CHAPTER 4

CHAPTER 4
CAPACITY REVIEW

Introduction

This chapter presents a review of the hydraulic capacity and treatment process capacity of the existing WTP. This work will determine the current and possible future capacity of the WTP given the limitations of each process and the system as a whole. The hydraulic capacity is determined by the piping, pumping, and flow control systems. Each process or support system has its own capacity relative to certain design criteria or operating parameters which are independent of other unit processes. Presented as part of this work will be a determination of the most limiting or controlling process or feature of the WTP's capacity. As part of this capacity analysis, an estimation of the WTP's firm capacity will be made.

Hydraulic Capacity Evaluation

This section presents a methodology overview of the hydraulic capacity evaluation and results of this evaluation. The hydraulic capacity analysis performed in the previous 2004 Facility Plan used hand calculations to establish maximum and firm capacities of individual portions of the WTP from the intake to the finished water pumps. The analysis performed as part of this Facility Plan Update uses a computer model to simulate the hydraulic performance and plant operations and determine the impacts of specific existing limitations on upstream and downstream facilities that are hydraulically linked. Previous planning work used hand calculations for this determination of the plant's hydraulic capacity. The mathematical formulas used for open and closed conduit calculations are the same as those used for the 2004 plan.

Typical Plant Operation

This section describes standard operating procedures and physical conditions which were incorporated into the analysis.

Raw Water Pumping

Raw water pumps are operated at one of ten internally approved plant production or flow rates based on anticipated system demand. The approved flow rates have been developed to aid in water quality measurement and production calculations that are recorded for regulatory compliance monitoring. The approved flow rates are shown in Table 4-1.

Sedimentation Basins

Flow from the raw water pumps is split between sedimentation basins 1, 2 and 3. Flow is controlled and proportioned by throttling the inlet valve to basin 3. Further adjustment can be made through the positions of the mud valves at the inlets of basins 1 and 2. The plant is typically operated with the inlet valve to basin 3 throttled to control flow split and optimize individual basin resident time for compliance purposes. Basin dimensions and flow splitting are summarized in Table 4-2.

Table 4-1
Approved Plant Flow Rates

	Plant Production					
Gallons per minute	3,560	4,500	5,500	6,500	7,300	8,500
Million gallons per day	5.1	6.5	7.9	9.4	10.5	12.2
Gallons per minute	9,500	10,500	11,500	12,500	13,500	13,900
Million gallons per day	13.7	15.1	16.6	18.0	19.4	20.0

Table 4-2
Sedimentation Basin Summary

Parameter	Unit	Basin 1	Basin 2	Basin 3
Width	ft	61	38	80
Length	ft	98	98	80
Depth	ft	13	13	13
Surface Area	ft^2	5,978	3,724	6,400
Volume	ft^3	77,714	48,412	83,200
	gal	581,301	362,122	622,336
Tank Flow Percent of Total	%	37	23	40

Filtration

Water from each basin flows by gravity over weirs within the basins and collected by launders. The water flows from the launders and fills a common channel which conveys flow to the filters. The common channel water level is monitored at three points: near filters 3 and 5 and between filters 7 and 8. The water level in the common channel is kept at 3.6 feet (the total height of the channel is approximately 5 feet) by the plant's control system, which adjusts flow to each group of filters. The flow is optimally split by a ratio of flow to area and the number of filters in service. Filter dimensions and flow splitting are summarized in Table 4-3.

Flow through each filter is controlled by throttling the effluent valve on the filter. As the head loss through the filter increases due to increased flow or solids loading, the filter's effluent valve is opened farther to maintain a constant flow. Backwashes are initiated when the head loss through the filter is greater than 7 feet, turbidity is greater than 0.15 NTU, or the filter has not been backwashed for 80 hours. The maximum backwash time criteria includes both time in operation and time offline.

Table 4-3
Filter Summary

Parameter	Unit	Filters 1 to 3	Filters 4 and 5	Filters 6 to 8
Length	ft	17	21	18
Width	ft	15	18	18
Area of Each Filter	ft^2	255	378	324
Total Area	ft^2	765	756	972
Filter Flow Percent of Total	%	31	30	39
Each Filter Flow Ratio	%	10	15	13

The plant typically operates with one filter offline. The offline filter is brought online when another filter needs to be backwashed. This control strategy has helped to eliminate surges in the filter levels and a corresponding fluctuation in plant flow rate. At flows greater than 15 mgd, or if water is backing up into the common inlet channel (which can occur during maintenance activities that leave facilities offline), operation of all filters becomes necessary. Filter effluent is collected in closed manifold piping and flows to the clearwell.

Finished Water Storage

The clearwell is operated at a fixed water level that maximizes chlorine contact time for regulatory compliance. As the level rises and falls, the effluent pumps increase or decrease their speeds to maintain the constant water level, currently set at 14.5 feet.

Hydraulic Model

A digital hydraulic model was developed to determine the hydraulic capacity of the various conveyance systems at the WTP. The following sections describe model development, input, and results. Visual Hydraulics, a commercially available hydraulic analysis software program, was used to develop and run flow scenarios to assess the plant's hydraulic performance and to identify areas of hydraulic concern. These areas of concern were then further analyzed using hand calculations and discussion with City staff.

Conveyance Systems

The Visual Hydraulics program analyzes water surface profiles of water conveyance systems. Specifically, a downstream control point is selected, and the hydraulic profile is then determined upstream of that control point. Review of historical WTP record drawings were used to initially develop the model. Table 4-4 summarizes the values used in the model for different criteria. See Appendix B for a Hydraulic Model Schematic.

Table 4-4
Hydraulic Parameters Summary

Condition	Equation	Parameter	Value
Pressure Pipe	Hazen-Williams	C-coefficient	110
Pressure Pipe	90-Degree Bend Minor Loss	K-value	0.25
Pressure Pipe	Entrance Minor Loss	K-value	0.5
Pressure Pipe	Exit Minor Loss	K-value	1.0
Open Channel	Manning's Equation	Manning's *n*	0.013

Revisions were made to the model using City input and iterative refinements. The following is a summary of changes incorporated in developing the final hydraulic model.

- Minor Losses – Typical design values for minor losses, e.g. pipe entrance and exit losses, were used where applicable.
- City Experience – Through conversations with City staff, input on the hydraulic performance of the WTP was collected and compared to the preliminary results of this study. For example, filters 4 and 5 are not able to handle as much flow as would be anticipated from splitting flows based on comparative surface areas within the WTP.
- Flow Split – The flow split to the sedimentation basins and the filters was modified to more evenly match head loss through a basin or filter train relative to the other basins or filters.

Failure Criteria

In estimating the maximum hydraulic flow through the WTP, the flow used in the hydraulic model was increased in 0.5-mgd increments until one or more of the failure criteria were met. The failure criteria are as follows:

- Loss of containment – The estimated water levels across the entire treatment plant were compared to the top of the holding structures to determine if the plant flow being modeled would be contained within the system.
- Weirs fully flooded – The flow being modeled was considered to be at failure once a weir had become fully submerged and no appreciable drop was predicted across the weir.
- Adverse impact water elevations – The final failure criteria involved determining if the predicted water level would have an adverse impact on the operation of mechanical equipment at the plant.

The acceptable flow for the various flow scenarios was assumed to be 0.5 mgd below the flow triggering failure.

Pump Station Conveyance

There are three pumping facilities at the WTP: raw water pumping, high service or finished water pumping, and backwash pumping. The initial capacity rating of each facility was based on equipment data, supplemental information provided by the City, and previous documentation. The capacity of each facility was determined for two conditions, total capacity and firm capacity. Total capacity is the production capacity with all pumps in operation. Firm capacity is the production capacity with the largest pump out of service. This section includes descriptions of each pumping facility and their associated total and firm capacity assessments.

Raw Water Pumping

The WTP uses four 75-HP vertical turbine pumps for raw water pumping. Each pump has a design capacity of 3,200 gpm at a design TDH of 65 feet. They are each Worthington model 15HH-340 pumps. Since the 2004 Facility Plan, VFDs have been added to pumps 1 and 4 to allow additional flexibility in producing desired flow rates and splitting operational hours between pumps. The pumps were installed in the early 1980s when the raw water intake was built. Based on the design point, the pump station has a total capacity of approximately 20.2 mgd and a firm capacity of approximately 15.15 mgd.

There is space for six pumps within the pump station and if similar pumps are installed, the total pumping capacity would theoretically be 30.2 mgd. Based on comparing testing of flow and pressure in the raw water discharge line and head loss calculations, the raw water pumps may have been oversized, i.e., the design TDH is more than actual TDH. The pumps are likely pumping at higher flows than the original design anticipated, and a design-level analysis is needed to more accurately determine the actual capacity increase.

High Service Pumping

There are six pumps that transfer finished water from the clearwell into the distribution system. The size, design capacity, and pump control scheme is summarized in Table 4-5. The pumps are controlled by the staff and the SCADA system based on the distribution system demand. They are also operated to maintain the water level in the clearwell necessary to meet chlorine contact time (CT) requirements. Based on design points, the total pumping capacity is approximately 29.7 mgd, with a firm capacity of approximately 23.9 mgd. Assuming the velocity in the 36-inch diameter finished water pipeline is limited to a velocity of 6 feet per second (fps), the capacity of the pipeline that the pumps discharge to is approximately 27.4 mgd. Using a velocity of 6.5 fps, the existing 36-inch diameter pipeline is capable of conveying approximately 30 mgd. With the existing surge tank and the addition of three VFDs, the potential for surge has been reduced for these pumping facilities.

Table 4-5
High Service Pumping Summary

Pump Number	Model	Size (HP)	Head (ft)	Flow (gpm)	Control
1	Worthington Model 15HH-340	250	210	3,500	Soft Start
2	Fairbanks Morse Model 18HC	300	210	4,000	On/Off
3	National pump Company/Worthington Model H14XHC	250	220	3,500	VFD
3A	National pump Company/Worthington Model H14XHC	250	220	3,500	VFD
4	Worthington Model 15HH-340	250	210	3,500	On/Off
5	Worthington Model 15HH-277	200	210	2,600	VFD

Backwash Pumping

The two backwash pumps, including one pump that has just recently been added, are vertical turbine pumps which pump water out of the clearwell. Both pumps are controlled by VFDs. Table 4-6 summarizes the backwash pump capacity. The station has a redundant pump if one pump is not operable due to maintenance or damage. Because both pumps are on VFD control, the backwash system is able to prevent excessive surges in the backwash system and limit the flow velocity in the discharge line.

Table 4-6
Backwash Pumping Summary

Pump Number	Model	Size (HP)	Head (ft)	Flow (gpm)
1	Peabody Floway 22-BLK	200	62	7,000
2	Goulds Water Technology VIT-FFFM	150	60	7,600

Hydraulic Capacity Analysis Results

The following sections summarize results of the analysis and improvements that could increase hydraulic capacity.

Model Results

The hydraulic model of the WTP was first used to simulate plant operations as described in this chapter. At a plant flow of 21.0 mgd, the sedimentation basin weirs became flooded. If these weirs become flooded, flow splits in the plant will become more difficult to control and the sediment and floc loading to the filters will increase, diminishing their performance. However, this condition is not considered a failure for the WTP overall because the plant can still operate hydraulically above this flow. At a flow over 23.0 mgd, the mixing basin before sedimentation basins 1 and 2 is flooded and loses containment. At 23.0 mgd, the WTP could no longer pass additional flow, and this is considered the maximum hydraulic capacity of the WTP. Table 4-7 shows a summary of the hydraulic profile of the plant at 23 mgd.

Table 4-7
Hydraulic Summary at 23 mgd Maximum Capacity

<table>
<tr><th colspan="2">Hydraulic Element</th><th colspan="4">Water Surface Elevation</th><th rowspan="2">Limiting Criteria</th></tr>
<tr><th>Downstream</th><th>Upstream</th><th colspan="2">Downstream</th><th colspan="2">Upstream</th></tr>
<tr><td>Distribution System</td><td>Clearwell</td><td colspan="2">1,085 to 1,108 (70 to 80 psi)</td><td colspan="2">922.96</td><td>Pipe Velocity</td></tr>
<tr><td>Clearwell</td><td>Common Filter Channel</td><td colspan="2">922.96</td><td colspan="2">935.34</td><td>Pipe Velocity, Head Loss Through Filter, Loss of Containment</td></tr>
<tr><td rowspan="3">Common Filter Channel</td><td rowspan="3">Sedimentation Basins</td><td colspan="2" rowspan="3">935.34</td><td>Basin 1</td><td>935.39</td><td rowspan="3">Loss of Containment</td></tr>
<tr><td>Basin 2</td><td>935.42</td></tr>
<tr><td>Basin 3</td><td>935.49</td></tr>
<tr><td rowspan="2">Sedimentation Basin</td><td rowspan="2">Mixing Basin</td><td>No. 1</td><td>935.39</td><td colspan="2" rowspan="2">936.00</td><td rowspan="2">Weir Submergence, Loss of Containment</td></tr>
<tr><td>No. 2</td><td>935.42</td></tr>
<tr><td>Mixing Basin</td><td>River Intake</td><td colspan="2">936.00</td><td colspan="2">886.00</td><td>Pipe Velocity</td></tr>
</table>

After the initial results were obtained, operating parameters were changed in the model in an effort to determine if higher flows could be passed by the WTP. Optimization included splitting flow to the filters and basins in a manner that more evenly matched head loss through a train. Under this analysis, at a flow over 23.0 mgd, the sedimentation basin weirs are flooded. At flows over 24.5 mgd, the mixing basin is flooded. Operating the WTP in a manner similar to the optimized model would entail iterative adjustment of both manual and automated valves that control individual contact and filter basins and would result in differing contact times that would make regulatory compliance difficult to achieve. For this reason, the higher flows are not considered practical.

Maximum and Firm Hydraulic Capacities

Based on design capacity alone, the WTP capacity is currently limited by the raw water pump station capacity. The maximum overall hydraulic plant capacity is 20.2 mgd. The firm hydraulic capacity, with the largest river intake pump out of service, is approximately 15.1 mgd.

Increasing Hydraulic Capacity

Using the projected water demands, the current maximum plant capacity of 20.2 mgd will meet projected system MDD until the year 2028. Improvements could be made to the WTP to increase its hydraulic capacity to 25 mgd. The WTP would then be able to meet projected system MDD until year 2046. Increasing the hydraulic capacity of the WTP to 25 mgd would require substantial capital investments in the form of additional basin and conduit upgrades. If implemented collectively, the following improvements would increase the maximum plant hydraulic capacity to 25 mgd:

- Increase river intake pumping capacity by installing additional pumps or modifying existing pumps.
- Enlarge submerged opening in mixing basin baffle wall.
- Add additional launders to basins 1, 2, and 3.
- Filters 1 through 5 effluent pipe gallery modifications including weir plate invert set at consistent 926.62 feet.
- Perform operational tests of the raw water pump station and the high service pump station to determine the firm capacity of these facilities under actual operating conditions.

Process Capacity Evaluations

The capacity of each of the plant processes was evaluated for its ability to meet existing production needs and to estimate its maximum capacity. The evaluations are summarized in this section.

Chemical Feed Systems

The WTP's primary chemical storage, metering, and feed systems at the plant include:

- Liquid alum (50 percent) for coagulation
- ACH for coagulation
- Liquid sodium hypochlorite (12.5 percent) for disinfection, pre- and post-chlorination
- Dry polymer for filter aid
- Dry $KMnO_4$ for taste and odor control, used intermittently

The first four systems are typically used continuously whenever the plant is in operation. Potassium permanganate is used only during infrequent taste and odor events. The doses of each chemical depend on the plant production rate and raw water quality.

Alum

Alum is stored in a 6,000-gallon fiberglass tank inside the WTP's chemical storage room. Alum is added to the raw water to aid in coagulation prior to static mixing. Alum is dosed using positive displacement diaphragm pumps. The pumps are rated at 39.6 gph at 58 psi, and the other is rated at 15.9 gph at 145 psi. These pumps are also used to feed ACH (see below).

When alum was the only coagulant used, the maximum day alum usage from 2004 to 2007 was 2,445 ppd. With the use of ACH, the maximum day usage for alum was reduced to 1,123 ppd. The corresponding maximum day ACH usage rate is approximately 690 ppd. Both maximum coagulant usage days had similar water quality and flow parameters.

At the current maximum instantaneous plant flow of 20 mgd, an estimated maximum alum usage rate is 1,250 ppd at an alum dose of 7.5 mg/L. This equates to a maximum chemical pumping rate of 4.9 gph using 5.4 pounds of alum per gallon of solution, which is less than the current rated pumping capacity of the alum feed pumps. It is not expected that chemical feed pumps would need to be replaced due to increased demand requirements.

Chemical storage quantities depend on a plant's proximity to chemical distributors and ability to have chemicals delivered at any time of the year. It is typical to maintain 15 to 30 days of chemical storage based on maximum dosage and ADD. The current ADD is 5.5 mgd and the current alum dose is 25 mg/L. For these flow conditions, the necessary alum storage is approximately 3,250 gallons for 15 days or 6,500 gallons for 30 days. This is more than the 6,000-gallon tank storage at the WTP. There are several suppliers of alum nearby and the ACH dosage could be increased and alum dosage decreased, so this slight lack of alum storage volume does not appear to be of immediate concern.

Aluminum Chlorohydrate

Aluminum chlorohydrate is stored inside the WTP's chemical room in a 6,000-gallon fiberglass tank which was formerly used to store alum. ACH is added to the raw water at the static mixer with alum. ACH is dosed using positive displacement diaphragm pumps. Since beginning use of ACH on a daily basis, the average dose was 15.8 mg/L and the plant used an average of 54.4 gpd. Under average conditions, the plant has more than 100 days of storage of ACH using the 6,000-gallon tank.

Sodium Hypochlorite

Liquid sodium hypochlorite is delivered and stored at the plant in three fiberglass reinforced plastic tanks, each with a capacity of 2,300 gallons, for a total storage capacity of 6,900 gallons. These tanks are located inside the hypochlorite feed room adjacent to the chemical feed room. The storage tanks and metering pumps are located within a concrete containment area to contain a major leak. There are three positive displacement mechanical diaphragm metering pumps, each rated at 24.0 gph. Under normal operating conditions, one pump is dedicated for pre-disinfection, injecting into the static mixing vault. Another pump is for post-disinfection with injection into the clearwell. The last pump serves as backup. Space and a piping connection have been included for a future pump.

At the current maximum instantaneous plant flow of 20 mgd, the estimated hypochlorite usage is 500 ppd at a combined pre- and post-chlorination dose of 3.0 mg/L. The dosage used in this calculation conservatively estimates hypochlorite usage during peak season demands. This equates to a total chemical pumping rate of 20.9 gph total, or 10.5 gph per pump, well below the 24.0 gph rating of the current feed pumps. Using this same dose at 30 mgd, the existing pumping system should be capable of reliably meeting plant demands.

At the current ADD of 5.5 mgd and a maximum hypochlorite dose of 3.0 mg/L, hypochlorite storage required is approximately 2,000 gallons for 15 days and 4,000 gallons for 30 days. During periods of low demands, some utilities dilute the chemical to a concentration of 10 percent or less to reduce degradation of the chemical associated with longer holding times. Existing on-site storage capacity is sufficient for peak demand flows in excess of 30 mgd, providing more than 15 days of storage. No additional hypochlorite storage will be required in the foreseeable future.

Polymer

A low-molecular-weight polymer is added to the filter influent pipelines as a filter aid to improve filter performance. A dry feed system, including two 290-gallon mix/aging and feed tanks and one diaphragm positive displacement metering pump rated at 15.9 gph (at 145 psi), are used to make and feed the solution. Eight rotameters split the feed to each filter's influent pipe. Dry polymer is shipped in 55-pound bags and stored adjacent to the mixing tanks in the chemical room.

Using a filter aid dose of 0.05 mg/L and a plant flow of 20 mgd, the polymer used would be approximately 8.3 ppd. At 30 mgd, the plant would use approximately 12.5 ppd. The existing system is adequately sized and improvements or upgrades are not anticipated for increased demand. If improvements are made to the clarification process, the filter aid requirements and dosages would most likely decrease.

Potassium Permanganate

The plant infrequently adds potassium permanganate to the raw water pipeline and mixing basin for taste and odor control. The permanganate feed pump is a volumetric pump ($^1/_3$ HP, 1,800 rpm) type with a hopper that discharges to a flushing funnel and eductor which discharges the resulting solution to the application point. Prior to injection, the permanganate solution is further diluted; dilution water is controlled by a solenoid valve. Dry potassium permanganate is shipped in 110-pound steel drums and stored between the permanganate feeder and the polymer metering pumps.

Assuming a dose of 0.25 mg/L and a plant flow of 20 mgd, the permanganate used would be approximately 41.7 ppd. At 30 mgd, the plant would use approximately 62.5 ppd. The existing system is adequately sized and would not be expected to need improvements or upgrades for increased demand.

Coagulation Performance

Water from the Rogue River is generally considered a low turbidity, good quality supply, but some treatment challenges exist due to seasonal and diurnal variation in pH, seasonally variable turbidity, temperature, and occasional taste and odor events. These variable raw water quality conditions can significantly impact coagulation and sedimentation performance at the plant.

Elevated turbidity was historically treated using high doses of alum. High doses of alum corresponded with increased solids production and, in turn, put high stress on the old solids handling facilities. Increased alum also depressed pH to levels where pH adjustment chemical was required to bring the pH back to targeted levels for corrosion control. This resulted in higher overall chemical and operations and maintenance costs with a reduction in plant efficiency.

After the 2004 WTPFP, the plant began experimenting with different alternative coagulation chemicals and now uses two coagulants at the plant. PASS-C, a PACl derivative, was originally used until the plant transitioned to an ACH derivative. Alum usage and overall coagulant usage has decreased significantly under current operations and there is no longer a need for a pH adjustment chemical at the plant. The original lime feed system has already been decommissioned and removed from the plant.

Sedimentation Basins

The sedimentation basins currently provide contact time for disinfection and some solids removal prior to filtration; no formal flocculation is provided in the basins other than mild hydraulic turbulence. Basins 1 and 2 have a combined rated capacity of 12 mgd; basin 3 is rated at 8 mgd , so the total rated process capacity is 20 mgd. The basins provide satisfactory water for filtration most of the year. However, all basins experience challenges with regard to short-circuiting, high solids loading to the filters, sub-optimal flocculation and seasonal turbidity spikes. Basin 3 is particularly vulnerable to short-circuiting. In addition, there is no continuous solids removal system; as solids accumulate in the basins, effective volume is reduced, compromising CT compliance and reducing settling efficiencies.

Selected design criteria for the existing basins were summarized and compared to criteria that are considered optimal for pretreatment in the 2004 WTPFP. Based on the comparison, several improvements to the basins which could be made to ensure the current plant capacity can be fully realized are:

- Incorporation of formal flocculation by either mechanical or hydraulic means for improved settled water quality
- Installation of a continuous residual solids removal system to minimize short-circuiting associated with solids accumulation and to equalize residual solids loading to the solids handling system
- Installation of internal baffling in basin 3, in addition to flocculation, to minimize short-circuiting resulting from the geometry of the basin

The City completed pre-design of automated residual solids removal for basins 1 and 2 in February 2010, which also reviewed flocculation alternatives, but the project was deferred due to high costs which included significant structural improvements.

The suggested improvements are intended to optimize the treatment process, but will not necessarily increase the process capacity of the basins. Alternatives to address these process limitations are discussed in detail in Chapter 7.

Filtration

Chapter 2 presents a detailed evaluation of historical filter performance and a discussion of possible capacity limitations. The filter improvements made in 2006 have significantly improved filter performance. However, there are some deficiencies identified as part of the historical performance analysis and filter investigations which include the following:

- Filter production efficiencies currently range from 90 to 94 percent; 97 percent is considered the minimum desirable filter production efficiency.
- Plant records show that filters 6, 7 and 8 are backwashed approximately 25 percent more frequently than the other five filters. This can be attributed to short-circuiting of water through basin 3 (more turbid settled water than from basins 1 and 2) and therefore higher solids loading rates to the filters which increases the head loss accumulation rate. Flow-splitting or other improvements made to clarification may help balance filter run times to increase overall plant efficiency.
- The existing surface wash system is not optimal and regular cleaning by hand is required. The addition of an air scour system and filter trough modifications could help improve cleaning and reduce overall operations and maintenance.

Certain deficiencies in the sedimentation basins and filter media design make it difficult to operate the plant at 20 mgd for extended periods without frequent filter backwashes. This is consistent with plant operations staff experience. The existing filters are not adequate for flows higher than 20 mgd, so modifications to the filters or additional filters would be required to increase capacity. A discussion of alternatives to address these issues is presented in Chapter 7.

Clearwell

The existing 433,000-gallon clearwell is relatively small for a 20-mgd plant; CT compliance at the plant is only possible by carefully monitoring and controlling the chlorine residual through the basins, and also by not exceeding certain operating flow rates during winter and spring due to water quality constraints. The use of VFDs on selected high service pumps helps maintain a relatively high water level in the clearwell. However, multiple “back-to-back” backwashes can create challenges to CT compliance because this tends to lower the clearwell level. Running the plant at lower production rates for longer periods of time during challenging water quality conditions, mainly cold water events, can help ensure continued CT compliance in the near-term.

Clearwell volume will need to be expanded in the future when plant demands exceed 20 mgd if free chlorine continues to be used for primary disinfection. Alternatives to integrate additional clearwell volume with the existing clearwell and high service pump station are discussed in Chapter 7.

Disinfection and Disinfection Byproduct Formation

The plant is currently capable of meeting CT requirements within the existing basins and clearwell by using pre-chlorination residual and maximizing the operating level in the clearwell. However, the dependence of disinfection compliance on the contact time achieved through the basins significantly limits operational flexibility at the plant; free chlorine residual must be carefully monitored and maintained through the basins to meet CT requirements. In addition, efforts to increase the pre- and post-chlorination residual must be balanced with disinfection byproduct (DBP) control. Process challenges in meeting CT are related primarily to increased demands during the spring and fall when demands are still fairly high and water temperatures are lower. Chapter 3 discusses this issue and how the plant could make operational adjustments to run the plant for longer periods during these times to still meet CT.

Disinfection and DBP regulations may drive disinfection improvements at the plant in the coming years if ongoing monitoring indicates elevated concentrations of these compounds within the distribution system. Alternate process modifications may be necessary to avoid the reliance on free chlorine for disinfection. Such processes may include ozone or UV irradiation. Discussions of improvement alternatives for each case are presented in Chapter 7.

Washwater and Solids Handling Systems

The 2004 WTPFP concluded that the old mill pond was full of residual solids and needed to be cleaned. The old mill pond was deemed to be inadequate for residual solids drying and an alternative method for solids handling was needed. The City determined that mechanical dewatering systems were cost-prohibitive and that solar drying lagoons were space-prohibitive. The plant transitioned to an approach that utilizes geofabric bags for dewatering solids.

Residual solids conditioned with dewatering polymer are loaded into the geofabric bags and allowed to drain and dry. Once the dewatered residual solids are considered dry enough, the bags are cut open and the dried solids are hauled off-site for disposal. There is space reserved on the plant site for dewatering the residual solids from the sedimentation basins. The old mill pond is dredged using a remotely operated dredging system to bring residual solids to shore to be placed into the geofabric bags for dewatering on-shore. This current practice is effective and requires little maintenance, but it is labor-intensive and requires a lot of space. As plant production increases and space is needed for expansion or plant upgrades, an alternate solids handling approach will be necessary. A detailed discussion of alternative solids handling and disposal methods is presented in Chapter 6.

Summary

A summary of findings from the hydraulic capacity and treatment process evaluations is presented below. Alternatives to address deficiencies at the existing WTP are presented in Chapter 7.

- The existing raw water pumps and finished water pumps are capable of pumping at least 20 mgd into and out of the plant.
- The firm hydraulic capacity of the plant is approximately 15 mgd. Installation of an additional 5 mgd of raw water pumping capacity would provide added operational flexibility and redundancy when plant demands reach 15 mgd, which is anticipated to occur within the next 5 to 10 years.
- The current maximum hydraulic capacity of the plant is 21 mgd. Significant modifications and improvements would be required to provide more hydraulic capacity in the existing plant.
- The chemical systems appear to be adequate to meet demands for the next 10 years except for periodic maintenance and replacement. This equipment may need to be supplemented to provide additional capacity or replaced if the plant capacity is expanded beyond 20 mgd.
- The existing sedimentation basins have a maximum process capacity of 20 mgd. Additional clarification capacity is required if the plant is to be expanded. Also, basin 3 is not as efficient as basins 1 and 2 due to the square geometry and radial flow pattern. This deficiency inhibits filter and plant performance at higher flows.
- The existing filters have a maximum process capacity of 20 mgd. Additional filters are required if the plant capacity is to be expanded.
- Continuous residual solids removal systems in the sedimentation basins would equalize solids loading to the solids handling system, maximize the chlorine contact time and settling time by minimizing solids accumulation, and eliminate the need for taking basins out of service for cleaning. Basins cannot currently be taken out of service for solids removal during the summer months and this can become a constraint in the future as water demands and solids production increase.
- The plant is currently capable of meeting CT requirements as long as flow is restricted to 10 mgd during winter and spring. The clearwell will need to be expanded as plant demands increase or another method of disinfection will be required.
- The strategy of dredging the old mill pond on a semi-regular basis and periodically removing solids from the sedimentation basins is effective, but is labor- and time-intensive. As plant demands and solids production increase, the plant site may no longer be able to process all of the solids. An alternative long-

term strategy for solids handling and disposal will be necessary if the existing plant will continue to be used for the next 10 to 20 years, or longer.