WATER SUPPLIES MANUAL

SAN FRANCISCO FIRE DEPARTMENT
The goal of this manual is to establish standard operating practices as authorized by the Chief of Department and implemented by the Division of Training.

The purpose of this manual is to provide all members with the essential information necessary to fulfill the duties of their positions, and to provide a standard text whereby company officers can:

- Enforce standard drill procedures authorized as a basis of operation for all companies.
- Align company drills to standards as adopted by the Division of Training.
- Maintain a high degree of proficiency, both personally and among their subordinates.

All manuals shall be kept up to date so that all officers may use the material contained in the various manuals to meet the requirements of their responsibility.

Conditions will develop in fire fighting situations where standard methods of operation will not be applicable. Therefore, nothing contained in these manuals shall be interpreted as an obstacle to the experience, initiative, and ingenuity of officers in overcoming the complexities that exist under actual fire ground conditions.

To maintain the intent of standard procedures and practices, no correction, modification, expansion, or other revision of this manual shall be made unless authorized by the Chief of Department. Suggestions for correction, modification or expansion of this manual shall be submitted to the Division of Training. Suggestions will be given due consideration, and if adopted, notice of their adoption and copies of the changes made will be made available to all members by the Division of Training.

Joanne Hayes-White
Chief of Department
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Of all the factors that make up a fire department, water supply is a very important part. For this reason, no two agencies of municipal government are more closely related and mutually involved in fire protection than the fire department and the water department. This fact is very effectively demonstrated in the Grading Schedule of the Insurance Services Office which gives a weight of 50 points to the fire department, 40 points to the water department, and 10 points to the dispatch system. The mutual importance of the fire and water departments, and the fact that the effectiveness of one is limited by the effectiveness of the other, is reflected in the schedule which provides penalties when the adequacy of one department is good but that of the other is poor.

Water for fire fighting is supplied to the San Francisco Fire Department by the San Francisco Water Department system. This public water utility supplies the domestic and industrial water needs of the City as well as that required for fire service. Fire service requirements include not only the water supplied to the Fire Department low pressure hydrants, but also the water supplied to the storage reservoir and tanks of the Fire Department high pressure system. The supply of water to the City and the storage and distribution of water within the City is the responsibility of the Water Department. The location of all Fire Department hydrants as well as the maintenance and development of the entire Fire Department high pressure system is the responsibility of the Fire Department.

It is obvious that there are many areas of joint interest between the Fire Department and the Water Department. One of the primary concerns of the Fire Department is the location and condition of our low pressure and High Pressure Hydrants and the adequacy and reliability of the water flow from such hydrants. These and other details of the water supply system and the Fire Department hydrant system are periodically reviewed by the insurance rating organization of the Insurance Services Office. The rating of the total City fire defense is the basis for the rate which must be paid by the citizens of San Francisco for fire insurance protection. The surveys and reports used to appraise the total fire defense of the City value its water supply system as 40% of the entire calculation.

The Fire Department is also concerned with the nature and capacity of all sources of private and public water storage located within the City, which could be used in case the normal water supply is interrupted or becomes inoperative or inadequate through disaster or other cause.

These emergency water supplies include the bay, lakes, ponds, wells, swimming pools, and other supplies to which Fire Department pumpers have access and can position for draft. Because of this concern, City law also requires that all private water tanks and water supplies within, on or about any premises, capable of holding 5,000 gallons of water or over, other than tanks used to supply automatic sprinkler equipment, shall be provided with a pipe connection by which the Fire Department may use the water as a source of emergency supply.

There are 170 Fire Department cisterns strategically located throughout the City. They are designed and maintained for use as an emergency water supply in the event of a major interruption of the normal water supply. They are not connected with the water supply system but are filled from fire hydrants by the personnel of the Bureau of Water Supply.
Chief Officers have an information manual, entitled "SFFD Emergency Water Supplies." This lists all emergency water supply sources within the City which are accessible for Fire Department use in the event of major interruption of the normal supply system. It is the responsibility of Battalion Chiefs to see that each company within their respective districts is supplied with a listing of all such emergency water sources at least within the company's first alarm response area.

The ability of the domestic water system to supply automatic sprinkler systems is very important. Unless pressures are high and the sprinkler system is connected to a large main, pumpers connected to hydrants on the same main may draw pressures down to a point where the supply to the sprinkler system is inadequate. This condition would require the Fire Department to supply water to the sprinkler system.

Every member of the Fire Department, and especially the officers, need a thorough understanding of both the low pressure and high pressure water supply and distribution systems of the City. It is the intent of this manual to furnish this basic information.

To be effective, this manual must be supplemented by company reviews and periodic surveys of the water supply and hydrant system within each company's first alarm response area.
1. THE CITY WATER SUPPLY SYSTEM

CITY TERMINAL RESERVOIRS

The transmission mains from the Peninsula water supply system discharge into certain reservoirs, located within the City, called "terminal reservoirs." The phrase "terminal reservoir" is used because these particular City reservoirs are the terminus for the gravity flow of water supplied by the peninsula transmission system.

The fact that these reservoirs are supplied by gravity, and are not dependent on pumps for supply, is particularly important to the Fire Department. In the event of a major electric power failure in the City, these reservoirs will remain full by gravity flow, whereas the supply of those reservoirs and tanks dependent upon pumps powered by electricity may become depleted.

There are four terminal reservoirs in San Francisco:

- Sunset
- University Mound
- College Hill
- Merced Manor

These four reservoirs serve as primary distributing reservoirs. Lake Honda, with a capacity of 44 million gallons, formerly served as a terminal reservoir. It is now used only for emergency operations and for auxiliary storage.

CITY RESERVOIR-TANK-PUMP STATION DISTRIBUTION SYSTEM

The City of San Francisco varies in elevation from sea level to more than 900 feet above sea level. There are many hill areas with varying elevations, such as Twin Peaks, Telegraph Hill, Mount Davidson, Russian Hill, Nob Hill, and others. All require water service through a complicated distribution and pressure-zoning system.

The Water Department strives to maintain an average water pressure of between 40 to 60 psi in the distribution system. In order to maintain this average pressure, there are ten distribution reservoirs in use in the City which include the four terminal, primary-distribution reservoirs.

Each of the ten distributing reservoirs serves a different area and is located at different elevations, ranging from 135 feet to 800 feet above sea level. Storage capacity varies from one (1) million gallons to 177 million gallons.

There also are eight tanks at elevations of 290 to 900 feet, with capacities of from 75,000 to 4 million gallons each. These tanks serve relatively small, isolated areas where it is considered the more economical method of providing service.
1. City Water Supply System

The system also includes several pumping stations located within the City limits. These stations supply either tanks or reservoirs at higher elevations, or maintain a pressure head in the pump distribution system at isolated high elevations.

**Pressure Zone Districts**

The City water supply system is zoned into seven major pressure districts. These pressure zone districts have been established in order to provide satisfactory water pressure conditions throughout the City. They are located within the availability and the elevations of the reservoirs or tanks serving them. However, due to the uneven topography of the City, these zones are sub-divided, particularly in the higher elevations, into a number of isolated districts, so that there are some twenty-one different pressure zone districts established throughout the City with closed gates between the different parts of the system. These districts vary greatly in outline and area and frequently can be served from more than one source.

The pressure zone districts of the Water Department are delineated on a City map maintained at the Communications Center. This map is of particular importance to the Fire Department because it clearly indicates the nearest reliable source of major water supply in the event of interruption of supply to any one particular pressure zone district. The gate valve operator controlling normal or emergency supply to any pressure zone, as well as the operation of any other water distribution valve, is the responsibility of Water Department personnel. The information that may be obtained from this map by radio, telephone, etc., will be of particular value to chief officers in the event of a major break in, or interruption of supply to, any particular low pressure zone. This information would involve the proximity of the nearest reliable low pressure zone source of supply from which hose leads or hose relays may be made.

Operation of these valves is the means by which water supply can be boosted to the area of a major fire, or controlled in the event of a break in the distribution pipe system. The sequence and method of operation of these valves is a complicated procedure and their use by unauthorized personnel could easily result in excessive damage to the water system mains and to private property piping and water storage served by the Water Department. Therefore, operating any gate valve to the normal or emergency supply to any pressure zone by Fire Department officers and members is prohibited unless assisting an authorized representative of the San Francisco Water Department. Operation of the hydrant branch gate valve controlling the water flow to the hydrant is authorized and permissible for Fire Department units.

The seven major pressure zone districts:

1. Sunset,
2. University Mound
3. Sutro
4. Summit
5. College Hill
6. Stanford Heights
7. Merced Manor

These districts are supplied from the correspondingly named reservoirs. These seven districts serve approximately 90% of the closely built area of the City. Of the remaining districts, three
districts are supplied from the Lombard and Potrero Heights distributing reservoirs and McLaren tanks.

Excluding Lake Merced and Lake Honda, the reservoirs and tanks now in service within the City have a capacity of 413,000,000 gallons, and all are located above the level of the City's congested high value district except for a few high blocks along Bush Street. This storage provides more than four days supply for the entire City at the average daily consumption rate.

Personnel from the Water Department respond to second and greater alarms of fire. If required, they are available to operate such valves as may be necessary to provide a greater supply from other domestic system low pressure zones. Water Department emergency crews also are available to shut down supply to a broken main of the domestic distribution system and to close service supplies to buildings or other premises.

Personnel from the Water Quality Control Board, respond to second and greater alarms of fire to investigate "cross connections" that are a possible source of potable water contamination.

**Water Quality Control Inspectors have been directed to check all Low Pressure Hydrants in use for AMES or other appropriate back flow devices and will issue citations for any unprotected connections.**

**PUMP STATIONS**

The pumping system of the City water supply consists of fourteen pump stations, exclusive of two pumps which supply water to Treasure Island and Yerba Buena Island. These stations are designed to boost water to high elevation distributing reservoirs and tanks providing adequate pressure head in the mains at elevations above distributing tanks, or to maintain pressure during periods of high consumption. All of the pumps are electrically driven, with standby emergency power provided to the larger and more important stations.

Pumps which are designed for direct maintenance of pressure in the mains operate on a hydro-pneumatic pressure system and are under automatic control. Lake Merced Pump Station has the largest capacity, capable of discharging 54 million gallons per day. Under emergency conditions, the Lake Merced station may also pump from Lake Merced.

Palo Alto Pump Station operates a hydro-pneumatic pressure system which provides adequate head in the mains which lie in the highest elevations of the City between the 922-foot and 945-foot contours.

**WATER DISTRIBUTION PIPE SYSTEM (WATER MAINS)**

The water distribution pipe system in San Francisco may be divided into four classifications as follows:

1. **Transmission mains**
   
   transport water from sources of supply to the City terminal and distribution reservoirs
1. City Water Supply System

2. **Primary feeder mains**
   transport water from the terminal and distribution reservoirs to various points of the system for local distribution to smaller mains

3. **Secondary feeder mains**
   form the network of the water supply pipeline gridiron system within the various panels of the primary feeder system, they are usually pipes of intermediate size

4. **Distributor mains**
   smaller pipes which complete the gridiron arrangement and serve the individual fire hydrants and consumer blocks.

The entire City water distribution pipe system is arranged in a gridiron and loop system so that as far as possible two or more primary feeders run separate routes from the source of supply to practically all City districts. This system increases the capacity of the supply at any given point and assures that a break in a feeder main will not completely cut off the supply. Gate valves are located throughout the system so that no single accident, break, or repair will require the Water Department to shut down an extensive supply area.

The mains of the distribution system are constructed of ductile iron, cast iron, wrought iron, concrete, or steel. The Water Department uses welded steel for mains 20 inches or larger in diameter.

The largest size fire hydrant mains are 44 inches in diameter, the smallest fire hydrant mains are 4 inches in diameter. Most hydrants are connected to mains 6, 8, 12, and 16 inches in diameter. The size of other mains to which hydrants are connected is 4, 10, 20, 22, 24, 30, and 44 inches in diameter.

Although some of the hydrants are connected to mains of 4-inch diameter, it is the objective of the Water Department to eliminate these 4-inch mains. State and Federal Regulations state that no fire hydrant shall have a main size smaller than 6 inches for fire fighting. Therefore, all 4 inch main hydrant leads are upgraded during main replacements. When a 4-inch “single” hydrant receives a main upgrade and its available volume becomes sufficient the Serial number will be changed from type “D” to “B” or “double”. The Serial number of a Low Pressure Hydrant is stamped into the edge of the bonet (e.g. D2343). The size of the main supplying low pressure SFFD hydrants connection is stenciled on the barrel of the hydrant.

**PRESSURE AND FLOW IN MAINS**

The City water supply systems, high and low pressure, are divided into a number of different pressure zone districts. The mains in these zones are inter-connected and are controlled by valves so that in an emergency Water Department personnel, by operating certain valves, may increase the pressure in a low zone by diverting water into it from a higher zone, thus improving the supply for fire fighting purposes.

The volume of water that a main may deliver to a hydrant is equally as important as the pressure supplied to the hydrant. Flow of water to a hydrant depends on the size of the main, on the pressure available in the main, on the internal condition of the main, and lastly on the length
of the main and whether it is looped or gridded. These factors determine the amount of friction loss which will occur in a main and thus reduce the amount of water flowing to the hydrant.

It also is important to be fully aware that the static pressure available at a hydrant does not give a true indication of its capacity to deliver water; it is the residual pressure, as indicated on the compound pressure gauge of a pumper connected to a hydrant, which gives the more accurate indication of hydrant capacity. These factors are explained in the SFFD Manual for Pump Operators, which details the principles of pumping from a supply under pressure.

**WATER HAMMER**

The necessity for slowly closing shutoff nozzles, hydrant outlet valves, and hydrant branch shutoff valves is greatly emphasized in fire department training. This emphasis is necessary in order to avoid a phenomenon known as "water hammer" which may occur if the flow of water in the water main or hose line is suddenly stopped. The force of water hammer is, in some cases, sufficient to rupture hose lines or water mains and to damage pumps.

Water moving through a conduit possesses both mass and velocity. The energy of motion created by this flow (kinetic energy) varies with the square of its velocity. If this flow is suddenly shut off, the kinetic energy possessed by the moving water is instantly converted into pressure energy which must be absorbed by the conduit. The shock of this sudden pressure is the phenomenon which causes water hammer and, in many cases, damage. For example, it is estimated that a water flow of 200 gpm through approximately 400 feet of 3" rubber lined hose, when suddenly stopped, may be compared to a light motor vehicle running into a brick wall at a speed of about 10 mph. If, however, the flow is slowly shut down, no damage will occur, just as a vehicle is brought to a standstill without harm by gently applying the brakes.

It must be stressed that it is the velocity of flow that greatly determines the force exerted when water hammer occurs. Experience has shown, for instance, that damage caused by water hammer occurs most frequently in mains of 6 inch or less in diameter. The reason for this is the fact that, with the same quantity of flowing water, the velocity in the smaller mains must of necessity be considerably greater than in the larger size mains. It is also true that, the longer the main, the greater the kinetic energy, which also increases the effect of water hammer.

To avoid the danger of water hammer, it is standard fire department practice to operate nozzle shutoff valves and hydrant valves slowly. In the case of hose, the elasticity of the hose tends to reduce the danger from water hammer. However, the sudden closing of shutoff nozzles on long hose lines will often cause water hammer sufficient to rupture the hose.

The problem of water hammer is particularly acute with closed relays where perhaps 10% of the total relay pump pressure is at the nozzle with the remaining 90% being used to overcome friction loss in the hose relay. If the flow of water in the relay system is suddenly stopped at the nozzle, the friction loss in the hose is no longer present and the total pump pressure is exerted in the hose as static pressure, until pump governors, relief valves, or throttle can operate to reduce the pressure output.

The practice of slowly operating nozzle controls, hydrant and main valves is of particular importance in the operation of hose lines led from High Pressure Hydrants where no pumper is present to absorb a portion of the shock waves created by water hammer.
1. City Water Supply System

**WATER MAIN SHUT-OFFS**

When a section of the domestic distribution system is shut down for service or repair, or if a break should occur in the system, all stations are notified by message via the Computer Aided Dispatch System (CAD). Hydrants that are required to remain entirely out of service or have one outlet out of service have attached at their outlets either:

- **Black** wooden disks indicate a **complete shutdown**
- **Yellow** wooden disks indicate **that the outlet is out of service**.

This practice also applies to High Pressure Hydrants. All stations are likewise notified by CAD message of restoration of service.

In the event of a break in the pipeline distribution system the Bureau of Water Supply Supervisor and ADC of Support Services are to be notified through the Communications Center. An immediate survey of the area affected is particularly important for the following reasons:

- Property adjacent to the break may have to be protected from damage by water escaping from the break.
- Street surfaces may become unsafe due to washout of the sub-surface soil.
- Washout of sub-surfaces may also affect the stability of gas lines and require the shut down of gas supply to private property adjacent to the break. In the event of a break in a street water main, the Pacific Gas and Electric Company should always be notified. Their assistance is vital to the survey of the area as it affects the stability of sub-surface gas lines and the shut off of gas supply to exposed property. It may be necessary to evacuate occupants from the area of the break if the washout has caused an extensive break in the gas supply system.
- Finally, the survey is essential to the pre-planning of emergency hose leads in the event a fire occurs in the area of the break. It is particularly vital when the break involves the shut down of water supply to a large area or requires a considerable lapse of time before Water Department personnel can operate the valves necessary to bypass the water supply around the break.

The preplanning of hose leads is not only necessary to overcome the time loss of making exceptionally long leads, but it is also essential in determining the nearest reliable water supply. This may involve the planning of hose leads from an adjacent pressure zone, from emergency water supplies, and the reassignment of hose tenders to provide adequate hose supply for leads in the affected area.

Relay layouts also may be required. On the advice of Water Department personnel, it may be possible to bypass a damaged section of water supply pipeline by using hose lines between hydrants on each side of the break and thus maintain the supply, at least for fire fighting purposes, during the period of repair.

Fire Department procedure prohibits the operation of Water Department distribution valves by firefighters unless under the supervision of Water Department personnel. This provision is
particularly important in the case of a break in the pipeline system because unauthorized
operation of a valve may not only add to the extent of damage and delay the period of repair,
but also may seriously damage private property pipeline and water storage facilities.
2. LOW PRESSURE HYDRANTS

The fire hydrants connected to the pipelines of the Water Department distribution system are called "Low Pressure Hydrants" as distinguished from the "High Pressure Hydrants" connected to the SFFD Auxiliary Water Supply High Pressure System (AWSS). All low pressure hydrants are made in accordance with SFFD specifications, and their designed so as to provide a hydrant which is as free as possible from difficulty in operation, and which will supply water with minimum friction loss.

All low pressure hydrants are equipped with two 3-inch National Standard Thread male outlets. With the exception of The Fulton Street Emergency Hydrants, some Suction Hydrants, and a few Low Volume Hydrants equipped with one 3-inch outlet.

The control valve for each outlet on all low pressure hydrants opens uniformly by a counter-clockwise rotation of the valve spindle operating nut. There are more than 7,000 low pressure hydrants in San Francisco, most of which are connected to a Water Department pipeline by a 5-inch internal diameter branch pipe. The others are connected by 4 inch or 6 inch branch pipes.

If more volume is desired from low pressure hydrants at fires, the Water Supply Supervisor can act as a liaison to the water department. The Water Department is able to open Division Gate Valves providing greater volume to many areas of the domestic low pressure system. The Water Supply Supervisor is notified of all second alarms, responds to third alarms depending on the area of the incident and is always available through the Communications Center.

It is MANDATORY that every connection to a low-pressure hydrant has an Ames Cross-Connection Device attached to the outlets of said hydrant. There shall be no exceptions. One Ames Cross-Connection Device shall be pre-connected to each soft suction and one to the hydrant jumper if pre-connected.

SPACING OF LOW PRESSURE HYDRANTS

All low pressure hydrants are located and spaced in accordance with the recommendations of the San Francisco Fire Department. These recommendations are made with consideration of the use of the hydrants as reflected by the hazards of the locality in which they are installed. Consideration is also given to the elimination of excessively long hose leads from the hydrant to the buildings to be protected, and to the pressure available in the supply main to overcome friction loss.

Three hydrants are usually located at the street intersections in the high value districts, with one or more intermediate hydrants between intersections, depending on the length of the block and the hazards of the district. In closely built up residential districts, there are usually two hydrants at street intersections and in areas of less hazard, one hydrant. The average area served by low pressure hydrants in the congested high value district of the City is 51,000 square feet, which is reduced to 34,000 square feet by including the placement of High Pressure Hydrants. The average area served by hydrants in other districts is 99,000 square feet.
2. Low Pressure Hydrants

**INSTALLATION, INSPECTION, AND MAINTENANCE**

The internal diameter of the branch pipe of old installations is either 5-inch or 4-inch, the majority being 5-inch inside diameter. All branch pipes currently installed are 6 inches in diameter. The size of the branch pipe gate valve corresponds to the size of the branch pipe.

The average minimum depth of the underground hydrant installation setting is 3 feet below grade. Tie bolts and bands for protection against excessive movement often reinforce the branch pipe connection to the hydrant tee. A concrete block usually supports the elbow pipe.

The hydrant riser is made of cast iron and has a strength which is less than that of the hydrant body above it and the pipe fittings below it. This is done so that the hydrant setting will break at the riser without serious damage to other parts of the setting in the event of impact by a motor vehicle or other heavy object. However, some hydrants are installed without a riser where the branch pipe is too close to the surface of the ground to permit its installation.

The inspection and maintenance of the hydrant including the branch pipe gate valve is the responsibility of the Bureau of Water Supply. For this purpose, the City is divided into ten (10) districts with a member of the Bureau assigned to each district. Their duties include the thorough inspection of all hydrant settings within each district at least once or twice a year.

When the Dispatch Center receives a report of a minor low pressure hydrant leak they are to notify the Bureau of Water Supply for repairs. If an engine dispatched to a leaking low pressure hydrant finds a minor spindle leak, they are to return to service and refer the leak to the Bureau of Water Supply through the Communications Center.

The Bureau of Water Supply is upgrading low pressure hydrants in the City. Newly installed low pressure hydrants are built with O-Ring seals on the spindles replacing the old packing seals. This eliminates the problem of water leaking from the spindles. If you discover a “new” low pressure hydrant with a leaking spindle do not attempt to tighten the nut surrounding the spindle. The Bureau of Water Supply must replace the O-Rings to repair the hydrant. Report “new” low pressure hydrants leaking from the spindle to the Bureau of Water Supply.

Several additional inspections are made annually of the hydrants in the more hazardous and congested areas of his district. This inspection not only includes normal maintenance, but also operation of the branch pipe gate and of the outlet valves so as to flush out the complete hydrant setting. On the basis of the inspection, repair or replacement of defective parts is made, and maintenance, including painting and stenciling, is effected.

In addition to the inspections made by the Bureau of Water Supply, each engine company is required to make annual inspections of low pressure hydrants located within its first alarm area. These inspections are scheduled by engine captains and conducted on Saturdays.

A sample Low Pressure Hydrant Inspection form can be found in the Appendix.
This inspection includes connecting the assigned pumper to the hydrant in order to note and record the hydrant pressure indicated on the pump's compound gauge, and the forwarding of a monthly report thereon to Fire Department headquarters. The procedure for making this pressure test is as follows:

1. Remove hydrant outlet caps.
2. Open hydrant outlet valve.
   a. Select outlet from which stream flow will not damage parked vehicle, lawns, etc.
   b. Open valve only to the extent sufficient to flush sediment out of hydrant.
3. Close hydrant outlet valve.
4. Connect soft suction hose with Ames Device to hydrant and pumper.
5. Open selected hydrant valve to full extent.
6. Record pressure as indicated on compound gauge.
   a. Turbulence in the supply main may cause the gauge to fluctuate, record the average indicated pressure.
7. Close selected hydrant outlet valve.
8. Open pump inlet bleeder valve, relieve pressure.
9. Disconnect soft suction hose and replace hydrant outlet caps.

_Fittings equipped with pressure gauges and bleeders are also available from the BOE but they are prone to damage and rarely provide accurate readings._

_During these inspections, the company officer should note the occurrence of:_

1. Leaks around the spindle, outlets, the barrel itself or in water mains near the hydrant.
2. Damaged outlet threads or caps.
3. Excessive rusting or damaged paint.
4. Obstructions which hinder access and use of the hydrant.
5. Improperly located street valve cover for the hydrant branch gate valve.

Notice of any of the above conditions shall be noted on the monthly Low Pressure Hydrant Inspection Form. Deficiencies are reported by the officer to the Bureau of Water Supply by phone or email when returning to the firehouse.

If painting is needed or any other irregularity is noted on High Pressure Hydrants the condition of the hydrant shall be noted on a general form report forwarded to the Division of Support Services.
CLASSIFICATION OF LOW PRESSURE HYDRANTS

For firefighting purposes, low pressure hydrants can be classified as:

- **SINGLE HYDRANTS** low volume
- **DOUBLE HYDRANTS** normal volume

**Single Hydrants:**

Some low pressure hydrants have less available volume than others based on their location in the system. These hydrants are often at the edge of a grid (supplied from just one direction) and may be supplied by mains as small as 4”. These hydrants are classified as “Single Hydrants”. In the past Department Policy stated that only a “Single” engine could be connected to a “Single Hydrant” at a time. With the apparatus in use today any low pressure hydrant can supply only one engine.

“Single” hydrants are identified by either a ball top or, on the flat top hydrants a 3/4” black stripe painted above the main size number. It is the duty of the engine officer to report un-marked single hydrants to the Bureau of Water Supply Supervisor, by phone or email.

During Inspections noting the serial number will identify unmarked Single hydrants. Low pressure hydrants having serial numbers beginning with D are “Single” or low volume hydrants.

**Double Hydrants:**

Due to the pumping capacity of our newer apparatus, it is the policy of the San Francisco Fire Department that only one engine be connected to any low pressure hydrant (double or single).

All low pressure hydrants supplied with water under pressure are painted white.

Low pressure hydrants painted white with a green bonnet indicate that a Fire Department cistern is located nearby, usually within the intersection.

Low pressure hydrants painted white with a light blue bonnet indicate that this hydrant is supplied by brackish water.
LOW PRESSURE HYDRANT OPERATION

DESCRIPTION
The internal diameter of a low pressure hydrant is 6 inches. The average height of the lower outlet above grade is 18 inches. The upper outlet is about 25 inches above grade. The size of the Water Department supply pipeline is painted in a large black number on the hydrant barrel.

The average static pressure available at each low pressure hydrant is stamped on the end of the upper outlet valve spindle. This pressure is the average daytime static pressure as recorded at the time of the hydrant installation; static pressure will vary from this reading during periods of heavy or light domestic consumption of water.

All SFFD low pressure hydrant bodies are made of cast iron. The bonnet of the hydrant is cast as a curved deflector, designed to reduce friction loss and to permit delivering of full pressure at the outlets. Once installed, the hydrant is filled with full Water Department pipeline pressure in the hydrant at all times.

Each outlet is equipped with an independent valve which permits connection to either outlet without shutting off an outlet already in use. The outlet valve assembly consists of a hard rubber valve disc encased in a bronze carrier. The valve carrier is attached to a bronze valve spindle which is operated by a pentagon nut designed for use with fire department spanners. The operating nut is rotated counter-clockwise to open the valve and clockwise to close the valve.

When the outlet valve is fully open, the working parts of the valve are drawn back out of the flow as much as possible so as to enable the full flow of the hydrant to reach the outlet with minimum friction loss. The angle of the valve seat, and the design of the working parts of the valve, permit the valve to be opened or closed steadily with minimum resistance. This also will minimize the possibility of water hammer and valve chatter.

OPERATION
The efficient operation and use of a hydrant depends primarily on the knowledge of the company officer and pump operator. There is no substitute for the officer and the pump operator who is competent to place his/her pumper properly, who is efficient in the use of hydrants, and who has a thorough basic understanding of the water supply system available for fire fighting.

Also, a pump operator must be capable of interpreting pump gauge readings in relation to what these mean in the use of an individual hydrant. This capability is particularly important during the progress of a fire where several pumpers may be supplied from the same pipeline. In some instances, the opening of only one or two additional hydrants may change the capacity classification of a hydrant.

The principles of pumping from a supply under pressure, as at a hydrant, with particular reference to pump gauge readings are explained in the SFFD Pump Manual. The standard procedures and practices governing the operation and use of hydrants and the connecting of pumpers thereto are given in the SFFD Pump Manual.

1. Always remove both hydrant outlet caps and check to see that the outlet has not been packed with foreign materials.
2. Low Pressure Hydrants

2. Always open and close the hydrant outlet valve slowly to prevent water hammer and a possible burst main.

3. Always open a hydrant outlet valve to its full open position; otherwise the valve may vibrate due to the flow of water around it, causing valve to chatter and diminished flow.

4. Never force or jam a hydrant outlet valve in a closed or opened position. To do so may damage the valve spindle threads, the valve carrier lock pin, or the valve carrier body. Should this occur, it may be impossible to close the valve or, on attempting to open the valve, the valve spindle and carrier may retract but the water pressure in the hydrant may be sufficient to retain the hard rubber valve in the discharge seat and thus prevent adequate flow from the outlet.

5. If, on opening a hydrant outlet valve, there is little or no flow of water from the outlet, it should be evident that the valve is defective for probable reasons as stated above. Should this occur, never abandon the hydrant without testing the remaining outlet as in all probability only one outlet valve has been damaged, and the hydrant is still capable of supplying a pumper.

6. Always replace hydrant outlet caps spanner tight to prevent their being easily removed by unauthorized persons, or the outlet being packed with paper, rags, tennis balls, etc.

For the specifics of Low Pressure hydrant operations refer to BLOCK III of the SFFD Drill Manual

**LOW PRESSURE HYDRANT - BRANCH GATE VALVES**

Each low pressure hydrant is provided with a shut-off gate valve installed in the hydrant branch pipe. The location of the branch pipe gate valve is indicated on each low pressure hydrant by an arrow, stamped on top of the hydrant bonnet, pointing in the direction of the gate valve. The distance in feet and inches from the hydrant to the valve is stamped on the rim of the bonnet immediately below the arrow.

The valve operating nut is encased in a metal cylinder covered with a round metal plate. The letters “SFFD” identify the cover plate. Normally, the branch pipe gate valve is located in the street area. However, there are installations where the branch pipe gate valve is located in the sidewalk area because it was not possible or practical to install the hydrant branch pipe gate valve in the street area.

The body of the gate valve and the valve operating nut are made of cast iron; the valve nuts and bolts are made of steel, and the gaskets are made of rubber. The operating part of the valve consists of two bronze valve discs carried on a bronze valve spindle which is turned by the operating nut. In a closed position, the valve discs wedge against inclined valve seats; in an open position, the valve discs are carried into the valve bonnet so as to permit full flow through the branch pipe with a minimum of friction loss.

Contrary to normal valve operation, the low pressure hydrant branch gate valve is closed by a counter-clockwise rotation of the valve operating nut and opened by a clockwise rotation. There are, however, certain SFFD hydrants that were installed under private contract where the
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hydrant branch pipe gate valve operating nut is turned clockwise to close the valve and counter-clockwise to open the valve. These particular gate valves are at some SFFD hydrant settings located in Battalion 8, Battalion 9 and Battalion 10. New hydrants installed by private contractors follow the traditional method.

Normally, Fire Department companies are not required to operate low pressure hydrant branch pipe gate valves except in the case of a broken hydrant. Emergency action is necessary to prevent water damage to property adjacent to the broken hydrant and to conserve water flow. For this purpose, all engine companies are provided with a low pressure hydrant gate valve wrench. Knowledge of Low Pressure wrench dimensions may be of value when searching for gate valves in deluged environments.

The Dimensions of the Low Pressure Gate Wrench components are:

- Wrench 4-1/2 feet
- Extension 3 feet
- Handle 2-1/2 feet

It is the duty of the Incident Commander to notify promptly the various public utilities should the flow from the broken hydrant threaten to damage any of their installations. Protection must also be provided to exposed property from water damage, to persons endangered from gas leaks, to vehicular traffic, etc., where the emergency warrants such action. The provision of barricades, planking, flares, etc., or additional staffing will be provided on proper notification to the Communications Center.

Normally, the Bureau of Water Supply will also dispatch members for immediate repairs of a broken hydrant. However, their response is not required on Saturdays, Sundays, or holidays, nor between the hours of 1600 and 0800. In the absence of Utility Plumbers, it is the responsibility of the Incident Commander to see that the open riser of a broken hydrant does not expose pedestrians to injury, the hydrant body is taken to the station of the responding company for return to the Bureau of Water Supply. The Communication Center has 24/7 contact information for the Water Supply Supervisor.

In some instances, the cover to the gate valve may not be visible due to its being covered inadvertently by paving during street reconstruction, or a valve cover that does not have the "SFFD" identification may have been used. In this case, reliance must be placed on the directional information stamped on the hydrant bonnet. If the valve cover is not visible, the pavement must be opened at the point indicated by the hydrant in order to locate the valve.

Where the branch-pipe gate valve is located close to the hydrant riser, it may be necessary to devise means to deflect the flow from the break for protection of the firefighters operating the valve. If a vehicle has broken the hydrant, it may be necessary to tow or push the vehicle if it has stopped over the location of the branch-pipe gate valve. However, if the vehicle has stopped over the break, it may be left in this position until the flow is shut off, since the immediate concern is to shut off the escaping flow of water. If the valve cover is difficult to remove, striking it squarely with the maul often may loosen it.

Branch-pipe gate valves are designed to close or open steadily and slowly to prevent water hammer. They must be closed down firmly as they are wedge type gates. Branch-pipe gate valves are designed to be jammed open in case of packing gland leaks. Approximately 16 to 28
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Complete turns are required to close a low pressure hydrant branch gate valve, depending on the size and condition of the valve. Always replace the valve box cover as soon as the valve is closed to prevent exposure of persons or vehicles to the open valve box.

**BROADWAY TUNNEL HYDRANTS AND GATE VALVES**

The hydrant settings in the Broadway Tunnel are distinct from those of normal hydrant installation. A partition wall divides the tunnel into two bores; one bore provides a lane for east bound traffic, the other for west bound traffic. Fourteen SFFD double hydrants are installed in the tunnel pedestrian walkways so as to provide seven hydrants in each bore at identical locations.

Two 6-inch pipelines supply the tunnel hydrants, one in each bore. Each 6-inch pipeline connects to the Water Department mains on Powell Street and on Larkin Street. This setting provides a complete loop pattern with flow supplied from each end of the 6-inch pipeline. Average static pressure at each hydrant is 60 psi.

Gate valves are installed in each 6-inch hydrant supply pipeline near the east and west portals of the tunnel. The gate valves at the east portal of the tunnel are located 75 feet east of the eastern-most tunnel hydrants; those at the west portal are located 60 feet west of the western-most tunnel hydrants. Each gate valve is installed under the pedestrian walkway. In the event of a tunnel hydrant being broken, or in the event of a break in the 6-inch hydrant supply pipeline, the gate valves at each end of the involved 6-inch pipeline must be closed. This procedure shuts off supply to all seven hydrants of the involved tunnel bore.

Each tunnel hydrant also has a hand-wheel operated gate valve located under a screwed-down metal deck plate in the pedestrian walkway near the hydrant. These particular gate valves are provided primarily to shut-off flow to the hydrant during normal hydrant servicing or repair.

**OTHER DISTRIBUTION SYSTEMS**

There are several areas within the City limits of San Francisco occupied by private industry or government agencies, where the management has considered it economically practicable and more desirable to install private water supply and distribution systems.

These systems are privately installed and maintained. Water is usually supplied from the pipelines through a meter system. However, there are installations such as the Presidio, where the prime source of water is supplied from private wells. These systems usually include private storage reservoirs or tanks connected to distributors for supply of standpipes, sprinkler and hydrant systems as well as for supply of the private domestic or industrial water consumption.

It is the responsibility of Fire Department chief officers to be fully aware of such private water distribution systems located within their respective divisions and districts and to see that these systems are reviewed several times a year. Such reviews are necessary to maintain orientation with the system as it pertains to fire service usage. The more prominent private low pressure water distribution systems located within the City are described as follows.
YERBA BUENA ISLAND - TREASURE ISLAND - BAY BRIDGE

Included within the limits of the City and County of San Francisco are Yerba Buena and Treasure Islands in San Francisco Bay. The San Francisco Water Department furnishes the primary water supply to these islands by pumping from the University Mound Pressure Zone to a 3-million gallon terminal reservoir on Yerba Buena Island. This supply is transmitted through a 10-inch steel pipeline, 10,000 feet in length, supported under the upper deck of the San Francisco-Oakland Bridge.

Primary Water Supply

The Bay Bridge Pump Station, which provides the pressure necessary to supply water to Yerba Buena Island is located in the base of Bridge Pier W-1 on Spear Street between Harrison and Bryant Street. It contains two electrically driven pumps. The pump that is normally used to maintain the 3-million gallon Yerba Buena reservoir to capacity has a discharge of 1300 gpm at 180 psi. The other pump has a capacity of 1750 GPM at 237 psi. This pump is used to provide greater supply whenever water consumption on the islands exceeds the capacity of the smaller automatically operated pump. However, the 1750 GPM pump is not automatic in operation and must be operated under manual control by authorized Water Department personnel. These pumps are not capable of being operated in parallel or series and only one pump can be operated at a time.

Bay Bridge (West) Standpipes

The design of the 10-inch pipeline supported by the bridge includes specially constructed spherical and expansion joints which compensate for the various longitudinal, lateral, and vertical movements of the supporting bridge members and of the pipeline due to temperature, wind and loading. The 10-inch pipeline is provided with 17 wet standpipe branches on each deck of the bridge located on the north side of the bridge. Each branch is equipped with two 3-inch gated outlets. The branches are spaced within 180 feet of each other on that portion of the bridge located over Piers 24 and 26 and Embarcadero Street. Over the bay, their spacing varies to a maximum of 750 feet.

There are no standpipe branches in the tunnel on Yerba Buena Island.

When neither pump is in operation at Bay Bridge Pump Station, the water supply available to the Fire Department from the 10-inch pipeline is only that contained in the pipeline itself. This supply will amount to approximately 8000 gallons from Central Anchorage to Yerba Buena Island and approximately 4000 gallons from Central Anchorage to the western-most standpipe outlet. Under this condition, static pressure in the pipeline varies from nil at Central Anchorage, the highest elevation of the Bridge, to approximately 30 psi.

When the Bay Bridge Pump Station is in operation, the average standpipe outlet pressure supplied by the 10-inch bridge pipeline is 60 psi when the 1300 gpm pump is in operation, and 120 psi when the 1750 GPM pump is operating. Only one of these pumps may be operated at a time.

In the event of a fire occurring on that portion of the bridge which extends from San Francisco to Yerba Buena Island at which the water tank supply available on the responding apparatus is inadequate for fire extinguishment, the Water Department must place the 1750 GPM pump at Bay Bridge Pump Station in operation. It is the duty of the Incident Commander to immediately
notify the Communications Center and instruct them to contact the Water Department to initiate pumping.

**Bay Bridge (East) Standpipes**

Twelve wet standpipe branches, similar in design to those connected to the West 10-inch main are connected to the East 12-inch main. Outlets are available on both decks. When the East Bay pumping station is not in operation, a static head of 195 feet maintains the water level in the 12-inch main with sufficient pressure to supply pumpers connected to any standpipe outlet east of Bridge Pier E7. Pier E7 is the first pier east of the Oakland City Limits marker on the bridge.

**Yerba Buena and Treasure Island Hydrants**

Hydrants are well distributed on both islands. Average static pressure on Treasure Island hydrants is 105 psi; static pressure on Yerba Buena hydrants varies from 22 psi to 90 psi, depending on the elevation of the hydrant. Additional pressure is available at the Treasure Island hydrant, by valve control, from the two upper level Yerba Buena Island reservoirs. All hydrants on Treasure Island are similar in design to standard SFFD hydrants with double 3-inch outlets. Hydrants on Yerba Buena Island are of three types, a double 3-inch outlet hydrant, a double outlet hydrant with one 3-inch outlet and one 2-1/2 inch outlet, and a double outlet hydrant with one 3-inch outlet and one 4-1/2 inch outlet. All hydrants on both islands are painted yellow. The entire pipe system is well looped and gridded and is provided with adequate gate valve sectional control.

**GOLDEN GATE NATIONAL RECREATION AUTHORITY**

The Presidio derives its primary water supply from Lobos Creek and wells located in the southwestern portion of the reservation along Lobos Creek. A pumping station located near Bakers Beach pumps the supply from this source through 12-inch mains to a 6-million gallon reservoir located in the central portion of the reservation and to a 105,680-gallon reservoir at Fort Scott.

All hydrants, standpipes and sprinkler systems within the Presidio, including Fort Scott area, Presidio Park Apartments US Army Reserve Center located off Lincoln Boulevard, near 25th Avenue, and Letterman Digital Arts Center are supplied by gravity from these reservoirs. The feeders and distributor consist of cast iron and concrete pipelines which range in diameter from 6 to 10 inches. Most of the distribution system is laid in a loop and grid pattern. A water supply pressure gauge is maintained in the Presidio fire Station located in Building 218, on Lincoln Boulevard, where a constant record is kept of the pressure within the distribution system. The average daily pressure at this point in the system is approximately 80 psi.

An emergency auxiliary supply is provided to the Presidio through connection of the private distribution system to the San Francisco Water Department supply.

Connections are:

- 10-inch main connected near 25th Avenue and El Camino Del Mar
- 6-inch main connected near Lombard and Lyon Streets
- 6-inch main connected near Union and Lyon Streets
2.2 Low Pressure Hydrants

- 6-inch main connected near West Pacific and Fifth Avenue.

This auxiliary supply flows through metered valves which can be turned on by Facilities Engineer personnel. There is a 160,000-gallon swimming pool inside Building 1151 on Gorgas Avenue from which water can be drafted. Since there is no suction connection provided for the swimming pool, engine companies ordered to draft are advised to position their pumpers at the main entrance to Building 1151 on this Gorgas Avenue side and lead suction hoses from there.

There are approximately 290 private hydrants well distributed throughout the Presidio. About 80 percent of these hydrants have two 2-1/2 inch and one 4-1/2 inch outlets independently valved. Except for 14 hydrants in the Bakers Beach housing area, the remainder have two 2-1/2 inch outlets independently valved or two 2-1/2 inch outlets and one 4-1/2 inch outlet with one control valve for all outlets. Hydrants in the Presidio Park Apartments area, formerly Wherry Housing Project, are similar to San Francisco Fire Department low pressure hydrants with two 3-inch outlets independently valved.

The tops of all hydrants are painted to indicate the quantity of water available for fire fighting based on flow tests made on one hydrant at a time.

Color codes are:

- Green  1,000 or more GPM
- Orange  500 to 1,000 GPM
- Red   less than 500 GPM

The size of the main supplying each hydrant is stenciled on the hydrant barrel.

In the Presidio Park Apartments area, located near 25th Avenue and El Camino Del Mar, off Lincoln Boulevard, additional water for fire fighting can be obtained from three manifolds each having six 3-inch gated outlets, installed along a 12-inch feeder main running from the Bakers Beach Pump Station to the main reservoir. The pump station is capable of supplying greater pressure, if needed, in the 12-inch feeder and the manifolds. Supply to the manifolds is by an 8-inch riser with an 8-inch gate valve located in a pit adjacent to each manifold. To use these manifolds, it is necessary to remove a steel cover over the pit, climb down a ladder and open the 8-inch gate valve. These manifolds are located in the housing area off Lincoln Boulevard, one on Stillwell Drive; one on the north end of Pershing Drive. Pershing Drive is laid in a horseshoe pattern and joins Lincoln Boulevard at two points.

There is a water settling tank which holds 200,000 gallons of water located off Gibson Road near building 1778. Access is available at all times and this water can be used to draft.

FORT MASON

The private water distribution system at Fort Mason is supplied through metered connections from the San Francisco Water Department system. Primarily water is supplied to the system through a bank of meters located on Bay Street near the intersection of Van Ness Avenue. This supply is augmented automatically, on demand, through a second bank of meters located on Bay Street near Octavia Street. A 1,000 GPM centrifugal pump is maintained to increase the
2. Low Pressure Hydrants

pressure in the distribution system. Average daily pressure within the system varies between 100 psi and 120 psi.

The distribution system supplies thirty-six private hydrants which are well-distributed throughout the Fort area. These hydrants are equipped with either two 2-1/2 inch outlets, or two 2-1/2 inch outlets and one 4-1/2 inch outlet. Independent valves control hydrant outlets. The piers and all main buildings within the Fort area are equipped with automatic sprinklers.

Six SFFD High Pressure Hydrants are installed within the Fort Mason area. Three High Pressure Hydrants located at the lower elevation in the pier area are supplied from the lower zone. The three High Pressure Hydrants located in the eastern section that is a residential area are supplied from the upper zone. Several High Pressure Hydrants are also located along the southern and western perimeters of Fort Mason on Bay and Laguna Streets that could supply numerous hose leads in the event of a major fire within Fort Mason.

**FORT MILEY VETERANS ADMINISTRATION HOSPITAL**

Water for the Fort Miley Hospital area is supplied by metered connection from Water Department mains at Clement Street and 43rd Avenue. The distribution system consists of 8-inch feeder pipelines laid in a loop pattern. Two 250 GPM electric pumps increase pressure within the system for domestic use in case of electric power failure. An automatic starting diesel fire pump comes on line with a potential of 3100 GPM for fire fighting purposes.

The system also includes an elevated water storage tank of 40,000 gallons and a ground level reservoir of 417,000 gallons. A suction type hydrant connected to this reservoir can supply SFFD pumpers. There are 17 hydrants located within the hospital area.

**U.S. PUBLIC HEALTH SERVICE HOSPITAL (BUILDING 1801)**

This area is located in the Presidio and anchored by Wyman Street. Access is from 15th Avenue and Lake Street. A new 12-inch water main has been installed at this facility. This main supplies the sprinkler system as well as private hydrants within the area.

Tests produced static pressures of 105 to 110 psi while flow tests have shown a residual of 20 psi with over 2900 GPM flowing, making this water supply more than adequate for first alarm engine companies. Hydrant locations are readily accessible for pumpers required to supply any of the four dry standpipe systems.

SFFD engine companies should no longer use pre-fire plans requiring hose leads from Lake Street. First Alarm companies shall make orientation inspections of this facility to become familiar with hydrant, sprinkler and dry standpipe inlet locations. Reconstruction plans for entire area under development as of 2008.

**SAN FRANCISCO BAY NAVAL – HUNTERS POINT SHIPYARD**

The private water distribution system in San Francisco Bay Shipyard includes a salt water as well as a fresh water fire hydrant system.

The fresh water hydrants, identified by both the hydrant and bonnet being painted yellow, are well distributed throughout the area. A 16-inch feeder main from University Mound Reservoir
2. Low Pressure Hydrants

Supplies the distribution system to which these hydrants are connected. The fresh water system also includes a 420,000 gallon storage tank, located on the former naval property near Innes Avenue and Coleman Street, at an elevation of approximately 275 feet. Average static pressure at the fresh water hydrants is approximately 60 psi. Both salt water and fresh water hydrants are equipped with 2-1/2 inch and 4-1/2 inch outlets, with independent valves for each outlet.

A separate salt water system of protection has been installed to protect that area which is utilized in major aircraft carrier repairs. This system, which approximates a horseshoe shape, extends along, and serves both sides of the "North Pier", loops around Dry-dock No. 4, and extends to the water end and serves both sides of "South Pier." Two sets of pumps located on opposite sides of the system are capable of 3500 GPM at 125 psi at the dry-dock and pier level, or 2250 GPM at 150 psi at the carrier flight deck. Fireboat connections to the system are provided at the pier end of both the North and South piers.

SAN FRANCISCO REPAIR SHIPOYARD (PIER 70 – BAE)

The Pier 68 and 70 ship repair area, has been reduced by more than 50% due to the purchase by the San Francisco Port Commission of the shipbuilding ways and contiguous buildings.

The remaining 65 acre area, including all dry-docking facilities, is maintained and operated by British Aeronautical Engineering Systems (BAE). The fire hydrant system throughout Piers 68 & 70 and such adjacent Port-owned properties will be maintained in service until reconstruction starts.

The fire main grid provides a fresh water and salt water distribution system. Fresh water hydrants are painted red with yellow bonnets; salt water hydrants are painted red with white bonnets. The hydrants have two 3-inch outlets with independent valves. Average static pressure is 60 psi for fresh water hydrants and 90 psi for salt water hydrants.

The fresh water distribution system is supplied from University Mound Service, through metered valve-controlled connections at 20th and Illinois Streets, to a 12-inch main; and at 22nd and Illinois Streets, to an 8-inch main. The fresh water system includes a 10,000 gallon storage tank, and a 7,000 gallon pressure tank for supply of the area's sprinklers and wet standpipe system. Hose storage boxes, painted red, are located throughout the plant near the fresh water hydrants; they each store at least 100 feet of 1- 3/4 inch hose with nozzles and fittings.

The salt water hydrants are supplied by four electrically operated pumps capable of a total discharge of 7500 GPM. A fireboat manifold is located on the offshore end of Pier 3 and Pier 4. These manifolds are provided for auxiliary supply to the salt water system by connection of hose lines from the fireboat.

Dry-dock 2, which is a floating dry-dock, is equipped with a fire main extending the entire length of both "wing walls". The main running horizontally is approximately six feet above the deck of the dry dock. At intervals of several feet, 1-1/2 inch outlet valves are provided. Pressure maintained in the main is sufficient to provide good streams. Additional pressure can be developed and the volume increased with the use of the fireboat connection on the offshore end of each "wing wall". The fireboat connection consists of two 2-1/2 inch inlets on each wall.

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2. Low Pressure Hydrants

**GREAT HIGHWAY**

Though there are no regular hydrants along Upper Great Highway on the western boundary of the Sunset District, a limited water supply is available through use of 1-3/4 inch hose line and the Park Quill (see Hose Appliance Manual) connected to underground valves located near the west curb line of Lower Great Highway. These valves will be found approximately 3 feet in from the curb line and are spaced about every 60 feet from Lincoln Way to Sloat Boulevard. They are delineated by a paint mark on the west curb. Volume and pressure is sufficient for one small fire stream or for emergency refill of an engine’s tank.

**GOLDEN GATE PARK**

Water is supplied to the Golden Gate Park water distribution system by connection to Water Department mains and by supply from wells. Water from the wells is used for watering the park lawns and shrubbery, for supply of the various park lakes and reservoirs, and for supply to several fire hydrants. Fire Department pumpers can take a supply by drafting from several locations in the Park. These locations are listed in the Chief Officers Information Manual of Emergency Water Supplies. The private water supply is also available to the Fire Department by use of the City park adapter and the City park quill. A Blue Bonnet identifies fire hydrants supplied by well water. NOTE: Reclaimed water is no longer used in Golden Gate Park.

Several standard double outlet hydrants are located in the DeYoung Museum area of the park, one at the Police and Stadium Stables and one at the parking area of the Golden Gate Park Golf Course. There is also a suction hydrant supplied from Spreckels Lake located on Fulton Street between 34th and 35th Avenues. Two SFFD High Pressure Hydrants are located near the Academy of Science and Aquarium buildings, two near the DeYoung Museum, and one near the Hall of Flowers. These High Pressure Hydrants are supplied from a 12-inch high pressure pipeline extending from Lincoln Way to Fulton Street.

**LAGUNA HONDA HOSPITAL**

Water is supplied to Laguna Honda Hospital through metered valves connected to the Water Department distribution systems. Electrically operated pumps are provided which pump the supply to two interconnected 275,000 gallon storage tanks located on the hillside at the rear of the property. Standby pumps also are located in the property engine room for use in case of failure of the electric pumps.

Water is distributed from the storage tanks for both domestic and fire service use. Standard SFFD hydrants are located throughout the property supplied by pipeline distributors which vary from 6-inch to 10-inch in diameter.

**YOUTH GUIDANCE CENTER**

The Youth Guidance Center is located on Woodside Avenue near Portola Drive. Its water supply for firefighting comes through a metered connection on Woodside Avenue from an 8-inch Water Department main. From this connection, a 6-inch looped distribution pipeline encircling the facility supplies five low pressure hydrants.

The low pressure hydrants have two 3-inch outlets with independent valves. They are non-standard in that they have a check valve which shuts them down when the hydrant body is
2. Low Pressure Hydrants

broken off. An opening in the check valve allows the emission of a small stream of water to attract attention.

In the inner court of the detention area is a wet riser with a single 2-1/2 inch gated outlet. Most of the buildings in the complex have 1-1/2 inch outlets on wet standpipes. Only YGC’s Central Control opens doors and points of access to the outlet locations. This entire system is for fire fighting only and has no domestic outlets. Static pressure is approximately 120 psi.

UNIVERSITY OF CALIFORNIA MEDICAL CENTER

This property is located on the south side of Parnassus Avenue, between Hillway Avenue and Fifth Avenue.

The primary water supply is provided to this area by connection of an 8-inch pipeline from Summit Reservoir service which supplies two 20,000 gallon storage tanks elevated on the hill at the rear of the Medical Center. A secondary water supply is provided by connection of two private pipeline feeders to the Water Department 8-inch main on Parnassus Avenue. This secondary supply is boosted into the private distribution system by three pumps located at the rear of the Medical Center power house. These pumps also can be used to supply the two 20,000 gallon storage tanks in the event the primary supply fails.

The water distribution system supplies nine private double 3-inch outlet fire hydrants. Six of these hydrants are located along the roadway at the rear of the main buildings and three are on the road leading up from the main building. Ample distribution of both high and low pressure SFFD hydrants also is provided on the streets surrounding the property.

In the Medical Science Building, a "Horizontal Dry Standpipe" leads from the front of the building to two outlet manifolds at the rear of the building. Each outlet manifold consists of six 3-inch gated outlets. This standpipe is installed to aid the Fire Department in providing hose lines at the rear of this building. The inlet manifold is located on the front of the building near the west entrance on Parnassus Avenue. It consists of six 3-inch clapper valve inlets and is clearly identified by a sign "YARD OUTLETS ONLY." A high pressure hydrant is located near the inlet manifold on the same side of Parnassus Avenue as the manifold.

LONG HOSPITAL

This building on the UC campus is actually an addition physically interconnected with Moffit Hospital. The dry standpipe and sprinkler inlets are located at both the front and rear of the building and are interconnected; however, they have no connection to Moffit Hospital.

SAN FRANCISCO STATE UNIVERSITY

Water is supplied to the San Francisco State University area by metered connection to the Water Department main at I9th Avenue and Veteran Road. The private fire hydrants connected to the distribution system in this area are painted silver with Red Bonnets. All hydrants have 3-inch outlets; some have an additional 4-1/2 inch outlet.
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STONESTOWN APARTMENT AND SHOPPING AREA
This area, located west of 19th Avenue between Eucalyptus Drive and the San Francisco State University, is an extensive apartment house and shopping development. Most fire hydrants in the area are SFFD hydrants; some however, are of private design.

Water is supplied to the distribution system of this area by metered connection to the Water Department pipeline on 19th Avenue. The distribution system in the apartment house area consists of looped and gridded 8-inch pipelines. The primary feeder in the shopping area is a 12-inch pipeline which supplies a well gridded 8-inch distribution system.

PARKMERCED RESIDENTIAL COMMUNITY
Parkmerced is an extensive apartment house residential area located west of 19th Avenue between the San Francisco State University campus and Brotherhood Way. Water is supplied to Parkmerced through metered connections from the mains of the Water Department. The distribution system is well gridded and supplies water for the entire domestic and fire service system of the area. All fire hydrants in Parkmerced are standard SFFD double outlet hydrants.

SAN FRANCISCO INTERNATIONAL AIRPORT
The primary water supply system for the San Francisco International Airport consists of two separate supply-main connections to the Peninsula transmission system.

A 24-inch primary feeder is connected to the Peninsula transmission main. This primary feeder extends to a point within the westerly boundaries of the Airport where it reduces to a 20-inch secondary feeder main.

Another primary feeder, 24-inch in diameter also extends from the Peninsula transmission main to a point within the westerly boundaries of the Airport in the southerly area. At this point, it reduces to a 20-inch secondary main which transverses the southerly area of the airport.

The distribution system serving the individual hydrants, although well supplied from the secondary feeders, is not completely gridded. Average hydrant pressure throughout the system is approximately 100 psi.

The majority of hydrants located at the Airport are horizontal design with two outer 3-inch outlets and a center 41/2-inch outlet. There are some standard SFFD designed low pressure hydrants located throughout the airfield and in the older areas of the Airport. The front wall of Terminal One has wall mounted hydrants. Flow tests have indicated that all major hydrant groups are capable of supplying water to engine companies at a daytime residual pressure of 125 psi which can fluctuate up to 150 psi at night.

The San Francisco Bay provides a major auxiliary water supply, however there is not a safe platform for fire engines to set up drafting. The Bay’s depth at the shore is very shallow. Two surface tanks equipped with pumps and connected to the distribution system are also provided. A 320,000 gallon tank is located at the Airport Engineering Facility, and the other 300,000 gallon tank is located at the United Airline Maintenance Base.
There are five pump stations on the field designed to maintain an adequate flowing pressure. Two of these pump stations are located at the south end of the field. Another pump station is located at the American Air Lines Super Bay on the north end. Directly behind the pump station at American Air Lines Super Bay are three holding tanks of 750,000 gallons each or a total of 2.25 million gallons. These pumps come on line at the first flow of water. Extreme care must be exercised when using the hydrants in the immediate vicinity.

Open and close both pump inlets and hydrant spindles slowly or severe damage could occur to the main. The remaining two pump stations are located at the United Air Lines Maintenance Base at the west end and at the North Field Pump Station just west of JAL Cargo. Adjacent to Building 56 in the United Air Lines Maintenance base complex, there are two storage tanks of 500,000 gallons each or a total of 1 million gallons. Use of hydrants in these two areas is not as critical as these pumps come on line as the pressure falls.
3. HIGH PRESSURE AUXILIARY WATER SUPPLY SYSTEM

The San Francisco Fire Department uses two primary water supply systems for fire fighting:

- **DOMESTIC WATER SUPPLY** is the same system used in homes and by the general public.

- **AUXILIARY WATER SUPPLY** is used exclusively by the fire department for fire suppression.

The Auxiliary Water Supply presently consists of 170 underground Cisterns, five Waterfront Manifolds, two salt water pumping stations, and the High Pressure Pipe Distribution System.

Although the High Pressure System and High Pressure Hydrants were originally designed as part of the Auxiliary Water Supply System, High Pressure Hydrants are often used for day-to-day fire suppression. It is essential that all firefighters have a thorough knowledge of High Pressure Hydrant principles.

During the 1906 Earthquake and Fire, sections of the Domestic Water Supply System ruptured disrupting most of the Fire Department’s water supply. Shortly after the 1906 Earthquake, the Auxiliary Water Supply System was constructed as a more reliable source of water in the event of a similar event.

Since its original installation, the High Pressure System also known as Auxiliary Water Supply System (AWSS) has been progressively expanded. Today the system serves as a primary source of fire protection in practically all of the important industrial and mercantile high value districts and in many of the closely built residential districts of the City. It permits rapid concentration of powerful streams without the use of pumpers in the areas served. The Insurance Services Office rating engineers consider it a fire protection feature of the greatest value.

The Fire Commission and the Chief of Department control the system. The Water Supply Supervisor, in charge of the Bureau of Water Supply, under the Division of Support Services, is responsible for the maintenance, repair, and proper operation of the system. Qualified personnel are on 24-hour duty at Pump Station 2.
3. High Pressure Auxiliary Water Supply System

Pump Station 1, Jones Street Tank, Ashbury Tank and Twin Peaks Reservoir are no longer staffed. Pump Station 2 is staffed 24 hours a day. For purposes of checking daily readings and security, these High Pressure installations are monitored by the Auxiliary Water Supply System Supervisory Control And Data Acquisition system (AWSS-SCADA), as well as 24-hour video surveillance. When visiting these locations please contact the Department of Electricity by phone at extension 3265. Department key card IDs are required to gain access to all AWSS facilities.

The water level in the Jones Street Tank is maintained automatically by an Altitude Valve. The water levels of the Ashbury Tank and Twin Peak Reservoir are maintained manually by members of the Bureau of Water Supply. In the event of an emergency the ADC of Support Services or Chief of Department can order Pump Station 1 and Jones Street Tank staffed 24/7.

The Water Supply Supervisor is notified by the Communications Center of all greater alarm fires. The Supervisor responds to third or greater alarm fires depending on the area of the incident. A Bureau of Water Supply member responds to Jones Street Tank at the discretion of the Water Supply Supervisor.

The System is normally supplied with fresh water by gravity from the two storage tanks at moderate elevation. The fresh water supply stored in Twin Peaks Reservoir at high elevation is available to increase pressures in the entire system and, as necessary, to replenish the storage tanks.

The two pumping stations are continually maintained in readiness for emergency salt water supply. Five manifolds are provided through which fireboats can pump salt water into the system.

Normal supply is available for Twin Peaks Reservoir by connection of a 6-inch branch pipe to a 16-inch Water Department pipeline extending from Summit Reservoir to Sutro Reservoir Pump Station. This connection is made at the road entrance to Twin Peaks Reservoir on Marview Street and is controlled by a Water Department gate valve.

Emergency supply to the reservoir is controlled at Ashbury Tank Station where a 6 inch branch pipe connects to a 12-inch Water Department main. Two 750 GPM electric pumps, supplied by this source, pump water through either of the 20-inch reservoir pipelines into either bay of the reservoir. Two sources of electric power are available for operation of the pumps.

The high pressure system distribution pipelines are used only for hydrant supply. This area includes over 1,550 High Pressure Hydrants and 150 miles of pipeline.

By City ordinance, no municipal department, other than the Fire Department, and no private enterprise is permitted to use the High Pressure System. Automatic sprinkler systems are not allowed to be pre-connected to the system. The system is provided solely for the firefighting purposes of the San Francisco Fire Department.

The High Pressure Hydrants supplied by the system are of extra heavy cast iron construction and provide three 3-1/2 inch independently gated outlets. Fire Department practice requires the connection of Gleeson pressure reducing valves whenever a high pressure hydrant is used. These valves each reduce from a 3-1/2 inch outlet to two 3-inch outlets. A fully utilized high
3. High Pressure Auxiliary Water Supply System

Pressure hydrant will provide six 3-inch outlets delivering high volumes of water at independently controlled pressures.

The high pressure system is divided into three pressure zones.

<table>
<thead>
<tr>
<th>Color</th>
<th>Zone</th>
<th>Supply Source</th>
<th>EL.</th>
<th>Avg. psi</th>
<th>Gallons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue Bonnet</td>
<td>Lower Zone</td>
<td>Jones Street Tank</td>
<td>369'</td>
<td>130 psi</td>
<td>750,000</td>
</tr>
<tr>
<td>Red Bonnet</td>
<td>Upper Zone</td>
<td>Ashbury Tank</td>
<td>474'</td>
<td>143 psi</td>
<td>500,000</td>
</tr>
<tr>
<td>Black Bonnet</td>
<td>West of Twin Peaks</td>
<td>Twin Peaks Reservoir</td>
<td>758'</td>
<td>140 psi</td>
<td>10,500,000</td>
</tr>
</tbody>
</table>

The lower zone supplies the areas below the 150 ft. elevation.

The upper zone supplies the areas above the 150 ft. elevation.

The West of Twin Peaks zone serves the area west of Twin Peaks at various contours.

At City base (lowest elevation in the City), static pressure to a high pressure hydrant supplied from Jones Street Tank is 160 psi; from Ashbury Tank, 214 psi; and from Twin Peaks Reservoir, 328 psi.

Normal supply to the lower zone is from Jones Street Tank with pressure and supply increase available from Ashbury Tank and Twin Peaks Reservoir. Normal supply to the upper zone is from Ashbury Tank with pressure and volume increase available from Twin Peaks Reservoir. Water supply to the West of Twin Peaks Zone is from the Twin Peaks Reservoir.

A distributor pipe extends from one of the feeders between Twin Peaks Reservoir and Ashbury Tank. This pipeline supplies hydrants located between the levels of Ashbury Tank and Twin Peaks Reservoir. Pressure and volume can not be increased at these hydrants that are identified by having a black bonnet and black hydrant outlet caps. During the course of an incident other local demands on the system could further reduce the available pressure in these hydrants.

In order to maintain adequate working pressures in hose leads over the course of an incident, connect engines to hydrants identified by black bonnets and black caps for the engine’s water supply. The engines can safely supply working lines when connected to the hydrants with static pressure less than 120 psi hydrants.

A continual surveillance is maintained on the pressures available throughout the high pressure system by indicating pressure gauges maintained at each tank. Pressure recording gauges for all zones are maintained at Pumping Station 2 and at the Communications Center. The lower zone also has a pressure recording gauge at Pumping Station 1. Any fluctuations in pressure are immediately reported to the Bureau of Water Supply and are promptly investigated.

Twin Peaks Reservoir can supply Ashbury Tank or Jones Street Tank. This action requires the operation of manifold valves. The manifold valves at Ashbury Tank connecting Twin Peaks Reservoir with the Upper Zone of the Auxiliary Water Supply System are completely automated.
3. High Pressure Auxiliary Water Supply System

and the tank is not staffed. Operation of the manifold valves is controlled from Jones Street Tank. Manifold valves must be opened or closed slowly and one at a time to minimize surge and resultant water hammer. The standard procedure on opening a manifold is to open only one valve first and to allow sufficient time for pressure to equalize on each side of the manifold.

The Water Supply supervisor can provide greater volume to many areas of the Auxiliary Water Supply System by operating local branch valves. In many cases this will provide adequate flow without changing the zone supplying the High Pressure Hydrants involved.

The Incident Commander shall notify the Bureau of Water Supply Supervisor when they desire to use the Twin Peaks Reservoir to supply the Upper Zone. If the Bureau of Water Supply Supervisor is not available on scene, the Department of Emergency Communications should be used to contact him/her.

When the decision is made to increase available pressure and volume by connection to a higher source of the Auxiliary Water Supply System the Incident Commander must insure that there is continuous flow from the system. The flow must start before the connection is made and continue past such a time as the connection is closed again. Only by maintaining a continuous flow can the system be spared a severe water hammer that has broken high pressure mains in the past. The Water Supply Supervisor on scene will be able to provide the Incident Commander with confirmation that the system has been secured and that it is safe to stop the flow from the system.

It is suspected that introduction of Twin Peaks pressure into the Lower Zone has caused serious leaks in the lower Zone. Therefore, the use of Twin Peaks Reservoir into the Lower Zone requires the specific authorization of the Chief of Department or a Deputy Chief of Department.

When Twin Peaks Reservoir is no longer needed, the Incident Commander shall notify the Bureau of Water Supply Supervisor.
3. High Pressure Auxiliary Water Supply System

**HIGH PRESSURE HYDRANTS**

Hydrant Design: The high Pressure hydrant barrel is constructed of an extra heavy cast iron, which has an internal diameter of 10 inches, and an average length of 6 feet, 9 inches. Normal height of the hydrant above ground level is 3 feet; the average height of the outlets above ground is 20 inches.

The hydrants are designed with a view to their emergency use with salt water; bronze is used in all metal parts of the valves and valve seats and wherever corrosion is likely to interfere with either the strength, durability or proper use of the hydrant.

The hydrant is equipped with three 3-1/2 inch male thread outlets. Each outlet is protected with a cap secured by a chain.

Each outlet has an independent vertical sliding gate-valve control, operated by a vertical valve stem. Each of these valve stems has a square operating nut on the top of the hydrant bonnet.

Flow of water into the hydrant is controlled by vertical movement of a compression type valve, placed at the base of the hydrant barrel where it connects to the branch pipe elbow. This valve is named the "King Valve" and is equipped with a by-pass valve commonly called the "Pilot Valve." The function of the pilot valve is to permit equalization of water pressure on both sides of the king valve, before the king valve is opened, as explained under the subject of hydrant operation. The king valve and the pilot valve both are operated by a long vertical stem which terminates in a pentagonal operating nut located at the center of the hydrant bonnet. All hydrant valves are opened by turning the valve stem counter-clockwise and are closed by a clockwise rotation.
The bonnet of each hydrant is painted blue, red, or black to indicate the zone in which it is located and the initial supply source available at the hydrant.

The normal static pressure available at each hydrant, from each source as indicated above, is stamped on the edge of the hydrant flange just under the bonnet.

"J" designates Jones Street Tank supply
"A" designates Ashbury Tank supply
"T" designates Twin Peaks Reservoir supply.

The first stamped figure is the normal supply source and pressure available at the hydrant. High Pressure Hydrants which are shut down, or with disabled outlets, shall have either a black (Hydrant Out of Service) or yellow (Outlet Out of Service) disc attached to a capped outlet.

Hydrants which are located approximately at the same elevation as their first supply source, with a static pressure at the hydrant of less than 120 psi, are identified by their outlet caps being painted the same color as the hydrant bonnet. Pumpers are permitted to take supply from these particular hydrants, through connection of a Gleeson valve set at or below 80 psi. This practice is of particular value where the extent of the fire does not warrant a call for increased pressure from either Ashbury Tank or Twin Peaks Reservoir. Twin Peaks hydrants with black caps must be used as engine supply hydrants through connection of a Gleeson valve set at or below 80 psi.

HYDRANT INSTALLATION

High Pressure Hydrants are spaced so that in the congested high value district 15,000 gallons of water per minute can be concentrated on an average area of 100,000 square feet, with the average length of the hose lines not exceeding 400 feet. In other parts of the City protected by the high pressure system, hydrants are so situated that from 8000 to 12,000 gallons per minute can be concentrated on any one block. At least one high pressure hydrant is installed at each street intersection where high pressure mains are laid, with intermediate hydrants in long blocks with additional hydrants installed in the congested districts.

The connections between the hydrant and the main have an of 8-inch internal diameter. Bolted tie rods reinforce all joints of the branch pipe. The branch pipe is provided with an 8-inch gate valve with the valve stem operating nut enclosed in a cast iron valve box. The branch pipe elbow to which the hydrant barrel is connected is set in a reinforced concrete base and is braced by a concrete brace block. The location of the branch pipe gate valve is indicated on every high pressure hydrant by an arrow stamped on the ornamental bonnet which encircles the king valve operating nut. The distance from the hydrant to the valve is stamped on top of the king valve operating nut in feet and inches. (e.g. 6’2” = Six feet and two inches) The hydrant branch gate valve is placed as close to the main as practicable so that in case of injury to the hydrant, the gate may be accessible for shutting off supply to the hydrant.

OPERATION OF HIGH PRESSURE HYDRANT-BRANCH GATE VALVES

The closing of a hydrant-branch gate valve for the purpose of putting a high pressure hydrant out of service is seldom experienced by members of the fire fighting service because this is the duty of the Bureau of Water Supply. However, in the event of a broken hydrant, the fire service
company nearest the location of the break is dispatched to shut off the flow supply to the hydrant or to assist the Bureau personnel. Even this particular duty involving a fire service company is rare because High Pressure Hydrants are of particularly heavy construction designed to resist breakage due to impact.

A flow of water from a broken high pressure hydrant is also rare, primarily because the king valve opens against the flow of the water and would have to be forcibly dislodged upward from the valve seat by the break. This will seldom occur because even if the hydrant were broken and knocked over, the stem of the king valve would break away from its operating nut-carrier leaving the valve closed and intact. When a flow of water from a broken hydrant does occur, it is usually due to breakage in the narrow portion of the base elbow below the king valve.

The operation of a high pressure hydrant-branch gate valve is done manually with a High Pressure Wrench as described in the Manual of Standard Practices for Hose and Hose Appliances. The main precaution to observe in this operation is not to jam the gate valve in a closed position. Always back off the gate valve one-half turn after completing the shut-off. Do not attempt to return a broken high pressure hydrant to station quarters as required in the case of broken low pressure hydrants.

These hydrants weigh approximately 1,500 pounds. It is the duty of Bureau of Water Supply to replace broken high pressure hydrants. However, the hydrant must be secured in the most practical manner possible to minimize danger to pedestrians and vehicles.

In the event it is impossible to operate the branch-pipe gate valve of a broken hydrant, due to excessive water flow or other obstructions, shut-off can be made by closing the nearest supply pipeline gate valves on each side of the break. The branch-pipe gate valve should then be closed as soon as possible, followed by re-opening of the closed pipeline valves. Always notify the Communication Center and the Bureau of Water Supply of any broken hydrant and the operation of all valves necessary to shut off flow to the hydrant.

**OPERATING THE HIGH PRESSURE SYSTEM**

The mains in the lower zone at City base are under a static pressure of 160 psi. If during the progress of a fire in the lower zone, the Incident Commander desires an increase in pressure above that normally supplied to the lower zone, the Incident Commander will notify the Communications Center via radio and request additional pressure. The attendant at the Bureau of Water Supply will then open the manifold gate valves necessary to supply the mains of the lower zone with Ashbury Tank pressure. This action will increase the static pressure in the mains of the lower zone at City base to 214 psi.

If the Incident Commander needs to increase the water pressure further, the Bureau of Water Supply will operate the necessary manifold valves in order to admit Twin Peaks Reservoir pressure into the lower zone. Static pressure in the mains of the lower zone at City base would then increase to 328 psi. (Note: Average static pressure in the mains of the lower zone when supplied by Jones Street Tank is 130 psi.)

If, for any reason, the pressure or the quantity of water supply through the Jones Street Tank manifolds from Twin Peaks Reservoir is not sufficient, authorized personnel of the Bureau of Water Supply will be dispatched to open the necessary closed division gates between the
3. High Pressure Auxiliary Water Supply System

effected zones. These actions will by-pass the Jones Street Tank manifolds and provide a more
direct upper zone supply to the area involved.

The distributing system of the upper zone is normally supplied from Ashbury Tank. Under this
supply, the average static pressure in the mains of the upper zone is 143 psi. If desired, calling
for Twin Peaks Reservoir supply can increase the pressure. Operation of the proper manifolds
at Ashbury Tank Gate House will feed the upper zone distribution system directly from Twin
Peaks Reservoir. Static pressure will then average 264 psi in the lower areas of the upper
zone.

When large quantities of water are being supplied from the high pressure system, the discharge
pressure at the hydrant outlets will be materially less than the static pressure given above. For
example, when the mains of the lower zone are supplied from Twin Peaks Reservoir and water
is being discharged from the hydrants at a rate of 15,000 GPM, hydrant discharge pressure at
the foot of Market Street will be about 229 psi.

If, for any cause, the pressure or quantity of water delivered in either zone is insufficient, putting
either or both Salt Water Pump Stations in service can increase the supply. In addition, the
fireboat can be ordered to pump salt water into the distributing system through the inlet
manifolds previously described.

**HIGH PRESSURE HYDRANTS, OPEN AND DRAINING**

On occasions when contractors are performing work on the high pressure system, a high
pressure hydrant is normally left open and draining in order to prevent a pressure build-up from
endangering workers. In these cases, the operating nut is removed from the open slide gate to
prevent accidental or malicious closure of the outlet. Also, a black wooden disc is attached to
one of the other outlets to indicate that the hydrant is out of service.

Whenever a hydrant is left open and draining under these circumstances, a Dispatch Computer
message is issued bearing this information and the admonition "DO NOT CLOSE." It is
incumbent on company officers to be aware of these messages.

Under no circumstances should a high pressure hydrant with a black disc and/or missing
operating nut be touched by anyone outside the Bureau of Water Supply. These hydrants are
unable to supply water for firefighting operations and tampering with said hydrant could result in
serious injury to workers.
GLEESON VALVE

The Eight Gleeson Valve Components

1. 3-1/2" inch female swivel inlet
2. Two, 3 inch gated outlets
3. Two gated outlet control handles
   • Outlet(s) are closed when the handles are against the body of valve
   • Outlet(s) are open when the handles away from the body of valve
   • Lock in the fully open position only
     - Automatic by spring and pin
     - Must be released to close
   • Outlet(s) must be fully opened when being used
4. Outlet bleeders
   • One for each outlet
   • Open when inline with the outlet
   • Used to bleed hose lines attached to outlets when gates are shut down
5. Pressure regulator
   • 0-300 psi, in 20 psi increments
3. High Pressure Auxiliary Water Supply System

- Counterclockwise operation increases pressure
- Clockwise operation reduces pressure
- Pressure scale moves out from housing as pressure increases
- Indicated pressure will be supplied to both outlets

6. Tickler valve
- Metering valve for regulator
- Controls water pressure in Valve
- Also used to free sediment which has caused valve to malfunction
  - Pressure must be 80 psi or below when operating the Tickler
  - Pull and release up to three times
  - Never push in on tickler valve
    - Pushing allows full pressure to flow through valve with the potential of causing injury to firefighters or damage to equipment

7. Tell tale
- Hole located on valve body, below regulator
- Steady stream
  - Indicates you have water to the valve and have not exceeded the capacity of the hydrant.
  - Always maintain a tell tale stream
  - Regulating past the point of a flowing tell tail is dangerous for two reasons
    - You have no idea what pressure you are supplying
    - There is no control in place should pressure to the hydrant be increased suddenly exposing firefighters to extreme water hammer
- No stream
  - You are exceeding the capacity of the hydrant
  - Dial regulator down until steady stream is flowing
  - Inform the Incident Commander of the available capacity of hydrant
  - If warranted, request additional zone pressure from the Incident Commander

8. Emergency shut off lever
- Used only in extreme emergency
  - Instantly shuts off valve discharge causing water hammer
  - Risks injury to firefighters and damage to AWSS system
  - Must regulate down to zero before resetting

GLEESON HIGH PRESSURE SPANNER
- Carried attached to Gleeson Valve
- Necessary for operation of HP hydrant & gleeson valve

GLEESON VALVE MAINTENANCE
In order to operate properly, Gleeson Valves must be used frequently, if not at actual fires, then during hydrant drills.

All Gleeson Valves shall be tested weekly either in operations at a fire, High Pressure drill, or on a low pressure hydrant with water flowing through the valve.

When water is run through Gleeson Valves at low pressure hydrants with static pressures less than 80 pounds per square inch, flow from the outlets cannot be completely stopped. It is
3. High Pressure Auxiliary Water Supply System

recommended that low pressure hydrants above 80 pounds per square inch be used for Gleeson maintenance.

**GLEESON VALVE AND HIGH PRESSURE HYDRANT OPERATIONS**

For the specifics of Gleeson Valve and High Pressure hydrant operations please refer to BLOCK III of the SFFD Drill Manual

As many as three Gleeson Valves may be attached to one High Pressure Hydrant. Once the Gleeson Valve or valves are connected, a firefighter is to be assigned to the hydrant to control Gleeson Valve operations. This firefighter is required to remain at the hydrant just as a pump operator is required to stay at his or her pump panel.

<table>
<thead>
<tr>
<th>Because of the extremely high water pressures and volumes accessible in the Auxiliary Water Supply System and the possibility that pressures in the system can be increased by various means without the knowledge of those operating the hydrants,</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NEVER</strong> connect hose lines directly to a High Pressure hydrant 3-1/2” outlet!</td>
</tr>
<tr>
<td><strong>ALWAYS</strong> use a Gleeson Valve on High Pressure hydrants outlets!</td>
</tr>
</tbody>
</table>
3. High Pressure Auxiliary Water Supply System

THE HIGH PRESSURE PIPE DISTRIBUTION SYSTEM

AUXILIARY WATER SUPPLY

In the event of failure of the fresh water supply to the High Pressure distributing system, salt water may be pumped from the Bay into the system through either or both of two pumping stations. Salt water may be supplied to the system through inlet manifolds strategically located along the waterfront of the City.

SALT WATER MANIFOLD INLETS

In addition to the Pump Stations, salt water also may be pumped into the High Pressure distribution system, by fireboat pumps, through any of 5 manifold inlets located on the City's bay waterfront. The Phoenix has a pumping capacity of over 9,600gpm, equal to that of one of the stationary pumping facilities. The Guardian has the largest pumping capacity of any fireboat in the world (24,000gpm). The manifolds are installed at the following locations:

1. Fort Mason, off shore end of Pier 1 (western pier)
2. Foot of Leavenworth Street at Fisherman's Cove.
3. On the Embarcadero opposite the foot of Bay Street. (between piers 33 & 35)
4. On the East side of Illinois Street Bridge.
5. In front of Pier 22 1/2 at the fireboat

These manifolds are equipped with ten 3-inch swiveled female inlets arranged in a horizontal pattern. Each inlet is provided with a clapper valve; inlet plugs are secured to the manifold by a chain. The pipelines connecting the manifolds to the distribution system at Fort Mason, on the
3. High Pressure Auxiliary Water Supply System

Embarcadero opposite Bay Street, and at Pier 22 1/2 are equipped with Check valves; the other two manifold pipelines are not so equipped.

Ten large hose lines may be connected from the fireboat to each manifold, if necessary, to pump salt water into the high pressure system during emergencies involving the interruption of fresh water supply. It is estimated that the Fire Boat Phoenix is capable of supplying a manifold with a discharge of 9,600 GPM at 150 psi for a continuous period of approximately 34 hours without replenishment of fuel supply. These manifolds are designed solely as inlets and cannot be used as a means for obtaining water from the High Pressure system.

SALT WATER PUMPING STATIONS

The two salt water pumping stations are located on opposite sides of the distribution system. The water supply for each pumping station is drawn from the bay through a reinforced concrete tunnel. The tunnel is 5 feet in diameter and is located beneath the station and below the level of low tide so that water will flow directly from the bay into the station. The bay end of the tunnel may be suitably sealed and the water pumped from the tunnel when necessary to enter the tunnel for inspection and repair.

At both stations, each pump takes its supply through an independent suction pipe, from the station supply tunnel. Operation of the discharge controls at Station 1 will supply salt water to the lower zone, and operation of the controls at Station 2 will supply either the lower or upper zone. Station 1 also is capable of supplying the upper zone through required operation of closed division gates. Discharge is through two 20-inch pipelines which extend from each station into the system by different routes.

Pump Station 1 is located at Fire Department Headquarters, Second and Townsend Streets.

Four 4-stage turbine pumps, similar in operation to centrifugal pumps, are installed in the station. Each pump is operated by a 16 cylinder diesel engine, and is capable of a 3000gpm discharge at 300psi pump pressure or a total capacity of 10,000gpm at 300 psi.

Two underground fuel tanks each having a total capacity of 7,500 gallons of diesel fuel are located beneath the station. Each diesel engine uses 45 gallons of fuel per hour while operating at full capacity. It is estimated that this supply is sufficient for 40 hours of continuous operation. The station has an automatic self-starting diesel-driven generator in case of power failure.

Pump Station 2 is located at the foot of Van Ness Avenue at Fort Mason. This station has the same features as Station 1.
3. High Pressure Auxiliary Water Supply System

**AWSS-SCADA**

(Auxiliary Water Supply System - Supervisory Control And Data Acquisition)

The AWSS-SCADA System allows for remote monitoring of the Twin Peaks Reservoir, Ashbury Tank and Jones Street Tank. Water levels as well as water flow are communicated real time by the AWSS-SCADA.

The system is monitored 24 hours a day at the Department of Emergency Management (DEM) Any breaks in the system are picked up immediately and reported to the Bureau of Water Supply by the staff at the DEM (1011 Turk Street).

Remote Control Motorized Valve Actuators surround the AWSS’s infirm areas. Equipped with seismic sensors these valves are supplied with sufficient battery power to close automatically in the event of a large earthquake. This protects the integrity of the rest of the AWSS until the infirm areas can be assessed by the Bureau of Water Supply and returned to service. The AWSS-SCADA is able to monitor and control these valves through redundantly installed remote control stations connected to the individual sites via the 800mhz radio system. There is also a back-up telephone wire line connection, providing another level of insurance and system reliability.

**COMPONENTS:**

**Above Ground Control Vaults**
- System Status Displays
- Seismic Sensor
- Radio Transceiver
- Battery Charging System

**In Ground Battery Vaults**
- Battery capacity to operate the Valve (Open or Close) 3 times

**Remote Controlled Motorized Valve Actuators**
- Electric Motor
- Valve Actuator
- “Red Flag” Actuator Disconnect Lever/Indicator
3. High Pressure Auxiliary Water Supply System

Remote Control Locations

1. SFFD Bureau of Water Supply’s Jerrold Street Office
2. Department of Emergency Management
3. Fire Boat Phoenix
4. Fire Boat Guardian
5. SFFD Bureau of Water Supply Supervisor’s Portable Computer

REMOTE CONTROLLED MOTORIZED VALVE OPERATION:

A red lever called the red flag engages the motorized actuator. When the “red flag” is over the valve-operating nut the valve is in remote control mode. Moving the “red flag” reveals the valve-operating nut and puts the valve into local (manual) control mode. At no time are fire department personnel permitted to operate the motorized valve red flag lever without the direct involvement of Bureau of Water Supply.

When a main breaks, operators at the DEM are alerted by the AWSS-SCADA of excessive water flow in the system. Bureau of Water Supply personnel can then remotely monitor and operate key valves to quickly limit continuing damage to the system and surrounding underground utilities using any AWSS-SCADA consol. The system provides decentralized control & telemetry capabilities from many points; this is an invaluable asset in the event of a major disaster.

In the event of a significant earthquake each SCADA fitted valve’s local seismic sensor will trigger and they will close automatically. By isolating the infirm sections of the AWSS the remainder of the system will continue to operate normally, protected from any breaks in these at risk areas.

The seismic sensors incased in the stainless steel above ground control vaults are set to trigger only in the event of a major earthquake. A significant shock to the vault will actuate the valve serviced by that cabinet, as was the case when a commercial truck ran into a vault early in the systems installation. The Bureau of Water Supply Supervisor responded to the scene, identified the cause and returned the system to normal operation.

Units responding to incidents resulting in damage to AWSS-SCADA installations should notify the Bureau of Water Supply via the Communications Center. If the damage was caused by criminal negligence or vandalism request SFPD response for a case number.

A listing of remote control valve locations can be found in the Appendix.

Another benefit is that if more volume is needed then Division Gate valves can be opened or closed remotely, quickly allowing more feed into the area of the fire. The Remote Controlled Motorized Valve at 20th & Harrison has been operated for this purpose at incidents.
4.  EMERGENCY WATER SUPPLIES

CISTERNs

The San Francisco Fire Department is provided with a system of underground cisterns having a total storage capacity of approximately 11 million gallons of water. This cistern system consists of 170 cisterns strategically located throughout the City (see appendix) so as to provide the Fire Department with a dependable emergency supply of water in the event of major damage to the distribution system of the Water Department and to the Fire Department high pressure supply system.

The system may be considered under two classifications according to the grouping of the cisterns. One classification consists of cisterns individually located at points where it is estimated that the underground water supply mains are most susceptible to damage by earthquake shock. The other classification consists of cisterns grouped around or located along a point where it is estimated that control of a major conflagration could be effected. A good example of this latter classification are the cisterns located at street intersections along Van Ness Avenue from Bay to Market Streets, and along Dolores Street from Market to 30th Street.

The locations and capacities of all Fire Department cisterns are given in the Appendix. The location of Fire Department cisterns within the high pressure area is also identified on the maps of the high pressure system supplied to all divisions, battalions, and companies. A low pressure hydrant with a green painted bonnet indicates the availability of a nearby cistern. Many but not all cisterns are also marked with a ring of brick pavers.

Fire Department cisterns have no connection to either the Water Department or Auxiliary Water Supply System. They are under continual inspection by the Fire Department and are kept full by the Bureau of Water Supply.
Almost all cisterns are located at street intersections and are available to fire pumpers through manholes at which they may position to draft. There are two manholes for each cistern, one in the center and one on the edge. The opening on the edge has access to a ladder used in construction and maintenance. This ladder is a permanent installation and may be used to secure lines flowing water at drafting drills.

In addition to SFFD cisterns, practically all private and public water storage within the limits of the City are available to the Fire Department for emergency use. Those supplies which are reliable and at which pumpers may quickly position for draft, or which are provided with a hydrant, a suction connection, or a down-pipe connection are listed in the information manual of Emergency Water Supplies supplied to all Divisions, Battalions, and Bureaus.

Periodic inspections of emergency water supplies is essential in planning a course of action to use these emergency supplies should the need arise. No supply should be overlooked when planning for emergencies. In formulating emergency action, it also should be remembered that Fire Department cisterns, as well as private and public ground and surface tanks, form excellent emergency reservoirs for use in setting up an "open relay" as described in the Manual for Pump Operators. The San Francisco Bay also provides an inexhaustible emergency supply of water from which pumpers may draft and relay supply.

**PORTABLE WATER SUPPLY SYSTEM**

In order to more efficiently utilize our various water supply sources, the Fire Department has developed a portable water delivery system capable of moving water at high pressure for long distances. The distance that water can be moved with this system is dependent only on the availability of water supplies, the number of Engines and the imagination of the water supply officer.

It is now possible to recreate underground grid water supply systems rapidly by using the proper equipment above ground. Tests have demonstrated that with gridding the portable water system, flows of 6000 GPM with flowing pressures of 150 psi residual pressure can be achieved. To accomplish this, pumpers shall pump into the system at 200 psi or as close to this pressure as possible.

These new capabilities were accomplished by using large diameter 5" hose and a SFFD portable hydrant. The portable water system provides large amounts of water at high pressures and utilizes the large size hose to its maximum potential, thereby freeing pumpers that would normally be needed for relay operations where long distances are involved.
The Portable Water System can establish an emergency above ground water system to provide adequate flows and pressure for fire fighting when other sources of water supply fail or are not available.

The Portable Water System acts as an above ground High Pressure System.

- The 5-inch hose serves as an above ground water main.

- Portable hydrants serve as connection and distribution points along the above ground main. They operate as a high pressure hydrant, with a 3-1/2 inch outlet.

- Gleeson valves are ALWAYS connected to a Portable Hydrant outlet for discharge.

- Once an above ground main is charged, pressure is maintained at all times until Incident Commander closes down operation.

- Pumpers serve as high pressure pumping stations, maintain volume and pressure in above ground main.

This will enable SFFD to maintain pressure of 120 to 150 psi in the above ground main. This is to provide adequate water flows for fire fighting and other emergencies.

This means that with 200 psi at supply ends, flows along the line will cause friction loss. Calculate that for 1,000gpm flow, there will be a 5 psi loss per 100 feet. There will be 2-3 psi friction loss going through gate valves of the Portable Water System.

Pumpers pump from opposite ends of system to provide increased capacity and maintain pressure all along the line.

The fireboats are to be utilized whenever possible to support Portable Water Supply operations.

As many large lines as are practical shall be run from the fireboat into Portable Water System Siamese.

As always it is critical that pump operators protect the cities potable water supply by using an Ames device when connecting to low pressure hydrants. As demands on the system fluctuate engines pumping a peak 1500gpm into the system might have water forced through them towards the low pressure hydrants by a fireboat putting out 9600 to 24000gpm.
Pumpers can also pump into the system from any point along the hose line as the situation and water supply dictate.

**SUCTION CONNECTIONS**

There are two types of water front bay suction connections:

- Above grade pier edge connections
- Surface mounted curbside hydrants.

Curbside hydrants are similar to standard low pressure hydrants with a six-inch National Standard Thread (NST) female connection with no spindle valve. The pier suction connections are six-inch NST female swivel connections attached directly to a piece of pipe that protrudes into the bay. These differ in design only, not in function. Both types of suction connections are 6-inch, painted green with a white top on the hydrant and a white cap on the pier mount.

There are 36 bay suction connection installed at various locations along the waterfront between the St. Francis Yacht Club in the Marina district and station 25 on Third street. A complete list is found in the appendix.

It is more effective to connect the hard suction to the drafting connection first when drafting. This will allow the driver to reposition the apparatus. The majority of suction connections require only one hard suction to complete the connection. Whenever possible during drafting drills, select sights that will not interfere with auto and pedestrian traffic.
4. Emergency Water Supplies

The permanent suction intake pipes are submerged deeply enough to be covered by 2 feet of water at mean low tide. The intake is protected from large objects and debris by a heavy stainless steel grate.

**Flushing Bay Suction Connections**

Companies shall draft from the bay and pump into the bay suction connection for the purpose of flushing these connections on a regular basis. This shall be accomplished by pumping into the connection with an engine (or the fireboat) pumping at 150 psi for at least 10 minutes. Connect the 3" x 6" adapter to the suction outlet and 3 inch hose from the engine (fireboat) discharge into the adapter and begin pumping. NOTE: Fresh water from the domestic hydrant system shall not be used for this purpose and is prohibited by the State Department of Health Services (Title 17, California Code of Regulations sections 7583 through 7605 & refer to Appendix 4).

After performing the flushing operation, the engine company should draft through the suction connection. While drafting through the connection there should be a large volume of water flowing from the engine outlets. Flowing water through the deck gun with multiple lines will accomplish this purpose. Remove the deck gun from the apparatus and tie it off some distance from the apparatus. Deck guns should not be left on the apparatus when flowing water through them other than at fires. Salt water spray and mist can cause severe electrical problems and damage, along with causing rust and damage to the apparatus itself.

Due to the extensive amount of flushing that needs to be done to equipment subjected to salt water, after drafting from a salt water source, companies will proceed to a fresh water drafting location and thoroughly flush the apparatus pumping mechanisms. Companies shall use the same pump controls and equipment employed in the salt water draft. All equipment used with the salt water shall be thoroughly cleaned after flushing with fresh water. Water tanks of apparatus used for drafting salt water shall be completely drained, flushed and refilled with fresh water.

**Pool & Reservoir Connections**

Pools and reservoirs are emergency water supply sources. A list of emergency water supplies over 5000 gallons is carried in each chief officer’s vehicle. The sources are listed by battalion district. These supplies have either a 3" gated connect if under positive pressure, or a 6 inch suction connection if under low or static pressure.

In some cases pressures may be at a very low head and the outlet may be a 3 inch connection. In this situation, it may be necessary to draft by removing the Navarro or Keystone from the
apparatus and placing the 3 inch side directly to the emergency water supply, then connecting the 6 inch side of the Navarro Keystone to the pump using the 6 inch hard suction.

**FULTON STREET EMERGENCY HYDRANTS**

A total of 27 low pressure emergency hydrants have been installed in the sidewalk along the south side of Fulton Street, beginning at 22nd Avenue and terminating at 48th Avenue. Source of water for these hydrants is by gravity feed from Stow Lake in Golden Gate Park. A complete list is found in the Appendix.

For easy identification, hydrant bodies are painted green and tops are painted blue. The hydrant located midway between 34th Avenue and 35th gets its water by drafting from Spreckles Lake.

Each hydrant is provided with one 6 inch female swivel outlet. This system is designed to flow over 2,000 GPM at a residual pressure of 20 PSI at the hydrant outlet.
Each hydrant has its own individual shut-off gate valve. In addition, there are a total of five isolation valves in the 12 inch main: these valves are located at 22nd Avenue, 27th Avenue, 32nd Avenue, 37th Avenue and 42nd Avenue.

Station 14 shall check the static pressure at the hydrant located at 22nd Avenue once each month and include the information on their monthly report. A drop in the static pressure will indicate that air is getting into the system between this hydrant and Stow Lake. The Bureau of Water Supply will accomplish any corrective action.

Proper use of these hydrants depends on the amount of pressure available at the hydrant.

If the pressure is 30 psi or greater, Engines may connect to Fulton Emergency hydrants using a 6 inch to 3 inch reducer and the soft suction.

If pressure is under 30 psi, the 6 inch hard suction is to be used for hydrant connection. Hard suctions are rated for use at pressures lower than 30 psi.
EMERGENCY DRINKING WATER HYDRANTS

In a program developed by the City of San Francisco in 2006, 67 Fire Hydrants that are likely to supply safe drinking water in the event of a major earthquake have been marked with a blue water-drop symbol.

These 67 specially identified hydrants tap into the systems larger and newer water mains located throughout the City. The public will be directed to these hydrants for emergency rations of potable water in the event that a major earthquake effects the domestic water supply.

As these hydrants are located on newer sections of the cities hydrant grid, and deemed less likely to fail during a major earthquake, their location will be of interest to all officers and pump operators. Familiarity with the emergency drinking hydrant program will also prepare members of the Fire Department to better assist the public in the aftermath of a major earthquake.
A listing of emergency drinking water hydrant locations can be found in the Appendix.
5. HISTORY

The water supply system of the City and County of San Francisco is operated under the Public Utilities Commission through two departments, the San Francisco Water Department and the Hetch Hetchy Department.

The San Francisco Water Supply System is capable of a current supply of about 285 million gallons daily for municipal and domestic use and, under the master plan designed by the engineers of the Water Department, it may be further developed to increase yield to more than 400 million gallons daily.

EFFECTS OF 1906 EARTHQUAKE

No history of San Francisco's domestic water supply system would be complete without a few facts concerning the effects of the 1906 earthquake. The San Andreas Fault, which caused the 1906 catastrophe, extends from the southeastern end of the San Francisco Peninsula in a northwesterly direction to the Pacific Ocean just south of San Francisco.

Major damage to the water system within the City occurred in the City pipe distributing system and in service connections to buildings. Laguna Honda Reservoir suffered a crack in its western wall, which was quickly repaired; Lombard Street Reservoir and Clay Street Tank had their wooden roofs burned off.

The City pipe distributing system was broken in over 300 places, in many cases being completely torn and twisted off. The majority of these breaks occurred where the ground over which the streets had been constructed, consisted of poorly and loosely filled marsh, swamp, or ravine area. In solid ground, there were but very few breaks; in fact, the majority of breaks which did occur in solid ground was caused by the use of dynamite and other explosives employed in the destruction of buildings in an effort to form a fire break. Added to the useless discharge of water caused by these breaks in the pipe distributing system were the many thousands of breaks which occurred in service pipes connecting the water main to buildings and in-house supply pipes. These were broken or torn off and left running wide open during the conflagration. Thus the major cause of the water depletion within the City distribution system was the breaking of the water mains in the fire area and along the perimeter of the conflagration area, as well as in unburned areas of the City.

There is no comparison between the earthquake hazard of 1906 and that of today as it relates to the City's water supply and distribution facilities. Today, the main conduit lines used to transmit water from the source of supply to the City are all so located as to avoid ground areas known to be subject to excessive movement. The treatment of the local distributing system laid in reclaimed ground areas is such as to isolate these infirm areas by a system of gate-valves placed at points where the supply pipes cross the boundaries of the ground subject to movement. Only such numbers of these gate-valves are kept open as are necessary to provide normal supply to the infirm district. In the event of a destructive earthquake causing breaks in the pipe system within an infirm area, these few open gate-valves can be closed, leaving the remainder of the distributing system in-service without danger of water depletion. In addition, the
entire distributing system is under a continual program of improving the pipe gridiron and loop system and the installation of gate-valves.

THE PENINSULA WATER SUPPLY SYSTEM

LAKE MERCED
Lake Merced, located in the western portion of San Francisco just north of the county line, is considered as part of the Peninsula water supply system. It is a natural lake, deriving its supply from underground springs, and has a capacity of 2,565 million gallons of water. Lake Merced storm water drains empty into the Pacific Ocean diverting all surface drainage.

Lake Merced was used as a source of domestic supply until 1933. Since then its water has not been used for such purposes. This source is now used as an emergency standby supply for the domestic system and as a source of water for utility purposes in Harding Park.

There are three pumping stations located in the southern section of San Francisco near the county line, constructed to boost the water supplied from the Peninsula Transmission System to the City reservoirs. They are:

- Lake Merced Pump Station,
- Central Pump Station,
- Alemany (Standby) Pump Station.

The Lake Merced Pump Station boosts water supplied by the Peninsula Sunset Pipeline to Sunset and Sutro Reservoirs. This station may also be used in an emergency to pump from Lake Merced to either of these reservoirs.

The Central Pump Station boosts water supplied by San Andreas Pipeline and the Baden Merced pipeline to Stanford Heights Reservoir.

Alemany Pump Station, on standby service, is capable of boosting the Crystal Springs Pipelines supplies into the higher elevations of the City distribution system.

CITY WATER SOURCES

SUNSET RESERVOIR
Located in the western part of the City, the Sunset Reservoir covers several City blocks. the Sunset Reservoir has a total capacity of 177 million gallons and a high water level elevation of 385 feet. The district served by this reservoir includes approximately one-third of the City's residential and mercantile area as well as a portion of the City's high value district.

UNIVERSITY MOUND RESERVOIR
Located in the southeast part of the City the University Mound Reservoir has a total capacity of 141 million gallons and a high water level elevation of 172 feet. The district served by this
reservoir includes most of the highly congested downtown mercantile and commercial areas of the City and extends along the entire waterfront to the Presidio.

**SUTRO RESERVOIR**
Located in the center of the City the Sutro Reservoir has a total capacity of 31 million gallons and a high water level elevation of 500 feet.

**SUMMIT RESERVOIR**
Located in the center of the City the Summit Reservoir has a total capacity of 14 million gallons and a high water level elevation of 800 feet. This reservoir serves Twin Peaks.

**COLLEGE HILL RESERVOIR**
Located in the Mission District the College Hill reservoir has a total capacity of 13.5 million gallons and a high water level elevation of 255 feet. The district served by this reservoir includes portions of the City which adjoin and lie generally west of the area served by University Mound Reservoir.

**STANFORD HEIGHTS RESERVOIR**
Located in the center of the City the Stanford Heights reservoir has a capacity of 13 million gallons and a high water level elevation of 618 feet. The district served by this reservoir includes Stanford Heights.

**MERCED MANOR RESERVOIR**
Located in the south west of the City the Merced Manor Reservoir has a capacity of 9.5 million gallons and a high water level elevation of 187 feet. The district served by this reservoir includes the lower elevation of the City adjoining the shoreline of the ocean. Water is also supplied directly from this reservoir to Central Pump Station where it is boosted to Stanford Heights Reservoir.
5. History

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<th>Elevation</th>
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<td>Twin Peaks</td>
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<td>College Hill Reservoir</td>
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<td>255'</td>
<td>West of University Mound</td>
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<td>9,500,000</td>
<td>187'</td>
<td>Merced Manor</td>
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PRESSURE ZONE DISTRICTS

SUNSET

The Sunset pressure zone district supplies approximately a third of the built-up area of the City. It lies mostly in the northwestern part of the City with extensions to the east and southeast and ranges between elevations of 50 feet to 300 feet.

This zone includes a part of the City's high value district, but is mainly occupied by closely built frame residential buildings intermingled with apartment buildings and minor mercantile. It is regularly supplied by gravity from the two Sunset reservoir basins. It also may be supplied from Lake Honda reservoir in an emergency. The Lombard and Potrero Heights Reservoirs act as equalizers on subdivisions of the main service in this district.

UNIVERSITY MOUND AND FRANCISCO

University Mound and Francisco pressure zone district supplies that portion of the City which adjoins San Francisco Bay and which lies below the 90-foot elevation contour. It serves the major portion of the congested high value district, practically all of the industrial, and the warehouse, wharf and pier districts, as well as minor mercantile localities of high value, and a residential section most of which is closely built and intermingled with apartment buildings. It is supplied by gravity from the two basins of the University Mound reservoirs with Francisco reservoir as an equalizing reservoir.

SUTRO

Sutro pressure zone district, serves a certain residential area of the City which lies between the 300-foot and 400-foot elevation contours. These contours include areas in the Sunset residential district, areas in the Western Addition residential district, and limited areas in the north to south central sections of the City.

SUMMIT

Summit pressure zone district comprises a residential area of the City which lies between the 525-foot and 710-foot elevation contours, it is the highest of the major pressure zone districts in the City and is supplied from Summit reservoir with Forest Hill tanks as equalizers.
5. History

**College Hill**

College Hill pressure zone district supplies a built up area of the City which lies west of the University Mound and Francisco zone service with elevations ranging between 55 feet and 230 feet. It includes a small part of the City's high value district and minor mercantile districts but it is mainly occupied by closely built residential buildings. It is supplied by gravity from College Hill reservoir.

**Stanford Heights**

Stanford Heights pressure zone district supplies a moderate area of irregular shape, most of which lies on the hillsides near the geographic center of the City between the 350-foot and 500-foot elevation contour. Its occupancy is almost entirely residential. Part of this district is supplied from Stanford Height reservoir, the remaining portion is served directly from the supply main leading to the reservoir from Central Pump Station. This pump station takes water from either the Peninsula transmission pipeline or from Merced Manor reservoir.

**Merced Manor**

Merced Manor pressure zone district is supplied by gravity from Merced Manor reservoir. This district consists of a small narrow residential area of the City which adjoins the shoreline of the Pacific Ocean and lies below the 90-foot elevation contour. This district, though under pressure limits similar to the University Mound-Francisco Zone, is entirely separated from there by intervening hills.

**Yerba Buena, Treasure Island, & Bay Bridge Systems**

Yerba Buena Island Reservoirs: At Yerba Buena Island the 10-inch bridge pipeline (primary supply from pump station in San Francisco, see page 2.9) connects with a 12-inch main that skirts the island and delivers the water to the 3-million gallon Yerba Buena reservoir. The high water elevation level is 260 feet. This reservoir, in turn, supplies a 1-million gallon equalizer reservoir. These two reservoirs provide the primary water supply to Treasure Island and to elevations below the 260 feet contour on Yerba Buena Island.

Two other reservoirs are located on Yerba Buena Island: one, a 500,000 gallon reservoir at elevation 361 feet; the other, a 2-million gallon reservoir at elevation 339 feet. These are supplied by pumps from the 3 million gallon terminal reservoir and provide water to the upper levels of Yerba Buena Island and emergency supply for Treasure Island.

Auxiliary Water Supply: A standby water supply is available to the Yerba Buena terminal reservoir from the East Bay Municipal Utilities District Water System. This supply is conducted through approximately 2 miles of 12-inch pipeline installed on the underside of the upper deck of that section of the Bay Bridge which extends from Yerba Buena Island to the bridge approach in Oakland. A pumping station capable of filling the 3-million gallon Yerba Buena terminal reservoir is located near the Bridge's eastern approach. The Public Utilities Commision (PUC) must dispatch Gatemen from the Water Department to open this supply by manually opening gate valves at this pump station. PUC personnel are on duty 24 hours a day. SFFD personnel must call the Department of Emergency Management. The DEM will contact the Water Department Radio Dispatch to activate their emergency procedures and dispatch personnel.
This standby source of water affords a secondary supply in case of damage to or failure of the San Francisco primary source.

**YERBA BUENA & TREASURE ISLAND HYDRANTS**

Yerba Buena and Treasure Island Hydrants: The water main distribution system on both Yerba Buena and Treasure Island, as it relates to fire hydrant supply, consists of an 18 inch primary feeder main that leads from the 3-million gallon terminal reservoir and reduces to 16 inch, 12 inch, 10 inch, 8 inch, and 6 inch secondary feeders and distributors.

**AUXILIARY HIGH PRESSURE WATER SUPPLY SYSTEM**

The AWSS remains the only high-pressure network of its type in the United States.

The only public project funded by the citizenry following the Great Earthquake of 1906 was the AWSS. The system was developed with a $5.2 million bond issue approved by the people of San Francisco in 1908.

During the latter 1800's, and particularly during the administration of Dennis T. Sullivan as Chief of the Fire Department from 1893 to 1906, several attempts were made to provide the Fire Department with an auxiliary water supply system to be used for fire fighting only. Chief Sullivan also endeavored to obtain funds to restore, maintain and expand the number of cisterns which had been allowed to deteriorate following the development of the Spring Valley Water Company. Chief Sullivan's primary concern, realizing the extreme conflagration hazard which existed in the rapidly expanding City of San Francisco, was to provide the Fire Department with an auxiliary source of water entirely independent of the Spring Valley System. His efforts were successful only to the extent of land purchase for the site of Twin Peaks Reservoir. However, his judgment was vindicated in the conflagration which followed the 1906 earthquake when the water supply pipelines leading into San Francisco broke and left a major portion of the City with only the water contained in the City water distribution system.

Unfortunately, Chief Sullivan was fatally injured during the 1906 earthquake. However, the wisdom of his proposals for an auxiliary water supply system was now fully realized. In 1907, funds were made available and the City's engineers were directed to research and propose plans for an independent water supply system for the Fire Department. A research was made of similar systems in more than 250 cities throughout the world. A great many eminent engineers were consulted, particularly with regard to the system of water supply and to the amount of water needed at major fires. Exhaustive tests were made of pipeline, valve and hydrant materials, particularly in regard to their strength and durability.

It was finally determined to build an entire system of mains, independent of the domestic water supply, and that this system should be supplied with fresh water by gravity from a reservoir and two tanks located at high elevation in the City. This was to be known as the Auxiliary Water Supply System, but it is more commonly referred to as the SFFD High Pressure System.

It was also decided that auxiliary supply of salt water from The Bay so that, if the fresh water supply should fail, salt water could be pumped into the system for the purpose of fighting a conflagration. In addition, the City Decided to repair, install, and extend the system of cisterns.
throughout the City so that the Fire Department if driven to this last resort would still have a supply of water for fire extinguishment.

To provide for this independent high pressure system, a bond issue of $5,200,000 was voted by the people of San Francisco in 1908. It was the only public project funded by the citizenry. The entire original layout of the system was completed by 1913 and the system was formally accepted by the Fire Department in January, 1914. The original installation included Twin Peaks Reservoir, a 10,500,000 gallon reinforced concrete reservoir located on Twin Peaks, with a high water elevation of 758 feet; Ashbury Tank, a 500,000 gallon steel storage tank located on Clayton Street opposite Carmel Street, with a high water elevation of 494 feet; and Jones Street Tank, a reinforced concrete storage tank at Jones between Clay and Sacramento Streets with a storage capacity of 750,000 gallons and a high water elevation of 369 feet. Approximately 72 miles of extra heavy cast iron distributing mains radiated from these sources of supply throughout the business section of the City and supplied 889 High Pressure Hydrants.

To provide for use of salt water from the bay as an emergency supply, two pumping stations were built on the bay shore. Pumping Station 1 is located on the northwest corner of Second and Townsend Streets; Pumping Station 2 is located at the foot of Van Ness Avenue adjacent to Fort Mason. These stations contain pumping equipment which, at a moment's notice, can begin pumping salt water into the high pressure system. If necessary, this water can be pumped from the bay up to Twin Peaks Reservoir; or, by operation of street valves, the water can be directed through the high pressure mains in any desired direction. Maximum combined capacity of the two pump stations is now 20,000 GPM at 300 psi.

In adherence to the principles proposed by Chief Sullivan, 54 of the old cisterns were repaired and placed back in service. In addition to these, 85 new reinforced concrete cisterns were built. The new cisterns were built to contain 75,000 gallons each; the old cisterns, built of brick, vary in capacity from approximately 10,000 to 95,000 gallons. Additional cisterns have been built in the past years which now provide the Fire Department with a total of 170 cisterns.

Two other important units also were added to the City's fire fighting system by the High Pressure System bond issue. They were two fireboats, one known as the Dennis Sullivan and the other, the David Scannell. These twin fireboats were provided primarily for the protection of the waterfront; however, they also were capable of delivering salt water through specially designed manifold connections into the mains of the high pressure system, as are the present fireboats.

Every practical safeguard against damage by earthquake was incorporated into the design of this system. The entire distributing system is divided into three zones, designated the upper, lower, and West of Twin Peaks zones. The upper zone is normally supplied from Ashbury Tank and includes the pipelines at 150 foot or higher elevation. All pipelines in the upper zone are on firm ground. The lower zone, normally supplied from Jones Street Tank, includes all pipelines at elevations less than 150 feet. The third zone is the West of Twin Peaks zone which supplies that area west of Twin Peaks at various elevation contours.

Anticipating the possibility of the high pressure pipelines being ruptured by earthquake, as happened to the mains of the Spring Valley Water Company in 1906, the infirm areas are divided into separate units. By the closing of one gate valve an entire infirm area or unit may be shut off without affecting the rest of the high pressure system. Gate valves are placed at
frequent intervals throughout both zones by which a damaged section of pipeline or a damaged hydrant setting may be shut off separately, leaving the remainder of the system in operation.

Pipelines are of extra heavy cast iron construction varying in size from 20 inches to 10 inches in diameter, with an 8 inch branch pipe from main to hydrant. A special type of pipe-joint gives added flexibility in the filled-in areas which are subject to ground settlement. Recent installations have utilized ductile iron pipe. The pumping stations were constructed on solid rock. Two separate feeders to the distributing system connect each station.

**TWIN PEAKS RESERVOIR**

Twin Peaks Reservoir is located opposite the intersection of Marview and Farview Streets near Palo Alto Avenue. At high water elevation of 758 feet, the reservoir has a capacity of 10,500,000 gallons and a maximum water depth of 26 feet. The reservoir is constructed in a rock excavation and is lined with concrete slabs having expansion joints. It is divided into two equal parts or bays by a reinforced concrete division wall. Each bay has a capacity of 5,250,000 gallons. This division provides for normal discharge from one bay only so that, in the event of a sudden break in the pipelines or distributing system during discharge from the reservoir, it would be impossible for the supply in more than one bay to be wasted. The remaining 5,250,000 gallons stored in the other bay would then be available for use immediately on the completion of the necessary repairs. The division wall also permits simultaneous discharge from one bay and filling of the other bay so as to maintain adequate reserve during the course of a fire.

Each bay is provided with a concrete forebay and a discharge gate valve chamber located at the northern end of the division wall. A sump also is located at the southern end of the division wall for drainage of surplus overflow from each bay into the street sewers during the heavy rain season.

Each forebay is the primary outlet or inlet for its respective reservoir bay. It contains the necessary discharge chambers, sluice gates and screens, and drain pipes. Discharge is through two 36 inch pipes reduced to two 30 inch pipes in the valve chamber, where it is further reduced to the two 20 inch pipes which extend to Ashbury Tank. A 20 inch by-pass pipe controlled by a gate valve connects the forebays. This by-pass permits the equalizing of supply of water from one bay to the other.

The discharge gate valve chamber is well constructed of reinforced concrete and contains the gate valve for control of discharge to or supplies from the 20 inch pipelines extending to Ashbury Tank. The necessary discharge drain valves are also located in the gate valve chambers. A 20 inch by-pass pipe controlled by gate valves also connects the two gate valve chambers.

Normal supply is available for Twin Peaks Reservoir by connection of a 6 inch branch pipe to a 16 inch Water Department pipeline extending from Summit Reservoir to Sutro Reservoir Pump Station. This connection is made at the road entrance to Twin Peaks Reservoir on Marview Street and is controlled by a Water Department gate valve.

Emergency supply to the reservoir is controlled at Ashbury Tank Station where a 6 inch branch pipe connects to a 12 inch Water Department main. Two 750 GPM electric pumps, supplied by this source, pump water through either of the 20 inch reservoir pipelines into either bay of the reservoir. Two sources of electric power are available for operation of the pumps.
Discharge flows from the open end of the 6 inch branch pipe into the west bay of the reservoir. Water from this source also may be supplied to the east bay of the reservoir by operation of the reservoir forebay by-pass valves.

During operation of the Sutro Pump Station, the 31,500,000 gallon supply of Sutro Reservoir is available for this emergency supply; when the pump station is not in operation, the 14,000,000 gallon supply of Summit Reservoir, at an elevation of 800 feet, is available by gravity flow. Normal discharge flow from the 6 inch emergency supply branch-pipe is 1,560 GPM. It also is contemplated to provide an additional emergency branch-pipe, supplied by this source for direct supply to the east bay of the reservoir.

**ASHBURY TANK**

Ashbury Tank and Gate House are located on the east side of Clayton Street opposite Carmel Street. This tank is constructed of riveted steel plates, supported on a reinforced concrete base and has a wooden roof covered with asbestos shingles. A scuttle is constructed in the roof for drainage of rain water. The tank is 55 feet in diameter and 29 feet high. At high water elevation of 494 feet, it contains 500,000 gallons of water. An 8 inch drain pipe to the street sewer is connected to the tank for drainage of overflow at the top level or for complete drainage of the tank at bottom level.

Normally the tank is supplied with fresh water from the Water Department distribution system. A 6 inch gated branch pipe connects the tank to a 12 inch Water Department main in front of the Gate House. During a fire, where water is supplied from Ashbury Tank, the tank is normally replenished by opening the 6 inch branch pipe gate valve and the tank supply valve. Water also is supplied from this source to replace tank water lost through leaks and seepage by use of 1 inch by-pass pipes around the tank fresh water supply valves.

The tank also may be supplied with water from Twin Peaks Reservoir. This reservoir supply would be necessary in the event of failure of the domestic supply to the tank; it is also used on occasion to relieve Twin Peaks Reservoir of excess water accumulated during a heavy rain season rather than waste the water by draining it to the sewers. This procedure involves the opening of the tank by-pass valve and the operation of other valves as detailed in the instruction sheet maintained in the Gate House.

The reservoir east and west bay lead valves, No. 37 and No. 38 are normally kept open so that Twin Peaks pressure is available directly at each of the two manifolds. In the event of a high pressure call for Twin Peaks pressure, the action that is normally necessary at Ashbury Tank is to open the required manifold which will immediately admit Twin Peaks pressure into the distribution system. Normally only one manifold is opened at a time so as to maintain one of the reservoir bays in reserve.

On operation of either or both manifolds, Twin Peaks pressure will immediately close the tank discharge pipe check valves. The obvious precaution is to make certain that the tank by-pass valves, No. 23 and No. 24, are closed and that the 6 inch domestic supply gate is closed so as to prevent overflow of the tank from either Twin Peaks Reservoir or from domestic supply.

The manifold valves must be opened or closed slowly and one at a time to minimize surge and resultant water hammer. The standard procedure on opening a manifold is to open only one valve first and to allow sufficient time for pressure to equalize on each side of the manifold.
Discharge from Ashbury Tank into the upper zone leads through three 18 inch pipelines. A fourth closed end discharge pipeline also is available at the Gate House for future extension of the distribution system.

The Gate House also contains two electrically operated centrifugal pumps used to supply Twin Peaks Reservoir. These pumps are usually supplied from the 6 inch branch-pipe connected to the Water Department supply. Each pump is capable of a 750 GPM discharge, and may be operated either singly or in parallel; they are not equipped to operate in series. By valve operation, each pump may discharge singly into either of the Twin Peaks 20 inch pipelines or total discharge may be diverted into either pipeline. Supply to the pumps also may be delivered from Ashbury Tank. The pumps are also capable of pumping water from one reservoir bay to the other.

The manifold valves at the Ashbury Tank, connecting Twin Peaks Reservoir with the Upper Zone of the Auxiliary Water Supply System are completely automated and the Tank unmanned. Operation of the manifold valves is controlled from Jones Street Tank.

**JONES STREET TANK**

Jones Street Tank is located on the west side of Jones Street between Sacramento and Clay Streets. The tank is of reinforced concrete construction and is covered with a tile roof. It is 35 feet high and 60 feet in diameter. At high water elevation of 369 feet it has a capacity of 750,000 gallons. A 10 inch drain pipe is connected to the tank for drainage of overflow at the top level and for complete drainage of the tank at bottom level.

Water is normally supplied to the tank by gravity from an 8 inch gated branch pipe connected to a 12 inch Water Department main on Jones Street. The gate valve controlling this supply is located in the Gate House. During a fire in the lower zone where High Pressure Hydrants supplied by Jones Street Tank are used, the branch pipe gate valve is opened fully to replenish the tank. In the event of failure of domestic supply, the tank may be supplied from Ashbury Tank by operation of a tank by-pass valve, one Ashbury supply manifold, and certain other valves as detailed in the instruction sheet maintained in the Gate House.

High Pressure Hydrants in the lower zone are supplied from Jones Street Tank through two 18 inch feeders. Upper zone pressure, either Ashbury or Twin Peaks, also is available to the lower zone by connection of two upper zone feeders to the Jones Street Gate House manifolds. Ashbury supply valves 1 and 2 are normally kept open so that upper zone pressure is immediately available at each Jones Street Tank manifold. When necessary to supply the lower zone with Ashbury pressure, all that is then required is to open either manifold. The tank check valves prevent flow of water into the tank; however, the obvious precaution is to make certain that the tank by-pass valves are closed to prevent overflow of the tank. Normally only one manifold is opened when necessary to supply the lower zone with upper zone pressure. However, in the event of two or more fires occurring in the lower zone, where High Pressure Hydrants are used and upper zone pressure is required, both manifolds would usually be opened. Operation of the manifold is identical to those of Ashbury Tank.

During the period of supply from the upper zone to the lower zone, the tank may be filled by opening the 8 inch domestic branch supply gate-valve. However, this valve must be completely closed when the tank is full to prevent overflow since upper zone pressure would have closed the tank check-valves.
HIGH PRESSURE PIPELINES

Two 20 inch pipelines extend northeasterly from Twin Peaks to Ashbury Tank where each, through two manifolds (normally closed) connects with the 18 inch Ashbury Tank Header. The header is normally supplied from Ashbury Tank; but, when required, Twin Peaks Reservoir is delivered to the header on opening of either manifold. Each manifold is equipped with five 8 inch gate valves (normally closed). The header supplies three 18 inch upper zone primary feeders. The first feeder leads down Clayton and Oak Streets to the gridiron to the upper zone and extends through the central portion of the upper zone to Jones Street Tank. The second extends down Ashbury and Haight Streets to the gridiron of the upper zone. The third leads down 17th Street to Castro Street where it connects with an 18 inch lower zone feeder which is normally kept closed by a division gate valve. The upper zone gridiron system may be supplied directly with salt water from Pumping Station 2 and indirectly from the fireboat manifold located at Fort Mason Pier 1. Minor distributors in the upper zone are mostly 12 and 14 inch internal diameter with a small amount of 10 inch and are so arranged as to form a well looped gridiron system.

Two feeders connect the Jones Street Tank header with Ashbury Tank or Twin Peaks Reservoir supply through two manifolds (normally closed) identical to those of Ashbury Tank. Supply is normally provided to the header from Jones Street Tank. Additional pressure from Ashbury Tank is provided on opening either or both of the Jones Street Tank manifolds with Twin Peaks Reservoir supply available on opening of the manifolds at Jones Street Tank Gate House and at Ashbury Tank Gate House. There are two 18 inch primary feeders which extend from the Jones Street Tank Header into the grid of the lower zone. One constructed along Pleasant, Taylor and Sacramento Streets connects with an 18 inch secondary feeder in Kearny Street. The other is laid along Jones, Sacramento, and Taylor streets and connects with the distributing system at Sutter Street. The Easterly section of the lower zone is transverse by secondary feeders 18 and 20 inches in diameter which terminate at Pumping Station 1 and 2. An 18 inch secondary feeder cross-connected to the grid system, extends most of the length of Market Street.

Minor distributors in the lower zone are mostly 12 and 14 inches in internal diameter with small amounts of 10- and 16-inch distributors. The feeders and distributors are so arranged to form a closed gridiron pattern, particularly in the congested districts. A 12-inch pipeline extends through the industrial district south of Islais Creek and terminates the southerly end of the lower zone where it dead ends at Evans and Keith Streets. This dead end section is provided with one fireboat manifold for emergency salt water supply at Islais Creek. There also are four other fireboat manifolds connected to 14- and 16-inch feeders in the main portion of the lower zone. Pump Station 1 can also provide emergency salt water supply to the lower zone through two 20 inch feeders and Pump station 2 through one 20-inch feeder.

The High Pressure System is now using a new piping design. The pipe is made of ductile iron which is stronger than the cast iron pipe formerly used, but of equal longevity. The joints are sealed with a compressed rubber-type gasket, which provides greater flexibility in case of earth shock than does the lead joint of cast iron mains. All future mains will use this construction. The internal diameter of pipelines used in the High Pressure System are 10 inch, 12 inch, 14 inch, 16 inch, 18 inch and 20 inch. The internal diameter of the branch pipe connecting the hydrant to the main is 8 inches. Prior to the use of ductile iron, all pipelines installed in the high pressure system were of tar coated cast iron. This pipe, manufactured to specification, was designed to meet the requirements of high pressure flow, probable earthquake shock, and possible use of salt water in the system.
5. History
## APPENDIX 1. CISTERN LOCATIONS

### BATTALION DISTRICT 1

<table>
<thead>
<tr>
<th>No.</th>
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<td>2.</td>
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<td>30.</td>
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## Appendix 1. Cistern Locations

### Battalion District 2

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<tr>
<td>37.</td>
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</tr>
<tr>
<td>120</td>
<td>Dolores &amp; 14th</td>
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<tr>
<td>121</td>
<td>Douglass &amp; Elizabeth</td>
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</tr>
<tr>
<td>122</td>
<td>Eureka &amp; 21</td>
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</tr>
<tr>
<td>123</td>
<td>Guerrero &amp; Cumberland</td>
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<td>124</td>
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<td>125</td>
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<tr>
<td>126</td>
<td>Noe &amp; Hill</td>
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</tr>
<tr>
<td>127</td>
<td>Noe &amp; 24th</td>
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<td>Noe &amp; 29th</td>
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<td>Preceta &amp; Alabama</td>
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<td>130</td>
<td>Shotwell &amp; 22nd</td>
<td>70,700</td>
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<td>So. Van Ness &amp; 20th</td>
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<td>132</td>
<td>Bryant &amp; 21st</td>
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<td>York &amp; 19th</td>
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<td>York &amp; 22nd</td>
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<tr>
<td>135</td>
<td>Bryant &amp; 26th</td>
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</tr>
<tr>
<td>136</td>
<td>Andover &amp; Crescent</td>
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### Battalion District 7

<table>
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<tr>
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<tr>
<td>137</td>
<td>Arguello &amp; Clement</td>
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<tr>
<td>138</td>
<td>Calif. &amp; Commonwealth</td>
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</tr>
<tr>
<td>139</td>
<td>Geary &amp; 5th Ave.</td>
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</tr>
<tr>
<td>140</td>
<td>Legion of Honor, West</td>
<td>75,000</td>
</tr>
<tr>
<td>141</td>
<td>Legion of Honor, East</td>
<td>75,000</td>
</tr>
<tr>
<td>142</td>
<td>34th &amp; Balboa</td>
<td>55,666</td>
</tr>
<tr>
<td>143</td>
<td>41st &amp; Balboa</td>
<td>55,667</td>
</tr>
<tr>
<td>144</td>
<td>Funston &amp; California</td>
<td>55,665</td>
</tr>
<tr>
<td>145</td>
<td>30th &amp; Geary</td>
<td>55,665</td>
</tr>
<tr>
<td>146</td>
<td>38th &amp; Geary</td>
<td>55,666</td>
</tr>
<tr>
<td>147</td>
<td>46th &amp; Geary</td>
<td>55,667</td>
</tr>
</tbody>
</table>
Appendix 1. Cistern Locations

BATTALION DISTRICT 8
148. Irving & 5th Ave. 75,000
149. Judah & 47th Ave. 75,000
150. Judah & 9th Ave. 75,000
151. Vicente & 43rd 55,668

BATTALION DISTRICT 9
152. Lakeview & Josiah 75,000
153. Plymouth & Sadowa 75,000
154. Vienna S. of Persia 75,000

BATTALION DISTRICT 10
155. 3rd & Kirkwood 45,000
156. Kansas & Army 75,000
157. Kansas & 20th 75,000
158. Kansas & 23rd 75,000
159. 3rd & Oakdale 34,000
160. Fitzgerald & Hawes 50,396
161. Gambier & Felton 75,000
162. Hamilton & Dwight 75,000
163. Ingalls & Shafter 50,397
164. Peninsula & Blanken 50,395
165. Sunnydale & Sawyer 50,395
166. 3rd & Thomas 50,397
167. Connecticut & 20th 75,000
168. Pennsylvania & 22nd 75,000
169. San Bruno & 25th 75,000

POOLS, RESERVOIRS, TANKS & LAKES (PARTIAL LIST)

There are approximately 371 additional locations for emergency water supplies that include pools, reservoirs and tanks, above and below ground. Some have outlets for SFFD to connect our hoses. Some will require drafting, depending on the water level and the location of the fire apparatus. The “SFFD Emergency Water Supply” Manual is in each Battalion Chief vehicle. This manual is under revision during January 2008 with the assistance of the Bureau of Fire Prevention. The SFFD Division of Training will post the update on line via “AO Reports” and Training Bulletins when the update is completed.

<table>
<thead>
<tr>
<th>#</th>
<th>Location</th>
<th>(Name)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lombard &amp; Mason</td>
<td>(North Beach Pool)</td>
</tr>
<tr>
<td>2</td>
<td>Wawona &amp; 20&lt;sup&gt;th&lt;/sup&gt;</td>
<td>(Sava/Larson Pool)</td>
</tr>
<tr>
<td>3</td>
<td>Linda &amp; 19&lt;sup&gt;th&lt;/sup&gt;</td>
<td>(Mission Pool)</td>
</tr>
<tr>
<td>4</td>
<td>Post &amp; Steiner</td>
<td>(Hamilton Pool)</td>
</tr>
<tr>
<td>5</td>
<td>Arguello &amp; Anza</td>
<td>(Rossi Pool)</td>
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</table>
### Appendix 1. Cistern Locations

<table>
<thead>
<tr>
<th></th>
<th>Location</th>
<th>Pool Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Harrison &amp; 25&lt;sup&gt;th&lt;/sup&gt;</td>
<td>(Garfield Pool)</td>
</tr>
<tr>
<td>7</td>
<td>Havelock &amp; San Jose</td>
<td>(Balboa Pool)</td>
</tr>
<tr>
<td>8</td>
<td>Visitation &amp; Hahn</td>
<td>(Coffman/McClaren Pool)</td>
</tr>
<tr>
<td>9</td>
<td>Page &amp; Stanyan</td>
<td>(SF Boys &amp; Girls Club)</td>
</tr>
<tr>
<td>10</td>
<td>3&lt;sup&gt;rd&lt;/sup&gt; St. &amp; Carroll</td>
<td>(King Pool)</td>
</tr>
<tr>
<td>11</td>
<td>22&lt;sup&gt;nd&lt;/sup&gt; &amp; Wisconsin</td>
<td>(reservoir)</td>
</tr>
<tr>
<td>12</td>
<td>681 Market at 3&lt;sup&gt;rd&lt;/sup&gt; St.</td>
<td>(The Monadnock Building)</td>
</tr>
<tr>
<td>13</td>
<td>Golden Gate Park, 43&lt;sup&gt;rd&lt;/sup&gt; Ave.</td>
<td>Chain of Lakes</td>
</tr>
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</table>
## Appendix 2. Fulton Street Emergency Hydrant Locations

<table>
<thead>
<tr>
<th>Fulton &amp; ...</th>
<th>PSI</th>
<th>to Gate</th>
<th>Hydrant #</th>
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</thead>
<tbody>
<tr>
<td>1. 22nd Avenue</td>
<td>45</td>
<td>5'</td>
<td>A9261</td>
</tr>
<tr>
<td>2. 23rd Avenue</td>
<td>50</td>
<td>5'5&quot;</td>
<td>A9260</td>
</tr>
<tr>
<td>3. 24th Avenue</td>
<td>55</td>
<td>5'</td>
<td>A9259</td>
</tr>
<tr>
<td>4. 25th Avenue</td>
<td>55</td>
<td>5'5&quot;</td>
<td>A9258</td>
</tr>
<tr>
<td>5. 26th Avenue</td>
<td>55</td>
<td>5'2&quot;</td>
<td>A9257</td>
</tr>
<tr>
<td>6. 27th Avenue</td>
<td>60</td>
<td>5'3&quot;</td>
<td>A9256</td>
</tr>
<tr>
<td>7. 28th Avenue</td>
<td>70</td>
<td>5'9&quot;</td>
<td>A9255</td>
</tr>
<tr>
<td>8. 29th Avenue</td>
<td>70</td>
<td>5'5&quot;</td>
<td>A9254</td>
</tr>
<tr>
<td>9. 30th Avenue</td>
<td>70</td>
<td>5'10&quot;</td>
<td>A9253</td>
</tr>
<tr>
<td>10. 31st Avenue</td>
<td>75</td>
<td>5'3&quot;</td>
<td>A9252</td>
</tr>
<tr>
<td>11. 32nd Avenue</td>
<td>75</td>
<td>5'5&quot;</td>
<td>A9251</td>
</tr>
<tr>
<td>12. 33rd Avenue</td>
<td>80</td>
<td>5'9&quot;</td>
<td>A9250</td>
</tr>
<tr>
<td>13. 34th Avenue</td>
<td>80</td>
<td>5'5&quot;</td>
<td>A9249</td>
</tr>
<tr>
<td>14. * between 34th &amp; 35th</td>
<td>75</td>
<td>3'6&quot;</td>
<td>A9069 from Spreckles</td>
</tr>
<tr>
<td>15. 35th Avenue</td>
<td>80</td>
<td>5'6&quot;</td>
<td>A9248</td>
</tr>
<tr>
<td>16. 36th Avenue</td>
<td>80</td>
<td>5'6&quot;</td>
<td>A9247</td>
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<tr>
<td>17. 37th Avenue</td>
<td>80</td>
<td>7'3&quot;</td>
<td>A9246</td>
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<tr>
<td>18. 38th Avenue</td>
<td>85</td>
<td>7'3&quot;</td>
<td>A9245</td>
</tr>
<tr>
<td>19. 39th Avenue</td>
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<td>A9244</td>
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<td>20. 40th Avenue</td>
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<td>21. 41st Avenue</td>
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<td>23. 43rd Avenue</td>
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<td>24. 44th Avenue</td>
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<td>25. 45th Avenue</td>
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<td>4'9&quot;</td>
<td>A9238</td>
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<tr>
<td>26. 46th Avenue</td>
<td>110</td>
<td>5'5&quot;</td>
<td>A9237</td>
</tr>
<tr>
<td>27. 47th Avenue</td>
<td>115</td>
<td>5'3&quot;</td>
<td>A9236</td>
</tr>
<tr>
<td>28. 48th Avenue</td>
<td>120</td>
<td>5'5&quot;</td>
<td>A9134</td>
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* The hydrant located midway between 34th Avenue and 35th Avenue gets its water by drafting from Spreckles Lake.
## Appendix 3. Bay Suction Connection Locations

<table>
<thead>
<tr>
<th>#</th>
<th>Intersection</th>
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<tbody>
<tr>
<td>1</td>
<td>Yacht Harbor at The Marina lighthouse</td>
</tr>
<tr>
<td>2</td>
<td>Yacht Harbor - Foot of Broderick</td>
</tr>
<tr>
<td>3</td>
<td>Marina Boulevard &amp; Broderick</td>
</tr>
<tr>
<td>4</td>
<td>Marina Boulevard &amp; Divisadero</td>
</tr>
<tr>
<td>5</td>
<td>Marina Boulevard and Cervantes</td>
</tr>
<tr>
<td>6</td>
<td>Marina Green Boulevard &amp; Avila</td>
</tr>
<tr>
<td>7</td>
<td>Marina Green Boulevard &amp; Fillmore</td>
</tr>
<tr>
<td>8</td>
<td>Jefferson - foot of Hyde</td>
</tr>
<tr>
<td>9</td>
<td>Jefferson - foot of Leavenworth</td>
</tr>
<tr>
<td>10</td>
<td>Jefferson &amp; Jones</td>
</tr>
<tr>
<td>11</td>
<td>Embarcadero - east of Taylor</td>
</tr>
<tr>
<td>12</td>
<td>Embarcadero &amp; Powell</td>
</tr>
<tr>
<td>13</td>
<td>Embarcadero &amp; Stockton (Pier 39)</td>
</tr>
<tr>
<td>14</td>
<td>North Side (Pier 39)</td>
</tr>
<tr>
<td>15</td>
<td>East End (Pier 39)</td>
</tr>
<tr>
<td>16</td>
<td>South Side (Pier 39)</td>
</tr>
<tr>
<td>17</td>
<td>Embarcadero &amp; Bay</td>
</tr>
<tr>
<td>18</td>
<td>Embarcadero - North of Pier 27 (Chestnut Street)</td>
</tr>
<tr>
<td>19</td>
<td>Embarcadero at Pier 27 (Greenwich Street)</td>
</tr>
<tr>
<td>20</td>
<td>Embarcadero at Pier 9 (Broadway Street)</td>
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<tr>
<td>21</td>
<td>Embarcadero at Pier 7 (Pacific Street)</td>
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<tr>
<td>22</td>
<td>Embarcadero at Pier 5 (Jackson Street)</td>
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<tr>
<td>23</td>
<td>Embarcadero &amp; Ferry Plaza East</td>
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<tr>
<td>24</td>
<td>Embarcadero &amp; Folsom</td>
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<tr>
<td>25</td>
<td>Embarcadero at Pier 30 (Bryant Street)</td>
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<tr>
<td>26</td>
<td>Embarcadero at Pier 34 (Brannan Street)</td>
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<tr>
<td>27</td>
<td>Embarcadero - North of Pier 38 (Townsend)</td>
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<tr>
<td>28</td>
<td>Embarcadero at South Beach Harbor (North) (King Street)</td>
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<tr>
<td>29</td>
<td>Embarcadero at South Beach Harbor (South) (Berry Street)</td>
</tr>
<tr>
<td>30</td>
<td>Mission Creek Marina &amp; 3rd Street</td>
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<tr>
<td>31</td>
<td>Mission Creek Marina &amp; 4th Street (South)</td>
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<tr>
<td>32</td>
<td>Mission Creek Marina &amp; 4th Street (North)</td>
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<td>33</td>
<td>Rankin &amp; Custer</td>
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<td>34</td>
<td>Islais Creek Channel &amp; 3rd Street (South/West)</td>
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<td>35</td>
<td>Islais Creek Channel &amp; 3rd Street (North/East)</td>
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<td>36</td>
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# APPENDIX 4. AWSS-SCADA MOTORIZED VALVE LOCATIONS

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</tr>
<tr>
<td>2.</td>
<td>Fillmore &amp; Carvantes</td>
<td>NW</td>
</tr>
<tr>
<td>3.</td>
<td>Leavenworth &amp; Bay St.</td>
<td>NW</td>
</tr>
<tr>
<td>4.</td>
<td>Van Ness &amp; Bay</td>
<td>SE</td>
</tr>
<tr>
<td>5.</td>
<td>Kearny &amp; Francisco</td>
<td>NE</td>
</tr>
<tr>
<td>6.</td>
<td>Powell &amp; Chestnut</td>
<td>SW</td>
</tr>
<tr>
<td>7.</td>
<td>Sutter &amp; Montgomery</td>
<td>NE</td>
</tr>
<tr>
<td>8.</td>
<td>Powell &amp; Sacramento</td>
<td>SW</td>
</tr>
<tr>
<td>9.</td>
<td>Sacramento &amp; Kearny</td>
<td>SE</td>
</tr>
<tr>
<td>10.</td>
<td>Drumm &amp; California St.</td>
<td>SE</td>
</tr>
<tr>
<td>11.</td>
<td>17th St. &amp; Collingwood</td>
<td>SE</td>
</tr>
<tr>
<td>12.</td>
<td>Franklin &amp; Ellia</td>
<td>SW</td>
</tr>
<tr>
<td>13.</td>
<td>Scott &amp; Green</td>
<td>SW</td>
</tr>
<tr>
<td>14.</td>
<td>7th Ave. &amp; Irving</td>
<td>SE</td>
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<tr>
<td>15.</td>
<td>Irving St. &amp; 17th Ave.</td>
<td>SE</td>
</tr>
<tr>
<td>16.</td>
<td>7th &amp; Dolores St.</td>
<td>SE</td>
</tr>
<tr>
<td>17.</td>
<td>Harrison &amp; 20th</td>
<td>NE</td>
</tr>
<tr>
<td>18.</td>
<td>5th St. &amp; Brannon</td>
<td>SE</td>
</tr>
<tr>
<td>19.</td>
<td>7th &amp; Brannon</td>
<td>SW</td>
</tr>
<tr>
<td>20.</td>
<td>2nd &amp; Brannon</td>
<td>SE</td>
</tr>
<tr>
<td>21.</td>
<td>2nd &amp; Mission</td>
<td>NW</td>
</tr>
<tr>
<td>22.</td>
<td>6th St. &amp; Market</td>
<td>SE</td>
</tr>
<tr>
<td>23.</td>
<td>Market &amp; New Montgomery</td>
<td>SE</td>
</tr>
<tr>
<td>24.</td>
<td>Sutter &amp; Polk St.</td>
<td>NE</td>
</tr>
<tr>
<td>25.</td>
<td>Market &amp; Larkin</td>
<td>NE</td>
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<tr>
<td>26.</td>
<td>Larkin &amp; Eddy</td>
<td>SE</td>
</tr>
<tr>
<td>27.</td>
<td>4th &amp; Channel</td>
<td>NE</td>
</tr>
<tr>
<td>28.</td>
<td>4th &amp; Channel</td>
<td>SE</td>
</tr>
<tr>
<td>29.</td>
<td>Kansas &amp; 16th</td>
<td>SW</td>
</tr>
<tr>
<td>30.</td>
<td>Evans &amp; Napoleon</td>
<td>NW</td>
</tr>
<tr>
<td>31.</td>
<td>Twin Peaks Reservoir WEST Bay Discharge</td>
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<tr>
<td>32.</td>
<td>Twin Peaks Reservoir EAST Bay Discharge</td>
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<tr>
<td>33.</td>
<td>Twin Peaks Reservoir Balancing Valve</td>
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## Appendix 5. Emergency Drinking Hydrant Locations

### North West San Francisco

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<tr>
<td>3</td>
<td>Clement St. &amp; 44th Ave.</td>
<td>SE</td>
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<td>4</td>
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<td>SE</td>
</tr>
<tr>
<td>5</td>
<td>Geary Blvd. &amp; 21st Ave.</td>
<td>SE</td>
</tr>
<tr>
<td>6</td>
<td>Geary Blvd. &amp; Funston Ave.</td>
<td>SW</td>
</tr>
<tr>
<td>7</td>
<td>Arguello St. &amp; Edward St.</td>
<td>NE</td>
</tr>
<tr>
<td>8</td>
<td>Euclid Ave. &amp; Collins St.</td>
<td>NE</td>
</tr>
<tr>
<td>9</td>
<td>Divisadero St. &amp; Pacific Ave.</td>
<td>SW</td>
</tr>
<tr>
<td>10</td>
<td>Broderick St. &amp; Bay St.</td>
<td>SE</td>
</tr>
<tr>
<td>11</td>
<td>Ashbury St. &amp; Waller St.</td>
<td>NW</td>
</tr>
<tr>
<td>12</td>
<td>Irving St. &amp; 12th Ave.</td>
<td>NE</td>
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<td>24th Ave. &amp; Judah St.</td>
<td>NW</td>
</tr>
<tr>
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<td>45th Ave. &amp; Kirkham St.</td>
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### South West San Francisco

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<tr>
<td>16</td>
<td>24th Ave. &amp; Pacheco St.</td>
<td>NE</td>
</tr>
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<td>17</td>
<td>Quintara St. &amp; Cragmont Ave.</td>
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<td>19</td>
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<td>24</td>
<td>Ocean Ave. &amp; San Fernando Way</td>
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<td>25</td>
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APPENDIX 6. GENERAL ORDER – USE OF AMES DEVICE

SAN FRANCISCO FIRE DEPARTMENT

GENERAL ORDER

File Code 02 A-46

June 10, 2002

From: Chief of Department
To: Distribution List "A"
Subject: Use of the Ames Cross-Connection Device
Reference: Rules and Regulations, Section 402
Enclosure: None

1. The San Francisco Fire Department (SFFD) utilizes The City’s domestic water system (low-pressure hydrants) and the Auxiliary Water Supply System (AWSS); the dedicated high-pressure system to provide water for firefighting efforts. The pumping stations and fireboats and/or engine companies pumping into fireboat manifolds can support the AWSS. Many other static sources of water are also available throughout The City for fire suppression use. The City’s domestic system is a potable supply, where the AWSS, San Francisco Bay Water and other static sources are a non-potable supply.

2. During greater alarm fire fighting operations, SFFD equipment sometimes is inadvertently connected to both the domestic water system and the AWSS simultaneously. The State Department of Health Services has determined that these actions constitute direct cross connections between approved potable water and unapproved non-potable water sources and expose water users to undue public health hazards. Further, such cross-connections are prohibited under Title 22, California Code of Regulations (CCR) and are in violation of Section 116555 of the California Health Safety Code.

3. Since August 24, 1992, the State Department of Health has required The City to have cross-connection control measures in place to prevent backflow of non-potable water into the domestic water system if there is an inadvertent cross-connection to the AWSS. General Orders 88 A-68 and 96 A-28 were developed and identify a number of safeguards to be employed by the SFFD during fire ground operations to prevent introduction of non-Potable water into the potable water supply system.
Even with these safeguards in place, the SFFD was determined to have caused several events of unprotected cross-connection between the domestic water system and the AWSS.

4. On September 29, 1995, the State Department of Health Services issued Compliance Order 02-04-95CO-006 to the San Francisco Public Utilities Commission (PUC) to take corrective actions to protect the domestic water supply system from cross-connection hazards.

5. To protect the domestic water system, the SFFD must provide an additional level of protection against the introduction of non-potable water into the domestic water supply system. The SFFD has issued a single check device; capable of being tested, called the Ames Cross-Connection Device to address this compliance order.

6. Each Engine, Attack Hose Tender and 5” Hose Tender, has been issued 3 Ames Cross-Connection Devices. It is **MANDATORY** that every connection to a low-pressure hydrant has an Ames Cross-Connection Device attached to the outlets of said hydrant. There shall be no exceptions. One Ames Cross-Connection Device shall be pre-connected to each soft suction and one to the hydrant jumper if pre-connected.

7. These devices shall be inspected daily and after each use. Ames Cross-Connection Devices previously issued and any new devices added to inventory will be stamped with a serial number to facilitate testing and tracking of the test results. The serial number shall be located in a position that allows for ease of identification when connected to a low-pressure hydrant. The Ames Cross-Connection Device will be tested annually, as scheduled, by utility plumbers of the AWSS with members of the PUC staff present to validate the test results for the State. If damaged, i.e. missing the washer, deterioration of the washer, or failure of the valve is noted, the Bureau of Equipment shall be notified immediately. The Bureau of Equipment is responsible for pick up and replacement of the damaged or failed device. The Bureau of Engineering and Water Supply is responsible for the repair of the Ames Cross-Connection Device.

8. The Ames Cross-Connection Device consists of a 3” female swivel coupling for connection to the hydrant and a 3” male coupling for connection to a 3” hose line. There is an arrow near the handle to show the proper direction of water flow to ensure proper placement of the device. An annual training evolution shall be incorporated into a Battalion Based Training Module to address the importance of the proper use of the Ames Cross-Connection Device. Additionally an initial presentation will be made to all probationary classes at the Division of Training during pump operations training.

9. Standard operation procedures of the SFFD state that a pumper may be hooked up to a high-pressure hydrant through the use of a Gleeson Valve. Every attempt however should be made to make high pressure hose leads directly to the master stream device they wish to supply and control pressure at the Gleeson Valve. Occasionally initial water taken from a LPH through an engine is inadequate to supply a master stream device and needs to be augmented by high-pressure water. When this happens the low-pressure supply shall be disconnected first from the master stream device and then all supply leads shall come from a high-pressure source. Whenever bay water is used, from engines at draft or from fireboats, for fire fighting purposes it is imperative that no cross-connections are made with the potable distribution system.

10. It is the duty of the San Francisco Fire Department’s Water Supply Supervisor to insure that no cross-connections occur while combating greater alarm fires. It is also the water supply Supervisors responsibility to be sure there is a sufficient water supply for fire fighting purposes. The Supervisor will report to the Incident Commander when arriving on the scene, and will communicate with the
San Francisco Water Department representatives on the scene as well as the PUC Water Quality representatives. PUC Water Quality representatives shall also report to the Incident Commander to link up with the Water Supply Officer assigned for the incident before conducting a cross-connection inspection. This will allow for immediate correction of any deficiencies noted during the inspection.

11. When the Water Supply Supervisor is not on the scene the Incident Commander shall assign a water supply officer at all fire incidents to insure compliance with this General Order, the Safety Officer may perform this function in addition to other safety related duties.

12. Company Officers are directed to include this General Order, as well as a review of the pertinent sections of the Pump Operators Manual and the Water Supply Manual into their daily drill schedule. It is the goal of this General Order to be 100% compliant in attaching the Ames Cross-Connection Device to low-pressure hydrants and avoid cross-connection whenever possible.