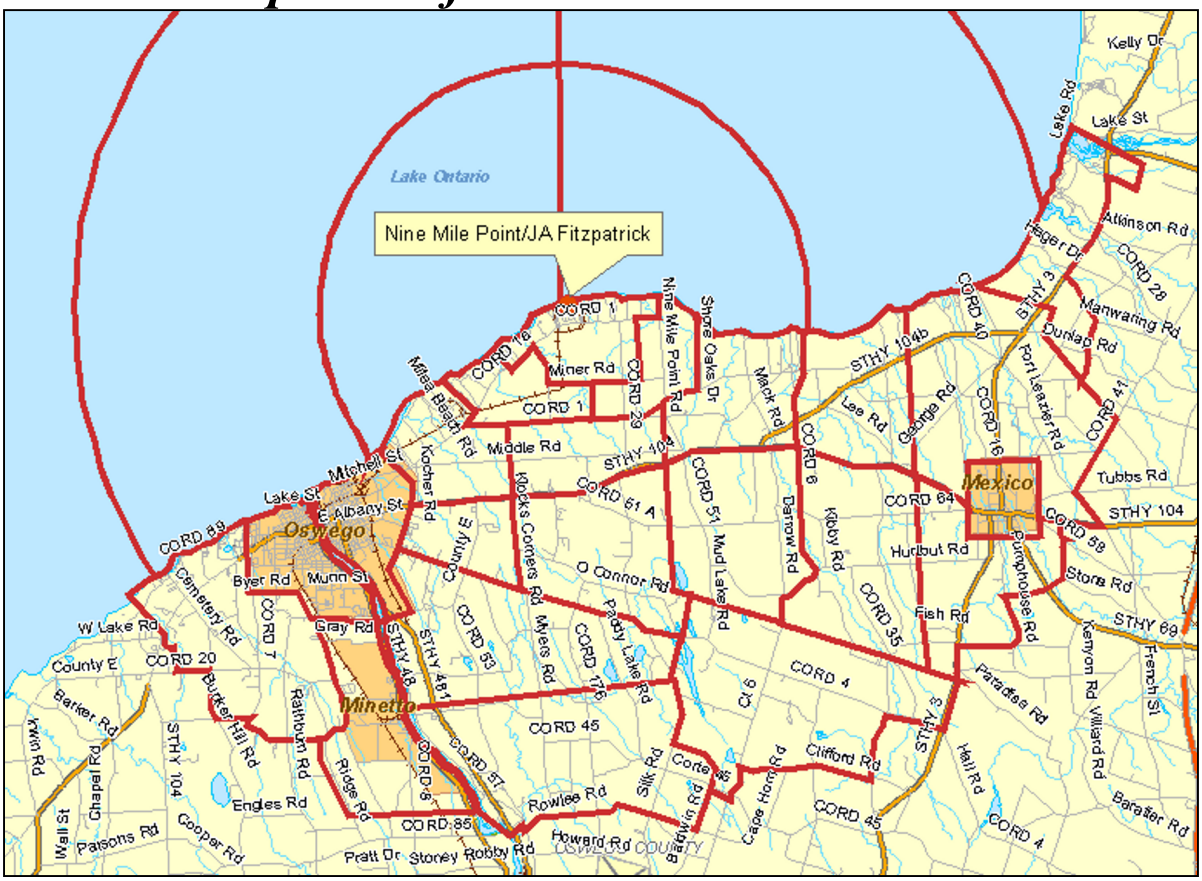
KLD ASSOCIATES, INC.
INNOVATION IN TRANSPORTATION

Nine Mile Point/JA Fitzpatrick Nuclear Facility
Development of Evacuation Time Estimates



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TABLE OF CONTENTS

Section	Title	Page
1.	INTRODUCTION	1-1
1.1.	Overview of Plan Update Process	1-1
1.2.	The Nine Mile Point/JA Fitzpatrick Nuclear Facility Location	1-3
1.3.	Preliminary Activities	1-5
1.4.	Comparison with Prior ETE Study	1-8
2.	STUDY ESTIMATES AND ASSUMPTIONS	2-1
2.1	Data Estimates	2-1
2.2	Study Methodological Assumptions	2-2
2.3	Study Assumptions	2-4
3.	DEMAND ESTIMATION	3-1
4.	ESTIMATION OF HIGHWAY CAPACITY	4-1
5.	ESTIMATION OF TRIP GENERATION TIME	5-1
6.	DEMAND ESTIMATION FOR EVACUATION SCENARIOS	6-1
7.	GENERAL POPULATION EVACUATION TIME ESTIMATES	7-1
7.1	Patterns of Traffic Congestion during Evacuation	7-17
8.	TRANSIT AND SPECIAL FACILITY EVACUATION TIME ESTIMATES	8-1
8.1	Transit-Dependent People-Demand Estimate	8-2
8.2	School Population-Transit Demand	8-5
8.3	Medical Facility Demand	8-5
8.4	Evacuation Time Estimates for Transit-Dependent People	8-10
9.	TRAFFIC MANAGEMENT STRATEGY	9-1
10.	TRAFFIC ROUTING PLANS	10-1
11.	SURVEILLANCE OF EVACUATION OPERATIONS	11-1

LIST OF APPENDICES

Appendix A - Glossary of Traffic Engineering Terms

Appendix B - Traffic Assignment Model

Appendix C - Traffic Simulation Model: PCDYNEV

Appendix D - Detailed Description of Study Procedure

Appendix E - Special Facility Data

Appendix F - Telephone Survey

Appendix G - Traffic Control Plans Oswego County

Appendix H - Evacuation Region Maps

Appendix I - Evacuation Sensitivity Studies

Appendix J - Summary of Evacuation Time Estimates And Evacuation Time Graphs

Appendix K - Evacuation Roadway Network Characteristics

Appendix L - ERPA Boundaries

Appendix M - Ingestion Pathway Population

LIST OF FIGURES

Figure	Title	Page
1-1	Nine Mile Point/JA Fitzpatrick Nuclear Facility General Site Area	1-4
1-2	Nine Mile Point/JA Fitzpatrick Nuclear Facility Link-Node Network	1-7
2-1	Shadow Evacuation Methodology	2-3
3-1	Nine Mile Point/JA Fitzpatrick Nuclear Facility EPZ ERPA's	3-3
3-2	Permanent Residents by Sector	3-7
3-3	Permanent Resident Vehicles by Sector	3-8
3-4	Transients by Sector	3-13
3-5	Transient Vehicles by Sector	3-14
3-6	Employees and Employee Vehicles by Sector	3-17
4-1	Fundamental Relationship Between Volume and Density	4-3
5-1	Events and Activities Preceding the Evacuation Trip	5-5
5-2	Comparison of Trip Generation Distributions	5-12
6-1	Nine Mile Point/JA Fitzpatrick Nuclear Facility ERPA Boundaries	6-3
7-1A	Time to Clear the Indicated Area of 50 Percent of the Affected Population	7-3
7-1B	Time to Clear the Indicated Area of 90 Percent of the Affected Population	7-6
7-1C	Time to Clear the Indicated Area of 95 Percent of the Affected Population	7-9
7-1D	Time to Clear the Indicated Area of 100 Percent of the Affected Population	7-12
7-1	Evacuation Response Within EPZ	7-15
7-2	Shadow Region	7-16
7-3	Areas of Traffic Congestion, 1 Hour after the Evacuation Recommendation	7-19
7-4	Areas of Traffic Congestion 2 Hours after the Evacuation Recommendation	7-20
7-5	Areas of Traffic Congestion 3 Hours after the Evacuation Recommendation	7-21
7-6	Area of Traffic Congestion 4 Hours after the Evacuation Recommendation	7-22
7-7	Evacuation Time Estimates for NMP Summer, Midweek, Midday, Good Weather	7-23

LIST OF FIGURES

Figure	Title	Page
8-1	Schools in Oswego County	8-7
8-2	Medical Facilities in Oswego County	8-9
9-1	Oswego County Traffic Control Points	9-3
9-2	City of Oswego Traffic Control Points	9-4
9-3	Oswego County Access Control Points	9-8
10-1	General Population Reception Center	10-2
10-2	Evacuation Routes – Oswego County	10-3

LIST OF TABLES

Table	Title	Page
1-1	ETE Comparisons	1-9
3-1	EPZ Permanent Population Growth	3-4
3-2	Permanent Resident Population and Vehicles by ERPA	3-6
3-3	Transient Population by ERPA	3-11
3-4	Transient Vehicles by ERPA	3-12
3-5	Non-EPZ Resident Employee Population by ERPA	3-16
5-1	Trip Generation Time Histograms for Midweek and Weekend Scenarios	5-13
6-1	Definition of Evacuation Regions	6-2
6-2	Evacuation Scenario Definitions	6-4
6-3	Percent of Population Groups for Various Scenarios	6-5
6-4	Vehicle Estimates for Various Combinations of Regions and Scenarios	6-6
8-1	Transit Dependent Population Estimates	8-3
8-2	School Population Demand Estimates	8-6
8-3	Medical Facility Transit Demand	8-8
8-4	Transportation Resources	8-11
8-5	Demand and Supply of Bus Resources	8-14
8-6	Outbound Highway Speeds During Evacuation	8-15
8-7	School Evacuation Time Estimates	8-16
8-8	Transit-Dependent Evacuation Time Estimates	8-16
8-9	Second Wave Transit-Dependent Evacuation Time Estimates	8-18
9-1	Summary of Traffic Control Points	9-5
9-2	Summary of Access Control Points	9-9

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 Nine Mile Point/JA Fitzpatrick Nuclear Facility, located in Lycoming, New York. Evacuation time estimates provide State and local governments with site-specific information helpful for Protective Action decision-making.

In the performance of this effort, all available prior documentation relevant to Evacuation Planning was reviewed. Work products developed by previous consultants were incorporated, where appropriate.

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

We wish to express our appreciation to all the directors and staff members of the Oswego County Emergency Management Offices, New York State Emergency Management Office (SEMO), and local and state law enforcement agencies, who provided valued guidance and contributed information contained in this report.

1.1 Overview of the Plan Update Process

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

1. Information Gathering:
   - Attended initial meetings with representatives of Constellation Nuclear, to define the scope of work.
   - Reviewed existing reports describing past evacuation studies.
   - Attended meetings with Oswego County officials to identify issues to be addressed and resources available.
   - Conducted a field survey of the EPZ highway system and of area traffic conditions.

- Attended meetings and briefings with state and county officials.
- Obtained demographic data from New York State Emergency Management Office.
- Conducted a random sample telephone survey of EPZ residents.
- Conducted a data collection effort by mail and telephone to identify and describe schools, special facilities, major employers, transportation providers, and other important sources of information.

2. Estimate distributions of Trip Generation times representing the time required by various population groups (permanent residents, employees, and transients) to prepare for the evacuation trip. These estimates were primarily based upon the random sample telephone survey performed as part of the data collection effort.
3. Define 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. Define a traffic management strategy. Traffic control is applied at specified Traffic Control Posts (TCP) located within the Emergency Planning Zone (EPZ), and at Access Control Posts (ACP) located outside the EPZ. Local and state police personnel review all traffic control plans.
5. Define Evacuation Areas or Regions. The EPZ is partitioned into Emergency Response Planning Areas (ERPA). These existing ERPA were accepted as the basis for the ETE analysis presented herein. "Regions" are groups of contiguous ERPA that form areas for which protective action recommendations are developed. The configurations of these Regions depend upon wind direction and the radial extent of the impacted area. Each Region, other than those that approximate circular areas, approximates a "keyhole section" within the EPZ as required by NUREG 0654.
6. Estimate demand for transit services for persons at "Special Facilities" and for transit-dependent persons at home.
7. Prepare the input streams for the IDYNEV system.
   - Estimate the traffic demand, based on the available information derived from Census data, from prior studies, from data provided by county and state agencies and from the telephone survey.
   - Employ 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.

- Develop the link-node representation of the evacuation network, which is used as the basis for the computer analysis that calculates the Evacuation Time Estimates (ETE). The IDYNEV System, developed by KLD for FEMA, was used to perform these calculations.
- Calculate the evacuating traffic demands for each Region and for each Evacuation Scenario.
- Represent the traffic management strategy.
- Specify the candidate destinations of evacuation travel consistent with outbound movement relative to the location of the nuclear station.
- Prepare the input stream for the IDYNEV System.
- Execute the IDYNEV models to provide the initial estimates of evacuation routing and Evacuation Time Estimates (ETE) for a single scenario.

8. Generate a complete set of ETE for all specified Regions and Evacuation Scenarios. In addition, two "special event" ETE were calculated.
9. Document ETE in formats responsive to NUREG 0654.
10. Calculate the ETE for all transit activities including those for special facilities (schools, health-related facilities, etc.) and for the transit-dependent.

Steps 4 through 8 are iterated as described in Appendix D.

1.2 The Nine Mile Point/JA Fitzpatrick Nuclear Facility Location

The Nine Mile Point/JA Fitzpatrick Nuclear Facility is located on the shore of Lake Ontario, in Oswego County, New York. The site is situated approximately 6 miles northeast of the City of Oswego at longitude 76^{o} 24' W and latitude 43^{o} 32'N.

The Emergency Planning Zone contains parts of Oswego County. Figure 1-1 displays the site area surrounding the Nine Mile Point/JA Fitzpatrick Nuclear Facility (NMP). This map identifies the communities in the area and the major roads.



Figure 1-1. Nine Mile Point/ JA Fitzpatrick Nuclear Facility General Site Area

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 NMP 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 south to include the City of Fulton. 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
	Geometries: Curves, grades

Unusual characteristics: Narrow bridges, sharp curves, poor pavement, flood warning signs, inadequate delineations, etc.

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

Telephone Survey

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

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

Developing the Evacuation Time Estimates

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

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

Analytical Tools

The IDYNEV System that was employed for this study is comprised of several integrated computer models. One of these is the PCDYNEV (DYnamic Network EVacuation) microscopic simulation model that was developed by KLD under contract with the Federal Emergency Management Agency (FEMA) and subsequently migrated from a VAX mini-computer to the PC world.

PCDYNEV consists of three submodels:

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

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

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

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

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



Figure 1-2. Nine Mile Point
JA Fitzpatrick
Link-Node 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 NMP, to the extent practicable
  - 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 NMP.

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

The simulation model is then executed to provide a detailed description of traffic operations on the evacuation network. This description enables the analyst to identify bottlenecks and to develop countermeasures that are designed to expedite the movement of vehicles.

As outlined in Appendix D, this procedure consists of an iterative design-analysis-redesign sequence of activities. If properly done, this procedure converges to yield an Emergency 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 produced in 1994.

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:

1. An increase of approximately 4 percent in resident population, based on Census data.
2. An increase in the number of evacuating vehicles per household of approximately 25 percent based on the results of the telephone survey.
3. Explicit treatment of trip generation times based upon the results of a telephone survey.
4. Explicit consideration of the impact of Shadow Region traffic movement on evacuation time.

Table 1-1 ETE Study Comparisons

Topic	Treatment	
	Previous ETE Study	**Current ETE Study**
Resident Population Basis	1990 Census	2000 Census, extrapolated to 2003. Approximately 1.5 percent growth between 2000 and 2003
Resident Population Vehicle Occupancy	Assumed 1.0 vehicle per household	Based on residential telephone survey, County specific range from 1.24 to 1.27 vehicles per household
Employee Population	Combined with transients. Based on 1991 New York State Department of Labor statistics	Treated as a separate population group. Employment journey to work data identified the proportion of employees who commute into the EPZ relative to the total number of employees. These proportions were applied on an ERPA by ERPA basis to total employment information for the year 2000 from NYS Dept. of Labor.
Employee Vehicle Occupancy	Assumed 1.1 employees per vehicle	County specific values ranging from 1.05 to 1.07 employees per vehicle. Data obtained from 2000 Census
Transient Population	Parks and recreational facility data inventoried by Oswego County Emergency Management Office. Hotel and motel occupancy estimated using 1991 Oswego County Accommodations Guide and included employees within county.	Based on telephone calls to individual facilities. Employees treated separately.

Table 1-1 ETE Study Comparisons

Topic	Treatment	
	Previous ETE Study	**Current ETE Study**
Voluntary evacuation from within EPZ in areas outside region to be evacuated	No treatment identified	50 percent within circle. 30 percent in annular ring between the circle and EPZ boundary.
Shadow Evacuation	Not considered	Population in areas south of the EPZ boundary, including the City of Fulton was considered. Nominally, 30 percent of this population will move away from the EPZ.
Roadway Geometric Data	Field surveys conducted in 1991 Road capacities based on 1985 HCM	Field surveys conducted in 2002 Road capacities based on 2000 HCM
Network Size	235 links	964 links
Transit Dependent Population	Defined as non-auto owning population by ERPA.	Defined as households with 0 vehicles + households with 1 and 2 vehicles with commuters who do not return home. Household size varies by county and number of vehicles in household
School Evacuation	Direct evacuation	Direct evacuation
Ridesharing	50 percent	50 percent
Special Events	Classic Weekend and Harborfest	Classic Weekend and Harborfest
Bus Availability	Based on inventory of resources	Based on inventory of resources
Trains	None considered	None considered

Table 1-1 ETE Study Comparisons		
Topic	**Treatment**	
	Previous ETE Study	**Current ETE Study**
Boats, Airports	Coast Guard alerts boaters who leave area in boats. Airport not considered for ETE purposes	Coast Guard alerts boaters who leave area in boats. Airports not considered for ETE purposes
Trip Generation for Evacuation	Public assumed to take 20 minutes	Based on residential telephone survey of specific pre-trip mobilization activities: Residents with commuters returning leave between 30 and 135 minutes Residents without commuters returning leave between 15 and 120 minutes Employees and transients leave between 15 and 90 minutes. Times measured from the Order to Evacuate for all above. Additional time to clear snow added to residential evacuation times for snow scenarios.
Traffic and Access Control	Critical bottlenecks and links identified, no treatment suggested	Explicit treatment of 60 traffic and access control locations. Each location is identified, mapped, and schematics. Manning, equipment and priority assignments are defined for each location.
Weather	Clear or Adverse	Clear or Rain or Snow

Table 1-1 ETE Study Comparisons

Topic	Treatment	
	Previous ETE Study	**Current ETE Study**
Modeling	Static model, not further identified	IDYNEV System: TRAD and PCDYNEV
Evacuation Time Estimates	Reported for 100 percentile population. Results presented by ERPA	Reported for 50, 90, 95, and 100th percentile population. Results presented by Region
Evacuation Time Estimate Comparisons	Winter midweek midday good weather = 5 Hours Summer weekend midday good weather = 5 Hours	Winter midweek midday good weather = 4 Hours, 30 Minutes Summer weekend midday good weather = 4 Hours, 20 Minutes

2. STUDY ESTIMATES AND ASSUMPTIONS

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

2.1 Data Estimates

1. Population estimates are based upon Census 2000 data, projected to year, 2003. County-specific projections are based upon growth rates estimated by comparing the 1990 and 2000 census data. Where specific areas within the county experience growth rates that are different than the county-wide average, these areas are considered separately. Estimates of employees who commute into the EPZ to work are based upon the New York State Journey to Work Database, applied to the Year 2000 employment data stratified on an ERPA basis. Specific major employers were also considered.
2. Population estimates at special facilities are based on available data, telephone contacts and mail surveys.
3. Roadway capacity estimates are based on field surveys and the application of Highway Capacity Manual 2000[1]. Roads, which are seasonally closed, are identified in the county-specific assumptions section.
4. Population mobilization times are based on a statistical analysis of data acquired by a telephone survey. No assumptions are made, all times are supported by local data.
5. The relationship between resident population and evacuating vehicles is developed from the results of the telephone survey detailed in Appendix F. Results[2] found for Oswego County:
    a. 1.25 vehicles per household, on average
    b. 2.74 persons per household, on average yields
    c. 2.19 persons per vehicle

[1] Highway Capacity Manual (HCM2000), Transportation Research Board, National Research Council, 2000.
[2] Compare the telephone survey results with Institute for Environmental Studies, University of Toronto, THE MISSISSAUGA EVACUATION FINAL REPORT, June 1981. The report indicates that 75,500 households evacuated the area using 93,400 vehicles, yielding 1.24 evacuating vehicles per household. (Page 5-10).

6. The relationship between persons and vehicles for special facilities is as follows:

   a. Hotel/motel: one vehicle per occupied room (Source: telephone contacts with individual facilities)

   b. Recreational: 2.4 persons per vehicle excluding buses (Source: empirical observations at Seabrook and Pilgrim EPZ recreation facilities)

   c. Employees: 1.0 employee per vehicle (Sources: telephone survey shows 80-90% of commuters use single person occupancy autos; and 2002 Field Study)

7. Evacuation Time Estimates (ETE) will be presented for the 100 percentiles of population for each Region and for each Scenario, and for the 2-mile, 5-mile and 10-mile distances. ETEs will also be presented graphically showing the values of ETE associated with the 50, 90 and 95 percentiles of population. Evacuation Regions are defined as a group of Emergency Response Planning Areas (ERPA) that is issued the Order to Evacuate for a given scenario.

2.2 Study Methodological Assumptions

1. The Evacuation Time is defined as the period of time between the issuance of an evacuation order to a specific Region of the EPZ and the time that region is declared clear of a fixed percentage (95%, 100%) of its population.

2. This evacuation time estimate study is in strict compliance with NUREG 0654 and related guidelines.

3. The ETE are computed and presented in a format compliant with NUREG 0654, CR-1745 and CR-4831. The ETE for each evacuation area ("Region" comprised of included ERPA) will be presented in both statistical and graphical formats.

4. Evacuation movements (paths of travel) will be generally outbound relative to the power station to the extent permitted by the highway network, as computed by the computer models. All available evacuation routes will be used in the analysis.

5. Regions are defined by the underlying "keyhole" or circular" configurations as specified in NUREG 0654. These Regions, as defined, display irregular boundaries reflecting all the ERPAs included within these underlying configurations.

6. The impact of both "Voluntary Evacuation" and "Shadow Evacuation" will be determined as part of the analysis. Voluntary evacuation occurs when people in areas of the EPZ not ordered to evacuate nevertheless choose to evacuate at the same time as people evacuate from regions ordered to do so. The accompanying figure presents the assumptions used for voluntary evacuation. Within the annular ring defined by the distance to be evacuated, 50 percent of the people not advised to evacuate are assumed to evacuate within the same time-frame. Between the annular ring, defined by the extent of the evacuation order to the EPZ boundary, it is assumed that 35 percent of people will voluntarily evacuate.

Shadow evacuation occurs when people in areas outside the EPZ choose to relocate during the course of an evacuation. These people can use the same roads as evacuees from the EPZ and can potentially delay evacuees from leaving the area at risk. In the area south of the EPZ boundary, including the City of Fulton, it will be assumed that 30 percent of the people will evacuate spontaneously. Sensitivity studies explored the effect on ETE, of increasing the percentage of shadow evacuees.

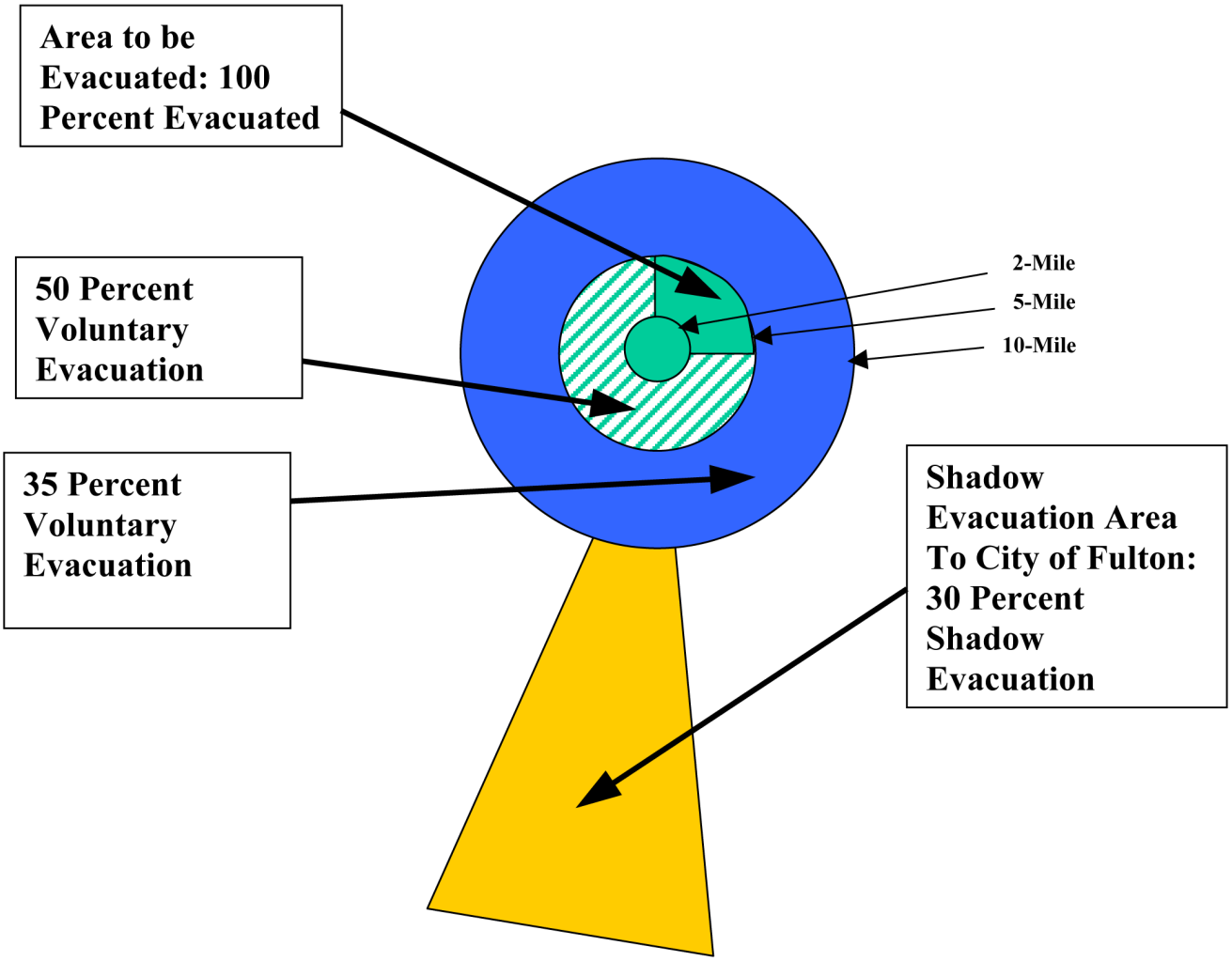


Figure 2-1. Shadow Evacuation Methodology

7. A total of 14 "Scenarios" representing different seasons, time of day, day of week and weather will be considered. Two special event scenarios are also included. These scenarios will be fully defined in Chapter 6.

Scenarios	Season	Day of Week	Time of Day	Weather	Special Events
1	Summer	Midweek	Midday	Good	None
2	Summer	Midweek	Midday	Rain	None
3	Summer	Weekend	Midday	Good	None
4	Summer	Weekend	Midday	Rain	None
5	Summer	Midweek, Weekend	Evening	Good	None
6	Winter	Midweek	Midday	Good	None
7	Winter	Midweek	Midday	Rain	None
8	Winter	Midweek	Midday	Snow	None
9	Winter	Weekend	Midday	Good	None
10	Winter	Weekend	Midday	Rain	None
11	Winter	Weekend	Midday	Snow	None
12	Winter	Midweek, Weekend	Evening	Good	None
13	Summer	Weekend	Midday	Good	Classic Weekend
14	Summer	Midweek	Midday	Good	Harborfest

8. The models of the IDYNEV System represent the state of the art, and have been recognized as such by Atomic Safety Licensing Boards (ASLB) in past hearings. (Sources: Atomic Safety & Licensing Board Hearings on Seabrook and Shoreham; Urbanik[3]).

2.3 Study Assumptions

1. The Planning Basis Assumption for the calculation of ETE is a rapidly accelerating accident that requires evacuation, and includes the following:

   a. Order to Evacuate follows the activation of the ANS sirens.

   b. Mobilization of the general population will commence within 10 minutes after activation of the ANS sirens.

   c. ETE are measured relative to Order to Evacuate.

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

A rapidly escalating accident scenario assumes that the general population will evacuate during the same time frame as do the school children, the transit-dependent population, and the special facility population. This assumption generally leads to longer evacuation time estimates than those for scenarios that are more slowly escalating, and provides for a worst-case review.

2. Everyone within the group of ERPAs forming a Region that is issued an Order to Evacuate will, in fact, respond in general accord with the planned routes.

3. a. Early dismissal to home of school children is contemplated. Early dismissal is only an option in the event of a slowly escalating scenario. As long as the early dismissal process is completed prior to the issuance of a protective action recommendation, then no impacts on ETE are anticipated. The planning basis for this study contemplates a rapidly escalating event where early dismissal is not feasible.

   b. Parents with access to vehicles will attempt to pick up their children from school (if in session), to the aggregate extent of at least half of all school children are evacuated via this method. Parental pick-ups can occur at any time prior to the arrival of the evacuation buses. The effect of parental pickup is to reduce the number of buses required to transport the balance of students left at school. Since the planning basis assumes that school evacuations will take place during the same time as the movement of the general population, the potential reduction in the number of buses assigned to schools would not affect the ETEs.

   c. A portion of those households with access to a vehicle will evacuate without awaiting the arrival home of all commuters. Data from the telephone survey indicate that approximately 33 percent of households with commuters, who have other vehicles available for evacuation, will not wait for the commuter to arrive home before leaving the area.

4. A portion of the population outside the evacuated Region will elect to evacuate even though not advised to do so ("voluntary evacuation"). This portion is assumed to be…

   a. 50 percent of the population residing within the radial distance (5 or 10 miles) of the evacuated Region and the extension of this Region beyond this distance.

   b. 35 percent of the population residing beyond this radial distance, and outside this Region.

   Shadow evacuation assumes the movement of people outside of the EPZ who could delay EPZ evacuees. This population group is assumed to be …

   c. 30 percent of the population residing south of the EPZ but within the southern city limits of Fulton.

Assumptions a. and b. are bounded by the limiting case of an evacuation of the entire EPZ simultaneously. Changing the percentage of shadow evacuees and computing the associated change in the ETE value is the methodology for testing Assumption c.

5. 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 will be assumed present at the start of the emergency. Subsequent to this initial period, no vehicles will enter the EPZ.

6. Access Control Points (ACP) will be staffed within approximately one hour following the Order to Evacuate, to divert traffic attempting to enter the EPZ. Earlier activation of ACP locations would delay returning commuters.

7. Traffic Control Points (TCP) within the EPZ will be manned over time, beginning at the Order to Evacuate. Their number and location will depend on the Region to be evacuated and resources available. It is assumed that drivers will act rationally, travel in the directions identified in the plan, and obey all control devices and traffic guides.

8. Traffic Control Points (TCP) outside the EPZ will be established to facilitate evacuation flow through the "shadow evacuation" area.

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

   a. If schools are in session, transport (buses) will evacuate students not picked up by their families directly to the assigned school reception center. It is assumed that half the children will be picked up by parents, prior to the arrival of buses. We also identify the number of buses required if all children are evacuated by bus.

   b. Buses needed to evacuate special facilities are estimated based on need and on "in-house" vehicle availability.

   c. School children, if in session will be given priority.

   d. Bus mobilization time will be considered in ETE calculations.

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

10. The transit-dependent portion of the general population will be evacuated to the reception center by bus. It is reasonable to assume that a proportion of this population 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 in other emergency situations,[4] which cites previous evacuation experience.

[4] 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).

11. 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 at about the same time as the evacuation order is issued. Thus, transient populations are not affected. That is, no weather-related reduction in the number of transients who may be present in the EPZ is assumed.

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

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

Scenario	Highway Capacity*	Free Flow Speed*	Mobilization Time
Rain	90%	90%	No Effect
Snow	80%	80%	Clear driveway before leaving home (Source: Telephone survey)

*** Adverse weather capacity and speed values are given as a percentage of good weather conditions**

12. School buses used to transport the transit-dependent general population and students are assumed to load below capacity to reflect some inefficiency in loading. The assumed load factors vary and are detailed in Section 8. Children below the age of Middle School are assigned to occupy 2/3 of an adult seat.

3. DEMAND ESTIMATION

The estimates of demand, expressed in terms of people and vehicles, constitute a critical element in developing an evacuation plan. This estimate consists 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. A variation of the approach defined above was used to estimate traffic in parks. This change in approach was necessary since the majority of park traffic consists of transients, most of whom enter the EPZ from locations outside. Our primary source of population data, the 2000 Census, is not adequate for estimating some transient groups directly.

As a result, we relied on empirical observation of the number of vehicles that can physically be accommodated within park areas. This technique is valid since discussions with public officials confirmed that, with few exceptions, people at the park have access to either a private vehicle or a bus. Thus, the number of people evacuating from the park area will be primarily reflected in the number of evacuating private vehicles.

Estimates of population in parks can be based on estimates of per-vehicle person occupancy. Thus, for the park area, we estimate the number of evacuating vehicles based on parking capacity, then multiply by the per-vehicle person occupancy.

During the summer season, vacationers and tourists enter the EPZ. These non-residents may dwell within the EPZ for a short period (e.g. one or two weeks), for a weekend, overnight, 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 Nine Mile Point/JA Fitzpatrick Nuclear Facility (NMP) EPZ indicates the need to identify three distinct groups:

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

Estimates of the population and number of evacuating vehicles for each of the population groups will be presented for each Emergency Response Planning Area (ERPA) and by polar coordinate representation (population rose). The NMP EPZ has been subdivided into 29 ERPAs. These areas are shown in Figure 3-1.

Permanent Residents

The primary source for estimating permanent population is the latest U.S. Census data. Comparing census information, it is possible to estimate the rate of population change over time and to project the year 2000 resident population to a 2003 base year. Table 3-1 presents these estimates.

Table 3-1 shows that the EPZ population has increased about 1.5 percent over the last 3 years. The annual growth rate for Oswego County was estimated using the 1990 and 2000 census results. The growth rates were used to project population grown over the most recent 3-year period.

We designed the telephone survey (Appendix F) to estimate the average number of people who may be expected to occupy each evacuating vehicle. The survey revealed the average household size and the expected number of evacuating vehicles per household. The results of the survey showed there to be 1.25 vehicles per household on average in Oswego County, 2.74 persons per household on average, yielding 2.19 persons per vehicle.

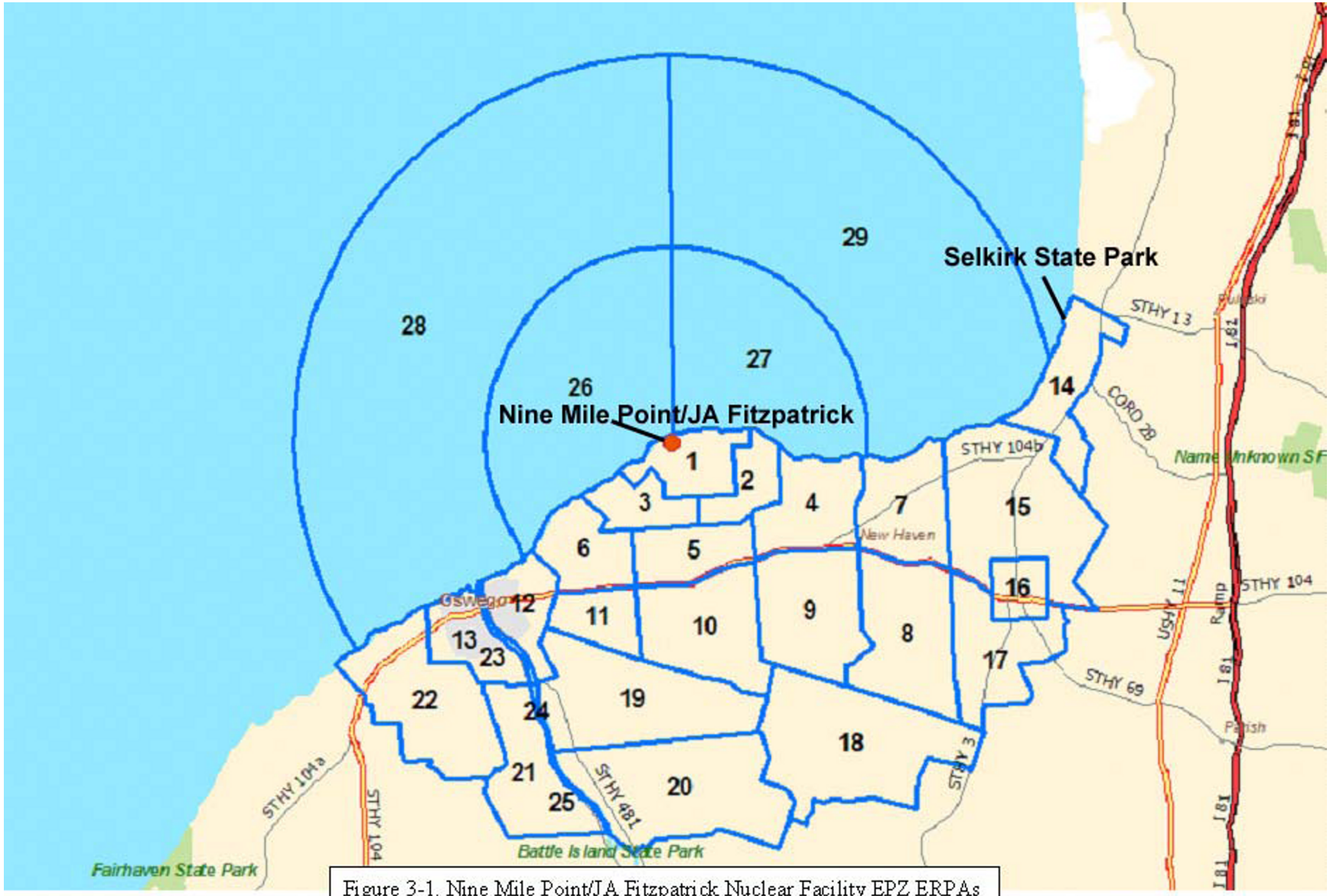


Figure 3-1. Nine Mile Point/JA Fitzpatrick Nuclear Facility EPZ ERPAs

Table 3-1. EPZ Permanent Population Growth

ERPA	POPULATION		ERPA	POPULATION	
	2000	2003		2000	2003
1	236	240	**16**	1,592	1,616
2	469	476	**17**	519	527
3	370	376	**18**	1,138	1,155
4	655	665	**19**	1,513	1,536
5	836	849	**20**	1,697	1,722
6	943	957	**21**	1,798	1,825
7	734	745	**22**	4,776	4,848
8	788	800	**23**	-	-
9	625	634	**24**	-	-
10	1,119	1,136	**25**	-	-
11	2,008	2,038	**26**	-	-
12	7,686	7,801	**27**	-	-
13	10,361	10,516	**28**	-	-
14	239	243	**29**	-	-
15	1,182	1,200	**TOTAL**	**41,284**	**41,903**

Permanent population and vehicle estimates for 2003 are presented in Table 3-2. Figures 3-2 and 3-3 present the resident population and resident vehicle estimates by sector and distance from the Nine Mile Point Nuclear Station. This "rose" was constructed using GIS software.

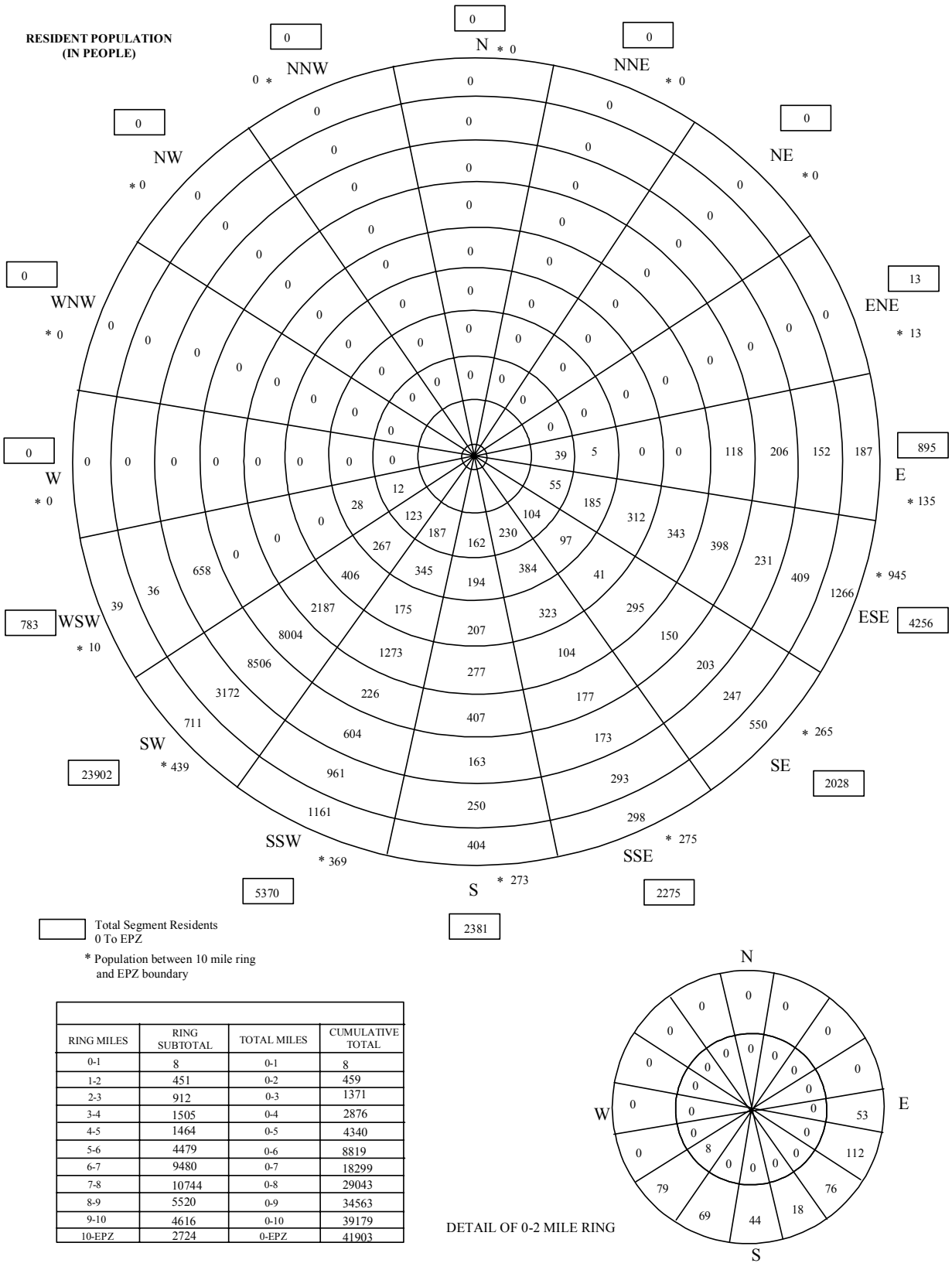
It can be argued that this estimate of permanent residents overstates, somewhat, the number of evacuating vehicles, especially during the summer. It is certainly reasonable to assert that some portion of the population would be on vacation during the summer and would travel elsewhere. A rough estimate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

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

On this basis, the resident population would be reduced by 5 percent in the summer and by a lesser amount in the off-season. This five percent reduction translates into about 1,000 vehicles. **Given the uncertainty in this estimate, we elected to apply no reductions in permanent population for the summer scenarios to account for residents who may be out of the area.**

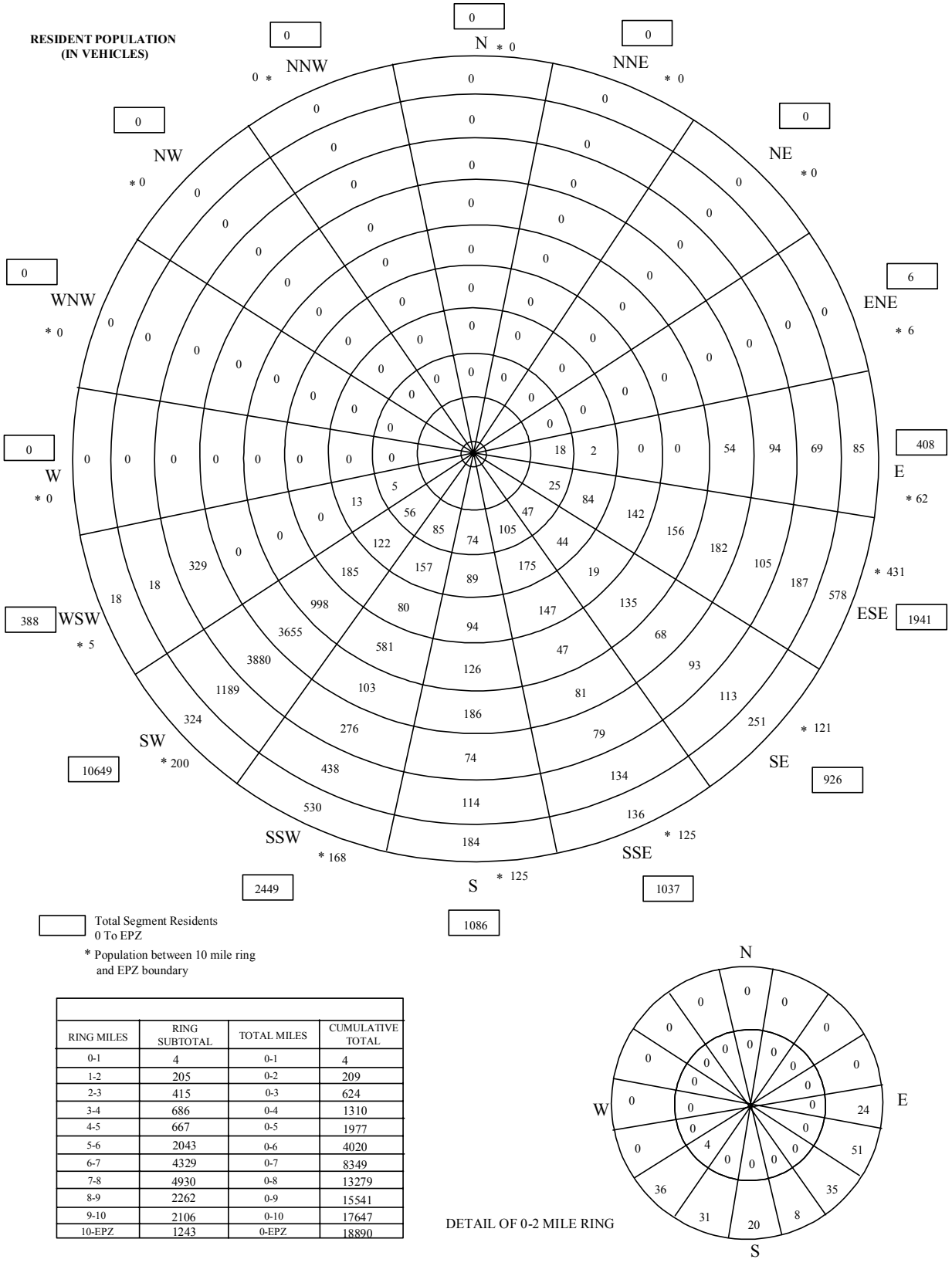
Table 3-2. Permanent Resident Population and Vehicles by ERPA

ERPA	Persons	Vehicles	ERPA	Persons	Vehicles
1	240	110	**16**	1,616	735
2	476	217	**17**	527	242
3	376	173	**18**	1,155	526
4	665	303	**19**	1,536	701
5	849	388	**20**	1,722	787
6	957	436	**21**	1,825	832
7	745	340	**22**	4,848	1,983
8	800	366	**23**	-	-
9	634	289	**24**	-	-
10	1,136	517	**25**	-	-
11	2,038	930	**26**	-	-
12	7,801	3,558	**27**	-	-
13	10,516	4,800	**28**	-	-
14	243	111	**29**	-	-
15	1,200	546	**TOTAL**	**41,903**	**18,890**



RING MILES	RING SUBTOTAL	TOTAL MILES	CUMULATIVE TOTAL
0-1	8	0-1	8
1-2	451	0-2	459
2-3	912	0-3	1371
3-4	1505	0-4	2876
4-5	1464	0-5	4340
5-6	4479	0-6	8819
6-7	9480	0-7	18299
7-8	10744	0-8	29043
8-9	5520	0-9	34563
9-10	4616	0-10	39179
10-EPZ	2724	0-EPZ	41903

Figure 3-2. Permanent Residents by Sector



RING MILES	RING SUBTOTAL	TOTAL MILES	CUMULATIVE TOTAL
0-1	4	0-1	4
1-2	205	0-2	209
2-3	415	0-3	624
3-4	686	0-4	1310
4-5	667	0-5	1977
5-6	2043	0-6	4020
6-7	4329	0-7	8349
7-8	4930	0-8	13279
8-9	2262	0-9	15541
9-10	2106	0-10	17647
10-EPZ	1243	0-EPZ	18890

DETAIL OF 0-2 MILE RING

Figure 3-3. Permanent Resident Vehicles by

State University of New York at Oswego

The following statistics were provided by Oswego County for the student population at the state university.

	Fall	Spring	Summer
Residents	3600	3500	100
Commuters	5175	4900	2000

We have been informed that the county plans call for 18 buses to be dispatched to the university. Assuming 40 people per bus, a total of 720 people can be transported by buses. We assume that the balance of campus residents will evacuate in private autos with 2 persons per auto.

Commuters who live within the EPZ will proceed home first. These people will have already been considered as EPZ residents. Commuters who live outside the EPZ will evacuate directly from the campus. It is assumed that 50% of commuters live outside the EPZ. These commuters will use autos with a vehicle occupancy of 1.5 persons to evacuate

Residents Evacuating in Buses	720	720	100
Residents Evacuating in Autos	2880	2780	0
Commuters Evacuating Directly From Oswego	2588	2450	1000

The following table summarizes the evacuation traffic generated by the State University at Oswego. The university population is considered as a separate population group. Note that people employed at the university are considered as part of the employee population group.

Vehicle Summaries (in Vehicle-equivalents)			
Buses (1 bus = 2 vehicle equivalents)	36	36	36
Autos (Residents)	1440	1390	0
Autos (Commuters)	1725	1633	667
Totals	3201	3059	1036

Transient Population

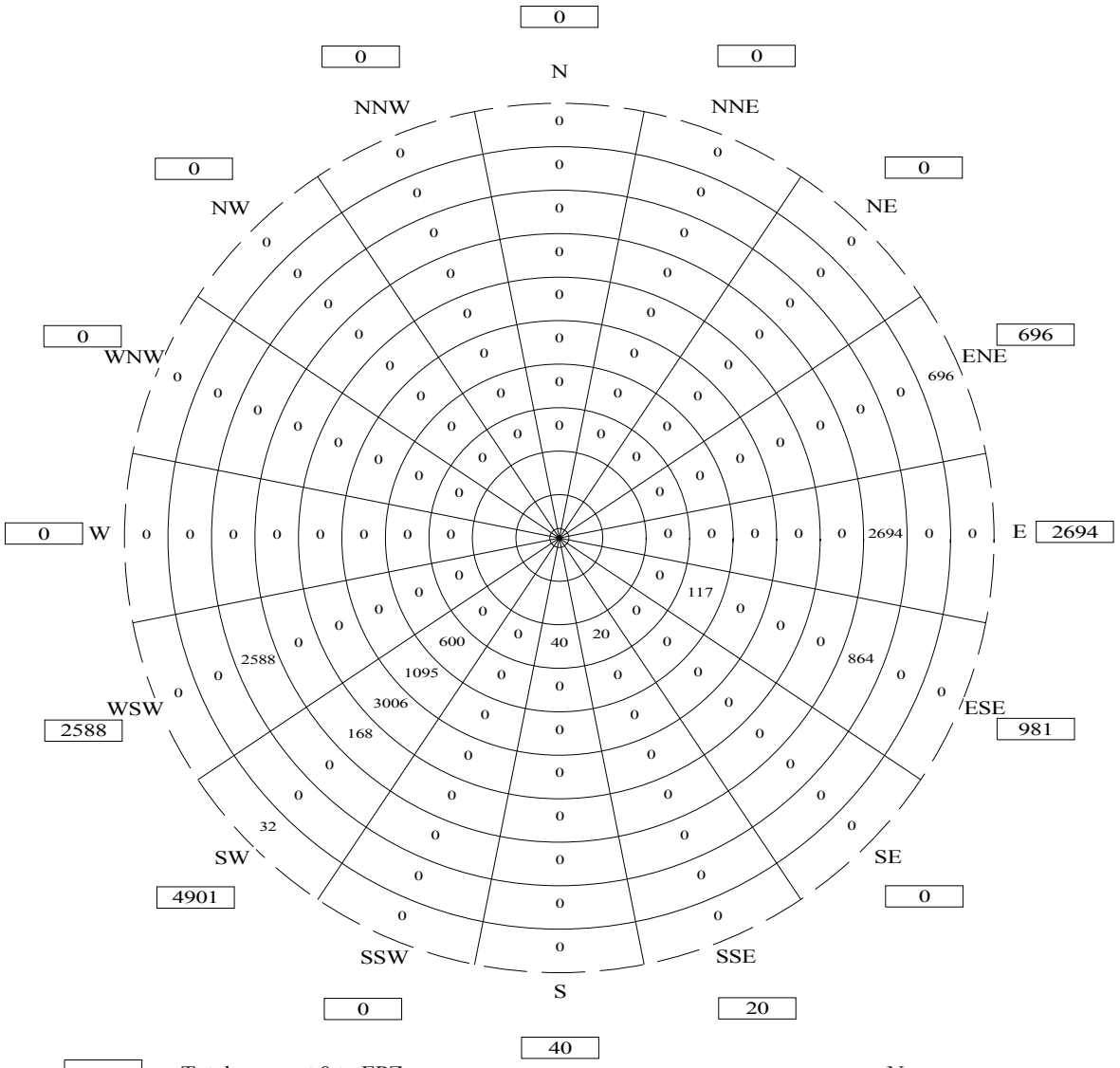
Transient population groups are defined as those people who enter the EPZ for a specific purpose (shopping, recreation) and who leave on the same day or who stay overnight at camping facilities or hotels and motels

Because the great majority of people utilizing these facilities travel in private vehicles, it is possible to estimate the transient population by first obtaining an estimate of the parking capacity of each facility and then applying a per vehicle occupancy factor to arrive at the population estimate. Care must be taken to avoid double-counting vehicles belonging to permanent residents who use the facilities.

Tables 3-3 and 3-4 present transient population and vehicle estimates by ERPA, respectively. Figures 3-4 and 3-5 present the transient population and vehicle estimates by sector.

Table 3-3. Transient Population by ERPA					
ERPA	**SUNY Oswego**	**Hotels**	**Marinas and Campgrounds**	**Shoppers**	**Total Persons**
1					
2					
3					
4			117		117
5		59			
6				600	600
7					
8					
9					
10					
11					
12		297	234	1,095	1,626
13		56	1,987	525	2,568
14		33	772		805
15			3,557		3,557
16					
17					
18					
19					
20					
21					
22	2,588				59
23					
24					
25					
Totals	**2,588**	**445**	**6,668**	**2,220**	**9,332**

Table 3-4. Transient Vehicles by ERPA					
ERPA	**SUNY Oswego**	**Hotels**	**Marinas and Campgrounds**	**Shoppers**	**Total Vehicles**
1					
2					
3					
4			20		20
5		30			
6				250	250
7					
8					
9					
10					
11					
12		148	175	456	779
13		28	200	218	446
14		16	622		638
15			1,162		1,162
16					
17					
18					
19					
20					
21					
22	1,725				30
23					
24					
25					
Totals	**1,725**	**222**	**2,179**	**924**	**3,325**



Transients			
Ring Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	0	0-1	0
1-2	0	0-2	0
2-3	0	0-3	0
3-4	60	0-4	60
4-5	717	0-5	777
5-6	1095	0-6	1872
6-7	3006	0-7	4878
7-8	168	0-8	5046
8-9	6146	0-9	11192
9-10	0	0-10	11192
10-EPZ	728	0-EPZ	11920

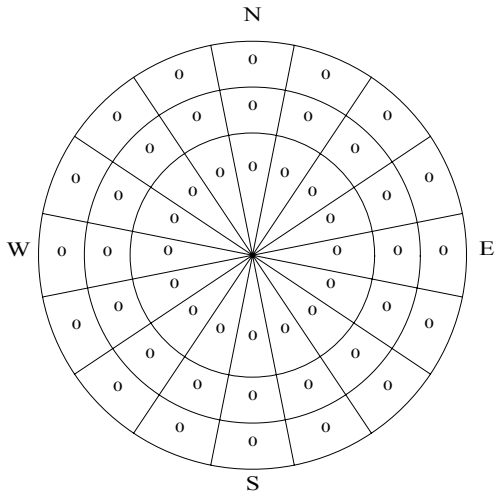
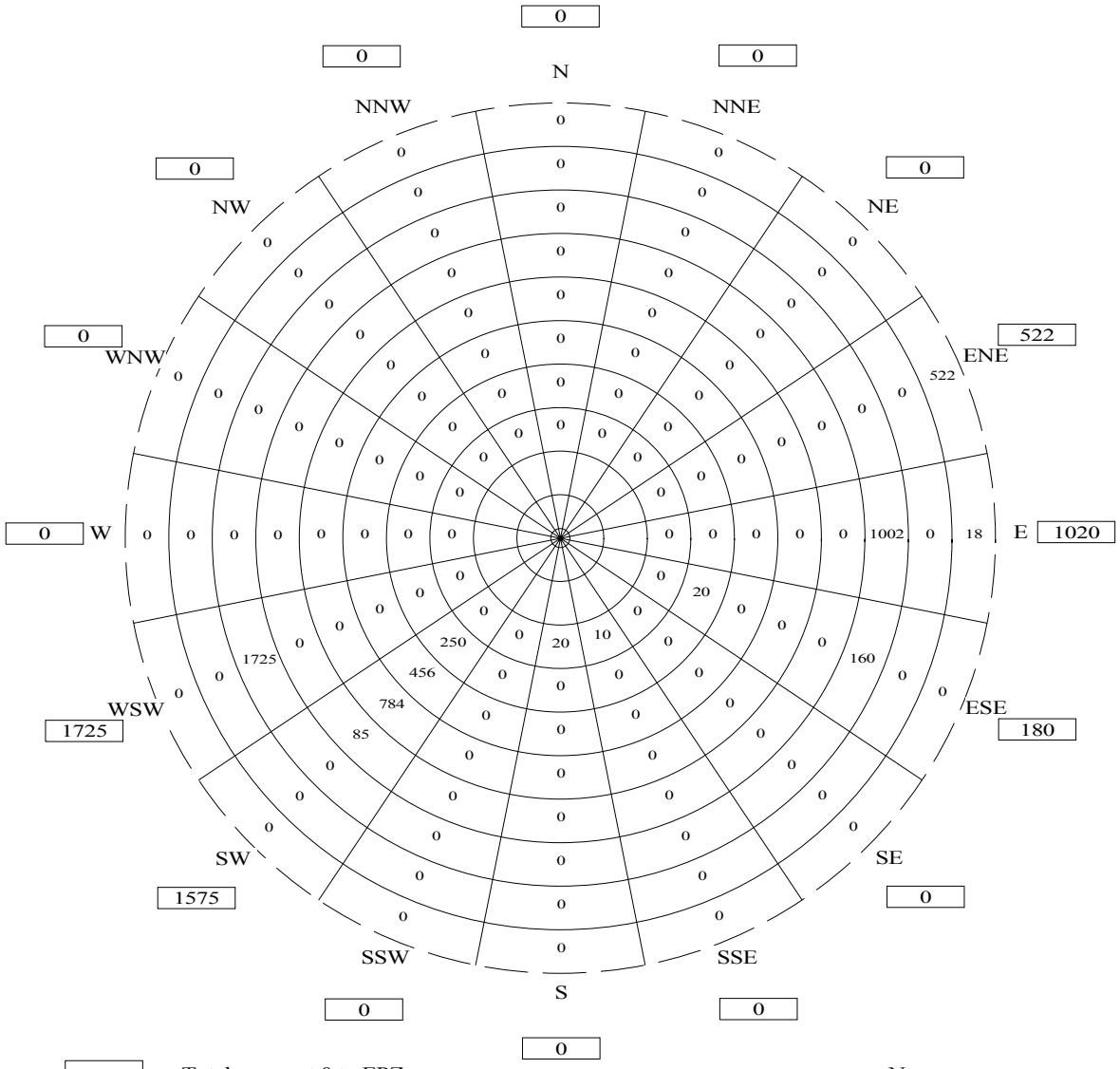


Figure 3-4. Transients by Sector



Transients			
Ring Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	0	0-1	0
1-2	0	0-2	0
2-3	0	0-3	0
3-4	30	0-4	30
4-5	270	0-5	300
5-6	456	0-6	756
6-7	784	0-7	1540
7-8	85	0-8	1625
8-9	2887	0-9	4512
9-10	0	0-10	4512
10-EPZ	540	0-EPZ	5052

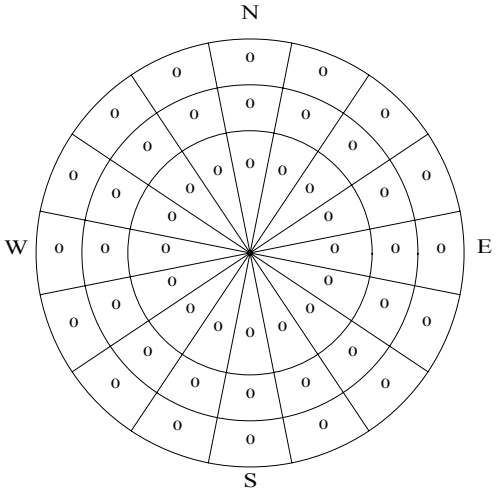


Figure 3-5. Transient Vehicles by Sector

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 have already been counted as part of the permanent population. To avoid double counting, we focus on those employees who will evacuate along with the permanent population.

The major areas of employment within the Nine Mile Point EPZ are:

- Nine Mile Point / JA Fitzpatrick Nuclear Plants
- Alcan Aluminum
- State University of New York, Oswego

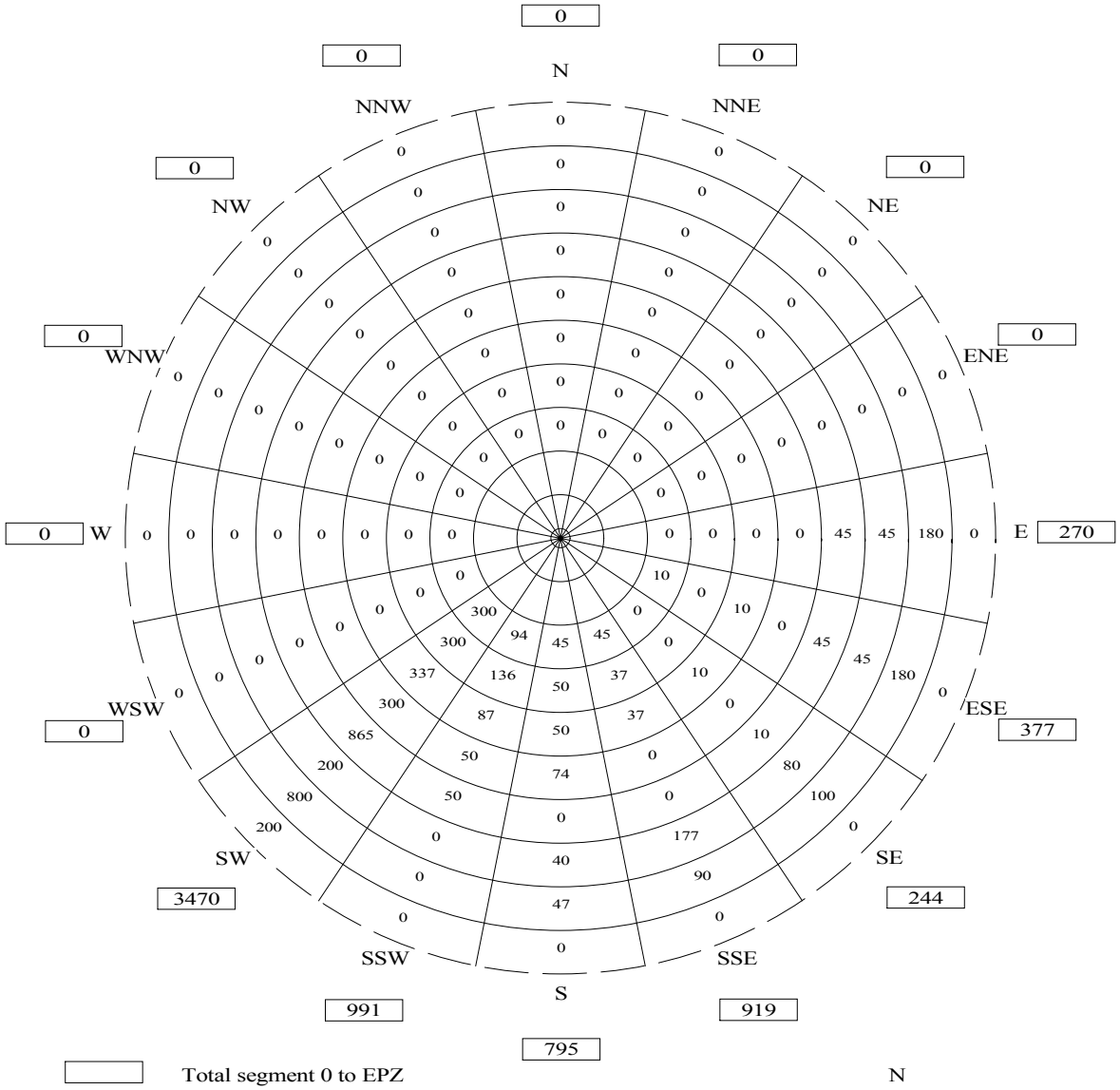
To represent the number of persons that work in the EPZ but live outside the EPZ, 1990 New York State journey-to-work data[1] was used. The data defines the number of persons working in a specified location (municipality) by their place of residence (origin municipality). The data indicates that, on average, 46 percent of workers in any municipality come from outside the EPZ. This figure agrees with data obtained by the KLD employment survey. The total number of jobs in any municipality was determined from NYS Department of Labor statistics for the year 2000. Thus in each ERPA, the number of jobs held by people who enter the EPZ on a daily basis was obtained by multiplying this percentage by the total number of employees.

A factor of 1 person per employee vehicle was obtained by observing vehicles at shift change at the NMP site. This value is confirmed by the results of the telephone survey, which indicates the vast majority of employees commute to work in single occupant automobiles.

Table 3-5 presents non-EPZ-Resident employee and vehicle estimates by ERPA. Figures 3-6 and 3-7 present this data by sector.

[1] Journey to Work data based on 2000 Census information was not available at this time.

Table 3-5. Non-EPZ Resident Employee Population by ERPA		
ERPA	**Persons**	**Vehicles**
1	1334	1334
2	174	174
3	252	252
4	10	10
5	270	270
6	698	698
7	10	10
8	10	10
9	10	10
10	174	174
11	174	174
12	637	637
13	865	865
14	180	180
15	180	180
16	180	180
17	180	180
18	87	87
19	174	174
20	87	87
21	180	180
22	1200	1200
23	0	0
24	0	0
25	0	0
26	0	0
27	0	0
28	0	0
29	0	0
Total	**7066**	**7066**



EMPLOYEES			
Ring Miles	Ring Subtotal	Total Miles	Cumulative Total
0-1	667	0-1	667
1-2	837	0-2	1504
2-3	391	0-3	1895
3-4	494	0-4	2389
4-5	523	0-5	2912
5-6	531	0-6	3443
6-7	424	0-7	3867
7-8	1015	0-8	4882
8-9	587	0-9	5469
9-10	1397	0-10	6866
10-EPZ	200	0-EPZ	7066

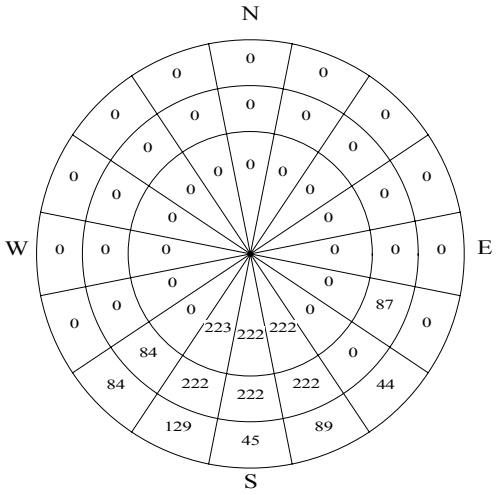


Figure 3-6. Employees and Employee Vehicles by Sector

Medical Facilities

The existing plans for Oswego County presents estimates of the populations of medical facilities such as hospitals, nursing and retirement homes and other health-related facilities. The number and type of evacuating vehicles that need to be provided depends on the patients' state of health. Buses can transport up to 40 people; vans, up to 12 people; ambulances, up to 2 people (patients).

Total Demand in Addition to Permanent Population

There will be vehicles traveling through the EPZ (external-external trips) at the time of the accident. After the Order to Evacuate is announced, these through travelers will also evacuate. These through vehicles are assumed to travel on the major highways in the area, which are the primary routes through the EPZ. It is assumed that this traffic will continue to enter the EPZ during the first 60 minutes following the Order to Evacuate. We estimate approximately 5,500 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. During the winter months, we estimate free speed and capacity reductions of approximately 20 percent under snow conditions, as a reasonable expectation.

Given the small urban and rural character of the EPZ, its areas of higher population density, and the availability of well-maintained highways, we expect some congestion arising from evacuation. Therefore, estimates of roadway capacity must be determined with great care. Because of its importance, a brief discussion of the major factors that influence capacity is presented in this section.

Capacity Estimations on Approaches to Intersections

At-grade intersections are apt to become the first bottleneck locations under 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. See Appendix G for details.

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

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

where:

$Qcap,m$	=	Capacity of a single lane of traffic on an approach, which executes movement, m, upon entering the intersection; vehicles per hour (vph)
h_m	=	Mean queue discharge headway of vehicles on this lane that are executing movement, m; seconds per vehicle
G_m	=	The mean duration of GREEN time servicing vehicles that are executing movement, m, for each signal control cycle; seconds
L	=	The mean "lost time" for each signal control cycle; seconds
C	=	The duration of each signal control 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 $h_{sat}, F_1, F_2, ...$

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

$$h_m \geq h_{sat}$$

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.

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

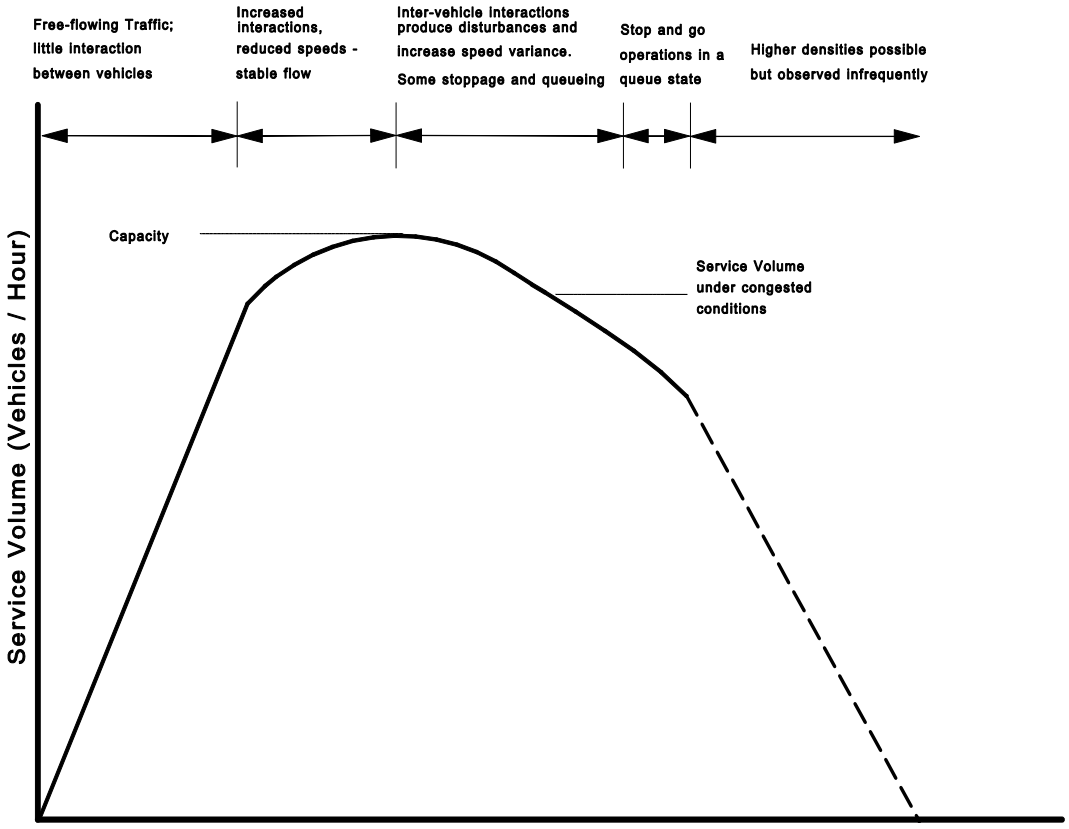


Figure 4-1. Fundamental Relationship Between Volume and Density

As indicated, there are two flow regimes: (1) Free Flow (left side of curve); and (2) Forced Flow (right side). 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) actually declines 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 that is applied during LOS F condition, V_F, which 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 our observations 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. We 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 NMP EPZ

As part of the development of the NMP 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 NMP EPZ consists primarily of two categories of roads and, of course, intersections:

- Two-lane roads: Local, State
- 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 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 (unsignalized 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 station is characterized by the following Emergency Action Classification Levels (see Appendix 1 of NUREG 0654 for details):

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

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

a. The Order to Evacuate will be announced following the activation of the ANS sirens.

b. Mobilization of the general population will commence up to 10 minutes after the activation of the ANS sirens.

c. Evacuation Time Estimates (ETE) are measured relative to the Order to Evacuate.

A rapidly escalating accident scenario assumes that the general population will evacuate over the same time frame as do the school children, the transit-dependent population, and the special facility population. This assumption generally leads to longer evacuation time estimates than those for scenarios that escalate more slowly,

We emphasize that the adoption of this planning basis is not a representation that these events will occur at the Nine Mile Point/JA Fitzpatrick Nuclear Facility (NMP) within the indicated time frame. Rather, these assumptions are necessary in order to:

- Establish a temporal framework for estimating the Trip Generation distribution in the format recommended in Appendix 4 of NUREG 0654.

- Identify temporal points of reference for the purpose of uniquely defining "Clear Time" and Evacuation Time Estimates (ETE).

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

For example, suppose one hour will elapse from the declaration of a General Emergency to the Order to Evacuate. In this case, it is reasonable to expect some degree of spontaneous evacuation by the public during this hour period. As a result, the population within the Emergency Planning Zone (EPZ) will be lower when the Order to Evacuate is announced, than at the time of the General Emergency. Thus, the time needed to evacuate the EPZ, after the Order to Evacuate will be less than the estimates presented in this report.

The notification process consists of two events:

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

The peak population within the EPZ exceeds 40,000 persons who are deployed over an area of approximately 157 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 more accurate assessments may be obtained.

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

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	No-accident condition
2	Awareness of accident situation
3	Depart place of work to return home
4	Arrive home
5	Leave to evacuate the area

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

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

These relationships are shown graphically in Figure 5-1.

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

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

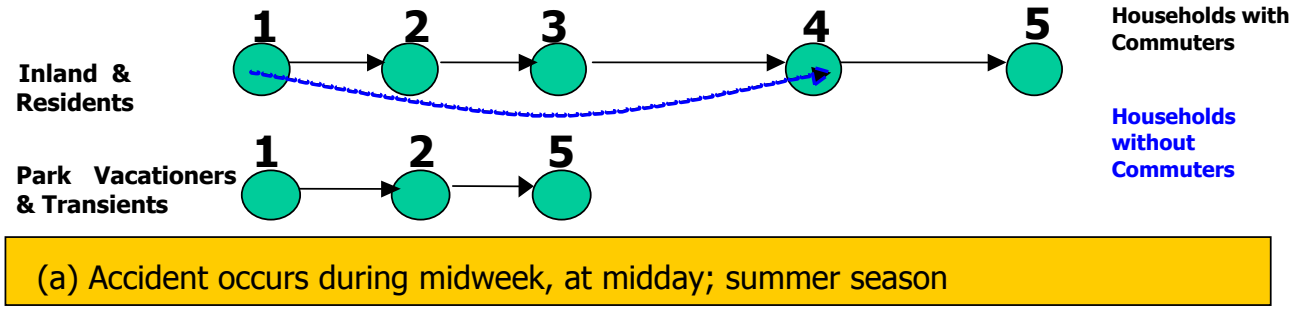
Estimated Time Distributions of Activities Preceding Event 5

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

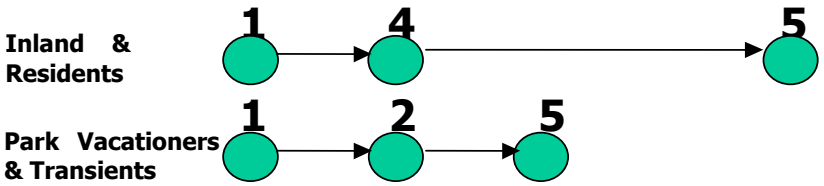
Time Distribution No. 1, Notification Process: Activity 1 $\rightarrow$ 2

It is reasonable to expect that 85 percent of the people within the EPZ will be aware of the accident within 30 minutes with the remainder notified within the following 20 minutes. The resulting distributions for this notification activity are given below.

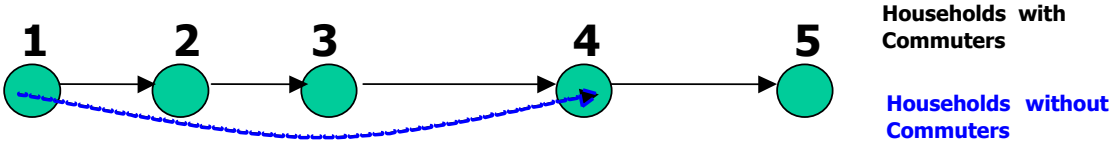
Elapsed Time (Minutes)	Percent of Population Notified
0	0
5	7
10	13
15	26
20	46
25	65
30	85
35	90
40	95
45	98
50	100



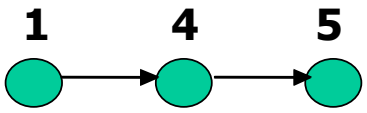
(a) Accident occurs during midweek, at midday; summer season



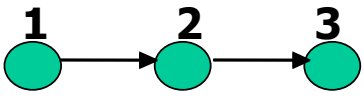
(b) Accident occurs during weekend, at midday; summer season



(c) Accident occurs during midweek, at midday; non- summer season



(d) Accident occurs in the evening; non -summer season



(e) Employees who live outside the EPZ

1 Notification
2 Prepare to Leave Activity
3 Travel Home
4 Prepare to Leave Home
5 Begin Evacuation Trip

Increasing Time

Event

Activity

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 responsible for equipment would require additional time to secure the 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	46
10	64
15	74
20	79
25	81
30	88
35	89
40	91
45	93
50	93
55	94
60	98
70	100

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

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	24
10	49
15	66
20	78
25	84
30	88
35	90
40	91
45	96
50	97
55	97
60	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 Percent Ready to Evacuate
0	0
5	12
10	25
15	40
20	50
25	60
30	71
35	75
40	79
45	81
50	84
55	88
60	91
65	92
70	95
75	97
80	98
85	99
90	100

NOTE: The original data was obtained in 15-minute increments. The above figures were calculated by interpolation and normalized as before.

Snow Clearance Time Distribution

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

Consequently, it is reasonable to assume that the highway system will remain passable -- albeit at a lower capacity -- under the vast majority of snow conditions. Nevertheless, for the vehicles to gain access to the highway system, it may be necessary for driveways and employee parking lots to be cleared **to the extent needed to permit vehicles to gain access to the roadways.** These clearance activities take time, which must be incorporated into the trip generation time distributions. . Note that 80 percent of the population estimates that it would take less than 30 minutes to make their driveway passable. These data are provided directly by the telephone survey. This distribution is plotted in Figure 5-2 and listed below.

Distribution No. 5, Time to Clear Driveway of Snow

Elapsed Time (Min)	Cumulative Percent Driveways Cleared
0	0
5	15
10	30
15	45
20	56
25	67
30	79
35	81
40	84
45	88
50	89
55	90
60	92
65	93
70	95
75	96
80	97
85	98
90	100

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:			
Distributions 1 and 2	To Obtain Distribution A	That defines	Event No. 3
Distributions A and 3	To Obtain Distribution B	That defines	Event No. 4
Distributions B and 4	To Obtain Distribution C	That defines	Event No. 5
Distributions A and 4	To Obtain Distribution D	That defines	Event No. 5
Distributions C and 5	To Obtain Distribution E	That defines	Event No. 5
Distributions D and 5	To Obtain Distribution F	That defines	Event No. 5

Distributions A through F are described below; distributions A, C, D, E, F are shown in Figure 5-2:

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 leaving home to begin the evacuation trip with snow clearance activities.
F	Time distribution of residents without commuters returning home to begin the evacuation trip with snow clearance activities.

Figure 5-2 presents the combined trip generation distributions designated A, C, D, E, and F. These distributions are presented on the same time scale. The PCDYNEV simulation model is designed to accept varying rates of vehicle trip generation for each origin centroid, expressed in the form of histograms.

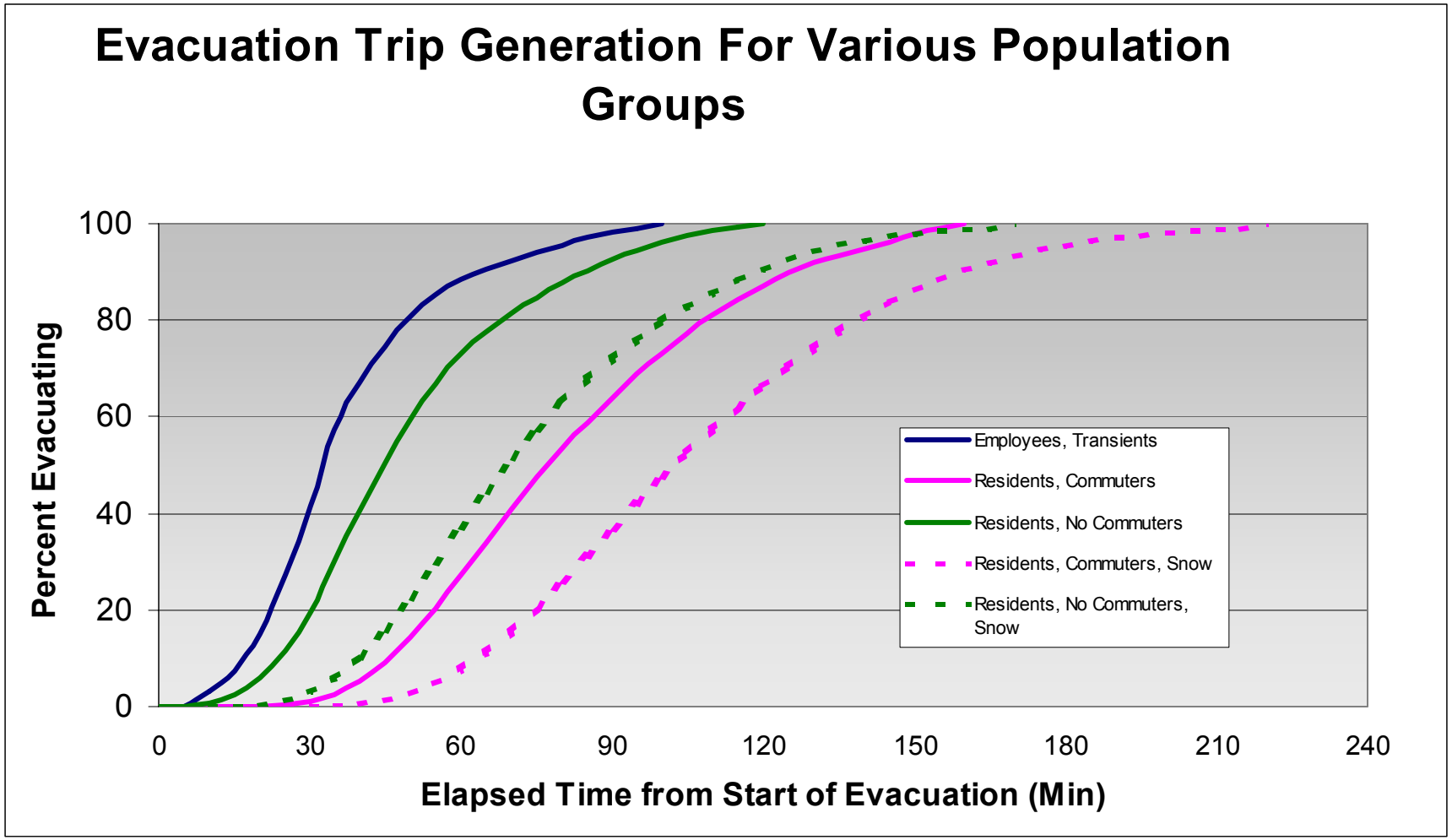


Figure 5-2. Comparison of Trip Generation Distributions

6. DEMAND ESTIMATION FOR EVACUATION SCENARIOS

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

Region — A grouping of contiguous evacuation ERPAs, that forms a "keyhole" sector-based area, or 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 members of, and response times for the affected population groups.

A total of 51 Evacuation Regions were defined which encompass all the groupings of ERPA considered. These Regions are defined in Table 6-1. The ERPA configurations are identified in Figure 6-1. Each keyhole sector-based area consists of a central circle centered at the Nine Mile Point/JA Fitzpatrick Nuclear Facility (NMP), and three adjoining sectors, each with a central angle of 22.5 degrees. These sectors extend to a distance of 5 miles from NMP (Regions R4 to R27), or 10 miles (Regions R28 to R51). The azimuth of the center sector defines the orientation of these Regions.

A total of 14 Scenarios were evaluated for all Regions (714 cases). Table 6-2 is a description of all Scenarios.

Each combination of evacuation region and accident scenario implies a specific population to be evacuated. Table 6-3 presents the percentage of each population group assumed to evacuate with each scenario. Table 6-4 presents the actual population and vehicle counts for each scenario that were used for the simulation.

Table 6-1. Definition of Evacuation Regions					
Region	**ERPAs in Region**		**Region**	**ERPAs in Region**	
R1	1,2,3,26,27	**2 mile**			
R2	1-6,9-12,26,27	**5 mile**			
R3	1-29	**Full EPZ**			
	Evacuation to 5 Miles	**Wind From**		**Evacuation to EPZ Boundary**	**Wind From**
R4	1-3,26,27	214 to 222	**R28**	1-3,14,26,27,29	214 to 222
R5	1-3,26,27	223 to 233	**R29**	1-3,14,26,27,29	223 to 233
R6	1-3,7,26,27	234 to 240	**R30**	1-3,7,14,15,26,27,29	234 to 240
R7	1-4,7,26,27	241 to 254	**R31**	1-3,4,7,14,15,26,27,29	241 to 254
R8	1-4,7,26,27	255 to 262	**R32**	1-3,4,7,14-17,26,27,29	255 to 262
R9	1-4,7,9,26,27	263 to 278	**R33**	1-3,4,7-9,14-17,26,27,29	263 to 278
R10	1-5,7,9,26,27	279 to 292	**R34**	1-5,7-9,14-18,26,27,29	279 to 292
R11	1-5,7,9,10,26,27	293 to 305	**R35**	1-5,7-10,14-18,26,27,29	293 to 305
R12	1-5,7,9,10,26,27	306 to 311	**R36**	1-5,7-10,14-20,26,27,29	306 to 311
R13	1-5,7,9,10,26,27	312 to 332	**R37**	1-5,7-10,14-20,26,27	312 to 332
R14	1-5,9-11,26,27	333 to 340	**R38**	1-5,8-11,15-21,25-27	333 to 340
R15	1-5,9-11,26,27	341 to 349	**R39**	1-5,8-11,17-21,24-27	341 to 349
R16	1-3,5,6,9-11,26,27	350 to 356	**R40**	1-3,5,6,8-13,18-22,24-27	350 to 356
R17	1-3,5,6,9-11,26,27	357 to 12	**R41**	1-3,5,6,9-13,18-27	357 to 12
R18	1-3,5,6,10,11,26,27	13 to 20	**R42**	1-3,5,6,10-13,18-27	13 to 20
R19	1-3,5,6,10,11,26,27	21 to 51	**R43**	1-3,5,6,10-13,19-28	21 to 51
R20	1-3,5,6,11,26,27	52 to 56	**R44**	1-3,5,6,11-13,19-24,26-28	52 to 56
R21	1-3,5,6,11,26,27	57 to 61	**R45**	1-3,5,6,11-13,19,21-24,26-28	57 to 61
R22	1-3,6,11,26,27	62 to 70	**R46**	1-3,6,11-13,19,21-24,26-28	62 to 70
R23	1-3,6,26,27	71 to 89	**R47**	1-3,6,12,13,21-24,26-28	71 to 89

R24	1-3,6,26,27	90 to 95	**R48**	1-3,6,26-28	90 to 95
R25	1-3,26,27	96 to 114	**R49**	1-3,26-28	96 to 114
R26	1-3,26,27	115 to 146	**R50**	1-3,26-28	115 to 146
R27	1-3,26,27	147 to 213	**R51**	1-3,26-29	147 to 213

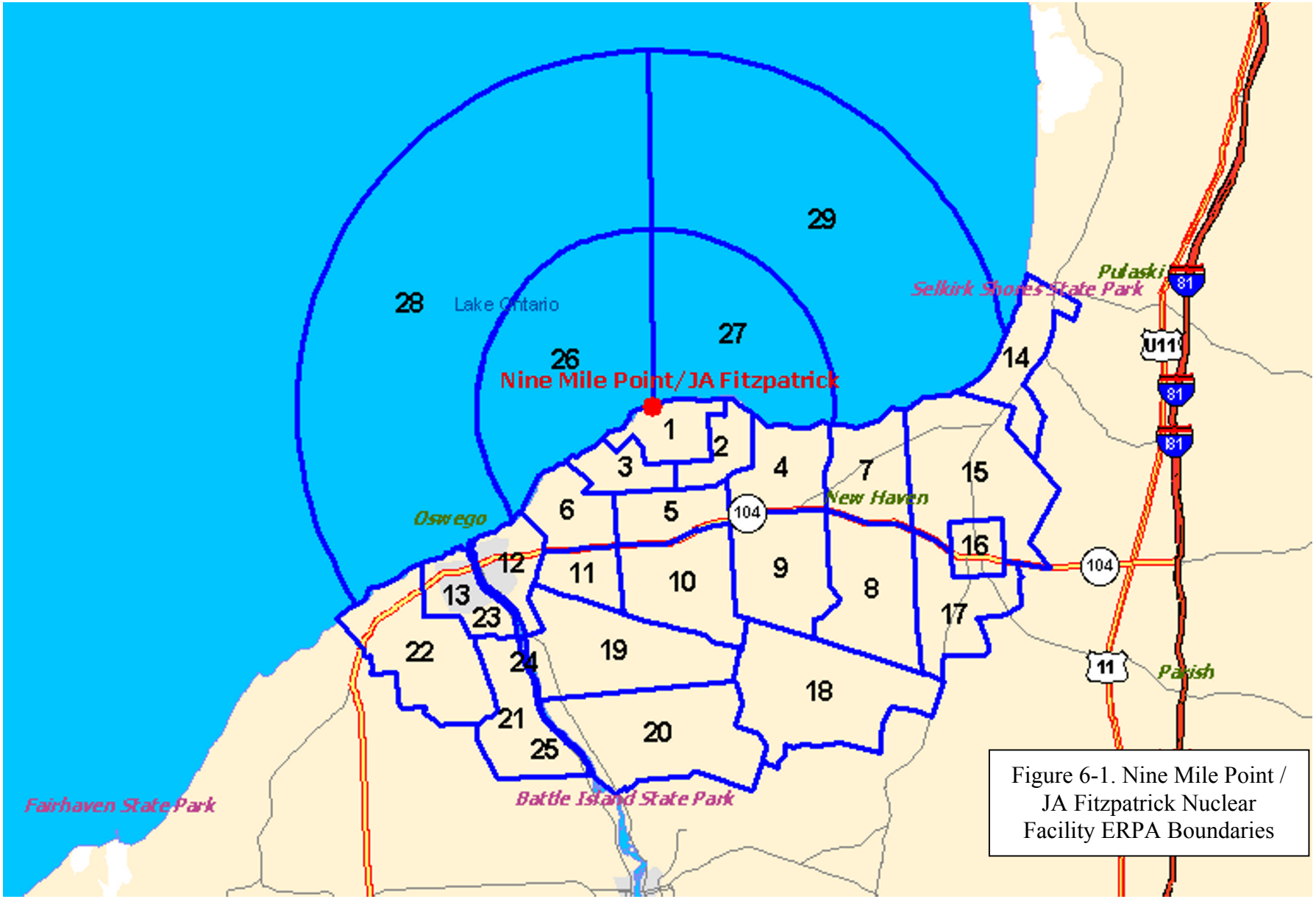


Figure 6-1. Nine Mile Point / JA Fitzpatrick Nuclear Facility ERPA Boundaries

Table 6-2. Evacuation Scenario Definitions

Scenario	Season	Day of Week	Time of Day	Weather	Special Events	Comments
1	Summer	Midweek	Midday	Good	None	Residents are at home or at work; employees are at 100% of mid-week work force; 50% of peak transient population is present; schools are not in session.
2	Summer	Midweek	Midday	Rain	None	As above. Sudden rain occurs.
3	Summer	Weekend	Midday	Good	None	Most residents are based at home; employees are at 40% of mid-week work force; 100% of transient population is present; schools are not in session.
4	Summer	Weekend	Midday	Rain	None	As above. Sudden rain occurs
5	Summer	Midweek, Weekend	Evening	Good	None	Residents are at home; employees (including shift workers) are at 10% of mid- week peak; 30% of transient population is present.
6	Winter	Midweek	Midday	Good	None	Residents are at home or at work; employees are at 100% of mid-week work force; 40% of peak transient population is present; schools are in session.
7	Winter	Midweek	Midday	Rain	None	As above. Sudden rain occurs
8	Winter	Midweek	Midday	Snow	None	As above. Snow is present requiring driveway clearance.
9	Winter	Weekend	Midday	Good	None	Most residents are based at home; employees are at 40% of mid-week work force; 40% of peak transient population is present; schools are not in session.
10	Winter	Weekend	Midday	Rain	None	As above. Sudden rain occurs
11	Winter	Weekend	Midday	Snow	None	As above. Snow is present requiring driveway clearance.
12	Winter	Midweek, Weekend	Evening	Good	None	Residents are at home; employees (including shift workers) are at 9% of mid- week peak; 20% of transient population is present.
13	Summer	Weekend	Midday	Good	Classic Weekend	As Scenario 3 with additional special event population
14	Summer	Midweek	Midday	Good	Harborfest	As Scenario 1 with additional special event population

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

Scenarios	Residents	Employees	Transients	Shadow	Special Events	School Buses	Transit Buses	External Through Traffic
1	100%	100%	50%	40%	0%	30%	100%	100%
2	100%	100%	50%	40%	0%	30%	100%	100%
3	100%	40%	100%	34%	0%	0%	100%	100%
4	100%	40%	100%	34%	0%	0%	100%	100%
5	100%	25%	30%	33%	0%	0%	100%	60%
6	100%	100%	40%	40%	0%	100%	100%	100%
7	100%	100%	40%	40%	0%	100%	100%	100%
8	100%	100%	40%	40%	0%	100%	100%	100%
9	100%	40%	40%	34%	0%	30%	100%	100%
10	100%	40%	40%	34%	0%	30%	100%	100%
11	100%	40%	40%	34%	0%	30%	100%	100%
12	100%	25%	20%	33%	0%	0%	100%	60%
13	100%	40%	100%	34%	50%	0%	100%	100%
14	100%	25%	100%	33%	100%	0%	100%	100%

Residents Households of EPZ residents

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 Oswego area associated with a Classic Weekend and Harborfest.

School and Transit Buses Vehicle-equivalents present on the road during evacuation servicing schools and transit-dependent people.

External Through Traffic Traffic on local highways and major arterial roads at the start of the evacuation. This traffic is stopped by access control at about 1:00 after the evacuation begins.

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

Scenarios	Residents	Employees	Transients	Shadow	Special Events	School Buses	Transit Buses	External Traffic	Total Scenario Vehicles
1	19,014	7,066	1,662	3,303	-	92	253	5,508	36,995
2	19,014	7,066	1,662	3,303	-	92	253	5,508	36,995
3	19,014	2,826	3,324	2,810	-	-	253	5,508	33,735
4	19,014	2,826	3,324	2,810	-	-	253	5,508	33,735
5	19,014	1,767	997	2,686	-	-	253	3,305	28,022
6	19,014	7,066	1,330	3,303	-	306	253	5,508	36,877
7	19,014	7,066	1,330	3,303	-	306	253	5,508	36,877
8	19,014	7,066	1,330	3,303	-	306	253	5,508	36,877
9	19,014	2,826	1,330	2,810	-	92	253	5,508	31,833
10	19,014	2,826	1,330	2,810	-	92	253	5,508	31,833
11	19,014	2,826	1,330	2,810	-	92	253	5,508	31,833
12	19,014	1,767	665	2,686	-	-	253	3,305	27,690
13	19,014	2,826	3,324	2,810	6,100	-	253	5,508	39,835
14	19,014	1,767	3,324	2,686	12,200	-	253	5,508	44,752

Residents Households of EPZ residents

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 Oswego area associated with a Classic Weekend and Harborfest.

School and Transit Buses Vehicle-equivalents present on the road during evacuation servicing schools and transit-dependent people. The numbers shown are double the actual number of buses on the road since the data presented is in units of vehicle-equivalents (1bus = 2 autos) We conservatively place some school buses on the road during the summer, midweek period and the winter, weekend period

External Through Traffic Traffic on local highways and major arterial roads at the start of the evacuation. This traffic is stopped by access control at about 1:00 after the evacuation begins.

7. GENERAL POPULATION EVACUATION TIME ESTIMATES (ETE)

This section presents the current results of the computer analyses using the IDYNEV System. These results cover the 51 Evacuation Regions within NMP EPZ and the 14 Evacuation Scenarios, discussed in Section 6.

The ETE for each Evacuation Case are presented in Tables 7-1A through 7-1D. These tables present the estimated time to clear the indicated population percentages from the Evacuation Regions. These tabulated values of ETE are obtained by interpolating from PCDYNEV output, which are generated at 30-minute intervals, then rounded to the nearest 5 minutes. Exhibit 1 is a sample use of these tables.

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

The ETE for NMP addresses the issue of voluntary evacuees in the manner shown in Figure 7-1. Within the circle defined by the furthest radial extent of the Evacuation Region, 50 percent of the population in ERPAs outside the Evacuation Region who are not advised to evacuate, are assumed to do so. Within the annual ring extending from the radial extent of the Evacuation Region (if less than 10 miles), to the EPZ boundary, it is assumed that 35 percent of the population will elect to evacuate.

Figure 7-2 presents the area identified as the "Shadow Region". This Region extends from the southern boundary of the EPZ to the southern city limits of Fulton in the area of New York State Routes 481 and 48. This area was selected because these routes are major evacuation routes for the City of Oswego and the City of Fulton is densely populated in the area surrounding these state routes. Thus, traffic generated within this Shadow Region, traveling away from the NMP location, has a potential for impeding evacuating vehicles from within the Evacuation Region. We assume that the traffic volumes emitted within the Shadow Region corresponds to 30 percent of the residents plus a proportionate number of employees in that region. All ETE calculations include this shadow traffic movement.

Exhibit 1
Utilization of Tables 7-1A through 7-1D

In the event of an emergency requiring a protective action recommendation, the following procedure is used.

1. Identify the season (Summer or Winter)
2. Identify the Day of the Week (Midweek, Weekend)
   (Note: Schools are in session generally during Winter, Midweek periods.)
3. Identify the Time of Day (Midday, Evening)
4. Identify the Weather Conditions (Good Weather, Rain, Snow with Passable Roads)
5. Identify the furthest extent of the protective action recommendation (2-miles, 5-miles, EPZ Boundary)
6. Identify the direction the wind is heading from
7. Knowing wind direction and extent of protective action needs, identify the region to be evacuated
8. Identify the Evacuation Percentile of Interest (50, 90, 95, or 100th percentile)
9. Go to Table 7-1A for a 50th percentile evacuation time, Table 7-1B for a 90th percentile evacuation time, Table 7-1C for a 95th percentile evacuation time, or Table 7-1D for a 100th percentile evacuation time
10. Identify the row of interest by matching the region with the region number on the table
11. The season, day of week, time of day, and weather conditions identify the column of interest
12. Evacuation times are read from the intersection of the row and the column selected from the table.

Example:
Sunday, August 14, at 2PM in rain, Region 14 has been selected. The scenario is therefore (Summer, Weekend, Midday, Rain), or Column 4 on the tables. The ETE are:

50th Percentile	0:45	Table 7-1A
90th Percentile	1:25	Table 7-1B
95th Percentile	1:40	Table 7-1C

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

	Summer		Summer		Summer		Winter			Winter			Winter		Summer	Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend			Midweek Weekend		Weekend Classic Weekend	Weekend Harbor Fest
	Midday		Midday		Evening		Midday			Midday			Evening		Midday	Midday
Region	Good Weather	Rain	Good Weather	Rain	Good Weather	Region	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Region	Good Weather	Good Weather
Entire 2-Mile, 5-Mile Circles and EPZ																
R01	0:40	0:45	0:40	0:40	0:45	R01	0:40	0:45	0:45	0:40	0:40	0:50	0:45	R01	0:40	0:45
R02	1:05	1:10	1:00	1:00	1:00	R02	1:05	1:10	1:25	1:00	1:00	1:25	0:55	R02	1:20	2:30
R03	1:15	1:20	1:10	1:15	1:10	R03	1:25	1:30	1:50	1:10	1:15	1:35	1:10	R03	1:45	2:30

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

	Summer		Summer		Summer		Winter			Winter			Winter		Summer	Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend			Midweek Weekend		Weekend Classic Weekend	Weekend Harbor Fest
	Midday		Midday		Evening		Midday			Midday			Evening		Midday	Midday
Region	Good Weather	Rain	Good Weather	Rain	Good Weather	Region	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Region	Good Weather	Good Weather
Regions Extending to 5-Miles																
R04	0:40	0:45	0:40	0:40	0:45	R04	0:40	0:45	0:45	0:40	0:40	0:50	0:45	R04	0:40	0:45
R05	0:40	0:45	0:40	0:40	0:45	R05	0:40	0:45	0:45	0:40	0:40	0:50	0:45	R05	0:40	0:45
R06	0:50	0:55	0:45	0:45	0:45	R06	0:50	0:55	1:00	0:45	0:45	0:55	0:45	R06	0:45	0:45
R07	1:05	1:05	0:45	0:50	0:50	R07	1:05	1:10	1:20	0:45	0:50	1:05	0:50	R07	0:45	0:50
R08	1:05	1:05	0:45	0:50	0:50	R08	1:05	1:10	1:20	0:45	0:50	1:05	0:50	R08	0:45	0:50
R09	1:05	1:10	0:45	0:50	0:50	R09	1:05	1:10	1:20	0:45	0:50	1:05	0:50	R09	0:45	0:50
R10	1:00	1:05	0:45	0:50	0:45	R10	1:00	1:05	1:20	0:45	0:50	1:05	0:50	R10	0:45	0:50
R11	1:00	1:05	0:45	0:50	0:50	R11	1:05	1:05	1:20	0:50	0:50	1:10	0:50	R11	0:50	0:50
R12	1:00	1:05	0:45	0:50	0:50	R12	1:05	1:05	1:20	0:50	0:50	1:10	0:50	R12	0:50	0:50
R13	1:00	1:05	0:45	0:50	0:50	R13	1:05	1:05	1:20	0:50	0:50	1:10	0:50	R13	0:50	0:50
R14	0:55	0:55	0:45	0:45	0:45	R14	0:55	0:55	1:10	0:45	0:45	1:05	0:45	R14	1:00	1:40
R15	0:55	0:55	0:45	0:45	0:45	R15	0:55	0:55	1:10	0:45	0:45	1:05	0:45	R15	1:00	1:40
R16	0:50	0:50	0:45	0:45	0:45	R16	0:50	0:50	1:00	0:45	0:45	1:00	0:45	R16	0:55	1:30
R17	0:50	0:50	0:45	0:45	0:45	R17	0:50	0:50	1:00	0:45	0:45	1:00	0:45	R17	0:55	1:30
R18	0:50	0:50	0:45	0:45	0:45	R18	0:50	0:50	1:00	0:45	0:45	1:00	0:45	R18	1:00	1:45
R19	0:50	0:50	0:45	0:45	0:45	R19	0:50	0:50	1:00	0:45	0:45	1:00	0:45	R19	1:00	1:45
R20	0:50	0:50	0:45	0:45	0:45	R20	0:50	0:50	0:55	0:45	0:45	1:00	0:45	R20	1:05	2:20
R21	0:50	0:50	0:45	0:45	0:45	R21	0:50	0:50	0:55	0:45	0:45	1:00	0:45	R21	1:05	2:20
R22	0:45	0:50	0:45	0:45	0:45	R22	0:50	0:50	0:55	0:45	0:45	0:55	0:45	R22	1:05	2:30
R23	0:45	0:45	0:40	0:45	0:45	R23	0:45	0:45	0:50	0:45	0:45	0:55	0:45	R23	0:40	0:50
R24	0:45	0:45	0:40	0:45	0:45	R24	0:45	0:45	0:50	0:45	0:45	0:55	0:45	R24	0:40	0:50
R25	0:40	0:45	0:40	0:40	0:45	R25	0:40	0:45	0:45	0:40	0:40	0:50	0:45	R25	0:40	0:45
R26	0:40	0:45	0:40	0:40	0:45	R26	0:40	0:45	0:45	0:40	0:40	0:50	0:45	R26	0:40	0:45
R27	0:40	0:45	0:40	0:40	0:45	R27	0:40	0:45	0:45	0:40	0:40	0:50	0:45	R27	0:40	0:45

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

	Summer		Summer		Summer		Winter			Winter			Winter		Summer	Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend			Midweek Weekend		Weekend Classic Weekend	Weekend Harbor Fest
	Midday		Midday		Evening		Midday			Midday			Evening		Midday	Midday
Region	Good Weather	Rain	Good Weather	Rain	Good Weather	Region	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Region	Good Weather	Good Weather
Regions Extending to EPZ Boundary																
R28	0:40	0:40	0:45	0:45	0:40	R28	0:40	0:40	0:45	0:40	0:40	0:50	0:45	R28	0:40	0:40
R29	0:40	0:40	0:45	0:45	0:40	R29	0:40	0:40	0:45	0:40	0:40	0:50	0:45	R29	0:40	0:40
R30	0:50	0:55	0:50	0:50	0:45	R30	0:55	0:55	1:00	0:45	0:45	0:55	0:45	R30	0:45	0:45
R31	1:05	1:05	0:50	0:55	0:50	R31	1:05	1:10	1:15	0:50	0:50	1:00	0:50	R31	0:50	0:50
R32	1:05	1:05	0:50	0:55	0:50	R32	1:05	1:10	1:15	0:50	0:50	1:05	0:50	R32	0:50	0:50
R33	1:05	1:10	0:50	0:55	0:50	R33	1:05	1:10	1:20	0:50	0:55	1:05	0:50	R33	0:50	0:50
R34	1:05	1:05	0:50	0:55	0:50	R34	1:05	1:10	1:20	0:50	0:50	1:10	0:50	R34	0:50	0:50
R35	1:05	1:10	0:50	0:55	0:50	R35	1:05	1:10	1:20	0:50	0:55	1:10	0:50	R35	0:50	0:55
R36	1:10	1:15	0:55	0:55	0:55	R36	1:10	1:15	1:30	0:55	0:55	1:15	0:55	R36	0:55	1:00
R37	1:10	1:15	0:55	0:55	0:55	R37	1:10	1:15	1:30	0:55	0:55	1:15	0:55	R37	0:55	1:00
R38	1:10	1:10	0:55	0:55	0:55	R38	1:10	1:10	1:25	0:55	0:55	1:15	0:55	R38	1:00	1:10
R39	1:10	1:15	0:55	0:55	0:55	R39	1:10	1:15	1:30	0:55	0:55	1:15	0:55	R39	1:00	1:10
R40	1:15	1:20	1:05	1:05	1:00	R40	1:20	1:25	1:45	1:05	1:10	1:30	1:05	R40	1:25	1:35
R41	1:10	1:15	1:00	1:05	1:00	R41	1:15	1:20	1:40	1:05	1:10	1:25	1:05	R41	1:25	1:35
R42	1:10	1:15	1:05	1:10	1:05	R42	1:20	1:25	1:45	1:05	1:10	1:30	1:05	R42	1:25	1:40
R43	1:10	1:20	1:10	1:15	1:05	R43	1:20	1:25	1:50	1:10	1:15	1:35	1:10	R43	1:35	1:50
R44	1:10	1:15	1:10	1:15	1:05	R44	1:20	1:25	1:45	1:10	1:15	1:35	1:10	R44	1:35	1:50
R45	1:15	1:15	1:10	1:15	1:10	R45	1:20	1:25	1:45	1:10	1:15	1:35	1:10	R45	1:45	2:20
R46	1:15	1:15	1:10	1:15	1:10	R46	1:20	1:25	1:45	1:10	1:15	1:35	1:10	R46	1:45	2:20
R47	1:10	1:15	1:10	1:15	1:05	R47	1:20	1:25	1:45	1:10	1:15	1:35	1:10	R47	1:30	1:55
R48	0:45	0:45	0:40	0:45	0:45	R48	0:45	0:45	0:50	0:45	0:45	0:55	0:45	R48	0:40	0:50
R49	0:40	0:45	0:40	0:40	0:45	R49	0:40	0:45	0:45	0:40	0:40	0:50	0:45	R49	0:40	0:45
R50	0:40	0:45	0:40	0:40	0:45	R50	0:40	0:45	0:45	0:40	0:40	0:50	0:45	R50	0:40	0:45
R51	0:40	0:45	0:40	0:40	0:45	R51	0:40	0:45	0:45	0:40	0:40	0:50	0:45	R51	0:40	0:45

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

	Summer		Summer		Summer		Winter			Winter			Winter		Summer	Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend			Midweek Weekend		Weekend Classic Weekend	Weekend Harbor Fest
	Midday		Midday		Evening		Midday			Midday			Evening		Midday	Midday
Region	Good Weather	Rain	Good Weather	Rain	Good Weather	Region	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Region	Good Weather	Good Weather
Entire 2-Mile, 5-Mile Circles and EPZ																
R01	1:25	1:25	1:15	1:20	1:20	R01	1:25	1:25	1:40	1:15	1:20	1:40	1:20	R01	1:15	1:20
R02	2:30	2:40	2:40	2:55	2:20	R02	2:30	2:35	3:05	2:25	2:40	3:10	2:15	R02	3:30	6:35
R03	3:00	3:20	3:15	3:35	3:00	R03	3:10	3:25	4:05	3:00	3:15	3:45	3:00	R03	4:40	6:35

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

	Summer		Summer		Summer		Winter			Winter			Winter		Summer	Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend			Midweek Weekend		Weekend Classic Weekend	Weekend Harbor Fest
	Midday		Midday		Evening		Midday			Midday			Evening		Midday	Midday
Region	Good Weather	Rain	Good Weather	Rain	Good Weather	Region	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Region	Good Weather	Good Weather
Regions Extending to 5-Miles																
R04	1:25	1:25	1:15	1:20	1:20	R04	1:25	1:25	1:40	1:15	1:20	1:40	1:20	R04	1:15	1:20
R05	1:25	1:25	1:15	1:20	1:20	R05	1:25	1:25	1:40	1:15	1:20	1:40	1:20	R05	1:15	1:20
R06	2:00	2:10	1:20	1:25	1:25	R06	2:00	2:10	2:20	1:20	1:25	1:50	1:25	R06	1:20	1:25
R07	2:10	2:25	1:25	1:30	1:25	R07	2:10	2:25	2:30	1:25	1:35	1:55	1:25	R07	1:25	1:25
R08	2:10	2:25	1:25	1:30	1:25	R08	2:10	2:25	2:30	1:25	1:35	1:55	1:25	R08	1:25	1:25
R09	2:05	2:25	1:25	1:30	1:25	R09	2:10	2:20	2:30	1:25	1:35	1:55	1:25	R09	1:25	1:25
R10	2:05	2:15	1:25	1:35	1:25	R10	2:10	2:15	2:35	1:30	1:35	2:00	1:25	R10	1:30	1:25
R11	2:10	2:15	1:25	1:35	1:30	R11	2:10	2:15	2:30	1:30	1:35	2:00	1:30	R11	1:30	1:50
R12	2:10	2:15	1:25	1:35	1:30	R12	2:10	2:15	2:30	1:30	1:35	2:00	1:30	R12	1:30	1:50
R13	2:10	2:15	1:25	1:35	1:30	R13	2:10	2:15	2:30	1:30	1:35	2:00	1:30	R13	1:30	1:50
R14	1:50	1:55	1:25	1:25	1:25	R14	1:50	2:00	2:15	1:25	1:25	1:55	1:25	R14	2:55	6:15
R15	1:50	1:55	1:25	1:25	1:25	R15	1:50	2:00	2:15	1:25	1:25	1:55	1:25	R15	2:55	6:15
R16	1:45	1:50	1:25	1:25	1:25	R16	1:45	1:50	2:10	1:25	1:25	1:55	1:25	R16	2:50	6:15
R17	1:45	1:50	1:25	1:25	1:25	R17	1:45	1:50	2:10	1:25	1:25	1:55	1:25	R17	2:50	6:15
R18	1:40	1:40	1:25	1:25	1:25	R18	1:40	1:45	2:05	1:25	1:25	1:55	1:25	R18	3:00	6:20
R19	1:40	1:40	1:25	1:25	1:25	R19	1:40	1:45	2:05	1:25	1:25	1:55	1:25	R19	3:00	6:20
R20	1:35	1:35	1:20	1:20	1:25	R20	1:35	1:40	2:00	1:20	1:20	1:50	1:25	R20	3:10	6:30
R21	1:35	1:35	1:20	1:20	1:25	R21	1:35	1:40	2:00	1:20	1:20	1:50	1:25	R21	3:10	6:30
R22	1:35	1:35	1:20	1:20	1:25	R22	1:35	1:35	2:00	1:20	1:20	1:50	1:25	R22	3:15	6:35
R23	1:30	1:30	1:20	1:20	1:20	R23	1:30	1:30	1:50	1:20	1:20	1:45	1:20	R23	1:20	1:45
R24	1:30	1:30	1:20	1:20	1:20	R24	1:30	1:30	1:50	1:20	1:20	1:45	1:20	R24	1:20	1:45
R25	1:25	1:25	1:15	1:20	1:20	R25	1:25	1:25	1:40	1:15	1:20	1:40	1:20	R25	1:15	1:20
R26	1:25	1:25	1:15	1:20	1:20	R26	1:25	1:25	1:40	1:15	1:20	1:40	1:20	R26	1:15	1:20
R27	1:25	1:25	1:15	1:20	1:20	R27	1:25	1:25	1:40	1:15	1:20	1:40	1:20	R27	1:15	1:20

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

	Summer		Summer		Summer		Winter			Winter			Winter		Summer	Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend			Midweek Weekend		Weekend Classic Weekend	Weekend Harbor Fest
	Midday		Midday		Evening		Midday			Midday			Evening		Midday	Midday
Region	Good Weather	Rain	Good Weather	Rain	Good Weather	Region	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Region	Good Weather	Good Weather
Regions Extending to EPZ Boundary																
R28	1:25	1:25	1:30	1:40	1:20	R28	1:25	1:25	1:40	1:15	1:15	1:35	1:20	R28	1:15	1:20
R29	1:25	1:25	1:30	1:40	1:20	R29	1:25	1:25	1:40	1:15	1:15	1:35	1:20	R29	1:15	1:20
R30	2:10	2:20	1:35	1:45	1:25	R30	2:10	2:20	2:35	1:30	1:40	2:00	1:25	R30	1:30	1:25
R31	2:20	2:25	1:40	1:50	1:30	R31	2:20	2:35	2:50	1:40	1:45	2:10	1:30	R31	1:40	1:30
R32	2:25	2:30	1:45	1:55	1:40	R32	2:25	2:35	2:45	1:45	1:55	2:20	1:40	R32	1:45	1:40
R33	2:25	2:35	1:45	1:55	1:40	R33	2:25	2:35	2:50	1:45	1:55	2:20	1:40	R33	1:45	1:40
R34	2:20	2:25	1:45	1:55	1:40	R34	2:20	2:25	2:40	1:45	1:50	2:15	1:40	R34	1:45	1:40
R35	2:20	2:25	1:45	1:55	1:40	R35	2:20	2:30	2:40	1:45	1:50	2:20	1:40	R35	1:45	1:50
R36	2:20	2:25	1:50	2:00	1:45	R36	2:20	2:30	2:45	1:50	1:55	2:25	1:45	R36	2:05	2:35
R37	2:20	2:25	1:50	2:00	1:45	R37	2:20	2:30	2:45	1:50	1:55	2:25	1:45	R37	2:05	2:35
R38	2:25	2:30	1:55	2:05	1:50	R38	2:25	2:30	2:55	1:55	2:05	2:30	1:50	R38	2:25	3:30
R39	2:25	2:30	1:55	2:05	1:50	R39	2:25	2:30	2:50	1:55	2:00	2:30	1:50	R39	2:30	3:35
R40	2:40	2:55	2:45	3:00	2:35	R40	3:00	3:15	3:50	2:30	2:50	3:15	2:30	R40	4:05	5:45
R41	2:35	2:55	2:45	3:00	2:35	R41	3:00	3:15	3:50	2:35	2:50	3:15	2:35	R41	4:05	5:45
R42	2:40	3:00	2:50	3:05	2:40	R42	3:00	3:20	3:55	2:40	2:55	3:20	2:35	R42	4:10	5:50
R43	2:50	3:05	3:00	3:15	2:50	R43	3:10	3:25	4:05	2:45	3:00	3:30	2:45	R43	4:20	5:55
R44	2:50	3:10	3:00	3:20	2:50	R44	3:10	3:25	4:05	2:50	3:00	3:30	2:45	R44	4:20	6:00
R45	3:00	3:20	3:15	3:35	2:55	R45	3:10	3:25	4:05	3:00	3:15	3:45	2:55	R45	4:40	6:25
R46	3:00	3:20	3:15	3:35	3:00	R46	3:10	3:25	4:05	3:00	3:15	3:45	2:55	R46	4:40	6:30
R47	3:00	3:15	3:15	3:35	3:00	R47	3:10	3:25	4:05	3:00	3:15	3:45	3:00	R47	4:10	5:15
R48	1:30	1:30	1:20	1:20	1:20	R48	1:30	1:30	1:50	1:20	1:20	1:45	1:20	R48	1:20	1:45
R49	1:25	1:25	1:15	1:20	1:20	R49	1:25	1:25	1:40	1:15	1:20	1:40	1:20	R49	1:15	1:20
R50	1:25	1:25	1:15	1:20	1:20	R50	1:25	1:25	1:40	1:15	1:20	1:40	1:20	R50	1:15	1:20
R51	1:25	1:25	1:15	1:20	1:20	R51	1:25	1:25	1:40	1:15	1:20	1:40	1:20	R51	1:15	1:20

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

	Summer		Summer		Summer		Winter			Winter			Winter		Summer	Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend			Midweek Weekend		Weekend Classic Weekend	Weekend Harbor Fest
	Midday		Midday		Evening		Midday			Midday			Evening		Midday	Midday
Region	Good Weather	Rain	Good Weather	Rain	Good Weather	Region	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Region	Good Weather	Good Weather
Entire 2-Mile, 5-Mile Circles and EPZ																
R01	1:40	1:40	1:25	1:25	1:30	R01	1:40	1:40	2:05	1:25	1:25	1:55	1:30	R01	1:25	1:30
R02	2:50	3:05	3:05	3:25	2:40	R02	2:50	3:05	3:35	2:45	3:00	3:35	2:35	R02	3:55	7:05
R03	3:30	3:55	3:40	4:05	3:25	R03	3:30	3:50	4:30	3:25	3:45	4:15	3:20	R03	5:15	7:05

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

	Summer		Summer		Summer		Winter			Winter			Winter		Summer	Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend			Midweek Weekend		Weekend Classic Weekend	Weekend Harbor Fest
	Midday		Midday		Evening		Midday			Midday			Evening		Midday	Midday
Region	Good Weather	Rain	Good Weather	Rain	Good Weather	Region	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Region	Good Weather	Good Weather
Regions Extending to 5-Miles																
R04	1:40	1:40	1:25	1:25	1:30	R04	1:40	1:40	2:05	1:25	1:25	1:55	1:30	R04	1:25	1:30
R05	1:40	1:40	1:25	1:25	1:30	R05	1:40	1:40	2:05	1:25	1:25	1:55	1:30	R05	1:25	1:30
R06	2:15	2:25	1:30	1:40	1:30	R06	2:10	2:25	2:40	1:30	1:40	2:05	1:30	R06	1:30	1:30
R07	2:20	2:40	1:35	1:45	1:40	R07	2:25	2:40	2:50	1:40	1:45	2:10	1:40	R07	1:40	1:40
R08	2:20	2:40	1:35	1:45	1:40	R08	2:25	2:40	2:50	1:40	1:45	2:10	1:40	R08	1:40	1:40
R09	2:20	2:40	1:35	1:45	1:40	R09	2:20	2:35	2:50	1:35	1:45	2:10	1:40	R09	1:35	1:40
R10	2:20	2:25	1:35	1:45	1:40	R10	2:25	2:30	2:55	1:40	1:45	2:10	1:40	R10	1:40	1:40
R11	2:25	2:30	1:40	1:45	1:45	R11	2:25	2:30	2:50	1:40	1:45	2:15	1:45	R11	1:40	2:20
R12	2:25	2:30	1:40	1:45	1:45	R12	2:25	2:30	2:50	1:40	1:45	2:15	1:45	R12	1:40	2:20
R13	2:25	2:30	1:40	1:45	1:45	R13	2:25	2:30	2:50	1:40	1:45	2:15	1:45	R13	1:40	2:20
R14	2:05	2:10	1:35	1:40	1:35	R14	2:00	2:10	2:25	1:35	1:40	2:10	1:35	R14	3:20	6:55
R15	2:05	2:10	1:35	1:40	1:35	R15	2:00	2:10	2:25	1:35	1:40	2:10	1:35	R15	3:20	6:55
R16	2:00	2:05	1:35	1:35	1:35	R16	1:55	2:05	2:20	1:30	1:35	2:10	1:35	R16	3:20	6:55
R17	2:00	2:05	1:35	1:35	1:35	R17	1:55	2:05	2:20	1:30	1:35	2:10	1:35	R17	3:20	6:55
R18	1:55	1:55	1:35	1:35	1:35	R18	1:55	2:00	2:15	1:30	1:35	2:10	1:40	R18	3:25	7:00
R19	1:55	1:55	1:35	1:35	1:35	R19	1:55	2:00	2:15	1:30	1:35	2:10	1:40	R19	3:25	7:00
R20	1:55	1:55	1:30	1:30	1:30	R20	1:55	1:55	2:15	1:30	1:30	2:05	1:30	R20	3:30	7:05
R21	1:55	1:55	1:30	1:30	1:30	R21	1:55	1:55	2:15	1:30	1:30	2:05	1:30	R21	3:30	7:05
R22	1:55	1:55	1:30	1:30	1:30	R22	1:55	1:55	2:15	1:30	1:30	2:05	1:30	R22	3:35	7:05
R23	1:45	1:45	1:30	1:30	1:30	R23	1:45	1:45	2:10	1:30	1:30	2:00	1:30	R23	1:25	1:55
R24	1:45	1:45	1:30	1:30	1:30	R24	1:45	1:45	2:10	1:30	1:30	2:00	1:30	R24	1:25	1:55
R25	1:40	1:40	1:25	1:25	1:30	R25	1:40	1:40	2:05	1:25	1:25	1:55	1:30	R25	1:25	1:30
R26	1:40	1:40	1:25	1:25	1:30	R26	1:40	1:40	2:05	1:25	1:25	1:55	1:30	R26	1:25	1:30
R27	1:40	1:40	1:25	1:25	1:30	R27	1:40	1:40	2:05	1:25	1:25	1:55	1:30	R27	1:25	1:30

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

	Summer		Summer		Summer		Winter			Winter			Winter		Summer	Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend			Midweek Weekend		Weekend Classic Weekend	Weekend Harbor Fest
	Midday		Midday		Evening		Midday			Midday			Evening		Midday	Midday
Region	Good Weather	Rain	Good Weather	Rain	Good Weather	Region	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Region	Good Weather	Good Weather
Regions Extending to EPZ Boundary																
R28	1:35	1:35	1:40	1:55	1:25	R28	1:35	1:40	2:00	1:25	1:25	1:55	1:30	R28	1:25	1:25
R29	1:35	1:35	1:40	1:55	1:25	R29	1:35	1:40	2:00	1:25	1:25	1:55	1:30	R29	1:25	1:25
R30	2:30	2:40	1:45	1:55	1:35	R30	2:30	2:40	3:00	1:45	1:50	2:15	1:35	R30	1:45	1:35
R31	2:40	2:45	1:50	2:00	1:40	R31	2:30	2:50	3:10	1:50	1:55	2:20	1:40	R31	1:50	1:40
R32	2:45	2:55	1:55	2:15	1:50	R32	2:45	3:00	3:10	2:00	2:10	2:35	1:50	R32	2:00	1:50
R33	2:45	3:05	2:00	2:15	1:55	R33	2:50	3:05	3:20	2:00	2:15	2:40	1:55	R33	2:00	1:50
R34	2:40	2:50	1:55	2:10	1:55	R34	2:40	2:50	3:10	2:00	2:10	2:35	1:55	R34	2:00	1:50
R35	2:40	2:50	1:55	2:10	1:55	R35	2:40	2:55	3:10	2:00	2:10	2:35	1:55	R35	2:00	2:05
R36	2:40	2:50	2:05	2:20	2:00	R36	2:40	2:55	3:10	2:05	2:15	2:45	2:00	R36	2:20	3:00
R37	2:40	2:50	2:05	2:20	2:00	R37	2:40	2:55	3:10	2:05	2:15	2:45	2:00	R37	2:20	3:00
R38	2:45	3:00	2:15	2:25	2:10	R38	2:45	2:55	3:25	2:15	2:25	2:55	2:10	R38	2:55	4:25
R39	2:40	2:55	2:20	2:25	2:10	R39	2:40	2:55	3:15	2:15	2:25	2:50	2:10	R39	2:55	4:30
R40	3:10	3:35	3:25	3:50	3:10	R40	3:25	3:45	4:20	3:10	3:25	4:00	3:10	R40	4:55	6:35
R41	3:15	3:40	3:25	3:50	3:15	R41	3:25	3:45	4:25	3:15	3:30	4:00	3:10	R41	4:55	6:35
R42	3:20	3:45	3:30	3:55	3:15	R42	3:25	3:50	4:25	3:15	3:30	4:05	3:10	R42	4:55	6:35
R43	3:25	3:50	3:35	4:00	3:20	R43	3:30	3:50	4:30	3:20	3:40	4:10	3:15	R43	5:00	6:40
R44	3:30	3:50	3:35	4:00	3:20	R44	3:30	3:50	4:30	3:25	3:40	4:10	3:20	R44	5:00	6:45
R45	3:30	3:55	3:40	4:05	3:20	R45	3:30	3:50	4:30	3:25	3:45	4:15	3:20	R45	5:10	7:00
R46	3:30	3:55	3:40	4:05	3:25	R46	3:30	3:50	4:30	3:25	3:45	4:15	3:20	R46	5:15	7:00
R47	3:30	3:45	3:40	4:00	3:20	R47	3:30	3:45	4:25	3:25	3:45	4:15	3:20	R47	4:40	5:55
R48	1:45	1:45	1:30	1:30	1:30	R48	1:45	1:45	2:10	1:30	1:30	2:00	1:30	R48	1:25	1:55
R49	1:40	1:40	1:25	1:25	1:30	R49	1:40	1:40	2:05	1:25	1:25	1:55	1:30	R49	1:25	1:30
R50	1:40	1:40	1:25	1:25	1:30	R50	1:40	1:40	2:05	1:25	1:25	1:55	1:30	R50	1:25	1:30
R51	1:40	1:40	1:25	1:25	1:30	R51	1:40	1:40	2:05	1:25	1:25	1:55	1:30	R51	1:25	1:30

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

	Summer		Summer		Summer		Winter			Winter			Winter		Summer	Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend			Midweek Weekend		Weekend Classic Weekend	Weekend Harbor Fest
	Midday		Midday		Evening		Midday			Midday			Evening		Midday	Midday
Region	Good Weather	Rain	Good Weather	Rain	Good Weather	Region	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Region	Good Weather	Good Weather
Entire 2-Mile, 5-Mile Circles and EPZ																
R01	2:20	2:20	1:50	1:50	1:50	R01	2:20	2:20	2:30	1:50	1:50	2:20	1:50	R01	1:50	1:50
R02	3:20	3:40	3:45	4:10	3:05	R02	3:20	3:40	4:10	3:05	3:35	4:10	2:55	R02	4:55	7:45
R03	4:30	4:55	4:20	4:50	4:00	R03	4:30	4:45	5:35	4:10	4:30	5:05	4:00	R03	6:55	8:20

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

	Summer		Summer		Summer		Winter			Winter			Winter		Summer	Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend			Midweek Weekend		Weekend Classic Weekend	Weekend Harbor Fest
	Midday		Midday		Evening		Midday			Midday			Evening		Midday	Midday
Region	Good Weather	Rain	Good Weather	Rain	Good Weather	Region	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Region	Good Weather	Good Weather
Regions Extending to 5-Miles																
R04	2:20	2:20	1:50	1:50	1:50	R04	2:20	2:20	2:30	1:50	1:50	2:20	1:50	R04	1:50	1:50
R05	2:20	2:20	1:50	1:50	1:50	R05	2:20	2:20	2:30	1:50	1:50	2:20	1:50	R05	1:50	1:50
R06	2:35	2:50	1:45	1:45	1:45	R06	2:30	2:55	3:05	1:45	1:45	2:30	1:45	R06	1:45	1:45
R07	2:35	2:55	2:00	2:00	2:05	R07	2:40	2:55	3:10	2:00	2:05	2:30	2:05	R07	2:00	2:05
R08	2:35	2:55	2:00	2:00	2:05	R08	2:40	2:55	3:10	2:00	2:05	2:30	2:05	R08	2:00	2:05
R09	2:35	3:00	1:45	1:50	2:05	R09	2:40	2:55	3:10	1:45	1:50	2:30	2:05	R09	1:45	2:05
R10	2:40	2:50	1:45	2:00	2:05	R10	2:45	2:50	3:25	2:05	2:05	2:30	2:05	R10	2:05	2:05
R11	2:45	2:55	1:45	2:15	2:05	R11	2:45	3:00	3:20	1:45	2:15	2:30	2:05	R11	1:45	3:45
R12	2:45	2:55	1:45	2:15	2:05	R12	2:45	3:00	3:20	1:45	2:15	2:30	2:05	R12	1:45	3:45
R13	2:45	2:55	1:45	2:15	2:05	R13	2:45	3:00	3:20	1:45	2:15	2:30	2:05	R13	1:45	3:45
R14	2:20	2:20	2:05	2:15	1:45	R14	2:20	2:30	2:45	1:45	2:15	2:30	1:45	R14	4:00	7:40
R15	2:20	2:20	2:05	2:15	1:45	R15	2:20	2:30	2:45	1:45	2:15	2:30	1:45	R15	4:00	7:40
R16	2:15	2:20	2:05	2:05	2:05	R16	2:15	2:30	2:40	1:40	2:05	2:30	2:05	R16	4:00	7:45
R17	2:15	2:20	2:05	2:05	2:05	R17	2:15	2:30	2:40	1:40	2:05	2:30	2:05	R17	4:00	7:45
R18	2:20	2:20	2:05	2:05	2:15	R18	2:20	2:20	2:35	1:40	2:05	2:30	2:15	R18	4:00	7:45
R19	2:20	2:20	2:05	2:05	2:15	R19	2:20	2:20	2:35	1:40	2:05	2:30	2:15	R19	4:00	7:45
R20	2:20	2:20	1:45	1:45	1:40	R20	2:20	2:20	2:30	1:45	1:40	2:30	1:45	R20	4:00	7:40
R21	2:20	2:20	1:45	1:45	1:40	R21	2:20	2:20	2:30	1:45	1:40	2:30	1:45	R21	4:00	7:40
R22	2:25	2:25	1:40	1:40	1:45	R22	2:25	2:30	2:30	1:40	1:40	2:30	1:45	R22	4:00	7:40
R23	2:25	2:25	1:40	1:40	1:40	R23	2:30	2:30	2:30	1:40	1:40	2:30	1:40	R23	1:40	2:10
R24	2:25	2:25	1:40	1:40	1:40	R24	2:30	2:30	2:30	1:40	1:40	2:30	1:40	R24	1:40	2:10
R25	2:20	2:20	1:50	1:50	1:50	R25	2:20	2:20	2:30	1:50	1:50	2:20	1:50	R25	1:50	1:50
R26	2:20	2:20	1:50	1:50	1:50	R26	2:20	2:20	2:30	1:50	1:50	2:20	1:50	R26	1:50	1:50
R27	2:20	2:20	1:50	1:50	1:50	R27	2:20	2:20	2:30	1:50	1:50	2:20	1:50	R27	1:50	1:50

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

	Summer		Summer		Summer		Winter			Winter			Winter		Summer	Summer
	Midweek		Weekend		Midweek Weekend		Midweek			Weekend			Midweek Weekend		Weekend Classic Weekend	Weekend Harbor Fest
	Midday		Midday		Evening		Midday			Midday			Evening		Midday	Midday
Region	Good Weather	Rain	Good Weather	Rain	Good Weather	Region	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Region	Good Weather	Good Weather
Regions Extending to EPZ Boundary																
R28	2:25	2:25	1:55	2:15	1:50	R28	2:25	2:25	2:35	2:00	2:00	2:30	1:50	R28	2:00	1:50
R29	2:25	2:25	1:55	2:15	1:50	R29	2:25	2:25	2:35	2:00	2:00	2:30	1:50	R29	2:00	1:50
R30	3:05	3:15	2:05	2:15	1:45	R30	2:55	3:20	3:40	2:05	2:15	2:40	1:45	R30	2:05	1:45
R31	3:05	3:15	2:05	2:20	2:05	R31	2:55	3:20	3:45	2:05	2:20	2:40	2:05	R31	2:05	2:05
R32	3:15	3:25	2:15	2:35	2:05	R32	3:15	3:35	3:45	2:15	2:40	3:05	2:05	R32	2:15	2:05
R33	3:20	3:40	2:20	2:45	2:10	R33	3:20	3:40	4:00	2:20	2:45	3:10	2:10	R33	2:20	2:10
R34	3:20	3:35	2:25	2:45	2:10	R34	3:25	3:35	4:00	2:25	2:45	3:15	2:10	R34	2:25	2:10
R35	3:20	3:40	2:25	2:45	2:15	R35	3:25	3:45	4:00	2:25	2:50	3:15	2:15	R35	2:25	3:45
R36	3:20	3:40	2:40	3:00	2:30	R36	3:25	3:45	4:00	2:35	2:50	3:15	2:30	R36	3:00	3:40
R37	3:20	3:40	2:40	3:00	2:30	R37	3:25	3:45	4:00	2:35	2:50	3:15	2:30	R37	3:00	3:40
R38	3:20	3:40	3:00	3:25	3:00	R38	3:20	3:35	4:10	3:00	3:10	3:45	3:00	R38	3:55	7:45
R39	3:20	3:30	3:00	3:25	3:00	R39	3:20	3:30	4:00	3:00	3:10	3:45	3:00	R39	3:55	7:45
R40	4:25	4:50	4:20	4:50	4:00	R40	4:30	4:45	5:35	4:10	4:30	5:05	4:00	R40	6:55	8:20
R41	4:25	4:50	4:20	4:50	4:00	R41	4:30	4:45	5:35	4:10	4:30	5:05	4:00	R41	6:55	8:20
R42	4:25	4:50	4:20	4:50	4:00	R42	4:30	4:45	5:35	4:10	4:30	5:05	4:00	R42	6:55	8:20
R43	4:25	4:50	4:20	4:50	4:00	R43	4:30	4:45	5:35	4:10	4:30	5:05	4:00	R43	6:55	8:20
R44	4:30	4:55	4:20	4:45	4:00	R44	4:30	4:45	5:35	4:10	4:30	5:05	4:00	R44	6:55	8:15
R45	4:25	4:45	4:20	4:45	4:00	R45	4:30	4:40	5:25	4:10	4:30	5:00	4:00	R45	6:30	8:15
R46	4:30	4:45	4:20	4:45	4:00	R46	4:30	4:40	5:30	4:05	4:30	5:00	4:00	R46	6:30	8:15
R47	4:20	4:40	4:15	4:45	4:00	R47	4:20	4:40	5:25	4:05	4:30	5:00	4:00	R47	5:45	7:25
R48	2:25	2:25	1:40	1:40	1:40	R48	2:30	2:30	2:30	1:40	1:40	2:30	1:40	R48	1:40	2:10
R49	2:20	2:20	1:50	1:50	1:50	R49	2:20	2:20	2:30	1:50	1:50	2:20	1:50	R49	1:50	1:50
R50	2:20	2:20	1:50	1:50	1:50	R50	2:20	2:20	2:30	1:50	1:50	2:20	1:50	R50	1:50	1:50
R51	2:20	2:20	1:50	1:50	1:50	R51	2:20	2:20	2:30	1:50	1:50	2:20	1:50	R51	1:50	1:50

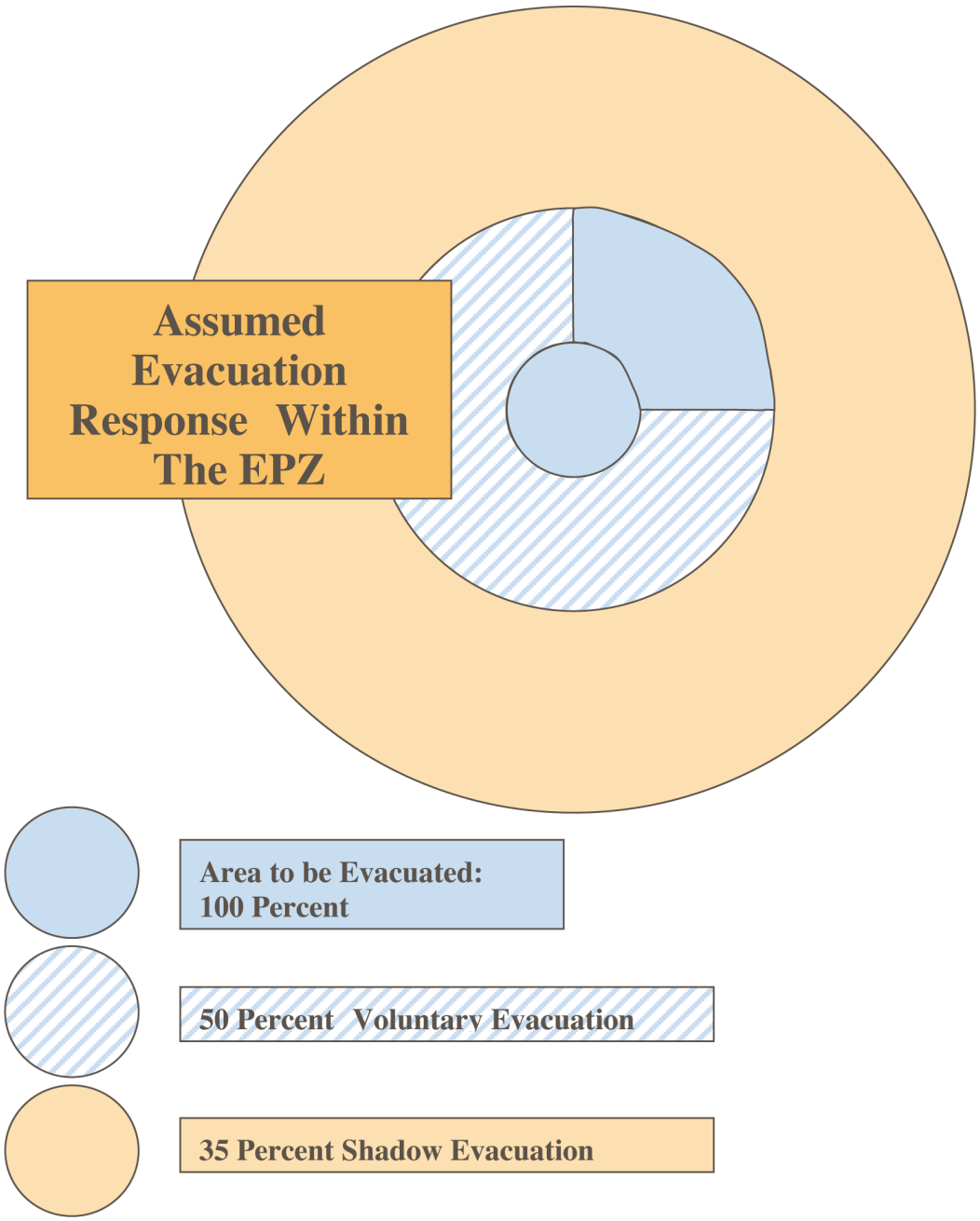


Figure 7-1. Evacuation Response Within the EPZ

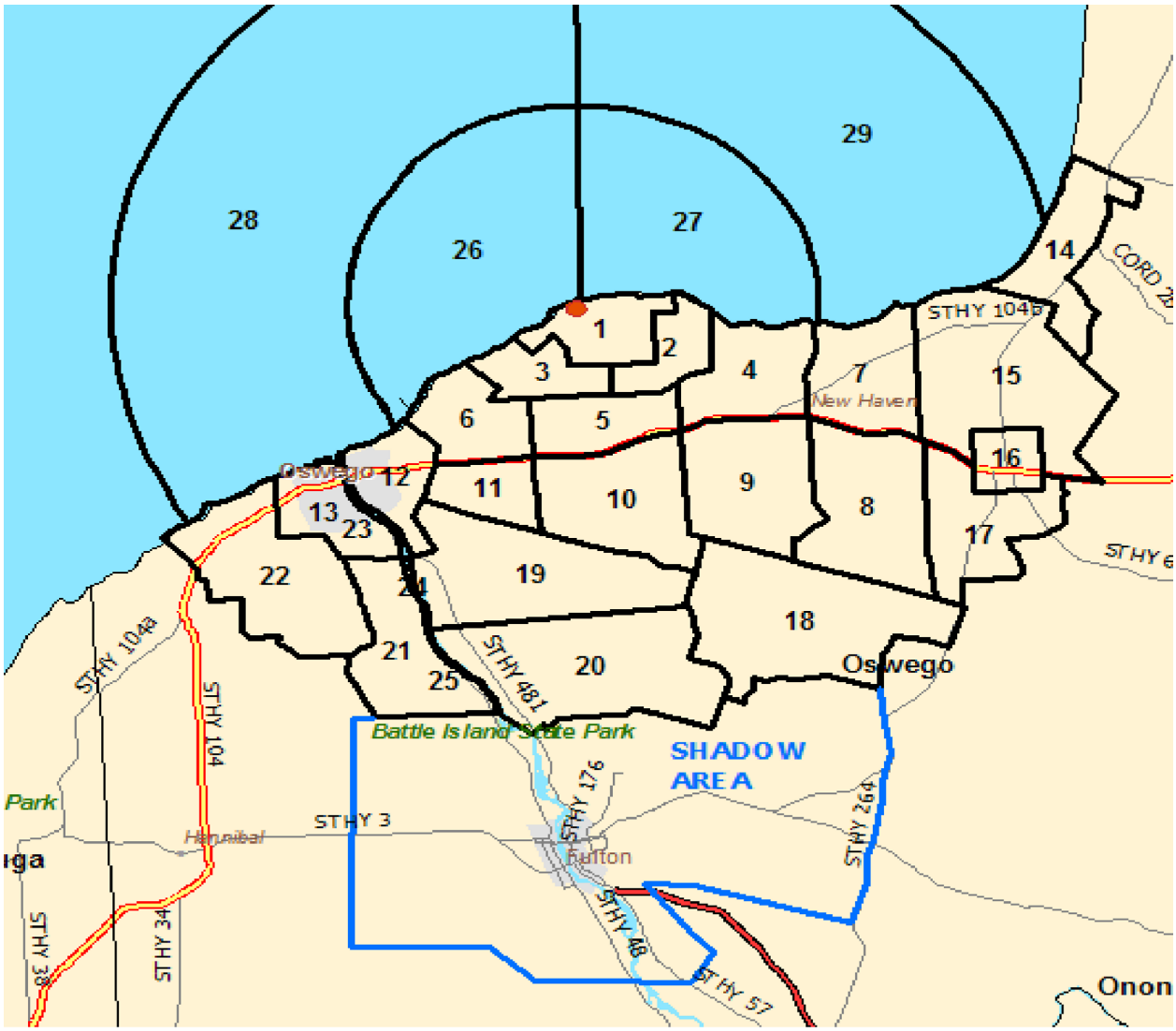


Figure 7-2. Shadow Region

7.1 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 R3) is ordered to evacuate during the summer, midweek, midday period under good weather conditions (Evacuation Scenario 1).

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

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

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

All highway "links" which experience LOS F are delineated in these Figures by a thick red line; all others are lightly indicated. Congestion develops rapidly around concentrations of population and traffic bottlenecks. By 1 hour (Figure 7-3) after the evacuation order several areas are congested:

- Downtown Oswego
- SUNY Oswego campus area
- Southbound Route 48 in Fulton
- Routes leading away from the NMP site

Figure 7-4 presents the congestion pattern 2 hours after evacuation is ordered. Major areas of congestion are:

- Route 48 southbound from Fulton
- Downtown Oswego
- SUNY Oswego campus area

Figure 7-5 presents congestion levels at 3 hours after the start of evacuation. Congestion has begun to clear in most areas.

Figure 7-6 presents the congestion levels at 4 hours after the start of evacuation. Note that most areas of heavy congestion have cleared by this time. Congestion still exists through the Fulton area on Route 48. At this time this congestion is outside of the EPZ.

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

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 a full 10-mile evacuation under the indicated conditions. Appendix L presents these figures for the all scenarios.

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 Order to Evacuate at different rates, then flow builds rapidly (slopes of curves increase). When the system becomes congested, traffic flow remains at rates somewhat below capacity until some evacuation routes have cleared. As more routes clear, the rate of egress slows since many vehicles have already left the EPZ. Towards the end of the process, a relative few evacuation routes service the remaining demand.

This decline in aggregate flow rate, with time, is characterized by these curves 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.

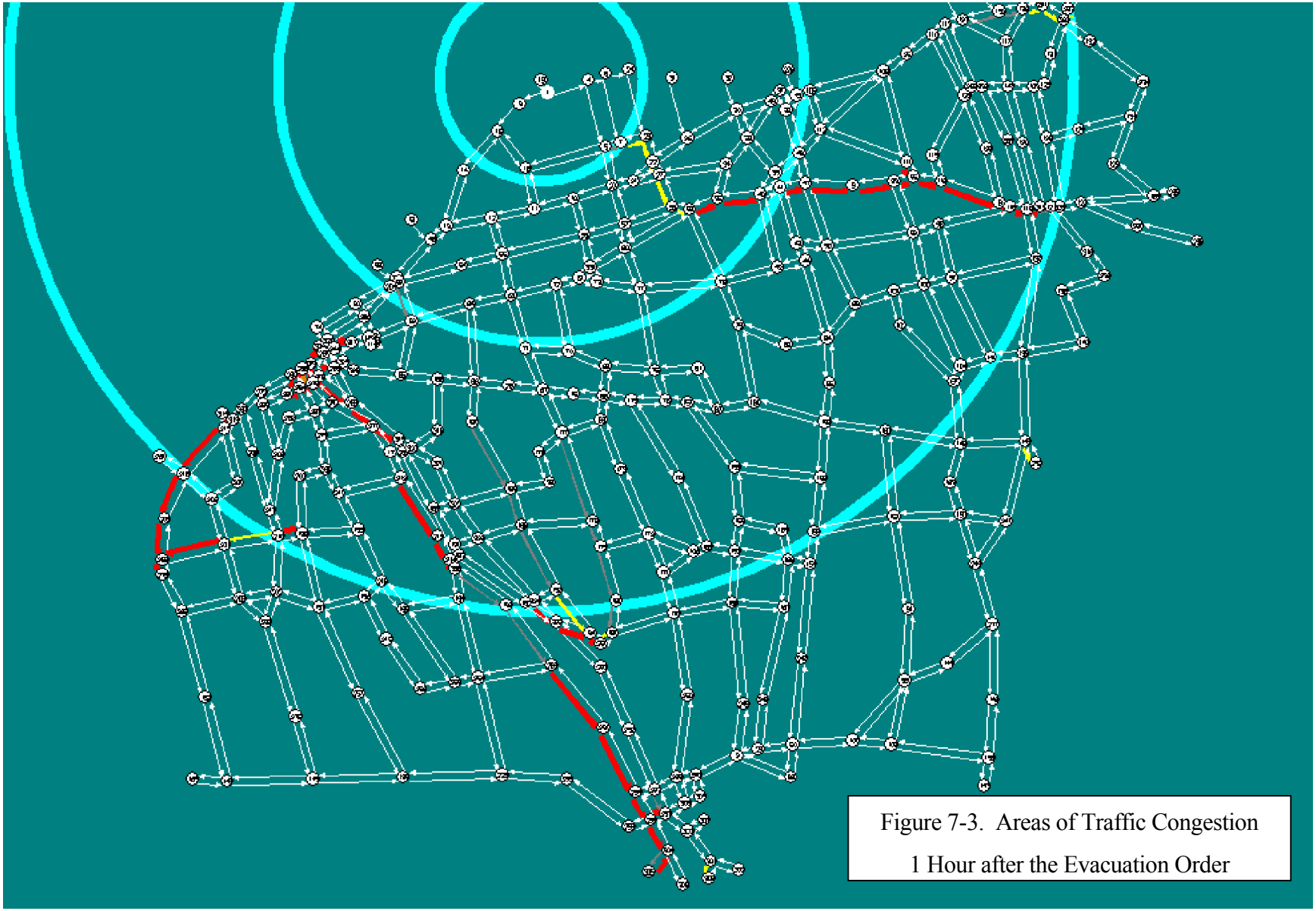


Figure 7-3. Areas of Traffic Congestion
1 Hour after the Evacuation Order

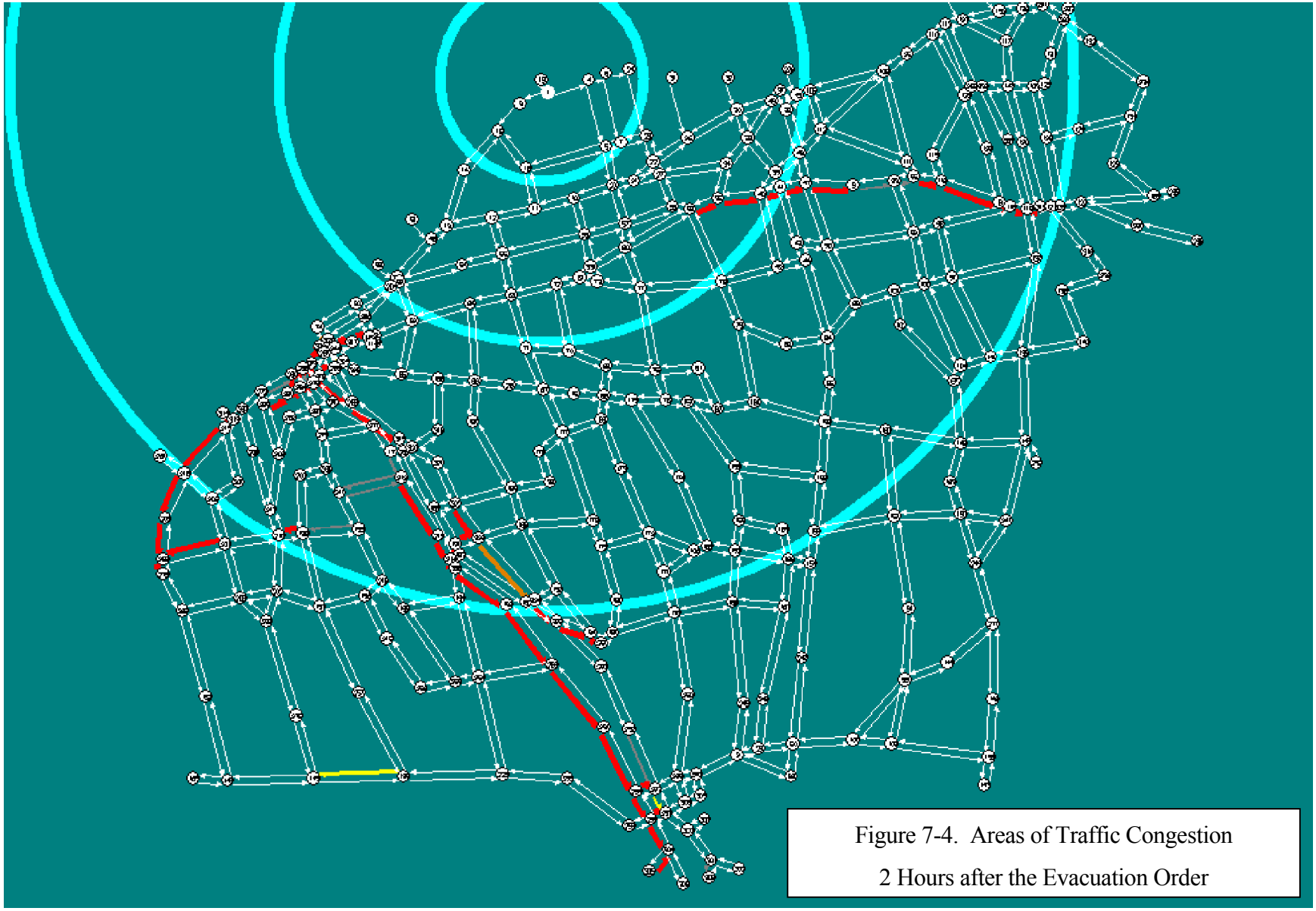


Figure 7-4. Areas of Traffic Congestion
2 Hours after the Evacuation Order

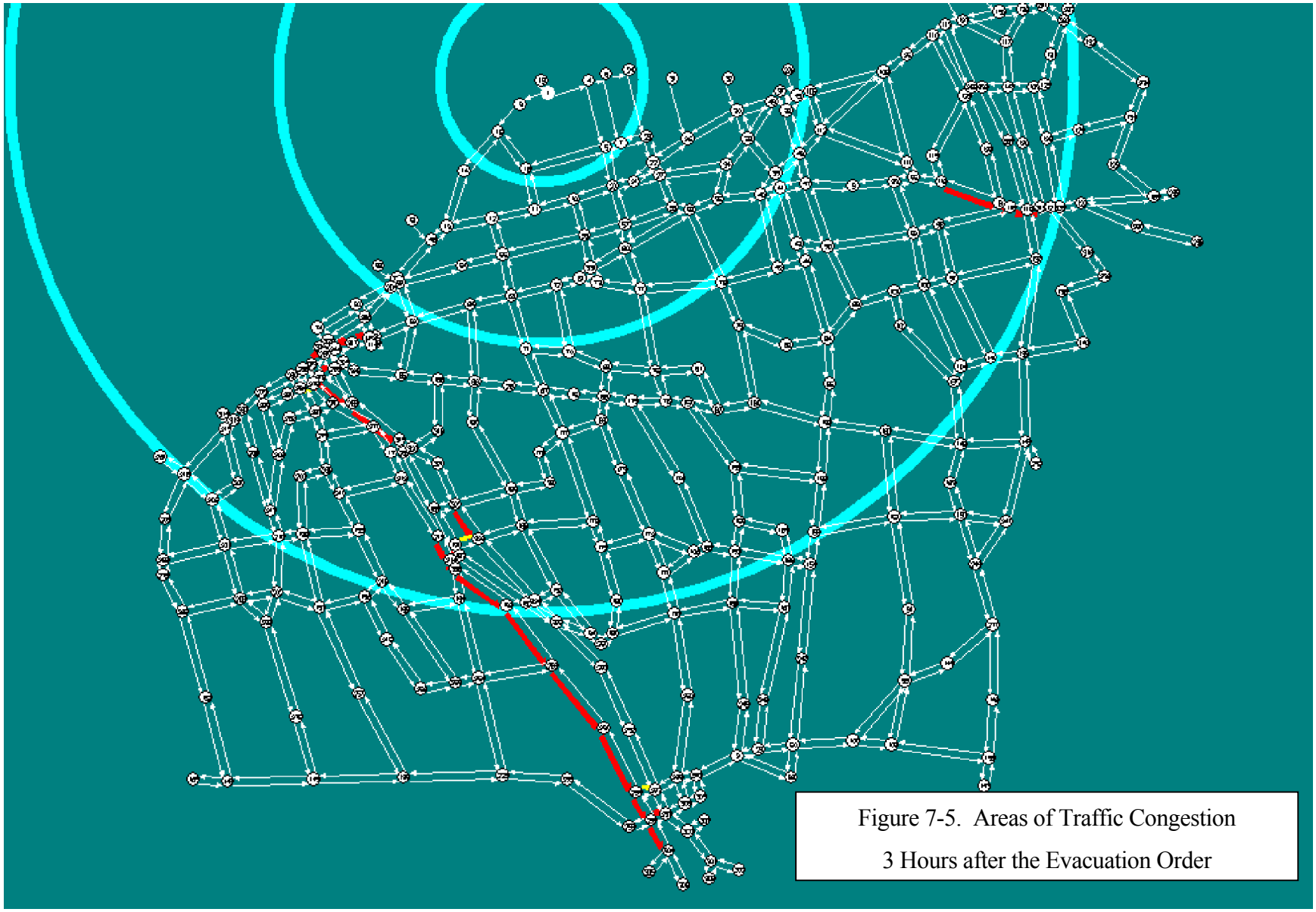


Figure 7-5. Areas of Traffic Congestion
3 Hours after the Evacuation Order

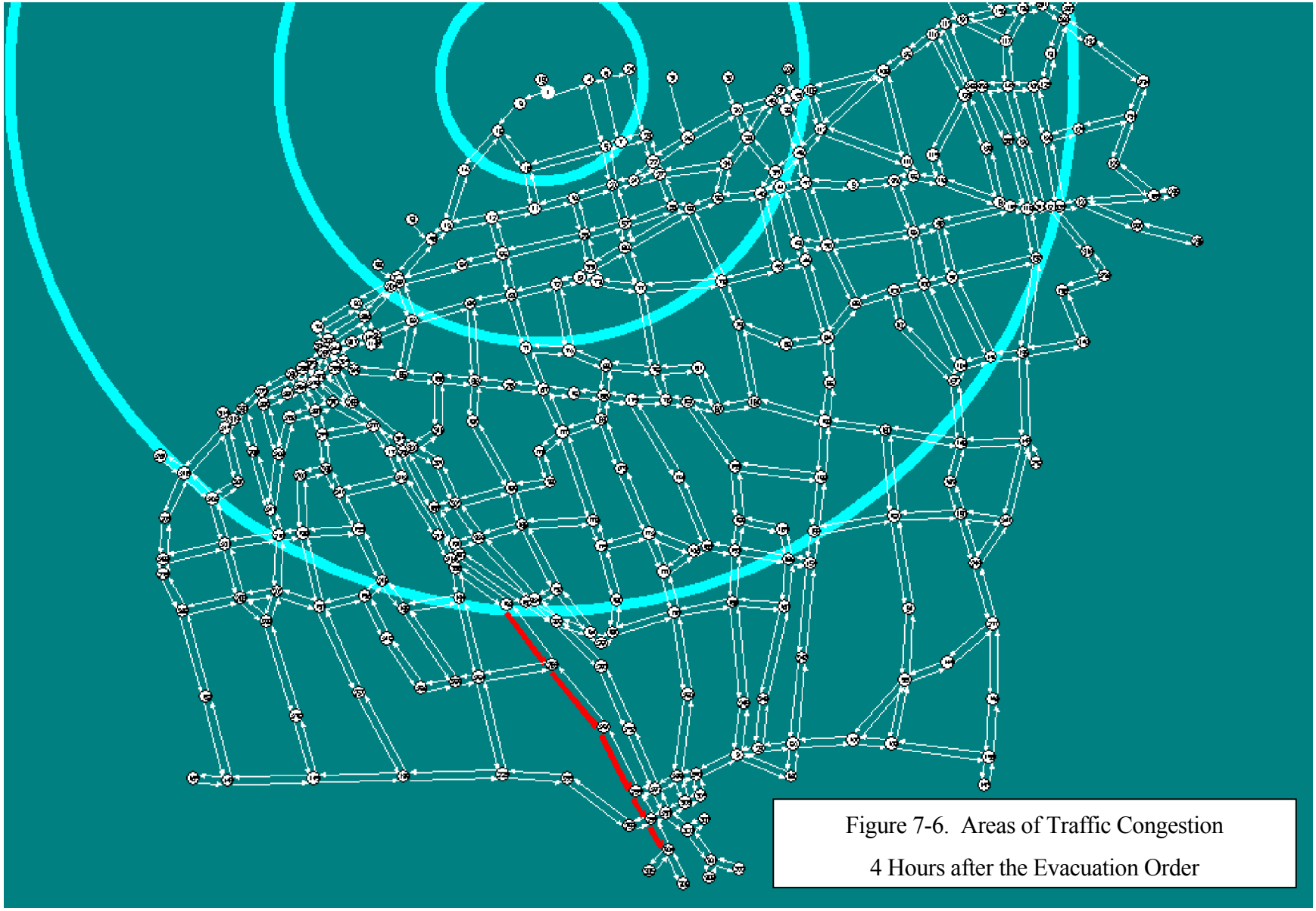


Figure 7-6. Areas of Traffic Congestion
4 Hours after the Evacuation Order

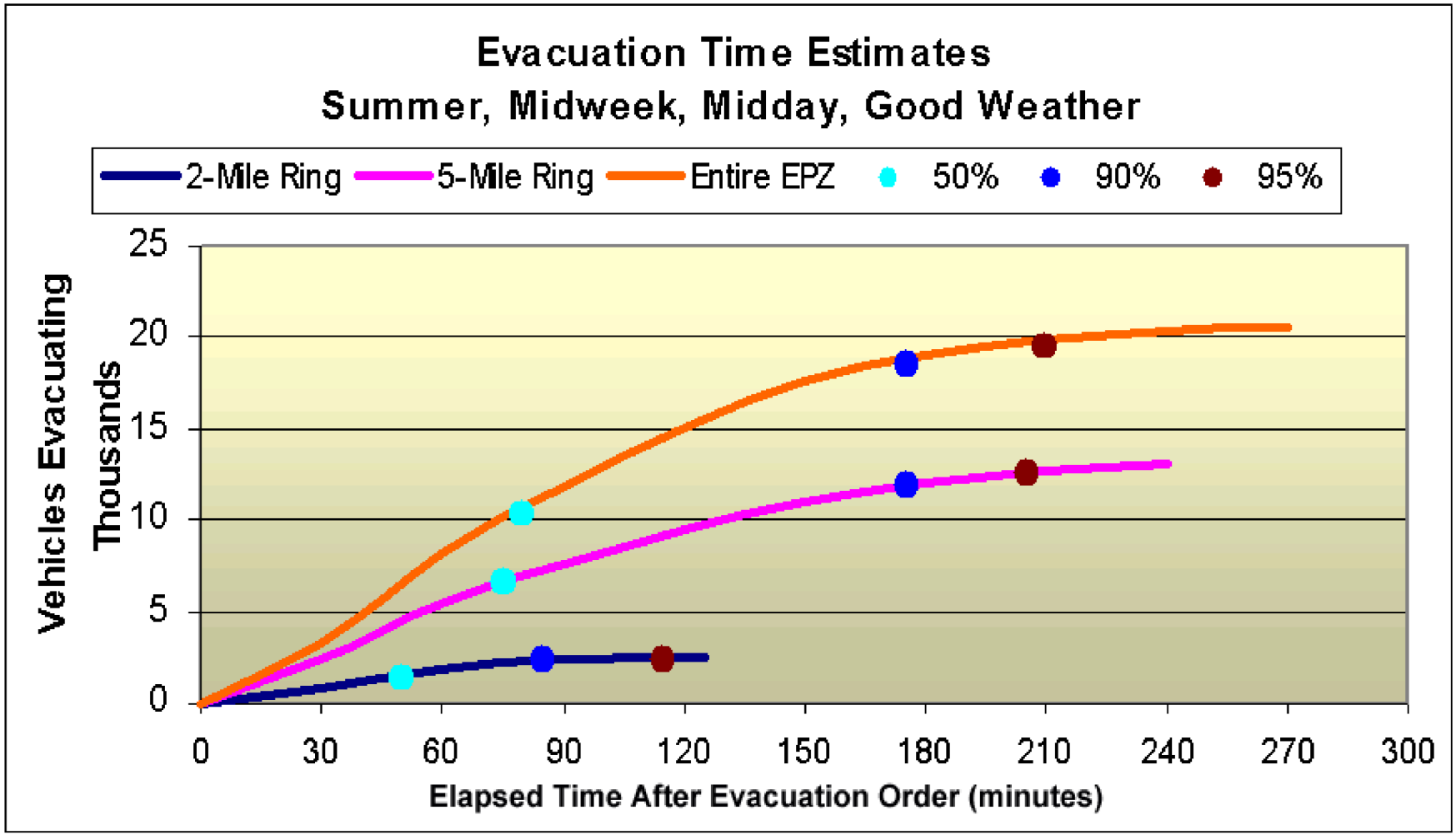


Figure 7-7. Evacuation Time Estimates For NMP
Summer, Midweek, Midday, Good Weather

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 and transients with no vehicles available; and (2) residents of special facilities such as schools, health-support facilities, institutions and child-care facilities.

These transit vehicles merge into, and become a part of the general evacuation traffic environment, which is comprised mostly of "passenger cars" (pc), or private automobiles. 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 pcs. This equivalence represents the longer size and more sluggish operating characteristics of a transit vehicle, relative to those of a private automobile.

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

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

These activities consume time. Based on discussion with local officials and with transport providers, it is estimated that bus mobilization time will average approximately 90 minutes extending from the Order to Evacuate to the time when buses are dispatched from their depots.

During this mobilization period, other mobilization activities are taking place. One of these is the action taken by parents 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 units is universally prevalent during emergencies and should be anticipated in the planning process.

For this reason, we provide estimates of required transit resources based on the reasonable expectation that many children will be picked up from school and reunited with their respective families, prior to the arrival of buses at these schools. We also provide estimates of buses under the assumption that no children will be picked up, to present an upper bound estimate.

The procedure is:

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

8.1 Transit-Dependent People - Demand Estimate

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

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

In the latter group, the vehicle(s) may be used by a commuter(s) who do 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 evacuation is ordered, 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 ridesharing with neighbors, friends or family. For example, nearly 80 percent of those who evacuated from Mississauga, Ontario, and 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 at the conclusion of the bus run, of 30 persons. Table 8-6 documents transit vehicle seated-capacities that 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(10)= 27. On this basis, the average load factor anticipated is (27/40) 100= 68 percent. Thus, if the actual demand for service exceeds the estimates of Table 8-1 by 50 percent, the available bus seating capacity allows us to service the total demand.

Table 8-1 indicates that transportation must be provided for almost 3,800 people. Therefore, a total of 127 bus runs are required to transport this population to the reception center.

Table 8-1. Transit Dependent Population Estimates

2003 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	People Requiring Transport	Estimated Ridesharing Percentage	People Requiring Transit	Percent of Population
	0	1	2		0 Veh-icle	1 Veh-icle	2 Veh-icle						
41,323	2.76	2.51	3.85	15,081	2%	33%	40%	89%	33%	4,002	50%	2,001	4.8%
SUNY Oswego 5,175	(Note: of the 5175 students at SUNY Oswego, 3600 are resident on campus. It is assumed that all of these people are transit-dependent)									3,600	50%	1,800	35%
												3,801	

The calculations on the first line of Table 8-1 are explained as follows:

- All members of households (HH) with no vehicles will evacuate by transit or ride-share. The term 15081 x 0.02 x 2.76 [household size x fraction of households with no vehicles x average household size for those households], accounts for these people.

- The number of people at home in HH with 1 vehicle away equals (2.51-1) [average household size for 1 vehicle households - one person who drives the vehicle away from home]. The number of HH where the commuter will not return home is equal to (15081 x 0.33 x 0.89 x 0.33) [households x fraction of households with 1 vehicle x fraction of households with commuters x fraction of commuters who do not return]. The number of persons who will evacuate by transit or ride-share is equal to the product of these two terms.

- The number of people at home in HH with 2 vehicles that are away is equal to (3.42 – 2) [average household size of with 2 vehicles – 2 people who drive away and will not return]. The number of HH where neither commuter will return home is equal to 15081 x 0.40 x $(0.89 \times 0.33)^2$ [households x fraction of households with 2 vehicles x {fraction of households with commuters x fraction of commuters who do not return}$^{2 \text{ commuters who do not return}}$]. The number of persons who will evacuate by 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 transit is the sum of such people in HH with 0, 1, and 2 vehicles that are all 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. Figure 8-1 shows the location of all schools.

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:

- Half of all students may be picked up their parents prior to the arrival of the buses. Although we recognize that parental pickups will occur, the discussion that follows does not take this fact into account. The effects of parental pickups will be to reduce the number of buses required to transport the remaining students to the reception center. School buses not used to pick up students can be reassigned to other functions.

- Bus capacity, expressed in students per bus, is set to 56 for primary schools and 38 for middle and high schools. These estimates allow 10 percent "inefficiency" in loading the buses (since the actual seating capacities are about 60 and 40, respectively) and for seating of at least one adult staff member to accompany the students on each bus.

- Those staff members who do not accompany the students will evacuate in their private vehicles.

The County Plan calls for assigning buses to evacuate the entire student body at every school. The column in Table 8-2 entitled "Buses Available" specifies the number of buses to be allocated for each school under the County Plans. To obtain these estimates, we assign seating capacities of 56 and 38 students per bus for elementary and higher-level schools, respectively, reflecting the higher loading efficiency associated with evacuating the entire student body. No allowance is made for student absenteeism that is in the neighborhood of 3 percent, daily.

8.3 Medical Facility Demand

Table 8-3 presents the current census of medical facilities, which includes nursing homes and adult homes in the EPZ. Approximately 885 people have been identified as living in, or being treated in, these facilities. This census also indicates the number of wheelchair-bound people and the number of bed-ridden people. The transportation requirements for this group are also presented. The number of ambulance runs is determined by assuming 2 patients can be accommodated per ambulance trip; the number of wheelchair van runs assumes 4 wheelchairs per run; and the number of bus runs estimated assumes 30 ambulatory patients per run.

Figure 8-2 presents the location of each medical facility in the EPZ.

Table 8-2. School Population Demand Estimates								
ERPA	Distance (Miles)	Direction	School Name	City	Enrolment	Staff	Buses Required	Buses Available (2)
17	9.2	SE	BOCES-Occupational	Mexico	425	250	7	
17	9.2	SE	BOCES-Special Education	Mexico	333	85	5	
13	7	SW	BOCES-Occupational-Oswego Hospital	Oswego	20	-	1	
12	7.2	SSW	BOCES-Occupational-Public Safety Center	Oswego	16	-	1	21
17	9.2	SE	BOCES-Special Education-Oswego Academy	Mexico	47	13	1	
16	9.5	ESE	BOCES-Special Education-Manufacturing Plus	Mexico	13	5	1	
16	10	ESE	BOCES-Special Education-Pemberton Stables	Mexico	12	3	1	
12	6.5	SW	Charles E. Riley Elementary School	Oswego	489	77	5	10
12	6	SW	Fitzhugh Park Elementary School	Oswego	486	65	5	10
13	7.5	SW	Frederick Leighton Elementary School	Oswego	540	75	6	11
13	7	SW	Kingsford Park Elementary School	Oswego	450	71	5	9
16	9.5	ESE	Mexico Elementary School	Mexico	373	40	4	7
16	9.5	ESE	Mexico High School	Mexico	821	172	13	17
15	9.2	ESE	Mexico Middle School	Mexico	874	138	14	17
21	9.2	SSW	Minetto Elementary School	Minetto	453	80	5	9
4	5.2	ESE	New Haven Elementary School	New Haven	250	42	3	5
11	5.4	SW	Oswego Community Christian	Oswego	89	12	1	2
13	7.5	SW	Oswego High School	Oswego	1,720	154	26	32
13	8	SW	Oswego Middle School	Oswego	854	106	13	16
out 18	12	SSE	Palermo Elementary School	Fulton	274	44	3	6
22	8.2	SW	State University College at Oswego (1)	Oswego	8,775	1,200	18	18
12	6.2	SW	Trinity Catholic School - St. Paul's	Oswego	171	12	2	6
			Totals:		**17,485**	**2,644**	**140**	**196**

(1) SUNY Oswego has 5,175 students who commute and 3,600 resident students. All commuting students will travel home (if they live within the EPZ) or evacuate directly (if they live outside the EPZ) using autos with ridesharing.

Resident students will evacuate using county-supplied buses or private autos with ridesharing.

(2) Bus availability based on County plans.

Number	ERPA	SCHOOL
01	17	BOCES-Special Education
02	13	BOCES-Occupational-Oswego Hospital
03	12	BOCES-Occupational-Public Safety Center
04	17	BOCES-Occupational
05	16	BOCES-Special Education-Manufacturing Plus
06	17	BOCES-Special Education-Oswego Academy
07	16	BOCES-Special Education-Pemberton Stables
08	12	Charles E. Riley Elementary School
09	12	Fitzhugh Park Elementary School
10	13	Frederick Leighton Elementary School
11	13	Kingsford Park Elementary
12	16	Mexico Elementary School
13	16	Mexico High School
14	15	Mexico Middle School
15	21	Minetto Elementary School
16	04	New Haven Elementary School
17	11	Oswego Community Christian School
18	13	Oswego High School
19	13	Oswego Middle School
20	18	Palemo Elementary School
21	22	State University College at Oswego
22	12	Trinity Catholic Schools - St. Paul's Campus

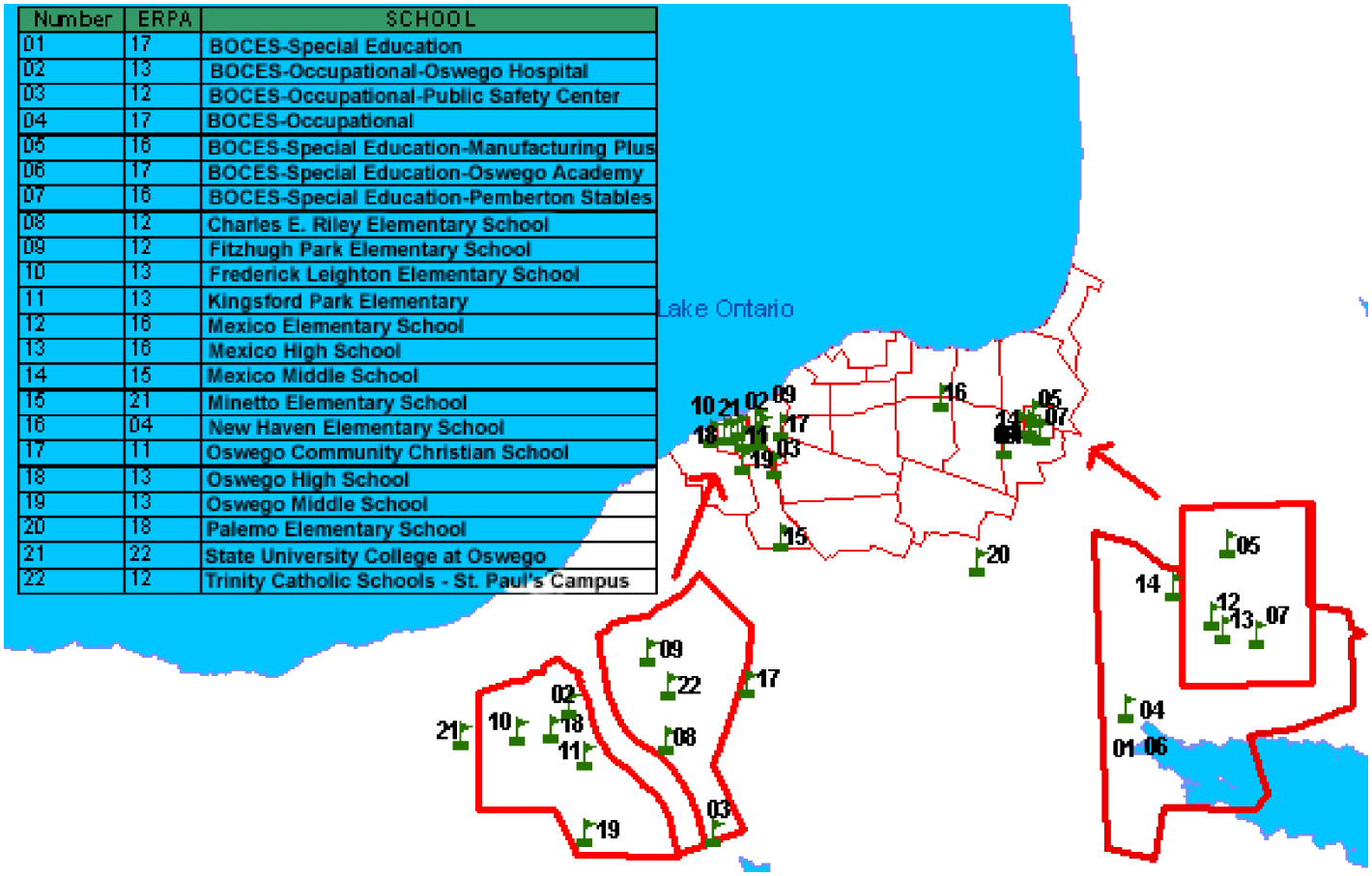


Figure 8-1. Schools in Oswego County

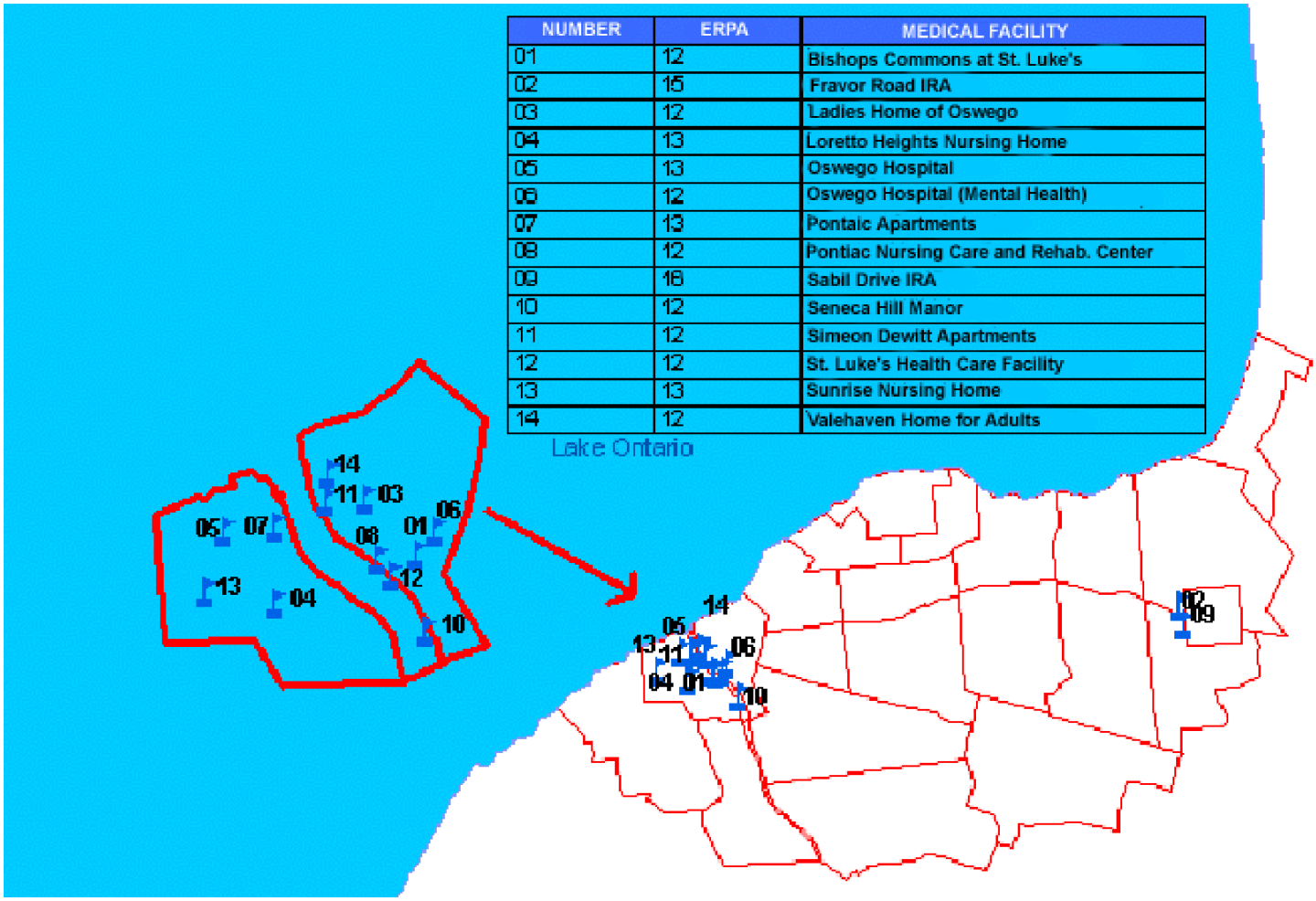
Table 8-3. Medical Facility Transit Demand

ERPA	Facility Name	Capac-ity	Current Census	Ambu-latory	Wheel-chair Bound	Bed-ridden	Ambulance*		Wheelchair Van		Bus	
							Re-quired	Avail-able	Re-quired	Avail-able	Re-quired	Avail-able
15	Fraver Road IRA	10	6	4	2	0	0		1		1	
12	Ladies Home of Oswego	21	21	21	0	0	0		0		1	
13	Loretto Heights Nursing Home	120	116	26	84	6	3		7		1	
13	Oswego Hospital	164	40	9	28	3	6		29		2	
12	Oswego Hospital (Mental Health)	30	30	30	0	0	0		0		1	
12	Pontiac Nursing Care & Rehab	80	68	12	56	0	0		17		1	
19	Public Safety Center	159	121	121	0	0	0		0		4	
16	Sabil Drive IRA	6	6	6	0	0	0		0		1	
12	Seneca Hill Manor	137	135	16	115	4	1		29		1	
12	Simeon Dewitt Apartments	150	130	120	10	0	0		3		5	
12	St. Luke's Health Care Facility	200	199	42	155	2	1		40		2	
13	Sunrise Nursing Home	120	27	20	4	3	7		5		3	
12	Valehaven Home for Adults	34	34	34	0	0	0		0		2	
	Totals:	**1231**	**933**	**461**	**454**	**18**	**18**	**12**	**131**		**25**	**22**

*Ambulance Company Name	Location	Available Ambulances for Evacuation
Oswego City Fire Department Ambulance Corp	Oswego, NY	3
Oswego County Hearse & Ambulance Service	Fulton, NY	4
Donald McFee Ambulance Corp	Mexico, NY	3
Northern Oswego County Ambulance	Pulaski, NY	2
Total		12

Notes: All resources are based on facility capacities; ambulance capacity presumes 2 persons per ambulance; wheelchair van capacity presumes 4 patients per van; buses presumes 30 passengers per bus.

The following assisted-living medical facilities are not included in Table 8-3 because the residents have their own transportation: Bishops Commons at St. Luke's and Pontiac Apartments.



NUMBER	ERPA	MEDICAL FACILITY
01	12	Bishops Commons at St. Luke's
02	15	Fravor Road IRA
03	12	Ladies Home of Oswego
04	13	Loretto Heights Nursing Home
05	13	Oswego Hospital
06	12	Oswego Hospital (Mental Health)
07	13	Pontaic Apartments
08	12	Pontiac Nursing Care and Rehab. Center
09	16	Sabil Drive IRA
10	12	Seneca Hill Manor
11	12	Simeon Dewitt Apartments
12	12	St. Luke's Health Care Facility
13	13	Sunrise Nursing Home
14	12	Valehaven Home for Adults

Figure 8-2. Medical Facilities in Oswego County

8.4 Evacuation Time Estimates for Transit-Dependent People

Buses used to evacuate transit-dependent people from the EPZ are stored at several depots. Table 8-4 presents the transportation resources available to evacuate all the schools, special facilities and transit-dependent persons in the EPZ.

Table 8-5 presents a summary of transit resource needs and availability. It is seen that the available resources expressed in terms of bus-seats, are sufficient in Oswego County to service the evacuation demand in a "single-wave". In general, the buses will transport the evacuees to the appropriate relocation center and need not return to the EPZ for a second trip.

Exceptions to this rule may occur where the supply of transit resources is adequate to service the demand but where the margin is lower. In the event that the allocation of buses dispatched from the depots to the varying facilities and to the bus routes is somewhat "inefficient", or if there is a shortfall of drivers, then there may be a need for some buses to return to the EPZ to complete a "second wave" of providing transport service to evacuees. For this reason, the ETE will be calculated for both one wave and for two waves.

Transit resources will be assigned to schools as a first priority. When these needs are satisfied, subsequent assignments of buses to service the transit-dependent should be sensitive to their mobilization time. Clearly, the buses should be dispatched after people have completed their mobilization activities and are in a position to board the buses when they arrive at the pick-up points. These considerations may influence the ETE for transit-dependent evacuees.

Table 8-4. Transportation Resources

Facility Name and Address	BUS (Capacities in Children)					VAN (Capacities in Children)				
	Number of Buses	Cap-acity	WC Cap.	HC Equip-ped	Total Pas-sengers	Number of Vans	Capacity	WC Cap.	HC Equip-ped	Total Pas-sengers
Central Square Central School District NY 11 Central Square, NY	55	66			3630					0
	2	36	2	2	72					0
	11	20			220					0
Phoenix Central School District Volney Street Phoenix, NY	12	66			792	2	8			16
	11	65			715	2	7			14
	1	59			59					0
	4	47			188					0
	1	36	2	1	36					0
	2	26	2	2	52					0
	1	21			21					0
A & E Transport, Inc. 34 County Route 31 Minetto, NY	1	22			22	2	6			12
	1	19	3	1	19					0
	5	20			100					0
	1	8	2	1	8					0
	7	16			112					0
	1	6	3	1	6					0
	1	4	3	1	4					0
CNY CENTRO, Inc. 200 Cortland Avenue Syracuse, NY	6	53			318	15	16	2	15	240
	5	49	2	5	245	9	15	2	9	135
	37	45	2	37	1665					0
	72	44	2	72	3168					0
	88	43	2	88	3784					0
	9	39			351					0

Table 8-4. Transportation Resources

Facility Name and Address	BUS (Capacities in Children)					VAN (Capacities in Children)				
	Number of Buses	Cap-acity	WC Cap.	HC Equip-ped	Total Pas-sengers	Number of Vans	Capacity	WC Cap.	HC Equip-ped	Total Pas-sengers
CNY CENTRO, Inc. 512 E. Seneca Street Oswego, NY	2	53	2	2	106	3	15	2	3	45
	8	45	2	8	360					0
CENTRO of Cayuga, Inc. 5 Frank Smith Avenue Auburn, NY	10	53	2	10	530	1	15	2	1	15
	5	38			190					0
City School District of Oswego Mark Fitzgibbons Drive Oswego, NY	36	71			2556	2	7	2	2	14
	16	66			1056					0
	1	54	1	1	54					0
	1	44	2	1	44					0
	1	29	3	1	29					0
	1	23	3	1	23					0
	3	20			60					0
	1	15	3	1	15					0
Mexico Academy and Central School U.S. 104 Mexico, NY	21	66			1386					0
	9	65			585					0
	3	63			189					0
	3	60			180					0
	1	54			54					0
	1	29			29					0
	1	19			19					0
	1	16			16					0
	2	14			28					0
	4	8			32					0
	2	8	4	2	16					0
	2	7			14					0
Oswego County BOCES	1	66			66					0

Table 8-4. Transportation Resources

Facility Name and Address	BUS (Capacities in Children)					VAN (Capacities in Children)				
	Number of Buses	Cap-acity	WC Cap.	HC Equip-ped	Total Pas-sengers	Number of Vans	Capacity	WC Cap.	HC Equip-ped	Total Pas-sengers
County Route 64 Mexico, NY	1	65			65					0
	1	32	4	1	32					0
	3	16			48					0
	9	15	2	9	135					0
	1	13	2	1	13					0
	3	12	2	3	36					0
	1	4	3	1	4					0
	1	4	4	1	4					0
Oswego County Opportunities 24 Pierce Drive Fulton, NY	1	31			31					0
	2	30	2	2	60					0
	9	28	3	9	252					0
	1	27			27					0
	3	20			60					0
	2	19			38					0
	8	16	2	8	128					0
	1	16			16					0
	6	14	2	6	84					0
	1	12			12					0
	8	12	2	8	96					0
	1	10			10					0
	2	9	2	2	18					0
Totals:	**535**		**77**	**289**	**24393**	**36**		**10**	**30**	**491**

Table 8-5. Demand and Supply of Bus Resources					
County	Number of Students	Transit Dependents	Ambulatory and Wheelchair Medical Demand	Weighted Total Number of Seats Required	Number of Available Bus Seats
Oswego	7,844	3,801	1,105	11,570	24,393

Notes: The number of students includes all students in elementary, middle, and high schools. Students at SUNY Oswego are assumed to evacuate in private automobiles and transit dependent buses.

Seats are "weighted" as follows: each elementary school child occupies 2/3 seat. All other people occupy a single seat per person

Evacuation Time Estimates for Transit Trips were developed using both good weather and adverse weather conditions. The following list of activities present the chronology of events relevant to transit operations. The elapsed time for each activity will now be discussed.

Activity A: Mobilize Drivers

Mobilization is the elapsed time from the Order to Evacuate until the time the buses are dispatched from their respective depots.

Discussions with local personnel indicate that, historically, it takes between 30 and 45 minutes to alert bus drivers to the need for an early dismissal due to inclement weather. During conditions that could lead to early school dismissals (snow, storms), standard practice has bus drivers ready to respond even before they are notified. For a rapidly escalating radiological emergency, however, with no observable indication before the fact, drivers would likely require a longer period of time to mobilize for an emergency. Consequently, providers agreed that a mobilization time of 90 minutes is a reasonable expectation.

Activity B: Travel to Facility

We will conservatively assert that travel speeds are those computed by the PCDYNEV simulation model for evacuees traveling outbound. Table 8-8 presents the evacuation travel speeds within Oswego County, as functions of elapsed time from the Order to Evacuate and of weather conditions. By interpolation of the speeds in Table 8-8, we will assign an average travel speed of 18 mph (15 mph snow) at a time one hour and 30 minutes (2 hours, snow) after the Order to Evacuate, when the buses are dispatched from their depots.

The average distance from each depot to each assignment (school, special facility) is estimated as 6 miles, given the dispersion at bus depots. Thus, this travel time is estimated at 25 minutes.

Activity C: Board Passengers

Studies have shown that passengers can board a bus at headways of 2-4 seconds (Ref. HCM2000 Page 27-27). Therefore, passengers may board a bus to capacity in about 5 minutes. Allowing time to position the buses expands this estimate to 15 minutes.

Activity D: Travel to Region Boundary

The average distance from a facility within the EPZ to the Region boundary is conservatively estimated at 8 miles for a Region that extends to the EPZ boundary. The speeds within the EPZ are obtained from Table 8-6. We will assign, as an average speed of travel, the computed values at 3 hours after the Order to Evacuate.

Table 8-6 Outbound Highway Speeds During Evacuation

Elapsed Time from Evacuation Recommendation	Oswego County		
	Outbound Speed (MPH)		
	Good Weather	Rain	Snow
1:00	23	20	21
2:00	13	11	11
3:00	10	9	9
4:00	20	18	8

Those buses servicing the transit-dependent (routes 1-76) will first travel along their pick-up routes, then leave the Region. The additional travel along their respective routes within the Region is estimated by using the individual route maps.

Table 8-7 presents the evacuation time estimates for schools in the EPZ. Since the school evacuations will be completed in a single wave, then evacuation time can be computed as the sum of travel times associated with Activities A→B, B→C, C→D, and D→E. Using the procedures described above for these activities and the data of Table 8-6 yields the values in Table 8-7.

The time at which buses will be dispatched from the depots for the general population transit-dependent evacuation will be later than for the buses dispatched to the schools. The buses should be scheduled so that they arrive at their respective routes after their passengers have completed their mobilization. Thus, we estimate an average dispatch time of 2 hours and 30 minutes.

Table 8-7 School Evacuation Time Estimates

County	Region Extends to EPZ Boundary		
	Good Weather	Rain	Snow
Oswego	2:45	2:50	3:20

Table 8-8 presents the transit-dependent population evacuation time estimates. These ETE are based in part, on route speeds in Table 8-6 plus 15 minutes, to account for stop-and-go operations along the route to pick up passengers. The ETE for a second wave is presented in the event there is a shortfall of available buses or that fewer drivers are available to man first-wave buses.

Table 8-8. Transit-Dependent Evacuation Time Estimates

County	Region Extends to EPZ Boundary		
	Good Weather	Rain	Snow
Oswego	5:30	5:55	5:55

Activity E: Travel to Reception Center

The distance from the EPZ boundary to the reception center is approximately 40 miles. For a one-wave evacuation, this travel time does not contribute to the ETE. For a two-wave evacuation, it must be considered. Since this travel time will be outside the EPZ, a reasonable estimate in speed is 20 mph. Thus, this travel time is estimated as two hours.

Activity F: Passengers Leave Bus

A bus can empty in 5 minutes.

Return to Route for Second Wave

The inbound trip to the EPZ will be at a higher speed since the direction of travel will be counter-flow relative to evacuating traffic. The travel distance should be 40 miles at an average speed of 40 mph (speeds moving towards the EPZ should not be constrained by evacuation traffic), which yields a travel time of, say, 60 minutes. The bus then completes its route and travels to the EPZ boundary. (Only Regions extending to the EPZ boundary would possibly require a second wave).

Note that the turn-around time is 3 hours and 5 minutes from the time the bus leaves the EPZ during the first wave, until it begins servicing its route again. Its route speed will be higher during this second wave since the network would be flushed. A route speed of 12 mph and a length of 6 miles will yield a route travel time of 30 minutes. Traveling 8 miles to the EPZ boundary at 20 mph adds 25 minutes. Thus, the second wave is completed in 3:05 + 0:30 +0:25 = 4 hours after the time the bus exited the EPZ at the end of the first wave.

The completed ETE at the end of the second wave for these buses, are given in Table 8-9. It should be noted that the need for a second wave of buses returning from the reception center is not likely. A more probable requirement is the dispatch of additional buses from depots to pick up any people who missed the bus along any bus route. If these buses are dispatched from depots at 3 hours and 30 minutes after the Order to Evacuate, then they can complete their routes within the general population evacuation time estimate. Table 8-9 present both of these second wave evacuation time estimates.

Table 8-9. Second Wave Transit-Dependent Evacuation Time Estimates						
County	Second Wave Completion Time Using Buses Coming From Bus Depots			Second Wave Completion Time Using Buses Coming From Dropping First Wave Evacuees at the Reception Center		
	Good Weather	Rain	Snow	Good Weather	Rain	Snow
Oswego	5:50	6:05	7:30	9:50	10:05	11:30

.

Evacuation of Ambulatory Persons from Medical Facilities

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

- These buses will leave the depots later--say at 2 hours.
- The passenger loading time will be longer -- say 30 minutes.

Thus, these buses will leave the EPZ 45 minutes later than the ETE values given in Table 8-7.

Emergency Medical Services (EMS) Vehicles

The previous discussion focused on transit operations for ambulatory and wheelchair-bound persons within the EPZ. It is also necessary to provide transit services to non-ambulatory persons who do not -- or cannot -- have access to private vehicles. As shown in Table 8-3, a total of 9 ambulance runs is anticipated for an evacuation of the entire EPZ. There are sufficient resources in the area, which exceed the number of ambulance runs required.

Consequently, only a single wave evacuation is contemplated. The ETE should be comparable to those for schools since the activities are the same. Thus, the ETE of Table 8-7 is also applicable for ambulances.

9. TRAFFIC MANAGEMENT STRATEGY

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

- Personnel with the capabilities of performing the planned control functions of traffic guides.
- Equipment to assist these personnel in the performance of their tasks:
  - Traffic Barriers
  - Traffic Cones
  - Signs
- A plan that defines all necessary details and is documented in a format that is readily understood.

The functions to be performed in the field are:

1. Facilitate evacuating traffic movements that serve to expedite travel out of the EPZ along routes that the analysis has found to be most effective.

2. Discourage traffic movements that permit evacuating vehicles to travel in a direction which takes them significantly closer to the power station, or which interferes with the efficient flow of other evacuees.

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

- A driver may be traveling home from work or from another location, to join other family members preliminary to evacuating.
- An evacuating driver may be taking a detour from the evacuation route in order to pick up a relative.
- The driver may be an emergency worker en route to perform an important activity.

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

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

1. A field survey of these critical locations.

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

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

3. Prioritization of TCPs.

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

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

In each schematic that appears in Appendix G, the control tactic at each TCP is presented. Figure 9-1 identifies the location of each traffic control point. Figure 9-2 presents the location of the traffic control points in the City of Oswego. Tables 9-1 and 9-2 present a summary of traffic control requirements and access control requirements, respectively. Figure 9-3 presents an overview of the access control points used for the two, five and full EPZ regions.

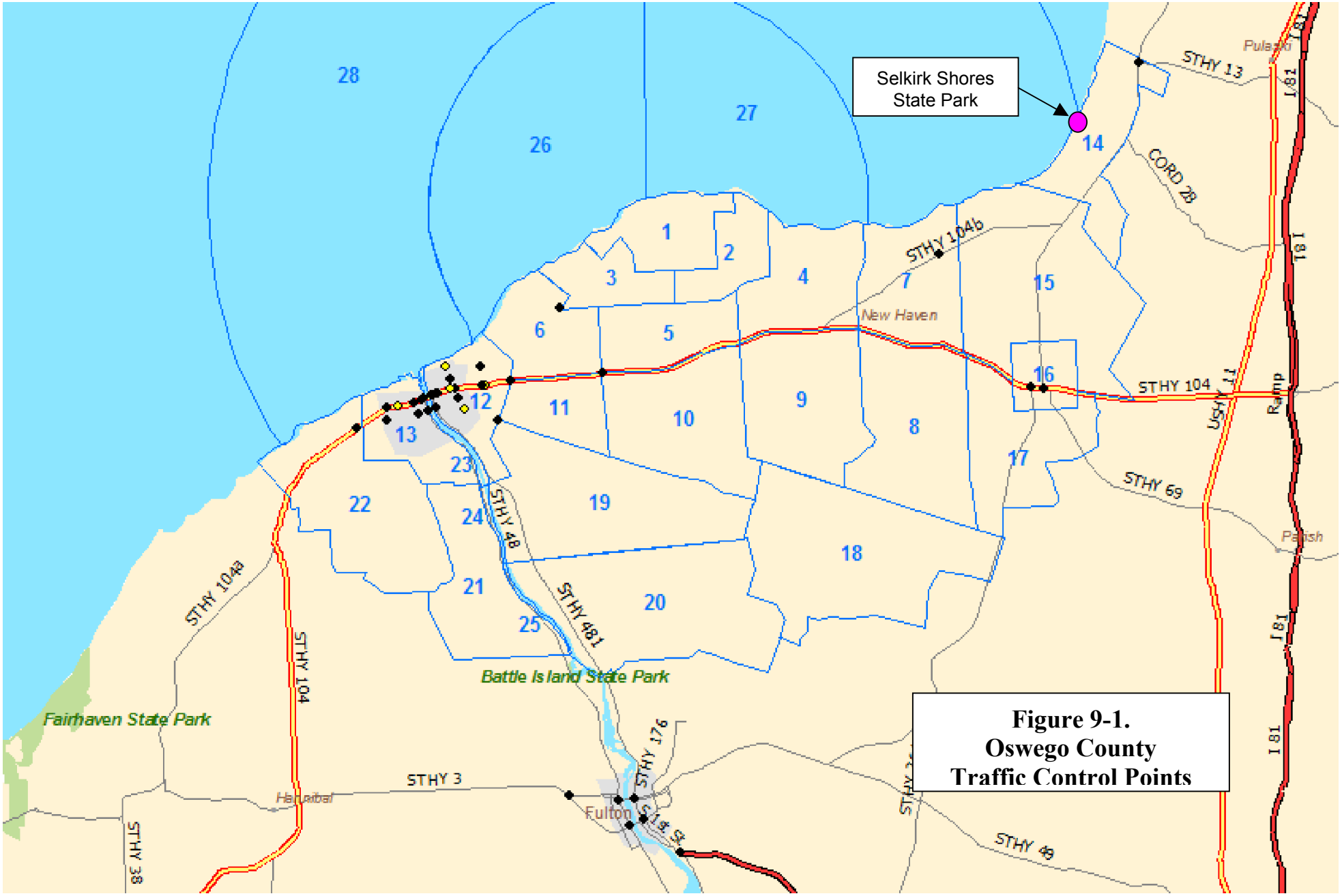


Figure 9-1.
Oswego County
Traffic Control Points

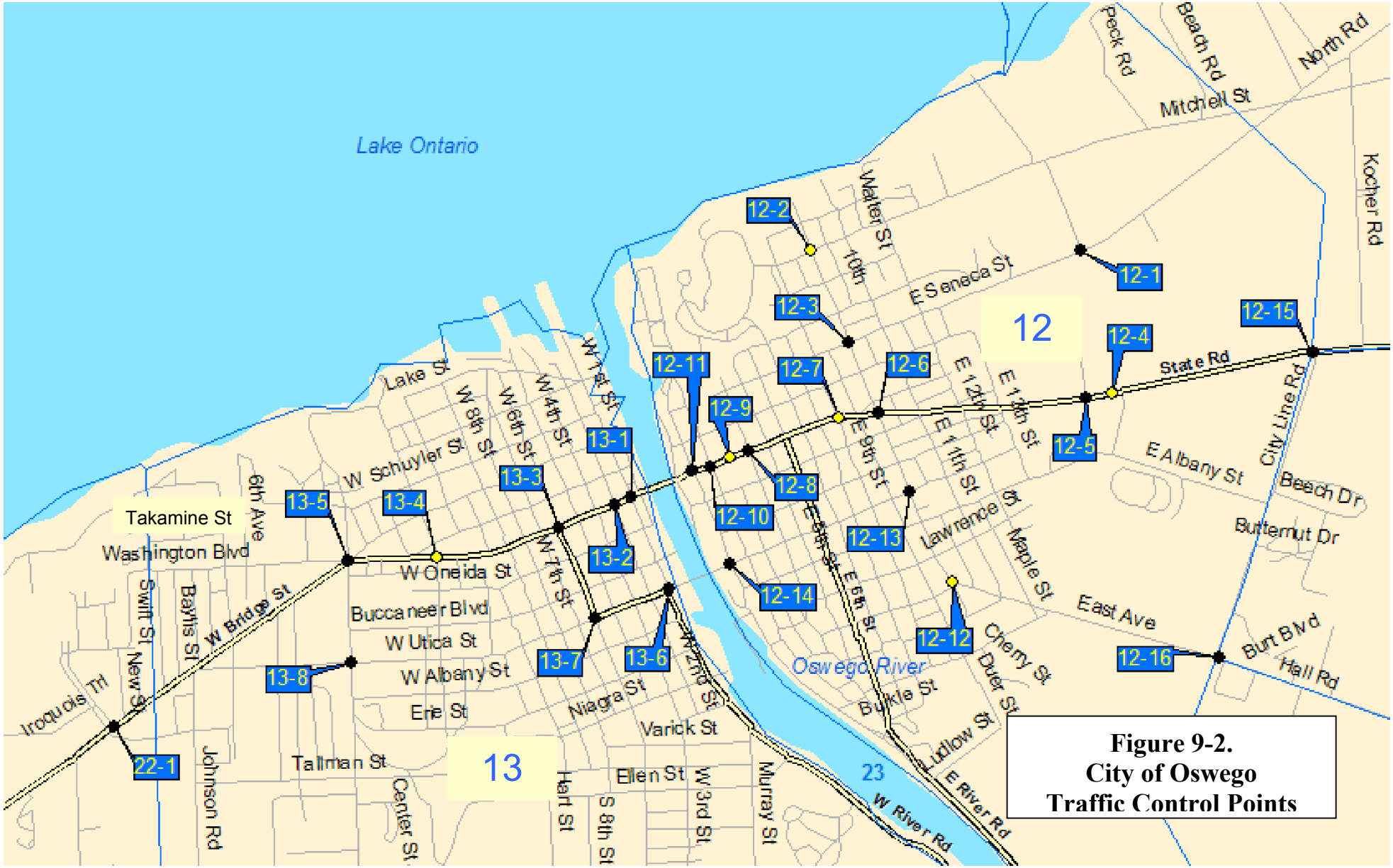


Figure 9-2.
City of Oswego
Traffic Control Points

Table 9-1. Summary of Traffic Control Points

TCP ID	INTERSECTION	ERPA	TOWN	PRIORITY	NO. OF GUIDES	NO. OF CONES	DISCOURAGED MOVEMENTS
3-1	North Rd (CR 1) & Lake Rd (CR 1A)	3	Scriba	2	1	6	NB Lake, EB North Rd
7-1	NY 104B & North Rd (CR 1)/ Tollgate Rd (CR 43)	7	New Haven	2	1	6	WB 104B, WB North Rd
10-1	NY 104 & Creamery Rd/Klocks Corners Rd	10	Scriba	2	1	6	NB Creamery, EB NY 104
12-1	E Seneca St (CR 1) & St. Paul St/George St	12	Oswego	2	1	6	EB E. Seneca, NB St. Paul
12-3	E Seneca St & E 10th St	12	Oswego	2	1	6	EB E. Seneca, NB E 10th
12-5	NY Rte 104 & George St	12	Oswego	2	1	3	EB NY 104
12-6	E Bridge St (NY 104) & E 10th St	12	Oswego	2	1	9	EB E Bridge, NB E 10th
12-8	E Bridge St (NY 104) & E 4th St	12	Oswego	2	1	9	EB E Bridge, NB E 4th
12-10	E Bridge St (NY 104) & E 2nd St	12	Oswego	2	1	9	EB E Bridge, NB E 2nd
12-11	E Bridge St (NY 104) & E 1st St (NY 481)	12	Oswego	1	2	9	EB E Bridge, NB E 1st
12-13	E Utica St & E 10th St	12	Oswego	2	1	6	EB E Utica, NB E 10th
12-14	E Utica St & E 1st St (NY 481)	12	Oswego	1	2	9	EB E Utica, NB E 1st
12-15	NY 104 & City Line Rd	12	Oswego	3	1	3	EB NY 104
12-16	East Ave (CR 4) & City Line Rd	12	Oswego	3	1	3	EB East Ave
13-1	W Bridge St (NY 104) & W 1st St	13	Oswego	1	2	9	EB W Bridge, NB W 1st
13-2	W Bridge St (NY 104) & W 2nd St	13	Oswego	2	1	3	NB W 2nd

TCP ID	INTERSECTION	ERPA	TOWN	PRIORITY	NO. OF GUIDES	NO. OF CONES	DISCOURAGED MOVEMENTS
13-3	W Bridge St (NY 104) & W 5th St	13	Oswego	2	1	3	NB W 5th
13-5	NY Rte 104, George Washington Blvd & Hillside Ave	13	Oswego	1	2	15	EB NY 104, EB W Seneca
13-6	W Utica St & W 1st St (NY 48)	13	Oswego	1	2	9	EB W Utica, NB W 1st
13-7	W Utica St & W 5th St (NY 48)	13	Oswego	1	1	9	NB W 5th
13-8	W Utica St & Hillside Ave	13	Oswego	2	1	6	NB Hillside, EB W Utica
14-1	NY 3 & NY 13	14	Richland	3	1	6	SB NY 3, WB Sharoun Dr
16-1	Main St (NY 104) & Norman Ave (NY 3)/Academy St (CR 16)	16	Mexico	3	1	6	WB Main, NB Academy
16-2	Main St (NY 104) & Scenic Ave (NY 3)	16	Mexico	3	1	3	WB Main
22-1	SUNY Oswego - NY Rte 104 & Sweet Rd/Mollison St	22	Oswego	1	1	3	EB NY 104
30-1	N 2nd St (NY 481) & Oneida St	Shadow	Fulton	1	1	6	NB N 2nd
30-2	E Broadway (NY 3) & S 2nd St (NY 481)	Shadow	Fulton	1	2	3	NB S 2nd
30-3	W 1st St (NY 48) & Oneida St/Gansvoort St	Shadow	Fulton	1	1	3	NB W 1st
30-4	W Broadway (NY 3) & W 1st St (NY 48)	Shadow	Fulton	1	2	3	NB W 1st
30-5	NY Rte 481 & CR 57	Shadow	Fulton	1	1	6	NB NY 481
30-6	NY 3 & Hannibal St (CR3)	Shadow	Fulton	3	1	3	EB Hannibal, EB NY 3

TCP ID	INTERSECTION	ERPA	TOWN	PRIORITY	NO. OF GUIDES	NO. OF CONES	DISCOURAGED MOVEMENTS
THE FOLLOWING INTERSECTIONS SHOULD BE SET TO FLASHING SIGNALS BY LAW ENFORCEMENT							
12-2	Mitchell St & E 10th St	12	Oswego	--	--	--	--
12-4	NY Rte 104 & Ames/Tops Plaza	12	Oswego	--	--	--	--
12-7	E Bridge St (NY 104) & E 9th St	12	Oswego	--	--	--	--
12-9	E Bridge St (NY 104) & E 3rd St	12	Oswego	--	--	--	--
12-12	Cherry St & East Ave	12	Oswego	--	--	--	--
13-4	W Bridge St (NY 104) & Liberty St	13	Oswego	--	--	--	--


Figure 9-3.
Oswego County
● = Access Control Points

Table 9-2. Summary of Access Control Points

REGION	ACP ID	INTERSECTION	ERPA	TOWN	PRIORITY	NO. OF GUIDES	NO. OF CONES	DISCOURAGED MOVEMENTS
R1 ERPAs Within 2 Mi Radius	1-1	North Rd (CR 1) & Kocher Rd (CR 63)	6	Scriba	3	1	3	EB on CR 1
	1-2	NY 104 & Creamery Rd/ Klocks Corners Rd	10	Scriba	2	1	6	NB on Creamery, EB on 104
	1-3	NY 104 & Duke Rd	5	Scriba	1	1	3	NB on Duke
	1-4	NY 104 & CR 29	5	Scriba	1	1	6	NB on CR 29, WB on 104
	1-5	NY 104 & Middle Rd	4	New Haven	1	1	6	WB on Middle, WB on 104
	1-6	NY 104B, Tollgate Rd (CR 43) & North Rd (CR 1)	7	New Haven	3	1	6	WB on CR 1, WB on 104B
R2 ERPAs Within 5 Mi Radius	2-1	W Bridge St (NY 104) & W 5th St (NY 48)	13	Oswego	2	1	3	NB on W 5th
	2-2	CR 53 & CR 45	20	Volney	1	1	3	NB on CR 53
	2-3	Hall Rd (CR 4) & Whittaker Rd (CR 176)/Hay Fly Rd	10	Scriba	1	1	6	NB on Hay Fly, WB on CR 4
	2-4	Hall Rd (CR 4) & N Volney Rd (CR 6)	18	Volney	3	1	6	NB on CR 6, WB on CR 4
	2-5	CR 6 & CR 51/Darrow Rd	9	New Haven	3	1	6	NB on Darrow, WB on CR 51
	2-6	See 1-6						
	2-7	NY 481 & CR 45	20	Volney	1	1	3	NB on 481
	2-8	Main St (NY 104), Norman Ave (NY 3), & Academy St (CR 16)	16	Mexico	3	1	6	WB on Main, NB on Academy

REGION	ACP ID	INTERSECTION	ERPA	TOWN	PRIORITY	NO. OF GUIDES	NO. OF CONES	DISCOURAGED MOVEMENTS
R3 FULL EPZ	3-1	NY 104 & CR 20	Shadow	Oswego	1	1	6	EB on 104, EB on CR 20
	3-2	CR 7 & Cunningham Rd (CR 85)	Shadow	Hannibal	3	1	3	NB on CR 7
	3-3	Cunningham Rd (CR 85) & Minetto Lysander Rd (CR 8)	Shadow	Granby	3	1	3	NB on CR 8
	3-4	Cunningham Rd (CR 85) & NY 48	Shadow	Granby	1	1	3	NB on 48
	3-5	NY 481 & Van Buren Dr	Shadow	Volney	1	1	9	NB on 481, WB on Van Buren
	3-6	CR 57 & Van Buren Dr	Shadow	Volney	2	1	3	NB on 57
	3-7	Whittaker Rd (CR 176) & Howard Rd	Shadow	Volney	1	1	3	NB on 176
	3-8	Mount Pleasant-Palermo Rd (CR 45) & N Volney Rd (CR 6)	18	Volney	2	1	6	NB on 6, WB on 45
	3-9	NY 3 & Palermo Rd (CR 45)	Shadow	Palermo	3	1	3	NB on NY 3
	3-10	Hall Rd (CR 4) & NY 3	18	Palermo	2	1	6	WB on CR 4, NB on NY 3
	3-11	US 11 & NY 69	Shadow	Mexico	1	1	3	WB on NY 69
	3-12	US 11 & NY 104	Shadow	Mexico	1	1	3	WB on 104
	3-13	NY 3, NY 13 & Sharoun Dr	14	Richland	1	1	6	SB on NY 3, WB on Sharoun

10. TRAFFIC ROUTING PLANS

Evacuation routes are composed of two distinct components:

- Routing from an ERPA being evacuated to the boundary of the Emergency Planning Zone (EPZ)
- Routing of evacuees from the EPZ boundary to the reception center.

Evacuees should be routed within the EPZ in such a way as to minimize their exposure to risk. This requirement is met by routing traffic so as to move away from the location of NMP, to the extent practicable, and by delineating evacuation routes that expedite the movement of evacuating vehicles.

The routing of evacuees from the EPZ boundary to the reception center must also 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 center.
- Relate the anticipated volume of traffic destined to the reception center, to the capacity of the reception center facilities.

Figure 10-1 presents a map showing the general population reception center for Oswego County. The routing plans are presented in Figure 10-2.



Figure 10-1. General Population Reception Center


Nine Mile Point
&
Fitzpatrick Plants
28
26
27
29
Nine Mile Pt Rd
Lake View Rd
Shore Oaks Dr
Creamery Rd
Middle Rd
OSWEGO
MEXICO
To Rochester
To Syracuse
To Syracuse
FULTON
Lake St
NY Rte. 13
Salina St
Atmison Rd
Sherman Rd
Cole Rd
Valley Rd
Tubbs Rd
Hurlbut Rd
La Casse Rd
Rice Rd
Tudo Rd
Paddock Rd
Hall Rd
Howard Rd
Rowlee Rd
Weller Rd
Maple Ave
Owens Rd
Peat Bed Rd
Phinney Rd
Harris Hill Rd
Fulton St
Mill St
Williamstown Rd
Old State Rd
Marsh Rd
Tug Hill Rd
County E
W Lake Rd
Cemetery Rd
E Bryant Rd
W 6th St
N 6th St
Ridge Rd
Rathbun Rd
Chase Rd
Red Schoolhouse Rd
Baratier Rd
Pemphorn Rd
Perrigo Rd
Island Rd
Willard Rd
French St
Kibby Rd
Myers Rd
Silk Rd
Baldwin Rd
Pumphouse Rd
Towne Rd
Rte 81
United States
Figure 10-2. Evacuation Routes
Oswego County

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 patrol may be undertaken along well-defined paths to ensure coverage of those highways that serve as major evacuation routes.

These concurrent surveillance procedures are designed to provide coverage of the entire EPZ as well as the area around its periphery. With this coverage, any blockage caused by a disabled vehicle should be quickly identified:

Tow Vehicles

In a low-speed traffic environment, any vehicle disablement is likely to arise due to a low-speed collision, mechanical failure or exhausting the fuel supply. In any case, the disabled vehicle can be pushed onto the shoulder, thereby restoring traffic flow. Experience in other emergencies indicates that evacuees who are living in 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.

APPENDIX A

Glossary of Traffic Engineering Terms

APPENDIX A: GLOSSARY OF TRAFFIC ENGINEERING TERMS

Term	Definition
Capacity	Maximum number of vehicles which have a reasonable expectation of passing a given section of roadway in one direction during a given time period under prevailing roadway and traffic conditions. These are estimates which are expressed as vehicles per hour (vph).
Centroid	An origin or destination located in the interior of the EPZ.
Content	Number of vehicles occupying a section of roadway at a particular point in time.
Destination	A location in the network, either within the interior or on the periphery, of the EPZ to which trips are attracted.
Entry Node	A network node, that serves only as an origin. Vehicles are generated there and move onto the network to travel toward their respective destinations.
Exit Node	A network node, usually located on the periphery of a network, which serves only as a destination. Vehicles that arrive at an exit node are discharged from the network.
Green-Time to Cycle Time Ratio (G/C Ratio)	The ratio of the duration of a green interval to the signal cycle length. This ratio is the proportion of time available to service specified traffic movement discharging from specified approaches to an intersection.
Internal Node	All nodes that are not Entry or Exit nodes. Vehicles travel through these nodes from one link to the next along their respective paths toward their respective destinations.
Level of Service	An index (A, B, ..., F) which is a qualitative descriptor of the operational performance of traffic on a section of roadway, usually expressed in terms of speed, travel time or density. In practice, each Level of Service index is often associated with a range of service volumes. This relation depends on the type of facility (freeway, rural road, urban street).

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 in the network, either within the interior, or on the periphery, where trips are generated at a specified rate expressed 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	Relate 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 Level of Service, E, approximates Capacity.) Service Volume is usually expressed as vehicles per hour (vph).
Shadow Evacuation	The movement of people from areas ***outside*** the EPZ for whom no protective action recommendation has been issued. This movement may delay EPZ evacuees from leaving the area at risk I na timely fashion.
Signal Cycle, Cycle Time, Length	The total elapsed time to display all signal indications, in sequence. The cycle length is expressed in seconds.

Term	Definition
Signal Interval	A single combination of signal indications. The interval duration is expressed in seconds. In general, a sequence of intervals comprise a signal phase.
Signal Phase	A set of signal indications (and intervals) which services a particular combination of traffic movements on selected approaches to the intersection. The phase duration is expressed in seconds.
Traffic 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 Distribution	A process for determining the destination 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 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.

Term	Definition
Voluntary Evacuees	People who live in ERPAs within the EPZ, for which an Order to Evacuate has not been issued, yet who nevertheless, elect to evacuate