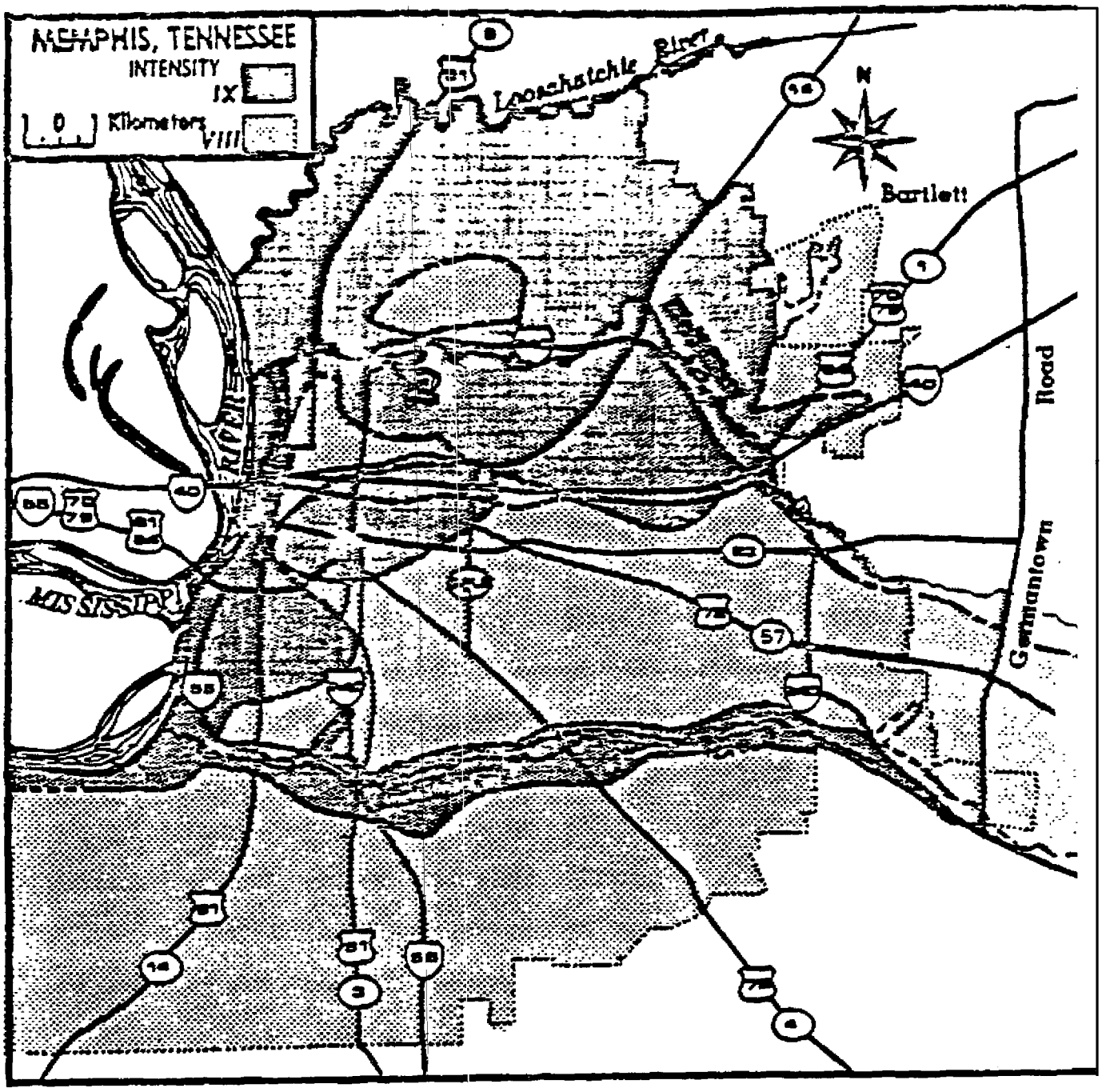
SECTION 7

MEMPHIS, TN

The estimates of vulnerability and availability presented in this report represent statistical averages and overall assessments resulting from the application of a new, preliminary methodology. They are intended for emergency management and planning purposes only.

7.1 Location and Characteristics

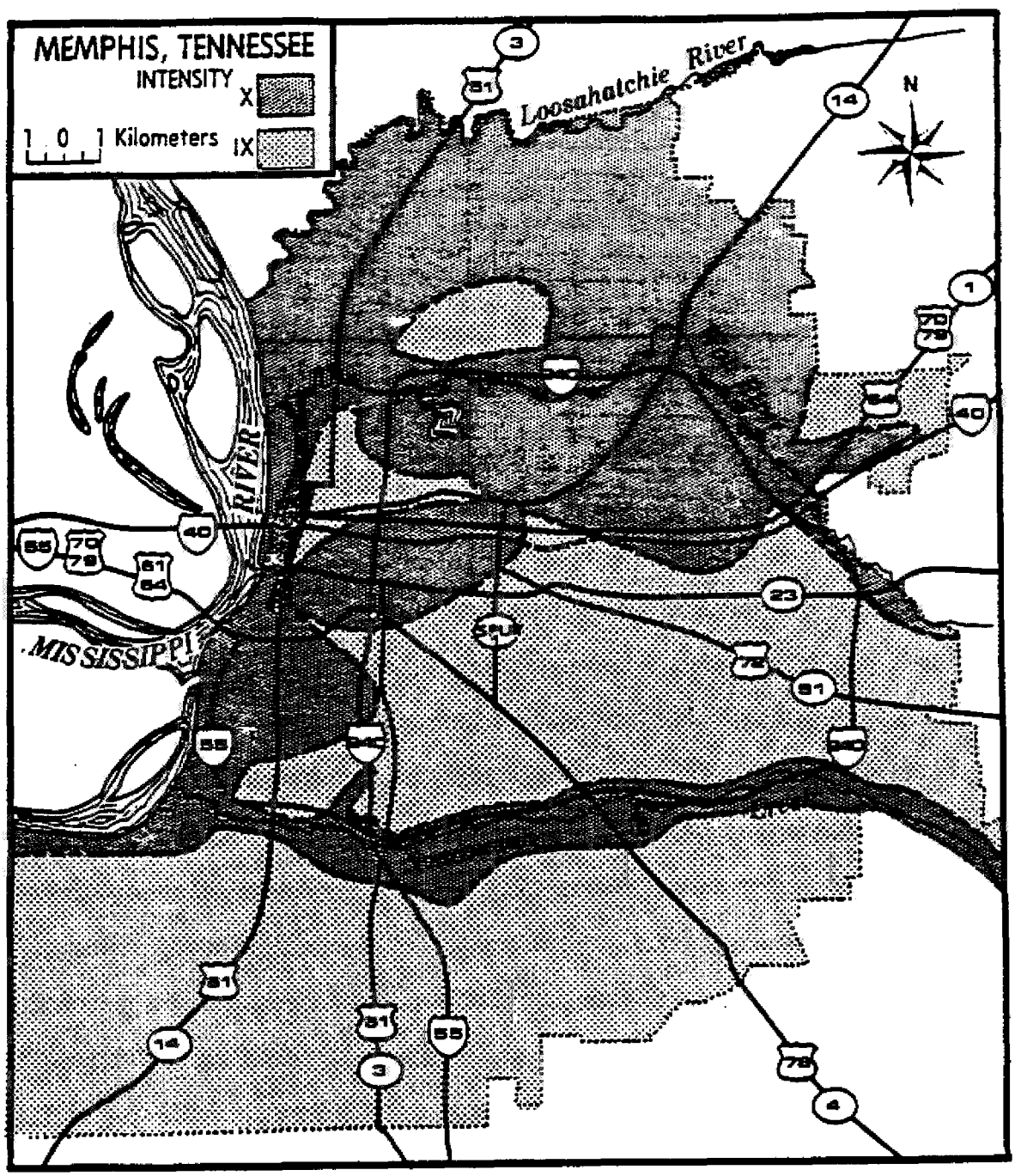
The City of Memphis is located in extreme southwest Tennessee, on the eastern bank of the Mississippi River. With a 1980 population of slightly more than 646,000 persons, it is the most populous of the six cities: Memphis is a major regional and national center for all transportation modes, for commerce, and health services.



Hypothetical intensity map for Memphis, Tennessee, for a magnitude M(S)=7.6 earthquake. For an earthquake near the south end of the New Madrid seismic zone, intensities projected for Memphis are: IX in the alluvial valleys and in the areas found by Sharma and Kovacs (1980) to have high amplification factors or to be susceptible to liquefaction, and VIII in the rest of the city. For an earthquake near the north end of the New Madrid seismic zone, the intensities at Memphis would be lower

Reference 16

FIGURE 7-1



Hypothetical intensity map for Memphis, Tennessee. For an Ms=8.6 earthquake near the south end of the New Madrid seismic zone, intensities projected for Memphis are: X in the alluvial valleys and in the areas found by Sharma and Kovacs (1980) to have high amplification factors (figure 20) or to be susceptible to liquefaction (figure 19), and IX in the rest of the city. For an earthquake near the north end of the New Madrid seismic zone, the intensities at Memphis would be lower.

Reference 16

FIGURE 7-2

7.2 Medical Resources and Facilities

Memphis possesses, as does any city, a wide variety of medical services and facilities. Beyond this, the city serves as a major regional medical center, with a large number of major and small hospitals, clinics and similar facilities. These activities have caused considerable health care support and peripheral activities to develop and prosper. The entities surveyed in this project are: Major Hospitals, Blood Banks, Clinical Laboratories, Ambulance Services and Personnel.

7.2.1 Major Hospitals

The City of Memphis serves as a major regional Medical Care Center, with large university, religious sponsored and private health care facilities which serve general, specialty and research medical needs. Hospital facilities are distributed throughout the City, with a majority being concentrated within the central city area.

Damage to hospitals in Memphis will be serious following the scenario earthquakes, due to the strong ground motion and potentially adverse soil conditions in the region. Of the twenty-five major structures associated with the thirteen major hospitals surveyed, only half are estimated to be available following the Ms=7.6 earthquake; a third are estimated to be available following the Ms=8.6 event. The 5,711 beds associated with these hospitals constitute 86% of all hospital beds in Shelby County, where Memphis is located. The remaining beds are distributed among other, small hospitals in the area. Of the beds located in the structures of the 13 surveyed hospitals, 3,320, or 52% are estimated to be available following the Ms=7.6 quake, 2,290 (37%) following the Ms=8.6 event. Emergency

power units serving the surviving hospital structures are also estimated to be available. Table 7-1 presents these findings.

TABLE 7-1
AVAILABILITY OF MAJOR HOSPITAL FACILITIES
MEMPHIS, TN

Base Information		
Major Hospitals Surveyed	Hospital Structures Surveyed	Beds In Surveyed Structures
13	25	5,711

AVAILABILITY ANALYSIS

Earthquake	Hospital Structures Estimated To Be Available/Percent	Beds Estimated To Be Available/ Percent	Emergency Power Unit Available
Ms=7.6	13/51%	3,230/52%	Yes
Ms=8.6	8/32%	2,290/37%	Yes

7.2.2 Blood Banks

Availability of blood storage facilities in Memphis following the Ms=7.6 and Ms=8.6 earthquakes is shown in the following table. These structures are normally provided with emergency power units, which are estimated to be available for service.

BLOOD STORAGE FACILITIES
(Blood Banks)
Memphis, TN

Number of Facilities Surveyed		Number Estimated to be Available Ms=7.6	Ms=8.6
Major Hospital:	13	7/54%	5/38%
Non-Hospital:	6	3/50%	2/33%
Total	19	10/54%	7/37%

7.2.3 Clinical Laboratories

The availability of clinical laboratory facilities in Memphis

following an occurrence of the Ms=7.6 and the Ms=8.6 earthquakes is depicted in the following table. Those facilities associated with major hospitals can utilize the hospitals' emergency power systems. The availability of emergency power to non-hospital laboratories was not inventoried.

AVAILABILITY OF CLINICAL LABORATORIES
MEMPHIS, TN

	Total Number Surveyed	Number To Be Available/Percent	
		Ms=7.6	Ms=8.6
Major Hospitals	13	8/62%	7/54%
Others	6	4/67%	3/50%
Totals	19	12/63%	10/53%

7.2.4 Ambulance Services

The availability of ambulance service structures in Memphis following an occurrence of the Ms=7.6 and the Ms=8.6 earthquakes is depicted in the following table. As ambulances are frequently parked outdoors, the survival of vehicles is likely to be good, but difficult to quantify. Structures contain supplies, communications equipment and personnel, and thus contribute significantly to the providing of this service.

AVAILABILITY OF AMBULANCE SERVICE STRUCTURES
MEMPHIS, TN

Number of Structures Surveyed	Number Estimated to be Available	
	Ms=7.6	Ms=8.6
22	11/50%	6/27%

7.2.5 Personnel

Casualties among medical personnel are presented collectively in Tables 3-2 and 3-3, Section 3.

7.3 Public Services

This part presents the estimated availability of selected vital services, facilities and systems in Memphis, following the occurrence of the Ms=7.6 and the Ms=8.6 earthquakes. These services include fire fighting and police.

7.3.1 Fire Services

The following table shows the estimated availability of fire fighting structures. Since fire fighting vehicles and other equipment are typically located inside a structure, the loss of a structure contributes to the non-availability of needed equipment.

AVAILABILITY OF FIRE SERVICE STRUCTURES
MEMPHIS, TN

Total Structures Surveyed	Structures Estimated To Be Available	
	Ms=7.6	Ms=8.6
57	30/53%	22/39%

7.3.2 Police Services

The following table shows the estimated availability of police service structures in Memphis.

AVAILABILITY OF POLICE SERVICES STRUCTURES
MEMPHIS, TN

Total Structures Surveyed	Structures Estimated To Be Available	
	Ms=7.6	Ms=8.6
2	1/50%	0/0%

7.4 Communications

The following table shows the estimated availability of radio, television, and telephone structures in Memphis following the occurrence of the Ms=7.6 and the Ms=8.6 earthquakes.

AVAILABILITY OF COMMUNICATIONS STRUCTURES
MEMPHIS, TN

	Total Structures Surveyed	Structures Estimated To Be Available	
		Ms=7.6	Ms=8.6
Radio	15	10/67%	8/53%
Television	10	6/60%	4/40%
Telephone	-	-	-
Total	25	16/64%	12/48%

7.5 Transportation Systems

7.5.1 Highways

The probable effects of the two earthquakes on major highways in Memphis and Shelby County are summarized in the following distribution of section survival probabilities:

Probability of Survival	Number of Sections (City Only)		Number of Sections (City + County)	
	Ms=7.6	Ms=8.6	Ms=7.6	Ms=8.6
0.00 - 0.25	23	31	23	36
0.26 - 0.50	5	7	8	8
0.51 - 0.75	6	8	10	9
0.76 - 1.00	20	8	21	9
Total	54	54	62	62

The probabilities of survival calculated for the individual sections are shown in Table 7-2. Figures 7-3 and 7-4 indicate graphically the sections most likely to remain passable after the stronger of the two earthquakes.

Within the city limits, damage to the major highway network would be extensive from the Ms=7.6 scenario event. Half the highway sections would have survival probability of less than 0.50. One of the two Mississippi River crossings would probably not be usable, and most of I-240 around the city would be impassable. An Ms=8.6 event

TABLE 7-2

PROBABILITY THAT ALL BRIDGES ON AND OVER HIGHWAY SECTIONS WOULD SURVIVE NEW MADRID EARTHQUAKE

MEMPHIS/SHELBY COUNTY

Highway Section No.	Route No.	No. of Support Structures		No. of Over-passing Struct.	Earthquake Intensity (MMI)		Probability of Survival	
		Single Struct.	Parall. Pairs		Ms=7.6	Ms=8.6	Ms=7.6	Ms=8.6
1	I240			6	IX	X	.02	.00
2	I240		2	2	IX	X	.21	.02
3	I240		3	4	IX/VIII	X/IX	.14	.01
4	I240	0	5	8	IX/VIII	X/IX	.01	.00
5	I240	1	3	4	IX	X	.02	.00
6	I240		1	9	IX/VIII	X/IX	.08	.00
7	I240	1	1	2	VIII/IX	IX/X	.12	.02
8	I240			4	IX	X	.06	.00
9	I240	5	2	1	VIII/IX	IX/X	.00	.00
10	I240	3	5	2	IX	X	.02	.00
11	I240	2	1		IX	X	.43	.08
12	I240	1	2		IX	X	.38	.11
13	I240X	1		1	IX	X	.12	.02
14	I40	1			IX	X	.69	.37
15	I40	1		1	VIII	IX	.93	.61
16	I40	4	1	2	VIII/IX	IX/X	.00	.00
17	I40	3	4	6	IX/VIII	X/IX	.09	.00
18	I40		6	2	IX/VIII	X/IX	.13	.00
19*	I40		4	4	VIII	IX	.68	.10
20	I55	2	4	5	VIII	IX	.54	.03
21	I55	2	3		IX	X	.39	.05
22	I55	1	3	5	IX/VIII	X/IX	.04	.00
23	I55	2	4	11	IX	X	.00	.00
24	I55	2			IX	X	.09	.02
25	SR83			2	IX	X	.84	.57
26	SR83	1		1	VIII	IX	.93	.61
27	SR83	1	1		VIII/IX	IX/X	.16	.01
28	SR83			1	IX	X	.89	.70
29	US51	4			VIII	IX	.87	.35
30	US51	7		2	IX/VIII	X/IX	.02	.00
31	US51			2	VIII	IX	.96	.79
32	US51				IX	X	1.00	1.00
33	US51				VIII	IX	1.00	1.00
34	US51	2		1	IX	X	.28	.05
35	US51	4	2		IX	X	.16	.01
36*	US51	1	2		IX	X	.39	.08
37	US61	2	1		VIII/IX	IX/X	.52	.12

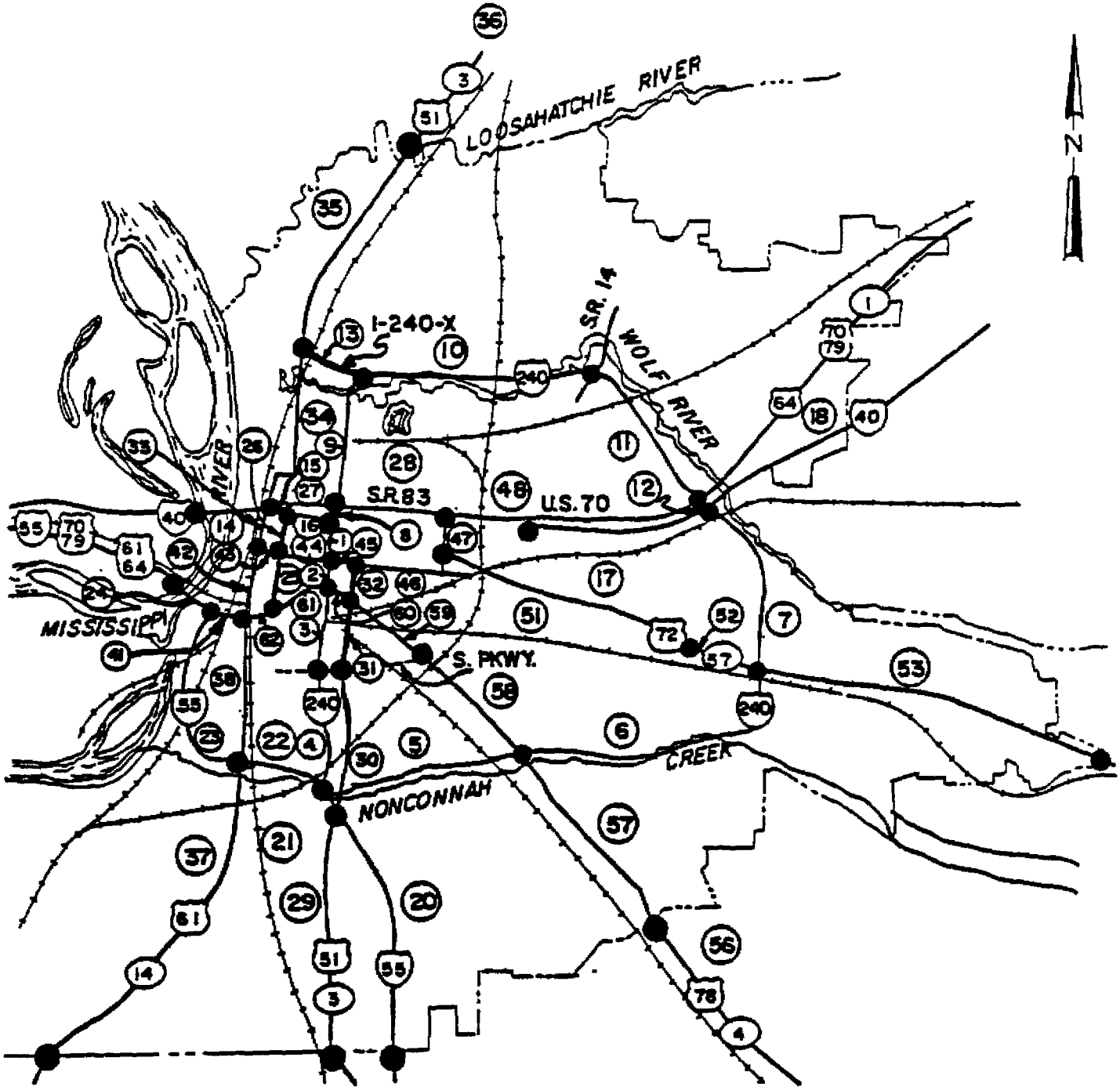
TABLE 7-2

PROBABILITY THAT ALL BRIDGES ON AND OVER HIGHWAY SECTIONS WOULD SURVIVE NEW MADRID EARTHQUAKE

MEMPHIS/SHELBY COUNTY (Page 2)

Highway Section No.	Route No.	No. of Support Structures		No. of Over-passing Struct.	Earthquake Intensity (MMI)		Probability of Survival	
		Single Struct.	Parall. Pairs		Ms=7.6	Ms=8.6	Ms=7.6	M=s8.6
38	US61	5		1	VIII/IX	IX/X	.12	.00
39*	US64	2		2	VIII	IX	.48	.12
40*	US64	2			VIII	IX	.93	.59
41	US70			1	IX	X	.89	.70
42	US70			1	IX	X	.89	.70
43	US70	1			IX	X	.69	.37
44	US70	1			IX	X	.78	.49
45	US70				IX	X	1.00	1.00
46	US70	1			VIII	IX	.75	.43
47	US70				IX	X	1.00	1.00
48	US70	3		2	IX/VIII	X/IX	.28	.04
49	US70	2			IX	X	.18	.04
50*	US70	10	1		VIII	IX	.29	.01
51	US72	2			VIII	IX	.93	.59
52	US72		1		VIII	IX	.80	.29
53	US72				VIII	IX	1.00	1.00
54*	US72	1			VIII	IX	.98	.86
55*	US72	2			VIII	IX	.73	.37
56*	US78	2			VIII	IX	.56	.18
57	US78	6		1	VIII/IX	IX/X	.07	.00
58	US78	1	1	1	IX/VIII	X/IX	.52	.17
59	US78			2	VIII	IX	.97	.84
60	US78			2	IX	X	.79	.49
61	US78			2	IX	X	.88	.66
62	US78				IX	X	1.00	1.00

* Located in Shelby County but outside the city limits of Memphis.

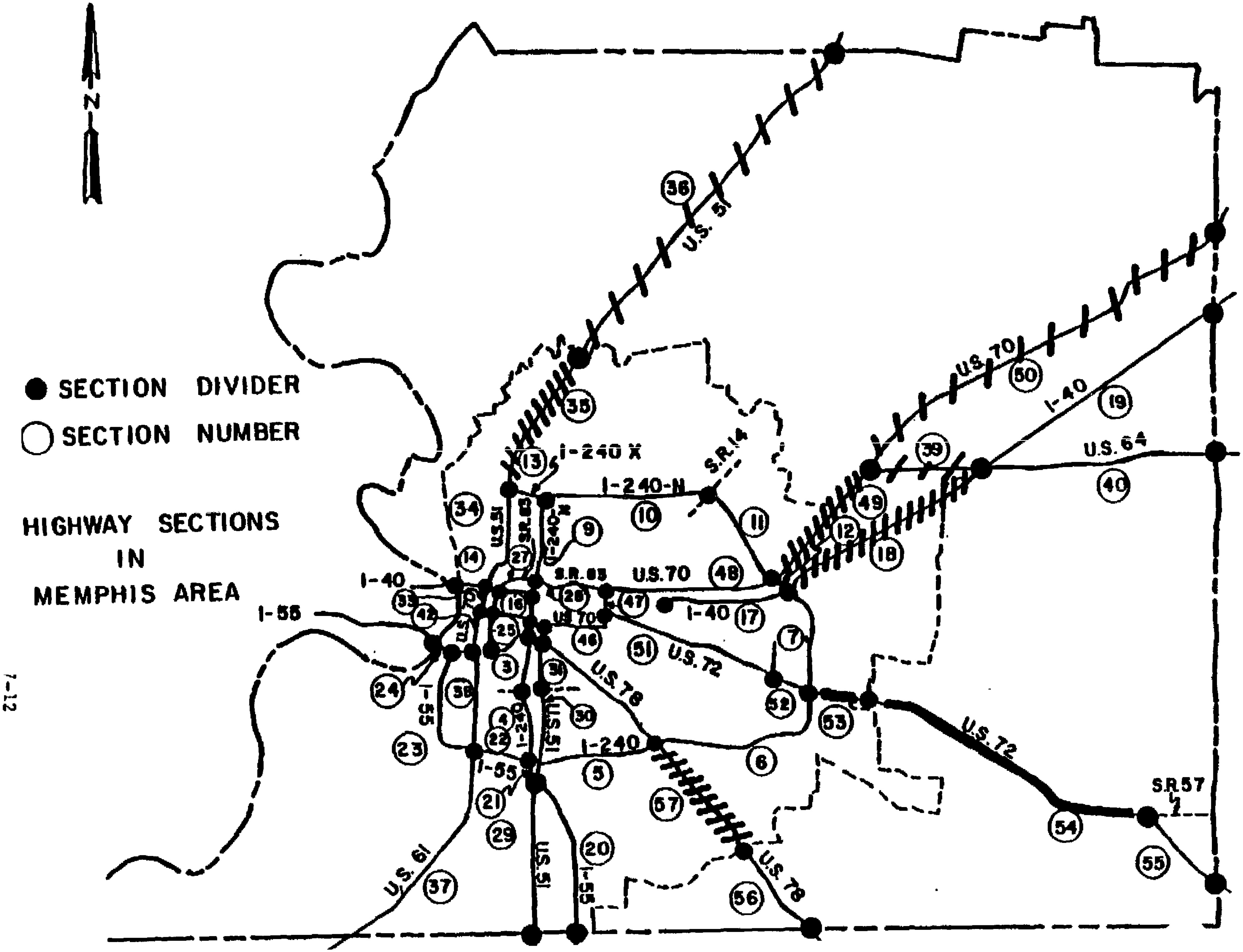


● SECTION DIVIDER

○ SECTION NUMBER

HIGHWAY SECTIONS IN MEMPHIS CITY LIMITS

FIGURE 7-3



HIGHWAY SECTIONS IN MEMPHIS AREA

would leave very few major highway sections available for use, severely restricting mobility throughout the city.

Outside the city, the access route most likely to remain open would be U.S. 72 from the southeast. The routes most prone to damage would be U.S. 51 and U.S. 70 from the north and east. After an Ms=7.6 event, access to the city would probably be interrupted in at least half the major routes. An Ms=8.6 event would probably close all but two or three of the eleven access routes.

7.5.2 Railways

The probable effects of the two earthquakes on major railway lines in Memphis and Shelby County are summarized in the following distribution of section survival probabilities:

Probability of Survival	Number of Sections (City Only)		Number of Sections (City + County)	
	Ms=7.6	Ms=8.6	Ms=7.6	Ms=8.6
0.00 - 0.25	12	18	12	20
0.26 - 0.50	2	5	3	7
0.51 - 0.75	6	1	8	1
0.76 - 1.00	7	3	8	3
Total	27	27	31	31

The probabilities of survival calculated for the individual sections are shown in Table 7-3. Figures 7-5 and 7-6 indicate graphically the sections most likely to remain passable after the stronger of the two earthquakes.

Within the city limits, the Ms=7.6 earthquake scenario would render impassable close to half of the sections of the major rail lines. North-south movement would be difficult, if not impossible. One of the two briges across the Mississippi would probably survive. An Ms=8.6 event would probably take out both those bridges and would leave few operable sections. Rail movement within the city would

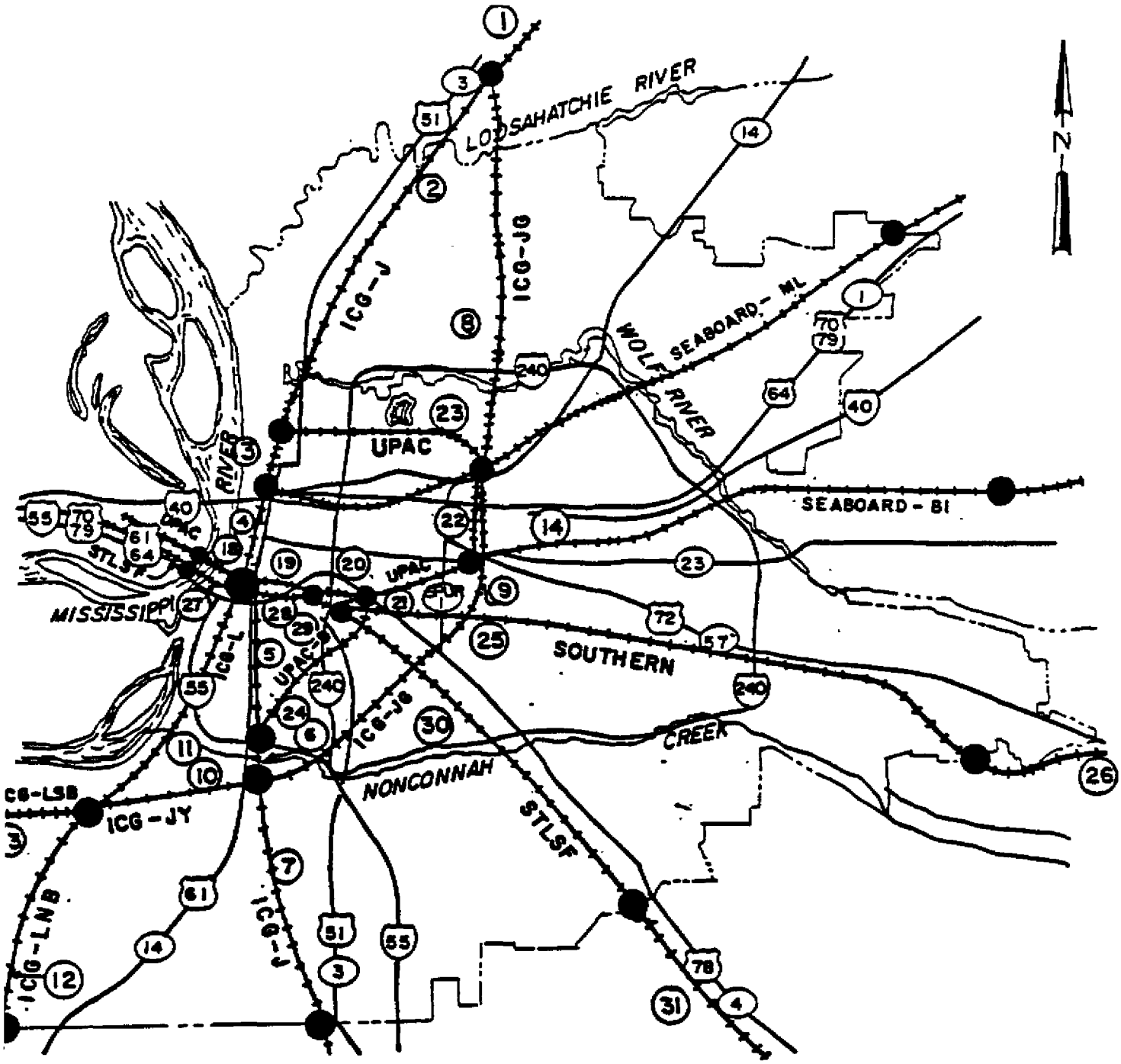
TABLE 7-3

PROBABILITY THAT ALL BRIDGES ON AND OVER RAILWAY SECTIONS WOULD SURVIVE NEW MADRID EARTHQUAKE

MEMPHIS/SHELBY COUNTY

Railway Section No.	Line	No. of Support Structures: Single Struct.	No. of Support Structures: Parall. Pairs	No. of Over-passing Struct.	Earthquake Intensity (MMI): Ms=7.6	Earthquake Intensity (MMI): Ms=8.6	Probability of Survival: Ms=7.6	Probability of Survival: Ms=8.6
1*	ICG-J	1	5		IX	X	.63	.13
2	ICG-J	8		4	IX	X	.14	.00
3	ICG-J				IX	X	1.00	1.00
4	ICG-J	6	1	3	IX	X	.18	.01
5	ICG-J	1	2	3	IX/VIII	X/IX	.49	.12
6	ICG-J	1	1		VIII	IX	.97	.71
7	ICG-J	5		1	IX/VIII	X/IX	.58	.10
8	ICG-JG	3	2	4	IX	X	.02	.00
9	ICG-JG	15	1	13	IX/VIII	X/IX	.05	.00
10	ICG-JY	1		2	IX	X	.65	.28
11	ICG-L	4		4	IX	X	.03	.00
12	ICG-LN	2	1	1	VIII	IX	.90	.46
13	ICG-LS	9		2	IX/VIII	X/IX	.45	.04
14	SEABOARD-B1	5		3	VIII/IX	IX/X	.02	.00
15	SEABOARD-ML	3		3	IX/VIII	X/IX	.18	.01
16	SEABOARD-ML	8		1	IX	X	.05	.00
17	SEABOARD-ML*	7		2	VIII	IX	.46	.03
18	UPAC	1	3		IX	X	.60	.16
19	UPAC	4	4	3	IX/VIII	X/IX	.23	.01
20	UPAC		1		VIII	IX	1.00	.90
21	UPAC	5	3	1	VIII	IX	.82	.21
22	UPAC	2		3	VIII/IX	IX/X	.25	.04
23	UPAC	1		1	IX	X	.69	.34
24	UPAC-D	3		6	VIII/IX	IX/X	.05	.00
25*	SOUTHERN	2		1	VIII	IX	.76	.35
26	SOUTHERN	5		1	VIII	IX	.86	.31
27	STLSF	1	1		IX	X	.66	.27
28	STLSF		8	3	IX/VIII	X/IX	.67	.08
29	STLSF		1		VIII	IX	1.00	.95
30	STLSF	3	4	8	VIII/IX	IX/X	.04	.00
31*	STLSF	1	3		VIII	IX	.75	.37

* Located in Shelby County outside the city limits of Memphis.

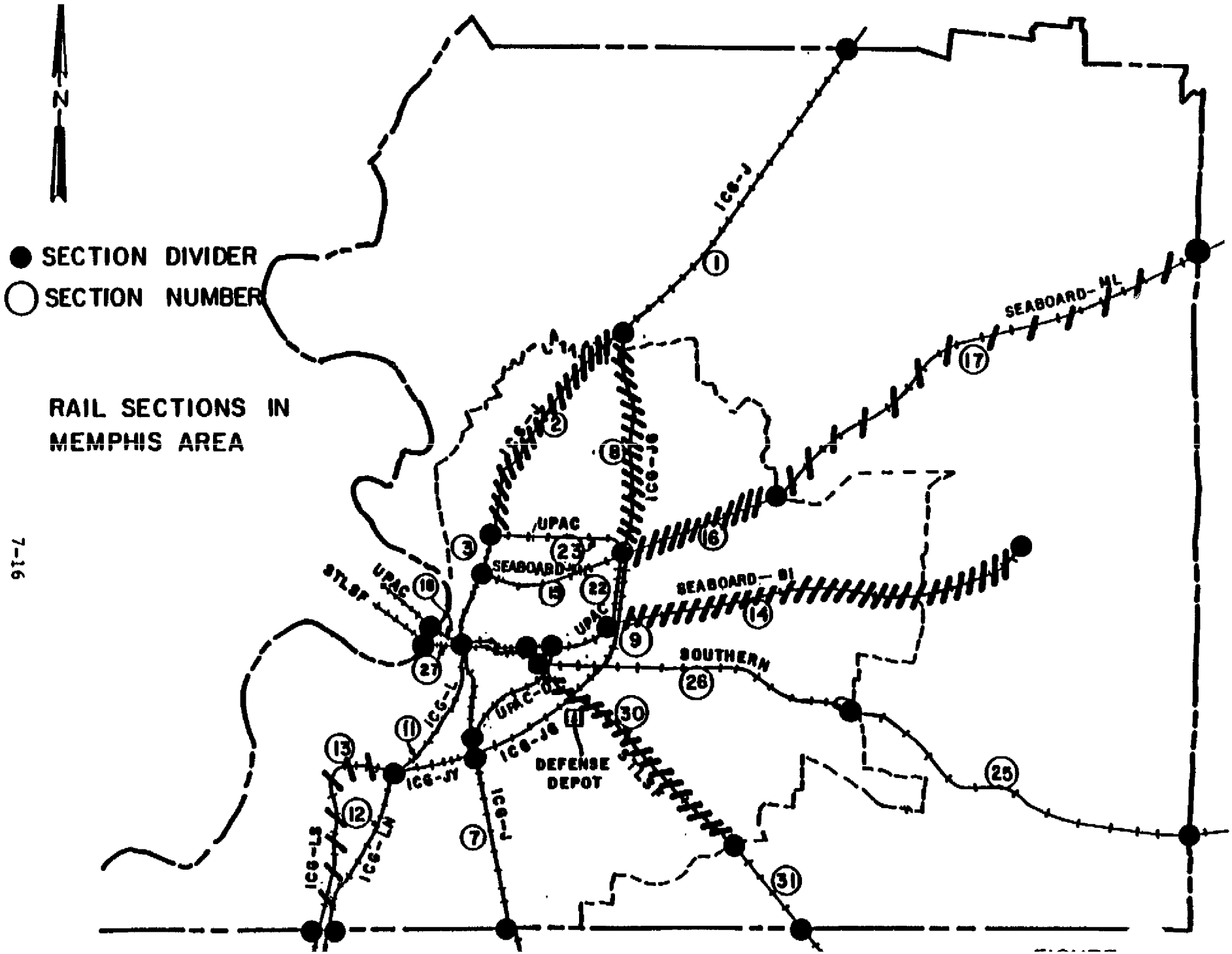


● SECTION DIVIDER

○ SECTION NUMBER

RAIL SECTIONS IN MEMPHIS CITY LIMITS

FIGURE 7-5


N
SECTION DIVIDER
SECTION NUMBER
RAIL SECTIONS IN MEMPHIS AREA
ICG-J
SEABOARD-ML
UPAC
SEABOARD-ML
SEABOARD-SL
STLSF
UPAC
UPRC
SOUTHERN
ICG-L
UPRC-GS
ICG-JS
DEFENSE DEPOT
ICG-JN
ICG-I
ICG-LS
ICG-LN
1
2
3
6
7
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31

generally be infeasible.

Outside the city, a similar situation would prevail. After the Ms=7.6 event, access would probably be available via the Southern line from the east and perhaps via one of the ICG lines from the south and the ICG line from the north. An Ms=8.6 event would probably leave at most one rail line open into the city, either from the south or east. Access would be severely restricted.

7.5.3 River Ports

Due to the generally unfavorable soil conditions which are typical for the river bank locations of port and dock facilities, it is estimated that these facilities will not be available for use in Memphis following an occurrence of either of the scenario earthquakes.

7.5.4 Airports

As discussed in the general section on airports (Section 3.5.4) airport runways will generally be at least partially available for use in Memphis following either quake. Delicate and complex landing-aid instruments and devices, as well as general lighting, are not estimated to be available. Airport buildings will sustain damage typical for other buildings in the area of similar structural type.

7.6 Public Utilities

7.6.1 Electric Utilities

Memphis Light, Gas and Water (MLG&W), which purchases its power from TVA, serves Memphis and vicinity (population 646,000). MLG&W has three major interconnections with TVA at 161 kV or higher. These three interconnects supply power to six bulk power stations which supply power to the MLG&W subtransmission grid and distribution

substation. MLG&W has approximately 3,000 employees and a total of 300 radio equipped vehicles (does not include 200 portable transceivers). MLG&W has access to TVA's mobile spares, some located in Jackson, TN.

Allen Steam Plant (620 MW capacity) owned by MLG&W is leased to TVA and is located near Mississippi River levee. This is a 161 kV source for MLG&W, and a 500 kV interconnect with Arkansas Power & Light, crossing the Mississippi River, is also located here. Figure 7-7 shows major elements of the Memphis electric system.

Availability Analysis

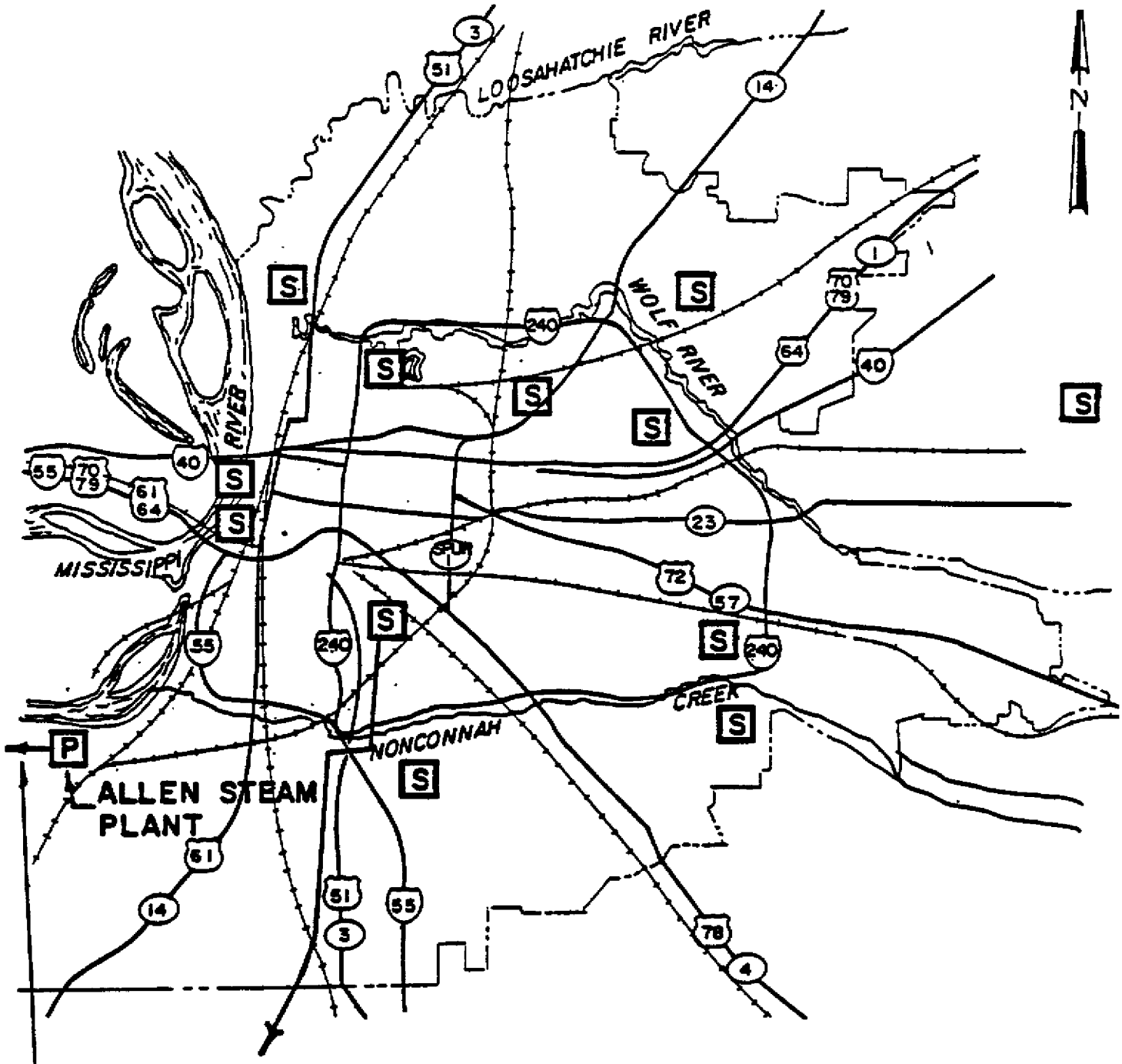
The following table presents the results of the availability analysis. Fragility techniques and system factors indicate that damage to the system will be extensive and that the system will not be available following an occurrence of either earthquake. Both the Allen Steam generating plant and the substations surveyed would be generally unavailable.

AVAILABILITY OF ELECTRIC UTILITIES
MEMPHIS, TN

Total Number Of Structures Surveyed		Structures Estimated To Be Available/Percent		Overall System Availability(Yes/No)	
		Ms=7.6	Ms=8.6	Ms=7.6	Ms=8.6
Substations	11	0/0%	0/0%	No(Partial)	No
Power Plants	1	0/0%	0/0%		
Total	12	0/0%	0/0%		

7.6.2 Water Utility

The Memphis Light, Gas & Water Division (MLG&W) operates the water system for the City of Memphis and much of Shelby County. The source of water for the Memphis area is groundwater taken primarily



ELECTRIC UTILITIES
MEMPHIS, TENNESSEE

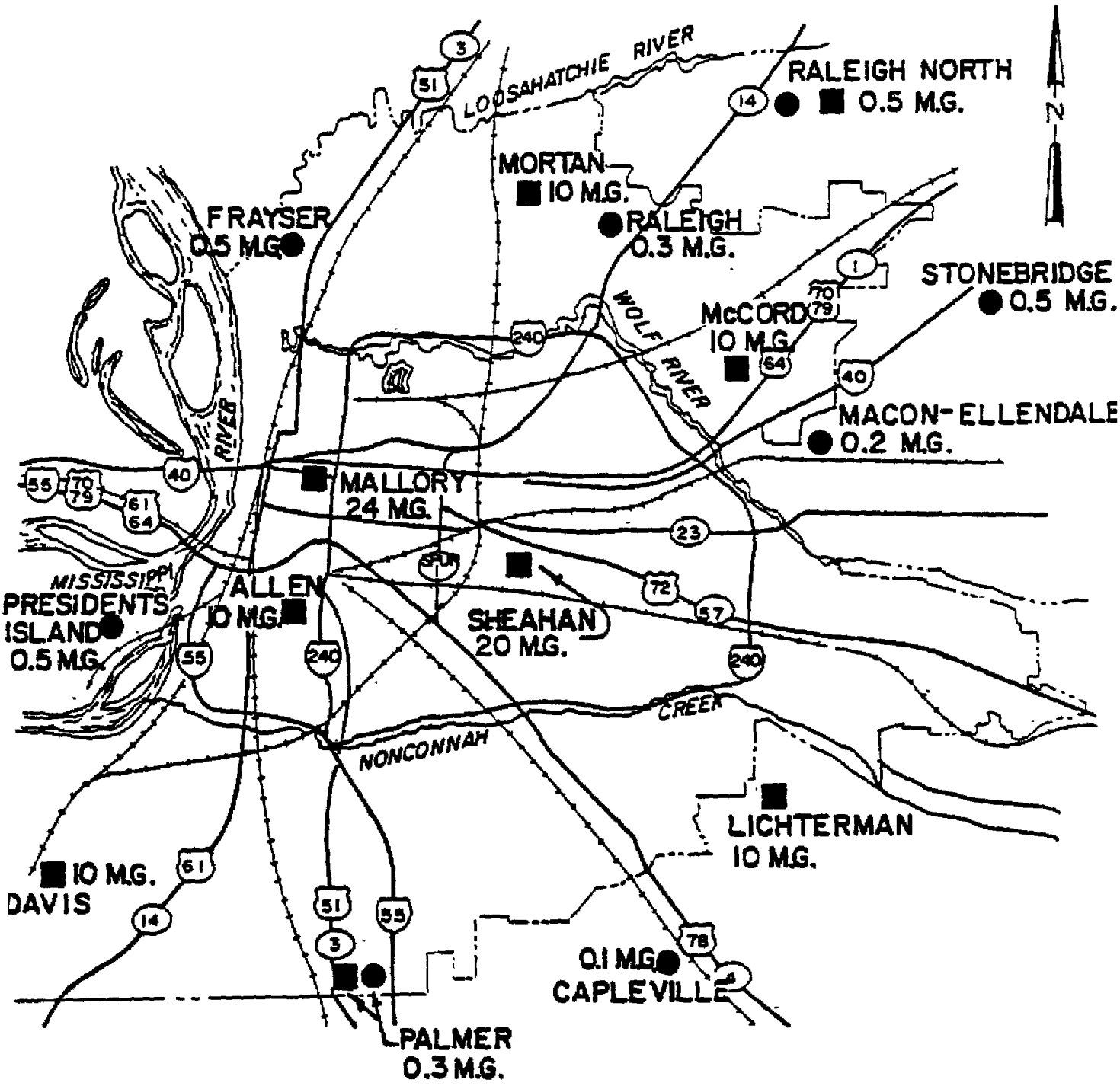
FIGURE 7-7

from the "500 foot sands" of the Claiborne group. The Division operates nine (9) water treatment plants and pumping stations of which seven (7) provide the major portion of the area's water. Generally, the facilities at each station consist of aerators, filters, an underground storage reservoir and pumps. Water is supplied to each treatment facility by 10 to 26 wells. The total treatment capacity at the seven major stations is 195 MGD. Total underground storage at these stations is 94 MG. The well capacity, treatment capacity, and storage capacity for each of the seven major stations is listed in Table 7-4.

TABLE 7-4
WATER TREATMENT PLANTS AND PUMPING STATIONS
MEMPHIS, TN

Station	No. Wells	Pumping Capacity, MGD	Treatment Capacity, MGD	Storage Capacity, MG
Mallory	26	60	35	24
Sheahan	25	60	35	20
Allen	26	60	35	10
McCord	24	60	30	10
Lichterman	20	60	30	10
Davis	14	25	15	10
Morton	10	37.5	15	10
TOTAL	145	362.50	195	94

The total elevated storage in the immediate vicinity of Memphis is 2.9 MG. The elevated storage tanks are located primarily on the outskirts of the city limits. The capacities of the elevated tanks are outlined in Table 7-5. The locations of the water treatment facilities and storage tanks are indicated in Figure 7-8.



● ELEVATED STORAGE TANK

■ WATER TREATMENT, UNDERGROUND STORAGE AND PUMPING STATION

WATER SYSTEM
MEMPHIS, TENNESSEE

FIGURE 7-8

TABLE 7-5
ELEVATED WATER STORAGE TANKS
MEMPHIS, TN

Storage Tank	Capacity Gallons
Presidents Island	500,000
Frayser	500,000
Raleigh North	500,000
Raleigh South	300,000
Stonebridge	500,000
Macon-Ellendale	200,000
Palmer	300,000
Capleville	100,000
TOTAL	2,900,000

The water distribution system is composed of various types of pipe ranging in size from 6 to 36 inches. For the most part, the pumping stations at the water treatment plants provide adequate pressure in the system. However, there are a few booster pumping stations located in outlying areas.

There is one diesel fueled auxiliary engine for emergency use at the Allen Station. This engine can operate one 15 MGD pump and five wells which pump 10 MGD.

Availability Analysis

The following table presents the findings of the availability analysis for Memphis' water system. These findings resulted from a fragility study of the system's structures (i.e. treatment plants, and storage tanks) and system specific factors, such as well and distribution system construction. A major factor was the probable unavailability of electric power. As a result of this analysis, it was concluded that this water system will not be available following either the Ms=7.6 or the Ms=8.6 earthquake. The system may, however, following the Ms=7.6 event, be capable of partial restoration relatively quickly.

AVAILABILITY ANALYSIS WATER UTILITY
MEMPHIS, TN

Total Number of Structures Surveyed		Structures Estimated To Be Available/Percent M=s7.6	Ms=8.6
Treatment Plants	9	1/11%	0/0%
Storage Tanks:			
Elevated	8	4/50%	2/25%
Non-elevated	9	8/89%	5/56%
Total	26	13/50/%	7/27%

SYSTEM AVAILABILITY (Yes/No)	
Ms=7.6	Ms=8.6
No	No

7.6.3 Natural Gas Utility

The natural gas system of Memphis, Tennessee is municipally owned and operated. The system has six (6) purchase points and buys its gas from Texas Gas Transmission Company. There is one LNG plant in the system that stores twelve million six hundred thousand (12,600,000) gallons of liquid natural gas. Two thousand eight hundred forty one (2,841) miles of piping make up the system, of which two thousand three hundred ninety-three (2,393) miles is steel, three hundred sixty (360) miles cast iron, and the remaining eighty-eight (88) miles plastic.

The LNG plant is designed for some seismic resistance. Due to its relative isolation, this plant is not a hazard to the community at large. The cast-iron piping in the Memphis system would crack and rupture in many places in the event of even moderate earth movements in the area. Falling buildings and debris during a major quake would also rupture many natural gas service lines forcing authorities to shut down the entire system.

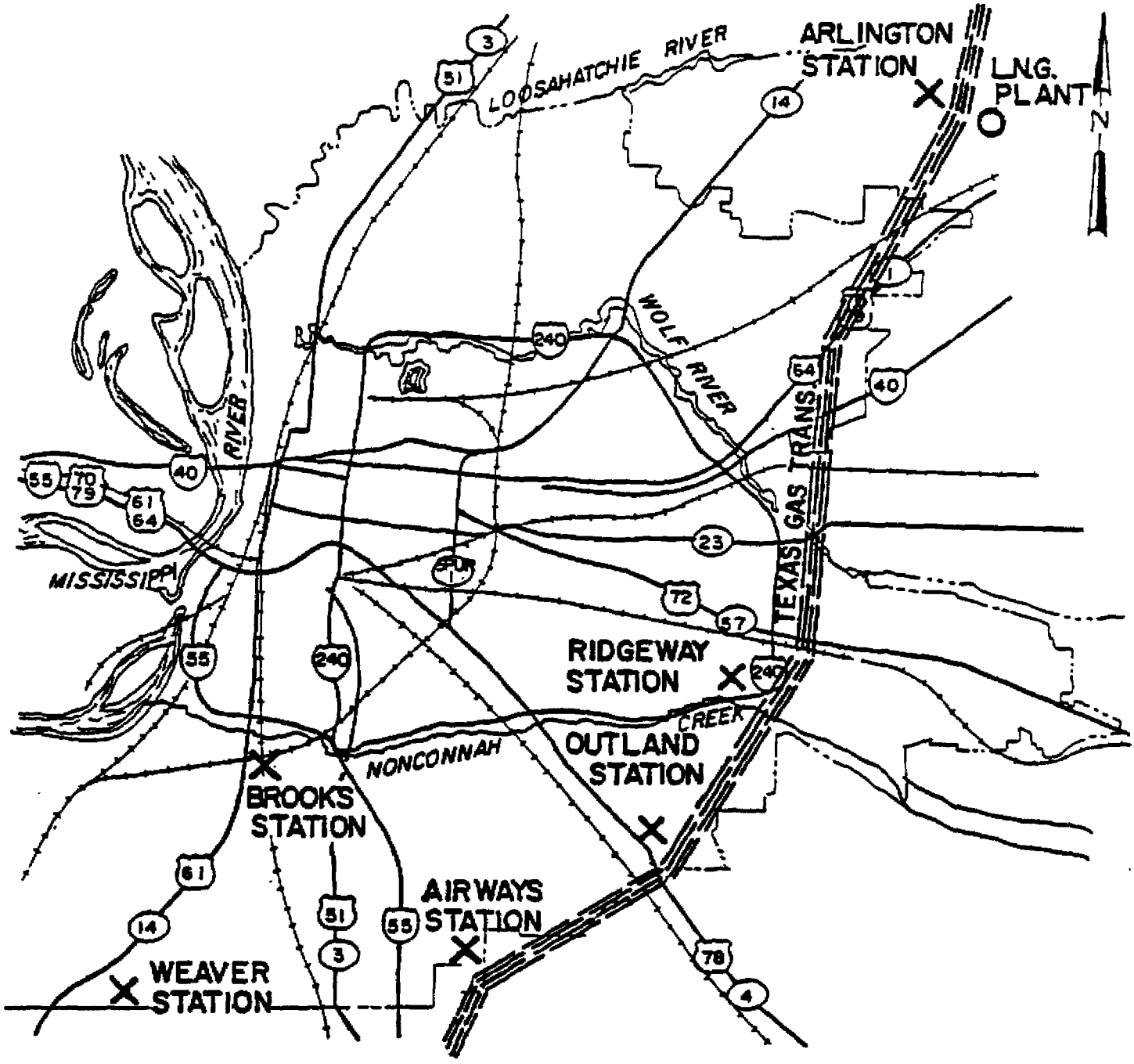
The Memphis system is designed such that some small sections of the system could be checked and repaired as necessary to restore natural gas service to a few selected buildings (shelters) within 24 hours of either earthquake. Complete restoration of service to the community would require six (6) weeks or longer with additional sections of the community regaining service as the work progressed. Major system elements are shown in Figure 7-9.

Availability Analysis

The natural gas utility system for Memphis, Tennessee is not estimated to be available following an occurrence of either earthquake. This is due primarily to the likelihood of extensive system damage and to the need to shut down the system immediately following the earthquake in order to prevent fire and explosions.

7.6.4 Sewage System

The City of Memphis and the immediately surrounding area are served by two contact stabilization, activated sludge wastewater treatment plants. The North Wastewater Treatment Plant has a design capacity of 135 MGD and discharges into the Mississippi River. The treatment facilities consist of an influent pumping station, grit chambers, contact stabilization tanks, clarifiers, chlorine contact basins, and sludge treatment facilities. The T. E. Maxson Wastewater Treatment Plant (South Plant) has a design capacity of 85 MGD and also discharges treated wastewater into the Mississippi River. The treatment process is basically the same as the North WWTP with an influent pumping station, grit chambers, contact stabilization tanks, clarifiers, chlorine contact basins, and sludge treatment facilities. Both of the wastewater treatment plants are served by two separate



X GATE STATION
—— TRANSMISSION LINE
O LIQUEFIED NATURAL GAS PLANT

NATURAL GAS FACILITIES
MEMPHIS, TENNESSEE

FIGURE 7 - 9

sources of electrical power. No other auxiliary power source is available. Figure 7-10 shows the location of the wastewater treatment plants.

Wastewater pumping stations are located throughout the service area. Sanitary and storm sewer systems are separate in Memphis. The sanitary sewers range in size from 8-inch to 108-inch pipe. Approximately 95 percent of the pipe in the Memphis wastewater collection system is concrete. There is also some cast iron and plastic pipe.

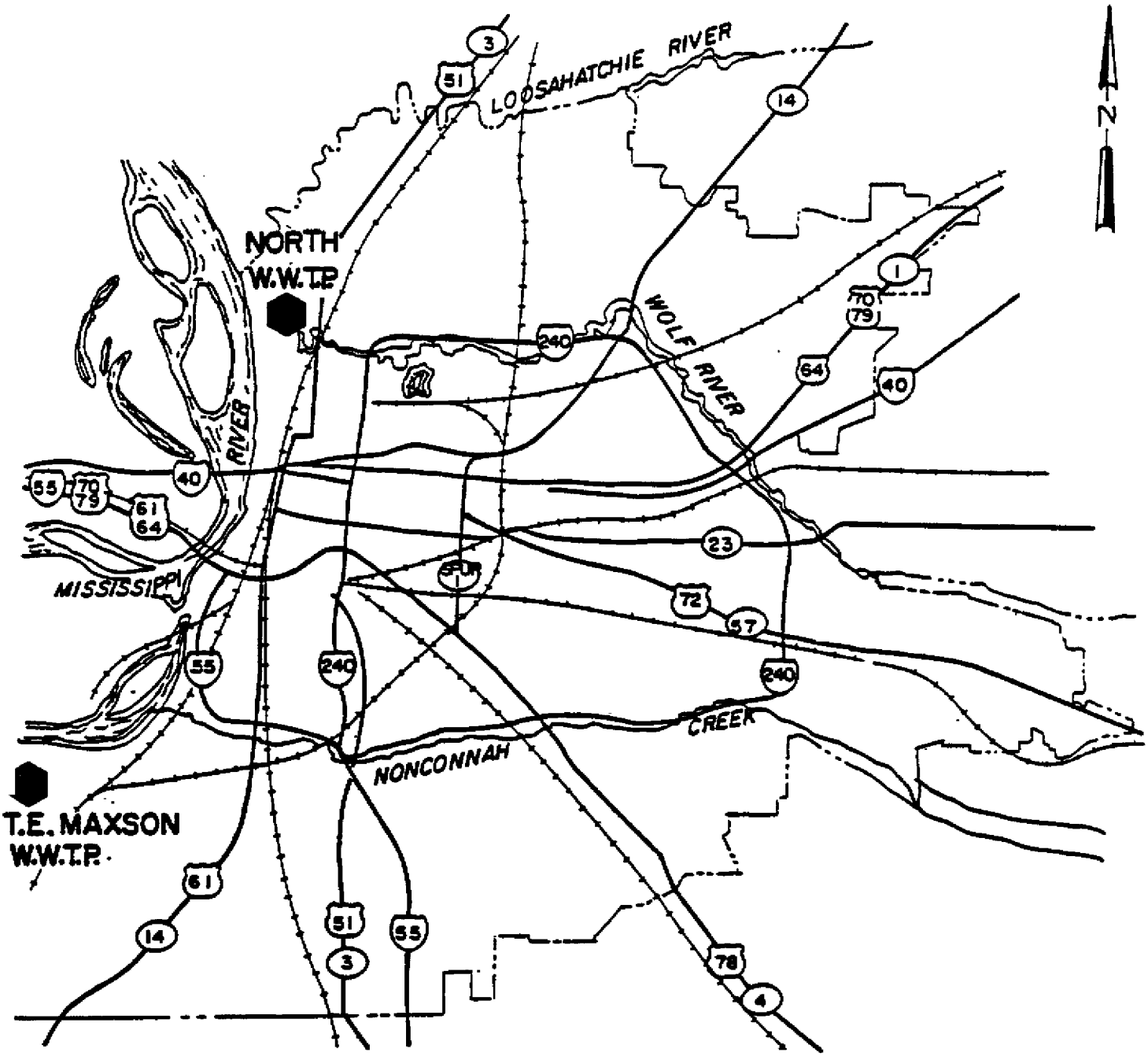
Availability Analysis

The following table shows the results of the availability analysis for the Memphis Sewer System. This system is not estimated to be available following either scenario earthquake. This is due to the loss of electricity and structural damage to both the treatment plants, and to the collection system. Some in-line storage would be available, and, as most of the system is of gravity-flow type, emergency diversion to the Mississippi River is possible.

AVAILABILITY ANALYSIS SEWAGE SYSTEMS
MEMPHIS, TN

	Number of Structures Surveyed	Structures Estimated To Be Available/Percent	
		Ms=7.6	Ms=8.6
Treatment Plants	2	0/0%	0/0%

SYSTEM AVAILABILITY (Yes/No)	
Ms=7.6	Ms=8.6
No	No



● WASTEWATER TREATMENT PLANT (W.W.T.P.)

WASTEWATER TREATMENT FACILITIES
MEMPHIS, TENNESSEE

FIGURE 7-10

7.7 Dams and Levees

The general circumstances involved with the failure of dams and levees was discussed in Section 3.7. Figure 7-11 depicts areas of Memphis which are subject to flooding due to levee failure caused by both the Ms=7.6 and the Ms=8.6 earthquakes. Persons displaced by flooding are tabulated in Section 6.9.2.

7.8 Residential, Commercial and Industrial Buildings

Section 3.8, Tables 3-6 and 3-7, contains tabulations of damage to these structures for Memphis. This information was used to compute casualties and building availability.

7.9 Casualties, Displaced Persons and Shelter

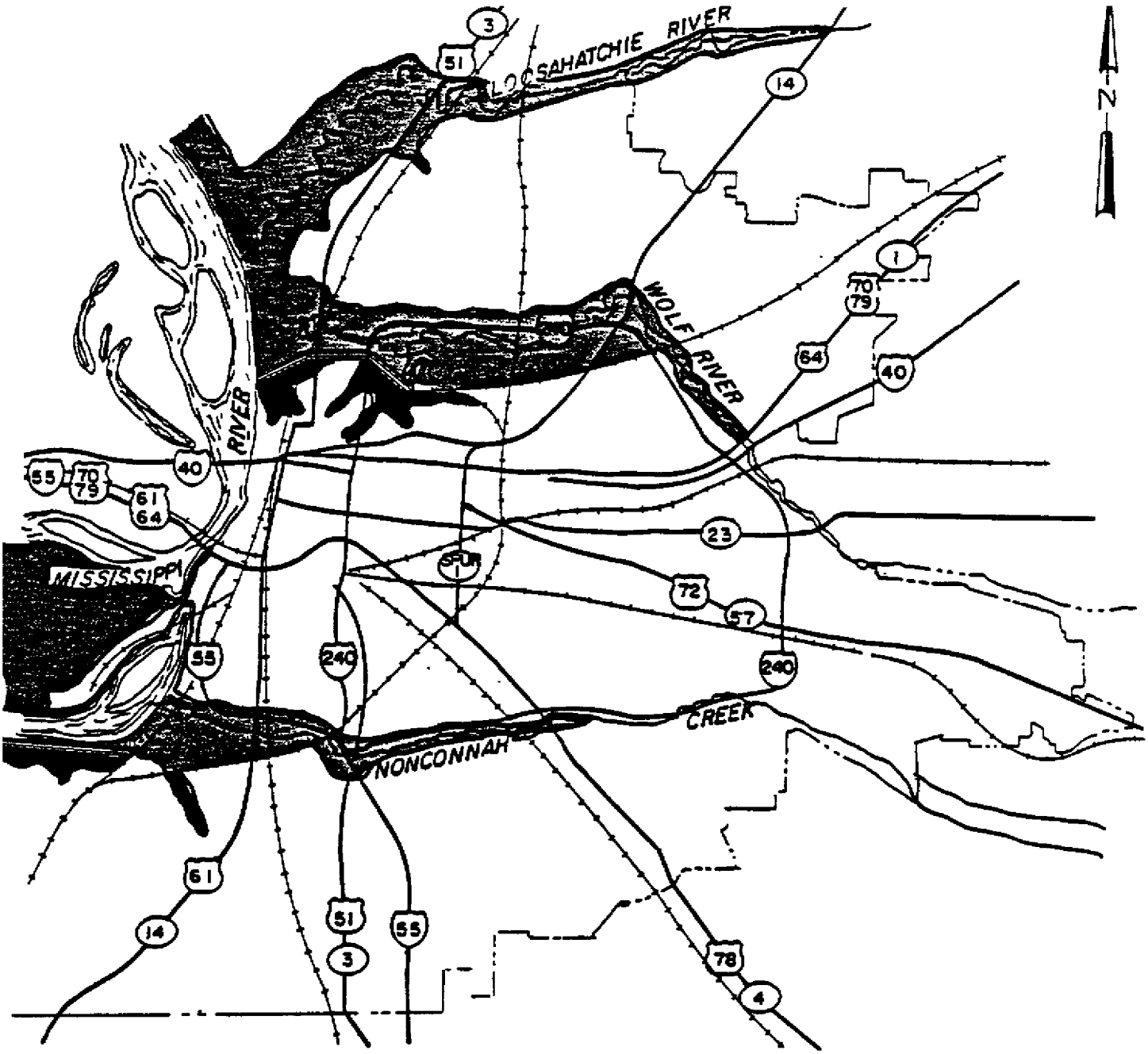
7.9.1 Deaths, Injuries and Displaced Persons

The estimated deaths and injuries which would occur in Memphis as a consequence of the two postulated earthquakes are summarized in the following table:

Source of Casualties	Ms=7.6				Ms=8.6			
	Deaths		Injuries		Deaths		Injuries	
	Night	Day	Night	Day	Night	Day	Night	Day
Residential struct.	79	24	318	95	240	72	960	288
Commercial/Industrial	85	1,699	340	6,793	122	2,446	487	9,749
Hospitals	39	73	155	291	59	109	234	437
Schools		651		2,602		1,016		4,064
Universities	8	76	31	305	14	143	57	573
Total est. casualties	211	2,523	844	10,086	435	3,786	1,738	15,111
Per 100,000 Population*	33	392	131	1,567	68	588	270	2,348

* Based upon U.S. Bureau of Census Figure

About two-thirds of the casualties of a daytime earthquake in Memphis would be incurred in offices, commercial centers and factories. About one-fourth would be experienced among school



LEGEND	
LEVEE	
100 YR. FLOOD PLAIN	
100 YR. FLOOD PLAIN IF LEVEE FAILS	

MEMPHIS, TENNESSEE
AREAS SUBJECT TO FLOODING

FIGURE 7-11

children. Because of the daytime presence in the city of a large number of workers who are not counted in the city's population, the casualty rates per 1,000,000 population are increased.

About one-fourth of the casualties of a daytime earthquake would be experienced in the Central Business District and Medical Center area (Memphis Planning District No. 1), bounded by the Seaboard Systems Railroad to the south, I-240 to the east, Jackson Avenue (State Route 14) to the north and the Mississippi River to the west. Over 40 percent of the casualties of an Ms=7.6 nighttime event and about one-third of the casualties of an Ms=8.6 nighttime event would be experienced in the same area.

An additional 30 percent of the casualties of a daytime event would be likely to occur in the southern part of the city, specifically in the South Memphis area along the river and the Whitehaven-Levi and Oakhaven-Parkway Village areas (Planning Districts 12, 15 and 8, respectively). The rest of the daytime casualties and the nighttime casualties outside the CBD area would be spread relatively evenly throughout the rest of the city.

Damage to residences, many of which would no longer be habitable, would displace the following numbers of persons:

	Estimated Number of Displaced Persons	
	Ms=7.6	Ms=8.6
From single family residences	159,100	239,500
From multi-family structures	72,600	114,250
Total	231,700	353,750
Percentage of population	36%	55%

Flooding from damaged levees could displace and additional 10,100 persons in the area south of the Wolf River and could result in one or two deaths and injuries.

7.9.2 Shelter

The following table shows the number of school structures estimated to be available for use as shelters after the occurrence of the earthquake scenarios.

AVAILABILITY OF SCHOOL STRUCTURES FOR SHELTERS
LITTLE ROCK, AR

Total Structures Surveyed	Structures To Be Available/Percent	
	Ms=7.6	Ms=8.6
769	102/13%	41/5%