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Final Report

August 1969

DS-11101-4334A-07

**INTER-SYSTEMS RELATIONSHIPS  
LOCAL VULNERABILITY OF UTILITIES  
SAN JOSE**

Prepared for:

OFFICE OF CIVIL DEFENSE  
OFFICE OF THE SECRETARY OF THE ARMY  
WASHINGTON, D.C. 20310

CONTRACT DAHC-20-67-C-0135  
OCD Work Unit 4334A

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*Final Report*  
*Detachable Summary*

*August 1969*  
*BS-11101-4334A-07*

**INTER-SYSTEMS RELATIONSHIPS  
LOCAL VULNERABILITY OF UTILITIES  
SAN JOSE**

*By:* ELLIS E. PICKERING

*Prepared for:*

OFFICE OF CIVIL DEFENSE  
OFFICE OF THE SECRETARY OF THE ARMY  
WASHINGTON, D.C. 20310

CONTRACT DAHC-20-67-C-0136  
OCD Work Unit 4334A

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#### SUMMARY

The purpose of this report is to examine the interrelationships of utility systems in San Jose, California, in their individual damaged states resulting from a hypothetical 5-MT nuclear detonation in the vicinity of Moffett Field.

Systems studied included water supply, sewerage and drainage, electric power, gas, telephone, radio broadcasting and television, petroleum distribution, and local transportation.

Characteristics and processes of individual systems were analyzed, and required inputs from other systems were identified. The points of interconnection between supporting and receiving systems were located, and the availability of the supporting utility was determined. The effect of the loss of the supporting utility input on elements and the total of the receiving system was calculated, and the total post-attack capability of each system was evaluated.

Strong dependencies for "point" supporting utilities were found only in the case of electric power for operating well and booster pumps in the water supply system and for powering radio broadcasting and television studios and transmitters and, in the case of telephone system circuits, for studio to transmitter links and Emergency Broadcast System links in the radio broadcast and television system. Only in the latter case did the affected area extend a substantial distance beyond the area in which the system was nonoperational due to other causes, primarily physical damage from blast.

Strong dependencies for critical "area" type supporting utilities were found in the cases of electric power for operation of radio and television sets, water supply for introduction and carriage of sewage in the sewerage and drainage system, and for electric power for pumps at gasoline service stations. Generally, however, the areas affected by the loss of these supporting utilities were essentially the same as the

area of nonavailability due to other causes (physical blast damage to the utility system or to residences and other buildings).

Without considering total burn conditions, the availability of utilities in the San Jose area is limited to areas outside the 2.5 to 3 psi overpressure radius. Considering total burn, the area is reduced to as far as the 1.5-psi radius, depending on the time after attack assumed. Demands for utilities services within the burn area would be small.



STANFORD RESEARCH INSTITUTE  
MENLO PARK, CALIFORNIA

*Final Report*

*August 1969*

*SS-11101-4334A-07*

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**ABSTRACT**

This report examines the inter-systems relationships for utility systems of San Jose, California, in their post-nuclear attack state. Systems studied included water supply, sewerage and drainage, electric power, gas, telephone, radio broadcasting and television, petroleum distribution, and local transportation.

For each system, input requirements from other systems were identified, the points of interconnection located, the availability of the input determined, and the effect of such availability on the output of the system evaluated.

Net total post-attack systems capabilities were then calculated.



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#### ACKNOWLEDGMENTS

The research covered in this report was conducted in the Facilities and Housing Research Department of Stanford Research Institute under Contract Number OCD-DAHC-20-67-C-0136, Work Unit Number 4334A. Ellis E. Pickering conducted the research under the direction of C. A. Grubb, manager of the Facilities and Housing Research Department.

The research was technically monitored by Robert M. Rodden of the Civil Defense Technical Office of Stanford Research Institute.

Overall technical program guidance for the Office of Civil Defense was provided by George F. Divine, Systems Evaluation Division (Research) whose assistance and guidance are sincerely appreciated.

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## I INTRODUCTION

This study was an element of the overall Office of Civil Defense (OCD) Five City Study, Work Unit 4334, "Local Vulnerability of Utilities." The study, entitled, "Inter-Systems Relationships-Local Vulnerability of Utilities - San Jose," examined the input-output relationships among the several separate utility studies for San Jose conducted under Work Unit 4334. The overall purpose of the study was to determine the degradation of post-attack utility system capability resulting from the nonavailability of supporting utilities.

### Control References

This study was organized and guided by the provisions of the following OCD Five City Study Control references:

1. Five City Study, Guide for Participants<sup>1\*</sup> (OUO)
2. Five City Study, Specifications for the Damaged Target Model<sup>2</sup> (OUO)
3. Five City Study, Pert Analysis<sup>3</sup> (OUO)
4. Five City Study, Process Description<sup>4</sup> (OUO)

### San Jose Situation References

Additionally, the study was conducted within the framework of the following OCD Five City Study basic references pertaining to San Jose:

1. City of San Jose, Attack Preparation Scenario.<sup>5</sup> (OUO)
2. Attack Environment Model San Jose.<sup>6</sup> (S-RD)

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\* Subscripts refer to numbered references included in Appendix A.

Separate Utility Vulnerability Studies

Eight separate studies were conducted of the post-attack capability of individual utility systems by various agencies. The systems, agencies, and report titles follow:

1. Water Supply System -- Study conducted by Stanford Research Institute, report - "Vulnerability of the Water, Sewerage, and Drainage Systems in San Jose."<sup>7</sup> (OUO)
2. Sewerage and Drainage System -- Study conducted by Stanford Research Institute; report - "Vulnerability of the Water, Sewerage and Drainage Systems in San Jose."<sup>7</sup> (OUO)
3. Gas System -- Study conducted by the Office of Oil and Gas, U.S. Department of the Interior; report - "City of San Jose, California - Vulnerability of Gas Utilities to Nuclear Attack."<sup>8</sup> (OUO)
4. Electric Power System -- Study conducted by the Defense Electric Power Administration, U.S. Department of the Interior; report - "Analysis of Electric Power Facilities - San Jose, California."<sup>9</sup> (OUO)
5. Telephone System\* -- Study conducted by Stanford Research Institute, report - "Civil Defense Communications: Requirements for San Jose, California."<sup>10</sup> (OUO)
6. Local Transportation System -- Study conducted by Stanford Research Institute; report - "Effects of Nuclear Attack on Local Transportation - San Jose, California."<sup>11</sup> (OUO)
7. Local Petroleum Distribution System -- Study conducted by Checchi and Company, report - "Vulnerability of the Local Petroleum Distribution System - San Jose, California."<sup>12</sup> (OUO)
8. Radio Broadcasting and Television Systems -- Study conducted by Stanford Research Institute, report - "Vulnerability of Radio Broadcasting and Television Services in San Jose, California."<sup>13</sup> (OUO)

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\* The study of the telephone system was not part of Work Unit 4334 - Local Vulnerability of Utilities, but was conducted under OCD Work Unit 2211C - Communications Systems Study. As a part of the study, the Post Attack Capability of the telephone system for San Jose was partially assessed. The telegraph system was not assessed.

### Definition

The definition of the term "Inter-Systems Relationships (Utilities)" as given by the Specifications for the Damaged Target Model<sup>2</sup> is: "Outputs from one utility system that are inputs to another such that they limit the output of the second system."

Examples of such outputs would include:

1. Electric energy, as an output of the electric power system, serving as an input to the water supply system to drive well and booster pumps.
2. Water, as an output of the water supply system, serving as an input to the electric power system in the form of boiler make-up or condenser cooling water for a thermal electric generating plant.
3. Gas heat energy, as an output of the gas system, serving as an input to the electric power system for boiler heat in a thermal electric generating plant.

Other examples of possible input-output relationships are given in Appendix B, Inter-Systems Relationship Matrix.

Relationships can be both "point," wherein one system delivers its output at one or more separate points as a direct input to the process of a second system, or "area" where a system delivers its output to another system at one or many points as a service input that does not directly enter the process of the second system.<sup>4</sup> An example of a point relationship is the electric power supplied by the electric power system to a pump motor of a well of the water supply system. An example of an area relationship is light and heat provided by the electric power and gas systems to a telephone system central office. Point relationships will be generally critical to the receiving system except where standby or alternate sources of the input are available, as for instance through the provision of liquid fuel engine driven pump auxiliaries in the water supply system. Area relationships may only cause inconveniences; however each situation requires careful study.

The possibility of system on system relationships must not be overlooked. Examples of possible critical relationships are:

1. Electric power for plant start-up for electric generating stations in the electric power system.



2. Filtered wash water for backwash of sand filters in a water purification plant.

### Objectives

The general objective of this study as extracted from Reference 2 was to:

"Analyze the utility systems in the area, identify the inter-connections, establish the relationship as defined, and derive, for each interconnection, a coefficient by which the effect of a change in input can be estimated."

Another objective was to estimate the net (after inter-systems relationships degradation) utilities services that were available on an areal basis.

A final objective was to develop a methodology for inter-systems relationships studies for application to other cities in the Five-City-study program.

### Scope of Work

To carry out the foregoing objectives, it was necessary to conduct an analysis of all separate utility studies through a process outlined by the following scope of work elements:

1. Define a composite study area. Since each separate utility system has a unique orientation it was necessary to define some reasonable area that contains substantially all of each system and that was reasonably representative of the San Jose urban area.
2. For each system determine supporting utility input requirements. Determine points of interconnection and identify as point and area relationships.
3. Determine auxiliary sources of the inputs.
4. Determine the effect of the absence of the input on the system output. Also determine the effect of degrees (coefficients) of absence of input. This step is required for both point and area relationships.

5. Determine the further limited (by absence of supporting utility inputs) capability of each individual post-attack damaged system.
6. Construct a net utility services availability map for the composite San Jose area.

#### Method of Approach

The approach taken in the conduct of the study consisted of a series of analytical steps described as follows:

1. The study area was defined. The separate utility vulnerability reports were analyzed, their areas of study were compared, and a final composite area was selected.
2. A study was made of the characteristics and processes of each utility in a general form, and potential supporting utility requirements were compiled. These requirements were summarized in the form of an "Inter-Systems Relationships Matrix."\*
3. Each separate utility vulnerability report for San Jose was analyzed, using the Matrix as a check list, and its actual supporting utility requirements were identified. The requirements were further identified as being of point or area nature.
4. The Target Model  $\left(\frac{TM}{S}\right)^\dagger$  of each separate utility was studied in order to identify the interconnections of the supporting utilities.
5. The post-attack capability of each supporting utility to supply the required service at the point of interconnection was then determined from a review of the Initial System Damage  $\left(\frac{CSD}{1}\right)^\dagger$  of each such utility.
6. The effect of the presence or absence (or intermediate degree) of supporting utilities at the various points of interconnection of each system was then evaluated and its total system damage  $\left(\frac{CSD}{T}\right)^\dagger$  and post-attack system capability evaluated.

---

\* Appendix B.

† Symbols defined in References 2 and 4.

7. Net post attack utility availability map was constructed as the final step.
8. The approach is summarized in graphical form on Figure 1, Process Description, Inter-System Relationship Study.

#### Requirements of Separate Systems Studies

To meet the objectives previously stated, it was necessary that each separate utility vulnerability study have:

1. Identified system interconnections.
2. Determined quality and quantity of the supporting utility required.
3. Determined the effect of absence (in toto, and in degree) of supporting utility inputs on damaged system capabilities.

The precision with which the previously stated objectives of this study were met was governed by the attention given to the above requirements by the separate system studies.

#### Nuclear Weapons Effects Considered

The San Jose series of studies of the "Local Vulnerability of Utilities" portion of the Five City Study required consideration of fewer weapons effects than will be considered by later city studies. Specifically, the effects of electromagnetic pulse (em) and ground shock (gs) are not included in the effects data provided.<sup>6</sup> Additionally, the position and height of burst of the detonation\* is such that earth (e), water (w), and residual radiation (rr) effects in the San Jose area are not of consequence. Secondary effects including building damage, debris, and fire (f) were considered although the generalized effects data were produced by other than the utility vulnerability researchers.<sup>†</sup> All other usual nuclear weapons effects were considered. The report on fire<sup>14</sup> was

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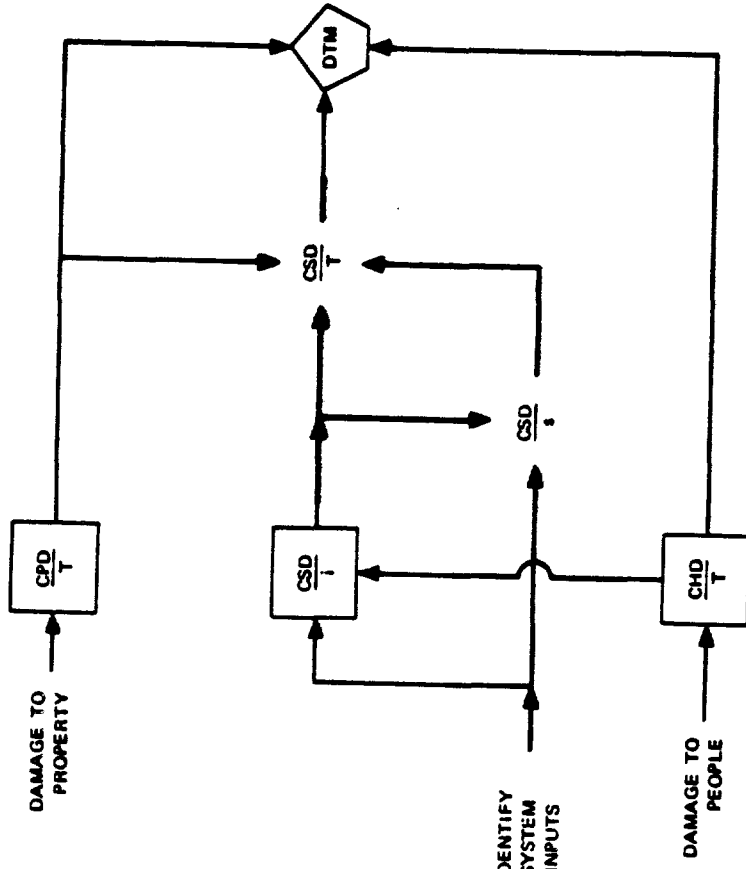
\* 5 MT air burst at height of burst of 14,500 feet just north of Moffett Field, Lat 37° 27' 35" N, Long 122° 03' 29" W at 2052 H, Tuesday, Aug. 24, 1965.

† Building damage and debris by URS Corporation. Fire by IITRI.

**DEFINITIONS**

- $\frac{CPD}{T}$  -- Calculate Property Damage, Total
- $\frac{CHD}{T}$  -- Calculate Human Damage, Total
- $\frac{CSD}{I}$  -- Calculate System Damage, Initial
- $\frac{CSD}{S}$  -- Calculate Systemic Damage
- $\frac{CSD}{T}$  -- Calculate System Damage, Total
- DTM -- Damaged Target Model

DAMAGE TO SYSTEMS → ANALYZE SYSTEM RELATIONSHIPS → IDENTIFY SYSTEM INPUTS



Processes pertinent to this study

FIGURE 1 PROCESS DESCRIPTION, INTER-SYSTEMS RELATIONSHIP STUDY

not available to separate utility researchers at the time of their studies. To fill the absence of fire damage calculations in the original studies, this study examined this effect in a limited manner.

#### Major Assumptions

The major assumption affecting the conduct of this study and the separate utility system studies was that the San Jose situation was to be treated in isolation--i.e., no consideration was given to other weapons of the Civ-Log Attack in the area and the regular outside utility sources (such as electric power, gas, petroleum products, etc.) were assumed to be available.

## II SUMMARY OF FINDINGS

### Introduction

The process of analyzing the local utility systems in San Jose gave considerable insight into the nature of utility systems and potential and real interrelationship problems.

### Nature of Systems

The utility systems studied for the San Jose area fell into two distinct types. One could be called fixed or network systems wherein the utility was moved through a fixed network and service was provided to the individual customer at some physical connection which was more or less permanent. Systems in this category included the water supply system, the sewerage and drainage system, the electric power system, the gas system, and the telephone system. The distinguishing feature of this type of system is that damage to any portion of the network may result in loss of service to individual customers located at any point on the network.

The other type could be termed "service" or "flexible" in that there is no physical connection between the system and the customer. Systems of this type include the petroleum distribution system, the local transportation system and the radio broadcasting and television system. The distinguishing feature of these systems is that damage to any part of the system would result only in loss of a degree of overall capability but would not deprive individual customers of service. These latter systems may contain features of the fixed systems, i.e., a portion of the system may be fixed. Examples would be pipeline petroleum transport (alternative means are available), fixed rail lines (alternative transportation means are available), and the requirement of an electric power outlet to operate radio and television sets.

### Nature of Systems Interrelationships

Several different types of potential and real systems interrelationships were distinguished as follows:

1. Direct--Relationships included a system process that depends critically on the input of another system and there is no alternate or substitute input available. Examples include electric power for well production in the water supply system (a real case in San Jose) and gas for boiler heat for a thermal electric power generating plant (a potential case not applicable to San Jose).
2. Chain--Relationships exist where the availability of two or more systems must be operational to provide service to a third. An example is Air Transport Service (a real case at San Jose) when aircraft fuel must be available from the petroleum distribution system and electric power available to lift it from underground tankage.
3. Cycle--Relationships exist when one system input is required by a second system to provide input to the former. A potential example would be a water system depending on electric power to provide water to boilers in a thermal electric generating plant that provides electricity for the water system. No relationships of this type were found in San Jose.
4. System-on-System--The system-on-system relationship utilizes the output of a system as an input to the system itself. An example is for start-up electric power for an electric generating plant that does not have auxiliary means of providing such power. No such case was found in San Jose.

#### Input-Output Relationships and Systems Degradation

The results of the analytical process described in the "Method of Approach" section of this report are summarized in Table 1. This table summarizes those input requirements deemed critical to the receiving system that were not available from the supplying system. Resulting degradation to the receiving system is indicated. The summary does not consider the effects of total burn as extracted from Reference 14.

Reference 2 requires the derivation "for each interconnection" of "a coefficient by which the change of input can be estimated." This requirement implies that a numerical degree of original output be calculated for each point of interconnection for each system. The nature of systems in the San Jose area and the data available from the original utility vulnerability studies prevented the meeting of this requirement in a quantitative manner. Nonavailability of a supporting utility input at a point of interconnection generally resulted in zero output for that station or portion of the receiving system. There was a degree of degradation of capability to the overall system, but this has been difficult to describe quantitatively because of the nature of the data available from the original studies. Quantitative degradations are discussed however, where possible in the following sections of this report.

Table 1  
POST-ATTACK UTILITY INPUT-OUTPUT RELATIONSHIPS  
SAN JOSE

SYSTEM	CRITICAL INPUT LOSS	DEGRADATION OF OUTPUT
WATER SUPPLY	<ol style="list-style-type: none"> <li>1. Loss of electric power at 6 groundwater production wells.</li> <li>2. Loss of electric power at 6 booster pumps.</li> </ol>	<p>6 of total of 159 wells are unproductive. 6 of a total of 131 booster pumps lifting water to reservoirs or higher pressure zones are unproductive. Overall degradation of system capability is very minor. Two small pressure zones and small portions of three larger zones are without service. Water service generally unavailable within 2.5-psi radius due to damage to buildings and water services.</p>
SEWERAGE AND DRAINAGE	<ol style="list-style-type: none"> <li>1. Loss of electric power at 2 sewage lift stations.</li> <li>2. Loss of water supply in area within 2.5-psi radius.</li> <li>3. Loss of gas service to the treatment plant.</li> </ol>	<p>2 of a total of 19 sewage lift stations are out of operation. The area served by these stations is very small. Minor contamination might result. The area enclosed by the 2.5-psi radius does not have sewerage service due to lack of water. Area is however in zone of moderate to heavy blast damage and would generate little sewage. Loss of gas to treatment plant is of no immediate consequence since plant is severely damaged. System has essentially 100% collection capacity but no treatment capability.</p>
ELECTRIC POWER	None	<p>There is no degradation due to loss of critical inputs. Electric power service is available in the study area except within the 2.5-psi line.</p>
GAS	<ol style="list-style-type: none"> <li>1. Loss of electric power for controls at Milpitas Gas Terminal.</li> <li>2. Loss of electric power for motorized valve at Bayberry Road.</li> <li>3. Loss of electric power for compressors at Gas Holder.</li> <li>4. Loss of telephone circuits at Milpitas Gas Terminal and at 3 telemetered pressure points.</li> </ol>	<p>No effective degradation. Controls can be operated manually, pressure points can be observed by maintenance personnel and compressor is not essential to system. System is without service within about the 3-psi radius due to isolation because of heavy building damage.</p>



Table 1 (concluded)

<p>TELEPHONE</p>	<p>Loss of electric power supply to 2 central exchanges in the study area.</p>	<p>No effective degradation of service since the central exchange has an auxiliary liquid fuel engine generator. Blast damage caused 100% loss of service out to about the 2.5-psi radius and from 60% to 10% loss of service throughout the remainder of the area.</p>
<p>RADIO BROADCAST AND TELEVISION</p>	<p>1. Loss of electric power in area within about the 2.5-psi radius. 2. Loss of telephone circuit studio to transmitter links for stations KEEN (AM) and KHAY (FM). 3. Loss of telephone circuit EDS link between EOC and KEEN (AM).</p>	<p>Loss of electric power within 2.5-psi radius prevents reception of post-attack CB information. Area is however suffering from moderate to severe blast damage. KEEN (AM) suffered severe blast damage also. KHAY (FM) suffered light blast damage. All other stations are non-operational due to blast damage except KTEH (TV) (Audio channel only) and KSJS (FM).</p>
<p>PETROLEUM</p>	<p>1. Loss of electric power in area within about the 2.5-psi radius. 2. Loss of electric power to Shell Oil and Southern Pacific pipeline terminals for product pumps. 3. Loss of electric power to Shell Oil Avgas bulk plant at San Jose Airport for UG tank pumps. 4. Loss of electric power to Bay Area Vangas LPG facility for LPG pumps.</p>	<p>Service stations within the 2.5-psi radius cannot pump fuel. They are also damaged by blast. Two of the three pipeline terminals cannot load tank trucks except by gravity. No Avgas can be pumped at San Jose Airport. One of four LPG facilities cannot fill tanks or trucks. Overall capability of the system is not materially degraded by input losses.</p>
<p>LOCAL TRANSPORTATION</p>	<p>1. Loss of electric power at the Newhall RR yard. 2. Loss of electric power at the San Jose Municipal Airport. 3. Loss of telephone circuit at SP Traffic Control Center. 4. Loss of Avgas supply at San Jose Municipal Airport.</p>	<p>Yard handling capacity at Newhall RR yard will be reduced due to lack of electrical controls. Traffic control at San Jose Airport will be affected by lack of communications power. No night operations can be performed. Alternate RR traffic control methods will be necessary. San Jose Airport cannot fuel aircraft, therefore only through traffic not requiring fuel can be accepted.</p>

## Total Systems Capabilities

Total damaged post-attack systems capabilities considering the degradation caused by nonavailability of supporting utility inputs are summarized in the following paragraphs. Capabilities are discussed under two conditions (1) considering the limited fire lines used by the original utility vulnerability studies, and (2) considering total burn\* as extracted from Reference 14.

### Water Supply System

Under conditions of no total burn it is estimated that the total post-attack system capability is at least 90% of pre-attack potential. Unavailability of supporting utility inputs would cause only minor degradations of capability and they would be confined to areas in which moderate to severe blast damage occurred to buildings. On an area basis there would be no water service from about the 2.5-psi overpressure radius inward or for about 10% of the service area.

Considering total burn conditions, essentially all of the well producing stations would be damaged by fire or be without electric power or both. This would result in a reduction of total system capability to about 20% of that under pre-attack conditions. On an area basis there would be no water service from the fire line inward (between the 1.5- and 2-psi overpressure radii) or for about 60% of the service area.

### Sewerage and Drainage System

Under conditions of no total burn it is estimated that the system has essentially pre-attack collection and transmission capability (100%) but no treatment capability (0%). On an area basis the collection system depended directly on the availability of water; consequently no service would be available from about the 2.5-psi overpressure radius inward or for about 2.0% of the service area.

Considering total burn conditions the system collection capability would be limited to the area outside the fire line (between the 1.5- and 2-psi overpressure radii) or to about 40% of the total system area.

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\* "Total burn" refers to the condition wherein 50% of the buildings are burned or burning after 10 hours.

### Electric Power System

Under conditions of no total burn it is estimated that electric power would be available over about 90% of the area studied. There would be no degradation caused by unavailability of supporting utilities. The loss of electric service started at about the 2.5-psi overpressure radii.

Considering total burn conditions, electric power would be available in only about 40% of the area, or outside of the 1.5- to 2-psi overpressure radius.

### Gas System

Under conditions of no total burn it is estimated that gas service would be available to about 80% of the area studied or to essentially all of the corporate area of San Jose. The loss of service started at about the 3-psi overpressure radius. There would be no substantial loss of service due to the unavailability of supporting utilities.

Considering total burn conditions, gas service would be available to only about 30% of the study area or about 40% of the corporate area of San Jose. The area of service would be that beyond the fire line or about the 1.5- to 2-psi overpressure radius.

### Telephone System

Under conditions of no total burn it is estimated that telephone service would be completely out in about 10% of the area studied (coinciding with the corporate area of San Jose); and would be reduced by from 60% to about 10% for the remainder of the area. The area of no service coincided approximately with the 3-psi overpressure radii. Essentially no degradation would be caused by unavailability of supporting utilities.

Considering total burn conditions, telephone service would be limited to about 40% of the area studied, and this would be degraded by some 10% unavailability of circuits or exchange service. The area of service would be that beyond the fire line or about the 1.5- to 2-psi overpressure radius.

### Radio Broadcasting and Television System

Under conditions of no total burn it is estimated that stations KTEH (TV) and KSJS (FM) would be immediately operational as soon as personnel arrived. KXRX (AM) (EBS station) would be operational after repair of light damage. KLOCK (AM) (Alt EBS Station), KLIV (AM) would be operational after repair of moderate physical damage. KBAY (FM) would be operational after repair of light physical damage and restoration of the studio to transmitter telephone link. Other stations would be severely damaged and cannot be considered as being operational within the time frame. The operational and lightly damaged stations would have ranges adequately covering the study area. Electric power for reception would be available over about 90% of the study area (beyond the 2.5-psi overpressure radius).

Considering total burn conditions, only stations KTEH (TV), KLOCK (AM) and KSJO (FM) are located in the area unaffected. KTEH (TV) does not have television studio facilities, but its audio system would be fully operational. KLOCK (AM) (Alt EBS) was moderately damaged from blast, its standby staff injured and could not be considered operational until other staff arrived and repairs were completed. KSJO (FM) was severely damaged and would not be operational until major repairs were completed. Under the condition of total burn the only immediate post-attack radio broadcasting and television capability in San Jose would be the audio channel of KTEH (TV) with the alternate EBS station, KLOCK (AM), becoming available relatively soon after repairs were completed. The areas of coverage of both KTEH (TV) and KLOCK (AM) were sufficient to reach all parts of the study area. Electric power for reception would be available outside the fire line.

### Petroleum Distribution System

Under conditions of no total burn it is estimated that all elements of the petroleum distribution system could be considered as being operational except for a small portion of the study area wherein service stations were non-operational due to physical damage and lack of electric power. The operational area covered approximately 90% of the corporate area of San Jose.

Considering total burn conditions, the post attack capability of the petroleum distribution system would probably be seriously degraded. There was a high probability that terminal and bulk plant stocks within the fire line would be destroyed, particularly those contained in tanks leaking as a result of blast damage. The stocks on hand at unaffected

service stations (covering about 40% of the corporate area of San Jose) would be available.

#### Local Transportation System

Under conditions of no total burn it is estimated that the local transportation system was not seriously affected by the attack. Only a small portion of the total capabilities in the study area would be physically damaged. Both railroad and highway transport to the north and west would be unavailable due to physical damage outside the study area.

Considering total burn conditions, very little post attack capability would exist in the study area except for privately owned vehicles, that could be moved during the progress of fire spread.

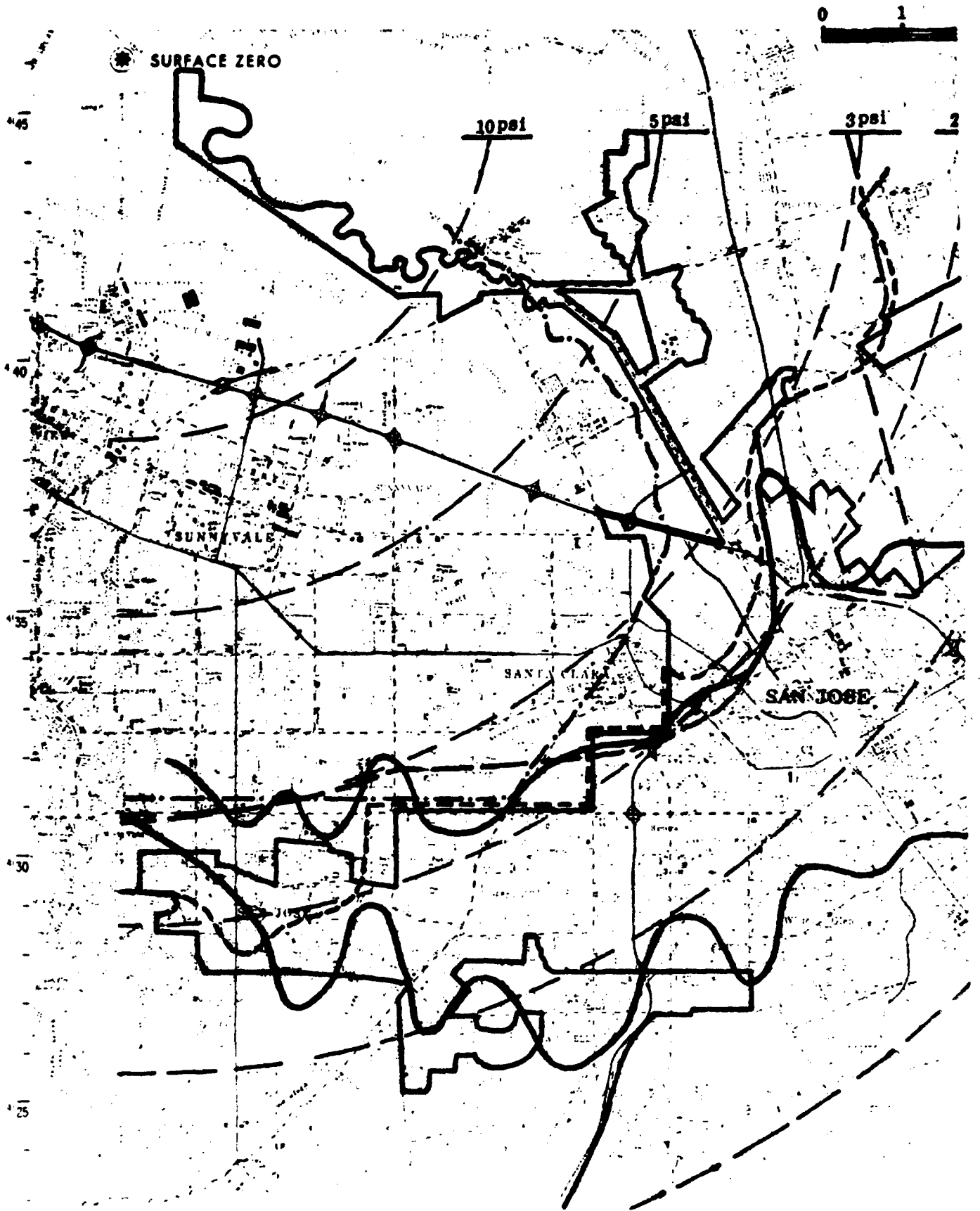
#### Net Utility Availability

A composite picture of the post-attack availability of all utilities, considering both no total burn and total burn conditions is shown by Figure 2. Lines indicating the extent of fire spread (50% of buildings burned or burning) after three hours and after ten hours have been plotted on Figure 2 for comparison purposes. These lines generally extends to about the 2.5- and 2-psi overpressure radii, respectively.

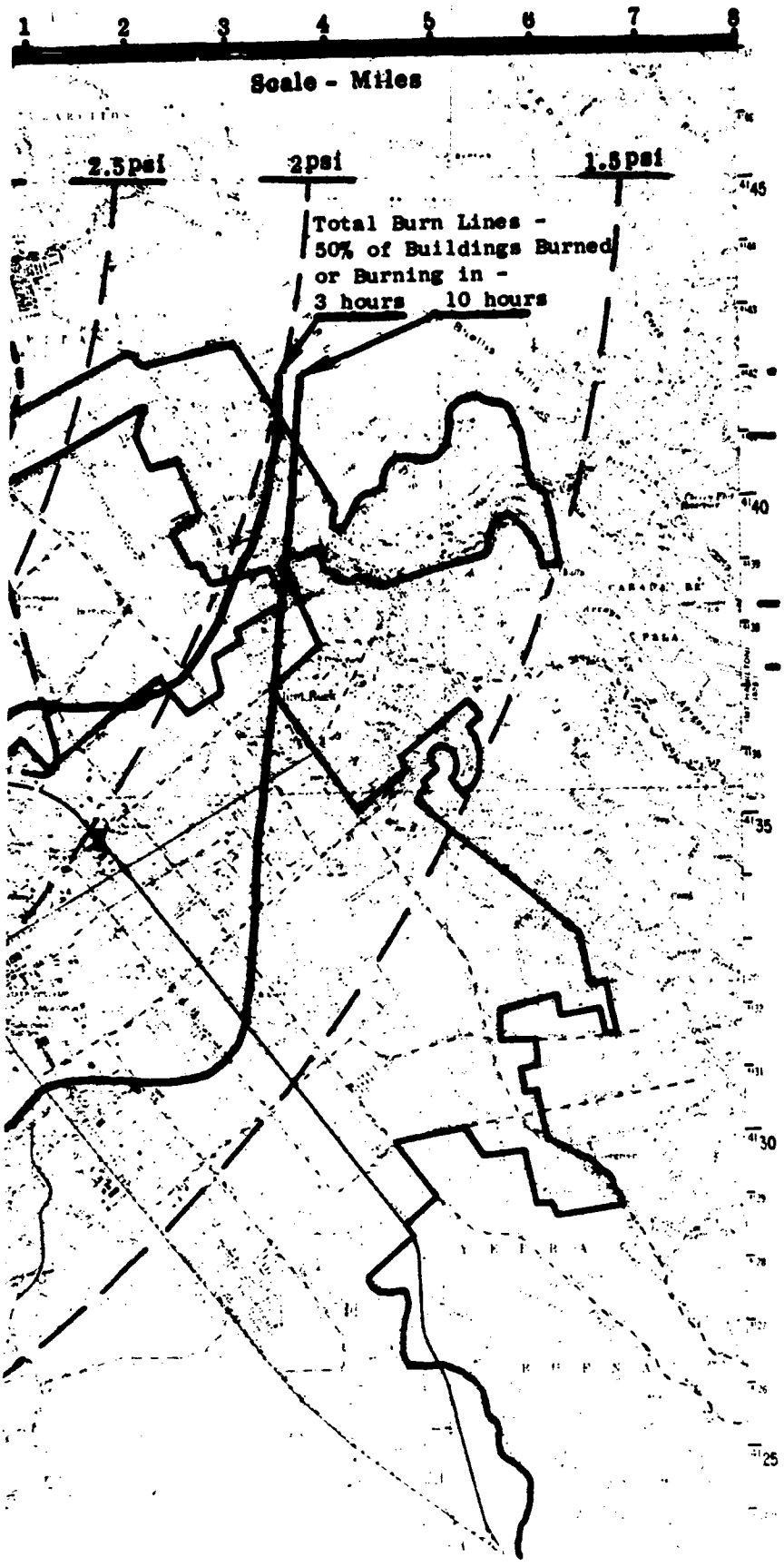
#### Other Findings

Major associated findings resulting from this study include:

1. Unavailability of utilities service in the post-attack period in the San Jose area will extend approximately to the 2.5-psi overpressure radius because of blast damage to the physical features of the utility systems themselves or to the receiving facility or both.
2. Consideration of total burn conditions reduced the area of post-attack utilities availability rather drastically to an overpressure radius of from 2.5- to 1.5-psi depending on the time after attack considered.
3. Certain utility systems which have no physical connection with the receiving customer have much more flexibility and consequently would have more capability in the post-attack period



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**LEGEND**

- San Jose City Limits
- - - - Overpressure Radii
  
- NON-AVAILABILITY LINES**
- . - . Telephone
- . . - Gas
- Electric Power  
(Includes Radio and TV Reception and Gasoline Service Stations)
- Water Supply and Sewerage and Drainage  
(Same as 2.5 PSI Overpressure Radius)

**FIGURE 2 POST ATTACK UTILITIES AVAILABILITY**

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than those that are physically connected and are subject to wide unavailability because of damage to only a portion of the network.

4. Strong dependencies on point inputs were found only in the cases of electric power for the water system and electric power and telephone service for the radio broadcast and television system. Only in these cases did the loss of input cause a material degradation of post-attack system capability. Other dependencies caused only inconveniences or minor losses of capability.
5. Certain inter-systems relationships, termed critical area relationships, were detected that had a strong influence on the post-attack capability of the receiving system. These included the sewerage and drainage system which depends on water supply on an area basis for the introduction and carriage of sewage in the collection system, the radio broadcasting and television system which requires electric power on an area basis for the operation of radio and television sets, and finally the petroleum distribution system which required electric power at service stations for the dispensing of motor vehicle fuel.
6. Under the Attack Environment Model and Target Model conditions applying to San Jose, it appears that utilities would generally be nonavailable within about the 2.5- to 3-psi overpressure radii. This area also coincided generally with the area of moderate to heavy blast damage to residences and other buildings and utilities services demand would be at a minimum. Utility intersystems relationships did not have a strong influence on availability of service outside this area in San Jose, but could possibly under other Attack Environment Model and Target Model conditions.



### III DEFINITION OF THE STUDY AREA

In each of the separate studies of the Local Vulnerability of Utilities research program, a study area was selected, using criteria relating to the specific nature of the utility system. None of the areas selected were alike, since the various utility systems have different orientations. As examples:

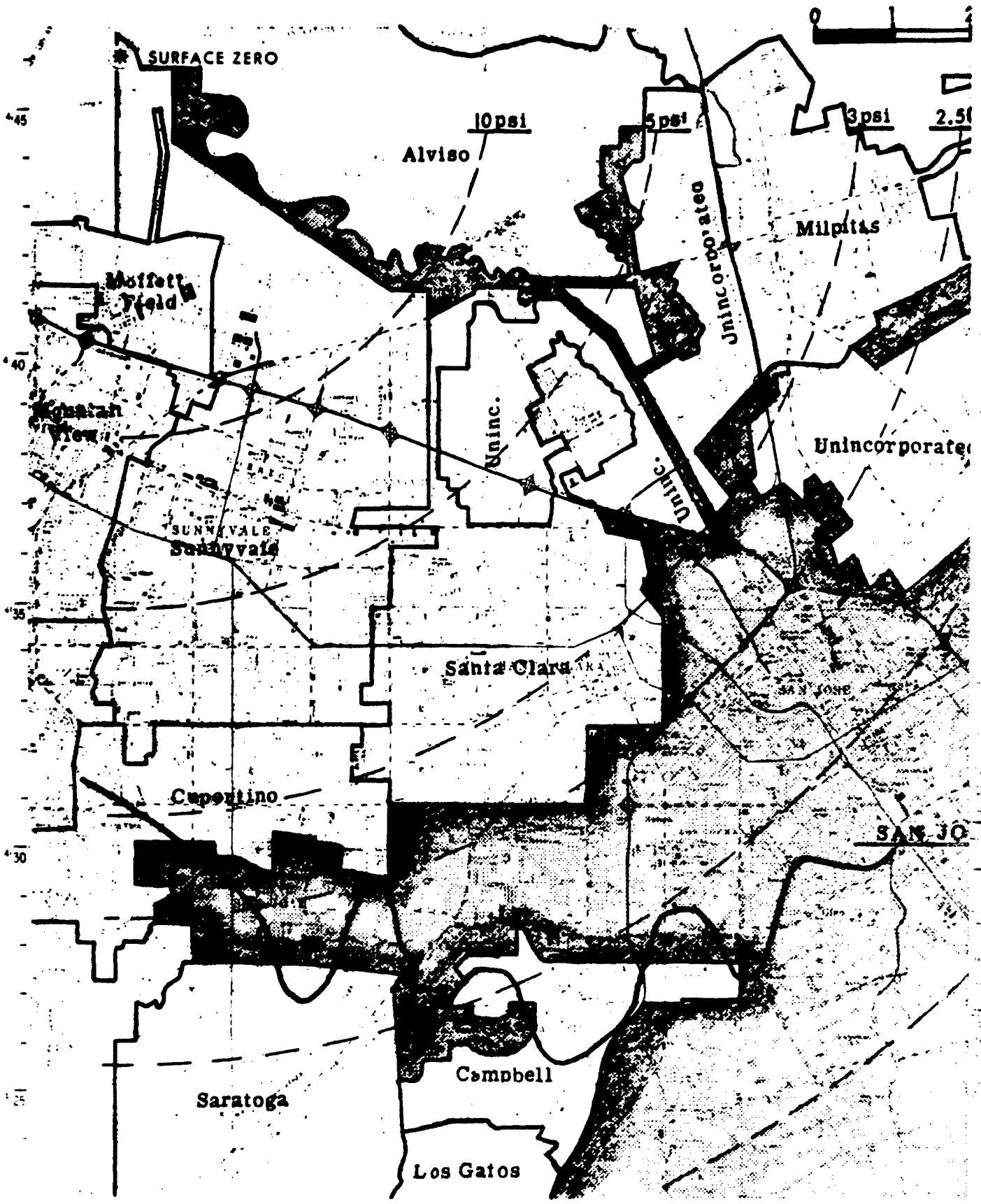
1. Municipal water, sewerage and drainage systems are generally oriented to the corporate boundaries of the municipality.
2. Regulated public utilities including the telephone and telegraph system, the electric power system, the gas system, and elements of the local transportation system are generally oriented to population density and distribution in the larger urban scheme.
3. The local petroleum distribution system and the radio broadcasting and television are also oriented to population density and distribution.
4. Portions of the local transportation system (waterways, railroads and air transport) may be oriented in accordance with geographical and topographical features. Also transmitting facilities of the radio broadcasting and television systems are topographically oriented.

For the purposes of this study however, it was necessary to study a single area for a point-by-point analysis of the effect of the presence or absence of supporting utilities on each utility.

#### The San Jose Area

The San Jose urban area may be generally described as that urban area included on the map in Figure 3. It includes the incorporated areas of San Jose, Santa Clara, Sunnyvale, Milpitas, Campbell, and portions of Los Gatos, Saratoga, Cupertino, and Mountain View. Within the general corporate limits of San Jose and other incorporated communities, there are substantial unincorporated parcels utilized for agricultural purposes. The corporate area of San Jose also has several panhandle appendages noted on Figure 3. The appendages are present for various reasons. The

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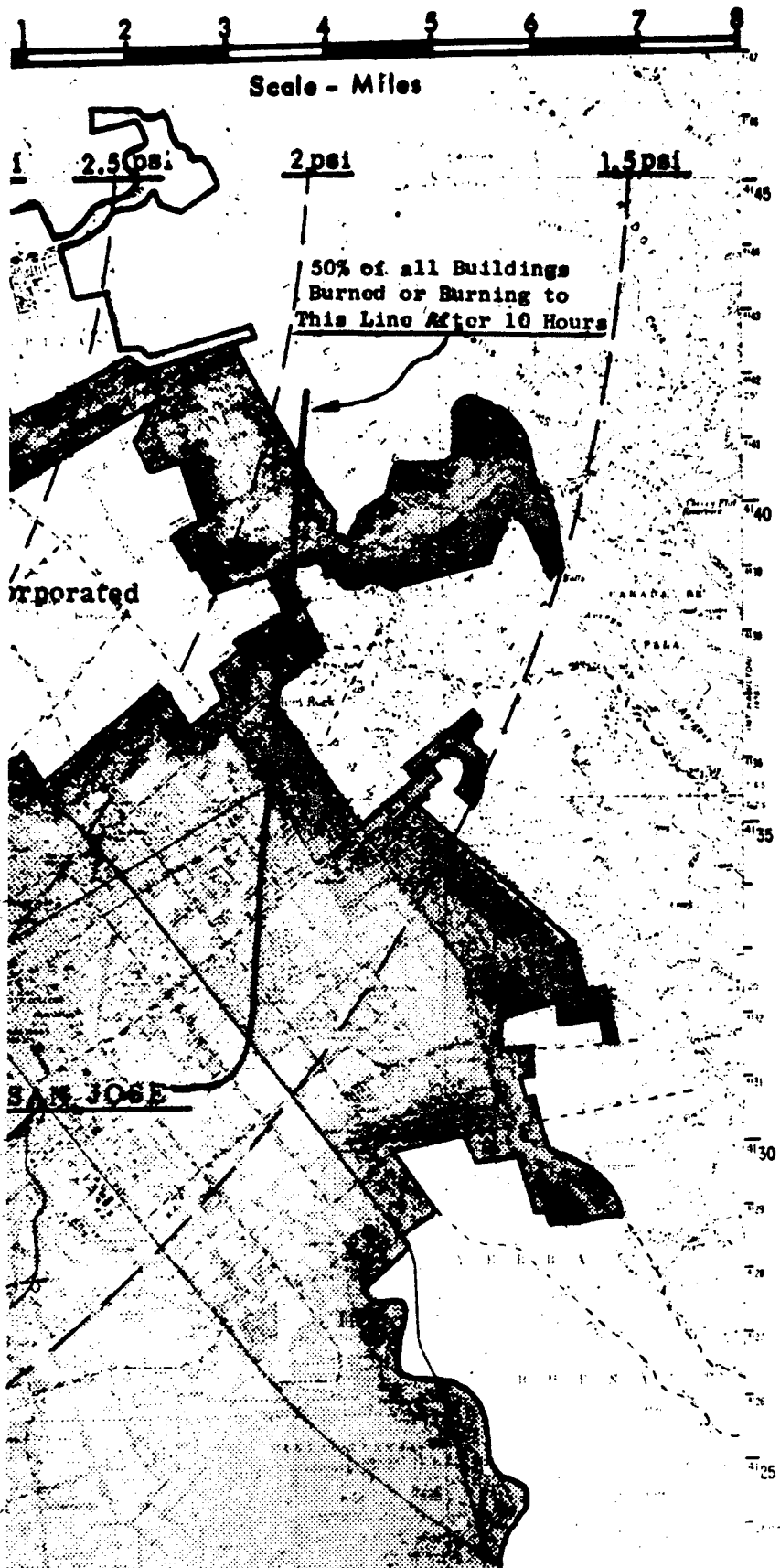


FIGURE 3 CORPORATE BOUNDARIES, SAN JOSE AREA

one to the northwest provides access to the shoreline of San Francisco Bay for possible port uses, the one to the north provides access to the water pollution control plant, and the one to the north east bounds a large city park.

#### Areas of the Separate Utility Studies

References 7, 8, 9, 10, 11, 12, and 13 identify the study areas selected for each separate utility vulnerability study. A summary follows.

##### Water Supply System

The Water Supply System area studied is indicated on Figure 4. It is the boundary of the system owned and operated by the San Jose Water Works, Inc., a privately owned public utility. The area is roughly coincident with the corporate limits of San Jose on the north and east except for exclusion of the panhandles. On the west and south it includes portions of Saratoga and Los Gatos and all of Campbell. Since the system is privately owned, it has no relationship to corporate boundaries in the usual manner although the company is franchised by the City of San Jose.

##### Sewerage and Drainage

The sewerage and drainage system area studied is indicated on Figure 5. It is coincident with the boundaries of the sewerage and drainage collection system operated as a municipal utility by the City of San Jose. The area is roughly coincident with the corporate boundaries of San Jose except that it includes all of Campbell and a portion of Los Gatos.

##### Electric Power

The area selected for study of electric power is indicated on Figure 6. The electric power utility in San Jose is a small segment of the Pacific Gas and Electric Company electric power operation in the general area and has no boundaries related to the corporate area of San Jose. The area selected for study, however, was chosen to include all substation service areas lying generally within the corporate limits of San Jose. The area includes portions of Santa Clara and Milpitas and all of Saratoga, Campbell, and Los Gatos.

### Gas

The area selected for study of the gas utility is indicated on Figure 7. The gas utility in San Jose is also a small segment of the Pacific Gas and Electric Company gas operation in the general area and has no boundaries related to the corporate area of San Jose. The area studied includes San Jose, Santa Clara, Sunnyvale, Saratoga, Campbell, Los Gatos, and Milpitas and a great deal of unincorporated area.

### Telephone

The area selected for study of the telephone system is indicated on Figure 8. The area is roughly coincident with the corporate boundaries of San Jose with some major inclusions of unincorporated areas.

### Radio Broadcasting and Television

The radio broadcasting and television area studied is that which includes all of the studios (all within the corporate limits of San Jose) and separate locations of the transmitters, some of which are outside the limits of the San Jose urban area. The area is indicated in Figure 9. The broadcast service area for each station covers an area much larger.

### Petroleum Distributor

The petroleum distribution area selected for study is indicated in Figure 10. It is an area 17 miles square with the northwest corner at surface zero of the detonation. In addition to San Jose it includes all of Santa Clara, Sunnyvale, Saratoga, Campbell, Los Gatos, Milpitas, a portion of Mountain View, and all unincorporated areas.

### Local Transportation

The local transportation area selected for study is indicated in Figure 11. It generally coincides with the corporate boundaries of San Jose but includes major unincorporated areas.

### Considerations in the Selection of a Study Area

For the inter-systems relationship study, the primary consideration in the selection of a composite study area relates to the interdependence of systems. Thus the area selected should be one in which the major portion of strongly interdependent utilities are located. This is more important in the area of, or direction toward, most damage.

Other considerations include:

1. The area should include the urbanized portion of the San Jose corporate limits because utilities exist to serve people and industry.
2. The area should include insular (or near-insular) unincorporated areas.
3. The area should be carefully defined where any damage to utility systems is expected.
4. The major supporting utilities to other utility systems are electric power and telephone. Therefore the area for other utilities should not be larger than the study areas of the electric and telephone systems, particularly in the area of heavy damage.

### Study Area Selected

Except for the gas system and the petroleum distribution system, study areas selected by the individual utility vulnerability projects coincide in a general way with the corporate boundaries of San Jose and also included all of the corporate area of Campbell and a portion of Los Gatos. Both the gas system and petroleum distribution system included large areas to the north and west of San Jose including the cities of Sunnyvale, Cupertino, and Saratoga.

The more critical interdependent utilities (electric power, water supply, sewerage and drainage and radio broadcasting and television) studied the general corporate area of San Jose including Campbell and Saratoga. This permits point analysis of relationships between these latter utilities except in small areas where some interpolation was required. For the purpose of this study, therefore, the study area is that encompassed by the corporate limits of San Jose, Campbell, and Saratoga including insular and near-insular unincorporated areas.

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#### IV WATER SUPPLY SYSTEM

##### Target Model

The water supply system serving San Jose is owned and operated by the San Jose Water Works, Inc., a privately owned regulated utility. The system is supplied primarily (79%) from ground water sources with a complex system of wells, booster stations, and distribution reservoirs. Twenty-one percent of the supply is from surface sources that flow into the system by gravity. Surface water is filtered and chlorinated whereas ground water is generally untreated. The physical system is composed of 113 named stations\* and transmission mains constituting the supply aspect of the system and a network of mains, divided into 29 pressure zones, constituting the distribution portion.<sup>7</sup>

##### Initial System Damage

The only physical damage suffered by the system consisted of blast damage to electrical service drops and to reservoir float level devices at 19 of the 113 stations. Damaged stations are indicated on Figure 4. No transmission and distribution mains were damaged. Casualties to personnel were considered to be insignificant insofar as overall system capability was concerned.<sup>7</sup>

Post-attack systems capability was considered under two assumptions: (1) with electric power available and (2) with no electric power. In the former case it was concluded that normal demands could be supplied over approximately 90% of the system. In the latter case it was concluded that the system could supply normal demands for a maximum of about 2.2 days from water in storage.<sup>7</sup>

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\* A station may consist of well(s), booster pump(s), collection reservoir(s), distribution reservoir(s), impoundment reservoir, filter plant, or combinations.

## Supporting Utility Requirements

Reference 7 does not define supporting utility requirements in detail; however, requirements can be inferred from descriptions of station functions, lists of wells, and boosters. Such requirements are described below.

### Electric Power

Point electric power inputs are required for well pump motors, booster pump motors, motor operated valves, and float level flow control devices.

Area electric power inputs are required for security lighting at stations and plants, convenience lighting in offices, shops and plants, and other generalized electrical services such as the operation of recording equipment.

### Gas

No point requirements are known to exist.

Area requirements are for fuel for convenience heating in offices, shops, and plants.

### Sewage and Drainage

No point requirements exist.

Area requirements are for sanitary service for offices, shops and plants.

### Telephone Service

No point requirements are indicated by Reference 7.

Area requirements are the normal telephone service communications for administrative and operations use. A mobile radio system is available as an auxiliary source of communications.



Radio Broadcasting and Television

There are no requirements except for general CD information transmission and warning, and emergency instructions to customers.

Petroleum

No point requirements exist.

Area requirements exist for fuel for motor vehicles for transportation of operations, maintenance personnel, and supplies.

Local Transportation

No requirements exist, since the system is self-supporting with its own transportation.

Water

A point requirement may exist in the form of filtered water for washing filters; however, Reference 6 does not treat this matter.

Area requirements are for water for drinking and sanitary purposes at offices, shops, and plants.

Supporting Utility Interconnections and Availability

Figure 4 indicates the points of interconnection of point supporting utility requirements. Area requirements in no case would be critical to the system and therefore are not indicated.

The only point supporting utility requirements of the water system considered critical are those pertaining to the supply of electric energy to the well and booster pump installations. If telephone circuits are utilized for the transmission of control information between reservoirs and booster pumps, they would not be entirely limiting as the available uninjured operating personnel could provide manual operation if the circuits were out.

The availability of electric power to meet the point supporting utilities requirements at interconnections is extracted from Reference 9

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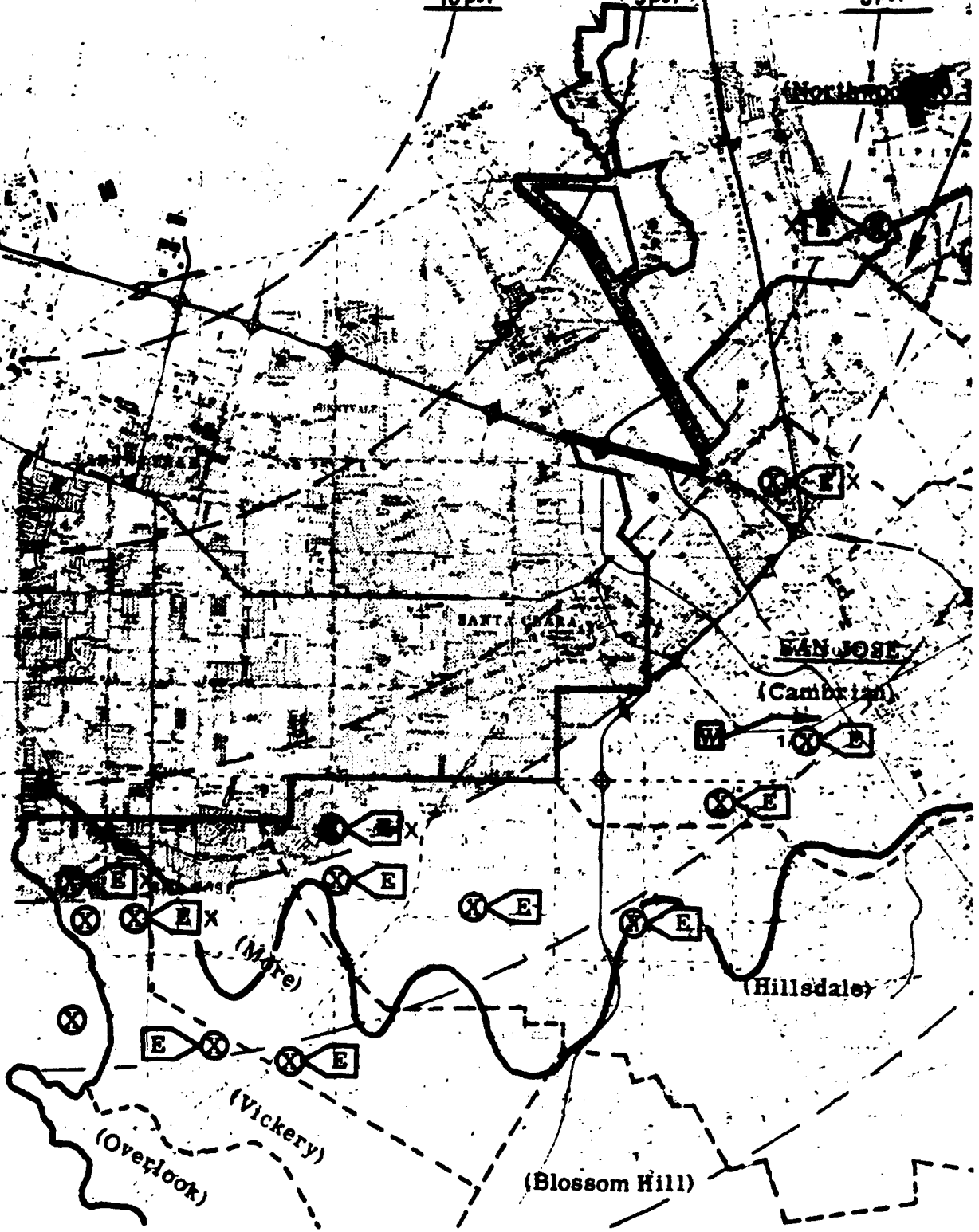


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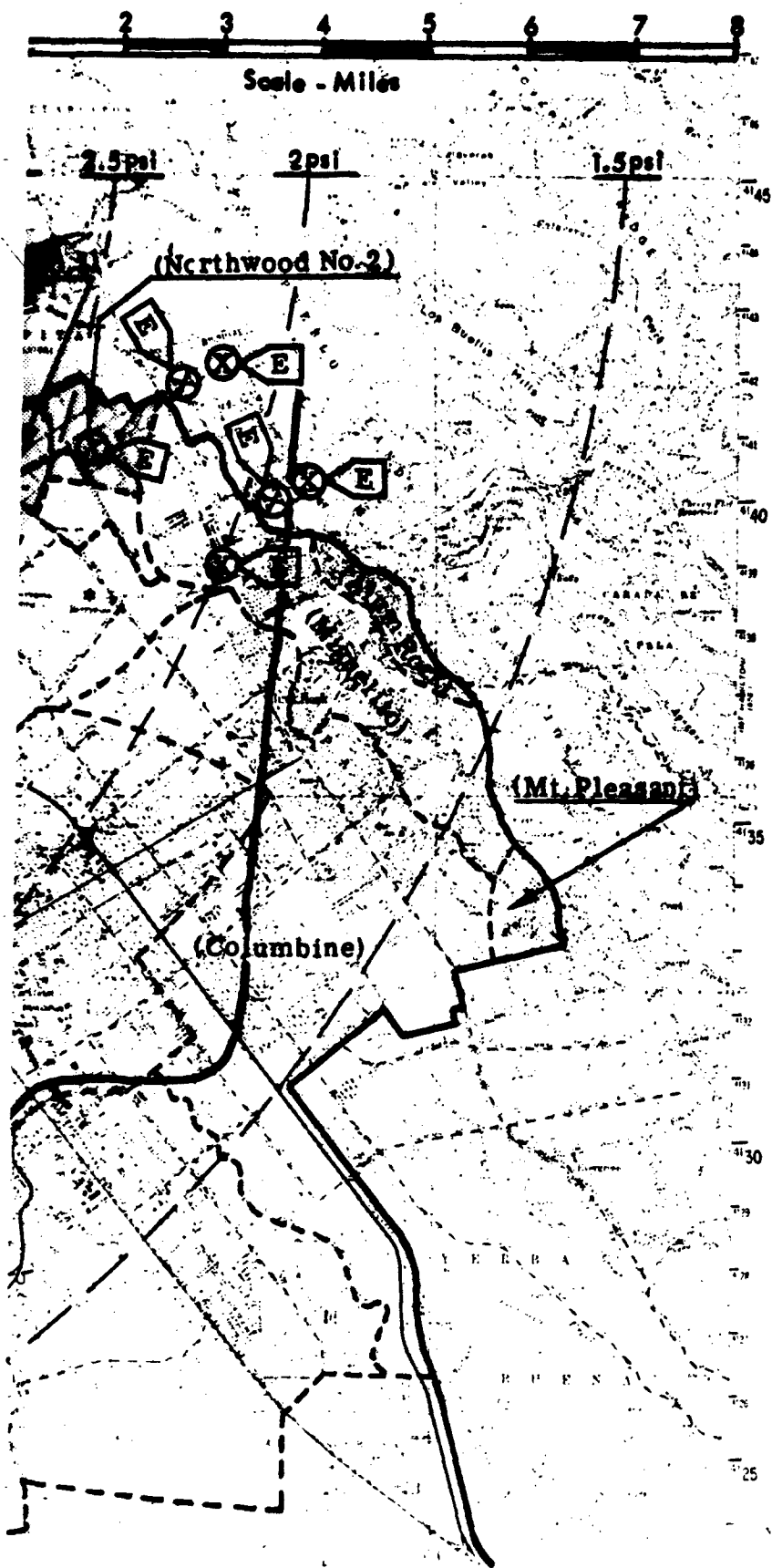
10 psi

5 psi










3 psi



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**LEGEND**

-  Water Supply System Study Area
-  Pressure Zone Boundary
-  Overpressure Radii
-  Water Supply System Station, "X" Indicates Physical Damage
-  Utility Inter-Connection. "E" Indicates Electric Power, "X" Indicates Non-Availability
-  Water Supply System Information Not Available in This Area
-  Water System Service Center
-  Area of No Water Service
-  50 % of all Buildings Burned or Burning to This Line After 10 Hours

**FIGURE 4 WATER SUPPLY SYSTEM—UTILITY INTERCONNECTIONS, PHYSICAL DAMAGE AND TOTAL POST ATTACK SYSTEM CAPABILITY**

and is reflected graphically in Figure 4. Electric power is available to all stations except:

- Lakewood Station-Northwood No. 1 Pressure Zone--Power was not available at this station for the operation of three well pumps and two booster pumps lifting water to Northwood No. 1 Pressure Zone.
- Gish Road Station-Cambrian Pressure Zone--Power was not available at this station for the operation of three well pumps and two booster pumps lifting water to the Hillsdale Pressure Zone.
- Rainbow Drive Station-Vickery Pressure Zone--Power was not available at this station for the operation of three well pumps and two booster pumps lifting water to the Hillsdale Pressure Zone.
- Regnart Station-Vickery Pressure Zone--Power was not available for the operation of one booster pump lifting water to the Vickery Pressure Zone.

#### Total System Damage and Post-Attack System Capability

Before analyzing the effect of the lack of electric power on the total post attack water supply system capability it is considered desirable to determine the effects of the following information that was not considered in Reference 7.

#### Fire

The area consumed by total burn would require isolation of the water supply system therein to prevent leakage resulting from broken internal fixtures. This would probably be done initially by closing valves on the mains serving the areas. Later, as time and personnel became available, individual building services would be cut off and pressure in the main restored. A fire line taken from Reference 14 has been plotted on Figure 4. The line indicates the extent of the area wherein 50% of the buildings were burned or burning after 10 hours.

### Building Damage

A secondary effect not considered in Reference 7 is that of water system loss due to fixture and pipe breakage in blast damaged buildings. In order to prevent system drainage through such leakage, isolation of blast damaged areas would become a matter of first priority in the immediate post attack period. This would probably be accomplished, as in the case for fire. For the purpose of analyzing the effect, over-pressure radii have been indicated on Figure 4. It may be approximately calculated from Table 12.19 of Reference 15 that the area between the 2- and 3-psi radii would produce damage to residential and apartment type buildings, ranging from moderate to severe. Although, only about 10% of building systems would be expected to be broken in the area of moderate damage, the proportion would be expected to rise to perhaps 90% in areas of severe damage. Therefore, it can be assumed that at about 50% of the building systems would be broken at about the 2.5-psi radius. This would be sufficient to cause serious drainage losses in the water pressure zones affected. This would require isolation of the affected areas to prevent loss of stored water. Although lesser system drainage effects would occur at further radii, these could be controlled by selective isolation without depriving the entire area of supply. A gross assumption is, therefore, made that no water supply service is available in the area out to the 2.5-psi radius.

Point supporting utility requirements (electric power) are available for water supply system elements in all pressure zones except Northwood No. 1, Cambrian, Hillsdale, and Vickery. Northwood No. 2, Miguelito, and More pressure zone stations have electric power available but some are inoperative due to blast damage. There are no area supporting utility requirements having significant limiting effects. The total post attack situation in the affected pressure zones was as follows:

#### Northwood No. 1 Pressure Zone

Three well pumps and two booster pumps are inoperative due to blast damage to electric power drops and to the general unavailability of electric power in the area. The pressure zone is in the area of moderate to severe blast damage to residences and would require isolation of the distribution system. The pressure zone, therefore, has no production or distribution capability.

#### Northwood No. 2 Pressure Zone

Control devices for reservoir levels at Northwood No. 2 station would be inoperable due to blast damage. The devices control the booster pumps at Copley station which would be inoperable due to the failure of electric power drops. Electric power supply would be available however. Northwood No. 2 pressure zone, also in the area of at least moderate building damage and consequent leakage would require isolation of the distribution system. The pressure zone, therefore, has no production or distribution capacity.

#### Miguelito Pressure Zone

Electric power would be available to the well pumps and boosters at Piedmont Road Station; however, the float level control device in the collection tank and that at Dutard reservoir is inoperable. Manual operation of controls will permit the pressure zone to produce and distribute water. No building damage breakage losses would occur.

#### Cambrian Pressure Zone

The Gish Road groundwater pumping station would be without electric power supply and the service drops would be down. The water supply would not be available to the Cambrian Zone. Delmas Avenue station has damage to collection tank float level controls but electric power supply would be available to the ground water pumps. The booster pumps would be operable to lift water to Fleming reservoir. A similar situation would exist at Buena Vista station. A portion of the area lies within the 2.5-psi line and the distribution system in that area would require isolation. The remainder of the pressure zone would be unaffected and sufficient production and distribution capacity would exist to supply normal requirements.

#### Hillsdale Pressure Zone

The Sterling Boulevard station would be without electric power supply and the service drops would be out. The collection tank float level control would be damaged. The station would have no production or boosting capability. The Doyle station would have electric power availability, but the collection tank float level device would be inoperable. Manual operation would permit production and boosting. A similar situation would exist at the Williams Road and Three Mile stations. A very small portion of the pressure zone would be within the

2.5-psi line. This area would require isolation. The remainder of the pressure zone would be considered to have adequate production and distribution capacity to meet normal requirements.

#### More Pressure Zone

All stations within the pressure zone have electric power available; however, reservoir float level devices at Congress Junction station reservoirs would be inoperable. Manual operation of booster pump controls, together with supply from other stations would permit normal usage except in the area within the 2.5-psi line which would be isolated.

#### Vickery Pressure Zone

Electric power supply would not be available to the booster pumps at Regnart station lifting water to the Vickery distribution system. The capacity would be lost to the Vickery system. The float level device at Upland Way reservoir would be inoperable; however, booster pumps at the other stations (except Regnart) may be controlled manually. Electric power would not be available to the Rainbow Drive booster pump station. The Prospect Road reservoir would have its float level control damaged and the booster pumps serving the reservoirs (Regnart and Rainbow Drive) would be without electric power supply. The Vickery Pressure Zone is also supplied from a surface source (Lake McKenzie) which would provide sufficient water for emergency requirements. A small portion of the pressure zone lies within the 2.5-psi level and would require isolation. The overall capacity of the pressure zone would be limited, but may be considered capable of meeting emergency requirements.

#### Summary of Total Post Attack System Capability

Although 19 stations of 113 would receive some physical damage and five of these are located in areas where electric power supply would not be available, the net loss of production and distribution capability would be minor. Relatively small areas would require isolation due to blast damage to buildings. The normal supply requirements of these areas will probably be equal to the general loss of system capacity. The total burn area encompasses a large area wherein the system would be otherwise undamaged and operational. The nature of the exact effects of fire on the water system is beyond the purposes of this study; however, it may be assumed that the water system together with supporting utilities would be largely non-operational in such an area. Demand (except for fire-fighting) would also be largely nonexistent.

In summary--the nature of availability of post-attack supporting utilities would be such that the water system would have essentially normal pre-attack capability except for small areas requiring isolation due to leakage caused by building damage. Considering the effect of total burn, the water supply system capabilities would be seriously degraded. With total burn the system would be essentially limited to surface sources which would supply about 20% of normal requirements. This would probably be adequate to serve the domestic demands of the unburned area under emergency conditions but would not provide for massive fire fighting.

Figure 4 indicates the area capable of receiving normal water supply, not considering the effects of total burn.

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## V SEWERAGE AND DRAINAGE SYSTEM

### Target Model

The sewerage and drainage system serving San Jose is a municipal entity managed and operated by the Public Works Department of the City of San Jose. The sewerage system is divided into two subsystems, (1) the collection subsystem consisting of the underground sewer main, trunk, and transmission line network together with 11 electrically powered sewage lift stations, and, (2) the treatment subsystem consisting of a centralized, complex sewage treatment facility. The drainage system, although physically separate, is considered to be part of the collection subsystem and consists of storm water catch basins and closed and open channel transmission systems eventually discharging into natural channels leading to San Francisco Bay.<sup>7</sup>

### Initial System Damage

The only physical damage suffered by the collection subsystem was the breakage of electric power drops leading to two of the 11 sewerage lift stations.<sup>7</sup> Damaged and undamaged stations are indicated on Figure 5.

The treatment subsystem, however, suffered extensive physical damage due to the location of the treatment facility in a relatively high overpressure zone. The treatment subsystem was unable to perform its function and untreated sewerage would be passed directly into the San Francisco Bay.<sup>7</sup>

Casualties to personnel were not considered to be limiting to the post-attack system capability.

### Supporting Utility Requirements

Reference 7 does not define supporting utility requirements in detail; however, requirements can be inferred from system descriptions contain therein. Such requirements are:



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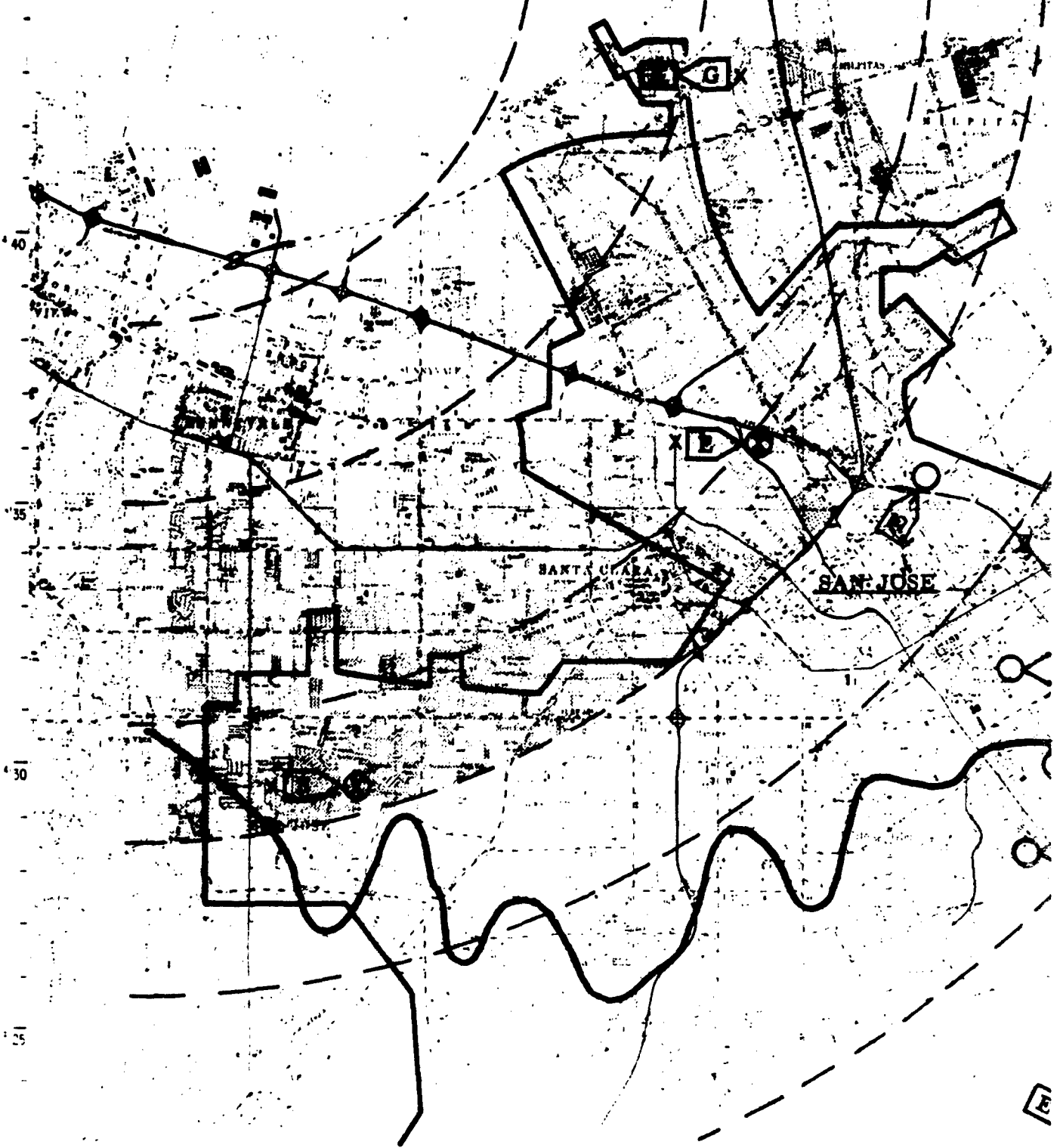
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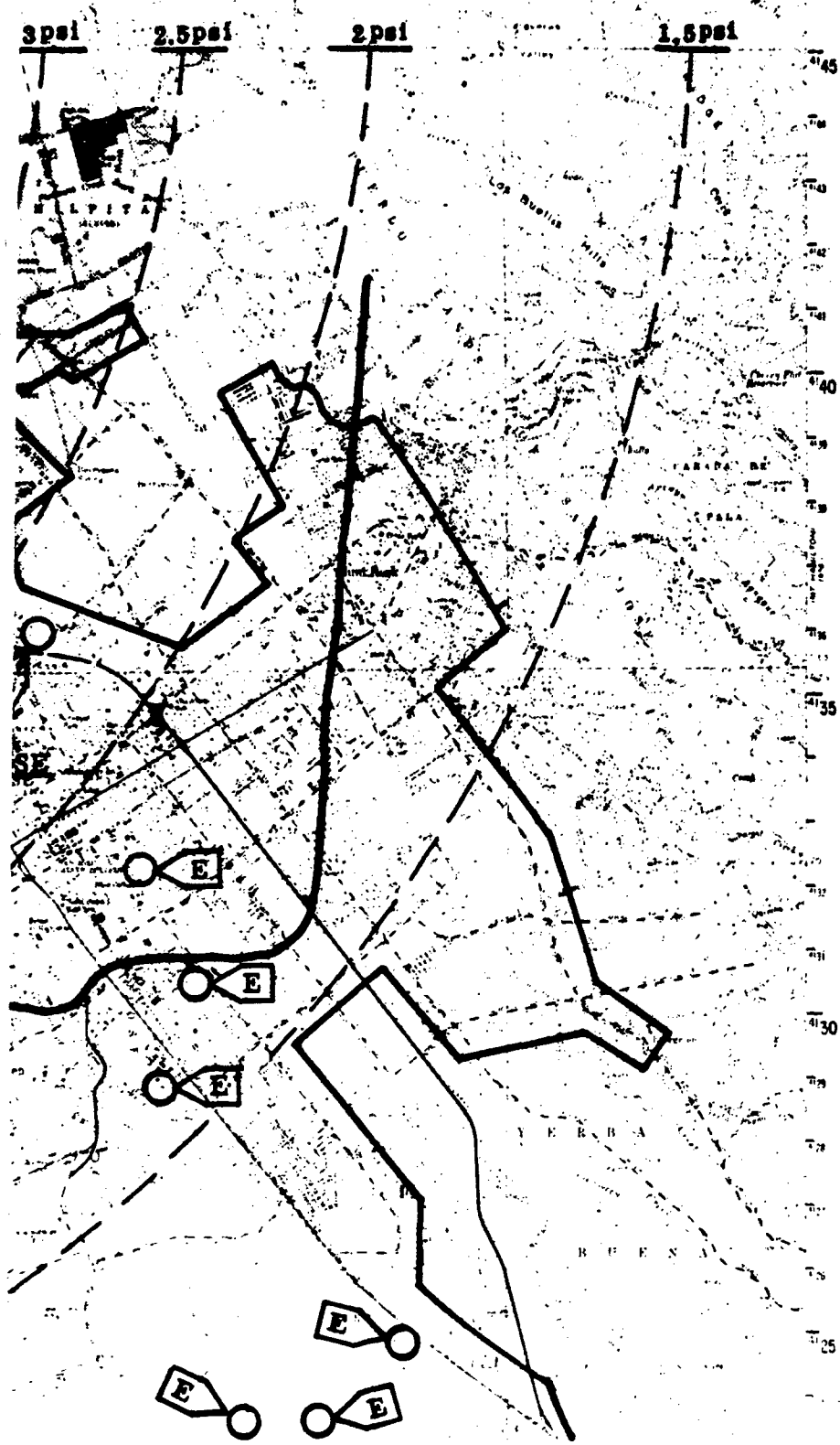
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**LEGEND**

Sewerage and Drainage Systems Study Area

Overpressure Radii



Sewerage Lift Station. "X" Indicates Physical Damage



Sewerage Treatment Plant. "X" Indicates Physical Damage



Utility Inter-Connection. "E" Indicates Electric Power, "G" Indicates Gas, "X" Indicates Non-Availability



Sewerage and Drainage System Service Center



Area of No Sewerage Service



50% of all Buildings Burned or Burning to This Line After 10 Hours

**FIGURE 5 SEWERAGE AND DRAINAGE SYSTEM—UTILITY INTERCONNECTIONS, PHYSICAL DAMAGE AND TOTAL POST ATTACK SYSTEM CAPABILITY**

Electric Power

Point electric power inputs are required for sewerage lift station pumps in the collection subsystem. A potential point requirement exists for electric power for the operation of pumps, motor operated valves, and process control mechanisms in the treatment plant. This plant has, however, an internal electric power supply in the form of sludge gas fueled engine-generator power plants and no external supply of electric power is present.

Area electric power inputs are required for convenience lighting in offices and shops.

Gas

A semi-point requirement for gas exists in the treatment plant in the form of an auxiliary fuel supply for the gas engine generators which use sludge gas as a primary fuel. Commercial gas service is available as an auxiliary fuel source and is used at times for blending with sludge gas and as a primary fuel supply in cases of breakdown in the sludge gas producing system. Serious physical damage to the sludge gas system could generate a primary point requirement for the commercial gas supply. Area requirements are for fuel for convenience heating in offices and shops.

Sewerage and Drainage

There are no system-on-system relationships for sewerage and drainage except for sanitary service to offices and shops.

Telephone Service

There are no point requirements for telephone service that can be identified.

Area requirements are the normal telephone service communications for administrative and operational use. A mobile radio system is available as an auxiliary source of communication.

### Radio Broadcasting and Television

There are no requirements for radio broadcasting and television except for general CD information transmission and warning, and emergency instruction to customers.

### Petroleum

No point requirements exist for petroleum. Area requirements exist in the need for fuel for motor vehicles for transportation of maintenance and repair personnel and supplies.

### Local Transportation

No requirements exist for local transportation. This system is self-supporting with its own transportation.

### Water

The collection subsystem is entirely dependent on an adequate area-wide water supply for the introduction and movement of wastes in the main network. Although this might be considered as being of a point nature, because of the extremely large number of interconnection points (essentially every building in the area), it is in reality a critical area requirement.

### Supporting Utility Interconnections and Availability

Figure 5 indicates the points of interconnection of point supporting utility requirements. Although the water supply area requirement is critical to the system, interconnections are not indicated because of their extreme number.

The only point supporting utility requirements of the sewerage and drainage system considered critical are those pertaining to the supply of electric power to sewerage lift stations and supply of auxiliary gas fuel to the treatment plant. As heretofore mentioned, water supply service is critical on an area basis to the collection subsystem.

The availability of supporting utilities to meet the point requirements at interconnections is extracted from References 8 and 9, and is reflected graphically on Figure 5. Availability is summarized as follows:

- **Electrical Requirements at Sewerage Lift Stations--All sewerage lift stations except two (Tantau and Mobile Country Club) have electric power available.**
- **Gas Supply to Treatment Plant--Gas service is not available at the treatment plant.**
- **Water Supply--Water supply for waste introduction and carriage is available in all areas except that indicated on Figure 5.**

**Total System Damage and Post-Attack System Capability**

Fire and blast damage to buildings (other than sewage and drainage system structures) would have no effect on system operation or post-attack capability other than to reduce system loads in the damaged areas.

The nonavailability of point electric power requirements for the Tantau and Mobile Country Club sewage lift stations would have little effect on system capabilities since these stations lie in areas of rather heavy blast damage and very little, if any, wastes would be generated in the areas served by these stations. What little sewage that might overflow at these stations would provide very minor sanitation problem.

The nonavailability of gas service to the treatment plant would not be critical since the plant would be extensively damaged and gas supply could no doubt be restored at least as fast as the required plant repairs could be accomplished.

The nonavailability of water supply in the areas of heavy building damage may be considered critical; however, there would be no people present to generate waste loads requiring water for introduction and carriage in the collection sub-system. The area affected by lack of water supply is shown on Figure 5.

The fire line taken from Reference 14 is also plotted on Figure 5. If this effect is taken into consideration the area wherein water is not available becomes much larger and further limits the post-attack system capability. Two additional sewage lift stations would also be affected since it would not be expected that electric power would be available within the fire line.

There are no intersystem effects on the drainage system.

**In summary:**

1. Without considering total burn, the post-attack capability of the collection subsystem is essentially that of the pre-attack system except for areas wherein water is not available due to building damage. Considering total burn, the area of non-availability becomes much larger.
2. The treatment sub-system is nonoperational.

VI ELECTRIC POWER SYSTEM

Target Model

The San Jose area is provided electrical service by the Pacific Gas and Electric Company, a regulated public utility. Locally, electric service is managed by the San Jose Division of the company with a service area including San Jose, Santa Clara and other incorporated and unincorporated communities in the general area.<sup>9</sup>

There are no electric generating facilities in the general San Jose area. Electric power is transmitted to the area through the main Pacific Gas and Electric Company transmission network, the nearest major generating station contributing power to the network is located at Moss Landing, 33 miles South, on Monterey Bay.<sup>9</sup>

The San Jose area is serviced by two separate transmission voltage substations, one located at Newark, about 15 miles northwest of San Jose and the other at Metcalf, about ten miles southeast. Electric power is transmitted from the two transmission voltage substations to local distribution voltage substations located throughout the area of study. These latter stations reduce voltage to distribution values for local service.<sup>9</sup>

Facilities of the San Jose Division include:

1. San Jose division office located at 86 South 3rd Street San Jose. This office provides management and business activities for the system in the area.
2. Cupertino Service Center, located at 10900 N. Blaney Street, Cupertino. This is a base of operation for maintenance and construction crews and contains a store of materials.
3. San Jose Service Center #1 located at 650 Lenzen Street, San Jose, Functions and stores are similar to the Cupertino Center.
4. San Jose Service Center #2 located at 65 North Montgomery Street, San Jose. Similar to Cupertino and San Jose Service Center #1.



The distribution substations and the division office and service centers are indicated on Figure 6.

The electric power system in the San Jose area has a company owned micro-wave communications system connecting major offices. It also has a comprehensive mobile radio system linking most service vehicles to each other and to main offices.<sup>9</sup>

#### Initial System Damage

Physical damage to the electric power system as reported by reference 9 included the following:

##### Transmission Substations

Newark transmission substation was completely destroyed but the Metcalf station was undamaged.

##### Study Area Transmission Network

The transmission network leading from the Newark Station to the distribution substations servicing the San Jose area was severely damaged.

##### Distribution Substations

Of the 7 distribution substations studied in detail in Reference 9 only 2 received physical damage resulting in inability to distribute power to their service areas.

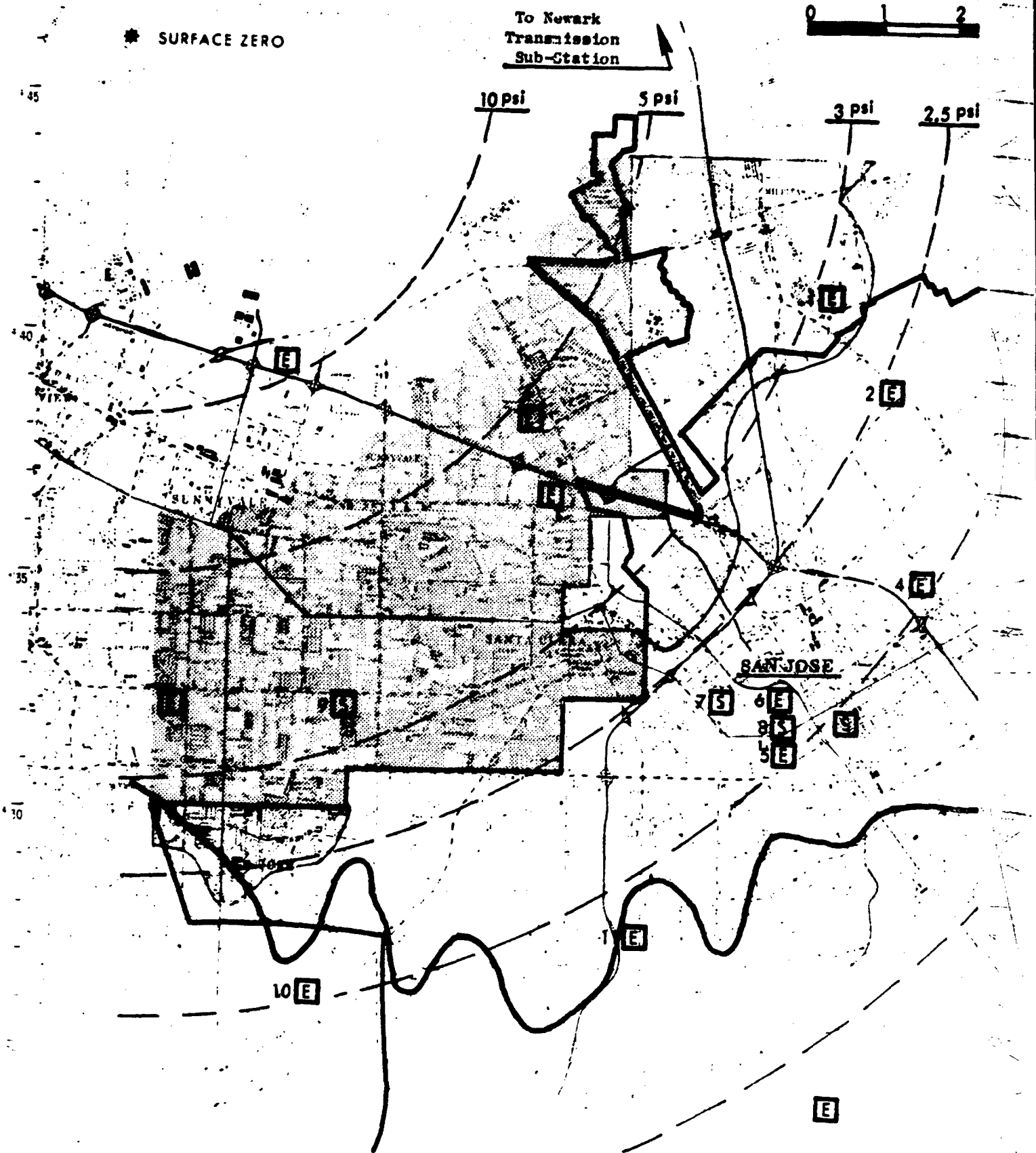
##### Distribution System

Damage to the distribution system is indicated on Figure 6. Reference 9 also indicates that short-term damage would occur at larger distances from surface zero but gives no quantifying data.

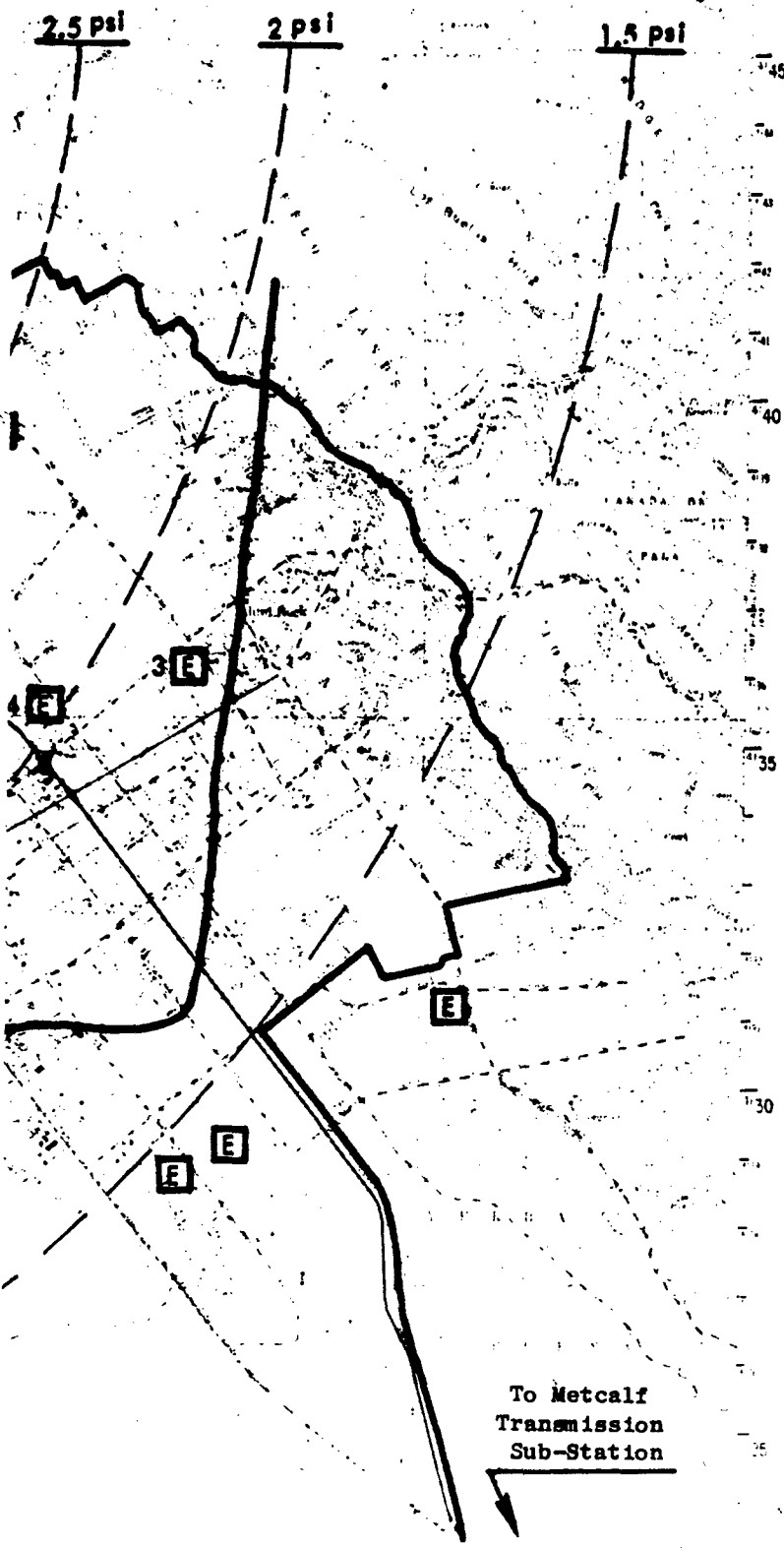
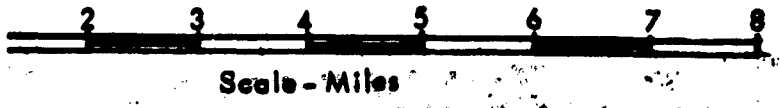
Damage to staff was determined to be nonlimiting to the post-attack capability of the electric power system.

Electric power service from generating plant outside the study area was assumed to be available (primarily from Moss Landing) to the Metcalf transmission substation.

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**LEGEND**

**Electric Power System Study Area**  
**Overpressure Radii**

\* **(E)** Distribution Sub-Station

\* **(S)** Service Center

\* Number Corresponds to Facilities Studied in Detail in Electrical Study

Area of No Power Service Due to Damage to Distribution System

Area of No Power Service Due to Damage to Transmission System and Substations

50% of all Buildings Burned or Burning to This Line After 10 Hours

**FIGURE 6** ELECTRIC POWER SYSTEM—UTILITY INTER-CONNECTIONS, PHYSICAL DAMAGE AND TOTAL POST ATTACK SYSTEM CAPABILITY

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The information contained in Reference 9 concludes generally that electric power service would be available in areas receiving less than about 2.5-psi of blast overpressure.

Supporting Utility Requirements

There are no point requirements.

Area supporting utility requirements would include:

- Electric Power--Security and convenience lighting at substations office and shops
- Gas--Convenience heating in offices and shops
- Sewerage and Drainage--Sanitary services for offices and shops
- Telephone Service--General administrative communications services
- Radio Broadcasting and Television--There are no requirements except for general CD information and warning and emergency instructions to customers.
- Petroleum--Fuel for motor vehicles
- Local Transportation--None
- Water--Sanitary service in offices and shops

Supporting Utility Interconnections and Availability

There are no point supporting utility interconnections.

Area supporting utility requirements are in no case critical and interconnections are therefore not indicated on Figure 6.

Total System Damage and Post Attack System Capability

The capability of the post attack electrical system would not be degraded in any degree by the unavailability of supporting utilities. The post attack electrical service availability information concluded

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in Reference 9 is illustrated graphically on Figure 6. A line reflecting the points to which 50% of all buildings are burned or burning after 10 hours is also indicated on Figure 6 for illustrative purposes since total burn was not considered by Reference 9. The fire line extends much farther than the electrical service nonavailability line. It is considered very unlikely that electrical service would be available behind the fire line because of fire damage to the above ground distribution system.

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VII GAS SYSTEM

Target Model

The gas system for the San Jose area is owned and operated by the Pacific Gas and Electric Company through the Central District of the company's San Jose Division. Besides San Jose, the Central District includes the incorporated cities of Sunnyvale, Santa Clara, Mountain View, Los Altos Hills, and Monte Sereno.<sup>8</sup>

Gas enters the Central District area through transmission mains coming in from the south and east. The mains terminate at Milpitas Gas Terminal where regulation occurs, and the gas is re-transmitted to distribution service areas on both sides of San Francisco Bay including the Central District serving the San Jose area.<sup>8</sup>

The gas distribution system serving the Central District is supplied by connections to the transmission system leading to or from Milpitas Gas Terminal. A network of mains of all sizes distributes gas to customers in the study area.<sup>8</sup>

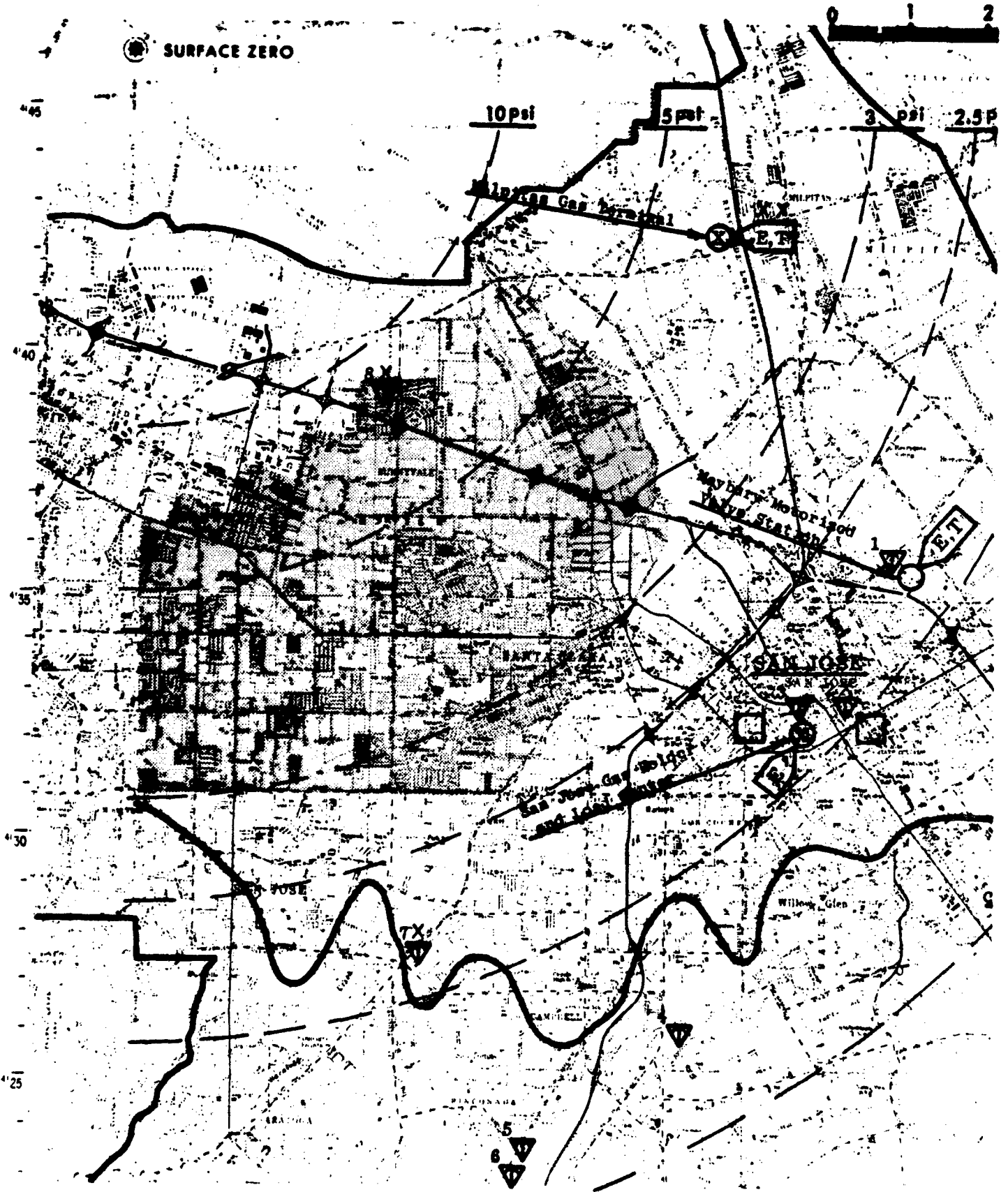
Critical physical features of the system include 13 telemetered pressure points within the distribution system, a motorized control valve station at Maybury Road, Silver Creek cross-over regulating station, a gas holder and load control center in downtown San Jose, two centers for maintenance and service, several above-ground transmission line exposures, and the Milpitas Gas Terminal. These features are indicated on Figure 7.

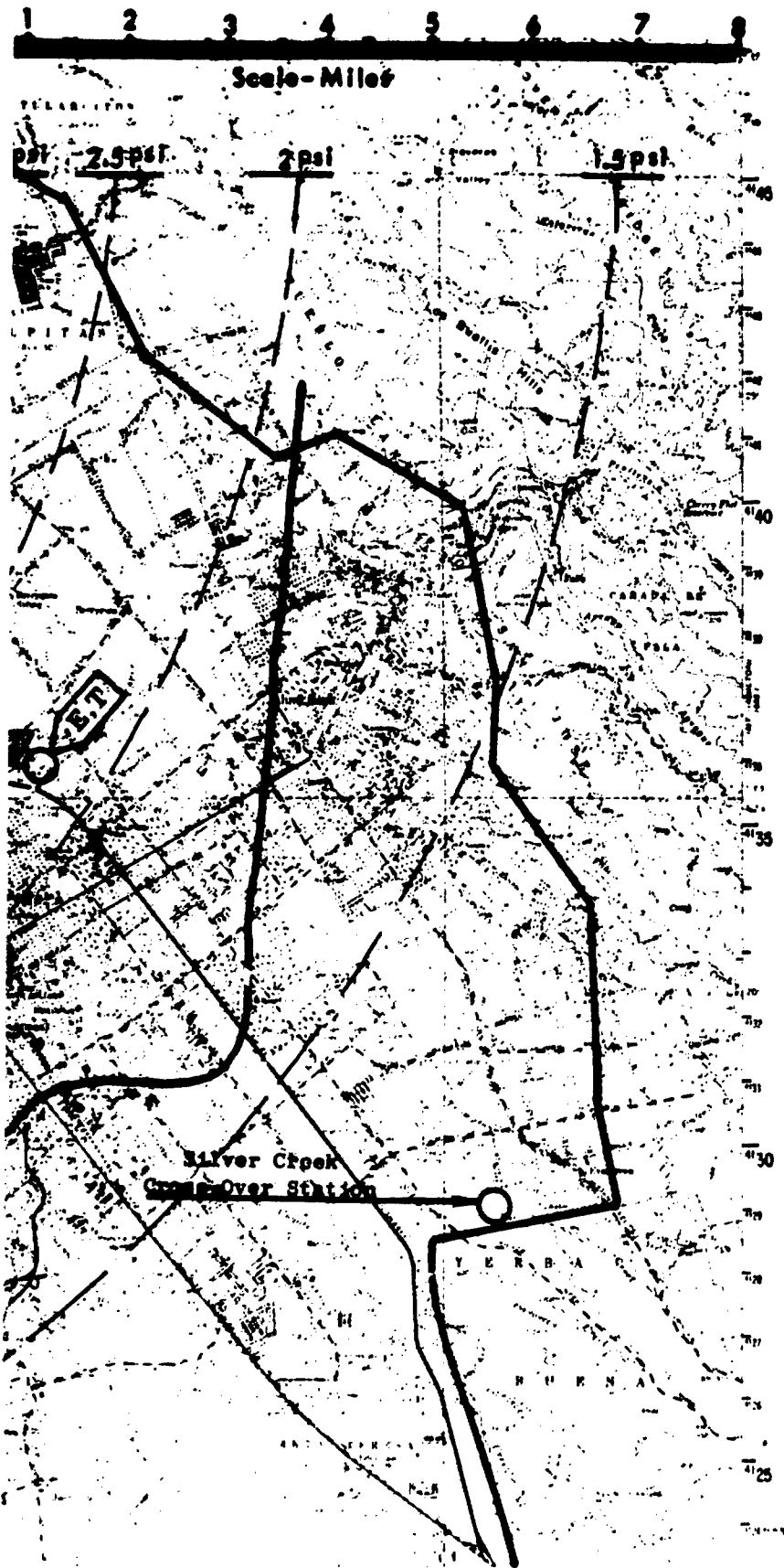
The gas system has its own internal communications system consisting of micro-wave, private wire, and mobile radio. It does utilize the commercial telephone service, however, for administrative communications and for telemetry circuits for the pressure points.

Initial System Damage









Reference 8 reported that damage to the Milpitas Gas Terminal was light and that the station was operational except for loss of some automatic controls that could be operated manually. Communication with the San Jose Load Center was lost. All other critical features received

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**LEGEND**

-  Gas System Study Area
-  Overpressure Radii
-  Gas System Critical Station, "X" Indicates Physical Damage
-  Gas System Service Center
-  Utility Interconnection  
"E" Indicates Electric Power  
"T" Indicates Telephone  
"X" Indicates Non-Availability
-  Telemetered Pressure Point. Telephone Circuit Required. "X" Indicates Non-Availability
-  Area of No Gas Service
-  50% of all Buildings Burned or Burning to This Line After 10 Hours

**FIGURE 7 GAS SYSTEM—UTILITY INTERCONNECTIONS, PHYSICAL DAMAGE AND TOTAL POST ATTACK SYSTEM CAPABILITY**



insignificant damage. However, due to heavy damage to customers premises extending out from surface zero a distance of about nine miles (about 3-psi), the gas utility managers elected to isolate this area by closing mains to prevent system leakage. Damage to the San Jose gas holder was heavy, however, this feature is not critical to the system.

Damage to staff was not found to be significant.

The area isolated is indicated on Figure 7.

#### Supporting Utility Requirements

Supporting utility requirements include:

##### Electric Power

Point requirements exist for operation of the motorized valves and controls at the Milpitas Gas Terminal; for operation of the compressors at the San Jose Gas Holder and Load Center, and the motorized valve at Maybury Road.

Area requirements exist for convenience lighting at stations, offices, and shops.

##### Sewerage and Drainage

There are no point requirements for sewerage and drainage. Area requirements are for general sanitary services at stations, offices, and shops.

##### Telephone Service

Point requirements exist for a communications circuit between Milpitas Gas Terminal and San Jose Load Center, for telephone system circuits to serve eight telemetered pressure points in the study area and for a circuit to control the motorized valve at Maybury Road.

Area requirements are for general communications services. Company owned microwave, private wire, and mobile radio systems are available as auxiliaries.

### Radio Broadcasting and Television

There are no requirements for radio broadcasting and television except for general CD information and warning and emergency instructions to customers.

### Petroleum

No point requirements exist for petroleum. Area requirements exist in the need for fuel for motor vehicles for transportation of operations and maintenance personnel and supplies.

### Local Transportation

No requirements exist for local transportation. The system is self supporting with its own transportation.

### Water

No point requirements exist for water. Area requirements exist for water for drinking and sanitary purposes at stations, offices and shops.

### Supporting Utility Interconnections and Availability

Figure 7 indicates the points of interconnection of point supporting utility requirements. Area requirements are in no case critical to the system and are therefore not indicated. The availability of the point requirements is as follows:

- Electric Power--Not available to the Milpitas Gas Terminal. Available to the compressors at San Jose Gas Holder and Load Center and at the Motorized Valve at Maybury Road.
- Telephone Service--Not available to Milpitas Gas Terminal; available to the Maybury Road Motorized Valve. Not available to three of the eight telemetered pressure points. (See Appendix C for special random number analysis of telephone service availability).

### Total System Damage and Post-Attack System Capability

The initial system damage reported in Reference 8 is not materially changed by the nonavailability of supporting utilities. Reference 8

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assumed that electric power and telephone service was not available at Milpitas Gas Terminal. The nonavailability of telephone circuits to serve the three affected telemetered pressure points is not considered critical since these can be observed manually. The area where gas service could not be supplied due to system isolation is illustrated on Figure 7.

Reference 8 did not consider the effects of total burn. A line reflecting the points to which 50% of the buildings are burned or burning after 10 hours is indicated on Figure 7. This line extends to much further distances than the line of no service reported by Reference 8. It is considered likely that all service between these two lines would be lost due to gas leakage from building loss which would require system isolation.

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## VIII TELEPHONE SYSTEM

### Target Model

The San Jose area is provided telephone service by the Pacific Telephone and Telegraph Company, one of the 23 operating companies of the American Telephone and Telegraph Company.<sup>10</sup>

The study area is served by seven central exchanges; locations are indicated on Figure 8. The exchanges are all connected to each other by trunk circuits which are mostly underground. Each central exchange also has direct access to outside (toll) trunks connected to other cities.<sup>10</sup>

About 80% of the circuits leading from central offices to subscribers in the study area are underground. The remainder is above ground.<sup>10</sup>

Each central office has an emergency electric generator with liquid fuel. Additionally, the San Jose Reports Center (Telephone Service) is equipped with a piped gas fueled generator.<sup>10</sup>

### Initial System Damage

Physical damage to the telephone system as reported in Reference 10 included the following:

1. Central Exchanges--Damage to switching equipment varying from 5% to 100% for the various central exchanges. This situation is indicated on Figure 8.
2. Underground Circuits--No damage
3. Above-Ground Circuits--10% damage

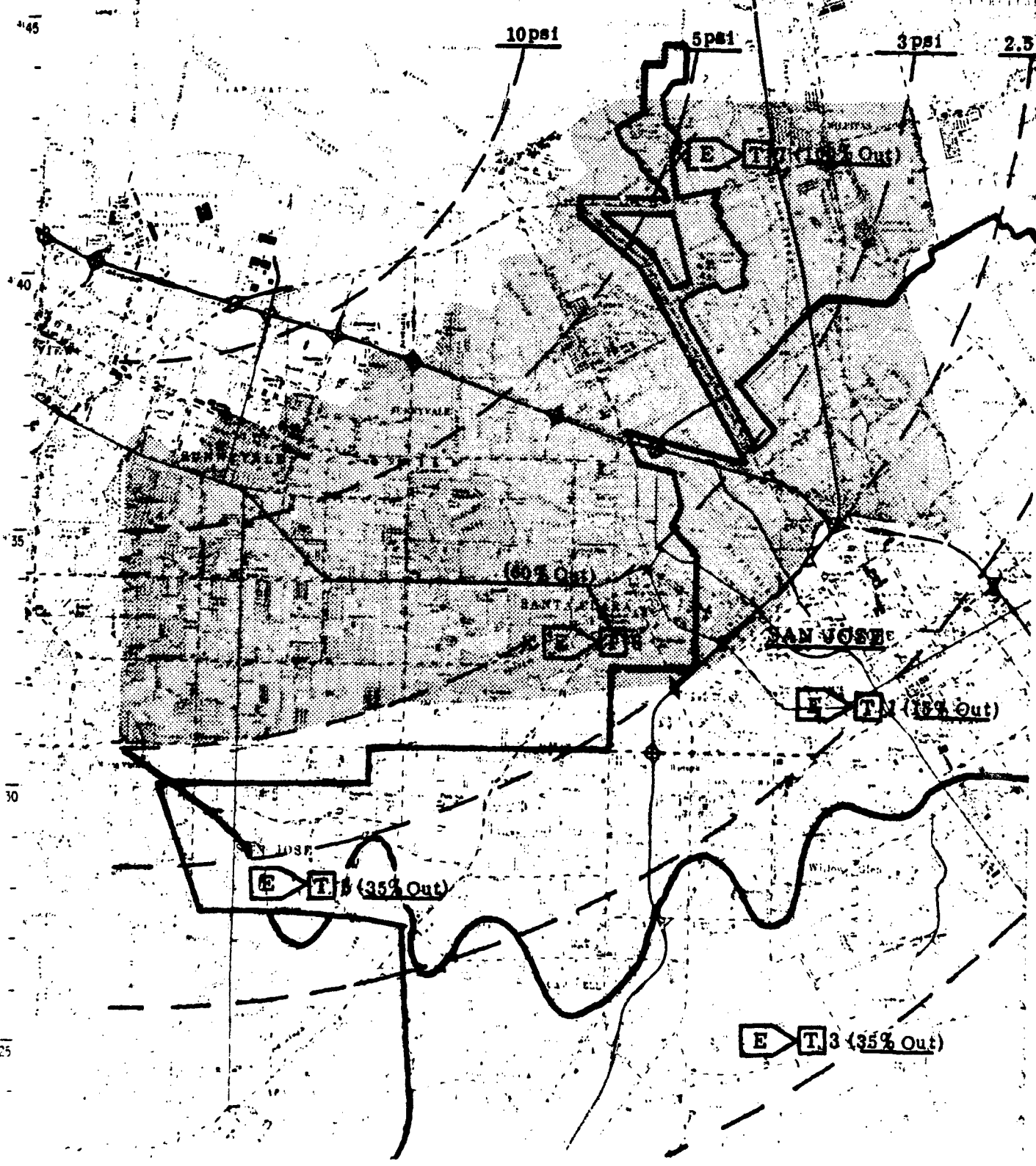
Damage to staff was not calculated; however, it is assumed to be nonlimiting as in the other utility systems.

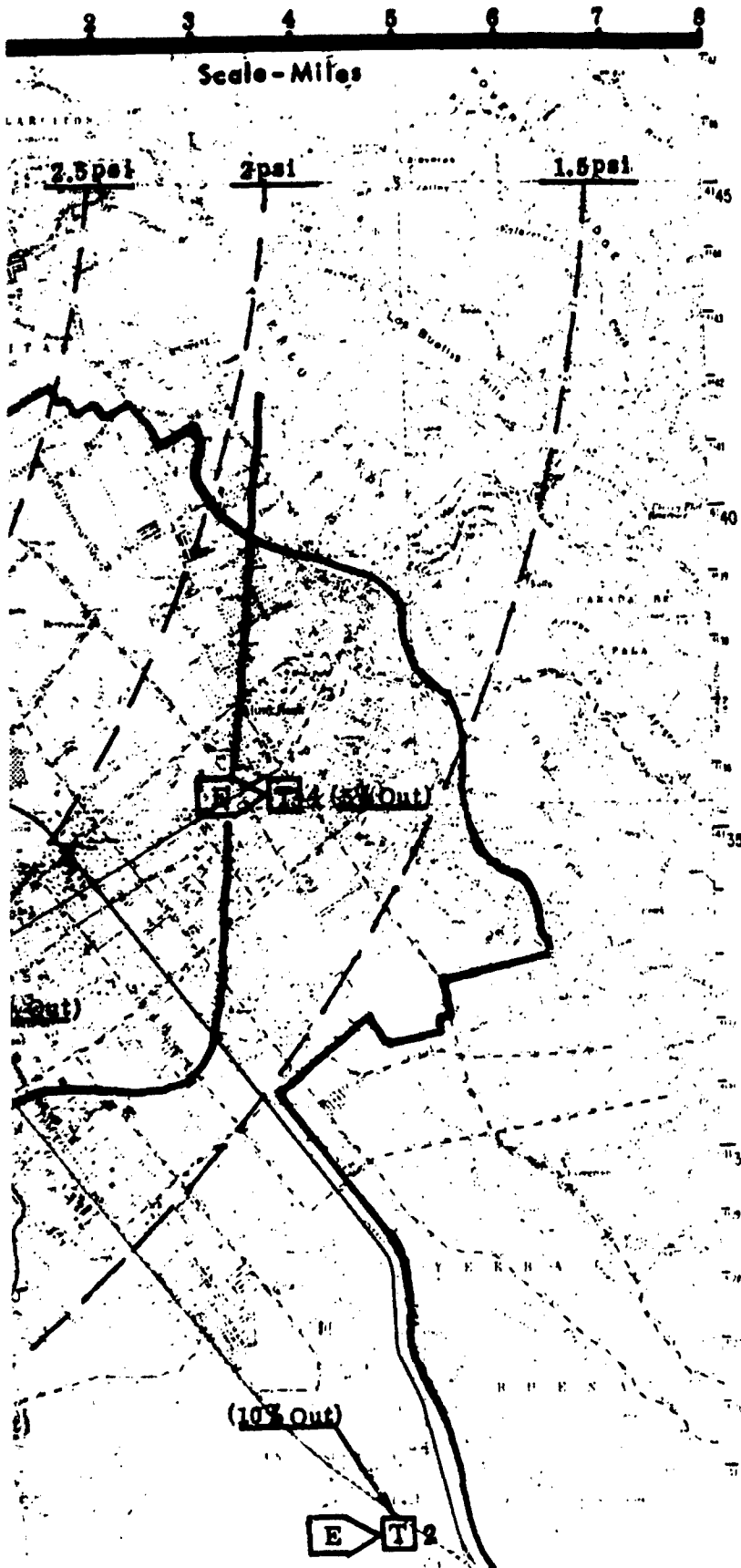
The initial post-attack service capability was not calculated on an area basis by Reference 10. An area basis service availability has

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SURFACE ZERO





**LEGEND**

-  Telephone System Study Area
-  Overpressure Radii
-  Telephone Central. Outage Due to Physical Damage Indicated
-  Utility Interconnection  
"E" Indicates Electric Power  
"X" Indicates Non-Availability
-  Area of No Telephone Service

50% of all Buildings Burned or Burning to This Line After 10 Hours

Note: Area to South and East of No Service Line Has Approximately 10% Loss of Service Due to Physical Damage to Outside Plant

**FIGURE 8 TELEPHONE SYSTEM—UTILITY INTERCONNECTIONS, PHYSICAL DAMAGE AND TOTAL POST ATTACK SYSTEM CAPABILITY**

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been constructed; however, from the limited data available from Reference 10 together with certain other analyses. This availability is indicated on Figure 8.

#### Supporting Utility Requirements

Point supporting utility requirements are limited to electric power service to central exchanges, and to piped gas for the generator at the Service Center. Auxilliary liquid fueled electric generators are available and have substantial fuel supplies. Technically, Point requirements exist for fuel and cooling water to service these units.

Area supporting utilities requirements include the following:

- Electric Power--Convenience lighting at central exchanges, offices, and shops.
- Sewerage and Drainage--Sanitary services in exchanges, offices and shops.
- Telephone Service--General communications services. A mobile radio system is available as an auxilliary.
- Radio Broadcasting and Television--CD information transmission and warning.
- Petroleum--Fuel for motor vehicles
- Local transportation--None. System is self-supporting with internal transportation.
- Water--Sanitary services in offices and shops.

#### Supporting Utility Interconnections and Availability

Point supporting utility interconnections are indicated on Figure 8. These consist of electric power services to central exchanges. Electric power is available to five of the seven exchanges in the study area.\*

---

\* Reference 10 assumed no electric power availability.

Area supporting utility requirements are in no case critical and are not indicated on Figure 8.

#### Total System Damage and Post-Attack System Capability

The capability of the post-attack telephone system is not degraded in any appreciable degree by the unavailability of supporting utilities. The area of availability of telephone service is illustrated by Figure 8.

Reference 10 assumed a fire line extending to Nimitz and Junipero Serra Freeways which includes only a small portion of the corporate area of San Jose and coincides generally with the area of heavy blast damage to central exchanges. The fire line extracted from Reference 14 (line to which 50% of all buildings are burned or burning after ten hours) is plotted on Figure 8 for comparison purposes. It is noted that the line extends out to much larger distances than the telephone service non-availability line. It is considered unlikely that telephone service would be available behind this line because of fire damage to exchanges and circuits.

Since Reference 10 did not contain sufficiently detailed information to provide the point availability of telephone service to the other utility systems studied herein, it was necessary to construct this availability through random number stochastic techniques.\* This was necessary for the Radio Broadcasting and Television system, the Gas system and a portion of the Transportation system.

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\* See Appendix C.



## IX RADIO BROADCASTING AND TELEVISION SYSTEM

Target Model

The Radio Broadcasting and Television system located in the San Jose Area consists of two television stations, three FM radio broadcasting stations and four AM radio broadcasting stations.<sup>13</sup> In their undamaged condition the broadcast service area of each station, with the exception of the low powered FM station KSJS, is much larger than the study area considered in this report. The service area of KSJS is essentially the same as the study area.<sup>13</sup>

KSJS (FM) is a noncommercial, low powered station owned and operated by San Jose State College. KTEH (TV) is a noncommercial educational TV station operated by the Santa Clara County Office of Education, which has no studio of the conventional type, but utilizes tape and film directly from the transmitter site. All other stations are conventional.<sup>13</sup>

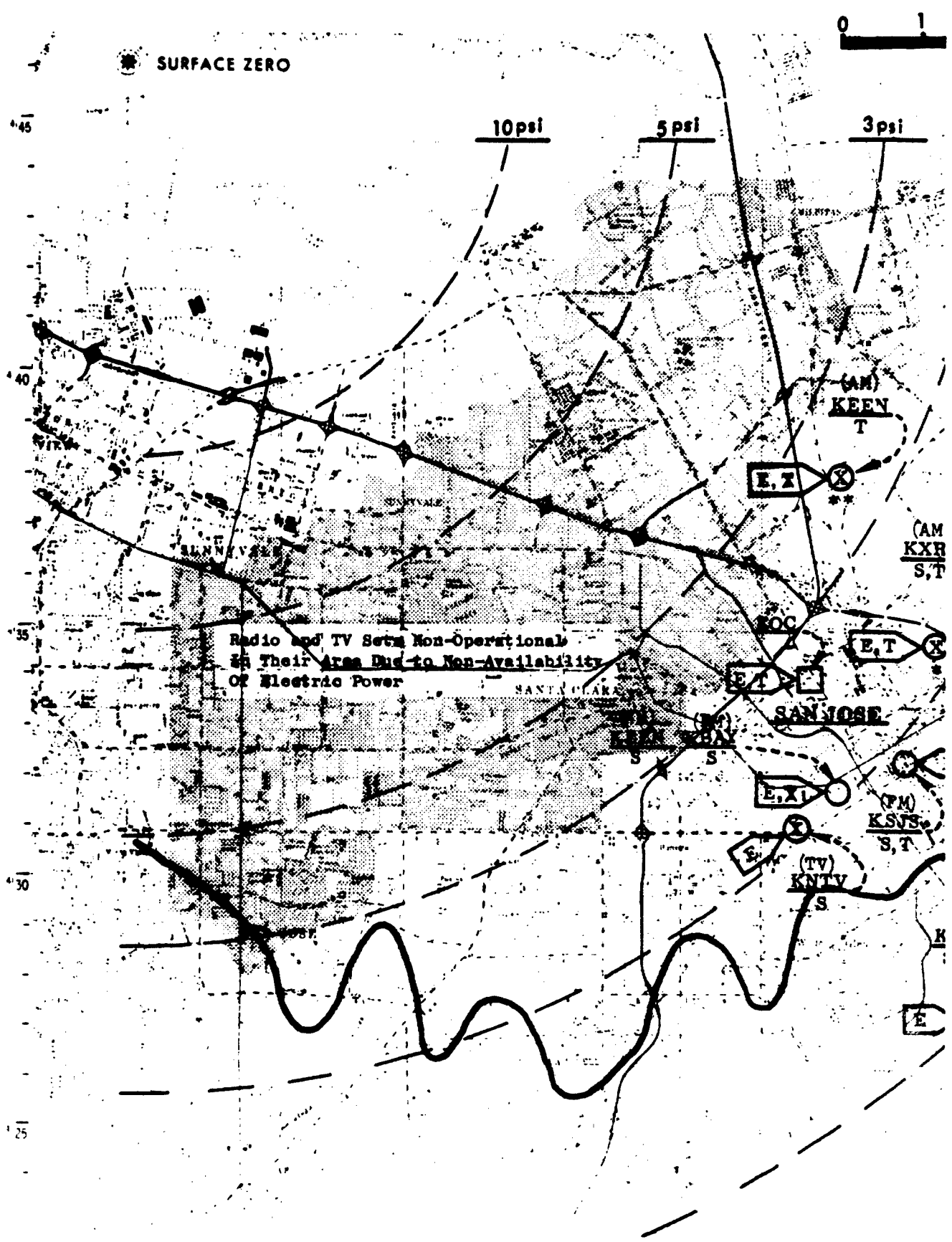
Stations and their characteristics are summarized in the following table:

Table 2

## RADIO BROADCAST AND TELEVISION FACILITIES IN SAN JOSE

<u>Station Name</u>	<u>Type</u>	<u>Power</u>	<u>Frequency</u>	<u>Remarks</u>
KNTV	TV	26.8 KW	Channel 11	
KTEH	TV	22.9 KW	Channel 54	
KXRX	AM	5 KW	1500 KHz	EBS Station
KLOK	AM	10 KW	1170 KHz	Alt EBS Station
KLIV	AM	5 KW	1590 KHz	
KEEN	AM	5 KW	1370 KHz	Alt EBS Station
KSJS	FM	85 W	90.7 MHz	
KBAY	FM	38 KW	100.3 MHz	
KSJO	FM	20 KW	92.3 MHz	

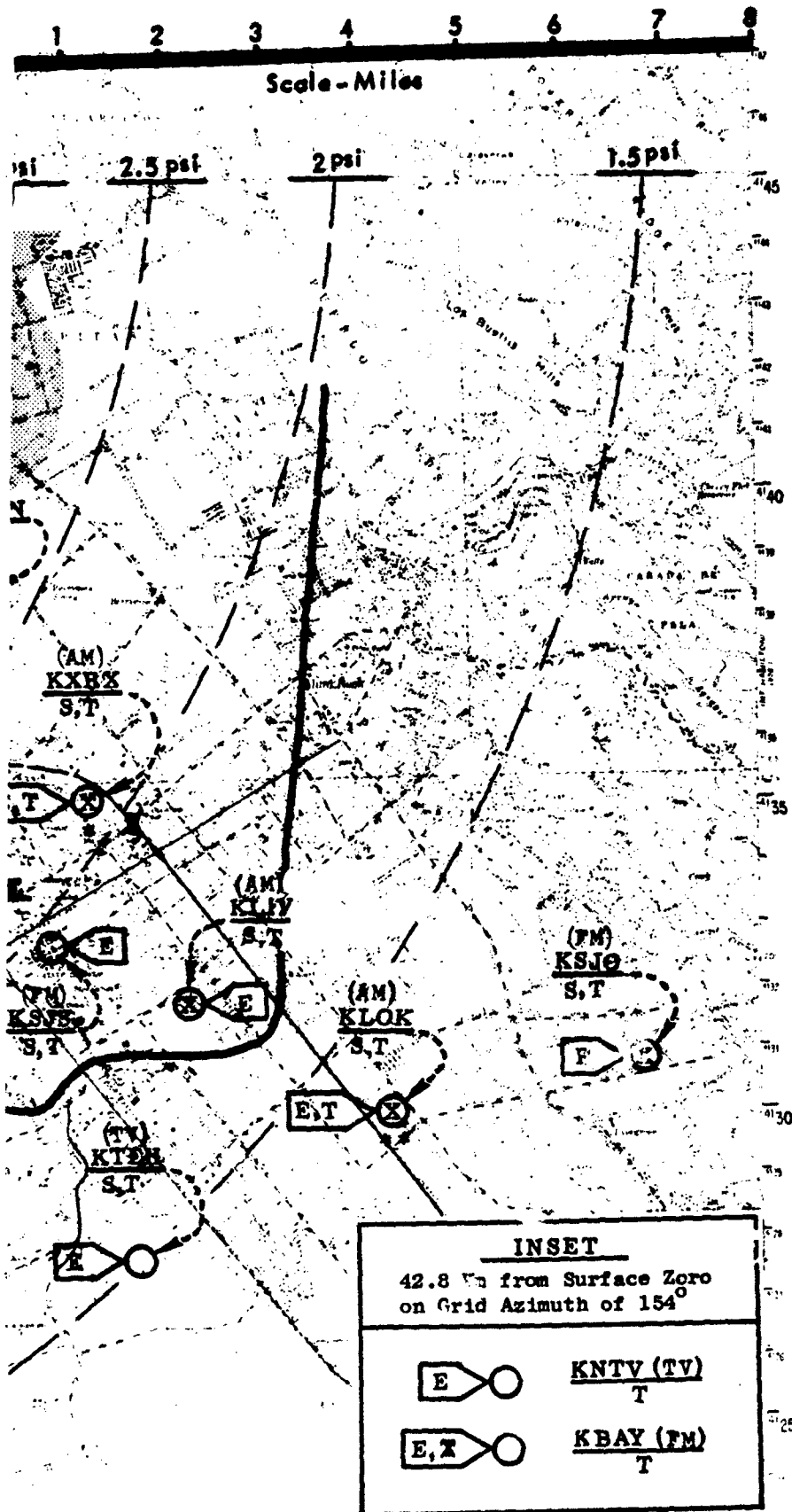
The locations of studios and transmitters of the San Jose stations are indicated on Figure 9.



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**LEGEND**

— — — Overpressure Radii

⊗ Station. "X" Indicates Physical Damage, "S" Indicates Studio, "T" Indicates Transmitter

□ Emergency Operations Center

\* Emergency Broadcast System Station (EBS)

\*\* Alternate EBS



Utility Interconnection  
 "E" Indicates Electric Power  
 "T" Indicates Telephone  
 X Indicates Non-Availability

— — —  
 50% of all Buildings  
 Burned or Burning to  
 This Line After 10 Hours

**FIGURE 9 RADIO BROADCAST AND TELEVISION SYSTEM.**  
 Utility interconnections and physical damage.

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KXRX (AM) is designated as the EBS (Emergency Broadcast System) station with KLOK (AM) and KEEN (AM) designated as alternates. A special radio link and a telephone circuit link connects the EBS station with the EOC (Emergency Operations Center) in San Jose, and telephone circuit links connect the alternate EBS's with the EOC. These links permit emergency information to be passed to the general public from the Civil Defense staff at the EOC.

Initial System Damage

Initial system damage as reported in Reference 13 is summarized as follows:

KNTV (TV)

Physical damage

Studio building	Moderate to severe damage
Studio equipment	Moderate damage
Studio to transmitter link	Severe damage
Transmitter building	Light damage
Transmitter equipment	Light damage
Antenna	No damage
Emergency generator	Moderate damage

Staff damage--Nonlimiting

Operational status--Nonoperational until major repairs were accomplished.

KTEH (TV)

Physical damage

Studio building	Moderate damage
Studio equipment	Insignificant damage
Studio to transmitter link	Not applicable
Transmitter building	Moderate damage
Transmitter equipment	Insignificant damage
Antenna	No damage
Emergency generator	No damage

Staff damage

No damage

Operational status--Station is operational when personnel arrive.

KXRX (AM) (EBS)

Physical damage

Studio building	Light damage
Studio equipment	Light damage
Studio to transmitter link	Not applicable
Transmitter building	Not applicable
Transmitter equipment	Light damage
Antenna	Insignificant damage
Emergency generator	No damage

Staff damage--Nonlimiting

Operational status--Operational within two or three hours through minor repair, parts replacement and emergency generator start-up.

KLOK (AM) (alt EBS)

Physical damage

Studio building	Light damage
Studio equipment	Light damage
Studio to transmitter link	Not applicable
Transmitter building	Not applicable
Transmitter equipment	Light damage
Antenna	No damage
Emergency generator	Not applicable

Staff damage--Standby staff injured

Operational status--Nonoperational until minor repairs accomplished and electric power available.

KLIV (AM)

Physical damage

Studio building	Light damage
Studio equipment	Light damage
Studio to transmitter link	Not applicable
Transmitter building	Not applicable
Transmitter equipment	Light damage
Antenna	No damage
Emergency generator	Not applicable

Staff damage--No damage

Operational status--Nonoperational until minor repairs accomplished and electric power available.

KEEN (AM) (alt EBS)

Physical damage

Studio building	Light damage
Studio equipment	Light damage
Studio to transmitter link	Depends on availability of telephone service
Transmitter building	Severe damage
Transmitter equipment	Severe damage
Antenna	Severe damage
Emergency generator	Not applicable

Staff damage--Critical staff injured

Operational status--Nonoperational due to severe damage to transmitter.

KSJS (FM)

Physical damage

Studio building	Light damage
Studio equipment	Insignificant damage
Studio to transmitter link	Not applicable
Transmitter building	Not applicable
Transmitter equipment	No damage
Antenna	Insignificant damage
Emergency generator	Not applicable

Staff damage--Nonlimiting

Operational status--Operational upon arrival of personnel and availability of electric power.

KBAY (FM)

Physical damage

Studio building	Light damage
Studio equipment	No damage
Studio to transmitter link	Insignificant damage
Transmitter building	No damage
Transmitter equipment	No damage
Antenna	No damage
Emergency generator	No damage

Staff damage

No damage

Operational status--Operational on arrival of personnel and availability of electric power.

KSJO (FM)

Physical damage

Studio building	Severe damage
Studio equipment	Severe damage
Studio to transmitter link	Not applicable
Transmitter building	Not applicable
Transmitter equipment	Severe damage
Antenna	No damage
Emergency generator	Not applicable

Staff damage

No damage

Operational status--Nonoperational due to severe damage.

Supporting Utility Requirements

Supporting utility requirements are:

Electric Power

Point electric power inputs are required for all studios and transmitters for power supply. Point electric power inputs are also required at each location of radio and television sets. This latter might be termed an Area requirement because of the large number of sets and the broad area of location. In any case, it is a critical requirement to the reception of broadcast and televised information. Battery powered radio sets constitute one alternate means of reception.

Other Area electric power inputs are required for all studios and separate transmitters for convenience lighting.

Gas

No Point requirements are known to exist for gas.

Area requirements are for fuel for convenience heating in studios and separate transmitters.

Sewerage and Drainage

No Point requirements exist for sewerage and drainage.

Area requirements are for sanitary services at studios and transmitters.

Telephone Service

Point telephone service requirements exist in three areas, viz:

1. For studio to transmitter (STL) links for stations KBAY (FM) and KEEN (AM).
2. For special Emergency Broadcasting System (EBS) links between the Emergency Operations Center (EOC) and the primary and alternate Emergency Broadcasting Stations. The links are required for the purpose of carrying pre-attack and post-attack civil defense emergency instructions from the EOC to the EBS stations and broadcast to the public. The stations involved are KXRK (AM), KEEN (AM) and KLOK (AM).
3. KNTV (TV) is an American Broadcasting System Network station and depends on both local and long-lines telephone services for the receipt and rebroadcast of national emergency and conventional programs.

Area telephone service requirements are for general administrative and informational use. The latter might be considered of some importance since radio and television stations serve as a source of information to the general public through telephone calls thereto, particularly during emergencies.

Radio Broadcasting and Television

There are no system on system requirements for radio broadcasting and television.

Petroleum

Point requirements exist for fuel supplies for emergency electric generators for stations KNTV (TV) (Transmitter), KTEH (TV) (Studio and



Transmitter), KBAY (FM) (Transmitter), and KXRX (AM) (Studio and Transmitter).

Area requirements exist in the need for fuel for motor vehicles for transportation of operations and maintenance personnel and supplies.

#### Local Transportation

No requirements exist. The system is self supporting with system-owned and personal transportation.

#### Water

Point requirements exist for cooling water for emergency electric generators at stations KNTV (TV) (Transmitter), KTEH (TV) (Studio and Transmitter), KBAY (FM) (Transmitter), and KXRX (Studio and Transmitters).

Area requirements are for water for drinking and sanitary purposes at studio and transmitter locations.

#### Supporting Utility Interconnections and Availability

Figure 9 indicates the points of interconnection of Point supporting utility requirements. The area of coverage of nonavailability of electric power for reception is also indicated. Other Area requirements are not critical and are not indicated. The post-attack availability of point supporting utility requirements to each station is summarized as follows:

#### KNTV (TV)

- Electric Power--Available to both the studio and the transmitter.
- Telephone Service--Telephone service is available for the network lines.\*
- Petroleum (generator fuel)--Available to transmitter location.

---

\* See Appendix C for special random number analysis of telephone service availability.

- Water (coolant for engine generator)--Available to transmitter location.

KTEH (TV)

- Electric Power--Available to the combined studio-transmitter location.
- Petroleum (generator fuel)--Available to studio-transmitter location.
- Water (coolant for engine generator)--Available to studio-transmitter location.

KXRX (AM)

- Electric Power--Available to the combined studio-transmitter location.
- Telephone Service--Service is available for the EBS link.
- Petroleum (generator fuel)--Available to the combined studio-transmitter location.
- Water (coolant for engine generator)--Available to studio-transmitter location.

KLOK (AM)

- Electric Power--Available to the combined studio-transmitter location.
- Telephone service--Service is available for the EBS link.

KLIV (AM)

- Electric Power--Available to the combined studio-transmitter location.

KEEN (AM)

- Electric Power--Available to the studio and transmitter location.
- Telephone Service--No service is available for either the STL or EBS link.

KSJS (FM)

- Electric Power--Available to the combined studio-transmitter location.

KBAY (FM)

- Electric Power--Available to both the studio and transmitter locations.
- Telephone Service--No service is available for the STL
- Petroleum (generator fuel)--Available to the transmitter location

KSJO (FM)

- Electric Power--Available to the combined studio-transmitter location.

Total System Damage and Post-Attack System Capabiality

The influence of availability of supporting utilities on the post-attack capability of the various stations is as follows:

- KNTV (TV)--No degradation of capability occurs due to the lack of supporting utilities.
- KTEH (TV)--No degradation of capability occurs due to the lack of supporting utilities.
- KXRX (AM (EBS Station))--No degradation occurs due to the lack of supporting utilities.

- KLOK (AM) (alt EBS Station)--No degradation occurs due to the lack of supporting utilities.
- KLIV (AM)--No degradation occurs due to the lack of supporting utilities.
- KEEN (AM) (alt EBS Station)--The STL and EBS links are not operable due to damage to the telephone system. Station cannot operate.
- KSJS (FM)--No degradation occurs due to the lack of supporting utilities.
- KBAY (FM)--The STL is not operable due to damage to the telephone system. Station cannot operate.
- KSJO (FM)--No degradation occurs due to the lack of supporting utilities.

The degradation due to the lack of supporting utilities affected only two stations (KEEN and KBAY). Of these KEEN was reported in Reference 12 as severely damaged from blast while KBAY was only negligibly damaged. A summary of the total post-attack system capability for radio broadcasting and television in San Jose follows:

<u>Station</u>	<u>Operational Status</u>	<u>Remarks</u>
KNTV (TV)	Nonoperational, moderate physical damage	
KTEH (TV)	Operational	
KXRK (AM)	Nonoperational, light physical damage	EBS Station
KLOK (AM)	Nonoperational, moderate physical damage	Alt EBS Station
KLIV (AM)	Nonoperational, moderate physical damage	
KEEN (AM)	Nonoperational, severe physical damage, loss of STL and EBS telephone service links	Alt EBS Station
KSJS (FM)	Operational	
KBAY (FM)	Nonoperational, loss of STL in telephone system. Light physical damage	
KSJO (FM)	Nonoperational. Severe physical damage	

Reception, however, is limited to the area of post-attack availability of electric power.

Reference 13 did not consider the effects of total burn on post-attack system capability. A fire line (points to where 50% of the buildings are burned or burning after 10 hours) has been plotted on Figure 9. When total burn is considered, the capability of the system for both broadcast and reception is seriously degraded. Only stations KTEH (TV), KLOK (AM) and KSJO (FM) are unaffected. The latter two are moderately and severely damaged and are nonoperational. The audio channel of KTEH (TV) would then be the only service available.

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## X PETROLEUM DISTRIBUTION SYSTEM

### Target Model

The local petroleum distribution system in the San Jose area consists of pipeline bulk transmission lines and terminals, bulk petroleum product plants, packaged product warehouses, transport equipment for moving products from pipeline terminals and bulk plants to service stations and large customers, service stations, and liquified petroleum gas (LPG) facilities.<sup>12</sup>

The system is characterized by the large number of independent bulk plant operations (10) and numerous retail service stations (517). There are five warehouse operators and four LPG facilities.<sup>12</sup>

Figure 10 illustrates the locations of the major facilities including pipeline terminals, bulk plants, packaged product warehouses, and LPG facilities. Service station locations are not indicated.

### Initial System Damage

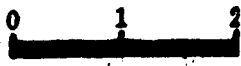
The three pipeline terminal facilities received only light damage and had essentially the same capacity as in the pre-attack period.<sup>12</sup>

Four of the ten bulk plants received moderate damage with consequent leakage of stored products which presents a serious fire hazard. The other six bulk plants received only light damage and were essentially operational.<sup>12</sup>

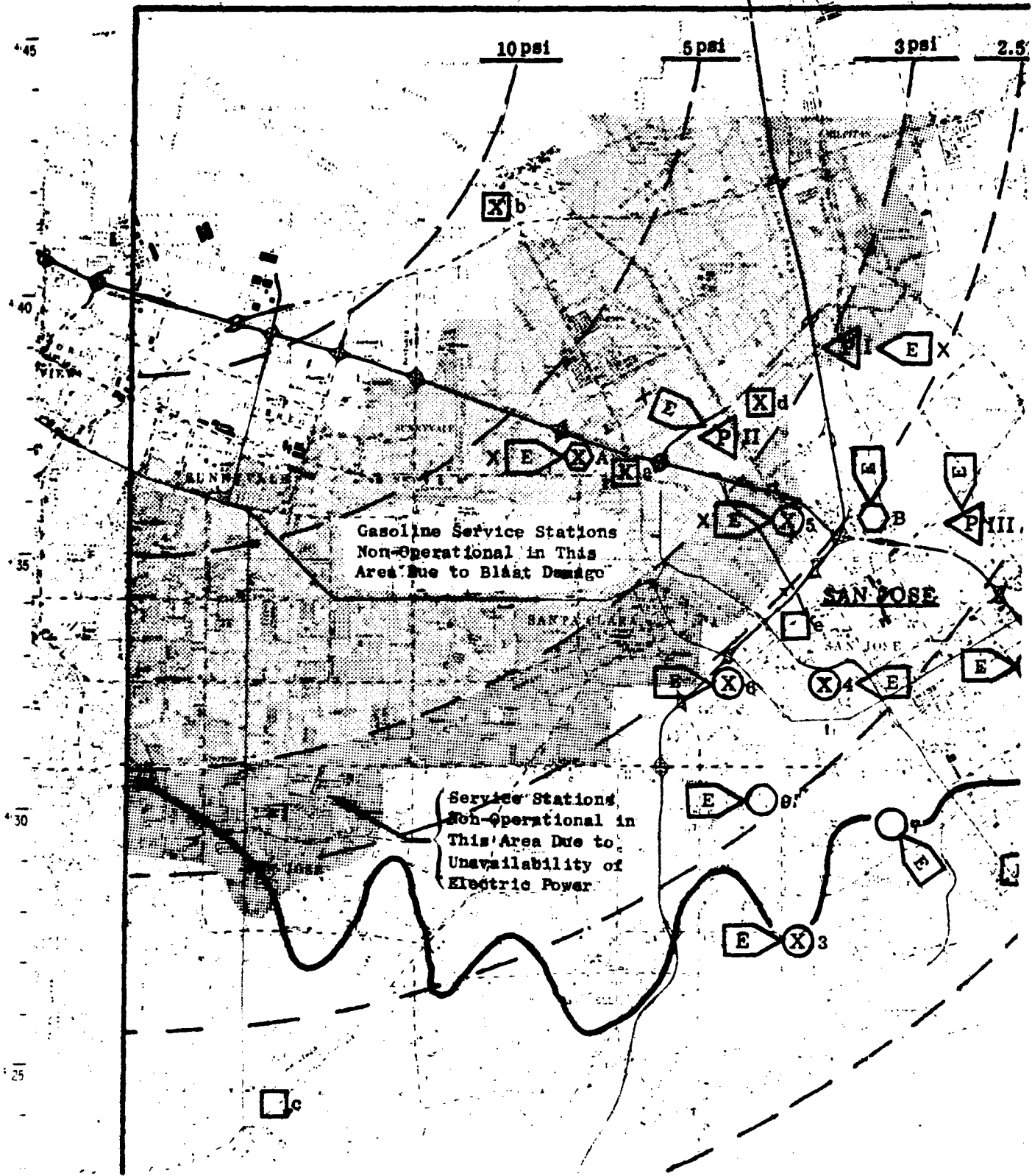
Two of the five warehouse operations received heavy damage with probably loss of inventory through fire, two received moderate damage with inventory essentially unharmed, and one received light damage with inventory unharmed.<sup>12</sup>

Two of the four LPG facilities received moderate damage and two received light damage. All inventories are available.

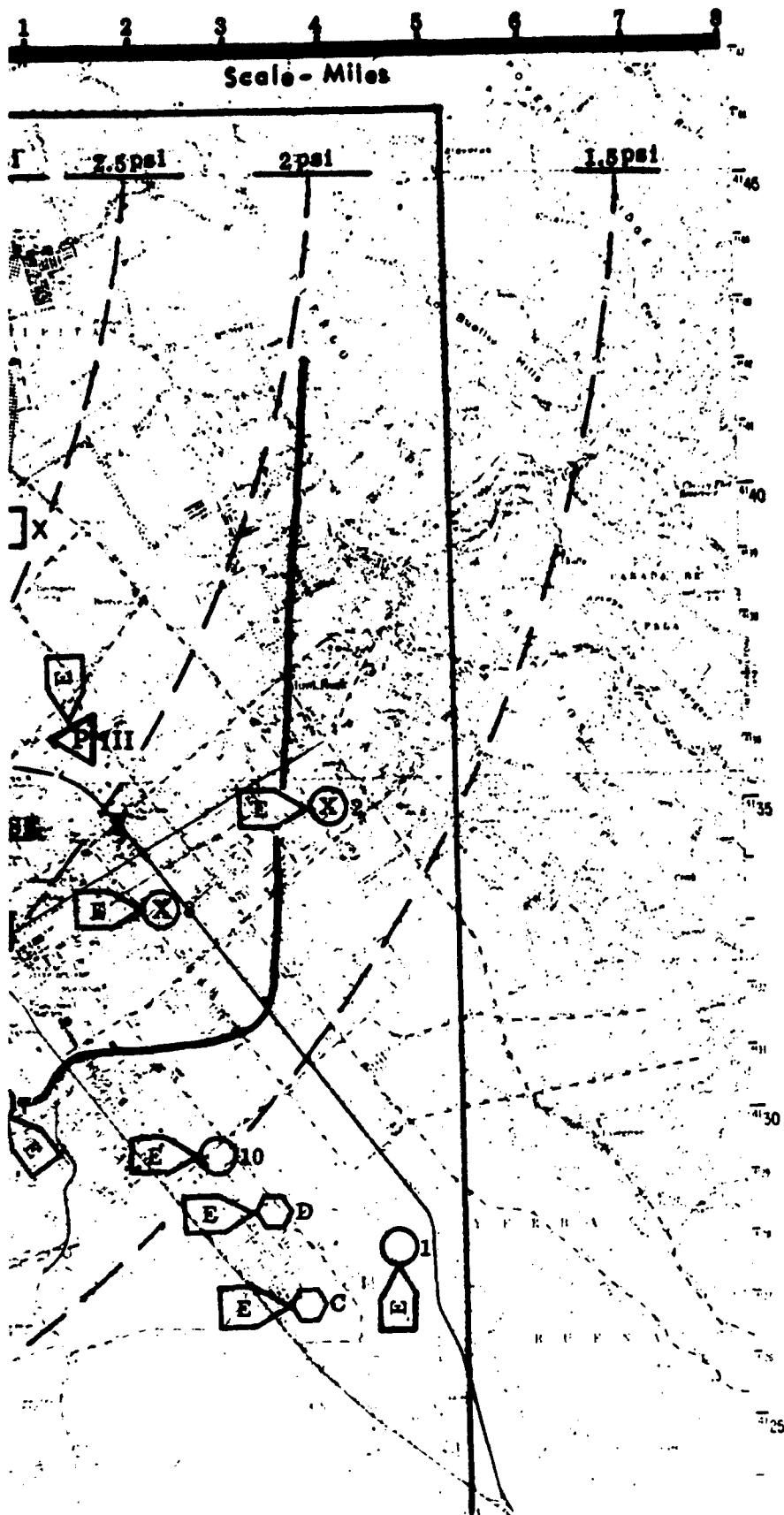
Retail service stations within the 3-psi overpressure radius are assumed to be damaged to a condition wherein they are not operational.










**SURFACE ZERO**



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### LEGEND

-  Gas System Study Area
-  Overpressure Radii
-  Pipeline Terminal
-  Bulk Plant  
"X" Indicates Physical Damage
-  LPG Facility  
"X" Indicates Physical Damage
-  Warehouse  
"X" Indicates Physical Damage
-  Utility Inter-Connection  
"E" Indicates Electric Power  
"X" Indicates Non-Availability

50% of All Buildings  
Burned or Burning to  
This Line After 10 Hours

Note: Numbers and  
Letters Following  
Facility Symbols  
Correspond to Those  
Used in Petroleum  
Study

FIGURE 10 PETROLEUM DISTRIBUTION SYSTEM. Utility interconnections and physical damage.



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Damaged facilities are indicated on figure 10. Only moderate or heavy damage is indicated.

#### Supporting Utility Requirements

Point supporting utility requirements are for electric power for petroleum product pumps at all terminals, bulk plants and LPG facilities. Point requirements also exist for electric power for all retail service stations in the study area. Because of the large number, this latter requirement might well be termed a critical area requirement.

Other area supporting utility requirements include the following:

1. Electric Power--Convenience lighting in terminals, plants, warehouses and offices.
2. Gas--Convenience heating in terminals, plants, warehouses, and offices.
3. Sewerage and Drainage--Sanitary services in terminals, plants, and offices.
4. Telephone Service--Order and delivery communications and general communications services.
5. Radio Broadcasting and Television--CD warning and information.
6. Petroleum--Fuel for transport and service vehicles.
7. Local Transportation--Transport of bulk petroleum products.
8. Water--Sanitary services in terminals, plants, warehouses, and offices.

#### Supporting Utility Interconnections and Availability

Figure 10 indicates the points of interconnection of the point supporting utility requirements. Figure 10 also indicates the area wherein electric power service is unavailable to retail service stations. Other area supporting utility requirements are not considered critical in any case and are not indicated.

The availability of the electric power point supporting utility requirements is as follows:

1. Available to the Standard Oil pipeline terminal; not available to the Shell Oil and Southern Pacific pipeline terminals.
2. Not available to the Shell Oil Plant at the San Jose Airport; available to all other bulk plants.
3. Not available to the Bay Area Vangas LPG facility; available to the other three LPG facilities.

#### Total System Damage and Post-Attack System Capability

The initial system damage reported by Reference 12 is not materially changed by the nonavailability of supporting utilities. The facilities receiving at least moderate blast damage are also without electric power. Remaining products in storage in above-ground tanks at these facilities can be at least partially recovered by gravity flow. It would be difficult to fill such tanks; however, without auxiliary electric power sources. Underground tank storage facilities (primarily the Shell Bulk Plant at San Jose Airport) would not be operational until electric power is restored or auxiliary electric generators provided. The area wherein electric power is not available to service stations is slightly larger than the area of blast damage reported by Reference 12.

A fire line, extracted from Reference 14 has been plotted on Figure 10. This line encloses the area wherein 50% of all buildings are burned or burning after 10 hours. If this effect is taken into consideration the post-attack capability of the petroleum distribution system would probably be seriously degraded. The probability of ignition of above ground petroleum storage facilities, although not well documented, is considered quite high, particularly in the case where a facility has leaking storage tanks resulting from blast damage. Assuming total loss behind the fire line, only three of the ten bulk plants would be operational, two of the four LPG facilities, no warehouses, and no pipeline terminals. A majority of the service stations would also probably be affected; however Reference 12 does not provide location data. In the case of one product (gasoline), post-attack stored inventory would be only 0.8% of the pre-attack stock at pipeline terminals and bulk plants. LPG stocks would be reduced to 46% of pre-attack inventory. Only 3% of pre-attack warehouse stocks would be available.

Without considering the fire line, the only material degradation of the post-attack capability of the petroleum distribution system would be loss of capability of the Shell Oil Avgas Bulk Plant at the San Jose Airport.

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## XI LOCAL TRANSPORTATION SYSTEM

### Target Model

The local transportation system in San Jose consists of railroads, air transport, highway truck transport, marine transport, warehousing, and public and private motor vehicle transportation.<sup>11</sup>

The basic study evaluated the following:<sup>11</sup>

1. Two railroad lines including a total of four yards and one passenger-traffic control station.
2. Two airports, one commercial and the other private.
3. Limited marine transport (all operations conducted outside of the study area).
4. The primary highway system.
5. 30 Commercial (for hire) motor trucking firms and 11 private specialty firms (mostly concrete transit-mix operators).
6. Six commercial bus lines and 16 school districts bus systems.
7. Three taxicab companies and three ambulance service operations.
8. About 200,000 privately owned motor vehicles including light trucks.
9. Fifty commercial warehouse operations.

The locations of the major features of the railroad, commercial truck, commercial bus and airport systems are indicated on Figure 11.

### Initial System Damage

Reference 11 reported initial physical damage to the various systems of significance as follows:



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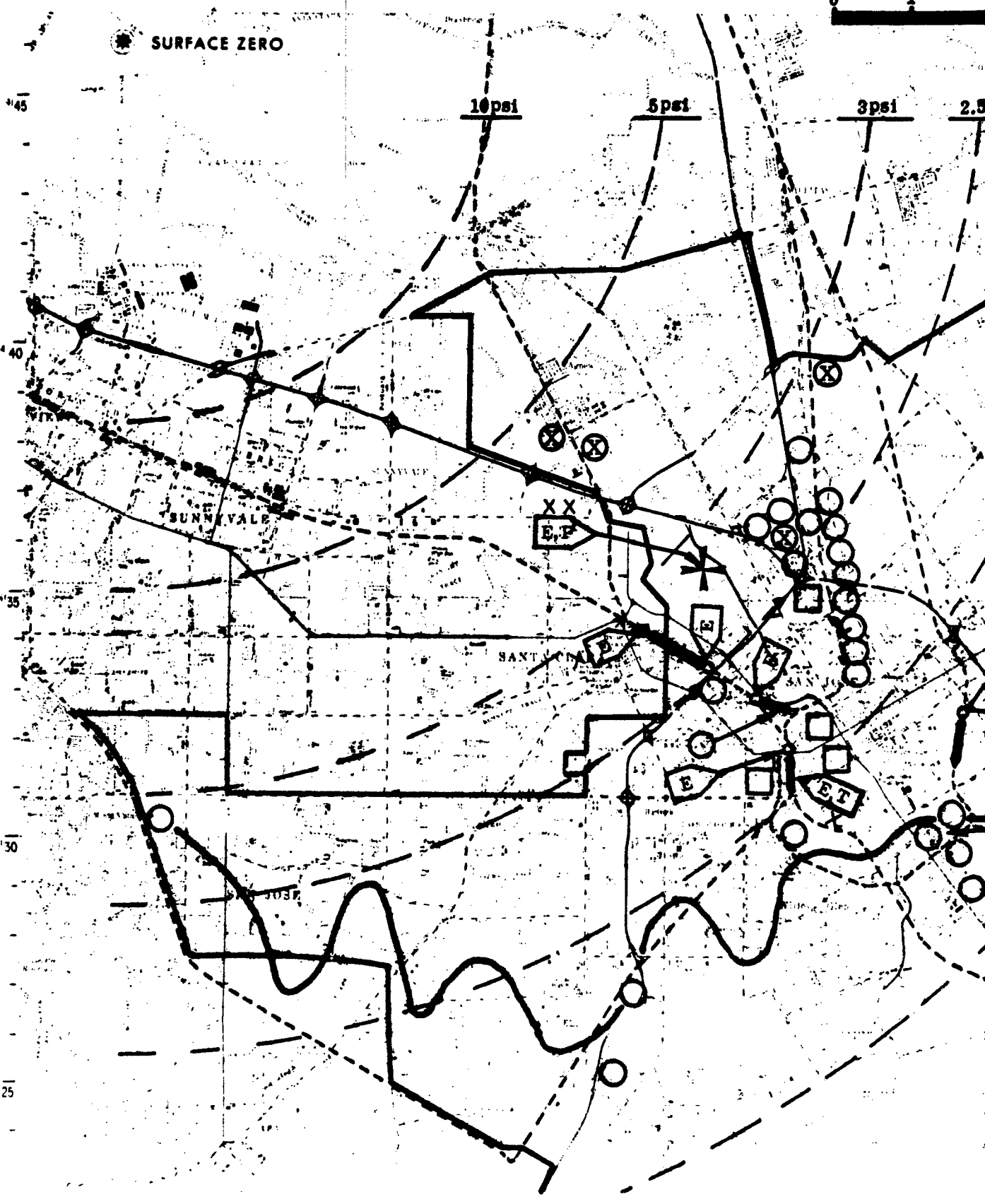
45  
40  
35  
30  
25

10psi

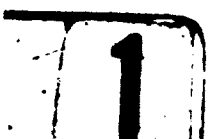
5psi

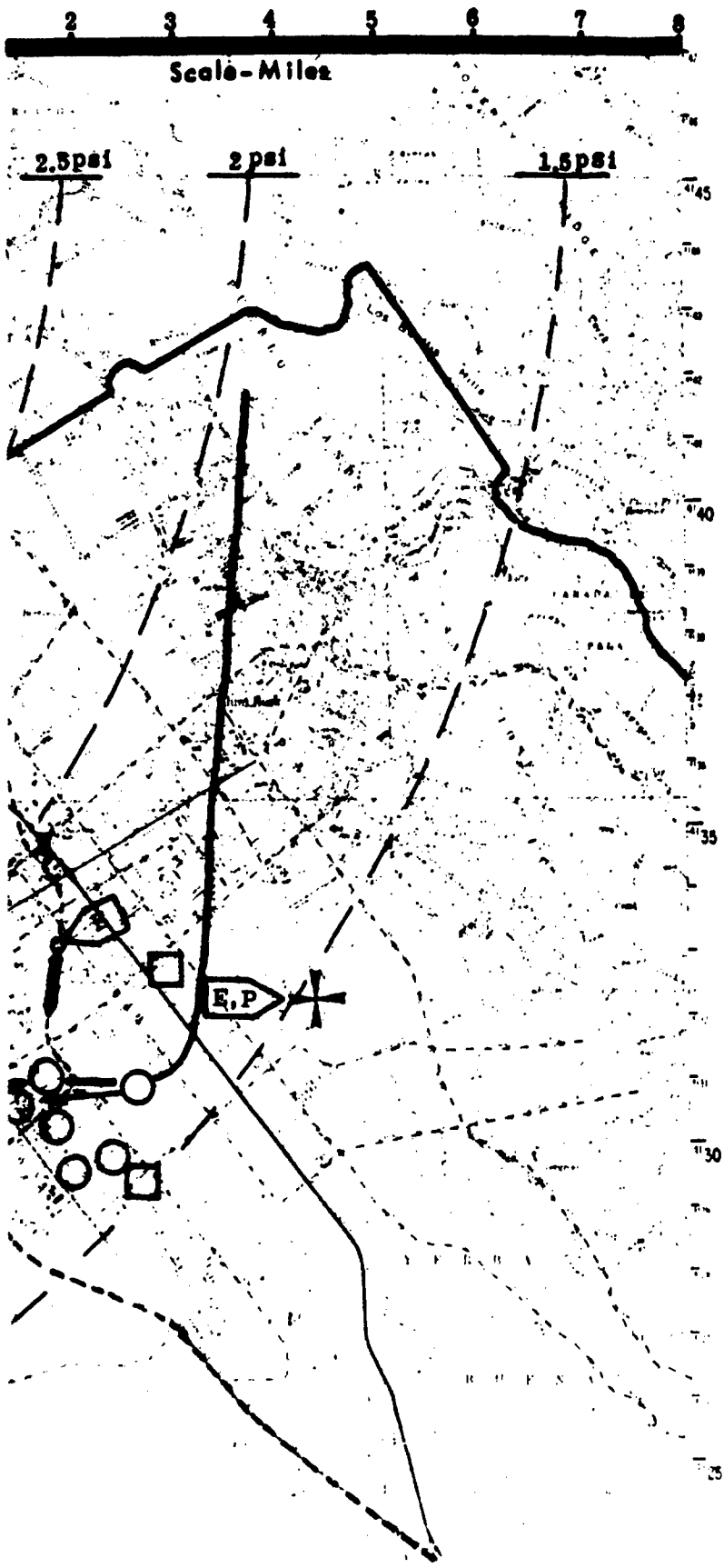
3psi

2.5






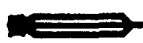
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**LEGEND**

-  Local Transportation System Study Area
-  Overpressure Radii
-  Rail Lines

 Rail Yard.  
"X" Indicates Physical Damage


 Airport

 Truck Terminal  
"X" Indicates Physical Damage

 Commercial Bus Park  
"X" Indicates Physical Damage



Utility Interconnection  
"E" Indicates Electric Power  
"X" Indicates Non-Availability

  
50% of all Buildings  
Burned or Burning to  
this Line After 10 Hours

**FIGURE 11 LOCAL TRANSPORTATION SYSTEM—UTILITY INTERCONNECTIONS AND PHYSICAL DAMAGE**

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Railroad

Probable blockage of rail lines and yards within the study area by debris from blast damaged structures and moderate damage to the switching tower at the Newhall Southern Pacific Yard.

Air Transport

No significant damage occurred to facilities of the Reid-Hillview Airport although parked aircraft suffered moderate damage. Damage at the San Jose Municipal Airport included moderate building damage and moderate to severe damage to parked aircraft. Runways were undamaged.

Highway System

No structural damage occurred to the highway system. Reference 11 discussed the possibility of debris blockage of highways within the study area, but reaches no useful conclusions.

Commercial Trucking

About 11% of the truck inventory was damaged beyond immediate use.

Commercial Passenger Transport

No damage was suffered by commercial passenger vehicles or school buses.

Privately-Owned Motor Vehicles

Only about 5% of the total inventory of privately owned motor vehicles in the study area received incapacitating damage.

Damage to people was not considered limiting in any of the transportation subsystems.

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## Supporting Utility Requirements

Supporting utility requirements include:

### Electric Power

Point requirements exist in the railroad subsystem for electric power service for the switching towers and yard control towers at all yards and for the traffic control center at the Southern Pacific station. Point electrical requirements also exist for night lighting and communications power at both airports.

Area requirements exist for all elements of the transportation system for convenience lighting. The railroad system has an area requirement for electric power for the signal system which might be considered in the critical category.

### Gas

No point requirements are known to exist for gas, however area requirements exist for convenience heating at terminals, offices, shops, etc.

### Sewerage and Drainage

No point requirements are known to exist for sewerage and drainage. Area requirements exist for sanitary services in terminals, offices, shops, etc.

### Telephone

A point requirement exists for a telephone system circuit to Sacramento from the Southern Pacific RR traffic control center for traffic control purposes.

Area requirements exist for all subsystems for general purpose communications. This might be considered a critical requirement in the case of the commercial truck operation since most ordering of service is done through the telephone. Although not treated by Reference 11, commercial trucking firms also use telephone circuit teletype systems for ordering and traffic control. These would also present a potential critical area requirement.



### Radio Broadcasting and Television

There are no point requirements for radio broadcasting and television. Area requirements exist for CD information transmission and warning.

### Petroleum

Point requirements exist for aviation fuels at both airports. Point requirements probably exist for motor fuels at truck and bus terminals and RR yards although Reference 11 does not deal with this subject. It could also be stated that each gasoline service station requires a point input from the petroleum distribution system; however, because of their very large number they will be considered critical area requirements.

### Local Transportation

There are no system on system requirements for local transportation except in the relationships of one subsystem to another. As an example, the commercial trucking system must be capable of clearing the railroad freight terminals.

### Supporting Utility Interconnections and Availability

Point supporting utility interconnections are indicated on Figure 11. These consist of electric power service to the switching and yard control towers and the traffic control center of the railroad system; electric power for lighting and communications power at both airports; telephone service to the railroad traffic control center, and Avgas supply at both airports.

Critical area type requirements exist in the form of fuel supplies for truck and bus terminals, railroad yards, and retail service stations. Inter connections are not indicated on Figure 11; however, because of their extreme number.

Availability of the point supporting utility requirements is indicated on Figure 11 and consists of:

- Electric power--Available to all points of interconnection except the San Jose Municipal Airport and the Newhall yard control tower.

- Telephone--Not available to the Southern Pacific Traffic Control Center.\*
- Petroleum--Not available to San Jose Municipal Airport due to lack of electric power to lift from underground tanks. Available to all truck and bus terminals and railroad yards. Available to all service stations except those damaged (within the 3-psi overpressure line.)

#### Total System Damage and Post-Attack System Capability

The unavailability of supporting utilities does not materially affect the post-attack capability of elements of the local transportation system although some loss of efficiency results. Degrations of capability included:

##### Railroads

The loss of electric power to the Newhall railroad yard control tower would require resorting to manual classification, signalling, and yard control. This would result in considerably reduced yard handling capacity. The loss of electric power for track signals to the north and west of San Jose does not present a major problem since these lines run through very high overpressure areas and are assumed to be unusable. The loss of the telephone circuit from the traffic control center to Sacramento cannot be considered to be critical since there is no possibility of north or westbound traffic. In any event, alternate circuits could be provided in a short time.

##### Air Transport

The loss of electric power to the underground Avgas facility serving the San Jose Municipal Airport would result in some inconvenience since only essential aircraft can be served by tank trucks loading at one of the pipeline terminals or bulk plants handling aviation fuels. There would be minimum traffic expected.

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\* See Appendix C.

All other subsystems would be essentially unaffected by the loss of supporting utilities.

Reference 11 considered a fire line extending to Nimitz and Junipero Serra Freeways only. The fire line extracted from Reference 14 extends to a much further distance. It is not expected that much transportation equipment would survive within this line except for perhaps some private motor vehicle transportation which could be moved as the fire progresses. If the extended fire line is considered there would be very few commercial transportation resources available in San Jose in the immediate post attack period.

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## **XII LIMITATIONS OF THE STUDY**

The precision of the results of this study was influenced by the separate approaches, methods, techniques, assumptions, and scopes of work utilized by the several research groups performing the initial damage analysis on individual utility systems. In the introductory section of this report, mention was made also of the requirements of each system study in order that this study result in a high degree of precision of findings. Some consequences of the limitations of the individual system vulnerability studies on the precision of the intersystems relationships study are discussed in the following paragraphs.

Different damage criteria was assumed for similar structures. Examples include:

1. The water supply system study concluded that electric power drops to pumps at certain locations were damaged and out of service while the electric power study concluded that electric power was available in the area.
2. The radio broadcasting and television system study calculated that microwave receiving antenna located on Loma Prieta mountain in an area of about 0.75-psi overpressure were damaged. The gas and electric power system studies concluded that similar antenna were undamaged.
3. The radio broadcasting and television study calculated that the transmitter towers of station KEEN were severely damaged while the electric power study concluded that electric power lines in the area were undamaged.

The local transportation report did not include communications requirements (telephone and teletype) for operation of the commercial truck subsystem.

The water system report did not describe the nature of the system utilized to control pumps from the tank float level measuring devices.

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The local transportation system report did not describe the source of electric power for the railroad signal system and the radio system, the points of interconnection and standby resources.

The local transportation system report did not describe the nature of the airways communication, air traffic control and runway lighting systems, the source of electric power, the points of interconnection and standby resources.

The telephone system report did not describe the local and longlines microwave systems, the nature of the power supply, the points of interconnection and standby resources.

Individual system reports in general did not provide sufficiently detailed data on the effect of loss of inputs so that quantitative coefficients could be calculated, indicating the degree of degradation of system capability.

The areas selected for study by the separate research groups varied considerably. This required gross assumptions to be made wherein an area of one study requiring a utility input was not supported by a study of availability of the input in the same area. The areas involved were, however, either in localities of sparse population or in areas of heavy physical damage wherein no utilities services were likely to be available.

The utility systems with fixed networks generally assumed an all on or all off situation at a fixed line of demarkation. In a real situation, a fairly wide variance would exist between the line of no service and the line of full service. The exception to this situation was the telephone system study which did present a service gradation varying with distance from surface zero.

The limitations discussed above do not; however, affect the general findings and conclusions (general total systems damage and post-attack systems capabilities) in a material manner.

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XIII

Appendices

- A REFERENCES
- B INTER-SYSTEMS RELATIONSHIPS MATRIX
- C RANDOM NUMBER ANALYSIS OF TELEPHONE SERVICE AVAILABILITY

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**Appendix A**

**REFERENCES**

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7. Stanford Research Institute, Vulnerability of Water, Sewage and Drainage Systems in San Jose, 5S-11101-4334A-01. (OUO)
8. U.S. Dept. of Int., Office of Oil and Gas, City of San Jose, California Vulnerability of Gas Utilities to Nuclear Attack, 5S-11101-4334C-01. (OUO)
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11. Stanford Research Institute, Effects of Nuclear Attack on Local Transportation - San Jose, California, 5S-11101-4334A-02. (OUO)
12. Checchi and Company, Vulnerability of the Local Petroleum Distribution System - San Jose, California, 5S-11101-4361A-01. (OUO)
13. Stanford Research Institute, Vulnerability of the Radio Broadcasting and Television Systems in San Jose, California, 5S-11101-4334A-03. (OUO)

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Appendix A

REFERENCES (Cont'd)

14. IIT Research Institute, Development and Application of a Computer Fire - Spread Model: Volume IV (Application phase, San Jose), SS-11101-2538B-03. (OUO) (Draft)
15. U.S. Gov't. Printing Office, Effects of Nuclear Weapons, 1962



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## OUTPUTS

		WATER SUPPLY	SEWERAGE AND DRAINAGE	ELECTRIC POWER	GAS	TELEPHONE
INPUTS	WATER SUPPLY	Filter Wash Water. Sanitary Services.	Sewage Carriage Water. Sanitary Services.	Condensor Cooling. Engine Cooling. Boiler Make-Up. Sanitary Services.	Compressor Engine Cooling. Process Water For Hfg Gas. Sanitary Services.	Standby Generating. Sanitary Services.
	SEWERAGE AND DRAINAGE	Filter Wash Water Disposal. Water Borne Waste Disposal.	Water Borne Waste Disposal.	Water Borne Waste Disposal.	Water Borne Waste Disposal.	Water Borne Waste Disposal.
	ELECTRIC POWER	Well or Intake Pumps. Treatment Plant Pumps. Pressure Booster Pumps. Motor Operated Valves and Controls. Power For Mobile Communications. Light and Heat.	Sewage and Storm Water Lift Pumps. Treatment Plant Pumps and Mechanical Equip. Motor Operated Valves and Controls. Power For Mobile Communications. Light and Heat.	Generation Station Auxiliary Equip Power. Station Start-up Power. Transmission Line Info and Control System Carrier Power. Power For Communications Systems. Light and Heat.	Compressor Power. Motor Operated Valves and Controls. Light and Heat.	Central Exchange Micro-Wave Radio Station Power. Light and Heat.
	GAS	Gas Engine Driven Well or Intake Pumps. Gas Engine Driven Treatment Plant Pumps. Gas Engine Driven Pressure Booster Pumps. General Heating.	Gas Engine Driven Sewage and Storm Water Lift Pumps. Gas Engine Driven Treatment Plant Pumps. Sludge Digester Tank Heating. General Heating.	Generating Plant Boiler Fuel. General Heating.	Gas Engine Driven Compressors. General Heating.	Gas Engine Driven Auxiliary Electromotors. General Heating.
	TELEPHONE	Telephone Circuit Information and Control Systems General Communications.	Telephone Circuit Information and Control Systems General Communications.	Telephone Circuit Information and Control Systems General Communications.	Telephone Circuit Information and Control Systems General Communications.	Telephone Circuit Information and Control Systems General Communications.
AND TV	Emergency CD Information.	Emergency CD Information.	Emergency CD Information.	Emergency CD Information.	Emergency CD Information.	

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## OUTPUTS

GAS	TELEPHONE	RADIO AND TV	PETROLEUM	TRANSPORTATION
Compressor Engine Cooling. Process Water For Mfg. Sanitary Services.	Standby Generator Cooling. Sanitary Services.	Standby Generator Cooling. Sanitary Services	Standby Generator Cooling. Sanitary Services	Engine Cooling. Sanitary Services.
Water Borne Waste Disposal.	Water Borne Waste Disposal.	Water Borne Waste Disposal.	Water Borne Waste Disposal.	Water Borne Waste Disposal.
Compressor Power. Motor Operated Valves and Controls. Light and Heat.	Central Exchange Power. Micro-Wave Repeater Station Power. Light and Heat.	Radio and TV Reception. Studio and Transmitter Power. Light and Heat.	Pipeline Pumping Power. Bulk Plant Loading Pumps. Service Station Pumps. Light and Heat.	Power for Electrified RR and Streetcars. RR Signal and Control System Power. Electrified Maintenance Equipment. Airport Lighting and Communications. Light and Heat.
Gas Engine Driven Compressors. General Heating.	Gas Engine Driven Auxiliary Electric Generators. General Heating.	Gas Engine Driven Auxiliary Electric Generators. General Heating.	Gas Engine Driven Pipeline Pumps. General Heating.	LPG Motor Vehicle Fuel. General Heating.
Telephone Circuit Information and Control Systems General Communications.	Telephone Circuit Information and Control Systems General Communications.	Telephone Circuit Link Between Studio and Transmitter. Long Lines Telephone Circuit Network Links. Telephone Circuit EBS Links Between MOC and Studios. General Communications.	Orders and Delivery Communications. Telephone Circuit Information and Control Systems. General Communications.	TWX Dispatch Systems. Telephone Circuit RR Signal and Control Systems. Telephone Circuit Airways Communications and Control Systems. General Communications.
Emergency CD Information.	Emergency CD Information.	Emergency CD Information.	Emergency CD Information.	Emergency CD Information.

INPUTS

<b>ELECTRIC</b>	Pressure Booster Pumps. Motor Operated Valves and Controls. Power For Mobile Communications. Light and Heat.	and Mechanical Equip. Motor Operated Valves and Controls. Power For Mobile Communications. Light and Heat.	Transmission Line Info and Control System Carrier Power. Power For Communications Systems. Light and Heat.	Compressor Power. Motor Operated Valves and Controls. Light and Heat.	Central Exchange For Micro-Wave Repeater Station Power. Light and Heat.
<b>GAS</b>	Gas Engine Driven Well or Intake Pumps. Gas Engine Driven Treatment Plant Pumps. Gas Engine Driven Pressure Booster Pumps. General Heating.	Gas Engine Driven Sewage and Storm Water Lift Pumps. Gas Engine Driven Treatment Plant Pumps. Sludge Digester Tank Heating. General Heating.	Generating Plant Boiler Fuel. General Heating.	Gas Engine Driven Compressors. General Heating.	Gas Engine Driven Auxiliary Electric Generators. General Heating.
<b>TELEPHONE</b>	Telephone Circuit Information and Control Systems. General Communications.	Telephone Circuit Information and Control Systems. General Communications.	Telephone Circuit Information and Control Systems. General Communications.	Telephone Circuit Information and Control Systems. General Communications.	Telephone Circuit Information and Control Systems. General Communications.
<b>RADIO AND TV</b>	Emergency CD Information. Emergency Instructions To Customers.	Emergency CD Information. Emergency Instructions To Customers.	Emergency CD Information. Emergency Instructions To Customers.	Emergency CD Information. Emergency Instructions To Customers.	Emergency CD Information. Emergency Instructions To Customers.
<b>PETROLEUM</b>	Liquid Fuel Engine Driven Well or Intake Pumps. Liquid Fuel Driven Treatment Plant Pumps. Liquid Fuel Driven Pressure Booster Pumps. Fuel For Vehicles and Equipment. General Heating.	Liquid Fuel Engine Driven Sewage and Storm Water Lift Pumps. Liquid Fuel Engine Driven Treatment Plant Pumps. Fuel For Vehicles and Equipment. General Heating.	Generating Plant Boiler Fuel. Fuel For Vehicles and Equipment. General Heating.	Liquid Fuel Engine Driven Compressors. Raw Material For Mfg Gas. Fuel For Vehicles And Equipment. General Heating.	Liquid Fuel Engine Driven Auxiliary Electric Generators. Fuel For Vehicles A Equipment. General Heating.
<b>TRANSPORTATION</b>	Transportation of Treatment Plant Liquid. Gas and Dry Chemicals. Miscellaneous Personal and Material Transport.	Miscellaneous Personal and Material Transport.	Transportation of Fuel For Generating Plant Boilers. Miscellaneous Personal And Material Transport.	Miscellaneous Personal And Material Transport.	Miscellaneous Personal And Material Transport.

APPENDIX B  
INTER-SYSTEMS RELATIONSHIPS MATRIX

3

<p>Motor Power. Operated Valves Controls. Light and Heat.</p>	<p>Central Exchange Power. Micro-Wave Repeater Station Power. Light and Heat.</p>	<p>Radio and TV Reception, Studio and Transmitter Power. Light and Heat.</p>	<p>Pipeline Pumping Power. Bulk Plant Loading Pumps. Service Station Pumps. Light and Heat.</p>	<p>Power for Electrified RR and Streetcars. RR Signal and Control System Power. Electrified Maintenance Equipment. Airport Lighting and Communications. Light and Heat.</p>
<p>Engine Driven Com- pressors. General Heating.</p>	<p>Gas Engine Driven Aux- iliary Electric Gen- erators. General Heating.</p>	<p>Gas Engine Driven Aux- iliary Electric Gen- erators. General Heating.</p>	<p>Gas Engine Driven Pipe Line Pumps. General Heating.</p>	<p>LPG Motor Vehicle Fuel. General Heating.</p>
<p>Telephone Circuit In- formation and Control Systems General Communications.</p>	<p>Telephone Circuit In- formation and Control Systems General Communications.</p>	<p>Telephone Circuit Link Between Studio and Transmitter. Long Lines Telephone Circuit Network Links. Telephone Circuit EBS Links Between BOC and Studios. General Communications.</p>	<p>Orders and Delivery Communications. Telephone Circuit in- formation and Control Systems. General Communications.</p>	<p>TWX Dispatch Systems. Telephone Circuit RR Signal and Control Systems. Telephone Circuit Air- ways Communications And Control Systems. General Communications.</p>
<p>Emergency CD Inform- ation. Emergency Instructions To Customers.</p>	<p>Emergency CD Inform- ation. Emergency Instructions To Customers.</p>	<p>Emergency CD Inform- ation. Emergency Instructions To Customers.</p>	<p>Emergency CD Inform- ation. Emergency Instructions To Customers.</p>	<p>Emergency CD Inform- ation. Emergency Instructions To Customers.</p>
<p>Liquid Fuel Engine Driven Compressors. Material For Mfg Fuel For Vehicles And Equipment. General Heating</p>	<p>Liquid Fuel Engine Driven Auxiliary El- ectric Generators. Fuel For Vehicles And Equipment. General Heating.</p>	<p>Liquid Fuel Engine Driven Auxiliary El- ectric Generators. General Heating.</p>	<p>Liquid Fuel Engine Driven Pipeline Pumps. Fuel For Transport Vehicles. General Heating.</p>	<p>Fuel For RR, Aircraft, Auto, Truck and Marine Transportation. Fuel For Materials Handling Equipment. General Heating.</p>
<p>Miscellaneous Personal And Material Transport.</p>	<p>Miscellaneous Personal And Material Transport.</p>	<p>Miscellaneous Personal And Material Transport.</p>	<p>RR, Truck and Marine Transport of Petroleum Products. Miscellaneous Personal And Material Transport.</p>	<p>Truck Transport To Clear RR Terminals. Miscellaneous Personal And Material Transport.</p>

APPENDIX B

INTER-SYSTEMS RELATIONSHIPS MATRIX

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Appendix C

**RANDOM NUMBER ANALYSIS OF TELEPHONE SERVICE AVAILABILITY**

Introduction

Reference 10, and subsequent analyses performed by the present study, do not provide sufficiently detailed information of telephone service availability to permit the determination of availability of service to meet point supporting utility requirements for the other utility systems studied. Availability information is limited to generalized remaining capacity of central exchanges and customer circuit systems.

In order to obtain a precise availability of point supporting utility requirements at interconnections it was therefore necessary to construct such an availability through random number stochastic procedures.

Since telephone service was found to be critical to only the radio broadcasting and television system and potentially critical to the gas and railroad systems, the analysis was conducted for these systems only.

Procedure

The process used in the analysis consisted of three steps:

1. Determination of availability of central exchange service in the area wherein the point of interconnection was located. The probable central exchange was determined through proximity to the point of interconnection.\* The percentage of capacity remaining in the exchange in its damaged condition was ascertained from Reference 10 and this value was assumed to be equal to the probability of service to the point of interconnection. A random number table was then consulted to determine whether central exchange service was or was not available.

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\* Central exchange service areas were not described by Reference 10.

2. Determination of the availability of the circuit from the exchange to the point of interconnection was determined in a manner similar to step 1. Only two probabilities of service applied. (0% and 90%).
3. If results of either of steps (1) or (2) were negative, the supporting utility service was assumed to be not available.

Results

Radio Broadcasting and Television System

1. KNTV (TV)-Network link available.
2. KEEN (AM)-Studio to transmitter link not available.
3. KBAY (FM)-Studio to transmitter link not available.
4. KXRX (AM)-EBS link available.
5. KEEN (AM)-EBS link not available.
6. KLOK (AM)-EBS link available.

Gas System

1. Maybury Road motorized valve control circuit available.
2. San Jose Load Center telemetry receiving point circuits available.
3. Telemetry pressure point numbers 2, 7 and 8, circuits not available.
4. Telemetry pressure point numbers 1, 3, 4, 5 and 6, circuits available.

Railroad System

Telephone circuit at Southern Pacific traffic control center not available.

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For each system, input requirements from other systems were identified, the points of intersection located, the availability of the input determined, and the effect of such availability on the output of the system was calculated.

Net total post-attack systems capabilities were then derived.

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UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R & D		
<i>(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)</i>		
1. ORIGINATING ACTIVITY (Corporate author) Stanford Research Institute 333 Ravenwood Avenue Menlo Park, California 94025		2a. REPORT SECURITY CLASSIFICATION <b>UNCLASSIFIED</b>
3. REPORT TITLE <b>INTER-SYSTEMS RELATIONSHIPS - LOCAL VULNERABILITY OF UTILITIES - SAN JOSE</b>		2b. GROUP
4. DESCRIPTIVE NOTES (Type of report and inclusive dates) Final Report		
5. AUTHOR(S) (First name, middle initial, last name)  Ellis E. Pickering		
6. REPORT DATE August 1969	7a. TOTAL NO. OF PAGES 100	7b. NO. OF REFS 15
8a. CONTRACT OR GRANT NO. OCD DAHC-20-67-C-0136	8b. ORIGINATOR'S REPORT NUMBER(S)  55-11101-4334A-07	
A. PROJECT NO. OCD Work Unit 4334A  c. 5S-1101-4334A-07  4	8c. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)	
10. DISTRIBUTION STATEMENT This document may be further distributed by any holder only with the specific prior approval of the Research Directorate, Office of Civil Defense.		
11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY Office of Civil Defense Department of The Army Washington D C. 20310	
13. ABSTRACT  This report examines the inter-systems relationships of utility systems at San Jose, California in their post nuclear-attack state. Systems studied included water supply, sewerage and drainage, electric power, gas, telephone, radio broadcasting and television, petroleum distribution and local transportation.  For each system, input requirements from other systems were identified, the points of inter-connection located, the availability of the input determined and the effect of such availability on the output of the system calculated.  Net total post-attack systems capabilities were then derived.		

DD FORM 1473

NOV 66

REPLACES DD FORM 1473, 1 JAN 64, WHICH IS OBSOLETE FOR ARMY USE.

UNCLASSIFIED

Security Classification



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Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
CIVIL DEFENSE SYSTEMS (Utility Systems, Inter-systems Relationships)						
NUCLEAR WEAPONS (Nuclear Attack)						
NUCLEAR EXPLOSION DAMAGE						
VULNERABILITY						
ELECTRIC POWER SYSTEMS						
WATER SUPPLIES (Water Supply Systems)						
SEWAGE (Sewerage and Drainage Systems)						
FUELS (Gas Systems, Petroleum Distribution Systems)						
TRANSPORTATION (Local Transportation Systems)						
TELEPHONE COMMUNICATIONS SYSTEMS						
TELEVISION COMMUNICATIONS SYSTEMS (Broadcasting)						
RADIO COMMUNICATIONS SYSTEMS (Broadcasting)						
PERFORMANCE (Post-Attack Systems Capabilities)						
SAN JOSE						

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