CHAPTER 6.0 – PLANT CAPACITY ANALYSIS

In an effort to identify potential bottlenecks in the treatment process, each plant component has been evaluated to determine both the hydraulic capacity and process performance capacity. A summary of the capacities are shown in Table 6.1. The following sections describe the basis for the capacity rating.

TABLE 6.1 – PLANT CAPACITY RESULTS

Component	Capacity[1] (MGD)	2012 Capacity Needed (MGD)	Existing[2] Deficiency	Limiting Factor[3]
Headworks Screens	<10	7.0 (PHF)	NA	Performance
Headworks Grit Chambers	<10	7.0 (PHF)	NA	Performance
Parshall Flume Flow Meter	15	8.8 (PIF)	NA	Hydraulic
Bio-tower Feed Pump Station	3.7	7.0 (PHF)	3.3 MGD	Redundancy requirement limits analysis to 2 pumps in service
Bio-Towers	24,000 lb BOD /day	22,000 lb BOD/day	NA	BOD loading (can be increased with tower modifications)
Bio-tower Recycle Pump Station	0.75 gal/min/sf		NA	Adequate for wetting media, but lacks redundancy
Aeration Basins	7,700 lb BOD/day	11,000 lb BOD/day	3,300 lb BOD/day	Based on maximum aeration capacity
Mixed Liquor Pump Station	3.3	3.2 (MMF)	NA	In terms of accommodation plant influent flow
MBR System	2.7	3.2	0.5 MGD	Recommended max month flux based on 13.3 gfd
UV System	5.0	6.4	1.4 MGD	System PHF rating
Effluent Weir	9.1	8.8	NA	Hydraulic limitation

[1]Capacity flow numbers are used only for comparative purposes. Loading and other factors dictate the rating of the treatment system.

[2]Deficiency is for current flows and loads, does not account for permitted flows and loads

[3]PHF – Peak Hour Flow, PIF – Peak Instantaneous Flow, MMF – Maximum Month Flow, MGD – million gallons per day

6.1 HEADWORKS

Headworks refers to the preliminary treatment facilities located at the beginning of the treatment process and includes screening of solids, grit removal, and metering. The headworks must be able to provide screening for the peak flow with one unit out of service (IDAPA 460.01.b). According to the manufacturer, each existing screen is sized to handle 10.0 MGD. However, the headworks has serious operational limitations which limit the capacity to less than the manufacturer's rating of 10 MGD. The plant influent sampler is located downstream of the screens. In an effort to obtain a true influent sample, the operators route the influent flow through one screen and the plant recycle flow through the other screen. The result is that one screen is used much more than the other. Relocating the sampler ahead of the screens and combining the influent and recycle flow ahead of the screens will allow each screen to see equal loadings.

The screen has a clean water rating of 13.6 MGD and a wastewater capacity of 10.0 MGD. As the screen collects debris, the capacity is reduced to as much as half before a cleaning cycle would typically be initiated. Thus as the peak flows approach the rated capacity of the screens, more frequent cleaning will be required to maintain flow without excessive headloss. The level control system will automatically increase cleaning during peak flow events.

As stated above the theoretical capacity of each screen is 10 MGD; however, they are not functioning as they should in terms of removing solids and debris. Further, the effective peak flow capacity is most likely less than 10 MGD considering the screens operate somewhere between clean and partially clean. When considering the adequacy of screening at the Jerome WWTP, it is important to consider that screening is one of the most important processes in a MBR system and not having adequate screening greatly increases the potential for problems and premature failure of the membranes.

The horizontal shafted screw conveyor has a manufacturer capacity rating of 70 cubic feet per hour (1,680 ft^3 per day). A typical removal quantity for a 3 mm fine screen would be 20 to 25 ft^3 per million gallons. For the 10 MGD screens, the expected removal would be from 200 to 250 ft^3 per day (7 to 9 yards). Thus the screw conveyor has plenty of capacity for both screens.

Each of the two grit chambers is rated at 5.0 MGD by the manufacturer, for a total grit removal capacity of 10 MGD. The grit classifier has a manufacturer capacity rating of 205 gpm.

Though the Idaho Department of Environmental Quality (DEQ) does not require redundancy for grit removal, this is based on conventional treatment processes and other than MBRs. With MBRs, redundancy is needed in grit removal to ensure there are not any problems with objects passing the grit chamber and fouling up the membranes. While the theoretical peak flow capacity of the grit chamber is 5 MGD, the chambers are apparently not performing adequately as objects have been found in the MBRs that should have been removed in the chambers. Considering this, the effective peak flow of each grit chamber is most likely less than 5 MGD.

The existing 18” Parshall flume is rated for a maximum flow of 15.0 MGD which corresponds to 2.41 feet of water depth (head). At heads greater than 2.41 feet the accuracy of the flow measurement decreases.

6.2 BIO-TOWERS

The bio-tower system must have capacity to treat the maximum month flow rate. The total pumping capacity of the bio-tower feed pump station with the existing three pumps is 5.5 MGD. If a fourth pump were installed, the total capacity would be 7.2 MGD. Flows in excess of the pump capacity overflow to the aeration basin inlet structure. To ensure that minimal problems occur in the MBRs, all the influent flow needs to be treated in the towers. With only three pumps, the firm capacity (one pump off-line) is only 3.74 MGD, not 5.5 MGD. This effectively limits how the towers can be operated, and flows in excess of 3.74 MGD have a greater probability of not being treated before entering the membranes. If the pump for Bio-Tower #2 is out of service, the piping configuration is such that influent cannot be pumped to the tower, which creates a redundancy issue and dramatically decreases the capacity.

Each bio-tower is equipped with a distribution system that spreads the untreated wastewater across the top of the bio-tower. For each tower, the maximum hydraulic capacity is 6,000 gpm (8.64 MGD), which includes recycle flow. Adjusting for rates yields a total maximum BOD loading capacity of 24,000 pounds per day (lb/day) both bio-towers, based on 120,000 ft^3 of media per tower and 100 pounds BOD per thousand cubic feet (lb BOD/kcf) treatment capacity for the media.

The recycle pump station has two pumps with a rated capacity of 3,300 gpm (4.75 MGD) per tower. DEQ requires that each bio-tower have two recycle pumps capable of pumping 0.5 to 4 times the average daily flow (IDAPA 490.01.e.iii). The current pumps can pump from 1,650 gpm to 3,300 gpm using the VFDs. Using 3,300 gpm and a 4 times average flow requirement means the pumps have the capacity for an average flow of 1.19 MGD to each tower, or a total of 2.38 MGD for two towers. Typically a minimum constant flow to a plastic media tower is 0.75 gpm/ft^2. Using this loading rate, the flows to the towers should be at least 3,800 gpm. Based on observations, 3,800 gpm is more than can be handled hydraulically since the recycle pumps lack sufficient capacity, there is no redundancy for recycle, and the piping arrangement limits the ability to recycle flow if a pump is out of service.

These limitations in hydraulic capacity and redundancy, and the problems that occurred when the towers were out of service highlight the importance of having adequate flexibility and redundancy. To correct these deficiencies and be able to treat expected flows without compromising the performance of the activated sludge and MBR processes will require a new bio-tower pump station and yard piping modifications to improve plant hydraulic capacity.

Treatment Analysis

The two 80-foot diameter bio-towers used at the WWTP are designed to operate as “roughing filters” to provide removal of BOD prior to the flow entering the aeration basins. Each tower contains 24 feet of cross-flow and vertical plastic media with a surface area of 30 sqft/cf and 31 sqft/cf, respectively. The total media volume in the two towers is 240,000 cubic feet. Based on an estimated current average BOD loading to the WWTP of 15,660 lb/day, the bio-tower BOD load is 65 lb BOD/kcf. This loading is well within the effective capacity of the bio-towers.

Normally, the effective capacity of plastic media bio-towers is limited more by the potential for odor generation than by the volumetric BOD loading. With adequate wetting and ventilation, bio-towers can operate at BOD loadings up to about 100-125 lb BOD/kcf without major odor generation. However, the influent wastewater characteristics can sometimes result in significant odors being generated at these loadings. With adequate ventilation and odor control, plastic media bio-towers can be operated at BOD loadings up to a maximum of about 300 lb BOD/kcf. However, at these higher BOD loadings, the removal efficiency will decrease.

The bio-towers are equipped with mechanical rotary distributors. These distributors are presently operated to provide one revolution every 16 minutes. At this speed, with a total flow to each bio-tower of 3,000 gpm, the flushing intensity (SK) is about 100 mm/pass. At a BOD loading of 72 lb/kcf, the flushing intensity appears to be in the correct range.

Process monitoring around the bio-towers has been limited to infrequent TSS and COD measurements. Therefore, a special sampling program was conducted to assess the bio-tower operation and performance. Table 6.2 summarizes the data collected during the testing period.

TABLE 6.2 – BIO-TOWER SAMPLING DATA

Sample Date	Sample Analysis	Inlet Channel	Bio Tower 1		Bio Tower 2		Recycle Well
			Top	Bottom	Top	Bottom	
3/12/2012	Total BOD	813	998	779	1,270	1,680	1,210
	Sol BOD	461	154	40	94	42	69
	TSS	920	--	--	--	--	--
3/13/2012	Total BOD	497	1,890	1,540	1,140	1,050	408
	Sol BOD	70	103	<3	28	<3	<3
	TSS	1,220	760	760	920	1,520	1,240
3/14/2012	Total BOD	792	519	632	629	929	1,380
	Sol BOD	403	111	60	91	72	72
	TSS	400	3,960	4,320	3,880	4,160	3,920
3/15/2012	Total BOD	1,140	1,200	822	1,430	1,200	768
	Sol BOD	631	120	66	105	28	<3
	TSS	520	1,800	280	2,200	3,040	1,720
3/16/2012	Total BOD	987	836	201	990	1,193	953
	Sol BOD	349	76	24	54	27	50
	TSS	--	1,900	10	3,150	2,260	2,290

The results of the sampling indicate that the bio-towers are not operating as "roughing filters", but more as an activated bio-filter process (ABF) with recycle of mixed liquor from the aeration basins over the bio-towers. What appears to be happening is that the tower feed pumps generally pump more flow than that entering the WWTP. When this occurs, mixed liquor from the aeration basins recirculates back to the feed pump wet well through the 15-inch pipe connection to maintain the level. The amount of mixed liquor flow varies over the day depending on the influent flow to the WWTP.

It is difficult to determine the performance of the bio-towers due to the mixed liquor solids in the flow. The mixed liquor significantly increases the TSS and the total BOD in the flow due to the biological solids in the mixed liquor. The increase in TSS and total BOD from the mixed liquor overshadows what should normally be observed such that the bio-tower performance cannot be determined from the data collected. In addition, there appear to be inconsistences in the data collected that further complicate analysis of the data.

An evaluation of the data collected indicates the following:

1. The data generally show significantly higher total BOD and TSS in the bio-tower feed and effluent than that measured in the influent flow, due to the recycle of

mixed liquor solids from the aeration basins. Also, the total BOD and TSS in Bio-Tower #2 is generally higher than what is measured in Bio-Tower #1. This is because the mixed liquor solids are preferentially pumped to Bio-Tower #2.

2. For 3/12/12, the data appears to show that there was some mixed liquor return to the bio-towers because the BOD on the top of both towers was higher than the inlet channel BOD. It also appears that the amount of mixed liquor pumped to Bio-Tower #2 was higher than for Bio-Tower #1, based on the higher BOD in Boi-Tower #2. It appears that the towers, with mixed liquor solids that absorb soluble BOD, provided about 85% soluble BOD removal.

3. For 3/13/12, the data shows inconsistencies. The inlet channel TSS analysis (1,220 mg/l) may not be correct. Since the BOD samples from the top and bottom of the bio-towers show much higher BOD than the influent, it appears that there was mixed liquor in the tower feed. This tends to be supported by the fairly high TSS values in the bio-tower samples. The recycle well total BOD value is inconsistent with the high TSS value and with the bio-tower BOD values. The soluble BOD values <3 mg/l are questionable.

4. For 3/14/12, the TSS data appears to show a high mixed liquor return in all bio-tower samples plus the recycle well sample. However, the total BOD values in the bio-tower samples are not consistent with having a high mixed liquor flow. The apparent soluble BOD removal, with high MLSS, was about 82%.

5. For 3/15/12, the TSS data again appears to show mixed liquor in the tower feed. The bottom TSS sample from Bio-Tower #1 appears to be incorrect, as it is much lower than it should be. The bottom TSS sample from Bio-Tower #2 may be higher than it should be. The total BOD appears to be in line with what one would expect compared to other data. However, the recycle well soluble BOD value of <3 mg/l is questionable.

6. For 3/16/12, it appears that there was mixed liquor feed to the towers and that there are inconsistencies in the data. The bottom sample from Bio-Tower #1 appears to have much lower BOD and TSS than it should. The apparent soluble BOD removal, with high MLSS, was about 85%.

Since it was not possible to accurately determine the performance of the bio-towers at the Jerome WWTP, data from other treatment facilities was reviewed to assess the potential total BOD removal at Jerome. The total BOD removal data from five treatment facilities using bio-towers is summarized in Table 6.3. As indicated, the BOD removal data for three of the facilities includes the performance in both the bio-towers and with settling of the bio-tower effluent.

TABLE 6.3 – BIO-TOWER TOTAL BOD REMOVAL PERFORMANCE

Treatment Plant	Bio Tower Feed (mg/l)	Tower Effluent (mg/l)	Clarifier Effluent (mg/l)	Tower Removal (%)	Removal w/ Sedimentation (%)
San Pablo, CA	139	88	--	37%	--
Fairfield, CA	250	143	61	43%	76%
Watsonville, CA	234	137	--	41%	--
Williamsburg, VA	641	404	289	37%	55%
Modesto, CA	210	113	88	46%	58%

Based on the information presented in Table 6.3, the total BOD removal ranged from 37 percent to 46 percent in the bio-towers without settling. With settling, the total BOD removal increased to as much as 76 percent. The increase in removal with sedimentation is related to the soluble BOD removal in the bio-towers and the settleability of the solids produced. It should be noted that the bio-towers at Williamsburg, VA were highly loaded and had lower soluble BOD removal than the other facilities.

Based on this data, together with experience with the ABF tower at Twin Falls, ID, which achieved 38 percent total BOD removal, it is estimated that the Jerome bio-towers should be capable of removing about 40 to 50 percent of the total BOD without settling. In a bio-tower, soluble BOD is converted to biological solids which continue to exert an oxygen demand. If the solids are not removed from the bio-tower effluent, this oxygen demand is passed on to the aeration basins. Not removing the biological solids effectively limits the total BOD removal. While the 2004 facilities plan indicates a design BOD removal efficiency of 65 percent in the bio-towers, this is not likely without removal of the TSS in the bio-tower effluent. The maximum bio-tower loading based on 100 lb BOD/kcf is 24,000 lb BOD/day.

6.3 AERATION TANKS

The aeration basins at Jerome were originally constructed in 1979. Modifications to the aeration equipment have been made over the years, resulting in the existing fine bubble aeration system that was installed in 2003. The basins were designed using side slopes on the floor to minimize construction costs and accommodate jet aeration equipment. The original basin volume was 1.5 MG, but this was reduced slightly to 1.4 MG during the conversion of the process to a membrane bioreactor (MBR) process.

The aeration system installed in 2003 consists of a fine bubble aeration grid system that covers the flat portion of the aeration basin floor. The aeration system was furnished by Environmental Dynamics, Inc. (EDI). Due to the side slopes of the aeration basin, the aeration grid was limited to about 33 percent of the total basin plan area. A total of about 1,606 diffusers are installed in the grid, and the system is designed for an air flow of 7,667 scfm. Based on information in the 2004 Aqua Facilities Plan, it appears that the aeration system was designed based on a clean water SOTE oxygen transfer efficiency of 21.3 percent and an actual oxygen transfer capability of 650 pounds of oxygen per hour. It should be noted that this design appears to be based on operation as a conventional activated sludge process before conversion to operate as a MBR process.

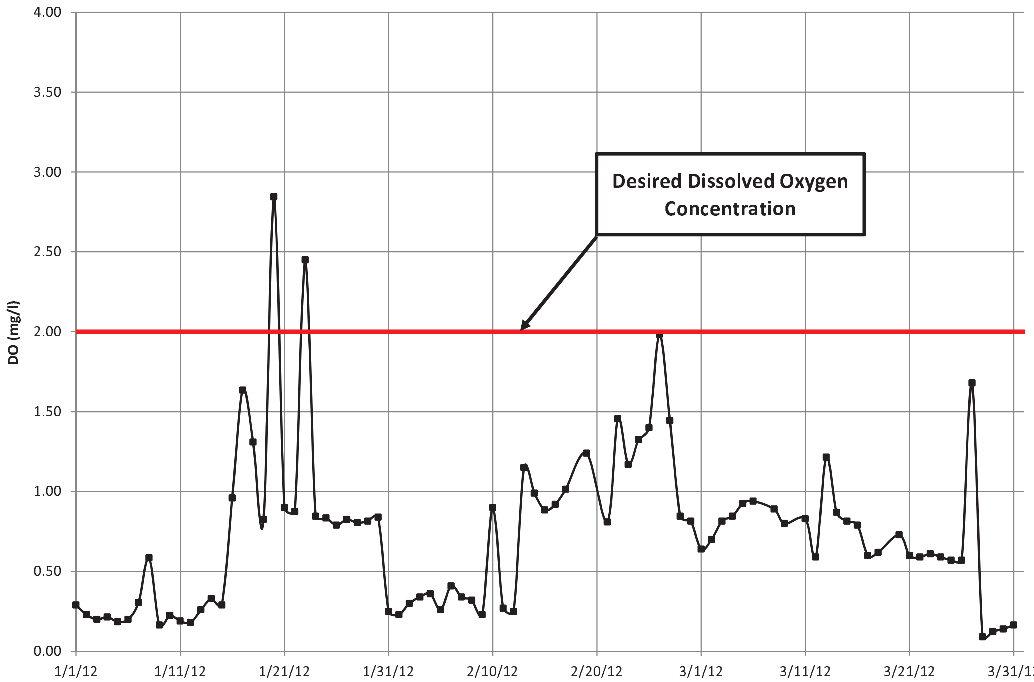
As part of a previous WWTP upgrade project, two new aeration blowers were installed, in addition to two existing blowers, to furnish air for the aeration basins. The aeration blower system now consists of four 150 HP multistage blowers. Normally, three blowers are used for delivering air to the aeration basins and one blower is used to deliver air to the aerobic digester. With three blowers in operation, the total air flow delivered to the aeration basins is about 7,500 cfm. The WWTP staff has indicated that in the mornings during cold weather, the blower motors can become overloaded and trip out on overload due to more dense air increasing the horsepower required. Also, they have reported that there are some problems with blower surge on hot days if the blower output is reduced.

The most important criteria in the operation of the aeration basins is to maintain the desired dissolved oxygen (DO) concentration. Normally, it is desirable to maintain 2.0 mg/l DO in the aeration basins to ensure adequate oxygen is available for metabolism of the influent organic matter (BOD) by the microorganisms in the process, and to ensure nitrification. With the high mixed liquor concentrations used in a MBR process, it may be desirable to maintain DO concentrations greater than 2.0 mg/l. Other process operating conditions, such as Enviroquip's SymBio process, may call for less than 2.0 mg/l DO.

Because of the existing loadings to the WWTP, the staff has found it is better to operate the MBR process with continuous aeration, rather than intermittent aeration and the use of the basin mixers to promote nutrient removal. With continuous aeration, it is reported that there is better floc buildup and improved MBR operation.

The aeration basin DO data was reviewed. The daily average DO concentration for the first three months of 2012 is presented in Figure 6.1. The aeration basin DO has generally been below 1.0 mg/l, and has only exceeded the desired DO concentration of 2.0 mg/l twice during the first three months of 2012. Since three blowers were generally operated at maximum capacity to deliver about 7,500 cfm, the data indicate a severe aeration capacity deficiency.

FIGURE 6.1 – AERATION BASIN DISSOLVED OXYGEN



Since the fine bubble aeration system was manufactured and supplied by EDI, an analysis of the oxygen transfer capacity of the existing aeration system was evaluated using EDI's Aeration System/Diffuser Design design tools program. Based on the EDI calculations, using an alpha factor of 0.4 to account for higher MLSS with MBR system operation, it appears that the effective oxygen transfer capacity of the existing aeration system is about 450 lb O_2/hr or 10,800 lb O_2/day. Assuming 1.4 lb O_2/lb BOD, the existing aeration system has sufficient capacity to handle a maximum BOD load of 7,700 lb/day. Based on this analysis, the effective oxygen transfer capacity of the existing system is much less than that indicated previously.

In terms of blower capacity, it appears that three aeration blowers are required at all times. Because one of the four blowers is used for aeration of the aerobic digester, there is no redundancy in the blower system. If one blower is out of service, it would be necessary to reduce the air flow to the aeration basins, further reducing the effective capacity of the system. DEQ requires that the aeration system provide the maximum oxygen demand with the largest blower out of service (IDAPA 490.02.iii.b).

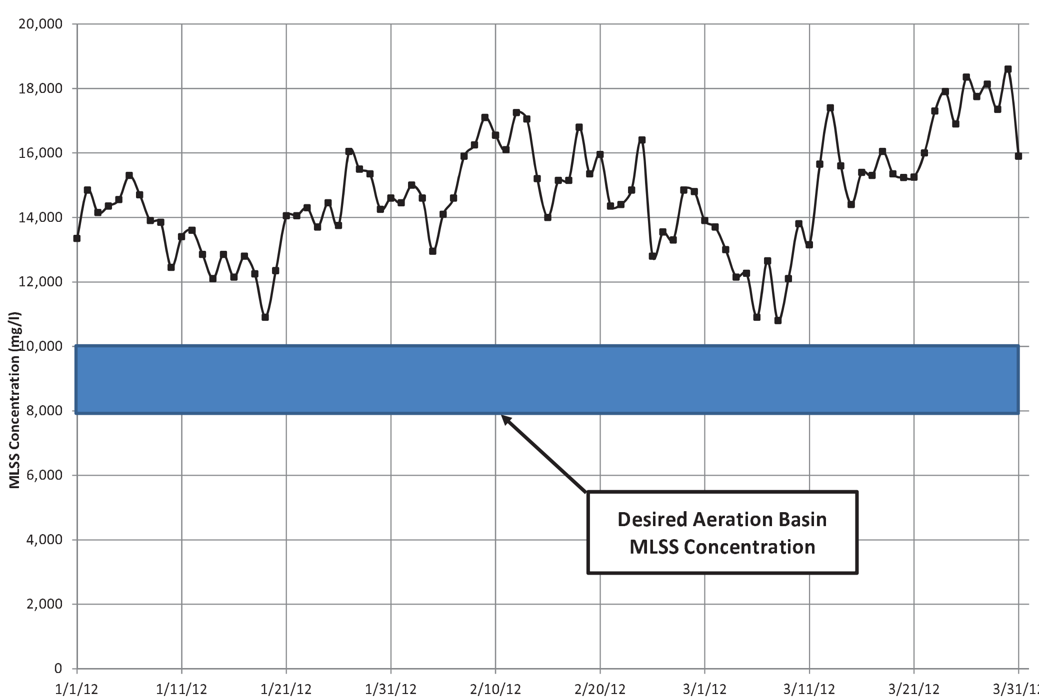
Based on the estimated existing BOD removal rate in the bio-towers, the maximum allowable BOD load in the WWTP influent without exceeding the aeration capacity is about 12,800 to 15,400 lb/day. Since the estimated average total BOD load to the WWTP is 17,000 to 18,000 lb/day, with maximum daily loads in excess of this average loading, the capacity of the aeration system is much less than what is currently required for existing WWTP influent BOD loads.

When evaluating the effective capacity of the aeration basins themselves, the ability to maintain the desired operating conditions in terms of mean cell residence time (MCRT) is one of the most important operating criteria. The MCRT, which is an effective loading criterion for all activated sludge processes (including MBRs), determines the relative stability of the mixed liquor, the ability to nitrify, and the removal or stabilization of organic matter that could potentially cause problems with the membranes. During the first three months of 2012, the WWTP staff set a target MCRT of between 23 and 30 days for operation of the process. Based on the reported data, the actual average MCRT was 31 days. While there appear to be some questions concerning the sludge wasting and MCRT calculations, this value is reasonable.

One critical factor in the operation of a MBR process is the MLSS concentration in the aeration basins and the MBR basins. Normally, it is desirable to maintain a MLSS concentration of 8,000 mg/l – 10,000 mg/l in the aeration basins, and a MLSS of 10,000 mg/l – 12,000 mg/l in the MBR basins. Higher mixed liquor concentrations can be used but additional air scour (resulting in increased energy cost) and increased wear and tear on the membrane are factors to consider. These concentrations also depend on the season, as in the winter the desire is to carry a little more solids for operation.

The average daily MLSS concentration in the aeration basins during the first three months of 2012 is shown in Figure 6.2. It can clearly be seen that the actual operating MLSS concentration in the aeration basins exceeded the desired operating range. High MLSS concentrations indicate overloading of the process and potential problems in the MBRs due to fouling of the membranes, reduced permeability, and a higher potential for solids caking between the membrane plates. While the MBR system can operate with higher MLSS concentrations for short periods of time, this is not desirable on a long-term basis due to potential failure or deterioration of the membranes.

FIGURE 6.2 – AERATION BASIN MLSS CONCENTRATION



To estimate the effective capacity of the aeration basins, an aeration basin MCRT of 20 days was selected together with a MLSS concentration of 10,000 mg/l in the aeration basins and a sludge production of 0.7 lb TSS/lb influent BOD. With four MBR basins in service, the total MLSS inventory in the system would be about 117,600 lb MLSS. Based on the estimated sludge production of 0.7 lb TSS/lb influent BOD, the aeration basins have an effective capacity of about 8,400 lb BOD/day.

Overall, based on both the existing aeration capacity and the aeration basin volume, the maximum influent BOD capacity of the existing aeration basins and aeration system is about 8,000 lb BOD/day. This effective capacity is significantly less than the existing BOD load to the WWTP as well as the Phase 1 design capacity of 13,370 lb BOD/day. On an average basis, the aeration basin capacity is about 83 percent of that needed for the existing BOD loadings to the plant.

The aeration system, which must be able to maintain dissolved oxygen in the basins under maximum loading conditions, is not capable of meeting the existing loadings to the WWTP. Based on the maximum permitted industrial BOD load of 18,700 lb/day, plus 4,000 lb BOD domestic load, the aeration system should be capable of handling a total influent BOD load of 22,700 lb BOD/day. Since the effective capacity of the aeration system is estimated to be 8,000 lb/day, when accounting for an approximate removal of 45% BOD through the bio-towers, the existing system is only rated for about 64% of the permitted treatment load. In addition, there is no redundancy in the blower equipment, so if a blower is out of service, the aeration capacity is further reduced.

The design flow for each of the existing mixed liquor pumps is 3,473 gpm at 22 feet of total dynamic head. Thus the total maximum flow from the pump station is approximately 13,892 gpm (20 MGD). With three pumps in service, the maximum pumping capacity is 11,664 gpm (16.8 MGD). Normally, the mixed liquor flow from the aeration basins to the MBR basins is about five times the influent flow. This high flow ensures that the MLSS concentration in the MBR basins does not become too high. The pump firm capacity (when redundancy is considered) is reduced to accommodating a plant influent flow of 3.3 MGD as the pumps convey the recycle and influent flow. Currently increasing the pump size alone will not fix this problem as the MBRs are limited by flux capacity. Higher mixed liquor pumping recycle rates should be considered when tanks 5 and 6 are equipped with membranes.

6.4 MEMBRANE BIO-REACTOR (MBR)

Currently, MBR Basins 1 and 2 each contain 10 RW400 cassettes in a double stack configuration of five cassettes on the bottom and five on top. MBR Basins 3 and 4 each contain 10 EW400 cassettes. Each membrane cassette consists of 400 cartridges. Each RW400 cartridge has 15.61 ft^2 of surface area for a total of 6,244 ft^2 per membrane cassette, while each EW400 cartridge has 13.45 ft^2 of surface area for a total of 5,380 ft^2 per membrane cassette.

The MBR system was initially designed for maximum month flux rate of 12.9 gallons per square foot per day (gfd), a peak day flux of 20.0 gfd, and a peak hour flux of 26.6 gpd. Given the high industrial loadings and the necessary biological treatment, more conservative flux rates and/or a conservative biological design is recommended. A conservative design would use an average daily flux rate of 9.0 gfd, a peak day flux of 14.5 gfd, and a peak hour flux of 23.5 gpd.

Using these conservative flux rates, the capacity of the existing four MBR basins is 1.98 MGD average day, 3.19 MGD peak day, and 5.17 MGD peak hour. If the EW400 cassettes in basins 3 and 4 were replaced with the RW400 cassettes, the treatment capacity of the MBR system based on the conservative flux rates would be 2.00 MGD average day, 3.26 MGD peak day, and 5.28 MGD peak hour. If basins 1 through 4 each had 10 RW400 cassettes and the two empty basins were also each outfitted with 10 of the RW400 cassettes, the treatment capacity of the MBR system based on the conservative flux rates would be increased to 3.37 MGD average day, 5.43 MGD peak day, and 8.80 MGD peak hour.

If the biological process design is modified to include volume necessary for a conservative solids retention time and mixed liquor concentration, then a maximum flux of 13.3 gfd for maximum month flows as recommended by the manufacturer is appropriate along with 20.0 gfd for peak day flows, and 26.6 gfd for peak hour flows. For all six basins each populated with 10 of the RW400 cassettes, this provides a membrane capacity of 5.0 MGD maximum month, 7.5 MGD peak day, and 10.0 MGD peak hour. It should be noted that these capacity numbers do not account for plant recycle and therefore do not correspond directly with plant design criteria.

The design rating for the permeate pumps is 1,268 gpm at 18.2 feet TDH (pump speed of 720 rpm per the manufacturer’s submittal pump curve). This is the peak flow rate, as the pump can be slowed down with a VFD. With the existing four pumps, the current permeate capacity is 5,072 gpm (7.3 MGD). With two more equal pumps installed, the future permeate pumping capacity would be 7,608 gpm (11.0 MGD). Thus the permeate pump capacity would exceed the required flux capacity of the membranes.

However, the piping arrangement for the permeate pumps is such that there is a lack redundancy. Because each permeate pump is connected to membranes in more than one basin, if one pump is inoperable two MBR basins are affected. Losing mebrane capacity is very critical to the plant as the membranes are already at capacity. Additional membranes should be added to basins 5 and 6 and piping should be configured to individual basins to provided recommended plant redundancy for the membranes.

The NPDES permit limits effluent total phosphorus (TP) to a monthly average of 204.5 pounds per day on a year-round basis. For an effluent flow of 5.0 MGD, this would be an effluent concentration of 4.90 mg/L. The average effluent TP has been approximately 11 mg/L. To reduce TP from 11 mg/L to 4.9 mg/L would require a stoichiometric dose of approximately 1.0 pounds of aluminum for each pound of phosphorus to be removed, or a dose of approximately 105 mg/L of alum. To provide this dose of alum would require a pumping rate of 395 gpd, or 16.5 gph. Thus the existing chemical addition system, with a capacity of 30 gph, could provide the required dosage up to an effluent flow rate of 10 MGD.

6.5 ULTRAVIOLET (UV) DISINFECTION

There are two UV reactors that provide disinfection of the effluent before discharging to waters of the US. The UV system needs to be able to disinfect the peak flow rate. The Jerome UV reactors are stainless steel reactors (Wedeco type LBX750), and are each rated at 5.0 MGD based on a UV dose of 80 milliJoules per square centimeter (mJ/cm^2), an assumed UV transmittance of 70% for the MBR effluent, and an effluent limit of less than 2 fecal coliform per 100 mL. However, since the NPDES effluent limit is 126 E. coli per 100 mL, it may be possible to re-rate the UV system to a higher capacity.

For the existing UV system and design UV dose, the total capacity is 10 MGD, or 5 MGD with redundancy requirements met (treatment with one unit off-line), for a limit of 126 E. coli per 100 mL.

There is an existing location to add a third UV reactor. The third unit should be installed when MBR basins 5 and 6 are added to the system.

6.6 EFFLUENT WEIR AND FLOW MEASUREMENT

The effluent weir and flow meter must be able to measure the peak instantaneous flow. The current peak hour flow is 6.4 MGD with the potential 2015 peak hour flow of 8.4 MGD (see section 6.4.4). The distance from the top of the existing concrete wall around the utility water storage tank is approximately 29” above the V. A 90^{o} V-notch weir is rated to measure 9.14 MGD with 24” of head. Thus the existing V-notch weir is sufficient for current and future peak flows until about 2020. However, the freeboard in the storage tank will be less than recommended at about 5” at peak flow.

6.7 AEROBIC DIGESTERS

To provide for Class B sludge, aerobic digesters must allow for a minimum of 40 days solids retention time (SRT) at 20^{o}C, or 60 days at 15^{o}C to meet 503 regulations. These SRTs should be maintained to ensure adequate digestion of the sludge. The typical design range parameters used for aerobic digester design are provided in Table 6.4.

TABLE 6.4 – AEROBIC DIGESTION FOR THE JEROME WWTP

Parameter	Design Range[1]
Detention Time (days)	40-60
Volatile Solids Loading Rate, ppd/ft^3	0.1-0.3
Oxygen Requirements, lb O_2/lb VSS destroyed	2.3
Energy Requirement for Mixing, cfm/1000 ft^3	20-40
DO in Digester, mg/L	1-2
VSS Reduction, %	38-50

Notes:
1. Metcalf and Eddy, Wastewater Engineering, 4th Edition

The City has a current volume of 537,000 gallons in Digester 1. There is the potential to add 280,000 gallons in the sludge storage tanks and 170,000 in Digester 2. The operators currently waste an average of 110,000 gallons per day. This results in a hydraulic retention time (HRT) of about five days in the existing digester, and nine days if sludge storage and Digester 2 were included. The digester volume needed to meet the required 60-day HRT during the winter is 6,600,000 gallons at current wasting levels. A thickening process would reduce the required digester volume.

In summary, the digesters are currently not meeting the 503 regulations, due to insufficient volume. Recommendations for improvements will be discussed in Chapters 8 and 9.

6.8 DEWATERING

The dewatering belt filter press has a rated capacity of 2,000 dry pounds per hour and a maximum hydraulic throughput of 250 gpm.

At 250 gpm, the belt press can process 110,000 gallons of digested sludge in 7 hours. The operators are dewatering in 8 hour shifts, 7 days a week to keep up with the volume of sludge produced. The solids content of the dewatered sludge is approximately 16% due to operational improvements and upgrades to the polymer feed system.

The belt filter press does not have the dewatering capacity to meet the current dewatering needs for the City. This inability to control and manage sludge wasting, sludge storage/digestion, and dewatering is one of the biggest operational limitations in the plant. Potentially, these limitations could result in complete failure of the plant. If the belt press or press feed pump were to be out for more than a day, this would result in severe problems. The inability to control or maintain wasting amounts creates a “bottleneck” in the system. To effectively maintain adequate overall process control and operation of the activated sludge and MBR systems this bottleneck needs to be eliminated.

The lack of holding tanks, digestion, piping configuration, pumping systems, and redundancy provisions will require a major upgrade to the solids handling system.

6.9 SLUDGE DRYING BEDS

The sludge drying beds are used for temporary storage and have an area of approximately 2.42 acres. Based on pan evaporation and precipitation data for the Jerome area, the existing sludge drying beds are sized to dry approximately 1.5 million pounds of sludge per year on a dry solids basis. This drying capacity represents approximately 30% of the City’s current sludge production.

6.10 SUMMARY

This section summarizes the effective capacity, limitations, and conclusions for the headworks, bio-tower system, MBR basins, and solids handling as previously discussed in Chapter 5 as well as in this chapter. Table 6.5 presents a summary of the major issues that currently limit the plant capacity to treat liquid waste. In addition to these major issues, there are several lesser issues that need to be addressed.

TABLE 6.5 – SUMMARY OF CURRENT CAPACITY ISSUES

Item	Existing Capacity	Existing Capacity Needs
Bio-tower Feed Pump Station[1]	3.7 MGD Firm Capacity with 2 pumps running	7.0 MGD based on pumping peak hour and plant recycle flows
Aeration Basin[2]	7,700 lb./day BOD based on Max Day Load (less with a diurnal peaking factor)	11,000 lb./day BOD based on permit sold and plant loading data
Mixed Liquor Pump Station	16.8 MGD based on influent flow plus a recycle rate of 4	Flows of 16.8 MGD recycle flow is adequate for a process flow of 3.3 MGD or an influent of 3.3 MGD
Membranes	2.7 MGD based on manufacturer recommended maximum month flux rates	3.2 MGD 3.5 MGD when plant recycle is accounted for

[1]- No pump redundancy to bio-tower #2 due to piping configuration
[2]-Capacity is based on diffusers; if blower redundancy is accounted for, the capacity is less

Headworks: The effectiveness of the headworks is limited by the screening configuration and single grit chamber. Only one screen can receive influent raw sewage, and the other screen receives only the plant drain and septage flows. This allows for uneven loading on the screens. This arrangement also creates problems for measuring flow and providing a complete description of the plant influent as the domestic and industrial waste are currently not metered separately. Further, the theoretical capacity of the screen is less than 10 MGD when considering that operation is typically not with a fully clean screen. There is no redundancy with a single grit chamber, and the chamber is not removing items that are fouling up the membranes. Adequate grit removal is important in membrane performance, and redundancy is a limiting factor that needs to be considered even though it is not a DEQ requirement.

Bio-towers: The firm capacity of the bio-tower feed pumps is 3.74 MGD. Considering all influent flow needs to be treated to ensure minimal problems in the MBRs, there is a redundancy issue with the pumping system that will require a new bio-tower pumping station as well as revised plant hydraulics to correct the problems. Additional concerns include the piping configuration. If the pump to Bio-tower #2 is out of service, no influent can be pumped to that tower. The result is that flow bypasses the bio-towers during peak flow events and Bio-tower #1 can be overloaded. Also the recycle pumps don't have any redundancy provisions, and the piping arrangement could result in severe limitations if one of the recycle pumps is out of service. This system requires improvements to provide adequate flexibility and redundancy so that the performance of the activated sludge and MBR process is not compromised.

Aeration: The existing aeration basins can treat up to 7,700 lbs BOD/day based on the existing diffuser system ratings. This corresponds to an influent BOD load of approximately 14,000 lb/day. This could be increased by improving the aeration system with changes to blowers, piping, and diffusers. However, the aeration basins are also limited by the available volume for an appropriate mixed liquor concentration and solids retention time. Based on standard solids retention times (20 to 25 days) and mixed liquor concentrations (10,000 to 12,000 mg/L), the current aeration basin volume cannot support the existing BOD load. This requires the plant to be operated in a less conservative manner and adds to the concern with risk associated with membrane fouling.

MBR System: The limitations of the MBR basin include the feed system, which has no flow meter or control valves to accurately control flow to each basin. Also, the permeate pump piping is configured so that two tanks are taken offline for maintenance or membrane replacement, which significantly reduces the firm capacity of the existing membranes. A more conservative biological system is recommended when using the current membrane flux rates. Basins 5 and 6 should be populated to decrease the flux through the membranes to a more conservative rate. Another limitation to the performance is the lack of a redundant turbo blower, as the positive displacement blowers have been problematic.

Solids Handling: The solids handling system is not able to meet Class B regulations, which limits the disposal options. Also, the digesters are too small to stabilize the solids sufficiently to prevent odors from the sludge drying beds. The sludge drying beds are too small to dry all the solids that are currently produced at the plant. There is only one belt filter press that has the capacity to process 250 gpm. The press is run 12 to 18 hours a day to keep up with sludge production. Another belt filter press is needed to provide redundancy within the solids handling system and keep up with the solids wasting. If the belt filter press or feed pump is offline for more than a day, severe problems could occur due to the lack of sludge storage available. Due to the configuration and limitations of the holding tanks, digester, and pump systems, the solids handling system is a bottleneck that constrains what can be wasted and how wasting can be controlled.

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