Chapter 3: Operational & Design Criteria

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Chapter Highlights:

This chapter presents the operational and design criteria utilized by WYA for the evaluation of the District's retail water system. These criteria reflect typical water system design industry standards, including the California Safe Drinking Water Act and related laws, and the American Water Works Association.

These criteria will serve a critical role in the evaluation of the District's 2025 water system and development of the 2025 Capital Improvement Program. The following is a key assumption related to the reliability of water supply:

- *Since the District is currently adding redundancy to the raw water supply pipeline into the WTP, and recently added redundancy to the WTP processes, the reliability of the WTP has been increased substantially. Therefore, it is assumed that:*
  - *100% of the District's maximum day water supply will be available from Hinkle Reservoir for 12 hours; or*
  - *50% of the District's average day water supply will be available from Hinkle Reservoir for an extended ou*

CHAPTER 3. PLANNING AND DESIGN CRITERIA

In this chapter, planning and design criteria for the performance of system analysis of the District's retail water system are defined. These criteria include the desired minimum and maximum pressures, maximum velocity and head loss, fire flow and duration, definition of "emergency events", and storage components, including operational, fire flow and emergency. Subsequent sections of this chapter are as follows:

- Fire Flow Requirements
- Water System Supply Capacity During High Demand Periods
- Pumping Facility Capacity
- Water Storage Capacity
- Water Transmission and Distribution System Sizing.

These criteria, summarized in Table 3-1, reflect typical water system industry standards, including the California Safe Drinking Water Act and related laws, and American Water Works Association standards.

FIRE FLOW REQUIREMENTS

The District is the purveyor of water for the retail area, but there are several independent fire agencies concerned with the availability of adequate water supply. These include the City of Folsom, the City of Roseville, the South Placer Fire District, and the Sacramento Metropolitan Fire District (Metro Fire). The District is responsible for supply and distribution of water, whereas the fire districts establish minimum the water flows required for fire fighting purposes.

The fire agencies use Uniform/California Fire Code (UFC/CFC) Table A-111-A-1 *Minimum Required Fire Flow and Flow Duration for Buildings* to assist them in establishing minimum fire flows and durations. The District's current fire flow requirements by land use type are presented in Table 3-2. Comparison of the District's generalized fire flow requirements, with those of other agencies, indicates the District's fire flow requirements are typical for a water agency of similar size.

As discussed in subsequent sections of this chapter, fire flows presented in Table 3-2 and their expected duration were also used to establish storage capacity requirements.

Table 3-1. San Juan Water District Operational and Design Criteria

Component	Criteria	Remarks / Issues
PERFORMANCE CRITERIA FOR PLANNING & DESIGN [(a)]		
Fire Flow Requirements (flow [gpm] @ duration [hours])		
Single-Family Residential	1,500 gpm @ 2 hrs	Fire flows based on new development requirements. Existing development will be evaluated on a case by case basis, because of the historical varying standard.
Multi-Family Residential	2,500 gpm @ 2 hrs	
Commercial	3,000 gpm @ 3 hrs (with approved automatic sprinkler system)	
Institutional (schools, hospitals, etc.)	4,000 gpm @ 4 hrs (with approved automatic sprinkler system)	
Industrial / Business Park	4,000 gpm @ 4 hrs (with approved automatic sprinkler system)	
Water Supply Capacity		
Maximum Day Demand Plus Fire Flow	Provide capacity equal to maximum day demand plus fire flow	
Peak Hour Demand	Provide capacity to equal peak hour demand	
Pumping Facility Capacity		
Booster Pump Capacity	Equal to the maximum day demand plus fire flow or peak hour (whichever is larger) w/ the largest pump out of service.	Design for peak hour only if no gravity storage is available
Backup Power	Equal to the maximum day or equal to maximum day demand plus fire flow, when fire storage is not located in zone.	On-site generator for large stations. Plug in portable for smaller stations.
Water Storage and System Peaking Capacity		
Operational	25 percent of maximum day demand	
Fire	Varies (see requirements listed in remarks column)	Varies depending on required fire flow duration. Highest fire flow demand in any particular area controls size of required storage. 1,500 gpm @ 2 hrs = 0.18 MG 2,500 gpm @ 2 hrs = 0.30 MG 3,000 gpm @ 3 hrs = 0.54 MG 4,000 gpm @ 4 hrs = 0.96 MG
Emergency	Average day demand	Based on DHS recommendations
Total Water Storage Capacity	Operational + Fire + Emergency	
Water Transmission Line Sizing		
Diameter	18-inches in diameter or larger	Criteria based on requirements for new development, existing transmissions mains will be evaluated on case-by-case basis. Evaluation will include age, material type, velocity, headloss, and pressure.
Average Day Demand Condition		
Minimum Pressure [psi]	35 psi	
Maximum Pressure [psi]	100 psi	
Maximum Velocity [ft/sec]	3 fps	
Maximum Day Demand Condition		
Minimum Pressure [psi]	35 psi	
Maximum Head loss [ft/1000 ft]	3 ft/kft	
Maximum Velocity [ft/sec]	5 fps	
Peak Hour Demand Condition		
Minimum Pressure [psi]	35 psi	
Maximum Head loss [ft/1000 ft]	3 ft/kft	
Maximum Velocity [ft/sec]	5 fps	
Hazen Williams "C" Factor	130	For consistency in hydraulic modeling.
Pipeline Material	Ductile Iron, Concrete Cylinder or Steel	
Water Distribution Line Sizing		
Diameter	Less than 18-inches in diameter	Must verify pipeline size with max day and fire flow analysis.
Maximum Day w/ Fire Flow Demand Condition		Criteria based on requirements for new development, existing distribution mains will be evaluated on case-by-case basis. Evaluation will include age, material type, velocity, headloss, and pressure.
Minimum Pressure [psi] (at fire node)	20 psi	
Maximum Head loss [ft/1000 ft]	10 ft/kft	
Maximum Velocity [ft/sec]	10 fps	
Peak Hour Demand Condition		
Minimum Pressure [psi]	35 psi	
Maximum Head loss [ft/1000 ft]	10 ft/kft	
Maximum Velocity [ft/sec]	7 fps	
Minimum Pipeline Sizes		
Low Density Residential	12" [sq mi grid], 8" [1/4 mi grid], 6" [other]	
Commercial	8" + 12" [sq mi grid]	
Industrial	12"	
Distribution to cul-de-sac / dead end street	8-inch	
Distribution to fire hydrants	8-inch	
Hazen Williams "C" Factor	120 (Ductile, Iron, Steel); 130 (PVC)	For consistency in hydraulic modeling.
Pipeline Material	PVC, Ductile Iron, or Steel	
OTHER CRITERIA		
Maximum Number of residential lots that can be served by a non-looped water pipeline	25 lots	If a non-looped water line goes out-of-service, all associated residences lose water service.

[(a)] The average day demand to maximum day and peak hour factors are specific for each pressure zone. See Table 5-5.

Table 3-2. Fire Flow Requirements[a,b]

Land Use	Existing Criteria[c]		Future Criteria[d]	
	Fire Flow, gpm	Duration, hours	Fire Flow, gpm	Duration, hours
Single-Family Residential	1,000	2	1,500	2
Multi-Family Residential	1,000	2	2,500	2
Commercial	1,000	2	3,000	3
Institutional	1,000	2	4,000	4
Industrial/Business Park	1,000	2	4,000	4
School	3,000	3	4,000	4

(a) Construction type and fire area are not generally known during the development of a master plan; consequently, fire flow requirements set forth in this table are based on previous estimates for these land use types and similar communities.

(b) Unique projects or projects with alternate materials may require higher fire flows and will be reviewed by the Fire Marshal on a case-by-case basis (e.g., proposed commercial/industrial areas and schools).

(c) Specific fire flows were determined from the San Juan Water District Water Master Plan, October 1995.

(d) Specific fire flows were determined from Table A-III-A-1 of the 2001 CFC, and depend on construction type and fire area. These fire flow requirements are based on buildings being fully sprinklered.

For planning purposes, minimum fire flows are assumed to be met concurrently with a maximum day demand condition, while maintaining a minimum residual system pressure of 20 psi. Fire flows and the expected duration are also used to establish treated water storage requirements (as described below). The existing criteria, as presented above, will be used for the evaluation of the existing system since a large portion of the District's retail service area was constructed to meet older, lower fire flow requirements. All future development will be required to meet the future fire flow criteria.

WATER SUPPLY CAPACITY DURING HIGH DEMAND PERIODS

The following criteria should be used to assess the adequacy of the District's water supply during high demand periods.

Maximum Day Demand plus Fire Flow

In accordance with typical industry standards, the District's water supply system should have the capability to meet a system demand condition equal to the occurrence of a maximum day demand condition concurrent with a fire flow event. Furthermore, the analysis of specific fire flow evaluations will be conducted assuming the largest booster pump is offline (i.e., firm capacity of the pump station). This ensures the reliability of these systems to provide sufficient flow during emergency fire flow conditions. For future system improvement analyses, pump stations with

only one booster pump, or without back-up power capability (either an on-site generator, or adaptor for a plug-in generator), will not be considered to be reliable during fire flow analysis.

For planning purposes, it is assumed that the maximum day plus fire flow demand condition will consist of a single fire flow event.

Peak Hour Demand

Peak hour demand should be met from a combination of supply sources and treated water storage reservoirs.

PUMPING FACILITY CAPACITY

Sufficient water system pumping capacity should be provided to meet the greater of a fire flow concurrent with the maximum day demand or peak hour demand (unless peak hour is met with gravity storage), with the largest pump at the pump station in standby mode. This maximum supply requirement sets the pumping capacity requirement.

All pumping facilities should also be equipped with an on-site, back-up power generator or a plug-in adapter to allow interconnection to a portable generator, which will be brought to the site by District staff during a prolonged power outage.

The fire flow should be supplied with a National Fire Protection Association (NFPA) rated fire pump that is diesel engine driven. If an NFPA rated fire pump is not used, then a pump(s) and motor(s) combination with a backup power source of sufficient capacity to meet the required maximum fire flow and pressure requirements, as determined by the fire district's Fire Marshal, will be required.

WATER STORAGE CAPACITY

The total treated water storage and system peaking capacity requirements will be evaluated based on the following three components:

- Operational Storage,
- Fire Storage, and
- Emergency Storage.

A discussion of these three components follows.

Operational Storage

Over any 24-hour period, water demands will vary. Typically, higher water demands will occur during the early morning hours when people are irrigating landscape and getting ready to go to work and school. Water demands will then decline to some nominal baseline level (depending on the proximity to and water use patterns of adjacent commercial/industrial areas), and will then begin to ramp up again depending on outside water needs (and corresponding temperature), again reaching a higher water demand in the early evening hours as people return home from work.

Throughout the year, the peaks of this cycle will vary according to customer needs; thereby, creating a maximum day and peak hour demand.

Typically, water treatment plants are operated at a constant rate over a 24-hour period (baseline), augmented by flow from storage tanks during higher daily demand periods. The tanks are normally refilled when demands drop below the baseline water production flow rate. The storage volume used to meet these peak demand periods is called operational storage.

For a typical system, the recommended volume of water to be held in reserve for operational storage should be at least equal to 25 percent of the total volume of water used on a maximum day.

Fire Storage

Fire fighting flow requirements are identified in the Insurance Service Office, Inc. (ISO) guidelines and UFC. These requirements are based on flow (in gpm) for the building use type (*i.e.* commercial. residential, school, industrial *etc*.), size of building (in square feet), and type of construction (wood frame, metal, masonry, installation of sprinklers, *etc*.). After a fire flow requirement is established, it is multiplied by the required fire fighting duration to produce an estimate of the total volume of fire flow required. Table 3-2 presents the recommended fire flow criteria.

The highest ISO recommended fire flow requirement in the District (see Table 3-2) is 4,000 gpm, for a duration of four hours for industrial areas (if sprinklered). The resulting volume needed for fire flow storage is 0.96 MG. The resulting fire flow volume determined for the District, where feasible, should be stored in reservoirs located within the closest pressure zone or readily available by gravity from storage in higher pressure zones. For all existing development, a fire flow storage requirement of 1,000 gpm for 2 hours (0.12 MG) or 3,000 gpm for 3 hours (0.54 MG) will be used, except where noted (see Chapter 7).

Emergency Storage

A reserve of stored water is also required to meet demands during periods of supply emergency. An emergency is defined as an unforeseen or unplanned event that may degrade the quality or quantity of potable water supplies available to serve customers. There are three types of emergency events that a utility typically prepares for:

- Minor emergency. A fairly routine, normal, or localized event that affects few customers, such as a pipeline break, malfunctioning valve, hydrant break, or a brief power loss. Utilities plan for minor emergencies and typically have staff and materials available to correct them.
- Major emergency. A disaster that affects an entire, and/or large, portion of a water system, lowers the quality and quantity of the water, or places the health and safety of a community at risk. Examples include water treatment plant failures, raw water contamination or major power grid outages. Water utilities infrequently experience major emergencies.

- Natural disaster. A disaster caused by natural forces or events that create water utility emergencies. Examples include earthquakes, forest or brush fires, hurricanes, tornados or high winds, floods, and other severe weather conditions such as freezing or drought.

Determination of the volume of emergency storage is a policy decision based on the assessment of the risk of failures and the desired degree of system reliability. The amount of required emergency storage is a function of several factors including the diversity of the supply sources, redundancy and reliability of the production facilities, and the anticipated length of the emergency outage. In general, a vulnerability analysis, as described in the American Water Works Association (AWWA) Manual M19, *Emergency Planning for Water Utility Management*, should be used to identify the emergency storage requirements. However, because a vulnerability analysis was not completed as a part of the Retail Water Master Plan Update, typical industry standards were used and the recommended criteria and assumptions are described in the following paragraphs.

The treated water emergency supply requirements, as published by the State Department of Health Services (DHS) in Title 22 Chapter 16, call for a minimum emergency supply in each pressure zone equivalent to the average day demand. However, the AWWA guidelines call for a more conservative assumption that is equal to twice the average day demand in summer months plus fire flows.

For this Retail Water Master Plan Update, it has been assumed that the emergency storage requirement will be based on minor emergencies and *specific* major emergency criteria. Currently, the District is improving the reliability of their raw water supply through key improvements to the raw water supply pipelines to the WTP. In addition, redundancy was recently added to specific treatment processes within the WTP. Based on these improvements, the following assumptions for the available water supply have been made:

- 100 percent of maximum day supply, for up to 12 hours, will be available from Hinkle Reservoir; and
- 50 percent of average day supply, for an extended outage, will be available from Hinkle Reservoir.
- Raw water contamination and/or a natural disaster are not be used to assess the District's required emergency storage volume.

It is recommended that the District use DHS's suggested guideline of having a minimum quantity of emergency storage volume equivalent to the District's average day demand.

Total Storage Capacity

The District's minimum treated water storage capacity should be determined as follows:

- Operational: Volume of water necessary to meet diurnal peaks observed throughout the day, usually designed to be equivalent to at least 25 percent of the maximum day demand; plus

- Fire Flow: Volume of water necessary to provide the maximum fire flow in the service area times the duration the flow rate must be maintained; plus
- Emergency: Volume of water necessary to provide an average day demand.

The actual amount of total supply and system peaking capacity required to meet these criteria will change over time as the District continues to grow.

WATER TRANSMISSION AND DISTRIBUTION PIPELINE SIZING

The following criteria are to be used as guidelines for new transmission and distribution pipeline sizing. The District's existing system will be evaluated on a case–by-case basis. For example, if an existing pipeline experiences head loss in excess of the criteria described below during a maximum day plus fire flow event, this condition, by itself, does not necessarily indicate a problem as long as the minimum pressure criterion is satisfied. Although these criteria and guidelines have been established, and will be used to size new pipelines, the District's existing system will be evaluated using pressure as the primary criterion and secondary criteria, such as velocity, head loss, age, and material type, will be used as indicators for where water system improvements may be needed.

Water Transmission System

Transmission pipelines are generally 18 inches in diameter or larger and should be designed based on the criteria described below for average day, maximum day plus fire flow, and peak hour demand conditions. The criteria reflect industry standards and WYA's experience working with the District's existing retail water system.

Average Day Demand

- Pressures should be maintained between a maximum of 100 psi and a minimum of 35 psi.
- Maximum velocity within transmission pipelines should be 3 feet per second (fps).
- Head losses within the transmission pipelines should be limited to 3 feet per thousand feet (ft/kft) of pipeline.

Maximum Day Demand

- The minimum allowable service pressure in the water transmission main should be 35 psi.
- The maximum velocity within the transmission system pipelines should be 5 fps.
- Head losses within the transmission system pipelines should be limited to 3 ft/kft of pipeline.

Peak Hour Demand

- The minimum residual pressure during a peak hour demand should be 35 psi.
- The maximum pipeline velocity should be 5 fps.
- Head losses within the transmission system pipelines should be limited to 3 ft/kft of pipeline.

Water Distribution System

Distribution pipelines are generally less than 18 inches in diameter, and should be sized based on the criteria described below for maximum day plus fire flow, and peak hour demand conditions. The criteria reflect industry standards and WYA's experience working with the District's existing water system.

Maximum Day Demand plus Fire Flow

- The minimum allowable service pressure should be 20 psi at the flowing fire hydrant.
- The maximum velocity within the distribution system pipelines should be 10 fps.
- Head losses within the distribution system pipelines should be limited to 10 ft/kft of pipeline.

Peak Hour Demand

- The minimum residual pressure during a peak hour demand should be 35 psi.
- The maximum pipeline velocity should be 7 fps.
- Head losses within the distribution system pipelines should be limited to 10 ft/kft of pipeline.