West Basin Facility Plan Project 7054

TECHNICAL MEMORANDUM 2

Rock Creek WRRF Capacity Assessment

FINAL / April 2025

Produced by: carollo

Clean Water Services

Clean Water Services

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Rock Creek WRRF Capacity Assessment

FINAL / August 2025

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Abbreviations

°C	degrees Celsius
A2O	anaerobic, anoxic, oxic
AB	aeration basin
ADW	average dry weather
ADWF	average dry weather flow
Al	aluminum
AO	anaerobic, oxic
AOB	ammonia oxidizing bacteria
aSRT	aerobic solids retention time
AWW	average wet weather
CAMP®	concentrated, accelerated, motivated, problem-solving
cBOD	carbonaceous biochemical oxygen demand
$cBOD_5$	five-day carbonaceous biochemical oxygen demand
CCB	chlorine contact basin
CEPT	chemically enhanced primary treatment
COD	chemical oxygen demand
DEQ	Oregon Department of Environmental Quality
District	Clean Water Services
FP2014	2014 Facility Plan
ft/s	feet per second
GBT	gravity belt thickener
gpm/m	gallons per minute per meter
gpm/sf	gallons per minute per square foot
HLR	hydraulic loading rate
hp	horsepower
HRC	high-rate clarification
HRT	hydraulic retention time
IPS	influent pump station
kg/d	kilograms per day
lb TS/hour	pounds of total solids per hour
lb/m/hr	pound per meter per hour
MAO	mutual agreement and order
MDWWF	maximum day wet weather flow
MG	million gallons
mg P/L	milligrams of phosphorus per liter
mg/L	milligrams per liter

mgd	million gallons per day
MHWWF	maximum hour wet weather flow
mL/g	milliliters per gram
MLSS	mixed liquor suspended solids
MMDW	max month dry weather
MMWW	maximum month wet weather
MMWWF	maximum month wet weather flow
MWDW	maximum week dry weather
N/A	not applicable
NOB	nitrite oxidizing bacteria
NPDES	National Pollutant Discharge Elimination System
NTS	natural treatment system
PDDWF	peak day dry weather flow
PE	primary effluent
PHF	peak hour flow
ppd	pounds per day
ppd VS/cf	pounds per day of volatile solids per cubic foot
ppd/sf	pound per day per square foot
RAS	return activated sludge
SC	secondary clarifier
SDC	sewage discharge contract
SLR	solid loading rate
SOR	surface overflow rate
TMDL	total maximum daily loads
TP	total phosphorus
TPS	thickened primary sludge
TS	total solids
TSS	total suspended solids
TTWAS	twice-thickened waste activated sludge
TWAS	thickened waste activated sludge
UFAT	unified fermentation and thickening
VFA	volatile fatty acid
VSLR	volatile solids loading rate
WAS	waste activated sludge
WASSTRIP	Waste Activated Sludge Stripping to Recover Internal Phosphate
WRRF	Water Resource Recovery Facility

TM 2 ROCK CREEK WRRF CAPACITY ASSESSMENT

2.1 Introduction and Major Assumptions

The following capacity assessment identifies process capacity deficiencies for the various liquid and solids stream treatment systems at the Rock Creek Water Resource Recovery Facility (WRRF), shown schematically in Figure 2.1). This assessment updates the previous capacity evaluation completed as part of the last facility planning project (FP2014)[1] as well as the preliminary capacity evaluation completed as part of the West Basin Alternatives CAMP®[2]. The design criteria, projections, and capacities determined in these previous assessments are referenced herein for comparison.

The results of current capacity assessment are summarized in Figure 2.2, which depicts the trigger years for each of the processes. As shown, tertiary filters, anaerobic digestion, primary solids thickening, and secondary treatment all have capacity limitations in the next decade (2024–2034). Trigger year ranges were adopted where appropriate to reflect uncertainty surrounding the projections and capacities (described below).

2.1.1 Flows and Loads

The flow and load projections used for all unit process capacity evaluations herein are those summarized in the West Basin Flow and Loads memorandum, with the following modifications:

- The original flow and load projections included significant growth projection for a significant industrial contributor (Intel). Between CAMP® and the present analysis, Intel revised their load projections significantly lower. The flow and load projections adopted herein have accounted for this reduction; however, the influent load has not been reduced to Intel's projection. Rather, the maximum load that Intel is able to discharge as part of their contract has been adopted. As a result, the five-day influent carbonaceous biochemical oxygen demand ($cBOD_5$) load to Rock Creek WRRF is higher than currently measured. Clean Water Services (the District) has elected to retain this conservatism in the influent $cBOD_5$ load projection to ensure the capacity remains available for Intel (see Table 2.1).
- During this capacity assessment, it was determined that the influent load projections for the Rock Creek WRRF collection system were biased high by the contribution of the transfer flows from Hillsboro WRRF and Forest Grove WRRF in the influent composite sample. The District reviewed the Rock Creek WRRF influent data and revised the historical $cBOD_5$ and total suspended solids (TSS) loads to account for this contribution. These historical values were then used to update the corresponding projections.

[1] Carollo Engineers, Inc., (October 2012). Technical Memorandum 3.2 - Rock Creek Facilities Plan Update – Capacity Evaluation, West Basin Facilities Plan.
[2] Carollo Engineers, Inc., (March 2023). Technical Memorandum 1 - West Basin Alternatives CAMP® Documentation, West Basin Facility Plan Project 7054.

The projections are in good alignment with the measured data from 2015 through 2020 and project increases in flows and loads from 2020 through buildout. These projections were used for all unit process capacity evaluations except as follows:

- The District saw a reduction in influent $cBOD_5$ loads in 2019 and 2020 that have not yet returned to pre-pandemic levels. As such, the projections yielded a conservative trigger year for secondary treatment (Section 2.2.4). To account for this delayed increase, the primary effluent load was shifted out by four years. This resulted in a trigger year range for secondary treatment (Figure 2.2).
- A trigger year range was also developed for primary sludge thickening (Section 2.3.1). Historically, the primary clarifier mass balance has not closed, with more solids measured entering the process than leaving. As such, the modeled degritted primary solids loads resulted in a conservative trigger year for the primary sludge thickening. To account for the uncertainty inherent in historical mass balance data on which the models were calibrated, the degritted primary solids load was reduced by 5 percent (consistent with the historical mass balance error) to develop the trigger year range. This reduction was found to have approximately the same effect as shifting the degritted primary solids load out by four years.
- Given that anaerobic digestion treats solids from both secondary treatment and primary solids thickening, the initial $cBOD_5$ projections and modeled primary solids loads resulted in conservative trigger years for this process as well. A trigger year range for anaerobic digestion was developed by shifting the modeled thickened waste activated sludge and thickened primary solids loads out by four years, in keeping with the adjustment made for secondary treatment and primary sludge thickening.
- Finally, while a trigger year range was developed for tertiary treatment, this range reflects uncertainty in secondary clarifier performance, tertiary filter design criteria, and future regulatory requirements (Section 2.2.5). The flow and load projections were not modified for tertiary treatment.

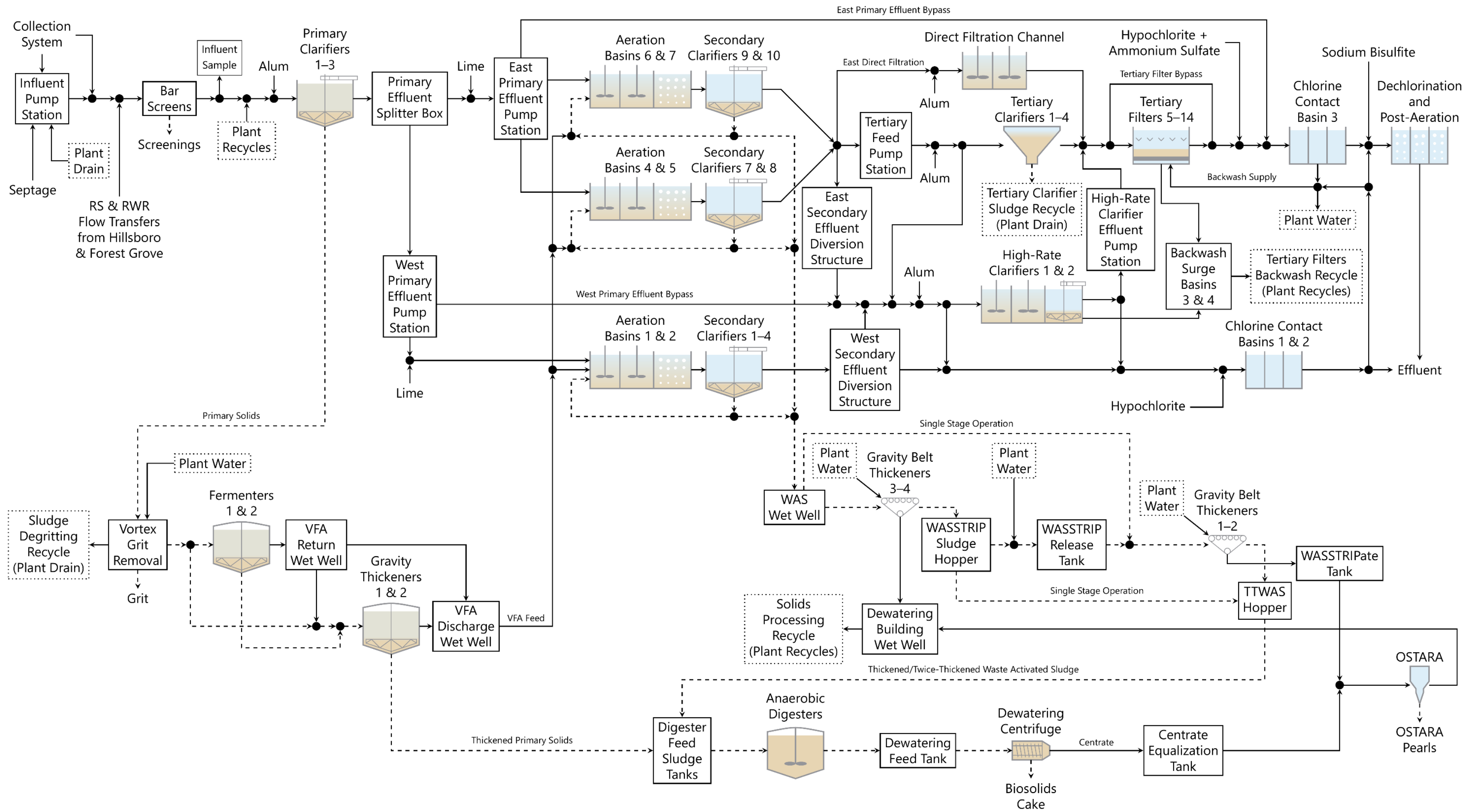

Figure 2.1 Rock Creek WRRF Simplified Process Flow Diagram

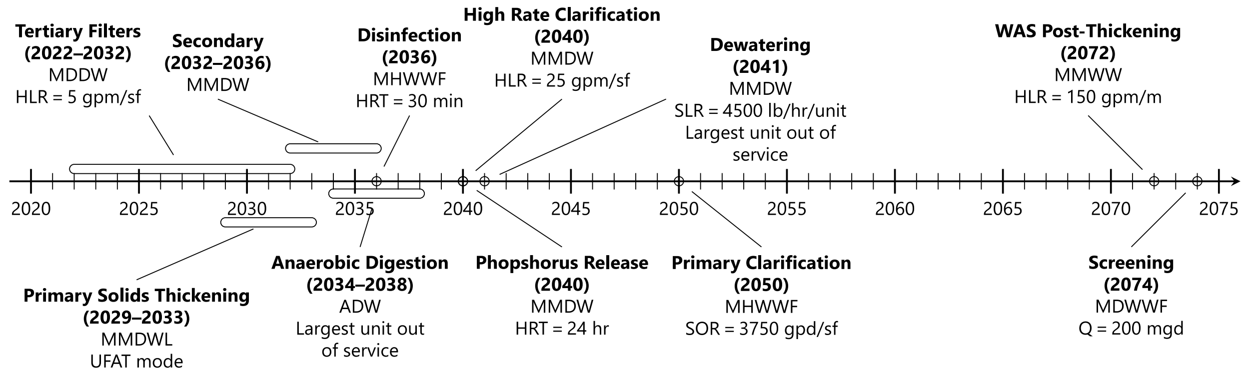

Figure 2.2 Rock Creek WRRF Process Triger Year Summary Timeline

Table 2.1 Intel $cBOD_5$ Load Contribution Comparison

Historical/Projection	Average Annual Flow (mgd)	Average Annual $cBOD_5$ Load (ppd)
Historical (average, 2015 through 2021)	5.5	5,745
Projections at 2045		
CAMP® (2020)	12.9	14,309
Projections used herein (SDC-based)	7.2	8,054

Notes:
SDC - sewage discharge contract.

2.1.2 Overall West Basin Operation and Flow Transfers

Based on the West Basin Alternatives CAMP® recommendations, the present analysis assumes the following operation for the West Basin.

- All solids generated at the Forest Grove and Hillsboro WRRFs will be transferred to the Rock Creek WRRF for treatment.
- Forest Grove WRRF:
  - Will operate year-round.
  - Will have a primary clarifier operational by 2025.
  - Primary solids, waste activated sludge (WAS), and transfer flows will be conveyed to the Rock Creek WRRF via the flow transfer system.
  - Peak flows up to 30 mgd will be treated during the wet weather season.
  - Influent flows exceeding 12 million gallons per day (mgd) during the dry weather season will be transferred to the Rock Creek WRRF via the flow transfer system (limited by the natural treatment system [NTS]). CWS is currently reviewing the hydraulic capacity of the NTS as part of the ongoing Forest Grove WRRF capacity evaluation. Depending on the outcome of this analysis, this assumption may need to be revisited.
- Hillsboro WRRF:
  - Will operate during the wet weather season, with primary solids, WAS, and primary effluent transfer flows being conveyed to the Rock Creek WRRF via the flow transfer system.

- » Primary effluent flows exceeding 19 mgd during the wet weather season will be transferred to Rock Creek WRRF via the flow transfer system.
- » Will transfer screened and degritted collection system influent to the Forest Grove WRRF during the dry weather season after the primary clarifiers are completed at the Forest Grove WRRF. Until then, primary effluent will be transferred to the Forest Grove WRRF.

2.1.3 Regulatory Assumptions

The current capacity analysis assumes that the current National Pollutant Discharge Elimination System (NPDES) permit for the Rock Creek WRRF will remain in effect. Except for Rock Creek WWRF's effluent total phosphorus (TP) limit, the regulatory assumptions adopted for the current analysis are consistent with those adopted for the West Basin Alternatives CAMP®. Specific assumptions include:

- The current TP limit of 0.1 milligrams of phosphorus per liter (mg P/L) would be enforced. The District is currently working with the Oregon Department of Environmental Quality (DEQ) to clarify the effluent TP limit for the Rock Creek WRRF. In the months between the West Basin Alternatives CAMP® and the present capacity assessment, the mutual agreement and order (MAO) between DEQ and the District that allowed the Rock Creek WRRF to discharge to a maximum monthly median TP limit of 0.5 mg P/L from May through September expired. This MAO was developed to provide an opportunity to evaluate the impact of ceasing alum addition to tertiary processes on aluminum in the Tualatin River. A separate MAO was obtained for operation in 2023 and 2024 that reduces the TP limit to 0.4 mg P/L and 0.3 mg P/L in each of these years. The purpose of this MAO is to provide the opportunity for testing the tradeoff between effluent aluminum concentration and effluent phosphorus. After this MAO expires, the Rock Creek WRRF is required to meet the current NPDES monthly median effluent TP permit of 0.1 mg P/L from May through September by the year 2025.
- TSS mass load limit will increase in the future such that the current effluent TSS concentration may be maintained. The Rock Creek WRRF's effluent TSS must comply with individual federal secondary treatment standards as well as a bubbled TSS mass load limit across the District's four facilities. The current bubbled average monthly mass load limit under low river flow conditions is 3000 pounds per day (ppd) (assuming the Rock Creek, Forest Grove, and Durham WRRFs are discharging).

2.1.4 Design Criteria

The design criteria used in this analysis were developed based on values established in FP2014[3] and those used in the West Basin Alternatives CAMP® capacity assessment[4]. Each criterion was evaluated in the context of recent historical data from 2015 through 2021. Consistent with previous capacity assessments, the design criteria used to evaluate unit process capacity are largely based on process performance. In general, hydraulic limitations and limitations in ancillary or supporting systems (e.g., pumping and aeration) were not considered. Hydraulic constraints will be identified as part of the Rock Creek WRRF hydraulic modeling task currently underway as part of the West Basin Facility Plan Project 7054.[5]

[3] Carollo Engineers, Inc., (October 2012). Technical Memorandum 3.2 - Rock Creek Facilities Plan Update – Capacity Evaluation, West Basin Facilities Plan.
[4] Carollo Engineers, Inc., (March 2023). Technical Memorandum 1 - West Basin Alternatives CAMP® Documentation, West Basin Facility Plan Project 7054.
[5] Carollo Engineers, Inc. (Forthcoming). Technical Memorandum 9 - Rock Creek Hydraulic Capacity Assessment, West Basin Facility Plan Project 7054.

2.2 Liquid Treatment Process Capacity

The Rock Creek WRRF liquid stream process is shown schematically in Figure 2.1. The capacities of each liquid stream process—including influent pumping, screening, primary treatment, primary effluent pumping, secondary treatment, tertiary treatment, and disinfection—are described below.

2.2.1 Influent Pumping

The influent pump station (IPS) includes five 900 horsepower (hp) and two, 400 hp non-clog centrifugal pumps (Table 2.2). The two 400 hp pumps were added in 2008 to increase capacity and reduce ongoing clogging issues. The total IPS capacity is 202 mgd and the firm pump station capacity is 168 mgd.

Table 2.2 Influent Pump Station Information

	Large Pumps	Small Pumps
Number of Pumps	5	2
Pump hp	900	400
Capacity per pump, mgd	34	16
Total dynamic head, feet	120	120

The IPS needs to have the capacity to pump the peak day flow (maximum day wet weather flow [MDWWF]) with one unit out of service and the peak hour flow (maximum hour wet weather flow [MHWWF]) with all units in service (Table 2.3). Currently, offsite pump stations and the flow transfer system divert a portion of the influent flow around the influent pump station to the screens (Figure 2.1). Offsite pump station capacity and upstream flow distribution have been evaluated separately as part of the collection system modeling. For the purposes of the current evaluation, two extreme scenarios for the IPS influent flow were developed as part of the collection system evaluation:

- Scenario 1: Maximum flow to the IPS - Includes pumped bypass of IPS to headworks for existing Dawson, Aloha, River Road Pump Stations. Increased flows from North Hillsboro area above Dawson Pump Station firm capacity (with limited upgrades to 27.5 mgd) will flow into the IPS.
- Scenario 2: Minimum flow to the IPS - Includes pumped bypass of IPS to headworks for existing Dawson, Aloha, River Road Pump Stations. Increased flows from North Hillsboro area also bypass the IPS with new pump station(s).

Table 2.3 Rock Creek WRRF Influent Pumping Design Criteria

Flow/Load Condition	Design Criteria	Redundancy Criteria	Performance Assumption	Reference
MHWWF	Installed Rated Capacity	All units in service	N/A	FP2014
MDWWF	Installed Firm Capacity	Largest unit out of service	N/A	FP2014

Notes:
N/A - not applicable.

Figure 2.3 depicts the capacity of the IPS relative to the influent flow projections for the two collection system scenarios. Notably, the current influent flow projections depicted are significantly lower than those used in the CAMP® capacity evaluation and previous facility planning effort due to higher flows projected for the off-site pump stations. Under both scenarios, the IPS is projected to have sufficient capacity through 2075 (Table 2.4).

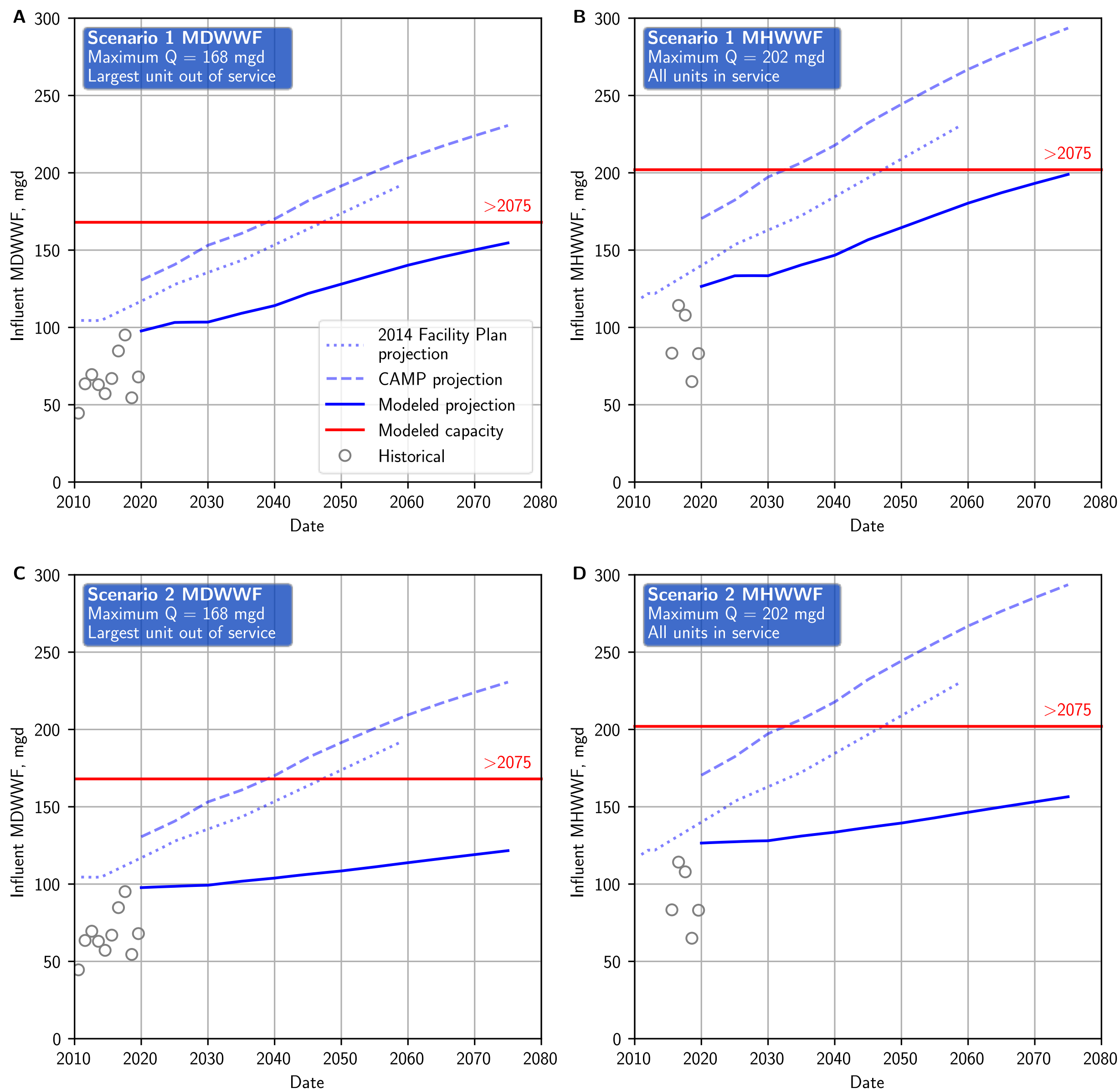

Figure 2.3 Influent Pump Station Trigger Plots

Panels A and C depict the influent pump station capacity under maximum day wet weather flow with the largest unit out of service. Panels B and D depict the influent pump station capacity under peak hour wet weather flow with all units in service. Trigger plots A and B depict the collection system scenario that maximizes modeled projection flow to the influent pump station. Trigger plots C and D depict the collection system scenario the minimizes modeled projection flow to the influent pump station.

Table 2.4 Influent Pump Station Capacity

Parameter	MDWWF (Firm)	MDWWF (Total)
Influent pump station capacity, mgd	168	202
Estimated capacity year	> 2075	> 2075

2.2.2 Headworks

The headworks at the Rock Creek WRRF consists of six channels, four of which have mechanically cleaned screens, (Table 2.5). The existing screening system has a total rated capacity of 300 mgd and a firm capacity (largest unit out of service) of 200 mgd.

Table 2.5 Screening Information

Mechanical Screens	Width (feet)	Screen Opening (inches)	Rated Capacity Per Screen (mgd)
Channel 1	4	NA	NA
Channel 2	6	1/4	100
Channel 3	4	3/8	50
Channel 4	4	3/8	50
Channel 5	6	1/4	100
Channel 6	4	N/A	N/A

The design criteria (Table 2.6) require the influent screens to have the capacity to treat the MHWWF with all units in service and the MDWWF with one unit out of service. Figure 2.4 compares the current screening capacity to the projected MHWWF and MDWWF. Consistent with the IPS trigger plots, the MHWWF and MDWWF projections in the current analysis are lower than in previous evaluations. As a result, the current analysis indicates that the existing screens will have sufficient capacity through buildout (Table 2.7).

Table 2.6 Influent Screening Design Criteria

Flow/Load Condition	Design Criteria	Redundancy Criteria	Performance Assumption	Reference
MHWWF	Installed rated capacity	All units in service, can use either Channel 1 or 6 as a bypass if needed.	N/A	FP2014
MDWWF	Installed firm capacity	Largest unit out of service.	N/A	FP2014

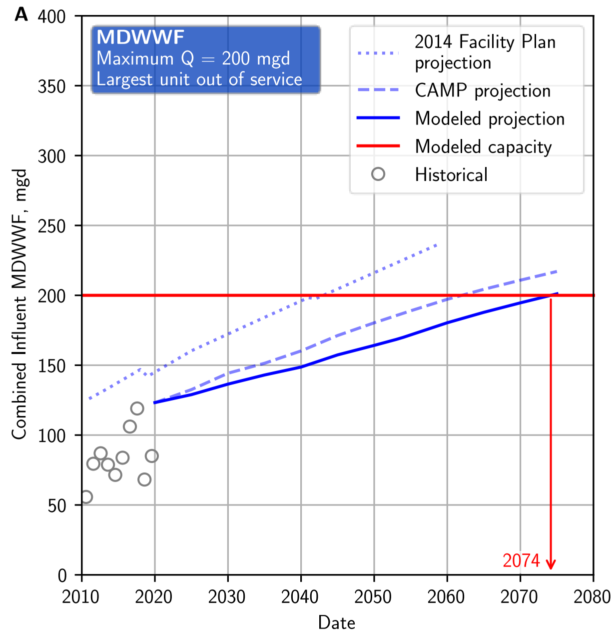

Figure 2.4 Screening Trigger Plots

Table 2.7 Screening Capacity

Parameter	MHWWF (Total)	MDWWF (Firm)
Headworks capacity, mgd	300	200
Estimated capacity year	> 2075	2074

2.2.3 Primary Clarification

Primary treatment at the Rock Creek WRRF is provided with three existing 140-foot diameter clarifiers. A fourth 140-foot diameter clarifier is currently under construction. During the wet weather season, two to three primary clarifiers are typically online and operated conventionally. During the dry weather season, chemically enhanced primary treatment (CEPT) is practiced with alum addition to the primary clarifier influent. Under the 0.1 mg P/L effluent TP limit, additional alum solids are returned from tertiary treatment.

2.2.3.1 Primary Clarification Design Criteria

Primary clarifier design criteria are summarized in Table 2.8. Primary clarifier capacity is rated based on the surface overflow rate (SOR). Redundancy is provided in the dry weather season, which is consistent with the District's historical preference to operate with units out of service while operating CEPT.

The SOR design criteria for average dry weather flow (ADWF) and maximum month wet weather flow (MMWWF) shown in Table 2.8 are consistent with the primary clarification analysis conducted as part of the fourth primary clarifier design[6] (Kennedy Jenks, 2019). The Kennedy Jenks memorandum assumed

[6] Kennedy/Jenks Consultants (August 2019). Rock Creek Primary Treatment Alternative Analysis. Memorandum K/J 1876008*10.

higher ADWF and MMWWF SORs at 1800 gallons per day per square foot (gpd/sf) than the values adopted in the 2009 and 2014 facility plan assessments (1500 gpd/sf) based on observed performance at higher overflow rates. For MHWWF conditions, the primary clarifiers need to be able to hydraulically pass the flow. For this reason, the MHWWF SOR of 3750 gpd/sf identified in the FP2014 was used. This value will need to be confirmed as part of the hydraulic modeling planned as a part of this project.

Table 2.8 The Rock Creek WRRF Primary Clarification Design Criteria

Flow/Load Condition	Design Criteria	Redundancy Criteria	Performance Assumption	Reference
MHWWF	SOR = 3750 gpd/sf	All units in service	N/A	▪ FP 2014. To be updated with the planned hydraulic modeling.
MMWWF	SOR = 1800 gpd/sf(1)	All units in service	TSS removal = 60%(2)	▪ SOR from Rock Creek Primary Clarifier Alternative Analysis (Kennedy Jenks, 2019). ▪ Wet weather TSS average removals = 68%, 60% was selected to be conservative.
ADWF	SOR = 1800 gpd/sf with CEPT(1)	Largest unit out of service	TSS removal = 70%	▪ SOR from Rock Creek Primary Clarifier Alternative Analysis (Kennedy Jenks, 2019). ▪ Dry weather TSS average removals = 75%, 70% was selected to be conservative. (with CEPT).

Notes:
(1) SOR values differ from the West Basin Alternatives CAMP® and the FP2014. An SOR of 1500 gpd/sf was adopted for the ADWF condition in both. The West Basin Alternatives CAMP® analysis assumed 2200 gpd/sf for MMWW. The SORs adopted herein are consistent with the Rock Creek Primary Clarifier Alternatives Analysis (Kennedy Jenks, 2019).
(2) The West Basin Alternatives CAMP® analysis adopted a lower TSS removal of 40%. In the current analysis, this conservative removal was found to yield primary effluent loads that resulted in overly conservative for mixed liquor suspended solids concentrations.
ADWF - average dry weather.

Historical primary clarifier performance

Plots of primary clarifier chemical oxygen demand (COD) and TSS removal versus SOR from 2015 through2021 are shown in Figure 2.5 and Figure 2.6 for dry and wet weather conditions, respectively. The number of primary clarifiers online was not included in the historical data provided by the District; as a result, the recent historical primary clarifier performance relative to SOR is uncertain. Figure 2.5 and Figure 2.6 were prepared based on typical operation: the SOR was calculated for the dry weather season assuming one to two primary clarifiers online and two to three primary clarifiers online for the wet weather season. Given the uncertainty in this approach, data were excluded from transition months (April, May, October, and November) when changes in influent flow rate would prompt clarifiers to be put into or taken out of service.

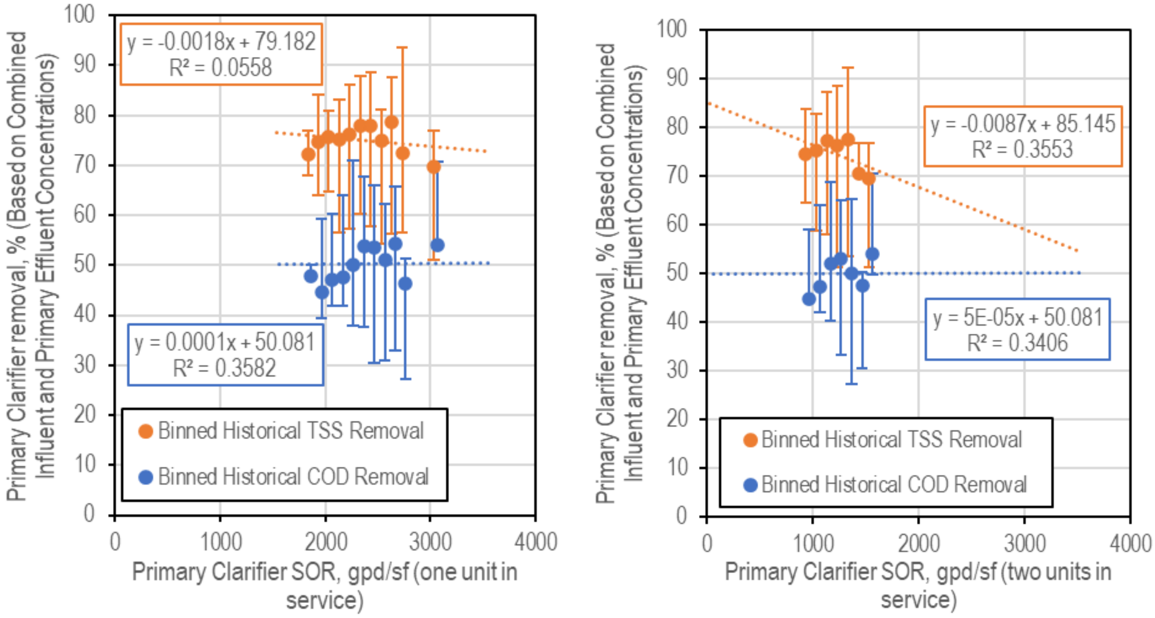

Figure 2.5 Historical Dry Weather Primary Clarifier Performance

TSS and COD removals are estimated from concentrations measured in the combined influent and primary effluent (flow and load contributions from internal recycles are not accounted for in the combined influent due to sampling location) in CEPT mode. Removals greater than 100 percent and less than 0 percent have been dropped. Historical data were binned by SOR with bins of width 100 gpd/sf. Median values shown with upper and lower bars denoting the 25th and 75th percentile, respectively. Bins with fewer than three observations are not shown.

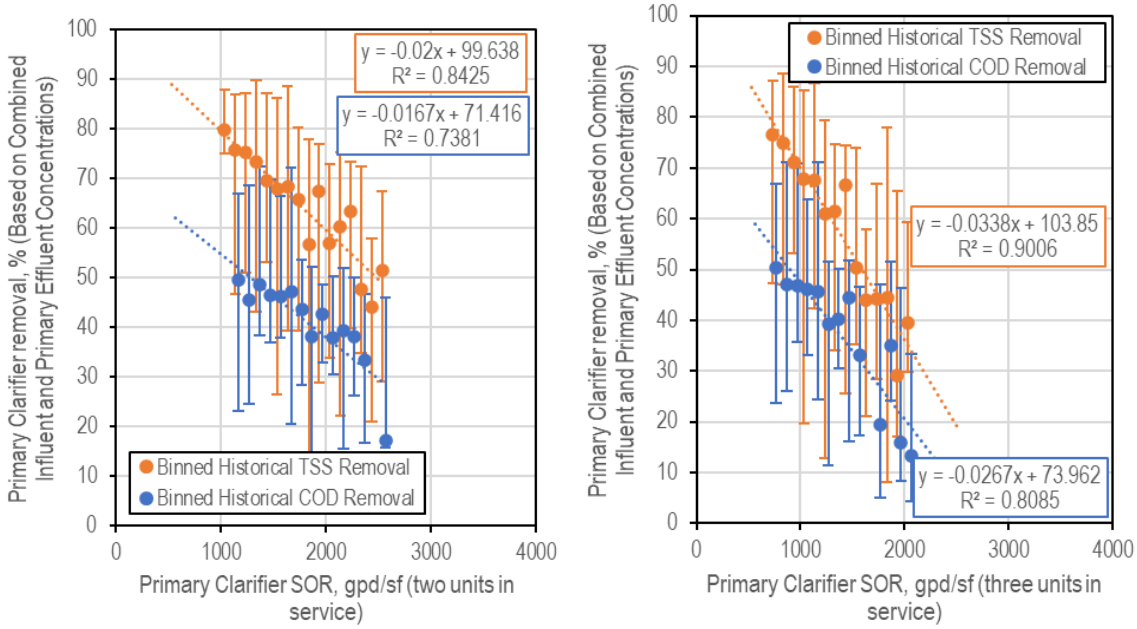

Figure 2.6 Historical Wet Weather Primary Clarifier Performance

TSS and COD removals are estimated from concentrations measured in the combined influent and primary effluent (flow and load contributions from internal recycles are not accounted for in the combined influent due to sampling location). Removals greater than 100 percent and less than 0 percent have been dropped. Historical data were binned by SOR with bins of width 100 gpd/sf. Median values shown with upper and lower bars denoting the 25th and 75th percentile, respectively. Bins with fewer than three observations are not shown.

For the dry weather season, Figure 2.5 shows that high TSS and COD removals have been achieved at elevated SORs (consistent with expectations for CEPT). These removals have been relatively constant over the range of SORs. Based on this information, the primary clarifier TSS removal rate was assumed to be 70 percent during the dry weather period which is approximately equal to the lowest median value shown in Figure 2.5 at SORs between 1500 and 1800 gpd/sf.

As shown in Figure 2.6, the historical primary clarifier TSS and COD removal in the wet weather exhibits a greater dependency on SOR than in dry weather. This is due, in part, to the wider range of SORs operated under in the wet weather season. Based on this information, the primary clarifier TSS removal was assumed to be 60% during the wet weather period which is approximately equal to the average median removal shown in Figure 2.6 for an SOR equal to 1800 gpd/sf (with two units in service).

2.2.3.2 Primary Clarification Capacity

Based on the design criteria established in Table 2.8, the four primary clarifiers will have an ADWF of 83 mgd with one clarifier out of service with CEPT, a MMWWF capacity of 111 mgd and a peak hour flow (PHF) capacity of 231 mgd (Table 2.9) with all units in service. Figure 2.7 shows the primary clarifier trigger plot for each flow condition. As shown, a fifth primary clarifier would be needed in 2050 to meet the MHWWF criteria.

Table 2.9 Primary Clarification Capacity

Parameter	ADWF (Firm)	MMWWF (Total)	MHWWF (Total)
Primary influent flow, mgd	83	111	231
Estimated capacity year	> 2075	2052	2050

As noted above, the SOR design criterion of 1800 gpd/sf for the ADWF and MMWWF conditions were adopted for consistency with the Rock Creek Primary Clarifier Alternatives Analysis (Kennedy Jenks, 2019). Historically, when operated with CEPT, the primary clarifiers have removed approximately 70 percent of the influent TSS when operating at SORs in the vicinity of 1800 gpd/sf. During the wet weather season, with no CEPT, the primary clarifiers have removed approximately 45 to 60 percent of the influent TSS when operating in the vicinity of 1800 gpd/sf. An SOR of 1500 gpd/sf was adopted for both the ADWF and MMWF conditions in the 2014 facility plan. At this lower SOR, the redundancy criterion would still be satisfied through 2075 and the trigger year for the MMWWF condition would move up to 2033. If the primary clarifiers were operated conventionally during the dry weather season, a lower SOR design criterion would be appropriate. Typical average SORs for conventionally operated primary clarifiers range from 800 to 1200 gpd/sf (Metcalf and Eddy, 2005). With an SOR of 1000 gpd/sf, for example, the redundancy criterion would be reached in 2035.

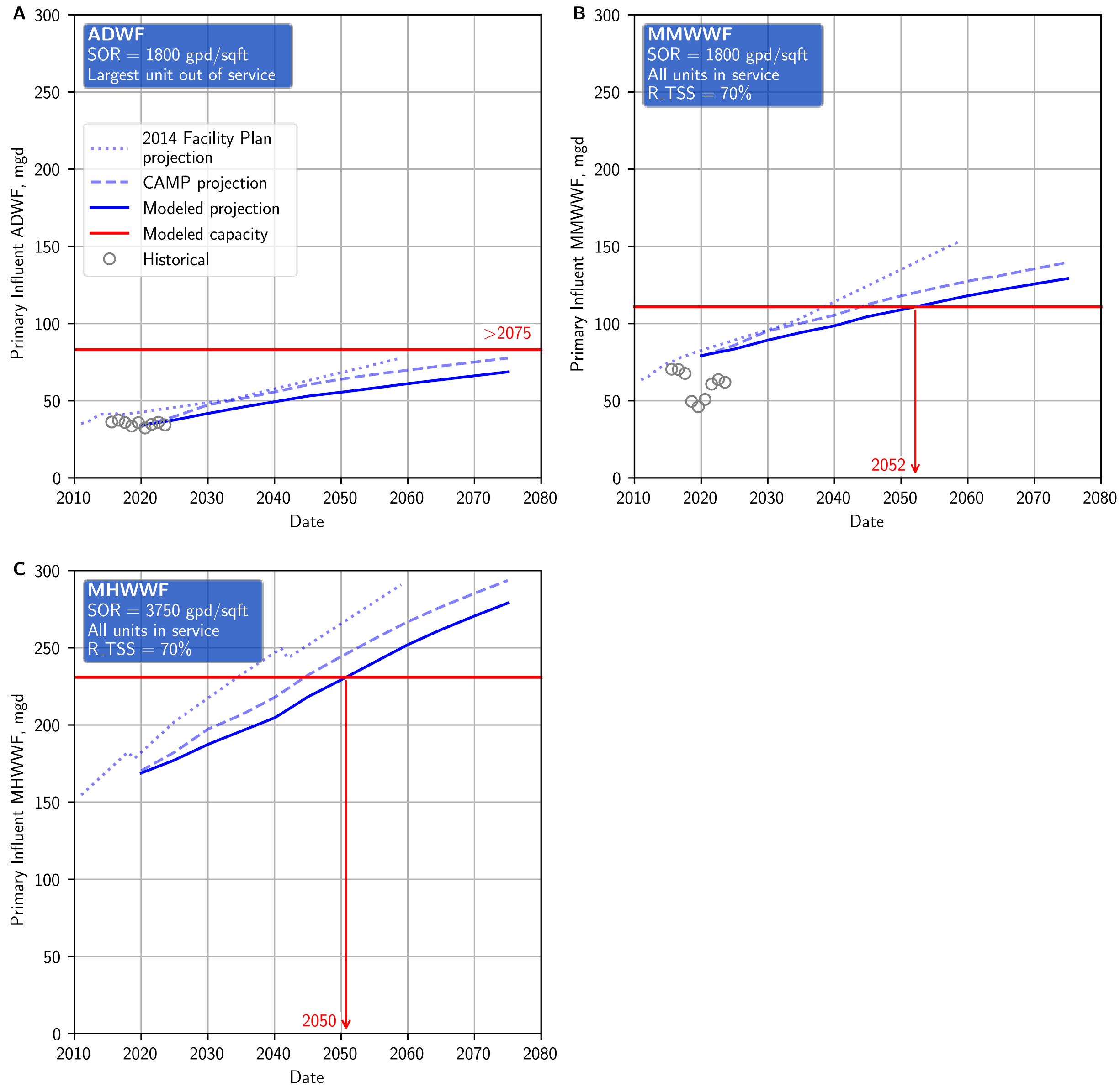

Figure 2.7 Primary Clarification Trigger Plots

Conditions depicted include (A) average dry weather flow with the largest unit out of service with CEPT; (B) maximum month dry weather flow with all units in service; (C) maximum month wet weather flow with all units in service; and (D) peak hour wet weather flow with all units in service.

Finally, concerns have been raised that a fifth primary clarifier may be infeasible given site constraints in the vicinity of the existing primary clarifiers. If a fifth primary clarifier is not installed by buildout, the SORs under the projected 2075 MMWWF and MHWWF would be 2100 gpd/sf and 4300 gpd/sf, respectively. While these SORs would be high for conventional primary clarification, they may be feasible with CEPT. This analysis should be revisited once the trigger point for building a fifth primary clarifier is closer.

2.2.4 Secondary Treatment

Secondary treatment at the Rock Creek WRRF is performed by west and east treatment trains. The two west treatment trains (Aeration Basins 1 and 2) are operated as a single system with Secondary Clarifiers 1 through 6. Secondary Clarifiers 5 and 6 are not used in general because their organ-pipe scraper mechanisms were not upgraded to Tow-Bro mechanisms with the rest of the west secondary clarifiers in 2015. The four east treatment trains have normally been operated independently, with Aeration Basins 4, 5, 6 and 7 coupled with Secondary Clarifiers 7, 8, 10, and 9, respectively. The flexibility exists to group the individual east treatment trains together.

Aeration Basins 1 and 2 each have a total volume of 2.17 million gallons (MG), four 147,500-gallon selector zones, and a 21-foot side water depth. Return activated sludge (RAS), primary effluent and volatile fatty acid (VFA) feed from the unified fermentation and thickening (UFAT) process are all directed to the first anaerobic zone. The basins are configured to operate in either an anaerobic, oxic (AO) configuration for biological phosphorus removal during the winter when nitrification is not required or in the anaerobic, anoxic, oxic (A2O) configuration for biological phosphorus removal when nitrification is required. In the A2O configuration, internal mixed liquor pumps return nitrate to the third selector zone (Figure 2.8). The anaerobic and aerobic zones are approximately 13.5 percent of the total volume each.

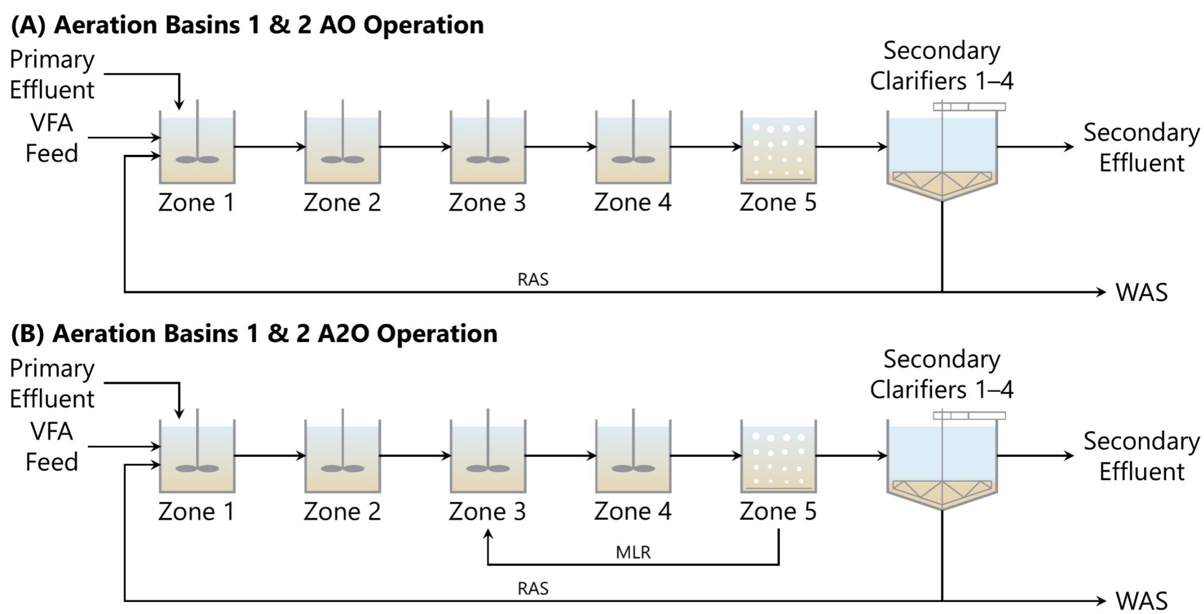

Figure 2.8 Aeration Basins 1 and 2 Operating Modes

Aeration Basins 4 and 5 each have a total volume of 1.7 MG, three selector zones, and a 15-foot side water depth. The first two selector zones are 85,000 gallons and the third selector zone is 170,000 gallons. RAS and VFA feed from the UFAT process are directed to the first selector zone while primary effluent can be directed to either the first or the third selector zone. Internal mixed liquor pumps return nitrate to the third selector zone. This flexibility allows the District to operate Aeration Basins 4 and 5 in one of four different configurations depicted in Figure 2.9. In the summer season, Aeration Basins 4 and 5 are operated in an A2O configuration, while during the winter the District typically operates these basins in either an AO configuration or a step-feed configuration depending on if extra nitrification is required to allow the District to meet their effluent ammonia limit. The anaerobic zones (selector zones 1 and 2) and the anoxic zones (selector zones 3 and 4) are approximately 10 percent of the total volume each, while the aerobic zone is approximately 80 percent of the total volume.

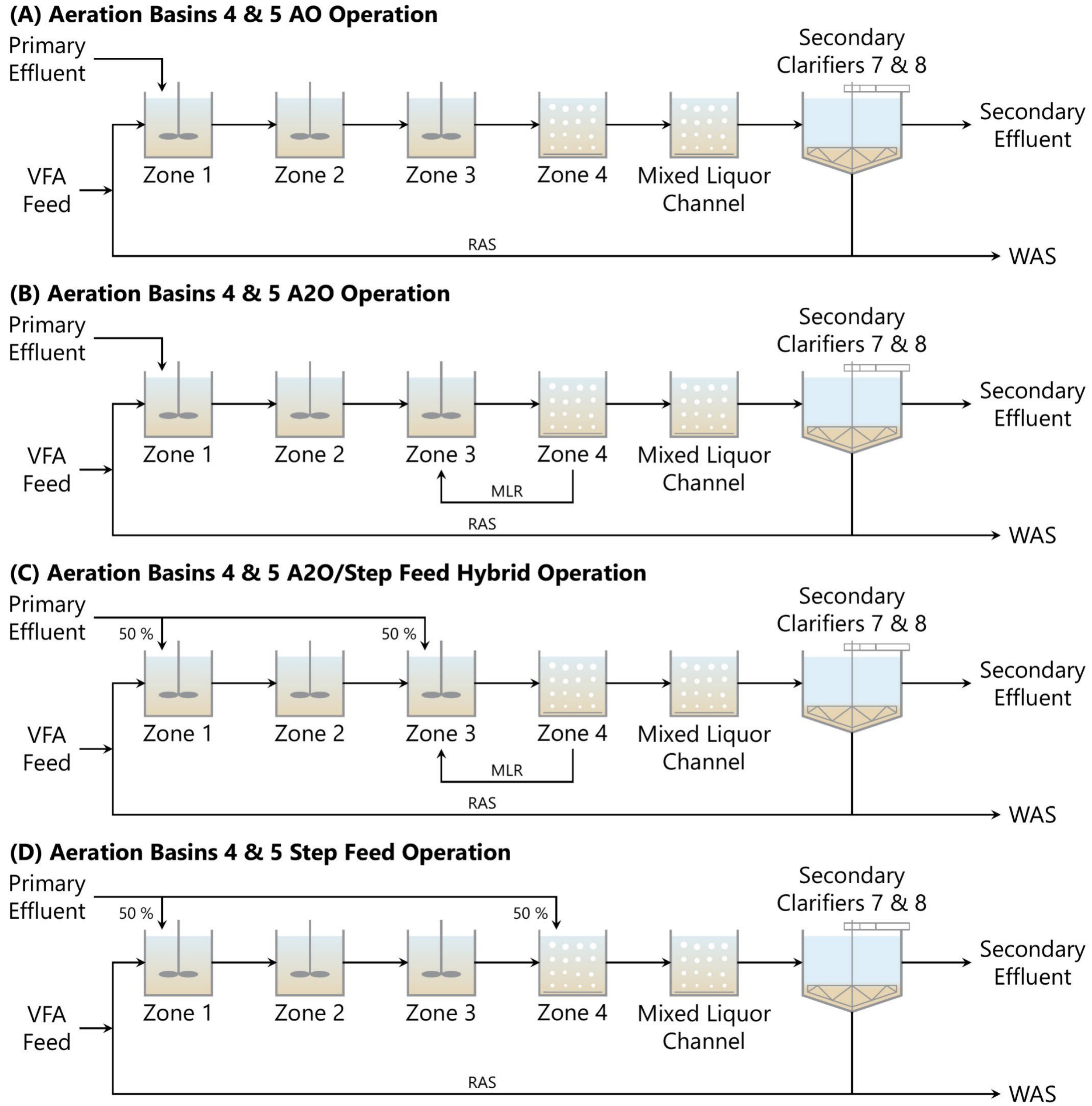

Figure 2.9 Aeration Basins 4 and 5 Operating Modes

Aeration Basins 6 and 7 were designed as multipurpose basins capable of operating in a range of configurations (Figure 2.10). Each basin has a total volume of 1.7 MG consisting of nine zones. In general, the basins can operate in plug flow or step feed. In plug flow, internal mixed liquor pumps are available to return nitrate to the third selector zone, allowing the basins to operate in an A2O configuration for biological phosphorus removal during the dry weather season and in the AO configuration for biological phosphorus removal during the wet weather season.

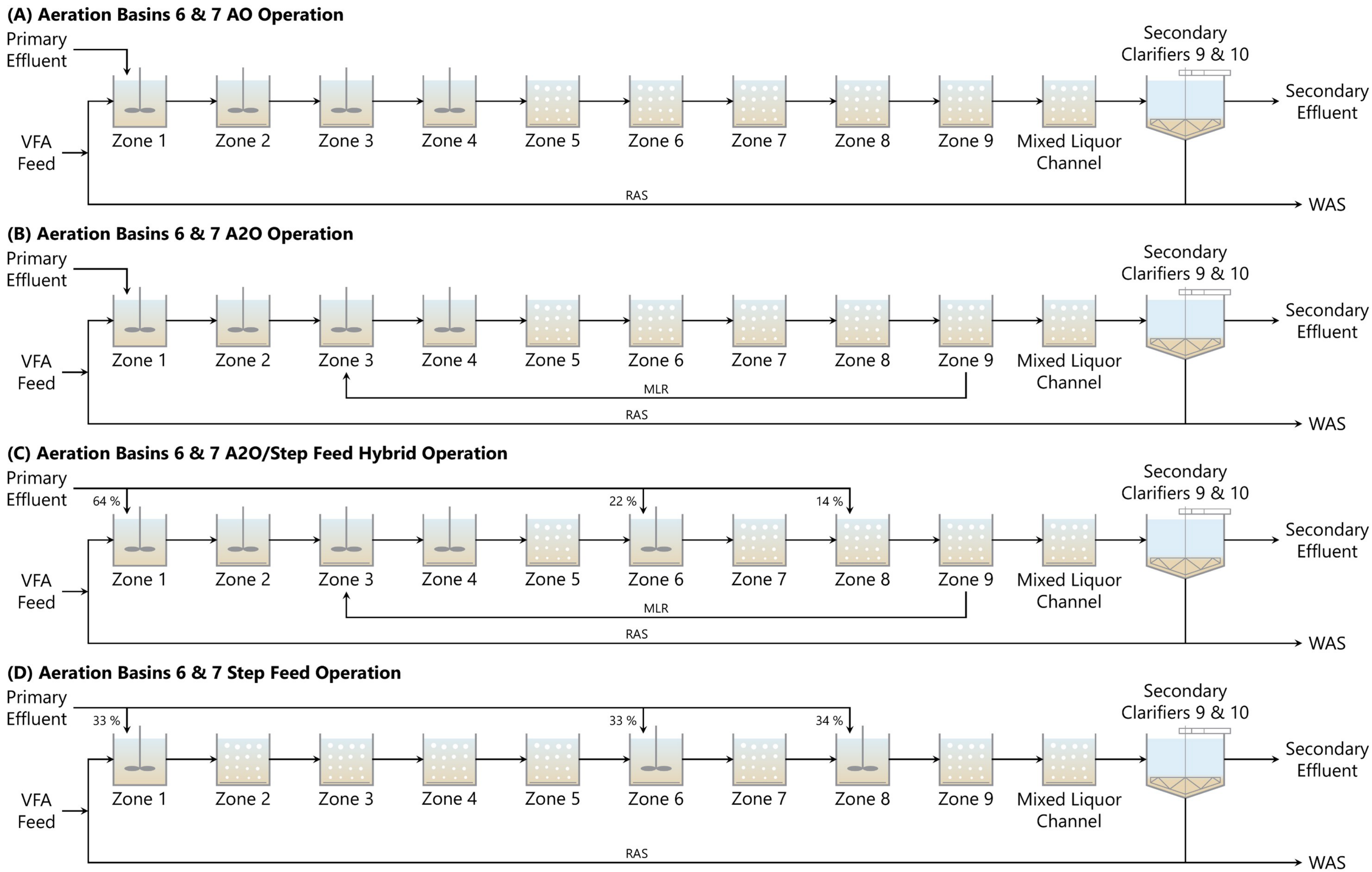

Figure 2.10 Aeration Basins 6 and 7 Operating Modes

The anaerobic zones are approximately 10 percent of the total volume, the anoxic zones are approximately 10 percent of the total volume, and the aerobic zones are approximately 80 percent of the total volume. In the step-feed mode, primary effluent is split between Zones 1, 6 and 8, which are anoxic. In this mode, the anoxic zones are approximately 20 percent of the total volume and the aerobic zones are approximately 80 percent of the total volume. The District has also successfully operated the basins in a hybrid A2O/step feed mode where a portion of the primary effluent is added to the second anoxic zone to provide additional denitrification capacity. In the hybrid A2O/step feed mode, the total volume of the aerobic zones is approximately 67 percent of the total volume.

2.2.4.1 Secondary treatment design criteria

Table 2.10 summarizes the design criteria adopted in the secondary treatment capacity evaluation. Both dry and wet weather conditions were evaluated. For dry weather conditions, secondary treatment capacity is rated by the sum of the maximum sustained overflow flowrates that each secondary clarifier can pass with the secondary inventory resulting from the max month dry weather (MMDW) primary effluent load as determined through a combination of biological process modeling and a state point analysis. As discussed below, the operating configuration and aerobic solids retention time (aSRT) were selected to ensure robust biological phosphorus removal and complete nitrification as needed to meet the stringent dry weather effluent TP and ammonia limits.

The Rock Creek WRRF also needs to meet an effluent ammonia limit in the wet weather season; however, this does not require complete nitrification. The District has been able to meet this permit limit by operating two secondary treatment trains with an aSRT sufficient for full nitrification, two with an aSRT that ensures nitrifier washout, and two at an aSRT that is partially nitrifying. With this configuration, the District is able to bring the two partially nitrifying trains to complete nitrification relatively quickly if additional nitrification capacity is required.

Overall, the aSRT in four of the six secondary treatment trains is lower under wet weather conditions than dry weather conditions. Moreover, the District can divert peak primary effluent flows through high-rate clarification in the wet weather season. Taken together, secondary treatment capacity is not limiting under wet weather conditions; however, the peak flow capacity of secondary treatment under the maximum month wet weather (MMWW) condition was determined below to estimate the primary effluent bypass flow requirements. Additionally, the District prefers to take advantage of the lower overall aSRT and flexibility in managing peak flows to take aeration basins and secondary clarifiers out of service for maintenance in the wet weather season.

Table 2.10 Secondary Treatment Design Criteria

Flow/Load Condition	Design Criteria	Redundancy Criteria	Performance Assumption	Reference
▪ ABs evaluated on MMDW PE COD load. ▪ SCs evaluated on PDDWF.	▪ All ABs at an aSRT of 5.6 d. ▪ ABs 1, 2, 4, 5, 6 and 7 in A2O. ▪ SLR ≤ 48 ppd/sf at peak flow. ▪ Terminal MLSS ≤ 4300 mg/L.	▪ SCs 5 and 6 out of service. ▪ All ABs in service.	▪ Complete nitrification at nitrifying aSRTs. ▪ SVI = 112 mL/g.	▪ Nitrifying aSRT calculated assuming a 2.0 safety factor. ▪ 90th percentile SVI data.
▪ ABs evaluated on MMWW PE COD load. ▪ No specific flow condition for SCs.	▪ ABs 1 and 2 not nitrifying at an aSRT of 3 days in AO. ▪ ABs 4 and 5 partially nitrifying at an aSRT of 3.9 d in Step Feed. ▪ ABs 6 and 7 nitrifying at an aSRT of 6.2 d in Step Feed. ▪ Terminal MLSS ≤ 4300 mg/L.	▪ SCs 5 and 6 out of service. ▪ All ABs in service.	▪ Complete nitrification at nitrifying aSRTs. ▪ SVI = 150 mL/g.	▪ Non-nitrifying aSRT from FP2014. ▪ Nitrifying aSRT calculated assuming a 2.0 safety factor. ▪ Partial nitrification aSRT calculated assuming a 1.25 safety factor. ▪ 90th percentile SVI data.
▪ ABs evaluated on AWW PE COD load. ▪ No specific flow condition for SCs.	▪ ABs 1, 2, 4, and 5 not nitrifying at an aSRT of 3 d in AO. ▪ AB 6 and 7 nitrifying at an aSRT of 6.2 d in Step Feed. ▪ Terminal MLSS ≤ 4300 mg/L.	▪ SCs 5 and 6 out of service. ▪ One AB out of service.	▪ Complete nitrification at nitrifying aSRTs. ▪ SVI = 150 mL/g.	▪ Non-nitrifying aSRT from FP2014. ▪ Nitrifying aSRT calculated assuming a 2.0 safety factor. ▪ 90th percentile SVI data.
▪ ABs evaluated on AWW PE COD load. ▪ No specific flow condition for SCs.	▪ ABs 1, 2, 4, and 5 not nitrifying at an aSRT of 3 d in AO. ▪ AB 6 and 7 nitrifying at an aSRT of 6.2 d in Step Feed. ▪ Terminal MLSS ≤ 4300 mg/L.	▪ SCs 5 and 6 out of service. ▪ One SC out of service (in addition to SCs 5 and 6 which are out of service).	▪ Complete nitrification at nitrifying aSRTs. ▪ SVI = 150 mL/g.	▪ Non-nitrifying aSRT from FP2014. ▪ Nitrifying aSRT calculated assuming a 2.0 safety factor. ▪ 90th percentile SVI data.

Notes:
AB - aeration basin; AWW - average wet weather; mg/L - milligram per liter; mL/g - milliliters per gram; MLSS - mixed liquor suspended solids; PDDWF - peak day dry weather flow; PE - primary effluent; ppd/sf - pounds per day per square foot; SC - secondary clarifier; SLR - solids loading rate; SVI - sludge volume index.

Aerobic Solids Retention Time

Nitrification is required at the Rock Creek WRRF during the dry weather season to meet stringent ammonia limits. The effluent ammonia limits are less stringent in the wet weather season and the District has historically employed a differential operation strategy to meet them. The aSRT is the key operating parameter that controls nitrification, and is selected based upon minimum temperature, basin configuration, and effluent permit requirements. In the dry weather season, all basins are operated with a high enough aSRT to ensure complete nitrification. In the wet weather season, Aeration Basins 1 and 2 are operated at a low aSRT to preclude nitrification while providing good settling, while Aeration Basins 6 and 7 are operated with an aSRT that is high enough to achieve complete nitrification, and Aeration Basins 4 and 5 are operated at an intermediate aSRT to achieve partial nitrification. By operating Aeration Basins 4 and 5 in partial nitrification, the District is able to quickly increase nitrification capacity as the need arises. This strategy has allowed the District to balance the need to meet their river-flow-dependent effluent ammonia limit with the needs to limit aeration, minimize alkalinity consumption, and provide sufficient residual ammonia to reduce disinfection byproduct formation.

To ensure complete nitrification, both ammonia and nitrite oxidizing bacteria (AOBs and NOBs, respectively) need to be maintained in the system. The minimum aSRT required to prevent the nitrifiers from washing out of the system was estimated for both AOBs and NOBs with the following equation:

$$\mathrm{aSRT_{min}} = \mathrm{SF} \cdot \frac{1}{\mu_{max} \cdot \theta_{\mu,max}^{T-20} - b \cdot \theta_b^{T-20}}$$

Where:

- SF is the nitrification safety factor,
- μ_{max} is the maximum specific growth rate of the nitrite oxidizing bacteria,
- $\theta_{\mu,max}$ is the Arrhenius coefficient for the maximum specific growth rate,
- b is the specific rate of decay,
- θ_b is the Arrhenius coefficient for the specific rate of decay, and
- T is the temperature in degrees Celsius (°C).
- The parameter values adopted for this analysis are summarized in Table 2.11.

Table 2.11 Aerobic Solids Retention Time Parameter Values

Parameter name	Symbol	Units	AOBs(1)	NOBs(1)
Maximum specific growth rate	μ_{max}	d^{-1}	0.85(2)	0.65
Arrhenius coefficient for μ_{max}	$\theta_{\mu,max}$	unitless	1.072	1.060
Specific rate of decay	b	d^{-1}	0.17	0.15
Arrhenius coefficient for b	θ_b	unitless	1.030	1.030

Notes:
(1) Unless otherwise noted, default parameters values in the Sumo2S model were used in this capacity assessment.
(2) The District uses a lower maximum specific growth rate for AOBs (the default in the Sumo2S model is 0.90 d^{-1}) to account for nitrifier inhibition.

The minimum aSRT calculated for each operating condition in the current capacity assessment are summarized in Table 2.12. In general, these values are consistent with previous assessments. The FP2014 adopted minimum aSRTs for complete nitrification during the dry weather season of 5.5 days for Aeration Basins 6 and 7 and 6.0 days for Aeration Basins 1, 2, 4, and 5. For complete nitrification at the Durham WRRF, the East Basin Master Plan adopted minimum aSRTs of 5.8 days (dry weather) and 6.4 days (wet weather). Importantly, the dry and wet weather temperatures used in the Durham WRRF assessment were lower than adopted here (13.2°C versus 13.6°C for wet weather and 14.4°C versus 15.1°C for dry weather).

Table 2.12 Aerobic Solids Retention Time Calculation Summary

Condition	Minimum aSRT, $aSRT_{min}$ (d)	Nitrification Safety Factor, SF	Temperature, T (°C)
Dry Weather, Full Nitrification	5.6	2.00	15.05(1)
Wet Weather, Full Nitrification	6.2	2.00	13.64(2)
Wet Weather, Partial Nitrification	3.9	1.25	13.64(2)
Wet Weather, No Nitrification	3.0(3)	N/A(3)	N/A(3)

Notes:
(1) Minimum 30 days running average of the influent temperature during the dry weather seasons from 2015 through 2021.
(2) Minimum 30 days running average of the average of the influent and effluent temperatures during the wet weather seasons from 2015 through 2021.
(3) The minimum aSRT for non-nitrifying trains is driven by good settling sludge. A value of 3.0 days was adopted in the FP2014 and was used in the current analysis.

State Point Analysis

Secondary clarification capacity was evaluated using state point analysis. This approach estimates secondary clarifier performance by graphically comparing the applied solids flux and underflow solids flux to the solids settling flux. The solids settling flux was modeled using the Vesilind relationship for the solids settling velocity, reduced by a non-ideality factor of 1.2:

$$V = V_0 \cdot e^{-n \cdot X}$$

The District has developed their own correlation between SVI and the Vesilind settling velocity parameters V0 and n. The Vesilind parameters for the SVIs adopted herein are summarized in Table 2.13.

Table 2.13 SVI and Vesilind Parameters Based on the District's Correlation

SVI, mL/g	Initial Settling Velocity V0 (ft/s)(1)	Exponent, n (mL/g)(2)
112	40.6	0.4420
150	34.4	0.4078

Notes:
(1) The initial settling velocity was estimated using the District's correlation: $V_0 = 589.37 \cdot SVI^{-0.567}$ where the SVI is in units of mL/g and V_0 has units of ft/hr.
(2) The exponential parameter, n, was calculated using the District's correlation: $n = 0.5428 - 0.0009 \cdot SVI$ where SVI is in units of mL/g n has units of L/g.
ft/s - feet per second.

2.2.4.2 Secondary treatment capacity

The trigger plot for the MMDW condition is depicted in Figure 2.11. This plot compares the measured MMDW primary effluent loads to the projections. As is shown in Figure 2.11, the aeration basins are projected to have sufficient capacity through the year 2032. Given the divergence between the measured and projected loads in recent years, the timing of this improvement is likely conservative. The discrepancy between the modeled projection shown in Figure 2.11 and the measured values is likely due to declining influent $cBOD_5$ loads as shown in Figure 2.12. In addition to the lower influent load, the projections conservatively include the entire $cBOD_5$ load that Intel may discharge as part of their contract. The impact of this conservatism is depicted in Figure 2.12. Removing this conservatism from the influent $cBOD_5$ projection brings the influent $cBOD_5$ more into alignment with the historical primary effluent carbonaceous biochemical oxygen demand (cBOD) loads in 2020, which is when the projections were developed.

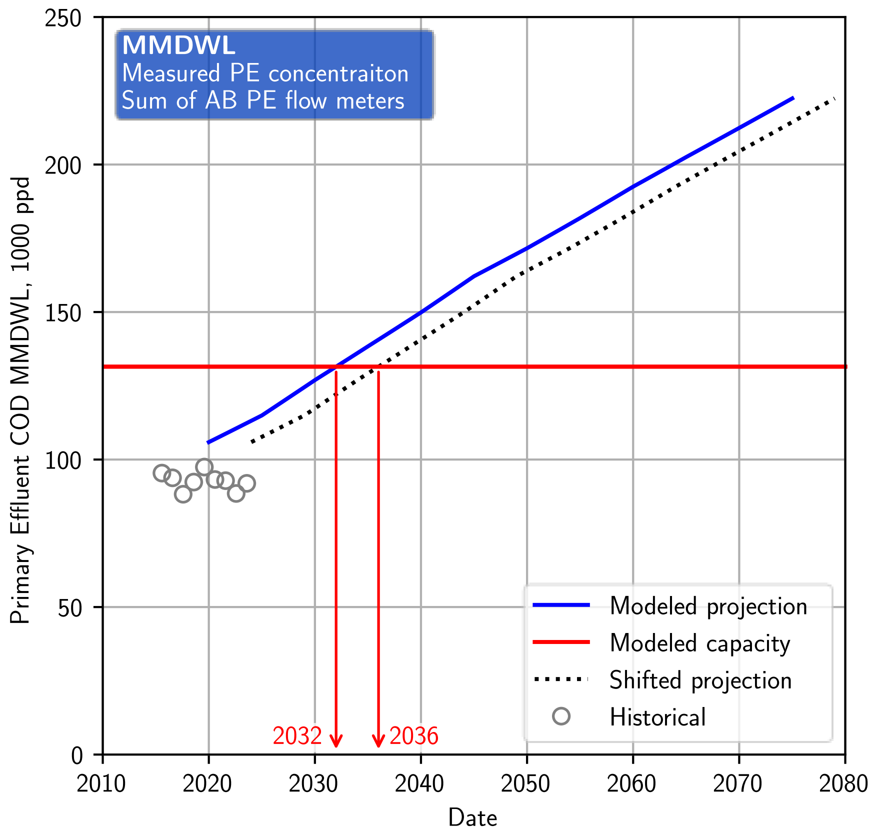

Figure 2.11 Secondary Treatment Trigger Plot

The modeled projection is based on influent loads developed in 2020 and includes the full $cBOD_5$ load that Intel may discharge as part of their contract. The shifted projection is the same projection only shifted later by four years.

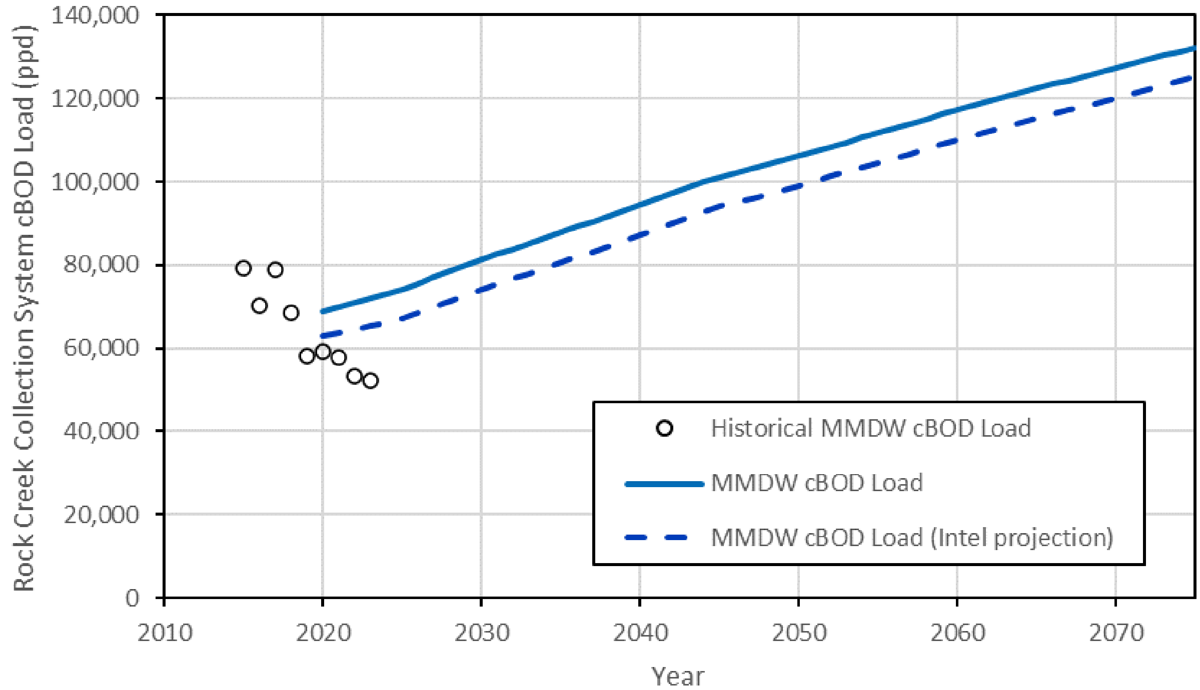

Figure 2.12 Measured and Projected Collection System MMDW $cBOD_5$ Loads

Given the departure between the projected and measured primary effluent COD loads, a trigger year range is appropriate for the secondary treatment process capacity. For the upper bound of the range, the projected primary effluent MMDW COD loads were shifted later by four years (to reflect the constancy in load from the origin of the projections to today). With this shifted projection (shown as the dotted black line in Figure 2.11), a seventh secondary treatment train would be required in 2036.

During the wet weather season, peak primary effluent flows that exceed the capacity of the secondary treatment process may be directed through high-rate clarification. With the MMWW inventory, the peak day flow capacity of secondary treatment is approximately 91 mgd at 2032.

During AWWFs the District desires to have the capacity to remove one basin or one secondary clarifier from service at a time. The peak flow capacity with each unit out of service in the year 2032 (the capacity year based on the original projections and the MMDW primary effluent COD loads) are summarized in Table 2.14.

Table 2.14 Secondary Treatment Peak Day Flow Capacity for Redundancy Criteria

Unit out of service	Peak day flow capacity at 2032 (mgd)
Aeration Basin 1 or 2	99
Secondary Clarifier 1, 2, 3, or 4	104
Aeration Basin 4 or 5	103
Secondary Clarifier 7 or 8	95
Aeration Basin 6 or 7	112
Secondary Clarifier 9 or 10	89

Importantly, the secondary treatment capacities listed above were subject to the hydraulic limitations identified from the last hydraulic model completed as part of the FP2014. This analysis identified a 48 mgd hydraulic capacity limitation in the west secondary effluent distribution structure (excluding RAS), which corresponds to a maximum overflow flow rate of 8 mgd for each of the west secondary clarifiers. The Rock Creek WRRF hydraulic model is currently being updated[7] and the secondary capacities may need to be updated following this analysis.

2.2.5 Tertiary Treatment

Tertiary treatment is required for the Rock Creek WRRF to meet stringent effluent TP and TSS limits. Tertiary treatment consists of tertiary clarification, high-rate clarification, and tertiary filtration. Tertiary clarification has been achieved at Rock Creek through four Claricones. A portion of the secondary effluent (typically from the east secondary treatment trains) is dosed with alum and directed to the tertiary clarifiers in the dry weather season as required to meet the facility's 0.1 mg P/L effluent TP limit.

Two high-rate clarifiers (Actiflo) were installed at the Rock Creek WRRF in 2014 to provide additional tertiary and peak flow treatment capacity. In dry weather conditions, these high-rate clarifiers replaced the historically under-performing west tertiary clarifiers (Secondary Clarifiers 5 and 6) and the west filters (Filters 1 through 4) that previously treated west secondary effluent. Under peak wet weather flow conditions, primary effluent may bypass secondary treatment and be sent directly through Actiflo. Provisions have been made for a third Actiflo train; however, the District has noted diminished tertiary filter performance when effluent from the existing Actiflo trains is filtered.

The Rock Creek WRRF has 10 constant level, mono-media tertiary filters (numbered 5 through 14) located on the east side of the facility. Each of the existing filters has a surface area of 900 square feet and is backwashed with a combination of air and water.

As noted in Section 2.1.3, the District is currently working with the DEQ to clarify their effluent TP limit. The District anticipates that the maximum monthly median effluent TP concentration from May through October will be either 0.1 mg P/L (their current NPDES limit) or 0.5 mg P/L (consistent with the previous MAO). Tertiary treatment requirements differ significantly between these two alternatives, and both were considered below. Additionally, an effluent aluminum limit may be imposed following the United States Environmental Protection Agency's issuance of the aquatic life criteria for aluminum. Given the uncertainty surrounding future tertiary treatment requirements, three scenarios were developed (Table 2.15):

- Scenario A reflects the requirements if the total maximum daily loads (TMDL) is successful and the effluent requirements from the previous MAO are reinstated. In this scenario, tertiary clarification and alum addition are not necessary to meet the effluent TP limit of 0.5 mg P/L. It is assumed that all secondary effluent is directly filtered to meet the bubbled TSS mass load limit.
- Scenario B is the first phase of the District needing to meet the current NPDES permit limit of 0.1 mg P/L. This scenario assumes that while an effluent TP limit of 0.1 mg/L imposed, an effluent aluminum limit is not yet in effect. Based on historical performance with Actiflo, the facility will be capable of meeting the TP limit, but will have a high effluent aluminum concentration if not filtered. This scenario was developed to provide the District with an operational strategy until tertiary filtration

[7] Carollo Engineers, Inc. (Forthcoming). Technical Memorandum 9 - Rock Creek Hydraulic Capacity Assessment, West Basin Facility Plan Project 7054.

capacity became an issue with Scenario C (below). Tertiary alum addition will be necessary in this scenario; however, effluent from the high-rate clarifiers does not necessarily need to be filtered.

- Scenario C reflects the current NPDES permit limit for TP and assumes an effluent aluminum limit is also imposed. If enacted, the District anticipates this will require all the secondary effluent to be filtered. Given the District's historical difficulty in filtering high-rate clarifier effluent, it is assumed that the west secondary effluent is directly filtered (i.e., the Actiflo process is only used to dose coagulant).

Table 2.15 Future Tertiary Treatment Requirements by Potential Permit Limit

Parameter	Scenario A	Scenario B	Scenario C
Motivation	Successful TMDL Revision	Necessary to meet 0.1 mg P/L in 2025	Requirement to meet 0.1 mg P/L and future Al limit
Effluent TP Limit	0.5 mg P/L	0.1 mg P/L	0.1 mg P/L
Aluminum Limit	N/A(1)	None(2)	Enacted
TSS Limit	N/A(3)	N/A(3)	N/A(3)
Tertiary Treatment Process Operation			
Claricones	Not operating	Operating	Operating
East Direct Filtration	Not operating	Operating	Operating
Actiflo	Not operating	Full Actiflo operation with effluent to CCB 1/2	Coagulation + flocculation operation only with effluent to east granular media filters
East Granular Media Filters	Operating	Operating	Operating

Notes:
(1) An aluminum (Al) limit would likely not impact Scenario A as the 0.5 mg/L effluent TP limit could be achieved without tertiary alum addition.
(2) It may be possible to satisfy an Al limit in the near term with this scenario. Given its increasing reliance on Actiflo and the high alum dose that would be necessary to meet the 0.1 mg P/L, it was not considered likely that this Scenario would be able to meet an Al limit through buildout.
(3) The effluent TSS mass load limit was not treated as a driver for future tertiary treatment in this analysis (section 2.1.3).
CCB - chlorine contact basin.

2.2.5.1 Tertiary clarification and high-rate clarification

The design criteria adopted for tertiary clarification and high-rate clarification are summarized in . The MMDWF condition was adopted for tertiary treatment capacity evaluations. In the 2009 Facility Plan, the east side tertiary clarification capacity of 20 mgd (5 mgd per Claricone) could be combined with 10 mgd of direct filtration for a total east side equivalent tertiary clarification capacity of 30 mgd. In recent years the District has found that filter effluent performance has improved and it may be possible to direct filter a higher flow allowing for a larger equivalent east tertiary clarification capacity. The District plans to test the capacity of the direct filtration during the summer of 2025 to determine if a higher direct filtration flow can be achieved.

Table 2.16 Tertiary Clarification and High-Rate Clarification Design Criteria

Flow/Load Condition	Design Criteria	Redundancy Criteria	Performance Assumption	Reference
MMDWF	▪ Capacity split between the following: » Actiflo: 25 gpm/sf (Scenario B). » Claricone: 5 mgd per unit (Scenario B and C).	▪ All units in service (units can be taken out of service during the wet weather season)	▪ Tertiary effluent TSS concentrations: » HRC: 7 mg/L to 10.8 mg/L. » Claricone: 7.2 mg/L.	▪ Tertiary clarification bypass and Claricone capacity from FP2014. ▪ HRC SOR calculated from design criteria in Tertiary Treatment Project drawings. ▪ Tertiary effluent TSS concentration based on median summer values from 2015-2019. ▪ HRC 7 mg/L from Tertiary Treatment Project.
MDWWF	▪ Actiflo: 37 gpm/sf.	▪ All units in service.	▪ N/A	▪ HRC SOR calculated from design criteria in Tertiary Treatment Project drawings.

Notes:
gpm/sf – gallons per minute per square foot; HRC - high-rate clarification.

While the District has observed issues filtering the effluent from the west side high-rate clarification process (Actiflo), it is able to achieve an effluent TP concentration of less than 0.1 mg/L without filtration of this stream. Due to the concerns over a possible aluminum limit, the District does not typically operate in this manner, but could if tertiary capacity is required before an aluminum limit is imposed. If the District was able to filter effluent from the existing Actiflo units, this could provide up to an additional 30 mgd of MMDW tertiary clarification capacity.

Figure 2.13 compares the capacity of the Actiflo process to the secondary effluent flow that would require treatment. This figure shows that the will reach capacity by 2040. As discussed previously, the District is planning on testing the direct filtration capacity of the east filters during the summer of 2025 to see if the improvements in filter performance could allow higher direct filtration flows, potentially offsetting capacity losses if the Actiflo process cannot be used due to filterability issues and concerns over meeting effluent aluminum limits.

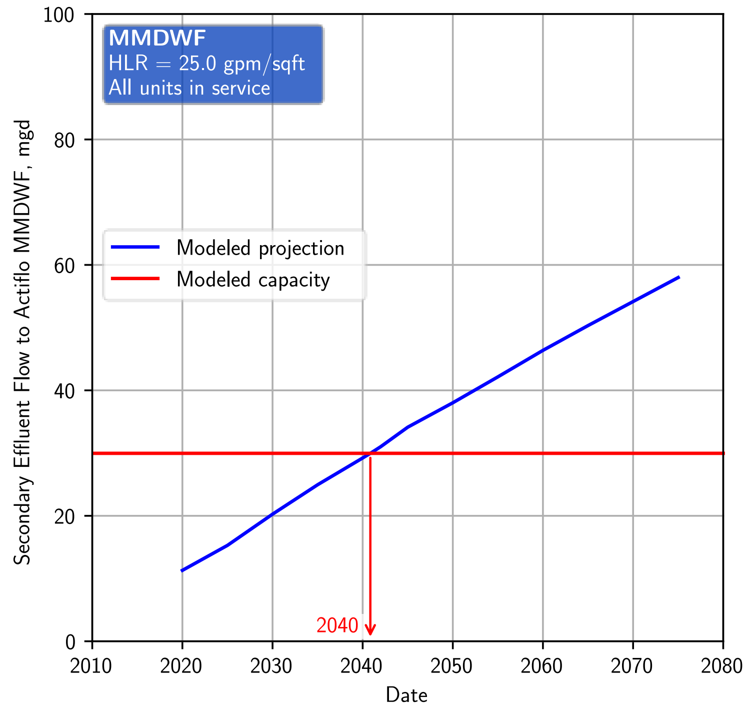

Figure 2.13 High-Rate Clarification Secondary Effluent Trigger Plot

The Actiflo process serves a dual role and provides capacity for 45 mgd primary effluent treatment during the wet weather season (MDWWF and MHWWF). Figure 2.14 compares the projected MDWWF and MHWWF primary effluent bypass to the capacity of the Actiflo process. These figures show a saw tooth pattern in the projected primary effluent bypass which reflects the step-wise addition of secondary treatment trains to address capacity constraints. As is shown in Figure 2.14:

- The projected MDWWF primary effluent bypass remains less than the capacity of the Actiflo process through the planning period.
- The projected MHWWF primary effluent bypass exceeds the capacity of the high-rate clarification process for the entire planning period. The District's goal for the last two facility plans has been to treat all flows through peak day flows. Coupled with future secondary expansion, the two existing Actiflo units will provide sufficient capacity to meet that objective through the planning period (panel A in Figure 2.14). Two additional Actiflo units would be required to treat MHWWF through approximately 2068. Importantly, the secondary clarification capacities used to determine the primary effluent MHWWF bypass may be conservative as they are the same as those used to determine MDWWF (SOR = 842 gpd/sf for secondary clarifiers 1 through 4, 1200 gpd/sf for Secondary Clarifiers 7 and 8, and 1500 gpd/sf for Secondary Clarifiers 9 and 10). It is likely that higher flow rates could be passed through secondary treatment for short durations if not hydraulically limited. As noted in Section 2.2.4.2, the maximum SOR for Secondary Clarifiers 1 through 4 is based on a hydraulic limitation identified in the previous facility plan. In additional to refining these SORs based on the updated hydraulic model, clarifier stress testing is recommended to determine the peak hour flow capacity of the secondary clarifiers.

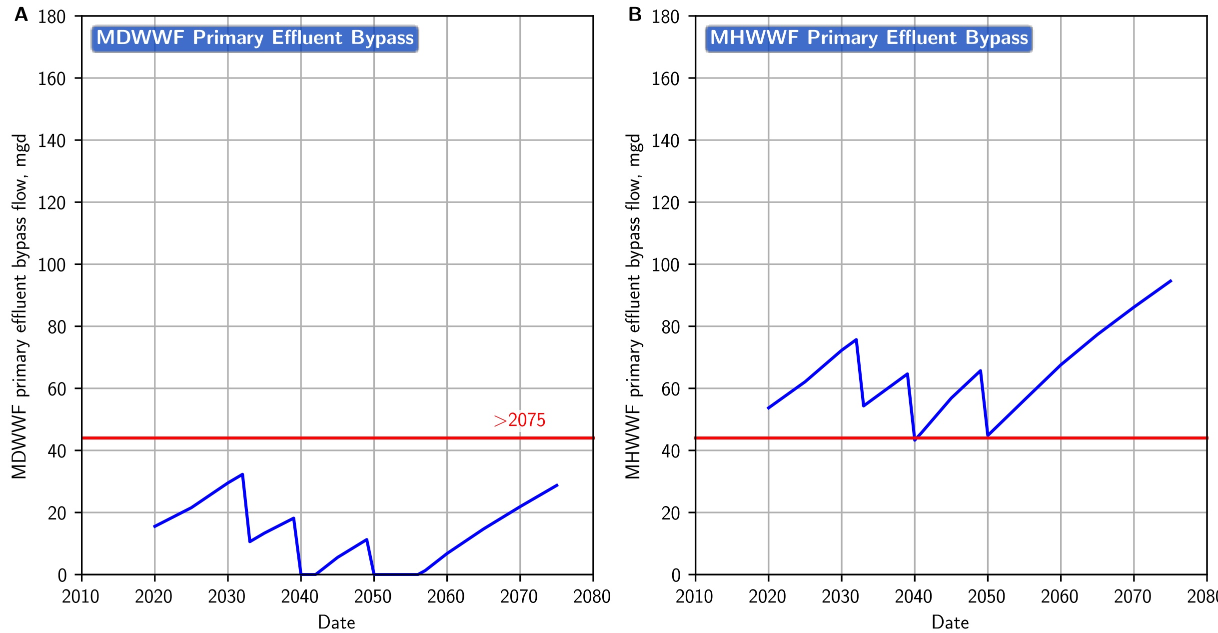

Figure 2.14 High-Rate Clarification Primary Effluent Bypass Trigger Plots

2.2.5.2 Tertiary Filtration Design Criteria

The tertiary filter design criteria (summarized in Table 2.17) reflect the original tertiary filter design criteria (hydraulic loading rate [HLR]) and those adopted in the previous facility plan. Tertiary filter capacity is evaluated based on the MMDWF and ADWF for the redundancy criteria. The MDDWF condition was not used to establish capacity since the District has not filtered the entire secondary effluent flow under the MDDWF condition.

Table 2.17 Tertiary Filtration Design Criteria

Flow/Load Condition	Design Criteria	Redundancy Criteria	Performance Assumption	Reference
MMDWF	▪ HLR = 4 gpm/sf ▪ SLR = 0.45 ppd/sf	All units in service	Effluent TSS: ▪ <0.6 mg/L (Scenario A) ▪ <1.5 mg/L (Scenarios B and C)	▪ HLR calculated from Phase 3 design criteria. ▪ SLR from 2014FP. ▪ Effluent TSS: » Scenario A is the median of the 2020–2022 measured dry weather effluent TSS without alum addition. » Scenarios B and C is the median of the 2015–2019 measured dry weather effluent TSS with alum addition.

Flow/Load Condition	Design Criteria	Redundancy Criteria	Performance Assumption	Reference
ADWF	▪ HLR = 4 gpm/sf ▪ SLR = 0.45 ppd/sf	1 filter out of service	Effluent TSS: ▪ <0.6 mg/L (Scenario A) ▪ <1.5 mg/L (Scenarios B and C)	▪ HLR calculated from Phase 3 design criteria. ▪ SLR from 2014FP. ▪ Effluent TSS: » Scenario A is the median of the 2020–2022 measured dry weather effluent TSS without alum addition. » Scenarios B and C is the median of the 2015–2019 measured dry weather effluent TSS with alum addition.

2.2.5.3 Tertiary Filtration Capacity

Tertiary filtration capacity was evaluated based on the design criteria established in Table 2.17. The trigger plots for Scenario A are shown in Figure 2.15 and Figure 2.16 and show that the existing filters have sufficient capacity through the year 2032. For Scenario A where tertiary alum addition is not required but the entire flow needs to be filtered through the east filters, the existing filtration process is limited by the MMDWF HLR of 4 gpm/sf.

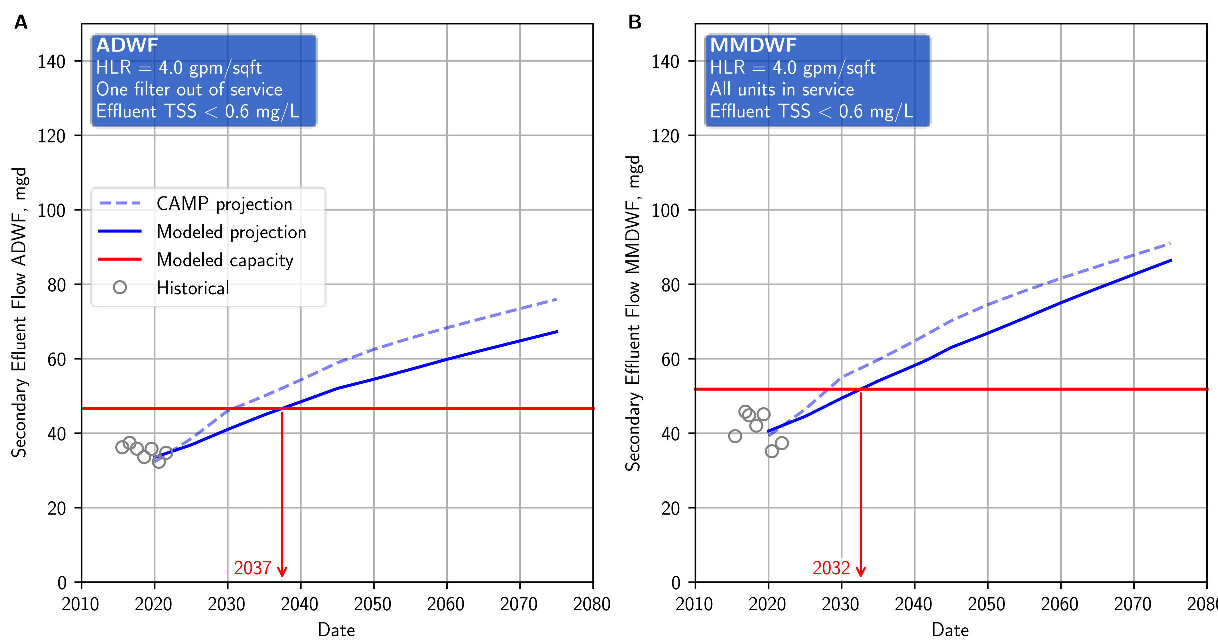

Figure 2.15 Tertiary Filtration HLR Trigger Plots for Scenario A

CAMP® projections were based on the original Intel projections which contributed a flow of 12.9 mgd by 2045. The modeled projection uses the updated Intel projection, which assumes a constant flow of 7.2 mgd from 2025 through buildout. See Section 2.1.1 for additional information.

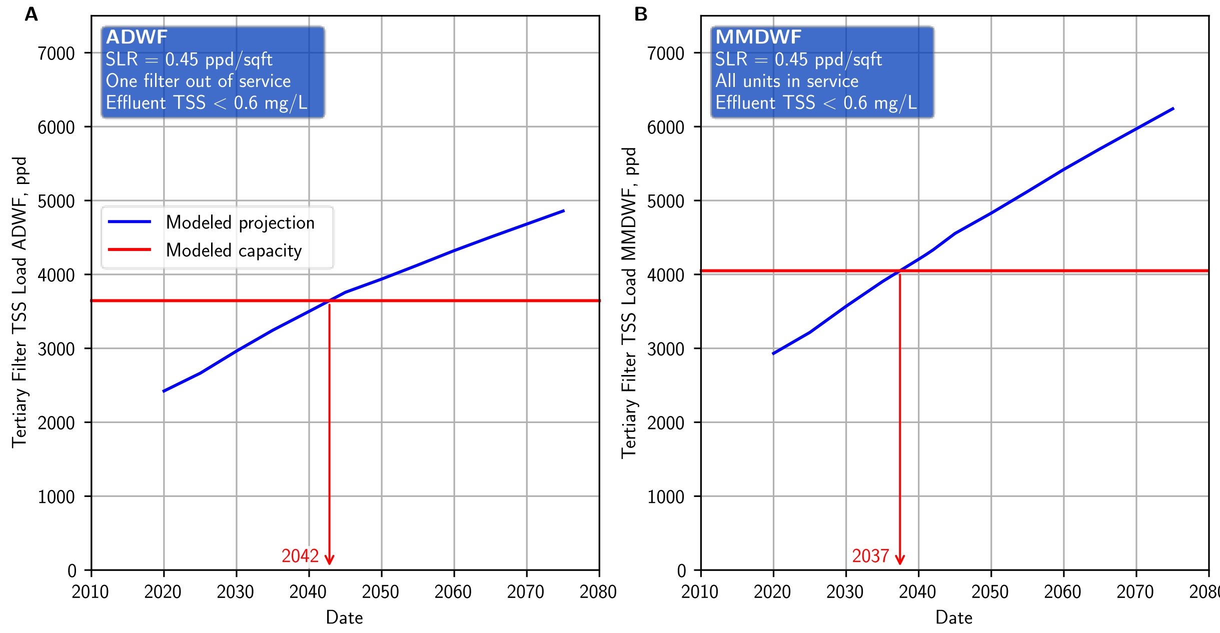

Figure 2.16 Tertiary Filtration SLR Trigger Plots for Scenario A

The trigger plots for Scenario B are shown in Figure 2.17 and Figure 2.18 and show that the existing filters have sufficient capacity until 2051.

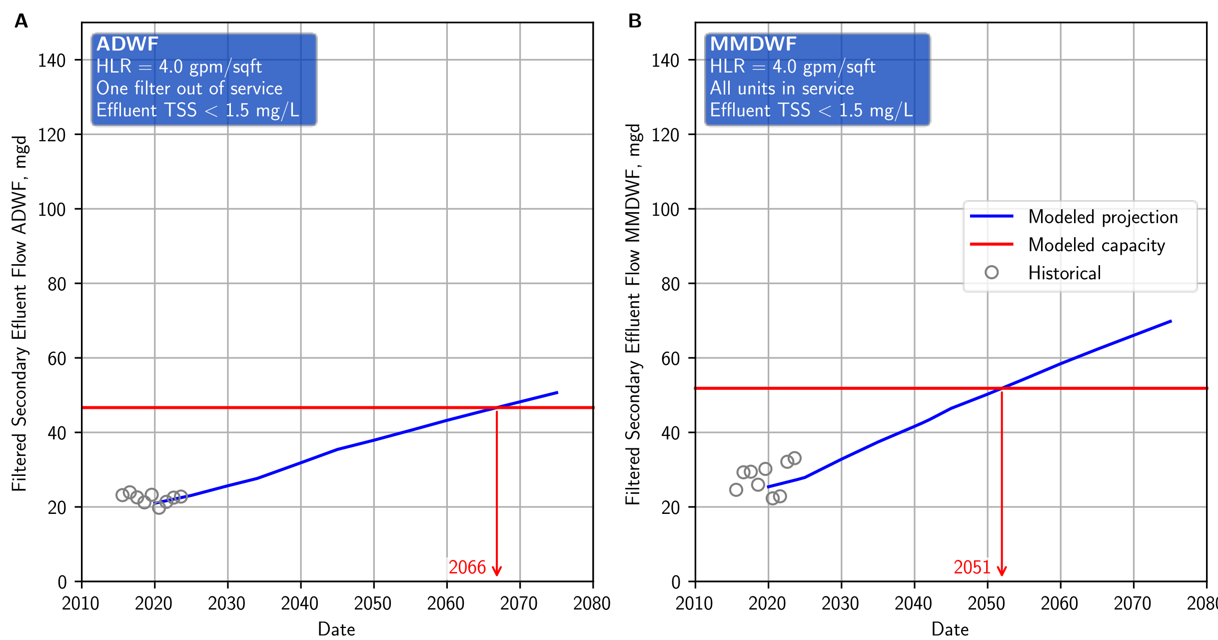

Figure 2.17 Tertiary Filtration HLR Trigger Plots for Scenario B

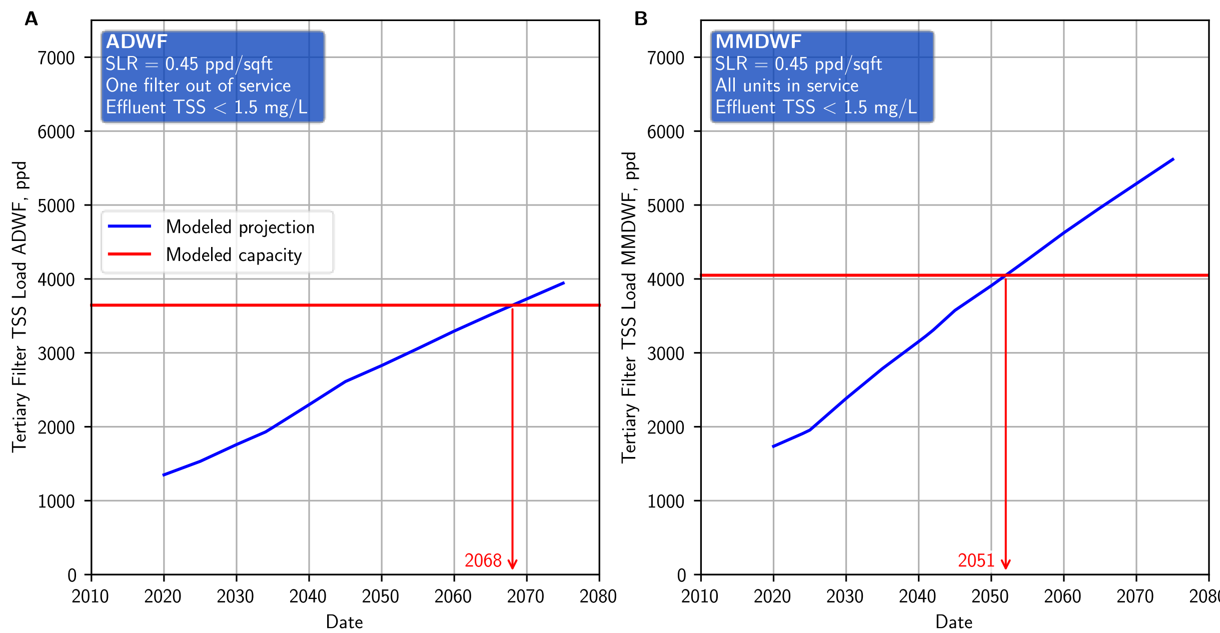

Figure 2.18 Tertiary Filtration SLR Trigger Plots for Scenario B

The trigger plots for Scenario C are shown in Figure 2.19 and Figure 2.20. For Scenario C, two filter influent TSS load projections have been developed. The upper projection assumes the load-weighted 92nd percentile west secondary effluent concentration (16.5 mg/L), the median east secondary effluent TSS concentration (4.0 mg/L), and the historical median direct filtration alum dose (19 mg/L). The lower projection assumes the median east and west secondary effluent TSS concentrations (4.0 mg/L and 8.8 mg/L, respectively) and a lower direct filtration alum dose (15 mg/L) that the District has targeted recently. These figures show that if the District needed to meet an effluent TP limit of 0.1 mg/L while the west secondary effluent TSS concentrations were poor (the upper projection), the MMDW SLR to the filters would currently exceed 0.45 ppd/sf. If the west secondary effluent is closer to the median and the currently targeted direct filtration alum dose was able to achieve an overall effluent TP of 0.1 mg/L, the SLR could stay below 0.45 ppd/sf (the lower projection). As shown, the tertiary filters would remain under the 0.45 ppd/sf limit through 2032 with one filter out of service and ADWFs and 2027 with all units in service under MMDWFs.

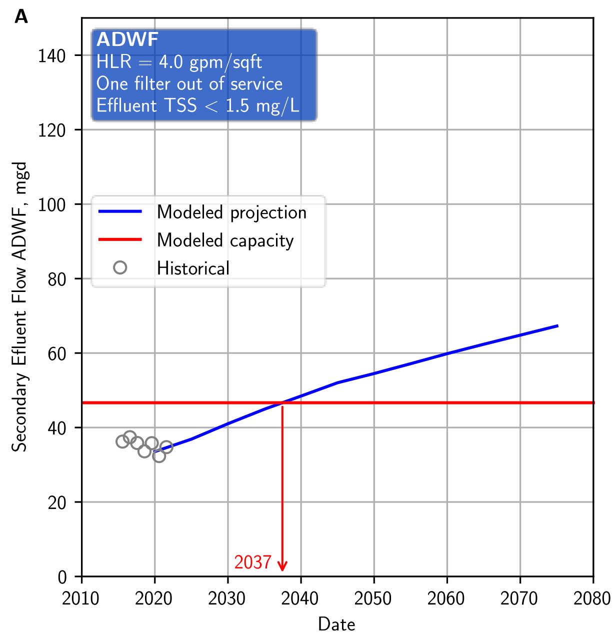

Figure 2.19 Tertiary Filtration HLR Trigger Plots for Scenario C

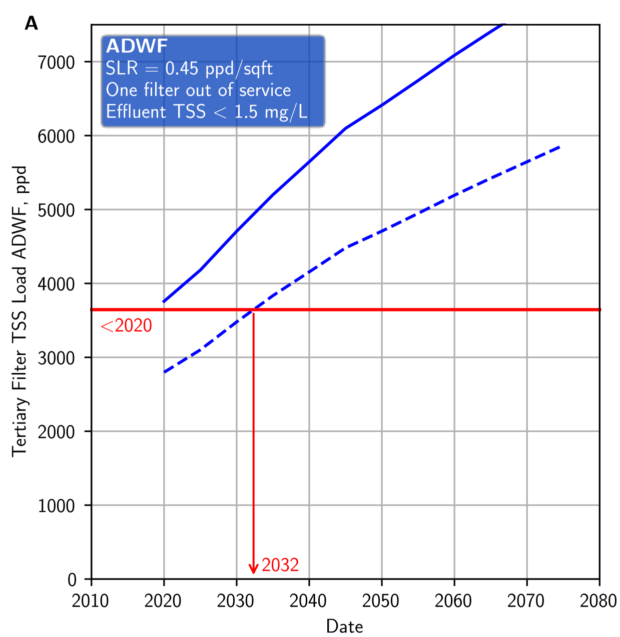

Figure 2.20 Tertiary Filtration SLR Trigger Plots for Scenario C

The upper projections assumed the median east secondary effluent TSS concentration (4.0 mg/L), the load-weighted 92nd percentile west secondary effluent TSS concentration (16.5 mg/L), and the median direct filtration alum dose (19 mg/L). The lower projections depict the median east and west secondary effluent TSS concentrations (4.0 mg/L and 8.8 mg/L, respectively) and the more recent typical direct filtration alum dose (15 mg/L).

Table 2.18 summarizes the tertiary filter requirements for each scenario. If the District is required to meet an effluent TP limit of 0.5 mg/L (Scenario A), tertiary alum addition is not required, and additional tertiary filtration capacity would be required by 2032. If the District is required to meet an effluent TP limit of 0.1 mg/L (Scenario C), the existing filtration process could only provide sufficient capacity to treat the entire east flow through the year 2025 if both the east and west secondary effluent TSS concentrations are similar to historic median concentrations and the historic median direct filtration alum dose is targeted. If secondary effluent TSS concentrations exceed historic median concentrations, the District could opt to use the Actiflo process to treat the west secondary effluent (Scenario B). Under this operating mode, the Actiflo effluent would bypass filtration which would allow the SLR to stay below the design criteria of 0.45 ppd/sf through the year 2028.

Table 2.18 Future Tertiary Filter Requirements by Potential Permit Limit

Parameter	Scenario A	Scenario B	Scenario C
Trigger Year Current	2032	2051	<2020–2032
Trigger Year Limitation	HLR = 4 gpm/sf	HLR = 4 gpm/sf SLR = 0.45 ppd/sf	SLR = 0.45 ppd/sf

2.2.6 Disinfection

Disinfection is accomplished at the Rock Creek WRRF with chlorine in up to three CCBs, (Table 2.19). CCBs 1 and 2 are located on the west side of the facility and CCB 3 is located on the east side of the facility. Recently, a chloramination system has been installed for CCB 3 to reduce disinfection byproducts during the dry weather season when the secondary treatment system is fully nitrifying. Disinfected effluent flows through a dechlorination/post-aeration basin prior to discharge.

Table 2.19 Disinfection Information

Parameter	CCB 1	CCB 2	CCB 3
Volume, gallons	312,500	312,500	703,000
Length-to-width ratio	38:1	38:1	80:1

The design criteria (Table 2.20) require a minimum retention time of 30 minutes with all units in service under the MMDWF. Redundancy is provided under the ADWF condition when flows are lower. Notably, only one CCB is available on the east side; as such, the ADWF redundancy criterion was not evaluated for CCB 3. Under peak hour flows, higher chlorine doses may be administered to offset lower retention times. A minimum retention time of 10 minutes has been adopted for the MHWWF condition.

Table 2.20 Disinfection Design Criteria

Flow/Load Condition	Design Criteria	Redundancy Criteria	Performance Assumption	Reference
MHWWF	HRT = 10 min	All units in service	N/A	FP2014
MMDWF	HRT = 30 min	All units in service	N/A	FP2014
ADWF	HRT = 30 min	Largest unit out of service	N/A	FP2014

Notes:
HRT - hydraulic retention time.

Disinfection capacity depends on the secondary, tertiary, and primary effluent bypass flow distribution. As shown in Figure 2.1, the District has significant flexibility to shift flows between the east and west sides of the facility. Given this flexibility, it was assumed that secondary and tertiary effluent flows could be redirected as needed to maintain the design criteria. Based on the criteria outlined in Table 2.20, the overall disinfection capacity is 194 mgd under MHWWF, 65 mgd under MMDWF, and 49 mgd with either CCB 1 or CCB 2 out of service under ADWF (Table 2.21). Figure 2.21 depicts the disinfection trigger plots for all conditions considered. The MHWWF criteria limits the capacity of the disinfection process and the system is projected to provide sufficient capacity through the year 2036.

Table 2.21 Disinfection Capacity

Parameter	MHWWF (Total)	MMDWF (Total)	ADWF (Firm)
Total disinfection influent flow, mgd	194	65	49
Estimated capacity year	2036	2050	2043

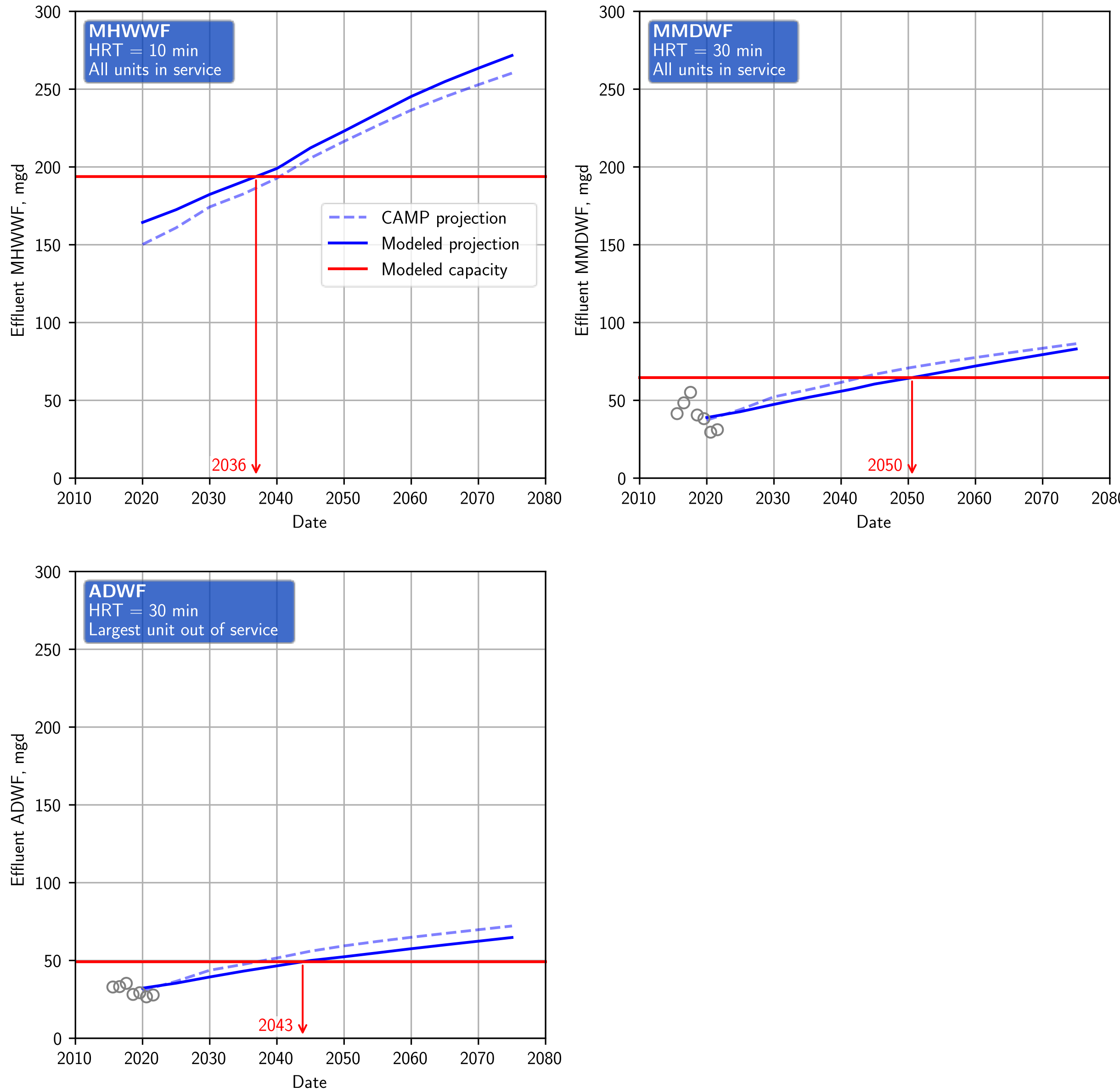

Figure 2.21 Disinfection Trigger Plots

2.3 Solids Treatment Process Capacity

The Rock Creek WRRF solids stream process is shown schematically in Figure 2.1. The capacities of each solid stream process—including primary sludge thickening, WAS thickening, anaerobic digestion, and phosphorus recovery—are described below.

2.3.1 Primary Sludge Thickening

A UFAT process was installed to ferment and thicken primary solids. The system consists of four 50 foot diameter gravity thickeners, which may be operated in either thickening mode or fermentation/thickening (UFAT) mode. In the UFAT mode, primary solids are first fermented in one gravity thickener. The thickened sludge and overflow from the first gravity thickener are combined and sent to the second gravity thickener where the fermented primary sludge is thickened. Historically, the District has operated the system in UFAT mode during the dry weather season to generate volatile fatty acids to support biological phosphorus removal in the aeration basins. Thickening mode operation is typically used in the wet weather season when stringent phosphorus limits are no longer in effect.

2.3.1.1 Primary Sludge Thickening Design Criteria

The design criteria (Table 2.22) are based SLRs which are driven by gravity thickener performance. Consistent with the capacity evaluation completed for the Durham Facility, an SLR of 25 ppd/sf has been adopted for each condition. As noted above, the District operates the primary solids thickening process typically in the UFAT mode during the dry weather season, which results in reduced thickening capacity. Operation can transition to thickening mode under high primary solids loads (maximum week dry weather [MWDW]) as required. Finally, the redundancy criterion is specified under lower, ADW load conditions.

Table 2.22 Primary Solids Thickening Design Criteria

Flow/Load Condition	Design Criteria	Redundancy Criteria	Performance Assumption	Reference
MWDW Primary Sludge TS Load	▪ SLR = 25 ppd/sf	▪ All units in service in thickening mode	▪ TPS = 5% ▪ Capture = 90% (overall)	▪ SLR from Durham 2020 Facility Plan ▪ Measured average capture = 85% which includes TS reduction in fermenter, this works out to 5% TS reduction in the fermenter coupled with 89% capture on the thickener.
MMDW Primary Sludge TS Load	▪ SLR = 25 ppd/sf	▪ All units in service in fermenting/thickening mode	▪ TPS = 5% ▪ Capture = 90% (overall)	▪ SLR from Durham 2020 Facility Plan ▪ Measured average capture = 85% which includes TS reduction in fermenter, this works out to 5% TS reduction in the fermenter coupled with 89% capture on the thickener.
ADW Primary Sludge TS load	▪ SLR = 25 ppd/sf	▪ One unit out of service, one unit in thickening mode, remaining units in fermenting/thickening mode	▪ TPS = 5% ▪ Capture = 90% (overall)	▪ SLR from Durham 2020 Facility Plan ▪ Measured average capture = 85% which includes TS reduction in fermenter, this works out to 5% TS reduction in the fermenter coupled with 89% capture on the thickener.

Notes:
TPS - thickened primary sludge; TS - total solids.

Historical operating data for the primary solids thickening system from 2015 through 2021 are summarized in Figure 2.22. The median TPS concentration shown in Figure 2.22 is approximately 4.7 percent. Since the low TPS concentrations has been attributed to mechanical issues that have recently been resolved; the District is comfortable assuming a 5 percent TPS concentration in this plan.

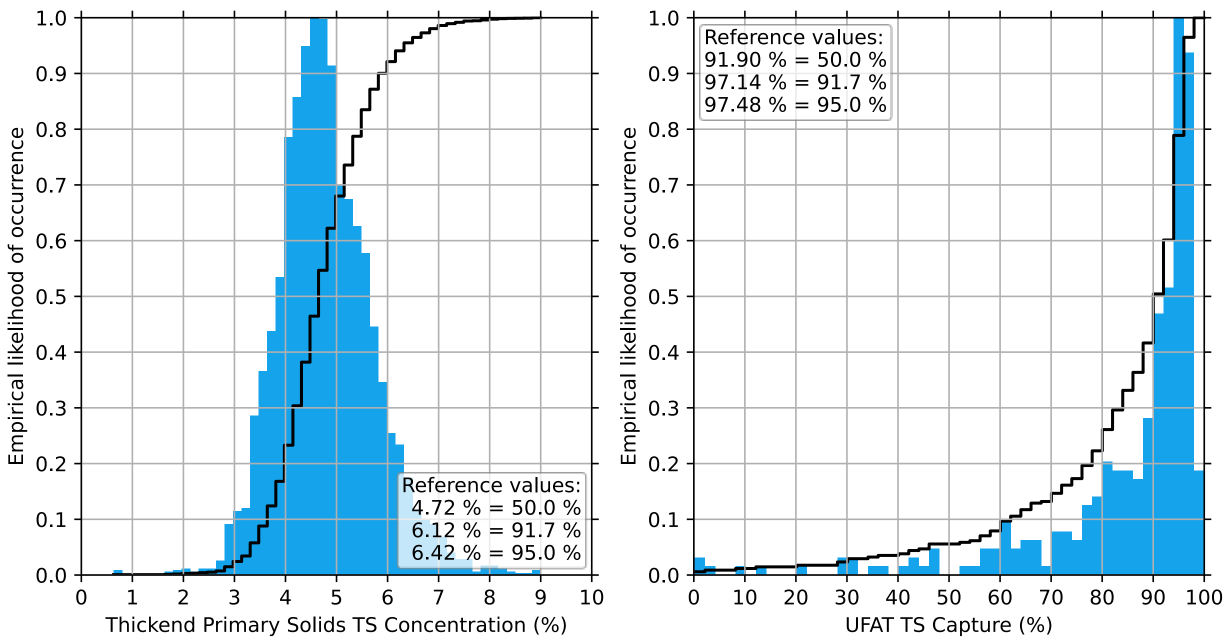

Figure 2.22 Historical Primary Solids Thickening Performance

As shown in Figure 2.22, capture in the primary solids thickening process has been historically variable. While the median of dry weather data from 2015 through 2021 is greater than 90 percent, the mean is approximately 85 percent and 25 percent of the data are below 82 percent. Capture in the primary solids thickening process has a significant impact on secondary treatment capacity given that the unsettled solids in the gravity thickener are conveyed to the aeration basins via the VFA Feed stream.

A TSS removal of 90 percent (roughly consistent with the median historical performance) was adopted for the current capacity evaluation. Given the significant impact primary solids thickening capture has on secondary treatment capacity, however, the District has elected to investigate potential underlying causes for the low capture and identify potential approaches for improvement.

2.3.1.2 Primary Sludge Thickening Capacity

Based on the design criteria established in Table 2.22, the primary solids thickening process has a primary solids capacity of 49,100 ppd for each unit operated as a gravity thickener. This translates to primary solids capacity of 98,200 ppd in ADW, MMDW, and MWDW in UFAT mode. For gravity thickening mode, the primary solids capacity is 196,400 ppd (Table 2.23).

Table 2.23 Primary Sludge Thickening Capacity

Parameter	ADW (Firm)	MMDW (Total)	MWDW (Total)
Operational mode	Three units in service, one unit in thickening mode, remaining units in UFAT mode	Four units in service, UFAT	Four units in service, thickening mode
Primary solids load capacity, ppd	98,200	98,200	196,400
Estimated capacity year	2041-2045	**2029–2033**(1,2)	2064-2071

Notes:
(1) Trigger years set in bold occur in the next ten years (2024–2034).
(2) Range reflects the projected primary solids load (2028) and a 5 percent reduction in the primary solids load to better align with historical data.

Figure 2.23 shows the primary sludge thickening trigger plot for each primary solids load condition. As shown, an additional gravity thickener would be needed in 2029 to meet the MMDW criteria. However, the primary solids load projections are conservative relative to historical data. As was identified in the process model calibration and validation efforts,[8] the measured primary clarifier flow and mass balances have not historically closed within the targeted 5 percent to 10 percent. In the model calibration and validation efforts, this resulted in primary solids loads that were higher than measured. Given this known limitation, a second projection was evaluated for the MMDW condition which reduced the primary solids load by 5 percent to bring the primary solids load projections into alignment with historical data. Under this reduced projection, the MMDW condition is still limiting; however, the trigger year is pushed to 2033.

[8] Carollo Engineers, Inc. (2023). Technical Memorandum 3 - West Basin Treatment Modeling Documentation.

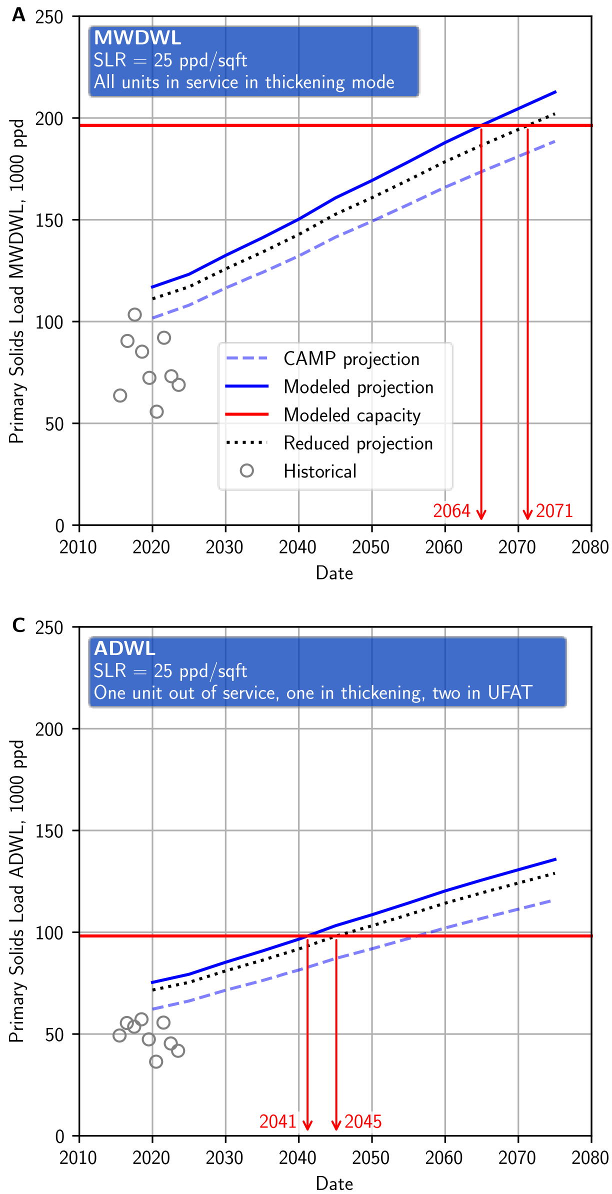

Figure 2.23 Primary Sludge Thickening Trigger Plots

The CAMP® projections were with lower recycle solids loads than in the modeled projections, due to a lower VSR in the digesters (55 percent vs. 59 percent), higher TWAS capture (96 percent vs. 95 percent), and exclusion of the claricone backwash. Additionally, the CAMP® projections did not include alum solids or the precipitation of colloidal material in the primary clarifiers resulting from primary alum addition (which resulted in an 8 percent increase in primary sludge load). The reduced projection are the modeled projections, reduced by 5 percent to reflect historical error in the primary clarifier mass balance.

2.3.2 WAS Thickening

Waste activated sludge (WAS) thickening was upgraded as part of the primary solids thickening and phosphorus release upgrades. The system may be operated as a single stage to produce thickened WAS (TWAS) or in two stages to produce twice-thickened WAS (TTWAS) from TWAS. Two-stage operation is the Waste Activated Sludge Stripping to Recover Internal Phosphate (WASSTRIP) process, wherein the TWAS is stored in an anaerobic release tank to release stored phosphate for subsequent recovery as struvite. In general, two stage operation is only used in the dry weather season when the phosphorus limits are in effect.

The system consists of four gravity belt thickeners (GBT). GBTs 1 and 2 are each 2-meter wide and GBTs 3 and 4 are each 3-meter wide. In two-stage operation, WAS is thickened to TWAS on GBTs 3 and 4 and TWAS is thickened to TTWAS on GBTs 1 and 2. In single stage operation, either set of GBTs may be used to thicken the WAS prior to digestion.

2.3.2.1 WAS Thickening Design Criteria

The design criteria for WAS thickening (Table 2.24) are based on hydraulic and solids loading rates for the GBTs at each stage with values taken from the design criteria for the WAS thickening project. Dry and wet season conditions are evaluated based on typical operation in those seasons. Redundancy is provided in the wet season when single stage operation allows GBTs to be serviced.

Table 2.24 WAS Thickening (First and Second Stage) Design Criteria

Flow/Load Condition	Design Criteria	Redundancy Criteria	Performance Assumption	Reference
MMDW: ▪ WAS or TWAS flow. ▪ WAS or TWAS TS load.	▪ HLR = 150 gpm/m. ▪ SLR = 1000 lb/m/hr.	▪ All units in service. ▪ 7-days/week 24-hours/day operation. ▪ Two stage operation.	▪ TWAS = 3.3%. ▪ TTWAS = 6%. ▪ TWAS capture = 90%. ▪ TTWAS capture = 74% (overall) and 90% on the second. stage GBT	▪ HLR, SLR from GBT project. ▪ Median TWAS TS = 3.2%, District target = 3.3%. ▪ Median TTWAS TS = 5.7%, District target = 6%. ▪ TWAS median capture = 89%, rounded up to 90%. ▪ TTWAS measured median capture = 74%. This calculation is based on the measured WAS load. If we assume a capture of 90% for the first and second stage GBTs and 7% TS reduction through WASSTRIP, the resulting “capture” = 75%.
MWWW: ▪ WAS flow. WAS TS load.	▪ HLR = 150 gpm/m. ▪ SLR = 1000 lb/m/hr.	▪ 1 unit out of service. ▪ 7 days/week 24 hours/day operation. ▪ One stage operation with bypassing of WAS phosphorus release.	▪ TWAS = 6%. ▪ TWAS capture = 90%.	▪ HLR, SLR from GBT project. ▪ Same captures and TS concentration as the MMDW condition.

Notes;
gpm/m - gallons per minute per meter; lb/m/hr – pounds per meter per hour.

Table 2.25 summarizes the design criteria for the WASSTRIP release tank. The HRT design criterion was developed from bench testing completed by the District as part of the WAS thickening and P-release upgrades. While the provision has been included to introduce VFAs from the UFAT process to the WASSTRIP tank to enhance phosphorus release, the District has not historically operated in this manner. The 24 hour HRT design criterion assumes no supplemental volatile fatty acids are added to the WASSTRIP tank.

Table 2.25 WAS Phosphorus Release Design Criteria

Flow/Load Condition	Design Criteria	Redundancy Criteria	Performance Assumption	Reference
MMDW TWAS flow	HRT = 24 hours	▪ All units in service. ▪ Unit can be taken out of service in the winter.	N/A	

Historical operating data for the WAS thickening system from 2015 through 2019 are depicted in Figure 2.24. As shown, the assumed performance for both TWAS and TTWAS concentrations (3.3 percent and 6 percent, respectively) both fall near the median of their respective historical distributions. Importantly, the variability reflected in the TTWAS concentration reflects changes to GBT operation to achieve a targeted TS concentration (the District typically operates with a targeted combined anaerobic digester feed concentration). Higher TTWAS concentrations than assumed for the current analysis have been achieved historically.

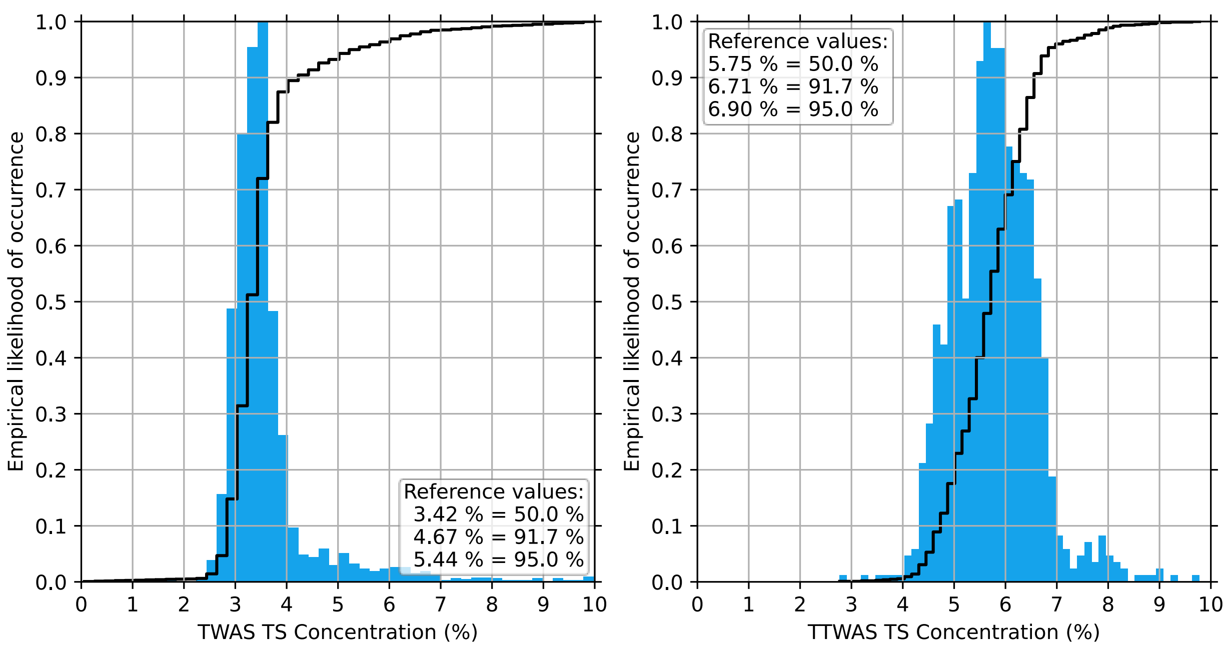

Figure 2.24 Historical Dry Weather Thickened and Twice-Thickened WAS Concentrations

2.3.2.2 WAS Thickening Capacity

Based on the design criteria in Table 2.24, the first thickening stage (pre-thickening) has a WAS capacity of 1.296 mgd or 144,000 ppd. The second stage has a TWAS capacity of 0.864 mgd or 96,000 ppd in two-stage operation and WAS capacity of 1.512 mgd or 168,000 ppd in single stage operation. Note this assumes one of the unused GBTs 3 and 4 may also be used to thicken WAS prior to digestion. Finally, the WASSTRIP release tank has a TWAS capacity of 0.196 mgd (Table 2.26).

Table 2.26 WAS Thickening Capacity

Parameter	MMDW (Total)	MWWW (Firm)
TWAS Thickening (pre-thickening)		
WAS flow, mgd	1.296	N/A
Estimated capacity year	> 2075	N/A
WAS load, ppd	144,000	N/A
Estimated capacity year	> 2075	N/A
TWAS Thickening (post-thickening)		
WAS flow, mgd	N/A	1.512
Estimated capacity year	N/A	2072
WAS load, ppd	N/A	168,000
Estimated capacity year	N/A	> 2075
TTWAS Thickening (post-thickening)		
TWAS flow, mgd	0.864	N/A
Estimated capacity year	> 2075	N/A
TWAS load, ppd	96,000	N/A
Estimated capacity year	> 2075	N/A
WASSTRIP Tank		
TWAS flow, mgd	0.196	N/A
Estimated capacity year	2040	N/A

The WAS thickening trigger plots are depicted in Figure 2.25 (pre-thickening), Figure 2.26 (WASSTRIP release tank), and Figure 2.27 (post-thickening). As shown, sufficient GBT capacity is available through 2072. The WASSTRIP release tank has the earliest capacity limitation in 2040. The addition of VFAs from the UFAT process would shorten the WASSTRIP HRT requirement which would result in the WASSTRIP process having sufficient capacity past the year 2040.

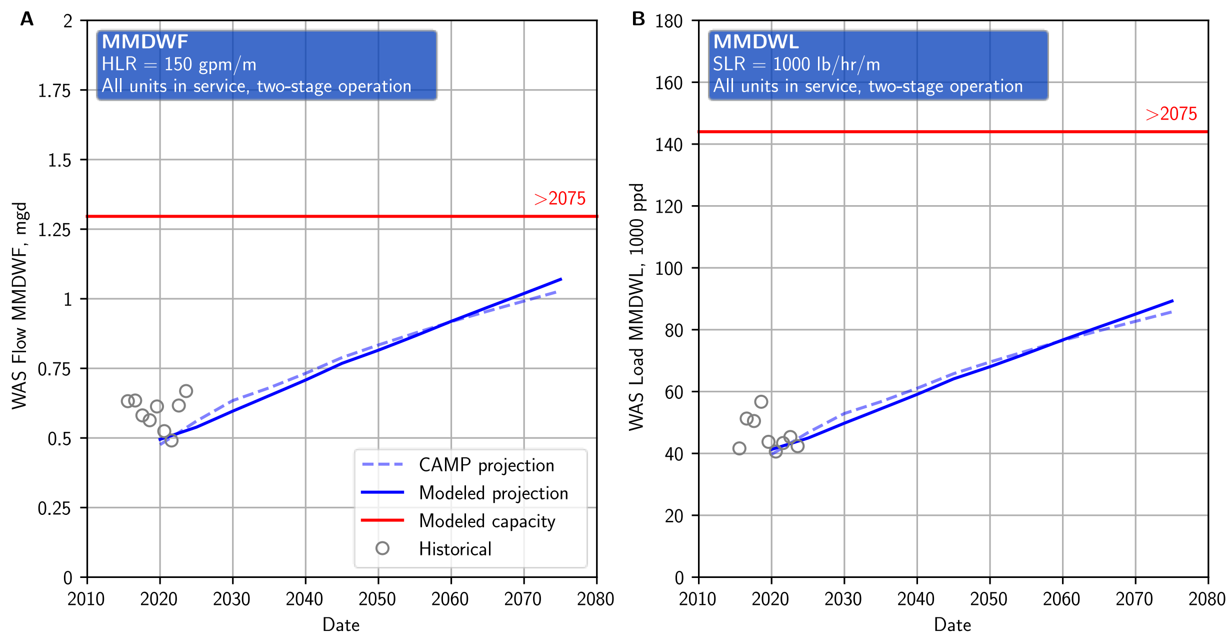

Figure 2.25 WAS Pre-Thickening Trigger Plots

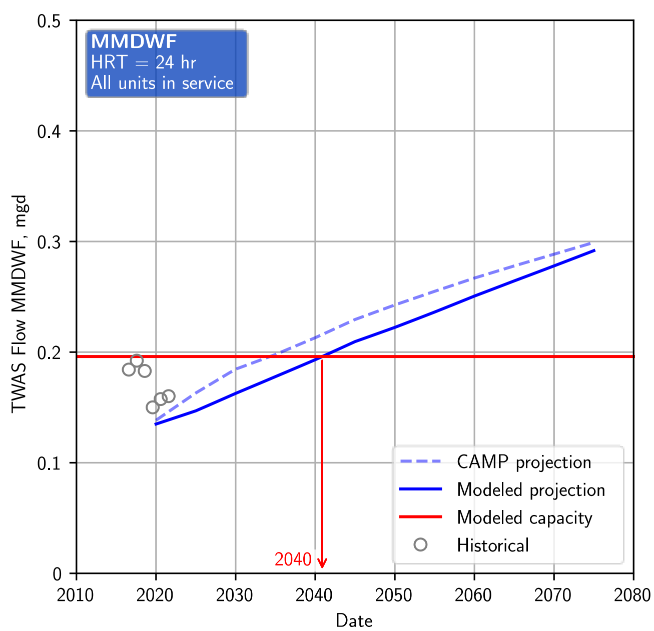

Figure 2.26 WAS Release Trigger Plot

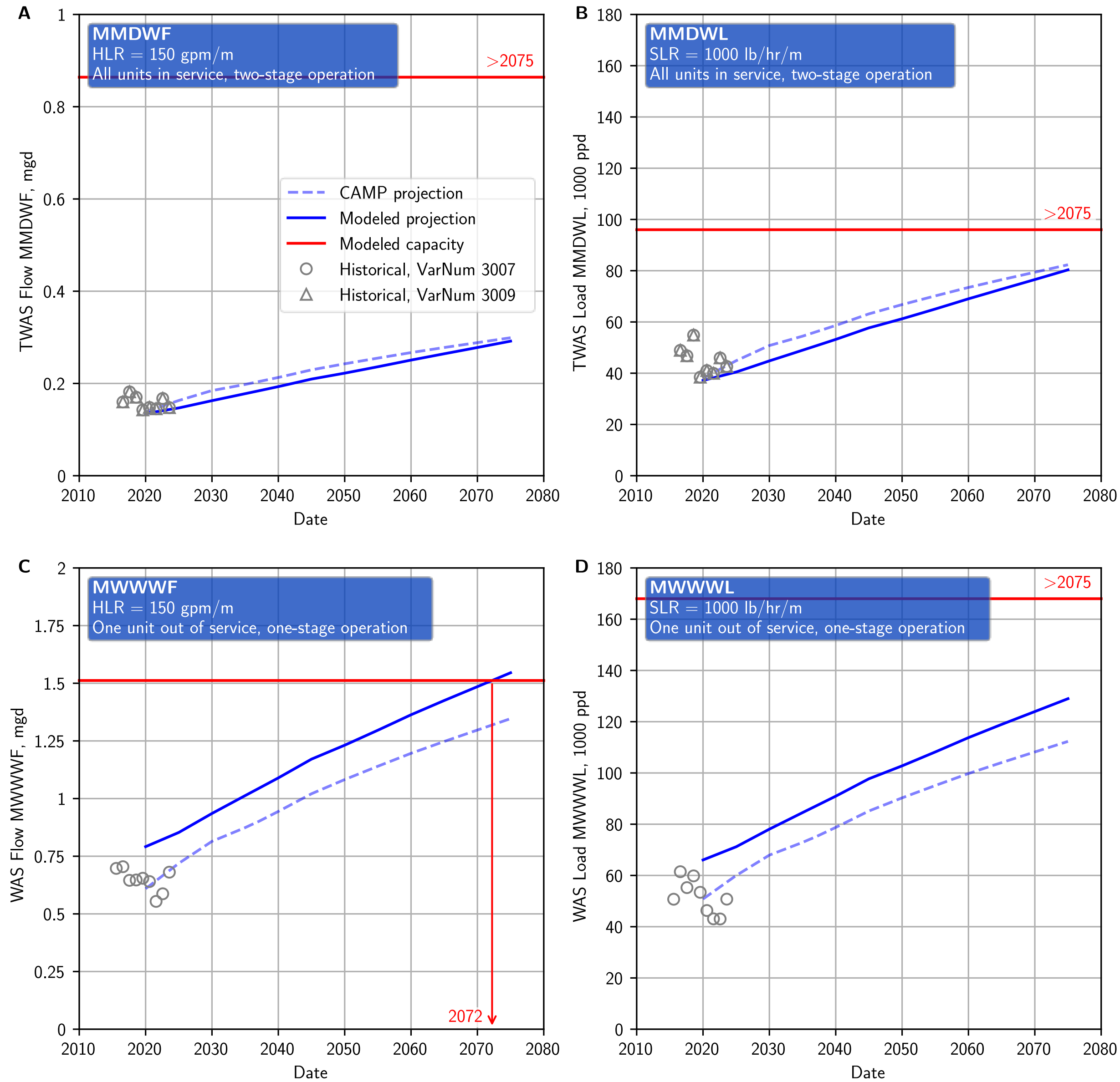

Figure 2.27 WAS Post-Thickening Trigger Plots

2.3.3 Anaerobic Digestion

Anaerobic digestion at the Rock Creek WRRF is performed by five anaerobic digesters (Table 2.27). One of the small, cylindrical digesters (currently Digester 2) serves as the dewatering feed holding tank. The District generates Class B biosolids that are land applied year round. Gas from the digesters is currently used for heat in boilers. The cogeneration system was decommissioned and removed in 2023.

During the wet weather season, the District prefers to keep two of the small digesters out of service. This provides sufficient capacity to take small digesters out of service as needed to maintain mixers and hold solids if the wet weather land application site is temporarily unable to accept biosolids.

Table 2.27 Anaerobic Digester and Dewatering Feed Tank Information

Digester/Dewatering Feed Tank	Form Factor	Nominal Volume, each (MG)	Assumed Operating Volume, each (MG)(1)
Digesters 1, , 3, and 4	Cylindrical	0.67	0.64
Digesters 5 and 6	Egg-like	1.45	1.45
Dewatering feed tank (Digester 2)	Cylindrical	0.67	0.64

Notes:
(1) Assumed 5 percent of the nominal volume in the small, cylindrical digesters was occupied by grit/struvite. This is based on the volume of material removed from these digesters during their last cleaning. The District has found solids deposition and retention in the large, egg-like digesters to be negligible; therefore, no reduction of the nominal volume was applied to these digesters.

The District is currently exploring opportunities to introduce high strength waste to the digesters to improve gas production in the anaerobic digesters (which is currently practiced at the Durham WRRF). Given the nascent nature of this possibility, the impact of high strength waste co-digestion was not considered in the current capacity assessment.

2.3.3.1 Anaerobic Digestion Design Criteria

The design criteria adopted for the anaerobic digestion capacity evaluation are summarized in Table 2.28. Digester capacity is rated on both HRT and volatile solids loading rate (VSLR). A minimum HRT of 15 d has been adopted for all conditions to ensure biosolids will satisfy class B requirements. A VSLR of 0.2 pounds per day of volatile solids per cubic foot (ppd VS/cf) has been adopted based on the District's historical operating experience. Both wet and dry weather conditions were evaluated, with maximum month in both seasons adopted for determining total capacity. Redundancy was provided under average loading conditions, with provisions for one small digester being taken out of service in the dry weather season and one large digester being taken out of service in the wet weather season.

Table 2.28 Anaerobic Digestion Design Criteria

Flow/Load Condition	Design Criteria	Redundancy Criteria	Performance Assumption	Reference
MMDW	▪ HRT = 15 day ▪ VSLR = 0.2 ppd VS/cf	All units in service(1)	N/A	Modified at CAMP®
MMWW	▪ HRT = 15 day ▪ VSLR = 0.2 ppd VS/cf	All units in service(1)	N/A	Modified at CAMP®
ADW	▪ HRT = 15 day ▪ VSLR = 0.2 ppd VS/cf	One small digester out of service(1)	N/A	Modified at CAMP®
AWW	▪ HRT = 15 day ▪ VSLR = 0.2 ppd VS/cf	One large digester out of service(1)	N/A	Modified at CAMP®

Notes:
(1) The small digester used as the dewatering feed tank (Digester 2) is not included in the digestion volume. The all units in service condition consists of three small digesters (1, 3, and 4) and two large digesters (5 and 6) for a total digestion volume of 4.81 MGl. The one small digester out of service condition consists of two of the three small digesters (1, 3, or 4) and the two large digesters (5 and 6) for a total digestion volume of 4.17 MG. The one large digester out of service condition consists of the three small digesters (1, 3, and 4) and either of the large digesters (5 or 6) for a total digestion volume of 3.36 MG.

It should be noted that the volume of one large digester (1.45 MG) is roughly comparable to that of two small digesters (1.27 MG). As such, the redundancy criteria of one large digester out of service is roughly comparable to the By adopting one large digester out of service under the AWW conditions, the current digester capacity assessment allows for the planned maintenance of a large digester as well as the District's current practice of reserving a small digester to get them through periods when the Gorge shuts down traffic access route to land application.

2.3.3.2 Anaerobic Digestion Capacity

Based on the design criteria in Table 2.28, the anaerobic digesters have a combined digester feed flow capacity of 0.22 to 0.32 mgd and a combined digester volatiles solids load capacity of 89,800 ppd to 129,000 ppd (Table 2.29).

Table 2.29 Anaerobic Digestion Capacity

Parameter	ADW (Firm)	MMDW (Total)	AWW (Firm)	MMWW (Total)
Combined digester feed flow, mgd	0.28	0.32	0.22	0.32
Estimated capacity year(1)	2040-2044	2038-2042	**2034**–2038(2)	2046-2050
Combined digester feed volatile solids load, ppd	112,000	129,000	89,800	129,000
Estimated capacity year(1)	2044-2048	2043-2047	2036-2040	2048-2052

Notes:
(1) The low end of the range reflects the original projection while the high end of the range is four years above this value due to the observations that digester feed loads have not kept pace with the projections since 2020.
(2) Trigger years set in **bold** occur in the next ten years (2024–2034).

Figure 2.28 and Figure 2.29 depict the anaerobic digester trigger plots for HRT and VSLR criteria, respectively. As depicted in these figures, the flow and load to the digesters have generally fallen in recent years. This may be attributed in part to lower WAS loads resulting from the lower collection system dry weather cBOD loads observed for the same period (section 2.2.4.2). In contrast, the combined feed volatile solids load has remained relatively constant in the wet weather season (Figure 2.29). The lower wet weather combined feed flow in recent years (Figure 2.28) may be attributed to an increase of the District's target for the combined digester TS concentration to 5 percent to 6 percent. The recent reduction in combined feed flow to the digesters has caused the projected combined feed flow to depart from the measured flow.

As shown in Figure 2.28, an additional anaerobic digester would be needed by 2034 to meet the HRT criteria in the AWW condition. This trigger year may be conservative given that digester feed flows and loads from have not exceeded the measured values seen in 2020. Given that digester feed flows and loads have not matched the projections in recent years, a trigger year range was developed by pushing out the digester feed projections by four years. This is consistent with the shifted projection evaluated for secondary treatment (section 2.2.4.2). Given that a lower projection was also evaluated for primary sludge thickening (section 2.3.1.2), this shifted projection provides a conservative upper limit for the trigger year range.

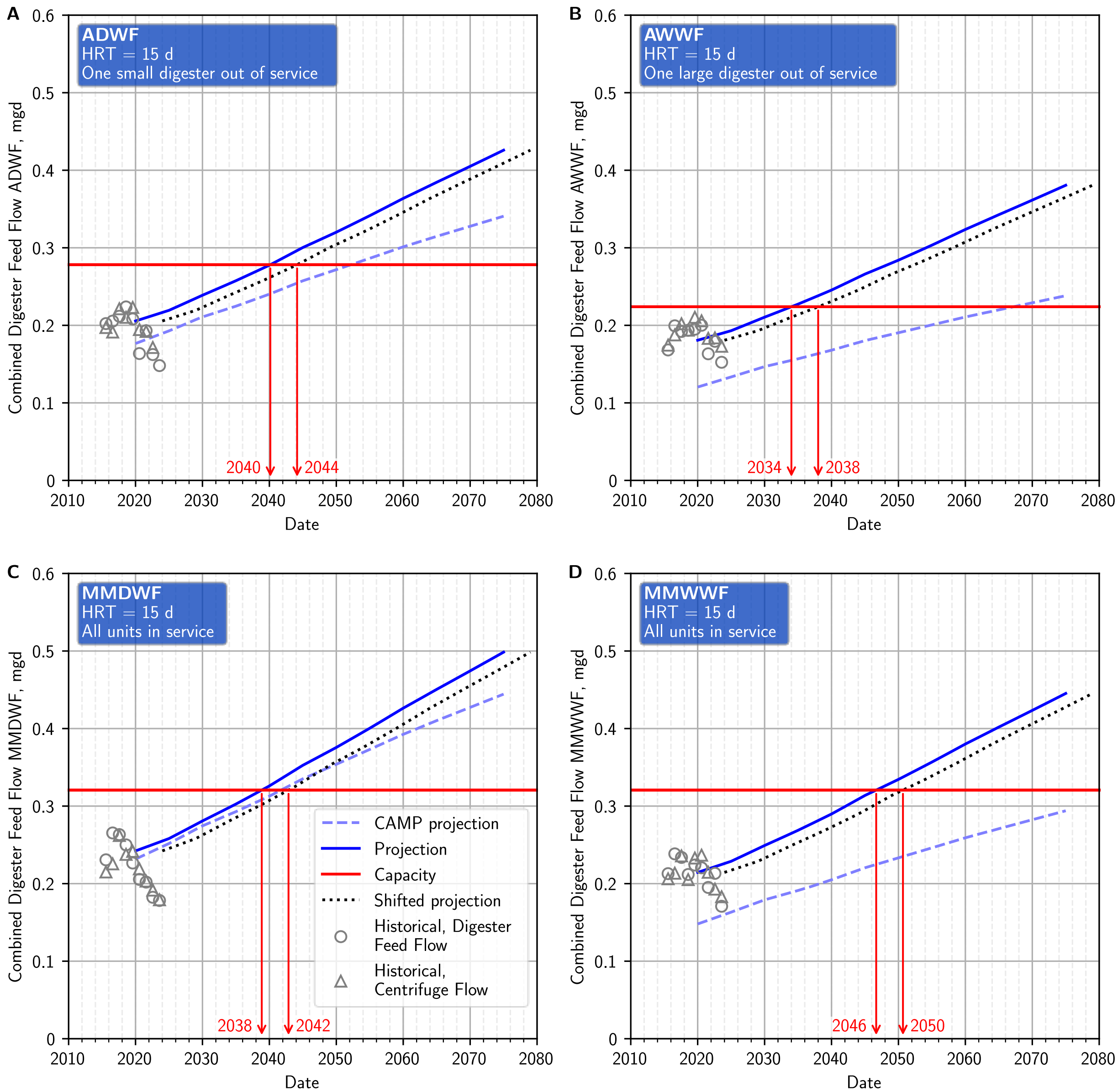

Figure 2.28 Anaerobic Digester Hydraulic Retention Time Trigger Plot

CAMP® projections were developed assuming 6 percent TS and 9 percent TS for TPS and TTWAS, respectively, 40 percent TSS removal in the primary clarifiers in wet weather, and no tertiary alum addition in the dry weather. This resulted in lower projections than modeled, particularly for the wet weather scenarios where a higher TSS removal was used for the primary clarifiers. The shifted projections are the modeled projections shifted later by four years.

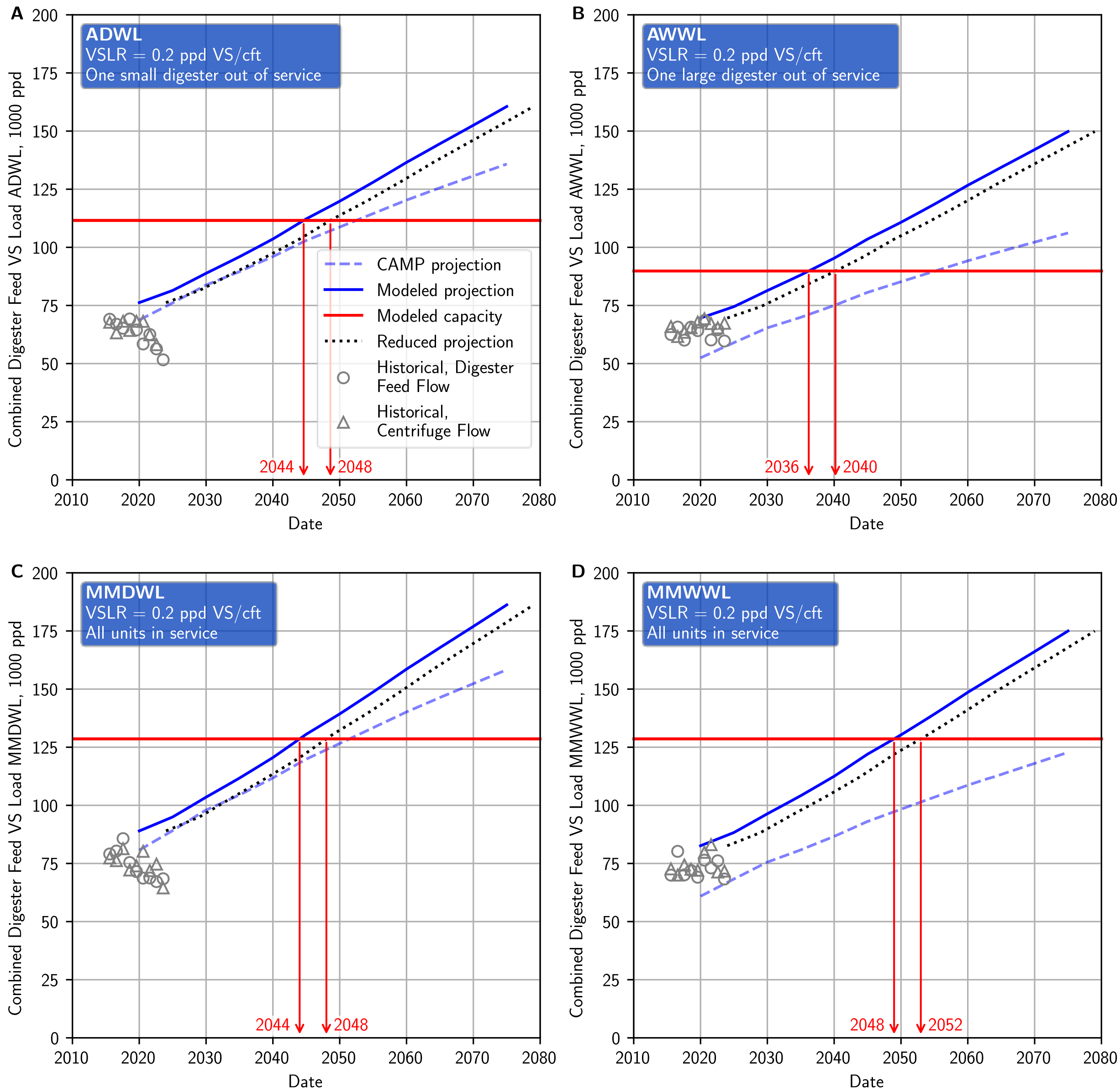

Figure 2.29 Anaerobic Digester Volatile Solids Loading Rate Trigger Plot

CAMP® projections were developed assuming 6 percent TS and 9 percent TS for TPS and TTWAS, respectively, 40 percent TSS removal in the primary clarifiers in wet weather, and no tertiary alum addition in the dry weather. This resulted in lower projections than modeled, particularly for the wet weather scenarios where a higher TSS removal was used for the primary clarifiers. The shifted projections are the modeled projections shifted later by four years.

2.3.4 Dewatering

Biosolids dewatering is achieved with two recently upgraded dewatering centrifuges. Table 2.30 summarizes the dewatering design criteria adopted for the current capacity evaluation. Under normal maximum month operation, each centrifuge has a solids loading rate (SLR) capacity of 3000 pounds of total solids per hour (lb TS/hour). However, each centrifuge can operate at higher SLRs of 4500 lb TS/hour for short periods while a unit is out of service. The dewatering centrifuges SLR design criteria as well as the biosolids cake solids concentration of 22 percent were adopted from the centrifuge project.

Table 2.30 Dewatering Design Criteria

Flow/Load Condition	Design Criteria	Redundancy Criteria	Performance Assumption	Reference
MMDW Digested sludge load	SLR = 3000 lb TS/hr/unit	▪ All units in service. ▪ 6 days/week 22 hours/day operation.	▪ Cake TS = 22%. ▪ Capture = 96%.	▪ SLRs and capture from Centrifuge Project. ▪ Cake TS = District design point based on commissioning of new centrifuge.
MMWW Digested sludge load	SLR = 3000 lb TS/hr/unit	▪ All units in service. ▪ 6 days/week 22 hours/day operation.	▪ Cake TS = 22%. ▪ Capture = 96%.	▪ SLRs and capture from Centrifuge Project. ▪ Cake TS = District design point based on commissioning of new centrifuge.
MMDW Digested sludge load	SLR = 4500 lb TS/hr/unit	▪ Largest unit out of service. ▪ 6 days/week 22 hours/day operation.	▪ Cake TS = 22%. ▪ Capture = 96%.	▪ SLRs and capture from Centrifuge Project. ▪ Cake TS = District design point based on commissioning of new centrifuge.
MMWW Digested sludge load	SLR = 4500 lb TS/hr/unit	▪ Largest unit out of service. ▪ 6 days/week 22 hours/day operation.	▪ Cake TS = 22%. ▪ Capture = 96%.	▪ SLRs and capture from Centrifuge Project. ▪ Cake TS = District design point based on commissioning of new centrifuge.

Notes:
lb TS/hr/unit - pounds of total solids per hour per unit

2.3.4.1 Dewatering Capacity

Based on the design criteria in Table 2.31, the dewatering centrifuges have a capacity of 113,000 ppd with both units in service and 84,900 ppd with one out of service.

Table 2.31 Dewatering Capacity

Parameter	MMDW (Firm)	MMDW (Total)	MMWW (Firm)	MMWW (Total)
Digested solids load	84,900	113,000	84,900	113,000
Estimated capacity year	2041	2064	2051	2073

Figure 2.30 depicts the dewatering trigger plots for all conditions considered. Based on the original projections, the dewatering centrifuges are projected to provide sufficient capacity through the year 2041. As with the combined digester feed volatile solids load, the measured digested solids load is lower from 2019 to today, particularly in the dry weather season. This drop in digested sludge load may be attributed to lower collection system cBOD loads and the cessation of tertiary alum addition from 2019 through 2023. Given the deviation between the measured and projected digester feed loads in recent years, the actual trigger year may be beyond this value.

Dewatering capacity is limited by the redundancy criterion, which results in dewater capacity being reached before the end of the planning period. To reach the end of the planning period with one centrifuge out of service, District staff could extend the operating duration slightly for the remaining unit in service (from 22 hours per day to 24 hours per day, 6 days per week).

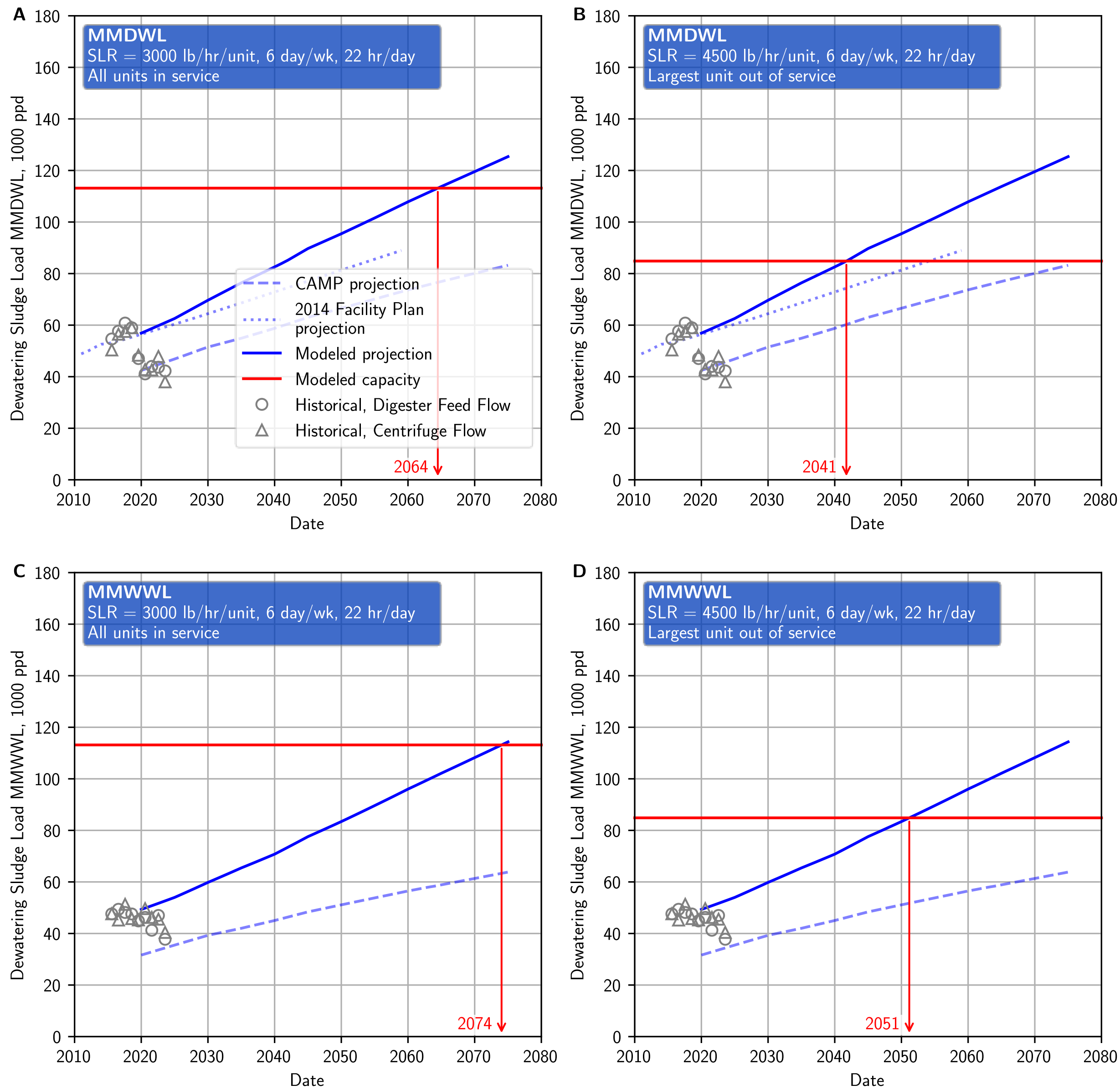

Figure 2.30 Dewatering Trigger Plots

2.3.5 Biosolids Storage

Biosolids storage is necessary during the winter to provide a buffer for poor road conditions as well as down times for unplanned processing equipment repairs and planned maintenance. In the previous facility plan, the District established a goal of four days, which was provided with both liquid and solids processes.

The District has two 2600 cf vertical dewatered sludge silos that may be used for biosolids storage. Additionally, one of the digesters (Digester 2) serves as the dewatering feed tank. Assuming the full volume of 0.67 MG is available for storage, the dewatering feed TS concentration is 2.52 percent (the historical median wet weather concentration from 2015 through 2023), and the dewatering centrifuge performance outlined in Table 2.30, the District currently has the ability to store biosolids for approximately four days under MMWW conditions (Figure 2.31). If one of the small digesters is kept out of service during the wet weather season for use as a standby dewatering feed tank, the biosolids storage target of 4 days could be extended through 2054.

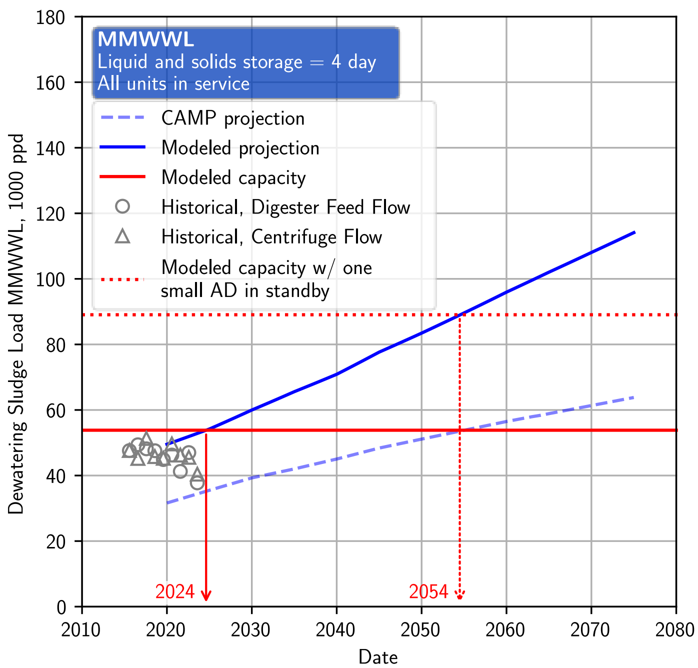

Figure 2.31 Biosolids Storage Trigger Plot

2.3.6 Phosphorus Recovery

Phosphorus is recovered as struvite from second stage GBT filtrate (WASSTRIP) and dewatering centrate using two Ostara reactors. The phosphorus recovery system was added in 2014 as part of the WAS and primary solids thickening upgrades.

The design criteria for the phosphorus recovery system were adopted from the manufacturer's proposal (Table 2.32). The manufacturer's rated capacity of the units is 2000 kilograms per day (kg/d) of struvite produced. Assuming a phosphorus recovery of 80 percent based on data collected at Durham, this 2000 kg/d of struvite capacity equates to an influent TP load capacity of 692 ppd per reactor. As is depicted in Figure 2.32, this provides sufficient capacity through 2075.

Table 2.32 Phosphorus Recovery Design Criteria

Flow/Load Condition	Design Criteria	Redundancy Criteria	Performance Assumption	Reference
MMDW centrate and TTWAS filtrate phosphorus load.	2000 kg/d of struvite per reactor (assuming 80% recovery, this equals 692 ppd of feed TP per reactor).	▪ All units in service. ▪ Units can be taken down for maintenance in the winter.	▪ Struvite recovery = 95%. ▪ Phosphorus recovered = 80%.	▪ Ostara proposal for design load. ▪ For Durham the average struvite recovery (calculated by dividing the struvite OP mass recovered by the struvite OP mass removed) = 100% from 2018 – 2020. Assumed 95% to be conservative. ▪ For Durham, the SRF converted OP = 81% from 2018 – 2020. Assumed 80% to be conservative.

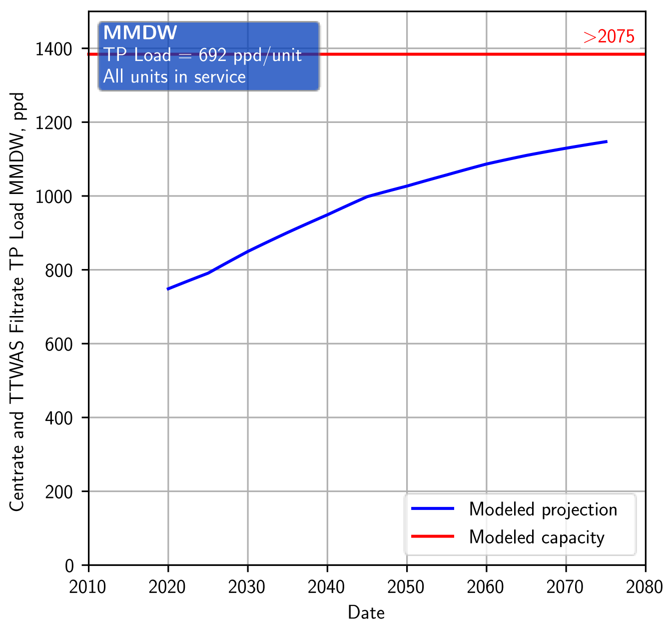

Figure 2.32 Phosphorus Recovery Trigger Plot

2.4 Capacity Results

Table 2.33 summarizes the liquid and solids treatment process capacity trigger years. Trigger years occurring between 2024 and 2034 are highlighted in bold and include: secondary treatment, tertiary filtration, primary sludge thickening, and anaerobic digestion.

Table 2.33 Capacity Summary

Unit Process	ADW	MMDW	MWDW	MDDW	AWW	MMWW	MWWW	MDWW	MHWW
Liquid Treatment Process									
Influent Pump Station	N/A	N/A	N/A	N/A	N/A	N/A	N/A	>2075	>2075
Headworks	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2074	>2075
Primary Clarification	>2075	N/A	N/A	N/A	N/A	2052	N/A	N/A	2050
Secondary Treatment	N/A	**2032**-2036(1)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tertiary Treatment/HRC	N/A	N/A	2040	N/A	N/A	N/A	N/A	>2075	N/A
Tertiary Filtration	2037	**2022-2032**(1)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Disinfection	2043	2050	N/A	N/A	N/A	N/A	N/A	N/A	2036
Solids Treatment Process									
Primary Sludge Thickening	2041-2045	**2029-2033**(1)	2064-2071	N/A	N/A	N/A	N/A	N/A	N/A
WAS Thickening	N/A	>2075	N/A	N/A	N/A	N/A	2072	N/A	N/A
Phosphorus Release	N/A	2040	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Anaerobic Digestion	2040-2044	2038-2042	N/A	N/A	**2034**-2038(1)	2046-2050	N/A	N/A	N/A
Dewatering	N/A	2041	N/A	N/A	N/A	2051	N/A	N/A	N/A
Phosphorus Recovery	N/A	>2075	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Notes:
(1) Values in **bold** occur in the next ten years (2024 to 2034).