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SOURCES OF EMERGENCY WATER SUPPLIES IN SAN MATEO COUNTY, CALIFORNIA

By P. R. Wood

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CONVERSION FACTORS

Factors for converting English units to metric units are given below to four significant figures. However, in the text the metric equivalents are shown only to the number of significant figures consistent with the values for the English units.

English	*Multiply by*	*Metric*
ft (feet)	3.048×10^{-1}	m (metres)
in (inches)	2.540×10^{1}	mm (millimetres)
qt (quarts)	0.9462	l (litres)
gal (gallons)	3.785	l (litres)
gal/min (gallons per minute)	0.06309	l/s (litres per second)
Mgal/d (million gallons per day)	4.381×10^{1}	dm^3/s (cubic decimetres per second)
	4.381×10^{-2}	m^3/s (cubic metres per second)
	3.785×10^{4}	m^3/d (cubic metres per day)

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SOURCES OF EMERGENCY WATER SUPPLIES IN SAN MATEO COUNTY, CALIFORNIA

By P. R. Wood

ABSTRACT

San Mateo County has several densely populated urban areas that get most of their water supplies from surface-water sources that could by damaged by a major earthquake or other general disaster. In the event of such a disaster, limited supplies of potable water may be obtained from selected wells, springs, and perennial streams.

This report outlines the principal sources of existing water supplies, gives information on the need for emergency water-supply procedures, presents general criteria needed for selecting emergency water-supply wells, summarizes information for 60 selected water wells, numerous springs, and perennial streams that can be used as sources of water, and describes emergency water-purification procedures that can be used by individuals or small groups of people.

INTRODUCTION

A major emergency affecting many people may occur anytime and anywhere. It could be a disaster caused by a flood, tornado, fire, storm, earthquake, or nuclear holocaust. In any type of general disaster, lives can be saved if people are prepared for the emergency and know what actions to take when it occurs.

San Mateo County gets most of its public water supplies from the Hetch Hetchy Aqueduct and from water-storage reservoirs. The aqueduct crosses several major faults (surfaces or zones along which rocks have been fractured and displaced). The water-storage reservoirs occupy parts of stream valleys that are alined along faults. Although engineering firms are cognizant of the earthquake hazard and have considered it in the design and construction of water facilities, a major earthquake near one of the reservoirs or along one or more of the faults crossed by the aqueduct could damage the facility and cause a serious water problem in the county.

This report outlines the principal sources of existing water supplies, gives information on the need for emergency water-supply procedures, presents general criteria needed for selecting emergency water-supply wells, summarizes information for 60 selected water wells, numerous springs, and perennial streams that can be used as sources of water, and describes emergency water-purification procedures that can be used by individuals or small groups of people. Perhaps the report will also serve as a guide for similar studies in other areas.

SOURCES OF EXISTING WATER SUPPLIES IN SAN MATEO COUNTY

The water supplies for most of the residents in San Mateo County are obtained from the San Francisco Water Department, a municipal system owned and maintained by the City and County of San Francisco. Figure 1 shows the service areas of the principal water-distribution agencies, and table 1 gives summary information on sources of water, population serviced, and water-use data.

Montara and Moss Beach are served by wells and springs. Princeton, El Granada, and Half Moon Bay obtain some of their water supplies from wells and springs, but most of their water comes from Pilarcitos Reservoir which is owned by the San Francisco Water Department. Small residential areas in Menlo Park and East Palo Alto are served by wells. Daly City, South San Francisco, and San Bruno obtain water from wells and by purchase from the San Francisco Water Department. Other small towns, unincorporated communities, and people living outside municipal water-service areas depend chiefly on shallow wells, springs, or streams to supply water for domestic, stock, and other uses.

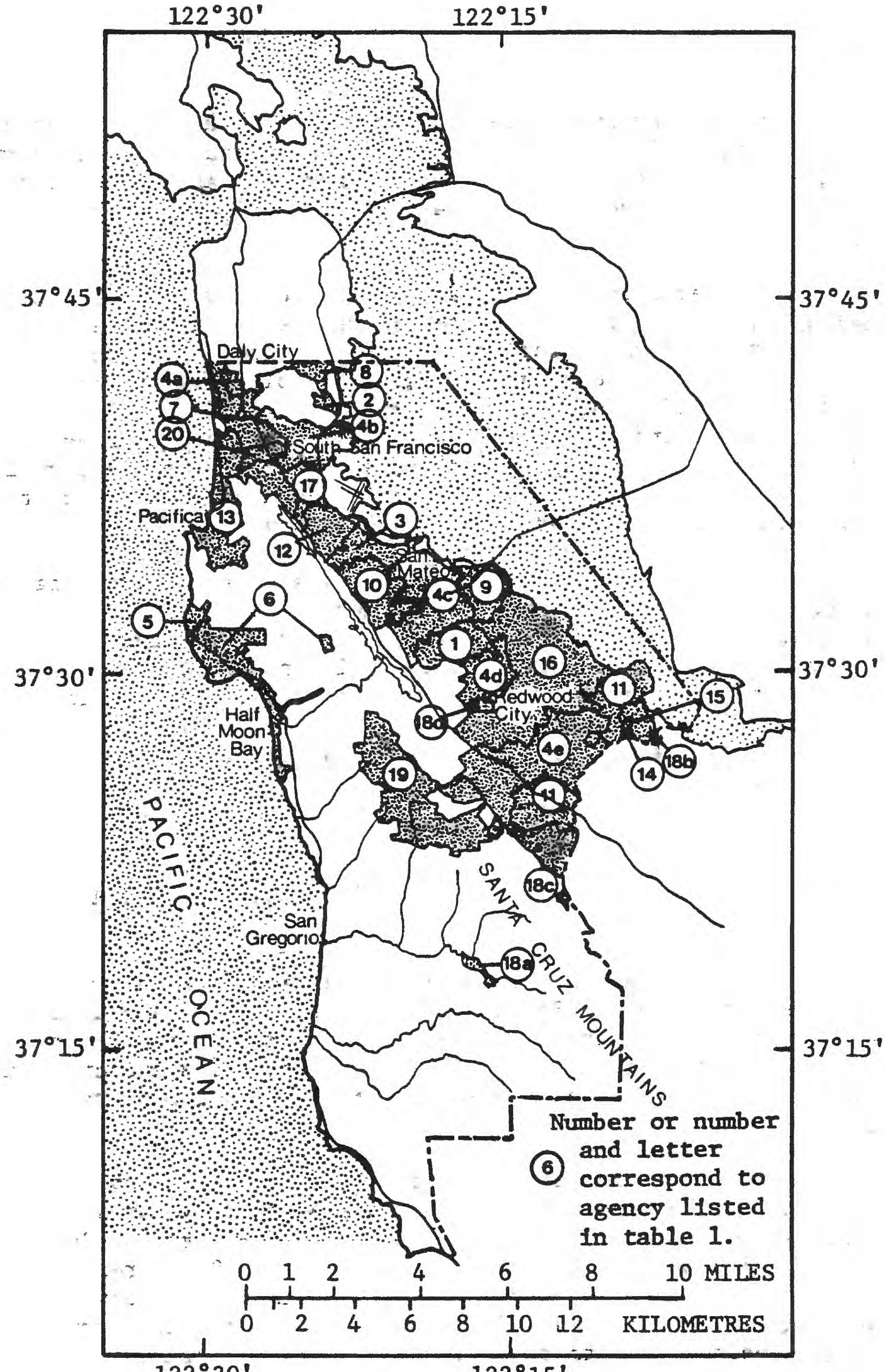

FIGURE 1.--San Mateo County area showing boundaries of the principal water-distribution agencies. (Modified after Limerinos and Van Dine, 1971)

TABLE 1.--*Principal water-distribution agencies in San Mateo County*

[Data for 1970 conditions, estimates for projected population and water use, and county totals after Limerinos and Van Dine, 1971. Agency names modified in places. Number identifies area serviced by water-distribution agency. Location of agency shown by number in figure 1. SFWD, San Francisco Water Department]

Number	Agency	1970 conditions				Projected population and water use		
		Source of water	Population serviced	Service connections	Water use (Mgal/d)[1]	Year	Population	Water use[2] (Mgal/d)
1	Belmont County Water District	SFWD	24,000	6,085	3.56	2000	50,000	-
2	Brisbane	SFWD	3,000	900	.27	1980	27,000	-
3	Burlingame	SFWD	[3]27,700	8,534	4.43	1980	28,000	-
	California Water Service Co.							
4a	Broadmoor-Colma area	SFWD	5,000	1,654	.77	-	-	-
4b	South San Francisco	SFWD and wells	46,706	11,604	8.02	-	-	-
4c	San Mateo	SFWD	78,991	22,547	12.2	1990	115,000	-
4d	San Carlos	SFWD	25,924	8,358	4.36	-	-	-
4e	Atherton, Woodside, Menlo Park and Portola Valley	SFWD and local runoff	34,500	14,998	10.9	-	-	-
5	Citizens Utilities Co. (Montara and Moss Beach areas)	Springs and wells	2,500	700	.35	1980	30,000	1.80
6	Coastside County Water District (El Granada and Half Moon Bay areas)	SFWD (Pilarcitos Reservoir) and wells	7,700	2,300	.78	1990	79,000	10.0
7	Daly City	SFWD and wells	67,000	16,697	6.90	1980	90,000	9.22
8	Diamond Public Utility District	SFWD	2,450	700	.21	-	-	-
9	Estero Municipal Improvement District (Foster City area)	SFWD	12,438	2,963	1.41	1980	36,200	4.30
10	Hillsborough	SFWD	8,800	2,987	2.95	1980	9,600	3.40
11	Menlo Park	SFWD	-	3,500	3.70	-	-	-
12	Milbrae	SFWD	20,850	5,000	3.16	1980	23,000	-
13	North Coast County Water District (Pacifica area)	SFWD, springs, San Pedro Creek	36,000	9,500	3.52	1980	70,000	-
14	O'Connor Tract Cooperative Water Co. (Menlo Park area)	Wells	908	227	-	-	-	-
15	Palo Alto Park Mutual Water Co. (East Palo Alto area)	Wells	2,100	600	.41	-	-	-
16	Redwood City	SFWD	58,200	16,662	8.81	-	-	-
17	San Bruno	SFWD and wells	35,976	11,500	3.32	1980	45,000	-
	San Mateo County Water Works District							
18a	County Service Area No. 7	Springs, Mindego Creek, and shallow wells	945	270	.06	-	-	-
18b	East Palo Alto County Water Works District	SFWD	14,400	3,600	2.36	-	-	-
18c	Los Trancos County Water District	SFWD	640	170	.05	-	-	-
18d	Palomar Park County Water Works District	SFWD	700	165	.07	-	-	-
19	Skyline County Water District	SFWD	665	190	.06	-	-	-
20	Westborough County Water District	SFWD	4,000	1,200	.39	1980	5,000	-
	County total		[4]522,093	153,611	[5]83.02	1980	[6]737,600	[2]117

[1]One million gallons per day (Mgal/d) = 0.04381 m^3/s or 3,785 m^3/d.
[2]Water-use projection for year 1980 was based on 1970 per capita water use.
[3]Includes service to 1,000 people in unincorporated areas.
[4]Excluding city of Menlo Park; population data not available.
[5]Excluding O'Connor Tract Cooperative Water Co.; water use not metered.
[6]Population projection for year 1980 from Bay Area Transportation Study Commission, 1969.

NEED FOR EMERGENCY WATER-SUPPLY PROCEDURES

Basic considerations in a well-integrated program to be used during a disaster are to make adequate provisions for safeguarding water supplies against contamination and destruction and to plan for emergency water supplies in the event that normal service is interrupted.

A nuclear explosion would cause a wide variety of water-related problems. Among the more serious of these problems are direct radioactive contamination of surface-water sources, destruction of water and electric-power plants and their distribution systems, and interruption of water service through breakage of water and sewer mains.

A major earthquake probably would disrupt electric-power distribution lines; rupture potable water-collection, treatment, and distribution systems; and damage wastewater-collection, treatment, and disposal facilities. Surface-water reservoirs could be destroyed or rendered temporarily unusable because of earthslides and turbidity problems. Steel and concrete water-storage tanks could be ruptured, knocked off their foundations, or otherwise damaged and rendered largely unusable. Water wells located near the faults responsible for the earthquakes could be damaged or destroyed as a result of casing failures or alinement problems between pumping units and well casings. Some wells distant from faulted areas probably would have little damage. However, broken electrical-power transmission lines and ruptured water mains could make the wells unusable until repairs were made.

Thus, a major part of the normal water-supply system in San Mateo County could be seriously damaged or destroyed beyond repair. To prepare for such an emergency city and county officials can (1) Identify emergency water sources, (2) inventory the availability, location, size, and type of portable internal-combustion engine-driven electrical generators and water-pumping equipment, (3) locate temporary water-storage containers (railroad tank cars, tank trucks, swimming pools, tanks, and barrels), portable pipelines (pipe, couplings, and accessories), and emergency water-treatment equipment (portable chloriantors, mobile water-filtration units, and chemicals), (4) seek out sources of bottled water and sources of ½-gal (1.9 l) milk cartons or plastic containers that can be used to store and transport water, (5) learn about equipment and materials needed to fill and seal large numbers of milk cartons or plastic containers mentioned in 4 above, and (6) obtain information on personnel knowledgeable in the installation, use, and maintenance of emergency water-supply systems.

Emergency Sources of Water

Postdisaster water may be available either from local or imported sources. The water may be from sources in use at the time of the disaster, from water in storage, or from auxiliary or alternative sources of supply. In addition, emergency sources in the household itself should not be overlooked, and residents should be notified that such sources are available.

Industrial, irrigation, or other private supplies can be used for supplying emergency water. Water-storage facilities on private property including tanks, reservoirs, lakes, ponds, swimming pools, shallow wells, springs, and streams may be possible sources of supplies. In using these sources consideration can be given to their accessibility for emergency pumping, their location in relation to points of need, and treatment that may be required before the water can be used for domestic purposes. Local surface-water sources not normally used for domestic purposes (lakes, ponds, reservoirs, streams, and drainage ditches) offer large volumes of water for firefighting, decontamination, and sanitary purposes. Salt-water from the Pacific Ocean and from San Francisco Bay, out of necessity, may be used for such purposes if freshwater sources are not available in sufficient quantities.

When no water can be brought into a damaged area, or if the water available is of questionable quality, emergency sources within the household can be considered. Water stored in water-heater tanks, water-storage tanks of flush toilets (not the bowls), water-softening units, cooling towers, and building piping systems could be used, as could the melted ice cubes in refrigerators. Water-packed fruits or vegetables and juices protected in cans are a good source of liquids. People living in apartment complexes may be able to obtain water from building piping systems[1], water-storage tanks, or cooling towers used in conjunction with air-conditioning units.

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[1]Water in the pipes of buildings may be salvaged if the main water valves have been turned off before the water is allowed to drain by gravity flow from ruptured water lines. If the main valves have been closed before water pressure in the system is lost, all the pipes in the building will still be full of potable water. To use this water, *turn on* a faucet that is located at the *highest* point in the building, to let air into the piping system; then draw water, as needed, from a faucet that is located at the *lowest* point in the building.

If local sources of supply are not available for emergency use, imported sources can be considered. Emergency pipelines can be laid to bring water from sources that are not too distant. Water may be delivered to normally dry streambeds, ditches, or storm sewers to carry it to the area of need. In some areas, water delivered in vehicles may be the only source available until more permanent delivery facilities are established. Vehicles used for hauling water can be commercial water-hauling trucks, milk trucks, street-flushing trucks, construction trucks, fire department trucks, or other vehicles used for hauling nontoxic fluids. Portable tanks, drums, or barrels may be mounted on vehicles and used to deliver water.

Another source of potable water is bottled water that may be obtained from bottled-water distributors or water obtained by using the processing facilities of dairies, soft-drink companies, or canneries.

Emergency Water Use and Minimum Allowances for Survival

The determination of emergency water allowances should be made on the basis of quantity and quality for various categories of use. The uses considered in this report include potable water, sanitary water, and firefighting and decontamination water.

Potable water is used for drinking and cooking. After a disaster the primary concern will be contamination by sewage effluents or other highly toxic materials. Contaminated water that has been treated with chlorine or other disinfectant may have to be used without further treatment to assure its purity. Whenever possible, the State or the County Health Department should be consulted to determine the acceptability of the available water supplies.

Sanitary water is used for personal washing, cleansing of living and work areas, and for flushing domestic, commercial, and industrial wastes, provided there is sufficient water and provided wastewater facilities are usable. Sanitary water will be needed from the start of the disaster period, and, although it is desirable that the water meet potable standards when delivered through the potable water system, this may be impossible during the emergency.

Firefighting and decontamination water is used to control fires, to cool debris, or to decontaminate the surfaces of buildings, streets, or other areas. Large volumes of water may be needed, and any available water may be used if it does not clog piping and damage pumping equipment.

The U.S. Office of Civil Defense (1966, table XV, p. 52) compiled information showing the minimum quantity of potable and sanitary water that would need to be provided during a nuclear disaster. These minimum quantities, given in table 2, probably are equally acceptable for disasters caused by earthquakes or other catastrophic events.

TABLE 2.--*Minimum potable and sanitary water-quality requirements during emergencies*

[From U.S. Office of Civil Defense, 1966, table XV, p. 52]

Facility or installation	Water requirement (range, in gallons per person per day)
Hospitals and other medical care facilities	5 to 25
Mass-care centers and other welfare installations	
Mass-feeding station--cooking and sanitary uses only	3 to 10
Lodging center--drinking and face and hand washing only	2
Lodging and emergency feeding station	5 to 15
Lodging center with operative flush-toilet facilities--drinking, feeding, and sanitary uses only	25
Households	
Drinking, cooking and cleansing only	5 to 15
With operative flush-toilet facilities	25

Following a disaster, water may be available only in limited quantities. The primary requirements would be for drinking and for medical use. During the recovery period, increased quantities of water will be needed for various uses. The estimated *minimum* potable water allowances for survival and for different phases of the recovery period are given in table 3. Water allowances for other categories of use can be developed by local water utilities or by city and county agencies.

TABLE 3.--*Estimated minimum potable water allowances for survival during emergencies*

[From U.S. Office of Civil Defense, 1966, table XVI, p. 52]

Facility or installation	Minimum water allowance for specified period (gallons per person per day)			
	Survival	Early recovery	Restoration	Reconstruction
Household	0.5	0.5-5	5-40	40
Hospital and medical-care center	5	15	25-40	40
Mass-care or lodging center	3	10	15-25	25

CRITERIA FOR SELECTING EMERGENCY WATER-SUPPLY WELLS

Wells may provide the most satisfactory and reliable source for an emergency water supply. Surface-water supplies from reservoirs, lakes, ponds, or streams can be contaminated or lost as a result of a disaster whereas ground water cannot be lost suddenly and is not as easily contaminated.

The suitability of a well for inclusion in an emergency water-supply plan depends on the intended use of the water and on several characteristics of the well. For domestic use (drinking, cooking, and medical) such factors as well yield, accessibility, source of power, and water quality are important. For general use (*sanitary, firefighting, or decontamination*) little or no importance may be associated with water-quality characteristics.

Well Yield

The yield of a well in gallons per minute (gal/min) or litres per second (l/s) is useful for determining the volume of water that can be pumped during a specific period of time and for estimating the number of people that can be supplied from the well. According to the San Mateo County Planning Commission, there were 571,100 people living in the county in January 1974. About 558,600 people lived in the heavily populated eastern one-third of the county, and only 12,500 people lived in the larger area west of Skyline Boulevard on the crest of the Santa Cruz Mountains and south of Devils Slide near Pacifica (fig. 2).

A well pumping 50 gal/min (3.1 l/s) over a 16-hour period would yield 48,000 gal of water (182,000 l). Six wells pumping at the above rate would yield 288,000 gal of water (1,100,000 l), which is more than adequate for supplying the minimum daily drinking-water requirement[2] of the county's present population.

Table 4 gives examples of the volume of water that can be obtained from wells being pumped at a certain rate for a specific period of time.

Accessibility

Ideally, wells selected as sources of emergency water supply should be accessible at all times of the year. Many wells used for irrigating lawns, ornamental trees, and landscaped plots in Atherton, Menlo Park, and San Mateo are not easily accessible because the wells are away from streets and near buildings, trees, hedges, fences, or other obstacles. Some irrigation wells along unpaved roads may be relatively inaccessible, particularly following a prolonged period of rain, but would otherwise be acceptable sources of supply. These may be considered if high-pressure fire hoses, portable irrigation pipe, or steel pipelines are available to transmit water to locations accessible to water-hauling equipment.

[2]The U.S. Office of Civil Defense (1968, p. 46) indicated that the average person in a home fallout shelter would need at least 1 qt (0.9 l) of water or other liquids per day to drink, but more would be useful. In this report ½-gal, or 2 qt (1.9 l), per person per day is used as a minimum water allowance as recommended in an earlier report (U.S Office of Civil Defense, 1966, p. 34).

TABLE 4.--*Volume of water obtained from a well pumped at rate indicated for 1-, 8-, and 12-hour periods*

Pumping rate (gal/min)	Volume of water pumped, in gallons		
	1 hour	8 hours	12 hours
5	300	2,400	3,600
15	900	7,200	10,800
25	1,500	12,000	18,000
35	2,100	16,800	25,200
50	3,000	24,000	36,000
75	4,500	36,000	54,000
125	7,500	60,000	90,000
175	10,500	84,000	126,000
225	13,500	108,000	162,000
275	16,500	132,000	198,000

Pumping rate (gal/min) x 60 = gallons per hour (gal/h).

Gal/h x hours = volume of water pumped, in gallons.

Gallons x 2 = number of persons that may be served the minimum daily allowance (0.5 gal/d) of potable water.

One gallon per minute (gal/min) = 0.063 litre per second (l/s) or 226.8 litres per hour (l/h).

Source of Power

Electric power may fail following some types of disasters. Consequently, it is desirable when formulating emergency plans to consider the inclusion of wells equipped with internal-combustion engines either for direct drive of the pump or to drive a generator. Wells equipped with electrically operated pumps also may be made serviceable by changing the pump heads to permit operation of the pumping unit by either belt-drive or direct-drive internal-combustion engines.

Water Quality

Water for emergency domestic use should not contain concentrations of bacteria or dissolved substances, or emit radiation that would be harmful to the human body. Water from deep wells commonly meets this requirement.

EMERGENCY WATER SUPPLIES IN SAN MATEO COUNTY

Wells

In 1966 the San Mateo County Emergency Operations Center inventoried about 40 wells and other water sources that could be used in emergencies. That well inventory was checked in the field and updated, and a field inspection was made in the eastern and northwestern parts of San Mateo County, during this study. As a result, water wells that may be suitable for sources of emergency water supply are proposed herein, subject to the owners' approval. The location of the wells is shown in figure 2, and pertinent well information is summarized in table 5. Data for other wells in the county can be found in reports by Kirker, Chapman, and Associates (1972) and Lowney-Kaldveer Associates (1974).

Water-Storage Facilities, Perennial Streams, and Springs

In addition to the water wells listed in table 5, the map (fig. 2) shows the location of most of the water-storage facilities (large steel tanks, concrete reservoirs, and redwood-stave tanks) used by municipal and private water-distribution companies, perennial streams that drain westward to the Pacific Ocean, and springs that are shown on 7½-minute quadrangle maps published by the U.S. Geological Survey.

If a disaster occurs, water outlet valves on the water-storage facilities should be closed immediately to minimize the loss of potable water by gravity flow from ruptured water lines. Later, an individual water-storage facility can be placed in service as needed.

Moderate to large quantities of water can be obtained quickly by erecting low check dams across the channels of perennial streams or by dredging large pits a few feet below the water table in alluvial deposits near stream channels. However, water from the streams or from the dredged pits should receive emergency water treatment before it is used for domestic purposes.

The springs shown on the map (fig. 2) are a small fraction of the many springs known to occur in the western and southwestern parts of the county. Cursory observation of topographic maps, aerial photographs, and soils maps suggests that most of the springs could be classed as either gravity springs or seepage springs.

Gravity springs occur where the land surface intersects the water table, or where water percolating through permeable material overlying an impermeable stratum comes to the land surface. The water of such a spring percolates from permeable materials under the action of gravity. Most gravity springs are sensitive to seasonal fluctuations in ground-water storage. During dry periods the discharge frequently dwindles or disappears entirely.

Seepage springs occur in areas where water percolates from numerous openings in permeable materials. These springs may occur along the top of an impermeable stratum, but they occur more commonly in places where a stream or drainage course has cut into the zone of saturated materials below the water table. Many of the larger springs have extensive seepage areas and support abundant vegetation.

Springs that have been properly developed (Wagner and Lanoix, 1959; and U.S. Public Health Service, 1962) can supply a considerabale quantity of water that generally is free from harmful bacteria. However, springs are subject to pollution from surface runoff and from animal activities.

TABLE 5.--*Data for emergency water-supply*

Map number: Location and identification number shown in figure 2.

State well number: Each well is identified according to its location in the rectangular system for the subdivision of public land. For example, in the number 3S/5W-33Q1, which was assigned to a municipal well near the fire station at the San Bruno city hall and civic center, 567 El Camino Real, the part of the number preceding the slash indicates the township (T. 3 S.) south of the Mt. Diablo base line, and the number between the slash and the hyphen indicates the range (R. 5 W.) west of the Mt. Diablo meridian; the number between the hyphen and letter indicates the section (sec. 33), and the letter (Q) indicates the 40-acre subdivision of the section as shown in the accompanying diagram. The final digit is a serial number for each well in a 40-acre subdivision.

D	C	B	A
E	F	G	H
M	L	K	J
N	P	Q	R

Location: City, town, or facility and street, avenue, road, or court nearest well site.

Use: Principal use, or uses of water. Ind, industry; Irr, irrigation; Ins, institution; PS, public supply; S, school.

Depth, in feet below land surface.

Perforations: Depth to the top and bottom of the perforated interval in well casing.

Map number	State well number	Location	Owner and well number or name	Use	Depth (ft)	Casing diameter (in)	Perforations (ft) Top	Perforations (ft) Bottom	Well Yield (gal/min)
1	3S/5W-7N1	Colma, near S boundary of cemetery 850 ft S of F St. and Clark Ave.	Italian Cemetery	Irr	400	-	217	385	250
2	3S/5W-18D2	Colma, near W boundary of cemetery, 350 ft NE of El Camino Real	Olivet Memorial Park, 3	Irr	580	28	-	-	450
3	3S/5W-18F1	Colma, near W boundary of cemetery, 600 ft NW of large lake	Cypress Lawn Memorial Park, 2	Irr	600	12	191	585	150
4	3S/5W-18F2	Colma, near E boundary of cemetery, 400 ft NE of large lake	Cypress Lawn Memorial Park, 3	Irr	600	12	-	-	300
5	3S/5W-18F3	Colma, N of railroad track, 1,300 ft NW of main office	Holy Cross Cemetery	Irr	482	14	-	-	300
6	3S/5W-18K1	Colma, N of railroad track, 800 ft NW of main office	Holy Cross Cemetery	Irr	500	14	220	460	460
7	3S/5W-19A1	South San Francisco, near Colma Creek 900 ft NE of main office	Rod McLellan Co.	Irr	450	8	-	-	60
8	3S/5W-20	South San Francisco, near Orange Memorial Park	California Water Service Co.	PS	-	-	-	-	-
9	3S/5W-20M1	South San Francisco, 50 ft N of Westborough Blvd., 1,600 ft SW of El Camino Real, near NE end of golf course	California Golf Club of San Francisco, 4	Irr	603	14	260	600	375
10	3S/5W-20M2	South San Francisco, 50 ft N of Westborough Blvd., 1,500 ft SW of El Camino Real, near well 20M1	California Golf Club of San Francisco, 5	Irr	600	12	-	-	400
11	3S/5W-33F1	San Bruno, near Elm Ave. and San Bruno Ave., west	San Bruno Water Dept., 12	PS	500	14	140	500	1,000
12	3S/5W-33Q1	San Bruno, near fire station at civic center, 180 ft NW of Sylvan Ave., 20 ft SW of El Camino Real	San Bruno Water Dept., 13	PS	510	14	155	500	250

[1]Brand name used as an aid in identification. It does not imply endorsement by the U.S.Geological Survey.

wells, San Mateo County

Yield: Volume of water discharged, in gallons per minute.

Specific capacity: The yield, in gallons per minute per foot of drawdown. Drawdown is the difference, measured in feet, between the static, or nonpumping, water level and the pumping water level. It represents the head, in feet of water, that causes water to flow toward the well bore at the rate that water is being pumped.

Pump:[1] S, submersible; a, Byron-Jackson; b, Western; V, vertical turbine; 1, Berkeley; 2, Borg-Warner; 3, Byron-Jackson; 4, Campbell and Budlong; 5, Deming; 6, Fairbanks-Morse; 7, Johnston; 8, Nash; 9, Peerless; 10, Pomona; 11, Universal; 12, Western, 13, Smith and Sons.

Power:[1] E, electric motor and rated horsepower; a, Byron-Jackson; b, General Electric; c, U.S. Motors; d, Westinghouse; e, Fairbanks-Morse; s, single-phase source; t, three-phase source; y (yes) or n (no) indicates that the well has, or does not have, an alternate source of power for use in an emergency.

Discharge pipe: Diameter, in inches; a, covered from point near pump to terminal point; b, turn-on valve near pump head will allow discharge at well site; c, joint near well head that can be broken with wrenches; d, metal sand trap unit in discharge line at well site; e, pumping unit in concrete-lined vault below ground level, special equipment needed for modification; f, discharge pipe can be modified easily--well easily accessible to large trucks or water-hauling equipment.

data				
Specific capacity	Pump	Power	Discharge pipe (in)	Remarks
2.5	S a	E - a t n	4 a	Two buried horizontal steel pressure tanks and two horizontal steel pressure tanks on surface near well site. Thirty hp booster pump delivers water to lawn sprinklers.
4.1	S a	E 100 a t n	6 a e	Concrete water-storage tank, 1.4 million gallons, near well site. Water pumped from large tank to lawn sprinklers at cemetery and at Cypress Hills Golf Course. Before using for emergency domestic purposes, water needs to be chlorinated.
-	S	E 40 - t n	6 a e	Water pumped to large lake near maintenance shops and then pumped from lake to lawn sprinklers.
-	S b	E 40 - t n	6 a	Do.
-	V 5	E 60 b t n	8 a	Water pumped to large above-ground concrete sand filtering unit near Mission Road and then pumped from filtering unit to other open reservoirs and to lawn sprinklers.
6.8	V 9	E 75 c t n	8a	Do.
-	V 12	E 15 b t n	3 c d	Water pumped to a 3,000-gallon concrete storage tank near main office and used to irrigate plants and shrubs.
-	-	- - - - -	-	Several deep wells in an area bounded by Colma Creek, Oak Ave., Commercial Ave., and Eucalytus Ave. Water pumped by electrically operated pumps and delivered to water mains for use in South San Francisco area.
11.9	V 2	E 50 c t n	6 a	Water pumped to desanding unit near well then to 300,000-gallon water-storage tank on hill near SW end of golf course.
-	S a	E 50 a t n	6 a	Do.
-	S	E 100 - t n	10 a e	Water pumped to city water mains.
3.5	S	E 75 - t y	10 a e	Water pumped to city water mains. Generator at city hall and civic center can be used to run pumping unit.

TABLE 5.--*Data for emergency water-supply*

Map number	State well number	Location	Owner and well number or name	Use	Depth (ft)	Casing diameter (in)	Perforation (ft) Top	Perforation (ft) Bottom	Well Yield (gal/min)
13	3S/6W-1K1	Daly City, Water Works Division headquarters, Citrus and Niantic Avenues	Daly City Water Works, Division, 8	PS	479	12	-	-	300
14	3S/6W-1K2	Daly City, Water Works Division headquarters, Citrus and Niantic Avenues	Daly City Water Works, Division, 9	PS	465	12	-	-	110
15	3S/6W-1K3	Daly City, NW of Water Works Division headquarters, 250 ft S of Westlake Ave., 100 ft W of railroad track	Daly City Water Works, Division, 10	PS	522	14	230	515	450
16	3S/6W-1K4	Daly City, Water Works Division headquarters, Citrus and Niantic Avenues	Daly City Water Works, Division, 11	PS	506	14	300	494	347
17	3S/6W-2R1	Daly City, Westlake Station, 400 ft NW of Franklin School	Daly City Water Works, Division, 1	PS	382	14	190	370	360
18	3S/6W-2R2	Daly City, Westlake Station 400 ft NW of Franklin School	Daly City Water Works, Division, 2	PS	388	14	255	369	380
19	3S/6W-2R3	Daly City, Westlake Station 500 ft E of Franklin School	Daly City Water Works, Division, 3	PS	414	14	170	375	342
20	3S/6W-12K1	Daly City, junction of Reiner St. and B St.	Daly City Water Works Division, 12	PS	552	14	135	532	469
21	4S/4W-17K1	San Mateo, Coyote Point Golf Course, near E Poplar Ave. and Bayshore Rd.	San Mateo County Parks and Recreation Dept.	Irr	-	10	-	-	110
22	4S/4W-17L1	San Mateo, Coyote Point Golf Course, near E Poplar Ave. and Bayshore Rd.	San Mateo County Parks and Recreation Dept.	Irr	335	12	-	-	250
23	4S/4W-18L1	Burlingame, high school, Carolan and Oak Grove Aves., near entrance from Plymouth Way	San Mateo Union High School District, Burlingame, 1	S	60	8	-	-	90
24	4S/4W-18L2	Burlingame, high school, Carolan and Oak Grove Aves., behind main building, near water-storage tanks	San Mateo Union High School District, Burlingame, 2	S	500	10	-	-	130
25	4S/4W-18L3	Burlingame, high school, Carolan and Oak Grove Aves., near girls' gymnasium	San Mateo Union High School District, Burlingame, 3	S	390	8	-	-	100
26	4S/4W-20D1	San Mateo, high school, E. Popular Ave. and Delaware St., near SW corner gymnasium	San Mateo Union High School District, San Mateo, 2	S	-	-		-	-
27	4S/4W-20D2	San Mateo, high school, E Poplar Ave. and Delaware St., in boiler room near swimming pool	San Mateo Union High School District, San Mateo 1	S	176	8	152	176	70
28	4S/4W-20G1	San Mateo, King Community Center, Mount Diablo Ave., and Fremont St.	San Mateo City Parks and Recreation Department	Irr	175	8	-	-	90

wells, San Mateo County--Continued

data			Discharge pipe (in)	Remarks
Specific capacity	Pump	Power		
11	S a	E 50 a t y	8 a e	Water pumped to a 60,000-gallon covered concrete tank at Water Works Division headquarters and then pumped to city water mains. Any two of three wells (8, 9, 11) at headquarters can be operated by an emergency diesel-electric motor-generator unit.
30	S a	E 40 a t y	8 a e	Do.
5.8	S e	E 100 a t n	8 a e	Water pumped to a 60,000-gallon tank at Water Works Division headquarters and to city water mains.
9.7	S a	E 75 a t y	8 a e	Water pumped to a 60,000-gallon covered concrete tank at Water Works Division headquarters and then pumped to city water mains. Any two of three wells (8, 9, 11) at headquarters can be operated by an emergency diesel-electric motor-generator unit.
101	V 8	E 60 c t y	8 a e	Water pumped to a 60,000-gallon tank at Westlake Station and to city water mains. Well 1 and well 2 can be operated by a natural gas engine and generator unit located at the station.
69	V 12	E 40 d t y	8 a e	Do.
11	S a	E 75 12 t n	8 a e	Water pumped to 60,000-gallon tank at Westlake Station and to city water mains.
10	S a	E 100 12 t n	8 a d	Water pumped to city water mains.
-	V 9	E 7½ d t n	4 f	Water pumped to one of two open concrete-lined reservoirs and used to irrigate golf course. Two reservoirs hold about 500,000 gallons of water.
-	V 5	E 15 a t n	6 f	Do.
-	V	E 5 b t n	3 a f	Water pumped 300 ft SW to water-storage tanks and then pumped to lawn sprinklers, gymnasium shower rooms. Two horizontal steel pressure tanks and two redwood-stave water tanks used for temporary storage.
-	V 5	E 7½ - t n	2 a	Do.
-	V 13	E 5 - t n	2 a f	Do.
-	S	E - - t n	3 a f	Water pumped to a large redwood-stave tank in boiler room located near swimming pool. Water pumped to lawn sprinklers, gymnasium shower rooms, and swimming pool.
-	V 8	E 5 c t n	3	Do.
-	V	E 7½ - t n	3 f	Water used to irrigate lawns and baseball park.

TABLE 5.--*Data for emergency water-supply*

Map number	State well number	Location	Owner and well number or name	Use	Depth (ft)	Casing diameter (in)	Perforation (ft) Top	Perforation (ft) Bottom	Well Yield (gal/min)
29	4S/4W-29B1	San Mateo, Central Park, E of El Camino Real and W of walkway from 9th Ave.	San Mateo City Parks and Recreation Department	Irr	180	12	-	-	120
30	4S/5W-4A1	San Bruno, Water Department Corporation yard, San Felipe and Huntington Avenues	San Bruno Water Department, 1	PS	532	12	-	-	550
31	4S/5W-4A2	San Bruno, Water Department Corporation yard, San Felipe and Huntington Avenues	San Bruno Water Department, 3	PS	548	14	220	548	400
32	4S/5W-4F1	San Bruno, near swimming pool, San Bruno City Park	San Bruno Water Department, 14	PS	442	12	-	-	250
33	4S/5W-4R1	Milbrae, Millwood Dr. and Barcelona Dr.	Green Hills Golf and Country Club	Irr PS	400	12	-	-	60
34	4S/6W-34H1	Montara, at unnamed creek, 400 ft S of point where Elm St. joins Rivera Rd.	Citizens Utilities Co., Wagner 2	PS	96	10	24	96	30
35	4S/6W-34H2	Montara, at unnamed creek, 400 ft S of point where Elm St. joins Rivera Rd.	Citizens Utilities Co., Wagner 3	PS	-	-	-	-	100
36	4S/6W-34K1	Montare, beside creek near intersection of Harte St. and Date St.	Citizens Utilities Co., Park well	PS	134	10	56	134	65
37	5S/3W-15K2	Menlo Park, at wastewater treatment plant, end of Marsh Rd. near San Francisco Bay	Menlo Park Sanitary District	Ins	300	8	146	280	30
38	5S/3W-20F1	Redwood City, near intersection of Spring St. and Chestnut St.	Diamond Shamrock Chemical Co.	Ind	193	12	143	183	45
39	5S/3W-21G1	Redwood City, East Bayshore Rd. 1 mile E of Harbor Blvd.	Harbor Village Mobile Home Park	PS	380	10	183	367	200
40	5S/3W-22B1	Menlo Park, at head of Flood Slough near Marsh Rd. and Bayshore Freeway	Menlo Park Sanitary District	Ins	192	8	172	176	-
41	5S/3W-25M2	East Palo Alto, Garden St. and Addison Ave.	Palo Alto Psrk Mutual Water Co., 3	PS	330	-	-	-	-
42	5S/3W-25M4	East Palo Alto, Garden St. and Addison Ave.	Pelo Alto Park Mutual Water Co., 5	PS	306	10	219	279	-
43	5S/3W-25M5	East Palo Alto, Garden St. and Addison Ave.	Palo Alto Park Mutual Water Co., 6	PS	260	10	188	251	-
44	5S/3W-26L2	Menlo Park, Willow Rd., near bldgs 219 and 303	U.S. Veterans Administration Hospital, 1, bldg 129	Ins	620	12	-	-	-
45	5S/3W-27Q1	Atherton, Middlefield Rd. and Ringwood Ave., near gymnasium	Sequoia Union High School District. Menlo-Atherton High School	S	316	12	163	295	-

wells, San Mateo County--Continued

data				
Specific capacity	Pump	Power	Discharge pipe (in)	Remarks
-	V 7	E 15 e t n	3 a	Water pumped to horizontal steel pressure tank and used to irrigate plants, shrubs, and lawns.
-	S a	E 60 a t n	4	Water pumped to a large covered concrete water-storage reservoirs at water department corporation yard.
-	S	E 50 - t n	4	Do.
-	S a	E 75 a t n	4 d	Water pumped to city water mains.
-	V 8	E 25 - t n	3	Water pumped to a 25,000-gallon reservoir. Water can be delivered to city water mains or to facilities at country club.
-	V 1	E 10 c t n	1½ b	Water pumped to city water mains.
-	V 6	E 20 b t n	3 b	Do.
-	V 1	E 10 c t n	3 b	Do.
-	V 6	E 5 c s n	3 b	Water used in treatment processes, cleaning equipment and floors of buildings and sprinklers. Not used for domestic purposes.
-	V 6	E 7½ c s n	2	Well not used because of low yield. Pump and motor in operating condition. Redwood-stave water-storage tank at well site. Accessible to water-hauling trucks.
1.2	V 5	E 10 e t n	4 a	Water-pumped to a buried 25,000-gallon concrete water-storage tank and a 6,000-gallon steel pressure tank for use at mobile home park.
-	V 6	E 2 d s n	2 b	Water used to clean floors and equipment in wastewater pumping station. Not used for domestic purposes. Test bacterial quality of water before emergency domestic use.
-	V 11	E 25 c t n	6 a	Water pumped to water mains or to 102,400-gallon water-storage tank. Company service area is tied to the Hetch Hetchy system and to the O'Connor Tract Cooperative Water Co.
-	V	E 15 c t n	6 a b	Do.
-	V 4	E 20 c t n	8 a	Do.
-	V 3	E 25 e t y	4 a	Water used at hospital facility. Water-storage facilities capable of holding about 320,000 gallons of potable water and a large swimming pool are available if additional water is needed. A portable gasoline-powered electrical generator can be used to power pumping unit, if not needed at the hospital facility.
-	V 11	E 15 c t n	5	Water pumped to a horizontal steel pressure tank and used to irrigate lawns and shrubs. Not used for domestic purposes.

TABLE 5.--*Data for emergency water-supply*

Map number	State well number	Location	Owner and well number or name	Use	Depth (ft)	Casing diameter (in)	Perforation (ft) Top	Perforation (ft) Bottom	Well Yield (gal/min)
46	5S/3W-28Q2	Atherton, 120, Burns Ave., in vault in driveway to garage	John Beinert	Irr	300	-	-	-	-
47	5S/3W-28R3	Atherton, Holbrook Palmer Park	Atherton	Irr	284	-	-	-	110
48	5S/3W-33F1	Atherton, 1,000 ft NE along Alajandra Ave. from El Camino Real	Menlo School and College, 4	Irr	250	-	-	-	-
49	5S/3W-33G1	Atherton, 1,000 ft NE along Alajandra Ave., near Kratt Hall, Howard Hall, and Michaels Hall	Menlo School and College, 3	Ins	250	12	-	-	250
50	5S/3W-33K2	Atherton, 600 ft NW of Valparaiso Ave. on Emile Ave.	Convent of the Sacred Heart, Sacred Heart Schools	Ins	450	-	-	-	-
51	5S/3W-33K3	Atherton, near elevated steel water tank at school	Menlo School and College,1	Ins	240	-	-	-	250
52	5S/3W-33K4	Atherton, at buildings and ground office	Menlo School and College,2	Ins	250	-	-	-	250
53	5S/3W-35D2	Menlo Park, near swimming pool, N of main building	St. Patrick's Seminary	Ins	641	12	160	440	840
54	5S/3W-36B2	East Palo Alto, near swimming pool at high school	Sequoia Union High School District, Ravenswood High School	S	-	-	-	-	-
55	5S/3W-36D1	Menlo Park, near 220 Oak Court and O'Connor School	O'Connor Tract Cooperative Water Co.	PS	305	12	72	291	300
56	5S/3W-36D2	Menlo Park, near 220 Oak Court and O'Connor School	O'Connor Tract Cooperative Water Co.	PS	550	12	181	532	1,200
57	5S/6W-11E1	Half Moon Bay Airport, between Moss Beach and El Granada	Citizens Utilities Co., north well	PS	-	-	-	-	-
58	5S/6W-11E2	Half Moon Bay Airport, between Moss Beach and El Granada	Citizens Utilities Co., south well	PS	-	-	-	-	-
59	5S/6W-11F1	El Granada, near Denniston Creek, S of Sea Crest Ct.	Coastside County Water District, Princeston, 1	PS	130	10	-	-	75
60	5S/6W-11F2	El Granada, near Denniston Creek, W of Sea Crest Ct.	Coastside County Water District, Princeeton, 3	PS	110	10	-	-	80
61	5S/6W-11L1	El Granada, near Denniston Creek, W of Shelter Dr.	Coastside County District, Princeston, 2	PS	112	10	-	-	80

wells, San Mateo County--Continued

data				
Specific capacity	Pump	Power	Discharge pipe (in)	Remarks
-	S	E - - t n	2	Water pumped to a 200-gallon steel pressure tank buried near well. Water used to irrigate lawns and shrubs. Accessible to water-hauling vehicles if discharge line is extended about 120 feet to Burns Ave.
-	V 6	E 20 b t n	4 a	Water pumped to lawn sprinkler system. Not used for domestic purposes.
-	S	E 25 - t n	4 a	Water used to irrigate lawns and athletic fields.
-	V 8	E 25 b t n	4 a c	Water used in school buildings and to irrigete lawns.
-	V 3	E 25 d t n	5 a c	Water pumped to an elevated 34,000-gallon steel water tank and used at the convent and to irrigate lawns, shrubs, and orchards.
-	V 8	E - - t n	4 a c	Water used in school buildings and to irrigate lawns and shrubs.
-	V 8	E 25 - t n	5 a c	Do.
17	V 11	E 60 c t n	8 c	Water pumped to large horizontal steel pressure tank and used for swimming pool and irrigating lawns and shrubs.
-	V 6	E 15 c t n	4 a	Water used to irrigate lawns and athletic fields. Test bacterial quality before emergency domestic use.
5	V 9	E 20 b t n	6 a	Water pumped to one of two horizontal steel pressure tanks and to water mains.
48	V 11	E - - t n	6 a	Do.
-	V 1	E 15 c t n	4 a	Water pumped to company watsr mains in Moss Beach and Montara.
-	V 11	E 15 c t n	4 a	Do.
-	S 10	E - - t n	2	Not in use 1974 because of legal problems. Mechanically well could be operated if electrical wires were spliced.
-	S	E - - t n	2	Do.
-	S	E - - t n	2	Do.

EMERGENCY WATER TREATMENT

The objective for service of potable water during a disaster is a supply that can be used safely for drinking. For most of the other uses, practically any water could be used if it does not clog piping or pumps. Surface sources may be contaminated from radioactive fallout, from sewage, or from industrial chemicals. Water mains fractured simultaneously with nearby sanitary sewers could be grossly contaminated, and special precautions would be required to disinfect them prior to their being placed back in service. Low or negative pressure in water mains caused by unusual demands from firefighting or ruptured pipes could result in back siphonage of sewage or industrial wastewater that would contaminate a large part of the water system.

Treatment facilities used by the various water-distribution agencies should have a maximum degree of flexibility. Provisions can be made for conversion of all automated operations and controls to manual operation. After a disaster changes probably would be necessary in the operation of the water-treatment works. Disaster-control procedures can provide for increased dosages of some chemicals and elimination of other chemicals during emergencies. Special treatment, such as increased chlorination, needs to be considered, as well as provision for bypassing the treatment works. The U.S. Office of Civil Defense (1966, p. 54) recommends that a minimum 30-day chemical supply should be maintained at water-treatment plants.

Authorities need to know where chemicals can be obtained, how soon the chemicals can be made available on an emergency basis, where emergency water-treatment equipment is located, and the names and addresses of personnel trained in the use of chemicals and equipment. Mobil water-treatment facilities, including chlorination units and filtration units with coagulation facilities would provide flexibility in treating polluted water at any point in the various water service areas.

The San Francisco Water Department maintains emergency equipment including a water-treatment truck that can filter and chlorinate water at rates as great as 50 gal/min (3.15 l/s), portable chlorinators and hypochlorinators that can be used to chlorinate water, and a large supply of 6-in (15 mm) diameter portable aluminum pipe that can be used in places where water mains have ruptured. The California Water Service Co. maintains several portable pumping units, each of which can deliver as much as 1 Mgal/d (3,785 m^3/d).

The type and degree of treatment to be given emergency water sources will of necessity rely on the judgment and decisions of local water utility and health department personnel. The crisis probably will not permit time for conventional laboratory analysis as a basis for determining treatment methods. Color, taste, odor, and turbidity of the water together with the sanitary location of the source will need to be evaluated before it can be determined if simple chlorination will suffice or if coagulation settling and filtration will be required. For some emergencies, simple and rapid radiological detection techniques would be needed to detect radioactive substances, and the chlorine residual test could be relied on as a measure of water supply safety against disease organisms. A membrane filter test provides the most rapid method of determining possible bacterial contamination.

If necessary, individuals, families, or small groups of people can purify water by following these procedures:

1. Strain the water through a paper towel or several thicknesses of clean cloth to remove dirt and other particles. Or else let the water settle in a container for 24 hours, by which time solid particles will have sunk to the bottom of the container. A handful of clay soil in each gallon of water would improve this settling process, but the settling time may have to be extended to 48 or 72 hours.

2. After the filtering or settling procedure, disinfect the water by boiling or chemically treating it (U.S. Public Health Service, 1962, p. 111). Vigorous boiling for at least 1 minute will adequately disinfect water. When boiling is not feasible, either of the following methods of chemical disinfection may be used: (1) Add chlorine. Household bleach contains hypochlorite which is an effective disinfectant. The procedure to be followed is often given on the label. If not, find the percentage of available chlorine on the label, and then use the following as a guide.

Available chlorine[1] (in percent)	Drops per quart of clear water[2]
1	10
4-6	2
7-10	1

[1]If strength unknown add 10 drops per qt.

[2]Double amount for turbid or colored water.

Mix the treated water thoroughly and allow it to stand for 30 minutes before use. (2) Add iodine. Common household iodine (2 percent tincture of iodine) may be used to disinfect water by adding five drops to each 1 qt (0.9 l) and letting the solution stand for 30 minutes. Double the dosage for turbid water.

According to the U.S. Office of Civil Defense (1966, p. 55) chlorination, in spite of some shortcomings, effectively eliminates pathogenic organisms. A free available chlorine residual of 5 milligrams per litre with a 30-minute contact time throughout the distribution system will destroy disease-producing organisms (U.S. Department of the Army, 1967, p. 78). However, the length of time chlorine stocks will last should be considered before using high residuals in the emergency water-supply system.

Water that is taken from stream channels, ditches, or other surface sources may be highly turbid, contain pathogenic organisms, and have a very high chlorine demand. An earthern settling basin constructed downgradient from the water source will permit partial clarification of the water prior to further treatment and pumping to the point of use. Alum added to the water entering the settling basin would improve the clarification efficiency of the unit. Care should be exercised so that pump suction from such basins does not roil the water.

Citizens may learn about emergency procedures from publications issued by the U.S. Office of Civil Defense, 1966 and 1968. More detailed information on water-supply procedures, water-treatment processes, establishment of water-distribution points, water purification, field tests, and equipment may be obtained from the U.S. Department of the Army, 1967. Complete citations can be found in the list of nontechnical references at the end of this report.

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