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ESTIMATES OF EVACUATION TIME FOR THE SEABROOK NUCLEAR POWER STATION

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FOR NEW HAMPSHIRE PUBLIC SERVICE

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1. INTRODUCTION AND SUMMARY

The purpose of this report is to provide estimates of evacuation times around Seabrook Station. Evacuation time estimates were prepared for Emergency Planning Zones (EPZs) within the two, five, and ten mile radii per Appendix 3 to NUREG-0654/FEMA-RER-1 and Reference b). Figures 1 through 10 (in Section 2) indicate the areas for which evacuation time estimates were made. Time estimates for three area conditions were developed. First, estimates are made for the fair weather summer weekend during which the peak population condition for the area is experienced. Second, estimates are made for an off-season, typical weekday population condition. Third, estimates are made for the off-season, typical weekday condition and an assumed reduction in the capacity of the evacuation road netowrk of 30%, which is intended to represent impediments to traffic flow during adverse weather such as fog, rain, or snow. Estimates of the number of vehicles associated with an evacuation of the permanent and transient population were developed assuming a general evacuation by private passenger vehicle.

A summary of the time estimates for the evacuation cases considered is presented in Table 4. These estimates assumed no formal traffic control measures would be in effect, existing traffic patterns would prevail, and no specified evacuation routings would be enforced[1]. These clear time calculations were undertaken using available data

(1) As area evacuation plans are developed, additional analyses can be performed to account for and actually assist in specifying emergency evacuation control measures.

and a traffic simulation model, EVAC. This model is described in an appendix to this report.

2. STUDY AREA

2.1 Communities Within 2, 5, and 10 Miles

The area within a 10 mile radius of Seabrook Station includes portions of both New Hampshire and Massachusetts. Areas within approximately two, five and ten miles of Seabrook Station were analyzed:

- 2 Mile Radius

  The two mile radius falls entirely within New Hampshire. It includes portions of three communities: Hampton, Hampton Falls and Seabrook.

- 5 Mile Radius

  The town of Seabrook is entirely within this radius, as are portions of five other New Hampshire communities including North Hampton, Hampton, Hampton Falls, Kensington, and South Hampton. In addition, portions of two Massachusetts communities, Amesbury and Salisbury, are within the five mile radius.

- 10 Mile Radius

  In addition to the above noted communities, East Kingston and portions of Newton, Kingston, Brentwood, Exeter, Newfields, Stratham, Greenland, Portsmouth and Rye (New Hampshire) and portions of Merrimac, Haverhill, West Newbury, Newburyport and Newbury (Massachusetts) are within the 10 mile radius of Seabrook Station.

2.2 Sector Analyses

Figures 1 to 10 show the geographical bounds of the cases for which evacuation clear time estimates have been compiled. The following is a brief description of these study areas. The areas are roughly based upon the 2, 5 and 10 mile radii and various 90^{o} and 180^{o} sectors. The precise bounds of the analysis areas, however, largely follow town boundaries and major geographic landmarks such as the coastal beaches or major highways. This should be noted as it produces slightly modified and expanded geographical areas for evacuation estimate than requested by the NRC in Reference b).

Figure	Sectors/Distance	Boundaries
1	180^{o} North, 0 to 2 miles	Hampton Falls, Hampton
2	180^{o} South, 0 to 2 miles	Seabrook
3	90^{o} Northeast, 0 to 5 miles	North Hampton, Hampton, and Hampton Falls east of I-95
4	90^{o} Southeast, 0 to 5 miles	Seabrook and Salisbury
5	90^{o} Southwest, 0 to 5 miles	South Hampton, Amesbury, and western portions of Salisbury and Seabrook
6	90^{o} Northwest, 0 to 5 miles	Hampton Falls, Kenginston
7	90^{o} Northeast, 0 to 10 miles	North Hampton, Hampton, Hampton Falls east of I-95, and portions of Greenland and Rye within 10 mile radius
8	90^{o} Southeast, 0 to 10 miles	Seabrook, Salisbury, Newburyport, and Newbury
9	90^{o} Southwest, 0 to 10 miles	South Hampton, Amesbury, Merrimac, West Newbury, and portions of Newton and Seabrook
10	90^{o} Northwest, 0 to 10 miles	Seabrook, Hampton Falls, Kensington, South Hampton and portions of Newton, Exeter and Stratham and Seabrook

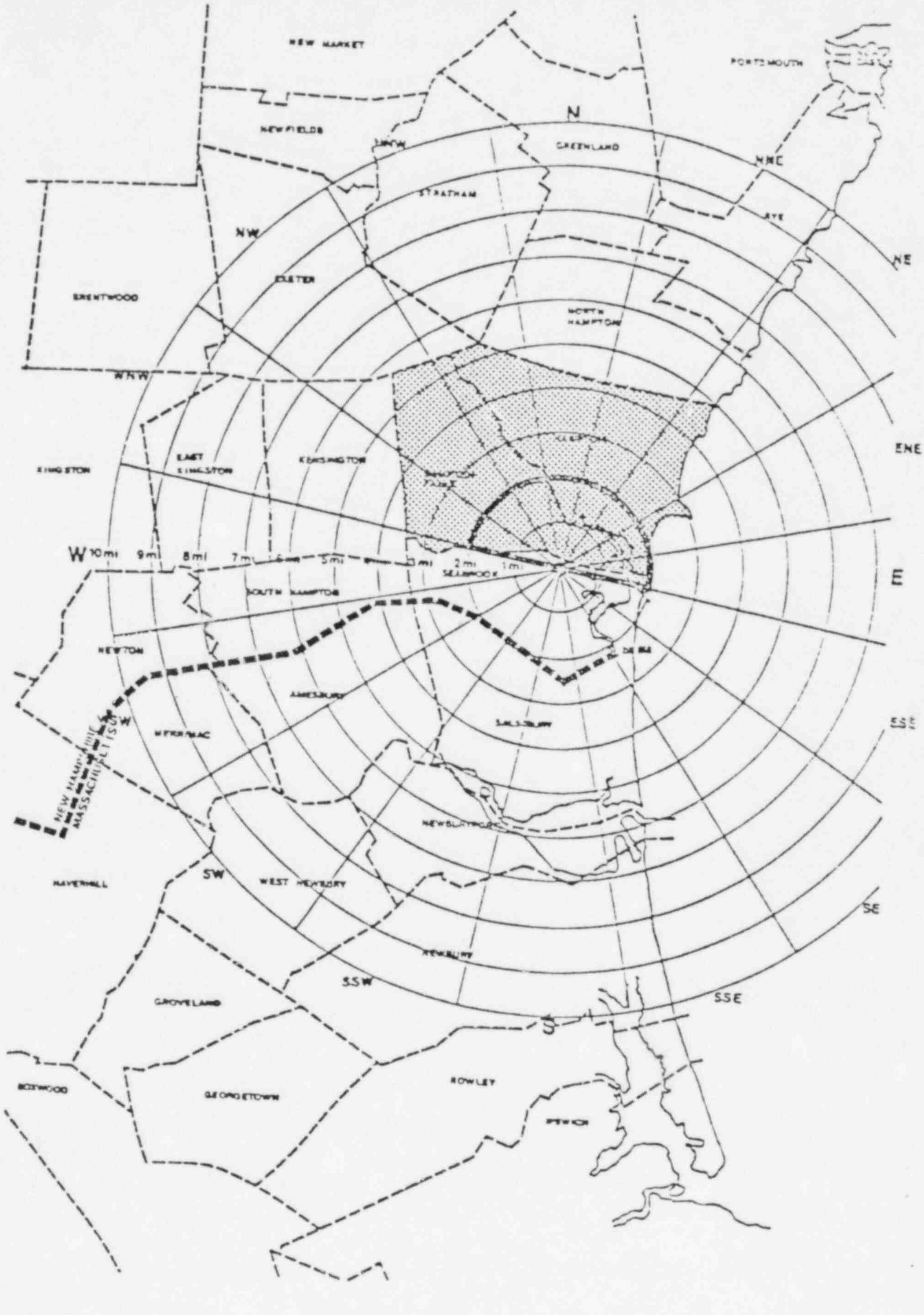

FIGURE 1 - 180° North, 0 to 2 Miles

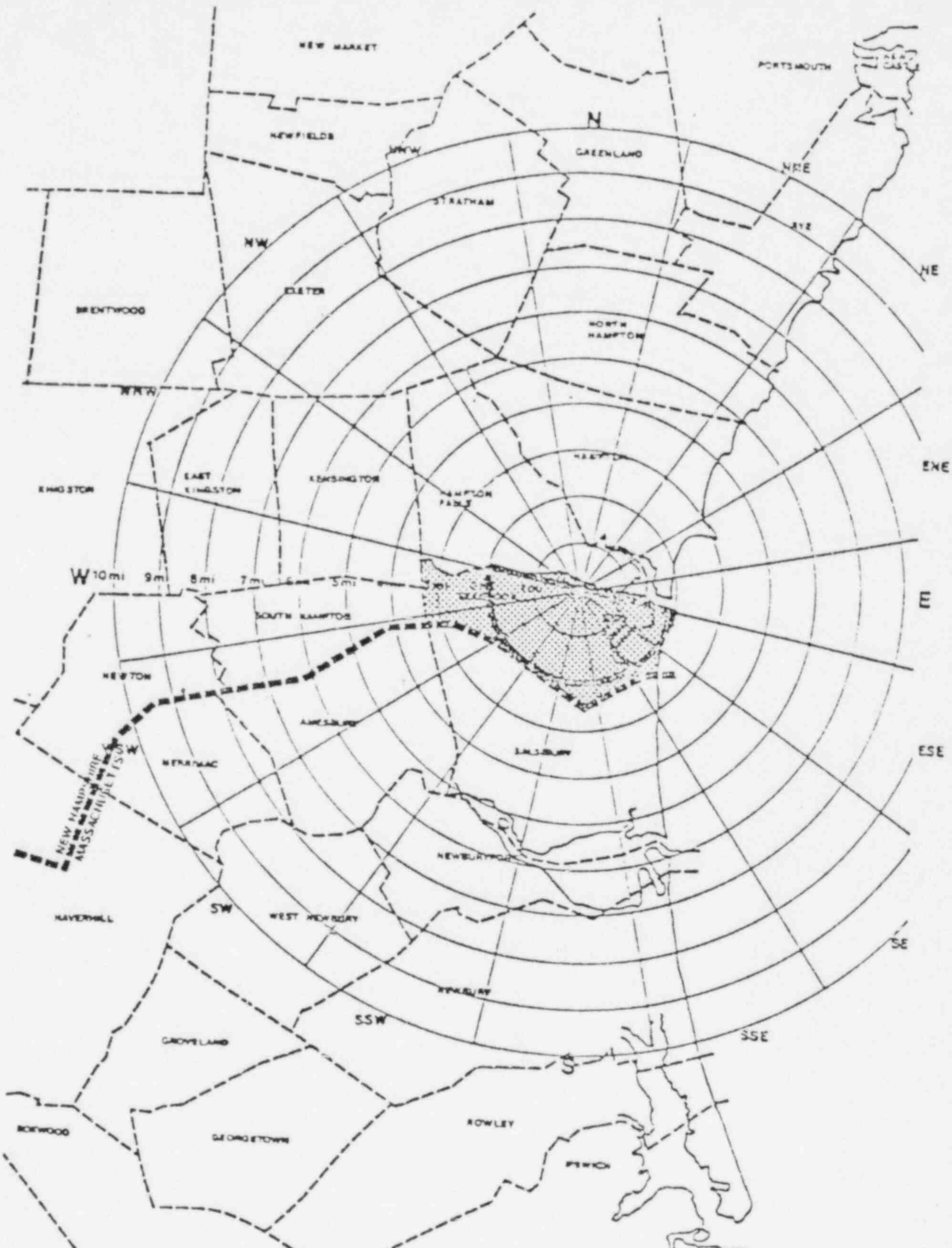

FIGURE 2 - 180° South, 0 to 2 Miles

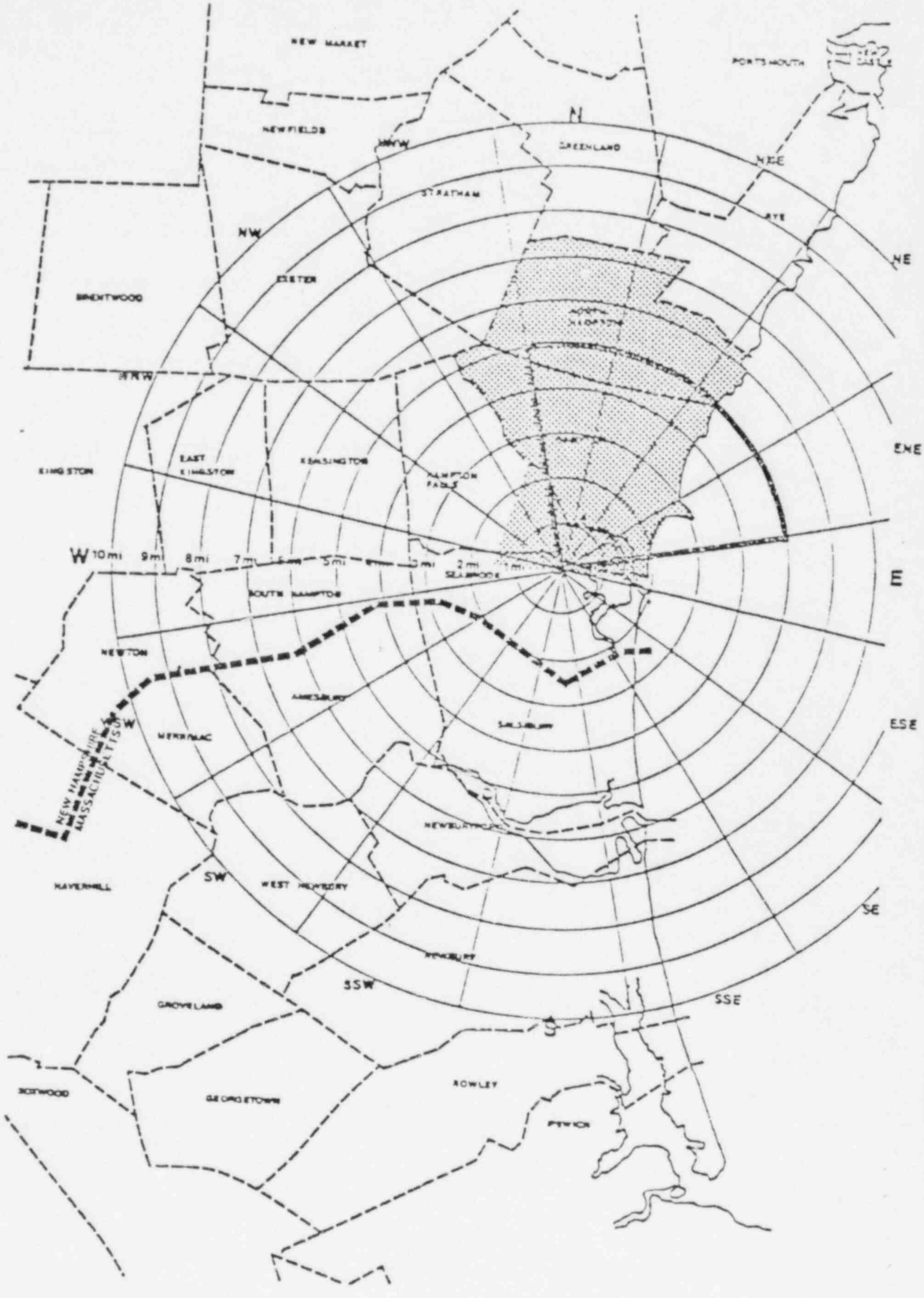

FIGURE 3 - 90° Northeast, 0 to 5 Miles

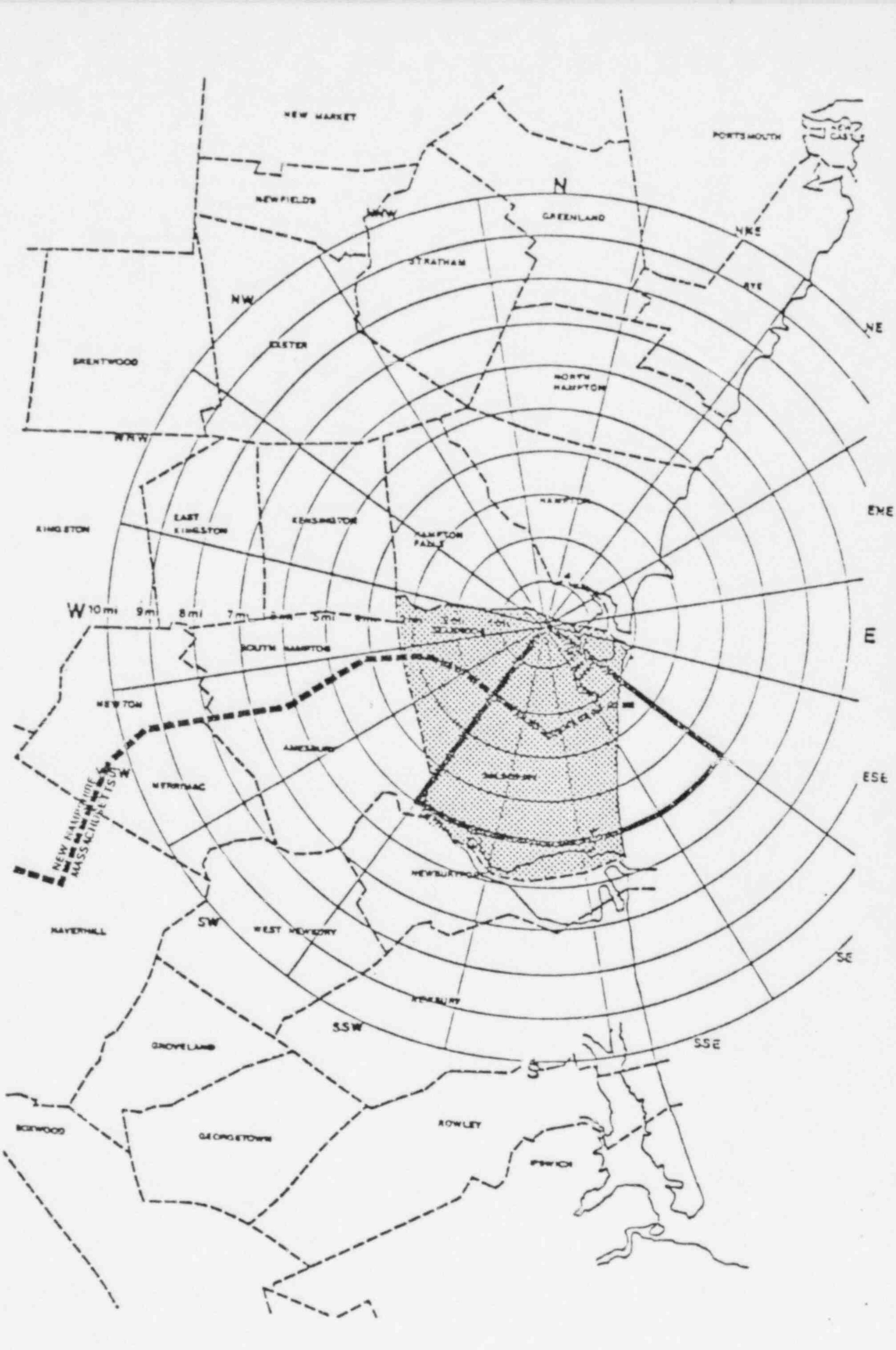

FIGURE 4 - 90° Southeast 0 to 5 Miles

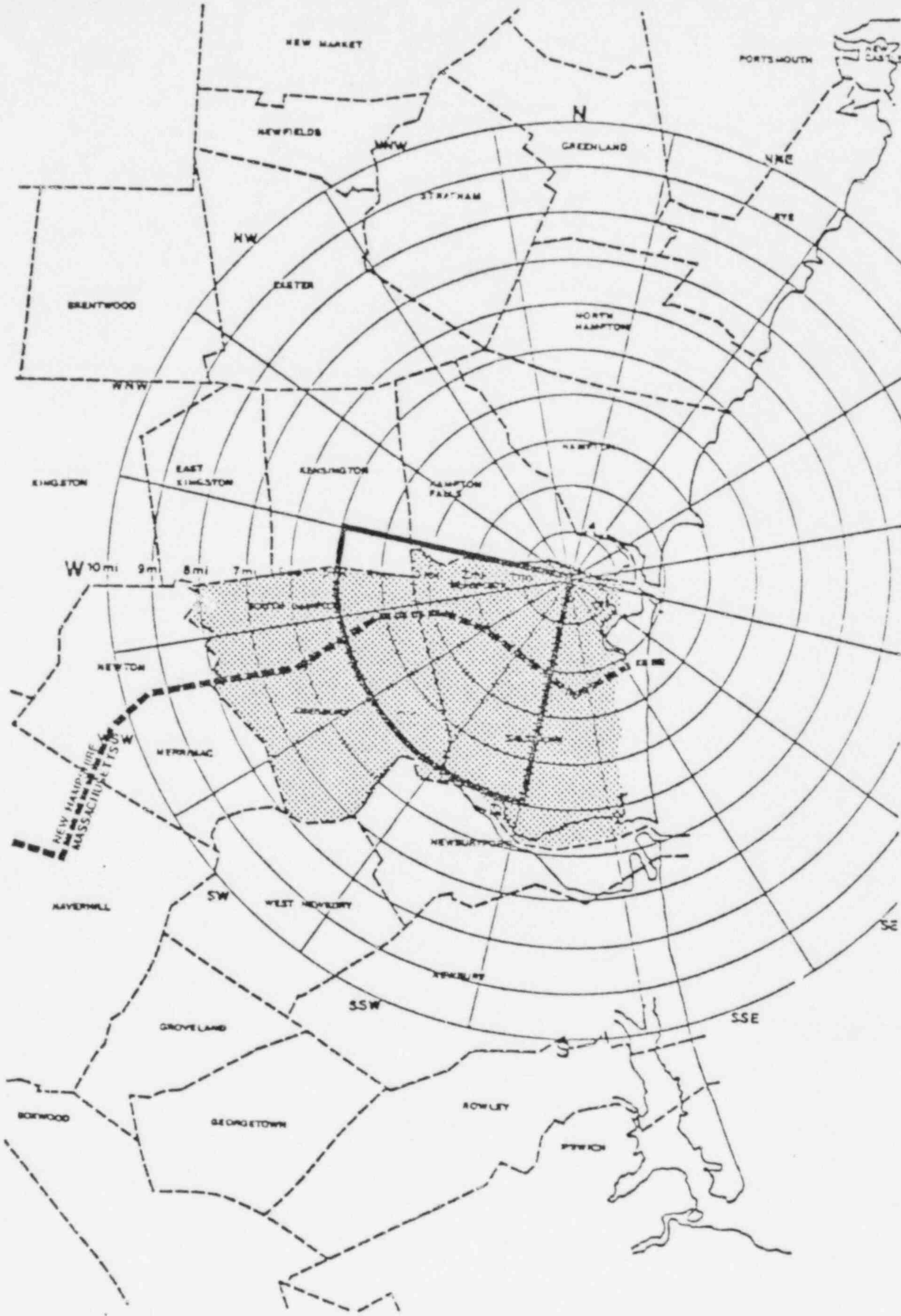

FIGURE 5 - 90° Southwest, 0 to 5 Miles

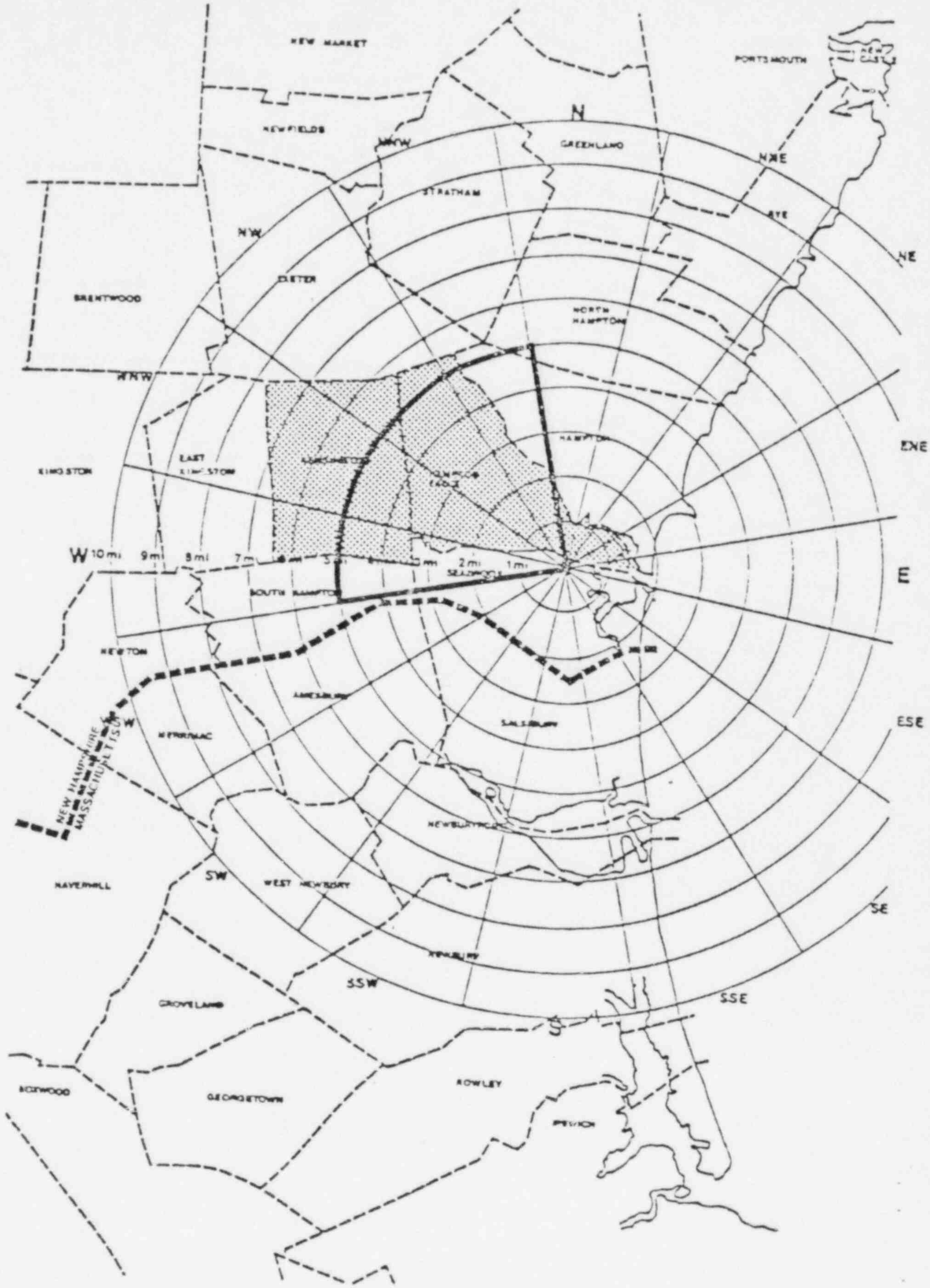

FIGURE 6 - 90° Northwest, 0 to 5 Miles

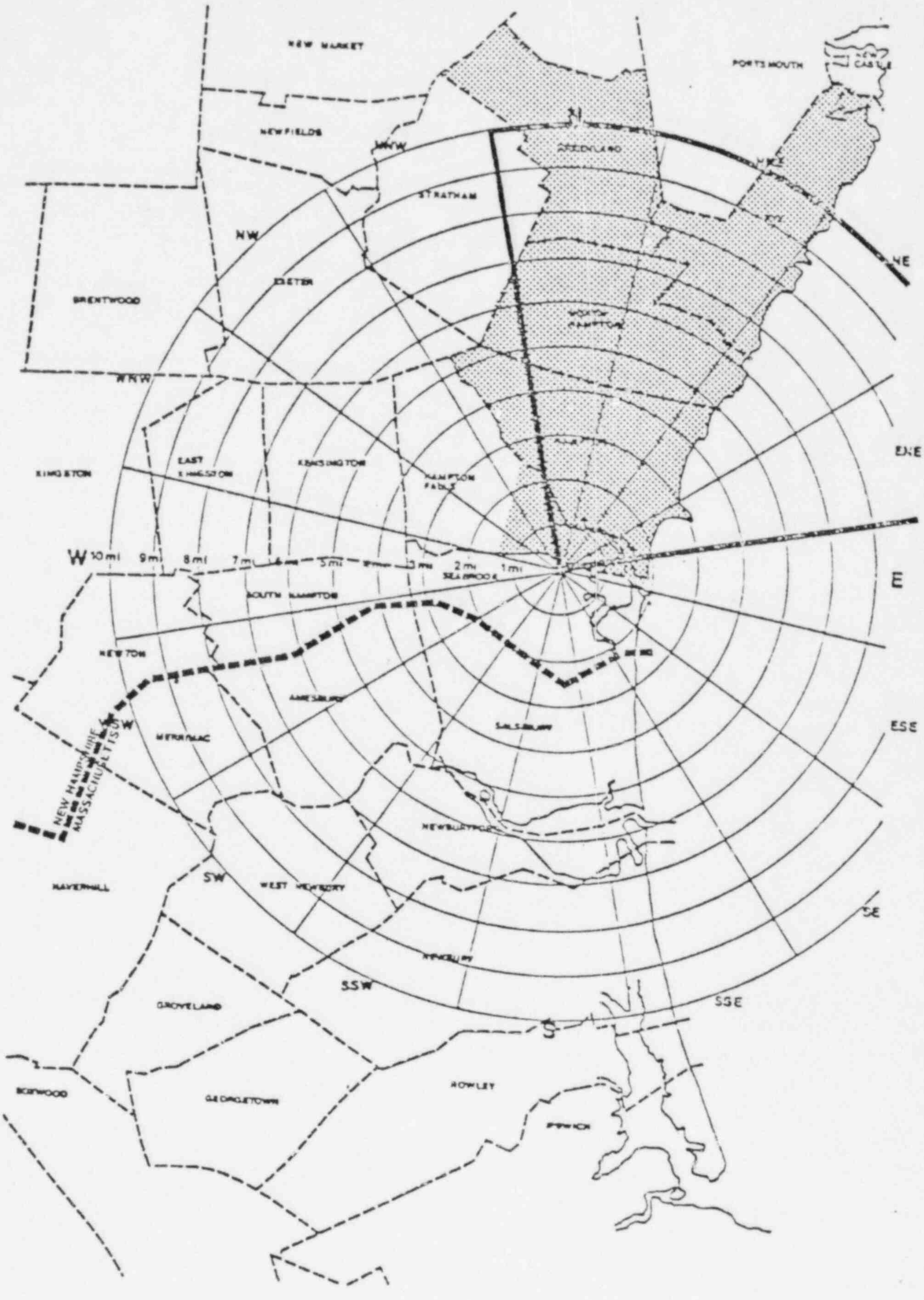

FIGURE 7 - 90° Northeast, 0 to 10 Miles

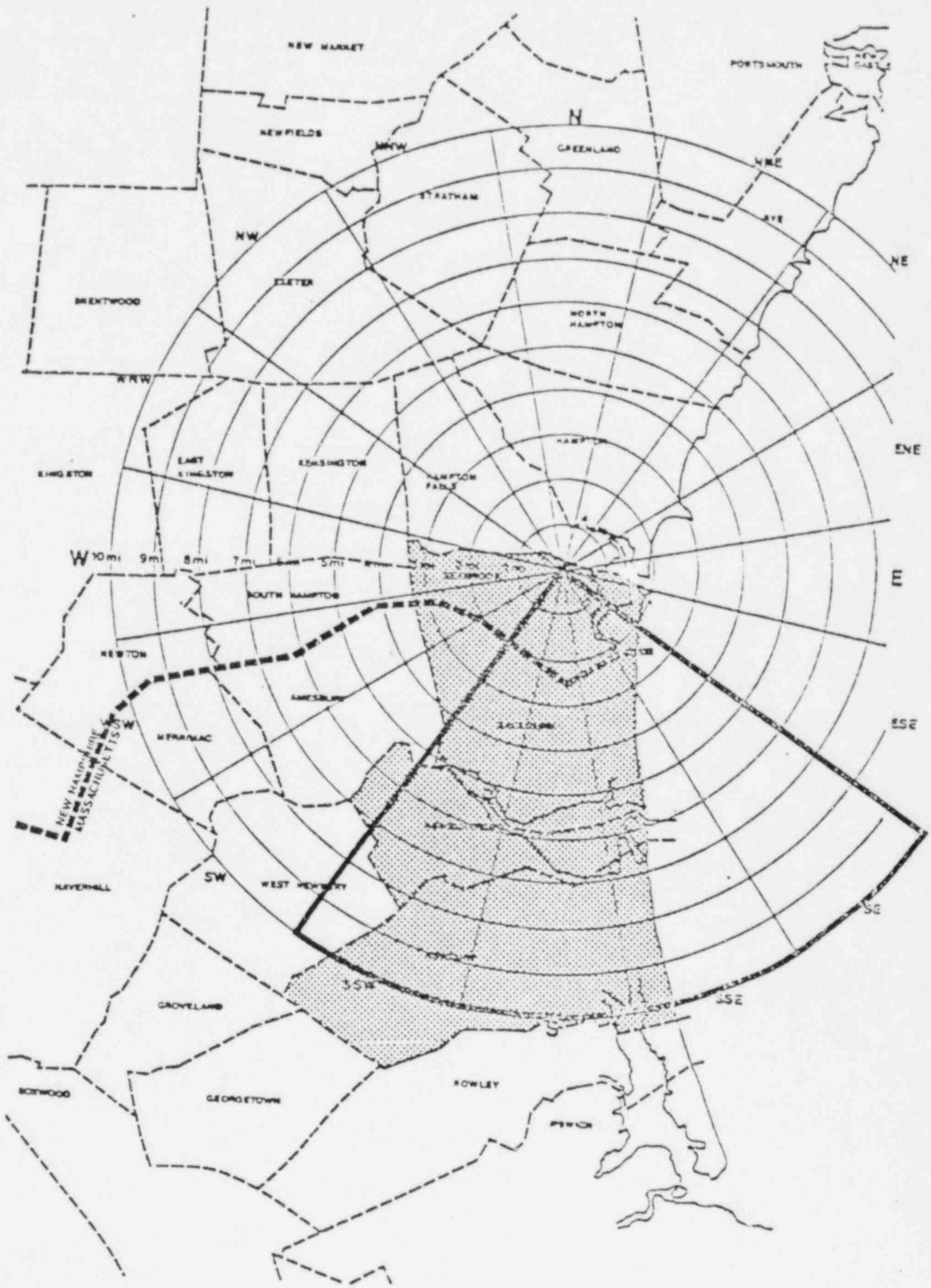

FIGURE 8 - 90° Southeast, 0 to 10 Miles

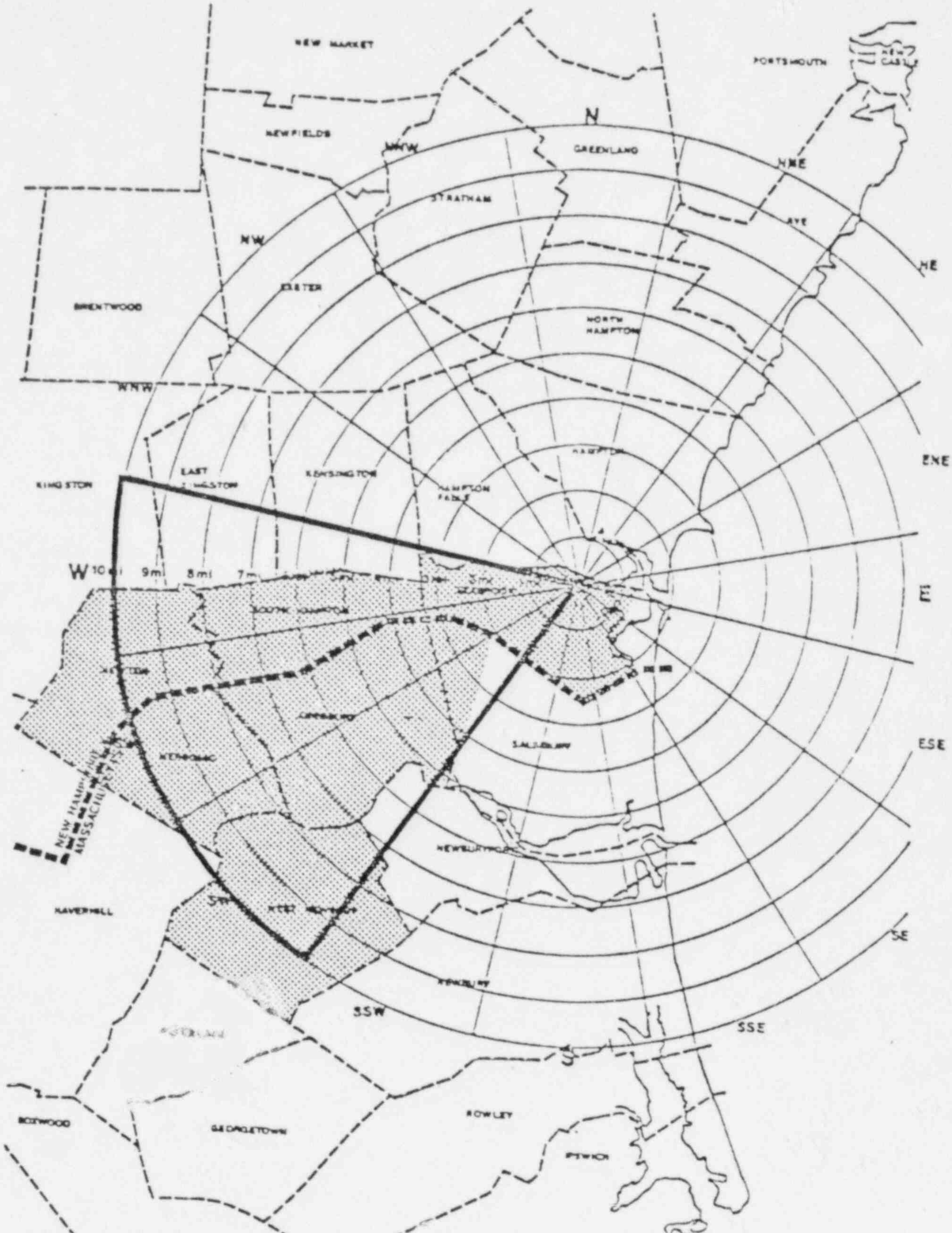

FIGURE 9 - 90° Southwest, 0 to 10 Miles

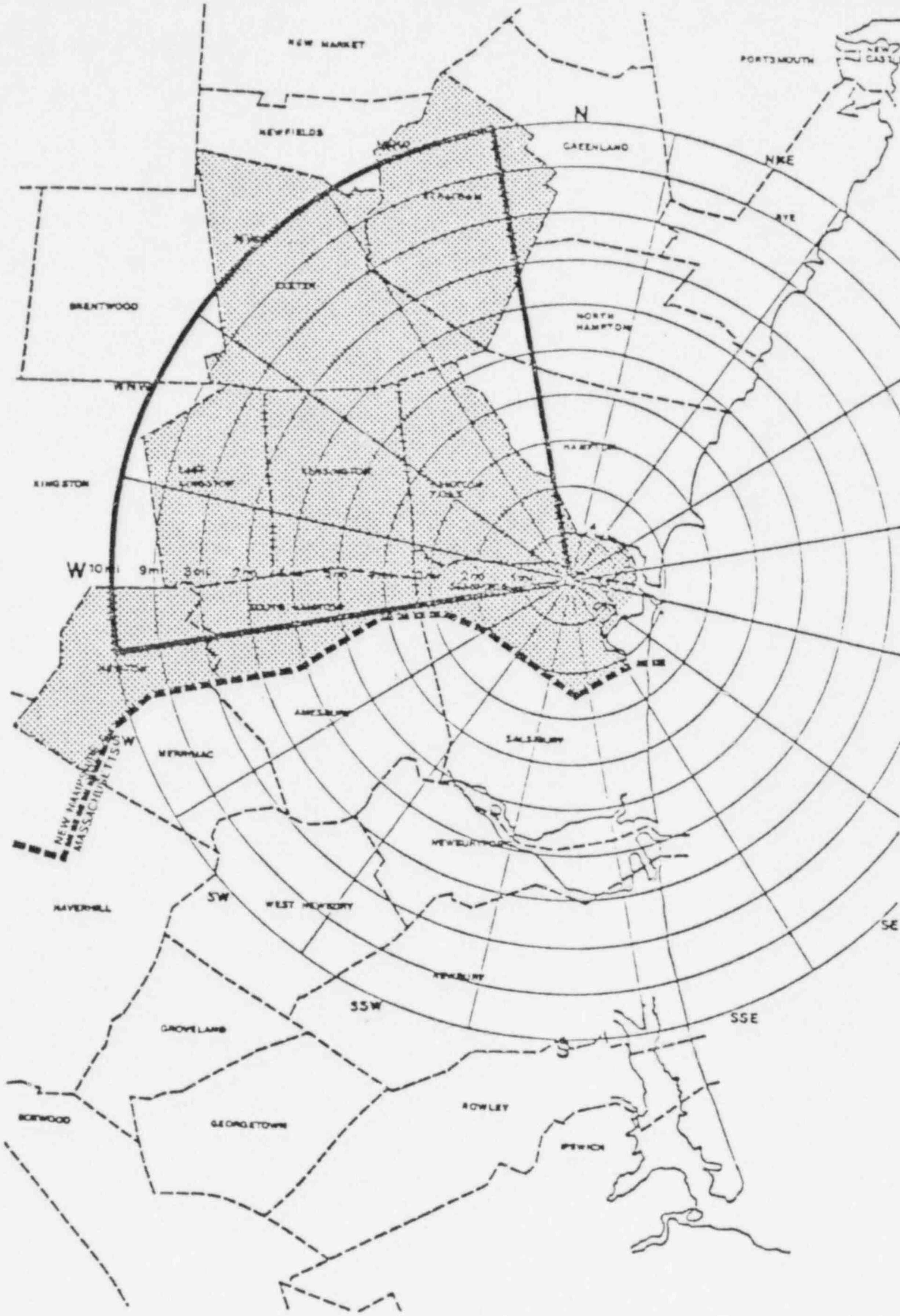

FIGURE 10 - 90° Northwest, 0 to 10 Miles

3. EVACUATION NETWORK

An inventory of physical and operational characteristics of the traffic network likely to be used by departing persons was undertaken in order to estimate evacuation times.

The transportation network elements considered in the modeling consist of major streets and intersections within the study area(1). Figure 11 shows the major aspects of this road network. The major streets within the 10-mile study area include roadways of the following classifications:

- Expressways. As characterized by high design standards, limited access, grade separation and primarily through traffic. Routes I-95, I-495 and the Hampton-Exeter Expressway, which is two lanes running east-west between Exeter and beach area of Hampton, are the expressways found in the 10-mile radius of the site.

- Arterial Streets. As characterized by continuity of travel; connecting business, population, or major recreation areas, and traffic controls and geometric designs which enhance traffic flow and safety. Examples of main arterials in the evacuation area include U.S. Route 1, Massachusetts Route 110, New Hampshire 286, and Route 1A in New Hampshire and Massachusetts.

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(1) The study area has been designed to be consistent with the plume exposure emergency planning zone (EPZ) suggested by the Nuclear Regulatory Commission (NRC). The plume exposure EPZ as defined by NRC is the area within approximately 10 miles of the station site.

Collector Streets are links between residential areas served by local roads and arterial streets. These are characterized by low design standards and frequent stops at minor intersections. Examples of collector streets include Depot and Walton Roads in Seabrook, Woodland and Mill Roads in Seabrook, and Congress Street in Amesbury and Salisbury.

A total of 435 links, representing actual road segments, are included in the evacuation road network. A total of 211 major intersections have been included in the network.

For modeling purposes, certain intersections in the network are designated as "entry nodes," or points where automobiles enter the network. These entry nodes act as surrogates for all the parking lots, driveways, etc. from which the evacuating automobiles originate. In the Seabrook evacuation network, the number of vehicles enter at 136 entry nodes. Once in the network, vehicle volumes are modeled to travel along the network links and intersections as they evacuate the designated area (i.e., analysis areas as indicated on Figures 1 to 10).

At certain points just outside the study area, "exit nodes" are located. At these exit nodes, are used to record the number of vehicles leaving the evacuation network.

A description of the EVAC traffic simulation model and input requirements is included as Appendix A.

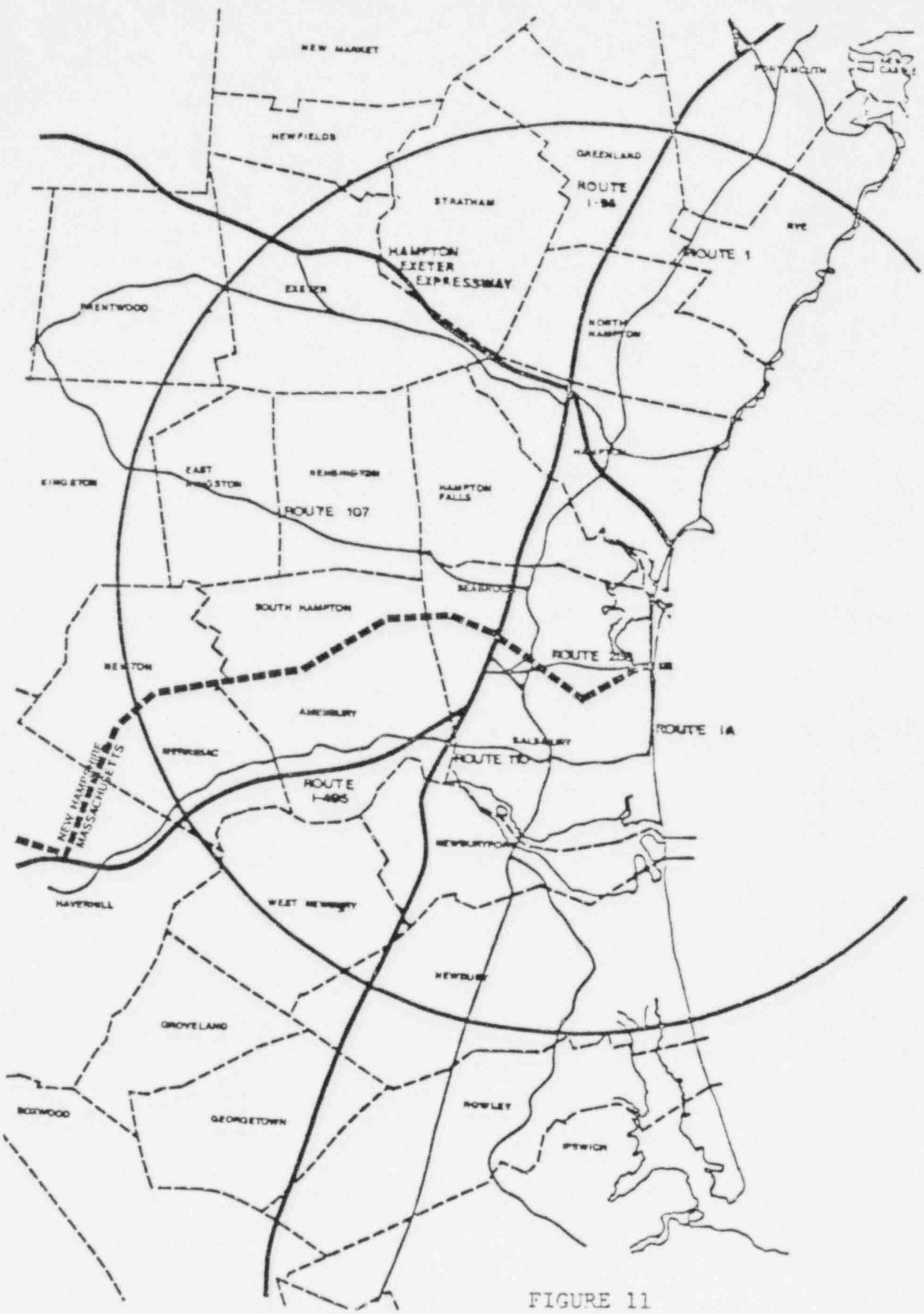

FIGURE 11

MAJOR ROUTES IN 10 MILE STUDY

4. POPULATION AND AUTOMOBILE DATA USED FOR CLEAR TIME ESTIMATES

In order to estimate the evacuation times, 1983 summer and off-season vehicle demands were developed for areas within the 10-mile EPZ. For Seabrook the total vehicle demands were developed based on a review of three components of population: permanent resident, seasonal resident, and dialy transient population. These data provided the basis for estimating the potential number of vehicles involved in a general evacuation.

Since the study area has a significant influx of population in the beach area during the summer period, a vehicle demand estimate for a summer weekend condition was made and used for this evacuation time analysis. This estimate is representative of peak total population in the study area. A second vehicle demand estimate was made for a winter weekday condition. This second demand estimate was used to evaluate evacuation times under both typical and adverse weather conditions. The vehicle demand estimates are described below for both the summer and off-season periods.

Summer Vehicle Demand Estimate

Permanent Population

Table 1 provides a summary of the projected 1983 permanent population for communities in the vicinity of the site. Appendix B includes a figure indicating the general distribution of this permanent population (note Figure B-1). This distribution of population for the

area within the five mile radius of Seabrook Station was based on the number of year-round electric meters in 1979. Equal area allocation and review of local USG maps provided the basis for distributing the population between the 5 and 10 mile radii[1]. Vehicle demand estimates for the permanent population by an average automobile occupancy factor of 3.0 persons[2]. Figure 12 shows the resulting estimate of automobiles and their distribution.

Seasonal Residents

The seasonal resident vehicle demand was estimated from the number of seasonal residences in the area. Several sources of data were reviewed in order to develop this estimate. These sources included: (1) 1961 general highway maps of Rockingham County, NH; (2) 1970 U.S. Census of Housing, (3) 1978-79 electric meter use data and a 1978 weekday-weekend occupancy survey.

The distribution and number of automobiles associated with the summer weekend seasonal resident population is shown on Figure 13, which assumes two vehicles per seasonal unit.

Daily Transient Population

In addition to the permanent and seasonal resident populations a large influx of daily transients to the beach area can be observed

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(1) i.e. population was assigned proportional to the size of the area to which it was assigned, or distributed evenly over each town.

(2) 1970 U.S. Census of Housing, persons per occupied dwelling: New Hampshire - 3.5, Massachusetts - 3.1, Rockingham County, New Hampshire - 3.3.

during the summer period. This influx is greatest on a fair weather weekend or holiday. Estimates of daily transient visitor vehicle demand are included as Figures in Appendix B. Automobiles associated with the daily transient component were estimated as follows:

• Overnight Accommodations (Hotels & Motels)	- 1 vehicle per unit (Figure B-2)
• Campgrounds	- 1 vehicle per campsite (Figure B-2)
• Beaches and Beach Area Facilities	- Capacity estimate of fee and free parking lots available to the general public and estimate of on-street parking (Figure B-3)
• Seabrook Greyhound Park	- Capacity estimate of lot (Figure B-4)
• Seabrook Station	- Estimate of 2000 vehicles (Figure B-4)
• Route 1	- Capacity estimate of major shopping facilities (Figure B-5)

Table 2 provides a summary of vehicle demand estimates associated with the summer transient population (seasonal residents, overnight visitors and daily transients). Figure 14 shows the distribution of this estimated vehicle demand. These estimates were combined with the automobile demand related for the permanent population to obtain the estimated total number of vehicles which would be evacuated.

Off-Season Vehicle Demand Estimate

A similar approach to estimate vehicle demand during an off-season period was used. The off-season automobile estimate included consideration of the same components of population as noted above for

the summer case. Automobile demand for the permanent population was estimated in the same manner as for the summer case. However, a smaller seasonal resident component was also included to account for some off-season rentals and general use. This was estimated at one vehicle per unit associated with 10% of the total seasonal units (Figure B-6). The off-season daily transient automobile demand estimated also included:

- o Overnight Accommodations - 1 vehicle per unit for units open year-round (Figure B-7)
- o Seabrook Greyhound Park, Seabrook Station and Route 1 Major Shopping - Same as estimate for summer periods (Figure B-4 and B-5)
- o Major Employers - Estimated at 1 vehicle per employee for major manufacturers (Figure B-8)

Table 3 provides a summary of the estimated vehicle demand for the seasonal resident and daily transient population components. Figure 15 shows the distribution of this off-season automobile demand. These estimates were combined with those for the permanent resident population to obtain the total number of automobiles to be evacuated for the off-season case modeled in this report.

TABLE 1

POPULATIONS OF MUNICIPALITIES WHOLLY OR PARTIALLY WITHIN 10 MILES OF THE SITE

	1970[1]	1980[2]	1983[4]
New Hampshire			
Brentwood[5]	1,468	2,170	2,668
East Kingston	838	1,190	1,376
Exeter	8,892	10,720	11,230
Greenland	1,784	2,210	2,564
Hampton	8,011	10,820	12,278
Hampton Falls	1,254	1,500	1,602
Kensington	1,044	1,350	1,518
Kingston[5]	2,882	4,640	5,018
Newfields[5]	843	1,000	1,060
Newton	1,920	4,060	4,678
North Hampton	3,259	4,910	5,888
Portsmouth[5]	25,717	28,430	28,580
Rye	4,083	5,230	6,034
Seabrook	3,053	6,000	6,672
South Hampton	558	800	920
Stratham	1,512	2,500	3,040
Massachusetts			
Amesbury	11,388	16,560[3]	17,000
Haverhill[5]	46,120	46,340	47,300
Merrimac	4,245	4,710	4,800
Newbury	3,804	4,920	5,010
Newburyport	15,807	16,740	17,000
Salisbury	4,179	5,150	5,250
West Newbury	2,254	2,690	2,750

(1) U.S. Census of Population, 1970.

(2) Interim Revision, New Hampshire Population Projections for Towns and Cities to the Year 2000. August, 1977. NH Office of Comprehensive Planning. Projected 1980 populations for East Kingston, Exeter, Seabrook, and Stratham are less than 1978 population estimates for the same communities, Rockingham and Stratford County Population Data: 1978 Estimates - Rockingham Stratford Census Project. This is also noted for these same communities and Portsmouth in the 1978 Population Estimates of N.H. Cities and Towns prepared by the NH Office of Comprehensive Planning, August 1979.

(3) Population Projections 1980-1985, Massachusetts Department of Public Health, Office of State Health Planning, August, 1978.

(4) Estimates based on same sources indicated on footnotes (2) and (3) and interpolated for 1983.

(5) Permanent population of these municipalities not included in clear time estimates because only small portions lie within the 10 mile EPZ.

TABLE 2

SUMMARY - ESTIMATE OF VEHICLES ASSOCIATED WITH SUMMER TRANSIENT POPULATION (Seasonal Residents, Overnight Visitors, and Daily Transients) - 1983
Seabrook Station

Sector	Population Type	Distance (in miles) from Seabrook Station 0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10
N	Seasonal	0	10	24	22	8	76	16	16	16	30
	Overnight Accommodations	0	0	92	23	61	0	0	0	0	0
	Beach Area Parking Lots and on-street Parking	0	0	0	0	0	0	0	0	0	0
	Campgrounds	0	0	125	0	0	190	0	0	0	0
	Total	0	10	241	45	69	266	16	16	16	30
NNW	Seasonal	0	26	16	14	10	46	30	30	22	22
	Overnight Accommodations	0	30	0	0	0	0	0	0	0	0
	Beach Area Parking Lots and on-street Parking	0	0	0	0	0	0	0	0	0	0
	Campgrounds	0	0	0	0	0	0	0	0	0	0
	Total	0	56	16	14	10	46	30	30	22	22
NW	Seasonal	0	14	20	16	14	8	16	60	60	8
	Overnight Accommodations	0	0	0	0	0	0	0	35	55	0
	Beach Area Parking Lots and on-street Parking	0	0	0	0	0	0	0	0	0	0
	Campgrounds	0	0	0	0	300	0	0	148	0	0
	Total	0	14	20	16	314	8	16	243	115	8
WNW	Seasonal	0	2	10	4	22	22	26	30	34	38
	Overnight Accommodations	0	0	0	0	0	0	0	0	0	0
	Beach Area Parking Lots and on-street Parking	0	0	0	0	0	0	0	0	0	0
	Campgrounds	0	0	0	0	0	0	0	0	0	0
	Total	0	2	10	4	22	22	26	30	34	38

TABLE 2 (Continued)

SUMMARY - ESTIMATE OF VEHICLES ASSOCIATED WITH SUMMER TRANSIENT POPULATION (Seasonal Residents, Overnight Visitors, and Daily Transients) - 1983
Seabrook Station

Sector	Population Type	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10
		Distance (in miles) from Seabrook Station									
W	Seasonal	2	20	6	8	22	16	30	30	38	38
	Overnight Accommodations	0	80	0	0	0	0	0	0	0	0
	Beach Area Parking Lots and on-street Parking	0	0	0	0	0	0	0	0	0	0
	Campgrounds	0	0	0	0	0	0	0	0	0	0
	Seabrook Greyhound Park	0	0	3077	0	0	0	0	0	0	0
	Seabrook Station	2000	0	0	0	0	0	0	0	0	0
	Total	2002	100	3083	8	22	16	30	30	38	38
WSW	Seasonal	0	28	30	8	30	38	10	10	20	20
	Overnight Accommodations	0	45	0	0	0	0	0	0	0	0
	Beach Area Parking Lots and on-street Parking	0	0	0	0	0	0	0	0	0	0
	Campgrounds	0	0	0	0	0	0	0	244	0	0
	Total	0	73	30	8	30	38	10	254	20	20
SW	Seasonal	2	26	12	4	72	28	2	2	2	2
	Overnight Accommodations	0	28	0	0	60	28	0	0	0	0
	Beach Area Parking Lots and on-street Parking	0	0	0	0	0	0	0	0	0	0
	Campgrounds	0	0	0	0	0	0	0	0	0	0
	Total	2	54	12	4	132	56	2	2	2	2
SSW	Seasonal	4	8	14	16	14	150	150	38	18	18
	Overnight Accommodations	0	0	23	0	0	11	0	0	0	0
	Beach Area Parking Lots and on-street Parking	0	0	0	0	0	0	0	0	0	0
	Campgrounds	0	0	0	0	0	0	0	0	0	0
	Total	4	8	37	16	14	161	150	38	18	18

TABLE 2 (Continued)

SUMMARY - ESTIMATE OF VEHICLES ASSOCIATED WITH SUMMER TRANSIENT POPULATION (Seasonal Residents, Overnight Visitors, and Daily Transients) - 1983
Seabrook Station

Sector	Population Type	Distance (in miles) from Seabrook Station 0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10
S	Seasonal	4	10	36	30	64	26	412	26	26	26
	Overnight Accommodations	0	0	0	5	208	0	29	0	0	0
	Beach Area Parking Lots and on-street Parking	0	0	0	0	0	0	0	0	0	0
	Campgrounds	0	75	0	0	80	0	0	0	0	0
	Total	4	85	36	35	352	26	441	26	26	26
SSE	Seasonal	0	6	172	514	604	0	560	560	0	0
	Overnight Accommodations	0	0	0	40	196	8	0	29	0	0
	Beach Area Parking Lots and on-street Parking	0	0	0	1280	1813	2029	514	599	71	0
	Campgrounds	0	0	0	0	485	0	0	0	0	0
	Total	0	6	172	1834	3098	2037	1074	1188	71	0
SE	Seasonal	0	22	440	0	0	0	0	0	0	0
	Overnight Accommodations	0	0	0	0	0	0	0	0	0	0
	Beach Area Parking Lots and on-street Parking	0	0	698	0	0	0	0	0	0	0
	Campgrounds	0	0	0	0	0	0	0	0	0	0
	Total	0	22	1138	0	0	0	0	0	0	0
ESE	Seasonal	0	724	0	0	0	0	0	0	0	0
	Overnight Accommodations	0	0	0	0	0	0	0	0	0	0
	Beach Area Parking Lots and on-street Parking	0	966	0	0	0	0	0	0	0	0
	Campgrounds	0	0	0	0	0	0	0	0	0	0
	Total	0	1690	0	0	0	0	0	0	0	0

TABLE 2 (Continued)

SUMMARY - ESTIMATE OF VEHICLES ASSOCIATED WITH SUMMER TRANSIENT POPULATION (Seasonal Residents, Overnight Visitors, and Daily Transients) - 1983
Seabrook Station

Sector	Population Type	Distance (in miles) from Seabrook Station 0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10
E	Seasonal	0	690	0	0	0	0	0	0	0	0
	Overnight Accommodations	0	429	0	0	0	0	0	0	0	0
	Beach Area Parking Lots and on-street Parking	0	2808	0	0	0	0	0	0	0	0
	Campgrounds	0	0	0	0	0	0	0	0	0	0
	Total	0	3927	0	0	0	0	0	0	0	0
ENE	Seasonal	0	948	1102	104	0	0	0	0	0	0
	Overnight Accommodations	0	1156	849	0	0	0	0	0	0	0
	Beach Area Parking Lots and on-street Parking	0	2439	870	59	0	0	0	0	0	0
	Campgrounds	0	0	0	0	0	0	0	0	0	0
	Total	0	4543	2821	163	0	0	0	0	0	0
NE	Seasonal	0	122	162	1088	492	24	72	72	48	24
	Overnight Accommodations	0	0	82	250	22	0	0	108	32	26
	Beach Area Parking Lots and on-street Parking	0	0	0	982	664	179	0	587	409	180
	Campgrounds	0	0	0	190	0	0	0	0	0	0
	Total	0	122	244	2510	1178	203	72	767	489	230
NNE	Seasonal	0	0	64	56	2	22	26	30	34	38
	Overnight Accommodations	0	0	44	12	0	0	0	19	21	0
	Beach Area Parking Lots and on-street Parking	0	0	0	0	0	0	0	0	0	0
	Campgrounds	0	0	0	0	0	0	0	0	0	0
	Total	0	0	108	68	2	22	26	49	55	38

TABLE 3

SUMMARY - ESTIMATE OF VEHICLES ASSOCIATED WITH OFF SEASON TRANSIENT POPULATION (Seasonal Residents, Overnight Visitors, and Daily Transients) - 1983
Seabrook Station

Sector	Population Type	Distance (in miles) from Seabrook Station 0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10
N	Seasonal (10%) with 1 Veh/DW	0	1	1	1	0	4	1	1	1	3
	Overnight Accommodations	0	0	75	23	30	0	0	0	0	0
	Major Employers	0	26	0	280	125	0	0	0	0	74
	Route 1	0	58	0	0	792	148	0	0	0	0
	Total	0	85	76	304	822	152	1	1	1	77
NNW	Seasonal (10%) with 1 Veh/DW	0	1	1	1	1	3	2	2	1	1
	Overnight Accommodations	0	20	0	0	0	0	0	0	0	0
	Major Employers	0	0	0	0	0	0	0	400	0	0
	Route 1	0	24	0	0	0	0	0	0	0	0
	Total	0	45	1	1	1	3	2	402	1	1
NW	Seasonal (10%) with 1 Veh/DW	0	1	1	1	1	0	1	3	3	0
	Overnight Accommodations	0	0	0	0	0	0	0	35	55	0
	Major Employers	0	9	0	0	0	0	0	508	394	0
	Route 1	0	43	0	0	0	0	0	0	0	0
	Total	0	53	1	1	1	0	1	546	452	0
WNW	Seasonal (10%)	0	0	1	0	1	1	1	2	2	2
	Overnight Accommodations	0	0	0	0	0	0	0	0	0	0
	Major Employers	0	0	0	0	0	0	0	0	0	0
	Route 1	35	0	0	0	0	0	0	0	0	0
	Total	35	0	1	0	1	1	1	2	2	2
W	Seasonal (10%)	0	1	0	1	1	1	2	2	2	2
	Overnight Accommodations	0	80	0	0	0	0	0	0	0	0
	Major Employers	0	44	12	0	0	0	0	0	0	0
	Route 1	710	93	0	0	0	0	0	0	0	0
	Seabrook Greyhound Park	0	0	3077	0	0	0	0	0	0	0
	Seabrook Station	2000	0	0	0	0	0	0	0	0	0
	Total	2710	138	3089	1	1	1	2	2	2	2

TABLE 3 (Continued)

SUMMARY - ESTIMATE OF VEHICLES ASSOCIATED WITH OFF SEASON TRANSIENT POPULATION (Seasonal Residents, Overnight Visitors, and Daily Transients) - 1983
Seabrook Station

Sector	Population Type	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10
		Distance (in miles) from Seabrook Station									
WSW	Seasonal (10%)	0	1	2	1	2	2	1	1	1	1
	Overnight Accommodations	0	0	0	0	0	0	0	0	0	0
	Major Employers	0	950	95	0	194	15	0	0	188	0
	Route 1	0	37	0	0	0	0	0	0	0	0
	Total	0	988	97	1	196	17	1	1	189	1
SW	Seasonal (10%)	0	1	1	0	4	1	0	0	0	0
	Overnight Accommodations	0	0	0	0	60	28	0	0	0	0
	Major Employers	0	98	0	0	938	396	302	0	0	0
	Route 1	0	976	0	0	0	0	0	0	0	0
	Total	0	1075	1	0	942	425	302	0	0	0
SSW	Seasonal (10%)	0	1	1	1	1	8	8	2	1	1
	Overnight Accommodations	0	0	20	0	0	11	0	0	0	0
	Major Employers	0	0	5	0	20	1409	497	0	0	0
	Route 1	0	0	0	0	0	50	0	0	0	0
	Total	0	1	26	1	21	1417	505	2	1	1
S	Seasonal (10%)	0	1	2	2	3	1	21	1	1	1
	Overnight Accommodations	0	0	0	0	13	0	29	0	0	0
	Major Employers	0	80	0	0	54	0	279	72	0	0
	Route 1	0	0	0	76	17	264	530	0	0	0
	Total	0	81	2	78	87	265	859	73	1	1
SSE	Seasonal (10%)	0	0	9	26	30	0	28	28	0	0
	Overnight Accommodations	0	0	0	8	38	0	0	7	0	0
	Major Employers	0	0	0	0	0	0	0	0	0	0
	Route 1	0	0	0	0	0	0	0	0	0	0
	Total	0	0	9	26	68	0	28	35	0	0

TABLE 3 (Continued)

SUMMARY - ESTIMATE OF VEHICLES ASSOCIATED WITH OFF SEASON TRANSIENT POPULATION (Seasonal Residents, Overnight Visitors, and Daily Transients) - 1983

Seabrook Station

Sector	Population Type	Distance (in miles) from Seabrook Station 0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10
SE	Seasonal (10%)	0	1	22	0	0	0	0	0	0	0
	Overnight Accommodations	0	0	0	0	0	0	0	0	0	0
	Major Employers	0	0	0	0	0	0	0	0	0	0
	Route 1	0	0	0	0	0	0	0	0	0	0
	Total	0	1	22	0	0	0	0	0	0	0
ESE	Seasonal (10%)	0	36	0	0	0	0	0	0	0	0
	Overnight Accommodations	0	0	0	0	0	0	0	0	0	0
	Major Employers	0	0	0	0	0	0	0	0	0	0
	Route 1	0	0	0	0	0	0	0	0	0	0
	Total	0	36	0	0	0	0	0	0	0	0
E	Seasonal (10%)	0	35	0	0	0	0	0	0	0	0
	Overnight Accommodations	0	125	0	0	0	0	0	0	0	0
	Major Employers	0	0	0	0	0	0	0	0	0	0
	Route 1	0	0	0	0	0	0	0	0	0	0
	Total	0	160	0	0	0	0	0	0	0	0
ENE	Seasonal (10%)	0	47	55	5	0	0	0	0	0	0
	Overnight Accommodations	0	246	285	0	0	0	0	0	0	0
	Major Employers	0	0	0	0	0	0	0	0	0	0
	Route 1	0	0	0	0	0	0	0	0	0	0
	Total	0	246	340	5	0	0	0	0	0	0
NE	Seasonal (10%)	0	6	8	54	24	1	4	4	2	1
	Overnight Accommodations	0	0	32	18	0	0	0	0	7	19
	Major Employers	0	0	0	0	0	0	0	0	0	0
	Route 1	0	0	0	0	0	0	0	0	0	0
	Total	0	6	40	72	24	1	4	4	9	20
NNE	Seasonal (10%)	0	0	3	3	0	1	1	2	2	2
	Overnight Accommodations	0	0	0	0	0	0	0	0	0	0
	Major Employers	0	0	0	0	46	0	0	0	0	0
	Route 1	0	0	0	0	0	0	0	0	0	0
	Total	0	0	3	3	46	1	1	2	2	2

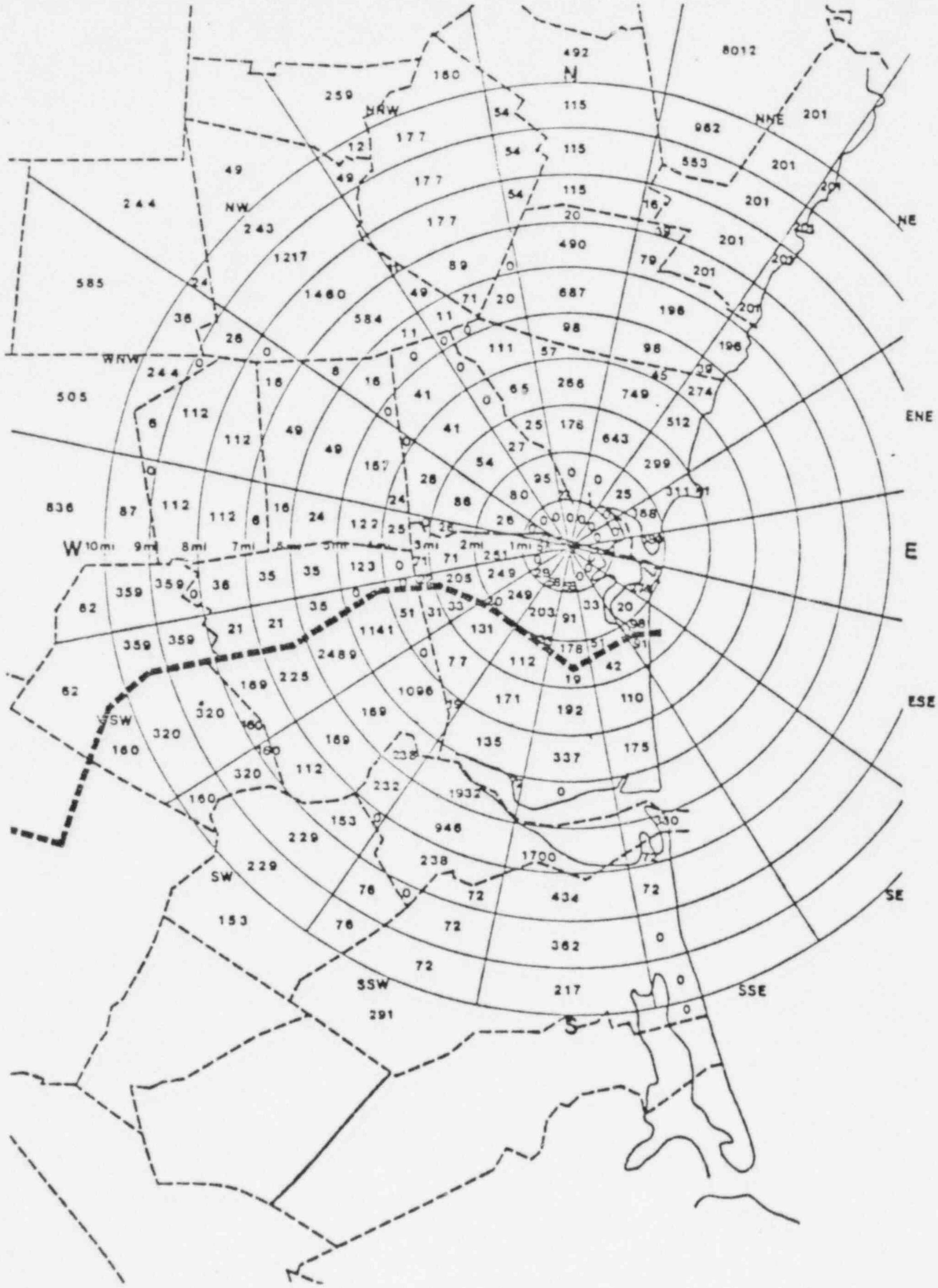


FIGURE 12

ESTIMATED AUTOMOBILE DEMAND - 1983 RESIDENT POPULATION
(1 Vehicle per Occupied Unit, 3 Persons per Household)

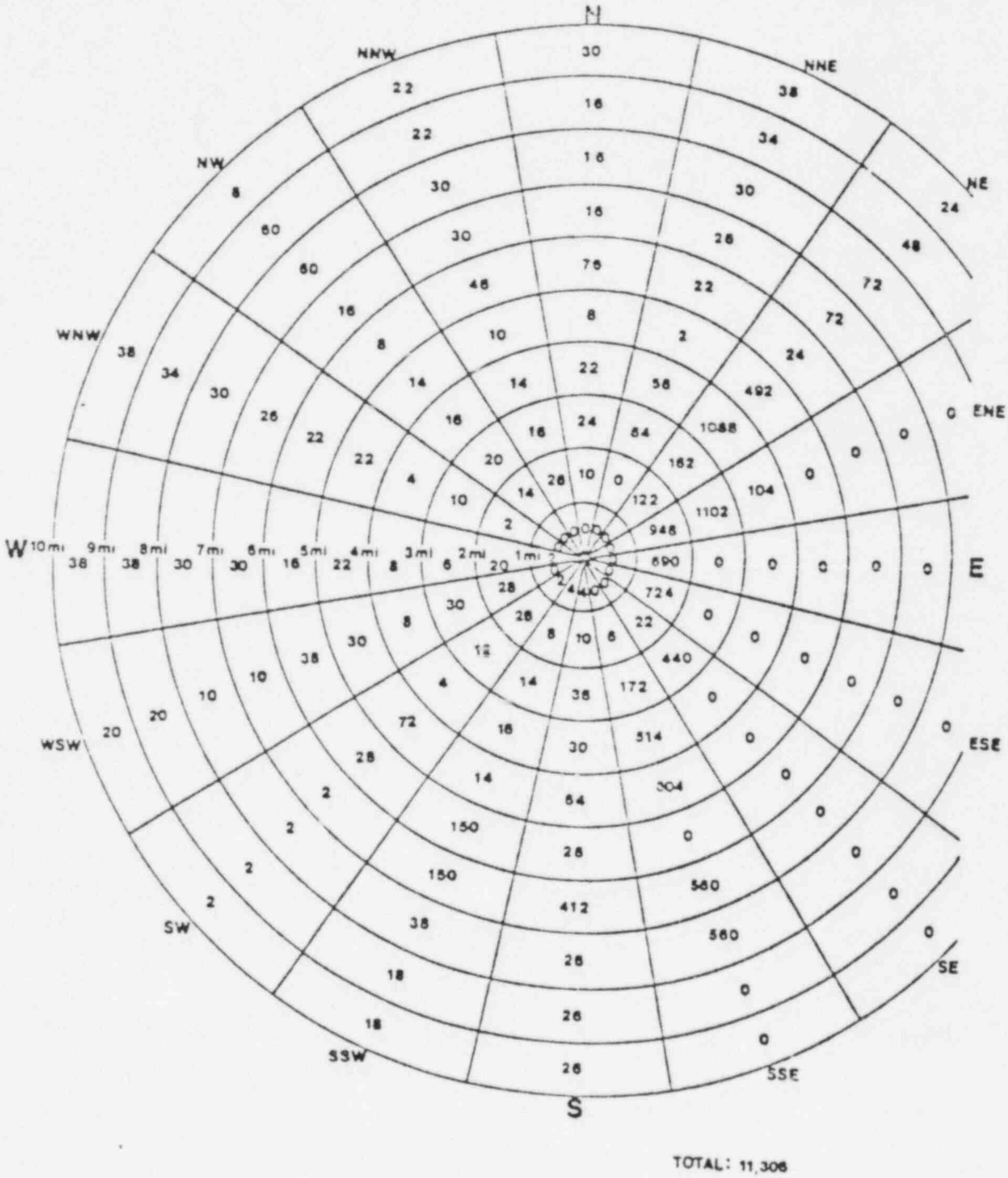


FIGURE 13
ESTIMATED VEHICLE DEMAND OF SEASONAL RESIDENTS
(2 vehicles/D.U.)

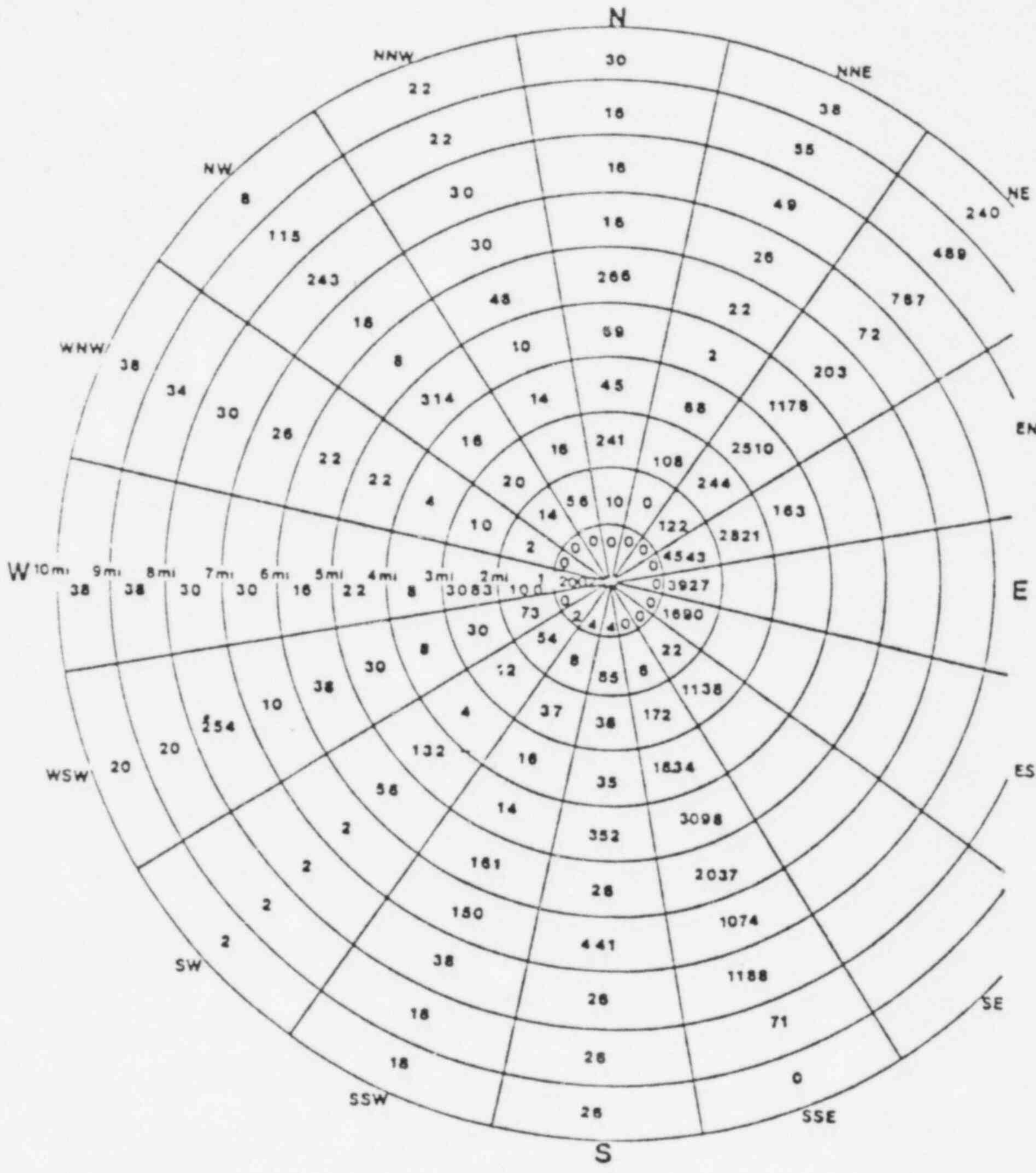
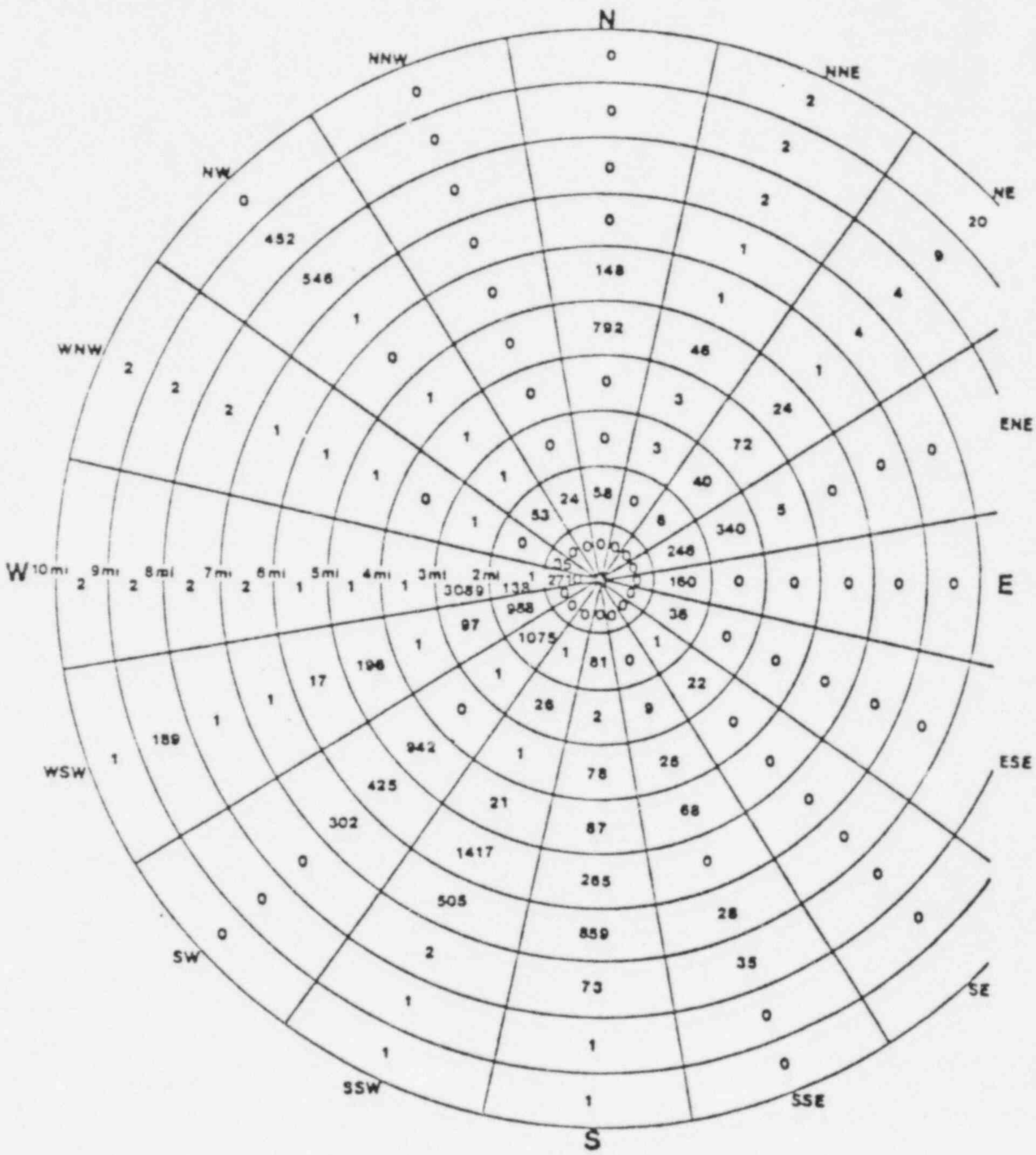


FIGURE 14

ESTIMATE OF SUMMER, 1983 TRANSIENT VEHICLE DEMAND

(Composite: Includes Seasonal Residents, Overnight Visitors, and Daily Transients)



TOTAL: 16,944

FIGURE 15
OFF-SEASON TRANSIENT 1983 VEHICLE DEMAND ESTIMATE

5. ESTIMATES OF EVACUATION TIMES

An analysis has been performed to estimate the time that might elapse for completing a public evacuation of each of the sector configurations shown in Figures 1 through 10. These times are from the start of the evacuation to the point when evacuation of the last automobile has been completed. Additional time for notification, evacuation of special facilities and persons with special needs, and for confirmation that an evacuation has been completed is not included in the estimates provided. These considerations will be developed in detail as the arrangements for Seabrook Station are established.

The results of the evacuation clear time calculations are summarized in Table 4 for the various 90° and 180° areas within 2, 5, and 10 miles of the site. These cases correspond to those for which the NRC requests clear time estimates in Appendix 3, NUREG-0654 and Reference b). For each geographical configuration, three different area conditions were evaluated. The first represents a fair weather summer weekend which corresponds to the peak population condition for the area. The second represents a fair weather, off-season, weekday population condition. The third is for the off-season, weekday population condition with an assumed 30% reduction in the capacity of the road network to represent adverse weather conditions such as fog, rain, or snow.

It should be noted that these cases were simulated with the road network operating in its normal mode, with no special traffic controls

in place. These preliminary analyses, therefore, assumed existing traffic patterns (i.e., one-way, two-way operation) prevail; emergency planning personnel/traffic controllers are not available; and no specified evacuation routings are enforced.

The estimates for the off-season, fair weather cases are shorter or equal to the corresponding off-season, adverse weather cases. For most cases, the difference between adverse and fair weather condition is within 20 minutes. This happens in evacuation sectors which have low vehicle demand and good evacuation road networks, where, in fair weather, the road network is not used to capacity. Therefore, during adverse weather, the reduced capacity of the roadway does not affect clear times significantly. There are two cases which have significant (approximately 1 hour) differences between the fair and adverse weather. These are the Southeast 0-10 mile and Northeast 0-10 mile. These two sectors have large populations in proportion to the available roadway capacities in the area which causes the significant difference. Within the Southeast 0-10 mile sector, is the city of Newburyport, which contains a large permanent population and is densely settled. The Northeast 0-10 mile sector contains several major employers and shopping centers on Route 1, in addition to the permanent resident population.

TABLE 4

ESTIMATES OF EVACUATION CLEAR TIMES
BY EPZ ANALYSIS AREAS TO CLEAR TOWN BOUNDARY
(Hours/Minutes)

	Summer Weekend		Off-Season Weekday Fair Weather		Off-Season Weekday Adverse Weather	
	Hrs.	Min.	Hrs.	Min.	Hrs.	Min.
1. 180° North, 0 to 2 miles	4	20	2	30	2	30
2. 180° South, 0 to 2 miles	3	10	2	50	2	50
3. 90° Northeast, 0 to 5 miles	4	20	1	50	2	00
4. 90° Southeast, 0 to 5 miles	3	50	3	00	3	00
5. 90° Southwest, 0 to 5 miles	3	40	3	10	3	10
6. 90° Northwest, 0 to 5 miles	3	20	3	00	3	00
7. 90° Northeast, 0 to 10 miles	4	30	2	00	2	50
8. 90° Southeast, 0 to 10 miles	3	50	3	00	4	10
9. 90° Southwest, 0 to 10 miles	3	45	3	10	3	20
10. 90° Northwest, 0 to 10 miles	3	40	3	00	3	10

6. INSTITUTIONAL EVACUATION TIMES

The matter of planning arrangements for evacuation of the various institutions within the Seabrook Station EPZ is somewhat premature at this stage of station construction and overall emergency plan development. As state and local emergency planning considerations specific to the Seabrook area are developed, arrangements for such elements as institutions and special facility notification and evacuation will be specified.

Some indication about institutional evacuation can be gained from contact that has been made for two specific facilities and some comparison analysis offered by the Massachusetts Civil Defense Agency.

The Seacoast Health Center, located between 3 and 4 miles NNE from the site, is an intermediate care facility with a 76 bed capacity. It currently has an emergency plan and will have a radiological specific annex to include with the Town of Hampton plan. According to the Center's administrator, the estimated time to evacuate the facility in a situation where the area is evacuating is 2 to 3 hours. This facility experienced an actual evacuation of all its residents recently. The situation arose without prior warning at night while the residents were in bed. Upon notice, thirty minutes were taken to call emergency personnel, open a reception center, call ambulances (12) and a bus, and evaluate the situation. When the order to evacuate was given, it took 29 minutes to transfer all the patients to the reception center; 30% by bus and the remainder in ambulances.

The Exeter Hospital, located between 7 and 8 miles NW of the site, is a major care facility with a 100 bed capacity. It currently has an emergency plan and will have a radiological specific annex to include with the Town of Exeter plan. According to the Hospital's administrator, the estimated time to evacuate the facility in a situation where the area is evacuating is 6 to 8 hours.

Additional information on the question of institutional evacuations is given in the letter from the Massachusetts Civil Defense Agency, included as Appendix C.

APPENDIX A

THE EVAC MODEL

APPENDIX A

THE EVAC MODEL

The EVAC model is a numerical transportation network simulation model. It was developed specifically to provide evacuation clear time estimates and related information for use in emergency planning.

As an initial step, the transportation network is defined as a series of links and nodes, with entry nodes used to input the demand volumes and exit nodes used as network links. Links are coded directionally, from A-mode to B-node. Required geometric and operational inputs include:

- Link length;
- Lane width and number of lanes;
- Roadway type (urban, rural; one-way, two-way; parking, no parking);
- Location within metropolitan area (central business district, fringe, outer business district, residential);
- Free flow speed;
- Intersection approach width;
- Special turning lanes;
- Traffic control (stop sign, fixed-time signal, actuated signal); and
- Intersection approach green times (for signalized intersections).

Given the evacuation highway network data and time-dependent loading rates and points, the model calculates flow moved from each link

leading into an intersection, to each link moving out of an intersection, based on:

1) User preferences regarding movement along each outbound link;
2) The capacities of both the inbound and outbound links; and
3) A linear relationship between speed and density[1].

Route choices are dynamically determined at each intersection as a function of predetermined preference factors and traffic conditions on the downstream link. The most direct route out of the evacuation area is generally given a higher preference factor; alternative routes are given lower preference factors. When congestion develops and traffic speeds for preferred routes decline, traffic is routed to alternative routes with higher travel speeds. The EVAC model applies the principles of the Highway Research Board (HRB) Highway Capacity Manual in evaluating traffic operations and capacity restrictions during the evacuation.

The EVAC model updates statistics on the entire network and on each link at the end of each specified time increment. The statistics reported include capacity, flow, queues, current and total volumes, speeds, network occupancy, and cumulative link departures. From these data, the magnitude and impact of network flows can be traced through the term of the evacuation.

---

1 Greenshield's relationship, refer to Traffic Flow Theory, Transportation Research Board Special Report 165, National Research Council, Washington, D.C., 1975.

APPENDIX B

AUTOMOBILE DEMAND ESTIMATES ASSOCIATED WITH PERMANENT AND DAILY TRANSIENT POPULATION (SUMMER AND OFF-SEASON ESTIMATES)

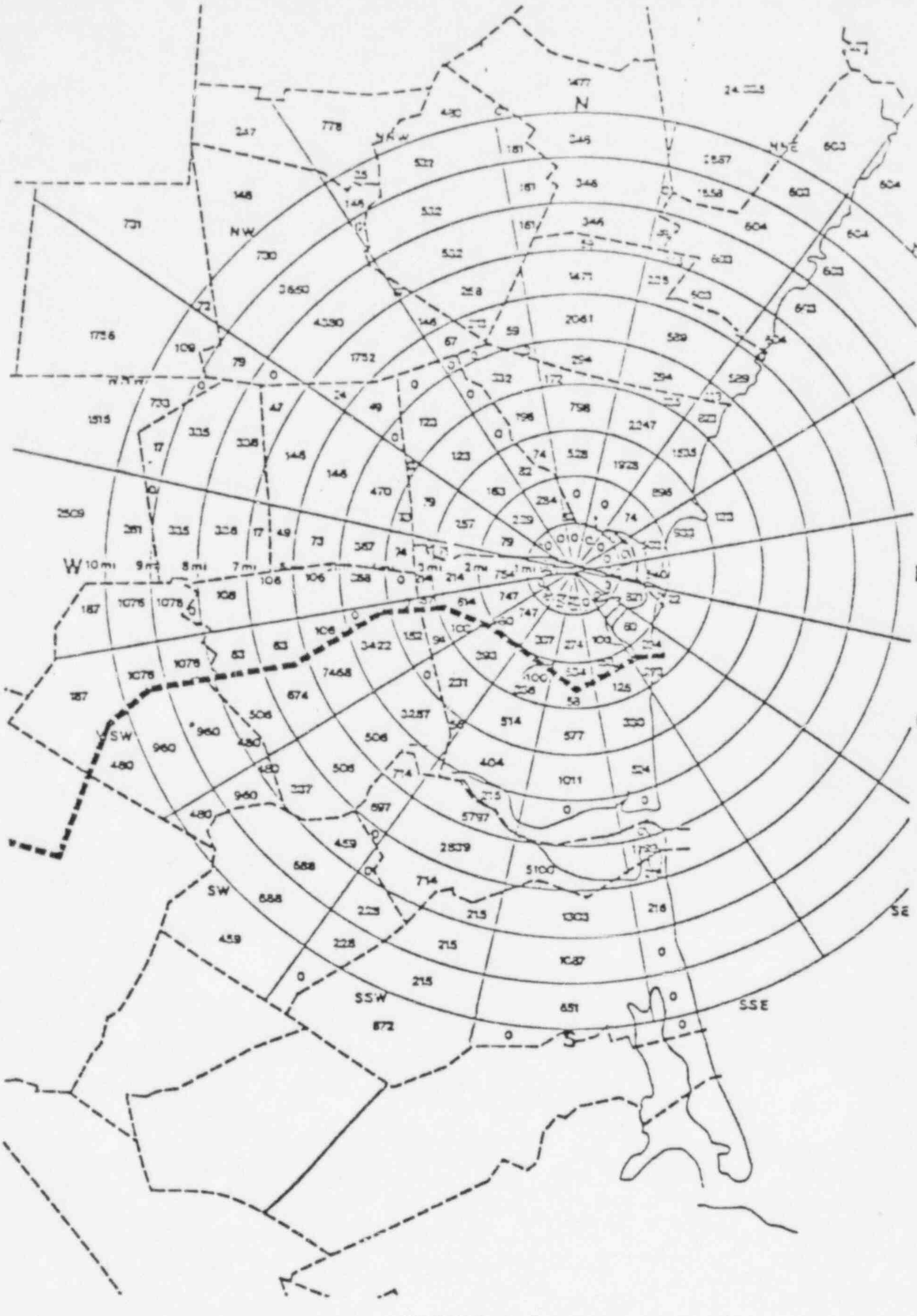
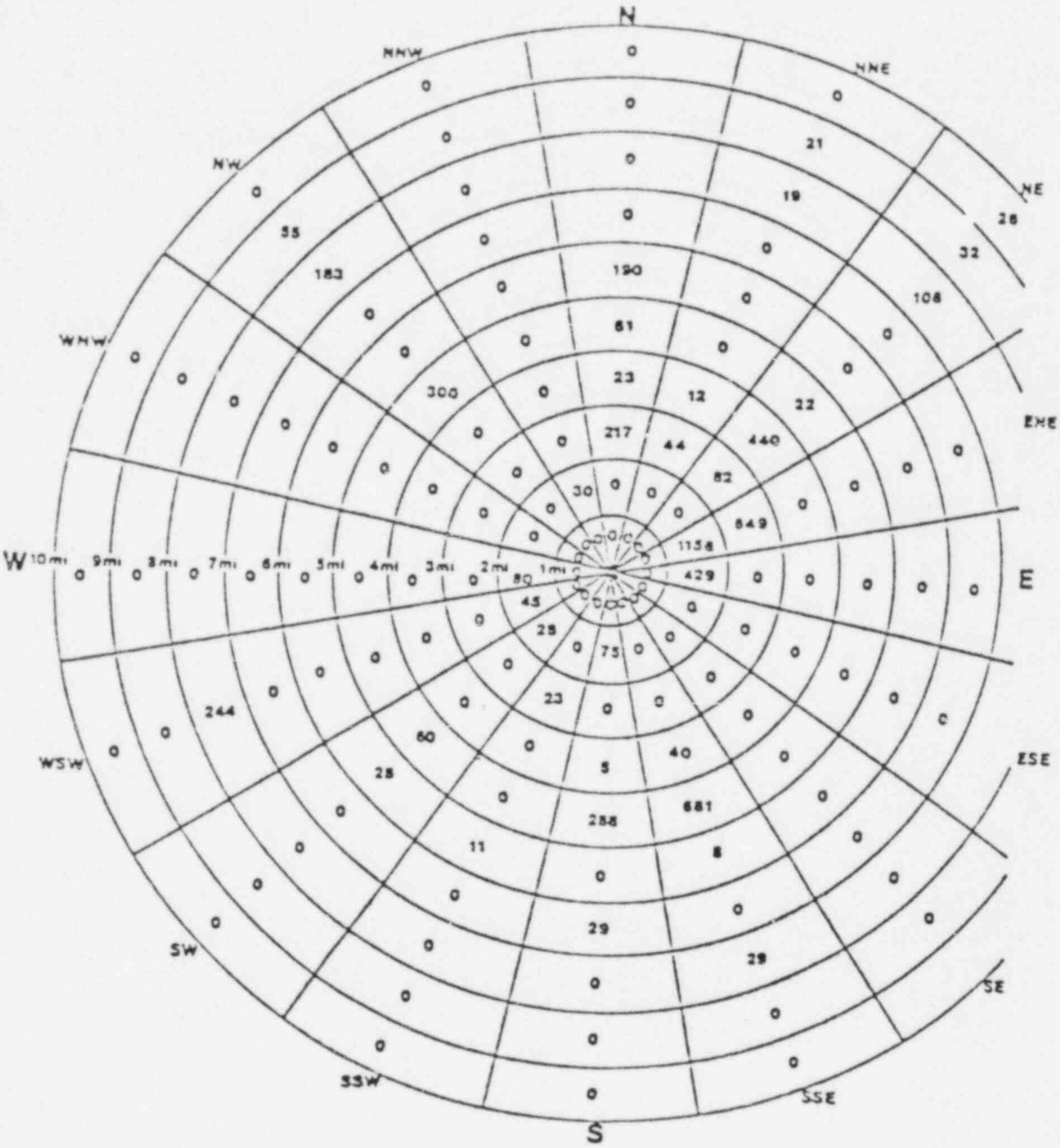


FIGURE B-1

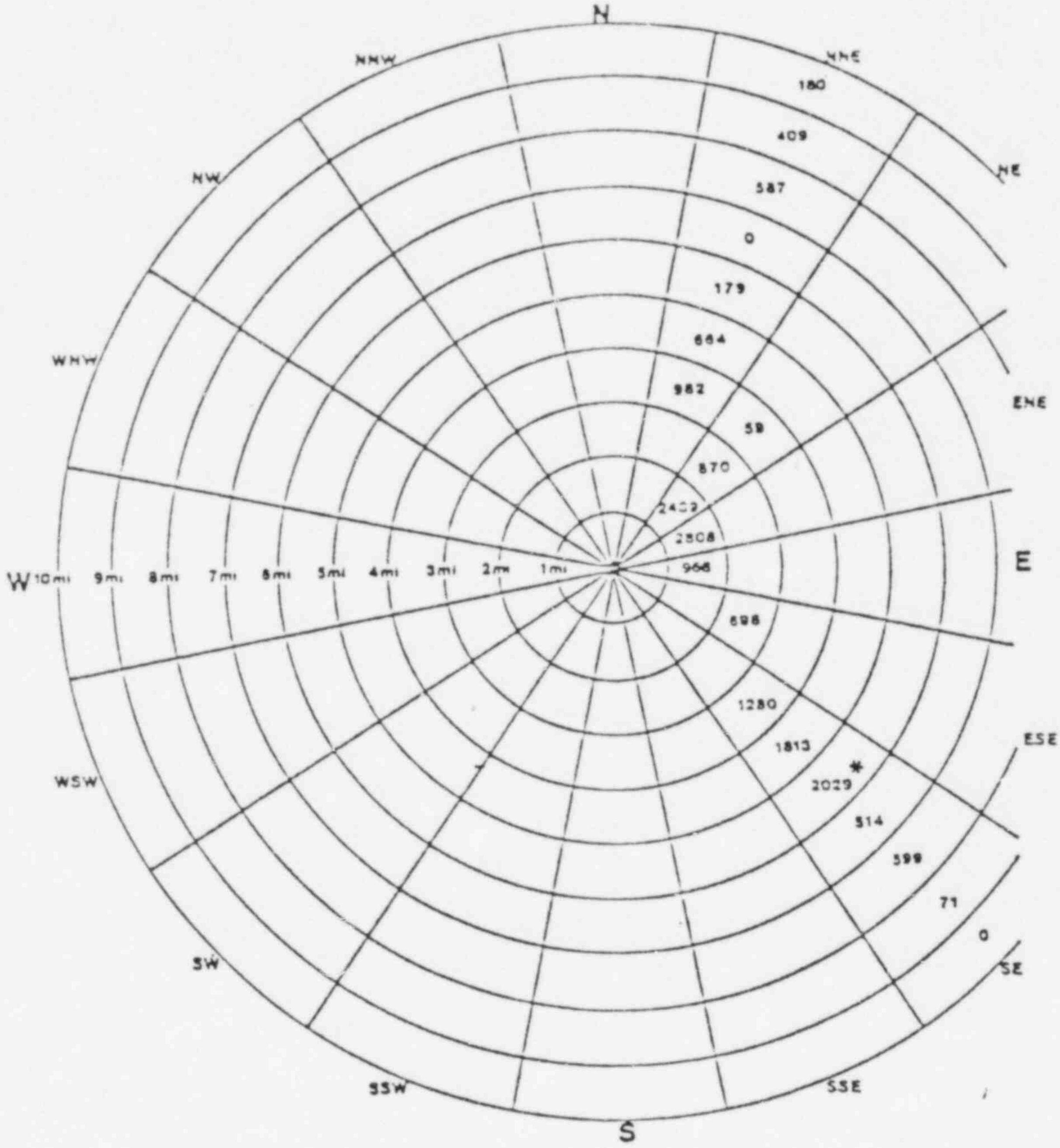
ESTIMATED 1983 PERMANENT RESIDENT POPULATION



TOTAL: 6008

FIGURE B-2

ESTIMATE OF VEHICLE DEMAND ASSOCIATED WITH OVERNIGHT ACCOMMODATIONS AND CAMPING FACILITIES



* less leased spaces

TOTAL: 17,147

FIGURE B-3

ESTIMATE OF BEACH AREA LOTS AND ON-STREET P RKING

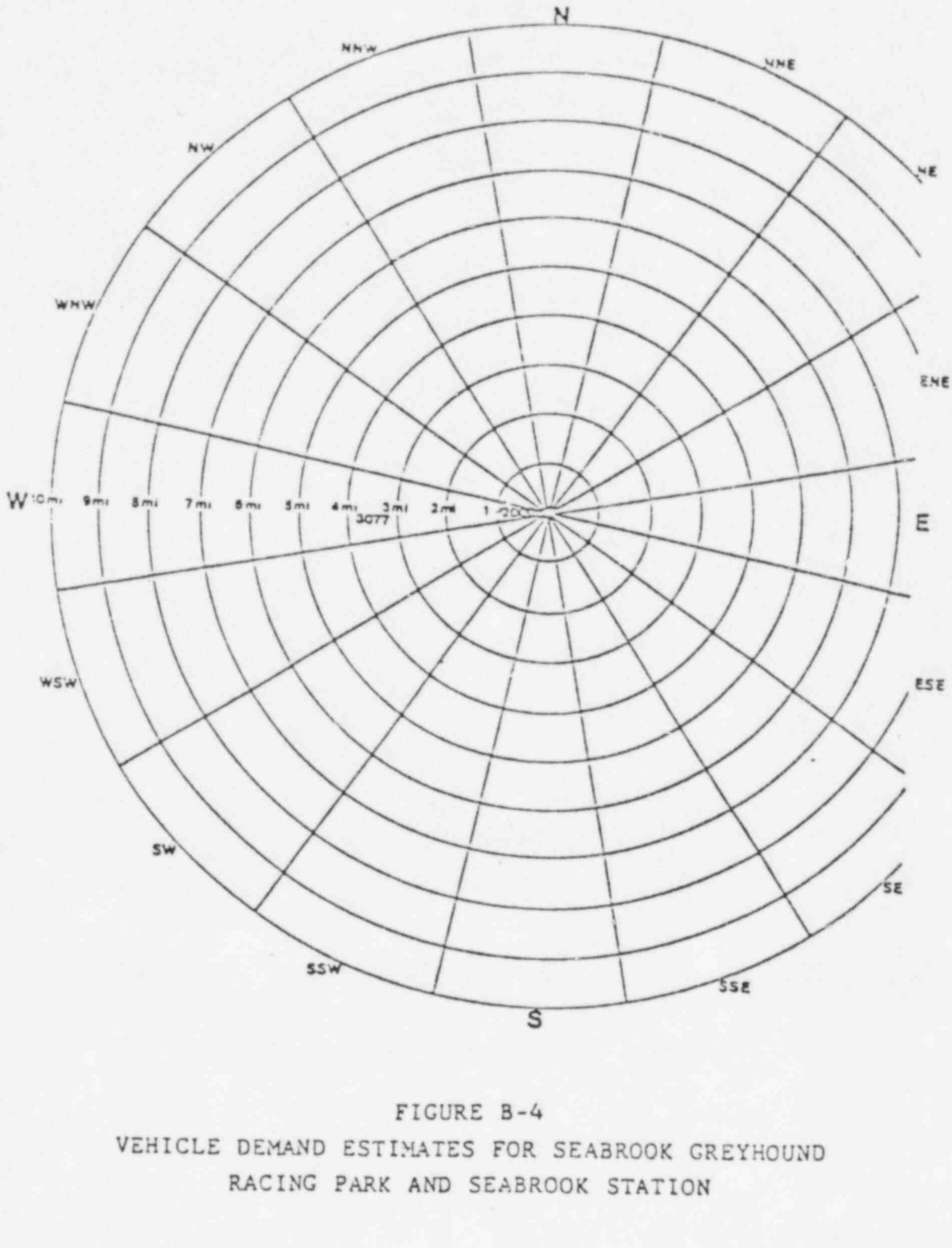


FIGURE B-4
VEHICLE DEMAND ESTIMATES FOR SEABROOK GREYHOUND
RACING PARK AND SEABROOK STATION

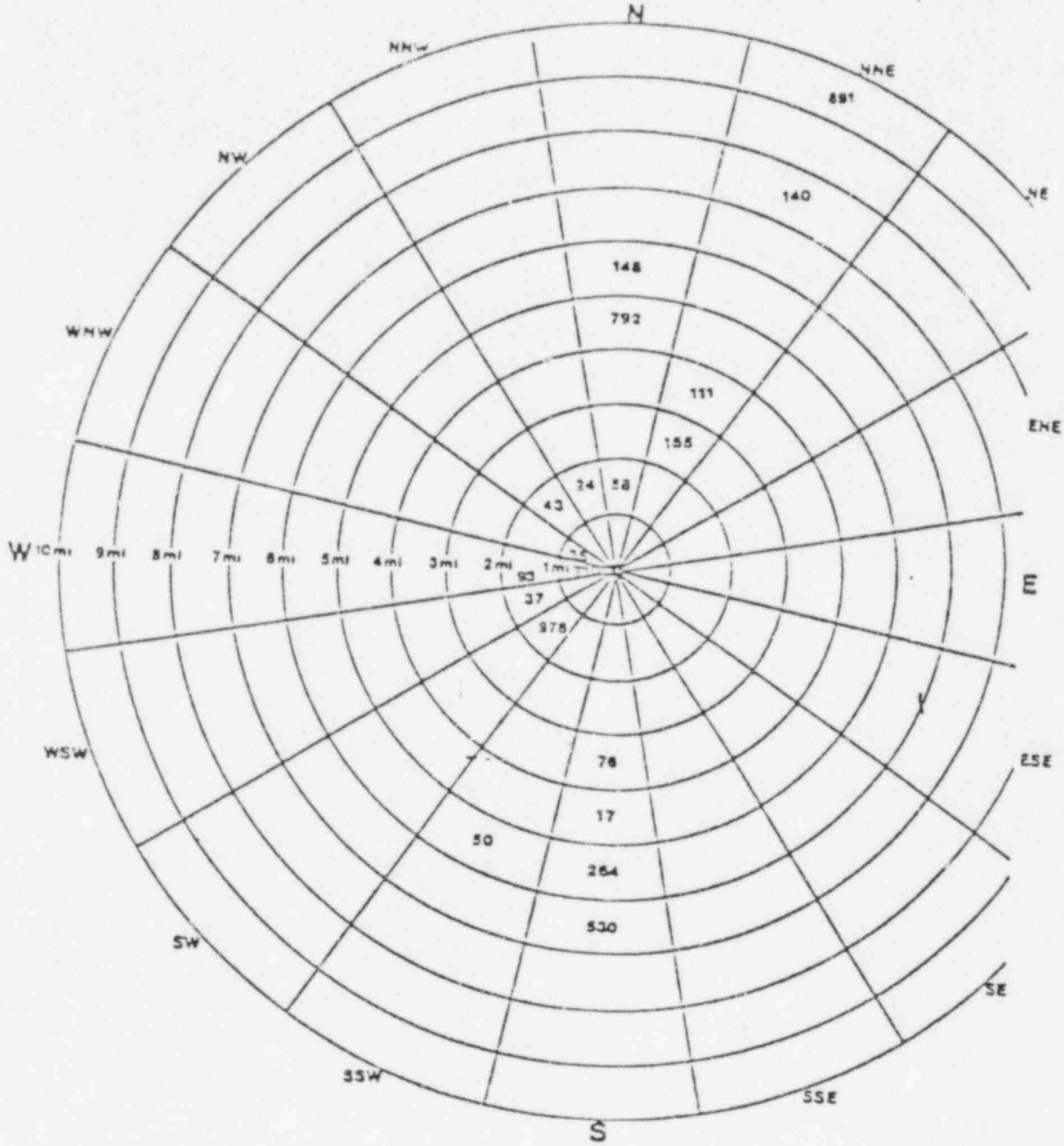


FIGURE B-5
ESTIMATED ROUTE 1 VEHICLE DEMAND, MAJOR PARKING LOTS

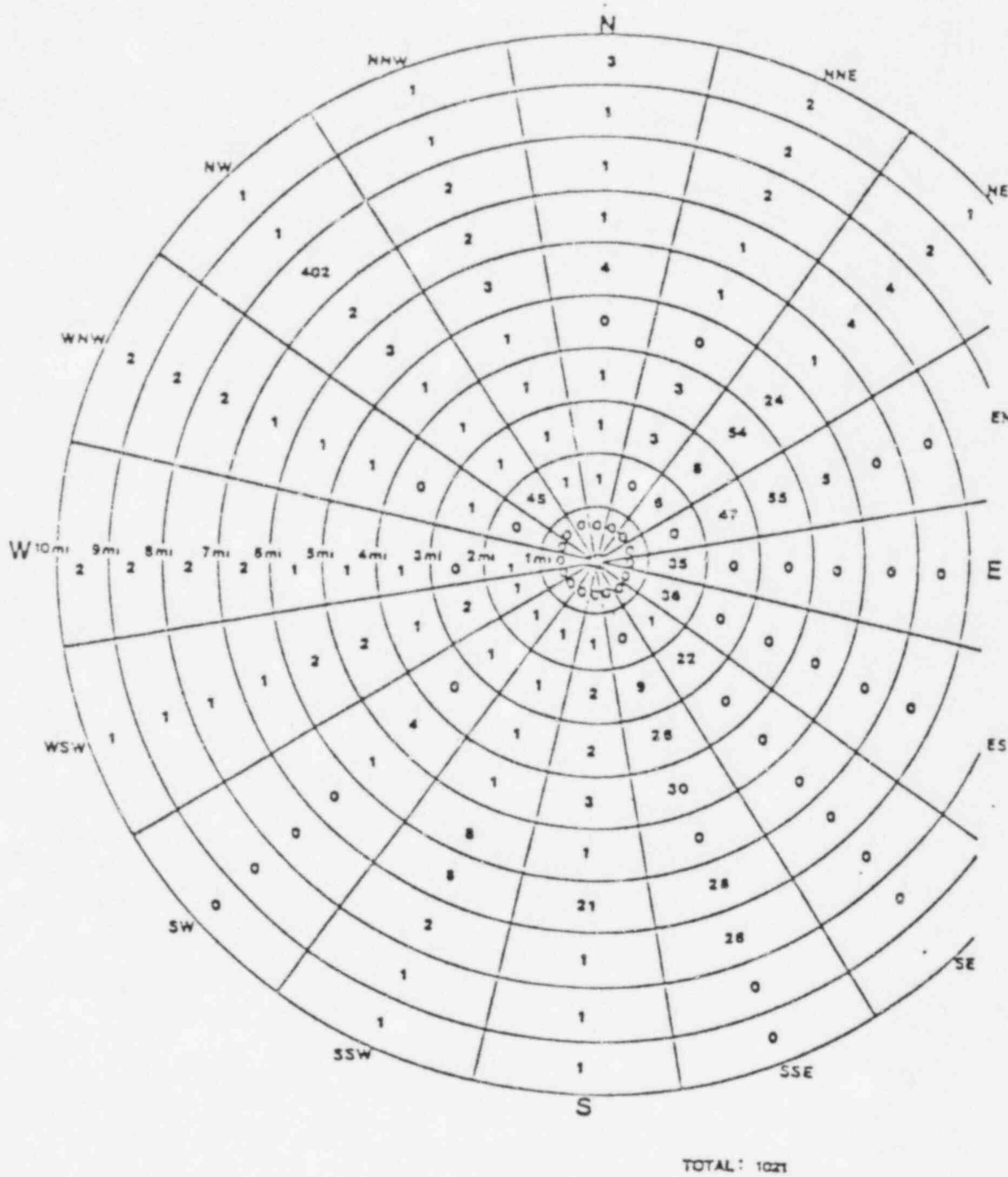


FIGURE B-6
ESTIMATE OF OFF-SEASON SEASONAL RESIDENT VEHICLE DEMAND
(Assumes 10% of Total Seasonal Units X 1 Vehicle
per Seasonal Unit)

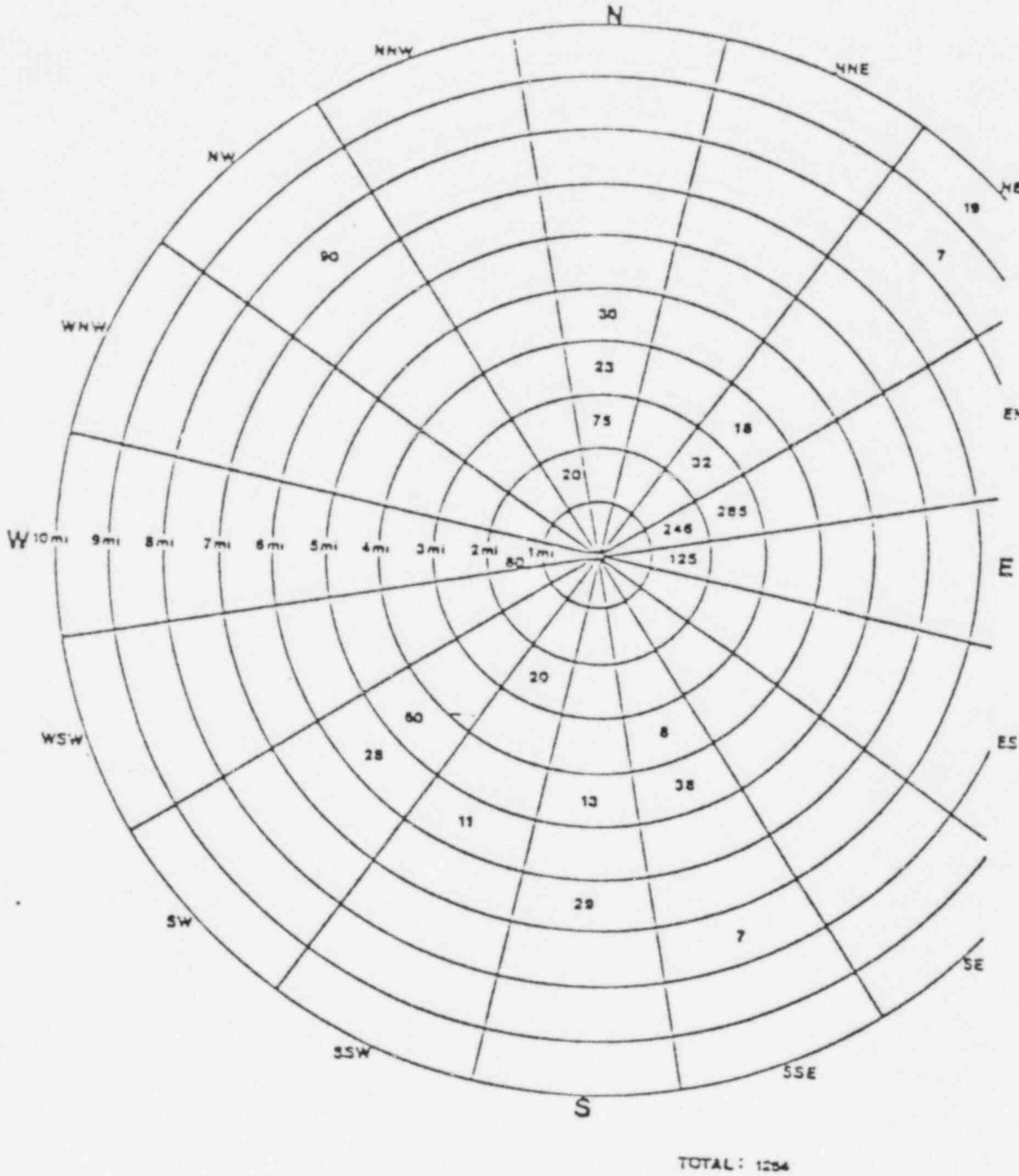
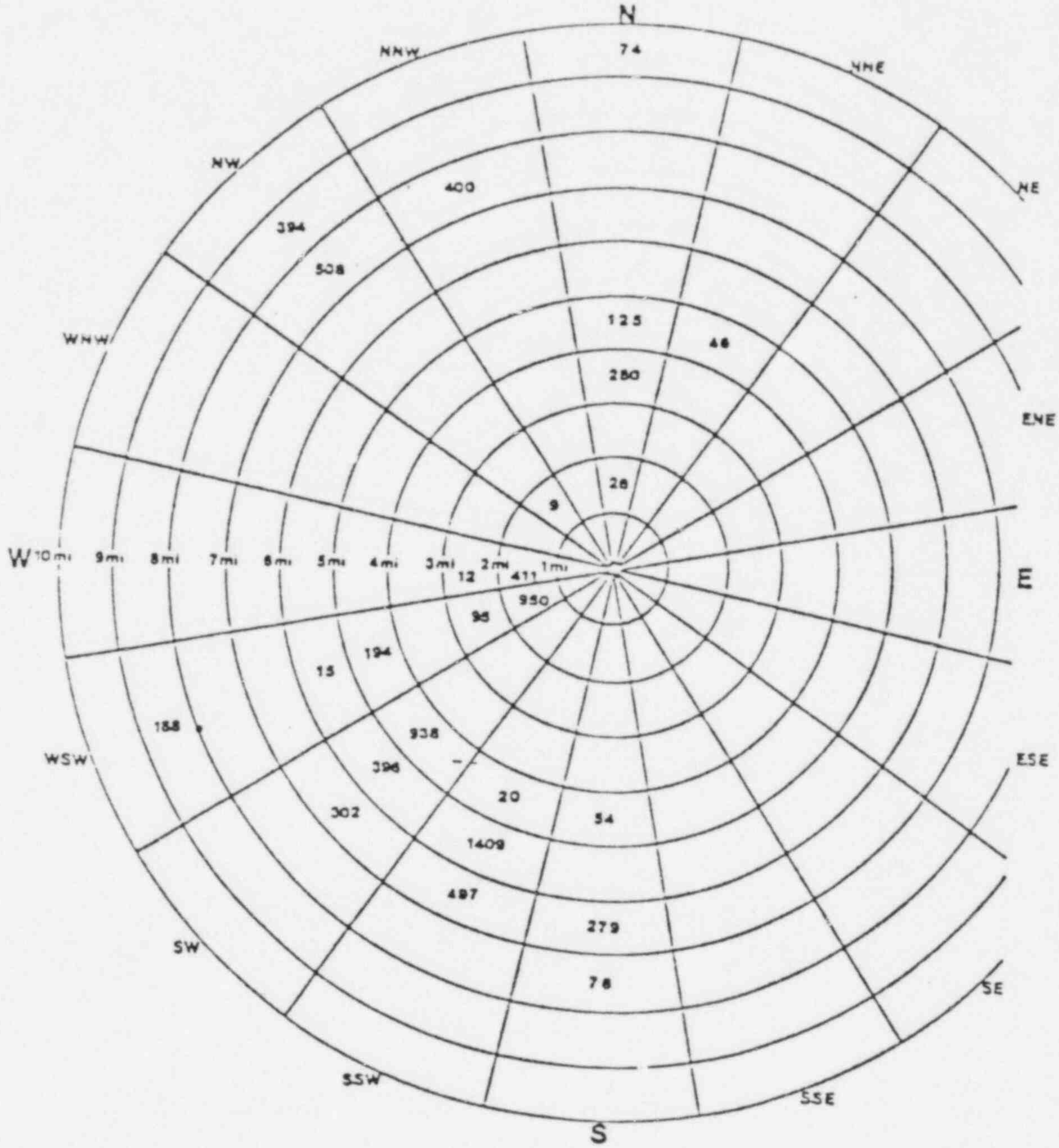


FIGURE B-7
ESTIMATED OFF-SEASON VEHICLE DEMAND - OVERNIGHT ACCOMMODATIONS
(1 Vehicle/Unit)



TOTAL: 7877

FIGURE B-8
ESTIMATE OF VEHICLE DEMAND ASSOCIATED WITH
MAJOR MANUFACTURING EMPLOYERS

APPENDIX C

COMMENTS BY MASSACHUSETTS CIVIL DEFENSE AGENCY

THE COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE DEPARTMENT

CIVIL DEFENSE AGENCY AND OFFICE OF EMERGENCY PREPAREDNESS
400 WORCESTER ROAD
FRAMINGHAM, MASS 01701

EDWARD J. KING
GOVERNOR

PAUL J. CAHILL
DIRECTOR

August 4, 1980

Mr. James McDonald
Yankee Atomic Electric Company
20 Turnpike Road
Westborough, Massachusetts 01581

Dear Mr. McDonald:

Please accept this letter as the official commentary of the Massachusetts Civil Defense Agency on Yankee Atomic's submission to the Nuclear Regulatory Commission entitled: Preliminary Evacuation Clear Time Estimates for Areas Near Seabrook Station.

1. Evacuation Time Estimates

The calculated evacuation time estimates are consistent with MCDA's estimates,-which were based upon experience, and upon some basic load-loading analyses using techniques developed in the context of the FEMA Crisis Relocation Planning Program. More importantly, MCDA is familiar with the methodology used in generating the estimates, and with the EVAC model, from experience with work done in the Pilgrim NPS area. The Pilgrim area results have generated a high degree of confidence in both the EVAC model and in HMM's personnel.

Because planning for the Seabrook NPS is in a prototypical stage, the estimates will be very useful in the route design and traffic management components of the actual evacuation plans, which will be developed over the coming months.

2. Special Facilities

There are a number of similarities in demography, topography, and physical infrastructure between the Seabrook and Pilgrim NPS sites. Experience in planning for the Pilgrim site indicates that while specialized planning is critical for safe efficient evacuation of the school population, once these plans are in place, the schools can be readily evacuated in an orderly manner. In no case should evacuation of the school population exceed time estimates for the population in general.

There are sixteen hospitals and nursing homes in the Seabrook area in Massachusetts. Again, Pilgrim planning experience indicates that specialized plans for each such facility are needed. MCDA officials, and local officials queried to date generally feel that the nursing homes could be evacuated within the time estimates. Work with Jordan Hospital in Plymouth inidcates that total evacuation of the three hospitals (Anna Jaques Hospital in Newburyport, 6½ miles south, Newburyport Manor Chronic Hospital, 6½ miles south, and Amesbury Hospital 5½ miles southwest) could require more than the time estimated for the general population. The critical component here is in provision of life sustaining equipment while transporting patients from post-surgical, coronary care, and similar units, and in making the necessary decisions to proceed with evacuation of such patients. (There is a lack of guidance in this area, from NRC and from NIH.)

3. Confirmation of Evacuation

MCDA plans to provide for confirmation of evacuation through the use of local law enforcement officials, travelling pre-assigned routes. This is the only mechanism found effective in evacuation for other purposes. Alternative suggestions seem to present more shortcomings than they resolve. Assignment of 35-45 minute confirmation times are reasonable, although it is important ot note that confirmation of evacuation would begin, and proceed, throughout the projected evacuation time period.

4. Notification Times

Notification time estimates (35 minutes good weather, 45 minutes bad weather) appropriately reflect MCDA estimates of the time necessary to complete notification to 100% of the public within 5 miles, and 90% of the public within ten miles, using existing local capabilities.

Addition of this notification time to computed evacuation times in all cases yields a conservative result. The reason for this is that a majority of residents within either 5 or 10 miles would receive notification within 15 minutes, at which time any recommended evacuation would begin. To the extent that route capacities constrain evacuation times, simple addition of the notification time is a conservative approach. The State, local governments, and the utility have been working on various "prompt alert" mechanisms, and timely compliance with any future Federal regulations involving "prompt alert" provisions can be assured.

The material in the proposed submission will prove a useful tool in determining the appropriateness of various protective

actions in the event of an accident. MCDA will incorporate the results in the Massachusetts radiological emergency response plan, after Federal officials have had an opportunity to review them. The results will be made available to local emergency response officials.

Sincerely,

Paul J. Cahill
Director

RPA01B00:

ACRSR-0839

Sent to PDR 8/14/79

AUG 14 1979

MEMORANDUM FOR: Commissioner Ahearne

FROM: Max W. Carbon, Chairman, ACRS

SUBJECT: QUANTITATIVE SAFETY GOALS

REFERENCE: Memo from Commissioner Ahearne to Max W. Carbon, Subject: Quantitative Safety Goals dated 6/11/79

In order to develop further the concept of establishing safety goals for nuclear power reactors, the Committee has assigned this project to our Subcommittee on Reliability and Probabilistic Assessment. We anticipate that up to a year may be needed to arrive at the recommendations we feel are appropriate.

We would be pleased to discuss the topic on an interim basis as you might wish.

ORIGINAL SIGNED BY
MAX W. CARBON

Max W. Carbon
Chairman

cc:
Chairman Hendrie
Commissioner Gilinsky
Commissioner Kennedy
Commissioner Bradford
S. Chilk, Secretary of the Commission
ACRS Members

FILE: RPA-T
X OP 2.1

OFFICE	ACRS	ACRS			
SURNAME	FRALEY/	RFF FOR ACRS CHMN			
DATE	8/13/79	8/13/79			

NRC FORM 318 (9-76) NRCM 0240 ★ U.S. GOVERNMENT PRINTING OFFICE: 1978 - 265 - 769

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ACRSR-0831

Sent to PDR 5/16/79

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, D. C. 20555

May 16, 1979

Honorable Joseph M. Hendrie
Chairman
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Subject: REPORT ON QUANTITATIVE SAFETY GOALS

Dear Dr. Hendrie:

The Advisory Committee on Reactor Safeguards recommends that consideration be given by the Nuclear Regulatory Commission to the establishment of quantitative safety goals for overall safety of nuclear power reactors. This could be helpful, for example, in developing criteria for NRC actions concerning operating plants. The ACRS recognizes the difficulties and uncertainties in the quantification of risk and understands that in many situations engineering judgment will be the only or the primary basis for a decision. Nevertheless, the ACRS believes that the existence of quantitative safety goals and criteria can provide important yardsticks for such judgment.

The ACRS believes that such NRC goals and criteria should be proposed for comment, not only by the public but by the Congress. Ultimately the Congress should be asked to express its views on the suitability of such goals and criteria in relation to other relevant aspects of our technological society, such as large dams, and manufacturing, storage, or disposal facilities for hazardous chemicals.

The ACRS believes that it is time to place the discussion of risk, nuclear and nonnuclear, on as quantitative a basis as feasible.

Sincerely,

Max W. Carbon

Max W. Carbon
Chairman

7906230056
PDR