Study Report for the

CALLAWAY PLANT

PRELIMINARY EVACUATION TIME ESTIMATES

Prepared for:

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APPENDIX I
REVISION SUMMARY SHEET

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CHAPTER I. INTRODUCTION

PURPOSE OF THIS REPORT

This report summarizes the estimate of time required to evacuate the population of the Emergency Planning Zone (EPZ) surrounding the Callaway Nuclear Power Plant in Callaway County, Missouri.

LOCATION OF THE CALLAWAY PLANT

The Callaway Plant is located in Callaway County, Missouri, approximately 100 miles west of St. Louis, 25 miles northeast of Jefferson City, and 10 miles southeast of Fulton, as shown in Figure 1.

CHARACTERISTICS OF THE AREA

The area within the 10-mile radius of the Callaway Plant is predominantly rural. The City of Fulton is located approximately 10-miles northwest of the plant. Fulton has a population of 11,000, and serves as the Callaway County Seat. Industry includes a shoe factory, two firebrick plants, a potato chip company, farm implement manufacturers and other diversified businesses. Callaway County is also a clay-mining area and has other valuable mineral resources, including iron and silica deposits.

Westminster College and William Woods College for Women are also located in Fulton, as well as the Missouri School for the Deaf. Fulton is also the site of a state mental hospital with facilities for 1,200 patients.

The highway system in the 10-mile vicinity of the Callaway Plant is typical of a rural area. The two major facilities are Interstate I-70 crossing the area in an east-west direction approximately 10 miles north of the plant, and a north-south highway, Route 54, approximately 10 miles west of the plant. Figure 2 exhibits the area around the Callaway Plant, showing highways and governmental jurisdictions.

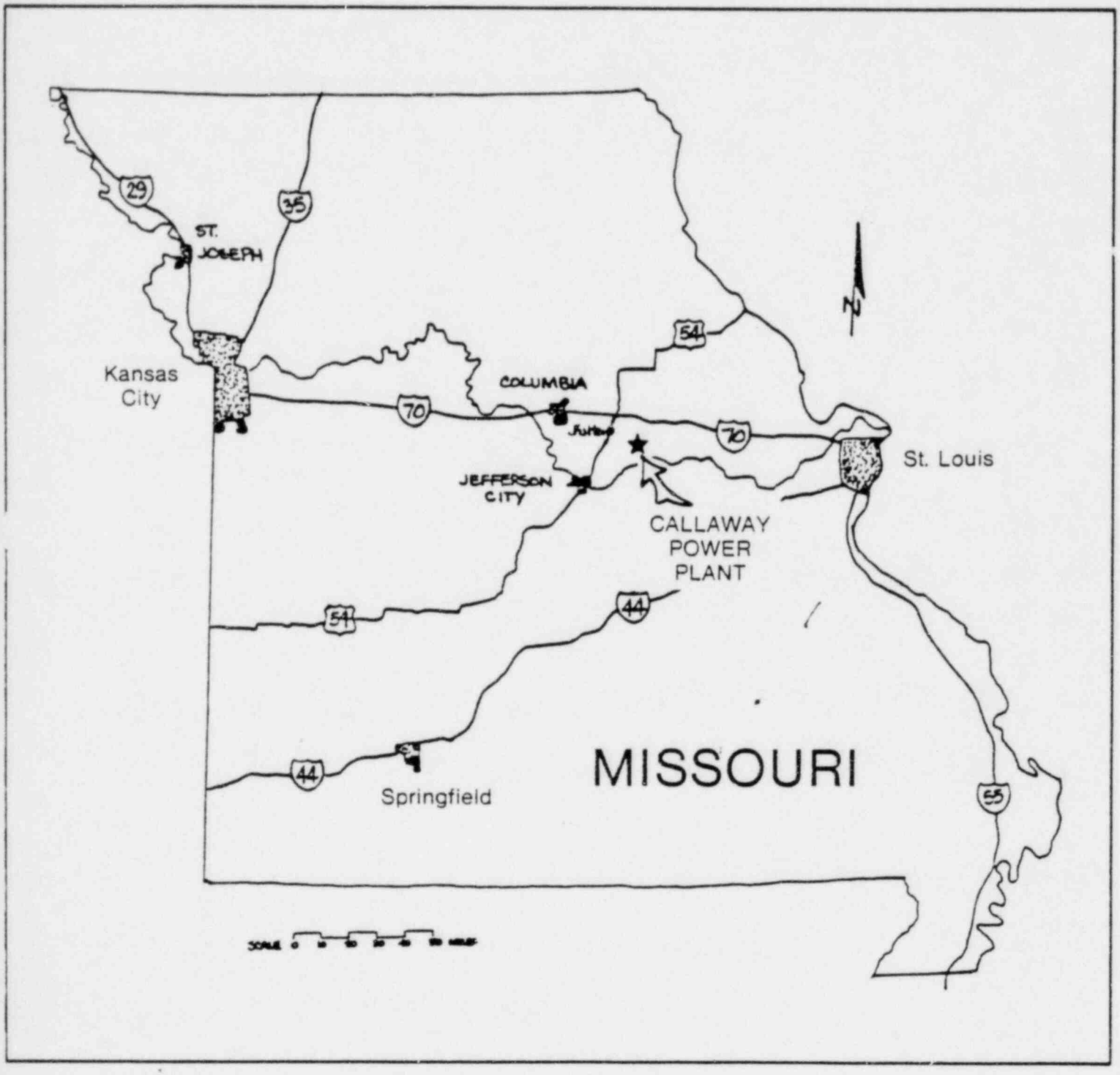

Figure 1. Vicinity Map

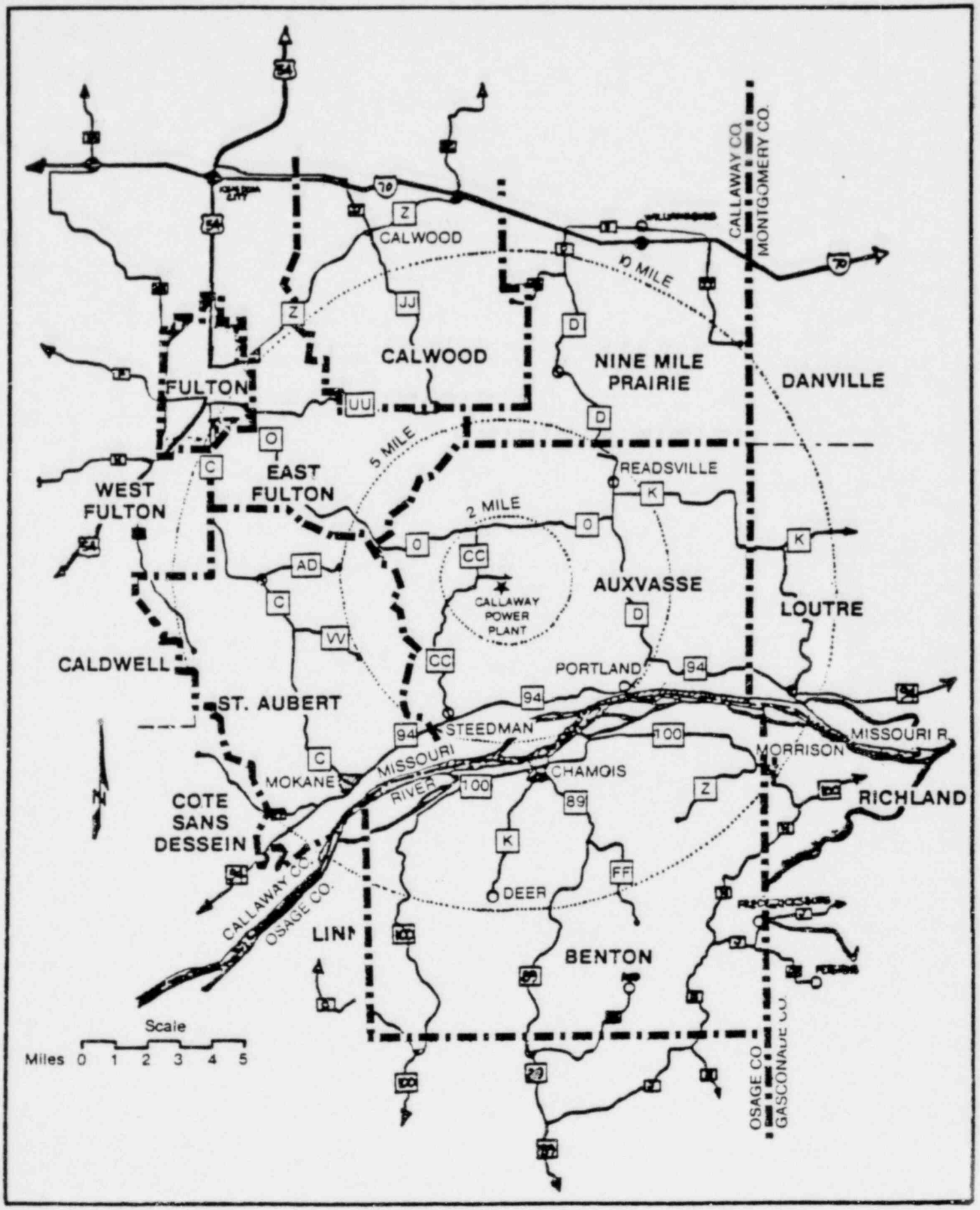

Figure 2. Plant Location

Other major physical features of the area include the Missouri River which flows from west to east approximately five miles south of the plant. Two railroad lines, the Missouri-Kansas-Texas and the Missouri Pacific, are located immediately to the north and south, respectively, of the river.

CHAPTER II. GENERAL ASSUMPTIONS AND METHODOLOGY

LOCAL OFF-SITE PREPAREDNESS PLANNING

An off-site emergency response plan will be developed under the direction of the State Disaster Services Agency and the counties in which the EPZ is located (Callaway, Montgomery, Gasconade, and Osage). This plan will provide for resources and manpower needed for the successful evacuation of the area as well as the following:

- Detailed evacuation plans, addressing notification, routing, manpower and resource requirements, confirmation of evacuation and transportation of non-vehicle-owning population (schools, households without vehicles, and persons in institutions)
- Communication within EPZ, and between the plant, state agencies, the counties and local governments within the EPZ
- Local (city and town) mobilization and decisionmaking
- Local notification procedures, including siren, public address and telephone notification, procedures for radio and television information
- Detailed traffic control plan
- Securing buses for transporting the school population
- Securing buses or other vehicles for transporting non-auto-owning population and persons in institutions
- Securing ambulances for non-ambulatory population
- Reception centers and procedures for clearing evacuated population through them
- Manpower (traffic control, supervisory, security emergency services) for conducting the evacuation

EVACUATION TIME ESTIMATION

Three preliminary steps are required prior to actual estimation of evacuation times as follows:

1. EPZ Definition

The EPZ is defined in accordance with Federal guidelines which also require establishment of subareas or sectors within the EPZ. In the following chapter the EPZ and subareas for the Callaway Plant are defined in detail.

2. Demand Estimation

The permanent resident population to be evacuated is estimated using census data. Segments of the population, such as those in special facilities, transients, school children, etc., are not included in the census statistics and must be estimated through data from other sources. Generally these are obtained from administrators of the various schools, hospitals, etc.

Also obtainable from the census are statistics indicating the number of automobiles available to each housing unit. From these statistics, average auto occupancy can be estimated as well as the number of autos which will be used in an evacuation. These statistics and assumptions are described in detail in the following chapters.

3. Estimation of Available Resources

This step deals with the roadway capacity available during an evacuation. Other resources, such as buses, ambulances, reception centers, manpower, etc., are addressed in the aforementioned off-site emergency response plan.

Identification of routes to be used in an evacuation is detailed in later chapters; however, general assumptions regarding roadway capacity are explained here.

In general, the capacity of a route is constrained by the capacities of its intersections. Most routes contain a critical intersection or "bottleneck" location. This is typically a location where (1) the evacuation route has a high traffic volume, and (2) cross-street traffic volume at the intersection is high, reducing the amount of time available for the major evacuation flow to enter the intersection.

The capacity of an intersection is based on a maximum vehicular flow of 1,500 vehicles per lane hourly, with full assignment of the right-of-way (that is, with no cross traffic).[1] At the critical intersections which are establishing the capacity of the evacuation routes, the total capacity is adjusted downward to 80 percent of the maximum to reflect this cross-street traffic. The resulting capacity is 1,200 vehicles per lane per hour on the surface roads.

DESCRIPTION OF EVACPLAN MODELS USED IN THE ANALYSIS OF EVACUATION TIMES

After demand and resource availability are estimated, analyses are conducted to determine evacuation times. The PRC EVACPLAN package used for the analysis of evacuation times consists of two modules:

1. EVACURVE module, which establishes the rate at which the population of the risk area completes preparations to evacuate and enters (or attempts to enter) the relocation road network.

2. QUEUE module, which simulates the flow of traffic out of the EPZ, portrays the impact of traffic control measures employed, and identifies the location, extent and severity of any traffic congestion that occurs during the relocation process. The QUEUE module computes the total time needed for evacuation, on a route-by-route basis.

These modules incorporate features particularly important in the analysis of evacuation times:

1. Dynamic – the EVACPLAN program recognizes that the entire process changes continuously as evacuation proceeds. For example, the rate of discharge of vehicles onto the roadway is neither a single event nor a steady rate, but rather is a distribution that varies with the elapsed time after the start of evacuation.

   In a similar manner, traffic congestion does not occur in a regular manner throughout the area and throughout the entire evacuation process, but rather it appears at different locations and for different durations at these locations. Also, the severity of traffic congestion varies sharply from location to location, even within a single evacuation route.

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1. Highway Capacity Manual, 1965, Highway Research Board Special Report Number 87.

2. Behavior-based – The EVACPLAN program recognizes that the population of the risk area will not evacuate as a single body, with the entire population completing one step of the process (for example, assembling the family unit) before beginning the next step. Rather, the population will proceed at its own pace, with different portions of the population at various stages of the evacuation sequence at any given time.

3. Probabilistic – The EVACPLAN program recognizes that the time distributions for completing each of the various relocation steps are, in the statistical sense, conditional probability, distributions, contingent on completion of the previous steps. Total departure times--that is, the times needed for the entire preparation process—are derived by computing the joint probability distribution from the individual time distributions for each step.

4. Sensitive to control measures – the EVACPLAN model can reflect the full range of measures that might be employed to improve the evacuation traffic flow. This range includes actions to regulate the flow of traffic onto the road system (demand measures), actions to increase the available road capacity for relocation flows (supply measures), and actions to improve the capacity of the available roads (traffic control measures).

The EVACURVE Module

The EVACURVE module calculates the "departure curve" for the EPZ population; that is, the distribution of time needed for the EPZ population to complete preparations to evacuate. The departure curve, therefore, also defines the rate at which the EPZ population enters (or attempts to enter) the evacuation route system.

The EVACURVE module calculates the departure curve from a series of time distributions needed to complete each step of the evacuation sequence. Statistically, the time distribution for each individual step is a conditional probability distribution; the final departure curve is calculated by computing the joint probability distribution of all the component steps.

Inputs to the EVACURVE Module

The series of action steps which comprise the evacuation sequence is identified. The time distribution required to complete each individual step of the evacuation

sequence will be established. Methods for establishing these distributions will be based on local preparedness plans, projections of shut-down times by employers and institutions (such as schools), driving time to return home and distribution of time needed for securing households as derived from evacuation studies for nuclear power plants and natural disasters.

The time distributions for each step are characteristically in the "S-curve" form. This reflects the behavioral realities of the risk area population; that is, some of the population will complete a particular step rapidly (the low "tail" of the curve), most of the population will complete the step in times which cluster around the center of the distribution (the steep central portion of the curve), and a small part of the population will require a very long time for the step (the "tail" at the high end of the distribution.

Computation Procedure for the EVACURVE Module

The EVACURVE program computes the final departure curve for the EPZ population; that is, the rate at which the EPZ population enters the road system. This curve is computed as the joint probability distribution of each of the steps which comprise the relocation.

The EVACURVE program can compute the departure curve at any desired level of detail; that is for any time interval. Typically, a time interval of five minutes is appropriate for computing the departure curve; that is, a value of the departure distribution is computed for each five-minute interval of the evacuation period.

The Queue Module

The QUEUE module begins with the evacuation road network (that is, the system of roads available for evacuation) and the distribution of population onto this network. The QUEUE module then simulates the traffic flow through the evacuation road network. This simulation is iterative; that is, it is repeated for small increments of time. Consequently, the status of traffic congestion is calculated at each time interval, and the dynamic aspects of traffic flow and congestion can be traced.

Inputs to the QUEUE Module

Inputs to the QUEUE program are:

1. Road network used for evacuation. This includes the major evacuation routes, branches to these routes (evacuation subroutes), and points at which the population enters the evacuation route system (loading points).

2. Departure curve for the risk area population, which gives the rate at which the population enters the road system. The departure curve is the direct output of the EVACURVE module as described above.

3. Traffic flow parameters to reflect the capacity of the roads in the relocation network.

The evacuation route network within the EPZ is coded into a form needed for entry into the QUEUE program. This coding process consists of:

1. Designating the major evacuation routes. The number of such routes depends on the specific corridor being considered: typically, there are two to five major evacuation routes in any given corridor.

2. Designating the subroutes; that is, the roads that feed traffic onto the major evacuation routes. The number of subroutes also depends on the specific corrdor being considered; typically, there are 2-4 subroutes for each major relocation route.

3. Establishing the loading points, locations at which relocation traffic is assumed to be generated and at which it enters the relocation road system. Loading points are an abstraction of the actual road system, representing concentrations of households, workplaces, etc. Typically, a total of 10-15 loading points is established for each of the major evacuation routes.

Computation Procedure for the QUEUE Module

The QUEUE program calculates, for each time interval, the arrival and departure of traffic at all locations throughout the evacuation road system. Arrival rates of traffic are determined by:

1. The output of the EVACURVE module, which establishes for all evacuation routes the rate at which traffic enters (or attempts to enter) the evacuation road system, and

2. The loading of traffic onto the individual evacuation routes. This loading is made on the basis of population concentrations and special activity centers.

The rate of discharge of traffic through intersections is determined by:

1. The available lanes of roadway

2. The traffic flow rate, typically 1,200 vehicles per hour on each departure lane for surface roads, and 1,800 per lane on freeways. Traffic flow rates can be adjusted to reflect adverse conditions or other obstacles to free traffic flow.

Traffic queues at any given location are discharged at a rate proportional to their magnitude; i.e., the longer a queue the greater its priority at the intersection where the queue originates. This algorithm simulates the traffic control that would be achieved by a competent traffic control officer on duty at such locations.

The QUEUE program identifies locations at which congestion occurs and calculates the extent of such congestion. Measures which are computed include the length (time) of the period over which congestion persists at particular locations, the maximum delay experienced by a vehicle passing through any congested location, and the extent (distance) of congestion on the relocation road network.

CHAPTER III. THE EMERGENCY PLANNING ZONE FOR THE CALLAWAY PLANT

CRITERIA FOR DEFINING THE EMERGENCY PLANNING ZONE (EPZ)

Federal regulations establish a 10-mile radius for the protection of populations from direct radiation exposure (the plume exposure Emergency Planning Zone).

In adapting this 10-mile radius to any particular site, several general considerations are observed:

- The EPZ must include at least the 10-mile radius as specified in the Federal and state guidelines.
- The EPZ must be easily identifiable. Rather than adhering strictly to an intangible radius, the EPZ boundary should follow natural features (shorelines, streams), man-made features (highways, railroads), or political boundaries.
- The EPZ boundary should not split major coherent populations. Rather, the EPZ boundary should either include or exclude such concentrations in their entirety.
- The EPZ boundary should be regulary and consistent, with reasons for inclusion apparent and supportable. Potential evacuation of large population groups well beyond the 10-mile radius should be avoided.

ESTABLISHING THE EPZ BOUNDARY FOR THE CALLAWAY NUCLEAR POWER PLANT

Several features of the area around the Callaway Plant affect the plume exposure EPZ:

- Concentration of population in the City of Fulton is situated about 10-miles from the Callaway Plant. This accounts for nearly 75 percent of the EPZ population.
- There are very few natural or man-made physical features which could serve as portions of an EPZ boundary.
- There are a number of local governmental boundaries in the area.
- A network of regularly-spaced state, county and township roads exist in the area.

In light of these features, an EPZ boundary was established (Figure 3) to:

- Follow township and other local municipal lines along much of the proposed EPZ boundary.
- Follow selected roads for several portions of the boundary.
- Follow the 10-mile radius for a small segment of the boundary through a sparsely populated area of Montgomery County.

The resulting EPZ boundary encompasses at least the 10-mile radius from the Callaway Plant except for small areas (approximately one square mile or less) in Caldwell, Cote Sans Dessein, Loutre and Linn Townships. These areas have no primary roads, negligible population and employment, and their exclusion from the proposed EPZ does not appear to cause any appreciable erosion of the 10-mile-radius guideline. Table 1 summarizes local government jurisdictions within the 10-mile radius of the Callaway Plant and also within the proposed EPZ.

The proposed EPZ boundary is defined as follows:

> The northerly limit is defined by Interstate I-70 from the interchange with Highway 2 in Calwood Township easterly to the Callaway County/Montgomery County Line.
>
> The easterly boundary consists of the Callaway/Montgomery County line southerly to the 10-mile radius in Danville Township to Highway K in Loutre Township, west on Highway K to first local road southerly to Route 94 in Bluffton, east on Route 94 to the 10-mile radius across the Missouri River to Baileys Creek, southerly to the Morrison/Richland Township boundary to the Osage County/Gasconade County line.
>
> The southerly boundary is the Benton/Crawford Township line.
>
> The westerly boundary consists of the Benton/Linn Township line northerly to the Missouri Pacific Railroad tracks southwesterly to the Missouri River, across the river, following the St. Aubert/Cote Sans Dessein Township line, north to the St. Aubert/Caldwell Township line, north to Highway NN at the St. Aubert/West Fulton Township line, north on Highway NN to Route 54 north to and including the City of Fulton. From Fulton the boundary continues north on Highway Z through East Fulton and Calwood Townships to I-70.

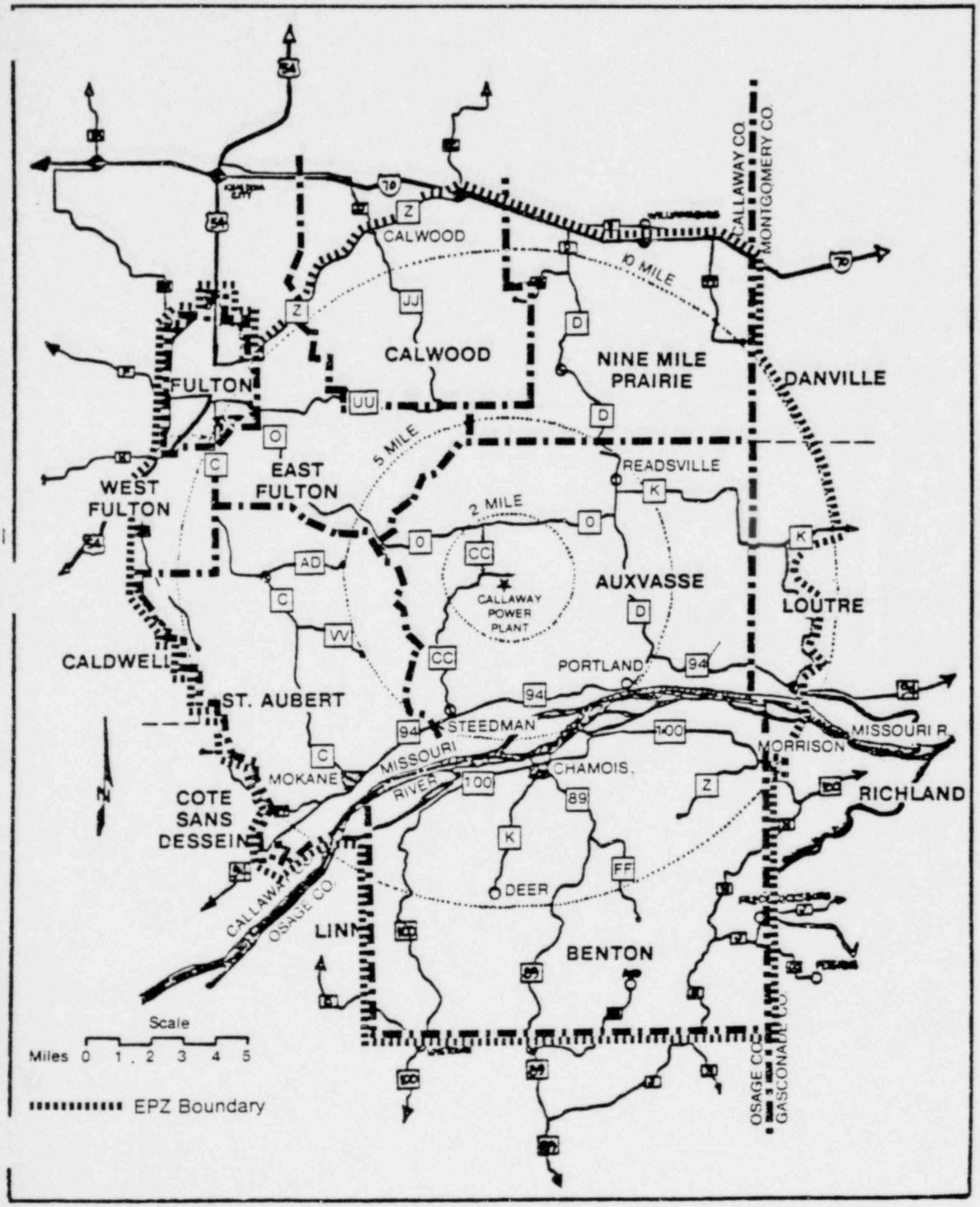


Figure 3. Proposed EPZ Boundary

TABLE 1. LOCAL GOVERNMENT JURISDICTIONS WITHIN THE 10-MILE RADIUS OF THE CALLAWAY PLANT WITHIN THE PROPOSED PLUME EXPOSURE EPZ

Local Government Jurisdiction	Area of the Local Government Jurisdiction Within 10-Mile Radius	Area of the Local Government Jurisdiction Within Proposed Plume Exposure EPZ
Callaway County		
Auxvasse	All	All
Caldwell	Part	None
Calwood	Part	Part
East Fulton	Part	Part
Nine Mile Prairie	Part	Part
St. Aubert	Part	Part
Fulton	Part	All
Cote Sans Dessein	Part	None
Mokane	All	All
Montgomery County		
Danville	Part	Part
Loutre	Part	Part
Osage County		
Benton	Part	Part
Chamois	All	All
Gasconade County		
Richland	Part	Part
Morrison	Part	All

CRITERIA FOR DEFINING SECTORS WITHIN THE EPZ

Federal guidelines call for establishing, within the plume exposure EPZ, a series of sectors as follows:

Distance from Power Station	Definition of Sectors
2 Miles	Four - 90-Degree Sectors
5 Miles	Four - 90-Degree Sectors
To Boundary of Plume Exposure EPZ (about 10 miles)	Four - 90-Degree Sectors

These criteria are guidelines only. Actual sector boundaries depend on the shape of population concentrations and physical features. In particular, it is desirable that sectors not divide contiguous concentrations of population.

Establishing Sectors for the Callaway Plant EPZ

The roadway network and location of political boundaries facilitate establishment of 90-degree sectors within the 2- and 5-mile boundaries and also within the EPZ boundary. Figure 4 illustrates a sector plan for the Callaway Plant EPZ that makes use of the roads or political division boundaries. The sectors are defined below:

Sectors A, B, C and D are defined by the 2-mile radius line through heavily wooded and sparsely populated areas and by Highway O to the north of the plant. The boundaries of Sector A are further defined by Highway CC. Boundaries between Sectors B and C and C and D are local roads as shown on Figure 2. The boundaries defined by the 2-mile radius and the local roads are located in areas of negligible population and employment.

Sectors E, F, G and H are located in the 2- to 5-mile radius from the plant. The 5-mile radius is approximated by a readily definable boundary, that being Auxvasse Township in its entirety. Sector E is further defined by two local roads, one directly west of the plant and the other northwesterly from the plant. Population in the sector appears to be confined to the area along Highway O. Sector F includes the area east of Sector E to a boundary of Highway O, Highway D and Highway K as shown in Figure 2. This sector includes the Canyon Lake area and also the community of Readsville. Sector G comprises the southeasterly portion of Auxvasse Township from Sector F to a boundary defined by a local road due south of the plant and Route 94 southwesterly. Sector H includes the remainder of Auxvasse Township, with population centered along Highway CC and in the community of Steedman. The major portion of Auxvasse Township, also that portion in the prevailing wind direction, is included in Sectors F and G.

Sectors I, J, K and L are located in the area beyond the 5-mile boundary. Sector I is defined by the St. Aubert/East Fulton and the St. Aubert/West Fulton Township lines west of the plant, and the Nine Mile Prairie Township line with Calwood and East Fulton north of the plant. The City of Fulton is included in Sector I. Sector J stretches through Nine Mile Prairie Township to Highway K in Loutre Township. Sector K includes the southeasterly portion of the EPZ from Highway K in Loutre Township to the Missouri River and the entire Osage County portion of the EPZ. Sector L includes St. Aubert Township in its entirety. The community of Mokane is included in Sector L.

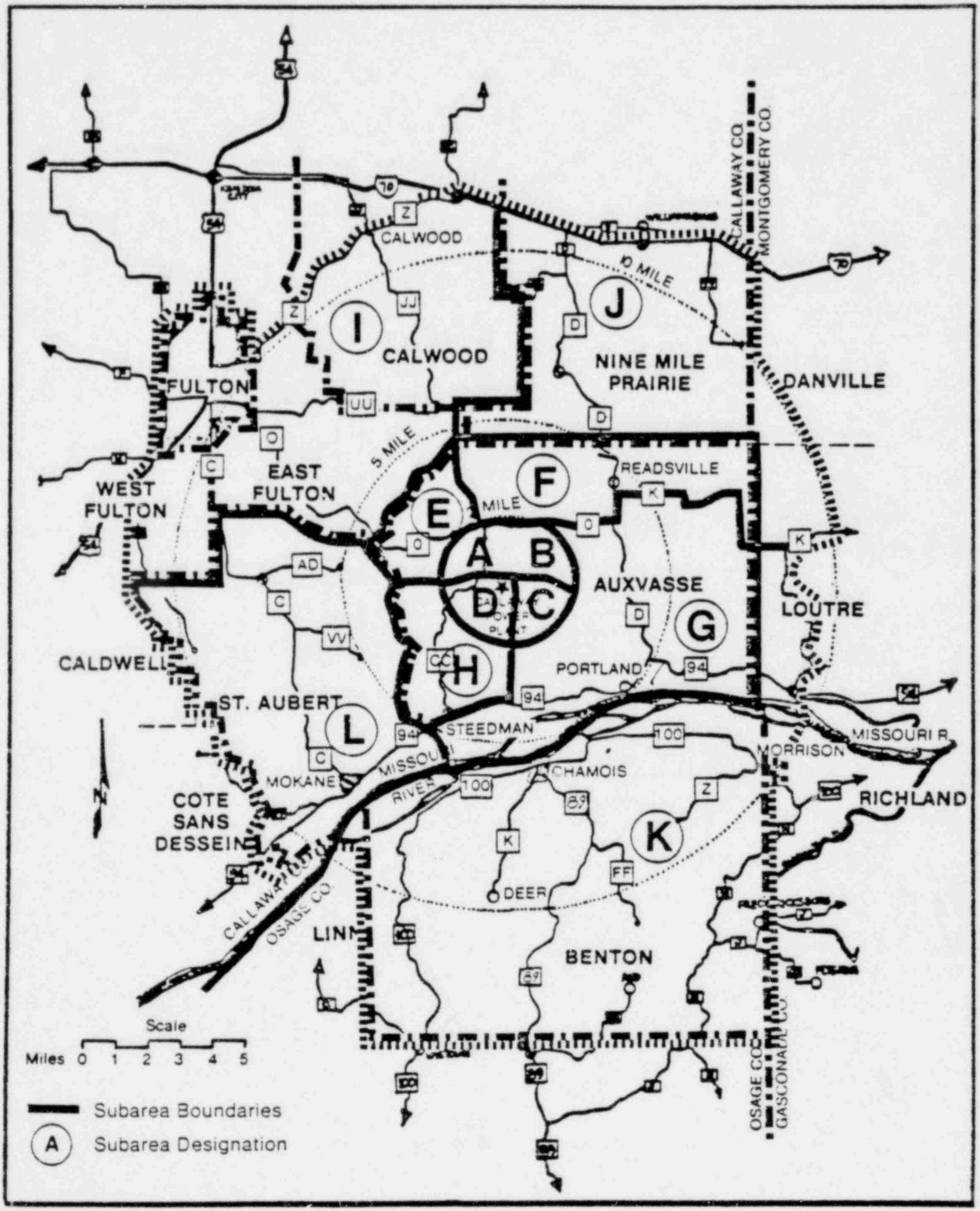


Figure 4. Proposed Subareas

CHAPTER IV. DEMAND ESTIMATION

POPULATION SEGMENTS

In estimating the evacuation time for the Callaway EPZ, three population segments are considered.

1. Permanent Resident -- Those persons living full-time in the EPZ. Two subgroups of permanent residents are recognized:

   - Auto-owning Population -- Those permanent residents having an automobile available for their evacuation from the EPZ.

   - Transport-dependent Population -- Those permanent residents not having an automobile available for their evacuation, and who therefore must be transported by other means.

   The permanent resident population for the EPZ is shown in Table 2.

2. Transient Population -- Non-residents of the EPZ temporarily within it, primarily for recreational purposes. The transient population is estimated at 685 as shown in Table 3.

3. Special Facility Population -- Concentration of population in institutions. This includes schools, hospitals, and nursing homes and is summarized in Table 4. Much of the special facility population is at the State Hospital in Fulton. This institution includes a facility for the criminally insane, within the mental hospital.

POPULATION DISTRIBUTION

Population within a 10-mile radius of the Callaway Plant totals 5,430, distributed as shown in Figure 5. From this figure it can be seen that the permanent population within two miles of the plant is only 103, and within five miles less than 1,000. The fact that Fulton is generally beyond the 10-mile radius accounts for the difference in population of the 10-mile radius and the EPZ. In addition, much of the State Hospital is beyond the 10-mile radius, accounting for the differences in the institution population between Figure 5 and the total.

Transient population within the 10-mile radius is displayed in similar fashion in Figure 6.

TABLE 2. 1980 CENSUS POPULATION WITHIN EPZ

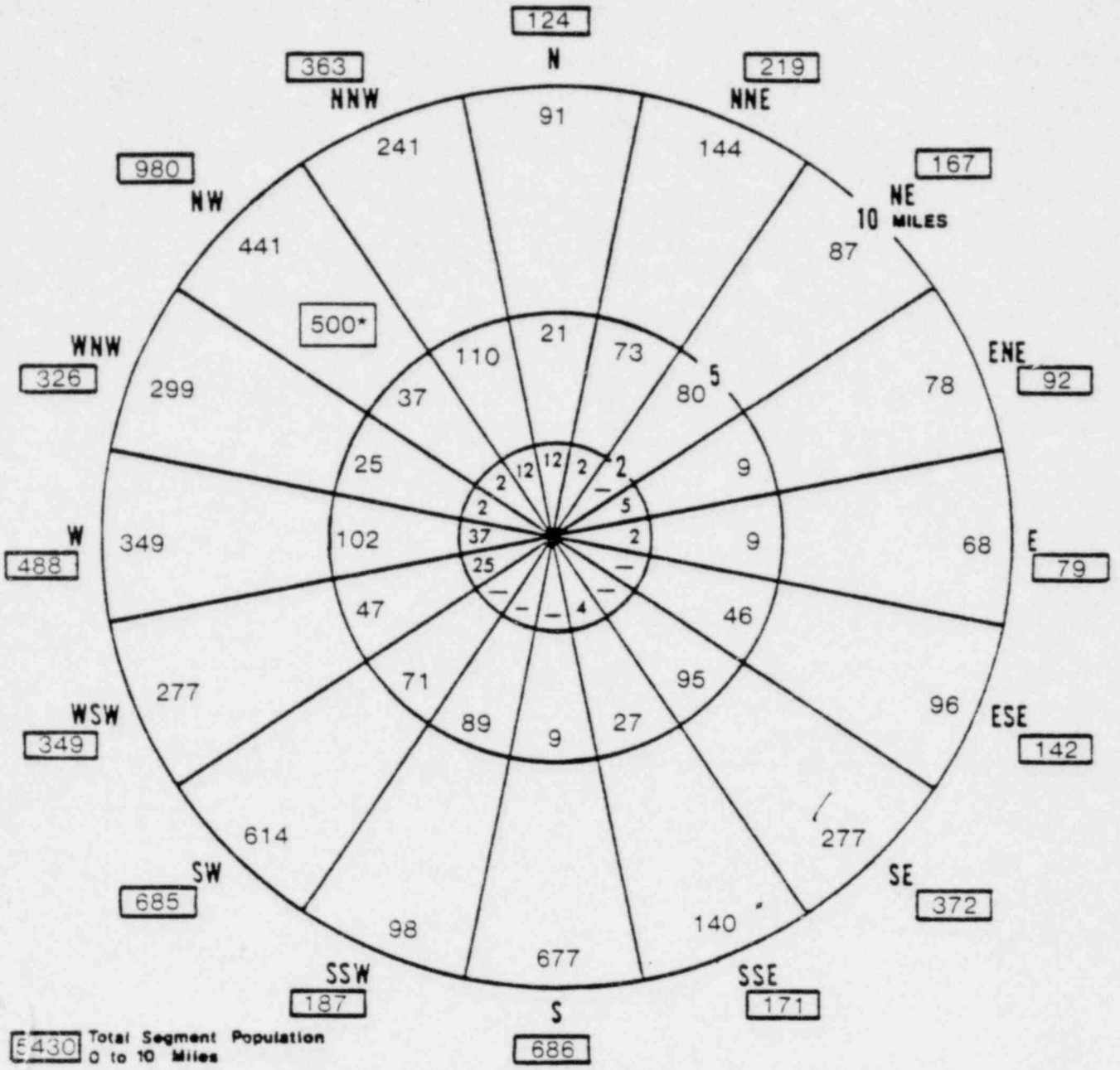
Jurisdiction		Population
Callaway County		15,349
Auxvasse	941	
Calwood	536	
East Fulton (without Fulton)	784	
Nine Mile Prairie	379	
St. Aubert (without Mokane	1,141	
West Fulton (without Fulton)	229	
Fulton	11,046	
Mokane	293	
Montgomery County		116
Danville	18	
Loutre	98	
Osage County		1,412
Benton (without Chamois)	866	
Chamois	546	
Gasconade County		217
Richland (without Morrison)	48	
Morrison	169	
Total		17,094

TABLE 3. TRANSIENT POPULATION IN EPZ

Distance from Plant	Location	Population
3 NNW	Canyon Lake	48
3.5 WNW	Harmony Hill Youth Camp	40
5 NNW	Thunderbird Lake	32
4.5-6 NNE	Lake Lochaweeno	213
6 SE	Paradise Lake	150
7 NNE	Yucatan area	12
7.5 E	Along County Line	3
10 NE	Route YY	9
10 NW	Glover Spring Lake	39
10 NNW	Leisure Lake	54
0	Reform wildlife management area /	85
		685

TABLE 4. 1980 SPECIAL FACILITY POPULATION IN EPZ

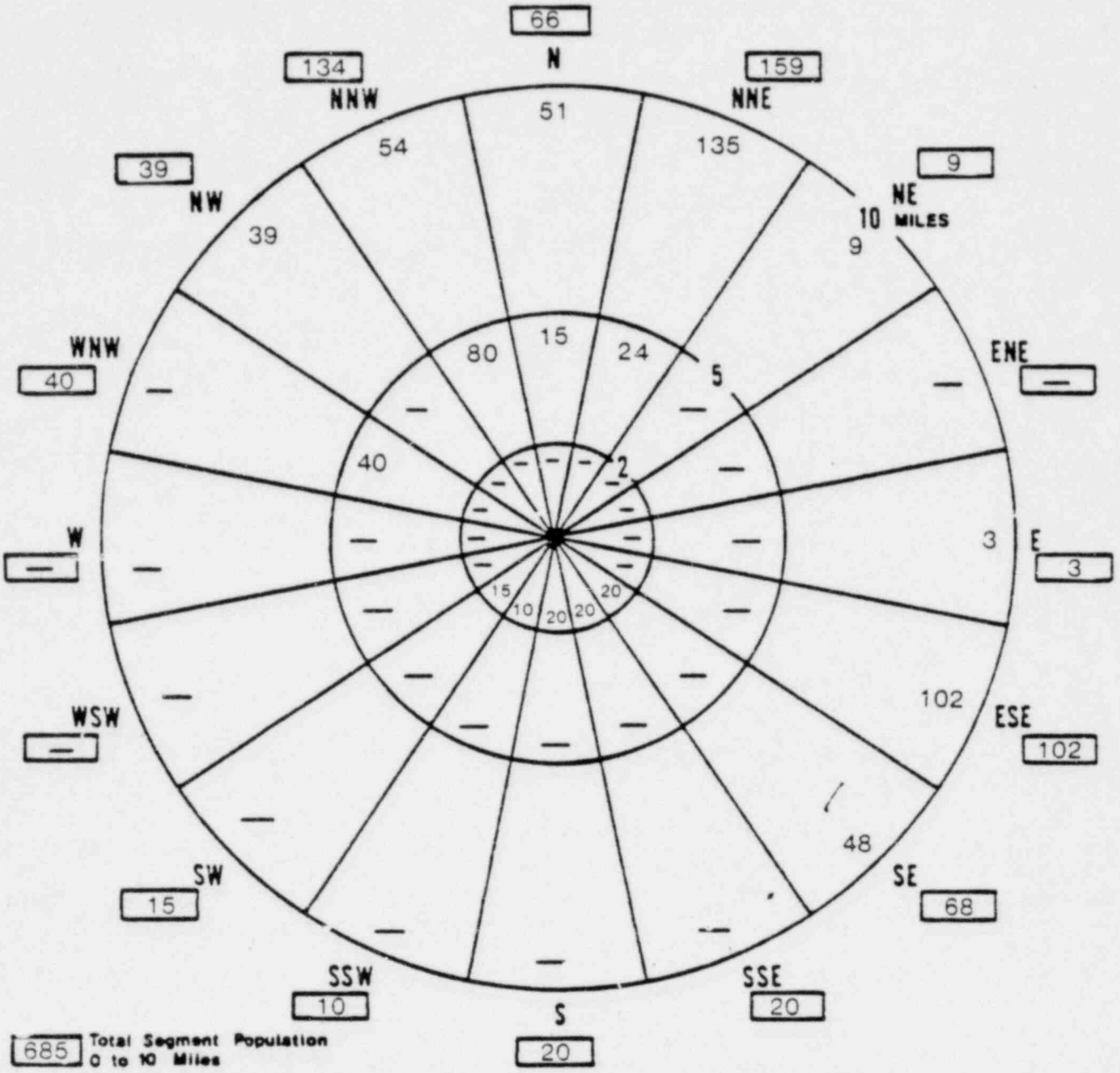
COLLEGE				2,100
Westminster			850	
Dormitory		200		
William Woods			1,250	
Dormitory		850		
SCHOOL				4,000
Fulton Public Schools			2,250	
Fulton High School				
Fulton Junior High School				
Fulton Elementaries				
Bartley				
Bush				
Carver				
Center				
McIntire				
R-I (Chamois)			313	
R-II (Mokane)			725	
St. Peter's Catholic (Fulton)			100	
Ark. Christian Elementary (Fulton)			100	
Missouri School for the Deaf			500	
INSTITUTION	Patients	Staff	Total	3,150
State Hospital Number 1	1,200	1,500	2,700	
State Program for Retarded Children	250	200	450	
MEDICAL	Patients	Staff	Total	350
Callaway Memorial Hospital	24	18	42	
Kingdom Nursing Home	44	29	73	
Fulton Manor Nursing	50	38	88	
Presbyterian Home Life	62	40	102	
Riverside Nursing Home	25	19	45	
TOTAL				9,600



POPULATION TOTALS			
RING, MILES	RING POPULATION	TOTAL MILES	CUMULATIVE POPULATION
0 - 2	103	0 - 2	103
2 - 5	850	0 - 5	953
5 - 10	4477	0 - 10	5430

* Missouri State Mental Hospital

Figure 5: 1980 Census Population within 10-mile Radius



POPULATION TOTALS			
RING, MILES	RING POPULATION	TOTAL MILES	CUMULATIVE POPULATION
0 - 2	85	0 - 2	85
2 - 5	159	0 - 5	244
5 - 10	441	0 - 10	685

Figure 6. 1980 Transient Population within 10-mile Radius

In general, the majority of the population and nearly all the special facility population are located in the sector northwesterly of the plant, and beyond the 10-mile radius.

Population by subarea as defined in the previous chapter is summarized in Table 5.

AUTOMOBILE AVAILABILITY

Table 6 indicates the methodology used in deriving the number of autos used in an evacuation. Census statistics indicate the number of available automobiles per housing unit in Callaway County. These percentages were used to calculate the number of housing units in the EPZ with 0, 1, 2, etc., number of autos. The assumption was then made that if a housing unit had one auto, then it would be used in an evacuation; if two were available, some would use one, some families two, an average of 1.5 autos per housing unit. For those housing units with three or more autos available, it was assumed that an average of two would be used for an evacuation. These figures were extended and checked against the total number of housing units in the EPZ, yielding an average of 1.06 cars per household used in an evacuation.

TABLE 6. GENERAL POPULATION VEHICLE CALCULATION

Available Autos	Percentage of Occupied Housing Units[1]	EPZ Housing Units	Average Autos Used in Evacuation	EPZ Autos Used in Evacuation
0	15.7	1,000	0.0	00
1	47.1	3,002	1.0	3,002
2	31.1	1,982	1.5	2,973
3+	6.1	389	2.0	778
		6,373		6,753

Autos Used per Housing Unit = 6,753/6,373 = 1.06

1. 1970 Housing Census, Callaway County.

TABLE 5. 1980 POPULATION BY SUBAREA IN EPZ

Subarea	Total Census Population	Transient Population	Special Facility
2-Mile			
A	40	--	--
B	7	--	--
C	4	40	--
D	52	45	--
5-Mile			
E	57	80	--
F	274	--	--
G	326	153	--
H	181	--	--
10-Mile			
I	12,440	39	8,490
J	583	--	--
K	862	328	--
L	2,268	--	1,110
Total	17,094	685	~9,600

CHAPTER V. THE EVACUATION SEQUENCE

The sole purpose of the evacuation is to remove the population of the Callaway EPZ as rapidly as possible. The evacuated population is either directed to relocation centers where they are temporarily lodged, or they will go to destinations of their own choosing, primarily homes of nearby relatives and acquaintances.

Wherever possible, the evacuating population will leave the EPZ in private automobiles. Persons without automobile transportation will be transported by transit vehicles, ambulances, and other available vehicles.

Almost all motorists will leave the EPZ by the most direct route; that is, the shortest route out of the EPZ. Traffic direction at some key locations will help balance the traffic volumes on the evacuation routes. Throughout the EPZ, normal traffic flow will be observed, with streets open to all traffic and functioning in their usual manner.

Separate evacuation time estimates are made for the three population groups identified in Chapter IV: (1) permanent residents, (2) transient populations, and (3) special facility populations. Each of these groups follows a different procedure in evacuation:

- Permanent Resident Population -- The auto-owning permanent resident population, after receiving the broadcast instructions to evacuate, assembles by family at home (except for children at school), prepares for evacuating the home, and drives out of the EPZ.

  The non-auto-owning permanent resident population prepares for leaving their homes, assembles at collection locations, and is then collected and transported out of the EPZ in buses or other vehicles.

- Transient Population -- The transient population, after receiving instructions to evacuate, will assemble the group (if any) that is traveling together, and will drive out of the EPZ, using their private vehicles.

- Special Facility Population -- The school population is transported out of the EPZ directly from the schools, and under control of school staff. School buses are used to evacuate this population.

Persons in institutions (hospitals, nursing homes, jails, etc.) are prepared for evacuation, then transported out of the EPZ in buses, ambulances and possibly automobiles.

TIME PERIODS IN WHICH EVACUATION MIGHT OCCUR

The procedure for evacuating the Callaway EPZ will vary, depending on the time of day, day of week, and season of the year in which the evacuation occurs. Various combinations of time, day, and season must be considered as shown in Figure 7.

Day or Night Evacuation

In general, evacuation is likely to be more difficult in the daytime than in the nighttime.

During the day, there is a relatively large chance that families are not assembled at home, but rather are dispersed at work, shopping, on personal business, etc. On school days, the school population is not at home for most of the daytime period. Also, more transients are in the EPZ during the day.

In a night evacuation, the notification process would be slowed by people having to wake up and comprehend the evacuation information being broadcast. Also, additional time (relative to the daytime situation) would be required to prepare vehicles for evacuation in the dark. On the other hand, for most of the population, the families would be intact at the time of notification, since schools are not in session and relatively few employees are on the job.

Weekday or Weekend Evacuation

In general, a weekday evacuation is likely to be more difficult than one on a weekend.

On a typical weekday, much of the population is away from home, mainly at work. During the school year, the school population is also away from home during the day.

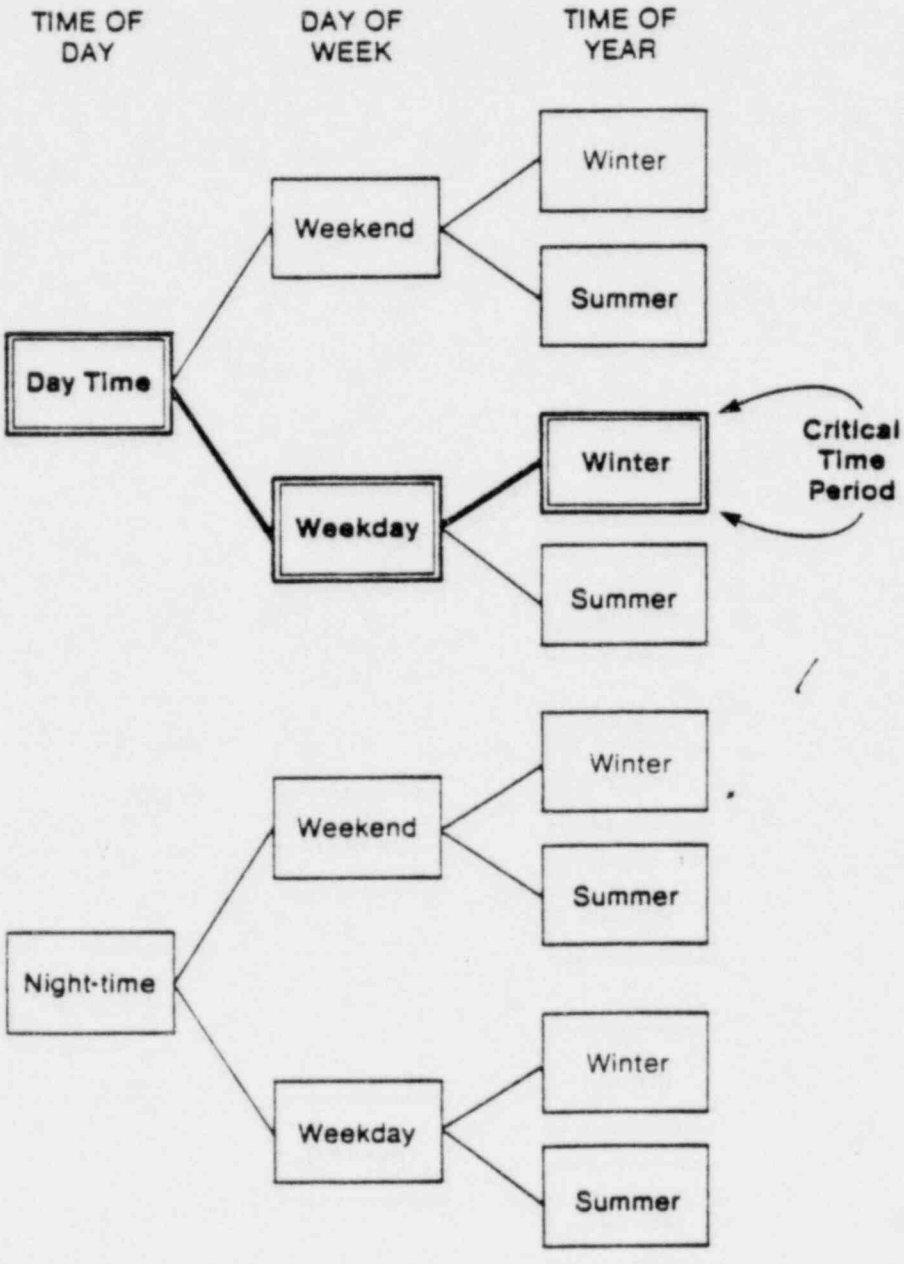


Figure 7. Time Periods In Which Evacuation Can Occur

On the weekends, on the other hand, a number of people are away from the home for reasons other than work or school. However, the assembly of these people at home on a weekend does not present the same problem as assembling them on a typical work and school day, when a much larger percentage is not at home.

Winter or Summer Evacuation

In general, an evacuation during the winter period is more difficult than an evacuation during the summer season. In the winter period, schools are in session, and therefore any weekday evacuation would have to involve the evacuation of the school population. Also, the number of employees at work is at a maximum since few workers are on vacation.

In the summer period, evacuation can be complicated by the presence of non-residents at recreational areas. However, these factors cause less difficulty in evacuation than that caused by the full worker and school population on a winter weekday.

Critical Time Period Adopted for the Evacuation

In estimating the evacuation time for the Callaway EPZ, the critical time period--that is, the time period for which evacuation is likely to require the most time--is the winter weekday period during the daytime (Figure 7). During this period, the time needed to assemble family units is likely to be at a maximum since most employees are at work at this time. Also, the likelihood of being away from home for other reasons (for example, shopping, personal business, etc.) is fairly high during this period. Finally, evacuation during the winter weekday period raises issues of school population evacuation which do not exist in other time periods.

POPULATION SEGMENTS TO BE EVACUATED

Separate evacuation time estimates are made for each of the three population groups identified in Chapter IV:

- Permanent Residents, who evacuate either in private automobiles (if they are auto-owning population) or are transported out in buses or other vehicles (if they are non-auto-owning)

- Transient Population, who evacuate primarily in private automobiles

- Special Facility Population, who are transported out of the EPZ in school buses, public transit buses, other public vehicles and in some cases, in private automobiles

Family Units

Families (excluding children in school) evacuate as units. On weekdays, family members return home from their jobs, shopping, etc. On weekends, many families are already assembled and can immediately prepare to leave home. Non-resident families (for example, recreational visitors) are already assembled and evacuate with almost no further preparation.

EVACUATION ACTION STEPS

For each population segment, the evacuation sequence consists of a series of clearly-defined actions, performed in a predictable sequence (see Figure 8).

Subdividing the evacuation process into these discrete steps improves the accuracy of the estimates of time needed for the entire evacuation. In place of a single estimate of the entire evacuation process, for which data are not available, this process permits the estimation of time for each individual step, for which data are more readily available, or for which reasonable estimates can be made.

Public Agency and Private Steps

Some of the evacuation steps identified in Figure 8 are performed by public agencies. For all population groups, the "Evacuation Notice" action is the responsibility of public agencies. For those persons evacuated by means other than privately-owned vehicles, public agencies have the additional responsibility for the actual transportation out of the EPZ; for example, "Evacuate School Population in Buses", "Evacuate Non-Auto-Owning Population in Buses", etc. For most popu-

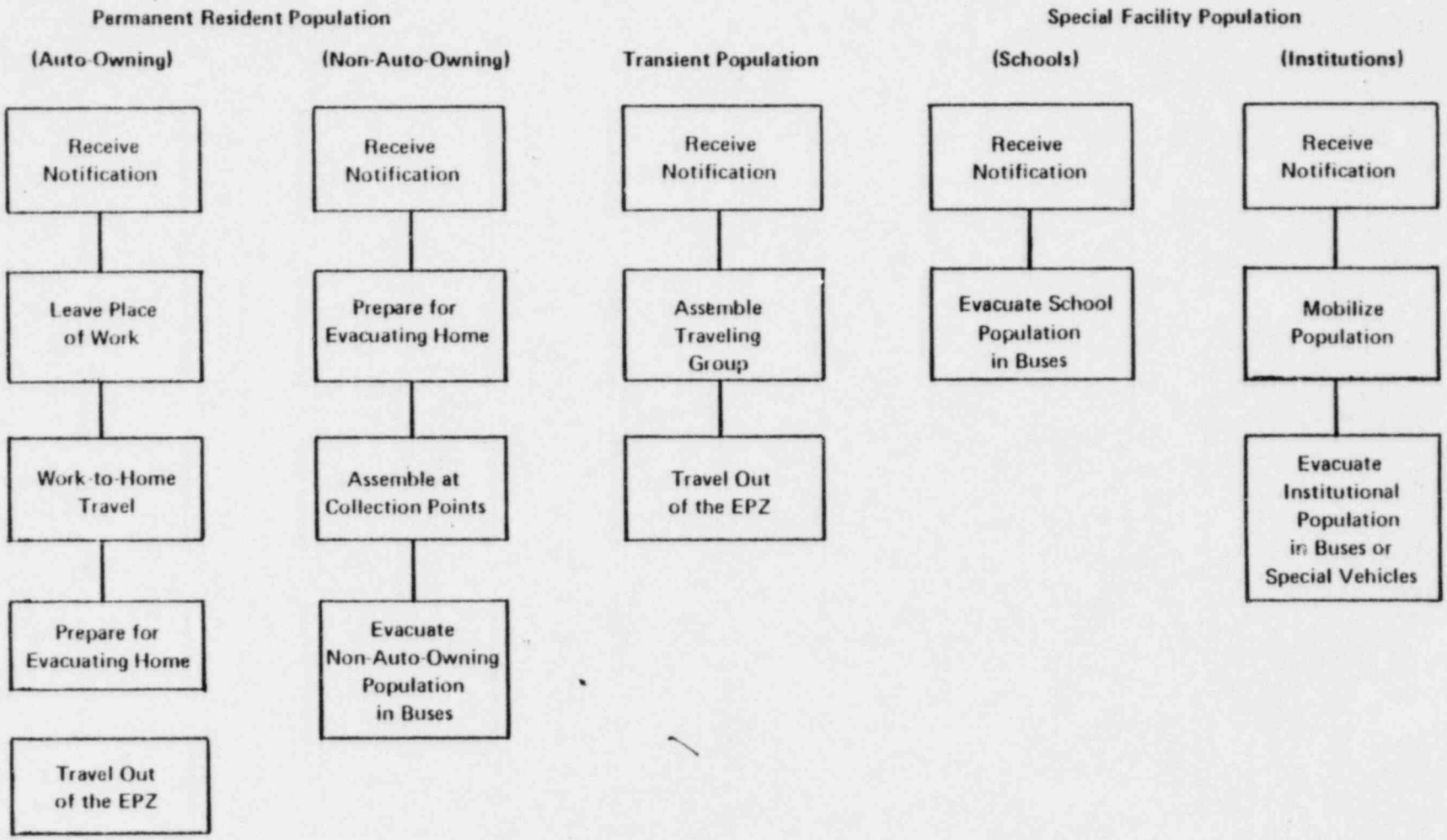


Figure 8. Population Segments and Evacuation Sequences

lations in institutions, the "Mobilize Population" step is also a public agency responsibility.

Those action steps not the responsibility of public agencies are done at the initiative of the individuals being evacuated. For the auto-owning population, all steps after the intitial "Receive Broadcast Information" are private actions; that is, they are initiated by the individuals being evacuated. Similarly, some steps in the evacuation of non-auto-owning households are private steps.

EVACUATION OF PERMANENT RESIDENT POPULATION (AUTO-OWNING)

The action steps described in the following sections describe the sequence of evacuation for the resident auto-owning population of the Callaway EPZ during a winter weekday period.

Receive Notification

Following the decision to evacuate, the first activity is the notification of the public that an emergency exists. This includes the sounding of sirens, followed by broadcast information, and possibly some direct notification by telephone.

Various other backup measures are used to inform the population which might not be reached by the above means. Mobile public address units, for example, may be used to notify boaters on the lakes.

This notification alerts the public that an emergency exists, and that they should tune in to radio and television broadcasts for further information. The notification, by itself, does not inform the public of the nature of the emergency or of the response that they should make.

Information on the nature of the emergency and the instructions on evacuation are given through radio and television broadcasts over cooperating local stations in the Emergency Broadcast System (EBS).

Leave Place of Work

The rate at which area workers will leave their jobs to return home to prepare for evacuation depends on the particular work environment and upon the responsibility level of the worker. It is to be expected that most of the work force will be able to leave their jobs almost immediately, quite similar to a normal departure from work at the end of the workday. A number of workers, however, will require some job "close-down" time in work situations; for example, those that involve machinery, construction equipment, or cash registers in retail sales establishments. Supervisory employees, managers and independent business operators will generally require the greatest amount of time to secure their place of work and to assure that all employees and others on the premises have departed.

Work-to-Home Travel

Travel of the employees from their place of work to home is identical to the daily work-to-home travel pattern. The maximum length for work trips for people living and working in the EPZ is not likely to exceed 20 miles. An average travel speed of 20 to 30 miles per hour is typical for the work-to-home travel for area workers.

This movement of workers, because of the short time over which it occurs, can be expected to cause some traffic congestion, similar to that occurring during the twice-daily work travel peak. The road system can handle this volume of traffic with essentially the same level of service as during the peak hours on a typical working day.

Prepare for Evacuating Home

People can be expected to react differently to any emergency situation, and the conditions imposing an evacuation need on the area population are likely to generate great differences in the amount of time that people will spend in preparing to leave their homes. Three factors in particular affect the amount of time needed to prepare for evacuating a household:

(1) Whether or not adults are at home when notice to evacuate is received. If so, preparation time is shortened (compared to households where no adults are at home) since preparation for evacuation can begin before workers arrive home.

(2) Number of children and other dependents at home. These increase the time needed to prepare the household for evacuation.

(3) The amount of property to be secured. Farms are the extreme case and may require up to two hours to secure. On the other hand, small households can be prepared for evacuation in minutes.

Travel Out of the EPZ

After households are secure, residents of auto-owning households will drive out of the EPZ. It is expected that most motorists will use the most direct route available.

Public agencies will give routing advice for this travel, by means of preparedness plans prior to the emergency and through information broadcasts during the actual evacuation. Police officers will also channel flow of traffic at critical locations as defined in local preparedness plans and in response to actual conditions.

Local evacuation plans assume that traffic will use almost all available roads out of the EPZ. Attempting to confine traffic to some selected roads complicates the evacuation unnecessarily and increases travel time.

The auto-owning resident population will drive either to relocation centers established outside the EPZ, or to other destinations (primarily homes of friends and relatives) of their own choosing.

During the evacuation, normal traffic operations will generally prevail. Specifically, roads will continue in two-way operation, traffic signals will continue to function, and so forth. At key locations, mainly intersections, traffic control will be under direction of police officers or other personnel as designated by local evacuation plans.

On most roads, traffic will flow freely, although at reduced speeds. However, at certain locations and during certain portions of the evacuation period, traffic congestion is expected. The location and extent of this traffic congestion is discussed in Chapter VII of this Report.

EVACUATION OF PERMANENT RESIDENT POPULATION (NON-AUTO-OWNING)

Receive Notification

The procedure for receiving broadcast information is the same as for auto-owning population (above). This includes the sounding of sirens followed by broadcast information and supplemented by mobile public address.

Prepare for Evacuating Home

This step is the same as for auto-owning population (above). As in the case of auto-owning population, primary factors in the time required for this action are whether or not an adult is at home at the time of notification, the number of dependents to be evacuated, and the extent of property to be secured.

Assembly at Collection Points

A significant fraction of the non-auto-owning population (perhaps as much as 50 percent) will be evacuated as passengers in private vehicles driven by family, neighbors or friends. This component of the non-auto-owning population is considered as part of the auto-owning population, and their evacuation procedure follows that of the auto-owning population described above.

Persons from non-auto-owning households who do not evacuate as passengers in private vehicles will assemble at locations (for example, fire stations) designated as collection points. From the collection points, buses will transport them to the reception centers.

Most of the population in settled areas lives within walking distance of a collection point, and the majority of this population will walk there. Persons unable to walk to the collection point will, by telephone, request transit service from their homes to the collection point. Rural non-auto-owning population will be taken to collection points in fire department vehicles and in some cases, automobiles.

Evacuate Non-Auto-Owning Population in Buses

School buses will pick up evacuees who have assembled at the collection points and take them to the reception centers outside the EPZ.

The primary source of buses are school buses in areas adjacent to the EPZ.

EVACUATION OF TRANSIENT POPULATION

Receive Notification

Most of the transient population, particularly employees and vacationers are notified by the siren system. Some boaters may also be notified by mobile public address systems mounted on boats or aircraft.

Assemble Traveling Group

The traveling group (usually family) is assembled. Preparations for evacuating (for example, closing a cabin, docking a boat) are made.

Travel Out of the EPZ

After assembling their traveling group, the transient population will drive out of the EPZ using their private vehicles.

Transient population will return to their own homes outside the EPZ, or they may choose to drive to a reception center.

Public agencies will give routing advice for this travel through information broadcasts during the evacuation. Police officers will also direct traffic flows out of the EPZ.

EVACUATION OF SPECIAL FACILITY POPULATION (SCHOOLS)

Receive Notification

Following the decision to evacuate, the Counties notify schools directly of the need for evacuation. This is done through the siren system and telephone calls directly to the schools.

Evacuate School Population in Buses

The school population is transported directly by bus from school to relocation centers. Generally, an entire school will be transported to the same relocation center. School children will not return home prior to evacuation. The picking up of school children at school by their families is discouraged.

All school buses normally used within the Callaway EPZ will be used for evacuation. These will be supplemented by buses from outside the EPZ but within the four counties partially within the EPZ. These additional buses will provide sufficient capacity to transport students who are not normally bused, for example many students at the Missouri School for the Deaf.

EVACUATION OF SPECIAL FACILITY POPULATION (INSTITUTIONS)

Receive Notification

Following the decision to evacuate, the local preparedness agencies will notify institutions directly about the need to evacuate. This is done by radio warning systems and telephone calls.

Mobilize Population

The institutional population is instructed to evacuate by the staff of that particular institution. Necessary personal effects are assembled. Essential medical records are gathered.

Evacuate Institutional Population in Buses or Special Vehicles

Buses will pick up ambulatory hospital patients, nursing home residents and other persons not requiring ambulance transportation. These passengers will be transported directly to the relocation centers. Generally, all residents of a given institution will be evacuated to the same reception center. The potential source of buses is the school bus fleet outside the EPZ but within the counties partially inside the EPZ.

Non-ambulatory persons will be transported directly from institutions by ambulance. These vehicles will be drawn from the fleets normally based within the EPZ, supplemented by ambulances from outside the EPZ.

Sheltering of Institutional Population

In the case of the Fulton State Hospital, state officials have determined that it is preferable to provide shelter for the population rather than to attempt evacuation. This decision is based on several factors:

- Time required to evacuate the population due to special vehicle needs, particularly for the criminally insane.
- Location of the facility beyond the 10-mile radius and "upwind" of the prevailing wind direction.
- Availability of shelter areas within the institution due to the type of structures.

SUMMARY OF THE EVACUATION PROCESS

In order to examine the "worst case" for which evacuation times are at a maximum, the evacuation is assumed to occur during the daytime on a winter weekday.

Three population groups, having distinctly different evacuation methods, are recognized:

- Permanent Residents who will evacuate in private vehicles (if auto-owning) or who will be transported in transit vehicles (if non-auto-owning)
- Transient Population who will evacuate in private vehicles
- Special Facility Population who are transported out of the EPZ in school buses, public transit buses, other public vehicles and in some cases, private automobiles

For each population group, the evacuation sequence consists of a number of clearly-defined action steps as summarized in Table 7.

TABLE 7. SUMMARY OF EVACUATION ACTION STEPS

Population Segment	Action Steps and Description
Permanent Resident Population (Auto-Owning) (All members of households, except school children, having a private vehicle available for evacuation)	1. RECEIVE NOTIFICATION, including instructions for evacuating 2. LEAVE PLACE OF WORK 3. WORK-TO-HOME TRAVEL, similar to normal work trip 4. PREPARE FOR EVACUATING HOME (close house, secure property) 5. TRAVEL OUT OF THE EPZ in private vehicles, using most direct routes
Permanent Resident Population (Non-Auto-Owning) (Persons not having a private vehicle available for evacuation	1. RECEIVE NOTIFICATION, including instructions for evacuating 2. PREPARE FOR EVACUATING HOME (close house, secure property) 3. ASSEMBLE AT COLLECTION POINTS such as public buildings 4. EVACUATE NON-AUTO-OWNING POPULATION IN BUSES
Transient Population (Workers, recreational visitors)	1. RECEIVE NOTIFICATION, including instructions for evacuating 2. ASSEMBLE TRAVELING GROUP 3. TRAVEL OUT OF THE EPZ in private vehicles
Special Facility Population (Schools)	1. RECEIVE NOTIFICATION, including instructions for evacuating 2. EVACUATE SCHOOL POPULATION IN BUSES from districts in EPZ and other sources
Special Facility Population (Institutions)	1. RECEIVE NOTIFICATION, including instructions for evacuating 2. MOBILIZE POPULATION, prepare population for evacuation 3. EVACUATE INSTITUTIONAL POPULATION IN BUSES OR SPECIAL VEHICLES 4. SHELTER INSTITUTIONAL POPULATION OF FULTON STATE HOSPITAL

CHAPTER VI. EVACUATION ROUTES

DESIGNATED EVACUATION ROUTES

A series of evacuation routes out of the 10-mile area has been designated for the EPZ evacuation. (Figure 9). This set of evacuation routes meets the criteria for a reasonable basis for evacuation time estimates, specifically:

- The routes use all available roads out of the EPZ, and do not limit evacuation traffic to a few selected roads (as is sometimes done for security or to channel evacuees to relocation centers).
- The routes lead as directly as possible out of the EPZ. In almost all instances, the designated evaucation route is the fastest way out of the EPZ for the area served by the particular route.
- The routes do not require special traffic control measures, such as one-way operation on normally two-way roads, contra-flow on freeways, etc.

CAPACITIES OF THE EVACUATION ROUTES

The capacities of the individual evacuation routes out of the EPZ are then established. A general discussion of the assumptions used in determining the capacities was given in Chapter II. Table 8 illustrates the estimated capacity of each roadway segment shown in Figure 9.

EVACUATION TRAVELSHEDS

The travelshed of a particular evacuation route is the "catchment" area of population for that route; that is, the area of population for which that route is the fastest means of exit from the EPZ.

The travelsheds for the evacuation routes in the Callaway EPZ are determined by extending the major evacuation routes, as indentified in Figure 9, so that all of the road system in the EPZ is attached to one or another of the evacuation routes. This process is simple for those sections of roadway immediatly adjacent to the

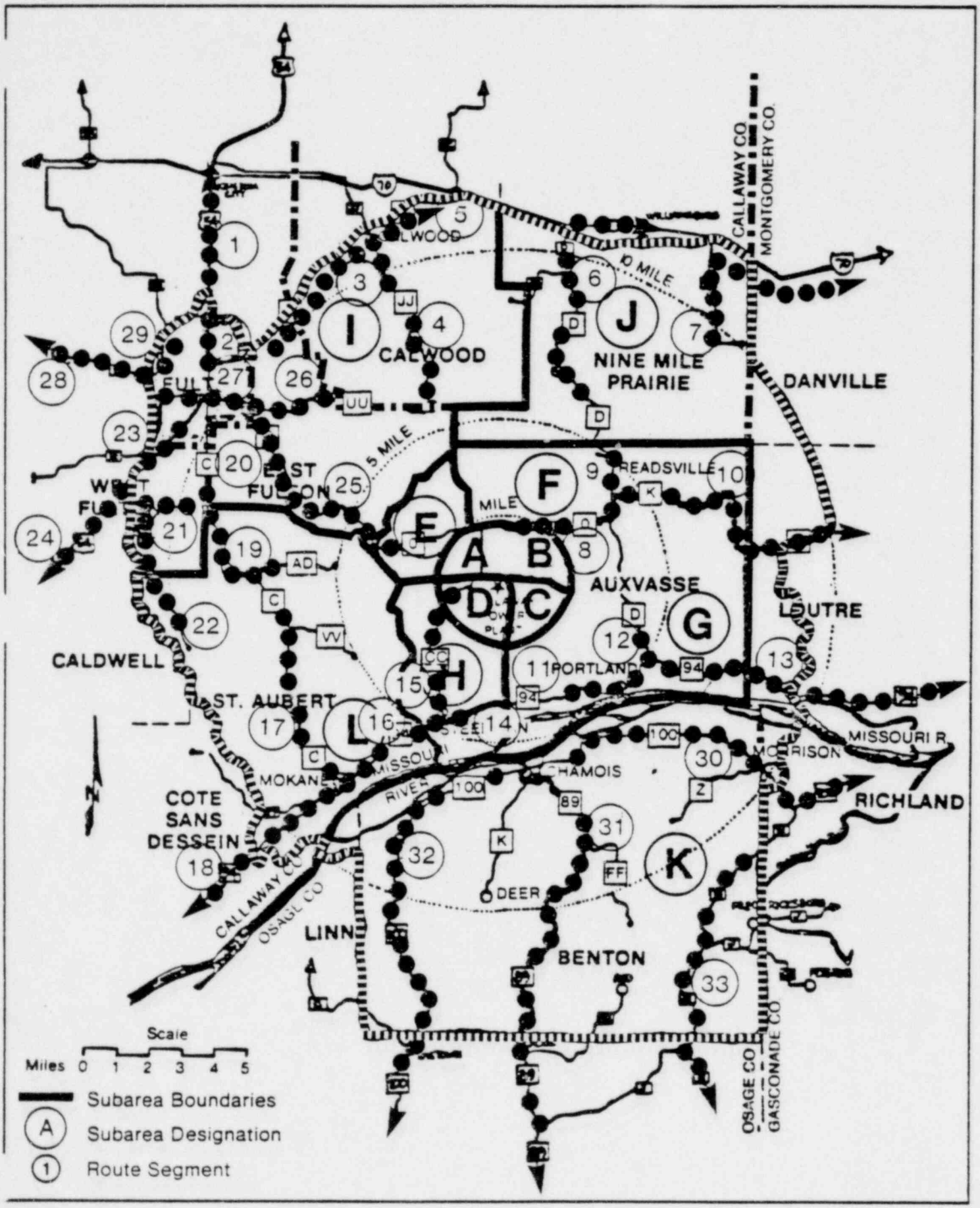


Figure 9. Primary Evacuation Route Map

TABLE 8. ROADWAY SEGMENT CHARACTERISTICS

Segment	Total Lanes (Both Directions)	Facility Type[1]	Hourly Capacity (per lane)
1 54N	4	F	1,500
2 54 Bus	2	U	1,200
3 Z	2	R	1,200
4 JJ	2	R	1,200
5 Z	2	R	1,200
6 D	2	R	1,200
7 YY	2	R	1,200
8 O	2	R	1,200
9 D	2	R	1,200
10 K	2	R	1,200
11 94E	2	R	1,200
12 D	2	R	1,200
13 94E	2	R	1,200
14 94W	2	R	1,200
15 CC	2	R	1,200
16 94W	2	R	1,200
17 C	2	R	1,200
18 94W	2	R	1,200
19 C	2	R	1,200
20 C	2	R	1,200
21 Local	2	R	1,200
22 NN	2	R	1,200
23 54S	2	U	1,200
24 54S	2	F	1,500
25 O	2	R	1,200
26 UU	2	R	1,200
27 O/F	2	U	1,200
28 F	2	R	1,200
29 54N	2	F	1,500
30 100E	2	R	1,200
31 89	2	R	1,200
32 100W	2	R	1,200
33 N	2	R	1,200

Note: F = Freeway/Expressway
U = Urban Street
R = Rural Highway

major evacuation routes, where it is obvious what sections of roadway feed any given evacuation route. For sections more distant from the major evacuation routes, the evacuation path is not as clear, and routings are made on the basis of travel time estimates. Some sections of roadway are midway between evacuation routes, and are equally well served by two different routes. These areas define the boundaries between the travelshed areas for the different evacuation routes.

The vehicles in each travelshed are then assigned to the appropriate evacuation route, or strand, for analysis purposes. Figure 10 indicates the letter designation of the strands, and Table 9 shows the number of vehicles assigned to each.

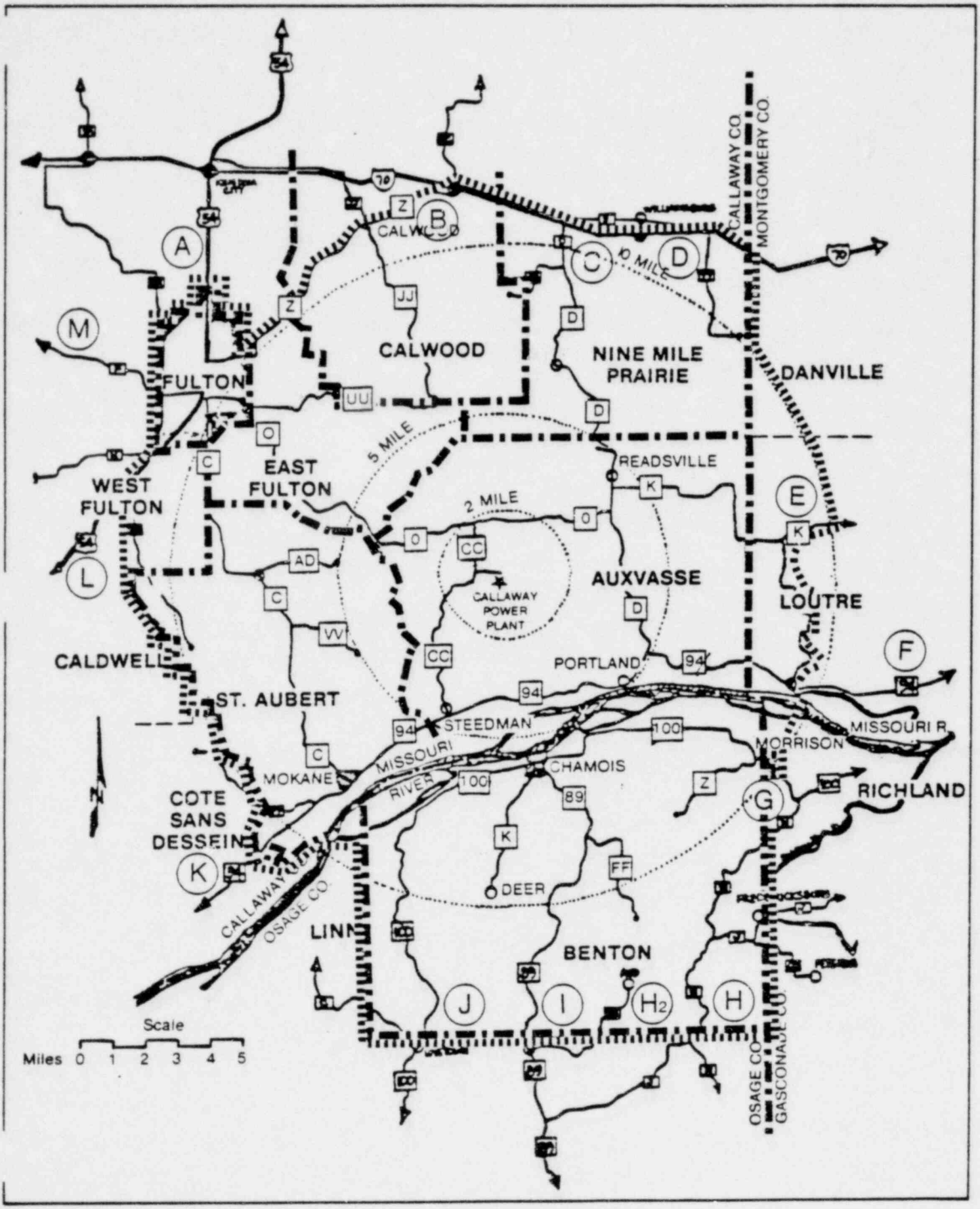


Figure 10. Strand Designation

TABLE 9. PRIMARY EVACUATION ROUTE VEHICLES

Strand	Segment[1]	State Route No.	Gen'l. Population Vehicle in Use
A	1		1,604
B	5	Z	486
C	6	D	198
D	7	YY	59
E	10	K	206
F	13	94E	198
G	30	100E	278
H	33	N	74
H_2	N/A	HH	26
I	31	89	337
J	32	100W	130
K	18	94W	551
L	24	94S	1,259
M	28	F	1,536
			6,942

1. See Figure 9, Primary Evacuation Route Map

CHAPTER VII. SUMMARY OF EVACUATION TIME ESTIMATES

METHOD FOR ESTIMATING EVACUATION TIME

Population Segments

Evacuation time is estimated separately for each of the three population groups discussed earlier: (1) Permanent Resident Population; (2) Transient Population; and (3) Special Facility Population.

Time Periods

Evacuation time is estimated for the critical time period; that is, for the period in which evacuation times are likely to be at a maximum. This period is daytime on a winter weekday.

Local Notification and Evacuation Capability

These evacuation time estimates assume that an effective plan is in operation, and that virtually complete coverage of the EPZ population with a prompt alerting and notification system is achieved.

Action Steps

Each population segment follows a specific sequence of action steps in evacuating the EPZ. (See Chapter V for a detailed discussion of these steps.) The time needed to complete each of these steps is then estimated. The time needed to complete each step is stated as the distribution of time, relating the fraction of the population completing a particular step to the elapsed time after that action step is first started.

Time Required for a Series of Action Steps

The total evacuation time is calculated by linking together the time required to complete the individual steps. The resulting total time for evacuation is calculated (as are the times for the individual steps) as a distribution of time, showing the fraction of the population which completes the total evacuation process within a given amount of elapsed time.

Distribution of the Traffic to the Evacuation Routes

The evacuation traffic is distributed to the available roads out of the EPZ. Delays due to traffic congestion are calculated and, if necessary, the evacuation times are adjusted to reflect these delays.

EVACUATION TIME FOR THE PERMANENT RESIDENT POPULATION (AUTO-OWNING)

The evacuation sequence for the permanent resident auto-owning population includes five steps: (1) Receive Notification; (2) Leave Place of Work; (3) Work-to-Home Travel; (4) Prepare for Evacuating Home; and (5) Drive Out of the EPZ. The time required to complete each of these steps is established. Then, a total evacuation time for the auto-owning population is obtained by combining the time required for each of the five action steps.

Receive Notification

Some of the auto-owning permanent resident population receives the broadcast information almost immediately; for example, 10 percent of this population is assumed to receive broadcast information in 15 minutes (Table 10). These are individuals who immediately comprehend the notification and promptly tune into the EBS broadcasts. This group also includes individuals already listening to radio and television broadcasts, and are therefore informed immediately of the emergency and the need to evacuate the EPZ.

TABLE 10. TIME DISTRIBUTION FOR "RECEIVE NOTIFICATION" STEP

Time After Start of Notification	Estimated Percentage of Population Receiving Notification
15 minutes	10
20 minutes	10
25 minutes	30
30 minutes	30
35 minutes	10
40 minutes	5
45 minutes	5

A large fraction of the population of the EPZ is estimated to receive the broadcast information between 20 and 30 minutes after the start of notification. These individuals require several minutes to comprehend the notification, and then several more minutes to tune into the EBS broadcasts.

At the high end of the range, some of the population (10 percent of the total) are assumed to require over 35 minutes to receive the broadcast information. These are mainly persons not reached by the notification system, not understanding the significance of the siren warning, or without access to a radio or television set.

It is estimated that all of the population receives the broadcast information within 45 minutes of the start of notification.

Leave Place of Work

It is estimated that a sizeable portion of the permanent resident auto-owning population can leave work within 10 minutes after receiving the broadcast information, or after this information is conveyed to them by their employer (Table 11). In general, these are workers not having managerial responsibility or whose jobs do not require shutdown time.

TABLE 11. TIME DISTRIBUTION FOR "LEAVE PLACE OF WORK" STEP

Time After Receipt of Notification	Estimated Percentage of Workers Leaving Place of Work
10 minutes	50
15 minutes	30
20 minutes	10
30 minutes	5
45 minutes	5

Another large group of workers (an estimated 40 percent of the total) will need between 10 and 20 minutes to leave their place of work. These are employees whose jobs require some shutdown time, and managers who remain until other employees have left.

At the high end of the range, an estimated 5 percent of the workers require over 30 minutes to prepare for leaving work. These individuals are mainly managers, persons responsible for securing cash or property, and persons needed to shut down industrial processes.

All employees complete preparation to leave their place of work within 45 minutes of receiving the broadcast information (Table 11).

Work-to-Home Travel

The time needed for this step is similar to that needed for the daily trip home during the afternoon peak hour. This time depends primarily on the distance from work to home. This distribution of estimated travel-to-home time is for only those workers having their residence and place of work in the EPZ. At the low end of the range, an estimated 50 percent of the workers can complete the trip home within 5 minutes (Table 12). Another large group of workers live within 5 miles of their job, and can return home in 10 to 15 minutes. At the upper end of the range, an

estimated 20 percent of all employees will need more than 15 minutes for their travel home.

TABLE 12. TIME DISTRIBUTION FOR "WORK-TO-HOME TRAVEL" STEP

Time After Workers Begin to Leave Place of Work	Estimated Percentage of Workers Arriving at Home
5 minutes	50
10 minutes	30
15 minutes	10
20 minutes	10

Some employees working outside the EPZ, particularly at locations near the EPZ boundary, will return home before the EPZ is closed to entering traffic and will evacuate in the same manner as auto-owning households. However, employees who work at some distance outside the EPZ will not be able to enter the EPZ since all roads will be barricaded to incoming traffic as soon as possible after the start of the evacuation.

Prepare for Evacuating Home

The time needed to prepare for evacuating the home depends on three factors: (1) whether or not an adult member of the household is home at the time of notification; (2) the number of dependents in the household; and (3) the amount of household property to be secured prior to evacuation.

At the low end of the range, an estimated 15 percent of all of the auto-owning population can prepare for evacuating their households within 20 minutes after the arrival of the workers from their jobs (Table 13). These are generally households with an adult member present at home, with few dependents, and no property to be secured.

TABLE 13. TIME DISTRIBUTION FOR "PREPARE FOR EVACUATING HOME" STEP

Time After Workers Arrive Home	Estimated Percentage of Auto-Owning Population Leaving Home
15 minutes	10
20 minutes	5
25 minutes	10
30 minutes	15
35 minutes	15
40 minutes	25
50 minutes	10
60 minutes	5
95 minutes	5

An estimated 80 percent of the auto-owning population can prepare to leave home within 40 minutes of the arrival at home of the household workers. These are likely to be households with dependents at home and a typical single-family residence to secure.

At the upper end of the range, an estimated 10 percent of the population requires over 40 minutes to prepare for evacuating their homes. Generally, these are households with more than one dependent and extensive household property to be secured (for example, a farm).

Final Departure Curve

Figure 11 illustrates the distribution of time needed by the EPZ population to complete each of the evacuation steps. The final departure curve (that is, the time needed to complete all action steps except the final driving from the EPZ) is completed at 3 hours 10 minutes after the start of notification.

Drive Out of the EPZ

The time needed for the final step--"Drive out of the EPZ"--depends on the level of traffic congestion encountered on the specific evacuation route considered. On routes with no traffic congestion, a maximum of 15 minutes is needed to drive out

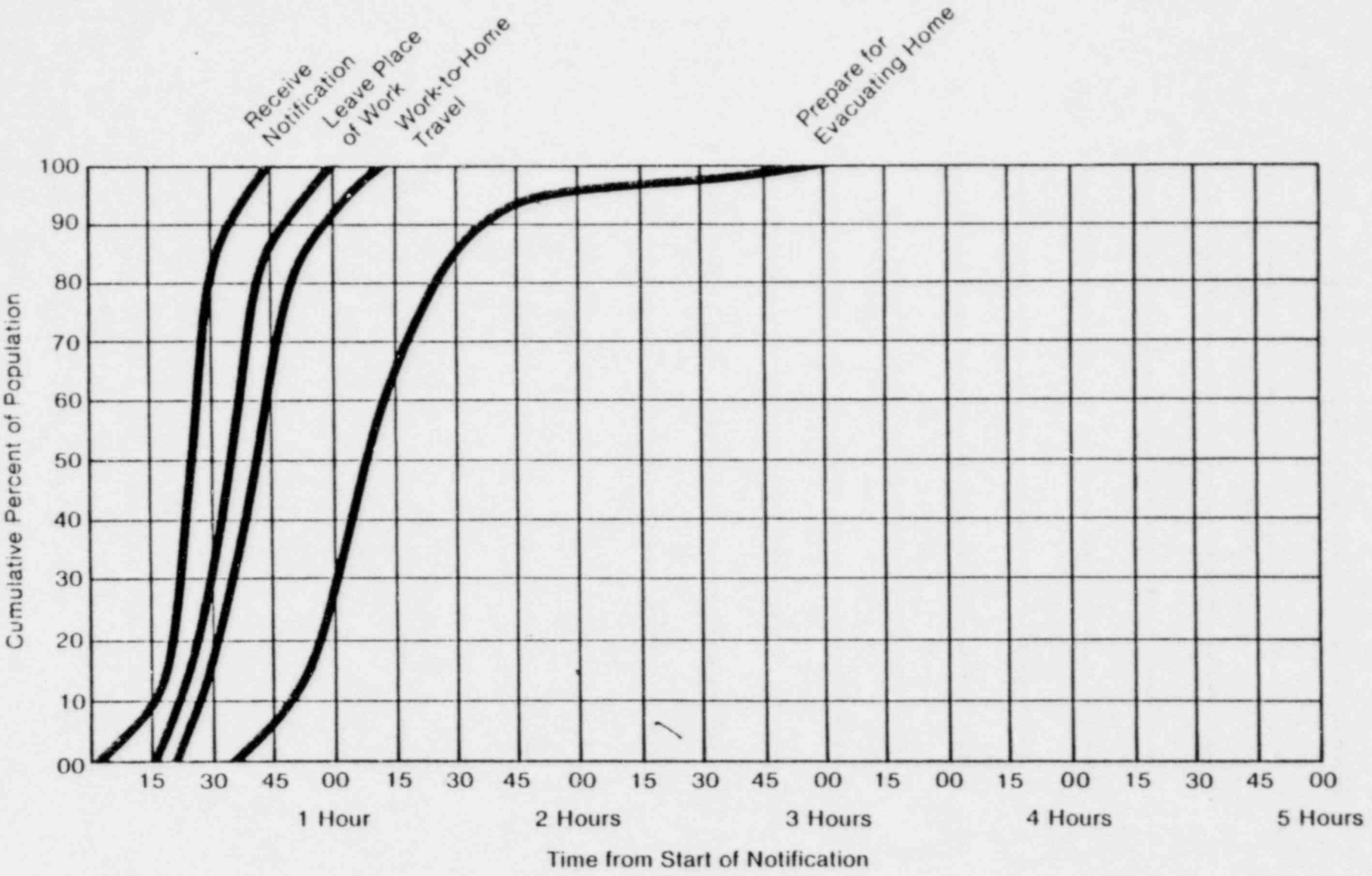


Figure 11. Evacuation Time for the Permanent Resident Population (Auto-Owning)

of the EPZ, and for such routes the total evacuation time is 3 hours and 25 minutes (3 hours and 10 minutes as noted in Figure 11 plus 15 minutes driving time). On routes with traffic congestion, driving times may be determined by traffic delays, as discussed below.

Routing -- It is expected that motorists will drive out of the EPZ by the most direct route available. Routes are identified in Chapter VI of this report.

Public agencies will give routing advice for this travel, by means of preparedness plans prior to the emergency and through information broadcasts during the actual evacuation.

In some instances, motorists may not use the most direct route, particularly when: (1) they are trying to get to a location, such as the home of a relative near the EPZ, and not merely trying to get to the nearest reception center outside the EPZ; and (2) when they are not aware of the quickest route out of the EPZ.

Traffic Control -- At critical locations--primarily key intersections within the EPZ--traffic will be controlled by State and local police, as established in local preparedness plans. This traffic control will accomplish two purposes: (1) ensure orderly traffic flow at that particular location; and (2) direct motorists to the best available route out of the EPZ.

During the evacuation, normal traffic control will continue, two-way streets will operate in their usual manner as two-way streets, and traffic control devices, such as signals, will continue to be observed. The only exception will be the replacing of traffic signal control at some key intersections with traffic direction by police officers.

Method For Analyzing Evacuation Traffic Flows -- The evacuation traffic flow is analyzed with a computer program package consisting of two modules:

1. EVACURVE, which calculates the final departure curves (Figure 11) giving the distribution of times at which the auto-owning population completes preparations to leave home and enters the road system.

The EVACURVE module calculates the departure curve from the series of time distributions for completing each step of the evacuation sequence. Statistically, each time distribution for an individual step is a conditional probability distribution; the final departure curve is obtained by computing the joint probability distribution; the final departure curve is obtained by computing the joint probability distribution of all the steps.

2. QUEUE, which simulates the flow of traffic through the evacuation routes, and identifies the location and extent of traffic congestion.

   The QUEUE module begins with the evacuation network and the distribution of traffic onto this network. The program then calculates the arrival and departure of traffic at all locations throughout the evacuation network. This simulation is iterative, being repeated for 15-minute intervals of the evacuation period.

   The QUEUE module identifies locations at which traffic congestion occurs, and calculates the extent of such congestion. Measures which are computed include the time period over which congestion occurs at a particular location, the maximum delay experienced by a vehicle passing through any congested location and the extent (distance) of congestion on the evacuation road network.

Traffic Congestion -- Results of the QUEUE program indicate that on 11 of the 14 evacuation routes, the road capacities exceed the rate at which vehicles leave households. On these routes, there is no significant congestion at any point in the evacuation process, and the time needed to drive out of the EPZ is determined solely by the free-flow travel time.

On 3 of the 14 designated evacuation routes, traffic backups (queues) will form during some part of the evacuation process. These are caused as the auto-owning population completes the necessary preparations to leave their homes and enters the street system at a rate greater than the capacity of that street system to carry them. As a consequence, traffic begins to back up, starting at critical intersections where:

1. Substantial volumes of evacuating traffic converge onto the evacuation route, or

2. The capacity of the evacuation route is restricted by a bridge, ramp, pavement width, etc., or

3. Cross-street traffic is substantial, reducing the amount of time available for the movement of evacuating traffic at that point

Traffic congestion first appears as the volume of traffic entering the street system begins to increase sharply, at about 1 hour-40 minutes after the start of notification. Once started, congestion spreads rapidly in the upstream direction, blocking traffic attempting to enter the evacuation route from side roads. In the worst case, congestion spreads generally throughout an area, with all arterial and collector streets, and even some local streets, blocked.

During the period in which this congestion is occurring, the rate of evacuation is fixed by the capacity of the street system, and is no longer determined by the rate at which the population finishes preparations to leave their households. Motorists leaving their homes and entering the street system during such a period are simply "stored" in traffic queues in the street system.

Possible Levels of Traffic Congestion -- Three possible conditions of traffic congestion are analyzed in Figure 12. In the instance with no traffic congestion (Type "A" in Figure 12), the departure from the EPZ depends solely on the rate at which people prepare to leave their households and drive, in a free-flow manner, out of the EPZ. At no point in the evacuation period does traffic congestion slow this progress out of the EPZ.

On routes where traffic congestion occurs (Types "B" and "C" in Figure 12), traffic congestion appears as the rate of vehicles entering the street exceeds the capability of the street to carry them. Congestion continues to build as long as the rate of vehicles entering the street system continues to exceed the vehicular capacity of the evacuation route.

At some point in the evacuation process, the rate at which vehicles enter the street system reaches a maximum and begins to decrease.

Congestion begins to diminish as the rate of vehicles entering the street system begins to fall below the capacity of the evacuation route to carry them. This decrease in traffic congestion continues until the queues disappear, and free traffic flow is restored on the evacuation route.

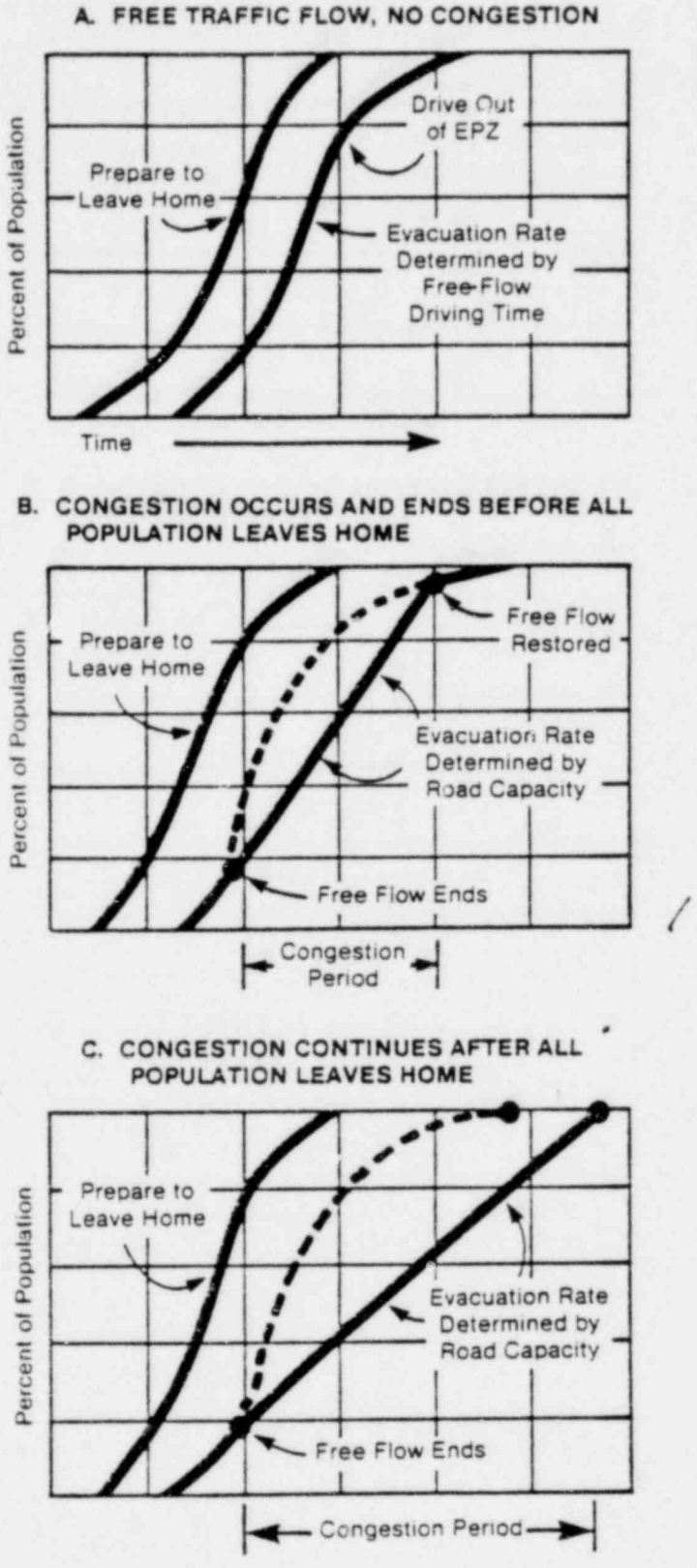


Figure 12. Possible Levels of Traffic Congestion

In the less severe instances of congestion (Type "B" in Figure 12), this occurs before the population has finished preparations to leave home. From the point at which congestion is dissipated onward until the completion of evacuation, the rate of evacuation is once again determined by the rate at which households complete their preparation to leave home and enter the street system.

In the more severe instances of congestion (Type "C" in Figure 12), the traffic backups continue even after all the population has completed preparations to leave home. In this type of congestion, the backups are too large to be discharged prior to the time that all population has completed preparations to leave home. In this case, evacuation times are no longer dictated by the time at which preparations for leaving home plus a free-flow driving time, but rather by the traffic capacity of the evacuation route.

Location of Traffic Congestion -- Figure 13 illustrates the location of traffic congestion in the Callaway EPZ, and indicates the extent of the anticipated congestion when it is at a maximum. As indicated in Figure 13, the greatest extent of traffic congestion occurs on Route 54 and Highway F in the Fulton area.

Summary of Evacuation Times for the Permanent Resident Population (Auto-Owning

Even on the routes which experience some congestion, that congestion dissipates before all the resident population has completed preparations to leave home, as in Type "B", above. The overall evacuation time, therefore, on all routes, is based on the rate at which households complete their preparation to leave home. The permanet resident auto-owning population can be evacuated in 3 hours and 25 minutes.

EVACUATION TIME FOR THE PERMANENT RESIDENT POPULATION (NON-AUTO-OWNING)

The evacuation of the non-auto-owning population includes four steps: (1) Receive Notification; (2) Prepare for Evacuating Home; (3) Assemble at Collection Points; and (4) Evacuate Non-Auto-Owning Population in Buses. The time required to

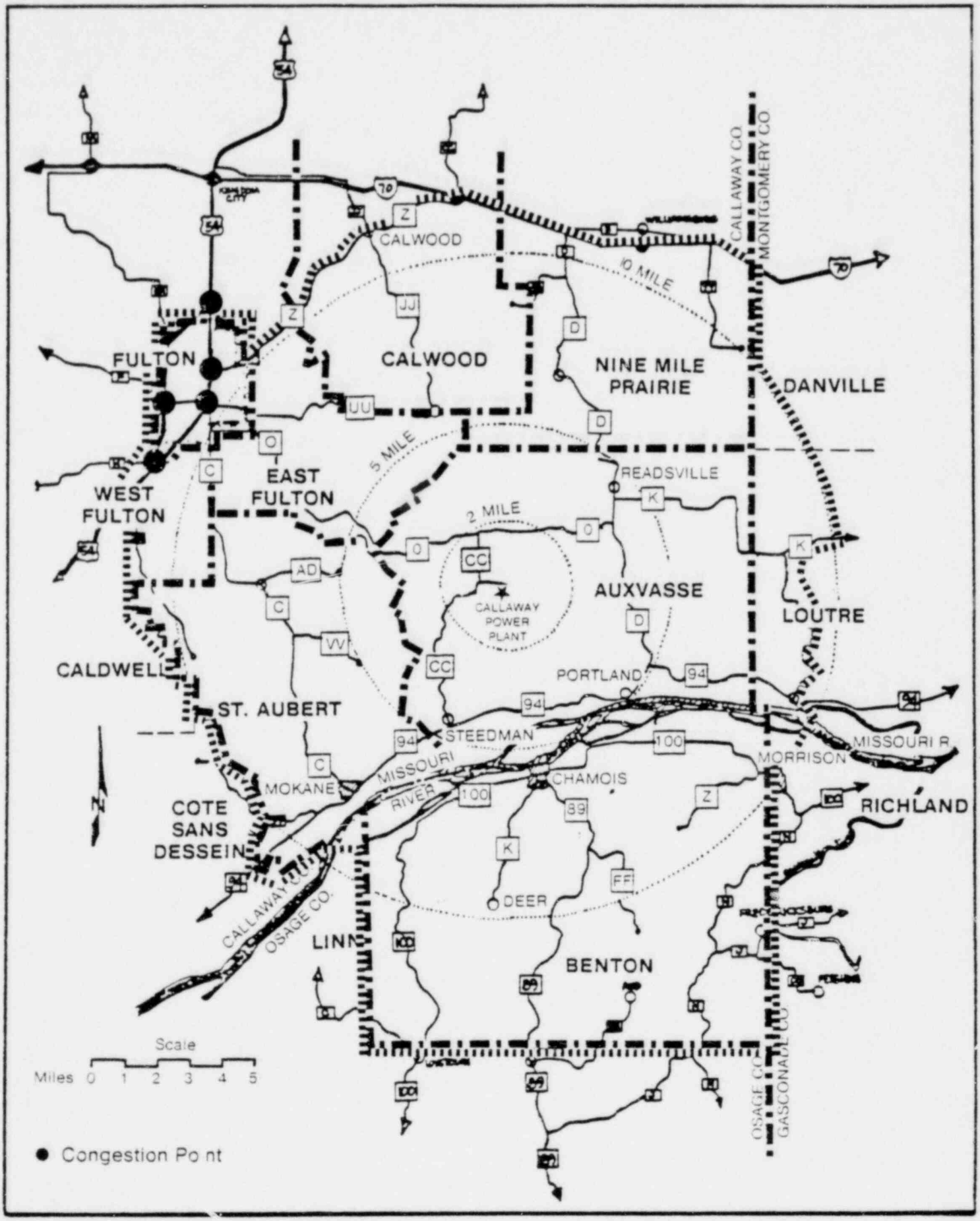


Figure 13. Traffic Congestion Points

complete each of these steps is established, and the total time for the evacuation of the non-auto-owning population is obtained by combining the time required for each of the four steps.

Receive Notification

Notification times and the explanation for these times are the same as for the permanent resident auto-owning population discussed above. All of the non-auto-owning population is notified within 45 minutes of the start of notification.

Prepare for Evacuating Home

The time needed to prepare for evacuating the home depends on: (1) whether or not an adult member of the household is home at the time of notification; (2) the number of dependents in the household; and (3) the amount of household property to be secured before the family can evacuate.

It is estimated that 20 percent of the non-auto-owning population can prepare to leave home within 20 minutes of receiving notification to evacuate (Table 14). Typically, these are small households with few dependents and no property to secure before leaving.

TABLE 14. TIME DISTRIBUTION FOR "PREPARE FOR EVACUATING HOME" STEP FOR NON-AUTO-OWNING POPULATION

Time After Receiving Notification	Estimated Percentage of Population Completing Preparations to Leave Home
15 minutes	10
20 minutes	10
25 minutes	10
30 minutes	20
35 minutes	20
40 minutes	20
45 minutes	10

At the upper end of the range, it is estimated that 50 percent of the non-auto-owning population needs 30-45 minutes to prepare for leaving home. These are generally households with a dependent at home and a residence to secure before leaving.

Assemble at Collection Points

The time needed for the non-auto-owning population to assemble at collection points depends on the proximity of these points to the household.

For 50 percent of the non-auto-owning population, the collection point is assumed to be located within one-half mile of their homes and the collection point can be reached by walking less than 20 minutes (Table 15). The travel time needed to reach a collection point is typical of the built-up areas, such as Fulton, where collection points can be located within a short distance of all households.

TABLE 15. TIME DISTRIBUTION FOR "ASSEMBLE AT COLLECTION POINTS" STEP

Time After Leaving Home	Estimated Percentage of Population Arriving at Collection Point
10 minutes	10
20 minutes	40
30 minutes	25
40 minutes	15
50 minutes	10

At the other end of the range, it is estimated that 25 percent of the population will require over 40 minutes to reach the collection points. This longer time is typical of the rural areas of the EPZ, where the collection points are not within walking distance of all the non-auto-owning households. In such a situation, travel from home to the collection point is done in buses, vans, or publicly-owned automobiles.

A bus fleet large enough to carry the non-auto-owning population in two round trips out of the EPZ is assumed in estimating the evacuation time. This fleet should be drawn from vehicles in operation in the EPZ and nearby areas, and from private operators with whom standing agreements are negotiated

It is estimated that one-half of the non-auto-owning population can be evacuated by 2 hours and 5 minutes after the start of notification (Table 16). The remainder of the non-auto-owning population is estimated to be evacuated by 3 hours after the start of evacuation.

TABLE 16. TIME DISTRIBUTION FOR "EVACUATE NON-AUTO-OWNING POPULATION IN BUSES" STEP

Time After Start of Notification	Estimated Percent of Non-Auto-Owning Population Evacuated in Buses
1 hour, 45 minutes	25
2 hours, 5 minutes	25
2 hours, 25 minutes	25
3 hours	25

Summary of Evacuation Times for the Permanent Resident Population (Non-Auto-Owning)

The time required for completion of the various steps in the evacuation of the non-auto-owning population is summarized in Figure 14. The determining factor in the time needed for the evacuation of the non-auto-owning population is the time needed for this population to complete preparations for leaving home and to assemble at the collection points.

EVACUATION TIME FOR THE TRANSIENT POPULATION

The evacuation sequence for the transient population includes three steps: (1) Receive Notification, (2) Assemble Traveling Group, and (3) Drive Out of the EPZ. The time required to complete each of these steps is established. Then, a

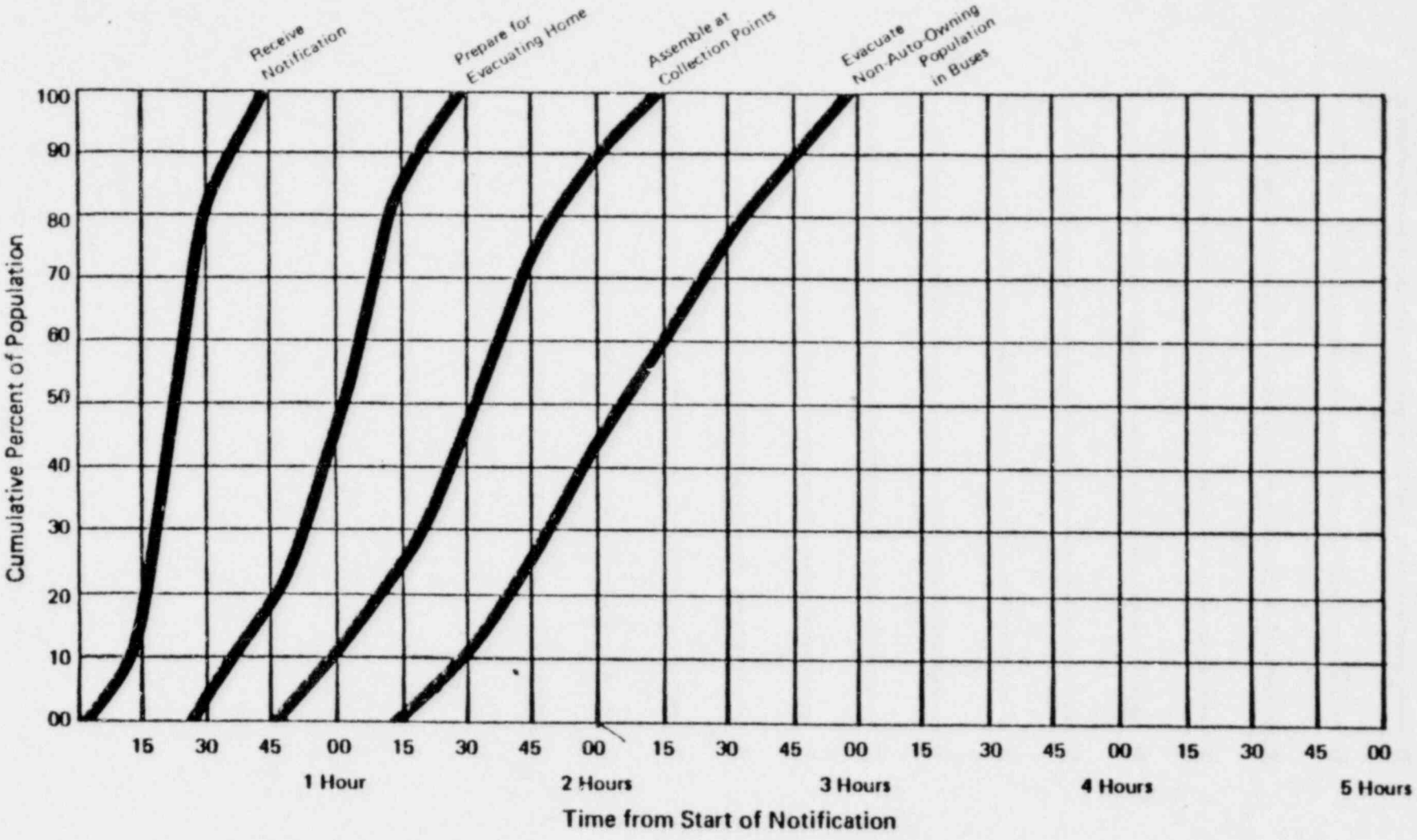


Figure 14. Evacuation Times for the Permanent Resident Population (Non-Auto-Owning)

total evacuation time for the transient population is obtained by combining the time required for each of the three action steps.

Receive Notification

Notification times and the explanation for these time are the same as for the permanent resident auto-owning population discussed previously. All of the transient population is assumed to be notified within 45 minutes of the start of notification.

Assemble Traveling Group

The traveling group (usually family or coworkers) is assembled and prepared for evacuation. It is assumed that some groups (for example, employees at work) can assemble and prepare for evacuation almost immediately. This is reflected in the distribution in Table 17, which estimates that 50 percent of the transient population can assemble their traveling group and prepare to depart within 15 minutes after receiving instructions to evacuate.

TABLE 17. TIME DISTRIBUTION FOR "ASSEMBLE TRAVELING GROUP" STEP FOR TRANSIENT POPULATION

Time After Receiving Notification	Estimated Percentage of Population Assembling Traveling Group
10	20
15	30
20	30
30	20

At the other end of the distribution, some transient groups will require up to an estimated 30 minutes to assemble their groups and prepare to evacuate. Examples of this situation are residents at seasonal homes who would have to complete certain preparations, such as securing boats and cabins, before evacuating the area.

Drive Out of the EPZ

After assembling their traveling group and completing preparations to evacuate, the transient population will drive out of the EPZ using their private vehicles.

In evacuating the EPZ, the transient population will encounter free-flow traffic conditions (i.e., no congestion) throughout their trip out of the EPZ. This is a result of the small size of the transient population and the early stage at which they begin to evacuate the population. All transient population is evacuated from the EPZ before the major part of the traffic buildup from the permanent resident population begins to occur.

Summary of Evacuation Times for the Transient Population

It is estimated that some of the transient population in the EPZ evacuates within 45 minutes of the start of notification (Figure 15). The transient population is estimated to complete their trips out of the EPZ at 1 hour and 45 minutes after the start of notification.

EVACUATION TIME FOR THE SPECIAL FACILITY POPULATION (SCHOOLS)

The evacuation sequence for the school population includes two steps: (1) Receive Notification and (2) Evacuate School Population in Buses.

Receive Notification

School administrations will be notified immediately through telephone calls. Notification of student bodies will then be accomplished almost instantaneously through school public address systems. After notification, preparation to leave the school premises is almost immediate (similar to a routine fire drill).

The majority of the school population is assumed to be notified within 20 minutes of the start of notification (Table 18). All school population is assumed to be notified within 45 minutes of the start of notification.

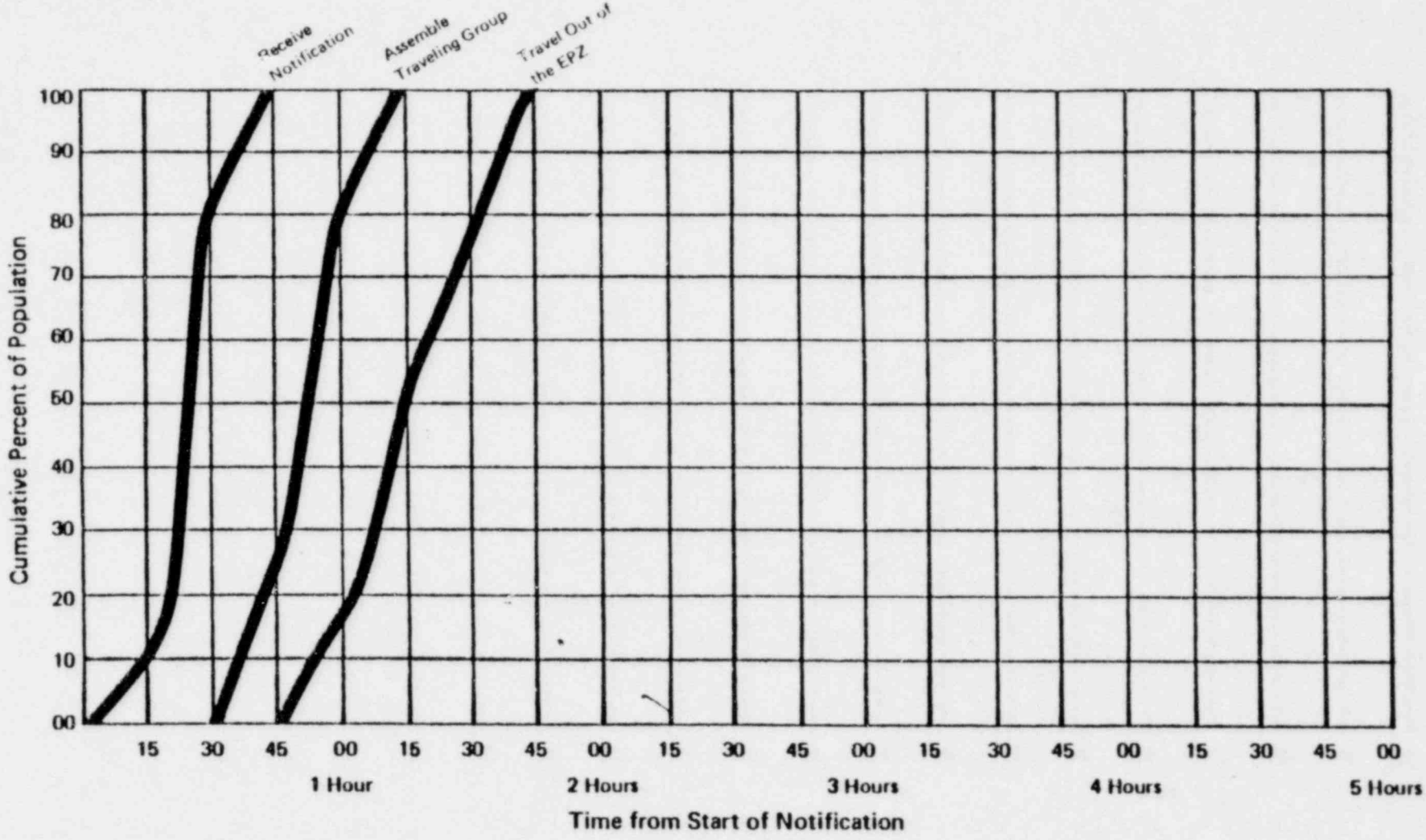


Figure 15. Evacuation Times for the Transient Population

TABLE 18. TIME DISTRIBUTION FOR "RECEIVE NOTIFICATION" STEP FOR SCHOOL POPULATION

Time After Start of Notification	Estimated Percentage of of Population Receiving Notification
10 minutes	10
15 minutes	40
20 minutes	20
25 minutes	10
35 minutes	10
45 minutes	10

Evacuate School Population in Buses

The determining factor in the time needed for evacuation of the school population in buses is the time required for mobilizing the bus fleet and bringing buses to the schools.

A bus fleet sufficiently large to carry the entire school population is assumed in estimating the evacuation time. This fleet will be drawn from all districts within or partially within the EPZ. In addition, school buses will be mobilized from other school districts not themselves within the EPZ but in the close vicinity.

As indicated in Table 19, an estimated 20 percent of the school population can be transported out of the EPZ within 1 hour after the start of notification. These students are those that are transported in vehicles in regular use in the school districts in the EPZ and which can be readily mobilized. Another 60 percent of the school population is assumed to be transported out of the EPZ by 1 hour and 30 minutes after the start of notification.

TABLE 19. TIME DISTRIBUTION FOR "EVACUATE SCHOOL POPULATION IN BUSES" STEP

Time After Start of Notification	Estimated Percentage of School Population Evacuated by Bus
60 minutes	20
1 hour, 15 minutes	35
1 hour, 30 minutes	25
1 hour, 45 minutes	20

The students evacuated in these later stages are those riding in buses which are brought from outside the EPZ.

All students are evacuated from the EPZ within 1 hours and 45 minutes after start of notification.

The distribution of the evacuation time for the school population is given in Figure 16.

EVACUATION TIME FOR THE SPECIAL FACILITY POPULATION (INSTITUTIONS)

The evacuation of the population in institutions involves three steps: (1) Receive Notification: (2) Mobilize Population; and (3) Evacuate Institutional Population in Buses or Special Vehicles. The time needed to complete each of these steps is established, and the total time for the evacuation of the population in institutions is obtained by combining the time required for each of the three steps.

Receive Notification

Notification time is the same as for the auto-owning population discussed above. All of the population in institutions is assumed to be notified within 45 minutes after the start of notification.

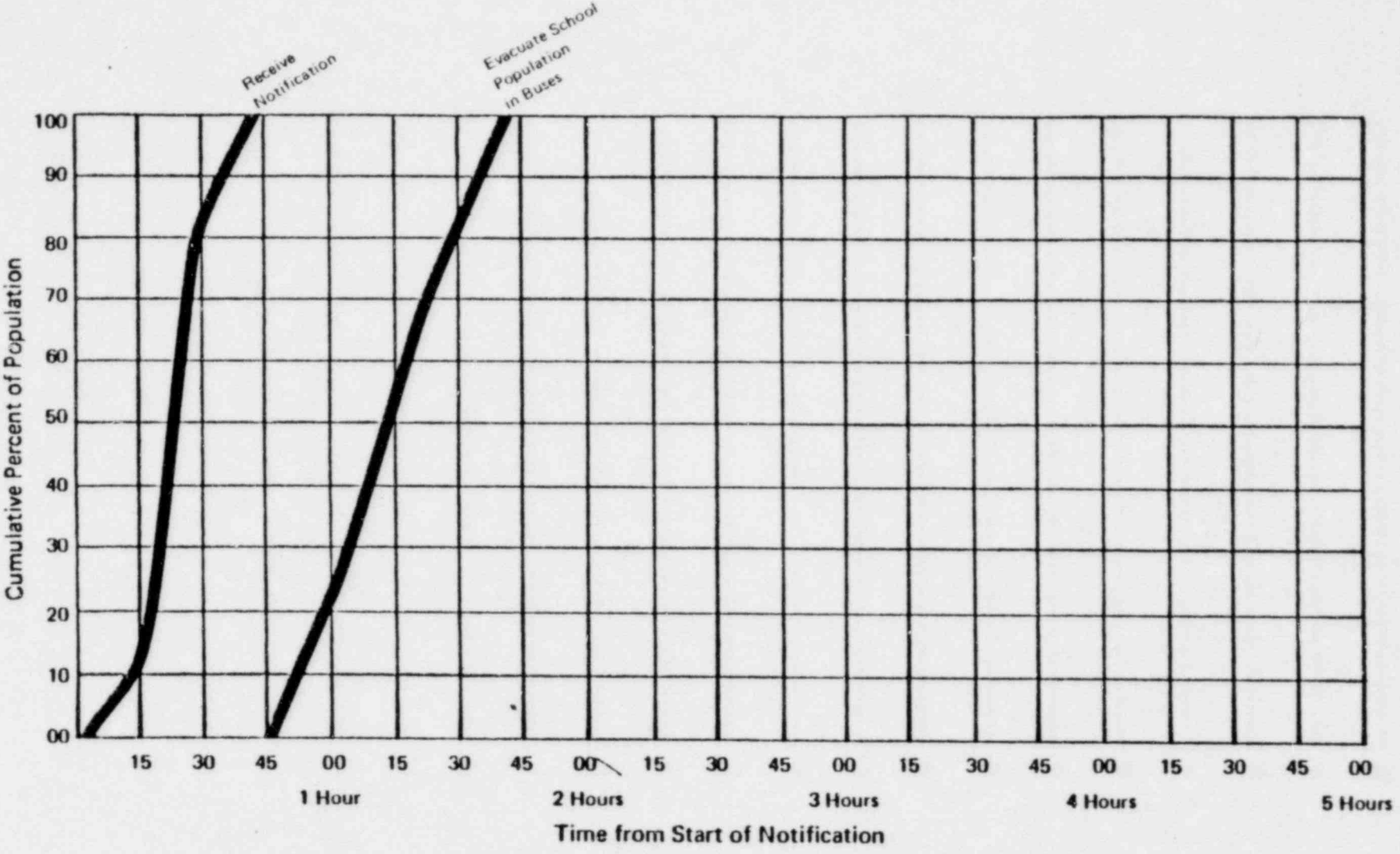


Figure 16. Evacuation Times for the Special Facilities Population (Schools)

Mobilize Population

For a significant part of the population in institutions, mobilization can be accomplished almost immediately after notification of the need to evacuate. For example, it is estimated that 70 percent of the population in institutions can be mobilized to evacuate within 20 minutes after the start of notification (Table 20). This element of the population is typically ambulatory patients in hospitals and nursing homes.

TABLE 20. TIME DISTRIBUTION FOR "MOBILIZE POPULATION" STEP FOR POPULATION IN INSTITUTIONS

Time After Receipt of Notification	Estimated Percentage of Population in Institutions Mobilized
10 minutes	30
20 minutes	40
30 minutes	30

At the upper end of the range, it is estimated that 30 percent of the population in institutions requires up to 30 minutes for mobilization (Table 20). Typically, these are non-ambulatory patients in hospitals, or other persons (such as prisoners in jails) for whom special treatment is necessary.

Following the mobilization step, the institutional population is evacuated or, in the case of the Fulton State Hospital, sheltered.

Evacuate Institutional Population in Buses or Special Vehicles

A fleet of buses and special vehicles (ambulances, rescue vehicles, vans, etc.) large enough to carry out the institutionalized population of the EPZ in a single round trip (buses) and two round trips (specialized vehicles) is assumed in estimating the evacuation times. The fleet of special vehicles will be drawn from ambulance operators in the EPZ and in the adjacent areas, and from some municipally-owned vehicles in the EPZ and adjacent areas.

It is estimated that 50 percent of the ambulatory population can be evacuated by 1 hour and 35 minutes after the start of notification (Table 21). The remainder of the ambulatory population is evacuated by 2 hours after the start of notification.

TABLE 21. TIME DISTRIBUTION FOR "EVACUATE INSTITUTIONAL POPULATION IN BUSES AND SPECIAL VEHICLES" STEP

Time After Start of Notification	Estimated Percent of Population in Institutions Evacuated in Buses and Special Vehicles
By Bus (Ambulatory Persons)	
1 hour, 35 minutes	50
2 hours	100
By Special Vehicle (Non-Ambulatory Persons)	
1 hour, 50 minutes	50
2 hours, 45 minutes	100

It is estimated that 50 percent of the non-ambulatory population can be evacuated by ambulance and special vehicle by 1 hour and 50 minutes after the start of notification. The remainder of the non-ambulatory population can be evacuated by 2 hours and 40 minutes

The estimated time required for the completion of the individual steps in the evacuation of the institutional population is summarized in Figure 17. The determining factor in the time needed for the evacuation of the population group is the time needed to complete three round trips out of the EPZ by the special vehicle fleet, mainly ambulances.

A special vehicle (bus and ambulance) fleet large enough to evacuate the population in institutions in one and two trips, respectively, is critical to achieve the total evacuation time of 2 hours and 45 minutes for this population segment. If a

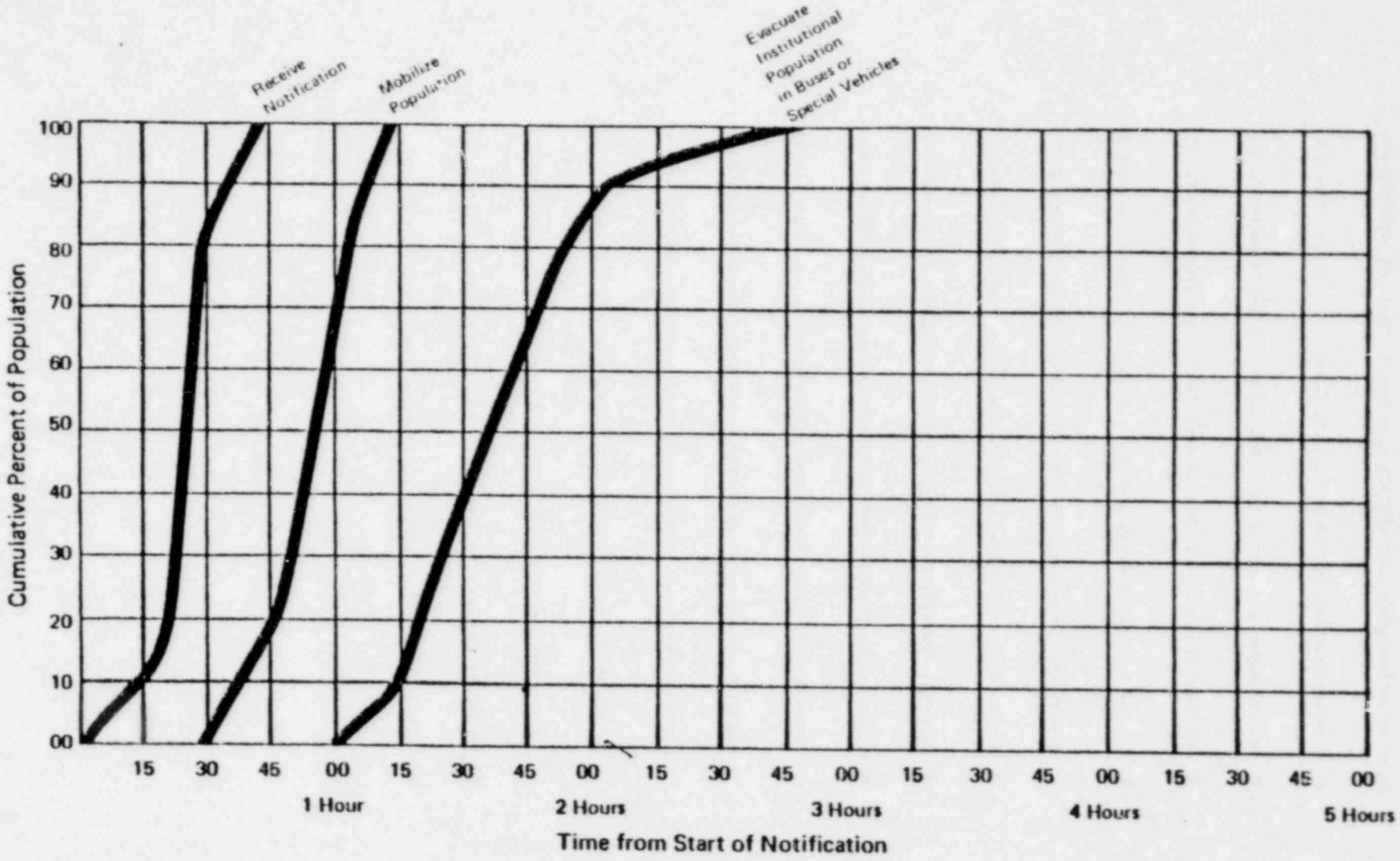


Figure 17. Evacuation Times for the Special Facility Population (Institutions)

sufficiently large bus and ambulance fleet could not be mobilized and additional trips out of the EPZ were needed (even by only a few of the vehicles), the total evacuation time for the population in institutions would increase by approximately one hour, to 3 hours and 45 minutes after the start of notification.

SUMMARY OF EVACUATION TIMES FOR NORMAL CONDITIONS

Table 22 summarizes the evacuation times for normal conditions. As indicated in this table the evacuation times vary according to the population segments considered. The maximum evacuation time for the entire EPZ, established by the time needed for the "Permanent Resident (auto-owning)" segment of the population, is 4 hours.

SUMMARY OF EVACUATION TIMES FOR ADVERSE CONDITIONS

Adverse conditions, for the Callaway EPZ, are defined as (1) severe winter weather conditions, with accumulations of snow or ice on the roadways within the EPZ and (2) flooding conditions severe enough to close Route 94.

The impact of winter weather conditions on the evacuation process is reflected in reduced road capacities, due to reduced vehicle speeds and a reduction in vehicular capacity at intersections. Typically, under adverse winter weather conditions, an intersection functions at only 60 percent of its normal capacity. The impact of flooding resulting in closure of Route 94 is greater, requiring rerouting of traffic, and additional volumes on Route 54.

Both conditions have been analyzed and are shown in Table 22. The winter conditions scenario results in an evacuation time of 3 hours and 30 minutes, while in the event of closure of Route 94, the time for the evacuation of the entire EPZ becomes 3 hours and 45 minutes.

TABLE 22. SUMMARY OF EVACUATION TIMES

Areas	Permanent Population	Permanent Population Vehicles	Transient Population	Transient Population Vehicles	Evacuation Capacity per Hour	Notification Time	Preparation Time	Permanent Population Response Normal Conditions	Permanent Population Response Adverse Conditions	Transient Population Response Normal Conditions	Transient Population Response Adverse Conditions	General Population Evacuation Time -- Normal Conditions	General Population Evacuation Time -- Adverse Conditions	Confirmation Time	Special Population Evacuation Time -- Normal Conditions	Special Population Evacuation Time -- Adverse Conditions
	Within Two Miles (Nominally)															
A	40	19	--	--	1,500	a	b	c	c	d	d	3:25	3:30	1:00	g	g
B	7	4	--	--	1,500	a	b	c	c	d	d	3:25	3:25	1:00	g	g
C	4	3	40	16	1,500	a	b	c	c	d	d	3:25	3:25	1:00	g	g
D	52	36	45	19	1,500	a	b	c	c	d	d	3:25	e	1:00	g	g
Subtotal	103	62	--	--	6,000	a	b	c	c	d	d	3:25	f	1:00	g	g
	Within Five Miles (Nominally)															
E	57	34	80	36	1,500	a	b	c	c	d	d	3:25	3:30	1:00	g	g
F	274	149	--	--	1,500	a	b	c	c	d	d	3:25	3:25	1:00	g	g
G	326	201	153	63	1,500	a	b	c	c	d	d	3:25	3:25	1:00	g	g
H	181	112	--	--	1,500	a	b	c	c	d	d	3:25	e	1:00	g	g
Subtotal	941	558	233	99	6,000	a	b	c	c	d	d	3:25	f	1:00	g	g
	Within Ten Miles (Nominally)															
I	12,440	5,832	39	16	7,500	a	b	c	c	d	d	3:25	3:30	1:00	2:45	3:45
J	583	303	328	130	4,500	a	b	c	c	d	d	3:25	3:25	1:00	g	g
K	862	379	--	--	7,500	a	b	c	c	d	d	3:25	3:25	1:00	g	g
L	2,268	1,061	--	--	3,000	a	b	c	c	d	d	3:25	e	1:00	2:45	3:45
Total EPZ	17,094	8,133	685	280	21,000	a	b	c	c	d	d	3:25	f	1:00	2:45	3:45

a. See Distribution Table 10.

b. See Distribution in Table 13 and Table 14.

c. See Distribution in Tables 11, 12, and 15.

d. See Distribution in Table 17.

e. 3:45 under flooding of Route 94, otherwise 3:25.

f. 3:30 under winter conditions, 3:45 under flooding.

g. No special facilities in this area.

SUMMARY OF TIMES FOR SELECTIVE EVACUATIONS

The times needed for the selective evacuation of the subareas within the Callaway EPZ are summarized in Table 22. In the evacuation of most of the subareas, traffic congestion is not a factor, and the evacuation time is solely dependent on the rate at which the resident population prepares to leave home. Thus, for all of the subareas, the selective evacuation time is 3 hours and 25 minutes under normal conditions. Under severe winter weather, the northwesterly subarea (including Fulton) would require 3 hours and 30 minutes.

VIII. CONFIRMATION OF EVACUATION

CONFIRMATION PROCESS

The confirmation process measures how effectively the evacuation is being accomplished. Confirmation is conducted by the local preparedness agencies, beginning at about the time at which evacuation is estimated to be substantially completed.

Confirmation of evacuation is essential for security reasons, to assure that all population has left the area, and to assist those persons having difficulties in evacuating.

POSSIBLE APPROACHES TO CONFIRMING THE EVACUATION OF THE EPZ

Confirmation of evacuation may be approached in various ways:

- Active or passive: Proof of evacuation may require some action by the evacuee, or, on the other hand, may be accomplished through other means, without any action on the part of the evacuee.

- Extent of converage of the population: The confirmation process may attempt to include 100 percent of the population (that is, every household) or it may be on a sampling basis, with some fraction of the total population surveyed.

- Detailed method of confirmation: A variety of detailed methods of confirmation is possible. One such method is for the evacuating household to leave some indication (sign, flag, symbol, etc.) at their residence upon evacuating. Security personnel would patrol through the EPZ, monitoring the progress of the evacuation and the rate at which the residents are leaving. Another method of confirmation is to have monitors call households by telephone and ascertain that they have left the area.

These methods may be supplemented by monitoring the outbound flow of traffic and recording the cumulative number of people leaving the area.

RECOMMENDED CONCEPT FOR CONFIRMING EVACUATION IN THE CALLAWAY EPZ

The population, road system and other characteristics of the Callaway EPZ suggest a confirmation concept having these features:

- Passive -- The compliance problems with active methods of confirmation (that is, which require action on the part of the evacuees) are large, and substantial numbers of the evacuation population would not comply with any such plan. Furthermore, the size of the population in the Callaway EPZ dictates major administrative effort in simply monitoring the confirmation indicators. For this reason, a passive confirmation concept (that is, one not requiring any action by the evacuee) is preferable.

- Sampled -- It is not realistic to plan a confirmation system for the Callaway EPZ that is expected to provided timely information on evacuation progress when such a system is based on 100 percent confirmation that each of the households has evacuated. To do this would require either (a) an unreasonable number of monitors to cover all households in the EPZ or (b) a length of time required that extends far beyond the expected maximum evacuation time. The accuracy of a sampled approach is likely to be as good, or even better, than an active system with its attendant problems of non-compliance by the evacuating households.

Confirmation by Telephone -- One possible method for accomplishing a passive, sampled confirmation of evacuation is through a telephone sampling method. In such a method, monitors call a randomly selected group of households to confirm the evacuation has occurred. If continuing information on a cross-section of households is desired, this sampling could be repeated at regular intervals.

TIME REQUIRED FOR CONFIRMATION

The time required for confirmation depends on the degree of assurance desired. For example, a survey of 100 percent of the EPZ population would assure an accurate measure of the success of the evacuation. On the other hand, such a survey would be lengthy and costly in terms of resources that would be needed for other preparedness activities that would be occurring at that time. Partial surveys of the EPZ population (samples) when properly devised, can offer a high degree of reliability without the cost of a full survey.

At the 95 percent confidence level, an accuracy of plus or minus 2 percent can be obtained with a survey of 250 households. In other words, on the basis of 250 telephone calls (whether answered or not) there can be a 95 percent assurance that the survey fraction of population evacuated is within 2 percent of the true "true" fraction evacuated (as would be established with a 100 percent survey of all EPZ households).

This level of accuracy is likely to be higher than any other method of confirmation, particularly those that require an evacuating family to leave a signal indicating that they have departed the EPZ household.

The time required for a telephone survey of confirmation, yielding the accuracy described above, is 1 hour. This time is based on a staff of three telephone surveyors, completing an average of 1.5 calls per minute.

APPENDIX J

CALLAWAY PLANT RERP
CROSS INDEX TO
NUREG-0654

NUREG-0654, Section II	Callaway Plant RERP
A.1.a	5.4
A.1.b	5.4
A.1.c	Figure 5.3
A.1.d	5.2.1
A.1.e	5.1 5.4 7.2
A.2.a	Not Applicable (N/A)
A.2.b	N/A
A.3	Appendix C
A.4	5.2.1
B.1	5.2.1 thru 5.2.2.8
B.2	5.2.1
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C.1.a	5.4.1

NUREG-0654, Section II	Callaway Plant RERP
C.1.b	5.4
C.1.c	7.1.1 7.1.3 7.2.2.8 7.2.2.10 7.4.3 7.4.4
C.2.a	N/A
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D.4	N/A
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G.1.b	6.4
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I.6	6.2.1
I.7	6.2.3.1
I.8	6.2.3.1
I.9	6.2.3.1
I.10	6.2.3.1
I.11	N/A
J.1.a	6.4.1.1
J.1.b	6.4.1.1

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J.1.d	6.4.1.1
J.2	6.4.1.1
J.3	6.4.1.1
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K.2	6.5.1.1
K.3.a	6.5.1.1
K.3.b	6.5.1.1
K.4	N/A
K.5.a	6.5.1.1
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O.1.a	8.1.1.3
O.1.b	N/A
O.2	8.1.1.1 thru 8.1.1.1.5
O.3	8.1.1.1.5
O.4.a	8.1.1.1.1

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O.4.f	8.1.1.1.5
O.4.g	8.1.1.2
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APPENDIX K

LIST OF SUPPORTING RADIOLOGICAL EMERGENCY RESPONSE PLANS

DETAILED LIST TO BE
SUPPLIED LATER

APPENDIX L

PROMPT NOTIFICATION SYSTEM

APPENDIX L
REVISION SUMMARY SHEET

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Table L-1	5	8/82
Figure 1	5	8/82
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APPENDIX L

PROMPT NOTIFICATION SYSTEM

The notification system will consist of approximately sixty fixed sirens which will provide immediate notification to 100 percent of the population within the Callaway Plant EPZ. The siren system may be supplemented by other methods of public notification for certain segments of the population.

The majority of the sirens will have a rated output power of approximately 125 dB at 100 ft. Each of these sirens can provide a 70 dB sound intensity, or greater, over an area of 2.6 square miles; and provides a 60 dB sound intensity, or greater, over an area of approximately 10 square miles. Omni-directional type sirens with a rated output power of approximately 115 dB will be installed near the perimeter of the EPZ. For the medium-to-small urban areas, the rural areas, and the overall topography in the Callaway Plant EPZ, this signal strength is appropriate.

Please refer to Figure No. 1 which illustrates the proposed siren system.

For certain segments of the population, supplemental methods of public notification may be used. These are described below.

POPULATION IN TRANSIT

During an emergency condition it can be expected that a number of persons will be travelling on the EPZ road system. These travellers may be local residents or persons from other areas travelling through or to areas within the EPZ. Local trips within the EPZ will, of course, be short trips with an average travel time of about 10 minutes. These local tripmakers can, therefore, be expected to be advised of the emergency condition at their trip destinations, within or near the required 15-minute notification period. Non-local travellers will need to be diverted from entering the EPZ at the earliest possible time, not only for their own protection but also to provide maximum available road capacity for evacuation of area residents. There are a total of 20 major roadway entry points to the EPZ that can be expected to be used by the majority of the through traffic. To preclude any persons from entering the EPZ, all entry points will need to be manned; however, the initial urgent need for traffic diversion is at the 20 major locations (please refer to Figure No. 2).

POPULATION AT SCHOOLS AND OTHER INSTITUTIONS

Although all schools in the EPZ are within range of the proposed outdoor siren system, this notification may be supplemented by the existing radio tone alert system. The tone alert would allow notification of each school administration of an emergency condition and, in turn, the schools could effect their internal alerting of

students and staff through existing PA systems.

A similar notification system to selected institutions such as medical facilities may be considered. The need for establishing such systems is based primarily on the expected mobilization time requirments for the institutional population and the resources to evacuate them. The greater the mobilization time, the greater the need for the alert notification capability.

Please refer to Table No. L-1 which summarizes the prompt notification systems that may be employed for the different population segments in the EPZ.

TABLE NO. L-1

ALERT SYSTEMS FOR SPECIFIC POPULATION SEGMENTS

POPULATION SEGMENT	ALERT SYSTEM
Population at Home	Sirens
Population at Work	
At Business Centers	Sirens
At Industrial Centers	Sirens
At Places Outside the EPZ	------
On Farms	Sirens
Population in Transit	
On the Road System	Sirens/Authorities at EPZ perimeter notification points.
On the River	Sirens/radio
Population at Business Centers	Sirens
Population at Schools	Sirens/Possible supplemental notification methods.
Population in Other Institutions	Sirens/Possible supplemental notification methods.
Population at Recreational Areas	
Hunting, Fishing, Camping, Hiking, etc.	Sirens/Possible supplemental notification methods.
At Sporting Events	Sirens

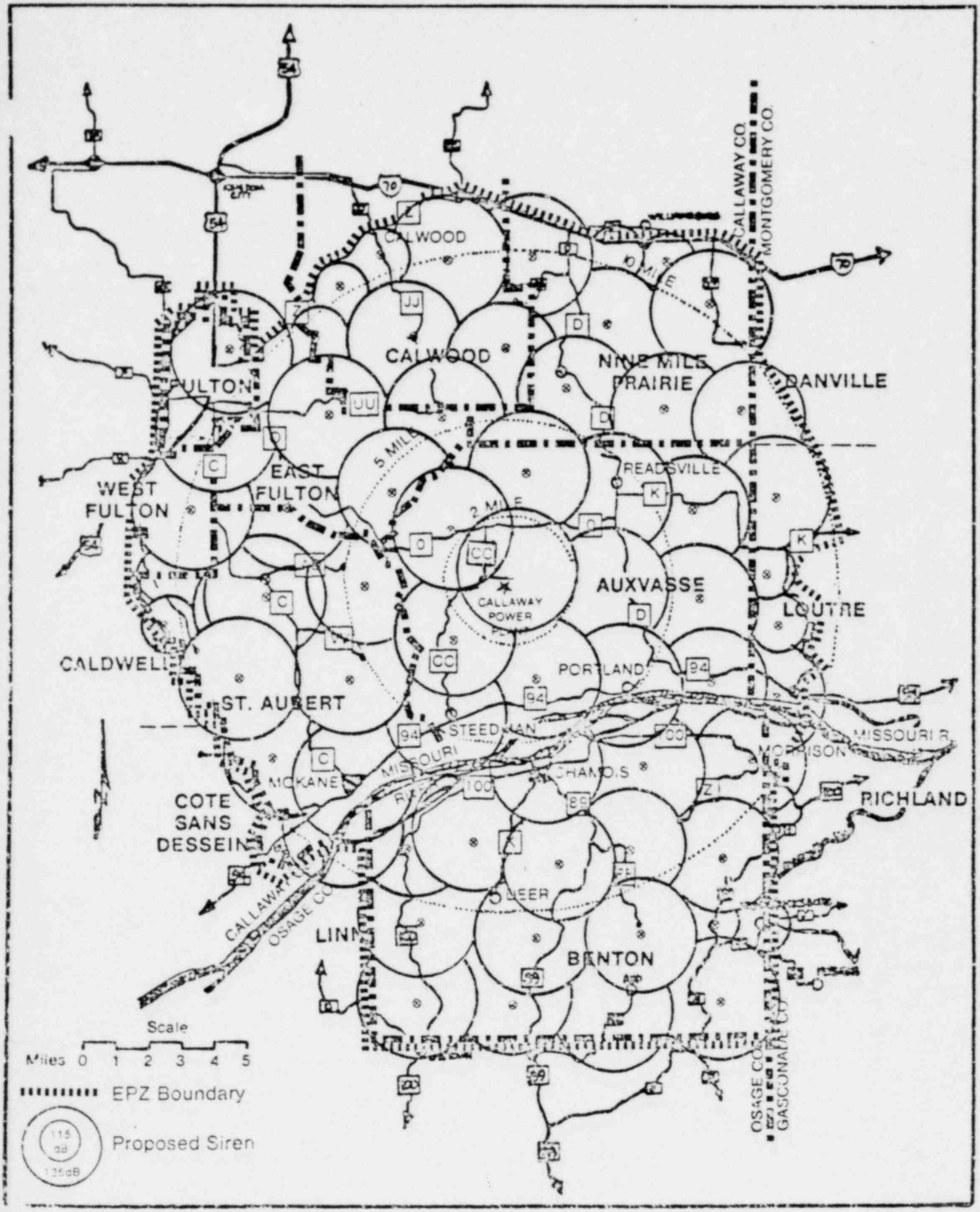

Figure 1 Proposed Siren System

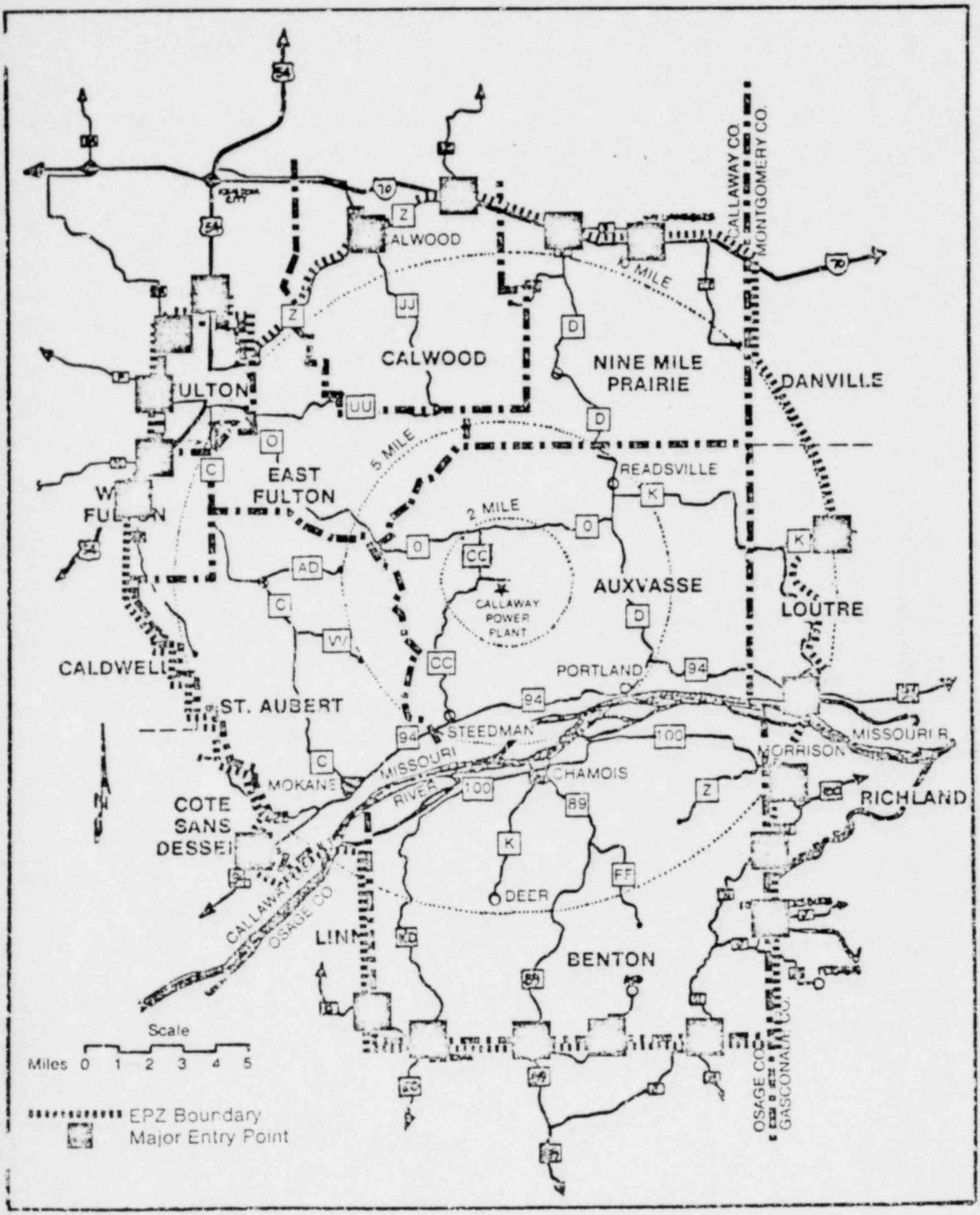

Figure 2. Notification Points for In-Transit Population