# 5 ESTIMATION OF TRIP GENERATION TIME

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

## 5.1 Background

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

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

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

1. The Advisory to Evacuate will be announced coincident with the siren notification.
2. Mobilization of the general population will commence within 15 minutes after the siren notification.
3. ETE are measured relative to the Advisory to Evacuate.

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

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

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

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

remaining to evacuate the EPZ after the Advisory to Evacuate, will both be somewhat less than the estimates presented in this report. Consequently, the ETE presented in this report are higher than the actual evacuation time, if this hypothetical situation were to take place.

The notification process consists of two events:

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

The population within the EPZ is dispersed over an area of approximately 160 square miles and is engaged in a wide variety of activities. It must be anticipated that some time will elapse between the transmission and receipt of the information advising the public of an accident.

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

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

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

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

## 5.2 Fundamental Considerations

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

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

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

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

**Table 5-1. Event Sequence for Evacuation Activities**

| Event Sequence | Activity | Distribution |
|---|---|---|
| 1 → 2 | Receive Notification | 1 |
| 2 → 3 | Prepare to Leave Work | 2 |
| 2,3 → 4 | Travel Home | 3 |
| 2,4 → 5 | Prepare to Leave to Evacuate | 4 |
| N/A | Snow Clearance | 5 |

These relationships are shown graphically in Figure 5-1.

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

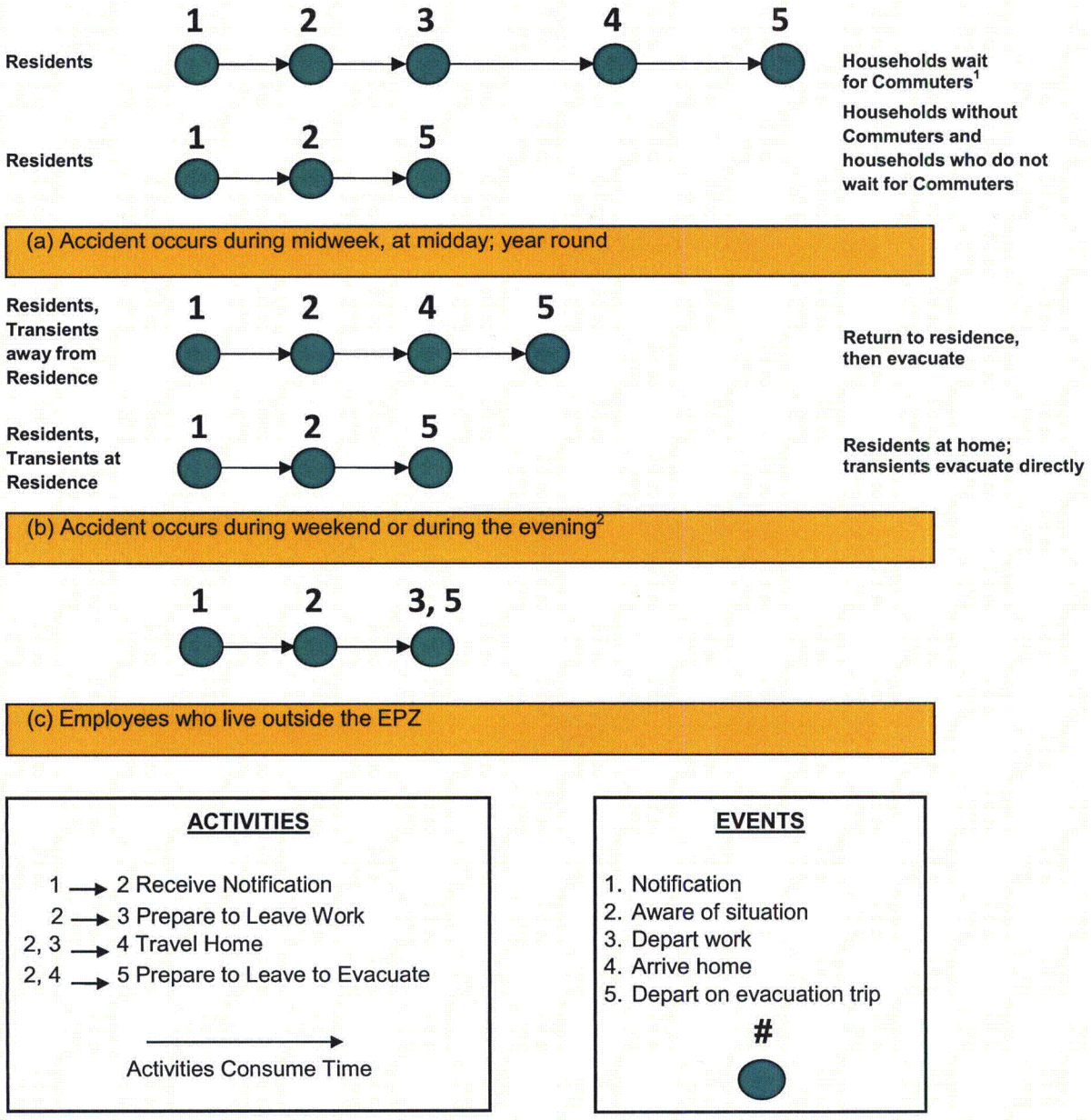
As such, a completed Activity changes the 'state' of an individual (e.g. the activity, 'travel home' changes the state from 'depart work' to 'arrive home'). Therefore, an Activity can be described as an 'Event Sequence'; the elapsed times to perform an event sequence vary from one person to the next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

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

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

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

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




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

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

## 5.3 Estimated Time Distributions of Activities Preceding Event 5

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

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

It is assumed (based on the presence of sirens within the EPZ) that 87 percent of those within the EPZ will be aware of the accident within 30 minutes with the remainder notified within the following 15 minutes. The notification distribution is given below:

**Table 5-2. Time Distribution for Notifying the Public**

| Elapsed Time (Minutes) | Percent of Population Notified |
|---|---|
| 0 | 0.0% |
| 5 | 7.1% |
| 10 | 13.3% |
| 15 | 26.5% |
| 20 | 46.9% |
| 25 | 66.3% |
| 30 | 86.7% |
| 35 | 91.8% |
| 40 | 96.9% |
| 45 | 100.0% |

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

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

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

| Elapsed Time (Minutes) | Cumulative Percent Employees Leaving Work | Elapsed Time (Minutes) | Cumulative Percent Employees Leaving Work |
|---|---|---|---|
| 0 | 0.0% | 45 | 96.0% |
| 5 | 49.6% | 50 | 96.3% |
| 10 | 66.0% | 55 | 96.3% |
| 15 | 76.7% | 60 | 99.0% |
| 20 | 80.6% | 75 | 100.0% |
| 25 | 82.1% | | |
| 30 | 93.1% | | |
| 35 | 93.5% | | |
| 40 | 94.5% | | |

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

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

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

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

| Elapsed Time (Minutes) | Cumulative Percent Returning Home | Elapsed Time (Minutes) | Cumulative Percent Returning Home |
|---|---|---|---|
| 0 | 0.0% | 40 | 94.0% |
| 5 | 20.4% | 45 | 99.1% |
| 10 | 39.0% | 50 | 99.3% |
| 15 | 55.9% | 55 | 99.5% |
| 20 | 73.1% | 60 | 100.0% |
| 25 | 77.7% | | |
| 30 | 88.9% | | |
| 35 | 90.7% | | |

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

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

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

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

| Elapsed Time (Minutes) | Cumulative Percent Ready to Evacuate |
|---|---|
| 0 | 0.0% |
| 15 | 20.0% |
| 30 | 62.4% |
| 45 | 72.3% |
| 60 | 88.0% |
| 75 | 93.4% |
| 90 | 94.6% |
| 105 | 95.1% |
| 120 | 97.9% |
| 135 | 100.0% |

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

Distribution No. 5, Snow Clearance Time Distribution

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

Consequently, it is reasonable to assume that the highway system will remain passable – albeit at a lower capacity – under the vast majority of snow conditions. Nevertheless, for the vehicles to gain access to the highway system, it may be necessary for driveways and employee parking lots to be cleared to the extent needed to permit vehicles to gain access to the roadways. These clearance activities take time; this time must be incorporated into the trip generation time distributions. These data are provided by those households which responded to the telephone survey. This distribution is plotted in Figure 5-2 and listed in Table 5-6.

Note that those respondents (34.9%) who answered that they would not take time to clear their driveway were assumed to be ready immediately at the start of this activity. Essentially they would drive through the snow on the driveway to access the roadway and begin their evacuation trip.

**Table 5-6. Time Distribution for Population to Clear 6"-8" of Snow**

| Elapsed Time (Minutes) | Cumulative Percent Completing Snow Removal |
|---|---|
| 0 | 34.9% |
| 15 | 49.2% |
| 30 | 81.2% |
| 45 | 86.6% |
| 60 | 94.0% |
| 75 | 96.6% |
| 90 | 97.5% |
| 105 | 98.0% |
| 120 | 100.0% |

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

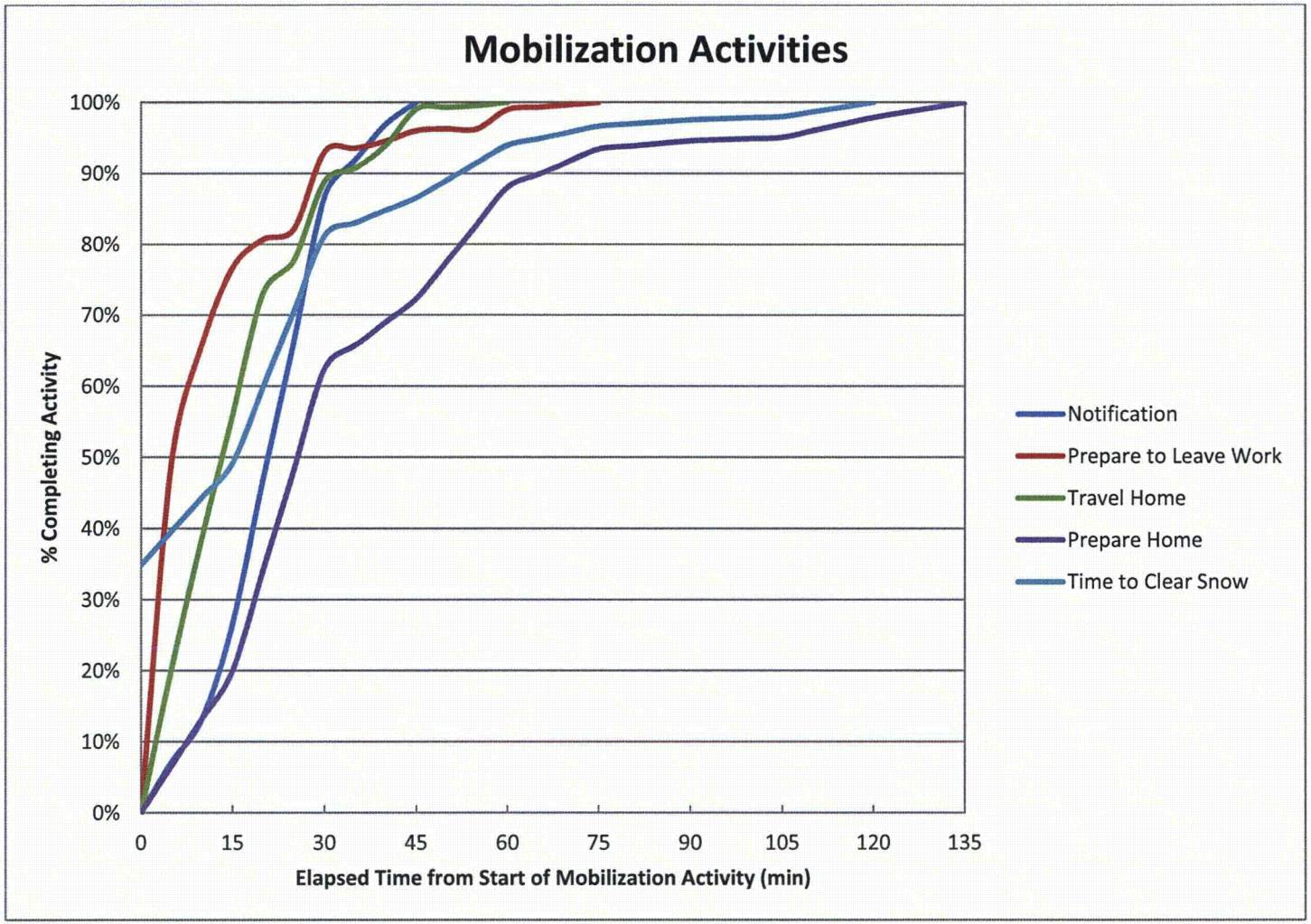



**Figure 5-2. Evacuation Mobilization Activities**

## 5.4 Calculation of Trip Generation Time Distribution

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

To calculate the time distribution of an event that is dependent on two sequential activities, it is necessary to "sum" the distributions associated with these prior activities. The distribution summing algorithm is applied repeatedly as shown to form the required distribution. As an outcome of this procedure, new time distributions are formed; we assign "letter" designations to these intermediate distributions to describe the procedure. Table 5-7 presents the summing procedure to arrive at each designated distribution.

**Table 5-7. Mapping Distributions to Events**

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

Table 5-8 presents a description of each of the final trip generation distributions achieved after the summing process is completed.

**Table 5-8. Description of the Distributions**

| Distribution | Description |
|---|---|
| A | Time distribution of commuters departing place of work (Event 3). Also applies to employees who work within the EPZ who live outside, and to Transients within the EPZ. |
| B | Time distribution of commuters arriving home (Event 4). |
| C | Time distribution of residents with commuters who return home, leaving home to begin the evacuation trip (Event 5). |
| D | Time distribution of residents without commuters returning home, leaving home to begin the evacuation trip (Event 5). |
| E | Time distribution of residents with commuters who return home, leaving home to begin the evacuation trip, after snow clearance activities (Event 5). |
| F | Time distribution of residents with no commuters returning home, leaving to begin the evacuation trip, after snow clearance activities (Event 5). |

### 5.4.1 Statistical Outliers

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

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

In assessing outliers, there are three alternates to consider:

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

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

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

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

There is considerable statistical literature on the identification and treatment of outliers singly or in groups, much of which assumes the data is normally distributed and some of which uses non-

parametric methods to avoid that assumption. The literature cites that limited work has been done directly on outliers in sample survey responses.

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

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

2) The individual mobilization activities (prepare to leave work, travel home, prepare home, clear snow) are reviewed for outliers, and then the overall trip generation distributions are created (see Figure 5-1, Table 5-7, Table 5-8);

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

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

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

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

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

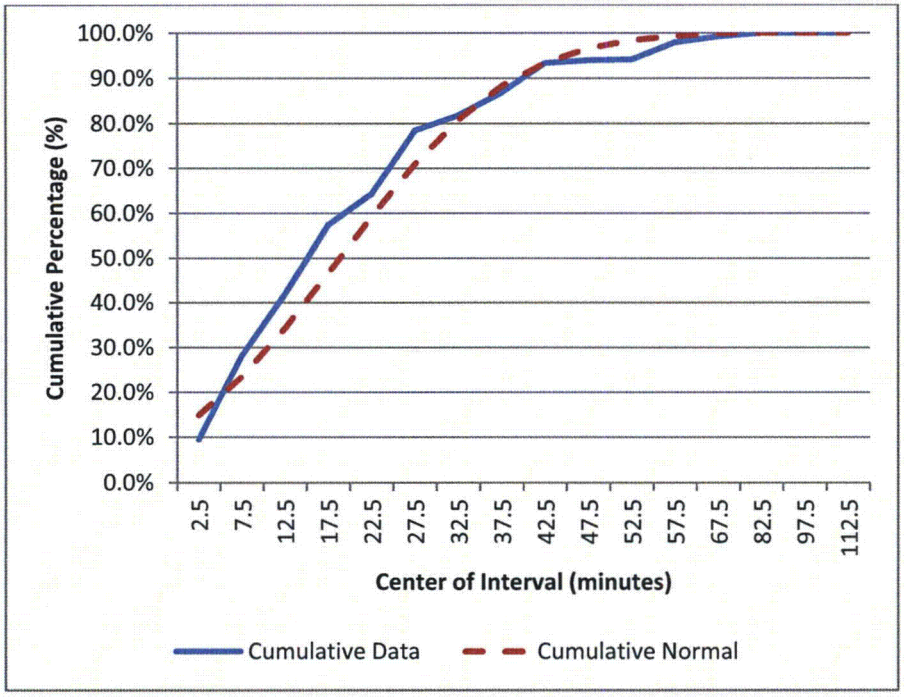



**Figure 5-3. Comparison of Data Distribution and Normal Distribution**

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

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

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

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

This is done by using the data sets and distributions under different scenarios (e.g. commuter returning, no commuter returning, no snow or snow in each). In general, these are additive, using

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

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

The DYNEV II simulation model is designed to accept varying rates of vehicle trip generation for each origin centroid, expressed in the form of histograms. These histograms, which represent Distributions A, C, D, E and F, properly displaced with respect to one another, are tabulated in Table 5-9 (Distribution B, Arrive Home, omitted for clarity).

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

### 5.4.2 Staged Evacuation Trip Generation

As defined in NUREG/CR-7002, staged evacuation consists of the prompt evacuation of the 2 mile region, while those beyond 2 miles shelter-in-place. As discussed in Section 6, the PBNP always evacuates at least the 5 mile radius. Thus, this study considers staged evacuation based on a 5 mile prompt evacuation as discussed below:

1. The Subarea comprising the 5 mile region is advised to evacuate immediately
2. Subareas comprising regions extending from 5 to 10 miles downwind are advised to shelter in-place while the five mile region is cleared
3. As vehicles evacuate the 5 mile region, sheltered people from 5 to 10 miles downwind continue preparation for evacuation
4. The population sheltering in the 5 to 10 mile region are advised to begin evacuating when approximately 90% of those originally within the 5 mile region evacuate across the 5 mile region boundary
5. Non-compliance with the shelter recommendation is the same as the shadow evacuation percentage of 20%

<u>Assumptions</u>

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

<u>Procedure</u>

1. Trip generation for population groups in the 5 mile region will be as computed based upon the results of the telephone survey and analysis.
2. Trip generation for the population subject to staged evacuation will be formulated as follows:
    a. Identify the 90$^{th}$ percentile evacuation time for Subarea 5 which comprises the 5 mile region. This value, $T_{Scen}^{*}$, is obtained from simulation results. It will become the time at which the region being sheltered will be told to evacuate for each scenario.
    b. The resultant trip generation curves for staging are then formed as follows:

i. The non-shelter trip generation curve is followed until a maximum of 20% of the total trips are generated (to account for shelter non-compliance).
ii. No additional trips are generated until time $T_{Scen}^*$
iii. Following time $T_{Scen}^*$, the balance of trips are generated:
    1. by stepping up and then following the non-shelter trip generation curve (if $T_{Scen}^*$ is $\leq$ max trip generation time) or
    2. by stepping up to 100% (if $T_{Scen}^*$ is > max trip generation time)

c. Note: This procedure implies that there may be different staged trip generation distributions for different scenarios. NUREG/CR-7002 uses the statement "approximately 90th percentile" as the time to end staging and begin evacuating. The value of $T_{Scen}^*$ is 1:35 for non-snow scenarios and 2:10 for snow scenarios.

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

Figure 5-5 presents the staged trip generation distributions for both residents with and without returning commuters; the 90th percentile 5 mile region evacuation time is 95 minutes for good weather and 130 minutes for snow scenarios. At the 90th percentile evacuation time, 20% of the population (who normally would have completed their mobilization activities for an un-staged evacuation) advised to shelter has nevertheless departed the area. These people do not comply with the shelter advisory. Also included on the plot are the trip generation distributions for these groups as applied to the regions advised to evacuate immediately.

Since the 90th percentile evacuation time occurs before the end of the trip generation time, after the sheltered region is advised to evacuate, the shelter trip generation distribution rises to meet the balance of the non-staged trip generation distribution. Following time $T_{Scen}^*$, the balance of staged evacuation trips that are ready to depart are released within 30 minutes. After $T_{Scen}^*$+30, the remainder of evacuation trips are generated in accordance with the unstaged trip generation distribution.

Table 5-10 provides the trip generation histograms for staged evacuation.

### 5.4.3 Trip Generation for Waterways and Recreational Areas

Annex 1, Section 4 of the Manitowoc County Emergency Operations Plan states that warning will be accomplished by outdoor warning sirens, radio pagers, public broadcasting media (i.e., Emergency Alert System-EAS and cable TV systems serving the 10-mile EPZs and mobile public address equipment.) People fishing on Lake Michigan will be warned by the U.S. Coast Guard and if weather is favorable, by aircraft/public address system fly-over. The aircraft will also notify Kewaunee County population along Lake Michigan shoreline, or as siren system back-up, upon request of Kewaunee County Sheriff or designee.

As indicated in Table 5-2, this study assumes 100% notification in 45 minutes, consistent with the FEMA REP Program Manual. Table 5-9 indicates that all transients will have mobilized within 75 minutes. It is assumed that this timeframe is sufficient time for boaters, campers and other transients to return to their vehicles and begin their evacuation trip.

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

| Time Period | Duration (Min) | Percent of Total Trips Generated Within Indicated Time Period | | | | | |
|---|---|---|---|---|---|---|---|
| | | Employees (Distribution A) | Transients (Distribution A) | Residents with Commuters (Distribution C) | Residents Without Commuters (Distribution D) | Residents With Commuters Snow (Distribution E) | Residents Without Commuters Snow (Distribution F) |
| 1 | 15 | 8% | 8% | 0% | 1% | 0% | 0% |
| 2 | 15 | 36% | 36% | 1% | 11% | 0% | 5% |
| 3 | 15 | 35% | 35% | 4% | 27% | 2% | 13% |
| 4 | 15 | 14% | 14% | 14% | 26% | 6% | 18% |
| 5 | 15 | 4% | 4% | 20% | 14% | 12% | 18% |
| 6 | 15 | 2% | 2% | 19% | 10% | 15% | 16% |
| 7 | 30 | 1% | 1% | 26% | 6% | 30% | 17% |
| 8 | 30 | 0% | 0% | 10% | 4% | 19% | 7% |
| 9 | 30 | 0% | 0% | 4% | 1% | 9% | 4% |
| 10 | 15 | 0% | 0% | 1% | 0% | 3% | 1% |
| 11 | 15 | 0% | 0% | 1% | 0% | 2% | 1% |
| 12 | 15 | 0% | 0% | 0% | 0% | 1% | 0% |
| 13 | 15 | 0% | 0% | 0% | 0% | 0% | 0% |
| 14 | 15 | 0% | 0% | 0% | 0% | 1% | 0% |
| 15 | 600 | 0% | 0% | 0% | 0% | 0% | 0% |

**NOTE:**

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

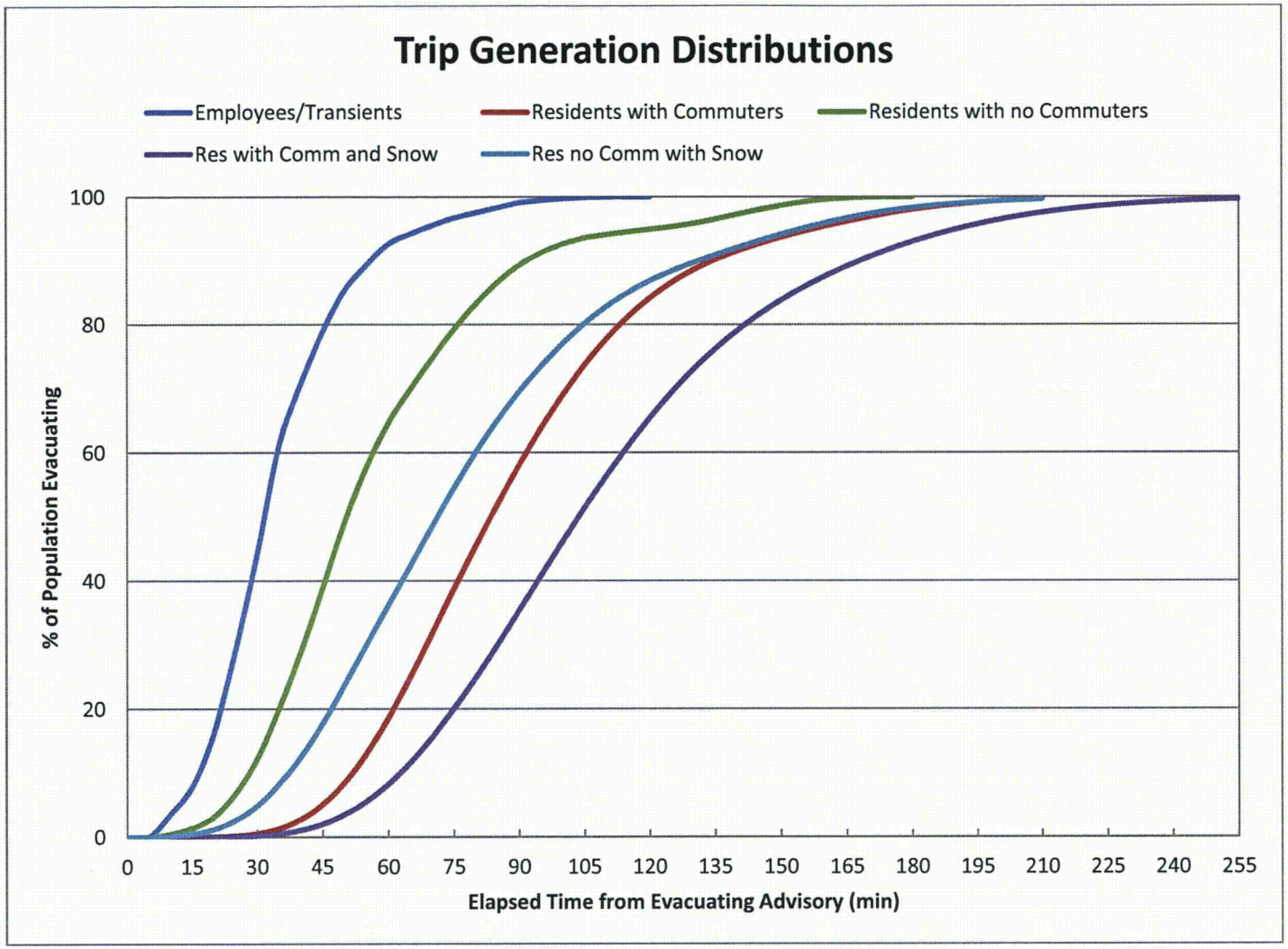



**Figure 5-4. Comparison of Trip Generation Distributions**

**Table 5-10. Trip Generation Histograms for the EPZ Population for Staged Evacuation**

| Time Period | Duration (Min) | Percent of Total Trips Generated Within Indicated Time Period* | | | |
|---|---|---|---|---|---|
| | | Residents with Commuters (Distribution C) | Residents Without Commuters (Distribution D) | Residents With Commuters Snow (Distribution E) | Residents Without Commuters Snow (Distribution F) |
| 1 | 15 | 0% | 0% | 0% | 0% |
| 2 | 15 | 0% | 2% | 0% | 1% |
| 3 | 15 | 1% | 6% | 0% | 3% |
| 4 | 15 | 3% | 5% | 2% | 3% |
| 5 | 15 | 4% | 3% | 2% | 4% |
| 6 | 15 | 4% | 2% | 3% | 3% |
| 7 | 30 | 72% | 77% | 6% | 3% |
| 8 | 30 | 10% | 4% | 71% | 77% |
| 9 | 30 | 4% | 1% | 9% | 4% |
| 10 | 15 | 1% | 0% | 3% | 1% |
| 11 | 15 | 1% | 0% | 2% | 1% |
| 12 | 15 | 0% | 0% | 1% | 0% |
| 13 | 15 | 0% | 0% | 0% | 0% |
| 14 | 15 | 0% | 0% | 1% | 0% |
| 15 | 600 | 0% | 0% | 0% | 0% |

*Trip Generation for Employees and Transients (see Table 5-9) is the same for Unstaged and Staged Evacuation.

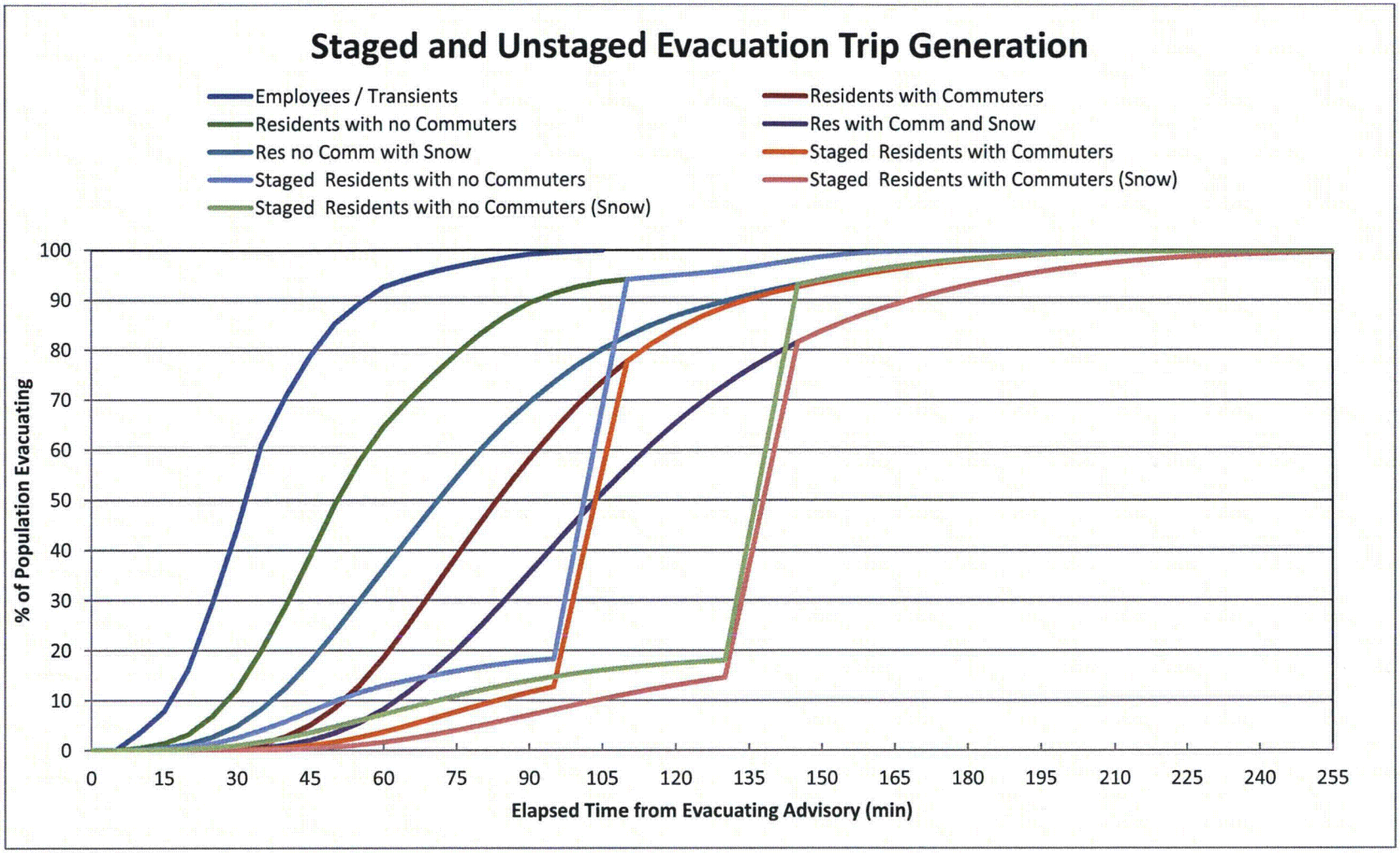



**Figure 5-5. Comparison of Staged and Unstaged Trip Generation Distributions in the 5 to 10 Mile Region**

# 6 DEMAND ESTIMATION FOR EVACUATION SCENARIOS

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

**Region** A grouping of contiguous evacuating subareas 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 19 Regions were defined which encompass all the groupings of subareas considered. These Regions are defined in Table 6-1. The subarea configurations are identified in Figure 6-1. Each keyhole sector-based area consists of a central circle centered at the power plant, and three adjoining sectors, each with a central angle of 22.5 degrees, as per NUREG/CR-7002 guidance. The central sector coincides with the wind direction. These sectors extend to 5 miles from the plant (Region R01) or to the EPZ boundary (Regions R02 through R17). Regions R01 and R02 represent evacuations of circular areas with radii 5 and 10 miles, respectively. Regions R10 through R16 are identical to Regions R03 through R09 respectively and R02 is identical to R17. However, in R10 through R17, those subareas between 5 miles and 10 miles are staged until 90% of the 5-mile region (Region R01) has evacuated. In addition, PBNP specific PARs involving 4 and 5 adjacent sectors result in two additional regions (R18 and R19).

A total of 14 Scenarios were evaluated for all Regions. Thus, there are a total of 19x14=266 evacuation cases. Table 6-2 is a description of all Scenarios.

Each combination of region and scenario implies a specific population to be evacuated. Table 6-3 presents the percentage of each population group estimated to evacuate for each scenario. Table 6-4 presents the vehicle counts for each scenario for an evacuation of Region R02 – the entire EPZ.

The vehicle estimates presented in Section 3 are peak values. These peak values are adjusted depending on the scenario and region being considered, using scenario and region specific percentages, such that the average population is considered for each evacuation case. The scenario percentages are presented in Table 6-3, while the regional percentages are provided in Table H-1. The percentages presented in Table 6-3 were determined as follows:

The number of residents with commuters during the week (when workforce is at its peak) is equal to the product of 56% (the number of households with at least one commuter) and 46% (the number of households with a commuter that would await the return of the commuter prior to evacuating). See assumption 3 in Section 2.3. It is estimated for weekend and evening scenarios that 10% of households with returning commuters will have a commuter at work during those times.

Employment is assumed to be at its peak during the winter, midweek, midday scenarios. Employment is reduced slightly (96%) for summer, midweek, midday scenarios. This is based on the estimation that 50% of the employees commuting into the EPZ will be on vacation for a week during the approximate 12 weeks of summer. It is further estimated that those taking vacation will be uniformly dispersed throughout the summer with approximately 4% of employees vacationing each week. It is further estimated that only 10% of the employees are working in the evenings and during the weekends.

Transient activity is estimated to be at its peak during summer weekends and less (75%) during the week. As shown in Appendix E, there is a significant amount of lodging and campgrounds offering overnight accommodations in the EPZ; thus, transient activity is estimated to be high during evening hours – 63% for summer and 35% for winter. Transient activity on winter weekends is estimated to be 55%.

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

$$20\% \times \left(1 + \frac{978}{2{,}852 + 8{,}284}\right) = 22\%$$

One special event – Outage at Kewaunee Power Station – was considered as Scenario 13. Thus, the special event traffic is 100% evacuated for Scenario 13, and 0% for all other scenarios.

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

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

**Table 6-1. Description of Evacuation Regions**

| Region | Description | Subarea | | | | | |
|---|---|---|---|---|---|---|---|
| | | 5 | 10N | 10NW | 10W | 10SW | 10S |
| R01 | 2-Mile Ring | X | | | | | |
| N/A | 5-Mile Ring | Refer to Region R01 | | | | | |
| R02 | Full EPZ | X | X | X | X | X | X |
| **Evacuate 2-Mile Radius and Downwind to 5-Mile Radius** | | | | | | | |
| Region | Wind Direction From: | Subarea | | | | | |
| | | 5 | 10N | 10NW | 10W | 10SW | 10S |
| N/A | All Directions | Refer to Region R01 | | | | | |
| **Evacuate 5-Mile Radius and Downwind to EPZ Boundary** | | | | | | | |
| Region | Wind Direction From: | Subarea | | | | | |
| | | 5 | 10N | 10NW | 10W | 10SW | 10S |
| R03 | NNW, N | X | | | | | X |
| R04 | NNE | X | | | | X | X |
| R05 | NE, ENE | X | | | X | X | X |
| R06 | E | X | | X | X | X | |
| R07 | ESE, SE | X | X | X | X | | |
| R08 | SSE | X | X | X | | | |
| R09 | S, SSW | X | X | | | | |
| N/A | SW, WSW, W, WNW, NW | Refer to Region R01 | | | | | |
| **Staged Evacuation 5-Mile Radius Evacuates, then Evacuate Downwind to the EPZ Boundary** | | | | | | | |
| Region | Wind Direction From: | Subarea | | | | | |
| | | 5 | 10N | 10NW | 10W | 10SW | 10S |
| R10 | NNW, N | X | | | | | X |
| R11 | NNE | X | | | | X | X |
| R12 | NE, ENE | X | | | X | X | X |
| R13 | E | X | | X | X | X | |
| R14 | ESE, SE | X | X | X | X | | |
| R15 | SSE | X | X | X | | | |
| R16 | S, SSW | X | X | | | | |
| N/A | SW, WSW, W, WNW, NW | Refer to Region R01 | | | | | |
| R17 | Full EPZ | X | X | X | X | X | X |
| **PBNP Specific Regions** | | | | | | | |
| Region | Description | Subarea | | | | | |
| | | 5 | 10N | 10NW | 10W | 10SW | 10S |
| R18 | PB Evac 5 | X | | X | X | X | X |
| R19 | PB Evac 7 | X | X | X | X | X | |

| | | |
|---|---|---|
| **Subarea(s) Shelter-in-Place until 90% ETE for R01/R02, then Evacuate** | **Subarea(s) Shelter-in-Place** | **Subarea(s) Evacuate** |

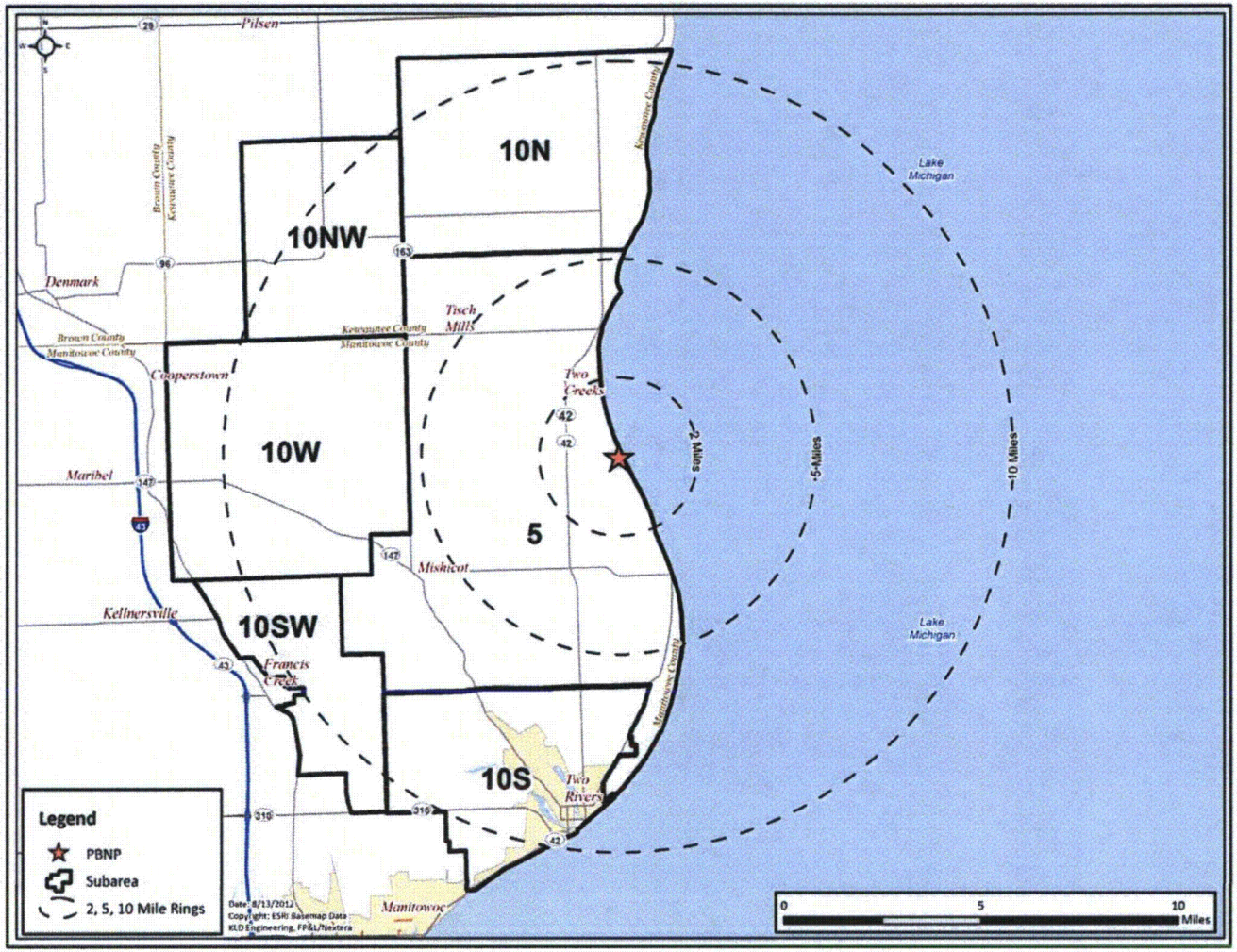



**Figure 6-1. PBNP EPZ Subareas**

**Table 6-2. Evacuation Scenario Definitions**

| Scenario | Season[1] | Day of Week | Time of Day | Weather | Special |
|---|---|---|---|---|---|
| 1 | Summer | Midweek | Midday | Good | None |
| 2 | Summer | Midweek | Midday | Rain | None |
| 3 | Summer | Weekend | Midday | Good | None |
| 4 | Summer | Weekend | Midday | Rain | None |
| 5 | Summer | Midweek, Weekend | Evening | Good | None |
| 6 | Winter | Midweek | Midday | Good | None |
| 7 | Winter | Midweek | Midday | Rain | None |
| 8 | Winter | Midweek | Midday | Snow | None |
| 9 | Winter | Weekend | Midday | Good | None |
| 10 | Winter | Weekend | Midday | Rain | None |
| 11 | Winter | Weekend | Midday | Snow | None |
| 12 | Winter | Midweek, Weekend | Evening | Good | None |
| 13 | Winter | Midweek | Midday | Good | Plant outage at Kewaunee Power Station |
| 14 | Summer | Midweek | Midday | Good | Roadway Impact – Close SB lane on SR 42 |

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

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

| Scenario | Households With Returning Commuters | Households Without Returning Commuters | Employees | Transients | Shadow | Special Events | School Buses | Transit Buses | External Through Traffic |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 26% | 74% | 96% | 75% | 22% | 0% | 10% | 100% | 100% |
| 2 | 26% | 74% | 96% | 75% | 22% | 0% | 10% | 100% | 100% |
| 3 | 3% | 97% | 10% | 100% | 20% | 0% | 0% | 100% | 100% |
| 4 | 3% | 97% | 10% | 100% | 20% | 0% | 0% | 100% | 100% |
| 5 | 3% | 97% | 10% | 63% | 20% | 0% | 0% | 100% | 40% |
| 6 | 26% | 74% | 100% | 41% | 22% | 0% | 100% | 100% | 100% |
| 7 | 26% | 74% | 100% | 41% | 22% | 0% | 100% | 100% | 100% |
| 8 | 26% | 74% | 100% | 41% | 22% | 0% | 100% | 100% | 100% |
| 9 | 3% | 97% | 10% | 55% | 20% | 0% | 0% | 100% | 100% |
| 10 | 3% | 97% | 10% | 55% | 20% | 0% | 0% | 100% | 100% |
| 11 | 3% | 97% | 10% | 55% | 20% | 0% | 0% | 100% | 100% |
| 12 | 3% | 97% | 10% | 35% | 20% | 0% | 0% | 100% | 40% |
| 13 | 26% | 74% | 100% | 41% | 22% | 100% | 100% | 100% | 100% |
| 14 | 26% | 74% | 96% | 75% | 22% | 0% | 10% | 100% | 100% |

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

**Table 6-4. Vehicle Estimates by Scenario**

| Scenario | Households With Returning Commuters | Households Without Returning Commuters | Employees | Transients | Shadow | Special Events | School Buses | Transit Buses | External Through Traffic | Total Scenario Vehicles |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2,852 | 8,284 | 978 | 1,226 | 3,641 | 0 | 12 | 26 | 4,384 | 21,403 |
| 2 | 2,852 | 8,284 | 978 | 1,226 | 3,641 | 0 | 12 | 26 | 4,384 | 21,403 |
| 3 | 285 | 10,851 | 102 | 1,635 | 3,377 | 0 | 0 | 26 | 4,384 | 20,660 |
| 4 | 285 | 10,851 | 102 | 1,635 | 3,377 | 0 | 0 | 26 | 4,384 | 20,660 |
| 5 | 285 | 10,851 | 102 | 1,030 | 3,377 | 0 | 0 | 26 | 1,754 | 17,425 |
| 6 | 2,852 | 8,284 | 1,019 | 670 | 3,653 | 0 | 118 | 26 | 4,384 | 21,006 |
| 7 | 2,852 | 8,284 | 1,019 | 670 | 3,653 | 0 | 118 | 26 | 4,384 | 21,006 |
| 8 | 2,852 | 8,284 | 1,019 | 670 | 3,653 | 0 | 118 | 26 | 4,384 | 21,006 |
| 9 | 285 | 10,851 | 102 | 899 | 3,377 | 0 | 0 | 26 | 4,384 | 19,924 |
| 10 | 285 | 10,851 | 102 | 899 | 3,377 | 0 | 0 | 26 | 4,384 | 19,924 |
| 11 | 285 | 10,851 | 102 | 899 | 3,377 | 0 | 0 | 26 | 4,384 | 19,924 |
| 12 | 285 | 10,851 | 102 | 572 | 3,377 | 0 | 0 | 26 | 1,754 | 16,967 |
| 13 | 2,852 | 8,284 | 1,019 | 670 | 3,653 | 769 | 118 | 26 | 4,384 | 21,775 |
| 14 | 2,852 | 8,284 | 978 | 1,226 | 3,641 | 0 | 12 | 26 | 4,384 | 21,403 |

Note: Vehicle estimates are for an evacuation of the entire EPZ (Region R02)

# 7 GENERAL POPULATION EVACUATION TIME ESTIMATES (ETE)

This section presents the ETE results of the computer analyses using the DYNEV II System described in Appendices B, C and D. These results cover 19 regions within the PBNP EPZ and the 14 Evacuation Scenarios discussed in Section 6.

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

## 7.1 Voluntary Evacuation and Shadow Evacuation

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

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

Figure 7-2 presents the area identified as the Shadow Region. This region extends radially from the plant to cover a region between the EPZ boundary and approximately 15 miles. The population and number of evacuating vehicles in the Shadow Region were estimated using the same methodology that was used for permanent residents within the EPZ (see Section 3.1). As discussed in Section 3.2, it is estimated that a total of 31,504 people reside in the Shadow Region; 20 percent of them would evacuate. See Table 6-4 for the number of evacuating vehicles from the Shadow Region.

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

## 7.2 Staged Evacuation

For this study, staged evacuation consists of the following:

1. Subareas comprising the 5 mile region are advised to evacuate immediately.
2. Subareas comprising regions extending from 5 to 10 miles downwind are advised to shelter in-place while the five mile region is cleared.

3. As vehicles evacuate the 5 mile region, people from 5 to 10 miles downwind continue preparation for evacuation while they shelter.
4. The population sheltering in the 5 to 10 mile region is advised to evacuate when approximately 90% of the 5 mile region evacuating traffic crosses the 5 mile region boundary.
5. Non-compliance with the shelter recommendation is the same as the shadow evacuation percentage of 20%.

See Section 5.4.2 for additional information on staged evacuation.

## 7.3 Patterns of Traffic Congestion during Evacuation

Figure 7-3 through Figure 7-7 illustrate the patterns of traffic congestion that arise for the case when the entire EPZ (Region R02) 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 (HCM 2010, page 5-5):

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

All highway "links" which experience LOS F are delineated in these Figures by a thick red line; all others are lightly indicated.

At 30 minutes after the ATE, the population is beginning to mobilize.

Figure 7-3 displays congestion beginning to develop in the City of Two Rivers and the City of Manitowoc which lies in the shadow region. The 5-mile region never experiences congestion, with roadways exhibiting LOS C or lower.

At 1 hour after the ATE, Figure 7-4 shows that the city of Two Rivers is fully congested and congestion persists in the City of Manitowoc in the southern portion of the Shadow Region.

Congestion begins to build at the roundabouts along SR 310 with CR B and CR Q. Evacuees from Two Rivers are utilizing SR-310 to access the Manitowoc County Highway Shop (Reception Center) and I 43. Evacuating vehicles reduce their speeds to 20 mph to navigate these roundabouts causing significant congestion along this route. Evacuees have begun to seek alternate access out of the EPZ causing congestion to build along Mirro Dr at the intersection with SR 42.

At 2 hours and after the ATE, Figure 7-5 shows that congestion in Two Rivers and Manitowoc begin to dissipate. Congestion persists at the roundabouts along SR 310 and along Mirro Dr at the intersection with SR 42.

Figure 7-6 shows congestion on SR 310 begins to clear at 2 hours and 30 minutes after the ATE. Congestion persists along Mirro Dr at the intersection with SR 42. Congestion also persists in Manitowoc and continues to dissipate in Two Rivers.

Figure 7-7 shows the EPZ is essentially clear of congestion at 3 hours after the ATE. The last remnants of congestion are along Mirro Dr. The stop sign at this intersection impedes the flow of evacuees who have chosen this alternate route out of the EPZ. This congestion clears at 3 hours and 15 minutes after the ATE.

## 7.4 Evacuation Rates

Evacuation is a continuous process, as implied by Figure 7-8 through Figure 7-21. These figures indicate the rate at which traffic flows out of the indicated areas for the case of an evacuation of the full EPZ (Region R02) under the indicated conditions. One figure is presented for each scenario considered.

As indicated in Figure 7-8, there is typically a long "tail" to these distributions. Vehicles begin to evacuate an area slowly at first, as people respond to the ATE at different rates. Then traffic demand builds rapidly (slopes of curves increase). When the system becomes congested, traffic exits the EPZ at rates somewhat below capacity until some evacuation routes have cleared. As more routes clear, the aggregate rate of egress slows since many vehicles have already left the EPZ. Towards the end of the process, relatively few evacuation routes service the remaining demand.

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

## 7.5 Evacuation Time Estimate (ETE) Results

Table 7-1 and Table 7-2 present the ETE values for all 19 Evacuation Regions and all 14 Evacuation Scenarios. Table 7-3 and Table 7-4 present the ETE values for the 5-Mile region for both staged and un-staged keyhole regions downwind to 10 miles. The tables are organized as follows:

| Table | Contents |
|---|---|
| 7-1 | ETE represents the elapsed time required for 90 percent of the population within a Region, to evacuate from that Region. All Scenarios are considered, as well as Staged Evacuation scenarios. |
| 7-2 | ETE represents the elapsed time required for 100 percent of the population within a Region, to evacuate from that Region. All Scenarios are considered, as well as Staged Evacuation scenarios. |
| 7-3 | ETE represents the elapsed time required for 90 percent of the population within the 5-mile Region, to evacuate from that Region with both Concurrent and Staged Evacuations. |
| 7-4 | ETE represents the elapsed time required for 100 percent of the population within the 5-mile Region, to evacuate from that Region with both Concurrent and Staged Evacuations. |

The animation snapshots described above reflect the ETE statistics for the concurrent (un-staged) evacuation scenarios and regions, which are displayed in
Figure 7-3 through Figure 7-7. All of the congestion in the EPZ is located in Two Rivers (subarea 10S) which is beyond the 5-mile area; this is reflected in the ETE statistics:

- The 90$^{th}$ percentile ETE for Region R01 (5-mile region) ranges between 1:35 and 1:40 (higher during snow scenarios).
- The 90$^{th}$ percentile ETE for regions which extend to the EPZ boundary are significantly longer and range from 2:20 to 2:45 (slightly higher during snow scenarios).

The 100$^{th}$ percentile ETE for all regions and scenarios parallel mobilization time. This fact implies that the congestion within the EPZ dissipates prior to the end of mobilization under typical conditions, as is displayed in Figure 7-7.

Comparison of Scenarios 6 and 13 in Table 7-1 indicates that the Special Event – an outage at Kewaunee Power Station (KPS) – does not materially impact ETE at the 90$^{th}$ percentile. There is sufficient capacity to accommodate the additional 769 employee vehicles at the KPS. For some regions, the resulting ETE is slightly (5 minutes) less during an outage because the additional workers mobilize at the same rate as employees (see Table 5-9).

Comparison of Scenarios 1 and 14 in Table 7-1 indicates that the roadway closure – a single lane on SR 42/Memorial Dr. Southbound – significantly impacts the 90th percentile ETE for evacuating regions which include Two Rivers (subarea 10S) with increases of up to 45 minutes.

Winds toward the south carry the plume over Two Rivers, which routes traffic onto SR 42/Memorial Dr southbound. With one lane closed, the capacity of SR 42/Memorial Dr is reduced to half, increasing congestion and prolonging ETE. The roadway closure has no effect on regions which do not involve the evacuation of Two Rivers. The roadway impact scenario also materially impacts the 100$^{th}$ percentile ETE with increases of up 25 minutes.

The results of the roadway impact scenario indicate that events such as adverse weather or traffic accidents which close a lane on SR 42/Memorial Dr could impact ETE. State and local police should consider traffic management tactics such as using the shoulder of the roadway as a travel lane or re-routing traffic along other evacuation routes to avoid overwhelming SR 42/Memorial Dr. All efforts should be made to remove the blockage along SR 42/Memorial Dr, particularly within the first 2 ½ hours of the evacuation.

## 7.6 Staged Evacuation Results

Table 7-3 and Table 7-4 present a comparison of the ETE compiled for the concurrent (un-staged) and staged evacuation studies. Note that Regions R10 through R17 are the same geographic areas as Regions R03 through R09 and R02, respectively.

To determine whether the staged evacuation strategy is worthy of consideration, one must show that the ETE for the 5 Mile region can be reduced without significantly affecting the region between 5 miles and 10 miles. As shown in Figure 7-4 traffic in the 5 to 10-mile region never accumulates to a point where it would become an impedance to those evacuees from within the 5-mile region. In all cases, as shown in these tables, the ETE for the 5 mile region is unchanged when a staged evacuation is implemented.

While failing to provide assistance to evacuees from within 5 miles of the PBNP, staging produces a negative impact on the ETE for those evacuating from within the 10-mile region. A comparison of ETE between Regions R10 through R17 and R03 through R09 and R02; reveals that staging retards the 90$^{th}$ percentile evacuation time for those in the 5 to 10-mile area by up to 20 minutes (see Table 7-1). This extending of ETE is due to the delay in beginning the evacuation trip experienced by those who shelter, plus the effect of the trip-generation "spike" (significant volume of traffic beginning the evacuation trip at the same time) that follows the eventual ATE, in creating congestion within the EPZ beyond 5 miles.

In summary, the staged evacuation protective action strategy provides no benefits to evacuees from within 5 miles and adversely impacts many evacuees located beyond 5 miles from the PBNP.

## 7.7 Guidance on Using ETE Tables

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

1. Identify the applicable **Scenario**:
   - Season
     - Summer
     - Winter (also Autumn and Spring)
   - Day of Week
     - Midweek
     - Weekend
   - Time of Day
     - Midday
     - Evening
   - Weather Condition
     - Good Weather
     - Rain
     - Snow
   - Special Event
     - Outage at Kewaunee Power Station
     - Road Closure (One southbound lane on SR 42/Memorial Dr.)
   - Evacuation Staging
     - No, Staged Evacuation is not considered
     - Yes, Staged Evacuation is considered

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

- The conditions of a summer evening (either midweek or weekend) and rain are not explicitly identified in the Tables. For these conditions, Scenarios (2) and (4) apply.
- The conditions of a winter evening (either midweek or weekend) and rain are not explicitly identified in the Tables. For these conditions, Scenarios (7) and (10) for rain apply.
- The conditions of a winter evening (either midweek or weekend) and snow are not explicitly identified in the Tables. For these conditions, Scenarios (8) and (11) for snow apply.
- The seasons are defined as follows:
  - Summer assumes that public schools are not in session.
  - Winter (includes Spring and Autumn) considers that public schools are in session.
- Time of Day: Midday implies the time over which most commuters are at work or are travelling to/from work.

2. With the desired percentile ETE and Scenario identified, now identify the **Evacuation Region**:
   - Determine the projected azimuth direction of the plume (coincident with the wind direction). This direction is expressed in terms of compass orientation in compass direction. Determine the distance that the Evacuation Region will extend from the nuclear power plant. The applicable distances and their associated candidate Regions are given below:
     - 5 Miles (Region R01)
     - To EPZ Boundary (Regions R02 through R19)
   - Enter Table 7-5 and identify the applicable group of candidate Regions based on the distance that the selected Region extends from the PBNP. Select the Evacuation Region identifier in that row, based on the azimuth direction of the plume, from the first column of the Table.
3. Determine the **ETE Table** based on the **percentile** selected. Then, for the **Scenario** identified in Step 1 and the **Region** identified in Step 2, proceed as follows:
   - The columns of Table 7-1 are labeled with the Scenario numbers. Identify the proper column in the selected Table using the Scenario number defined in Step 1.
   - Identify the row in this table that provides ETE values for the Region identified in Step 2.
   - The unique data cell defined by the column and row so determined contains the desired value of ETE expressed in Hours:Minutes.

Example

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

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

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

1. Identify the Scenario as summer, weekend, evening and raining. Entering Table 7-1, it is seen that there is no match for these descriptors. However, the clarification given above assigns this combination of circumstances to Scenario 4.
2. Enter Table 7-5 and locate the Region described as "Evacuate 5-Mile Radius and Downwind to the EPZ Boundary" for wind direction from NNE and read Region R04 in the first column of that row.
3. Enter Table 7-1 to locate the data cell containing the value of ETE for Scenario 4 and Region R04. This data cell is in column (4) and in the row for Region R04; it contains the ETE value of **2:45**.

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

| | Summer | | Summer | | Summer | Winter | | | Winter | | | Winter | Winter | Summer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Midweek | | Weekend | | Midweek Weekend | Midweek | | | Weekend | | | Midweek Weekend | Midweek | Midweek |
| Scenario: | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
| | Midday | | Midday | | Evening | Midday | | | Midday | | | Evening | Midday | Midday |
| Region | Good Weather | Rain | Good Weather | Rain | Good Weather | Good Weather | Rain | Snow | Good Weather | Rain | Snow | Good Weather | Special Event | Roadway Impact |
| **Entire 5-Mile Region, and EPZ** | | | | | | | | | | | | | | |
| **R01** | 1:40 | 1:40 | 1:30 | 1:30 | 1:35 | 1:45 | 1:45 | 2:10 | 1:35 | 1:35 | 2:10 | 1:35 | 1:35 | 1:40 |
| **R02** | 2:25 | 2:35 | 2:25 | 2:35 | 2:25 | 2:20 | 2:30 | 2:55 | 2:20 | 2:35 | 2:55 | 2:20 | 2:15 | 3:00 |
| **5-Mile Region and Keyhole to EPZ Boundary** | | | | | | | | | | | | | | |
| **R03** | 2:25 | 2:40 | 2:30 | 2:45 | 2:25 | 2:20 | 2:40 | 2:55 | 2:25 | 2:40 | 3:00 | 2:20 | 2:25 | 3:10 |
| **R04** | 2:25 | 2:35 | 2:25 | 2:45 | 2:25 | 2:25 | 2:35 | 2:50 | 2:20 | 2:35 | 2:55 | 2:20 | 2:20 | 3:10 |
| **R05** | 2:25 | 2:35 | 2:25 | 2:35 | 2:25 | 2:20 | 2:35 | 2:55 | 2:25 | 2:35 | 2:55 | 2:20 | 2:20 | 3:05 |
| **R06** | 1:50 | 1:50 | 1:40 | 1:40 | 1:40 | 1:50 | 1:55 | 2:20 | 1:40 | 1:45 | 2:15 | 1:45 | 1:50 | 1:50 |
| **R07** | 1:50 | 1:50 | 1:35 | 1:40 | 1:40 | 1:50 | 1:50 | 2:20 | 1:40 | 1:40 | 2:15 | 1:40 | 1:45 | 1:50 |
| **R08** | 1:45 | 1:45 | 1:35 | 1:35 | 1:35 | 1:50 | 1:50 | 2:15 | 1:35 | 1:40 | 2:10 | 1:40 | 1:45 | 1:45 |
| **R09** | 1:45 | 1:45 | 1:35 | 1:35 | 1:35 | 1:45 | 1:45 | 2:15 | 1:35 | 1:35 | 2:10 | 1:40 | 1:40 | 1:45 |
| **Staged Evacuation - 5-Mile Region and Keyhole to EPZ Boundary** | | | | | | | | | | | | | | |
| **R10** | 3:00 | 3:10 | 2:55 | 3:05 | 2:55 | 3:00 | 3:10 | 3:50 | 2:55 | 3:05 | 3:55 | 3:00 | 3:00 | 3:30 |
| **R11** | 3:00 | 3:05 | 2:55 | 3:00 | 2:55 | 3:00 | 3:10 | 3:45 | 2:55 | 3:05 | 3:45 | 2:55 | 3:00 | 3:30 |
| **R12** | 3:00 | 3:05 | 2:50 | 3:00 | 2:55 | 3:00 | 3:10 | 3:45 | 2:55 | 3:00 | 3:45 | 2:55 | 2:55 | 3:25 |
| **R13** | 2:00 | 2:00 | 2:00 | 2:00 | 2:00 | 2:00 | 2:00 | 2:30 | 2:00 | 2:00 | 2:30 | 2:00 | 2:00 | 2:00 |
| **R14** | 2:00 | 2:00 | 2:00 | 2:00 | 2:00 | 2:00 | 2:00 | 2:30 | 2:00 | 2:00 | 2:30 | 2:00 | 2:00 | 2:00 |
| **R15** | 1:55 | 2:00 | 1:55 | 1:55 | 1:55 | 2:00 | 2:00 | 2:30 | 2:00 | 2:00 | 2:30 | 2:00 | 1:55 | 1:55 |
| **R16** | 1:55 | 1:55 | 1:55 | 1:55 | 1:55 | 1:55 | 1:55 | 2:25 | 1:55 | 1:55 | 2:25 | 1:55 | 1:55 | 1:55 |
| **R17** | 3:00 | 3:05 | 2:50 | 3:00 | 2:50 | 2:55 | 3:10 | 3:45 | 2:50 | 3:00 | 3:40 | 2:50 | 2:55 | 3:25 |
| **PBNP Specific Regions** | | | | | | | | | | | | | | |
| **R18** | 2:25 | 2:35 | 2:25 | 2:35 | 2:25 | 2:20 | 2:35 | 2:55 | 2:25 | 2:35 | 2:55 | 2:20 | 2:20 | 3:05 |
| **R19** | 1:50 | 1:50 | 1:40 | 1:40 | 1:40 | 1:55 | 1:55 | 2:20 | 1:40 | 1:45 | 2:15 | 1:45 | 1:50 | 1:50 |

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

| | Summer | | Summer | | Summer | Winter | | | Winter | | | Winter | Winter | Summer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Midweek | | Weekend | | Midweek Weekend | Midweek | | | Weekend | | | Midweek Weekend | Midweek | Midweek |
| Scenario: | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
| | Midday | | Midday | | Evening | Midday | | | Midday | | | Evening | Midday | Midday |
| Region | Good Weather | Rain | Good Weather | Rain | Good Weather | Good Weather | Rain | Snow | Good Weather | Rain | Snow | Good Weather | Special Event | Roadway Impact |
| **Entire 5-Mile Region, and EPZ** | | | | | | | | | | | | | | |
| **R01** | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 3:35 |
| **R02** | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 4:25 | 3:40 | 3:40 | 4:25 | 3:40 | 3:40 | 4:00 |
| **5-Mile Region and Keyhole to EPZ Boundary** | | | | | | | | | | | | | | |
| **R03** | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 4:25 | 3:40 | 3:40 | 4:25 | 3:40 | 3:40 | 4:05 |
| **R04** | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 4:25 | 3:40 | 3:40 | 4:25 | 3:40 | 3:40 | 4:00 |
| **R05** | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 4:25 | 3:40 | 3:40 | 4:25 | 3:40 | 3:40 | 4:05 |
| **R06** | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 4:25 | 3:40 | 3:40 | 4:25 | 3:40 | 3:40 | 3:40 |
| **R07** | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 4:25 | 3:40 | 3:40 | 4:25 | 3:40 | 3:40 | 3:40 |
| **R08** | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 4:25 | 3:40 | 3:40 | 4:25 | 3:40 | 3:40 | 3:40 |
| **R09** | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 4:25 | 3:40 | 3:40 | 4:25 | 3:40 | 3:40 | 3:40 |
| **Staged Evacuation - 5-Mile Region and Keyhole to EPZ Boundary** | | | | | | | | | | | | | | |
| **R10** | 3:50 | 4:00 | 3:50 | 3:50 | 3:45 | 3:50 | 4:00 | 4:40 | 3:45 | 3:55 | 4:30 | 3:45 | 3:50 | 4:15 |
| **R11** | 3:50 | 4:00 | 3:50 | 3:50 | 3:45 | 3:55 | 4:00 | 4:35 | 3:45 | 3:50 | 4:25 | 3:45 | 3:55 | 4:20 |
| **R12** | 3:50 | 3:55 | 3:50 | 3:55 | 3:45 | 3:55 | 4:00 | 4:35 | 3:45 | 3:50 | 4:25 | 3:45 | 3:55 | 4:20 |
| **R13** | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 4:25 | 3:40 | 3:40 | 4:25 | 3:40 | 3:40 | 3:40 |
| **R14** | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 4:25 | 3:40 | 3:40 | 4:25 | 3:40 | 3:40 | 3:40 |
| **R15** | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 4:25 | 3:40 | 3:40 | 4:25 | 3:40 | 3:40 | 3:40 |
| **R16** | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 4:25 | 3:40 | 3:40 | 4:25 | 3:40 | 3:40 | 3:40 |
| **R17** | 3:50 | 3:50 | 3:50 | 3:55 | 3:45 | 3:55 | 4:00 | 4:35 | 3:45 | 3:45 | 4:25 | 3:45 | 3:55 | 4:20 |
| **PBNP Specific Regions** | | | | | | | | | | | | | | |
| **R18** | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 4:25 | 3:40 | 3:40 | 4:25 | 3:40 | 3:40 | 4:00 |
| **R19** | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 3:40 | 4:25 | 3:40 | 3:40 | 4:25 | 3:40 | 3:40 | 3:40 |

**Table 7-3. Time to Clear 90 Percent of the 5-Mile Area within the Indicated Region**

| | Summer | | Summer | | Summer | Winter | | | Winter | | | Winter | Winter | Summer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Midweek | | Weekend | | Midweek Weekend | Midweek | | | Weekend | | | Midweek Weekend | Midweek | Midweek |
| Scenario: | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
| Region | Midday | | Midday | | Evening | Midday | | | Midday | | | Evening | Midday | Midday |
| | Good Weather | Rain | Good Weather | Rain | Good Weather | Good Weather | Rain | Snow | Good Weather | Rain | Snow | Good Weather | Special Event | Roadway Impact |
| **Entire 5-Mile Region, and EPZ** | | | | | | | | | | | | | | |
| **R01** | 1:40 | 1:40 | 1:30 | 1:30 | 1:35 | 1:45 | 1:45 | 2:10 | 1:35 | 1:35 | 2:10 | 1:35 | 1:35 | 1:40 |
| **R02** | 1:40 | 1:40 | 1:30 | 1:35 | 1:35 | 1:45 | 1:45 | 2:15 | 1:35 | 1:35 | 2:10 | 1:40 | 1:40 | 1:40 |
| **Unstaged Evacuation - 5-Mile Region and Keyhole to EPZ Boundary** | | | | | | | | | | | | | | |
| **R03** | 1:40 | 1:40 | 1:30 | 1:30 | 1:35 | 1:45 | 1:45 | 2:10 | 1:35 | 1:35 | 2:10 | 1:35 | 1:40 | 1:40 |
| **R04** | 1:40 | 1:40 | 1:30 | 1:35 | 1:35 | 1:45 | 1:45 | 2:10 | 1:35 | 1:35 | 2:10 | 1:40 | 1:40 | 1:40 |
| **R05** | 1:40 | 1:40 | 1:30 | 1:35 | 1:35 | 1:45 | 1:45 | 2:10 | 1:35 | 1:35 | 2:10 | 1:40 | 1:40 | 1:40 |
| **R06** | 1:40 | 1:40 | 1:30 | 1:30 | 1:35 | 1:45 | 1:45 | 2:10 | 1:35 | 1:35 | 2:10 | 1:35 | 1:40 | 1:40 |
| **R07** | 1:40 | 1:40 | 1:30 | 1:30 | 1:35 | 1:45 | 1:45 | 2:10 | 1:35 | 1:35 | 2:10 | 1:35 | 1:40 | 1:40 |
| **R08** | 1:40 | 1:40 | 1:30 | 1:30 | 1:35 | 1:45 | 1:45 | 2:10 | 1:35 | 1:35 | 2:10 | 1:35 | 1:40 | 1:40 |
| **R09** | 1:40 | 1:40 | 1:30 | 1:30 | 1:35 | 1:45 | 1:45 | 2:10 | 1:35 | 1:35 | 2:10 | 1:35 | 1:40 | 1:40 |
| **Staged Evacuation - 5-Mile Region and Keyhole to EPZ Boundary** | | | | | | | | | | | | | | |
| **R10** | 1:45 | 1:45 | 1:35 | 1:35 | 1:40 | 1:50 | 1:50 | 2:15 | 1:40 | 1:40 | 2:15 | 1:45 | 1:40 | 1:45 |
| **R11** | 1:45 | 1:45 | 1:40 | 1:40 | 1:45 | 1:50 | 1:50 | 2:20 | 1:45 | 1:45 | 2:15 | 1:45 | 1:45 | 1:45 |
| **R12** | 1:50 | 1:50 | 1:45 | 1:45 | 1:45 | 1:50 | 1:50 | 2:20 | 1:50 | 1:50 | 2:20 | 1:50 | 1:45 | 1:50 |
| **R13** | 1:50 | 1:50 | 1:45 | 1:45 | 1:45 | 1:50 | 1:50 | 2:20 | 1:45 | 1:45 | 2:20 | 1:50 | 1:45 | 1:50 |
| **R14** | 1:45 | 1:45 | 1:40 | 1:40 | 1:45 | 1:50 | 1:50 | 2:20 | 1:45 | 1:45 | 2:20 | 1:50 | 1:45 | 1:45 |
| **R15** | 1:45 | 1:45 | 1:35 | 1:35 | 1:40 | 1:45 | 1:50 | 2:15 | 1:40 | 1:40 | 2:15 | 1:45 | 1:40 | 1:45 |
| **R16** | 1:40 | 1:45 | 1:35 | 1:35 | 1:40 | 1:45 | 1:45 | 2:15 | 1:40 | 1:40 | 2:10 | 1:40 | 1:40 | 1:40 |
| **R17** | 1:50 | 1:50 | 1:45 | 1:45 | 1:50 | 1:50 | 1:50 | 2:20 | 1:50 | 1:50 | 2:20 | 1:50 | 1:45 | 1:50 |
| **Point Beach Specific Regions** | | | | | | | | | | | | | | |
| **R18** | 1:40 | 1:40 | 1:30 | 1:35 | 1:35 | 1:45 | 1:45 | 2:15 | 1:35 | 1:35 | 2:10 | 1:40 | 1:40 | 1:40 |
| **R19** | 1:40 | 1:40 | 1:30 | 1:30 | 1:35 | 1:45 | 1:45 | 2:10 | 1:35 | 1:35 | 2:10 | 1:35 | 1:40 | 1:40 |

**Table 7-4. Time to Clear *100* Percent of the 5-Mile Area within the Indicated Region**

| | Summer | | Summer | | Summer | Winter | | | Winter | | | Winter | Winter | Summer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Midweek | | Weekend | | Midweek Weekend | Midweek | | | Weekend | | | Midweek Weekend | Midweek | Midweek |
| Scenario: | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
| Region | Midday | | Midday | | Evening | Midday | | | Midday | | | Evening | Midday | Midday |
| | Good Weather | Rain | Good Weather | Rain | Good Weather | Good Weather | Rain | Snow | Good Weather | Rain | Snow | Good Weather | Special Event | Roadway Impact |
| **Entire 5-Mile Region, and EPZ** | | | | | | | | | | | | | | |
| **R01** | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 3:35 |
| **R02** | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 3:35 |
| **5-Mile Region and Keyhole to EPZ Boundary** | | | | | | | | | | | | | | |
| **R03** | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 3:35 |
| **R04** | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 3:35 |
| **R05** | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 3:35 |
| **R06** | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 3:35 |
| **R07** | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 3:35 |
| **R08** | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 3:35 |
| **R09** | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 3:35 |
| **Staged Evacuation - 5-Mile Region and Keyhole to EPZ Boundary** | | | | | | | | | | | | | | |
| **R10** | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 3:35 |
| **R11** | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 3:35 |
| **R12** | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 3:35 |
| **R13** | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 3:35 |
| **R14** | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 3:35 |
| **R15** | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 3:35 |
| **R16** | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 3:35 |
| **R17** | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 3:35 |
| **Point Beach Specific Regions** | | | | | | | | | | | | | | |
| **R18** | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 3:35 |
| **R19** | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 4:20 | 3:35 | 3:35 | 3:35 |

**Table 7-5. Description of Evacuation Regions**

| Region | Description | Subarea | | | | | |
|---|---|---|---|---|---|---|---|
| | | 5 | 10N | 10NW | 10W | 10SW | 10S |
| R01 | 2-Mile Ring | X | | | | | |
| N/A | 5-Mile Ring | Refer to Region R01 | | | | | |
| R02 | Full EPZ | X | X | X | X | X | X |
| **Evacuate 2-Mile Radius and Downwind to 5-Mile Radius** | | | | | | | |
| Region | Wind Direction From: | Subarea | | | | | |
| | | 5 | 10N | 10NW | 10W | 10SW | 10S |
| N/A | All Directions | Refer to Region R01 | | | | | |
| **Evacuate 5-Mile Radius and Downwind to EPZ Boundary** | | | | | | | |
| Region | Wind Direction From: | Subarea | | | | | |
| | | 5 | 10N | 10NW | 10W | 10SW | 10S |
| R03 | NNW, N | X | | | | | X |
| R04 | NNE | X | | | | X | X |
| R05 | NE, ENE | X | | | X | X | X |
| R06 | E | X | | X | X | X | |
| R07 | ESE, SE | X | X | X | X | | |
| R08 | SSE | X | X | X | | | |
| R09 | S, SSW | X | X | | | | |
| N/A | SW, WSW, W, WNW, NW | Refer to Region R01 | | | | | |
| **Staged Evacuation 5-Mile Radius Evacuates, then Evacuate Downwind to the EPZ Boundary** | | | | | | | |
| Region | Wind Direction From: | Subarea | | | | | |
| | | 5 | 10N | 10NW | 10W | 10SW | 10S |
| R10 | NNW, N | X | | | | | X |
| R11 | NNE | X | | | | X | X |
| R12 | NE, ENE | X | | | X | X | X |
| R13 | E | X | | X | X | X | |
| R14 | ESE, SE | X | X | X | X | | |
| R15 | SSE | X | X | X | | | |
| R16 | S, SSW | X | X | | | | |
| N/A | SW, WSW, W, WNW, NW | Refer to Region R01 | | | | | |
| R17 | Full EPZ | X | X | X | X | X | X |
| **Point Beach Specific Regions** | | | | | | | |
| Region | Description | Subarea | | | | | |
| | | 5 | 10N | 10NW | 10W | 10SW | 10S |
| R18 | PB Evac 5 | X | | X | X | X | X |
| R19 | PB Evac 7 | X | X | X | X | X | |
| Subarea(s) Shelter-in-Place until 90% ETE for R01/R02, then Evacuate | | Subarea(s) Shelter-in-Place | | | | Subarea(s) Evacuate | |

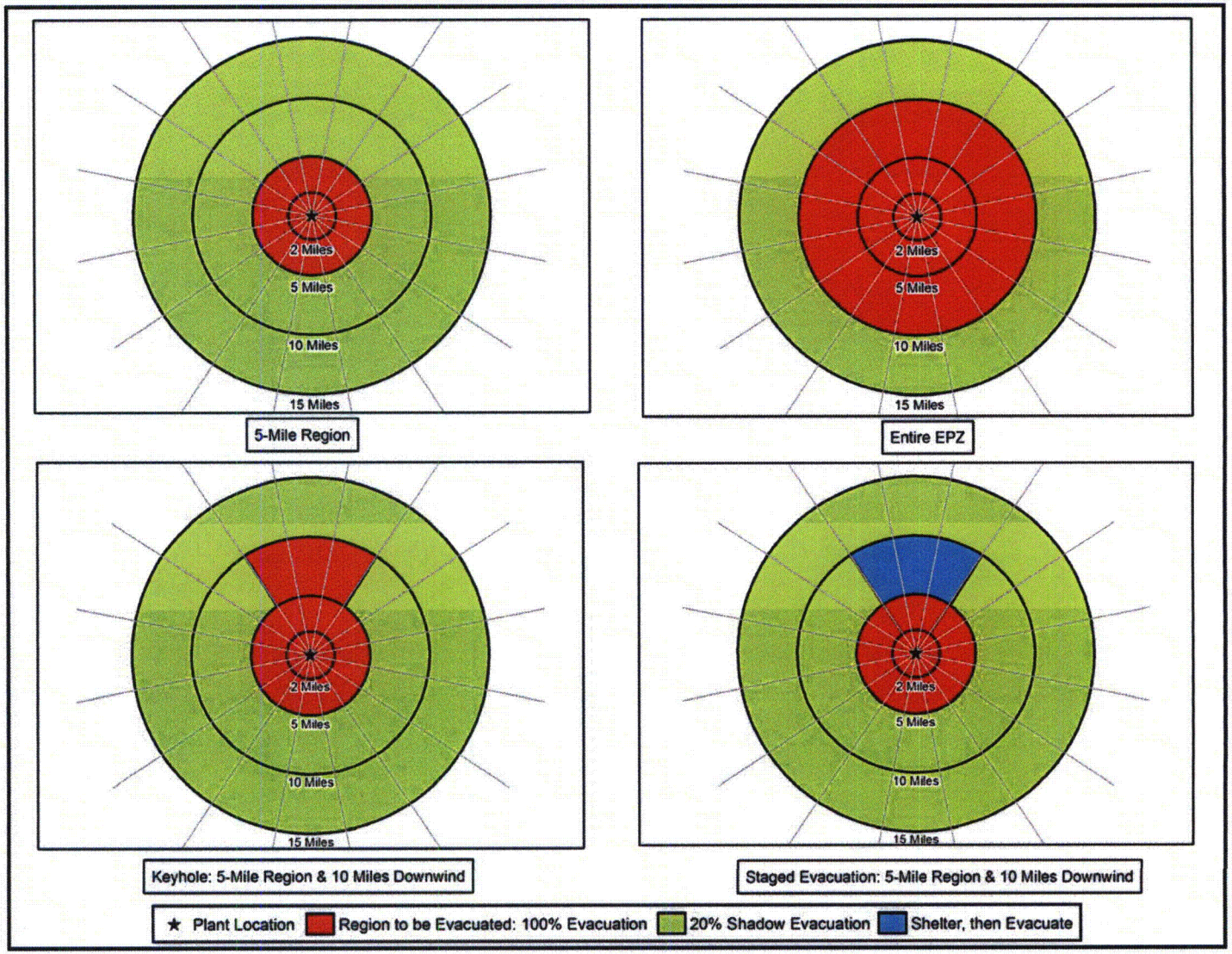



**Figure 7-1. Voluntary Evacuation Methodology**

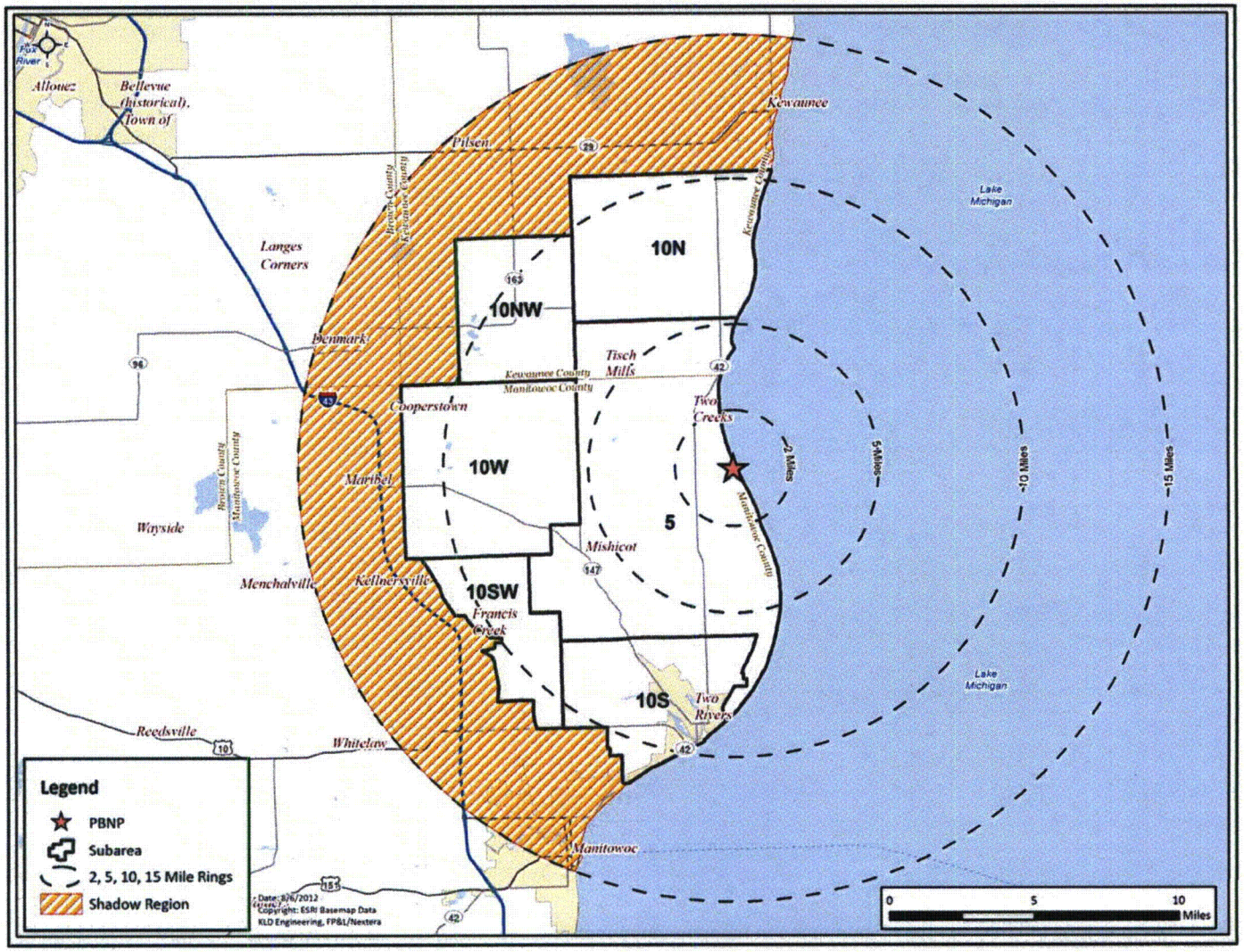



**Figure 7-2. PBNP Shadow Region**

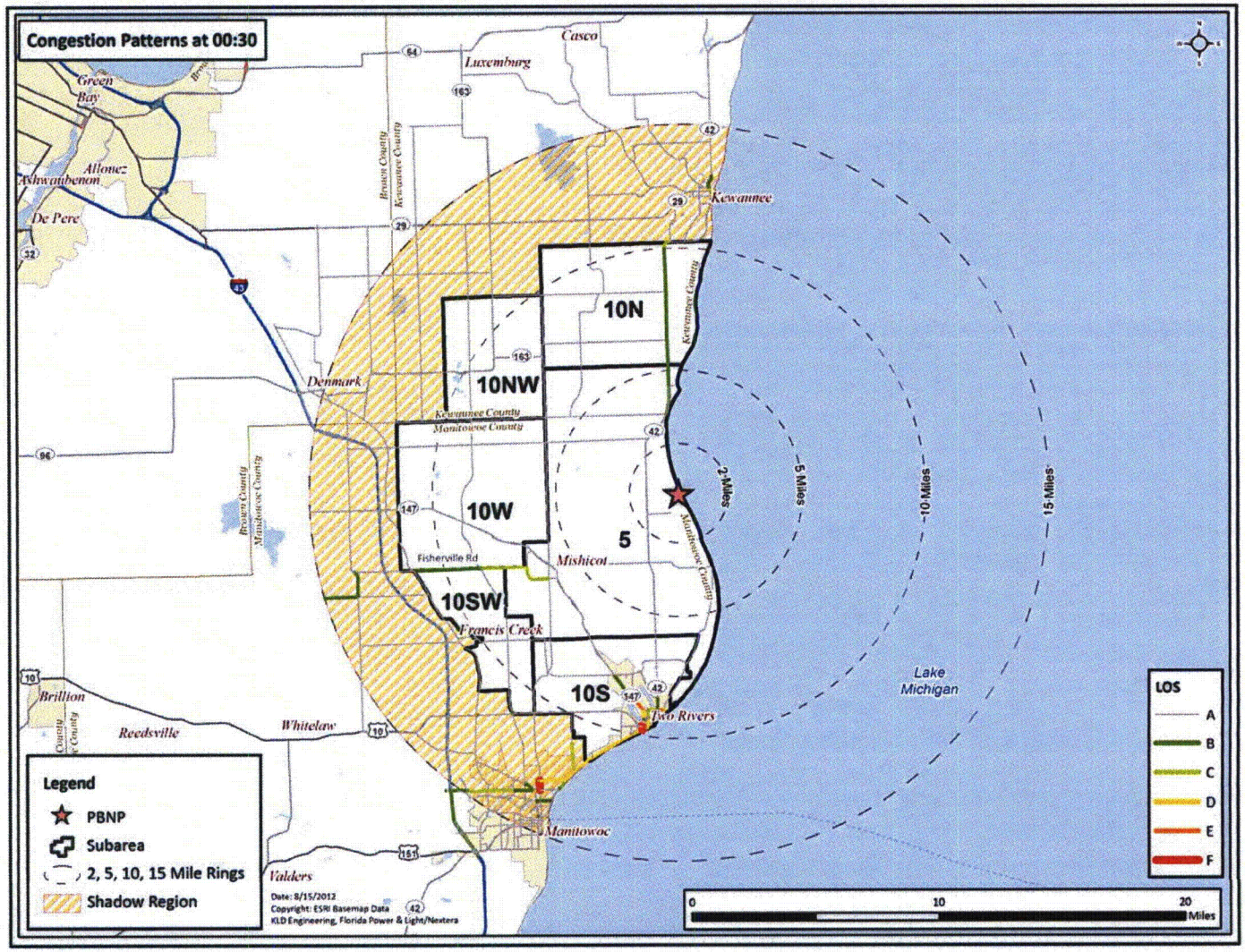



**Figure 7-3. Congestion Patterns at 30 Minutes after the Advisory to Evacuate**

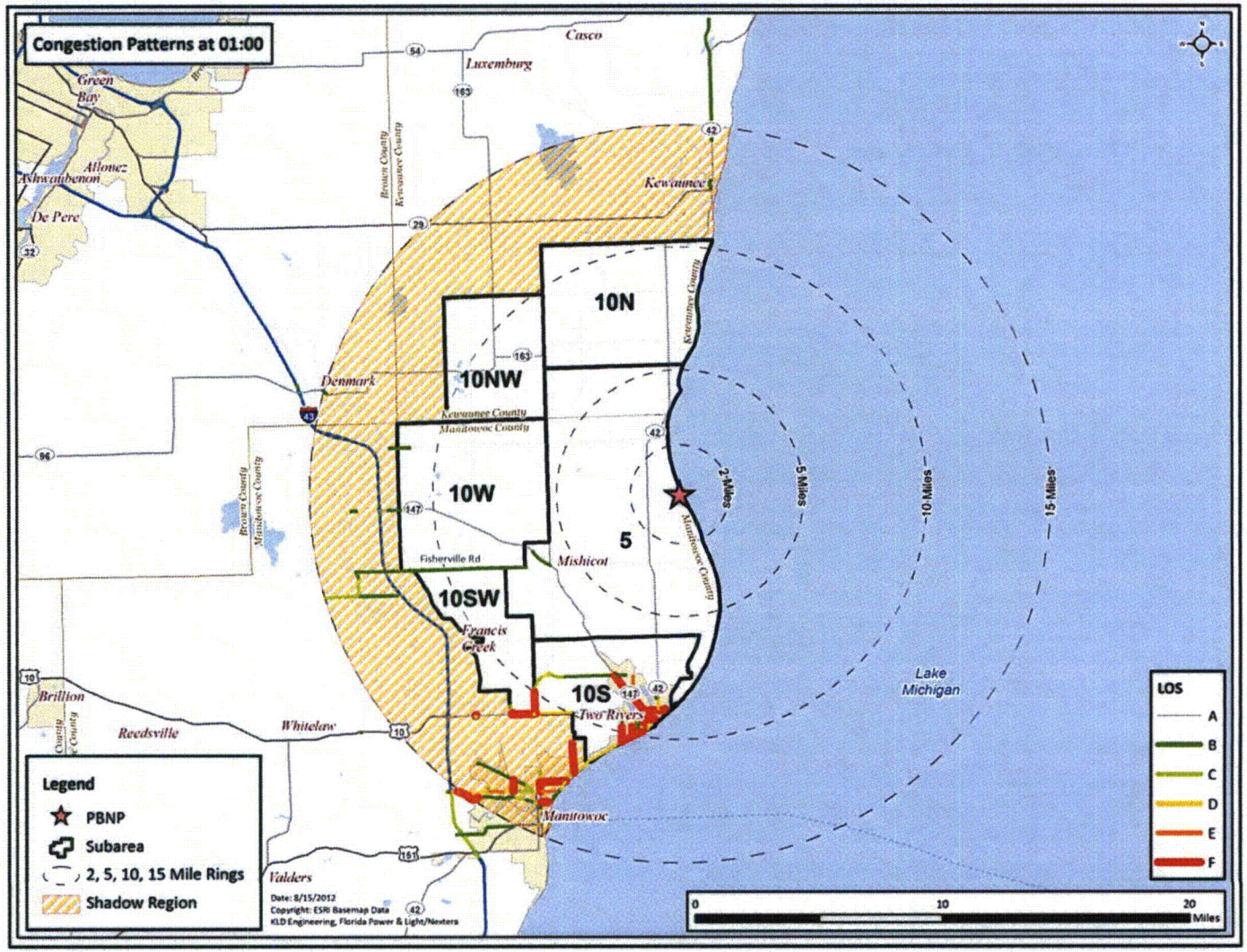



**Figure 7-4. Congestion Patterns at 1 Hour after the Advisory to Evacuate**

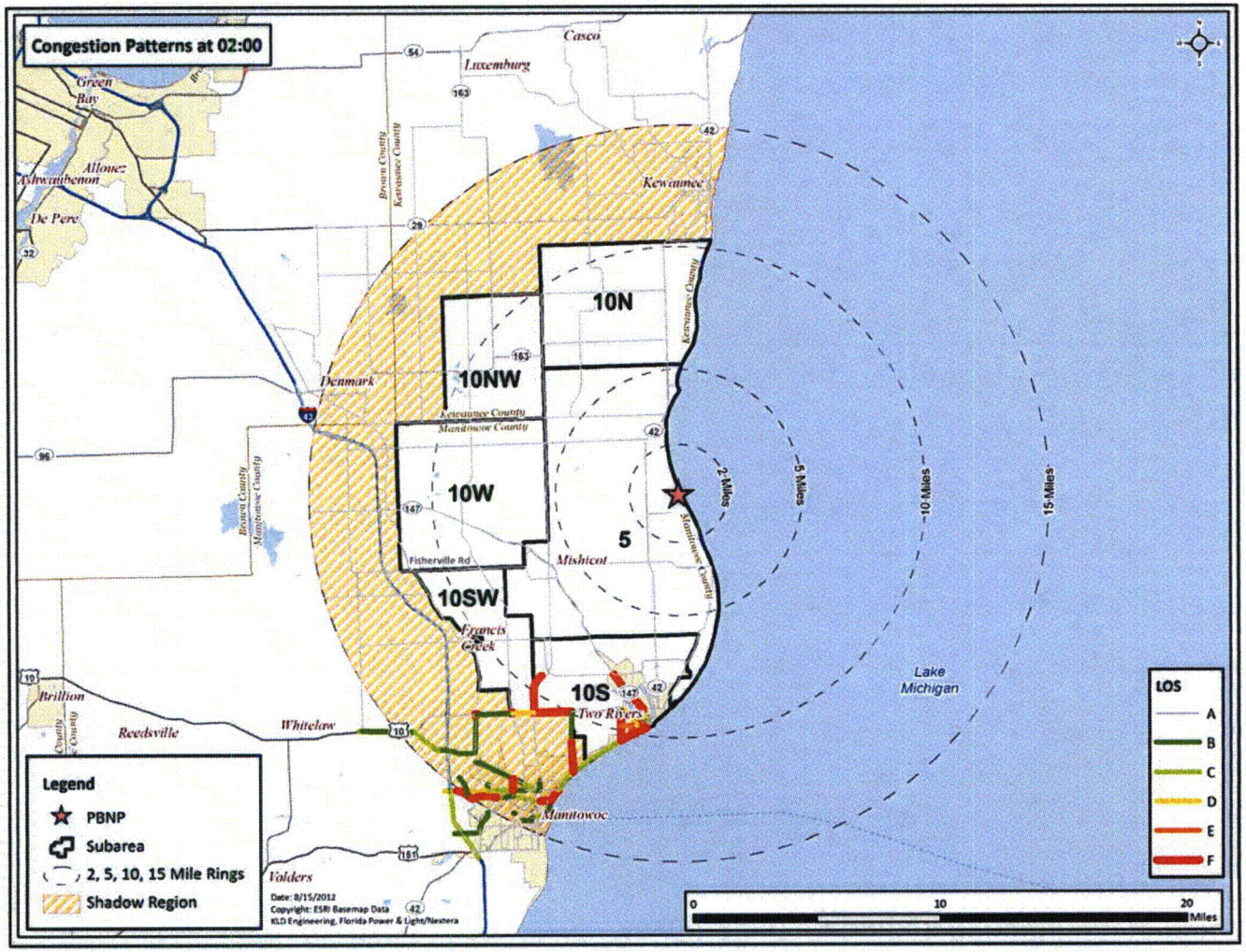



**Figure 7-5. Congestion Patterns at 2 Hours after the Advisory to Evacuate**

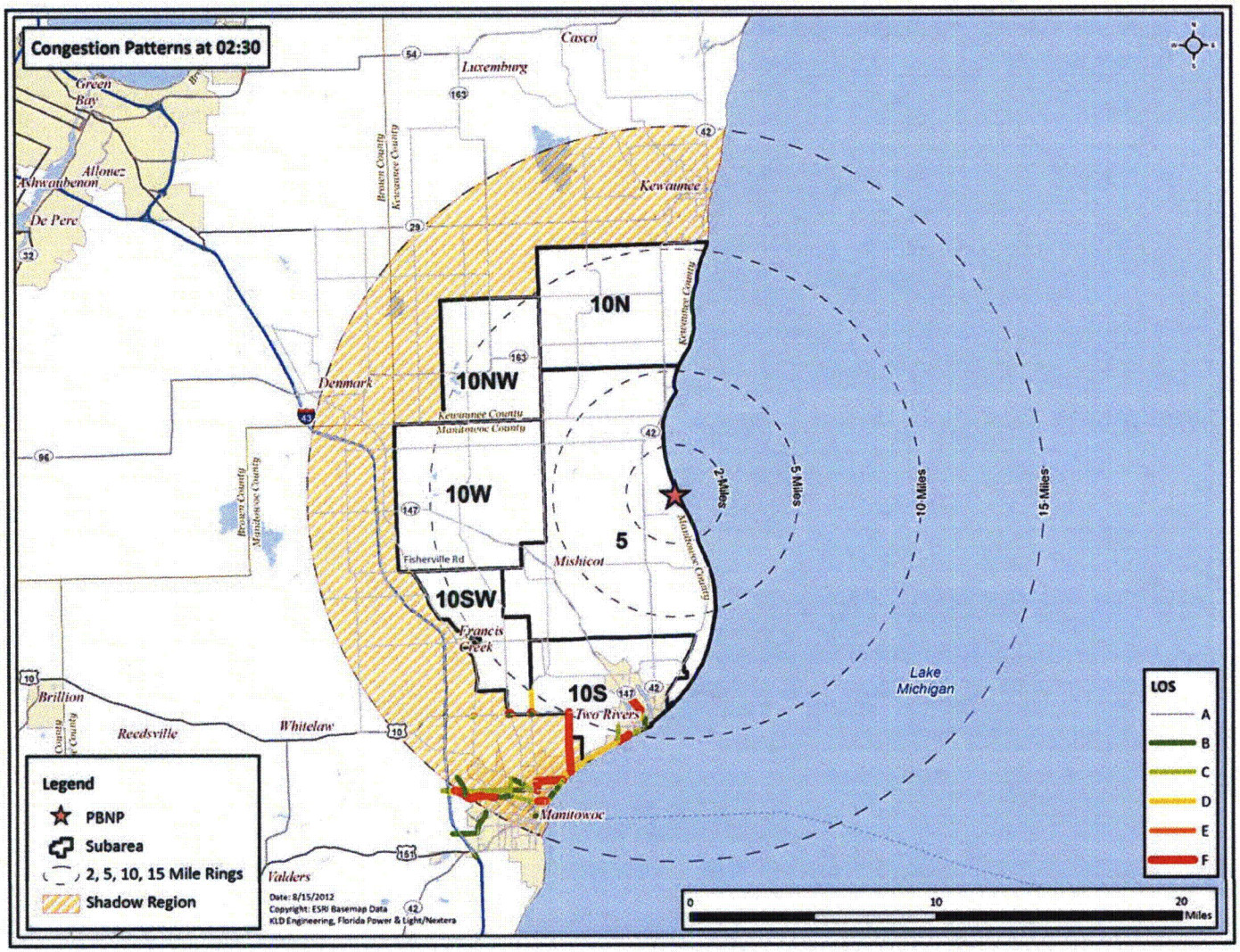



**Figure 7-6. Congestion Patterns at 2 Hours, 30 Minutes after the Advisory to Evacuate**

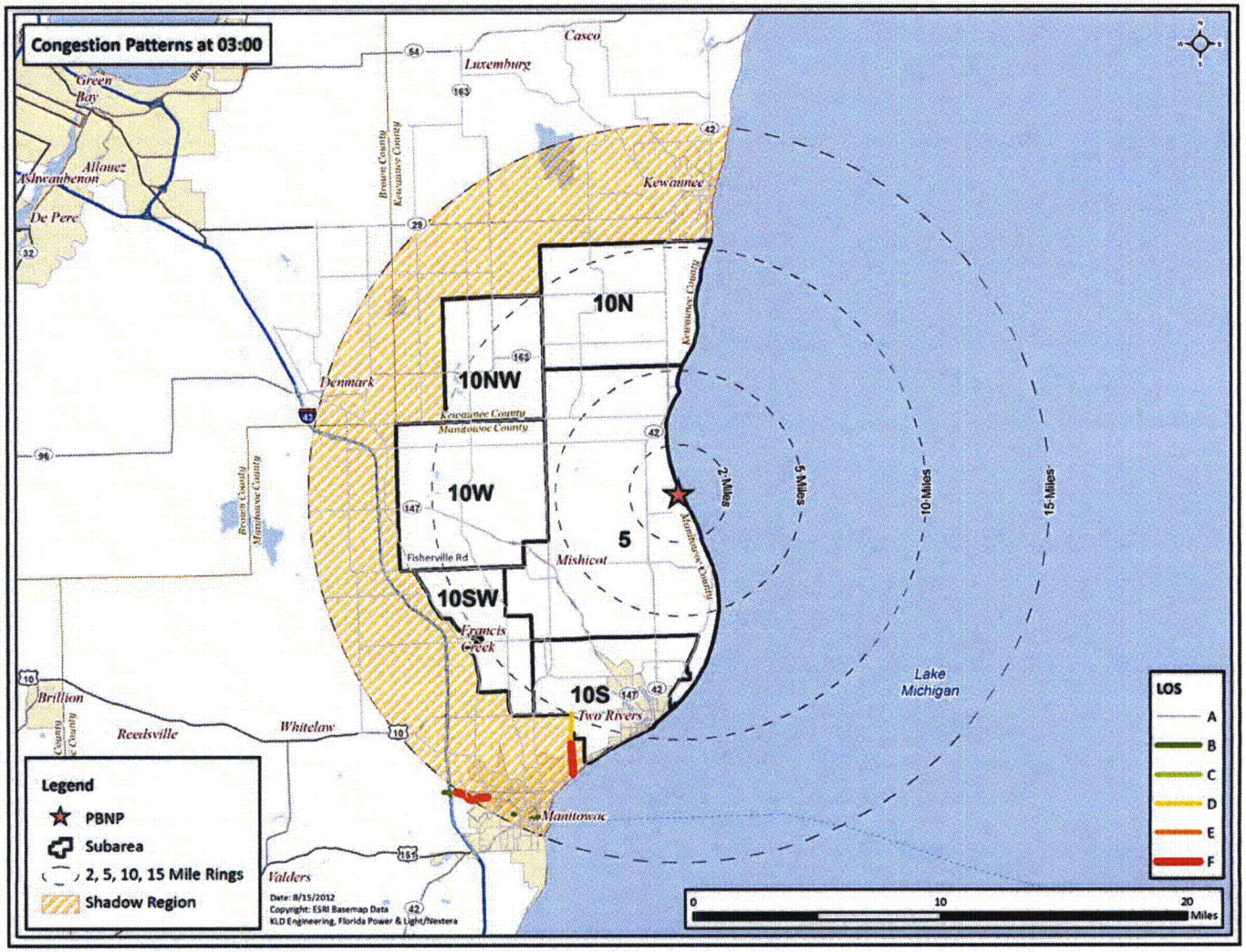



**Figure 7-7. Congestion Patterns at 3 Hour after the Advisory to Evacuate**

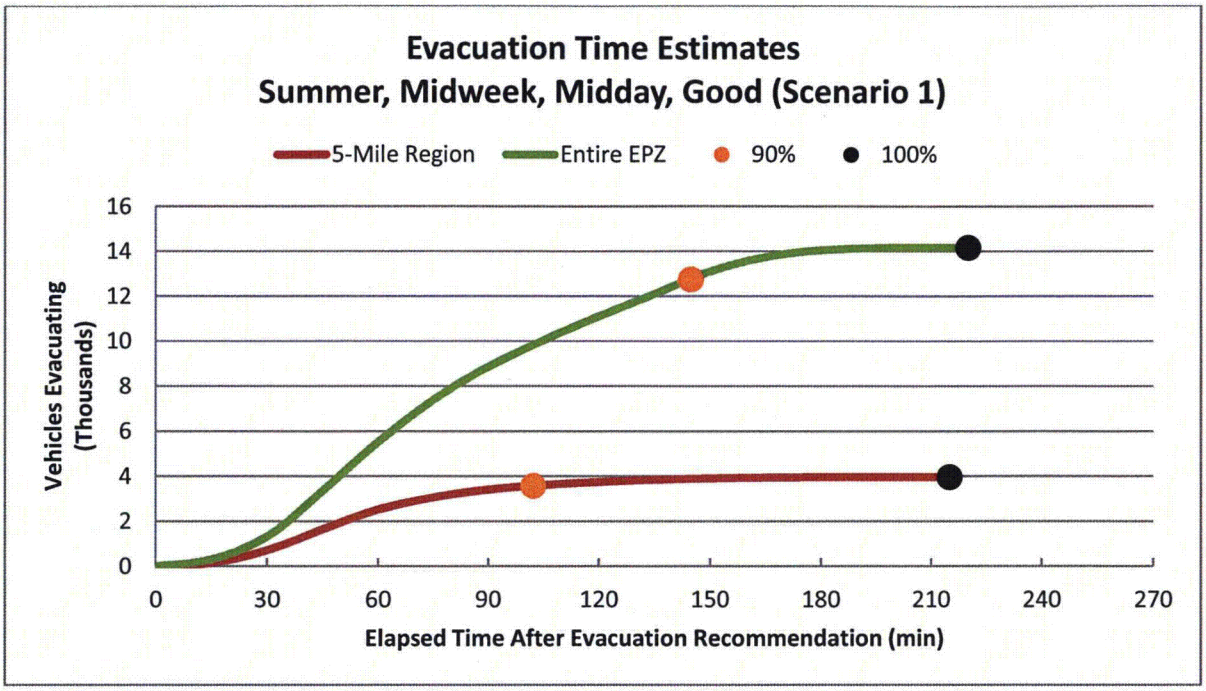



**Figure 7-8. Evacuation Time Estimates - Scenario 1 for Region R02**

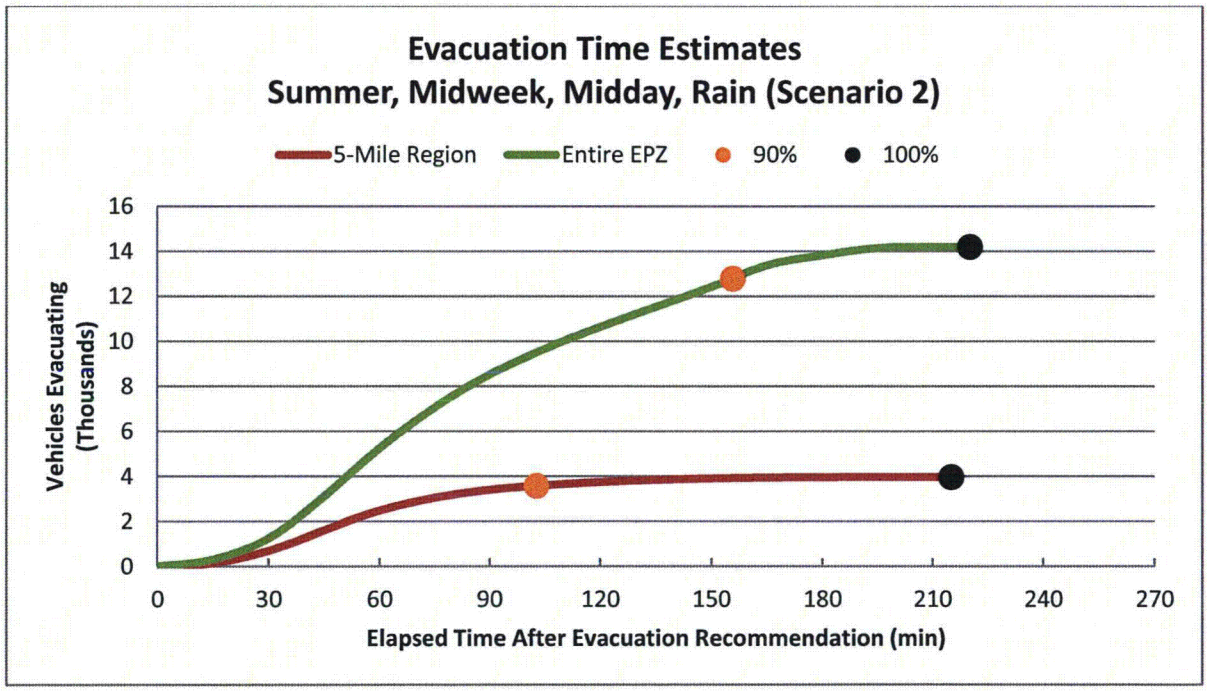



**Figure 7-9. Evacuation Time Estimates - Scenario 2 for Region R02**

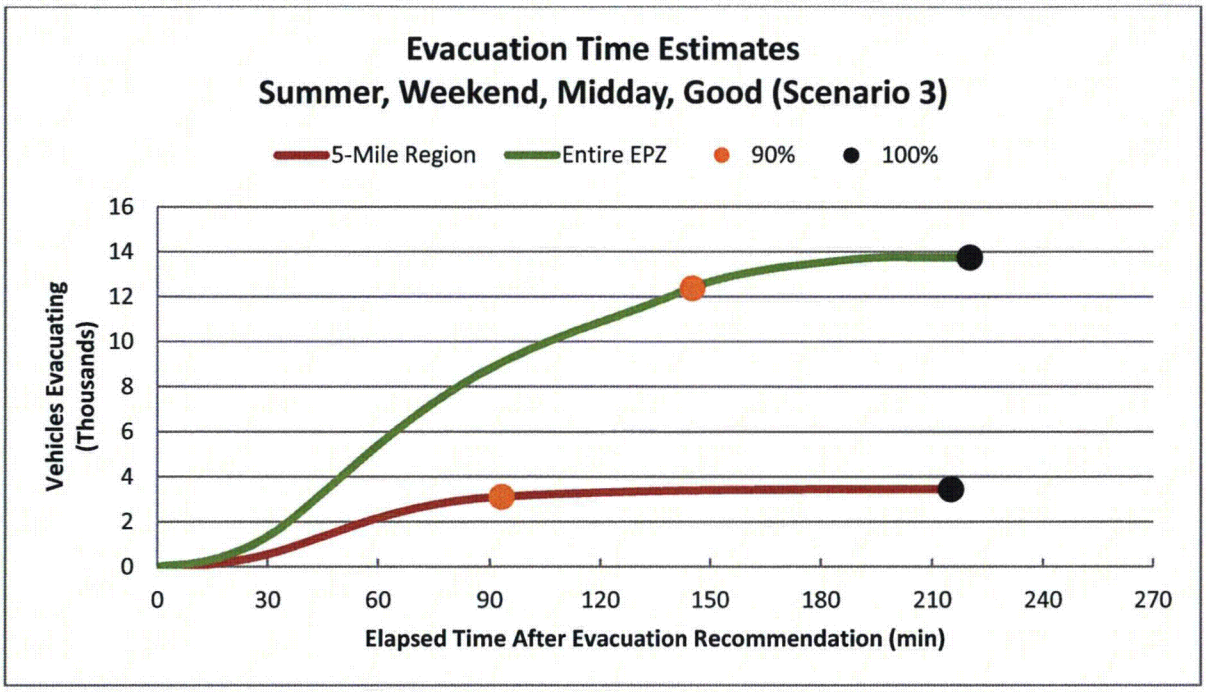



**Figure 7-10. Evacuation Time Estimates - Scenario 3 for Region R02**

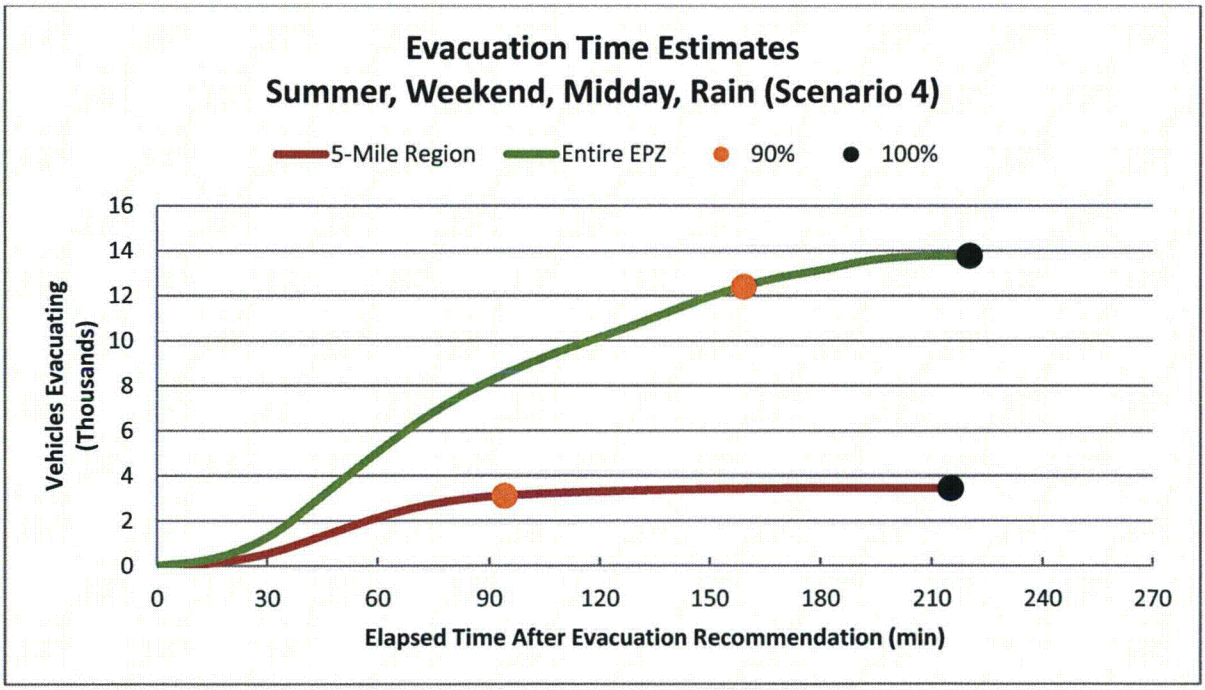



**Figure 7-11. Evacuation Time Estimates - Scenario 4 for Region R02**

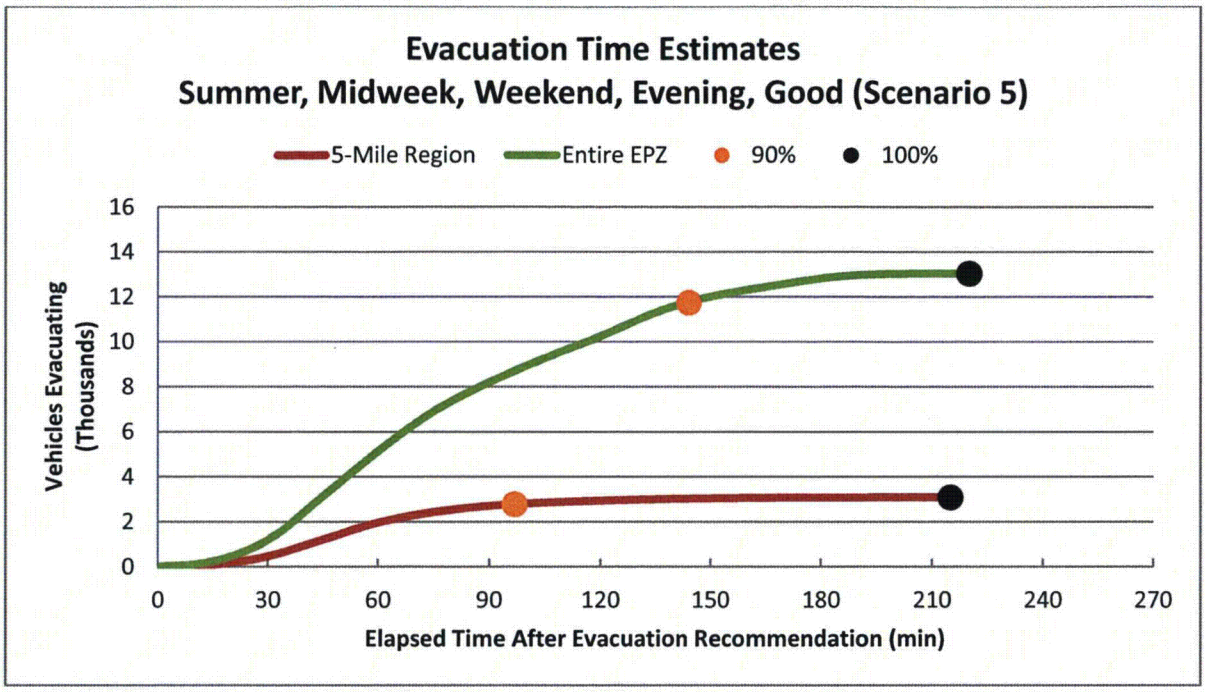



**Figure 7-12. Evacuation Time Estimates - Scenario 5 for Region R02**

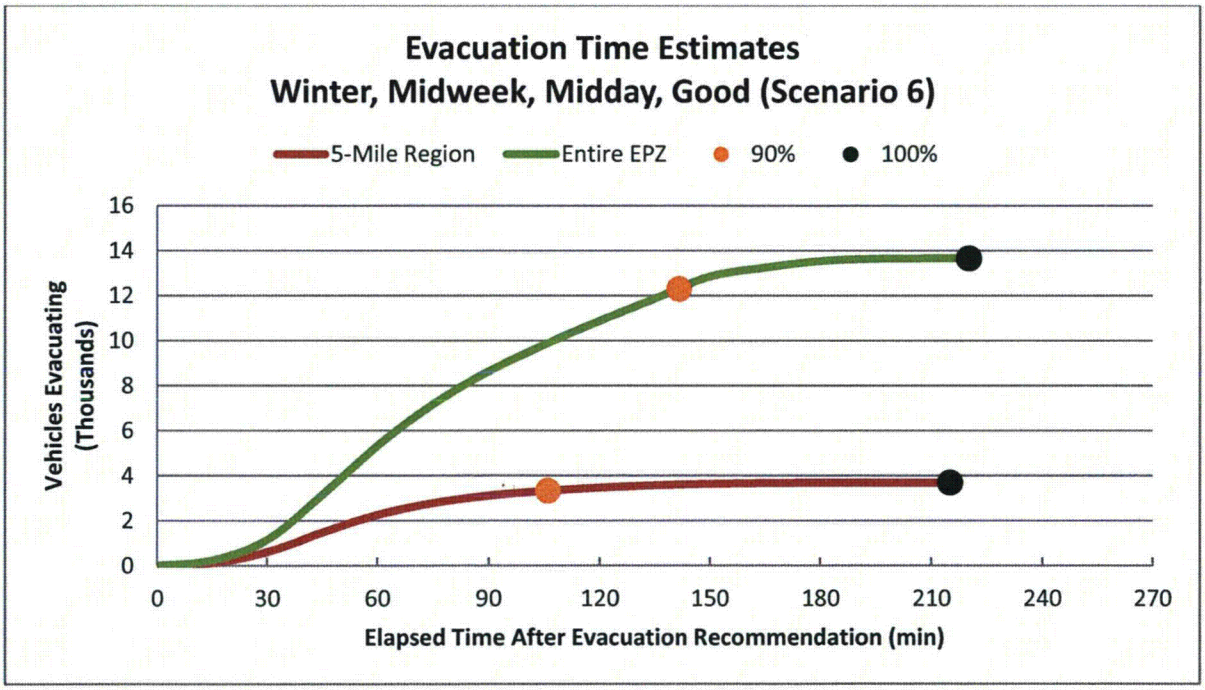



**Figure 7-13. Evacuation Time Estimates - Scenario 6 for Region R02**

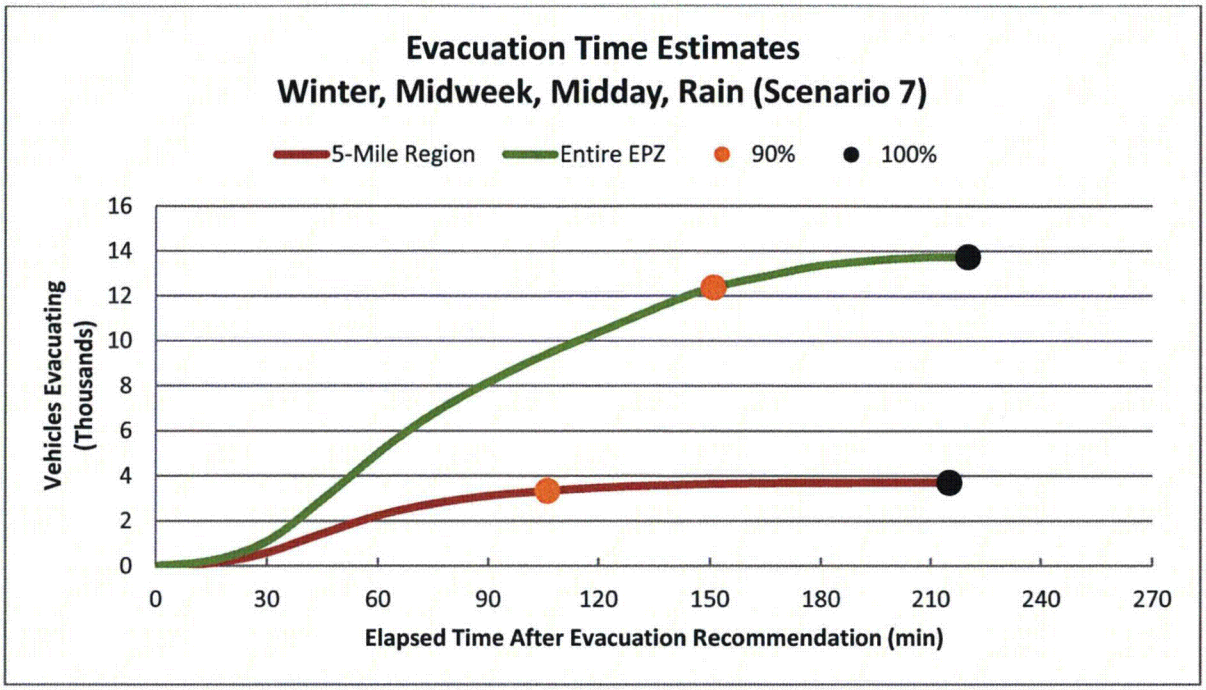



**Figure 7-14. Evacuation Time Estimates - Scenario 7 for Region R02**

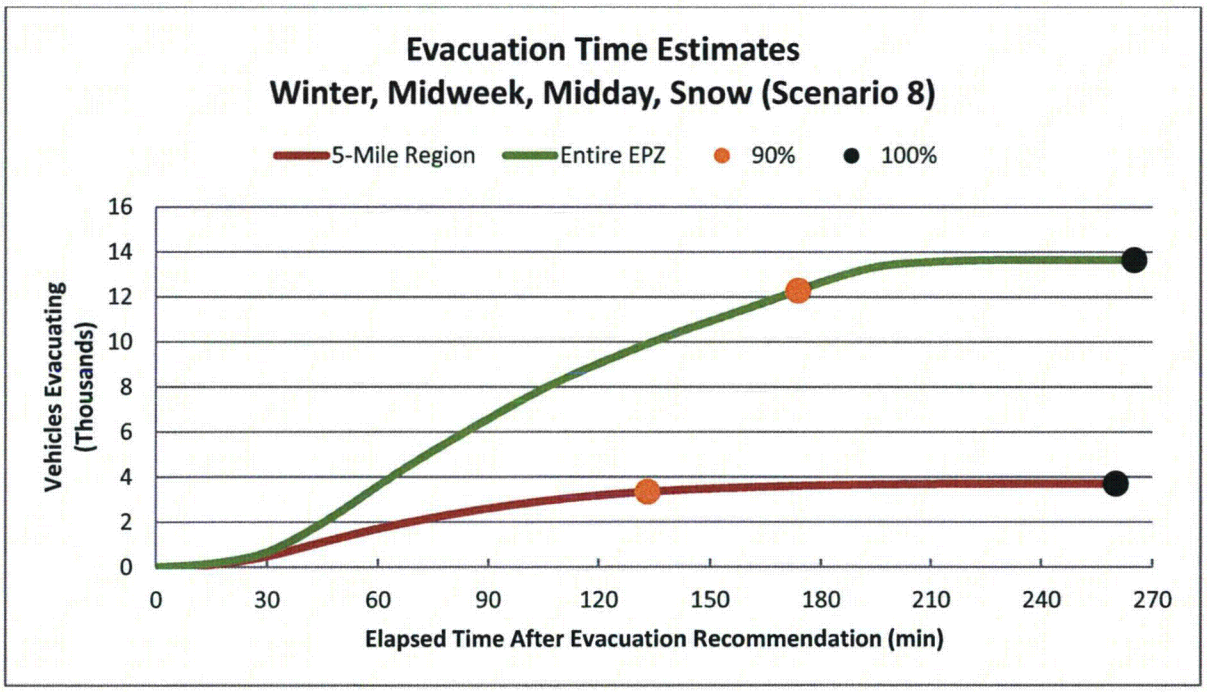



**Figure 7-15. Evacuation Time Estimates - Scenario 8 for Region R02**

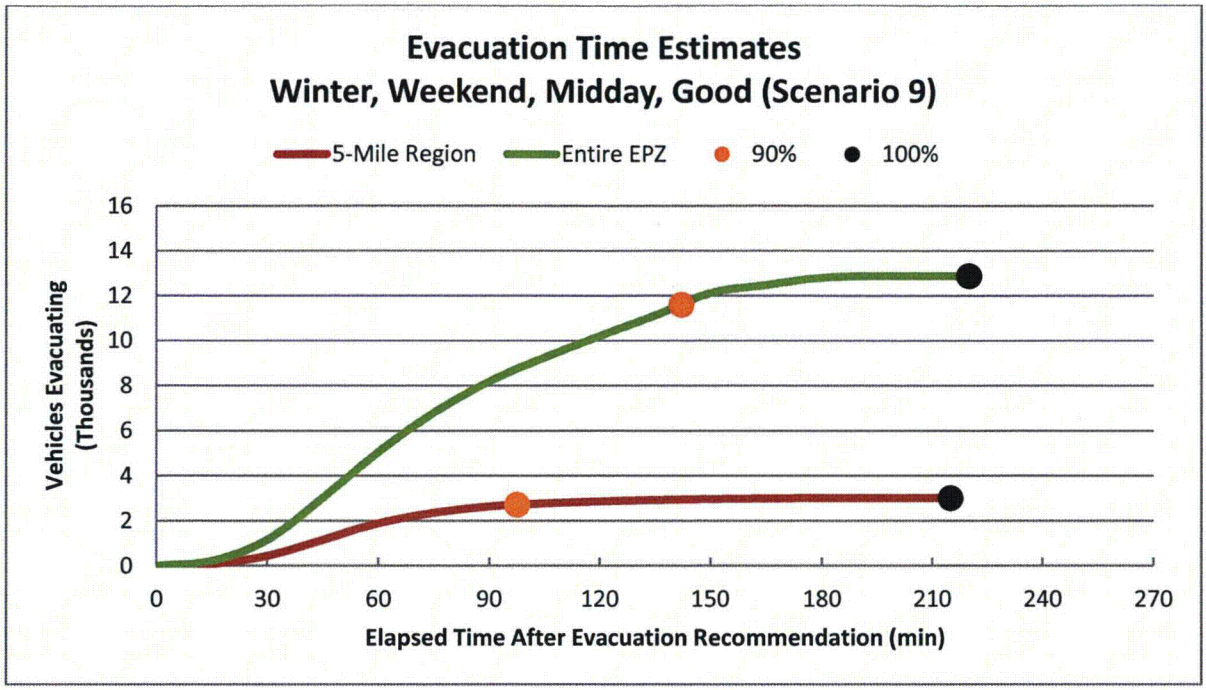



**Figure 7-16. Evacuation Time Estimates - Scenario 9 for Region R02**

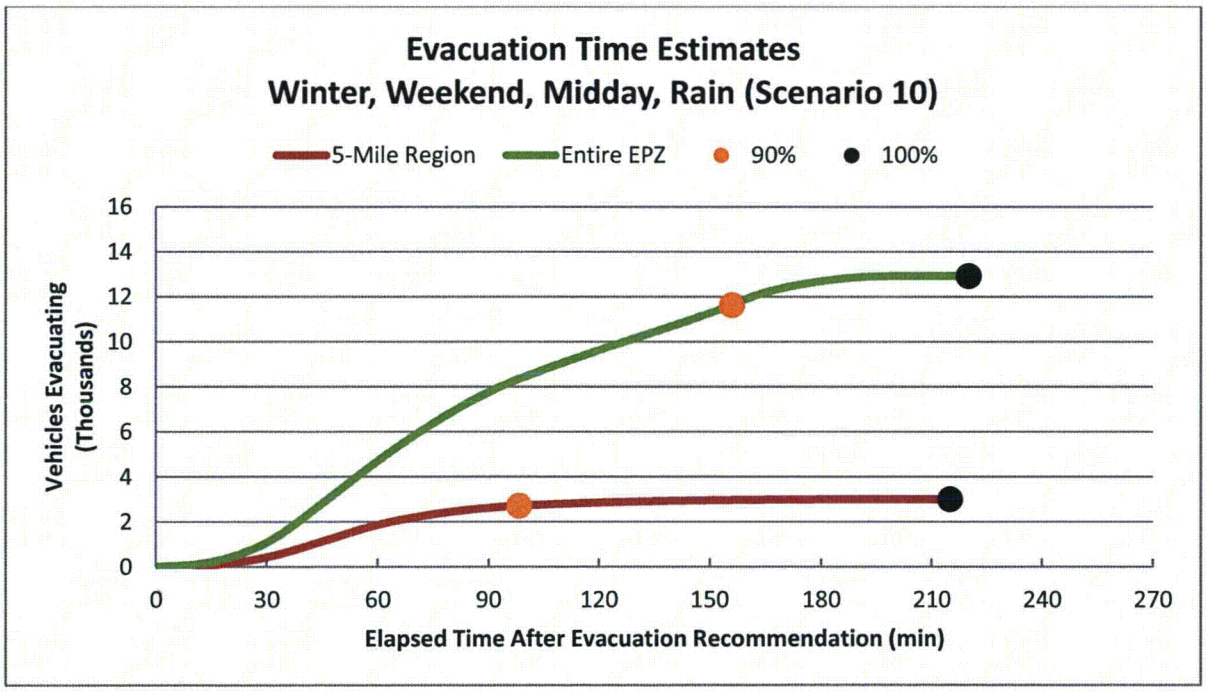



**Figure 7-17. Evacuation Time Estimates - Scenario 10 for Region R02**

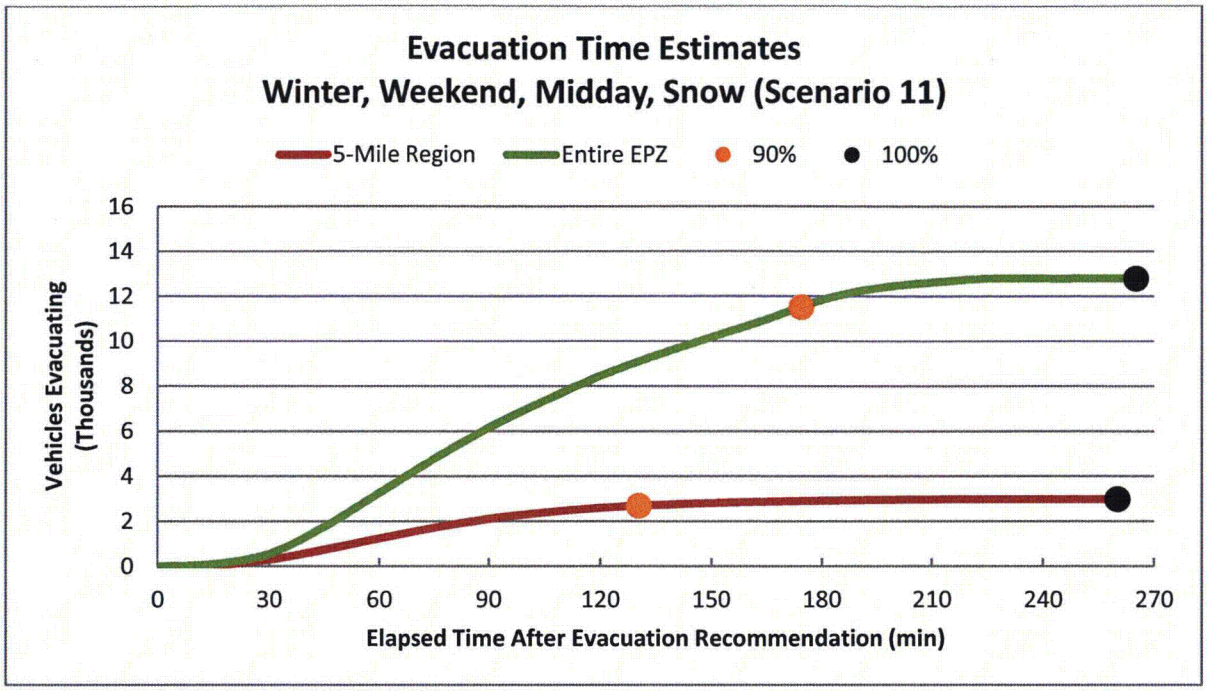



**Figure 7-18. Evacuation Time Estimates - Scenario 11 for Region R02**

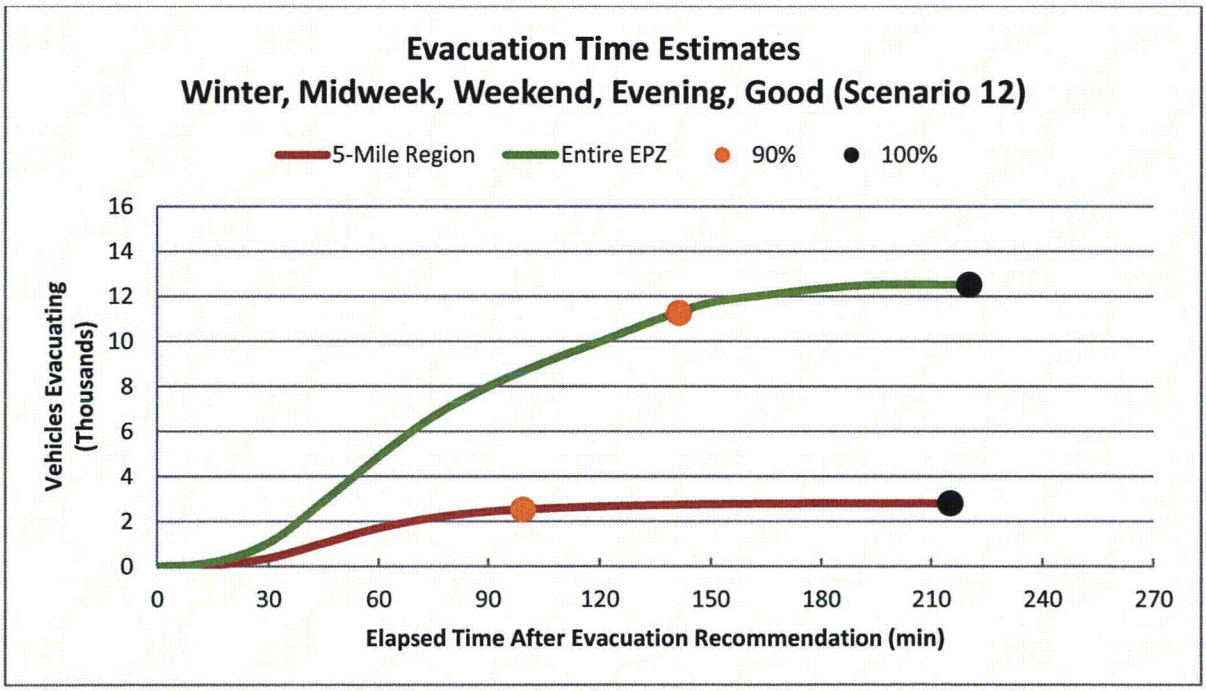



**Figure 7-19. Evacuation Time Estimates - Scenario 12 for Region R02**

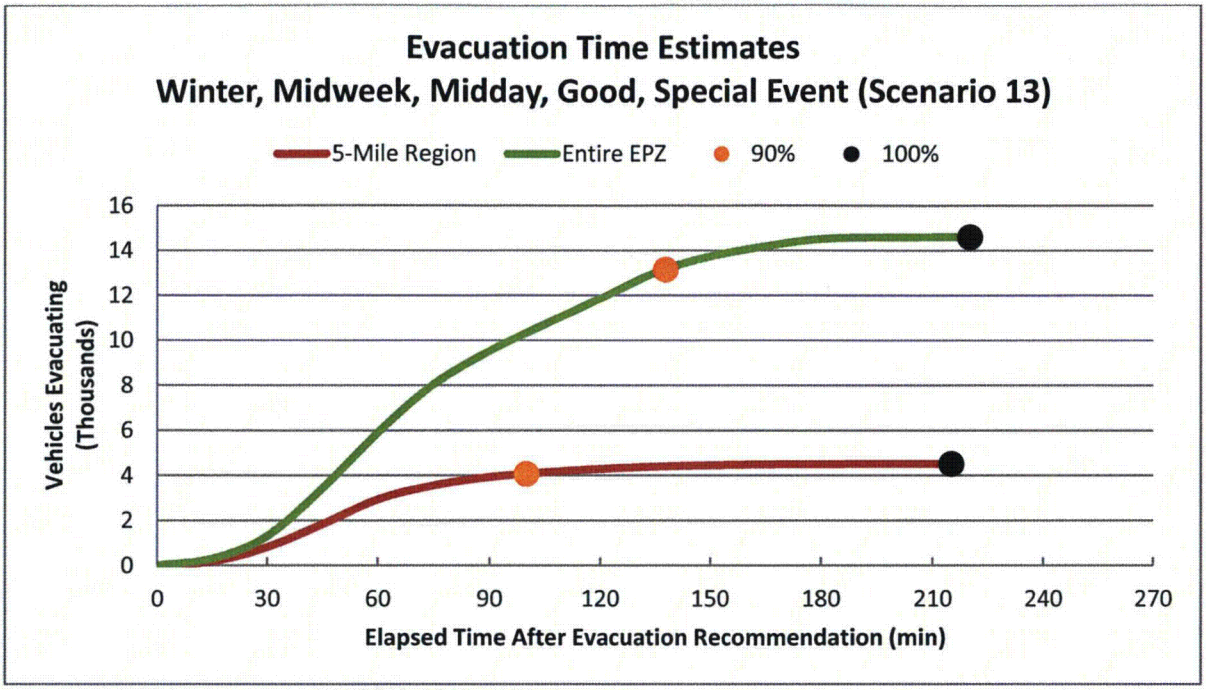



**Figure 7-20. Evacuation Time Estimates - Scenario 13 for Region R02**

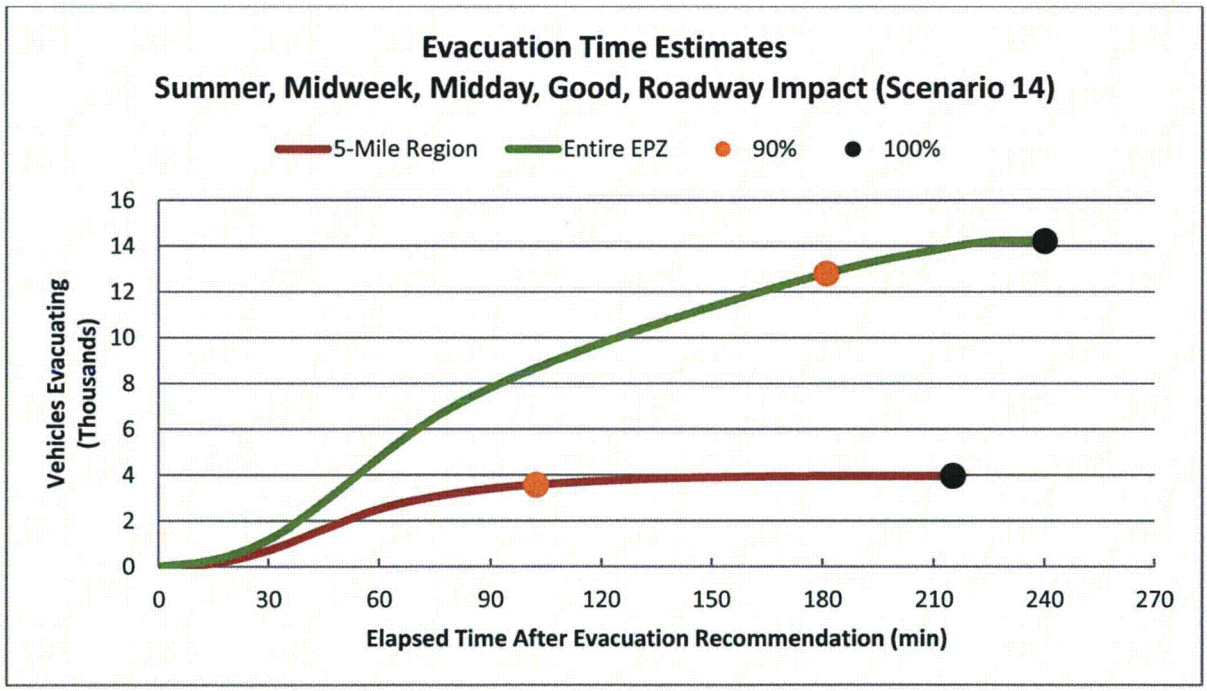



**Figure 7-21. Evacuation Time Estimates - Scenario 14 for Region R02**