6.1 INTRODUCTION

Wastewater treatment process considerations must be updated from the *2002 Wastewater Facilities Plan* and the *2003 Wastewater Facilities Plan Amendment* to account for the extremely low effluent phosphorus requirements of the Washington Department of Ecology's Dissolved Oxygen Total Maximum Daily Load (TMDL) and the June 30, 2006 *Foundational Concepts for the Spokane River TMDL Managed Implementation Plan.* Spokane County must meet a phosphorus wasteload allocation of 0.67 lbs/day based on a flow 8 mgd and the seasonal average phosphorus concentration target of 10 µg/L. A targeted seasonal average effluent total phosphorus concentration of 50 µg/L for the Spokane County Regional Water Reclamation Facility is combined with "target pursuit actions" for eliminating the delta between 50 µg/L and 10 µg/L phosphorus at 8 mgd average flow. This newly targeted seasonal average effluent total phosphorus concentration of 50 µg/L requires re-examination of the preferred treatment process, as well as establishment of the basis for future reduction to a seasonal average of 10 µg/L. This chapter describes the technology selection protocol as described in *Foundational Concepts for the Spokane River TMDL Managed Implementation Plan* for meeting the treatment process objectives.

This wasteload allocation is to be met by a combination of treatment technology and other phosphorus reduction actions. The *Foundational Concepts* document calls for the County to prepare a "delta elimination plan" to account for the difference between what advanced treatment technologies can achieve at 50 µg/L (3.34 lbs/day) and the County's wasteload allocation based on 10 µg/L (0.67 lbs/day). The County's "delta" is 2.67 lbs/day and will be met by a combination of septic tank elimination, water conservation, effluent reuse, and other nonpoint source reductions, as described in Chapter 11.

This chapter focuses on updating the treatment process for the Spokane County Regional Water Reclamation Facility (SCRWRF) to produce a seasonal average effluent total phosphorus of 50 µg/L or lower. This chapter also summarizes the wastewater conveyance system associated with the SCRWRF, including the effluent discharge outfall to the Spokane River.

6.2 ADVANCED WASTEWATER TREATMENT PROCESS PERFORMANCE

Chapter 173-221 WAC Discharge Standards and Effluent Limitations for Domestic Wastewater Facilities establishes surface water discharge standards which represent "all known, available, and reasonable methods of prevention, control, and treatment" (AKART) for domestic wastewater treatment facilities, as required by Chapter 90.48 RCW. These are often referred to as technology based standards. For domestic wastewater, AKART is considered to be secondary treatment, as presented in Chapter 173-221 WAC. However, if secondary treatment is not sufficient to meet water quality standards, additional treatment may be required. If the technology-based discharge standards or the alternative standards presented in Chapter 173-221 WAC are not sufficient to meet the water quality standards, then more stringent discharge requirements will apply. Since the Washington Department of Ecology's Dissolved Oxygen Total Maximum Daily Load (TMDL) phosphorus concentration target of 10 µg/L on a seasonal basis is so low, additional analysis regarding the limits of treatment technology has taken place since 2004. This analysis has included a survey of exemplary treatment plants producing very low effluent phosphorus, review of full-scale operating facilities and site visits, treatment equipment vendor presentations, and review of the results from pilot testing. The analysis of technologies included in this 2006 Wastewater Facilities Plan Amendment meets the requirements of AKART, and additionally meets the more stringent requirements of the Foundational Concepts for the Spokane River TMDL Managed Implementation Plan.

6.2.1 Advanced Wastewater Treatment Process Workshop

On August 16, 2006 an advanced wastewater treatment process workshop was held to identify, update, and discuss the state-of-the-art in treatment technology for extremely low effluent phosphorus. This workshop was attended by Spokane River dischargers, wastewater treatment process engineers, academics, federal and state regulatory agencies, representatives of environmental groups, and treatment equipment vendors. The purpose of this session was to utilize the workshop to address technology development, readiness, pilot testing, technology issues, and other development requirements for applicability to Spokane River dischargers. Conclusions and recommendations from the treatment technology workshop were intended to be used by Spokane River dischargers in site-specific plant process selection evaluations.

Notes from the August 16, 2006 workshop are included as Appendix C. A summary of the discussion and conclusions from the workshop are as follows:

- Results of phosphorus removal at many plants were presented. In general, the best results were in the 20 to 30 µg/L range and were being achieved by a variety of processes. There were some exceptions that were achieving better results: two very small plants with very limited data and two plants in Breckenridge, Colorado.
- There is substantial variability in phosphorus removal performance and in the chemical analysis for phosphorus that must be considered when establishing treatment performance requirements.
- Plants with no sludge processing on-site produce lower effluent phosphorus concentrations.
- Reported effluent phosphorus concentrations are lower in smaller plants. Potential reasons include the simpler (or absent) solids handling processes generally used in smaller plants (less recycle) and the fact that small plants may not be sampled each day. Some data from larger plants where the effluent was sampled each day illustrated how routine equipment maintenance and day-to-day process variability can impact the effluent total phosphorus and elevate the average reported phosphorus concentrations. Such events are generally not detected when effluents are sampled periodically rather than daily.
- There is a long learning curve in starting up the operation of new phosphorus removal plants that must be considered when establishing treatment performance requirements.

- The removal of colloidal, refractory phosphorus is a potentially fertile area for research and may be needed to address what appears to be in many instances a refractory level of about 20 ug/L total phosphorus.
- The status of the Department of Ecology plans for proceeding with the Managed Implementation Plan was described.
- The City of Spokane, the City of Coeur d'Alene, and Inland Empire Paper described their pilot plant projects.
- Spokane County described the status of their planning.
- There is a willingness among those attending the workshop to share data as work proceeds.
- A desire was expressed to reconvene the workshop group again next year to share information.

6.2.2 Capabilities of Treatment Technology and Discharge Permitting

A key aspect of the discussions about advanced wastewater treatment technologies is performance capabilities compared to potential effluent discharge permit limits. For a facility the size of the 8 mgd SCRWRF, with anaerobic digestion and solids stream recycle loadings, the current estimate of effluent concentration from advanced treatment technologies is 50 µg/L on a long-term average, or median, basis. Day-to-day variability in effluent concentration may range significantly above these levels based on the analysis of data from reference facilities. For this reason, it is inappropriate for discharge permit requirements to restrict effluent concentrations to daily or weekly maximums that are higher than 50 ug/L. Although daily effluent performance may vary, average effluent performance will be excellent at these extremely low concentration levels. Daily variations are not significant in terms of receiving water quality and do not adversely impact nutrient enrichment or dissolved oxygen conditions.

6.3 ADVANCED WASTEWATER TREATMENT PROCESS EVALUATION

The proposed process design outlined in the *2002 Wastewater Facilities Plan* and the *2003 Wastewater Facilities Plan Amendment* revolves around a membrane bioreactor designed for nitrification and denitrification (N/DN) with chemical addition for phosphorus removal. The new requirements, however, increase the demand on phosphorus removal such that multiple treatment steps are required to ensure reliable treatment performance. The 2002/2003 N/DN process design concept provides only two phosphorus removal points; primary and secondary chemical removal. In addition, the primary chemical removal generates a conflict of interest with regard to carbon substrate, or biochemical oxygen demand (BOD), to support the denitrification process. Carbon substrate (BOD) is removed at a much higher rate in the primary clarifier when significant amounts of Alum or Ferric are added for phosphorus removal. This can limit the nitrogen removal capability of the treatment system due to carbon deficiency and may require supplemental carbon (methanol) addition.

Four advanced treatment alternatives for extremely low effluent phosphorus using biological and tertiary processes as additional phosphorus removal stages are being evaluated as part of this *2006 Wastewater Facilities Plan Amendment*.

6.3.1 Originally Proposed Process Design

The originally proposed design from the *2002 Wastewater Facilities Plan* and the *2003 Wastewater Facilities Plan Amendment* features membrane bioreactor technology with nitrification and denitrification for secondary treatment (Figure 6-1). Plant influent is screened and degritted prior to primary clarification. Primary clarifier effluent enters the secondary treatment after an intermediate fine screening. The secondary treatment process consists of three zones: anaerobic and anoxic for denitrification; aerobic for oxidation of BOD and nitrification; and the membrane tank. While the primary function of the membrane tank is housing the membrane modules, it is also aerated and becomes part of the aerobic fraction of the total aeration basin volume. The secondary effluent, or membrane permeate, is disinfected with a sodium hypochlorite based disinfection system and is either reused or dechlorinated and discharged to the Spokane River.

Primary sludge and waste activated sludge are co-thickened with dissolved air flotation after which they are anaerobically digested. The digested solids are dewatered and hauled for disposal. Dewatering centrate is sent to a holding tank to equalize its ammonia load before being returned to the secondary treatment process.

Phosphorus removal is provided by Alum addition to the primary clarifier and secondary process. The process is designed to provide effluent total phosphorus concentration of less than 0.1 mg/L on a monthly average basis.

Using both the primary and secondary chemical addition, thus two removal stages, would provide sufficient reliability and redundancy for meeting a monthly average 0.05 mg/L effluent total phosphorus limit. However, the required chemical dosages are substantial, and the increased primary BOD removal may create limiting conditions for denitrification.

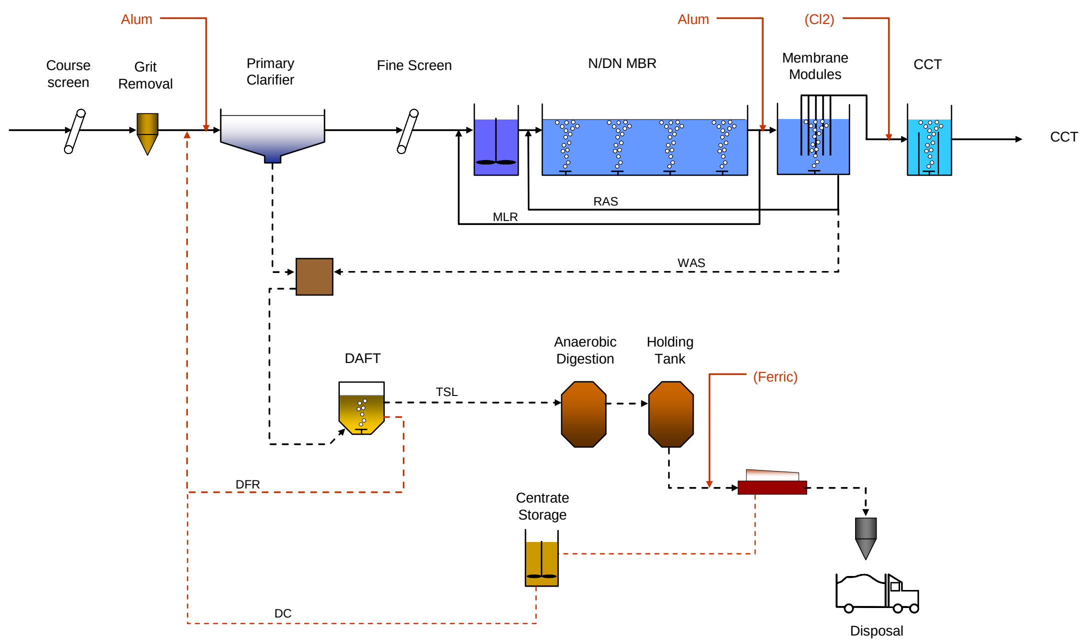

Figure 6-1: Schematic of Proposed Process Design from 2003 Facility Plan Amendment

6.3.2 Advanced Process Alternative Analysis for Low Phosphorus

The alternative analysis focused the changes to the mass balance resulting from the different process designs targeted on very low effluent phosphorus The mass balance analysis assumes treatment performance for biological phosphorus removal and denitrification. The effluent quality assumptions are based on experience from other facilities with similar process designs.

Effluent total phosphorus of 50 µg/L on an average seasonal basis and total nitrogen of 8 mg/L is considered in this analysis. It is assumed that pursuit of lower effluent phosphorus levels approaching 10 µg/L will require additional treatment process steps which will be explored in demonstration testing in the SCRWRF in the future.

For this advanced wastewater treatment alternative analysis the *2003 Wastewater Facilities Plan Amendment* process design (AWT Alternative 1) is being compared with three new process designs (AWT Alternatives 2 through 4);

- AWT Alternative 1 – Membrane bioreactor (MBR) with nitrogen removal and chemical phosphorus removal
- Similar to the *2003 Wastewater Facilities Plan Amendment* process, but with additional chemical feed
- AWT Alternative 2 - Membrane bioreactor (MBR) with biological nutrient removal (BNR) and chemical polishing

- AWT Alternative 3 - Membrane bioreactor (MBR) with biological nutrient removal (BNR) and tertiary chemical polishing
- Tertiary chemical polishing could be accomplished with a variety of treatment technologies such as BlueWater Technology Blue CEPT®, Parkson D2® dual sand filtration, US Filter Trident® HS-1, or an additional microfiltration membrane
- AWT Alternative 4 – Conventional activated sludge with tertiary membrane filtration

6.3.3 Impact of Key Process Parameters

- **Solids Retention Time (SRT) vs. Membrane Flux**

  The maximum flux and membrane fouling rate is very dependent on the Solids Retention Time (SRT). Longer SRTs allow higher flux rates and reduce membrane fouling. This correlation is due to the decreasing presence of extracellular polymeric substances (EPS) with increasing SRT. With lower EPS concentrations membrane fouling decreases, the membrane cake layer is more effectively removed by scour air, and the membrane clean in place (CIP) provided better flux recovery. Therefore, a minimum aerobic SRT of 15 days is recommended for the MBR design.

- **Internal Recycle vs. Average Mixed Liquor Suspended Solids (MLSS)**

  Unlike conventional activated sludge biological nutrient removal (BNR), the MBR BNR process does not have a high total suspended solids (TSS) return activated sludge that is returned to the head of the process. Instead the MBR return activated sludge is returned to the font of the aerobic zone. That is because otherwise the combination of high recycle rate of 4 Q to 5 Q and high dissolved oxygen of 6 mg/L to 8 mg/L would be inhibiting biological phosphorus removal and/or denitrification if returned to the front of the process.

  Instead, two additional internal recycles provide biomass to the anaerobic zone and nitrates to the anoxic zone. This results in a very pronounced MLSS profile with concentration in the membrane tank being up to 5 times higher then in the anaerobic zone. The average mixed liquor solids is several hundred mg/L lower than the mixed liquor solids in the membrane tank, which is the governing mixed liquor concentration for the MBR design. For this design, the maximum mixed liquor solids concentration in the membrane tank of 12,000 mg/L results in an average mixed liquor of 9,000 mg/L in for the biological nutrient removal MBR and 9,800 mg/L in the nitrification/denitrification MBR.

- **Location of Chemical Phosphorus Removal vs. Solids Mass Balance**

  Even if the total amount of chemicals added, and chemical sludge generated, remains the same, the location at which the chemicals are added impacts the size of the solids processing, aeration basin size, and BNR performance. In addition, the chemical addition location also impacts phosphorus removal efficiency, thus chemical demand. The treatment process options under consideration are as follows:

  - **Primary Alum Addition**. This option results in increased primary TSS and BOD removal. This reduces the required aeration basin volume and oxygen demand. However, it also reduces the amount of available carbon substrate required for denitrification and could subsequently limit nitrogen removal.

- **Secondary Alum Addition**. This option increases the aeration basin MLSS by adding chemical sludge to the mixed liquor. The fraction of chemical sludge increases with increasing SRT and can occupy up to 50 percent of the aeration basin volume. Without a tertiary treatment stage however, the addition to the secondary treatment process is the only option to polish the effluent and to assure permit compliance.
- **Tertiary Alum or Ferric Addition**. This option usually involves much smaller doses than primary and secondary addition; therefore its impact is less severe. Typically solids produced in the tertiary treatment stage are returned to the head of the plant. Consequently, most of the tertiary chemical sludge would enter the solids processing stream via primary clarification with the primary sludge.
- **Ferric Addition to Digested Sludge**. This option would remove the phosphate released during the anaerobic digestion of solids. This is especially important for processes with biological phosphorus removal, since a large fraction of the stored phosphorus is released in the anaerobic digester. The main advantage of this chemical addition point is that the phosphorus is concentrated, providing more favorable conditions for precipitation and the chemical sludge generated is disposed of immediately with the dewatered biosolids. The latter reduces the overall amount of chemical sludge in the system, in both liquid and solids treatment streams.

- **Volatile Fatty Acids (VFA) vs. Biological Phosphorus Removal**

  Biological phosphorus removal requires a sufficient supply of volatile fatty acids to the anaerobic zone. While the influent VFAs are often sufficient under average conditions, biological phosphorus removal plants that add additional VFAs have shown to be much more reliable, consistent, and produce lower effluent phosphate concentrations.

- **Supplemental Alkalinity Addition**

  Some of the treatment processes (nitrification) and chemical dosing for phosphorus removal (alum) will deplete alkalinity in the wastewater and could require the addition of supplemental alkalinity to avoid pH depressions. Alkalinity data for influent wastewater is not available, however the drinking water supply gives some indication of the alkalinity expected to be present in the wastewater. Source water supply alkalinity varies widely in the Spokane Valley Aquifer with a reported range from 5 mg/L to 523 mg/L as $CaCO_3$. Average alkalinity in the aquifer is 122.5 mg/L as $CaCO_3$. The net consumption of alkalinity for nitrogen removal with nitrification/denitrification is approximately 4.6 mg/l $CaCO_3$ per mg/l of influent ammonia. The alkalinity consumption from alum addition for phosphorus removal is approximately 0.5 mg/l $CaCO_3$ per mg/l of alum dose. Total alkalinity reduction for these estimates is approximately 230 mg/l $CaCO_3$ and exceeds the average alkalinity in the source drinking water in the Spokane Valley Aquifer. Sampling will be conducted on the North Valley Interceptor and the Spokane Valley Interceptor to measure wastewater alkalinity.

6.3.4 AWT Alternative 1 – Membrane Bioreactor (MBR) with Nitrogen Removal and Chemical Phosphorus Removal

AWT Alternative 1 is almost identical to the process design proposed in the *2003 Wastewater Facilities Plan Amendment* (Figure 6-2). The key difference is that the loss of carbon substrate to the nitrogen removal process is addressed by providing either the ability to feed a carbon substrate, such as methanol, or utilize a primary sludge fermentation process, such as unified fermentation and thickening (UFAT), to generate the additional soluble BOD from primary sludge, or both.

The process still relies solely on chemical addition for phosphorus removal with maximum phosphorus removal in the primary clarifier. It is assumed that the resulting solids removal rates are comparable to those of a chemically enhanced primary. This results in a smaller secondary treatment process but larger solids processing facility. The latter is a result of not only the chemical sludge production, but also the additional primary clarifier solids removal.

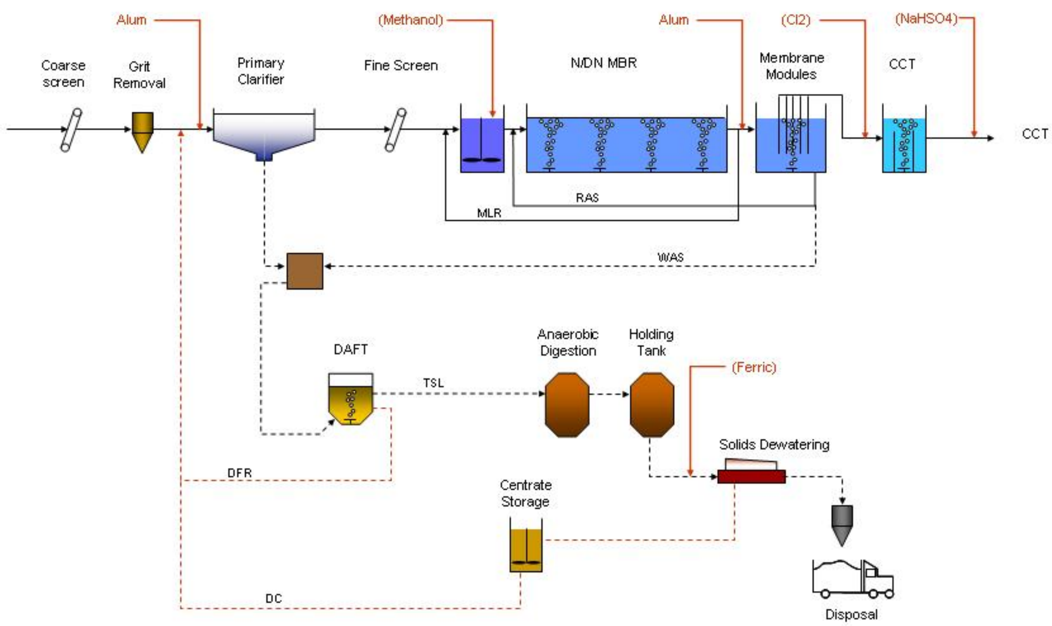

Figure 6-2: Schematic of AWT Alternative 1 – Membrane Bioreactor (MBR) with Nitrogen Removal and Chemical Phosphorus Removal

Advantages of AWT Alternative 1 are as follows:

- The process consists of two relatively simple treatment stages.

- A third treatment step for phosphorus removal can easily be added in the future provided that footprint space and hydraulic profile is reserved.
- The increased TSS and BOD removal decreases the size of the aeration basin by 50 percent and decreases the oxygen demand by 30 percent.
- Disadvantages of Alternative 1 are as follows:
- The primary BOD removal reduces nitrogen removal capacity and may require supplemental carbon addition.
- The significant primary chemical sludge volume would increase the size of the optional fermenter.
- Total solids loading to anaerobic digestion increases significantly.
- Only two phosphorus removal stages.

6.3.5 AWT Alternative 2 - Membrane Bioreactor (MBR) with Biological Nutrient Removal (BNR) and Chemical Polishing

AWT Alternative 2 introduces biological phosphorus removal (Figure 6-3). The main objective of this process design is to reduce the required chemical dose and subsequent chemical sludge production and sludge handling costs.

The design approach is to maximize biological phosphorus removal and rely on chemical backup for permit compliance. This provides two treatment stages, but primary alum addition would be retained as a backup. Since a significant fraction of the biologically stored phosphorus would be released during anaerobic digestion, the BNR system still relies on chemical precipitation to a large degree. That is to say that the phosphate re-released during anaerobic digestion would be returned to the secondary treatment system with the dewatering centrate, if it is not chemically precipitated.

The phosphorus precipitation from digested sludge is much more efficient and reduces chemical demand by utilizing naturally accruing metal ions such as Ca, K, or Na to precipitate phosphorus. In addition, when added just upstream of dewatering, the chemical sludge produced is immediately removed from the treatment system and does not further impact the solids or liquid treatment.

An additional ferric feed would be provided to the digester influent for struvite control. Struvite (magnesium ammonium phosphate) is a metal phosphate crystal that forms when its maximum solubility is exceeded. Struvite formation is likely in a BNR system because of the transfer of the otherwise limiting magnesium and non-chemically bound phosphorus. Struvite can cause scaling-related operational problems and become a costly nuisance. However, when properly managed, operational issues can be avoided.

Unlike Alternative 1, the primary sludge fermentation now becomes an essential component to the process to supplement the influent volatile fatty acids required for stable and reliable biological phosphorus removal. The selected UFAT fermentation process features higher VFA generation and elutriation rates, as well as very effective thickening characteristics with thickened primary sludge concentrations in excess of 7 percent. The principal design concept of the UFAT process is to operate a static fermenter/thickener and conventional gravity thickener in series. Primary sludge is retained for several days in the fermenter to generate the desired volatile fatty acids. In order to efficiently elutriate the acids, underflow and overflow of the fermenter are remixed and settled out again in the downstream thickener. This also causes the stripping of micro-gas bubbles, which otherwise have the tendency to reduce primary sludge blanket density and diminish thickening performance.

Advantages of AWT Alternative 2 are as follows:

- Better nitrogen removal performance compared to Alternative 1 due to reduced primary BOD removal.
- Lower solids loading to anaerobic digestion due to reduced primary solids removal and reduced primary and secondary chemical addition.
- Smaller anaerobic digestion and solids processing facilities.
- Reduced chemical use and chemical sludge production.

Disadvantages of AWT Alternative 2 are as follows:

- Biological phosphorus removal is not 100 percent reliable and requires chemical backup and polishing.
- The BNR process with a UFAT fermenter has a higher degree of operation and process control complexity than Alternative 1.
- The aeration basin volume is larger than Alternative 1.

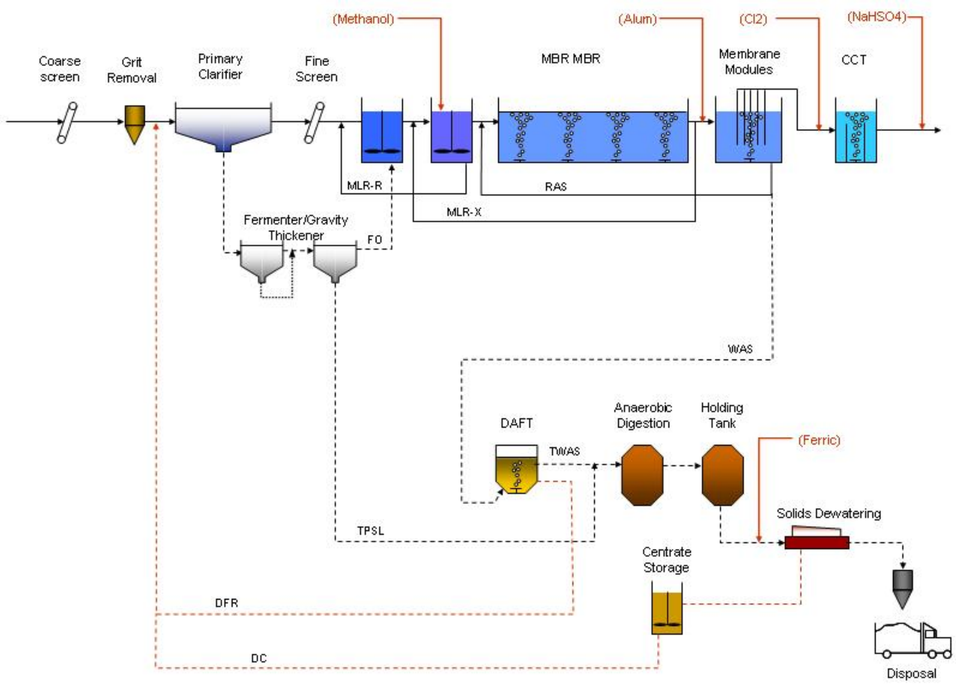

Figure 6-3: Schematic of AWT Alternative 2 - MBR with BNR and Chemical Polishing

6.3.6 Alternative AWT Alternative 3 - Membrane Bioreactor (MBR) with Biological Nutrient Removal (BNR) and Tertiary Chemical Polishing

AWT Alternative 3 is the combination of AWT Alterative 2 MBR with BNR, and tertiary phosphorus removal (Figure 6-4). While it is expected that both previous alternatives would be sufficient for permit compliance, this alternative offers a higher level of redundancy and reliability with regard to phosphorus removal. Under normal conditions the process would operate in BNR mode with chemical addition only to the tertiary system and to the digested sludge. The backup for the biological phosphorus removal is provided by optional alum feed to the primary clarifier.

The BlueWater Technology BlueCEPT process is shown in Figure 6-4 for illustrative purposes. This type of process has some potential to further reduce the overall chemical demand and also produce effluent total phosphorus concentration less than 50 μg/L. While effluent concentrations have been demonstrated under controlled conditions at the BlueWater Technology research facility, the capabilities of the process have not been demonstrated in full-scale operation in a process train similar to AWT Alternative 3. Alternately, other tertiary filtration technologies could also be considered, such as the Parkson D2 dual sand filtration, a second Microfiltration step, or the US Filter Trident® HS-1. Performance of these process train options and various tertiary technologies may be investigated in demonstration testing at the SCRWRF.

Advantages of AWT Alternative 3 are as follows:

- Better reliability and a higher degree of redundancy due to three phosphorus removal stages.
- Potential further reduction in total chemical use.
- Better nitrogen removal performance compared to Alternative 1 due to reduced primary BOD removal.
- Lower solids loading to anaerobic digestion due to reduced primary solids removal and reduced primary and secondary chemical addition.
- Smaller anaerobic digestion and solids processing facilities than Alternative 1.
- Reduced chemical use and chemical sludge production.

Disadvantages of AWT Alternative 3 are as follows:

- Additional 10 percent to 15 percent reject recycle flow from tertiary filtration (BlueWater Technology BlueCEPT only)
- Biological phosphorus removal is not 100 percent reliable and requires chemical backup and polishing.
- The BNR process with a UFAT fermenter and tertiary phosphorus removal has a higher degree of operation and process control complexity compared to Alternative 1.

- The aeration basin volume is larger than Alternative 1

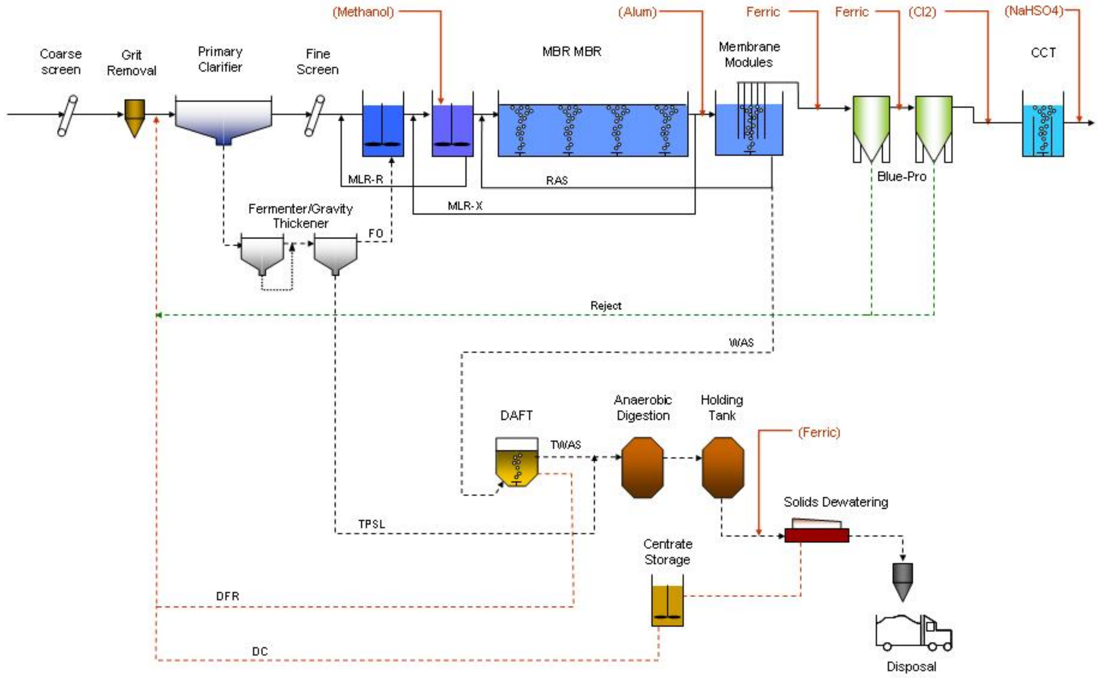

Figure 6-4: Schematic of AWT Alternative 3 - Membrane Bioreactor (MBR) with Biological Nutrient Removal (BNR) and Tertiary Chemical Polishing

6.3.7 AWT Alternative 4 – Conventional Activated Sludge with Tertiary Membrane Filtration

AWT Alternative 4 takes a different approach to phosphorus removal. While the previously discussed alternatives are suited to produce 50 µg/L effluent total phosphorus, they share one disadvantage in that the tertiary treatment process step following the membrane uses a less effective solids separation technology (i.e., the membrane filtration is followed by sand filtration). Therefore, AWT Alternative 4 reverses the sequence of treatment process units with conventional activated sludge with BNR followed by tertiary treatment (Figure 6-5) with membrane filtration as the final step. Secondary solids separation would be provided by high rate secondary clarifiers. Since the plant will likely be operated with capped peak flows, clarifier design solids loading of 40 lb/sf/d are feasible, which reduces the size of the secondary clarifiers significantly. The membrane flux can also be increased as well, resulting in fewer membranes.

The footprint of the aeration system could be reduced by introducing Integrated Fixed-film Activated Sludge (IFAS) technology. The reduction in aeration basins volume for an IFAS BNR versus a conventional BNR would be expected in the range of 10 percent to 30 percent. Because of the limited full scale experience with IFAS BNR, IFAS should be implemented as a facility upgrade in the future perhaps as a measure deferred to the first plant expansion. However, the IFAS upgrade may be taken into consideration during the design of the conventional BNR facility to make the upgrade possible without major facility modifications.

Advantages of AWT Alternative 4 are as follows:

- Three phosphorus removal stages for reliability and redundancy.
- Membrane filtration costs are reduced by filtering secondary effluent instead of mixed liquor.
- Lower activated sludge SRT

Disadvantages of AWT Alternative 4 are as follows:

- Larger aeration basin volume compared to the MBR options.
- Biological phosphorus removal is not 100 percent reliable and requires chemical backup and polishing.
- The BNR process with a UFAT fermenter and tertiary phosphorus removal has a higher degree of operation and process control complexity compared to Alternative 1, Alternative 2, and Alternative 3.
- Secondary clarifiers are required.

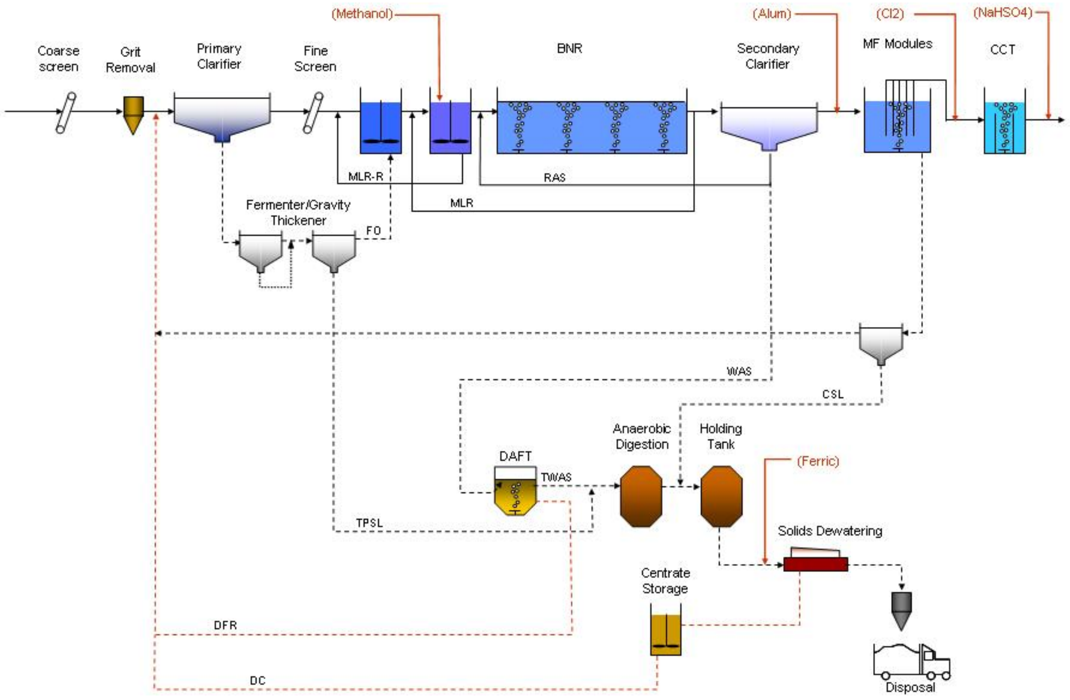

Figure 6-5: Schematic of AWT Alternative 4 – Conventional Activated Sludge with Tertiary Membrane Filtration

6.3.8 Advanced Treatment Process Alternatives Mass Balance Analysis

The mass balance analysis has highlighted the advantages and disadvantages of upgrading the original treatment process design concept from the *2003 Wastewater Facilities Plan Amendment* with biological phosphorus removal and tertiary treatment.

Given the new effluent phosphorus treatment average seasonal performance target of 50 µg/L, a minimum of two treatment stages are required for reliable phosphorus removal. Two chemical treatment stages produce significant chemical sludge and also can interfere with nitrogen removal objectives. Substituting one chemical removal stage with a biological removal stage reduces chemical cost, chemical sludge production, and the cost associated with chemical handling.

Table 6-1 summarizes the mass balances for all four AWT Alternatives. The BNR options reduce the overall chemical demand by roughly 50 percent and the solids production by 20 percent to 25 percent. Adding tertiary treatment does not impact the overall mass balance and sizing of primary and secondary treatment facilities significantly. Depending on the selected technology, the internal recycle from process backwashes could increase the flow through primary and secondary treatment by up to 15 percent.

AWT Alternative 4 increases the aeration basin volumes significantly, but reduces the required membrane surface and provides three phosphorus removal stages.

Overall, it appears that AWT Alternative 2 provides the best solution given the current economic and regulatory parameters. However, it would be beneficial to design the facility such that later changes in technology, additions, or upgrades can be implemented without major changes to the existing facilities. This would include adequate footprint space and allowance for hydraulic profile requirements.

Table 6-1. AWT Alterative Analysis Mass Balance Summary

	Units	AWT Alt 1	AWT Alt2	AWT Alt3	AWT Alt 4
MLSS	mg/L	9,800	9,000	9,000	4,000
AER SRT	day	15	15	15	10
Total SRT	day	18.8	21.4	21.4	14.3
Total Alum	lb/d	8,846	4,304	-	-
Total Ferric	lb/d	998	639	4,042	3,632
Total Yield	lb/lb	0.48	0.57	0.57	0.61
Alkalinity Consumption	mg/L	154	123	106	103
Alkalinity Supplement	lb $CaCO_3$/d	6,940	4,870	3,740	3,540
Aeration Basin Volume	MG	1.09	2.32	2.38	3.38
Total DF Sludge	lb/d	24,420	16,920	18,410	18,470
Cake Solids	lb/d	12,610	10,150	11,490	11,270
Digester Volume[1]	MG	0.90	0.73	0.82	0.81
SCL area	sf	-	-	-	10,000[2]
BW Filter Area	sf	-	-	3,780	3,780

[1] 2.5% TSS and 15 day SRT
[2] 40 lb/sf

6.3.9 Proposed Treatment Process

Based on the mass balance comparison, AWT Alternative 2 - Membrane bioreactor (MBR) with biological nutrient removal (BNR) and chemical polishing is recommended as the proposed facility design for the new Spokane County Regional Water Reclamation Facility (Figure 6-6). The process design consists of the following key elements:

- Influent prescreening with course screens
- Grit removal
- Primary clarification
- Fine screening
- BNR MBR system
- Sodium hypochlorite effluent disinfection
- Primary sludge fermentation facility (UFAT)
- Dissolved air flotation thickening for waste activated sludge
- Anaerobic digestion with sludge holding
- Centrifuge dewatering
- Dewatering centrate storage and equalization
- Alum feed to influent of membrane tank for polishing
- Alum feed to primary clarifier for BNR emergency backup
- Ferric feed to digester influent
- Ferric feed to dewatering feed
- Alkalinity supplement feed to primary effluent and/or centrate storage

6.3.10 Projected Effluent Performance

With completion of the dissolved oxygen TMDL, it is anticipated that more stringent effluent limits will be established for BOD, ammonia-nitrogen and phosphorus. The more stringent limits form the primary basis for the County's proposal to use membrane technology. The expectation is that MBR will provide a higher quality effluent than required to meet the anticipated initial NPDES permit effluent limits. Anticipated effluent quality using an MBR process is listed in Table 6-2 with the following comments:

- Use of the membranes on a year-round basis will result in low concentrations of BOD, total suspended solids and turbidity during both summer and winter permit seasons.
- It is anticipated that phosphorus removal will be required only during the summer permit season; consequently, chemical dosing for phosphorus would not be practiced during the winter permit season.

- Nitrate removal is not required to meet anticipated permit limits; however reducing nitrate levels during the summer season will minimize impacts to groundwater quality if reclaimed water is irrigated over the aquifer, or if water discharged to the river recharges groundwater. This is a voluntary effluent quality target established by Spokane County. Nitrate removal will vary during the winter season as wastewater temperatures fall.

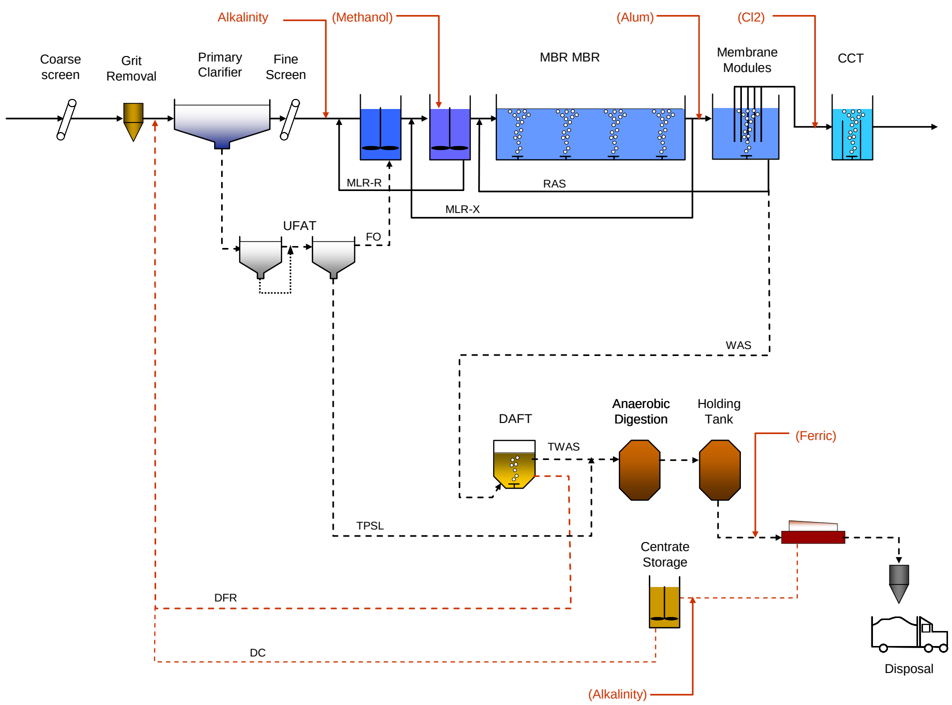

Figure 6-6: Schematic of Preferred AWT Alternative 2 - MBR with BNR and Chemical Polishing

- From an operational perspective, it is anticipated that the SCRWRF will be operated in a nitrification mode on a year-round basis. This is because use of a long sludge age (which results in nitrification) minimizes membrane fouling potential. On the other hand, low concentrations of ammonia-nitrogen are not needed in the winter to meet water quality requirements. Given these considerations, there may prove to be an economical mode of operation that does not provide full nitrification during the winter permit season. The SCRWRF may also be operated with nitrification/denitrification year-round for alkalinity and pH control.

Table 6-2. Projected Performance of Proposed SCRWRF

Parameter	Summer Permit Season	Winter Permit Season
5-Day Carbonaceous Biochemical Oxygen Demand ($CBOD_5$), mg/L	<2	<2
Total Suspended Solids (TSS), mg/L	<2	<2
pH	7 to 9	7 to 9
Ammonia-Nitrogen, mg/L	<0.25	[a]
Nitrate-Nitrogen, mg/L	<1	[a]
Total Nitrogen, mg/L	<10	[a]
Total Phosphorus, mg/L	<0.050	<5
Turbidity, NTU (Daily Average)	<0.2	<0.2
Turbidity, NTU (Maximum)	<0.5	<0.5
Total Coliform Organisms, weekly average, organisms per 100 ml	<2.2	<2.2
Total Coliform Organisms, maximum single sample value, organisms per 100 ml	<23	<23

[a.] Operate facilities in nitrification/denitrification mode in winter season for nitrogen reduction

When reviewing this table, the following should be noted:

- Use of the membranes on a year-round basis will result in low concentrations of BOD, total suspended solids and turbidity during both summer and winter permit seasons.
- It is anticipated that phosphorus removal will be required only during the summer permit season; consequently, chemical precipitation of phosphorus will not be practiced during the winter.
- Nitrate removal is not required to meet anticipated permit limits; however, reducing nitrate levels during the summer season will be required to minimize impacts to groundwater quality if the water is irrigated or infiltrated over the aquifer or if water discharged to the river recharges groundwater.

It is anticipated that the SCRWRF will be operated in a nitrification/denitrification mode on a year-round basis. This is because use of a long sludge age (which results in nitrification) minimizes membrane fouling potential. Low concentrations of ammonia-nitrogen and nitrate-nitrogen are not needed in the winter to meet water quality requirements; however, a significant advantage with respect to alkalinity conservation and aeration air reduction can be achieved.

6.4 PROJECTED EFFLUENT PERFORMANCE

This section summarizes the recommended treatment facilities to be incorporated in the Spokane County Regional Water Reclamation Facility (SCRWRF). Two phases of expansion are anticipated to provide the required facilities for this design condition:

- **Phase 1** will provide an average capacity of 8 mgd and will be operational by the end of 2011
- **Phase 2** will increase average capacity to 12 mgd.

Flow and loading projections associated with ultimate buildout of the service area were used to size selected hydraulic conveyance facilities and to guide overall master planning for the site.

6.4.1 Design Flows and Loads

Design flows and loadings for the SCRWRF are summarized in Table 6-3 (Projected Flows and Loadings). Upon startup of the new facility, the County intends to divert all flow from North Valley Interceptor (NVI) and nearly all flow from the Spokane Valley Interceptor (SVI) to the SCRWRF. The objective is to maximize use of the design capacity in the SCRWRF to treat County flows. Any excess flow generated in the County's Valley service area will be sent through the SVI to the City of Spokane RPWRF.

6.4.2 Process Schematics

The overall process schematic drawings of the liquid and solids treatment processes are presented in Drawing 6-1 (Overall Liquids Process Schematic) and Drawing 6-2 (Overall Solids Process Schematic), respectively. (These drawings are at the end of this Chapter 6.)

6.4.3 Mass Balance

A mass balance diagram of operation of the plant during is presented in Drawing 6-3 (Mass Balance Diagram).

6.4.4 Unit Process Design Criteria

Table 6-4 (Summary of Design Criteria) summarizes design criteria for each unit process.

6.4.5 Hydraulic Profile

A preliminary hydraulic profile for the plant is presented in Drawing 6-4 (Hydraulic Profile, High/Low Flow).

Table 6-3. Projected Flows and Loadings

	Phase 1	Phase 2
Septage		
Flow, gpd	24,000	24,000
BOD_5, lb/d	1,200	1,200
Total Suspended Solids, lb/d	3,000	3,000
Total Nitrogen, lb/d	140	140
Total Phosphorus, lb/d	50	50
Influent From Pump Stations[1]		
Average Day		
Flow, mgd	8.0	12.0
BOD_5, lb/d	16,000	23,800
Total Suspended Solids, lb/d	16,000	23,800
Total Nitrogen, lb/d	2,700	4,000
Total Phosphorus, lb/d	480	710
Maximum Month		
Flow, mgd	8.5	12.6
BOD_5, lb/d	17,000	25,200
Total Suspended Solids, lb/d	17,000	25,200
Total Nitrogen, lb/d	2,800	4,200
Total Phosphorus, lb/d	510	750
Maximum Day		
Flow, mgd	12.1	17.8
BOD_5, lb/d	24,300	35,600
Total Suspended Solids, lb/d	24,300	35,600
Total Nitrogen, lb/d	4,000	5,900
Total Phosphorus, lb/d	730	1,100
Peak Hour		
Flow, mgd	18.4	26.4
Temperature		
Summer, ^oC	17	17
Winter , ^oC	12	12

All values except temperature apply to both summer and winter loading conditions.

Table 6-4. Summary of Design Criteria

Component	Phase 1	Phase 2
LIQUID PROCESS COMPONENTS		
<u>Septage</u>		
Trucks per day	24	24
Holding Tank		
Number	1	1
Volume, gal	4,000	4,000
Pumps		
Type	Chopper (Grinder)	Chopper (Grinder)
Number	2	2
Capacity, gpm	150	150
<u>Influent Flow Measurement</u>		
Type	Magnetic Meter	Magnetic Meter
Number	2	2
Location	NVI and SVI Force Mains	NVI and SVI Force Mains
<u>Preliminary Treatment</u>		
Coarse Screens		
Number	2	2
Screen opening, mm	10	10
Capacity, each, mgd	26.4	26.4
Fine Screens		
Number	2	2
Type	Rotating Drum	Rotating Drum
Screen opening, mm	1	1
Capacity, each, mgd	26.4	26.4
Screenings Washer/Compactor		
Number	2	2
Capacity, each, cu ft/hr	150	150
Grit Removal Units		
Number	2	2
Type	Forced Vortex	Forced Vortex
Capacity, each, mgd	26.4	26.4
Grit Pumps		
Type	Recessed Impeller Centrifugal	Recessed Impeller Centrifugal

Component	Phase 1	Phase 2
Number	2	2
Capacity, gpm	250	250
Grit Concentrators		
Type	Cyclone	Cyclone
Number	2	2
Capacity, gpm	250	250
Grit Classifiers		
Type	Screw	Screw
Number	2	2
Size	12-inch	12-inch
Primary Treatment		
Primary Clarifiers		
Number	2	3
Diameter, ft	70	70
Sidewater depth, ft	12	12
Overflow rate, gpd/sf		
Average	1,039	1,031
Max. month	1,104	1,091
Max. day	1,572	1,542
Peak hour	2,391	2,287
Primary Sludge Pumps (sized for CEPT)		
Number	3	4
Type	Progressive cavity	Progressive cavity
Capacity, each, gpm	165	165
Primary Scum Pumps		
Number	2	2
Type	Progressive cavity	Progressive cavity
Capacity, each, gpm	10	10
Biological Treatment Trains		
Number	2	3
Activated sludge tanks side water depth, ft	20	20
Membrane tanks side water depth, ft	9	9
Anaerobic Zone (Summer)		
Active Volume, total, 1000 gal	220	330
Detention Time, (MMF), hr	0.62	0.63

Component	Phase 1	Phase 2
Summer MLSS mg/L	2,000	2,000
Anaerobic Internal Recycle (MMF)	50%	50%
Anaerobic Mixed Liquor Recycle Pumps		
Number per train	3	3
Total number	6	9
Type	Axial Flow	Axial Flow
Capacity, each, gpm	492	492
Anaerobic Zone Mixers		
Number per train	3	3
Total number	6	9
Type	Axial Flow	Axial Flow
Anoxic Zone (Summer)		
Active Volume, total, 1000 gal	440	660
Detention Time, (MMF), hr	1.24	1.26
Summer MLSS mg/L	5,600	5,600
Anoxic Internal Recycle (MMF)	150%	150%
Anoxic Mixed Liquor Recycle Pumps		
Number per train	3	3
Total number	6	9
Type	Axial Flow	Axial Flow
Capacity, each, gpm	1,475	1,475
Anoxic Zone Mixers		
Number per train	3	3
Total number	6	9
Type	Axial Flow	Axial Flow
Aerobic Zone (Summer)		
Active Volume, total, 1000 gal	748	1,122
Detention Time, (MMF), hr	2.11	2.14
Summer MLSS mg/L	9,700	9,700
Return Activated Sludge (MMF)	400%	400%
Return Activated Sludge Pumps		
Number	3	4
Type	Axial Flow	Axial Flow
Capacity, each, gpm	11,800	11,800
Membrane Zone		

Component	Phase 1	Phase 2
Active Volume, total, 1000 gal (varies by manufacturer)	792	1,188
Detention Time, (MMF), hr	2.24	2.26
Summer MLSS mg/L	12,000	12,000
Summer Operating Mode		
Active Volume, total, 1000 gal	2,200	3,300
Detention time, max. month, hr	6.22	6.29
Average MLSS mg/L	9,000	9,000
Winter Operating Mode		
Active volume, total, 1000 gal (all aerobic)	2,200	3,300
Detention time, max. month, hr	6.22	6.29
Average MLSS mg/L	9,000	9,000
Air Supply		
Aeration Basin Diffusers		
Type	Fine bubble	Fine bubble
Material	Membrane	Membrane
Process air (ADF) scfm	4,500	6,750
Process Air Blowers		
Number	3	4
Type	Centrifugal	Centrifugal
Capacity each, scfm	6,100	6,100
Membrane Air Scour Blowers		
Air required (coarse bubble) scfm	15,500	23,250
Number	5	6
Type	Centrifugal	Centrifugal
Capacity each, scfm	6,000	6,000
Membrane Subtrains		
Number per biological train (varies by manufacturer)	4	4
Total number	8	12
Membrane Quantity		
Minimum design temperature, winter, °C	12	12
Minimum design temperature, summer, °C	17	17
Number of membrane subtrains	8	12

Component	Phase 1	Phase 2
Firm Capacity (one subtrain out of service) Design Flux @12 °C for MDF, gsfd	14.1	12.6
Firm Capacity (one subtrain out of service) Design Flux @12 °C for PHF, gsfd	20.5	18.8
Permeate Pumps		
Type	Self-Priming Centrifugal	Self-Priming Centrifugal
Number per subtrain	1	1
Total number	8	12
Capacity, each, gpm	2,200	2,200
MBR Scum Pumps		
Number	2	2
Type	Progressive cavity	Progressive cavity
Capacity, each, gpm	10	10
WAS Pumps		
Type	Centrifugal	Centrifugal
Number	2	2
Capacity, each, gpm	200	200
Backpulse/CIP Pumps (varies with manufacturer)		
Type	Self-Priming Centrifugal	Self-Priming Centrifugal
Number	2	3
Capacity, each, gpm	2,000	2,000
<u>Chlorine Contact Tanks</u>		
Number	2	2
Contact Time , min	30	30
Volume, each, 1000 gal	276	276
<u>Chemical Feed Systems</u>		
Alum Storage Tanks		
Number	2	3
Volume, each, gallons	5,000	5,000
Diameter, ft	9	9
Height, ft	13	13
Sodium Hypochlorite Storage Tanks		

Component	Phase 1	Phase 2
Number	2	2
Volume, each, gallons	2,500	2,500
Diameter, ft	8	8
Height, ft	9	9
Sodium Bisulfite Storage Tanks		
Number	2	2
Volume, each, gallons	2,500	2,500
Diameter, ft	8	8
Height, ft	9	9
Alum Feed (CEPT for Backup P Removal)		
Average dosage, mg/L	100	100
Storage period, days	7	7
Feed pumps		
Number	2	2
Type	Diaphragm	Diaphragm
Capacity, each, gpm	10	10
Alum Feed (Secondary Polishing)		
Average dosage, mg/L	100	100
Storage period, days	7	7
Feed pumps		
Number	2	2
Type	Diaphragm	Diaphragm
Capacity, each, gpm	10	10
Sodium Hypochlorite Feed (CIP)		
Storage period, days	30	30
Feed pumps		
Number	2	2
Type	Progressive cavity	Progressive cavity
Capacity, each, gpm	30	30
Sodium Hypochlorite Feed (Disinfection)		
Storage period, days	30	30
Feed pumps		
Number	2	2
Type	Diaphragm	Diaphragm
Capacity, each, gpm	1	1
Citric Acid Feed (CIP)		

Component	Phase 1	Phase 2
Storage period, days	60	60
Feed pumps		
Number	2	2
Type	Diaphragm	Diaphragm
Capacity, each, gpm	12	12
SOLIDS HANDLING COMPONENTS		
Unified Fermentation and Thickening (UFAT)		
Fermenter		
Number	1	1
Volume, gal	4,000	4,000
Diameter, ft	40	40
Sidewater Depth, ft		
Water Cap, ft	8.1	5.2
Blanket Depth, ft (Solids @ 4%. …..Target SRT 3 days)	5.9	8.8
Total, ft	14.0	14.0
Underflow Pump		
Number	1	1
Type	Progressive cavity	Progressive cavity
Capacity, each, gpm	100	100
Gravity Thickener		
Number	1	1
Minimum Surface Area, sf	232	345
Diameter, ft	25	25
Sidewater Depth, ft	13.8	13.8
Thickened Sludge Pump		
Number	1	1
Type	Progressive cavity	Progressive cavity
Capacity	100	100
Backup Pump		
Number	1	1
Type	Progressive cavity	Progressive cavity
Capacity, each, gpm	100	100
Dissolved Air Flotation Thickening		
Number	2	2
Diameter, each, ft	20	20

Component	Phase 1	Phase 2
Solids Loading, winter, lb/day/sf	13.5	20
Solids Capture, percent	95	95
TWAS and Bottom Sludge Pumps		
Number	2	2
Type	Progressive cavity	Progressive cavity
Capacity, each, gpm	50	50
DAFT Recycle Pumps		
Number	3	3
Type	Non Clog Centrifugal	Non Clog Centrifugal
Capacity, each, gpm	250	250
<u>Anaerobic Digesters</u>		
Number	2	3
Volume, each, 1,000 gal	750	750
Diameter, ft	60	60
Sidewater Depth, ft	35	35
Solids Retention Time, days (with one out of service)	15	15
Mixing System		
Type	To be determined by DBO Company	
Recirculation Pumps		
Number	3	4
Type	Recessed Impeller Centrifugal	Recessed Impeller Centrifugal
Capacity, each, gpm	400	400
Heat Exchangers		
Number	2	3
Capacity, each MMBTU	1.3	1.3
<u>Liquid Biosolids Storage Tank</u>		
Number	1	1
Volume, each, 1,000 gal	750	750
Diameter, ft	60	60
Sidewater Depth, ft	35	35
Mixing System		
Type	To be determined by DBO Company	
<u>Dewatering Centrifuges</u>		
Number	2	2

Component	Phase 1	Phase 2
Type	High solids	High solids
Drive	Variable Speed	Variable Speed
Capacity, each, gpm	160	160
Capacity, each lbs/hr	2,000	2,000
Solids Capture, percent	95	95
Dewatered cake solids concentration, percent	25	25
Feed Pumps		
Number	2	2
Type	Progressive Cavity	Progressive Cavity
Drive	Variable Speed	Variable Speed
Capacity, each, gpm	320	320
Dewatered Cake Conveyors		
Number	To be determined by DBO Company	
Type	To be determined by DBO Company	
Poly Feed System		
Type	To be determined by DBO Company	
Dilute Polymer Feed Pumps		
Number	2	2
Type	Progressive Cavity	Progressive Cavity
Capacity, each, gpm	10	10
Dewatered Cake Hopper		
Number	1	1
Volume, yards	10	10
Centrate Storage Tanks		
Number	2	2
Volume, each, 1,000 gal	70	70
Detention Time, total, days	2.7	1.8
SITE SUPPORT SYSTEMS		
Non-Potable Water Pumps		
Number	2	2
Type	Centrifugal	Centrifugal
Capacity, each, gpm	600	600
Irrigation Pump		

	Component	Phase 1	Phase 2
	Number	1	1
	Type	Centrifugal	Centrifugal
	Capacity, each, gpm	240	240
Plant Drainage Pumps			
	Number	2	2
	Type	Non Clog Submersible	Non Clog Submersible
	Capacity, each, gpm	600	600

6.5 PRELIMINARY SITE LAYOUT

A preliminary layout of the treatment plant components on the Stockyards Site is presented in Drawing 6-5 at the end of this Chapter 6. Facilities associated with the Phase 1 and Phase 2 expansions are differentiated by shading patterns. Dashed lines show the footprints of facilities needed for ultimate expansion. It is anticipated that the plant site would have two entrances.

The public entrance would be from Freya Street and would provide access to administration and laboratory buildings. Any public amenities built into the project (e.g., public safety facilities, public meeting rooms, etc.) would be accessible by this entrance. Extending Julia Street to the plant site would provide an operational entrance. All truck traffic associated with septage hauling, biosolids hauling, chemical deliveries, equipment deliveries, and general operation and maintenance would use this entrance.

6.6 SUMMARY DESCRIPTION OF UNIT PROCESSES

The following narrative summarizes the recommended unit processes. Actual final design may vary somewhat, but the appropriate functionality should be retained.

6.6.1 Influent Flow Measurement and Influent Junction Box

Influent flow measurement will be provided by magnetic flow meters located along the force mains from the SVI Pumping Station and the NVI Pumping Station. Both force mains will discharge to an influent junction box that will divide flow between the initial headworks structure (to serve Phase 1 and 2 flows) and a future headworks structure (to serve flows beyond Phase 2).

6.6.2 Septage Handling

A septage-receiving tank will be placed on the treatment plant site. To discharge to the tank, septage haulers will drive into a small enclosure that will shield the operation from view, provide weather protection to the haulers, and provide odor containment. Septage will be pumped to the influent junction box.

6.6.3 Preliminary Treatment

To provide capacity for Phase 1 and Phase 2 flows (maximum-month flow of 12.6 mgd), the headworks will have two mechanical bar screens with 3/8-inch openings, and two forced-vortex grit removal basins. A screenings washer and compactor will be provided to reduce the volume of screenings removed in both the headworks and the fine-screening building located after primary clarification. Cyclones and classifiers will be used to reduce the grit volume. Separate hoppers will be provided for dewatered screenings and grit to allow their disposal at the regional incinerator and local landfill, respectively.

6.6.4 Primary Treatment

A primary influent flow split structure will be built to receive flow from the headworks and plant recycle streams, and to distribute this flow to primary clarifiers. To provide a maximum-month capacity of 8.5 mgd, two clarifiers will be built initially. A third unit will be added in Phase 2 to increase capacity to 12.6 mgd. During the summer permit season, alum will be fed ahead of the clarifiers to chemically precipitate phosphorus. Primary and chemical sludge will be thickened within the primary clarifiers prior to being pumped to anaerobic digesters. A primary sludge and scum pumping station will be built adjacent to the clarifiers.

6.6.5 Fine Screening

Following the primary clarifiers, a fine-screening facility will be built to remove material larger than 1 millimeter (mm). Removed screenings will be pumped to the headworks for washing, compaction, and storage, prior to haul.

6.6.6 Membrane Bioreactors

Two membrane bioreactors (MBRs) will be installed initially to handle a maximum-month flow of 8.5 mgd. A third train will be installed in Phase 2 to increase the capacity to 12.6 mgd. The MBR system will be capable of meeting Class A reclaimed water standards for effluent reuse with the entire plant flow. During the summer, the activated sludge system will be operated with anaerobic, anoxic, and aerobic zones to provide phosphorus removal and nitrification and denitrification (NDN) such that river discharge requirements for phosphorus and ammonia nitrogen are met. Additionally, total nitrogen requirements shall be met for Class A reclaimed water for effluent reuse in urban irrigation, industrial reuse, and wetlands restoration. During the April through October phosphorus removal period to be required in the NPDES permit, alum may be fed to the MBR system for phosphorus control. All equipment associated with mixed-liquor pumping, permeate pumping, waste-activated sludge (WAS) pumping, secondary scum pumping, process air supply, and membrane scour air supply will be provided within the overall MBR facility.

6.6.7 Effluent Flow Measurement

A Parshall flume will be provided to measure effluent flow. This facility will be located upstream of the sodium hypochlorite disinfection facility to provide a flow signal to control chlorination and dechlorination chemical feeds.

6.6.8 Disinfection and Dechlorination

Disinfection will be provided using a liquid sodium hypochlorite system followed by a liquid sodium bisulfite dechlorination facility. Two channels will be installed with sufficient hydraulic capacity to handle projected peak flows at buildout with a split of effluent flows to multiple locations, including outfall to river, on-site landscape irrigation, internal process water, and larger volume effluent reuse. Some of these effluent end uses will not require dechlorination. However, the design and construction shall provide provisions for all of these uses. The dechlorination system will be designed for full plant flow to maintain 100 percent discharge to the river outfall and the system shall be designed to control chlorine residual to meet NPDES permit limitations in the effluent discharge. The system shall also be capable of maintaining a chlorine residual in effluent diverted to reuse, as required to meet Class A reclaimed water standards for effluent reuse in urban irrigation, industrial reuse, and wetlands restoration. The entire facility will be enclosed in a building.

6.6.9 Postaeration

A cascade aerator will be provided to increase the dissolved oxygen level in the plant effluent.

6.6.10 Reclaimed Water Pumping

The County will implement a reclaimed water program, providing Class A reclaimed water for reuse in urban irrigation, industrial reuse, and wetlands restoration. Consequently, the site layout and hydraulic profile must accommodate a reclaimed water pumping station, as shown on the liquid process schematic and site layout (Drawing 6-1 and Drawing 6-5). The primary disinfectant for the reclaimed water will be liquid sodium hypochlorite capable of maintaining a disinfectant residual in the reclaimed water distribution system which meets the State of Washington criteria for Class A reclaimed water.

6.6.11 Chemical Feed Systems

A chemical feed and storage building will be constructed to house the following feed systems: alum, ferric, sodium hypochlorite, citric acid, polymer, methanol, supplemental alkalinity addition (if required), and other chemical systems necessary to meet effluent phosphorus discharge limits and maintain the MBR system and other plant systems.

6.6.12 Primary Sludge Thickening and Fermentation

A primary sludge thickening and fermentation system shall be built to thicken primary sludge and generate volatile fatty acids (VFA) to support the phosphorus removal process. A thickener overflow and thickened primary sludge pumping station will be built adjacent to the thickener/fermentors.

6.6.13 Waste Activated Sludge Thickening

One flotation thickener will be installed initially to handle sludge associated with a maximum-month liquid-stream flow rate of 8.5 mgd. A second thickener will be installed in Phase 2 to increase capacity to 12.6 mgd. Associated pumping, piping, and air injection equipment will be located in an adjacent below-grade structure.

6.6.14 Anaerobic Digestion

Sludge stabilization will be accomplished using single-stage mesophilic anaerobic digestion. Initially, two digesters will be constructed to meet Phase 1 capacity requirements. A third tank will be constructed in Phase 2. A digester control building will house gas handling equipment, sludge recirculation equipment, and energy recovery facilities.

6.6.15 Liquid Biosolids Storage

A liquid biosolids storage (holding) tank will be provided that is nearly identical to the digesters. This facility will provide a minimum of storage time of seven days in the event that bad weather prevents haul of dewatered sludge to application sites. The biosolids holding tank also will provide digester gas storage.

6.6.16 Digester Gas Management

Digester gas generated in the anaerobic digestion process shall be recovered in a system that includes scrubbing, gas storage, and cogeneration facilities. For this conceptual design, it has been assumed that the gas would be used in boilers and cogeneration facilities to heat the sludge as it enters the digesters and maintain digester temperature by heating recirculating sludge. Electrical power produced in the cogeneration system will be used in the treatment facility and/or fed to the electrical power utility. A waste gas incineration system will be provided for unused gas during periods when the gas utilization system is out of service.

6.6.17 Solids Dewatering

Two high solids centrifuges along with centrifuge feed pumps and a polymer feed system will be provided. The centrifuges will be located on the top floor of the solids handling building and discharge to screw conveyors for conveyance to the dewatered biosolids hopper.

6.6.18 Dewatered Biosolids Storage

A dewatered biosolids hopper will be provided to load trucks and to temporarily store biosolids when full trucks are removed and empty trucks are moved into position for loading. The hoppers will be located above a drive-through truck loading area.

6.6.19 Centrate Storage

Centrate from the dewatering operation will be stored in two mixed tanks in the lower level of the solids processing building. These tanks will be used to equalize the centrate recycle to the liquid treatment process, thus avoiding spikes in ammonia loading to the biological treatment process. During the April through October phosphorus removal period to be required in the NPDES permit, ferric and/or alum may be fed to the centrate return system for phosphorus control. Additional centrate side stream treatment may be considered in the final design of the SCRWRF, such as reaeration, anamox, ammonia stripping, etc. The DBO should discuss the pros and cons of side stream treatment from their perspective.

6.7 AESTHETIC CONCEPT AND IMPACT MITIGATION MEASURES

The County's intent is to create a treatment plant site that is aesthetically attractive and compatible with surrounding uses. Examples of facilities that the County has cited to the public are the treatment plants built in Vancouver (Marine Park) and Edmonds, WA.

6.7.1 Architecture

The architectural concept selected for the site was developed based on a series of workshops with neighbors of the proposed site and other stakeholders. To give the public some idea as to what the site may look like, an initial series of computer sketches were developed. A preliminary site layout of the facilities is presented in Drawing 6-5 (Preliminary Site Plan).

The facility site is located in a primarily industrial neighborhood. The design concept for the facility borrows both building forms and materials to blend with its locality. The construction palette includes durable and low-maintenance finishes such as exposed concrete and prefinished steel siding and roofing. The straightforward nature of the facilities is accented by exposed, recycled wood timbers, which highlight the entry and service canopies.

Nearly all treatment processes will be housed inside one- or two-story structures. These structures are sized to adequately accommodate the treatment process equipment and their service clearances. Additionally, these buildings will screen equipment and piping from view, provide acoustical and odor control, and offer architectural interest to an otherwise utilitarian facility. A variety of roof slopes over simple building forms create an image more commonly associated with commercial shopping malls or light industry campuses, and avoids the traditional treatment plant look.

6.7.2 Landscaping

The facility site will be landscaped to soften the appearance of the facilities and to provide an attractive buffer between it and adjoining properties. More formal and extensive landscaping will be implemented around the plant entrance of Freya Street; around the administrative, laboratory and maintenance buildings; and along the northern and eastern property lines. The overall landscaping scheme and choice of materials will be consistent with other attractive industrial campuses in the Spokane area.

6.7.3 Odor Control

All significant sources of odors will be enclosed in buildings or covered, including the following unit processes:

- Septage handling structure
- Influent junction box

- Headworks (including grit basins)
- Primary influent split box
- Primary clarifiers
- Fine-screening building and channels
- MBR split box
- MBR basins (activated sludge basins and membrane tanks)
- Primary thickener/fermentor
- Dissolved air flotation thickeners (DAFT)
- Anaerobic digesters and their overflow boxes
- Liquid biosolids storage overflow boxes
- Biosolids dewatering process
- Dewatered biosolids storage and loadout facility
- Centrate storage tanks

Exhaust air from these structures will be routed to a compost filter bed for odor scrubbing. Initially, three compost beds will be installed. This will allow effective control of odor when the compost media is replaced in one of the beds.

To reduce the quantity of air that must be passed through the biofilters, it is anticipated that a portion of the foul air collected from selected unit processes will first be routed to the MBR process for use as an air supply for the process air and membrane scour systems. The exhaust air from the MBR tanks would then be sent to the biofilters.

6.7.4 Noise Control

All equipment with significant noise generation will be enclosed within buildings or shrouded within sound attenuation structures. A maximum allowable noise level at the facility boundary will be established as a mandatory performance requirement for the facility.

6.7.5 Lighting Control

Facility lighting will be designed to minimize offsite impacts, yet provide a safe working environment for the staff. Measures will include use of horizontal baffles or cutoffs to direct the light toward the ground and limit horizontal travel, control of reflective surfaces that could cause offsite impacts, and maintenance of low-intensity lighting along parking areas and walkways.

6.7.6 Security

A variety of security measures will be used, including perimeter fencing and closed-circuit television. The County will work with neighbors of the site to select a fence and gate design that meets both security and aesthetic requirements.

6.8 OTHER TREATMENT PLANT FEATURES

6.8.1 Electrical Power Supply

To meet power supply reliability requirements, Avista will provide two independent power supplies to the facility site. The County is currently evaluating whether to further increase reliability by providing an onsite generator to supply critical process equipment during emergencies.

6.8.2 Other Utilities

All other utilities needed for operation (potable water, natural gas, telephone, and cable) are close to the proposed facility site. Additional, dedicated telecommunication lines may be installed between the SCRWRF and the influent pump stations for reliable pumping and process control.

6.8.3 Instrumentation and Control

It is anticipated that a distributed control system using programmable logic controllers (PLCs) will be installed for monitoring and control of facility operations.

6.8.4 Stormwater Management

Stormwater generated near unit processes or other working areas on the facility site will be collected and processed through the treatment process. Stormwater generated at parking lots and other general areas of the facility site where no wastewater or biosolids are handled will be routed to bioinfiltration swales for treatment, prior to infiltrating into the ground surface.

Containment and spill procedures will be provided where chemicals are stored or loaded. The treatment facility will comply with all applicable regulations pertaining to chemical storage and containment.

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Drawing 6-2 Overall Solids Process Schematic

Drawing 6-3 Mass Balance Diagram

Drawing 6-4 Hydraulic Profile

Drawing 6-5 Site Layout

Drawing 6-6 Preliminary Site Plan

Drawing 6-7 Oblique Views of SCRWRF

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