	100%	50%	100%	100%	50%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
15	35%	35%	100%	35%	35%	35%	35%	50%	50%	50%	50%	50%	100%	100%	100%	50%	50%	50%	50%	50%	50%	50%
16	35%	35%	100%	35%	35%	35%	35%	50%	50%	50%	50%	50%	100%	100%	100%	50%	50%	50%	50%	50%	50%	50%
17	35%	35%	100%	35%	35%	35%	35%	50%	50%	100%	100%	100%	100%	50%	50%	50%	50%	50%	50%	50%	50%	50%
18	35%	35%	100%	35%	35%	35%	35%	50%	100%	100%	100%	100%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%
19	35%	35%	100%	35%	35%	35%	35%	50%	50%	100%	100%	100%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%
20	35%	35%	100%	35%	35%	35%	35%	100%	100%	100%	100%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%
21	35%	35%	100%	35%	35%	35%	35%	50%	100%	100%	100%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%
22	35%	35%	100%	35%	35%	35%	35%	50%	50%	50%	100%	100%	100%	100%	50%	50%	50%	50%	50%	50%	50%	50%
23	35%	35%	100%	35%	35%	35%	35%	50%	50%	50%	50%	50%	50%	50%	100%	100%	100%	100%	50%	50%	50%	50%
24	35%	35%	100%	35%	35%	35%	35%	50%	50%	50%	50%	50%	50%	50%	50%	100%	100%	100%	100%	50%	50%	50%
25	35%	35%	100%	35%	35%	35%	35%	50%	50%	50%	50%	50%	50%	50%	50%	50%	100%	100%	100%	50%	50%	50%
26	35%	35%	100%	35%	35%	35%	35%	50%	50%	50%	50%	50%	50%	50%	50%	50%	100%	100%	100%	100%	50%	50%
27	35%	35%	100%	35%	35%	35%	35%	50%	50%	50%	50%	50%	50%	50%	50%	50%	100%	100%	100%	100%	100%	50%


Legend
SSES
Bell Bend
2, 5, & 10 Mile Rings
ERPA
ERPA to be Evacuated
0
2
4
6
8
10
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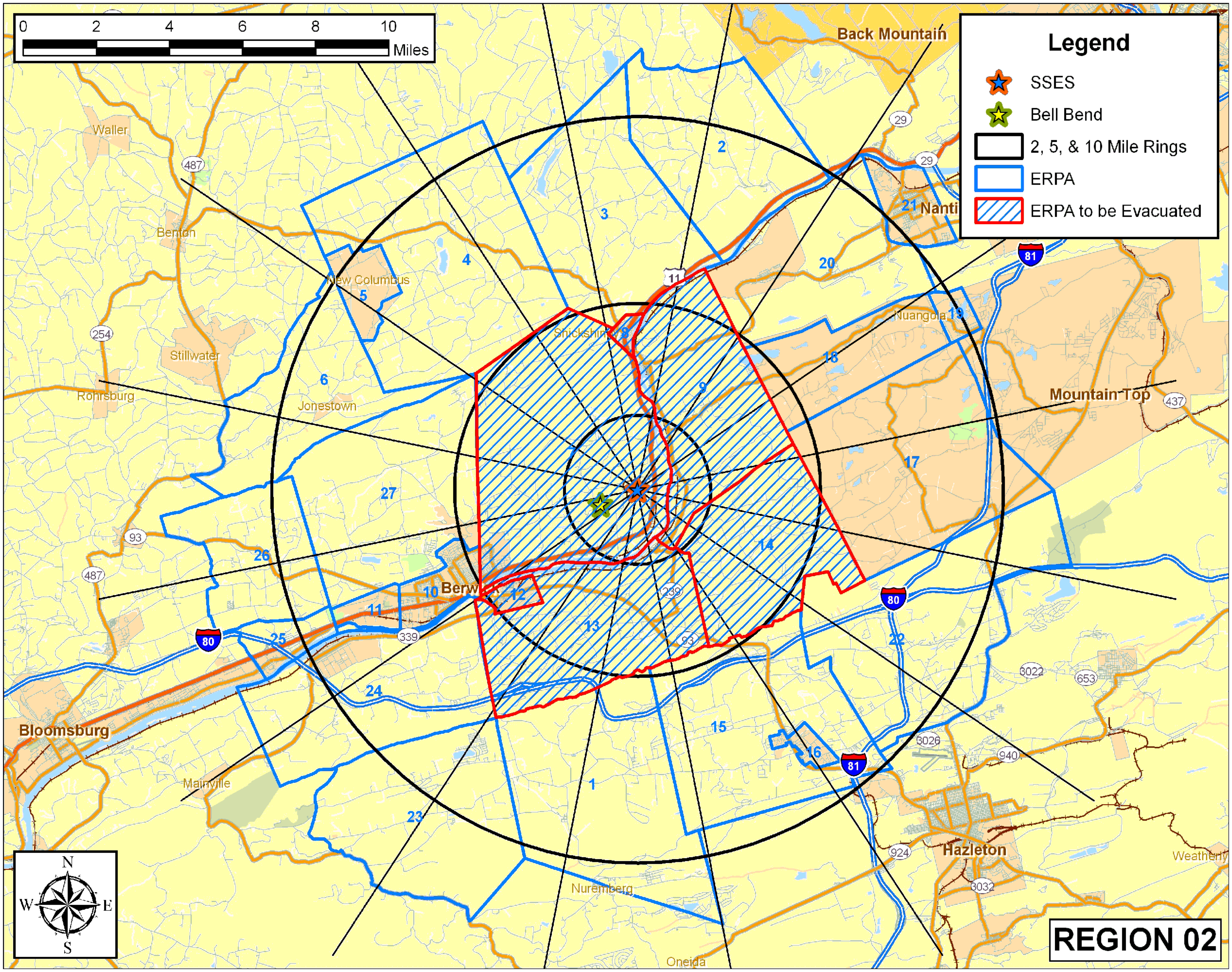
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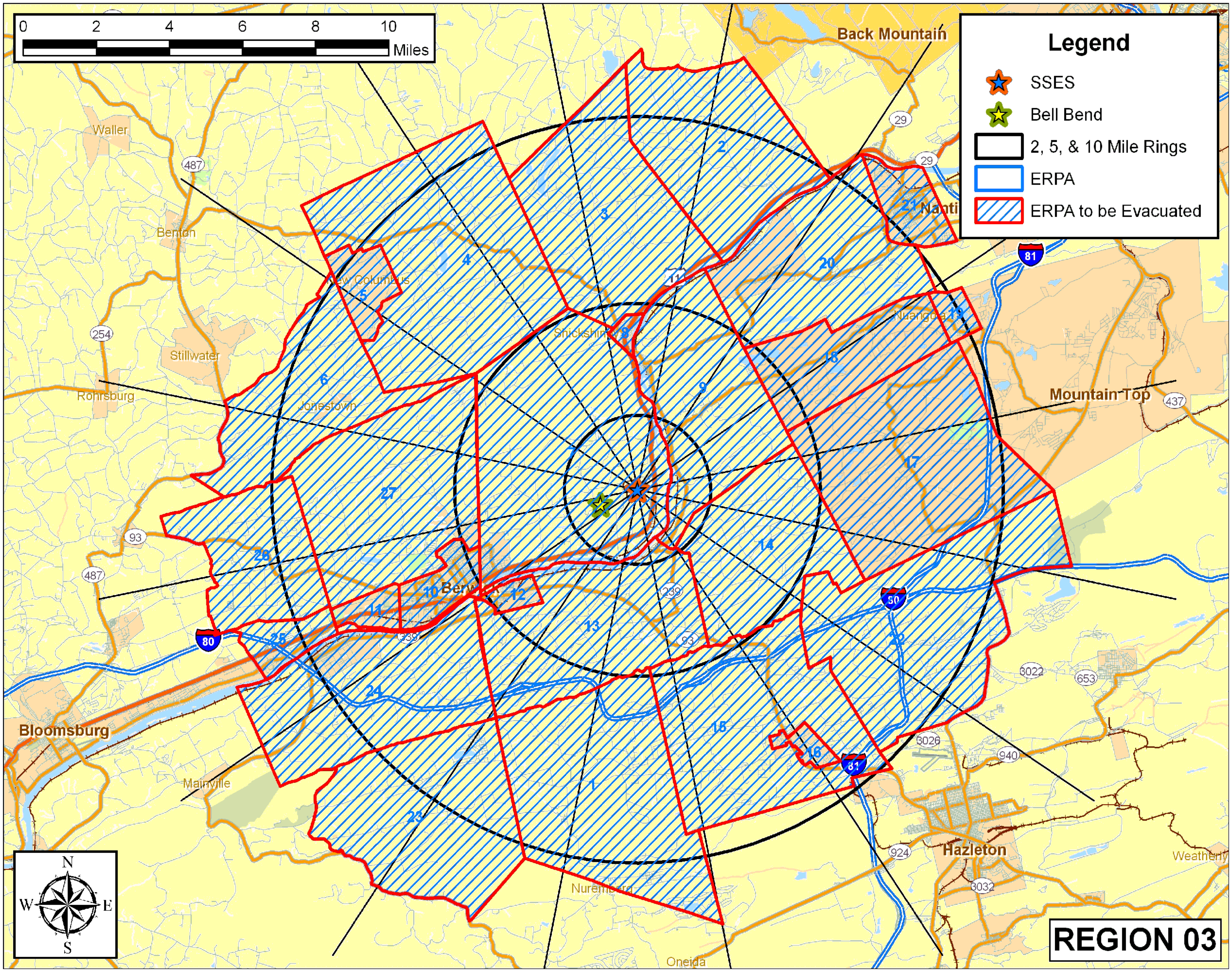
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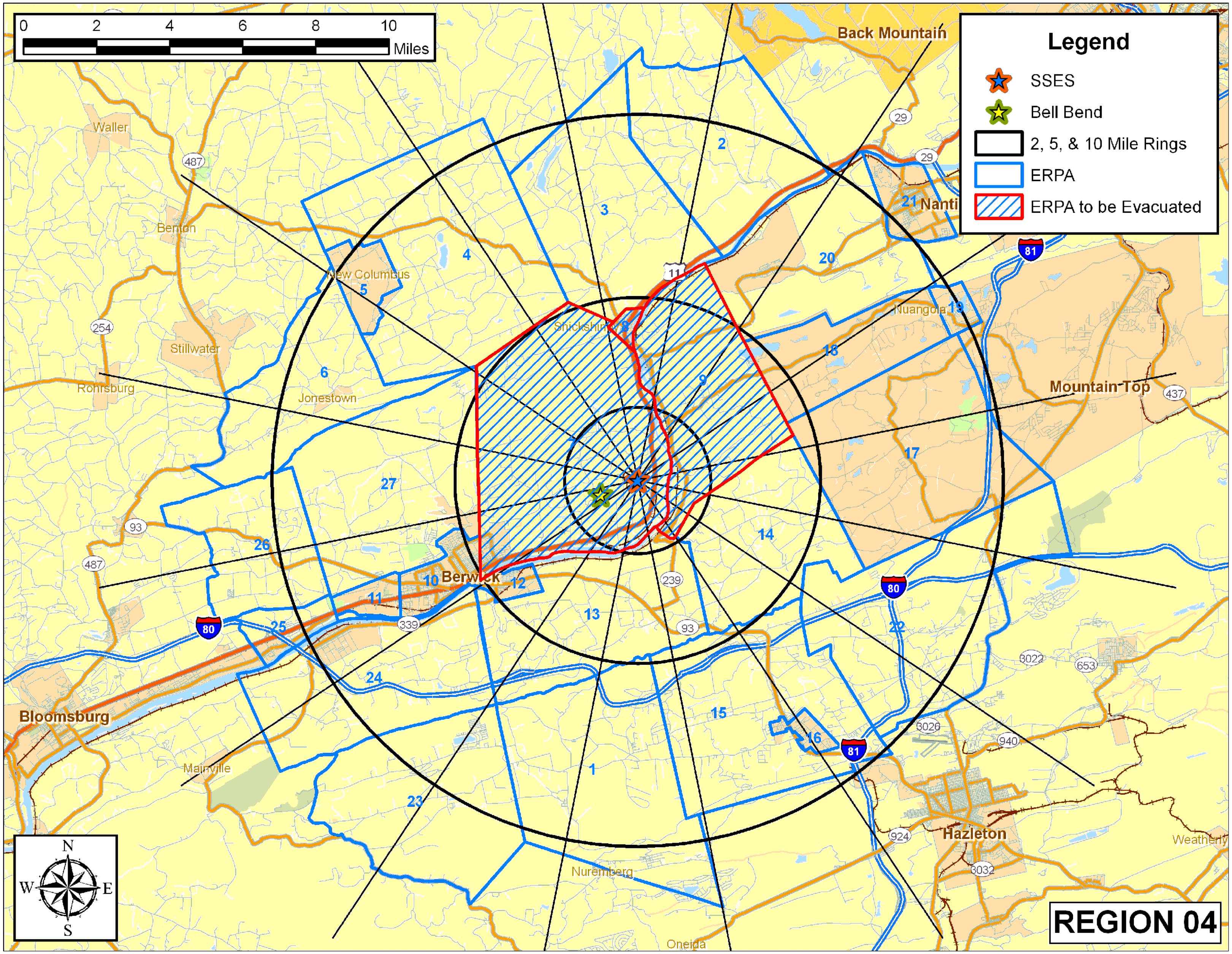

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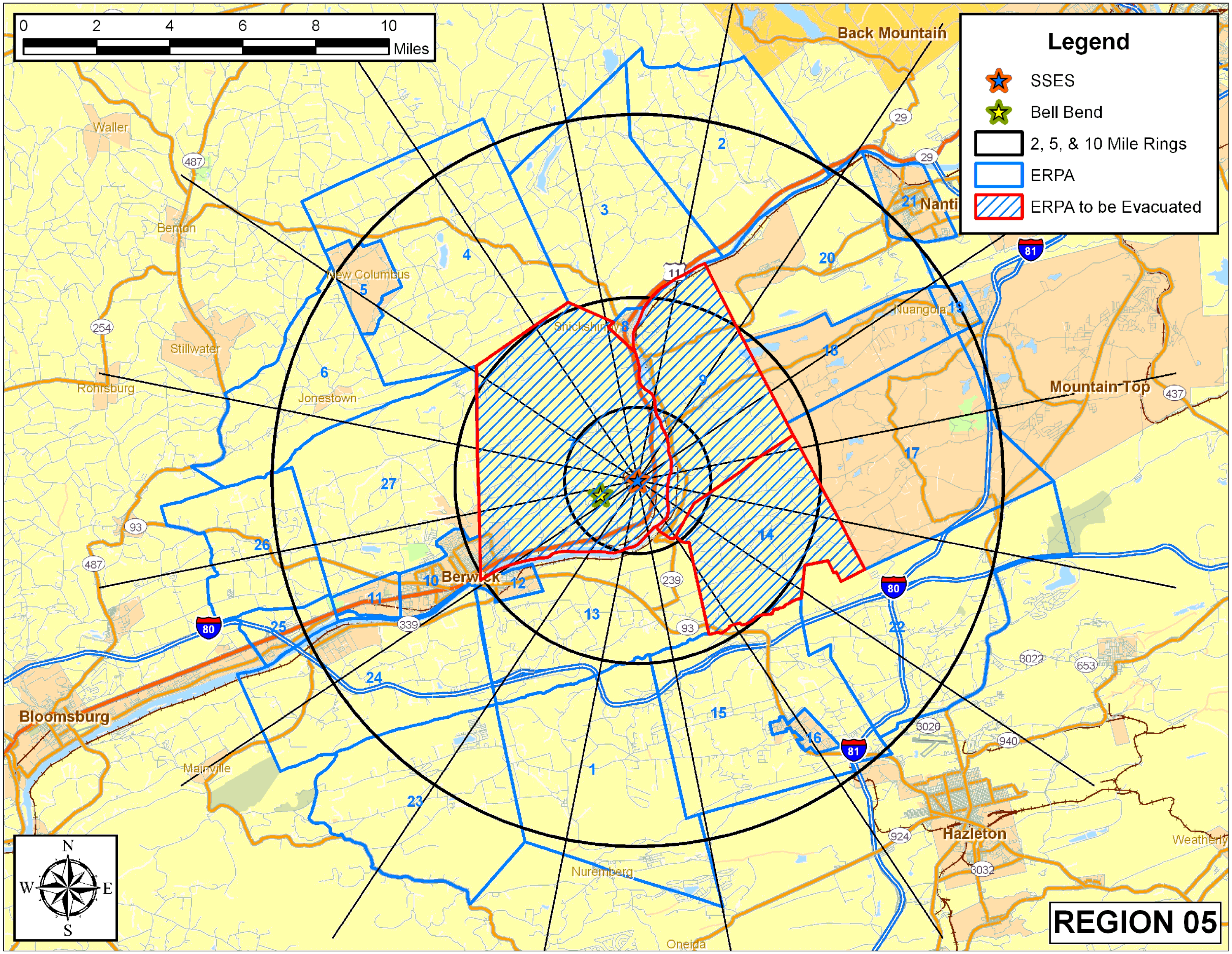

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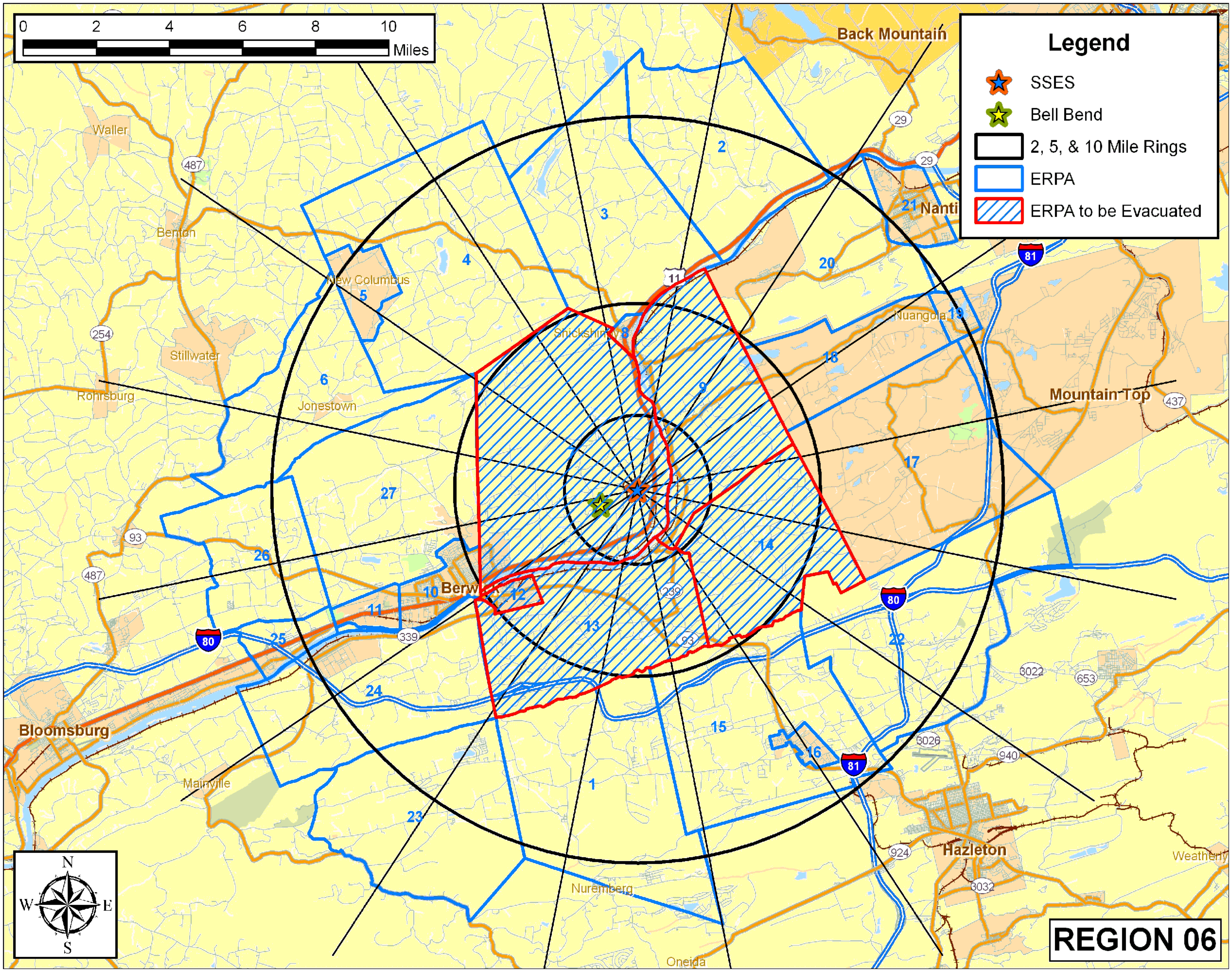

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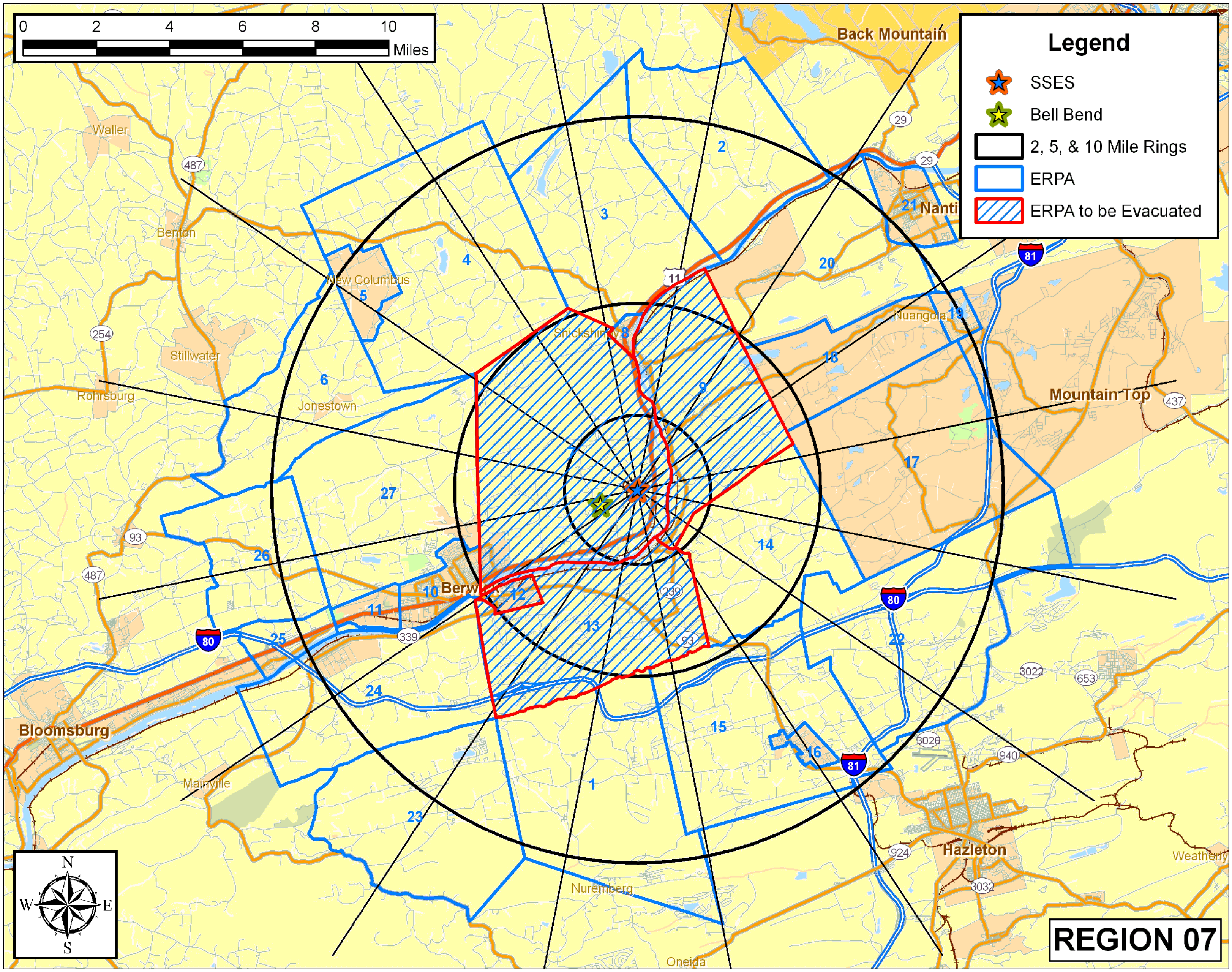
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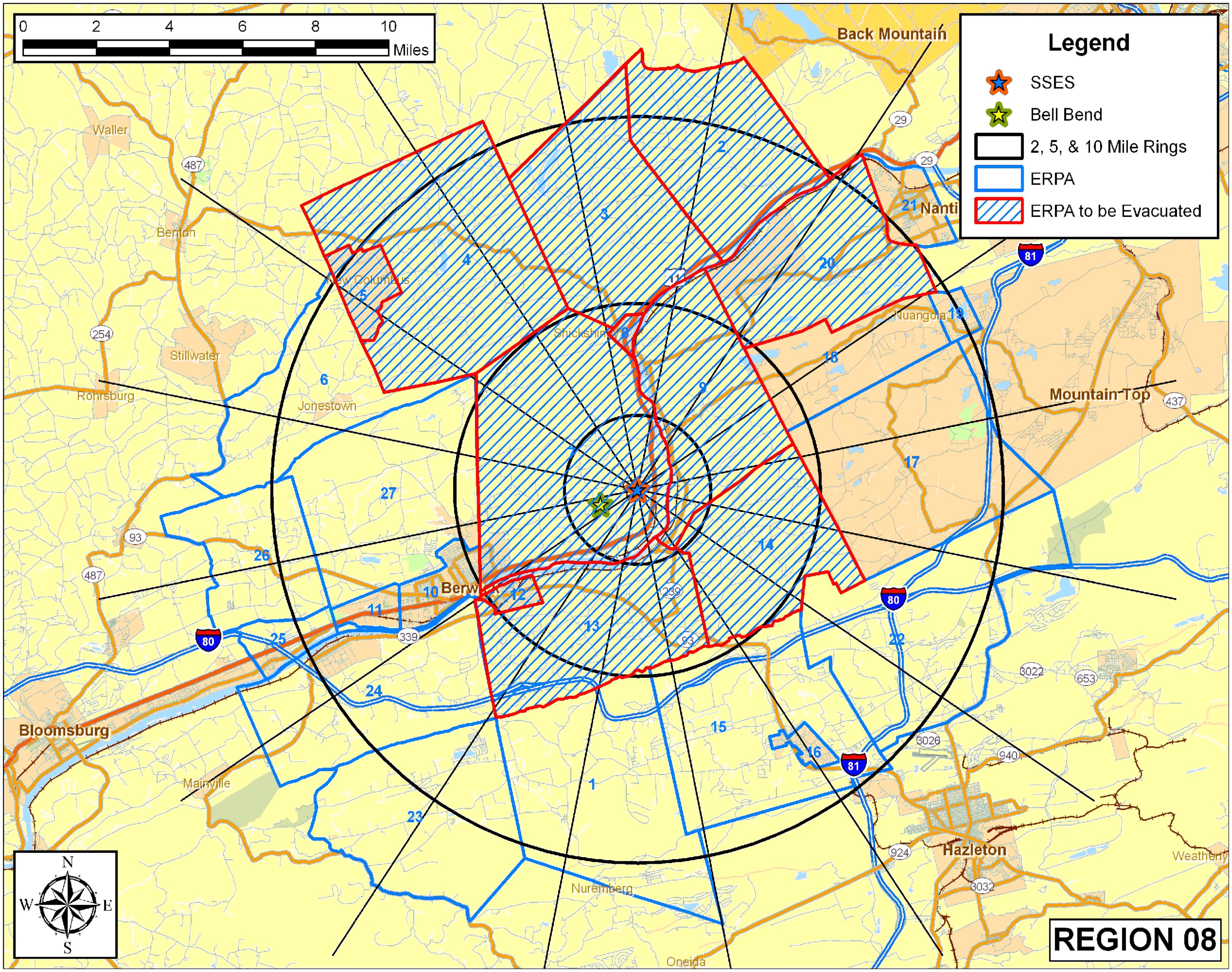

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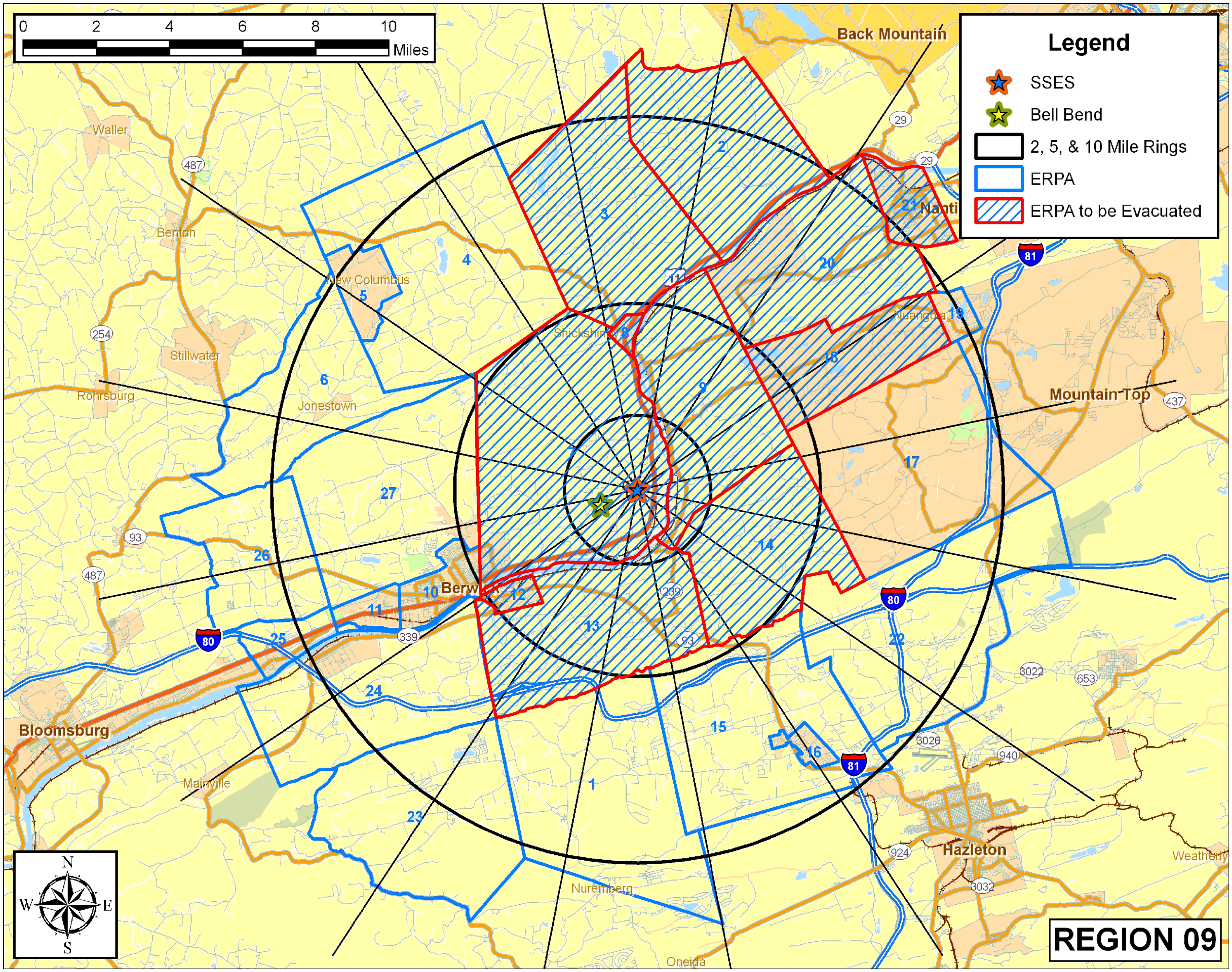

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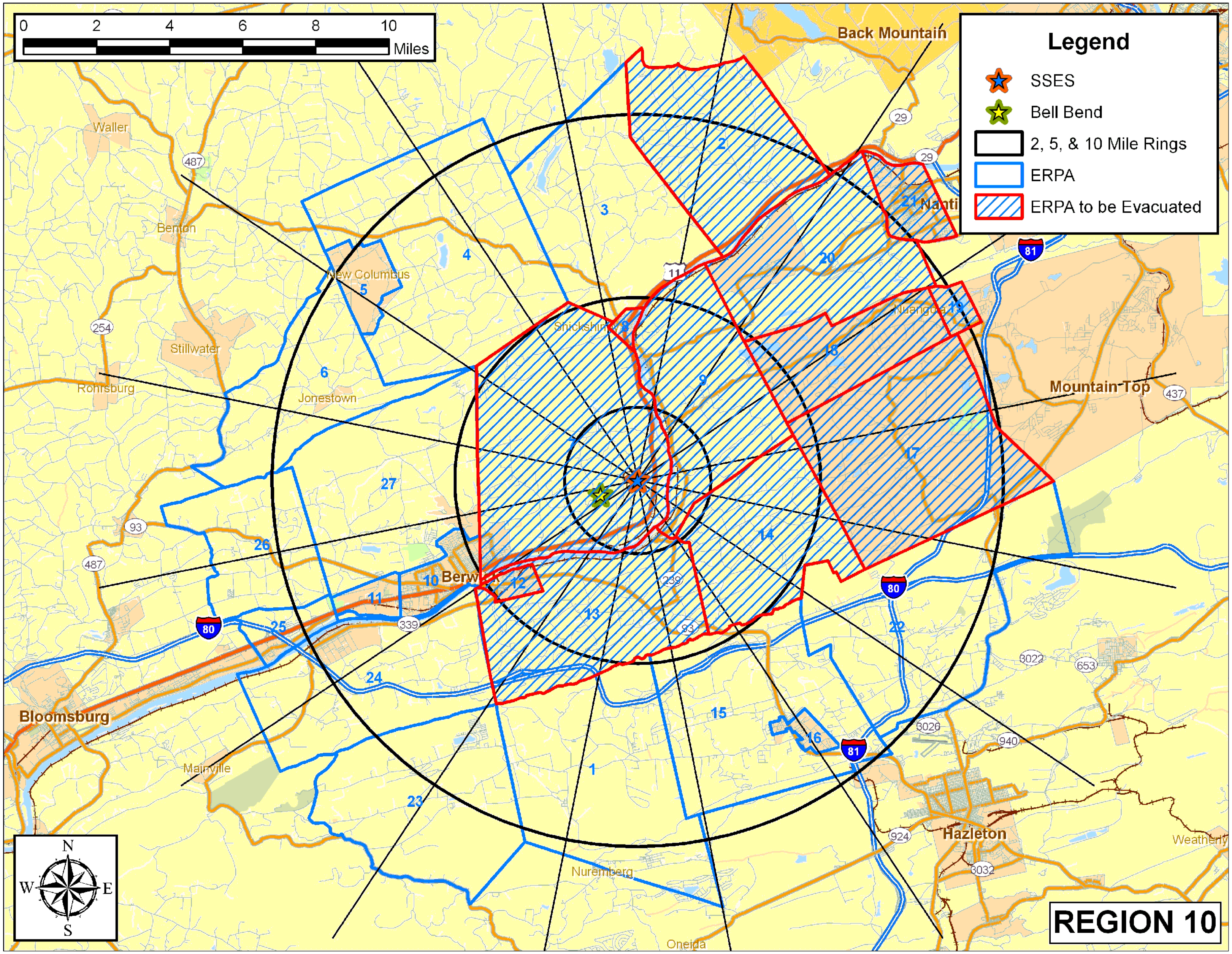
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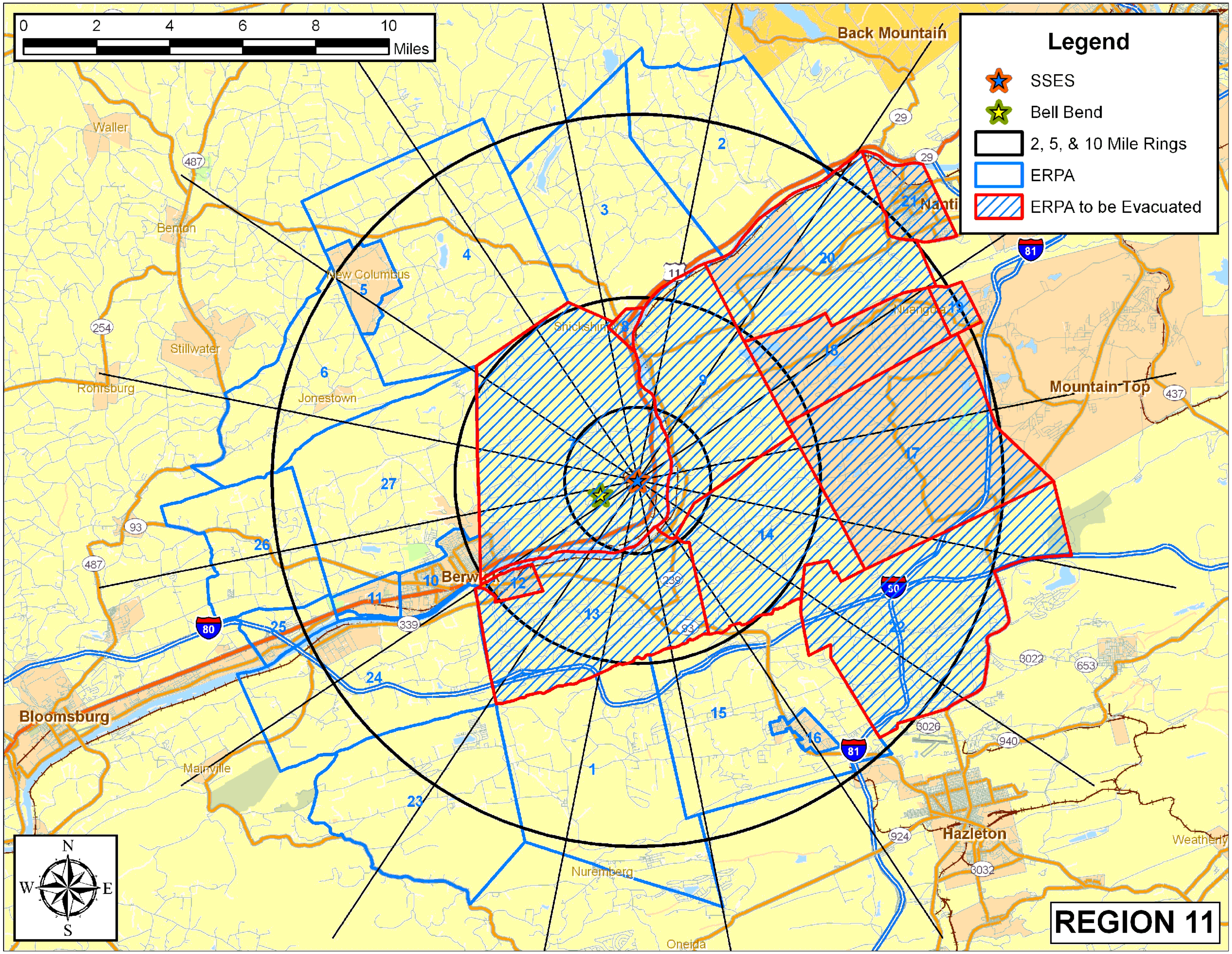

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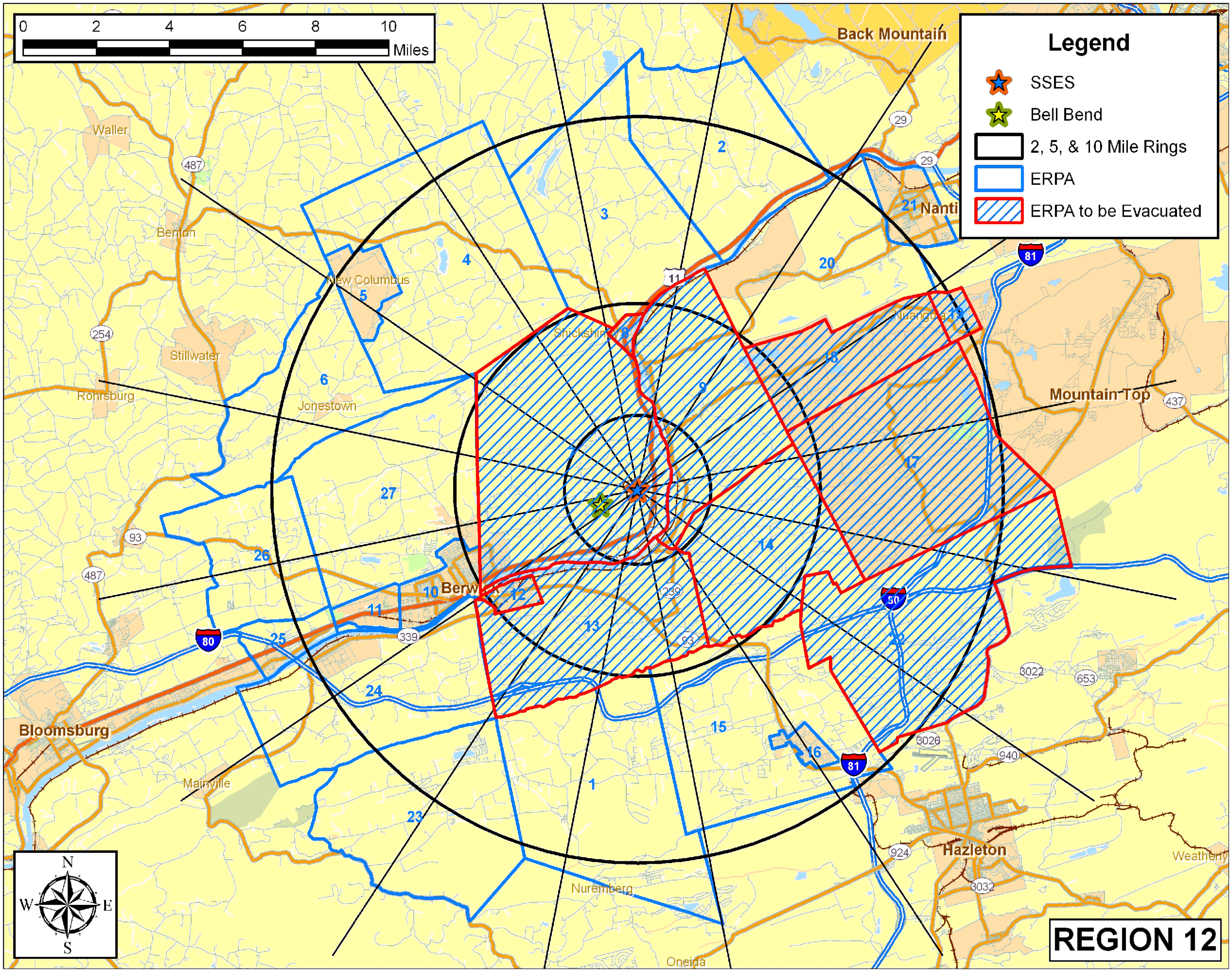

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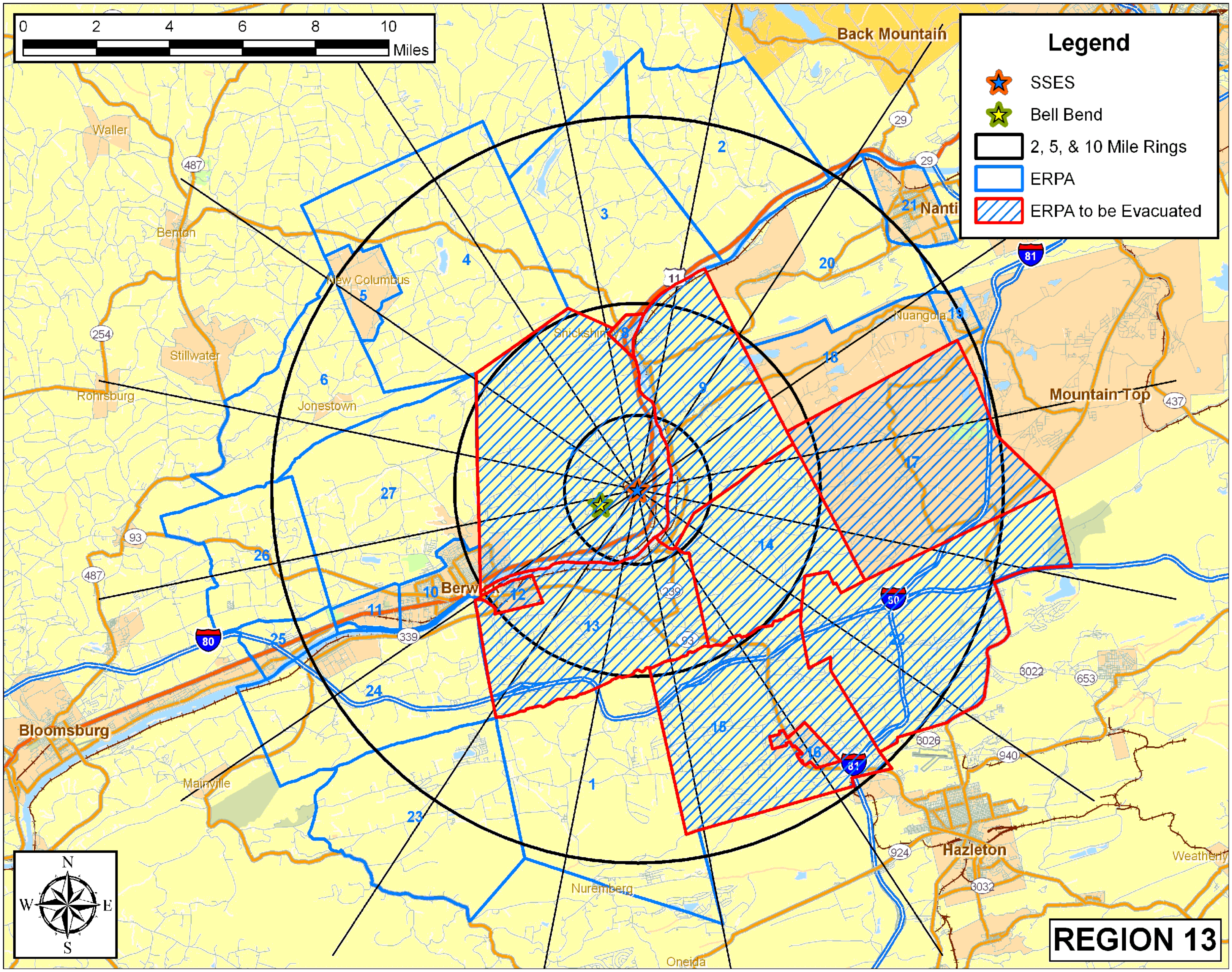

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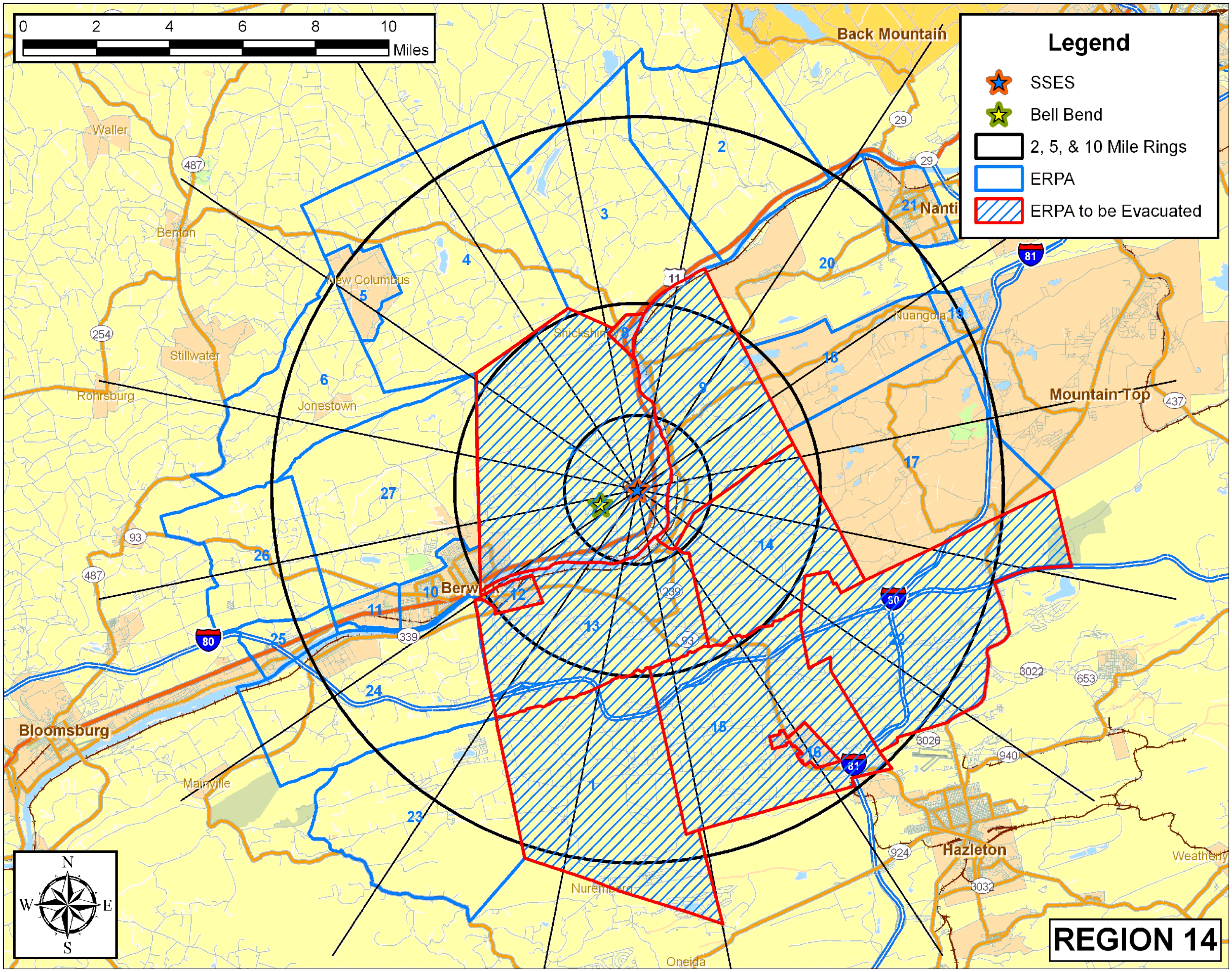

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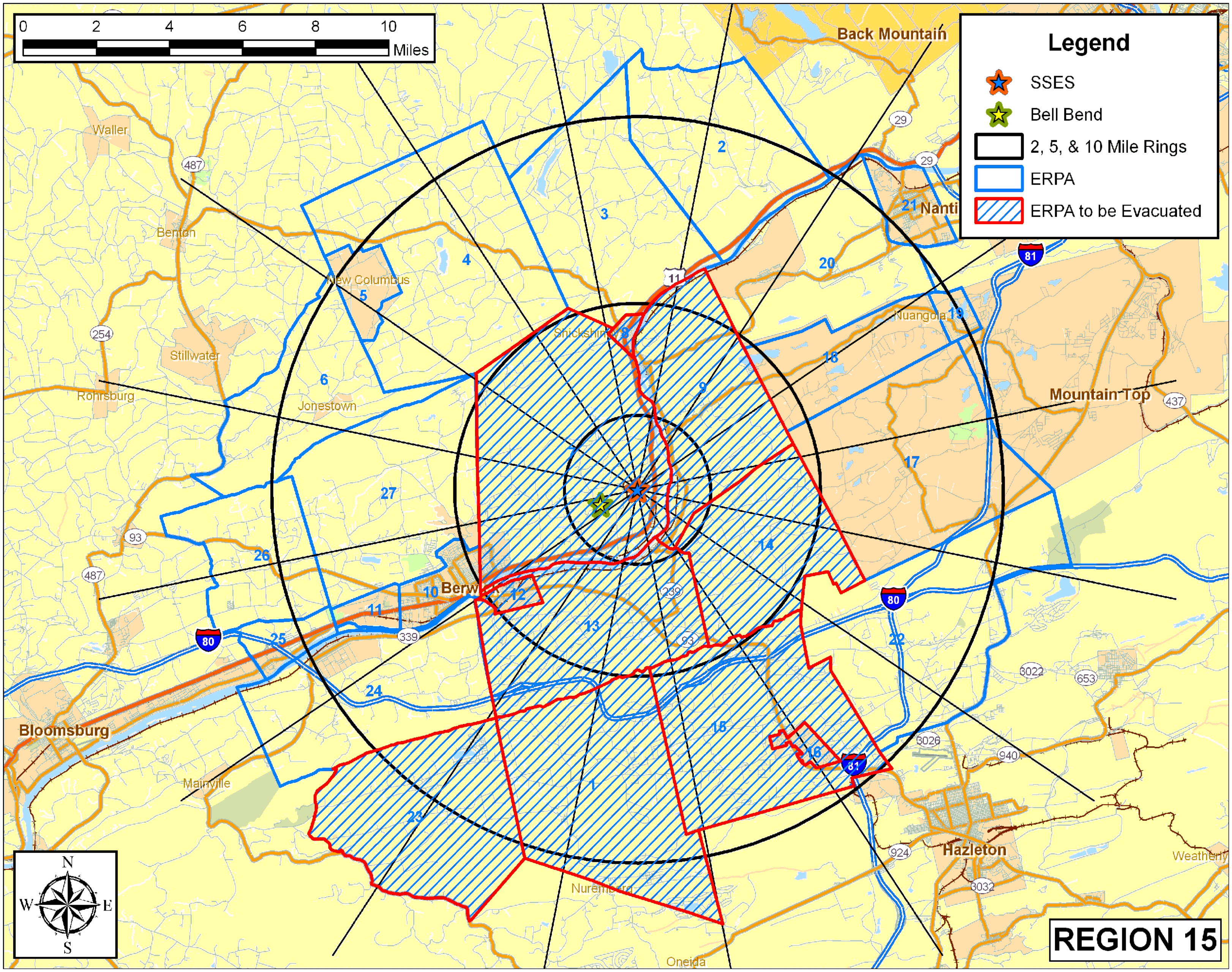

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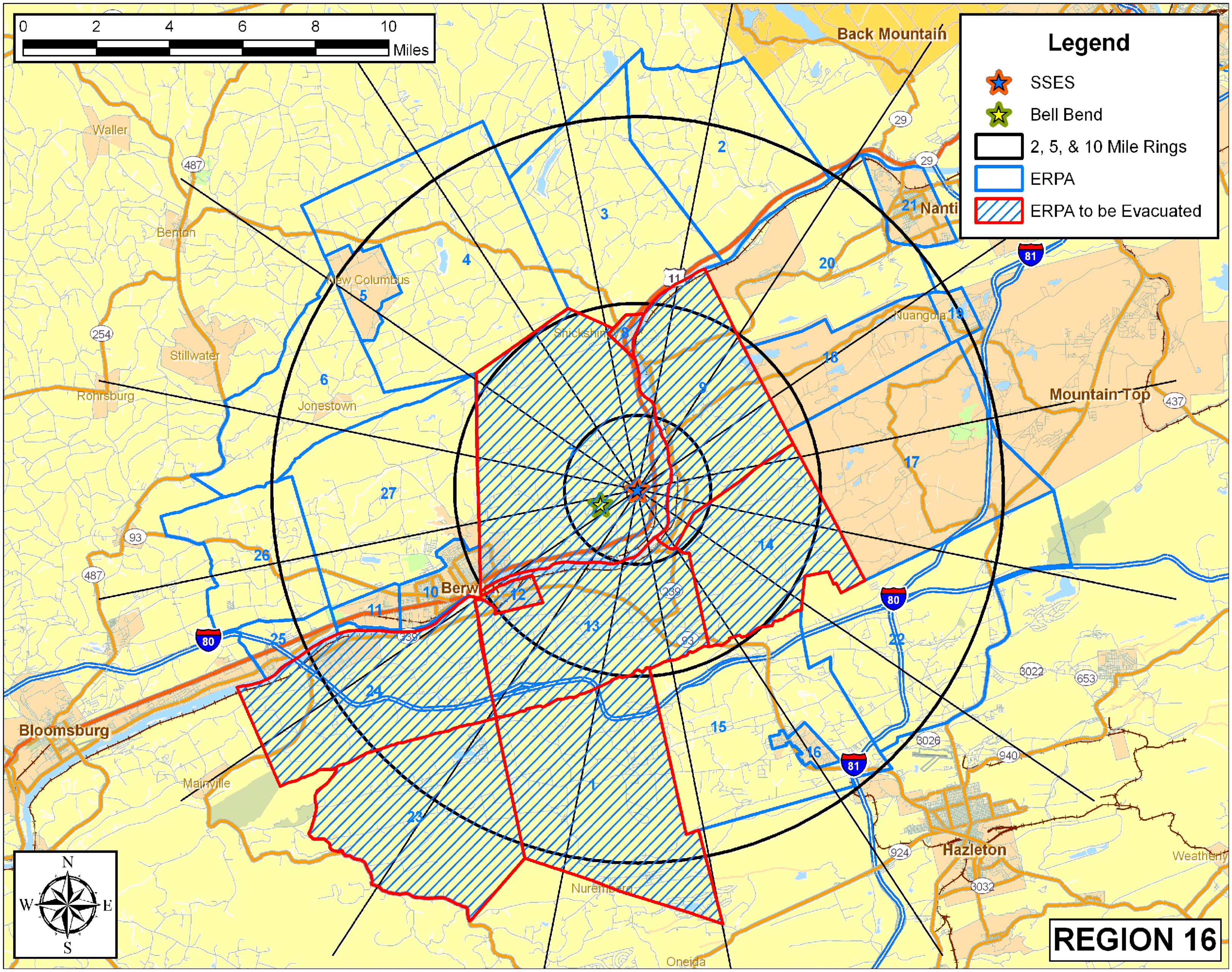
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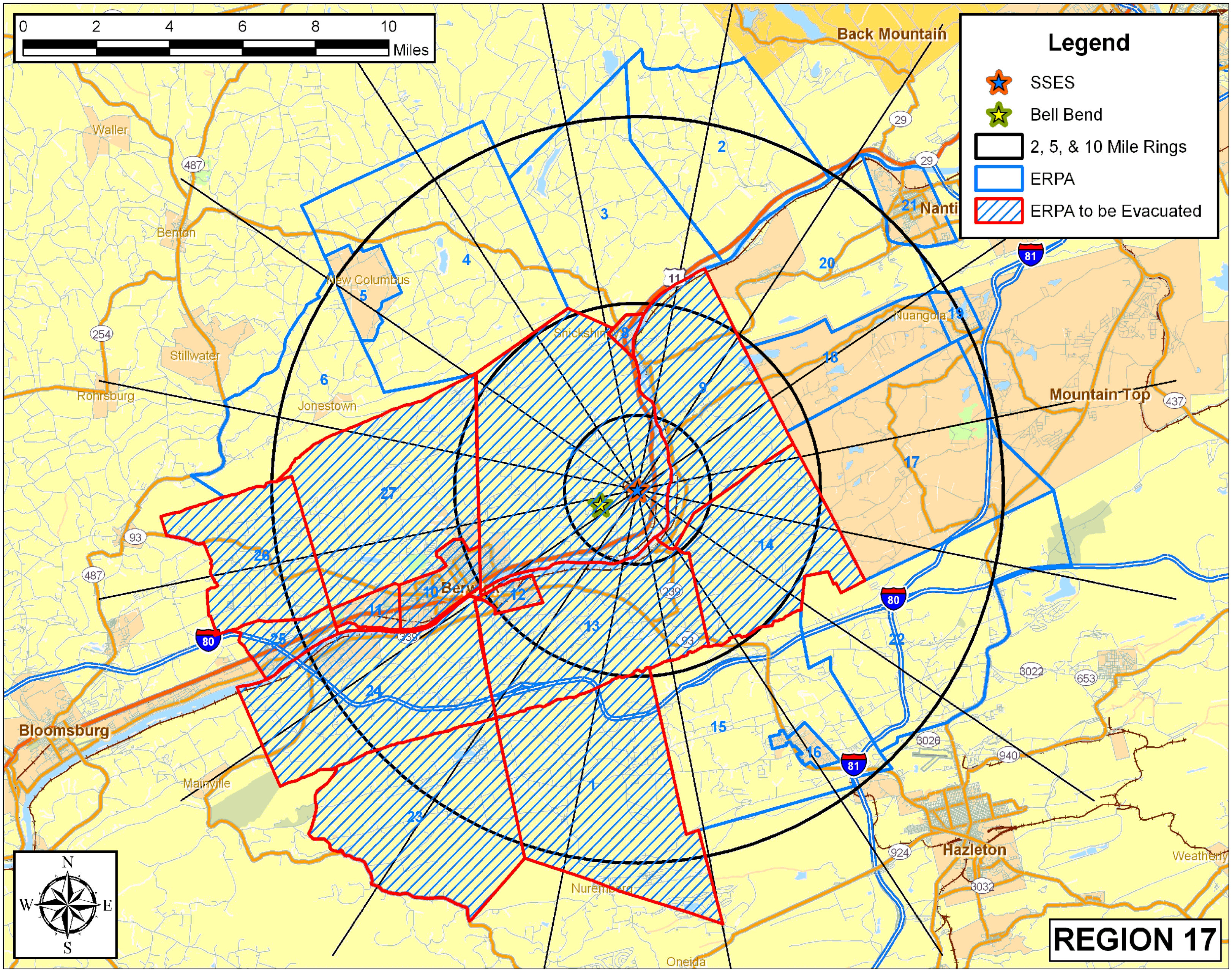

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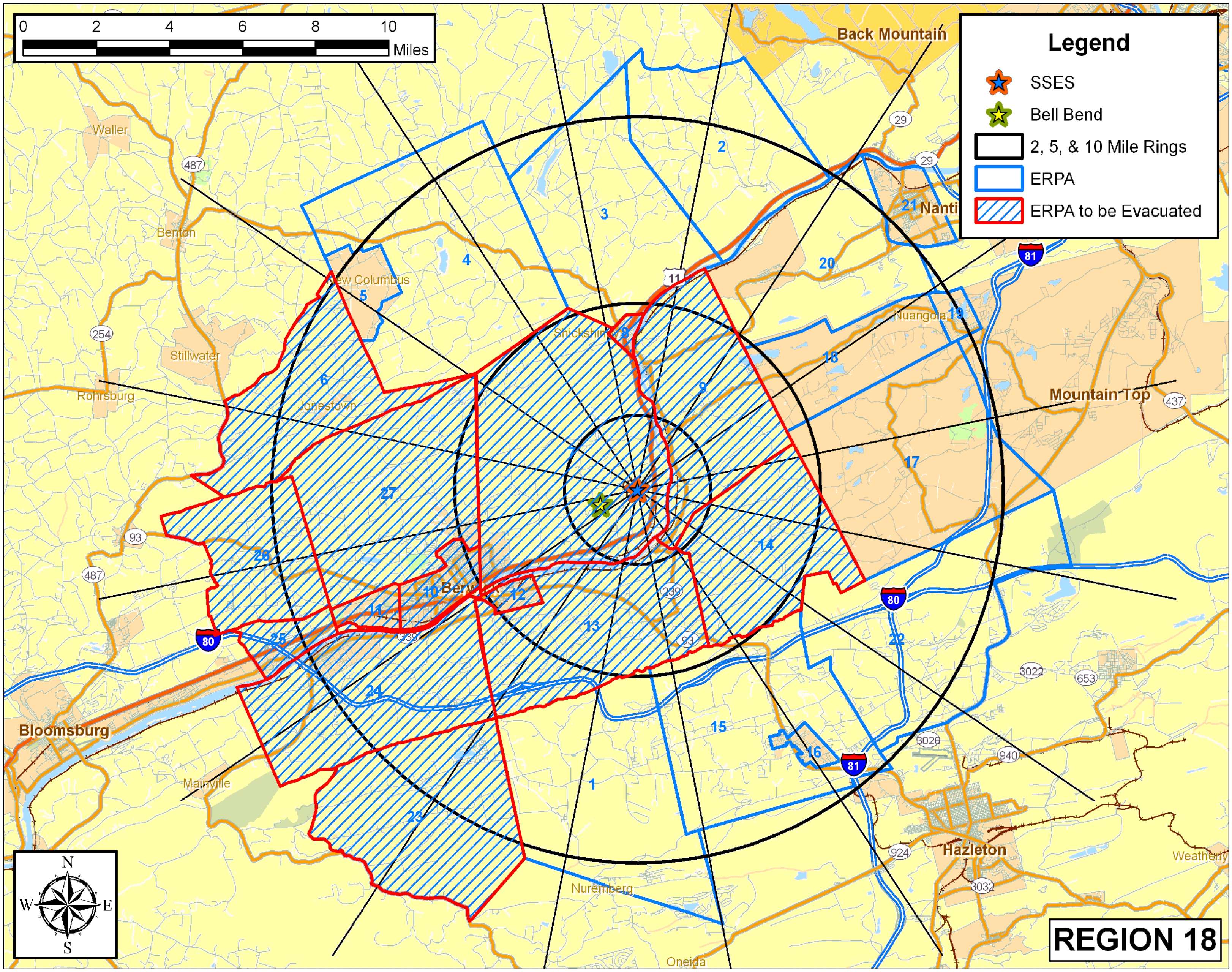

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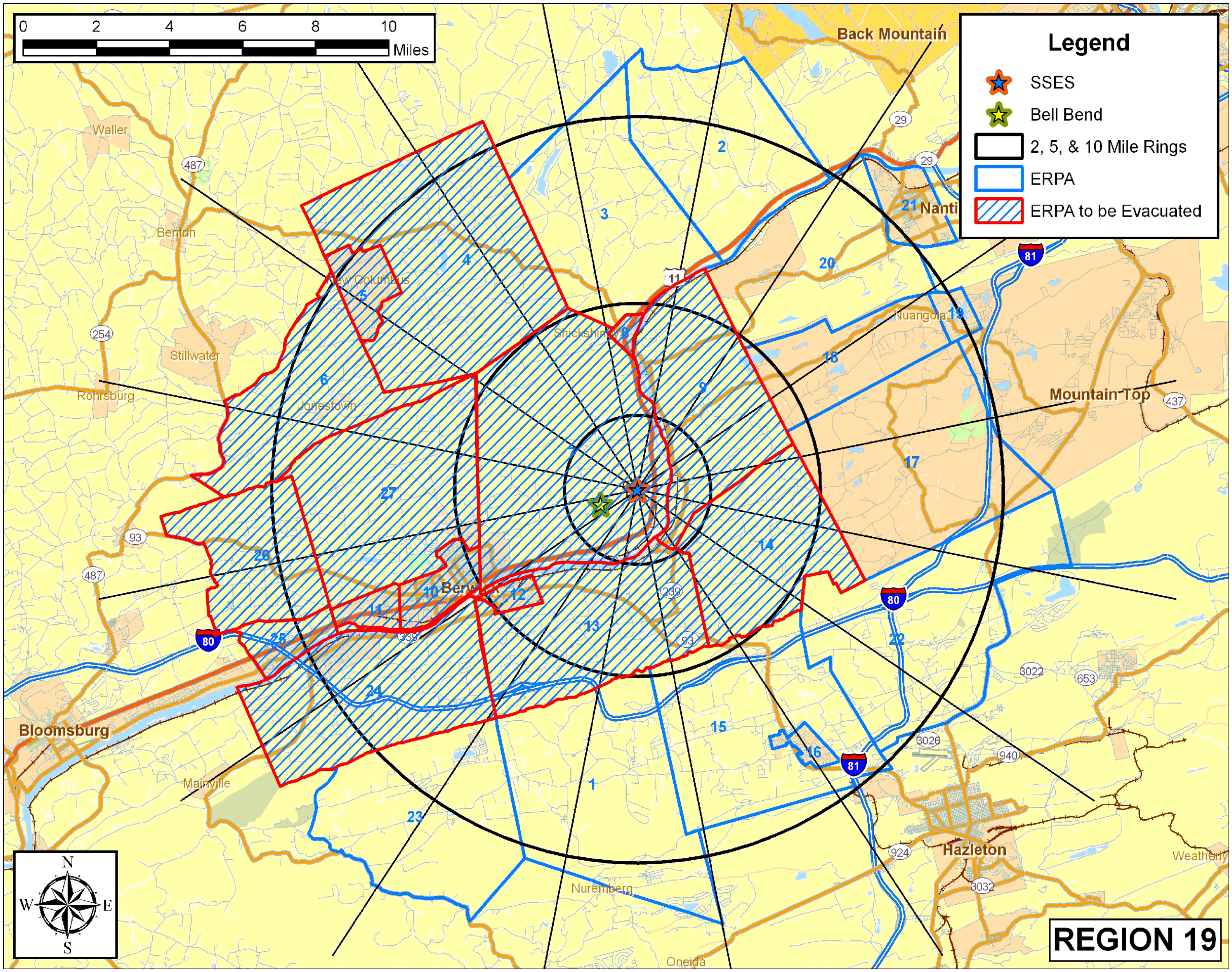
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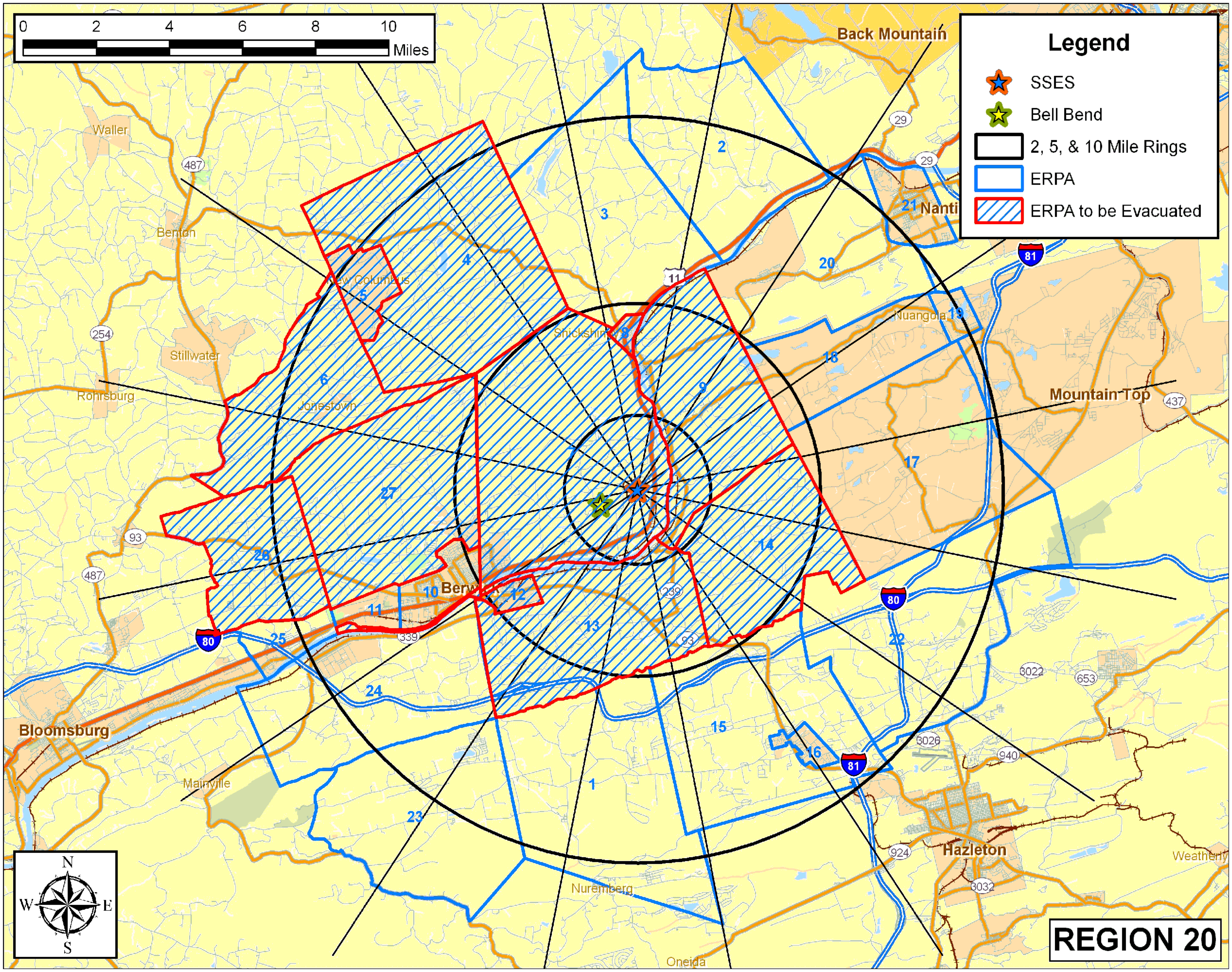

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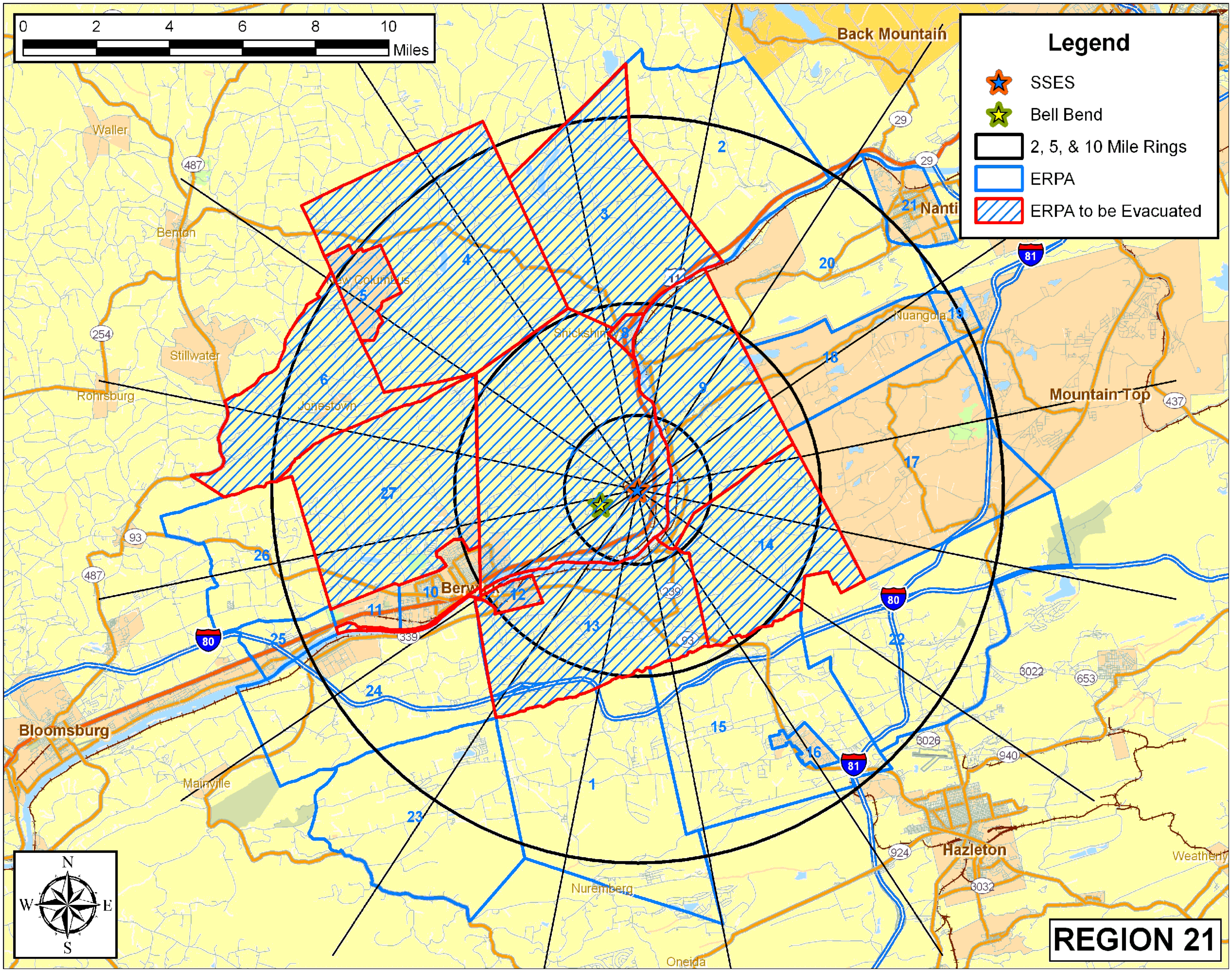
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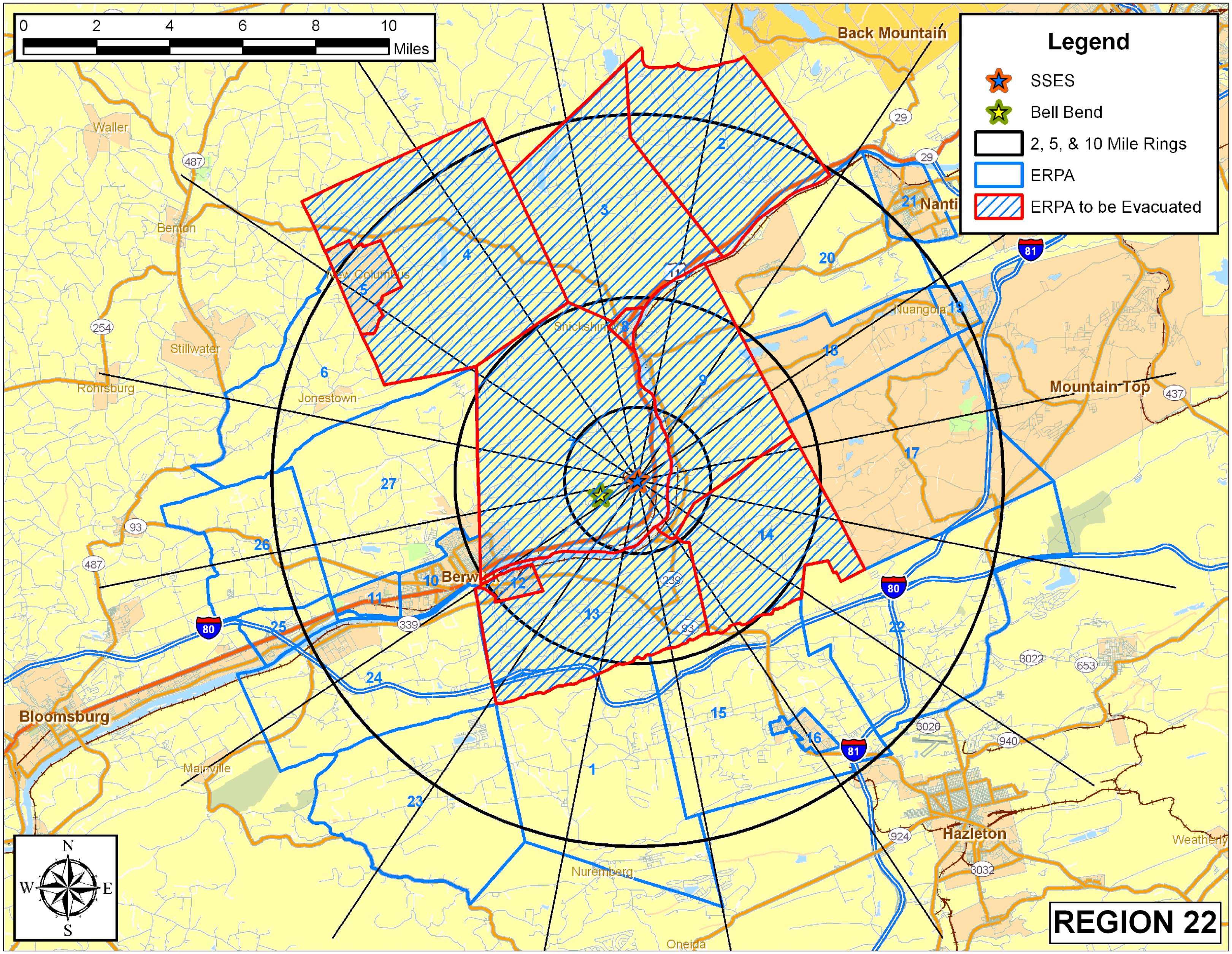
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APPENDIX I

Evacuation Sensitivity Study

APPENDIX I: EVACUATION SENSITIVITY STUDY

A sensitivity study was conducted to determine the effects on 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 the potential to impede vehicles evacuating from an evacuation region within the EPZ. The Scenario 1, Region 3 case is used for this sensitivity study.

Table I-2 presents the evacuation time estimates for this study. The ETE for all regions remain unchanged as the percentage of people who decide to relocate from within the shadow region varies from 15% to 60%. There are a total of 89,340 people (46,088 vehicles) within the shadow region. The animation displays of the evacuation traffic environment indicate that congestion intensifies in the outer areas of the EPZ (where the effect of shadow evacuation is greatest) as the number of evacuees from the shadow region rises; however, the ETE does not extend beyond the base ETE.

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

Shadow Data			Evacuation Region		
Percent Shadow Evacuation	**Number of Shadow Residents**	**Number of Shadow Evacuating Vehicles**	**2-Mile Region (R01)**	**5-Mile Region (R02)**	**Entire EPZ (R03)**
15	13,877	7,159	5:30	5:30	5:40
30 (Base)	27,755	14,318	5:30	5:30	5:40
60	55,510	28,636	5:30	5:30	5:40

APPENDIX J

Evacuation Time Estimates for All Evacuation Regions and Scenarios
and
Evacuation Time Graphs for Region R03, for all Scenarios

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

AND

EVACUATION TIME GRAPHS FOR REGION R03, FOR ALL SCENARIOS

This appendix presents the ETE Results for all 22 Regions and all 13 Scenarios (Tables J-1A through J-1D) and may be used as a convenient "pull-out" by decision-makers.

Plots of Evacuating Vehicles vs. Elapsed Time are presented for evacuees leaving the 2-mile and 5-mile circular areas around SSES/Bell Bend, and from the entire EPZ, (Region R03) for all 13 scenarios. Each plot has points indicating the evacuation times corresponding to the 50^{th}, 90^{th}, and 95^{th} percentiles of evacuated vehicles.

J.1 Guidance on Using ETE Tables

Tables J-1A through J-1D present the ETE values for all 22 Evacuation Regions and all 13 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
     - Summer (schools not in session)
     - Winter (also Autumn and Spring)
   - The Day of Week
     - Midweek (work-day)
     - Weekend, Holiday

- The Time of Day
  - Midday (work and commuting hours)
  - Evening
- Weather Condition
  - Good Weather
  - Rain
  - Snow
- Special Event (if any)
  - Construction of new unit

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, Scenario (10) applies. For snow, scenario (11) applies.
- 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 (and column in the Table) identified, now identify the **Evacuation Region**:

- Determine the projected azimuth direction of the plume (coincident with the wind direction). This direction is expressed in terms of compass orientation: *towards* N, NNE, NE…
- Determine the distance that the Evacuation Region will extend from the nuclear power plant. The applicable distances and their associated candidate Regions are given below:
  - 2 Miles (Region R01)
  - 5 Miles (Regions R02, R04 through R07)
  - to EPZ Boundary (Regions R03, R08 through R22)
- Enter Table J-2 and identify the applicable group of candidate regions based on the wind direction and on the distance that the selected region extends from SSES/Bell Bend. 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 J-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 *towards* the southwest (SW).
- 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 J-1C is applicable because the 95th-percentile population is desired. Proceed as follows:

1. Identify the Scenario as summer, weekend, evening and raining. Entering Table J-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. Enter Table J-2 and locate the group entitled “5-Mile Ring and Downwind to EPZ Boundary”. Scan down the second column of that group (with the heading, “Description”), to identify the row with “SW” (southwest azimuth) and read region “R17” 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 R17. This data cell is in the fifth column with the heading for Scenario (4) and in the row for Region R17 SW; it contains the ETE value of **3:30**.

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

	Summer		Summer		Summer		Winter			Winter			Winter		Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend			Midweek Weekend		Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	Scenario:	(6)	(7)	(8)	(9)	(10)	(11)	(12)	Scenario:	(13)
	Midday		Midday		Evening		Midday			Midday			Evening		Midday
Region Wind Toward:	Good Weather	Rain	Good Weather	Rain	Good Weather	Region Wind Toward:	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Region Wind Toward:	Bell Bend Construction and SSES Refueling
Entire 2-Mile Region, 5-Mile Region, and EPZ															
R01 2-Mile Region	1:25	1:25	1:15	1:15	1:15	R01 2-Mile Region	1:25	1:25	1:50	1:15	1:15	1:45	1:15	R01 2-Mile Region	1:30
R02 5-Mile Region	1:10	1:10	1:05	1:05	1:05	R02 5-Mile Region	1:10	1:10	1:25	1:05	1:05	1:20	1:05	R02 5-Mile Region	1:15
R03 Entire EPZ	1:30	1:35	1:20	1:25	1:25	R03 Entire EPZ	1:30	1:35	1:55	1:20	1:25	1:45	1:25	R03 Entire EPZ	1:35
2-Mile Ring and Downwind to 5 Miles															
R04 N,NNE,NNW	1:25	1:25	1:10	1:10	1:10	R04 N,NNE,NNW	1:25	1:25	1:55	1:10	1:10	1:45	1:10	R04 N,NNE,NNW	1:35
R01 NE,W,WNW,NW	See Region R01					R01 NE,W,WNW,NW	See Region R01							R01 NE,W,WNW,NW	See Region R01
R05 ENE,E,ESE	1:25	1:25	1:10	1:10	1:10	R05 ENE,E,ESE	1:25	1:25	1:55	1:10	1:10	1:45	1:10	R05 ENE,E,ESE	1:30
R06 SE,SSE	1:10	1:10	1:05	1:05	1:10	R06 SE,SSE	1:10	1:10	1:25	1:05	1:05	1:20	1:10	R06 SE,SSE	1:15
R07 S, SSW,SW,WSW	1:10	1:10	1:05	1:05	1:10	R07 S, SSW,SW,WSW	1:10	1:10	1:25	1:05	1:05	1:20	1:10	R07 S, SSW,SW,WSW	1:15
5-Mile Ring and Downwind to EPZ Boundary															
R08 N	1:20	1:20	1:10	1:10	1:15	R08 N	1:20	1:20	1:40	1:10	1:10	1:30	1:15	R08 N	1:25
R09 NNE	1:25	1:25	1:15	1:15	1:20	R09 NNE	1:25	1:30	1:50	1:15	1:15	1:40	1:20	R09 NNE	1:30
R10 NE	1:15	1:20	1:10	1:10	1:15	R10 NE	1:20	1:20	1:35	1:10	1:10	1:30	1:15	R10 NE	1:20
R11 ENE	1:15	1:15	1:10	1:10	1:15	R11 ENE	1:15	1:20	1:30	1:10	1:10	1:25	1:15	R11 ENE	1:15
R12 E	1:10	1:10	1:05	1:05	1:10	R12 E	1:10	1:10	1:20	1:05	1:05	1:20	1:10	R12 E	1:10
R13 ESE, SE	1:15	1:15	1:05	1:10	1:10	R13 ESE, SE	1:15	1:15	1:30	1:05	1:10	1:25	1:10	R13 ESE, SE	1:15
R14 SSE	1:15	1:15	1:05	1:05	1:10	R14 SSE	1:15	1:15	1:30	1:05	1:05	1:25	1:10	R14 SSE	1:15
R15 S	1:10	1:10	1:05	1:05	1:05	R15 S	1:10	1:10	1:25	1:05	1:05	1:20	1:05	R15 S	1:15
R16 SSW	1:20	1:25	1:10	1:15	1:15	R16 SSW	1:20	1:25	1:40	1:10	1:15	1:35	1:15	R16 SSW	1:25
R17 SW	1:35	1:35	1:20	1:25	1:25	R17 SW	1:35	1:35	1:55	1:20	1:25	1:45	1:25	R17 SW	1:40
R18 WSW	1:35	1:35	1:25	1:25	1:30	R18 WSW	1:35	1:35	2:00	1:25	1:25	1:50	1:30	R18 WSW	1:40
R19 W	1:35	1:35	1:25	1:25	1:25	R19 W	1:35	1:35	2:00	1:25	1:25	1:50	1:25	R19 W	1:40
R20 WNW	1:20	1:20	1:10	1:10	1:15	R20 WNW	1:20	1:20	1:40	1:10	1:10	1:35	1:15	R20 WNW	1:25
R21 NW	1:20	1:20	1:10	1:10	1:10	R21 NW	1:20	1:20	1:40	1:10	1:10	1:30	1:10	R21 NW	1:25
R22 NNW	1:15	1:20	1:05	1:10	1:10	R22 NNW	1:15	1:20	1:35	1:05	1:10	1:30	1:10	R22 NNW	1:25

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

	Summer		Summer		Summer		Winter			Winter			Winter		Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend			Midweek Weekend		Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	Scenario:	(6)	(7)	(8)	(9)	(10)	(11)	(12)	Scenario:	(13)
	Midday		Midday		Evening		Midday			Midday			Evening		Midday
Region Wind Toward:	Good Weather	Rain	Good Weather	Rain	Good Weather	Region Wind Toward:	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Region Wind Toward:	Bell Bend Construction and SSES Refueling
Entire 2-Mile Region, 5-Mile Region, and EPZ															
R01 2-Mile Region	2:40	2:40	2:20	2:25	2:20	R01 2-Mile Region	2:40	2:40	3:30	2:20	2:25	2:55	2:20	R01 2-Mile Region	2:55
R02 5-Mile Region	2:10	2:10	1:50	1:55	2:10	R02 5-Mile Region	2:10	2:10	2:50	1:50	1:55	2:30	2:10	R02 5-Mile Region	2:40
R03 Entire EPZ	3:00	3:10	2:50	3:00	2:50	R03 Entire EPZ	3:00	3:10	3:50	2:50	3:00	3:40	2:50	R03 Entire EPZ	3:20
2-Mile Ring and Downwind to 5 Miles															
R04 N,NNE,NNW	2:40	2:40	2:20	2:20	2:20	R04 N,NNE,NNW	2:40	2:40	3:30	2:20	2:20	2:55	2:20	R04 N,NNE,NNW	2:55
R01 NE,W,WNW,NW	See Region R01					R01 NE,W,WNW,NW	See Region R01							R01 NE,W,WNW,NW	See Region R01
R05 ENE,E,ESE	2:40	2:40	2:20	2:20	2:20	R05 ENE,E,ESE	2:40	2:40	3:30	2:20	2:20	2:55	2:20	R05 ENE,E,ESE	2:55
R06 SE,SSE	2:10	2:10	1:50	1:55	2:10	R06 SE,SSE	2:10	2:10	2:50	1:50	1:55	2:30	2:10	R06 SE,SSE	2:40
R07 S, SSW,SW,WSW	2:10	2:10	1:50	1:55	2:10	R07 S, SSW,SW,WSW	2:10	2:10	2:50	1:50	1:55	2:30	2:10	R07 S, SSW,SW,WSW	2:40
5-Mile Ring and Downwind to EPZ Boundary															
R08 N	2:40	2:40	2:15	2:20	2:20	R08 N	2:40	2:40	3:30	2:15	2:20	3:00	2:20	R08 N	3:00
R09 NNE	2:50	3:00	2:30	2:40	2:40	R09 NNE	2:55	3:05	3:40	2:30	2:40	3:20	2:40	R09 NNE	3:00
R10 NE	2:40	2:40	2:20	2:30	2:30	R10 NE	2:45	2:50	3:20	2:20	2:30	3:00	2:30	R10 NE	2:50
R11 ENE	2:30	2:30	2:10	2:10	2:20	R11 ENE	2:30	2:40	3:10	2:10	2:10	2:50	2:20	R11 ENE	2:40
R12 E	2:00	2:00	1:50	1:50	2:00	R12 E	2:00	2:05	2:40	1:50	1:50	2:20	2:00	R12 E	2:20
R13 ESE, SE	2:10	2:20	1:55	2:00	2:00	R13 ESE, SE	2:10	2:20	2:55	1:55	2:00	2:30	2:00	R13 ESE, SE	2:30
R14 SSE	2:10	2:20	1:55	1:55	2:00	R14 SSE	2:10	2:20	2:55	1:55	1:55	2:30	2:00	R14 SSE	2:30
R15 S	2:10	2:10	1:50	1:50	2:00	R15 S	2:10	2:10	2:50	1:50	1:50	2:30	2:00	R15 S	2:30
R16 SSW	2:50	2:50	2:30	2:30	2:30	R16 SSW	2:50	2:50	3:20	2:30	2:30	3:00	2:30	R16 SSW	3:00
R17 SW	3:05	3:20	3:00	3:10	3:00	R17 SW	3:10	3:20	4:00	3:00	3:10	3:45	3:00	R17 SW	3:30
R18 WSW	3:05	3:20	3:00	3:10	3:00	R18 WSW	3:10	3:20	4:00	3:00	3:10	3:50	3:00	R18 WSW	3:30
R19 W	3:05	3:15	3:00	3:10	3:00	R19 W	3:05	3:20	4:00	3:00	3:05	3:50	3:00	R19 W	3:30
R20 WNW	2:30	2:30	2:10	2:10	2:15	R20 WNW	2:30	2:30	3:10	2:10	2:10	2:50	2:15	R20 WNW	2:40
R21 NW	2:30	2:30	2:05	2:10	2:10	R21 NW	2:30	2:30	3:10	2:05	2:10	2:50	2:10	R21 NW	2:40
R22 NNW	2:40	2:40	2:10	2:15	2:20	R22 NNW	2:40	2:40	3:20	2:10	2:15	2:50	2:20	R22 NNW	3:00

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

	Summer		Summer		Summer		Winter			Winter			Winter		Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend			Midweek Weekend		Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	Scenario:	(6)	(7)	(8)	(9)	(10)	(11)	(12)	Scenario:	(13)
	Midday		Midday		Evening		Midday			Midday			Evening		Midday
Region Wind Toward:	Good Weather	Rain	Good Weather	Rain	Good Weather	Region Wind Toward:	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Region Wind Toward:	Bell Bend Construction and SSES Refueling
Entire 2-Mile Region, 5-Mile Region, and EPZ															
R01 2-Mile Region	3:10	3:10	2:40	2:40	2:40	R01 2-Mile Region	3:00	3:00	4:10	2:40	2:40	3:50	2:40	R01 2-Mile Region	3:10
R02 5-Mile Region	2:40	2:40	2:20	2:20	2:30	R02 5-Mile Region	2:40	2:40	3:40	2:20	2:20	2:50	2:30	R02 5-Mile Region	3:00
R03 Entire EPZ	3:25	3:35	3:15	3:30	3:15	R03 Entire EPZ	3:25	3:35	4:20	3:15	3:20	4:10	3:10	R03 Entire EPZ	3:40
2-Mile Ring and Downwind to 5 Miles															
R04 N,NNE,NNW	3:10	3:10	2:40	2:40	2:40	R04 N,NNE,NNW	3:00	3:00	4:10	2:40	2:40	3:50	2:40	R04 N,NNE,NNW	3:10
R01 NE,W,WNW,NW	See Region R01					R01 NE,W,WNW,NW	See Region R01							R01 NE,W,WNW,NW	See Region R01
R05 ENE,E,ESE	3:00	3:10	2:40	2:40	2:40	R05 ENE,E,ESE	3:00	3:00	4:10	2:40	2:40	3:50	2:40	R05 ENE,E,ESE	3:10
R06 SE,SSE	2:40	2:40	2:20	2:20	2:30	R06 SE,SSE	2:40	2:40	3:40	2:20	2:20	2:50	2:30	R06 SE,SSE	3:00
R07 S, SSW,SW,WSW	2:40	2:40	2:20	2:20	2:30	R07 S, SSW,SW,WSW	2:40	2:40	3:30	2:20	2:20	2:50	2:30	R07 S, SSW,SW,WSW	3:00
5-Mile Ring and Downwind to EPZ Boundary															
R08 N	3:00	3:10	2:40	2:40	2:50	R08 N	3:10	3:10	4:00	2:40	2:40	3:30	2:50	R08 N	3:30
R09 NNE	3:10	3:20	2:50	3:00	3:00	R09 NNE	3:20	3:30	4:10	2:50	3:00	3:50	3:00	R09 NNE	3:20
R10 NE	3:00	3:10	2:40	2:50	2:50	R10 NE	3:10	3:20	4:00	2:40	2:50	3:40	2:50	R10 NE	3:10
R11 ENE	2:50	3:00	2:40	2:50	2:50	R11 ENE	3:00	3:10	3:50	2:40	2:50	3:40	2:50	R11 ENE	3:00
R12 E	2:40	2:40	2:10	2:10	2:20	R12 E	2:40	2:40	3:30	2:10	2:10	2:50	2:30	R12 E	3:00
R13 ESE, SE	2:50	2:50	2:20	2:20	2:30	R13 ESE, SE	2:50	2:50	3:40	2:20	2:20	3:00	2:30	R13 ESE, SE	3:00
R14 SSE	2:50	2:50	2:20	2:20	2:30	R14 SSE	2:50	2:50	3:40	2:20	2:20	3:00	2:30	R14 SSE	3:00
R15 S	2:40	2:40	2:10	2:10	2:30	R15 S	2:40	2:40	3:30	2:10	2:20	2:50	2:30	R15 S	3:00
R16 SSW	3:10	3:10	2:50	3:00	2:50	R16 SSW	3:10	3:10	3:50	2:50	3:00	3:30	2:50	R16 SSW	3:20
R17 SW	3:25	3:35	3:15	3:30	3:10	R17 SW	3:25	3:35	4:20	3:20	3:30	4:10	3:10	R17 SW	3:50
R18 WSW	3:25	3:35	3:15	3:30	3:15	R18 WSW	3:25	3:35	4:20	3:15	3:30	4:10	3:15	R18 WSW	3:50
R19 W	3:20	3:35	3:15	3:30	3:15	R19 W	3:25	3:35	4:20	3:15	3:25	4:10	3:15	R19 W	3:50
R20 WNW	2:50	2:50	2:30	2:30	2:30	R20 WNW	2:50	2:50	4:00	2:30	2:30	3:20	2:30	R20 WNW	3:00
R21 NW	2:50	2:50	2:30	2:30	2:30	R21 NW	2:50	2:50	4:00	2:30	2:30	3:20	2:30	R21 NW	3:00
R22 NNW	3:00	3:00	2:40	2:40	2:50	R22 NNW	3:00	3:10	3:50	2:40	2:40	3:30	2:50	R22 NNW	3:30

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

	Summer		Summer		Summer		Winter			Winter			Winter		Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend			Midweek Weekend		Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	Scenario:	(6)	(7)	(8)	(9)	(10)	(11)	(12)	Scenario:	(13)
	Midday		Midday		Evening		Midday			Midday			Evening		Midday
Region Wind Toward:	Good Weather	Rain	Good Weather	Rain	Good Weather	Region Wind Toward:	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Region Wind Toward:	Bell Bend Construction and SSES Refueling
Entire 2-Mile Region, 5-Mile Region, and EPZ															
R01 2-Mile Region	5:30	5:30	5:00	5:00	5:00	R01 2-Mile Region	5:30	5:30	6:30	5:00	5:00	6:00	5:00	R01 2-Mile Region	5:30
R02 5-Mile Region	5:30	5:30	5:00	5:00	5:00	R02 5-Mile Region	5:30	5:30	6:30	5:00	5:00	6:00	5:00	R02 5-Mile Region	5:30
R03 Entire EPZ	5:40	5:40	5:10	5:20	5:10	R03 Entire EPZ	5:40	5:40	6:40	5:10	5:20	6:20	5:10	R03 Entire EPZ	5:40
2-Mile Ring and Downwind to 5 Miles															
R04 N,NNE,NNW	5:30	5:30	5:00	5:00	5:00	R04 N,NNE,NNW	5:30	5:30	6:30	5:00	5:00	6:00	5:00	R04 N,NNE,NNW	5:30
R01 NE,W,WNW,NW	See Region R01					R01 NE,W,WNW,NW	See Region R01							R01 NE,W,WNW,NW	See Region R01
R05 ENE,E,ESE	5:30	5:30	5:00	5:00	5:00	R05 ENE,E,ESE	5:30	5:30	6:30	5:00	5:00	6:00	5:00	R05 ENE,E,ESE	5:30
R06 SE,SSE	5:30	5:30	5:00	5:00	5:00	R06 SE,SSE	5:30	5:30	6:30	5:00	5:00	6:00	5:00	R06 SE,SSE	5:30
R07 S, SSW,SW,WSW	5:30	5:30	5:00	5:00	5:00	R07 S, SSW,SW,WSW	5:30	5:30	6:30	5:00	5:00	6:00	5:00	R07 S, SSW,SW,WSW	5:30
5-Mile Ring and Downwind to EPZ Boundary															
R08 N	5:30	5:30	5:00	5:00	5:10	R08 N	5:30	5:30	6:30	5:00	5:00	6:10	5:00	R08 N	5:30
R09 NNE	5:30	5:30	5:00	5:00	5:00	R09 NNE	5:30	5:30	6:30	5:00	5:10	6:10	5:00	R09 NNE	5:30
R10 NE	5:30	5:30	5:00	5:10	5:10	R10 NE	5:30	5:30	6:40	5:00	5:10	6:10	5:00	R10 NE	5:30
R11 ENE	5:30	5:30	5:10	5:10	5:10	R11 ENE	5:30	5:30	6:30	5:10	5:10	6:10	5:10	R11 ENE	5:30
R12 E	5:30	5:30	5:10	5:10	5:10	R12 E	5:30	5:30	6:30	5:10	5:10	6:00	5:10	R12 E	5:30
R13 ESE, SE	5:30	5:30	5:10	5:10	5:10	R13 ESE, SE	5:30	5:30	6:40	5:10	5:10	6:10	5:10	R13 ESE, SE	5:30
R14 SSE	5:30	5:30	5:10	5:10	5:10	R14 SSE	5:30	5:30	6:40	5:10	5:10	6:00	5:10	R14 SSE	5:30
R15 S	5:30	5:30	5:00	5:00	5:00	R15 S	5:30	5:30	6:30	5:00	5:00	6:00	5:00	R15 S	5:30
R16 SSW	5:30	5:40	5:10	5:10	5:10	R16 SSW	5:30	5:30	6:40	5:10	5:10	6:10	5:10	R16 SSW	5:30
R17 SW	5:40	5:40	5:10	5:20	5:10	R17 SW	5:40	5:40	6:40	5:10	5:20	6:10	5:10	R17 SW	5:40
R18 WSW	5:40	5:40	5:10	5:10	5:10	R18 WSW	5:40	5:40	6:40	5:10	5:10	6:10	5:10	R18 WSW	5:40
R19 W	5:40	5:40	5:10	5:10	5:10	R19 W	5:40	5:40	6:40	5:10	5:10	6:20	5:10	R19 W	5:40
R20 WNW	5:30	5:30	5:10	5:10	5:10	R20 WNW	5:40	5:40	6:40	5:10	5:10	6:10	5:10	R20 WNW	5:30
R21 NW	5:30	5:30	5:10	5:10	5:10	R21 NW	5:30	5:30	6:40	5:10	5:10	6:10	5:10	R21 NW	5:30
R22 NNW	5:30	5:30	5:00	5:00	5:00	R22 NNW	5:30	5:30	6:30	5:00	5:00	6:00	5:00	R22 NNW	5:30

Table J-2. Description of Evacuation Regions

Region	Description	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
		ERPA																										
R01	2 mile ring							x		x																		
R02	5-mile ring							x	x	x			x	x	x													
R03	Full EPZ	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
2-MileRing and 5-Mile Downwind																												
		ERPA																										
Region	**Description**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**
R04	N,NNE,NNW							x	x	x																		
-	NE,W,WNW,NW	Refer to Region R01																										
R05	ENE,E,ESE							x		x					x													
R06	SE, SSE							x		x			x	x	x													
R07	S, SSW,SW,WSW							x		x			x	x														
5-Mile Ring and Downwind to EPZ Boundary																												
		ERPA																										
Region	**Description**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**
R08	N		x	x	x	x		x	x	x			x	x	x						x							
R09	NNE		x	x				x	x	x			x	x	x				x		x	x						
R10	NE		x					x	x	x			x	x	x			x	x	x	x	x						
R11	ENE							x	x	x			x	x	x			x	x	x	x	x	x					
R12	E							x	x	x			x	x	x			x	x	x			x					
R13	ESE, SE							x	x	x			x	x	x	x	x	x					x					
R14	SSE	x						x	x	x			x	x	x	x	x						x					
R15	S	x						x	x	x			x	x	x	x	x							x				
R16	SSW	x						x	x	x			x	x	x									x	x			
R17	SW	x						x	x	x	x	x	x	x	x									x	x	x	x	x
R18	WSW						x	x	x	x	x	x	x	x	x									x	x	x	x	x
R19	W				x	x	x	x	x	x	x	x	x	x	x										x	x	x	x
R20	WNW				x	x	x	x	x	x			x	x	x												x	x
R21	NW			x	x	x	x	x	x	x			x	x	x													x
R22	NNW		x	x	x	x		x	x	x			x	x	x													

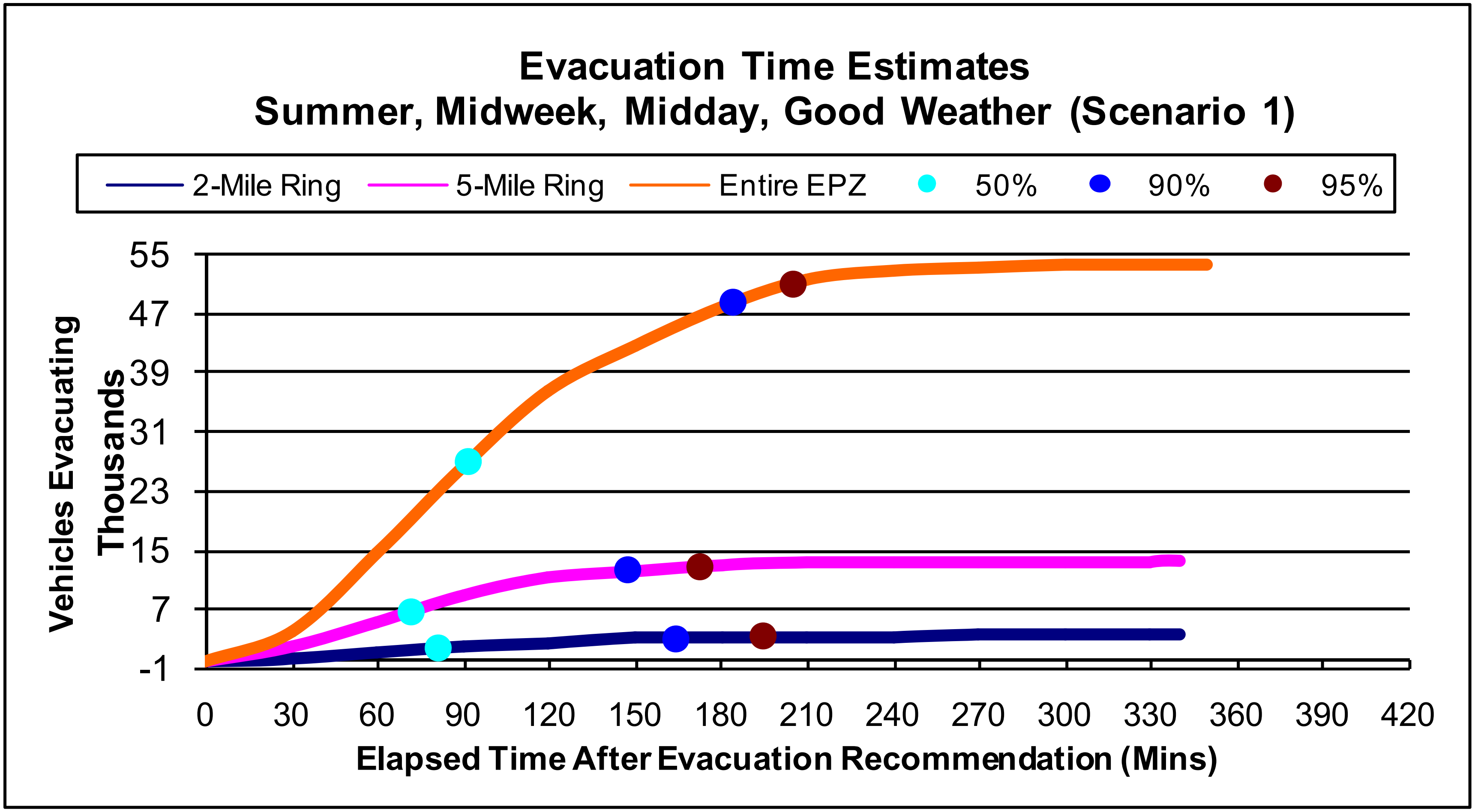

Figure J-1. Evacuation Time Estimates – Scenario 1 for Region R03 (Entire EPZ)

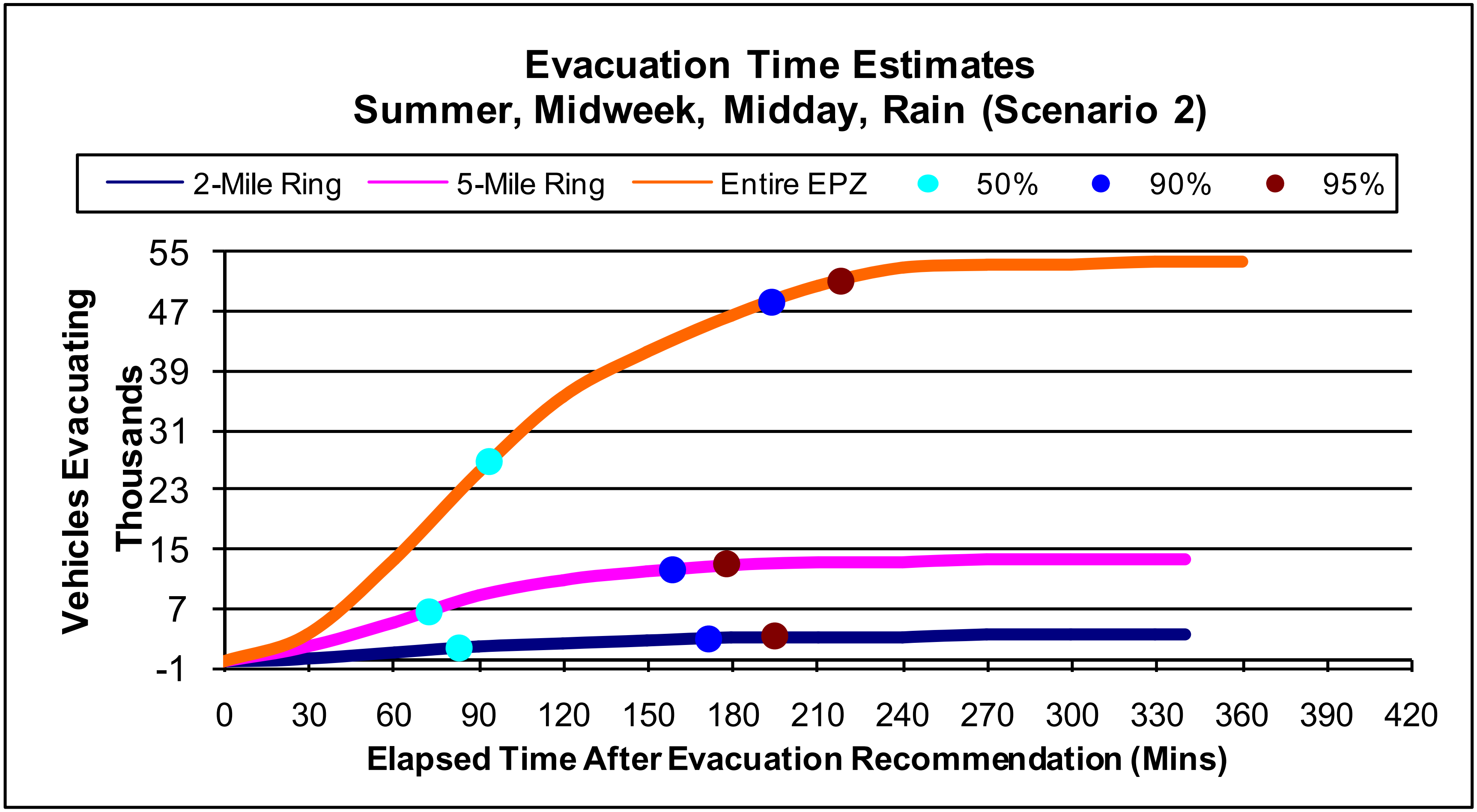

Figure J-2. Evacuation Time Estimates – Scenario 2 for Region R03 (Entire EPZ)

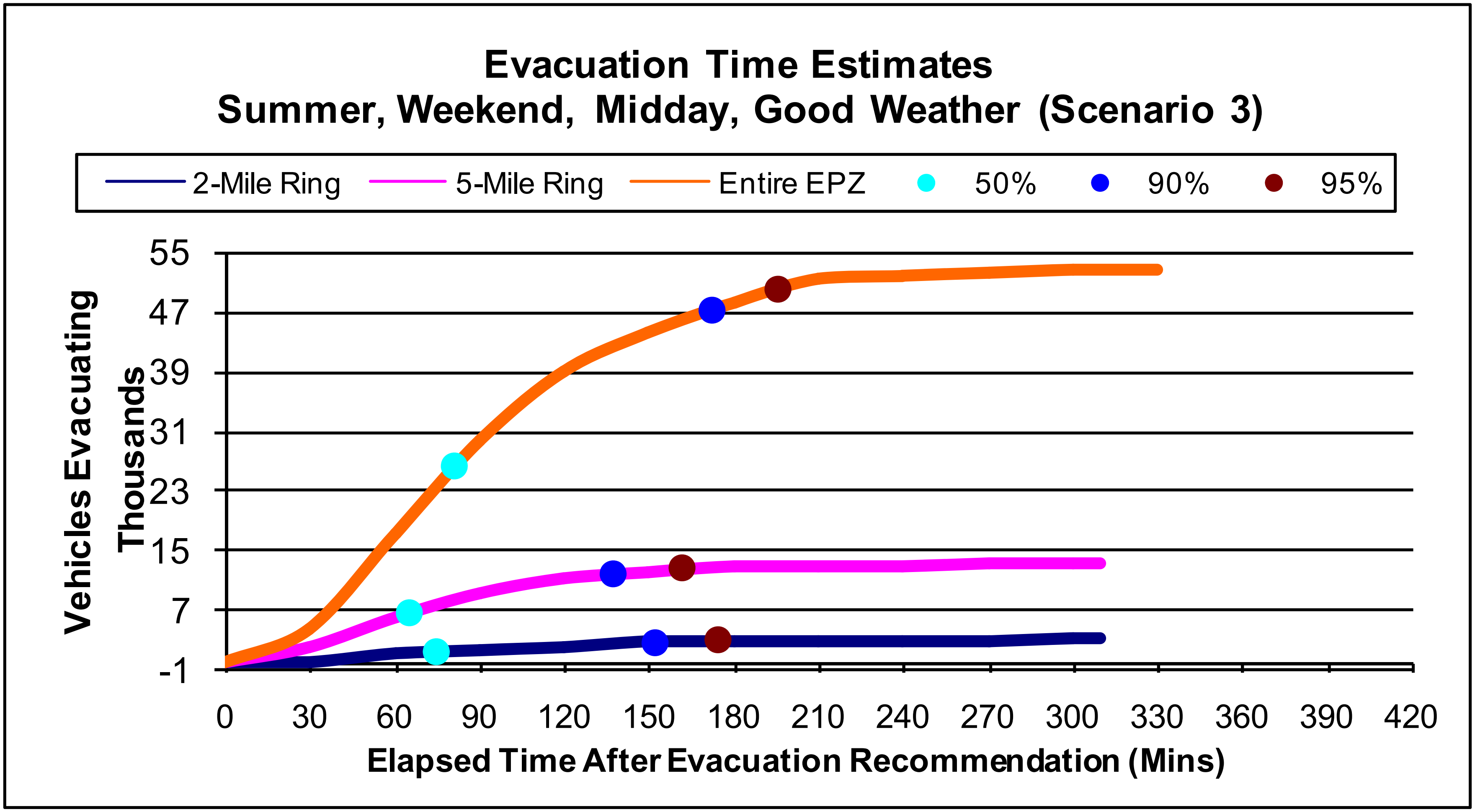

Figure J-3. Evacuation Time Estimates – Scenario 3 for Region R03 (Entire EPZ)

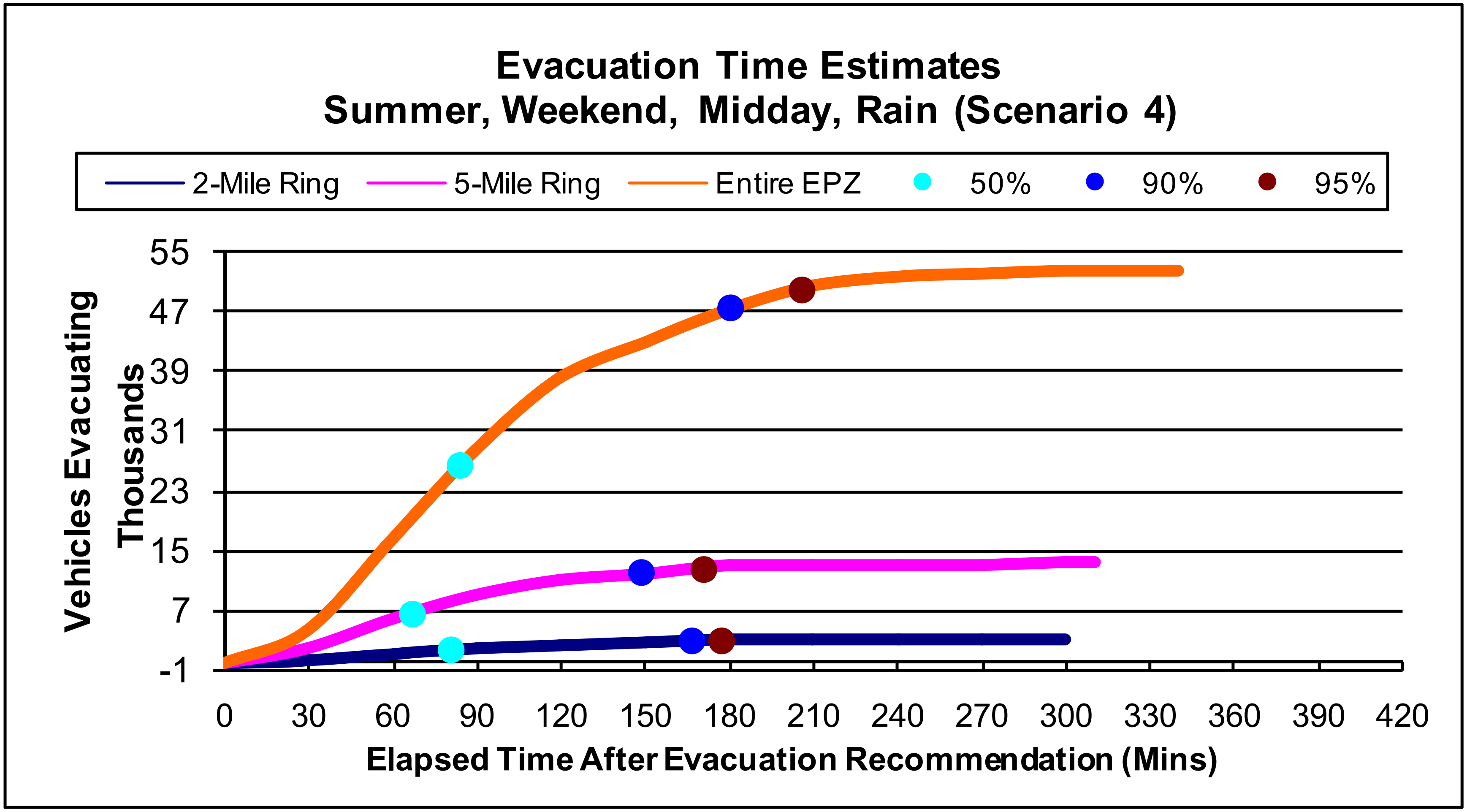

Figure J-4. Evacuation Time Estimates – Scenario 4 for Region R03 (Entire EPZ)

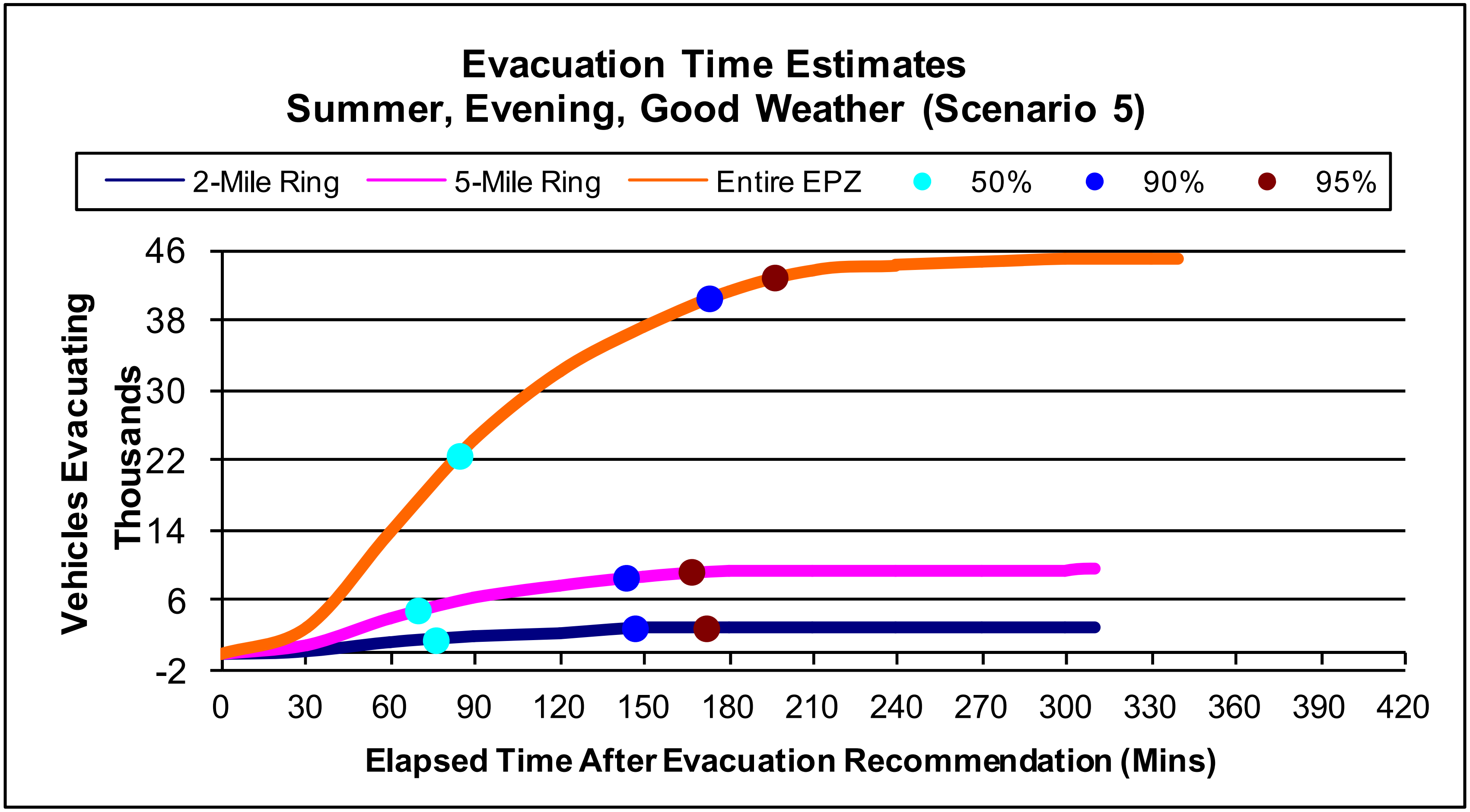

Figure J-5. Evacuation Time Estimates –
Scenario 5 for Region R03 (Entire EPZ)

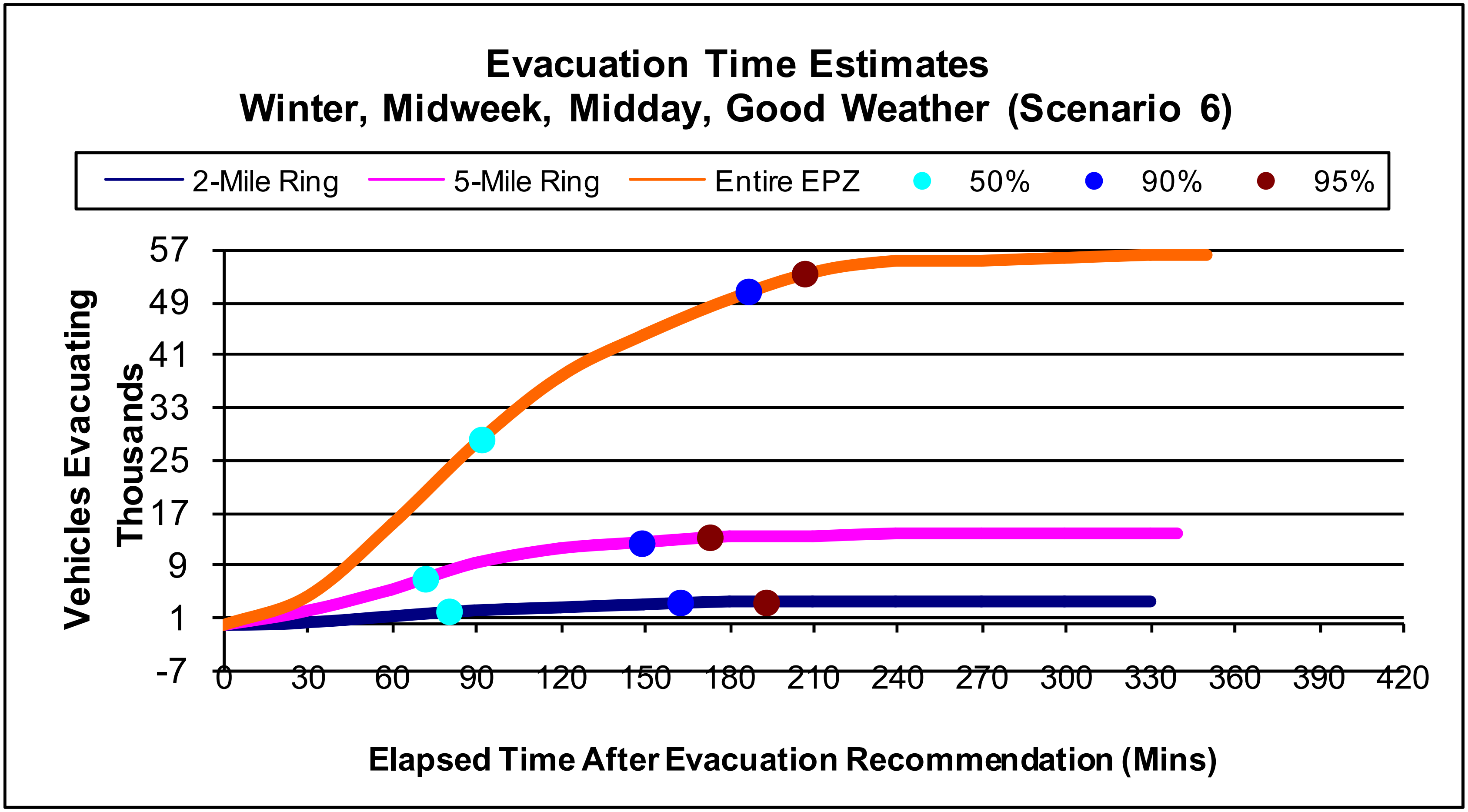

Figure J-6. Evacuation Time Estimates –
Scenario 6 for Region R03 (Entire EPZ)

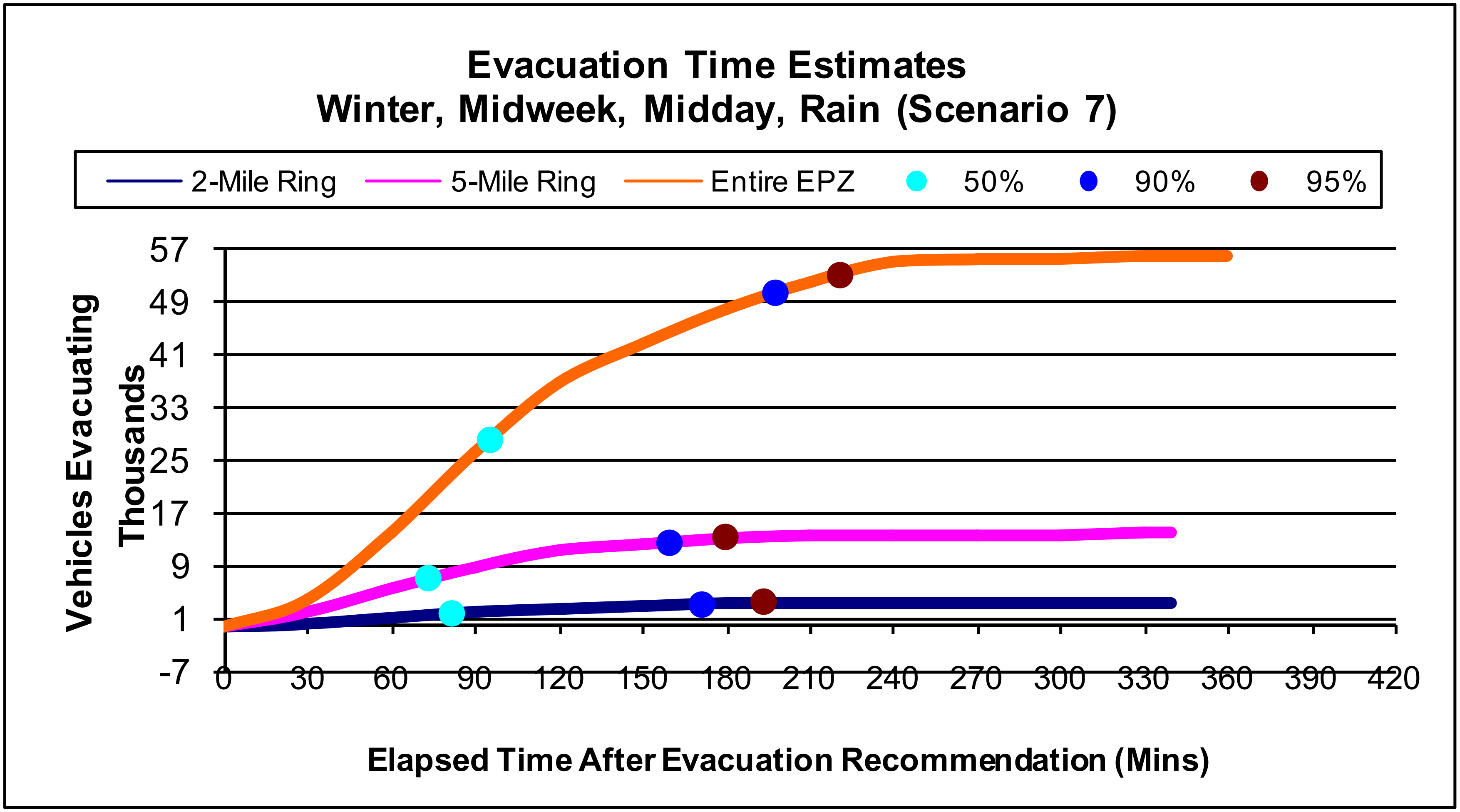

Figure J-7. Evacuation Time Estimates – Scenario 7 for Region R03 (Entire EPZ)

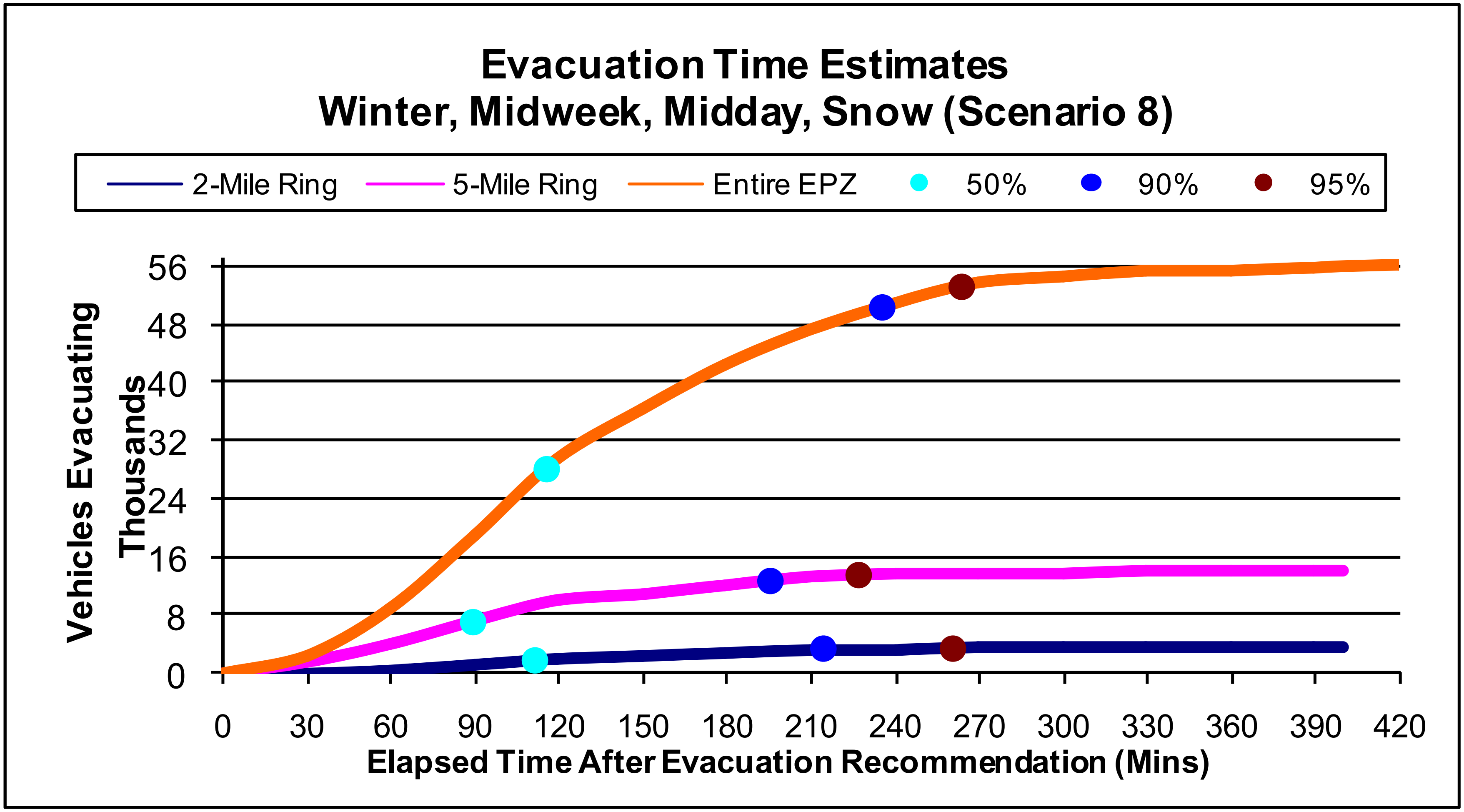

Figure J-8. Evacuation Time Estimates – Scenario 8 for Region R03 (Entire EPZ)

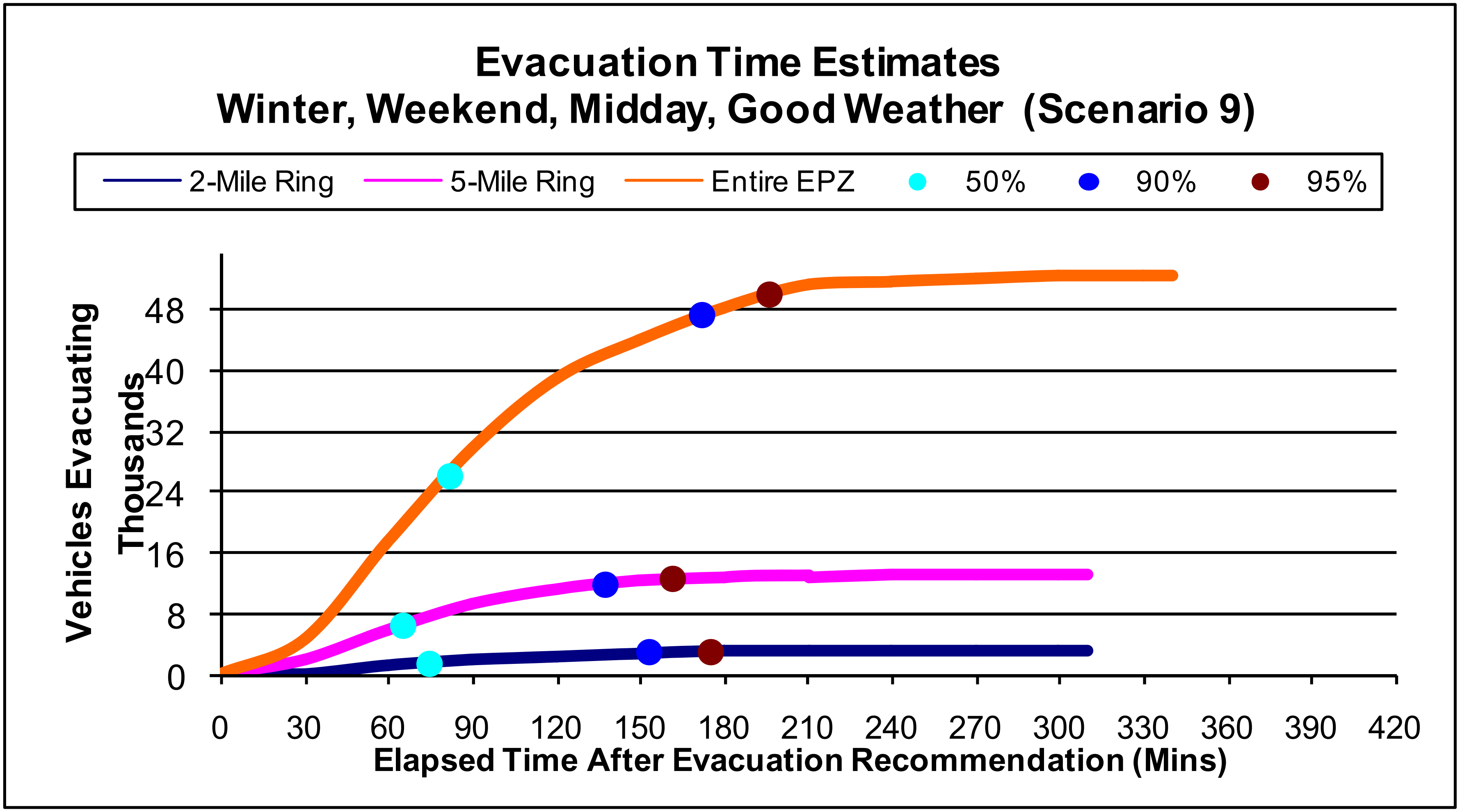

Figure J-9. Evacuation Time Estimates – Scenario 9 for Region R03 (Entire EPZ)

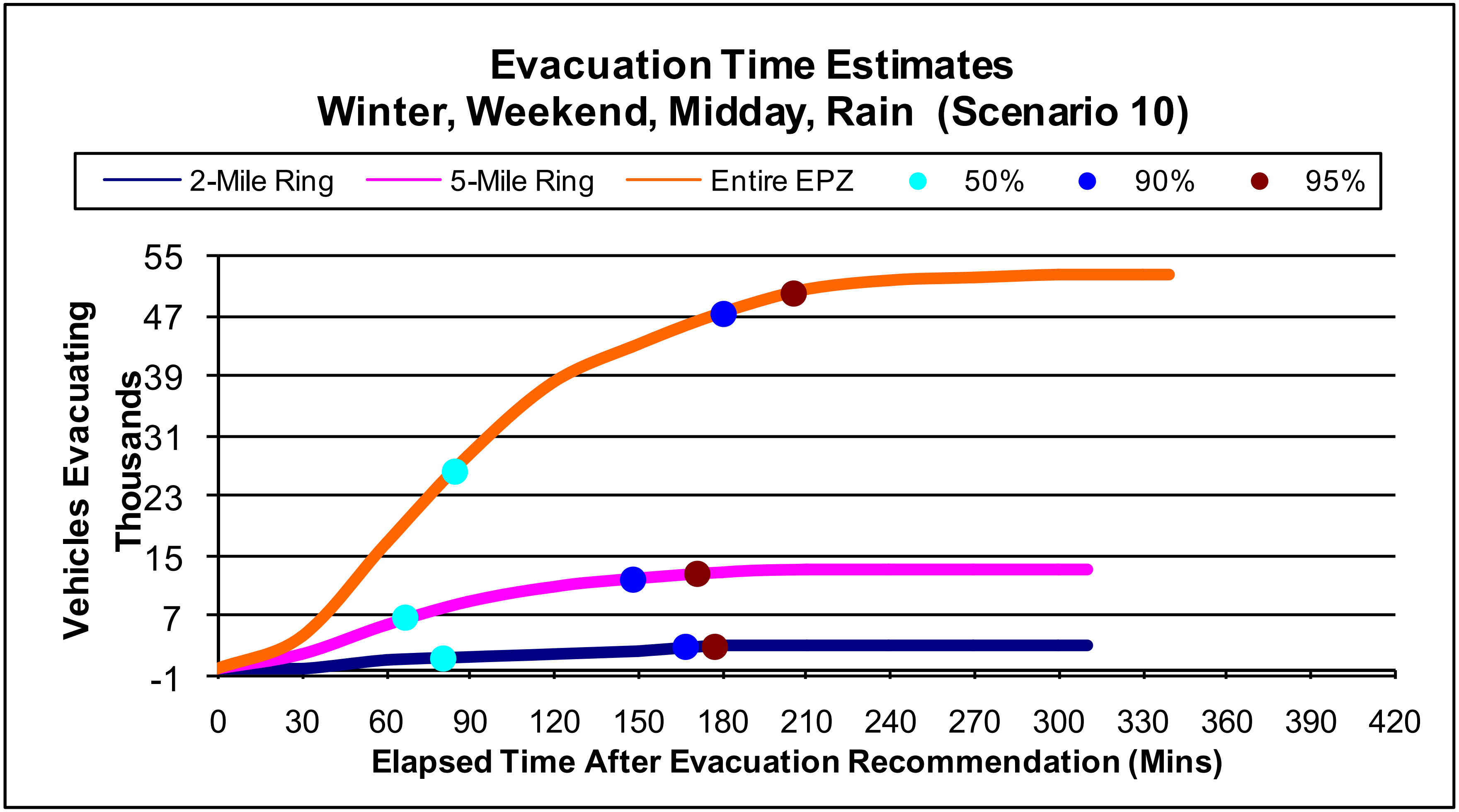

Figure J-10. Evacuation Time Estimates – Scenario 10 for Region R03 (Entire EPZ)

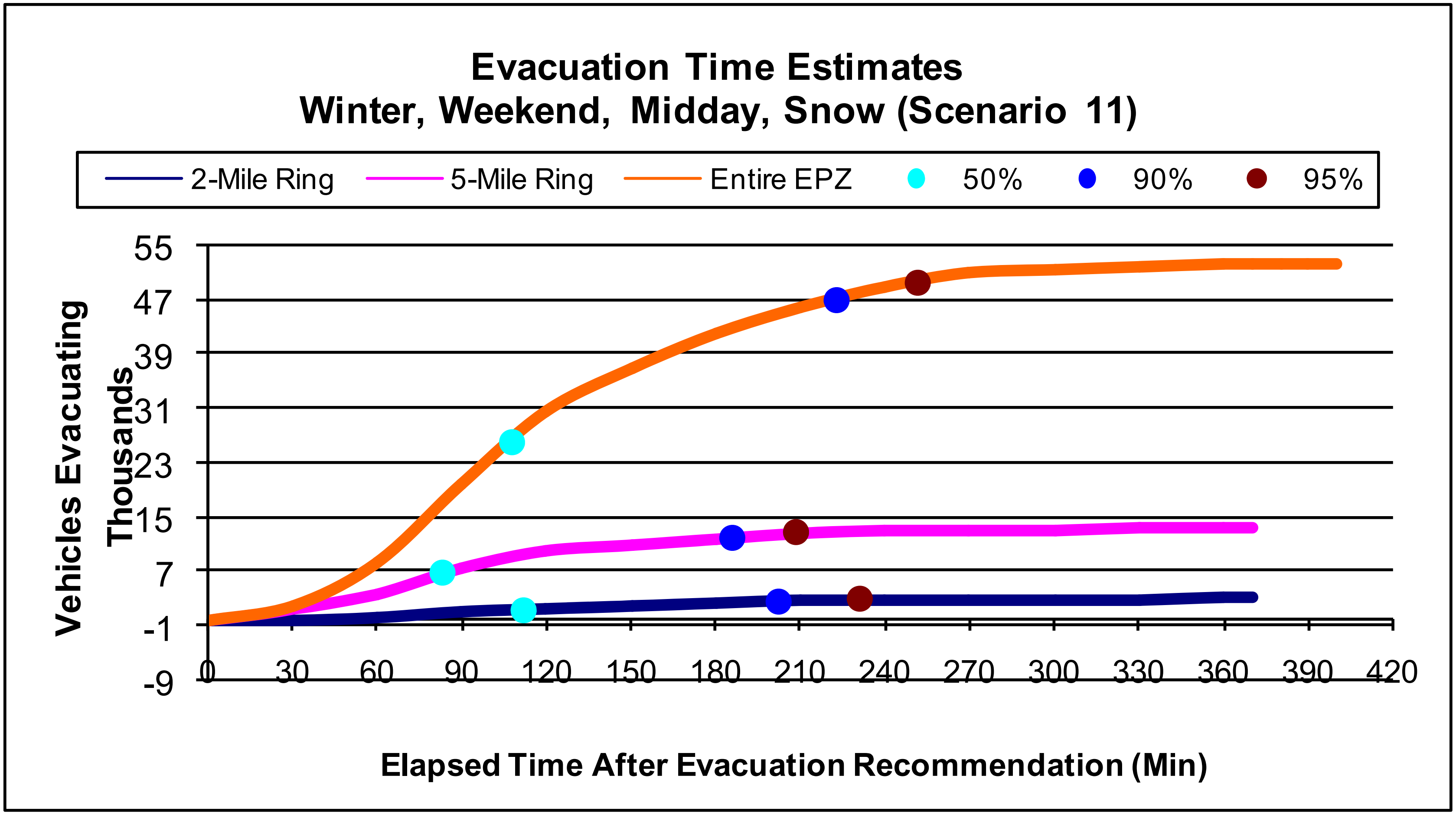

Figure J-11. Evacuation Time Estimates – Scenario 11 for Region R03 (Entire EPZ)

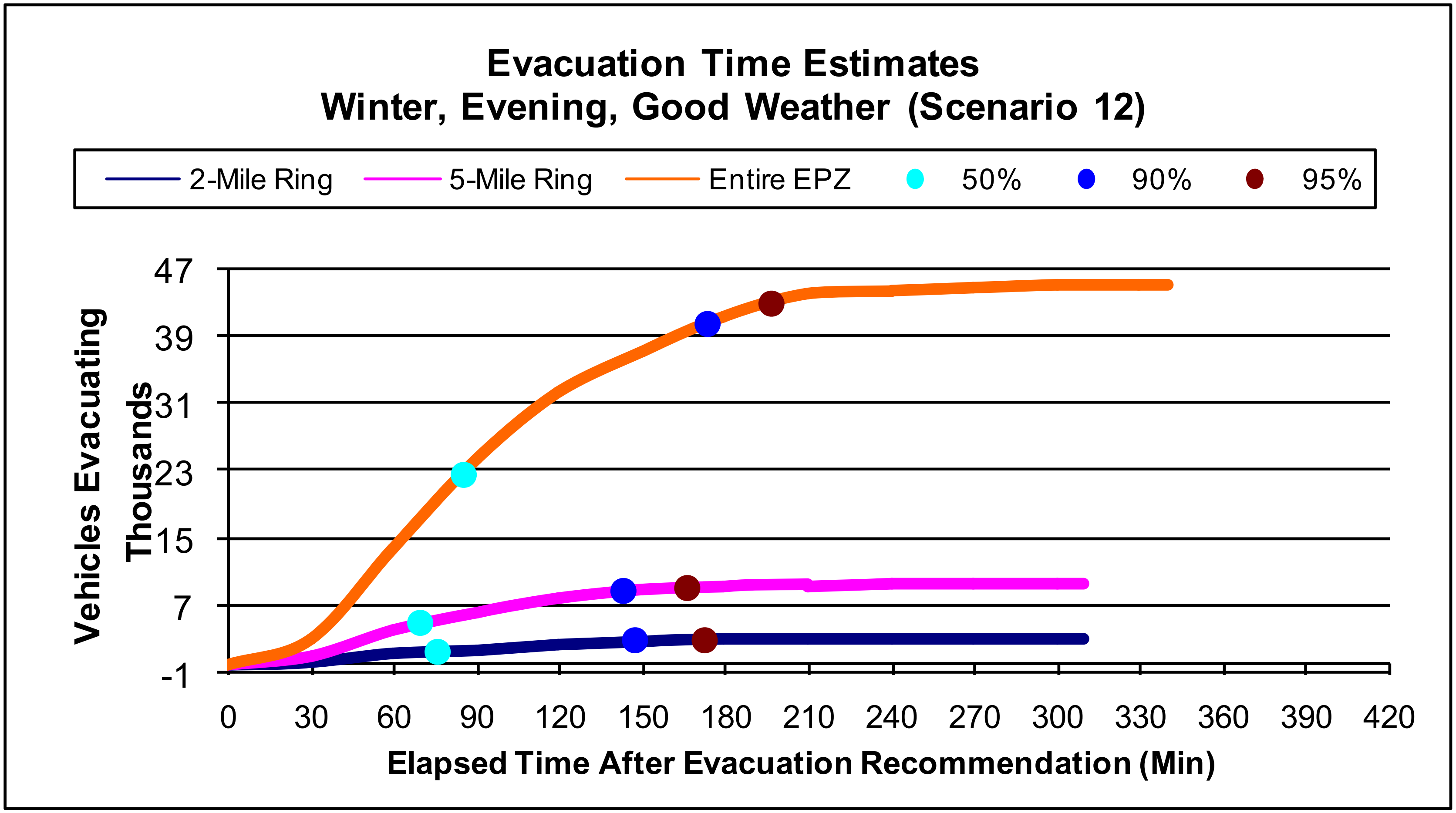

Figure J-12. Evacuation Time Estimates – Scenario 12 for Region R03 (Entire EPZ)

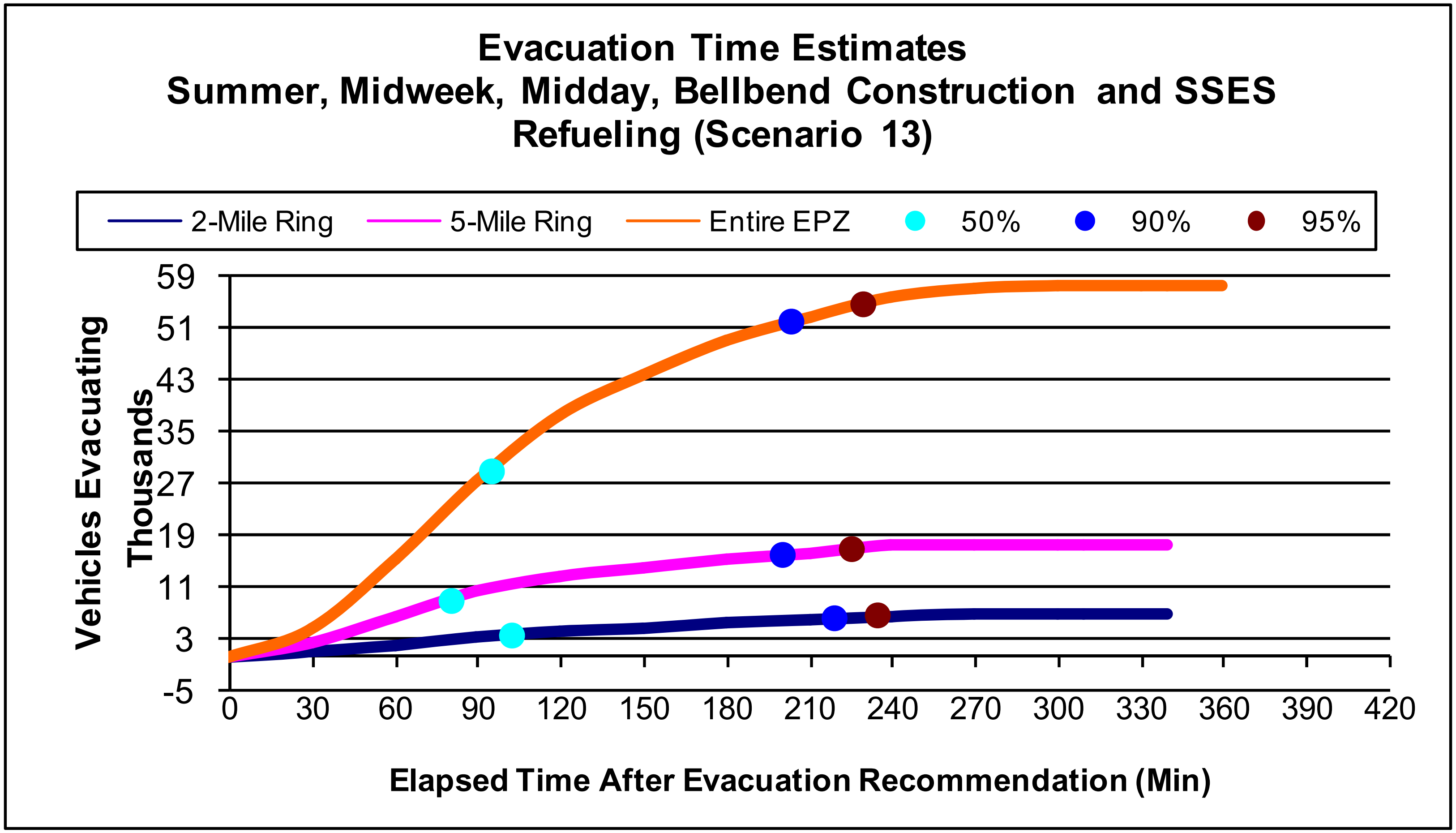

Figure J-13. Evacuation Time Estimates – Scenario 13 for Region R03 (Entire EPZ)

APPENDIX K

Evacuation Roadway Network Characteristics

APPENDIX K: EVACUATION ROADWAY NETWORK CHARACTERISTCS

Table K-1 lists the characteristics of each roadway section modeled in the ETE analysis. Each link is identified by its upstream and downstream node numbers. These node numbers can be cross-referenced to the electronic version of Figure 1-2 to identify the geographic location of each link. As mentioned in Section 1-3, the roadway characteristics were observed during the roadway survey; key roadway sections and intersections were video archived during the survey, including audio recordings of the comments made during the survey. A tablet personal computer equipped with GIS and GPS technologies was also used to note key observations during the survey. GIS shapefiles of the roadway characteristics and traffic control devices observed were created based on field observations and on the audio and video recordings.

The term, “Full Lane” identifies the number of lanes that extend throughout the length of the link. Many links have additional lanes on the immediate approach to an intersection; these have been recorded and entered into the IDYNEV System input stream.

Table K-1. Evacuation Roadway Network Characteristics

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
1	536	0.20	1	1,714	40
2	122	0.51	3	2,250	65
2	124	0.26	1	1,500	30
2	125	0.25	2	2,250	65
3	39	0.16	3	2,250	60
3	44	0.09	2	2,250	60
4	7	0.10	2	2,250	70
4	641	0.33	2	2,250	70
5	8	0.07	1	1,714	45
5	4	0.26	1	1,714	50
6	8	0.09	1	1,500	30
7	6	0.11	1	1,500	30
7	9	0.13	2	2,250	70
7	4	0.10	2	2,250	70
8	5	0.07	1	1,714	50
8	11	0.12	2	1,714	45
9	7	0.13	2	2,250	70
9	10	0.08	1	1,500	30
9	13	0.08	2	2,250	70
10	11	0.14	1	1,500	30
11	8	0.12	1	1,714	45
11	12	0.05	2	1,714	45
12	13	0.28	1	1,714	50
12	11	0.05	1	1,714	45
12	339	0.06	1	1,714	40
13	170	0.68	2	2,250	70
13	9	0.08	2	2,250	70
14	64	0.91	2	2,250	70
14	19	0.23	1	1,714	30
14	15	0.41	2	2,250	70
15	158	1.29	2	2,250	70
15	20	0.27	1	1,714	40
15	14	0.41	2	2,250	70
16	32	0.17	2	1,500	30
16	25	0.28	1	1,714	40
16	33	0.69	2	2,250	70
17	165	0.80	2	2,250	70

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
18	34	0.84	2	2,250	70
19	20	0.19	1	1,714	40
19	15	0.23	1	1,714	50
20	19	0.19	1	1,714	40
20	14	0.17	1	1,714	40
21	513	0.52	1	1,714	40
21	106	0.61	2	1,286	40
22	162	0.76	2	2,250	70
22	163	0.26	2	2,250	70
23	162	0.33	2	2,250	70
23	161	2.63	2	2,250	70
24	972	0.77	1	1,714	45
25	26	0.14	2	1,714	40
25	30	0.34	1	1,714	40
26	31	0.13	1	1,500	30
26	28	0.18	1	1,500	30
26	27	0.20	2	1,714	40
26	25	0.14	2	1,714	40
27	26	0.20	2	1,714	40
27	16	0.43	1	1,714	50
27	187	0.54	1	1,714	45
28	29	0.09	1	1,500	30
29	30	0.16	2	2,250	70
29	32	0.25	2	2,250	70
30	34	0.65	2	2,250	70
30	27	0.30	1	1,714	40
30	29	0.16	2	2,250	70
31	32	0.11	1	2,250	70
32	29	0.25	2	2,250	70
32	16	0.17	2	2,250	70
33	36	2.41	2	2,250	65
33	16	0.69	2	2,250	70
34	30	0.65	2	2,250	70
34	17	0.73	2	2,250	70
35	783	0.56	2	1,714	45
35	41	0.37	1	1,714	45
36	40	0.33	1	1,714	50
36	33	2.41	2	2,250	70

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
36	37	0.17	2	2,250	60
37	52	0.31	3	2,250	60
38	37	0.09	1	1,200	25
39	40	0.16	2	2,250	60
39	53	0.39	1	1,714	50
39	38	0.11	1	1,200	25
39	3	0.16	2	2,250	60
40	175	0.98	2	2,250	70
40	39	0.16	2	2,250	60
41	35	0.37	1	1,714	45
42	36	0.23	2	2,250	60
42	43	0.15	1	1,200	20
43	44	0.13	1	1,200	20
44	3	0.09	3	2,250	60
44	46	0.28	2	2,250	60
45	767	0.69	1	1,714	50
46	44	0.28	2	2,250	60
46	47	0.11	1	1,500	30
46	49	0.16	2	2,250	60
46	36	0.63	1	1,714	50
47	48	0.18	1	1,500	30
48	42	0.26	3	2,250	60
49	831	0.48	3	2,250	70
49	46	0.16	2	2,250	60
50	49	0.15	2	1,714	40
51	48	0.25	2	2,250	60
51	50	0.13	1	1,714	40
52	53	0.10	2	2,250	60
52	50	0.28	1	1,714	40
53	54	0.76	2	2,250	70
54	80	0.84	2	2,250	70
54	51	0.60	2	2,250	70
55	69	0.24	1	1,714	45
55	66	0.20	2	1,714	45
56	60	0.22	2	1,714	45
56	70	0.21	1	1,714	55
57	55	0.15	2	1,714	35
58	343	0.17	3	1,714	45

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
59	58	0.18	2	1,714	45
59	62	0.30	1	1,714	50
60	59	0.21	2	1,714	45
61	57	0.32	1	1,714	40
61	62	0.18	2	2,250	70
61	168	0.71	2	2,250	70
62	61	0.18	2	2,250	70
62	68	0.41	1	1,714	40
62	64	0.37	2	2,250	70
63	76	0.07	3	1,714	45
64	14	0.91	2	2,250	70
64	65	0.09	1	1,714	40
64	62	0.37	2	2,250	70
65	63	0.22	1	1,500	25
65	58	0.19	1	1,714	40
66	67	0.14	1	1,714	30
66	68	0.20	2	1,714	45
67	64	0.21	1	1,714	50
68	63	0.23	2	1,714	45
69	197	0.39	1	1,714	45
69	55	0.24	1	1,714	40
70	56	0.21	1	1,714	55
70	359	0.43	1	1,714	55
71	72	0.21	2	2,250	70
71	75	0.13	1	1,714	30
71	80	0.89	2	2,250	70
72	79	1.03	2	2,250	70
72	73	0.13	1	1,714	30
72	71	0.21	2	2,250	70
73	75	0.17	2	1,714	50
73	71	0.14	1	1,714	50
73	189	0.64	2	1,714	50
74	773	0.26	1	1,714	30
74	967	0.19	1	1,714	40
75	73	0.17	2	1,714	50
75	72	0.14	1	1,714	50
76	60	0.10	1	1,714	40
76	56	0.21	2	1,714	45

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
77	204	0.54	1	1,714	55
77	78	0.69	1	1,714	50
78	386	0.52	1	1,714	50
78	77	0.69	1	1,714	50
79	166	2.27	2	2,250	70
79	72	1.03	2	2,250	70
80	71	0.89	2	2,250	70
80	54	0.84	2	2,250	70
81	85	0.33	1	1,714	50
81	82	0.26	1	1,714	40
82	84	0.42	1	1,714	50
82	81	0.26	1	1,714	40
82	83	0.38	1	1,714	50
83	82	0.38	1	1,714	40
83	804	0.58	1	1,714	50
84	87	0.93	2	2,250	70
84	85	0.74	2	2,250	70
84	81	0.38	1	1,714	30
85	171	1.43	2	2,250	70
85	84	0.74	2	2,250	70
85	82	0.43	1	1,714	30
86	90	0.24	2	2,250	70
86	95	0.23	1	1,714	40
86	172	1.18	2	2,250	70
87	96	0.21	1	1,714	40
87	90	0.34	2	2,250	70
87	84	0.94	2	2,250	70
88	95	0.09	1	1,500	30
88	89	0.05	2	1,714	40
89	95	0.10	1	1,500	30
89	91	0.08	2	1,714	45
90	87	0.34	2	2,250	70
90	86	0.24	2	2,250	70
91	93	0.08	1	1,714	40
91	92	0.07	2	1,714	45
91	89	0.08	2	1,714	40
92	91	0.07	2	1,714	45
92	98	0.32	2	1,714	60

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
92	93	0.11	1	1,714	40
93	86	0.20	1	1,714	50
94	218	0.44	2	1,895	50
95	90	0.11	1	1,500	40
95	88	0.09	1	1,714	40
96	91	0.10	1	1,714	30
96	92	0.12	1	1,714	40
97	88	0.17	2	1,714	45
98	429	1.10	2	1,895	60
98	92	0.32	2	1,714	45
99	106	0.16	2	1,714	45
99	104	0.10	1	1,714	40
99	100	0.05	2	1,714	45
100	99	0.05	2	1,714	45
100	105	0.11	2	1,714	45
101	107	0.30	2	2,250	70
101	103	0.24	2	2,250	70
101	102	0.19	1	1,500	25
102	104	0.04	1	1,714	30
102	100	0.12	1	1,500	30
103	101	0.24	2	2,250	70
103	394	0.23	1	1,714	40
103	172	0.98	2	2,250	70
104	99	0.10	1	1,714	30
104	103	0.28	1	1,714	50
105	108	0.04	2	1,714	45
105	100	0.11	2	1,714	45
105	109	0.08	1	1,714	30
106	21	0.61	1	1,286	50
106	99	0.16	2	1,714	45
107	173	0.74	2	2,250	70
107	101	0.30	2	2,250	70
108	105	0.04	2	1,714	45
108	109	0.09	1	1,714	30
108	805	0.29	2	1,714	45
109	107	0.17	1	1,714	50
110	111	0.30	2	2,250	65
110	112	0.22	1	1,714	30

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
110	384	0.21	2	2,250	65
111	177	2.07	2	2,250	65
111	113	0.18	1	1,714	30
111	110	0.30	2	2,250	65
112	111	0.13	1	1,714	50
112	113	0.17	1	1,714	40
112	192	0.15	1	1,714	30
113	110	0.15	1	1,714	50
113	112	0.17	1	1,714	40
114	116	0.33	1	1,714	30
114	117	0.47	2	2,250	65
114	177	1.94	2	2,250	65
115	116	0.29	1	1,714	40
115	114	0.31	1	1,714	50
116	115	0.29	1	1,714	40
116	117	0.19	1	1,714	50
117	114	0.47	2	2,250	65
117	119	0.30	3	2,250	65
118	115	0.32	1	1,714	40
119	117	0.30	2	2,250	65
119	118	0.26	1	1,714	30
119	178	0.58	3	2,250	65
120	118	0.16	1	1,714	40
121	123	0.16	2	1,895	50
121	126	0.32	2	2,250	60
121	122	0.23	1	1,500	50
122	133	0.41	3	2,250	65
122	2	0.51	2	2,250	65
123	121	0.16	2	2,250	65
123	124	0.48	1	1,500	30
124	123	0.48	1	1,500	30
124	125	0.29	1	1,500	50
125	2	0.25	2	2,250	65
125	123	0.55	1	1,714	40
125	757	0.39	2	2,250	65
126	127	0.09	1	1,714	30
126	130	0.05	2	2,250	60
126	121	0.32	3	2,250	65

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
127	130	0.06	1	1,500	25
127	710	1.10	1	1,714	40
128	126	0.19	1	1,714	50
128	127	0.14	1	1,714	40
129	128	0.15	1	1,714	30
129	130	0.25	2	2,250	60
129	132	0.47	2	2,250	60
130	126	0.05	2	2,250	60
130	129	0.26	2	2,250	60
131	128	0.35	1	1,714	40
132	129	0.47	2	2,250	60
132	138	0.50	2	2,250	60
133	122	0.41	2	2,250	65
133	179	0.54	3	2,250	65
134	135	0.21	2	2,250	60
134	138	0.37	2	2,250	60
135	134	0.21	2	2,250	60
135	137	0.18	1	1,714	30
135	180	0.64	2	2,250	60
136	334	0.53	1	1,714	40
136	134	0.27	1	1,714	50
136	137	0.36	1	1,714	40
137	136	0.36	1	1,714	40
137	138	0.42	1	1,714	50
138	132	0.50	2	2,250	60
138	134	0.37	2	2,250	60
138	136	0.17	1	1,714	30
139	140	0.08	2	1,714	40
139	143	0.34	1	1,500	30
139	144	0.21	2	1,714	40
140	139	0.08	2	1,714	40
140	149	0.28	1	1,714	40
140	543	1.07	2	1,714	40
141	142	0.14	2	2,250	60
141	143	0.12	2	2,250	60
142	141	0.14	2	2,250	60
142	180	0.78	2	2,250	60
142	140	0.29	1	1,714	30

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
143	141	0.12	2	2,250	60
143	145	0.05	1	1,500	25
143	149	0.15	2	2,250	60
144	139	0.21	3	1,714	40
144	148	0.11	2	1,714	40
145	144	0.23	1	1,500	25
146	131	1.27	1	1,714	30
147	141	0.20	1	1,714	40
148	144	0.11	2	1,714	40
148	147	0.10	1	1,714	30
149	143	0.15	2	2,250	60
149	150	0.55	2	2,250	60
150	149	0.55	2	2,250	60
150	151	0.15	1	1,500	30
150	154	0.13	1	1,714	40
151	150	0.15	1	1,714	40
151	152	0.16	1	1,714	40
152	150	0.19	1	1,714	40
152	155	0.06	2	1,714	40
152	842	0.24	1	1,714	40
153	407	0.60	1	1,714	40
153	835	0.26	1	1,714	40
154	422	0.16	2	1,714	40
154	155	0.18	1	1,714	40
155	151	0.16	1	1,500	30
155	154	0.18	2	1,714	40
156	181	0.29	1	1,714	40
156	842	0.10	2	1,714	40
157	223	0.25	2	1,714	40
157	422	0.28	1	1,714	40
157	842	0.83	1	1,714	40
158	159	0.92	2	2,250	70
158	15	1.29	2	2,250	70
159	158	0.92	2	2,250	70
159	160	0.94	2	2,250	70
160	159	0.94	2	2,250	70
160	161	2.04	2	2,250	70
161	23	2.63	2	2,250	70

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
161	160	2.03	2	2,250	70
162	22	0.76	2	2,250	70
162	23	0.33	2	2,250	70
163	22	0.26	2	2,250	70
163	164	1.00	2	2,250	70
164	165	1.24	2	2,250	70
164	163	1.00	2	2,250	70
165	18	0.70	2	2,250	70
165	164	1.24	2	2,250	70
166	79	2.27	2	2,250	70
166	830	0.85	2	2,250	70
167	682	0.89	2	2,250	70
167	830	0.61	2	2,250	70
168	61	0.71	2	2,250	70
168	169	1.35	2	2,250	70
169	168	1.35	2	2,250	70
169	170	1.51	2	2,250	70
170	169	1.51	2	2,250	70
170	13	0.68	2	2,250	70
171	85	1.43	2	2,250	70
171	683	0.41	2	2,250	70
172	86	1.18	2	2,250	70
172	103	0.98	2	2,250	70
173	107	0.74	2	2,250	70
173	174	1.06	2	2,250	70
174	173	1.06	2	2,250	70
174	175	1.84	2	2,250	70
175	40	0.98	2	2,250	65
175	174	1.84	2	2,250	70
176	672	0.54	3	2,250	70
176	384	1.14	2	2,250	65
177	111	2.07	2	2,250	65
177	114	1.94	2	2,250	65
178	119	0.58	2	2,250	65
178	367	0.54	3	2,250	65
179	133	0.54	2	2,250	65
179	360	0.87	3	2,250	65
180	135	0.64	2	2,250	60

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
180	142	0.78	2	2,250	60
181	156	0.29	1	1,714	40
181	406	0.27	1	1,714	40
181	501	0.78	1	1,714	30
182	183	0.62	1	1,714	60
182	402	1.80	1	1,714	60
183	182	0.61	1	1,714	60
183	404	0.79	1	1,714	60
184	970	0.54	1	1,714	40
185	20	0.19	1	1,714	40
186	25	0.21	1	1,714	40
187	27	0.54	1	1,714	40
187	514	0.94	1	1,714	40
188	75	0.84	2	1,714	50
189	73	0.64	1	1,714	50
189	596	0.56	2	1,714	50
190	104	0.81	1	1,714	40
191	805	0.20	2	1,714	45
191	809	0.40	2	1,714	45
192	112	0.15	1	1,714	40
192	594	0.52	1	1,714	40
193	868	0.33	1	1,714	40
194	195	0.48	1	1,714	50
194	340	0.30	2	1,714	50
195	194	0.48	2	1,714	50
195	196	1.00	1	1,714	55
196	195	1.00	1	1,714	55
196	197	1.26	1	1,714	55
197	196	1.26	1	1,714	55
197	69	0.39	1	1,714	45
198	359	0.21	1	1,714	55
198	361	0.09	1	1,714	40
198	364	0.38	1	1,714	50
199	203	0.54	1	1,714	35
199	738	0.86	1	1,714	35
200	379	0.32	2	1,714	30
200	389	0.06	2	1,714	30
200	467	0.35	1	1,714	30

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
201	202	0.87	1	1,714	50
201	382	0.40	1	1,714	40
202	201	0.87	1	1,714	50
202	386	1.09	1	1,714	50
203	214	0.07	1	1,714	30
203	239	0.18	1	1,714	30
203	199	0.54	1	1,714	35
204	77	0.54	1	1,714	55
204	392	0.28	1	1,714	55
205	206	0.45	1	1,714	55
205	600	0.60	1	1,714	55
206	205	0.45	1	1,714	55
206	207	0.50	1	1,714	55
207	206	0.50	1	1,714	55
207	391	0.37	1	1,714	55
208	370	0.20	1	1,714	30
208	404	0.59	1	1,714	25
209	247	0.47	1	1,714	60
209	407	1.90	1	1,714	60
210	406	0.45	1	1,714	40
210	835	0.18	1	1,714	40
211	223	0.24	1	1,714	40
211	248	0.57	1	1,714	35
212	248	0.38	1	1,714	30
212	412	0.33	1	1,714	30
213	415	0.18	1	1,714	30
213	787	0.20	1	1,714	30
214	371	0.20	1	1,714	30
214	239	0.19	1	1,714	30
215	449	1.08	1	1,714	35
216	448	0.58	1	1,500	40
217	445	0.75	1	1,500	40
218	228	0.19	2	1,895	50
219	918	0.74	1	1,714	50
220	219	1.19	1	1,714	50
221	439	0.68	1	1,714	50
221	919	0.45	1	1,500	40
222	424	0.88	1	1,500	45

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
223	157	0.24	2	1,714	40
223	211	0.23	1	1,714	40
224	931	0.08	1	1,500	40
225	215	1.04	1	1,714	35
225	452	0.16	1	1,714	45
226	227	1.83	1	1,714	45
227	899	0.84	1	1,714	55
228	230	0.35	2	1,895	50
229	567	0.53	1	1,714	45
229	897	0.23	1	1,714	45
230	231	0.47	2	1,895	50
231	233	0.41	2	1,895	50
232	894	0.79	1	1,714	55
232	896	0.23	1	1,714	55
233	236	0.51	2	1,895	50
234	455	0.45	1	1,714	30
234	893	0.50	1	1,714	50
235	455	0.80	1	1,714	40
236	242	0.28	2	1,714	50
237	347	0.27	1	1,714	35
237	1052	1.43	1	1,714	55
238	885	0.57	1	1,714	40
239	203	0.18	1	1,714	35
239	214	0.19	1	1,714	30
239	369	0.13	1	1,714	30
240	467	0.41	1	1,714	30
240	468	0.32	1	1,714	30
241	689	0.45	1	1,714	55
242	244	0.19	1	1,714	50
242	252	0.49	2	1,714	50
243	890	0.29	1	1,714	55
244	758	0.13	3	2,250	65
245	243	0.92	1	1,714	55
245	966	0.07	1	1,714	40
246	245	0.81	1	1,714	55
247	209	0.47	1	1,714	60
247	1042	1.16	1	1,714	60
248	211	0.57	1	1,714	40

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
248	212	0.38	1	1,714	30
249	250	1.97	1	1,714	50
250	251	0.65	1	1,714	35
251	185	0.53	1	1,714	35
251	361	0.52	1	1,714	35
252	268	0.56	2	1,714	50
253	470	2.07	1	1,714	50
254	255	0.95	1	1,714	55
254	472	0.43	1	1,714	55
255	256	0.85	1	1,714	55
256	257	0.63	1	1,714	55
257	186	1.04	1	1,286	45
258	397	0.31	1	1,714	25
258	859	0.32	1	1,714	30
259	263	1.33	1	1,714	40
259	477	1.94	1	1,714	40
260	259	1.60	1	1,714	40
260	715	1.54	1	1,714	40
261	474	0.42	1	1,714	40
262	662	0.15	1	1,200	30
262	860	0.20	1	1,200	30
263	264	1.54	1	1,714	40
264	265	1.78	1	1,714	40
265	266	1.67	1	1,714	40
266	487	0.79	1	1,714	40
267	270	0.93	1	1,714	40
269	865	0.40	1	1,500	30
270	271	1.02	1	1,714	40
271	336	0.61	1	1,714	40
272	479	0.28	1	1,500	30
273	272	0.85	1	1,714	40
273	274	0.58	1	1,500	30
274	867	0.48	1	1,714	40
275	193	1.12	1	1,714	40
276	277	1.99	1	1,714	50
277	279	1.67	1	1,714	50
277	843	1.30	1	1,714	40
278	623	0.27	1	1,714	40

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
278	628	0.61	1	1,714	40
279	280	0.38	1	1,714	45
280	698	0.72	1	1,714	45
281	856	0.72	1	1,714	40
282	494	0.77	1	1,714	30
283	731	0.70	1	1,714	45
284	504	0.75	1	1,714	30
285	1053	0.06	1	1,714	30
285	500	0.30	1	1,714	30
286	285	1.20	1	1,714	40
287	1044	0.27	1	1,714	30
288	335	1.54	1	1,714	40
289	334	0.82	1	1,714	40
289	543	0.44	2	1,714	40
289	1022	0.22	2	1,714	40
290	184	0.74	1	1,714	45
291	290	0.51	1	1,714	45
292	458	0.30	1	1,714	30
293	974	0.61	1	1,714	40
294	979	0.29	1	1,500	40
295	296	0.27	1	1,500	30
295	980	0.77	1	1,500	40
296	981	0.27	1	1,200	20
297	635	1.02	1	1,500	40
298	299	0.34	1	1,500	40
299	982	0.14	1	1,500	30
300	984	0.56	1	1,500	40
301	454	0.13	1	1,500	30
302	622	1.10	1	1,714	45
303	304	0.71	1	1,714	55
303	553	0.52	1	1,714	35
304	305	0.98	1	1,714	55
305	555	0.28	1	1,714	55
306	434	0.07	3	1,500	30
306	440	0.37	2	1,500	30
307	425	0.22	1	1,714	40
307	656	0.09	2	1,500	30
307	685	0.33	2	1,500	30

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
308	661	0.29	1	1,500	30
309	308	0.68	1	1,500	30
310	804	0.08	2	1,714	50
310	537	0.87	2	1,895	50
310	746	0.08	1	1,714	50
311	401	0.40	1	1,714	50
311	403	0.39	1	1,714	60
312	408	0.36	1	1,714	50
312	436	0.55	1	1,714	40
313	446	0.35	1	1,714	30
313	447	0.15	1	1,714	40
313	522	0.53	1	1,500	30
314	442	0.38	1	1,714	30
314	523	0.53	1	1,500	30
315	549	0.23	1	1,714	60
315	799	0.20	2	1,714	40
316	545	0.20	1	1,714	40
316	491	0.92	2	1,714	60
317	318	0.69	2	1,714	45
318	188	0.54	1	1,714	50
319	1006	0.48	1	1,714	45
320	321	0.51	1	1,714	40
321	1007	0.19	1	1,714	30
322	1009	0.45	1	1,714	30
323	435	0.80	1	1,714	40
324	323	0.37	1	1,500	35
324	427	0.22	1	1,500	30
325	649	0.54	1	1,714	40
326	650	1.26	1	1,714	40
327	711	0.48	1	1,500	40
327	648	0.51	1	1,714	55
328	493	0.57	1	1,714	35
329	652	0.71	1	1,714	50
330	329	0.63	1	1,714	40
331	332	0.18	1	1,714	40
332	338	0.30	1	1,714	40
333	513	0.37	1	1,714	40
333	514	1.03	1	1,714	40

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
334	136	0.53	1	1,714	40
334	548	1.35	1	1,714	40
335	137	0.45	1	1,714	40
336	115	0.26	1	1,714	40
337	116	0.26	1	1,714	40
338	339	0.54	1	1,714	40
339	643	0.55	1	1,714	45
339	12	0.06	1	1,714	45
340	194	0.30	1	1,714	50
340	786	0.22	2	1,714	45
341	356	0.37	1	1,714	40
342	776	0.60	1	1,714	40
343	57	0.11	2	1,714	45
343	67	0.12	1	1,714	40
344	347	0.13	1	1,714	35
344	350	0.17	1	1,714	35
345	566	1.13	1	1,714	40
346	237	0.48	1	1,714	45
347	237	0.27	1	1,714	40
347	344	0.13	1	1,714	35
348	345	0.35	1	1,714	40
349	348	0.37	1	1,714	40
350	344	0.17	1	1,714	35
350	368	0.07	1	1,714	35
351	349	0.33	1	1,714	40
352	94	0.29	1	1,714	50
352	354	0.13	1	1,714	45
353	197	0.39	1	1,714	25
353	351	0.59	1	1,714	40
354	355	0.24	1	1,714	45
355	358	0.29	1	1,714	45
356	357	0.40	1	1,714	40
357	69	0.36	1	1,714	30
357	353	0.40	1	1,714	40
358	718	0.26	1	1,714	45
359	70	0.43	1	1,714	55
359	198	0.21	1	1,714	50
360	179	0.86	2	2,250	65

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
360	365	1.16	3	2,250	65
361	198	0.09	2	1,714	35
361	251	0.52	1	1,714	35
361	362	0.91	1	1,714	50
362	341	0.27	1	1,714	40
363	251	0.30	1	1,714	30
364	198	0.38	1	1,714	50
364	366	0.91	1	1,714	50
365	376	0.34	3	2,250	65
366	364	0.91	1	1,714	50
366	368	0.44	1	1,714	35
367	374	0.44	3	2,250	65
368	350	0.07	1	1,714	35
368	366	0.44	1	1,714	35
368	738	0.39	1	1,714	35
369	239	0.13	2	1,714	30
369	742	0.41	2	1,714	30
370	397	0.30	1	1,714	25
370	208	0.20	1	1,714	25
371	238	0.51	1	1,714	40
371	214	0.20	1	1,714	30
372	238	0.29	1	1,714	40
372	346	0.25	1	1,714	40
373	371	0.52	1	1,714	30
373	372	0.48	1	1,714	40
374	375	0.42	3	2,250	65
375	360	0.47	2	2,250	65
376	178	0.62	2	2,250	65
377	744	0.12	1	1,714	30
377	960	0.79	1	1,714	30
378	959	0.78	1	1,714	30
378	377	0.31	1	1,714	35
379	380	0.24	1	1,714	40
379	388	0.06	1	1,714	30
380	379	0.24	1	1,714	30
380	382	0.29	1	1,714	40
381	378	0.24	1	1,714	35
381	380	0.86	1	1,714	35

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
382	201	0.40	1	1,714	40
382	380	0.29	1	1,714	40
383	382	0.29	1	1,714	35
384	110	0.20	2	2,250	65
384	176	1.13	2	2,250	70
385	683	0.26	2	2,250	70
385	395	0.38	2	2,250	70
386	202	1.09	1	1,714	50
386	78	0.52	1	1,714	50
387	386	0.67	1	1,714	35
388	389	0.32	2	1,714	30
389	200	0.06	2	1,714	30
389	390	0.12	2	1,714	30
390	742	0.05	1	1,714	30
390	888	0.21	2	1,714	30
391	207	0.37	1	1,714	55
391	392	0.95	1	1,714	55
392	204	0.28	1	1,714	55
392	391	0.95	1	1,714	55
393	205	0.81	1	1,714	35
394	105	0.04	1	1,714	30
394	108	0.06	1	1,714	40
395	385	0.38	2	2,250	70
396	208	0.25	1	1,714	25
397	258	0.31	1	1,714	30
397	370	0.30	1	1,714	30
397	604	0.33	1	1,714	25
398	209	0.46	1	1,500	40
399	210	0.38	1	1,714	40
401	746	0.68	1	1,714	50
401	311	0.40	1	1,714	50
402	182	1.80	1	1,714	60
402	1042	0.35	1	1,714	60
403	311	0.39	1	1,714	50
403	408	0.65	1	1,714	60
404	183	0.79	1	1,714	60
404	208	0.59	1	1,714	25
405	841	0.27	1	1,500	40

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
406	181	0.27	1	1,714	40
406	210	0.45	1	1,714	40
407	153	0.60	1	1,714	40
407	209	1.90	1	1,714	60
408	403	0.65	1	1,714	60
408	312	0.36	1	1,714	40
409	674	0.74	2	1,714	40
410	212	0.24	1	1,714	30
411	212	0.20	1	1,714	30
412	212	0.33	1	1,714	30
412	415	0.27	1	1,714	30
413	412	0.43	1	1,714	30
414	412	0.12	1	1,714	30
415	213	0.18	1	1,714	30
415	412	0.27	1	1,714	30
416	415	0.19	1	1,714	30
417	787	0.13	1	1,714	30
417	418	0.46	1	1,714	30
417	709	0.20	1	1,714	40
418	417	0.46	1	1,714	30
419	213	0.08	1	1,714	30
420	931	0.42	1	1,714	40
421	224	0.10	1	1,500	40
422	154	0.16	1	1,714	40
422	157	0.28	2	1,714	40
423	421	0.17	1	1,500	40
424	588	0.31	1	1,500	45
425	307	0.22	1	1,714	30
425	427	0.42	1	1,500	30
425	527	0.25	1	1,714	30
426	425	0.09	1	1,714	40
426	656	0.23	1	1,500	30
427	425	0.42	1	1,714	40
427	528	0.27	1	1,500	30
427	324	0.22	1	1,500	30
428	222	0.42	1	1,714	45
428	430	0.60	1	1,714	45
429	98	1.10	2	1,714	60

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
429	518	0.28	2	1,714	40
430	431	0.41	1	1,714	50
431	221	0.91	1	1,714	40
432	433	0.13	1	1,500	30
433	434	0.10	1	1,500	30
434	823	0.20	2	1,500	30
434	655	0.06	2	1,714	40
434	306	0.07	2	1,500	30
435	312	0.30	1	1,714	40
437	307	0.08	1	1,714	30
437	657	0.08	1	1,500	30
438	437	0.34	1	1,714	30
438	685	0.08	1	1,500	30
439	220	1.31	1	1,714	50
440	306	0.37	2	1,500	30
440	656	0.10	2	1,500	30
441	440	0.07	1	1,500	30
442	529	0.20	1	1,714	30
443	442	0.63	1	1,714	30
443	308	0.21	1	1,500	30
444	916	0.27	1	1,500	40
445	444	0.24	1	1,500	40
446	313	0.35	1	1,714	30
446	314	0.07	1	1,714	30
447	313	0.15	1	1,714	30
447	532	0.32	1	1,714	40
448	915	0.87	1	1,500	40
449	451	0.60	1	1,714	55
450	935	1.54	1	1,714	55
451	658	0.78	1	1,714	55
452	644	0.32	1	1,714	45
453	229	0.36	1	1,714	40
454	465	0.10	1	1,500	30
455	234	0.45	1	1,714	30
455	456	0.40	1	1,500	30
456	891	0.35	1	1,714	45
457	637	0.35	1	1,500	30
458	24	0.91	1	1,714	45

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
459	292	0.44	1	1,500	45
460	532	0.43	1	1,714	40
460	801	0.48	1	1,714	40
461	293	0.85	1	1,500	40
462	629	0.61	1	1,500	40
463	490	0.59	1	1,714	40
463	800	0.66	1	1,714	40
464	988	0.31	1	1,714	55
465	471	0.20	1	1,500	40
466	299	0.58	1	1,500	40
467	200	0.35	1	1,714	30
467	240	0.41	1	1,714	30
468	747	0.34	1	1,714	40
469	240	0.29	1	1,714	30
470	469	0.72	1	1,714	30
471	462	0.49	1	1,500	40
472	253	1.00	1	1,714	55
473	254	1.58	1	1,714	40
474	254	0.81	1	1,714	40
475	474	1.32	1	1,714	40
476	861	0.68	1	1,714	40
477	858	2.50	1	1,714	45
477	859	0.12	1	1,714	30
478	668	0.18	1	1,500	30
479	866	0.35	1	1,500	30
480	463	0.16	1	1,714	40
481	266	0.71	1	1,714	40
481	267	1.13	1	1,714	40
482	271	0.25	1	1,714	40
483	481	0.96	1	1,714	40
484	336	0.45	1	1,714	40
484	120	0.49	1	1,714	40
485	852	0.26	1	1,714	30
486	485	0.23	1	1,714	30
487	485	1.41	1	1,714	45
488	838	0.15	1	1,500	40
489	837	0.17	1	1,500	30
490	807	0.30	2	1,714	40

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
491	316	0.92	1	1,714	60
491	549	0.24	1	1,714	60
492	496	0.29	1	1,714	40
493	946	0.51	1	1,714	40
494	283	0.77	1	1,714	30
495	492	0.57	1	1,714	40
496	497	0.32	1	1,714	40
497	322	0.43	1	1,714	30
498	669	0.11	1	1,714	40
499	284	1.65	1	1,714	30
500	284	0.56	1	1,714	30
501	508	0.59	1	1,500	30
501	181	0.78	1	1,714	40
502	506	0.50	1	1,500	30
502	287	0.74	1	1,500	30
503	501	0.51	1	1,200	30
503	502	0.07	1	1,500	30
504	501	0.24	1	1,714	30
505	503	0.45	1	1,500	30
506	508	0.34	1	1,500	30
506	288	0.73	1	1,500	30
507	146	0.10	1	1,714	30
508	148	0.49	1	1,714	40
509	507	0.52	1	1,714	40
510	509	0.72	1	1,714	40
511	333	0.52	1	1,714	40
512	333	0.40	1	1,714	40
513	21	0.52	1	1,714	40
513	333	0.37	1	1,714	40
514	333	1.03	1	1,714	40
514	187	0.94	1	1,714	45
515	514	1.15	1	1,714	40
516	514	0.46	1	1,714	40
517	822	0.10	2	1,500	30
517	819	0.09	2	1,500	35
517	518	0.19	1	1,714	30
518	655	0.29	2	1,714	40
518	429	0.28	2	1,714	40

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
519	819	0.32	2	1,500	35
519	816	0.44	2	1,714	45
520	521	0.47	2	1,714	45
520	814	0.17	2	1,714	45
521	809	0.30	2	1,714	45
521	520	0.47	2	1,714	45
522	523	0.45	1	1,500	30
522	1000	0.43	1	1,500	30
523	824	0.41	1	1,500	30
523	314	0.53	1	1,714	30
523	432	0.57	1	1,500	30
524	816	0.13	2	1,714	45
524	814	0.09	2	1,714	45
525	818	0.32	1	1,500	30
526	311	0.85	1	1,714	40
527	409	0.30	1	1,714	30
527	528	0.42	1	1,500	30
528	527	0.42	1	1,714	30
528	311	0.76	1	1,714	40
529	437	0.30	1	1,714	30
529	660	0.10	1	1,500	30
530	681	0.32	1	1,714	45
531	322	0.25	1	1,714	30
532	551	0.19	1	1,714	40
532	802	0.22	1	1,714	40
532	447	0.32	1	1,714	40
533	446	0.61	1	1,714	30
534	535	0.61	1	1,500	30
535	443	0.15	1	1,500	30
535	533	0.27	1	1,500	30
536	391	0.13	2	1,714	40
537	400	0.58	1	1,714	40
538	608	0.41	1	1,714	55
539	337	1.20	1	1,714	40
540	278	0.84	1	1,714	40
541	675	1.68	1	1,714	40
541	278	0.83	1	1,714	40
542	352	0.23	1	1,714	45

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
543	140	1.07	2	1,714	40
543	289	0.44	2	1,714	40
544	734	0.48	2	1,714	40
545	316	0.20	1	1,714	40
545	796	0.13	1	1,714	40
546	734	0.58	1	1,714	40
547	1023	0.29	1	1,714	30
547	289	0.13	1	1,714	30
548	1021	0.22	1	1,714	40
549	491	0.24	1	1,714	60
549	315	0.23	1	1,714	60
550	304	0.26	1	1,714	40
551	552	0.51	1	1,714	45
552	673	0.45	1	1,714	45
553	991	0.37	1	1,714	55
554	990	0.54	1	1,714	55
555	302	1.69	1	1,714	45
556	625	0.34	1	1,714	45
557	302	0.15	1	1,714	30
558	556	0.24	1	1,714	30
558	624	0.17	1	1,714	30
559	625	0.12	1	1,714	30
560	97	0.26	1	1,714	30
561	98	0.08	1	1,714	30
562	517	0.53	1	1,500	30
563	293	0.37	1	1,500	40
564	295	0.60	1	1,500	40
565	498	0.31	1	1,500	30
566	194	0.35	1	1,714	30
566	737	0.30	1	1,714	40
567	226	0.67	1	1,714	55
568	653	0.50	1	1,714	40
569	568	1.47	1	1,500	40
570	569	0.88	1	1,500	40
571	793	0.48	2	1,714	45
572	570	1.65	1	1,500	40
573	572	1.00	1	1,500	40
574	794	0.83	1	1,714	40

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
575	933	0.17	1	1,500	40
575	1046	0.70	1	1,500	40
576	575	0.98	1	1,500	40
577	574	1.23	1	1,714	40
578	576	1.43	1	1,500	40
579	578	0.77	1	1,500	40
579	580	0.72	1	1,500	40
580	423	0.49	1	1,500	40
581	453	1.11	1	1,500	40
582	581	0.63	1	1,500	40
583	950	0.53	1	1,500	40
584	953	0.36	1	1,500	40
585	951	0.85	1	1,500	40
586	585	0.54	1	1,500	40
587	586	1.28	1	1,500	40
588	930	0.43	1	1,500	45
589	420	0.74	1	1,714	40
590	577	1.33	1	1,714	40
591	538	0.45	2	1,714	55
591	594	0.19	1	1,714	40
591	596	0.17	2	1,714	50
592	883	0.28	1	1,714	40
593	592	1.11	1	1,714	40
593	595	1.13	1	1,714	40
594	591	0.19	1	1,714	40
594	192	0.52	1	1,714	30
595	597	1.14	1	1,714	40
596	591	0.17	2	1,714	50
596	189	0.56	1	1,714	50
597	217	1.14	1	1,714	50
598	654	0.88	1	1,714	40
599	598	0.93	1	1,714	40
599	601	1.52	1	1,714	40
600	205	0.60	1	1,714	55
600	602	0.48	1	1,714	55
601	603	1.48	1	1,714	40
602	604	1.13	1	1,714	55
602	600	0.48	1	1,714	55

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
603	605	0.98	1	1,714	40
604	397	0.30	1	1,714	25
604	602	1.13	1	1,714	55
605	606	0.81	1	1,714	40
606	607	0.80	1	1,714	40
606	941	0.33	1	1,714	45
608	276	1.30	1	1,714	55
609	610	0.61	1	1,714	40
609	439	1.61	1	1,714	50
610	612	0.79	1	1,500	30
611	277	0.38	1	1,714	40
612	613	1.32	1	1,714	40
613	614	0.59	1	1,714	40
614	615	0.87	1	1,714	40
615	616	0.53	1	1,714	40
616	617	0.89	1	1,714	40
617	618	0.91	1	1,714	40
618	619	0.72	1	1,714	40
619	620	0.66	1	1,714	55
619	945	1.21	1	1,714	55
620	621	3.58	1	1,714	55
621	653	1.03	1	1,714	45
622	556	0.21	1	1,714	45
623	611	0.48	1	1,714	40
624	557	1.09	1	1,714	30
624	622	0.23	1	1,714	40
625	626	0.50	1	1,714	45
626	97	0.17	2	1,714	45
627	398	0.70	1	1,500	40
628	539	0.45	1	1,714	40
629	630	0.82	1	1,500	40
630	986	0.31	1	1,500	40
631	632	0.22	1	1,714	45
632	633	0.28	1	1,714	45
634	985	0.29	1	1,500	40
635	298	0.69	1	1,500	40
636	977	0.64	1	1,500	40
637	638	0.71	1	1,714	55

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
638	892	0.79	1	1,714	55
639	640	0.58	1	1,714	50
640	5	0.32	1	1,714	50
641	4	0.33	2	2,250	70
641	642	1.56	2	2,250	70
642	641	1.56	2	2,250	70
642	764	0.74	2	2,250	70
643	967	0.69	1	1,714	40
643	339	0.55	1	1,714	40
644	908	0.28	1	1,714	45
646	898	0.50	1	1,714	55
646	895	0.31	1	1,714	55
647	241	1.28	1	1,714	55
648	326	0.99	1	1,714	55
649	330	0.41	1	1,714	40
650	325	0.55	1	1,714	40
651	328	0.41	1	1,714	50
652	651	0.24	1	1,714	50
653	493	0.26	1	1,714	40
654	217	0.46	1	1,714	50
655	518	0.29	2	1,714	40
655	306	0.11	1	1,500	30
655	434	0.06	2	1,500	30
656	307	0.09	2	1,200	30
656	440	0.10	2	1,500	30
657	656	0.07	1	1,500	30
657	441	0.11	1	1,500	30
658	692	2.00	1	1,714	55
659	125	0.45	2	2,250	65
660	657	0.25	1	1,500	30
660	432	0.42	1	1,500	30
661	529	0.35	1	1,714	30
661	684	0.09	1	1,500	30
662	864	0.49	1	1,714	20
663	664	0.20	1	1,500	40
663	550	0.22	1	1,500	30
664	303	0.43	1	1,714	35
665	663	0.62	1	1,500	30

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
666	665	0.86	1	1,500	30
667	994	0.31	1	1,500	40
668	996	0.37	1	1,500	40
669	478	0.21	1	1,500	40
670	997	0.29	1	1,500	40
671	995	1.31	1	1,500	40
672	176	0.54	3	2,250	70
672	831	0.68	2	2,250	70
673	1004	0.19	1	1,714	45
674	310	0.40	2	1,714	40
675	698	0.87	1	1,714	40
676	593	1.26	1	1,714	40
676	693	0.65	1	1,714	40
676	957	0.31	1	1,714	30
677	587	0.41	1	1,500	40
677	678	0.62	1	1,500	40
678	696	0.48	1	1,500	40
679	680	0.63	1	1,714	40
680	221	0.39	1	1,714	40
681	1010	0.46	1	1,714	45
682	167	0.89	2	2,250	70
683	171	0.41	2	2,250	70
683	385	0.26	2	2,250	70
684	438	0.39	1	1,500	30
685	324	0.10	2	1,500	30
686	687	0.79	1	1,714	40
687	688	0.70	1	1,714	40
688	639	0.29	1	1,714	40
689	235	0.90	1	1,714	45
690	686	1.49	1	1,714	40
691	670	0.82	1	1,500	40
692	450	0.24	1	1,714	55
693	694	0.41	1	1,714	40
694	883	0.56	1	1,714	40
695	679	0.40	1	1,714	40
696	695	0.58	1	1,500	40
697	220	1.22	1	1,714	50
698	849	0.44	1	1,714	45

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
699	975	0.20	1	1,714	40
700	699	2.06	1	1,714	40
701	700	2.27	1	1,714	40
702	701	1.27	1	1,714	40
703	702	1.64	1	1,714	40
704	703	0.89	1	1,714	40
705	704	1.30	1	1,714	40
705	706	2.57	1	1,714	40
706	707	0.72	1	1,714	40
707	511	0.54	1	1,714	40
708	705	0.30	1	1,714	40
709	417	0.20	1	1,714	30
711	836	0.15	1	1,500	25
712	719	0.90	1	1,714	40
713	712	0.51	1	1,714	40
714	475	0.32	1	1,714	40
715	262	0.36	1	1,714	40
716	713	0.70	1	1,714	40
716	717	1.23	1	1,714	40
717	714	0.15	1	1,714	40
718	727	0.44	1	1,714	45
719	720	1.31	1	1,714	40
720	721	0.69	1	1,714	40
721	273	0.68	1	1,714	40
722	240	0.14	1	1,714	30
723	387	0.56	1	1,714	35
724	723	0.56	1	1,714	35
725	724	0.61	1	1,714	35
726	393	1.33	1	1,714	35
726	725	0.87	1	1,714	35
727	733	0.32	1	1,714	45
728	383	0.52	1	1,714	30
729	377	0.31	1	1,714	35
730	381	0.26	1	1,714	30
730	728	0.29	1	1,714	30
731	499	0.60	1	1,714	40
731	286	0.65	1	1,714	45
732	208	0.15	1	1,714	25

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
733	741	0.27	1	1,714	45
734	1020	0.32	2	1,714	40
735	548	0.25	1	1,714	40
735	734	0.26	1	1,714	40
736	786	0.77	1	1,714	45
736	833	0.76	2	1,714	45
737	340	0.37	1	1,714	30
737	785	0.21	1	1,714	40
738	199	0.86	1	1,714	35
738	368	0.39	1	1,714	35
739	738	0.09	2	1,714	25
740	199	0.34	1	1,714	35
741	851	0.28	1	1,714	45
742	200	0.12	2	1,714	30
743	749	0.75	1	1,714	50
744	887	0.48	1	1,714	30
745	469	0.13	1	1,714	30
745	722	0.29	1	1,714	30
746	310	0.08	2	1,714	50
746	401	0.68	1	1,714	50
747	748	0.54	1	1,714	50
748	249	1.29	1	1,714	50
749	760	0.30	1	1,714	50
750	764	0.73	2	1,714	40
750	756	0.75	2	2,250	70
751	753	0.15	1	1,500	30
752	751	0.17	2	1,714	45
753	750	0.14	1	1,500	50
754	659	0.90	2	2,250	65
754	755	0.50	2	2,250	65
755	754	0.50	2	2,250	65
756	765	0.43	2	2,250	70
756	750	0.75	2	2,250	70
757	244	0.22	2	2,250	65
758	754	0.64	2	2,250	65
759	752	0.28	2	1,714	50
760	761	0.40	1	1,714	50
761	762	1.12	1	1,714	50

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
763	784	0.22	1	1,714	40
764	642	0.74	2	2,250	70
764	750	0.73	2	2,250	70
765	756	0.43	2	2,250	70
766	781	0.13	1	1,714	40
767	768	0.22	1	1,714	50
768	759	0.33	1	1,714	50
769	770	1.09	2	1,200	25
769	782	0.20	1	1,714	35
770	769	1.09	2	1,200	25
770	771	0.35	1	1,200	25
770	773	0.31	1	1,714	30
771	770	0.35	1	1,500	25
771	772	0.08	2	1,500	25
771	774	0.20	2	1,714	35
772	771	0.08	2	1,500	25
772	777	0.61	1	1,714	40
773	74	0.26	1	1,714	30
773	770	0.31	1	1,714	40
774	771	0.20	2	1,714	35
774	833	0.16	1	1,714	35
775	832	0.30	1	1,714	40
776	775	0.33	1	1,714	40
777	778	0.33	1	1,714	40
778	779	0.40	1	1,714	40
779	780	0.35	1	1,714	40
781	45	0.16	2	1,714	45
782	781	0.13	1	1,714	40
782	783	0.19	2	1,714	40
782	769	0.20	1	1,714	35
783	35	0.56	2	1,714	45
783	766	0.11	1	1,500	30
783	782	0.19	2	1,714	40
784	844	0.65	1	1,714	40
785	342	0.46	1	1,714	40
785	786	0.41	1	1,714	30
786	340	0.22	1	1,714	50
786	736	0.77	2	1,714	45

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
786	331	0.30	1	1,714	40
787	213	0.20	1	1,714	30
787	417	0.13	1	1,714	30
788	787	0.17	1	1,714	30
789	790	0.69	1	1,714	40
790	632	0.81	1	1,714	40
791	188	0.21	1	1,714	40
792	188	1.00	1	1,714	40
793	317	0.37	2	1,714	45
794	793	0.28	1	1,714	40
795	793	0.38	1	1,714	40
796	545	0.13	2	1,714	40
796	571	0.25	1	1,714	40
797	796	0.14	1	1,714	30
798	796	0.12	1	1,714	30
799	315	0.20	2	1,714	40
799	802	0.87	2	1,714	40
800	1003	0.42	1	1,714	40
801	799	0.11	2	1,714	40
802	313	0.41	2	1,714	30
803	802	0.13	1	1,714	30
804	83	0.58	1	1,714	50
804	310	0.08	2	1,714	50
805	191	0.20	2	1,714	45
805	108	0.29	2	1,714	45
806	805	0.06	2	1,714	30
807	191	0.19	2	1,714	40
808	191	0.51	1	1,714	40
809	191	0.40	2	1,714	45
809	521	0.30	2	1,714	45
810	809	0.07	1	1,500	30
811	287	0.37	1	1,714	30
812	521	0.17	1	1,714	30
813	520	0.25	1	1,714	40
814	520	0.17	2	1,714	45
814	524	0.09	2	1,714	45
815	814	0.10	1	1,500	25
816	519	0.44	2	1,714	45

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
816	524	0.13	2	1,714	45
817	816	0.08	1	1,500	30
818	524	0.12	1	1,500	35
818	816	0.09	1	1,500	30
819	517	0.09	2	1,500	35
819	519	0.32	2	1,500	35
820	819	0.52	1	1,500	30
821	819	0.15	1	1,500	30
821	822	0.14	1	1,500	30
822	517	0.10	2	1,500	30
822	823	0.09	2	1,500	30
823	822	0.09	2	1,500	30
823	434	0.20	2	1,500	30
824	825	0.19	1	1,500	30
824	519	0.17	1	1,500	30
825	821	0.17	1	1,500	30
825	826	0.11	1	1,500	30
826	433	0.34	1	1,500	30
826	823	0.25	1	1,500	30
827	518	0.23	1	1,714	40
828	730	0.35	1	1,714	30
829	889	0.06	1	1,714	30
829	963	0.70	1	1,714	30
830	167	0.61	2	2,250	70
830	166	0.85	2	2,250	70
831	49	0.48	2	2,250	70
831	672	0.68	3	2,250	70
832	772	0.31	1	1,714	35
832	833	0.12	1	1,714	30
833	736	0.76	1	1,714	45
833	774	0.16	1	1,714	35
834	203	0.23	1	1,714	35
835	153	0.26	1	1,714	40
835	210	0.18	1	1,714	40
836	489	0.38	1	1,500	25
837	488	0.63	1	1,500	25
838	839	0.51	1	1,500	40
839	840	0.12	1	1,500	40

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
840	405	0.19	1	1,500	40
841	399	0.15	1	1,500	40
842	152	0.24	2	1,714	30
842	156	0.10	2	1,714	40
843	763	0.25	1	1,714	40
844	760	0.09	1	1,714	40
845	279	0.67	1	1,714	40
845	846	0.51	1	1,714	40
846	847	0.28	1	1,714	40
847	848	0.19	1	1,714	40
848	749	0.13	1	1,714	40
849	542	0.70	1	1,714	45
850	849	0.56	1	1,714	40
850	851	0.52	1	1,714	40
851	743	0.39	1	1,714	45
852	853	0.22	1	1,714	30
853	484	0.15	1	1,714	30
854	494	0.18	1	1,714	30
855	494	0.13	1	1,714	30
856	282	0.30	1	1,714	30
857	281	0.39	1	1,714	40
858	857	0.47	1	1,714	40
859	258	0.25	1	1,714	30
859	477	0.05	1	1,714	30
860	476	0.46	1	1,714	40
861	863	0.86	1	1,714	40
862	470	0.43	1	1,714	40
863	862	1.13	1	1,714	40
864	261	1.13	1	1,714	40
865	267	0.45	1	1,714	40
866	269	0.34	1	1,500	30
867	275	0.69	1	1,714	30
868	113	0.10	1	1,714	40
869	870	0.85	1	1,714	40
869	876	1.17	1	1,714	40
870	871	0.21	1	1,714	35
871	872	0.50	1	1,714	30
872	873	0.17	1	1,500	25

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
873	874	0.19	1	1,500	25
874	875	0.31	1	1,714	35
875	729	0.14	1	1,714	35
876	877	0.25	1	1,714	40
877	878	0.71	1	1,500	40
878	879	0.27	1	1,500	40
879	880	0.78	1	1,500	35
880	881	0.10	1	1,200	20
881	882	1.21	1	1,500	30
882	954	0.21	1	1,500	30
883	583	0.13	1	1,500	40
884	1049	1.70	1	1,714	40
884	889	0.67	1	1,714	30
885	237	0.17	1	1,714	40
886	962	0.30	1	1,714	30
887	886	0.20	1	1,714	30
887	961	0.31	1	1,714	30
888	369	0.20	2	1,714	30
889	373	0.14	1	1,714	30
889	829	0.06	1	1,714	30
890	647	0.39	1	1,714	55
891	457	0.24	1	1,714	45
892	639	0.65	1	1,714	50
893	234	0.50	1	1,714	30
893	894	0.14	1	1,714	55
894	232	0.79	1	1,714	55
894	893	0.14	1	1,714	50
894	913	0.31	1	1,714	40
895	646	0.31	1	1,714	55
895	896	0.46	1	1,714	55
896	232	0.23	1	1,714	55
896	895	0.46	1	1,714	55
897	229	0.23	1	1,714	45
897	898	0.41	1	1,714	55
898	646	0.36	1	1,714	55
898	897	0.41	1	1,714	45
899	900	0.79	1	1,714	45
900	225	0.58	1	1,714	40

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
901	645	0.45	1	1,714	45
902	901	1.84	1	1,714	40
903	902	0.32	1	1,714	45
904	903	0.59	1	1,714	45
905	904	0.44	1	1,714	45
906	905	0.43	1	1,714	45
907	906	0.26	1	1,714	45
908	907	0.17	1	1,714	45
909	901	1.10	1	1,714	40
910	909	0.45	1	1,714	45
911	910	0.85	1	1,714	45
912	911	0.40	1	1,714	45
913	912	0.22	1	1,714	40
914	901	0.69	1	1,714	40
915	215	0.17	1	1,714	40
916	216	1.26	1	1,500	40
917	918	1.51	1	1,714	50
918	217	0.48	1	1,714	50
919	920	1.73	1	1,500	40
920	921	1.48	1	1,500	40
921	922	0.22	1	1,500	40
922	923	0.58	1	1,500	40
923	929	0.25	1	1,500	40
924	932	0.47	1	1,500	40
925	926	0.73	1	1,500	40
926	927	0.60	1	1,500	40
927	627	0.57	1	1,500	40
928	396	0.22	1	1,714	30
929	924	0.35	1	1,500	40
930	224	0.34	1	1,500	40
931	928	0.82	1	1,500	40
932	575	0.13	1	1,500	40
933	934	0.41	1	1,500	40
934	925	1.91	1	1,500	40
935	936	0.32	1	1,714	55
936	937	0.52	1	1,714	55
937	938	0.30	1	1,714	45
938	939	0.30	1	1,714	40

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
939	940	1.05	1	1,714	45
941	939	0.52	1	1,714	45
942	606	0.20	1	1,714	45
943	942	1.22	1	1,714	45
944	943	2.40	1	1,714	45
945	944	0.60	1	1,714	55
946	947	1.02	1	1,714	50
948	582	0.60	1	1,500	40
949	948	0.32	1	1,500	40
950	949	0.24	1	1,500	40
951	952	0.28	1	1,500	40
952	584	0.43	1	1,500	40
953	583	0.12	1	1,500	40
954	955	0.19	1	1,500	30
955	956	0.17	1	1,500	30
956	583	0.14	1	1,500	40
957	958	0.21	1	1,714	30
958	917	0.98	1	1,714	30
959	388	0.04	1	1,714	30
959	960	0.31	1	1,714	30
960	389	0.05	1	1,714	30
960	961	0.12	1	1,714	30
961	390	0.05	1	1,714	30
961	962	0.21	1	1,714	30
962	963	0.20	1	1,714	30
962	888	0.05	1	1,714	30
963	369	0.07	1	1,714	30
964	690	0.94	1	1,714	40
965	964	0.27	1	1,714	40
966	965	0.87	1	1,714	40
967	74	0.19	1	1,714	40
967	643	0.69	1	1,714	45
968	967	0.11	1	1,714	40
969	967	0.12	1	1,714	40
970	19	0.21	1	1,714	40
971	291	0.72	1	1,714	45
972	971	0.45	1	1,714	45
973	459	0.13	1	1,200	20

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
974	973	0.31	1	1,500	20
975	976	0.65	1	1,714	40
976	563	1.09	1	1,714	40
977	461	0.38	1	1,500	30
978	636	0.37	1	1,500	25
979	978	0.74	1	1,500	40
980	294	0.30	1	1,500	40
981	297	1.01	1	1,500	40
982	983	0.31	1	1,500	40
983	300	0.27	1	1,500	40
984	634	0.46	1	1,500	40
985	301	0.27	1	1,500	40
986	789	0.38	1	1,500	30
987	631	0.30	1	1,714	55
988	987	0.64	1	1,714	55
989	464	0.31	1	1,714	55
990	989	0.40	1	1,714	55
991	992	0.21	1	1,714	55
992	554	0.36	1	1,714	55
993	666	0.27	1	1,500	40
994	993	0.42	1	1,500	40
995	669	0.22	1	1,500	40
996	667	0.18	1	1,500	40
997	998	0.72	1	1,500	40
998	999	0.21	1	1,500	40
999	996	0.33	1	1,500	40
1000	525	0.16	1	1,500	20
1001	516	0.51	1	1,714	40
1002	1001	1.12	1	1,714	40
1003	799	0.17	2	1,714	40
1004	1005	0.37	1	1,714	45
1005	319	1.59	1	1,714	45
1006	320	0.39	1	1,714	30
1007	1011	0.58	1	1,714	40
1008	322	0.33	1	1,714	30
1009	530	0.45	1	1,714	45
1011	1008	0.06	1	1,714	30
1022	544	0.83	2	1,714	40

Upstream Node Number	Downstream Node Number	Length (Miles)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
1023	1022	0.09	1	1,714	30
1024	1022	0.13	1	1,714	30
1025	515	0.56	1	1,714	40
1025	590	0.71	1	1,714	40
1026	792	0.48	1	1,714	40
1027	1026	1.18	1	1,714	40
1028	1027	0.34	1	1,714	40
1029	1028	0.50	1	1,714	40
1030	1029	0.99	1	1,714	40
1031	1030	0.47	1	1,714	40
1032	512	0.52	1	1,714	30
1033	1032	0.74	1	1,714	30
1033	1034	1.19	1	1,714	40
1034	1035	0.88	1	1,714	40
1035	1037	0.12	1	1,714	40
1036	316	0.70	1	1,714	40
1037	1036	1.04	1	1,714	40
1038	370	0.25	1	1,714	30
1039	1038	1.82	1	1,714	40
1040	77	0.91	1	1,714	40
1041	1040	0.47	2	1,714	40
1042	247	1.16	1	1,714	60
1042	402	0.35	1	1,714	60
1043	1042	0.30	1	1,500	30
1044	288	0.24	1	1,714	30
1044	1045	0.42	1	1,714	30
1045	510	0.61	1	1,714	30
1046	1047	0.16	1	1,500	40
1047	1048	0.46	1	1,500	40
1048	573	0.23	1	1,500	40
1049	1050	0.22	1	1,714	40
1050	1051	0.40	1	1,714	40
1051	1052	0.38	1	1,714	40
1052	246	0.66	1	1,714	55
1053	1054	0.07	1	1,714	30
1054	811	0.66	1	1,714	30

APPENDIX L

Zone Boundaries

APPENDIX L - ZONE BOUNDARIES

Table L-1 defines the boundary of the EPZ for the 27 municipalities or emergency planning response areas (ERPA).

Table L-1. Description of Emergency Response Planning Areas (ERPA)

ERPA	Municipality	Bounded on the:	By:
1	Black Creek Township	North	This township is entirely within the EPZ
		South	
		West	
		East	
2	Hunlock Township	North	Pritchards Road (SR 4026)
		South	Hunlock Township Corporate Boundary
		West	Hunlock Township Corporate Boundary
		East	Hunlock Township Corporate Boundary
3	Union Township	North	This township is entirely within the EPZ
		South	
		West	
		East	
4	Huntington Township	North	This township is entirely within the EPZ
		South	
		West	
		East	
5	New Columbus	North	This borough is entirely within the EPZ
		South	
		West	
		East	
6	Fishing Creek Township	North	Strawberry Lane, Zaners Bridge Road (LR 19067)
		South	Fishing Creek Township Corporate Boundary
		West	Fishing Creek Township Corporate Boundary and State Highway 487
		East	Columbia/Luzerne County Boundaries
7	Salem Township	North	This township is entirely within the EPZ
		South	
		West	
		East	

8	Shickshinny Borough	North South West East	This borough is entirely within the EPZ
9	Conyngham Township	North South West East	This township is entirely within the EPZ
10	Berwick Borough	North South West East	This borough is entirely within the EPZ
11	Briar Creek Borough	North South West East	This borough is entirely within the EPZ
12	Nescopeck Borough	North South West East	This borough is entirely within the EPZ
13	Nescopeck Township	North South West East	This township is entirely within the EPZ
14	Hollenback Township	North South West East	This township is entirely within the EPZ
15	Sugarloaf Township	North South West East	This township is entirely within the EPZ
16	Conyngham Township	North South West East	This township is entirely within the EPZ

17	Dorrance Township	North	This township is entirely within the EPZ
		South	
		West	
		East	
18	Slocum Township	North	This township is entirely within the EPZ
		South	
		West	
		East	
19	Nuangola Borough	North	This borough is entirely within the EPZ
		South	
		West	
		East	
20	Newport Township	North	This township is entirely within the EPZ
		South	
		West	
		East	
21	Nanticoke City	North	This city is entirely within the EPZ
		South	
		West	
		East	
22	Butler Township	North	Butler Township Corporate Boundary
		South	Butler Township Corporate Boundary, State Highway 309, I-80
		West	Butler City Limit
		East	Butler Township Corporate Boundary
23	Beaver Township	North	Beaver Township Corporate Boundary
		South	Beaver Township Corporate Boundary
		West	Mifflin X Rd,Chape Hill Road, Beaver Valley Road, State Highway 339
		East	Beaver Township Corporate Boundary
24	Mifflin Township	North	This township is entirely within the EPZ
		South	
		West	
		East	
25	South Centre Township	North	South Center Township Corporate Boundary
		South	South Center Township Corporate Boundary
		West	Lows Street
		East	South Center Township Corporate Boundary

26	North Centre Township	North	North Centre City Limit
		South	North Centre City Limit
		West	McDowell Hill Road, Ridge Road, Harris Road, Fowlersville Road, Cabin Run Road, SR 93
		East	North Centre City Limit
27	Briar Creek Township	North	This township is entirely within the EPZ
		South	
		West	
		East	