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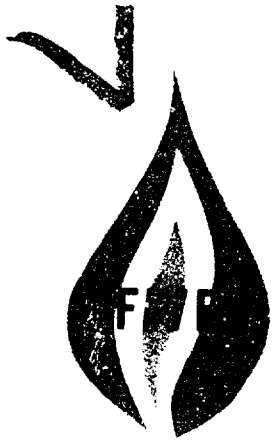
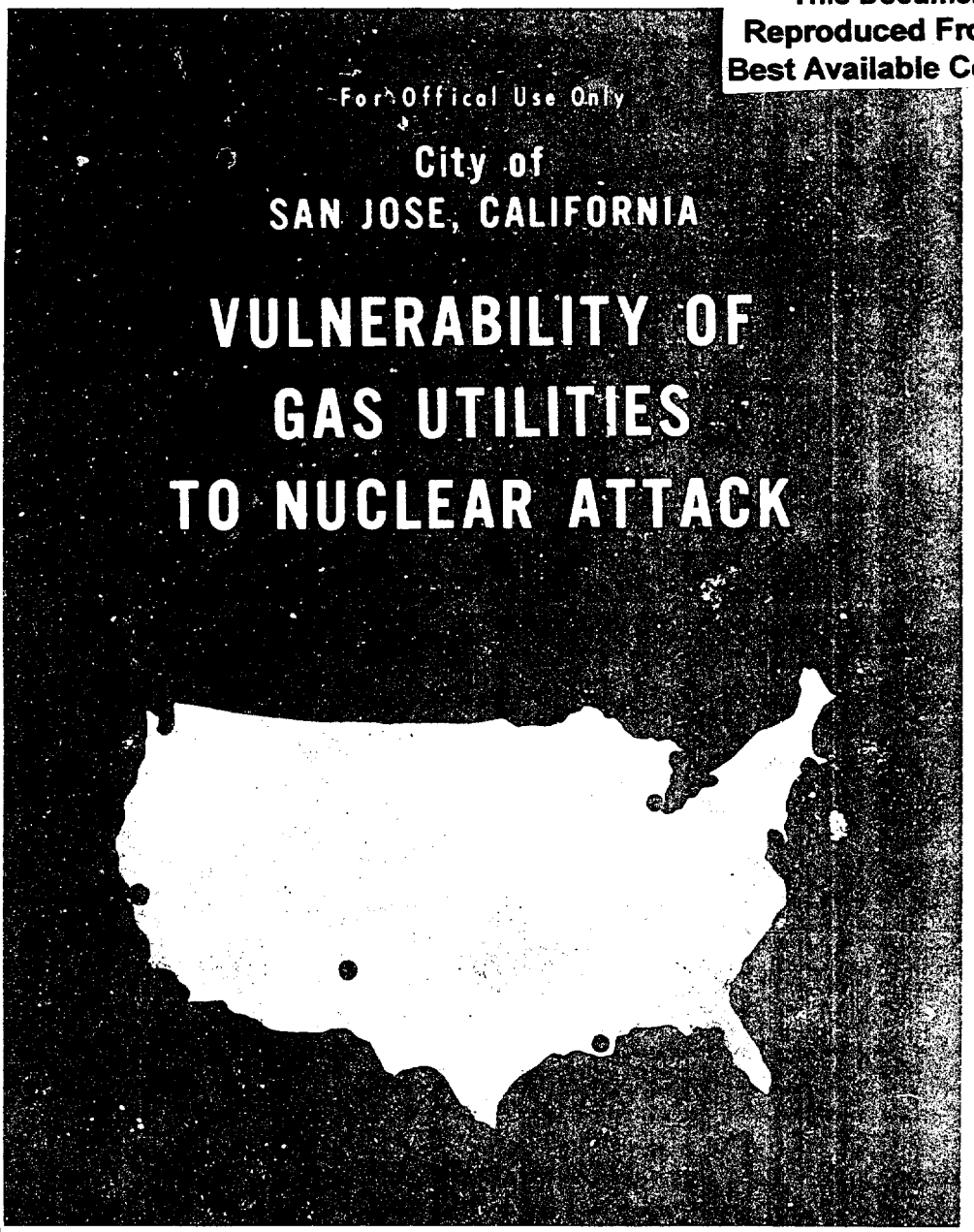
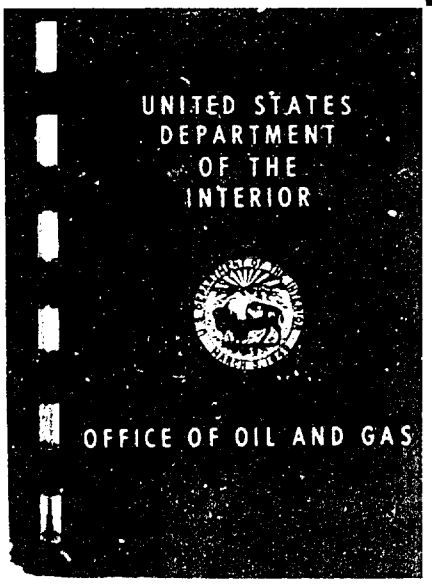


CITY STUDY

AUGUST 1967





Prepared for:

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

Work Order OCD-PS-66-100

Work Unit 4334C

UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF OIL AND GAS
WASHINGTON, D.C. 20240

August
1967

SUMMARY

5S-11101-4334C-01
OCD Work Unit 4334C

The effects of a hypothetical nuclear attack directed at Moffett Field, California on the gas system supplying the city of San Jose, the system's operating employees, buildings, communication, transportation and other supporting facilities are investigated, and the resulting postattack capability of the system to continue gas supply in San Jose is determined.

The study is directed primarily at gas facilities within the city. However, a larger area occupied by nearby cities also was examined for gas facility damage which might affect San Jose. Incoming and outgoing transmission mains in the expanded area together with the distribution system in San Jose are studied and analyzed. The study begins with transmission mains and terminates with underground distribution mains in the streets; it does not include service pipes, meter sets, houselines or other aboveground equipment on user's premises.

The area occupied by the city of San Jose is not symmetrical in shape. It has several sparsely occupied, semidetached areas projecting towards ground zero. These areas, which contain less than 100 gas meter accounts are exposed to overpressures up to 8 psi, whereas the remaining 119,000 meter accounts in downtown San Jose and contiguous residential sections have less than 3 psi exposure.

There is no interruption or degradation of gas supply in the city. Transmission mains are undamaged. Distribution facilities, other than the gas holders which are severly damaged and rendered inoperable but do not impair the system's capability, are unaffected.

There is, however, severe structural damage to houses and buildings in the area extending beyond the western corporate limits of San Jose. The study determines that the

utility will conclude, after a visual survey, that no foreseeable need for gas service exists in that area and will cut off and shutdown the distribution system therein. The purpose is to eliminate gas leakage in damage premises in the area of uninhabitable homes and buildings.

This area lies within an approximate arc having a radius of about 9 miles and a center at ground zero. The effect is to cut off gas supply to Santa Clara, Mt. View, Sunnyvale, Los Altos, Los Altos Hills and about one-half of Cupertino The remainder of the San Jose Area (including San Jose) totaling about 62 percent of the area population continues to receive an uninterrupted gas supply.

The study also determines that personnel, transportation and supplies are adequate for the post attack operation. A commercial power outage or shortage in the area has little detrimental effect on gas system operation. Electric power is not a prime mover of gas in the San Jose Area; it is primarily a convenience service for lighting, automatic controls, etc.

Several segments of the Company's private communication system in the area, namely, wire line and microwave channels to Milpitas and to the Service Center in Cupertino, are damaged and inoperable. The stationing of mobile radio units at these locations fills the need. The District has sufficient mobile radio vehicles to cover the operating area effectively.

CITY STUDY

City of SAN JOSE, CALIFORNIA

VULNERABILITY OF GAS UTILITIES TO NUCLEAR ATTACK

Prepared by: M.A. Richford and W.E. Davis
Under the Direction of: J.J. Simmons, III

AUGUST 1967

OCD REVIEW NOTICE

This report has been reviewed in the Office of Civil Defense and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Office of Civil Defense.

UNITED STATES
DEPARTMENT
OF THE
INTERIOR

OFFICE OF OIL AND GAS

Prepared for:

OFFICE OF CIVIL DEFENSE
DEPARTMENT OF THE ARMY
WASHINGTON, D.C.

Work Order OCD-PS-66-100
Work Unit 4334C

UNITED STATES DEPARTMENT OF THE INTERIOR

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J. CORDELL MOORE, *Assistant Secretary-Mineral Resources*

OFFICE OF OIL AND GAS

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John Ricca, *Deputy Director*

J. J. Simmons, III, *Assistant Director*

UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF OIL AND GAS
WASHINGTON, D.C. 20240

F O R E W O R D

It is hoped that the knowledge and information acquired from this study will serve to further stimulate all gas utility systems operating in the cities and communities of our Country to achieve an optimum state of readiness in the event of a nuclear attack.

Onnie P. Lattu
Director

PREFACE

Under Work Order No. 4334S-OCD-PS-66-100, the Office of Civil Defense, Department of the Army, engaged the Office of Oil and Gas, Department of the Interior, to determine the vulnerability of selected gas utility systems to hypothetical nuclear attacks.

This is a final report of the vulnerability of the San Jose gas system, the first in the "Five-City" series.

It describes normal preattack conditions and operations, outlines anticipated damage to gas facilities and estimates the capability of the system to continue to render gas service at several postattack time intervals.

ABSTRACT

The vulnerability of the natural gas transmission and distribution systems supplying the City of San Jose to a hypothetical 5 megaton nuclear air burst is herein investigated.

It is determined that there will be no interruption or degradation of gas supply in the City of San Jose. The capability of the systems to continue to supply gas in normal quantities to services (the interconnecting pipes between underground distribution mains in the streets and the above-ground meters on the users' premises) is unaffected by the attack.

However, as a byproduct of the study and after a survey, it is concluded that the utility will decide that there is no foreseeable need for gas service in the area west of the City where homes and buildings are severely damaged and uninhabitable and will proceed to value off and shut down the distribution system therein, even though it is undamaged.

The shut down area will lie within an approximate arc about 9 miles out from ground zero, beginning near the western fringes of San Jose and extending westerly to Palo Alto.

Estimates of casualties among employees living in the City of San Jose indicate that sufficient personnel with required occupational capabilities are available to carry out post attack emergency measures.

ACKNOWLEDGEMENT

A study of this complexity required the help of many individuals. Not only are the principles and mechanics of gas transmission and distribution involved but also many other equally complex, associated and supporting facilities, all of which are employed in operating a gas system.

Appreciation is expressed to Messrs. J. J. Simmons, III, Assistant Director, Office of Oil and Gas, Department of the Interior and E. H. Fisher, Vice President, Pacific Gas and Electric Company for supervision and guidance in carrying out the study program and the Messrs. E. F. Sibley, R. D. Smith, T. J. Bianucci, J. J. Pugh, and R. I. Stark of the Pacific Gas and Electric Company for time generously given in many discussions during progress of the study.

Special thanks are given for the assistance of Paul Holmgren in preparing illustrations and to R. A. Dangers for system analyses and to L. R. Reeder for local information applying to the San Jose Area.

M. A. RICHFORD

W. E. DAVIS

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ILLUSTRATIONS

TABLES

PURPOSE OF THE STUDY

The primary purpose of the study is to determine the effects resulting from a hypothetical nuclear attack[1] directed at Moffett Field, near the southern end of San Francisco Bay, on the facilities and operating capability of the gas system serving the City of San Jose, California. This requires that the effects of the weapon be appraised in terms of:

1. Physical damage to the gas system and the impairment of its ability to meet post-attack gas requirements.

2. Physical damage to operating buildings, communication and transportation equipment, losses in supplies and personnel and the disruptive effects therefrom on gas system operation.

A secondary purpose is to provide, for general reference, a description of the gas system and a functional inventory of the administration and operation buildings, warehouses, transportation, communications, and other equipment which support the gas supply system.

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[1] A 5 megaton nuclear explosion, 14,500 feet above ground, with ground zero (GZ) located at latitude 372735 N., longitude 1220329 W., (north of Moffett Field and at mouth of Coyote Creek) at 8:52 P.M., PDT, August 24, 1965.

SCOPE OF THE STUDY

While the study is directed primarily at the gas facilities in the City of San Jose, it was not confined solely to that City. A larger area, coupled by adjacent and nearby cities, was investigated for any contributory effects. This larger space is referred to in the report as the San Jose Area.

Much of the descriptive data contained in the report applies to the San Jose Area to show its relationship to the City of San Jose and dependency of both on the common gas supply facilities. Although the degradation analysis is focused on the gas facilities in the City and supported by quantitative data, the effect of the attack upon the balance of the area is assessed also but to a less precise degree. In this report, the degree of degradation of a gas facility is based on the extent that gas requirements of record can continue to be supplied by the facility rather than being related to a theoretical maximum capacity which the facility is presumed to possess.

The report analyzes, to the extent of basic available information, the physical effects of the attack on "gas facilities". Gas facilities is a broad term. In this report, it is considered to include all gas transporting equipment and physically connected accessories employed in the area by the utility to bring gas to the points where deliveries are made to services.[2]

---

[2]See Glossary of Terms.

SECTION I

GENERAL SYSTEM DESCRIPTION

GENERAL

The City of San Jose is situated at the southern end of an area known as the San Francisco Peninsula. Figure 1 shows San Jose and the high pressure gas transmission facilities supplying the City and the intervening area to San Francisco. These facilities are owned and operated by the Pacific Gas and Electric Co. (P.G. and E.), a private utility regulated by the Public Utilities Commission of the State of California.

The area in and around the City of San Jose, given consideration in the study, comprises the cities listed in Table 1. Also given are the numbers of gas customers and gas sales for August 1965. These cities lie in the Central District, one of four districts making up the Company's San Jose Division. The gas service area of the Central District covers about 200 square miles.

San Jose is the largest city in the district accounting for 53% of the gas meters installed and 52% of the gas distribution. It should be noted in Table 1 that the volume of "interruptible" base nearly equals the amount used by "firm" customers who constitute all other classes such as residential, commercial cooking, building heat, and small industry. The significance is that the "interruptible" volume would be available, as provided by contract, if needed for "firm" customers. Since "interruptible" users also need electric power their gas requirements would largely cease and automatically become available to "firm" customers if a general power failure followed the attack.

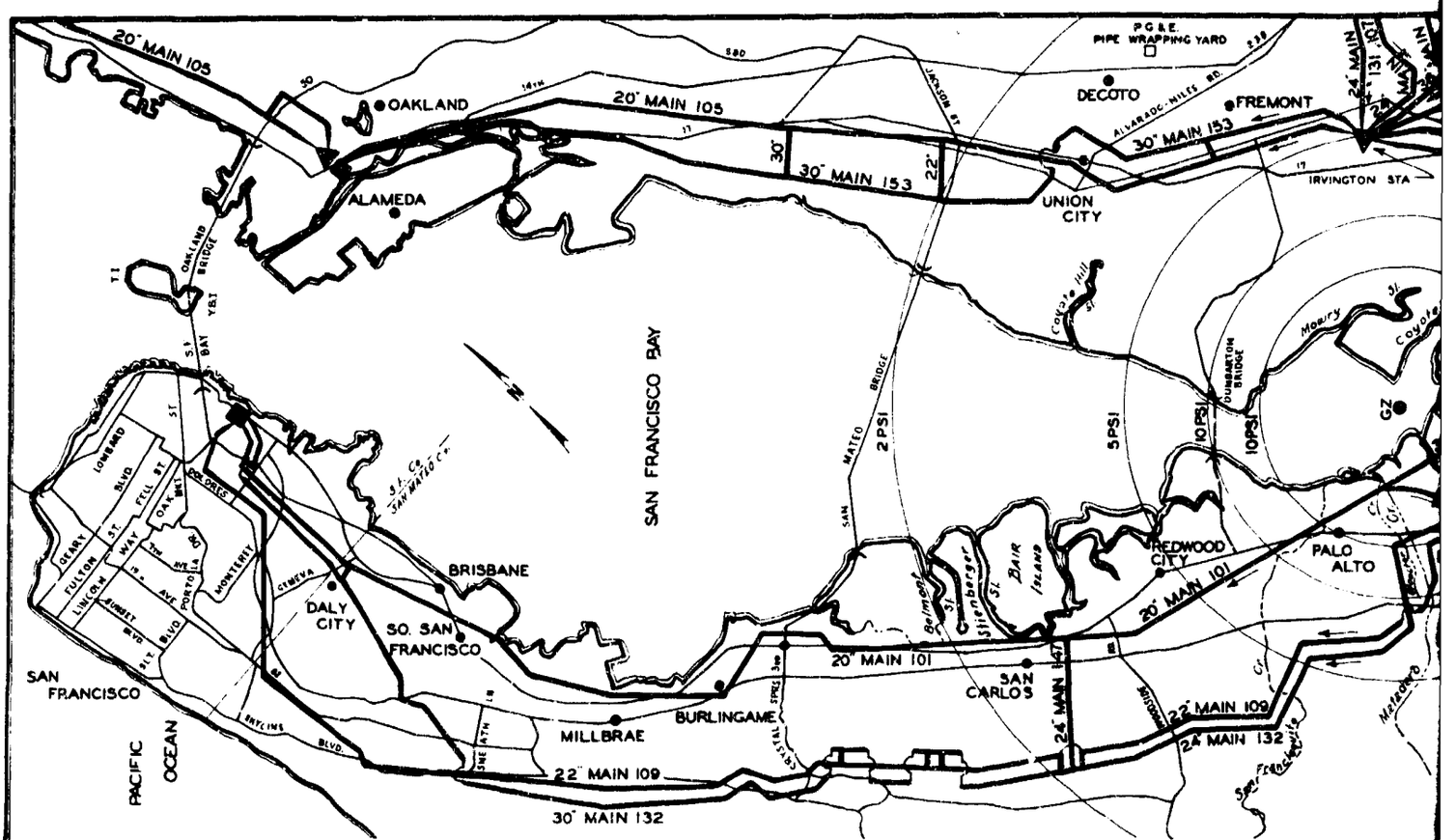
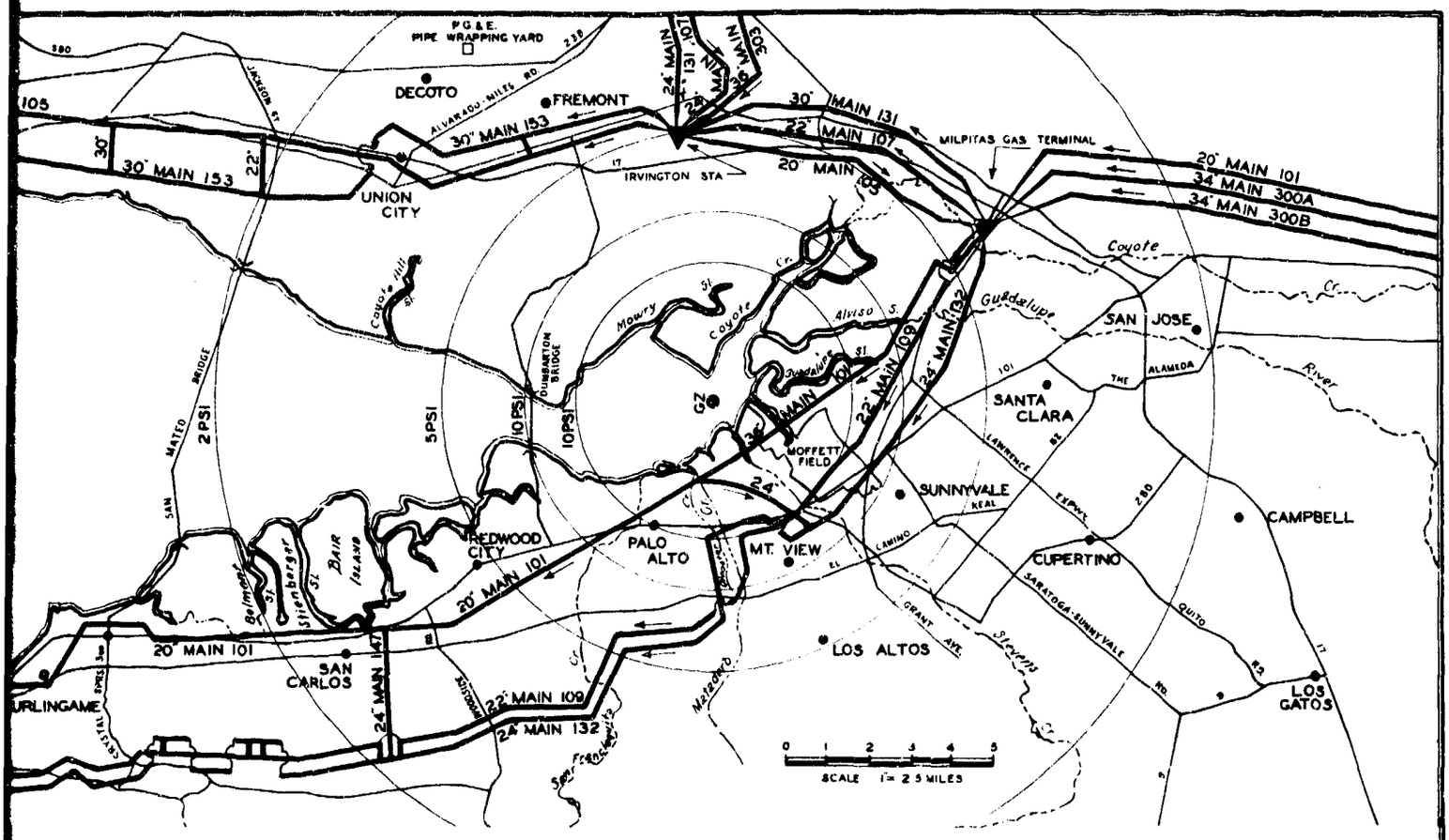


fig 1. GAS TRANSMISSION SYSTEM - SAN JOSE AND SAN FRANCISC



ANSMISSION SYSTEM - SAN JOSE AND SAN FRANCISCO BAY AREAS

2

TABLE I–Gas Customers, Gas Sales and Estimated Population in San Jose Area, Month of August 1965

	Gas Customers		Gas Sales Mcf.		Estimated Population
	Firm	Interruptible[1]	Firm	Interruptible[1]	
1. San Jose	119,045	74	625,855	540,524	328,300
2. Sunnyvale	29,964	15	149,221	99,109	82,350
3. Santa Clara	24,032	21	126,424	351,211	82,500
4. Mt. View	17,391	9	97,406	29,559	47,450
5. Los Altos	9,060	1	48,046	4,194	23,500
6. Campbell	7,768	2	36,713	4,210	21,800
7. Los Gatos	6,976	3	36,614	5,362	16,500
8. Saratoga	6,188	4	37,028	5,382	20,700
9. Cupertino	3,499	2	21,488	6,775	11,150
10. Los Altos Hills	1,423	-	11,669	-	5,000
11. Monte Sereno	730	-	3,540	-	1,800
TOTAL	226,076	131	1,194,004	1,046,326	641,050

[1] Interruptible gas sales contracts are limited to large users and stipulate that buyers have have standby fuel such as oil, and will discontinue use of gas when requested by Company during emergencies or when such gas is needed to supply "firm" customers.

HISTORICAL

The San Jose Gas Company, the first to supply gas in the area, was incorporated in 1860. In 1877, a carburetted water gas plant was built at 65 N. Montgomery Street, San Jose, the present location of the storage holders. Most of the manufactured gas was distributed at inches of water column pressure, although in 1921 an 8-inch steel main operating at 60 pounds per square inch (psi) linked the San Jose and San Francisco plants, a distance of 50 miles.

During the early period, the use of cast iron pipe predominated in distribution main construction. Approximately 52 miles of these mains varying in diameters from 4 to 20 inches and representing about 80 percent of the originally installed footage remain in service today in downtown San Jose and a small area in Los Gatos. Four and six-inch sizes make up 93 percent of the total. Since the introduction of natural gas in 1929, more than 85 percent of the bell and spigot joints of the cast iron portion of the system have been leak clamped.

NATURAL GAS TRANSMISSION SYSTEM IN THE SAN JOSE AREA

Natural gas is brought into the San Jose Area by two segments of the Pacific Gas and Electric Company's Northern California integrated transmission system:

1. A segment, consisting of three high pressure mains, numbered 100[3], 300A, and 300B, comes up from the south and ends at Milpitas Gas Terminal. It is shown in Figure 1

[3]Converted in 1966 to a distribution main from Milpitas Terminal south to Valve 134.5, a distance of 15 miles.

and in more detail by Figure 2 and by the Gas Supply System Map in Pocket of the back cover.

Main 100 starts at Kettleman Compressor Station, 149 miles to the south, and transports gas to Milpitas primarily from the Kettleman Hills Field. Mains 300A and 300B start at the Company's Topock Compressor Station on the Arizona border, 502 pipeline miles from Milpitas, where gas is received from the El Paso Natural Gas Company's San Juan Basin, New Mexico system.

2. The second segment, consisting of two mains numbered 105 and 107, comes down from the north and brings a mixture of Canadian and local California gases to Milpitas Terminal and also ends there. A parallel third main, number 131, always takes gas away from Milpitas for delivery to Irvington Station enroute to Oakland. During part of the year, particularly in summer, 107 may also transport gas away from Milpitas.

Incoming transmission mains and Milpitas Terminal are operated by the Company's Department of Pipeline Operations. Outgoing transmission mains are under the jurisdiction of the operating divisions of the Company through which the pipelines pass. Milpitas Terminal is the focal point of supply for the San Jose-San Francisco Bay area. It functions to measure incoming supply and to deliver measured and pressure regulated volumes to the outgoing transmission mains. To secure area-wide uniformity in gas quality, it also serves as a mixing station by blending the volume from the north with a portion of the supply from the south.

A portion of the blend is delivered to the 20-inch King Road distribution trunk running south from Milpitas along the east side of San Jose. It supplies about 119,000 meters or over 99.5 percent of the gas used in the city. The trunk ends at the Silver Creek Pressure Limiting Station, 11 miles south of Milpitas, where it is connected back into transmission

through a standby regulator. Normally, the regulator is inactive and all supply to King Road must pass through Milpitas Terminal.

The balance of the blended gas is routed to the San Francisco Peninsula in Mains 101, 109, and 132 supplying 104,000 meters in the San Jose Area (of which less than 100 are direct transmission taps within San Jose's city limits) and 415,000 meters in San Francisco and the intervening area. In addition, wholesale gas is delivered to the City of Palo Alto for municipal distribution to its 61,000 population.

The unmixed portion from the south passes through Milpitas Terminal and continues in Main 131 to Irvington Station, where it is mixed with gas diverted from 107 and 131 incoming from the north before delivery to the Oakland area. Milpitas handles the mixing operation by remote control.

Table II gives pipe data and the volumes transported on August 24, 1965, the day of the hypothetical strike. Also tabulated are volumes for the peak day of 1965. Comparison of the volumes 319 and 741 MMcf listed as "Totals to San Jose Area-SF" under "Out at Milpitas" shows that the transmission system is capable of meeting the August needs of the San Jose Area by a factor of at least 2.3.

NATURAL GAS DISTRIBUTION SYSTEM IN THE SAN JOSE AREA

Gas is distributed in the San Jose Area by three integrated systems; two operating at pounds per square inch (psi) pressure supplemented by a third system in downtown San Jose operating at inches of water column (W.C.) pressure. The three systems are:

1. A high pressure primary system of major trunks operating at 100 to 175 psi and consisting of 4 to 20-inch steel mains. This system[4] consists of the Maybury, Story, and

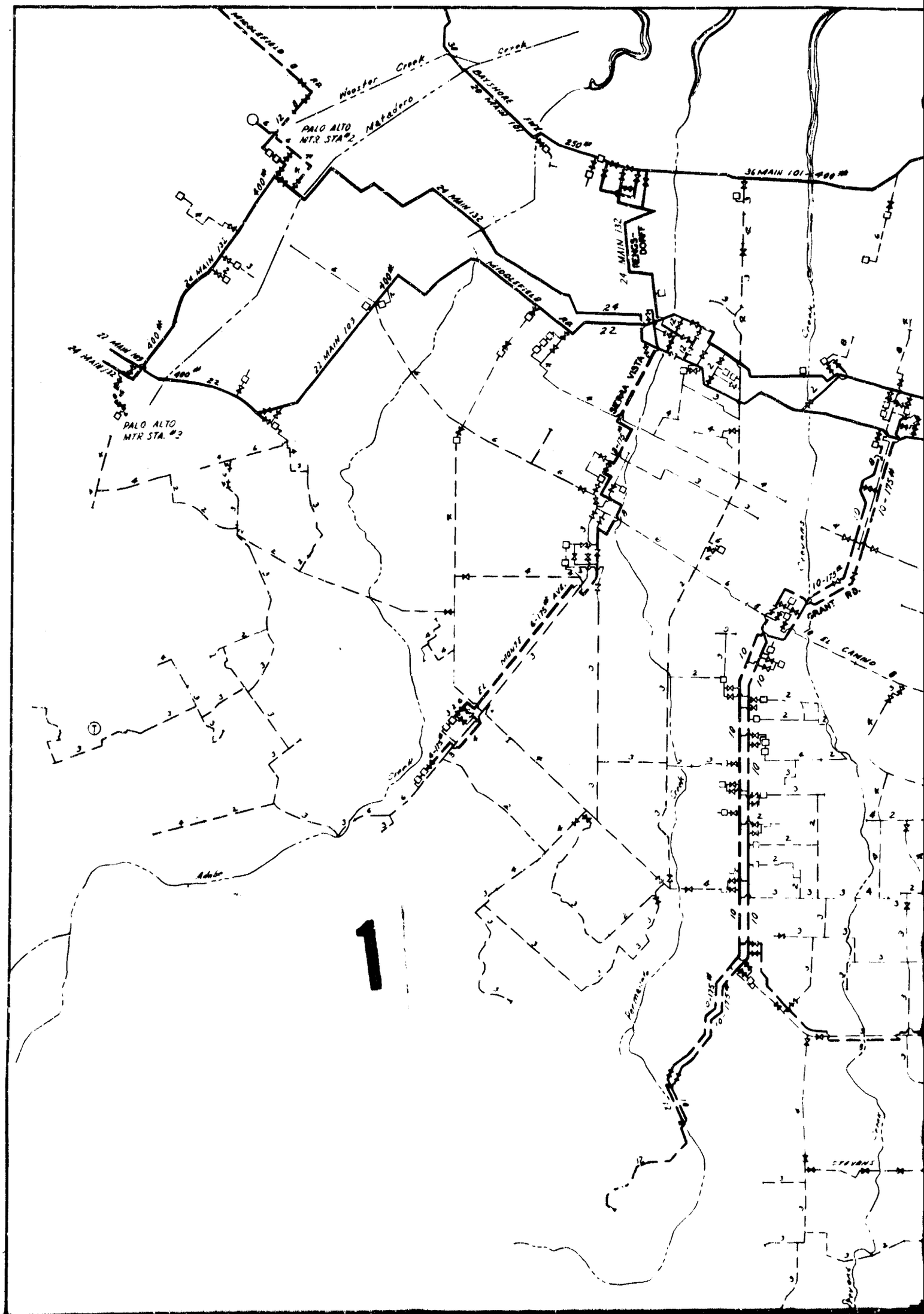
[4]See Figure 2 and Glossary of Terms.

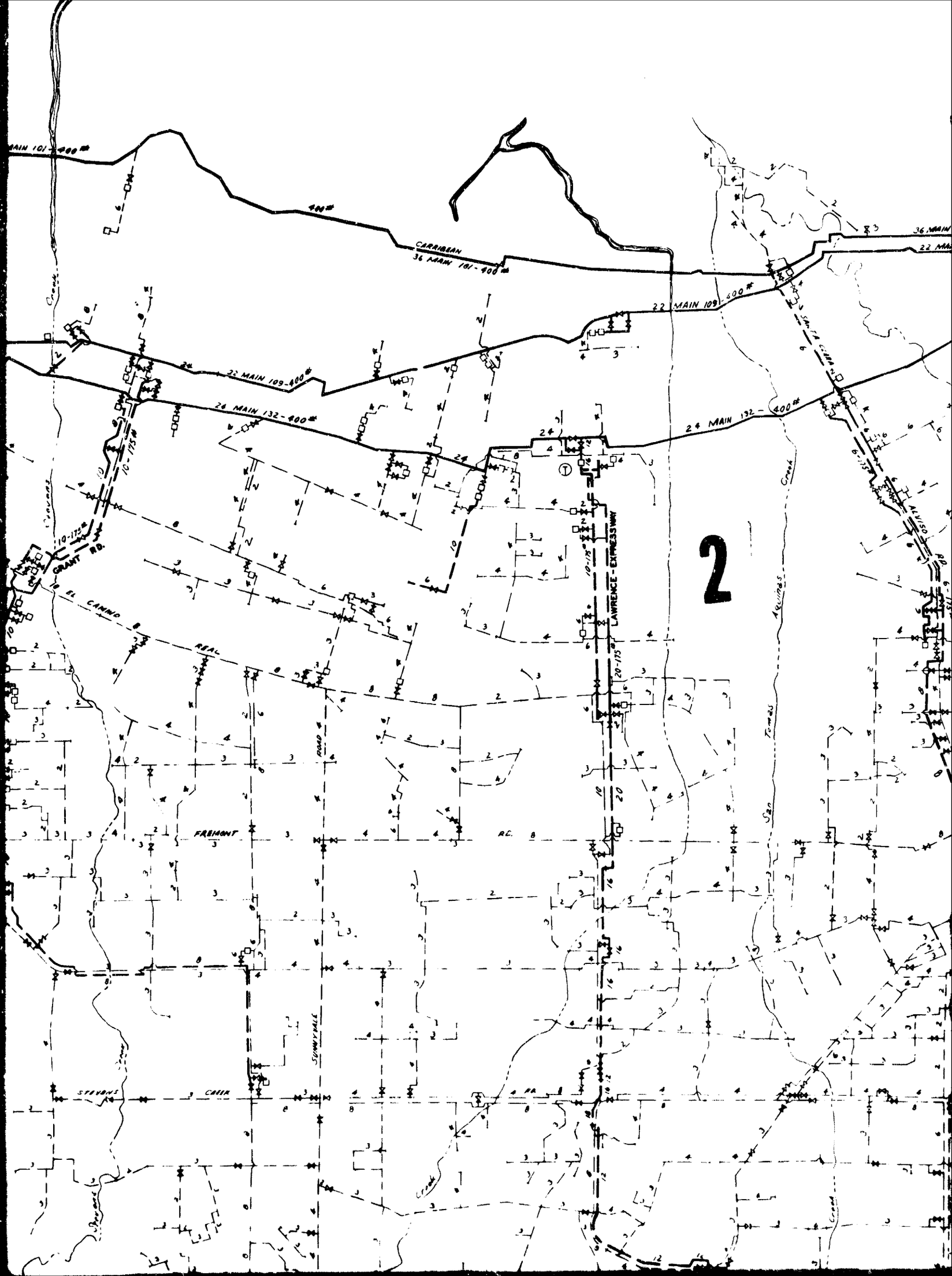
TABLE II–Transmission Mains in San Jose Area – Sizes, Pressures, and Transport Volumes for August 24, 1965 and Peak Day 1965

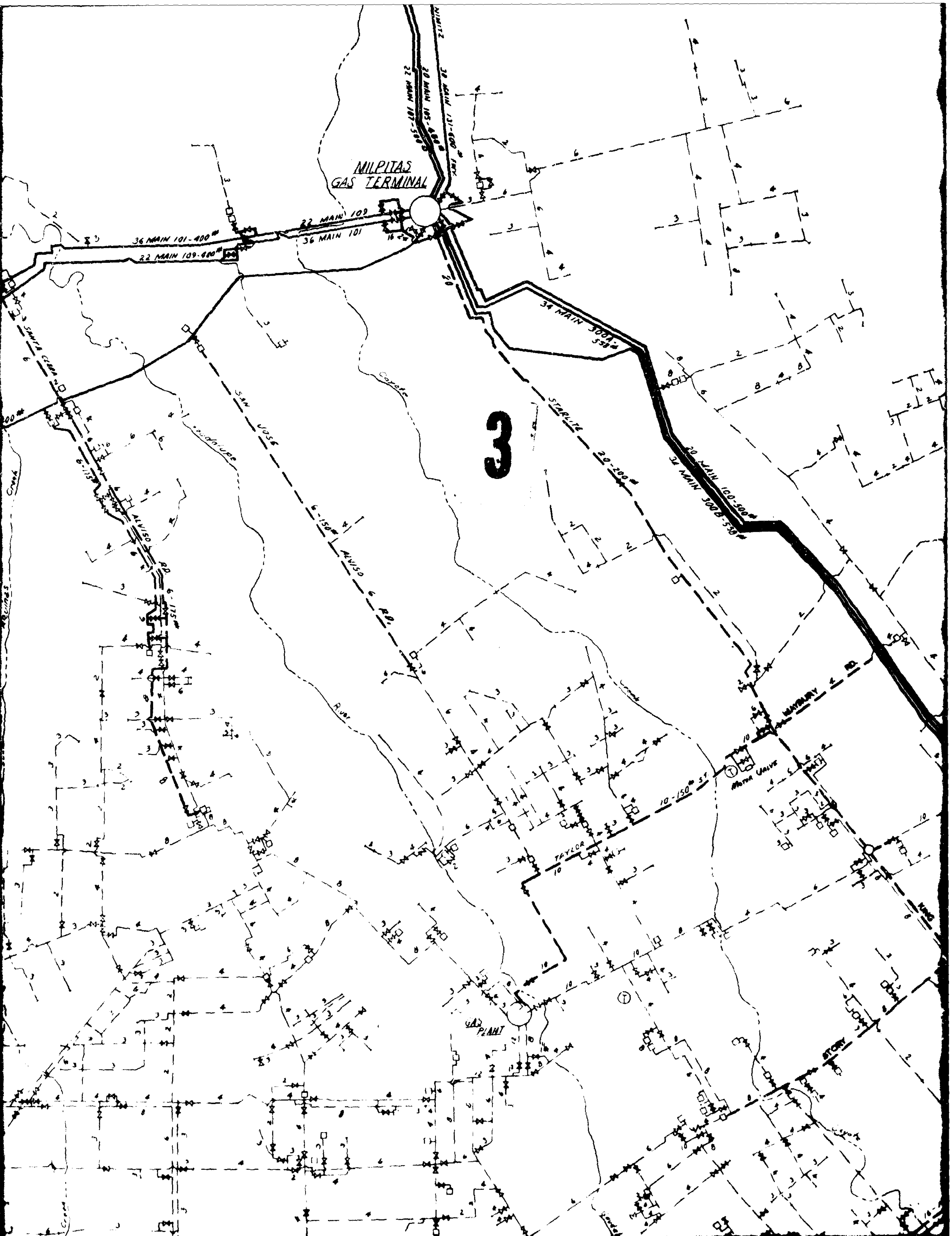
Main No.	O.D. Inch	Wall Thick Inch	Max. Opr. Press. Psi.	Volumes Transported – 24 Hrs. – MMcf			
				August 24, 1965		Peak Day 1965	
				MMcf	Av. Press. Psi	MMcf	Av. Press. Psi
In At Milpitas Terminal							
100	20	0.3125	500	72	250	46	341
105	22	0.3125	480	101	455	185	348
107	22	0.3125	500			166	337
300A	34	0.344	558	60	527	216	506
300B	34	0.344	558	271	429	293	342
In At Milpitas				504		906	
Out At Milpitas Terminal							
To San Jose City 20" King Road	20	0.281	200	46	168	108	200
To San Jose Area & S.F.							
101	20	0.281	[1]250	86	200	134	250
109	22	0.3125	400	74	250	206	336
132	24	0.3125	400	113	250	293	336
Total – San Jose, S.F.				319		741	
To Oakland							
107	22	0.3125	500	60	355		
131	30	0.3125	600	127	250	166	316
Total Out Milpitas				506		907	

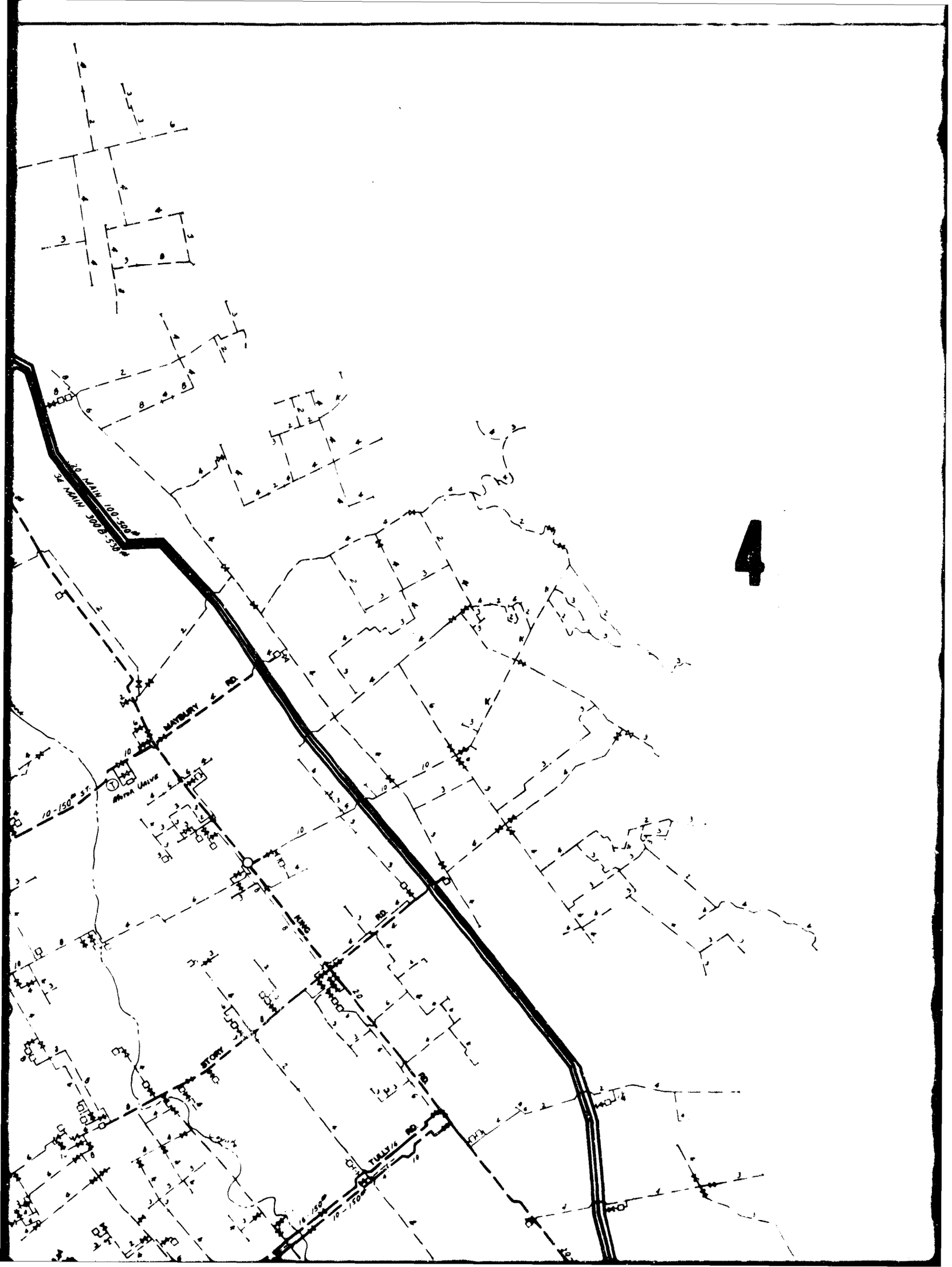
NOTE: Maximum operating pressure is determined by "location class" G.O. 112-A, California Public Utilities Commission.

[1]The first 9.78 miles of this main downstream from Milpitas Terminal has a maximum operating pressure of 400 psi.


Wooster Creek
Matadero
PALO ALTO MTR STA #2
PALO ALTO MTR STA. #3
24 MAIN 132
22 MAIN 103
MIDDLEFIELD RD.
SIERRA VISTA
FENGS-DORFF
36 MAIN 101
10-175# AVE.
GRANT RD.
EL CAMINO
STEVENS
1


2
MAIN 101 - 400 #
CARRIBEAN
36 MAIN 101 - 400 #
22 MAIN 109 - 400 #
24 MAIN 132 - 400 #
LAWRENCE - EXPRESSWAY
GRANT RD.
EL CAMINO REAL
FREMONT
ROAD
SUNNYVALE
STEVENS CREEK
Calabazas Creek
Saratoga Creek
Permanente Creek
Adobe Creek
Stevens Creek
Permanente Creek


MILPITAS
GAS TERMINAL
36 MAIN 101-400#
22 MAIN 109
36 MAIN 101
22 MAIN 109-400#
3
SAN JOSE
ALVISO
STARLITE
20-200#
TAYLOR
River
GAS PLANT
STORY


30 MAIN 100-500'
36 MAIN 300'B-350'
MAYBURY RD.
10-150' ST.
MAIN VALVE
KING RD.
STORY RD.
TULLY RD.
10-150'
4

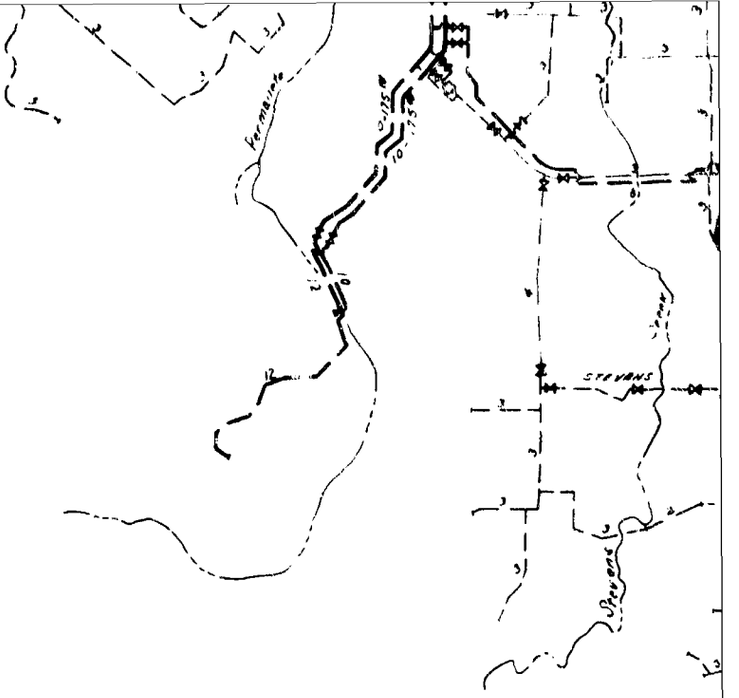
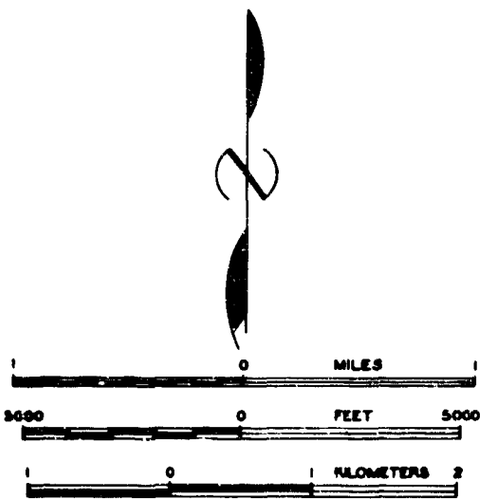


fig. 2

GAS SYSTEM OPERATING MAP

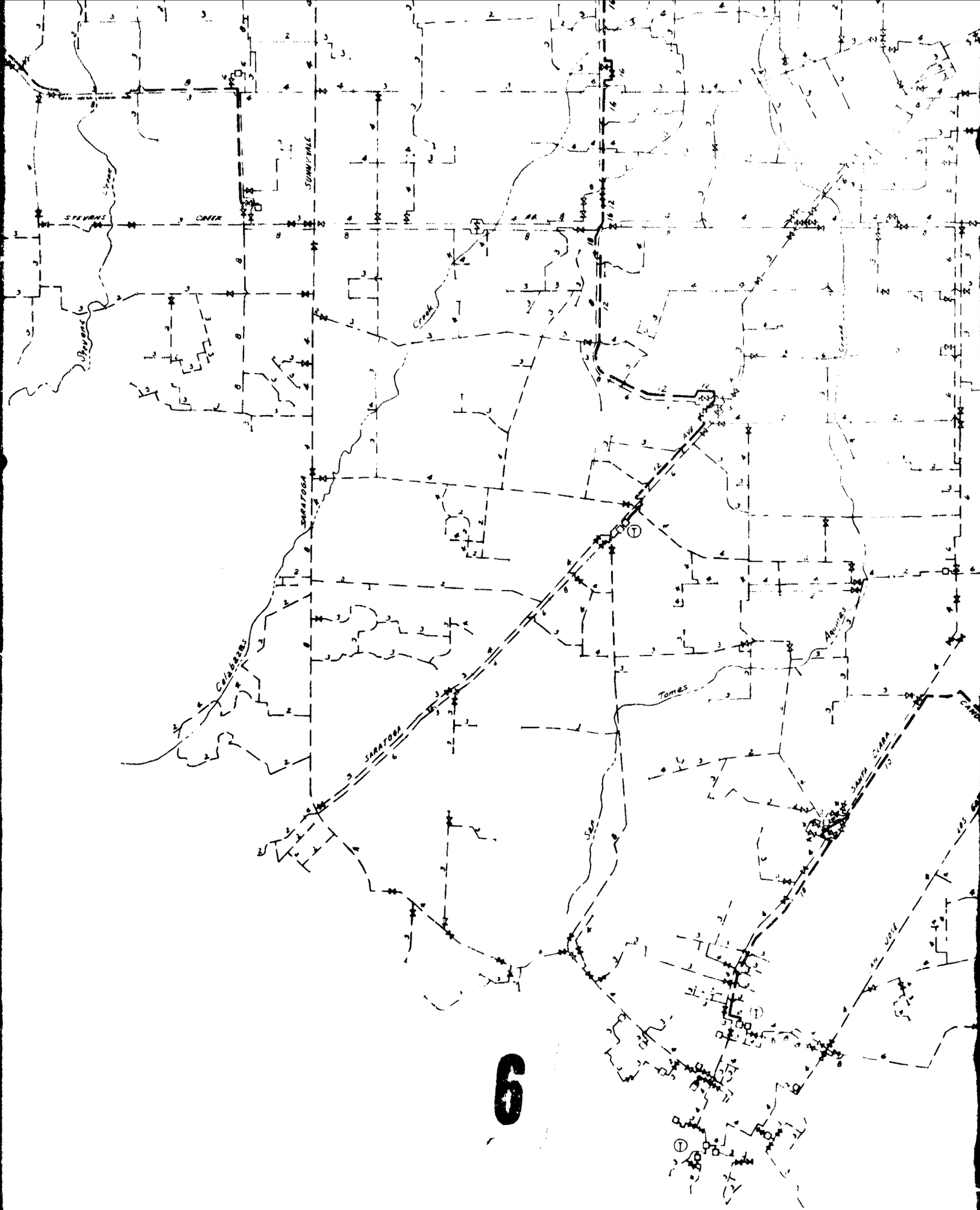
SAN JOSE AREA

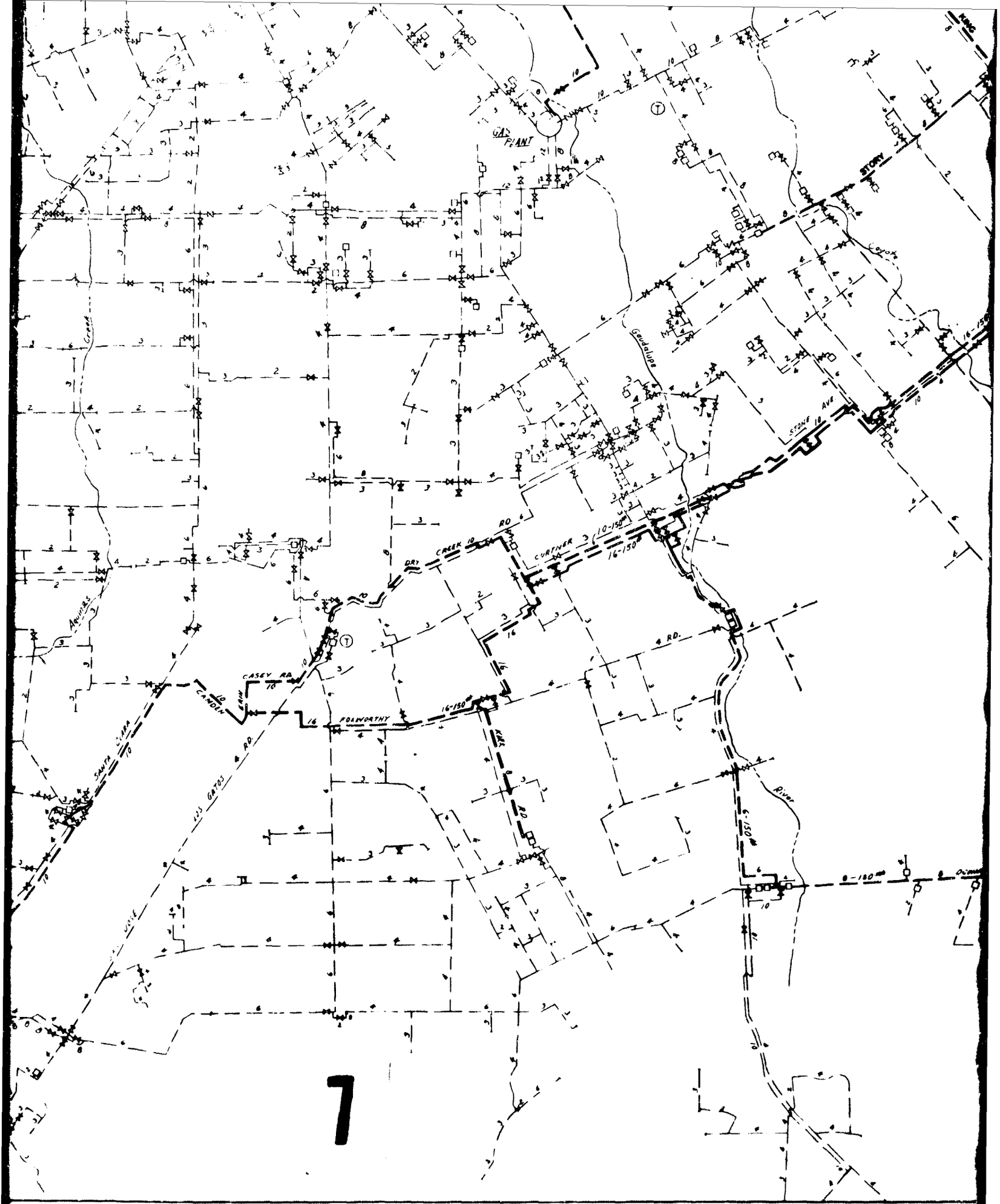


5

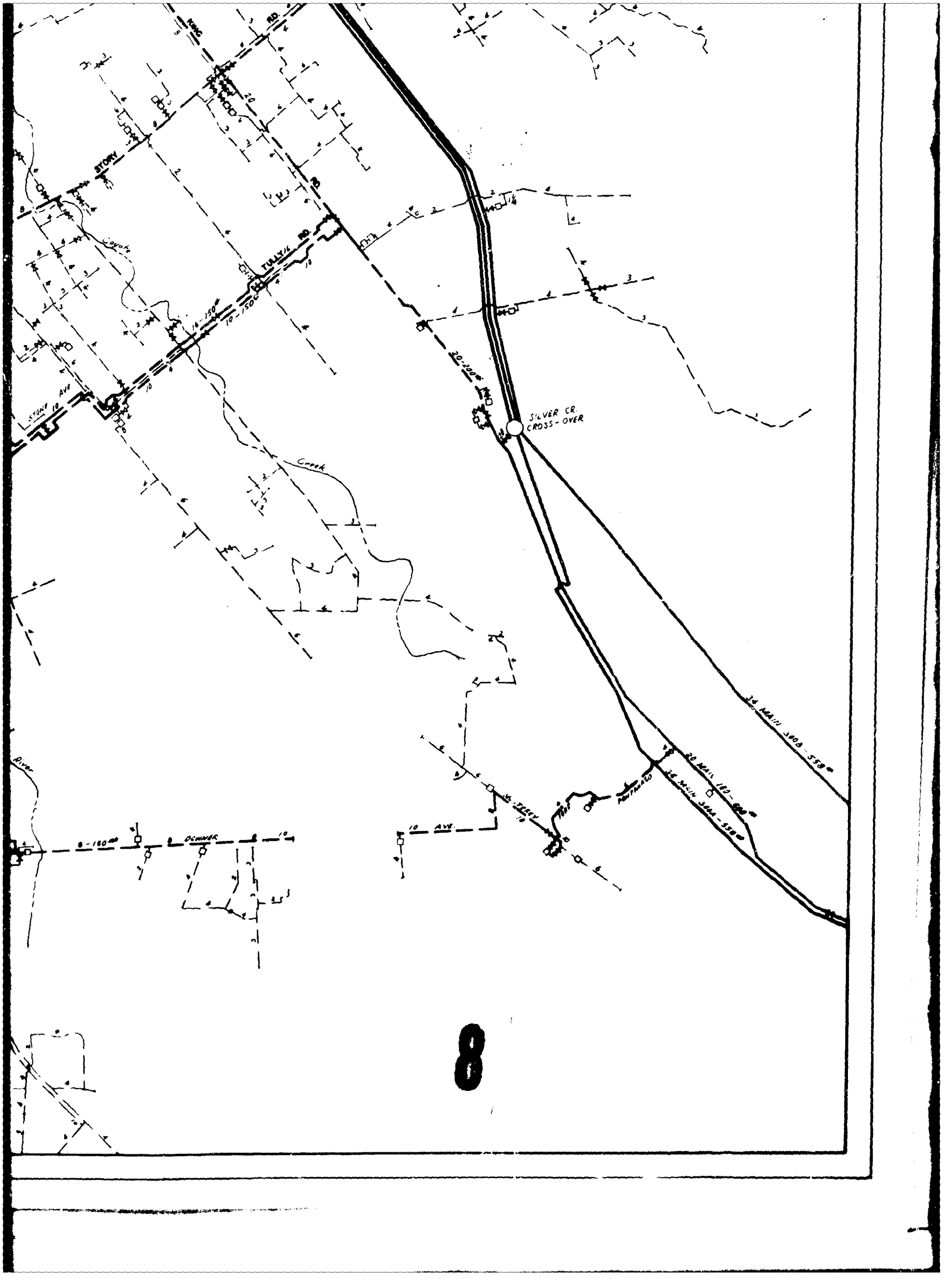
LEGEND

- TRANSMISSION MAIN
- MAJOR DISTRIBUTION " MAIN
- SECONDARY " MAIN
- REGULATOR
- VALVE
- (T) TELEMETER PRESSURE POINT


STEVENS
CREEK
SUNNYVALE
SARATOGA
Calabazas
Tomes
SARATOGA
AVE
Aquinas
SANTA CLARA
SAN JOSE


GAS PLANT
STORY
Guadalupe
STONE AVE
CURTNER
CASEY RD.
DRY CREEK
FOXWORTHY
ALMADEN
CAMDEN
SANTA CLARA
LOS GATOS
RD.
River

7


STORY
TULLY RD
Creek
STONE AVE
SILVER CR. CROSS-OVER
Creek
10 AVE
River
DENMAN

Tully Road trunks supplying gas to San Jose from an easterly direction and the Alviso Road, Santa Clara Road, Lawrence Expressway, Grant Road, and Sierra Vista trunks bringing gas into the area from a northerly direction.

2. A secondary system[5] of 2 to 10-inch steel mains, operating at intermediate pressures of 30-50 psi. It is supplied from the foregoing trunks by monitoring regulators in underground covered pits. This system, in conjunction with 2-inch size mains of which a few only are shown, supplies built-up areas block by block. Services carry the intermediate 50 psi (or less) gas from the secondary mains to meter sets[6] on customers' premises. At a residential meter set, a service regulator ahead of the meter reduces pressure to 7 inches W.C. From the meter, the low pressure gas enters the houseline of the premises for use in appliances. Smallest size service pipe is 3/4 inch.

While most users of gas are served at the standard 7-inch W.C. pressure, industry may be served at pounds pressure, provided the plant is near an intermediate or high pressure main.

3. The third level is a low pressure network[7] operating at inches of W.C. pressure. It consists of 4 to 20-inch cast iron mains confined to a portion of downtown San Jose surrounding the former gas plant and to a small area in Los Gatos. A 20-inch cast iron, low pressure main originating at the former gas plant is the principal supply for the low pressure system in San Jose, supplemented at peripheral points from the 50 psi system through regulator pits.

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[5]See Figure 2 and Glossary of Terms.

[6]See Glossary of Terms.

[7]See Downtown San Jose Distribution Facilities Map (in pocket).

DIRECTION OF GAS FLOW IN THE CITY OF SAN JOSE

The direction of gas flow into the San Jose distribution system is principally from east to west. It is shown statistically in Table III, that 94 percent of San Jose's supply is apportioned between Maybury, Story, and Tully distribution trunks. This flow pattern prevails throughout the year.

The balance of supply (6%) normally comes in from the north through the San Jose-Alviso, Santa Clara Road, Lawrence and Grant Road trunks. While these trunks primarily supply areas adjacent and nearby to San Jose, they stabilize pressure around the western fringe of the City by backfeeding towards the City. Their support to San Jose, although necessary in winter, is not critical in summer as evidenced by their small contributions to San Jose's requirement.

TABLE III–Volumes Handled by Distribution Trunks in San Jose Area–
24 Hours - August 24, 1965

	City of San Jose				San Jose Area	
Name of Gas Main	Maximum Capacity Mcf/Hour	24 Hrs. Volume Mcf	Max. Hour Mcf	Percent of Requirement	24 Hrs. Volume Mcf	Max. Hour Mcf
Tuly Road	3,345	16,110	966	[1]38.6	19,470	1,170
Story Road	1,385	8,220	493	[1]19.7	9,560	574
Mabury Road	1,470	14,920	795	[1]35.7	14,920	795
Alviso - S.J. Road	320	960	58	2.3	7,680	460
Santa Clara Road	1,350	325	15	0.7	19,200	865
Lawrence	5,400	415	25	1.0	12,020	722
Grant Avenue	3,000	415	25	1.0	27,850	1,670
Sierra Vista	880	-	-	-	2,090	125
Miscellaneous[2]	-	385	17	1.0	1,185	53
Totals	17,150	41,750	2,394	100.0	113,975	6,434

[1]These three trunks supply 94% of San Jose's requirements.
[2]Supplied to users by taps directly from transmission mains.

The table lists the maximum hourly rate which each main is capable of sustaining and gives corresponding maximum hour demands in the City and the San Jose Area on the day of attack. The combined maximum capabilities of Maybury, Story, and Tully exceed the demand of the City of San Jose on that day by a factor of 2.6.

Obviously, significant damage to these three distribution trunks, or King Road (their source of supply), would be critical to San Jose. On the other hand, a reduced supply or complete outage of the other trunks (Santa Clara Road, Grant Road, etc.) would have minimal effect on San Jose. In that event Maybury, Story, and Tully would automatically step up delivery, completely supply San Jose, and to a degree make up deficiencies in adjoining areas.

DETAILS OF TYPICAL SECONDARY DISTRIBUTION FACILITIES IN SAN JOSE

The plat sheets (in pocket) on the back cover show typical layouts of distribution facilities:

1. *Downtown San Jose.* The gas mains, indicated by solid lines and operate at inches of W.C. pressure, usually are of cast iron construction and predate natural gas. Dashed lines indicate intermediate pressure mains up to 50 psi. These latter mains are steel and have been installed subsequent to the cast iron system, either to augment it by adding supply at regulator pits or to serve individual industrial plants whose demands would overtax the low pressure capacity.

The predominance of cast iron construction identifies a long established system dating back to a manufactured gas period. Early cast iron systems are limited to comparatively low pressures and require special devices to secure leak proof joints. The notation LC means that the joints have been leak clumped.

Services to the street addresses given on the map are represented by lines perpendicular to street mains. They are wrapped steel and 1-1/4 inches in diameter or larger. Service regulations are not required since the pressure is in inches W.C.

2. *Suburban San Jose.* Gas distribution in suburban areas is characterized by steel construction, relatively high saturation of customers per mile of main and employment of intermediate pressures up to 50 psi. Service pipes to residential customers are usually 3/4 inch. Pressure is reduced at the meter set by a service regulator to the standard 7 inch W.C. pressure.

3. *Rural San Jose.* Gas distribution in rural areas is exemplified by a low satura- saturation of customers per mile of main and the presence of unavoidable dead ends. Pressure is in psi and service regulators are required at each residential meter set to deliver the 7 inch W.C. pressure.

Isolated users in the rural areas may be served directly from a transmission main if nearby. In such cases, double regulation is employed. In addition, the opening into the transmission main is usually a small orifice in order to restrict flow in event of damage to the service.

MILEAGE OF PIPE IN SAN JOSE AREA

The estimated total mileages of utility owned gas piping in the San Jose Area including the Milpitas-Irvington transmission mains are:

	Miles
Transmission, 20 to 34 inch diameter	90
Distribution, 2 to 20 inch diameter	2,300
Service, 3/4 to 6 inch diameter	2,500

LOAD CENTER[8]

The Load Center, continuously manned with one attendant per shift, is located in the former gas plant yard at 65 N. Montgomery St., San Jose. Its function is to continuously monitor pressure levels in the San Jose Area by means of incoming telemetered values from thirteen strategic locations to to take action when needed to keep the system in pressure balance. Balancing is done by adjusting pressure in the Maybury Road trunk by remote operation of a motorized valve located where it taps the King Road main. Normally, this motorized valve acts as a self actuated regulator except when overridden by Load Center action.

STORAGE GAS

Two water-sealed holders having a combined capacity of 3.5 MMcf are located at the Load Center. Each throws a pressure of about 10 inches W.C., are valved off, and do not float on the low pressure system. A 500 Mcf per hour, 21 inch W.C. maximum pressure, electrically driven booster is used to withdraw and send out holder gas. No high pressure storage or other supplemental supply such as liquefied natural gas or LP-air exists in the area.

Storage holder gas is not held solely for the San Jose Area; it is part of system reserves maintained to alleviate peak demands on the transmission system. However, need is generally local during winter to support the low pressure system and assist the Maybury trunk. When used for this purpose the decision is made locally. The load center attendant handles the operation by remote operation of the booster and motorized valves.

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[8] A point in the area where the telemetered pressures and volume rates are under observation and control can be exercised; the name has no geographical significance.

PACIFIC GAS AND ELECTRIC CO. ORGANIZATION IN SAN JOSE AREA

The Company employs decentralized management in its thirteen (13) operating divisions. In a division all responsibilities and functions including physical operations are assigned to the Division Manager. Each division in turn may have one or more subdivisions called districts, each headed by a District Manager who is likewise responsible for all functions within his area.

San Jose Division

San Jose Division has four districts. The Central District, which is the largest and includes the City of San Jose, accounts for 62 percent of the division's gas customers. On a divisional basis San Jose has 32 percent of the gas accounts.

The division office is in downtown San Jose at 86 S. 3rd St. It occupies a three-story building and a two-story annex occupied by the Division Manager and his staff consisting of Division Gas[9] and Division Electric Superintendents and Managers of Commercial-Sales, Personnel, Customer Service and General Services, together with other supervisors such as the Storkekeeper, Credit Supervisor, Claims Investigator and others all of whose activities are division-wide. The Manager of the Central District also is located here.

Central District (and San Jose)

Physical operations are directed by the District Gas Superintendent who is located at the Service Center at 10900 N. Blaney St., Cupertino, approximately eight miles from the division office. Distribution employees are headquartered at two locations; the Load Center in San Jose and the Service Center in Cupertino. Work is district-wide; no distribution people are assigned specifically to San Jose.

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[9]The Division Gas Superintendent and his staff of 45 were moved to the Cupertino Service Center in 1966.

Meters for all districts in the San Jose Division are tested and repaired at the Meter Shop, 650 Lenzen Ave., San Jose, by a force of twenty employees.

Gas appliance adjustment and related services available to customers such as establishing service, applicance adjustment, replacing electric fuses, investigating leaks, lighting pilots, and others are provided by a force of eighty-four (84) combination gas and electric servicemen under the Central District Gas Department's jurisdiction. A total of 30,500 calls were handled during August 1965.

Servicemen are headquarters at various locations to minimize travel time:

Location:	Number
Load Center - San Jose	46
Service Center - Cupertino	13
325 Saratoga Ave., Los Gatos	8
750 W. Olive Ave., Sunnyvale	
490 W. Bryant St., Mt. View	11

Twenty-four hour service, restricted to emergencies after 11 p.m. and handled by servicemen "on call", is available seven days per week. Normally, eight (8) radio equipped service trucks are in the field after 5 p.m. and until 9 p.m. and five (5) thereafter until 11 p.m.

Telephone facilities for receiving requests for service or reporting emergencies are handled by Gas Department Service Operators located in the Division office. This switchboard is maintained from 7:30 a.m. until 11 p.m.; thereafter calls are routed to the Distribution Operator (Electric Department) located at the Cupertino Service Center. At the hour of the hypothetical attack, two Gas Department Service Operators are on shift, with one preparing to go off duty at 9 p.m.

Personnel

The total full time gas operating employees in the Central District's clerical and physical forces is 324, supplemented by 238 San Jose division office employees contributing part time to Central District operations.

PACIFIC GAS AND ELECTRIC CO. COMMUNICATIONS IN SAN JOSE AREA

General

Microwave is the primary means of long distance communication in the Company's private integrated telephone system. Every important gas and electric operating center, including gas transmission main operating points in Canada, can be reached by microwave.

The older private wire system of the Company, while still available for long distance calls, is now used mainly for communication needs within local areas. It also supplements microwave by providing wire connection between the nearest microwave terminus and those subcenters in the same area not directly served by microwave. In addition, local operating centers and offices dealing with the public use the services of the telephone utility in the area. Power lines are not used as carriers for communication purposes in this area.

Company policy is to have alternate means of telephone communication between load control and operational departments in its General Office in San Francisco and the more important gas and electric local operating centers. In keeping with this policy, the San Jose downtown office, two main electric substations in the San Jose Area, and Milpitas Gas Terminal not only have both microwave and direct private wire line connections with the General Office but also can be reached through the facilities of Pacific Telephone and Telegraph Company. In addition, Milpitas Terminal can be reached from the General Office via an alternate private wire route through Oakland, or indirectly by microwave through Fresno and Kettleman Compressor Station and then by private wire to Milpitas.

Microwave Facilities

Figure 3 shows the geographical arrangement of microwave facilities between San Francisco, the San Jose Area, and points outside of the area handled by this segment of the integrated communication system. Also shown are the offices and operating centers reached directly by microwave without transfer to wire facilities.

Two parallel microwave systems and two repeater stations are required to service the area. Locations of repeater stations are:

1. Monte Bello Ridge, elevation 2560 feet, 14 miles west of the San Jose Division office and 12 miles from ground zero. This system provides 6 voice channels between San Francisco and San Jose area.

2. Loma Prieta Peak, elevation 3798 feet, 16 miles south of the San Jose Division office and 26 miles from ground zero. This system provides 9 voice channels.

Stand-by engine-generator sets are maintained at both locations.

In addition to the San Jose area, these repeater stations serve San Mateo and Redwood City to the north on the peninsula, the Coast District of San Jose Division to the west, and the Company's Coast Valleys Division lying further south.

Wire Line Facilities

Figure 4 shows a schematic arrangement of the private wire line facilities in the San Jose Area. Generally, they are Company owned and, outside of downtown areas, are carried above ground on electric distribution or leased pole space. In downtown sections, leased underground facilities are used.

The San Jose Division office and the Cupertino Service Center are the hubs of the wire system in the San Jose Area linking all offices, except Los Gatos.

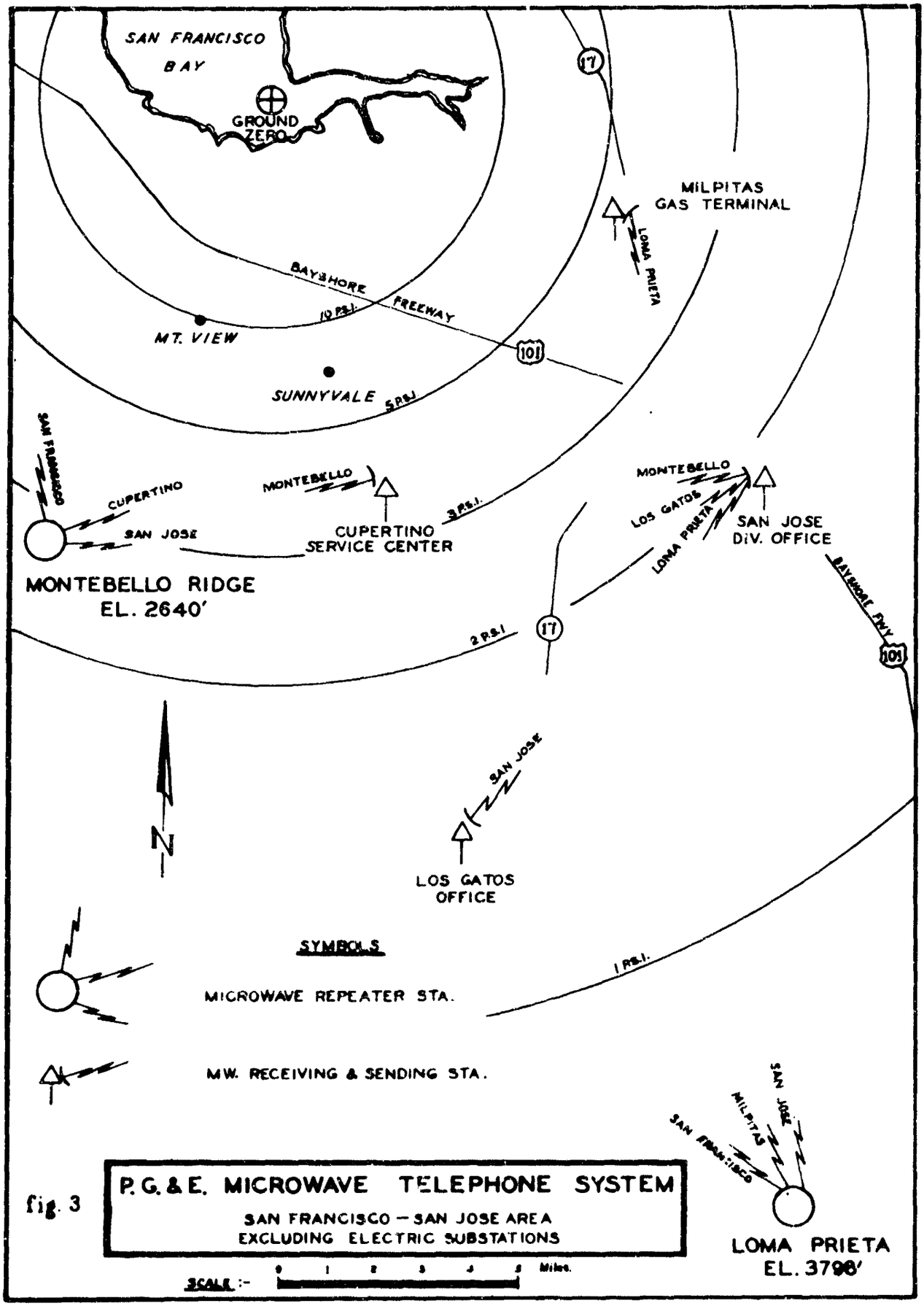


fig. 3

P. G. & E. MICROWAVE TELEPHONE SYSTEM

SAN FRANCISCO – SAN JOSE AREA
EXCLUDING ELECTRIC SUBSTATIONS

fig. 4

P.G.&E. WIRE LINE TELEPHONE SYSTEM

SAN FRANCISCO – SAN JOSE AREA

EXCLUDING ELECTRIC SUBSTATIONS

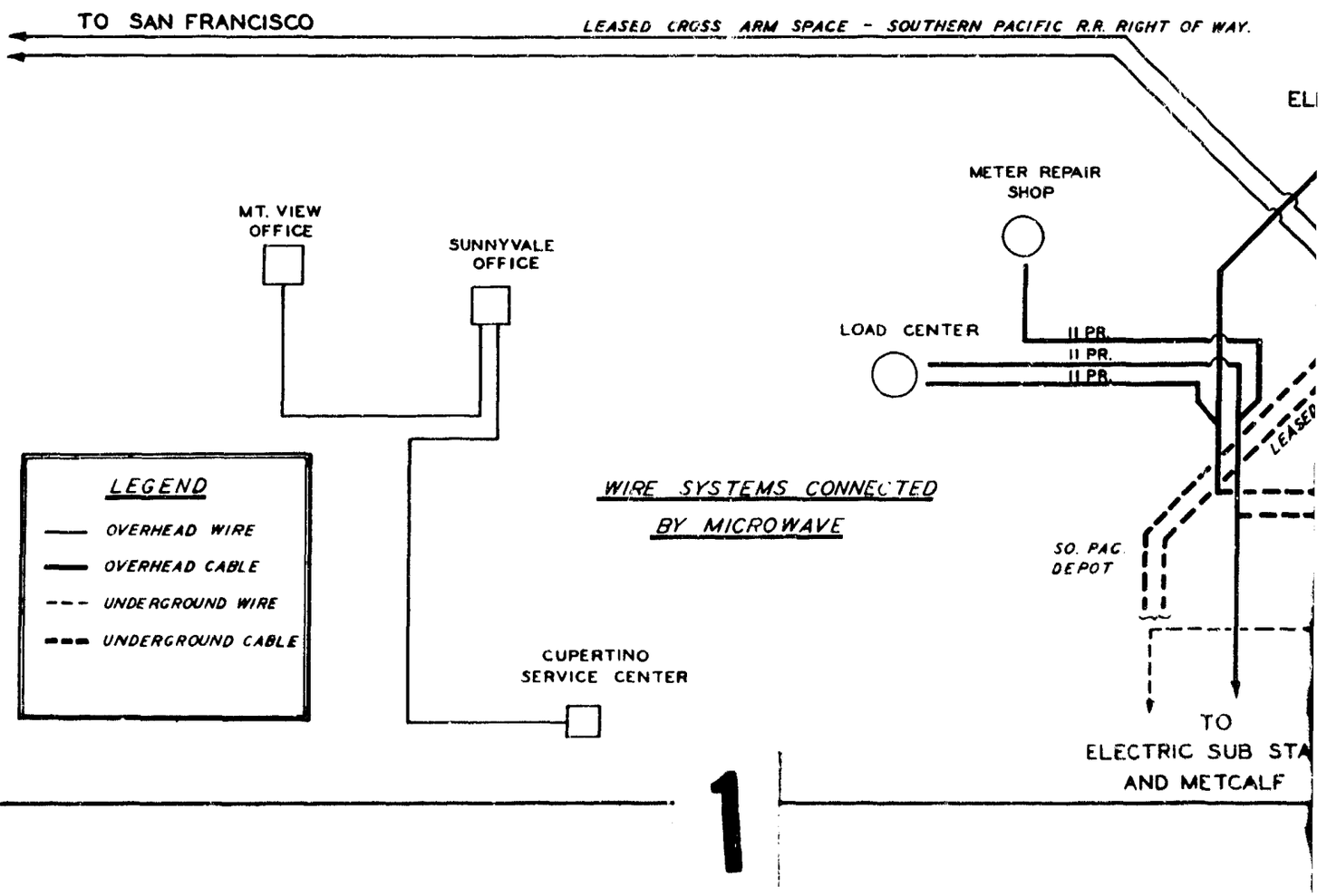
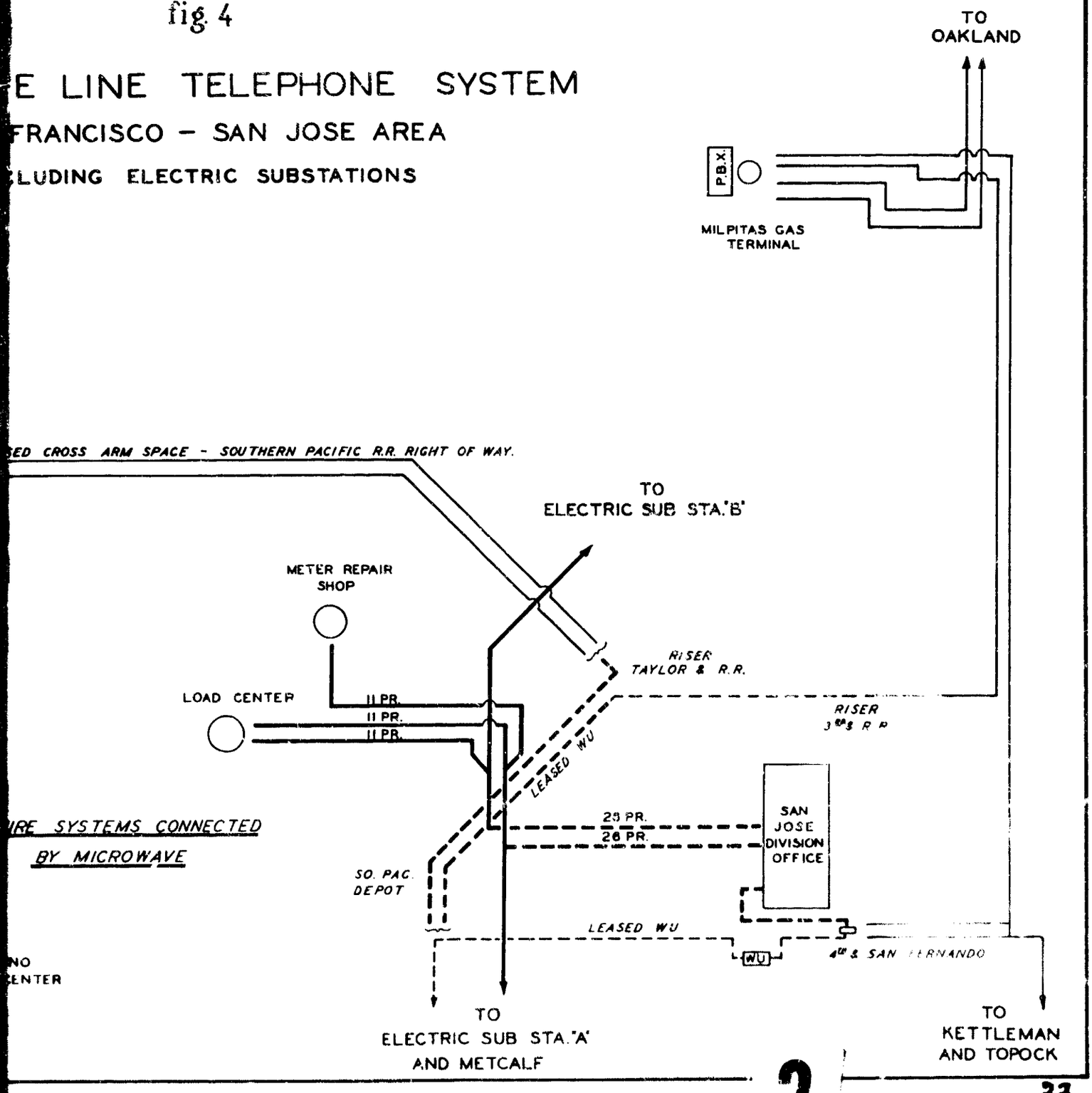


fig. 4

E LINE TELEPHONE SYSTEM

FRANCISCO – SAN JOSE AREA

LUDING ELECTRIC SUBSTATIONS



2

The Milpitas-San Francisco wire line is a part of a 500 mile segment that follows the gas transmission right of way to the Topock Compressor Station on the Arizona border. It links San Francisco, Milpitas, Hollister, and three compressor stations located at Kettleman Hills, Hinckley, and Topock.

Radio Communication Facilities

The Company uses five assigned radio frequencies in the San Jose Area, one each for the Gas Department, the Electric Department and the Company's General Construction Department. One of the two frequencies assigned to Pipeline Operations is used by the Milpitas base station; the other is shared with Hollister for operation of the remotely actuated transmitter on Loma Prieta. General Construction uses its assigned frequency throughout the entire P. G. and E. system.

The San Jose Gas Department's base station antenna is located on top of the storage holder guide frame. The facility is shared by Gas Service for dispatching customer service requests to servicemen in the field and by the Gas Distribution Department for contacting distribution crews. Transmitting and receiving consoles are located in the Gas Service office at 86 S. 3rd St., San Jose, the distribution office at the Load Center, and the Load Center office. Stand-by engine-generator sets are maintained at both locations.

Pipeline Operations has two base stations in the area; (1) at Milpitas Terminal to enable Milpitas to contact local personnel operating out of the Terminal and (2) a transmitter on Loma Prieta Peak. The latter can be remotely actuated by Pipeline mobile radio sets to contact Hollister (a Pipeline Operations station 40 miles south of Milpitas) or Pipeline crews operating beyond the immediate Milpitas area. Stand-by power is maintained at both locations.

General Construction does not have a base station. Communication between its personnel is accomplished by mobile radio.

The number of radio-equipped vehicles in Gas Operations in the San Jose Area, exclusive of General Construction, are:

	San Jose Gas Department	Department of Pipeline Operations
Passenger cars (supervisors)	9	1
Trucks	36	3

All mobile radios are two-way, but each department is restricted to its assigned frequency, and cannot communicate with each other.

PACIFIC GAS AND ELECTRIC CO. SUPPLY STORES IN SAN JOSE AREA

The Central Warehouse of the Company is located at Emeryville, a city adjacent to Oakland. The following three substores supply the San Jose Area: (1) the Load Center, (2) the Cupertino Service Center, and (3) the Meter Repair Shop at 650 Lenzen Ave., San Jose. Supplies stored at the Meter Repair Shop are limited to meters, service regulators, and repair parts.

Supplies in San Jose stocks tend to favor distribution sizes, thus excluding extensive amounts of large diameter materials. There are two reasons: (1) need for transmission repair or maintenance is infrequent, and (2) such work would be assigned to the Company's General Construction Department, which normally would arrange for delivery to the job site from the Decoto Pipe Wrapping Yard approximately 22 miles distant. See Figure 1.

Small amounts of larger diameter pipe are carried at Hollister for transmission emergency repair south of Milpitas by Pipeline Operation maintenance crews operating out of Hollister.

Substore Inventory in San Jose

There are more than four hundred items available, excluding small items classified as "expendible" such as rags, hand tools, etc., which do not appear in inventory counts, from stock. To reduce the list to a reasonable length, the inventory given in this report omits many items under four (4) inch diameter; for example, threaded pipe nipples of various diameters and lengths. Inventory lists are in Appendix A.

SECTION II

VULNERABLE LOCATIONS AND DAMAGE APPRAISALS

GAS SUPPLY SYSTEM

SAN JOSE AREA

INTRODUCTION

Since this strike is an air burst and not a surface one, "cratering" with its circular area of totally destroyed surface and subsurface facilities is not analogous. The assessment of potential damage to gas supply and support facilities in the San Jose Area is a matter of individual consideration of the magnitudes of the other products of the detonation: (1) water effects from San Francisco Bay [10], (2) thermal radiation, (3) airborne debris, (4) ground shock, (5) dynamic pressure, and (6) overpressure.

Thermal radiation and airborne debris have no potential to do damage to underground facilities. Likewise, overpressure, dynamic pressure, and ground shock can be eliminated also, because of the inherent flexibility of buried steel pipe to absorb shock when located outside of a cratered area. In this respect, the new 36 inch main 101 comes within 2.1 miles of ground zero. The force transmitted to the buried main from the 10 psi ground surface overpressure is not significant, in that it increases the existing operational 19,000 psi bursting and backfill stresses by less than 2,300 psi.[11] Other transmission mains are several miles farther away.

For aboveground gas facilities, thermal radiation, airborne debris, dynamic pressure and overpressure need to be considered. Thermal radiation cannot cause damage because of the absence of combustible components except the synthetic diaphragms and composition seats in distribution regulators. These devices, however, have sufficient metal mass to

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[10] Water effects (wave action and flooding from San Francisco Bay) are not specifically evaluated in this report. However, they are not considered able to cause significant damage to principle gas facilities.

[11] Spangler, M. G., Stresses in Buried High Pressure Pipe Lines. Petroleum Engineer, November 1954.

absorb radiated heat without injury to the synthetic materials. In only a few instances in the San Jose Area, principally at the Load Center, are distribution regulators above ground. Usual practice is to employ concrete pits with locked, steel pate covers. The computed rise in temperature of the body of a typical regulator at the San Jose Load Center from thermal radiation will not exceed 20°F, far below a destructive temperature. Thus, overpressure, dynamic pressure and airborne debris are the three effects which have potential to do damage in this attack.

GAS SYSTEM VULNERABLE LOCATIONS IN SAN JOSE AREA

The San Jose Area is unique in the Pacific Gas and Electric Company territory in having a high concentration of stream crossings. In the twelve (12) miles between downtown San Jose and Palo Alto, there are ten (10) rivers and creeks intercepting both transmission and distribution trunks in seventy (70) locations within the 2 psi range.

Each of the 70 stream crossings was evaluated to identify which mains, if damaged, might impair the capability of the system to deliver gas to the City of San Jose. Inspection of the system map indicated twenty-two (22) crossings, even if damaged, could not affect San Jose, leaving forty-eight (48) which might directly or indirectly have effect. A field survey was made of each crossing. Thirty-two (32) were found to be underground and not vulnerable and nine (9) were attached to concrete bridges which provided sufficient support and protection from blast and debris. The remaining seven involved exposed pipe which, if damaged, could significantly affect gas supply in San Jose. These data are summarized in Table 4.

None of the transmission mains incoming to Milpitas either from the south or north or the King Road trunk are considered vulnerable. There are no aboveground exposures and the closest approach to ground zero is 8.4 miles.

TABLE IV–Stream Crossings in San Jose Area and Potential to Impair Gas Supply in the City of San Jose.

Stream	Total No.	No potential to impair (number)	Potential to impair			
			Total number	Found underground	Found above ground	
					Supported on bridges	Exposed
Wooster Creek	1	0	1	0	0	1
Matadero Creek	3	2	1	0	0	1
Adobe Creek	4	1	3	3	0	0
Permanente Creek	8	6	2	2	0	0
Stevens Creek	14	6	8	2	2	[1]4
Calabasas Creek	13	4	9	8	0	1
Saratoga Creek	11	3	8	6	2	0
Guadalupe River	7	0	7	4	3	0
Coyote Creek	5	0	5	3	2	0
Penitencia Creek	4	0	4	4	0	0
Total	70	22	48	32	9	7

[1]Two (2) of these are the parallel Grant Road crossing.

GAS SYSTEM VULNERABLE LOCATIONS AND DAMAGE APPRAISALS

Locations of six aboveground gas main, stream crossings vulnerable to blast and missile damage are shown in Figure 5. Attack environmental data and results of damage appraisals are given in Damage Appraisals Nos. 1 through 5. A sample computation of pipe stress on which the appraisals are based is given in Appendix P.

The Calabasas Creek crossing, not included in the numbered appraisals, consists of 14 feet of 3 inch distribution main resting on the top surface of the concrete side wall of the bridge. Overpressure is 2.5 psi and angle of incidence is 89 degrees. The bridge sidewall and adjacent 6 foot chain fence provide missile protection. The main is not damaged by the attack.

Shown in Figure 5 are two locations where damages to other elements of the gas system are expected, namely, Milpitas Gas Terminal and the Load Center. They are described in Damage Appraisals 6 and 7.

No significant damage is incurred by the downtown San Jose cast iron system[12] because of the flexibility feature of leak clamped joints and the diminished ground shock at eight (8) miles from ground zero. A few circumferential fractures may occur, predicated on the basis that the occasional ones occurring under normal conditions will be hastened by the shock. The loss of gas and effect on local supply would be inconsequential, because of the low operating pressure (inches W.C.) and the leakage retarding effect of the surrounding soil.

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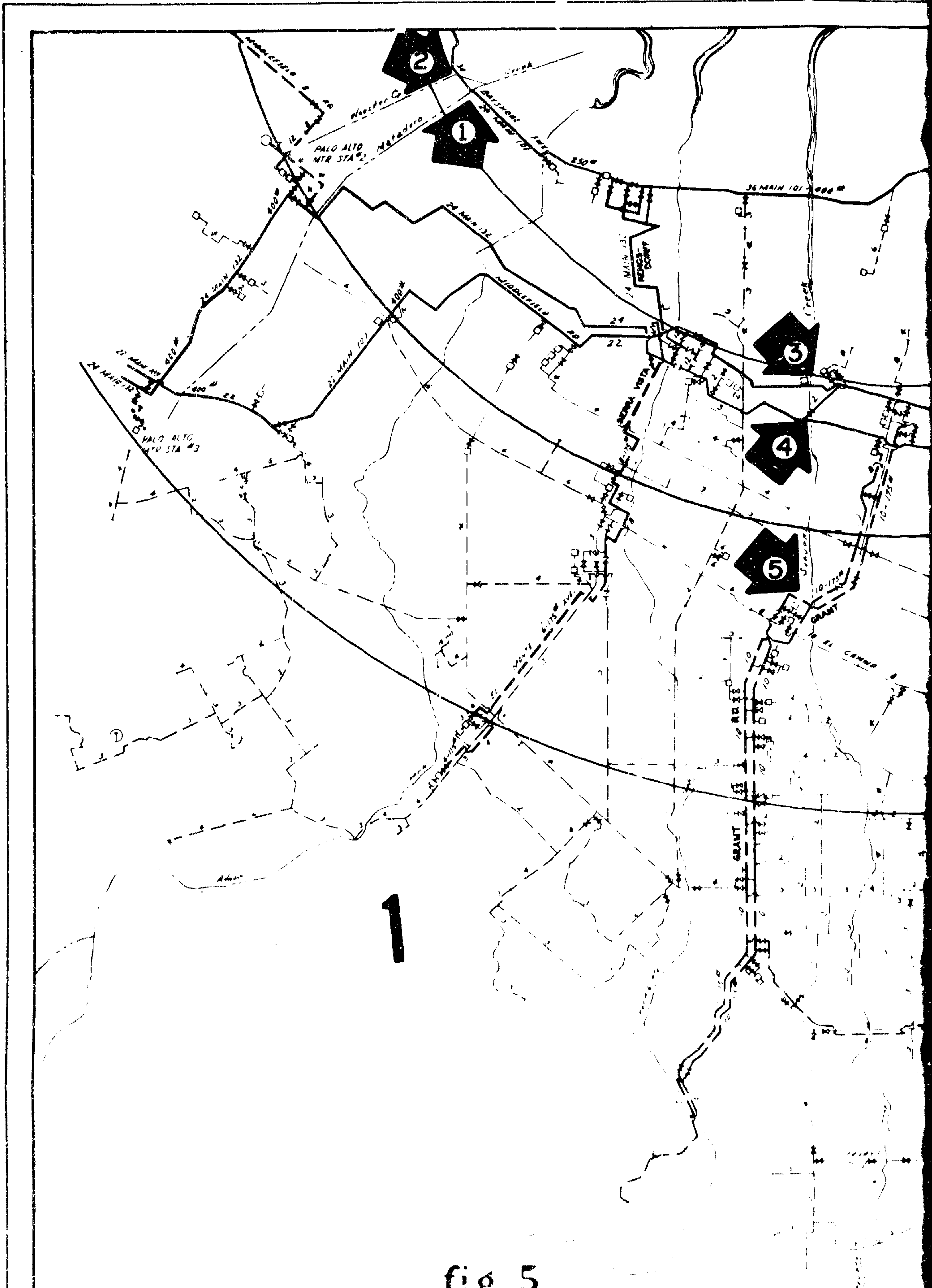
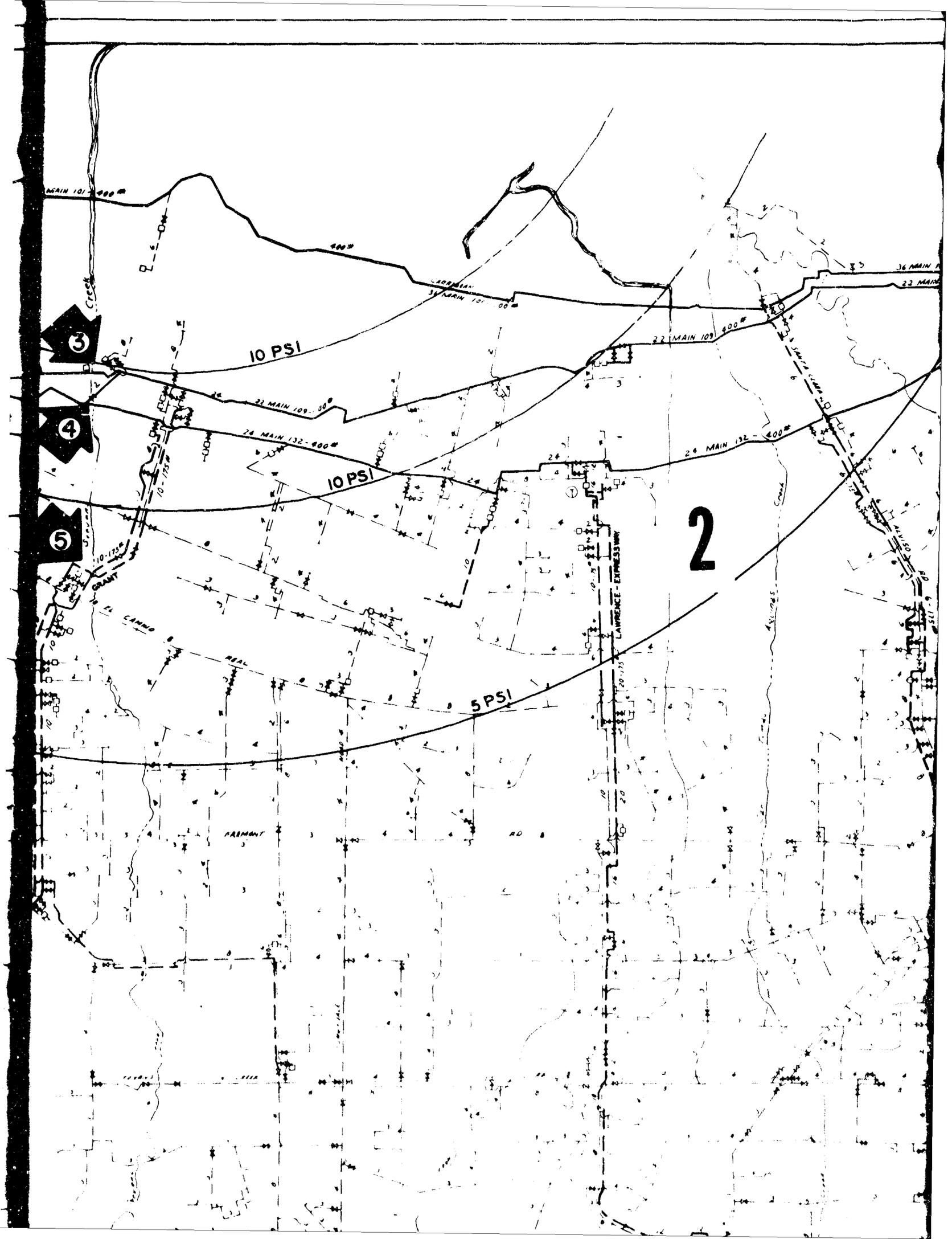
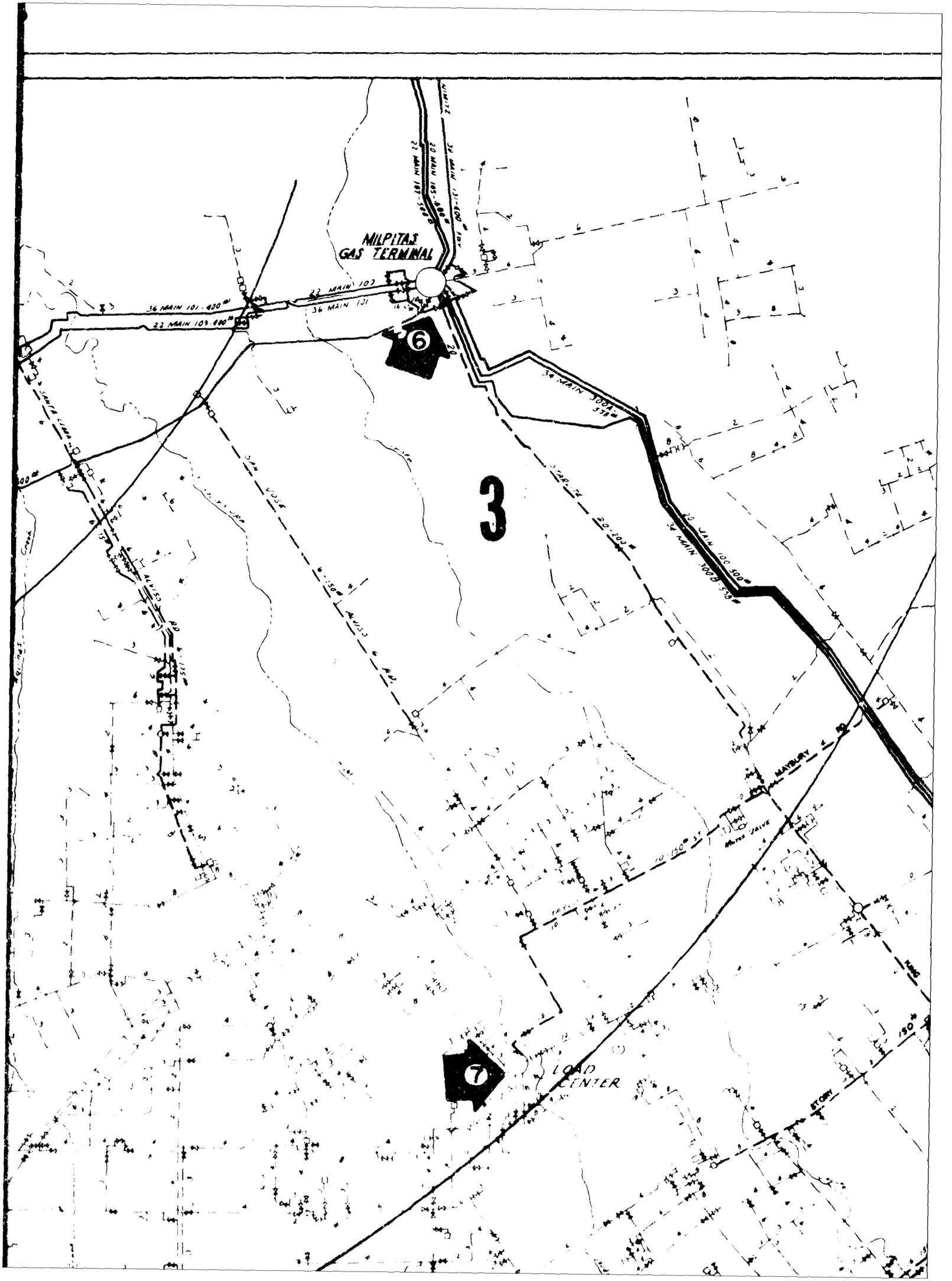
[12] Effects of Nuclear Weapons. U.S. Department of Defense and U.S. Atomic Energy Commission. U.S. Printing Office, Washington, D. C., April 1962, page 45.

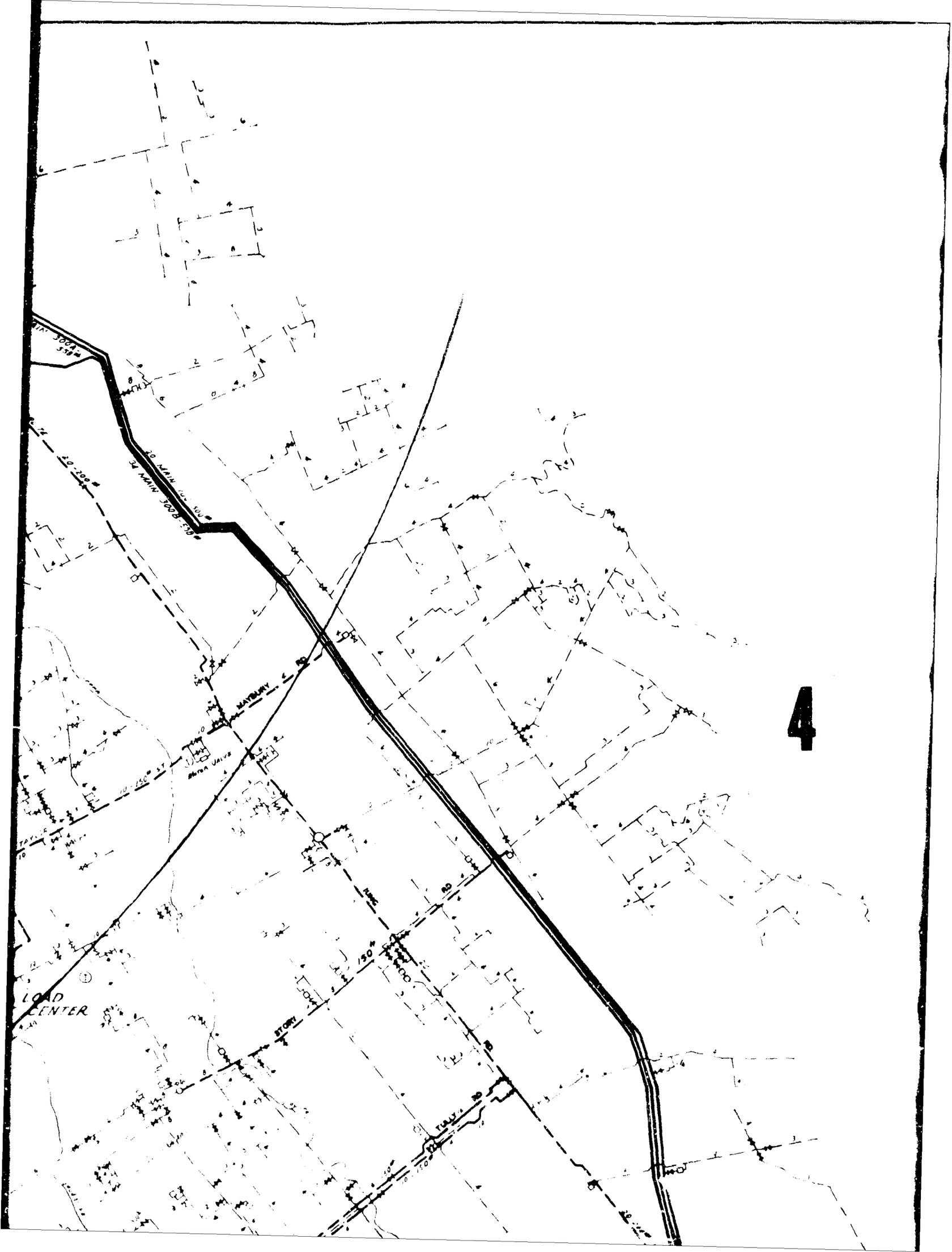


PALO ALTO MTR STA #2
PALO ALTO MTR STA #3
MIDDLEFIELD
SIERRA VISTA
GRANT
EL CAMINO
Wooster C.
Matadero
1

fig. 5


3
10 PSI
4
24 MAIN 132 - 400#
10 PSI
5
5 PSI
2
LAWRENCE - EXPRESSWAY
FREMONT
RD


MILPITAS GAS TERMINAL
36 MAIN 101 - 420#
22 MAIN 109 - 400#
22 MAIN 107
36 MAIN 101
6
3
7
MAYBURY
LOD CENTER


4
LOAD CENTER
HATBURY RD
STORY RD
TULLY RD
MAIN
150'

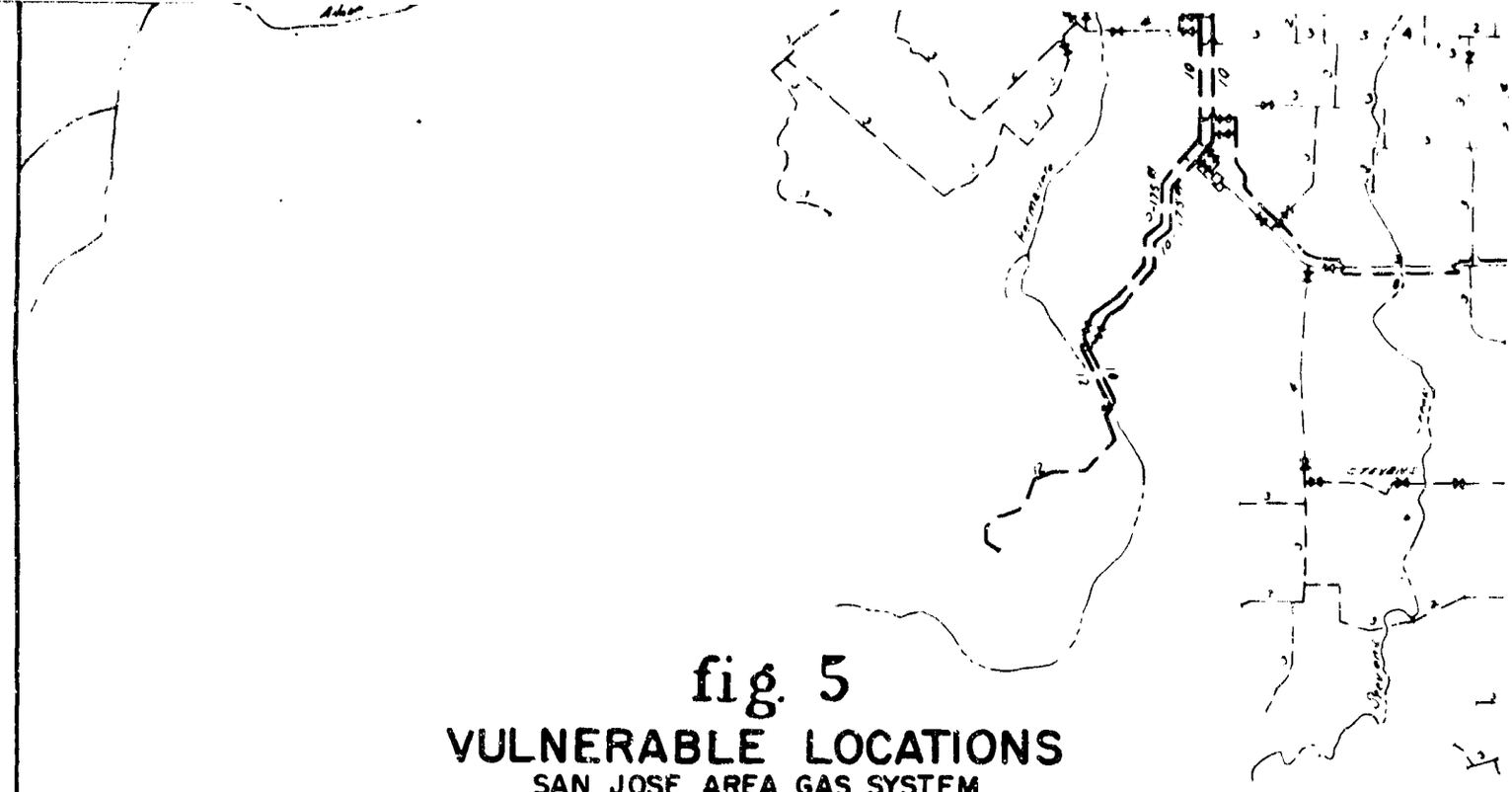


fig. 5

VULNERABLE LOCATIONS

SAN JOSE AREA GAS SYSTEM

1 MAIN 101 - MATADERO CREEK CROSSING

2 MAIN 101 - WOOSTER CREEK CROSSING

3 MAIN 109 - STEVENS CREEK CROSSING

4 MAIN 132 - STEVENS CREEK CROSSING

5 GRANT ROAD - STEVENS CREEK CROSSING

6 MILPITAS GAS TERMINAL

7 SAN JOSE LOAD CENTER

1 0 1 MILES

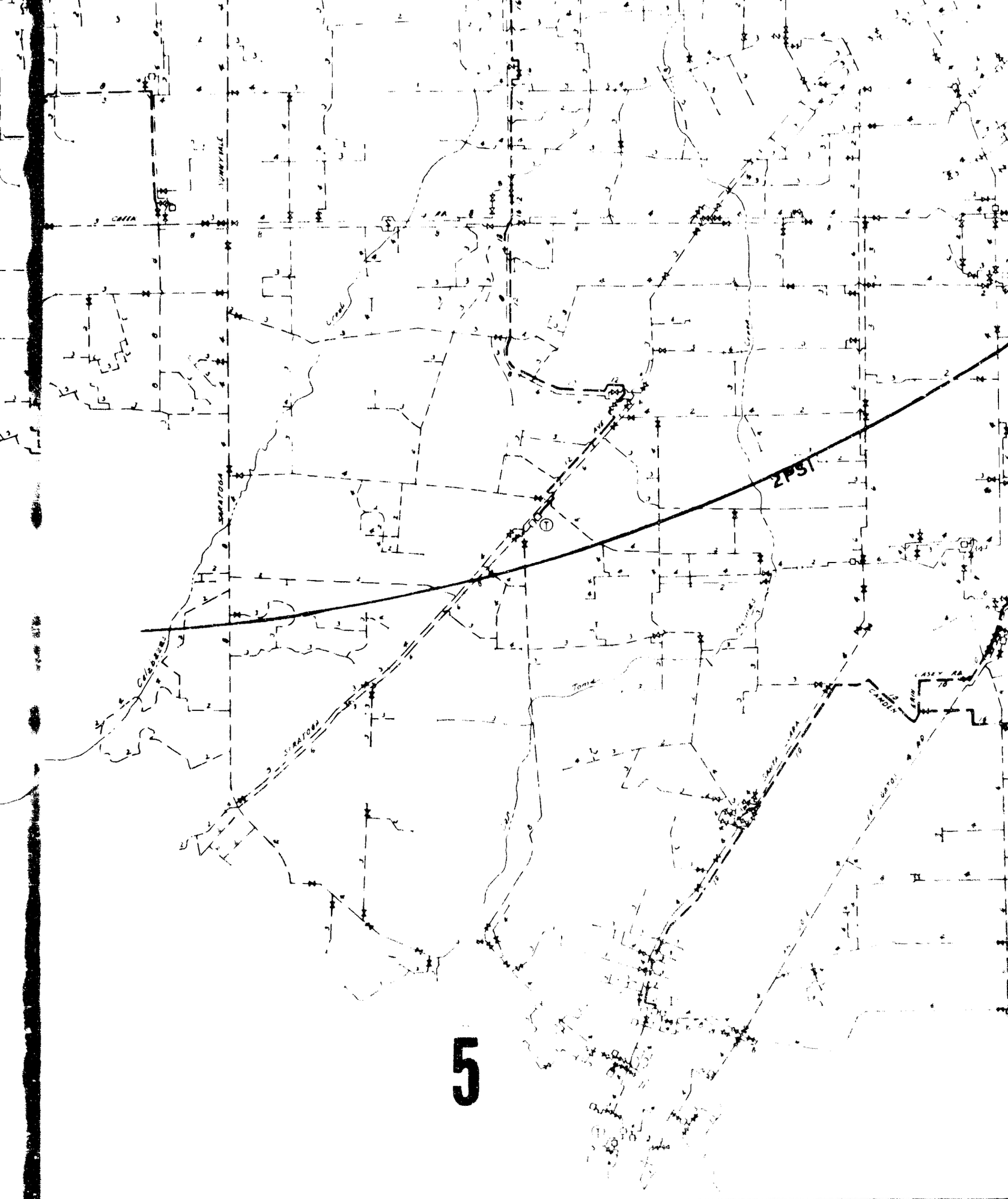
5000 0 5000 FEET

1 0 1 2 KILOMETERS

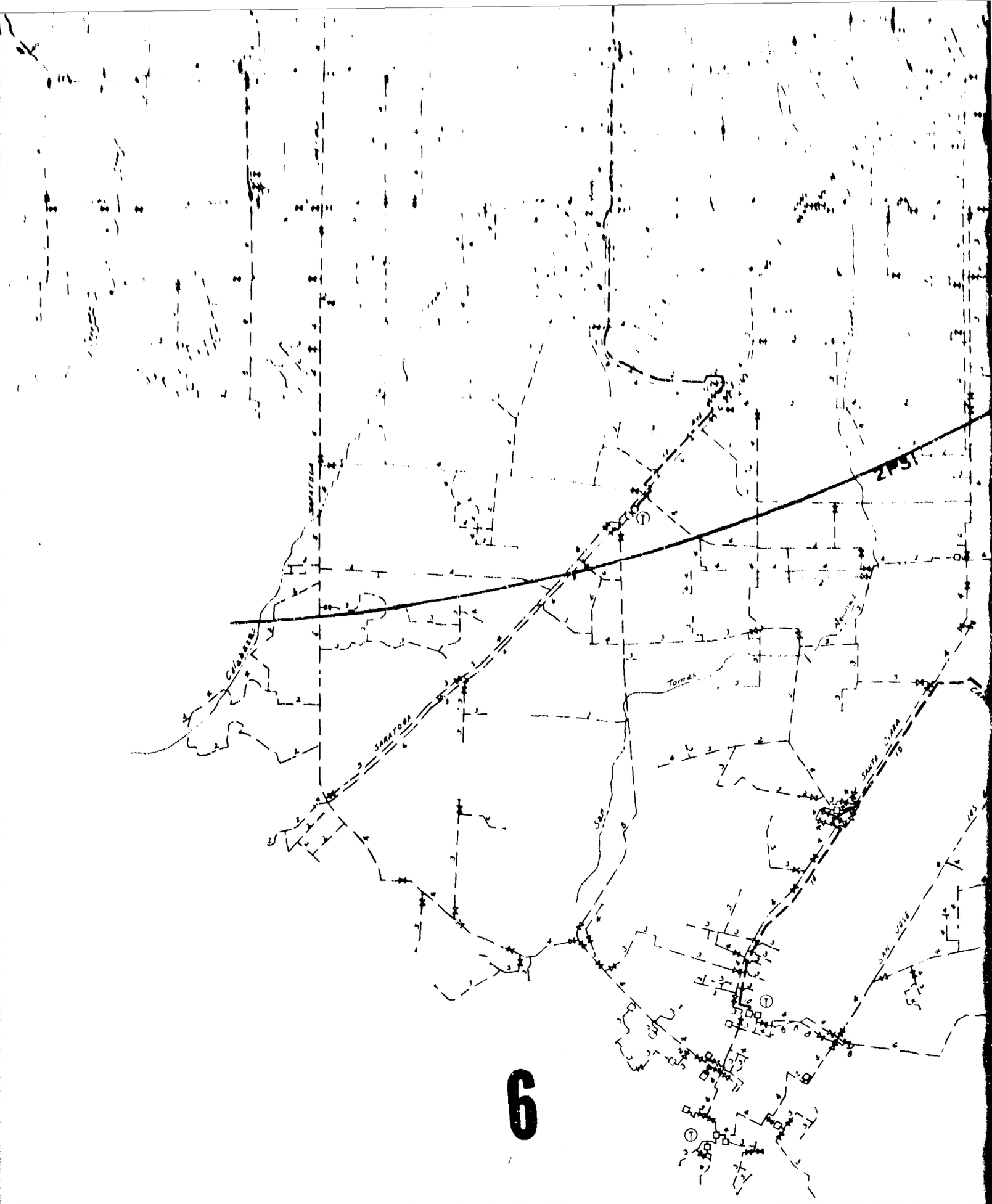
4

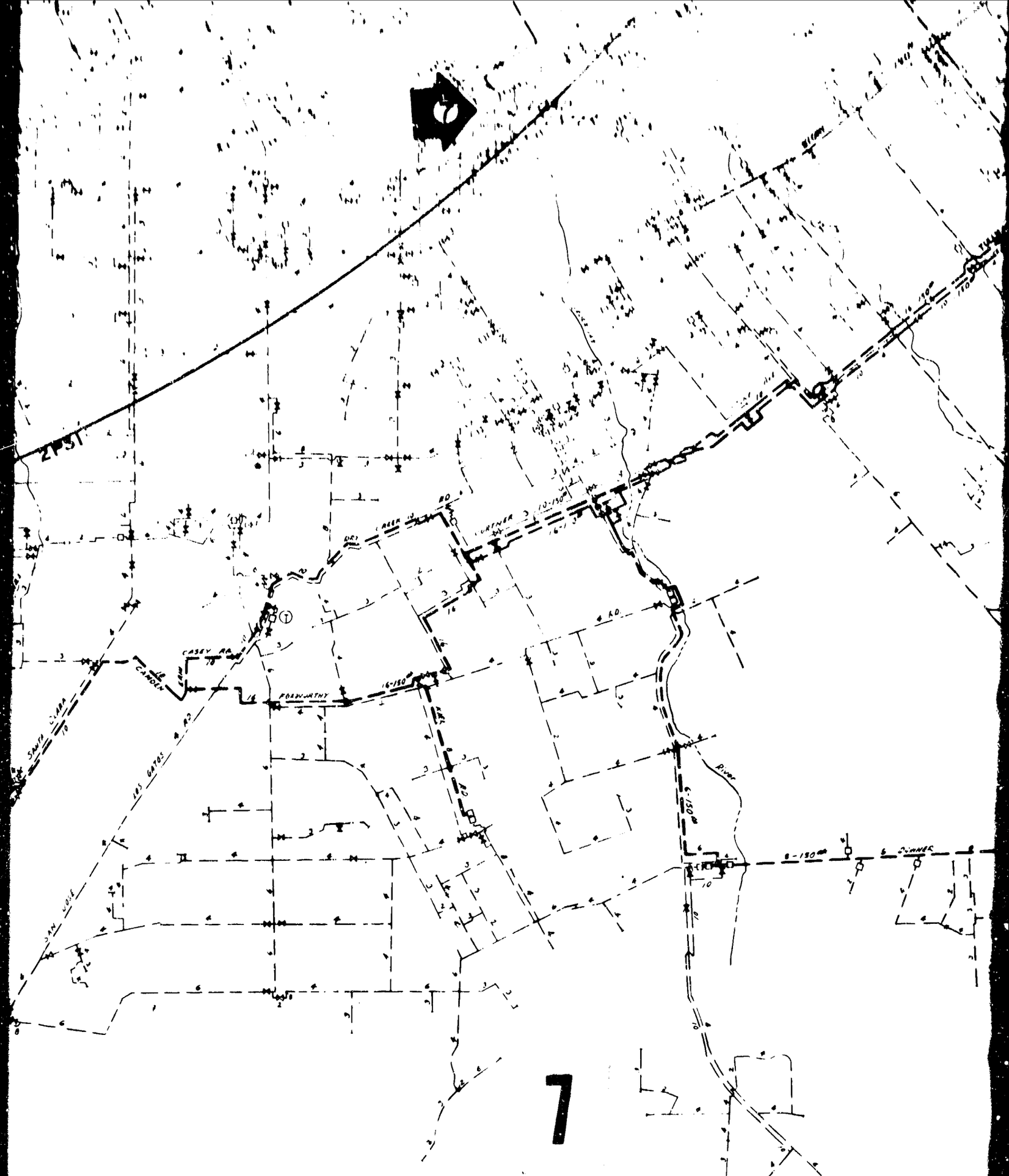
LEGEND

- TRANSMISSION MAIN
- MAJOR DISTRIBUTION MAIN
- SECONDARY " MAIN
- REGULATOR
- VALVE
- (T) TELEMETER PRESSURE POINT

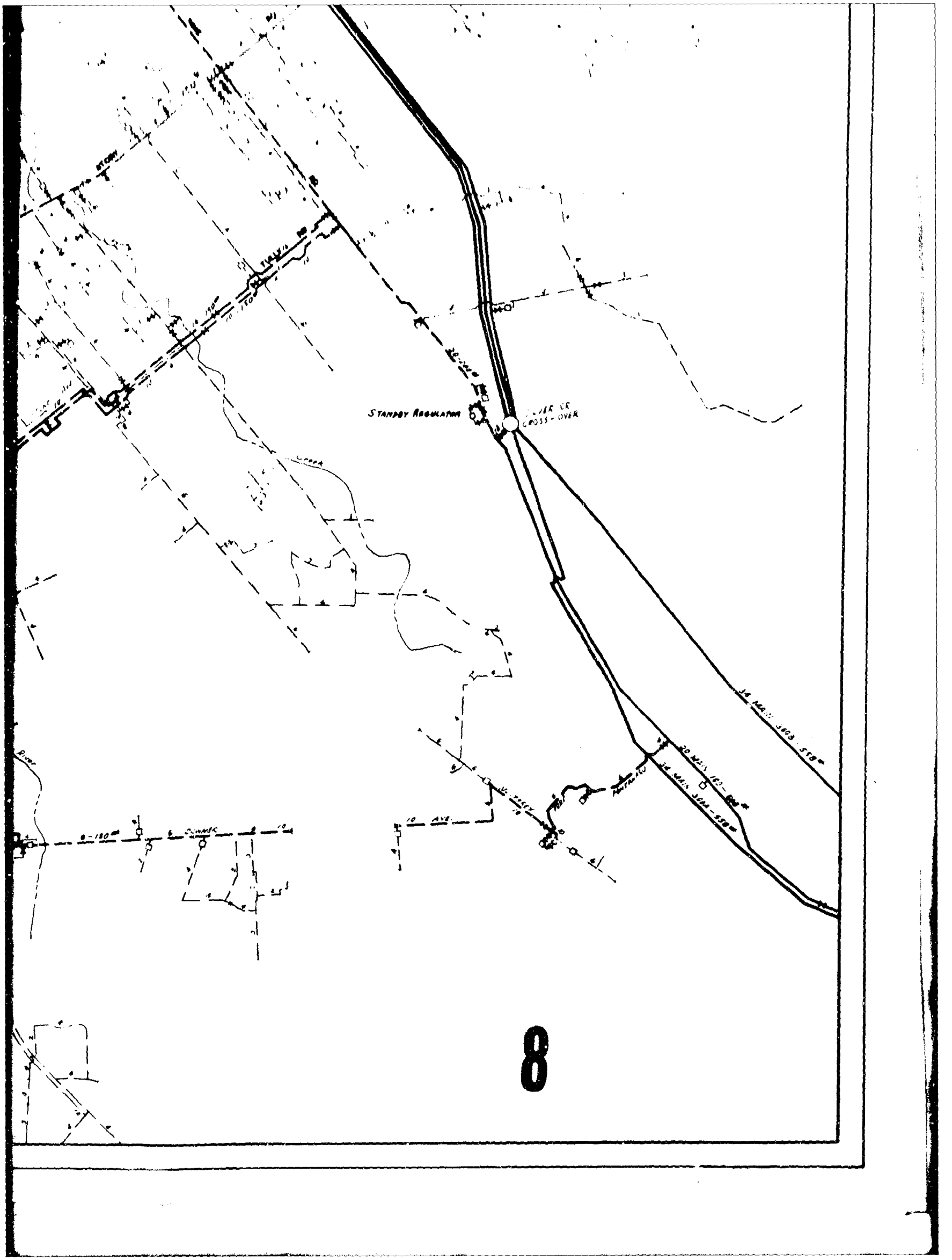


5


SARATOGA
Tomas
SARATOGA
SAN JOSE


CASEY RD
CAMDEN
FRANKLIN
SANTA CLARA
LOS GATOS
SAN JOSE
River

7


STANDBY REGULATOR
CROSS - OVER
10 AVE
River

DAMAGE APPRAISAL NO. 1 - Main 101 - MATADERO CREEK CROSSING

Figure 6. Main 101 Crossing Matadero Creek

I. Attack Data

Distance from GZ	5.4 km
Angle of Incidence	1.0 deg.
Overpressure	10.2 psi
Dynamic pressure	2.3 psi
Duration positive phase	5.7 sec.
Wind speed	291 mph
Thermal radiation	240 cal/cm^2
Residual nuclear radiation	-0-

II. Description of Facility

Pipe span is 22 inch OD, 5/16 inch wall, oxy-acetylene weld, 65 Mpsi tensile strength, 7.5 foot height, centerline measurement, above the 20 inch OD, 0.281 inch wall, 65 Mpsi underground main. Exposed length excluding the 3 - 20 degree bends each end is 56 feet. Underground connection between bend and main is made with 22 inch - 20 inch reducers. Welds are rated at 85 percent.

Facility is vulnerable to bending stress in span and to torsional stresses where underground ells and main connect.

III. Extent of Damage

There is no damage[13]; both bending and torsional stresses are less than the minimum yield strength of the pipe. Open fields and a freeway in the direction of ground zero eliminate missile damage.

[13]See stress analysis in Appendix A.

DAMAGE APPRAISAL NO. 2 - Main 101 - WOOSTER CREEK CROSSING

I. Attack Data

Figure 7. Main 101 crossing Wooster Creek

Distance from GZ	5.6 km
Angle of incidence	22 deg.
Overpressure	10.0 psi
Dynamic pressure	2.4 psi
Duration positive phase	5.8 sec.
Wind speed	295 mph
Thermal radiation	220 cal/cm^2
Residual nuclear radiation	-0-

II. Description of Facility

Pipe span is 30 inch OD, 0.375 inch wall, arch weld, 65 Mpsi tensile strength, 13.5 foot height, centerline measurement, above the underground main of the same specifications. Exposed length between centerlines of ells is 117 feet. Welds are rated at 100 percent.

Facility is vulnerable to bending stress in span and to torsional stresses where underground ells and main connect.

III. Extent of Damage

There is no damage; both bending and torsion are less than minimum yield strength of the pipe. Open fields and a freeway in direction of ground zero eliminate missile damage.

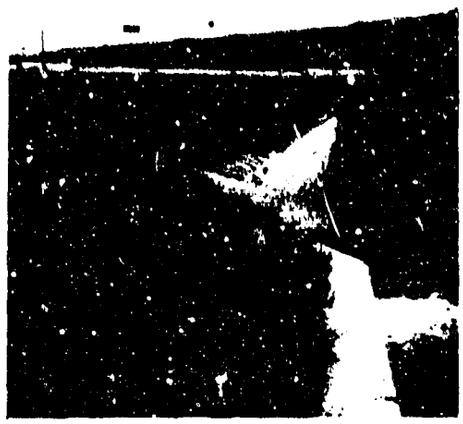


Figure 8. Main 109 Stevens Creek Crossing

I. Attack Data

Distance from GZ	5.9 km
Angle of incidence	8 deg.
Overpressure	10.0 psi
Dynamic pressure	2.6 psi
Duration positive phase	5.9 sec.
Wind speed	310 mph
Thermal radiation	195 cal/cm^2
Residual nuclear radiation	-0-

II. Description of Facility

Pipe span is 22 inch OD, 5/16 inch wall, arc weld, 65 Mpsi tensile strength, 7 foot height, centerline measurement, above the underground main of same specifications. Exposed length excluding 22 degree bends is 30 feet. Welds are rated at 100 percent.

Facility is vulnerable to bending stress in span, concrete abutment prevents torsional movement.

III. Extent of Damage

There is no damage; bending stress is less than minimum yield strength. Open fields and a freeway in direction of ground zero eliminate missile damage.

Figure 9. Main 132 crossing Stevens Creek

I. Attack Data

Distance from GZ	6.5 km
Angle of incidence	7 deg.
Overpressure	11.0 psi
Dynamic pressure	2.6 psi
Duration positive phase	6.0 sec.
Wind speed	309 mph
Thermal radiation	180 cal/cm^2
Residual nuclear radiation	-0-

II. Description of Facility

Pipe span is 24 inch OD, 0.281 inch wall, arc weld, 75 Mpsi tensil strength, 7.5 foot height, centerline measurement, above the underground main of the same specifications. Exposed length, including one 20 degree bend on each end, is 41 feet. Welds are rated at 100 percent.

Facility is vulnerable to bending stress in the span and to torsional stresses where bends connect to the underground main.

III. Extent of Damage

There is no damage; both bending and torsion are less than minimum yield strength of the pipe. Open fields and a freeway in the direction of ground zero eliminate missile damage.

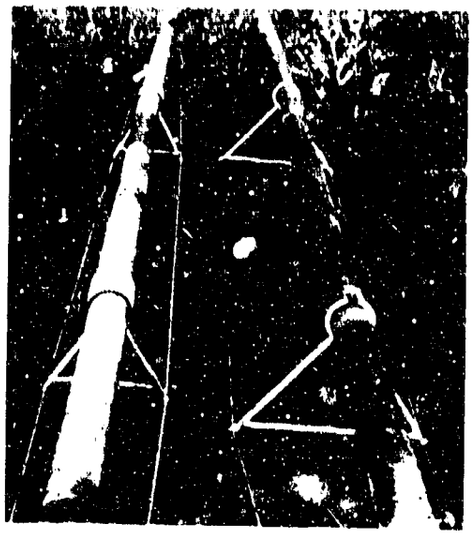


Figure 10. Grant Road distribution trunks crossing Stevens Creek

I. Attack Data

Distance from GZ	8.7 km
Angle of incidence	23 deg.
Overpressure	8.0 psi
Dynamic pressure	1.0 psi
Duration positive phase	6.2 sec.
Wind speed	195 mph
Thermal radiation	110 cal/cm^2
Residual nuclear radiation	-0-

II. Description of Facility

Each of the 2 - 10-3/4 inch OD, 0.238 inch wall, 74 foot spans receives vertical support assistance from 2 - 7/8 inch cables and "A" frames. Spans are anchored with 1,600 pound concrete blocks.

Facility is vulnerable to bending stresses in midspan and debris damage from trees lining banks of the creek.

III. Extent of Damage

There is no damage. Horizontal bending stress is less than minimum yield strength. The remaining strength (70 percent of maximum) is expected to withstand impact of debris.

Figure 11. Front of Control

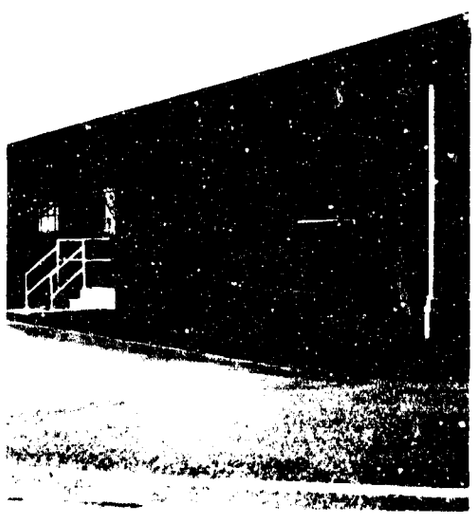


Figure 12. North Wall of Control Building

I. Attack Data

Distance from GZ	12.8 km
Angle of incidence[14]	56 deg.
Overpressure	4.0 psi
Dynamic pressure	0.3 psi
Duration positive phase	6.7 sec.
Wind speed	100 mph
Thermal radiation	50 cal/cm^2
Residual nuclear radiation	-0-

II. Description of Facility

The terminal is located on a 135 foot x 500 foot lot fronting on Alviso-Milpitas Road. Open fields and orchards extend from the rear of the lot toward ground zero. Six buildings comprise the terminal: control, compressor, garage, residence, and two small sheds housing the water and gasoline pumps. Only two are important to operations.

Control Building. A 30-foot x 88-foot one story steel frame, concrete block building reinforced for greater resistance to shifting and twisting from seismic shock than State requirements.

[14] With respect to north wall of Control Building.

The flat tar and gravel roof structure rests on steel decking tacked to steel roof I beams, supported by steel columns tied together at the top with angle iron and further stiffened by six 3/4 inch diameter diagonal tie rods. Floor beams are steel. Concrete block walls are reinforced on 2 foot 8 inch centers with vertical 5/8 inch rods. Window frames are cast steel and tied into walls with horizontal reinforcing rods above and below the frames.

The 20 foot x 36 foot control room contains three 5 foot x 7 foot windows and one exterior door (upper half glass) in the north and west walls facing ground zero. The steel instrument panels are tied into the building steel at floor and ceiling levels.

The building contains a 9 foot wide concrete lined full length basement, of which, 5 feet in depth is below ground level. The south, east, and west walls of the basement are foundation walls. The north wall is likewise a foundation wall supporting the instrument panel. Except for the below ground level metal door, several ventilating openings in the foundation walls, partially screened with reinforcing rods, and a ducts (metal covered outside of the building) for entry of pressure tubing lines, the basement affords good shielding to personnel from the blast. There is, however, a slot in the ceiling 10 inches wide extending along the back of the instrument board for accommodating the tubing lines to the various instruments. Small pieces of debris might penetrate the basement.

Compressor Building. This is a steel frame pitch roof, metal siding building housing two air compressors (for pneumatic operation of gas valve operators) and a standby 16 HP engine-5KW generator set. The 30 inch x 30 foot air receiver is outside. The generator set provides emergency power for lighting, radio and microwave transmissions and air motor control.

Yard Piping. The 165 foot deep front yard contains the incoming and outgoing transmission mains, all underground. The regulating control valves are buried except for stems

and attached air power motors and gear for manual operation. Bypass regulators are contained in plank covered concrete pits.

Water Tower. A 3,000 gallon wood stave, water tank 5/6 full sits on a wood platform 30 feet above ground level. It is located 30 feet west of the northwest corner of the control building towards ground zero.

III. Extent of Damage

Control Building. No damage to the exterior walls is expected except broken windows and blown down doors.[15] Partitions are damaged and shifted, but the building is usable. The instrument panels are not shifted. Glass windows in the doors of the instruments are broken, pens are bent, and readings are unreliable. Fire is not expected.

Compressor Building. The siding and roof are ripped off[16] and in so doing damage the wiring and accessories of the engine-generator set and render it unusable until repaired. The air receiver is undamaged.

Water Tower. The tank is undamaged, but the cover is crushed.

Yard Piping. No damage is expected to the underground piping. However, stems and attached gear of six valves of outgoing mains 101, 109, and 132 located in the West side of the yard are exposed to debris from the water and gasoline pump houses. Each main contains two valves in series about 30 feet apart. Some valve stems may be damaged, but it is expected that one valve at least in each main continues to be manually operable.

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[15] Jenkins, M. E., Saunders, D. L., City of San Jose Preliminary Casualty Estimate Five City Study. The Dikewood Corp., December 1966, page 214.

[16] op. cit., page 220.

IV. Results of Damage

Automatic operation in the Terminal temporarily ceased as a result of loss of auxiliary power and pneumatic air. However, pressure regulators bypassing the main control valves continue to function normally and control pressures within their settings.

Partial automatic operation of the st ion will be regained after the portable engine driven air compressor (stationed in the yard) is connected into the pneumatic air system and a portable electric generator (a readily available stock tool item) is secured.

Two of the three operators who took shelter in the basement are unharmed. After a period of checking with spare indicating pressure gauges and manometers, they will conclude that the flow rate leaving the Terminal in the outgoing transmission mains 101, 109, 132, and King Road is within the capability of the system.

Lacking means to communicate directly with either San Jose[17] or San Francisco, the operators will decide to hold normal pressures in the Terminal and advise Hollister to relay that information to San Francisco and San Jose.

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[17] See damage to communication facilities in Section 4.

Figure 13. Load Center Building

I. Attack Data

Distance from GZ	19.6 km
Angle of incidence[18]	31 deg.
Overpressure	2.2 psi
Dynamic pressure	0.2 psi
Duration positive phase	8.0 sec.
Wind speed	55 mph
Thermal radiation	20 cal/cm^2
Residual nuclear radiation	-0-

II. Description of Facility

This is the site of the former gas plant. It is now used as a distribution M&O supply sub-headquarters and for load center operations. Distribution facilities exposed to the blast are: (a) two water-sealed holders having a combined capacity of 3.5 MMcf and an electrically driven booster and (b) battery of five distribution regulators located above-ground in the yard for regulating Maybury trunk supply into the 50 psi distribution system and into the 20 inch downtown San Jose low pressure, cast iron main. There are 11 buildings on the property, only three of which are pertinant to this study:

1. Load Center. A one-story 24 foot x 30 foot reinforced, concrete block, tar and gravel roof building containing a gauge board with telemeter recording instruments.

2. Distribution Operations. A 46 foot x 28 foot reinforced concrete building used as an operating sub-headquarters by the Distribution Department.

[18] With respect to back wall of Load Center Building.

III. Extent of Damage

1. Water-sealed Holders and Booster. The lifts of the two holders are crushed, but are retained within the guide frames. The stored gas escapes, but does not ignite because of the height of release above ground level. The booster, being a piece of heavy equipment is undamaged.

2. Battery of Regulators in Yard. No damage is expected. The 6 foot surrounding chain fence and regulator control lines of steel piping are expected to withstand impact of any missiles.

3. Load Center Building. Its location in back of the large holder provides some protection from the blast. Doors and windows are blown in and roof rafters cracked, but otherwise building is usable. Recording instruments are along the east wall and out of line of the entering blast and are not damaged; doors are clear plastic.

4. Distribution Operations. Doors and windows are blown in. Interior and contents receive minor damage but are usable.

IV. Results of Damage

None of the damage at this location impairs gas distribution in the City of San Jose or the San Jose Area in any significant degree. The holder gas is unneeded, and the buildings remain usable. There are, however, some lost functions:

1. Ability to remotely operate the Maybury valve at King Road, assuming a power outage in the area.

2. Ability to obtain pressure conditions at eight (8) of the thirteen (13) telemeter points; five (5) are in the yard and unaffected.

Until power is restored, the Maybury valve can be hand-operated if there is need, but it is unlikely in view of the 700 Mcf/hr capacity of the bypass regulator.

Restoration of power will not reactivate telemeter transmittal at all pressure points; some are in the severly damaged area where wire circuits are destroyed. However, lack of knowledge of pressure at all points in the summer season is not critical.

SECTION III

POSTATTACK
CAPABILITY OF THE SAN JOSE GAS SYSTEM

INTRODUCTION

The area occupied by the City of San Jose is not compact and symmetrical; rather it is sprawling with several sparsely occupied, annexed areas in the vicinity of Milpitas Terminal which are connected to the city by the long slender stems shown in Figure 13. This results in parts of San Jose, represented by these semidetached areas, being exposed to overpressures as high as 8 psi; otherwise overpressure will not exceed 3 psi in the larger and more important part of the city proper. These semi-isolated areas are evaluated, even though they are relatively unimportant parts of the city from a population viewpoint.

Postattack evaluation of the degradation and capability of the gas system in San Jose is based on two time intervals:

1. Before the start of emergency measures by the utility. Although the duration of this period is short term and temporary, it is discussed to indicate the initial effects of the damage.

2. After completion of emergency measures. This period is expected to begin within 24 to 36 hours after the attack, depending on delays caused by debris.

Although the study is directed at the City of San Jose, the impairment in gas service in the larger San Jose Area is included to round out the analysis.

GENERAL

Prior to the attack the gas flow rate through Milpitas Terminal will drop sharply from the 14 MMcf rate as industry shuts down. After the attack the rate will increase, developing from damaged meter sets and houselines on customers' premises in the area west of

the city where severe structural damage is experienced. An estimation of the added gas demand from these sources is not part of this study, but the aggregate amount is not considered large enough to tax the capacity of the transmission system incoming to Milpitas. Rather, it partially offsets the demand that otherwise normally would be made by curtailed industry.

The conclusion that the transmission system is not endangered by excessive demand, is reached by Milpitas uninjured operating personnel after checking station pressures with spare gauges and manometers. Having no immediate means to communicate with either San Jose[19] or San Francisco, they will stand by and make volume or pressure adjustments as needed by manual means.

EFFECT ON SAN JOSE BEFORE EMERGENCY MEASURES

Gas continues to be available in normal quantities in all parts of the San Jose distribution system immediately following the attack. Gas supply in the city is unaffected for the reason that 94 percent (see Table III) comes in from the undamaged King Road, Maybury, Story, and Tully trunks. Pressure in King Road is adequate at all times. Even if trouble should develop at Milpitas and the outgoing King Road pressure should decline, the stand-by regulator at Silver Creek would react to support King Road and maintain pressure into San Jose.

EMERGENCY MEASURES IN THE SAN JOSE AREA

It is expected that several hours will be required by San Jose Division to put radio equipped vehicles into the field and survey conditions following the "all clear" signal.

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[19] See damage to Milpitas communication facilities in Section IV.

The survey will show no need for gas service in the foreseeable future in the heavily damaged and uninhabitable buildings in the area west of the city although the distribution system therein is undamaged. This conclusion, plus the need to eliminate hazard of leaks from damaged meter sets and houselines, will dictate that the area should be isolated and gas system therein shut down.

The shutdown measures, which will be carried out concurrently, are:

1. Valving off the Santa Clara Road, Lawrence, Grant Road, and Sierra Vista distribution trunks from the transmission lines.

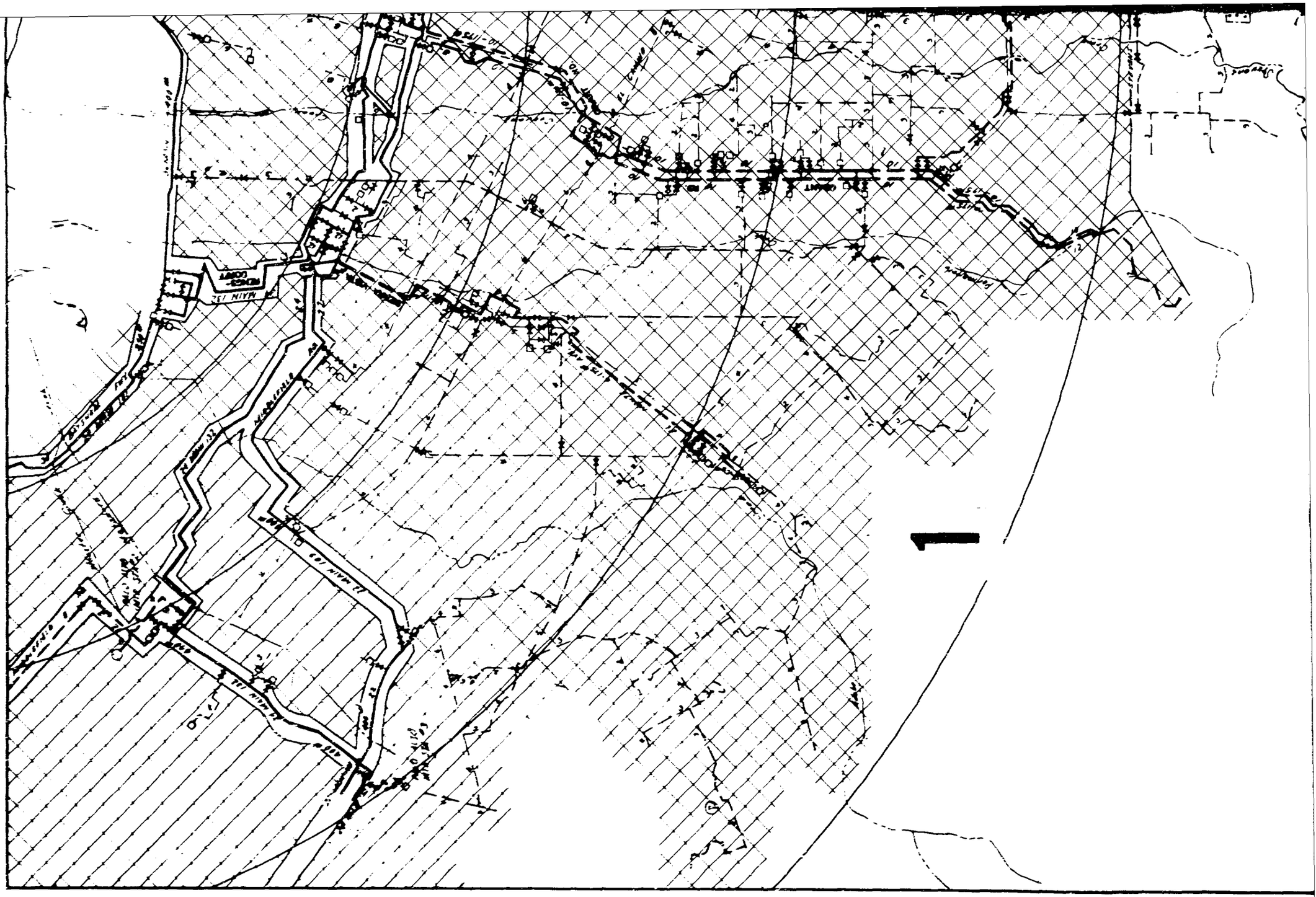
2. Valving or otherwise cutting off the secondary mains feeding into the heavily damaged area from the east.

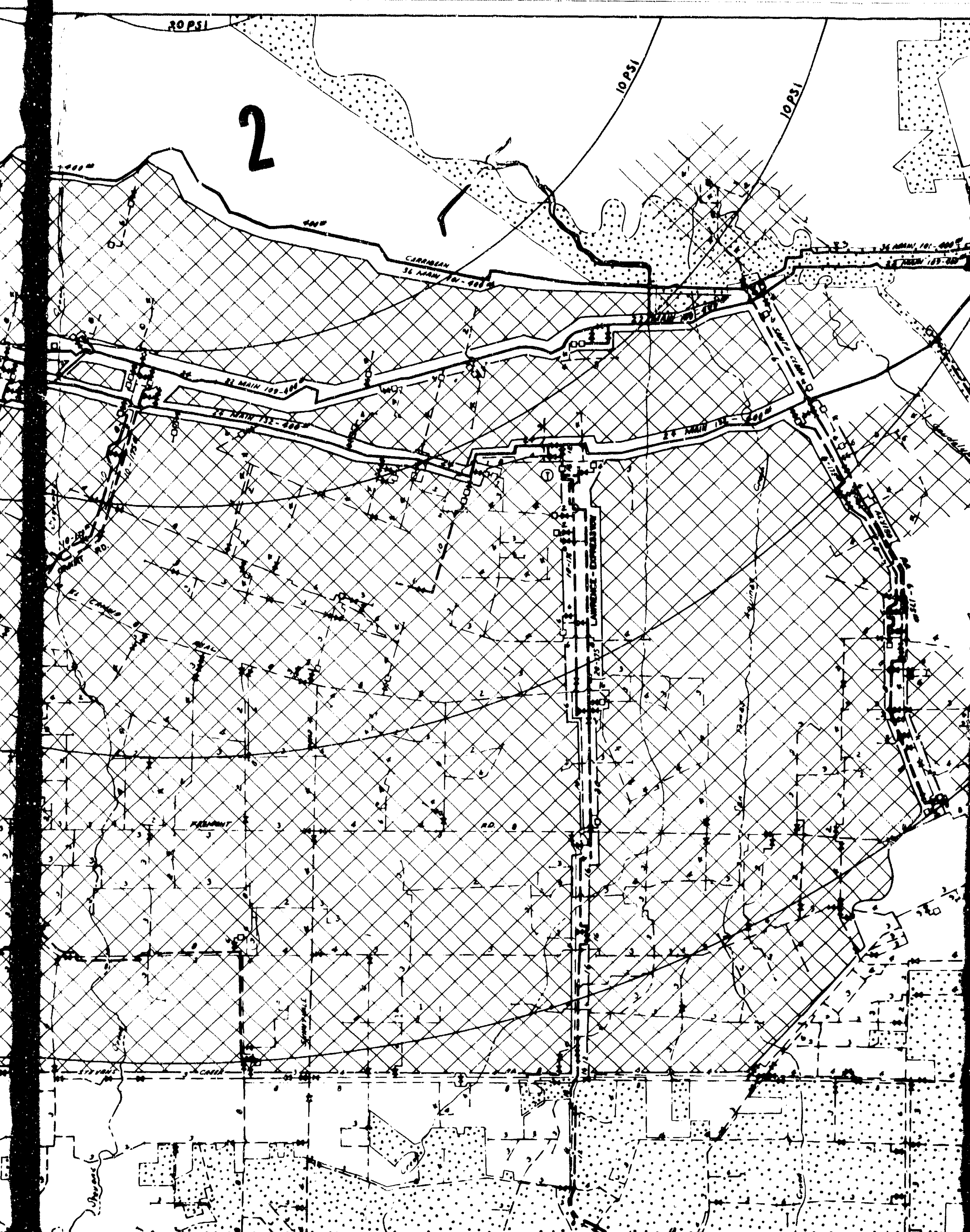
It is expected that the line of separation will lie approximately along an arc having a radius of about nine (9) miles and a center at ground zero (see Figure 14). This is the most feasible route. It not only contains nearly all valves required, but minimizes proximity of personnel to fire by following a wide street and open fields. A few small secondary mains lacking valves will require squeezing or plugging.

EFFECT ON SAN JOSE DURING PROGRESS OF EMERGENCY MEASURES

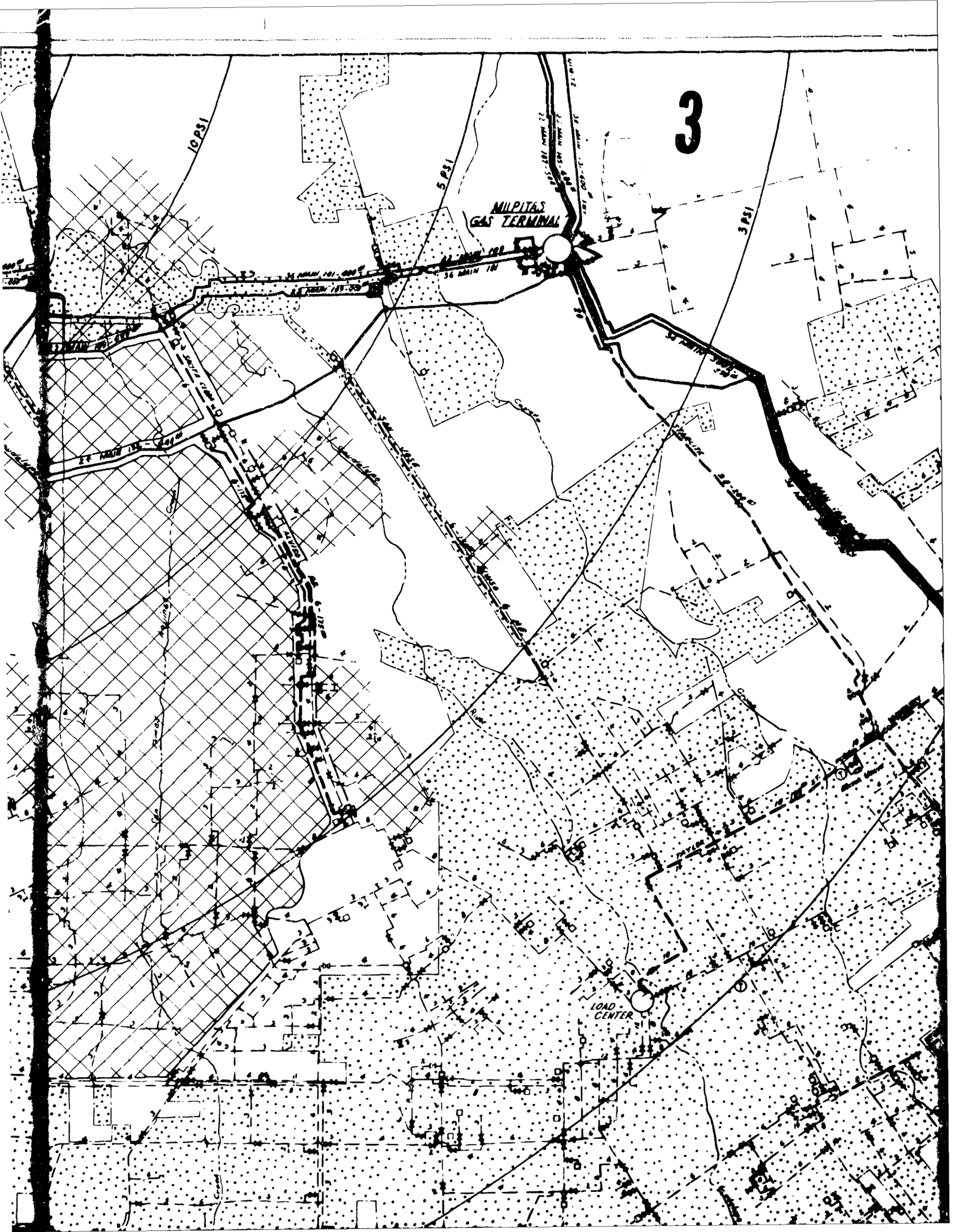
The shutting down of the Santa Clara Road, Lawrence, and Grant Road trunks, which jointly supply approximately 3.8 percent (see Table III) of San Jose's requirements, does not diminish supply in the city.

The reserve capacity of the Maybury, Story, and Tully trunks is easily capable of making up the 3.8 percent loss in support. Story and Tully regulators will automatically respond in order to step up supply. The motorized plug valve of Maybury is expected to be in a closed position at this time of night and remains so because of telemeter failure.





20 PSI
10 PSI
10 PSI
2
CARRIBEAN
36 MAIN
22 MAIN 109-400
24 MAIN 132-400
24 MAIN
LAWRENCE - EXPRESSWAY
FREMONT
RD.
STEVENS
CREEK

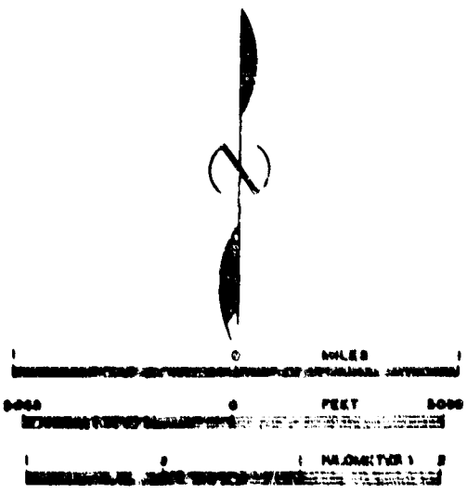

3
10 PSI
5 PSI
3 PSI
MILPITAS
GAS TERMINAL
LOAD
CENTER


4

fig 14

POST ATTACK GAS SUPPLY SYSTEM

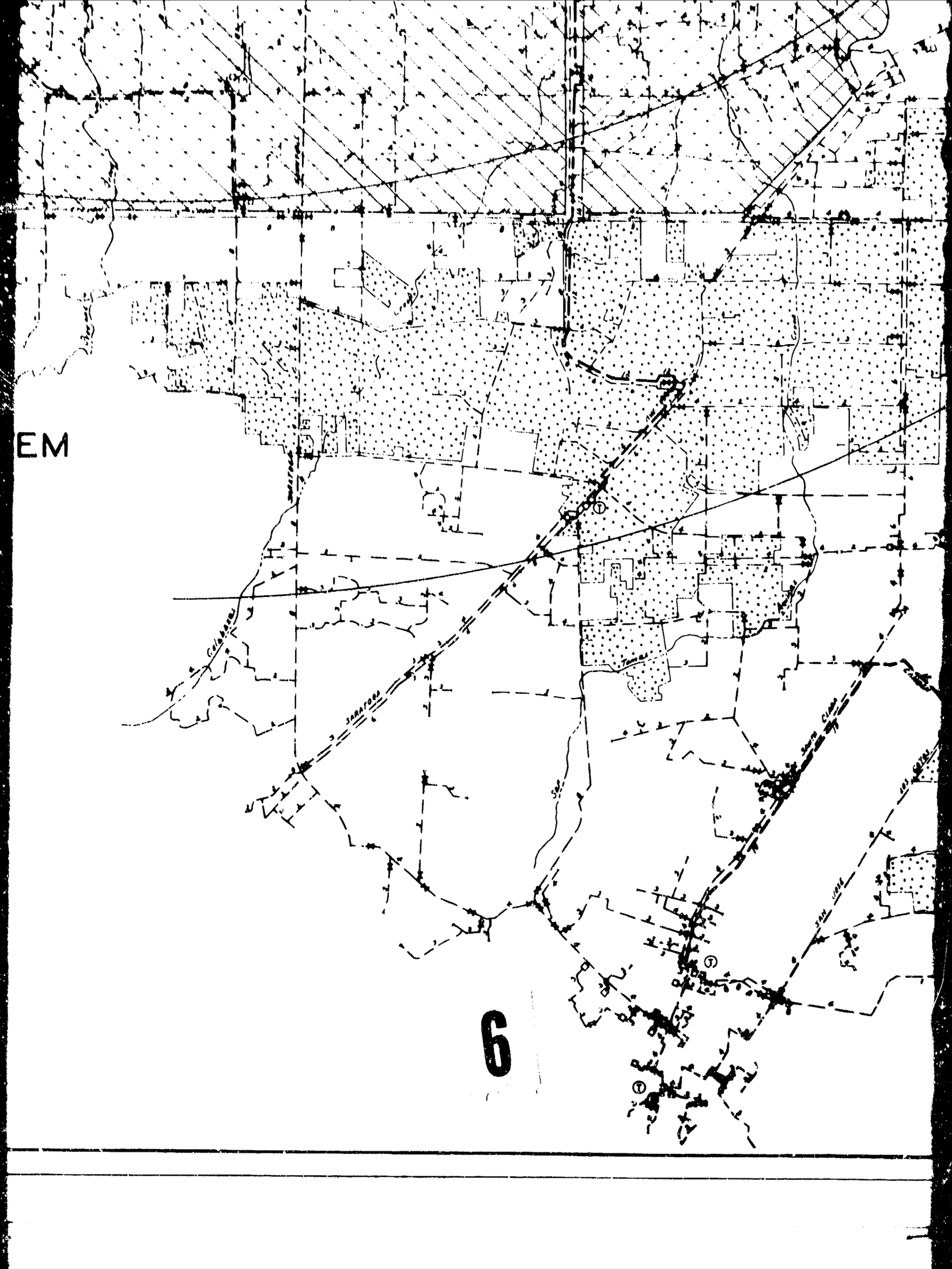
SAN JOSE AREA

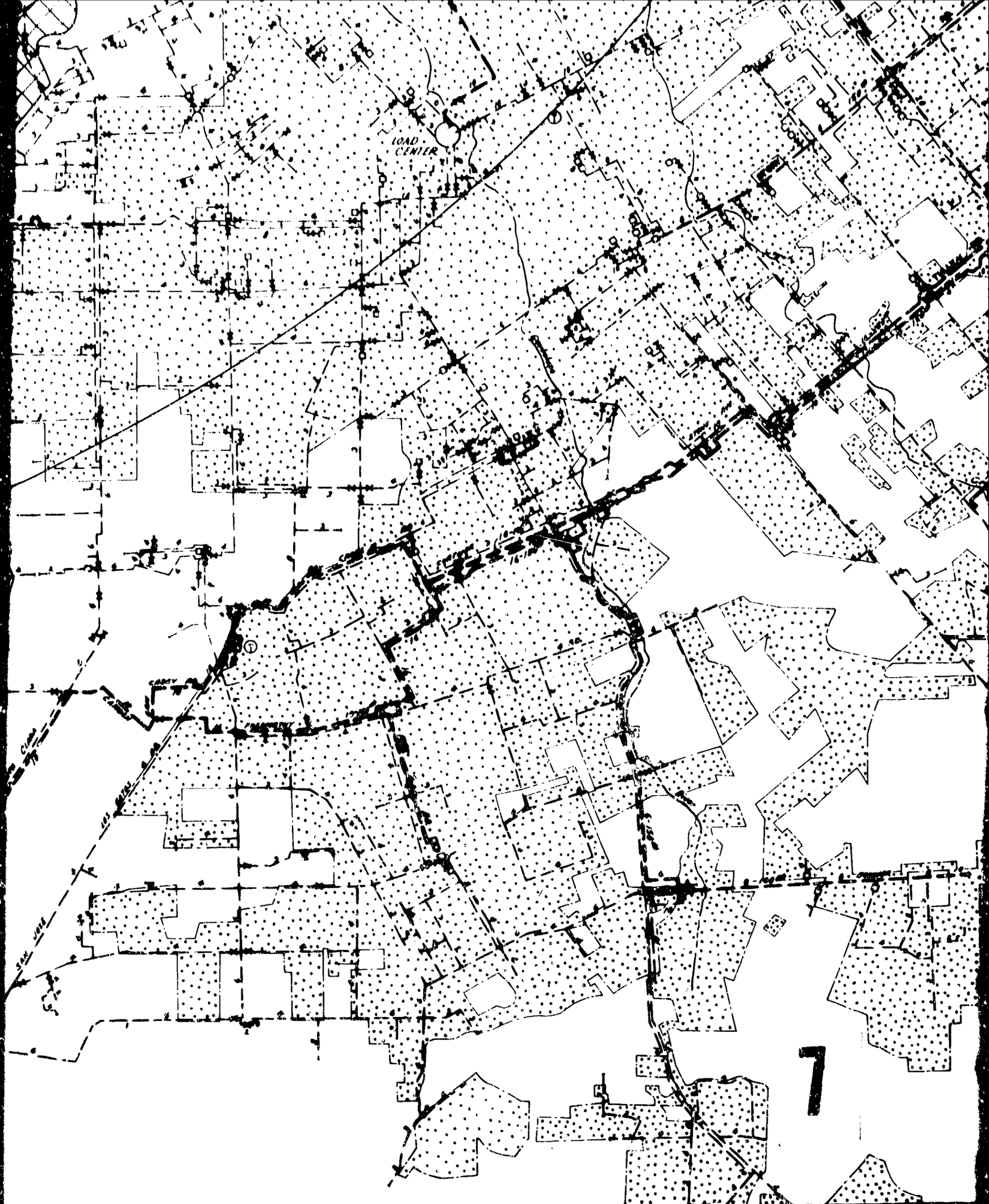


5

LEGEND

- CITY OF SAN JOSE
- DISTRIBUTION SYSTEM SHUT DOWN
- TRANSMISSION MAIN
- MAJOR DISTRIBUTION MAIN
- SECONDARY " MAIN
- REGULATOR
- VALVE
- TELEMETER PRESSURE POINT


EM
6


ROAD
CENTER
7


SILVER CR.
CROSS-OVER
8

Its immobilization is not critical, because its bypass regulator with an estimated capacity of 700 Mcf/hr is operative. The added supply from the three trunks will sweep out beyond the limits of San Jose and tend to take over nearby portions of Cupertino, Sunnyvale, and Santa Clara.

The final step in the emergency measures will be to return the Santa Clara Road and Lawrence trunks to operation after stripping them of delivery into the isolated area by closing valves to their secondary distribution mains in regulator pits. The undamaged Grant Road trunk can be returned to operation whenever needed.

POSTATTACK CAPABILITY OF THE SAN JOSE GAS SYSTEM

There is no degradation of gas supply in the City of San Jose or at any time during or after the attack. This applies also the the adjacent towns of Campbell, Saratoga, Los Gatos, Monte Sereno, and parts of Cupertino, totaling approximately 62 percent of the San Jose area population.

The returning of the Santa Clara Road, Lawrence, and Grant Road trunks to operation, while not needed for San Jose, does provide alternate supply routes into the City and, at the same time, enables service to be extended into the isolated area as needed.

COUNTERMEASURES

Suggested countermeasures which would tend to reduce the vulnerability of the San Jose gas system and strengthen continuity of operation are:

1. Install important gas system facilities underground. In the San Jose Area this applies to: (1) the five existing transmission and major distribution aboveground unprotected spans over creeks downstream from Milpitas Terminal, and (2) the battery of aboveground regulators in the Load Center yard.

Although not damaged in this attack because of the distance from ground zero a closer strike could inflict significant damage particularly to the regulator set which is vulnerable to missiles.

The exposed span probably will be eliminated in time in any event; in recent years eight (8) similar crossings have been placed underwater.

2. Loose planks covering regulator pits should be secured in order to reduce exposure of static and other small diameter pressure lines to damage from planks jostled and dislodged by the blast wave and subsequently falling back into the pit.

3. Prepare emergency plans for stations with personnel on duty, directed specifically toward employee protection, where to take shelter, actions to take with respect to windows, doors and operation of equipment under emergency conditions.

4. Develop an awareness in key personnel to recognize practices or conditions that could lead to adverse results in the event of an attack. For example, on an initial visit to the Load Center last fall it was felt that the aboveground regulator set at the Load Center would not be damaged from airborne missiles because of absence of material in the general area. However, on June 17th it was observed that a stack of meter platforms employing short lengths of loose 2 inch x 12 inch planks was piled adjacent to the regulator set upstream towards ground zero. These loose boards could become airborne and damage regulator control lines.

SECTION IV

GAS SYSTEM SUPPORT FACILITIES DAMAGE APPRAISALS
SAN JOSE AREA

GENERAL

The gas system support facilities and services considered in this study comprise the following: warehouse supplies, utility owned communication equipment, electric power, transportation equipment and major portable tools.

Descriptions of the facilities, locations where they are stationed or used, attack overpressure, expected damage and effect on gas system operation are given below:

GAS SYSTEM MAINTENANCE AND OPERATING SUPPLIES

Supply items, except pipe which is stacked in the yards, is warehoused in buildings at two locations:

1. Load Center - San Jose. The bulk of the supplies is contained in a single story 132 foot x 60 foot steel frame, iron siding, pitch roof building. Distribution regulators, flanges and associated materials are warehoused in a 24 foot x 80 foot brick building located on the lee side of the large holder.

Overpressure is 2.2 psi. Buildings sustain light damage consisting of doors and windows blown in and siding panels dished or ripped off. Supplied, although disarranged are accessible and usable. Fire is not expected.

2. Service Center - Cupertino. The building is a single story, 103 foot x 51 foot concrete block, flat tar and gravel roof. Roof structure is supported on laminated wood beams. Connecting at right angles on each side are loading platforms open on two sides, likewise having tar and gravel roofs.

Overpressure is 3.5 psi. The roofs are splintered, dislodged and collapse, carrying parts of the concrete walls. Supplies are covered with debris but are accessible and usable. No fire is expected; wide parking areas bordered by orchards isolate the buildings on three sides with a freeway on the fourth.

Salvageable supplies are considered ample for the San Jose Area in the immediate postattack period. Need will come later when the isolated area is rebuilt.

COMMUNICATION FACILITIES

In normal times, local operation of the San Jose Area gas system depends on communication between four centers: (1) Milpitas Terminal, (2) Load Center, San Jose, (3) Service Center, Cupertino, and (4) the Division Office (to a limited extent).

In the initial postattack period the immediate need is communication between Milpitas and the Load Center to coordinate operation of the San Jose Area system. This is based on the premise that the Center will be the headquarters of field recovery operations.

The facilities at each location, overpressures, anticipated damage and effect upon gas system operation are:

1. Milpitas Terminal. Normally, the Terminal is linked to all division points and San Francisco by microwave via Loma Prieta, and by private wire lines to the Division Office and to both San Francisco and Oakland, (see Figures 3a and 9). In addition, its base radio station and antenna in the yard and the remotely controlled transmitter on Loma Prieta provide wide coverage of its operations. Automatic standby electric power is maintained. Details of the facilities are:

(a) Microwave parabolic antenna. It is located on the south side of the building approximately 8 feet above the roof line and clamped to 4 inch extra strong pipe.

Pipe is tied into a steel beam at roof level and bolted to a concrete pad at ground level.

(b) Radio antenna. It is a four leg 2 inch x 2 inch x 3/16 inch angle iron, lattice construction mast - approximately 100 feet high and guyed at top and one-third levels with 3/8 inch cable.

(b) Private telephone wire lines. Wires drop from a poleline along Alviso Road to a 20 foot high pole in the S.E. corner of the yeard; then are conveyed by underground conduit to the control building.

Overpressure is 4.0 psi. Following the blast the wire line and microwave telephone facilities are inoperative from three causes: (1) wire line and power poles are down along Alviso Road[20], (2) the PBX board in the control room is damaged by window fragments and (3) the station is out of power (see Milpitas compressor building damage in Section II).

The Terminal, however, can communicate with Hollister (a Pipeline Station 40 miles south) by mobile radio via the undamaged remotely actuated transmitter on Loma Prieta. Two radio vehicles are usually parked at the Terminal at night, one on the lee side of the building with respect to ground zero.

In addition, Milpitas and the Load Center can exchange information by relay through Hollister using the undamaged microwave channel between Hollister and the Division Office. This will suffice in the immediate post attack period to coordinate operations until San Jose positions a radio truck at the Terminal for direct communications.

The Terminal's radio mast and antenna in the yeard and the transmitter in its protected location behind the gauge board are not damaged. The spare microphone in the

[20] Jenkins, M. E., Saunders, D. L., City of San Jose Preliminary Casualty Estimate Five City Study. The Dikewood Corp., December 1966, page 640.

transmitter cabinet permits the facility to be returned to operation as soon as a portable generator set is secured (a stock item and readily available).

2. Load Center, San Jose. The Load Center is connected to the Division Office and Milpitas Terminal by private wire lines and to the balance of the division points by transfer to microwave. The Center is also the location of radio transmitting and receiving equipment to and from mobile radio vehicles in the field. Emergency power is maintained at the Center. Details of the facilities are:

(a) The private wire line circuits between the Center and Division Office are partly underground cable and overhead wires.

(b) The radio antenna is mounted at the top of the frame of the large holder; the transmitter is located in a protected location behind the gauge board in the Load Center building. Three consoles jointly using the radio facilities are: (1) Load Center, (2) Distribution Field Office (at the Center), and (3) Customer Service in the Division Office building.

The overpressure is 2.2 psi. Several or more wire line circuits between the Center and the downtown office are expected to survive. The eleven (11) interconnecting circuits provide diversity from complete outage by missiles. However, wire line communication with Milpitas in interrupted because of downed poles in the vicinity of Milpitas. Communication remains intact between the Load Center and Hollister (and also San Francisco) via undamaged telephone equipment in the downtown office and the Loma Prieta repeater station. By utilizing Hollister as a relay point, the Load Center can relay information to Milpitas or vice versa.

3. Service Center, Cupertino. Gas Department communication with other points in the area is by microwave via Montebello Ridge and Loma Prieta. Except for mobile radios in vehicles headquartered at this location there are no radio facilities.

Overpressure is 3.5 psi. The microwave antenna, clamped to a 4 inch E. H. pipe mast supported by the roof, is disoriented by damage to the roof strucutre. As a consequence, mobile radio remains the sole means of communication with the Load Center and Division Office. Although this is an inconvenience it is not serious, since the Load Center will be the center of recovery operations.

4. Division Office. The Division Office and operating centers are linked by microwave and wire lines (see Figure 4). The five microwave antennas are supported by pipe masts bolted to the exterior concrete walls at the top of the building.

The overpressure is 1.8 psi. Neither the telephone board equipment nor the microwave antennas are damaged. The 3 story building is reinforced concrete and sustains only window breakage. The height of the antennas above ground precludes missile damage.

Radio communication between the Center and its radio equipped vehicles in the field is unaffected by the attack. The holder frame, although experiencing some distortion, does not affect the antenna; the console in the Load Center office, although blown from the desk, remains operable[21] and the transmitter in its protected location is undamaged.

Mobile radio, which normally handles the bulk of communication between local operating offices and field operating personnel, will continue to do so in the post attack period. The Central District has sufficient mobile equipment to cover the operating area effectively and handle the interchange of information required to conduct recovery operations.

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[21] Jenkins, M. E., Saunders, D. L., City of San Jose Preliminary Casualty Estimate Five City Study. The Dikewood Corp., December 1966, page 272.

AUTOMOTIVE EQUIPMENT AND PORTABLE MAJOR EQUIPMENT

Automotive equipment listed in Table 5 ranges from 1/2 ton pickups to 2-ton trucks equipped with compressors and arc welding machines. Portable equipment is almost exclusively trailer mounted.

At the Load Center, service pickups are parked in the open around the large holder. A concrete building and the storage holder shield about 75 percent of these vehicles from

TABLE V–Central District Distribution Trucks and Portable Equipment

	Load Center San Jose	Service Center Cupertino
Automotive:		
Trucks, crew	5	11
Trucks, crew compressor	12	12
Trucks, crew, arc machine	1	1
Trucks, dump	3	3
Trucks, water tank	1	1
Trucks, pickups, 1/2 ton, service	46	14
Trucks, pickups, 3/4 ton	11	2
Trucks, flat bed	0	1
Trucks, flat bed, tapping	1	0
	80	45
Major Portable Equipment:		
Back Hoes	2	3
Trencher Jeep	1	1
Trencher Cleveland	1	1
Loaders	1	1
Dozier	-	1
Boom truck, hydraulic	-	1
Arc welders, trainer	3	1
Air Compressors, trailer	7	7
	15	16

direct blast. The large trucks are parked in the open, and while shielded to some extent by the warehouse building, are exposed to debris therefrom.

At the Service Center, twelve of the larger trucks are parked under the cover of the loading platform. The remainder are parked in rows in the open at an angle of about 45 degrees to the blast. About 90 percent of the windows of the vehicles are closed as a rule.

Damage at both locations, in general, will consist of cracked and broken windshields and windows, dished cabs and hoods and bent and distorted metal canopies. Overturning is prevented by closeness in parking. With the exception of those parked under the loading platforms, the roofs of which are expected to collapse, vehicles will be operable as needed.[22]

Gasoline storage tanks are 8,000 and 10,000 gallons at the Load Center and Service Center, respectively. Pumps require electricity, but can be operated by portable generator sets in an emergency. Vehicle tanks are usually filled at night from 500 gallon tank trucks.

ELECTRIC POWER

Principal uses of commercial electric power in the San Jose gas system operations are: energizing electric controls, telemeter and communication facilities and such convenience uses as lighting, pumping gasoline, power tools, etc. It is not a prime mover of gas except the occasional use of the booster at the Load Center to sent out storage gas.

Since power outages can occur at any time, standby gasoline engine driven generator sets are maintained at the Division Office, Load Center, Milpitas Terminal, Loma Prieta, and Monte Bello Ridge to supply minimum needs of lighting, telemeter, communication,

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[22]Jenkins, M. E., Saunders, D. L., City of San Jose Preliminary Casualty Estimate Five City Study. The Dikewood Corp., December 1966, page 248.

and electric control. At Milpitas Terminal, an engine driven large volume air compressor is also stationed there to supply emergency air for pneumatic operation of station control valves in addition to the smaller electric driven compressor.

Interrpution of commercial power other than being an inconvenience, particularly at night, will not significantly affect gas system operation. The one need not provided for by supplementary means, namely, booster operation at the Lead Center, would rareiy, if ever, be critical.

ESTIMATES OF CASUALTIES AMONG GAS SYSTEM OPERATING EMPLOYEES

The distribution of P G and E employees at time of attack as to numbers at home by type of residence, numbers in shelters of various types, and numbers outdoors is taken to be the same for each Standard Location Area (SLA) as for the total population in the SLA in the Dikewood report.[23] The results therefore are statistical rather than enumerative; that is, neither is an attempt made in the present analysis to trace the probable whereabouts or movement of each individual employee nor to ascertain his actual shielding category.

Casualties are estimated from a map plot by occupational category of the residence location of each gas operating employee living in San Jose. Dikewood SLA casualty rates are applied to the residence totals in each area and corresponding casualties of P G and E personnel obtained. The results of this procedure are presented in Table VI.

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[23] Jenkins, M. E., Baker, W. L., Tuttle, Helen E., City of San Jose Population Locations Five City Study. The Dikewood Corp., December 1966.

TABLE VI–Casualties Among P G & E Gas Operations Employees Residing in San Jose

Occupational Category	Total Number of Employees	Fatalities		Injured	
		Number	Percent	Number	Percent
Staff	14	0	0	2	14
Supervisors	31	1	3	7	23
Operators	73	3	4	17	23
Helpers	89	4	5	21	24
Total	207	8	4	47	23

The markedly lower casualty incidence among staff employees is due to a greater proportion of these employees living in the outlying areas in the south and east portions of the city; 65 percent of staff employees living outside the 1.5 psi radius as compared to 41 percent for all employees.

Casualty estimates for the employees at the Milpitas Gas Terminal were produced by the same procedure and the results are presented in Table VII.

TABLE VII–Casualties Among Milpitas Gas Terminal Employees

	Total Number of Employees	Fatalities		Injured	
		Number	Percent	Number	Percent
On duty at Terminal [1]	3	0	0	1	33
Off duty	13	1	7	4	31
Total	16	1	6	5	31

[1] Terminal building considered to be in Dikewood shielding category LSFB (basement of light steel frame structure).

Approximately three-quarters of Central District Gas Operations personnel residing in San Jose and two-thirds of the Milpitas operators, regardless of their home locations, are uninjured. These numbers of available employees are adequate for immediate post-attack emergency measures and operation.

SECTION V

SUMMARY

SUMMARY

The effects of a hypothetical nuclear attack directed at Moffett Field, California on the gas system supplying the city of San Jose, the system's operating employees, buildings, communication, transportation and other supporting facilities are investigated, and the resulting postattack capability of the system to continue gas supply in San Jose is determined.

The study is directed primarily at gas facilities within the city. However, a larger area occupied by nearby cities also was examined for gas facility damage which might affect San Jose. Incoming and outgoing transmission mains in the expanded area together with the distribution system in San Jose are studied and analyzed. The study begins with transmission mains and terminates with underground distribution mains in the streets; it does not include service pipes, meter sets, houselines or other aboveground equipment on user's premises.

The area occupied by the city of San Jose is not symmetrical in shape. It has several sparsely occupied, semidetached areas projecting towards ground zero. These areas, which contain less than 100 gas meter accounts are exposed to overpressures up to 8 psi, whereas the remaining 119,000 meter accounts in downtown San Jose and contiguous residential sections have less than 3 psi exposure.

There is no interruption or degradation of gas supply in the city. Transmission mains are undamaged. Distribution facilities, other than the gas holders which are severly damaged and rendered inoperable but do not impair the system's capability, are unaffected.

There is, however, severe structural damage to houses and buildings in the area extending beyond the western corporate limits of San Jose. The study determines that the

utility will conclude, after a visual survey, that no foreseeable need for gas service exists in that area and will cut off and shutdown the distribution system therein. The purpose is to eliminate gas leakage in damage premises in the area of uninhabitable homes and buildings.

This area lies within an approximate arc having a radius of about 9 miles and a center at ground zero. The effect is to cut off gas supply to Santa Clara, Mt. View, Sunnyvale, Los Altos, Los Altos Hills and about one-half of Cupertino. The remainder of the San Jose Area (including San Jose) totaling about 62 percent of the area population continues to receive an uninterrupted gas supply.

The study also determines that personnel, transportation and supplies are adequate for the post attack operation. A commercial power outage or shortage in the area has little detrimental effect on gas system operation. Electric power is not a prime mover of gas in the San Jose Area; it is primarily a convenience service for lighting, automatic controls, etc.

Several segments of the Company's private communication system in the area, namely, wire line and microwave channels to Milpitas and to the Service Center in Cupertino, are damaged and inoperable. The stationing of mobile radio units at these locations fills the need. The District has sufficient mobile radio vehicles to cover the operating area effectively.

APPENDIX A

INVENTORY OF GAS MATERIALS–CUPERTINO SERVICE CENTER

Material	Size	In Stock
Pipe Steel Bare	6-5/8	64
	6-5/8	147
	10-3/4	24
	16	15
	20	9
	22	11
Pipe DW	3/4	28224
	1-1/4	24
Pipe Somastic	4-1/2	122
Base 5 XL	10-3/4	11
	12-3/4	11
	14	38
	24	18
XTru Coat	1-1/4	745
	2	8741
	3-1/2	1593
	4-1/2	192
Caps Screwed	2	36
Weld	3	18
	4	10
	6	10
	8	2
	12	2
Clamps Repair		
6" Wide	3/4	2
6" Wide	1-1/4	3
3" Wide	2	3
9" Wide	2	4
3/4" Wide	3	5
6" Wide	3	1
9" Wide	3	1
6" Wide	4	1
9" Wide	4	4
Fittings Assy	3	2
	4	2
Line Stopper	2	5
Valves Gas Service	3/4	9
Valves Plug	3/4	18
	1-1/4	20
	4	1
Valves Gate	2	1

Material	Size	In Stock
Pipe DW	2	160
	3-1/2	1259
	4-1/2	1723
	6-5/8	345
	8-5/8	337
	10-3/4	408
	12-3/4	7
Pipe Galvanized	1	147
	2-1/2	54
Clamps Repair		
9" Wide	8	1
Couplings Dresser	3/4	33
"	1	11
"	1-1/4	26
"	2	26
Couplings Copper	1 x 1	1
Flanges Lap	2 x 6	4
	4 x 9	2
Cans, Gas Main Repair		
12" long	4-1/2	2
12" long	8-5/8	8
24" long	4-1/2	2
24" long	8-5/8	10
Ells Weld 45°	2	1
	3	9
	4	5
	8	1
90°	3	13
	4	29
	6	5
Fitting PCF	3/4	60
	2	9
	3	10
	4	4
	6	2
Reducer	2 x 3/4	31
	2 x 1-1/4	7
	3 x 2	4
	4 x 3	7
	6 x 3	2
Unions Insulating	3/4	25
	2	25

INVENTORY OF GAS MATERIALS–65 N. MONTGOMERY STREET, SAN JOSE

Material	Size	In Stock
Pipe, Bare	6	29
	10-3/4	45
	16	19
	22	11
	30	3
Pipe, DW	3/4	11151
		13230
	4-1/2	1165
	6-5/8	242
	8-5/8	190
	10-3/4	79
	12-3/4	12
Pipe, XTru Coat	6	49
Caps Weld	4	6
	6	1
Clamps Bell	4	11
	8	1
	10	3
	24	4
Clamps Economy	4	5
	6	2
	8	8
Clamps Emergency	4	1
	20	6
	22	2
Clamps Half only	4	4
Pipeline	4	2
Clamps Split	8	2
Clamps Split	10	4
Couplings	6	3
	8	3
Couplings Split	6	1
	8	2
	10	4
Cans, Gas Main Repair		
12" long	6-5/8	
24" long	6-5/8	7
12" long	8-5/8	12
24" long	8-5/8	12

Material	Size	In Stock
Clamps H P Weld	4	2
	6	5
	8	6
	10	4
	12-3/4	2
	16	1
	20	2
	22	2
Clamps Repair	4	1
	4-1/2	5
	6	6
	6 x 2	11
	6 x 3	10
	6 x 4	16
	8	3
	6.95	1
Clamps, Repair C.I.	6	1
	6 x 3/4	7
	6 x 1	2
	6 x 1-1/4	14
	9 x 2	20
	9 x 3	7
	9 x 4-1/2	1
Clamps Mueller	6	1
Clamps " 2" -IPS Tap	6	3
Flanges Lap	2 x 6	4
	2 x 6-1/2	3
	3 x 7-1/2	6
	3 x 8-1/2	1
	4 x 9	1
	4 x 10	1
Flanges Weld Neck	3 x 7-1/2	22
	4 x 9	11
Flange insulating	2	29
	4	3
Gaskets Asbestos	2	191
	3	116
	4	30
	6	11

INVENTORY—GAS LINE PIPE IN STOCK AT DECOTO AS OF MARCH, 24, 1967

DESCRIPTION Size	Wall Thickness	Type & Grade	Bare	Double Wrapped	TOTAL Bare & Wrapped	On Order Gen. Constr. & Sub-stores	NET Available
3/4"	.113	CW CL-2	54697	269619	324316	3528	320788
3/4"	.113	SMLS GR-B	4977	4271	9248	105	9143
1-1/4"	.140	CW CL-2	65284	73269	138553	10	138543
2-3/8"	.154	CW CL-2	56472	239121	295593	31474	264119
2-3/8"	.154	SMLS GR-B	0	43469	43469	0	43469
2-3/8"	.109	F-35	0	3204	3204	0	3204
3-1/2"	.188	CW CL-2	20799	18490	39289	4036	35253
3-1/2"	.188	ERW GR-B	0	24248	24248	0	24248
3-1/2"	.188	SMLS GR-B	0	4286	4286	110	4176
4-1/2"	.	CW					
4-1/2"	.148	ERW GR-B	1798	26163	27961	25133	2828
4-1/2"	.156	ERW					
4-1/2"	.148	SMLS					
4-1/2"	.156	SMLS					
4-1/2"	.188	ERW GR-B	0	0	0	2700	2700
4-1/2"	.188	SMLS GR-B	0	1518	1518	3272	1754
4-1/2"	.237	SMLS	0	15	15	0	15
6-5/8"	.280		(R) 468	0	468	0	468
6-5/8"	.188	ERW X-42	5898	27068	32966	7890	25076
6-5/8"	.375	SMLS	0	81	81	0	81
8-5/8"	10-Gauge[1]		20	0	20	0	20
8-5/8"	.188	ERW X-42	40261	13967	54228	35588	18640
8-5/8"	.322	SMLS	0	357	357	464	107
8-5/8"	.500	SMLS	9	3036	3045	0	3045
10-3/4"	.250	X-42	0	75	75	0	75
10-3/4"	.188	ERW X-42	23087	12836	35923	25033	10890
10-3/4"	.219	ERW X-42	5050	48	5098	0	5098
10-3/4"	.279	SMLS GR-B	0 0	105	105	0	105
10-3/4"	.307	ERW X-42	0	(R) 298	298	0	298
10-3/4"	.375	X-42	0	35	35	0	35

[1] This pipe is double dipped

(R) Reconditioned Pipe

(C) Casing Pipe only.

TYPE CODE

CW - Continuous Weld
ERW - Elec. Resis. Weld
SMLS - Seamless
DSAW - Double submerged arc weld. (Fusion-weld)

INVENTORY–GAS LINE PIPE IN STOCK AT DECOTO AS OF MARCH, 24, 1967

DESCRIPTION Size	Wall Thickness	Type & Grade	Bare	Double Wrapped	TOTAL Bare & Wrapped	On Order Gen. Constr. & Sub-stores	NET Available
10-3/4"	.500	SMLS X-52	162	0	162	0	162
10-3/4"	.750		27	0	27	0	27
12-3/4"	.219	ERW X-42	25113	138	25251	2295	22956
12-3/4"	.219	ERW X-52	89	3690	3779	631	3148
12-3/4"	.250	ERW X-42	5139	6718	11857	6022	5835
12-3/4"	.250	ERW X-52	0	333	333	0	333
12-3/4"	.219	X-42	(R) 167	(R) 4213	4380	965	3415
12-3/4"	.250	X-42	(R) 439	0	439	0	439
12-3/4"	.281	X-42	(R) 29	0	29	0	29
12-3/4"	.312	X-42	(R) 158	0	158	0	158
12-3/4"	.312	ERW X-42	990	0	990	0	990
12-3/4"	.375	X-42	8	0	8	6	2
12-3/4"	.500	SMLS X-42	0	177	177	201	24
12-3/4"	.843	SMLS GR-B	197	0	197	0	197

(R) Reconditioned Pipe

(C) Casing Pipe only.

TYPE CODE

CW - Continuous Weld
ERW - Elec. Resis. Weld
SMLS - Seamless
DSAW - Double submerged arc weld. (Fusion-weld)

INVENTORY–GAS LINE PIPE IN STOCK AT DECOTO AS OF MARCH, 24, 1967

DESCRIPTION Size	Wall Thickness	Type & Grade	Bare	X-TRU COAT	TOTAL Bare & Wrapped	On Order Gen. Constr. & Sub-stores	NET Available
3/4"	.113	CW					
3/4"	.113	SMLS					
1-1/4"	.140	CW					
2-3/8"	.154	CW	0	96901	96901	0	96901
2-3/8"	.154	SMLS					
3-1/2"	.188	CW	0	7445	7445	2500	4945
3-1/2"	.188	ERW					
3-1/2"	.188	SMLS					
4-1/2"	.	CW					
4-1/2"	.148	ERW	0	12551	12551	3700	8851
4-1/2"	.156	ERW					
4-1/2"	.148	SMLS					
4-1/2"	.156	SMLS					
4-1/2"	.188	ERW					
4-1/2"	.188	SMLS					
6-5/8"	.188	ERW X-42	6254	924	7178	0	7178
8-5/8"	.188	ERW X-42	0	0	0	0	0
8-5/8"	.						
10-3/4"	.188	ERW X-42					
10-3/4"	.219	ERW X-42					
10-3/4"	.						
10-3/4"	.						
10-3/4"	.						
12-3/4"	.219	ERW X-42					
12-3/4"	.219	ERW X-52					
12-3/4"	.250	ERW X-42					
12-3/4"	.250	ERW X-52					
12-3/4"	.						
12-3/4"	.						
12-3/4"	.						

THE ABOVE PIPE IS AT STARDARD PIPE PROTECTION CO., ANTIOCH, CALIF.

(R) Reconditioned Pipe.

(C) Casing Pipe only.

TYPE CODE
CW - Continuous weld
ERW - Elec. Resis. Weld
SMLS - Seamless
DSAW - Double submerged arc weld. (Fusion-weld)

INVENTORY–GAS LINE PIPE IN STOCK AT DECOTO AS OF MARCH, 24, 1967

DESCRIPTION Size	Wall Thinkness	Type & Grade	Bare	Double Wrapped	TOTAL Bare & Wrapped	On Order Gen. Constr. & Sub-stores	NET Available
16"	.250	GR-b	(R) 4947	(R) 38914	43861	3410	40451
16"	.281	ERW X-42					
16"	.281	SMLS X-42	(R) 46	175	221	0	221
16"	.312		87	42	129	0	129
16"	.375		96	0	96	42	54
16"	.438	X-42	23	0	23	0	23
16"	.500	SMLS GR-B	146	17	163	0	163
18"	.281		0	40	40	0	40
18"							
20"	.500	X-42	48	0	48	0	48
20"	.250	X-42	(R)[2] 7878	2526	10404	50	10354
20"	.281	X-42	(R)[2] 6020	0	6020	0	6020
20"	.281	X-42	35	0	35	0	35
20"	.312	X-42	56	3025	3081	10	3071
20"	.344						
20"	.375	X-42	31	0	31	15	16
20"	.375	DSAW X-52					
22"	.281	X-42	0	(R) 1321	1321	380	941
22"	.312	X-42	19	0	19	0	19
22"	.312	X-42	(R)[2] 7877	0	7877	1359	6518
22"	.375	DSAW X-42	0	35	35	0	35
24"	.312	X-42	(R) 2355	0	2355	0	2355
24"	.250	ERW X-52	2325	72	2397	0	2397
24"	.250	X-42	0	979	979	0	979
24"	.281	X-42	(C) 501	(R) 491	992	105	887
24"	.312	DSAW X-42	7355	1078	8433	380	8053
24"	.312	X-42	452	0	452	45	407
24"	.281	X-52	0	119	119	0	119
24"	.312	ERW X-52	0	261	261	230	31
24"	.375	X-52	0	15	15	0	15
24"	.700		32	0	32	0	32
26"	.312	X-42	(R) 265	0	265	0	265
26"	312	X-42	(C) 123	0	123	0	123
26"	.375	X-42	0	80	80	0	80
26"	.500	X-42	45	0	45	0	45
30"	.312	DSAW X-42					
30"	.312	X-52	0	6874	6874	9394	2520
30"	.312	SMLS X-42					
30"	.213	SMLS GR-B					

[2] 300# PRESSURE ONLY

(R) Reconditioned Pipe.

(C) Casing Pipe only.

TYPE CODE
CW - Continuous Weld
ERW - Elec. Resis. Weld
SMLS - Seamless
DSAW - Double submerged arc weld (Fusion-weld)

INVENTORY–GAS LINE PIPE IN STOCK [illegible] 1967

DESCRIPTION Size	DESCRIPTION Wall Thinkness	Type & Grade	Bare	[illegible] Wrapped	TOTAL Bare & Wrapped	On Order Gen. Constr. & Sub-stores	NET Available
30"	.344						
30"	.375	DSAW X-42					
30"	.375	DSAW X-52					
30"	.290	DSAW X-52	0	1523	1523	0	1523
30"	.						
32"	.360	X-60	0	3703	3703	0	3703
32"	.375	X-42	45	0	45	0	45

(R) Reconditioned Pipe.

(C) Casing Pipe only.

TYPE CODE

CW - Continuous Weld

ERW - Elec. Resis. Weld

SML - Seamless

DSAW - Double submerged arc weld. (Fusion-weld)

INVENTORY–GAS LINE PIPE IN STOCK AT DECOTO AS OF MARCH, 24, 1967

DESCRIPTION Size	Wall Thinkness	Type & Grade	Bare	Double Wrapped	TOTAL Bare & Wrapped	On Order Gen. Constr. & Sub-stores	NET Available
34"	.250	X-42	11	0	11	0	11
34"	.344	X-42	28	0	28	0	28
34"	.375	X-60	0	1464	1464	0	1464
34"	.						
34"	.						
34"	.						
36"	.500	X-42	12	0	12	0	12
36"	.360	X-42	(R) 85	0	85	0	85
36"	.312	DSAW X-42					
36"	.312	DSAW X-52	16	3024	3040	1174	1866
36"	.360	X-52	0	816	816	0	816
36"	.360	X-60	0	191	191	0	191
36"	.500	DSAW X-52	0	1107	1107	0	1107
36"	.422	X-42	0	179	179	0	179
36"	.531	X-42	11	193	204	0	204
36"	.563	X-42	34	0	34	0	34
36"	.625	X-42	80	0	80	0	80
36"	.688	X-52	0	223	223	0	223
42"	.500	X-42	13	0	13	0	13
42"	.						
TOTALS			352435	849335	1201770	166057	1042818

PIPE TO BE RECONDITIONED

6-5/8"	.						
8-5/8"	.						
10-3/4"	.						
12-3/4"	.						
16"	.250		18240	0	18240	0	18240
20"	.250		17831	0	17831	0	17831
22"	.312		1264	0	1264	0	1264
24"	.						

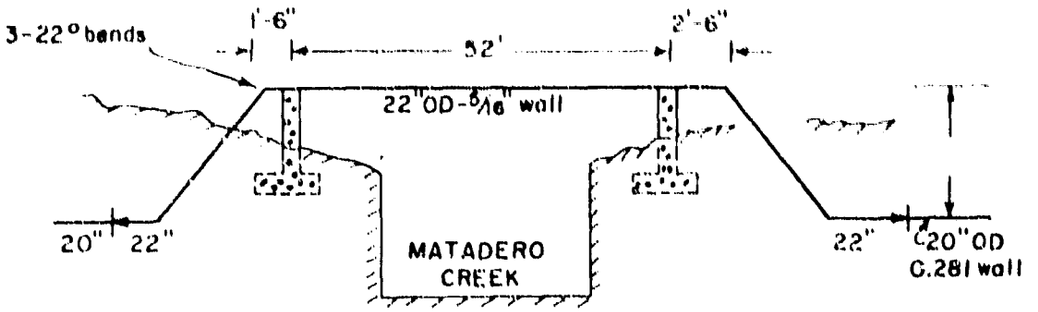
(R) Reconditioned Pipe.

(C) Casing Pipe only.

TYPE CODE
CW - Continuous Weld
ERW - Elec. Resis. Weld
SMLS - Seamless
DSAW - Double submerged arc weld. (Fusion-weld)

DESCRIPTION	QUANTITY
SLEEVES, WELDING, 1/2" X 14" X 16-1/2"	1
SLEEVE, WELDING, 1/2" X 10" X 22"	1
SLEEVE, WELDING, 5/8" X 10" X 30"	1
SLEEVE, WELDING, 1/2" X 12" X 30"	1
CAPS, WELDING, 34"	2
ELBOWS, WELDING, 20", 30 DEGREE	1
ELBOWS, WELDING, 20", 45 DEGREE	1
ELBOWS, WELDING, 34", .500" WALL, 57 DEGREE	1
ELBOWS, WELDING, 30", 60 DEGREE	1
ELBOWS, WELDING, 30", X .500" WALL, 30 DEGREE	1
ELBOWS, WELDING, LONG RADIUS, 36" X .375" WALL, 90 DEGREE	8
ELBOWS, WELDING, 36" X .375" WALL, 13 DEGREE	1
ELBOWS, WELDING, 36" X .375" WALL, 17 DEGREE	1
ELBOWS, WELDING, 36" X .375" WALL, 23 DEGREE	1
ELBOWS, WELDING, 36" X .625" WALL, 31 DEGREE	1
ELBOWS, WELDING, 36" X .375" WALL, 56 DEGREE	1
ELBOWS, WELDING, 36" X .375" WALL, 90 DEGREE	4
ELBOWS, WELDING, 36" X .440" WALL, 32 DEGREE	1
ELBOWS, WELDING, 36" X .480" WALL, 43 DEGREE	1
ELBOWS, WELDING, 36" X .740" WALL, 45 DEGREE	1
ELBOWS, WELDING, 36" X .850" WALL, 32 DEGREE	1
TEES, WELDING, .500" WALL, 24" X 24" X 16"	1
TEES, WELDING, .525" WALL, 24" X 24" X 24"	1
REDUCERS, .500" WALL, 30" X 22"	1
REDUCERS, .500" WALL, 34" X 24"	1

APPENDIX B



PROFILE – MAIN 101 – MATADERO CREEK CROSSING–NO SCALE

1. Attack Data:

(a)	distance to GZ	= 5.4 km.
(b)	height of burst	= 4.4 km.
(c)	overpressure	= 10.2 psi
(d)	dynamic pressure	= 2.3 psi
(e)	angle of incidence	= 1 deg.

2. Facility Data:

(a)	diameter of pipe OD	= 22 & 20 in.
(b)	wall thickness: 20" = 0.281 and 22 in.	= 5/16 in.
(c)	equiv. expos. span length	= 62 ft.
(d)	centerline span height	= 11 ft.
(e)	span between supports	= 52 ft.

3. Span Loading by the Blast. The exposed pipe is considered to be "wind" loaded with the loading being the product of the axial cross sectional area of the pipe, the dynamic pressure and the shape (drag) coefficient.

4. Angle of Blast. The dynamic pressure of 2.3 psi will strike the span at an angle of 39° with respect to ground (tan 4.4 ÷ 5.4) and exert a downwardly force on the pipe. It can be resolved into a vertical component of 1.45 psi (2.3 x sin 39°) and a horizontal component of 1.79 psi (2.3 x cos 39°). Each component strikes the pipe normal to an axial cross sectional plane.

5. Facility Parts Vulnerable to the Blast. The span is subject to damage from (1) bending moments at midspan from the forces 1.45 and 1.79 and (2) torsional moments in the 20 inch underground welds from the horizontal force 1.45 psi.

6. Existing Stresses in Span Before Blast. These stresses are bending (Sb) from its unsupported weight, circumferential (Sc) and longitudinal (S_l), the later two from internal pressure.

[24]Slide Rule Accuracy.

7. Basic Formulae and Calculated Stresses Existing in Span Without Blast Effects.

(a) $S_b = \frac{1.2\,wL^2}{Z}$

$= 2.1$ Mpsi

(Span is treated as a beam with restrained ends.)

(b) $S_c = \frac{P(D-2t)}{2t}$

$= 6.7$ Mpsi for 22 in.
$= 6.8$ Mpsi for 20 in.

(c) $S_l = \frac{P(D-2t)}{4t}$

$= 3.3$ Mpsi for 22 in.
$= 3.4$ Mpsi for 20 in.

Definitions and Values

S_b = bending stress (vertical) in psi
S_c = circumferential stress in psi
S_l = longitudinal stress in psi
W = weight pipe, lb./ft. 22" = 73 lbs.
L = distance between supports = 52 ft.
Z = section modulus 22" = 114 in.^{3}
P = internal gas pressure = 195 psi
D = diameter OD = 22 or 20 in.
t = wall thickness 22" = 5/16 in.
20" = 0.281 in.
C_d = shape coefficient (drag) = 0.4

8. Added Stress in 22" Span from Blast:

(a) $S_b = \frac{1.2\,wL^2}{Z}$

$= 4.4$ Mpsi

Definitions and Values

w = force on pipe lbs./lineal ft. (1.45)(0.4)(22)(12)

The existing stresses 6(a) 6(b) and 6(c) for 22 inch pipe are additive. Total is $4.4 + 2.1 + 6.7 + 3.3 = 16.5$ Mpsi.

(b) Torsion

$S_s = \frac{Tc}{2J}$

$= 9.3$ Mpsi

Definitions and Values

S_s = torsional (shear) stress (at 20 inch underground welds) in psi
T = torque, product of force on pipe and =(22)(62)(12)(1.45)(0.4)(11)(12)
C = distance outer fibre = 10 in.
J = polar moment of inertia = 1690 in.^{4}

Total Fibre stress $= 1/2[S_l + S_c + \sqrt{4S_s^2 + (S_l - S_c)^2}$

$= 14.0$ Mpsi

Both bending and torsional stresses caused by the blast are less than the miminum yield strength of 28 Mpsi corrected for 85% joint efficiency.

APPENDIX C

GLOSSARY OF TERMS

1. Gas Main. A general term for a pipe transporting fuel gas.

(a) Transmission Main. A gas main, generally of large diameter and operating on a private right-of-way at pressure of 200 psig or more, used for delivering gas to major distribution mains or trunks.

(b) Major Distribution Main (trunk). A gas main, usually located in a city street or public thoroughfare and operating at pressures up to a maximum of 175 psig, used for delivering a pressure regulated supply to secondary distribution mains.

(c) Secondary Distribution Main (feeder, distributor). A gas main, usually located in a city street or public thoroughfare and operating at pressures up to 60 psig, used for delivering gas to services.

(d) Service. The gas piping which conveys gas from a secondary main at the secondary main pressure to a meter set. Gas may be delivered directly to a service from a transmission main or distribution trunk after suitable pressure regulation.

(e) Meter Set. An assembly of equipment, usually located on the customer's premises and owned by the utility, which receives gas from a service, records its volume (and in some cases temperature and pressure) and delivers it to the inlet of a customer's houseline. The set usually consists of a stop valve, regulator, meter and interconnecting piping, except in a low pressure distribution system where the regulator is omitted.

2. Low Pressure Distribution System. A term usually denoting a network of secondary mains and services operating at inches of water column pressure. However, a network of secondary mains and services operating at a few pounds per square inch pressure (2-5 psi) is often called a low pressure system.

REFERENCES

1. Spangler, M. G., Stresses in Buried High Pressure Pipe Lines. Petroleum Engineer, November 1954.

2. Jenkins, M. E., Baker, W. L., Tuttle, Helen E., City of San Jose Population Locations Five City Study. The Dikewood Corp., December 1966.

3. Jenkins, M. E., Saunders, D. L., City of San Jose Preliminary Casualty Estimate Five City Study. The Dikewood Corp., December 1966.

4. Effects of Nuclear Weapons. U.S. Department of Defense and U.S. Atomic Energy Commission. U.S. Printing Office, Washington, D. C., April 1962.

5. Corfield, Guy, Operation Teapot. Effects of a Nuclear Explosion on Typical Natural and Manufactured Gas Underground and Aboveground Installations, Including Appliances in Houses. Available from Clearinghouse for Federal Scientific and Technical Information, National Bureau of Standards, U. S. Department of Commerce, Springfield, Va.

PACIFIC GAS & ELECTRIC COMPANY

SAN JOSE DIVISION

TYPICAL RURAL GAS DISTRIBUTION FACILITIES SAN JOSE AREA

1

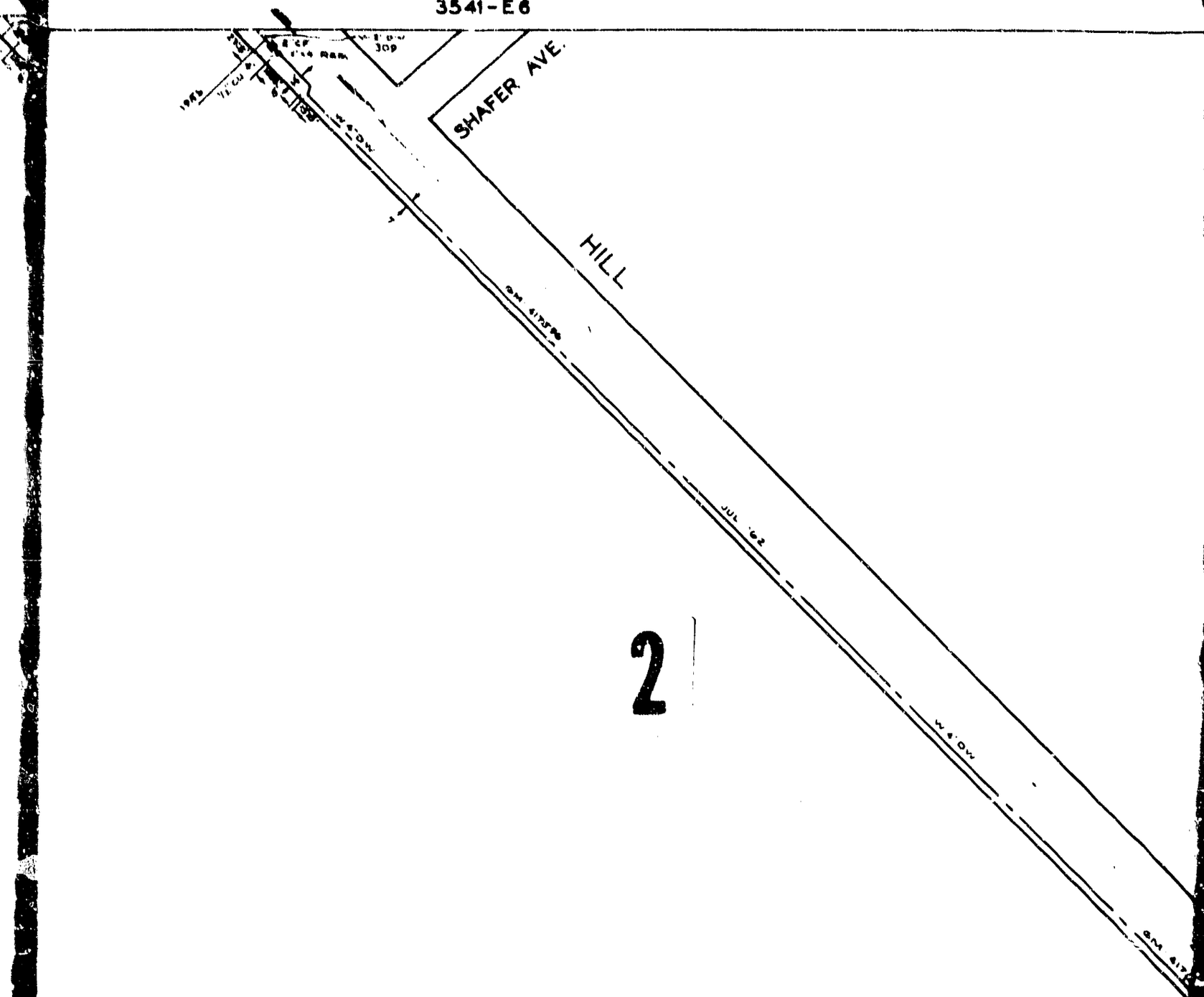
GAS DISTRIBUTION MAP

SCALE: 1" = 100'

3541-E6

DRAWN

1-64



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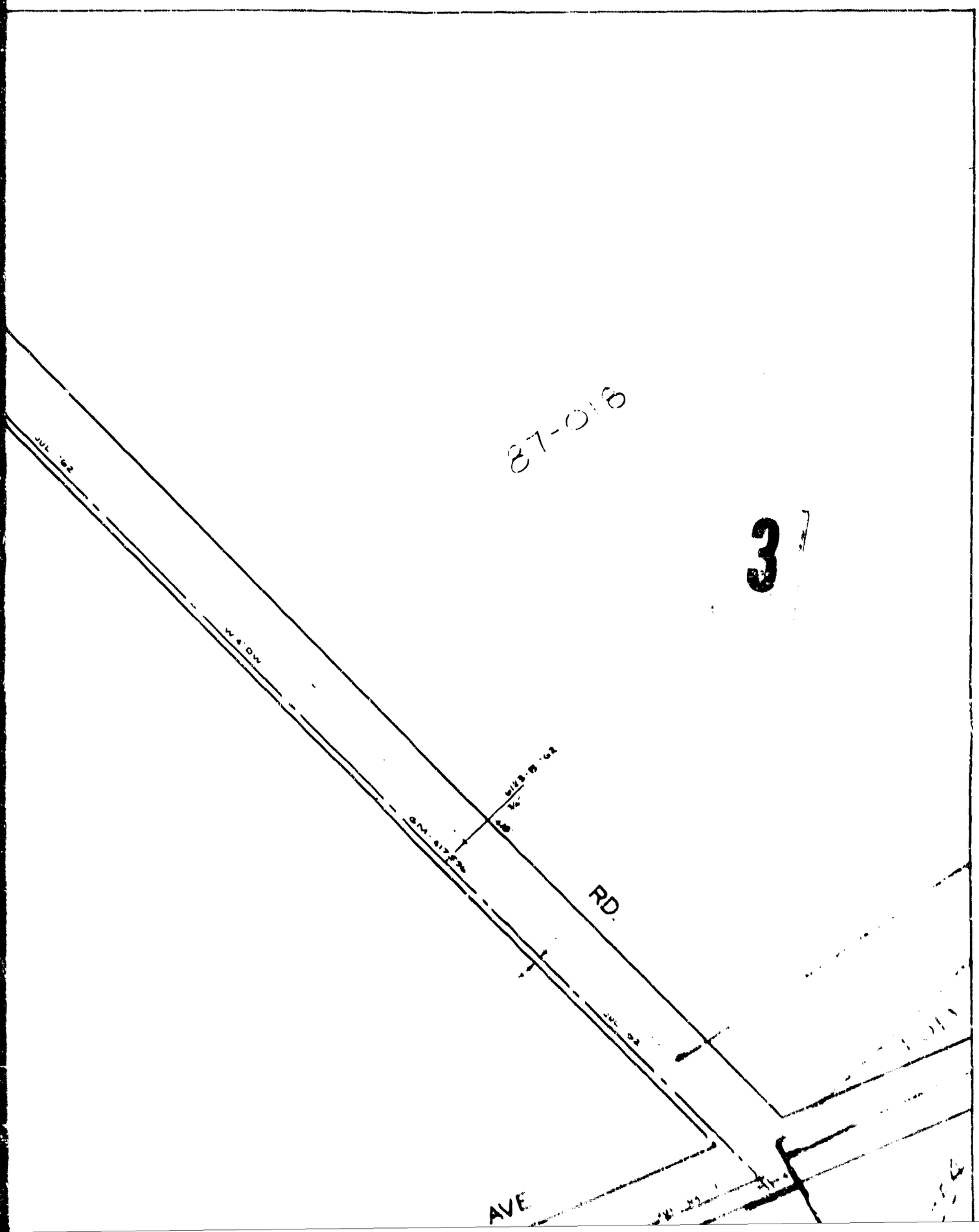

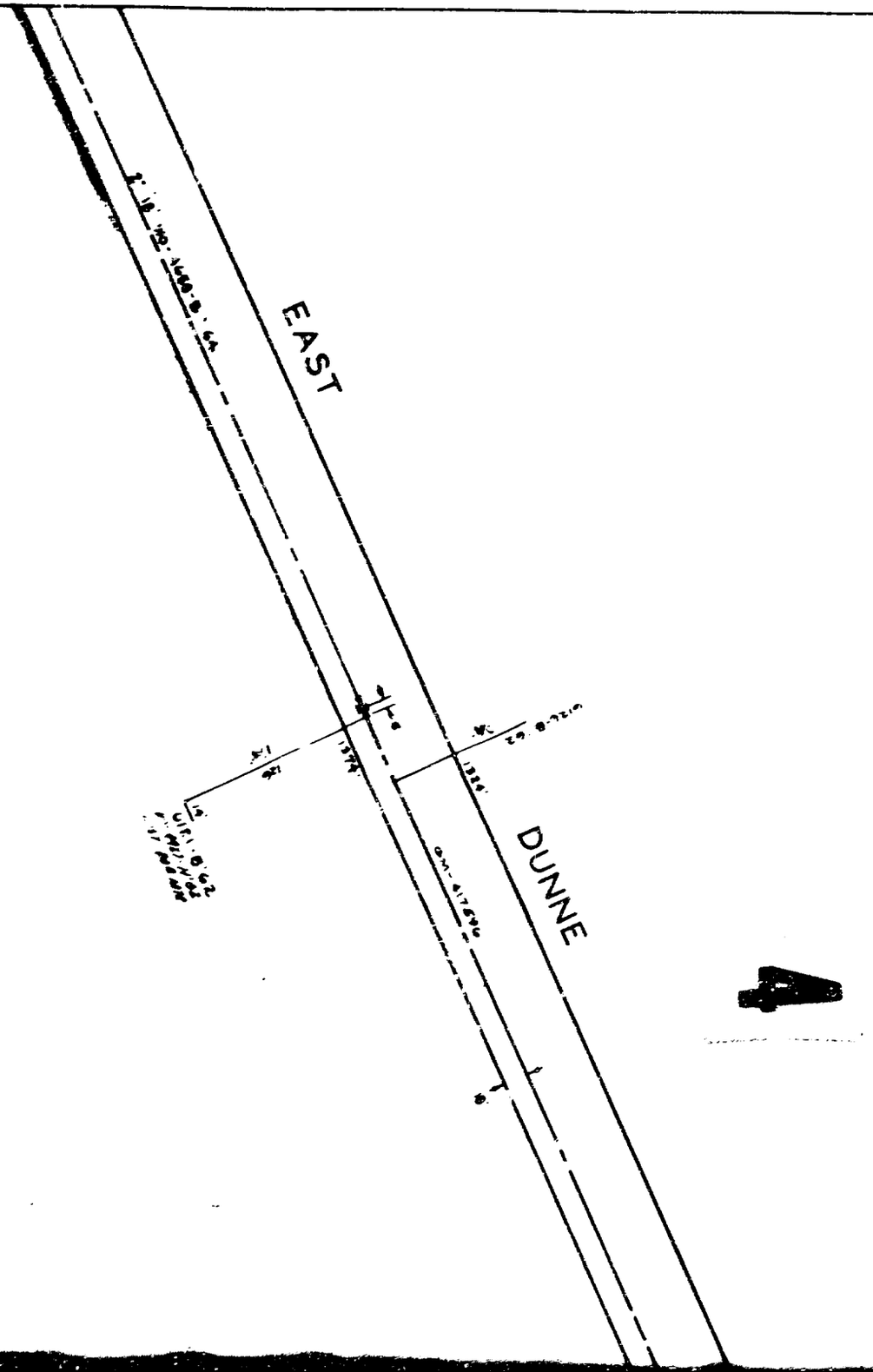
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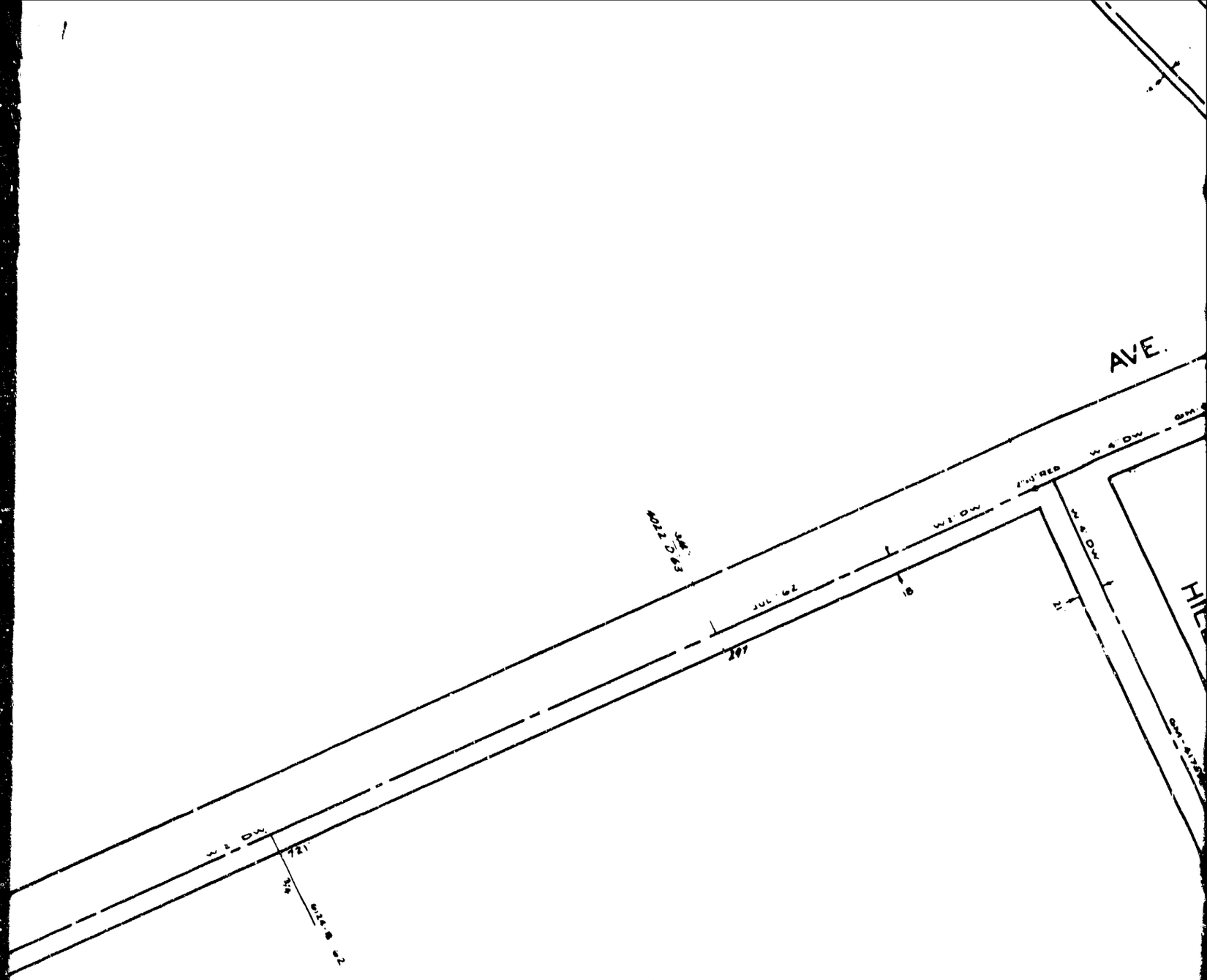

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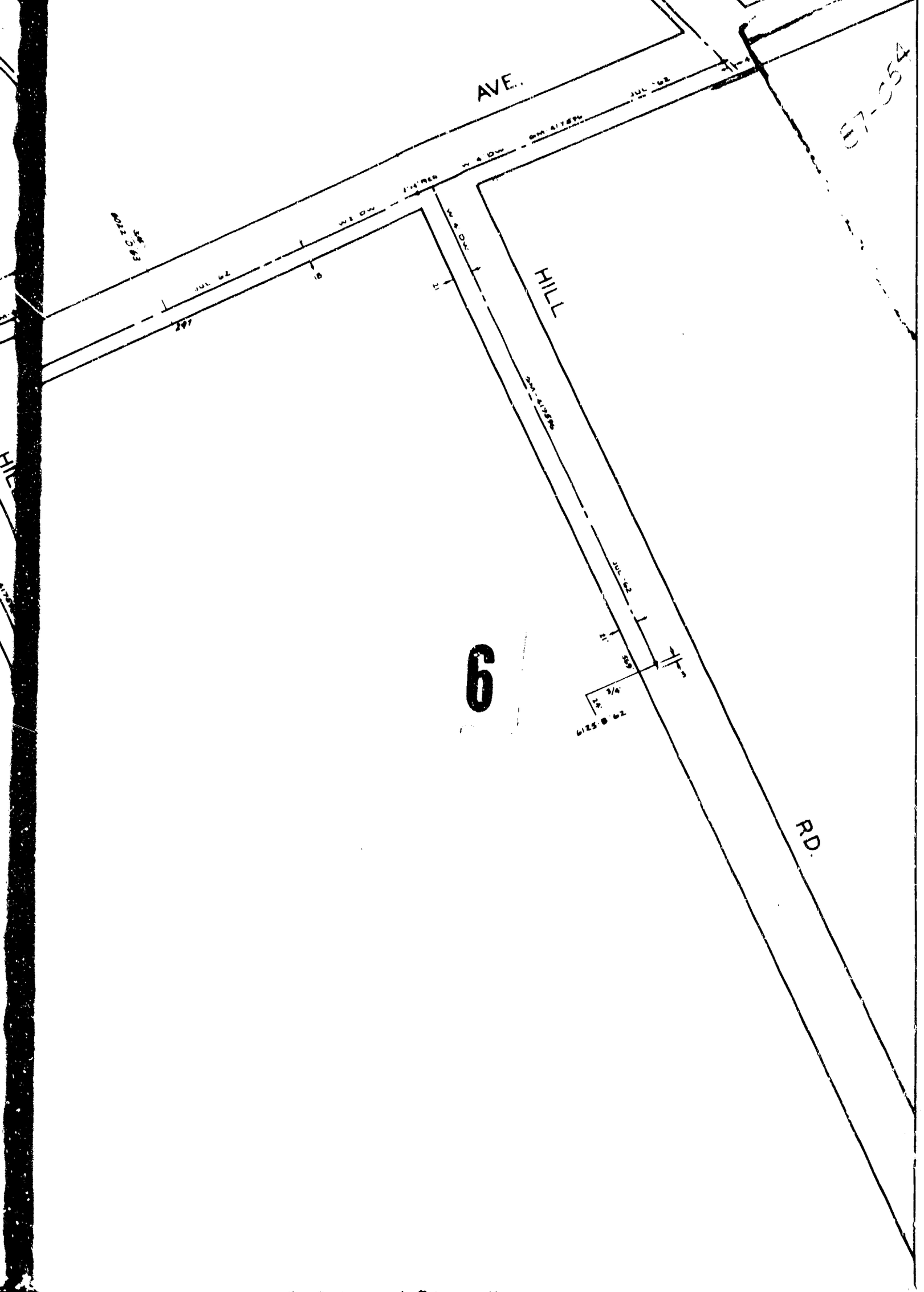
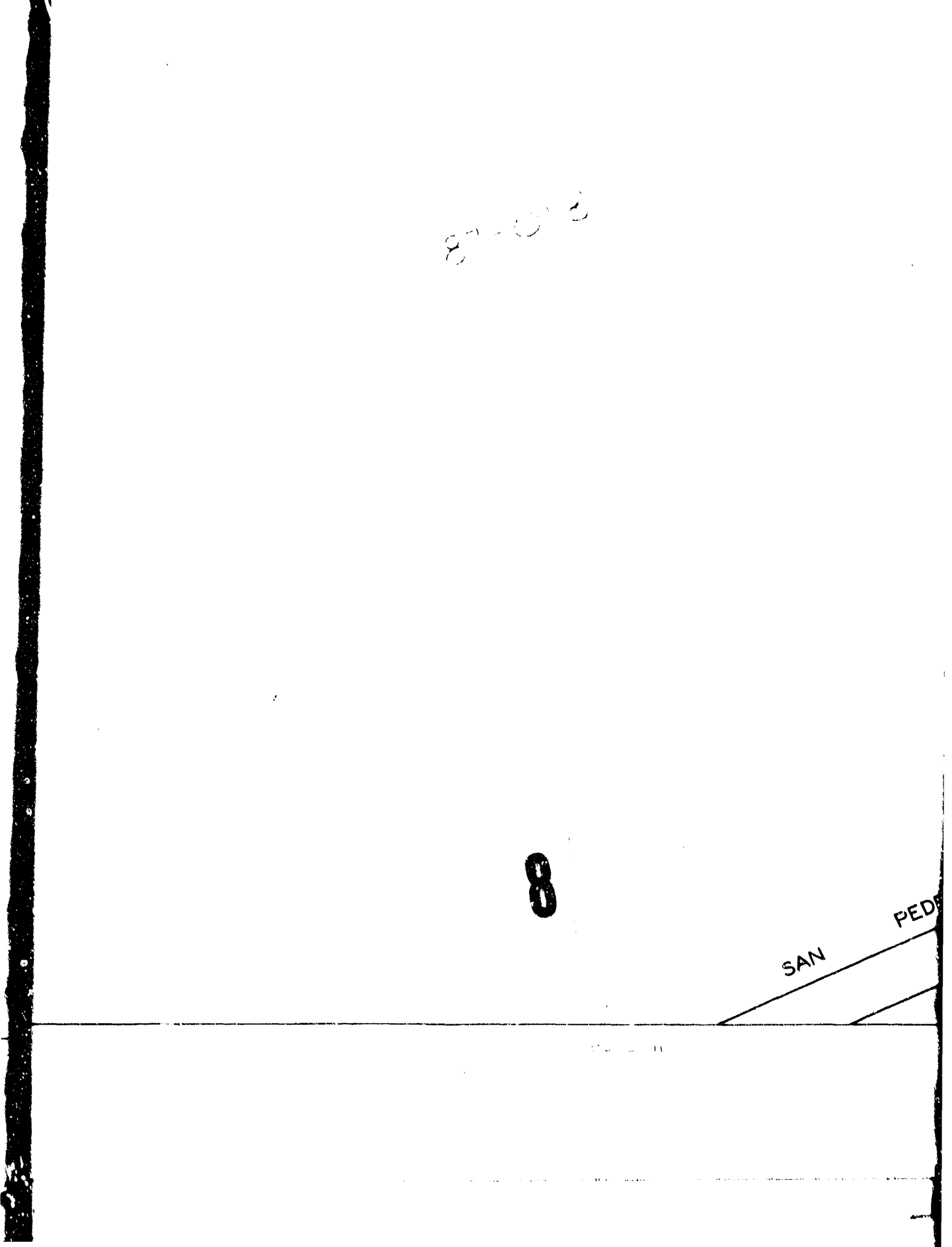

AVE.
HILL
RD.
6

1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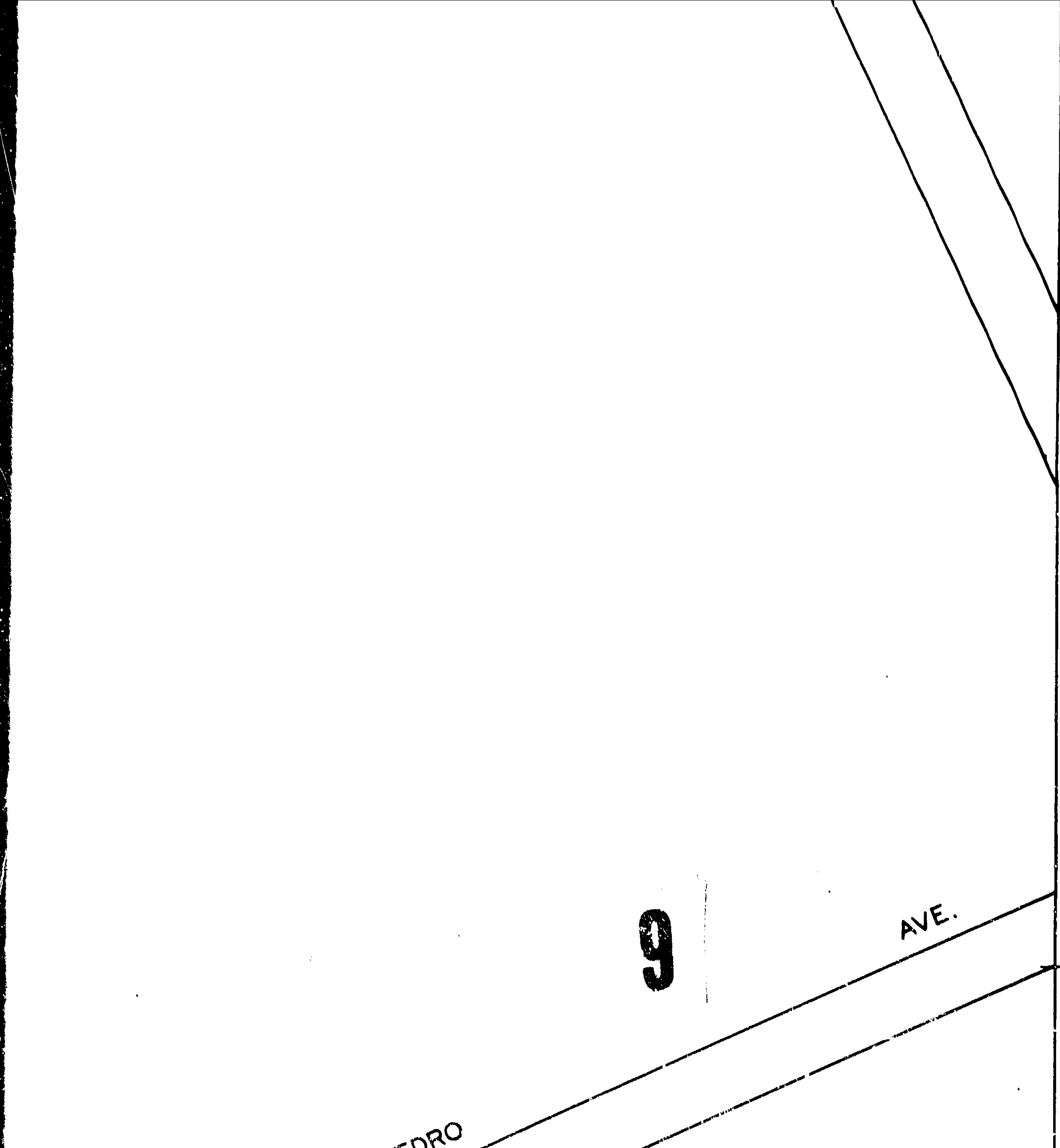
SAN
PED



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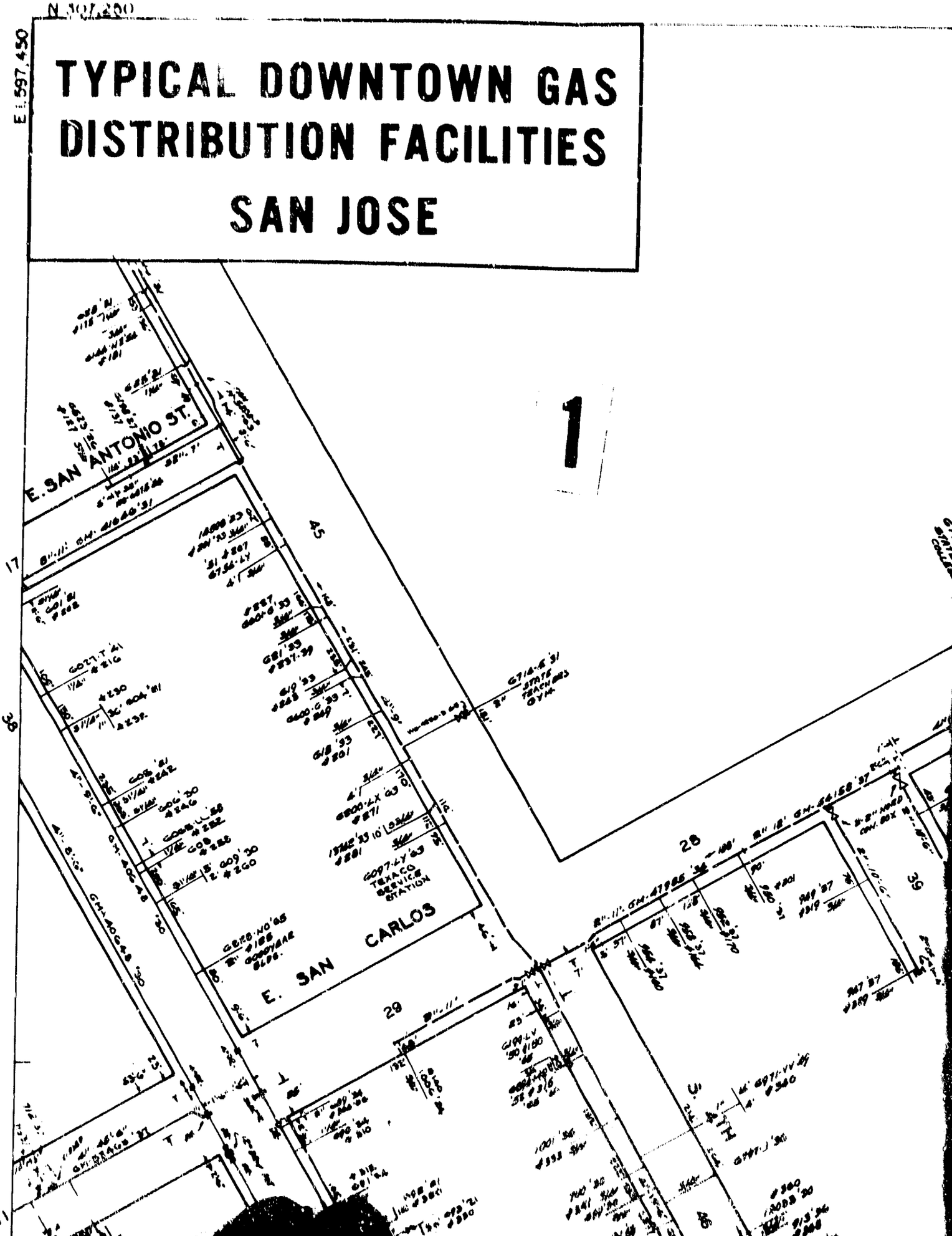
PACIFIC GAS AND ELECTRIC CO.

SAN JOSE DIVISION

TYPICAL DOWNTOWN GAS DISTRIBUTION FACILITIES SAN JOSE



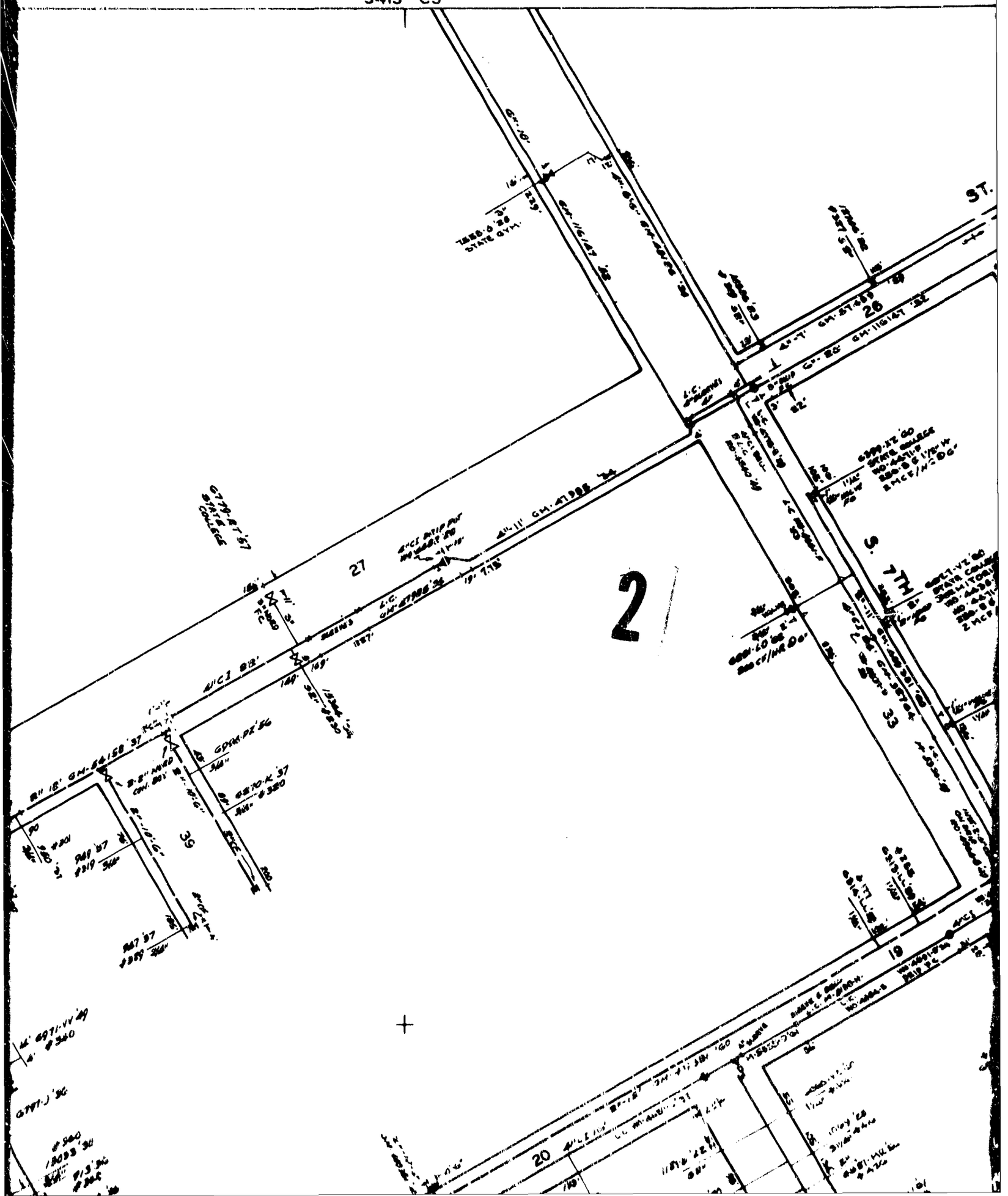
GAS DISTRIBUTION MAP

SCALE 1" =100' ZONE 3

DRAWN

6-30-65

3413 - C5



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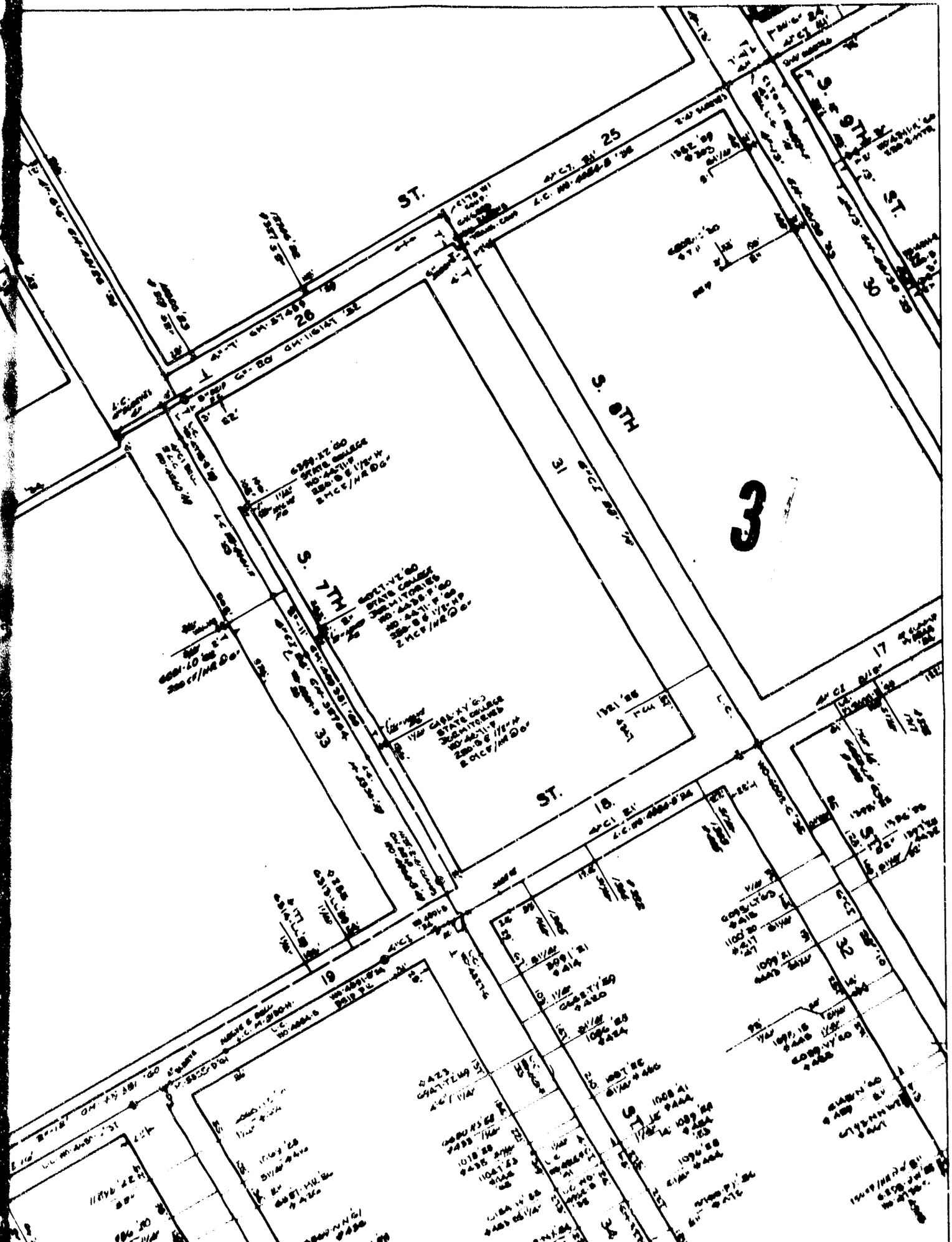

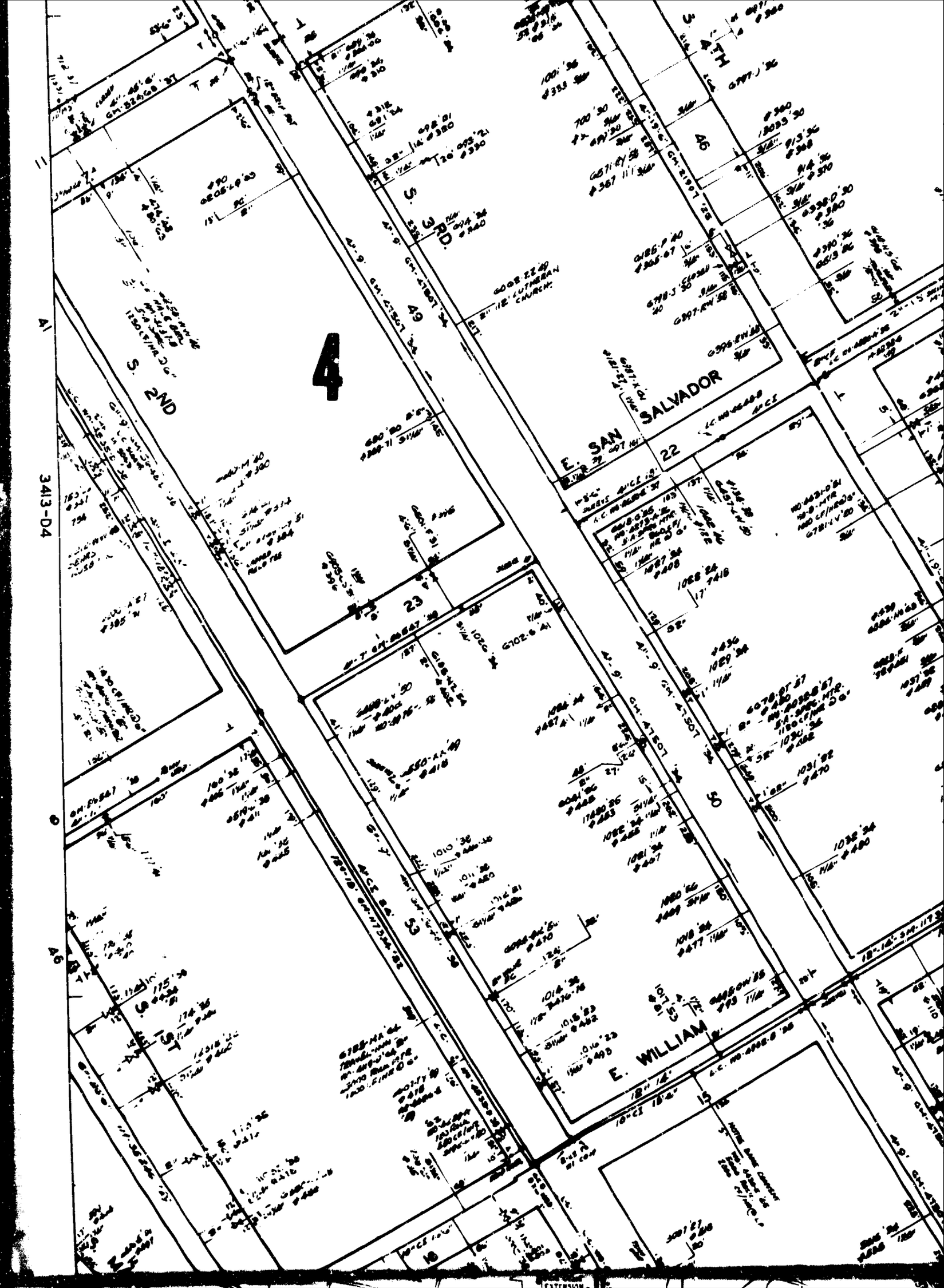
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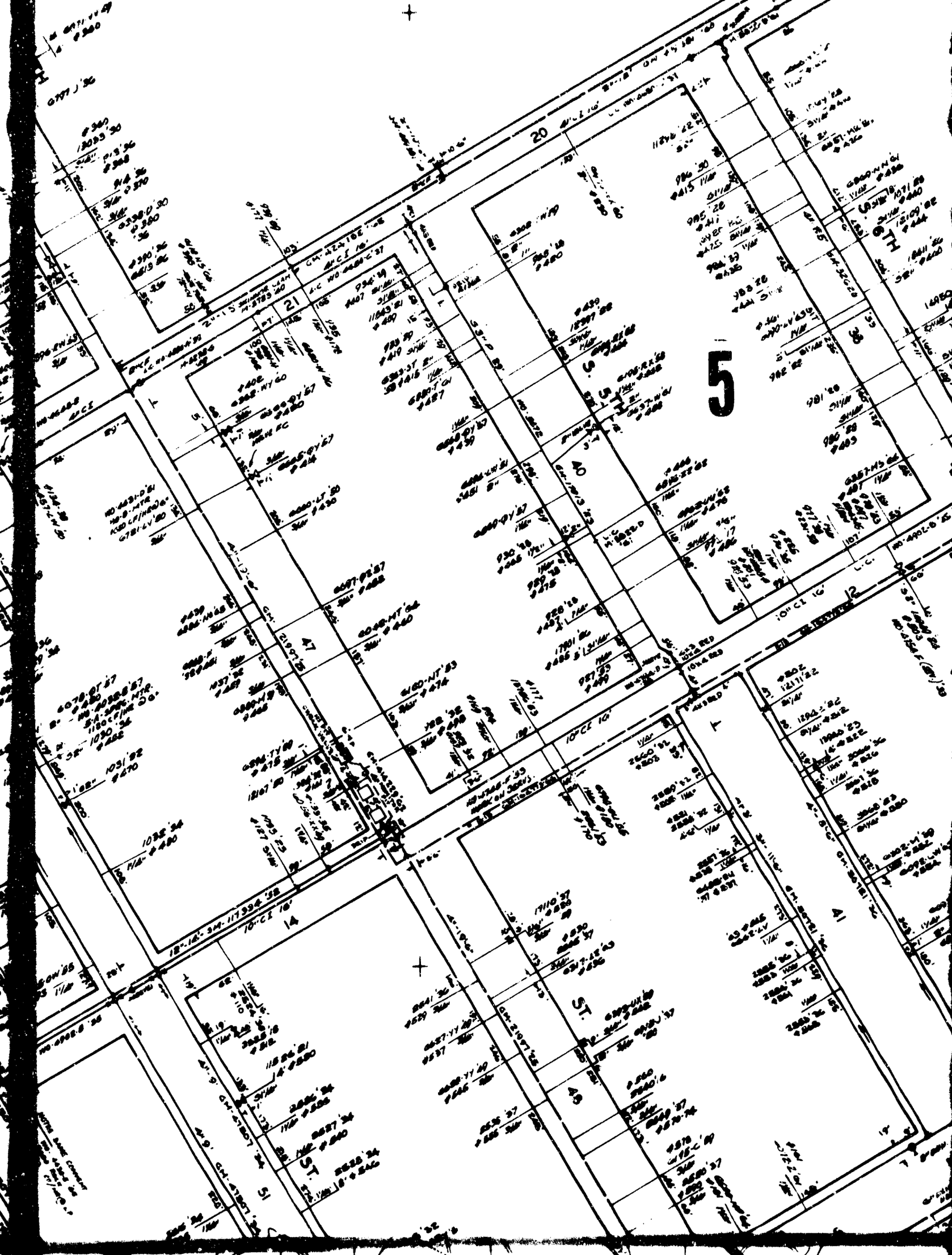
S. 2ND
S. 3RD
E. SAN SALVADOR
E. WILLIAM
49
50
53
22
23
A6
A1
3413-D4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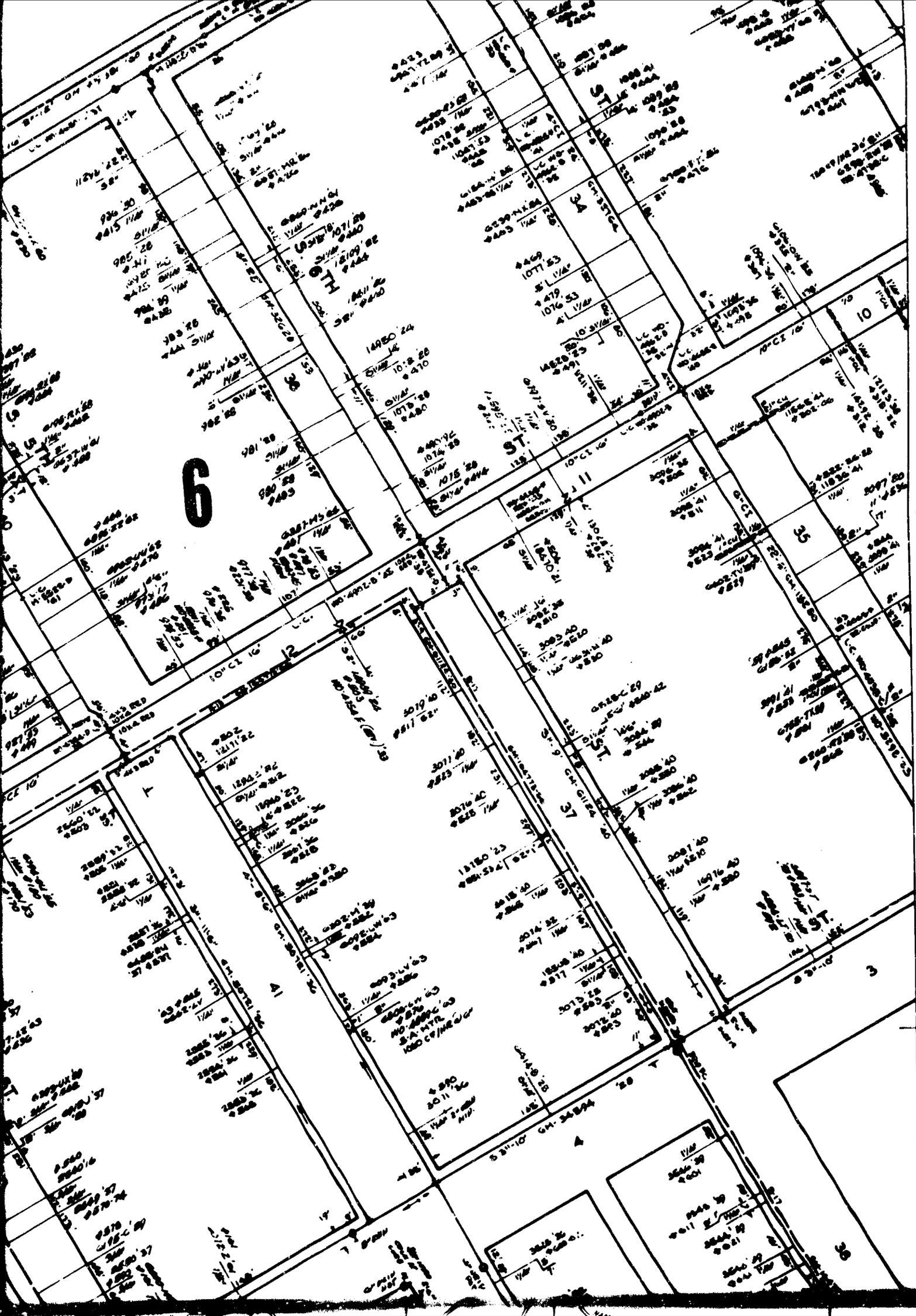
A7
A1
A9
14
ST.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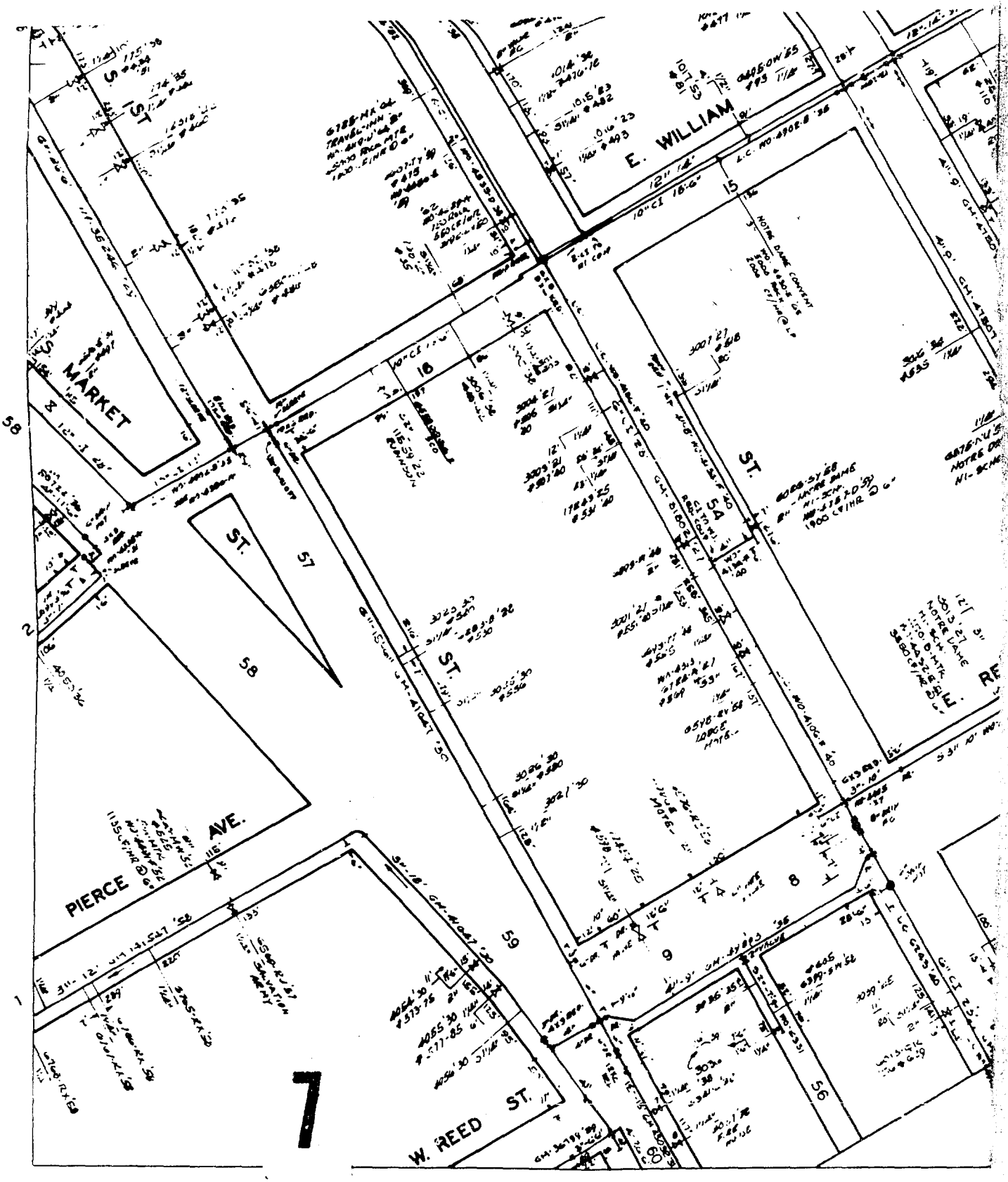
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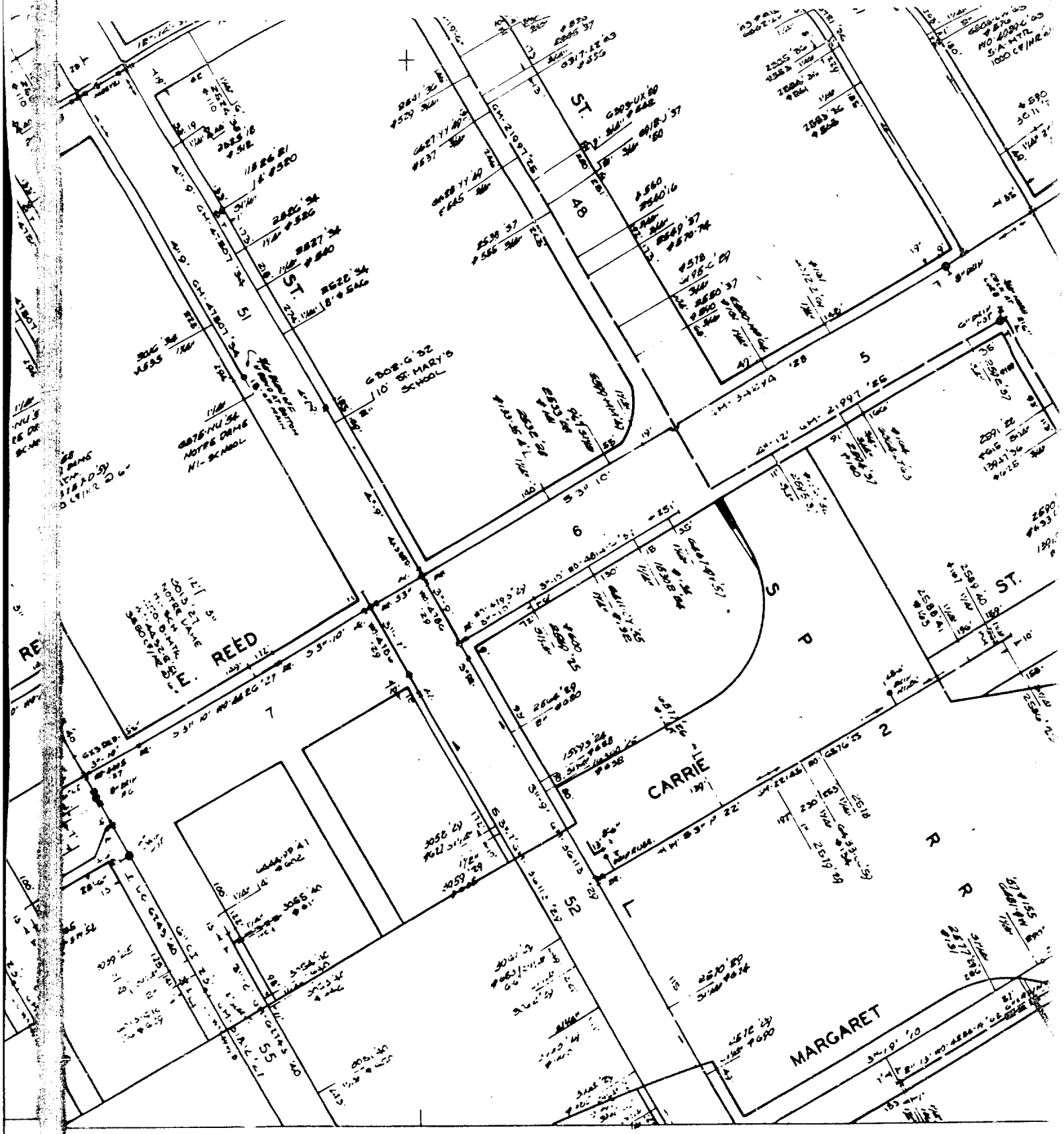
MARKET
PIERCE AVE.
W. REED ST.
ST.
7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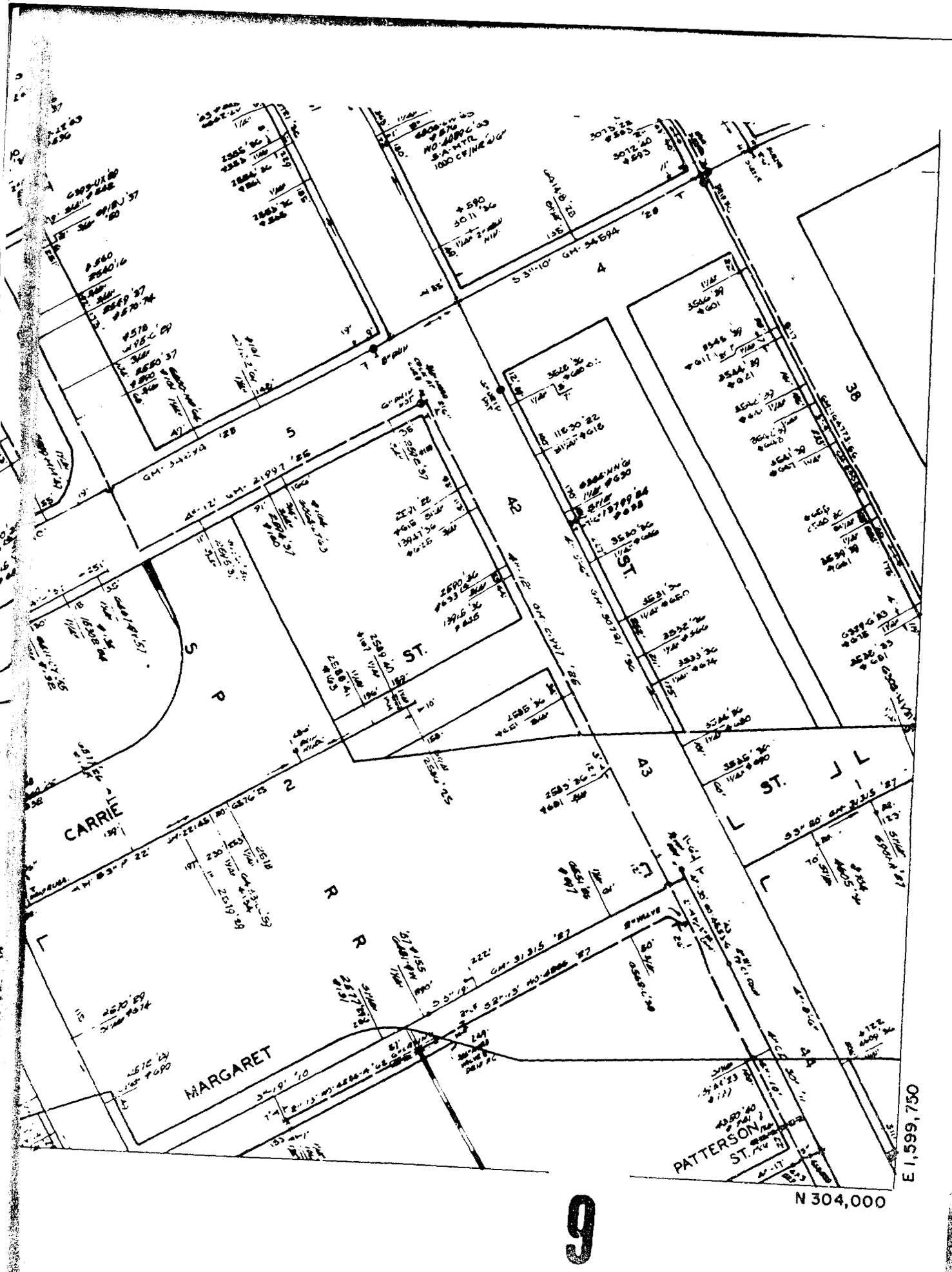
CARRIE
MARGARET
3413-E5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PATTERSON
ST.
ST.
ST.
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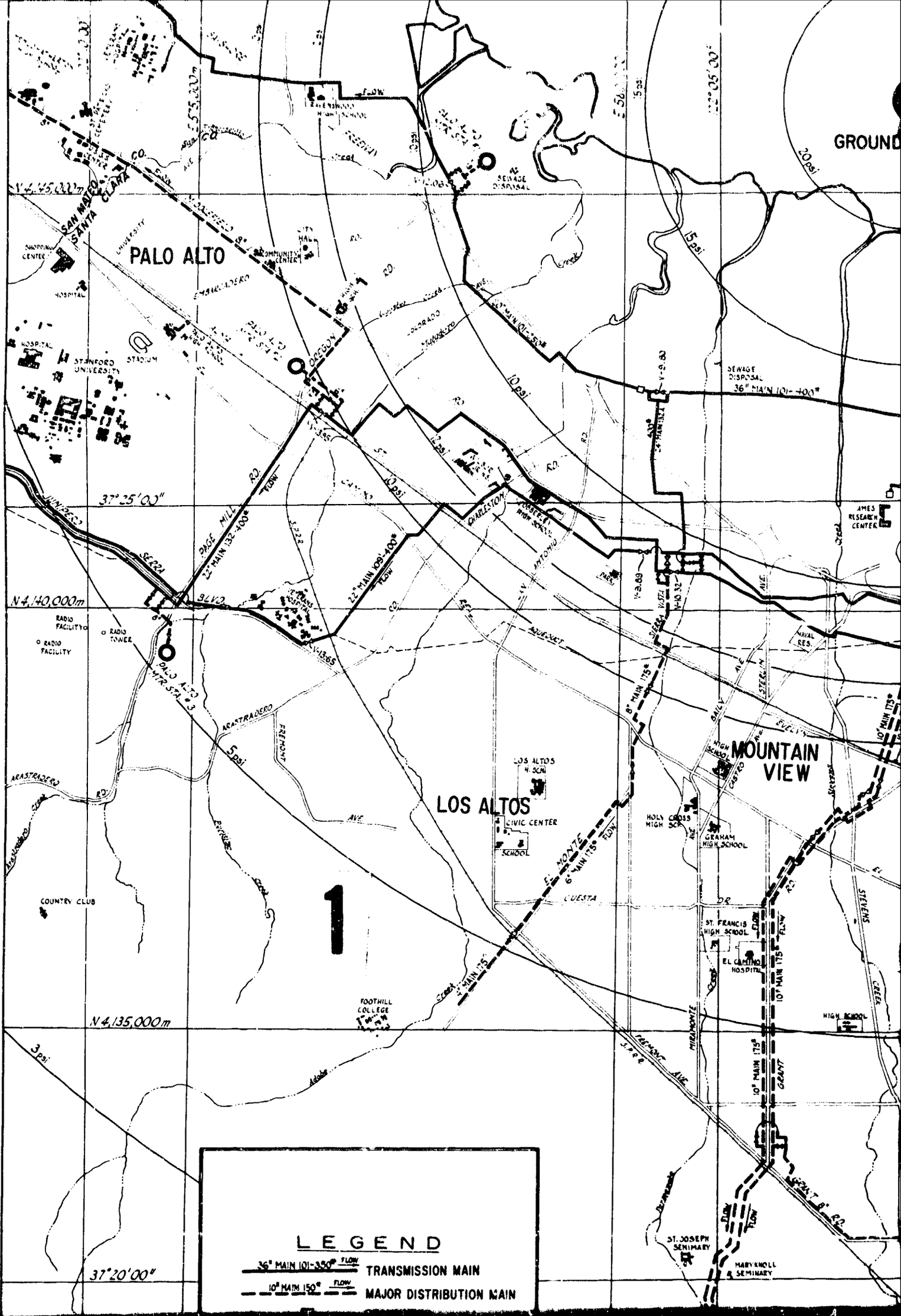
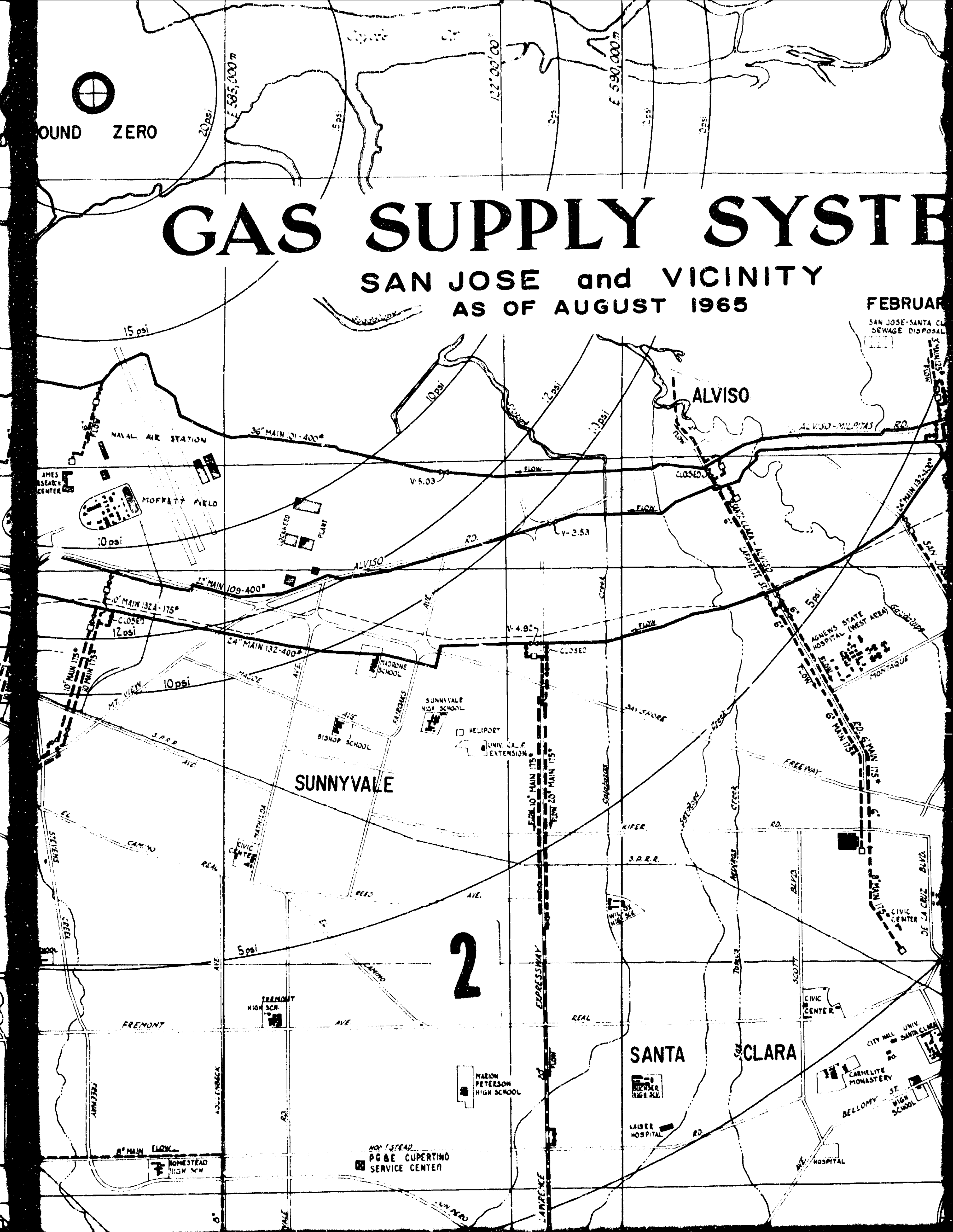
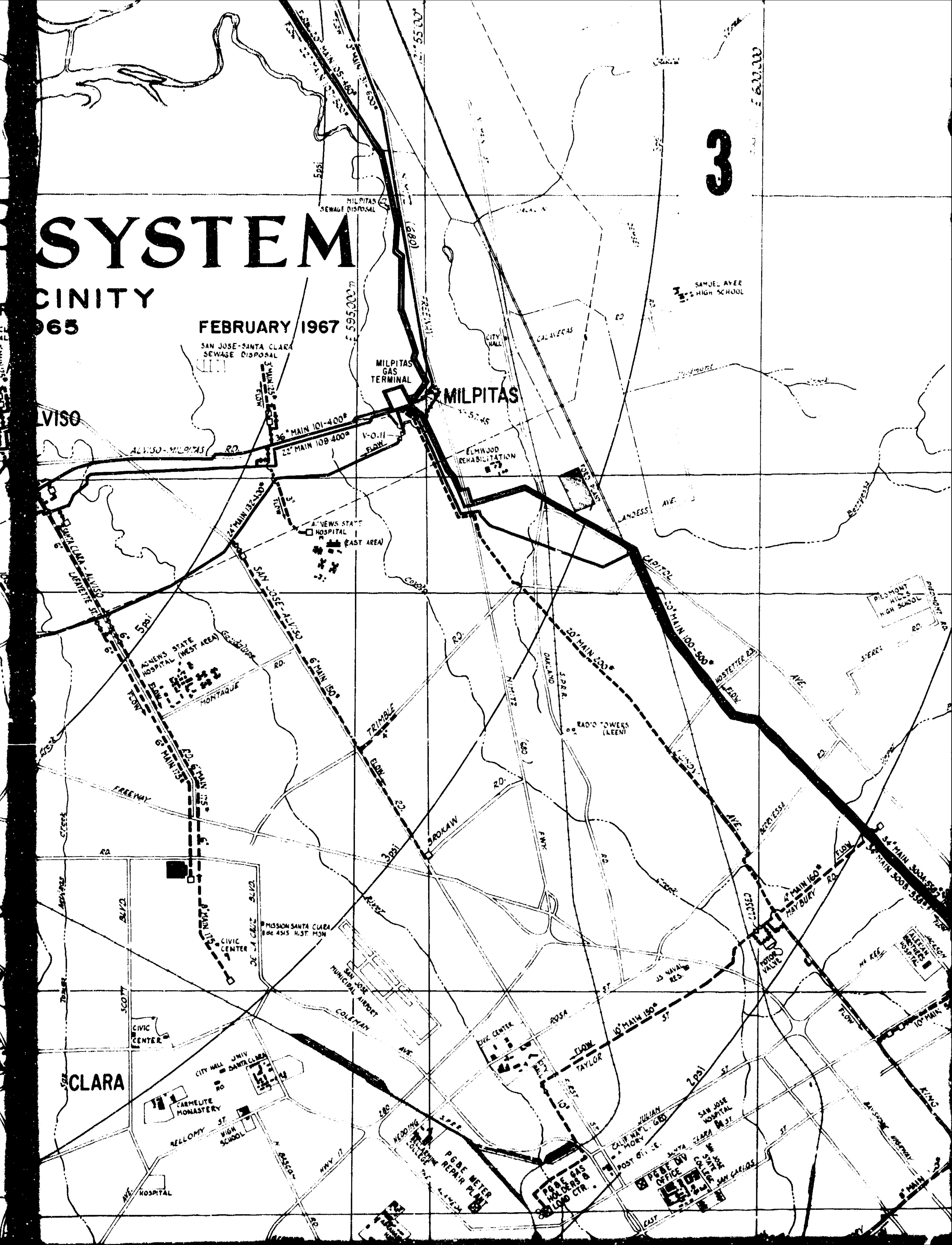
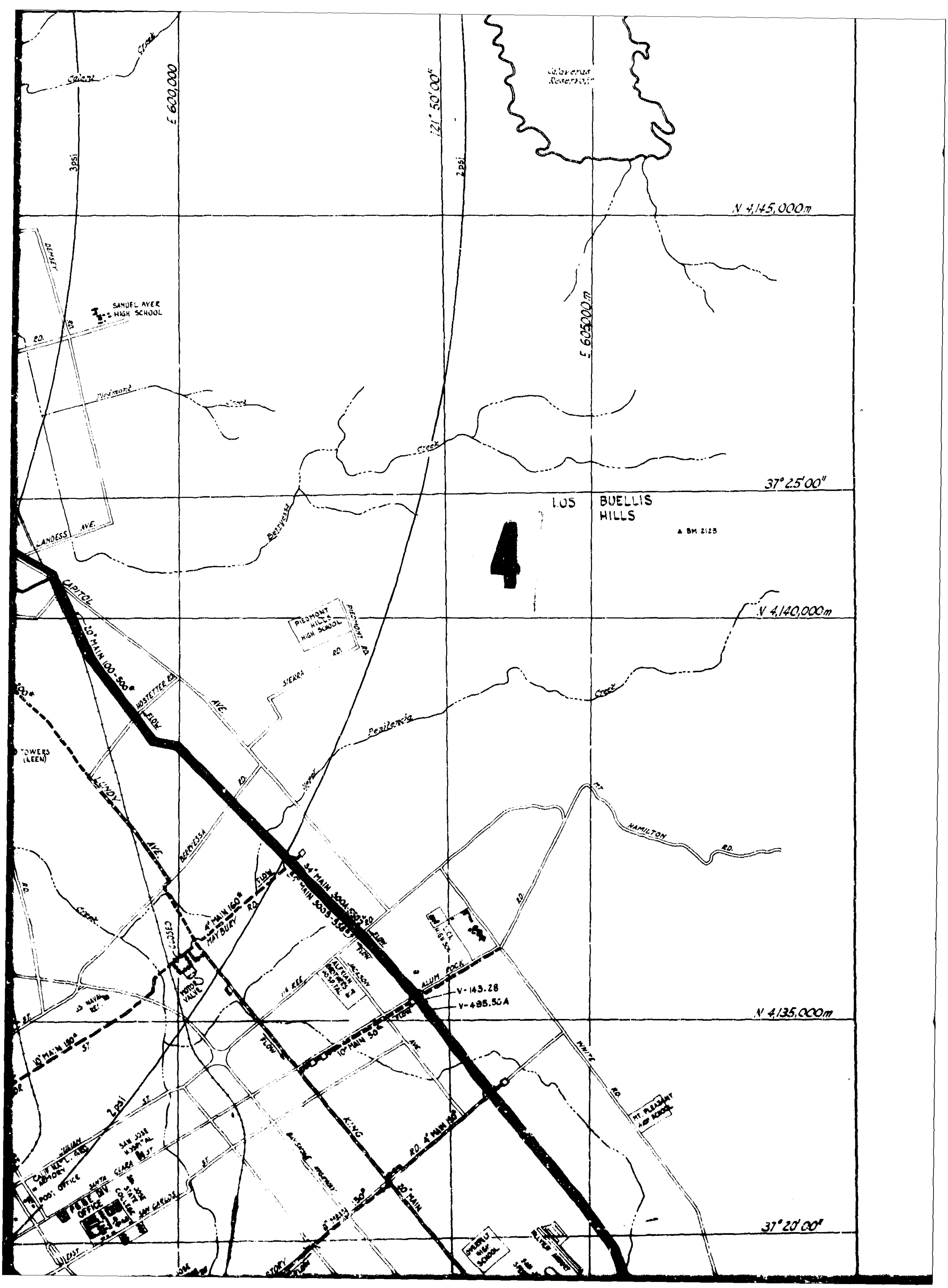

PALO ALTO
LOS ALTOS
MOUNTAIN VIEW
GROUND
SEWAGE DISPOSAL
36" MAIN 101-400"
22" MAIN 109-400"
22" MAIN 132-400"
8" MAIN 175"
6" MAIN 175" FLOW
10" MAIN 175"
N 4,145,000m
N 4,140,000m
N 4,135,000m
37°25'00"
37°20'00"
122°05'00"
122°00'00"
5 psi
10 psi
15 psi
20 psi
1
LEGEND
36" MAIN 101-350" FLOW
TRANSMISSION MAIN
10" MAIN 150" FLOW
MAJOR DISTRIBUTION MAIN

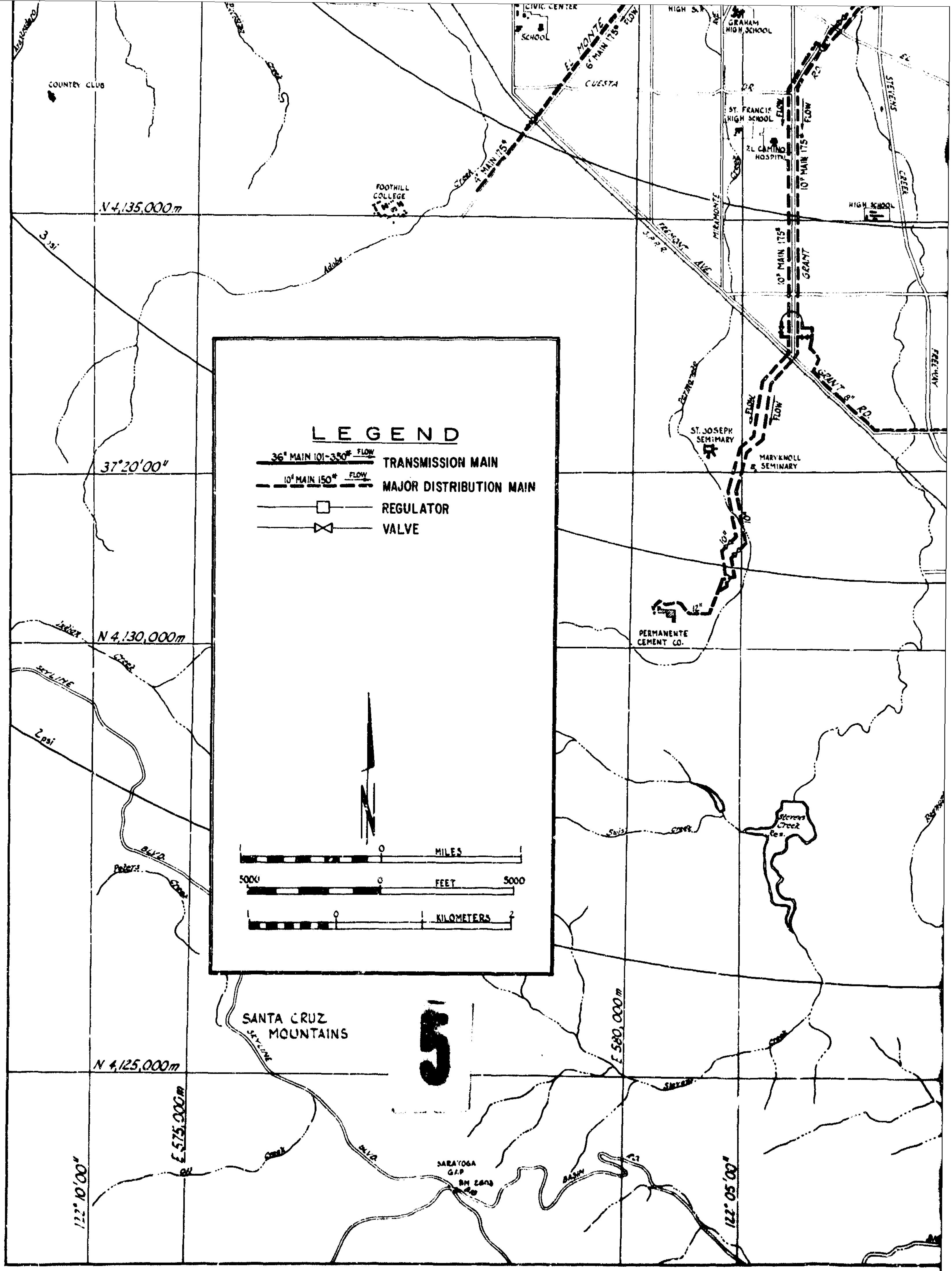

GROUND ZERO
GAS SUPPLY SYSTE
SAN JOSE and VICINITY
AS OF AUGUST 1965
FEBRUAR
SAN JOSE-SANTA CL
SEWAGE DISPOSAL
E 585,000 m
122°00'00"
E 590,000 m
20 psi
15 psi
12 psi
10 psi
5 psi
ALVISO
ALVISO-MILPITAS RD.
NAVAL AIR STATION
AMES RESEARCH CENTER
MOFFETT FIELD
36" MAIN 101-400#
22" MAIN 109-400#
10" MAIN 132A-175#
24" MAIN 132-400#
24" MAIN 132-400#
V-5.03
V-2.53
V-4.92
FLOW
CLOSED
ALVISO RD.
MADRONE SCHOOL
SUNNYVALE HIGH SCHOOL
BISHOP SCHOOL
HELIPORT
UNIV. CALIF EXTENSION
SUNNYVALE
AGNEWS STATE HOSPITAL (WEST AREA)
MONTAGUE
BAYSHORE
FREEWAY
KIFER RD.
S.P.R.R.
CIVIC CENTER
MATHILDA
FAIR OAKS
REED AVE.
2
FREMONT HIGH SCH.
FREMONT AVE.
EL CAMINO REAL
EXPRESSWAY
LAWRENCE
SANTA CLARA
CIVIC CENTER
CITY HALL
UNIV. SANTA CLARA
CARMELITE MONASTERY
BELLOMY ST.
HIGH SCHOOL
MARION PETERSON HIGH SCHOOL
BUCHSER HIGH SCH.
KAISER HOSPITAL
HOSPITAL
HOMESTEAD
PG&E CUPERTINO SERVICE CENTER
HOMESTEAD HIGH SCH.
8" MAIN FLOW
DE LA CRUZ BLVD.
SCOTT BLVD.
CALABAZAS
SAN TOMAS AQUINO
SAN JOSE



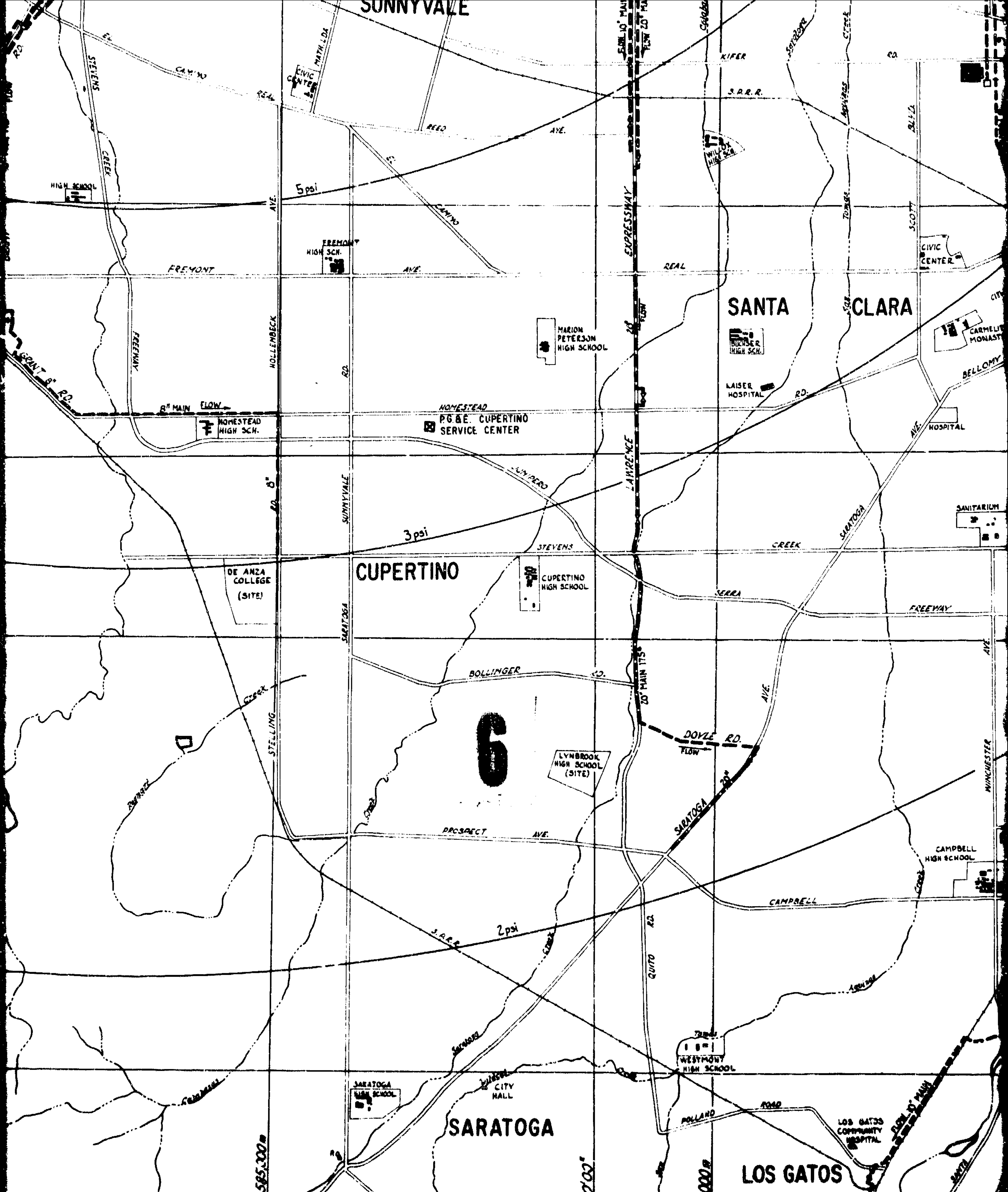
SYSTEM
CINITY
965
FEBRUARY 1967
3
SAN JOSE-SANTA CLARA SEWAGE DISPOSAL
MILPITAS SEWAGE DISPOSAL
MILPITAS GAS TERMINAL
MILPITAS
LVISO
36" MAIN 101-400#
22" MAIN 109-400#
ALVISO-MILPITAS RD.
ELMWOOD REHABILITATION
SAMUEL AYER HIGH SCHOOL
CITY HALL
CALAVERAS
LANDESS AVE.
AGNEWS STATE HOSPITAL (EAST AREA)
AGNEWS STATE HOSPITAL (WEST AREA)
24" MAIN 132-430#
SAN JOSE-ALVISO RD.
SANTA CLARA-ALVISO
LAFAYETTE ST.
MONTAQUE
6" MAIN 150#
CAPITOL
20" MAIN 100-500#
20" MAIN 200#
HOSTETTER RD.
PIEDMONT HILLS HIGH SCHOOL
SIERRA
RADIO TOWERS (LEENI)
TRIMBLE
BROKAW
FREEWAY
OAKLAND
S.P.R.R.
BERRYESSA
MAYBURY RD.
4" MAIN 160#
34" MAIN 300#
MOTOR VALVE
ALEXIAN BROTHERS HOSPITAL
MISSION SANTA CLARA
CIVIC CENTER
DE LA CRUZ BLVD.
SAN JOSE MUNICIPAL AIRPORT
COLEMAN AVE.
US NAVAL RES.
10" MAIN 150#
TAYLOR
ROSA
CLARA
CITY HALL
UNIV SANTA CLARA
CARMELITE MONASTERY
BELLOMY ST.
HIGH SCHOOL
HOSPITAL
HEDDING
PG&E METER REPAIR PLANT
PG&E GAS HOLDERS & LOAD CTR.
JULIAN
SAN JOSE HOSPITAL
POST OFFICE
PG&E DIV OFFICE
SAN JOSE STATE COLLEGE
SAN CARLOS
KING
McKEE
JACKSON
BAYSHORE FREEWAY



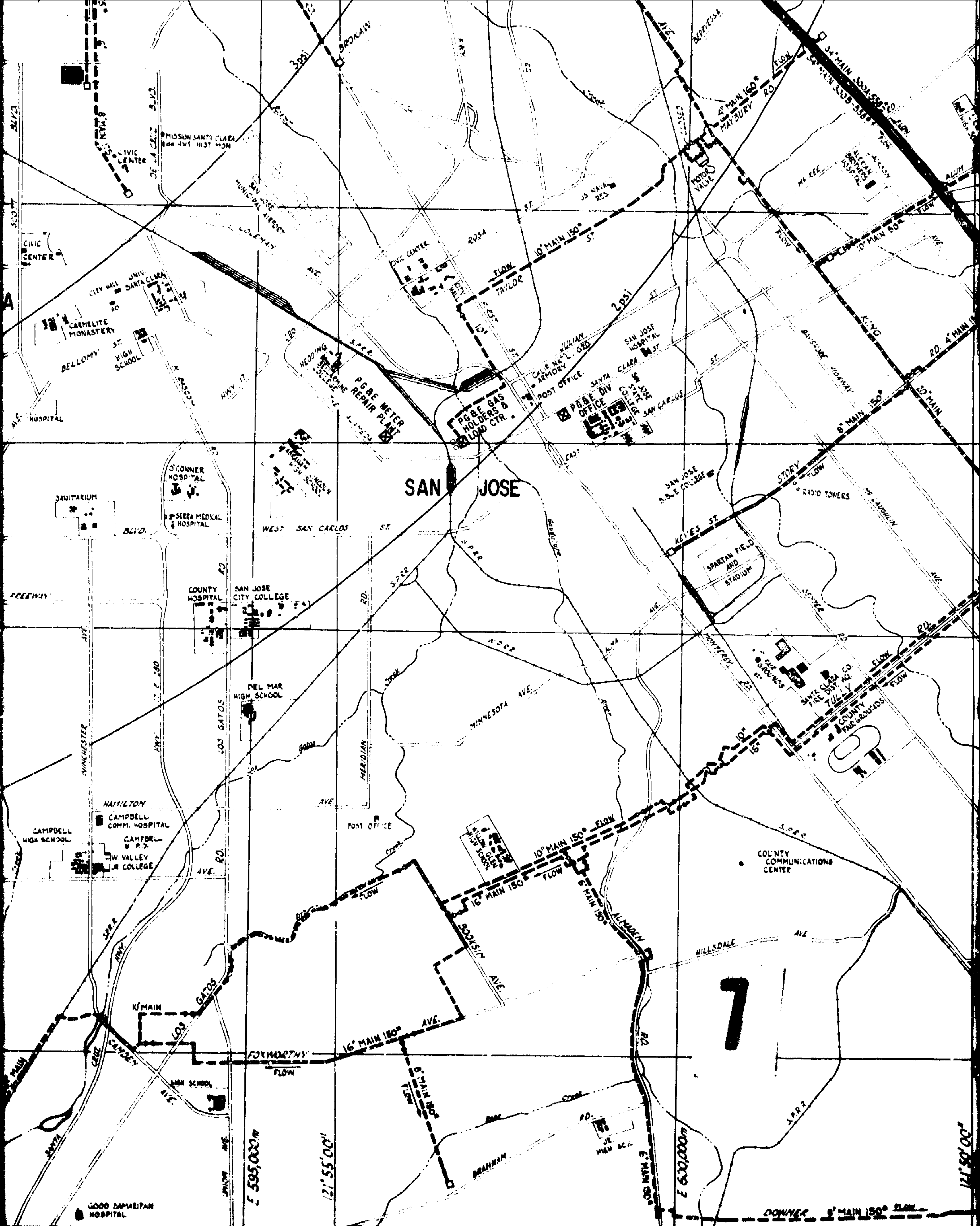
Calaveras Reservoir
E 600,000
121° 50'00"
3psi
2psi
N 4,145,000m
SAMUEL AYER HIGH SCHOOL
E 605000m
Piedmont Creek
Creek
37° 25'00"
LOS BUELLIS HILLS
BM 2123
4
Berryessa
LANDESS AVE.
CAPITOL
PIEDMONT HILLS HIGH SCHOOL
PIEDMONT RD.
N 4,140,000m
20" MAIN 100-300#
HOSTETTER RD.
FLOW
SIERRA RD.
AVE.
Penitencia Creek
TOWERS (LEEN)
LUNDY AVE.
BERRYESSA RD.
MT HAMILTON RD.
34" MAIN 300#
4" MAIN 160#
MAYBURY RD.
ALUM ROCK
V-143.28
V-495.50A
N 4,135,000m
10" MAIN 180#
10" MAIN 50#
MOTOR VALVE
FLOW
KING
WHITE RD.
MT. PLEASANT HIGH SCHOOL
2psi
RD. 4" MAIN 160#
20" MAIN
POST OFFICE
SANTA CLARA
SAN CARLOS
SAN JOSE STATE COLLEGE
OVERFELT HIGH SCHOOL
31° 20'00"



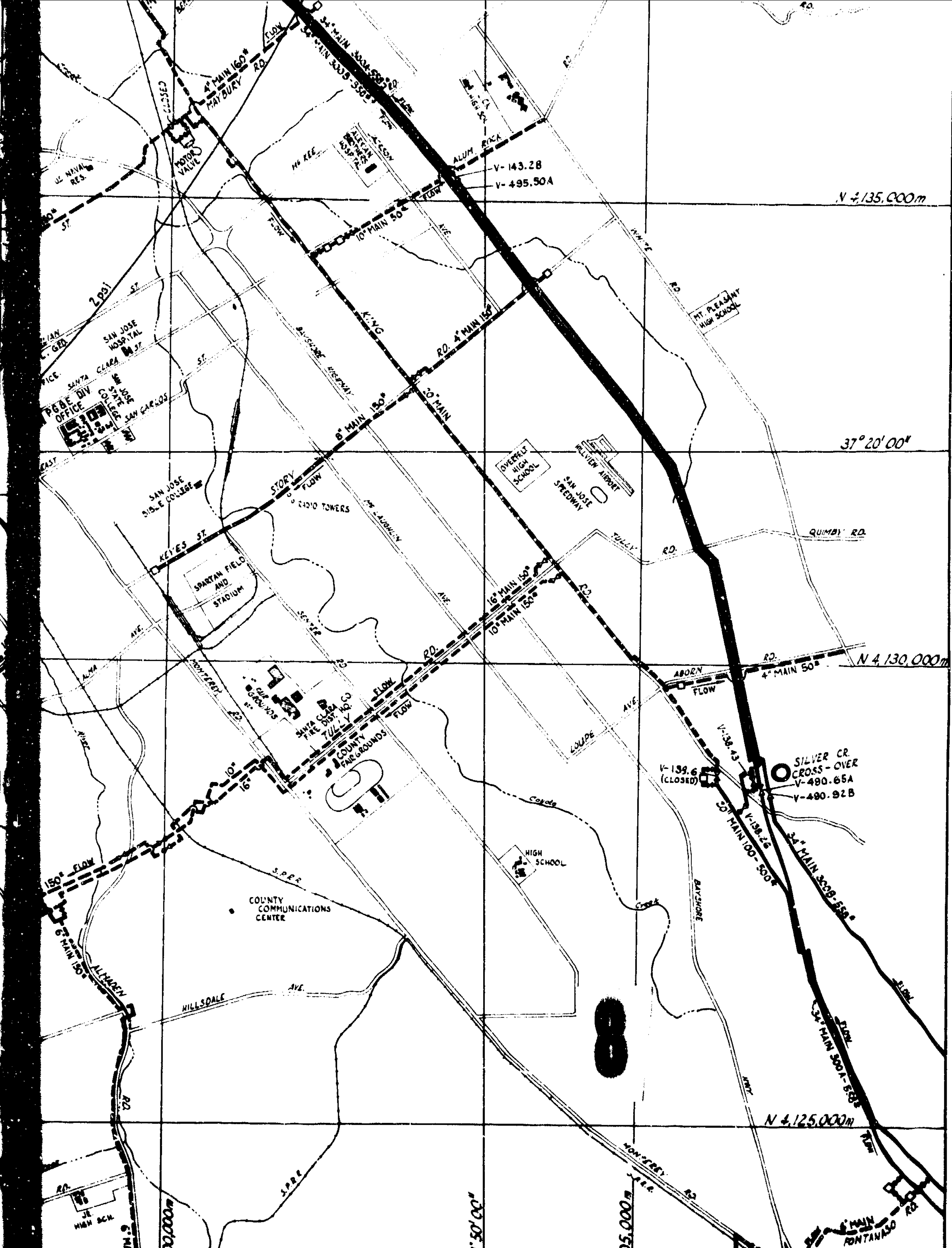
LEGEND
36" MAIN 101-350# FLOW
TRANSMISSION MAIN
10" MAIN 150# FLOW
MAJOR DISTRIBUTION MAIN
REGULATOR
VALVE
MILES
5000
FEET
5000
KILOMETERS
CIVIC CENTER
SCHOOL
HIGH SCHOOL
GRAHAM HIGH SCHOOL
EL MONTE
6" MAIN 175# FLOW
CUESTA
DR
ST. FRANCIS HIGH SCHOOL
EL CAMINO HOSPITAL
10" MAIN 175#
FLOW
COUNTRY CLUB
FOOTHILL COLLEGE
4" MAIN 175#
N 4,135,000m
3 psi
Adobe
FREMONT AVE.
S.P.R.R.
MIRAMONTE
10" MAIN 175#
GRANT
STEVENS
CREEK
FREEWAY
GRANT 8" RD.
ST. JOSEPH SEMINARY
MARYKNOLL SEMINARY
37°20'00"
10"
12"
PERMANENTE CEMENT CO.
N 4,130,000m
SKYLINE
2 psi
BLVD.
Peters
Creek
Swiss
Stevens Creek Res.
SANTA CRUZ MOUNTAINS
5
E 580,000m
N 4,125,000m
E 575,000m
122°10'00"
122°05'00"
SARATOGA GAP
BASIN



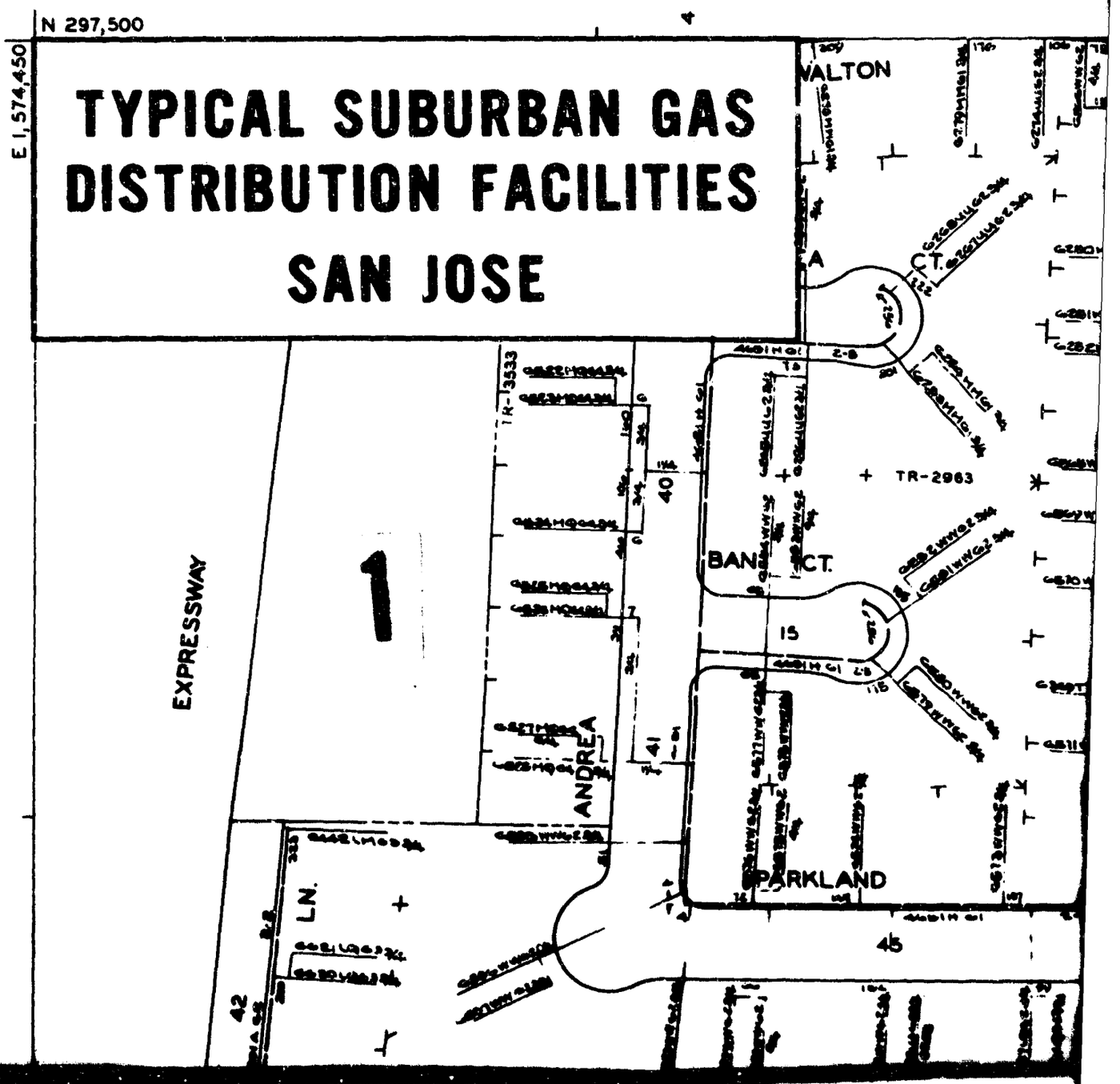
SUNNYVALE
SANTA CLARA
CUPERTINO
SARATOGA
LOS GATOS
6
5psi
3psi
2psi
HIGH SCHOOL
CIVIC CENTER
FREMONT HIGH SCH.
MARION PETERSON HIGH SCHOOL
WILCOX HIGH SCH.
BUCHSER HIGH SCH.
KAISER HOSPITAL
CARMELITE MONASTERY
HOSPITAL
SANITARIUM
HOMESTEAD HIGH SCH.
P.G.&E. CUPERTINO SERVICE CENTER
8" MAIN FLOW
DE ANZA COLLEGE (SITE)
CUPERTINO HIGH SCHOOL
LYNBROOK HIGH SCHOOL (SITE)
CAMPBELL HIGH SCHOOL
WESTMONT HIGH SCHOOL
SARATOGA HIGH SCHOOL
CITY HALL
LOS GATOS COMMUNITY HOSPITAL
DOYLE RD.
FLOW
EXPRESSWAY
LAWRENCE
HOMESTEAD
JUNIPERO
STEVENS CREEK
SERRA FREEWAY
BOLLINGER RD.
PROSPECT AVE.
CAMPBELL
SARATOGA AVE.
QUITO RD.
POLLARD ROAD
FREMONT AVE.
REAL
KIFER RD.
S.P.R.R.
BELLOMY
WINCHESTER
HOLLENBECK AVE.
STELLING
SUNNYVALE RD.
E 585,000 m
E 590,000 m
122° 00' 00"



SAN JOSE
7
BROKAW
BERRYESSA
MAYBURY RD.
4" MAIN 160#
MOTOR VALVE
ALUM
KING
RD. 4" MAIN
20" MAIN
8" MAIN 150#
STORY
FLOW
RADIO TOWERS
10" MAIN 50#
10" MAIN 150#
TAYLOR
ROSA
2 psi
3 psi
CIVIC CENTER
MISSION SANTA CLARA
CITY HALL
UNIV. SANTA CLARA
CARMELITE MONASTERY
BELLOMY ST.
HIGH SCHOOL
HOSPITAL
SCOTT BLVD.
HWY. 17
P.G.&E. METER REPAIR PLANT
P.G.&E. GAS HOLDERS & LOAD CTR.
P.G.&E. DIV OFFICE
POST OFFICE
CALIF. NAT'L. GRD. ARMORY
JULIAN
SAN JOSE HOSPITAL
SANTA CLARA ST.
SAN JOSE STATE COLLEGE
SAN CARLOS
SAN JOSE BIBLE COLLEGE
KEYES ST.
SPARTAN FIELD AND STADIUM
O'CONNER HOSPITAL
SANITARIUM
SERRA MEDICAL HOSPITAL
WEST SAN CARLOS ST.
COUNTY HOSPITAL
SAN JOSE CITY COLLEGE
FREEWAY
S.P.R.R.
W.P.R.R.
MINNESOTA AVE.
DEL MAR HIGH SCHOOL
WINCHESTER AVE.
LOS GATOS RD.
MERIDIAN AVE.
MONTEREY RD.
ALMA
SANTA CLARA CO. FIRE DIST. NO. 1
TULLY RD.
COUNTY FAIRGROUNDS
HAMILTON
CAMPBELL COMM. HOSPITAL
CAMPBELL HIGH SCHOOL
CAMPBELL P.D.
W. VALLEY JR COLLEGE
POST OFFICE
10" MAIN 150# FLOW
16" MAIN 150
6" MAIN 150#
BOOKSIN AVE.
ALMADEN RD.
HILLSDALE AVE.
COUNTY COMMUNICATIONS CENTER
10" MAIN
LOS GATOS
FOXWORTHY AVE.
16" MAIN 150#
CAMDEN AVE.
HIGH SCHOOL
8" MAIN 150#
BRANHAM
JR. HIGH SCH.
UNION AVE.
E 595,000m
121°55'00"
E 630,000m
121°50'00"
DOWNER 8" MAIN 150# FLOW
GOOD SAMARITAN HOSPITAL

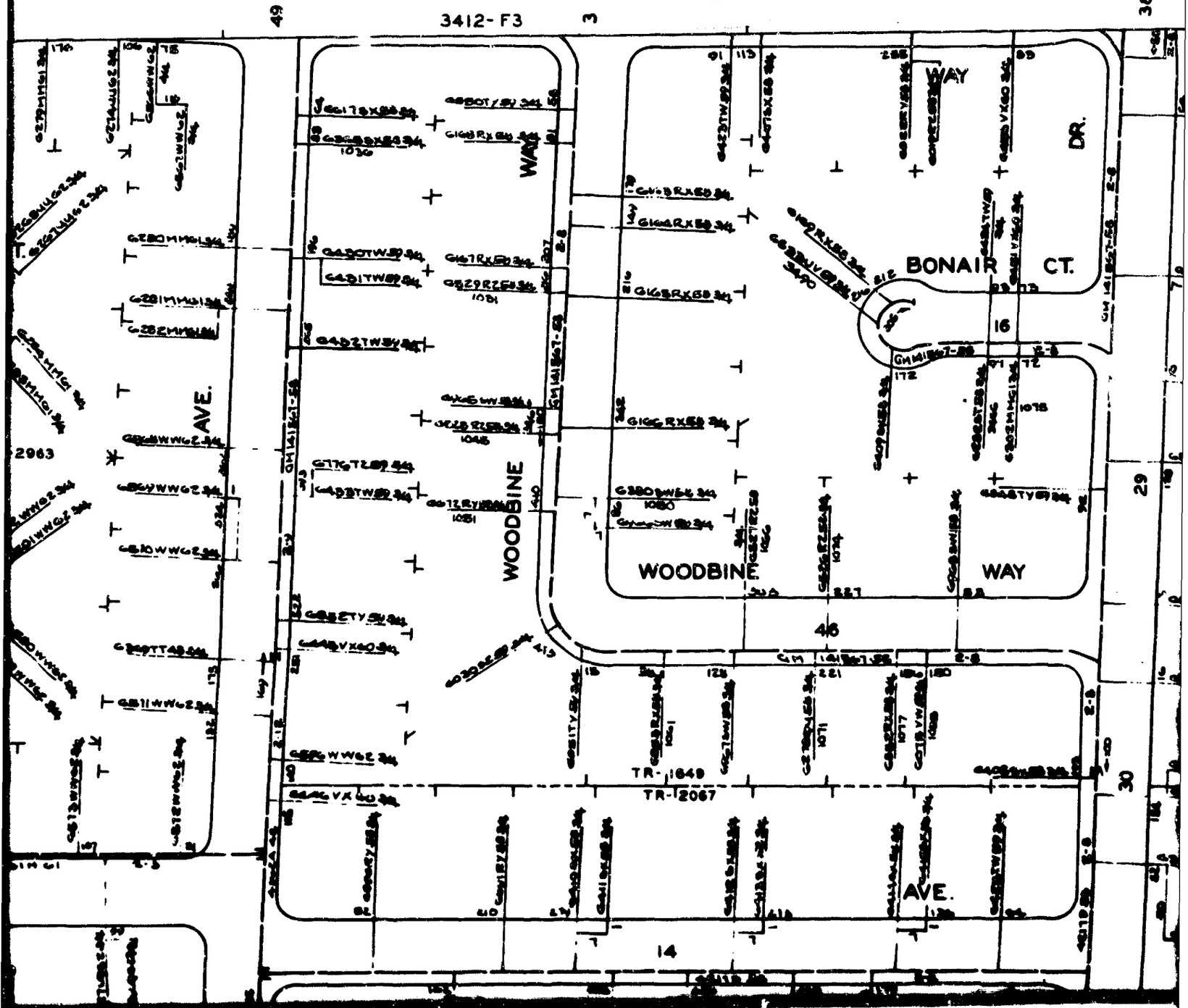

34" MAIN 300A-5.68
34" MAIN 300B-5.50
FLOW
4" MAIN 160
MAYBURY RD.
CLOSED
MOTOR VALVE
U.S. NAVAL RES.
McKEE
ALEXIAN BROTHERS HOSPITAL
ALUM ROCK
V-143.28
V-495.50A
N 4,135,000m
10" MAIN 50
AVE.
RD.
MT. PLEASANT HIGH SCHOOL
2 psi
ST.
SAN JOSE HOSPITAL
SANTA CLARA
ST.
SAN JOSE STATE COLLEGE
SAN CARLOS
PG&E DIV OFFICE
KING
RD. 4" MAIN 150
BAYSHORE HIGHWAY
20" MAIN
8" MAIN 150
37° 20' 00"
OVERFELT HIGH SCHOOL
HILLVIEW AIRPORT
SAN JOSE SPEEDWAY
SAN JOSE BIBLE COLLEGE
STORY
RADIO TOWERS
McLAUGHLIN
TULLY
RD.
QUIMBY RD.
KEYES ST.
SPARTAN FIELD AND STADIUM
16" MAIN 150
10" MAIN 150
AVE.
SENTER
RD.
ABORN
RD.
4" MAIN 50
N 4,130,000m
ALMA
MONTEREY
FAIR GROUNDS
SANTA CLARA FIRE DIST. NO. 3
TULLY
COUNTY FAIRGROUNDS
LOUPE AVE.
V-138.43
V-139.6 (CLOSED)
SILVER CR. CROSS-OVER
V-490.65A
V-490.92B
10"
16"
20" MAIN 100-500
V-138.26
34" MAIN 300B-5.58
Coyote
HIGH SCHOOL
150 FLOW
S.P.R.R.
COUNTY COMMUNICATIONS CENTER
6" MAIN 150
ALMADEN
BAYSHORE
Creek
HILLSDALE
AVE.
HWY
34" MAIN 300A-5.68
FLOW
N 4,125,000m
MONTEREY
RD.
S.P.R.R.
JR. HIGH SCH.
6" MAIN 150
E 600,000m
121° 50' 00"
E 605,000m
6" MAIN
FONTANOSO RD.
DOWNER
8" MAIN 150 FLOW
AVE.
10" MAIN

PACIFIC GAS AND ELECTRIC CO.
SAN JOSE DIVISION



GAS DISTRIBUTION MAP
SCALE 1" = 100' ZONE 2

DRAWN
6-29-66



DRAWN

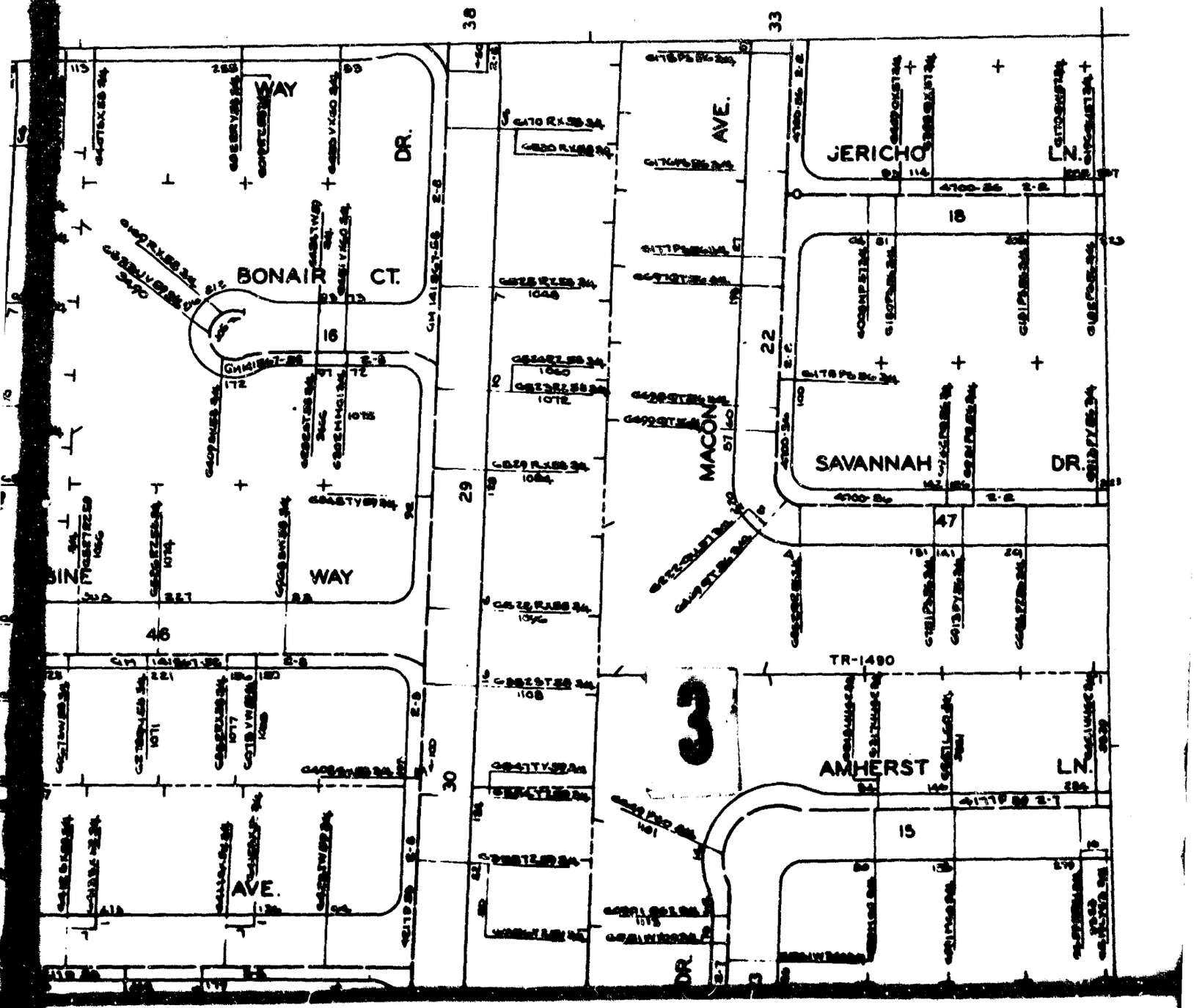
6-29-66

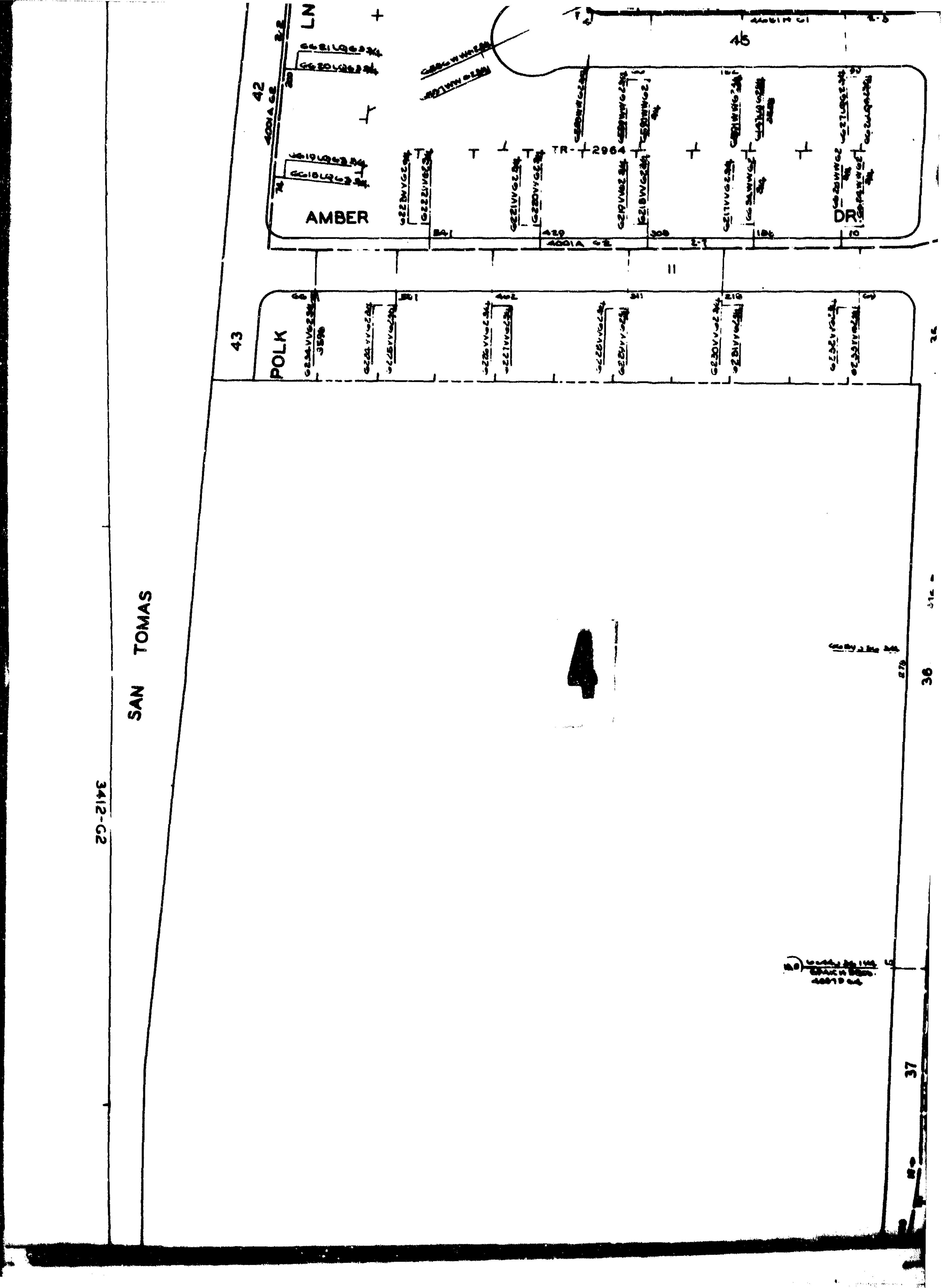
DATE LAST CORRECTED

3412-G3

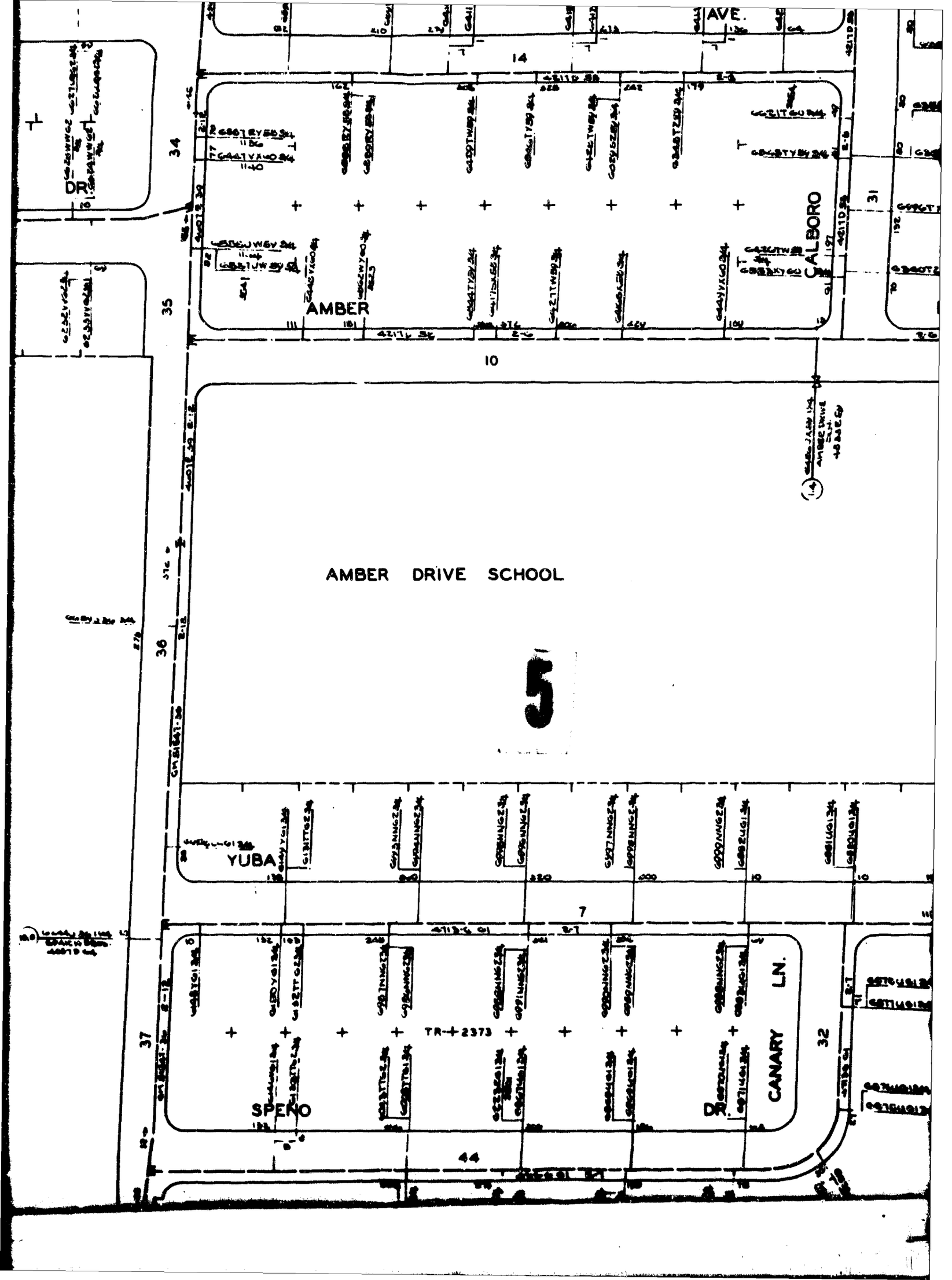
H-15-9

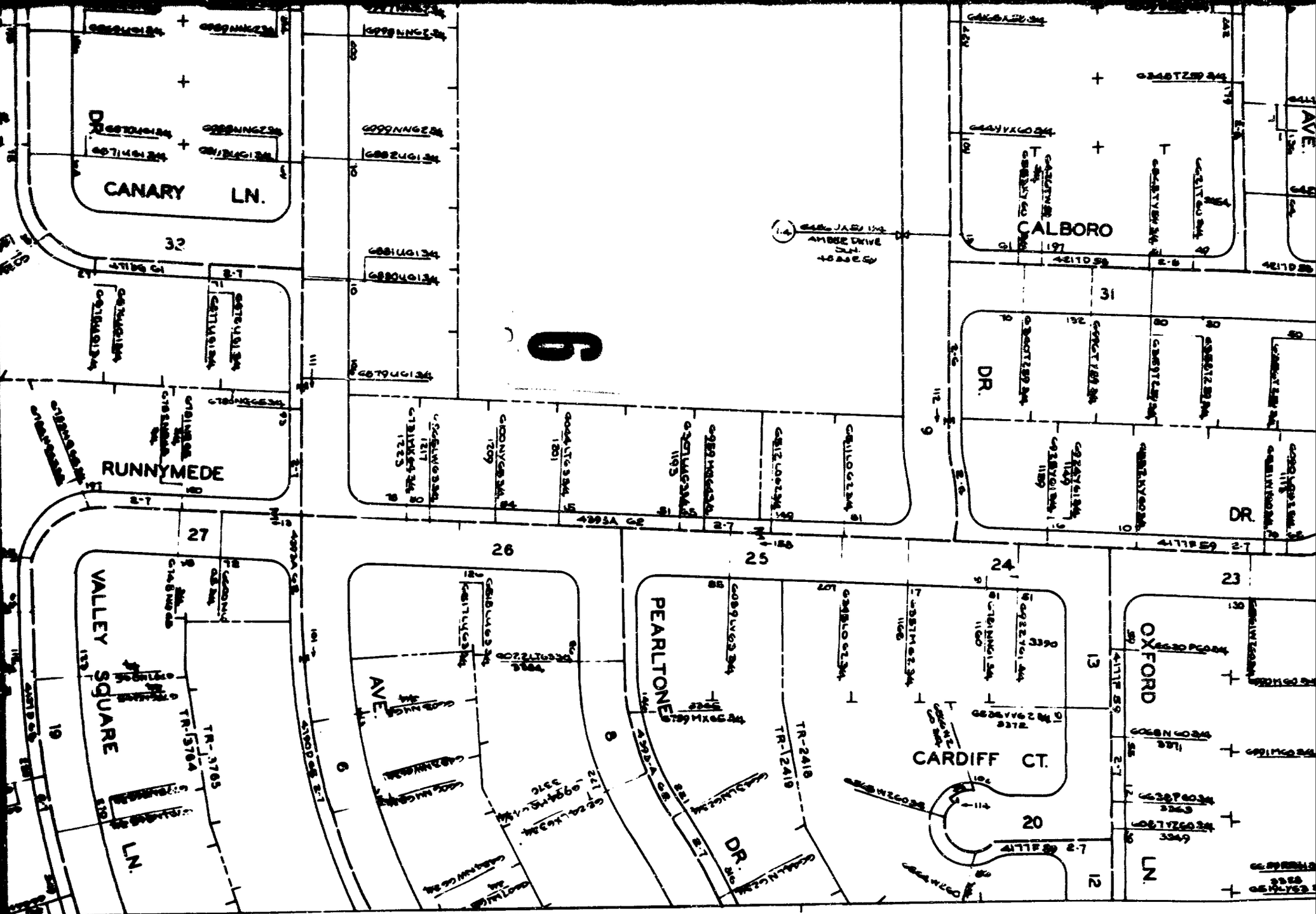
46





LN
45
42
AMBER
DR
TR-2964
11
43
POLK
SAN TOMAS
3412-G2
36
37


AVE.
14
DR.
34
AMBER
CALBORO
31
35
10
AMBER DRIVE SCHOOL
36
5
YUBA
7
37
TR-2373
SPENO
CANARY LN.
32
44


CANARY LN.
RUNNYMEDE
CALBORO
DR.
AMBER DRIVE
VALLEY SQUARE
LN.
AVE.
PEARLTONE
DR.
CARDIFF CT.
OXFORD
LN.
32
31
27
26
25
24
23
20
19
13
12
6
8
9
TR-3705
TR-3704
TR-2418
TR-2419
3412-G4

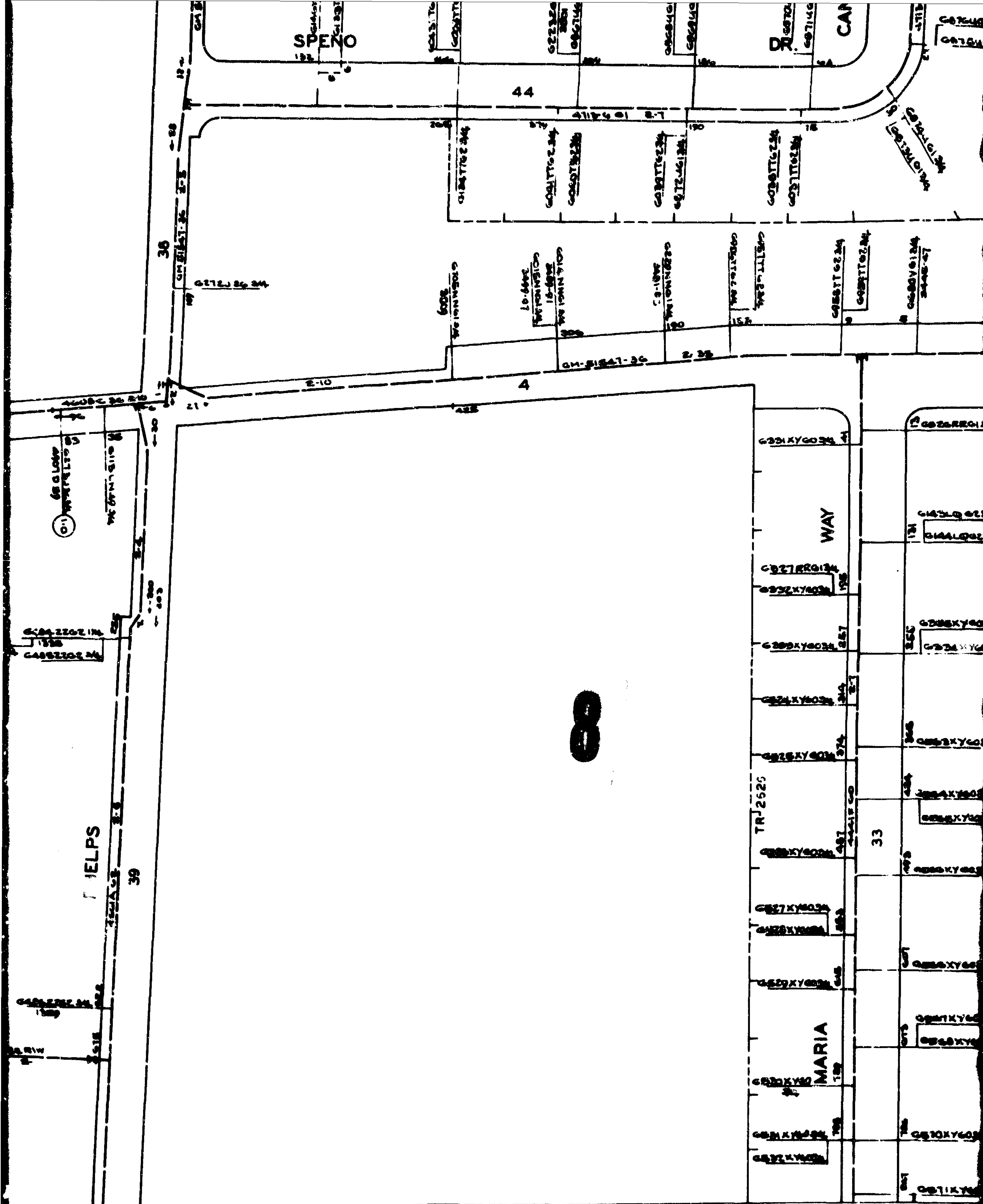
PHELPS

PAYNE

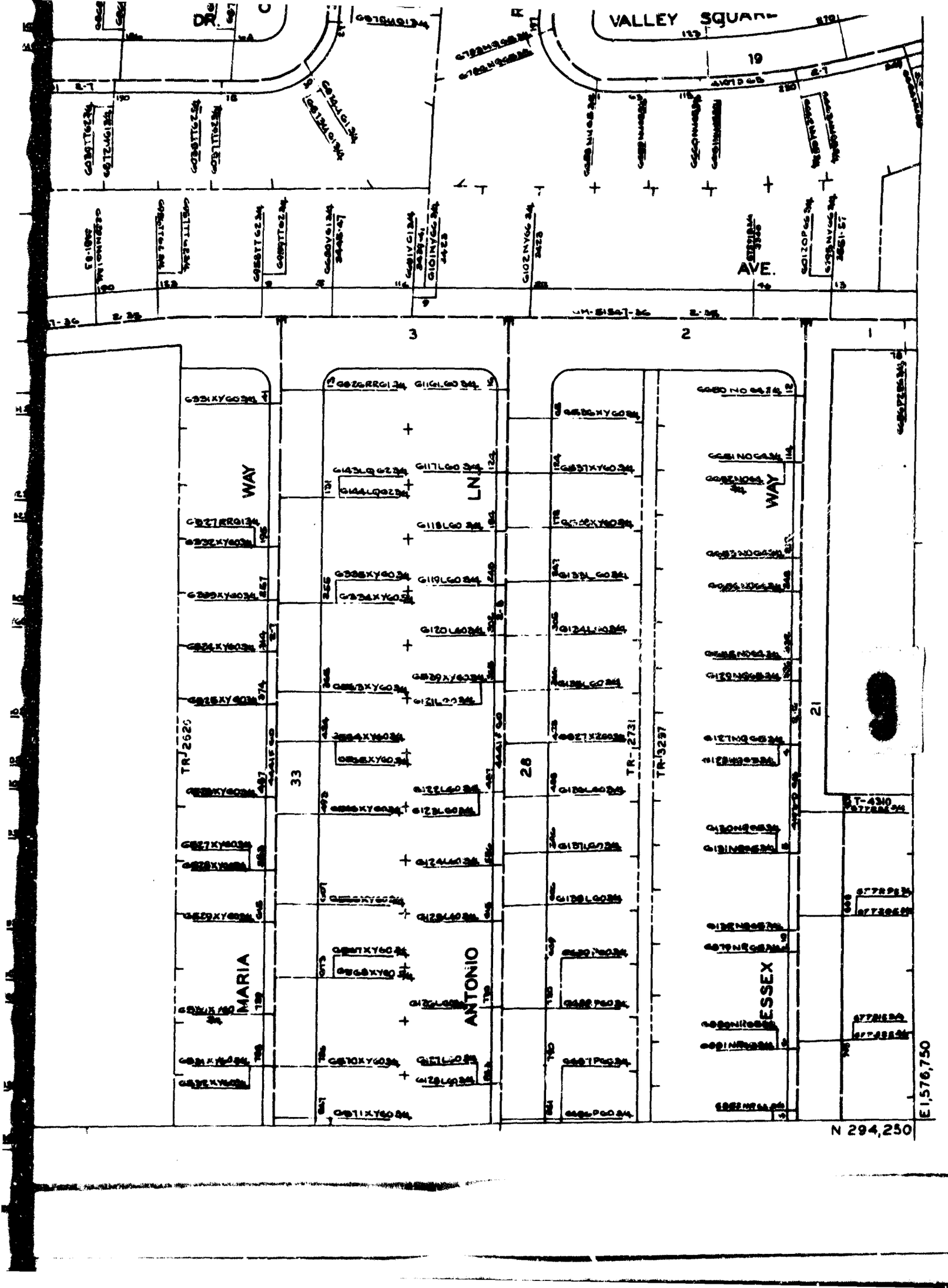
SAN TOMAS

SAN TOMAS AQUINO PARKWAY

EXPRESSWAY



3412-H3


DR.
VALLEY SQUARE
AVE.
WAY
LN
WAY
MARIA
ANTONIO
JESSEX
TR-2620
TR-2731
TR-3297
33
28
21
3
2
1
19
E 1,576,750
N 294,250

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13. ABSTRACT

Purposes of the report are: (1) to examine the effects resulting from a hypothetical nuclear attack on the facilities and operating capability of the gas system supplying San Jose, California, and (2) to describe normal operation of the system and provide a functional inventory of buildings, transportation, communication and other support equipment.

It determines that there is no damage to the gas trasmission and distribution system supplying the City of San Jose. The capability of the system to continue normal supply is unaffected by the attack.

It is concluded also as a byproduct of the study that the utility will cut off and shut down that part of the distribution system in the area west of the City experiencing severe structural damage, even though the distribution system therein is undamaged.

This area lies within an approximate arc about nine miles out from ground zero, beginning near the western fringes of San Jose and extend westerly to Palo Alto. The purpose is to eliminate gas leakage from gas equipment in the severely damaged and uninhabitable homes and buildings where need for gas service no longer exists.

Estimates of casualties among employees living in the City of San Jose indicate sufficient personnel with required occupational capabilities will be available to carry out postattack emergency measures.

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Nuclear attack						
Vulnerability						
Damage						
Gas facilities						
Gas system						
Degradation of gas system						
Emergency measures						
Postattack capability						

Security Classification