Hazen and Sawyer
150 E. Campus View Boulevard, Suite 200
Columbus, OH 43235

Northstar Water Reclamation Facility

Contract # 21-34
Hazen Project # 50098-009
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Executive Summary

This report presents the current capacity and proposed improvements of Delaware County Regional Sewer District's (DCRSD's) Northstar Water Reclamation Facility (NWRF) to treat current and future flows and meet future regulatory conditions. With some relatively minor modifications, NWRF has sufficient capacity for current and future flows within the effluent limits of the existing Land Application Management Plan (LAMP) with only one process train in service.

Several improvements were identified for management of anticipated operating conditions and are categorized into four alternatives:

1. Baseline improvements: minimum recommended improvements for consistency of O&M as flows increase to 0.4 mgd.
2. Future LAMP permit conditions at permitted capacity of 0.4 mgd
3. Future NPDES permit conditions at permitted capacity of 0.4 mgd: potential discharge to Little Walnut Creek would require more stringent effluent limits and improved treatment.
4. Future considerations as infrastructure ages and/or flows increase above 0.4 mgd

A summary of the baseline improvements is presented in **Table 5-1**.

Table 5-1. Summary of Baseline Improvements (2021 Dollars)

Improvement	Opinion of Probable Construction Cost	Notes
Reconfiguration of RAS control	$100,000	Includes replacement of two submersible pumps with dry pit submersible pumps on VFDs
Connection of RAS header at influent end of biological treatment	$5,000	
Lower RAS piping	$10,000	Labor only – no new materials
NPW system leak repairs	$50,000	
Influent header extension with valves	$100,000	
Dewatering Building unloading area enclosure	$100,000	Odor control system not included in cost
Subtotal	$365,000	
General Conditions 15%	$55,00	
Contractor Overhead and Profit 20%	$84,000	
Bonds and Insurance 3%	$15,000	
Concept Level Design Contingency 40%	$208,000	(% markups are cumulative)
TOTAL	**$727,000**	

A summary of the improvements for 0.4 mgd with LAMP effluent limits is presented in **Table 5-2**.

Table 5-2. Summary of Improvements for 0.4 mgd with LAMP Effluent Limits (2021 Dollars)

Improvement	Opinion of Probable Construction Cost	Notes
Supplemental carbon feed	N/A*	Repurpose of existing sodium hypochlorite storage and feed system
BNR Improvements	$50,000	IMLR pumps only – conversion of EQ to pre-anoxic covered in baseline improvements. Relocation of mixer assumed by DCRSD
Subtotal	$50,000	
General Conditions 15%	$8,000	
Contractor Overhead and Profit 20%	$12,000	
Bonds and Insurance 3%	$2,000	
Concept Level Design Contingency 40%	$20,000	(% markups are cumulative)
TOTAL	**$100,000**	

*Ongoing O&M cost for supplemental carbon anticipated to be $10,000-$30,000 annually

A summary of the improvements for 0.4 mgd with NPDES effluent limits is presented in **Table 5-3**.

Table 5-3. Summary of Improvements for 0.4 mgd with NPDES Effluent Limits (2021 Dollars)

Improvement	Opinion of Probable Construction Cost	Notes
Alum feed	N/A*	Repurpose of existing ferric chloride storage and feed system
Conversion to disc filters	$500,000	
Post Aeration	$100,000	Diffused aeration in existing clearwell, and repurpose of existing blower
Effluent force main to Little Walnut Creek	$200,000	
Subtotal	$800,000	
General Conditions 15%	$120,00	
Contractor Overhead and Profit 20%	$184,000	
Bonds and Insurance 3%	$33,000	
Concept Level Design Contingency 40%	$455,000	(% markups are cumulative)
TOTAL	**$1,592,000**	

*Ongoing O&M cost for alum anticipated to be $5,000-$15,000 annually

Future considerations as infrastructure ages and / or influent flows increase above 0.4 mgd include aeration system improvements, such as replacement of coarse bubble aeration with fine bubble diffused aeration, automatic DO control, and more efficient blowers. Costs were not estimated for these improvements since the timeframe and detailed scope are uncertain. In approximately 20 years, the original NWRF infrastructure will likely be nearing the end of its useful life. Accordingly, a significant replacement project should be kept on the planning horizon for the 15-20 year timeframe.

1. Background

1.1 Plant History

The Northstar Water Reclamation Facility (NWRF) was initially constructed in 2007 to serve the Northstar community but was out of service until December 2016. In February 2017, rehabilitations were completed around the existing tanks and DCRSD accepted ownership of NWRF. NWRF has a design permitted capacity of 0.4 MGD, which is equivalent to 1,379 single family residential sanitary sewer connections. Currently, NWRF treats an average daily flow rate of 0.022 mgd. NWRF's current effluent discharge limits are controlled by a Land Application Management Plan (LAMP) permit as presented in **Table 1-1**.

Table 1-1. Current LAMP Permit Limits by Constituent

Pollutant	Monthly Average
Total Suspended Solids (TSS), mg/L	45
Carbonaceous Biochemical Oxygen Demand (CBOD5), mg/L	40
Total Inorganic Nitrogen (TIN), mg/L	10 (max)
E. Coli, #/100 mL	126 (max)
Oil & Grease, mg/L	10 (max)
pH, S.U.	6.0 - 9.0

1.2 Objectives of Study

The objective of the study is to evaluate the NWRF treatment and hydraulic capacity under the following four conditions:

1. Existing LAMP permit at the current flow and loadings.
2. Existing LAMP permit at the original design flow and loadings.
3. Seasonal LAMP permit and coupled with a seasonal NPDES permit discharge limits.
4. Continuous NPDES permit discharge limits.

2. Existing Conditions

Hazen and Sawyer toured the NWRF on January 28, 2021 with DCRSD. A detailed condition assessment was not performed; no tank entry was made to assess existing structural integrity, but the overall condition of the plant was reviewed and discussed with operations personnel from the operating platforms. A summary of the major unit processes is presented in **Table 2-1**.

Table 2-1. Summary of NWRF Unit Processes

Unit Process	Quantity	Design Criteria	Notes
Influent Pumps	2	923 gpm at 65.9 ft (each pump)	Flygt NT-3171.170 HT (offsite pump station)
Influent Grinder	1	Sized for 1.0 mgd avg daily flow	JWC Muffin Monster Model No. CMD3210-AD
Influent Screens	1 + 1	Mechanical screen sized for 1.0 mgd average daily flow. Manual bar screen intended for backup.	(1) JWC Muffin Monster Model No. AMA3200 (1) manually cleaned screen in bypass channel
Odor Control Biofilter	2	600 SF, 2000 CFM each bed 99% H2S removal	Activated soil media with 20-year design life
Equalization Tanks	2	110,330 gallons (each)	
EQ Pump	2	350 gpm at 20 ft TDH (each pump)	Flygt NP-3085
Axonic / Aeration Tanks	4	61,920 gallons (each)	14 ft side water depth (SWD), Pulsair large bubble mixing
Aeration Tanks	2	61,950 gallons (each)	14 ft SWD, coarse bubble diffusers
Secondary Clarifiers	2	149,183 gallons (each)	46 ft diameter, 12 ft SWD
Return Activated Sludge (RAS) Pumps	2	700 GPM at 34 ft TDH	Flygt NP-3127.180 Both VFD equipped
Sand Filter	2	120 SF, 8,229 gal (each)	(2) 840 gpm backwash pumps
Clearwell	1	35,429 gal	9.17 ft side water depth (SWD)
UV Disinfection	1		Trojan UV3800K-1
Effluent Pumps	2	525 gpm at 30 ft TDH	Flygt NP-3127
Blowers	3	Aeration: 691 CFM (2 Operating)	Gardner Denver 559 centrifugal
	1	Flow EQ: 505 SCFM	Roots URAI-68 positive displacement
	3	Sludge Holding: 765 SCFM (2 Operating)	Roots URAI-711 positive displacement
	1	Air Scour: 120 SCFM	Roots URAI-33 positive displacement

The effluent pumps convey treated effluent to the reservoir / holding pond. From the reservoir, the effluent is conveyed to an irrigation system at the Northstar Golf Club by a pump station that is not owned or operated by DCRSD. **Figure 2-1** presents a process schematic for reference.

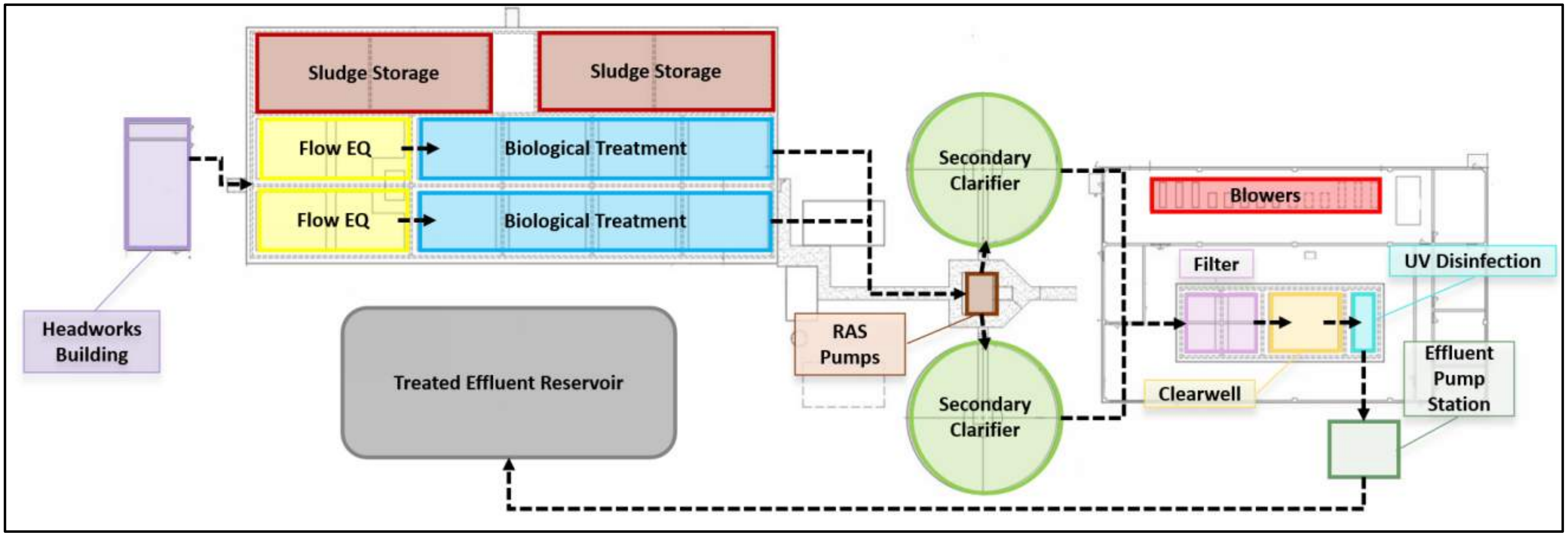


Figure 2-1. NWRF Facility Layout and Process Flow Diagram

2.1 Headworks Building

The existing drum screen and grinder appear to be working satisfactorily under current conditions. A manual bar screen exists in parallel if bypass of the mechanical screen is ever necessary. Although the air inside the building was odorous, there was little to no odor detected outside the building. The odor control biofilter beds are in the grass area north of the Headworks Building. The odor control fan inside the building was operational. No indications of excessive corrosion were noted.

Figure 2-2 presents an overall view of the screening and related systems.

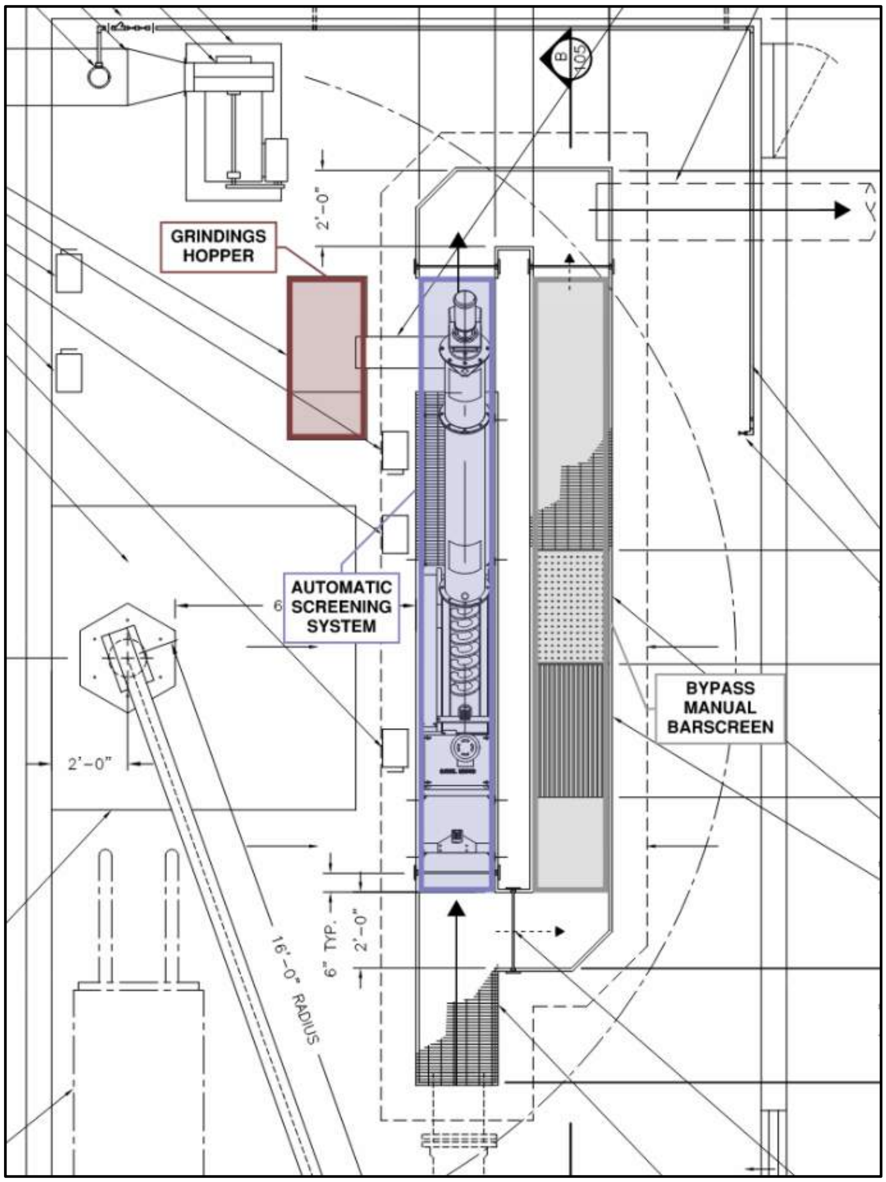


Figure 2-2. Influent Screening System and Related Structures

The spray system on the screen auger was not operational since there are several leaks in the buried non-potable water (NPW) system around the plant. Due to these leaks, the operations staff does not turn on the NPW system until it is needed. **Figure 2-3** includes a photo of the screenings auger in the Headworks Building.

Figure 2-3. Headworks Building

There are electrical equipment, conduit, fittings, and cable throughout the Headworks Building that appear to have been designed and installed in accordance with National Fire Protection Association (NFPA) 820 *Standard for Fire Protection in Wastewater Treatment and Collection Facilities*. According to NFPA 820, this building would be a classified space even with 12 air changes per hour. A comprehensive review for conformance to the 2020 NFPA 820 standards was not conducted.

2.2 Equalization (EQ) Tanks and Biological Treatment

Downstream of the Headworks Building, the influent flow is discharged to the north EQ tank. The north and south EQ tanks can be hydraulically connected by opening a mud valve in the north EQ tank on a buried pipe that leads to the south EQ tank. The flow EQ pumps in the north EQ tank convey influent up to the distribution box continuously (unless there is a low level), where it is distributed to the north and/or south biological treatment tanks using manually adjustable weirs (see **Figure 2-4**).

Figure 2-4. Influent Distribution Box

From the distribution box, influent can be routed to any of the biological treatment basins by gravity via exposed pipes by lowering the manual weirs. Mixed liquor can be routed from any of the aerobic zones to the secondary clarifiers, which provides some flexibility in operational tank volume.

All the EQ and biological treatment tanks use coarse bubble aeration at the side(s) of the tank to induce mixing and aeration of the tank contents. The anoxic/aerobic basins also include separate equipment to provide mixing without aeration. DCRSD is in the process of replacing the Pulsair large bubble mixing systems in the anoxic/aerobic basins with floating mixers due to ease of maintenance of the floating mixers.

The operational challenges of the EQ tanks and biological treatment tanks are listed below.

- Requirement to use EQ pumps for influent conveyance: There is no ability to route influent flow to the biological treatment tanks without pumping from the EQ tanks to the distribution box, as shown in **Figure 2-5**. There appears to be sufficient hydraulic head to flow directly to biological treatment from the influent line without pumping.

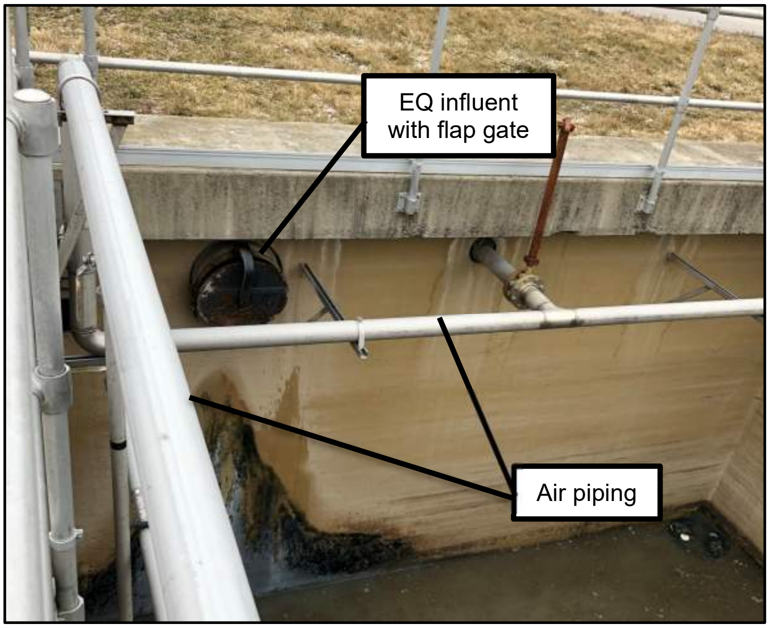


Figure 2-5. Influent to EQ

- Limited control of return activated sludge (RAS) routing: Currently RAS can be conveyed to the north or south tanks, but not both at the same time. DCRSD suggested that connecting the RAS piping on the influent end of the EQ tanks would allow splitting of flow to both trains.
- Potential freezing of RAS piping: The use of exposed piping above the water levels for RAS routing presents a challenge with freezing during cold temperatures (see **Figure 2-6**).

Figure 2-6. Exposed RAS Piping

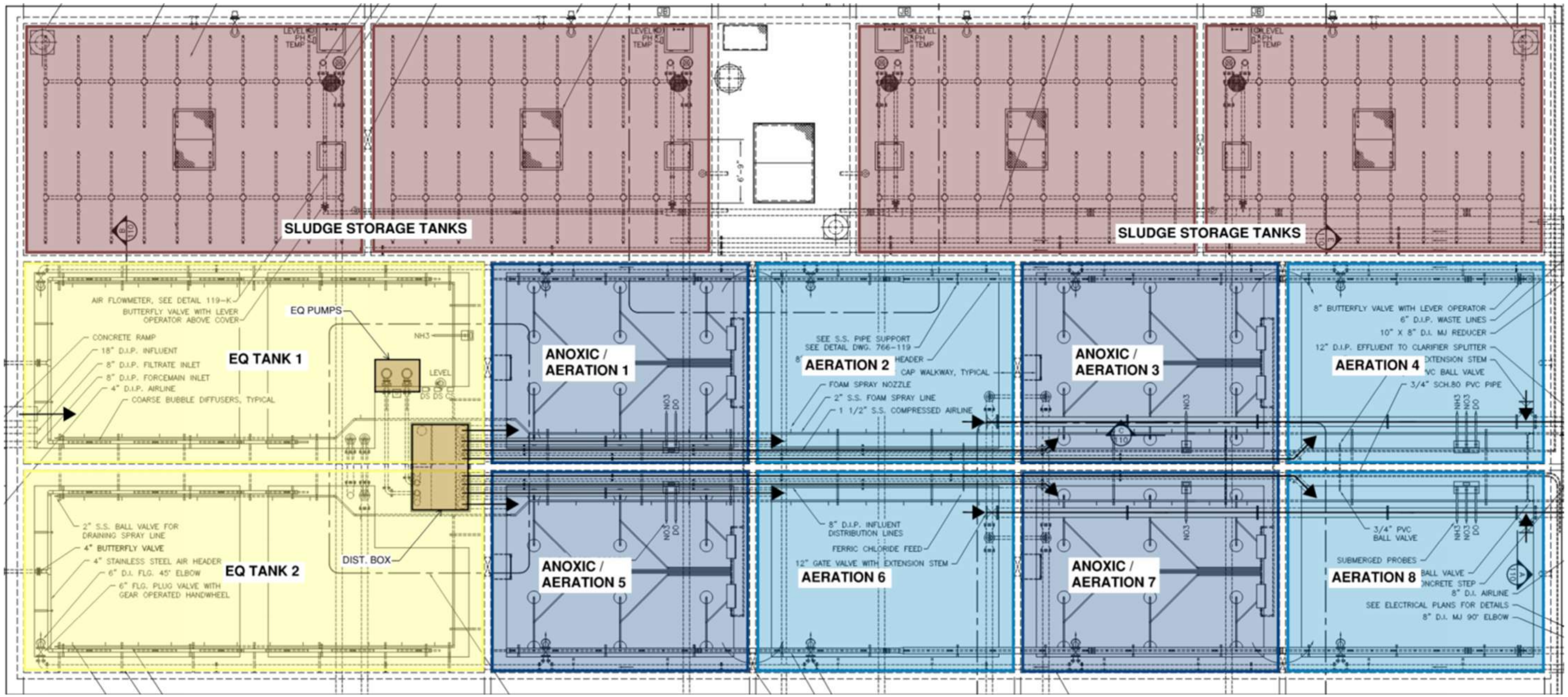


Figure 2-7. Layout of EQ Tanks and Biological Treatment Tanks

2.3 Secondary Clarifiers

Mixed liquor is conveyed from the biological treatment tanks to a distribution box, which contains a manually cleaned bar rack and gates to isolate each clarifier. Only one clarifier is needed under current conditions; during the current low flows, stagnant areas form in certain areas of the mixed liquor distribution box.

The two 46-ft diameter secondary clarifiers have a firm capacity of 1.7 mgd (3.3 mgd total) without exceeding the typical design overflow rate of 1000 gpd/sf. The clarifiers include stainless steel effluent launders with fiberglass covers. The clarifiers have suction tube headers that convey RAS to the RAS Pump Station (PS), which contains submersible pumps. The RAS withdrawal rate is controlled via manual telescoping valves inside the RAS PS, and the pumps run based on wet well level via variable frequency drives (VFDs).

RAS / WAS routing is accomplished in the RAS / WAS Distribution Valve Vault. The vault contains electrically actuated open/close valves to route RAS to either the north or south train, or WAS to the sludge storage tanks. Because the valve actuators are open/close service rather than modulating, a flow balance to the different locations could be difficult to achieve at NWRF's full capacity. The electric actuators are above grade as shown in Figure 2-8.

Figure 2-8. RAS / WAS Valve Actuators

Figure 2-9 presents an overall view of the secondary clarifier area and related structures. Secondary Clarifier No. 2 is to the south, not shown in the figure.

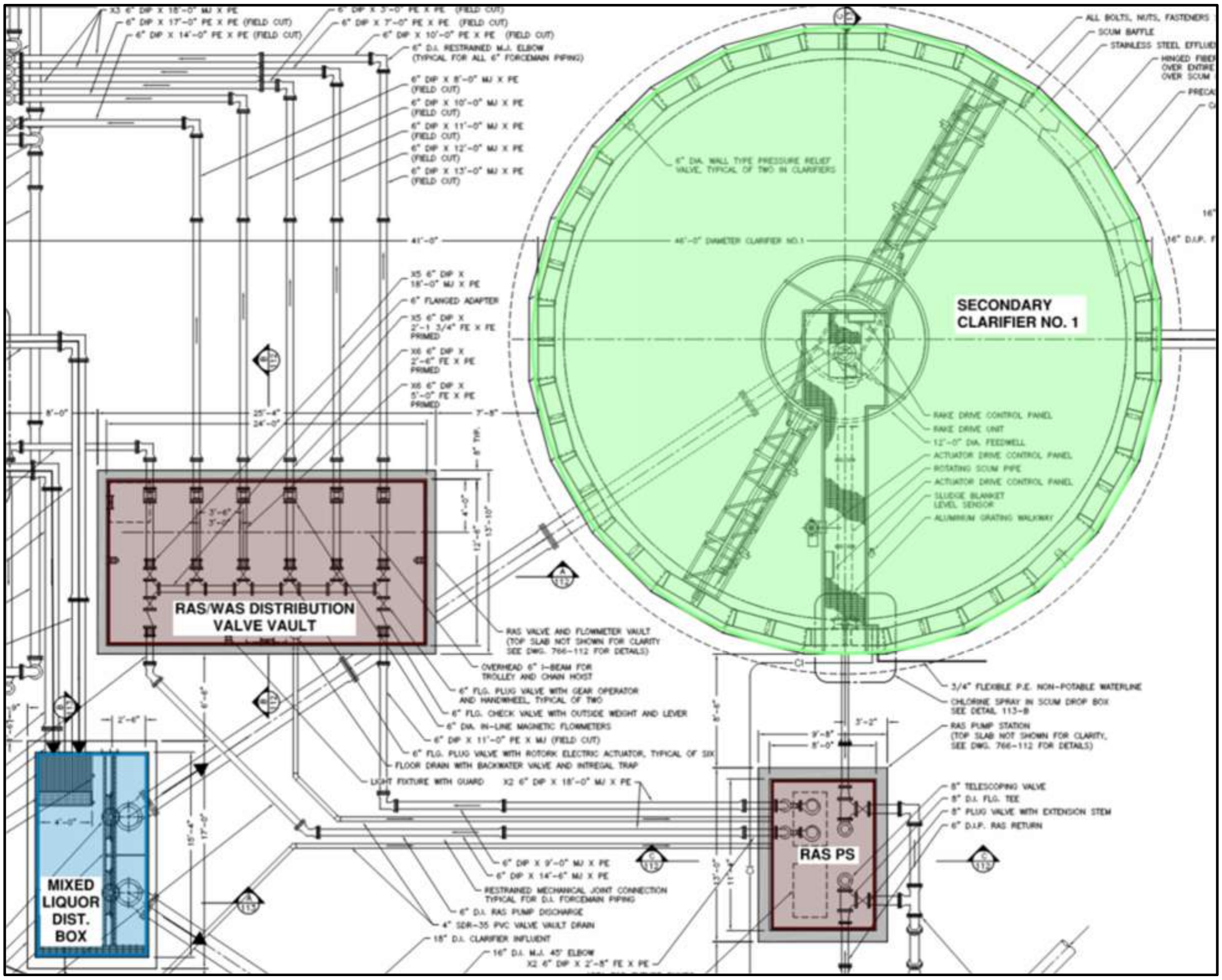


Figure 2-9. Secondary Clarifier Area

2.4 Tertiary Filtration

Secondary effluent is conveyed through a 16-inch ductile iron pipe to a filter distribution box inside the final treatment building. Once inside the filter distribution box, the water is directed into two filter influent troughs by way of two adjustable-height 90 degree v-notch weirs. The water leaves the troughs through adjustable v-notch weir plates on both sides of the trough to enter the filters. Once the water is filtered, the effluent is conveyed to the downstream clearwell. This clearwell contains the filter backwash pumps in addition to the NPW pumps.

The tertiary filter design criteria is listed below and is considered adequate for the foreseeable flow conditions, especially with future expansion area available for increase flows and loads.

- 1.15 gpm/sf at 0.4 mgd with two cells online
- 2.30 gpm/sf at 0.4 mgd with one cell online

Figure 2-10 presents an overall view of the tertiary filters and related structures.

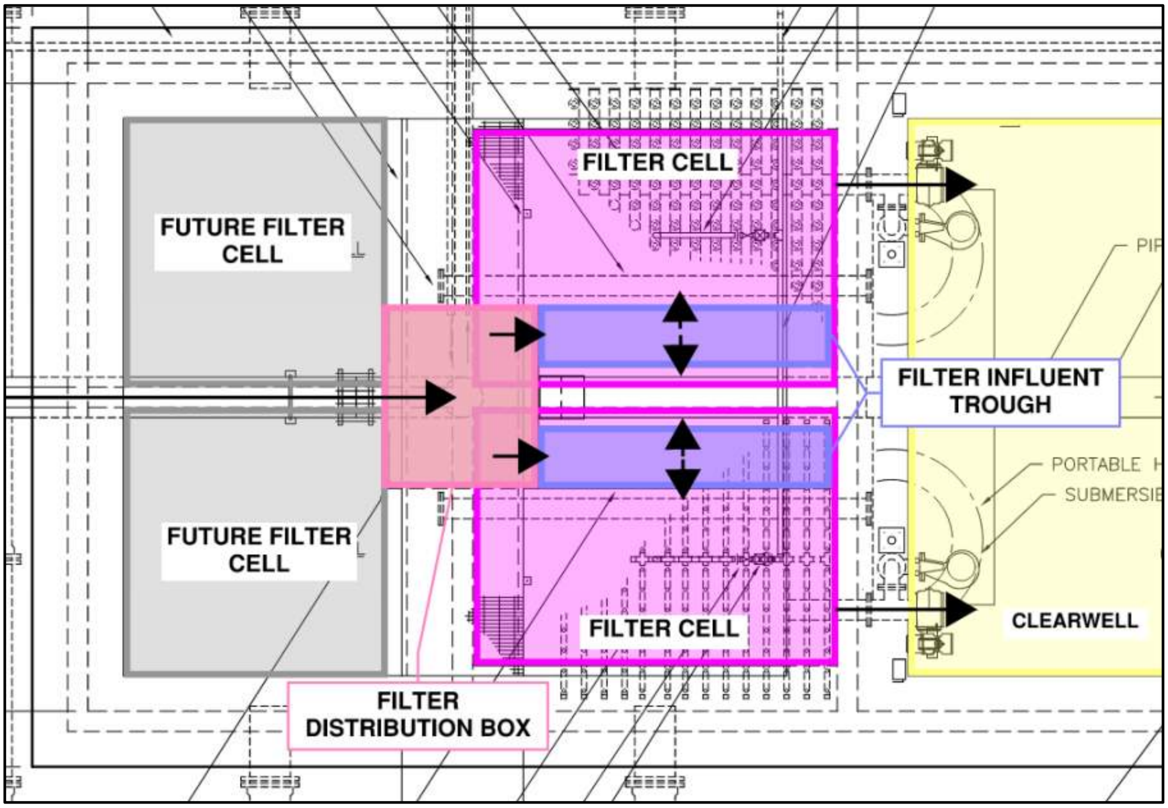


Figure 2-10. Tertiary Filter Area

2.5 UV Disinfection

Effluent from the tertiary filters is conveyed to the clearwell where it passes through a transfer port and into the UV disinfection area. The UV disinfection process is comprised of two identical units placed in series. At current flows, only one of the two UV units is in use. After disinfection, effluent is conveyed through a stilling baffle, over a 22.5-degree v-notch weir and to a 16-inch ductile iron pipe where it is directed to the Effluent Pump Station.

Figure 2-11 presents an overall view of the UV disinfection units and related structures.

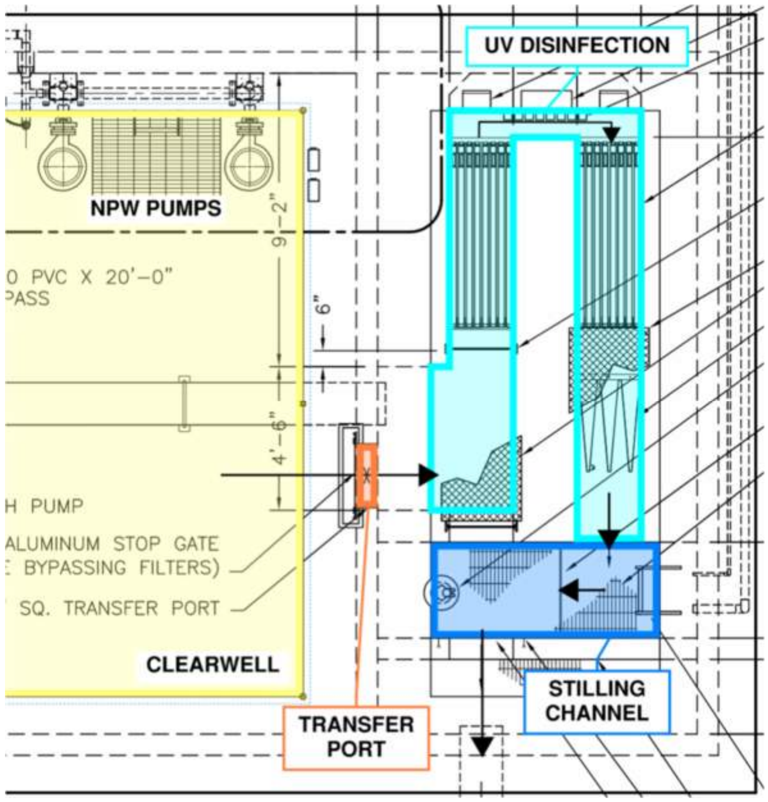


Figure 2-11. UV Disinfection Area

2.6 Solids Handling

NWRF has approximately 380,000 gallons of aerated sludge holding volume, which provides more than 60 days of aerobic detention time under the permitted influent capacity of 0.4 mgd. Currently the vast majority of that volume is unused as liquid sludge is most often hauled to one of DCRSD's other plants for dewatering. There is an existing dewatering centrifuge at NWRF that reportedly has never been in regular operation. The centrifuge would discharge to an existing pleated belt conveyor, which lifts dewatered sludge to an adjacent covered open air truck bay.

There are also two 2500-gallon chemical storage tanks with chemical feed pumps in the Dewatering Building that have never been in regular operation, as well as a containment area for storage of 330-gallon chemical totes. **Figure 2-12** presents a plan view of the Dewatering Building, showing the locations of the chemical storage tanks and dewatering centrifuge area.

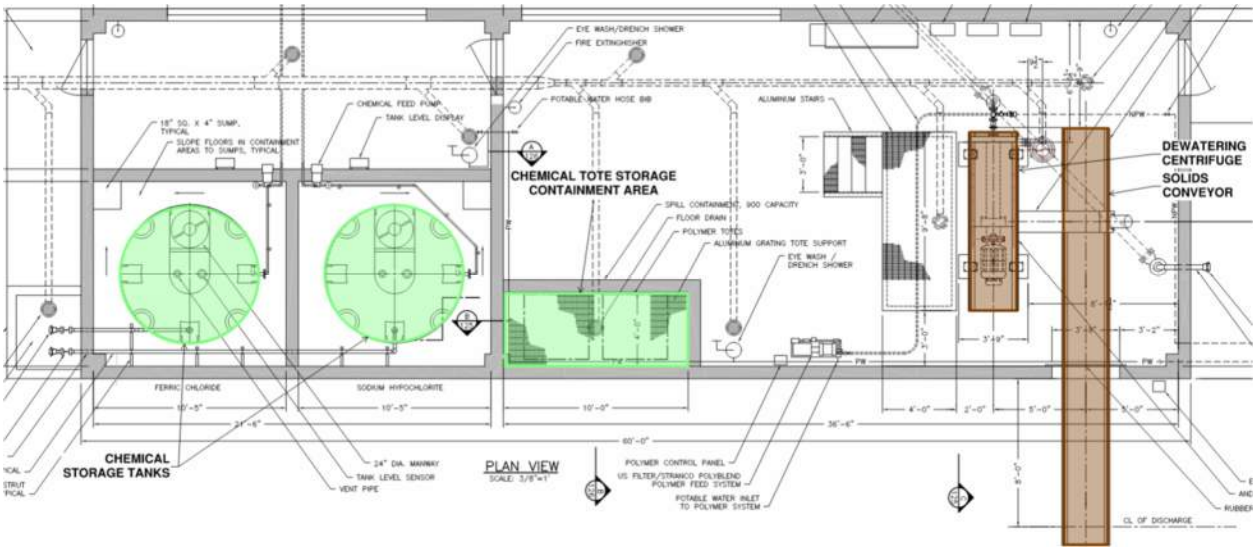


Figure 2-12. Dewatering Building Plan

3. Hydraulic Evaluation

A wastewater treatment plant's hydraulic profile is a graphical representation of the hydraulic grade line (HGL) at all points along a plant's process train. To determine the hydraulic profile of NWRF, a Microsoft Excel-based program developed by Hazen and Sawyer known as HazenPro was utilized. HazenPro leverages a variety of industry standard equations to determine the changes in HGL. These equations are built into interchangeable modules that can be placed in series as needed. These modules are designed to model the different types of condition changes that occur throughout a treatment plant. Changes in flow rates are tracked in the modules to account for return activated sludge (RAS) and parallel treatment trains. To accurately identify the required condition changes at NWRF, the plant's record drawings, site pictures, and meeting notes with DCRSD were referenced.

Several assumptions were made throughout this process, as noted below:

- The hydraulic grade line is equivalent to the energy grade line when a fluid is at atmospheric pressure and moving slowly. When there was a possibility of a discrepancy between the two, a conversion module was used.
- The physical elevations and dimensions throughout the plant's record drawings are accurate.
- NWRF is operating generally with the flow path shown on the record drawings and as modified by operational changes noted by DCRSD. When certain process units had manufacturer-specific or variable headlosses, such as UV disinfection or tertiary filters, the hydraulic profile on the record drawings was referenced.

The hydraulic profile was first developed based on the current flow path and modeled under the following flow conditions:

1. Current annual average flows (0.022 mgd)
2. Permitted capacity flows (0.4 mgd)
3. Peak hourly flows (1.3 mgd)

Subsequently, the hydraulic profile was used to model conditions with proposed recommendations implemented. The hydraulic profiles for these proposed conditions are presented in **Section 5**.

Figure 3-1 presents the hydraulic profile for NWRF under current conditions. There are no hydraulic restrictions at in the current operational scheme at any of the modeled flow conditions.

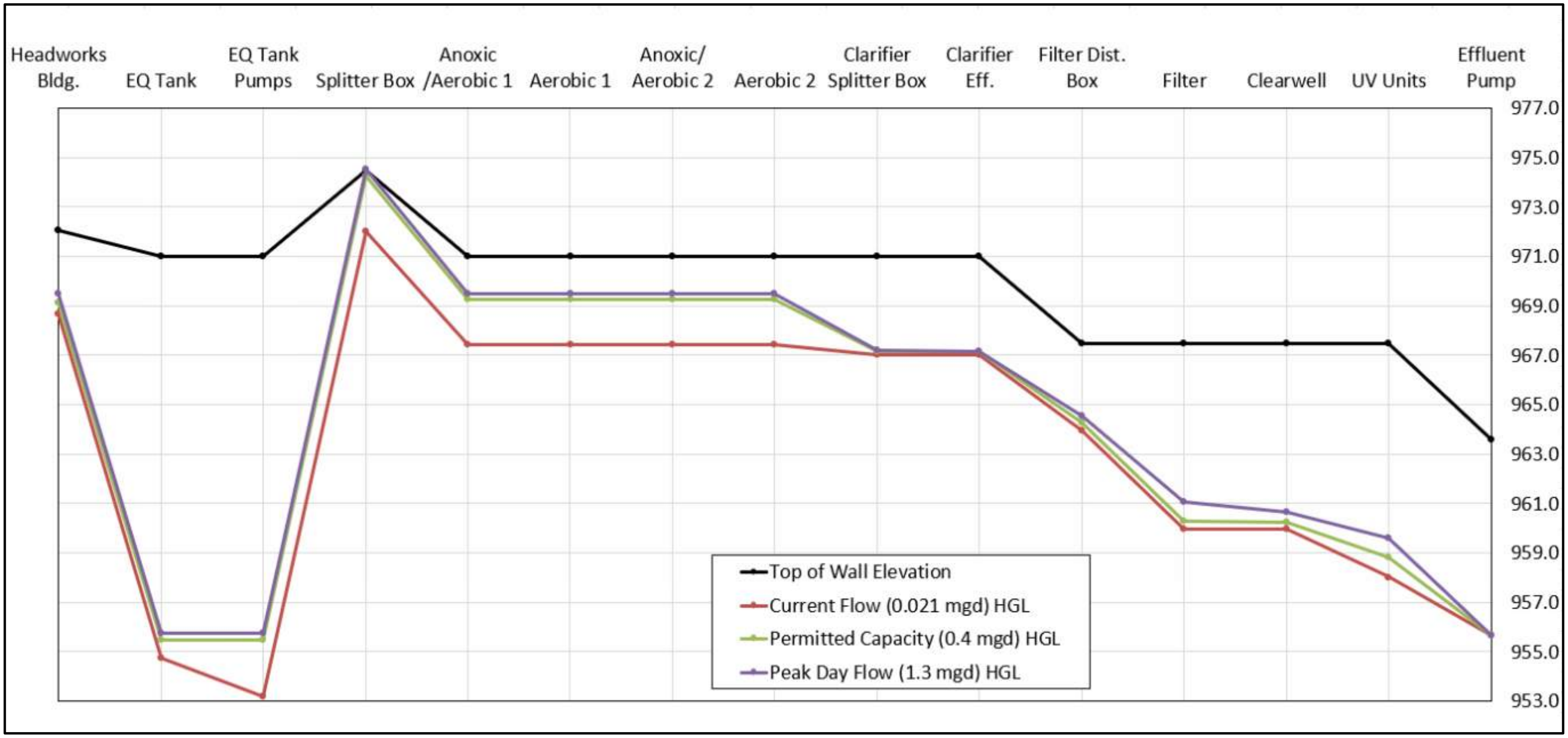


Figure 3-1. Hydraulic Profile of NWRF at Current Conditions

4. Treatment Evaluation

4.1 Biological Treatment

A process model of the NWRF was developed using BioWin 6.2 by EnviroSim Associates Ltd. The model is considered uncalibrated due to limited available influent data, which is not required to be monitored regularly by DCRSD per permit. DCRSD conducted influent sampling intermittently for about a month in 2019, as summarized in **Table 4-1**.

Table 4-1. NWRF Influent Sampling Data (October 21 – December 3, 2019)

Parameter	Units	Sample Count	Monitoring Frequency	Average	Minimum	Maximum
Ammonia, NH_3-N	mg/L	24	Weekdays	38	30	45
Total Kjeldahl Nitrogen, TKN	mg/L	24	Weekdays	47	40	52
Total Phosphorus, TP	mg/L	9	Weekdays 11/19-12/3	5	3	6
Total Suspended Solids, TSS	mg/L	14	Weekdays 10/28-11/19	92	52	164
Carbonaceous biochemical oxygen demand (5-day), $cBOD_5$	mg/L	11	Weekdays 10/23-10/31, 11/6-11/14	57	36	77

Table 4-2 presents a summary of the NWRF effluent characteristics.

Table 4-2. Effluent Flow and Sampling Data (July 2, 2019 – December 23, 2020)

Parameter	Units	Sample Count	Monitoring Frequency	Average	Minimum	Maximum
Flow	mgd	550	Daily	0.02	0.00	0.20
eColi	#/100 mL	11	2/week	14.64	0.00	96.00
TSS	mg/L	23	1/week	2.78	1.20	14.80
TIN	mg/L	72	1/week	5.65	0.55	25.54
$cBOD_5$	mg/L	26	1/week	2.91	1.30	8.20
pH	s.u.	18	1/month	7.39	6.90	7.80

The BioWin model was used to evaluate future projected flows and loads as well as varying permit limits. As noted in **Section 1.2**, the objective of this study is to evaluate the NWRF under the following conditions:

1. Existing LAMP permit at the current flow and loadings.
2. Existing LAMP permit at the original design flow and loadings.
3. Seasonal LAMP permit and seasonal NPDES permit discharge limits.
4. Continuous NPDES permit discharge limits.

Table 4-3 presents a comparison of the current LAMP permits and the anticipated NPDES permits, based on a letter from OEPA to DCRSD dated March 2, 2017. The preliminary limits were provided based on a seasonal discharge during the winter; these could vary if the discharge was changed to be continuous year-round.

Table 4-3. Comparison of LAMP and NPDES Permit Limits

Parameter	Current LAMP Permit Limits	Preliminary Stream Discharge (NPDES) Permit Limits	
	Monthly Average	Monthly Average	Weekly Average
Total Suspended Solids (TSS), mg/L	45	12	18
Ammonia-Nitrogen (NH_3-N), mg/L			
Summer	N/A	1.0	1.5
Winter		3.0	4.5
$CBOD_5$, mg/L	40	10	15
Total Inorganic Nitrogen (TIN), mg/L	10 (max)	10 (max)	N/A
E. Coli, #/100/mL	126 (max)	126	284
Oil & Grease, mg/L	10 (max)	10 (max)	
pH, S.U.	6.0 – 9.0	6.5 – 9.0	
Total Phosphorus (TP), mg/L	N/A	1.0	1.5
Dissolved Oxygen (DO), mg/L	N/A	6.0 (min)	

Because the objective of this evaluation is to confirm the capacity of NWRF, the focus of the process modeling was at the design influent condition of 0.4 mgd rather than current conditions. In addition, the BioWin model was used to optimize the individual zones of the biological treatment basins for biological nutrient removal (BNR), since both permit conditions have a TIN limit. The inherent flexibility of the treatment system, with the ability to implement either mixing or aeration in multiple zones and route influent / RAS to multiple locations, allows for relatively straightforward implementation of the modeled conditions. Using the treatment zone naming convention shown in **Figure 2-7**, the modeled conditions are summarized in **Table 4-4**.

Table 4-4. Modeled Conditions in BioWin

North Train Current Zones	North Train Modeled Conditions	South Train Current Zones	South Train Modeled Conditions
EQ 1	Pre-anoxic	EQ 2	Pre-anoxic
Anoxic / Aeration 1	Aerobic	Anoxic / Aeration 5	Aerobic
Aeration 2	Aerobic	Aeration 6	Aerobic
Anoxic / Aeration 3	Aerobic	Anoxic / Aeration 7	Aerobic
Aeration 4	Post-anoxic	Aeration 8	Post-anoxic

A schematic of the BioWin model that was used to model future BNR conditions (with the current zone naming conventions) is presented in **Figure 4-1**.

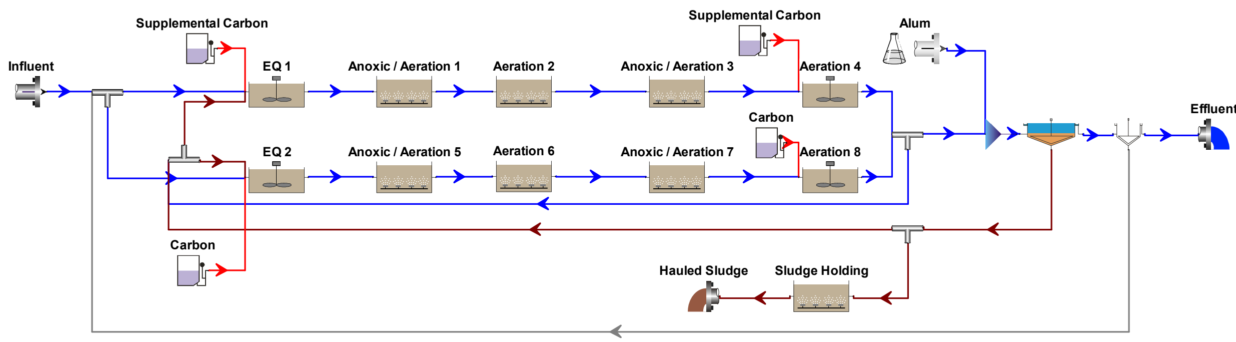


Figure 4-1. NWRF BioWin Model

Modeling was conducted under several scenarios with the operational conditions as listed in **Table 4-5**.

Table 4-5. BioWin Model Conditions

Parameter	LAMP Permit Condition	NPDES Permit Condition
Influent flow (mgd)	0.4	0.4
Trains in service	1	1
Aerobic zone dissolved oxygen concentration, mg/L	2.0	2.0
Target MLSS concentration (mg/L)	3,000	3,000
RAS flow rate (mgd)	0.2 (50% of influent)	0.2 (50% of influent)
Internal mixed liquor recycle (mgd)	1.2 (300% of influent)	1.2 (300% of influent)
Supplemental carbon feed, gpd	40	40
Aluminum sulfate feed, gpd (for phosphorus removal)	0	30

The model results indicate that the NWRF has sufficient biological treatment capacity to handle the design influent flow of 0.4 mgd under either LAMP or NPDES permit effluent limits. However, due to the apparently low carbon (i.e., low $cBOD_5$ concentration) influent, supplemental carbon is likely to be required for denitrification in both pre- and post-anoxic zones to meet the TIN limit for both conditions. The supplemental carbon supply is anticipated to be a non-hazardous glycerol product with a chemical oxygen demand (COD) of approximately 1,000,000 mg/L. If the future $cBOD_5$ value of the influent is greater than the influent conditions from the limited 2019 sampling, the supplemental carbon usage will be less (or potentially completely eliminated).

Based on the conditions described in **Table 4-5**, the effluent concentrations from each modeled scenario are presented in **Table 4-6**.

Table 4-6. BioWin Model Results

Parameter	LAMP Permit Condition	NPDES Permit Condition
Effluent CBOD, mg/L	< 1	< 1
Effluent NH3-N, mg/L	< 1	< 1
Effluent TIN, mg/L	6	6
Effluent TP, mg/L	4	< 1

4.2 Secondary Clarifiers

As noted above, the clarifiers have sufficient surface area to handle peak flows of up to 3.3 mgd based on a typical design guideline of 1000 gpd/sf. To supplement this design guideline, Hazen conducted a solids flux analysis, or state point analysis, on the clarifiers using an assumed sludge volume index (SVI) range of 150-230 mL/g, which conservatively reflects a poorly settling sludge. Even at peak day flows (1.3 mgd) with an SVI of 230 mL/g, it appears that the clarifiers can provide sufficient settling. See **Figure 4-2**.

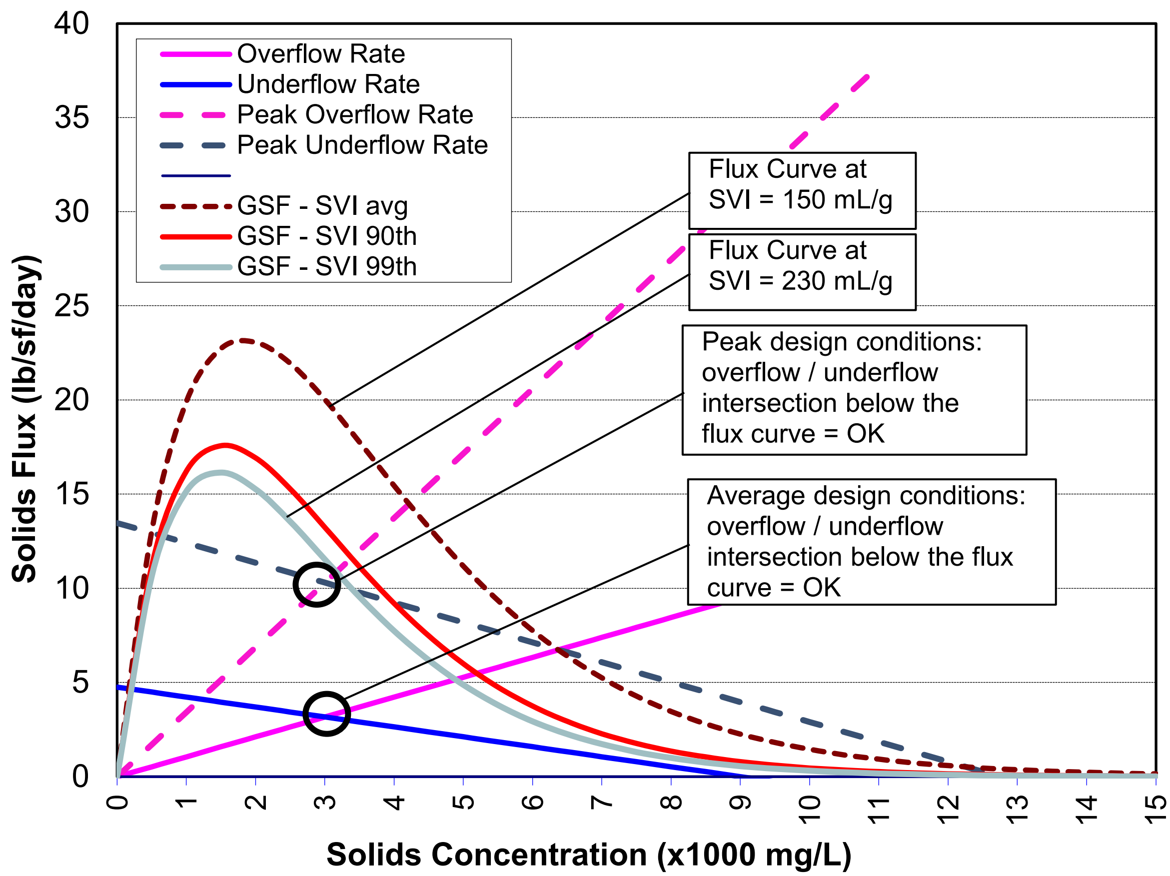


Figure 4-2. Solids Flux Analysis (i.e., State Point Analysis) of NWRF Secondary Clarifiers

5. Alternatives Evaluation

Because the existing NWRF infrastructure (with modifications) can be used to accomplish the necessary treatment at 0.4 mgd, there were limited alternatives that warranted evaluation. However, improvements have been identified that will allow the NWRF to be able to effectively and efficiently handle LAMP and NPDES permit conditions over the next 15-20 years. These improvements have been grouped into the following categories:

1. Baseline improvements: minimum recommended improvements for consistency of operation and maintenance (O&M) as flows increase to 0.4 mgd
2. Future LAMP permit conditions at permitted capacity of 0.4 mgd
3. Future NPDES permit conditions at permitted capacity of 0.4 mgd
4. Future considerations as infrastructure ages and/or flows increase above 0.4 mgd

5.1 Baseline Improvements

The following baseline improvements were identified for optimal operation of the facility and consistency among DCRSD's O&M protocol.

1. Reconfiguration of the return activated sludge (RAS) pump station with direction connection of RAS header to RAS pumps, to improve solids collection within the clarifiers and more directly control RAS removal and distribution. The reconfiguration would be similar to that shown in **Figure 5-1**.

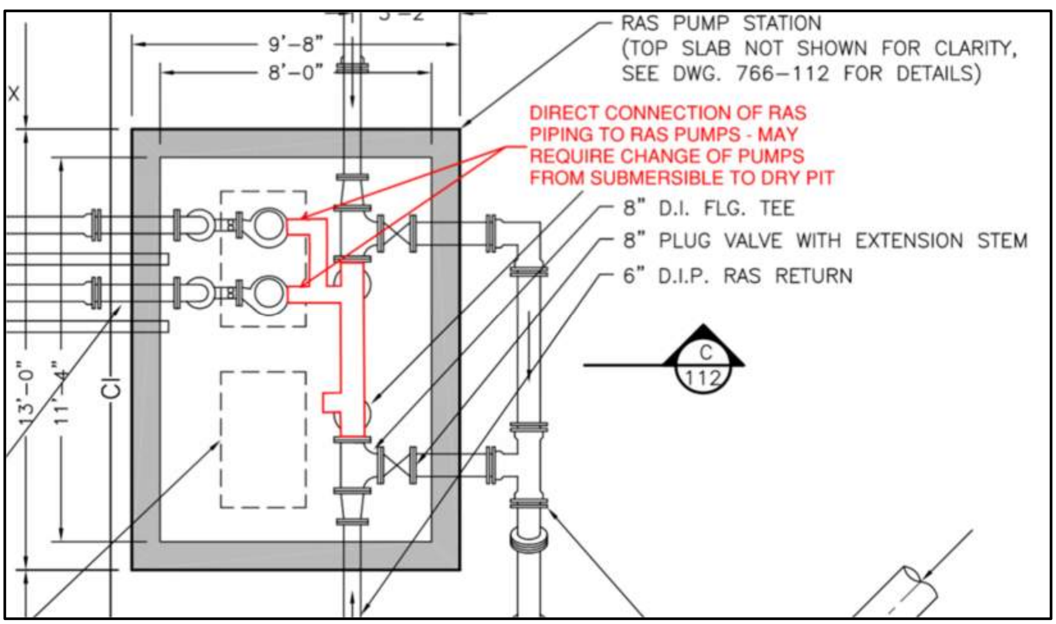
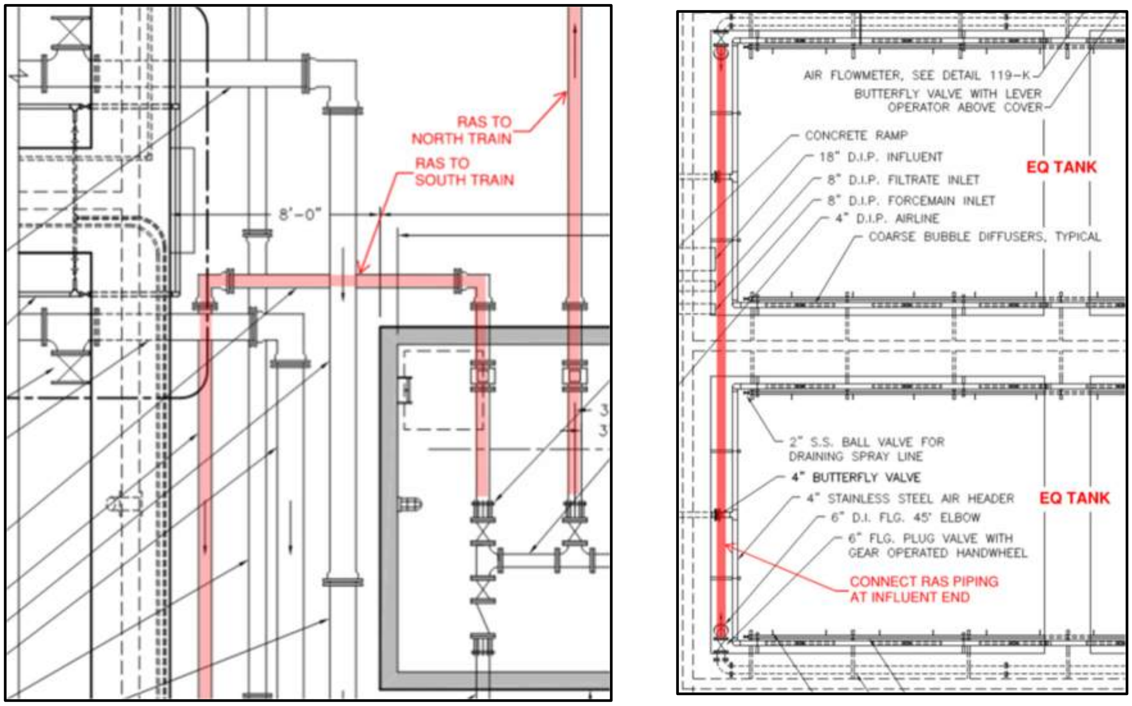


Figure 5-1. Proposed Reconfiguration of RAS Pump Station

2. Connection of the RAS lines at the influent end of the plant so that RAS can be distributed to either side of the plant from either of the two RAS valves. Actuators in RAS valve vault only allow for transmitting RAS to one train or another, as shown in **Figure 5-2**.



RAS Pipe routing at Valve Vault **RAS Pipe Connection at Influent End**

Figure 5-2. RAS Pipe Reconfiguration

3. Lower RAS piping within tanks: to reduce the risk of freezing during cold temperatures, the RAS piping should be lowered to below the operating water level. Alternatively, the RAS piping could be relocated to outside of the tanks in a buried installation to prevent freezing even when tanks are offline. However, this installation would be more costly and require buried valves, which are undesirable. The use of isolation valves to keep piping empty when in offline tanks has been included.

4. Repair leaks in NPW system: expose and repair leaks or replace piping segments in the NPW system so that the system can remain pressurized and operational at all times.

5. Extend influent line from headworks for conveyance of influent to EQ 1, EQ 2, Anoxic / Aeration 1, or Anoxic / Aeration 5 as shown in **Figure 2-7**. This additional piping and valves will allow operation of NWRF without continuously pumping influent from the EQ basins, which would improve reliability and reduce power costs. This proposed improvement is shown conceptually in **Figure 5-3**.

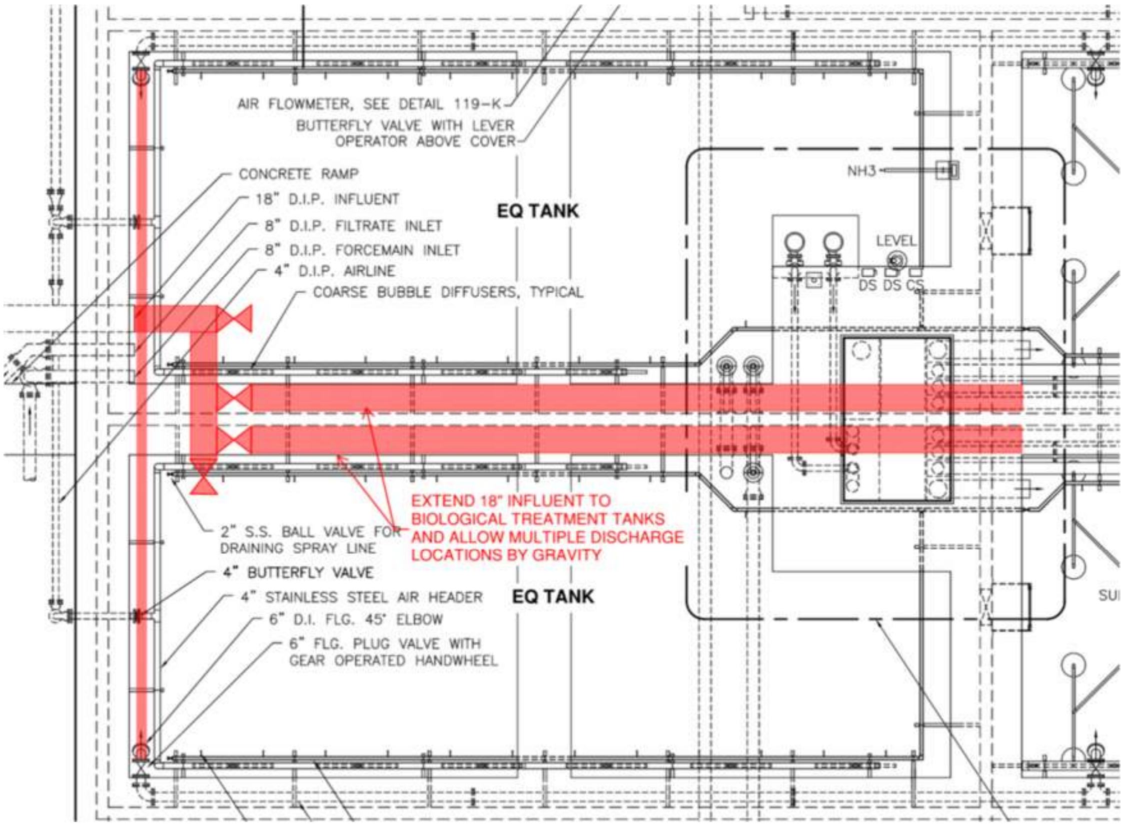


Figure 5-3. Proposed Extension of Influent Lines to Biological Treatment

Figure 5-4 presents the hydraulic profile for NWRF with influent conveyed directly to Anoxic / Aeration 1 and Anoxic / Aeration 5 while bypassing the EQ tanks, pumps, and splitter box. For peak day flows, it was assumed that both treatment trains would be in service.

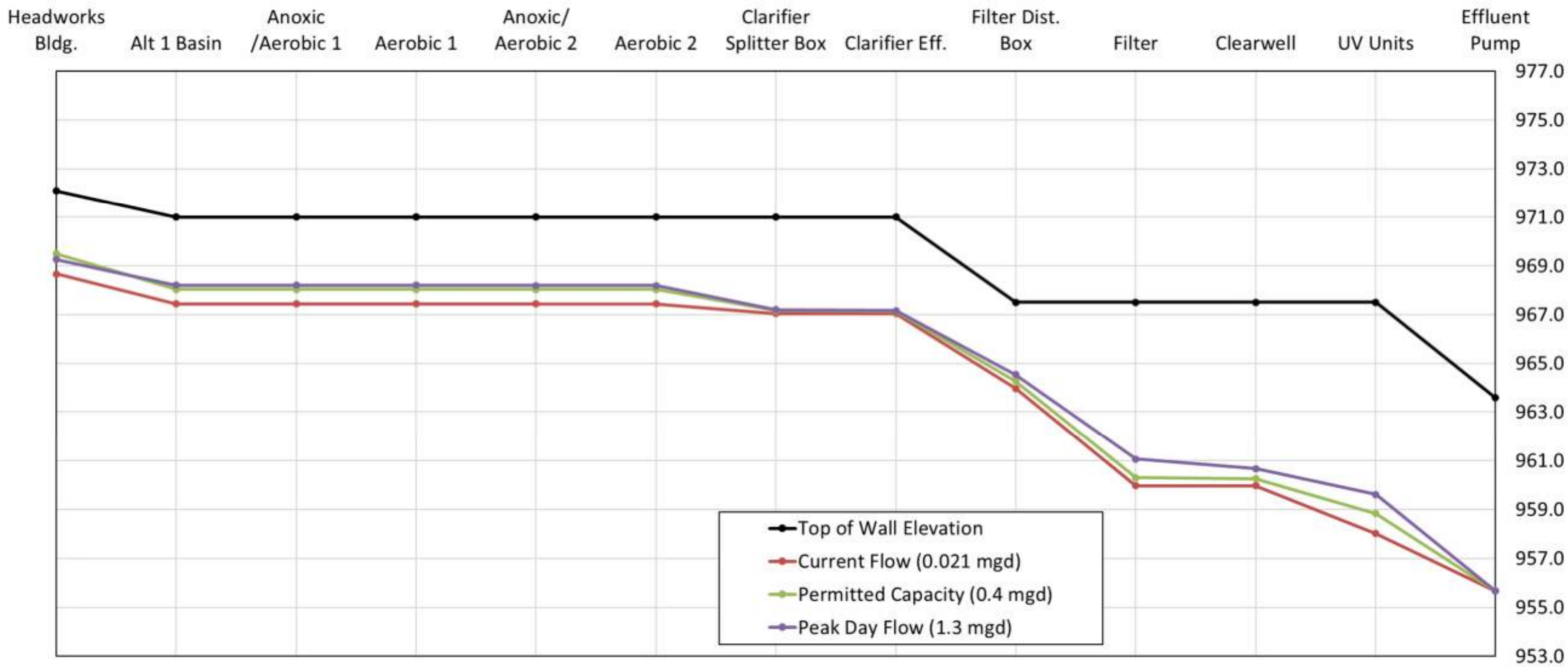


Figure 5-4. Hydraulic Profile for Influent EQ Tank and Pump Bypass

6. Enclose the dewatered solids unloading area for odor control: currently there is a covered area to park a dump truck or dumpster to store dewatered solids from the centrifuge, but there is no means to limit migration of odors if solids were stored in that area (see **Figure 5-5**). It is recommended to convert this structure to a fully enclosed building, and possibly connect the ventilation system exhaust from the area to a new odor control system.

Figure 5-5. Dewatering Building Unloading Area

A summary of the baseline improvements is presented in **Table 5-1**.

Table 5-1. Summary of Baseline Improvements (2021 Dollars)

Improvement	Opinion of Probable Construction Cost	Notes
Reconfiguration of RAS control	$100,000	Includes replacement of two submersible pumps with dry pit submersible pumps on VFDs
Connection of RAS header at influent end of biological treatment	$5,000	
Lower RAS piping	$10,000	Labor only – no new materials
NPW system leak repairs	$50,000	
Influent header extension with valves	$100,000	
Dewatering Building unloading area enclosure	$100,000	Odor control system not included in cost
Subtotal	$365,000	
General Conditions 15%	$55,00	
Contractor Overhead and Profit 20%	$84,000	
Bonds and Insurance 3%	$15,000	
Concept Level Design Contingency 40%	$208,000	(% markups are cumulative)
TOTAL	**$727,000**	

5.2 Improvements for Permitted Capacity of 0.4 mgd with LAMP Effluent Limits

In addition to the baseline improvements, this section outlines proposed improvements as flows increase to 0.4 mgd with the existing LAMP permit limits.

5.2.1 Supplemental Carbon

An increase in flows to 0.4 mgd while maintaining LAMP effluent limits is expected to require storage and feed facilities for supplemental carbon. The low cBOD5 of the influent indicates insufficient carbon to accomplish denitrification and meet the TIN effluent limit. Since the plant uses UV disinfection, it is anticipated that the existing chemical storage and feed system intended for sodium hypochlorite in the Dewatering Building could be repurposed for glycerol feed. Installation and/or rerouting of exposed chemical feed lines would be required.

5.2.2 BNR Improvements

To optimize conditions for BNR, an internal mixed liquor recycle (IMLR) pumping system is recommended to convey fully nitrified flow from the downstream end back to the pre-anoxic zone for denitrification. This practice takes advantage of the influent $cBOD_5$ as a carbon source for denitrification, thereby minimizing the need for supplemental carbon. Typically, the IMLR pumps are low-head pumps that are sized to convey approximately 300% of the design average flow.

Repurposing the existing EQ tanks to provide pre-anoxic conditions is also considered. Due to the relatively low flow conditions and excess volume available in the treatment tanks, these online EQ tanks are unnecessary. Conversion of the EQ tanks to treatment volume would provide additional treatment capacity for operations staff to operate with only one train online for most (if not all) foreseeable influent conditions. In addition, this conversion would eliminate the continuous pumping from the EQ tanks to the diversion box with implementation of baseline improvement no. 4. This improvement would require installation of mixing in the EQ zones, which could be accomplished by relocating existing floating mixers from their current locations to the EQ zones.

The hydraulic impacts of providing IMLR pumps and repurposing the EQ tanks were insignificant. A summary of the improvements for 0.4 mgd with LAMP effluent limits is presented in **Table 5-2**.

Table 5-2. Summary of Improvements for 0.4 mgd with LAMP Effluent Limits (2021 Dollars)

Improvement	Opinion of Probable Construction Cost	Notes
Supplemental carbon feed	N/A*	Repurpose of existing sodium hypochlorite storage and feed system
BNR Improvements	$50,000	IMLR pumps only – conversion of EQ to pre-anoxic covered in baseline improvements. Relocation of mixer assumed by DCRSD
Subtotal	$50,000	
General Conditions 15%	$8,000	
Contractor Overhead and Profit 20%	$12,000	
Bonds and Insurance 3%	$2,000	
Concept Level Design Contingency 40%	$20,000	(% markups are cumulative)
TOTAL	**$100,000**	

*Ongoing O&M cost for supplemental carbon anticipated to be $10,000-$30,000 annually

5.3 Improvements for Permitted Capacity of 0.4 mgd with NPDES Effluent Limits

The improvements needed to meet NPDES effluent limits compared to LAMP effluent limits are summarized in **Figure 5-6**.

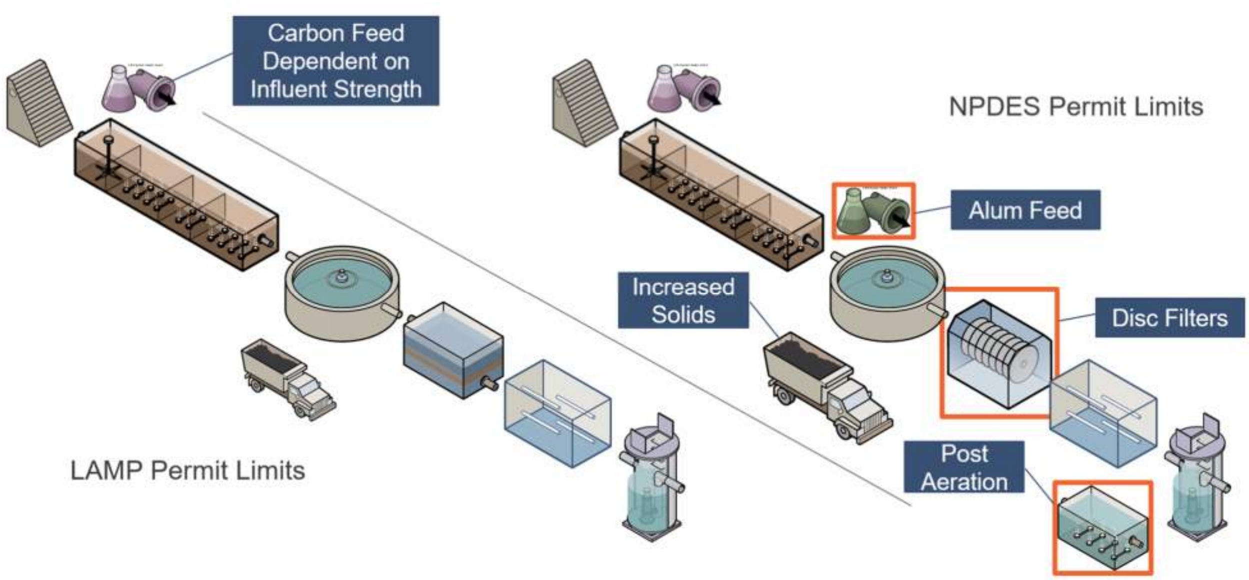


Figure 5-6. Comparison of Improvements for LAMP and NPDES Effluent Limits

5.3.1 Phosphorus Removal Improvements

Because the anticipated NPDES effluent limits include phosphorus, operational metal salt chemical feed facilities and conversion of the tertiary filters to disc filters is recommended. Although some enhanced biological phosphorus removal may be realized with the pre-anoxic zones, a metal salt to precipitate soluble phosphorus is recommended as a backup to meet the effluent limit. The existing chemical storage tank and feed pump in the Dewatering Building intended for ferric chloride (ferric) could be used for aluminum sulfate (alum) as an alternate metal salt to precipitate phosphorus. Ferric could also be used, but ferric often has an adverse impact on UV disinfection and consumes more alkalinity than alum, especially if overfed.

Conversion of the conventional tertiary filters to synthetic fiber disc filters is for operational simplicity in addition to consistency of performance to capture any solids that might cause a TP permit excursion. Disc filters are a proven technology that have reduced O&M compared to conventional media filters, since there is no migration of media to other process units during backwashing, and no air scour is necessary.

5.3.2 Post Aeration

To accomplish the effluent DO requirement of 6.0 mg/L for stream discharge, the following options could be considered:

- Diffused aeration in existing process tankage: there appears to be sufficient volume in the existing filter clearwell to accomplish post aeration with installation of new diffusers. NWRF currently has excess blower capacity for both process aeration and solids storage, so at least one blower could be repurposed for post aeration service.
- Cascade or other aeration at discharge site: although this would be a more impactful project at the stream discharge site, this would help ensure adequate DO at the discharge and reduce energy costs for diffused aeration.

5.3.3 Force Main to Little Walnut Creek

An anticipated discharge to Little Walnut Creek was considered by OEPA when providing the preliminary NPDES effluent limits referenced in **Table 4-3.** The anticipated discharge location would require approximately 1,000 feet of effluent force main from the Effluent Pump Station. The proposed force main routing was conceptually designed by Terrain Evolution in 2017 and determined to be feasible using a relatively direct route. There is also an existing casing pipe below Wilson Road that was installed for this purpose and could be used for the proposed force main routing. The casing pipe is believed to be more than adequately sized for an 8-inch force main, which is the current force main size.

A system curve for this force main routing was developed using 8-inch diameter piping. The existing effluent pumps, if operating at their original capacity, are each capable of conveying up to 1.0 mgd to the proposed discharge location to Little Walnut Creek. The proposed cost to install the new force main has been included in the improvements for this alternative.

A summary of the improvements for 0.4 mgd with NPDES effluent limits is presented in **Table 5-3**.

Table 5-3. Summary of Improvements for 0.4 mgd with NPDES Effluent Limits (2021 Dollars)

Improvement	Opinion of Probable Construction Cost	Notes
Alum feed	N/A*	Repurpose of existing ferric chloride storage and feed system
Conversion to disc filters	$500,000	
Post Aeration	$100,000	Diffused aeration in existing clearwell, and repurpose of existing blower
Effluent force main to Little Walnut Creek	$200,000	
Subtotal	$800,000	
General Conditions 15%	$120,00	
Contractor Overhead and Profit 20%	$184,000	
Bonds and Insurance 3%	$33,000	
Concept Level Design Contingency 40%	$455,000	(% markups are cumulative)
TOTAL	**$1,592,000**	

*Ongoing O&M cost for alum anticipated to be $5,000-$15,000 annually

5.4 Future Considerations

As infrastructure ages and / or influent flows increase above 0.4 mgd, overall improvements to the aeration system should be considered, including the following:

- Replacement of coarse bubble aeration with fine bubble diffused aeration. There would be a minor impact on the existing blower performance with increased pressure loss; however, the payback period on improved oxygen transfer with fine bubble diffusers is typically within 5-10 years.
- Automatic DO control
- Appropriately sized blowers for operational conditions. Currently the blower capacities available at the WRF are oversized and not optimal for the anticipated operational conditions.

In approximately 20 years, the original NWRF infrastructure will likely be nearing the end of its useful life. Accordingly, a significant replacement project should be kept on the planning horizon for the 15-20 year timeframe.