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SEABROOK STATION

EVACUATION ANALYSIS

DRAFT, REPORT

ESTIMATE OF EVACUATION TIMES

Prepared For

FEDERAL EMERGENCY MANAGEMENT AGENCY

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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

LIST OF TABLES

I. INTRODUCTION

STUDY OBJECTIVES

This report describes the estimation of the time required to evacuate the population from about a 10-mile radius of the Seabrook, New Hampshire, Nuclear Power Station.

Two objectives are served by this analysis:

(1) An independent assessment of evacuation times to serve as an additional viewpoint to the evacuation time estimates developed by the utility.

(2) To further develop a standardized approach, to estimating evacuation times, that can be applied to other locations.

LOCATION OF THE SEABROOK STATION

The Seabrook Station is located on the Atlantic coastline, in the town of Seabrook, New Hampshire, 40 miles north of Boston, MA, and 15 miles south of Portsmouth, NH. The station is 2 miles north of the Massachusetts-New Hampshire State Line. (See Figure 1.)

BACKGROUND AND CHRONOLOGY

The Seabrook Station is being developed by a consortium of New England utilities, under the leadership of Public Service of New Hampshire.

Application for licensing was begun in 1972, and construction started in 1976.

Start-up of the plant, originally planned for 1979, has been delayed by environmental opposition, court actions and work stoppages. The currently projected start-up date is 1983.

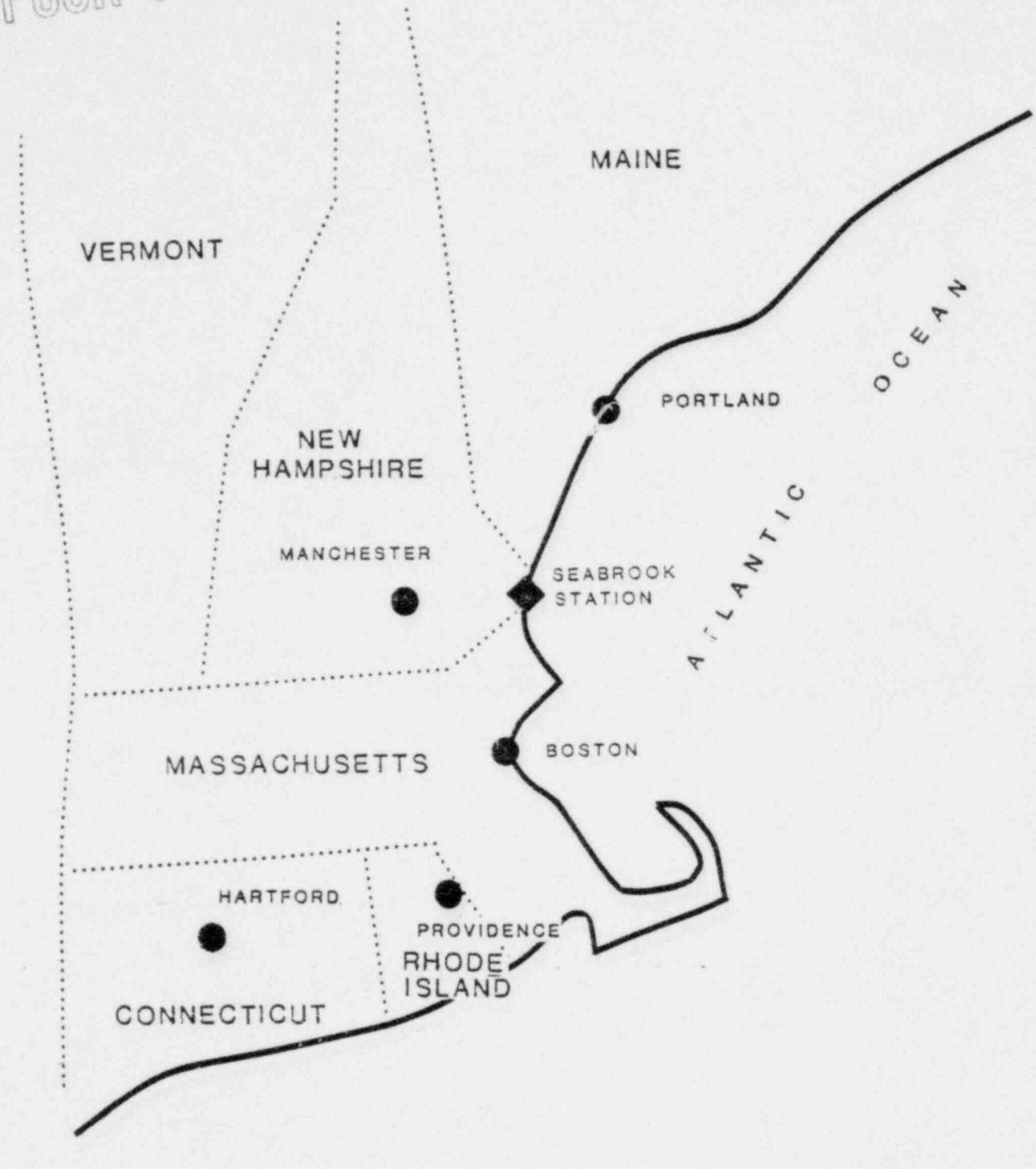

Figure 1. Location of the Seabrook Nuclear Power Station

OTHER STUDIES OF EVACUATION TIMES

An evacuation time estimate for the 10-mile radius of the plant is in the process of being prepared by New Hampshire Public Service. A preliminary estimate of slightly over 6 hours for the "clear time" for the population evacuating in private vehicles has been made. ("Clear time" is defined as the time required for evacuation, given that the population has already received the necessary information.)

LOCAL PREPAREDNESS AND EVACUATION PLANNING

An evacuation time estimate assumes that an effective local preparedness plan is in operation. Among the elements of such a local preparedness plan, some of the more critical elements are identified:

- Detailed evacuation plans, addressing notification, routing, manpower and resource requirements, confirmation of evacuation and transportation of non-vehicle owning population (schools, non-auto owning households and persons in institutions).

- Local notification procedures and hardware, including siren, public address and telephone notification, procedures for broadcasting radio and television information.

- Communication within EPZ, and between Seabrook Station, State Civil Defense Agencies and towns, and within towns themselves.

- Local (town) mobilization and decision-making.

- Detailed traffic control plan.

- Securing buses for transporting the school population.

- Securing buses or other vehicles for transporting non-auto owning households and persons in institutions.

- Securing ambulances for non-ambulatory populations.

- Reception centers and procedures for clearing evacuated population through them.

- Manpower (traffic control, supervisory, security emergency services) for conducting the evacuation.

It is assumed that, by the projected start-up of Seabrook Station in 1983, local preparedness planning will be developed to a level comparable to that now observed at operating plants with similar EPZ populations. In the absence of effective preparedness planning, the evacuation time estimates given in this report are invalid.

THE EMERGENCY PLANNING ZONE (EPZ) BOUNDARY

The Seabrook Station Emergency Planning Zone (EPZ) boundary is defined almost entirely along town boundaries. The only exceptions are the inclusion of small and lightly populated parts of the cities of Portsmouth, NH, and Haverhill, MA.

SUMMARY OF ESTIMATING TECHNIQUE

The method used in developing these evacuation time estimates is based on separating the population into segments, according to how they evacuate the area. For each population segment, a series of discrete action steps is identified, and the completion times for each step determined.

These times for completing each step are then linked together statistically to yield the total evacuation time for that population segment.

The advantage of this method is that travel times are estimated for each individual step of the evacuation sequence (for which data is readily available) rather than for the entire evacuation as a single entity (for which data is non-existent).

Two cases of evacuation time estimates are made: (1) for evacuation during a Summer Sunday, when temporary (beach) population is greatest, and (2) for evacuation on a Winter weekday, when schools are in session.

SUMMARY OF EVACUATION TIMES

For the critical time period (Summer Sunday), the total evacuation time (Table 1) is 6 hours 10 minutes. Times are measured from the beginning of notification until all population has cleared the EPZ. The critical component of this time is the evacuation of beach-area traffic; all non-beach areas of the EPZ can be cleared in 3 hours 55 minutes or less.

For the second most critical time period (Winter weekday) the total evacuation time is 3 hours 40 minutes after start of notification.

Evacuation times by sector range from 5 hours 10 minutes to 6 hours 10 minutes after start of notification, depending on combination of sectors considered.

Under severe weather conditions (Winter storm) the total evacuation time is 4 hours 30 minutes after start of notification, or 123 percent of the time for a Winter weekday evacuation under normal weather conditions.

For the critical time period (Summer Sunday), notification of the entire population within 15 minutes does not reduce the total evacuation time noticeably. The evacuation time for the Summer Sunday situation is determined almost totally by the rate at which the beaches can be evacuated; speeding up the notification process, under these circumstances, simply accelerates the rate at which motorists enter the existing traffic congestion.

TABLE 1

SUMMARY OF EVACUATION TIMES

Conditions	Time[1] Required To Evacuate All Population
Summer Sunday	5 hours 10 minutes
Winter Weekday, Normal Weather	3 hours 40 minutes
Winter Weekday, Severe Weather	4 hours 30 minutes
Selective Evacuation, 2-Mile Radius	5 hours 10 minutes
Selective Evacuation, 5-Mile Radius	5 hours 10 minutes to 5 hours 40 minutes
Selective Evacuation, 10-Mile Radius	5 hours 10 minutes to 6 hours 10 minutes

[1] Time measured from beginning of notification.

ISSUES RELATED TO EVACUATION TIME ESTIMATES

In estimating evacuation times for the Seabrook Station EPZ, several unresolved issues were encountered:

- Behavioral issues. In a Summer Sunday evacuation, a substantial portion of all evacuating population is delayed by traffic congestion. In the beach area, this delay ranges up to a maximum of 4 hours 15 minutes. Most of the traffic caught in congestion is within 5 miles of the Seabrook Station, with a substantial portion within direct sight of the plant. The behavior of drivers under these conditions of delay and proximity to the Seabrook Station can only be guessed. However, any breakdown in orderly evacuation traffic flow will result in evacuation times greater than those estimated. For an evacuation in which traffic control is generally ineffective, total evacuation times will range from 10 hours 30 minutes to 14 hours 40 minutes.

- Local preparedness planning. Evacuation times estimated in this report assume that an effective preparedness plan will be developed by 1983. However, the lack of funds at the local level for preparedness planning, as well as the shortage of manpower resources (police, etc.) needed to conduct an evacuation, raise some concern as to the actual state of preparedness by 1983.

- Transit vehicles. The transit-dependent population (i.e, persons who do not have access to a private vehicle for evacuation) in the Seabrook EPZ is substantial, and a sizeable fleet of buses would be needed for their evacuation. Arranging for a fleet of this size is a major undertaking, not yet addressed by local plans.

- Ambulance availability. Arranging for the number of ambulances needed to assure evacuation of the non-ambulatory transit-dependent population within a reasonable time is a major undertaking, which local preparedness planning has scarcely begun to address.

- Evacuation routes. All available roads must be used as evacuation routes, and in as balanced a manner as possible. Local plans, in subsequent iterations, need to reflect this.

RECOMMENDATIONS

Some possible actions to improve the evacuation process were suggested by this analysis:

- Sequential evacuation of the beach area would reduce the length of queues in the beach area, as well as reduce the chance for a breakdown in orderly traffic flow. Sequential evacuation could be achieved by selective notification, broadcast information and traffic control.

- Sheltering population in the beach area (at least for part of the evacuation period) may be preferable to allowing them to wait in traffic congestion. The trade-offs involved in this choice should be examined carefully.

- The use of I-95 as an evacuation route can be improved greatly (and at low cost) by means of supplemental, evacuation-only entrance ramps.

- Securing of vehicles for the non-auto owning population needs to be addressed

II. CHARACTERISTICS OF THE SEABROOK STATION VICINITY

HIGHWAY SYSTEM IN THE SEABROOK STATION VICINITY

Some important features of the highway system in the 10-mile vicinity of the Seabrook Station (Figure 2) are noted:

- An intercity major trunk highway, I-95, runs the north-south length of the area. This road is of little local travel significance (i.e., for travel within the immediate area). However, it is the primary means of long-distance travel to and from the Seabrook area.

- Two other primary highways, US 1 and State Route 1A, also run the north-south length of the area. Both of these highways serve multiple functions: (1) as longer distance intercity routes, particularly to the Boston and Portsmouth area; and (2) as local arterial roads within the more populated coastal areas, and as rural collectors outside the built-up areas.

- East-west and diagonal highways cross the region connecting most town centers.

- Outside the built-up areas of towns there is little road system other than the major arterial system described above. Specifically, there is little network of local roads, unpaved farm roads, etc.

EXISTING TRAFFIC VOLUMES

The existing traffic volumes (Figure 2) suggest some distinct patterns:

- Major intercity flows on I-95 -- 25,000 to 40,000 Average Daily Traffic (ADT) in the Seabrook Station area.

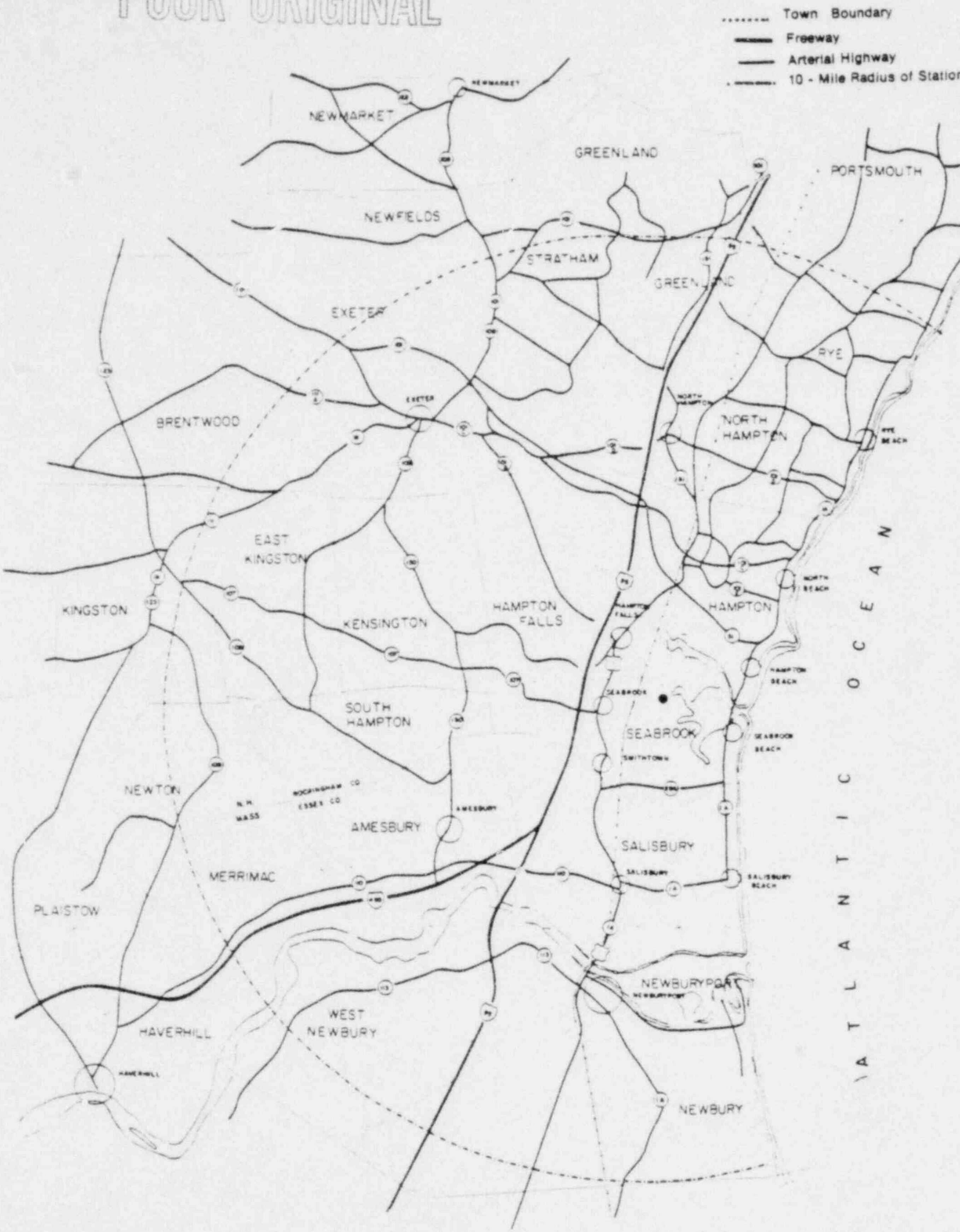

Figure 2. Highway System in the Vicinity of the Seabrook Station

- Large traffic volumes on the other primary north-south highways (US 1 and State Route 1A). The largest component of this traffic is local; i.e., beginning or ending a trip within the Seabrook Station vicinity. The remainder of the traffic is more long distance in nature.

- On arterial streets within the urbanized areas (Newburyport, Amesbury), daily traffic volumes typical of small urban areas.

- Light volumes on the east-west highways that do not penetr[illegible] a major town; for example, Exeter.

- Substantial volumes on east-west highways that penetrate major towns; for example, State Route 51 to Exeter.

OTHER TRANSPORTATION FACILITIES IN THE SEABROOK STATION AREA

Two active rail alignments run in the north-south direction through the region (Figure [illegible]).

Some small general aviation airports are located in the region. No scheduled carrier service is operated at these airports. A major military air base (Pease Air Force Base) is located slightly outside the 10-mile radius of the Seabrook Station.

Several harbor facilities for small vessels are located in the region. However, no harbor of commercial significance is located within the 10-mile radius of the Seabrook station.

GOVERNMENTAL JURISDICTIONS

The area, defined by a 10-mile radius from the Seabrook Station, includes parts of two states, two counties, and two cities. The area of the

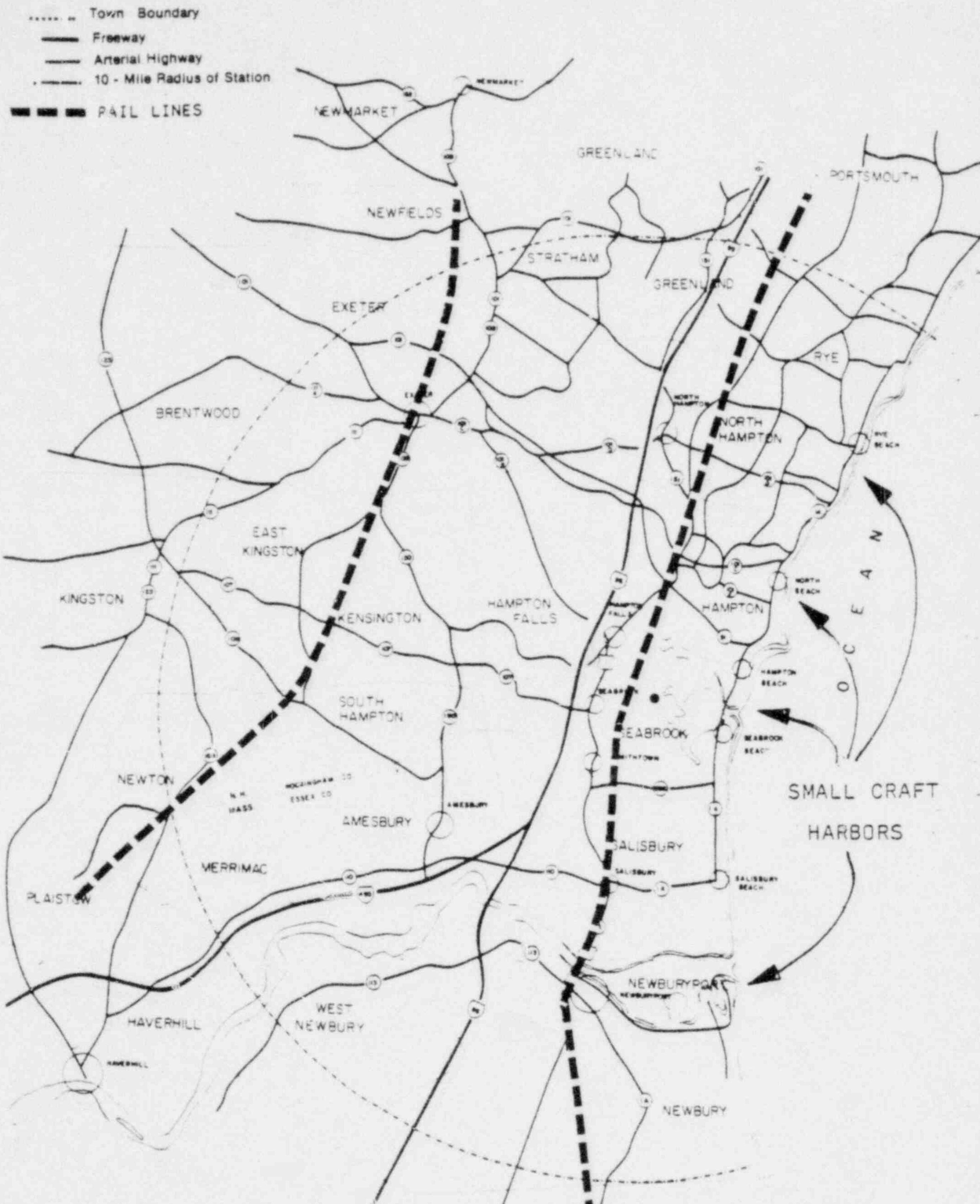

Figure 3. Other Transportation Facilities in the Vicinity of Seabrook Station

Atlantic Ocean within 10 miles of the Seabrook Station is under control of the U.S. Coast Guard.

Governmental jurisdictions are shown on Figure 4.

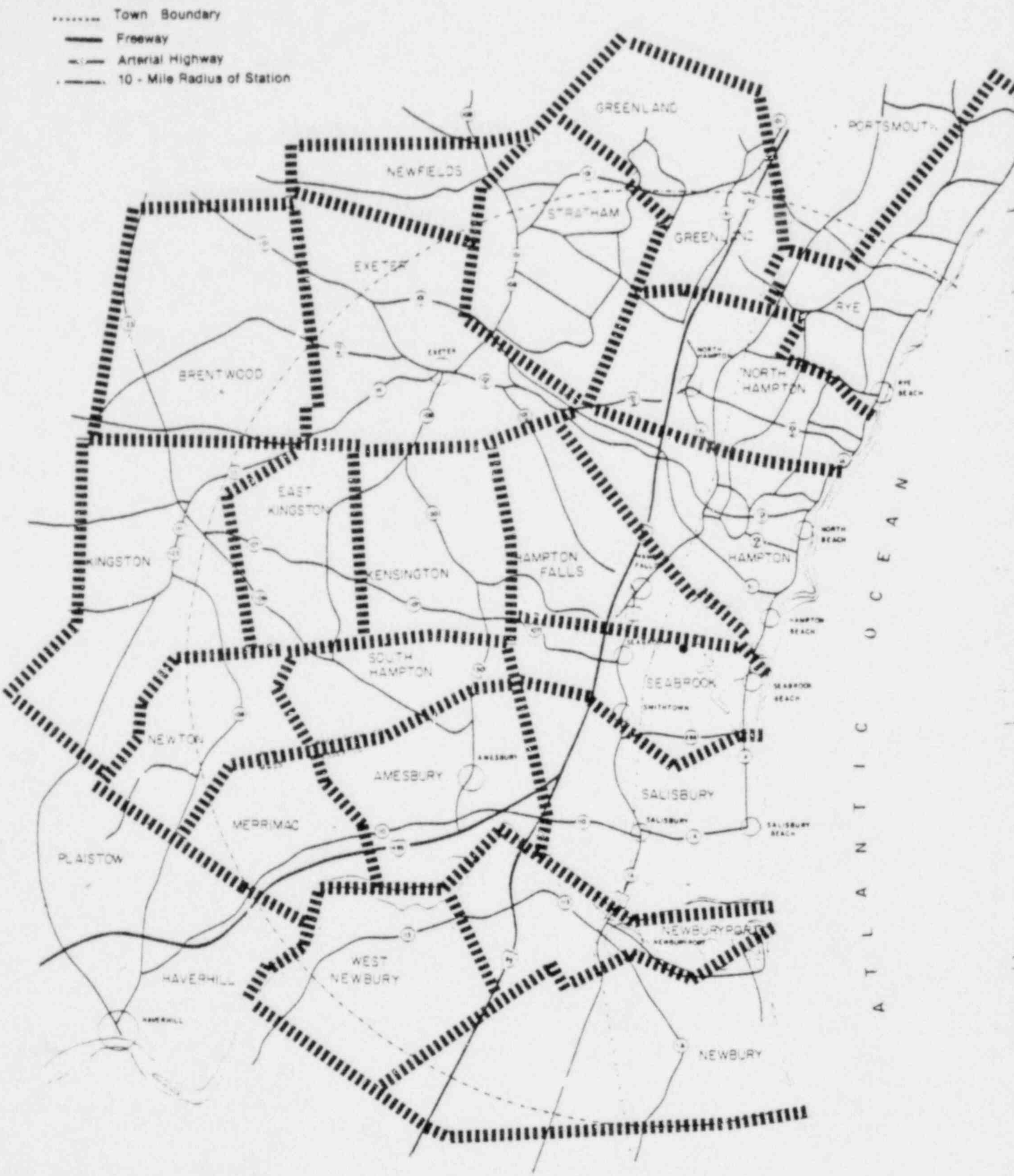

Figure 4. Local Government Jurisdictions

III. THE EMERGENCY PLANNING ZONE FOR SEABROOK STATION

GENERAL GUIDELINES FOR DEFINING THE EMERGENCY PLANNING ZONE (EPZ)

The Emergency Planning Zone (EPZ) is established by federal regulations as a 10-mile radius for the protection of population from direct radiation exposure.

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

- o The EPZ must include at least the 10-mile radius of the power station.
- o The EPZ must be easily identifiable. Rather than strictly following an intangible radius, the EPZ boundary should follow natural features (shorelines, streams), man-made features (highways, railroads), or governmental boundaries.
- o The EPZ boundary should not split major coherent populations, such as the cities of Haverhill or Portsmouth. Rather, the EPZ boundary should either include or exclude such concentrations in their entirety.
- o The EPZ boundary should be regular and consistent, with supportable reasons for including areas. Evacuation of large population groups well beyond the 10-mile radius should be avoided.

THE EPZ BOUNDARY FOR THE SEABROOK STATION

Several features of the area around the Seabrook Station help establish the plume exposure EPZ:

- Other than the Atlantic shoreline, there are few dominant natural or man-made physical features which could serve as portions of an EPZ boundary.

- There are a number of town boundaries in the area, and a strong awareness of towns as the primary governmental jurisdiction.

- Two concentrations of population (Haverhill and Portsmouth) are just beyond the south and north extremities of the EPZ.

In light of these features, an EPZ boundary is proposed (Figure 5) to:

- Follow town lines for almost all of the proposed EPZ boundary.

- Include only those portions of the cities of Haverhill and Portsmouth which are within the 10-mile radius of Seabrook Station.

The resulting EPZ boundary encompasses at least the 10-mile radius from Seabrook Station. At some points, sizable areas beyond a 10-mile radius are included, particularly along the western border of the EPZ. However, these areas contain negligible population.

The proposed EPZ boundary falls almost entirely along local government (town or city) lines, and consequently only two such local jurisdictions are divided by the EPZ boundary. Table 2 summarizes local government jurisdictions within the 10-mile radius of the Seabrook Station and also within the proposed EPZ.

CRITERIA FOR DEFINING SECTORS WITHIN THE EPZ

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

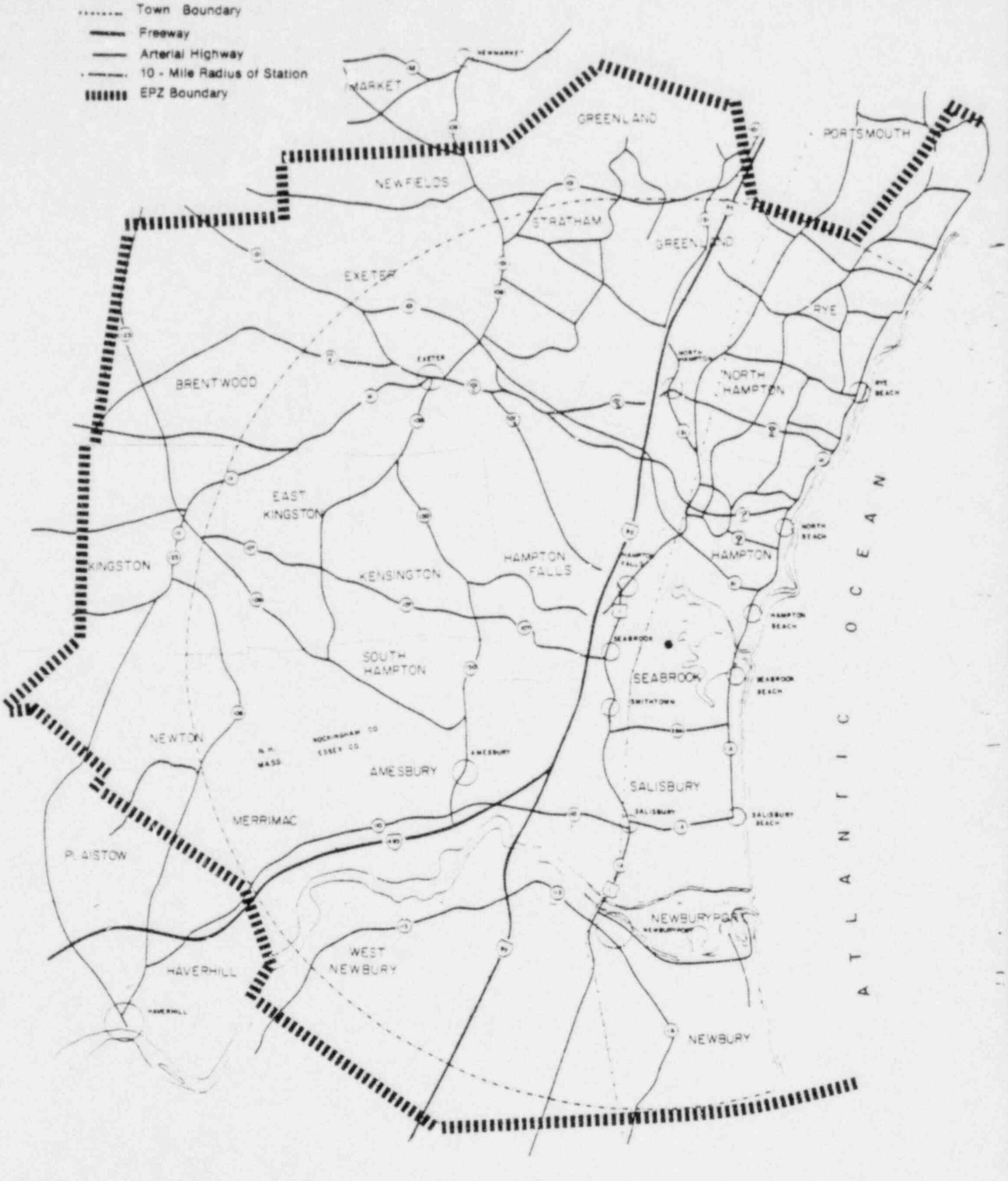

Figure 5. Plume Exposure EPZ Boundary

TABLE 2

GOVERNMENTAL UNITS WITHIN THE 10-MILE RADIUS AND EPZ OF THE SEABROOK STATION

	PORTION OF TOTAL LAND AREA WITHIN	
	10-MILE RADIUS OF SEABROOK STATION	SEABROOK EPZ
NEW HAMPSHIRE		
COUNTIES		
Rockingham	part	part
CITIES		
Portsmouth	part	part
TOWNS		
Brentwood	part	all
East Kingston	all	all
Exeter	part	all
Greenland	part	all
Hampton	all	all
Hampton Falls	all	all
Kensington	all	all
Kingston	part	all
Newfields	part	all
Newton	part	all
North Hampton	all	all
Rye	part	all
Seabrook	all	all
South Hampton	all	all
Stratham	part	all
MASSACHUSETTS		
COUNTIES		
Essex	part	part
CITIES		
Haverhill	part	part
Newburyport	all	all
TOWNS		
Amesbury	all	all
Merrimac	part	all
Newbury	part	all
Salisbury	all	all
West Newbury	part	all

Distance from Power Station	Definition of Sectors
2 miles	Two - 180-degree sectors
5 miles	Two - 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.

Selective evacuation sectors should also recognize wind patterns, so that areas of high probability of beind downwind from the power station can be evacuated separately, without the need for evacuating an unnecessarily wide area of the total EPZ.

SELECTIVE EVACUATION SECTORS FOR THE SEABROOK STATION

Figure 6 illustrates one possible division of the Seabrook Station EPZ into sectors for selective evacuation. These sectors follow the general guidelines above (2-mile, 5-mile and 10-mile radius from the Seabrook Station). In general, sector boundaries are defined along town boundaries, so that in any selective evacuation most towns are evacuated in their entirety. In a few instances, selective evacuation sectors are defined along a major highway.

Sector 1: 2-Mile Radius from the Seabrook Station

The basis for this sector is the 2-mile radius from the Seabrook Station. The north boundary of this sector is defined by the Hampton Falls town line, except at the eastern extremity, where the populated area of Hampton Beach is included. On the west, Sector 1 is bounded by I-95 (New Hampshire Turnpike). The Seabrook town line is the southern boundary of this sector.

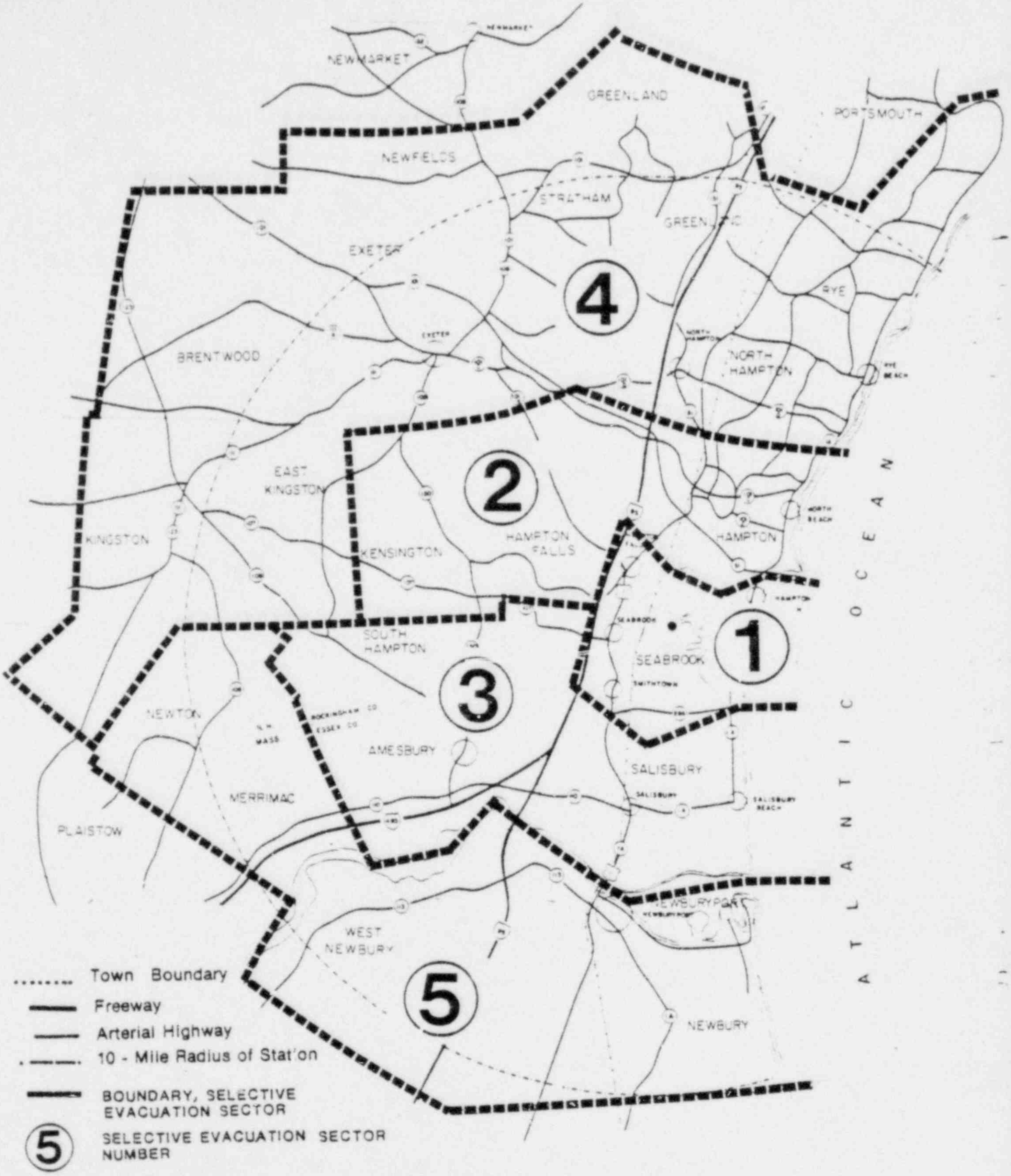

Figure 6. Selective Evacuation Sectors for the Seabrook Station EPZ

Sector 1 includes most of the town of Seabrook, a small part of Hampton and that portion of Hampton Falls east of I-95. The dominant population feature of Sector 1 is the beach area (Seabrook Beach and Hampton Beach).

Sectors 2 and 3: 2-5 Miles from the Seabrook Station

Sector 2 is based on the northern half of the 2-5 mile band from the Seabrook Station. The eastern edge of this sector is the Atlantic shoreline. On the North, Sector 2 is bounded by the Hampton, Hampton Falls and Kensington town lines. The Kensington town line also comprises the west boundary of Sector 2. Along the southern edge, Sector 2 is bounded by the Seabrook, Hampton Falls and Kensington town lines and by a short section of I-95.

Sector 2 includes the entire town of Kensington. Most of Hampton and Hampton Falls are also included in this sector.

Sector 3 is based on the southern half of the 2-5 mile band from the Seabrook Station. The eastern edge of this sector is the Atlantic shoreline. On the north, Sector 3 is bounded by the Seabrook and South Hampton town lines, and by a short section of I-95. To the west, Sector 3 is bounded by the South Hampton and Amesbury town lines. The southern boundary of Sector 3 is defined by the Amesbury and Salisbury town lines.

Sector 3 includes the entire towns of Amesbury and Salisbury. The portion of the town of Seabrook to the west of I-95 is also included in this sector.

Sectors 4 and 5: 5-10 Miles from the Seabrook Station

Sector 4 is the northern half of the 5-10 mile band from the Seabrook Station. The eastern boundary of Sector 4 is the Atlantic shoreline.

The inner boundary is defined along the North Hampton, Exeter and East Kingston town lines. The outer border of Sector 4, identical to the EPZ boundary, is defined by the Rye, Greenland, Newfields, Brentwood and Kingston town lines.

Sector 4 includes the entire towns of Rye, North Hampton, Greenland, Stratham, Newfields, Exeter, Brentwood, Kingston and East Kingston. A small portion of the City of Portsmouth is included.

The major population feature of Sector 4 is Exeter Center.

Sector 5 is the southern half of the 5-10 mile band from the Seabrook Station. The eastern boundary of this sector is the Atlantic shoreline. The inner boundary of Sector 5 is defined along the Salisbury, Amesbury and South Hampton town lines. The outer border of Sector 5, identical to the EPZ boundary, is defined by the Newbury, West Newbury, Merrimac, Newton and East Kingston town lines. A small portion of the City of Haverhill is also included.

Sector 5 includes the entire towns of Newburyport, Newbury, West Newbury, Merrimac and Newton. A small portion of the City of Haverhill is also included.

The major population feature of Sector 5 is Newburyport center.

IV. POPULATION OF THE SEABROOK STATION EPZ

TOTAL POPULATION CHARACTERISTICS

The total permanent resident population of the Seabrook Station EPZ, as defined for the purposes of this study, is 111,000 persons (Table 3). This population is distributed to 41,000 households.

The population of the EPZ is spread fairly evenly throughout the EPZ with no single concentration of population accounting for more than 15 percent of total EPZ population. Population along the coast is somewhat more concentrated than in the inland areas. The coastal towns and cities, with 37 percent of the total area of the EPZ, have 50 percent of the total EPZ population.

The EPZ population is concentrated into the town centers and cities. For example, four such concentrations (Exeter, Hampton, Amesbury and Newburyport) account for 50 percent of all population.

Seasonal and Transient Population

During the Summer months, the population of the EPZ is greatly increased by seasonal residents and transient persons visiting the area for short periods of time (overnight or day trips). Under peak conditions, on a Summer Sunday, 78,000 seasonal and transient persons are added to the permanent EPZ population of 111,000. This additional population is concentrated in the beach towns, with Hampton accounting for about 40,000 persons and Salisbury next with about 19,000 persons.

AUTOMOBILE OWNERSHIP

Table 4 shows the distribution of automobile-owning and non-automobile owning households in the Seabrook Station EPZ. Some patterns of automobile ownership of interest in estimating evacuation times are noted:

TABLE 3

TOTAL RESIDENT POPULATION OF THE SEABROOK STATION EPZ

GOVERNMENT UNIT	POPULATION		
NEW HAMPSHIRE	TOTAL JURISDICTION (1970)	TOTAL JURISDICTION (1980)*	SEABROOK EPZ
BRENTWOOD	1468	2170	2170
EAST KINGSTON	838	1190	1190
EXETER	8892	10720	10720
GREENLAND	1784	2210	2210
HAMPTON	8011	10820	10820
HAMPTON FALLS	1254	1500	1500
KENSINGTON	1044	1350	1350
KINGSTON	2882	4640	4640
NEWFIELDS	843	1000	1000
NEWTON	1920	4060	4060
NORTH HAMPTON	3259	4910	4910
PORTSMOUTH	25717	28430	1000
RYE	4083	5230	5230
SEABROOK	3053	6000	6000
SOUTH HAMPTON	558	800	800
STRATHAM	1512	2500	2500
MASSACHUSETTS			
AMESBURY	11388	16560	16560
HAVERHILL	46120	46340	200
MERRIMAC	4245	4710	4710
NEWBURY	3804	4920	4920
NEWBURYPORT	15807	16740	16740
SALISBURY	4179	5150	5150
WEST NEWBURY	2254	2690	2690
TOTAL	154915	184640	111070

*DATA SOURCES FOR 1980 ESTIMATES: New Hampshire Office of Comprehensive Planning. Interim Revisions, New Hampshire Population Projections for Towns and Cities to the Year 2000. August 1977; and Massachusetts Department of Public Health Office of State Health Planning. Population Projections 1980-1985. August 1978.

TABLE 4

AUTO OWNERSHIP IN THE SEABROOK STATION EPZ

ANALYSIS ZONE/ GOVERNMENT UNIT		SEABROOK EPZ POPULATION	HOUSEHOLDS	HOUSEHOLDS BY AUTOMOBILE AVAILABILITY 0	1	2	3+
NEW HAMPSHIRE							
1	BRENTWOOD	2170	804	67	443	247	47
2	EAST KINGSTON	1190	441	37	243	135	26
3	EXETER	10720	3970	619	2263	1004	84
4	GREENLAND	2210	819	68	452	251	48
5	HAMPTON	10820	4007	240	1851	1639	277
6	HAMPTON FALLS	1500	556	46	307	171	32
7	KENSINGTON	1350	500	42	276	154	28
8	KINGSTON	4640	1719	143	949	528	99
9	NEWFIELDS	1000	370	31	204	114	21
10	NEWTON	4060	1504	125	830	462	87
11	NORTH HAMPTON	4910	1819	151	1004	558	106
12	PORTSMOUTH	1000	370	31	204	114	21
13	RYE	5230	1937	45	1046	713	133
14	SEABROOK	6000	2222	209	1409	440	164
15	SOUTH HAMPTON	800	296	25	163	91	17
16	STRATHAM	2500	926	77	511	284	54
MASSACHUSETTS							
17	AMESBURY	16560	6133	1147	3434	1282	270
18	HAVERHILL	200	74	13	41	17	3
19	MERRIMAC	4710	1744	309	959	398	78
20	NEWBURY	4920	1822	322	1002	415	83
21	NEWBURYPORT	16740	6200	1321	3292	1345	242
22	SALISBURY	5150	1907	248	1064	494	101
23	WEST NEWBURY	2690	996	176	548	227	45
TOTAL		111070	41136	5492	22495	11083	2066

- Thirteen percent of the households in the EPZ do not own an automobile.

- A relatively large number of non-automobile owning households are in Newburyport and Amesbury. These two areas, with less than one-third of the EPZ population, have almost one-half of the non-automobile owning households in the EPZ.

- Relatively few non-automobile owning households are in the small towns and rural areas. For example, in Greenland, Kensington, North Hampton and Seabrook, the fraction of non-automobile owning households ranges from 8 to 9 percent.

The seasonal and transient population is, for purposes of evacuation time estimating, assumed to be 100 percent automobile owning.

POPULATION SEGMENTS AS DEFINED FOR EVACUATION ANALYSIS

In estimating evacuation times, four population segments are identified on the basis of how persons are evacuated from the EPZ (see Chapter VI):

(1) <u>Auto owning population</u>. This population segment consists of all members of car owning families, except children in school at the time of notification.

(2) <u>School population</u>. All children at school at the time of notification, regardless of the automobile ownership status of their families.

(3) <u>Non-automobile owning households</u>. All persons (except school children) in households where a car is not reasonably available for evacuation.

(4) Population in institutions such as hospitals and nursing homes, etc. and not having access to a private vehicle for evacuation.

Rearranging the EPZ population into these categories (Table 5) reveals that:

- o Most of the population (71 percent) is in the automobile-owning segment.

- o The next largest population segment is school population, accounting for about 19 percent of the EPZ population.

- o Non-automobile owning population accounts for 7 percent of Seabrook Station EPZ inhabitants. As noted above, this population is concentrated in the Amesbury and Newburyport areas.

TABLE 5

SEABROOK STATION EPZ POPULATION BY SEGMENTS

Population Segment	Population[1/]	Percent of Total Population
Automobile-Owning Population	78,790	71
School Population	21,600	19
Non-Automobile Owning Households	7,180	7
Population in Institutions	3,500	3
TOTAL	111,070	100

[1/] Permanent population. Seasonal and transient population of 78,000 persons not included. Seasonal and transient population is entirely in "Automobile-Owning Population" segment.

V. THE EVACUATION SEQUENCE FOR SEABROOK STATION

GENERAL CONCEPT OF EVACUATION

The overall purpose of the evacuation is simply to remove the population of the EPZ as rapidly as possible. The evacuated population is directed to reception centers, where it is temporarily lodged. Some of the evacuated population will go to the homes of nearby relatives and acquaintances.

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

In general, 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. Normal traffic flow will be observed, with streets open to all vehicles and functioning in their usual manner.

In estimating evacuation times, the EPZ population is grouped according to how it evacuates: (1) auto owning population, (2) school population (3) non-auto owning population and (4) persons in institutions.

Each of these groups follows a different sequence in evacuating:

- o the auto owning population, after receiving the notice to evacuate, assembles the family (except for children at school) at home, prepares for evacuating the home and drives out of the EPZ. Non-residents (for example, beach visitors) simply assemble the group with which they are traveling, and leave the area.

- the school population is transported out of the EPZ directly from the schools. School buses are used to evacuate this population.

- non-auto owning households prepare for leaving their home, assemble at collection locations, and are then transported out of the EPZ in buses or other vehicles.

- persons in institutions (hospitals, etc.) are prepared for evacuation, then transported out of the EPZ in buses and ambulances.

POSSIBLE EVACUATION TIME PERIODS

The length of time needed for evacuation of the Seabrook Station EPZ will vary, depending on the time of day, day of week and season of year in which the evacuation occurs. Four possible time periods are identified:

- Nighttime
- Daytime on a summer weekend ("Summer Sunday" case)
- Daytime on a winter weekend
- Daytime on a "winter weekday" case

In estimating evacuation times, the "worst cases" of these four time periods should be adopted; that is, evacuation time estimates should reflect conditions likely to cause the longest evacuation times.

Nighttime Evacuation

In a night evacuation, the notification process would be slowed by people having to wake up and comprehend the evacuation information being broadcast. Additional time would be required to prepare vehicles for evacuation in the dark. On the other hand, for most segments 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.

Daytime on a Summer Weekend ("Summer Sunday" Case)

In any daytime evacuation, the notification time is at a minimum, since most people are awake and many are already listening to radio and television broadcasts. Families are more likely to be at the same location on weekends, since schools are not in session and relatively few persons are at work. Outdoor recreation is at a maximum during this season, and many non-residents are at the beach areas.

Daytime/Weekday Evacuation ("Winter Weekday" Case)

During a daytime/weekday evacuation, a majority of the employed population would be on the job. During most of the year, schools are in session and the transportation of students becomes a large issue in any evacuation. For much of the population, a daytime/weekday evacuation creates additional action steps, since families must be assembled prior to leaving the home and evacuating the EPZ. Also, during the daytime/weekday period, the likelihood of persons being away from home without a vehicle are greatest.

Critical Time Periods

For the evacuation of the Seabrook Station EPZ, the critical time period--that is, the period for which evacuation is likely to require the most time--is the "Summer Sunday". During this period, the population and vehicle accumulation in the EPZ is at a maximum.

The next most critical time period is the "Winter Weekday" period. During this period, the time needed to assemble family units is likely to be at its maximum. Furthermore, the daytime/weekday periods raises issues of school population evacuation which do not exist in other time periods.

Separate evacuation time estimates are prepared for both of these time periods, i.e., for "Summer Sunday" and "Winter Weekday".

POPULATION SEGMENTS TO BE EVACUATED

As a first step in estimating the evacuation times for the Seabrook EPZ, its population is divided into segments. A separate time estimate is made for each of these segments. This method, by recognizing the various ways in which population leaves the EPZ, allows a more precise prediction of required times. The basis for the various population segments is HOW that segment of population leaves the EPZ. Consequently, four population segments are identified:

(1) Auto owning population, who evacuate by driving out in private automobiles. This population segment consists of all members of car-owning households, except children at school.

(2) School population; that is, all children at school. This population is evacuated directly from schools, in school buses.

(3) Non auto-owning households; all persons in households where a car is not reasonably available for evacuation. Some of this population is evacuated by friends and relatives. Those not evacuated by friends or relatives assemble at collection points, and are evacuated by bus.

(4) Population in institutions such as hospitals, nursing homes, jails, etc. This population is evacuated directly from the institution, by bus or special vehicle.

Family Units

Families (excluding children in school) are evacuated as units. On weekdays, assembly of the family units involves members returning 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, beach 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 action steps. These are clearly defined actions, performed in a predictable sequence (see Figure 7).

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 is not available, this process permits the estimation of times for each individual step, for most of which data is readily available.

Public Agency and Private Steps

Some of the evacuation steps identified in Figure 7 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 evacuation step; for example, "Evacuate School Population in Buses", "Evacuate Non-Auto Owning Households in Buses", etc. For population 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 initial "Receive Broadcast Information" are private actions; that is, they are initiated by the individuals being evacuated. Similarly, two of the steps in the evacuation of non-auto owning households are private steps.

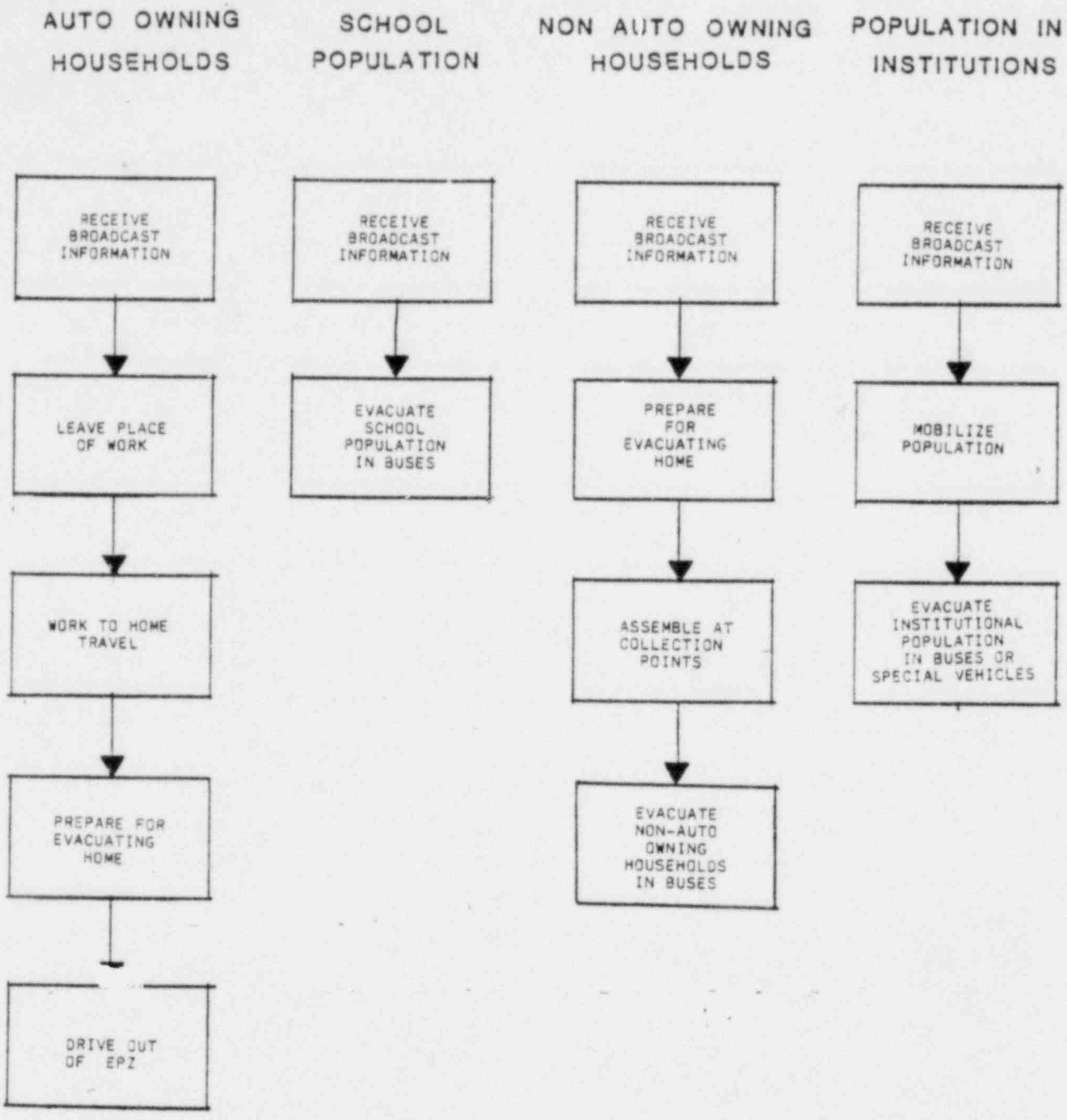

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Figure 7. Population Segments and Evacuation Sequences

EVACUATION OF AUTO OWNING POPULATION

The action steps described in the following sections describe the sequence of evacuation for resident auto owning households, evacuating the area during the daytime/weekday period. For some other components of the auto owning population, the sequence is shortened and certain action steps are omitted. For example, non-resident beach population does not need to return home from work, nor to prepare for leaving a household. In the calculation of evacuation times, only those action steps appropriate to the population component are included.

Receive Broadcast Information

Following the decision to evacuate, the first activity is the notification of the public that an emergency exists. This is accomplished by the sounding of sirens, and activation of other alert systems (such as NOAA). This notification alerts the public that an emergency exists, and that they should tune in to radio and television broadcasts for further information.

The next activity is the broadcast of radio and television information, with specific instructions for evacuating.

Various other backup measures are used to inform the population which might not be reached by the above means. Mobile public address units will circulate through built up areas of the EPZ. Public address systems will be used at large concentrations of population, such as the beaches and race track. Some households, particularly in the more remote rural areas, will be notified directly by telephone call.

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 essentially a normal journey-to-work travel time distribution. The maximum trip length for work trips in the EPZ is not likely to exceed 20 miles, and the average trip is less than three miles. An average travel speed of 20-30 miles per hour is typical for the travel home for area workers.

This movement of workers, because of the short time over which it occurs, can be expected to cause some traffic congestion. This level of congestion should be similar to that occurring during the twice-daily work travel peak. It is expected that the road system will 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 home. 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 at 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, for example, in apartments, can be prepared for evacuation in minutes.

Travel Out of the EPZ

After households are secure, auto owning households will drive out of the EPZ by the most direct routes available.

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

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 flows of traffic out of the EPZ.

Evacuating traffic will use all available roads out of the EPZ. Traffic volumes are too large to permit evacuation to be confined to some selected roads.

During the evacuation, normal traffic operations will generally prevail. Specifically, two-way streets will continue in two-way operation, traffic signals will continue to function, and so forth. Some modifications might be made; for example, some three-lane roads may be operated in an "imbalanced" manner, with two lanes flowing out of the EPZ and only one lane used for inbound traffic.

During much of the evacuation, traffic will flow freely, although at reduced speeds. However, at certain locations and during certain periods, traffic congestion is expected.

EVACUATION OF SCHOOL POPULATION

Receive Broadcast Information

Following the decision to evacuate, the local preparedness agencies notify schools directly of the need for evacuation. This is done through radio warning systems and telephone calls directly to the schools.

Siren systems will serve as a backup method of notifying schools. Coverage of the school population by this method is high, since almost all schools are in populated areas within siren range.

Evacuate School Population in Buses

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

School bus fleets from all districts within the Seabrook EPZ and from neighboring districts within about a 20 mile distance of the EPZ will be used for evacuation. All school buses used in these districts, whether publicly or privately owned, will be used to evacuate students from the EPZ.

NON-AUTO OWNING HOUSEHOLDS

Receive Broadcast Information

The procedure for receiving broadcast information is the same as for auto owning population (above). This includes the sounding of sirens, broadcast information, mobile public address and possibly some direct notification by telephone calls.

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.

Assemble 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 could then be considered, in effect, as part of the auto-owning population.

Persons from non auto-owning households who do not evacuate as passengers in private vehicles will assemble at locations (for example, churches and public buildings) 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 one mile 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 home to the collection point. Rural non-auto owning population will be taken to collection points in transit vehicles and in some cases, automobiles.

Evacuate Non-Auto Owning Households in Buses

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

Potential sources of buses include private common carrier fleets, public transit systems from within the EPZ, and public transit systems from outside the EPZ, particularly from the Boston urban area.

POPULATION IN INSTITUTIONS

Receive Broadcast Information

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

The siren notification system is a secondary backup method of notifying institutions. Siren coverage of institutions is high, since almost all of them are located in populated areas and therefore within range of a siren.

Mobilize Population

The institutional population is instructed about evacuation procedures 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

Transit 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 reception centers. Generally, all residents of a given institution will be evacuated to the same reception center. Potential sources of buses include private common carrier fleets, public transit systems within the EPZ and public transit systems from outside the EPZ, particularly from the Boston urban area.

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 neighboring communities.

Ambulances used in the evacuation of institutions will make three round trips.

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 summer weekend. The next most critical period, daytime on a weekday, is also examined.

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

(1) auto owning population, which evacuates in private automobiles

(2) school population, which evacuates in school buses

(3) non-auto owning households, which assemble at collection points and evacuate in buses

(4) persons in institutions, who are evacuated directly from the institutions in buses and ambulances.

For each population group, the evacuation sequence consists of a number of clearly defined action steps as summarized in Table 6.

TABLE 6

SUMMARY OF EVACUATION ACTION STEPS

POPULATION SEGMENT	ACTION STEPS AND DESCRIPTION
AUTO OWNING POPULATION (All members of households, except school children, having a private vehicle available for evacuation)	1. RECEIVE BROADCAST INFORMATION, 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. DRIVE OUT OF THE EPZ in private vehicles, using most direct routes
SCHOOL POPULATION (All persons in schools, whether public or private)	1. RECEIVE BROADCAST INFORMATION, including instructions for evacuating 2. EVACUATE SCHOOL POPULATION IN BUSES from districts in EPZ and other sources
NON-AUTO OWNING POPULATION (Persons not having a private vehicle available for evacuation)	1. RECEIVE BROADCAST INFORMATION, including instructions for evacuating 2. PREPARE FOR EVACUATING HOME (close house, secure property) 3. ASSEMBLE AT COLLECTION POINTS such as churches or public buildings 4. EVACUATE NON-AUTO OWNING POPULATION IN BUSES from EPZ and other sources
PERSONS IN INSTITUTIONS (Hospitals, nursing homes, Naval Base, etc.)	1. RECEIVE BROADCAST INFORMATION, including instructions for evacuating 2. MOBILIZE POPULATION, prepare population for evacuation 3. EVACUATE INSTITUTIONAL POPULATION IN BUSES OR SPECIAL VEHICLES

*These steps omitted by non-residents; for example, beach visitors.

VI. EVACUATION ROUTES

GENERAL STRATEGY OF EVACUATION ROUTING

This chapter considers the evacuation of the largest population segment of the EPZ: those using private automobiles. The basic objective of evacuation routing for automobile traffic is to permit vehicles to exit as rapidly as possible from the EPZ. The overall evacuation strategy is derived from key geographic features of the EPZ such as the location of the Seabrook Nuclear Power Station and the constraint on eastward movement presented by the Atlantic Ocean, as well as from the characteristics and configuration of the road network. The basis of the strategy is the evacuation of principal year-round population centers by the most direct movement possible. The major components of this strategy are illustrated in Figure 8 and summarized below:

- Newburyport, the largest population concentration of the EPZ, should be evacuated directly to the south.

- Amesbury, the second ranking population center, should be evacuated directly to the southwest.

- Hampton, the largest population center within a 5-mile radius of the power station, should be evacuated directly to the north.

- Exeter and its surrounding area should be evacuated directly to the west and northwest.

These four major movements define the corridors for evacuation of 50 percent of the winter weekday population of the EPZ. Clearly, this strategy provides for the separation of the major flows which is important to the minimization of traffic conflict.

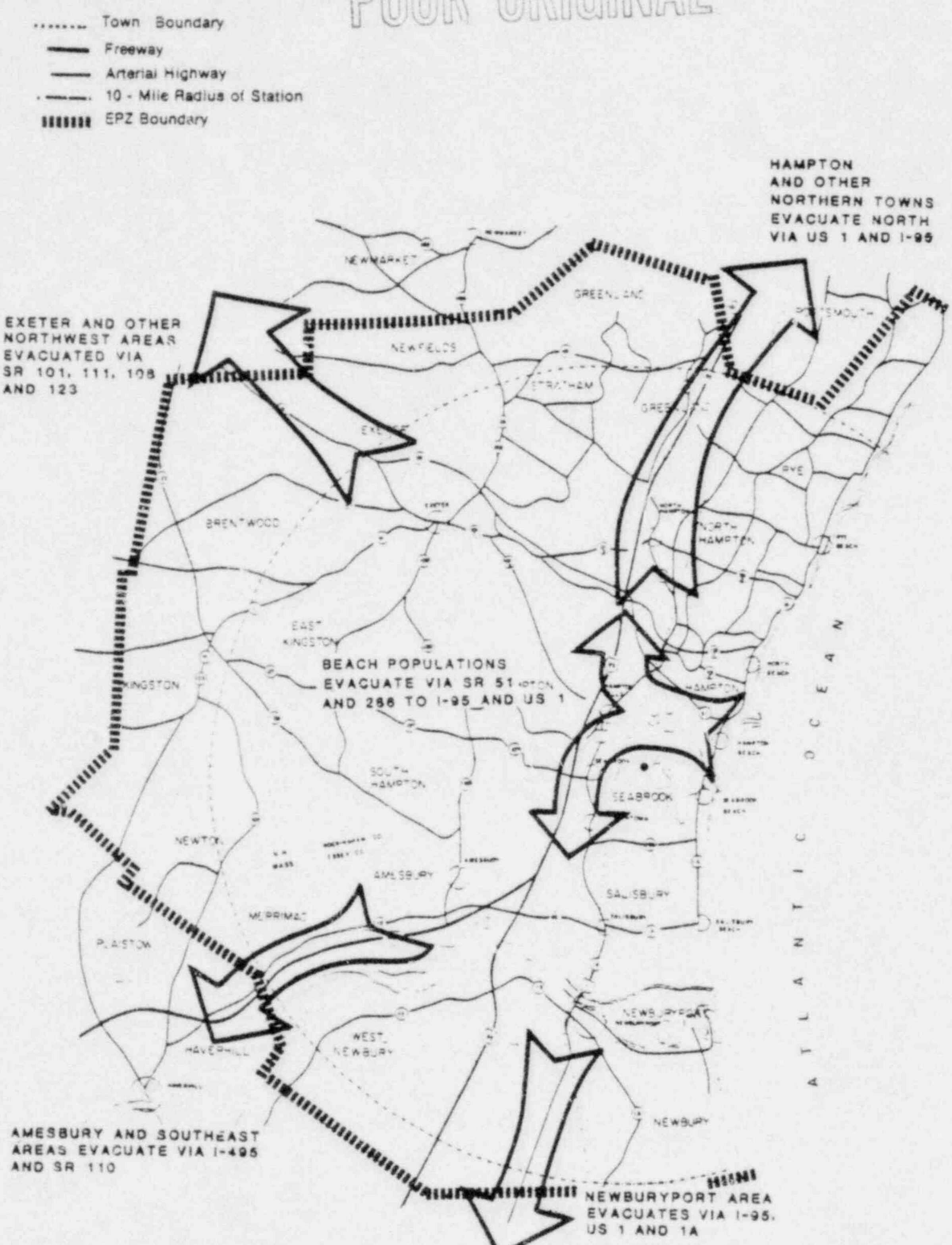

Figure 8. Evacuation Routing Strategy

ROAD NETWORK FOR VEHICLE EVACUATION

The characteristics of the road system within the EPZ were presented in Chapter II. A capsule description of the facilities available for evacuation traffic would note that the EPZ is served by a full range of facility types that includes two interstate highways, Federal primary system routes as well as primary and secondary state roads. Examination of the road network indicates that north-south movement is more direct than east-west travel patterns. The major facilities, I-95 and Route 1 are continuous and offer high capacity for traffic exiting the area to the north or south. Conversely, there is no facility of this capacity for east-west traffic and those roads that do serve this movement are relatively indirect.

Figure 9 identifies the "gateway" points where roads cross the boundary of the EPZ. This set of eighteen gateway points represents the total roadway capacity for evacuation. In general, the capacity of a roadway is determined by the capacities of its intersections, rather than by its cross section at the non-intersection locations. In the case of evacuation routes, capacity is likely to be determined by a "critical intersection". These are intersections that represent the "bottlenecks" on the evacuation routes. In general, they are locations at which (1) the evacuation route has a high traffic volume, after having collected traffic from various tributary roads, and (2) cross-street traffic at the intersection is significant, reducing the amount of time available for evacuation traffic to move through the intersection.

The capacity of an intersection is based on a maximum flow of 1500 vehicles per lane hourly, with full assignment of the right-of-way (or, in other words, 1500 vehicles hourly if there is no cross street traffic). This capacity is then adjusted downward to reflect the demands of the cross traffic. At the critical intersections, which are establishing the capacity on the evacuation routes, the total

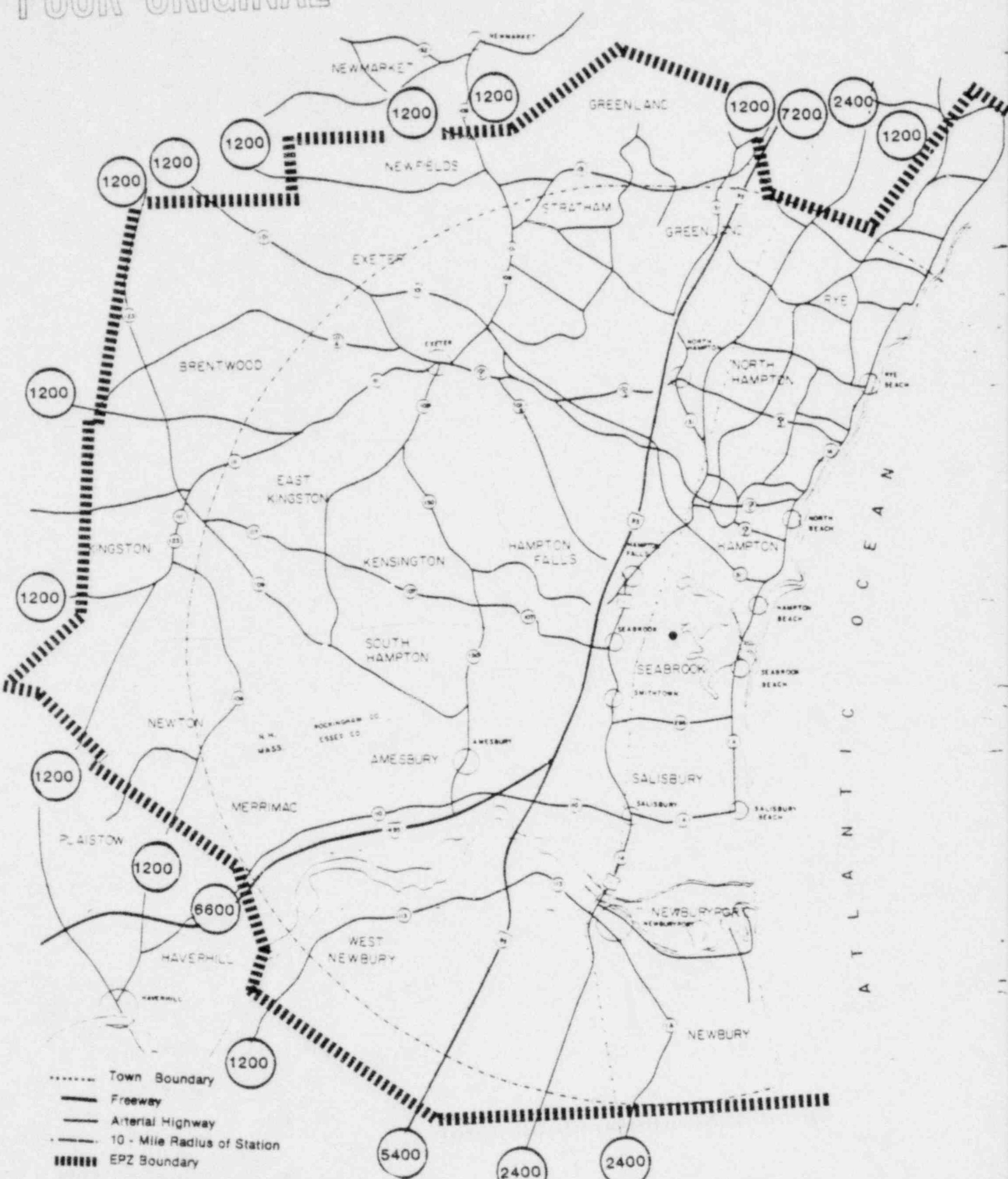

Figure 9. Evacuation Gateways and Capacities

capacity is adjusted downward to 80 percent of the maximum to reflect this cross street traffic. The resulting capacity is 1200 vehicles per lane per hour.

The total capacity of the Seabrook EPZ gateway points is approximately 38,400 vehicles per hour. This estimate of total capacity is based upon the use of hard surface highways and primary and secondary roads as evacuation routes and does not include local urban streets and unpaved roads. The gateway capacity of three-lane facilities such as Routes 1 and 1A has been calculated on the basis of assumed two-lane operation outbound.

FORECASTING EVACUATION TRAFFIC

The review of data on the characteristics of the population of the EPZ included an assessment of auto ownership patterns in the area. At this point in the analysis, we consider the generation of automobile vehicle trips for the evacuation of those households with an auto available. It is important to recognize that automobile evacuation trips and total automobiles within the EPZ are not necessarily the same.

The trip generation step is a calculation based upon the auto ownership patterns of the year-round residents and the vehicles associated with beach visitors and seasonal residents. The patterns of auto ownership and the median household size (number of persons per household) indicate that there are households with fewer vehicles than licensed drivers and households with more vehicles than licensed drivers. Recreational vehicles, for example, are often "excess" vehicles that are used only for special purposes. The trip generation step is built up from the segments of the auto-owning population and recognizes that households with only one or two vehicles will utilize a greater proportion of their households with three or more vehicles. Table 7 presents the total vehicle trips forecast for each zone under the two different evacuation scenarios.

TABLE 7

EVACUATION TRAFFIC FORECAST

(VEHICLE TRIPS)

	ANALYSIS ZONE/ GOVERNMENT UNIT	CASE A: SUMMER SUNDAY TOTAL	CASE A: SUMMER SUNDAY PEAK HOUR	CASE B: WINTER WEEKDAY TOTAL	CASE B: WINTER WEEKDAY PEAK HOUR
	NEW HAMPSHIRE				
1	BRENTWOOD	908	782	908	782
2	EAST KINGSTON	498	429	498	429
3	EXETER	3937	3390	3937	3390
4	GREENLAND	925	796	925	796
5	HAMPTON	18828	18152	4864	4188
6	HAMPTON FALLS	628	541	628	541
7	KENSINGTON	563	485	563	485
8	KINGSTON	1939	1669	1939	1669
9	NEWFIELDS	417	359	417	359
10	NEWTON	1697	1461	1697	1461
11	NORTH HAMPTON	2053	1768	2053	1768
12	PORTSMOUTH	417	359	417	359
13	RYE	2382	2051	2382	2051
14	SEABROOK	5419	5086	2397	2064
15	SOUTH HAMPTON	334	288	334	288
16	STRATHAM	1045	900	1045	900
	MASSACHUSETTS				
17	AMESBURY	5897	5077	5897	5077
18	HAVERHILL	73	63	73	63
19	MERRIMAC	1712	1474	1712	1474
20	NEWBURY	1791	1542	1791	1542
21	NEWBURYPORT	5794	4989	5794	4989
22	SALISBURY	7291	7012	2007	1728
23	WEST NEWBURY	979	843	979	843
	TOTAL	65227	59516	43257	37246

This forecast level of auto vehicle trips averages approximately 85 percent of the estimated total number of vehicles in the EPZ. This level of vehicle utilization appears reasonable when allowances are made for vehicles being outside the EPZ at the time of evacuation, vehicles being out of service for mechanical problems, and the number of "excess vehicles" in households where there are not as many licensed drivers as vehicles.

Table 7 also presents information on the distibution of the vehicle demand. Estimates for the peak hour of travel are shown for each evacuation scenario on a zone by zone basis. Demand peaking information is of interest because it places the total travel demand into the same temporal framework as capacity. The distribution of all evacuation activities over time is a central feature of the approach taken in this analysis, reflecting conditions as they are actually likely to occur. Inspection of the activity distribution curves developed in this study for the evacuation of the Seabrook EPZ indicated that 86 percent of the population would be attempting to exit within the peak hour of demand. These peak hour demand volumes can be related to the hourly capacities of the road network to estimate supply/demand imbalances and consequent traffic congestion and delay.

INDIVIDUAL EVACUATION ROUTES

In order to assess the time required to evacuate the Seabrook EPZ, individual exit routes were developed for each of the analysis zones or towns within the area. This enables a relatively "fine-grained" analysis that can be related to actual concentrations of population and the evacuation route options available to each subarea.

A series of individual evacuation routes are then determined for each zone following these guidelines:

- The route must lead fairly directly out of the EPZ, and should not have a circuity of greater than 150 percent. (Circuity is the amount by which the actual road distance exceeds the straight-line distance).

- The routes must be at least collector streets in the urban areas, or at least paved secondary roads in the rural areas. Local urban streets and unpaved rural roads are not designated as evacuation routes.

The resulting system of evacuation routes for each case is shown in Figures 10 and 11. Some of the roads are designated as the evacuation routes for more than one analysis zone. Also, some analysis zones have multiple evacuation routes designated.

For each of the evacuation scenarios carried through the analysis, the forecast traffic volumes were assigned to the system of evacuation routes. In the absence of a detailed local plan for the management of evacuation traffic, a number of assumptions must be made in order to reflect the conditions reasonably attainable with available local management resources. Therefore, for the purposes of this analysis, it was assumed that overall, traffic facilities would be operated in a relatively normal fashion. That is to say that few instances of special traffic management capability were assumed. Noteworthy exceptions include assumed two-lane entry to I-95 northbound at Route 51 and assumed use of the center left-turn lane as an outbound travel lane on Route 1 and 1A. In addition to these operating characteristics, a relatively low-level of traffic control intervention and direction was assumed for a limited number of intersections.

Beyond this, little effort was made to balance or optimize traffic flows. It is important to recognize that individual motorists will have very imperfect knowledge of traffic conditions elsewhere in the region and will only have a limited set of route options for evacuation. Thus, significant imbalances and congestion are inevitable because severe peaking characteristics foreclose chances of a situation where available

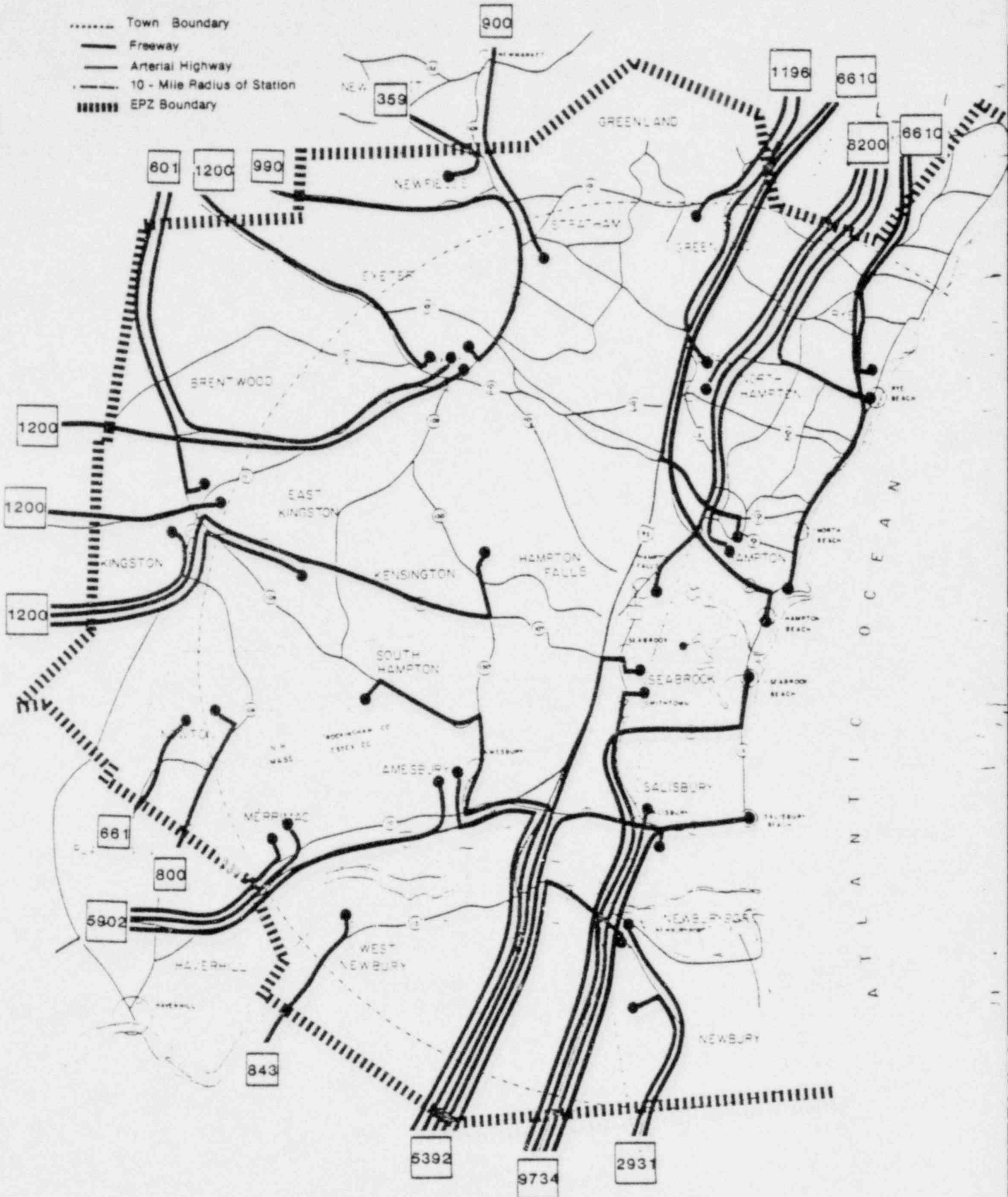

Figure 10. Evacuation Routes: Case A, Summer Sunday

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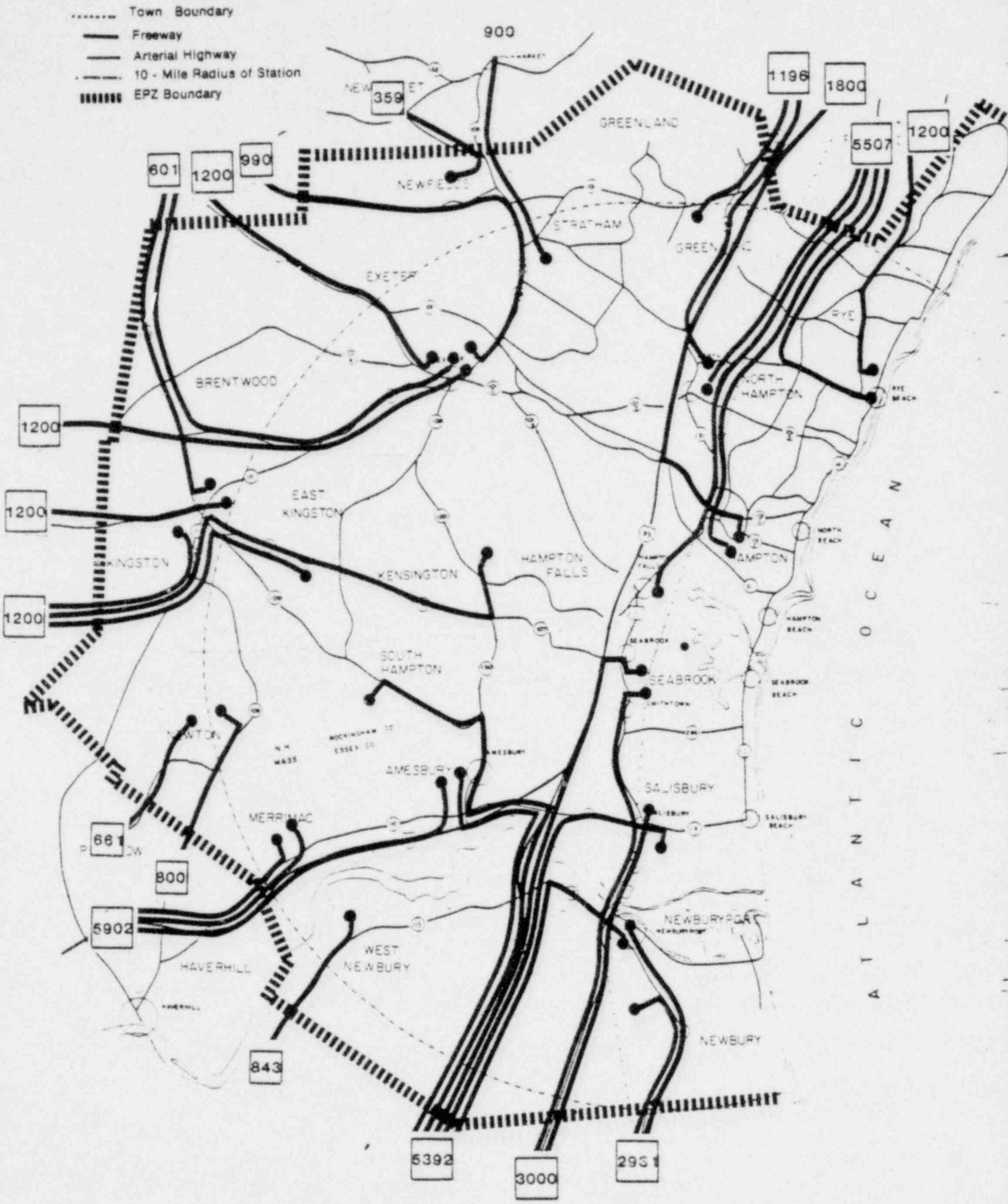

Figure 11. Evacuation Routes: Case B, Winter Weekday

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roadway capacity would be utilized most efficiently. Still, it is worth noting that even under an ideal assumption of optimal traffic balance with full utilization of gateway capacity, there would be 1.7 hours of traffic flow through the gateways in the summer-Sunday case and 1.1 hours in the winter-weekday case. Of course, actual evacuation times will be much longer reflecting the effects of "bottlenecks" and traffic congestion.

Figures 10 and 11 present the forecast peak hour traffic volumes by route for each of the evacuation scenarios. These volumes represent a believable balance of demand, based upon the congestion and route alternatives presented to motorists evacuating each zone.

PERFORMANCE OF THE EVACUATION TRAFFIC SYSTEM

The traffic volumes forecast for the evacuation routes indicate that there will be a broad range of traffic system operating conditions under both of the evacuation scenarios. The leading characteristics of the evacuation traffic system are described generally below. A more detailed analysis of the traffic congestion and delay is provided in a subsequent chapter. An overall assessment of evacuation traffic conditions indicates that:

- The largest problems in the winter-weekday case are related to north-south movement. A few areas and roadways emerge as critical areas for estimation of evacuation times and traffic delays.

- The largest problem in the summer-Sunday case is in westbound movement away from the beaches. The limited nature of the transportation network in beach areas means that the few available evacuation routes will be swamped with traffic. As vehicles clear the beach areas, problems will continue at north/south gateway points.

- Movement to the southwest, west and northwest are relatively unconstrained. Analysis indicates that backups will occur but that these should be relatively limited in scope and duration because the capacity exists to accommodate anticipated peak hour flows.

- The major traffic facility in the EPZ, I-95 will experience relatively poor utilization. As the largest facility in the area it would be expected that I-95 would be utilized to the utmost. Analysis indicates, however, that there are serious problems associated with the use of I-95 for evacuation.

- The proximity of the Seabrook Nuclear Power Station to I-95 is one factor limiting the use of this evacuation route. A fundamental tenet of evacuation planning is that few motorists will drive toward the source of the radiation and thus increase their exposure to health hazards. As a result, use of the access ramps to I-95 at Seabrook is largely precluded.

- Lack of access points prevents greater use of I-95 for northbound evacuees. The Hampton interchange at Route 51 is the only access to I-95 north of Seabrook within the EPZ. Thus the use of this major, multi-lane facility is constrained by the capacity of the on-ramps at a single interchange.

- As access routes to I-95 (both north and south of Seabrook) become congested, traffic is forced onto Route 1. As a result this facility will experience a larger volume of demand relative to its capacity than the interstate facility.

VII. SUMMARY OF EVACUATION TIME ESTIMATES

METHOD FOR ESTIMATING EVACUATION TIMES

Population Segments

Evacuation times are estimated separately for each of the four population groups discussed earlier:

(1) Auto Owning Population

(2) School Population

(3) Non Auto Owning Population

(4) Population in Institutions

Time Periods

Evacuation times are estimated for two different time periods (cases) as discussed previously in Chapter V:

(1) Daytime on a Summer Sunday", and

(2) Daytime on a "Winter Weekday"

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 times needed to complete each of these steps is then estimated. For the auto owning households, for example,estimates are made for the time required for (1) receiving broadcast information, (2) leaving place of work, and so forth.

The times needed to complete each step are not expressed as a single value of time, such as an average or a median value. Rather, the times required for each step are stated as the distribution of times, relating the fraction of the population completing a particular step to the elapsed time after notice to evacuate.

Time Required for a Series of Action Steps

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

Assignment of the Traffic to the Evacuation Routes

The traffic due to the evacuation of the auto owning households is "assigned" (that is, distributed) to the available roads out of the EPZ, as shown in the previous chapter. Delays due to this traffic are calculated, and the evacuation times are adjusted to reflect these delays.

EVACUATION TIMES FOR CASE A: SUMMER SUNDAY

Figure 12 shows the time needed to evacuate the population of the entire Seabrook Station EPZ under a summer weekend condition (that is, under Case A: Summer [illegible]y).

The critical population element is the auto owning population; in other words, it is this element of the population that establishes the total evacuation time. Other elements of the population (for example, popula-

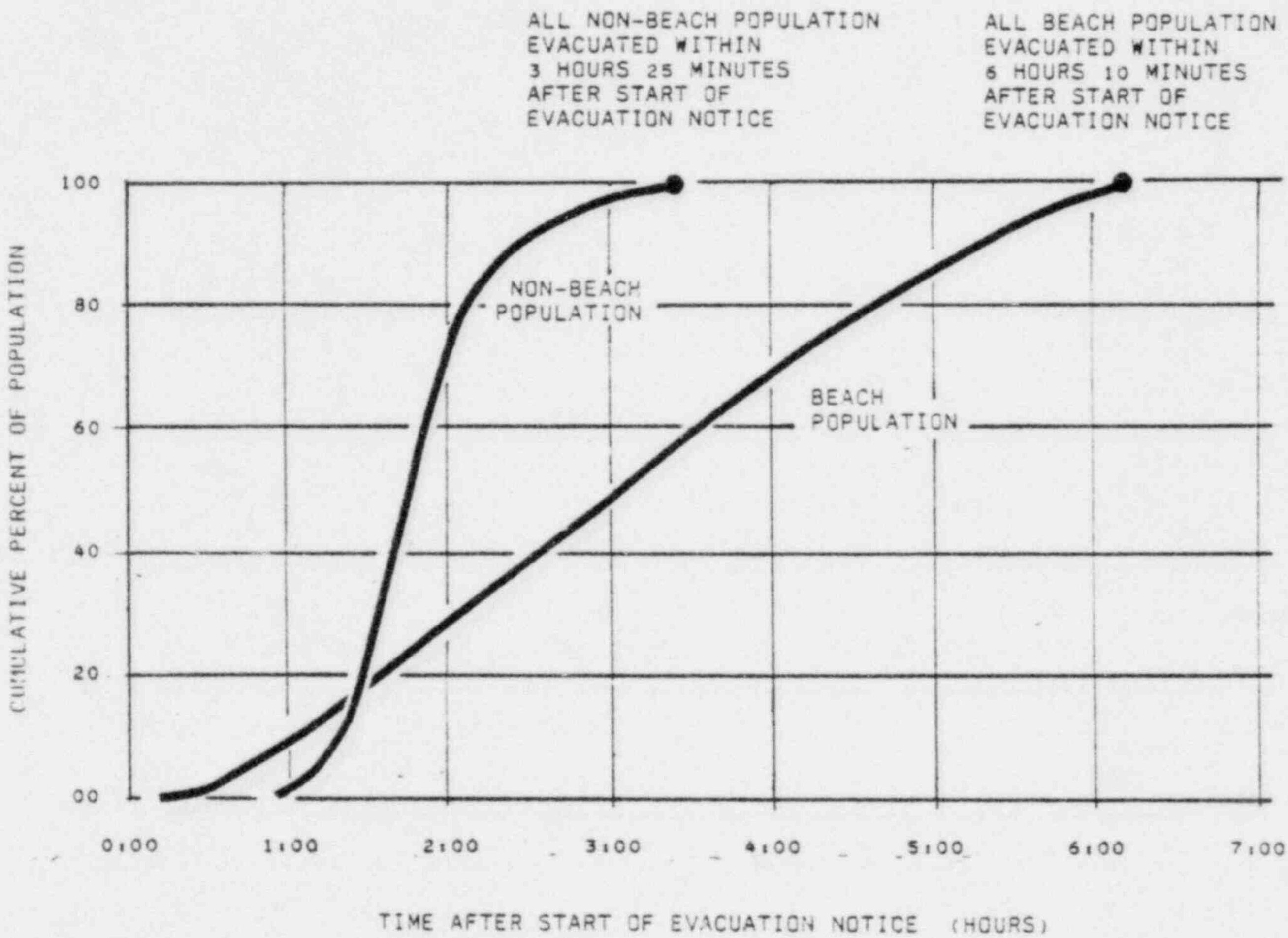


Figure 12. Evacuation Times: Case A, Summer Sunday

tion in institutions) can be evacuated in a shorter time than the auto owning population, provided that vehicles are available for their evacuation. Consequently, their evacuation does not add to the total evacuation time.

As indicated in Figure 12, there are two distinct components of the evacuation traffic under the Summer Sunday case (1) beach traffic population and (2) non-beach population. The non-beach population is cleared within 3 hours and 55 minutes after the start of notification. The beach traffic, on the other hand, is not cleared until 6 hours 10 minutes after the start of notification.

Formation of Traffic Congestion

At numerous points within the Seabrook EPZ particularly in the beach areas, 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 or the beach, and enters the street system at a rate greater than the capacity of that street system to carry them (Figure 12). As a consequence, traffic begins to back up, starting at critical intersections ("bottlenecks") at which traffic demands are the greatest. Congestion then spreads rapidly from these critical intersections. Shortly after they first form, queues spread along arterial streets, blocking traffic attempting to feed in from side streets. In the worst case, congestion spreads generally throughout the area, with all arterial and collector streets and even some local streets blocked. At this point, numerous private and commercial driveways are 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 or the beach. Motorists leaving their homes and entering the street system during such a period are simply "stored" in traffic queues in the street system. Under such conditions, increasing the speed of notification and the clearing of households and beaches does not improve the total evacuation times, but rather merely puts more vehicles into the traffic congestion.

Two possible levels of congestion are illustrated in Figure 13. In the less severe instance (upper diagram in Figure 13) the traffic queues end as the rate of vehicles entering the street system diminishes. At this point, free traffic flow is restored, and the rate of evacuation is once again determined by the rate at which the population completes preparations to leave home. This situation, occurring on most of the inland evacuation routes, results in a total evacuation time of 3 hours 45 minutes after the start of the notice to evacuate.

In the more severe example of congestion (lower diagram in Figure 13) typical of beach area traffic, traffic queues are so large that they continue even after all auto owning households have left home and entered the street system. Once started, this type of traffic congestion continues until evacuation is complete.

Extent of Traffic Congestion

Figure 14 illustrates the extent of traffic congestion and the length of delay during the evacuation period. These examples are focused on evacuation routes in the beach area, where the maximum delays occur.

The level of congestion, the length of time spent in traffic backups and the length of these backups are unlike anything that the population of the Seabrook EPZ has encountered previously, and it is important that the dimensions of this congestion be understood:

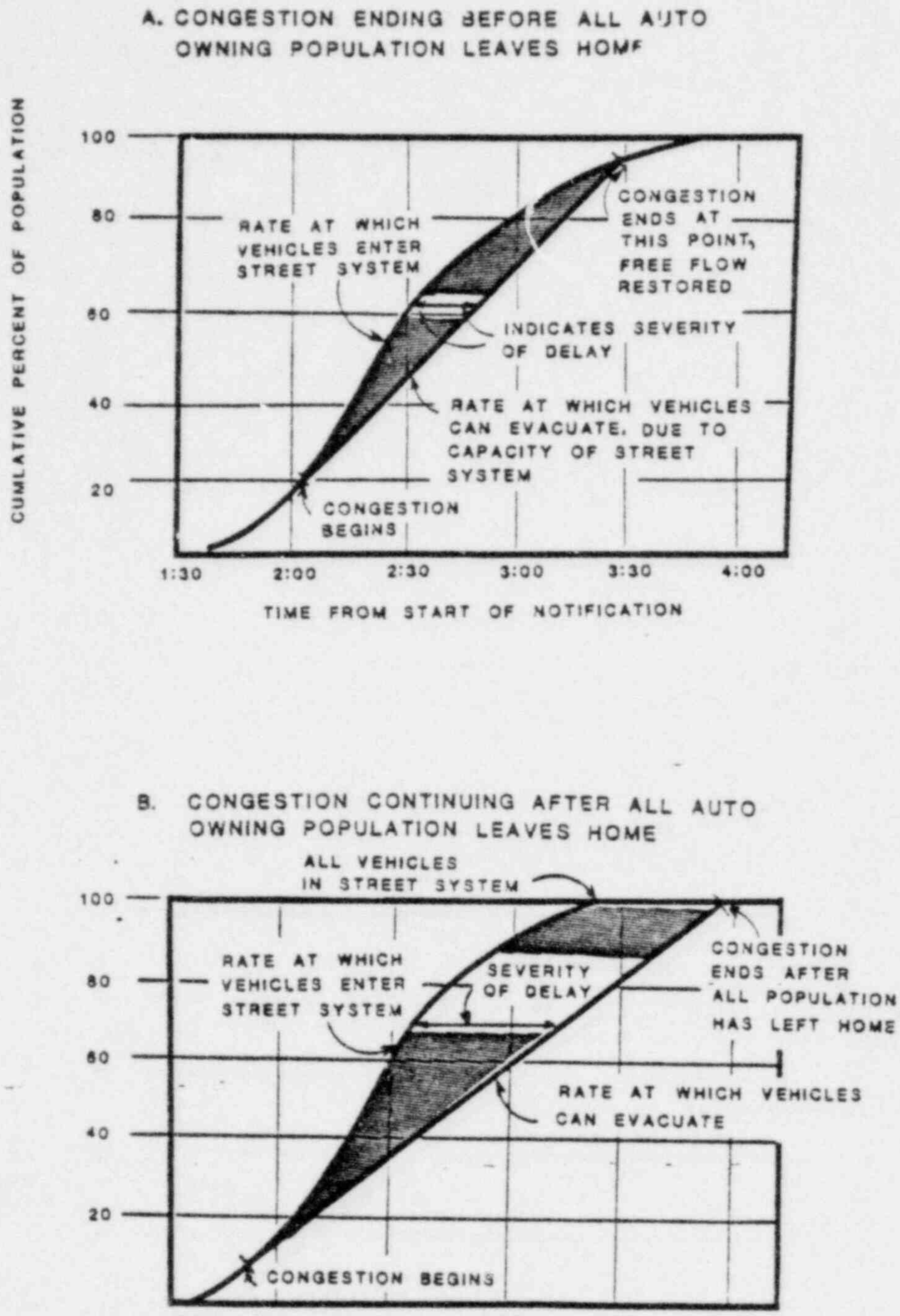


Figure 13. Traffic Congestion Analysis

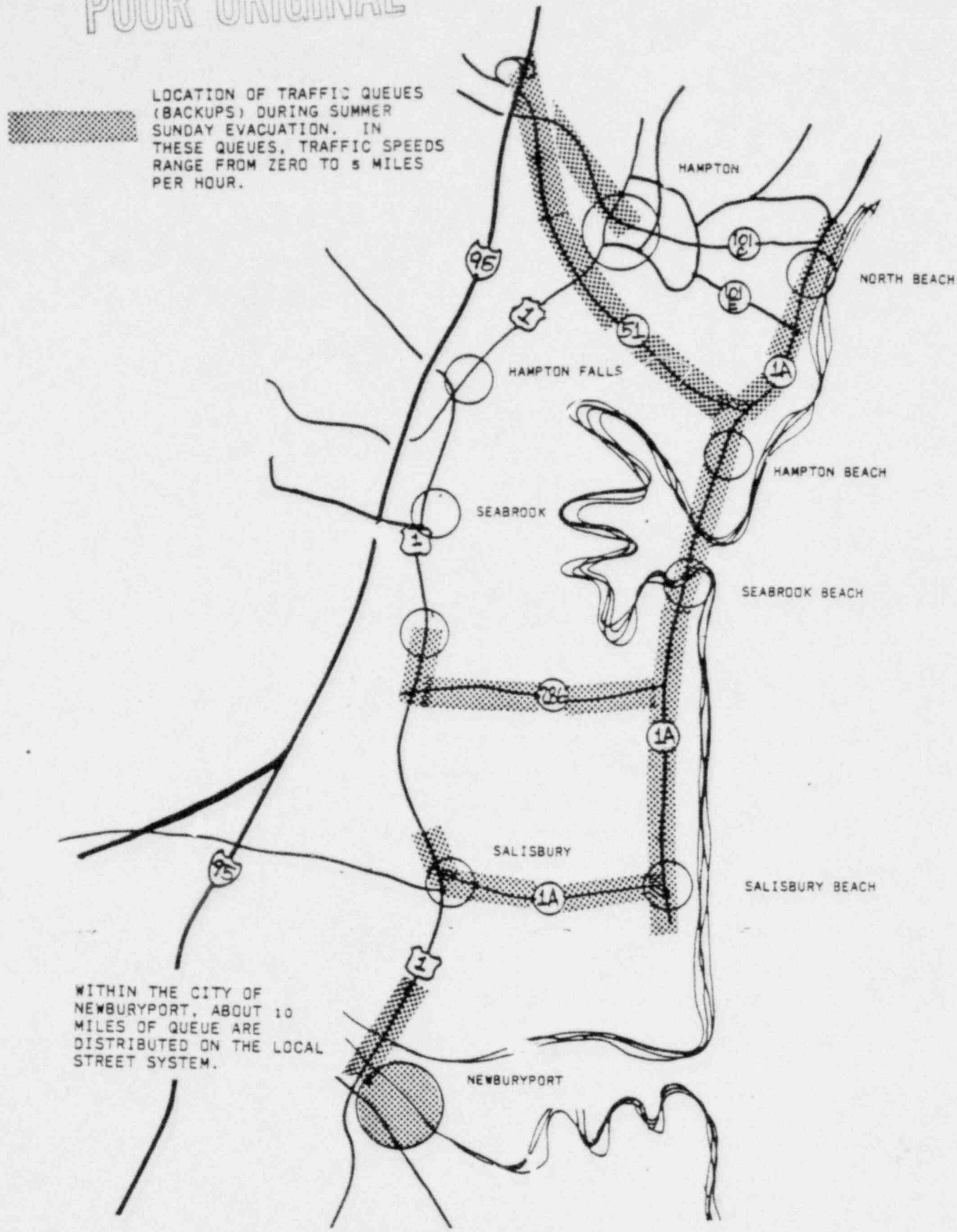


Figure 14. Traffic Congestion: Case A, Summer Sunday

- Length of delays: The maximum delay for the entire Seabrook Station EPZ will be experienced by traffic exiting from Salisbury Beach. For a vehicle entering the end of the traffic congestion at its maximum, the delay will be 4 hours and 15 minutes. In other words, a vehicle entering the street system at the peak of the congestions will not move (or will scarcely move) for a period of 4 hours and 15 minutes. This is the maximum time, which represents a worst case. Delay times for other motorists range downward from this maximum of 4 hours and 15 minutes; nevertheless, the majority of the Salisbury Beach population will have delay times in excess of 2 hours.

  The Hampton Beach traffic is next in order of length of traffic delay experienced, with a maximum delay of 3 hours and 15 minutes. This is followed by Seabrook Beach, with a maximum delay of 2 hours and 45 minutes.

  Other significant delays occur at the more inland locations. For example, for the inland portions of Northampton, Hampton and Salisbury, the maximum delay is 30 minutes, while at Newburyport the maximum delay is 60 minutes.

- Length of Traffic Backup: In several locations, the amount of traffic that is attempting to enter the street system exceeds the space available on the entire road system. In other words, there is not enough space on the streets to store the vehicles attempting to get onto the street system. Consequently, many vehicles will not be able to leave their parking spaces, driveways, etc.

  This situation is the most severe in the Hampton Beach area where a queue (backup) of 49 lane-miles[1] of traffic is attempting

1/ A lane-mile of traffic is one lane of traffic backed up for one mile. A lane-mile of traffic contains about 200 vehicles.

to enter a road system of about 11 miles in length. Even if much of the road system were operated with two lanes outbound, there would still be space, on the entire road system, for less than one-third of the vehicles attempting to enter it.

Next in terms of length of traffic backups are Salisbury Beach (27 lane-miles of traffic) and Seabrook Beach (11 lane-miles of traffic).

On the inland portions of the coastal towns, the backups are about one mile for Hampton and North Hampton, and no queue at all for Seabrook.

At the larger inland towns, significant queues are expected to form. For example, 4 miles of backup will form at Newburyport and about 7 miles will form in Amesbury. However, these backups are spread over numerous local streets, and are not concentrated on a single highway, as in the case of beach area congestion.

Traffic Congestion and Driver Behavior

There is considerable uncertainty as to what might happen to driver behavior in 30 to 90 minute traffic backups under circumstances such as an evacuation. The existing evidence for this type of occurrence is sketchy and uneven. In some more or less documented instances, such as evacuation after chemical spills or evacuation related to natural disasters, generally orderly traffic flow has been reported. On the other hand, experiences such as major snowfalls (even in regions accustomed to such type of weather) suggest that driver behavior deteriorates quite regularly under circumstances of 30 to 90 minute delays.

Some specific motorist behavior problems that could be caused by delays of the length expected in the Seabrook EPZ evacuation include:

- Creation of more lanes in the outbound directions; in effect, a one-way system out of the area, as motorists impatient with the length of queue simply begin using the left hand (that is, inbound) lanes for travel out of the area. This is not necessarily a poor strategy, if planned, but could be chaotic if it occurs spontaneously.

  Furthermore, if a two-lane flow must be returned to a single lane at some downstream point, then there is no advantage in the two lane flow. To the contrary, the merging activity as the two lanes are combined into one will cause a loss in capacity relative to a single smoothly flowing lane.

- Blocking cross streets at intersections: This is a common type of traffic disorder, even under normal traffic situations, and it can almost certainly be predicted that this will happen under evacuation circumstances, particularly since at times the length of queue will extend back through several intersections, and will fill the entire road system of the beach area.

- Disregard of normal traffic control devices (such as signals, lane markings, signs, etc.) is a frequent consequence of routine traffic congestion such as that occurring at sporting events, traffic accidents, construction locations, etc. Disregard of traffic control devices could be assumed to be even more widespread during evacuation of the Seabrook EPZ. Failure of traffic control causes a reduction of capacity, at a given location, to about 50-70 percent of the capacity that is obtained under well disciplined traffic flow.

- Total traffic stoppage: In this type of failure, traffic is backed up through the entire network of intersections, and no traffic can be discharged out of the tie-up. It is possible, under this condition, that the total amount of traffic moved out of a given area (the beach, for example) becomes far less than that under conditions where traffic is flowing. In fact, no traffic at all may move for some periods.

- Abandoning vehicles is frequently seen in situations no worse than routine large snowfalls. If vehicles are abandoned along the roadways, or in the traffic lanes, they will seriously diminish the capacity of the roadway and cause bottleneck situations.

- Running out of fuel: It is quite likely that in any sort of traffic tie-up, a number of vehicles will find themselves running out of fuel, particularly since there is no time to fill cars with fuel before starting. In this situation, abandoned vehicles along the roadways seriously impair the capacities of those roads.

- Attempting to re-enter area: Despite instructions to the contrary, some motorists will attempt to enter areas being evacuated, in order to gather family members, secure property, etc. Traffic caused by this activity will generate turning movements, could further reduce capacity at critical intersections and will ultimately be added to the total evacuating traffic.

  In the event of spontaneous one-way operation, re-entering traffic would cause a chaotic situation. In such a situation, even a few re-entering vehicles could result in the loss of an entire lane of outbound traffic.

EVACUATION TIMES FOR CASE B: WINTER WEEKDAY

Figure 15 shows the time needed to evacuate the population of the entire Seabrook EPZ under a working day during school hours (Case B: Winter Weekday).

The critical population element in this evacuation time is the auto-owning population; in other words, it is this element of the population that establishes the total evacuation time. Other elements of the population (for example, population in institutions) can be evacuated in less time than the auto-owning population, provided only that vehicles are available for their transport. Consequently, their evacuation does not add to the total evacuation time.

As indicated in Figure 15, the entire EPZ population is evacuated within 3 hours 40 minutes after the start of notification.

<u>Traffic Congestion in a Winter Weekday Evacuation</u>

Traffic congestion occurs on several evacuation routes during a Winter Weekday evacuation. However, under normal weather and traffic control conditions, this congestion dissipates prior to the time that all households have left home and entered the street system. (See upper diagram in Figure 13.) Consequently, evacuation time is determined by the rate at which the population finishes preparations to leave their households, and is not determined by the capacity of the street system.

In a Winter Weekday evacuation, the road system is operating at capacity for a substantial part of the evacuation period. Any appreciable loss of capacity (for example, because of severe weather, uncontrolled traffic flow, etc.) would cause evacuation times to be extended beyond the 3 hours 40 minutes estimated above.

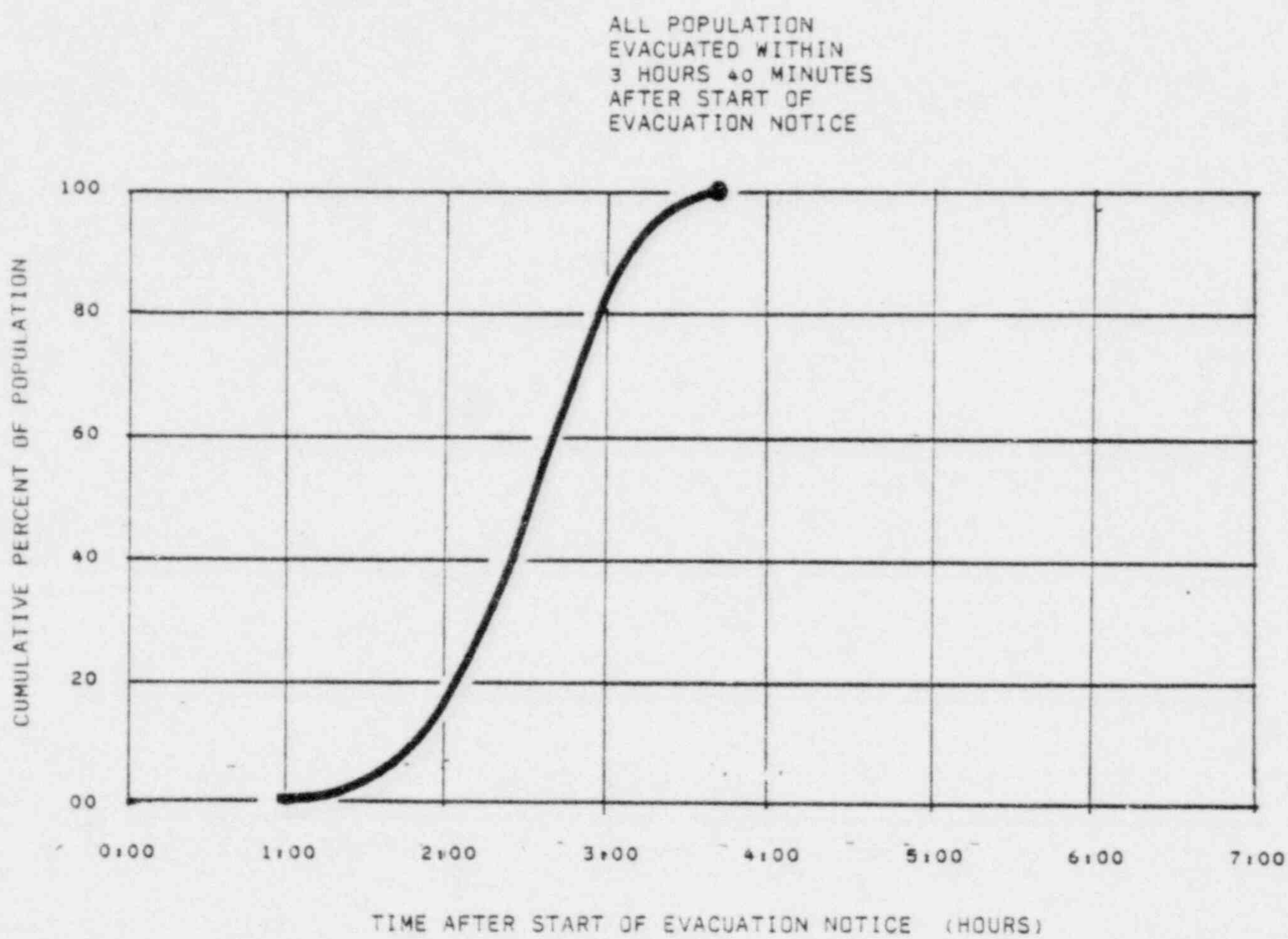


Figure 15. Evacuation Times: Case B, Winter Weekday

EVACUATION OF THE SCHOOL POPULATION

The determining factor in the times for the evacuation of the school population is mobilizing the available school bus fleet. The school population can be notified well in advance of the arrival of school buses. After notification, preparation to leave the school premises is almost immediate (similar to a routine fire drill). Buses will be loaded immediately upon arrival at the schools and will then travel directly out of the EPZ.

A bus fleet large enough to carry the entire school population in a single trip is assumed in estimating these evacuation times. This fleet will be drawn from all districts within or partly within the EPZ. In addition, other buses will be drawn from districts not within the EPZ but in the close vicinity of it.

EVACUATION OF THE NON-AUTO OWNING HOUSEHOLDS

The determining factor in the rate of evacuation for the non-auto owning population is the availability of buses for transporting this segment of the population. The non-auto owning population can be assembled at collection points well in advance of the arrival of buses for their evacuation. Buses will be loaded immediately upon arriving at the collection points, will travel directly to the reception center, and will return to the collection points for a second load.

A bus fleet sufficently large to evacuate the non-auto owning population in two trips is critical to achieving total evacuation times estimated above (6 hours 10 minutes on a Summer Sunday, and 3 hours 40 minutes on a Winter Weekday). If a sufficiently large bus fleet could not be mobilized, and a third trip out of the EPZ were needed (even if by only a few buses), the total evacuation time for the non-auto owning population would increase and could become the critical (i.e., determining) element of the evacuation time.

Interestingly, a bus fleet larger than that needed to carry the non-auto owning population in two trips provides only marginal savings in total evacuation times. For example, a fleet large enough to carry 75 percent of the non-auto owning population at one time would improve total evacuation times by only 10 minutes.

EVACUATION OF THE POPULATION IN INSTITUTIONS

The determining factor in the rate of evacuation for the population in institutions is the availability of buses and ambulances for transporting this segment of the population. The population in institutions can be mobilized for evacuation well in advance of the arrival of buses for their evacuation. Buses would be loaded immediately upon arrival at the institutions, would travel directly to the reception centers, and would return to the institutions for a second load.

A bus (and ambulance) fleet large enough to evacuate the population in institutions in two and three trips, respectively, is critical to achieving the total evacuation times estimated above. If a sufficiently large bus and ambulance fleet could not be mobilized, and additional trips out of the EPZ were needed (even if only by a few vehicles), the total evacuation time for the population in institutions would increase and could become the critical (i.e., determining) factor in evacuation times.

SELECTIVE EVACUATION OF AREAS WITHIN THE EPZ

Depending on wind conditions and the nature of the release at the Seabrook Station, the selective evacuation of the EPZ might be reasonable. Evacuation times for reasonable combinations of sectors within the EPZ are shown in Figure 16.

Evacuations within the two-mile and five-mile radius of the plant could be accomplished in less time than evacuation of the entire EPZ, due primarily to the availability, as evacuation routes, of several north-south roads (for example, US 1, State Route 1A) that would not be fully available to

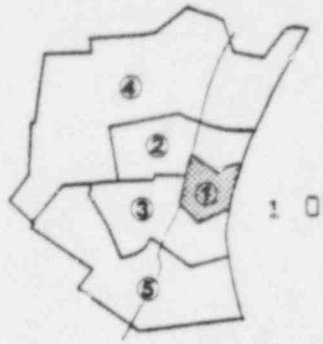
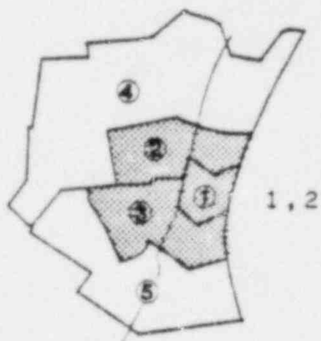
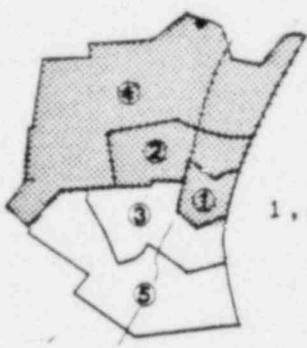
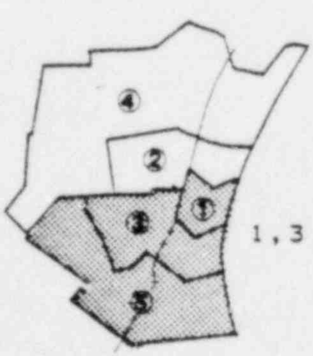
SECTORS	TRIGGERING CONDITIONS	EVACUATION TIME
 1 ONLY	EVACUATION TO 5 MILE RADIUS	5 HOURS 10 MINUTES
 1,2 AND 3	EVACUATION TO 2 MILE RADIUS	5 HOURS 40 MINUTES
 1,2 AND 4	EVACUATION TO 10 MILE RADIUS, NORTHWESTERLY WIND	5 HOURS 10 MINUTES
 1,3 AND 5	EVACUATION TO 10 MILE RADIUS, SOUTHWESTERLY WIND	6 HOURS 10 MINUTES

Figure 16. Selective Evacuation Times

the two-mile and five-mile radius populations in the event of a full EPZ evacuation.

Two possible selective evacuation combinations extend to the 10-mile radius:

1. Sectors 1, 2, and 4, a possible pattern in the event of a northwesterly wind.

2. Sectors 1, 3, and 5, a pattern in response to a southwesterly wind.

For the 10-mile selective evacuation which includes the Newburyport urban area, the total evacuation time is the same as for the evacuation of the full EPZ. This is because the maximum evacuation time for the entire EPZ is established by the level of traffic congestion in the Newburyport urban area, in combination with the beach traffic. In a selective evacuation which includes Newburyport, this same level of congestion and therefore same evacuation time prevail.

For the selective evacuation to the 10-mile radius but not including the urban area of Newburyport, the evacuation time is significantly less than for the full EPZ, and is the same as for the two-mile radius evacuation. This is mainly a reflection of the lack of traffic congestion in the northwest part of the Seabrook Station EPZ.

IMPACT OF 15-MINUTE NOTIFICATION ON EVACUATION TIMES

For the critical time period (Summer Sunday), a 15-minute notification would make almost no noticeable improvement in evacuation times over those estimated with the existing notification system in use. The evacuation time for the Summer Sunday situation is determined almost totally by the rate at which the beaches can be evacuated; speeding up the notification process, under these circumstances, simply accelerates the rate at which motorists enter the existing traffic congestion.

IMPACT OF SEVERE WEATHER ON EVACUATION TIMES

Severe weather, in the form of a major winter storm, would lengthen the normal weather evacuation times to 4 hours and 30 minutes after start of notification (i.e., 40 minutes more than evacuation times under normal weather conditions on a Winter Weekday).

This severe weather evacuation time assumes a slowdown in traffic but no loss in street capacity (i.e., no lanes or streets blocked). The impact of contingencies which cause loss of traffic capacity (i.e., blocked lanes or entire roads) cannot be estimated without specifying the exact nature of the problem. In general, any loss of capacity on any major evacuation route will cause major traffic problems throughout the evacuation period.

SUMMARY OF EVACUATION TIMES

Table 8 summarizes total evacuation times for:

- o Summer Sunday and Winter Weekday cases.
- o Normal weather conditions.
- o Severe weather conditions.
- o Evacuation in which a 15-minute notification is achieved.
- o Selective evacuation of the two-mile radius, five-mile radius, and 10-mile radius.

PROBLEM, ISSUES AND RECOMMENDATIONS

Beach Traffic Congestion

In a Summer Sunday evacuation at the beach area, traffic delay ranges up to a maximum of 4 hours 15 minutes; that is, a vehicle may be stopped for

TABLE 8

EVACUATION TIMES FOR SEABROOK STATION

	Case A Summer Sunday	Case B Winter Weekday
Normal Weather	6 hours 10 minutes	3 hours 40 minutes
Severe Winter Weather	(not applicable)	4 hours 30 minutes
With 15-Minute Notification	6 hours 10 minutes	(not estimated)
2-Mile Radius Selective Evacuation	5 hours 10 minutes	(not estimated)
5-Mile Radius Selective Evacuation	5 hours 40 minutes	(not estimated)
10-Mile Radius, Selective Evacuation to Northwest	5 hours 10 minutes	(not estimated)
10-Mile Radius, Selective Evacuation to Southwest	6 hours 10 minutes	(not estimated)

over four hours in traffic congestion. Most of the traffic caught in congestion is within five miles of the Seabrook Station, with a substantial portion within direct sight of the plant. The behavior of drivers under these conditions of delay and proximity to the Seabrook Station can only be guessed. However, any breakdown in orderly traffic flow will result in evacuation times greater than those estimated. For an evacuation in which traffic control is generally ineffective, total times will range from 10 hours 30 minutes to 14 hours 40 minutes.

Two possible actions can be taken to reduce the rate at which vehicles enter the street system, thereby reducing the length of traffic queues and the amount of time spent in them by motorists:

1. Sequential evacuation of the beach area. Under this strategy, evacuation of the beach area would be staged, with one section cleared before evacuation of the next section begins.

   Sequential evacuation can be managed through selective notification of the population, detailed broadcast information and traffic control.

   Sequential evacuation does not in itself reduce the total evacuation time. However, it reduces the amount of time spent in vehicles by the evacuating population, and it also reduces the chance of a chaotic breakdown in traffic control.

2. Sheltering on the beach. Some of the population may be sheltered in their residences on the beach, thereby reducing the number of vehicles attempting to enter the road system. Sheltering could be done as part of a sequential evaluation, in which sheltered population evacuates as congestion diminishes.

   The radiological exposure trade-off of sheltering vs. waiting in a vehicle stopped in traffic congestion is outside the scope of this analysis. However, available information suggests that exposure risk is high for persons in vehicles.

More Use of I-95

The capacity of I-95, as it presently operates, cannot be fully used in an evacuation. Entry ramps are limited in number and not located ideally for evacuation.

Additional emergency-only ramps could be added to I-95, southbound as well as northbound. These ramps, similar to maintenance-vehicle ramps already in use, would involve minimal construction and would not be used under normal conditions.

Buses for the Transit-Dependent Population

The dominating factor in the evacuation time for the transit-dependent population (i.e., the non-auto owning population and the population in institutions) is the availability of transit buses and ambulances. The estimated evacuation time in this report assumes an availability of vehicles such that half of the ambulatory transit-dependent population can be carried at one time. This assumption of bus availability, however, is far in advance of the actual number of buses secured by the local plans.

The consequences of a smaller fleet are substantial. As the fleet drops below the size necessary to accommodate one-half the ambulatory transit-dependent population at once, a third round-trip by some buses becomes necessary, sharply raising the time needed for evacuation of that population.

In view of the large bus requirements for evacuating the transit-dependent population, it is recommended that:

1. Sources of buses be clearly identified as the local preparedness plan develops, and that a fleet adequate to carry the transit-dependent population in two round-trips be secured (80-90 buses).

2. Reception areas for the transit-dependent population be located as close to the EPZ as possible to minimize the travel time.

VIII. VEHICLES AND MANPOWER REQUIRED FOR EVACUATING THE SEABROOK STATION EPZ

INTRODUCTION

Two resources needed for the evacuation of the Seabrook Nuclear Station EPZ are:

(1) Vehicles

- A. school buses, transit buses and ambulances for transporting persons not having access to a private vehicle for evacuation.
- B. traffic control and towing vehicles

(2) Manpower

- A. drivers for school buses, transit buses and ambulances
- B. tow truck operators
- C. traffic control personnel
- D. supervisory and coordination personnel

VEHICLE REQUIREMENTS

School Buses

A total of 220 school buses are required for the evacuation of the school population in the EPZ. This bus requirement is based on the transportation, in a single trip, of all school population from the EPZ.

School buses will be obtained from all districts within or partly within the EPZ, and from other school districts within about a 20-mile distance from the EPZ (that is, within a 40-mile radius of the Seabrook Station). Privately-owned fleets as well as publicly owned fleets will be mobilized.

Transit Buses

Between 80 and 90 transit buses are required for the evacuation of the non-auto owning households and persons in institutions. The range in this requirement is due to the variation that might occur in the number of persons from non-auto owning households that will be evacuated in private automobiles of friends, neighbors, or relatives. The bus requirement of 80 to 90 vehicles is based on transporting the non-auto owning population and the population in institutions in two trips per vehicle; that is, after carrying the first load of passengers to a reception center, each bus returns to the EPZ for a second load.

Transit buses will be mobilized from private common carrier fleets located in the vicinity of the EPZ, and from public transit fleets in the Portsmouth and Boston urban areas.

Ambulances

Between 80 and 130 ambulances are required for the evacuation of the non-ambulatory population in institutions. The range in this requirement is due to (1) fluctuations in the size of the non-ambulatory population in the EPZ (2) uncertainties as to the fraction of non-ambulatory population that might be evacuated in regular buses and (3) range in the fraction that might be sheltered within the EPZ rather than evacuated from it.

The requirement for 80 to 130 ambulances is based on each ambulance making three trips out of the EPZ.

Ambulances will be mobilized from all sources within the EPZ, including hospitals, nursing homes, rescue units, and private carriers. Ambulances will also be mobilized from all available sources within a 20-25 mile area surrounding the EPZ.

Traffic Control and Towing Vehicles

A total of 77 critical traffic control points have been identified for the routes assumed in this evacuation time estimate. Each of these locations requires a traffic control officer on duty for most of the duration of the evacuation process. Since radio communication with these traffic control points is critical, a need for 77 radio dispatched vehicles is identified for traffic control use at critical locations.

Between 30 and 50 towing vehicles will be needed during most of the evacuation time period. Tow trucks will remove disabled or abandoned vehicles which are blocking evacuation routes.

Tow trucks will be mobilized from the fleet now based within the EPZ, as well as from immediately surrounding areas.

MANPOWER REQUIREMENTS

School Bus, Transit Bus and Ambulance Drivers

Operation of the vehicle fleets as discussed above will require 220 school bus drivers, 80 to 90 transit bus drivers and 80 to 130 ambulance drivers.

Traffic Control

Providing traffic control at the 77 critical intersections in the EPZ will require 77 to 120 traffic control personnel. The range is due to the possibility that more than a single traffic control person will be needed at some locations.

Tow Truck Operators

Operation of the tow truck fleet as described above will require 30 to 50 tow truck operators.

Supervisory and Coordinating Personnel

A total of 360 to 430 persons are needed to conduct the evacuation at the local (town) level. Activities include operation of the notification system, supervision of traffic control, operation of collection points for non-auto owning population, manning of local evacuation headquarters and confirmation of evacuation. This personnel will consist of the local preparedness officers and designated staff.

SUMMARY OF VEHICLE AND MANPOWER REQUIREMENTS

Table 9 summarizes the vehicle and manpower requirements for the evacuation of the Seabrook Station EPZ.

It is stressed that these requirements are for only those activities related directly to transportation, and do not include requirements for many other evacuation activities. For example, vehicle and manpower requirements for such non-transportation activities as notification, public safety, sheltering activity or operation of the reception centers are not included in the requirements summarized in Table 8.

TABLE 9

VEHICLE AND MANPOWER REQUIREMENTS FOR EVACUATING SEABROOK STATION EPZ

RESOURCE	RANGE OF RESOURCES FOR EVACUATION OF ENTIRE SEABROOK STATION EPZ
VEHICLES	
SCHOOL BUSES	220 buses
TRANSIT BUSES	80-90 buses
AMBULANCES	80-139 ambulances
TRAFFIC CONTROL	77 police cruisers
TOWING	30-50 towing vehicles
MANPOWER	
SCHOOL BUS DRIVERS	220 drivers
TRANSIT BUS DRIVERS	80-90 drivers
AMBULANCE DRIVERS	80-130 drivers
TRAFFIC CONTROL	77-120 traffic officers
TOWING OPERATORS	30-50 towing operators
SUPERVISORY AND COORDINATION PERSONNEL	360-430 persons

IX. CONFIRMATION OF EVACUATION

CONFIRMATION PROCESS

The confirmation process measures how effectively the evacuation is being accomplished. Confirmation is conducted by the local civil defense agencies, beginning at about the time at which evacuation was estimated to be complete.

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 coverage of the population: The confirmation process may 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.