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Draft Final Report

EXECUTIVE SUMMARY: AN ASSESSMENT OF EVACUATION TIME AROUND THE INDIAN POINT NUCLEAR POWER STATION

Contract Number EMW-C-0257

Prepared for:

Federal Emergency Management Agency
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Center for Planning And Research

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1.0 INTRODUCTION

CONSAD Research Corporation with the Center for Planning and Research has recently completed an assessment of evacuation time for the population surrounding the Indian Point Nuclear Power Station. This assessment was conducted for the Federal Emergency Management Agency to assist it in providing an independent assessment of evacuation times around reactor sites which are in proximity to high population densities. The Indian Point Evacuation Planning Zone (EPZ) has an estimated population of 284,000 and is an area centered on the reactor site whose boundary is approximately ten miles from the power station.

This Executive Summary highlights key points of the CONSAD report. There are four sections following this introduction which are:

2.0 DATA COLLECTION

3.0 SCENARIO DESCRIPTION

4.0 METHODOLOGY

5.0 SCENARIO RESULTS

Some of the results presented in Section 5 were not provided in the Final Report delivered to FEMA in June, 1980. They are supplemental data which were gleaned from the computer runs and show not only the total evacuation times, but also the time distribution of the population evacuated for each EPU.

2.0 DATA COLLECTION

In carrying out this assessment data was assembled on the following:

- A system of 39 Evacuation Planning Units (EPUs);
- The evacuation road network; and
- Estimates of 1980 population and household data.

2.1 Evacuation Planning Units

Thirty nine Evacuation Planning Units (EPUs) make up the EPZ. Figure 1 depicts the 39 EPUs and their relationship to municipal boundaries. The development of these units was guided by the following considerations:

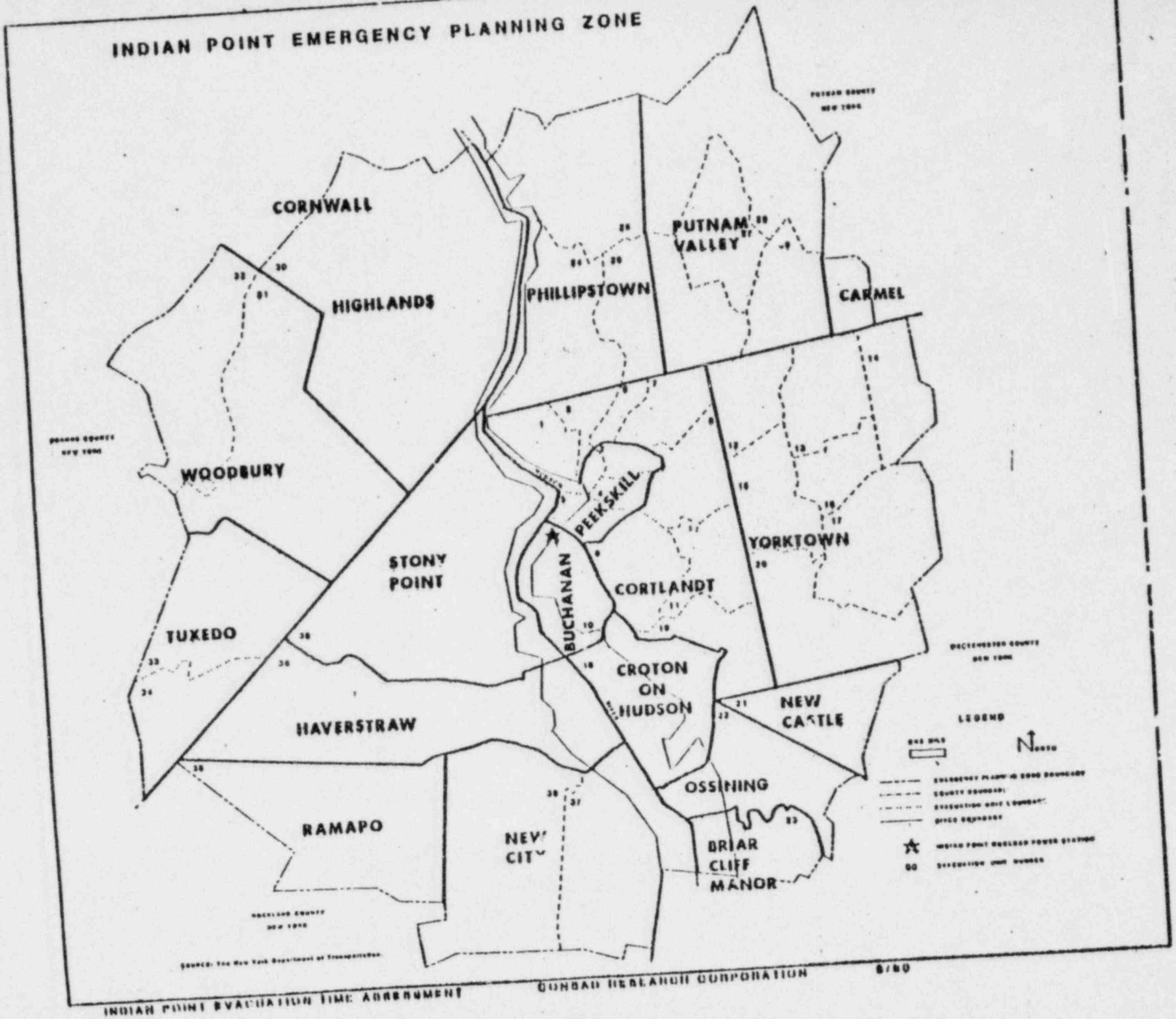
- The need for disaggregated analysis units;
- A respect for political boundaries; and
- The need for a readily identifiable system of analysis units.

The above three precepts were constrained by the types and levels of data required to conduct the evacuation time assessment. Each EPU had its size determined by the amount of population and complexity of the transportation network in the vicinity.

2.2 Evacuation Road Network

In order to simulate the evacuation a road network had to be identified. The following steps were taken:

- Inventory the roads in the EPZ;
- Choose a number of evacuation routes for each zone; and


INDIAN POINT EMERGENCY PLANNING ZONE
CORNWALL
HIGHLANDS
PHILLIPSTOWN
PUTNAM VALLEY
CARMEL
WOODBURY
STONY POINT
PEEKSKILL
BUCHANAN
CORTLANDT
YORKTOWN
TUXEDO
HAVERSTRAW
CROTON ON HUDSON
NEW CASTLE
OSSINING
RAMAPO
NEW CITY
BRIAR CLIFF MANOR
LEGEND
INDIAN POINT EVACUATION TIME ASSESSMENT
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- Identify all the evacuation routes to be used by each EPU during the simulation.

A road network map was initially prepared to include Interstate, U.S. and State Highways, Parkways, and County Roads. The evacuation routes for each EPU were determined based on the knowledge acquired through a field survey and judgement of the physical characteristics of the links comprising the network. The chosen evacuation network is shown in Figure 2. The evacuation routes are described in Table 1, and the physical characteristics of the evacuation routes are presented in Table 2.

2.3 Population and Housing Estimates

Estimates of population and households were developed from the 1970 U.S. Census.* The 1970 census data was chosen because it offered the only uniformly comprehensive data set. Also, the census tract and block detail allowed flexibility in the development of the EPUs . The steps involved in making the 1980 population estimate were the following:

- EPUs were categorized by political jurisdiction, i.e. town, city, minor civil division;
- 1977 percent change in population was recorded for each political jurisdiction**;
- Any increases in population between 1970 and 1977 were assumed to continue at a constant yearly rate to 1980;

*Census of Population and Housing: 1970 Census Tract Statistics, Bureau of the Census, Washington, D.C. (PHC (1)-145, Parts 1-3) and Census of Housing: 1970 Block Statistics, Bureau of the Census, Washington, D.C. (HC (3)-159, Part 2 and HC (3)-163).

**The sources for the 1977 population estimates was the Current Population Reports, 1977 Population Estimates for Counties, Incorporated Places, and Minor Civil Divisions in NY, Bureau of the Census, Washington, D.C. (Series P-25, #845).

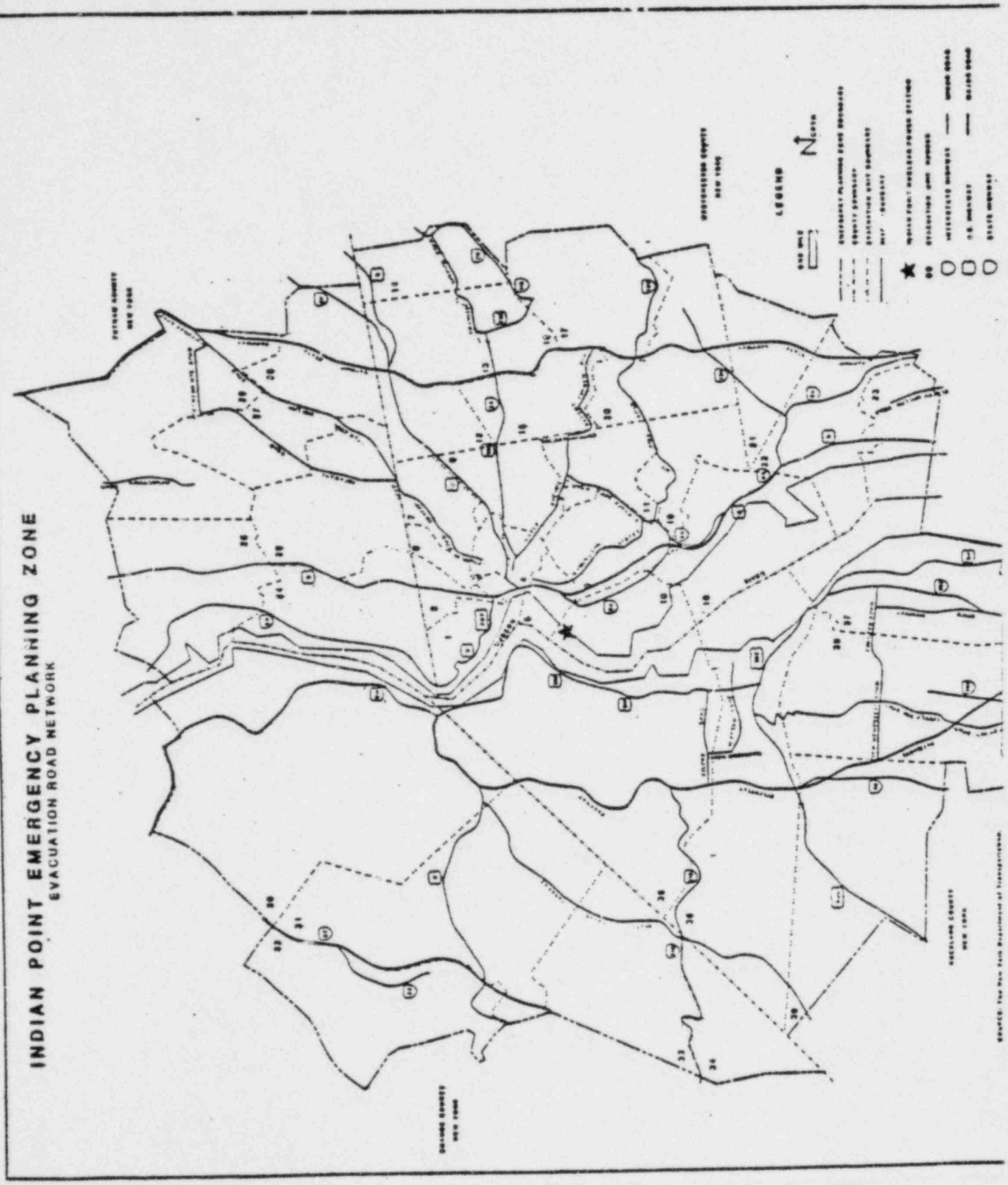


Figure 2: Evacuation Road Network

Table 1: Evacuation Routes

EPU	Route Description	Route Number
1	U.S. 6 N-State 9D. N	1
2	U.S. 9 N	2
3	U.S. 202 E- U.S. 202 E (State 35)	3-1
	U.S. 202 E- Taconic Pkw. N	3-2
	U.S. 202 E- Taconic Pkw. S	3-3
4	U.S. 202 E- U.S. 202 E (State 35)	4-1
	U.S. 202 E- Taconic Pkw. N	4-2
	Maple Ave. - Taconic Pkw. S	4-3
5	U.S. 9 S- State 9A S	5-1
	U.S. 9 N	5-2
6	Peekskill Hollow Road- Taconic Pkw. N	6-1
7	U.S. 6 E	7-1
	Peekskill Hollow Road-Taconic Pkw. N	7-2
8	U.S. 202 E- U.S.202 E (State 35)	8-1
	U.S. 202 E-Taconic Pkw. N	8-2
	U.S. 202 E-Taconic Pkw. S	8-3
9	U.S. 9 S State 9A S	9
10	U.S. 9 S State 9A S	10-1
	U.S. 9 N	10-2
11	Maple Ave.-Taconic Pkw. S	11
12	U.S. 6 E	12
13	U.S. 6 E	13-1
14	U.S. 202 E (State 35)	14-1
	Granite Springs Road E	14-2
15	U.S. 202 E- U.S. 202 E (State 35)	15-1
	U.S. 202 E- Taconic Pkw. N	15-2
	U.S. 202 E- Taconic W S	15-3
16	U.S. 202 E- (State 35)	16
17	U.S. 202 E- (State 35)	17-1
	State 129 E	17-2
18	State 9A S	18
19	Airy Road E- State 129 E	19
20	Taconic Pkw. S	20
21	Taconic Pkw. S	21
22	U.S. 9S	22-1
	State 9A S	22-2
23	U.S. 9S	23-1
	State 9A S	23-3
24	State 9D N	24-1
	U.S. 9 N	24-2
25	State 9D N	25-1
	U.S. 9 N	25-2

Table J: Evacuation Routes (continued)

EPU	ROUTE DESCRIPTION	ROUTE NUMBER
26	Peekskill Hollow Road - Taconic Pkw. N	26
27	Peekskill Hollow Road - Taconic Pkw. N	27
28	Taconic Pkw. N	28-1
	State N	28-2
29	Peekskill Hollow Road - Taconic Pkw. N	29-1
	Pennytown Road	29-2
30	U.S. 9W N	30-1
	U.S. 6 W	30-2
31	W.S. 6 W	31-1
	Seven Lakes Pkw.	31-2
32	Interstate 87 N	32-1
	U.S. 6 W	32-2
33	State 210 W	33
34	State 210 W	34
35	U.S. 9W S	35-1
	Filors Lane - Palisades Pkw. S	35-2
	Filors Lane - Palisades Pkw. S	35-3
	U.S. 202 W	
36	U.S. 9W S	36-1
	U.S. 202 W- Palisades Pkw. S	36-2
	U.S. 202 W	36-3
37	U.S. 9W S	37-1
	State 303 S	37-2
38	Middletown Road and State 304 S	38
39	Palisades Pkw. S	39-1
	State 45 D	39-2
	U.S. 202 W	39-3

Source: CONSAD Research Corporation, 1980

Table 2: Physical Characteristic of Evacuation Routes

Evacuation Route	EPU Trips Orig.	Travel Speed (MPH) Good Weather	Travel Speed (MPH) Bad Weather	Capacity (Volume/Hour)
1. U.S. 6N-State 9D N	1, 24-1, 25-1	20	15	650
2. U.S. 9N	2, 5-2, 10-2 24-2, 25-2	40	30	610-2,450
3. U.S. 202 E	3-1, 2, 3, 4-1, 2 8-1, 2, 3,15-1,2,3	40	30	600-950
4. U.S. 202 E State 118,E	3-1, 4-1, 8-1, 14-1, 15-1, 16 17-1	40	30	820-950
5. Taconic Pkw. N	3-2, 4-2, 8-2, 15-2, 28-1	55	40	2,070*
6. Peckskill Hollow Road	6, 7-2, 26, 27 29-1	30	20	600-750
7. Maple Avenue	4-3, 11	20	15	530*
8. Taconic Pkw. S	3-3, 4-3, 8-3 11, 15-3, 20 21	55	40	2,070*
9. U.S. 9S	22-1, 23-1	40	30	2,070-2,450
10. U.S. 9 + State 9A S	5-1, 9, 10-1 18, 22-2, 23-2	40	30	2,240-2,950
11. U.S. 6E	7-1, 12, 13-1,	40	30	550-950
12. Granite Spring Road E	13-2, 14-2	20	15	600*
13. Airy Road E-State 129 E	17-2, 19	30	20	610
14. State 6N	28-2	40	30	610
15. Denneytown Road	29-2	20	15	300
16. U.S. 6W	30-1, 31-1, 32-2	40	30	680-2,370
17. State 9W	30-2	40	30	2,070-2,370
18. Seven Lakes Pkw.	31-2	30	20	660*
19. Interstate 87N	32-1	55	40	2,950
20. State 210 W	33, 34	40	30	620
21. U.S. 202-State 9W	37-1	40	30	620-1,350
22. State 303 S	37-2	30	20	2,400
23. U.S. 202 W Palisades Pkw.	35-2, 36-2, 39-1	55	40	2,370-3,030*
24. U.S. 202	35-3, 36-3, 39-3	40	30	1,350-1,420
25. State 45 S	39-2	30	20	660

*The capacity values are estimated by using the formula developed by the New York Department of Transportation.

Source: CONSAD Research Corporation, 1980

- Areas experiencing a decline between 1970 and 1977 were held constant at 1977 levels for 1980; and
- Census tracts and blocks were aggregated to EPUs.

The factors used to update population were assumed to hold for all other variables. Some of the data derived using the above process are shown in Table 3. The columns indicating automobiles available by household presented in this table were used to estimate Passenger Car Equivalents (PCEs) for the general population in each EPU. Data pertaining to population and occupied housing units are displayed by EPU in Figures 3 and 4.

Table 3: 1980 Population and Housing Data

EPU	Population	Households	Households by Auto Ownership			
			0	1	2	+3
1	2,262	794	157	380	232	25
2	823	223	12	98	130	21
3	5,498	1,685	259	820	533	73
4	6,055	1,949	568	897	436	48
5	6,398	2,042	572	980	368	123
6	553	152	8	64	67	14
7	6,710	1,745	74	707	781	183
8	4,651	1,270	139	475	545	111
9	1,412	414	75	141	170	29
10	8,365	2,044	246	971	724	103
11	1,060	275	50	93	113	19
12	6,071	1,664	100	539	865	150
13	14,807	3,535	88	1,131	2,121	194
14	2,275	605	42	218	290	54
15	2,898	655	13	197	386	59
16	4,031	985	0	227	630	128
17	6,309	1,669	67	601	801	200
18	8,465	2,960	335	1,447	1,060	119
19	770	205	37	70	84	14
20	1,829	473	9	142	279	43
21	3,867	1,081	0	238	713	130
22	22,942	6,925	946	3,425	2,247	307
23	5,141	1,124	88	446	501	89
24	1,866	548	82	274	164	27
25	3,574	1,067	160	534	320	53
26	3,247	786	118	393	236	39
27	1,745	434	65	217	130	22
28	7,055	1,715	257	858	514	86
29	933	244	37	122	73	12
30	9,543	2,602	419	1,336	742	105
31	1,464	353	56	180	102	14
32	4,860	1,395	223	711	405	56
33	23	7	1	4	2	0
34	247	72	12	37	21	3
35	14,153	3,522	303	1,540	1,487	192
36	30,491	7,853	1,126	3,973	2,352	401
37	13,027	3,902	263	1,583	1,683	373
38	45,717	11,587	664	3,552	6,391	979
39	22,940	5,521	318	1,398	3,368	473
Total EPZ	284,078	76,082	7,989	31,029	32,039	5,035

Source: Projections using Census data.

Figure 3: EPU Population and Percent of Total EPZ Population

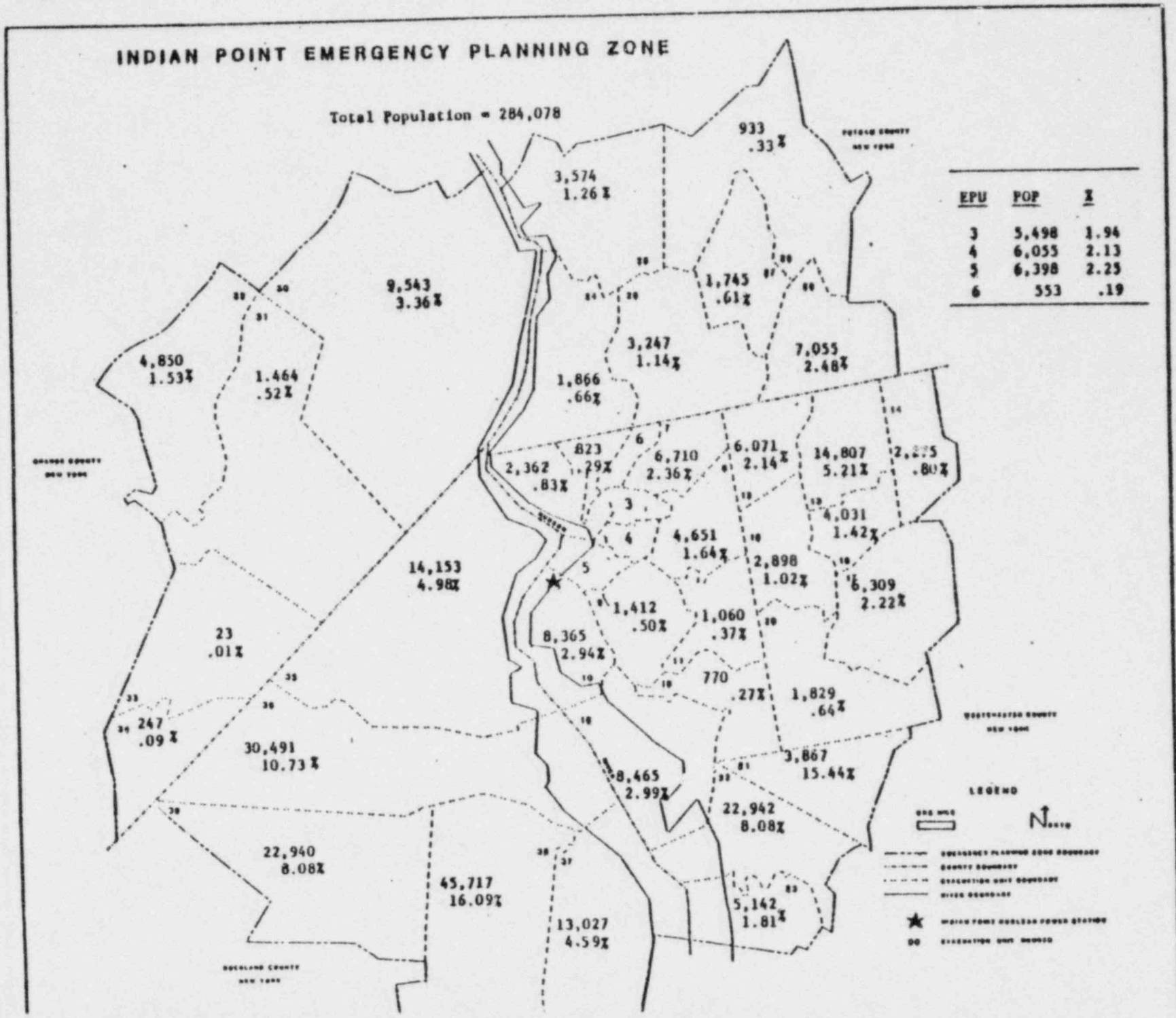
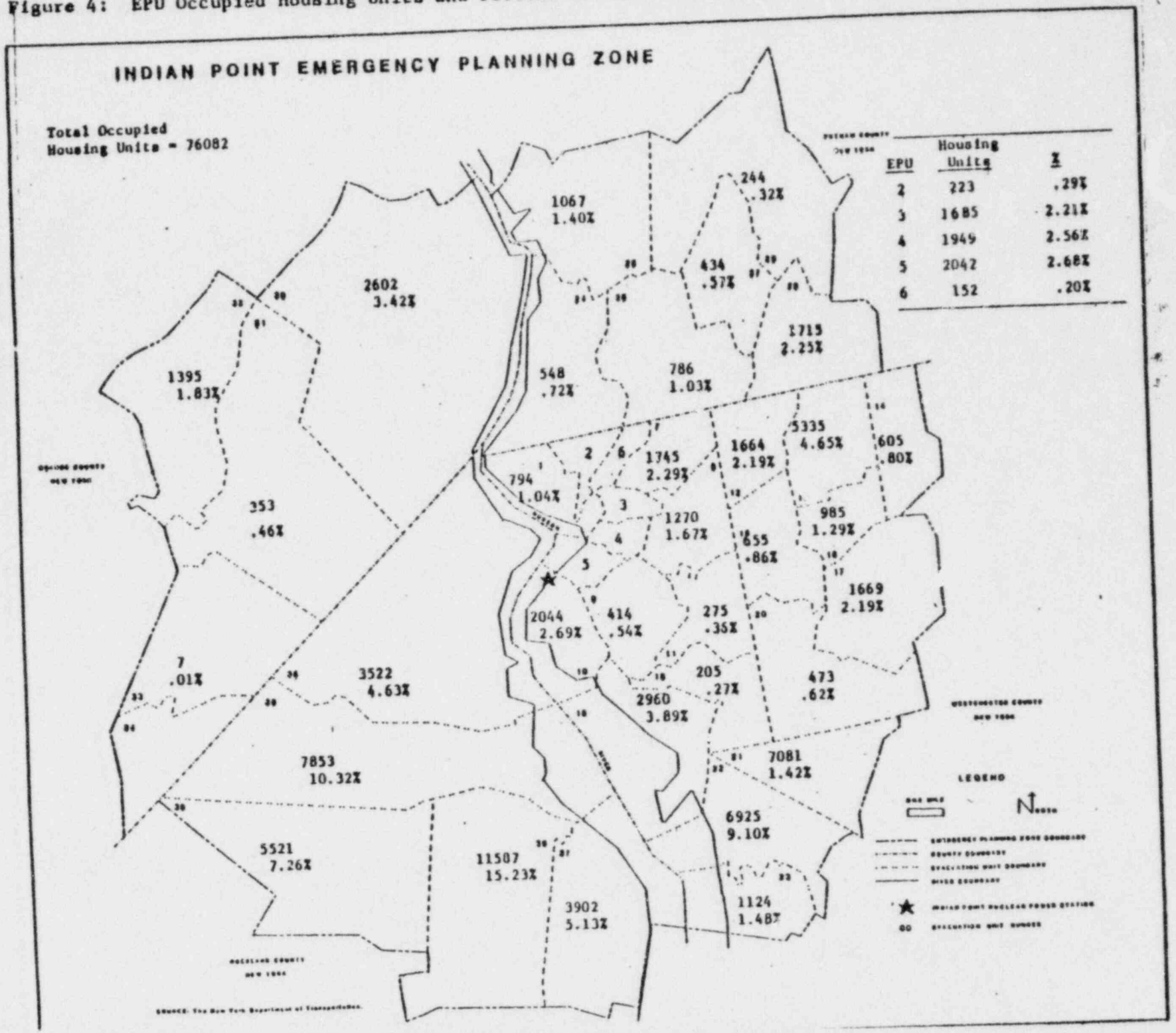


Figure 4: EPU Occupied Housing Units and Percent of Total EPZ Occupied Housing Units



3.0 SCENARIO DESCRIPTION

3.1 Evacuation Planning Zone

The Indian Point Emergency Planning Zone (EPZ) is located in a beautiful and historical area with some communities dating from the 17th century. More recently, however, part of the area has become a suburb of the New York City and Northern New Jersey urban industrial complex, and includes a number of cities and town (mostly under 20,000 population), such as Peekskill, Ossining, Haverstraw and New City. A major portion of the EPZ on the west side of the Hudson River consists of mountainous and wocded area including the Palisades Interstate Park System and part of West Point Military Academy.

The EPZ is centered on the Indian Point Nuclear Power Station which has two reactors, each of which is operated by a separate utility--Consolidated Edison and Power Authority of the State of New York (PASNY). The plant is located on the east bank of the Hudson River at Buchanan, New York, and in the northwestern corner of Westchester County.

CONSAD has chosen to use the EPZ defined in the Parsons Brinckerhoff Quade and Douglas and New York State Office of Disaster Preparedness Studies completed last winter for the Indian Point Nuclear Power Station. The EPZ as depicted in Figure 1 is in keeping with Nuclear Regulatory Commission guidelines that specify a perimeter at approximately ten miles from the power station. In fact, the EPZ goes beyond ten miles to obviate the need for splitting municipalities. The EPZ covers an area of about 415 (approximately 11.5 mile average radius) square miles and includes portions of Westchester, Putnam, Orange and Rockland

Counties.

3.2 Scenario Dimensions

In the course of conducting this assessment, eight scenarios were examined, reflecting all of the combinations contained in the three dimensions used to define each scenario The three dimensions are:

- Time of day-day or night;
- Rate of response to the alert (loading of traffic onto the network)-gradual or abrupt; and
- Weather Condition-good or bad.

The resultant eight scenarios are presented in Figure 5.

3.3 Four Phases of an Evacuation

The three dimensions mentioned in Section 3.2 which define the scenarios relate directly to three of four phases of an evacuation. The four phases are:

- Notification of government officials;
- Alerting of the general population;
- Movement preparation; and
- Vehicular travel time.

The first phase represents the time for a decision to be made to alert the public. It was not a focus of this study. Instead, the evacuation times reported in this study start from the moment that the alert of the public is initiated and end at the time the last bit of traffic leaves the EPZ.

4.0 METHODOLOGY

To analyze the movement of traffic out of the EPZ, an evacuation model was developed by CONSAD staff which has the following two significant attributes:

- It reflects the dynamic aspects of an evacuation; and
- It recognizes capacity constraints in the road network

Three sets of data are required as input to the model:

- PCEs leaving each EPU;
- Trip generation curves representing the PCEs leaving each EPU during each time interval; and
- Network characteristics.

A brief description of each input is presented below.

4.1 PCEs Leaving Each EPU

The Passenger Car Equivalents (PCEs) for each EPU are based on automobile ownership by households which was obtained from the 1970 U.S. Census and updated to 1980. In addition, PCEs for special facilities located within each EPU were estimated from data collected during site visits to the Indian Point area. PCEs is a concept used to measure vehicular flow on the network. A passenger car obviously counts for one PCE. In the case of special facilities, CONSAD has chosen a value of five for buses because of the hilly terrain in the EPZ.

The day/night dimension determines the number of PCEs leaving each EPU. During the day, schools are in session and special facilities have large staffs. During the night, children are at home and special

facilities have reduced staffs. The net effect of the day/night dimension is that during the day, there are a larger number of PCEs being generated in the EPZ than there are during the night. Figure 6 shows day-time and night-time PCEs.

4.2 Trip Generation Curves

As with PCEs leaving each EPU, the trip generation curves are also used to characterize the different scenarios. The curves are based upon two sources:

- Previous work done by the Center for Planning and Research which relates to residential population; and
- Data gathered from special facilities during site visits.

Combining departure curves for these two distinct populations yielded total trip generation curves for each EPU. To characterize the traffic loading dimension, different curves were developed for each case. The abrupt loading curves reflected an immediate loading of the network. The gradual buildup curve called for a slower loading of the network. Figure 7 presents the trip generation curves for both the gradual and abrupt loading of the network. These curves relate to evacuee ready time for the general population. The ready times for gradual and abrupt loading for larger special facilities are presented in Table 4.

In addition to the large special facilities, there are nearly 100 public and private school facilities with a pupil population of 60,000. There are also approximately 35 nursing homes, geriatric centers, convents, etc., with a population of 3,500 located within the EPZ. The following trip generation assumptions for evacuating schools, nursing homes, and

Figure 6: Day-time and Night-time Passenger Car Equivalents

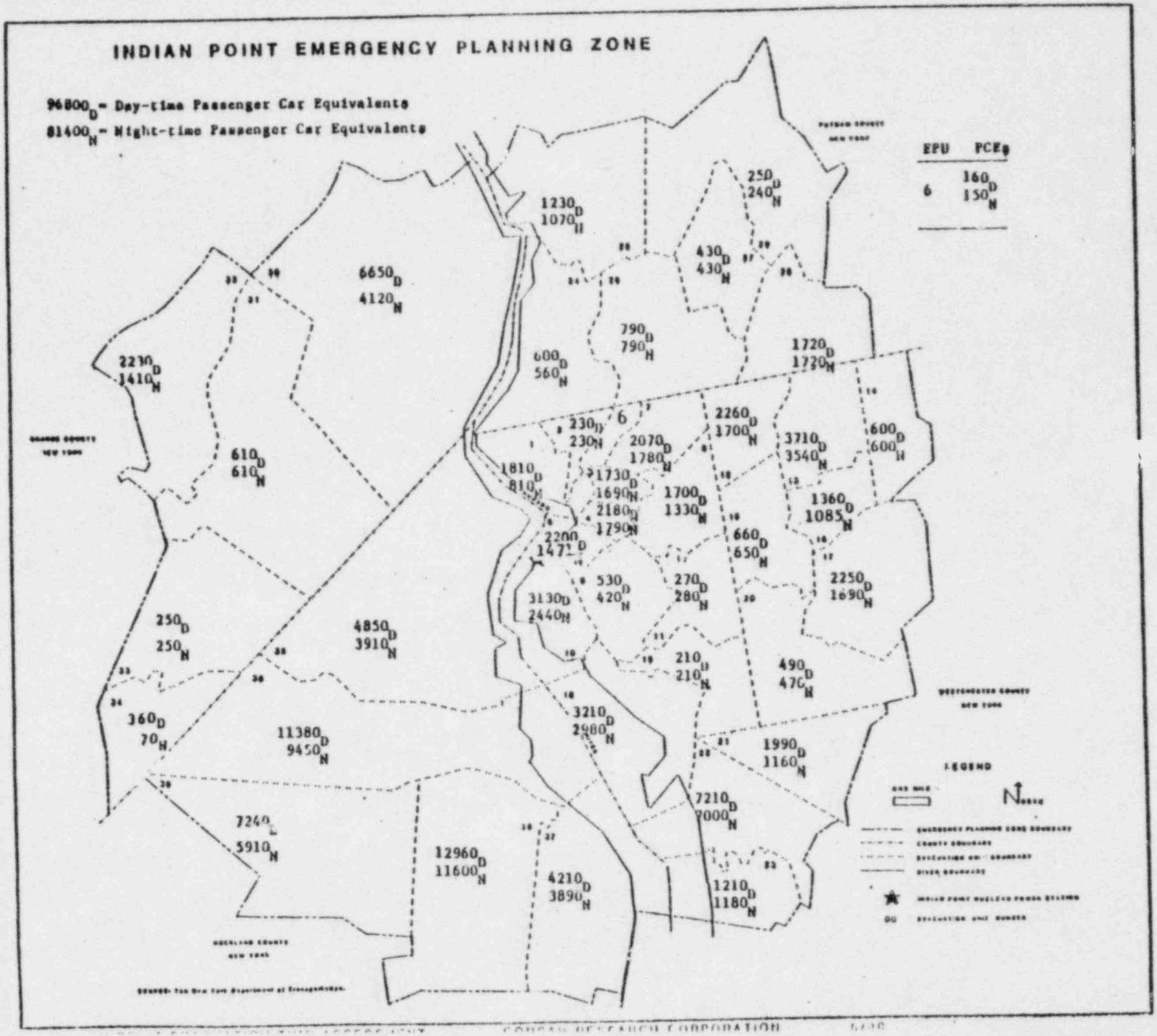


Figure 7: Trip Generation Curves For General Population

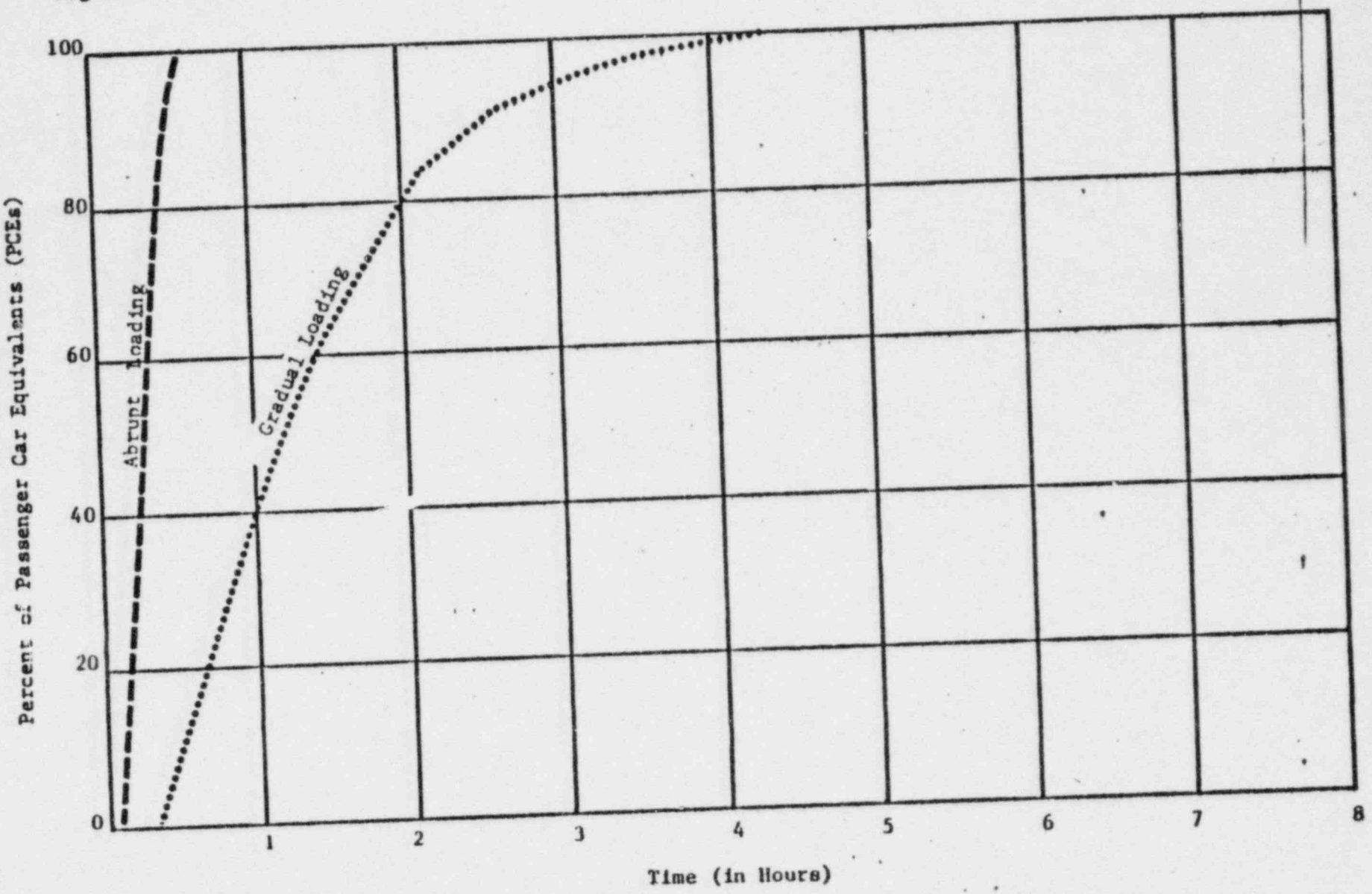


Table 4: Estimated Alerting-Preparing-Moving Times for Major Special Facilities

Evacuation Planning Unit	Name	Distance from plant (miles)	Population*	Activity	Times (min) under Gradual Loading Day	Times (min) under Gradual Loading Night	Times (min) under Abrupt Loading** Day	Times (min) under Abrupt Loading** Night
8	Peekskill Community Hospital	3.5	116	Alert Received:	30	60	5	5
				Preparation:	210	240	120	150
				Buses***	60	60	30	30
				Ambulances***	120	120	105	105
				First to Move:	90	120	45	60
				Last to Move:	240	300	125	155
10	FDR Veterans Administration	2.2	1,400	Alert Received:	30	60	5	5
				Preparation:	180	210	120	150
				Buses:	120	120	60	60
				Ambulances:	120	120	105	105
				First to Move:	90	120	45	60
				Last to Move:	210	270	125	155
22	Maryknoll Complex-Sisters Center, Nursing Home, St. Teresa's Hospital, Seminary	8.8	430	Alert Received:	30	60	5	5
				Preparation:	120	150	90	90
				Buses:	60	60	30	30
				Ambulances:	120	120	105	105
				First to Move:	90	120	45	45
				Last to Move:	150	210	110	110
22	Ossining Correctional Facility (Shelter option appears to be most feasible protective action)	9.1	1,400	Alert Received:	15	15	5	5
				Preparation:	1800	Rapid evacuation is not feasible		
				Shelter:	90	60	90	60
30	West Point Military Academy	8.2	10,000	Alert Received:	30	30	5	5
				Preparation:	60	90	30	60
				Buses:	240	210	120	120
				First to Move:	90	90	35	35
				Last to Move:	270	240	125	125

Table 4: Estimated Alerting-Preparing-Moving Times for Major Specail Facilities (continued)

Evacuation Unit No.	Name	Distance from plant (miles)	Population*	Activity	Times (min) under Gradual Loading		Times (min) under Abrupt Loading**	
					Day	Night	Day	Night
33, 34, 35, and 36	Palisades Interstate Park (Evacuation of campers 240 from residential camp sites)	5-10	10,000	Alert Received:	15	15	5	5
				Preparation:	120	150	75	100
				Buses***	360	300	180	180
				First Move:	75	75	45	45
				Last to Move:	375	315	185	185
36	Helen Hayes Rehabilitation Center	4.1	180	Alert Received:	30	60	5	5
				Preparation:	180	240	150	210
				Buses:	60	60	30	30
				Ambulances***	120	120	105	105
				First to Move:	90	90	45	60
				last to Move:	210	300	155	215
36	Letchworth Village Devel. Center	5.0	2,200	Alert Received:	30	60	5	5
				Preparation:	240	360	180	270
				Buses:	120	120	60	60
				Ambulances:	120	120	105	105
				First to Move:	90	120	45	60
				last to Move:	270	420	185	275
39	Rockland County Health Facility (Summit Park)	9.0	400	Alert Received:	30	60	5	5
				Preparation:	180	240	150	210
				Buses:	60	60	30	30
				Ambulances:	120	120	105	105
				First to Move:	90	120	45	60
				Last to Move:	210	300	155	215

*Number of inmates, patients, or residents at facility
**Assumes adequate planning, equipment installation, public education, etc. will take place for the EPZ.
***Estimated time for all required buses or ambulances to arrive at the facility

other such facilities were used:

Schools

- Under gradual loading, the pre-schools and public schools are presumed to receive the alert within one hour;
- Under abrupt loading, each school is presumed to have its own special radio receiver for automated telephone for rapid alert;
- Schools assume responsibility to transport all pupils to a safe area outside of EPUs.
- Not all bus drivers or buses will be parked at school facilities during the middle of the day, and thus they will have to be assembled;
- Under gradual loading, are based on an average number of 15 buses per school, it is assumed the first bus can be loaded and leave within 45 minutes and the last bus will depart the schools 90 minutes after the alert is received.
- Under abrupt loading when adequate planning has been made, the first bus can be loaded within 3 minutes, and the last bus can leave by 45 minutes after the alert is received.

Nursing Homes, Geriatric Centers, Convents Etc.

- Under gradual loading day-time alert is assumed to occur as result of patients or staff learning of the event through TV or radio, telephone calls, etc., and is estimated to be within 45 minutes. Night-time alert is assumed to be the same as the distribution curve for the general public.
- Under abrupt loading all such special facilities are assumed to be provided with special receivers or be on an automated telephone alert system and thus could be alerted within five minutes;
- Preparation time is estimated to be 90 minutes day-time and 150 minutes night-time under current conditions;
- The requirement of an average of three buses needed for each facility is estimated to be met within 60 minutes under current conditions; and

- The first bus can be loaded and enter an evacuation route at the middle of the preparation period following receipt of alert and the last at the end of the preparation period.

For the above two sets of special facilities the assumptions are based on estimates obtained from a sampling of such facilities.

4.3 Network Characteristics

Network characteristics consist of three factors:

- The evacuation routes defined for each EPU;
- Travel times associated with each segment; and
- Traffic capacities at critical points.

The evacuation routes were discussed earlier in Section 2. In specifying the scenarios, we used two different sets of travel times to reflect the impact of good and bad weather on the evacuation. Estimates of travel times were initially made for the network under good conditions. CONSAD chose to simulate bad weather by reducing travel speed across the network by 10 miles per hour which reflected increases travel times. Finally, capacities at critical points were taken from the 1978 New York State Sufficiency Ratings or derived using the NYSDOT capacity methodology.

4.4 Evacuation Model

The evacuation model processes the inputs mentioned above by moving traffic through the network according to the selected travel times in ten minute intervals, up to the point that the capacity of any point in the network is exceeded. Once capacity is exceeded, the traffic which exceeds capacity is delayed to the next iteration of the simulation.

The model keeps track of traffic movements in each EPU and runs until the total EPZ is completely evacuated.

5.0 SCENARIO RESULTS

The final report identified the Ideal (best) and Adverse (worst) Scenarios based on 100 percent evacuation time for the entire EPZ. The best scenarios were identified as NGLGW and NGLBW which both had 100 percent evacution times of 7.33 hours. The reason for the seemingly non-existent difference between good and bad weather (as reflected in identical evacuation times) occurs because the delay caused by bad weather turns out to be insignificant when compared to the delay created by capacity constraints. DALBW is the worst scenario based on its 100 percent evacution time of 8.67 hours. Table 5 summarizes the 100 percent evacuation times by scenario, as well as time estimates for each of the EPUs.

Althought CONSAD feels that the above approach that identifies the Ideal and Adverse scenarios based solely on 100 percent evacuation times is basically sound and meets all requirements of the FEMA work plan, for this summary we have taken the initiative to re-identify the best and worst scenarios based on a slightly different criterion. The criterion used defines the best and worst scenarios based on the highest and lowest portion of population evacuated at the point of five hours into the evacuation.

Table 6 presents both PCEs and population evacuated at five hours into the evacuation for each of the scenarios. Contrary to what is observed by looking at the 100% evacuation time, under the five hour criterion NALGW and DGLBW are the best and worst scenarios, respectively. At five hours into the evacuation the best scenario will have evacuated 90.0 percent of the estimated total (284,078) 1980 population, whereas, the

Table 5 : Summary of 100 Percent Evacuation Times by Scenario

EPU	DGLGW	DGLBW	DALGW	DALBW	NGLGW	NGLBW	NALGW	NALBW
1	4.83	4.83	4.67	4.67	6.50	6.67	2.83	3.0
2	5.67	5.67	5.50	5.50	5.0	5.0	4.67	4.67
3	7.17	7.33	8.50	8.67	6.50	6.67	7.83	8.0
4	6.33	6.33	7.17	7.17	6.50	6.67	6.50	6.67
5	7.83	7.67	7.83	7.67	7.17	7.0	7.0	2.33
6	4.33	4.33	4.0	3.67	4.33	4.33	3.83	3.50
7	7.0	7.50	7.17	7.67	6.33	6.67	6.17	6.67
8	6.33	6.17	6.0	6.17	6.17	6.33	4.83	5.0
9	7.67	7.67	7.50	7.67	7.0	7.0	6.83	6.83
10	7.67	7.67	7.67	7.67	7.0	7.0	6.83	6.83
11	4.33	4.33	2.67	2.33	4.33	4.33	2.0	1.83
12	6.50	6.83	5.83	6.17	6.33	6.50	4.67	5.0
13	5.17	5.33	4.33	4.33	5.0	5.17	4.17	4.17
14	4.17	4.17	2.33	2.33	4.17	4.17	1.83	1.67
15	6.0	6.0	5.67	5.67	4.67	4.67	4.33	4.33
16	6.17	6.33	5.83	6.0	4.67	4.83	4.33	4.50
17	6.33	6.33	5.0	5.0	6.17	6.17	3.67	3.67
18	7.67	7.50	7.50	7.50	7.0	6.83	6.83	6.67
19	4.17	4.17	1.50	1.33	6.0	6.17	1.83	1.83
20	4.17	4.17	1.83	2.0	4.17	4.17	1.50	1.33
21	4.17	4.33	2.50	2.50	6.50	6.33	2.0	2.0
22	7.67	7.67	7.17	7.50	7.0	7.0	5.67	6.17
23	4.0	4.0	1.67	1.67	6.0	6.0	1.67	1.67
24	4.0	4.0	4.50	4.50	6.0	6.0	2.67	2.67
25	4.17	4.33	3.0	3.17	4.17	4.33	2.33	2.50
26	4.0	4.0	3.50	3.50	4.0	4.0	3.33	3.33
27	4.0	4.0	2.17	2.0	4.0	4.0	2.0	1.83
28	4.17	4.33	2.33	2.50	4.17	4.33	2.17	2.50
29	4.0	4.0	0.83	0.67	4.0	4.0	0.83	0.67
30	4.50	4.67	2.83	3.0	6.0	6.33	2.17	2.33
31	6.50	6.67	3.33	3.50	5.50	5.67	3.33	3.50
32	4.17	4.33	1.33	1.50	4.17	4.33	1.83	2.0
33	6.33	6.33	3.17	3.17	5.33	5.33	3.17	3.17
34	3.33	3.33	1.0	1.0	3.33	3.33	0.33	0.33
35	6.50	6.67	6.17	6.33	5.50	5.67	5.17	5.33
36	6.33	6.33	6.17	6.17	7.33	7.33	5.50	5.33
37	5.67	5.83	5.17	5.17	5.33	5.33	4.33	6.17
38	7.33	7.33	7.17	7.17	6.50	6.50	6.33	6.33
39	6.17	6.17	6.0	6.0	5.0	5.0	5.0	5.0
TOTAL	7.83	7.67	8.50	8.67	7.33	7.33	7.83	8.0

Source: CONSAD Research Corporation, 1980

Table 6: PCEs and Population Evacuated at Five Hours into the Evacuation

Scenario	Total PCEs	Five Hours into Evacuation			
		PCEs Evacuated	% of PCEs	Population Evacuated	% of Population
DGLGW	96,833	83,664	86.4	24[illegible],971	86.6
DGLBW	96,817	81,423	84.1	238,569	84.0 *
DALGW	96,810	82,676	85.4	243,067	85.6
DALBW	96,815	82,099	84.8	241,371	85.0
NGLGW	81,348	73,376	90.2	256,082	90.1
NGLBW	81,333	73,037	89.8	254,899	89.7
NALGW	81,364	73,960	90.9	258,120	90.9**
NALBW	81,371	73,641	90.5	257,006	90.5

* Worst Scenario
** Best Senario

Source: CONSAD Research Corporation, 1980

worst scenario will have evacuated only 84 percent.

The following figures highlight the best and worst scenarios as identified by the five hour criterion by looking at both entire EPZ results and individual EPU result. A brief description of each of them is as follows:

- Figure 8 is a bar chart displaying population evacuated by two-hour time intervals for the entire EPZ.
- Figure 9 presents 50, 90, and 100 percent PCE evacuation time estimates for each EPU under the wrst scenario (DGLBW).
- Figure 11 is a graph of the results under Scenario NALGW comparing the percentage of PCEs evacuated over time for the entire EPZ with the EPUs which had the shortest and longest evacuation times.
- Figure 12 is a graph of the rusults under Scenario DGLBW comparing the percentage of PCEs evacuated over time for the entire EPZ with the EPUs which had the shortest and longest evacuation times.

The information presented in those figures was obtained from results of the computerized analysis; some of this information was not presented in the final report delivered to FEMA.

Figure 8: Comparison of Worst and Best Scenarios by Population Evacuated

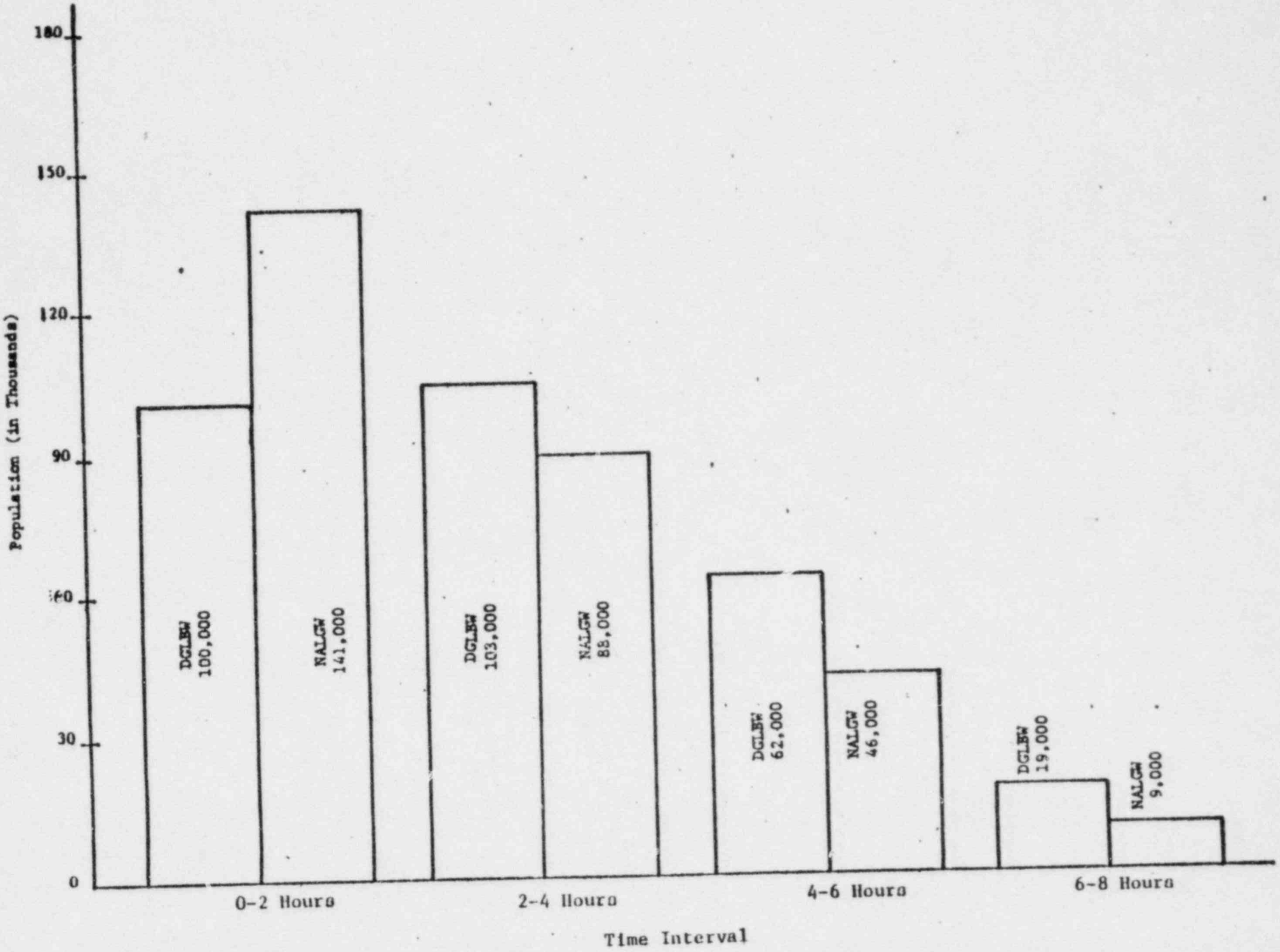


Figure 9: Best Scenario/NALGW-Evacuation Times at 50, 90, and 100% of EPU Evacuation

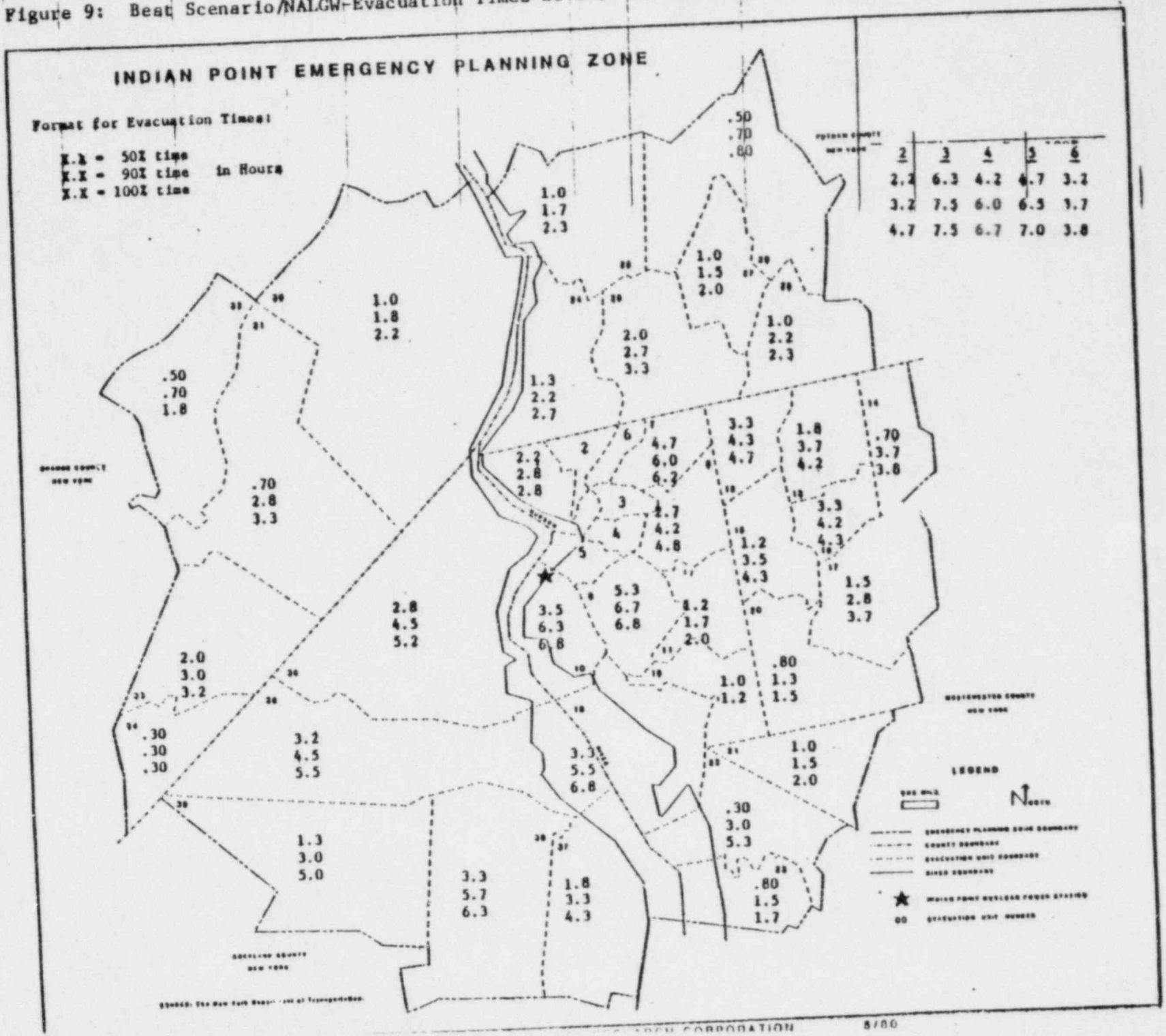
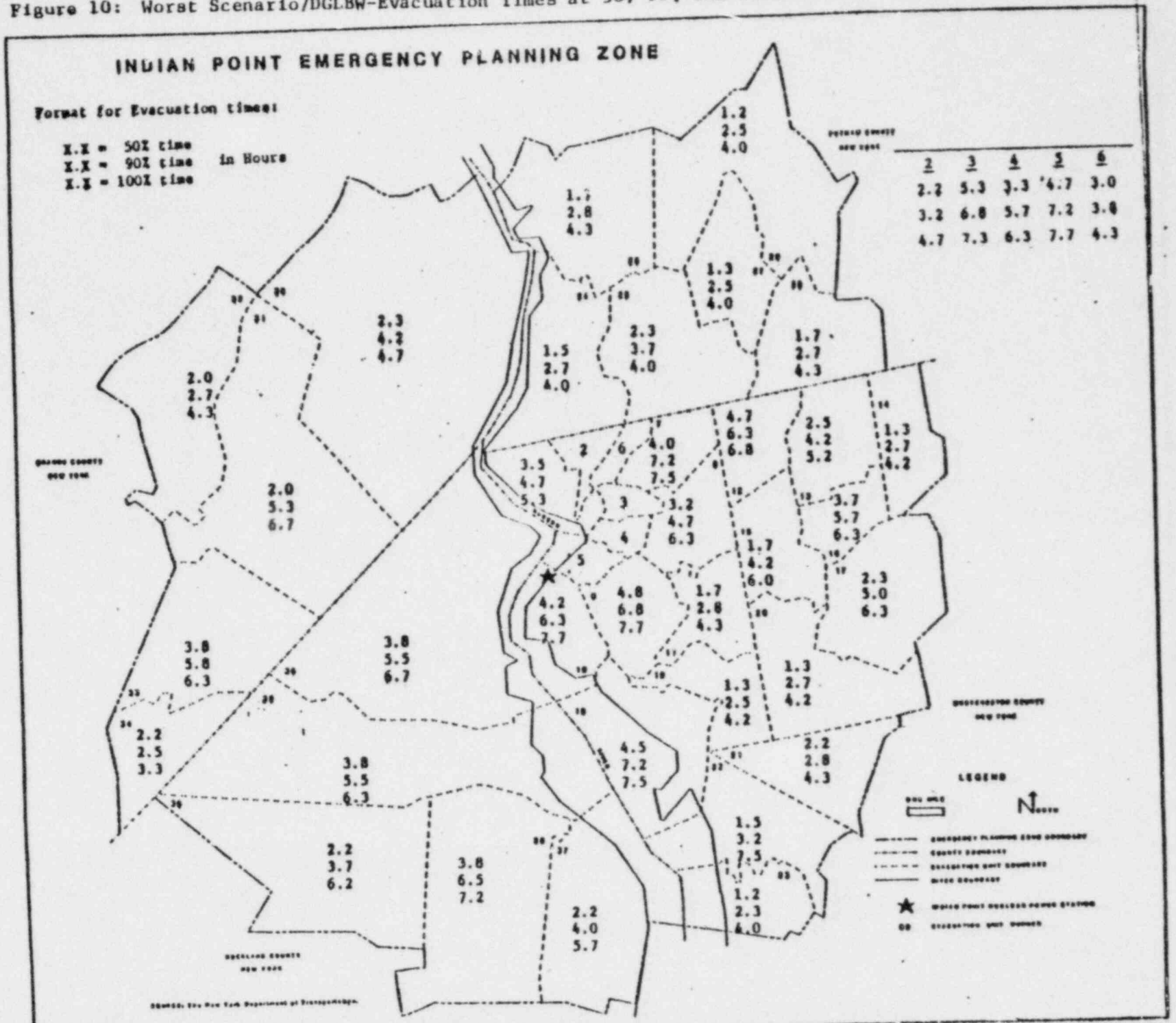


Figure 10: Worst Scenario/DGLBW-Evacuation Times at 50, 90, and 100% of EPU Evacuation



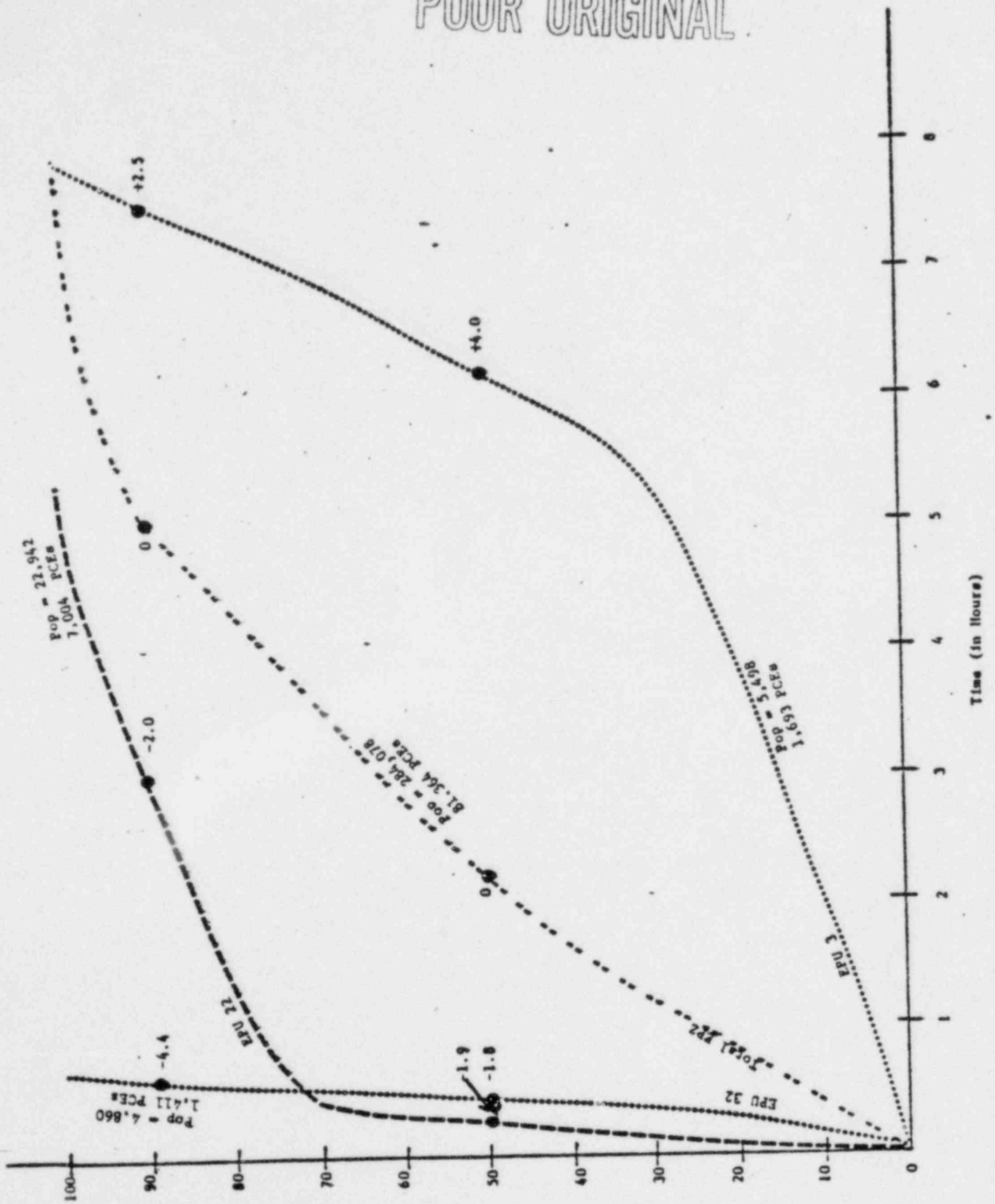


Figure 11: NALGW - Performance Charcteristics of Best and Worst Case EPUs Compared to Total EP2