KLD ASSOCIATES, INC.

43 Corporate Drive
Hauppauge, NY 11788
Phone: 631.617.5650
Fax: 631.617.5649

www.kldcompanies.com

January 21, 2010

Rick Woods
Calvert Cliffs Nuclear Power Plant
1650 Calvert Cliffs Parkway
Lusby, MD 20657

Ref: CCNPP ETE Study Final Report

Dear Rick:

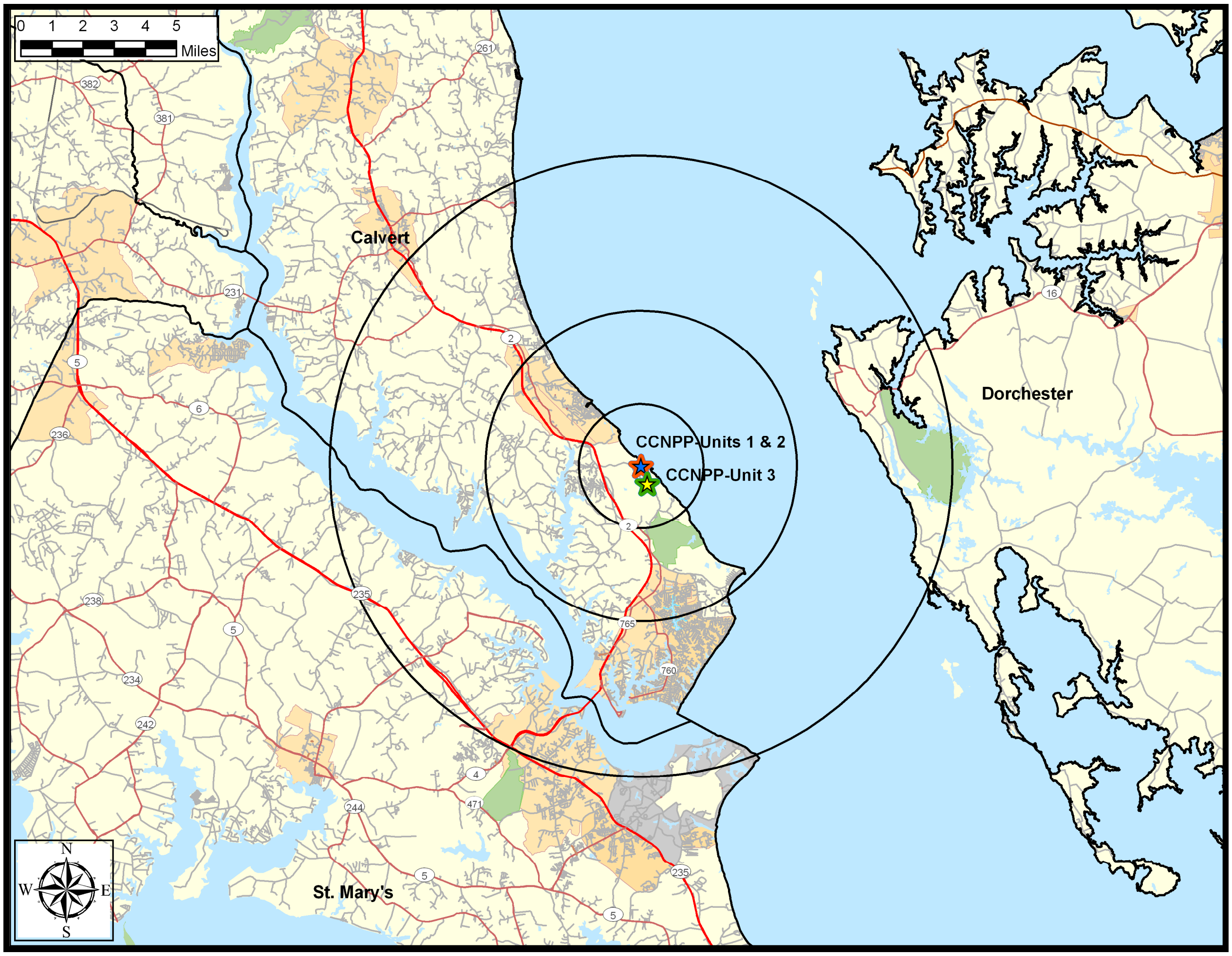
Enclosed is a PDF file containing the Final version of the CCNPP ETE Study Report (Revision 2). Kindly review and let us know if you have any questions or comments.

Sincerely yours,

Satya Muthuswamy, P.E.
Senior Traffic Engineer

Calvert Cliffs Nuclear Power Plant

Development of Evacuation Time Estimates



Prepared for:

Constellation Energy

by:

KLD Associates, Inc.
43 Corporate Drive
Hauppauge, NY 11788
satya@kldcompanies.com

January, 2010 **Final Report (Revision 2)** **KLD TR – 421**

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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 Calvert Cliffs Nuclear Power Plant (CCNPP) located in Lusby, Maryland. Evacuation time estimates are part of the required planning basis and provide CCNPP and State and local governments with site-specific information needed for Protective Action decision-making.

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

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

Overview of Project Activities

This project began in July, 2007 and extended over a period of 9 months. The major activities performed are briefly described in chronological sequence:

- Attended “kick-off” meetings with Constellation Energy personnel and emergency management personnel representing state and local governments.
- Reviewed prior ETE reports prepared for CCNPP and accessed U.S. Census Bureau data files for the year 2000. Studied Geographical Information Systems (GIS) maps of the area in the vicinity of CCNPP, then conducted a detailed field survey of the highway network.
- Synthesized this information to create an analysis network representing the highway system topology and capacities within the Emergency Planning Zone (EPZ), plus a “Shadow” area extending 15 miles radially from the plant.
- Designed and sponsored a telephone survey of residents within the EPZ to gather focused data needed for this ETE study that were not contained within the census database. The survey instrument was reviewed and modified by State and county personnel prior to the survey.
- 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 8 Zones. These Zones are then grouped within circular areas or “keyhole” configurations (circles plus radial sectors) that define a total of 14 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 scenario involving construction of a new unit at the CCNPP and one special scenario involving the Air Show at the Patuxent Naval Airbase were considered.

- The Planning Basis for the calculation of ETE is:

  - A rapidly escalating accident at CCNPP 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 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 196 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 14 Evacuation Regions to completely evacuate from that Region, under the circumstances defined for one of the 14 Evacuation Scenarios (14 x 14 = 196). 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 the impacted region will evacuate in response to this Advisory. The people occupying the remainder of the EPZ outside the impacted region may be advised to take shelter.

The computation of ETE assumes that a portion of the population within the EPZ but outside the impacted region, will elect to "voluntarily" evacuate. In addition, a portion of the population in the "Shadow" region beyond the EPZ that extends a distance of 15 miles from CCNPP, 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 (in general, outbound relative to the location of CCNPP), 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, which will be reviewed with State and local law enforcement personnel, 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 CCNPP site showing the layout of the 8 Zones that comprise, in aggregate, the Emergency Planning Zone (EPZ).
- Table 3-1 presents the estimates of permanent resident population in each Zone based on the 2000 Census data. Extrapolation to the year 2008 reflects population growth rates in each county derived from census data.
- Table 6-1 defines each of the 14 Evacuation Regions in terms of their respective groups of zones.
- Table 6-2 lists the 14 Evacuation Scenarios.
- Table 7-1D is a compilation of ETE. These data are the times needed to *clear the indicated regions* of 100 percent of the population occupying these regions. 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.

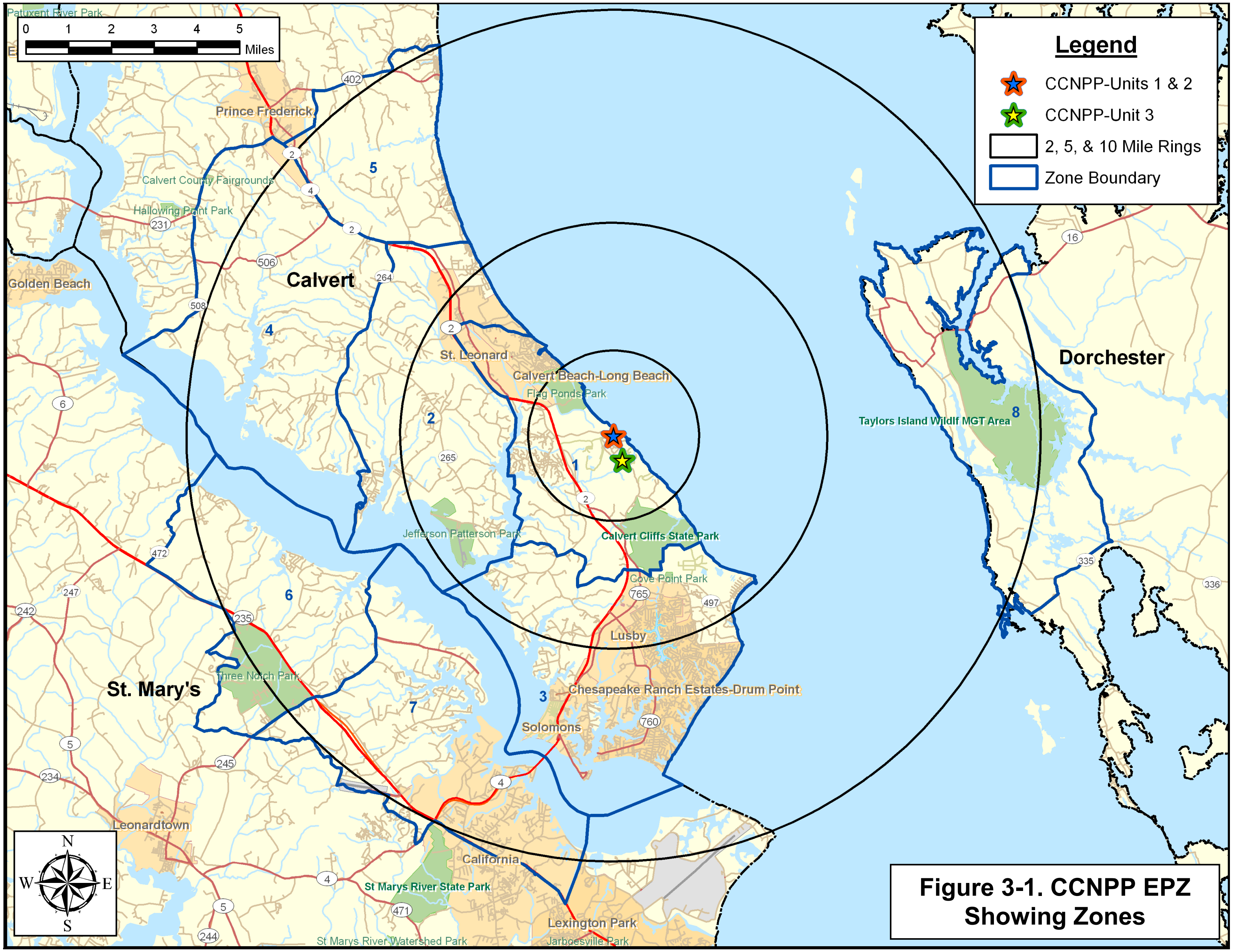


Figure 3-1. CCNPP EPZ Showing Zones

Table 3-1. EPZ Permanent Resident Population			
Zone	**County**	**2000 Population**	**2008 Population**
1	Calvert	5,250	6,484
2	Calvert	4,081	5,040
3	Calvert	17,069	21,080
4	Calvert	4,139	5,112
5	Calvert	2,283	2,820
6	St. Mary’s	4,246	5,074
7	St. Mary’s	7,770	9,284
8	Dorchester	295	311
TOTAL:		**45,133**	**55,205**
Population Growth:			**22.3%**

Table 6-1. Description of Evacuation Regions									
Region	**Description**	**ZONE**							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
R01	2-Mile Ring	**X**							
R02	5-Mile Ring	**X**	**X**	**X**					
R03	Full EPZ	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Evacuate 2-Mile Ring and 5 Miles Downwind									
Region	**Wind Direction Towards:**	**ZONE**							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	N, NNE, NE, ENE, E	**See Region 1**							
R04	ESE, SE, SSE, S	**X**		**X**					
	SSW, SW, WSW	**See Region 2**							
R05	W, WNW, NW, NNW	**X**	**X**						
Evacuate 5-Mile Ring and Downwind to EPZ Boundary									
Region	**Wind Direction Towards:**	**ZONE**							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	NNE	**See Region 2**							
R06	NE, ENE, E, ESE, SE	**X**	**X**	**X**					**X**
R07	SSE, S	**X**	**X**	**X**				**X**	
R08	SSW, SW	**X**	**X**	**X**			**X**	**X**	
R09	WSW	**X**	**X**	**X**	**X**		**X**	**X**	
R10	W	**X**	**X**	**X**	**X**		**X**		
R11	WNW	**X**	**X**	**X**	**X**	**X**	**X**		
R12	NW, NNW	**X**	**X**	**X**	**X**	**X**			
R13	N	**X**	**X**	**X**		**X**			
R14	*	**X**							**X**

*This Region was added at Constellation Energy's request. It is an evacuation of the 2-Mile Ring and downwind (Towards Dorchester County) to the EPZ Boundary.

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	Weekend	Midday	Good	None
9	Winter	Weekend	Midday	Rain	None
10	Winter	Midweek, Weekend	Evening	Good	None
11	Summer	Midweek	Midday	Good	New Plant Construction
12	Summer	Weekend	Midday	Good	Air Show at the Naval Base
13	Winter	Midweek	Midday	Snow	None
14	Winter	Weekend	Midday	Snow	None

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

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

Season		Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer	Winter	Winter	Season
Day of Week		Midweek		Weekend		All	Midweek		Weekend		All	Midweek	Weekend	Midweek	Weekend	Day of Week
Scenario:		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	Scenario
Time of Day		Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday	Midday	Midday	Time of Day
Zone	Region Wind Direction	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	New Plant Construction	Air Show at Base	Snow	Snow	Region Wind Direction Towards
Entire 2-Mile Region, 5-Mile Region, and EPZ																
1	R01 2-mile ring	4:10	4:10	4:05	4:15	4:05	4:10	4:15	4:10	4:10	4:15	4:30	4:00	5:15	5:15	R01 2-mile ring
1,2,3	R02 5-mile ring	5:25	6:05	5:55	6:30	5:00	5:20	5:55	5:20	5:55	4:50	5:50	6:35	6:45	6:40	R02 5-mile ring
1,2,3,4,5, 6,7,8	R03 Entire EPZ	6:00	6:45	6:25	7:10	5:30	5:50	6:20	5:50	6:30	5:25	6:30	11:30	7:25	7:25	R03 Entire EPZ
2-Mile Ring and Downwind to 5 Miles																
1	N, NNE, NE, ENE, E	Refer to Region 1														N, NNE, NE, ENE, E
1,3	R04 ESE, SE, SSE, S	5:25	6:05	5:55	6:35	4:55	5:20	5:50	5:15	5:50	4:50	5:45	6:20	6:45	6:40	R04 ESE, SE, SSE, S
1,2,3	SSW, SW, WSW	Refer to Region 2														SSW, SW, WSW
1,2	R05 W, WNW, NW, NNW	4:15	4:20	4:15	4:15	4:15	4:15	4:20	4:10	4:15	4:10	4:50	4:10	5:20	5:15	R05 W, WNW, NW, NNW
5-Mile Ring and Downwind to EPZ Boundary																
1,2,3	NNE	Refer to Region 2														NNE
1,2,3,8	R06 NE, ENE, E, ESE, SE	5:25	6:05	5:55	6:30	5:00	5:20	5:55	5:20	5:55	4:50	5:50	6:35	6:45	6:40	R06 NE, ENE, E, ESE, SE
1,2,3,7	R07 SSE, S	6:00	6:35	6:20	7:00	5:20	5:45	6:15	5:45	6:20	5:20	6:20	11:25	7:15	7:20	R07 SSE, S
1,2,3,6,7	R08 SSW, SW	6:00	6:45	6:25	7:10	5:30	5:50	6:20	5:50	6:30	5:25	6:30	11:30	7:25	7:30	R08 SSW, SW
1,2,3,4,6, 7	R09 WSW	6:00	6:45	6:25	7:10	5:30	5:50	6:20	5:50	6:30	5:25	6:30	11:30	7:25	7:25	R09 WSW
1,2,3,4,6	R10 W	5:45	6:20	6:15	7:00	5:20	5:45	6:20	5:45	6:20	5:20	6:10	11:20	7:05	7:05	R10 W
1,2,3,4,5, 6	R11 WNW	5:45	6:20	6:15	7:00	5:20	5:45	6:20	5:45	6:20	5:20	6:10	11:20	7:05	7:05	R11 WNW
1,2,3,4,5	R12 NW, NNW	5:25	6:05	5:55	6:30	4:55	5:20	5:55	5:20	5:55	4:50	5:50	6:35	6:45	6:40	R12 NW, NNW
1,2,3,5	R13 N	5:25	6:05	5:55	6:30	5:00	5:20	5:55	5:20	5:55	4:50	5:50	6:35	6:45	6:40	R13 N
1,8	R14	4:10	4:10	4:10	4:15	4:10	4:10	4:20	4:10	4:10	4:15	4:35	4:05	5:15	5:15	R14

Table 8-5A. School Evacuation Time Estimates - Good Weather 1st Wave

School	Driver Mobilization Time(min)	Loading Time (min)	Dist. to EPZ Boundary (mi.)	Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bdry to H.S. (mi.)	Travel Time EPZ Bdry to H.S. (min)	ETE to H.S. (hr:min)
Calvert County Schools								
Appeal Elementary School	90	5	8.0	26	**2:05**	40.9	62	**3:05**
Dowell Elementary School	90	5	6.6	21	**2:00**	36.7	56	**2:55**
Mill Creek Middle School	90	5	6.4	21	**2:00**	41.3	62	**3:00**
Mutual Elementary School	90	5	5.9	19	**1:55**	2.0	3	**2:00**
Our Lady Star of the Sea School	60	5	8.9	20	**1:25**	49.2	74	**2:40**
Patuxent Elementary School	90	5	8.0	26	**2:05**	42.8	65	**3:10**
Patuxent High School	90	5	8.8	28	**2:05**	48.7	74	**3:20**
Southern Middle School	60	5	10.2	23	**1:30**	48.7	74	**2:45**
St. Leonard Elementary School	90	5	7.0	22	**2:00**	14.6	22	**2:20**
St. Mary's County Schools								
Esperanza Middle School	60	5	0.0	0	**1:05**	8.9	14	**1:20**
Green Holly Elementary School	60	5	0.2	1	**1:10**	6.5	10	**1:20**
Hollywood Elementary School	60	5	6.1	14	**1:20**	5.8	9	**1:30**
St. John's Elementary School	60	5	0.7	2	**1:10**	5.9	9	**1:20**
Town Creek Elementary School	60	5	0.7	2	**1:10**	15.8	24	**1:35**
				Average for EPZ:	**1:40**		**Average:**	**2:20**

Table 8-7A. Transit Dependent Evacuation Time Estimate - Good Weather

Buses	Single Wave					Second Wave				
	Mobilization	Route Travel Time	Pickup Time	ETE	Mobilization	Unload Time	Driver Rest Time	Route travel Time	Pickup Time	ETE
Batch 1	90	183	30	5:05	140	5	10	183	30	6:10
Batch 2	120	236	30	6:30	170	5	10	236	30	7:35

1. INTRODUCTION

This report describes the analyses undertaken and the results obtained by a study to update the existing Evacuation Time Estimates (ETE) for the Calvert Cliffs Nuclear Power Plant (CCNPP), located in Calvert County, Maryland. Evacuation time estimates 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 prior documentation relevant to Evacuation Time Estimates was reviewed.

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

- Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants, NUREG 0654/FEMA-REP-1, Rev. 1, November 1980.

- Analysis of Techniques for Estimating Evacuation Times for Emergency Planning Zones, NUREG/CR-1745, November 1980.

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

We wish to express our appreciation to all the directors and staff members of the Calvert County, St. Mary's County and Dorchester 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 Update Process

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

1. Information Gathering:

   - Defined the scope of work in discussion with representatives of Constellation Energy.
   - Reviewed existing reports describing past evacuation studies.
   - Attended meetings with emergency planners from the three Evacuation Planning Zone (EPZ) Counties 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 census and state agencies.
- Conducted a random sample telephone survey of EPZ residents.
- Conducted a data collection effort to identify and describe schools, special facilities, major employers, transportation providers, and other important sources of information.

2. Estimated distributions of Trip Generation times representing the time required by various population groups (permanent residents, employees, and transients) to prepare (mobilize) for the evacuation trip. These estimates are primarily based upon the random sample telephone survey.
3. Defined Evacuation Scenarios. These scenarios reflect the variation in demand, trip generation distribution and in highway capacities, associated with different seasons, day of week, time of day and weather conditions.
4. Defined a traffic management strategy. Traffic control is applied at specified Traffic Control Points (TCP) located within the Emergency Planning Zone (EPZ), and at Access Control Points (ACP) located on the periphery of the EPZ. Local and state police personnel should review all traffic control plans.
5. Defined Evacuation Areas or Regions. The EPZ is partitioned into Protective Action Zones (Zones) which serve as a basis for the ETE analysis presented herein. Evacuation "Regions" are comprised of contiguous Zones 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.
6. Estimated demand for transit services for persons at "Special Facilities" and for transit-dependent persons at home.
7. Prepared the input streams for the IDYNEV system.
    - Estimated the traffic demand, based on the available information derived from Census data, from prior studies, from data provided by local and state agencies and from the telephone survey.
    - Applied the procedures specified in the 2000 Highway Capacity Manual (HCM) to the data acquired during the field survey, to estimate the capacity of all highway segments comprising the evacuation routes.

- Developed the link-node representation of the evacuation network, which is used as the basis for the computer analysis that calculates the ETE.
- Calculated the evacuating traffic demands for each Region and for each Evacuation Scenario. Considered the effects on demand of "voluntary evacuation" and of "shadow evacuation".
- Represented the traffic management strategy.
- Specified the candidate destinations of evacuation travel consistent with outbound movement relative to the location of the CCNPP.
- 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.

Steps 4, 7 and 8 are iterated as described in Appendix D.

1.2 The Calvert Cliffs Nuclear Plant Site Location

The Calvert Cliffs Nuclear Power Plant is located in Lusby, MD approximately 50 miles southeast of Washington, DC. The EPZ consists of parts of three counties: Calvert County, St. Mary's County and Dorchester County. Figure 1-1 displays the area surrounding the CCNNP. This map identifies the communities in the area and the major roads.

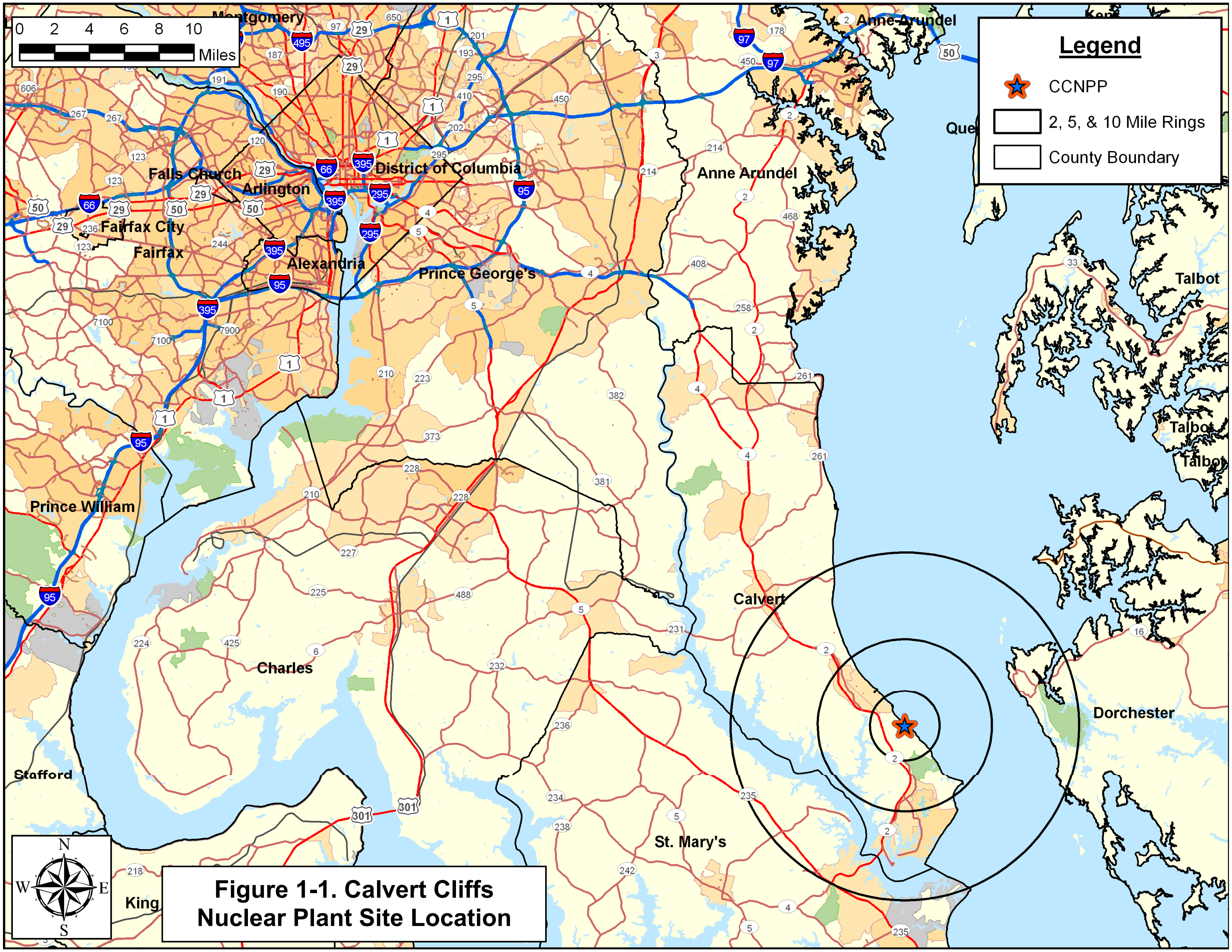


Figure 1-1. Calvert Cliffs Nuclear Plant Site Location

1.3 Preliminary Activities

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

Literature Review

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

Field Surveys of the Highway Network

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

• Number of lanes	• 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 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, and Mountainous) is a 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 HCM, 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 maps in Appendix K which are discussed below.

Telephone Survey

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

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

Developing the Evacuation Time Estimates

The overall study procedure is outlined in Appendix D. Demographic data were obtained from several sources, as detailed later in this report. These data were analyzed and converted into vehicle demand data.

Highway capacity was estimated for each highway segment based on the field surveys and on the principles specified in the 2000 Highway Capacity Manual (HCM[1]). The link-node representation of the physical highway network was developed using GIS mapping software and the observations obtained from the field survey. This network representation of “links” and “nodes” is shown in Figure 1-2. Appendix K contains large-scale maps detailing the link-node analysis network, with the node numbers clearly displayed.

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

Analytical Tools

The IDYNEV System that was employed 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).

I-DYNEV consists of three submodels:

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

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

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

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

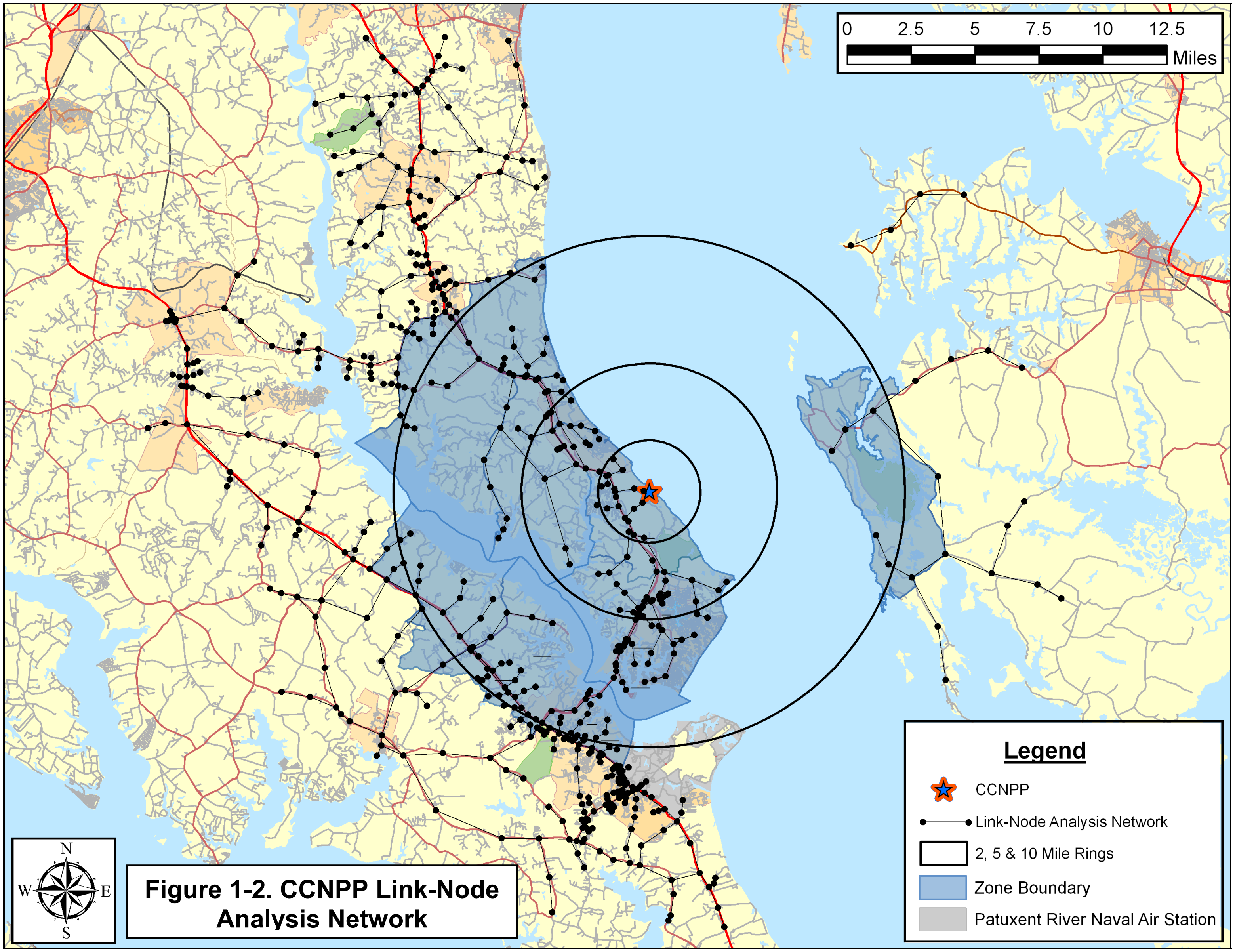


Figure 1-2. CCNPP Link-Node Analysis Network

The evacuation analysis procedures are based upon the need to:

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

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 evacuation routing used in the model is presented in Section 10 and also in the congestion diagrams in Section 7.

The simulation model is then executed to provide a detailed description of traffic operations on the evacuation network. This description enables the analyst to identify bottlenecks and to develop countermeasures that are designed to expedite the movement of vehicles. 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 is used to generate the ETE. 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 study performed in 2002. The major factors contributing to the differences between the ETE values obtained in this study and those of the previous study can be summarized as follows:

- An increase in 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 more detailed.
- Many more evacuation cases considered, responsive to NUREG/CR-6863.
- Traffic management plan included.

Table 1-1. ETE Study Comparisons		
Topic	**Treatment**	
	Previous ETE Study	**Current ETE Study**
Resident Population Basis	Maryland Department of Planning Estimate for population in 2000. Population = 50,058	ArcGIS Software using 2000 US Census blocks; block centroid method used; population extrapolated to 2008. Population = 55,205
Resident Population Vehicle Occupancy	Average household size varies by County. Assumed, 1 vehicle/evacuating HH resulting in an average vehicle occupancy of : Calvert County = 2.91, St. Mary's County = 2.72, Dorchester County = 2.36 persons/vehicle	Based on telephone survey, Average household size within EPZ = 2.80 person/household and 1.46 vehicles/evacuating household, resulting in average vehicle occupancy of 1.92 person/vehicle
Employee Population	Employee estimates based on information provided about major employers in EPZ. 1 employee/vehicle.	Employee estimates based on information provided about major employers in EPZ and on data provided by Census Journey-to-Work questionnaires. 1.03 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 radius being evacuated; 35 percent, in annular ring between the radius being evacuated and the EPZ boundary (See Figure 2-1).
Shadow Evacuation	Not considered.	30% of people outside of the EPZ within the shadow area (See Figure 7-2).
Network Size	204 links, 144 nodes	574 Internal Links; 422 Internal Nodes.

Table 1-1. ETE Study Comparisons		
Topic	**Treatment**	
	Previous ETE Study	**Current ETE Study**
Roadway Geometric Data	Field surveys conducted in 2001.	Field surveys conducted in 2006 and 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 Host School.	Direct evacuation to designated Host School.
Transit Dependent Population	Not considered explicitly. Local emergency plans will provide buses for transit dependents.	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 survey results used to estimate transit dependent population.
Ridesharing	100 percent of transit dependents will ride out with a friend.	50 percent of transit dependent persons will ride out with a neighbor of friend.
Trip Generation for Evacuation	Trip Generation curves created based on discussions with county emergency management officials.	Based on residential telephone survey of specific pre-trip mobilization activities: Residents with commuters returning leave between 30 and 240 minutes. Residents without commuters returning leave between 15 and 180 minutes. Employees and transients leave between 15 and 120 minutes. All times measured from the Advisory to Evacuate.

Table 1-1. ETE Study Comparisons		
Topic	**Treatment**	
	Previous ETE Study	**Current ETE Study**
Traffic and Access Control	List of Traffic control points identified.	Traffic and access control points identified and detailed schematics provided.
Weather	Normal or Adverse. The capacity of each link in the network is reduced by 30% for adverse weather.	Normal, Rain or Snow. The capacity and free flow speed of all links in the network are reduced by 10% in the event of rain and 20% for snow.
Modeling	NETVAC2	IDYNEV System: TRAD and PC-DYNEV.
Special Events	None considered. Only a sensitivity analysis of the closure of the Thomas Johnson Bridge for the Full EPZ.	2 Special Events – New Plant Construction, Air Show at the Naval Base.
Evacuation Cases	8 Regions, 2 seasons, 2 time of day, and 2 weather conditions producing 64 unique cases	14 Regions (central sector wind direction and each adjacent sector technique used) and 14 Scenarios producing 196 unique cases
Evacuation Time Estimates Reporting	ETE reported for 100th percentile population. Results presented by Region and Scenario.	ETE reported for the 50th, 90th, 95th and 100th percentile population. Results presented by Region and Scenario.
Evacuation Time Estimates for the entire EPZ, 100th percentile.	Full EPZ – Summer Daytime: Good weather = 5:50 Full EPZ – Summer Nightime: Good weather = 5:10 Full EPZ – Winter Daytime: Good weather = 6:10 Full EPZ – Winter Nightime: Good weather = 5:50	Summer Weekday Midday Good weather = 6: 00 Summer Evening Good weather = 5:30 Winter Weekday Midday Good weather = 5:50 Winter Evening Good weather = 5:25

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 2008. County-specific projections are based upon the estimates of the average annual growth rate for years between 2000 and 2010 provided by the Maryland Department of Planning, Planning Data Services. Estimates of employees who commute into the EPZ to work are based upon employment data obtained from county emergency management officials, company websites, the 2002 ETE Study Report, telephone calls to employers within the EPZ and the state Journey-to-Work census data.
2. Population estimates at special facilities are based on available data from county emergency management offices, direct phone calls to the facilities, related websites, and the 2002 ETE Study Report.
3. Roadway capacity estimates are based on field surveys and the application of Highway Capacity Manual 2000[1].
4. Population mobilization times are based on a statistical analysis of data acquired from the telephone survey.
5. The relationship between resident population and evacuating vehicles is developed from the telephone survey. The average values of 2.80 persons per household and 1.46 evacuating vehicles per household are used.
6. Where facility-specific vehicle data is unavailable, the relationship between persons and vehicles for special facilities is as follows:
    a. Parks/Recreational: 1 vehicle per family
    b. Employees: 1.03 employees per vehicle (telephone survey results),
7. ETE are presented for the evacuation of the 100th percentile of population for each Region and for each Scenario, and for the 2-mile, 5-mile and 10-mile distances. ETE are presented in tabular format and graphically, showing the values of ETE associated with the 50th, 90th and 95th percentiles of population. An Evacuation Region is defined as a group of Zones that is issued the Advisory to Evacuate.

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

2.2 Study Methodological Assumptions

1. The Evacuation Time is defined as the elapsed time from the Advisory to Evacuate issued to persons within a specific Region of the EPZ, and 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 Zones) 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. 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 Zones included within these underlying configurations.
5. Voluntary evacuation is considered as indicated in the accompanying Figure 2-1. Within the circle defined by the distance to be evacuated but outside the Evacuation Region, 50 percent of the people not advised to evacuate are assumed to evacuate within the same time-frame. In the outer annular area between the circle defined by the extent of the Evacuation Region and the EPZ boundary, it is assumed that 35 percent of people will voluntarily evacuate. In the area between the EPZ boundary and a 15-mile circular area centered at the plant (the "shadow region"), it will be assumed that 30 percent of the people will evacuate voluntarily. Sensitivity studies explored the effect on ETE, of increasing the percentage of voluntary evacuees in this area (Appendix I). The basis for our assumptions on voluntary evacuation is testimony proffered by Dennis Miletti, a professor at Colorado State University, and one of the nations top disaster response experts, at Atomic Safety and Licensing Board (ASLB) hearings, which were deemed acceptable. There are limited data pertaining to nuclear evacuations in the United States. The numbers we use are Professor Miletti's best estimates based on his years of experience in evacuation planning and emergency preparedness.
6. A total of 14 "Scenarios" representing different seasons, time of day, day of week and weather are considered. Two special event scenarios are studied: the peak construction period of a new unit at the CCNPP site, and the Airshow at the Patuxent Naval Air Base These Scenarios are tabulated below:

Table 2-1. Evacuation Scenario Definitions					
Scenario	Season	Day of Week	Time of Day	Weather	Special
1	Summer	Midweek	Midday	Good	None
2	Summer	Midweek	Midday	Rain	None
3	Summer	Weekend	Midday	Good	None
4	Summer	Weekend	Midday	Rain	None
5	Summer	Midweek, Weekend	Evening	Good	None
6	Winter	Midweek	Midday	Good	None
7	Winter	Midweek	Midday	Rain	None
8	Winter	Weekend	Midday	Good	None
9	Winter	Weekend	Midday	Rain	None
10	Winter	Midweek, Weekend	Evening	Good	None
11	Summer	Midweek	Midday	Good	New Plant Construction
12	Summer	Weekend	Midday	Good	Airshow at Base
13	Winter	Midweek	Midday	Snow	None
14	Winter	Weekend	Midday	Snow	None

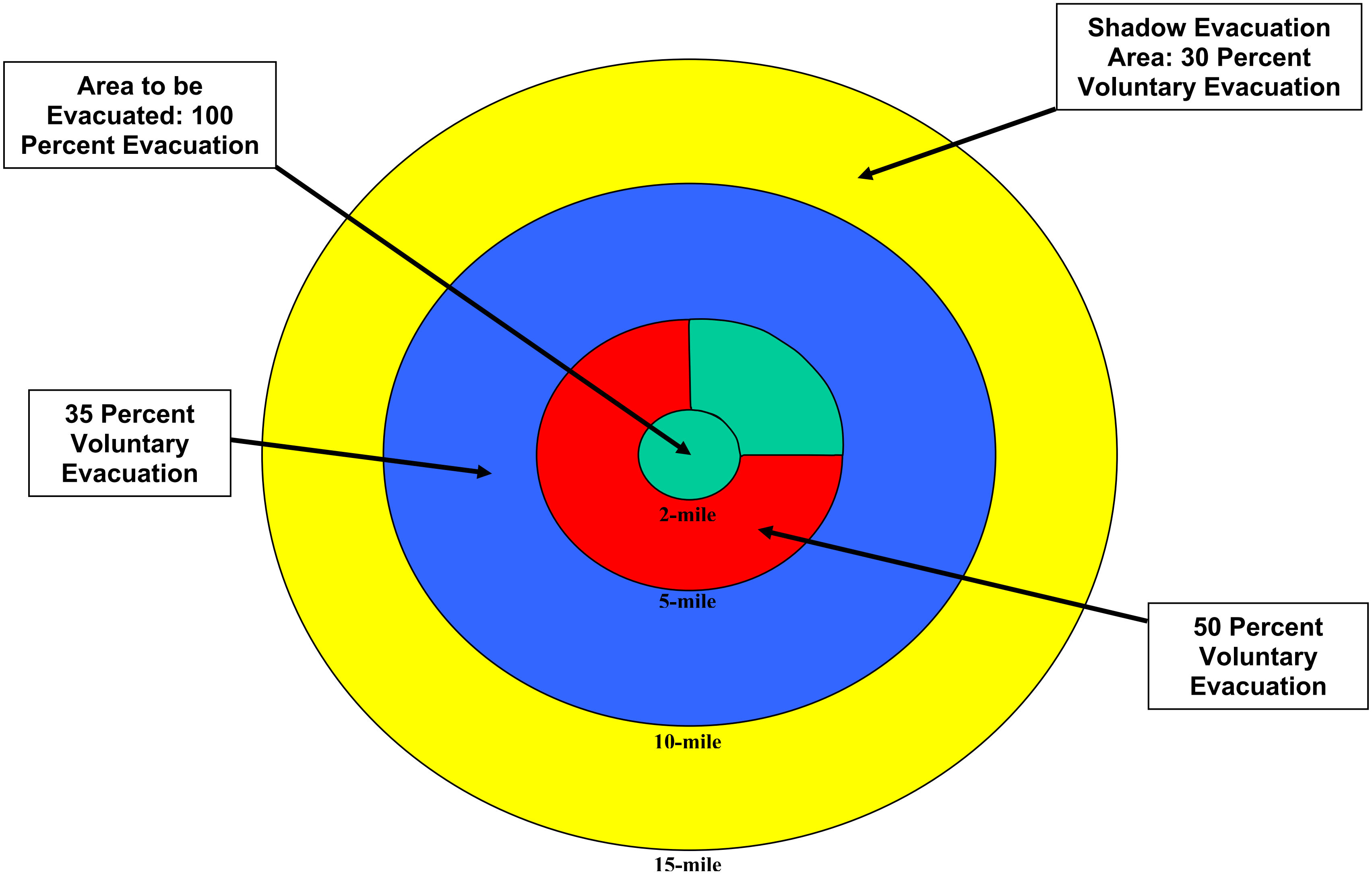


Figure 2-1. Voluntary Evacuation Methodology

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

2.3 Study Assumptions

1. The Planning Basis Assumption for the calculation of ETE is a rapidly escalating accident that requires evacuation, and includes the following:
   a. Advisory to Evacuate is announced coincident with the siren notification.
   b. Mobilization of the general population will commence within 10 minutes after the Advisory to Evacuate.
   c. ETE are measured relative to the Advisory to Evacuate.
2. It is assumed that everyone within the group of Zones forming a Region that is issued an Advisory to Evacuate will, in fact, respond in general accord with the planned routes.
3. It is further assumed that:
   a. Schools may be evacuated prior to notification of the general public, if possible.
   b. 65 percent of households in the EPZ have at least one commuter, 58 percent of which will await the return of a commuter before beginning their evacuation trip, based on the telephone survey results.
4. The ETE will also include consideration of "through" (External-External) trips during the time that such traffic is permitted to enter the evacuated Region. "Normal" traffic flow is assumed to be present within the EPZ at the start of the emergency.
5. Access Control Points (ACP) will be staffed approximately 90 minutes after the siren notifications, to divert traffic attempting to enter the EPZ. Earlier activation of ACP locations could delay returning commuters. It is assumed that no 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 the personnel resources available. 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. While the manning of TCPs may expedite evacuation traffic operations relative to existing controls, the calculation of ETE does not rely on any expedited

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

operations.

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 host schools.
   b. School children, 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 some of the transit-dependent people will ride-share with family, neighbors, and friends, thus reducing the demand for buses. We assume that the percentage of people who rideshare is 50 percent. This assumption is based upon reported experience for other emergencies,[3] which cites previous evacuation experience. 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 for either winter or summer scenarios. In the case of rain, it is assumed that the rain begins prior to, or at about the same time as the evacuation advisory is issued. No weather-related reduction in the number of transients who may be present in the EPZ is assumed.

   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 and free flow highway speeds. The factors assumed for the ETE study are:

Scenario	Highway Capacity*	Free Flow Speed*	Mobilization Time
Rain[4]	90%	90%	No Effect
Snow[4]	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

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

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

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.

3. DEMAND ESTIMATION

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

1. An estimate of population within the Emergency Planning Zone (EPZ), stratified into groups (resident, employee, transient).

2. An estimate, for each population group, of mean occupancy per evacuating vehicle. This estimate is used to determine the number of evacuating vehicles.

3. An estimate of potential double-counting of vehicles.

Appendix E presents much of the source material for the population estimates. Our primary source of population data, the 2000 Census, however, is not adequate for directly estimating some transient groups.

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

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

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

Furthermore, the number of vehicles at a location depends on time of day. For example, motel parking lots may be full at dawn and empty at noon. Similarly, parking lots at area parks, which are full at noon, may be almost empty at dawn. It is clearly wrong to estimate counts of vehicles by simply adding up the capacities of different types of parking facilities, without considering such factors.

Analysis of the population characteristics of the Calvert Cliffs Nuclear Power Plant (CCNPP) EPZ indicates the need to identify three distinct groups:

- Permanent residents - people who are year-round residents of the EPZ.
- Transients - people who reside outside of the EPZ, who enter the area for a specific purpose (e.g., boating, camping) 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 Zone and by polar coordinate representation (population rose). The CCNPP EPZ has been subdivided into 8 Zones 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 (2.80 persons/household) and the number of evacuating vehicles per household (1.46 vehicles/household) were adapted from the telephone survey results.

The rate of population change was found for each County in the EPZ and applied to project population to 2008. The estimated growth rates between 2000 and 2008 for the counties are as follows: Calvert County – 23.5%, St. Mary's County – 19.5%, and Dorchester County – 5.3%; this data was provided by the Maryland Department of Planning website, last updated in October of 2007. The data in Table 3-1 show that the EPZ population has increased by 22.3% over the last 8 years.

Permanent resident population and vehicle estimates for 2008 are presented in Table 3-2. Figures 3-2 and 3-3 present the permanent resident population and permanent resident vehicle estimates by sector and distance from the CCNPP. This "rose" was constructed using GIS software.

Construction

A "special event" scenario (Scenario 11) which represents a typical summer, mid-week, midday with good weather and with construction workers on-site during Shift 1 (7:30 AM to 4:00 PM) at the time of the emergency, is considered. This event is assumed to coincide with an outage at one of the two existing units. The peak construction period – based on discussions with Unistar Nuclear – would be in the year 2013, with workforce estimates of 3,940 workers, working in 3 shifts with 70%, 25%, and 5% of workers in each shift, respectively. An average vehicle occupancy of 1.3 workers per vehicle was used to convert workers to vehicles for Shift 1– 2,122 total vehicles. Additionally, 363 new employees (66% during max shift, 1.05 workers per vehicle, yielding 228 vehicles) related to the new unit and 750 employees (66% during max shift, 1.05 workers per vehicle, yielding 471 vehicles) present during the outage were considered. These employees combined with the construction staff resulted in a total of 2,821 additional vehicles. The existing roadway system is used for the construction scenario; no roadway improvements are considered; however, a new traffic signal at the entrance to the construction site along Nursery Road and Maryland Route 2/4 is used. Permanent resident population and shadow population are extrapolated to 2013 for this scenario.

Airshow at the Naval Air Base

Another special event considered (Scenario 12) is the Airshow at the Patuxent Naval Air Base. Based on information provided by the St. Mary's County Department of Public Safety, this event occurs every other year. The event lasts about 3 days and is normally during a summer weekend (May or June). The expected attendance is approximately 100,000 people for the Blue Angels performance. It is expected that nearly all the attendees will drive into the base and park their cars in the grass fields. An average occupancy of 2.3 people per vehicle is assumed based on a study conducted for a similar event in Seabrook, NH. Overall, this special event will result in a loading of 43,480 vehicles along Cedar Point Road at the intersection with Three Notch Road (Maryland Route 235).

Given the large number of transients and the close proximity of the event to the EPZ boundary, those people evacuating in an emergency will be affected by the large vehicle influx from this event as they will use the same exit route (Maryland Route 235). Thus, it is important to consider this special event, even though it takes place outside of the EPZ.

It is assumed that approximately three-quarters of the residents within the EPZ and the shadow area will attend this special event. In order to avoid double counting of the residents, the residents who attend the event are loaded at the base and only the remaining 25% are loaded within the EPZ and shadow area.

A sensitivity study was conducted to determine the effect on the ETE of changing the percentage of EPZ residents and shadow population who attend the air show from 75% to 50%. Since the balance of attendees are transients, the higher number of transient vehicles in the latter case results in an increase in vehicle demand and an increase in ETE. ETE from this sensitivity study are presented in Table I-4 of Appendix I.

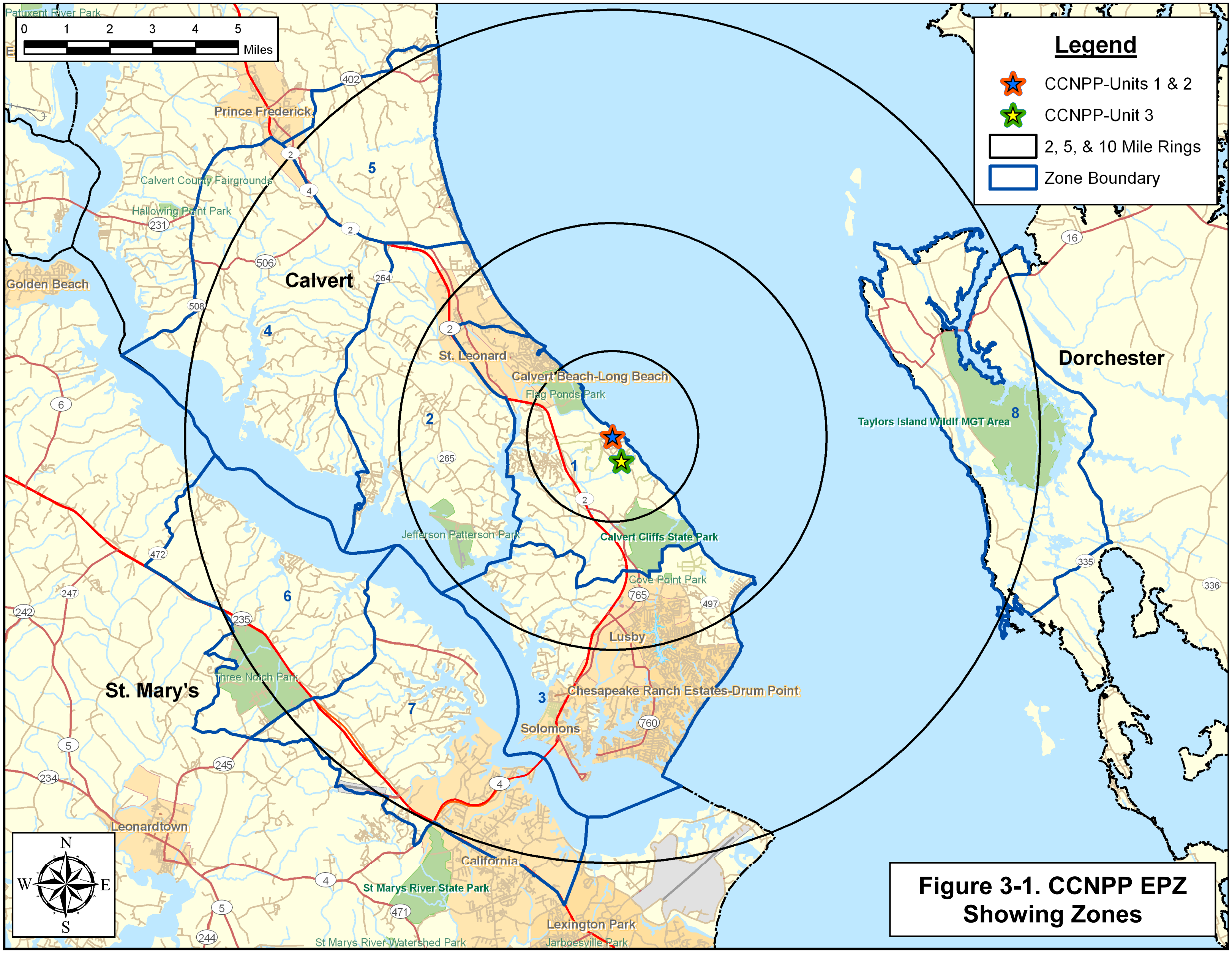
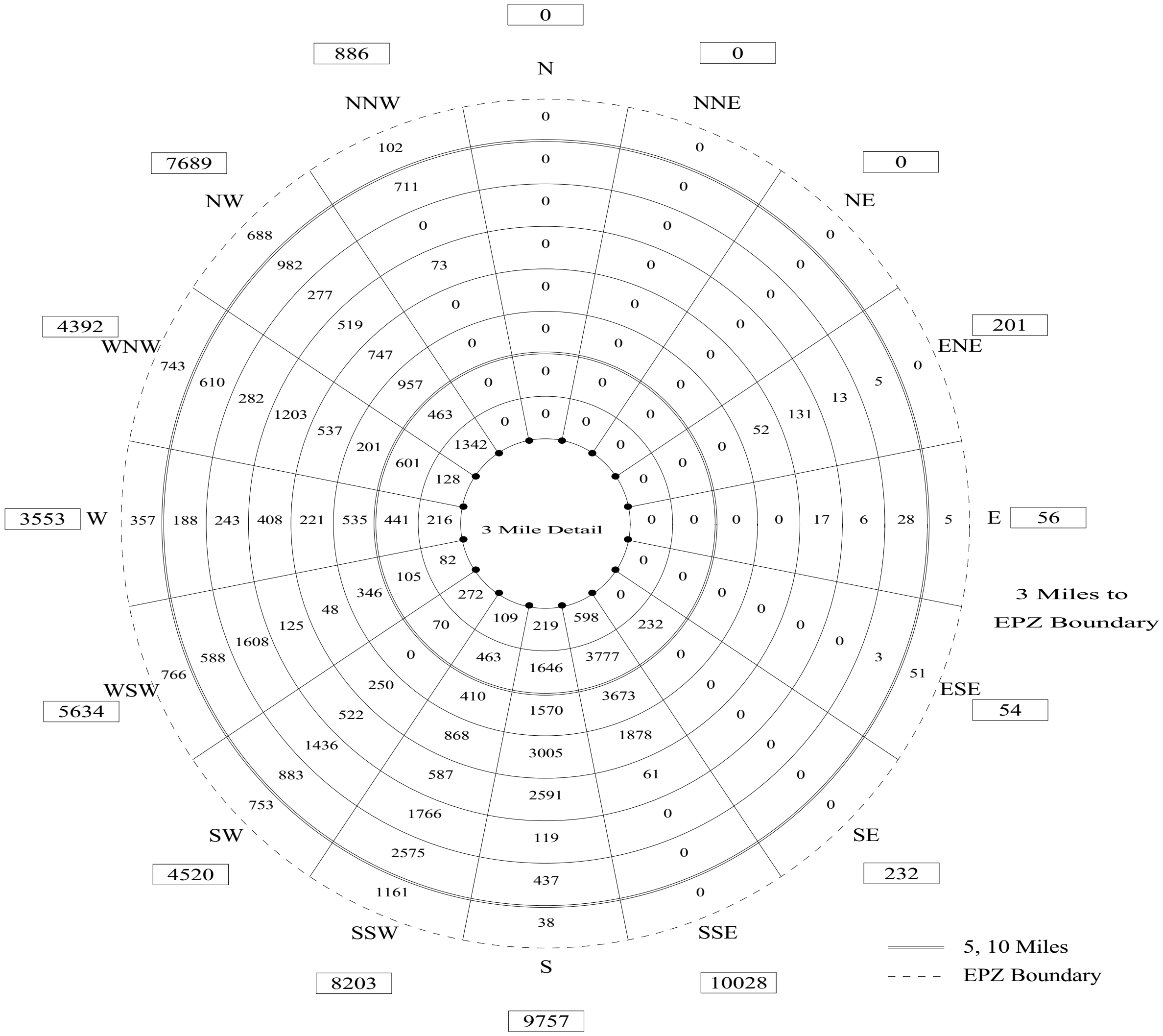


Figure 3-1. CCNPP EPZ Showing Zones

Table 3-1. EPZ Permanent Resident Population			
Zone	**County**	**2000 Population**	**2008 Population**
1	Calvert	5,250	6,484
2	Calvert	4,081	5,040
3	Calvert	17,069	21,080
4	Calvert	4,139	5,112
5	Calvert	2,283	2,820
6	St. Mary's	4,246	5,074
7	St. Mary's	7,770	9,284
8	Dorchester	295	311
TOTAL:		**45,133**	**55,205**
Population Growth:			**22.3%**

Table 3-2. Permanent Resident Population and Evacuating Vehicles by Zone			
Zone	**County**	**2008 Population**	**2008 Vehicles**
1	Calvert	6,484	3,385
2	Calvert	5,040	2,637
3	Calvert	21,080	11,001
4	Calvert	5,112	2,669
5	Calvert	2,820	1,475
6	St. Mary's	5,074	2,648
7	St. Mary's	9,284	4,852
8	Dorchester	311	164
TOTAL:		**55,205**	**28,831**



Resident Population			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	0	0-1	0
1-2	2771	0-2	2771
2-3	2711	0-3	5482
3-4	2966	0-4	8448
4-5	7798	0-5	16246
5-6	7692	0-6	23938
6-7	7606	0-7	31544
7-8	6237	0-8	37781
8-9	5750	0-9	43531
9-10	7010	0-10	50541
10-EPZ	4664	0-EPZ	55205

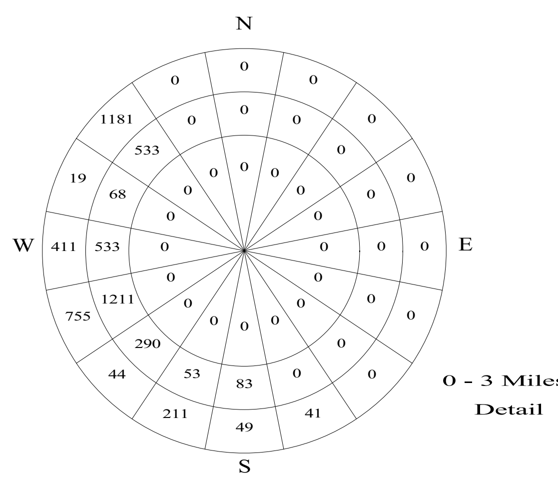
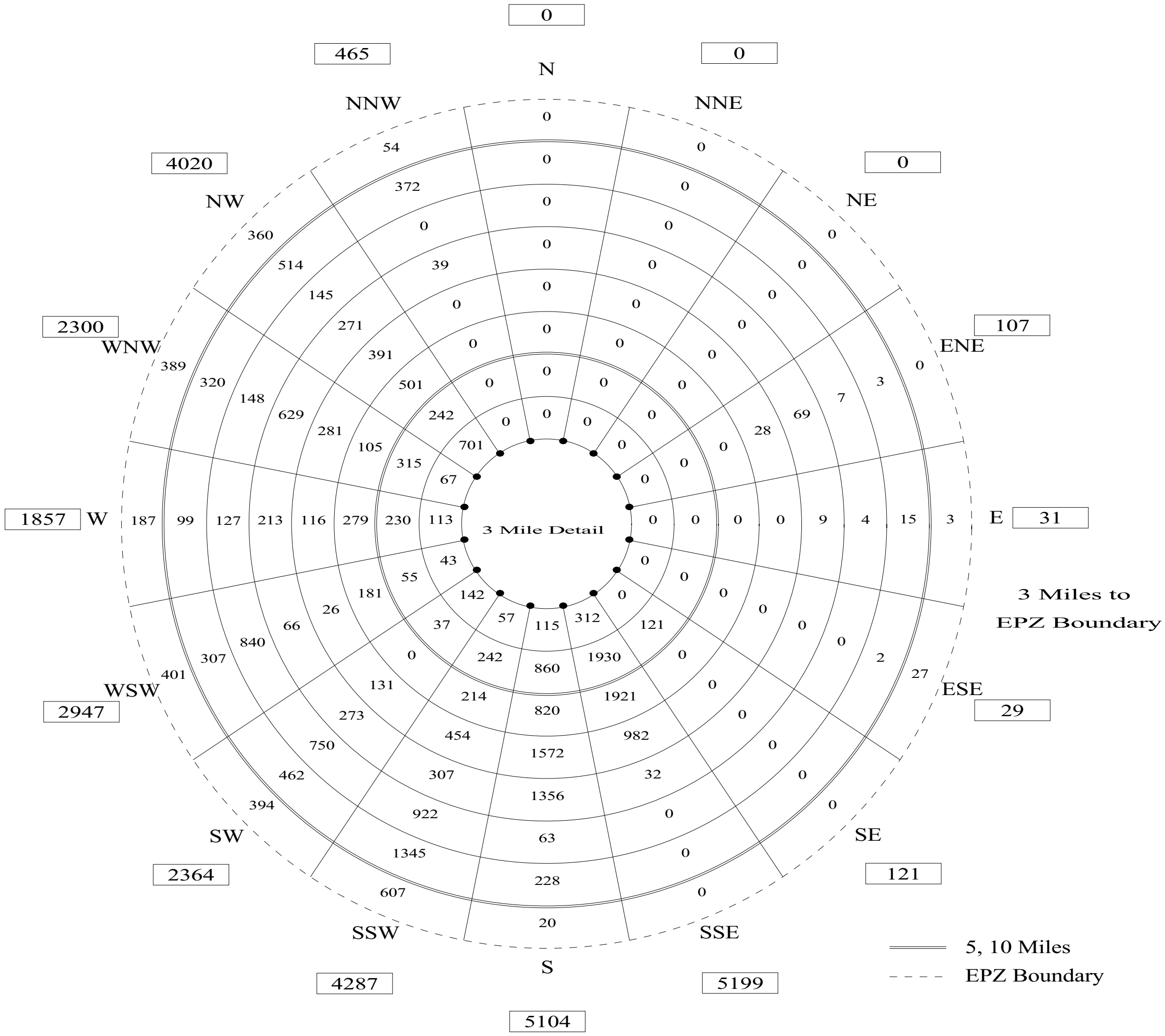


Figure 3-2. Permanent Residents by Sector



Resident Vehicles			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	0	0-1	0
1-2	1449	0-2	1449
2-3	1419	0-3	2868
3-4	1550	0-4	4418
4-5	4032	0-5	8450
5-6	4021	0-6	12471
6-7	3981	0-7	16452
7-8	3264	0-8	19716
8-9	3006	0-9	22722
9-10	3667	0-10	26389
10-EPZ	2442	0-EPZ	28831

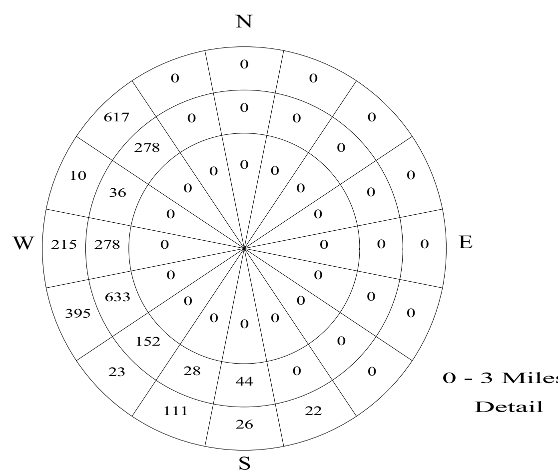


Figure 3-3. Permanent Resident Vehicles by Sector

Transient Population

Transients are defined as those people who are not permanent residents and who enter the EPZ for a specific purpose (shopping, recreation, business, social). Transients may spend less than one day or stay overnight or longer at rented apartments, camping facilities, hotels and motels.

The recreational areas in the CCNPP EPZ include parks, museums, recreation centers, campgrounds, a sports complex, marinas, and a historical site. Appendix E details the recreational data which were provided by the 2002 ETE Study Report, by county websites and county representatives, by phone calls to the facilities, and by websites for recreational facilities. The peak attendance at the recreational areas is estimated as 10,678 people evacuating in 3,601 vehicles. If site-specific data on the number of visitors per vehicle was not available, it was assumed that each evacuating vehicle holds one family; therefore an average vehicle occupancy of 2.8 (average household size) was used.

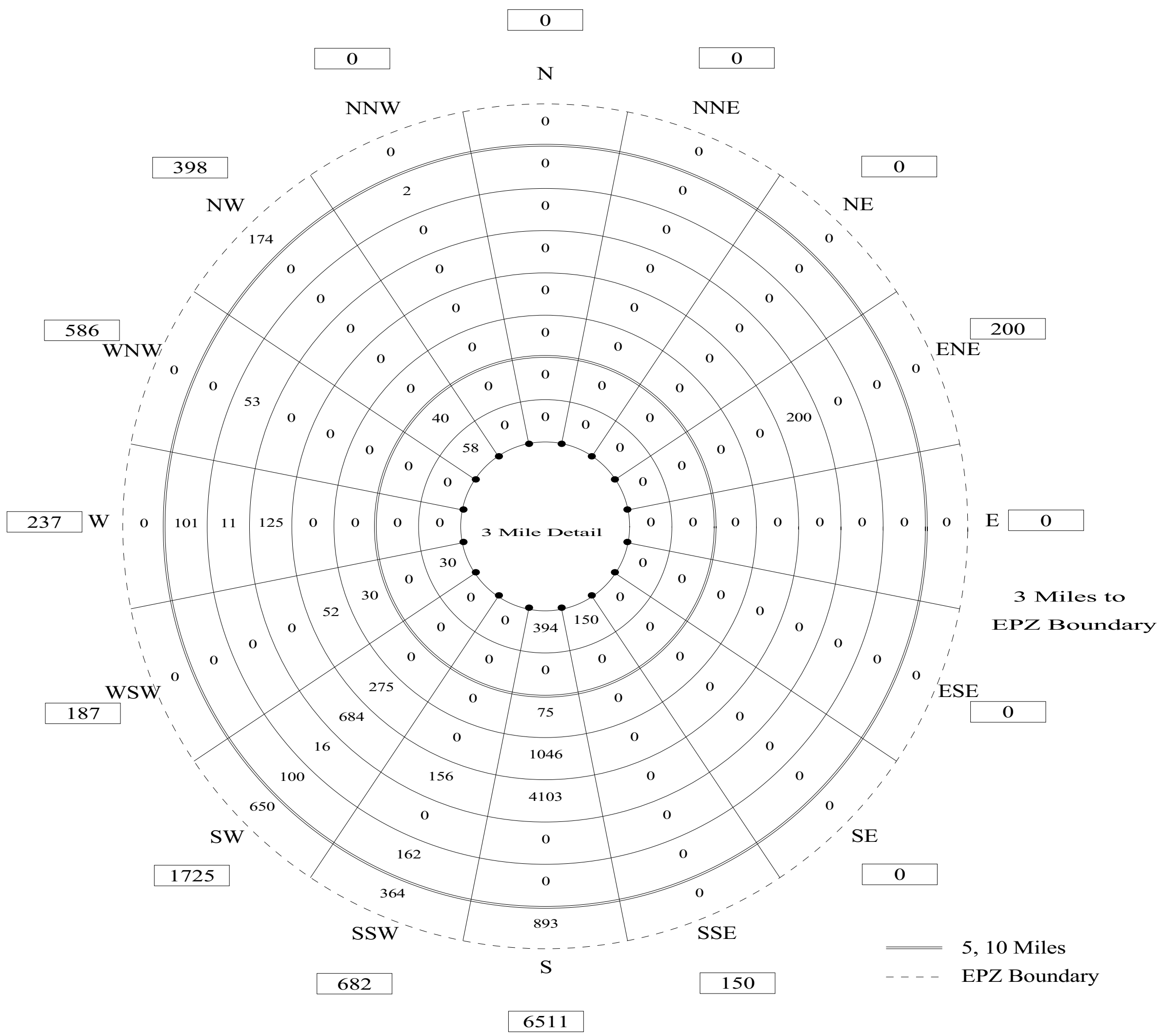
To avoid double counting residents, estimates were made of the number of visitors to the recreational facility that live outside the EPZ; only these people are counted as transients. These estimates were provided by some of the facilities; the percentage of transient visitors varied between 15% and 100%. Facilities for which this data was unavailable were assigned a percentage based on their similarity to other facilities.

Hotels and Motels

There are 10 major hotels (50 or more rooms), eight bed and breakfast lodgings and one cabin facility in the EPZ. Appendix E details the hotel data provided by county tourism websites as well as websites for the lodging facilities. At the hotels, motels and bed and breakfasts, we assume two people (1 evacuating vehicle) per room. The peak attendance at the hotels and motels is estimated as 2,534 people evacuating in 1,213 vehicles.

Table 3-3 summarizes the transient population and vehicles within the EPZ. This includes the major recreational areas, lodging facilities, and marinas.

Table 3-3. Summary of Transients by Zone		
Zone	**Transients**	**Transient Vehicles**
1	978	274
2	158	55
3	5,524	1,826
4	363	138
5	2	1
6	819	212
7	2,634	1,028
8	200	67
TOTAL	**10,678**	**3,601**



Transient Population			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	0	0-1	0
1-2	533	0-2	533
2-3	201	0-3	734
3-4	632	0-4	1366
4-5	40	0-5	1406
5-6	105	0-6	1511
6-7	1373	0-7	2884
7-8	5268	0-8	8152
8-9	80	0-9	8232
9-10	365	0-10	8597
10-EPZ	2081	0-EPZ	10678

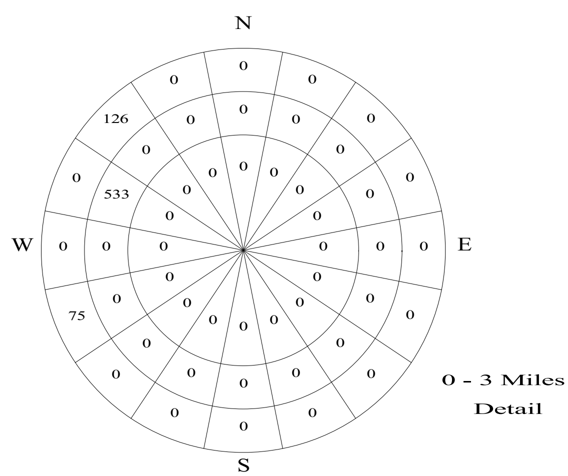
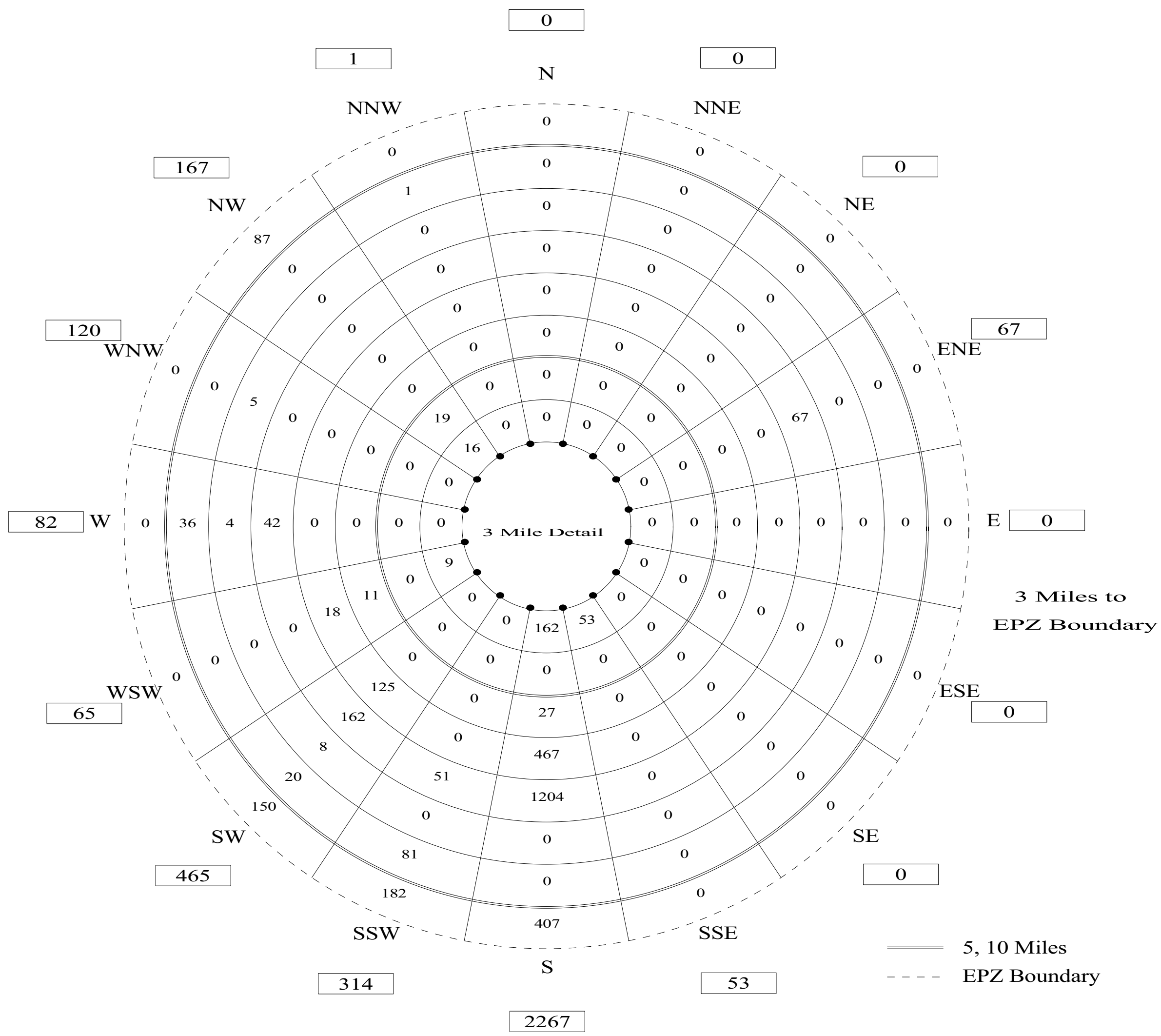


Figure 3-4. Transient Population by Sector



Transient Vehicles			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	0	0-1	0
1-2	115	0-2	115
2-3	72	0-3	187
3-4	240	0-4	427
4-5	19	0-5	446
5-6	38	0-6	484
6-7	610	0-7	1094
7-8	1526	0-8	2620
8-9	17	0-9	2637
9-10	138	0-10	2775
10-EPZ	826	0-EPZ	3601

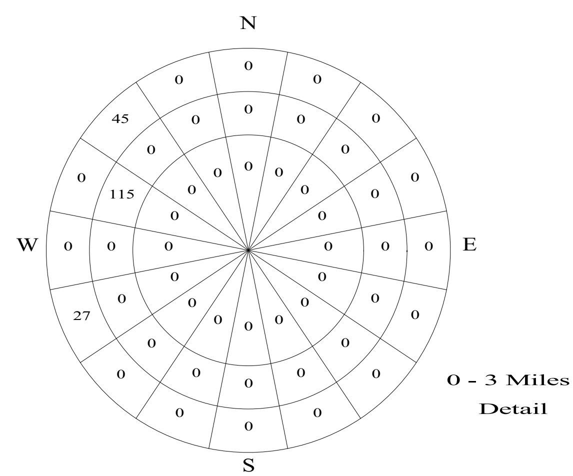


Figure 3-5. Transient Vehicles by Sector

Employees

Employees who work within the EPZ fall into two categories:

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

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

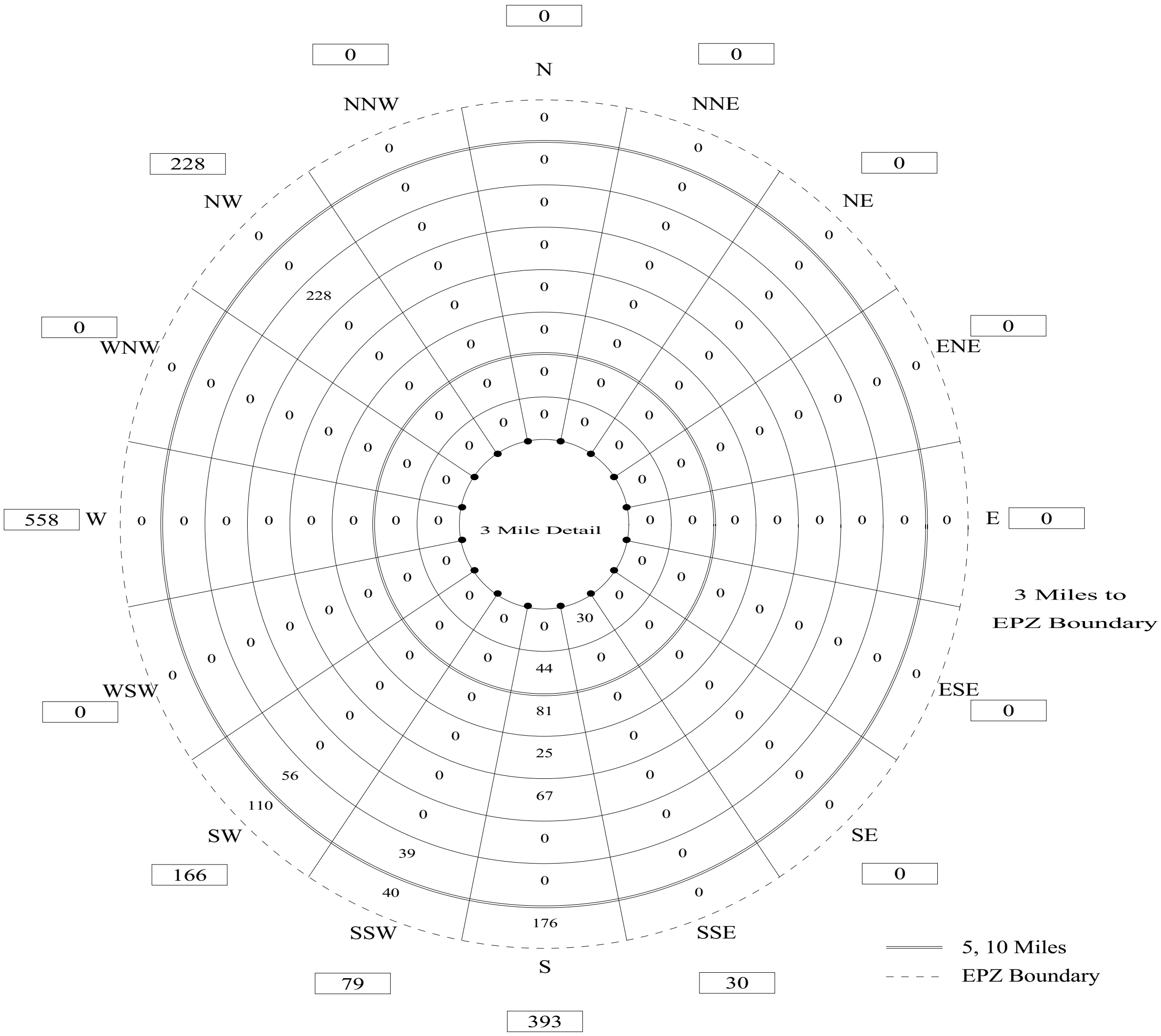
Data for major employers (more than 50 total employees) in the EPZ was provided by the county offices of emergency management, county websites, individual employer websites, and through phone calls to the workplace. The locations of these facilities were mapped using GIS software. The GIS map was overlaid with the evacuation analysis network and employees were loaded onto appropriate links. The map of major employers in the EPZ can be seen in Appendix E.

Journey to Work data provided by the Census indicates that, on average, 25% of the employees in the Calvert County portion of the EPZ and 20% of the employees in the St. Mary's County portion of the EPZ travel to work from outside the EPZ. These percentages were applied to estimate the total number of people commuting into the EPZ to work.

An occupancy of 1.03 persons per employee-vehicle obtained from the telephone survey is used to determine the number of evacuating employee vehicles.

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

Table 3-4. Summary of Non-EPZ Employees by Zone		
Zone	**Total Non-EPZ Employees**	**Employee Vehicles**
1	558	542
2	**No employment**	
3	247	240
4	77	75
5	151	147
6	56	54
7	365	355
8	**No employment**	
TOTAL:	**1,454**	**1,413**



Employees			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	558	0-1	558
1-2	0	0-2	558
2-3	0	0-3	558
3-4	30	0-4	588
4-5	44	0-5	632
5-6	81	0-6	713
6-7	25	0-7	738
7-8	67	0-8	805
8-9	228	0-9	1033
9-10	95	0-10	1128
10-EPZ	326	0-EPZ	1454

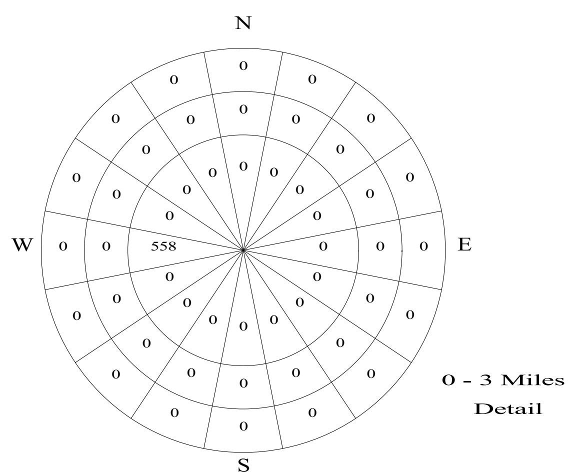
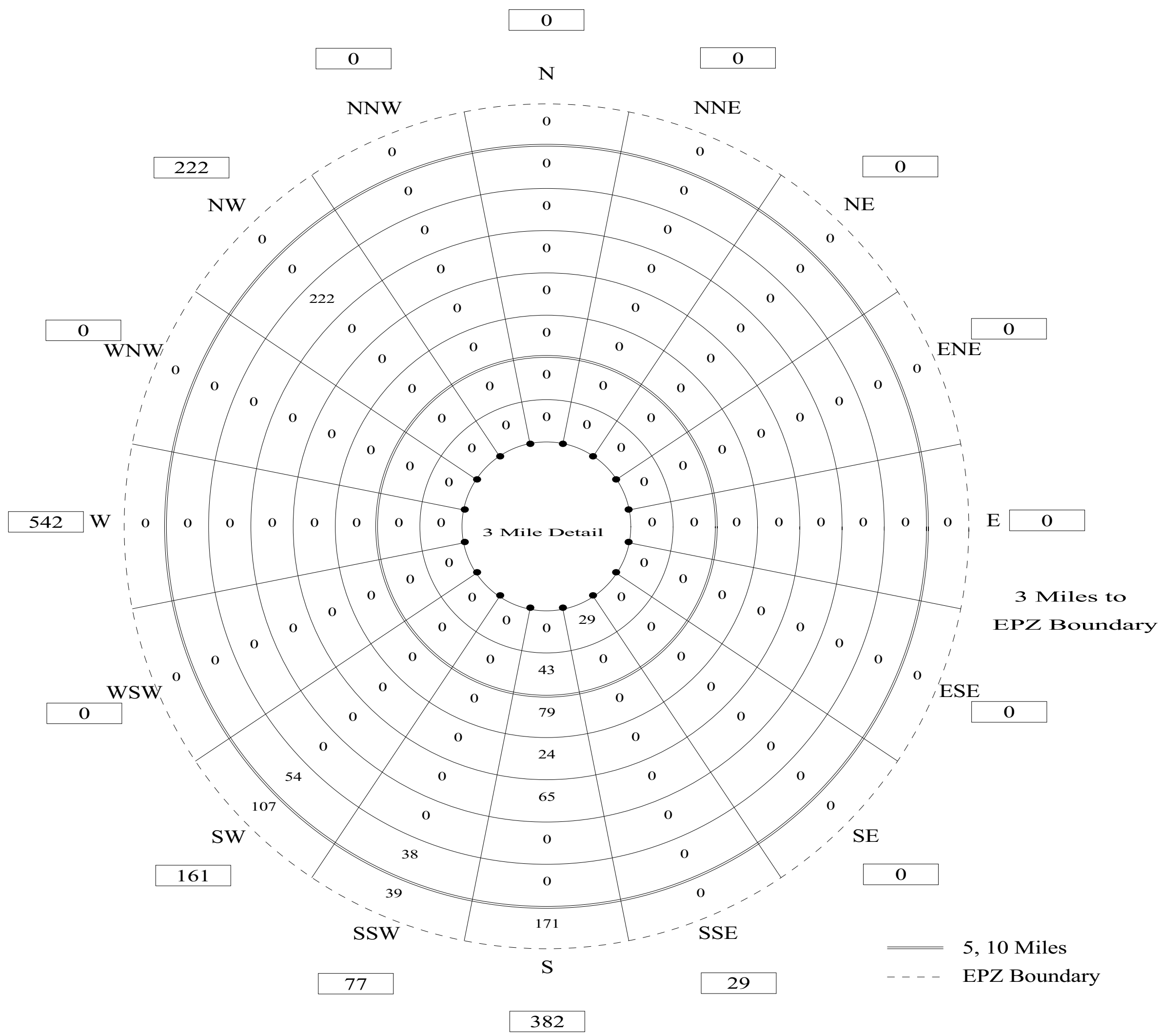


Figure 3-6. Employee Population by Sector



Employee Vehicles			
Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	542	0-1	542
1-2	0	0-2	542
2-3	0	0-3	542
3-4	29	0-4	571
4-5	43	0-5	614
5-6	79	0-6	693
6-7	24	0-7	717
7-8	65	0-8	782
8-9	222	0-9	1004
9-10	92	0-10	1096
10-EPZ	317	0-EPZ	1413

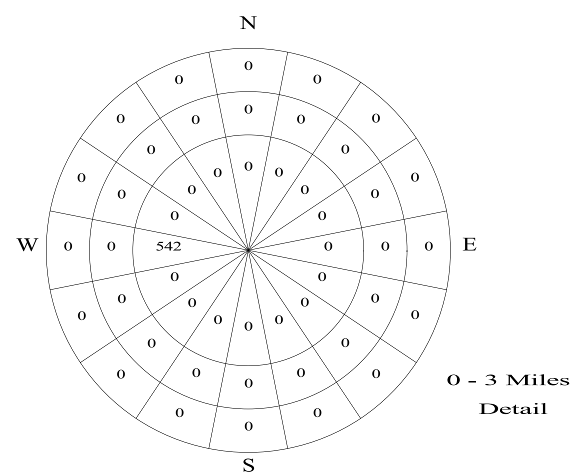


Figure 3-7. Employee Vehicles by Sector

Medical Facilities

There are no hospitals within the Calvert Cliffs EPZ; however, there are nursing homes and senior centers. Data for these facilities was obtained from nursing home websites and from the 2002 ETE Study Report.

Pass-Through Demand

Vehicles will be traveling through the EPZ (external-external trips) at the time of an accident. After the Advisory to Evacuate is announced, these through travelers will also evacuate. These through vehicles are assumed to travel on the major routes through the EPZ (e.g. Maryland Route 2/4 and Maryland Route 235). It is assumed that this traffic will continue to enter the EPZ during the first 90 minutes following the Advisory to Evacuate. We estimate approximately 300 vehicles per lane as the pass through demand; with 8 lanes entering the EPZ, a total of 2,400 vehicles enter the EPZ as external-external trips during this period.

4. ESTIMATION OF HIGHWAY CAPACITY

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

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

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

Given the population density within the EPZ and the limited availability of major evacuation routes (only two major thoroughfares - Route 235 and Route 2/4), congestion is expected to occur within the EPZ and especially in/around the Thomas Johnson Bridge. As such, estimates of roadway capacity must be determined with great care. Because of its importance, a brief discussion of the major factors that influence highway capacity is presented in this section.

Capacity Estimations on Approaches to Intersections

At-grade intersections are apt to become the first bottleneck locations under local heavy traffic volume conditions. This characteristic reflects the need to allocate access time to the respective competing traffic streams by exerting some form of control. During evacuation, control at critical intersections will often be provided by traffic control personnel assigned for that purpose, whose directions may supersede traffic control devices. The Traffic Management Plan identifies these locations (called Traffic Control Points, TCP) and the management procedures applied.

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

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

where:

$Q_{cap,m}$	=	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	=	The mean duration of GREEN time servicing vehicles that are executing movement, *m*, for each signal cycle; seconds
L	=	The mean "lost time" for each signal phase servicing movement, *m*; seconds
C	=	The duration of each signal cycle; seconds
P_m	=	The proportion of GREEN time allocated for vehicles executing movement, *m*, from this lane. This value is specified as part of the control treatment
m	=	The movement executed by vehicles after they enter the intersection: through, left-turn, right-turn, diagonal.

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

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

where:

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

The estimation of h_m for specified values of $h_{sat}, F_1, F_2, ...$ is undertaken within the 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

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.

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.

Capacity Estimation Along Sections of Highway

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

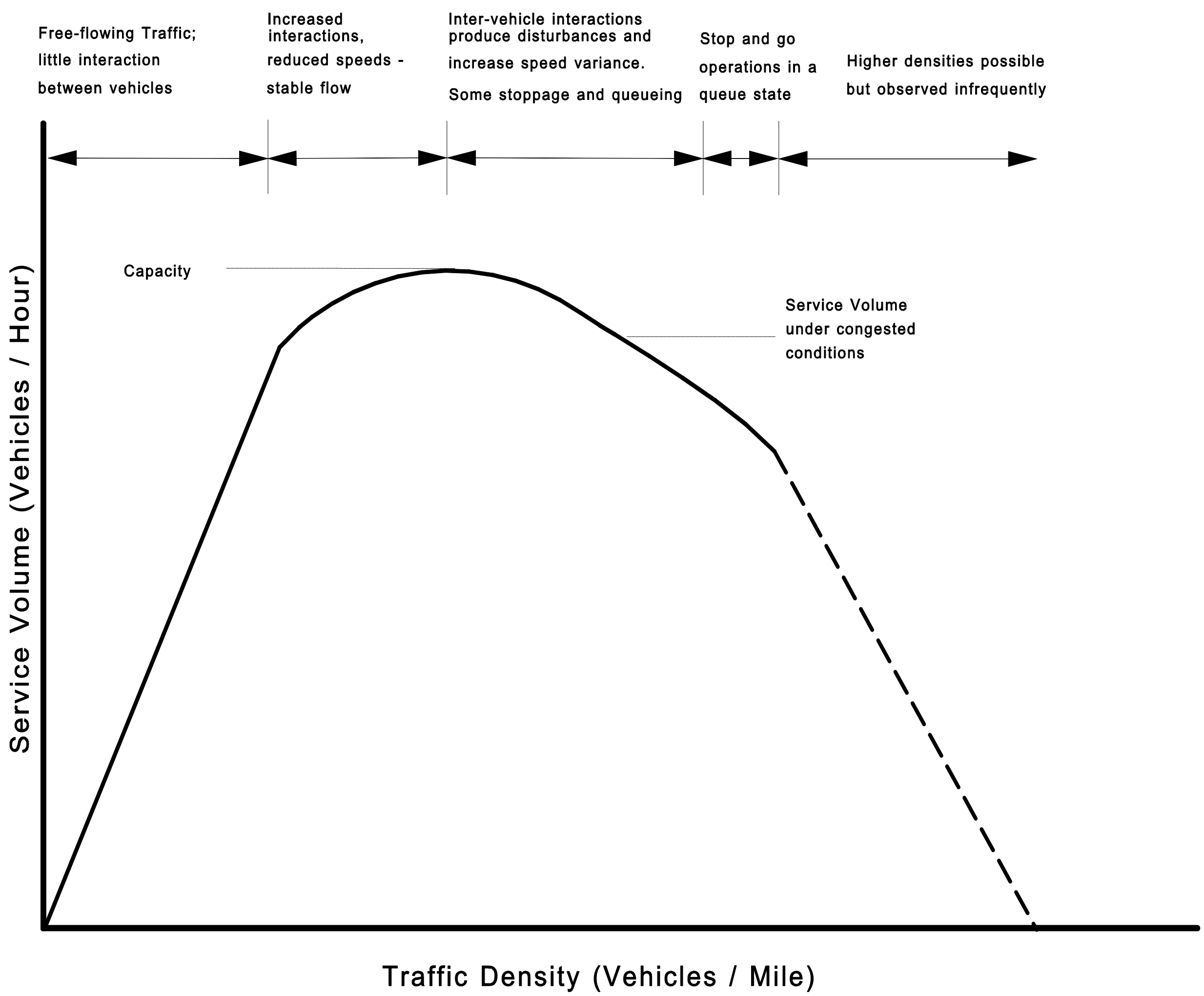


Figure 4-1. Fundamental Relationship between Volume and Density

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

The value of V_F can be expressed as:

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

where R = Reduction factor which is less than unity.

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

The estimated value of capacity is based primarily upon the type of facility and on roadway geometrics. Sections of roadway with adverse geometrics are characterized by lower free-flow speeds and lane capacity.

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

Application to the Calvert Cliffs Nuclear Power Plant EPZ

As part of the development of the Calvert Cliffs Nuclear Power Plant (CCNPP) 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 CCNPP EPZ consists primarily of two categories of roads and, of course, intersections:

- Two-lane roads: Local, State Routes
- Multi-lane Highways (at-grade)

Each of these classifications will be discussed.

Two-Lane Roads

Ref: HCM Chapter 20

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

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

- Most sections of two-lane roads within the EPZ are classified as “Class I”, with "level terrain"; some are “rolling terrain”.
- “Class II” highways are mostly those within city limits.

Multi-Lane Highway

Ref: HCM Chapter 21

Exhibit 21-23 (in the HCM) presents a set of curves that indicates a per-lane capacity of approximately 2100 pc/h, for free-speeds of 55-60 mph. Based on observation, the multi-lane highways outside of urban areas within the EPZ, service traffic with free-speeds in this range. The actual time-varying speeds computed by the simulation model reflect the demand:capacity relationship and the impact of control at intersections.

Intersections

Ref: HCM Chapters 16, 17

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

5. ESTIMATION OF TRIP GENERATION TIME

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). We define the sum of these distributions of elapsed times as the Trip Generation Time Distribution.

Background

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

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

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

a. The Advisory to Evacuate will be announced coincident with the emergency notification.
b. Mobilization of the general population will commence up to 10 minutes after the alert notification.
c. Evacuation Time Estimates (ETEs) are measured relative to the Advisory to Evacuate.
d. Schools will be evacuated prior to the Advisory to Evacuate; if circumstances permit.

We emphasize that the adoption of this planning basis is not a representation that these events will occur at the Calvert Cliffs Nuclear Power Plant (CCNPP) 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 more likely that a longer time will elapse between the various classes of an emergency at CCNPP and that the Advisory to Evacuate is announced somewhat later than the siren alert.

For example, suppose one hour elapses from the siren alert to the Advisory to Evacuate. In this case, it is reasonable to expect some degree of spontaneous evacuation by the public during this one-hour period, resulting in a lower number of people evacuating within the Emergency Planning Zone (EPZ) when the Advisory to Evacuate is announced. Thus, the time needed to evacuate the EPZ, after the Advisory to Evacuate will be less than the estimates presented in this report, since this study assumes no time lapse between the sirens and the Advisory to Evacuate.

The notification process consists of two events:

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

The peak permanent resident population within the EPZ approximates 55,000 persons who are deployed over an area of approximately 182 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 TV and/or radio. Those EPZ residents who are 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

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
	Snow clearance	5

*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, we adopt the conservative posture that all activities will occur in sequence.

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

Estimated Time Distributions of Activities Preceding Event 5

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

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

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

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

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

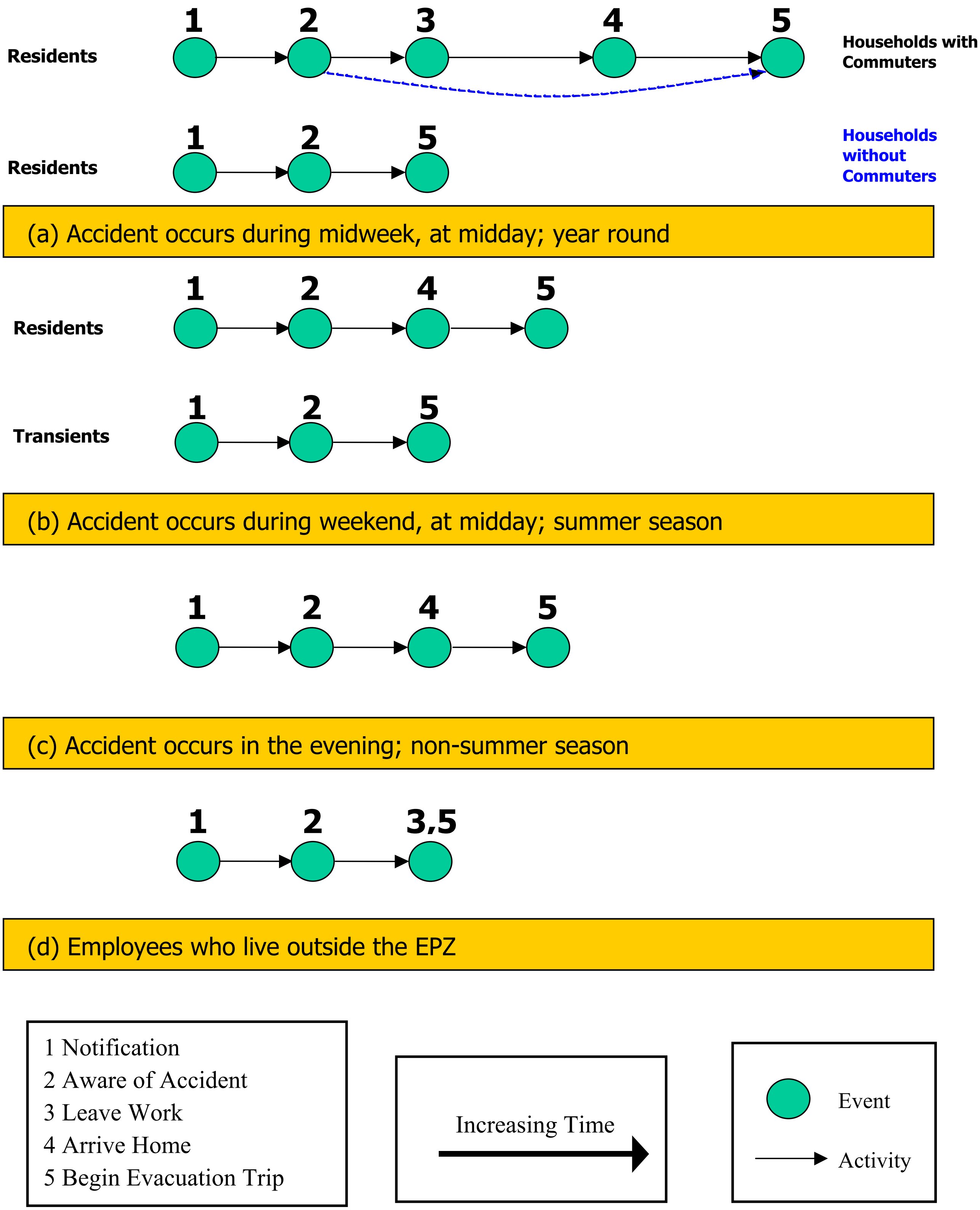


Figure 5-1. Events and Activities Preceding the Evacuation Trip

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
5	36
10	50
15	60
20	69
25	75
30	78
35	82
40	85
45	88
50	90
55	92
60	95
65	95
70	96
75	97
80	97
85	98
90	98
95	99
100	99
105	99
110	99
115	100

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
5	6
10	17
15	32
20	44
25	51
30	64
35	68
40	72
45	76
50	78
55	80
60	84
65	85
70	87
75	89
80	91
85	93
90	95
95	96
100	97
105	98
110	98
115	99
120	100

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
5	10
10	19
15	29
20	41
25	54
30	63
35	68
40	72
45	75
50	79
55	83
60	87
65	90
70	91
75	93
80	93
85	93
90	93
95	93
100	94
105	94
110	94
115	95
120	96
125	96
130	97
135	97
140	98
145	99
150	100

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.

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. The snow removal mobilization time distribution, recently obtained from the telephone survey results of the Susquehanna Steam Electric Station (SSES) EPZ, was adapted. 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

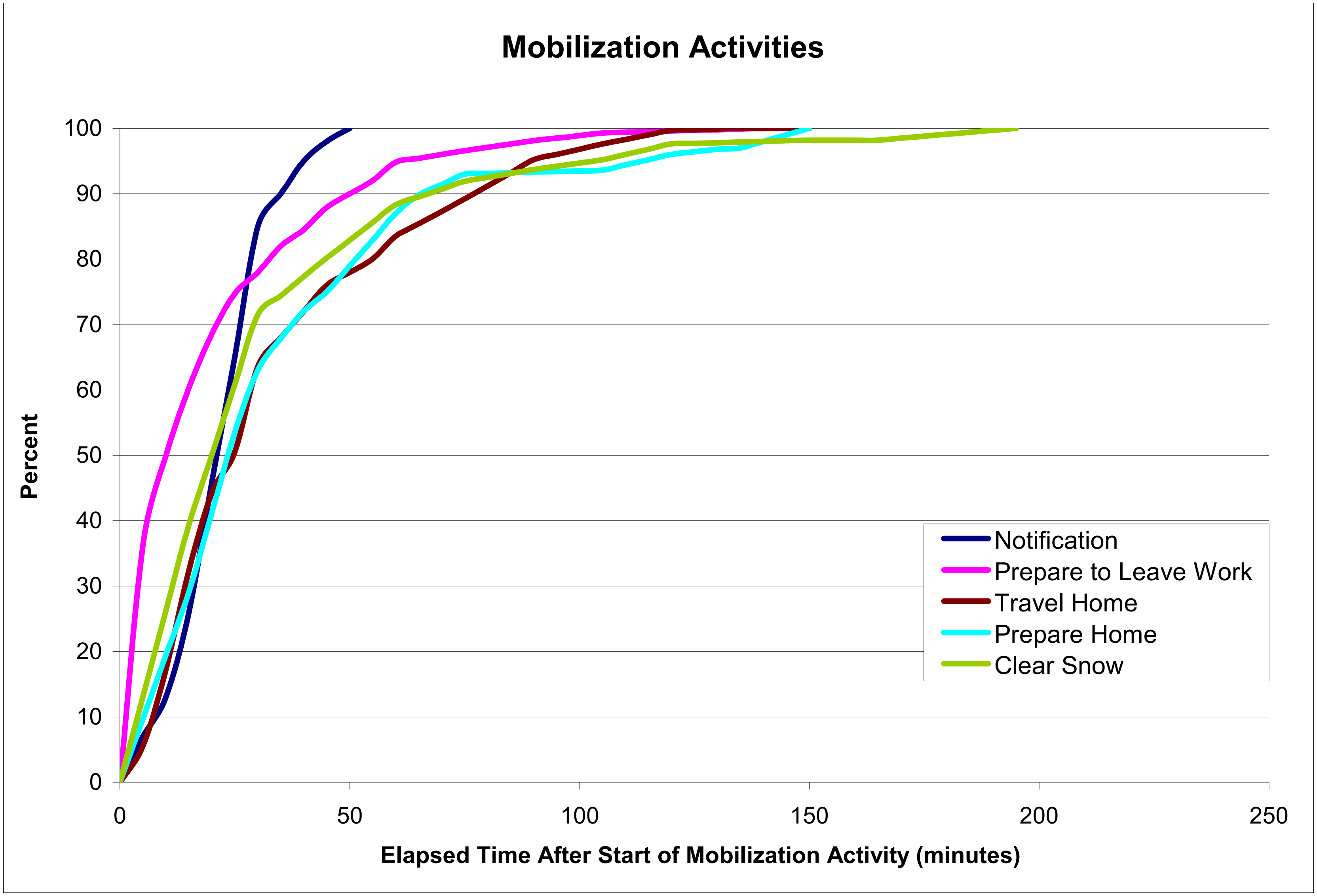


Figure 5-2. Evacuation Mobilization Activities

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. We assume that the stated events take place in sequence such that all preceding events must be completed before the current event can occur. For example, if a household awaits the return of a commuter, the work-to-home trip (Activity 3 $\rightarrow$ 4) must precede Activity 4 $\rightarrow$ 5.

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

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

Distributions A through D 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 who live outside, and to Transients within the EPZ.
B	Time distribution of commuters arriving home.
C	Time distribution of residents with commuters leaving home to begin the evacuation trip.
D	Time distribution of residents without commuters returning home to begin the evacuation trip.
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 who return home, leaving home 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).

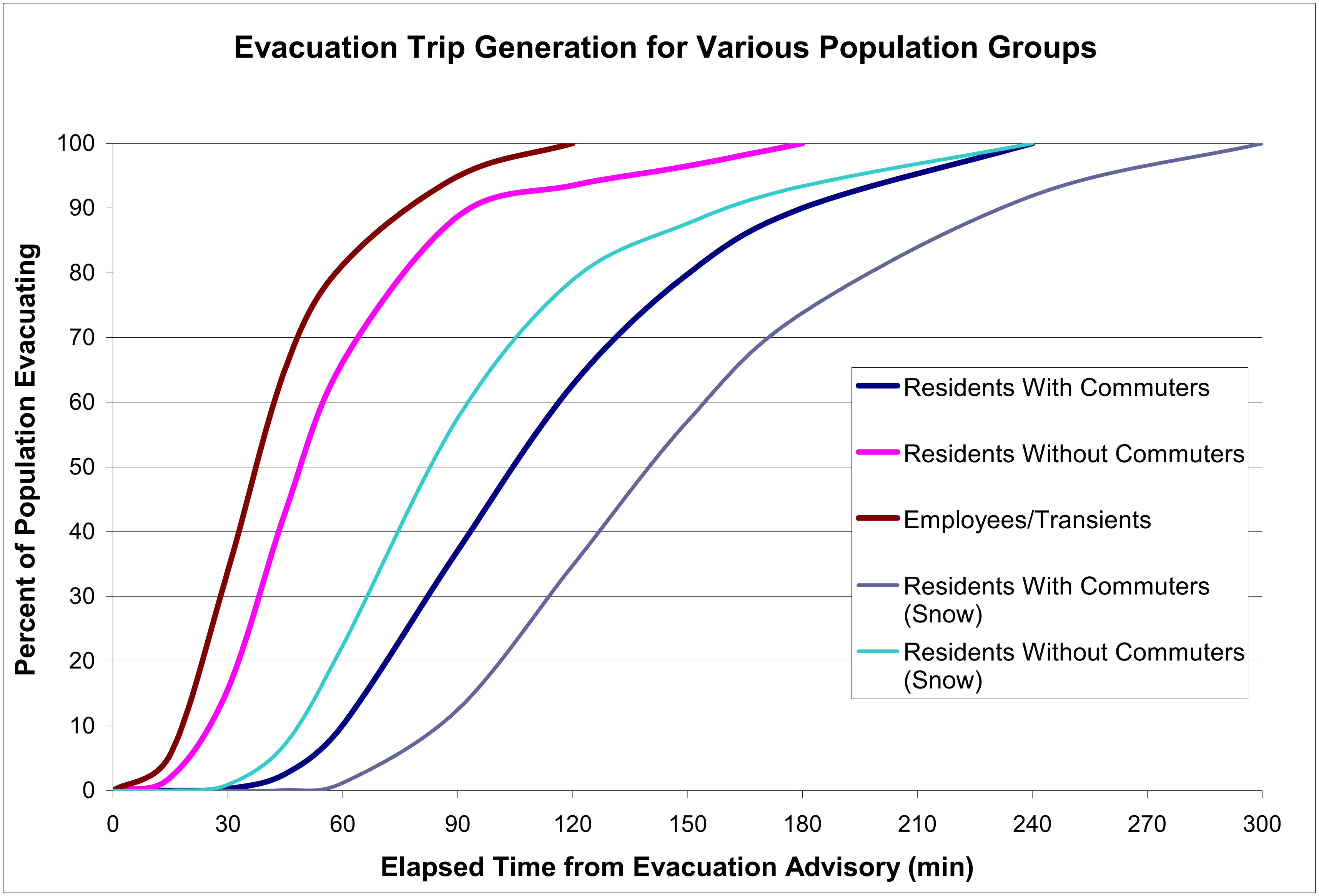


Figure 5-3. Comparison of Trip Generation Distributions

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

Time Period	Duration (Min)	Percent of Total Trips Generated Within Indicated Time Period					
		Residents With Commuters (Distribution C)	Residents Without Commuters (Distribution D)	Employees (Distribution A)	Transients (Distribution A)	Residents With Commuters Snow (Distribution E)	Residents Without Commuters Snow (Distribution F)
1	15	0	2	6	6	0	0
2	15	0	14	28	28	0	1
3	15	2	27	31	31	0	6
4	15	8	23	16	16	1	15
5	30	27	23	14	14	11	35
6	30	26	5	5	5	22	21
7	30	17	3	0	0	22	9
8	30	10	3	0	0	18	6
9	60	10	0	0	0	18	7
10	60	0	0	0	0	8	0
11	900	0	0	0	0	0	0

6. DEMAND ESTIMATION FOR EVACUATION SCENARIOS

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

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

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

A total of 14 Regions were defined which encompass all the groupings of Zones considered. These Regions are defined in Table 6-1. The zone configurations are identified in Figure 6-1. Each keyhole sector-based area consists of a circular area centered at the Calvert Cliffs Nuclear Power Plant (CCNPP), and three adjoining sectors, each with a central angle of 22.5 degrees. These sectors extend to a distance of 5 miles from CCNPP (Regions R4 and R5), or to the EPZ boundary (Regions R06 to R14). The azimuth of the center sector defines the orientation of these Regions.

A total of 14 Scenarios were evaluated for all Regions. Thus, there are a total of 14x14=196 evacuation cases. Table 6-2 is a description of all Scenarios.

Each combination of Region and Scenario implies a specific population to be evacuated. Table 6-3 presents the percentage of each population group assumed to evacuate for each Scenario. Table 6-4 presents the vehicle counts for each Scenario.

As discussed in Section 3, the construction scenario (Scenario 11) uses resident and shadow population numbers that are projected to 2013. Table 6-4 shows that the total number of permanent residents vehicles in 2013 is 30,959 (20,040 + 10,919); Table 6-5 lists the break-down by Zone.

Table 6-1. Description of Evacuation Regions									
Region	Description	ZONE							
		1	2	3	4	5	6	7	8
R01	2-Mile Ring	X							
R02	5-Mile Ring	X	X	X					
R03	Full EPZ	X	X	X	X	X	X	X	X
Evacuate 2-Mile Ring and 5 Miles Downwind									
Region	**Wind Direction Towards:**	**ZONE**							
		1	2	3	4	5	6	7	8
	N, NNE, NE, ENE, E	**See Region 1**							
R04	ESE, SE, SSE, S	X		X					
	SSW, SW, WSW	**See Region 2**							
R05	W, WNW, NW, NNW	X	X						
Evacuate 5-Mile Ring and Downwind to EPZ Boundary									
Region	**Wind Direction Towards:**	**ZONE**							
		1	2	3	4	5	6	7	8
	NNE	**See Region 2**							
R06	NE, ENE, E, ESE, SE	X	X	X					X
R07	SSE, S	X	X	X				X	
R08	SSW, SW	X	X	X			X	X	
R09	WSW	X	X	X	X		X	X	
R10	W	X	X	X	X		X		
R11	WNW	X	X	X	X	X	X		
R12	NW, NNW	X	X	X	X	X			
R13	N	X	X	X		X			
R14	*	X							X

*This Region was added at Constellation Energy's request. It is an evacuation of the 2-Mile Ring and downwind (Towards Dorchester County) to the EPZ Boundary.

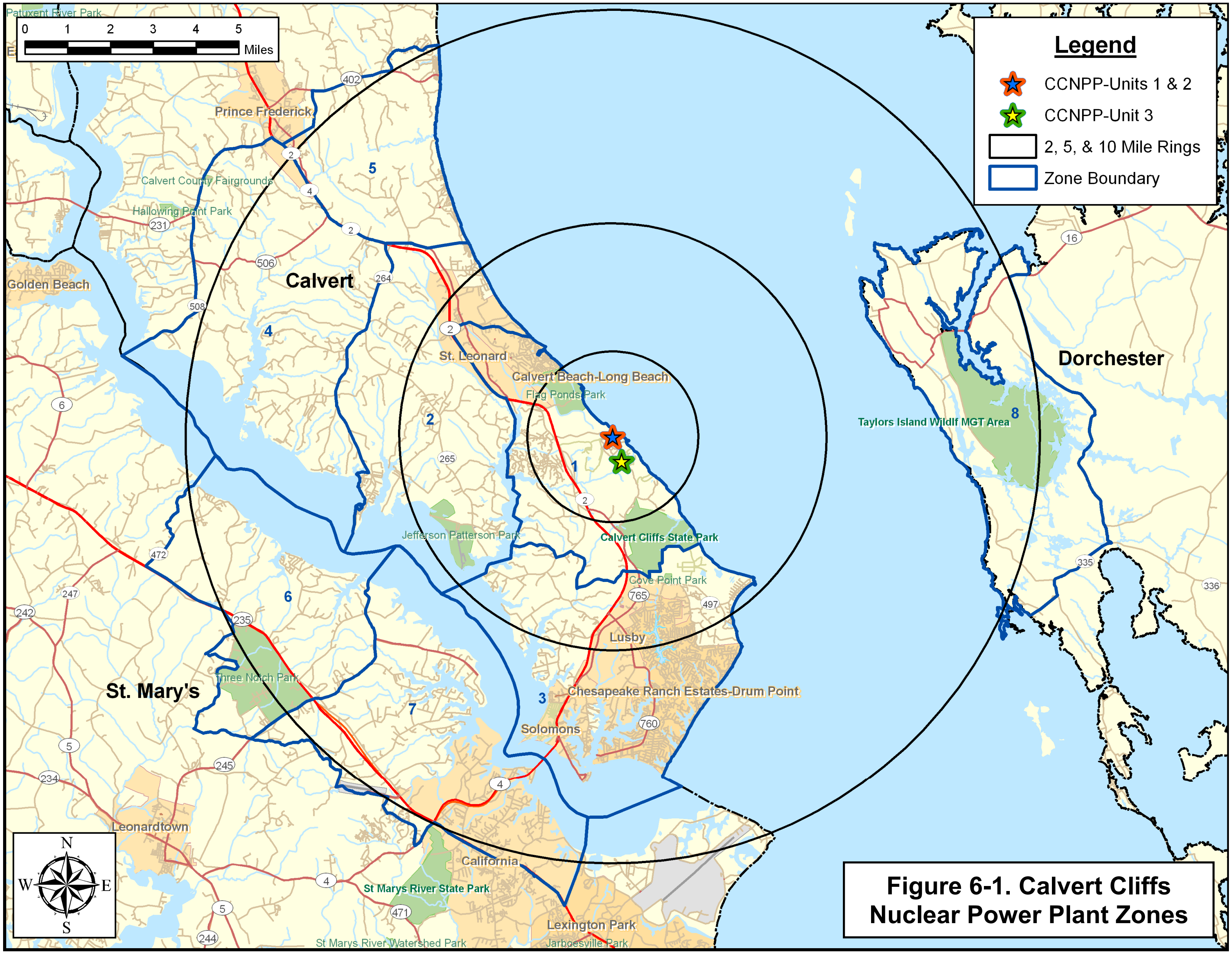


Figure 6-1. Calvert Cliffs Nuclear Power Plant Zones

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	Weekend	Midday	Good	None
9	Winter	Weekend	Midday	Rain	None
10	Winter	Midweek, Weekend	Evening	Good	None
11	Summer	Midweek	Midday	Good	New Plant Construction
12	Summer	Weekend	Midday	Good	Air Show at the Naval Base
13	Winter	Midweek	Midday	Snow	None
14	Winter	Weekend	Midday	Snow	None

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 Events	School Buses	Transit Buses	External Through Traffic
1	65%	35%	96%	50%	31%	0%	10%	100%	100%
2	65%	35%	96%	50%	31%	0%	10%	100%	100%
3	6%	94%	47%	100%	31%	0%	0%	100%	100%
4	6%	94%	47%	100%	31%	0%	0%	100%	100%
5	6%	94%	10%	25%	30%	0%	0%	100%	60%
6	65%	35%	100%	25%	31%	0%	100%	100%	100%
7	65%	35%	100%	25%	31%	0%	100%	100%	100%
8	6%	94%	47%	40%	31%	0%	0%	100%	100%
9	6%	94%	47%	40%	31%	0%	0%	100%	100%
10	6%	94%	10%	15%	30%	0%	0%	100%	60%
11	65%	35%	96%	50%	31%	100%	10%	100%	100%
12	6%	94%	47%	100%	31%	100%	0%	100%	100%
13	65%	35%	100%	25%	31%	0%	100%	100%	100%
14	6%	94%	47%	40%	31%	0%	0%	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 Events .... Additional vehicles in the CCNPP EPZ area during the construction phase of the new unit and the Air Show at the Patuxent Naval Air Base.

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.

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

Scenarios	Residents with Commuters	Residents without Commuters	Employees	Transients	Shadow	Special Events	School Buses	Transit Buses	External Traffic	Total Scenario Vehicles
1	18,665	10,166	1,356	1,801	9,898	-	30	66	2,400	44,382
2	18,665	10,166	1,356	1,801	9,898	-	30	66	2,400	44,382
3	1,867	26,965	664	3,601	9,671	-	-	66	2,400	45,234
4	1,867	26,965	664	3,601	9,671	-	-	66	2,400	45,234
5	1,867	26,965	141	900	9,500	-	-	66	1,440	40,879
6	18,665	10,166	1,413	900	9,917	-	294	66	2,400	43,821
7	18,665	10,166	1,413	900	9,917	-	294	66	2,400	43,821
8	1,867	26,965	664	1,440	9,671	-	-	66	2,400	43,073
9	1,867	26,965	664	1,440	9,671	-	-	66	2,400	43,073
10	1,867	26,965	141	540	9,500	-	-	66	1,440	40,519
11†	20,040	10,919	1,356	1,801	10,849	2,821	30	66	2,400	50,282
12*	473	6,775	664	3,601	2,595	43,480	-	66	2,400	60,054
13	18,665	10,166	1,413	900	9,917	-	294	66	2,400	43,821
14	1,867	26,965	664	1,440	9,671	-	-	66	2,400	43,073

†Permanent Resident population and Shadow population have been extrapolated to the Year 2013, which is when construction workforce will be at its peak.

***Based on an assumption that 75% of the population within the EPZ and Shadow will be attending the Air Show, the loading of the residents within the EPZ and in the shadow area have been adjusted appropriately.**

Populations for all Scenarios except Scenario 11 are projected to the year 2008.

Table 6-5. Estimated Permanent Resident Population in 2013			
Zone	**2008 Population**	**2013 Population**	**2013 Vehicles**
1	6,484	6,856	3,585
2	5,040	5,329	2,797
3	21,080	22,288	11,644
4	5,112	5,405	2,829
5	2,820	2,982	1,564
6	5,074	5,645	2,952
7	9,284	10,329	5,412
8	311	329	176
TOTAL:	**55,205**	**59,162**	**30,959**

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 14 regions within the CCNPP EPZ and the 14 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 areas. These data are generated at 10-minute intervals, then interpolated to the nearest 5 minutes.

NRC guidance suggests routing traffic during evacuation away from CCNPP and out of the EPZ to the extent practicable. Zone 3, which is the most populous of all zones within the EPZ is south of CCNPP and has only 1 evacuation route – Maryland Route 2/4. If all the traffic from this Zone were routed away from the plant in the southbound direction, they would have to use the Thomas Johnson Bridge (1-lane in either direction), which presents a significant traffic bottleneck. A sensitivity study was conducted to measure the effect of routing evacuees from Zone 3 northbound on Route 2/4. Balancing the vehicle demand from Zone 3 in the northbound and southbound directions on Route 2/4 results in a significant decrease in ETE (3 hours and 50 minutes less) than routing only southbound (See Appendix I). Although this routing moves some of the evacuees closer to CCNPP, the ETE is significantly reduced, minimizing the risk of exposure. **All the results presented in this section and in Appendix J are based on routing evacuating traffic from Zone 3 northbound and southbound on Route 2/4.**

7.1 Voluntary Evacuation and Shadow Evacuation

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

The ETE for the CCNPP addresses 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 Evacuation Region. This region extends radially from the boundary of the EPZ to a distance of 15 miles from CCNPP.

Traffic generated within this Shadow Evacuation Region, traveling away from the CCNPP location, has the potential for impeding evacuating vehicles from within the Evacuation Region. We assume that the traffic volumes emitted within the Shadow

Evacuation Region correspond to 30 percent of the residents there plus a proportionate number of employees in that region. **All ETE calculations include this shadow traffic movement.**

7.2 Patterns of Traffic Congestion During Evacuation

Figures 7-3 through 7-6 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 red line; all others are lightly indicated. Congestion develops in areas with concentrations of population and at traffic bottlenecks. Congestion develops at one and a half hours after the Advisory to Evacuate (ATE) along southbound Route 2/4 (south of CCNPP), especially around Rousby Hall Rd (State Route 760) and the Thomas Johnson Bridge. Additionally, sections of Route 2/4 around Broomes Island Road (Route 264) and Prince Frederick are congested (Figure 7-3).

Key links are labeled on Figures 7-3 to 7-6 and the average delay in minutes per vehicle is presented in a table on page 7-4.

Figure 7-4 presents the congestion pattern 3 and a half hours after the ATE. Congestion persists in the aforementioned areas within the EPZ and along Point Lookout Road (Route 5) in the shadow area. By four and three quarter hours (Figure 7-5), congestion is beginning to dissipate and only persists along Rousby Hall Rd (Route

760), the Southern/Lusby Connector, Broomes Island Road (Route 264), and Route 2/4, north of Prince Frederick. After five hours and forty minutes (Figure 7-6), congestion only remains around the Thomas Johnson Bridge. The absence of congestion on network links (white colored links) implies that traffic demand there has decreased below the roadway capacity for a period of time sufficient to dissipate any traffic queues. It does not necessarily imply that traffic has completely cleared from these roadway sections.

Average Delay for Selected Roadways in the CCNPP EPZ							
Congestion Point Number[1]	Link		Description	Average Delay (min/veh) at Indicated Time (hour:min) after Advisory to Evacuate			
	From Node	To Node		1:30	3:00	4:30	5:30
1	142	22	MD 264 Broomes Island Road Northbound	8.5	8.6	8.4	0.0
2	21	22	MD 2/4 Northbound in Port Republic	2.9	2.9	2.4	0.0
3	184	176	MD 760 Rousby Hall Road Westbound	9.2	9.0	0.0	3.1
4	12	13	TJ Bridge Southbound	3.2	3.6	3.3	3.3
5	293	66	MD 471 St. Andrews Church Road Southbound	0.0	0.0	0.0	0.0
6	74	328	MD 247 Loveville Road Southbound	0.0	0.0	0.0	0.0
7	45	16	MD 235 Three Notch Road Northbound in California	9.6	9.6	9.6	0.0
8	24	26	MD 2/4 Northbound in Prince Frederick	0.0	1.1	0.2	0.0

7.3 Evacuation Rates

Evacuation is a continuous process, as implied by Figures 7-3 through 7-6. 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. It is reasonable to expect that some evacuees may delay or lengthen their mobilization activities and evacuate at a later time as a result; these ETE estimates do not (and should not) be distorted to account for these relatively few stragglers.

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

7.4 Guidance on Using ETE Tables

Tables 7-1A through 7-1D present the ETE values for all 14 Evacuation Regions and all 14 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
     - New Plant Construction
     - Air show at Naval Air Base

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

- The conditions of summer evenings and rain are not explicitly identified in

Tables 7-1A through 7-1D. For these conditions, Scenario 4 provides a conservative estimate of ETE.

- Likewise, the conditions of winter evenings and rain are not explicitly identified in Tables 7-1A through 7-1D. For these conditions, Scenario 9 provides a conservative estimate of ETE.
- 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 CCNPP. The applicable distances and their associated candidate Regions are given below:
     - 2 Miles (Region R01)
     - 5 Miles (Regions R02, R04 and R05)
     - to EPZ Boundary (Regions R03 and R06 through R14)
   - 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 the CCNPP. Select the Evacuation Region identifier in that row from the first column of the Table.

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

<u>Example</u>

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

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

population from within the impacted Region.

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

1. Identify the Scenario parameters as: *Season*: summer; *Day of Week*: weekend; *Time of Day*: evening (non-work hours); and *Weather*: Rain. Entering Table 7-1C, it is seen that there is no match for these descriptors. However, based on the discussions above (Section 7.4, item 1), Scenario 4 provides guidance as an upper bound on ETE.

2. Enter Table 7-2 and locate the group entitled "Evacuate 5-Mile Ring and Downwind to EPZ Boundary". Under "Wind Direction Towards:", identify the NE (northeast) azimuth and read REGION R06 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 R06. This data cell is in column (4) and in the row for Region R06; it contains the ETE value of **5:45**.

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

Season		Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer	Winter	Winter	Season
Day of Week		Midweek		Weekend		All	Midweek		Weekend		All	Midweek	Weekend	Midweek	Weekend	Day of Week
Scenario:		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	Scenario
Time of Day		Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday	Midday	Midday	Time of Day
Zone	Region Wind Direction Towards	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	New Plant Construction	Air Show at Base	Snow	Snow	Region Wind Direction Towards
Entire 2-Mile Region, 5-Mile Region, and EPZ																
1	R01 2-mile ring	1:30	1:35	1:25	1:30	1:20	1:30	1:30	1:20	1:30	1:20	1:50	1:00	1:55	1:50	R01 2-mile ring
1,2,3	R02 5-mile ring	2:30	2:45	2:30	2:45	2:15	2:30	2:45	2:25	2:35	2:15	2:50	1:20	3:15	3:10	R02 5-mile ring
1,2,3,4,5, 6,7,8	R03 Entire EPZ	2:20	2:30	2:15	2:30	2:10	2:20	2:30	2:10	2:20	2:05	2:35	4:20	3:00	2:50	R03 Entire EPZ
2-Mile Ring and Downwind to 5 Miles																
1	N, NNE, NE, ENE, E	Refer to Region 1														N, NNE, NE, ENE, E
1,3	R04 ESE, SE, SSE, S	2:20	2:30	2:20	2:35	2:05	2:15	2:30	2:15	2:25	2:05	2:40	1:25	3:00	2:55	R04 ESE, SE, SSE, S
1,2,3	SSW, SW, WSW	Refer to Region 2														SSW, SW, WSW
1,2	R05 W, WNW, NW, NNW	1:45	1:55	1:45	1:55	1:40	1:45	1:55	1:40	1:50	1:40	2:10	1:00	2:20	2:15	R05 W, WNW, NW, NNW
5-Mile Ring and Downwind to EPZ Boundary																
1,2,3	NNE	Refer to Region 2														NNE
1,2,3,8	R06 NE, ENE, E, ESE, SE	2:30	2:45	2:30	2:45	2:15	2:30	2:45	2:20	2:35	2:15	2:50	1:20	3:15	3:10	R06 NE, ENE, E, ESE, SE
1,2,3,7	R07 SSE, S	2:25	2:35	2:20	2:35	2:10	2:20	2:30	2:15	2:25	2:10	2:40	4:35	3:00	2:55	R07 SSE, S
1,2,3,6,7	R08 SSW, SW	2:20	2:30	2:15	2:25	2:05	2:20	2:25	2:10	2:20	2:05	2:35	4:35	2:55	2:50	R08 SSW, SW
1,2,3,4,6, 7	R09 WSW	2:20	2:30	2:20	2:30	2:10	2:20	2:30	2:10	2:20	2:10	2:35	4:25	3:00	2:50	R09 WSW
1,2,3,4,6	R10 W	2:20	2:30	2:15	2:30	2:05	2:20	2:30	2:10	2:20	2:05	2:35	4:05	3:00	2:50	R10 W
1,2,3,4,5, 6	R11 WNW	2:20	2:30	2:15	2:30	2:05	2:20	2:30	2:10	2:25	2:05	2:35	4:00	3:00	2:50	R11 WNW
1,2,3,4,5	R12 NW, NNW	2:30	2:45	2:25	2:45	2:15	2:30	2:45	2:20	2:40	2:15	2:50	1:25	3:20	3:10	R12 NW, NNW
1,2,3,5	R13 N	2:30	2:45	2:30	2:45	2:15	2:30	2:45	2:25	2:35	2:15	2:50	1:30	3:15	3:10	R13 N
1,8	R14	1:30	1:35	1:25	1:30	1:20	1:30	1:35	1:20	1:30	1:20	1:50	1:00	1:55	1:50	R14

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

Season		Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer	Winter	Winter	Season
Day of Week		Midweek		Weekend		All	Midweek		Weekend		All	Midweek	Weekend	Midweek	Weekend	Day of Week
Scenario:		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	Scenario
Time of Day		Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday	Midday	Midday	Time of Day
Zone	Region Wind Direction	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	New Plant Construction	Air Show at Base	Snow	Snow	Region Wind Direction
Entire 2-Mile Region, 5-Mile Region, and EPZ																
1	R01 2-mile ring	2:45	2:50	2:30	2:45	2:25	2:50	2:50	2:25	2:40	2:25	3:25	1:50	3:40	3:20	R01 2-mile ring
1,2,3	R02 5-mile ring	4:20	4:50	4:30	5:10	3:55	4:15	4:45	4:10	4:40	3:55	5:00	4:55	5:30	5:25	R02 5-mile ring
1,2,3,4,5, 6,7,8	R03 Entire EPZ	4:30	5:00	4:35	5:05	4:10	4:30	4:50	4:20	4:45	4:05	5:10	9:55	5:40	5:35	R03 Entire EPZ
2-Mile Ring and Downwind to 5 Miles																
1	N, NNE, NE, ENE, E	Refer to Region 1														N, NNE, NE, ENE, E
1,3	R04 ESE, SE, SSE, S	4:25	4:55	4:40	5:15	4:00	4:15	4:50	4:15	4:45	3:50	4:40	4:55	5:35	5:35	R04 ESE, SE, SSE, S
1,2,3	SSW, SW, WSW	Refer to Region 2														SSW, SW, WSW
1,2	R05 W, WNW, NW, NNW	3:05	3:25	3:05	3:20	2:50	3:05	3:25	3:00	3:15	2:50	4:00	1:50	4:05	4:00	R05 W, WNW, NW, NNW
5-Mile Ring and Downwind to EPZ Boundary																
1,2,3	NNE	Refer to Region 2														NNE
1,2,3,8	R06 NE, ENE, E, ESE, SE	4:20	4:45	4:30	5:05	3:55	4:15	4:40	4:10	4:40	3:55	5:00	4:55	5:30	5:25	R06 NE, ENE, E, ESE, SE
1,2,3,7	R07 SSE, S	4:25	4:55	4:35	5:10	4:00	4:20	4:45	4:15	4:45	4:00	5:00	9:50	5:35	5:30	R07 SSE, S
1,2,3,6,7	R08 SSW, SW	4:25	4:55	4:35	5:10	4:00	4:20	4:40	4:10	4:40	3:55	5:00	9:55	5:30	5:30	R08 SSW, SW
1,2,3,4,6, 7	R09 WSW	4:30	5:00	4:35	5:05	4:10	4:30	4:50	4:20	4:45	4:05	5:10	9:55	5:40	5:35	R09 WSW
1,2,3,4,6	R10 W	4:30	4:55	4:35	5:10	4:10	4:25	4:55	4:20	4:45	4:05	5:05	9:40	5:40	5:35	R10 W
1,2,3,4,5, 6	R11 WNW	4:30	4:55	4:35	5:10	4:10	4:30	4:55	4:20	4:45	4:05	5:10	9:40	5:40	5:35	R11 WNW
1,2,3,4,5	R12 NW, NNW	4:30	4:55	4:35	5:05	4:10	4:30	4:55	4:20	4:45	4:05	5:15	4:40	5:45	5:35	R12 NW, NNW
1,2,3,5	R13 N	4:25	4:55	4:35	5:15	4:05	4:25	4:50	4:15	4:45	4:00	5:05	5:05	5:40	5:30	R13 N
1,8	R14	2:45	2:50	2:35	2:50	2:25	2:50	2:50	2:30	2:50	2:25	3:30	1:50	3:40	3:20	R14

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

Season		Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer	Winter	Winter	Season
Day of Week		Midweek		Weekend		All	Midweek		Weekend		All	Midweek	Weekend	Midweek	Weekend	Day of Week
Scenario:		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	Scenario
Time of Day		Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday	Midday	Midday	Time of Day
Zone	Region Wind Direction Towards	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	New Plant Construction	Air Show at Base	Snow	Snow	Region Wind Direction
Entire 2-Mile Region, 5-Mile Region, and EPZ																
1	R01 2-mile ring	3:10	3:15	2:45	3:00	2:45	3:10	3:15	2:45	2:55	2:45	3:50	2:05	4:05	3:40	R01 2-mile ring
1,2,3	R02 5-mile ring	4:45	5:20	5:05	5:45	4:20	4:40	5:15	4:40	5:10	4:15	5:15	5:45	6:00	6:00	R02 5-mile ring
1,2,3,4,5, 6,7,8	R03 Entire EPZ	4:55	5:30	5:10	5:45	4:30	4:50	5:15	4:45	5:15	4:25	5:35	10:35	6:10	6:10	R03 Entire EPZ
2-Mile Ring and Downwind to 5 Miles																
1	N, NNE, NE, ENE, E	Refer to Region 1														N, NNE, NE, ENE, E
1,3	R04 ESE, SE, SSE, S	4:50	5:25	5:10	5:45	4:25	4:45	5:15	4:45	5:15	4:20	5:05	5:40	6:05	6:05	R04 ESE, SE, SSE, S
1,2,3	SSW, SW, WSW	Refer to Region 2														SSW, SW, WSW
1,2	R05 W, WNW, NW, NNW	3:20	3:40	3:15	3:35	3:00	3:20	3:35	3:10	3:30	3:00	4:10	2:10	4:20	4:10	R05 W, WNW, NW, NNW
5-Mile Ring and Downwind to EPZ Boundary																
1,2,3	NNE	Refer to Region 2														NNE
1,2,3,8	R06 NE, ENE, E, ESE, SE	4:45	5:20	5:05	5:45	4:20	4:40	5:15	4:40	5:10	4:15	5:15	5:45	6:00	6:00	R06 NE, ENE, E, ESE, SE
1,2,3,7	R07 SSE, S	5:00	5:30	5:15	5:50	4:30	4:50	5:15	4:45	5:20	4:25	5:25	10:30	6:10	6:10	R07 SSE, S
1,2,3,6,7	R08 SSW, SW	5:00	5:30	5:15	5:50	4:30	4:50	5:15	4:45	5:20	4:25	5:20	10:40	6:10	6:10	R08 SSW, SW
1,2,3,4,6, 7	R09 WSW	4:55	5:30	5:10	5:45	4:30	4:50	5:15	4:45	5:15	4:30	5:35	10:40	6:10	6:10	R09 WSW
1,2,3,4,6	R10 W	4:50	5:25	5:10	5:50	4:30	4:50	5:20	4:45	5:15	4:25	5:30	10:30	6:05	6:05	R10 W
1,2,3,4,5, 6	R11 WNW	4:50	5:25	5:10	5:50	4:30	4:50	5:20	4:45	5:15	4:25	5:30	10:25	6:05	6:00	R11 WNW
1,2,3,4,5	R12 NW, NNW	4:50	5:20	5:00	5:35	4:25	4:45	5:15	4:40	5:10	4:25	5:30	5:35	6:05	6:00	R12 NW, NNW
1,2,3,5	R13 N	4:50	5:25	5:10	5:50	4:25	4:45	5:20	4:45	5:15	4:20	5:25	5:50	6:05	6:05	R13 N
1,8	R14	3:10	3:15	2:45	3:05	2:50	3:10	3:15	2:45	3:00	2:50	3:50	2:10	4:05	3:40	R14

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

Season		Summer	Summer	Summer	Summer	Summer	Winter	Winter	Winter	Winter	Winter	Summer	Summer	Winter	Winter	Season
Day of Week		Midweek		Weekend		All	Midweek		Weekend		All	Midweek	Weekend	Midweek	Weekend	Day of Week
Scenario:		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	Scenario
Time of Day		Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday	Midday	Midday	Time of Day
Zone	Region Wind Direction	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	New Plant Construction	Air Show at Base	Snow	Snow	Region Wind Direction Towards
Entire 2-Mile Region, 5-Mile Region, and EPZ																
1	R01 2-mile ring	4:10	4:10	4:05	4:15	4:05	4:10	4:15	4:10	4:10	4:15	4:30	4:00	5:15	5:15	R01 2-mile ring
1,2,3	R02 5-mile ring	5:25	6:05	5:55	6:30	5:00	5:20	5:55	5:20	5:55	4:50	5:50	6:35	6:45	6:40	R02 5-mile ring
1,2,3,4,5, 6,7,8	R03 Entire EPZ	6:00	6:45	6:25	7:10	5:30	5:50	6:20	5:50	6:30	5:25	6:30	11:30	7:25	7:25	R03 Entire EPZ
2-Mile Ring and Downwind to 5 Miles																
1	N, NNE, NE, ENE, E	Refer to Region 1														N, NNE, NE, ENE, E
1,3	R04 ESE, SE, SSE, S	5:25	6:05	5:55	6:35	4:55	5:20	5:50	5:15	5:50	4:50	5:45	6:20	6:45	6:40	R04 ESE, SE, SSE, S
1,2,3	SSW, SW, WSW	Refer to Region 2														SSW, SW, WSW
1,2	R05 W, WNW, NW, NNW	4:15	4:20	4:15	4:15	4:15	4:15	4:20	4:10	4:15	4:10	4:50	4:10	5:20	5:15	R05 W, WNW, NW, NNW
5-Mile Ring and Downwind to EPZ Boundary																
1,2,3	NNE	Refer to Region 2														NNE
1,2,3,8	R06 NE, ENE, E, ESE, SE	5:25	6:05	5:55	6:30	5:00	5:20	5:55	5:20	5:55	4:50	5:50	6:35	6:45	6:40	R06 NE, ENE, E, ESE, SE
1,2,3,7	R07 SSE, S	6:00	6:35	6:20	7:00	5:20	5:45	6:15	5:45	6:20	5:20	6:20	11:25	7:15	7:20	R07 SSE, S
1,2,3,6,7	R08 SSW, SW	6:00	6:45	6:25	7:10	5:30	5:50	6:20	5:50	6:30	5:25	6:30	11:30	7:25	7:30	R08 SSW, SW
1,2,3,4,6, 7	R09 WSW	6:00	6:45	6:25	7:10	5:30	5:50	6:20	5:50	6:30	5:25	6:30	11:30	7:25	7:25	R09 WSW
1,2,3,4,6	R10 W	5:45	6:20	6:15	7:00	5:20	5:45	6:20	5:45	6:20	5:20	6:10	11:20	7:05	7:05	R10 W
1,2,3,4,5, 6	R11 WNW	5:45	6:20	6:15	7:00	5:20	5:45	6:20	5:45	6:20	5:20	6:10	11:20	7:05	7:05	R11 WNW
1,2,3,4,5	R12 NW, NNW	5:25	6:05	5:55	6:30	4:55	5:20	5:55	5:20	5:55	4:50	5:50	6:35	6:45	6:40	R12 NW, NNW
1,2,3,5	R13 N	5:25	6:05	5:55	6:30	5:00	5:20	5:55	5:20	5:55	4:50	5:50	6:35	6:45	6:40	R13 N
1,8	R14	4:10	4:10	4:10	4:15	4:10	4:10	4:20	4:10	4:10	4:15	4:35	4:05	5:15	5:15	R14

Table 7-2. Description of Evacuation Regions									
Region	**Description**	**ZONE**							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
R01	2-Mile Ring	X							
R02	5-Mile Ring	X	X	X					
R03	Full EPZ	X	X	X	X	X	X	X	X
Evacuate 2-Mile Ring and 5 Miles Downwind									
Region	**Wind Direction Towards:**	**ZONE**							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	N, NNE, NE, ENE, E	**See Region 1**							
R04	ESE, SE, SSE, S	X		X					
	SSW, SW, WSW	**See Region 2**							
R05	W, WNW, NW, NNW	X	X						
Evacuate 5-Mile Ring and Downwind to EPZ Boundary									
Region	**Wind Direction Towards:**	**ZONE**							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	NNE	**See Region 2**							
R06	NE, ENE, E, ESE, SE	X	X	X					X
R07	SSE, S	X	X	X				X	
R08	SSW, SW	X	X	X			X	X	
R09	WSW	X	X	X	X		X	X	
R10	W	X	X	X	X		X		
R11	WNW	X	X	X	X	X	X		
R12	NW, NNW	X	X	X	X	X			
R13	N	X	X	X		X			
R14	*	X							X

*This Region was added at Constellation Energy's request. It is an evacuation of the 2-Mile Ring and downwind (Towards Dorchester County) to the EPZ Boundary.

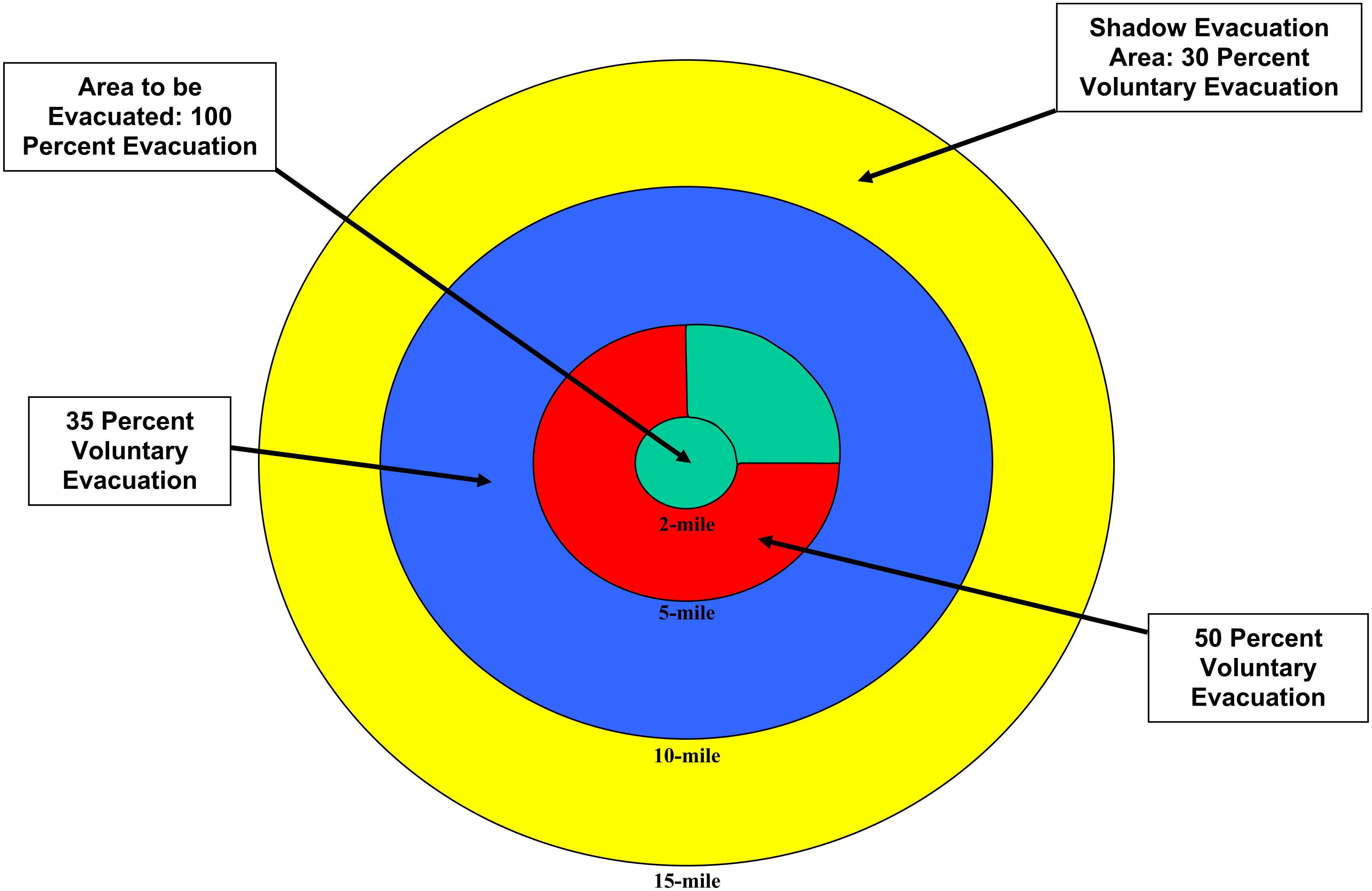


Figure 7-1. Assumed Evacuation Response

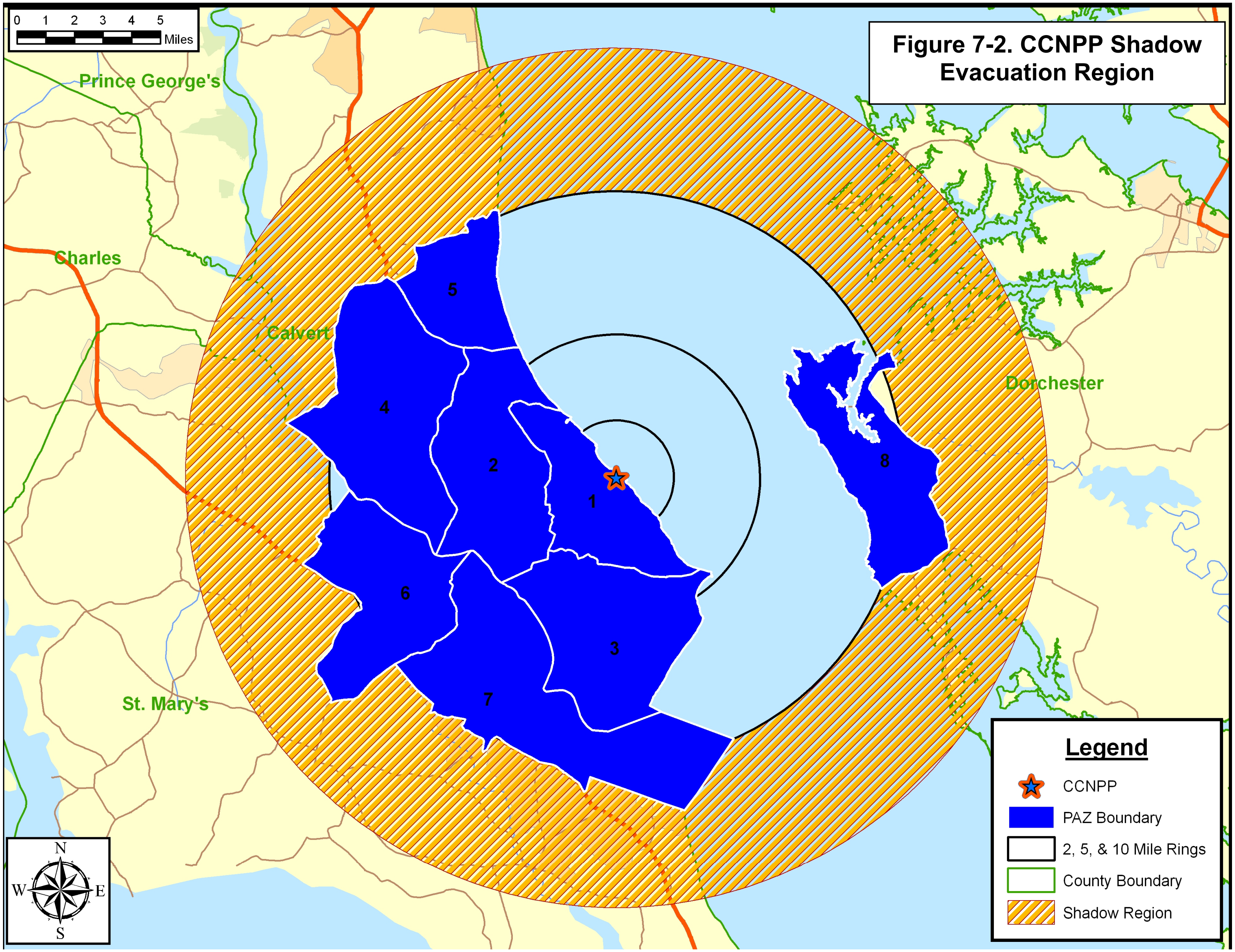


Figure 7-2. CCNPP Shadow Evacuation Region
0 1 2 3 4 5 Miles
Prince George's
Charles
Calvert
St. Mary's
Dorchester
1
2
3
4
5
6
7
8
N
S
E
W
Legend
CCNPP
PAZ Boundary
2, 5, & 10 Mile Rings
County Boundary
Shadow Region

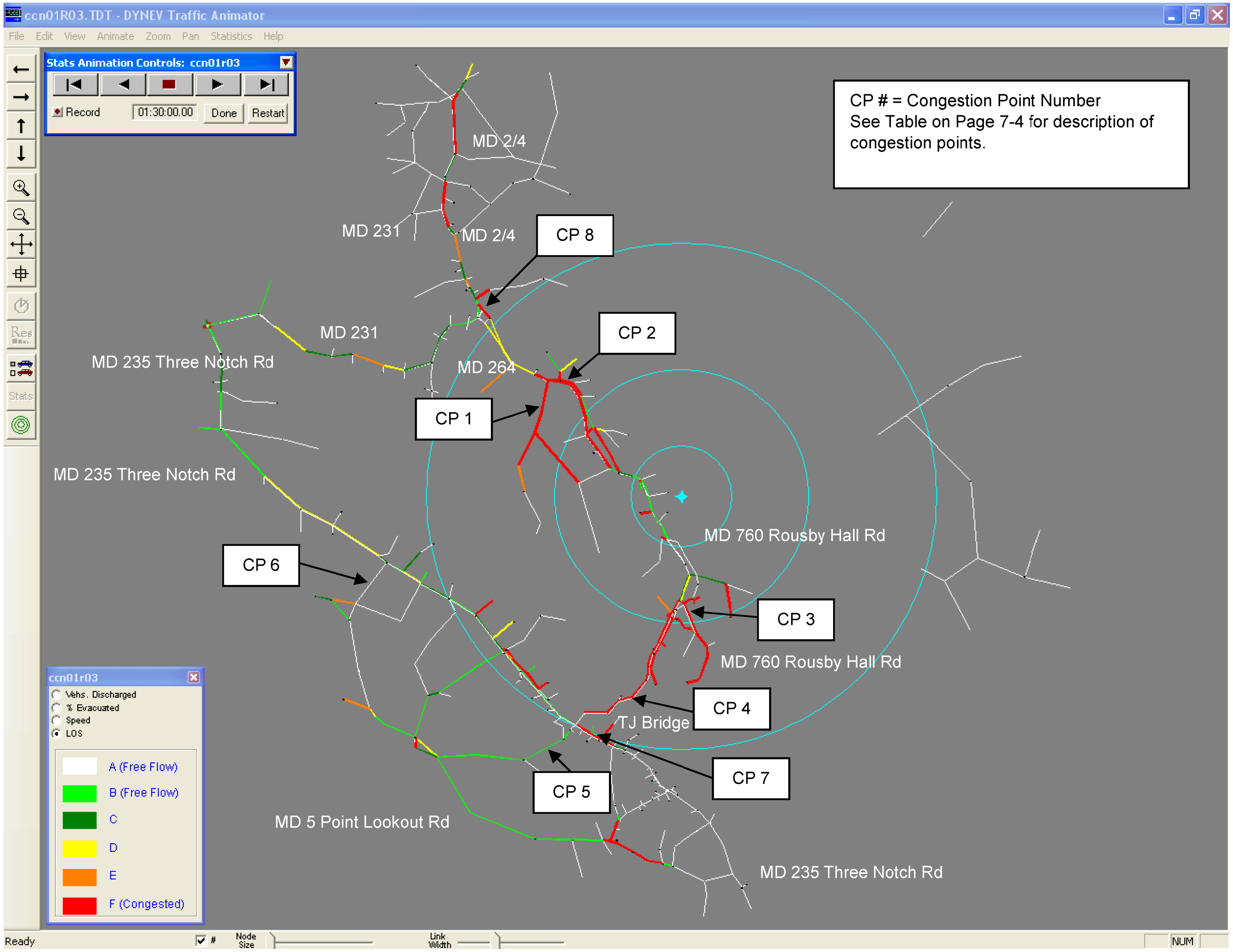


Figure 7-3. Congestion Patterns at 1½ Hours after the Evacuation Advisory – Scenario 1, Full EPZ

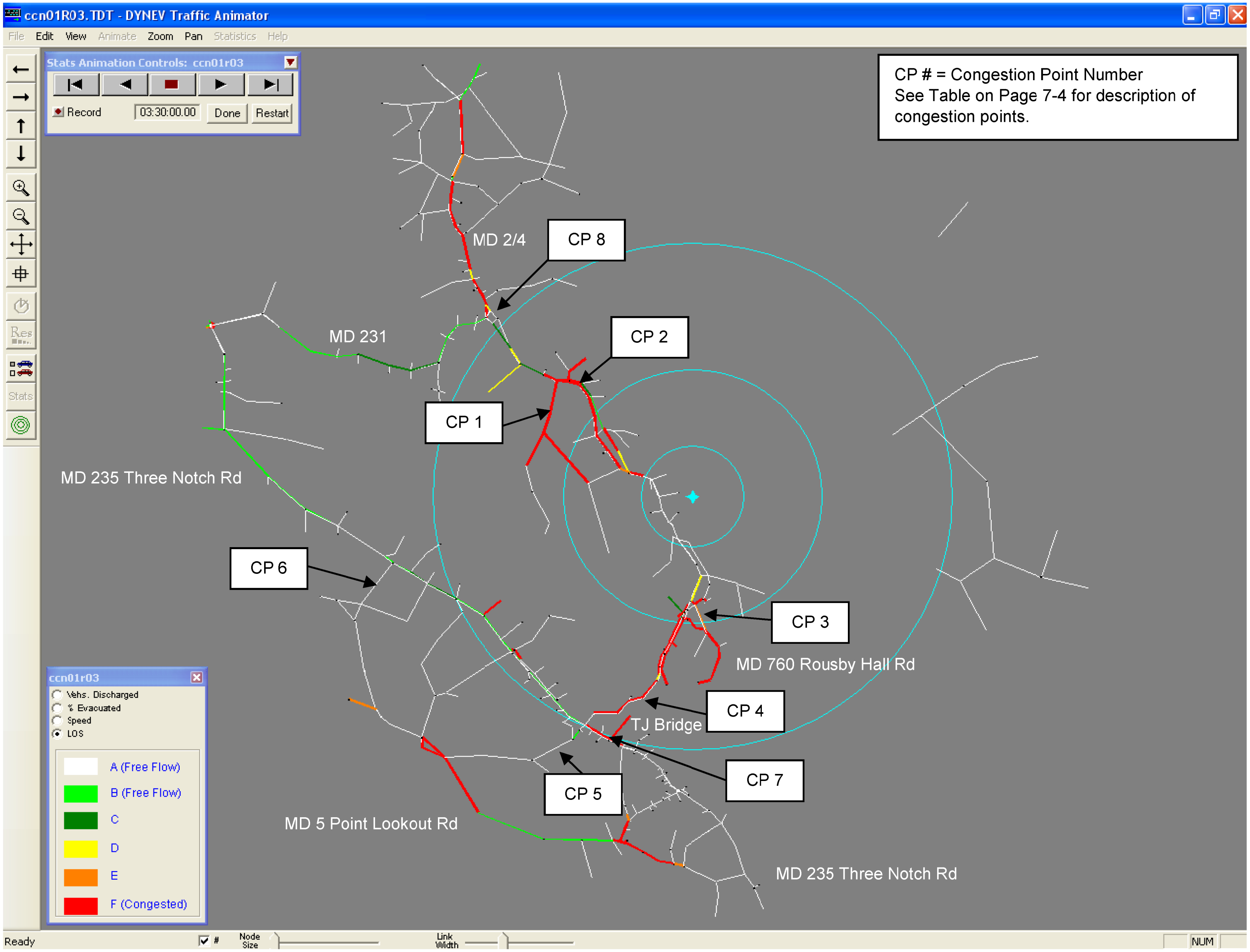


Figure 7-4 Congestion Patterns at 3 ½ Hours after the Evacuation Advisory – Scenario 1, Full EPZ

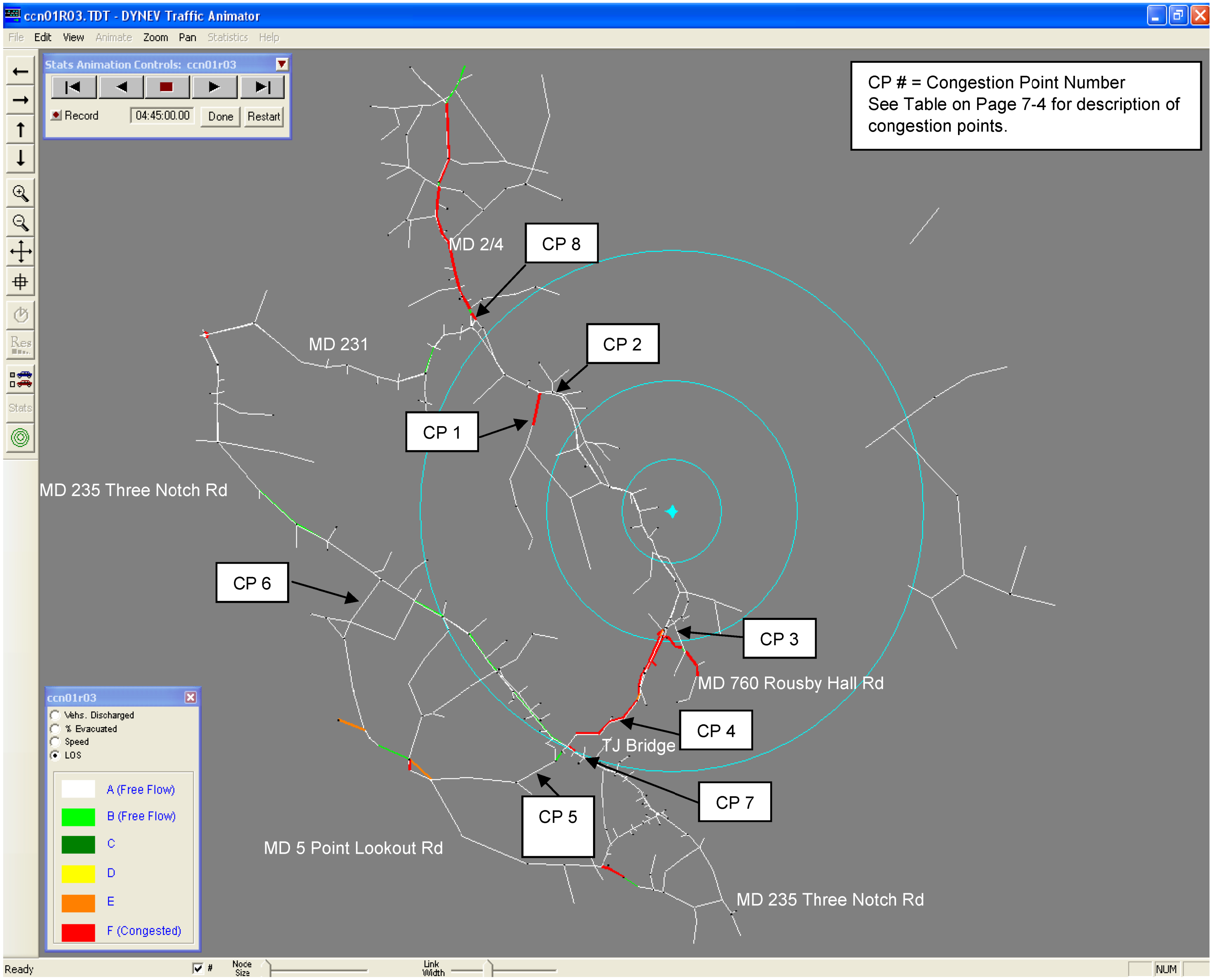


Figure 7-5 Congestion Patterns at 4 Hrs. 45 Mins. after the Evacuation Advisory– Scenario 1, Full EPZ

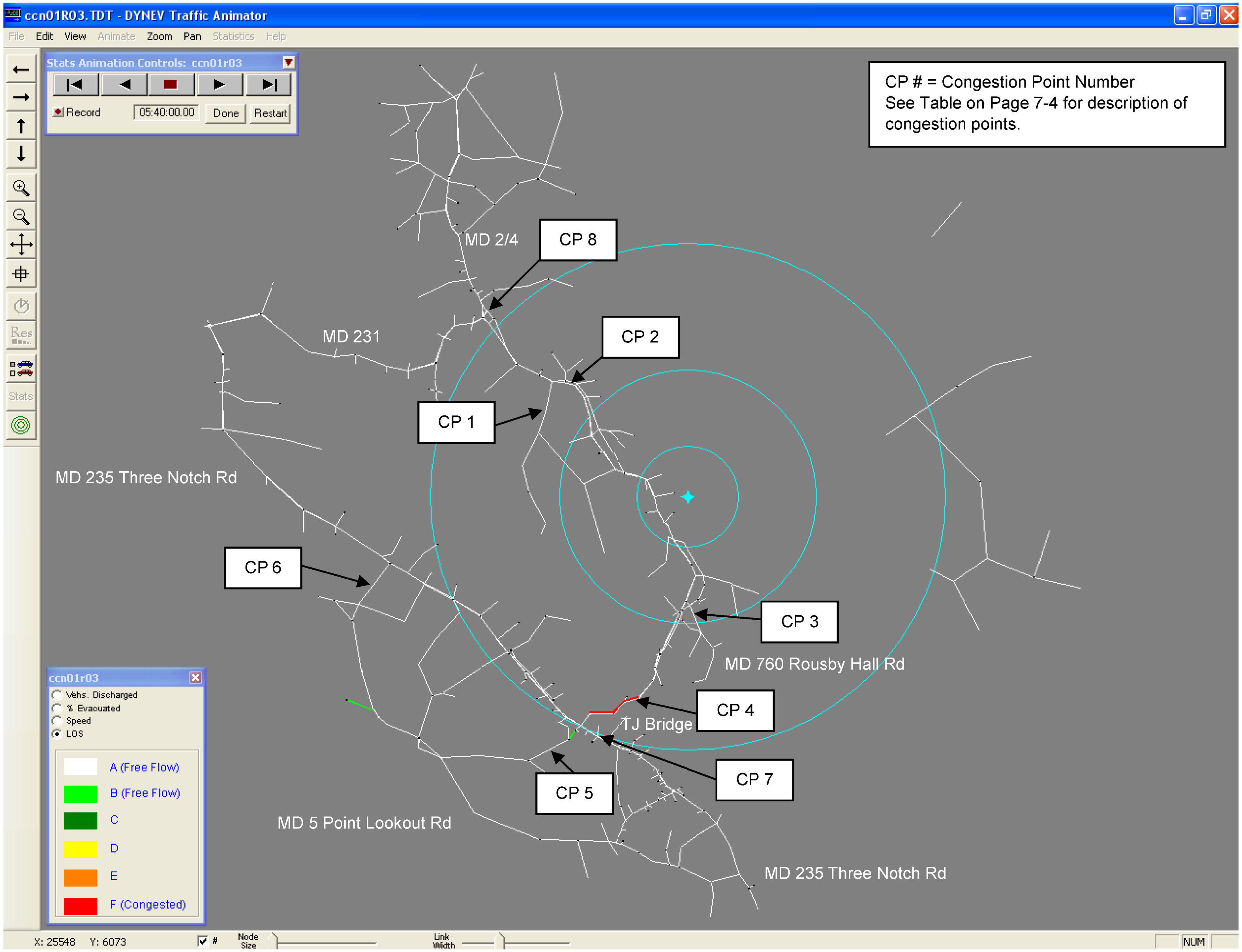


Figure 7-6 Congestion Patterns at 5 Hrs. 40 Mins. after the Evacuation Advisory – Scenario 1, Full EPZ

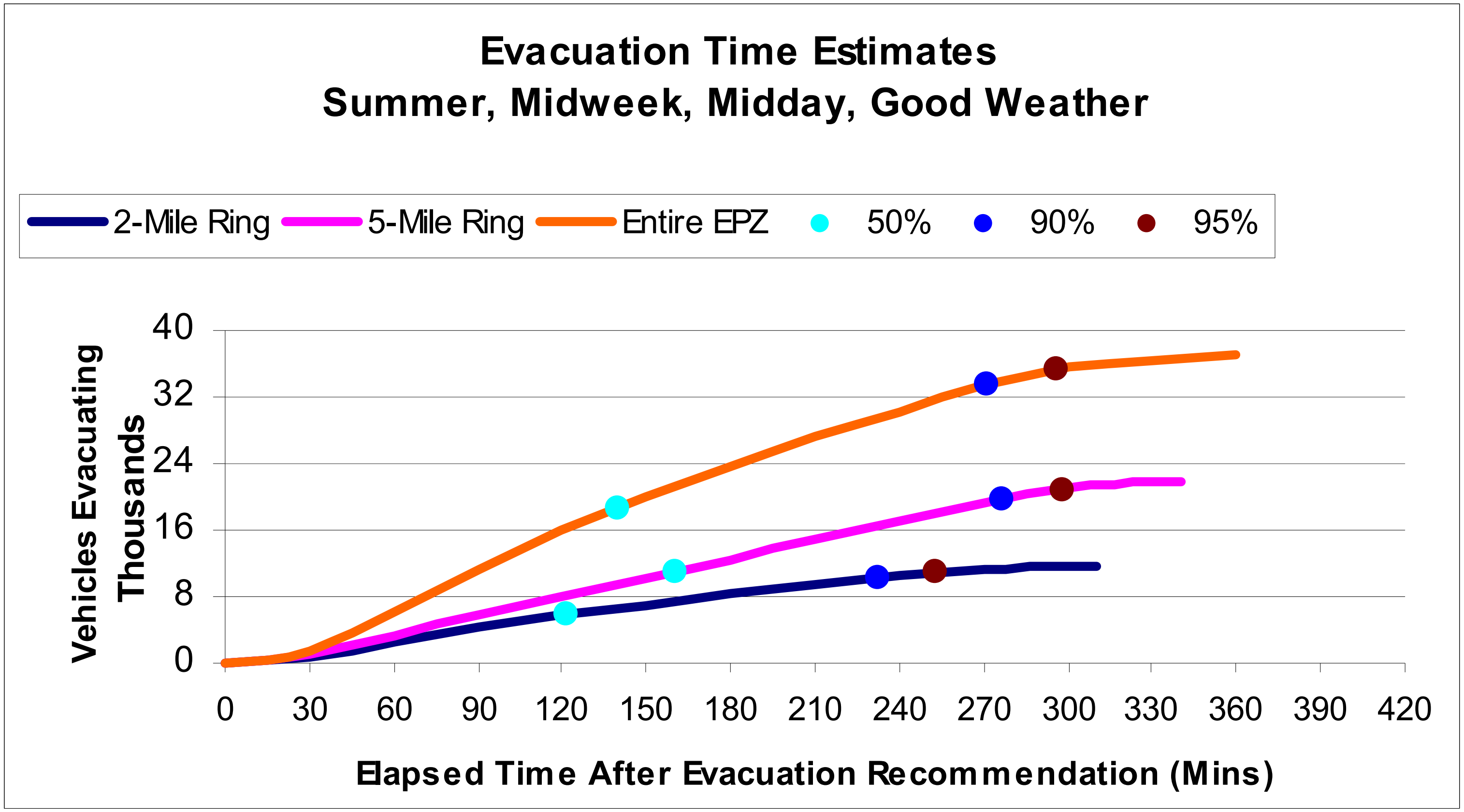


Figure 7-7. Evacuation Time Estimates for CCNPP Summer, Midweek, Midday, Good Weather Evacuation of Region R03 (Entire EPZ)

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 data provided by the emergency staff for the EPZ counties, it is estimated that bus mobilization time will average between 60 and 90 minutes extending from the Advisory to Evacuate to the time when buses arrive at their respective assignments.

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 the host schools to speed the evacuation of the school children in the event that buses need to return to the EPZ and evacuate transit dependents. We provide estimates of buses under the assumption that no children will be picked up at school by their parents as an upper bound estimate of the transit vehicles needed.

The procedure is:

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

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

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

- Estimates of persons requiring transit vehicles include school children. For those evacuation scenarios where children are at school when an evacuation is advised, separate transportation is provided for the school children. The actual need for transit vehicles by residents is thereby less than the given estimates. However, we will not reduce our estimates of transit vehicles since it would add to the complexity of the implementation procedures.
- It is reasonable and appropriate to consider that many transit-dependent persons will evacuate by ride-sharing with neighbors, friends or family. For example, nearly 80 percent of those who evacuated from Mississauga, Ontario[1] 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 980 people. Therefore, a total of 33 bus runs are required to transport this population to reception centers.

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[1] The Mississauga Evacuation – Final Report, The Institute for Environmental Studies, University of Toronto, June 1981

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 CCNPP EPZ:

$$P = 19{,}715 \times (0.025 \times 1.50 + 0.222 \times (1.64 - 1) \times 0.645 \times 0.42 + 0.393 \times (2.81 - 2) \times (0.645 \times 0.42)^2)$$
$$P = 19{,}715 * (0.09935) = 1{,}960$$
$$B = (0.5 \times P) \div 30 = 33$$

These calculations are explained as follows:

- All members (1.5 avg.) of households (HH) with no vehicles (2.5%) will evacuate by public transit or ride-share. The term 19,715 (number of households) x 0.025 x 1.5, accounts for these people.
- The members of HH with 1 vehicle away (22.2%), who are at home, equal (1.64-1). The number of HH where the commuter will not return home is equal to (19,715 x 0.222 x 0.645 x 0.42), as 64.5% of EPZ households have a commuter, 42% of which would not return home in the event of an emergency. The number of persons who will evacuate by public transit or ride-share is equal to the product of these two terms.
- The members of HH with 2 vehicles that are away (39.3%), who are at home, equal (2.81 – 2). The number of HH where neither commuter will return home is equal to 19,715 x 0.393 x $(0.645 \times 0.42)^2$. The number of persons who will evacuate by public transit or ride-share is equal to the product of these two terms.
- 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 which is in the neighborhood of 3 percent, daily.

The estimate of buses needed for ETE purposes in Table 8-2 are overstated in that no allowance is made for those high school students who drive to school on a daily basis, absentees, and students picked up by their parents.. Comparison of the information provided by the counties with the estimated bus needs in Table 8-2 indicated good agreement and representatives from St. Mary's County and Calvert County have confirmed that available bus resources can evacuate the schools in a single wave. However, for reference purposes, Tables 8-5A and 8-5B include information to show a second wave ETE for all schools. We recommend that the Counties introduce procedures whereby the schools are contacted prior to the dispatch of buses from the depot (approximately one hour after the Advisory to Evacuate), to ascertain the current estimate of students to be evacuated. In this way, the number of buses dispatched to the schools will reflect the actual number needed. 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 each school in the EPZ; Figure 8-3 maps all of the EPZ schools and their host schools. Those students not picked up by their parents prior to the arrival of the buses, will be transported to these host schools where they will be subsequently retrieved by their respective families.

8.3 Special Facility Demand

Table 8-4 presents the current census for special facilities obtained through phone calls to the facilities and through Internet searches. Approximately 103 people have been identified as living in, or being treated in, these facilities. This data also indicates the number of wheelchair-bound people. The transportation requirements for those people residing in special facilities are also presented. The number of bus runs estimated assumes 30 ambulatory patients per trip. Wheelchair buses can transport 15 patients while vans can transport 4 patients. There are 2 senior centers listed with a total of 59 seniors at the facilities during the day; there are no overnight accommodations at these facilities. Based on discussions with representatives from these facilities, most of the seniors drive to the facility each day. Some of the seniors, however, will require transportation. We have conservatively included all of the visitors to the senior centers as transit dependent people. In total, we estimate that 5 buses and 2 wheelchair vans are required to meet the special facility demand.

8.4 Evacuation Time Estimates for Transit-Dependent People

County bus resources are assigned to evacuating school children as the first priority in the event of an emergency. In the event that the allocation of buses dispatched from the depots to the various facilities and to the bus routes is somewhat “inefficient”, or if there is a shortfall of available drivers, then there may be a need for some buses to return to the EPZ from the host school after completing their first evacuation trip, to complete a “second wave” of providing transport service to evacuees. Based on discussions with the EPZ counties, there are sufficient bus resources to evacuate the schools in a single wave. There are not, however, sufficient bus resources to evacuate the transit-dependent population in a single wave, as most of the buses in the counties will be allocated for the evacuation of school children. For this reason, the ETE will be calculated for both a one wave transit-dependent evacuation and for two waves (Table 8-7). Of course, if the impacted Evacuation Region is other than R03 (the entire EPZ), then there will likely be ample transit resources relative to demand in the impacted Region and this discussion of a second wave would likely not apply.

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

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

Activity: Mobilize Drivers (A→B→C)

Mobilization is the elapsed time from the Advisory to Evacuate until the time the buses arrive at the facility to be evacuated. Based on data provided by the counties, for a rapidly escalating radiological emergency with no observable indication before the fact, drivers would likely require between 60 and 90 minutes (depending on the facility to be evacuated) to be contacted, to travel to the depot, be briefed, and to travel to the transit-dependent facilities. Mobilization time is extended by 10 minutes when raining to account for slower travel times.

Activity: Board Passengers (C→D)

Studies have shown that passengers can board a bus at headways of 2-4 seconds (Ref. HCM2000 Page 27-27). Therefore, the total dwell time to service passengers boarding a bus to capacity at a single stop (e.g., at a school) is about 5 minutes. A loading time of 10 minutes will be used for rain scenarios. For multiple stops along a pick-up route we must allow for the additional delay associated with stopping and starting at each pick-up point. This additional delay to service passengers expands this estimate of boarding time to 30 minutes in good weather, and 35 minutes in rain.

Activity: Travel to EPZ Boundary (D→E)

School Evacuation

The distance from a school to the EPZ boundary is measured using Geographical Information Systems (GIS) software along the most likely route out of the EPZ. The travel times to the EPZ boundary are based on evacuation speeds output by the model (PC-DYNEV). The average speed for an evacuation of the full EPZ under Scenario 6 (winter [school in session], good weather) and Scenario 7 (with rain) at 60 minutes is 26.7 mph and 23.6 mph, respectively, and at 90 minutes is 19.1 mph and 16.9 mph, respectively. The travel time from the EPZ boundary to the Host School is computed assuming average speeds of 40 mph and 35 mph for good weather and rain, respectively. These speeds are assumed outside of the EPZ as congestion will likely be less pronounced and travel speeds will be faster.

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 min. + 5 + 28= 2:05, rounded to the nearest 5 minutes, for Patuxent High 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. **Note: the evacuation routes used for some of the schools within Calvert County that are south of CCNPP travel through St. Mary's County along Three Notch Road (State Route 235), Hallowing Point Road (State Route 231) and State Route 2/4. The buses are not routed northbound along Route 2/4 because this would take the school buses directly towards the CCNPP. This results in longer routes and longer travel times than expected from the EPZ boundary to the Host Schools.**

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 will complete their mobilization when the first buses will begin their routes, 90 minutes after the Advisory to Evacuate.

Those buses servicing the transit-dependent evacuees will first travel along their pick-up routes, then proceed out of the EPZ. Table 8-7 presents the transit-dependent population evacuation time estimates for each route obtained using the procedures outlined above.

Activity: Travel to Reception Center/Host School (E→F)

The distances from the EPZ boundary to the host schools are measured using 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.

Activity: Passengers Leave Bus (F→G)

Passengers can de-board within 5 minutes. 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 school children as they will likely be the first resources available. Most of the host schools are in close proximity to the transit bus route identified below, thus the travel time to the start of the bus route is assumed to be negligible. The bus travels its route and picks up transit-dependent evacuees along the route.

Analysis of Bus Route Operations

Based on the highway network within the EPZ, the suggested route for bus operations to service the transit dependent population within the EPZ is shown in Figure 8-2. A single loop that traverses Three Notch Road (State Route 235), Hallowing Point Road (State Route 231) and State Route 2/4 would best service the transit dependent residents. These buses would be dispatched in 2 batches – one at 90 minutes after the Advisory to Evacuate and the second batch at 120 minutes. These buses would traverse this main route and circulate within the higher population areas in the EPZ. These passengers would be dropped off at the reception centers along the bus route. The mobilization times (140 minutes for good weather, 160 minutes for rain) for a second-wave evacuation are the average ETE for schools to arrive at the Host Schools, as these buses will return to the EPZ to service the transit dependent. The second batch of buses (if needed) will be delayed by 30 minutes in the second-wave also.

The ETE for good weather for each batch of buses is given in Table 8-7A. Table 8-7B provides the ETE for rain. The route length is approximately 58 miles; the average travel speeds output by PC-DYNEV are used to estimate route travel times. The average speed for an evacuation of the full EPZ under Scenario 6 (winter, good weather) and Scenario 7 (with rain) at 90 minutes is 19.1 mph and 16.9 mph, respectively, and at 120 minutes is 14.8 mph and 13 mph, respectively.

The ETE for a single wave transit-dependent evacuation in general, does not exceed the general population ETE; however, a two-wave evacuation would exceed the general population ETE.

Evacuation of Ambulatory Persons from Special Facilities

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

- Buses are assigned on the basis of 25-30 patients to allow for staff to accompany the patients.
- 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.

It is estimated that mobilization time averages 90 minutes for the "first-wave" evacuation.

The average distance of the four nursing homes and senior centers within the EPZ to the EPZ boundary is approximately 5 miles. Thus, buses will have to travel 5 miles, on average, to leave the EPZ. The average speed output by the model at 90 minutes for Region 3, Scenario 6 is 19.1 mph; thus, travel time out of the EPZ is 15 minutes.

The ETE for each medical facility is the sum of the mobilization time, loading time, and travel time out of the EPZ. For example, the calculation of ETE for the bus servicing the Southern Pines Senior Center with a census of 30 is:

ETE: 90 + 30 x 1 + 15 = 135 min. or 2:15.

A total of five buses are needed to evacuate the three special facilities in Calvert County and one bus for that in St. Mary's County (see page E-4). In the event there is a shortfall of transit vehicles for a "first-wave" evacuation, the buses used to evacuate the schools will have to return to evacuate the special facilities. In this case the mobilization time to be used for the ETE calculation is the average time that the buses reach the host schools. Given that these four facilities are south of the CCNPP, it follows that buses should be dispatched from the host schools to the south which service Zone 7. For good weather conditions, the first five buses reach the host schools in St. Mary's County at 1 hour and 20 minutes (Table 8-5A). The components of the "second-wave" evacuation are:

1. Unload school children (assume 5 minutes)
2. Driver rest/preparation (assume 10 minutes)
3. Return to EPZ boundary (at estimated speed of 40 mph)
4. Continue to facility (at 40 mph)

5. Load passengers (one minute per patient)

6. Drive to EPZ boundary (at the speed indicated by the DYNEV output)

The average distance of the host schools in Zone 7 (that would most likely service these facilities) from the EPZ boundary is about 7 miles (Table 8-5A); the average distance of the medical facilities from the EPZ boundary is approximately 5 miles. Thus, buses will have to travel about 12 miles, on average, to reach the facilities, which at 40 mph, will take 18 minutes. Measuring from the Advisory to Evacuate (ATE), the elapsed time will be 80 + 5 + 10 + 18 = 113 minutes when the bus reaches the medical facility. The loading time varies by facility; the speed exiting the EPZ is obtained from the model output for Region 3, Scenario 6.

Considering the Southern Pines Senior Center with a census of 30 (loading time of 30 minutes) the bus will leave the facility at 2 hours and 23 (113+30) minutes after the ATE, at which point the average roadway travel speed will be 14.6 mph.

ETE: 143 + 5/14.6x60 = 163 min. or 2:45, to the nearest 5 minutes.

Table 8-4 indicates that 2 wheelchair van runs are needed for the entire EPZ. Loading times are estimated at 5 minutes per wheelchair bound person as staff will have to assist them in boarding the van. The ETE for the wheelchair-bound patients is calculated in the same way as the ETE for the ambulatory patients. For example, the ETE for the wheelchair bound at Solomon's Nursing Center is:

ETE: 90 + 7 x 5 + 15 = 140 min. or 2:20.

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

ETE for Homebound Special Needs Population

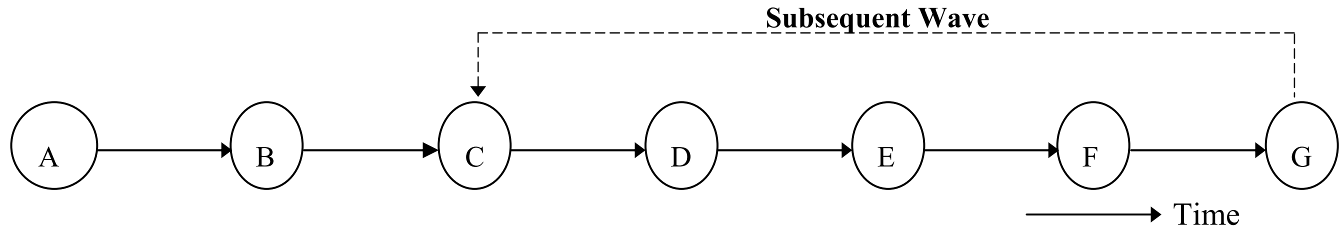
Communication with the counties has yielded the following data concerning special transportation for people at home:

Within EPZ	Calvert	St. Mary's	Dorchester
Need ambulances	12	0	1
Wheelchair bound	25	0	0
Registered special needs	417	8	1
Ambulances available	15	26	12

The counties have mutual aid agreements with neighboring counties for resources in the event of an emergency. Therefore, it is reasonable to expect that the requisite number of vans accommodating wheelchair bound persons, or additional ambulances (the 15+26+12 ambulances available are more than needed) would be available within a 90 minute mobilization time. Note that most special needs persons living at home have their transport needs provided by other members of the household.

To calculate ETE for the homebound special needs population, assume that the 37 persons in Calvert County are serviced in 19 ambulances (assume 2 persons per ambulance), with 4 ambulances provided by St. Mary's County. As stated above, mobilization time is assumed to be 90 minutes and each ambulance servicing the homebound bed-ridden population will make 2 stops within the EPZ and travel out of the EPZ. Allowing 15 minutes to load each patient, 15 minutes to travel to the second home, then 15 minutes to travel out of the EPZ yields:

ETE: 90 + 15 +15 +15 + 15 = 2:30 (hr:min)



Event

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

Figure 8-1. Chronology of Transit Evacuation Operations

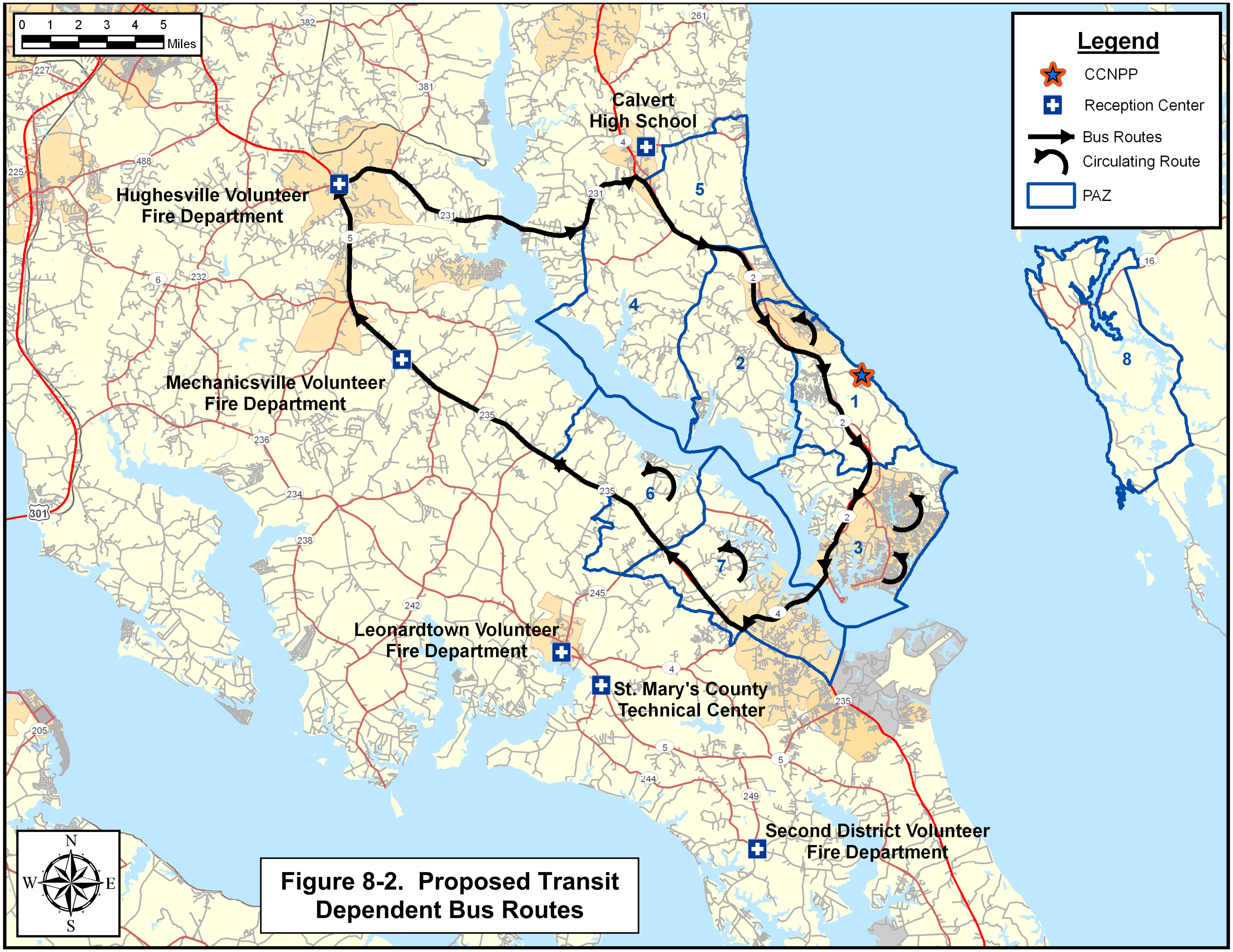
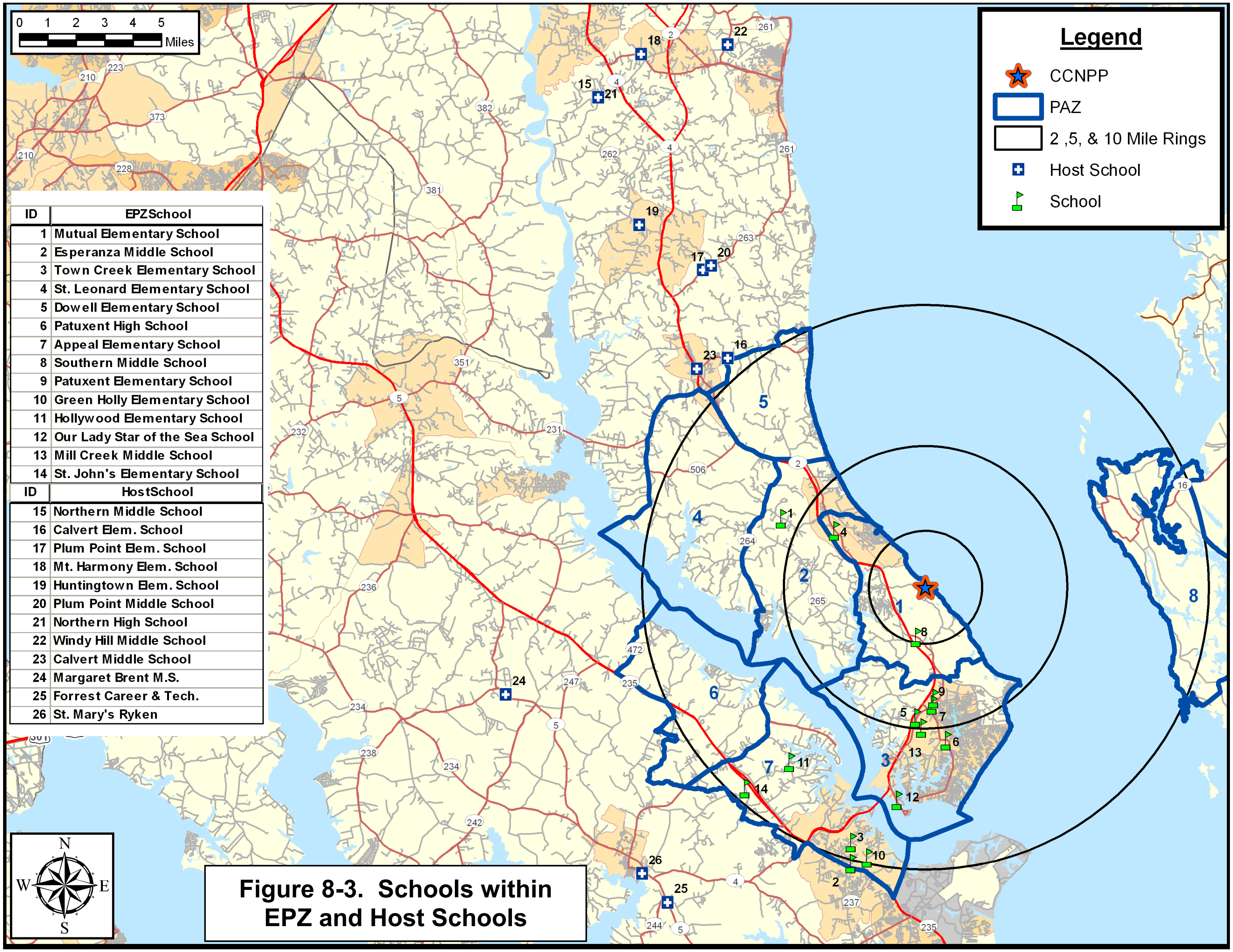


Figure 8-2. Proposed Transit Dependent Bus Routes



ID	EPZSchool
1	Mutual Elementary School
2	Esperanza Middle School
3	Town Creek Elementary School
4	St. Leonard Elementary School
5	Dowell Elementary School
6	Patuxent High School
7	Appeal Elementary School
8	Southern Middle School
9	Patuxent Elementary School
10	Green Holly Elementary School
11	Hollywood Elementary School
12	Our Lady Star of the Sea School
13	Mill Creek Middle School
14	St. John's Elementary School
ID	**HostSchool**
15	Northern Middle School
16	Calvert Elem. School
17	Plum Point Elem. School
18	Mt. Harmony Elem. School
19	Huntingtown Elem. School
20	Plum Point Middle School
21	Northern High School
22	Windy Hill Middle School
23	Calvert Middle School
24	Margaret Brent M.S.
25	Forrest Career & Tech.
26	St. Mary's Ryken

Figure 8-3. Schools within EPZ and Host Schools

Table 8-1. Transit Dependent Population Estimates

Facility Name	2008 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 Veh-icle	1 Veh-icle	2 Veh-icle						
Calvert Cliffs Nuclear Power Plant	55,205	1.5	1.64	2.81	19,715	2.5%	22.2%	39.3%	64.5%	42%	1,960	50%	980	1.8%

*See Section 8.1 for detailed calculation.

Table 8-2. School Population Demand Estimates

PAZ	Distance (miles)	Dir-ection	School Name	Municipality	Enroll-ment	Staff	Bus Runs Required
Calvert County							
1	1.8	S	Southern Middle School	Lusby	632	91	13
1	3.8	WNW	St. Leonard Elementary School	St. Leonard	739	40	11
2	5.6	WNW	Mutual Elementary School	Pt. Republic	628	82	9
3	4.0	S	Patuxent Elementary School	Lusby	503	44	8
3	4.2	S	Appeal Elementary School	Lusby	431	52	7
3	4.6	S	Dowell Elementary School	Lusby	695	79	10
3	4.8	S	Mill Creek Middle School	Lusby	631	87	13
3	5.5	S	Patuxent High School	Lusby	1,366	103	28
3	7.6	S	Our Lady Star of the Sea School	Solomons	194	25	3
				Calvert County Total:	5,819	603	102
St. Mary's County							
7	7.8	SW	Hollywood Elementary School	Hollywood	641	66	10
7	9.4	SSW	Town Creek Elementary School	Lexington Park	272	37	4
7	9.8	SSW	Green Holly Elementary School	Lexington Park	620	96	9
7	9.9	SW	St. John's Elementary School	Hollywood	221	21	4
7	10.1	SSW	Esperanza Middle School	Lexington Park	880	93	18
				St. Mary's County Total:	2,634	313	45
				EPZ Total:	**8,453**	**916**	**147**

Table 8-3. Host Schools		
School	**PAZ**	**Host School**
High Schools		
Patuxent High School	3	Northern High School
Middle Schools		
Southern Middle School	1	Northern Middle School
Mill Creek Middle School	3	Plum Point Middle School
Esperanza Middle School	7	Forrest Career and Technology Center
Elementary Schools		
St. Leonard Elementary School	1	Windy Hill Middle School
Mutual Elementary School	2	Calvert Elementary School
Appeal Elementary School	3	Plum Point Elementary School
Dowell Elementary School	3	Calvert Middle School
Our Lady Star of the Sea School	3	Mt. Harmony Elementary School
Patuxent Elementary School	3	Huntingtown Elementary School
Green Holly Elementary School	7	Forrest Career and Technology Center
Hollywood Elementary School	7	Margaret Brent Middle School
St. John's Elementary School	7	St. Mary’s Ryken
Town Creek Elementary School	7	Margaret Brent Middle School

Table 8-4. Special Facility Transit Demand

PAZ	Facility Name	Municipality	Cap-acity	Current Census	Ambu-latory	Wheel-chair Bound	Bed-ridden	Ambu-lance Runs	Wheel-chair Bus Runs	Wheel-chair Van Runs	Bus Runs
CALVERT COUNTY											
3	Asbury at Solomon's Island	Solomons	6	5	5	0	0	0	0	0	1
3	Solomon's Nursing Center	Solomons	40	39	32	7	0	0	0	2	2
3	Southern Pines (Senior Center)	Lusby	30	30	30	0	0	0	0	0	1
ST.MARYS COUNTY											
7	Vivian Ripple Center (Senior Center)	Hollywood	29	29	29	0	0	0	0	0	1
		Total:	**105**	**103**	**96**	**7**	**0**	**0**	**0**	**2**	**5**

Table 8-5A. School Evacuation Time Estimates - Good Weather 1st Wave

School	Driver Mobilization Time(min)	Loading Time (min)	Dist. to EPZ Boundary (mi.)	Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bdry to H.S. (mi.)	Travel Time EPZ Bdry to H.S. (min)	ETE to H.S. (hr:min)
Calvert County Schools								
Appeal Elementary School	90	5	8.0	26	**2:05**	40.9	62	**3:05**
Dowell Elementary School	90	5	6.6	21	**2:00**	36.7	56	**2:55**
Mill Creek Middle School	90	5	6.4	21	**2:00**	41.3	62	**3:00**
Mutual Elementary School	90	5	5.9	19	**1:55**	2.0	3	**2:00**
Our Lady Star of the Sea School	60	5	8.9	20	**1:25**	49.2	74	**2:40**
Patuxent Elementary School	90	5	8.0	26	**2:05**	42.8	65	**3:10**
Patuxent High School	90	5	8.8	28	**2:05**	48.7	74	**3:20**
Southern Middle School	60	5	10.2	23	**1:30**	48.7	74	**2:45**
St. Leonard Elementary School	90	5	7.0	22	**2:00**	14.6	22	**2:20**
St. Mary's County Schools								
Esperanza Middle School	60	5	0.0	0	**1:05**	8.9	14	**1:20**
Green Holly Elementary School	60	5	0.2	1	**1:10**	6.5	10	**1:20**
Hollywood Elementary School	60	5	6.1	14	**1:20**	5.8	9	**1:30**
St. John's Elementary School	60	5	0.7	2	**1:10**	5.9	9	**1:20**
Town Creek Elementary School	60	5	0.7	2	**1:10**	15.8	24	**1:35**
				Average for EPZ:	**1:40**		**Average:**	**2:20**

Table 8-5A(cont). School Evacuation Time Estimates - Good Weather 2nd Wave

School	Driver Mobilization Time(hr:min)	Unloading Time (min)	Driver Rest (min)	Dist. to School (mi.)	Travel Time to School (min)	Time School Reached (hr:min)	Loading Time (min)	Dist. to EPZ Boundary (mi.)	Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bdry to H.S. (mi.)	Travel Time EPZ Bdry to H.S. (min)	ETE to H.S. (hr:min)
Calvert County Schools													
Appeal Elementary School	**3:05**	5	10	48.9	74	**4:35**	5	8.0	24	**5:00**	40.9	62	**6:05**
Dowell Elementary School	**2:55**	5	10	43.3	65	**4:15**	5	6.6	23	**4:40**	36.7	56	**5:40**
Mill Creek Middle School	**3:00**	5	10	47.7	72	**4:30**	5	6.4	21	**4:55**	41.3	62	**6:00**
Mutual Elementary School	**2:00**	5	10	7.9	12	**2:30**	5	5.9	25	**2:55**	2.0	3	**3:00**
Our Lady Star of the Sea School	**2:40**	5	10	58.1	88	**4:25**	5	8.9	29	**4:55**	49.2	74	**6:10**
Patuxent Elementary School	**3:10**	5	10	50.8	77	**4:45**	5	8.0	22	**5:10**	42.8	65	**6:15**
Patuxent High School	**3:20**	5	10	57.5	87	**5:05**	5	8.8	24	**5:30**	48.7	74	**6:45**
Southern Middle School	**2:45**	5	10	58.9	89	**4:30**	5	10.2	33	**5:05**	48.7	74	**6:20**
St. Leonard Elementary School	**2:20**	5	10	21.6	33	**3:10**	5	7.0	28	**3:40**	14.6	22	**4:05**
St. Mary's County Schools													
Esperanza Middle School	**1:20**	5	10	8.9	14	**1:50**	5	0.0	0	**1:50**	8.9	14	**2:05**
Green Holly Elementary School	**1:20**	5	10	6.7	11	**1:50**	5	0.2	1	**1:55**	6.5	10	**2:05**
Hollywood Elementary School	**1:30**	5	10	11.9	18	**2:05**	5	6.1	25	**2:30**	5.8	9	**2:40**
St. John's Elementary School	**1:20**	5	10	6.6	10	**1:45**	5	0.7	2	**1:50**	5.9	9	**2:00**
Town Creek Elementary School	**1:35**	5	10	16.5	25	**2:15**	5	0.7	3	**2:20**	15.8	24	**2:45**
									Average for EPZ:	**3:45**		**Average:**	**4:25**

Table 8-5B. School Evacuation Time Estimates - Rain 1st Wave

School	Driver Mobilization Time(min)	Loading Time (min)	Dist. to EPZ Boundary (mi.)	Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bdry to H.S. (mi.)	Travel Time EPZ Bdry to H.S. (min)	ETE to H.S. (hr:min)
Calvert County Schools								
Appeal Elementary School	100	10	8.0	29	**2:20**	40.9	71	**3:30**
Dowell Elementary School	100	10	6.6	24	**2:15**	36.7	63	**3:20**
Mill Creek Middle School	100	10	6.4	23	**2:15**	41.3	71	**3:25**
Mutual Elementary School	100	10	5.9	21	**2:15**	2.0	4	**2:15**
Our Lady Star of the Sea School	70	10	8.9	23	**1:45**	49.2	85	**3:10**
Patuxent Elementary School	100	10	8.0	29	**2:20**	42.8	74	**3:35**
Patuxent High School	100	10	8.8	32	**2:25**	48.7	84	**3:50**
Southern Middle School	70	10	10.2	26	**1:50**	48.7	84	**3:10**
St. Leonard Elementary School	100	10	7.0	25	**2:15**	14.6	26	**2:45**
St. Mary's County Schools								
Esperanza Middle School	70	10	0.0	0	**1:20**	8.9	16	**1:40**
Green Holly Elementary School	70	10	0.2	1	**1:25**	6.5	12	**1:35**
Hollywood Elementary School	70	10	6.1	16	**1:40**	5.8	10	**1:50**
St. John's Elementary School	70	10	0.7	2	**1:25**	5.9	11	**1:35**
Town Creek Elementary School	70	10	0.7	2	**1:25**	15.8	28	**1:50**
				Average for EPZ:	**1:55**		**Average:**	**2:40**

Table 8-5B (cont). School Evacuation Time Estimates - Rain 2nd Wave

School	Driver Mobilization Time(hr:min)	Unloading Time (min)	Driver Rest (min)	Dist. to School (mi.)	Travel Time to School (min)	Time School Reached (hr:min)	Loading Time (min)	Dist. to EPZ Boundary (mi.)	Travel Time to EPZ Bdry (min)	ETE (hr:min)	Dist. EPZ Bdry to H.S. (mi.)	Travel Time EPZ Bdry to H.S. (min)	ETE to H.S. (hr:min)
Calvert County Schools													
Appeal Elementary School	**3:30**	10	10	48.9	84	**5:15**	10	8.0	23	**5:50**	40.9	71	**7:05**
Dowell Elementary School	**3:20**	10	10	43.3	75	**4:55**	10	6.6	22	**5:30**	36.7	63	**6:35**
Mill Creek Middle School	**3:25**	10	10	47.7	82	**5:10**	10	6.4	20	**5:40**	41.3	71	**6:55**
Mutual Elementary School	**2:15**	10	10	7.9	14	**2:50**	10	5.9	29	**3:30**	2.0	4	**3:35**
Our Lady Star of the Sea School	**3:10**	10	10	58.1	100	**5:10**	10	8.9	27	**5:50**	49.2	85	**7:15**
Patuxent Elementary School	**3:35**	10	10	50.8	88	**5:25**	10	8.0	23	**6:00**	42.8	74	**7:15**
Patuxent High School	**3:50**	10	10	57.5	99	**5:50**	10	8.8	23	**6:25**	48.7	84	**7:50**
Southern Middle School	**3:10**	10	10	58.9	101	**5:15**	10	10.2	30	**5:55**	48.7	84	**7:20**
St. Leonard Elementary School	**2:45**	10	10	21.6	38	**3:45**	10	7.0	32	**4:30**	14.6	26	**5:00**
St. Mary's County Schools													
Esperanza Middle School	**1:40**	10	10	8.9	16	**2:20**	10	0.0	0	**2:30**	8.9	16	**2:50**
Green Holly Elementary School	**1:35**	10	10	6.7	12	**2:10**	10	0.2	1	**2:25**	6.5	12	**2:40**
Hollywood Elementary School	**1:50**	10	10	11.9	21	**2:35**	10	6.1	30	**3:15**	5.8	10	**3:25**
St. John's Elementary School	**1:35**	10	10	6.6	12	**2:10**	10	0.7	3	**2:25**	5.9	11	**2:40**
Town Creek Elementary School	**1:50**	10	10	16.5	29	**2:40**	10	0.7	3	**2:55**	15.8	28	**3:25**
									Average for EPZ:	**4:25**		**Average:**	**5:10**

Table 8-6. Summary of Transit Dependent Bus Routes

Route Number	Number of Buses	Route Description
1	Batch 1 – 20 buses – after 90 minutes	Loop – State Route 235, State Route 2/4 and State Route 231
1	Batch 2 – 20 buses – after 120 minutes	Loop – State Route 235, State Route 2/4 and State Route 231

Table 8-7A. Transit Dependent Evacuation Time Estimate - Good Weather

Buses	Single Wave					Second Wave				
	Mobilization	Route Travel Time	Pickup Time	ETE	Mobilization	Unload Time	Driver Rest Time	Route travel Time	Pickup Time	ETE
Batch 1	90	183	30	5:05	140	5	10	183	30	6:10
Batch 2	120	236	30	6:30	170	5	10	236	30	7:35

Table 8-7B. Transit Dependent Evacuation Time Estimate - Rain

Buses	Single Wave					Second Wave				
	Mobilization	Route Travel Time	Pickup Time	ETE	Mobilization	Unload Time	Driver Rest Time	Route travel Time	Pickup Time	ETE
Batch 1	90	206	35	5:35	160	5	10	206	35	7:00
Batch 2	120	268	35	7:05	190	5	10	268	35	8:30

9. TRAFFIC MANAGEMENT STRATEGY

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

- Personnel with the capabilities of performing the planned control functions of traffic guides (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.

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

- A driver may be traveling home from work or from another location, to join other family members preliminary to evacuating.
- An evacuating driver may be taking a detour from the evacuation route in order to pick up a relative, 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 have extensively reviewed 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 have been developed in conjunction with county emergency management representatives and law enforcement personnel.

The control tactic at each TCP is presented in each schematic that appears in Appendix G.

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

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.

10. EVACUATION ROUTES

Evacuation routes are composed of two distinct components:

- Routing from a Protective Action Zone (PAZ) 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.

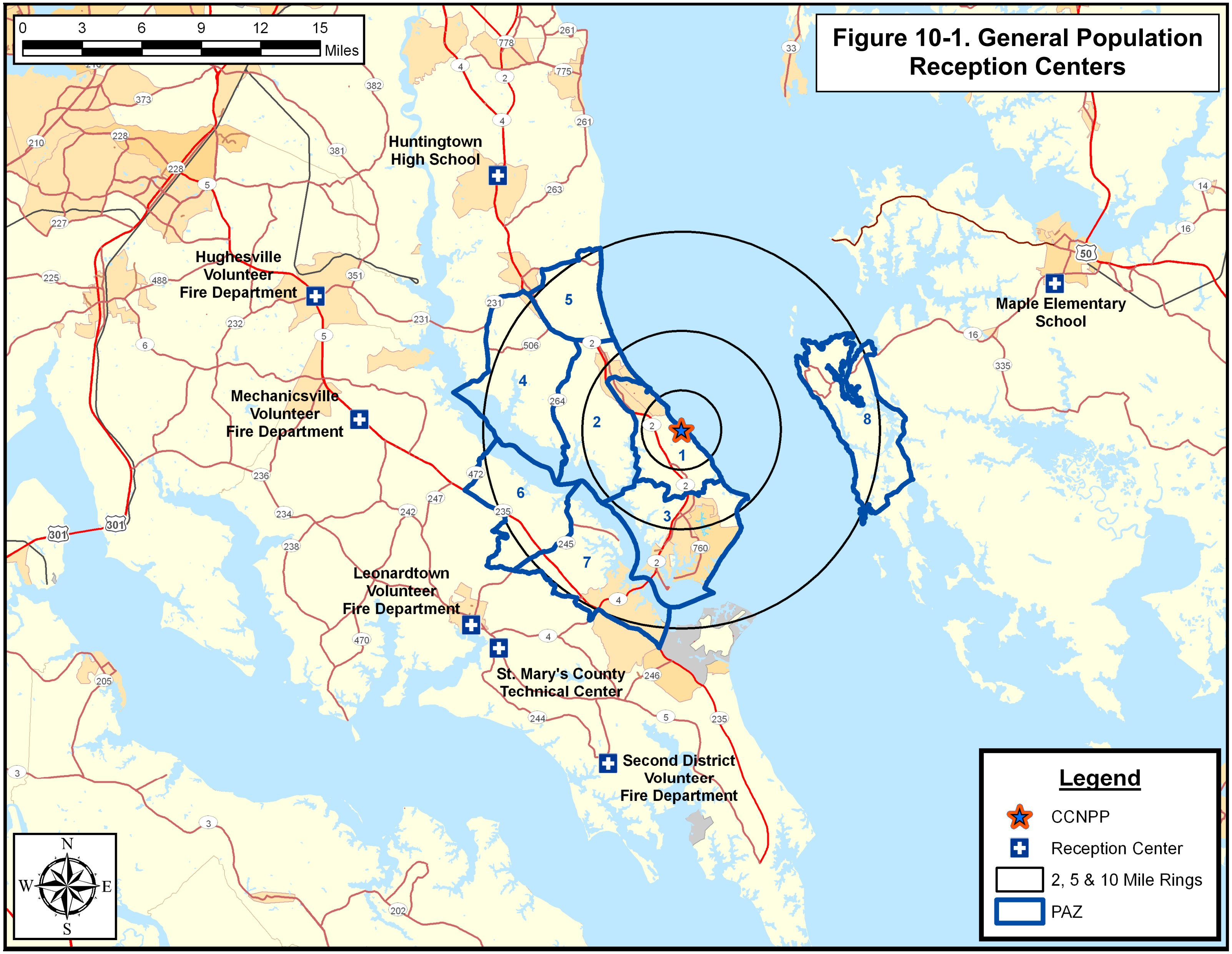
Evacuees should be routed within the EPZ in such a way as to *minimize their exposure to risk*. This primary requirement is met by routing traffic to move *away* from the location of the Calvert Cliffs Nuclear Power Plant, to the extent practicable, and by delineating evacuation routes that expedite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

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

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

Figure 10-1 presents a map showing the general population reception centers. The major evacuation routes for the three counties within the EPZ are presented in Figures 10-2 through 10-4.

Figure 10-1. General Population Reception Centers



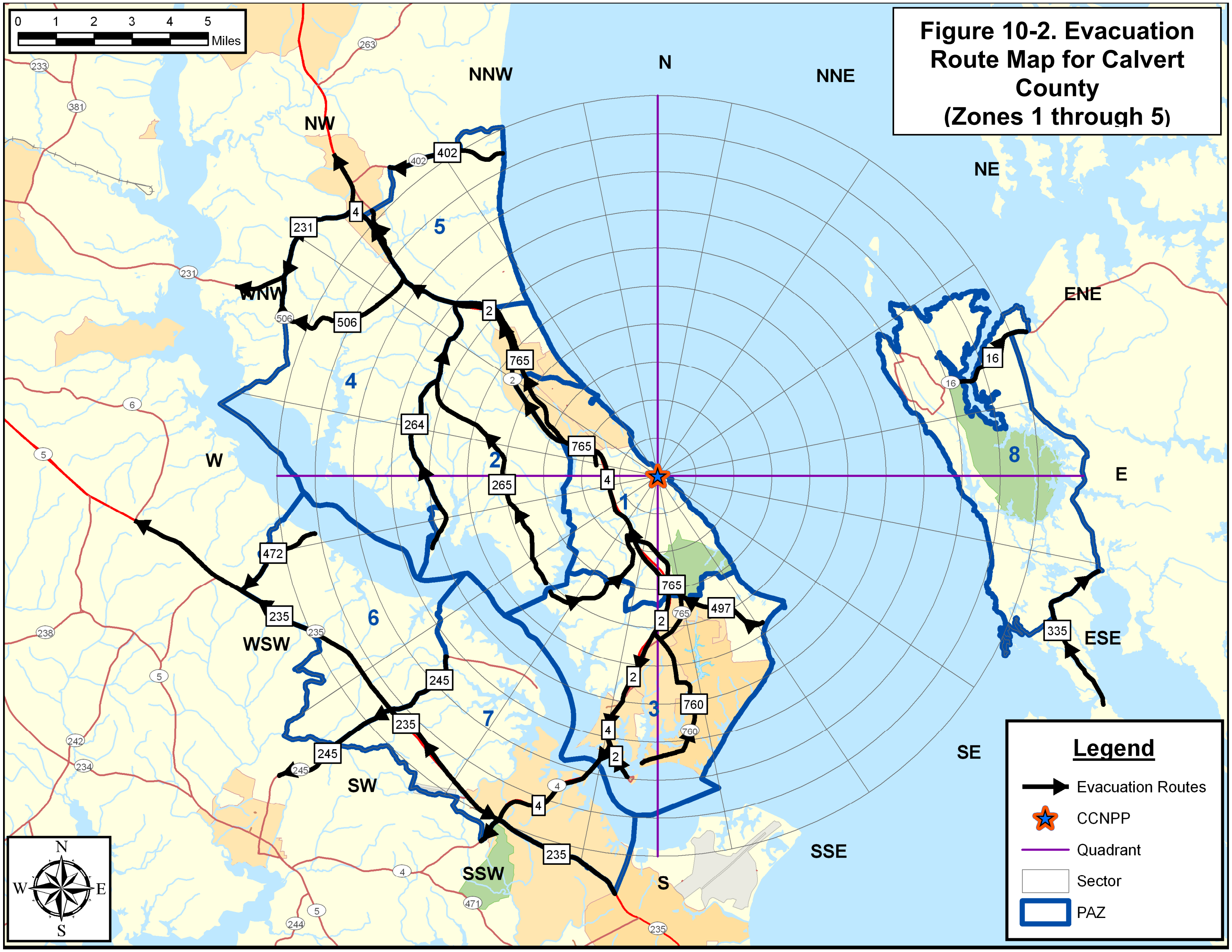


Figure 10-2. Evacuation Route Map for Calvert County (Zones 1 through 5)
0 1 2 3 4 5 Miles
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
Legend
Evacuation Routes
CCNPP
Quadrant
Sector
PAZ

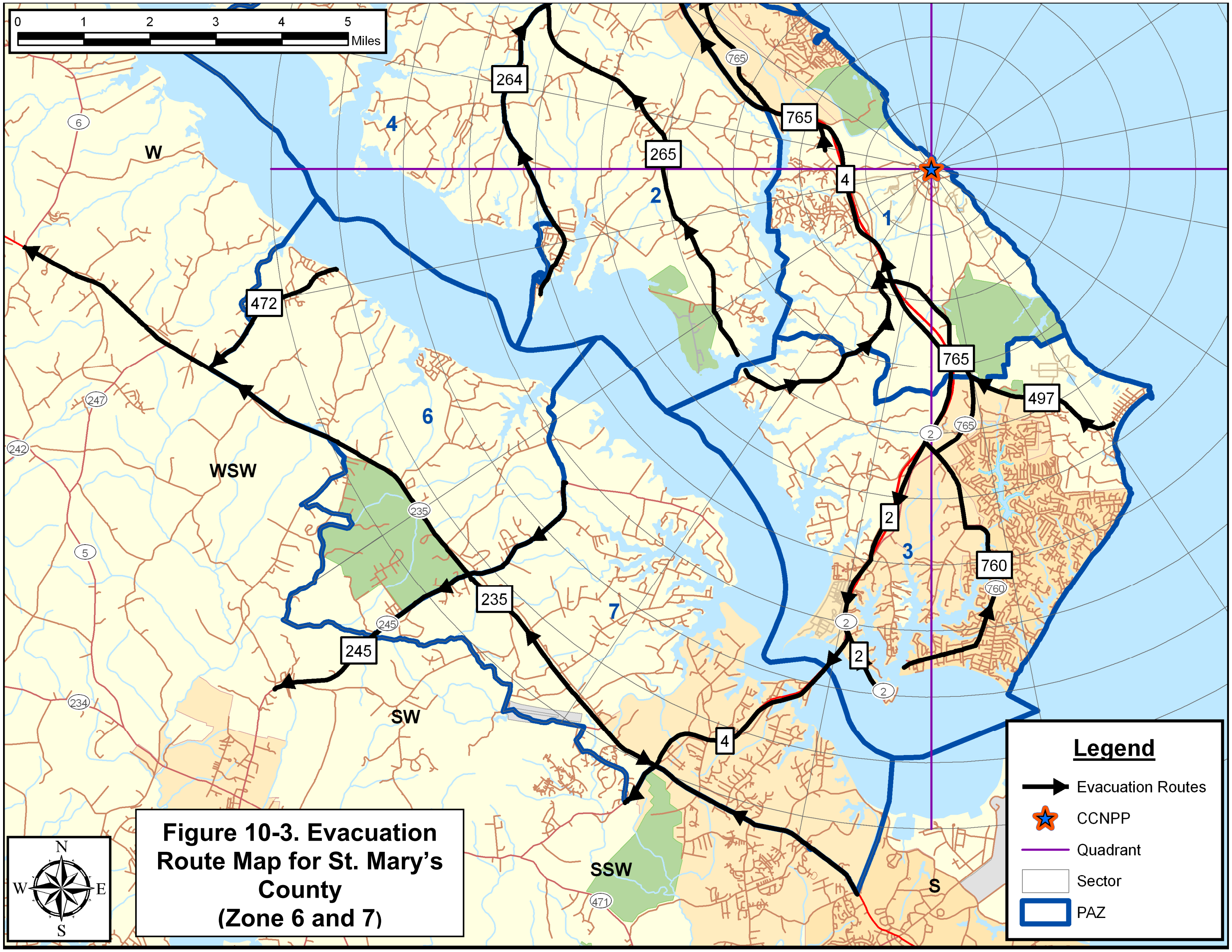


Figure 10-3. Evacuation Route Map for St. Mary's County (Zone 6 and 7)

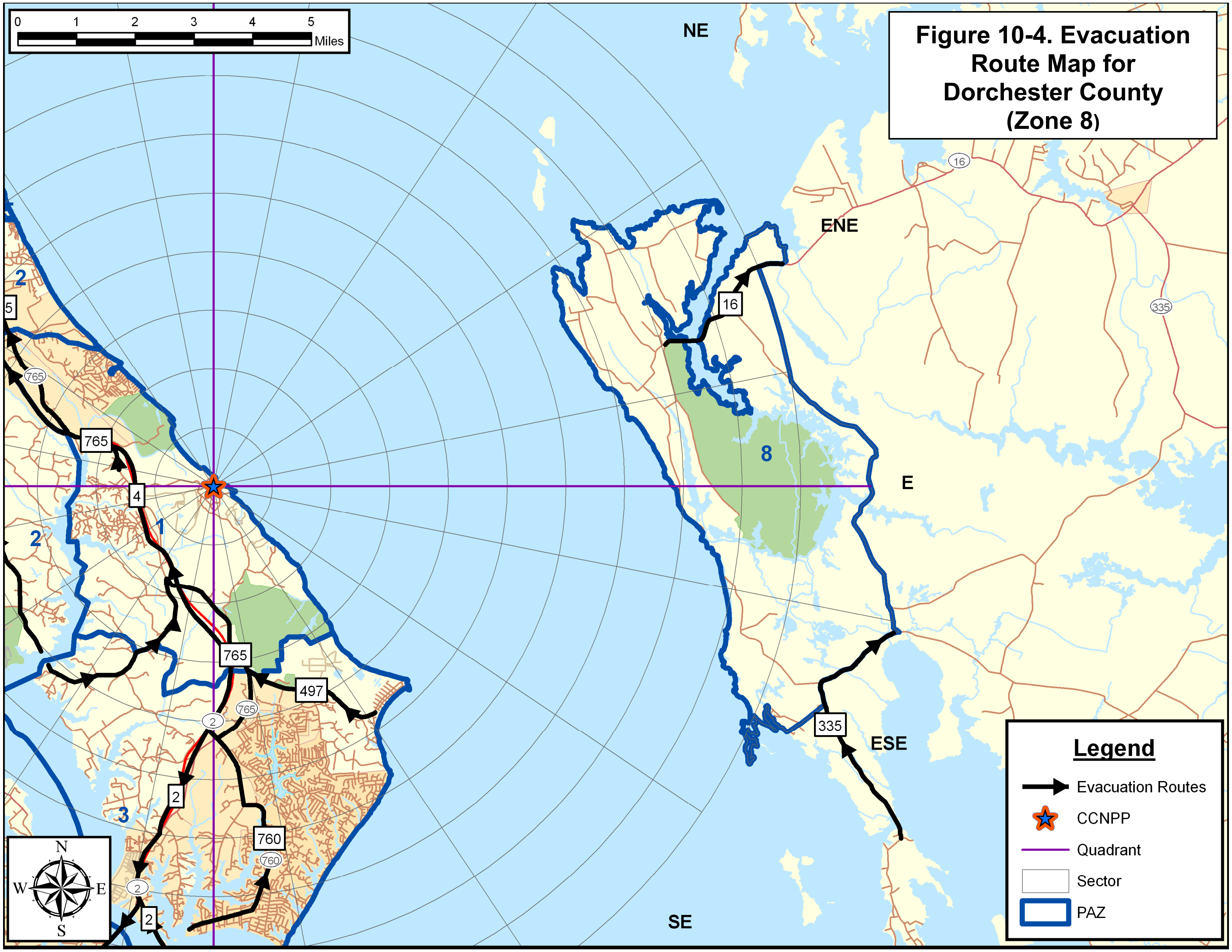


Figure 10-4. Evacuation Route Map for Dorchester County (Zone 8)
0
1
2
3
4
5
Miles
NE
ENE
E
ESE
SE
16
335
765
4
497
2
760
1
2
3
8
N
S
E
W
Legend
Evacuation Routes
CCNPP
Quadrant
Sector
PAZ

11. SURVEILLANCE OF EVACUATION OPERATIONS

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

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

It is necessary to confirm that the evacuation process is effective in the sense that the public is complying with the advisory to evacuate. Although Calvert, St. Mary's and Dorchester Counties may use their own procedures for confirmation, we suggest an alternative or complementary approach.

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

The confirmation process should start at about 3 hours after the advisory to evacuate, which is 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 7-1/2 person hours are needed to complete the telephone survey. If six people are assigned to this task, each dialing a different set of telephone exchanges (e.g., each person can be assigned a different set of Zones), then the confirmation process will extend over a time frame of about 75 minutes. Thus, the confirmation should be completed well before the evacuated area is cleared. Of course, fewer people would be needed for this survey if the Evacuation Region were only a portion of the EPZ. Use of modern automated computer controlled dialing equipment can significantly reduce the manpower requirements and the time required to undertake this type of confirmation survey.

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

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

Problem Definition

Estimate number of phone calls, n, needed to ascertain the proportion, 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.) = 19,715
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:

$$n_F = \frac{nN}{n + N - 1} = 303$$

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

13. RECOMMENDATIONS

The following recommendations are offered:

1. The traffic management plan should be reviewed by state and county emergency planners with local and state law enforcement agencies (See Section 9 and Appendix G). Specifically…
   - The number and locations of Traffic Control Points (TCP) and Access Control Points (ACP) should be reviewed in detail.
   - The indicated resource requirements (personnel, traffic control devices) should be reconciled with current assets.
2. Intelligent Transportation Systems (ITS) such as Dynamic Message Signs (DMS), Highway Advisory Radio (HAR), Automated Traveler Information Systems (ATIS), etc. should be used to facilitate the evacuation process (See Section 9). The placement of additional signage should consider evacuation needs.
3. Counties should implement procedures whereby schools are contacted prior to dispatch of buses from the depots to obtain an accurate count of students needing transportation and the number of buses required (See Section 8).
4. Counties should work with the Department of Transportation to have equipment needed for traffic control duties mobilized in a timely manner should an evacuation be advised (See Section 9).
5. Counties should establish strategic locations to position tow trucks in the event of a disabled vehicle during the evacuation process (See Section 11) and should encourage gas stations to remain open during the evacuation.
6. Counties should establish a system to confirm that the Advisory to Evacuate is being adhered to (see the approach suggested by KLD in Section 12).
7. A sensitivity study was performed to measure the effect of routing some evacuees from Zone 3 (the most populated Zone within the EPZ) northbound on State Route 2/4 even though it brings evacuees closer to CCNPP. The ETE is 3 hours and 50 minutes shorter when allowing Zone 3 evacuees to travel northbound and southbound on State Route 2/4. **It is recommended that evacuees from Zone 3 be advised to travel northbound or southbound on State Route 2/4 in order to evacuate the impacted area as quickly as possible. The ETE presented in Chapter 7 and Appendix J assume the routing of some residents within Zone 3 in the northbound direction along Route 2/4.**
8. The ETE for an evacuation of the full EPZ exceeds the mobilization time (about 4 hours) by 2 hours, on average. This indicates that there is congestion within the EPZ during evacuation which prolongs the ETE. The efficient use of traffic control personnel and equipment is highly recommended to facilitate the evacuation process (See Recommendations 1 and 2).
9. Counties should implement procedures to accurately estimate the number of transit-dependent people within the EPZ and to develop bus routes to service those transit-dependent people (See the suggestions in Section 8).

APPENDIX A

Glossary of Traffic Engineering Terms

APPENDIX A: GLOSSARY OF TRAFFIC ENGINEERING TERMS

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

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

APPENDIX B

Traffic Assignment and Distribution Model

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APPENDIX B: TRAFFIC ASSIGNMENT AND DISTRIBUTION MODEL

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

To apply TRAD, the analyst must specify the highway network, link capacity information, the volume of traffic generated at all origin centroids, a set of accessible candidate destination nodes on the periphery of the EPZ for each origin, and the approach capacity to each destination node. TRAD calculates the optimal trip distribution <u>and</u> 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 Assignment and Distribution Model

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

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

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

Specification of TRAD Model Inputs

The user must specify, for each origin node, the average hourly traffic volume generated, as well as a set of candidate accessible destinations. A destination is "accessible" to traffic originating at an origin node if there is at least one path connecting the origin to the destination node. There must be at least one destination node specified for each origin centroid. The number of trips generated at the origin node, which are distributed to each

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specified, accessible destination node within this set, is determined by the model in a way as to satisfy the network-wide objective function (Wardrop's Principle).

The user must also specify the total number of trips which can be accommodated by each destination node. This value reflects the capacities of the road(s) immediately servicing the destination node. Clearly, we require that the total number of trips traveling to a destination, j, from all origin nodes, i, should not exceed the capacities of the approaches to destination node, j. By summing over all destination nodes, this constraint also states that the total trips generated at all origin nodes should not exceed the total capacity to accommodate these trips at all of the specified destinations.

In summary, the user must specify the total trips generated at each of the origin nodes, the maximum number of trips that can be accommodated by each of the specified destination nodes and the highway network attributes which include the traffic control tactics. The TRAD model includes a function which expresses travel time on each network link in terms of traffic volume and link capacity. This function drives the underlying trip distribution and trip assignment decision-making process. Thus, the TRAD 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 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 software constructs an "augmentation" network that allows the user to specify the volume for each origin node and a set of candidate destinations on the periphery of the EPZ. The allocation of trips from the origin node to each candidate destination node is not specified and is determined internally by the model.
2. Each [real] link of the highway network is calibrated by relating speed to the volume:capacity (v/c) ratio.
3. The software constructs pseudo-links which service the assigned volumes, A_j, traveling to the destination nodes, j, in the augmented network.

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This analysis 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 [real] destination nodes, to the Super-Nodes which represent the user-specified set of destination nodes associated with each origin node.

Each Class of links provides a different function:

- Class I links represent the physical highway network. As such, each link has a finite capacity, a finite length and an estimated travel time for free-flowing vehicles. The nodes generally represent intersections, interchanges and, possibly, changes in link geometry. The topology of the Class I network represents that of the physical highway system.

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- 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 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 the capacity limitation of the Class II Pseudo-Links. This approach is much more suitable, computationally.
- The topology of the network augmentation (i.e., Class III Links and Nodes) is designed so that all traffic from an origin node can only travel to the single "Super-Node" by flowing through its set of real destination nodes, thence along the links of the augmented network.

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

Calculation of Capacities and Impedances

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

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

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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":

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

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

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

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

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

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

$a_1 = 0.8$ $b_1 = 5.0$

The values of a_2 and b_2, which are applicable for each Class II 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 destination node "capacity." In addition, these parameters must be chosen so that these Pseudo-Links all offer the same impedance to traffic when their assigned volumes are less than their respective specified maximum attractions. The weighting factor, W, is computed internally by the software.

Of course, it is still possible for the assignment algorithm within TRAD to distribute more traffic to a destination node than that node can accommodate. For emergency planning

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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.

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

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

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

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

- The QUEUE 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 stream. Each component is serviced at a different saturation flow rate as is the case in the real world. The logic recognizes when one component of the traffic flow encounters saturation conditions even if the others do not.

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

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

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

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

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

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

Table C-1. Measures of Effectiveness Output by 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 OPERATIONS CHARACTERISTICS

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

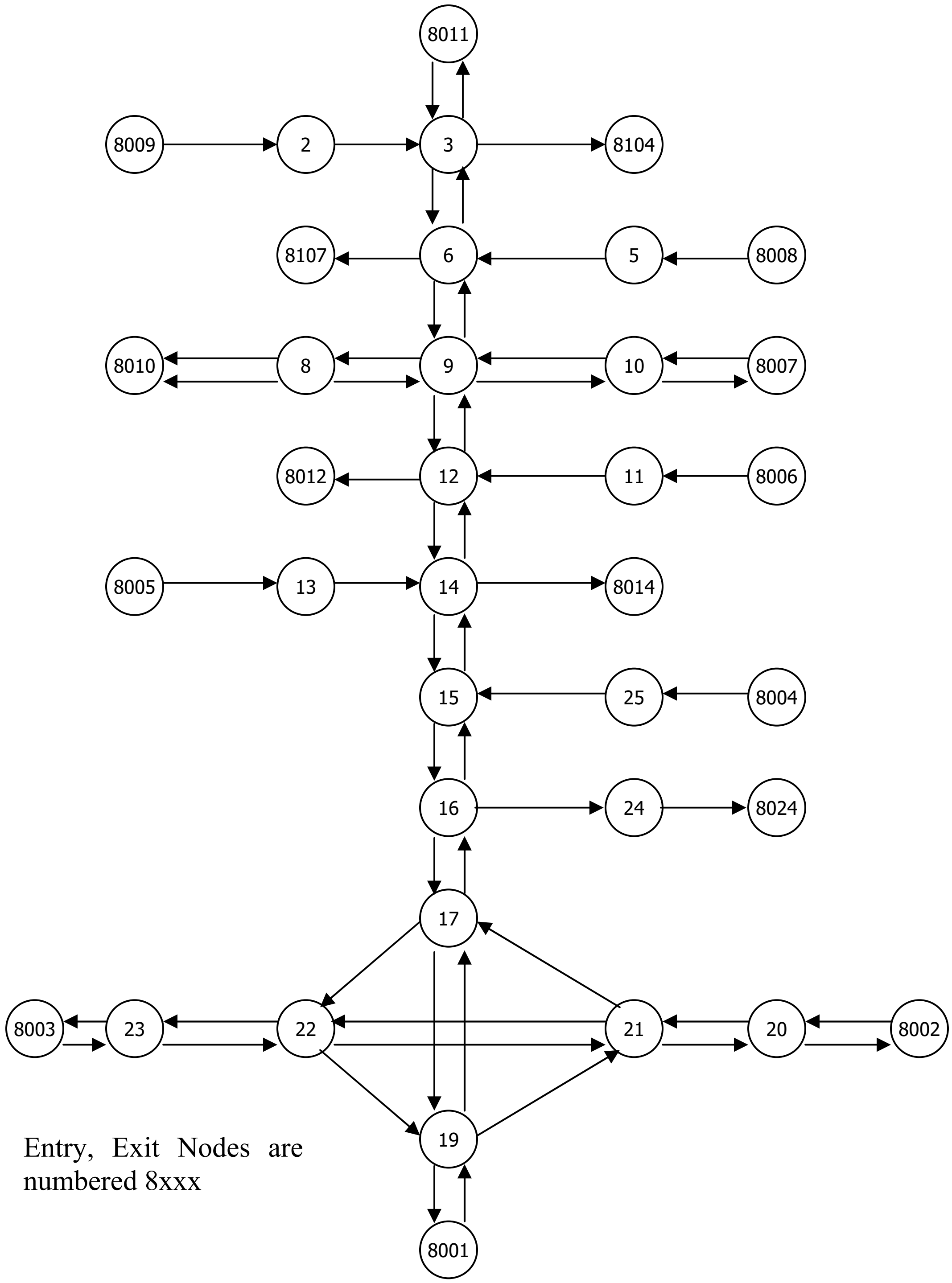


Figure C-1: Representative Analysis Network

APPENDIX D

Detailed Description of Study Procedure

APPENDIX D: DETAILED DESCRIPTION OF STUDY PROCEDURE

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

Step 1.
The first activity is to obtain data defining the spatial distribution and demographic characteristics of the population within the Emergency Planning Zone (EPZ). These data were obtained from U.S. Census files and from results of a telephone survey conducted within the EPZ. Employee population data were estimated by referencing state Journey-to-Work data provided by the U.S. Census. Transient population data were obtained from local sources of information and 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.

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

Step 5.
With the network drawn, proceed to estimate the capacities of each link and to locate the origin centroids where trips would be generated during the evacuation process.

Step 6.
With this information at hand, the data were entered into the computer to create the input stream for the TRaffic Assignment and Distribution (TRAD) model. This model was designed to be compatible with the 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, either as excess demand due to improper routing, as a shortfall of capacity, or as a quantitative error in the way the physical system was represented in the input stream. This examination leads to one of two conclusions:

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

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

Step 10.
There are many "treatments" available to the user in resolving such problems. These treatments range from decisions to reroute the traffic by imposing turn restrictions where they can produce significant improvements in capacity, changing the control treatment at critical intersections so as to provide improved service for one or more movements, or in prescribing specific treatments for channelizing the flow so as to expedite the movement of traffic along major roadway systems or changing the trip table. Such "treatments" take the form of modifications to the original input stream.

Step 11.
As noted above, the changes to the input stream must be implemented to reflect the modifications undertaken in Step 10. At the completion of this activity, the process returns to Step 8 where the TRAD model is again executed.

Step 12.
The output of the TRAD model includes the computed turn movements for each link. These data are required – and – accessed by the 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.

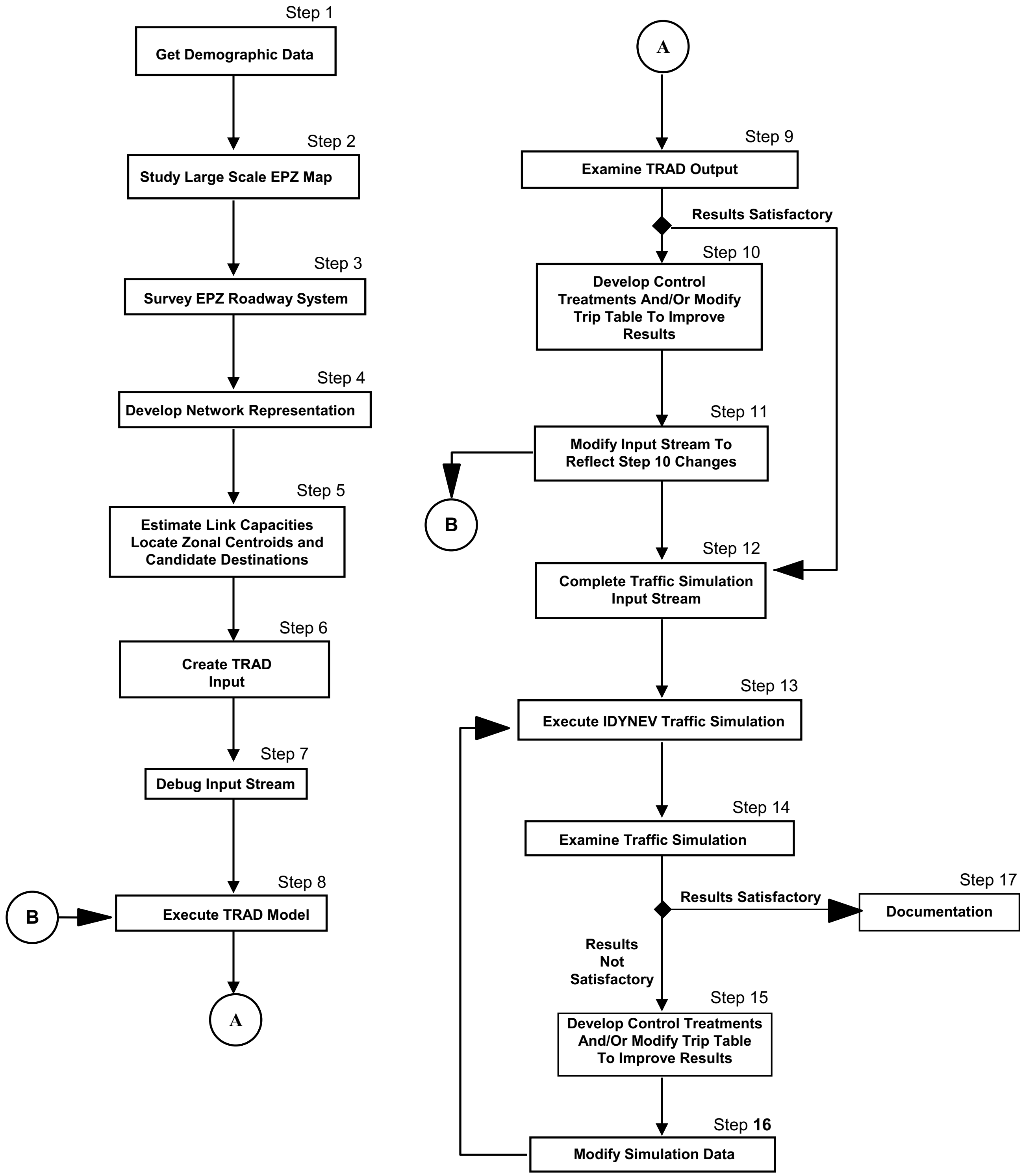


Figure D-1. Flow Diagram of Activities

APPENDIX E

Special Facility Data

APPENDIX E: SPECIAL FACILITY DATA

The following tables list population information for special facilities that are contained within the Calvert Cliffs Nuclear Power Plant EPZ. Special facilities are defined as schools, day care centers, hospitals and other medical care facilities, correctional institutions, and major employers. Transient population data is included in the tables for state parks, county parks, hotels and motels, and other recreational areas. Each table is grouped by county. The location of the facility is defined by its straight-line distance (miles) and direction (magnetic bearing) from the CCNPP.

Calvert Cliffs EPZ: Schools

PAZ	Distance (miles)	Dir-ection	School Name	Street Address	Municipality	Phone	Student Enrollment	Staff
CALVERT COUNTY								
1	1.8	S	Southern Middle School	9615 Hg Trueman Rd.	Lusby	410-535-7877	632	91
1	3.8	WNW	St. Leonard Elementary School	5370 St. Leonard Rd.	St. Leonard	410-535-7715	739	40
2	5.6	WNW	Mutual Elementary School	1455 Ball Rd.	Pt. Republic	410-535-7706	628	82
3	4.0	S	Patuxent Elementary School	35 Appeal Ln.	Lusby	410-535-7830	503	44
3	4.2	S	Appeal Elementary School	11655 Hg Trueman Rd.	Lusby	410-535-7800	431	52
3	4.6	S	Dowell Elementary School	12680 Hg Trueman Rd.	Lusby	410-535-7802	695	79
3	4.8	S	Mill Creek Middle School	12200 Margaret Taylor Rd.	Lusby	410-535-1700	631	87
3	5.5	S	Patuxent High School	12485 Rousby Hall Rd.	Lusby	410-535-7865	1,366	103
3	7.6	S	Our Lady Star of the Sea School	92 A St.	Solomons	410-326-3171	194	25
ST. MARY'S COUNTY								
7	7.8	SW	Hollywood Elementary School	44345 Joy Chapel Rd.	Hollywood	301-373-4350	641	66
7	9.4	SSW	Town Creek Elementary School	45805 Dent Dr.	Lexington Park	301-863-4044	272	37
7	9.8	SSW	Green Holly Elementary School	46060 Millstone Landing Rd.	Lexington Park	301-863-4064	620	96
7	9.9	SW	St. John's Elementary School	43900 St. John's Rd.	Hollywood	301-373-2142	221	21
7	10.1	SSW	Esperanza Middle School	22790 Maple Rd.	Lexington Park	301-863-4016	880	93
						Total:	**8,453**	**916**

Calvert Cliffs EPZ: Day Care Facilities

PAZ	Distance (miles)	Dir-ection	Name of Facility	Street Address	Municipality	Phone	Enroll-ment	Empl-oyees
CALVERT COUNTY								
1	2.6	NW	All Day Quality Care, Inc.	5845 Calvert Blvd.	St. Leonard	410-586-0957	N/A	N/A
2	4.5	WNW	You Are Loved Child Care Center	150 Ball Rd.	St. Leonard	410-586-1661	N/A	N/A
2	4.6	NW	Grover Place Child Care Center	4740 St. Leonard Rd.	St. Leonard	410-586-9364	N/A	N/A
3	4.0	S	Head Start	35 Appeal Ln.	Lusby	410-394-0200	N/A	N/A
3	4.3	S	Adventure Point Youth Center	11875 Hg Trueman Rd.	Lusby	410-394-1103	N/A	N/A
3	4.3	S	Solomons Daycare Center II	11875 Hg Trueman Rd.	Solomons	410-326-2298	N/A	N/A
3	5.2	SSE	Linda's Day Care	11701 Big Sandy Run Rd.	Lusby	410-394-0447	N/A	N/A
3	6.1	S	Solomons Daycare Center	105 Swaggers Point Rd.	Solomons	410-326-1433	N/A	N/A
5	10.5	NW	Busy Bee Nursery, Inc.	1660 Dares Beach Rd.	Prince Frederick	410-535-0687	N/A	N/A
ST. MARY'S COUNTY								
6	9.4	WSW	Smart Start Daycare	25468 Three Notch Rd.	Hollywood	301-373-7882	N/A	N/A
7	8.9	SSW	Honey MacCallum Christian	23421 Kingston Creek Rd.	California	301-863-8600	N/A	N/A
7	9.2	SW	Hollywood Utd. Meth. Church Chr. PS	24422 Mervell Dean Rd.	Hollywood	301-373-8738	N/A	N/A
7	9.2	SW	Prep & Play Day Care-Preschool	24442 Mervell Dean Rd.	Hollywood	301-373-3710	N/A	N/A
7	9.8	SSW	Holly Green Day Care	46060 Millstone Landing Rd.	Lexington Park	301-862-9205	12	2
7	10.0	SSW	Starmaker Learning Center, Inc.	23443 Cottonwood Pkwy.	California	301-863-7740	N/A	N/A
7	10.1	SSW	Creative Beginnings Preschool & Daycare	22840 Three Notch Rd.	California	301-863-2345	N/A	N/A
7	10.3	SSW	Recreation & Parks Childrens Center	Millstone Landing Rd.	Lexington Park	301-862-9205	N/A	N/A

N/A= Data was not available for most Day Care facilities within the EPZ. It is assumed that parents pick up their children at the facility before evacuating. This activity is accounted for in the work to home travel time portion of the trip generation discussed in Section 5.

Calvert Cliffs EPZ: Nursing Homes & Senior Center Facilities									
PAZ	Distance (miles)	Dir-ection	Name of Facility	Street Address	Municipality	Phone	Residents Capacity	Employees (Max Shift)	Employees (Total)
CALVERT COUNTY									
3	4.0	S	Southern Pines (Sen. Ctr.)	20 Appeal La.	Lusby	410-586-2748	30	5	5
3	6.0	S	Solomon's Nursing Center	13325 Dowell Rd.	Solomons	410-326-0077	84	11	11
3	6.3	SSW	Asbury at Solomon's Island	11750 Asbury Circle	Solomons	410-394-3072	33	5	5
ST. MARY'S COUNTY									
7	9.2	SW	Vivian Ripple Center	24400 Mervell Dean Rd.	Hollywood	301-373-6515	29	9	9
						Total:	**176**	**30**	**30**

Calvert Cliffs EPZ: Medical Facilities
There are no hospitals within the Calvert Cliffs EPZ

Calvert Cliffs EPZ: Correctional Facilities
There are no correctional facilties within the Calvert Cliffs EPZ

Calvert Cliffs EPZ: Major Employers

PAZ	Distance (miles)	Dir-ection	Name of Facility	Street Address	Municipality	Phone	Total Employees	Non-EPZ Employees
CALVERT COUNTY								
1	0.0	-	CCNPP	Calvert Cliffs Pkwy.	Lusby	410-783-2800	833	558
3	3.9	SSE	Dominion Cove Point LNG	2100 Cove Point Rd.	Lusby	410-286-5100	68	30
3	5.9	S	Solomons Nursing Center	13325 Dowell Rd.	Solomons	410-326-0077	147	37
3	6.0	S	Food Lion	13300 H G Trueman Rd.	Solomons	410-394-6236	175	44
3	6.8	S	Holiday Inn Select Conf. Ctr. & Marina	155 Holiday Dr.	Solomons	410-326-6311	100	25
3	7.2	S	Navy Recreation Center	13855 Solomons Island Rd.	Solomons	5529	120	30
3	8.0	S	Chesapeake Biological Laboratory	1 Williams St.	Solomons	4281	150	37
3	4.3	S	Food Lion	11760 H.G. Trueman Rd.	Lusby	410-326-9361	175	44
4	8.2	NW	Giant Food	655 Solomons Island Rd.	Prince Frederick	410-535-5641	310	77
5	8.2	NW	Walmart	150 Solomons Island Rd.	Prince Frederick	410-535-3790	605	151
ST. MARY'S COUNTY								
6	9.3	SW	Burch Oil Co., Inc.	24660 Three Notch Rd.	Hollywood	301-373-2131	280	56
7	9.7	SSW	Lowe's Home Improvement	45075 Worth Ave.	California	301-737-0232	193	39
7	10.1	SW	Merkle Mailing Services	43880 Commerce Ave.	Hollywood	3100	400	80
7	10.2	SW	Northrop Grumman PRB Systems	43865 Airport View Dr.	Hollywood	2360	150	30
7	10.3	SSW	Eagle Systems, Inc.	22560 Epic Dr.	California	301-863-2453	200	40
7	10.8	S	Eagan, Mcallister Associates, Inc.	46561 Expedition Dr.	Lexington Park	301-863-2204	507	101
7	10.8	S	Man Tech International	46610 Expedition Dr., Ste. 101	Lexington Park	301-862-2200	375	75
						Total:	**4,788**	**1,454**

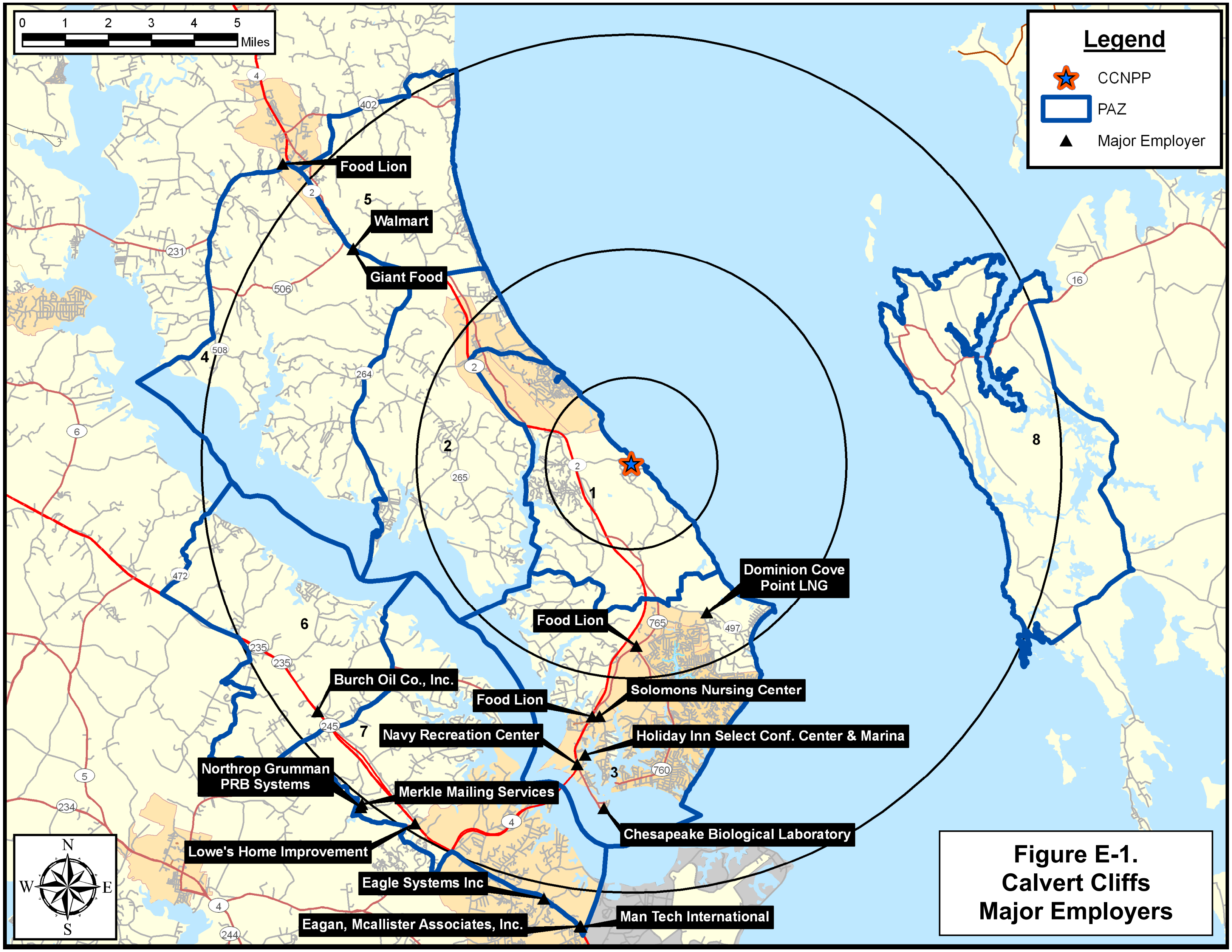


Figure E-1.
Calvert Cliffs
Major Employers

Calvert Cliffs EPZ: Recreational Areas										
PAZ	Distance (miles)	Direction	Name of Facility	Street Address	Municipality	Phone	Persons	Total Veh	Transient Persons	Transient Vehicles
				CALVERT COUNTY						
1	1.8	WNW	Flag Ponds Nature Park	1525 Flag Ponds Pkwy.	Lusby	410-586-1477	500	125	375	94
1	1.8	WNW	Flag Ponds Park CWMA	1525 Flag Ponds Pkwy.	Lusby	410-586-1477	*	*	*	*
1	1.9	WNW	Camp Bay Breeze	140 Walnut Cove Dr.	Lusby	310-743-7613	210	28 **	158	21
1	3.1	S	Calvert Cliffs State Park	9500 H. G. Truman Pkwy.	Lusby	301-743-7613	325	116	244	87
2	3.9	WSW	Jefferson Patterson Park & Museum	10115 Mackall Rd.	St. Leonard	410-586-8500	40	12	30	9
3	3.5	SSE	Cove Point Recreation Park	750 Cove Point Rd.	Lusby	410-326-2833	200	71	150	53
3	3.8	S	Southern Community Center	20 Appeal Ln.	Lusby	410-586-1101	200	100	150	75
3	7.2	S	Calvert County Marine Museum	14200 Solomons Island Rd. S	Solomons	410-326-2042	268	77	201	58
3	7.3	S	Navy Recreation Center	13855 Solomons Island Rd.	Solomons	410-286-5529	3,000	800	3,000	800
4	7.8	W	Patuxent Camp Sites	4774 Williams Wharf Rd.	St. Leonard	410-586-9880	125	42	125	42
4	8.9	WNW	Battle Creek Cypress Swamp Nature Area	2880 Gray's Rd.	Prince Frederick	410-535-5327	70	6 ***	53	5
				DORCHESTER COUNTY						
8	8.0	ENE	Taylors Island Family Campground	462 Bayshore Rd.	Taylor's Island	410-397-3275	200	67	200	67
				ST. MARY'S COUNTY						
2	4.6	NW	St. Leonard Recreation Area	4825 Maryland Ave.	St. Leonard	410-535-1600	50	20	8	3
6	6.9	WSW	Sotterley Mansion	44300 Sotterley Ln.	Hollywood	301-373-2280	69	25	52	18
6	10.9	SW	Judge P.H. Dorsey Memorial Park	24275 Hollywood Rd.	Leonardtown	301-475-4200	1,300	300	650	150
7	6.6	SW	Greenwell State Park	25420 Rosedale Manor Ln.	Hollywood	301-373-9775	550	250	275	125
7	7.8	SW	Hollywood Soccer Complex	44345 Joy Chapel Rd.	Hollywood	301-475-4200	1,300	300	650	150
7	8.0	SSW	Myrtle Point Park	24032 N. Patuxent Beach Rd.	California	301-475-4200	100	30	75	23
7	9.2	SW	Hollywood Recreation Center	24400 Mervell Dean Rd.	Hollywood	301-373-5410	200	40	100	20
						Total:	**8,707**	**2,409**	**6,496**	**1,800**

* These numbers are included in the numbers for Flag Ponds Nature Park.

** The total vehicles are 1 15-passenger van and 3 passenger cars per campsite. There are 7 sites in total.

*** The total vehicles are 1 school bus and 4 passenger cars. The school bus is counted as 2 vehicles.

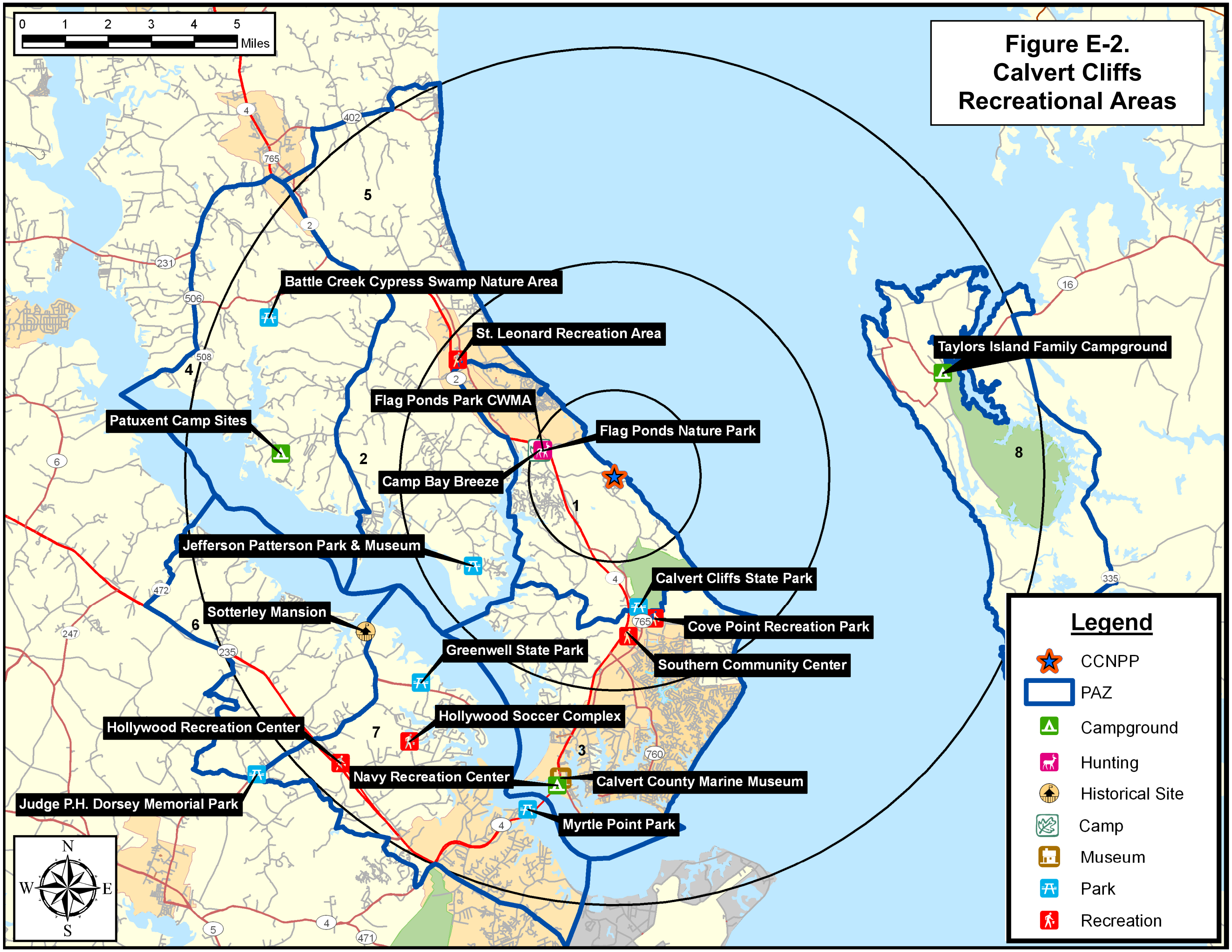


Figure E-2.
Calvert Cliffs
Recreational Areas

Calvert Cliffs EPZ: Lodging								
PAZ	Distance (miles)	Dir-ection	Name of Facility	Street Address	Municipality	Phone	Per-sons	Veh-icles
CALVERT COUNTY								
2	3.3	NW	Matoaka Beach Cabins	4510 Matoaka Ln.	St. Leonard	410-586-0269	58	16
2	4.6	NW	Cliffs Motor Inn	4785 St. Leonard Rd.	St. Leonard	410-586-1514	32	16
3	6.9	S	Holiday Inn Select	155 Holiday Dr.	Solomons	410-326-6311	652	326
3	7.1	S	Comfort Inn Beacon Marina	255 Lore Rd.	Solomons	410-326-6303	120	60
3	7.5	S	Webster House	14364 Sedwick Ave.	Solomons	410-326-0454	6	3
3	7.6	S	Back Creek Inn	210 Alexander Ln.	Solomons	410-326-2022	15	6
3	7.7	S	Blue Heron Inn Bed & Breakfast	14614 Solomons Island Rd. S	Solomons	410-326-2707	8	4
3	7.7	S	Locust Inn	14478 Solomons Island Rd. S	Solomons	410-326-9817	16	8
3	8.0	S	Solomons Victorian Inn	125 Charles St.	Solomons	410-326-4811	16	8
4	10.3	NW	Spring Hill Suites by Marriot	75 Sherry Ln.	Prince Frederick	443-968-3000	174	87
5	9.1	NNW	Cliff House	156 Windcliff Rd.	Solomons	410-535-4839	2	1
ST. MARY'S COUNTY								
6	8.2	SW	The Victorian Candle	25065 Peregrine Way	Hollywood	301-373-8800	16	8
7	9.9	SSW	Sleep Inn Lexington Park	23428 Three Notch Rd.	California	301-737-0000	162	81
7	10.2	SSW	Best Western	22769 Three Notch Rd.	California	301-862-4100	240	120
7	10.2	SSW	Lexington Park Super 8 Motel	22801 Three Notch Rd.	California	301-862-9822	124	62
7	10.8	S	Extended Stay America Lexington Pk	46565 Expedition Dr.	Lexington Park	240-725-0100	280	140
7	10.8	S	Towneplace Suites	22520 Three Notch Rd.	Lexington Park	301-863-1111	235	78
7	11.0	S	Fairfield Inn By Marriott Lexington Pk	22119 Three Notch Rd.	Lexington Park	301-863-0203	156	78
7	11.0	S	Hampton Inn	22211 Three Notch Rd.	Lexington Park	301-863-3200	222	111
						Total:	**2,534**	**1,213**

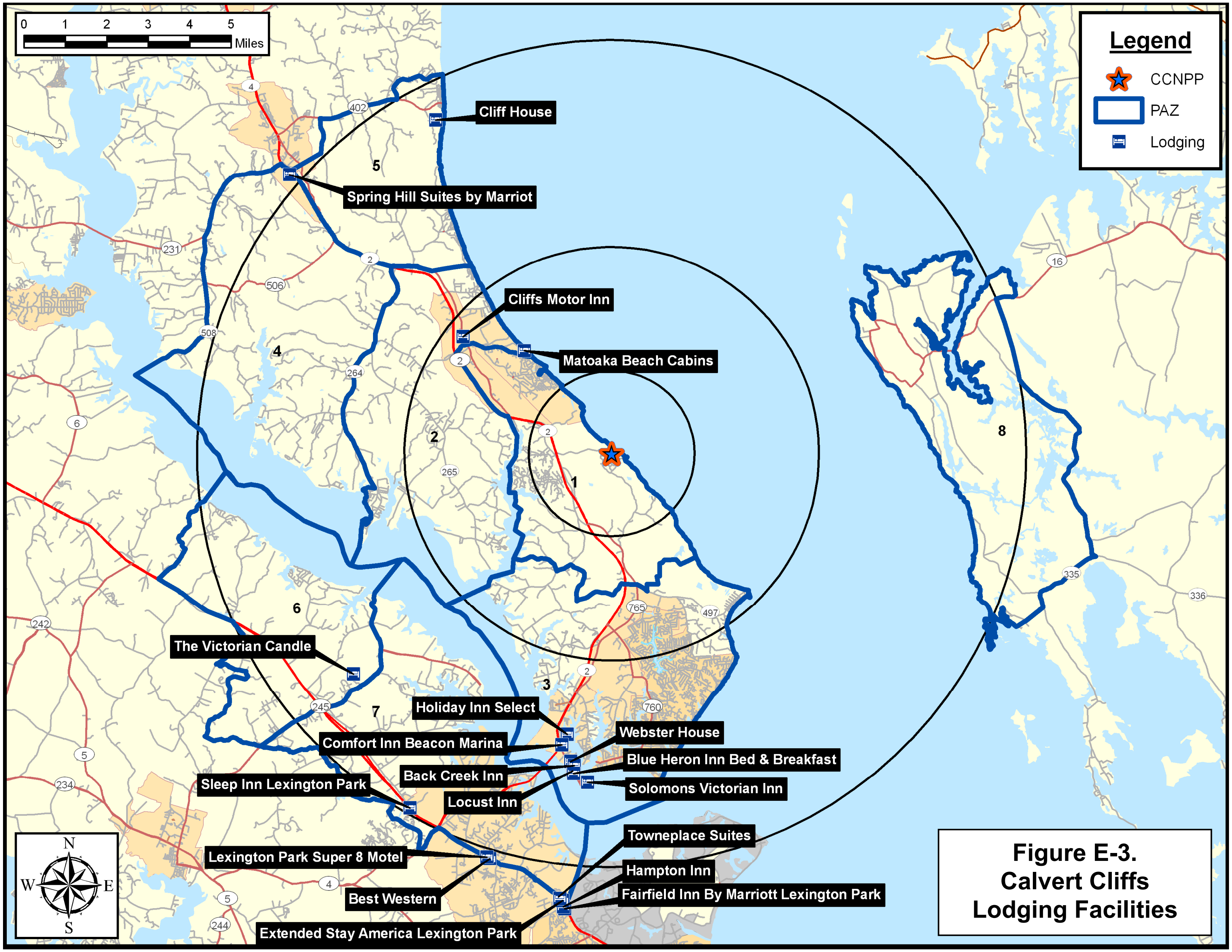


Figure E-3.
Calvert Cliffs
Lodging Facilities

Calvert Cliffs EPZ: Marinas

PAZ	Distance (miles)	Dir-ection	Name of Facility	Street Address	Municipality	Phone	Per-sons	Total Vehicles	Transient Persons	Transient Vehicles
				CALVERT COUNTY						
1	2.5	WSW	Vera's White Sands Marina	1200 White Sands Dr.	Lusby	410-586-1182	100	36	75	27
1	2.7	NW	Flag Harbor Yacht Haven	1565 Flag Harbor Blvd.	St. Leonard	410-586-1915	168	60	126	45
2	5.8	WSW	Broome's Island Marina	3939 Oyster House Rd.	Broomes Island	410-586-2941	40	14	30	11
3	5.5	S	KB Derr & Son Marina	12565 Rousby Hall Rd.	Lusby	410-326-7089	100	36	75	27
3	6.8	S	Hospitality Harbor Marina	205 Holiday Dr.	Solomons	410-326-1052	75	27	56	20
3	6.9	S	Calvert Marina	14485 Dowell Rd.	Solomons	410-326-4251	450	161	338	121
3	7.1	S	Beacon Marina	255 Lore Rd.	Solomons	410-326-6303	186	66	140	50
3	7.1	S	Spring Cove Marina	455 Lore Rd.	Solomons	410-326-2161	250	89	188	67
3	7.3	S	Zahnizer's Yachting Center	245 C St. & Back Creek	Solomons	410-326-2166	300	107	225	80
3	7.6	S	Solomons Yachting Center	255 Alexander Ln.	Solomons	410-326-2401	100	36	75	27
3	7.7	S	Bunky's Charter Boats	14448 Solomons Island Rd.	Solomons	410-326-3241	9	3	7	2
3	7.9	S	Harbor Island Marina, Inc.	105 Charles St.	Solomons	410-326-3441	115	41	86	31
4	8.5	W	Bill's	5040 Kings Rd.	St. Leonard	410-586-3599	15	5	11	4
				ST. MARY'S COUNTY						
6	9.8	W	Cape St. Mary's	27290 Holly Ln.	Mechanicsville	301-373-2001	135	48	101	36
7	7.1	SSW	Blackstone Marina	24845 Marina Way	Hollywood	301-373-2015	54	19	41	14
7	7.1	SW	Weeks Marine Railway	45046 Blackstone Circle	Hollywood	301-373-8710	45	16	34	12
7	8	SSW	Boatel California	23950 North Patuxent Beach Rd.	California	301-737-1400	53	19	40	14
						Total:	**2,195**	**783**	**1,648**	**588**

Note: The population associated with Marinas is assumed to be 25% EPZ residents. To avoid double counting, EPZ residents are not included in the transient population numbers.

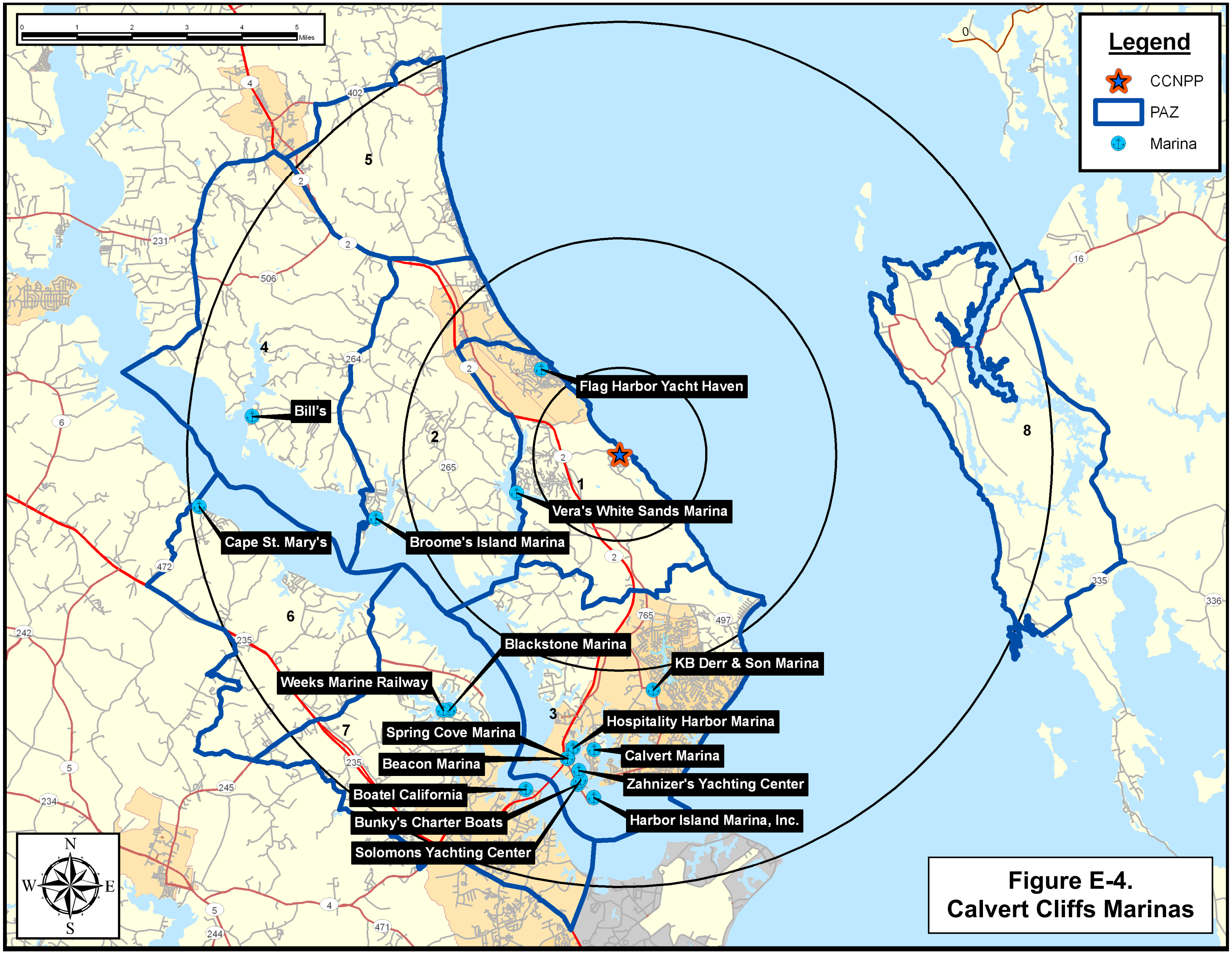


Figure E-4.
Calvert Cliffs Marinas

APPENDIX F

Telephone Survey

APPENDIX F: TELEPHONE SURVEY

1. INTRODUCTION

The development of evacuation time estimates for the Emergency Planning Zone (EPZ) of the Calvert Cliffs 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 for comment. Comments were received and the survey instrument was modified appropriately.

Following the completion of the instrument, a sampling plan was developed. A sample size of approximately 550 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. The completed survey adhered to the sampling plan.

Table F-1. Survey Sampling Plan			
CCNPP Telephone Survey			
Sampling Plan			
Zip Code	**EPZ Population in Zip Code (2000)**	**Households in EPZ**	**Required Sample**
20615	401	161	5
20657	18090	6120	209
20676	3092	1069	36
20678	3846	1306	45
20685	5597	1920	66
20688	1796	799	27
21622	70	34	1
21669	220	98	3
21648	5	4	0
20619	2226	1058	36
20636	6494	2397	82
20653	2270	778	27
20659	1026	377	13
20670	0	0	0
Total	**45,133**	**16,121**	**550**
Average Household Size		**2.80**	
Total Sample Required		**550**	

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 2.80 people, which was also the average household size as estimated using the 2000 Census data (Table F-1). The agreement between the estimates validates the telephone survey results.

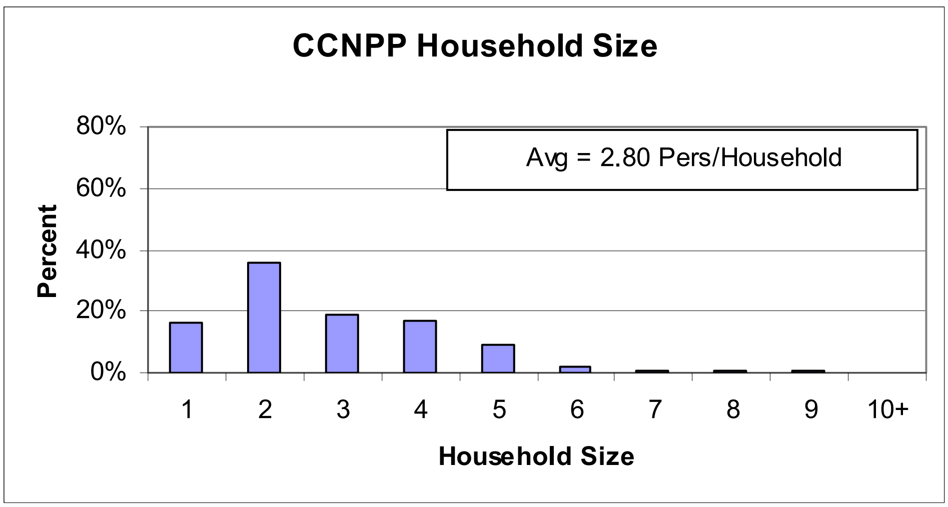


Figure F-1. Household Size in the EPZ

Automobile Ownership

The average number of automobiles per household in the EPZ is 2.30. 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 2.5 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.

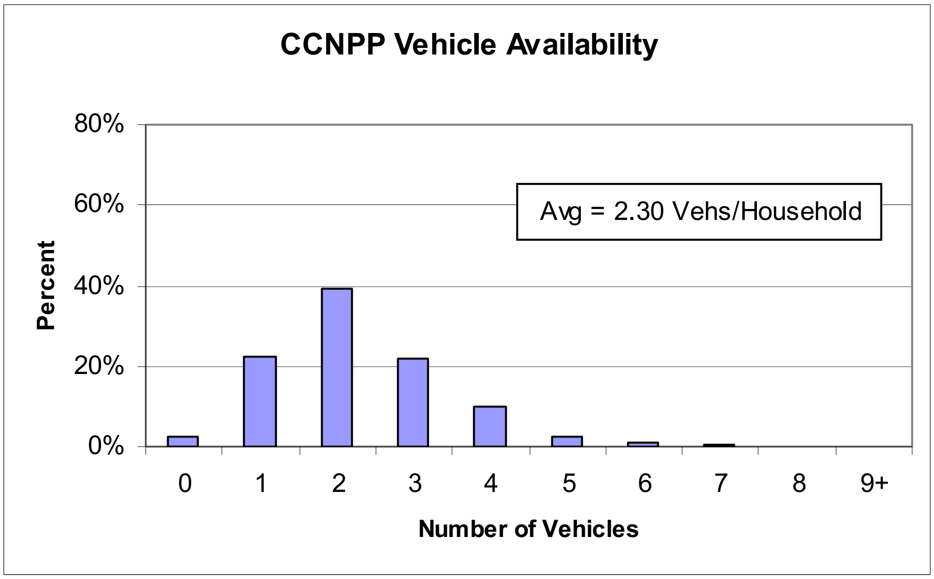


Figure F-2. Household Vehicle Availability

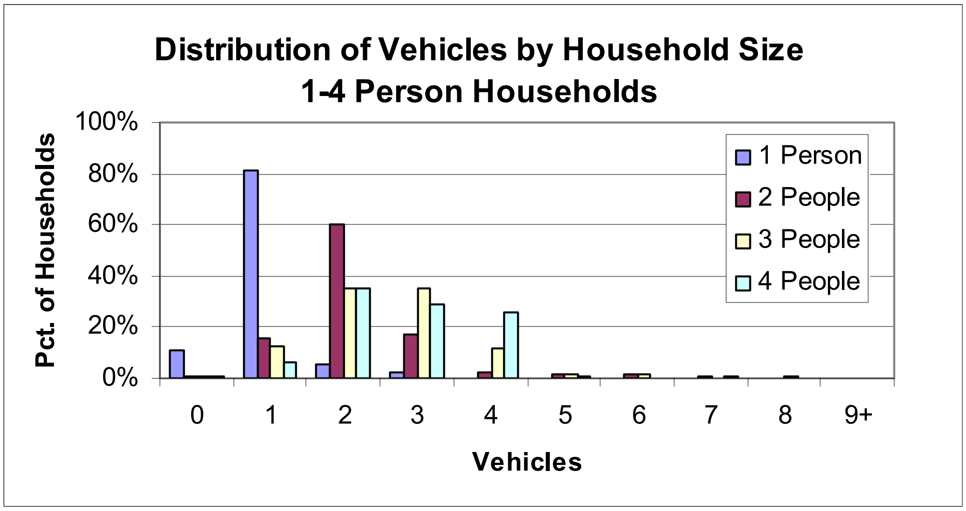


Figure F-3. Vehicle Availability – 1 to 4 Person Households

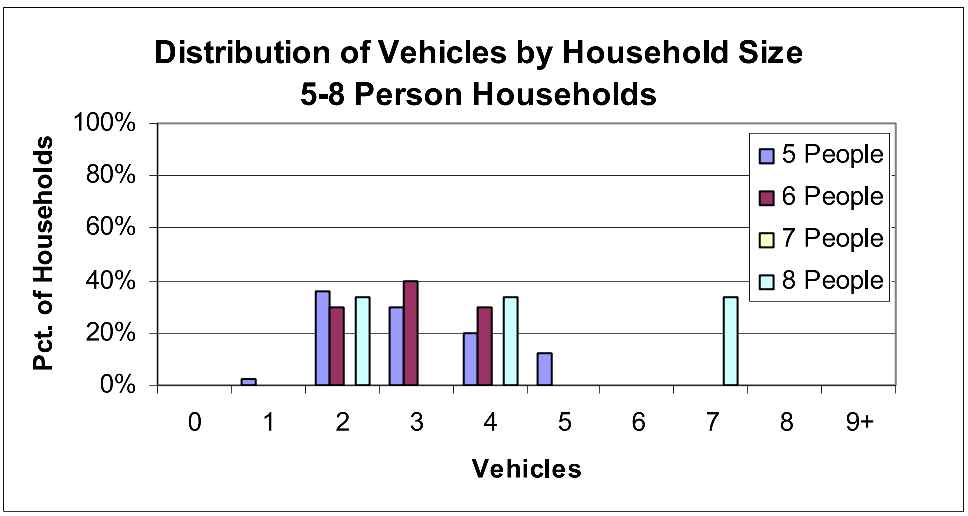


Figure F-4. Vehicle Availability – 5 to 8 Person Households

School Children

The average number of school children per household identified by the survey is 0.67. Figure F-5 presents the distribution of school children.

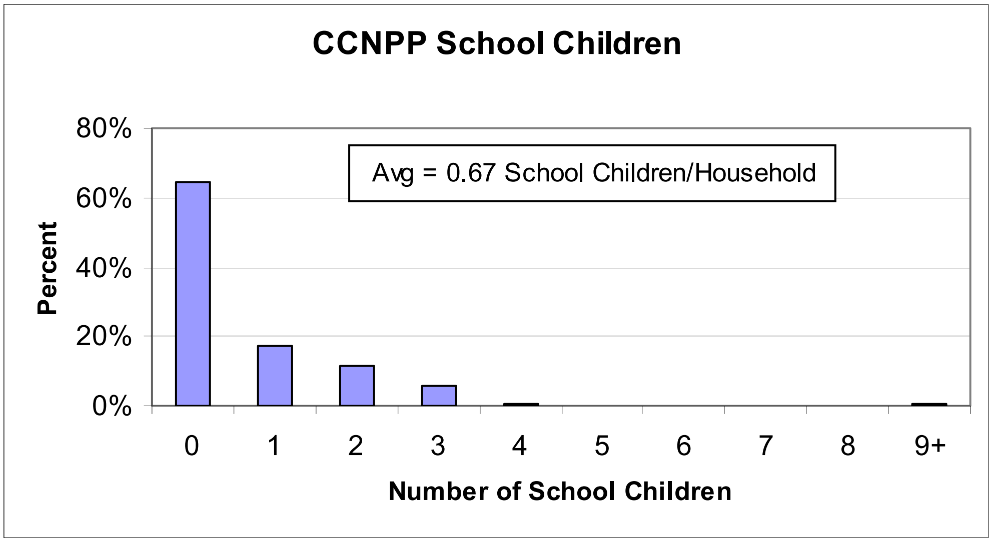


Figure F-5. School Children in Households

Commuters

Figure F-6 presents the distribution of the number of commuters in each household. The data shows an average of 1.13 commuters in each household in the EPZ.

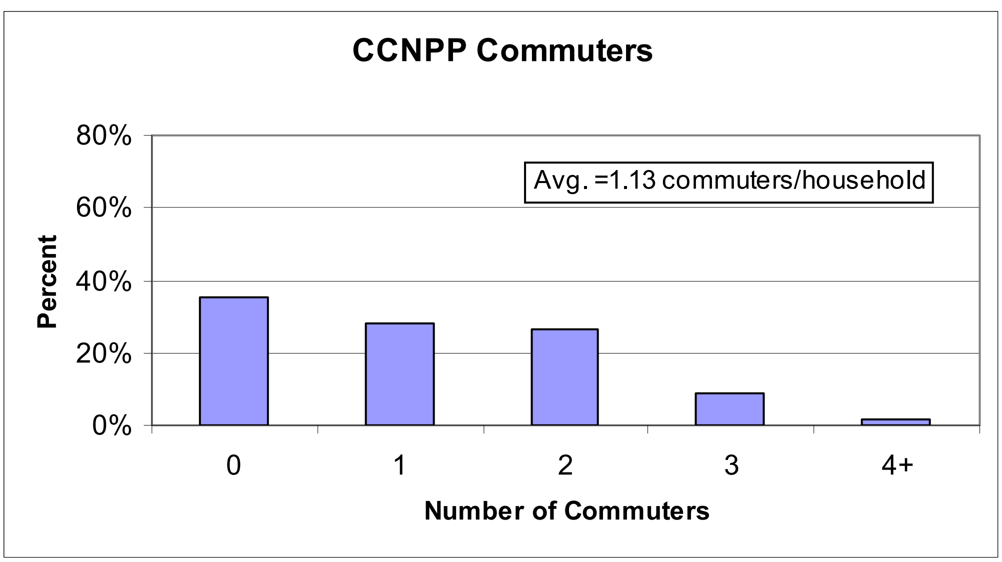


Figure F-6. Commuters in Households in the EPZ

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 to school.

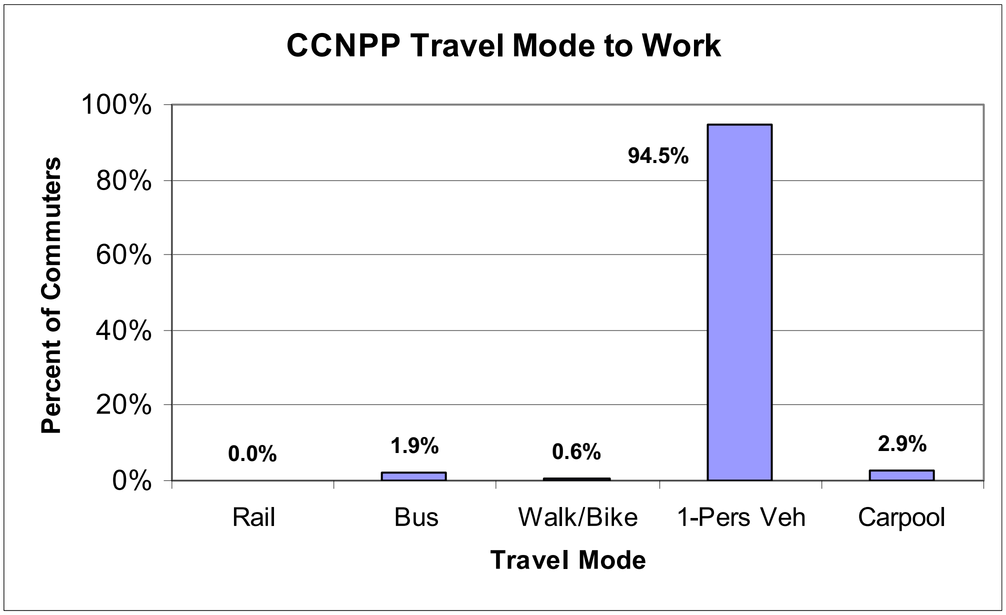


Figure F-7. Modes of Travel to Work by EPZ Residents

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, 1.46 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, 67 percent said that there was another vehicle available to evacuate, while 33 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, 58 percent said they would await the return of other family members before evacuating and 42 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, 59 percent of respondents said they would take their pets; 13 percent would not. The remaining 28 percent either did not have a pet, or did not give a definitive answer.

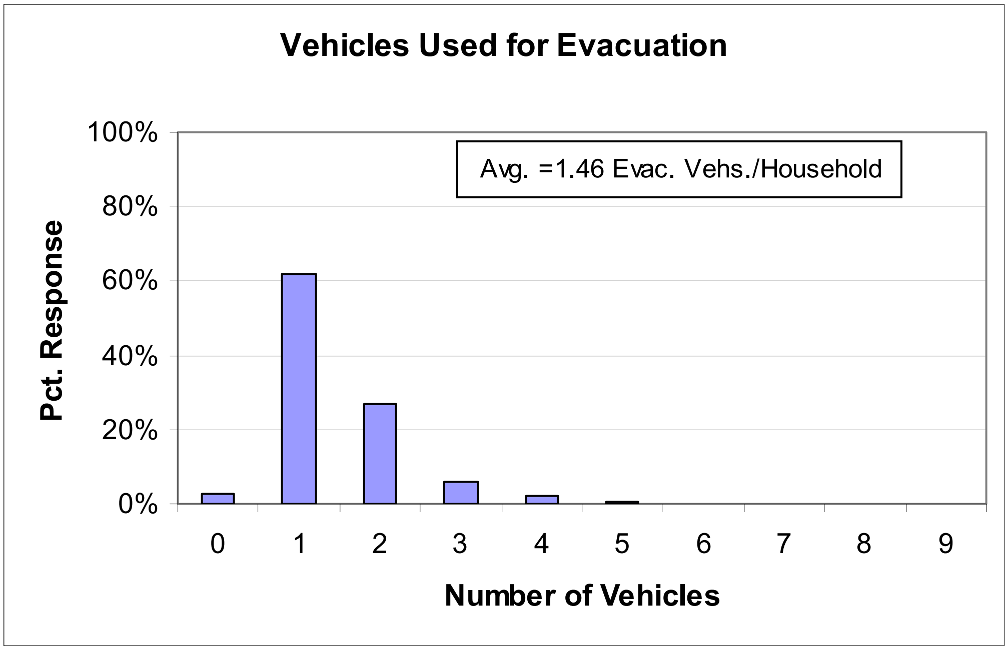


Figure F-8. Number of Vehicles Used for Evacuation

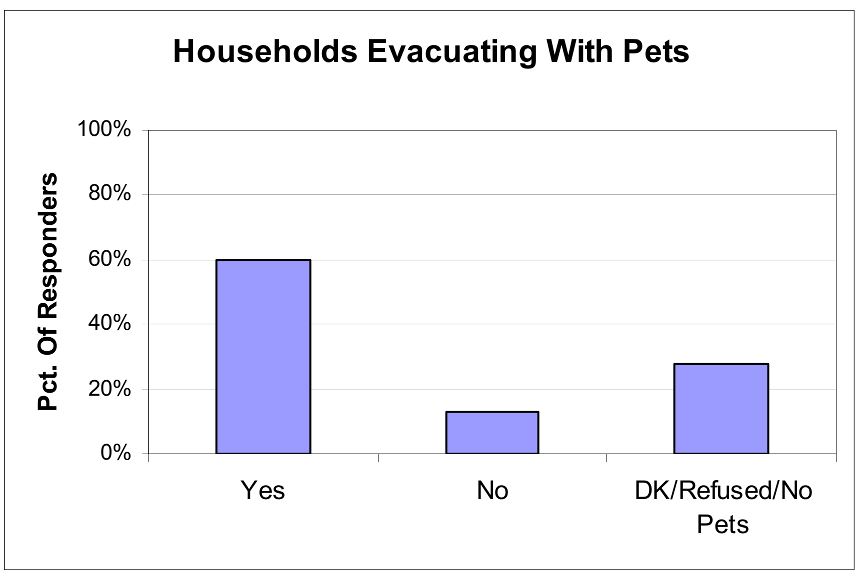


Figure F-9. Households Evacuating With Pets

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; the activity is completed by 115 minutes. Sixty percent can leave within 15 minutes.

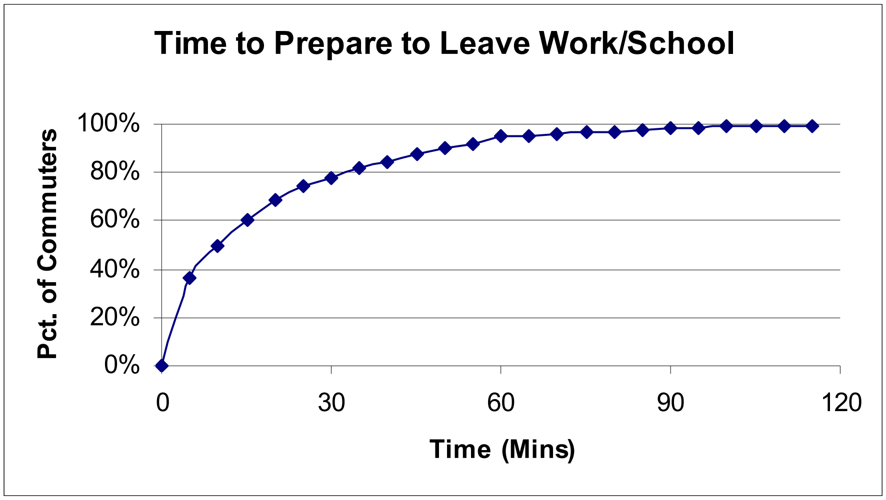


Figure F-10. Time Required to Prepare to Leave Work/School

How long would it take the commuter to travel home?
Figure F-11 presents the work to home travel time. In all cases, over 76 percent of commuters can arrive home within about 45 minutes of leaving work; all within 120 minutes.

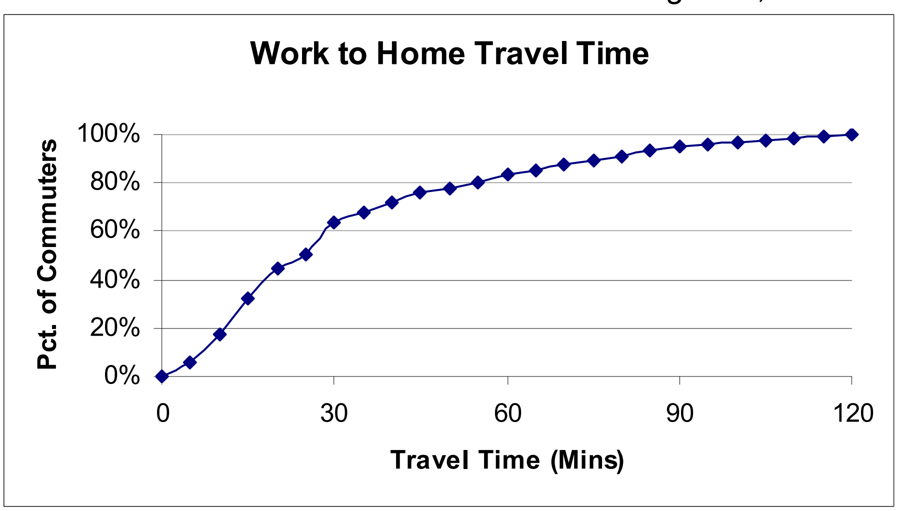


Figure F-11. Work to Home Travel Time

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 90 percent of households can be ready to leave home in approximately 1 hour; the remaining 10 percent of households can be ready to leave within 2 hours and 30 minutes.

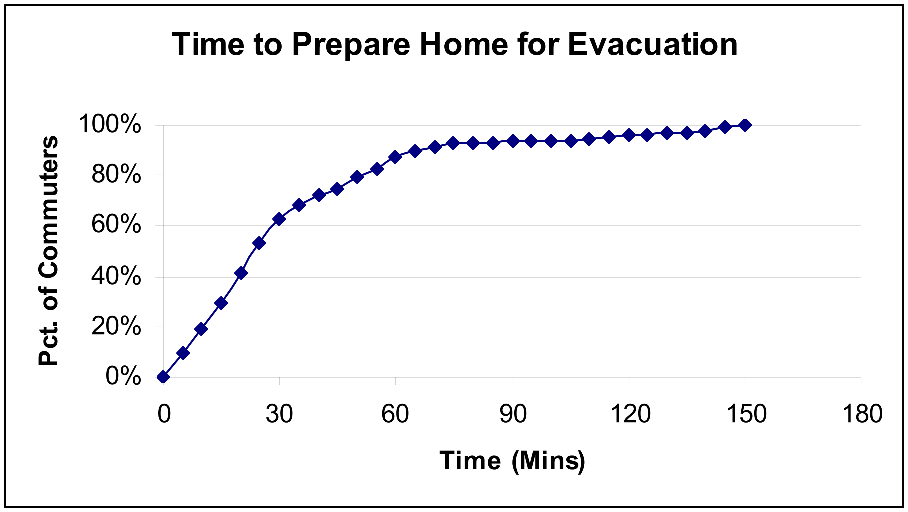


Figure F-12. Time to Prepare Home for Evacuation

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

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

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

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

DO NOT ASK:

1A. Record area code. To Be Determined

COL. 9-11

1B. Record exchange number. To Be Determined

COL. 12-14

---

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

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

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

---

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

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

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

COL.23

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

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

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

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

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

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

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

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

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

COMMUTER #1

COL.41

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

COL.42

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

COMMUTER #2

COL.43

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

COL.44

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

COMMUTER #3

COL.45

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

COL.46

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

COMMUTER #4

COL.47

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

COL.48

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

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

COMMUTER #1

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

COMMUTER #2

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

COMMUTER #3

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

COMMUTER #4

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

---

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

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

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

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

---

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

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

---

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

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

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

COL.62
1 DON'T KNOW

---

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

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

Thank you very much. ______________________________________
(TELEPHONE NUMBER CALLED)

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

County	Telephone Number
Calvert	(410)535-1600
Dorchester	(410)228-1818
St. Mary's	(301)475-4200

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 Calvert Cliffs Nuclear Power Station EPZ. Pages G-2 through G-23 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.

Pages G-24 through G-29 detail the Access Control Points (ACP), which are typically on the periphery of the EPZ; these points are established to divert vehicles from entering the EPZ. Doing so provides all of the available roadway capacity within the EPZ to the evacuees and also prevents people from entering the EPZ and being exposed to risk. Table G-2 summarizes the ACP and the manpower and equipment needed to establish access control, while Figure G-2 provides a detailed map of the location of each ACP.

Manpower and equipment shortages are likely to arise; 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.

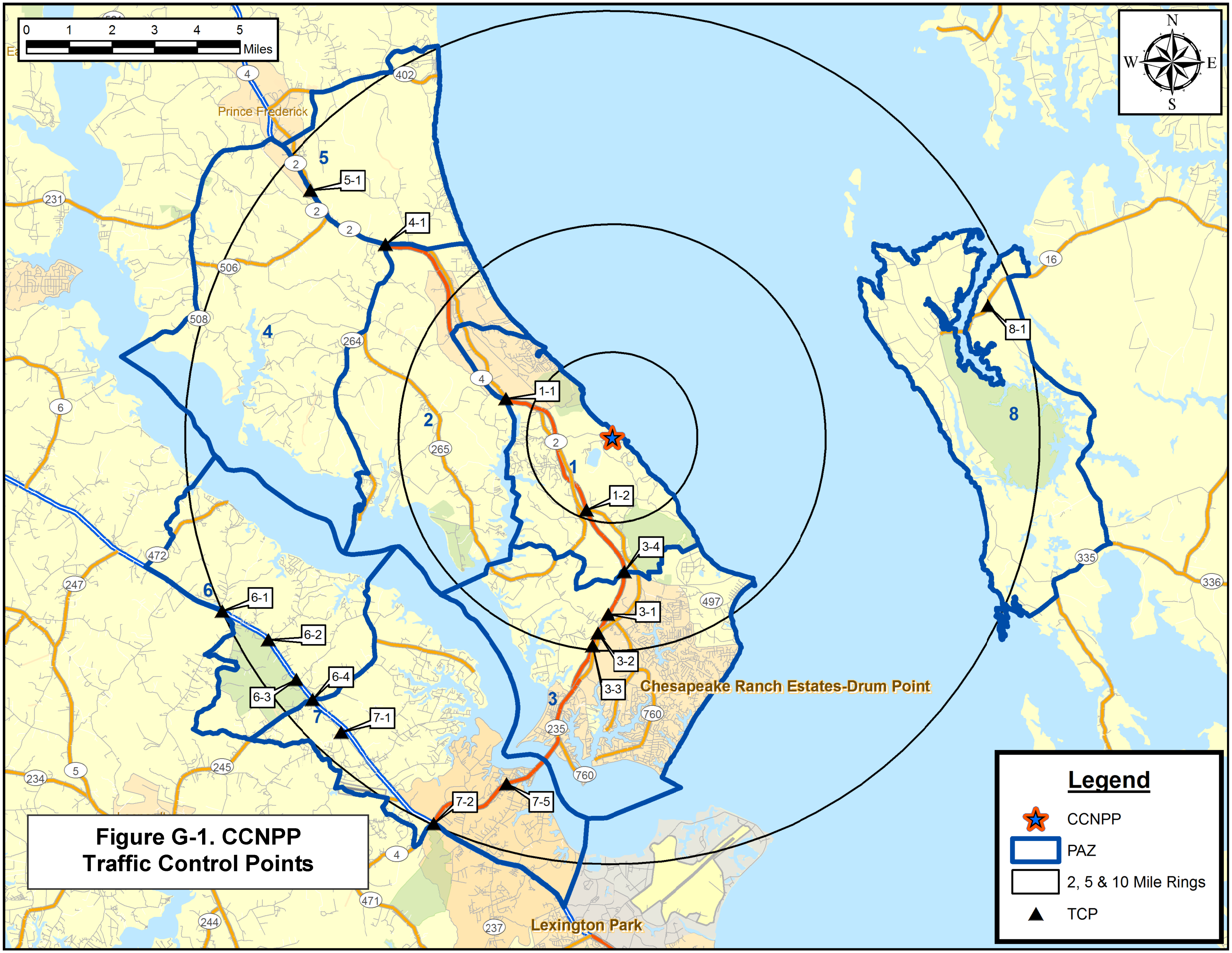


Figure G-1. CCNPP Traffic Control Points

Table G-1. Traffic Control Points					
Priority	ID#	Town	Intersection Location	# of Guides	# of Cones
CALVERT COUNTY					
1	3-1	Lusby	State Highway 2/4 & State Highway 760	2	0
1	3-2	Lusby	State Highway 2/4 & Coster Rd	2	12
1	3-3	Lusby	State Highway 2/4 & Southern Connector Rd/Lusby Connector	2	0
1	3-4	Lusby	State Highway 2/4 & Cove Point Rd	2	9
3	1-1	St. Leonard	State Highway 2/4 & State Highway 765	2	6
3	1-2	Lusby	State Highway 2/4 & State Highway 765	2	0
3	4-1	Port Republic	State Highway 2/4 & State Highway 264	4	12
3	5-1	Prince Frederick	State Highway 2/4 & State Highway 765	2	9
			Total Manpower & Equipment for Calvert County	**18**	**48**
DORCHESTER COUNTY					
3	8-1	Church Creek	State Highway 16 & Smithville Rd	1	6
			Total Manpower & Equipment for Dorchester County	**1**	**6**
ST. MARY'S COUNTY					
1	6-4	Hollywood	State Highway 235 & State Highway 245	4	9
1	7-2	California	State Highway 235 & State Highway 4	6	9
3	6-1	Mechanicsville	State Highway 235 & S Sandgates Rd	4	9
3	6-2	Hollywood	State Highway 235 & Jones Wharf Rd	2	9
3	6-3	Hollywood	State Highway 235 & Old Three Notch Rd	1	6
3	7-1	Hollywood	State Highway 235 & St. Johns Rd	4	6
3	7-5	California	State Highway 4 & N/S Patuxent Beach Rd	1	3
			Total Manpower & Equipment for St. Mary's County	**22**	**51**

TCP

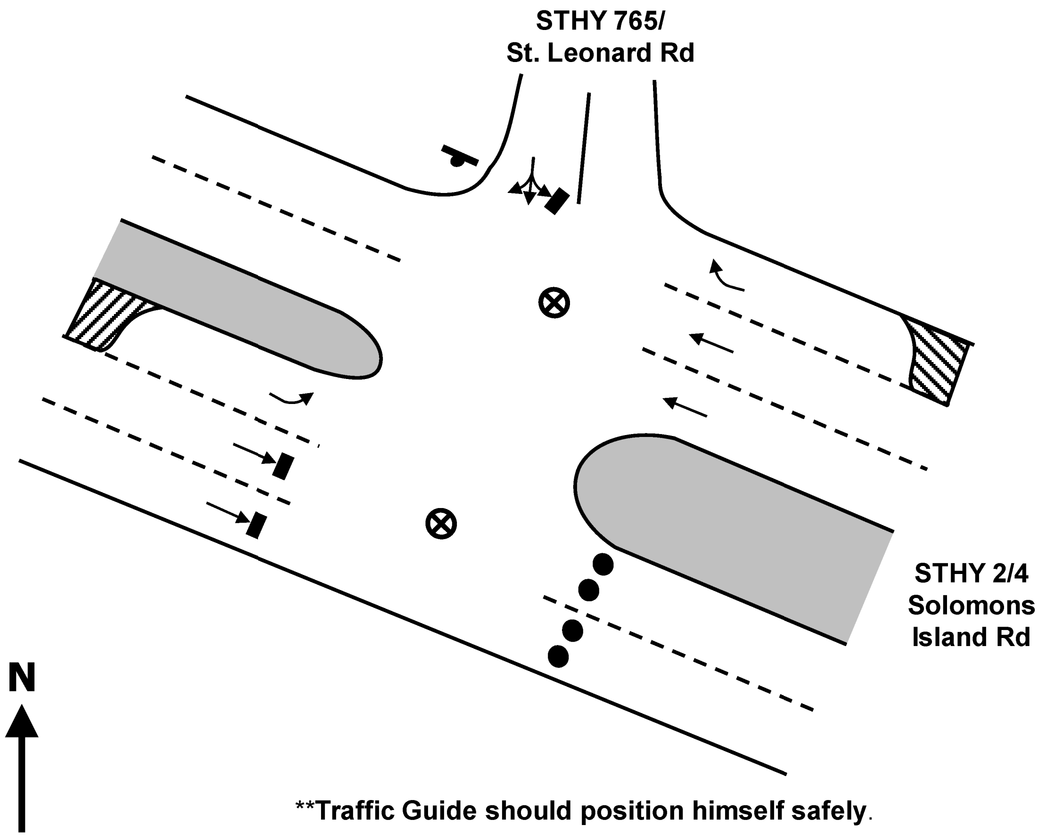
TOWN: ST. LEONARD

LOCATION: State Highway 2/4 & State Highway 765

TCP ID: 1-1

PAZ: 1

COUNTY: Calvert



**Traffic Guide should position himself safely.

Key

MOVEMENT FACILITATED

MOVEMENT DISCOURAGED/DIVERTED

TRAFFIC GUIDE

STOP SIGN

TRAFFIC BARRICADE

2 PER LANE (LOCAL ROADS AND RAMPS)

4 PER LANE (FREEWAY AND RAMPS)

2 ft

3 ft

TRAFFIC SIGNAL

TRAFFIC CONES SPACED TO DISCOURAGE TRAFFIC BUT ALLOW PASSAGE (3 PER LANE):

8 ft

DESCRIPTION

1. Discourage eastbound movement along State Hwy 2/4.

MANPOWER/EQUIPMENT

2 Traffic Guide(s)
6 Traffic Cones

LOCATION PRIORITY

3

TCP

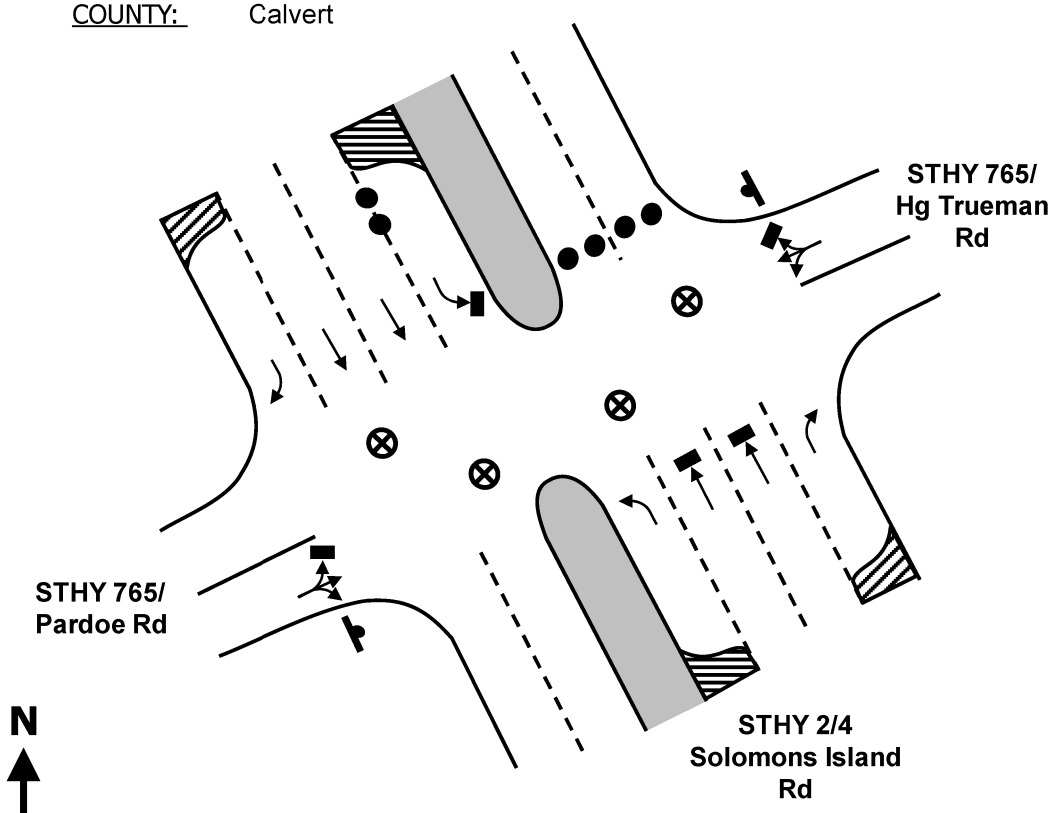
TOWN: LUSBY

LOCATION: State Highway 2/4 & State Highway 765

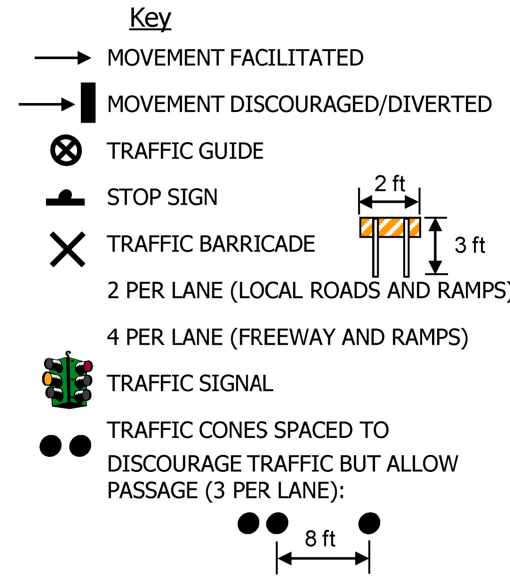
TCP ID: 1-2

PAZ: 1

COUNTY: Calvert



**Traffic Guide should position himself safely.



DESCRIPTION

1. Discourage northbound movement along State Hwy 2/4.

MANPOWER/EQUIPMENT

4 Traffic Guide(s)
9 Traffic Cones

LOCATION PRIORITY

3

TCP

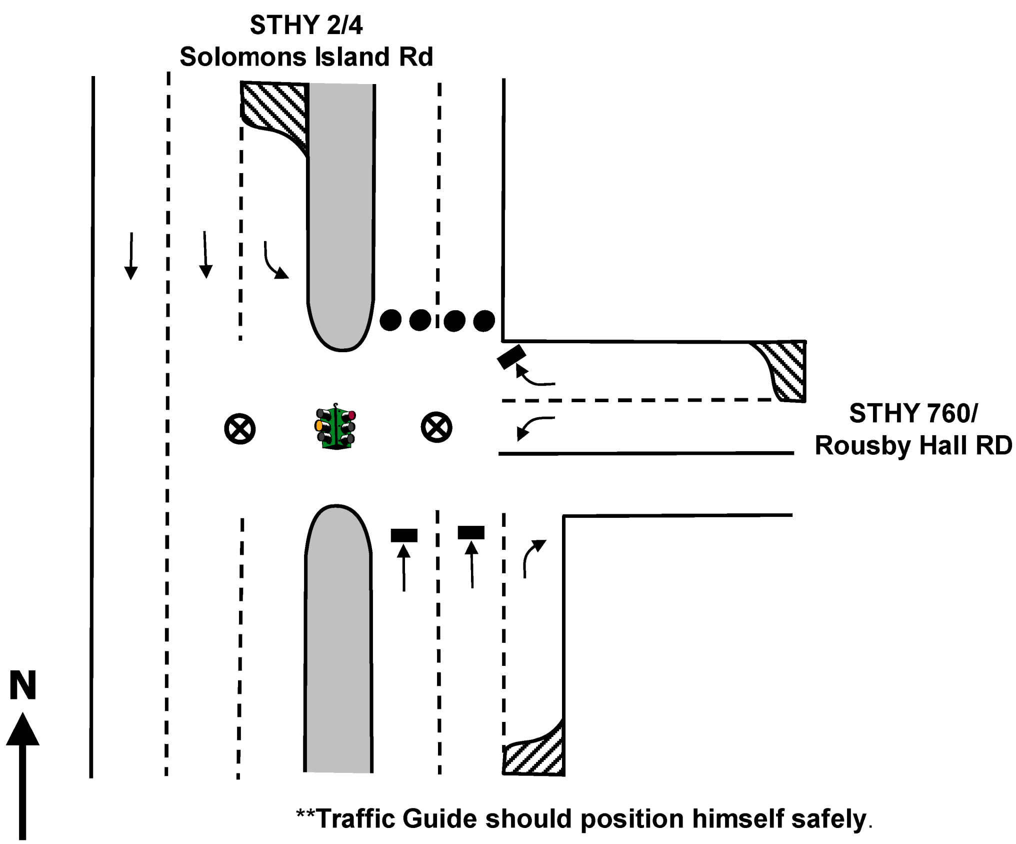
TOWN: LUSBY

LOCATION: State Highway 2/4 & State Highway 760

TCP ID: 3-1

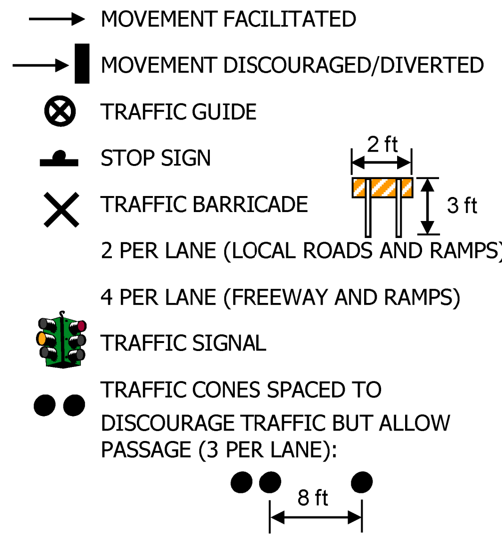
PAZ: 3

COUNTY: Calvert



**Traffic Guide should position himself safely.

Key



DESCRIPTION

1. Discourage northbound movement along State Hwy 2/4.

MANPOWER/EQUIPMENT

2 Traffic Guide(s)
6 Traffic Cones

LOCATION PRIORITY

1

TCP

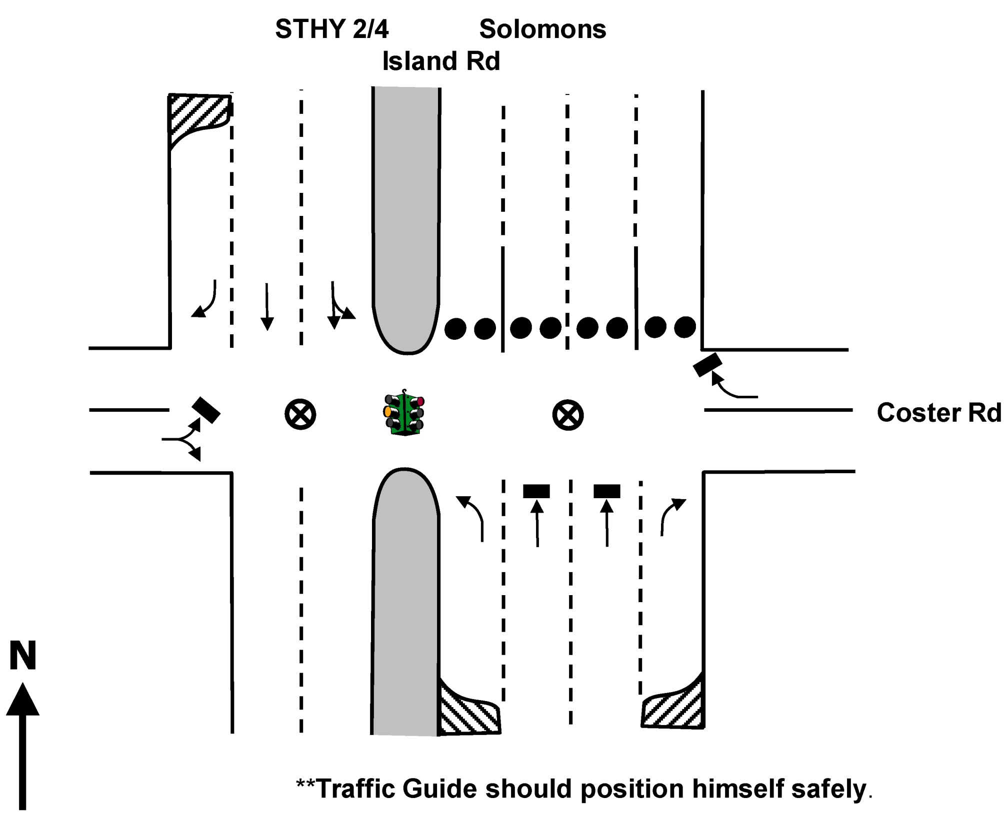
TOWN: LUSBY

LOCATION: State Highway 2/4 & Coster Rd

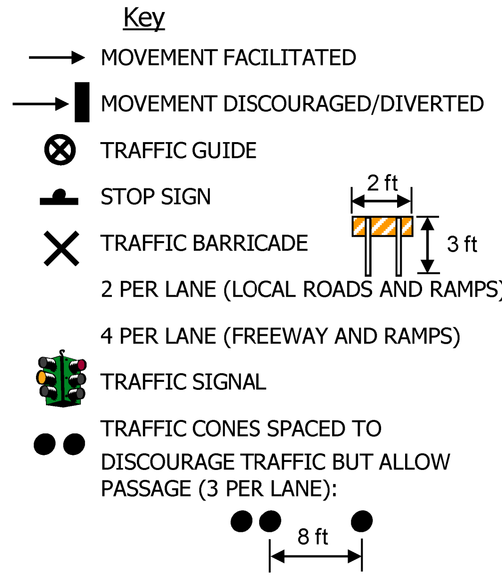
TCP ID: 3-2

PAZ: 3

COUNTY: Calvert



**Traffic Guide should position himself safely.



Key

MOVEMENT FACILITATED

MOVEMENT DISCOURAGED/DIVERTED

TRAFFIC GUIDE

STOP SIGN

TRAFFIC BARRICADE

2 PER LANE (LOCAL ROADS AND RAMPS)

4 PER LANE (FREEWAY AND RAMPS)

TRAFFIC SIGNAL

TRAFFIC CONES SPACED TO DISCOURAGE TRAFFIC BUT ALLOW PASSAGE (3 PER LANE):

DESCRIPTION

1. Discourage northbound movement along State Hwy 2/4.

MANPOWER/EQUIPMENT

2 Traffic Guide(s)
12 Traffic Cones

LOCATION PRIORITY

1

TCP

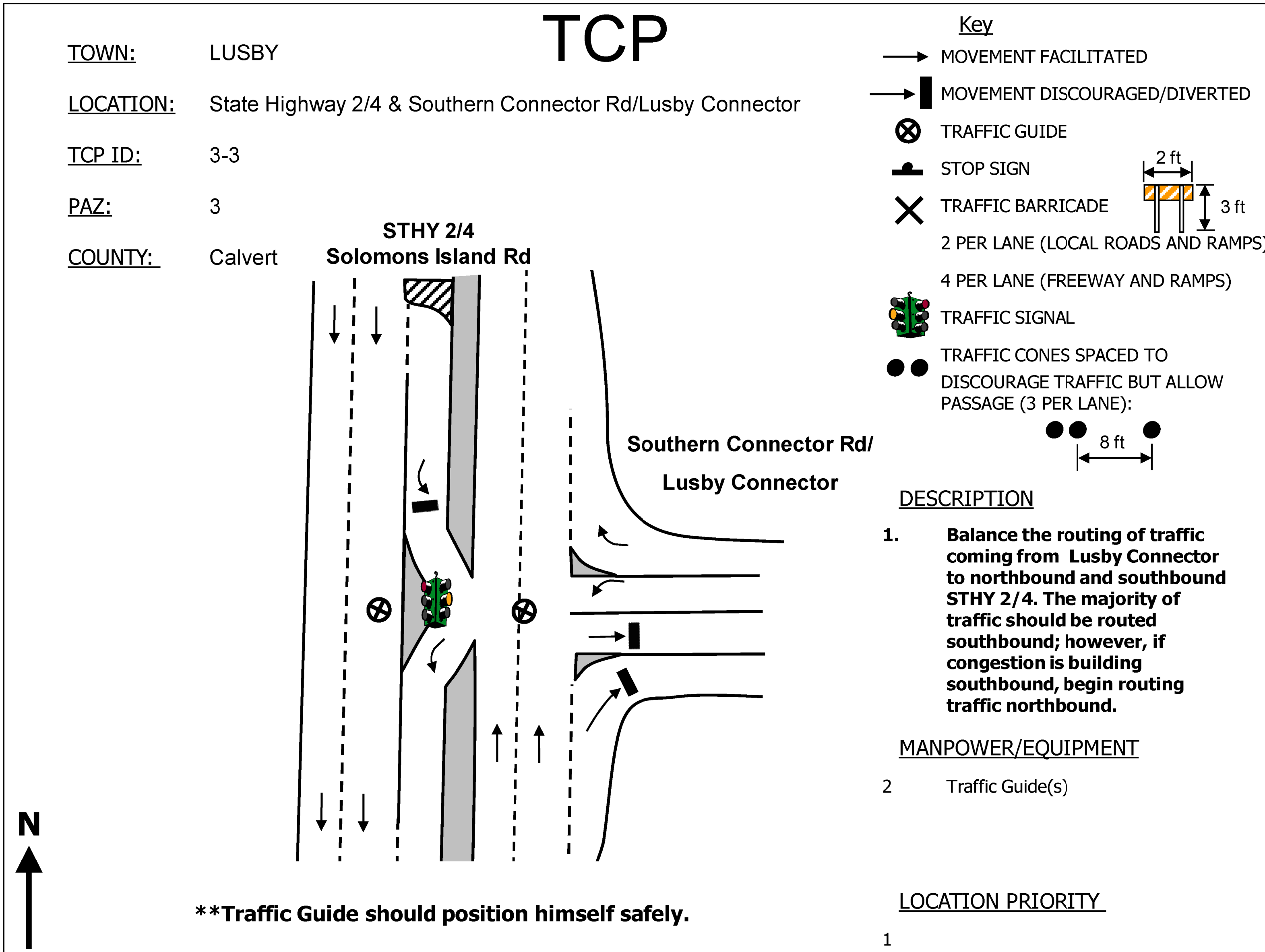
TOWN: LUSBY

LOCATION: State Highway 2/4 & Southern Connector Rd/Lusby Connector

TCP ID: 3-3

PAZ: 3

COUNTY: Calvert



Traffic Guide should position himself safely.

DESCRIPTION

1. **Balance the routing of traffic coming from Lusby Connector to northbound and southbound STHY 2/4. The majority of traffic should be routed southbound; however, if congestion is building southbound, begin routing traffic northbound.**

MANPOWER/EQUIPMENT

2 Traffic Guide(s)

LOCATION PRIORITY

1

TCP

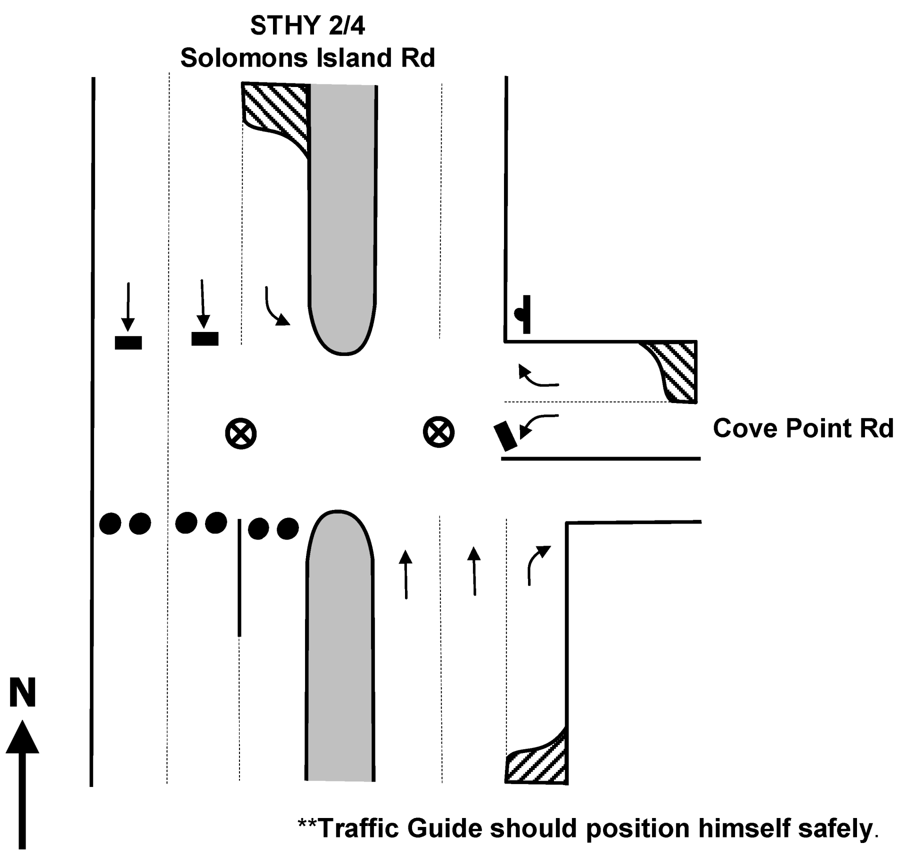
TOWN: LUSBY

LOCATION: State Highway 2/4 & Cove Point Rd

TCP ID: 3-4

PAZ: 3

COUNTY: Calvert



**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

DESCRIPTION

1. Discourage southbound movement along State Hwy 2/4.

MANPOWER/EQUIPMENT

2 Traffic Guide(s)
9 Traffic Cones

LOCATION PRIORITY

1

TCP

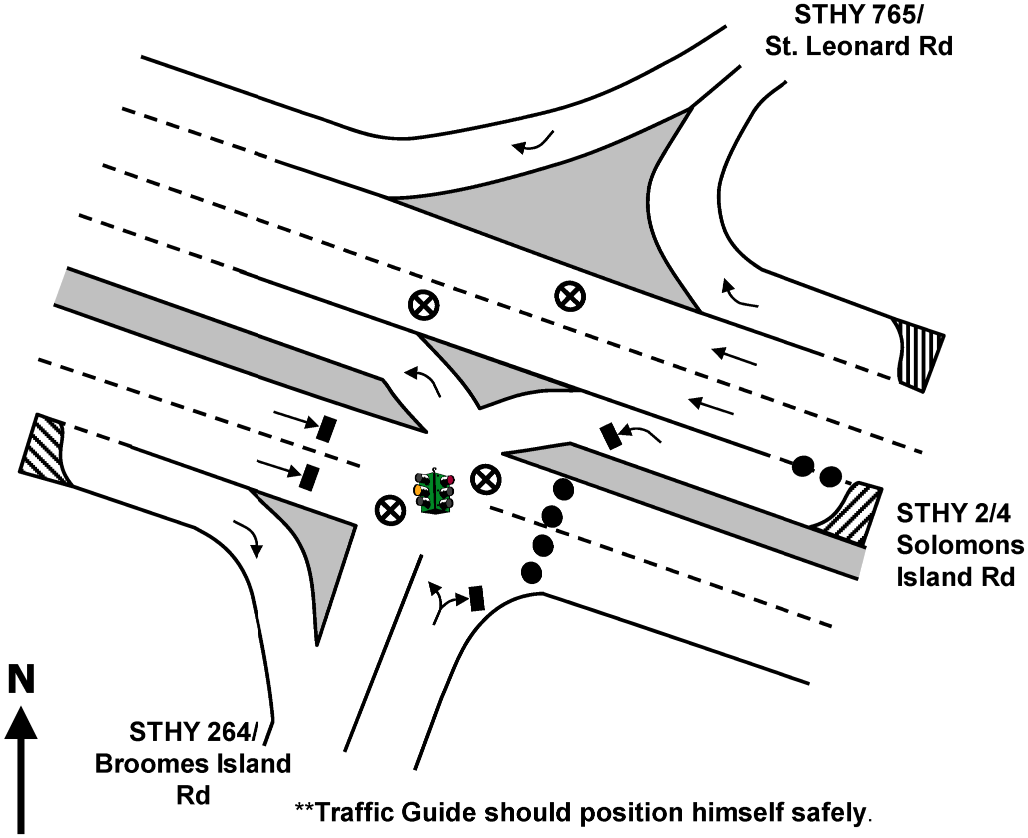
TOWN: PORT REPUBLIC

LOCATION: State Highway 2/4 & State Highway 264

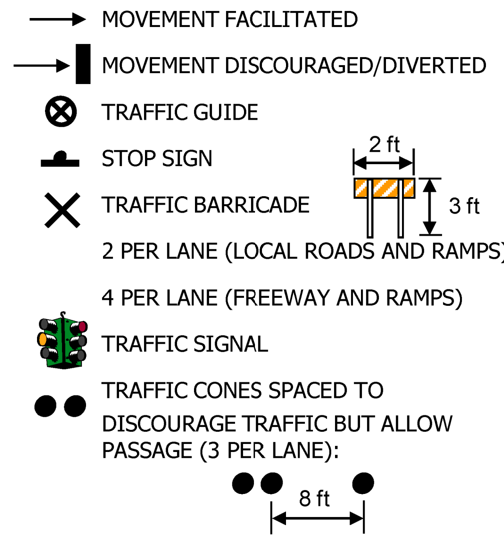
TCP ID: 4-1

PAZ: 4

COUNTY: Calvert



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



DESCRIPTION

1. Discourage southbound movement along State Hwy 2/4.

MANPOWER/EQUIPMENT

4 Traffic Guide(s)
9 Traffic Cones

LOCATION PRIORITY

3

TCP

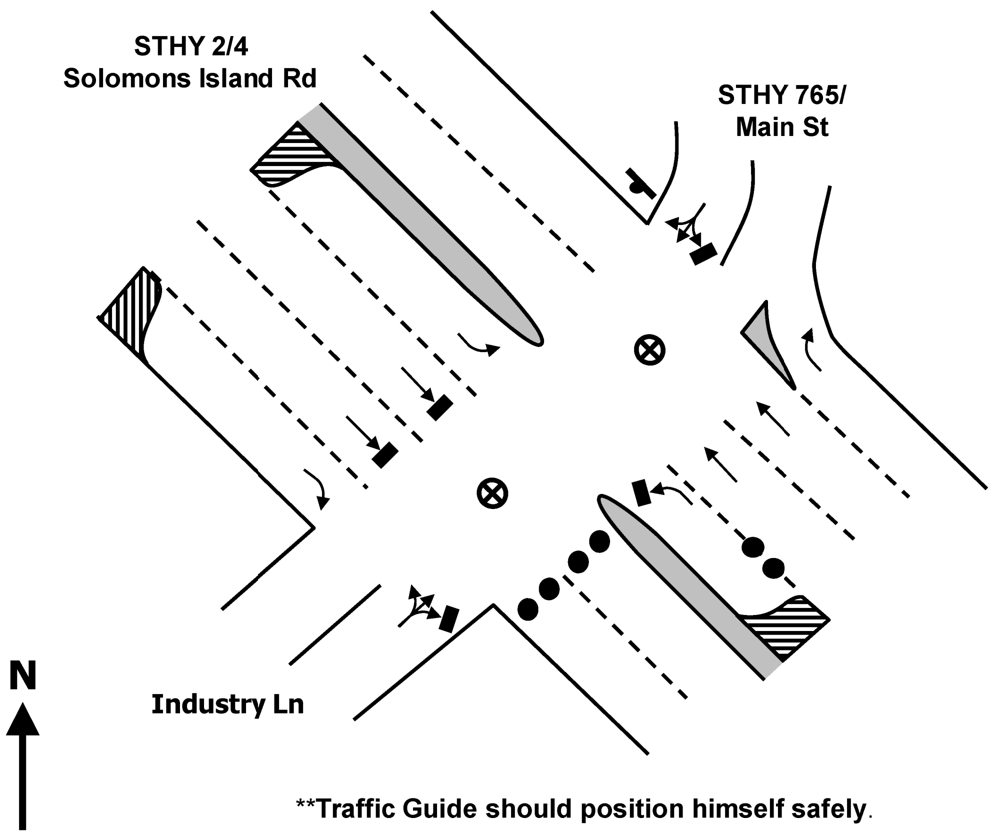
TOWN: PRINCE FREDERICK

LOCATION: State Highway 2/4 & State Highway 765

TCP ID: 5-1

PAZ: 5

COUNTY: Calvert



Traffic Guide should position himself safely.

Key

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

DESCRIPTION

1. Discourage southbound movement along State Hwy 2/4.

MANPOWER/EQUIPMENT

2 Traffic Guide(s)
9 Traffic Cones

LOCATION PRIORITY

3

TCP

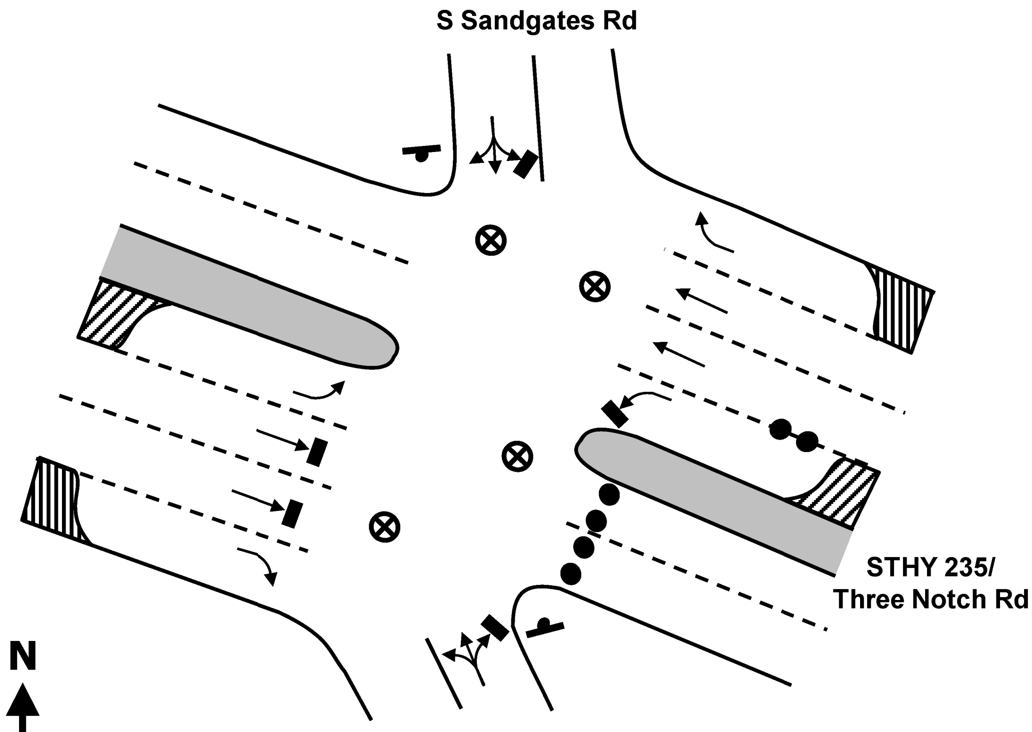
TOWN: MECHANICSVILLE

LOCATION: State Highway 235 & S Sandgates Rd

TCP ID: 6-1

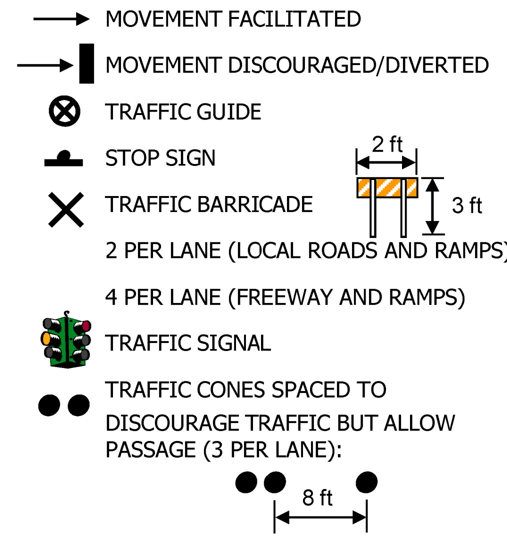
PAZ: 6

COUNTY: St. Mary's



**Traffic Guide should position himself safely.

Key



DESCRIPTION

1. Discourage eastbound movement on State Hwy 235.

MANPOWER/EQUIPMENT

4 Traffic Guide(s)
9 Traffic Cones

LOCATION PRIORITY

3

TCP

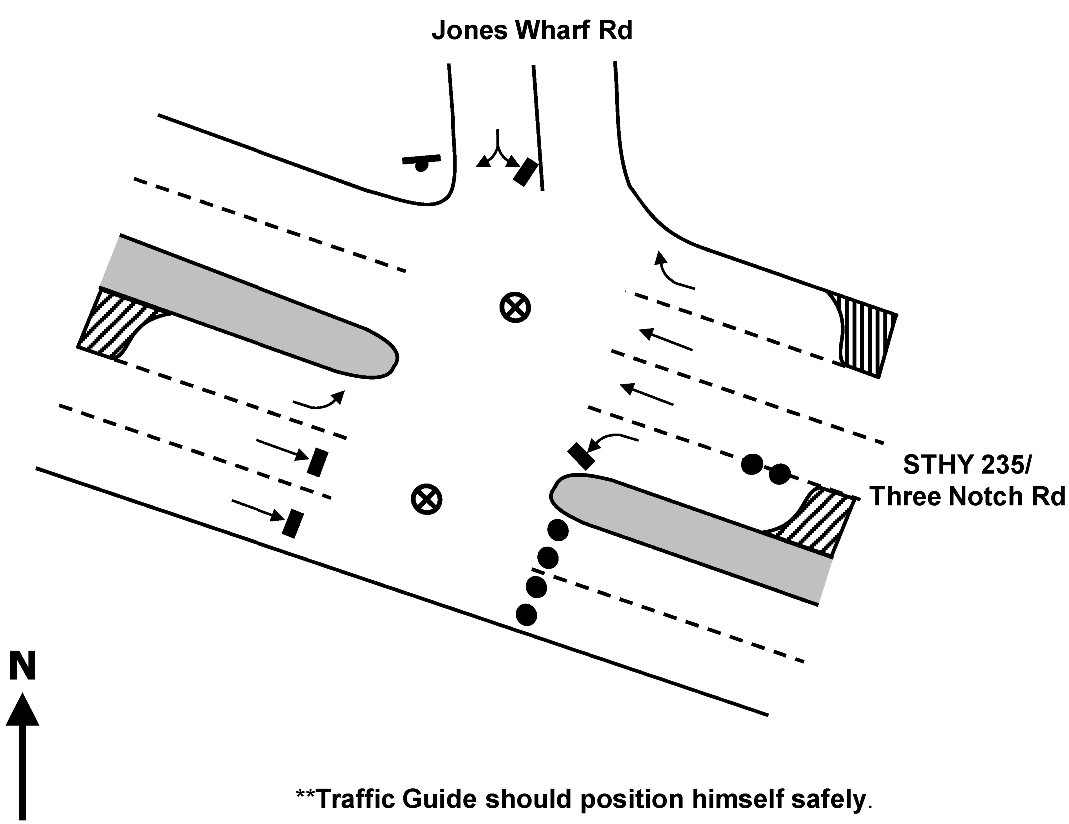
TOWN: HOLLYWOOD

LOCATION: State Highway 235 & Jones Wharf Rd

TCP ID: 6-2

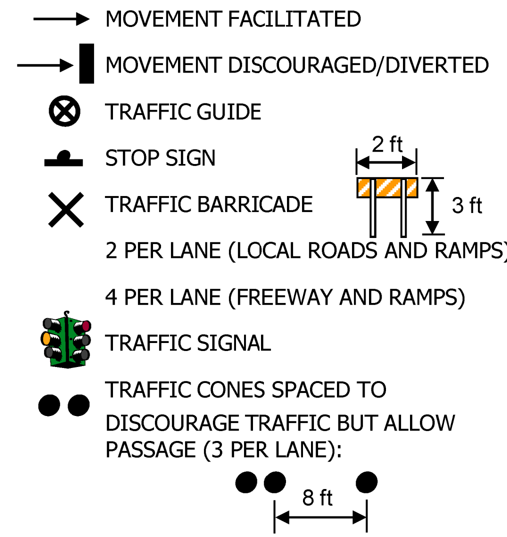
PAZ: 6

COUNTY: St. Mary's



Traffic Guide should position himself safely.

Key



DESCRIPTION

1. Discourage eastbound movement on State Hwy 235.

MANPOWER/EQUIPMENT

2 Traffic Guide(s)
9 Traffic Cones

LOCATION PRIORITY

3

TCP

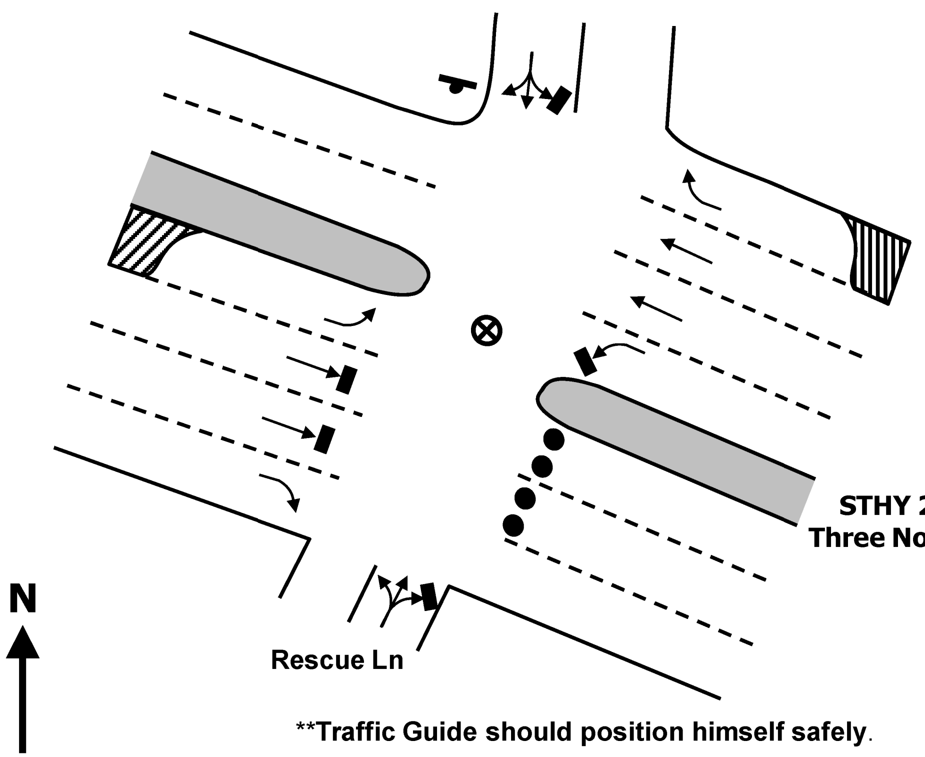
TOWN: HOLLYWOOD

LOCATION: State Highway 235 & Old Three Notch Rd

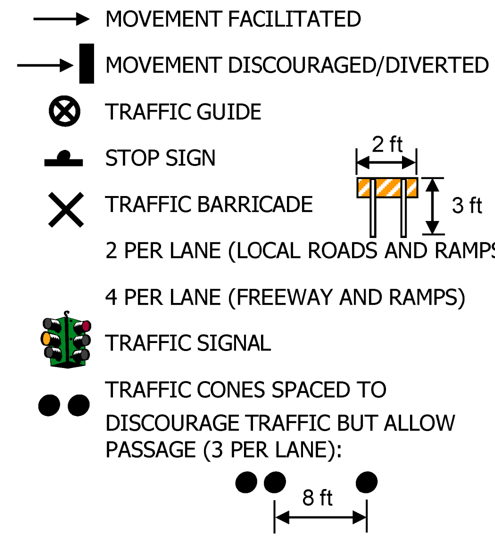
TCP ID: 6-3

PAZ: 6

COUNTY: St. Mary's



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



DESCRIPTION

1. Discourage eastbound movement on State Hwy 235.

MANPOWER/EQUIPMENT

1 Traffic Guide(s)
9 Traffic Cones

LOCATION PRIORITY

3

TCP

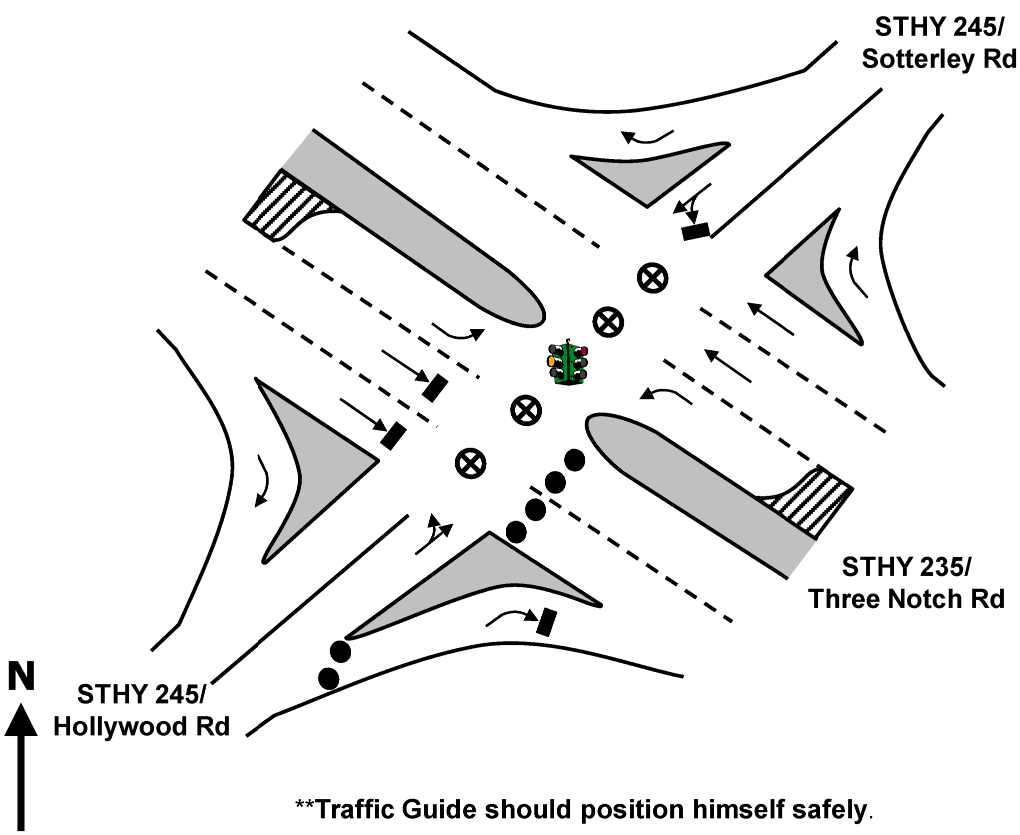
TOWN: HOLLYWOOD

LOCATION: State Highway 235 & State Highway 245

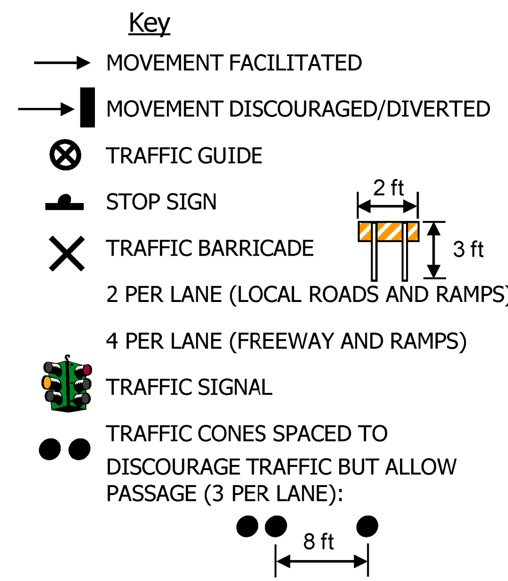
TCP ID: 6-4

PAZ: 6

COUNTY: St. Marys



**Traffic Guide should position himself safely.



DESCRIPTION

1. Discourage eastbound movement State Hwy 2/4.

MANPOWER/EQUIPMENT

4 Traffic Guide(s)
9 Traffic Cones

LOCATION PRIORITY

1

TCP

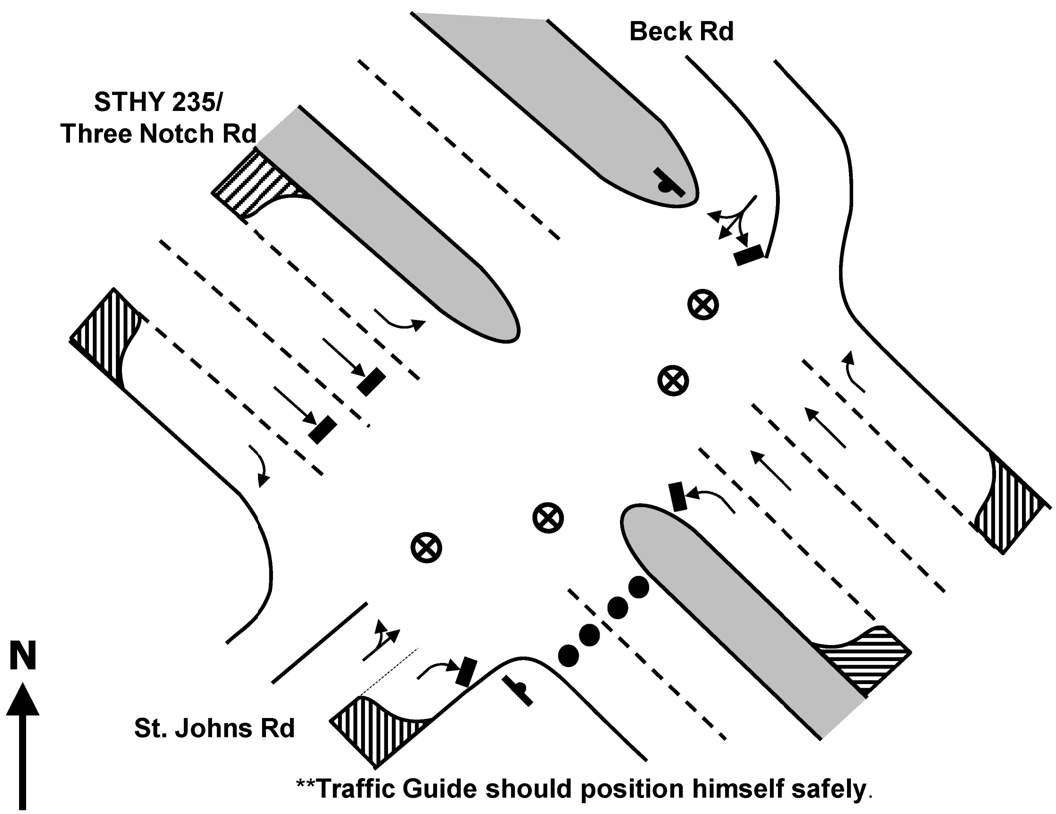
TOWN: HOLLYWOOD

LOCATION: State Highway 235 & St. Johns Rd

TCP ID: 7-1

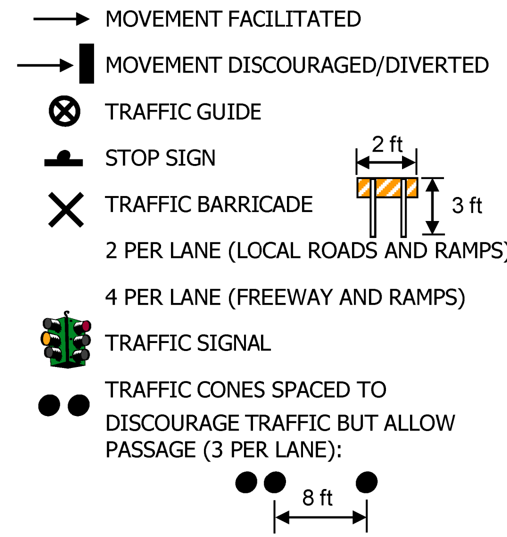
PAZ: 7

COUNTY: St. Mary's



**Traffic Guide should position himself safely.

Key



DESCRIPTION

1. Discourage southbound movement on State Hwy 235.

MANPOWER/EQUIPMENT

4 Traffic Guide(s)
6 Traffic Cones

LOCATION PRIORITY

3

TCP

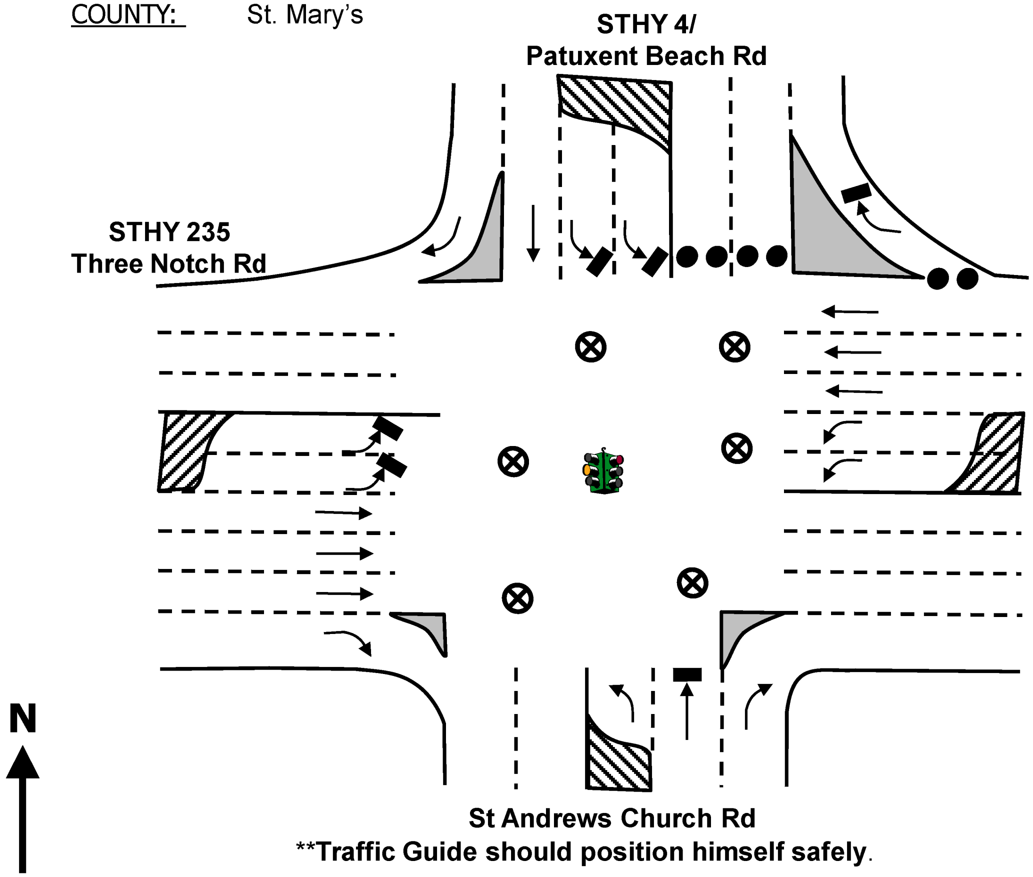
TOWN: CALIFORNIA

LOCATION: State Highway 235 & State Highway 4

TCP ID: 7-2

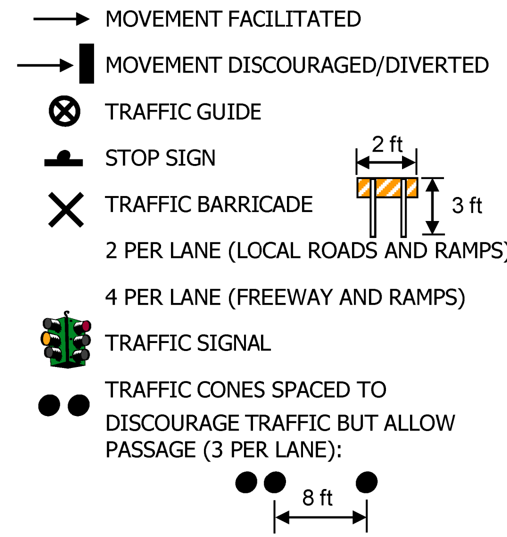
PAZ: 7

COUNTY: St. Mary's



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

Key



DESCRIPTION

1. Discourage northbound movement along State Hwy 4.

MANPOWER/EQUIPMENT

6 Traffic Guide(s)
9 Traffic Cones

LOCATION PRIORITY

1

TCP

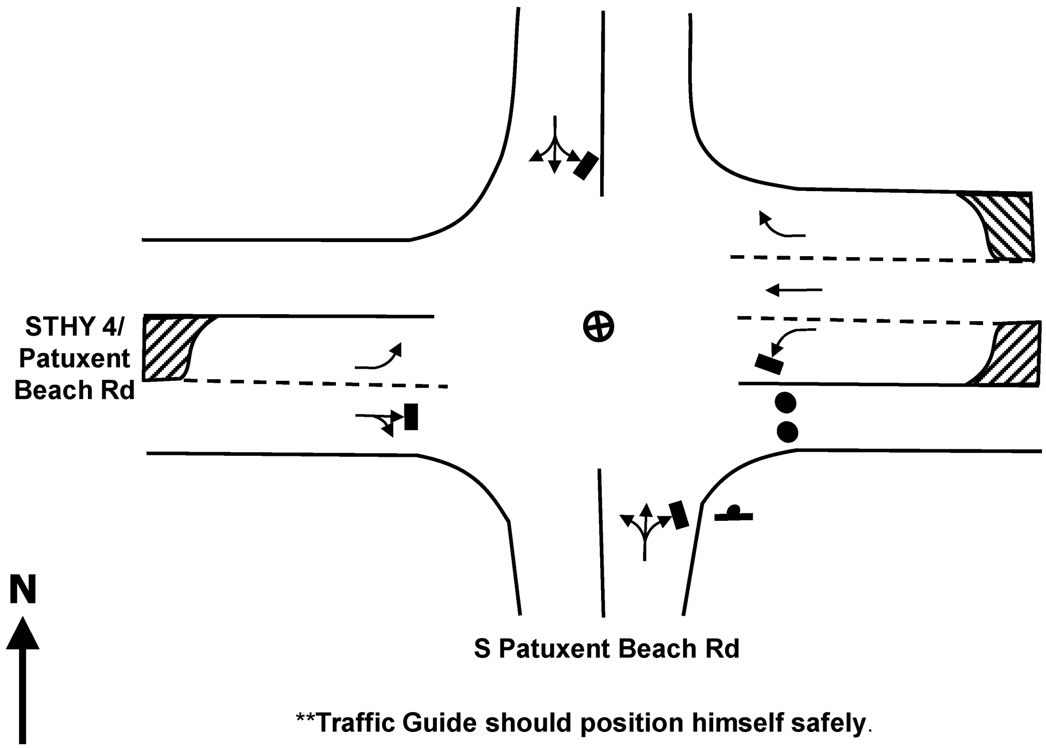
TOWN: CALIFORNIA

LOCATION: State Highway 4 & N/S Patuxent Beach Rd

TCP ID: 7-5

PAZ: 7

COUNTY: St. Mary's



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

DESCRIPTION

1. Discourage eastbound movement along State Hwy 4.

MANPOWER/EQUIPMENT

1	Traffic Guide(s)
3	Traffic Cones

LOCATION PRIORITY

3

TCP

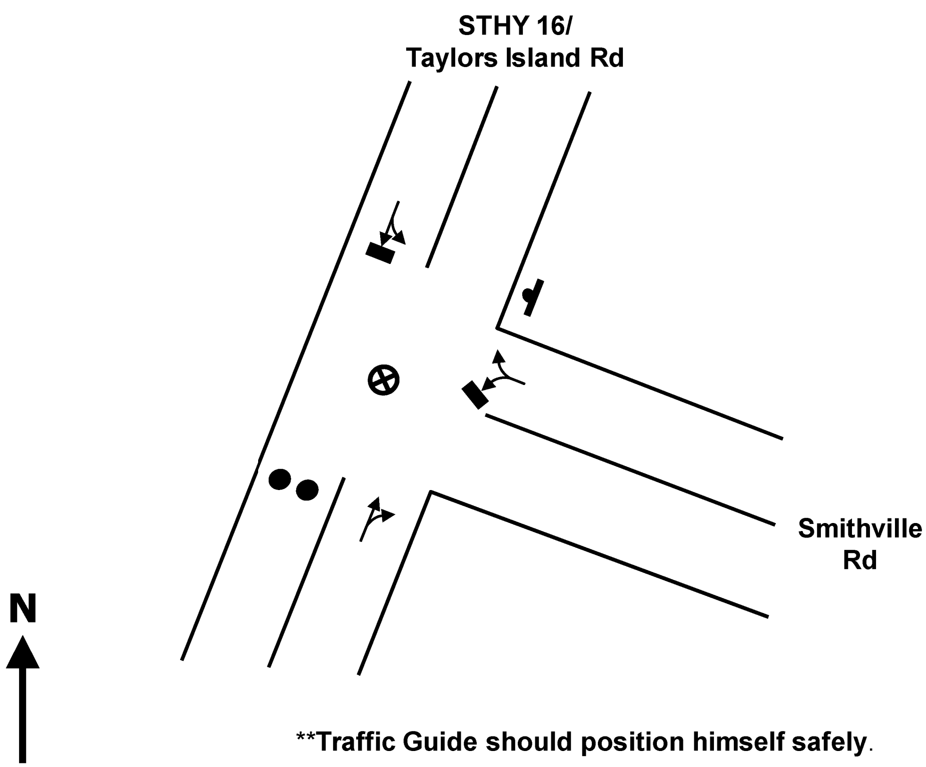
TOWN: CHURCH CREEK

LOCATION: State Highway 16 & Smithville Rd

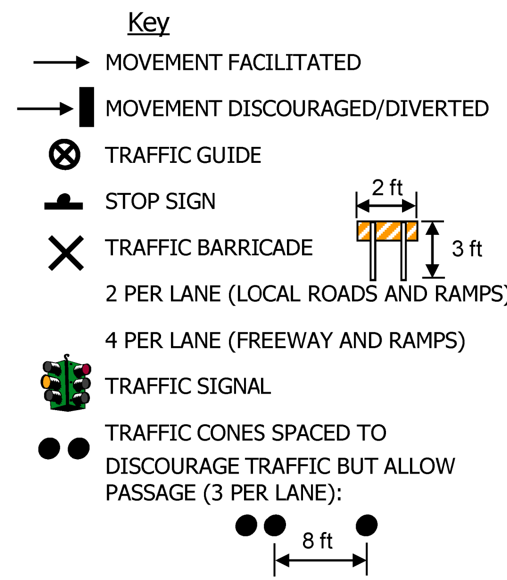
TCP ID: 8-1

PAZ: 8

COUNTY: Dorchester



Traffic Guide should position himself safely.



DESCRIPTION

1. Discourage southbound movement along State Hwy 16.

MANPOWER/EQUIPMENT

1 Traffic Guide(s)
3 Traffic Cones

LOCATION PRIORITY

3

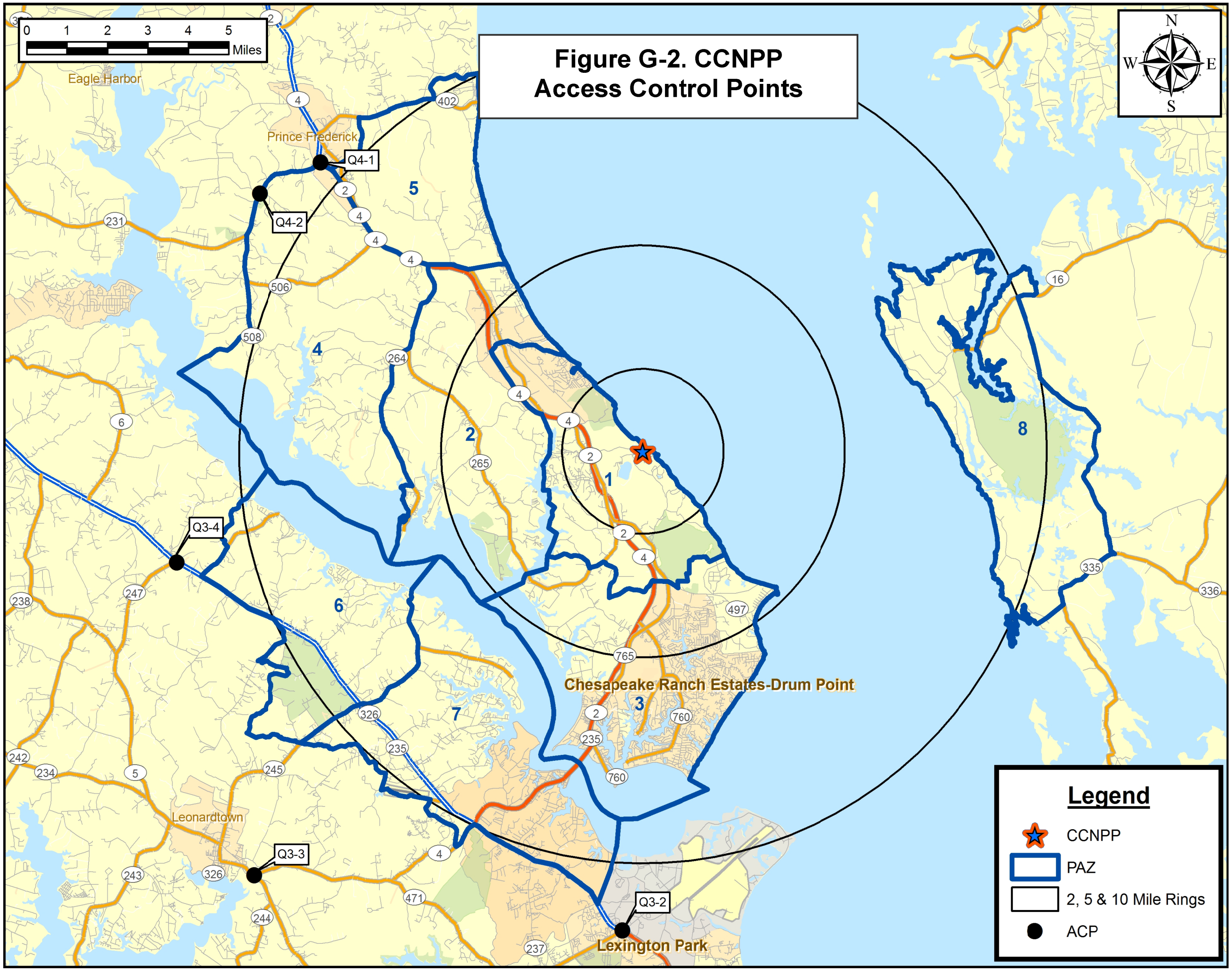


Figure G-2. CCNPP
Access Control Points
0 1 2 3 4 5 Miles
Eagle Harbor
Prince Frederick
Leonardtown
Chesapeake Ranch Estates-Drum Point
Lexington Park
Q4-1
Q4-2
Q3-2
Q3-3
Q3-4
1
2
3
4
5
6
7
8
Legend
CCNPP
PAZ
2, 5 & 10 Mile Rings
ACP
N
E
S
W

Table G-2. Access Control Points					
Priority	**ID#**	**Town**	**Intersection Location**	**# of Guides**	**# of Barricades**
CALVERT COUNTY					
1	Q4-1	Prince Frederick	State Highway 2/4 & State Highway 231	2	12
1	Q4-2	Prince Frederick	State Highway 231 & German Chapel Rd	1	2
			Total Manpower & Equipment for Calvert County	**3**	**14**
ST. MARY'S COUNTY					
1	Q3-2	Lexington Park	State Highway 235 & State Highway 246	6	8
1	Q3-3	Leonardtown	State Highway 5 & State Highway 4	1	4
1	Q3-4	Mechanicsville	State Highway 235 & State Highway 247	4	6
			Total Manpower & Equipment for St. Mary's County	**11**	**18**

ACP

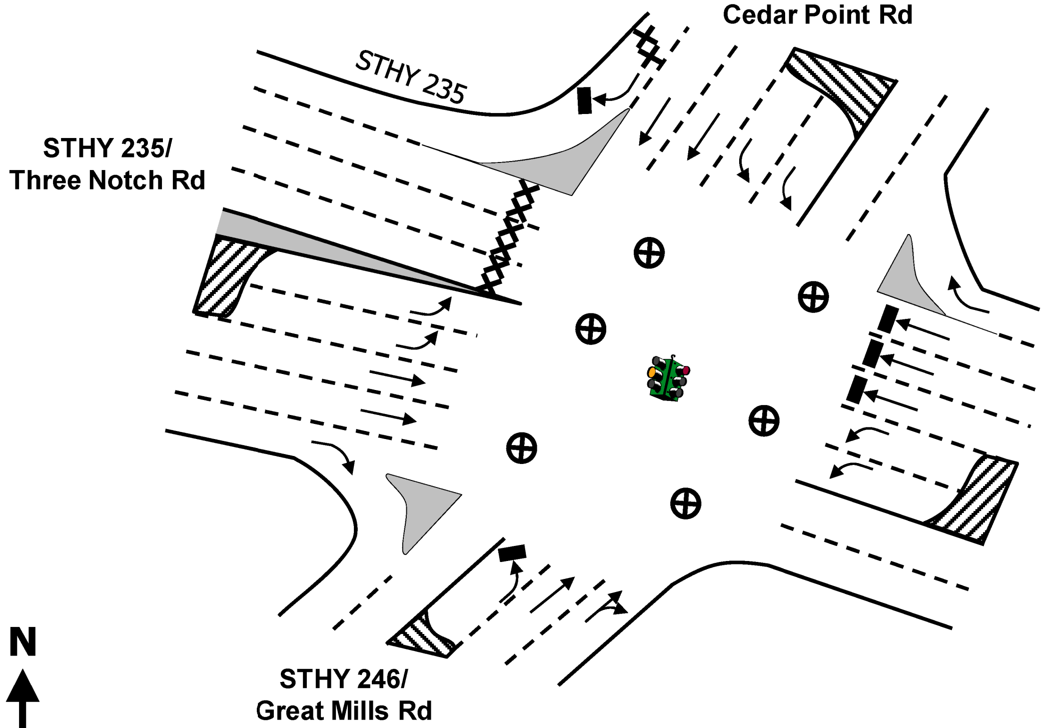
TOWN: LEXINGTON PARK

LOCATION: State Highway 235 & State Highway 246

ACP ID: Q3-2

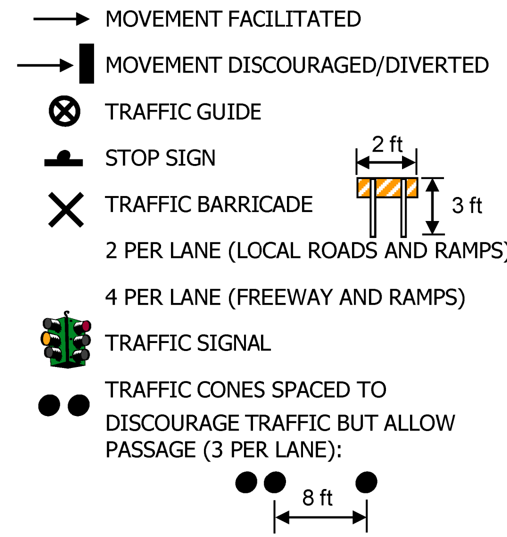
PAZ: Shadow

COUNTY: St. Mary's



**Traffic Guide should position himself safely.

Key



DESCRIPTION

1. Interdict and divert westbound movement on State Hwy 235.

MANPOWER/EQUIPMENT

6 Traffic Guide(s)
8 Traffic Barricades

LOCATION PRIORITY

1

ACP

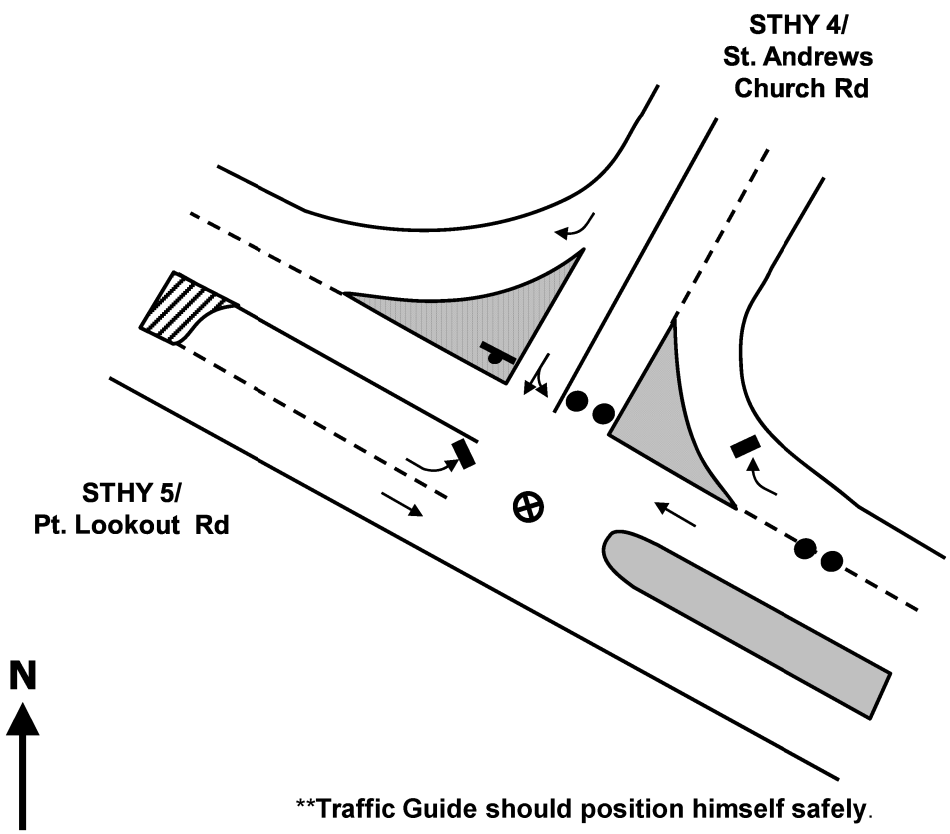
TOWN: LEONARDTOWN

LOCATION: State Highway 5 & State Highway 4

ACP ID: Q3-3

PAZ: Shadow

COUNTY: St. Mary's



**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

DESCRIPTION

1. Discourage northbound movement along State Hwy 4.

MANPOWER/EQUIPMENT

1 Traffic Guide(s)
6 Traffic Cones

LOCATION PRIORITY

3

ACP

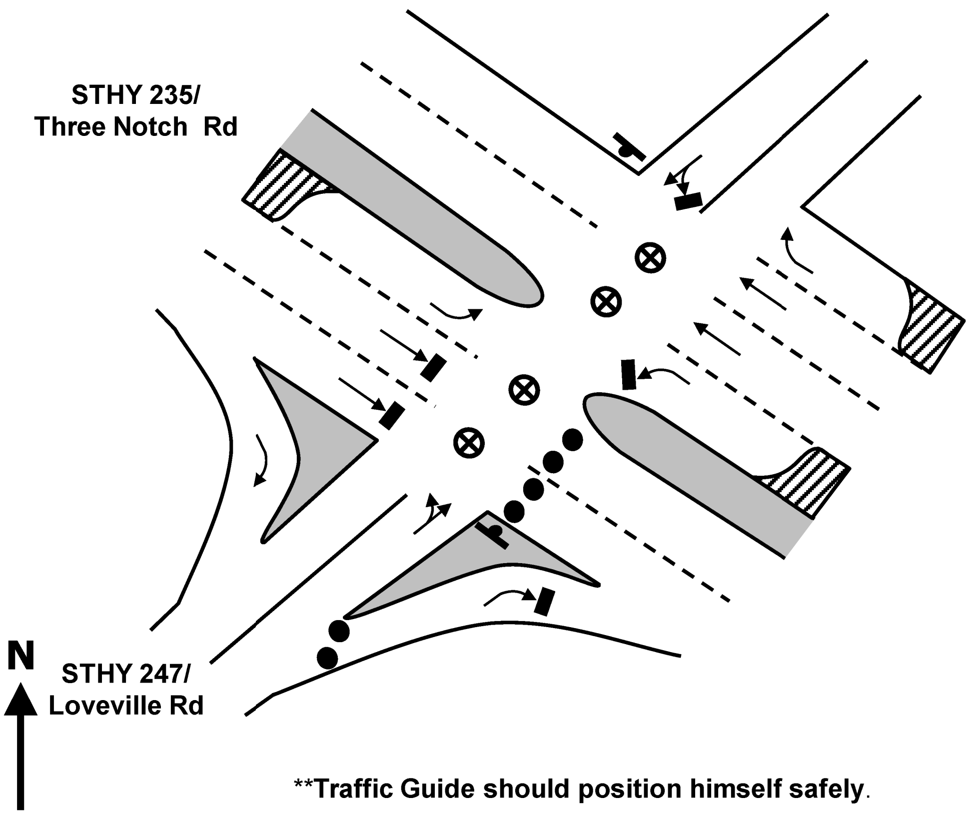
TOWN: MECHANICSVILLE

LOCATION: State Highway 235 & State Highway 247

ACP ID: Q3-4

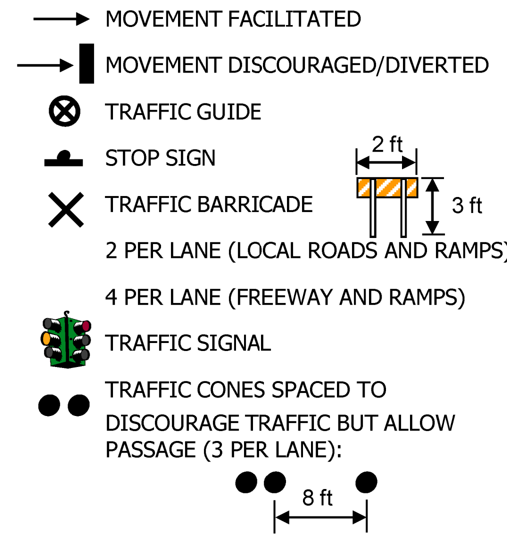
PAZ: Shadow

COUNTY: St. Mary's



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

Key



DESCRIPTION

1. Discourage southbound movement along State Hwy 235.

MANPOWER/EQUIPMENT

4 Traffic Guide(s)
9 Traffic Cones

LOCATION PRIORITY

3

ACP

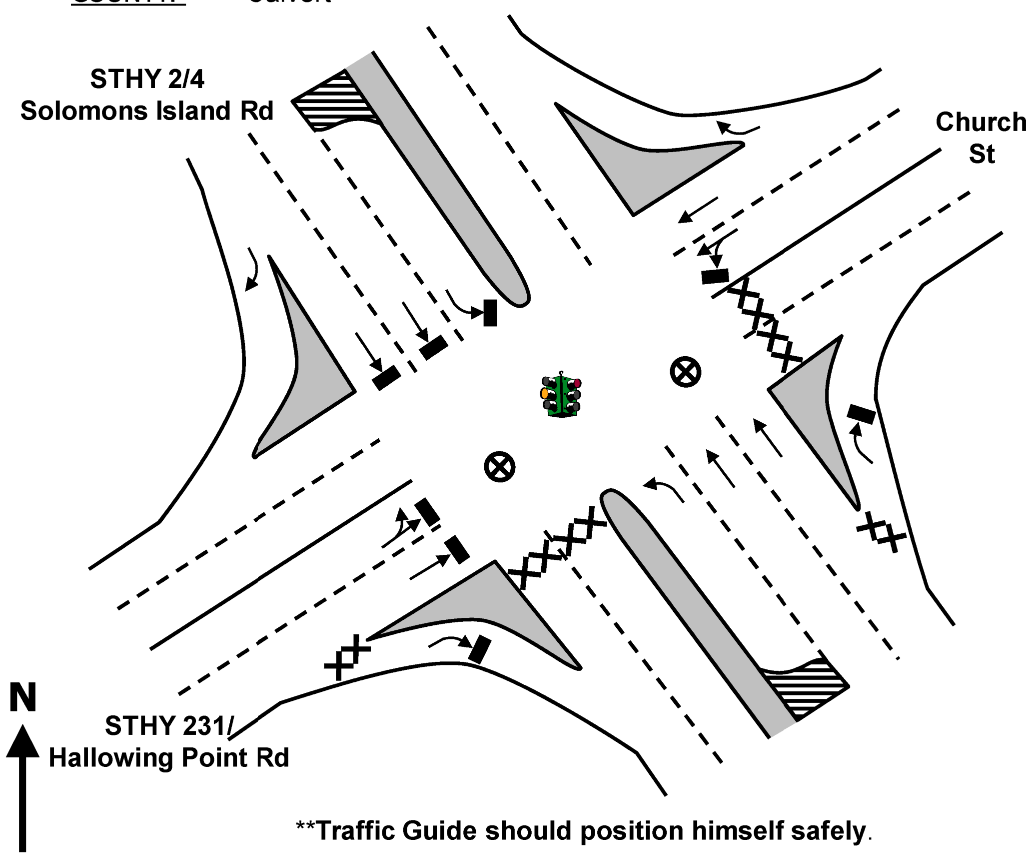
TOWN: PRINCE FREDERICK

LOCATION: State Highway 2/4 & State Highway 231

ACP ID: Q4-1

PAZ: Shadow

COUNTY: Calvert



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

DESCRIPTION

1. Interdict and divert southbound movement on State Hwy 2/4.
2. Interdict and direct eastbound movement on Church St.

MANPOWER/EQUIPMENT

2 Traffic Guide(s)
12 Traffic Barracades

LOCATION PRIORITY

3

ACP

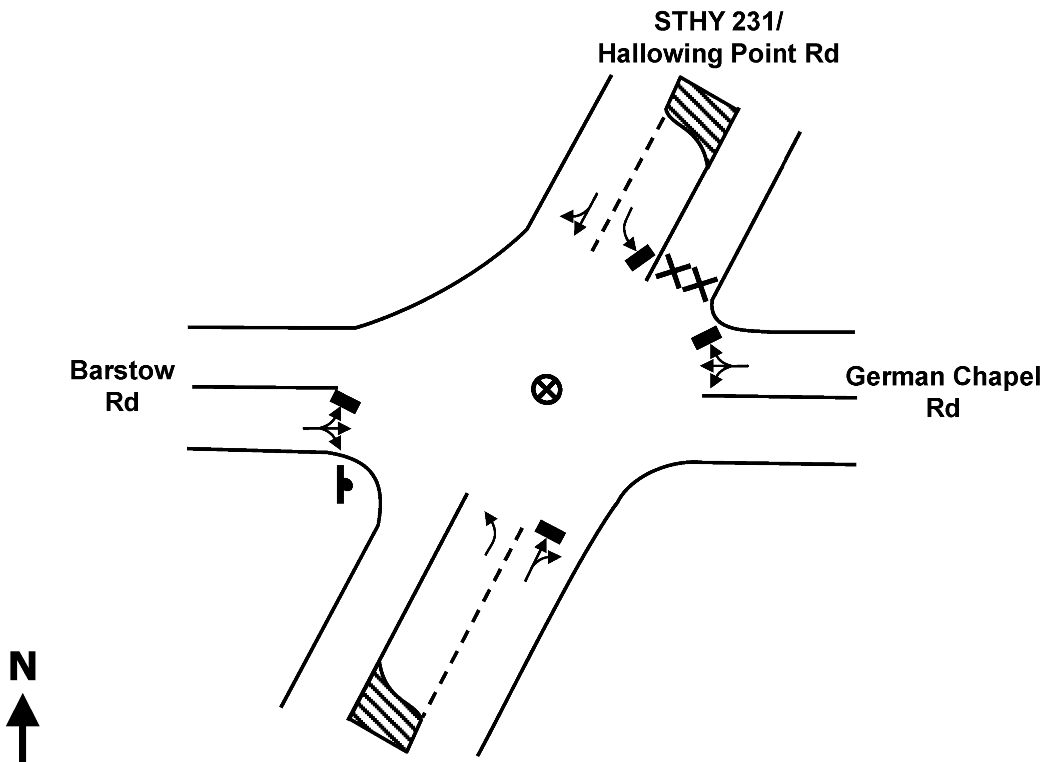
TOWN: PRINCE FREDERICK

LOCATION: State Highway 231 & German Chapel Rd

ACP ID: Q4-2

PAZ: Shadow

COUNTY: Calvert



**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

DESCRIPTION

1. Interdict and divert northbound movement on State Hwy 231.

MANPOWER/EQUIPMENT

1 Traffic Guide(s)
2 Traffic Barricades

LOCATION PRIORITY

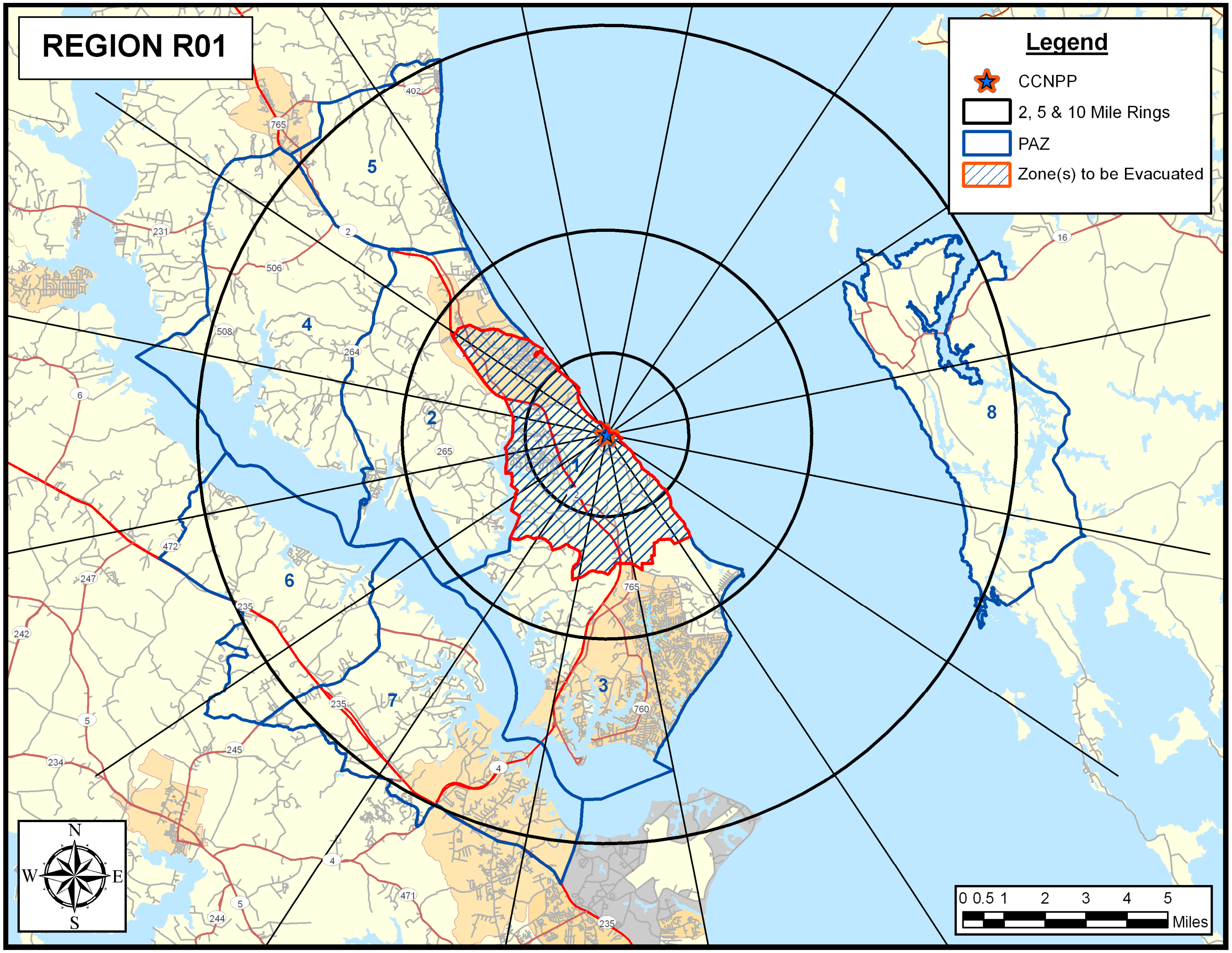
3

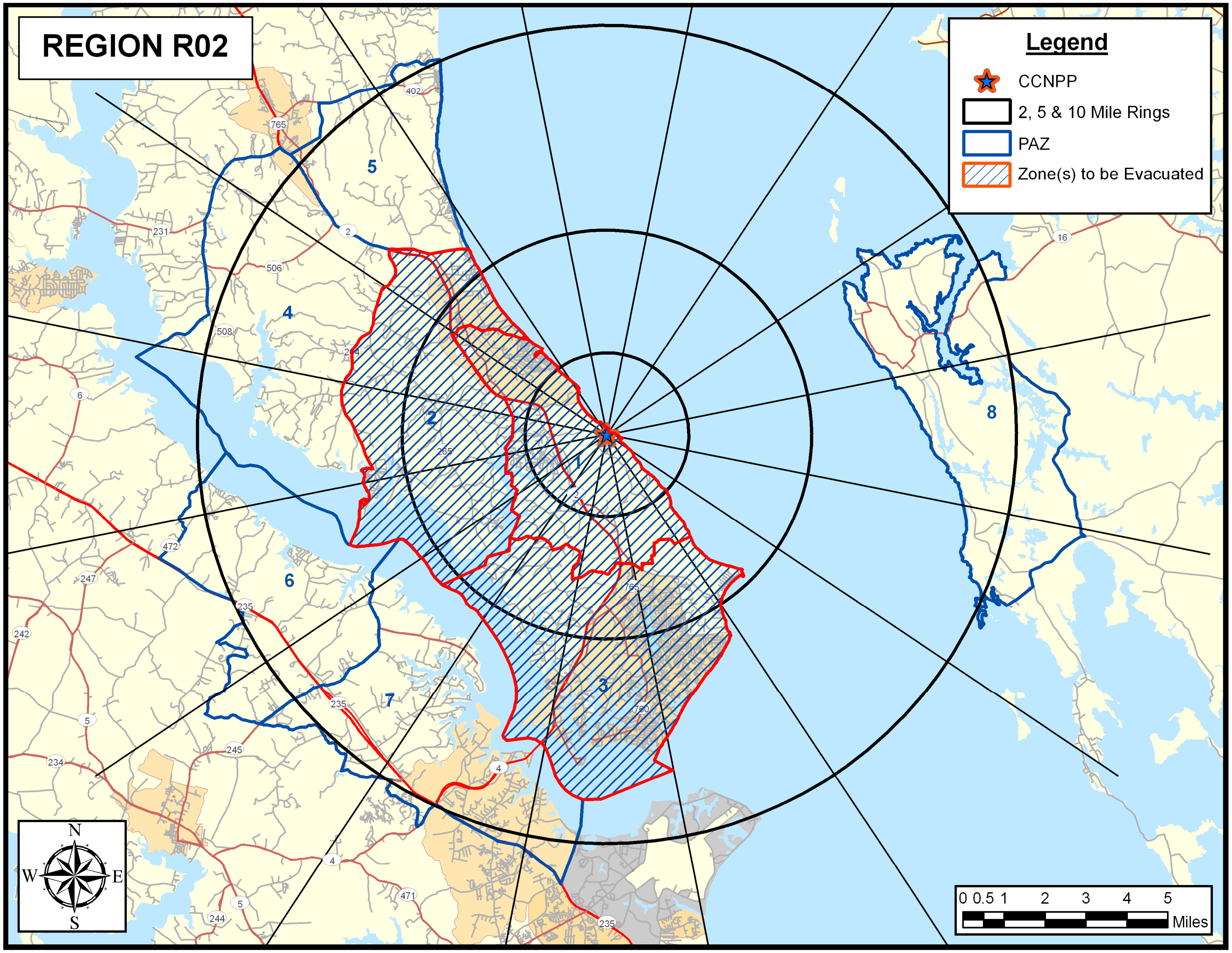
APPENDIX H

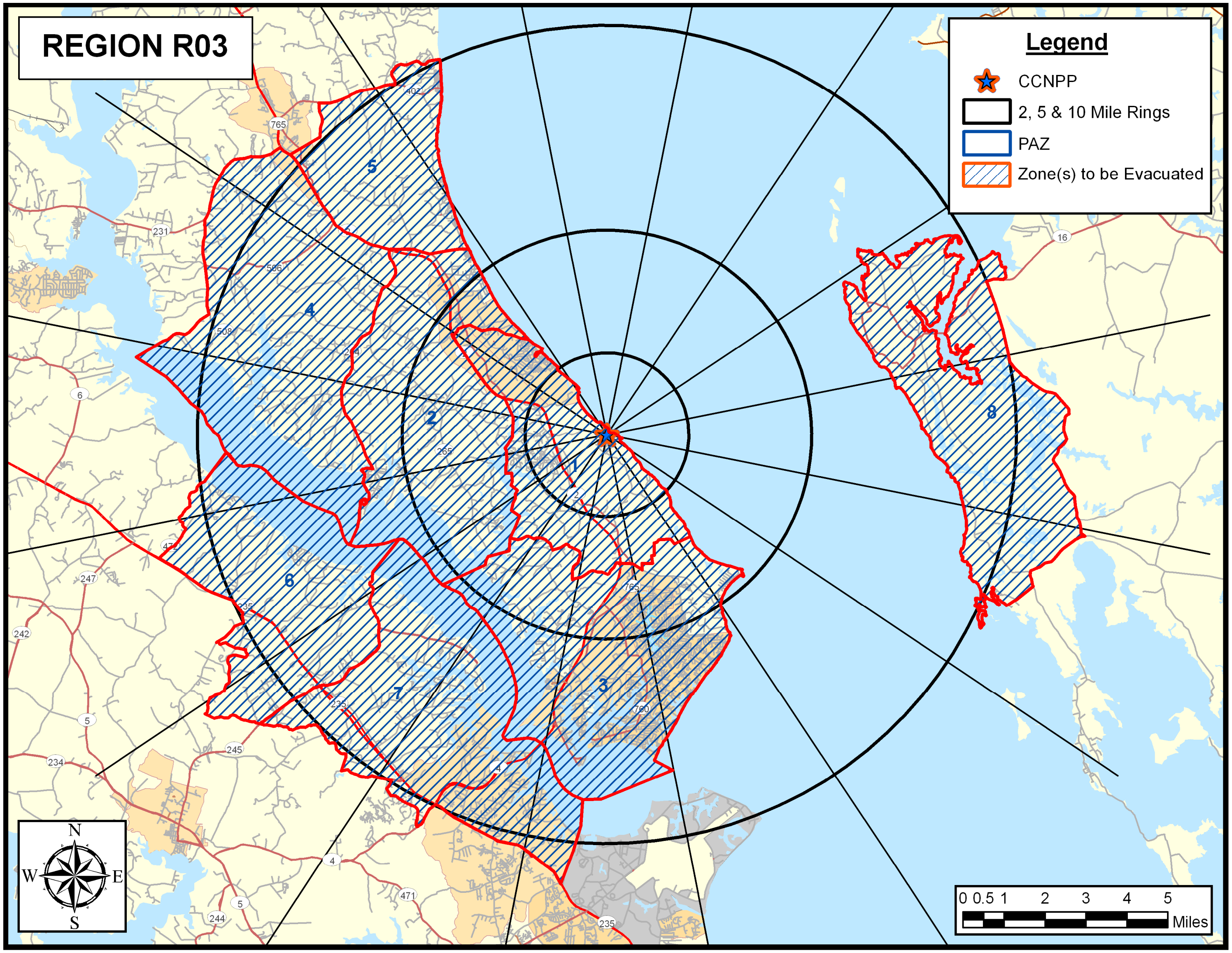
Evacuation Region Maps

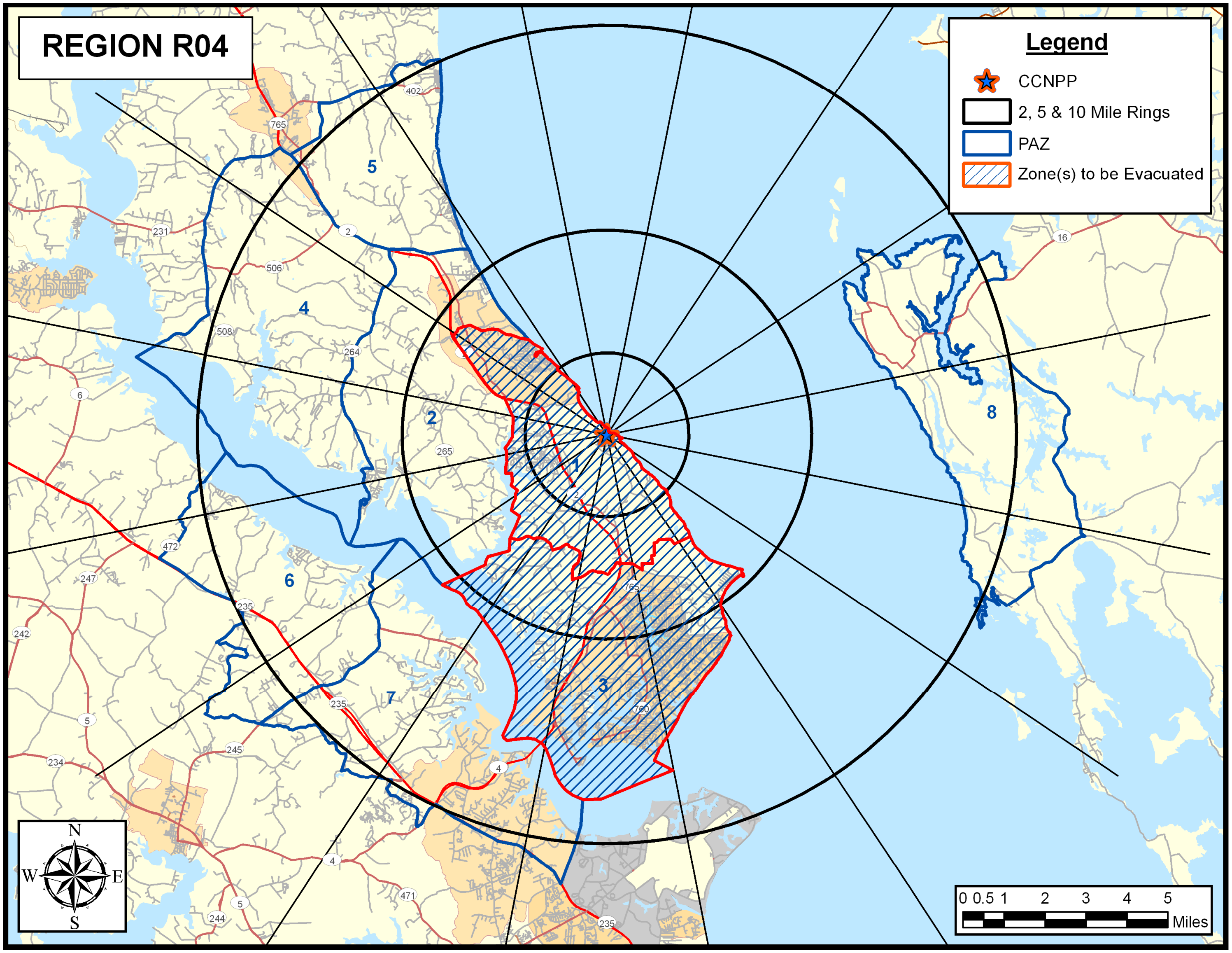
APPENDIX H: EVACUATION REGION MAPS

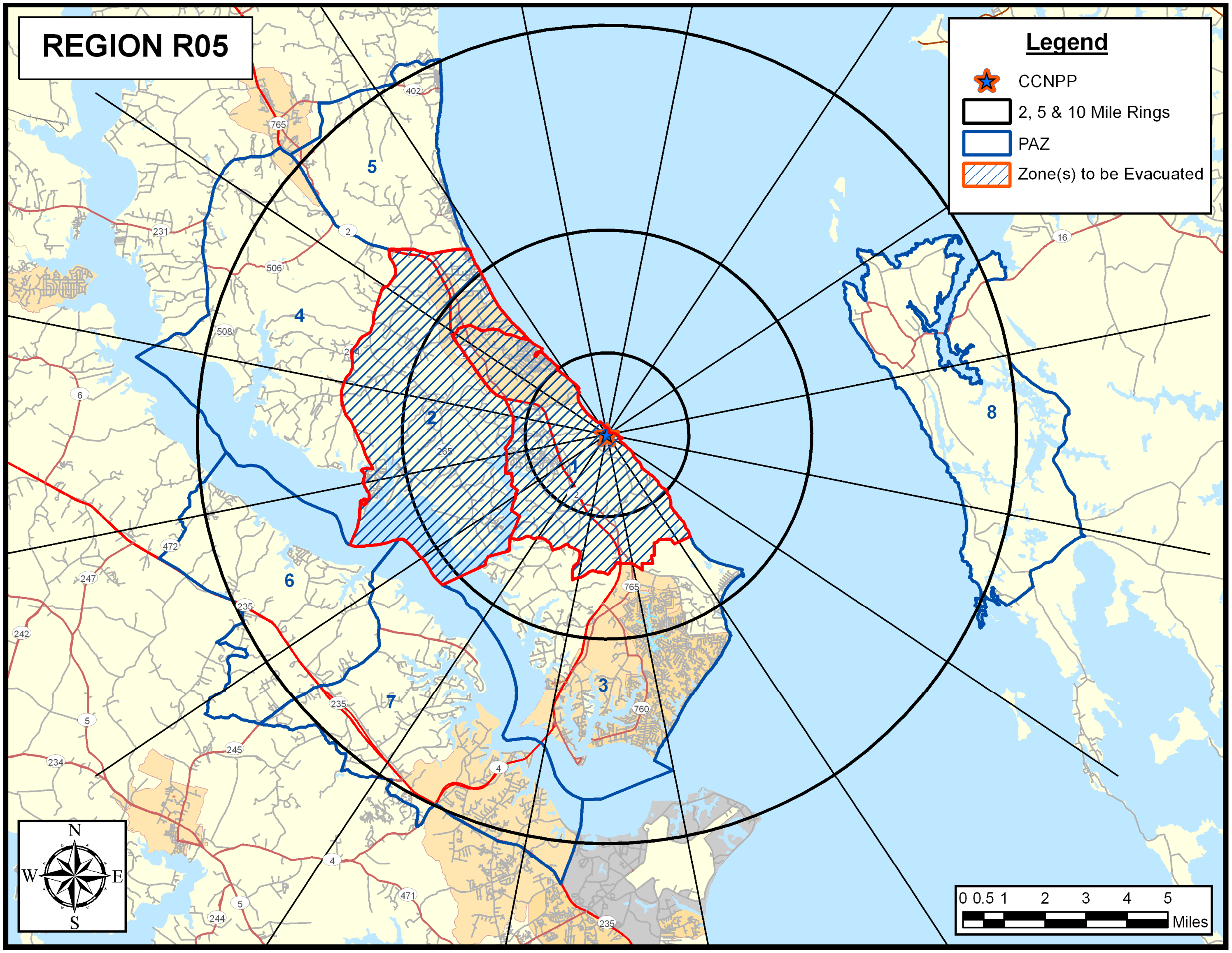
This appendix presents maps of all Evacuation Regions.

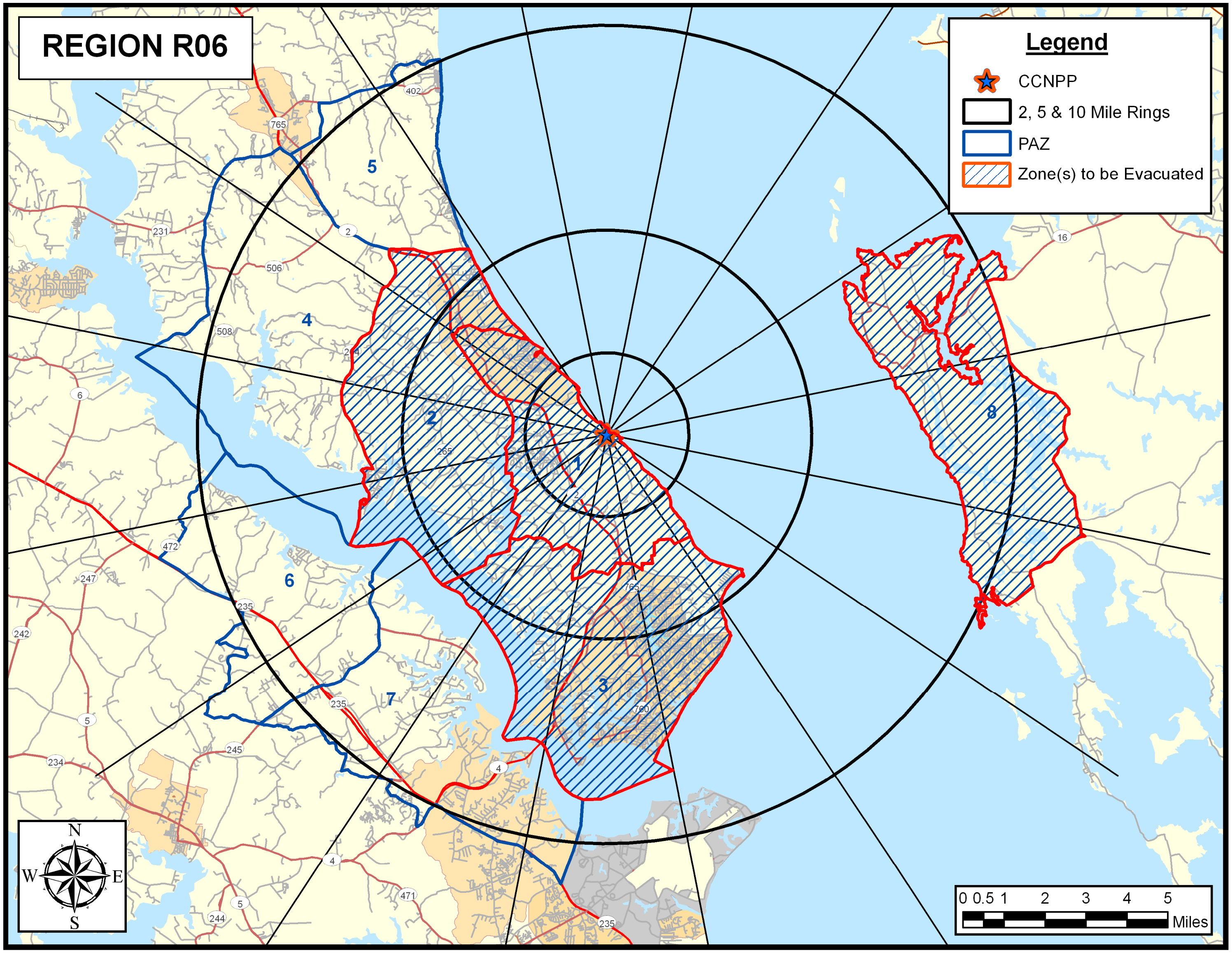

REGION R01
Legend
CCNPP
2, 5 & 10 Mile Rings
PAZ
Zone(s) to be Evacuated
0 0.5 1 2 3 4 5
Miles
N
S
E
W
1
2
3
4
5
6
7
8

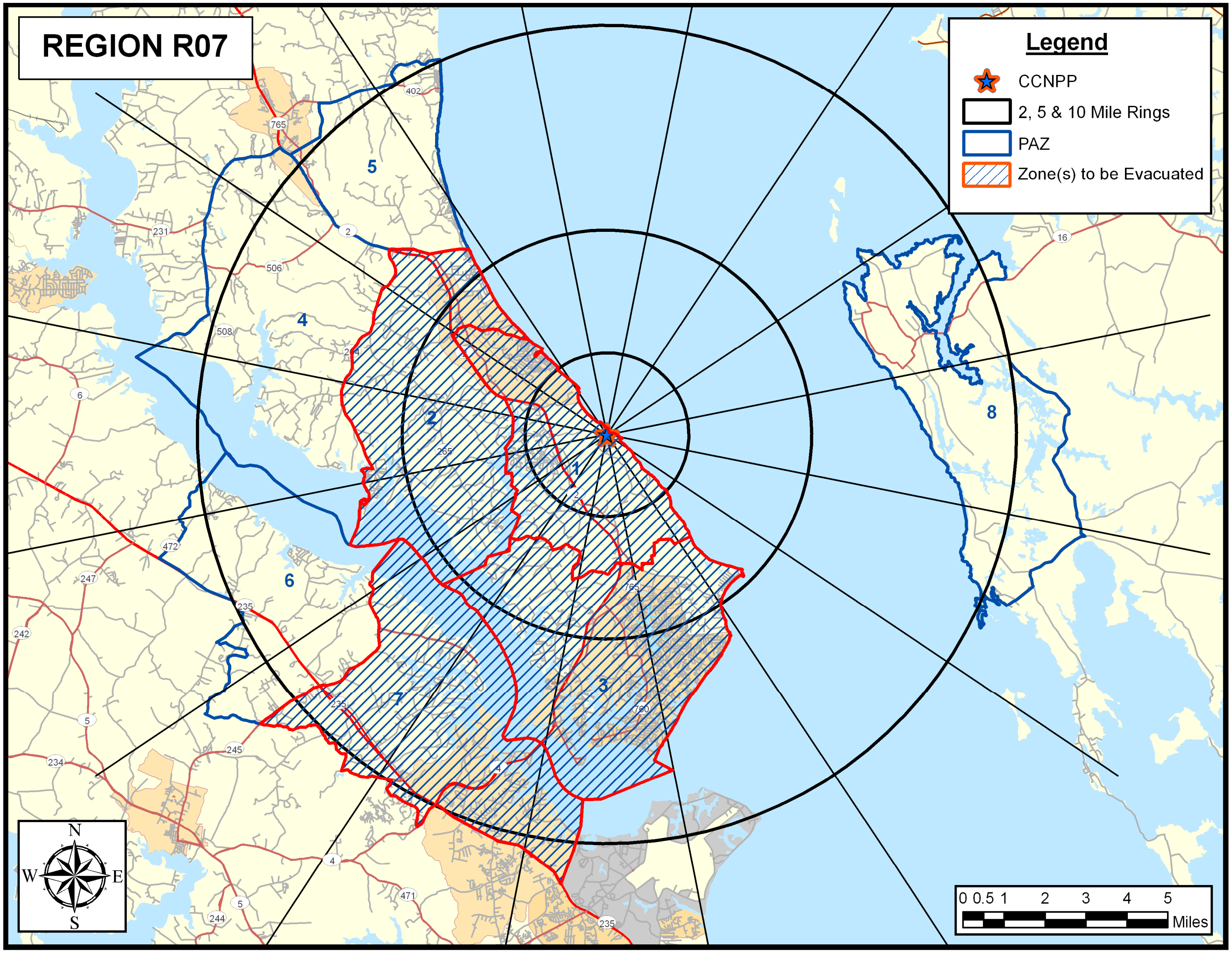

REGION R02
Legend
CCNPP
2, 5 & 10 Mile Rings
PAZ
Zone(s) to be Evacuated
1
2
3
4
5
6
7
8
N
S
E
W
0 0.5 1 2 3 4 5
Miles

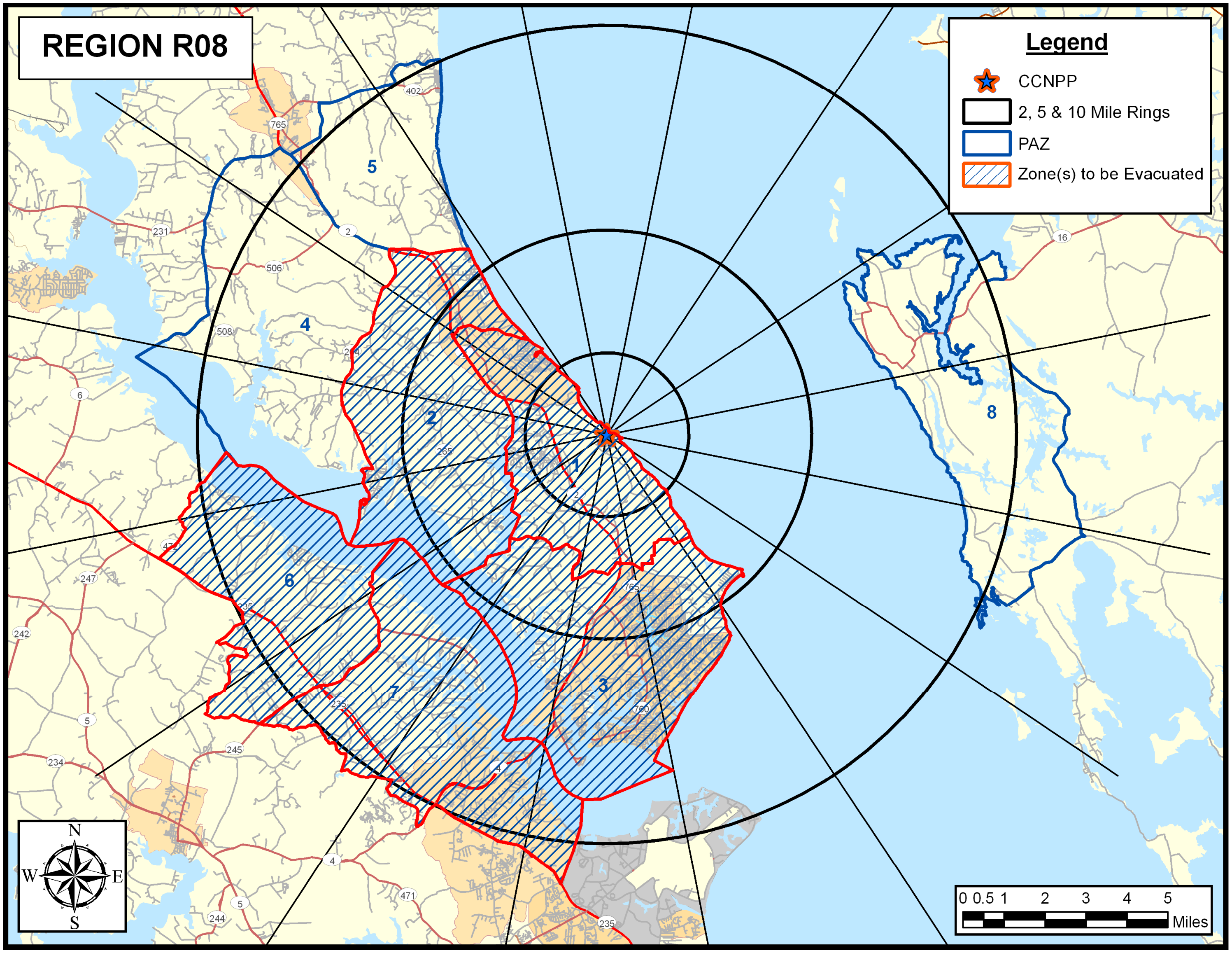

REGION R03
Legend
CCNPP
2, 5 & 10 Mile Rings
PAZ
Zone(s) to be Evacuated
0 0.5 1 2 3 4 5
Miles
N
S
E
W
1
2
3
4
5
6
7
8

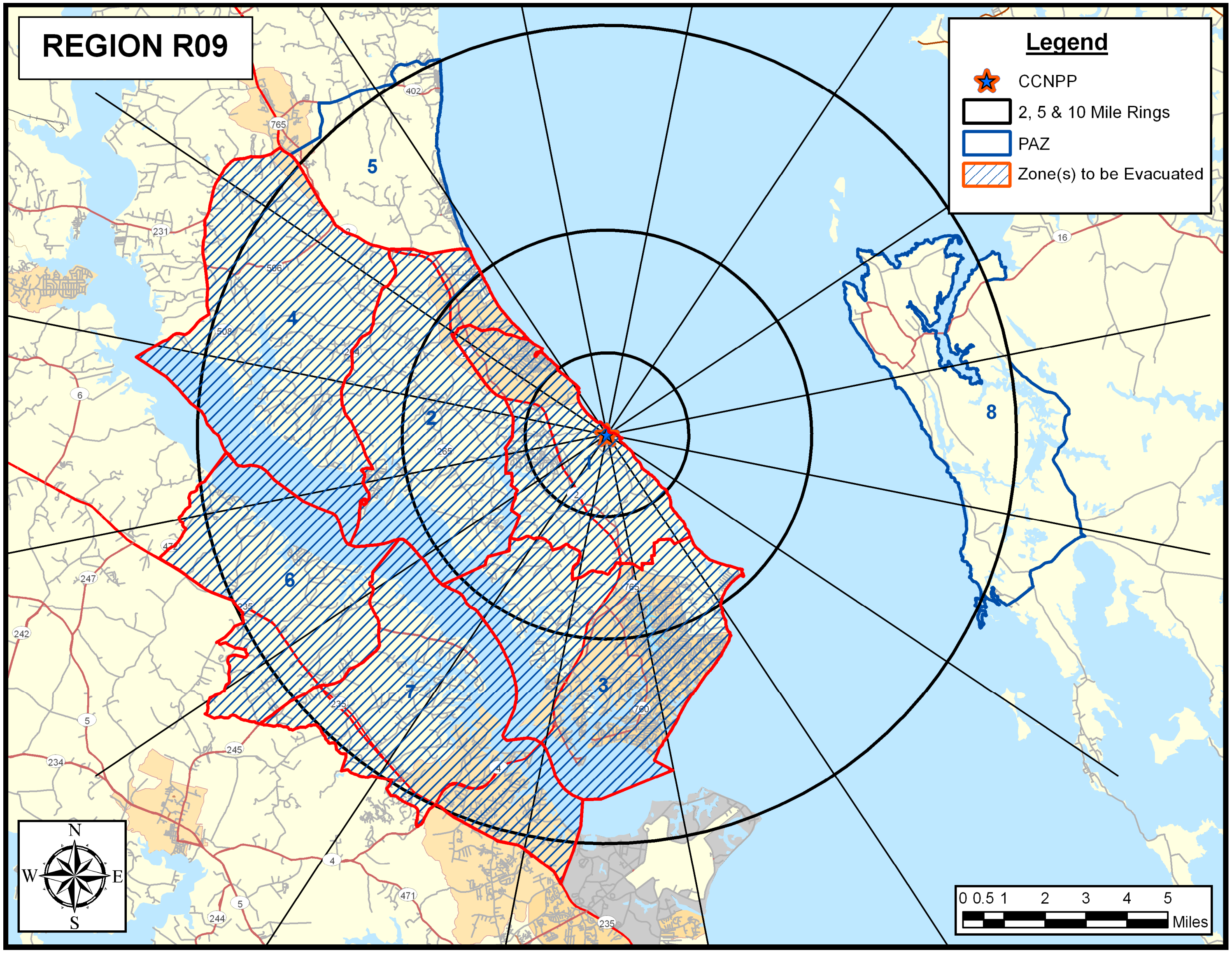

REGION R04
Legend
CCNPP
2, 5 & 10 Mile Rings
PAZ
Zone(s) to be Evacuated
1
2
3
4
5
6
7
8
N
S
E
W
0 0.5 1 2 3 4 5
Miles


REGION R05
Legend
CCNPP
2, 5 & 10 Mile Rings
PAZ
Zone(s) to be Evacuated
0 0.5 1 2 3 4 5
Miles
N
S
E
W
1
2
3
4
5
6
7
8


REGION R06
Legend
CCNPP
2, 5 & 10 Mile Rings
PAZ
Zone(s) to be Evacuated
0 0.5 1 2 3 4 5
Miles
N
S
E
W
1
2
3
4
5
6
7
8


REGION R07
Legend
CCNPP
2, 5 & 10 Mile Rings
PAZ
Zone(s) to be Evacuated
0 0.5 1 2 3 4 5
Miles
N
S
E
W
1
2
3
4
5
6
7
8


REGION R08
Legend
CCNPP
2, 5 & 10 Mile Rings
PAZ
Zone(s) to be Evacuated
1
2
3
4
5
6
7
8
0 0.5 1 2 3 4 5
Miles
N
S
E
W


REGION R09
Legend
CCNPP
2, 5 & 10 Mile Rings
PAZ
Zone(s) to be Evacuated
0 0.5 1 2 3 4 5
Miles
N
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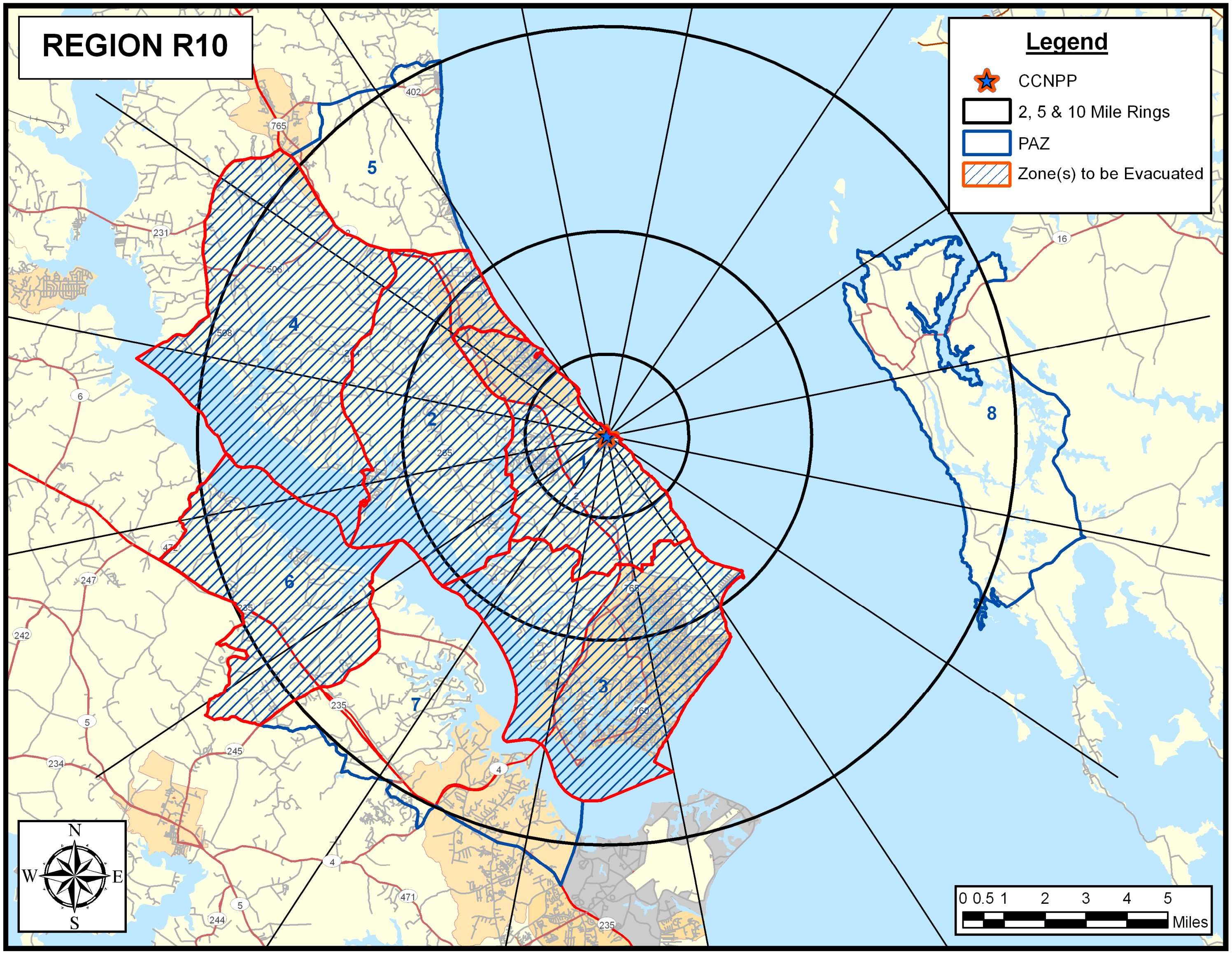
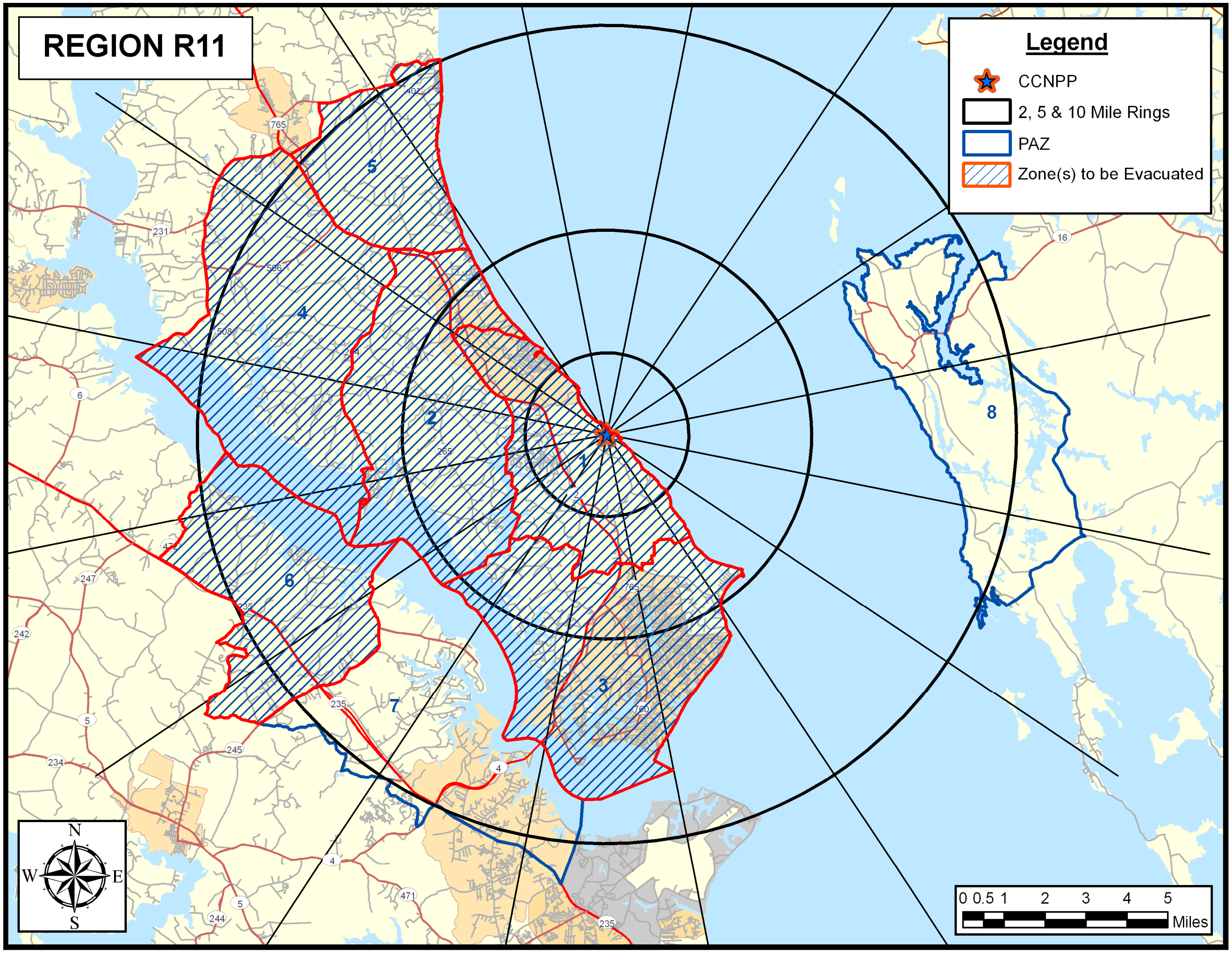
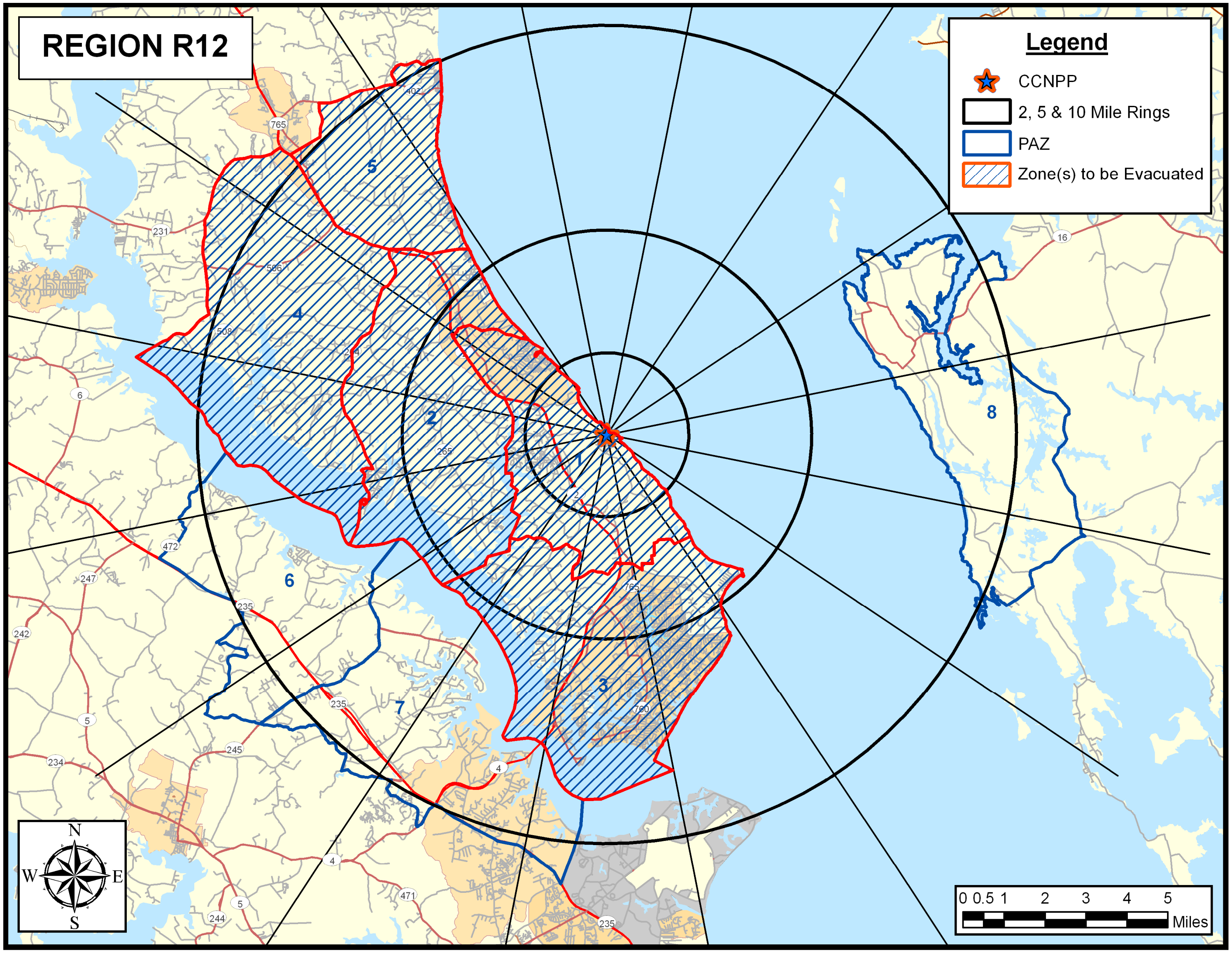
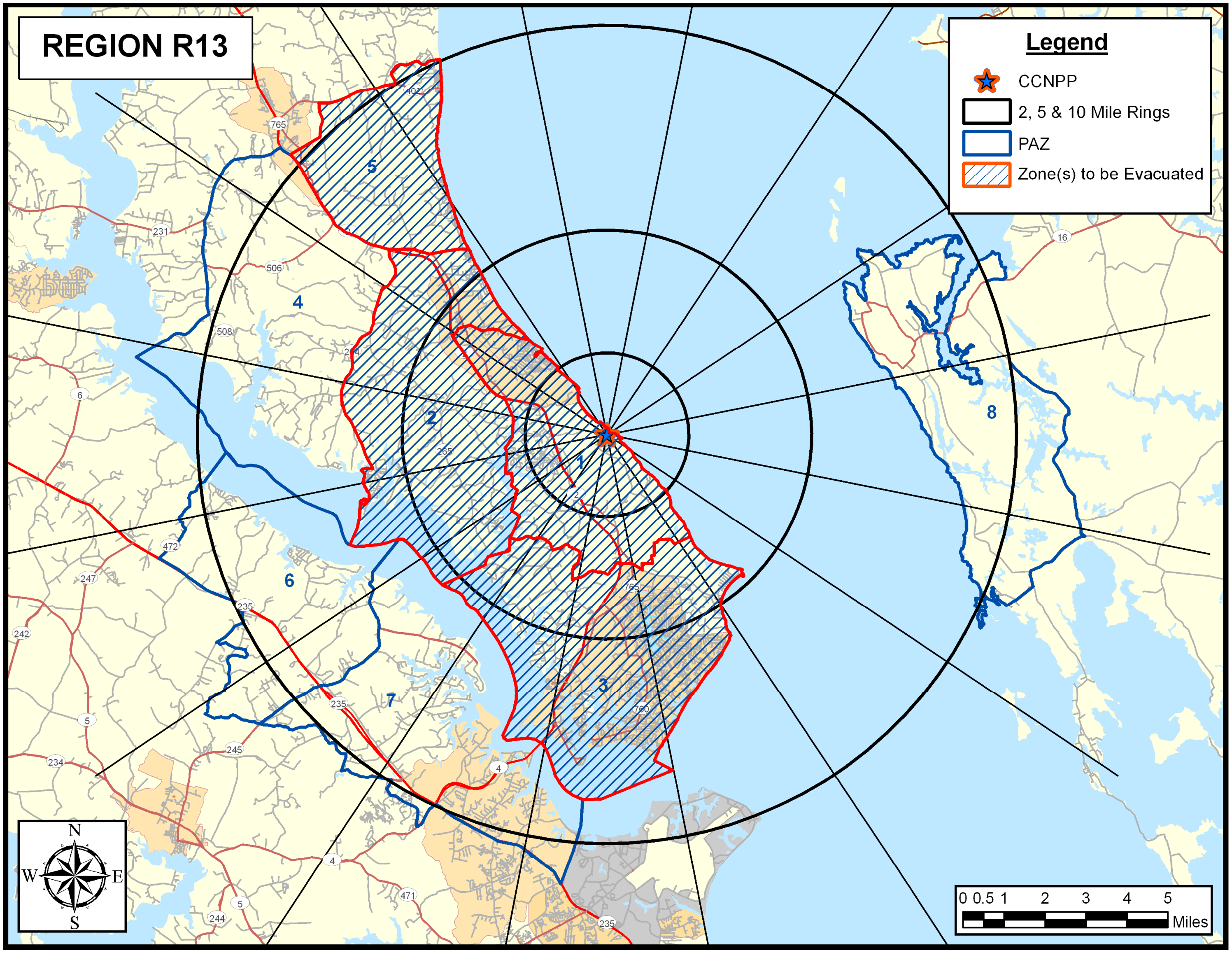
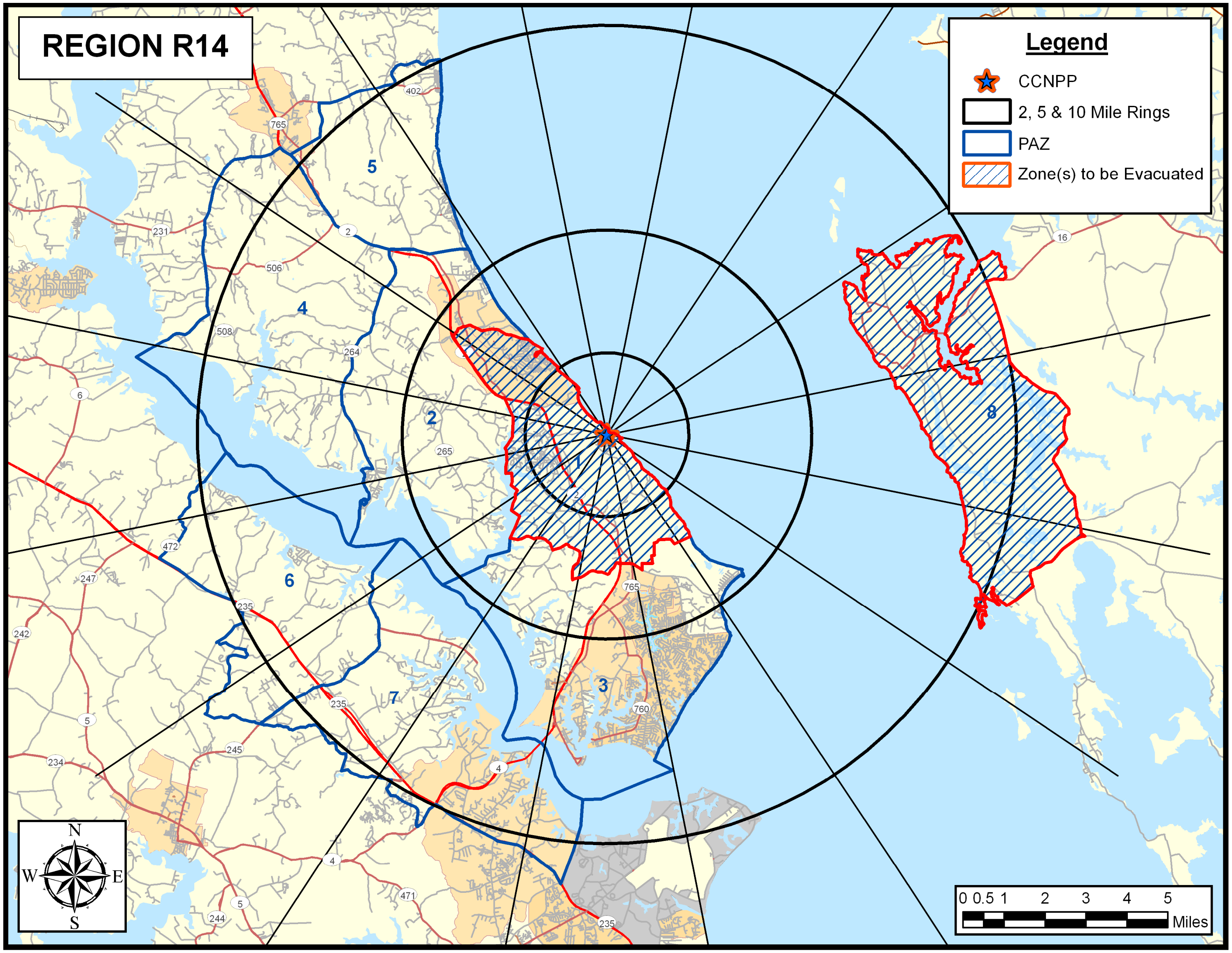
W
1
2
3
4
5
6
7
8


REGION R10
Legend
CCNPP
2, 5 & 10 Mile Rings
PAZ
Zone(s) to be Evacuated
0 0.5 1 2 3 4 5
Miles
N
S
E
W
1
2
3
4
5
6
7
8


REGION R11
Legend
CCNPP
2, 5 & 10 Mile Rings
PAZ
Zone(s) to be Evacuated
0 0.5 1 2 3 4 5
Miles
N
S
E
W
1
2
3
4
5
6
7
8


REGION R12
Legend
CCNPP
2, 5 & 10 Mile Rings
PAZ
Zone(s) to be Evacuated
1
2
3
4
5
6
7
8
0 0.5 1 2 3 4 5
Miles
N
S
E
W


REGION R13
Legend
CCNPP
2, 5 & 10 Mile Rings
PAZ
Zone(s) to be Evacuated
0 0.5 1 2 3 4 5
Miles
N
S
E
W
1
2
3
4
5
6
7
8


REGION R14
Legend
CCNPP
2, 5 & 10 Mile Rings
PAZ
Zone(s) to be Evacuated
0 0.5 1 2 3 4 5
Miles
N
S
E
W
1
2
3
4
5
6
7
8

APPENDIX I

Evacuation Sensitivity Studies

APPENDIX I: EVACUATION SENSITIVITY STUDIES

Sensitivity Study 1: Trip Generation

A sensitivity study was performed to determine whether changes in the estimated trip generation time have an effect upon the Evacuation Time Estimate (ETE) for the entire EPZ. The case considered was Scenario 1, Region 3; a summer, midweek (workday), midday (morning also), and good weather evacuation for the entire EPZ. Table I-1 presents the results of this study.

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

Trip Generation (Mobilization) Period	Evacuation Region		
	2-Mile Region (R01)	5-Mile Region (R02)	Entire EPZ (R03)
3 Hours	5:05	5:35	6:00
4 Hours (Base)	5:05	5:40	6:00
5 Hours	5:15	5:40	6:00

As discussed in Section 7, there is prolonged congestion within the EPZ which causes the ETE to extend beyond the mobilization time. The bottlenecks within the EPZ dictate the ETE since they meter the flow of traffic out of the area being evacuated. The change in trip generation rates has little effect on the ETE because of the congestion within the EPZ.

Sensitivity Study 2: Shadow Evacuation

A second sensitivity study was conducted to determine the effect 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 case considered was Scenario 1, Region 3; a summer, midweek (workday), midday (morning also), and good weather evacuation for the entire EPZ with the percent of shadow evacuation ranging from 15% to 60%. Table I-2 presents the evacuation time estimates for each of these cases.

Table I-2. Evacuation Time Estimates for Shadow Sensitivity Study					
Shadow Data			Evacuation Region		
Percent Shadow Evacuation	Number of Evacuating Shadow Residents	Number of Evacuating Shadow Resident Vehicles*	2-Mile Region (R01)	5-Mile Region (R02)	Entire EPZ (R03)
15%	9,046	4,727	5:05	5:40	6:00
30% (Base)	18,093	9,454	5:05	5:40	6:00
60%	36,185	18,907	5:05	5:40	6:50

* Telephone Survey data suggested average of 2.8 people/household with 1.46 evacuating vehicle/household, i.e. 1.91 people/evacuating household. Refer to Appendix F for details.

The ETE for the 2-Mile and 5-Mile regions remain unchanged as the percentage of people who decide to relocate from areas within the Shadow Region changes, showing the insensitivity of the ETE to shadow evacuation for those regions. The shadow area extends from 10 to 15 miles from CCNPP, thus it is reasonable that the 2-Mile and 5-Mile regions are not impacted.

The ETE for the entire EPZ, however, increases as the percentage of people who decide to relocate from the Shadow Region increases from 30% to 60%. The additional shadow vehicles between 10 and 15 miles from CCNPP interact with those vehicles evacuating from within the EPZ and further intensify congestion at existing bottlenecks and create additional bottlenecks, thereby increasing the ETE.

There are a total of 60,309 permanent residents (31,512 permanent resident vehicles) within the Shadow Region.

<u>Sensitivity Study 3: Zone 3 Evacuation</u>

A third sensitivity study related to the evacuation of Zone 3 is considered. Zone 3 in Calvert County has the highest population among all zones within the EPZ. It has a resident population of 21,079 (11,001 vehicles) which is 38.2% of the population of the entire EPZ.

The existing emergency plans for CCNPP suggest that those people in Zone 3 should evacuate southbound along Maryland Route 2/4. Analysis using PC-DYNEV of this routing pattern indicated prolonged congestion on Route 2/4 southbound, while there was far less congestion northbound. A sensitivity study was performed to analyze the impact of re-routing some of the evacuees from Zone 3 northbound on Route 2/4. Table I-3 clearly indicates that the ETE is significantly reduced by allowing Zone 3 evacuees to travel northbound on Route 2/4.

The ETE presented in Chapter 7 and Appendix J assume the routing of some residents within Zone 3 in the northbound direction along Route 2/4 towards CCNPP. Although vehicles are moved closer to the plant, the significant reduction in ETE minimizes the overall risk of exposure within the EPZ.

The case considered was Scenario 1, Region 3; a summer, midweek (work day), midday (morning also), good weather evacuation. As Table I-3 indicates, the ETE is significantly reduced for all regions when balancing the routing of Zone 3 vehicles northbound and southbound on Route 2/4.

Table I-3. Evacuation Time Estimates for Modified Routing for Zone 3

Trip Generation Period	Evacuation Region		
	2-Mile Region (R01)	5-Mile Region (R02)	Entire EPZ (R03)
Zone 3 allowed to use State Route 2/4 in both directions (Base)	5:05	5:40	6:00
Zone 3 allowed to use State Route 2/4 only in Southbound direction	6:30	9:30	9:50

Sensitivity Study 4: Origin of Attendees of Air Show

A fourth sensitivity study was conducted to determine the effect on the ETE of changing the percentage of EPZ residents and shadow population, who attend the air show. The base case considers that 75% of EPZ residents and shadow population attend the air show; in the sensitivity study this is decreased to 50%. This implies a higher number of transient vehicles (people from outside the EPZ) attending the event and results in increased vehicle demand. The case considered is Scenario 12, (summer, midday, weekend, with the air show), Region 3 (full EPZ evacuation). Table I-4 presents the evacuation time estimates for clearing the indicated evacuation region, for the base and sensitivity cases.

Table I-4A. Evacuation Time Estimates (ETE) for Air Show Special Event			
Percentage of EPZ Residents Attending Event	Evacuation Region		
	2-Mile Region (R01)	5-Mile Region (R02)	Entire EPZ (R03)
75% (Base)	4:10	6:45	11:30
50%	4:10	6:45	11:50

Table I-4B. Air Show Special Event Attendees and Vehicles				
Percentage of EPZ Residents Attending Event	EPZ Attendees	Shadow Attendees	Transient Attendees	Total Attendees
75% (Base)	41,404	45,232	13,365	100,000
50%	27,603	30,155	42,243	100,000
Percentage of EPZ Residents Attending Event	EPZ Vehicles	Shadow Vehicles	Transient Vehicles	Total Vehicles
75% (Base)	18,002	19,666	5,811	43479
50%	12,002	13,111	18,367	43480

The additional evacuating population at the Air Show increases ETE for Region 3. The traffic evacuating southbound on Route 2/4 from Zone 3 interacts with the traffic evacuating from the base northbound on MD 235, causing the increase in ETE.

This sensitivity study indicates that as the percentage of attendees who live outside the EPZ who come to the show increases, the higher impact it has on the ETE.

Sensitivity Study 5: Use of Contra-flow over Thomas Johnson Bridge

A sensitivity study using the Thomas Johnson Bridge as "contra-flow" was considered. We assume the following for this contra- flow scenario:

- Midweek (weekday), midday (day), and good weather evacuation
- An advisory to evacuate is issued to Zones 1, 2, and 3.

Contra-flow implies that Thomas Johnson Bridge only allows traffic southbound, thereby doubling the capacity. Additionally, it is assumed that at the intersection of MD 2/4 and MD 235, all traffic coming off the bridge is directed northbound on MD 235 and northbound traffic on MD 235 is directed onto MD 2/4 in the southbound direction. This ensures that traffic from this intersection does not back up onto the bridge.

This "contra-flow" scenario is only considered for conditions where Zone 3 is evacuated and Zone 6 and 7 are not evacuated. Table I-5 presents the ETE results for a Summer and a Winter Scenario.

Table I-5. Evacuation Time Estimates for Contra-Flow Scenario for Region 6 (Zones 1, 2, 3 and 8)

Season	Contra Flow	Region 6 (Zones 1, 2, 3, and 8) ETE
Summer	No	5:25
Summer	Yes	4:10
Winter	No	5:20
Winter	Yes	4:10

The results of this sensitivity study indicate that the use of contra-flow together with traffic control tactic detailed above reduces the ETE to mobilization time plus travel time to the region boundary.

Sensitivity Studies 6-9: Additional ETE for Specific Areas

These additional ETE were calculated at the specific request of St Mary's and Dorchester Counties. They are not included in Section 7 because they are not required by NUREG-0654 or NUREG/CR-6863 and cannot be used in the process of Protective Action Recommendations determination.

The Evacuation Time Estimates (ETE) for the following cases are presented:

6. Evacuation of Zone 6 in St. Mary's County Only,
7. Evacuation of Zone 7 in St. Mary's County Only,
8. Evacuation of Zone 8 in Dorchester County Only, and
9. Evacuation of the Full 10-Mile EPZ when the Thomas Johnson Bridge is closed.

The ETE for cases 6 through 8 are developed for all 14 scenarios considered in this Report. The scenarios are listed in Table I-6:

Table I-6 – List of Scenarios

Scenarios	Season	Day of Week	Time of Day	Weather	Special
1	Summer	Midweek	Midday	Good	None
2	Summer	Midweek	Midday	Rain	None
3	Summer	Weekend	Midday	Good	None
4	Summer	Weekend	Midday	Rain	None
5	Summer	Midweek, Weekend	Evening	Good	None
6	Winter	Midweek	Midday	Good	None
7	Winter	Midweek	Midday	Rain	None
8	Winter	Weekend	Midday	Good	None
9	Winter	Weekend	Midday	Rain	None
10	Winter	Midweek, Weekend	Evening	Good	None
11	Summer	Midweek	Midday	Good	New Plant Construction
12	Summer	Weekend	Midday	Good	Air Show at the Naval Base
13	Winter	Midweek	Midday	Snow	None
14	Winter	Weekend	Midday	Snow	None

The ETE for case 9 are calculated as a sensitivity study and compared to the ETE for Scenarios 1 and 6.

Methodology

The number of people (residents, employees and transients) and the corresponding vehicles within Zones 6, 7 and, 8 are presented in Tables I-7 and I-8.

Voluntary and shadow evacuations (as defined in Section 2 and Figure 2-1) are not considered for cases 6-8.

Table I-7. Population by Zone				
Zone	**Permanent Residents**	**Transients**	**Employees who reside outside the EPZ**	**Total**
6	5,074	819	56	5,146
7	9,284	2,634	365	10,683
8	311	200	No employment	511

Table I-8. Summary of Vehicles by Zone				
Zone	**Permanent Residents**	**Transients**	**Employees who reside outside the EPZ**	**Total**
6	2,648	212	54	2,710
7	4,852	1,028	355	5,674
8	164	67	No employment	231

The existing roadway network and demand (Section 3) are used for case 9 (TJ Bridge Closure). People evacuating from Zone 3 are not permitted to travel southbound along MD 2/4 as the TJ Bridge is closed for this case. Voluntary and shadow evacuations are considered for this case.

Results

An evacuation region consists of a zone or grouping of zones issued an advisory to evacuate. The ETE for 14 regions are presented in Section 7. Figures I-1, I-2 and I-3 show the 10 Mile EPZ for CCNPP with the Zones 6, 7 and 8 highlighted and identified as Regions 15 through 17, respectively. Tables I-9A through I9-D present the ETE for the evacuation of Zones 6, 7 and 8, individually. Guidance is provided in Section 7 for the use of these tables. The ETE for the 100th percentile of population is between 4:00 and 4:05 for all non-snow scenarios. The mobilization time (the time, measured from the Advisory to Evacuate, at which 100% of the population is mobilized) is 4:00, therefore these results indicate that public education programs may hasten mobilization time may result in a shorter ETE.

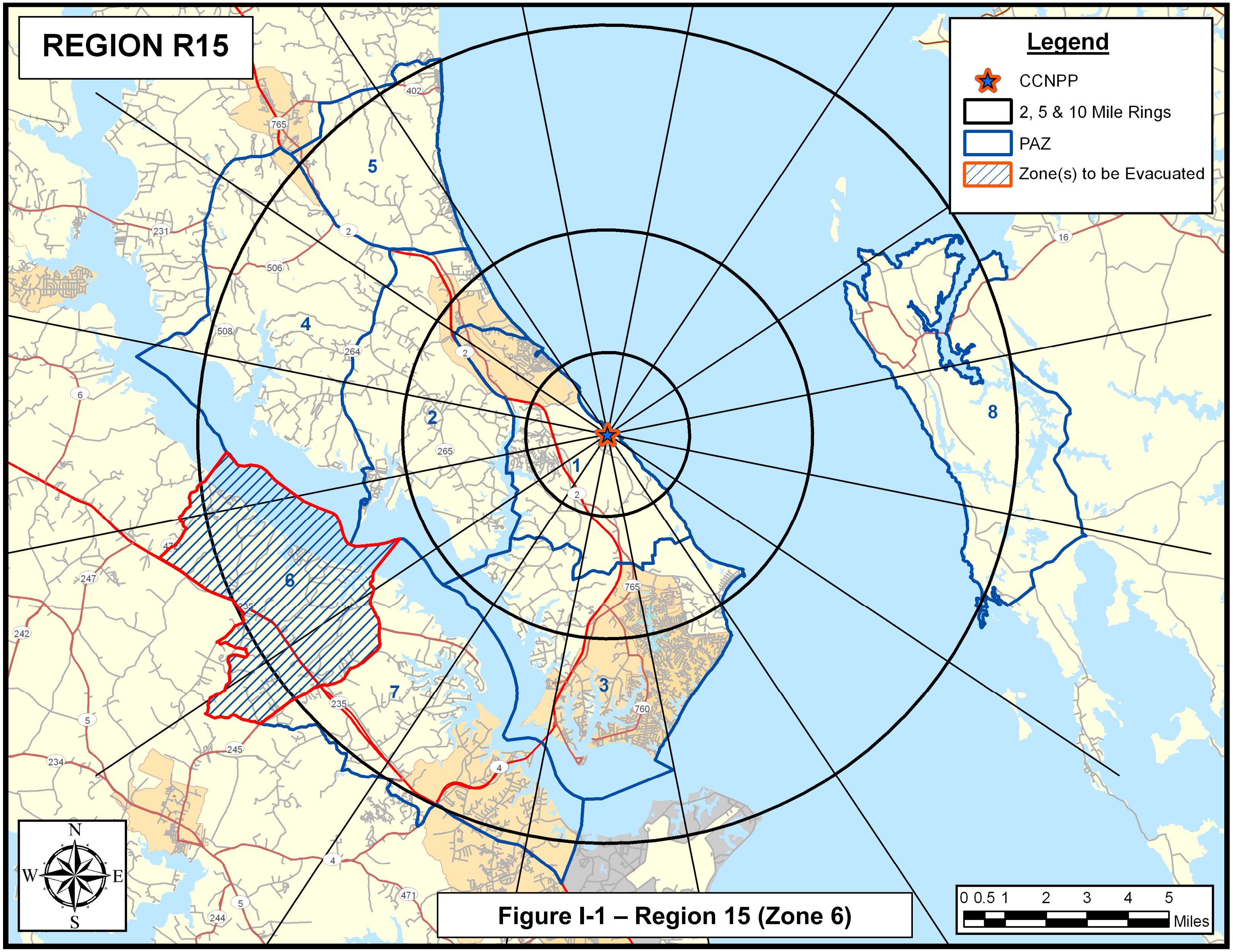


Figure I-1 – Region 15 (Zone 6)

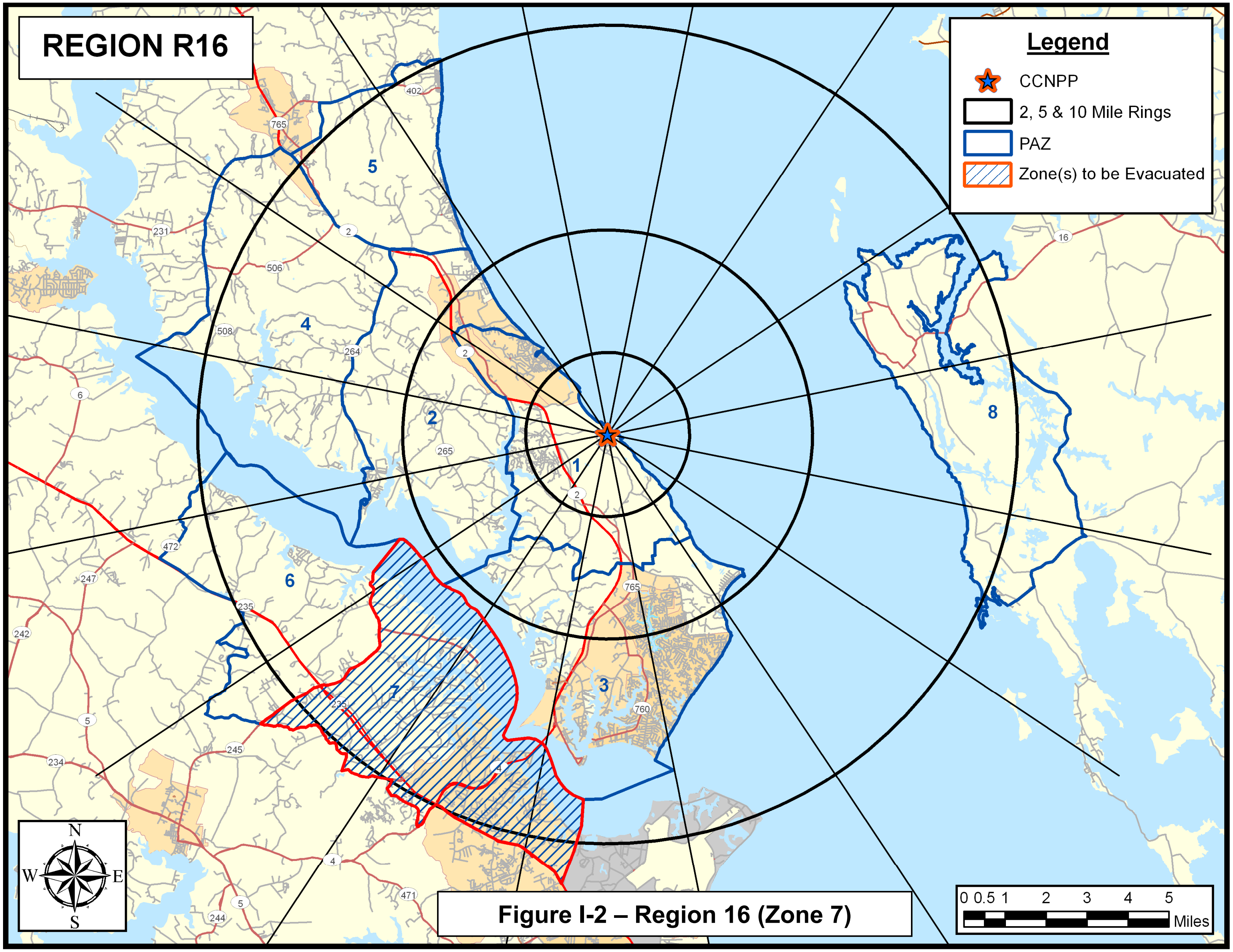


Figure I-2 – Region 16 (Zone 7)

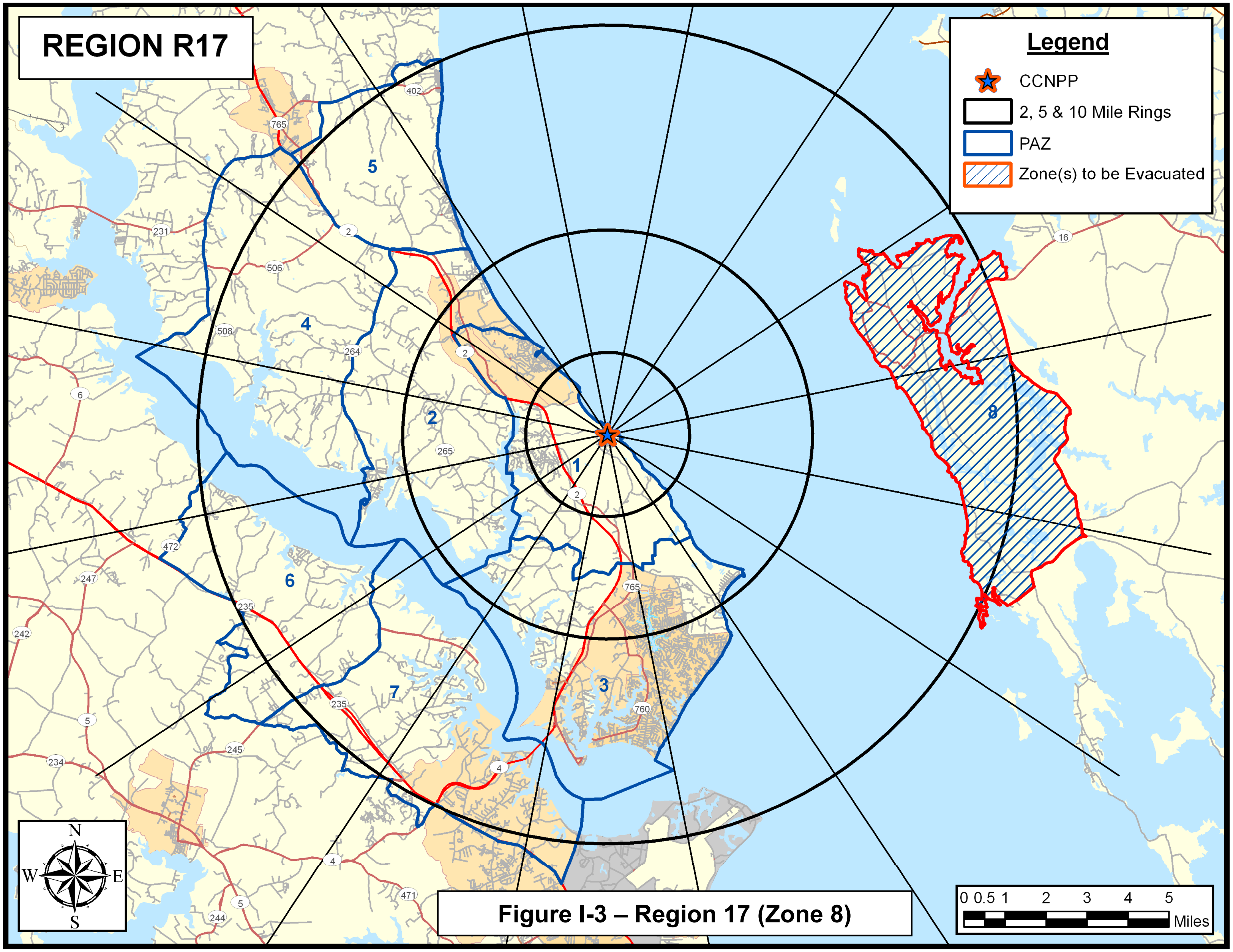


Figure I-3 – Region 17 (Zone 8)

Table I-9A. Time To Clear The Indicated Area of 50 Percent of the Affected Population

Season		Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer	Winter	Winter
Day of Week		Midweek		Weekend		All	Midweek		Weekend		All	Midweek	Weekend	Midweek	Weekend
Scenario:		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Time of Day		Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday	Midday	Midday
Zone	Region	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	New Plant Construction	Air Show at Base	Snow	Snow
6	R15	1:20	1:20	1:05	1:10	1:05	1:20	1:25	1:10	1:10	1:05	1:20	1:05	1:45	1:30
7	R16	1:30	1:30	1:25	1:25	1:20	1:30	1:30	1:20	1:20	1:20	1:30	1:05	1:50	1:40
8	R17	1:20	1:20	0:50	0:50	0:55	1:25	1:25	0:55	0:55	0:55	1:20	0:45	2:00	1:25

Table I-9B. Time To Clear The Indicated Area of 90 Percent of the Affected Population

Season		Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer	Winter	Winter
Day of Week		Midweek		Weekend		All	Midweek		Weekend		All	Midweek	Weekend	Midweek	Weekend
Scenario:		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Time of Day		Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday	Midday	Midday
Zone	Region	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	New Plant Construction	Air Show at Base	Snow	Snow
6	R15	2:30	2:30	2:00	2:05	2:00	2:30	2:30	2:00	2:05	2:00	2:30	1:55	3:15	2:35
7	R16	2:45	2:55	2:50	3:00	2:30	2:45	2:50	2:35	2:40	2:25	2:55	1:55	3:25	3:10
8	R17	2:50	2:50	1:45	1:50	1:55	2:55	2:55	1:55	1:55	1:55	2:50	1:35	3:45	2:55

Table I-9C. Time To Clear The Indicated Area of 95 Percent of the Affected Population

Season		Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer	Winter	Winter
Day of Week		Midweek		Weekend		All	Midweek		Weekend		All	Midweek	Weekend	Midweek	Weekend
Scenario:		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Time of Day		Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday	Midday	Midday
Zone	Region	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	New Plant Construction	Air Show at Base	Snow	Snow
6	R15	2:55	2:55	2:15	2:20	2:20	2:55	2:55	2:15	2:20	2:20	2:55	2:10	3:50	3:05
7	R16	3:00	3:15	3:05	3:15	2:40	3:00	3:10	2:45	2:55	2:40	3:10	2:10	3:55	3:25
8	R17	3:25	3:25	2:20	2:20	2:25	3:25	3:25	2:30	2:30	2:30	3:15	2:10	4:10	3:25

Table I-9D. Time To Clear The Indicated Area of 100 Percent of the Affected Population

Season		Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer	Winter	Winter
Day of Week		Midweek		Weekend		All	Midweek		Weekend		All	Midweek	Weekend	Midweek	Weekend
Scenario:		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Time of Day		Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday	Midday	Midday
Zone	Region	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	New Plant Construction	Air Show at Base	Snow	Snow
6	R15	4:05	4:05	4:05	4:05	4:00	4:05	4:05	4:00	4:05	4:05	4:05	4:00	5:05	5:05
7	R16	4:10	4:10	4:05	4:05	4:05	4:05	4:10	4:05	4:05	4:05	4:10	4:10	5:10	5:05
8	R17	4:10	4:10	4:00	4:00	4:00	4:10	4:10	4:00	4:00	4:00	4:00	4:00	5:00	4:10

Closure of the Thomas Johnson (TJ) Bridge

A sensitivity study was conducted to study the effects of closing the Thomas Johnson Bridge. This bridge serves as one of the major evacuation routes for Zone 3 (the most populous zone within the EPZ). In the event the bridge is closed, all evacuees from Zone 3 will be routed northbound on MD 2/4. The results are presented in Table I-10. The scenarios considered are summer and winter, Midweek (workday), and Midday (business hours). The ETE presented are for an evacuation of Region 3 (Full 10-Mile EPZ).

Table I-10. Time (hr:min) to Evacuate the Indicated Percentage of the 10-Mile EPZ

Scenario	Condition	50%	90%	95%	100%
Summer, Midweek, Midday	Base	2:20	4:30	4:55	6:00
	TJ Bridge Closed	2:35	5:55	6:30	7:10
Winter, Midweek, Midday	Base	2:20	4:30	4:50	5:50
	TJ Bridge Closed	2:30	5:50	6:25	7:00

As seen in Table I-10, the closing of the TJ Bridge results in increased ETE for all percentiles. This is attributed to the increased congestion at MD 2/4 at MD 497 (Cove Point Road). The major evacuation routes servicing Zone 3 are westbound along MD 497 and MD 760 and then northbound along MD 2/4. The traffic along these routes converges at the intersection of MD 2/4 and MD 497 (See Figure I-4) resulting in pronounced congestion. Vehicles evacuating Zone 3 have 3 lanes available in the base case – 2 lanes northbound on MD 2/4 and 1 lane southbound across the TJ Bridge. The closing of the bridge reduces the available capacity, thereby increasing congestion, reducing the rate of the egress and prolonging the ETE. This phenomenon is shown graphically in Figures I-5 and I-6 as the ETE plot is skewed towards longer ETE (dispersed evacuation curve) for the 90^{th} and 95^{th} percentiles.

These results indicate that the routing considered in the base case, which involves a balance of routing southbound and northbound along MD 2/4, represents an optimal use of the available roadway capacity.

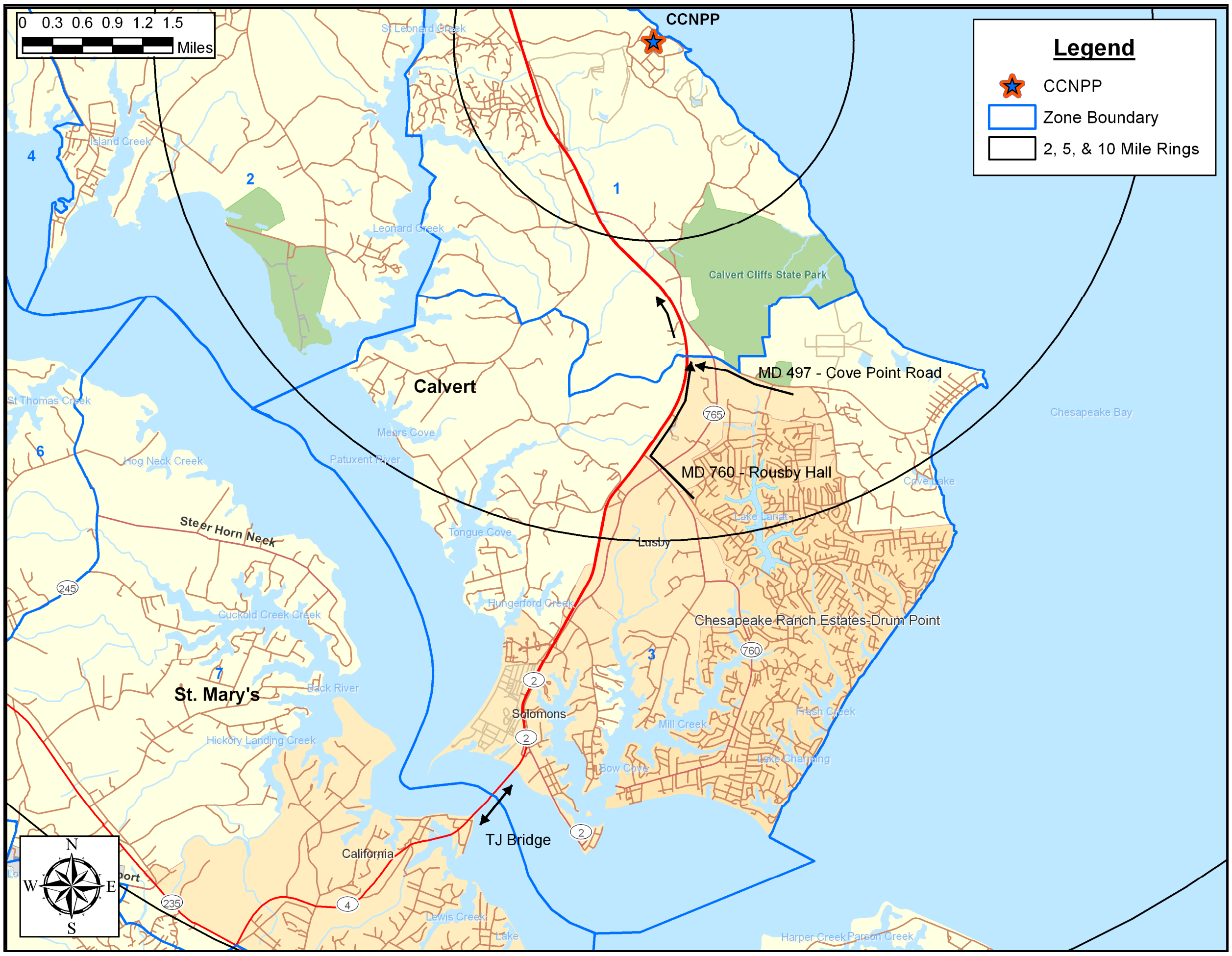


Figure I-4 – Primary Evacuation Routes Servicing Zone 3 with the TJ Bridge Closed

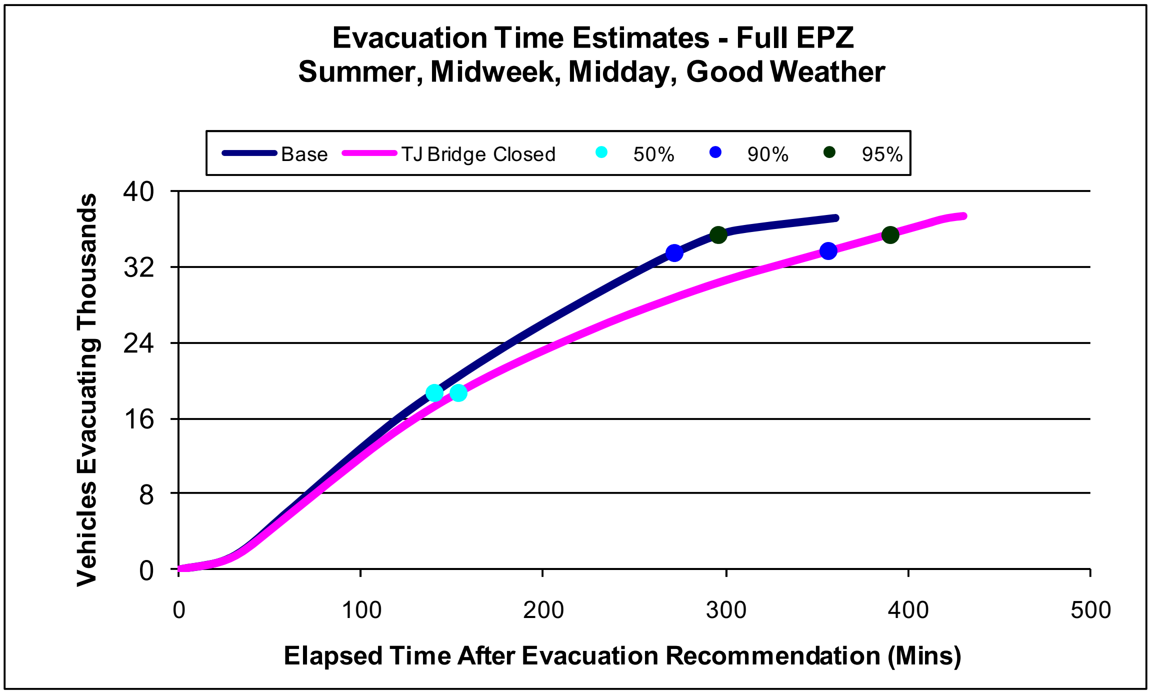


Figure I-5 –Evacuation Plot, Scenario 1 Region 3 with the TJ Bridge Closed

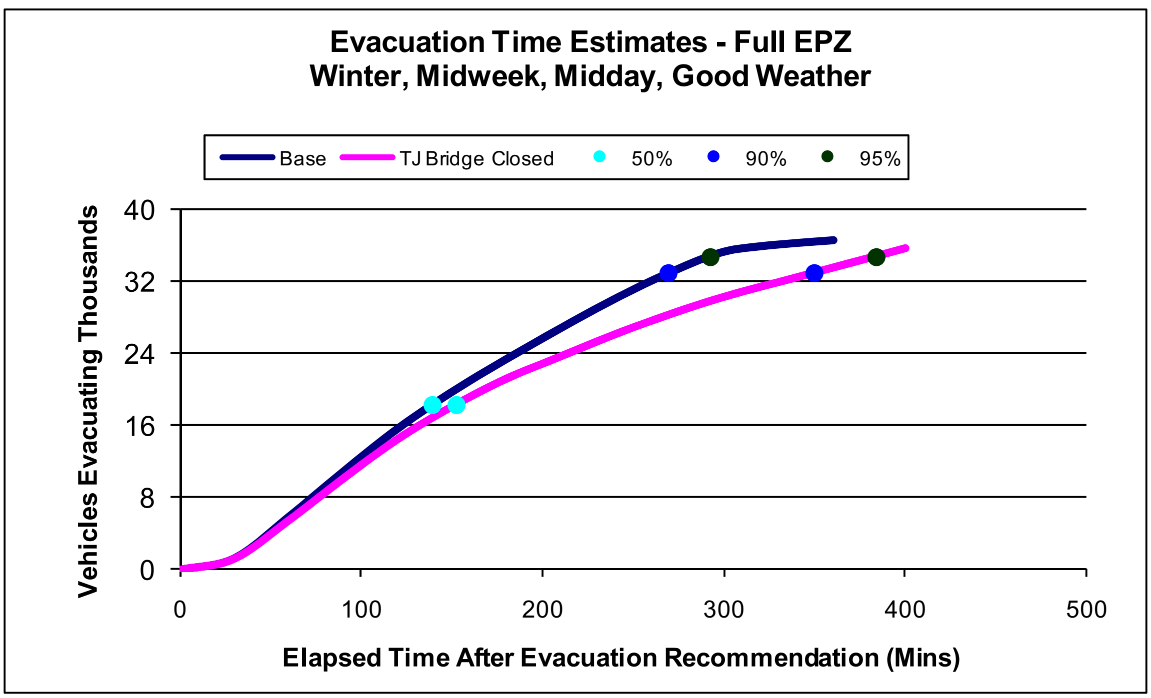


Figure I-6 – Evacuation Plot, Scenario 6 Region 3 with the TJ Bridge Closed

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 14 Regions and all 14 Scenarios (Tables J-1A through J-1D).

Plots of Evacuating Vehicles vs. Elapsed Time leaving the 2-mile and 5-mile circular areas around CCNPP and the entire EPZ for Region R03, for all 14 scenarios are presented. Each plot has points indicating the evacuation times corresponding to the 50th, 90th, and 95th percentiles of evacuated vehicles.

J.1 Guidance on Using ETE Tables

Tables J-1A through J-1D present the ETE values for all 14 Evacuation Regions and all 14 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
  - New Plant Construction
  - Air Show at Naval Air Base

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

- The conditions of all summer evenings and rain are not explicitly identified in Tables J-1A through J-1D. For these conditions, Scenario (4) provides a conservative estimate of ETE.
- Likewise, the conditions of all winter evenings and rain are not explicitly identified in Tables J-1A through J-1D. For these conditions, Scenario (9) provides a conservative estimate of ETE.
- 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 Calvert Cliffs Nuclear Power Plant. The applicable distances and their associated candidate Regions are given below:
  - 2 Miles (Region R01)
  - 5 Miles (Regions R02, R04 and R05)
  - to EPZ Boundary (Regions R03 and R06 through R14)
- 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 the CCNPP. 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 northeast (NE).
- Wind speed is such that the distance to be evacuated is judged to be 10 miles (to EPZ boundary).
- The desired ETE is that value needed to evacuate 95 percent of the population from within the impacted Region.

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

1. Identify the Scenario parameters as: *Season*: summer; *Day of Week*: weekend; *Time of Day*: evening (non-work hours); and *Weather*: Rain. Entering Table J-1C, it is seen that there is no match for these descriptors. However, based on the discussions above (Section J-1, item 1), Scenario 4 would provides guidance as an upper bound on ETE.

2. Enter Table J-2 and locate the group entitled “Evacuate 5-Mile Ring and Downwind to EPZ Boundary”. Under “Wind Direction Towards:”, identify the NE (northeast) azimuth and read REGION R06 in the first column of that row.

3. Enter Table J-1C to locate the data cell containing the value of ETE for Scenario 4 and Region R09. This data cell is in column (4) and in the row for Region R06; it contains the ETE value of **5:45**.

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

Season		Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer	Winter	Winter	Season
Day of Week		Midweek		Weekend		All	Midweek		Weekend		All	Midweek	Weekend	Midweek	Weekend	Day of Week
Scenario:		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	Scenario
Time of Day		Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday	Midday	Midday	Time of Day
Zone	Region Wind Direction Towards	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	New Plant Construction	Air Show at Base	Snow	Snow	Region Wind Direction Towards
								Entire 2-Mile Region, 5-Mile Region, and EPZ								
1	R01 2-mile ring	1:30	1:35	1:25	1:30	1:20	1:30	1:30	1:20	1:30	1:20	1:50	1:00	1:55	1:50	R01 2-mile ring
1,2,3	R02 5-mile ring	2:30	2:45	2:30	2:45	2:15	2:30	2:45	2:25	2:35	2:15	2:50	1:20	3:15	3:10	R02 5-mile ring
1,2,3,4,5, 6,7,8	R03 Entire EPZ	2:20	2:30	2:15	2:30	2:10	2:20	2:30	2:10	2:20	2:05	2:35	4:20	3:00	2:50	R03 Entire EPZ
								2-Mile Ring and Downwind to 5 Miles								
1	N, NNE, NE, ENE, E	Refer to Region 1														N, NNE, NE, ENE, E
1,3	R04 ESE, SE, SSE, S	2:20	2:30	2:20	2:35	2:05	2:15	2:30	2:15	2:25	2:05	2:40	1:25	3:00	2:55	R04 ESE, SE, SSE, S
1,2,3	SSW, SW, WSW	Refer to Region 2														SSW, SW, WSW
1,2	R05 W, WNW, NW, NNW	1:45	1:55	1:45	1:55	1:40	1:45	1:55	1:40	1:50	1:40	2:10	1:00	2:20	2:15	R05 W, WNW, NW, NNW
								5-Mile Ring and Downwind to EPZ Boundary								
1,2,3	NNE	Refer to Region 2														NNE
1,2,3,8	R06 NE, ENE, E, ESE, SE	2:30	2:45	2:30	2:45	2:15	2:30	2:45	2:20	2:35	2:15	2:50	1:20	3:15	3:10	R06 NE, ENE, E, ESE, SE
1,2,3,7	R07 SSE, S	2:25	2:35	2:20	2:35	2:10	2:20	2:30	2:15	2:25	2:10	2:40	4:35	3:00	2:55	R07 SSE, S
1,2,3,6,7	R08 SSW, SW	2:20	2:30	2:15	2:25	2:05	2:20	2:25	2:10	2:20	2:05	2:35	4:35	2:55	2:50	R08 SSW, SW
1,2,3,4,6, 7	R09 WSW	2:20	2:30	2:20	2:30	2:10	2:20	2:30	2:10	2:20	2:10	2:35	4:25	3:00	2:50	R09 WSW
1,2,3,4,6	R10 W	2:20	2:30	2:15	2:30	2:05	2:20	2:30	2:10	2:20	2:05	2:35	4:05	3:00	2:50	R10 W
1,2,3,4,5, 6	R11 WNW	2:20	2:30	2:15	2:30	2:05	2:20	2:30	2:10	2:25	2:05	2:35	4:00	3:00	2:50	R11 WNW
1,2,3,4,5	R12 NW, NNW	2:30	2:45	2:25	2:45	2:15	2:30	2:45	2:20	2:40	2:15	2:50	1:25	3:20	3:10	R12 NW, NNW
1,2,3,5	R13 N	2:30	2:45	2:30	2:45	2:15	2:30	2:45	2:25	2:35	2:15	2:50	1:30	3:15	3:10	R13 N
1,8	R14	1:30	1:35	1:25	1:30	1:20	1:30	1:35	1:20	1:30	1:20	1:50	1:00	1:55	1:50	R14

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

Season		Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer	Winter	Winter	Season
Day of Week		Midweek		Weekend		All	Midweek		Weekend		All	Midweek	Weekend	Midweek	Weekend	Day of Week
Scenario:		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	Scenario
Time of Day		Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday	Midday	Midday	Time of Day
Zone	Region Wind Direction	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	New Plant Construction	Air Show at Base	Snow	Snow	Region Wind Direction
Entire 2-Mile Region, 5-Mile Region, and EPZ																
1	R01 2-mile ring	2:45	2:50	2:30	2:45	2:25	2:50	2:50	2:25	2:40	2:25	3:25	1:50	3:40	3:20	R01 2-mile ring
1,2,3	R02 5-mile ring	4:20	4:50	4:30	5:10	3:55	4:15	4:45	4:10	4:40	3:55	5:00	4:55	5:30	5:25	R02 5-mile ring
1,2,3,4,5, 6,7,8	R03 Entire EPZ	4:30	5:00	4:35	5:05	4:10	4:30	4:50	4:20	4:45	4:05	5:10	9:55	5:40	5:35	R03 Entire EPZ
2-Mile Ring and Downwind to 5 Miles																
1	N, NNE, NE, ENE, E	Refer to Region 1														N, NNE, NE, ENE, E
1,3	R04 ESE, SE, SSE, S	4:25	4:55	4:40	5:15	4:00	4:15	4:50	4:15	4:45	3:50	4:40	4:55	5:35	5:35	R04 ESE, SE, SSE, S
1,2,3	SSW, SW, WSW	Refer to Region 2														SSW, SW, WSW
1,2	R05 W, WNW, NW, NNW	3:05	3:25	3:05	3:20	2:50	3:05	3:25	3:00	3:15	2:50	4:00	1:50	4:05	4:00	R05 W, WNW, NW, NNW
5-Mile Ring and Downwind to EPZ Boundary																
1,2,3	NNE	Refer to Region 2														NNE
1,2,3,8	R06 NE, ENE, E, ESE, SE	4:20	4:45	4:30	5:05	3:55	4:15	4:40	4:10	4:40	3:55	5:00	4:55	5:30	5:25	R06 NE, ENE, E, ESE, SE
1,2,3,7	R07 SSE, S	4:25	4:55	4:35	5:10	4:00	4:20	4:45	4:15	4:45	4:00	5:00	9:50	5:35	5:30	R07 SSE, S
1,2,3,6,7	R08 SSW, SW	4:25	4:55	4:35	5:10	4:00	4:20	4:40	4:10	4:40	3:55	5:00	9:55	5:30	5:30	R08 SSW, SW
1,2,3,4,6, 7	R09 WSW	4:30	5:00	4:35	5:05	4:10	4:30	4:50	4:20	4:45	4:05	5:10	9:55	5:40	5:35	R09 WSW
1,2,3,4,6	R10 W	4:30	4:55	4:35	5:10	4:10	4:25	4:55	4:20	4:45	4:05	5:05	9:40	5:40	5:35	R10 W
1,2,3,4,5, 6	R11 WNW	4:30	4:55	4:35	5:10	4:10	4:30	4:55	4:20	4:45	4:05	5:10	9:40	5:40	5:35	R11 WNW
1,2,3,4,5	R12 NW, NNW	4:30	4:55	4:35	5:05	4:10	4:30	4:55	4:20	4:45	4:05	5:15	4:40	5:45	5:35	R12 NW, NNW
1,2,3,5	R13 N	4:25	4:55	4:35	5:15	4:05	4:25	4:50	4:15	4:45	4:00	5:05	5:05	5:40	5:30	R13 N
1,8	R14	2:45	2:50	2:35	2:50	2:25	2:50	2:50	2:30	2:50	2:25	3:30	1:50	3:40	3:20	R14

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

Season		Summer		Summer		Summer	Winter		Winter		Winter	Summer	Summer	Winter	Winter	Season
Day of Week		Midweek		Weekend		All	Midweek		Weekend		All	Midweek	Weekend	Midweek	Weekend	Day of Week
Scenario:		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	Scenario
Time of Day		Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday	Midday	Midday	Time of Day
Zone	Region Wind Direction Towards	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	New Plant Construction	Air Show at Base	Snow	Snow	Region Wind Direction
Entire 2-Mile Region, 5-Mile Region, and EPZ																
1	R01 2-mile ring	3:10	3:15	2:45	3:00	2:45	3:10	3:15	2:45	2:55	2:45	3:50	2:05	4:05	3:40	R01 2-mile ring
1,2,3	R02 5-mile ring	4:45	5:20	5:05	5:45	4:20	4:40	5:15	4:40	5:10	4:15	5:15	5:45	6:00	6:00	R02 5-mile ring
1,2,3,4,5, 6,7,8	R03 Entire EPZ	4:55	5:30	5:10	5:45	4:30	4:50	5:15	4:45	5:15	4:25	5:35	10:35	6:10	6:10	R03 Entire EPZ
2-Mile Ring and Downwind to 5 Miles																
1	N, NNE, NE, ENE, E	Refer to Region 1														N, NNE, NE, ENE, E
1,3	R04 ESE, SE, SSE, S	4:50	5:25	5:10	5:45	4:25	4:45	5:15	4:45	5:15	4:20	5:05	5:40	6:05	6:05	R04 ESE, SE, SSE, S
1,2,3	SSW, SW, WSW	Refer to Region 2														SSW, SW, WSW
1,2	R05 W, WNW, NW, NNW	3:20	3:40	3:15	3:35	3:00	3:20	3:35	3:10	3:30	3:00	4:10	2:10	4:20	4:10	R05 W, WNW, NW, NNW
5-Mile Ring and Downwind to EPZ Boundary																
1,2,3	NNE	Refer to Region 2														NNE
1,2,3,8	R06 NE, ENE, E, ESE, SE	4:45	5:20	5:05	5:45	4:20	4:40	5:15	4:40	5:10	4:15	5:15	5:45	6:00	6:00	R06 NE, ENE, E, ESE, SE
1,2,3,7	R07 SSE, S	5:00	5:30	5:15	5:50	4:30	4:50	5:15	4:45	5:20	4:25	5:25	10:30	6:10	6:10	R07 SSE, S
1,2,3,6,7	R08 SSW, SW	5:00	5:30	5:15	5:50	4:30	4:50	5:15	4:45	5:20	4:25	5:20	10:40	6:10	6:10	R08 SSW, SW
1,2,3,4,6, 7	R09 WSW	4:55	5:30	5:10	5:45	4:30	4:50	5:15	4:45	5:15	4:30	5:35	10:40	6:10	6:10	R09 WSW
1,2,3,4,6	R10 W	4:50	5:25	5:10	5:50	4:30	4:50	5:20	4:45	5:15	4:25	5:30	10:30	6:05	6:05	R10 W
1,2,3,4,5, 6	R11 WNW	4:50	5:25	5:10	5:50	4:30	4:50	5:20	4:45	5:15	4:25	5:30	10:25	6:05	6:00	R11 WNW
1,2,3,4,5	R12 NW, NNW	4:50	5:20	5:00	5:35	4:25	4:45	5:15	4:40	5:10	4:25	5:30	5:35	6:05	6:00	R12 NW, NNW
1,2,3,5	R13 N	4:50	5:25	5:10	5:50	4:25	4:45	5:20	4:45	5:15	4:20	5:25	5:50	6:05	6:05	R13 N
1,8	R14	3:10	3:15	2:45	3:05	2:50	3:10	3:15	2:45	3:00	2:50	3:50	2:10	4:05	3:40	R14

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

Season		Summer	Summer	Summer	Summer	Summer	Winter	Winter	Winter	Winter	Winter	Summer	Summer	Winter	Winter	Season
Day of Week		Midweek		Weekend		All	Midweek		Weekend		All	Midweek	Weekend	Midweek	Weekend	Day of Week
Scenario:		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	Scenario
Time of Day		Midday		Midday		Evening	Midday		Midday		Evening	Midday	Midday	Midday	Midday	Time of Day
Zone	Region Wind Direction	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Good Weather	Rain	Good Weather	New Plant Construction	Air Show at Base	Snow	Snow	Region Wind Direction Towards
Entire 2-Mile Region, 5-Mile Region, and EPZ																
1	R01 2-mile ring	4:10	4:10	4:05	4:15	4:05	4:10	4:15	4:10	4:10	4:15	4:30	4:00	5:15	5:15	R01 2-mile ring
1,2,3	R02 5-mile ring	5:25	6:05	5:55	6:30	5:00	5:20	5:55	5:20	5:55	4:50	5:50	6:35	6:45	6:40	R02 5-mile ring
1,2,3,4,5, 6,7,8	R03 Entire EPZ	6:00	6:45	6:25	7:10	5:30	5:50	6:20	5:50	6:30	5:25	6:30	11:30	7:25	7:25	R03 Entire EPZ
2-Mile Ring and Downwind to 5 Miles																
1	N, NNE, NE, ENE, E	Refer to Region 1														N, NNE, NE, ENE, E
1,3	R04 ESE, SE, SSE, S	5:25	6:05	5:55	6:35	4:55	5:20	5:50	5:15	5:50	4:50	5:45	6:20	6:45	6:40	R04 ESE, SE, SSE, S
1,2,3	SSW, SW, WSW	Refer to Region 2														SSW, SW, WSW
1,2	R05 W, WNW, NW, NNW	4:15	4:20	4:15	4:15	4:15	4:15	4:20	4:10	4:15	4:10	4:50	4:10	5:20	5:15	R05 W, WNW, NW, NNW
5-Mile Ring and Downwind to EPZ Boundary																
1,2,3	NNE	Refer to Region 2														NNE
1,2,3,8	R06 NE, ENE, E, ESE, SE	5:25	6:05	5:55	6:30	5:00	5:20	5:55	5:20	5:55	4:50	5:50	6:35	6:45	6:40	R06 NE, ENE, E, ESE, SE
1,2,3,7	R07 SSE, S	6:00	6:35	6:20	7:00	5:20	5:45	6:15	5:45	6:20	5:20	6:20	11:25	7:15	7:20	R07 SSE, S
1,2,3,6,7	R08 SSW, SW	6:00	6:45	6:25	7:10	5:30	5:50	6:20	5:50	6:30	5:25	6:30	11:30	7:25	7:30	R08 SSW, SW
1,2,3,4,6, 7	R09 WSW	6:00	6:45	6:25	7:10	5:30	5:50	6:20	5:50	6:30	5:25	6:30	11:30	7:25	7:25	R09 WSW
1,2,3,4,6	R10 W	5:45	6:20	6:15	7:00	5:20	5:45	6:20	5:45	6:20	5:20	6:10	11:20	7:05	7:05	R10 W
1,2,3,4,5, 6	R11 WNW	5:45	6:20	6:15	7:00	5:20	5:45	6:20	5:45	6:20	5:20	6:10	11:20	7:05	7:05	R11 WNW
1,2,3,4,5	R12 NW, NNW	5:25	6:05	5:55	6:30	4:55	5:20	5:55	5:20	5:55	4:50	5:50	6:35	6:45	6:40	R12 NW, NNW
1,2,3,5	R13 N	5:25	6:05	5:55	6:30	5:00	5:20	5:55	5:20	5:55	4:50	5:50	6:35	6:45	6:40	R13 N
1,8	R14	4:10	4:10	4:10	4:15	4:10	4:10	4:20	4:10	4:10	4:15	4:35	4:05	5:15	5:15	R14

Table J-2. Description of Evacuation Regions									
Region	**Description**	**ZONE**							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
R01	2-Mile Ring	**X**							
R02	5-Mile Ring	**X**	**X**	**X**					
R03	Full EPZ	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Evacuate 2-Mile Ring and 5 Miles Downwind									
Region	**Wind Direction Towards:**	**ZONE**							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	N, NNE, NE, ENE, E	**See Region 1**							
R04	ESE, SE, SSE, S	**X**		**X**					
	SSW, SW, WSW	**See Region 2**							
R05	W, WNW, NW, NNW	**X**	**X**						
Evacuate 5-Mile Ring and Downwind to EPZ Boundary									
Region	**Wind Direction Towards:**	**ZONE**							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	NNE	**See Region 2**							
R06	NE, ENE, E, ESE, SE	**X**	**X**	**X**					**X**
R07	SSE, S	**X**	**X**	**X**				**X**	
R08	SSW, SW	**X**	**X**	**X**			**X**	**X**	
R09	WSW	**X**	**X**	**X**	**X**		**X**	**X**	
R10	W	**X**	**X**	**X**	**X**		**X**		
R11	WNW	**X**	**X**	**X**	**X**	**X**	**X**		
R12	NW, NNW	**X**	**X**	**X**	**X**	**X**			
R13	N	**X**	**X**	**X**		**X**			
R14	*	**X**							**X**

*This Region was added at Constellation Energy's request. It is an evacuation of the 2-Mile Ring and downwind (Towards Dorchester County) to the EPZ Boundary.

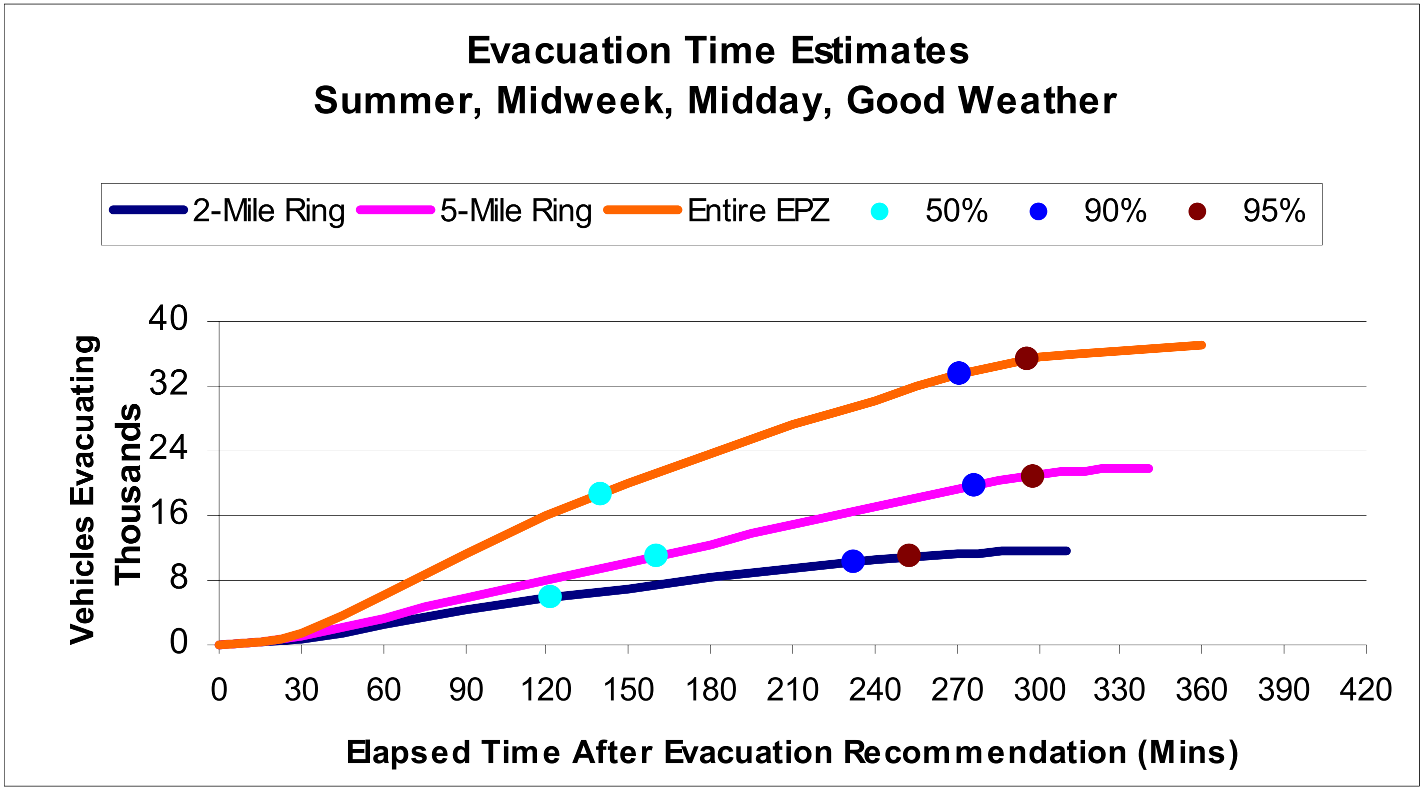


Figure J-1. Evacuation Time Estimates – Scenario 1 for Region R03 (Entire EPZ)

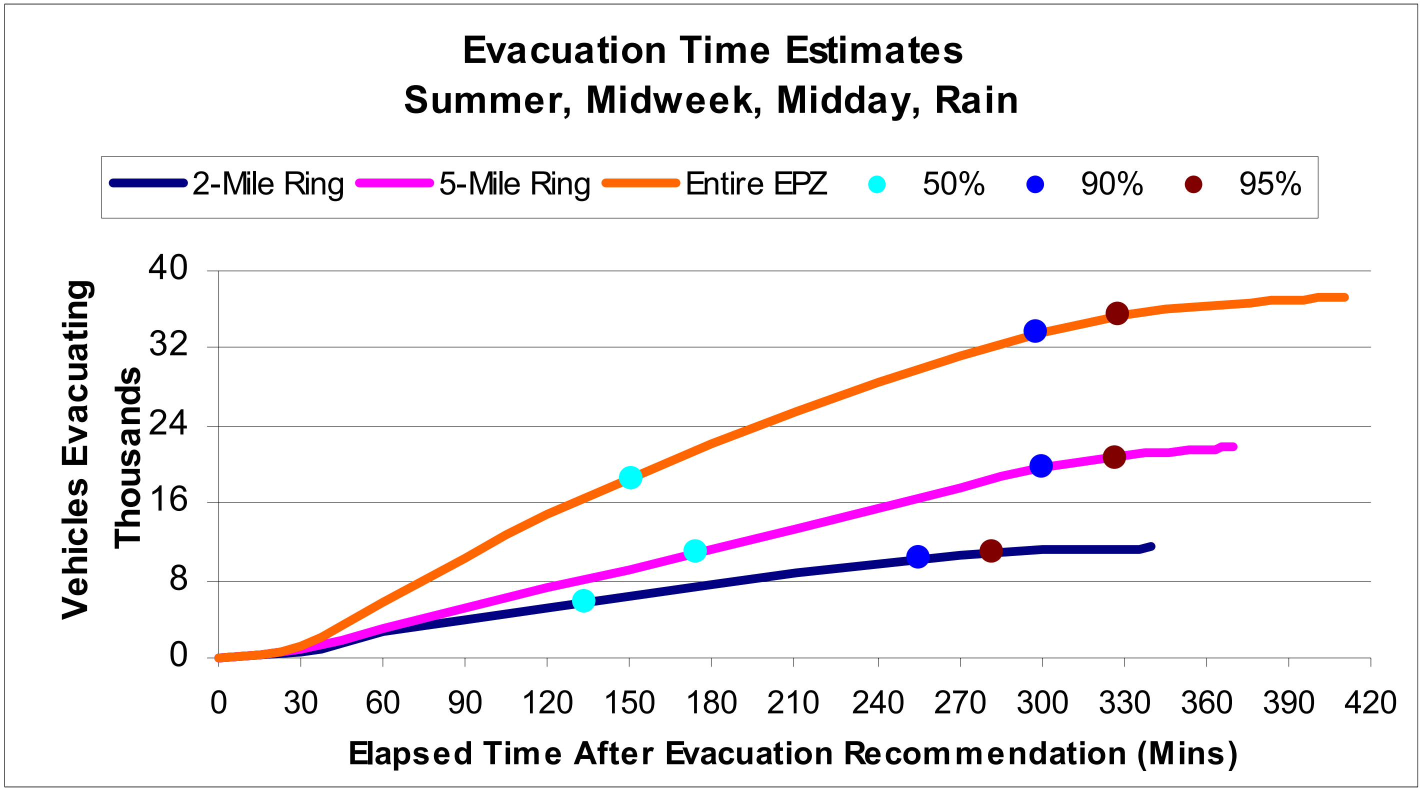


Figure J-2. Evacuation Time Estimates – Scenario 2 for Region R03 (Entire EPZ)

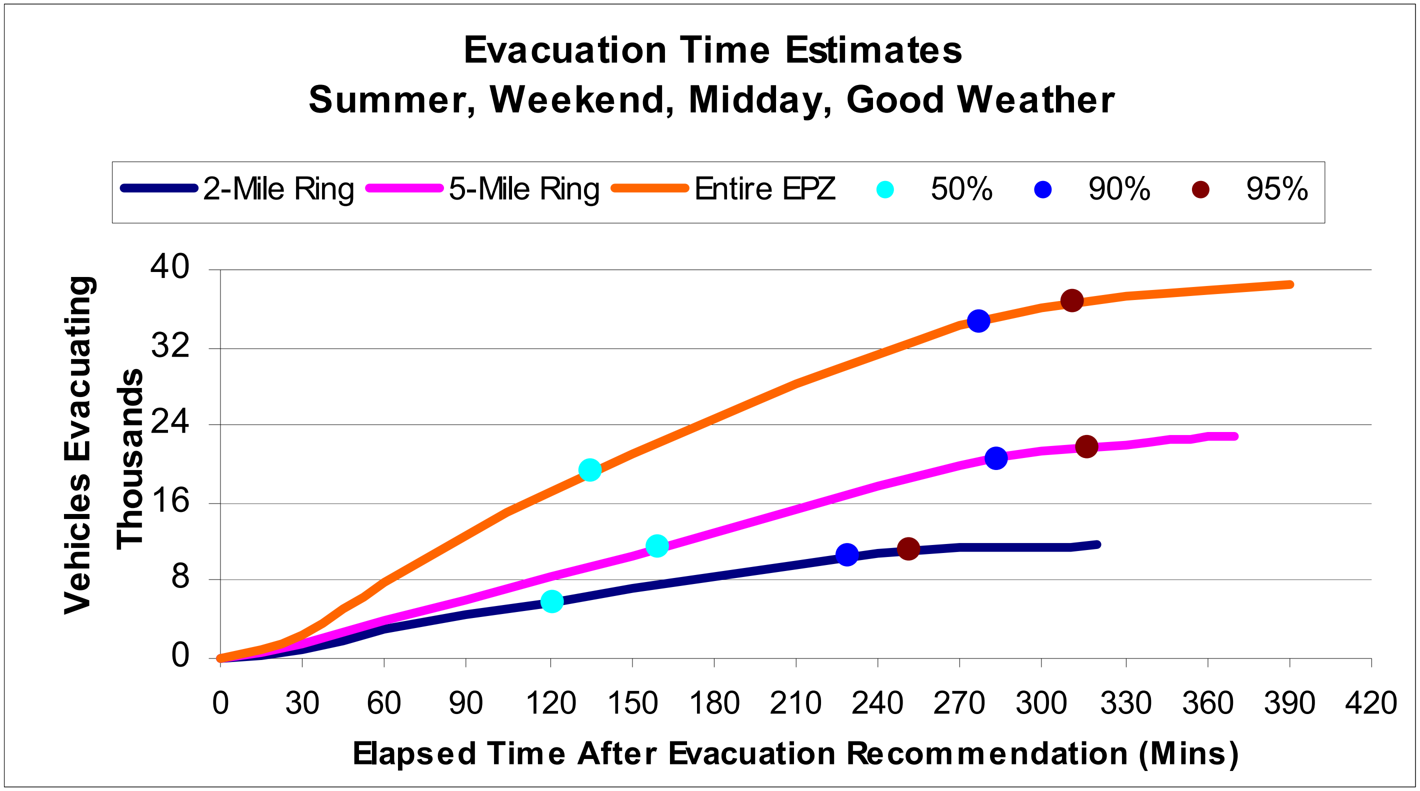


Figure J-3. Evacuation Time Estimates – Scenario 3 for Region R03 (Entire EPZ)

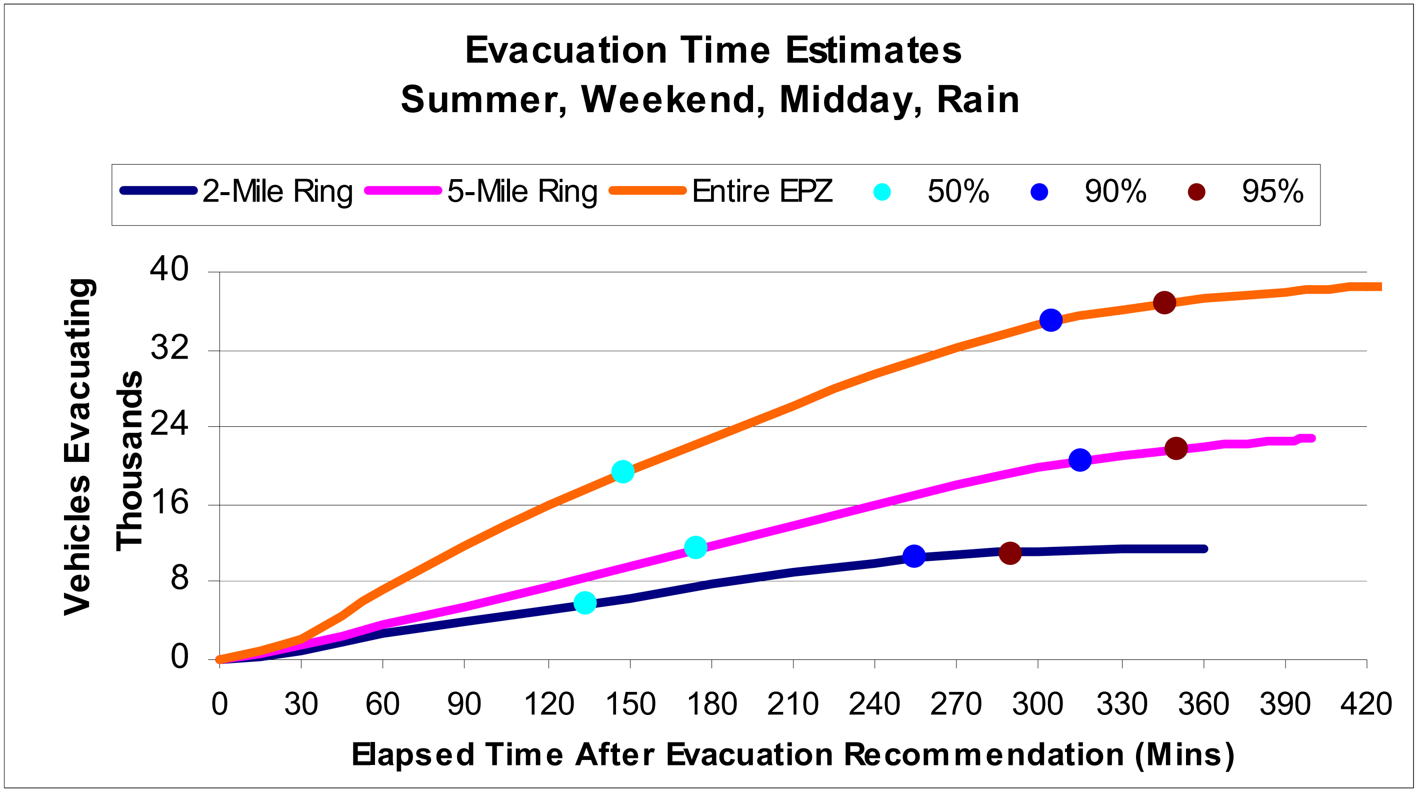


Figure J-4. Evacuation Time Estimates – Scenario 4 for Region R03 (Entire EPZ)

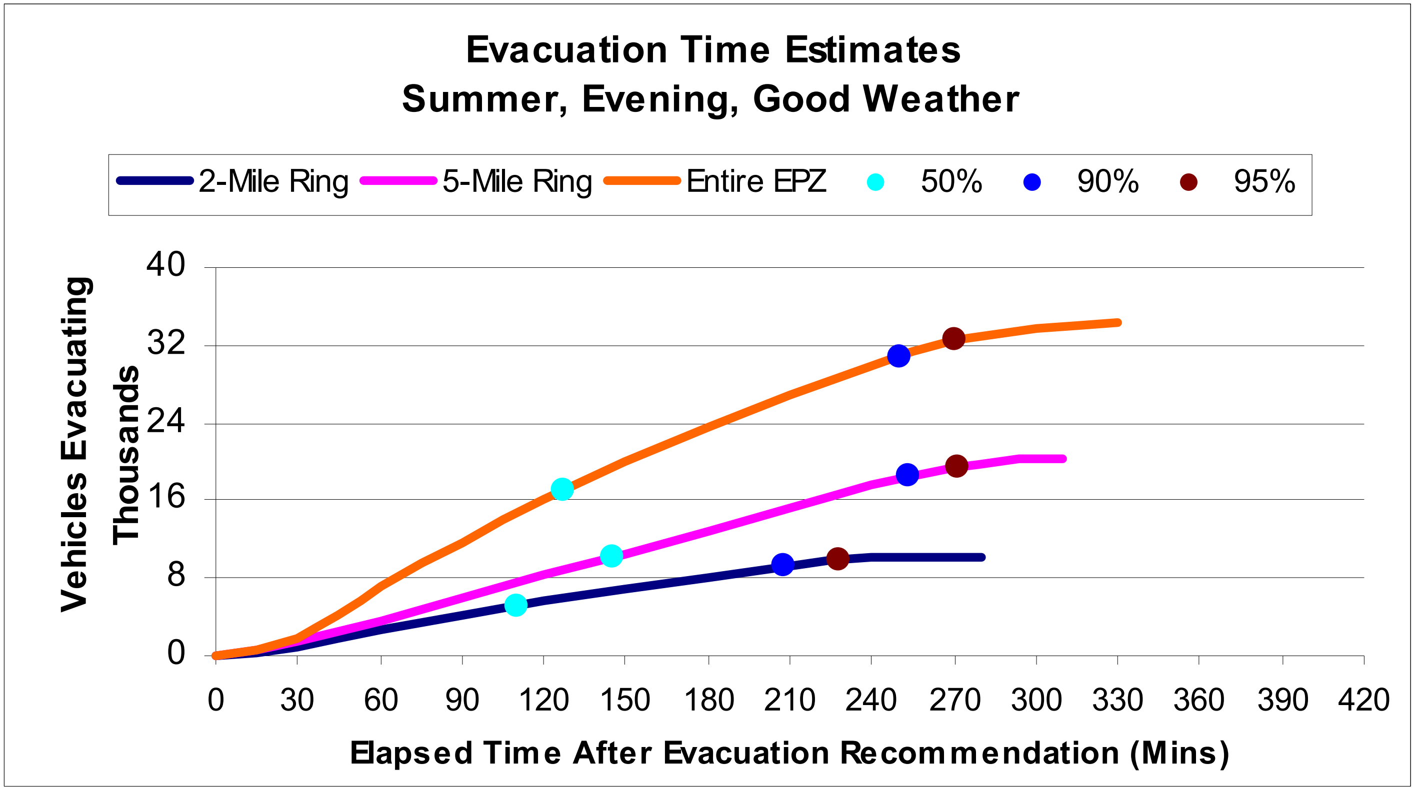


Figure J-5. Evacuation Time Estimates – Scenario 5 for Region R03 (Entire EPZ)

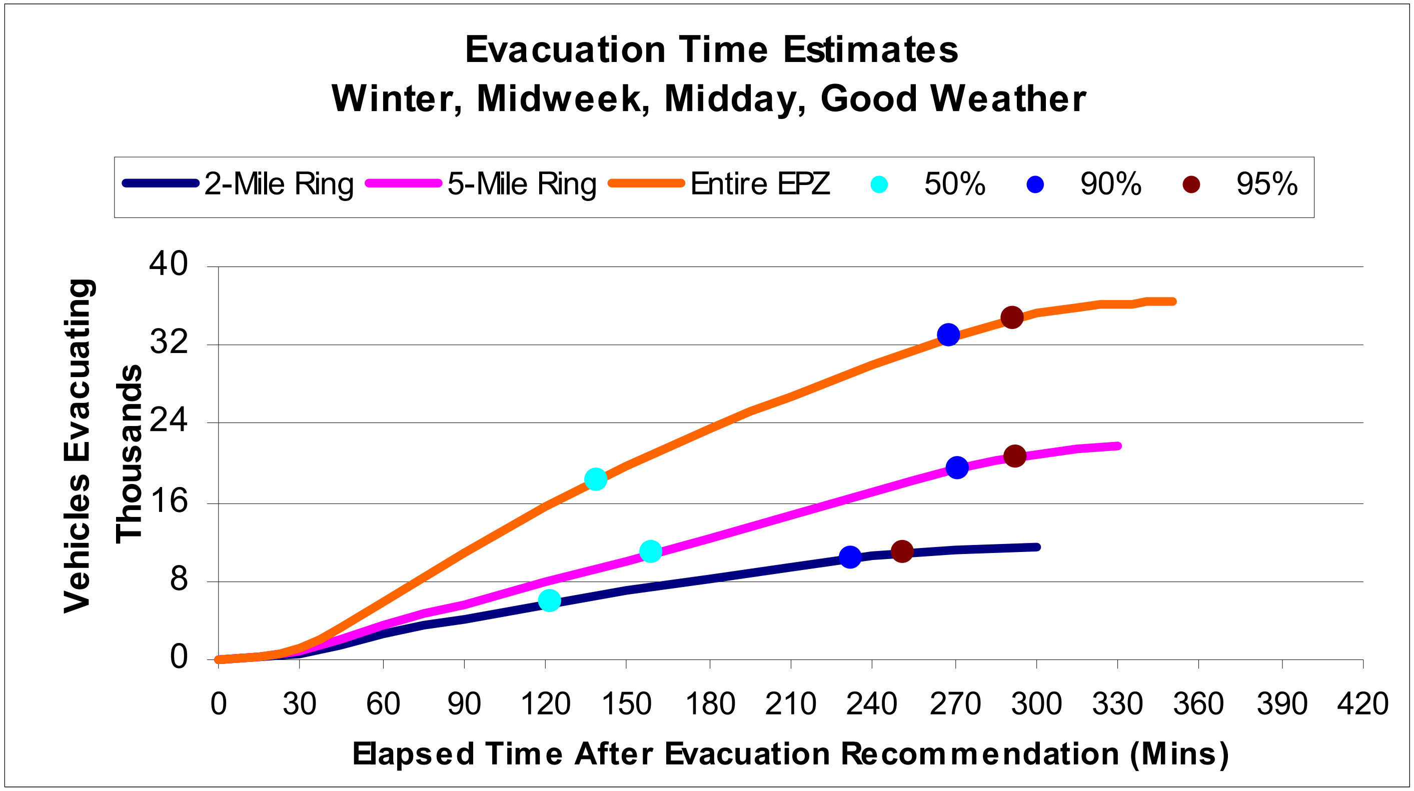


Figure J-6. Evacuation Time Estimates – Scenario 6 for Region R03 (Entire EPZ)

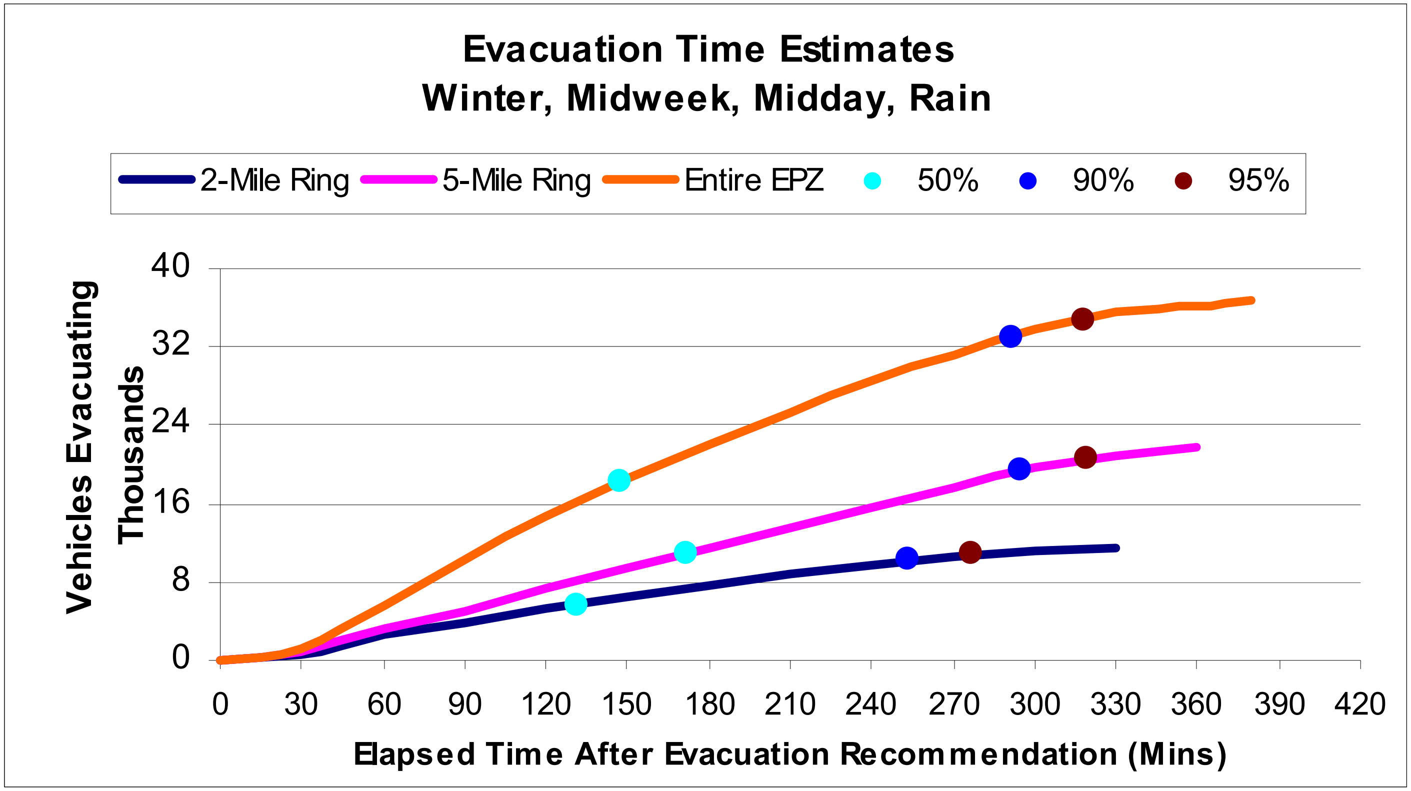


Figure J-7. Evacuation Time Estimates – Scenario 7 for Region R03 (Entire EPZ)

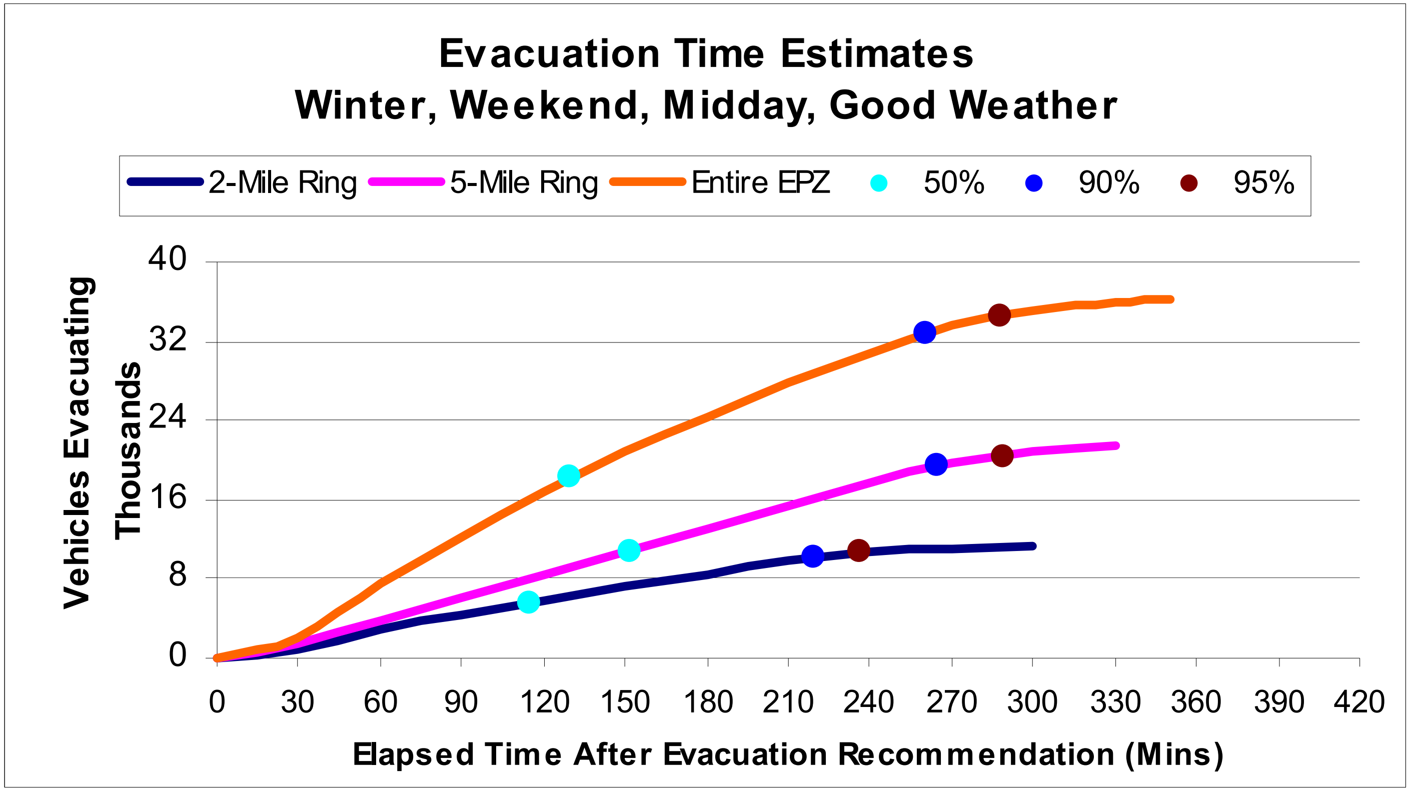


Figure J-8. Evacuation Time Estimates – Scenario 8 for Region R03 (Entire EPZ)

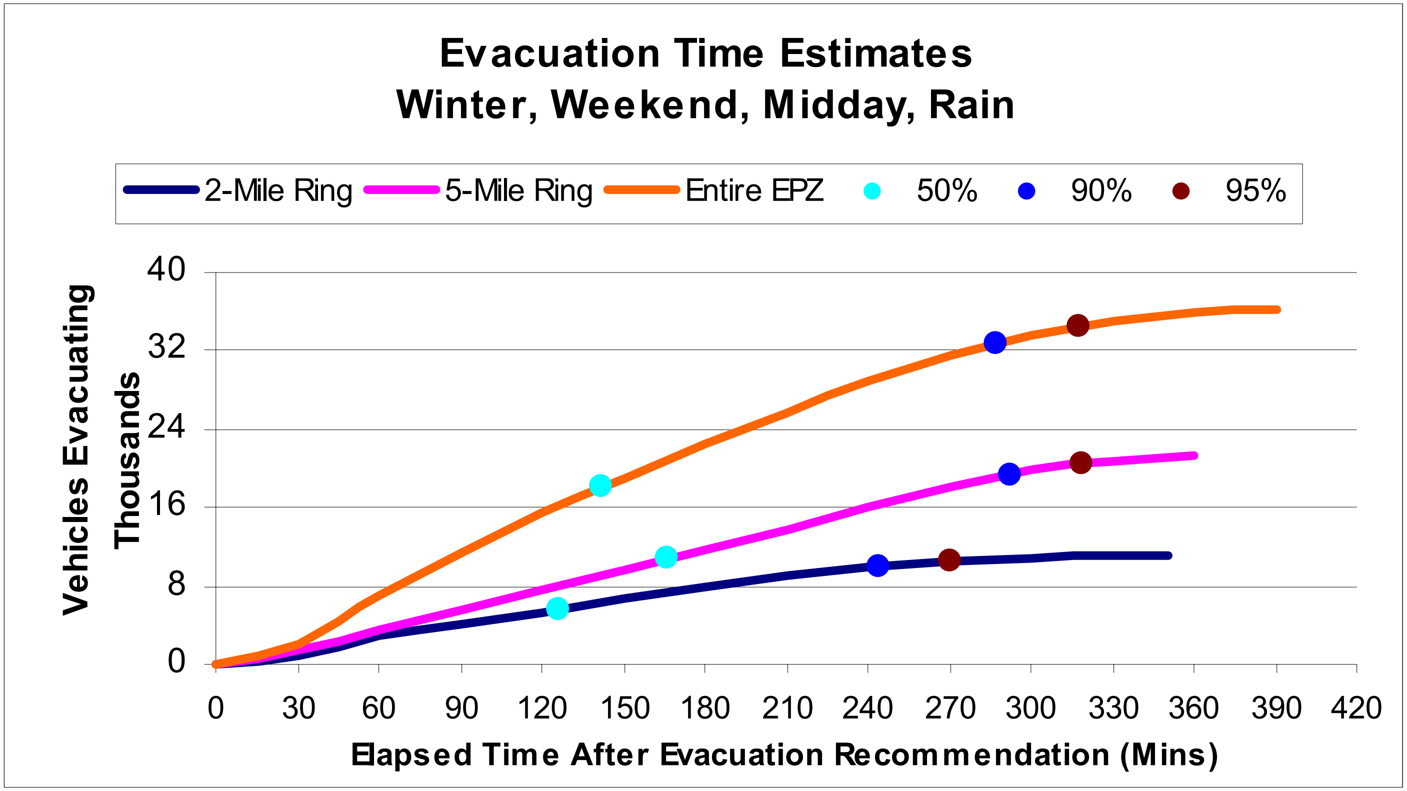


Figure J-9. Evacuation Time Estimates – Scenario 9 for Region R03 (Entire EPZ)

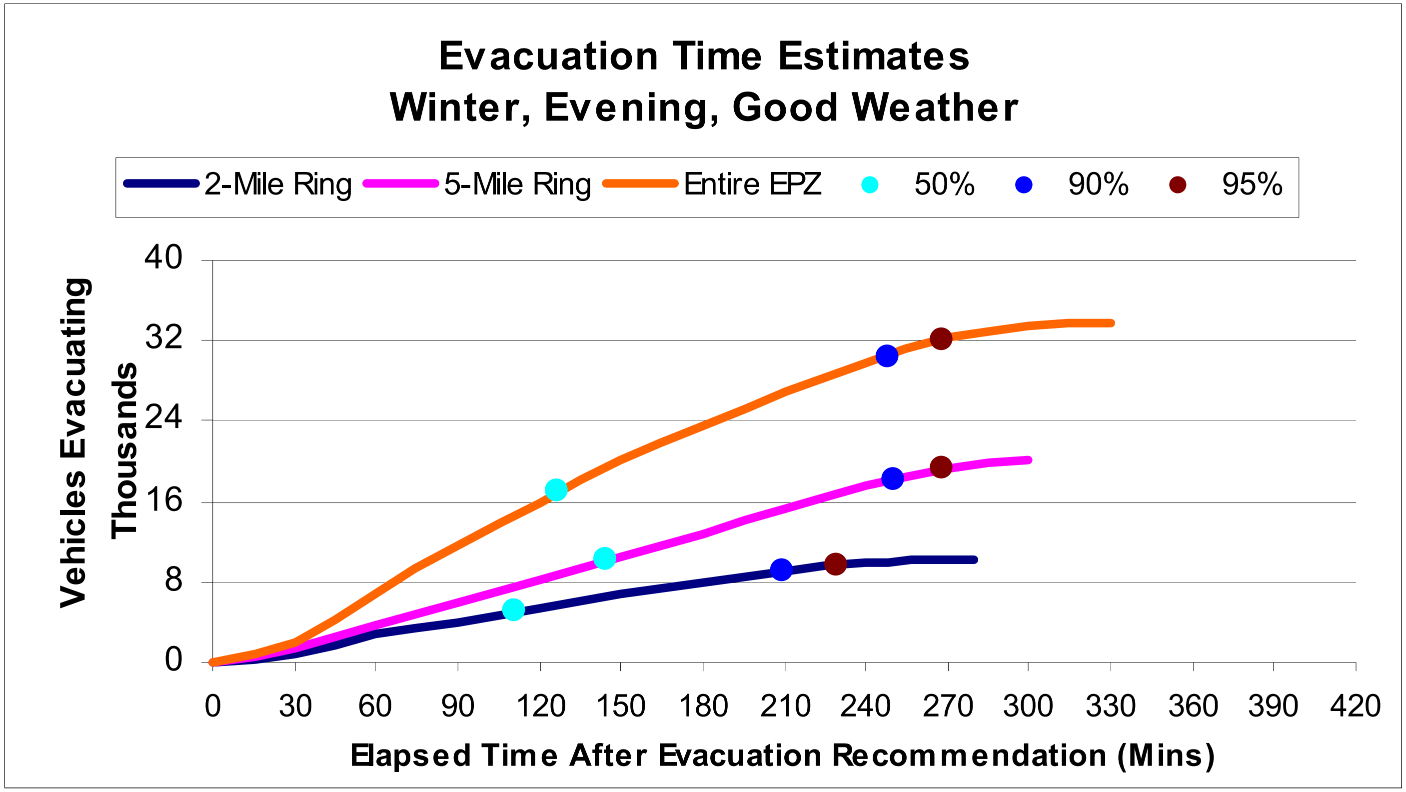


Figure J-10. Evacuation Time Estimates – Scenario 10 for Region R03 (Entire EPZ)

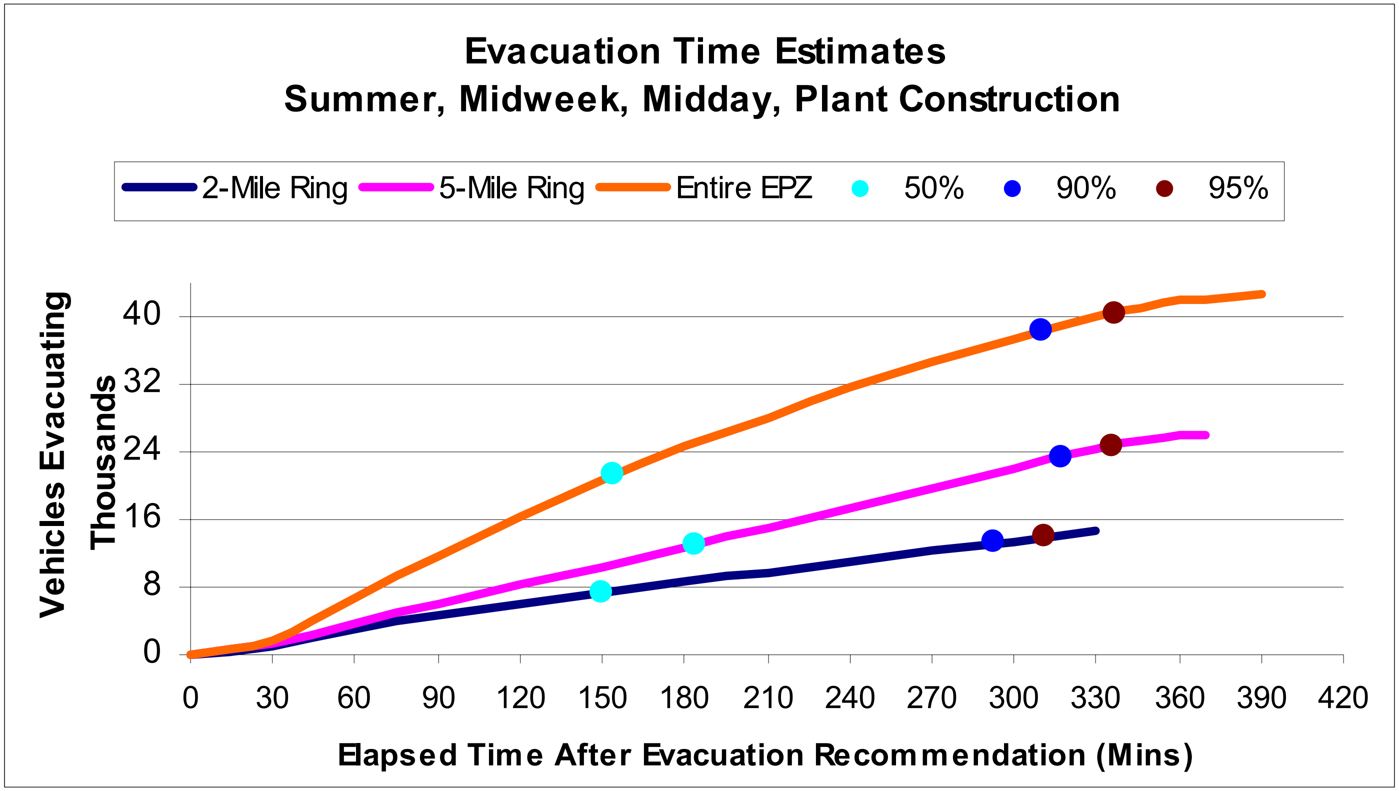


Figure J-11. Evacuation Time Estimates – Scenario 11 for Region R03 (Entire EPZ)

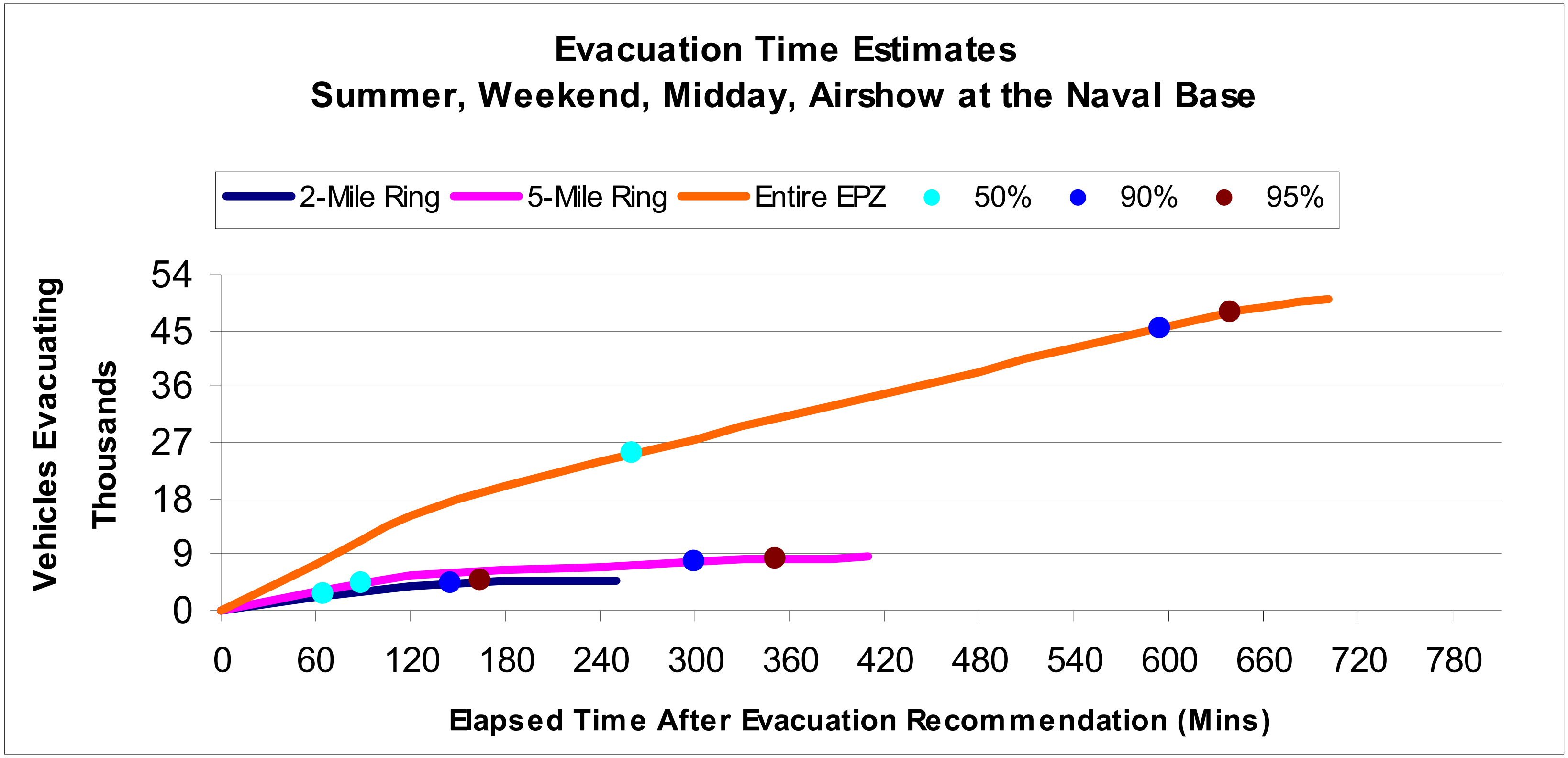


Figure J-12. Evacuation Time Estimates – Scenario 12 for Region R03 (Entire EPZ)

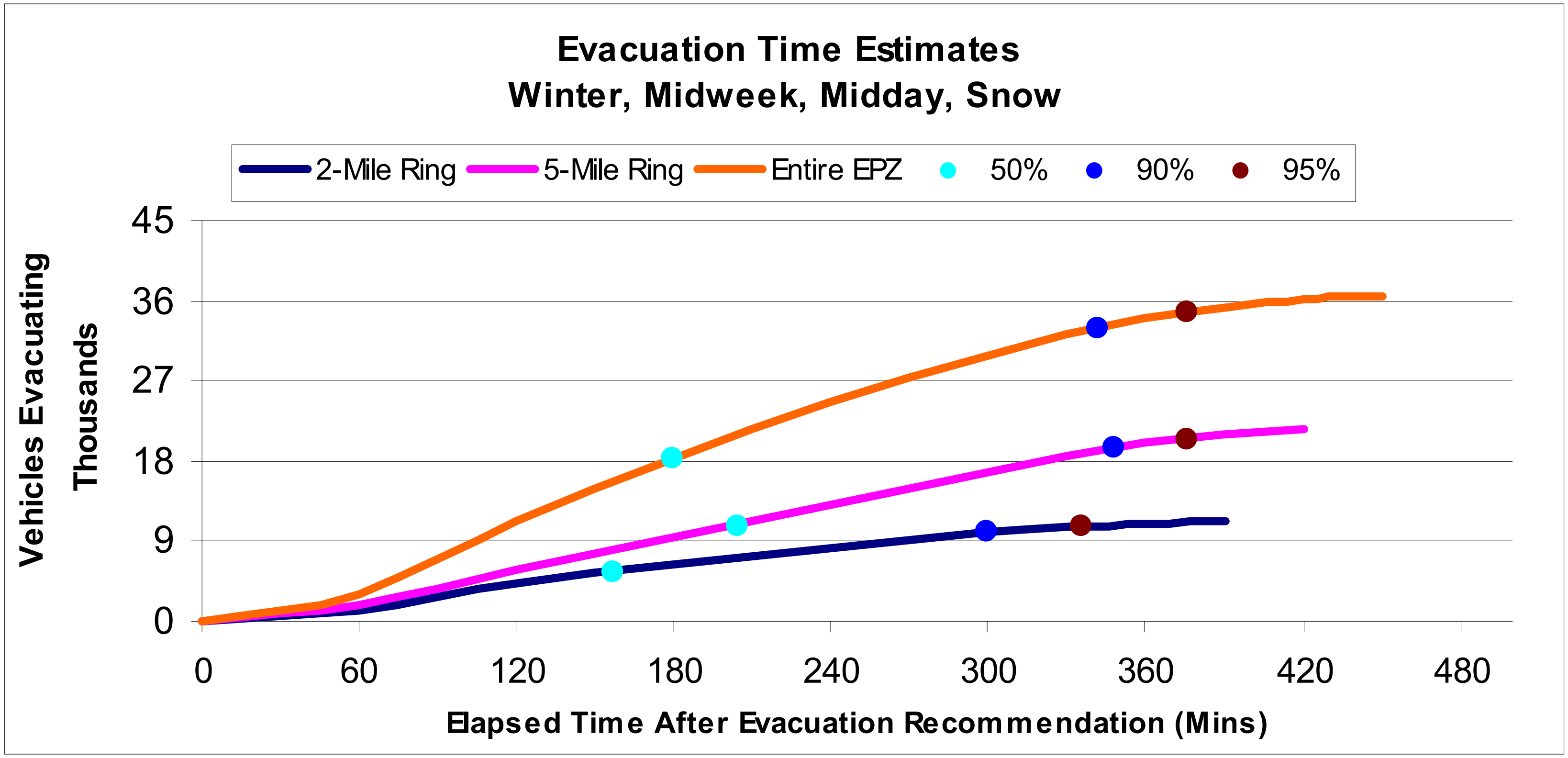


Figure J-13. Evacuation Time Estimates – Scenario 13 for Region R03 (Entire EPZ)

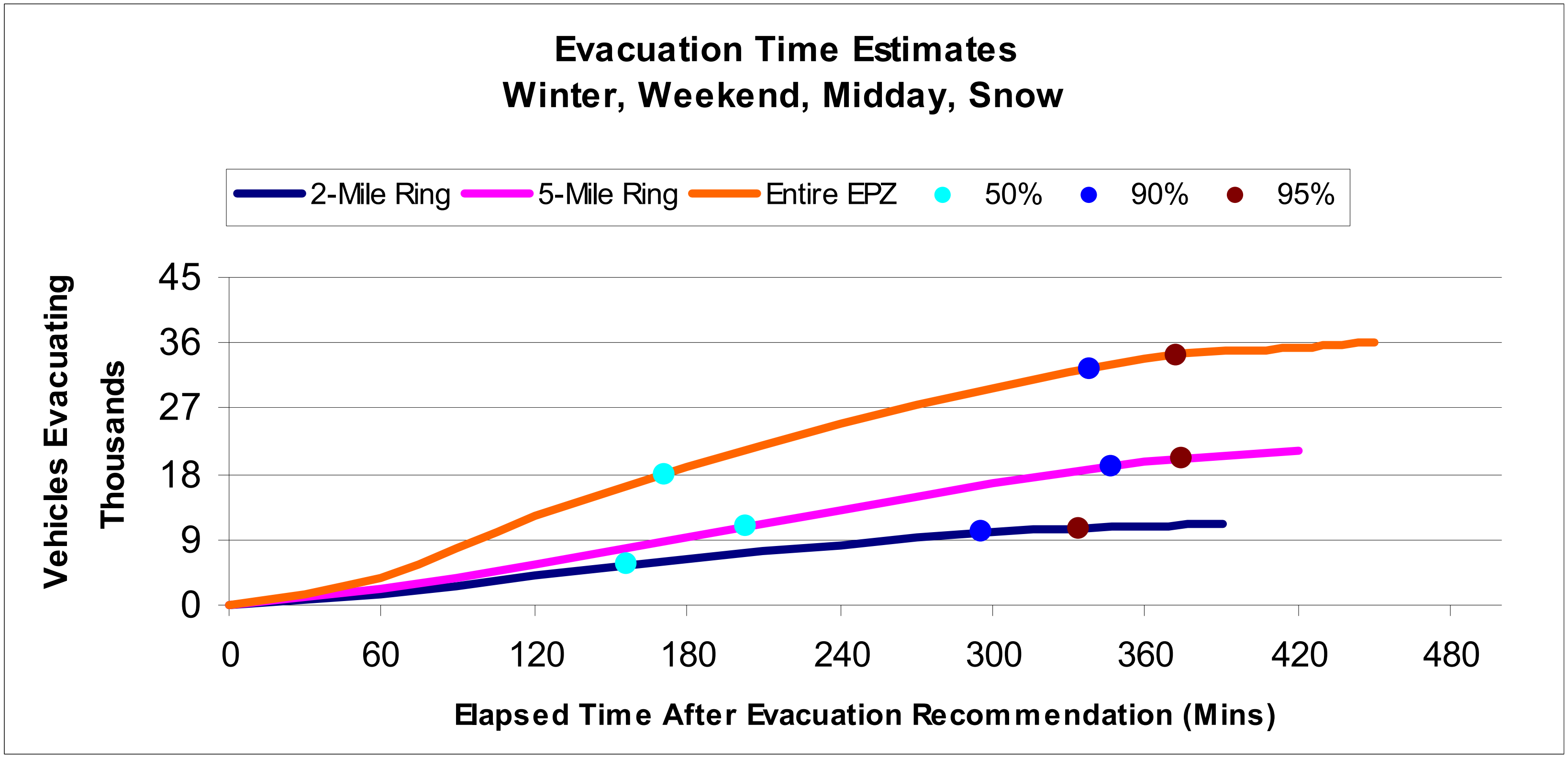


Figure J-14. Evacuation Time Estimates – Scenario 14 for Region R03 (Entire EPZ)

APPENDIX K

Evacuation Roadway Network

As discussed in Section 1.3, a computerized link-node analysis network was constructed to model the evacuation roadway network within the study area. Figure K-1 provides an overview of the link-node analysis network. The figure has been divided up into 13 more detailed figures (Figures K-2 through K-14) which show each of the links and nodes in the network.

The analysis network was calibrated using the observations made during the field survey conducted in June 2007. 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 Figures K-1 through K-14 to identify the geographic location of each link.

Entry and exit nodes are always identified with a number between 8000 and 8999. These are not included in Table K-1. The CCNPP network has 150 such nodes in addition to the 422 “internal” nodes (connecting two or more links).

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
1	34	213	2	1900	55
1	102	16	2	1900	55
1	103	31	1	1700	55
2	56	15	3	1900	50
2	57	16	2	1800	40
3	336	12	3	1900	55
3	337	20	3	1900	55
4	3	58	2	1900	55
4	165	52	2	1900	55
5	6	124	2	1900	55
5	167	57	2	1900	55
6	5	124	2	1900	55
6	7	46	2	1900	55
7	6	46	2	1900	55
7	8	108	2	1900	55
8	7	108	2	1900	55
8	491	17	3	1900	55
9	486	28	2	1900	55
9	492	10	3	1900	55
10	487	84	2	1900	55
11	12	28	1	1700	40
11	203	29	1	1700	50
12	11	28	1	1700	40
12	13	90	1	1700	40
13	12	90	1	1700	40
13	224	55	1	1700	40
14	15	90	1	1700	40
14	224	63	1	1700	40
15	14	90	1	1700	40
15	16	58	1	1700	40
16	15	58	2	1900	40
16	45	35	3	1900	50
16	67	28	2	1900	30
16	68	29	3	1900	55
17	158	55	2	1900	55
17	159	37	2	1900	55
18	158	41	2	1900	55
18	384	86	2	1900	55
19	338	73	2	1900	55
19	384	74	2	1900	55
20	335	61	2	1900	30
20	338	81	2	1900	55
21	22	46	2	1900	55
21	335	45	2	1900	30
22	21	46	2	1900	55

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
22	339	18	4	1900	55
23	22	151	2	1900	55
23	25	73	2	1900	55
24	26	49	2	1900	55
24	92	50	1	1700	50
24	148	31	1	1700	30
24	340	32	2	1900	55
25	23	73	2	1900	55
25	149	128	1	1700	30
25	340	121	2	1900	55
26	24	49	2	1900	55
26	342	21	2	1900	55
27	28	41	2	1900	30
27	441	33	2	1900	55
28	27	41	2	1900	55
28	38	36	2	1900	55
29	115	40	2	1900	55
29	441	107	2	1900	55
30	31	94	1	1700	30
31	32	172	1	1700	30
31	117	16	1	1700	30
32	118	60	1	1700	30
33	34	97	2	1900	55
33	118	20	2	1900	55
34	1	213	2	1900	55
34	33	97	2	1900	55
35	29	19	2	1800	40
36	28	28	1	1700	30
37	28	79	1	1700	30
38	28	36	2	1900	30
38	39	28	2	1900	55
39	38	28	2	1900	55
39	342	30	2	1900	55
43	342	65	1	1800	45
45	16	35	3	1900	50
45	46	42	3	1900	50
46	45	42	3	1900	50
46	47	31	3	1900	50
47	46	31	3	1900	50
47	48	18	3	1900	50
48	47	18	3	1900	50
48	231	11	3	1900	50
49	50	53	3	1900	50
49	231	30	3	1900	50
49	233	19	2	1900	30

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
50	49	53	3	1900	50
50	242	40	3	1900	50
51	53	15	3	1900	50
51	248	22	3	1900	50
52	53	13	3	1900	50
52	244	70	3	1900	50
53	51	15	3	1900	50
53	52	13	3	1900	50
54	55	18	3	1900	50
54	248	11	3	1900	50
55	54	18	3	1900	50
55	56	28	3	1900	50
56	2	15	2	1900	50
56	55	28	3	1900	50
56	57	14	2	1700	30
57	58	22	2	1800	40
58	59	16	2	1800	40
59	60	20	2	1800	40
60	276	44	2	1800	40
61	62	40	2	1800	40
62	63	16	2	1800	40
63	282	22	2	1800	40
64	65	29	1	1700	30
65	288	118	1	1700	40
66	297	186	1	1700	40
67	293	44	1	1700	30
68	16	29	3	1900	50
68	69	36	2	1900	50
69	68	36	2	1900	55
69	70	36	2	1900	50
70	69	36	2	1900	50
70	431	80	2	1900	50
71	301	123	1	1700	40
71	309	9	2	1900	55
71	316	62	2	1900	50
72	315	115	1	1700	40
73	74	75	2	1900	50
73	325	79	2	1900	50
74	73	75	2	1900	50
74	328	203	1	1700	50
74	330	42	2	1900	50
75	76	138	2	1900	50
75	330	217	2	1900	50
76	75	138	2	1900	50
76	333	196	2	1900	50

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
77	78	106	1	1700	50
78	367	64	1	1700	50
80	292	111	1	1700	30
80	329	161	1	1700	50
81	80	32	2	1800	50
82	81	44	2	1800	50
83	82	137	2	1800	50
83	298	40	2	1700	40
84	85	242	1	1700	40
85	86	148	2	1900	50
85	333	251	2	1700	50
85	334	84	1	1700	40
86	85	148	2	1900	50
86	87	39	2	1900	50
87	86	39	2	1900	50
87	88	48	2	1900	50
88	87	48	2	1900	50
88	354	62	2	1900	50
89	221	194	1	1700	55
89	349	11	1	1900	50
89	350	15	1	1700	50
90	135	113	1	1700	55
90	391	105	1	1700	50
91	389	49	1	1700	40
92	24	50	1	1700	40
92	390	67	1	1700	50
93	94	63	1	1700	50
93	130	38	1	1700	50
94	93	63	1	1700	50
95	96	71	2	1900	55
95	102	109	2	1900	55
96	95	71	2	1900	55
98	99	97	1	1700	30
99	100	109	1	1700	30
100	101	39	1	1700	30
101	102	49	1	1700	40
102	1	16	3	1900	55
102	95	109	2	1900	55
103	1	31	2	1900	50
103	102	29	1	1700	40
103	130	31	1	1700	50
105	106	90	1	1700	30
106	99	68	1	1700	30
107	32	78	1	1700	30
107	108	125	1	1700	30

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
108	109	89	1	1700	30
109	100	40	1	1700	30
110	107	112	1	1700	30
111	107	97	1	1700	30
115	29	40	2	1900	55
115	119	71	2	1900	55
116	117	105	1	1700	30
117	119	102	1	1700	30
118	33	20	2	1900	55
118	346	64	2	1900	55
119	115	71	2	1900	55
119	346	47	2	1900	55
120	346	48	1	1700	30
121	35	169	1	1700	40
121	347	107	1	1700	30
122	121	121	1	1700	40
123	122	81	1	1700	40
123	125	63	1	1700	30
124	123	155	1	1700	40
125	128	107	1	1700	30
125	132	215	1	1700	40
126	34	57	1	1700	30
128	126	179	1	1700	30
128	129	209	1	1700	30
129	130	135	1	1700	40
130	93	38	1	1700	50
130	103	31	2	1900	55
131	93	57	1	1700	50
132	133	160	1	1700	40
134	37	131	1	1700	30
135	90	113	1	1700	50
135	420	83	1	1700	55
136	43	128	1	1700	45
137	438	98	1	1700	40
138	23	162	1	1700	50
139	150	35	1	1700	30
140	139	93	1	1700	30
141	139	80	1	1700	30
142	22	127	1	1700	40
143	18	134	1	1700	30
143	379	263	1	1700	40
144	380	108	1	1700	40
146	143	285	1	1700	40
147	19	88	1	1700	30
148	24	31	1	1700	40

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
148	26	28	1	1700	30
149	148	41	1	1700	30
149	340	28	1	1700	30
150	21	10	1	1700	40
150	22	53	1	1700	40
151	150	46	1	1700	40
151	335	11	1	1700	30
152	20	12	1	1700	40
152	151	62	1	1700	40
153	19	39	1	1700	30
153	152	135	1	1700	40
154	151	72	1	1700	30
155	152	52	1	1700	40
156	153	43	1	1700	30
157	153	106	1	1700	30
158	17	55	2	1900	55
158	18	41	2	1900	55
158	157	97	1	1700	40
159	3	71	2	1900	55
159	17	37	2	1900	55
161	3	76	1	1700	30
162	163	33	1	1700	40
163	159	9	1	1700	40
164	159	59	1	1700	40
165	4	52	2	1900	55
165	167	19	2	1900	55
166	165	51	2	1700	30
167	5	57	2	1900	55
167	165	19	2	1900	55
169	4	46	2	1700	30
171	5	23	1	1700	30
173	171	99	1	1700	30
174	7	30	1	1700	30
174	175	155	1	1700	30
174	178	34	1	1700	30
175	5	43	1	1700	30
176	8	23	2	1700	40
176	184	124	1	1700	40
176	490	37	1	1700	40
177	187	10	1	1700	30
178	177	54	1	1700	30
179	174	113	1	1700	30
180	188	10	1	1700	30
182	183	95	1	1700	40
183	193	37	1	1700	50

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
184	176	124	1	1700	40
184	481	3	1	1700	40
185	184	99	1	1700	40
187	493	31	1	1700	30
188	187	13	1	1700	30
189	188	7	1	1700	30
190	180	17	1	1700	30
191	179	85	1	1700	30
192	179	112	1	1700	30
193	184	69	1	1700	50
194	193	37	1	1700	30
195	202	30	1	1700	40
196	10	14	2	1900	55
196	198	18	2	1900	50
197	198	23	2	1900	50
197	203	51	2	1900	50
198	196	18	2	1900	50
198	197	23	2	1900	50
199	200	69	1	1700	40
200	201	62	1	1700	40
201	202	21	1	1700	40
202	198	4	2	1800	40
203	11	29	1	1700	40
203	197	51	2	1900	50
204	195	23	1	1700	40
205	9	9	2	1700	30
206	214	183	1	1700	30
206	215	196	1	1700	30
207	206	196	1	1700	30
207	208	305	1	1700	30
208	209	361	1	1700	30
209	210	202	1	1700	30
210	450	163	1	1700	30
211	209	131	1	1700	30
212	207	160	1	1700	30
213	212	104	1	1700	30
216	212	217	1	1700	30
217	220	105	1	1700	55
217	423	78	1	1700	55
218	220	154	1	1700	55
218	221	83	1	1700	55
220	217	105	1	1700	55
220	218	154	1	1700	55
221	89	194	1	1700	50
221	218	83	1	1700	55

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
221	348	139	1	1700	30
223	45	21	2	1700	30
224	13	55	1	1700	40
224	14	63	1	1700	40
225	224	23	1	1700	30
226	46	41	2	1700	30
227	46	29	2	1700	30
228	48	26	1	1700	30
229	228	55	1	1700	30
230	229	44	1	1700	30
231	48	11	3	1900	50
231	49	30	3	1900	50
232	231	16	1	1700	30
233	234	76	1	1700	30
234	237	108	1	1700	30
235	62	25	2	1700	30
236	235	33	1	1700	30
237	236	33	1	1700	30
238	49	23	2	1900	30
239	50	14	2	1700	30
240	50	43	2	1900	30
241	240	43	1	1700	30
242	50	40	3	1900	50
242	244	10	3	1900	50
243	242	41	1	1700	30
244	52	70	3	1900	50
244	242	10	3	1900	50
245	244	16	1	1700	30
246	51	33	2	1700	30
247	51	13	2	1700	30
248	51	22	3	1900	50
248	54	11	3	1900	50
249	248	17	1	1700	30
250	264	63	1	1700	30
250	265	68	2	1900	50
251	252	88	1	1700	50
252	257	66	1	1700	50
253	252	24	1	1700	30
254	255	85	1	1700	30
255	256	55	1	1700	30
256	258	136	1	1700	30
257	256	114	1	1700	30
257	261	122	1	1700	50
258	270	40	1	1700	30
259	260	64	1	1700	30

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
260	285	75	1	1700	30
261	250	100	2	1900	50
262	250	39	1	1700	30
263	258	78	1	1700	30
264	263	106	1	1700	30
265	2	135	2	1900	50
266	265	24	1	1700	30
267	2	11	2	1900	30
268	267	31	1	1700	30
269	267	17	2	1900	30
270	259	65	1	1700	30
271	270	59	1	1700	30
272	271	77	1	1700	30
273	57	35	1	1700	30
274	58	25	1	1700	30
275	60	10	1	1700	30
276	278	16	2	1800	40
277	276	18	2	1700	30
278	61	54	2	1800	40
279	61	37	2	1700	30
280	62	5	2	1700	30
281	63	7	2	1700	30
282	64	57	2	1800	40
283	282	14	1	1700	30
284	285	15	1	1700	30
285	64	24	1	1700	30
286	65	64	1	1700	30
287	65	75	1	1700	30
288	289	146	1	1700	40
288	366	157	1	1700	30
289	290	278	1	1700	45
290	291	251	1	1700	40
291	83	115	1	1700	30
291	298	95	1	1700	30
293	66	178	1	1700	40
294	293	48	1	1700	30
295	69	35	2	1700	30
295	294	42	1	1700	30
296	66	78	1	1700	40
297	291	155	1	1700	40
298	83	40	2	1700	40
299	83	174	1	1700	40
300	299	40	1	1700	40
301	300	179	1	1700	40
302	299	135	1	1700	30

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
303	300	48	1	1700	30
304	70	27	1	1700	30
305	307	55	1	1700	30
306	305	42	1	1700	30
307	310	80	1	1700	30
308	307	49	1	1700	30
309	71	9	2	1900	55
309	312	94	2	1900	50
310	475	80	1	1700	30
311	310	44	1	1700	30
312	309	94	2	1900	55
312	431	124	2	1900	50
313	312	32	1	1700	30
314	313	26	1	1700	30
315	480	79	1	1700	40
316	71	62	2	1900	55
316	318	114	2	1900	50
317	316	107	1	1700	30
318	316	114	2	1900	50
318	319	126	2	1900	50
319	318	126	2	1900	50
319	322	58	1	1700	30
319	325	128	2	1900	50
320	73	103	1	1700	40
321	319	58	1	1700	30
322	323	143	1	1700	30
323	302	117	1	1700	30
324	318	89	1	1700	30
325	73	79	2	1900	50
325	319	128	2	1900	50
325	327	169	1	1700	30
327	328	190	1	1700	30
328	77	68	1	1700	50
328	78	96	1	1700	30
329	77	202	1	1700	50
330	74	42	2	1900	50
330	75	217	2	1900	50
331	330	42	1	1700	30
332	84	146	1	1700	40
333	76	196	2	1900	50
333	85	251	2	1900	50
335	20	61	2	1900	55
335	21	45	2	1900	55
336	159	59	2	1900	55
337	4	38	2	1900	55

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
338	19	73	2	1900	55
338	20	81	2	1900	55
339	436	35	2	1900	55
340	24	32	2	1900	55
340	25	121	2	1900	55
341	91	116	1	1700	30
342	26	21	2	1900	55
342	39	30	2	1900	55
343	39	25	1	1700	30
344	38	16	1	1700	30
345	115	23	1	1700	30
346	118	64	2	1900	30
346	119	47	2	1900	55
347	118	103	1	1700	30
349	350	10	1	1700	50
349	351	18	2	1900	50
349	352	14	2	1900	50
350	89	15	1	1700	50
350	351	14	1	1700	50
350	353	11	1	1700	50
351	89	11	1	1700	50
351	349	18	2	1900	50
351	354	114	2	1900	50
352	349	14	2	1900	50
353	350	11	1	1700	50
354	88	62	2	1900	50
354	351	114	2	1900	50
355	88	25	1	1700	30
356	87	28	1	1700	30
357	87	27	1	1700	30
358	86	13	1	1700	30
359	86	22	1	1700	30
360	359	69	1	1700	30
361	360	139	1	1700	30
362	333	29	1	1700	30
363	76	87	1	1700	30
364	75	65	1	1700	30
365	331	77	1	1700	30
368	67	11	1	1700	30
369	47	4	2	1900	30
370	52	11	2	1700	30
371	53	6	2	1700	30
372	54	15	2	1700	30
373	55	4	2	1700	30
374	375	181	1	1700	30

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
376	156	42	1	1700	30
377	376	59	1	1700	30
378	156	89	1	1700	30
379	142	85	1	1700	40
380	379	140	1	1700	50
381	382	44	1	1700	40
382	144	141	1	1700	40
383	338	11	1	1700	30
384	18	86	2	1900	55
384	19	74	2	1900	55
385	384	17	1	1700	30
386	91	27	1	1700	30
387	91	25	1	1700	30
388	341	49	1	1700	30
389	90	63	1	1700	40
390	92	67	1	1700	50
390	391	63	1	1700	50
391	90	105	1	1700	50
391	390	63	1	1700	50
400	173	93	1	1700	30
401	205	79	1	1700	30
402	205	26	1	1700	30
405	198	11	1	1700	30
406	197	7	1	1700	30
407	182	46	1	1700	40
409	191	51	1	1700	30
410	320	61	1	1700	40
411	325	50	1	1700	30
415	72	101	1	1700	40
420	135	83	1	1700	55
420	423	132	1	1700	55
421	420	28	1	1700	30
422	135	30	1	1700	30
423	217	78	1	1700	55
423	420	132	1	1700	55
424	423	36	1	1700	30
425	135	30	1	1700	30
426	217	34	1	1700	30
430	75	31	1	1700	30
431	70	80	2	1900	50
431	312	124	2	1900	50
432	431	37	1	1700	30
433	276	15	1	1700	30
434	278	20	1	1700	30
435	59	13	1	1700	30

Upstream Node Number	Downstream Node Number	Length (miles * 100)	Full Lanes	Saturation Flow Rate (Veh/hr/ln)	Free Flow Speed (MPH)
436	23	98	2	1900	55
437	436	22	1	1700	30
438	136	90	1	1700	40
439	125	64	1	1700	30
440	27	26	1	1700	30
441	27	33	2	1900	55
441	29	107	2	1900	55
442	441	34	1	1700	30
443	92	26	1	1700	30
444	92	30	1	1700	30
445	390	40	1	1700	30
446	391	28	1	1700	30
447	391	28	1	1700	30
450	451	149	1	1700	30
475	309	36	1	1700	30
475	480	42	1	1700	30
480	71	12	1	1700	40
481	482	19	1	1700	40
482	483	26	1	1700	40
483	484	50	1	1700	40
484	485	11	1	1700	30
485	195	108	1	1700	40
485	489	9	1	1700	30
486	487	19	3	1900	55
486	488	7	3	1900	55
487	10	84	2	1900	55
487	486	19	2	1900	55
488	9	21	2	1900	55
489	486	4	2	1700	40
490	485	36	1	1700	45
491	9	32	2	1900	55
492	8	40	2	1900	55
493	176	8	1	1700	30

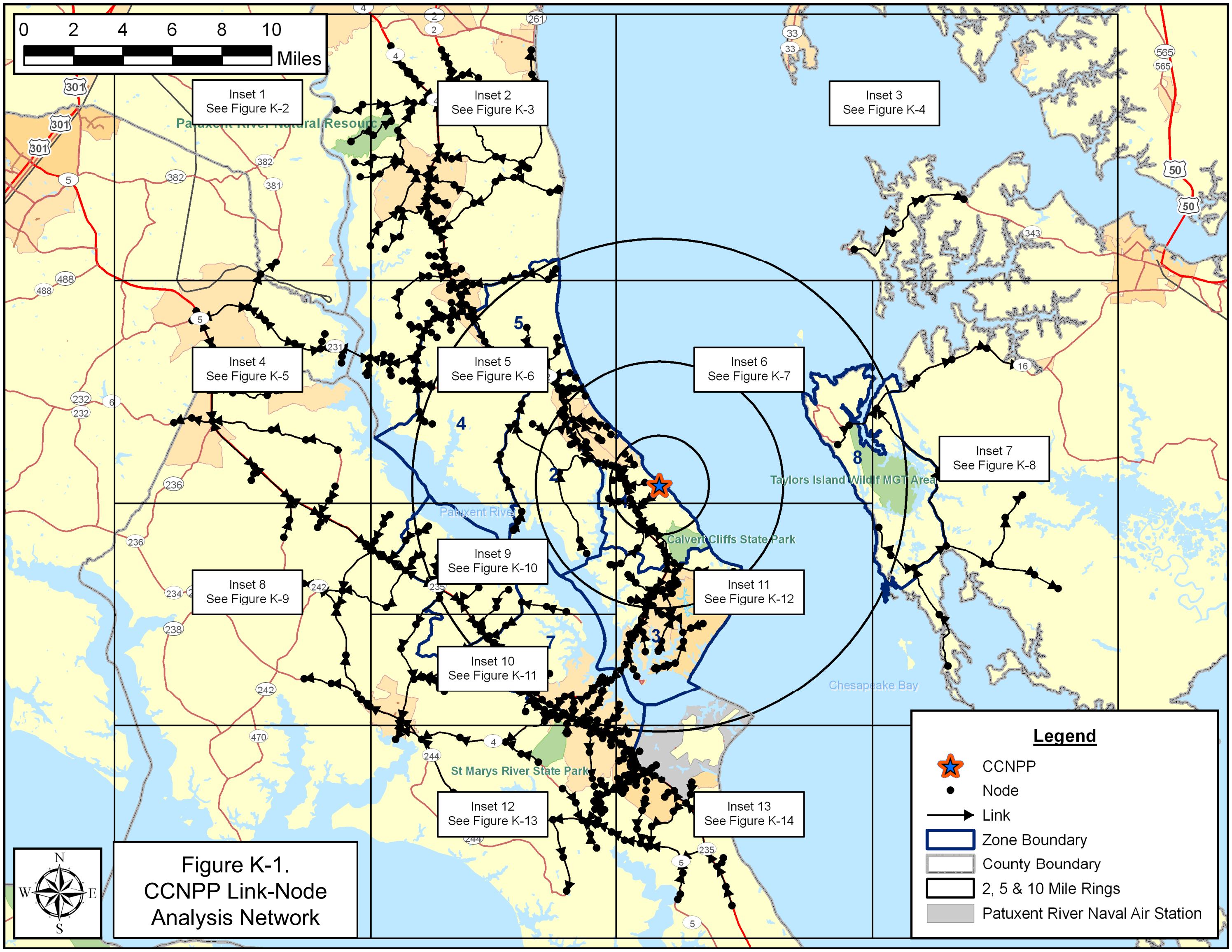


Figure K-1.
CCNPP Link-Node
Analysis Network

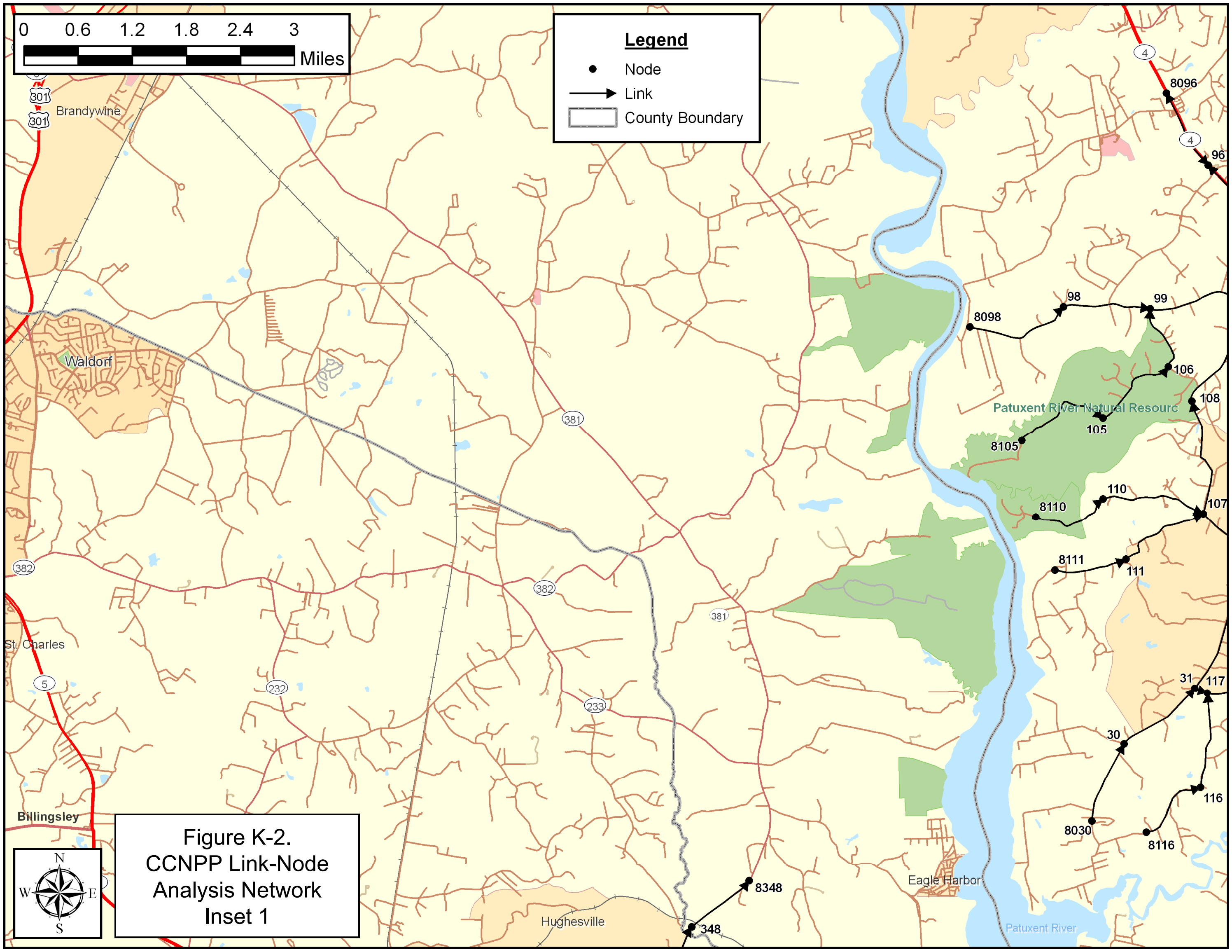
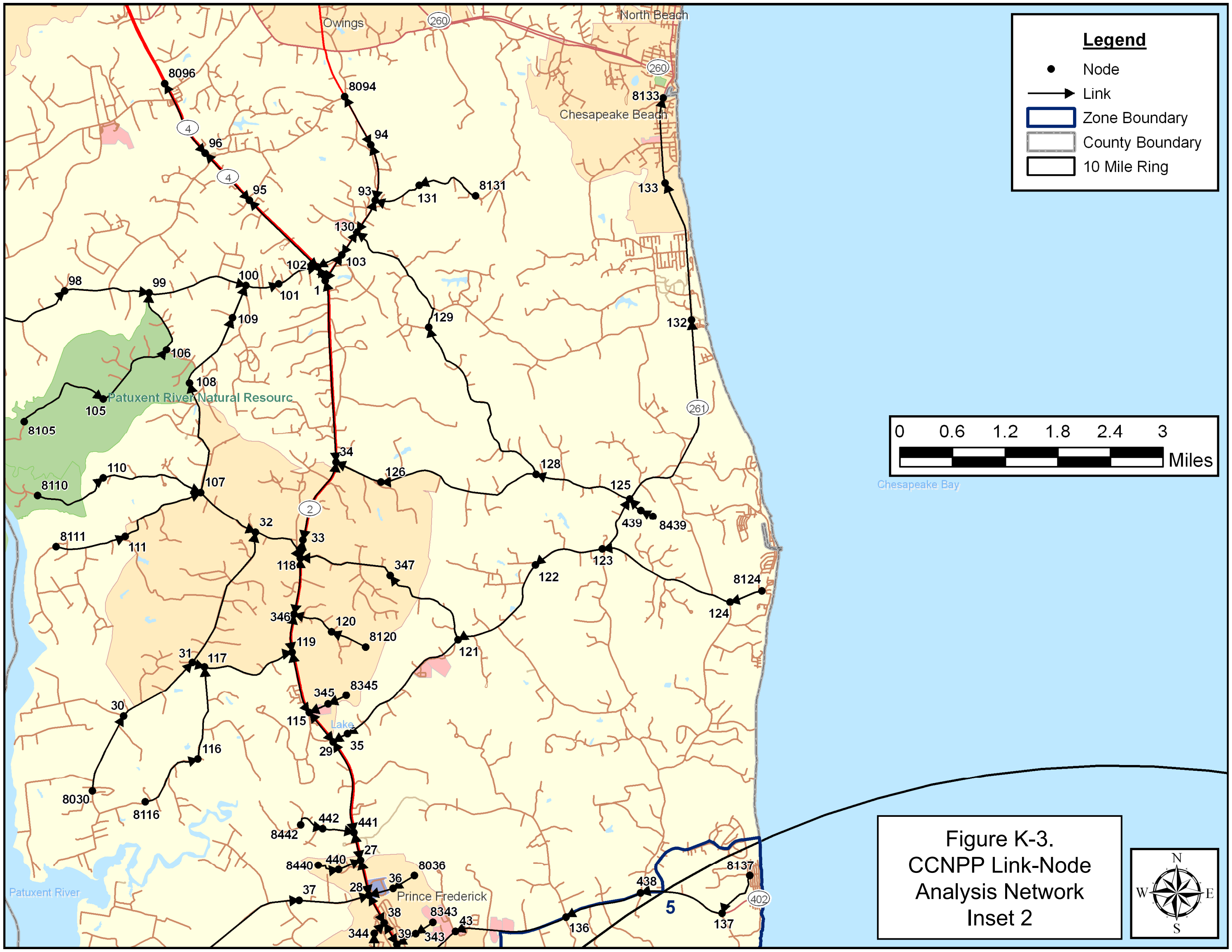


Figure K-2.
CCNPP Link-Node
Analysis Network
Inset 1



Legend
Node
Link
Zone Boundary
County Boundary
10 Mile Ring
0 0.6 1.2 1.8 2.4 3
Miles
Figure K-3.
CCNPP Link-Node
Analysis Network
Inset 2
Owings
North Beach
Chesapeake Beach
Chesapeake Bay
Patuxent River Natural Resourc
Patuxent River
Prince Frederick
Lake
5

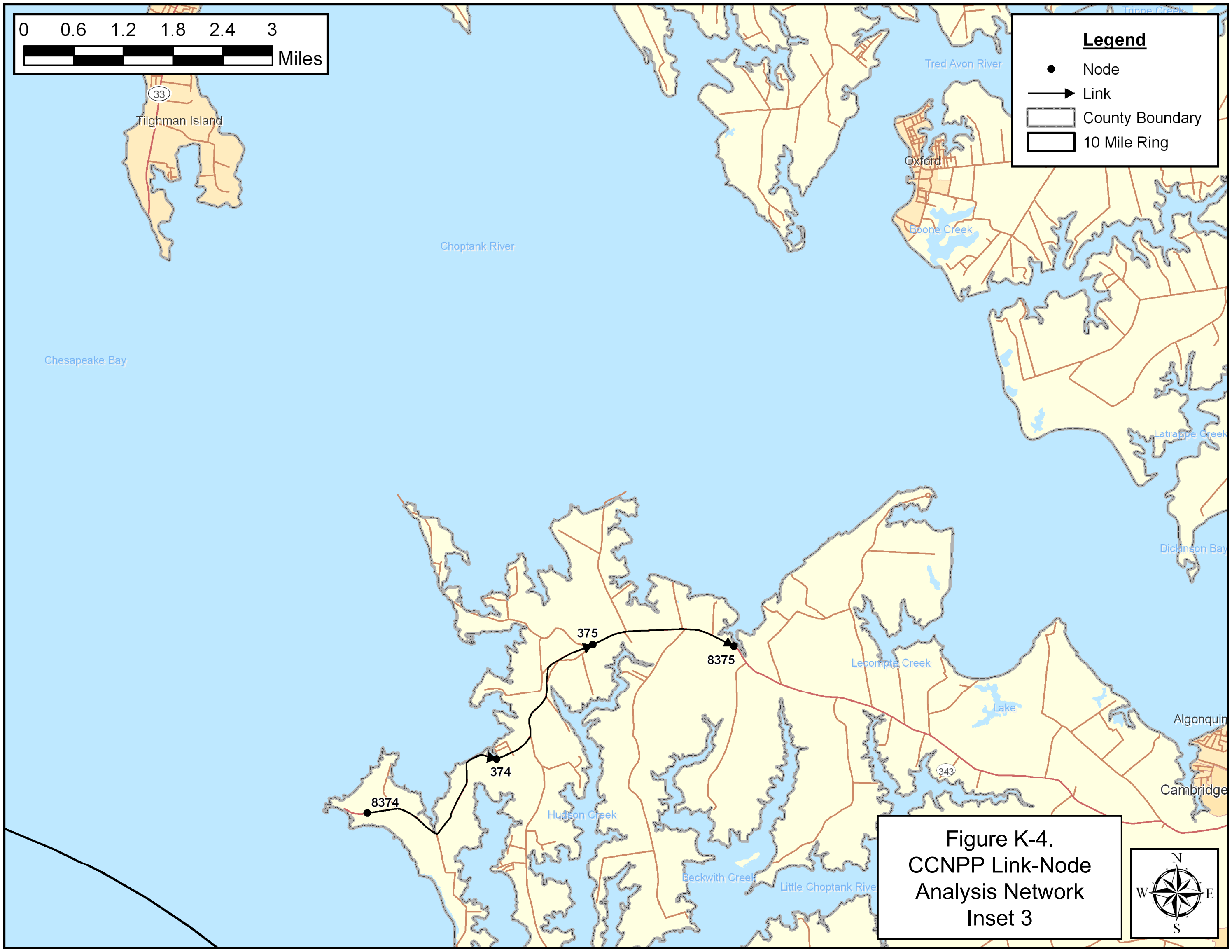


Figure K-4.
CCNPP Link-Node
Analysis Network
Inset 3

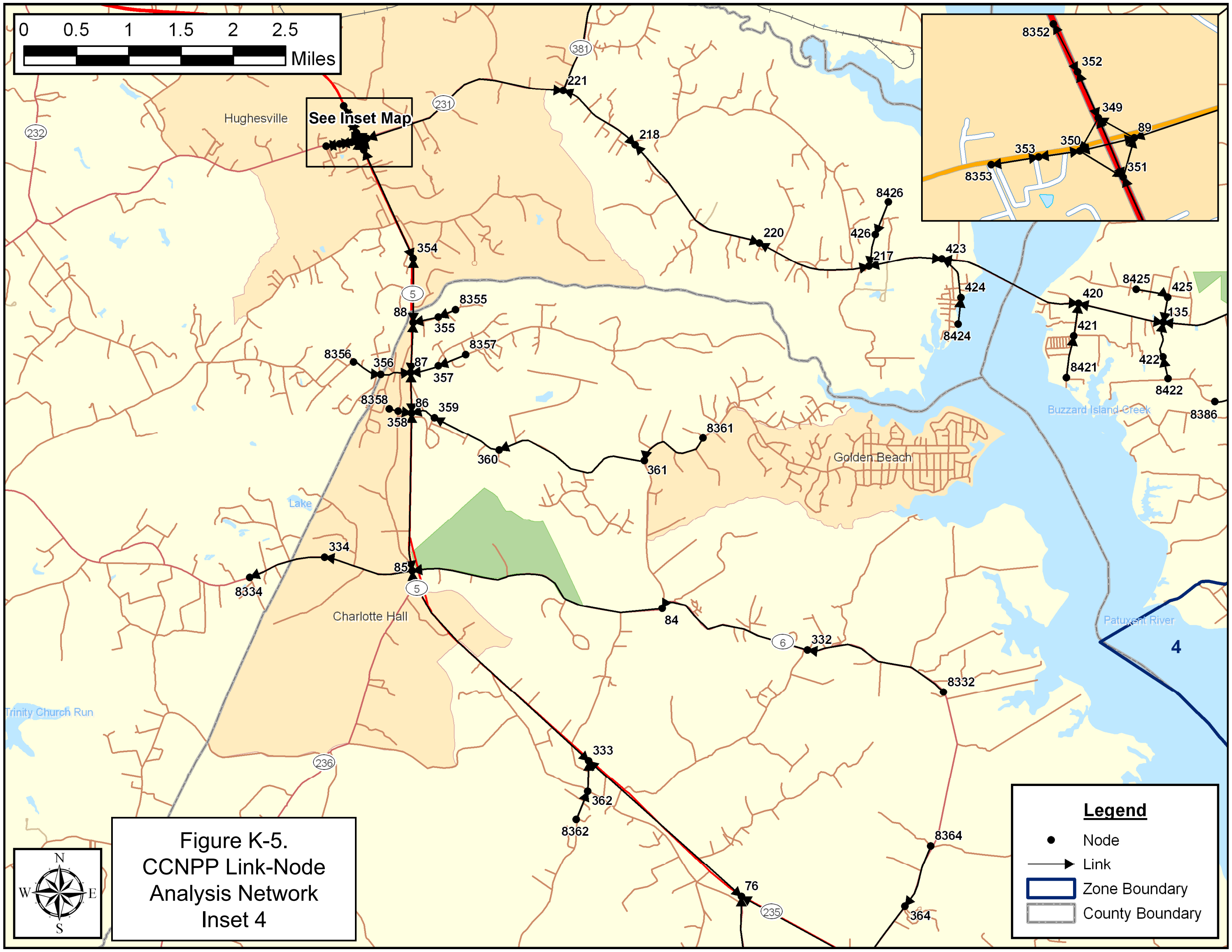


Figure K-5.
CCNPP Link-Node
Analysis Network
Inset 4

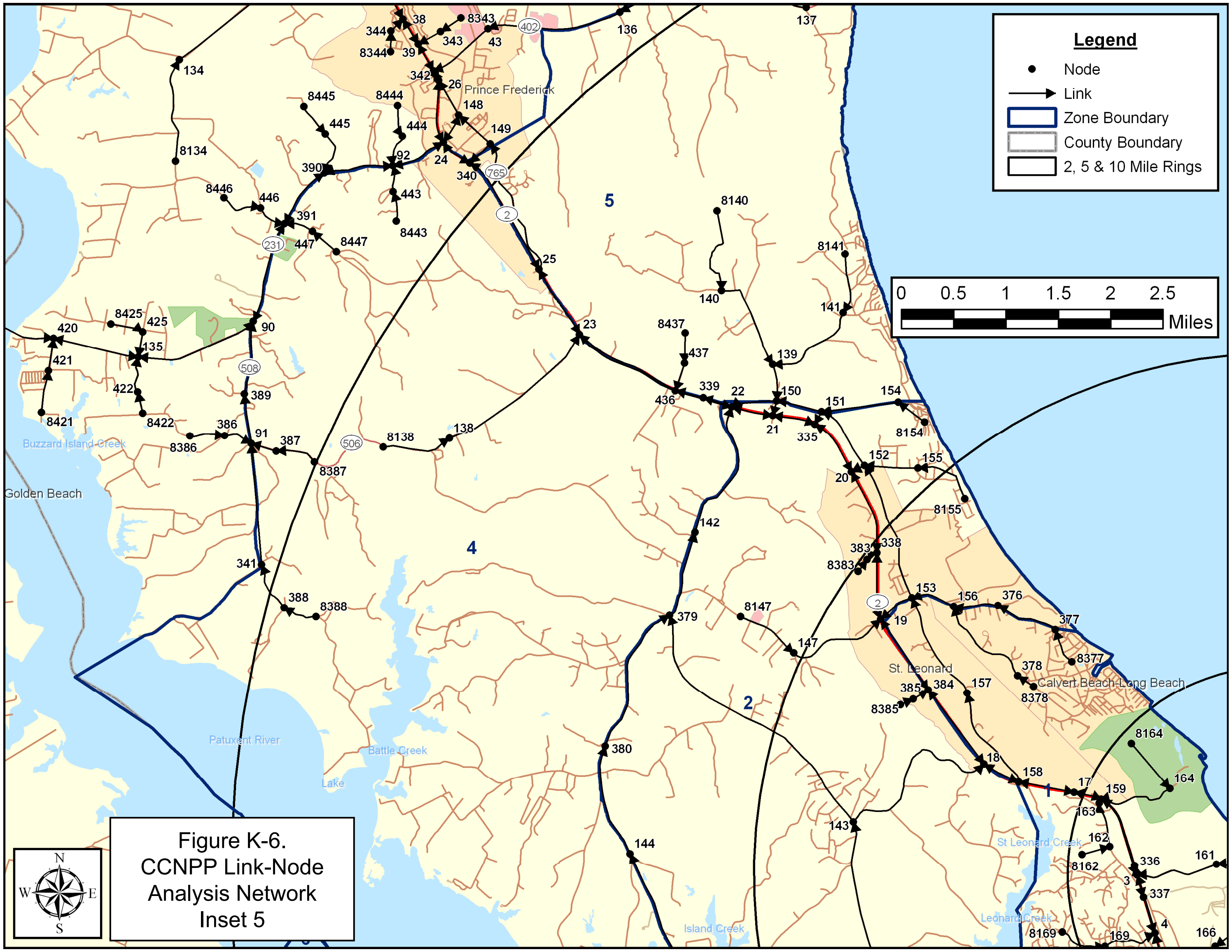


Figure K-6.
CCNPP Link-Node
Analysis Network
Inset 5

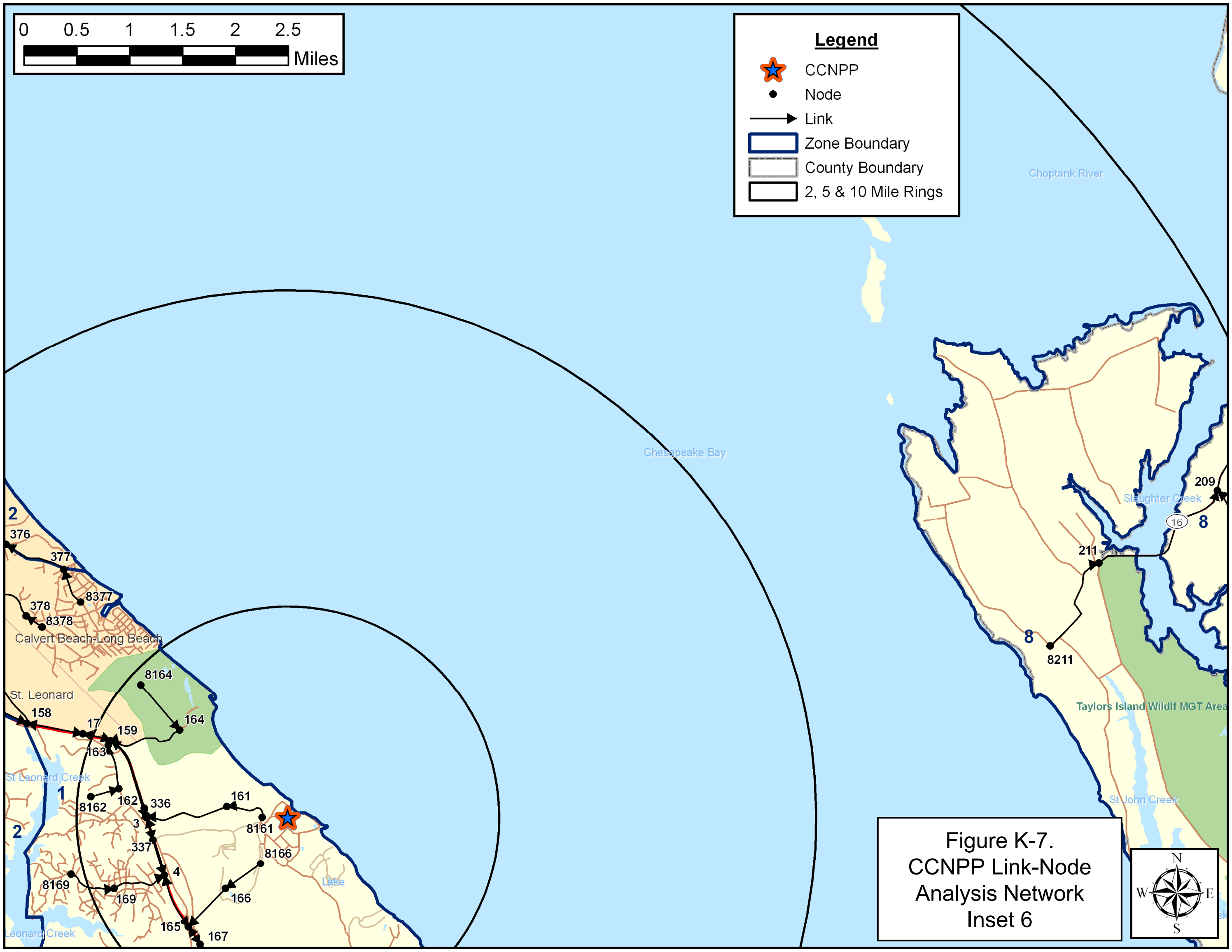


Figure K-7.
CCNPP Link-Node
Analysis Network
Inset 6

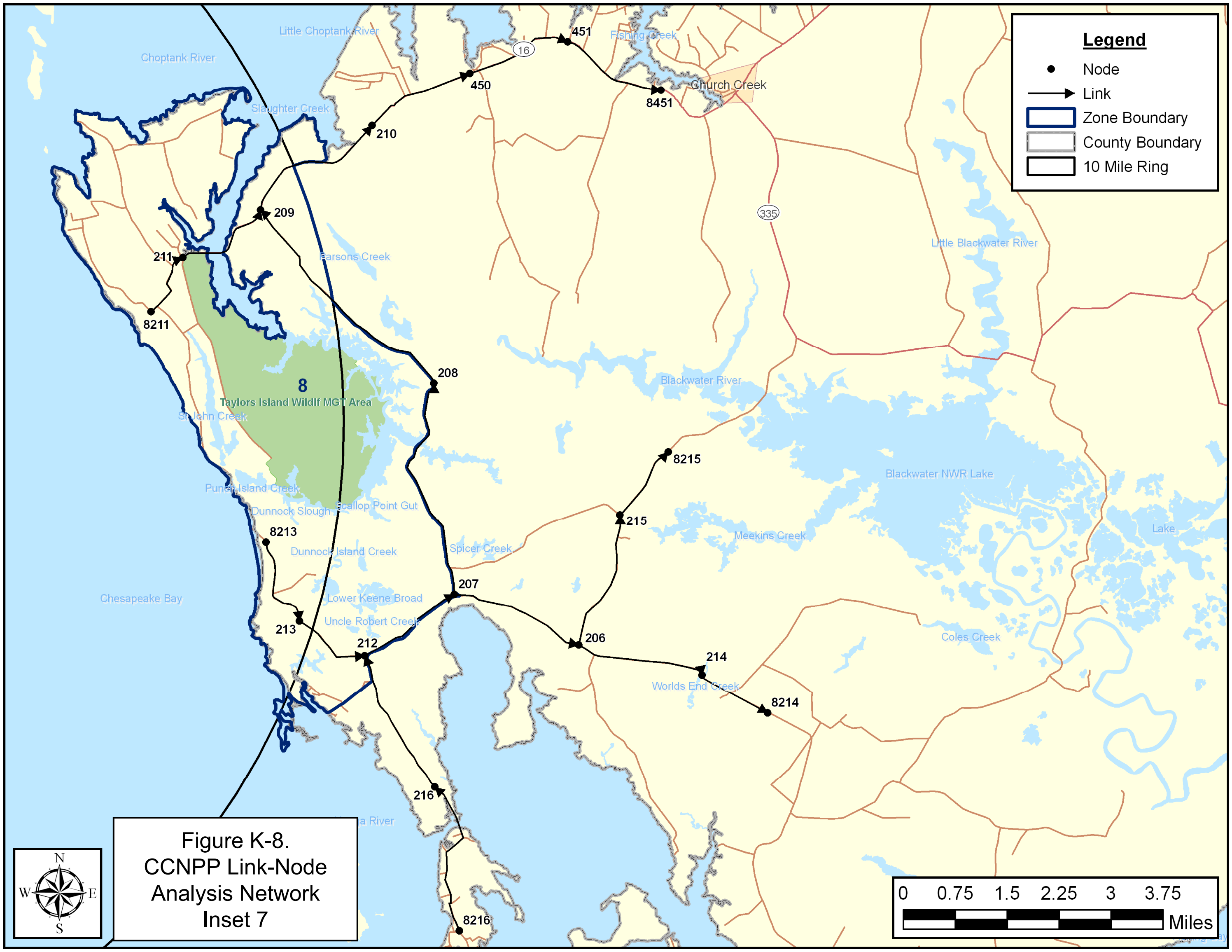


Figure K-8.
CCNPP Link-Node
Analysis Network
Inset 7

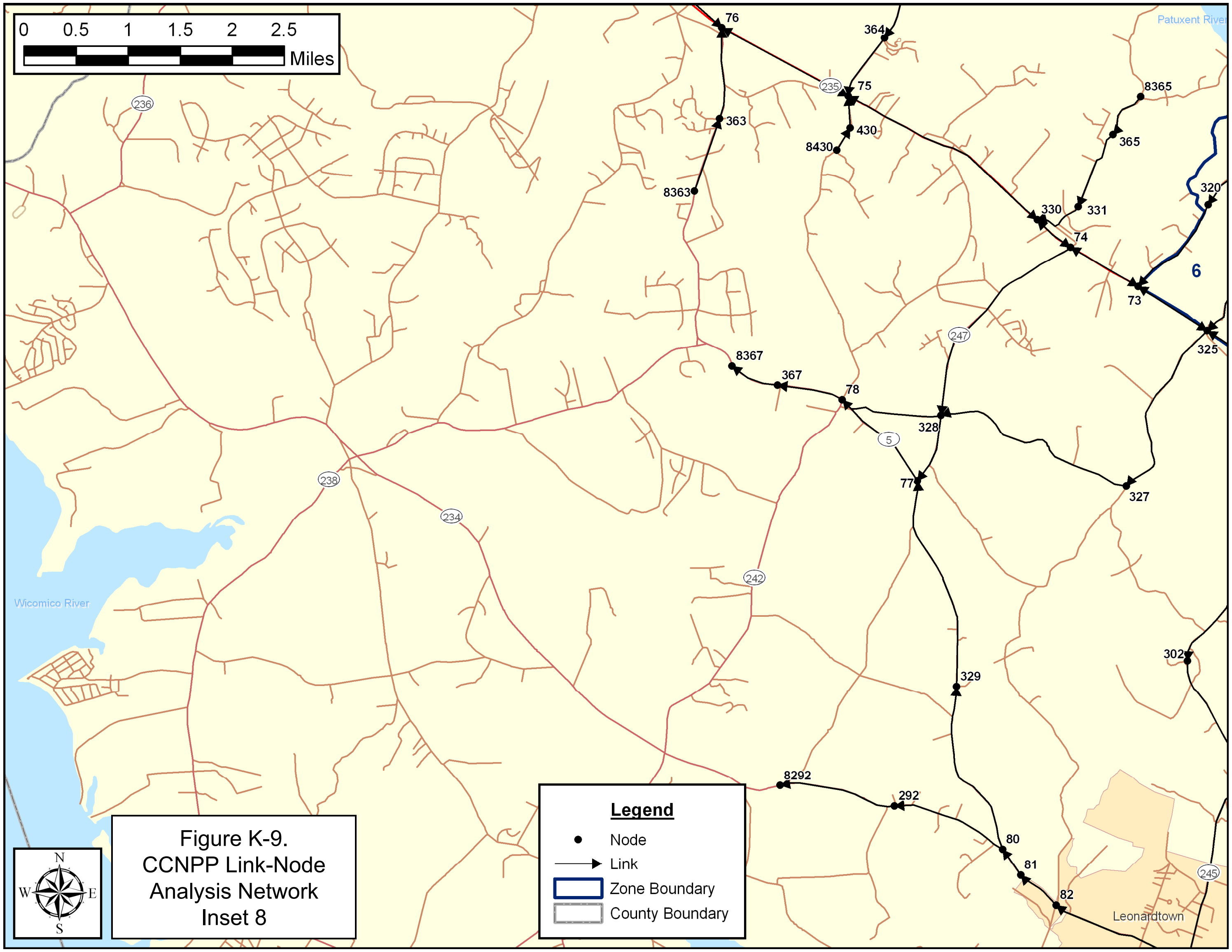
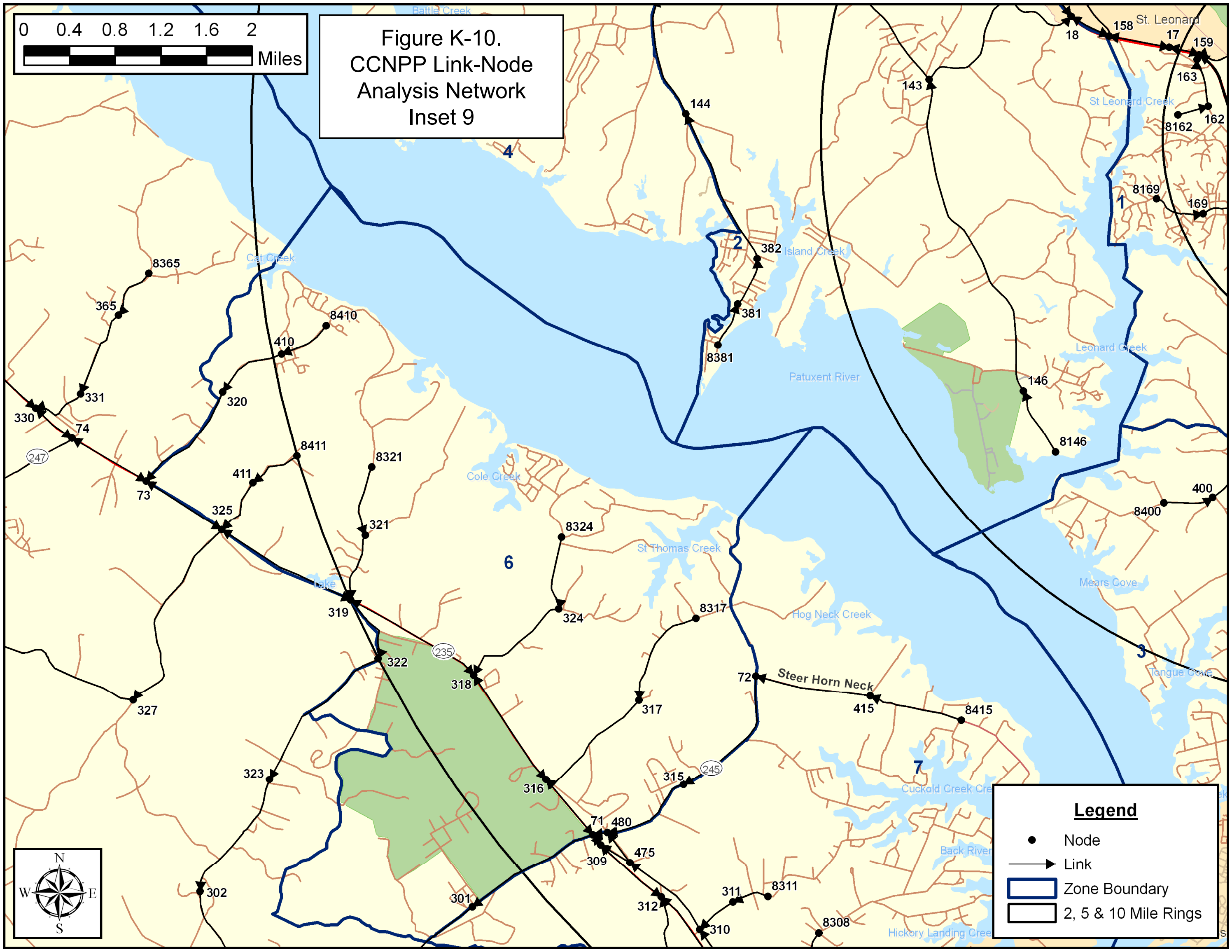


Figure K-9.
CCNPP Link-Node
Analysis Network
Inset 8



0 0.4 0.8 1.2 1.6 2
Miles
Figure K-10.
CCNPP Link-Node
Analysis Network
Inset 9
Legend
Node
Link
Zone Boundary
2, 5 & 10 Mile Rings
Patuxent River
St. Leonard
St Leonard Creek
Leonard Creek
Island Creek
Cole Creek
St Thomas Creek
Hog Neck Creek
Steer Horn Neck
Mears Cove
Tongue Cove
Back River
Battle Creek
Cat Creek
1
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8324
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8308
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302
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245
247

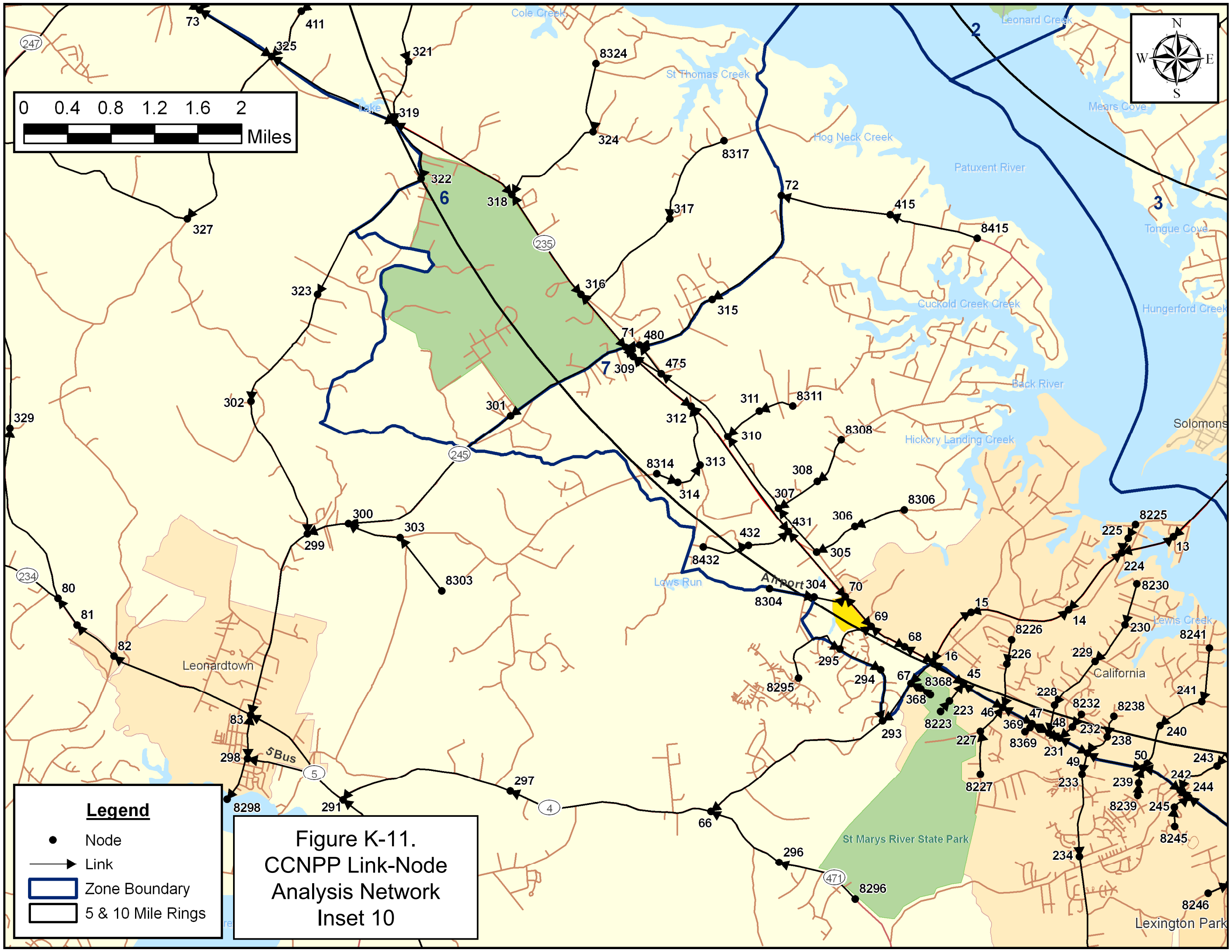

Figure K-11.
CCNPP Link-Node
Analysis Network
Inset 10

Figure K-12.
CCNPP Link-Node
Analysis Network
Inset 11

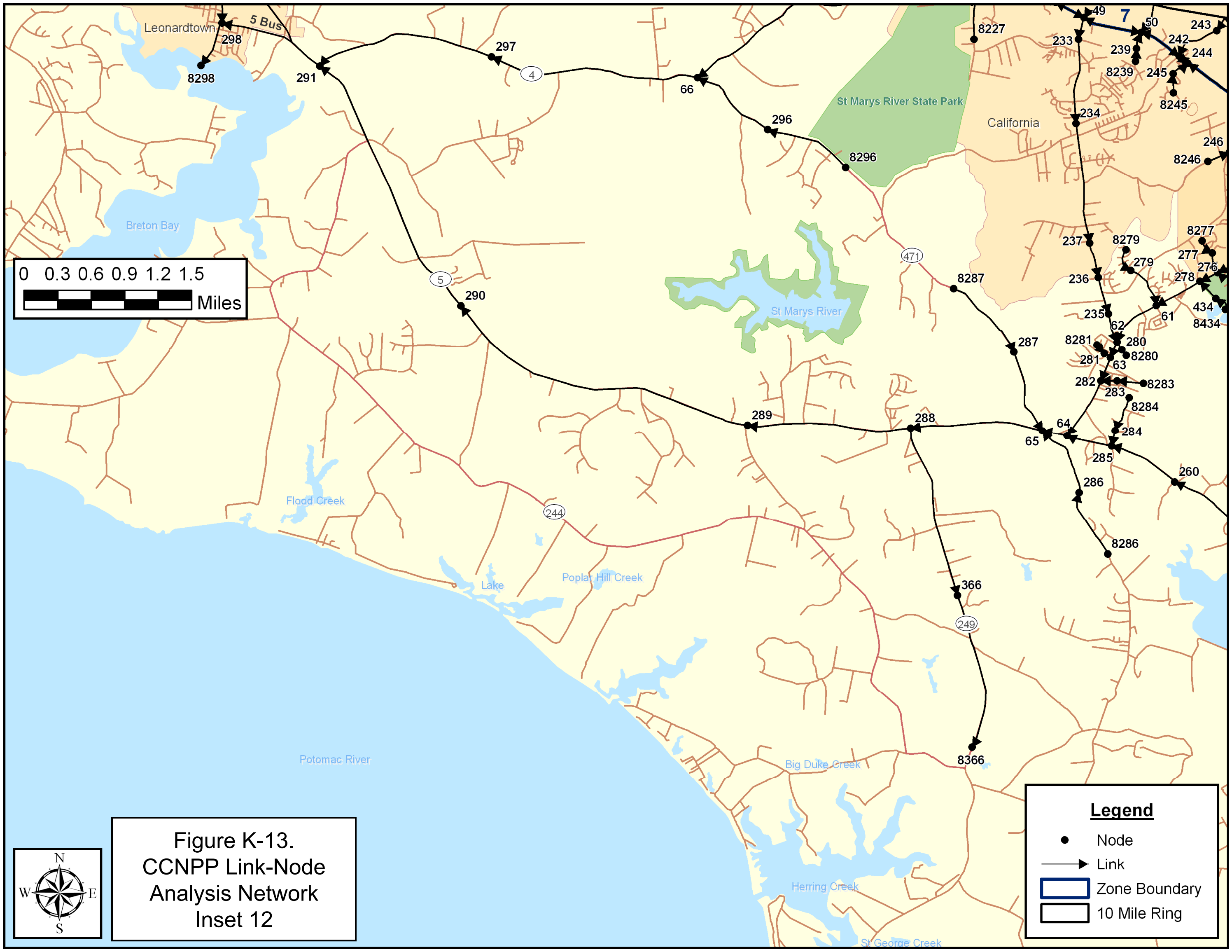

Figure K-13.
CCNPP Link-Node
Analysis Network
Inset 12

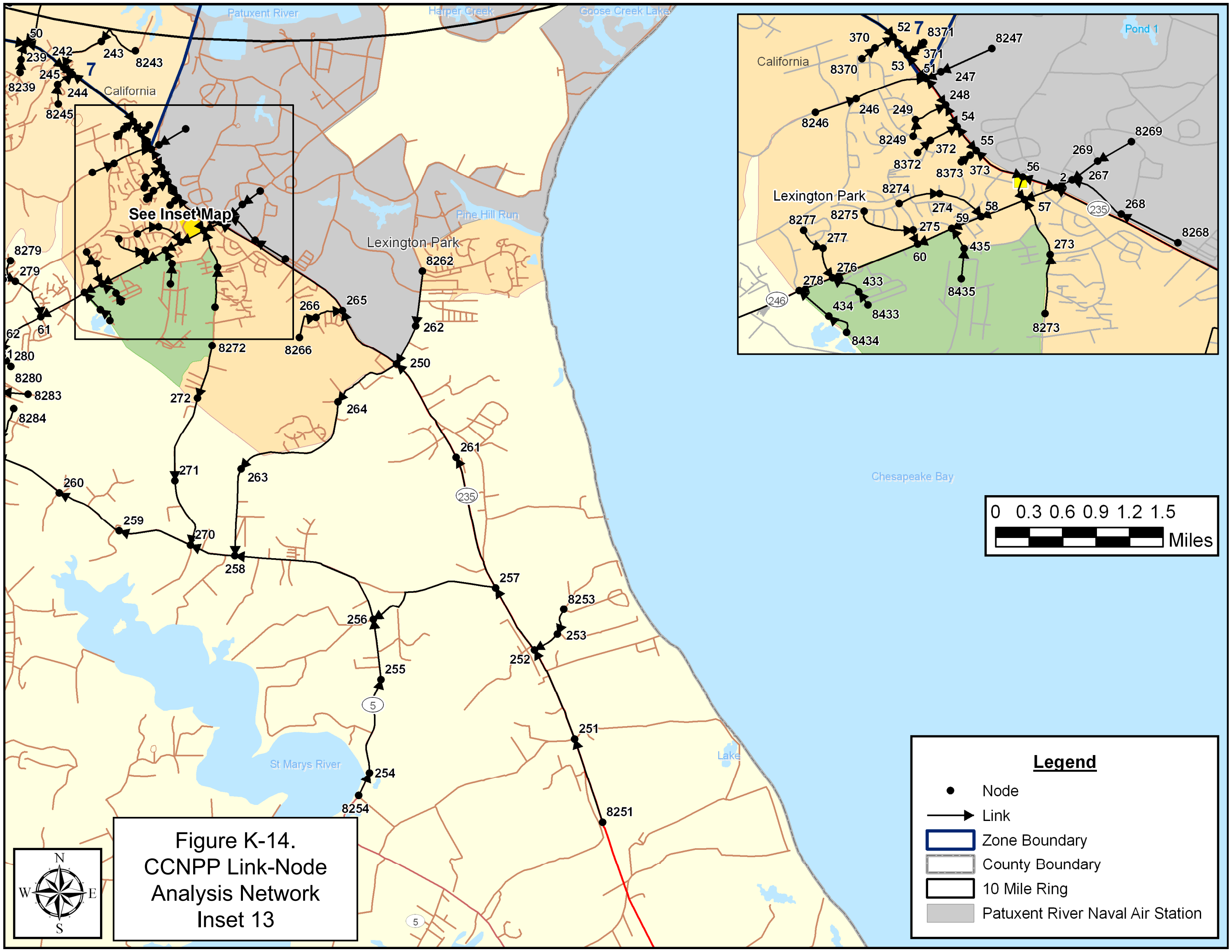

Figure K-14.
CCNPP Link-Node
Analysis Network
Inset 13

APPENDIX L

Zone Boundaries

APPENDIX L: ZONE BOUNDARIES

Zone 1:

Calvert County: Area bounded on the north by Calvert Beach Road, on the east by the Chesapeake Bay, on the south by Breeden Road, Sollers Wharf Road, Old Mill Road, Hellen Creek, St. Paul Branch, Route 492 and Calvert Cliffs State Park, and on the west by Route 2/4 and St. Leonard Creek.

Zone 2:

Calvert County: Area bounded on the north by Route 2/4 and Governor Run Road, on the east by the Chesapeake Bay, Route 2/4, and St. Leonard Creek, on the south by Calvert Beach Road and the Patuxent River and on the west by Broomes Island Road and Nan Cove.

Zone 3:

Calvert County: Area bounded on the north by Breeden Road, Sollers Wharf Road, Old Mill Road, Hellen Creek, St. Paul Branch, Route 497 and Calvert Cliffs State Park, on the east by the Chesapeake Bay, and on the south and west by the Patuxent River.

Zone 4:

Calvert County: Area bounded on the north by Route 2 & 4, on the east by Broomes Island Road and Nan Cove, on the south by the Patuxent River and on the west by Route 231, Adelina Road and Sheridan Road.

Zone 5:

Calvert County: Area bounded on the north by Dares Beach Road and Cassell Road, on the east by the Chesapeake Bay, on the south by Governor Run Road, and on the west by Tobacco Ridge Road (to Calvert County Property Gate), Main Street at Monitor Way (to Calvert Towne), and Route 2/4 (at Calvert Towne).

Zone 6:

St. Mary's County: Area bounded on the north by the Patuxent River, on the east by Hollywood Road and Sotterly Gate Road, on the south by Brooks Run, and on the west by Cat Creek Road, Sandgates Road, Route 235, Clover Hill Road, McIntosh Road, Riva Ridge Drive and McIntosh Run.

Zone 7:

St. Mary's County: Area bounded on the north by the Patuxent River, on the east by the Patuxent Naval Air Test Center, on the south by Brooks Run, Broad Run, Hayden Road, St. Mary's County Airport Drive, Cottonwood Parkway, Wildewood Parkway, Saint Andrews Church Road and Route 235, and on the west by Hollywood Road and Sotterly Gate Road.

Zone 8:

Dorchester County: Includes all of Taylor's Island, Smithville, and residents off Meekins Neck Road, Smithville Road (north of Beaver Dam Creek), and Route 16 (west of Parsons Creek).