West Basin Facility Plan Project 7054

TECHNICAL MEMORANDUM 10

Forest Grove WRRF Capacity Assessment

FINAL / June 2025

Produced by: Carollo

Clean Water Services

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Abbreviations

°C	Celsius
AAF	average annual flow
AB	aeration basin
ADW	average dry weather
ADW*	modified average dry weather
ADWF	average dry weather flow
ADWL	average dry weather load
AO	anaerobic/oxic
AOB	ammonia oxidizing bacteria
aSRT	aerobic solids retention time
AWW	average wet weather
AWWF	average wet weather flow
CAMP®	concentrated, accelerated, motivated, problem-solving
CBOD5	five-day carbonaceous biochemical oxygen demand
d	day
DEQ	Department of Environmental Quality
District	Clean Water Services
fps	feet per second
gpd/sf	gallons per day per square foot
HHPS	high-head pump station
hp	horsepower
IPS	influent pump station
MDDW	maximum day dry weather
MDDWF	maximum day dry weather flow
MDWW	maximum day wet weather
MDWWF	maximum day wet weather flow
mg/L	milligrams per liter
mg/L	milligram per liter
mgd	million gallons per day
MHWW	maximum hour wet weather
MHWWF	maximum hour wet weather flow
mL/g	milliliters per gram
MLSS	mixed liquor suspended solids
MMDW	maximum month dry weather
MMWW	maximum month wet weather
MMWWF	maximum month wet weather flow

MWDW	maximum week dry weather
MWWW	maximum week wet weather
N/A	not applicable
NOB	nitrite oxidizing bacteria
NPDES	National Pollutant Discharge Elimination System
NSF	nitrification safety factor
NTS	natural treatment system
PE	primary effluent
PH	peak hour
ppd/sf	pound per day per square foot
qty	quantity
RS	raw sewage
RWR	reclaimed wastewater
SC	secondary clarifier
sCOD	soluble chemical oxygen demand
SLR	solids loading rate
SOR	surface overflow rate
SVI	sludge volume index
TDH	total dynamic head
TSS	total suspended solids
UV	ultraviolet
VFW	vertical flow wetland
VSS	volatile suspended solids
WAS	waste activated sludge
WRRF	Water Resource Recovery Facility

TM 10 FOREST GROVE WRRF CAPACITY ASSESSMENT

10.1 Introduction and Major Assumptions

The following capacity assessment identifies process capacity deficiencies for the treatment systems at the Forest Grove Water Resource Recovery Facility (WRRF), shown schematically in Figure 10.1. This assessment includes contributions from the Council Creek Pump Station and treatment from primary clarifiers. Neither of these components exist currently but both are anticipated to be online within the next five years. 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® (CAMP2022)[2].

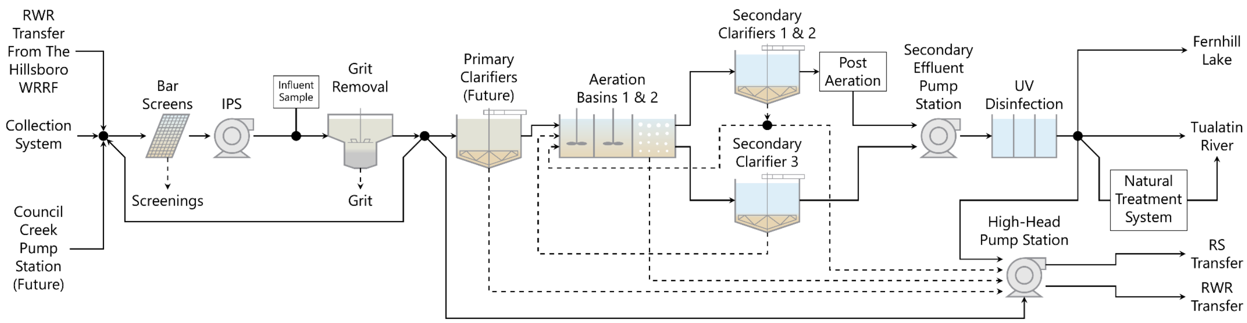

Figure 10.1 Forest Grove WRRF Process Flow Schematic

The results of current capacity assessment are summarized in Figure 10.2, which depicts the trigger years for each of the processes. As shown:

- Screening is currently limited by the redundancy criterion under maximum day wet weather flow (MDWWF) conditions.
- Secondary treatment will be limited between 2031 and 2035 based on the maximum month dry weather (MMDW) condition. This range reflects the impact of shifting the primary effluent five-day carbonaceous biochemical oxygen demand ($cBOD_5$) load by four years to account for the stable influent loads observed by Clean Water Services (District) since the projections were developed.
- The high-head pump station (HHPS) will be limited between 2038 and 2041. In 2038, both flow transfer system pipelines will be needed to transfer the maximum hour wet weather flow (MHWWF) and will result in competition between the HHPSs at the Forest Grove and Hillsboro WRRFs. In 2041, the maximum capacity of the Forest Grove WRRF HHPS (8 million gallons per day [mgd]) will be reached.
- Grit removal and influent pumping will be limited in 2044 based on the MHWWF condition.

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[1] Carollo Engineers, Inc., (February 2014). TM 4.5 - Hillsboro and Forest Grove Recommended Plan, West Basin Facilities Plan.
[2] Carollo Engineers, Inc., (March 2023). TM 1 - West Basin Alternatives CAMP® Documentation, West Basin Facility Plan Project 7054.

- The flow transfer pipelines will be limited under maximum day dry weather (MDDW) conditions by 2057.
- Primary clarification will be limited in 2071 based on the average wet weather flow (AWWF).
- The hydraulic capacity of the outfall and natural treatment system (NTS) were not treated as limiting in the current capacity assessment. The District will transfer flows exceeding the effluent capacity of the Forest Grove WRRF to the Rock Creek WRRF.

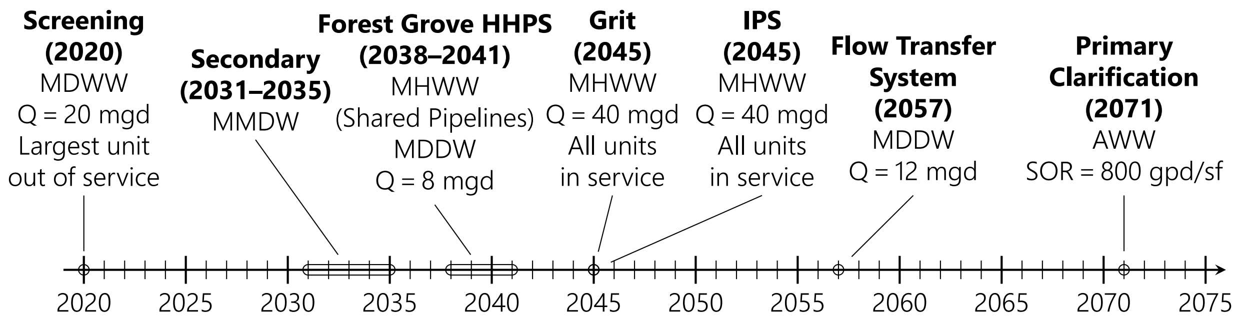

Figure 10.2 Forest Grove WRRF Process Trigger Year Summary Timeline

10.1.1 Flows and Loads

The flow and load projections used for all unit process capacity evaluations are those provided by the District on 2023-07-19. These projections are based on those summarized in the West Basin Flow and Load memorandum[3] but have been modified to include the planned construction of the Council Creek Pump Station. This pump station will intercept a portion of the collection system flow originating in Forest Grove that has traditionally been tributary to the Hillsboro WRRF and pump it to the Forest Grove WRRF headworks. The timing of the Council Creek Pump Station construction has not been finalized; however, it is expected in the next ten years. The projections adopted for the present evaluation assumed the pump station was online currently. This assumption is not expected to significantly alter the trigger years determined herein except for secondary treatment. Secondary treatment would be out of capacity at a later trigger year than determined herein if construction of the Council Creek Pump Station was delayed.

Table 10.1 summarizes the flow and load projections for 2020, the end of the current planning period (2045), and buildout (2075). The full projections are provided in Appendix 10A.

Table 10.1 Forest Grove WRRF Flow and Load Projection Summary

Facility/Year	MMDW cBOD Load	MMDW TSS Load	MMWW cBOD Load	MMWW TSS Load	MDDW Flow	MDWW Flow	PH Flow
	(ppd)	(ppd)	(ppd)	(ppd)	(mgd)	(mgd)	(mgd)
2020	11377	11389	10482	10065	10.5	25.7	35.5
2045	15083	15122	13896	13369	13.3	29.1	39.9
2075	20432	20318	18824	17951	17.3	33.0	45.0

Notes:
MDWW - maximum day wet weather; MMWW - maximum month wet weather; PH - peak hour; ppd – pound per day; TSS - total suspended solids.

[3] Jacobs (February 2022). West Basin Flow and Load Projections. Memorandum. West Basin Master Planning Preliminary Work. Project D3372600.

10.1.2 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.
- A new Council Creek pump station will be installed in the collection system. This pump station will redirect flow from Forest Grove that has historically been treated at the Hillsboro WRRF to the Forest Grove WRRF. For the present analysis, it was assumed that the pump station will operate year-round and discharge into the headworks at the Forest Grove WRRF.
- Forest Grove WRRF:
  - The Forest Grove WRRF will operate and discharge to the Tualatin River year-round.
  - The two new primary clarifiers are in the process of being constructed. The present analysis assumed the clarifiers will be in service by 2025.
  - Primary solids, waste activated sludge (WAS), and transfer flows will be conveyed to the Rock Creek WRRF via the flow transfer system. A minimum transfer flow of 1 mgd was assumed for all conditions.
  - Peak flows up to 30 mgd will be treated during the wet weather season.
  - Influent flows exceeding 12 mgd during the dry weather season will be transferred to the Rock Creek WRRF via the flow transfer system (limited by the NTS).
- Hillsboro WRRF:
  - The Hillsboro WRRF will operate and discharge to the Tualatin River 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.
  - During the dry weather season, the Hillsboro WRRF will transfer screened and degritted wastewater to the Forest Grove WRRF.

10.1.3 Regulatory Assumptions

The current capacity analysis assumes that the current National Pollutant Discharge Elimination System (NPDES) permit for the Forest Grove WRRF will remain in effect. The regulatory assumptions adopted for the current analysis are consistent with those adopted for the West Basin Alternatives CAMP®. Specific assumptions include:

- TSS mass load limit will increase in the future such that the current effluent TSS concentration may be maintained. The Forest Grove 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.
- The District's efforts to reduce effluent copper and adjust effluent water quality are anticipated to lessen the likelihood of future effluent copper limits being assigned to the Forest Grove WRRF. The District has monitored effluent copper concentrations at the Forest Grove WRRF since the Oregon

Department of Environmental Quality (DEQ) adopted a new copper water quality standard. The District has found that the NTS provides sufficient copper removal while operating during the dry weather season, but additional removal would be necessary during the wet weather season. The District is constructing primary clarifiers at the Forest Grove WRRF; one expected outcome of this addition is a reduction in effluent copper concentrations. Additionally, the District has identified a significant contributor in the collection system and will redirect influent flow from that contributor directly to the high-head pump station for transfer to the Rock Creek WRRF.

10.1.4 Design Criteria

The design criteria used in this analysis were developed based on values established in the last Facility Plan[4] and those used in the West Basin Alternatives CAMP® capacity assessment[5]. 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 constraints and limitations in ancillary or supporting systems (e.g., pumping and aeration) were not considered. Hydraulic constraints will be identified as part of Forest Grove WRRF hydraulic modeling task currently underway as part of the West Basin Facility Plan Project 7054.[6] The aeration system is known to be out of capacity currently. The capacity of this system as well as potential expansion options were evaluated separately.[7]

10.2 Liquid Treatment Process Capacity

The Forest Grove WRRF liquid stream processes are shown schematically in Figure 10.1. The capacities of each liquid stream process—including screening, influent pumping, grit removal, primary clarification, secondary treatment, secondary effluent pumping, disinfection, vertical flow wetland and natural treatment system, outfall, and the flow transfer system—are described below.

10.2.1 Influent Screening

The headworks at the Forest Grove WRRF consists of three channels, two of which contain mechanically cleaned bar screens (Table 10.2). The third channel may be used to bypass screening under high flows or when one unit is out of service. The facility does not have the ability to divert unscreened influent to the HHPS.

[4] Carollo Engineers, Inc., (February 2014). TM 4.5 - Hillsboro and Forest Grove Recommended Plan, West Basin Facilities Plan.
[5] Carollo Engineers, Inc., (March 2023). TM 1 - West Basin Alternatives CAMP® Documentation, West Basin Facility Plan Project 7054.
[6] Carollo Engineers, Inc. (Forthcoming). TM 14 - Forest Grove WRRF Hydraulic Capacity Assessment, West Basin Facility Plan Project 7054.
[7] Carollo Engineers, Inc. (Forthcoming). TM 12 - Forest Grove WRRF Secondary Treatment Aeration System Evaluation, West Basin Facility Plan Project 7054.

Table 10.2 Existing Influent Screening

Description	Units	Criteria
Number	quantity	2
Width	feet	4
Opening Size	inches	0.25
Capacity, Each	mgd	20

The design criteria (Table 10.3) 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. This redundancy criterion is consistent with the Rock Creek and Durham WRRFs. Figure 10.3 compares the current screening capacity to the projected MHWWF and MDWWF. As shown, influent screening is currently out of capacity.

Table 10.3 Influent Screening Design Criteria.

Flow/Load Condition	Design Criteria	Redundancy Criteria	Performance Assumption	Reference
MDWWF	Installed Firm Capacity	Largest unit out of service	N/A	FP2014
MHWWF	Installed Rated Capacity	▪ All units in service ▪ Can use bypass channel with bar rack	N/A	FP2014

Notes:
N/A - not applicable.

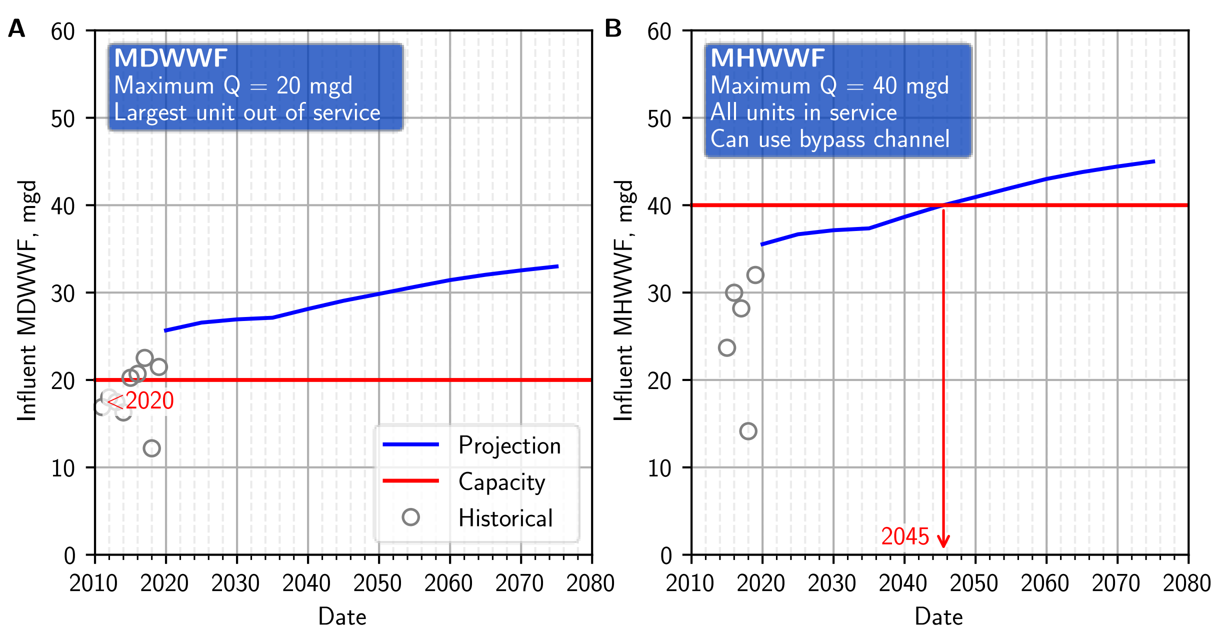

Figure 10.3 Influent Screening Trigger Plots

10.2.2 Influent Pumping

The influent pump station (IPS) consists of two identical wet wells each with three, 6.6 mgd, 60 horsepower (hp), submersible pumps. The IPS design criteria are consistent with those adopted for the

Rock Creek WRRF. As summarized in Table 10.4, the IPS needs to have the capacity to pump the MDWWF with one unit out of service and the MHWWF with all units in service.

Table 10.4 Influent Pump Station Design Criteria

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

Figure 10.4 depicts the current pumping capacity relative to the projected MDWWF and MHWWF flows (panels A and B, respectively). As shown, the IPS is projected to have sufficient capacity until 2045, at which point the IPS will no longer be able to pass the MHWWF.

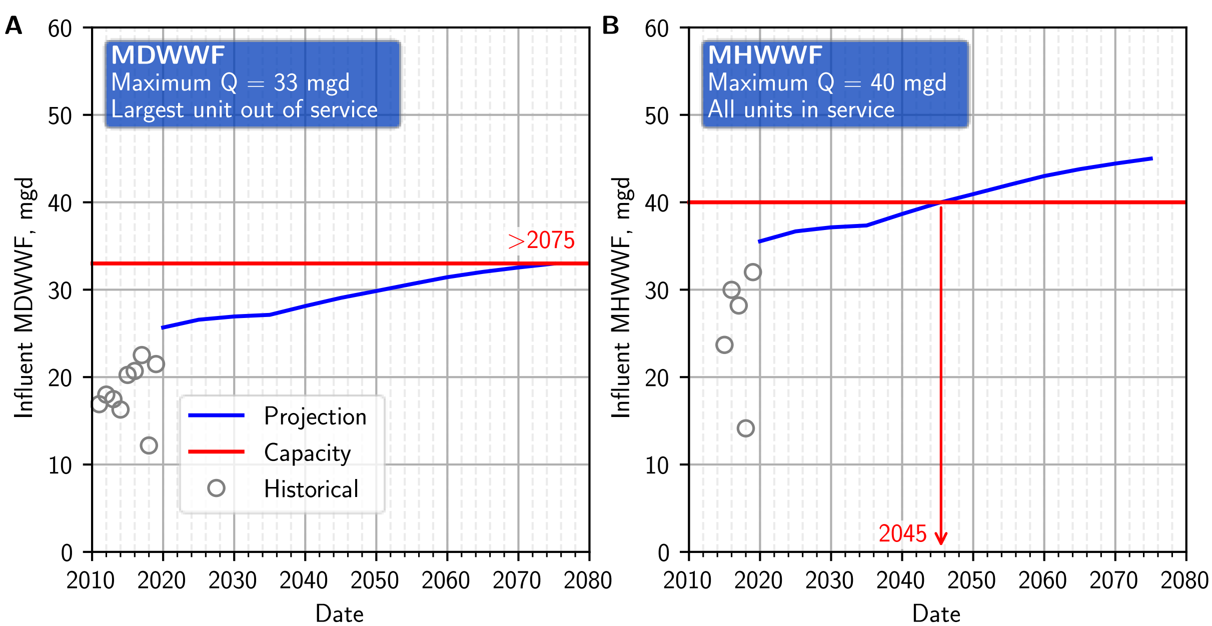

Figure 10.4 Influent Pumping Trigger Plots

10.2.3 Grit Removal

Two vortex grit removal chambers follow the influent pump station. The existing system has a design capacity of 20 mgd per chamber. The District has adopted a design criterion at the Durham WRRF for grit removal of all units in service under MHWWF (Table 10.5).[8] As noted above, peak wet weather flows cannot be diverted to the Rock Creek WRRF upstream of grit removal.

[8] Carollo Engineers, Inc., (June 2021). TM 11 - Liquids Treatment Process Capacity Analysis, East Basin 2019 Master Plan Project.

Table 10.5 Grit Removal Design Criteria.

Flow/Load Condition	Design Criteria	Redundancy Criteria	Performance Assumption	Reference
MHWWF	Installed Rated Capacity	All units in service	N/A	East Basin 2021

Figure 10.5 compares the grit removal capacity with the projected MHWWF. As shown, grit removal will reach the 40 mgd rated capacity in 2045. The District has noted a lower, hydraulically-based peak flow capacity through the grit removal system of 33 mgd. This limit was not included in this assessment and will be evaluated as part of the ongoing Forest Grove WRRF hydraulic capacity evaluation.[9]

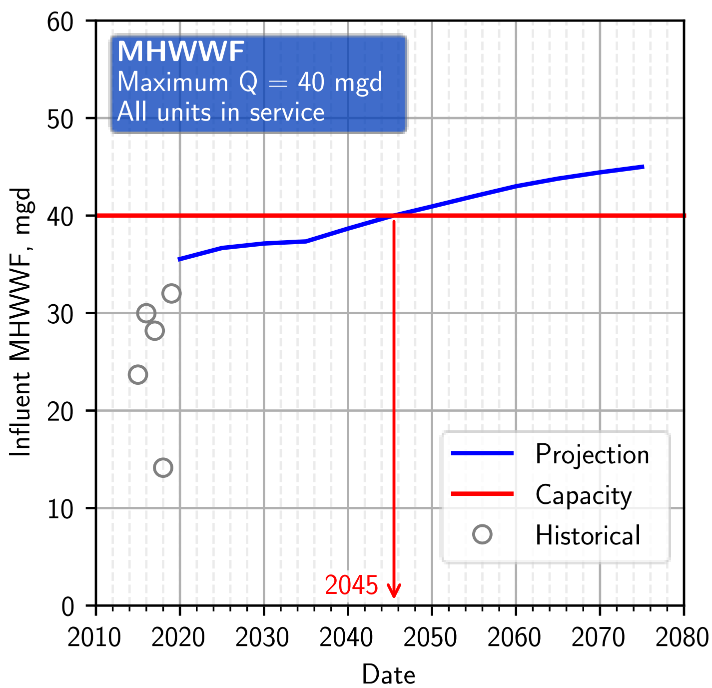

Figure 10.5 Grit Removal Trigger Plot

10.2.4 Primary Clarification

The District is currently adding two 100 foot diameter primary clarifiers to the Forest Grove WRRF. The primary clarifier design criteria (summarized in Table 10.6) were developed from the District's other facilities as well as copper removal tests completed by the District. Primary clarifier capacity is rated on the surface overflow rate (SOR) with redundancy provided in the dry weather season. The maximum month wet weather flow (MMWWF) design criterion is consistent with those adopted for the primary clarifiers at the Durham WRRF and the Hillsboro WRRF. A higher MMWWF SOR was adopted for the Rock Creek WRRF capacity evaluation based on preparatory work for the fourth primary clarifier.[10] The MHWWF SOR of 2500 gpd/sf is consistent with the Hillsboro WRRF design criteria.

[9] Carollo Engineers, Inc. (Forthcoming). TM 14 - Forest Grove WRRF Hydraulic Capacity Assessment, West Basin Facility Plan Project 7054.
[10] Carollo Engineers, Inc. (2024). TM 2 - Rock Creek WRRF Capacity Assessment, West Basin Facility Plan Project 7054.

Table 10.6 Primary Clarification Design Criteria.

Flow/Load Condition	Design Criteria	Redundancy Criteria	Performance Assumption	Reference
ADWF	1500 gpd/sf	Largest unit out of service	60% TSS Removal	Project design criteria
AWWF	800 gpd/sf	All units in service	55% TSS Removal	Project design criteria
MMWWF	1500 gpd/sf	All units in service	55% TSS Removal	Project design criteria
MHWWF	2500 gpd/sf	All units in service	N/A	Project design criteria

Notes:
ADW - average dry weather flow; gpd/sf - gallons per day per square foot.

A coagulant may be added to the primary clarifier influent to aid in copper removal. The dose is currently undetermined and the current planning is not considering potential improvements to overall TSS, $cBOD_5$, or phosphorus removal resulting from coagulant addition. As such, the primary clarifiers were treated as conventional primary clarifiers for the present capacity assessment.

Figure 10.6 depicts the primary clarifier capacities based on the design criteria in Table 10.6 with the historical and projected MHWWF, MMWWF, AWWF, and ADWF. Up to 39 mgd may be passed through the primary clarifiers based on the MHWWF design criterion, which is approximately equal to the hydraulic capacity of the upstream unit operations (40 mgd). However, the hydraulic capacity of the outfall is 30 mgd (discussed in Section 10.2.8). It was assumed for the present analysis that degritted influent would be diverted to the HHPS to satisfy this criterion. As a result, the MHWWF flow through the primary clarifiers (as depicted in Figure 10.6A) was capped at approximately 30.3 mgd with the difference being the primary solids and WAS flows. As shown in Figure 10.6C, the primary clarifiers will have sufficient AWWF capacity through 2071. An AWWF SOR criterion of 850 gpd/sf would allow the primary clarifiers to have sufficient capacity through buildout.

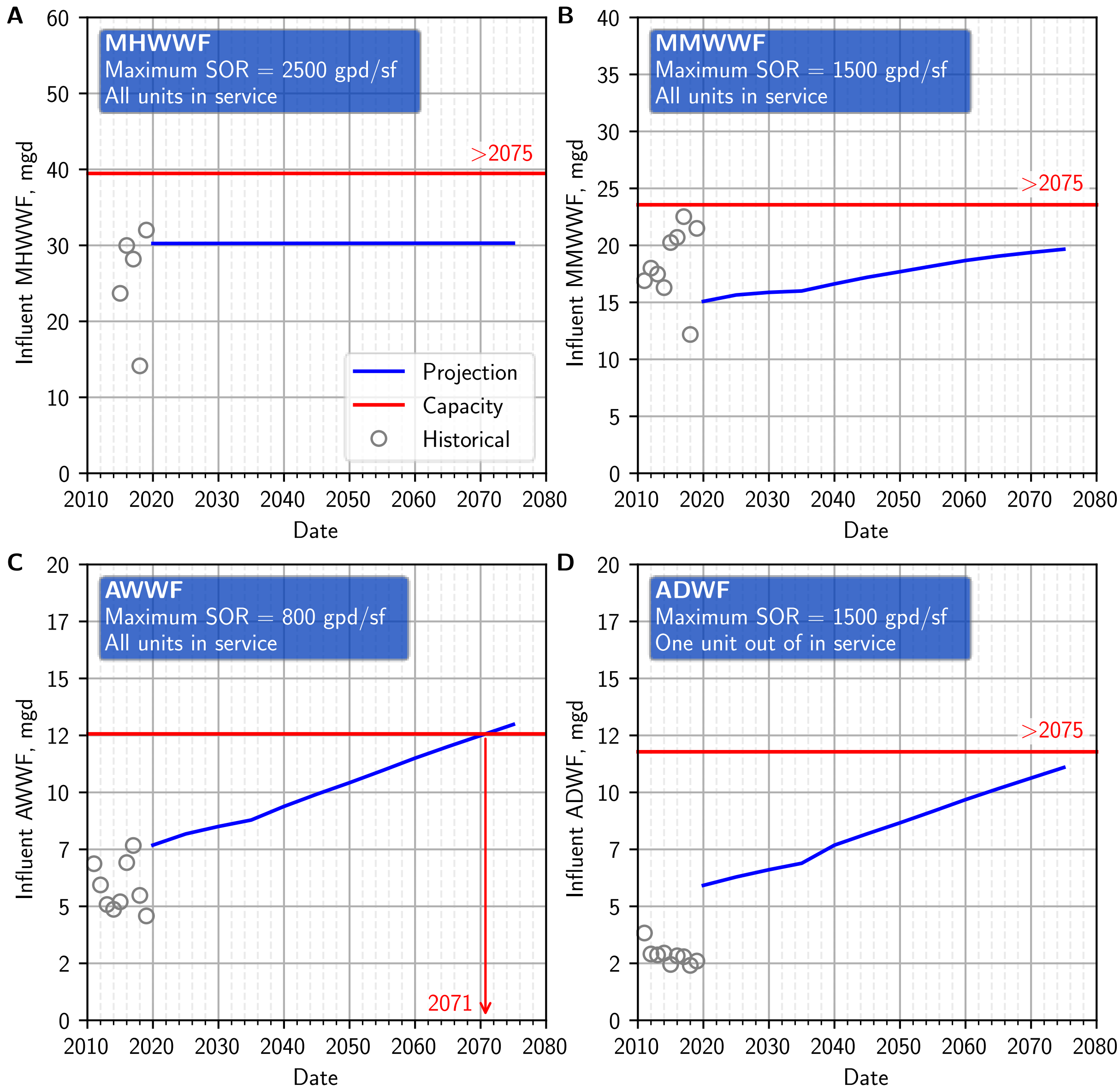

Figure 10.6 Primary Clarification Trigger Plot

Estimating primary clarifier TSS removal was necessary for evaluating secondary treatment capacity. Since the primary clarifiers at the Forest Grove WRRF do not yet exist, the performance of the District's other primary clarifiers were evaluated to establish anticipated performance. Since primary clarifier performance depends on the influent characteristics, historical influent data from the four facilities were compared to determine which of the other three facilities had influent wastewater that most closely resembled the influent at the Forest Grove WRRF. Four ratios were adopted as the basis for the comparison: soluble to total chemical oxygen demand (sCOD/COD), COD to carbonaceous biochemical oxygen demand (COD/$cBOD_5$), COD to TSS (COD/TSS), and volatile suspended solids (VSS) to TSS (VSS/TSS). The influent at the Hillsboro WRRF was found to be the most like the influent at the Forest Grove WRRF (comparison summarized in Table 10.7). As such, the historical primary clarifier performance data from the Hillsboro WRRF were used to estimate the performance of the future primary clarifiers at the Forest Grove WRRF.

Table 10.7 Influent Parameter Comparison

Parameter	Forest Grove WRRF(1)	Hillsboro WRRF(1)	Rock Creek WRRF(1)	Durham WRRF(2)
sCOD/COD	0.36	**0.28**(3)	0.24	0.26
COD/$cBOD_5$	2.29	**2.35**(3)	2.61	2.64
COD/TSS	1.11	**0.91**(3)	0.80	**1.29**(3)
VSS/TSS	0.88	**0.89**(3)	0.90	0.90

Notes:
(1) Median values determined from historical daily average influent data from 2015-01-01 through 2022-05-19.
(2) Median values determined from historical daily average influent data from 2015-01-01 through 2023-12-31.
(3) The values among the Hillsboro, Rock Creek, and Durham WRRFs that are closest to the corresponding value for the Forest Grove WRRF are set in **bold**.

Historical TSS and COD removals for the Hillsboro WRRF primary clarifiers were reviewed to characterize the anticipated performance under the projected SORs (shown in Figure 10.7). Historically, TSS and COD removals have decreased with increasing SOR and both have generally been consistent with expectations for conventional primary clarification (achieving 50 to 70 percent TSS removal and 25 to 40 percent COD removal for SORs less than approximately 1500 gpd/sf). The District noted that the primary effluent sample is collected from a location that includes both the primary effluent and screened and degritted flow that bypasses primary treatment. As such, the TSS and COD removals may not reflect the removals achieved by the clarifiers at elevated flows. The historical primary clarifier performance data were discounted in the Hillsboro WRRF Capacity Assessment[11] as the planning SORs were significantly higher than those considered here and more likely to be impacted by the primary effluent sample location. Two TSS removals are highlighted in the figure:

- The TSS removal of 60 percent assumed for dry weather conditions. The SOR anticipated during the planning period will range from 600 to 800 gpd/sf under MMDWF conditions and 400 to 500 gpd/sf under ADWF conditions. Based on the historical performance of the Hillsboro WRRF primary clarifiers, TSS removals greater than 65 percent would be expected at these SORs. Settling tests completed without coagulant as part of the District's copper removal testing had lower removals at an SOR of 800 gpd/sf (median of 51 percent). An intermediate value of 60 percent was adopted for the present analysis.
- The TSS removal of 55 percent assumed for wet weather conditions. The SOR anticipated during the planning period will range from 1000 to 1100 gpd/sf under MMWWF conditions and 500 to 600 gpd/sf under AWWF conditions. Based on the historical performance of the Hillsboro WRRF primary clarifiers, a removal of 55 percent would be expected for the MMWWF condition at the end of the planning period.

[11] Carollo Engineers, Inc. (2024). TM 11 - Hillsboro WRRF Capacity Assessment, West Basin Facility Plan Project 7054.

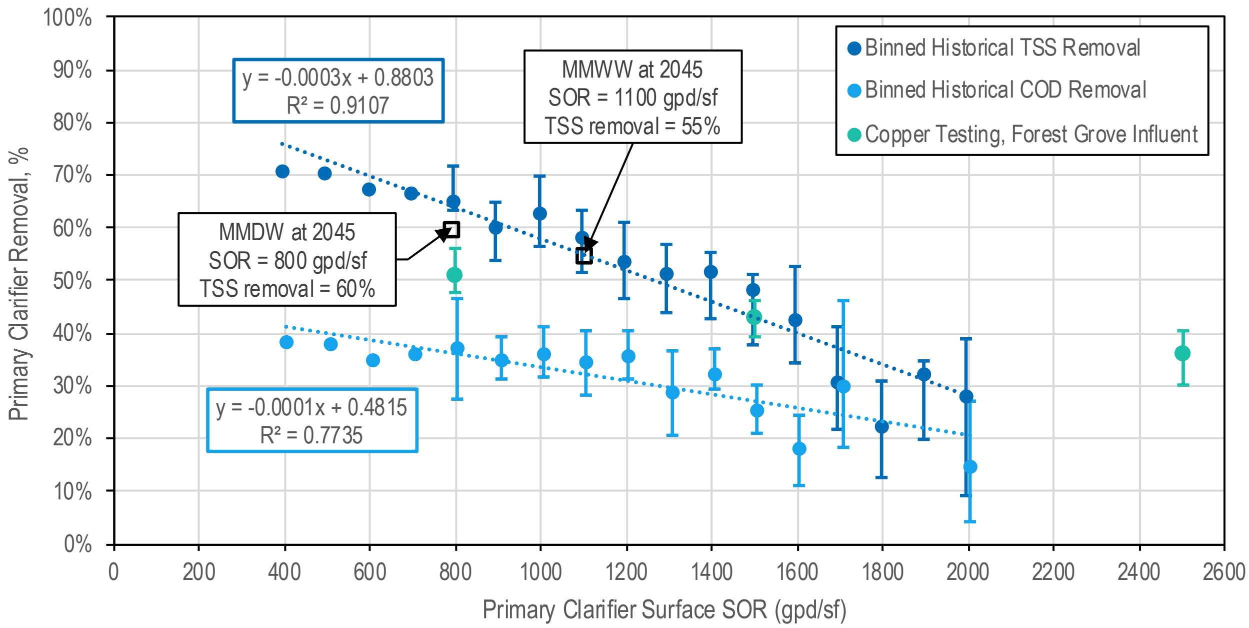

Figure 10.7 Historical Primary Clarifier Performance

TSS and COD removals are estimated from concentrations measured in the influent and primary effluent from November 1, 2014 through December 31, 2021. 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.

As discussed below, secondary treatment capacity is limited under the MMDW condition. This condition coincides with significant industrial discharges in the Forest Grove WRRF collection system. These contributions shift the incoming wastewater to a more soluble, higher strength influent characterization. The settling tests completed by the District as part of their copper removal testing did not capture this contribution. Additional settling tests of the Forest Grove WRRF influent are recommended when these contributions occur in the future. These tests may be used to refine the TSS removal assumed under dry weather conditions and improve the accuracy of the secondary treatment capacity assessment.

10.2.5 Secondary Treatment

Secondary treatment at the Forest Grove WRRF is performed by two 800,000 gallon aeration basins, each with six zones and side water depths of 19.7 feet. Figure 10.8 depicts the primary modes of operation available, including anaerobic/oxic (AO, panel A), step feed (panel B), and contact stabilization (panel C).

- The system is typically operated in AO mode with secondary influent being directed to Zone 2. Zone 1 is used to reduce nitrate in the return activated sludge when the system is nitrifying. The anaerobic fraction in this configuration is 10 percent.
- Mixed liquor may be split between three circular secondary clarifiers for solids settling. Secondary clarifiers 1 and 2 each have a diameter of 96.7 feet and side water depth of 14.5 feet. Secondary clarifier 3 has a diameter of 120 feet and a side water depth of 17.2 feet.
- Mixed liquor from the two aeration basins are typically commingled. With the addition of secondary clarifier 3, they may be operated as two independent trains.

- The solids retention time is typically controlled hydraulically, with WAS being withdrawn from Zone 2 in each aeration basin. Wasting may also be achieved from the underflow of secondary clarifiers 1 and 2.

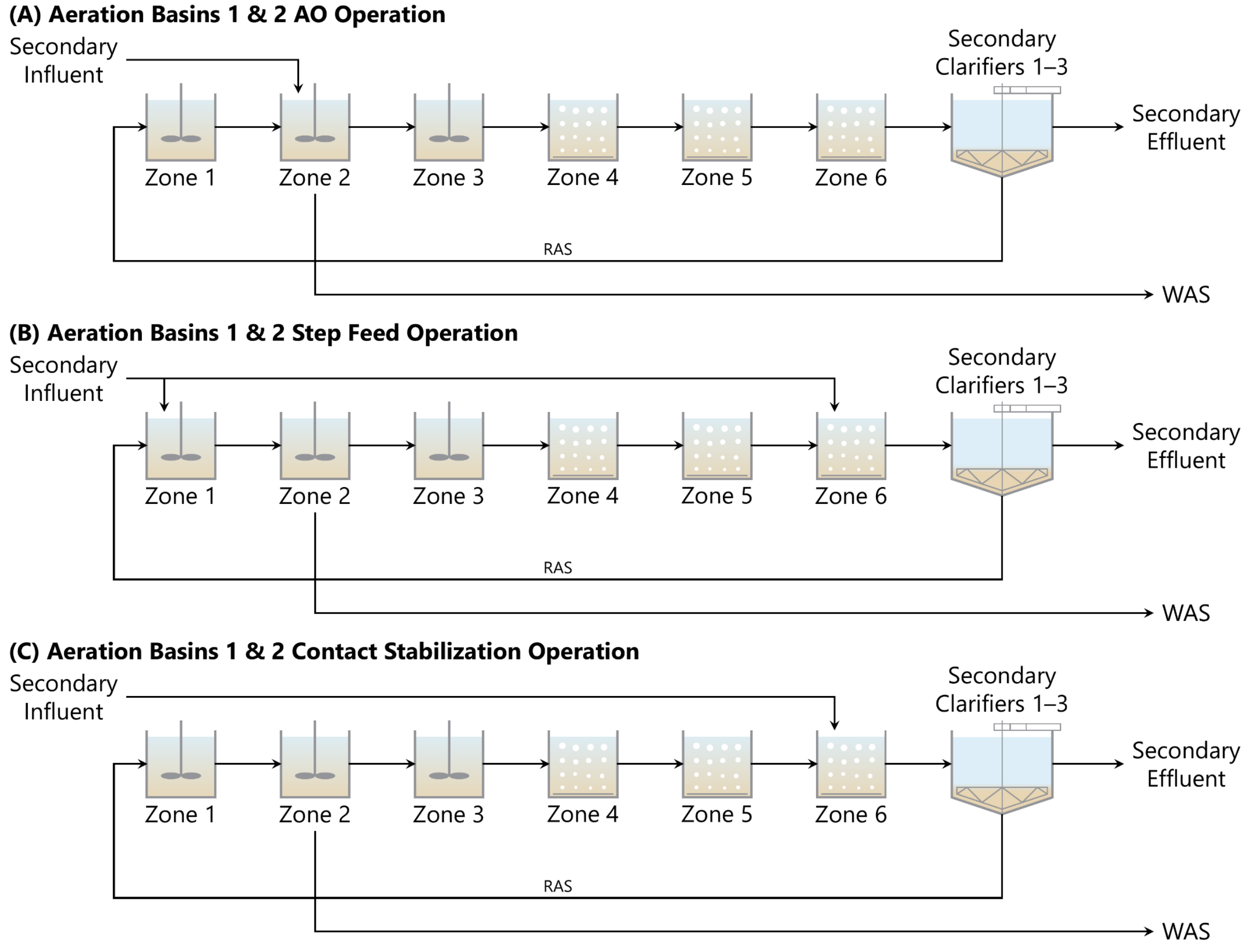

Figure 10.8 Aeration Basins 1 and 2 Operating Modes

Note: Contact stabilization has never been used successfully.

10.2.5.1 Secondary Treatment Design Criteria

Table 10.8 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 MMDW primary effluent load as determined through a combination of biological process modeling and state point analysis. As discussed below, the operating configuration and aerobic solids retention time (aSRT) were selected for complete nitrification during the dry weather season. The Forest Grove WRRF does not need to meet an effluent ammonia limit in the wet weather season. However, the District has found that operating to achieve nitrification year-round improves settleability. An aSRT allowing for partial nitrification was adopted for the present analysis (discussed below). The District aeration basins at the Rock Creek and Hillsboro WRRFs are operated to achieve partial nitrification during the wet weather season.

Table 10.8 Secondary Treatment Design Criteria.

Flow/Load Condition	Design Criteria	Redundancy Criteria	Performance Assumption	Reference
▪ ABs evaluated on AWW PE COD load ▪ SCs evaluated on MDWWF	▪ aSRT = 4.9 d, AO mode ▪ SLR ≤ 48 ppd/sf at peak flow ▪ Terminal MLSS ≤ 4000 mg/L	▪ One AB out of service ▪ All SCs in service	▪ Complete nitrification at nitrifying aSRT ▪ SVI = 164 mL/g	▪ Nitrifying aSRT with NSF of 1.25 at a temperature of 11.5°C ▪ 90th percentile SVI data
▪ ABs evaluated on AWW PE COD load ▪ SCs evaluated on MDWWF	▪ aSRT = 4.9 d, AO mode ▪ SLR ≤ 48 ppd/sf at peak flow ▪ Terminal MLSS ≤ 4000 mg/L	▪ All ABs in service ▪ One SC out of service	▪ Complete nitrification at nitrifying aSRT ▪ SVI = 164 mL/g	▪ Nitrifying aSRT with NSF of 1.25 at a temperature of 11.5°C ▪ 90th percentile SVI data
▪ ABs evaluated on ADW* PE COD load ▪ SCs evaluated on MDDWF	▪ aSRT = 6.2 d, AO mode ▪ SLR ≤ 48 ppd/sf at peak flow ▪ Terminal MLSS ≤ 4000 mg/L	▪ One AB out of service ▪ All SCs in service	▪ Complete nitrification at nitrifying aSRT ▪ SVI = 166 mL/g	▪ Nitrifying aSRT calculated assuming a 2.0 safety factor at a temperature of 13.7°C ▪ 90th percentile SVI data
▪ ABs evaluated on ADW* PE COD load ▪ SCs evaluated on MDDWF	▪ aSRT = 6.2 d, AO mode ▪ SLR ≤ 48 ppd/sf at peak flow ▪ Terminal MLSS ≤ 4000 mg/L	▪ All ABs in service ▪ One SC out of service	▪ Complete nitrification at nitrifying aSRT ▪ SVI = 166 mL/g	▪ Nitrifying aSRT calculated assuming a 2.0 safety factor at a temperature of 13.7°C ▪ 90th percentile SVI data
▪ ABs evaluated on MMWW PE COD load ▪ SCs evaluated on MDWWF	▪ aSRT = 4.9 d, AO mode ▪ SLR ≤ 48 ppd/sf at peak flow ▪ Terminal MLSS ≤ 4000 mg/L	▪ All units in service ▪ Can transfer flows to the Rock Creek WRRF during maintenance	▪ Complete nitrification at nitrifying aSRT ▪ SVI = 164 mL/g	▪ Nitrifying aSRT calculated assuming a 1.25 safety factor at a temperature of 11.5°C ▪ 90th percentile SVI data
▪ ABs evaluated on ADW* PE COD load ▪ SCs evaluated on MDDWF	▪ aSRT = 6.2 d, AO mode ▪ SLR ≤ 48 ppd/sf at peak flow ▪ Terminal MLSS ≤ 4000 mg/L	▪ All units in service ▪ Can transfer flows to the Rock Creek WRRF during maintenance	▪ Complete nitrification at nitrifying aSRT ▪ SVI = 166 mL/g	▪ Nitrifying aSRT calculated assuming a 2.0 safety factor at a temperature of 13.7°C ▪ 90th percentile SVI data
▪ ABs evaluated on MMDW PE COD load ▪ SCs evaluated on MDDWF	▪ aSRT = 4.5 d, AO mode ▪ SLR ≤ 48 ppd/sf at peak flow ▪ Terminal MLSS ≤ 4000 mg/L	▪ All units in service ▪ Can transfer flows to the Rock Creek WRRF during maintenance	▪ Complete nitrification at nitrifying aSRT ▪ SVI = 166 mL/g	▪ Nitrifying aSRT calculated assuming a 2.0 safety factor at a temperature of 18°C ▪ 90th percentile SVI data

Notes:
°C - degrees Celsius;AB - aeration basin; ADW* - modified average dry weather conditions; AWW - average wet weather; d - day; MDDWF - maximum day dry weather flow; mg/L - milligram per liter; mL/g - milliliters per gram; MLSS - mixed liquor suspended solids; NSF - nitrification safety factor - PE, primary effluent; ppd/sf - pound per day per square foot; SC - secondary clarifier; SLR - solids loading rate; SVI - sludge volume index.

As noted above, the Forest Grove WRRF receives a large industrial contribution during the dry weather season. This high load produces two dry weather conditions, each of which were considered for secondary treatment capacity:

- The maximum month dry weather load, maximum week dry weather load, and maximum day dry weather load conditions occur with the large industrial contribution. This contribution typically begins in July when the temperature is elevated and remains high through October.
- The influent load in May and June prior to the large industrial contribution is lower when the temperature is lower.
- The average dry weather load (ADWL) projections were developed from historical influent loads throughout the dry weather season. Therefore, the ADWL projections are higher than would be expected prior to the industrial contribution.
- The historical influent $cBOD_5$ load data for the Hillsboro WRRF were evaluated as an analog for the Forest Grove WRRF without the industrial contribution. The median wet and dry weather influent $cBOD_5$ loads at the Hillsboro WRRF between 2015 and 2021 were 6500 ppd and 6900 ppd, respectively (a 6 percent difference).
- An ADW* condition was developed to reflect the influent load to the Forest Grove WRRF prior to the industrial contribution. This projection used the AWWL for $CBOD_5$ and TSS and the ADWF.

Both the AWW and the ADW* conditions were considered for redundancy conditions as it was not clear which condition would be limiting.

Aerobic SRT

Nitrification is required at the Forest Grove WRRF during the dry weather season. The effluent ammonia limits are less stringent in the wet weather season; however, the District has found that maintaining nitrification year round improves settleability. The aSRT is the key operating parameter that controls nitrification, and is selected based upon minimum temperature, basin configuration, and effluent permit requirements. For 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:

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

Where:

- NSF 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 °C.
- The parameter values adopted for this analysis are summarized in Table 10.9.

Table 10.9 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.
AOB - ammonia oxidizing bacteria; NOB - nitrite oxidizing bacteria.

The minimum aSRTs calculated for each operating condition in the current capacity assessment are summarized in Table 10.10. These values are higher than the 3 d adopted in the 2014 Facility Plan that assumed the aeration basins would not be operated to nitrify. The District has found through testing that nitrification is necessary to maintain settleability. In general, the aSRTs in Table 10.10 are consistent with the District's other nitrifying facilities.

- The Rock Creek WRRF Capacity Assessment[12] adopted a minimum aSRT of 5.6 d during dry weather for complete nitrification at a temperature of 15.1°C. During wet weather, a range of aSRTs are used (3 d to 6.2 d) to balance nitrogen removal with capacity. An NSF of 1.25 with an aSRT of 3.9 d was adopted for partially nitrifying trains. Importantly, the minimum 30 d wet weather temperature at the Rock Creek WRRF (13.6°C) is higher than observed at the Forest Grove WRRF.
- The East Basin Master Plan[13] adopted minimum aSRTs of 5.8 d (dry weather) and 6.4 d (wet weather) for the Durham WRRF. The dry weather temperature used in the Durham WRRF assessment was 14.4°C, which is between the temperatures adopted herein for the MMDW and ADW* conditions.

Table 10.10 Aerobic Solids Retention Time Calculation Summary

Condition	Minimum aSRT, (d)	Nitrification Safety Factor	Temperature, (°C)
MMDW, Full Nitrification	4.5	2.00	18.0(1)
ADW*, Full Nitrification	6.2	2.00	13.7(2)
AWW and MMWW, Partial Nitrification	4.9	1.25	11.5(3)

Notes:
(1) Minimum 30 d running average of the influent temperature from 2015 through 2021 for July through October.
(2) Minimum 30 d running average of the influent temperature during the dry weather seasons from 2015 through 2021.
(3) Minimum 30 d running average of the average of the influent and effluent temperatures during the wet weather seasons from 2015 through 2021.

[12] Carollo Engineers, Inc. (2024). TM 2 - Rock Creek WRRF Capacity Assessment, West Basin Facility Plan Project 7054.
[13] Carollo Engineers, Inc., (June 2021). TM 11 - Liquids Treatment Process Capacity Analysis, East Basin 2019 Master Plan Project.

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 V_0 and n. The Vesilind parameters for the SVIs adopted herein are summarized in Table 10.11.

Table 10.11 SVI and Vesilind Parameters Based on the District's Correlation

SVI, mL/g	Initial Settling Velocity V_0 (fps)(1)	Exponent, n (mL/g)(2)
164	32.4	0.3925
166	32.5	0.3934

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.
fps - foot per second.

10.2.5.2 Secondary Treatment Capacity

Figure 10.9 depicts the secondary treatment capacity with all units in service under the MMDW (panel A), ADW* (panel B), and MMWW (panel C) conditions. Given that primary clarifiers have not been online at the Forest Grove WRRF, these plots compare the projected primary effluent $cBOD_5$ loads with historical secondary influent $cBOD_5$ loads. As noted in the Rock Creek WRRF capacity assessment,[14] influent $cBOD_5$ loads have remained relatively stable between 2020 and 2024. Consistent with the Rock Creek WRRF capacity assessment, the primary effluent $cBOD_5$ load projections in the present analysis were therefore shifted 4 years into the future to reflect the stable influent loads. The shifted projections are denoted with dashed lines in Figure 10.9). With the shifted projections:

- Secondary treatment capacity is limited under the MMDW condition with a trigger year of 2035 (Figure 10.9A).
- Secondary treatment capacity is limited under the ADW* condition three years later (Figure 10.9B) due to the higher aSRT (6.2 d vs. 4.5 d, nearly 40 percent higher) needed to maintain complete nitrification at lower temperatures.
- Wet weather operation does not limit secondary treatment capacity based on an NSF of 1.25 (Figure 10.9C). More complete nitrification with higher NSFs would cause wet weather operation to limit capacity.

[14] Carollo Engineers, Inc. (2024). TM 2 - Rock Creek WRRF Capacity Assessment, West Basin Facility Plan Project 7054.

- The maximum aeration basin MLSS concentration of 4000 mg/L adopted as the design criterion (Table 10.8) limits secondary treatment capacity under the dry weather conditions.
- Under the MMWW condition, secondary treatment capacity is limited by the 48 ppd/sf SLR adopted as the design criterion (Table 10.8). The MLSS concentration is 3800 mg/L at 2037 under the MMWW condition.

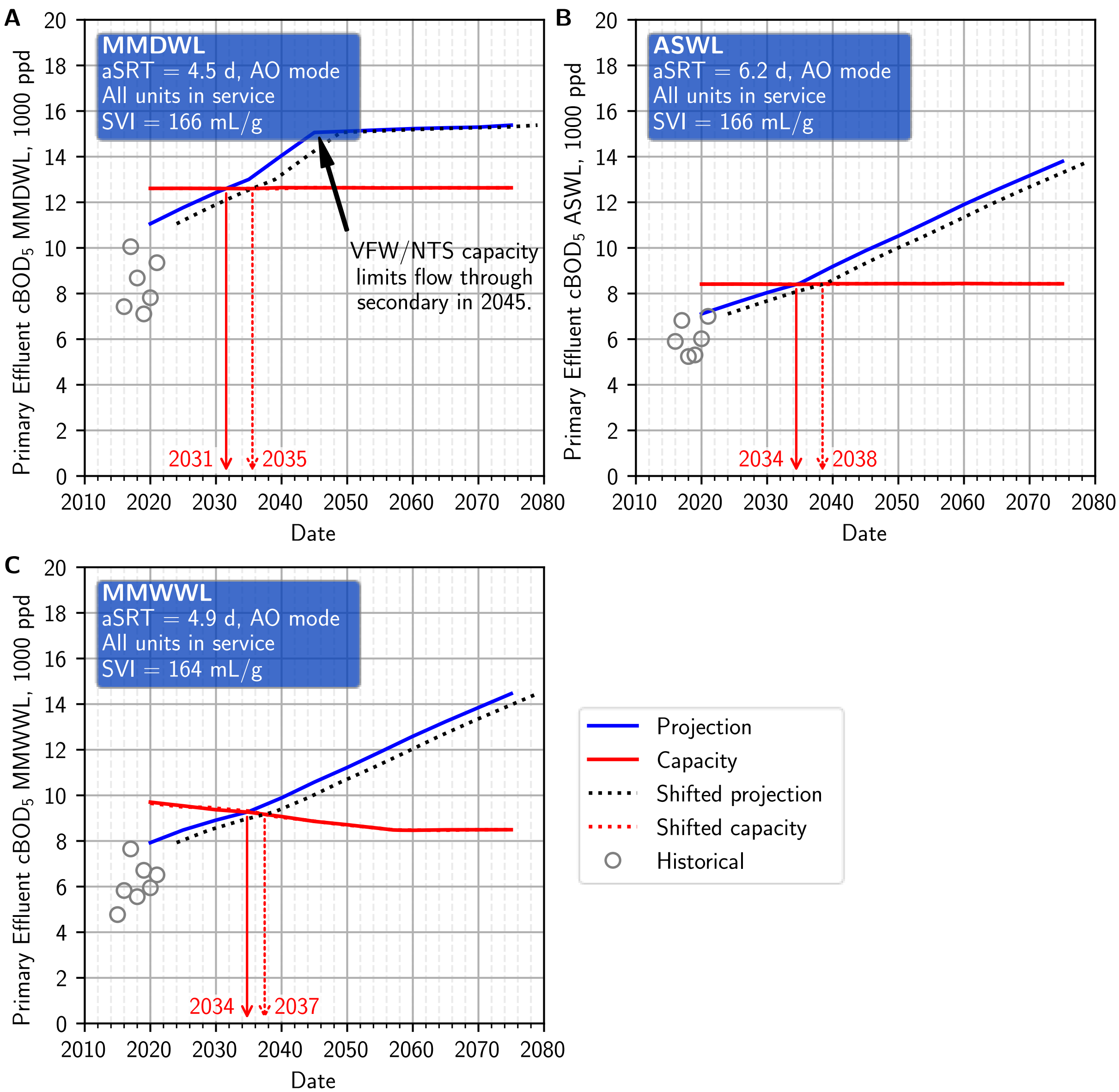

Figure 10.9 Secondary Treatment Trigger Plots

The secondary treatment capacity trigger years are projected to fall within the planning period, even with the installation of primary clarifiers at the Forest Grove WRRF. The projected loads to secondary treatment at the Forest Grove WRRF are higher than the facility has seen historically. The 2020 projected $cBOD_5$

loads were compared to the median historical loads from 2015 through 2021 to isolate the difference. This is summarized for the MMDW condition in Table 10.12 and may be explained as follows:

- The historical combined Hillsboro and Forest Grove collection system MMDW $cBOD_5$ load is consistent with the 2020 projected combined Hillsboro and Forest Grove MMDW $cBOD_5$ load.
- The projected 2020 MMDW combined influent $cBOD_5$ loads to the Forest Grove WRRF (consisting of the Forest Grove WRRF collection system, the new Council Creek pump station, and transfer flows from the Hillsboro WRRF) are 32 percent higher than the facility has seen. This difference is due to:
  - » Historically, the primary clarifiers at the Hillsboro WRRF have generally been online. The primary effluent $cBOD_5$ load ultimately transferred to the Forest Grove WRRF is reduced by removal in the primary clarifier as well as load reduction through flow diversion for carrier water.
  - » The District has identified a leaking valve at the Christmas tree. Due to this, not all the primary effluent from the Hillsboro WRRF found its way to the Forest Grove WRRF during previous dry weather seasons.
- The 2020 projected primary influent $cBOD_5$ load at the Forest Grove WRRF is 70 percent higher than the historical secondary influent $cBOD_5$ load. This discrepancy is higher than what is observed for the combined influent due to the lower projected grit effluent transfer flow to the HHPS.
- The 2020 projected MMDW primary effluent $cBOD_5$ load is 35 percent higher than the historical MMDW aeration basin influent load. The reduction in difference relative to the primary influent is due to projected cBOD5 removal in the new primary clarifiers. The removal achieved in these clarifiers is not projected to completely offset the higher primary influent resulting from reduced transfer loads to the Rock Creek WRRF.

Table 10.12 Comparison of Historical and Projected MMDW cBOD5 Loads

Condition/Stream	2015 – 2020 Historical(1) (ppd)	2020 Projected(2) (ppd)	Absolute Difference(3) (ppd)	Relative Difference(3) (%)
Collection System	16,000	15,000	-1200	-8
Combined Influent	12,000	17,000	**4700**	**32**
Grit Effluent Transferred to HHPS(4)	4700	1000	**-3600**	**-130**
Primary Influent(5)	7800	16,000	**8400**	**70**
Primary Effluent(5)	7800	11,000	**3300**	**35**

Notes:
(1) Median historical loads from 2015 through 2020.
(2) Projections for 2020.
(3) Absolute and relative differences set in **bold** denote projected values that are more than 30 percent different than seen historically.
(4) Historical grit effluent transfer to the HHPS calculated by difference between the aeration basin influent and combined influent loads.
(5) Historical primary influent and effluent loads are determined from the aeration basin influent flow and combined influent $cBOD_5$ concentration.

Figure 10.10 depicts secondary treatment capacity for the four redundancy conditions. As shown:

- The Forest Grove WRRF does not have sufficient secondary treatment capacity to take an aeration basin out of service under either the ADW* or AWW condition currently (Figure 10.10A and Figure 10.10C). In both conditions, halving the secondary treatment volume would increase the MLSS concentration above the 4000 mg/L maximum design criterion (Table 10.8).
  - » This evaluation is based on the updated flow and load projections that assume the new Council Creek pump station is operational currently and that the primary clarifiers at the Hillsboro WRRF are not operated during the ADW* condition.
  - » Operating the primary clarifiers at the Hillsboro WRRF and transferring approximately 3 mgd to the Rock Creek WRRF under the ADW* condition would be sufficient to push the trigger year for the one aeration basin out of service criterion to 2035 with the shifted projections.
  - » Given the District's ability to accommodate the aeration basin redundancy criterion by transferring flows to the Rock Creek WRRF, this was not treated as the limiting for secondary treatment capacity at the Forest Grove WRRF.
- Secondary clarifier 3 may be taken out of service under both the ADW* and AWW conditions (Figure 10.10B and Figure 10.10D). Secondary treatment capacity is more limited under the AWW condition.
  - » Under the ADW* condition, secondary treatment capacity is limited by the MLSS concentration in the aeration basins (as noted above for the ADW* condition with all units in service).
  - » Under the AWW condition, secondary treatment capacity is limited by the 48 ppd/sf SLR adopted as the design criterion (Table 10.8).
  - » Peak flows may be transferred to the Rock Creek WRRF under the AWW condition with secondary clarifier 3 out of service to push the trigger year later.
  - » To reach 2035 (the trigger year for the ADW* condition with the shifted projections, Figure 10.10B) such that both the ADW* and AWW limited for the secondary clarifier redundancy condition, 6.5 mgd would need to be transferred to the Rock Creek WRRF.
  - » Given the District's ability to accommodate the secondary clarification redundancy criterion by transferring flows to the Rock Creek WRRF, this was not treated as limiting for secondary treatment capacity at the Forest Grove WRRF.

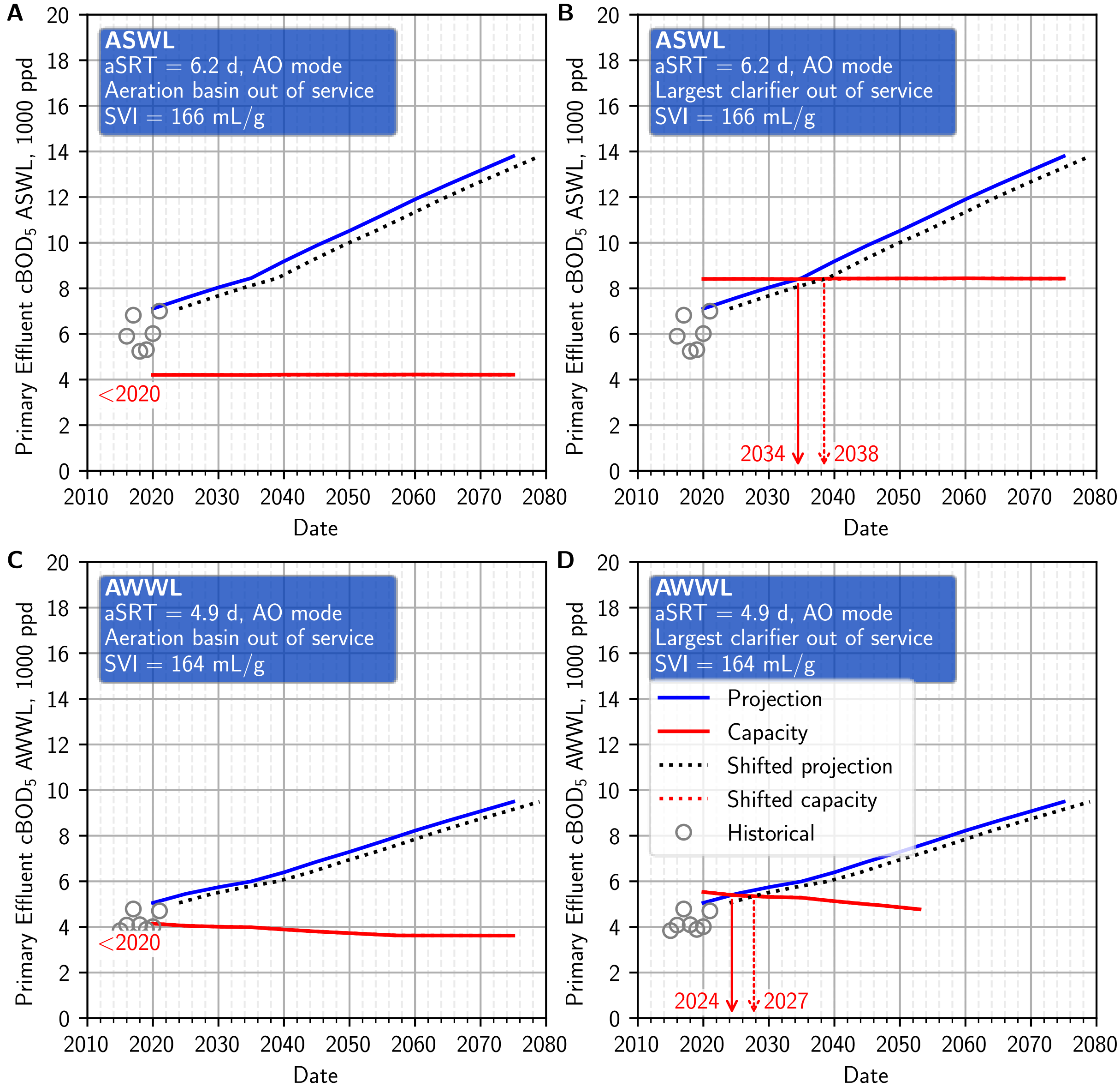

Figure 10.10 Secondary Treatment Trigger Plots for Redundancy Criteria

The trigger years summarized in Figure 10.9 and Figure 10.10 assumed the Hillsboro WRRF primary clarifiers would be offline during the dry weather season and screened and degritted wastewater from the Hillsboro WRRF would be transferred to the Forest Grove WRRF. This is the District's anticipated operating approach once the primary clarifiers at the Forest Grove WRRF are commissioned. This results in a higher overall load to the Forest Grove WRRF than if the primary clarifiers at the Hillsboro WRRF were operational and primary effluent was transferred to the Forest Grove WRRF. Additionally, these trigger years were developed assuming that the minimum transfer flow from the Forest Grove WRRF would be 1 mgd. This transfer flow was higher than the 0.5 mgd assumed in the Rock Creek and Hillsboro WRRF capacity evaluations[15] and reflects a value that is closer to historical operation. Higher minimum transfer flows require a higher diversion of grit effluent, which reduces the load onto subsequent treatment processes.

10.2.6 Secondary Effluent Pump Station

A new secondary effluent pump station was added at the Forest Grove WRRF in 2023. The secondary effluent pump station consists of seven pumps (Table 10.13) and can deliver the 30 mgd at 25 feet of total dynamic head (TDH) with one large pump out of service corresponding to the capacity of the wet weather outfall. Holding the outfall to this capacity, the secondary effluent pump station has sufficient capacity through buildout

Table 10.13 Existing Secondary Effluent Pump Station

Description	Units	Large Pumps	Small Pumps
Number of pumps	qty	4	3
Capacity per pump	mgd	6 at 48 ft TDH	3 at 48 ft TDH
Motor size	hp	85	50

10.2.7 Disinfection

A new ultraviolet (UV) disinfection system was added at the Forest Grove WRRF in 2023. The UV system consists of five low pressure, high output, closed vessel UV units, each with a dry and wet weather capacity of 6.9 mgd and 8.2 mgd, respectively.

Table 10.14 summarizes the design criteria for disinfection. Redundancy for disinfection has been provided under average dry weather flow (ADWF) conditions at the Rock Creek WRRF and average annual flow (AAF) at the Durham WRRF, both of which are consistent with Oregon DEQ guidance.[16] Historically, Carollo has designed UV disinfection systems to provide treatment under the peak day flow with one unit out of service. The design criteria in Table 10.14 reflect the 2023 design. Importantly, this redundancy criterion differs from the District's other UV disinfection system at the Hillsboro WRRF which was designed with the intention of passing the maximum week wet weather flow with one unit out of service.

Table 10.14 Disinfection Design Criteria.

Flow/Load Condition	Design Criteria	Redundancy Criteria	Performance Assumption	Reference
MDWWF	Installed Firm Capacity	One unit out of service	N/A	2023 Design
MHWWF	Installed Rated Capacity	▪ All units in service ▪ Can transfer flow to the Rock Creek WRRF during maintenance	N/A	2023 Design

[15] Carollo Engineers, Inc. (2024). TM 2 - Rock Creek WRRF Capacity Assessment, West Basin Facility Plan Project 7054. Carollo Engineers, Inc. (Forthcoming). TM 11 - Hillsboro WRRF Capacity Evaluation, West Basin Facility Plan Project 7054.
[16] Oregon Department of Environmental Quality. (2009-06) Implementing Oregon's Recycled Water Use Rules. Internal Management Directive.

Figure 10.11 depicts the disinfection trigger plots for the two conditions evaluated. As shown, the system will have sufficient capacity through buildout. This analysis assumes influent flow is diverted to the HHPS to limit flow through the facility based on the 30 mgd outfall capacity.

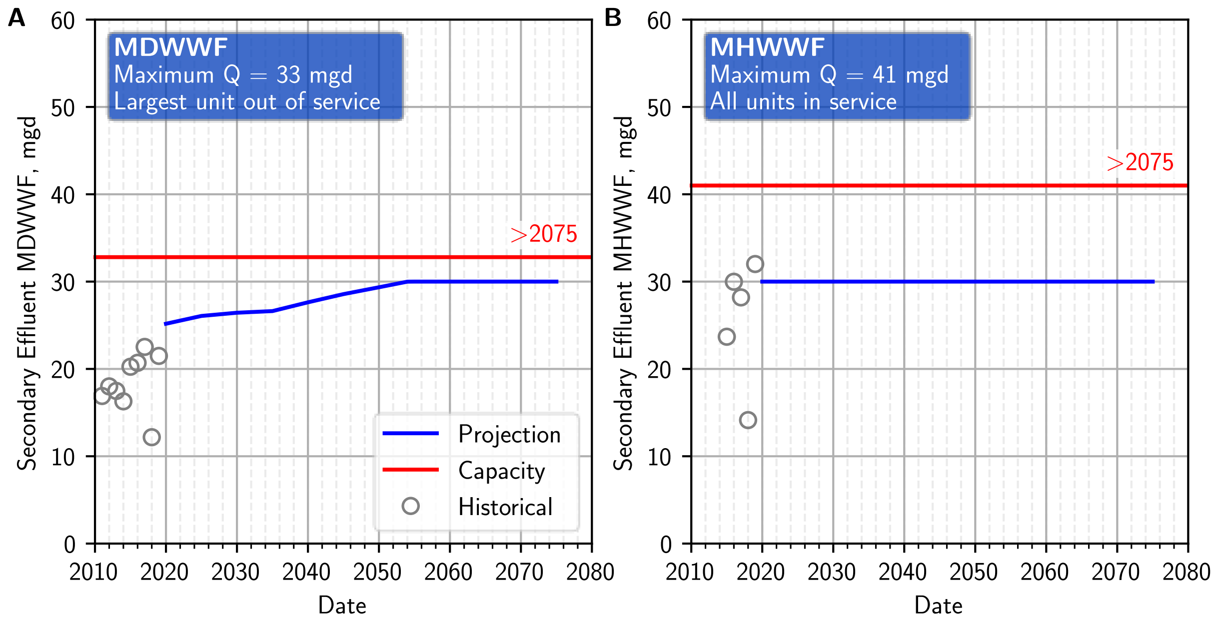

Figure 10.11 Disinfection Trigger Plot

10.2.8 Outfall

The Forest Grove WRRF discharges directly to the Tualatin River during the wet weather season. The hydraulic capacity of the outfall is 30 mgd, which will be verified as part of the Forest Grove WRRF hydraulic evaluation.[17] For the present analysis of the outfall capacity, it was assumed that the effluent flow under wet weather conditions would be limited to 30 mgd. Influent flow would be diverted to the HHPS from the primary influent as needed to maintain an effluent flow less than or equal to this threshold under wet weather conditions.

- The 30 mgd outfall capacity would require influent flows to be transferred to the Rock Creek WRRF as summarized in Table 10.15. As shown, maximum hour wet weather (MHWW) flows will need to be transferred currently while MDWW flows will not need to be transferred within the planning period. More frequent flows will not need to be transferred through buildout.

Table 10.15 Year Flow Transfer is Required for Wet Weather Outfall Hydraulic Capacity

Condition	AWW	MMWW	MWWW	MDWW	MHWW
Year	N/A	N/A	N/A	2054	**2020**

Notes:
(1) Values set in **bold** occur in the next ten years (2024 to 2034).
MWWW - maximum week wet weather.

[17] Carollo Engineers, Inc. (Forthcoming). TM 14 - Forest Grove WRRF Hydraulic Capacity Assessment, West Basin Facility Plan Project 7054.

- Effluent may also be directed to Fernhill Lake under high river flow conditions. This was not considered in the present evaluation.
- Expanding the wet weather outfall capacity would allow higher flows through the process. If completed, secondary treatment, secondary effluent pumping, disinfection, transfer flow pumping, and the flow transfer system pipelines may have trigger years earlier than identified herein.

10.2.9 Vertical Flow Wetland and Natural Treatment System

The Forest Grove WRRF discharges to the Tualatin River through a vertical flow wetland (VFW) and passive NTS during the dry weather season. The VFW was originally developed to remove ammonia. The District currently operates secondary treatment to nitrify and residual secondary effluent ammonia is oxidized in the VFW. The District achieves additional ammonia as well as copper, phosphorus, and TSS removal in the NTS.

The District has observed elevated TSS concentrations in the NTS effluent under high flows and has adopted 12 mgd as the process' hydraulic capacity. Like the wet weather outfall hydraulic capacity, it was assumed for the present analysis that effluent flows under dry weather conditions would be limited at this threshold. Influent flow would be diverted to the HHPS from the primary influent as needed to maintain an effluent flow less than or equal to 12 mgd under dry weather conditions.

- The 12 mgd NTS capacity requires influent flows to be transferred to the Rock Creek WRRF under dry weather conditions as summarized in Table 10.15. As shown, MDDW and maximum week dry weather (MWDW) flows will need to be transferred currently and MMDW will need to be transferred before the end of the planning period. The ADW flow will not need to be transferred through buildout.

Table 10.16 Year Flow Transfer is Required for Dry Weather NTS Hydraulic Capacity

Condition	ADW	MMDW	MWDW	MDDW
Year	N/A	*2042*	**2020**	**2020**

Notes:
(1) Values set in **bold** occur in the next ten years (2024 to 2034). Values set in *blue italic* occur after the next ten years, but within the planning period (2035 to 2045).

- Effluent may also be directed to Fernhill Lake under high river flow conditions. This was not considered in the present evaluation.
- The District is currently evaluating the 12 mgd hydraulic capacity of the NTS. The hydraulic capacity of the VFW (approximately 13.5 mgd) would provide the next limit. If this flow could be sustained through the VFW and NTS without increasing the effluent TSS concentration, several processes would have trigger years earlier than identified herein. These processes include secondary treatment, transfer flow pumping, and the flow transfer system pipelines.

10.2.10 High Head Pump Station and Flow Transfer System

The flow transfer system (shown schematically in Figure 10.12) allows for the transfer of liquid and solids streams between the Rock Creek, Hillsboro, and Forest Grove WRRFs. It consists of a HHPS at each facility, a pair of 24 inch diameter pipelines that run between the facilities, and a valve tree at the central nexus that interconnects the pipelines (colloquially referred to as the Christmas Tree by the District). Due to its interconnected nature, the capacity of the flow transfer system is addressed in the both the Forest Grove WRRF capacity evaluation and the Hillsboro WRRF capacity evaluation.[18]

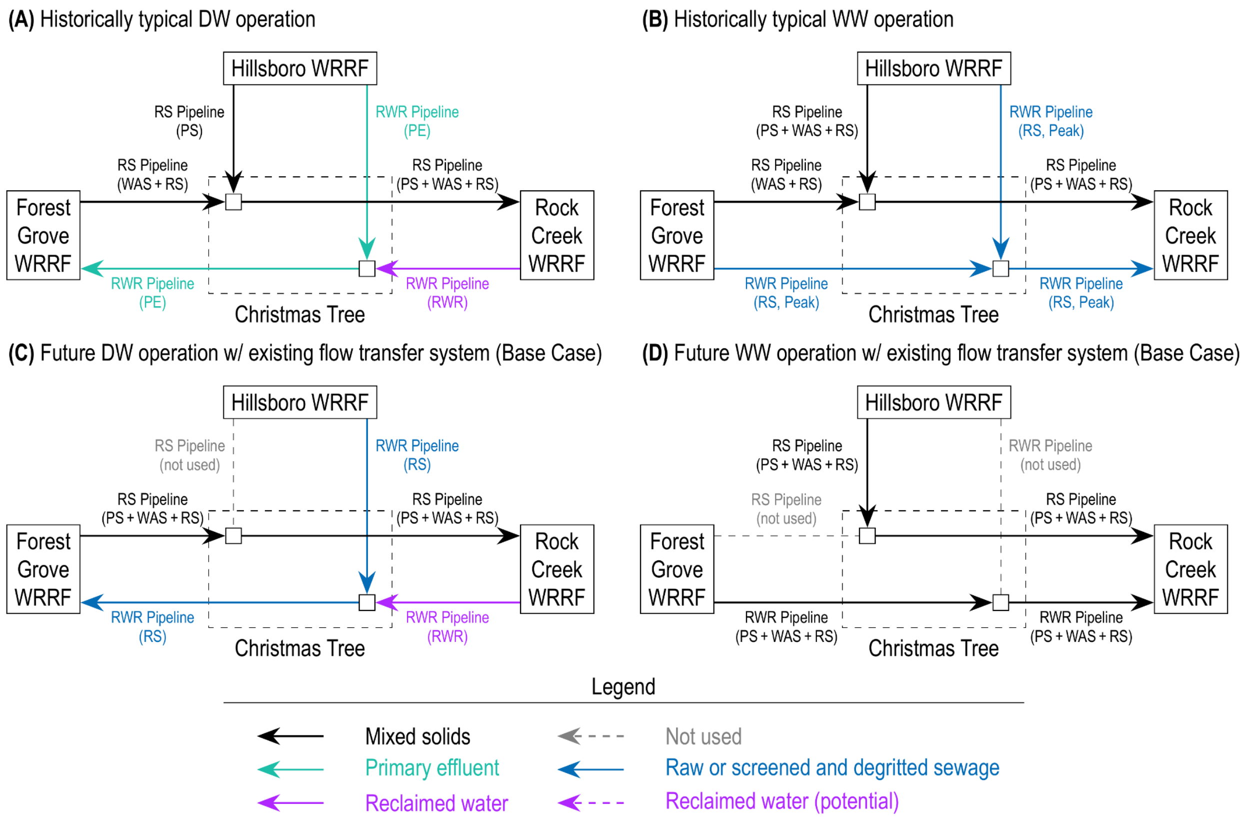

Figure 10.12 Flow Transfer System Schematic

Three pumps are available in the Forest Grove WRRF HHPS (Table 10.17) to transfer screened and degritted wastewater, final effluent, WAS, and primary solids (PS) to the Rock Creek WRRF via either the raw sewage (RS) or reclaimed water (RWR) pipelines. One of the two larger 10 mgd, 450 hp pumps is intended to provide reuse water for local irrigation (which is not currently practiced). This irrigation pump also provides redundancy for the other high-pressure pump. A smaller, low-pressure pump (10 mgd, 75 hp) is also available and is commonly used under low flow conditions.

Table 10.17 Existing High-Head Pump Station

Pump Name	Drive Motor (hp)	Nominal Capacity	Actual Capacity(1)
Low pressure pump	75	5 mgd at 56 feet	3.5 mgd
High pressure pump	450	10 mgd at 169 feet	8 mgd
Irrigation pump	450	10 mgd at 169 feet	8 mgd

Notes:
(1) Maximum capacity identified by the District based on historical operation.

[18] Carollo Engineers, Inc. (Forthcoming). TM 11 - Hillsboro WRRF Capacity Evaluation, West Basin Facility Plan Project 7054.

The actual flow transfer system capacity depends on the destination and the operation of the Hillsboro WRRF. Historically the Hillsboro and Forest Grove WRRFs have operated on independent pipelines (shown in Figure 10.12A and B). Competition between the pumps at the two facilities has made discharging to a common line difficult. Additionally, the existing transfer pumps are not able to deliver their nominal capacity. Based on the District’s operating experience, the Forest Grove WRRF HHPS can only deliver 8 mgd through each of the pipelines with the high-pressure and irrigation pumps and 3.5 mgd with the low-pressure pump (Table 10.17). These limitations were adopted for the present capacity evaluation. A hydraulic evaluation of the flow transfer system is underway to refine the capacity of both the HHPS and the flow transfer system pipelines.

Figure 10.12C and Figure 10.12D depict the flow transfer system configurations assumed for the present analysis under dry and wet weather conditions, respectively. Under dry weather conditions, the RWR line would be used to convey screened and degritted sewage to the Forest Grove WRRF from the Hillsboro WRRF and the Forest Grove WRRF would use the RS line to convey primary solids, WAS and peak flows in excess of 12 mgd to the Rock Creek WRRF. Under wet weather conditions, solids and peak flows would be transferred to the Rock Creek WRRF from the Forest Grove and Hillsboro WRRFs with the RWR and RS pipelines, respectively.

Figure 10.13 depicts the trigger plots for the RS and RWR pipelines leaving the HHPS for the limiting flow conditions when transfer is anticipated (MHWWF, MDWWF, and MDDWF). As shown:

- The MHWWF and MDWWF are less than the 16 mgd combined maximum for the RS and RWR lines leaving the HHPS (panels A, B, C, and D in Figure 10.13).
- Both pipelines would be required to transfer the MHWWF starting in 2038 (panels A and C in Figure 10.13).
- The MDWWF would not need to be transferred in both lines (panels C and D in Figure 10.13).
- The MHWWF would need to be transferred from the Forest Grove WRRF to the Rock Creek WRRF immediately (panel B). This is consistent with historical practice. MDWWF would need to be transferred starting in 2054 (Figure 10.13D).

The 8 mgd capacity is reached under the MDDWF condition in 2041 (Figure 10.13E). The trigger year would be moved to 2057 by alleviating the HHPS limitations at both facilities so that the flow could be transferred from the Forest Grove WRRF to the Rock Creek WRRF at the RS pipeline capacity of 12 mgd.

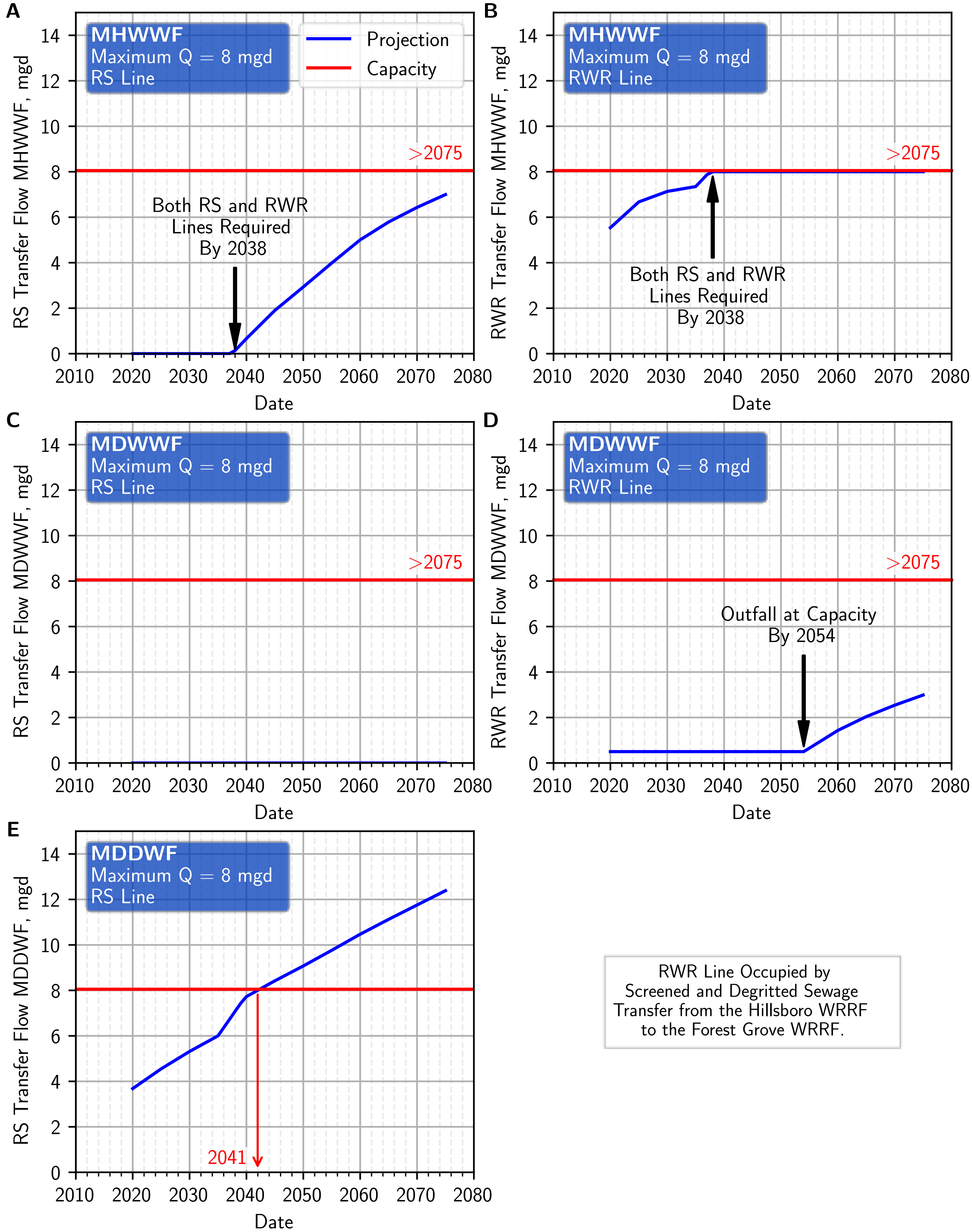

Figure 10.13 Flow Transfer System Trigger Plot, Forest Grove WRRF to the Christmas Tree

The capacity of the two 24 in pipelines between the Christmas Tree and the Rock Creek WRRF was also evaluated. The capacity of these lines depends on the operation of the Hillsboro WRRF and details specific to that facility are discussed in the Hillsboro WRRF Capacity Evaluation. The resulting capacity of the flow transfer system is depicted in Figure 10.14. As shown:

- Both facilities will need to discharge to the RS pipeline by 2038 to transfer MHWWF to the Rock Creek WRRF (panels A and B). At this year, the capacity of the HHPS at the Forest Grove WRRF requires the use of both the RS and RWR lines to transfer peak wet weather flows. As noted above, the Hillsboro WRRF uses the RS line to convey solids to the Rock Creek WRRF under wet weather conditions.
- MDWWF will need to be transferred to the Rock Creek WRRF from the Hillsboro WRRF starting in 2059 (panel C) and from the Forest Grove WRRF in 2054 (panel D).
- The RS line from the Christmas Tree to the Rock Creek WRRF will reach capacity in 2057 (panel E). At this year, the combined MDDWF transferred from the Hillsboro WRRF (flow greater than the transfer capacity of 7.1 mgd) and the Forest Grove WRRFs (flow greater than the NTS capacity of 12 mgd) will exceed the 12 mgd capacity.

Both the shared pipeline limitation and the 8 mgd limitation are driven by the capacity limitations in the HHPS. Therefore, flow transfer pumping at the Forest Grove WRRF has trigger years between 2038 and 2041.

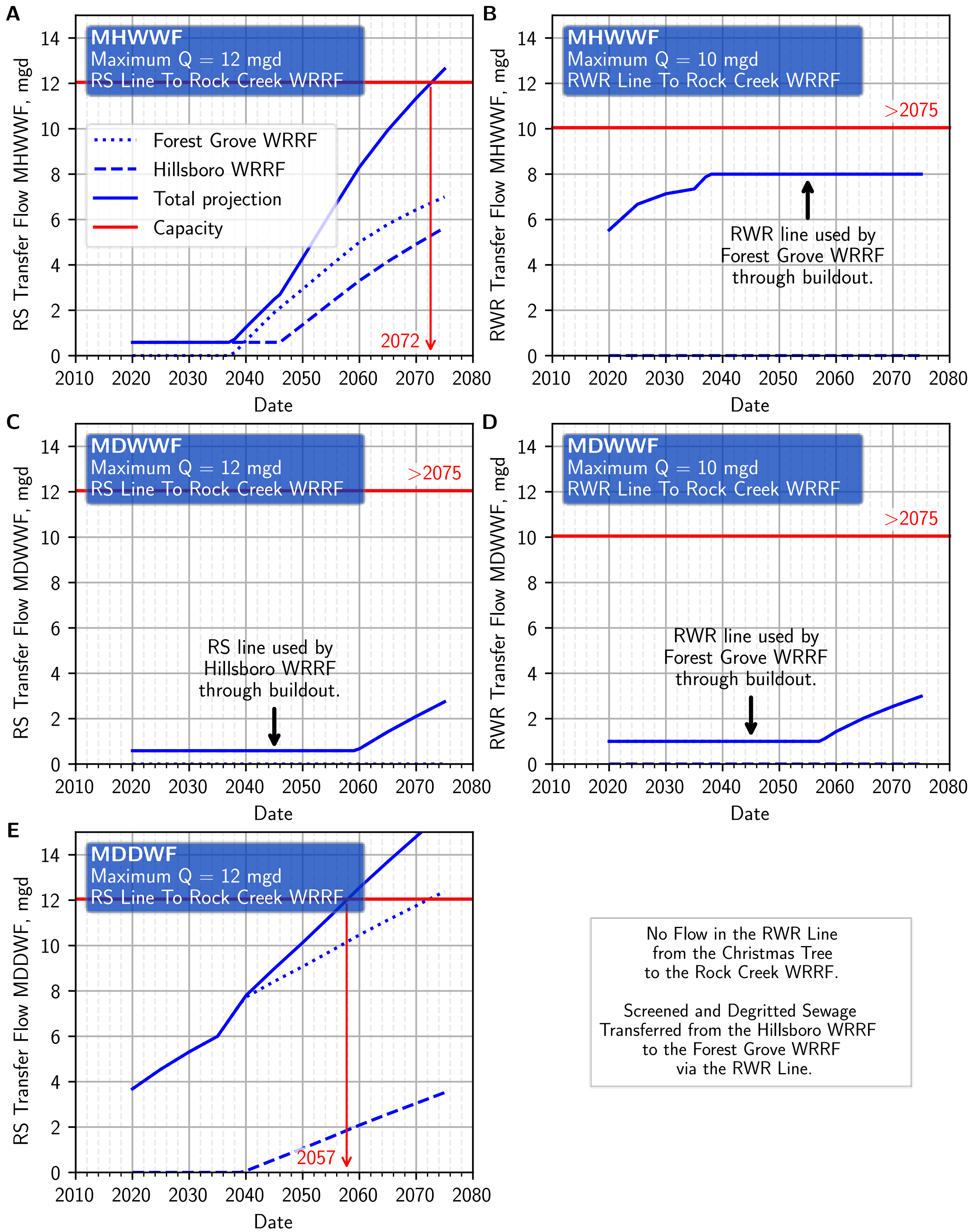

Figure 10.14 Flow Transfer System Trigger Plot, Christmas Tree to the Rock Creek WRRF

10.3 Capacity Results

Table 10.18 summarizes the treatment process capacity trigger years at the Forest Grove WRRF.

- Trigger years occurring in the next ten years (between 2024 and 2034) are set in **bold** and include influent screening which is out of capacity currently and secondary treatment. Additionally, a portion of the MHWWF and MDDWF and maximum week dry weather flow will need to be transferred to the Rock Creek WRRF to stay below the hydraulic capacity of the outfall and NTS.
- The influent pump station, grit removal, and the HHPS will be out of capacity in the last half of the planning period (set in *blue italic*). Additionally, a portion of the MMDWF will need to be transferred to the Rock Creek WRRF to stay below the hydraulic capacity of the NTS.
- The primary clarifier and the RS line are out of capacity before buildout. A portion of the MDWWF will need to be transferred to the Rock Creek WRRF before buildout to stay below the hydraulic capacity of the outfall.
- The remaining processes evaluated (effluent pumping and disinfection) have sufficient capacity through buildout.

Table 10.18 Capacity Summary

Unit Process	ADW	MMDW	MWDW	MDDW	AWW	MMWW	MWWW	MDWW	MHWW
Influent Screening	N/A	N/A	N/A	N/A	N/A	**<2020**	N/A	N/A	*2045*
Influent Pump Station	N/A	N/A	N/A	N/A	N/A	N/A	N/A	>2075	*2045*
Grit Removal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	>2075	*2045*
Primary Clarification	>2075	N/A	N/A	N/A	2071	>2075	N/A	N/A	>2075
Secondary Treatment	**2034-2038**	**2031-2035**	N/A	N/A	N/A	**2034–2037**	N/A	N/A	N/A
Effluent Pumping	N/A	N/A	N/A	N/A	N/A	N/A	N/A	>2075	>2075
Disinfection	N/A	N/A	N/A	N/A	N/A	N/A	N/A	>2075	>2075
Outfall(2)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2054	**2020**
NTS(2)	N/A	*2042*	**2020**	**2020**	N/A	N/A	N/A	N/A	N/A
High Head Pump Station	N/A	N/A	N/A	*2041*	N/A	N/A	N/A	N/A	*2038*
RS and RWR Pipelines	N/A	N/A	N/A	2057	N/A	N/A	N/A	N/A	N/A

Notes:
(1) Values set in **bold** occur in the next ten years (2024 to 2034). Values set in *blue italic* occur after the next ten years, but within the planning period (2035 to 2045).
(2) Years when flow must be transferred to the Rock Creek WRRF to accommodate hydraulic capacities of the outfall during wet weather and natural treatment system during dry weather.

APPENDIX 10A FLOW AND LOAD PROJECTIONS

FLOW AND LOAD PROJECTIONS

This appendix summarizes the flow and load projections for the Hillsboro and Forest Grove WRRFs used in Forest Grove WRRF capacity assessment.

Table 10A.1 Hillsboro WRRF Influent Flow Projections

Year	Baseflow	AA	ADW	MMDW	MWDW	MDDW	AWW	MMWW	MWWW	MDWW	PH
2020	2.3	3.4	2.4	3.6	4.6	5.2	4.4	9.0	11.9	14.1	15.9
2021	2.3	3.4	2.5	3.6	4.6	5.3	4.4	9.0	11.9	14.2	16.0
2022	2.3	3.5	2.5	3.7	4.7	5.3	4.5	9.0	12.0	14.2	16.0
2023	2.3	3.5	2.5	3.7	4.7	5.4	4.5	9.1	12.0	14.3	16.1
2024	2.4	3.5	2.5	3.7	4.8	5.4	4.5	9.1	12.1	14.3	16.1
2025	2.4	3.6	2.5	3.8	4.8	5.5	4.6	9.1	12.1	14.4	16.2
2026	2.4	3.6	2.6	3.8	4.9	5.5	4.6	9.2	12.2	14.4	16.3
2027	2.4	3.7	2.6	3.9	4.9	5.6	4.7	9.3	12.3	14.5	16.4
2028	2.5	3.7	2.6	3.9	5.0	5.7	4.7	9.3	12.3	14.6	16.5
2029	2.5	3.7	2.7	4.0	5.1	5.7	4.8	9.4	12.4	14.7	16.6
2030	2.5	3.8	2.7	4.0	5.1	5.8	4.9	9.4	12.5	14.8	16.7
2031	2.6	3.8	2.7	4.0	5.2	5.9	4.9	9.5	12.6	14.9	16.8
2032	2.6	3.9	2.8	4.1	5.2	5.9	5.0	9.5	12.6	15.0	16.9
2033	2.6	3.9	2.8	4.1	5.3	6.0	5.0	9.6	12.7	15.1	17.0
2034	2.6	4.0	2.8	4.2	5.3	6.1	5.1	9.6	12.8	15.1	17.1
2035	2.7	4.0	2.9	4.2	5.4	6.1	5.1	9.7	12.8	15.2	17.2
2036	2.8	4.1	3.0	4.4	5.6	6.3	5.3	9.9	13.2	15.6	17.6
2037	2.9	4.3	3.1	4.5	5.8	6.6	5.5	10.2	13.5	16.0	18.0
2038	2.9	4.4	3.2	4.7	5.9	6.8	5.6	10.4	13.8	16.4	18.5
2039	3.0	4.6	3.3	4.8	6.1	7.0	5.8	10.7	14.2	16.8	18.9
2040	3.1	4.7	3.4	4.9	6.3	7.2	6.0	11.0	14.5	17.2	19.4
2041	3.2	4.8	3.4	5.0	6.4	7.3	6.1	11.1	14.6	17.4	19.6
2042	3.2	4.8	3.4	5.1	6.5	7.4	6.2	11.2	14.8	17.5	19.8
2043	3.3	4.9	3.5	5.1	6.6	7.5	6.2	11.3	15.0	17.7	20.0
2044	3.3	5.0	3.5	5.2	6.7	7.6	6.3	11.4	15.1	17.9	20.2
2045	3.3	5.0	3.6	5.3	6.7	7.7	6.4	11.5	15.3	18.1	20.4
2046	3.4	5.1	3.6	5.3	6.8	7.8	6.5	11.6	15.4	18.3	20.6
2047	3.4	5.1	3.7	5.4	6.9	7.9	6.6	11.8	15.5	18.4	20.8
2048	3.5	5.2	3.7	5.5	7.0	8.0	6.7	11.9	15.7	18.6	21.0
2049	3.5	5.3	3.8	5.5	7.1	8.1	6.7	12.0	15.8	18.8	21.2
2050	3.6	5.3	3.8	5.6	7.2	8.2	6.8	12.1	16.0	19.0	21.4

Year	Baseflow	AA	ADW	MMDW	MWDW	MDDW	AWW	MMWW	MWWW	MDWW	PH
2051	3.6	5.4	3.9	5.7	7.3	8.3	6.9	12.2	16.1	19.1	21.6
2052	3.7	5.5	3.9	5.8	7.4	8.4	7.0	12.3	16.3	19.3	21.8
2053	3.7	5.5	4.0	5.8	7.4	8.5	7.1	12.4	16.4	19.5	22.0
2054	3.7	5.6	4.0	5.9	7.5	8.6	7.2	12.5	16.6	19.6	22.1
2055	3.8	5.7	4.1	6.0	7.6	8.7	7.2	12.6	16.7	19.8	22.3
2056	3.8	5.7	4.1	6.0	7.7	8.8	7.3	12.8	16.9	20.0	22.5
2057	3.9	5.8	4.2	6.1	7.8	8.9	7.4	12.9	17.0	20.2	22.7
2058	3.9	5.9	4.2	6.2	7.9	9.0	7.5	13.0	17.1	20.3	22.9
2059	4.0	5.9	4.2	6.3	8.0	9.1	7.6	13.1	17.3	20.5	23.1
2060	4.0	6.0	4.3	6.3	8.1	9.2	7.7	13.2	17.4	20.7	23.3
2061	4.1	6.1	4.3	6.4	8.2	9.3	7.8	13.3	17.6	20.8	23.5
2062	4.1	6.1	4.4	6.5	8.2	9.4	7.8	13.4	17.7	21.0	23.6
2063	4.1	6.2	4.4	6.5	8.3	9.5	7.9	13.5	17.8	21.1	23.8
2064	4.2	6.3	4.5	6.6	8.4	9.6	8.0	13.6	17.9	21.3	24.0
2065	4.2	6.3	4.5	6.7	8.5	9.7	8.1	13.7	18.1	21.4	24.1
2066	4.3	6.4	4.6	6.7	8.6	9.8	8.2	13.8	18.2	21.6	24.3
2067	4.3	6.5	4.6	6.8	8.7	9.9	8.2	13.8	18.3	21.7	24.5
2068	4.4	6.5	4.7	6.9	8.8	10.0	8.3	13.9	18.4	21.8	24.6
2069	4.4	6.6	4.7	6.9	8.8	10.1	8.4	14.0	18.5	22.0	24.8
2070	4.4	6.6	4.8	7.0	8.9	10.1	8.5	14.1	18.6	22.1	24.9
2071	4.5	6.7	4.8	7.1	9.0	10.2	8.6	14.2	18.8	22.2	25.1
2072	4.5	6.8	4.8	7.1	9.1	10.3	8.6	14.3	18.9	22.4	25.2
2073	4.6	6.8	4.9	7.2	9.2	10.4	8.7	14.4	19.0	22.5	25.3
2074	4.6	6.9	4.9	7.3	9.3	10.5	8.8	14.4	19.1	22.6	25.5
2075	4.6	7.0	5.0	7.3	9.3	10.6	8.9	14.5	19.2	22.7	25.6

Table 10A.2 Hillsboro WRRF Influent cBOD Load Projections

Year	AA	ADW	MMDW	MWDW	MDDW	AWW	MMWW	MWWW	MDWW
2020	4,976	5,078	6,097	9,818	13,191	4,847	5,568	6,764	11,431
2021	5,008	5,110	6,136	9,880	13,275	4,878	5,603	6,807	11,503
2022	5,039	5,142	6,174	9,942	13,358	4,909	5,638	6,849	11,575
2023	5,070	5,174	6,213	10,004	13,441	4,939	5,673	6,892	11,648
2024	5,102	5,206	6,251	10,066	13,524	4,970	5,709	6,935	11,720
2025	5,133	5,238	6,290	10,128	13,608	5,000	5,744	6,978	11,792
2026	5,196	5,303	6,367	10,252	13,775	5,062	5,814	7,063	11,937
2027	5,259	5,367	6,444	10,377	13,942	5,123	5,885	7,149	12,081
2028	5,322	5,431	6,522	10,501	14,109	5,185	5,955	7,235	12,226
2029	5,385	5,496	6,599	10,626	14,276	5,246	6,026	7,320	12,371

Year	AA	ADW	MMDW	MWDW	MDDW	AWW	MMWW	MWWW	MDWW
2030	5,448	5,560	6,676	10,750	14,443	5,307	6,096	7,406	12,516
2031	5,507	5,620	6,748	10,866	14,599	5,365	6,162	7,486	12,651
2032	5,566	5,680	6,820	10,982	14,755	5,422	6,228	7,566	12,786
2033	5,625	5,740	6,892	11,098	14,911	5,479	6,294	7,646	12,921
2034	5,684	5,800	6,964	11,214	15,067	5,537	6,360	7,726	13,056
2035	5,743	5,860	7,036	11,330	15,223	5,594	6,425	7,806	13,191
2036	5,852	5,972	7,171	11,546	15,513	5,701	6,548	7,955	13,443
2037	5,962	6,084	7,305	11,763	15,804	5,807	6,671	8,104	13,695
2038	6,071	6,196	7,439	11,979	16,095	5,914	6,793	8,253	13,947
2039	6,181	6,308	7,574	12,195	16,385	6,021	6,916	8,402	14,199
2040	6,291	6,420	7,708	12,412	16,676	6,128	7,039	8,551	14,451
2041	6,376	6,507	7,813	12,581	16,903	6,211	7,135	8,667	14,647
2042	6,462	6,594	7,918	12,750	17,130	6,295	7,230	8,784	14,844
2043	6,548	6,682	8,023	12,919	17,357	6,378	7,326	8,900	15,041
2044	6,633	6,769	8,128	13,088	17,584	6,461	7,422	9,016	15,237
2045	6,719	6,857	8,233	13,256	17,811	6,545	7,518	9,133	15,434
2046	6,798	6,937	8,330	13,413	18,021	6,622	7,607	9,241	15,616
2047	6,877	7,018	8,427	13,569	18,231	6,699	7,695	9,348	15,799
2048	6,957	7,099	8,524	13,726	18,441	6,777	7,784	9,456	15,981
2049	7,036	7,180	8,621	13,882	18,652	6,854	7,873	9,564	16,163
2050	7,115	7,261	8,719	14,039	18,862	6,931	7,962	9,672	16,345
2051	7,199	7,347	8,821	14,204	19,085	7,013	8,056	9,786	16,538
2052	7,283	7,433	8,924	14,370	19,307	7,095	8,150	9,900	16,731
2053	7,367	7,518	9,027	14,536	19,530	7,177	8,244	10,014	16,924
2054	7,451	7,604	9,130	14,702	19,753	7,258	8,338	10,128	17,117
2055	7,535	7,690	9,233	14,867	19,975	7,340	8,432	10,243	17,310
2056	7,622	7,778	9,339	15,038	20,205	7,424	8,528	10,360	17,508
2057	7,708	7,866	9,445	15,209	20,434	7,509	8,625	10,478	17,707
2058	7,795	7,954	9,551	15,379	20,663	7,593	8,722	10,595	17,906
2059	7,881	8,043	9,657	15,550	20,892	7,677	8,819	10,713	18,104
2060	7,968	8,131	9,763	15,721	21,121	7,761	8,915	10,830	18,303
2061	8,047	8,212	9,860	15,877	21,332	7,839	9,004	10,938	18,485
2062	8,126	8,293	9,957	16,033	21,542	7,916	9,093	11,046	18,667
2063	8,206	8,374	10,054	16,190	21,752	7,993	9,181	11,154	18,849
2064	8,285	8,454	10,151	16,346	21,962	8,070	9,270	11,261	19,031
2065	8,364	8,535	10,249	16,502	22,172	8,147	9,359	11,369	19,213
2066	8,440	8,613	10,342	16,653	22,374	8,222	9,444	11,473	19,389
2067	8,517	8,691	10,436	16,804	22,577	8,296	9,530	11,577	19,564

Year	AA	ADW	MMDW	MWDW	MDDW	AWW	MMWW	MWWW	MDWW
2068	8,593	8,769	10,529	16,954	22,779	8,371	9,615	11,680	19,740
2069	8,669	8,847	10,623	17,105	22,982	8,445	9,700	11,784	19,915
2070	8,746	8,925	10,716	17,256	23,184	8,519	9,786	11,888	20,090
2071	8,822	9,003	10,810	17,406	23,386	8,594	9,871	11,992	20,266
2072	8,898	9,081	10,903	17,557	23,589	8,668	9,957	12,095	20,441
2073	8,975	9,159	10,997	17,707	23,791	8,742	10,042	12,199	20,616
2074	9,051	9,237	11,090	17,858	23,993	8,817	10,128	12,303	20,792
2075	9,128	9,314	11,184	18,009	24,196	8,891	10,213	12,407	20,967

Table 10A.3 Hillsboro WRRF Influent TSS Load Projections

Year	AA	ADW	MMDW	MWDW	MDDW	AWW	MMWW	MWWW	MDWW
2020	5,911	5,820	7,229	8,469	14,608	6,012	7,286	12,524	21,036
2021	5,945	5,854	7,271	8,518	14,694	6,047	7,329	12,597	21,159
2022	5,980	5,888	7,313	8,568	14,779	6,082	7,371	12,671	21,282
2023	6,014	5,922	7,356	8,617	14,864	6,117	7,414	12,744	21,405
2024	6,049	5,956	7,398	8,667	14,950	6,152	7,457	12,817	21,528
2025	6,083	5,990	7,440	8,716	15,035	6,187	7,499	12,890	21,651
2026	6,158	6,063	7,531	8,823	15,219	6,263	7,591	13,048	21,915
2027	6,232	6,137	7,622	8,930	15,403	6,339	7,683	13,206	22,180
2028	6,307	6,210	7,713	9,036	15,587	6,414	7,774	13,363	22,445
2029	6,381	6,283	7,804	9,143	15,770	6,490	7,866	13,521	22,709
2030	6,455	6,356	7,895	9,249	15,954	6,566	7,958	13,678	22,974
2031	6,525	6,425	7,980	9,349	16,126	6,636	8,043	13,825	23,221
2032	6,594	6,493	8,065	9,448	16,297	6,707	8,129	13,972	23,468
2033	6,663	6,561	8,150	9,548	16,469	6,777	8,214	14,119	23,715
2034	6,733	6,630	8,235	9,647	16,640	6,848	8,300	14,266	23,962
2035	6,802	6,698	8,319	9,746	16,812	6,919	8,385	14,413	24,209
2036	6,920	6,814	8,464	9,916	17,104	7,039	8,531	14,664	24,629
2037	7,038	6,930	8,608	10,085	17,396	7,159	8,677	14,914	25,050
2038	7,157	7,047	8,753	10,254	17,687	7,279	8,822	15,164	25,470
2039	7,275	7,163	8,897	10,423	17,979	7,399	8,968	15,414	25,890
2040	7,393	7,279	9,042	10,592	18,271	7,519	9,113	15,665	26,310
2041	7,493	7,378	9,164	10,736	18,519	7,621	9,237	15,877	26,668
2042	7,594	7,477	9,287	10,880	18,767	7,723	9,361	16,090	27,025
2043	7,694	7,576	9,410	11,024	19,015	7,825	9,485	16,303	27,382
2044	7,794	7,675	9,533	11,168	19,264	7,928	9,608	16,516	27,740
2045	7,895	7,774	9,655	11,312	19,512	8,030	9,732	16,728	28,097
2046	7,987	7,864	9,768	11,444	19,740	8,123	9,846	16,924	28,425

Year	AA	ADW	MMDW	MWDW	MDDW	AWW	MMWW	MWWW	MDWW
2047	8,079	7,955	9,881	11,576	19,968	8,217	9,959	17,119	28,753
2048	8,171	8,046	9,994	11,708	20,196	8,311	10,073	17,314	29,082
2049	8,264	8,137	10,107	11,840	20,423	8,405	10,187	17,510	29,410
2050	8,356	8,228	10,219	11,972	20,651	8,499	10,300	17,705	29,738
2051	8,454	8,324	10,339	12,113	20,893	8,598	10,421	17,913	30,087
2052	8,552	8,420	10,459	12,253	21,135	8,698	10,542	18,120	30,435
2053	8,650	8,517	10,579	12,393	21,378	8,798	10,663	18,328	30,784
2054	8,748	8,613	10,699	12,534	21,620	8,897	10,783	18,535	31,132
2055	8,846	8,710	10,818	12,674	21,862	8,997	10,904	18,743	31,481
2056	8,946	8,809	10,942	12,819	22,111	9,099	11,029	18,957	31,840
2057	9,047	8,909	11,065	12,963	22,361	9,202	11,153	19,171	32,199
2058	9,148	9,008	11,189	13,108	22,610	9,305	11,277	19,385	32,559
2059	9,249	9,107	11,312	13,252	22,860	9,407	11,402	19,599	32,918
2060	9,350	9,207	11,436	13,397	23,109	9,510	11,526	19,812	33,277
2061	9,442	9,298	11,548	13,529	23,337	9,604	11,640	20,008	33,605
2062	9,535	9,388	11,661	13,661	23,565	9,698	11,754	20,203	33,933
2063	9,627	9,479	11,774	13,793	23,792	9,791	11,867	20,398	34,261
2064	9,719	9,570	11,887	13,925	24,020	9,885	11,981	20,594	34,589
2065	9,811	9,661	11,999	14,057	24,248	9,979	12,094	20,789	34,917
2066	9,900	9,748	12,108	14,185	24,467	10,069	12,204	20,977	35,233
2067	9,989	9,835	12,216	14,312	24,687	10,159	12,313	21,165	35,549
2068	10,077	9,923	12,325	14,439	24,906	10,250	12,423	21,353	35,865
2069	10,166	10,010	12,433	14,566	25,126	10,340	12,532	21,541	36,181
2070	10,255	10,098	12,542	14,693	25,345	10,430	12,642	21,729	36,497
2071	10,344	10,185	12,651	14,820	25,564	10,520	12,751	21,917	36,812
2072	10,432	10,272	12,759	14,948	25,783	10,611	12,860	22,105	37,128
2073	10,521	10,360	12,868	15,075	26,003	10,701	12,970	22,293	37,444
2074	10,610	10,447	12,976	15,202	26,222	10,791	13,079	22,481	37,760
2075	10,699	10,534	13,085	15,329	26,441	10,881	13,188	22,669	38,076

Table 10A.4 Forest Grove WRRF Influent Flow Projections

Year	Baseflow	AA	ADW	MMDW	MWDW	MDDW	AWW	MMWW	MWWW	MDWW	PH
2020	3.3	5.7	3.7	6.0	8.1	10.5	7.9	15.3	21.0	25.7	35.5
2021	3.4	5.8	3.7	6.1	8.2	10.6	8.0	15.4	21.2	25.9	35.8
2022	3.4	5.8	3.8	6.2	8.3	10.7	8.1	15.5	21.3	26.0	36.0
2023	3.5	5.9	3.8	6.2	8.4	10.8	8.2	15.6	21.5	26.2	36.2
2024	3.5	6.0	3.9	6.3	8.5	11.0	8.3	15.7	21.6	26.4	36.4
2025	3.5	6.1	3.9	6.4	8.6	11.1	8.4	15.9	21.8	26.6	36.7

Year	Baseflow	AA	ADW	MMDW	MWDW	MDDW	AWW	MMWW	MWWW	MDWW	PH
2026	3.6	6.1	3.9	6.4	8.7	11.2	8.5	15.9	21.9	26.6	36.8
2027	3.6	6.2	4.0	6.5	8.7	11.2	8.5	15.9	21.9	26.7	36.9
2028	3.6	6.2	4.0	6.5	8.8	11.3	8.6	16.0	22.0	26.8	37.0
2029	3.6	6.2	4.0	6.6	8.9	11.4	8.7	16.0	22.0	26.9	37.0
2030	3.7	6.3	4.1	6.6	8.9	11.5	8.7	16.1	22.1	26.9	37.1
2031	3.7	6.3	4.1	6.7	9.0	11.6	8.8	16.1	22.1	27.0	37.2
2032	3.7	6.4	4.1	6.7	9.0	11.6	8.8	16.1	22.2	27.0	37.2
2033	3.7	6.4	4.1	6.8	9.1	11.7	8.9	16.1	22.2	27.0	37.3
2034	3.8	6.4	4.2	6.8	9.1	11.8	8.9	16.2	22.2	27.1	37.3
2035	3.8	6.5	4.2	6.8	9.2	11.9	9.0	16.2	22.3	27.1	37.3
2036	3.8	6.6	4.2	6.9	9.3	12.0	9.1	16.3	22.4	27.3	37.6
2037	3.9	6.7	4.3	7.0	9.4	12.2	9.2	16.4	22.6	27.5	37.9
2038	4.0	6.8	4.4	7.1	9.6	12.3	9.4	16.6	22.8	27.7	38.1
2039	4.0	6.8	4.4	7.2	9.7	12.5	9.5	16.7	22.9	27.9	38.4
2040	4.1	6.9	4.5	7.3	9.8	12.6	9.6	16.8	23.1	28.1	38.7
2041	4.1	7.0	4.5	7.4	9.9	12.8	9.7	16.9	23.2	28.3	38.9
2042	4.2	7.1	4.6	7.5	10.0	12.9	9.8	17.0	23.4	28.5	39.2
2043	4.2	7.2	4.6	7.6	10.1	13.0	9.9	17.2	23.6	28.7	39.4
2044	4.2	7.2	4.7	7.6	10.3	13.2	10.0	17.3	23.7	28.9	39.7
2045	4.3	7.3	4.7	7.7	10.4	13.3	10.1	17.4	23.9	29.1	39.9
2046	4.3	7.4	4.8	7.8	10.5	13.5	10.2	17.5	24.0	29.2	40.1
2047	4.4	7.5	4.8	7.9	10.6	13.6	10.3	17.6	24.1	29.4	40.3
2048	4.4	7.5	4.9	8.0	10.7	13.7	10.4	17.7	24.3	29.5	40.5
2049	4.5	7.6	4.9	8.0	10.8	13.8	10.5	17.8	24.4	29.7	40.7
2050	4.5	7.7	5.0	8.1	10.9	14.0	10.6	17.9	24.5	29.9	40.9
2051	4.6	7.8	5.0	8.2	11.0	14.1	10.7	18.0	24.6	30.0	41.1
2052	4.6	7.8	5.1	8.3	11.1	14.2	10.8	18.1	24.8	30.2	41.4
2053	4.7	7.9	5.1	8.4	11.2	14.4	10.9	18.2	24.9	30.3	41.6
2054	4.7	8.0	5.2	8.4	11.3	14.5	11.0	18.3	25.0	30.5	41.8
2055	4.8	8.1	5.2	8.5	11.4	14.7	11.2	18.4	25.2	30.7	42.0
2056	4.8	8.1	5.3	8.6	11.5	14.8	11.3	18.5	25.3	30.8	42.2
2057	4.8	8.2	5.3	8.7	11.6	14.9	11.4	18.6	25.4	31.0	42.4
2058	4.9	8.3	5.4	8.8	11.8	15.1	11.5	18.6	25.6	31.1	42.6
2059	4.9	8.4	5.4	8.8	11.9	15.2	11.6	18.7	25.7	31.3	42.8
2060	5.0	8.5	5.5	8.9	12.0	15.4	11.7	18.8	25.8	31.4	43.0
2061	5.0	8.5	5.5	9.0	12.1	15.5	11.8	18.9	25.9	31.6	43.2
2062	5.1	8.6	5.6	9.1	12.2	15.6	11.9	19.0	26.0	31.7	43.3
2063	5.1	8.7	5.6	9.2	12.3	15.8	12.0	19.1	26.1	31.8	43.5

Year	Baseflow	AA	ADW	MMDW	MWDW	MDDW	AWW	MMWW	MWWW	MDWW	PH
2064	5.2	8.8	5.7	9.2	12.4	15.9	12.1	19.1	26.2	31.9	43.6
2065	5.2	8.8	5.7	9.3	12.5	16.0	12.2	19.2	26.3	32.0	43.8
2066	5.3	8.9	5.8	9.4	12.6	16.1	12.3	19.3	26.4	32.1	43.9
2067	5.3	9.0	5.8	9.5	12.7	16.3	12.4	19.3	26.5	32.2	44.0
2068	5.3	9.0	5.9	9.5	12.8	16.4	12.5	19.4	26.6	32.3	44.2
2069	5.4	9.1	5.9	9.6	12.9	16.5	12.6	19.5	26.7	32.4	44.3
2070	5.4	9.2	6.0	9.7	13.0	16.7	12.7	19.5	26.7	32.5	44.4
2071	5.5	9.3	6.0	9.8	13.1	16.8	12.8	19.6	26.8	32.6	44.5
2072	5.5	9.3	6.1	9.8	13.2	16.9	12.9	19.6	26.9	32.7	44.7
2073	5.6	9.4	6.1	9.9	13.3	17.0	13.0	19.7	27.0	32.8	44.8
2074	5.6	9.5	6.2	10.0	13.4	17.2	13.1	19.8	27.0	32.9	44.9
2075	5.6	9.5	6.2	10.1	13.5	17.3	13.2	19.8	27.1	33.0	45.0

Table 10A.5 Forest Grove WRRF Influent cBOD Load Projections

Year	AA	ADW	MMDW	MWDW	MDDW	AWW	MMWW	MWWW	MDWW
2020	8,204	9,172	11,377	15,400	19,710	7,230	10,482	11,279	13,904
2021	8,316	9,296	11,530	15,611	19,982	7,330	10,623	11,433	14,101
2022	8,428	9,420	11,684	15,823	20,254	7,430	10,764	11,586	14,299
2023	8,541	9,544	11,837	16,035	20,527	7,530	10,905	11,740	14,497
2024	8,653	9,668	11,990	16,246	20,799	7,630	11,046	11,894	14,694
2025	8,765	9,792	12,144	16,458	21,071	7,730	11,187	12,048	14,892
2026	8,857	9,895	12,270	16,631	21,295	7,812	11,303	12,174	15,053
2027	8,949	9,997	12,396	16,805	21,518	7,894	11,420	12,301	15,214
2028	9,041	10,099	12,522	16,978	21,741	7,976	11,536	12,427	15,374
2029	9,133	10,201	12,649	17,152	21,964	8,057	11,652	12,553	15,535
2030	9,225	10,303	12,775	17,325	22,187	8,139	11,769	12,680	15,696
2031	9,306	10,393	12,887	17,479	22,385	8,212	11,871	12,792	15,840
2032	9,388	10,484	12,998	17,633	22,584	8,285	11,974	12,904	15,984
2033	9,470	10,574	13,110	17,788	22,782	8,358	12,077	13,016	16,128
2034	9,551	10,664	13,222	17,942	22,981	8,430	12,180	13,128	16,272
2035	9,633	10,755	13,333	18,096	23,179	8,503	12,282	13,240	16,416
2036	9,744	10,881	13,492	18,302	23,440	8,599	12,429	13,393	16,590
2037	9,855	11,008	13,650	18,509	23,701	8,695	12,575	13,547	16,764
2038	9,967	11,135	13,808	18,715	23,963	8,791	12,721	13,700	16,937
2039	10,078	11,262	13,967	18,922	24,224	8,886	12,867	13,854	17,111
2040	10,189	11,389	14,125	19,128	24,485	8,982	13,013	14,007	17,285
2041	10,327	11,543	14,317	19,388	24,817	9,104	13,189	14,197	17,518
2042	10,466	11,698	14,508	19,647	25,149	9,226	13,366	14,387	17,752

Year	AA	ADW	MMDW	MWDW	MDDW	AWW	MMWW	MWWW	MDWW
2043	10,604	11,852	14,700	19,906	25,481	9,347	13,543	14,577	17,986
2044	10,742	12,007	14,892	20,166	25,812	9,469	13,719	14,767	18,220
2045	10,880	12,161	15,083	20,425	26,144	9,591	13,896	14,957	18,454
2046	11,007	12,303	15,259	20,662	26,447	9,702	14,058	15,131	18,666
2047	11,133	12,445	15,435	20,899	26,750	9,813	14,220	15,304	18,879
2048	11,259	12,586	15,611	21,136	27,053	9,924	14,382	15,478	19,091
2049	11,386	12,728	15,787	21,373	27,356	10,035	14,544	15,652	19,303
2050	11,512	12,869	15,962	21,610	27,658	10,146	14,706	15,826	19,515
2051	11,647	13,020	16,149	21,862	27,981	10,265	14,878	16,011	19,742
2052	11,781	13,171	16,336	22,114	28,303	10,383	15,050	16,196	19,968
2053	11,916	13,321	16,523	22,366	28,626	10,501	15,222	16,380	20,195
2054	12,050	13,472	16,710	22,618	28,948	10,619	15,394	16,565	20,421
2055	12,184	13,622	16,896	22,870	29,270	10,738	15,567	16,750	20,647
2056	12,323	13,777	17,089	23,130	29,603	10,860	15,744	16,941	20,881
2057	12,462	13,933	17,282	23,391	29,936	10,982	15,922	17,131	21,115
2058	12,600	14,088	17,474	23,651	30,268	11,104	16,099	17,322	21,349
2059	12,739	14,243	17,667	23,911	30,601	11,226	16,277	17,513	21,582
2060	12,878	14,398	17,860	24,171	30,933	11,348	16,454	17,704	21,816
2061	13,004	14,540	18,035	24,408	31,236	11,459	16,616	17,877	22,028
2062	13,131	14,682	18,211	24,645	31,539	11,570	16,778	18,051	22,241
2063	13,257	14,823	18,387	24,882	31,842	11,681	16,940	18,225	22,453
2064	13,383	14,965	18,563	25,119	32,145	11,792	17,102	18,399	22,665
2065	13,510	15,107	18,739	25,356	32,448	11,903	17,264	18,573	22,878
2066	13,632	15,243	18,908	25,584	32,740	12,010	17,420	18,740	23,082
2067	13,753	15,379	19,077	25,812	33,031	12,117	17,576	18,907	23,287
2068	13,875	15,516	19,247	26,040	33,323	12,224	17,732	19,075	23,491
2069	13,997	15,652	19,416	26,268	33,615	12,331	17,888	19,242	23,695
2070	14,118	15,788	19,585	26,497	33,906	12,438	18,044	19,410	23,900
2071	14,240	15,925	19,754	26,725	34,198	12,545	18,200	19,577	24,104
2072	14,362	16,061	19,924	26,953	34,489	12,652	18,356	19,744	24,308
2073	14,484	16,198	20,093	27,181	34,781	12,759	18,512	19,912	24,513
2074	14,605	16,334	20,262	27,409	35,073	12,866	18,668	20,079	24,717
2075	14,727	16,470	20,432	27,637	35,364	12,973	18,824	20,246	24,921

Table 10A.6 Forest Grove WRRF Influent TSS Load Projections

Year	AA	ADW	MMDW	MWDW	MDDW	AWW	MMWW	MWWW	MDWW
2020	8,323	9,168	11,389	16,321	30,729	7,487	10,065	15,486	28,920
2021	8,428	9,281	11,529	16,515	31,089	7,584	10,192	15,686	29,285
2022	8,532	9,393	11,669	16,709	31,450	7,680	10,319	15,886	29,650
2023	8,637	9,506	11,809	16,903	31,811	7,776	10,446	16,085	30,014
2024	8,741	9,619	11,949	17,097	32,171	7,873	10,572	16,285	30,379
2025	8,846	9,731	12,088	17,291	32,532	7,969	10,699	16,484	30,744
2026	8,952	9,848	12,234	17,498	32,920	8,066	10,828	16,684	31,115
2027	9,059	9,965	12,379	17,704	33,307	8,162	10,957	16,884	31,486
2028	9,166	10,082	12,524	17,911	33,695	8,259	11,087	17,084	31,857
2029	9,272	10,199	12,669	18,117	34,082	8,355	11,216	17,283	32,228
2030	9,379	10,316	12,814	18,324	34,470	8,452	11,345	17,483	32,599
2031	9,478	10,424	12,949	18,515	34,828	8,542	11,465	17,669	32,943
2032	9,577	10,532	13,084	18,706	35,187	8,631	11,584	17,854	33,287
2033	9,676	10,641	13,218	18,897	35,545	8,721	11,704	18,040	33,632
2034	9,775	10,749	13,353	19,088	35,904	8,811	11,824	18,226	33,976
2035	9,874	10,857	13,487	19,279	36,262	8,900	11,944	18,411	34,321
2036	9,971	10,967	13,624	19,482	36,651	8,984	12,060	18,585	34,655
2037	10,067	11,077	13,760	19,686	37,039	9,069	12,177	18,758	34,989
2038	10,164	11,186	13,896	19,889	37,428	9,153	12,293	18,932	35,323
2039	10,261	11,296	14,032	20,092	37,816	9,237	12,410	19,105	35,657
2040	10,358	11,405	14,168	20,296	38,205	9,321	12,526	19,279	35,992
2041	10,497	11,559	14,359	20,569	38,720	9,446	12,695	19,538	36,476
2042	10,636	11,713	14,550	20,843	39,235	9,571	12,863	19,797	36,960
2043	10,776	11,866	14,740	21,116	39,750	9,697	13,032	20,057	37,444
2044	10,915	12,020	14,931	21,389	40,264	9,822	13,200	20,316	37,928
2045	11,055	12,173	15,122	21,663	40,779	9,947	13,369	20,575	38,413
2046	11,179	12,310	15,292	21,908	41,241	10,059	13,519	20,805	38,844
2047	11,303	12,447	15,462	22,152	41,702	10,170	13,669	21,036	39,275
2048	11,427	12,584	15,633	22,397	42,163	10,282	13,819	21,266	39,706
2049	11,551	12,721	15,803	22,642	42,624	10,393	13,969	21,496	40,137
2050	11,675	12,858	15,973	22,886	43,085	10,504	14,119	21,727	40,568
2051	11,808	13,005	16,155	23,148	43,579	10,624	14,280	21,974	41,031
2052	11,942	13,152	16,338	23,411	44,073	10,743	14,441	22,221	41,493
2053	12,075	13,299	16,520	23,673	44,567	10,863	14,602	22,469	41,956
2054	12,208	13,446	16,703	23,935	45,061	10,983	14,763	22,716	42,418
2055	12,341	13,593	16,885	24,197	45,555	11,102	14,924	22,963	42,881
2056	12,479	13,745	17,074	24,468	46,066	11,226	15,091	23,219	43,360

Year	AA	ADW	MMDW	MWDW	MDDW	AWW	MMWW	MWWW	MDWW
2057	12,617	13,897	17,263	24,739	46,577	11,350	15,258	23,475	43,839
2058	12,755	14,049	17,452	25,011	47,088	11,474	15,424	23,732	44,318
2059	12,893	14,201	17,641	25,282	47,599	11,598	15,591	23,988	44,797
2060	13,031	14,353	17,830	25,553	48,110	11,722	15,758	24,244	45,276
2061	13,155	14,490	18,000	25,798	48,571	11,833	15,908	24,474	45,707
2062	13,279	14,627	18,170	26,043	49,033	11,944	16,058	24,705	46,138
2063	13,403	14,764	18,341	26,287	49,494	12,056	16,208	24,935	46,570
2064	13,527	14,901	18,511	26,532	49,955	12,167	16,358	25,166	47,001
2065	13,651	15,038	18,681	26,777	50,417	12,279	16,508	25,396	47,432
2066	13,771	15,170	18,845	27,012	50,860	12,386	16,652	25,617	47,847
2067	13,890	15,302	19,008	27,247	51,304	12,493	16,797	25,839	48,261
2068	14,009	15,434	19,172	27,483	51,747	12,600	16,941	26,060	48,676
2069	14,129	15,565	19,336	27,718	52,191	12,707	17,085	26,282	49,090
2070	14,248	15,697	19,499	27,953	52,634	12,814	17,230	26,503	49,505
2071	14,367	15,829	19,663	28,189	53,078	12,921	17,374	26,725	49,919
2072	14,487	15,961	19,827	28,424	53,522	13,028	17,518	26,946	50,334
2073	14,606	16,092	19,990	28,659	53,965	13,135	17,662	27,168	50,748
2074	14,726	16,224	20,154	28,895	54,409	13,242	17,807	27,389	51,163
2075	14,845	16,356	20,318	29,130	54,852	13,349	17,951	27,611	51,577

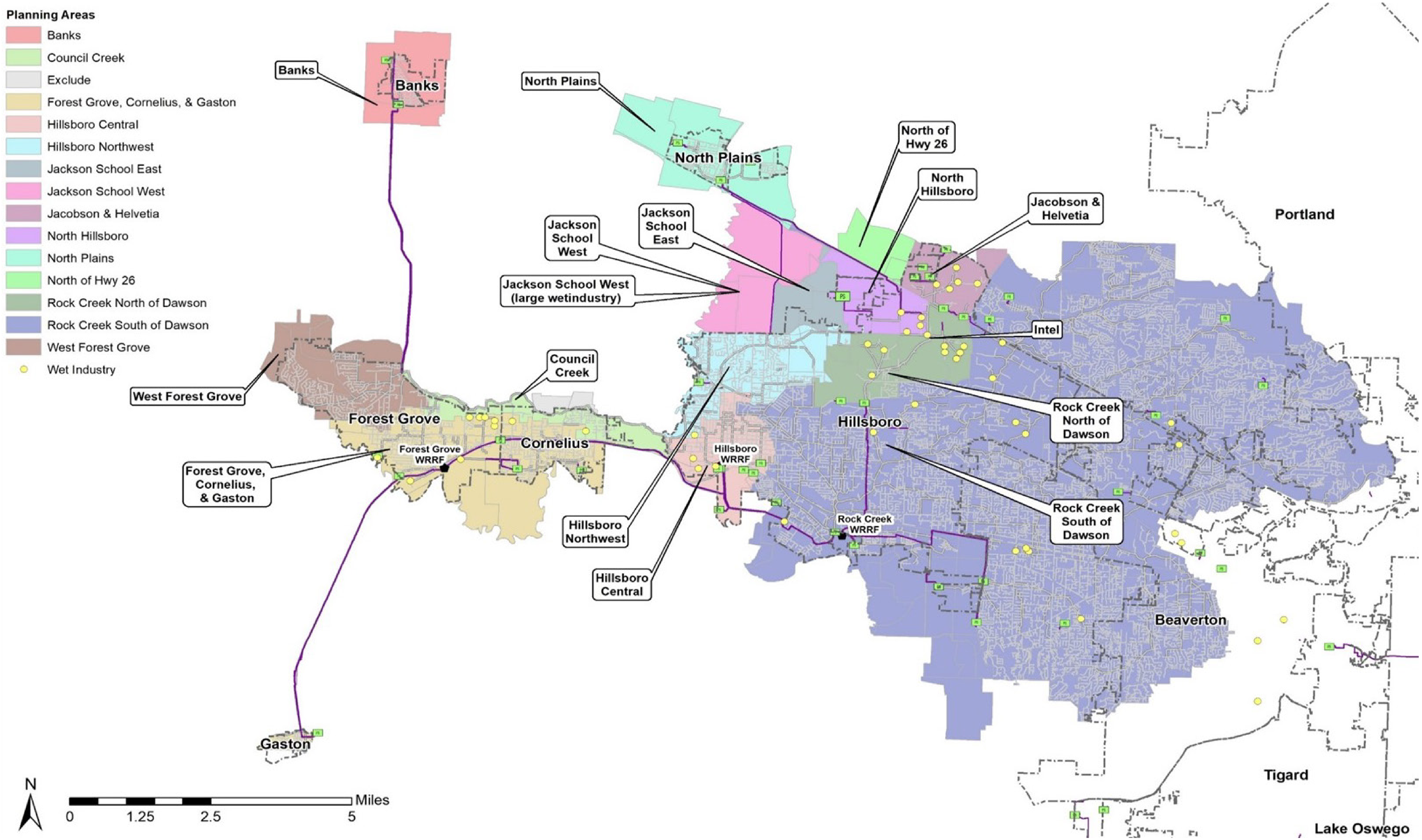

Figure 10A.1 Planning Areas