EXISTING SYSTEM EVALUATION

This chapter presents the results of the evaluation of the West Basin Municipal Water District's (West Basin) existing distribution systems. The hydraulic models were used to analyze the existing distribution systems to determine any deficiencies according to the planning and evaluation criteria and conditions outlined in Chapter 5. Any deficiencies found are discussed and recommendations are made to resolve the deficiencies.

7.1 DISTRIBUTION SYSTEM HYDRAULIC ANALYSES

7.1.1 Hyperion Secondary Effluent Pumping System

7.1.1.1 Criteria

The general analysis criteria used to evaluate the Hyperion Secondary Effluent Pumping System includes the following:

- Maximum headloss of 10 feet for each 1,000 feet of pipe length
- Maximum velocity of less than 7 fps in the force main.
- Surge pressures that will not cause pumps to operate outside of their allowable operating range

Analysis criteria specific to the Hyperion Secondary Effluent Pumping System includes:

- Sufficient firm capacity to deliver the maximum demand at the ELWRF

These criteria were used to evaluate the Hyperion Secondary Effluent Pumping System under existing demand conditions.

7.1.1.2 Analysis Conditions

The Hyperion Secondary Effluent Pumping System consists of the booster pump station and the 60-inch diameter PVC lined reinforced concrete pressure pipe force main that conveys secondary effluent the ELWRF. The pump station has two constant speed pumps (No. 1 and No. 4), and two variable speed pumps (No. 2 and No. 3). Normally, one constant speed pump is operated along with one variable speed pump on automatic control and the second variable speed pump on manual control to maintain a discharge pressure of 59 psi. As a result, the manually operated pump turns off and on due to near shut-off head conditions at low speeds, causing hydraulic transients (surge) in the system.

West Basin pumped an average flow of 32.4 mgd of secondary effluent from the Hyperion Wastewater Treatment Plant (HWWTP) in 2007. During the model calibration period, the average, maximum instantaneous, and minimum flows at the pump station were recorded as follows: 34.5 mgd, 45.6 mgd, and 6.75 mgd. It should be noted that the minimum flow occurred when the only variable speed pump shut off due to low speed (high pressure from the operating constant speed pump). The analyses were conducted with the existing firm capacity (reported to be 51 mgd), as well as the average and maximum instantaneous flows recorded during the calibration period. The existing firm capacity of the pump station is about 51.0 mgd, greater than the existing peak demand of 31,695 gpm (equivalent to 45.6 mgd).

Table 7.1, shows the average annual flows, as well as the maximum month and minimum month demands.

Table 7.1 Hyperion Secondary Effluent Pumping System Demands
Capital Implementation Master Plan
West Basin Municipal Water District

Condition	Average Annual	Average Daily	Average Instantaneous
Average Annual Demand(1)	36,300 afy	32.4 mgd	22,505 gpm
Average Demand - Calibration(2)	N/A	34.5 mgd	23,961 gpm
Maximum Demand - Calibration(2)	N/A	45.6 mgd	31,695 gpm
Minimum Month Demand(3)	N/A	6.75 mgd	4,688 gpm
Firm Capacity	N/A	51.0 mgd	35,417 gpm

Notes:
(1) Average annual demand from the 2007-2008 flow records
(2) October 14, 2008
(3) Minimum month demand (February) from the 2007-2008 flow records

The average flows recorded during the calibration period are slightly higher than the average flow pumped in 2007.

7.1.1.3 Analysis Results

The results from the analyses performed for each of the demand conditions described in Table 7.1 are presented below in Table 7.2.

As shown in Table 7.2, the velocities in the pipeline vary from 2.6 fps (average flow conditions) to 4.0 fps (firm design capacity conditions). This range of velocities is well below the maximum desired velocity of 7 fps. The head losses are well within acceptable limits with average unit headloss ranging from 0.1 feet to 2.9 feet per 1,000 feet of pipe.

The operation of the existing pump station should be further reviewed in detail to eliminate the need for continuous manual operation, which results in pumps turning on and off, resulting in surges in the system. While the surge pressures are not high enough to damage the system, the pumps operate outside their preferred operating range. Additionally, a secondary power supply should be provided to power the pump station during commercial/emergency power outages.

Table 7.2 Hyperion Secondary Effluent Pumping System Analyses
Capital Implementation Master Plan
West Basin Municipal Water District

Condition	Total Headloss(1)	Average Unit Headloss (ft/1,000 ft)	Pressure at Pump Discharge	60" Pipe Velocity	Maximum Travel Time(2) (Water Age)
Average Day Demand(3)	5.0 ft	1.3 ft	59.1 psi	2.6 fps	1.7 hr
Average Day Demand - Calibration	5.5 ft	1.4 ft	59.7 psi	2.7 fps	1.6 hr
Maximum Day Demand - Calibration(4)	9.3 ft	2.4 ft	58.9 psi	3.6 fps	1.2 hr
Minimum Month Demand(5)	0.2 ft	0.1 ft	59.4 psi	0.8 fps	0.8 hr
Firm Capacity (51 mgd)	11.5 ft	2.9 ft	59.7 psi	4.0 fps	1.1 hr

Notes:
(1) Maximum headloss predicted by model over 24-hour simulation period.
(2) Based on length of 15,445 feet.
(3) Pump 2 running at 75 percent speed and Pump 1 running at 71 percent speed to maintain ~59 psi discharge pressure at the pump station.
(4) Pump 2 running at 85 percent speed and Pump 1 running at 79 percent speed to maintain ~59 psi discharge pressure at the pump station.
(5) Pump 3 running at 70 percent speed to maintain ~59 psi discharge pressure at the pump station.

7.1.2 Title 22 Distribution System

7.1.2.1 Criteria

The general analysis criteria used to evaluate the existing Title 22 Distribution System include the following:

- Maximum headloss of 10 feet for each 1,000 feet of pipe length
- Velocities of 1 to 3 feet per second (fps) under normal operations, with maximum velocities of 7 fps. A minimum velocity of 1 fps is desired under average annual demands.
- Minimum pressure of 65 pounds per square inch (psi) at customer meter connections.
- Surge pressures within 10 percent of the operating pressures. (It should be noted that West Basin staff indicated surge tanks connected to the system are designed for a 10 psi deviation from the operating pressure, which may or may not be less than 10 percent, depending on the operating pressure.)
- Minimum chlorine residual of 1.0 mg/L.

Analysis criteria specific to the Title 22 Distribution System includes:

- Ability to deliver the peak hour flow of 37.2 million gallons per day (mgd) (as detailed in Chapter 4) with the largest pump out of service

These criteria were used to evaluate the Title 22 distribution system under existing demand conditions.

7.1.2.2 Analysis Conditions

The Title 22 Distribution System consists of two 5 million gallon (MG) storage tanks (Tank 1 and 2), a pump station with two constant speed and two variable speed pumps each on tank, and the distribution system consisting of about 83 miles of pipe varying from 4 inches to 60 inches in diameter.

Currently, a combination of variable speed and constant speed pumps are operated at each tank to meet the varying demands. During the calibration period between September 26 and October 24, 2008, one constant speed and one variable speed pump was operated at each tank except between October 16, 16:30 and October 17 00:25, when one pump operated at each tank. During the lower demand periods, the variable speed pumps are capable of supplying the entire system demands. The controls are set to maintain a pressure of 87 psi at the discharge pipe near Tank 1, with a desired variation of ± 5 psi.

The existing peak hour demand is estimated at 25,806 gallons per minute (gpm) or 37.2 mgd. The existing pump station has ample capacity (approximately 69 mgd) to meet this demand, even with one of the large capacity pumps out of service.

The analyses were conducted with the maximum month demands, including the peak hour period. The current maximum month demand is estimated at 24.0 mgd, with an associated peak hour demand of 25,806 gpm.

Table 7.3 shows the average annual demands, as well as the maximum month and associated peak hour demands.

7.1.2.3 Analysis Results

The Title 22 recycled water distribution system is able to provide the peak hour demands to most existing customers with adequate pressures. Figure 7.1 illustrates the pressure contours in the system with the peak hour demands.

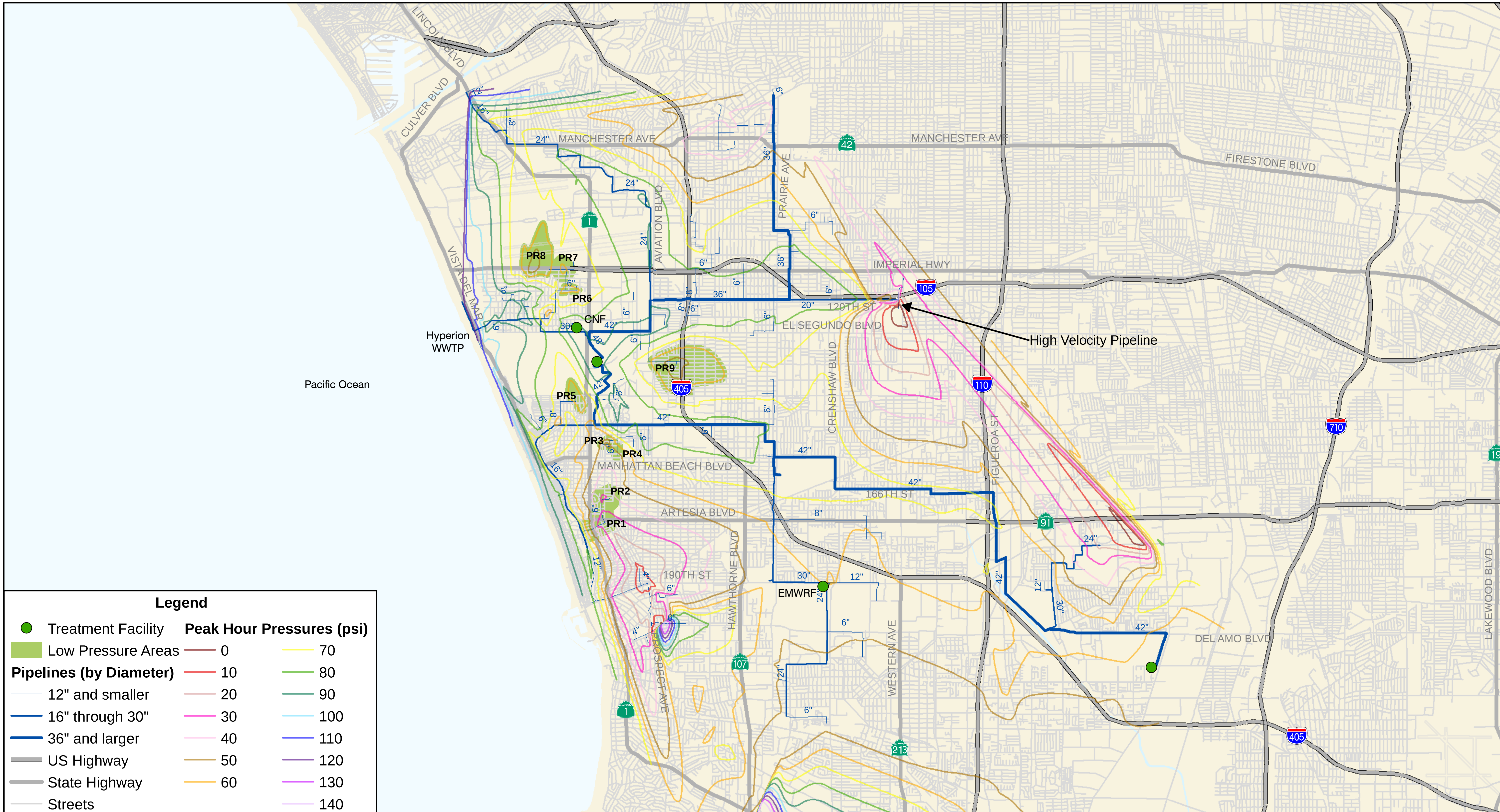

Figure 7.1
Title 22 Maximum Day, Peak Hour Pressure Contours

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West Basin Municipal Water District
Capital Implementation Master Plan For Recycled Water Systems

1 0.5 0 1
Miles

Table 7.3 Title 22 Distribution System Demands Capital Implementation Master Plan West Basin Municipal Water District			
Condition	**Average Annual**	**Average Daily**	**Average Instantaneous**
Average Annual Demand$^{(1)}$	17,392 afy	15.5 mgd	10,781 gpm
Maximum Month Demand$^{(2)}$	N/A	24.0 mgd	16,671 gpm
Maximum Month, Peak Hour Demand$^{(3)}$	N/A	37.2 mgd	25,806 gpm

Notes:
Recovery at ExxonMobil Water Recycling Facility (EMWRF) and Carson Regional Water Recycling Facility (CRWRF) is estimated at 85%. These demand estimates do not include the additional water required at EMWRF and CRWRF to produce the Industrial reverse osmosis (RO) and Industrial RO Ultra water. The additional water requirement is included in the hydraulic model for analysis.
(1) Average annual demand from the 2007-2008 flow records.
(2) Determined from flow records and peaking factors developed in Section 5.
(3) Determined from maximum month demands and the diurnal curves developed for this study.

The model indicates a few low pressures generally at higher elevations where the distribution system piping is small. With the Title 22 pump station discharge pressure maintained at 87 psi, the areas identified with pressures less than 65 psi during maximum month conditions are shown on Figure 7.1 and are listed in Table 7.4

Table 7.4 Title 22 Low Pressure Areas Capital Implementation Master Plan West Basin Municipal Water District			
Location	**City**	**Map ID**	**Average Pressure (psi)**
The area near Mira Costa High School	Manhattan Beach	PR1	43
The area near Pennekamp Elementary School	Manhattan Beach	PR2	49
The area near Meadows Elementary School	Manhattan Beach	PR3	54
The area near Polliwog Park	Manhattan Beach	PR4	52
The area near Rosecrans Avenue and Pine Avenue	Manhattan Beach	PR5	60
The area near Washington Park	El Segundo	PR6	61
The area near Sycamore Park	El Segundo	PR7	62
The area near Storm Drain Plant No. 17	El Segundo	PR8	59
The area near Holly Glenn Park	Hawthorne	PR9	40

Although the hydraulic model indicates these areas having pressures less than 65 psi during maximum month demand conditions, West Basin does not report any customer complaints. It is therefore not recommended to take any action to increase the pressures in these areas.

Velocities in the distribution system are generally within the range of the criteria specified in Chapter 5. The one exception to this is the 6-inch diameter lateral in Western Avenue south of 120th Street, feeding Chester Washington Golf Course in the incorporated Los Angeles County area east of Hawthorne. This pipeline is indicated on Figure 7.1. The model estimates velocities of up to 25 fps with peak flows at about 2,200 gpm (maximum month, peak hour). During the calibration period (October 2008), peak flows were measured up to 1,860 gpm. The calibration period demands are estimated to be slightly lower than the peak month demands. Therefore, it does not seem unreasonable that the actual peak flows could reach 2,200 gpm as simulated by the model. The diurnal curve developed for the golf course includes a peaking factor of nearly 5.8 for a period of 2-1/2 hours. It is recommended that West Basin review the existing golf course irrigation schedule with the customer to reduce their daily peak demands to a more reasonable level. This will reduce the stress on West Basin’s overall system and will extend the useful life of the 6-inch diameter lateral on Western Avenue.

In addition to these low pressure areas and the high velocity pipeline, there are three primary problems with the existing Title 22 system. These are:

- Pressure Surges
- Title 22 Pump Station Operation
- Water Quality

These three key issues are detailed below.

Pressure Surges

Surge pressures are experienced throughout the system and throughout the day. The surge pressures occur due to sudden changes in flows at the Carson Regional Water Recycling Facility (CRWRF), and the ExxonMobil Water Recycling Facility (EMWRF) during the microfiltration (MF) backwash cycles. Hydraulic transient analysis of the Title 22 system has been conducted independently of this study. However, the field pressure measurements at 5-minute increments indicated pressure variations of over 70 psi throughout the day. While these may be acceptable for ductile iron and steel pipe, the system includes a significant amount of PVC pipe, which is likely to experience fatigue failure due to frequent pressure variations. Therefore, it is essential that a proper method of surge control be implemented.

The Siemens continuous microfiltration (CMF) systems currently used at both the EMWRF and CRWRF are identical systems, which utilize compressed air backwash. It is important to understand that the MF units at both plants operate off the existing Title 22 Distribution line pressure, albeit reduced by pressure regulators at each site. No MF feed pumps are needed with this design and the MF units are hydraulically connected to the Title 22 distribution system.

A discussion of the CMF backwash process is useful to understand the causes of the pressure surges that are observed. Figure 7.2 shows the CMF unit schematic during normal filtration mode. The CMF units backwash on a 20-minute frequency interval at EMWRF and 30-minute interval at CRWRF. The entire backwash cycle takes approximately 2.5 to 3 minutes. Systems are controlled so that only one unit can backwash at once.

During normal filtration, unit feed valves are open, feedwater passes through the fibers and filtrate exits through another valve. During the next step, the feed valves are quickly closed (within seconds) as shown on Figure 7.3.

Figure 7.2
Normal Filtration Mode

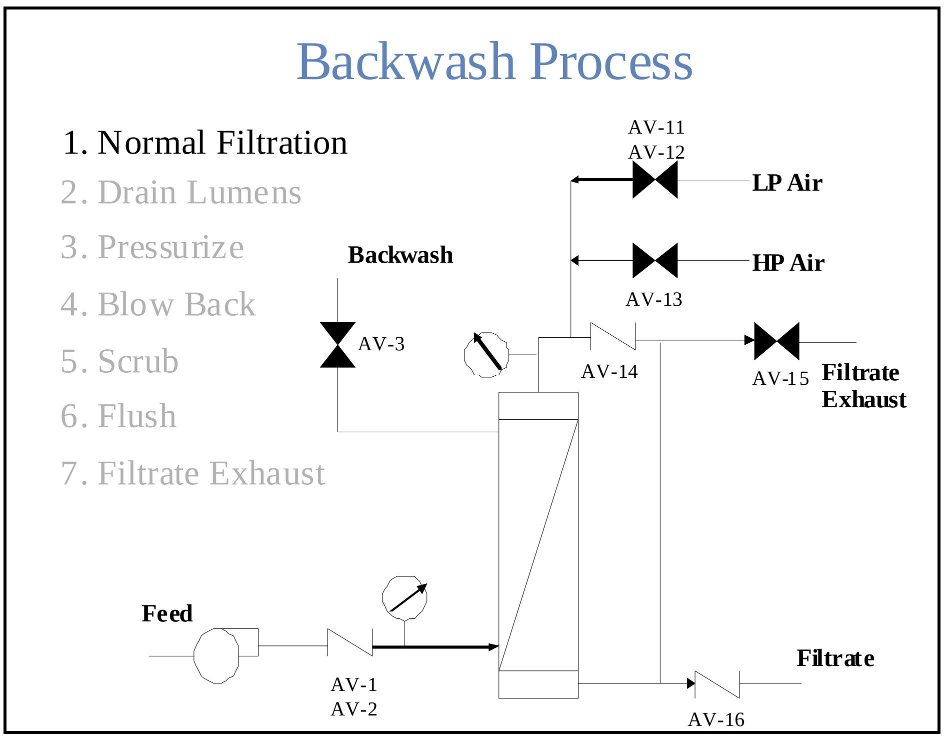
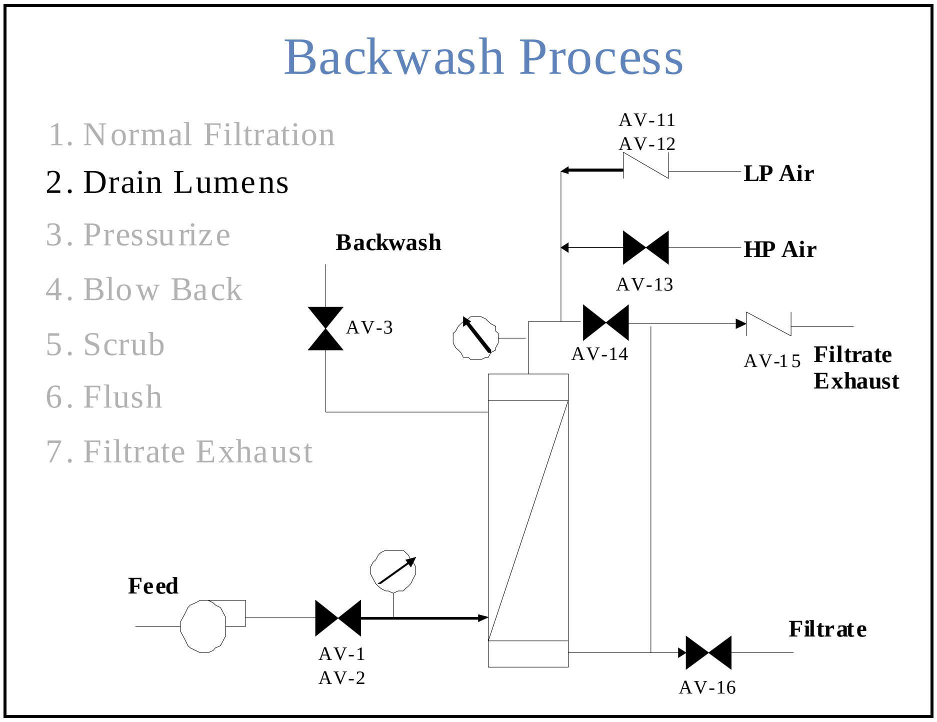


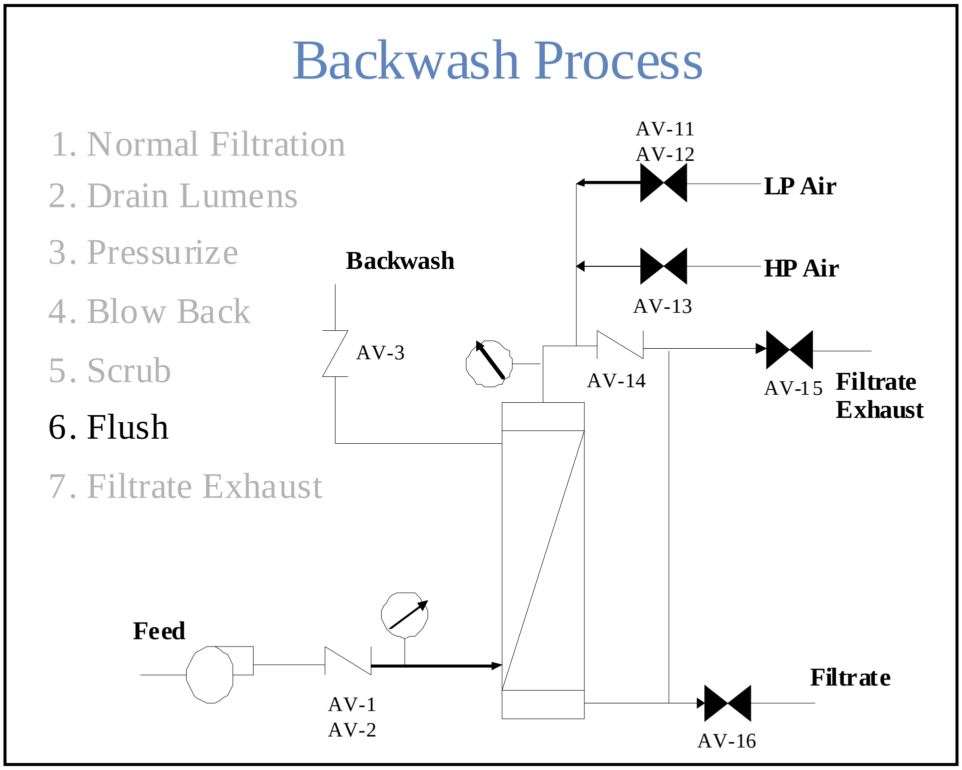
Figure 7.3
Closing of MF Feed Valves



An individual MF unit (of which there are six at EMWRF and nine at CRWRF) treats approximately 500 to 600 gpm of feedwater. The result of the feed valves closing quickly is that flow to the MF units is quickly reduced from approximately 3,000 gpm at EMWRF to 2,500 gpm. At CRWRF, the typical flow rate drops from 4,500 gpm to 4,000 gpm with in a few seconds. As these flows are quickly reduced, the change in momentum of the water in the feed line to the MF units creates pressure waves (surges), which propagate upstream into the Title 22 system.

Additional steps occur in the CMF backwash process, including lumen pressurization and pressure release. However, these steps do not create additional pressure surge problems. After the membrane fibers have been pressurized and depressurized, the solids that have been released from the fibers are removed from the fiber bundle in a flush or sweep flow step. In this step, feedwater is introduced into the shell side of the fiber bundle at 1.5 times normal filtration feed flow by once again quickly opening the feed valves, as shown on Figure 7.4.

Figure 7.4
Flush Step



Solids are carried out of the unit through the backwash valve AV-3. Since the resistance to flow through the shell side of the MF module is significantly less than that through the membrane, the flow rate during the flush or sweep step is significantly higher (1.5 times) than during normal filtration. For example, recent backwash snapshots at the CRWRF show sweep flows ranging from 900 to 2,500 gpm. The typical value is 1,500 gpm. As the feed valves open to provide this sweep flow, the water flow can quickly increase from the reduced level of 2,500 and 4,000 gpm for EMWRF and CRWRF respectively, to 4,000 gpm and 6,000 gpm, respectively. This dramatic and rapid increase in flow to the MF units can result in rapid reduction in pressure, which again can propagate through the Title 22 system.

Rapid changes in flows were captured in the data generated during the monitoring portion of the hydraulic modeling effort. Figure 7.5 and Figure 7.6 show the flows measured at EMWRF and CRWRF, respectively. Note that at each site, there are normally 432 individual MF backwash events occurring over any 24-hour period.

Figure 7.5
Flows Measured at EMWRF

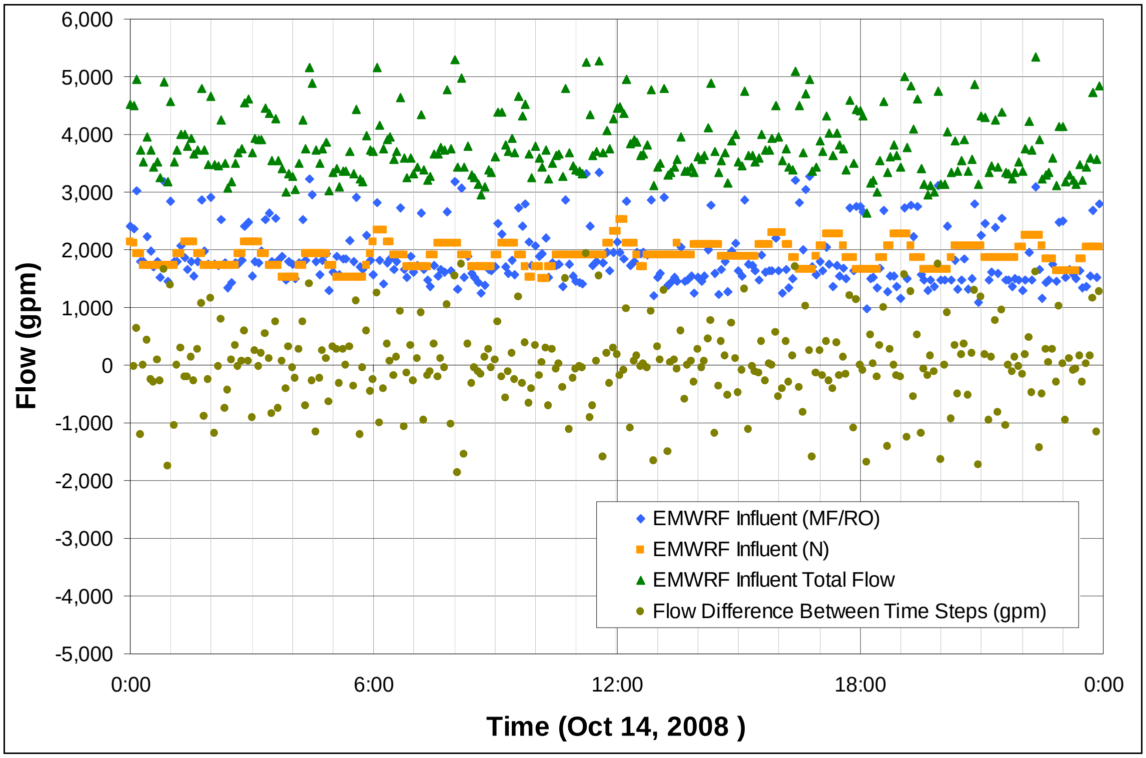
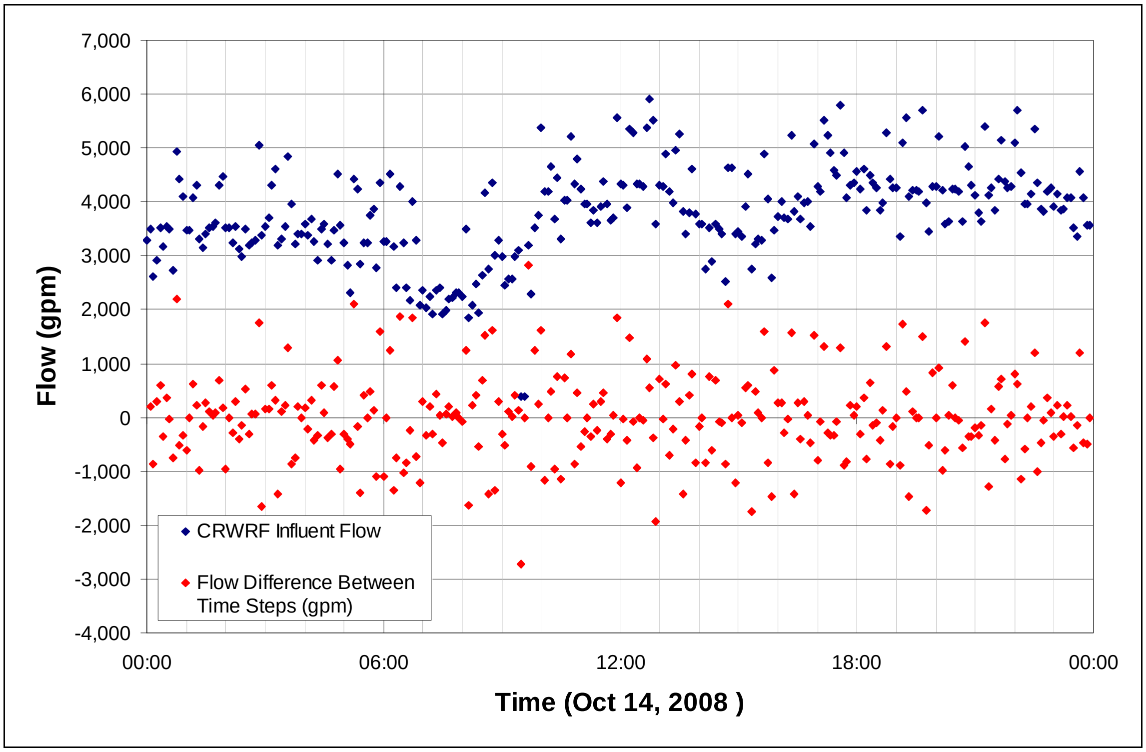


Figure 7.6
Flows Measured at CRWRF



These figures show the flow rates measured at 5-minute intervals over a 24-hour period on October 14, 2008. For EMWRF, the flows shown are total influent as well as influent to both the MF units and nitrification system. Also shown is the change in MF feed flow (Delta) observed between two successive data points. Negative Delta's indicate that the flow decreased from the previous data point, which can represent a unit that goes into backwash between data points. A positive Delta indicates an increase in flow from previous data point that can capture the increase in flow during the MF "Flush" portion of the backwash process. As shown on Figure 7.5, the change in flow at EMWRF ranges from -2,000 to +2,000 gpm in a 5-minute interval. Figure 7.6 shows that this range is even greater at CRWRF with a change in flows from -3,000 to +3,000 gpm. In order to fully analyze the pressure swings this change in flow causes, continuous pressure sampling would be required.

The results captured on Figure 7.5 and Figure 7.6 show, as expected, significant changes in flow. Decreases correspond to the initiation of the backwash process as well as the increases related to the membrane flush flows. These rapid changes in MF feed flow appear to be capable of producing the pressure surges observed in the Title 22 system. The magnitude of the changes in flow observed are consistent with the expected changes in flow understood to be occurring during the CMF backwash cycles. A further example of this is shown on Figure 7.7, which is obtained from the CRWRF flow and pressure data available on a finer time scale than what was recorded during the flow modeling data capture period.

Figure 7.7
Carson Feed Water Flow and Pressure during Backwash Cycle

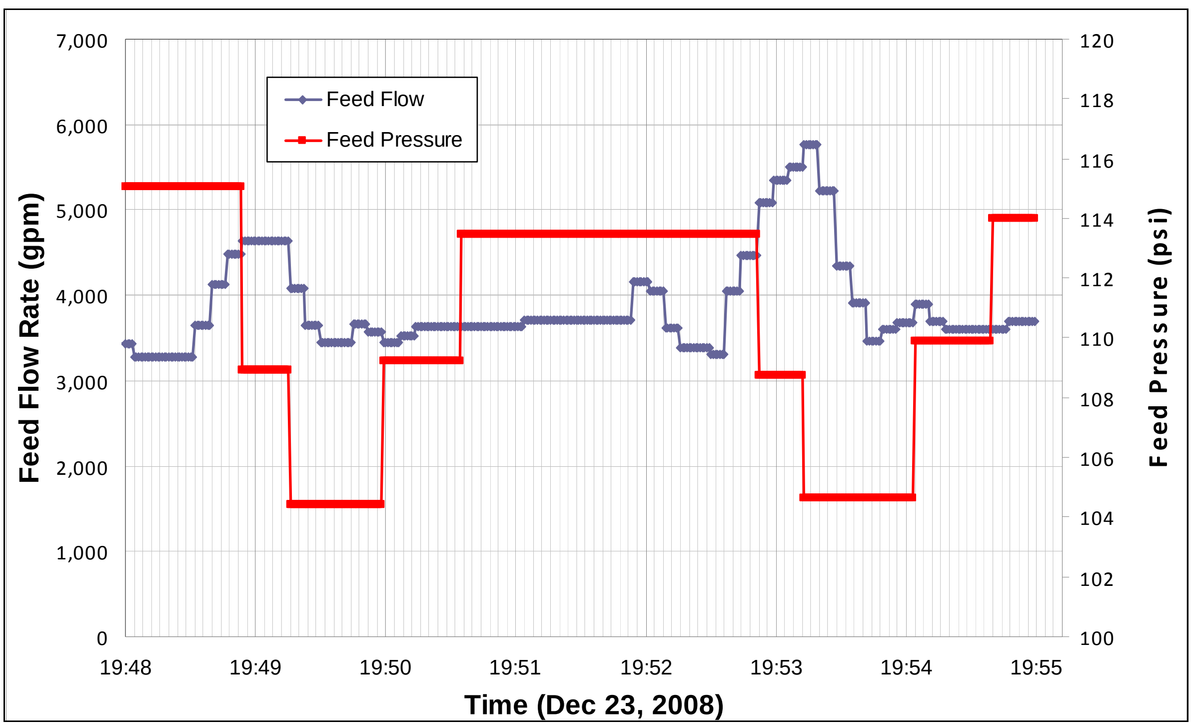


Figure 7.7 shows total feed to the MF system and pressure during a flush and subsequent membrane rewet cycle. As flows to the unit undergoing backwash increases, feed pressure to all units drop.

There appear to be several options for reducing the magnitude of the observed pressure surges. These include:

- Continued investigation of the existing surge tanks to verify and improve performance.
- Reducing valve closing and opening speed during the microfiltration backwash cycle. It was suggested that it may be possible to reduce the speed at which the feed valves close during initiation of backwash cycle as well as how quickly they open during the flush step in the backwash cycle. This is a relatively insignificant fix in terms of capital expense. These changes would need to be tested to ascertain that no negative impacts are introduced in the backwash efficiency as well as overall MF recovery. (Further investigation and West Basin staff indicated that this option had been discussed with the manufacturer and that it was not recommended due to reductions in backwash efficiency.)

Because simple adjustment of the backwash valve opening sequence is likely not feasible, additional options can be considered. These include:

- Construction of a dedicated flush line so that flush water is supplied by a dedicated tank and pump system. This would isolate the flush demand from the Title 22 supply. This would involve an additional tank, pumps, piping, valves and controls at both the CRWRF and EMWRF.
- Construction of break tank and feed pumps to physically isolate the MF units from the Title 22 system. This would result in additional capital expense as well as operating expense in that the available head from the Title 22 line pressure would be lost unless energy recovery were incorporated as is done at the Chevron Nitrification Facility where a hydraulic turbine recovers the energy provided by the Title 22 line pressure.
- Replacement of the CMF units at EMWRF and CRWRF using technology that does not induce pressure surges such as submerged membrane systems or pressure units that don't operate with a feed shell sweep sequence.

A detailed study of the various methods should be conducted in selecting the most feasible method during the design of the improvements to the CRWRF and the EMWRF. For planning purposes, it is assumed that the second-most expensive of these options is selected, adding break tanks and pumps to isolate the MF units from the Title 22 system.

Operation of the Title 22 Pump Station

Currently, each Title 22 product storage tank has four pumps. Two of these pumps are variable frequency drive operated with rated capacities of 4,500 gpm, and reported total dynamic head of 280 feet. The other two pumps are constant speed equipment with rated capacities of 8,000 gpm and similar total dynamic head. According to the record information, the shut-off head of the constant speed pumps (458 feet) are significantly greater than that of the variable speed pumps (387 feet). Field testing conducted during this study verified the shut-off head of the constant speed pumps. Only the shut-off head of one variable speed pump could be measured at Tank 1, which was 361 feet. This is 26 feet lower than the shut-off head indicated on the certified pump curve. At low demands, the variable speed pumps are operated at speeds that can be adjusted to deliver similar flow rates. At higher demand periods, one constant speed pump is operated with one variable speed pump on automatic control, and one variable speed pump on manual control. Review of the DCS data during the calibration period indicated one constant speed pump operating with one variable speed pump at each tank nearly the entire time. During this time, it was observed that the variable speed pumps quite often operate to the left of the preferred operating range, sometimes near the shut-off conditions. This will likely result in frequent physical pump failure.

The operation of the Title 22 pumping system should be studied in detail based upon the annual, seasonal, and daily variation in demands, following the formulation of a solution to the surge problem. The study should develop an efficient pumping system that allows operation of the pumps within the preferred operating ranges.

Water Quality

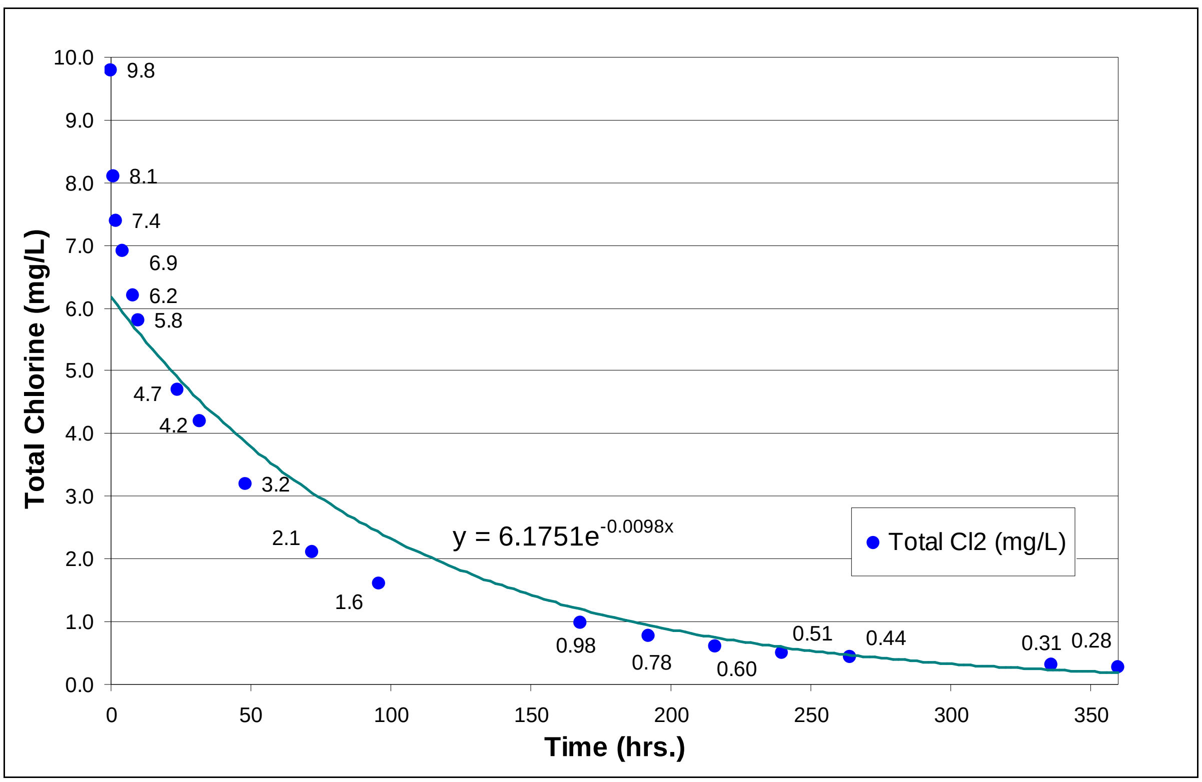
Water treated at ELWRF is disinfected with chlorine prior to distribution. In addition, there are two existing disinfection stations that add chlorine as needed. Operational logs for the two disinfection stations indicated a target chlorine residual level of about 3.0 mg/L at the station when stations were functional. These locations are depicted on Figure 7.9. However, as water travels through the distribution system, the chlorine is consumed and residual levels are reduced to nearly zero in the extreme location (dead-end) of the distribution system. Water age and biological growth, in particular nitrification, are two key factors in chlorine decay.

Water samples were collected at the 10 sites listed in Table 7.5 and tested for total chlorine.

Figure 7.8 depicts the chlorine decay measured in the Title 22 filter effluent at the bench scale in laboratory conditions. Figure 7.9 shows the water age during maximum month demand conditions.

Table 7.5	Title 22 Water Quality Calibration Locations Capital Implementation Master Plan West Basin Municipal Water District		
Site Number	**Location**	**Sampled Residual (mg/L)**	**Distance to Nearest Disinfection Station (mi)**
1B	Anschutz So Cal Sports (Home Depot)	0.04	3.7
9B	So. Cal Edison - El Segundo Generation Station	0.03	5.3
11B	Inglewood Park Cemetery	0.02	0.5
17	Toyota Motor Sales	0.08	0.9
18B	Chester Washington Golf Course	0.04	3.8
21	Loyola Marymount University	0.01	3.8
24	S/E corner Queen Ave. @ Eucalyptus	0.02	0.4
27	S/W corner Prairie Ave. @ 154th St.	0.06	3.0
29	On Greenbelt - Valley Dr @ 21st St.	0.96	3.8
30	17201 Figueroa St. (On Figueroa south of 168th St.)	0.59	3.2

Figure 7.8
Chlorine Residual Decay in Title 22 Effluent
(Bench Scale Results)



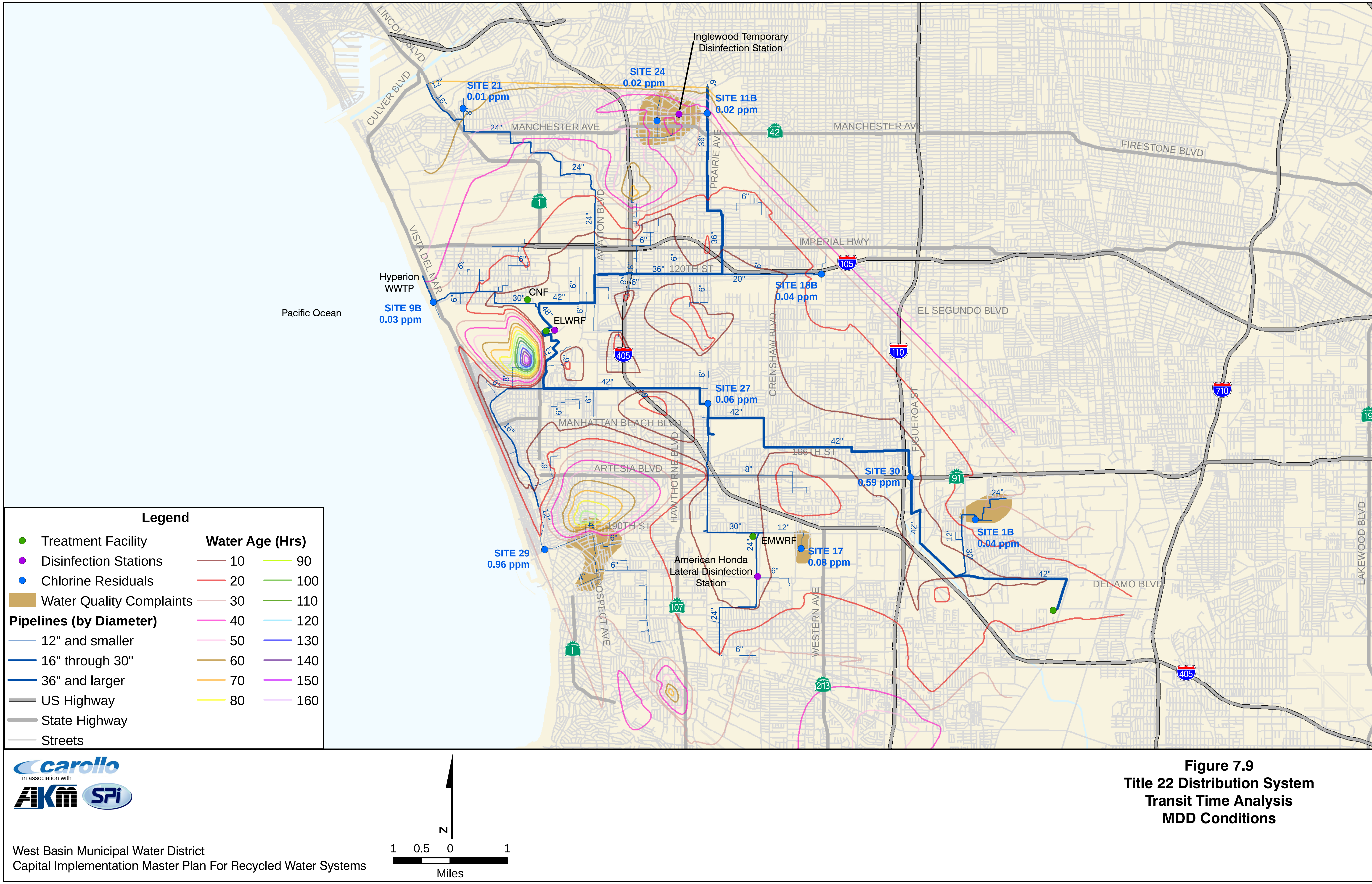


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Figure 7.9
Title 22 Distribution System
Transit Time Analysis
MDD Conditions

West Basin Municipal Water District
Capital Implementation Master Plan For Recycled Water Systems

As shown in Table 7.5, the initial chlorine concentration of 10 mg/L in the filter effluent decreases rapidly to 3 mg/L after 50 hours. It should be noted that the decay in the distribution pipelines is expected to occur even faster as the decay curve presented in Figure 7.9 represents a laboratory test rather than an actual pipeline with the potential of established biological growth, which will accelerate decay, sometimes in a non-linear way.

It is evident from the sample results shown in Table 7.5 that there is significant chlorine decay and residual loss in the system, indicating possible growth and nitrification in the distribution system pipes. Sample results for all locations indicated chlorine residuals below the minimum analysis criteria of 1.0 mg/L. While chlorine booster facilities may alleviate this problem, it is first recommended that West Basin initiate a pipe cleaning test program and assess its effectiveness in improving water quality and maintaining chlorine residuals. One possible method is to install pig launching and retrieval facilities in a section of the system and test it. Chlorine booster stations can then be added to evaluate the combined effectiveness. For conservative planning purposes, five chlorine booster stations are included in the CIP.

As mentioned in Chapter 2, the disinfection stations provide effective means of mitigating chlorine loss issues. However, the ability to maintain effective chlorine residual and water quality depends on consistent usage of recycled water to limit water age, hydraulic optimization of the system, as well as management of biogrowth in pipelines.

7.1.3 West Coast Barrier Water System

7.1.3.1 Criteria

The general analysis criteria used to evaluate the West Coast Barrier Water System includes the following:

- Maximum headloss of 10 feet for each 1,000 feet of pipe length
- Maximum velocity of 7 fps

Analysis criteria specific to the West Coast Barrier Water System includes:

- Adequate pressure at the Blend Station, approximately 78 psi
- Ability to deliver the maximum daily flow of 12.5 mgd with firm pumping capacity.
- Ability to deliver potable MWD water from the Blend Station to the RO Units when the Phase III Microfiltration units are out of service, and to the Title 22 System during an outage of the Title 22 Treatment System

These criteria were used to evaluate the existing West Coast Barrier Water System under existing demand conditions.

7.1.3.2 Analysis Conditions

The West Coast Barrier Water System consists of the Barrier Product Water Pump Station and the 30-inch diameter cement mortar lined and coated (CMLC) transmission main that conveys Barrier Water from ELWRF to the Barrier Blend Station, located north of the treatment facility on El Segundo Boulevard west of Nash Street in the City of El Segundo. The transmission main is approximately 4,720 feet in length.

The Barrier Product Water Pump Station was upgraded during the ELWRF Phase IV expansion by adding two 3,500-gpm pumps to the existing five pumps (with 10,500 gpm of firm capacity) to deliver up to 12.5 mgd of Barrier Water. During the 2007-2008 Fiscal Year, West Basin delivered a total of 11,129 acre-feet (af) of Barrier Water for injection into the West Coast Barrier. Currently, a control valve on the discharge pipe of the pump station maintains an approximate pressure of 73 psi on the downstream side of the valve. The existing system analysis was conducted with various pump flows, including the existing maximum demand of 12.5 mgd at this valve setting.

Table 7.6 shows the average annual flows, as well as the maximum month and minimum month demands.

Table 7.6 West Coast Barrier Water System Demands
Capital Implementation Master Plan
West Basin Municipal Water District

Condition	Average Annual	Average Daily	Average Instantaneous
Average Annual Demand(1)	11,000 afy	9.82 mgd	6,820 gpm
Maximum Month Demand(2)	N/A	11.30 mgd	7,846 gpm
Minimum Month Demand(3)	N/A	8.92 mgd	6,197 gpm
Design Demand	N/A	12.50 mgd	8,681 gpm

Notes:
(1) Calculated from historical billing records as detailed in Chapter 3.
(2) Maximum month demand (July) from the 2007-2008 flow records.
(3) Minimum month demand (February) from the 2007-2008 flow records.

The average, maximum and minimum flows recorded during the calibration period (6,595 gpm, 7,389 gpm, and 5,826 gpm) were verified and found to be similar to the average annual, maximum month, and minimum month values from the historical customer data.

7.1.3.3 Analysis Results

The results from the analyses performed for each of the demand conditions described in Table 7.6 are presented in Table 7.7.

Table 7.7 West Coast Barrier Water System Analyses
Capital Implementation Master Plan
West Basin Municipal Water District

Condition	Total Maximum Headloss(1)	Average Unit Headloss (ft/1,000 ft)	Pressure at Flow Control Valve	Velocity	Maximum Travel Time(2) (Water Age)
Average Day Demand(3)	4.2 ft	0.9 ft	73.0 psi	3.10 fps	25.4 min
Maximum Month Demand(4)	5.5 ft	1.2 ft	73.0 psi	3.56 fps	22.1 min
Minimum Month Demand(5)	3.5 ft	0.8 ft	73.0 psi	2.81 fps	28.0 min
Design Demand	6.6 ft	1.4 ft	73.0 psi	3.94 fps	20.0 min

Notes:
(1) Maximum headloss predicted by model over 24-hour simulation period.
(2) Based on length = 4,720 feet.
(3) Pump 3 and Pump 5 on.
(4) Pump 2, Pump 3, and Pump 5 on.
(5) Pump 3 and Pump 5 on.

As shown in Table 7.7, the velocities in the pipeline vary from 2.8 fps with the minimum month flows to 3.9 fps with the current design flows. These are well below the maximum desired velocity of 7 fps. The head losses are well within acceptable limits with the average unit head loss ranging from 0.8 to 1.4 feet per 1,000 feet of pipe.

The existing pump station has the firm capacity (13.5 mgd) to deliver 12.5 mgd to the West Coast Barrier System with a pump station discharge pressure of 98 psi. However, there is a significant loss of pressure at the control valve, where the pump station discharge pressure is reduced from approximately 98 psi to 73 psi. At the average flow of 6,700 gpm, this is a loss of approximately 638,000 kilowatt-hours per year. Assuming an average unit power cost of $0.10 per kilowatt-hour, this would equate to a financial cost of approximately $63,800 per year. It is recommended that the operational condition of the pump station be evaluated through a detailed study, and that a more efficient method of operation be developed to accommodate the ultimate demand (15.2 mgd) of the system in a cost effective manner. This may consist of replacing the existing pumps with lower head pumps, adding variable frequency drives to the existing pumps, or replacing the existing pumps with lower head pumps and adding variable frequency drives. Further evaluation of a revised method of operation should be conducted during the Phase V expansion.

7.1.4 Chevron High Pressure Boiler Feed System

7.1.4.1 Criteria

The general analysis criteria used to evaluate the Chevron High Pressure Boiler Feed (HPBF) System includes the following:

- Maximum headloss of 10 feet for each 1,000 feet of pipe length.
- Velocities of 1 to 3 fps under normal operations, with maximum velocities of 7 fps.
- Firm capacity at HPBF pump station should meet peak demands.

These criteria were used to evaluate the existing Chevron High Pressure Boiler Feed System under existing demand conditions.

7.1.4.2 Analysis Conditions

The Chevron High Pressure Boiler Feed System consists of the booster pump station and the 12-inch diameter HDPE and 16-inch diameter PVC transmission main that conveys Ultra Pure RO water to the Chevron El Segundo Refinery on-site High Pressure Boiler Feed Storage Tank. The transmission main is approximately 2 miles, or 10,030 feet, in length.

Under existing conditions, the Chevron High Pressure Boiler Feed system supplies 2.50 mgd of Industrial RO Ultra water to the Chevron El Segundo Refinery on an average annual basis. This average annual demand was established from historical billing records. Maximum month demands are calculated using the maximum monthly peaking factor of 1.1. As detailed in Table 7.8, the analyses were conducted during the average, maximum, and minimum demand conditions of 1,735 gpm, 1,882 gpm, and 1,590 gpm, respectively.

Table 7.8 Chevron High Pressure Boiler Feed System Demands
Capital Implementation Master Plan
West Basin Municipal Water District

Condition	Average Annual	Average Daily	Average Instantaneous
Average Annual Demand(1)	2,800 afy	2.50 mgd	1,735 gpm
Maximum Month Demand(2)	N/A	2.71 mgd	1,882 gpm
Minimum Month Demand(3)	N/A	2.29 mgd	1,590 gpm

Notes:
(1) Calculated from historical billing records as detailed in Chapter 3.
(2) Calculated by applying a seasonal peaking factor of 1.1 to the average annual demand, based on historical billing records and discussions with District staff.
(3) Minimum month demand from 2007-2008 billing records.

This analysis was conducted utilizing the aforementioned flow conditions, assuming a constant demand pattern.

7.1.4.3 Analysis Results

Table 7.9 presents model results for the analysis conducted under each of the demand conditions listed in Table 7.8.

Table 7.9 Chevron High Pressure Boiler Feed System Analyses
Capital Implementation Master Plan
West Basin Municipal Water District

Condition	Total Headloss[(1)]	Average Unit Headloss (ft/1,000 ft)	Pressure at Delivery Point	Velocity in 10" Pipe	Velocity in 12" Pipe	Maximum Travel Time[(2)] (Water Age)
Average Day Demand	27.8 ft	4.3 ft	17.3 psi[(3)]	4.9 fps	2.8 fps	1.0 hrs
Maximum Month Demand	32.3 ft	5.0 ft	16.3 psi[(4)]	5.3 fps	3.0 fps	0.9 hrs
Minimum Day Demand	23.6 ft	3.7 ft	20.1 psi[(5)]	4.5 fps	2.5 fps	1.0 hrs

Notes:
(1) Maximum headloss predicted by model over 24-hour simulation period.
(2) Based on length = 10,030 feet.
(3) One pump running at 81 percent speed to maintain 34 psi discharge pressure at pump station.
(4) One pump running at 84 percent speed to maintain 34 psi discharge pressure at pump station.
(5) One pump running at 79 percent speed to maintain 34-psi discharge pressure at pump station.

As shown in Table 7.9, the average unit headloss per 1,000 feet of pipe ranged from 3.7 feet to 5.0 feet, well below the analysis criteria of 10 feet per 1,000 feet. The maximum velocity ranged from 4.5 fps to 5.3 fps. Although the velocities are slightly higher than 3 fps under minimum and average day demand conditions, the velocities are not extreme and no recommendations are made at this time for increasing pipeline sizes.

Pressure at the point of delivery is dictated by the pressure at the discharge side of the HPBF pump station, which is currently maintained at 34 psi.

With one pump on stand-by, the firm capacity of the pump station is 1,800 gpm or 2.59 mgd. This is the design capacity of one pump. Although this firm capacity is less than the maximum demand of 2.71 mgd, analysis of the pump curve indicates that the pump can still provide this demand within its normal operating range. The difference between the existing maximum day demand and maximum month demand can be made up from storage at the Chevron El Segundo Refinery

Based on the above analyses, it is shown that the existing pipeline and pump station has sufficient capacity for the existing demand conditions evaluated.

7.1.5 Chevron Low Pressure Boiler Feed System

7.1.5.1 Criteria

The general analysis criteria used to evaluate the Chevron Low Pressure Boiler Feed (LPBF) System includes the following:

- Maximum headloss of 10 feet for each 1,000 feet of pipe length.
- Velocities of 1 to 3 fps under normal operations, with maximum velocities of 7 fps.
- Firm capacity at LPBF Pump Station should meet the maximum day demands.

These criteria were used to evaluate the Chevron Low Pressure Boiler Feed System under existing demand conditions.

7.1.5.2 Analysis Conditions

The Chevron Low Pressure Boiler Feed System consists of the booster pump station and the 10-inch diameter high-density polyethylene (HDPE) and 12-inch diameter PVC transmission main that conveys Pure RO water to the Chevron El Segundo Refinery on-site Low Pressure Boiler Feed Storage Tank. The transmission main is approximately 2 miles, or 10,400 feet, in length.

Under existing conditions, the Chevron Low Pressure Boiler Feed System supplies 0.98 mgd of Pure RO water to the Chevron El Segundo Refinery on an average annual basis. This average annual demand was established from historical billing records. Maximum month demands are calculated using the maximum monthly peaking factor of 1.5. Table 7.10 details the existing flow conditions for the Chevron Low Pressure Boiler Feed System.

Table 7.10 Chevron Low Pressure Boiler Feed System Demands
Capital Implementation Master Plan
West Basin Municipal Water District

Condition	Average Annual	Average Daily	Average Instantaneous
Average Annual Demand(1)	1,100 afy	0.98 mgd	681 gpm
Maximum Month Demand(2)	N/A	1.46 mgd	1,014 gpm
Minimum Month Demand(3)	N/A	0.39 mgd	274 gpm

Notes:
(1) Calculated from historical billing records as detailed in Chapter 3.
(2) Calculated by applying a seasonal peaking factor of 1.5 to the average annual demand, based on historical billing records and discussions with West Basin staff.
(3) Minimum month demand from 2007-2008 billing records.

This analysis was conducted utilizing the aforementioned flow conditions, assuming a constant daily demand pattern.

7.1.5.3 Analysis Results

Table 7.2 presents model results for the analysis conducted under each of the demand conditions listed in Table 7.11.

Table 7.11 Chevron Low Pressure Boiler Feed System Analyses
Capital Implementation Master Plan
West Basin Municipal Water District

Condition	Total Headloss(1)	Average Unit Headloss (ft/1,000 ft)	Pressure at Delivery Point	Velocity in 10" Pipe	Velocity in 12" Pipe	Maximum Travel Time(2) (Water Age)
Average Day Demand	18.1 ft	2.5 ft	20.2 psi(3)	2.8 fps	1.9 fps	1.4 hrs
Maximum Month Demand	37.8 ft	5.1 ft	11.6 psi(4)	4.1 fps	2.9 fps	1.0 hrs
Minimum Month Demand	3.3 ft	0.5 ft	27.1 psi(5)	1.1 fps	0.8 fps	3.6 hrs

Notes:
(1) Maximum headloss predicted by model over 24-hour simulation period.
(2) Based on length = 10,400 feet.
(3) One pump running at 77 percent speed and one pump running at 53 percent speed to maintain 34 psi discharge pressure at pump station.
(4) One pump running at 90 percent speed and one pump running at 60 percent speed to maintain 34 psi discharge pressure at pump station.
(5) One pump running at 60 percent speed to maintain 34 psi discharge pressure at pump station.

As shown in Table 7.11, the average unit headloss per 1,000 feet of pipe ranged from 0.5 feet to 2.5 feet, well below the analysis criteria of 10 feet per 1,000 feet. The maximum velocity ranged from 1.1 fps to 4.1 fps, which is also within the range of analysis criteria of 7 fps.

Pressure at the point of delivery is dictated by the pressure on the discharge side of the LPBF pump station, which is currently maintained at 34 psi.

With one pump on stand-by, the firm capacity of the pump station is 1,200 gpm or 1.73 mgd. This is also sufficient to meet the maximum day demand of 1.67 mgd.

Based on the above analyses, it is shown that the existing pipeline and pump station have sufficient capacity for the existing demand conditions evaluated.

7.1.6 Chevron Nitrified Water System

7.1.6.1 Criteria

The general analysis criteria used to evaluate the Chevron Nitrified Water System includes the following:

- Maximum headloss of 10 feet for each 1,000 feet of pipe length.
- Velocities of 1 to 3 fps under normal operations, with maximum velocities of 7 fps.

Analysis criteria specific to the Chevron Nitrified Water System includes:

- Adequate pressure at the Chevron Refinery for the cooling towers, of at least 80 psi.
- Ability to deliver potable water from the City of El Segundo's water system when Title 22 water is not available.
- Sufficient firm pumping capacity to deliver the existing maximum demands. Currently, the pump station is operated in the remote automatic mode with the variable speed high service pump adjusting speed to maintain a pre-set pressure. If the variable speed pump cannot maintain the pressure without dropping below 90 percent of full speed, one constant speed pump is started so that the two pumps maintain the set pressure.

These criteria were used to evaluate the existing Chevron Nitrified Water System under existing demand conditions.

7.1.6.2 Analysis Conditions

The Chevron Nitrified Water System consists of the following:

- An 80-foot diameter, 24-foot high, product water storage tank operated between a high level of 17.5 feet and a low level of 2.0 feet
- Nitrified Water Pump Station with one variable speed and two constant speed pumps, which are referred to as the High Service Pumps
- A surge tank on the discharge side of the pump station
- Approximately 2,970 feet of 20-inch diameter discharge pipe that extends to the Chevron El Segundo Refinery (El Segundo Boulevard and Lomita Street). The water is then supplied to the cooling towers.
- Estimated delivery point elevation of 143 feet.

Under existing conditions, the Chevron Nitrified Water System provides 3.12 mgd of nitrified water to cooling towers at the Chevron El Segundo Refinery. On an average annual basis, the maximum month demand of 4.19 mgd is obtained from West Basin's monthly billing records for March 2008.

As detailed in Table 7.12, the analyses were conducted with the average annual demands, as well as the maximum month and minimum month demands.

Table 7.12 Chevron Nitrified Water System Demands
Capital Implementation Master Plan
West Basin Municipal Water District

Condition	Average Annual	Average Daily	Average Instantaneous
Average Annual Demand(1)	3,500 afy	3.12 mgd	2,170 gpm
Maximum Month Demand(2)	N/A	4.19 mgd	2,912 gpm
Minimum Month Demand(3)	N/A	2.33 mgd	1,617 gpm
Instantaneous Maximum Demand(4)	N/A	5.40 mgd	3,754 gpm

Notes:
(1) Calculated from historical billing records as detailed in Chapter 3.
(2) Historical maximum month demand (March 2008) from billing records.
(3) Minimum monthly demand (February) from the 2007-2008 flow records.
(4) Instantaneous maximum demand from the calibration period records

Analyses were conducted with the average day, maximum month, and minimum month demands under the normal operating conditions and with the one constant speed pump out of service.

7.1.6.3 Analysis Results

The results of analyses for each of the demand conditions described in Table 7.12 are presented below in Table 7.13.

Table 7.13 Chevron Nitrified Water System Analyses
Capital Implementation Master Plan
West Basin Municipal Water District

Condition	Total Headloss	Average Unit Headloss (ft/1,000 ft)	Average Pressure at Delivery Point	Velocity	Maximum Travel Time(2) (Water Age)
Average Day Demand	2.3 ft	0.8 ft	74.6 psi	2.2 fps	22.5 min
Maximum Month Demand	4.0 ft	1.4 ft	73.8 psi	3.0 fps	16.5 min
Minimum Month Demand	1.3 ft	0.5 ft	75.8 psi	1.7 fps	29.1 min

As shown in Table 7.13, the velocities in the pipeline vary from 1.7 fps with the minimum month flows to 3.0 fps with the maximum month flows. These are well below the analysis criteria of 7 fps. The unit head loss per 1,000 feet of pipe ranged from 1.3 feet to 4.0 feet, which are also well within the analysis criteria of 10 feet per 1,000 feet.

The existing pump station has a total capacity of 4,300 gpm, and thus, can deliver the maximum month demand of 2,912 gpm. However, its firm capacity of 2,200 gpm is lower than the maximum month demand instantaneous maximum flows of up to 3,754 gpm observed during the calibration period. The existing pump station can provide the 80-psi pressure desired by Chevron at the entrance to the refinery when all three pumps operate with the maximum month demand. A detailed analysis of this pump station should be conducted to determine the most feasible means to provide the firm capacity, taking into account the potential increase in nitrified water demand.

The Chevron El Segundo Refinery cooling towers have back-up connections to the City of El Segundo's domestic water system. Therefore, additional storage or a new potable water connection to the nitrified water storage tank is not needed.

7.1.7 ELWRF Brine Line

7.1.7.1 Criteria

Analysis criteria for the ELWRF Brine Line consists the following:

- Maximum pipeline velocity of 10 fps

7.1.7.2 Analysis Conditions

The ELWRF Brine Line consists of an 18-inch diameter HDPE pipe that extends approximately 3.0 miles north and west from ELWRF, conveying concentrate from the ELWRF reverse osmosis trains to the HWWTP in El Segundo. The brine line discharges to the Hyperion Ocean Outfall.

Under existing conditions, the ELWRF brine line operates off the RO concentrate pressure, which averages approximately 22 psi at the plant. The existing average brine flow is 980 gpm. During the calibration data collection period, brine flows averaged 971 gpm, with a maximum flow of 1,261 gpm, and minimum flow of 530 gpm. The analysis was conducted with the average flow of 971 gpm, the flow patterns from the SCADA/DCS, and the pressure recordings at the plant, as shown in Table 7.14.

Table 7.14 ELWRF Brine System Flows
Capital Implementation Master Plan
West Basin Municipal Water District

Flow Type	Average Annual	Average Daily	Average Instantaneous
Average Flow	N/A	1.40 mgd	971 gpm
Maximum Instantaneous Flow	N/A	N/A	1,261 gpm
Minimum Instantaneous Flow	N/A	N/A	530 gpm

The brine line starts as a short section of 12-inch diameter pipeline constructed of HDPE, and increases to 18-inch diameter SDR 17 HDPE. Below elevation 83 feet, the pipe changes to SDR 15.5, and below elevation 58 feet, it changes to SDR 13.5. The pipeline has several high and low points along its alignment, which result in sections of the pipe flowing with a free surface. To accurately model the system, the Water Surface and Pressure Gradients (WSPG) computer program developed by the Los Angeles County Department of Public Works was utilized. The brine line terminates at the Hyperion Ocean Outfall through a manifold with six connections. The HWWTP staff indicated that the brine system and the Outfall are at atmospheric pressure.

7.1.8.3 Analysis Results

The average velocity within the sections of the pipe under full flow is 1.57 fps. The minimum and maximum full pipe velocities were 0.85 fps and 2.04 fps, respectively. These velocities are well below the maximum desired velocity of 7 fps. However, the low velocities in this pipeline may lead to build-up of materials and is cause for concern for occurrence of scaling.

Due to the steep slopes within the brine line (up to 9.2 percent on Grand Avenue), velocities reach as high as 13.75 fps with a Manning roughness coefficient of 0.009, and 12.22 fps with a Manning roughness coefficient of 0.011. These velocities exceed the maximum desired velocity of 10 fps. While the high-density polyethylene pipe manufacturer catalogues indicate resistance to abrasion with up to 25 fps velocities, the pipe should be inspected periodically to assess its condition.

The record documents do not show any access ports for pipe inspection. The brine line is an essential element of the overall recycled water system. In case of its failure, West Basin and its customers will have to convert to the use of potable water supplies. It is recommended that West Basin design and install inspection ports on the brine line so that its condition can be assessed, and corrective actions can be taken proactively. For conservative planning purposes, 12 access ports are included in the CIP.

To mitigate the high velocities, it is recommended that the downstream pressure near the Hyperion Ocean Outfall be increased. This would require installing a series of pinch valves or pipe restrictions to reduce the pressure gradually prior to discharge to the Outfall. A detailed study of this system should be conducted to develop the appropriate project. For conservative planning purposes, 10 pinch valves/reducers are included in the CIP.

7.1.8 bp Reverse Osmosis System

7.1.8.1 Criteria

Analysis criteria for the bp Carson Refinery (bp) RO system includes the following general criteria:

- Maximum headloss of 10 feet for each 1,000 feet of pipe length
- Velocities of 1 to 3 fps under normal operations, with maximum velocities of 7 fps
- Capacity should be met with at least one booster pump kept in reserve.

No analysis criterion specific to the bp RO system is included. These criteria were used to evaluate the existing bp RO system.

7.1.8.2 Analysis Conditions

The bp RO system consists of the booster pump station and the 30-inch diameter DIP and 24-inch diameter DIP transmission main that conveys Industrial RO water to the bp Carson Refinery. The transmission main is approximately 1.1 miles, or 5,980 feet, in length.

Under existing conditions, the bp RO system supplies the bp Carson Refinery with 3.1 mgd of RO recycled water on an average annual basis. This average annual demand was established from historical billing records. Maximum month demands are calculated using the maximum monthly peaking factor of 1.7. Minimum instantaneous demands were obtained from the minimum flows observed during the calibration data gathering period. As detailed in Table 7.15, this analysis was conducted during the average, maximum, and minimum demand conditions of 2,162 gpm, 3,675 gpm, and 1,473 gpm, respectively.

Table 7.15 bp RO System Demands
Capital Implementation Master Plan
West Basin Municipal Water District

Demand Type	Average Annual	Average Daily	Average Instantaneous
Average Annual Demand(1)	3,488 afy	3.11 mgd	2,162 gpm
Maximum Month Demand(2)	N/A	5.29 mgd	3,675 gpm
Minimum Instantaneous Demand(3)	N/A	N/A	1,473 gpm

Notes:
(1) Calculated from historical billing records as detailed in Chapter 3.
(2) Based on a seasonal peaking factor of 1.7 applied to the average annual demand, based on discussions with District staff.
(3) Based on a seasonal peaking factor of 0.7 applied to the average annual demand, obtained from minimum flow observed during calibration period. For conservative planning purposes, it was assumed this was the average flow during a 24-hour period using the same demand pattern as the other scenarios.

This analysis was conducted utilizing average conditions observed during the calibration period, including daily demand patterns.

7.1.8.3 Analysis Results

Table 7.16 presents model results for the analysis conducted under each of the demand conditions listed in Table 7.15.

Table 7.16 bp RO System Analysis
Capital Implementation Master Plan
West Basin Municipal Water District

Condition	Total Maximum Headloss[1]	Average Unit Headloss (ft/1,000 ft)	Pressure at Delivery Point	Maximum Velocity	Maximum Travel Time[2] (Water Age)
Average Annual Demand	1.7 ft	0.3 ft/kft	50.0 psi[3]	1.8 fps	2.3 hrs
Maximum Month Demand	4.6 ft	0.8 ft/kft	50.0 psi[3]	3.0 fps	1.8 hrs
Minimum Day Demands	0.8 ft	0.1 ft/kft	50.0 psi[3]	1.2 fps	3.0 hrs

Notes:
(1) Maximum headloss predicted by model over 24-hour simulation period.
(2) Travel time verified for 1-week simulation time.
(3) CRWRF RO Product Water pumps controlled by VSP analysis set to 50.0 psi delivery pressure.

As seen in Table 7.16, the average unit headloss per 1,000 feet ranged from 0.1 feet to 0.8 feet, well below the analysis criteria of 10ft/kft. The maximum velocity ranged from 1.2 fps to 3.0 fps, within the range of analysis criteria. Pressure at this site is regulated by the pump station, resulting in the 50 psi pressure maintained under all scenarios. Two of the three pumps were required under each of the scenarios.

Based on the above analyses, it is shown that the existing pipeline is predicted to have sufficient capacity for anticipated demands during each evaluated existing system conditions, and no additional recommendations are made.

7.1.9 bp Nitrified Water System

7.1.9.1 Criteria

Analysis criteria for the bp Nitrified Water System includes the following general criteria:

- Maximum headloss of 10 feet for each 1,000 feet of pipe length.
- Velocities of 1 to 3 fps under normal operations, with maximum velocities of 7 fps.
- Capacity should be met with at least one booster pump kept in reserve.

No analysis criterion specific to the bp Nitrification system is included. These criteria were used to evaluate the existing bp Nitrification system.

7.1.9.2 Analysis Conditions

The bp Nitrified Water system consists of the booster pump station and the 12-inch diameter DIP transmission main that conveys Nitrified water to the bp Carson Refinery. The transmission main is approximately 1.2 miles, or 6,110 feet, in length.

Under existing conditions, the bp Nitrified Water system supplies the bp Carson Refinery with 3.1 mgd of recycled water on an average annual basis. This average annual demand was established from historical billing records. Maximum month demands are calculated using the maximum monthly peaking factor of 1.7. Minimum instantaneous demands were obtained from the minimum flows observed during the calibration data-gathering period. As detailed in Table 7.17, this analysis was conducted during the average, maximum, and minimum demand conditions of 374 gpm, 486 gpm, and 302 gpm, respectively.

Table 7.17 bp Nitrified Water System Demands
Capital Implementation Master Plan
West Basin Municipal Water District

Demand Type	Average Annual	Average Daily	Average Instantaneous
Average Annual Demand(1)	603 afy	0.53 mgd	374 gpm
Maximum Month Demand(2)	N/A	0.69 mgd	486 gpm
Minimum Instantaneous Demand(3)	N/A	N/A	302 gpm

Notes:
(1) Calculated from historical billing records as detailed in Chapter 3.
(2) Calculated by applying a seasonal peaking factor of 1.3 to the average annual demand, based on discussions with District staff.
(3) Obtained from minimum flow observed during calibration period. For conservative planning purposes, it was assumed this was the average flow during a 24-hour period using the same demand pattern as the other scenarios.

This analysis was conducted utilizing average conditions observed during the calibration period, including daily demand patterns.

7.1.9.3 Analysis Results

Table 7.18 presents model results for the analysis conducted under each of the demand conditions listed in Table 7.17.

As seen in Table 7.18, the average unit headloss per 1,000 feet ranged from below 0.4 feet to 1.0 feet, well below the analysis criteria of 10ft/kft. The maximum velocity ranged from 1.0 fps to 1.6 fps, within the range of analysis criteria. Pressure at this site is regulated by the pump station, resulting in the 50 psi pressure maintained under all scenarios. Two of the three pumps were required under each of the scenarios.

Based on the above analyses, it is shown that the existing pipeline is predicted to have sufficient capacity for anticipated demands during each evaluated existing system condition, and no additional recommendations are made.

Table 7.18 bp Nitrification System Analysis
Capital Implementation Master Plan
West Basin Municipal Water District

Condition	Total Maximum Headloss(1)	Average Unit Headloss (ft/1,000 ft)	Pressure at Delivery Point	Maximum Velocity	Maximum Travel Time(2) (Water Age)
Average Annual Demand	3.8 ft	0.6 ft/kft	50.0 psi(3)	1.2 fps	2.4 hrs
Maximum Month Demand	6.1 ft	1.0 ft/kft	50.0 psi(3)	1.6 fps	2.0 hrs
Minimum Day Demands	2.5 ft	0.4 ft/kft	50.0 psi(3)	1.0 fps	2.8 hrs

Notes:
(1) Maximum headloss predicted by model over 24-hour simulation period.
(2) Travel time verified for 1-week simulation time.
(3) CRWRF Nitrified Product Water pumps controlled by VSP analysis set to 50.0 psi delivery pressure.

7.1.10 CRWRF Brine Line

7.1.10.1 Criteria

Analysis criteria for the CRWRF brine line includes the following general criteria:

- Maximum headloss of 10 feet for each 1,000 feet of pipe length
- Velocities of 1 to 3 fps under normal operations, with maximum velocities of 7 fps

Analysis criteria specific to the CRWRF Brine Line includes:

- Positive pressure at the Joint Water Pollution Control Plant (JWPCP) standpipe (as detailed in Chapter 6), corresponding to 8.0 psi at the standpipe sampling point.
- Maximum daily flow of 0.9 mgd (regulated by discharge permit, as detailed in Chapter 4)

These criteria were used to evaluate the existing CRWRF Brine Line system under existing demand conditions.

7.1.10.2 Analysis Conditions

The CRWRF brine line consists of:

- 28,190 lineal feet of 14-inch diameter AWWA C905 PVC pipe that runs from the RO concentrate discharge system at CRWRF to Lomita Street, south of the JWPCP.
- 216 lineal feet of 14-inch outer diameter (OD) standard dimension ratio (SDR) 11 HDPE pipe that runs from north of Lomita Boulevard to the LACSD's Outfall Surge Tower.

Under existing conditions, the CRWRF Brine Line conveys RO concentrate ranging on average daily basis from 0.2 mgd to 0.7 mgd. Based on average daily volumes, the rate of RO concentrate generation was determined in Chapter 4 to average 12.5 percent of the total influent to the CRWRF.

This rate of RO concentrate generation across instantaneous flow data observed during the calibration period was slightly higher, averaging 15.9 percent of CRWRF influent flow. The brine line flows represented on average 25.5 percent of the product water flows. Since the average annual flows were believed to represent more typical behavior of the system, this analysis will utilize the average daily volumes of 12.5 percent of total influent to CRWRF. It should be noted that the separate influent flows to the Nitrification and MF/RO portions of the CRWRF were not evaluated for this analysis, due to lack of annual data for the individual treatment processes (only the MF/RO portion of the CRWRF treatment processes contribute to the CRWRF Brine Line). The 12.5 percent RO concentrate generation assumes the ratio of flows to the Nitrification and MF/RO processes remains the same as 2007 conditions.

Table 7.19 CRWRF Brine Line System Flows
Capital Implementation Master Plan
West Basin Municipal Water District

Condition	Average Annual	Average Daily	Average Instantaneous
Average Annual Flow(1)	606 afy	0.54 mgd	376 gpm
Maximum Instantaneous Flow(2)	N/A	0.95 mgd	658 gpm
Minimum Day Flow(3)	N/A	0.11 mgd	162 gpm

Notes:
(1) Average annual flow from 2007 historical daily flows.
(2) Maximum flow observed during Dec.8 – Dec. 10 calibration data gathering (5-min sampling interval).
(3) Minimum daily flow observed from 2007 historical daily flows. For conservative planning purposes, it was assumed this was the average flow during a 24-hour period using the same demand pattern as the other scenarios.

As shown in Table 7.19, this analysis was conducted during the average, maximum, and minimum flow conditions of 376 gpm, 658 gpm, and 162 gpm, respectively.

This analysis was conducted utilizing conditions observed during the calibration period. Since limited data was available for this system from the calibration (48 hours of data), the RO train head pattern and flow patterns from the calibration were used for existing system analysis, and as such may not reflect average conditions in the system.

7.1.10.3 Analysis Results

The results of analyses for each of the flow conditions described in Table 7.19 are reported below in Table 7.20.

Table 7.20 CRWRF Brine Line System Analyses
Capital Implementation Master Plan
West Basin Municipal Water District

Condition	Total Headloss(1)	Average Unit Headloss (ft/1,000 ft)	Minimum Pressure at Standpipe(2)	Velocity Range	Maximum Travel Time(2) (Water Age)
Average Annual Flow	10.3 ft	0.4 ft/kft	12.0 psi	0.5 – 1.0 fps	12.0 hrs
Maximum Instantaneous Flow	28.9 ft	1.0 ft/kft	6.9 psi	0.9 – 1.8 fps	7.1 hrs
Minimum Day Flow	2.1 ft	0.1 ft/kft	14.0 psi	0.2 – 0.4 fps	23.7 hrs

Notes:
(1) Headloss across entire pipeline length.
(2) Pressure taken at junction CRB-300, which represents the sampling port of the JWPCP standpipe.

As shown in Table 7.20, the model predicts velocities in the pipeline of between 0.5 and 1.0 fps under average annual demand conditions, slowing to as low as 0.2 fps under minimum flow conditions, well below the analysis criteria of 1 to 3 fps. Such low velocities in this pipeline may lead to build-up of materials and is cause for concern. If possible, routine closed circuit television (CCTV) inspection of the pipeline may aid in determining whether deposits or scaling are occurring. The calibrated friction factor of 120 would suggest that deposits or scaling are not a significant problem at the present. Based on the record drawings for the CRWRF brine line, no access ports are currently installed to allow inspection of the brine line. It is recommended that access ports be installed to allow such inspections and clearing, if necessary. For conservative planning purposes, 8 access ports are included in the CIP.

As shown in Table 7.20, pressures are predicted to drop to 6.9 psi under maximum brine flow conditions, below the 8.0 psi required to maintain discharge into the surge tower. If the discharge pressure of the concentrate at the RO units is able to be increased, it may be possible to address this deficiency through revised operational parameters. However, with increased flow it may be necessary to add a pump station to raise the hydraulic head in order to maintain flow into the surge tower. West Basin staff have indicated significant pressure is available to increase the discharge pressure into the brine line.

The current permitted discharge for the CRWRF Brine Line is 0.9 mgd (CRWQCB 2006), equivalent to an average daily flow of 623 gpm. The peak instantaneous flow observed in the CRWRF Brine Line during calibration was 658 gpm (as shown in Table 7.19), but this was sustained for only one 5-minute sampling period, and the average flow for that day (December 9, 2008) was 495 gpm (0.7 mgd). The current discharge permit does not explicitly state an instantaneous flow limit (CRWQCB 2006). The maximum daily flow during the 2007 calendar year was 0.7 mgd, which is well below the permitted discharge flow rate.

Based on the above analyses, it is shown that the existing pipeline is predicted to have sufficient capacity for anticipated flows during existing system conditions, and no additional recommendations are made.

7.2 EXISTING SYSTEM RECOMMENDATIONS SUMMARY

Table 7.21 summarizes the recommendations made as a part of the existing system analysis. The project IDs used in this table correspond to the IDs used in the Capital Improvement Program as presented in Chapter 9 of this report. Items for which further study is recommended are not necessarily included in the CIP, so may not include an ID. Such studies are also summarized in Chapter 9. Moreover, additional recommendations included in the CIP not addressed in the existing system analysis cause the numbering to be non-consecutive.

Table 7.21 Existing System Recommendations Summary
Capital Implementation Master Plan
West Basin Municipal Water District

ID	Recommendation	System or Facility
-	For Title 22 Customer Chester Washington Golf Course, review the existing golf course irrigation schedule with the customer to reduce their daily peak demands to a more reasonable level in order to extend life of lateral.	Title 22 Distribution System
CRWRF-03, EMWRF-04, ELWRF-11	Detailed Study to determine the most feasible method for reducing the magnitude of the observed pressure surges.	Microfiltration process of ELWRF, CRWRF, and EMWRF; affects surges in Title 22 Distribution System
-	Detailed Study to develop an efficient pumping system that allows operation of the pumps within the preferred operating ranges.	Title 22 Distribution System

Table 7.21 Existing System Recommendations Summary
Capital Implementation Master Plan
West Basin Municipal Water District

ID	Recommendation	System or Facility
-	Study to evaluate whether pipe cleaning test program increases chlorine residual in distribution system, possibly including installation of pig launching and retrieval stations.	Title 22 Distribution System
T22-11	Add chlorine booster stations, depending on effectiveness and results of pipe cleaning test program.	Title 22 Distribution System
-	Detailed analysis to evaluate the pump station to resolve energy loss and establish a more efficient method of operation of the Barrier Product Water Pump Station.	West Coast Barrier System
-	Detailed analysis to optimize system controls, to eliminate the need for manual control of VFD.	Hyperion Secondary Effluent Pumping System
HPS-03	Add backup power to site, most likely consisting of a secondary power connection.	Hyperion Secondary Effluent Pumping System
-	Detailed analysis to maintain firm capacity of the pump station.	Chevron Nitrified Water System
CBRN-01	Design and install access ports for inspection and cleaning (8 access ports).	CRWRF Brine Line
-	Evaluate inspection of brine line and establish routine inspection program.	CRWRF Brine Line
EBRN-02	Design and install access ports for inspection and cleaning (12 access ports).	ELWRF Brine Line
-	Evaluate inspection of brine line and establish routine inspection program.	ELWRF Brine Line
EBRN-01	Detailed analysis to mitigate high velocities, possibly installing pinch valves or pipe restrictions (10 pinch valves/reducers).	ELWRF Brine Line

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