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TECHNICAL MEMORANDUM NO. 5

Water Restoration Plant Facility Plan

Liquid Stream Process Analysis

FINAL

October 2013

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City Of Grants Pass

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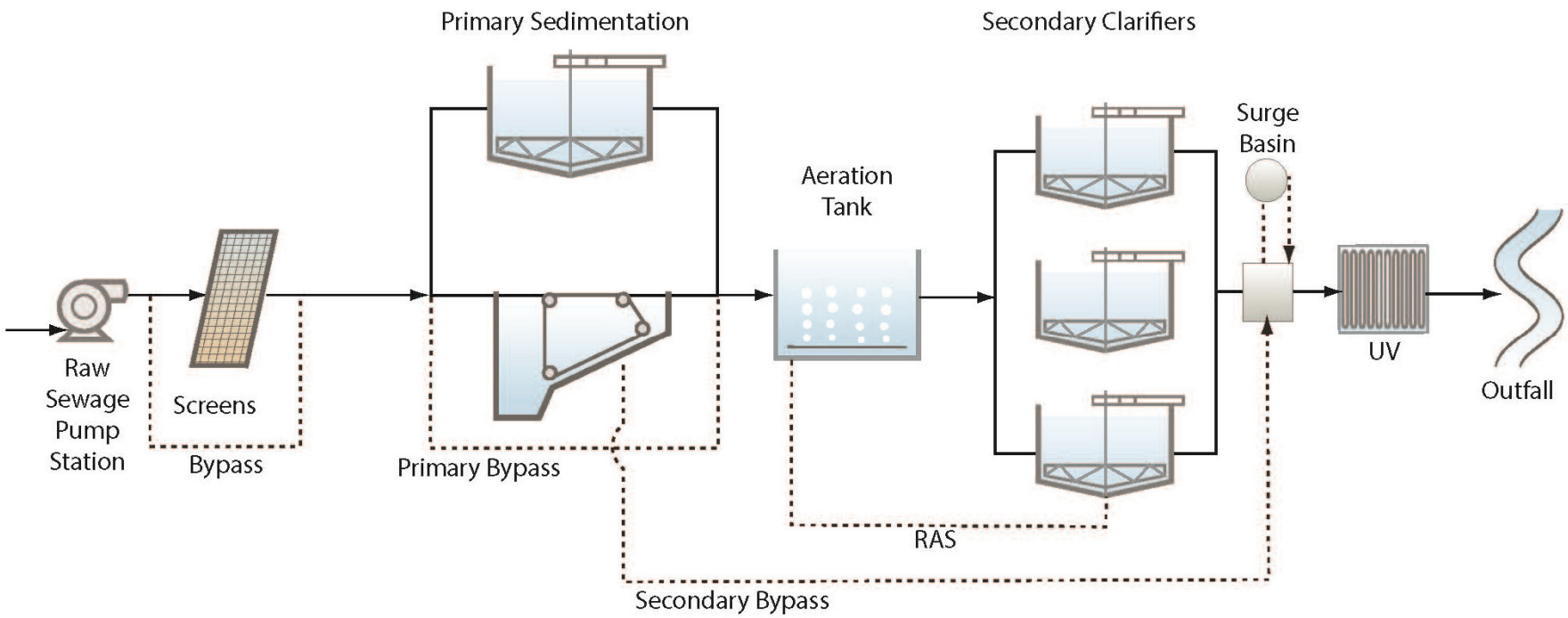
LIQUID STREAM PROCESS ANALYSIS

The Grants Pass Water Restoration Plant (WRP) provides partial nitrification in the summer and secondary treatment during winter months for the City of Grants Pass. The WRP began operation as a primary treatment plant at its current site in 1935, and was upgraded to secondary treatment in 1962. In 1974, the activated sludge process was implemented as part of a major plant upgrade project. Rectangular primaries and an ultraviolet (UV) disinfection system was added in 1995. There were subsequent upgrades in 1999 to add a second UV disinfection system. The most recent upgrade, which followed a Facilities Plan Update in 2001 (Parametrix 2001), included upgrades to the Raw Sewage Pump Station, a new Parshall flume, modifications to the activated sludge aeration tanks, a new secondary clarifier, and other ancillary improvements.

A schematic diagram of the liquid stream process units in the Grants Pass WRP is shown in Figure 1. The WRP includes the following major unit process elements:

- Raw Sewage Pump Station.
- Screening System.
- Primary Sedimentation Tanks.
- Aeration Tanks.
- Secondary Sedimentation Tanks.
- Ultraviolet Disinfection System.



GRANTS PASS WRP LIQUID STREAM PROCESS SCHEMATIC

FIGURE 1

CITY OF GRANTS PASS
LIQUID STREAM PROCESS ANALYSIS

1.0 RELIABILITY CRITERIA

To establish unit process capacity, criteria must be established for acceptable reliability of unit process elements. Reliability criteria were established by the United States Environmental Protection Agency (EPA) for national use in 1974 (EPA 1974) as part of the EPA's Construction Grants Program. Although these criteria were strictly applicable only to wastewater treatment plants constructed under that program, which no longer exists, they provide a recognized benchmark upon which to establish reliability requirements for wastewater treatment plants.

The EPA Reliability Criteria created three general reliability classes, depending on whether the effluent discharge was to receiving waters that “could be permanently or unacceptably damaged by effluent which was degraded in quality for only a few hours" (Class I) or "would not be permanently damaged, but could be damaged by continued (on the order of several days) effluent quality degradation" (Class II) or "not otherwise classified" (Class III). Reliability criteria for the unit processes in the Grants Pass WRP are shown in Table 1. The table includes reliability criteria for each major unit process in the Grants Pass WRP for each of the three EPA reliability classes and proposed reliability criteria for this Facilities Plan.

Table 1 Unit Process Reliability Criteria
City of Grants Pass – Liquid Stream Process Analysis

Unit Process	EPA Criterion Class I	EPA Criterion Class II	EPA Criterion Class III	Proposed Criterion for Grants Pass WRP
Trash removal	Shall contain	Same as for Class I	Same as for Class I	Mechanical screens provided
Grit removal	Shall contain	Same as for Class I	Same as for Class I	Provided
Mechanically-cleaned bar screens	Backup screen shall be provided (manual OK)	Same as for Class I	Same as for Class I	PHF with bypass channel(1)
Pumps	Largest unit out of service (OOS)	Same as for Class I	Same as for Class I	PHF with largest unit OOS
Primary sedimentation tank	50% capacity with largest unit OOS	Same as for Class I	At least two tanks	MMWWF (2) capacity with largest unit OOS
Aeration tank	At least two equal volumes	Same as for Class I	Single tank permissible	One tank OOS under AAF (3) (5)
Aeration blowers or aerators	Design rate with one unit OOS	At least two blowers or aerators	Same. One unit uninstalled acceptable	Max Month BOD load with one unit OOS

Table 1	**Unit Process Reliability Criteria** ***City of Grants Pass – Liquid Stream Process Analysis***			
Unit Process	**EPA Criterion Class I**	**EPA Criterion Class II**	**EPA Criterion Class III**	**Proposed Criterion for Grants Pass WRP**
Air Diffusers	Largest section OOS	Same as for Class I	Same as for Class I	Largest section OOS at AAF
Secondary clarifier	75% capacity with one unit OOS	50% capacity with one unit OOS	50% capacity with one unit OOS	One tank OOS under AAF (5)
Disinfectant contact tanks	50% capacity with one unit OOS	Same as for Class I	Same as for Class I	50% capacity with one unit OOS at PHF
Hydraulic profile	100% capacity with one unit OOS	Same as for Class I	Same as for Class I	No weir submergence at PHF with AIS (4)

Notes:
(1) PHF – Peak Hour Flow,OOS – Out of Service
(2) MMWWF – Maximum Month Wet Weather Flow
(3) AAF – Average Annual Flow
(4) AIS – All in service
(5) Either one aeration tank or one secondary clarifier out at average flow

2.0 RAW SEWAGE PUMP STATION

The Raw Sewage Pump Station at the Grants Pass WRP includes three main pumps, each with a capacity of 18 mgd and one smaller pump with a capacity of 8 mgd. With all pumps in service, the rated capacity of the pumping station is 62 mgd. The firm capacity (with one of the largest units out of service) is 44 mgd. As shown in Figure 2, the firm capacity of the raw sewage pump station should exceed the anticipated peak hour flow (PHF) demand throughout the planning period.

The Raw Sewage Pump Station was upgraded in 2007 to replace the three largest pumps. These pumps are screw centrifugal pumps manufactured by Hidrostal. The small pump is a conventional horizontal centrifugal pump originally installed in 1996. There have been no operational or maintenance problems with the pumps. The pump station itself was constructed in 1974 and is in good condition.

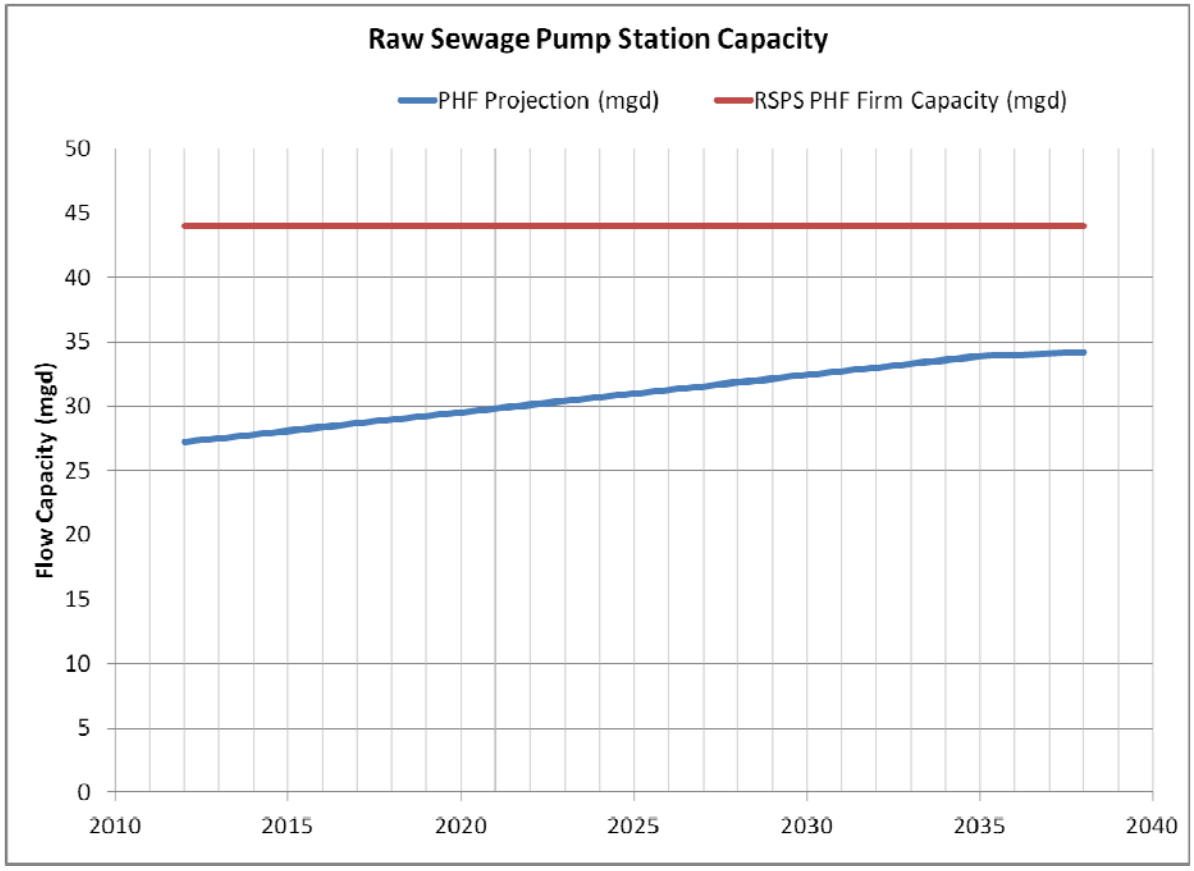


Figure 2 Raw Sewage Pumping Capacity Diagram

3.0 SCREENING SYSTEM

The raw wastewater screening system includes one mechanical screen with a PHF capacity of 23.5 mgd,and a perforated plate screen with the same PHF capacity. A bypass channel is provided. With both screens in service, the PHF capacity of the two screens is 47 mgd. The hydraulic capacity of the bypass channel with a one foot of freeboard below the top of the wall is approximately 10.5 mgd. Therefore, with one bar screen OOS and the bypass channel in service, the reliable PHF capacity of the screening system is 34 mgd. As shown in Figure 3, this is adequate capacity for the planning period. However, there are hydraulic limitations downstream of the screens that limit the flow through the screens to approximately 18.5 mgd. For a discussion of these limitations, see Section 8 below.

The screening system has one screw compactor / washer with a peak solids handling capacity of 25 cubic foot per hour (cf/hr). Assuming a screenings capture rate of 10 cubic foot per million gallons of flow, the predicted screenings quantity is compared to the capacity of the single screenings washer in Figure 4. The washer capacity is adequate for the projected planning period loading and there is adequate spare capacity after the recent purchase of a spare.

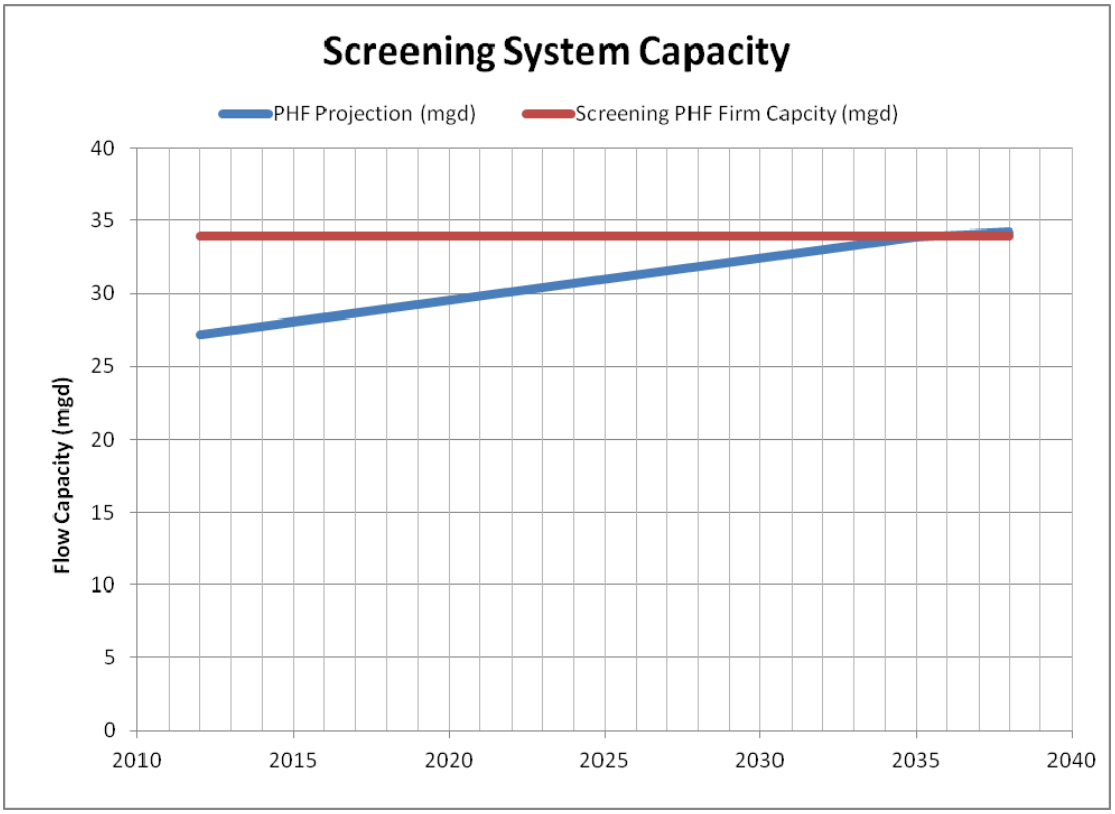


Figure 3 Screening System Capacity Diagram

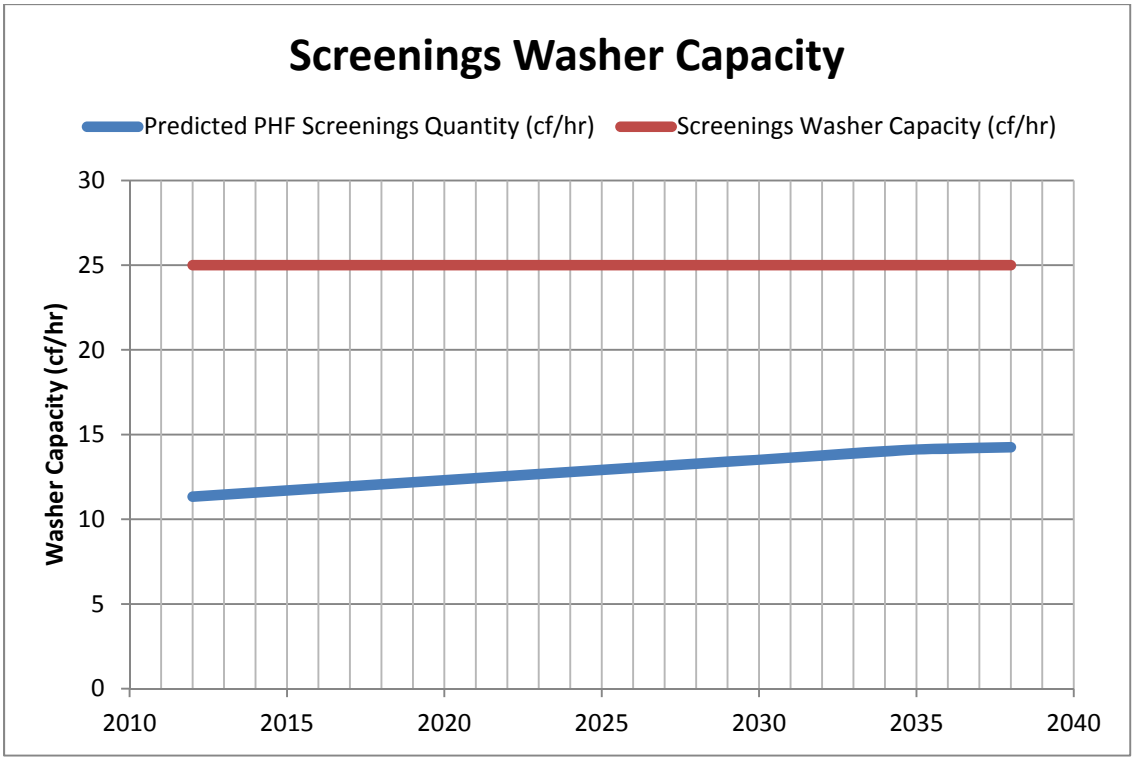


Figure 4 Screenings Washer Capacity Diagram

4.0 PRIMARY SEDIMENTATION

The Grants Pass WRP has two rectangular primary sedimentation tanks, each 108 foot by 21.5 foot, and one radial-flow circular unit, 70 foot in diameter. The circular unit was orignially configured for storm flow sedimentation, but has been converted under present operation for sludge storage and is not currently used for sedimentation.

Figure 5 presents data from the most recent five-year record of flows at the Grants Pass WRP for removal of total suspended solids (TSS) as a function of overflow rate, and Figure 6 presents comparable data for removal of five-day biochemical oxygen demand (BOD_5). Overflow rates were calculated based on both rectangular units in service except for a short period in 2011. The removal rate data show a typical scatter of performance due to the transient nature of influent solids properties. The figures show logarithmic data fits into the mean of the data.

Figure 7 presents calibration of the Carollo primary sedimentation model to the fitted mean of the measured data. This model calculates removal of rapidly settleable and slowly settleable solids particles based on assumed sewage wastewater characteristics calibrated to data from 2011. The figures show that the Carollo model is very well fitted to Grants Pass data for overflow rates up to 2,000 gpd/sf and conservative for higher overflow rates. This model was used to calculate loadings to the activated sludge system for design loadings.

Based on review of this data, Carollo recommends a design overflow criterion for max month wet weather flow (MMWWF) capacity of the primary sedimentation tanks at 2,000 gpd/sf, which produces a mean removal rate of approximately 40 percent for TSS. Based on the relatively good performance of the existing tanks under high flow conditions, we recommend a capacity rating for PHF at an overflow rate of 4,000 gpd/sf. With the two rectangular tanks in service, this produces a MMWWF capacity of 9.3 mgd and a PHF capacity of approximately 19 mgd. With only one unit in service, the capacity at 2,000 gpd/sf would be 4.6 mgd. This compares to current flows of 5.2 mgd average dry weather flow (ADWF), 10.2 mgd MMWWF, and 27.2 mgd PHF.

Figure 8 presents the MMWWF capacity of the existing rectangular units with both in service compared to projected MMWWF. The figure indicates that provision of one more rectangular unit of the same size as existing would extend MMWWF capacity to approximately the year 2020. Figure 9 presents comparable capacity comparison based on the PHF criterion. This shows that provision of two more rectangular units would provide sufficient PHF capacity beyond the year 2035.

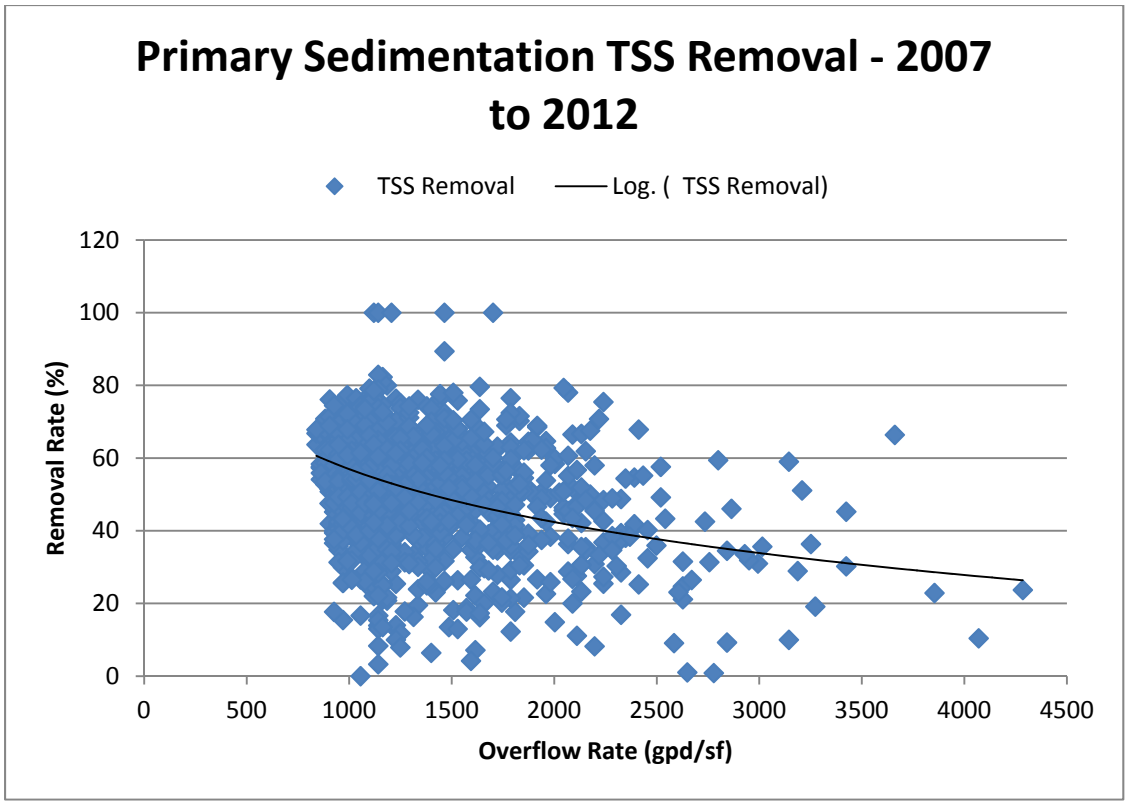


Figure 5 Primary Sedimentation TSS Removal Rate 748

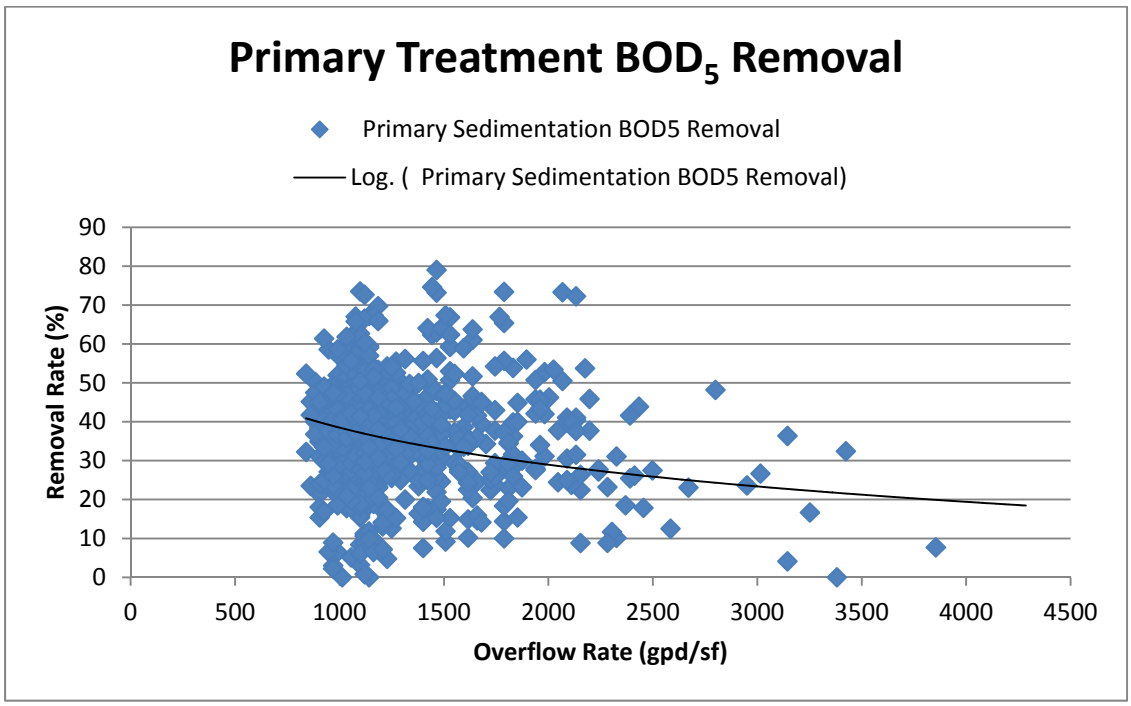
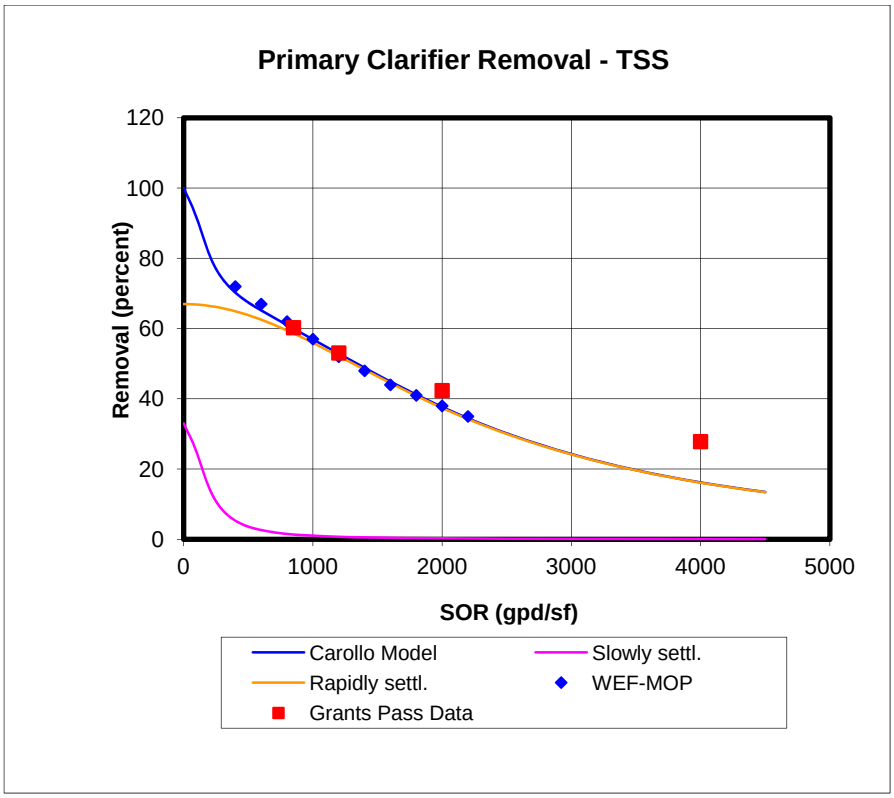


Figure 6 Primary Sedimentation BOD Removal Rate



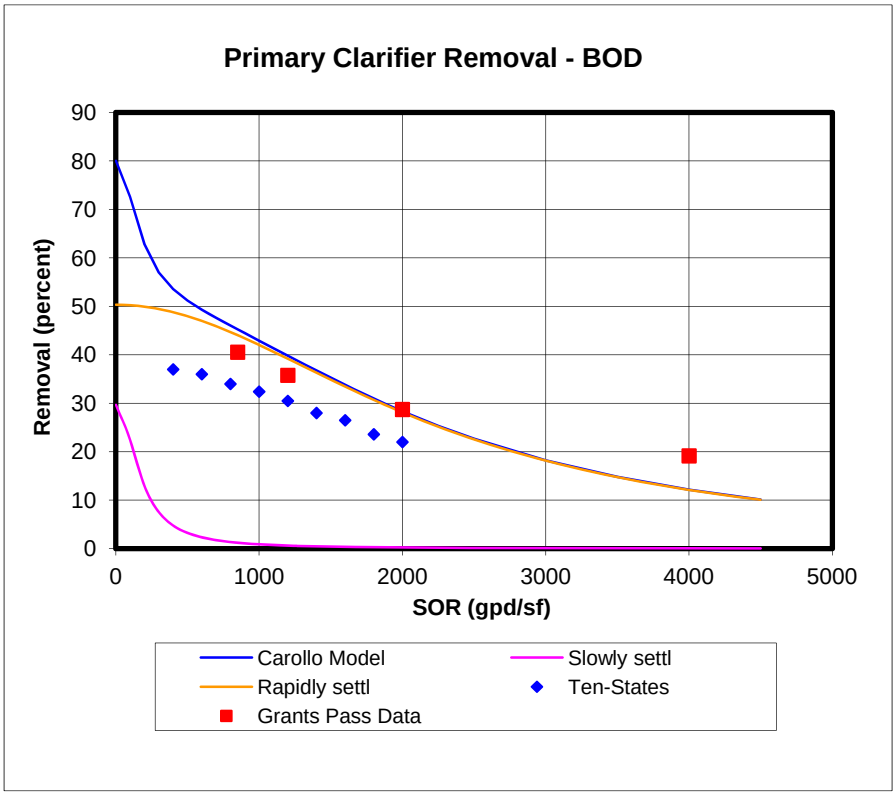


Figure 7 Comparison of Carollo Model to Grants Pass Data

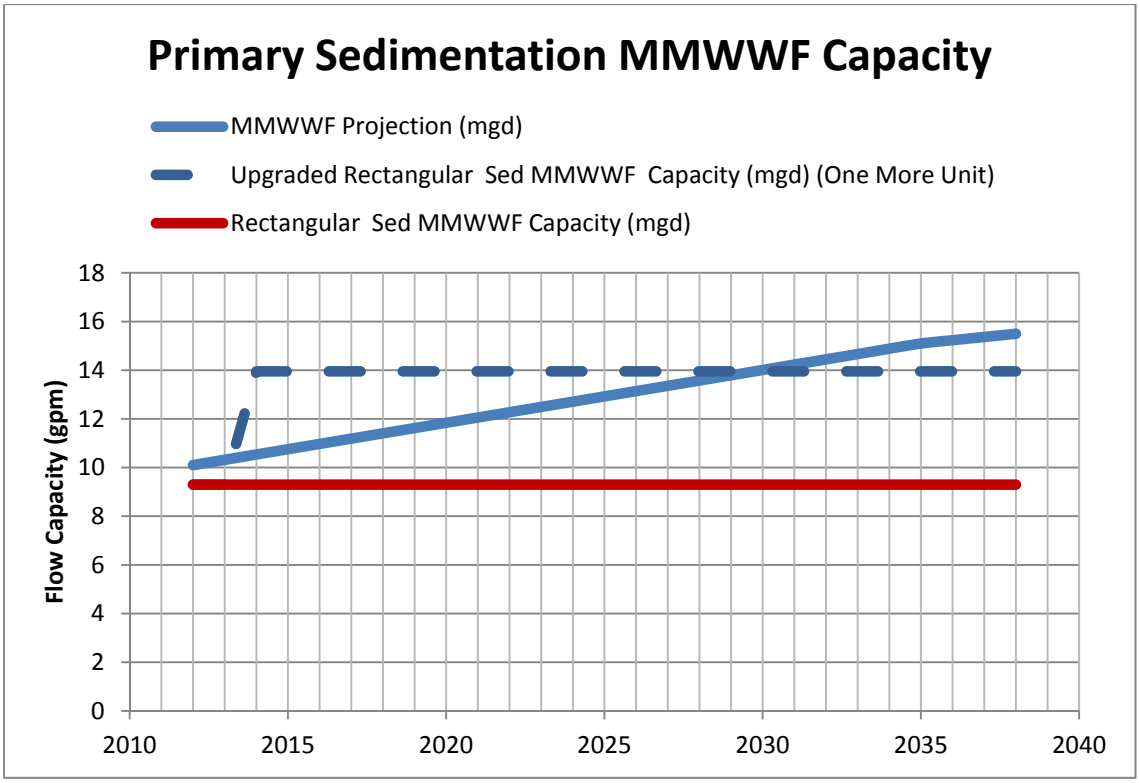


Figure 8 Primary Sedimentation MMWWF Capacity Diagram

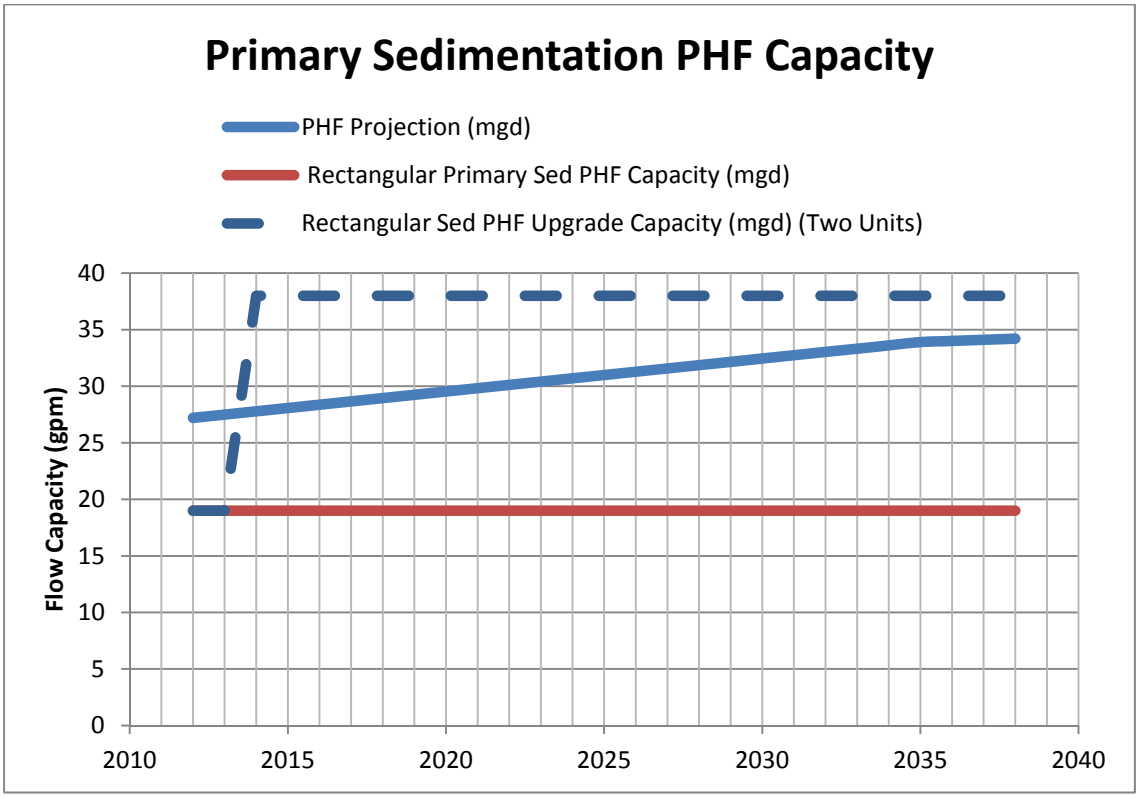


Figure 9 Primary Sedimentation PHF Capacity Diagram

5.0 GRIT REMOVAL SYSTEM

Grit removal at the Grants Pass WRP is provided by a system for pumping primary sludge through a grit separation cyclone. Grit from the cyclone is deposited into a screw sedimentation/ washer unit. Liquid sludge is directed to the gravity sludge thickener. There are three, 220-gallon per minute (gpm) capacity sludge grit pumps and two 220 gpm capacity grit cyclones, each with a slurry flow capacity of 16 gpm.

Figure 10 presents a capacity comparison for the grit system with one cyclone and one sludge/grit pump in service at a time. The figure shows the estimated total primary sludge flow at a concentration of one percent dry solids projected from current flows to 2035. The comparison indicates that the grit removal system should have adequate capacity throughout the planning period.

Grit removal equipment was installed in the 1996 plant upgrade and as such has nearly 20 years of service. Replacement should be considered well prior to the end of the planning period in 2035.

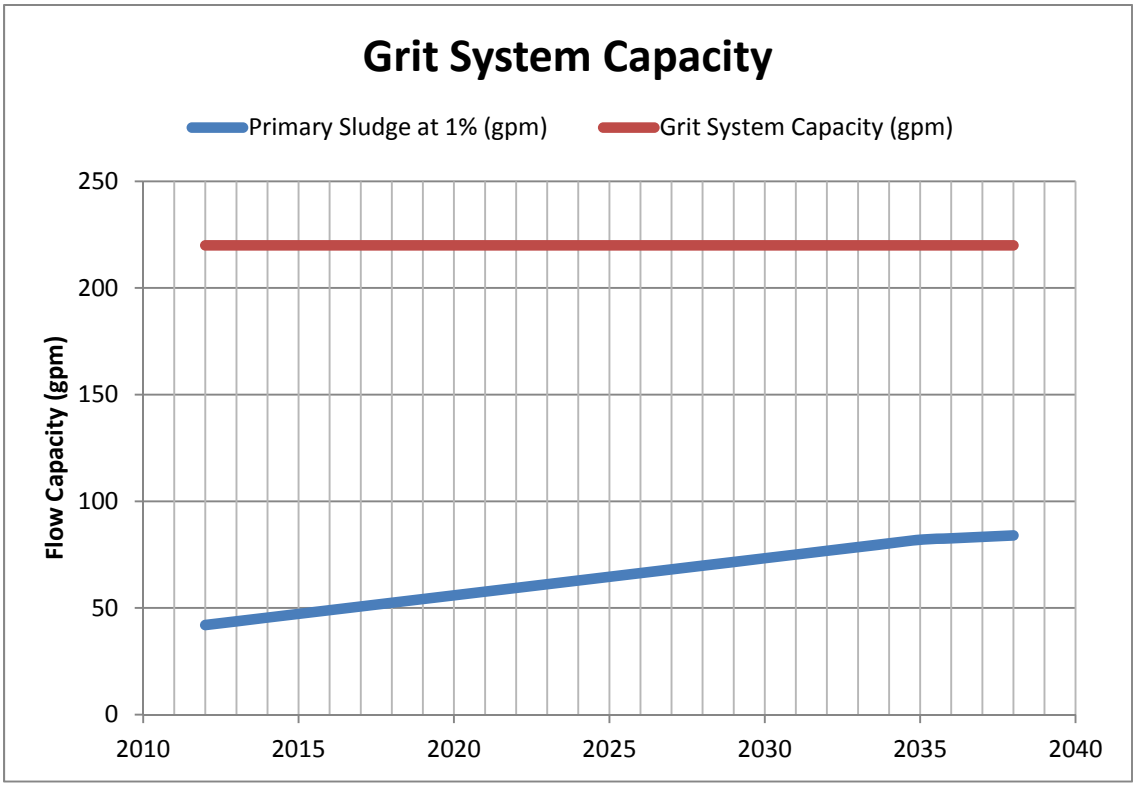


Figure 10 Grit Removal System Capacity Diagram

6.0 ACTIVATED SLUDGE SYSTEM

The activated sludge system at the Grants Pass WRP includes two aeration tanks, each with a volume of 0.42 million gallons (MG), two secondary clarifiers with a diameter of 75 feet, and one secondary clarifier with a diameter of 100 feet. The larger clarifier unit has nearly the same process area of the two smaller units combined.

The aeration tanks have a flexible configuration that permits operation in anaerobic selector plug flow aeration, conventional fully-aerobic aeration, and step feed or contact stabilization modes. The aeration tank configuration is illustrated schematically in Figure 11. The tanks are not identical in configuration. The south tank originally included five cells partitioned by fiberglass baffle walls unsuited for the hydrostatic pressure, but the partition wall between Cell 4 and Cell 5 has been removed. The first three cells in the south tank are provided with both submersible mixers and full-floor coverage panel aeration diffusers. The north tank has two, fully aerobic cells. In normal operation primary effluent (PE) and return activated sludge (RAS) flow is directed to Cell 1 and proceeds from Cell 1 through Cell 7 in series. In contact stabilization mode, RAS is directed to Cell 1 and PE is directed into the eastern-most inlet gate from the peripheral inlet channel into Cell 5.

The capacity of the activated sludge system is considered as a unit, including both aeration tanks and clarifiers, because the two elements can compensate for each other in provision of capacity. For example, an aeration tank with a high mixed liquor suspended solids (MLSS) concentration, and a relatively smaller aeration tank volume, can be compensated by providing a larger clarifier area, and conversely, a low MLSS concentration resulting from a larger aeration tank volume can permit a smaller clarifier area to be provided.

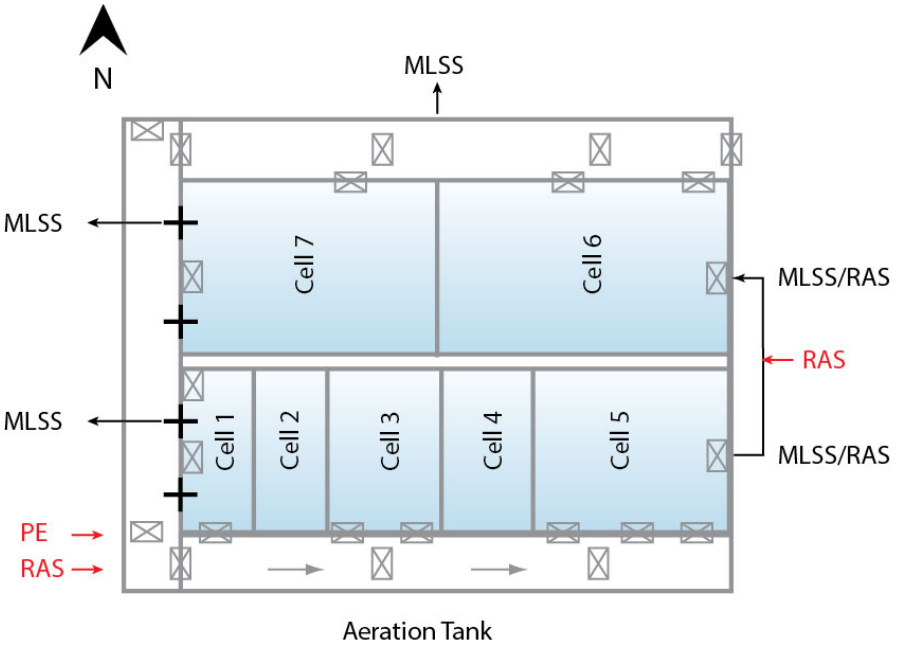


Figure 11 Aeration Tank Configuration

6.1 Activated Sludge Process Data

Key process data for determination of activated sludge capacity include:

- Flow.
- Organic loading.
- Temperature.
- MLSS concentration.
- Aerobic solids residence time (SRT).
- Effluent Ammonia.
- Sludge yield.
- SVI.
- Effluent quality.

Process data from the Grants Pass WRP process control records for the years from 2007 through 2012 are considered in the following paragraphs.

Figure 12 shows the influent flow for the period of record. Both average and peak daily flows are shown in the figure. The 30-period moving average of the average daily flow is also shown. The figure shows that the 30-day average flow reached nearly 10 mgd in the late winter of both 2010/2011 and 2011/2012. Since then, the highest peak flow reached 25 mgd in early 2011 and approximately 20 mgd several times over the period of record. On 2/5/2008 a peak flow of 40.6 mgd was recorded, but this flow appears to be an outlier and was not considered to be significant for this analysis. The aeration tanks are operated in contact stabilization mode during these high flow events. Flow directly affects activated sludge process capacity by limiting residence times in the aeration tanks and stressing secondary clarifiers. The limiting capacity of an activated sludge process occurs at the point where the aeration tank MLSS delivered to the secondary clarifiers under conditions of PHF results in solids loading failure. An appropriate safety factor needs to be used to account for turbulent flow in the clarifier. This will be illustrated in subsequent discussion.

Figure 13 shows influent loadings for influent BOD_5 for the period of record. The maximum 30-day average loading reached approximately 10,000 pounds per day (ppd) during early 2011. The figure shows estimated 2035 average annual and maximum month loadings. The experienced maximum month BOD_5 loading is approximately 60 percent of the estimated 2035 maximum month load.

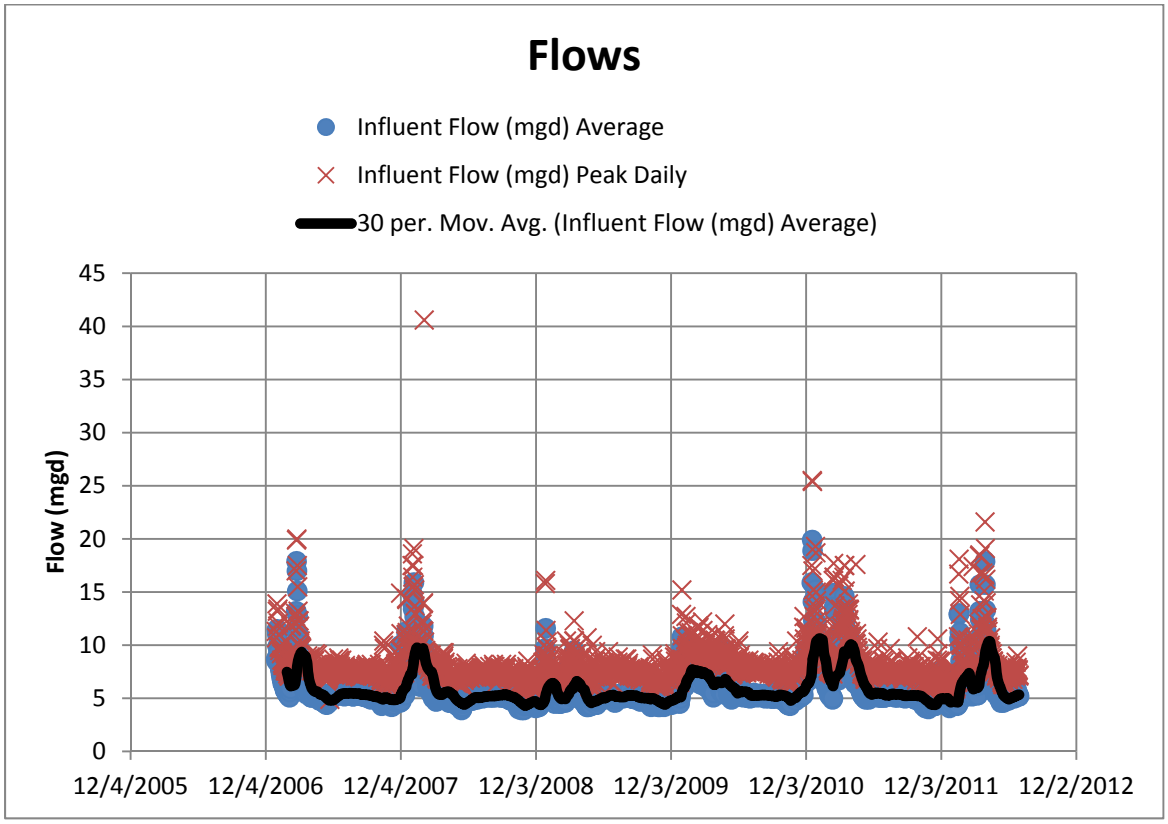


Figure 12 Flow Record

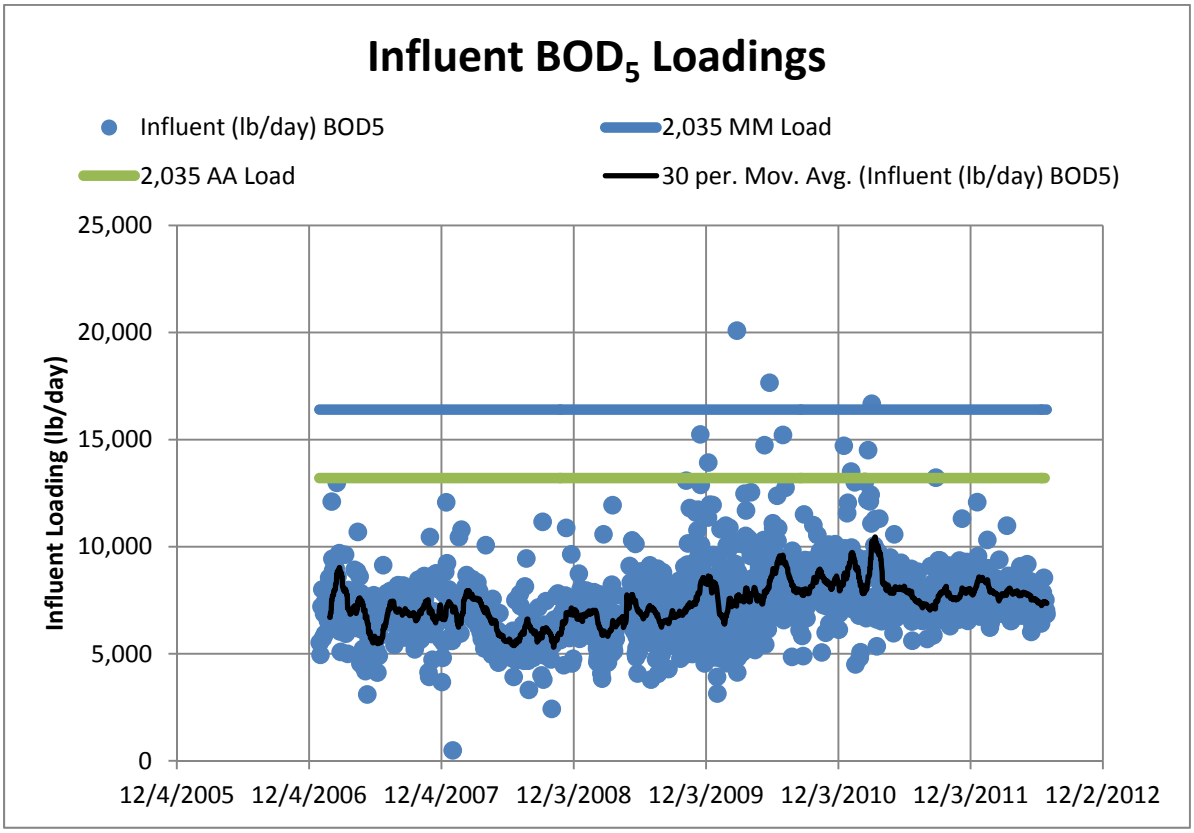


Figure 13 BOD Loading Record

Figure 14 shows temperature variation in the plant effluent. The plant measures both influent and effluent temperature, but only the effluent temperature is shown, since this more accurately reflects temperatures experienced by the activated sludge system. The minimum monthly summer temperature of 19 degrees Celsius and the minimum month winter temperature of 14 degrees Celsius are shown in the figure, and are used in the activated sludge process model.

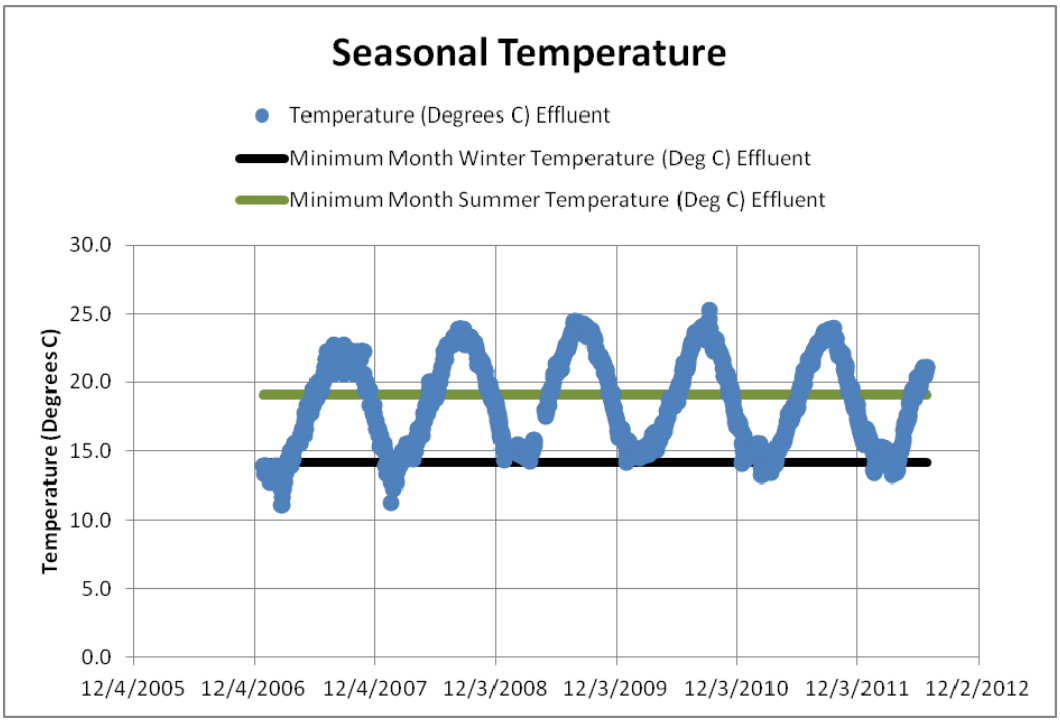


Figure 14 Temperature Record

Figure 15 presents data for MLSS concentration. It is seen that up until 2010 the WRP was operated with a MLSS concentration in the range of 1,000 to 2,500 mg/L. From 2010 on, the MLSS concentration was raised into the range of 2,000 to 4,000 mg/L. This change in operating strategy was made to improve performance of ammonia conversion (nitrification).

Figure 16 shows the consequence of the increased MLSS concentration on aerobic aeration tank SRT. The aerobic SRT is the mean time a suspended solids particle is retained in the aerated part of the aeration tanks. Aerobic SRT is an important process parameter for the activated sludge process because this sets a limit on the types of organisms that can be retained in the system. For example, typical floc-forming activated sludge bacteria may have a washout aerobic SRT on the order of 0.5 days; but the more specialized phosphorus accumulating organisms that are at least partly responsible for good settleability characteristics of activated sludge systems which, like Grants Pass WRP, contain anaerobic selector tanks, have a minimum (washout) aerobic SRT of around 2 days. The graph shows the average calculated daily value and the 30-day moving average. It is seen that the aerobic SRT averaged around 2 days during the period prior to 2010. After 2010, the average aerobic SRT increased into the range of 3 to 4 days. The minimum average SRT during this period of 2.5 days is shown in the figure. An aerobic SRT of 2.5 days was used for evaluation of capacity during the winter months and an SRT of 3.0 days during the summer partial nitrification season.

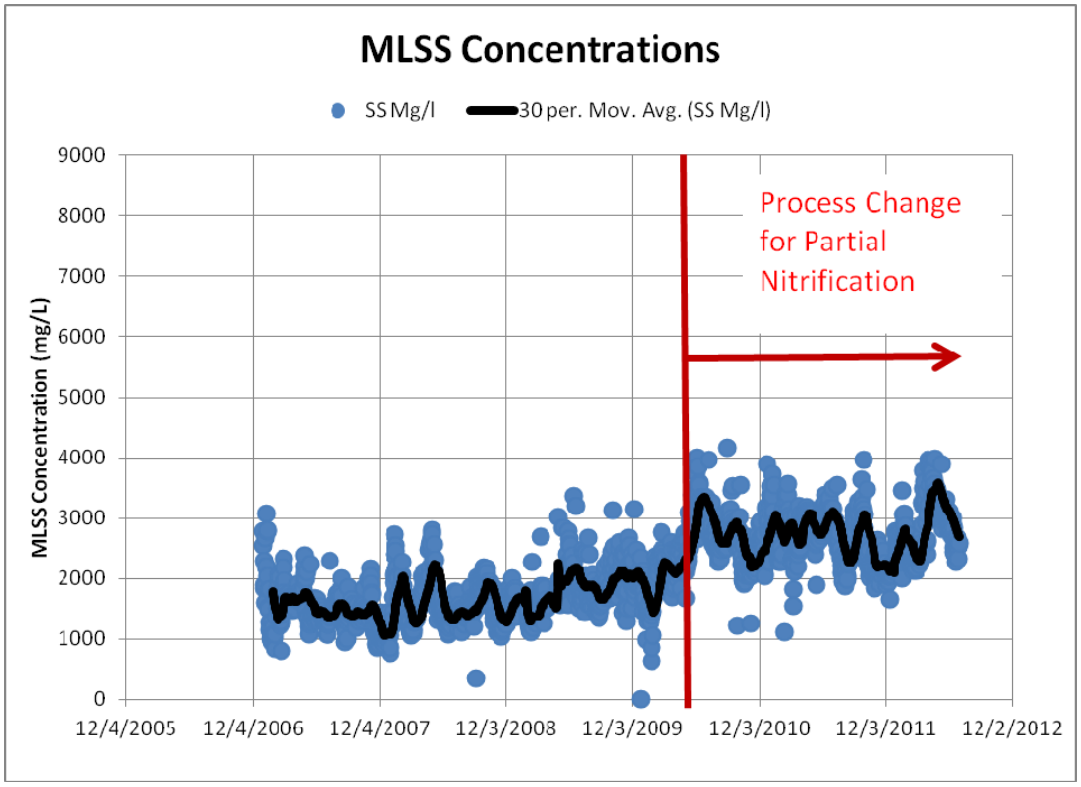


Figure 15 MLSS Concentration

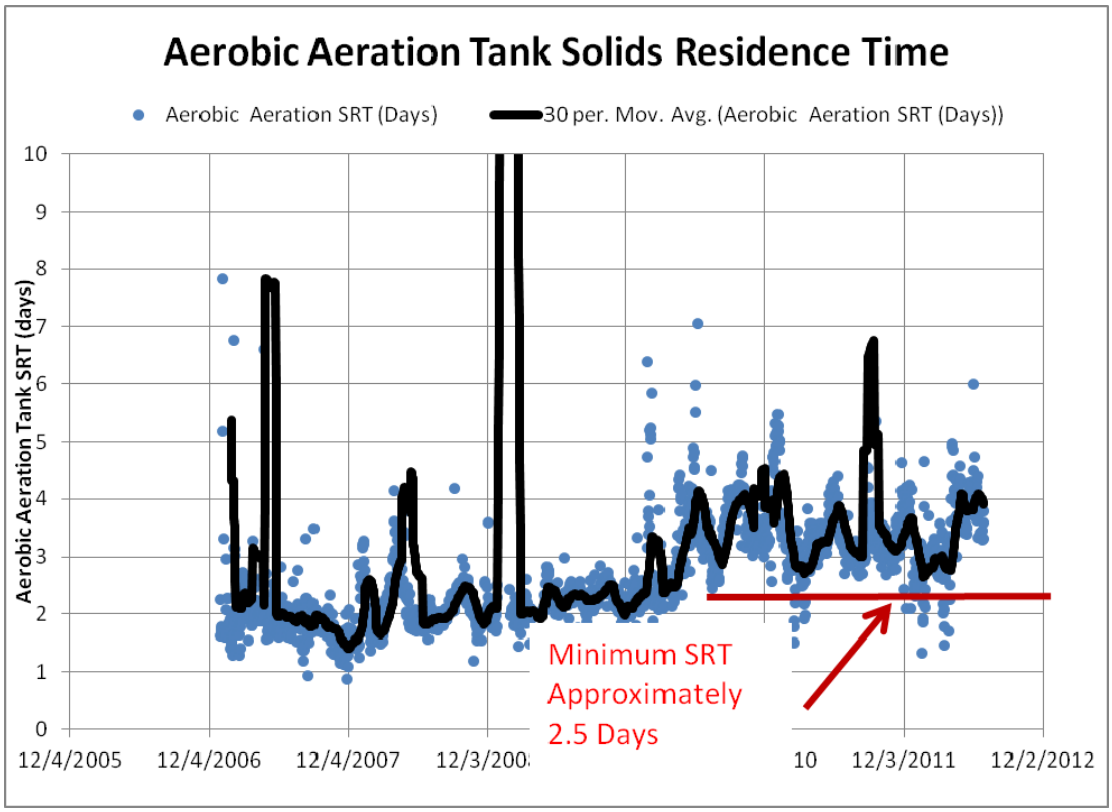


Figure 16 Aerobic Solids Residence Time (SRT)

This is consistent with improved nitrification as shown in Figure 17. It is seen that, prior to 2010, measured effluent ammonia concentrations were in a wide range from less than 5 to more than 25 mg/L. After increasing the aerobic SRT in 2010, the effluent ammonia concentration dropped into the range of less than 1 to less than 15 mg/l and less than 10 mg/L during the summer months. Maximum month and maximum day effluent ammonia levels from the NPDES permit are shown for comparison. The WRP has been in compliance for ammonia removal since raising the SRT in 2010.

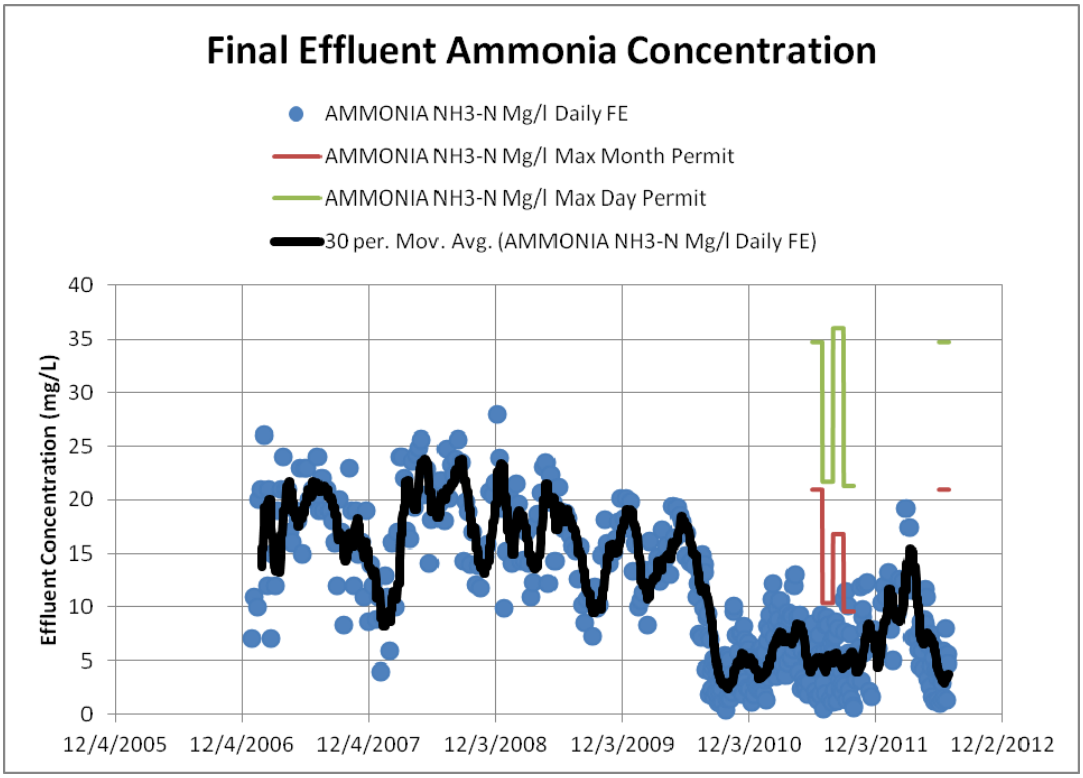


Figure 17 Effluent Ammonia Data

An important factor in activated sludge capacity is the sludge yield. The sludge yield is the weight in pounds (lb) of waste solids produced per lb of influent BOD_5 loaded to the activated sludge system. Figure 18 presents sludge yield data for the period of record. It is seen that the yield (combined effluent and waste activated sludge) was over 1.0 lb TSS per lb of BOD_5 loaded prior to 2010. In the years after 2010, the yield has decreased into the range of 0.5 to 1.0 lb per lb. This is consistent with the longer SRT used during recent years, which results in increased volatile solids destruction in the aeration tank. The average yield for 2011 was approximately 0.85 lb per lb., which was used as the yield calibration point in our process model.

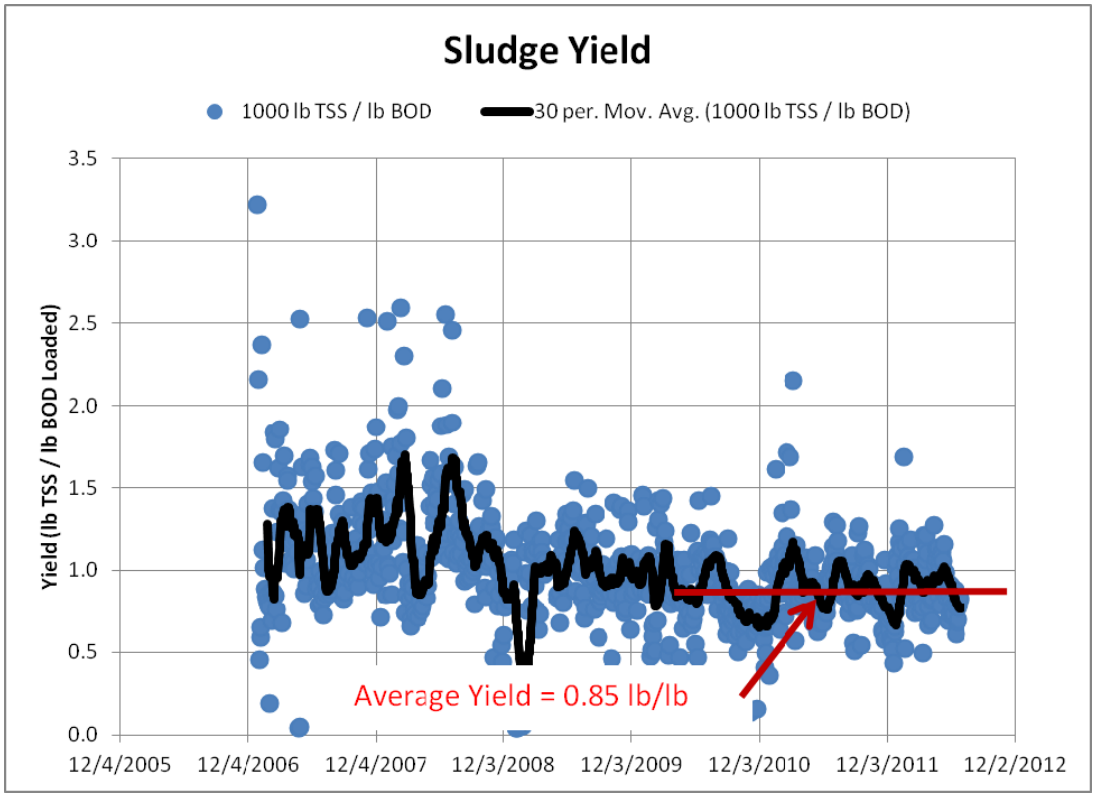


Figure 18 Sludge Yield

Another important parameter for capacity analysis of activated sludge systems is sludge settleability. The Grants Pass WRP measures settleability as sludge volume index (SVI) on a daily basis. Data for the period of record are shown in Figure 19. The data show that SVI has ranged from less than 100 milliliters per gram (mL/g) to as high as 400 mL/g. The average SVI during the summer of 2011 was approximately 150 mL/g and the average during the winter period was approximately 170 mL/g. These values were used for calculation of capacity for, respectively, the summer and winter season.

The final measure of activated sludge process success is in production of adequate secondary effluent quality. Figure 20 presents data for effluent suspended solids (ESS) concentration. Seasonal NPDES permit requirements for summer (10 mg/L) and winter (30 mg/L) are compared in the figure to effluent ESS concentration data from the recent record. The figure illustrates that average ESS has been under the summer limit of 10 mg/L and comfortably below the winter limit. Figures 21 and 22 present corresponding data for BOD_5. During the summer months, the WRP is required to meet a final effluent carbonaceous BOD_5 ($CBOD_5$) permit level of 10 mg/L. During the winter months, the WRP must meet a total BOD_5 limit of 30 mg/L. The data showsthat the 30-day average for both parameters has been comfortably below the NPDES permit level during both seasons.

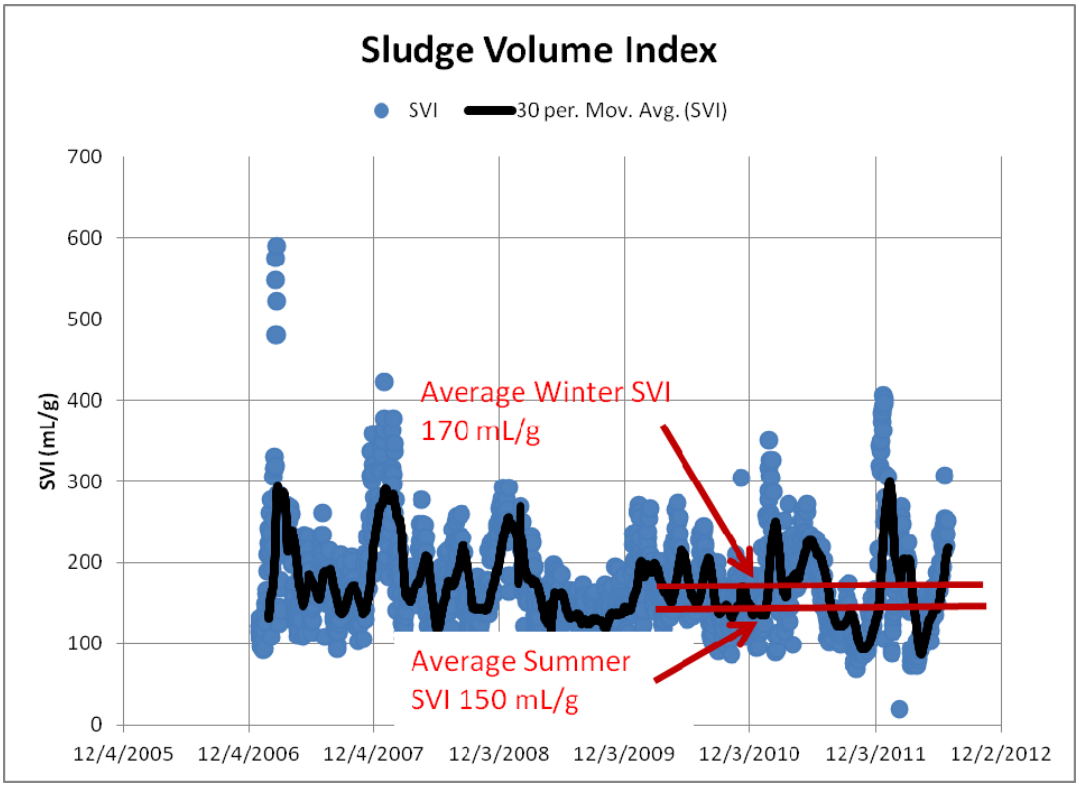


Figure 19 SVI

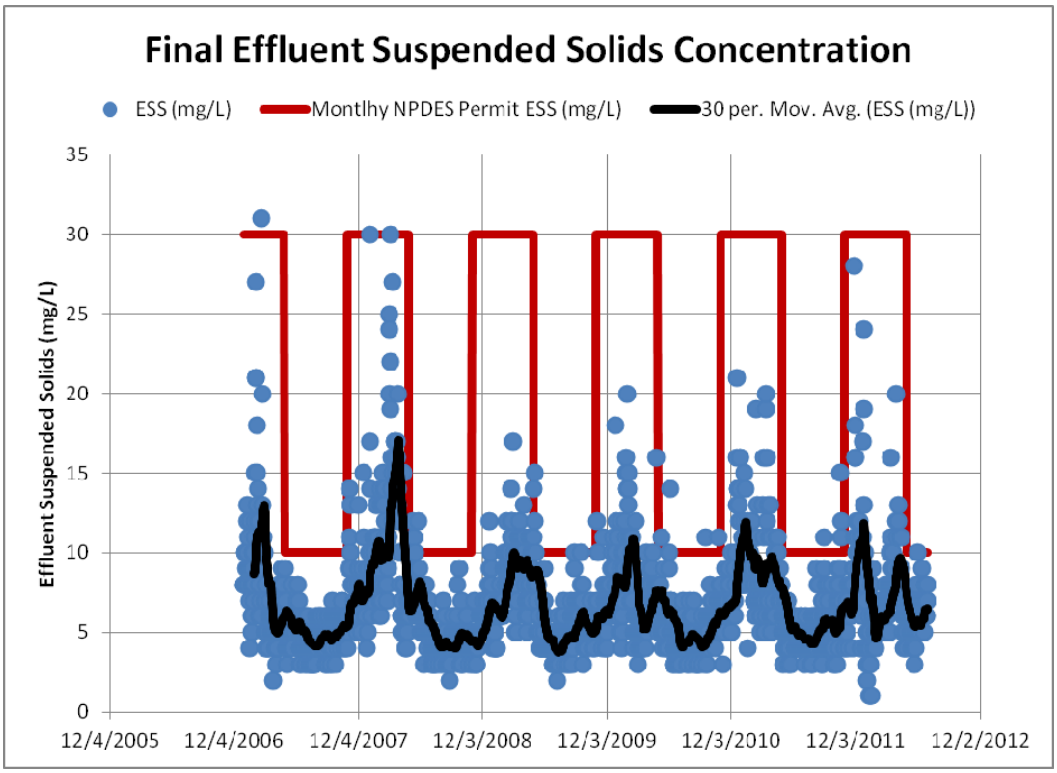


Figure 20 Effluent Suspended Solids (ESS)

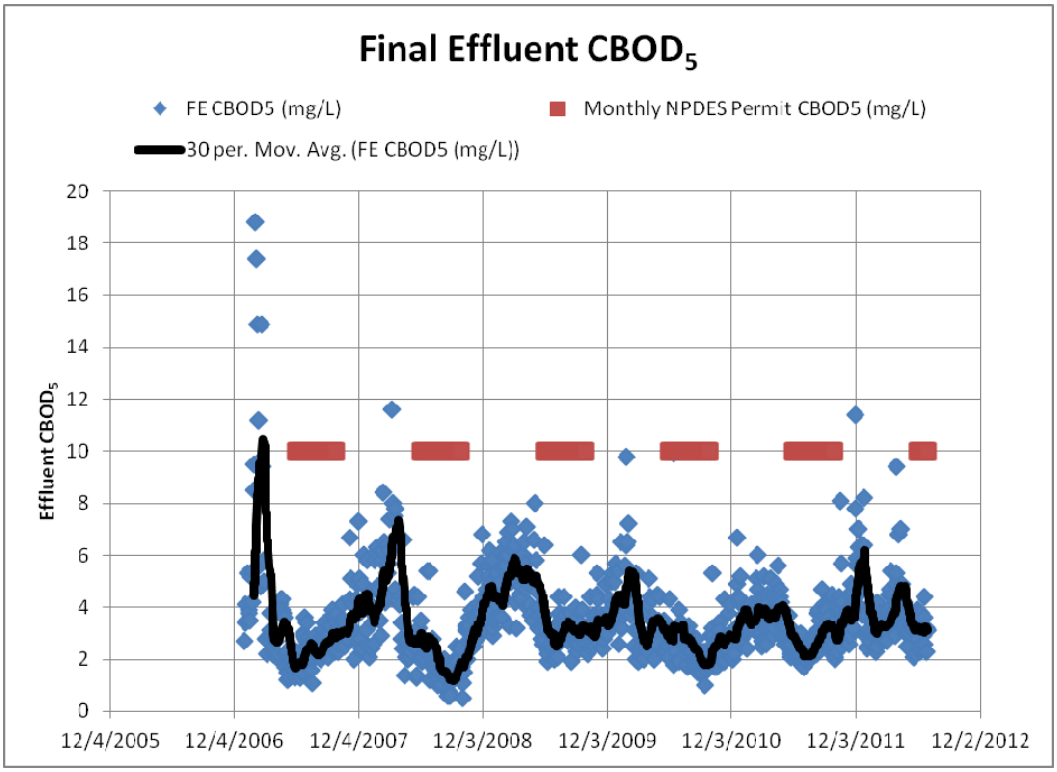


Figure 21 Effluent $CBOD_5$

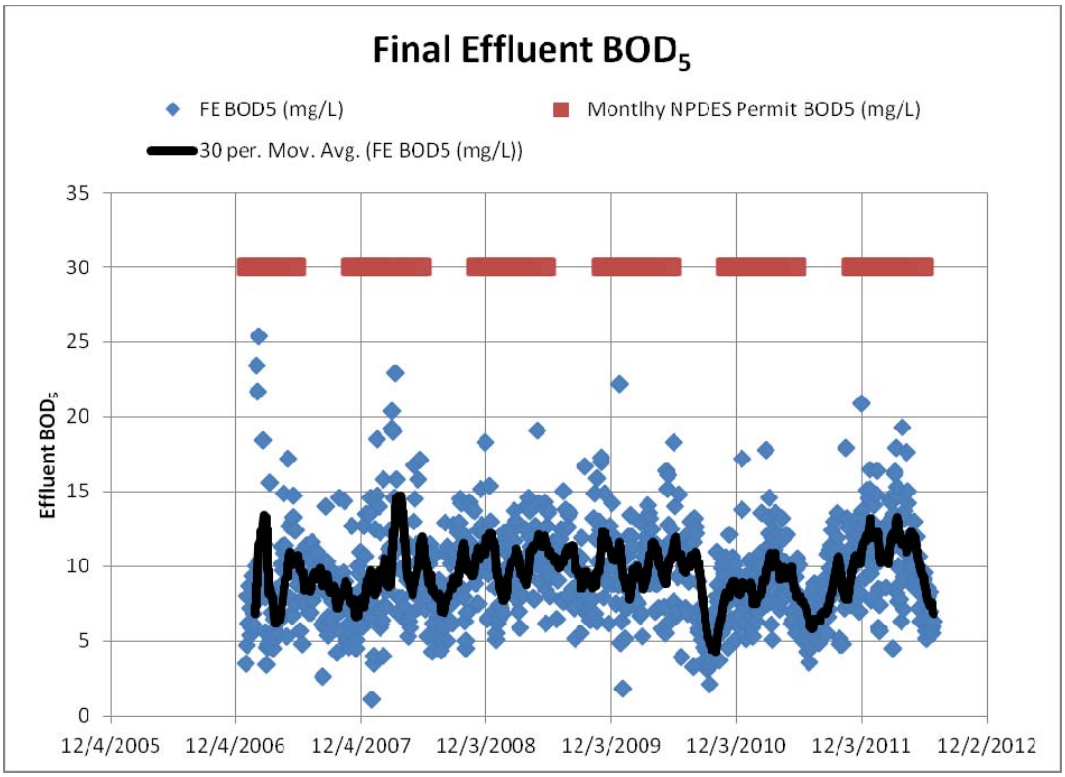


Figure 22 Effluent BOD_5

6.2 Activated Sludge Capacity Evaluation

Activated sludge system capacity was evaluated for four different loading conditions as follows:

1. Summer plug flow partial nitrification.
2. Winter plug flow secondary treatment.
3. Winter contact stabilization.
4. Summer full nitrification.

6.2.1 Summer Plug Flow Partial Nitrification

Since 2010, the Grants Pass WRP has been required by its NPDES permit to achieve partial nitrification during the months of June through September. The ammonia effluent permit level varies with river flow as follows:

- Maximum Month 21.0 mg/L and maximum day 34.7 mg/L from June 1 to June 30.
- Maximum Month 10.4 mg/L and maximum day 21.7 mg/L from July 1 to July 31.
- Maximum Month 16.8 mg/L and maximum day 36.0 mg/L from August 1 to August 31.
- Maximum Month 9.6 mg/L and maximum day 21.3 mg/L from September 1 to September 30.

Maximum month permit levels have been compared with effluent quality data in Figure 16. Performance during 2011 has shown that the new permit levels for ammonia can be met for current loadings. Based on this experience the following criteria were used for calculation of process capacity:

- Minimum aerobic aeration tank SRT of 3.0 day.
- Average yield of 0.85 lb TSS / lb BOD_5 loaded.
- Maximum month 2011 primary effluent BOD_5 concentration of 130 mg/L.
- Average 2011 primary effluent BOD_5 concentration of 110 mg/L.
- All aeration tanks and secondary clarifiers in service (AIS) at maximum month loadings.
- One aeration tank or one secondary sedimentation tank out of service (OOS) at average annual loadings.
- SVI of 150 mL/g.

Based on these criteria, activated sludge system capacity was calculated by comparing the permissible flow for the aeration tank (AT) as a function of MLSS compared to the capacity of the secondary clarifiers (SC) as a function of MLSS. The intersection of these two functions provides the system capacity. This is illustrated in Figures 23 and 24. Figure 23 shows that the flow capacity under the criteria outlined above is approximately 7 mgd, compared to a current MMDWF of 6.3 mgd. The average flow capacity with one aeration tank OOS is approximately 5 mgd compared to the current ADWF of 5.2 mgd. The average capacity with aeration tanks AIS but the large secondary clarifier OOS is higher, so the condition with one aeration tank OOS shown in Figure 23 is controlling. It should be noted that the maximum capacity with the large secondary clarifier OOS occurs at a lower MLSS concentration (approximately 2,500 mg/L) than with one AT OOS (approximately 4,000 mg/L). This indicates that the plant would have difficulty maintaining partial nitrification under current average loadings during the summer with a portion of the aeration basin taken off-line. Figure 25 presents a comparison of this capacity to future required capacity. The figure indicates that more capacity in the activated sludge system is required by 2015 based on the MMDWF capacity and sooner based on ADWF with one AT OOS.

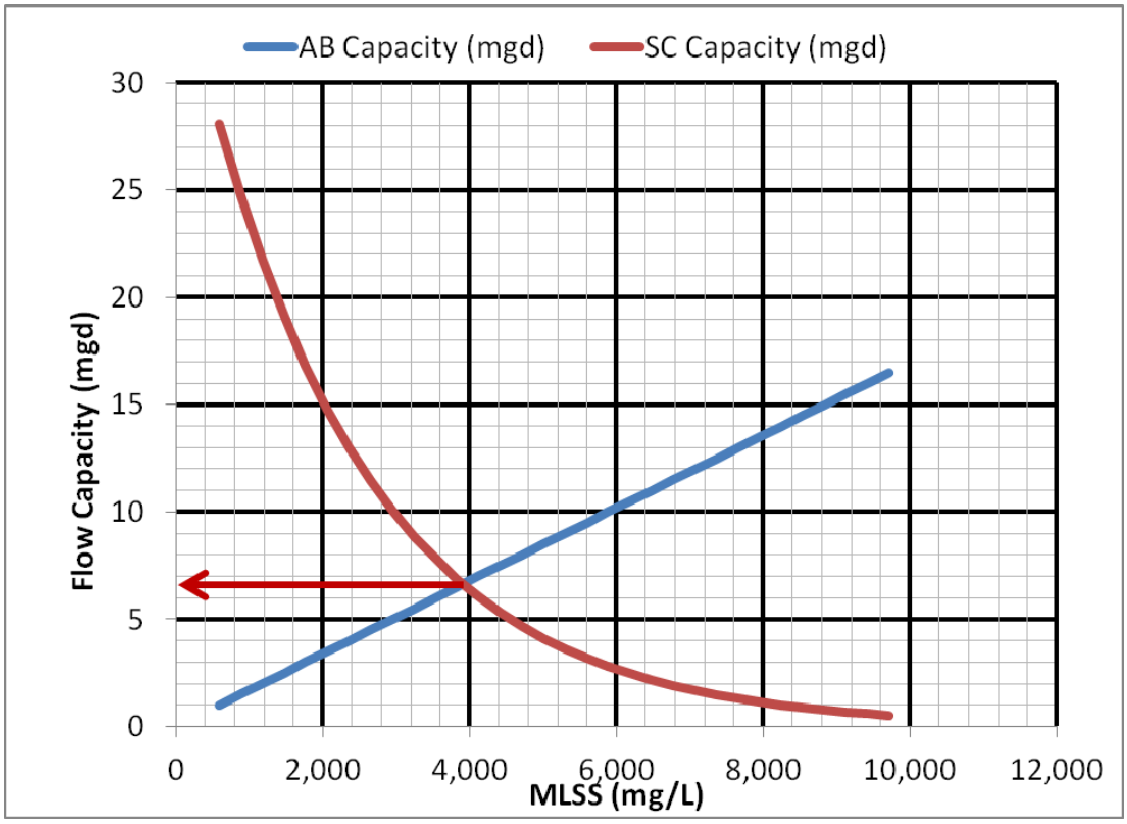


Figure 23 MMDWF Partial Nitrification Capacity (AIS)

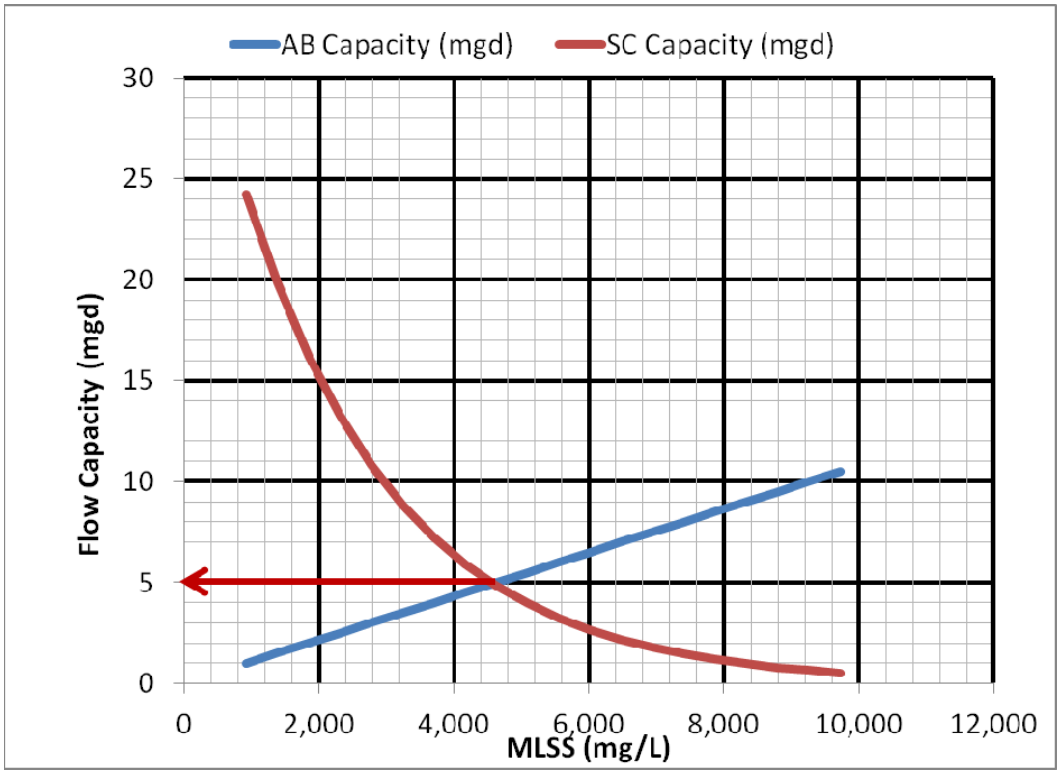


Figure 24 ADWF Partial Nitrification Capacity (One AB OOS)

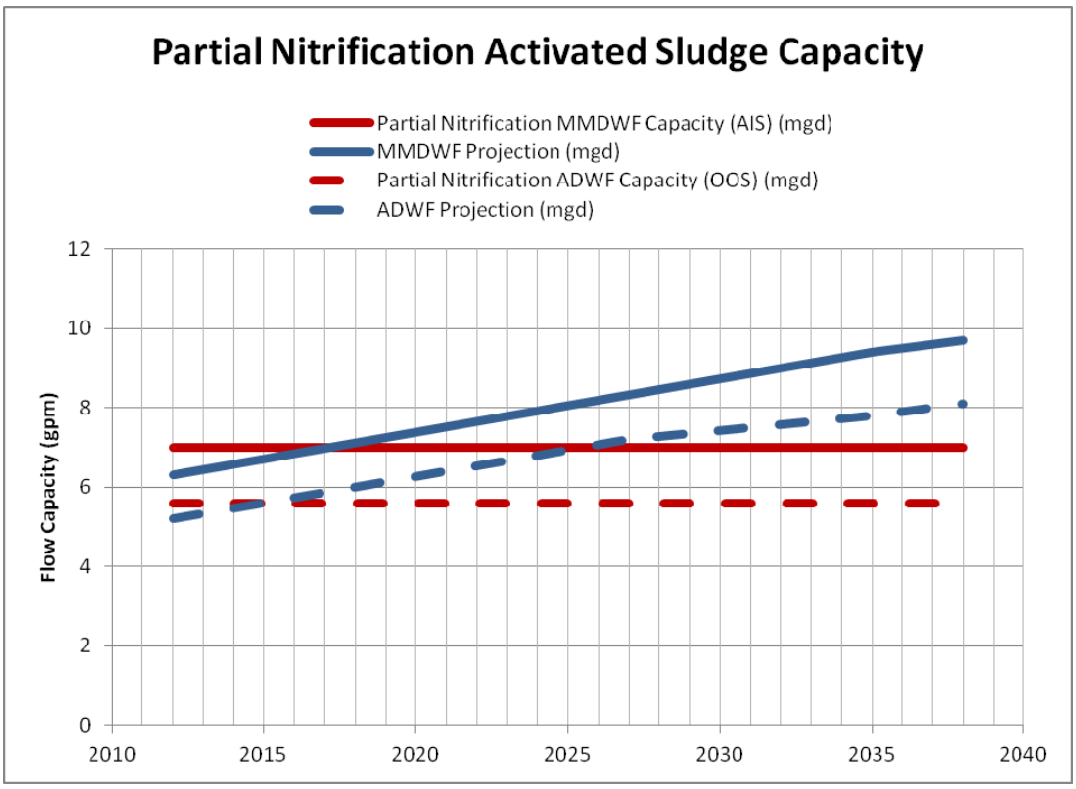


Figure 25 Partial Nitrification Capacity Compared to Future Demand

6.2.2 Plug Flow Secondary Treatment Capacity

The WRP can operate in either plug flow (serial flow from one tank stage to the next) or in contact stabilization (primary effluent feed to Stage 5) mode during the winter months (November to April). The plug flow mode is more sensitive to PHF capacity. Capacity criteria for this condition are as follows:

- Minimum aerobic aeration tank SRT of 2.5 day.
- Average yield of 0.82 lb TSS / lb BOD_5 loaded.
- Maximum month primary effluent BOD_5 concentration of 72 mg/L.
- Average primary effluent BOD_5 concentration of 98 mg/L.
- PHF primary effluent BOD_5 concentration of 55 mg/L.
- All aeration tanks in service (AIS) at maximum month loadings.
- All secondary clarifier tanks in service.
- SVI of 170 mL/g.

Figure 26 illustrates secondary treatment capacity at MMWWF in plug flow mode, and Figure 27 illustrates the approximate capacity limit for the activated sludge system in plug flow mode at PHF. The figures indicate a MMWWF secondary plug flow capacity of approximately 11 mgd, with a PHF capacity of approximately 13 mgd. Above 13 mgd the plant would need to change to contact stabilization mode. Current MMWWF is 10.1 mgd. As shown in Figure 28, with one aeration tank OOS the AWWF capacity by these criteria is approximately 6 mgd compared to a current AWWF of 7.1 mgd. With the large secondary clarifier OOS the capacity is approximately the same. These capacity calculations indicate that it is not advisable to take one tank OOS during the winter months under current flow and load conditions. Comparison of plug flow secondary treatment capacity to future demand is illustrated in Figure 29. This estimate indicates that MMWWF plug flow secondary treatment capacity would be reached in approximately 2018, which is slightly beyond the date MMDWF capacity is met.

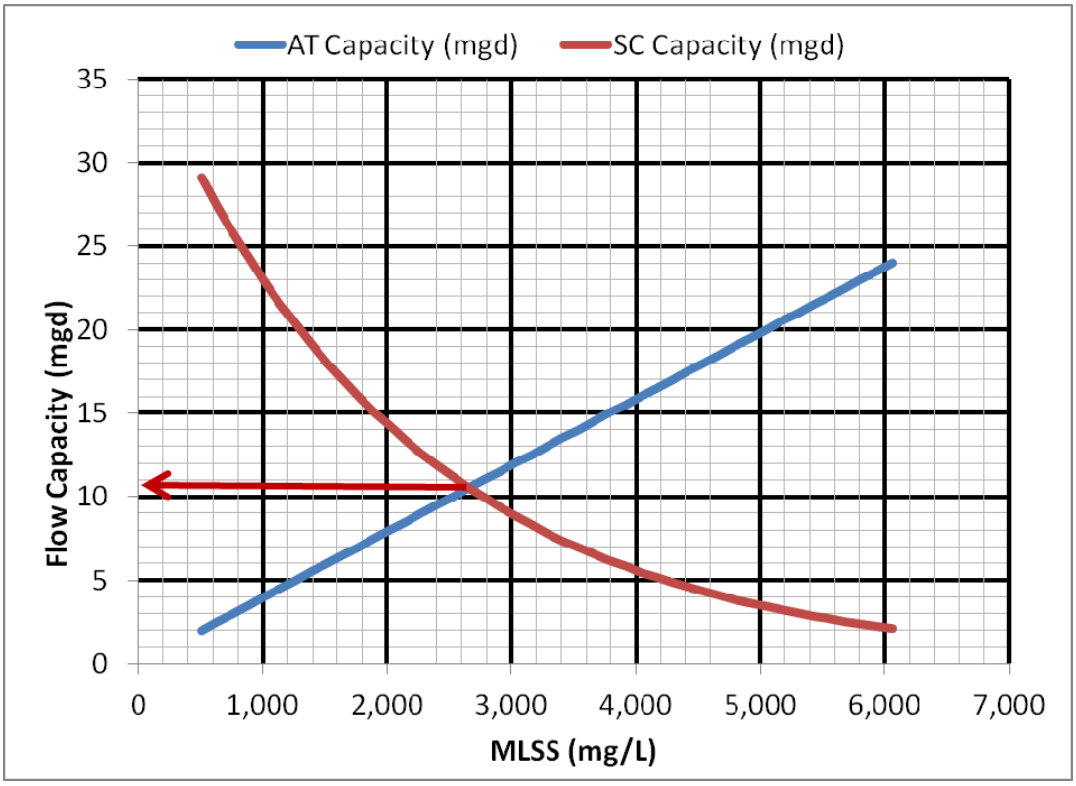


Figure 26 MMWWF Plug Flow Secondary Treatment Capacity (AIS)

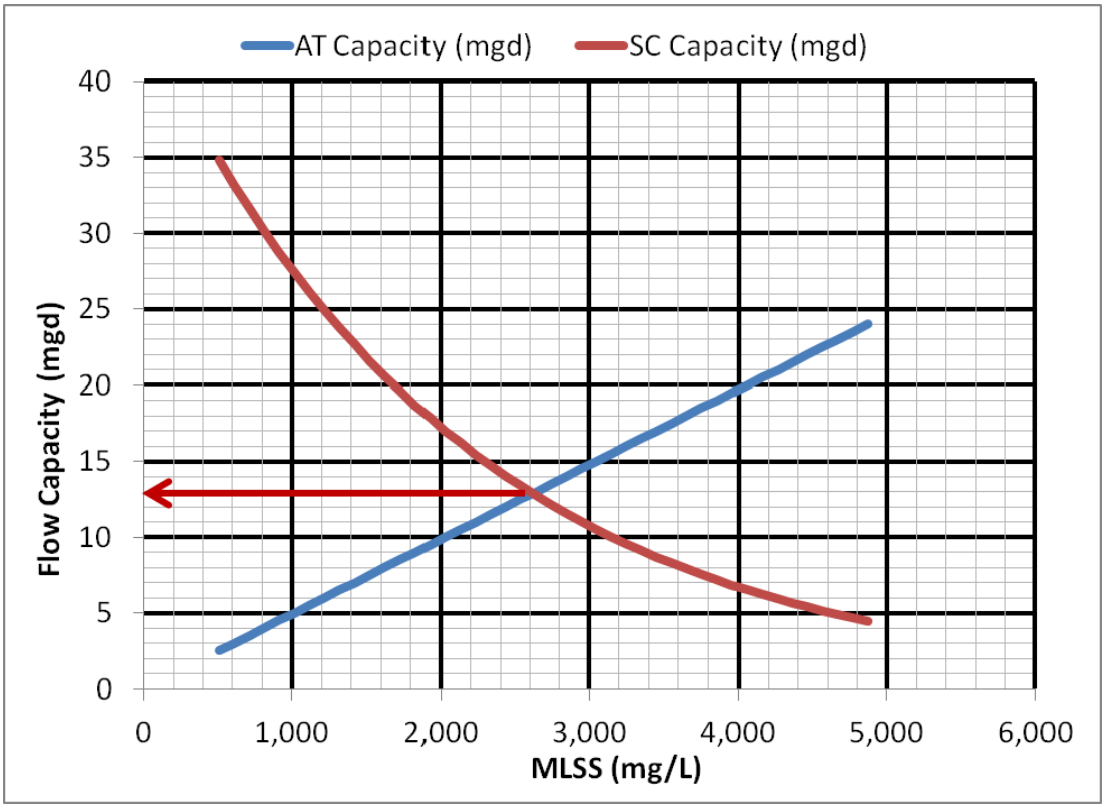


Figure 27 PHF Plug Flow Secondary Treatment Capacity (AIS)

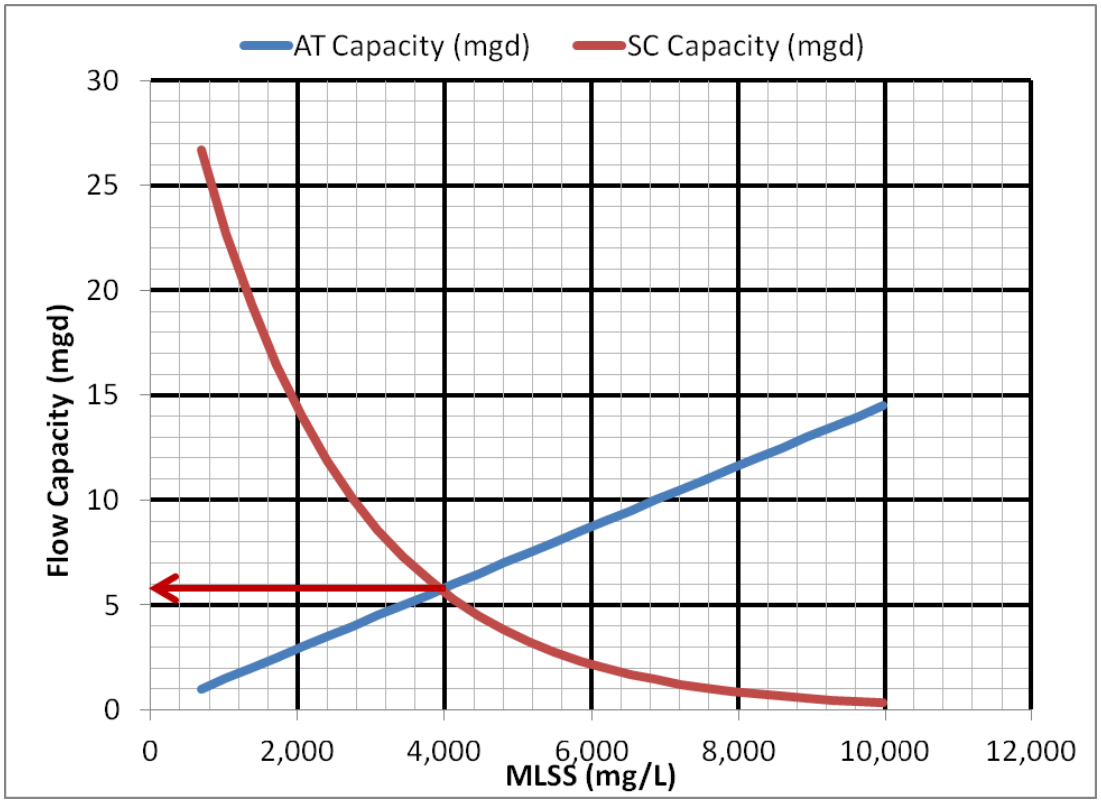
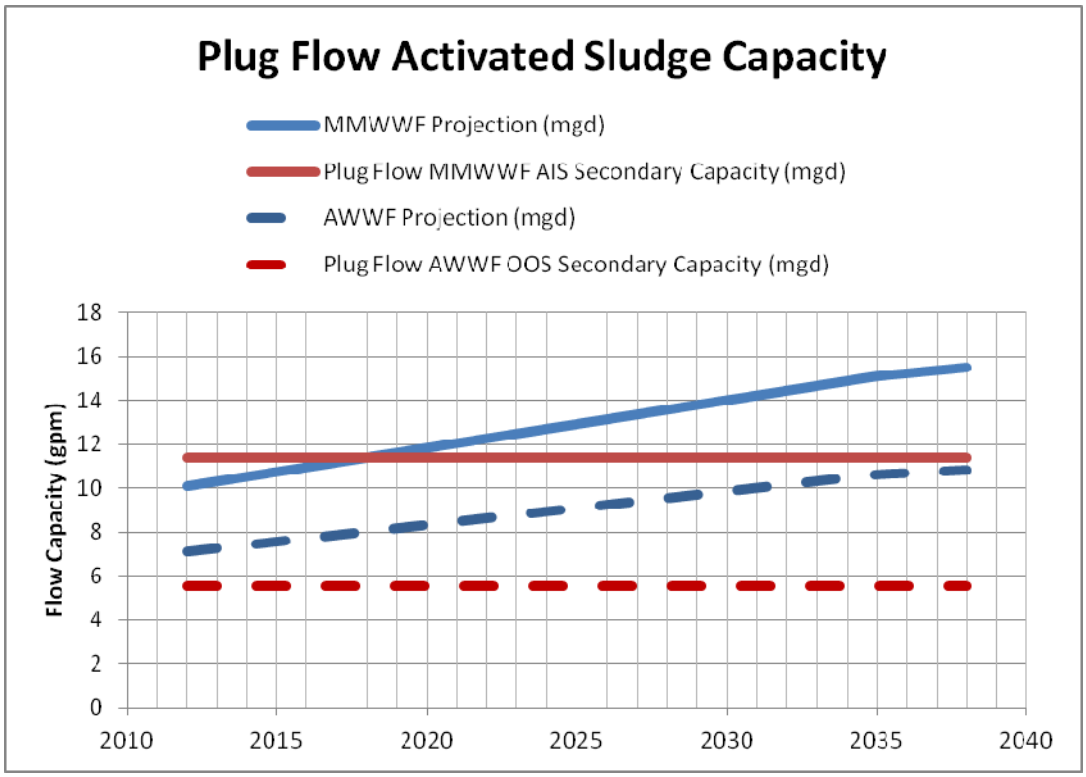


Figure 28 AWWF Plug Flow Secondary Treatment Capacity (One AT OOS)



Note: The flow projections are based on current per capita flows & loads, peaking factors, and anticipated community growth. The actual year when capacity is required may vary based on actual growth in the City.

Figure 29 Plug Flow Secondary Treatment Capacity Compared to Future Demand

6.2.3 Contact Stabilization Secondary Treatment Capacity

While PHF to the secondary treatment process should be limited to approximately 13 mgd in plug flow mode, by operating in contact stabilization mode the activated sludge system at the Grants Pass WRP can provide secondary treatment for a higher PHF. This is due to the fact that when primary effluent feed is directed to a downstream aeration tank stage, the same activated sludge inventory (and SRT) produces a lower MLSS concentration. This in turn provides increased secondary clarifier capacity. Criteria for contact stabilization operation are as follows:

- Minimum aerobic aeration tank SRT of 2.5 day.
- Average yield of 0.85 lb TSS / lb BOD_5 loaded.
- PHF primary effluent BOD_5 concentration of 55 mg/L.
- All aeration tanks in service (AIS) at PHF loadings.
- All secondary clarifier tanks in service.
- SVI of 170 mL/g.
- Overflow Rate (OFR) of 1250 gpd/sf

The capacity chart for this configuration is shown in Figure 30, and indicates that the system could accommodate a PHF as high as 30 mgd. However, the OFR design criteria limits the secondary treatment capacity to 20.8 mgd.

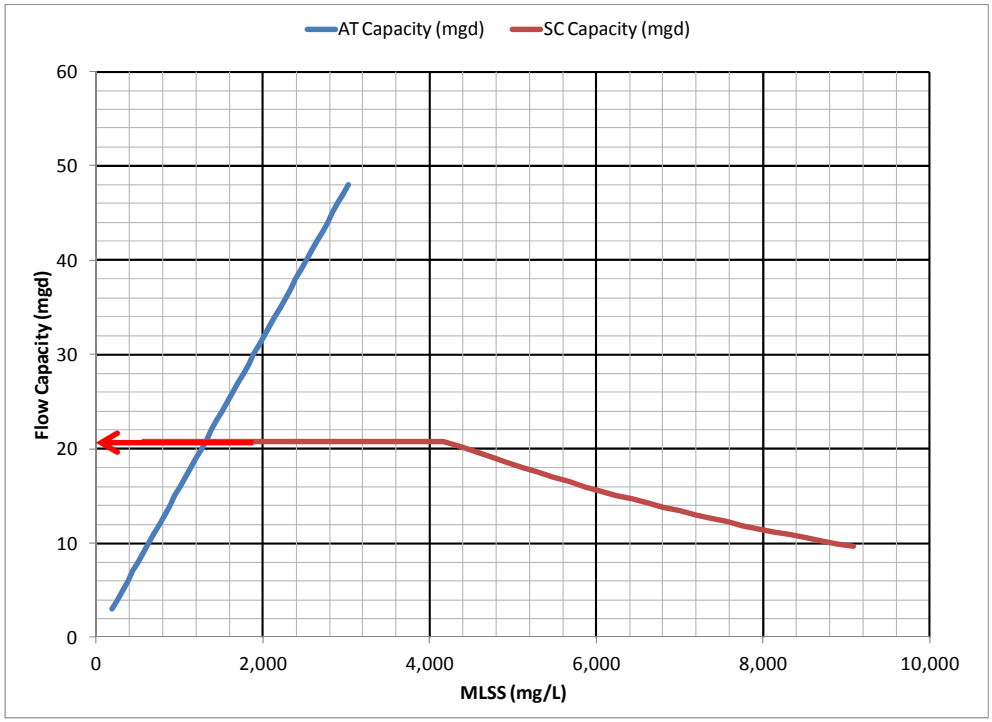


Figure 30 PHF Contact Stabilization Secondary Treatment Capacity

6.2.4 Full Nitrification Treatment Capacity

A fourth operating condition considered the capacity of the Grants Pass WRP in the event that full ammonia removal were required by the Oregon Department of Environmental Quality (DEQ) to a level of less than 1 mg/L. Capacity criteria for this mode of operation are as follows:

- Minimum aerobic aeration tank SRT of 7.5 days.
- Average yield of 0.7 lb TSS / lb BOD_5 loaded.
- MMDWF primary effluent BOD_5 concentration of 130 mg/L.
- All aeration tanks in service (AIS) at MMDWF loadings.
- All secondary clarifier tanks in service.
- SVI of 150 mL/g.
- Maximum MLSS concentration 4,000 mg/L.

Figure 31 presents the capacity chart for this condition. To keep MLSS concentrations below 4,000 mg/L, the MMDWF that could be accommodated by the existing aeration tanks and secondary clarifiers is approximately 3.5 mgd. This compares to existing MMDWF flows of 6.3 mgd and 2035 MMDWF of 9.4 mgd. Figure 32 presents the capacity diagram for full nitrification at MMDWF assuming aeration tanks were added to increase the current volume by a factor of three. This would increase system capacity to approximately 10 mgd, in excess of the MMDWF for 2035. Figure 33 presents a chart showing current full nitrification capacity compared to demand. It is seen that significant aeration tank capacity would need to be added if DEQ were to require full nitrification for the Grants Pass WRP.

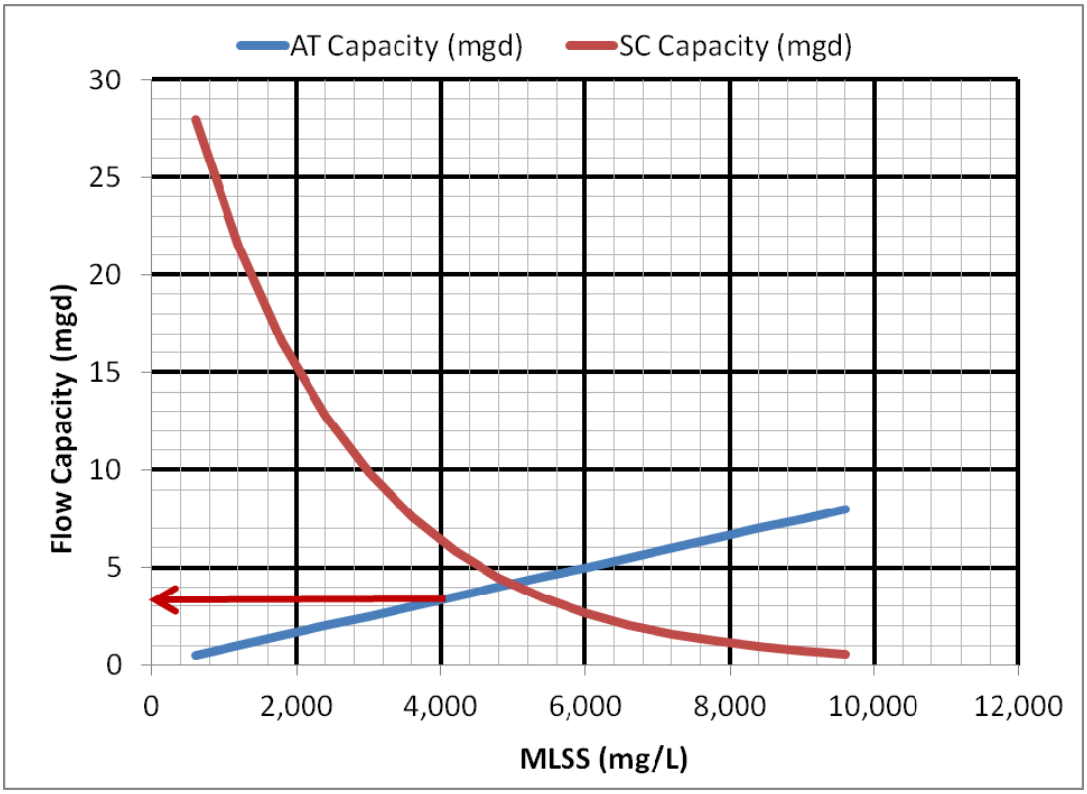


Figure 31 MMDWF Full Nitrification Treatment Capacity (AIS)

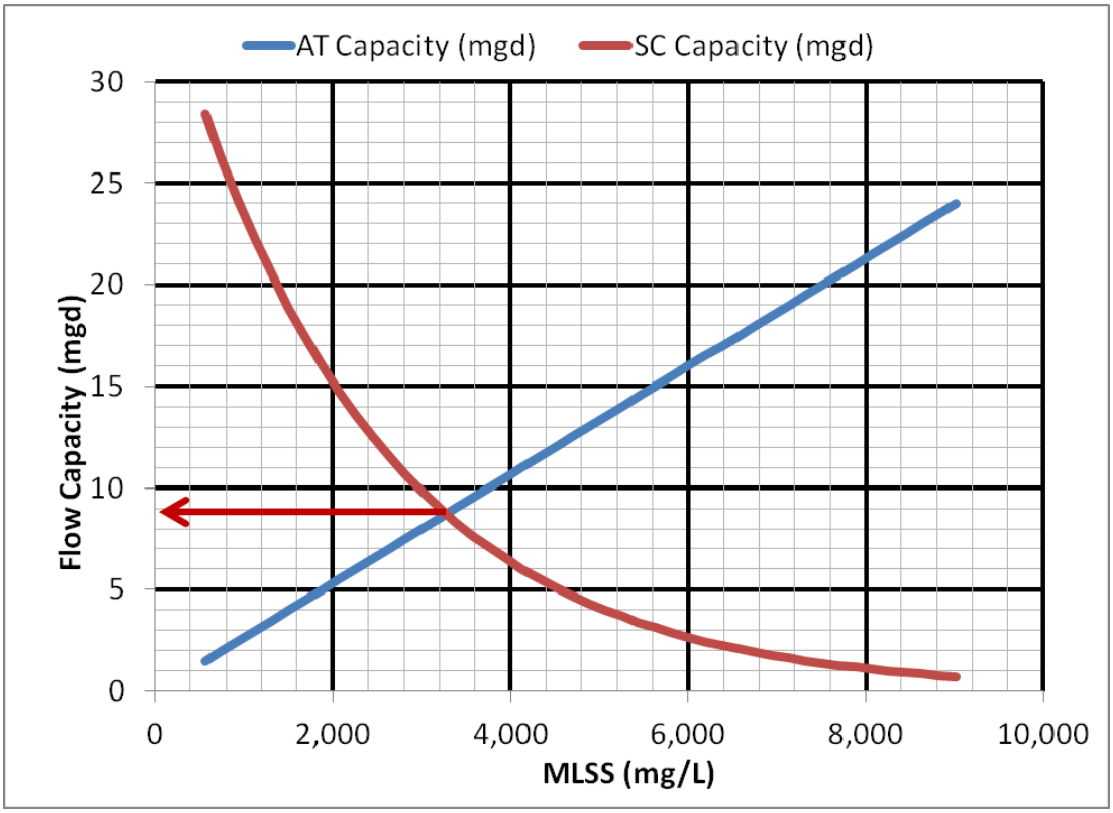


Figure 32 Upgraded MMDWF Full Nitrification Treatment Capacity (AIS)

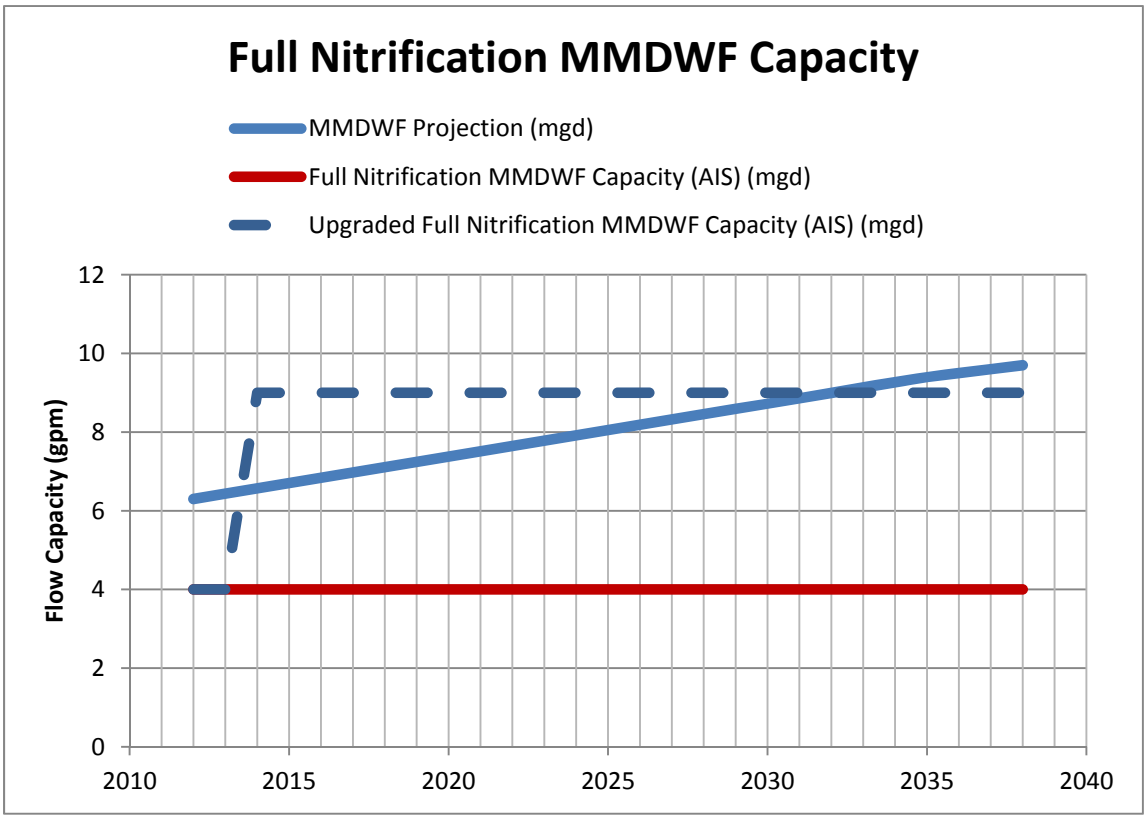


Figure 33 MMDWF Full Nitrification Treatment Capacity (AIS) Compared to Demand

6.2.5 Activated Sludge Aeration System

The aeration tanks for the Grants Pass WRP are provided with a diffused aeration system, including panel diffusers with two older 125 horsepower (hp) centrifugal blowers and two newer 3,000 standard cubic foot per minute (scfm) capacity, 200 hp centrifugal blowers. Figure 34 compares an estimate of peak future demand to the capacity of the two new blowers operating together. It is seen that, assuming the existing older blowers will have exceeded their useful life, new blowers may be required in approximately 2032.

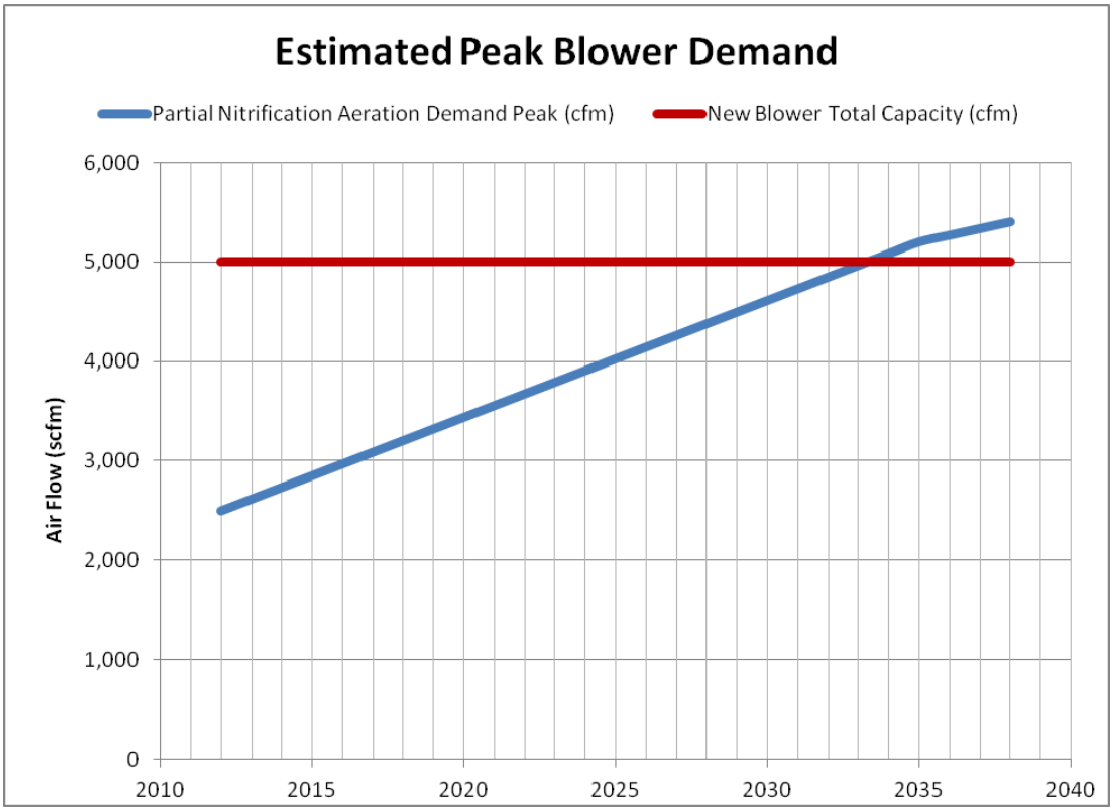


Figure 34 Estimated Peak Aeration Blower Demand to Existing Capacity (New Blowers)

7.0 ULTRAVIOLET DISINFECTION SYSTEM

The existing ultraviolet disinfection (UV) system at the Grants Pass WRP uses a Trojan Model 4000 UV system with medium pressure lamps. Characteristics of the system include the following:

- Peak flow: 23.5 MGD per channel.
- Design transmittance: 70% UVT.
- Number of channels: 2.
- Number of banks per channel: 2.
- Number of lamps per channel: 96.
- Power consumption at PHF: 269 KW.
- Expected design dose: 26 millijoules per square centimeter.

With one bank of lamps out of service, the PHF capacity of the system would be approximately 35 mgd. The capacity of the system is compared to projected demand in Figure 35. Based on these criteria, the UV system has sufficient capacity for 2035 PHF. While system capacity is adequate, there are several reasons to consider replacing the existing medium pressure system, which include:

- The system has had a poor track record for lamp and ballast failures.
- Medium pressure UV systems are very energy intensive compared to modern low pressure, high intensity systems.

Therefore, replacement of the medium pressure system by a newer system may be justified to save operation and maintenance costs compared to the current system.

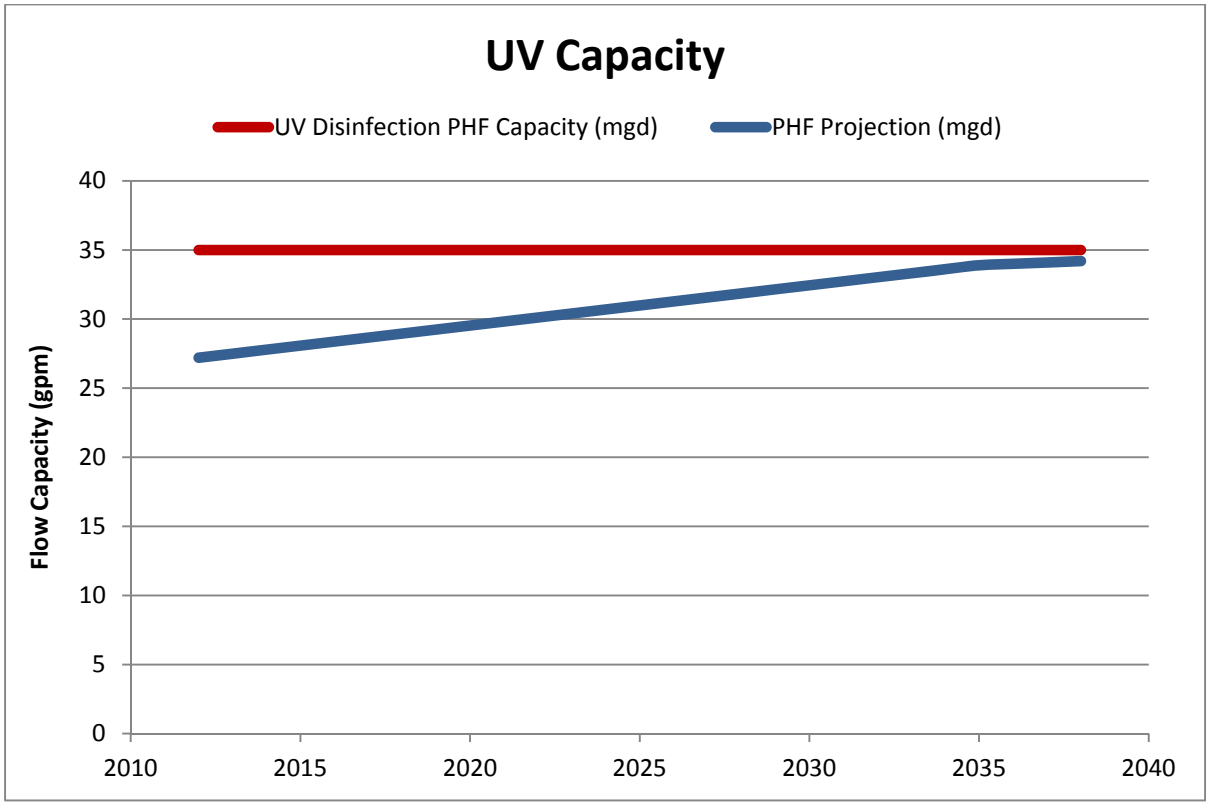


Figure 35 PHF UV System Treatment Capacity (One Bank OOS) Compared to Demand

8.0 HYDRAULIC CAPACITY

The following is a summary of the hydraulic capacity analysis for the existing City of Grant's Pass WRP. This analysis is provided to identify the hydraulic bottlenecks and capacity rating of each unit process at the WRP. Table 2 provides a summary of the capacities of each treatment process, assuming no bypassing of flows. These numbers are also independent of downstream process conditions or limitations and provide a hydraulic capacity for the specific process area only.

Table 2	Flow Capacity of Existing Processes *City of Grants Pass – Liquid Stream Process Analysis*	
	Process Area	**Max Flow, mgd**
	Raw Sewage Pump Station	44(1)
	Influent Screening Facilities	18.5
	Primary Sedimentation Tanks	20.9
	Aeration Tanks	13.5
	Aeration Tanks with ML Bypass Open	19.7
	Secondary Clarifiers	22.4
	UV Disinfection	47
	Effluent Outfall Diffuser	76(2)

Notes:
(1) Firm capacity, assumes largest pump out of service.
(2) Based on a Rogue River ordinary high water surface elevation of 890.00 feet.

8.1 Influent Screening Facilities

The Influent Screening Facilities where initially constructed in 1994, with additional improvements made in 2007. The hydraulic analysis for these facilities was based on record drawings from these projects. The screenings facilities and rectangular primary clarifiers are part of the same structure.

Pumped flow from the RS Influent Pumping Station discharges into the Influent Control Structure where it is metered through a Parshall flume. From there it flows by gravity through a 36-inch RS pipe to the Influent Screenings Structure inlet channel.

Alternately, there is an option to bypass the Screening Facilities and Primary Clarifiers. This can be accomplished by opening a buried butterfly valve at a wye fitting in the 36-inch RS pipe between the Influent Control Structure and Screenings Structure. Opening this valve allows the RS to flow directly into the Primary Effluent Junction Box and to the secondary treatment process.

At the Screenings Structure inlet channel, RS flow can be split into three separate channels. The western-most channel contains a Waste-Tech 3/8-inch perforated plate mechanical screen. The center channel contains a mechanical bar screen with 0.5-inch bar spacing. Motor actuated gates (GT-2001 and GT-2002) ahead of each channel are used to isolate the channels and allow flow to pass through either or both screens. It is assumed that both screening channels are used during peak flow conditions.

A screen bypass weir with an elevation of 915.52 feet allows flow to bypass the screens into a third channel without screens if the HGL upstream of the screens exceeds this elevation. This weir elevation is approximately two feet below the top wall of the structure, which has an elevation of 917.50 feet. With sewage flowing over the top of the weir with one foot of freeboard from the

top of the wall of the bypass channel, the capacity of the bypass channel is approximately 10.5 mgd.

The following assumptions where made in determining the maximum capacity of the screenings facility:

- Maximum capacity is based on an HGL of 915.52 feet upstream of the screens, meaning no flow bypasses the screens.
- It is assumed that one screen and the bypass channel are in service during peak flows.
- A maximum 30% blinding of screens was used.
- Assumed Gate GT-2013 remains closed so no flow is bypassed to the circular primary clarifier.

8.1.1 Hydraulic Limitations in the Screening Facilities

The hydraulic capacity of the screening facilities is limited by the screenings effluent channel. Once flow passes through the screens, it must pass through the two openings in the wall separating the primary clarifier influent channel from the screenings effluent channel. The openings create a sudden contraction in the channel, with a downstream width of only 12-inches per opening. This constriction in the flow path accounts for losses of approximately 1.65 feet at 18.5 mgd. Widening this wall opening to 6 feet would eliminate the constriction and increase the capacity of this process to 25 mgd. In this case, at 25 mgd the Parshall flume in the Influent Control Structure becomes submerged.

8.2 Primary Sedimentation Tanks

All flow from the Influent Screening Facility flows through the two rectangular primary sedimentation tanks. Based on current operations at the WRP, the hydraulic model assumes the existing circular primary sedimentation tank is not used for primary sedimentation.

Downstream of the screenings facilities there is an alternative flow path to bypass the primary clarification process and direct screened RS to the secondary treatment process. This can be accomplished by opening either or both of the two gates (GT-2201, GT-2202) located in the primary influent channel. Opening of these gates allows the screened RS to flow directly into the primary effluent channel.

Once influent flow passes the screens, it flows into a common primary influent channel. Each primary sedimentation tank has three isolation gates through which the influent flow passes into the tank. Each tank is 21-foot by 6-inch wide and includes chain and flight style sludge collectors and mechanical scum skimmers. At the end of each primary sedimentation tank are three 39 ft long by 1 ft 3-inch wide effluent troughs with rectangular notched weirs on each side. The rectangular notches are spaced at 6 inches on center and are 1.5-inch deep by 1.25-inch wide. The invert elevation of the weirs is at 913.01 ft. Primary Effluent (PE) flows over the weirs into the effluent troughs and drops into a common PE channel.

From the PE channel there is an option to bypass PE flow through a 20-inch diameter motor operated butterfly valve, which connects to the 42-inch PE pipe which bypasses the secondary treatment processes and allows the PE to flow into the Influent Vault at the old Chlorine Contact Tank (Surge Basin) just upstream of the UV disinfection process.

If the secondary treatment process is not bypassed, flow from the PE channel is routed through a 48-inch PE pipe to the PE Junction Box. Since no flow is sent to the circular primary sedimentation tank, no additional flows are contributed at the PE Junction Box. From the Junction Box, the PE flows through a 42-inch PE pipe to the Aeration Tank(s).

8.2.1 Hydraulic Limitations in the Primary Clarification Process

The hydraulic capacity of the primary tanks is limited by the effluent troughs. At flows above 20.9 mgd, the troughs fill and submerge the weirs regardless of downstream conditions in the PE channel.

The hydraulic capacity of the primary sedimentation tanks is further limited by the downstream conditions, either by the capacity of the Aeration Tanks or by the capacity of the Secondary Treatment Bypass. If all flow is sent to the Aeration Tanks, at 19.7 mgd, the flow in the primary effluent channel backs into the primary sedimentation tank effluent troughs and submerges the weirs. If all flow is sent to the Secondary Bypass, at flows above 18 mgd the flow backs into the primary sedimentation tank effluent troughs and submerges the weirs. The best hydraulic condition for the primary process, at flows above 19.7 mgd, is to split flow to the Aeration Tanks and Secondary Bypass. This will allow the maximum hydraulic capacity of 20.9 mgd to be pushed through the primary tanks.

8.3 Aeration Tanks

PE from the 42-inch PE pipe flows into the Aeration Tank inlet channel at the southwest corner of the structure. Return Activated Sludge (RAS) flow is also typically returned to this location. However, during Peak Flow conditions, the Aeration Tank is typically operated in contact stabilization mode. In this mode, RAS flow is introduced directly into Cell 1 of the Aeration Tank (through gate V-334), while PE flow is introduced into Cell 5 through gate SG-3117. This is the configuration that was assumed for this hydraulic analysis.

The facility is currently operated as a single tank with mixed liquor (ML) exiting the tank at the northwest side after Cell 7 (See Figure 10). A second outlet was added at Cell 7 during the 2005 WRP Phase 1 Upgrade. The second outlet is referred to as a 36-inch ML Bypass; however, this is somewhat of a misnomer as the ML is only bypassing a portion of Cell 7. A 36-inch butterfly valve with electric actuator allows flow to be diverted through the bypass. Both the 36-inch ML Bypass and the 36-inch ML pipe exiting the northwest side of the tanks combine into a single 48-inch diffuser pipe at the ML Splitter Box.

Five fiberglass baffle walls, fine bubble diffusers, and the gate between Cells 5 and 6 of the Aeration Tanks contribute to the hydraulic losses through the tanks.

At the ML Splitter Box, ML flow from the 48-inch ML diffuser pipe rises over a series of finger weirs into launders which discharge into three separate outlet boxes, one for each secondary clarifier. An isolation gate at the exit of each outlet box permits the secondary tanks to be removed from service.

8.3.1 Hydraulic Limitations at the Aeration Tank

The hydraulic capacity of the Aeration Tanks is limited primarily by the tank effluent channel. Without the ML Bypass open, the flow through the tanks is limited to 13.5 mgd before it begins to affect the primary process. The tank effluent channel is a completely submerged rectangular conduit. In the channel there is a wall with a 30-inch square opening that greatly constricts the flow path. With the ML Bypass open, there is an additional 36-inch conduit through which the ML can flow out of the tank. Opening the bypass increases the hydraulic capacity of the tanks to approximately 19.7 mgd.

8.4 Secondary Clarifiers

From the ML Splitter Box, the ML flows are split to each of the three secondary clarifiers (SC) through 36-inch and 30-inch pipes.

SC's No. 1 and 2 are identical and consist of 75-foot diameter tanks. The clarifiers are center feed, with ML entering the clarifier through ports in the center column into a flocculating well. The effluent launders are offset 4-feet from the inside face of the clarifier outer walls to the center of the 2-foot wide launder channel. The launders have v-notch weirs on both sides. From the effluent launder, secondary effluent (SE) exits the clarifier through a 27-inch SE pipe.

SC No. 3 is a 100-foot diameter tank with center feed and a perimeter effluent launder with v-notch weirs on the inside face. From the launder, SE flow drops into an effluent box and flows out a 30-inch SE pipe. This clarifier is located furthest north and, therefore, has the longest effluent piping.

The 30-inch SE piping from SC No. 3 connects to the 27-inch SE piping from SC No. 2 through a wye fitting. The size of the SE piping increases to 36-inch at SC No. 1 where all SE flows combine. The 36-inch SE piping is then routed to the old Chlorine Contact Tank (CCT), also referred to as a Surge Basin on some of the drawing sets.

8.4.1 Hydraulic Limitations at the Secondary Clarifiers

The hydraulic capacity of the secondary clarifiers is limited by SC No. 1 and No. 2. At flows above 22.4 mgd (with all tanks in service), the effluent weirs in these clarifiers become submerged. The limitations are primarily due to the narrowness and depth of the effluent launders in these clarifiers.

In SC No. 3, the effluent weirs do not become submerged until the combined flow increases to approximately 29.7 mgd.

8.5 Ultraviolet (UV) Disinfection Tanks

SE flows into the old CCT inlet box where it combines with any bypassed PE and flows into a 48-inch SE to the UV influent channel. Flow is split into two separate UV channels. Each channel contains two lamp banks with 48 medium pressure lamps per bank. A control gate at the end of the

UV channel maintains the water surface elevation at the end of the channel at 904.01 feet to ensure that the lamps are submerged and prevent overheating. The maximum water surface elevation downstream of the control gate cannot exceed 903.34 feet.

8.5.1 Hydraulic Limitation at the UV Disinfection Tanks

The UV Disinfection Tanks are limited hydraulically by the maximum allowable operating level upstream of the UV banks. The downstream elevation must be maintained at 904.01 feet while the upstream elevation must not exceed 905.51 feet (information based on 1994 drawings). The hydraulic capacity of each UV channel is currently 23.5 mgd based on the information received from the WRP staff.

8.6 Effluent Outfall Diffuser

Plant effluent flow from the UV tanks exits through a 48-inch outfall pipe to the Outfall Control Structure. This structure contains a gate to isolate the outfall diffuser as well as a weir set at elevation 900.50 ft. If the HGL in the structure exceeds this elevation, effluent flow is bypassed to the old 42-inch outfall to the Rogue River.

Normally, plant effluent flows from the Control Structure through approximately 300 linear feet of 48-inch pipe to the outfall diffuser in the Rogue River. The outfall diffuser is a 42-inch diameter concrete lined steel pipe with 12, 14-inch tideflex check valve diffusers with integral 90-degree long radius elbows.

The following assumptions were made in determining the maximum capacity of the outfall diffuser and pipeline:

- Capacity is based on a maximum water surface (WS) elevation in the Rogue River of 890.00 feet. This is the Ordinary High Water Level based on the 2005 WRP Phase 1 Upgrade Project. At higher river levels the capacity of the outfall decreases since the HGL is increased.
- Maximum capacity is based on overtopping the Outfall Control Structure Weir or exceeding the maximum water surface elevation of 903.34 feet downstream of the UV automatic level control gate.

8.6.1 Hydraulic Limitation at the Effluent Diffuser and Outfall Pipeline

At a Rouge River WS elevation 890.00 feet, the hydraulic model indicates the outfall has a maximum capacity of approximately 76 mgd. At flows above 76 mgd, the HGL at the Outfall Control Structure exceeds the bypass weir elevation. At this point, some of the effluent flow would be diverted to the old outfall structure. The HGL downstream of the UV Level Control Gate would still be below the maximum operating level at approximately 902.86 feet.

If the water surface elevation in the river increases above 890.00 feet, the capacity of the outfall would be reduced. The WRP peak flow condition of 30.7 mgd can be sent through the outfall diffuser without exceeding the bypass weir elevation as long as the river level is below an elevation

of 895.45 feet. This is above the 2-year flood elevation of 894.30 feet but below the 5-year flood elevation of 899.45 feet.

9.0 CAPACITY SUMMARY

The capacity of the Grants Pass WRP may be considered under several different capacity criteria corresponding to the applicable design flow for different unit processes as follows:

- PHF.
- MMWWF.
- Partial Nitrification MMDWF.
- Full Nitrification MMDWF.

9.1 PHF Capacity

Unit processes whose capacity is determined at PHF include:

- Raw Sewage Pump Station.
- Screening System.
- Primary Sedimentation.
- Activated Sludge System in Contact Stabilization.
- UV Disinfection.

Figure 36 presents a comparison of the PHF flow capacity of these unit processes to the current PHF and the anticipated PHF for the year 2035. It is seen that the raw sewage pump station, screening system, and UV disinfection system have adequate capacity for current and 2035 PHF. However, it should be noted that the screenings effluent channel limits the functional capacity of the screening system to 18.5 mgd, which is well below current peak hourly flows. The primary clarifiers and activated sludge system have inadequate PHF capacity at this time. In addition, these processes exceed overflow rate capacity criterion for current peak hourly flows by 46.5% and 30.5% respectively.

The current plant configuration requires significant process bypassing during PHF conditions. Due to hydraulic limitations downstream of the influent screening system up to 9 mgd of RS must be bypassed. Flow is bypassed again at a junction prior to the primary clarifier where approximately 9 mgd is sent directly to the aeration basins. It is likely that a portion of this flow will also not be screened. Due to the peak hour capacity of the secondary process, which is controlled by the overflow rate of the secondary clarifiers, 7.5 mgd of primary effluent will bypass secondary treatment and flow directly to the UV disinfection system. Flow splits are shown in Figure 37.

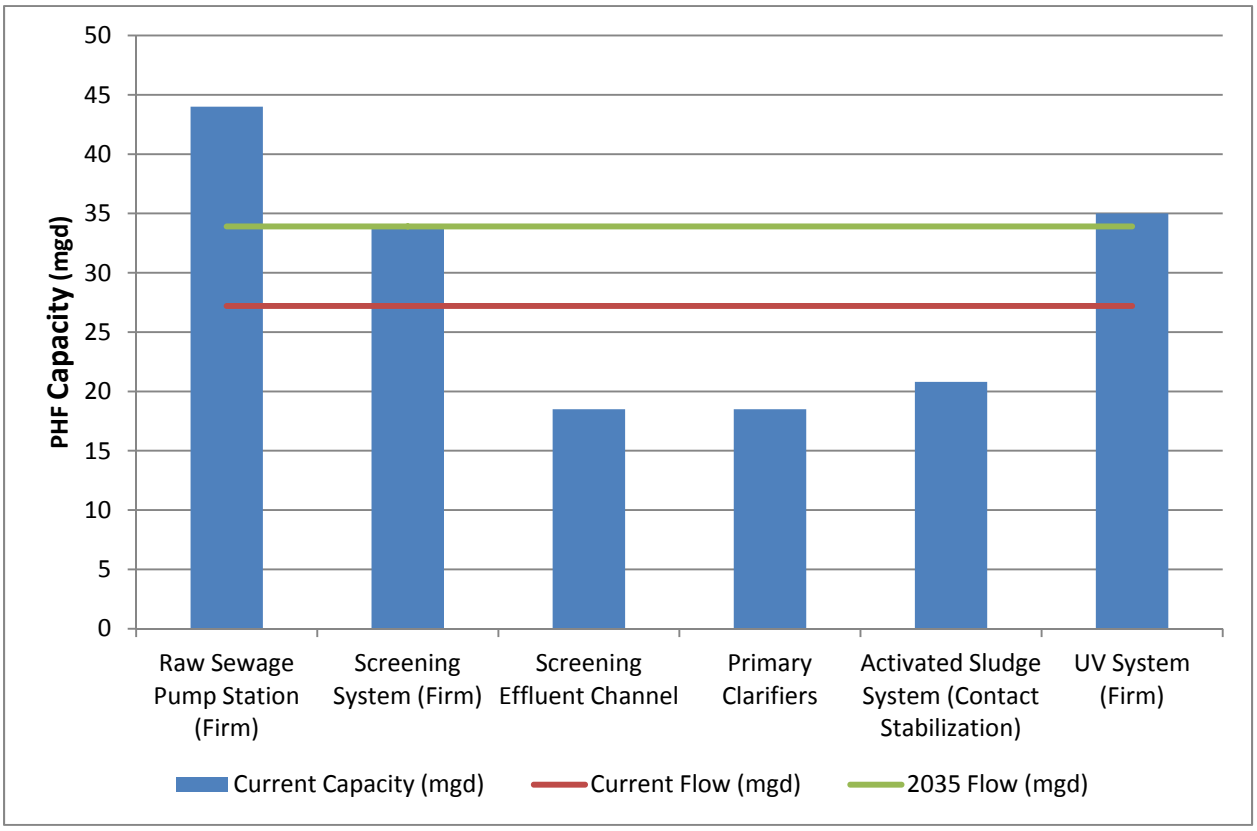
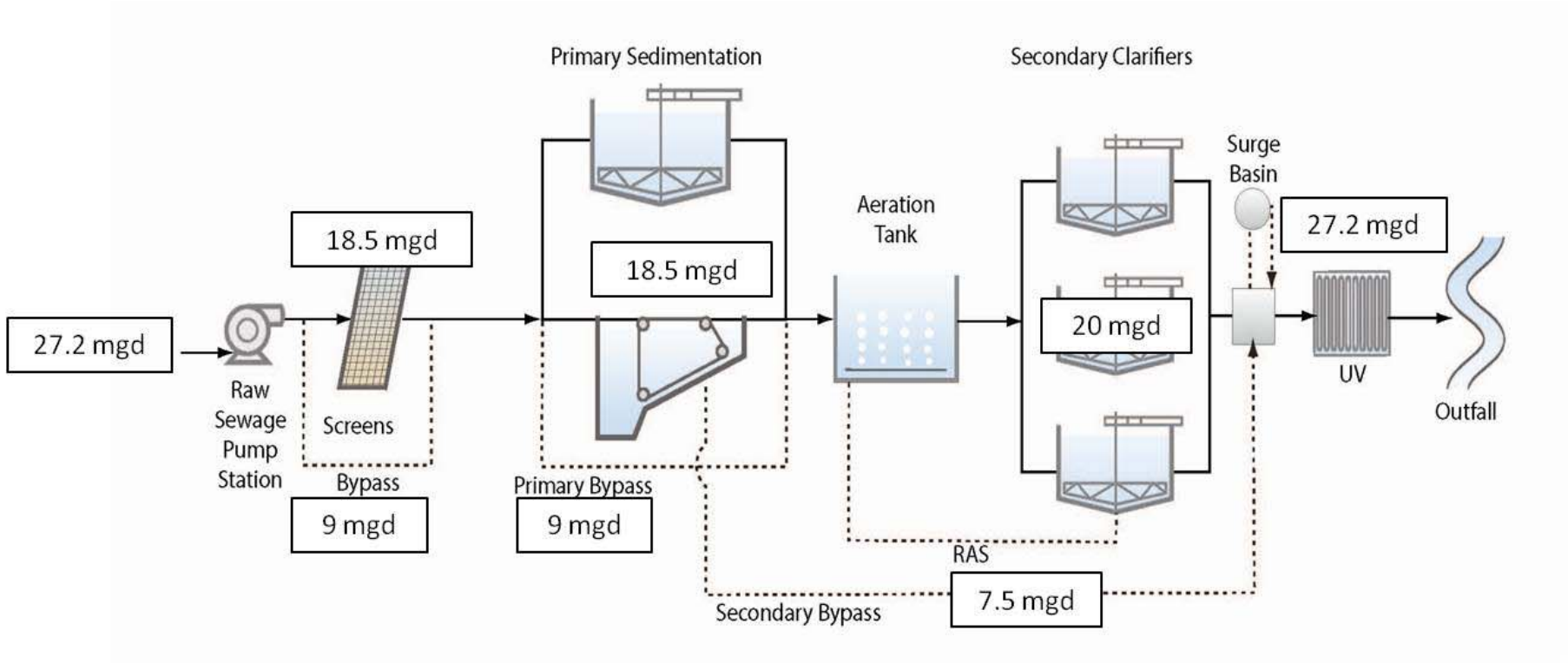


Figure 36 Summary PHF Capacity of Grants Pass WRP Unit Processes



PHF BYPASSING OF GRANTS PASS WRP UNIT PROCESSES

FIGURE 37

CITY OF GRANTS PASS
LIQUID STREAM PROCESS ANALYSIS

9.2 MMWWF Capacity

Unit processes whose capacity is determined at MMWWF include:

- Primary Sedimentation Tanks.
- Activated Sludge System.

Figure 38 presents capacity data based on MMWWF. It is seen that both unit processes have marginal capacity based on current flows and will require significant upgrade to accommodate future 2035 conditions.

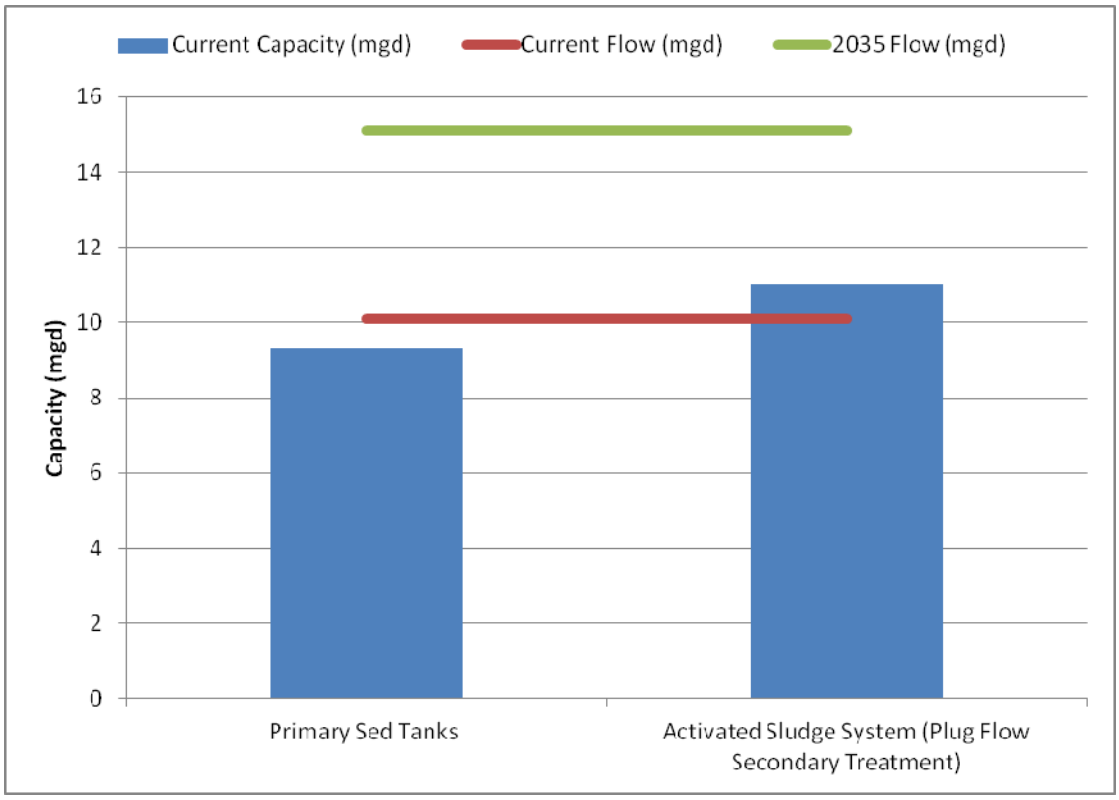


Figure 38 Summary MMWWF Capacity of Grants Pass WRP Unit Processes

9.3 Partial Nitrification MMDWF Capacity

Only the capacity of the activated sludge system is determined at MMDW. Figure 39 presents current capacity compared to current and future needs. The figure illustrates that the system has capacity for current MMDWF, but will require future upgrade to accommodate 2035 MMDWF.

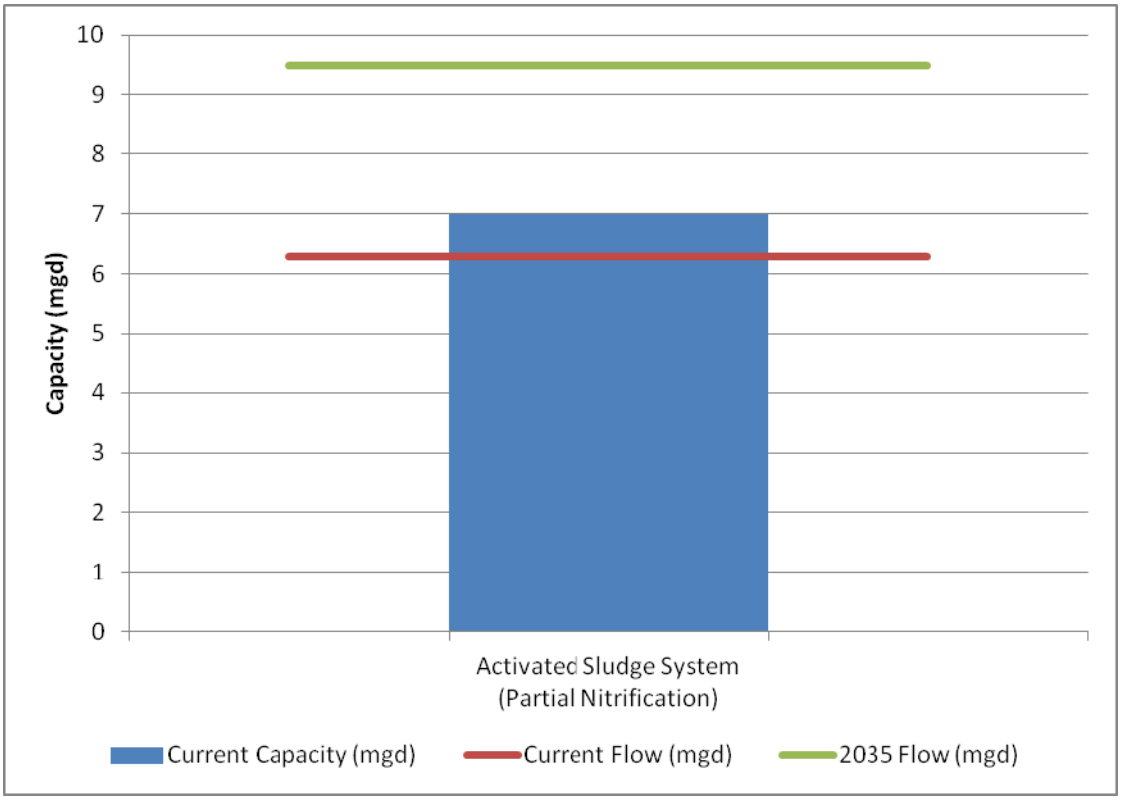


Figure 39 Partial Nitrification MMDWF Capacity of the Grants Pass WRP

10.0 EXISTING CONDITION

10.1 Condition Rating System

The condition assessment rating system described in Table 3 was used to assess the major liquid stream equipment components at the WRP. The mechanical rating addresses the overall mechanical and operational condition of the equipment. Mechanical service life is based upon input from plant staff and experience with similar equipment at other treatment plants. The structural condition is assessed in TM No. 6.

Table 3 Condition Rating System
City of Grants Pass – Liquid Stream Process Analysis

Value	Condition	Anticipated Service Life
1	Lowest priority for replacement – New or like new condition; proven to provide intended function.	20+ years
2	Low priority for replacement – signs of moderate wear; will provide service life with preventative maintenance.	10 – 20 years

Table 3	**Condition Rating System** ***City of Grants Pass – Liquid Stream Process Analysis***	
Value	**Condition**	**Anticipated Service Life**
3	Medium priority for replacement – serviceable but worn; should provide additional service life with maintenance, repair, or replacement of components.	5 – 10 years
4	High priority for replacement – serviceable but heavily worn; requires extensive rebuild, upgrade, or replacement for extended service life.	2 – 5 years
5	Highest priority for replacement- unit includes heavily worn or outdated equipment; service life is limited without replacement.	1 – 2 years

The condition of the existing major facilities is tabulated in Table 4. Major condition assessment issues that are recommended for repair are summarized below:

- The grit cyclone and classifier are worn and due for replacement.
- Diffuser within the aeration basin are due for replacement, however the ability to replace them is limited due to a lack of redundancy in the aeration basin.
- The UV disinfection system requires excessive maintenance and is difficult to access for maintenance. As previously discussed, replacement of the disinfection system may be a cost effective solution.

Table 4 Condition Assessment

City of Grants Pass – Liquid Stream Process Analysis

Liquids Unit Process or Facility	Quantity	Approximate Year Installed or Constructed	General Comments	Process Mechanical Comments	Overall Condition Assessment Rating
Influent Pumping Station					
Influent Pumps	4	(3) 2007 (1) 1995			2
Flow Monitoring	1				2
Mechanical Bar Screen	1	1996			2
	1	2007			1
Screenings Compactor	1	1996	No redundancy	Failed at least 3-4 times.	4
Composition monitoring	1	1994	Downstream of influent pumps		1
Primary Clarifiers					
Circular Primary Clarifier	1	1974	No longer used as PC. Used for sludge storage.	Hydraulically limited	3
Rectangular Primary Clarifier	2	1996		Have put 21 mgd through but it floods the weirs. Coatings failing on components within tank	2
Primary Sludge and Grit Pumps					
Primary Sludge and Grit Pumps					
Circular Primary Clarifier					
Rectangular Primary Clarifiers	3	1996			2
Primary Scum Pumps					3
Circular Primary Clarifier	1	1974	This clarifier is not currently used		3
Rectangular Primary Clarifiers	1	1996			
Grit Removal					
Grit Cyclone/Classifier	2	1996	Worn and has been patched many times. Due for replacement.		5
Grit washer	1	1996			4
Aeration Basins					
Contact Basins	2	10 yrs old	Aerostrip diffusers. System can be operated in plug flow, step feed, or contact stabilization mode. Submersible mixers in Zones 1-3.	Diffusers due for replacement Foam gets trapped. Need motorized gates. Control boards have failed on motorized valves.	5
Blowers					
Blowers	4	(2)2005 (2)1974	Never use older blowers.	Can't run two at low speeds, old ones not hooked to SCADA.	2
Secondary Clarifiers					
Clarifier 1 & 2	2	1974		1 drive replaced in 1980's. Suction tubes are failing. Coating failing. Mechanism scrapes.	3
Clarifier 3	1		Run on blanket depth pulled from Clarifier 3	Some short circuiting.	1
RAS Pumping		2005		Need crane for maintenance.	1
WAS Pumping		2005			1
UV Disinfection					
UV System	2 Channels with 2 lamp banks each	1996	1 - Not used 2 - high maintenance requirements and hard to work on.		4

11.0 REFERENCES

Environmental Protection Agency, Office of Water Programs (1974) *Design Criteria for Mechanical, Electric, and Fluid System and Component Reliability*, MCD-05.

Parametrix (2001) *Grants Pass Water Restoration Plant Wastewater Facilities Plan*.