CLACKAMAS
WATER ENVIRONMENT SERVICES

GREGORY L. GEIST | DIRECTOR

Water Quality Protection
Surface Water Management
Wastewater Collection & Treatment

MEMORANDUM

TO:	Clackamas County Board of County Commissioners (BCC)
FROM:	Water Environment Services (Presenters: Greg Geist, Director & Lynne Chicoine, PE, Consultant)
RE:	WES Willamette Facilities Plan
DATE:	November 1, 2022

REQUEST
Water Environment Services (WES) staff will provide a presentation to the BCC to inform the Board about the Willamette Facilities Plan, receive input and answer questions before finalizing the plan. No decisions are needed today.

BACKGROUND
The Willamette Facilities Plan (WFP, Plan) is the culmination of a planning project that identifies the wastewater treatment needs of the WES service area for the next 20 years. The WFP identifies improvements needed to the Tri-City and Kellogg Creek Water Resource Recovery Facilities (WRRF) to provide capacity for growth, address aging infrastructure, and protect human health and the environment by meeting regulatory requirements through the year 2040.

The formation of the 190 Partnership has allowed the District to consider planning for the Tri-City and Kellogg Creek WRRFs using a basin-wide approach which allows WES to maximize use of existing facilities. Recommended improvements presented in the Plan are based on an evaluation of regional alternatives that consider the Kellogg Creek and Tri-City WRRFs, as well as wastewater collection and conveyance facilities located throughout the service area. This comprehensive, regional approach allows the District to:

- Identify the best use of its wastewater collection, conveyance, and treatment infrastructure;
- Develop a prioritized Capital Improvement Program (CIP) to addresses current needs while preparing for potential future requirements;
- Implement sustainable, affordable solutions that support economic development; and
- Continue to protect Willamette River water quality now and into the future

The WFP recommended plan has a capital value of $119M (2021 $) that will expand wet weather capacity at the Tri-City WRRF and address reliability and rehabilitation (R&R) issues at both the Kellogg Creek and Tri-City WRRFs. Major projects include:

<u>Tri-City WRRF Recommended Projects</u>

Project	Estimated Capital Cost, $M
Expand peak wet weather capacity from 70 to 105 MGD	$53.7
Provide primary sludge thickening	$7.6
R&R Projects	$16.9
Total	**$78.2**

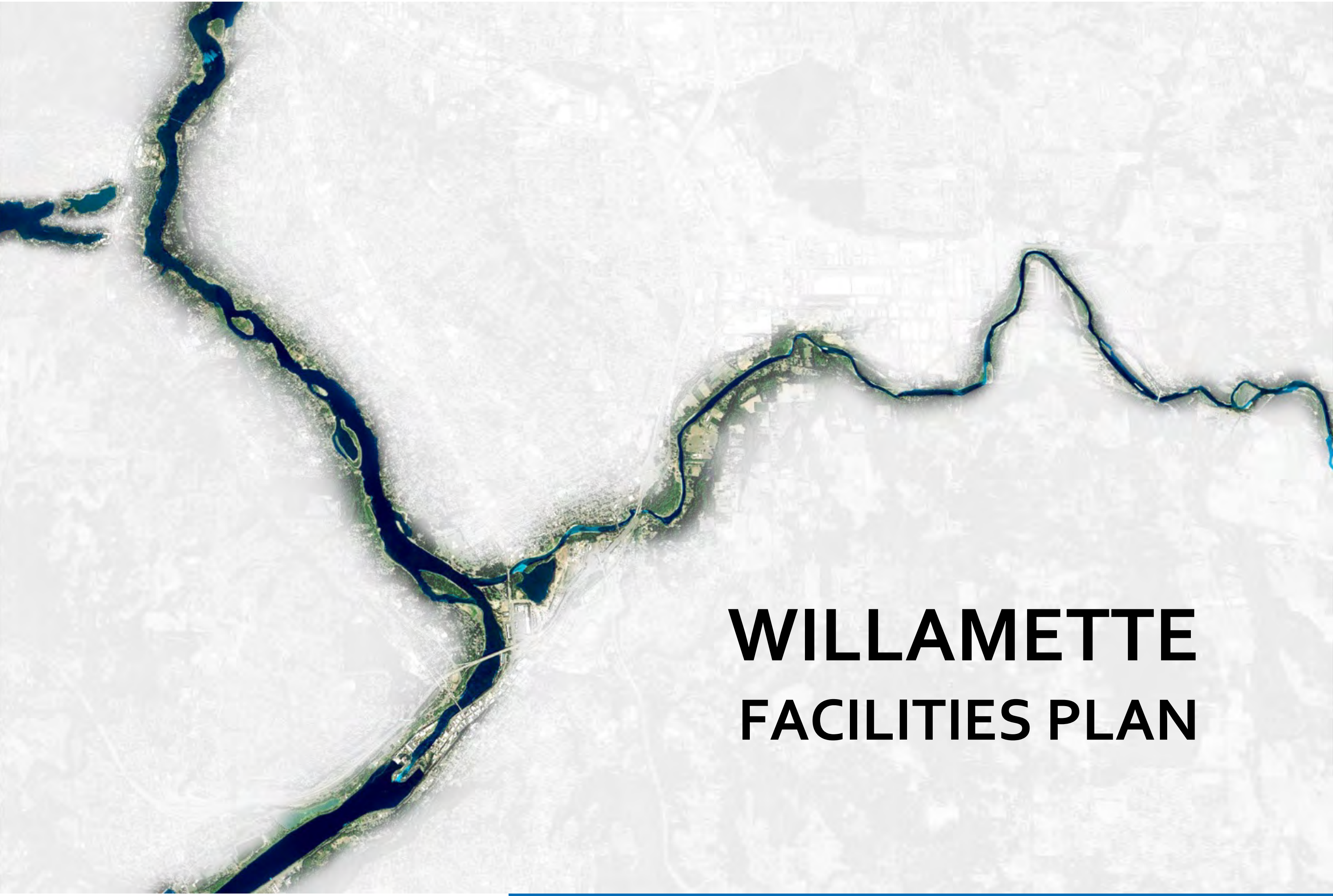
Kellogg Creek WRRF Recommended Projects

Project	Estimated Capital Cost, $M
Replace aging disinfection system	$2.8
Replace aging sludge thickening system, upgrade digesters, add dewatering process	$24.3
Replace and update aging gas utilization system	$5.9
R&R Projects	$7.9
Total	**$40.9**

Recommended projects with their costs and implementation schedule are included in the CIP to be presented to the Board on November 29, 2022.

Respectfully submitted,

Greg Geist
Director, Water Environment Services



WILLAMETTE
FACILITIES PLAN

Clackamas Water Environment Services

WILLAMETTE FACILITIES PLAN

DRAFT | March 2022

Clackamas Water Environment Services

WILLAMETTE FACILITIES PLAN

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This document is released for the purpose of information exchange review and planning only under the authority of Brian R. Matson, March 18,2022, State of Oregon PE No. 66976.

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Abbreviations

AA	average annual
AACE	Advancement of Cost Engineering
ACS	American Community Survey
ADWF	average dry weather flow
aSRT	aerobic solids retention time
AWWF	average wet weather flow
BOD	biochemical oxygen demand
BOD_5	five-day biochemical oxygen demand
BWF	base wastewater flow
C	Celsius
Carollo	Carollo Engineers, Inc.
CAS	conventional activated sludge
$CBOD_5$	five-day carbonaceous biochemical oxygen demand
CCB	chlorine contact basin
CCI	construction cost index
CCSD No. 1	Clackamas County Service District No. 1
CDC	Community Development Code
CIP	capital improvement plan
City	Cities of Gladstone, Happy Valley, Johnson City, Milwaukie, Oregon City, and West Linn
County	Clackamas County
CRB	Columbia River Basalt
CSZ	Cascadia Subduction Zone
CWR	cold-water refuge
DAFT	dissolved air flotation thickener
DDT	dichlorodiphenyltrichloroethane
DEQ	Department of Environmental Quality
DF	dilution factors
District	Clackamas Water Environment Services
DMA	designated management agencies
DOGAMI	Department of Geology and Mineral Industries
DW	dry weather
ELA	engineering, legal and administration fees
ENR	Engineering News Record
EPA	Environmental Protection Agency
ESA	Environmental Science Associates
°F	degrees Fahrenheit

FEMA	Federal Emergency Management Agency
ft	feet
FY	fiscal year
GBT	gravity belt thickener
GDP	gross domestic product
gpcpd	gallons per capita per day
gpd/sf	gallons per day per square foot
gpm	gallons per minute
Guide	Wastewater Facility Planning Guide
HRT	hydraulic retention time
HSD	Historic Sites Database
I/I	infiltration and inflow
I-205	Interstate-205
ILS	intensive level survey
IT2 PS	Intertie 2 Pump Station
IWRS	Integrated Water Resources Strategy
lb VS/d-lb VS	pounds per day of volatile solids fed per pound of volatile solids
lb/hr	pounds per hour
lb/m/hr	pounds per meter per hour
M	million
MAO	Mutual Agreement and Order
max	maximum
MBR	membrane bioreactor
METRO	Oregon Metro
mg/L	milligrams per liter
mgd	million gallons per day
min	minute(s)
mJ/cm2	millijoules per square centimeter
ml	milliliter
MLSS	mixed liquor suspended solids
MM	maximum month
MMDWF	maximum month dry weather flow
MMWW	maximum month wet weather
MMWWF	maximum month wet weather flow
MW	maximum week
MWDWF	maximum week dry weather flow
MWWWF	maximum week wet weather flow
NCRA	North Clackamas Revitalization Area
NOAA	National Oceanic and Atmospheric Administration

NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
OAR	Oregon Administrative Rule
OARRA	Oregon Archaeological Records Remote Access
ODFW	Oregon Department of Fish and Wildlife
OOS	out of service
ORS	Oregon Revised Statute
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyls
PDDWF	peak day dry weather flow
PDDWF	peak day dry weather flow
PDF	peak day flow
PDWWF	peak day wet weather flow
PH	peak hour
PHF	peak hour flow
Plan	Willamette Facilities Plan
ppcd	pounds per capita per day
ppd	pounds per day
ppd/sf	pounds per day per square foot
PS	primary sludge
PSU	Portland State University
R&R	repair & replacement
RLS	reconnaissance level inventory
RMZ	regulated mixing zone
RPA	reasonable potential analysis
SDC	system development charge
Senate Bill 100	Oregon Land Conservation and Development Act
SERP	State Environmental Review Process
SHPO	State Historic Preservation Office
SOR	surface overflow rate
SRF	State Revolving Fund
SRT	solids residence time
SVSLR	specific volatile solids loading rate
SWMACC	Surface Water Management Agency of Clackamas County
TAZ	Transportation Analysis Zones
TCSD	Tri-City Service District
TCSHI	Tri-City Solids Handling Improvements
TM	technical memorandum

TMDL	total maximum daily load
TSS	total suspended solids
USGS	United States Geological Survey
UV	ultraviolet
WAS	waste activated sludge
WES	Clackamas Water Environment Services
WFP	Willamette Facilities Plan
WRA	Water Resources Area
WRRF	Water Resource Recovery Facility
WW	wet weather
ZID	zone of initial dilution

Chapter 1

INTRODUCTION

1.1 Introduction

Clackamas Water Environment Services (WES), also referred to as the "District," is preparing a facilities plan for its wastewater treatment facilities that discharge to the Willamette River. The goal of the Willamette Facilities Plan (WFP, Plan) is to develop a 20-year capital plan that identifies improvements to the District's Kellogg Creek and Tri-City Water Resource Recovery Facilities (WRRF). Potential improvements to a 5-acre site owned by the District (Blue Heron Paper Mill), and associated conveyance infrastructure are also considered in the Plan. These improvements are designed to provide the best value to the District's ratepayers by maximizing the use of existing infrastructure and optimizing system operation while continuing to protect water quality and human health and supporting economic development.

1.1.1 Background

WES is an intergovernmental partnership formed pursuant to Oregon Revised Statute (ORS) 190 and owns and operates over 340 miles of conveyance infrastructure and three wastewater facilities that can or do discharge to the Willamette River. The Kellogg Creek WRRF discharges up to 25 million gallons per day (mgd) at River Mile 18.5. The remaining flow is treated at, and discharged from, the Tri-City WRRF, at River Mile 25.5. The District also owns the former outfall from the Blue Heron Paper Mill (at River Mile 27.8) and the load allocations associated with the National Pollutant Discharge Elimination System (NPDES) permit for this facility.

The District was created in 2016 under ORS 190 as a governmental partnership between Clackamas County Service District No. 1 (CCSD No. 1) and Tri-City Service District (TCSD). WES is managed by the County Department of the same name in a coordinated effort within the overall county organization to provide long-term certainty and stability for its customers.

In June 2017, the Surface Water Management Agency of Clackamas County (SWMACC) joined the partnership. On July 1, 2017, the District began providing wastewater treatment services at the Tri-City WRRF and surface water management services to the SWMACC service area. On July 1, 2018, the District began providing wastewater collection and treatment services to the CCSD No. 1 service area and surface water management services within the City of Happy Valley and unincorporated Clackamas County. That same year, the permits for Kellogg Creek WRRF, Tri-City WRRF, and Blue Heron Paper Mill were integrated under a single entity.

WES now serves as an independent municipal corporation authorized to provide specific services within specified boundaries within Clackamas County. The consolidation associated with the District's formation creates regulatory and operational opportunities, which the Plan will address.

1.1.2 Purpose

The purpose of the WFP is to develop and evaluate basin-wide scenarios to allow the District to plan for wastewater flows and load projections and address existing capacity constraints. The WFP describes basin-wide scenarios and recommended treatment and conveyance facilities throughout the District's service area. The Plan considers scenarios to increase inter-basin flow and load transfer by modifying existing facilities and/or adding new facilities and evaluates the use of the Blue Heron site for seasonal wet weather treatment and/or year-round satellite treatment and discharge.

The Plan was developed in a manner consistent with the District's regional approach to planning and operating its conveyance and treatment facilities, and in accordance with requirements for wastewater planning documents set forth by the Oregon Department of Environmental Quality (DEQ) that support subsequent Clean Water State Revolving Fund (SRF) funding.

1.1.3 Additional Plan Documents

The Kellogg Creek WRRF Facilities Plan and the Tri-City WRRF Facilities Plan were developed in conjunction with the WFP. The WFP describes basin-wide scenarios that were evaluated by the planning team and summarize the recommended treatment and conveyance facilities throughout the District service area. The Kellogg Creek WRRF and Tri-City WRRF Facilities Plans describe the evaluation of alternatives that are specific to each facility and define the implementation of recommended projects based on that evaluation.

1.1.4 Related Studies

The following sources were used to develop this Plan:

- Portland State University College of Urban & Public Affairs Population Research Center.
- US Census Bureau American Community Surveys, Clackamas County, 2009-2017.
- The Oregon Conservation Strategy, Oregon Department of Fish and Wildlife, 2016.

The following Clackamas County and District reports and plans were also referenced:

- Population Forecasts for Clackamas County Service Districts, August 2016, EcoNorthwest.
- Clackamas County Economic Landscape, Emerging Trends Update, 2017 Update, FCS Group.
- Sanitary Sewer System Master Plan for Water Environment Services, January 2019.
- Tri-City Solids Handling Improvements (TCSHI), 2018.
- Tri-City Site Master Plan, 2013 Update.
- 2018- 2023 WES Capital Improvement Plan, 2018.
- Proposed 2019-2020 WES Fiscal Year Budget, 2019.
- Watershed Action Plan Kellogg-Mt. Scott Watershed, June 2009.
- Watershed Action Plan Rock Creek Watershed, June 2009.

1.2 Plan Requirements

This Plan meets the requirements of three documents, which are briefly described in this section.

1.2.1 Oregon DEQ Wastewater Facility Planning Guide, July 2019

The Oregon DEQ developed a Wastewater Facility Planning Guide (Guide) to help communities develop and evaluate wastewater alternatives to meet their long-term needs. The Oregon DEQ administers the SRF, which provides below-market rate loans to public agencies for preparing planning and environmental review documents, designing and constructing wastewater facilities, and completing other water quality improvement design and construction projects.

The Guidelines for Preparing Wastewater Planning Documents and Environmental Reports for Public Utilities, last revised in July 2019, outline the required contents of a wastewater planning document. The WFP, as well as the Tri-City WRRF Facilities Plan and the Kellogg Creek WRRF Facilities Plan, were prepared in accordance with this Guide.

1.2.2 Oregon's Integrated Water Resources Strategy, 2017 Update

In 2012, the State of Oregon's Water Resource Commission adopted the Integrated Water Resources Strategy (IWRS). The goal was to bring various sectors and interests together to work toward the common goal of maintaining healthy water resources for Oregonians and the environment for generations to come.

The IWRS provides a blueprint to help the state focus its efforts on two key goals: improving the understanding of Oregon's water resources and meeting Oregon's water resources needs. The document discusses critical issues facing the state and recommends actions to address the issues, including meeting its instream and out-of-stream water needs relative to water quantity, water quality, and ecosystem needs. In 2017, the IWRS was updated and introduced nine new recommended actions.

Table 1.1 summarizes the IWRS-recommended actions applicable to wastewater planning and the District's fulfillment of the actions.

Table 1.1 IWRS Recommended Actions for Wastewater Planning

No.	Recommended Action Description	District Fulfillment of Action
7A	Develop and upgrade water and wastewater infrastructure.	WES maintains a 5-year CIP, updated annually. The FY 20 - FY 25 CIP identifies more than $200M in required improvements.
7B	Encourage regional (sub-basin) approaches to water and wastewater systems.	In 2018, the District finalized creation of a single regional WES entity that will allow a regional approach to wastewater and stormwater management.
9A	Continue to undertake place-based integrated, water resources planning.	The District has an active Citizens Advisory Committee composed of citizens and elected officials, and a Technical Advisory team, composed of WES and City technical staff, that meet regularly to create a solid platform for future collaborative water planning efforts. The current efforts focus on I/I reduction as a region.
10C	Encourage additional water reuse projects.	The Tri-City WRRF produces Class A water available through its MBR train. WES continues to identify opportunities for reuse, which could be permitted when the NPDES permit is renewed.

No.	Recommended Action Description	District Fulfillment of Action
10D	Reach environmental outcomes with non-regulatory alternatives.	The District plans and completes a variety of small and large-scale watershed restoration projects that deliver environmental outcomes. Some recent examples include: • The Carli Creek Water Quality Project completed in 2019 constructed a 15-acre water quality facility along the Clackamas River that reduces surface water pollutants originating from the surrounding Clackamas Industrial Area. The project also restored roughly 1,700 feet of stream habitat in Carli Creek including the confluence with the Clackamas River. • The Rock Creek Restoration Project completed in 2017 enhances stream health by increasing habitat complexity with large wood, reconnecting the creek to its floodplain, and restoring approximately 12-acres of riparian vegetation to native species. A strong educational component of the project brings hundreds of students from North Clackamas School District to the site for hands-on educational studies. • The 3-Creeks Floodplain Enhancement Project currently in development will improve floodplain function and stream/riparian habitat of Mt. Scott Creek within the District's nearly 90-acre natural area just east of Milwaukie. Construction is planned for 2023.
12B	Reduce the use of and exposure to toxics and other pollutants.	The District implements the following programs, projects, and partnerships that help reduce the use of and exposure to toxics and other pollutants: • Industrial wastewater pretreatment and permitting that reduces discharges of toxics and pollutants harmful to the District's treatment facilities, and the environment. • Stormwater pollution prevention programs for local businesses and industries, including technical assistance, and inspection of materials handling and storm systems on private property. • Illicit discharge detection and elimination projects that prohibit and enforce against illegal non-stormwater discharges. • Watershed Health Education projects and partnerships with community groups on reduced use of pesticides in yard care and general property management. • Promotion of and referrals via the District's website and customer serve calls to Metro's hazardous waste management facilities and programs. • Replacement of gaseous chlorine with hypochlorite at Tri-City WRRF for disinfection.
12C	Implement water quality pollution control plans.	The District implements the following programs, plans, and monitoring directed towards water quality: • The District jointly implements a Stormwater Management Program Plan with Clackamas County and the Cities of Happy Valley and Rivergrove. The Plan lays out the minimum stormwater control measures that WES and co-permittees implement to reduce pollution discharged from storm sewers, and the impact of stormwater discharges on receiving water. Measures include controls for construction and post-construction runoff, operation and maintenance of private and public stormwater facilities, spill and illicit discharge prevention, and environmental education.

No.	Recommended Action Description	District Fulfillment of Action
		• The District and the County develop and implement non-point source TMDL Implementation Plans in the Willamette (includes Clackamas) and Tualatin watersheds for E. coli, DDT/dieldrin, mercury, temperature, pH, phosphorus, and dissolved oxygen. The District also supports broader TMDL planning efforts in the County of the Molalla and Sandy watersheds. Updates to the TMDL plans are coming in 2021 2022. • The District routinely monitors water quality, biological health, and geomorphology of nine streams in the District, and performs trend analysis and stream health index calculations every two to three years to measure progress towards achieving water quality goals. • The District partners with the Clackamas Development Agency to implement a septic abatement program in the NCRA, including providing grants to low-income homeowners who live within boundaries of the NCRA sewer project to reduce financial hardship. The District also continues to honor pre-paid SDCs for homeowners making new connections to the District's infrastructure at a rate that is roughly a third of the current rate. • The District is currently developing its first Storm System Master Plan that will guide capital improvement and repairs of the publicly owned storm system. Projects include conveyance improvements that address localized flooding, water quality retrofits to improve pollutant removal, and restoration projects that improve stream function and watershed health. The plan will be completed was 2021.
13C	Invest in Local or Regional Water-Planning Efforts	The District invests in local or regional water-planning efforts through the following actions: • The District completed Watershed Action Plans in the Kellogg/ Mt. Scott and Rock Creek Basins. The goal of these plans is to develop basin-specific strategies for watershed management. The District continues to implement the plans and will transition to a more robust stormwater management plan, TMDL Implementation Plans, and a Storm System Master Plan in 2021. • The RiverHealth Stewardship Grant Program offers grants to support community groups, businesses, and property owners who want to improve the health of watersheds within the surface water areas served by the District. Grants are awarded annually for community-based planning, restoration, and education projects. • The District's Storm System Master Plan includes projects intended to improve resiliency and reduce localized flooding and property damage from the storm system, and from streams with impaired function.

Note:
Abbreviations: CIP - capital improvement plan; City - Cities of Gladstone, Happy Valley, Johnson City, Milwaukie, Oregon City, and West Linn; County - Clackamas County; DDT -Dichlorodiphenyltrichloroethane; FY - fiscal year; I/I - infiltration and inflow; M - million; MBR - membrane bioreactor; Metro - Oregon Metro; NCRA - North Clackamas Revitalization Area; SDC - system development charge; TMDL - total maximum daily load.

1.2.3 Statewide Land Use Goal 11, 2005 Update

In Oregon, the foundation for the statewide program for land use planning is a set of 19 statewide land use planning goals. The objective of Goal 11 is to plan and develop a timely, orderly, and efficient arrangement of public facilities and services to serve as a framework for urban and rural development. This goal directs local governments to establish an urban growth boundary and provide sewer services inside it.

Associated planning documents must describe the boundary and show compliance with Goal 11 and the local comprehensive plan. Wastewater planning documents must also include an affirmative land use compatibility statement from the local government to demonstrate compatibility with the comprehensive plan, which is included in Appendix A.

1.3 Plan Organization

The following is a summary of the WFP organization by chapter:

- **Chapter 1 - Introduction:** Describes the purpose and need for the WFP, including the Plan requirements, scope, and organization.
- **Chapter 2 - Planning Area Characteristics:** Describes the project planning area, the land use within the District's boundaries, the physical characteristics of the District's service area, and the population and employment trends and projections.
- **Chapter 3 - Wastewater Flows and Loads:** Presents an evaluation of historical wastewater flows and loads, and projects flow and load data for the Kellogg Creek and Tri-City service areas.
- **Chapter 4 - Permitting and Regulatory Considerations:** Presents the regulatory considerations that are used as a basis for determining current and future treatment requirements at the Tri-City and Kellogg Creek WRRFs.
- **Chapter 5 - Existing WRRF Capacity and Condition Summary:** Summarizes the capacity and condition of both WRRFs.
- **Chapter 6 - Basin-wide Scenarios:** Describes the process used to develop basin-wide scenarios, which are evaluated to help the District optimize operations and maximize the use of existing treatment and conveyance facilities through the planning period.
- **Chapter 7 - Recommended Plan:** Summarizes the recommended plan for each WRRF under the recommended basin-wide scenarios and presents the proposed schedule and capital improvement program (CIP) for the Kellogg Creek and Tri-City WRRFs.

Chapter 2

PLANNING AREA CHARACTERISTICS

2.1 Introduction

This chapter documents key planning area characteristics that will inform the Willamette Facilities Plan (WFP). These characteristics are summarized in a manner consistent with Clackamas Water Environment Services' (the District) regional approach to planning and operating its conveyance and treatment facilities, and in accordance with requirements for wastewater planning documents set forth by the Oregon Department of Environmental Quality (DEQ) that support subsequent Clean Water State Revolving Fund (SRF) funding.

2.2 Project Planning Area

This section defines the Project Planning Area and briefly describes the key wastewater conveyance and treatment infrastructure that will be evaluated under the WFP.

2.2.1 Service Area Definitions

The planning area considered by this Plan is consistent with the 2019 Sanitary Sewer Master Plan and consists of three service areas: Tri-City Service District (TCSD), Clackamas County Service District No. 1 (CCSD No. 1), and the Surface Water Management Agency of Clackamas County (SWMACC). When the District began providing service to these areas in 2017 and 2018, the areas were renamed Rate Zones 1, 2, and 3, respectively. The three service areas are shown in Figure 2.1, and briefly described below:

- TCSD (Rate Zone 1): This zone includes the cities of Gladstone, Oregon City, and West Linn, as well as a small number of retail customers. In July 2017, TCSD's operations were transferred to the Clackamas Water Environment Services (WES) partnership. Flow generated within Rate Zone 1 is tributary to the Tri-City WRRF. Rate Zone 1 is referred to throughout this plan as the "Tri-City Service Area."
- CCSD No. 1 (Rate Zone 2): This zone includes four separate, noncontiguous sewer services areas encompassing the areas listed below. Except for flow that is transferred to the Tri-City WRRF via the Intertie 2 Pump Station, flow generated within this Rate Zone is tributary to the Kellogg Creek Water Resource Recovery Facility (WRRF). Rate Zone 2 is referred to throughout this plan as the "Kellogg Creek Service Area" and includes the following areas:
  - Unincorporated areas of Clackamas County.
  - The City of Happy Valley.
  - The western edges of Damascus.
  - The communities of Hoodland, Boring, and Fischer's Forest Park.
  - Surface water management service area within the City of Happy Valley and in unincorporated Clackamas County.
  - The City of Milwaukie and Johnson City.
- SWMACC (Rate Zone 3): This zone includes the City of Rivergrove and portions of unincorporated Clackamas County that drain into the Tualatin River.

2.2.2 Existing Conveyance and Treatment Facilities

The District operates and maintains more than 356 miles of sanitary sewers, interceptors, and force mains; 21 wastewater pumping stations; five water resource recovery facilities; the local collection system in Happy Valley; and unincorporated areas within the service area. Figure 2.1 shows the existing wastewater system.

The location of three of the five wastewater treatment facilities: Tri-City WRRF, Kellogg Creek WRRF, and Fischer's Forest Park WRRF, operated by WES are also shown in Figure 2.1. Table 2.1 summarizes the construction year, capacity, and service area of each treatment facility. As previously noted, the focus of this Plan is on the conveyance infrastructure and treatment capacity for the Tri-City Service Area and the Kellogg Creek Service Area.

Table 2.1 Summary of Existing Treatment Facilities

Facility	Year	Capacity[1] (mgd)	Service Area
Fischer's Forest Park WRRF	1971	--	26 single family residences
Kellogg Creek WRRF	1972	10.0	City of Milwaukie and North Clackamas Service Area (Kellogg Creek Service Area)
Hoodland WRRF	1982	0.9	Hoodland, Welches, and the Wemme Recreational Corridor
Boring WRRF	1986	0.02	60 commercial and residential connections
Tri-City WRRF[2]	1987 2010	8.4 11.9	Cities of Oregon City, Gladstone, and West Linn (Tri-City Service Area) and North Clackamas Service Area

Notes:
(1) Dry weather flow capacity.
(2) In 1999, the facility began providing growth-related capacity for the Kellogg Creek Service Area.
Abbreviation: mgd - million gallons per day.

2.3 Land Use

The Statewide Goal 11: Public Facilities, Oregon Statue 197, and Oregon Administrative Rule (OAR) 660 require the following information to be included in facilities planning documents:

- An inventory and general condition assessment of all significant public facility systems supporting the land uses designated in the acknowledged comprehensive plan.
- A list of significant public facility projects that will support the land uses designated in the acknowledged comprehensive plan.
- Rough cost estimates for each public facility project.
- A map and written description of each public facility project's general location or service area.
- Policy statements or urban growth management agreements identifying the provider of each public facility system.
- An estimate of when each facility project will be needed.
- An assessment of the provider's existing funding mechanisms, their ability to fund the development of each public facility project or system, and possible new funding mechanisms.

Consistent with these requirements, Figure 2.2 shows the delineation of existing land use and zoning designations within the planning area. Figure 2.3 outlines the future service areas included in the planning area.

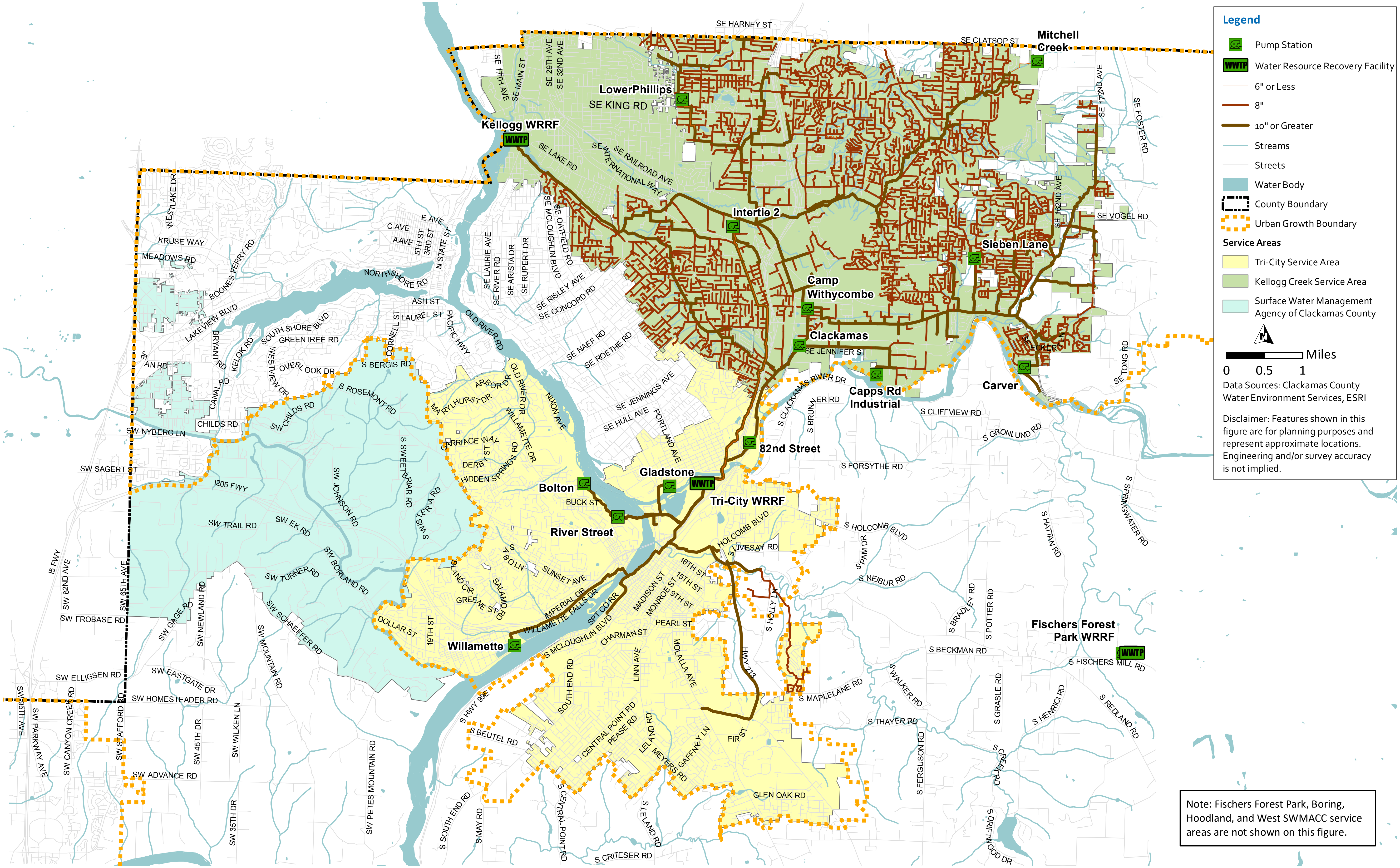


Figure 2.1 Conveyance Infrastructure and Treatment Facilities

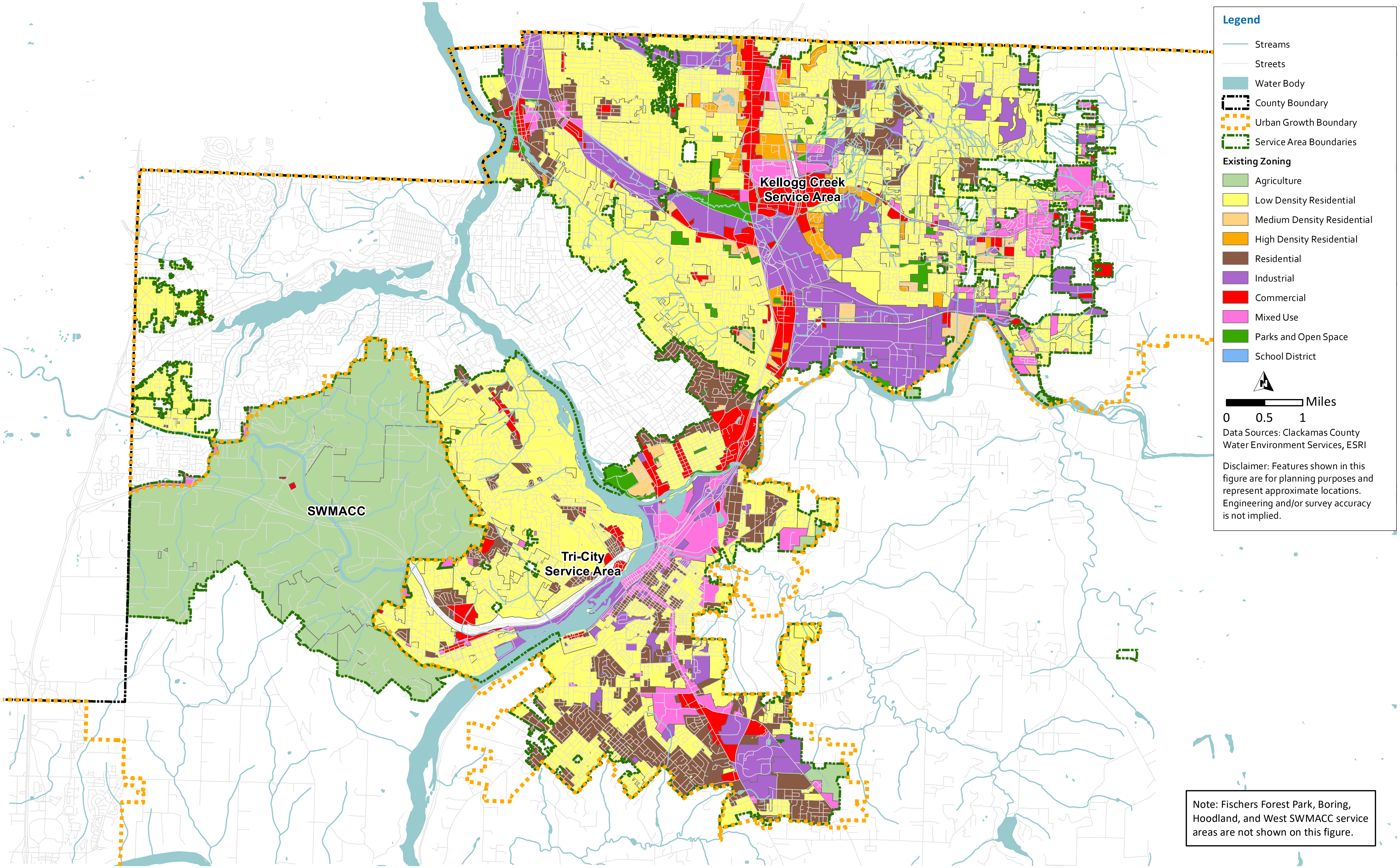


Figure 2.2 Zoning for Existing WES Service Area

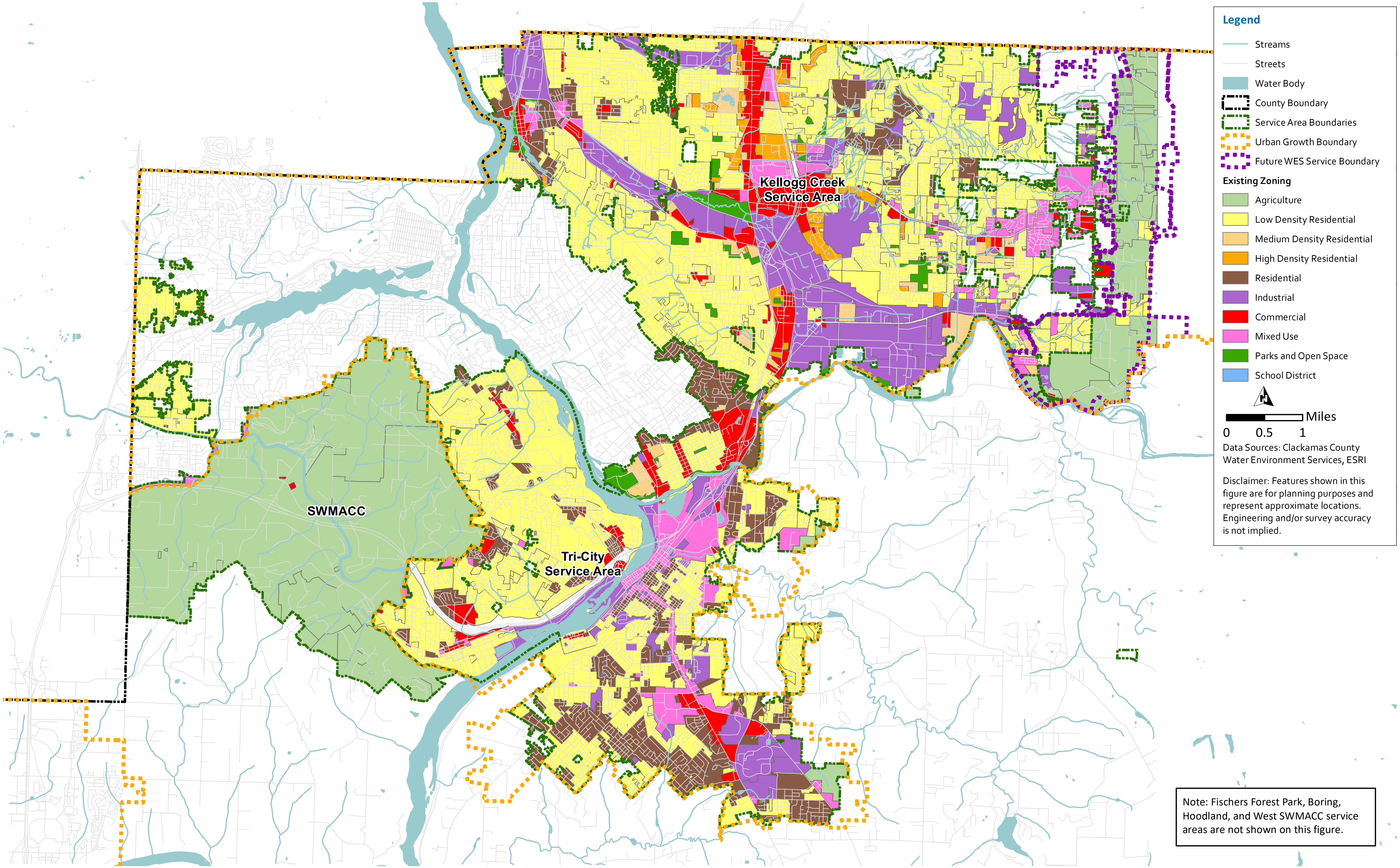


Figure 2.3 Zoning for Future WES Service Area

2.4 Physical Characteristics

The natural environment is an important determinant of growth within a region and is therefore a consideration in the WFP. The District's service area covers 65.4 square miles in a physically diverse part of Clackamas County. The Willamette River, Clackamas River, and Tualatin River all flow through the planning area. The main thoroughfares are the Interstate-205 (I-205) freeway and Highways 224, 212, and 99E. The planning area extends to the borders of Multnomah County to the north, and Washington County to the west. The following sections summarize the physical characteristics of the planning area.

2.4.1 Regional Climate

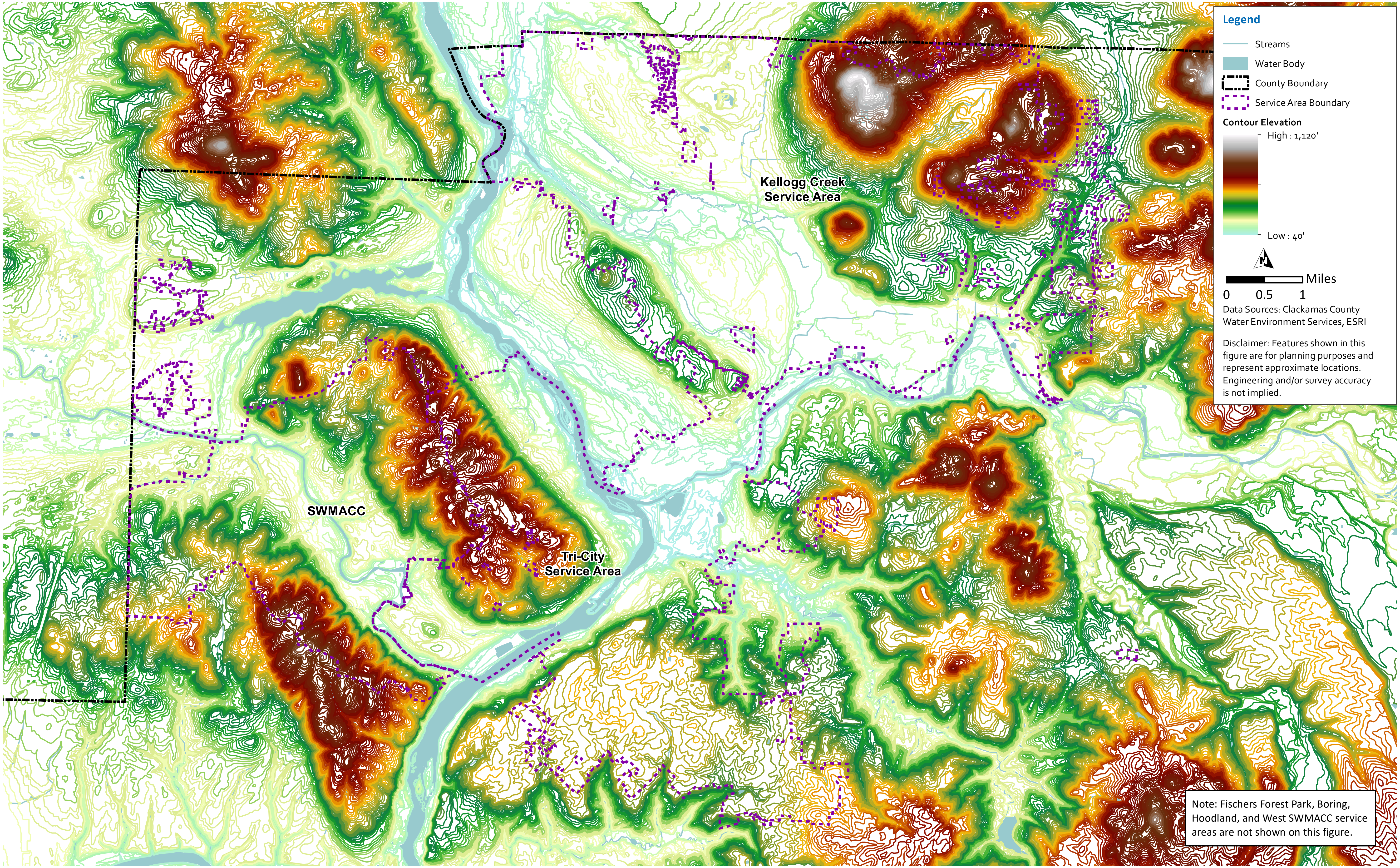
The planning area climate has warm, dry summers and cool, moist winters. The average daily temperature is 41-degrees Fahrenheit (F) during the winter and 64-degrees F during the summer. The total average annual precipitation is approximately 43 inches, 75 percent of which usually falls from October through March. During the wet winter season, rainfall is generally light with period of more intense rainfall. Summers are typically dry, with an average of five-inches of rain falling between June and September.

2.4.2 Regional Topography

The topography of the planning area is generally driven by river channels and floodplains, the Boring lava fields, and the foothills of Mt. Hood to the east. Figure 2.4 shows the topography in the planning area.

The elevation in the planning area ranges from sea level to approximately 1,100 feet (ft) above sea level, and typically increases toward the east and southeast. The Boring lava field produced small cinder cones, including Mt. Talbert and Mt. Scott, which are scattered throughout the northeast part of the planning area.

The Clackamas River runs from east to west and converges with the Willamette River southwest of Gladstone. The Tualatin River runs southeast and converges with the Willamette River south of the town of Willamette. The Willamette River, which runs south to north, contributed to steep slopes on the west side of the river channel and gentler slopes on the east side of the river channel.


Legend
Streams
Water Body
County Boundary
Service Area Boundary
Contour Elevation
High : 1,120'
Low : 40'
N
Miles
0 0.5 1
Data Sources: Clackamas County Water Environment Services, ESRI
Disclaimer: Features shown in this figure are for planning purposes and represent approximate locations. Engineering and/or survey accuracy is not implied.
Kellogg Creek Service Area
SWMACC
Tri-City Service Area
Note: Fischers Forest Park, Boring, Hoodland, and West SWMACC service areas are not shown on this figure.

2.4.3 Regional Geology and Soils

The geology of the District service area is dominated by Quaternary deposits consisting of backwater deposits from the Missoula Floods as well as glaciofluvial, lacustrine, and fluvial sedimentary deposits. Peaks and highlands within the area are dominated by basalts from the Columbia River deposits and the Boring lava.

The region's geologic history begins with the formation of the Columbia River Basalt (CRB) groups, which formed from millions of years of lava flows. The ancestral Columbia River and local streams carved through the CRB flows and began depositing fluvial sediments. The Boring volcanic field was then active in the Portland Basin, forming cinder cones and lava fields. Rivers again carved canyons through the lava formations.

Over thousands of years, the Catastrophic Missoula Floods left layers of flood deposits. Local streams reestablished their courses through the flood deposit, and widespread landslide failures, many of which are still active, started occurring in steep canyons. Local faults in the District's planning area include the Portland Hills Fault, the Bolton Fault, and the Oatfield Fault.

The planning area's morphology and soils were influenced significantly by the Boring Lava Domes and recent and persistent catastrophic flood events on the Columbia River known as the Missoula Floods. The Natural Resources Conservation Service (NRCS) classifies the planning area soils as hydrologic Group C, with some hydrologic Group B soils present. The NRCS categorizes Group C soils as somewhat poorly drained, with slow to rapid runoff and low permeability. Group B soils have moderately low runoff potential when thoroughly wet.

2.4.4 Environmentally Sensitive Areas and Species

The planning area extends across the following major watersheds:

- Clackamas.
- Molalla-Pudding.
- Lower Columbia-Sandy.
- Tualatin.
- Lower Willamette.

According to the Oregon Department of Fish and Wildlife (ODFW), the rivers and streams in the planning area serve as a habitat for endangered, threatened, or vulnerable native fish. Table 2.2 summarizes these species and the federal and state status of planning efforts for them.

Table 2.2 Aquatic Species Status

Species	Federal Status	State Status
Fall and spring chinook	Listed threatened	Sensitive vulnerable
Coho	Listed threatened	Sensitive vulnerable
Pacific lamprey	Species of concern	Sensitive vulnerable
Summer and winter steelhead	Listed threatened	Sensitive critical
White sturgeon	--	Data gap
Coastal cutthroat trout	Species of concern	Sensitive vulnerable

In 2016, ODFW produced the Oregon Conservation Strategy, which serves as an overarching state strategy for conserving fish and wildlife. The Conservation Strategy identifies key conservation issues that are landscape-scale threats affecting species and habitats throughout the state.

Table 2.3 summarizes the key conservation issues for the Willamette Valley Ecoregion, of which the District is a part.

Table 2.3 Key Conservation Issues of Concern in Willamette Valley Ecoregion

Conservation Issue	Description
Land use conversion and urbanization	Habitat continues to be lost through conversion to other uses.
Altered fire regimes	Maintaining open-structured strategy habitats, such as grasslands, oak savannas, and wet prairies, partly depends on periodic burning. Fire exclusion has allowed succession to more forested habitats.
Altered floodplain	The floodplain dynamics of the Willamette River have been significantly altered. Multiple braided channels dispersed floodwaters, deposited fertile soil, moderated water flow and temperatures, and provided a variety of slow-water habitats, such as sloughs and oxbow lakes. The Willamette River has largely been confined to a single channel and disconnected from its floodplain.
Habitat fragmentation	Habitats for at-risk native plant and animal species are largely confined to small and often isolated fragments, such as roadsides and sloughs.
Invasive species	Invasive plants and animals disrupt native plant and animal communities and affect populations of at-risk native species.
Wildlife hazards	Urban landscapes can present a variety of hazards for wildlife, such as bird collisions with windows, impacts due to light pollution, predation and pet disturbance, collisions with vehicles and power lines, exposure to pesticides and contaminants, and harassment and illegal take of wildlife.

The Conservation Strategy identifies habitats of conservation concern in Oregon that provide important benefits to strategy species. These species are defined as Oregon's "species of greatest conservation need." Table 2.4 summarizes strategy habitats in the Willamette Valley Ecoregion.

Table 2.4 Strategy Habitats in the Willamette Valley Ecoregion

Type	Name
Flowing River and Riparian Habitats	Flowing water and riparian habitats include all naturally occurring flowing freshwater streams and rivers as well as the adjacent riparian habitat.
Grasslands	Grasslands in the Willamette Valley, also called upland prairies, are dominated by grasses, forbs, and wildflowers.
Natural Lakes	Natural lakes are relatively large bodies of freshwater surrounded by land. For the Conservation Strategy, they are defined as standing water bodies larger than 20 acres.
Oak Woodlands	Oak woodlands are characterized by an open canopy dominated by Oregon white oak.
Wetlands	Wetlands are covered with water for all or part of the year. Permanently wet habitats include backwater sloughs, oxbow lakes, and marshes, while seasonally wet habitats include seasonal ponds, vernal pools, and wet prairies.

2.4.5 Cultural Resources

This section presents a brief summary of Oregon's cultural resource protection requirements and lists the potential types and numbers of resources that may be encountered during construction of projects identified in this plan. If further built environment resources, archaeological, or other historic resources are observed during formal Oregon State Environmental Review Process (SERP) review, they will be documented at a level appropriate for assessing them as potential historic properties. SERP review may include the WRRF facilities as well. In any event, an inadvertent discovery plan should be established prior to implementing projects that have the potential to impact cultural resources.

The Oregon Land Conservation and Development Act (Senate Bill 100) of 1973 was the first statewide comprehensive land use planning system in the nation. The Act requires every city and county in the state to prepare plans comprehensive to the state's general goals. Goal 5 (OAR660-023) of 1974, also adopted under the Act, and subsequently amended in 1988 and 1996, further addresses over a dozen types of resources, including historic places (Potter 2016). The revised Goal 5 Rule, adopted in 2017, makes compliance optional for local jurisdictions (Oregon State Historic Preservation Office [SHPO] 2018). Communities may regulate properties or sites listed in the National Register of Historic Places (NRHP) only if the local jurisdiction separately adopts additional protections through a public process, or if the properties or sites are locally listed. Exceptions are proposed for demolition or relocation; communities must perform a review of properties or sites in these circumstances. According to the foundation of Goal 5, communities must engage in the public process of identification and protection of their important historic resources (Potter 2016; SHPO 2018).

In 1980, Congress established the Certified Local Government Program, a federal, state, and local government partnership effort, promoting local preservation efforts (Potter 2016). During the 1980s, the State of Oregon initiated multiple policies for financial and programmatic investment in documentation and preservation of historic properties in Oregon (Department of Land Conservation and Development and SHPO 2018).

Cultural Resource review includes assessing direct effects to any potential archaeological resources related to project activities, as well as assessing any indirect impacts to historic properties listed in, or eligible for, inclusion in the NRHP that would result from the project and that are within a 0.5-mile radius study area.

Review of Oregon State Historic Preservation Historic Sites Database (HSD) shows there are 29 historic districts within Clackamas County, 6,943 historic buildings (some of which are included within districts), 18 objects (including historic tree groves, monuments, individual landmarks, road segments, etc.), 79 sites (some of which are included within districts; archaeological sites trails, cemeteries, road segments, campgrounds, etc.), and 101 structures (some of which are included within districts; including bridges, trails, dams and associated components, viewpoints, etc.).

Initially, approximately 3,000 were documented during reconnaissance level inventory (RLS) as part of the above-mentioned policies and programs (Clackamas County 2020), but some were already documented during the late 1970s. The HSD shows subsequent intensive level survey (ILS) performed in 2007 of 299 buildings and structures located within unincorporated areas of Clackamas County. These constitute the Clackamas County Historic Landmarks, with compilation complete in 2008. Of the 299 included in the ILS, 113 are considered eligible/significant (27 individually listed and two formally determined eligible), 166 eligible/contributing, nine not eligible/not contributing, one not eligible/out of period, and two as yet undetermined eligibility.

The HSD shows that 12 RLS/ILS inventories have been completed in the study areas surrounding the Willamette Facilities Plan Tri-City and Kellogg Creek WRRFs. There are 85 properties within the Tri-City WRRF study area and 93 properties within the Kellogg Creek WRRF study area. Of the 85 within the Tri-City WRRF study area, five are considered eligible/significant, 76 eligible/contributing, and four as yet undetermined eligibility. Of the 93 within the Kellogg Creek WRRF study area, seven are considered eligible/significant (three individually listed), 84 eligible contributing, and two as yet undetermined eligibility.

Review of the SHPO Oregon Archaeological Records Remote Access (OARRA) database shows that between 1977 and 2018, 19 cultural resource inventories were performed within the Tri-City WRRF study area. A total of four archaeological sites (two precontact, one historic-era, and one multi-component) are currently documented within the study area. Within the Kellogg Creek WRRF study area SHPO OARRA shows that between 1983 and 2014, 17 cultural resource inventories were performed. A total of seven archaeological sites (six historic-era, one multicomponent) are currently documented. Most cultural resource inventories relative to both WRRF study areas are associated with metropolitan or city-wide transportation or utility projects.

2.4.6 Regional Hazards

Natural hazards that may occur in the planning area include earthquakes, floods, and landslides. The District is within the active area of the Cascadia Subduction Zone (CSZ), which can cause a magnitude 9.0+ earthquake. According to the Oregon Department of Geology and Mineral Industries (DOGAMI), a CSZ earthquake could produce very strong to severe shaking in the District.

Flood hazards exist along the main rivers and creeks in the District's planning areas. If flooding occurs, the Willamette and Clackamas Rivers, as well as Kellogg Creek, Johnson Creek, Scott Creek, and Rock Creek, could cause extensive damage. Oregon Metro documented areas along these rivers and creeks that the Federal Emergency Management Agency (FEMA) designated as 100-year floodplains.

Throughout the region are landslide hazards on steep slopes. According to DOGAMI, landslide hazards in the District range from low (landslide unlikely) to very high (existing landslide).

2.4.7 Tri-City Surrounding Area

As shown in Figure 2.5, the Tri-City WRRF is located in Oregon City at the confluence of the Clackamas River and the Willamette River. The facility is bounded by I-205 to the south and east, and the Clackamas River to the north and west.

Clackamette Cove, which was once a gravel quarry, is located directly west of the facility. The Old Rossman Landfill, which used to be a municipal garbage landfill, is located directly south of the facility.

The site is approximately 40 to 50 feet above sea level. The facility is located within FEMA's 100-year floodplain for the Clackamas River, creating a flood hazard for the site.

Metro classifies the Tri-City WRRF site as a Riparian Class I habitat, which is an area supporting three or more riparian functions. Directly north of the facility, between the site and the Clackamas River, is a designated wetlands area. According to ODFW's Conservation Strategy, this site is a strategy habitat because of the wetlands and because the site contains a flowing river and riparian habitat.

ODFW identified the Willamette River and the Clackamas River as habitat for the following native fish that are endangered, threatened, or vulnerable species:

- Fall and spring chinook.
- Coho.
- Pacific lamprey.
- Summer and winter steelhead.
- Coastal cutthroat trout.

The dominant soils at the site include Quaternary surficial deposits, alluvial deposits, and mixed grained sediments. According to DOGAMI, a CSZ earthquake could produce severe shaking at the facility and the potential landslide hazard is high.

Figure 2.5 Tri-City WRRF Vicinity Map

2.4.8 Kellogg Creek Surrounding Area

As shown in Figure 2.6, the Kellogg Creek WRRF is located in Milwaukie at the confluence of Kellogg Creek and the Willamette River. The facility is bounded by Highway 99E to the east and the Willamette River to the west. Milwaukie Bay Park and downtown Milwaukie are directly north of the facility site. Directly south of the site is a residential area.

The site is approximately 30 to 40 ft above sea level. The facility is located within FEMAs 100-year floodplain for the Willamette River, creating a flood hazard.

According to Metro, a Riparian Class II habitat is an area supporting one or two primary riparian functions. Metro classifies the Kellogg Creek WRRF site as a Riparian Class II habitat but does not classify it as a wetland.

According to ODFW's Conservation Strategy, the site is a strategy habitat because it contains a flowing river and is a riparian habitat. ODFW has identified the Willamette River and Kellogg Creek as habitat for the following endangered, threatened, or vulnerable species of native fish:

- Fall and spring chinook.
- Coho.
- Pacific lamprey.
- Summer and winter steelhead.
- White sturgeon.
- Coastal cutthroat trout.

The dominant soils at the site include Quaternary surficial deposits, alluvial deposits, mixed grained sediments, and outburst flood deposits left by the Missoula floods. According to DOGAMI, a CSZ earthquake could produce severe shaking at the Kellogg Creek WRRF, and the potential landslide hazard is high.

Figure 2.6 Kellogg Creek WRRF Vicinity Map

2.5 Population and Employment

Population and employment trends are significant factors in the planning for wastewater conveyance and treatment facilities. This section describes the trends and projections used to determine future flows and loads as part of this plan.

2.5.1 Local Industry

Clackamas County's principal economic activities include agriculture, timber, manufacturing, and commerce. According to the Clackamas County Economic Landscape Emerging Trends Update from 2017, the gross domestic product (GDP) for 2015 was $18.8 billion. The 2015 GDP was up from $17.6 billion in 2014 and $18.1 billion in 2013. The top industries in Clackamas County, in order of annual GDP contribution to Clackamas County, are as follows:

- Professional business services.
- High-tech manufacturing.
- Wholesale trade.
- Healthcare.
- Advanced manufacturing - metals and machinery.
- Software and media production.
- Transportation and distribution.
- Agriculture and food production.
- Food and beverage processing.
- Nurseries and greenhouses.
- Wood manufacturing.

2.5.2 Socio-Economic Trends

The US Census Bureau conducted an annual American Community Survey (ACS) help local officials and businesses understand changes in their communities. The ACS provides data on jobs and occupations, educational attainment, and homeownership, in addition to other population trends. Table 2.5 summarizes socio-economic statistics and trends from 2009 to 2017 for Clackamas County.

Table 2.5 Clackamas County Socio-Economic Trends

Clackamas County	2009	2013	2017
Unemployment(1)	11.3%	7.2%	3.8%
Median household income (dollars)(2,3)	$74,905	$76,549	$72,408
Median nonfamily income (dollars)(2,3)	$36,266	$37,812	$42,366
Education: high school graduate or higher(2)	91.9%	93.1%	93.9%
Education: Bachelor's degree or higher(2)	30.0%	30.9%	34.9%
Below poverty level(2)	No data	9.8%	9.0%

Notes:
(1) Source: WES 2019-2020 Fiscal Year Budget.
(2) Source: U.S. Census Bureau American Community Surveys.
(3) Due to lack of 2009 data, 2010 data is shown.

According to Table 2.5, the economic trend for Clackamas County was generally positive from 2009 to 2017, with the unemployment rate steadily decreasing since 2009. Although the median household income decreased between 2013 and 2017, the median nonfamily income increased by approximately 18 percent from 2010 to 2017. Also, education levels increased from 2009 to 2017, and poverty decreased between 2013 and 2017.

2.5.3 Current Service Area Populations

Table 2.6 summarizes the District's estimated 2018 population by service area.

Table 2.6 Service Area Estimated Population (2018)

Service Area	2018
Tri-City Service Area	72,145
Kellogg Creek Service Area	100,905
SWMACC Service Area	7,900

Note:
(1) Source: WES 2019-2020 Fiscal Year Budget.

2.5.4 Households and Employment

Table 2.7 summarizes the household and employee projections for the service area, per the Sanitary Sewer System Master Plan for Water Environment Services.

Table 2.7 Planning Area Household and Employee Projections

	2015	2040
Number of households	76,200	84,700
Number of employees	102,600	123,000

Note:
(1) Source of data is the Sanitary Sewer System Master Plan for Water Environment Services.

2.5.5 Population Projections

In 2016, EcoNorthwest completed growth estimates for the various jurisdictions within the planning area (Population Forecasts for Clackamas County Service Districts, August 2016). The 20-year population forecasting efforts started with Portland State University (PSU) Population Research Center 2015 certified population estimates and the 2018 Oregon Metro Regional Transportation Plan.

Region-wide forecasts were allocated into Metro Transportation Analysis Zones (TAZs). Population projections included in this chapter were previously reviewed by local jurisdictions. Projections were prepared separately for the Tri-City Service Area and the Kellogg Creek Service Area. These projections included proposed extensions of the District's service areas, as shown in Figure 2.3. The 2040 estimates for the Kellogg Creek Service Area include the District's expansion in the Happy Valley/Former Damascus area.

Table 2.8 summarizes EcoNorthwest's population projections for both service areas through the year 2040, and Figure 2.7 shows the population projections graphically. The population in the planning area is estimated to increase approximately 33 percent from 2015 to 2040. As illustrated by Table 2.8 and Figure 2.7, 64 percent of the population growth is projected to occur in the Kellogg Creek Service Area, and 36 percent of population growth is expected to occur in the Tri-City Service Area.

Table 2.8 Planning Area Population Projection

Jurisdiction	2015	2020	2025	2030	2035	2040
Tri-City Service Area (1)	69,406	76,565	80,621	84,185	86,308	88,766
Kellogg Creek Service Area(2)	95,364	103,791	109,754	117,730	124,227	129,670
Planning Area Total(3)	**164,770**	**180,356**	**190,015**	**201,915**	**210,535**	**218,436**

Notes:
(1) EcoNorthwest growth estimate refers to the Tri-City Service Area as TCSD.
(2) EcoNorthwest growth estimate refers to the Kellogg Creek Service Area as CCSD No. 1.
(3) Sum of Tri-City Service Area Total and Kellogg Creek Service Area Total.

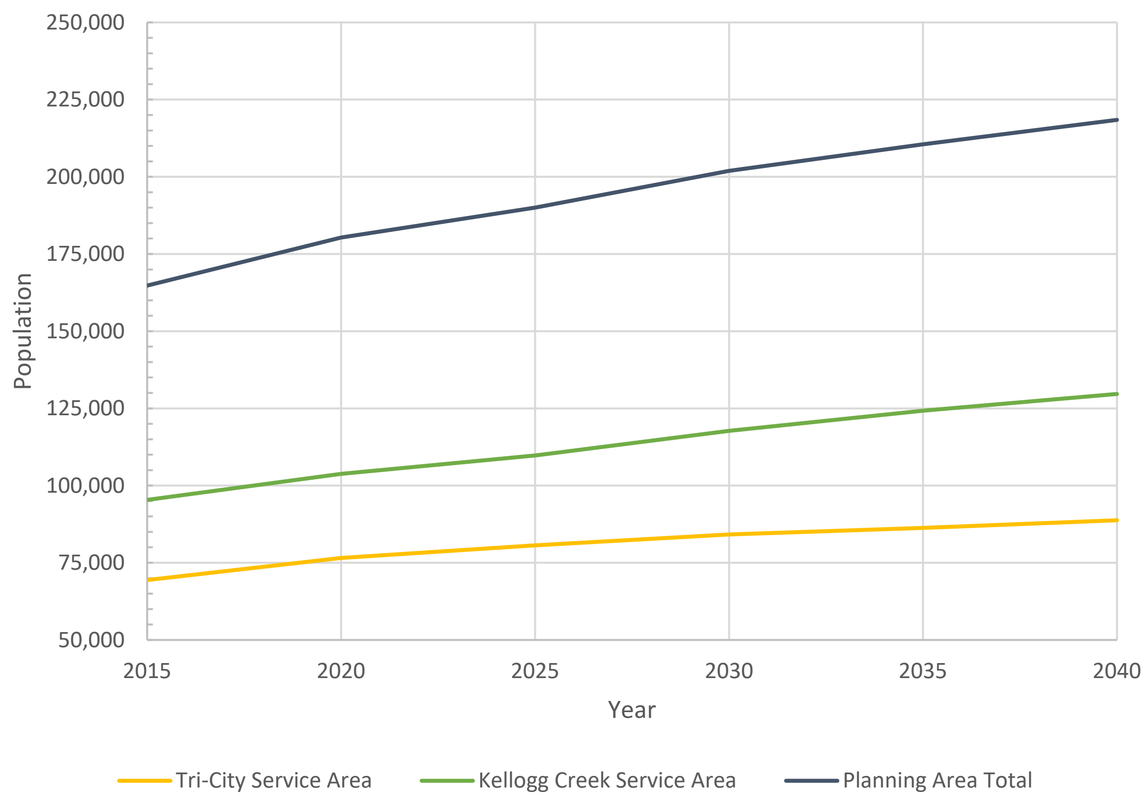


Figure 2.7 Planning Area Population Projection

2.5.5.1 Tri-City Service Area Population Projections

The EcoNorthwest population projections by jurisdiction for the Tri-City Service Area through the year 2040 are summarized in Table 2.9. Figure 2.8 shows the population projections graphically. The Tri-City Service Area population is forecasted to increase approximately 28 percent from 2015 through 2040. As shown in Figure 2.8, Oregon City will have the largest percent increase in population growth in the Tri-City Service Area between 2015 and 2040.

Table 2.9 Tri-City Service Area Population Projections

Jurisdiction	2015	2020	2025	2030	2035	2040
Gladstone[(1)]	11,505[(1)]	11,703	11,723	11,765	11,737	11,714
Oregon City[(1)]	33,940[(1)]	38,599	41,711	44,529	46,201	47,534
West Linn[(1)]	25,605[(1)]	27,794	28,559	29,068	29,185	30,087
Tri-City Service Area Total[(2)]	**69,406**	**76,565**	**80,621**	**84,185**	**86,308**	**88,766**

Notes:
(1) Certified Population Estimate, Portland State University, December 2015.
(2) EcoNorthwest growth estimate refers to the Tri-City Service Area as TCSD.

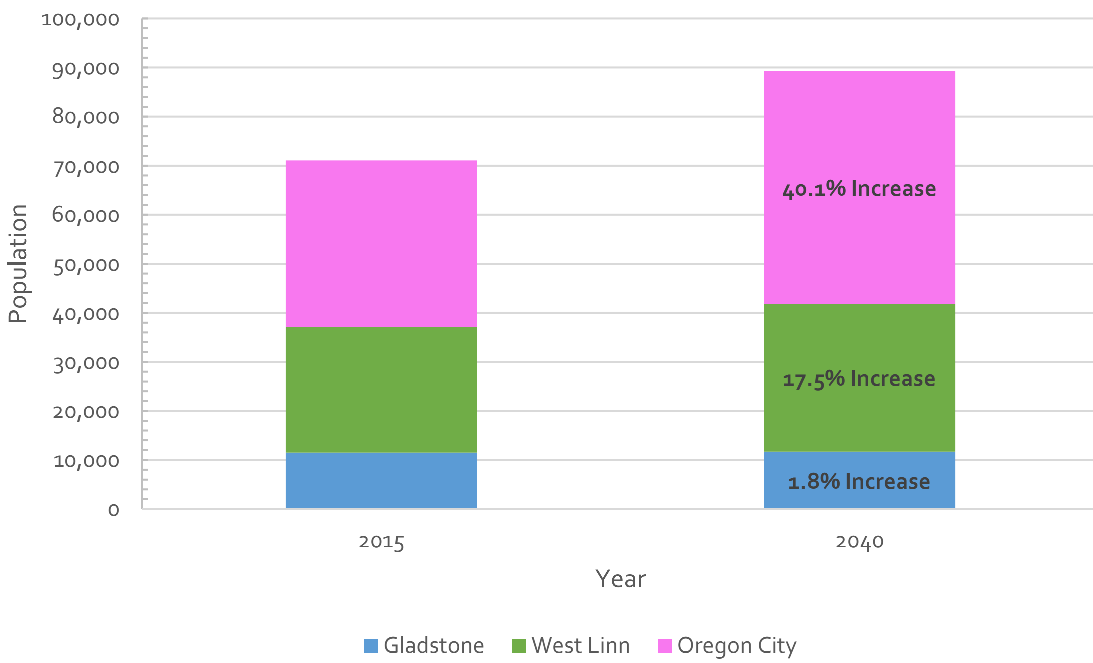


Figure 2.8 Tri-City Service Area Population Projection

2.5.5.2 Kellogg Creek Service Area Population Projections

The EcoNorthwest population projections by jurisdiction for the Kellogg Creek Service Area through the year 2040 are summarized in Table 2.10. Figure 2.9 shows the population projections graphically. The Kellogg Creek Service Area population is forecasted to increase approximately 36 percent from 2015 through 2040. As shown in Figure 2.9, Happy Valley will have the largest percent increase in population growth in the Kellogg Creek Service Area between 2015 and 2040.

Table 2.10 Kellogg Creek Service Area Population Projection

Jurisdiction	2015	2020	2025	2030	2035	2040
Unincorporated Clackamas County	74,294	81,944	87,236	94,996	101,625	107,236
Milwaukie(1)	20,505(1)	21,291	21,973	22,241	22,076	21,914
Johnson City(1)	565(1)	556	545	536	526	520
Kellogg Creek Service Area(2)	**95,364**	**103,791**	**109,754**	**117,730**	**124,227**	**129,670**

Notes:
(1) Certified Population Estimate, Portland State University, December 2015.
(2) EcoNorthwest growth estimate refers to the Kellogg Creek Service Area as CCSD No. 1.

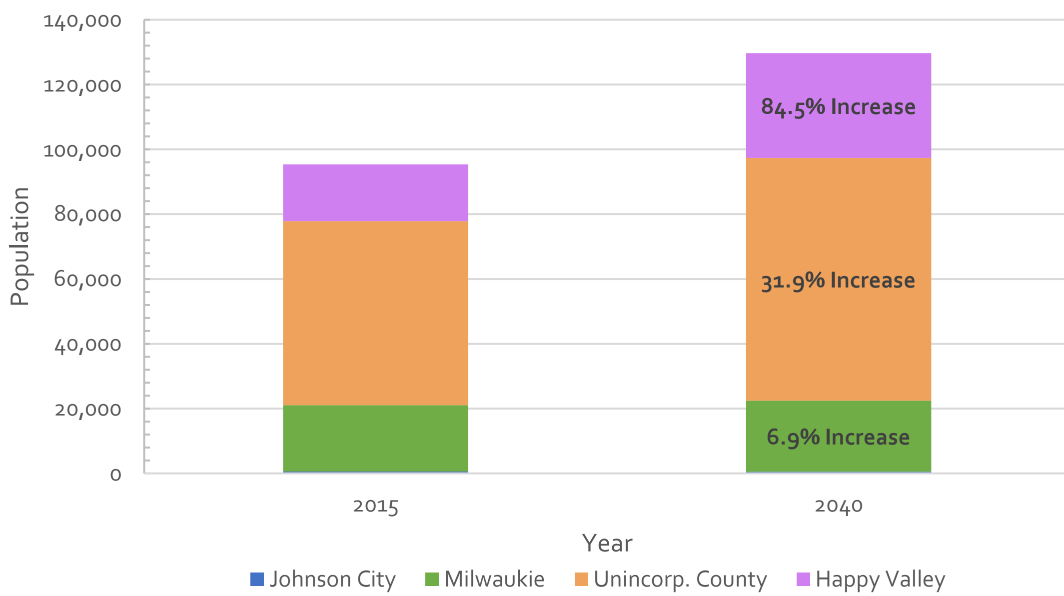


Figure 2.9 Kellogg Creek Service Area Population Projection
Note: Johnson City population is projected to decrease from 2015 to 2040.

2.5.6 Buildout Projections

According to the Sanitary Sewer System Master Plan for Water Environment Services (Master Plan), buildout for the District's service area is projected to occur in 2087 when the population is anticipated to reach 360,900 people. Buildout utilized per capita dry flows at the lower end of the range reported in Table 3-6 of the Master Plan (approximately 54 gallons per capita per day [gpcpd]). By 2087, 44 percent of the District's service area population will be in the Tri-City Service Area and 56 percent will be in the Kellogg Creek Service Area (43 percent upstream of Intertie 2 Pump Station and 13 percent downstream of the Intertie 2 Pump Station).

When buildout is reached in 2087, employment in the District's service area is anticipated to reach 206,500 employees. The buildout utilized per employee dry flows at the lower end of the range reported in Table 3-6 of the Master Plan (approximately 40 gpcpd). By 2087, 37 percent of employees are projected to be in the Tri-City Service Area and 63 percent in the Kellogg Creek Service Area (53 percent upstream of Intertie 2 Pump Station and 10 percent downstream of the Intertie 2 Pump Station).

Chapter 3

WASTEWATER FLOWS AND LOADS

3.1 Introduction

This chapter presents an evaluation of historical wastewater flows and loads generated in the Tri-City Water Resource Recovery Facility (WRRF) and Kellogg Creek WRRF service areas and establishes flow and load projections for total suspended solids (TSS), biochemical oxygen demand (BOD), ammonia, and total phosphorus.

3.2 Planning Basis

This section summarizes the service area, residential population, non-residential contribution, and rainfall records used in the analysis.

3.2.1 Service Area Delineation

As is documented in Chapter 2, Clackamas Water Environment Services (WES), also referred to as the "District," operates five treatment plants. This chapter and the Willamette Facilities Plan (WFP) address the flows and loads generated in the service areas feeding the District's two largest treatment plants (Tri-City and Kellogg Creek). As is shown in Figure 3.1, the Tri-City service area contributes flow to the Tri-City WRRF, and the Kellogg Creek service area contributes flow to the Kellogg Creek WRRF. The Intertie 2 Pump Station was constructed in 2013 to alleviate capacity constraints at the Kellogg Creek WRRF, and transfers wastewater from the Kellogg Creek service area to the Tri-City WRRF. The flow and load projections presented in this chapter account for this transfer, which will change over time as flows and loads increase to reflect growth in each service area.

3.2.2 Current and Future Populations

Table 3.1 summarizes the current and future populations used for the flow and load analysis, which were documented in Chapter 2.

Table 3.1 Service Area Population Projections

Jurisdiction	2015	2020	2040	Buildout
Tri-City Service Area	69,400	76,600	88,800	158,800
Kellogg Creek Service Area	95,400	103,800	129,700	202,100
District Planning Area Total	164,800	180,400	218,500	360,900

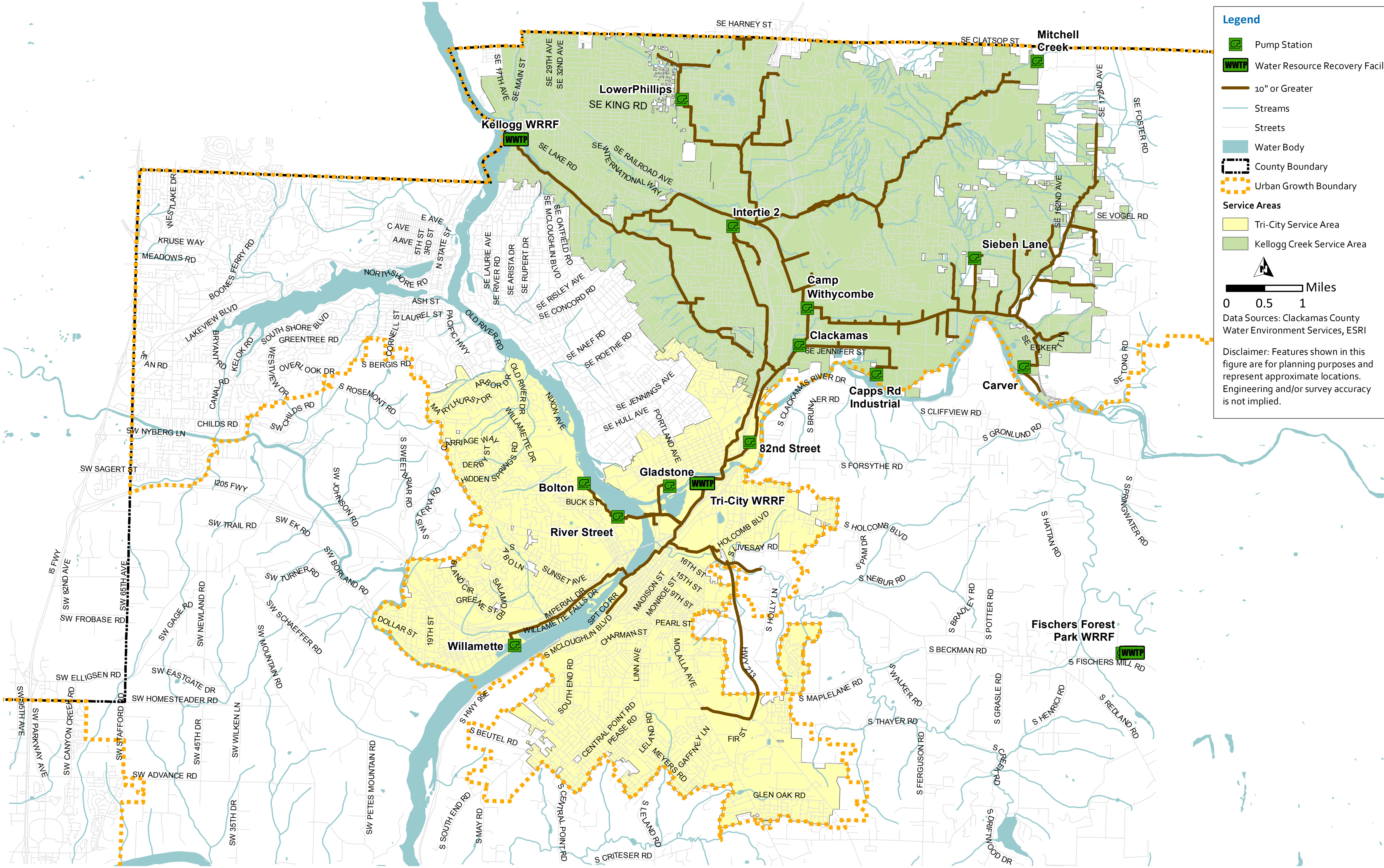


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Figure 3.1 Service Area Delineation

3.2.3 Non-residential Contribution

In addition to the wastewater generated by the residential population summarized in the previous section, the Tri-City WRRF also receives industrial wastewater and septage. The industrial flow and loads are primarily conveyed to the WRRF through the Clackamas Pump Station (shown in Figure 3.1). Current and projected industry and septage flows and loads used in this analysis were obtained from the *Tri-City Water Resource Recovery Facility Solids Handling Improvement Project TM3 Project Future Flows and Loads* (2016, Stantec).

Although there are no major sources of industrial and septage loads at the Kellogg Creek WRRF, this facility does receive aerobically digested sludge from the Hoodland WRRF. This small load is added to the Kellogg Creek WRRF during thickening and is not part of the influent sample.

The influent sample at both the Tri-City and Kellogg Creek WRRFs contain internal recycle flows and loads from the thickening process. The flow and loads from these internal recycles have been estimated through modeling and were discounted from the measured values provided herein.

3.2.4 Flow and Load Parameters

The flow parameters of primary interest for planning purposes are defined below. With the exception of base wastewater flow (BWF) and peak day dry weather flow (PDDWF), which were determined through analysis of historical plant records, two methods were used to define existing flows: 1) analysis of historical plant records; and 2) Oregon State Department of Environmental Quality (DEQ) Guidelines for Making Wet-Weather and Peak Flow Projections for Sewage Treatment in Western Oregon, herein described as the DEQ methodology. In each case, the most reasonable and conservative value was selected as the basis for determining the capacity of the WRRFs and will be used for subsequent alternatives evaluation:

1. **Base Wastewater Flow (BWF):**
   a. The average daily flow in the months of July and August.
2. **Average Dry Weather Flow (ADWF):**
   a. The average of daily flows over the six-month dry weather season, May 1 through October 31.
   b. The average flow during May through October corresponding to long-term average rainfall for the period from May through October.
3. **Average Wet Weather Flow (AWWF):**
   a. The average flow at the plant during the wet weather season, November 1 through April 30.
   b. The average flow during November through April corresponding to long-term average wet weather rainfall.
4. **Maximum Month Dry Weather Flow (MMDWF):**
   a. The maximum 30-day running average flow occurring during the months of May through October.
   b. The average monthly flow corresponding to the wettest dry weather month of high groundwater (May) with a 10 percent probability of occurrence in any given year.
5. **Maximum Month Wet Weather Flow (MMWWF):**
   a. The maximum 30-day running average flow occurring during the months of November through April.
   b. The anticipated monthly average flow corresponding to the wettest wet weather month of high groundwater (January) with a 20 percent probability of occurrence in any given year.

6. **Maximum Week Dry Weather Flow (MWDWF):**
   a. The maximum seven-day running average flow from May through October.
7. **Maximum Week Wet Weather Flow (MWWWF):**
   a. The maximum seven-day running average flow from November through April.
8. **Peak Day Dry Weather Flow (PDDWF):**
   a. The maximum daily flow from May through October.
9. **Peak Day Wet Weather Flow (PDWWF):**
   a. The maximum daily flow from November through April.
   b. The anticipated daily flow resulting from a 24-hour storm with a 1-in-5-year recurrence interval during a period of high groundwater and saturated soils.
10. **Peak Hour Flow (PHF):**
   a. The peak flow sustained for a one-hour period during the 24-hour, five-year return frequency storm, at a time when groundwater levels are high, and soils are saturated by previous storms.

In addition to these flow parameters this chapter considered the following parameters for BOD and TSS loads:

1. **Average Annual (AA):** The average load over a calendar year.
2. **Maximum Month (MM):** The maximum 30-day running average load.
3. **Maximum Week (MW):** The maximum 7-day running average load.

Note, the flow and loads analysis presented in this chapter include an evaluation of influent flow and load data through the year 2018. Since the analysis was completed, influent flow and load data for the years 2019 and 2020 became available. Appendix 3A includes updated historical flow and load graphs that include data from 2019 and 2020.

3.3 Historical and Existing Tri-City Flows

Because the transfer of wastewater between service areas has changed historically and will continue to change over time, flow and load estimates presented in this chapter were made for the service areas tributary to each treatment facility, rather than specific to each treatment facility itself. For the Tri-City service area, the wastewater flow is equal to the flow measured at the Tri-City WRRF minus the flow diverted from Kellogg Creek to Tri-City through the Intertie 2 Pump Station.

3.3.1 Base Wastewater Flow

The BWF for 2015 through 2018 was calculated as the average flow during the months with the least amount of rainfall, which are historically the months of July and August. These values are presented in Table 3.2. The residential per capita flow was calculated by subtracting the non-residential flow (plant recycles, industry and septage) from the calculated service area flow and dividing that value by the existing service area population. As shown in Table 3.2, the residential per capita flow for the years 2015 through 2017 is within expected range for treatment plants in the area, while the per capita flow of 46 gallons per capita per day (gpcd) measured in 2018 is substantially lower than typical values. To eliminate the influence of unexplained low flows in 2018, the per capita flow was calculated by averaging the per capita values from 2015 through 2017. Accordingly, a per-capita flow of 76 gpcd is used as the basis for projecting future flows based on population growth within the Tri-City service area.

Table 3.2 Tri-City Service Area BWF

Data Source	Population(1)	BWF, mgd(2)	Plant Recycles, mgd(3)	Industry, mgd(4)	Septage, mgd(5)	Residential BWF, mgd	Per capita, gpcd
2015 Flow	69,400	5.7	0.2	0.2	0.005	5.3	77
2016 Flow	70,800	6.2	0.1	0.3	0.006	5.7	81
2017 Flow	72,300	5.6	0.1	0.3	0.007	5.1	71
2018 Flow	73,700	3.8	0.1	0.3	0.008	3.4	46
Selected Value (2018)(6)							**76**

Notes:
(1) Based on the total Tri-City service area population projections provided for EcoNorthwest for the years 2015 and 2020. Values for the years 2016 through 2018 were determined through linear interpolation.
(2) Calculated on a daily basis by subtracting the flow routed from the Kellogg Creek Service Area to the Tri-City Plant (I2_TC_Q) from the daily flow measured at the Tri-City WRRF.
(3) Influent flow measured at Tri-City includes the recycles from the thickening process. This flow was estimated from modeling as 1.9 percent of the influent flow measured at Tri-City WRRF.
(4) Based on discussions from District staff, the majority of the industrial flow comes through the Diversion line. Estimated on a daily basis as the difference between the total diversion flow (D_Flow) and the flow routed from Kellogg Creek (I2_TC_Q).
(5) Based on values provided in the TM3 Projected Future Flows and Loads (MWH 2016) for 2015 and 2020. Values for the years 2016 through 2018 determined through linear interpolation.
(6) Average of 2015 - 2017.
Abbreviation: mgd - million gallons per day.

3.3.2 Average Flow

According to the DEQ methodology, the ADWF is determined by the relationship between total dry season rainfall and the average dry weather influent flow. DEQ methodology suggests using recent data to establish this parameter, so data from 2015 through 2018 are shown plotted in Figure 3.2. The total dry weather season (May through October) mean rainfall for the Oregon City weather station is 9.6 inches over the past 30 years (1989 through 2018). The ADWF corresponds to the intersection of the average long-term dry weather precipitation (9.6 inches) and the trendline for the 2015 through 2018 data. Using this method and data set, the ADWF would be 5.9 mgd (see Figure 3.2).

Similarly, the AWWF is determined based on the relationship developed between total wet season rainfall and the average wet weather influent flow. The total wet weather season mean rainfall (November through April) for the Oregon City weather station is 31.1 inches over the past 30 years (1989 through 2018). The AWWF corresponds to the intersection of the average long-term wet weather precipitation and the trendline for the 2015 through 2018 data. Using this method and data set, the AWWF would be 11.3 mgd (see Figure 3.3).

The peaking factors associated with the ADWF and AWWF, with respect to the BWF, are 1.0 and 1.8, respectively, using DEQ methodology. These flows and peaking factors are significantly lower than the observed average peaking factors from 2015 through 2017, shown in Table 3.3. As a result, the average flows and peaking factors from 2015 through 2017 are recommended for the purpose of determining future flows, rather than those calculated using the DEQ methodology.

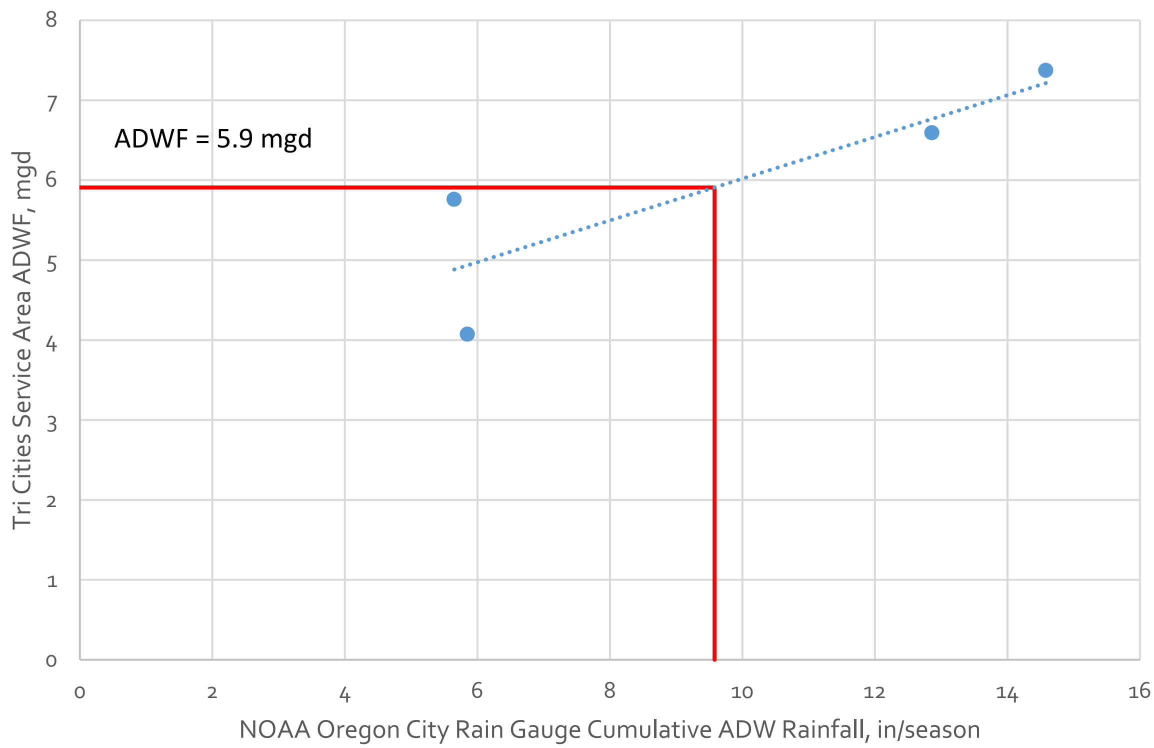

Figure 3.2 Tri-City Service Area Average Dry Weather Flows (DEQ Methodology)

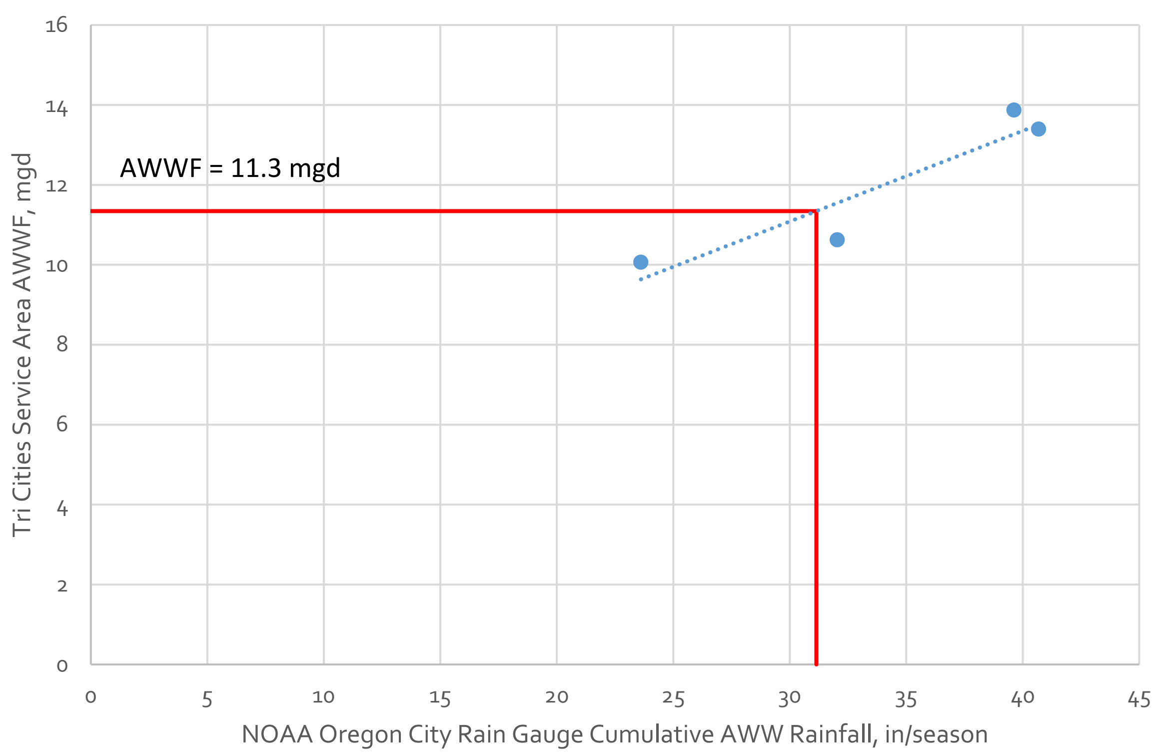

Figure 3.3 Tri-City Service Area Average Wet Weather Flows (DEQ Methodology)

Table 3.3 Tri-City Service Area Average Flows

Data Source	ADWF(1)	Peaking Factor	AWWF(1)	Peaking Factor
2015 Flow Data	5.8	1.0	11.8	2.1
2016 Flow Data	7.4	1.2	12.3	2.0
2017 Flow Data	6.6	1.2	13.0	2.4
2018 Flow Data	4.1	1.1	8.9	2.4
DEQ Method	5.9	1.0(3)	11.3	1.8(3)
Selected Value (2018)	**7.1(2)**	**1.2(4)**	**13.5(2)**	**2.2(4)**

Notes:
(1) Estimated in plant recycle flows from the thickening process backed out from measured flow.
(2) Calculated by applying the selected peak factor to the calculated 2018 BWF (2018 Tri-City service area population multiplied by 76 gpcd plus septage and industry) of 6.2 mgd. The industry flow used for this calculation is 0.55 mgd from the *Tri-City Water Resource Recovery Facility Solids Handling Improvement Project TM3 Project Future Flows and Loads* (2016, Stantec).
(3) Calculated by dividing the flow by the projected 2018 BWF (2018 Tri-City service area population multiplied by 76 gpcd plus septage and industry - 6.2 mgd).
(4) Average of 2015 - 2017.

3.3.3 Maximum Month Flow

Per DEQ methodology, the MMDWF is estimated by comparing monthly average plant flow for the months of January through May to the corresponding monthly rainfall over that same time period. The maximum month dry weather flow is defined as the flow that would be expected to occur when rainfall is at the 1-in-10-year probability level for the wettest month of the dry weather season. Although October is historically the wettest dry weather month for the area, dry weather flows are typically higher in May due to infiltration and inflow (I/I) associated with high springtime groundwater levels. Therefore, the 1-in-10-year probability cumulative rainfall for May (4.1 inches, which is calculated as the 90th percentile May precipitation over the last 30 years) was used to determine the MMDWF. Between 2015 and 2018, the May monthly cumulative rainfall did not exceed this long-term 90th percentile precipitation, with a maximum cumulative May rainfall of only 1.5 inches in May of 2018. Using an approximately linear relationship between flow and rainfall, as illustrated in Figure 3.4, the MMDWF was estimated at 10.3 mgd.

The MMWWF is defined by DEQ as the flow expected to occur when rainfall is at the 1-in-5-year probability level for January. The 1-in-5-year January cumulative rainfall is 8.4 inches (calculated as the 80th percentile January precipitation over the last 30 years). Between 2015 and 2018, the January monthly cumulative rainfall did not exceed this long-term 80th percentile precipitation which a maximum January cumulative monthly rainfall of 7.7 inches in January of 2018. The MMWWF corresponds to the intersection of the 1-in-5-year January rainfall and the trendline for the 2015 through 2018 data. Using these data, the MMWWF is 15.3 mgd (Figure 3.4).

Table 3.4 presents the summary of maximum month flows based on a 30-day running average and peaking factors from 2015 through 2018, along with the maximum month flows calculated using the DEQ methodology. From 2015 through 2018, the MMDWF has ranged from a low of 4.8 mgd (2018) to a high of 12.5 mgd (2016). During that same period, the MMWWF has ranged from a low of 13.1 mgd (2018) to a high of 21.7 mgd (2015). Even though the recent January and May rainfalls are below the DEQ guidance values, both the MMDWF and MMWWFs calculated using the DEQ method are below the highest values seen in recent years. To be conservative, the historical data were used as a source of selecting the current MMDWF and MMWWF and peaking factors.

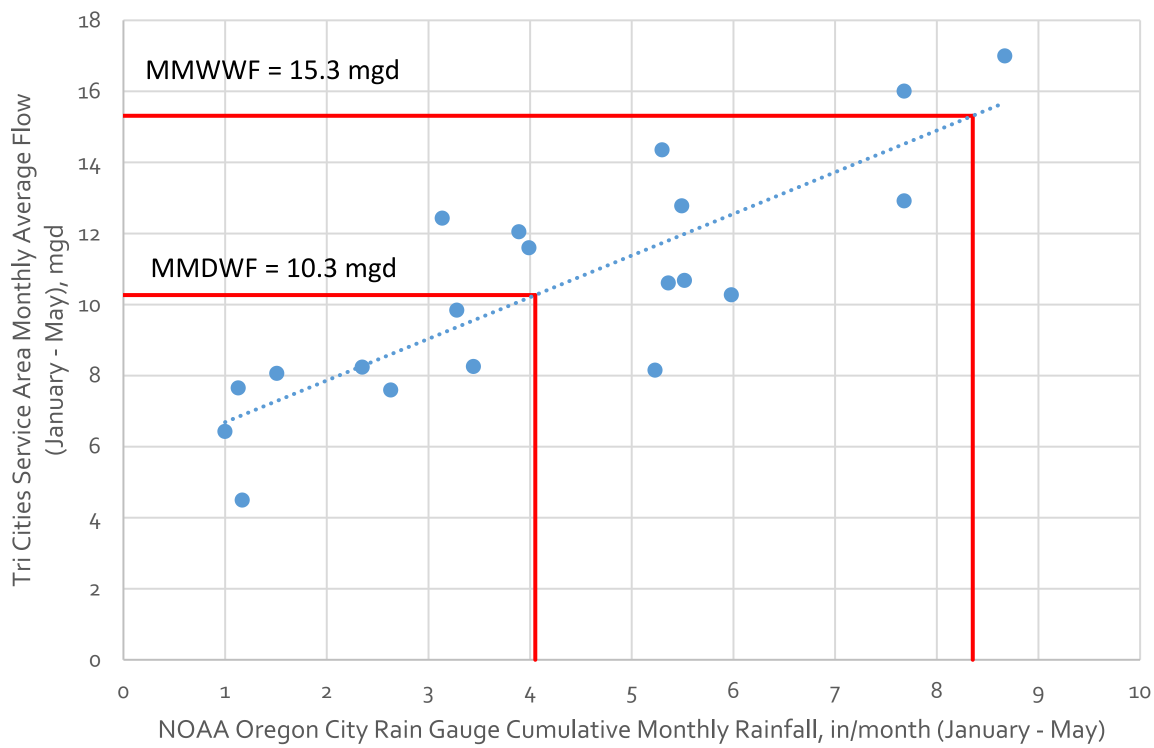

Figure 3.4 Tri-City Service Area Max Month Flows (DEQ Methodology)

Table 3.4 Tri-City Service Area Maximum Month Flows

Data Source	MMDWF(1)	Peaking Factor	MMWWF(1)	Peaking Factor
2015 Flow Data	6.3	1.1	21.7	3.9
2016 Flow Data	12.5	2.1	15.6	2.6
2017 Flow Data	10.3	1.9	16.6	3.0
2018 Flow Data	4.8	1.2	13.1	3.5
DEQ Method	10.3	1.7(3)	15.3	2.5(3)
Selected Value (2018)	**12.7(2)**	**2.1(4)**	**21.5(2)**	**3.5(5)**

Notes:
(1) Estimated in plant recycle flows from the thickening process backed out from measured flow.
(2) Calculated by applying the selected peak factor to the calculated 2018 BWF (2018 Tri-City service area population multiplied by 76 gpcd plus septage and industry) of 6.2 mgd.
(3) Calculated by dividing the flow by the projected 2018 BWF (2018 Tri-City service area population multiplied by 76 gpcd plus septage and industry - 6.2 mgd).
(4) Maximum peak factor of 2015 through 2017.
(5) Since the maximum peak factor from 2015 - 2017 yielded a MMWWF greater than the historic data and the average peak factor from 2015 - 2017 yielded a MMWWF less than the historic data, the 75th percentile peak factor was selected.

3.3.4 Maximum Week Flow

DEQ does not have a specific method to estimate the current MWDWF or MWWWF; as such, the historical data were used to establish the current MWDWF and MWWWF peaking factor. Table 3.5 presents the summary of maximum week flows based on a 7-day running average and peaking factors from 2015 through 2018. From 2015 through 2018, the MWDWF has ranged from a low of 6.3 mgd (2018) to a high of 18.2 mgd (2016). During that same period, the MWWWF has ranged from a low of 16.3 mgd (2018) to a high of 33.2 mgd (2015). Peak factors were selected based on the historic data to yield conservative maximum week flows.

Table 3.5 Tri-City Service Area Maximum Week Flows

Data Source	MWDWF(1)	Peak Factor	MWWWF(1)	Peak Factor
2015 Flow Data	8.0	1.4	33.2	6.0
2016 Flow Data	18.2	3.0	20.3	3.3
2017 Flow Data	15.1	2.8	22.9	4.2
2018 Flow Data	6.3	1.7	16.3	4.4
Selected Value (2018)	**18.3**(2)	**3.0**(3)	**34.7**(2)	**5.6**(3)

Notes:
(1) Estimated in plant recycle flows from the thickening process backed out from measured flow.
(2) Multiplied the selected peak factor to the projected 2018 BWF (Calculated by multiplying the 2018 Tri-City service area population by 76 gpcd plus septage and industry) of 6.2 mgd.
(3) Since the maximum peak factor from 2015 - 2017 produced a MWDWF and MWWWF that are higher than historic measured values and the average peak factor from 2015 - 2017 produced a MWDWF and MWWWF that are less than the maximum historic values s from 2015 - 2017, the 90th percentile of the peak factors from 2015 - 2017 was selected.

3.3.5 Peak Day Flow

DEQ outlines a method for determining PDWWF where daily flow is plotted against daily rainfall. The intersection of the trendline with 1-in-5-year 24-hour rainfall event of 3 inches (from National Oceanic and Atmospheric Administration [NOAA] Atlas 2 Volume X) is the PDWWF. Figure 3.5 was generated considering data from January through May when the groundwater levels are high.

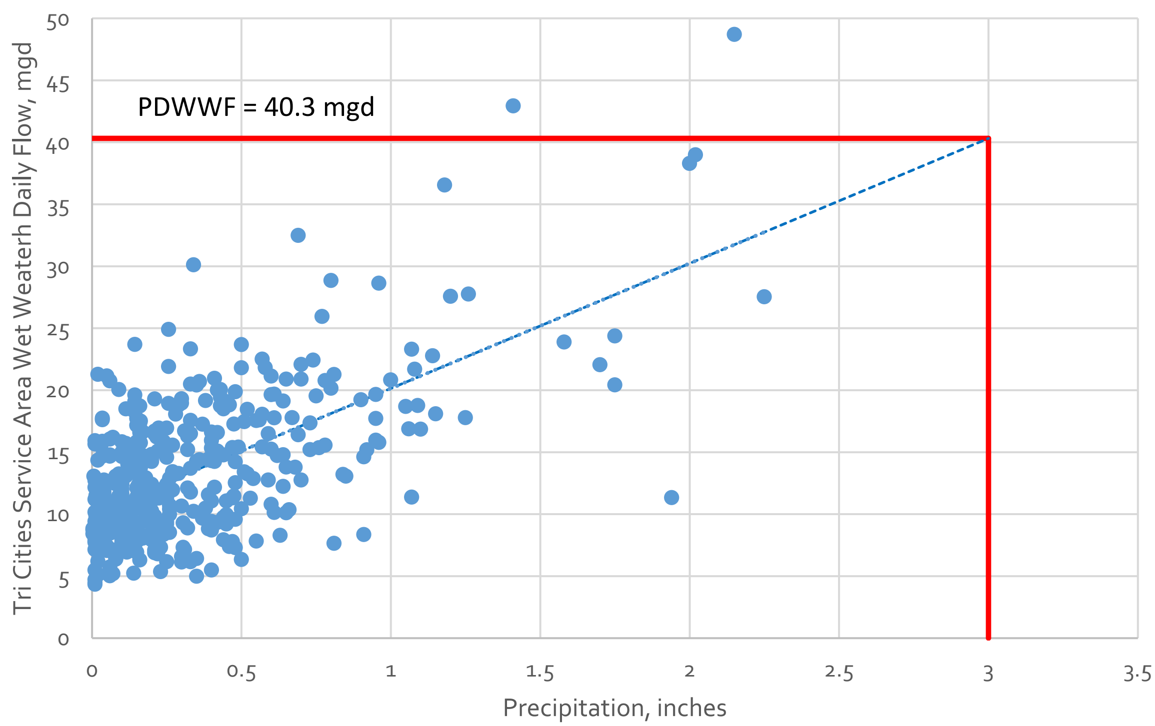

Figure 3.5 Tri-City Service Area Peak Day Flows (DEQ Methodology)

In addition to the DEQ method, the *Sanitary Sewer Master Plan for Water Environment Services* (2019, Jacobs) determined peak flows through modeling of the collection system. *The Sanitary Sewer Master Plan* conducted a flow and precipitation frequency analysis to select a design storm with an impact equal to or greater than the 5-year 24-hour storm. The 2019 Sanitary Sewer Master Plan did not document PDWWFs, but Jacobs provided the modeled PDWWF to PHF ratio of 0.815 to use to convert the modeled PHF to PDWWF. Using this ratio, the resultant Tri-City service area PDWWF was predicted to be 51.9 mgd in 2015 and 53.8 mgd in 2020. Using linear interpolation, the estimated modeled 2018 PDWWF is 53.0 mgd.

Table 3.6 summarizes peak day flows from 2015 through 2018 along with the PDWWF generated using the DEQ methodology and the PDWWFs generated from the collection system modeling done as part of the *Sanitary Sewer Master Plan for Water Environment Services* (2019, Jacobs). The PDWWF determined from the DEQ methodology is significantly lower than the PDWWF of 47.8 mgd, which was observed in 2015. Since the PDWWF determined from the PHFs in the *Sanitary Sewer Master Plan* is slightly higher than the highest observed PDWWF, this value is selected as the current PDWWF.

DEQ does not have a specific method to estimate the current PDDWF; as such, the historical data were used to establish the current PDDWF and peaking factor.

Table 3.6 Tri-City Service Area Peak Day Flows

Data Source	PDDWF(1)	Peak Factor	PDWWF(1)	Peak Factor
2015 Flow Data	17.1	3.1	47.8	8.6
2016 Flow Data	26.7	4.4	28.3	4.7
2017 Flow Data	25.4	4.7	37.7	6.9
2018 Flow Data	8.3	2.2	23.9	6.5
Sanitary Sewer Master Plan	NA	NA	53.0(4)	8.6(5)
DEQ	NA	NA	40.3	6.5(5)
Selected Value (2018)	**28.0(2)**	**4.5(3)**	**53.0(4)**	**8.6(5)**

Notes:
(1) Estimated in plant recycle flows from the thickening process backed out from measured flow.
(2) Multiplied the selected peak factor to the projected 2018 BWF (Calculated by multiplying the 2018 Tri-City service area population by 76 gpcd plus septage and industry) of 6.2 mgd.
(3) Since the maximum peak factor from 2015 - 2017 produced a PDDWF that was higher than historic measured PDDWF and the average peak factor from 2015 - 2017 produced a PDDWF that was less than two of the three PDDWFs from 2015 - 2017, the 75th percentile of the peak factors from 2015 - 2017 was selected.
(4) Data from Jacobs provided a 2015 PDWWF of 51.9 mgd and a 2020 flow of 53.8 mgd. The value for the year 2018 was determined through linear interpolation between these two values.
(5) Calculated by dividing the PDWWF for the year 2018 by the projected BWF for the year 2018 (2018 Tri-City service area population multiplied by 76 gpcd plus septage and industry - 6.2 mgd).

3.3.6 Peak Hour Flow

The DEQ method for PHF plots the reoccurrence frequency of the average flow (50 percent), MMWWF (1/12 or 8 percent), PDWWF (1/365 or 0.3 percent) on a log-normal plot. A linear trendline is drawn between these three points and extrapolated out to the reoccurrence frequency of the PHF (1/[365*24]) or 0.01 percent) to estimate the PHF. Using this method with the DEQ derived average flow (average of ADWF and AWWF), MMWWF and PDWWF, the estimated 2018 PHF is 62.6 mgd (Figure 3.6).

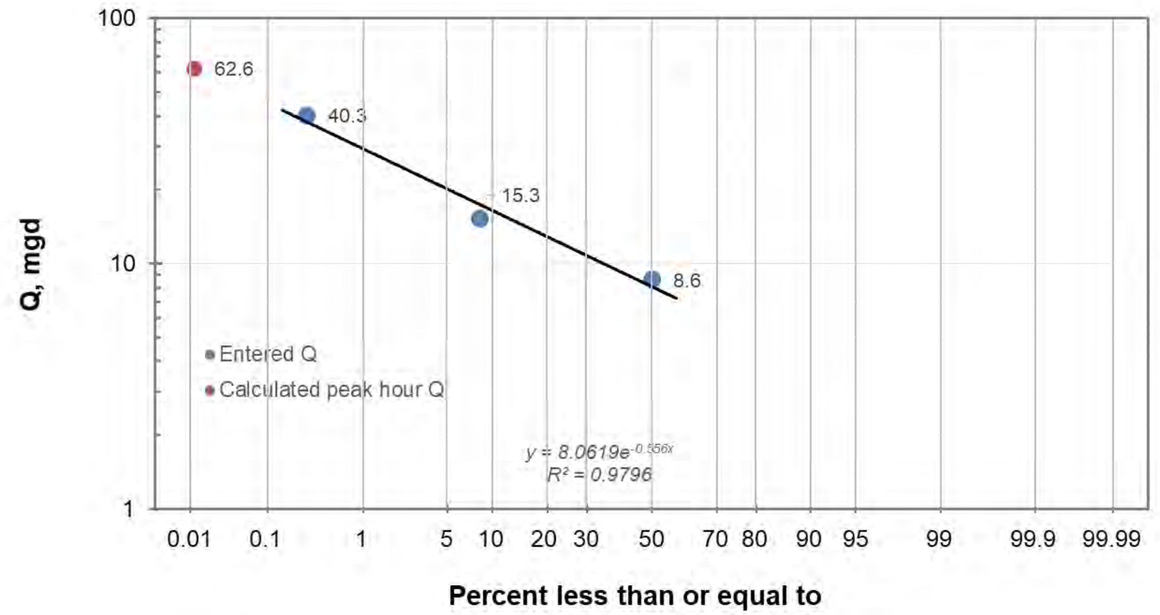

Figure 3.6 Tri-City Service Area Peak Hour Flows (DEQ Methodology)

The *Sanitary Sewer Master Plan* (2019, Jacobs) modeled the District's collection system and used this model to estimate PHFs. The Tri-City service area PHFs documented in the *Sanitary Sewer Master Plan* are 63.8 mgd for the year 2015. Since the *Sanitary Sewer Master Plan* was submitted the flows have changed slightly and subsequent communication with Jacobs has yielded updated Tri-City service area 63.6 mgd for the year 2015 and 66.1 mgd in the year 2020. Based on these two values, linear interpolation was used to calculate a 2018 PHF of 65.1 mgd. Due to the detailed analysis of PHFs that was conducted as part of the *Sanitary Sewer Master Plan*, the *Sanitary Sewer Master Plan* values for PHF will be used in this analysis.

3.4 Historical and Existing Kellogg Creek Flows

For the Kellogg Creek service area, the wastewater flow is calculated as the flow measured at the influent to the Kellogg Creek WRRF plus the flow diverted from Kellogg Creek to Tri-City through the Intertie 2 Pump Station.

3.4.1 Base Dry Weather Flow

The BWF for 2015 through 2018 was calculated as the average flow during the months with the least amount of rainfall, which are historically the months of July and August. These values are presented in Table 3.7. The residential per capita flow is calculated by subtracting plant recycles from the calculated service area flow, and then dividing this value by the existing service area population. As shown in Table 3.7, the residential per capita flow for the years 2015 through 2017 is within the expected range for treatment plants in the area. To be consistent with the methodology established for Tri-City, the per capita flow value was calculated by averaging data from 2015 through 2017. Accordingly, a per-capita flow value of 73 gpcd is used as the basis for projecting future flows based on population growth within the Kellogg Creek service area.

Table 3.7 Kellogg Creek Service Area BWF

Data Source	Population(1)	BWF, mgd(2)	Plant Recycles, mgd(3)	Residential BWF, mgd	Per capita, gpcd
2015 Flow Data	95,400	6.5	0.1	6.4	67
2016 Flow Data	97,000	7.4	0.1	7.3	75
2017 Flow Data	98,700	7.7	0.1	7.6	77
2018 Flow Data	100,400	7.3	0.1	7.2	72
Selected Value (2018)					**73(4)**

Notes:
(1) Based on the total Kellogg Creek service area population projections provided for EcoNorthwest for the years 2015 and 2020. Values for the years 2016 through 2018 were determined through linear interpolation.
(2) Calculated on a daily basis by adding the flow routed from the Kellogg Creek Service Area to the Tri-City Plant (I2_TC_Q) to the daily flow measured at the Kellogg Creek WRRF.
(3) Influent flow measured at Kellogg Creek includes the recycles from the thickening process. This flow was estimated from modeling as 2.0 percent of the influent flow measured at Kellogg Creek WRRF.
(4) Average of 2015 - 2017.

3.4.2 Average Flow

Similar to the approach used for Tri-City, data from 2015 through 2018 were plotted to determine ADWF (see Figure 3.7). The total dry weather season (May through October) mean rainfall for the Oregon City weather station is 9.6 inches over the past 30 years (1989 through 2018). The ADWF corresponds to the intersection of the average long-term dry weather precipitation (9.6 inches) and the trendline for the 2015 through 2018 data. Using this method and data set, the ADWF would be 7.6 mgd.

Similarly, the AWWF is determined by the relationship developed between total wet season rainfall and the average wet weather influent flow. The total wet weather season mean rainfall (November through April) for the Oregon City weather station is 31.1 inches over the past 30 years (1989 through 2018). The AWWF corresponds to the intersection of the average long-term wet weather precipitation and the trendline for the 2015 through 2018 data. Using this method and data set, the AWWF would be 10.8mgd (see Figure 3.8).

The peaking factors associated with the ADWF and AWWF, with respect to the BWF, are 1.1 and 1.5, respectively, using DEQ methodology. These flows and peaking factors are slightly lower than the observed average peaking factors from 2015 through 2017, shown in Table 3.8. As a result, the average flows and peaking factors from 2015-2017 are more conservative and are recommended for use in projecting future flows.

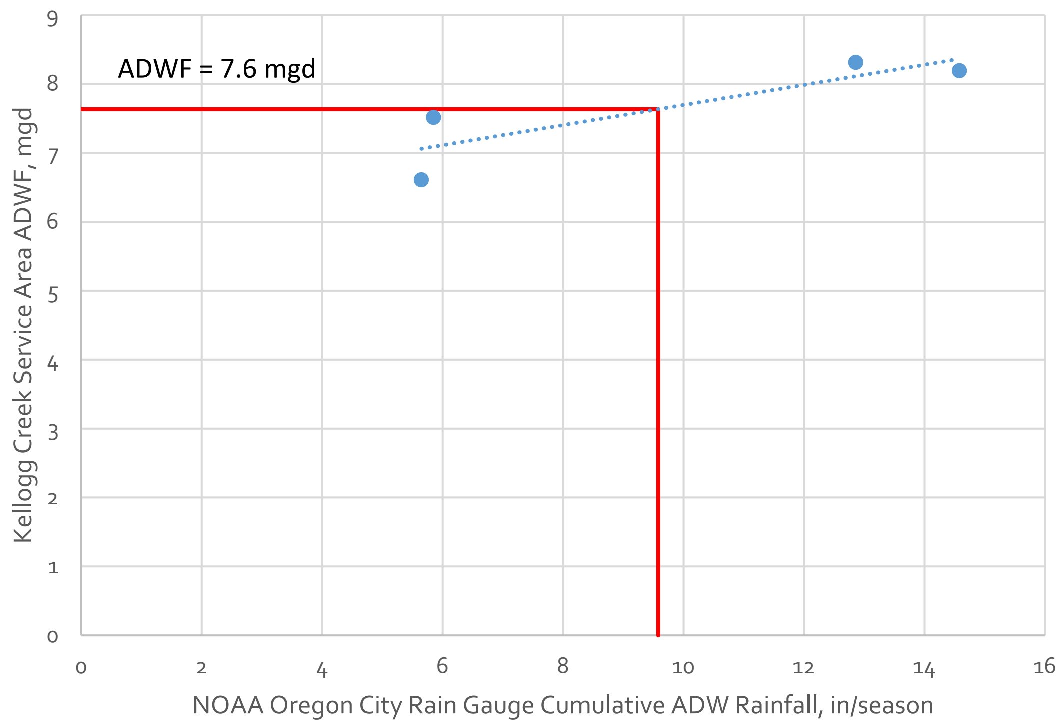

Figure 3.7 Kellogg Creek Service Area Average Dry Weather Flows (DEQ Methodology)

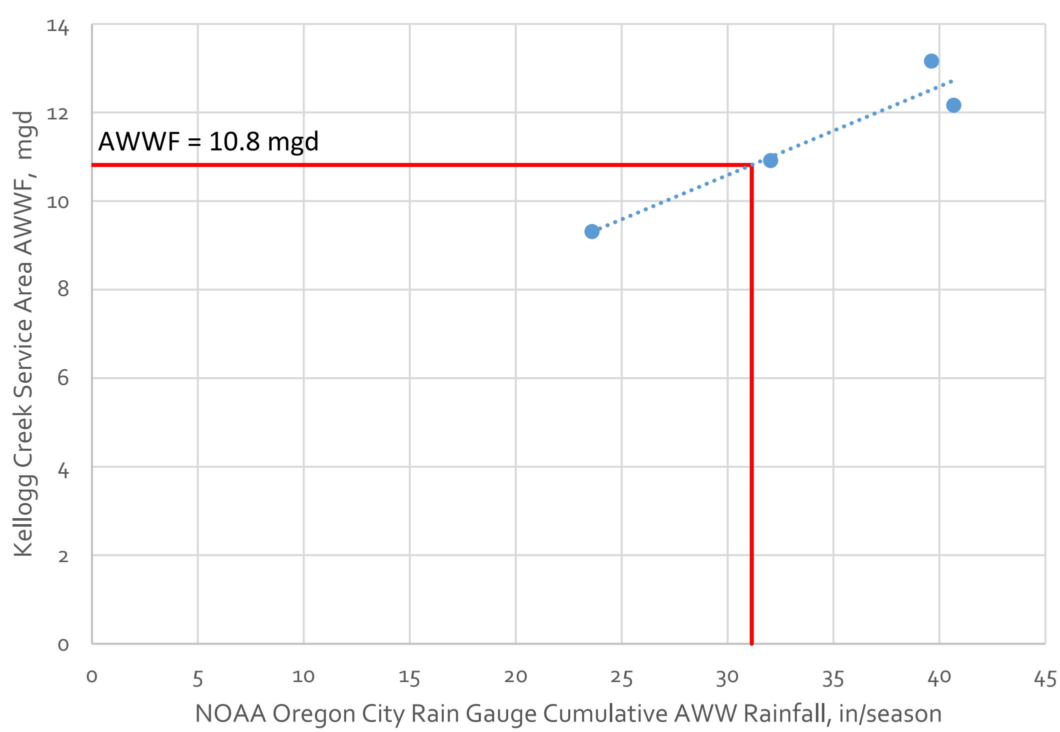

Figure 3.8 Kellogg Creek Service Area Average Wet Weather Flows (DEQ Methodology)

Table 3.8 Kellogg Creek Service Area Average Flows

Data Source	ADWF(1)	Peak Factor	AWWF(1)	Peak Factor
2015 Flow Data	6.6	1.0	10.4	1.6
2016 Flow Data	8.2	1.1	11.7	1.6
2017 Flow Data	8.3	1.1	12.5	1.6
2018 Flow Data	7.5	1.0	10.3	1.4
DEQ Method	7.6	1.1(2)	10.8	1.5(2)
Selected Value (2018)	**8.0**(3)	**1.1**(4)	**11.9**(3)	**1.6**(4)

Notes:
(1) Estimated in plant recycle flows from the thickening process backed out from measured flow.
(2) Calculated by dividing the average flow by the calculated 2018 BWF (2018 Kellogg Creek service area population multiplied by 73 gpcd - 7.3 mgd).
(3) Calculated by multiplying the selected peak factor by the projected 2018 BWF (2018 Kellogg Creek service area population multiplied by 73 gpcd - 7.3 mgd).
(4) Average of 2015 - 2017.

3.4.3 Maximum Month Flow

The MMDWF for Kellogg Creek was determined using the same method as previously described for Tri-City (using the 1-in-10-year probability cumulative rainfall for May). Between 2015 and 2018, the May monthly cumulative rainfall did not exceed this long-term 90th percentile precipitation, with a maximum cumulative May rainfall of only 1.5 inches in May of 2018. Using an approximately linear relationship between flow and rainfall, as illustrated in Figure 3.9, the DEQ method estimates a MMDWF of 10.7 mgd.

The MMWWF was determined for Kellogg by finding the intersection of the 1-in-5-year January rainfall and the trendline for the 2015-2018 data. Between 2015 and 2018, the January monthly cumulative rainfall did not exceed this long-term 80th percentile precipitation which a maximum January cumulative monthly rainfall of 7.7 inches in January of 2018. Using the data presented in Figure 3.9, the DEQ method estimates a MMWWF of 14.4 mgd.

Table 3.9 presents a summary of maximum month flows and peaking factors from 2015 through 2018 along with the maximum month flows calculated using the DEQ methodology. From 2015 through 2018, the MMDWF has ranged from a low of 7.0 mgd (2015) to a high of 11.4 mgd (2016 and 2017). During that same period, the MMWWF has ranged from a low of 12.5 mgd (2018) to a high of 16.7 (2015 and 2016). Since both the MMDWF and MMWWFs calculated using the DEQ method are below the highest values seen in recent years, the historical data was used as a source of selecting the current MMDWF and MMWWF and peaking factors.

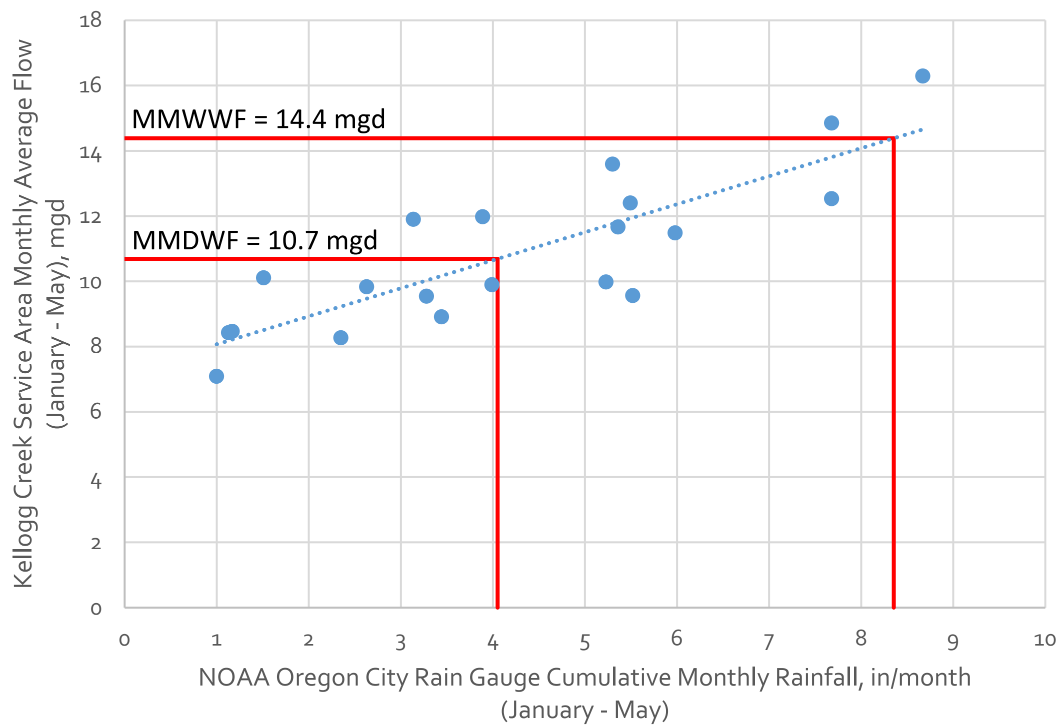

Figure 3.9 Kellogg Creek Service Max Month Flows (DEQ Methodology)

Table 3.9 Kellogg Creek Service Area Maximum Month Flows

Data Source	MMDWF(1)	Peak Factor	MMWWF(1)	Peak Factor
2015 Flow Data	7.0	1.1	16.7	2.6
2016 Flow Data	11.4	1.6	16.7	2.3
2017 Flow Data	11.4	1.5	16.0	2.1
2018 Flow Data	8.3	1.2	12.5	1.7
DEQ Method	10.7	1.5(2)	14.4	2.0(2)
Selected Value (2018)	**11.5**(3)	**1.6**(4)	**17.1**(3)	**2.3**(5)

Notes:
(1) Estimated in plant recycle flows from the thickening process backed out from measured flow.
(2) Calculated by dividing the max month flow by the calculated 2018 BWF (2018 Kellogg Creek service area population multiplied by 73 gpcd - 7.3 mgd).
(3) Calculated by multiplying the selected peak factor by the projected 2018 BWF (2018 Kellogg Creek service area population multiplied by 73 gpcd - 7.3 mgd).
(4) Maximum of 2015 - 2017.
(5) Average of 2015 - 2017.

3.4.4 Maximum Week Flow

DEQ does not have a specific method to estimate the current MWDWF or MWWWF; as such, the historical data were used to establish the current MWDWF and MWWWF peaking factor. Table 3.10 presents the summary of maximum week flows based on a 7-day running average and peaking factors from 2015 through 2018. From 2015 through 2018, the MWDWF has ranged from a low of 8.1 mgd (2015) to a high of 15.3 mgd (2016). During that same period, the MWWWF has ranged from a low of 15.3 mgd (2018) to a high of 23.1 mgd (2015). Peak factors were selected based on the historic data to yield conservative maximum week flows.

Table 3.10 Kellogg Creek Service Area Maximum Week Flows

Data Source	MWDWF(1)	Peak Factor	MWWWF(1)	Peak Factor
2015 Flow Data	8.1	1.3	23.1	3.6
2016 Flow Data	15.3	2.1	16.9	2.3
2017 Flow Data	12.8	1.7	20.6	2.7
2018 Flow Data	9.8	1.4	15.3	2.1
Selected Value (2018)	**15.4(2)**	**2.1(3)**	**23.2(2)**	**3.2(4)**

Notes:
(1) Estimated in plant recycle flows from the thickening process backed out from measured flow.
(2) Multiplied the selected peak factor to the projected 2018 BWF (Calculated by multiplying the 2018 Tri-City service area population by 76 gpcd plus septage and industry) of 6.2 mgd.
(3) Maximum peak factor from the years 2015 - 2017.
(4) Since the maximum peak factor from the years 2015 - 2017 yielded a MWWWF greater than the historic data and the average peak factor form the years 2015 - 2017 yielded a flow less than the maximum MWWWF observed, the 75th percentile of the peak factors observed between 2015 - 2017 was selected.

3.4.5 Peak Day Flow

DEQ outlines a method for determining PDWWF where daily flow is plotted against daily rainfall. The intersection of the trendline with 1-in-5-year 24-hour rainfall event of 3 inches (from NOAA Atlas 2 Volume X) is the PDWWF. Figure 3.10 was generated considering data from January through May when the groundwater levels are high.

Table 3.11 summarizes peak day flows from 2015-2018 along with the PDWWF generated using the DEQ methodology and the PDWWF generated from the collection system modeling done as part of the *Sanitary Sewer Master Plan* (2019, Jacobs). The PDWWF of 27.3 mgd determined from DEQ methodology is lower than the PDWWF of 28.7 mgd, which was observed in 2017.

In addition to the DEQ method, the *Sanitary Sewer Master Plan for Water Environment Services* (2019, Jacobs) determined the PDWWF through modeling of the collection system. *The Sanitary Sewer Master Plan* conducted a flow and precipitation frequency analysis to select a design storm with an impact equal to or greater than the 5-year 24-hour storm. The 2019 *Sanitary Sewer Master Plan* did not document peak day flows, but Jacobs provided the model developed PDWWF to PHF ratios of 0.815 to Carollo Engineers, Inc. (Carollo) for use in developing peak flows. The modeled Kellogg Creek service area PDWWF was predicted to be 32.2 mgd in 2015 and 34.4 mgd in 2020. Using linear interpolation, the estimated modeled 2018 PDWWF is 33.5 mgd. The PDWWF of 33.5 mgd established from the collection system modeling is greater than the highest PDWWF observed of 28.7 mgd in 2017. Part of the reason that the modeled collection system flow exceeded the measured service area flow is due to hydraulic limitations at the Kellogg Creek WRRF. During the 2015 storm, flow into the Kellogg Creek WRRF exceeded the facility's hydraulic capacity and the bypass gate was opened. Over the course of the 2015 peak day, between 3 and 10 million gallons were bypassed which was not metered *(Kellogg Creek Bypass Followup Report - December 7 - 10, 2015 Rainfall Event*, Richwine Environmental, 2015). For this reason, the 2015 PDWWF for the Kellogg Creek service area was probably between 30 and 37 mgd which is within the range projected by the collection system modeling. For this reason, the PDWWF determined from the 2019 *Sanitary Sewer Master Plan* is recommended as the design PDWWF.

DEQ does not have a specific method to estimate the current PDDWF; as such, the historical data were used to establish the current PDDWF and peaking factor.

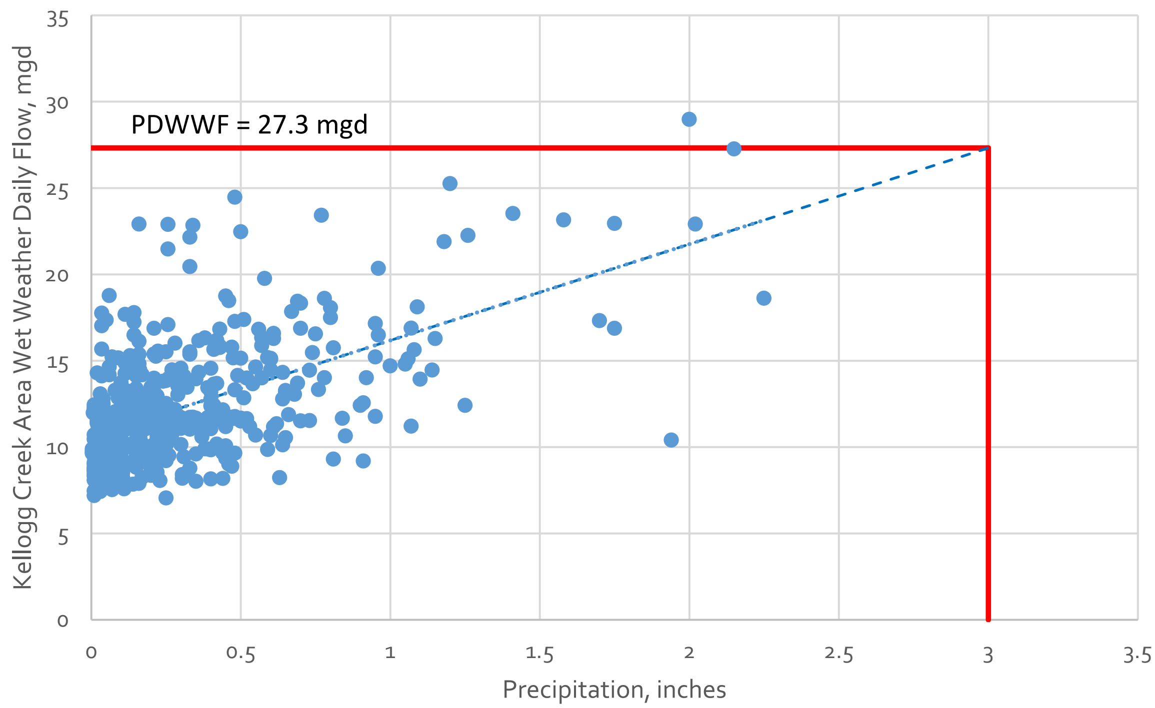

Figure 3.10 Kellogg Creek Service Area Peak Day Flows (DEQ Methodology)

Table 3.11 Kellogg Creek Service Area Peak Day Flows

Data Source	PDDWF[(1)]	Peak Factor	PDWWF[(1)]	Peak Factor
2015 Flow Data	12.1	1.9	27.0[(4)]	4.2
2016 Flow Data	19.6	2.7	22.0	3.0
2017 Flow Data	15.5	2.0	28.7	3.8
2018 Flow Data	10.6	1.5	22.7	3.2
Sanitary System Master Plan	NA	NA	33.5[(5)]	4.6[(6)]
DEQ	NA	NA	27.3	3.7[(6)]
Selected Value (2018)	**19.7[(2)]**	**2.7[(3)]**	**33.5[(5)]**	**4.6[(6)]**

Notes:
(1) Estimated in plant recycle flows from the thickening process backed out from measured flow.
(2) Calculated by multiplying the selected peak factor by the projected 2018 BWF (2018 Kellogg Creek service area population multiplied by 73 gpcd - 7.3 mgd).
(3) Maximum from 2015 - 2017.
(4) Artificially low due to an unmetered bypass ranging from 3 - 10 million gallons over the course of one day.
(5) Data from Jacobs provided a PDWWF of 32.2 for the year 2015 and a value 34.4 mgd for the year 2020. A PDWWF for the year 2018 was calculated by linear interpolation between the 2015 and 2020 values.
(6) Calculated by dividing the peak flow by the calculated 2018 BWF (2018 Kellogg Creek service area population multiplied by 73 gpcd - 7.3 mgd).

3.4.6 Peak Hour Flow

The DEQ method for PHF plots the reoccurrence frequency of the average flow (50 percent), MMWWF (1/12 or 8 percent), PDWWF (1/365 or 0.3 percent) on a log-normal plot. A linear trendline is drawn between these three points and extrapolated out to the reoccurrence frequency of the PHF (1/[365*24]) or 0.01 percent) to estimate the PHF. Using this method and the DEQ derived average flow (average of ADWF and AWWF), MMWWF and PDWWF, the estimated PHF is 37.8 mgd (Figure 3.11).

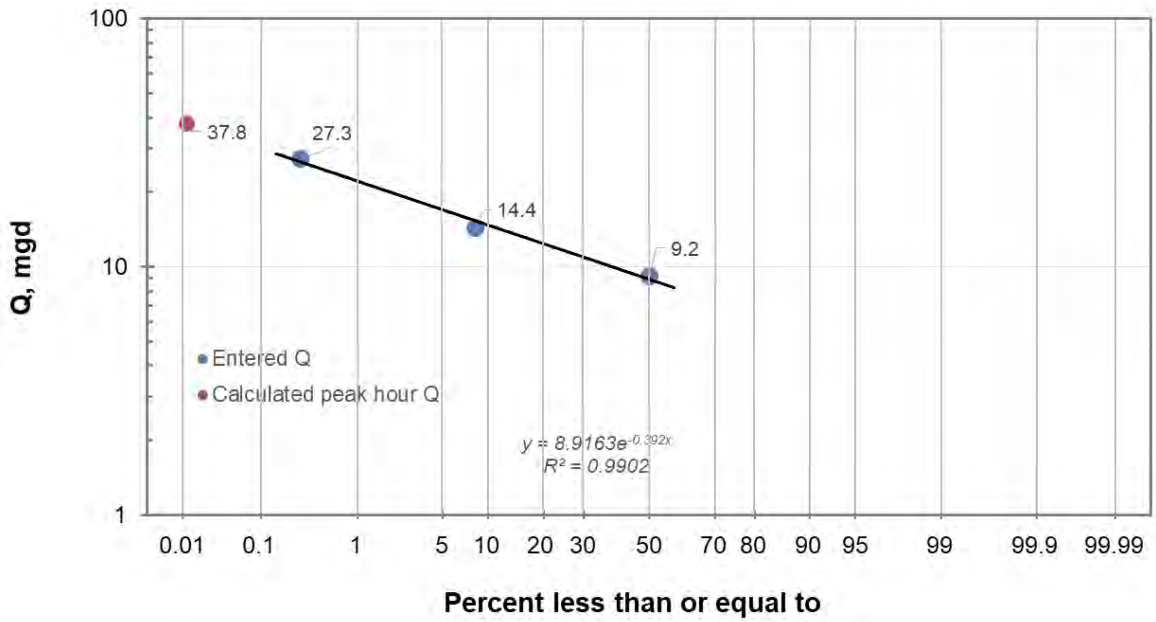

Figure 3.11 Kellogg Creek Service Area Peak Hour Flows (DEQ Methodology)

The *Sanitary Sewer Master Plan* (2019, Jacobs) modeled the District's collection system and used this model to estimate PHFs. The Kellogg Creek service area PHFs documented in the *Sanitary Sewer Master Plan* are 39.5 mgd for the year 2015. Since the *Sanitary Sewer Master Plan* was submitted the flows have changed slightly and subsequent communication with Jacobs has yielded updated Kellogg Creek service area PHF of 39.6 mgd for the year 2015 and 42.2 mgd for the year 2020. Based on these two values, linear interpolation was used to calculate a 2018 PHF of 41.2 mgd. Due to the detailed analysis of PHFs that was conducted as part of the *Sanitary Sewer Master Plan*, the *Sanitary Sewer Master Plan* values for PHF will be used in this analysis.

3.5 Flow Projections

Flow projections were developed by first projecting BWF from 2018 to future conditions based on the projected population growth as shown in Table 3.12. ADWF, AWWF, MMWWF, MMDWF and PDDWF were projected by multiplying the resulting BWF projection by the peaking factors developed for each parameter. Since the peak flows (PDWWF and PHF) are more related to collection system age and ground water infiltration than population growth, the collection system model developed during the *Sanitary Sewer Master Plan* (2019, Jacobs) was used to project PDWWF and PHF. Tables 3.13 and 3.14 summarize the projected flows for the Tri-City and Kellogg Creek service areas, respectively.

Table 3.12 BWF Projection

	Tri-City Service Area			Kellogg Creek Service Area		
	2018	2040	Buildout	2018	2040	Buildout
Population	73,700	88,800	158,800	100,400	129,700	202,100
Per capita flow	76	76	76	73	73	73
Residential BWF, mgd	5.6	6.8	12.1	7.3	9.5	14.7
Industrial Flow, mgd(1)	0.55	0.55	0.55	NA	NA	NA
Septage Flow, mgd(2)	0.008	0.01	0.01	NA	NA	NA
Total BWF, mgd	6.2	7.3	12.7	7.3	9.5	14.7

Notes:
(1) Industry flow projections taken from the Tri-City Water Resource Recovery Facility Solids Handling Improvement Project TM3 Projected Future Flows and Loads (2016, Stantec). Since the 2015 and 2020 values were both 0.55 mgd, the 2018 industrial flow was set equal to 0.55 mgd.
(2) Septage flow projections taken from the Tri-City Water Resource Recovery Facility Solids Handling Improvement Project TM3 Projected Future Flows and Loads (2016, Stantec). 2018 value is a linear interpolation between the 2015 value of 0.005 and the 2020 value of 0.01.

Table 3.13 Tri-City Service Area Flow Projection Summary

Flow Component	2018	2040	Buildout
BWF	6.2	7.3	12.7
ADWF	7.1	8.5	14.6
MMDWF	12.7	15.1	26.1
MWDWF	18.3	21.7	37.4
PDDWF	28.0	33.2	57.4
AWWF	13.5	16.0	27.7
MMWWF	21.5	25.5	44.0
MWWWF	34.7	41.2	54.0
PDWWF	53.0	58.2	65.2
PHF	65.1	72.2	80.0

Table 3.14 Kellogg Creek Service Area Flow Projection Summary

Flow Component	2018	2040	Buildout
BWF	7.3	9.5	14.7
ADWF	8.0	10.3	16.0
MMDWF	11.5	14.8	23.1
MWDWF	15.4	19.9	31.1
PDDWF	19.7	25.5	39.7
AWWF	11.9	15.4	24.0
MMWWF	17.1	22.1	34.5
MWWWF	23.2	29.9	46.7
PDWWF	33.5	46.6	87.9
PHF	41.2	57.2	107.8

3.6 Historical and Existing Loads

Unlike flows, which can be highly variable depending on the age and condition of the service area collection system, residential loads are typically similar between different service areas. For this reason, loads for both the Tri-City and Kellogg Creek services areas were developed together for planning purposes.

Since future discharge requirements may vary seasonally, it can be useful to develop load projections for both the dry weather and wet weather season loads, if peak loads consistently occur in one season or the other. Table 3.15 summarizes the occurrence of the peak loads between the dry and wet season. As shown, 22 percent of the time (or two years out of the nine years evaluated) the max month TSS load occurred in the dry season. For max week loads, 11 percent of the time (or one out of the nine years evaluated) peak loads occurred during the dry season. Although peak loads typically occur in the wet season, they do occasionally occur in the dry season. Since peak loads can occur in the dry season, seasonal loads were not developed. Instead, one set of peak loads was developed, and future analysis will assume that peak loads could occur during either the dry weather or wet weather season.

This section summarizes the current combined Tri-City and Kellogg Creek system load parameters to be used as the basis for future load projections. These include average annual, maximum monthly, and maximum weekly loads for TSS, BOD, ammonia, and total phosphorus.

Table 3.15 Peak Load Seasonal Occurrence

Flow Component	Dry Season	Wet Season
TSS		
Max Month	22%	78%
Max Week	11%	89%
BOD		
Max Month	22%	78%
Max Week	0%	100%
Ammonia		
Max Month	44%	56%
Max Week	33%	67%

During evaluation of influent load data, it was determined that TSS concentrations measured at the Kellogg Creek WRRF were occasionally very high (i.e., concentrations greater than 1,000 milligrams per liter [mg/L]). Although influent concentrations vary from one treatment plant to another, these high concentrations are unusual. It is unclear what is causing the high concentrations in the Kellogg Creek influent, but it could be due to the presence of the thickener return recycle stream in the influent sample. An outlier analysis was performed to eliminate these outliner data points for BOD, TSS and ammonia, which could skew the analysis. The procedure excluded data that were greater than an upper bound (1.5 times the sum of the interquartile range, which is the range between the 75th percentile and the 25th percentile, and the 75th percentile value of the dataset). Additionally, data points that were less than a lower bound (the 25th percentile value for the dataset minus 1.5 times the interquartile range) were also excluded. Figure 3.12 shows all the TSS concentrations measured at the Kellogg Creek WRRF and those data points that were excluded by the outlier analysis. Table 3.14 summarizes the BOD, TSS, and ammonia data excluded using this method to identify outliers.

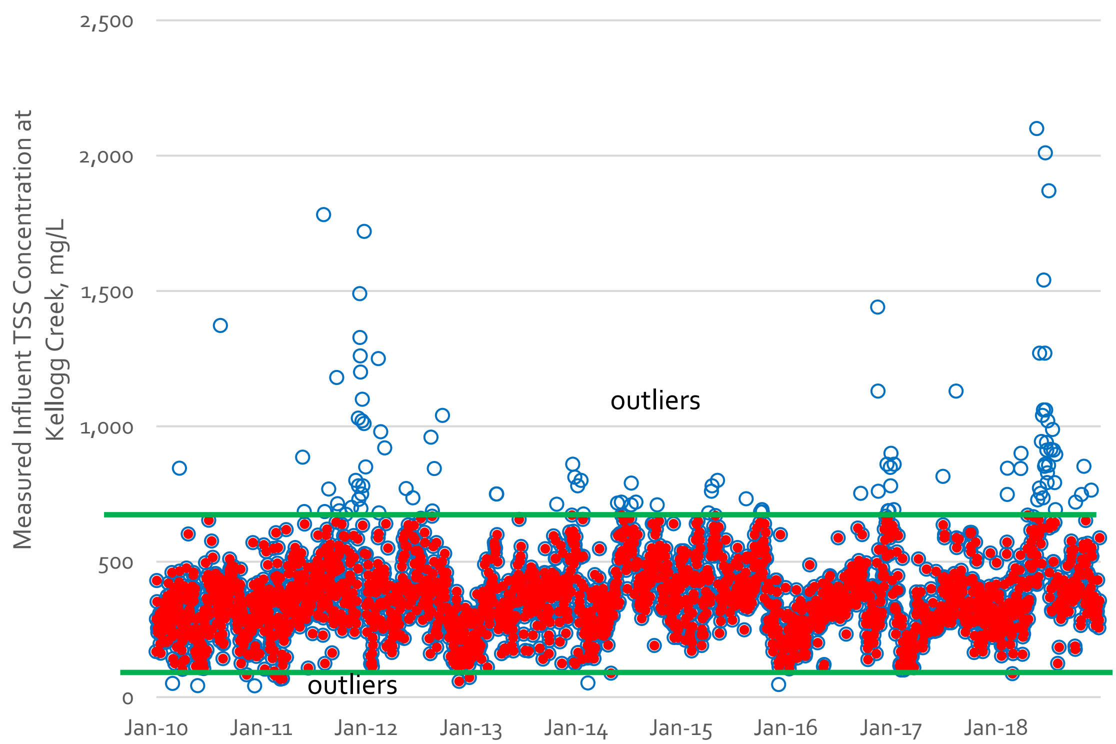

Figure 3.12 Influent TSS Concentrations Measured at Kellogg Creek WRRF

3.6.1 Biochemical Oxygen Demand

Per capita loads were estimated by dividing the residential AA BOD load by the total service area population. The residential BOD load was calculated by subtracting the estimated industrial, septage and internal recycle loads from the measured data. Table 3.16 summarizes the results of this analysis. As shown, the calculated BOD per capita load for the combined system ranges from 0.17 to 0.22 pounds per capita per day (ppcd). Between 2015 through 2017, the average per capita BOD load was 0.19 ppcd, a value that is very typical and matches the recommended per capita value as defined by Metcalf and Eddy.

Table 3.17 shows the maximum monthly and maximum weekly BOD loads and peaking factors from 2010 through 2018. Current maximum month and week BOD loads were calculated using the highest peaking factor observed between 2015 and 2017.

Table 3.16 Per Capita BOD Load Calculation

Data Source	Population(1)	AA, ppd(2)	Industry, ppd(3)	Septage, ppd(3)	Recycle, ppd(4)	Residential AA, ppd	Per Capita, ppcd
2010	149,200	31,331	3,000	500	552	27,279	0.18
2011	152,300	37,052	3,000	300	653	33,098	0.22
2012	155,400	36,651	3,000	700	646	32,305	0.21
2013	158,500	32,294	3,000	500	569	28,224	0.18
2014	161,700	35,420	3,000	500	624	31,296	0.19
2015	164,800	36,400	3,000	600	642	32,158	0.20
2016	167,900	36,576	3,000	600	645	32,332	0.19
2017	171,000	34,302	3,000	600	605	30,098	0.18
2018	174,100	33,911	3,000	600	598	29,713	0.17
Average 2015 - 2017							**0.19**
Typical Value							**0.19**

Notes:
(1) From EcoNorthwest projections for the years 2015 and 2020. Linear interpolation was used to develop the populations for the years 2016 - 2018. Linear extrapolation was used to develop the populations for the years 2010 - 2014.
(2) Combined load calculated daily using the measured flows and concentrations excluding the outliers as discussed above.
(3) Based on values provided in the TM3 Projected Future Flows and Loads (MWH 2016) for 2015 and 2020. Values for the years 2016 through 2018 determined through linear interpolation. Values for the years 2010 through 2014 developed through linear extrapolation.
(4) Estimated based on modeling as 1.8 percent of the measured influent load.
(5) From Metcalf and Eddy, 4th Edition.
Abbreviation: ppd - pounds per day.

Table 3.17 Max Month and Max Week BOD Load Peaking Factors

Data Source	Max Month(1)	Peaking Factor	Max Week(1)	Peaking Factor
2010 Load Data	34,719	1.13	38,606	1.25
2011 Load Data	41,815	1.15	51,932	1.43
2012 Load Data	43,697	1.21	55,613	1.54
2013 Load Data	39,252	1.24	44,532	1.40
2014 Load Data	40,468	1.16	43,728	1.26
2015 Load Data	42,760	1.20	46,697	1.31
2016 Load Data	41,927	1.17	46,856	1.30
2017 Load Data	42,989	1.28	47,204	1.40
2018 Load Data	41,550	1.25	44,682	1.34
Selected Value(2)		**1.28**		**1.40**

Notes:
(1) Estimated in plant recycle flows from the thickening process backed out from measured flow.
(2) Maximum peak factor from the years 2015 - 2017.

3.6.2 Total Suspended Solids

Per capita TSS loads were estimated by dividing the residential AA TSS (after excluding outliers) load by the total service area population. The residential TSS load was calculated by subtracting industrial, septage and internal recycle load estimates from the measured data. Table 3.18 shows the results of this analysis. As shown, the calculated TSS per capita load for the combined system ranges from 0.22 to 0.28 ppcd. For the more recent years (i.e., between 2015 through 2017, excluding 2018 to provide consistency with the analysis of flow data), the average per capita TSS load was 0.26 ppcd. This value is almost 25 percent greater than typical residential values at 0.21 ppcd as defined by Metcalf and Eddy and generally accepted in the industry. Therefore, as described in Section 3.7, the more typical per capita value of 0.21 ppcd was used to project future TSS loads.

Table 3.18 Per Capita TSS Load Calculation

Year	Population(1)	AA, ppd(2)	Industry, ppd(3)	Septage, ppd(3)	Recycle, ppd(4)	Residential AA, ppd	Per Capita, ppcd
2010	149,200	41,044	2,000	1,100	1,527	36,417	0.24
2011	152,300	47,053	2,000	1,200	1,750	42,103	0.28
2012	155,400	47,920	2,000	1,200	1,783	42,937	0.28
2013	158,500	45,553	2,000	1,300	1,695	40,558	0.26
2014	161,700	45,017	2,000	1,400	1,675	39,942	0.25
2015	164,800	47,056	2,000	1,300	1,751	42,005	0.25
2016	167,900	50,790	2,000	1,360	1,890	45,541	0.27
2017	171,000	46,582	2,000	1,420	1,733	41,429	0.24
2018	174,100	43,556	2,000	1,480	1,620	38,455	0.22
Average 2015 - 2017							**0.26**
Typical Value(5)							**0.21**

Notes:
(1) From EcoNorthwest projections for the years 2015 and 2020. Linear interpolation was used to develop the populations for the years 2016 - 2018. Linear extrapolation was used to develop the populations for the years 2010 - 2014.
(2) Combined load calculated daily using the measured flows and concentrations excluding the outliers as discussed above.
(3) Based on values provided in the TM3 Projected Future Flows and Loads (MWH 2016) for 2015 and 2020. Values for the years 2016 through 2018 determined through linear interpolation. Values for the years 2010 through 2014 developed through linear extrapolation.
(4) Estimated based on modeling as 3.7 percent of the measured influent load.
(5) From Metcalf and Eddy, 4th edition.

Table 3.19 shows maximum monthly and maximum weekly TSS loads, and peaking factors developed over the period from 2010 through 2018. Current maximum monthly and weekly TSS loads were calculated using the highest peaking factor observed between 2015 and 2017.

Table 3.19 Max Month and Max Week TSS Load Peaking Factors

Data Source	Max Month(1)	Peaking Factor	Max Week(1)	Peaking Factor
2010 Load Data	54,018	1.37	62,270	1.58
2011 Load Data	55,691	1.23	69,921	1.54
2012 Load Data	61,423	1.33	76,362	1.66
2013 Load Data	55,110	1.26	60,031	1.37
2014 Load Data	50,095	1.16	56,334	1.30
2015 Load Data	56,204	1.24	65,663	1.45
2016 Load Data	66,866	1.37	77,729	1.59
2017 Load Data	58,725	1.31	69,141	1.54
2018 Load Data	55,375	1.32	65,938	1.57
Selected Value(2)		**1.37**		**1.59**

Notes:
(1) Estimated in plant recycle flows from the thickening process backed out from measured flow.
(2) Maximum of 2015 - 2017.

3.6.3 Ammonia

Per capita loads were estimated by dividing the residential AA ammonia load by the total service area population. The residential ammonia load was calculated by subtracting the estimated industrial, septage and internal recycle loads from the measured data. Table 3.20 shows the results of this analysis. As shown, the calculated ammonia per capita load for the combined system ranges from 0.015 to 0.017 ppcd. Between 2015 through 2017, the average per capita BOD load was 0.017 ppcd - a value that is very typical and matches the recommended per capita value as defined by Metcalf and Eddy.

Table 3.21 shows the maximum monthly and maximum weekly ammonia loads and peaking factors developed over the period from 2010 through 2018. Current maximum month and week ammonia loads were calculated using the highest peaking factor observed between 2015 and 2017.

Table 3.20 Per Capita Ammonia Load Calculation

Year	Population(1)	AA, ppd(2)	Industry, ppd(3)	Septage, ppd(3)	Recycle, ppd(4)	Residential AA, ppd	Per Capita, ppcd
2010	149,200	3,037	396	66	72	2,503	0.017
2011	152,300	2,908	396	66	69	2,377	0.016
2012	155,400	3,251	396	66	77	2,712	0.017
2013	158,500	3,417	396	66	81	2,874	0.018
2014	161,700	3,220	396	66	76	2,681	0.017
2015	164,800	3,211	396	66	76	2,673	0.016
2016	167,900	3,416	396	66	81	2,873	0.017
2017	171,000	3,445	396	66	82	2,901	0.017
2018	174,100	3,188	396	66	76	2,650	0.015
Average 2015 - 2017							**0.017**
Typical Value(5)							**0.017**

Notes:
(1) From EcoNorthwest projections for the years 2015 and 2020. Linear interpolation was used to develop the populations for the years 2016 - 2018. Linear extrapolation was used to develop the populations for the years 2010 - 2014.
(2) Combined load calculated daily using the measured flows and concentrations excluding the outliers as discussed above.
(3) Based on values provided in the TM3 Projected Future Flows and Loads (MWH 2016) for 2015 and 2020. Values for the years 2016 through 2018 determined through linear interpolation. Values for the years 2010 through 2014 developed through linear extrapolation.
(4) Estimated based on modeling as 2.4 percent of the measured influent load.
(5) From Metcalf and Eddy, 4th Edition.

Table 3.21 Max Month and Max Week Ammonia Load Peaking Factors

Data Source	Max Month(1)	Peaking Factor	Max Week(1)	Peaking Factor
2010 Load Data	3,248	1.10	3,613	1.22
2011 Load Data	3,399	1.20	4,104	1.45
2012 Load Data	3,875	1.22	4,477	1.41
2013 Load Data	4,129	1.24	4,552	1.36
2014 Load Data	3,373	1.07	3,544	1.13
2015 Load Data	3,526	1.12	4,230	1.35
2016 Load Data	3,762	1.13	4,067	1.22
2017 Load Data	3,919	1.17	4,191	1.25
2018 Load Data	3,673	1.18	3,862	1.24
Selected Value(2)		**1.17**		**1.35**

Notes:
(1) Estimated in plant recycle flows from the thickening process backed out from measured flow.
(2) Maximum peak factor from 2015 - 2017.

3.7 Combined Load Projection

As previously described, analysis of existing load and population data resulted in reasonable per capita load values for BOD and ammonia. BOD and ammonia load projections presented in this chapter are therefore based on the calculated per capita values. Since no influent data were available for total phosphorus, the average per capita loads from Metcalf and Eddy (2003) were used. MM and MW total phosphorus loads were calculated assuming ammonia load peaking factors.

Elevated TSS concentrations measured in the influent samples at both the Tri-City and Kellogg Creek produced an unreasonably high per capital TSS load value for the combined system. In an attempt to reconcile this issue, the calibrated model developed as part of the capacity analysis was used to determine if the measured influent data could be matched to the measured and predicted solids production for both plants. The process model was calibrated to the most recent year of data (May 2018 through May 2019) and measured influent TSS and BOD data were compared to measured and estimated solids production rates. This in-depth analysis was inconclusive and did not result in a more reasonable estimate of TSS loads and the associated per capita values used to predict future TSS loads in the combined service area. Therefore, TSS load projections presented in this chapter are based on the more typical per capita value of 0.21 ppcd.

Table 3.22 summarizes the results of the per capita analysis for each load parameter, and shows the per capita value used for the load projections. Projected loads were developed by first projecting the average load from 2018 to current accounting for the anticipated growth in the residential population, industry and septage. Table 3.22 summarizes the load projections for 2018, 2040, and buildout.

Table 3.22 Projected AA Loads

	Population	Per Capita Load, ppcd	Residential AA, ppd	Industrial Load, ppd	Septage Load, ppd	Total AA, ppd
BOD						
2018	174,100	0.19	32,700	3,000	600	36,300
2040	218,400	0.19	41,000	3,000	600	44,600
Buildout	360,900	0.19	67,800	3,000	600	71,400
TSS						
2018	174,100	0.21	36,600	2,000	1,500	40,000
2040	218,400	0.21	45,900	2,000	1,600	49,500
Buildout	360,900	0.21	75,800	2,000	1,600	79,400
Ammonia						
2018	174,100	0.017	2,920	400	66	3,380
2040	218,400	0.017	3,360	400	66	4,120
Buildout	360,900	0.017	6,050	400	66	6,510
Total Phosphorus						
2018	174,100	0.007	1,220	NA	NA	1,220
2040	218,400	0.007	1,530	NA	NA	1,530
Buildout	360,900	0.007	2,530	NA	NA	2,530

Notes:
(1) Industry load projections taken from the *Tri-City Water Resource Recovery Facility Solids Handling Improvement Project TM3 Projected Future Flows and Loads* (2016, Stantec). Since there was no change in the load between 2015 and 2020, these values were assumed for 2018 as well.
(2) Septage flow projections taken from the *Tri-City Water Resource Recovery Facility Solids Handling Improvement Project TM3 Projected Future Flows and Loads* (2016, Stantec). 2018 value is a linear interpolation between the 2015 and the 2020.

Table 3.23 Load Projections

Load Parameter	2018	2040	Buildout
TSS			
AA	40,000	49,500	79,400
MM	54,800	67,600	108,600
MW	63,700	78,600	126,200
BOD			
AA	36,300	44,600	71,400
MM	46,300	57,000	91,100
MW	50,900	62,500	100,000
Ammonia			
AA	3,380	4,120	6,510
MM	3,940	4,810	7,590
MW	4,560	5,570	8,790
Total Phosphorus			
AA	1,220	1,530	2,530
MM	1,420	1,780	2,940
MW	1,640	2,060	3,410

3.8 Treatment Plant Flows and Loads

With the District's existing permit, the Kellogg Creek treatment plant can treat up to its hydraulic limit of 18 mgd through secondary treatment and 25 mgd with select treat. The remainder of the Kellogg Creek service area flows and loads are diverted to the Tri-City WRRF through the Intertie 2 Pump Station. Tables 3.24 through 3.26 summarize the anticipated flow distribution between the District's two plants with the existing permit and assuming that the Kellogg Creek treatment plant treats as much of the Kellogg Creek service area flows and loads as it has capacity to treat, with the exception that dry weather flows are capped such that the solids loads to the Kellogg Creek WRRF do not exceed the projected wet weather solids loads. This exception minimizes the necessary solids improvements at the Kellogg Creek WRRF while taking advantage of excess dry weather capacity at the Tri-City WRRF.

Table 3.24 2018 Existing Permit Condition Treatment Plant Flows and Loads

	Kellogg Creek	Tri-City	Total
Flows			
BWF	7.3	6.2	13.5
ADWF	8.0	7.1	15.1
MMDWF	11.5	12.7	24.2
MWDWF	13.3	20.4	33.7
PDDWF	18.0	29.7	47.7
AWWF	11.9	13.5	25.4
MMWWF	17.1	21.5	38.6
MWWWF	18.0	39.9	57.9
PDWWF	25.0	61.5	86.5
PHF	25.0	81.3	106.3
BOD			
ADW	18,900	17,400	36,300
MMDW	24,100	22,300	46,300
MWDW	22,700	28,100	50,900
AWW	18,900	17,400	36,300
MMWW	24,100	22,300	46,300
MWWW	20,500	30,400	50,900
TSS			
ADW	21,100	19,000	40,000
MMDW	28,800	25,900	54,800
MWDW	28,800	34,800	63,700
AWW	21,100	19,000	40,000
MMWW	28,800	25,900	54,800
MWWW	26,000	37,600	63,700
Ammonia			
ADW	1,700	1,700	3,400
MMDW	2,000	2,000	3,900
MWDW	2,000	2,600	4,600
AWW	1,700	1,700	3,400
MMWW	2,000	2,000	3,900
MWWW	1,800	2,800	4,600
Total Phosphorus			
ADW	700	500	1,200
MMDW	800	600	1,400
MWDW	800	800	1,600
AWW	700	500	1,200
MMWW	800	600	1,400
MWWW	700	900	1,600

Table 3.25 2040 Existing Permit Condition Treatment Plant Flows and Loads

	Kellogg Creek	Tri-City	Total
Flows			
BWF	9.5	7.3	16.8
ADWF	10.3	8.5	18.7
MMDWF	12.1	17.8	29.9
MWDWF	14.0	27.6	41.6
PDDWF	18.0	40.7	58.7
AWWF	15.4	16.0	31.4
MMWWF	18.0	29.6	47.6
MWWWF	18.0	53.1	71.1
PDWWF	25.0	80.5	105.5
PHF	25.0	104.4	129.4
BOD			
ADW	24,400	20,300	44,600
MMDW	25,300	31,600	57,000
MWDW	23,900	38,600	62,500
AWW	24,400	20,300	44,600
MMWW	25,300	31,700	57,000
MWWW	20,500	42,000	62,500
TSS			
ADW	27,200	22,200	49,500
MMDW	30,300	37,300	67,600
MWDW	30,300	48,300	78,600
AWW	27,200	22,200	49,500
MMWW	30,300	37,300	67,600
MWWW	26,000	52,600	78,600
Ammonia			
ADW	2,200	2,000	4,100
MMDW	2,100	2,700	4,800
MWDW	2,100	3,500	5,600
AWW	2,200	2,000	4,100
MMWW	2,100	2,700	4,800
MWWW	1,800	3,800	5,600
Total Phosphorus			
ADW	900	600	1,500
MMDW	900	900	1,800
MWDW	900	1,200	2,100
AWW	900	600	1,500
MMWW	900	900	1,800
MWWW	700	1,300	2,100

Table 3.26 Buildout Existing Permit Condition Treatment Plant Flows and Loads

	Kellogg Creek	Tri-City	Total
Flows			
BWF	12.0	15.4	27.4
ADWF	12.0	18.6	30.6
MMDWF	12.7	36.5	49.1
MWDWF	14.7	53.9	68.5
PDDWF	18.0	79.1	97.1
AWWF	18.0	33.7	51.7
MMWWF	18.0	60.5	78.5
MWWWF	18.0	82.7	100.7
PDWWF	25.0	128.1	153.1
PHF	25.0	162.8	187.8
BOD			
ADW	28,500	42,900	71,400
MMDW	26,600	64,600	91,100
MWDW	25,100	74,900	100,000
AWW	28,500	43,000	71,400
MMWW	25,300	65,800	91,100
MWWW	20,500	79,500	100,000
TSS			
ADW	31,800	47,600	79,400
MMDW	31,800	76,700	108,600
MWDW	31,800	94,400	126,200
AWW	31,800	47,600	79,400
MMWW	30,300	78,300	108,600
MWWW	26,000	100,200	126,200
Ammonia			
ADW	2,500	4,000	6,500
MMDW	2,200	5,400	7,600
MWDW	2,200	6,600	8,800
AWW	2,500	4,000	6,500
MMWW	2,100	5,500	7,600
MWWW	1,800	7,000	8,800
Total Phosphorus			
ADW	1,100	1,500	2,500
MMDW	900	2,000	2,900
MWDW	900	2,500	3,400
AWW	1,100	1,500	2,500
MMWW	900	2,100	2,900
MWWW	700	2,700	3,400

Chapter 4

PERMITTING AND REGULATORY CONSIDERATIONS

4.1 Introduction

This chapter presents information on the regulatory elements that are the primary driver for the immediate and potential future improvements to the Tri-City and Kellogg Creek Water Resources Recovery facilities (WRRF) as well as potential improvements at the Blue Heron Facility.

4.2 Framework

It is the responsibility of the Oregon Department of Environmental Quality (DEQ) to establish and enforce water quality standards that preserve the Willamette River's beneficial uses. The DEQ's general policy is one of antidegradation of surface water quality. Discharges from wastewater treatment plants are regulated through the National Pollutant Discharge Elimination System (NPDES). All discharges of treated wastewater to a receiving stream must comply with the conditions of an NPDES permit. The Environmental Protection Agency (EPA) oversees state regulatory agencies and can intervene if the state agencies do not successfully protect water quality.

The Tri-City WRRF discharges to the Willamette River at River Mile 25.5 just upstream of the confluence with the confluence of the Willamette River and the Clackamas River. The Kellogg Creek WRRF discharges to the Willamette River at River mile 18.5 near the confluence with Kellogg Creek.

4.2.1 Beneficial Uses

To assist in the development of water quality standards, a list of beneficial uses is established for each water body in the state. Oregon Administrative Rule (OAR) 340-041-0340 lists the beneficial uses for the Willamette River in the vicinity of the District's treatment plants as shown in Table 4.1.

Table 4.1 Designated Beneficial Uses for the Willamette River from the Mouth to the Willamette Falls

Beneficial Uses	
Public and Private Domestic Water Supply(1)	Wildlife & Hunting
Industrial Water Supply	Fishing
Irrigation	Boating
Livestock Watering	Water Contact Recreation
Fish & Aquatic Life	Aesthetic Quality
Commercial Navigation & Transportation	Hydro Power

Note:
(1) With adequate pretreatment (filtration and disinfection) and natural quality to meet drinking water standards.
Source: OAR 340-041-0340.

4.2.2 Oregon Administrative Rules for Wastewater Treatment

The state surface water quality and waste treatment standards for the Willamette Basin are detailed in the following sections of the OARs:

- OAR 340-041-0004 lists policies and guidelines applicable to all basins. DEQ's policy of antidegradation of surface waters is set forth in this section.
- OAR 340-041-0007 through 340-041-0036 describes the standards that are applicable to all basins.
- OAR 340-041-0061 describes the basis for establishing mass load limits.
- OAR 340-041-0340 through 340-041-0345 contain requirements specific to the Willamette Basin including beneficial uses, approved Total Maximum Daily Loads (TMDL) in the basin, and water quality standards and policies.

The surface water quality and waste treatment standards in the OARs are viewed as minimum requirements. Additionally, more stringent limits developed through the TMDL process would supersede the basin standards.

4.2.2.1 Total Daily Maximum Loads

The Clean Water Act requires DEQ to establish TMDLs and corresponding waste load allocations for all water bodies on the 303 (d) list. DEQ prepared a TMDL for mercury in 2006 and issued the revised draft TMDL in June 2019. The draft DEQ TMDL was rejected by EPA. In November of 2019 DEQ issued a revised TMDL which EPA disapproved. EPA established the Willamette Basin TMDL on December 30,2019. It is anticipated that a waste minimization strategy will be used along with a variance since the mercury targets may not be attainable in the near term.

DEQ also issued the temperature TMDL in 2006 which was initially approved by EPA. However, EPA's approval was challenged in Federal Court which ruled that the TMDL should not have been approved. DEQ will need to update the Willamette Basin TMDL. It is unlikely that the load allocations in the 2006 TMDL will be increased since the allocation is based in part on the human health allowance in the regulations. For dry season discharges to the Willamette River, DEQ allocated the following temperature loads to the District plants as shown in Table 4.2.

Table 4.2 Temperature TMDL Allocations

Facility	Temperature Increase (Celsius)	Thermal Load (Million Kcal/day)
Tri-City WRRF	0.0108	144
Kellogg Creek WRRF	0.0062	96
Blue Heron	0.0363	485

The thermal load allocations in Table 4.2 are fixed by the TMDL. To calculate the actual thermal load being discharged, the following calculation is required:

$$ETL = QE \times (TE - TR) \times Cf$$

Where:

- QE = Effluent flow in million gallons per day (mgd).
- TE = Temperature of the Effluent in the degree Celsius (C).
- TR = River temperature criterion (20°C).
- Cf = Conversion factor (2,446,665).

As is evident from this equation, the river temperature at the time of discharge is not a factor. The NPDES permit will set a thermal load limit expressed in million kilocalories and the actual load discharged will be calculated daily using the seven-day moving average of the plant's maximum daily effluent temperature.

4.2.3 Cold Water Refuge

DEQ published the "Draft Lower Willamette River Cold-Water Refuge Narrative Criterion Implementation Study", January 2020, for submittal to the National Marine Fisheries Service. This study identifies cold-water refuge (CWR) sites including Abernethy Creek and the Clackamas River near the Tri-City WRRF and Kellogg Creek and Johnson Creek near the Kellogg Creek WRRF. DEQ did not find enough evidence to recommend the creation of additional CWR in the migration corridor of the Willamette River. However, there are data gaps and United States Geological Survey (USGS) is also doing similar work which could add potential sites. Implementation of the cold-water refuge is outlined in the draft report and the three proposed steps are listed below:

1. DEQ will implement existing temperature TMDLs to address temperature reductions in the main stem and cold-water tributaries to maintain and enhance the CWRs identified in this report. For example, implementing the Clackamas Basin TMDL will protect the quality of cold-water refuge provided by the Clackamas River confluence.
2. Designated management agencies (DMA) along the mainstem Willamette River are required to address CWR according to the 5-year Willamette Basin TMDL Implementation Plans. The Implementation Plans require DMAs to evaluate impacts to existing CWR, now identified in this study, identify additional CWR if applicable, and provide options for protecting or enhancing such areas.
3. NPDES permits for discharges are required to evaluate and prohibit thermal impacts to CWR under the authority of OAR 340-041-0053 (d). When permits are issued for discharges within the migration corridor, potential for impacts to the CWR identified in this report or by DMAs must be evaluated and thermal plume limitations applied as necessary.

4.2.4 Clean Water Act 303 (d) Listing

The federal Clean Water Act requires that the responsible regulatory agency establish a list of water bodies that do not meet applicable water quality standards. In Oregon, this responsibility falls to the DEQ. This list, known as the 303 (d) list, is updated every three years. In April of 2020, DEQ submitted the Oregon 2018-20 Integrated Report to EPA. EPA approved the report on November 12, 2020, and this report is now effect. DEQ is now beginning work on the 2020-2022 integrated report.

DEQ's assessment is divided into river segments that are designated as assessment units. Figure 4.1 shows the extent of the assessment units that are relevant to the District's facilities.

The Tri-City WRRF discharges to the Willamette River assessment unit that spans from Champoeg Creek to the Clackamas River. The causes of impaired uses for the Willamette River for this part of the river are listed below:

- Temperature.
- Aquatic Weeds.
- Dissolved Oxygen.
- Biocriteria.
- Methylmercury.
- Dieldrin.

- Polychlorinated biphenyls (PCB).
- Dichlorodiphenyltrichloroethane (DDT) and derivatives.
- Dioxin.
- Aldrin

The Kellogg Creek WRRF discharges to the Willamette River just upstream of the Milwaukie Bay Park into the Clackamas River to Johnson Creek Assessment Unit. The following are the causes for impaired uses for this reach of the Willamette River:

- Temperature.
- Cyanide.
- Hexachlorobenzene.
- Ethylbenzene.
- Pentachlorophenol.
- Polycyclic Aromatic Hydrocarbons (PAH).
- Dieldrin.
- PCBs.
- DDT and derivatives.
- Aldrin.
- Biocriteria.

The Willamette River assessment unit immediately downstream of Milwaukie is known as the Johnson Creek to the Columbia River assessment unit. In addition to the causes for impairment shown above, Johnson Creek to the Columbia River assessment unit includes the following causes of impairment:

- Chlorophyll - a.
- Aquatic Weeds.
- Dissolved Oxygen.
- Harmful Algal Blooms.
- Iron.
- E. coli.
- Chlordane.

Aquatic weeds, harmful algal blooms, chlorophyll-a and the biocriteria could all be related to the nutrient loading in the river. Aquatic growth is stimulated by nutrients that are available in the water. DEQ has not evaluated the conditions in the river to determine if the river is either nitrogen or phosphorous limited. However, upstream tributaries have been found to be phosphorous limited. Dissolved oxygen is primarily influence by oxygen demand exerted by organic loading. A TMDL process will be necessary to establish future treatment requirements. Long-term planning should include provision of footprint at the plant for nutrient removal.

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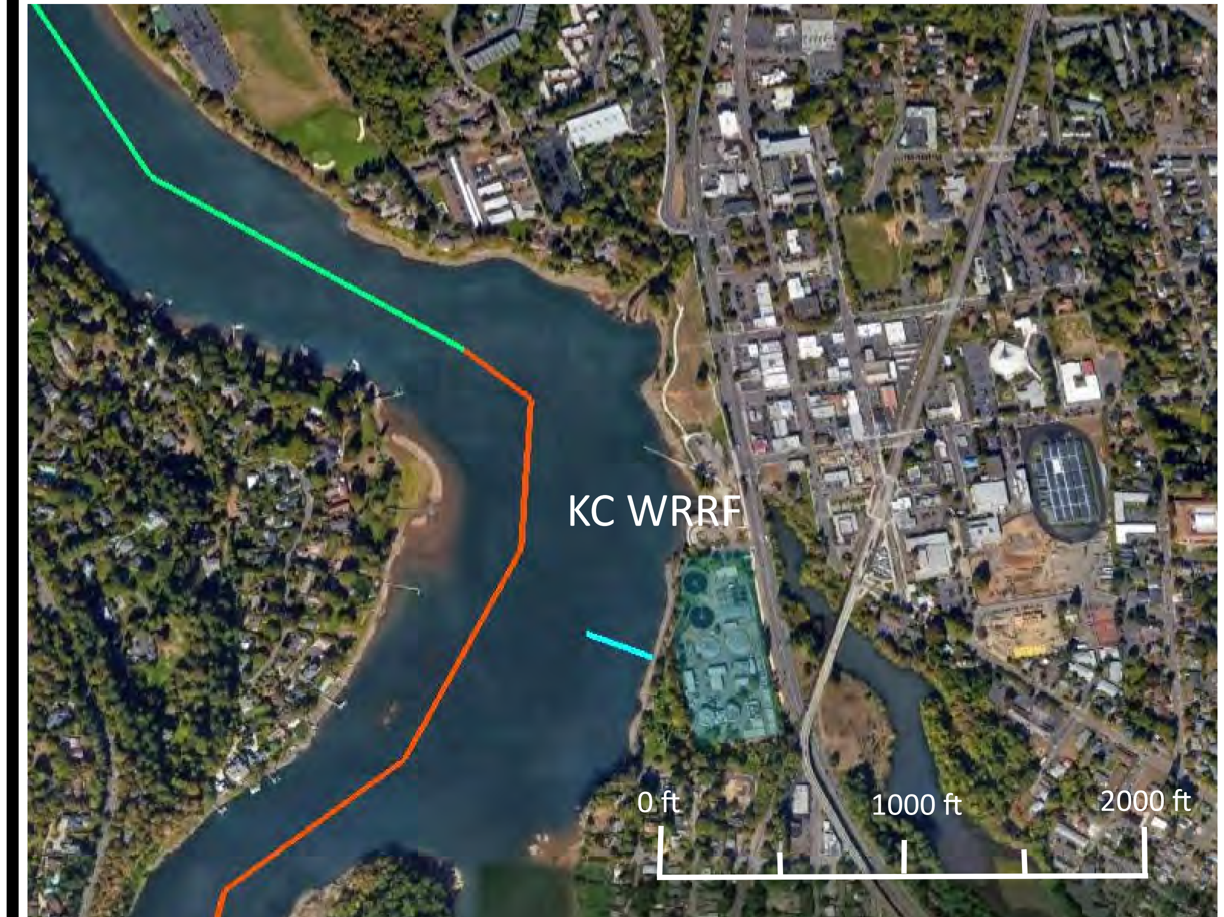
Willamette River Water Quality Assessment Units

Willamette River assessment units in the proximity of the Tri-City Water Resource Recovery Facility and the Kellogg Creek Water Resource Recovery Facility.



Kellogg Creek WRRF outfall

Tri-City WRRF outfall

Legend:

	DEQ ID	Reach
	OR_SR_1709000704_88_104020	Champoeg Creek to Clackamas River
	OR_SR_1709000704_88_104019	Clackamas River to Johnson Creek
	OR_SR_1709001202_88_104175	Johnson Creek to Columbia River

Kellogg Creek Outfall

Tri-City Outfall

N

Figure 4.1

Willamette River Water Quality Assessment Units

Water Environment Services
Regulatory Considerations

4.3 Existing Tri-City WRRF Considerations

The Tri-City WRRF discharges to the Willamette River at Clackamette Park just upstream of the confluence of the Willamette and Clackamas Rivers. Water quality factors specific to the Tri-City WRRF are addressed in the following sections.

4.3.1 Existing NPDES Permit Limits

The existing permit limits for the Tri-City WRRF are shown in Table 4.3.

Table 4.3 Tri-City Effluent Permit Limits

Parameter	Average Effluent Concentration		Monthly Average (lbs/day)	Weekly Average (lbs/day)	Daily Maximum (lbs)[(1)]
	Monthly	Weekly			
May 1 - October 31:					
$CBOD_5$	10 mg/L	15 mg/L	1050	1750	2100
TSS	10 mg/L	15 mg/L	1400	2100	2800
November 1 - April 30:					
BOD_5	25 mg/L	40 mg/L	2800	4500	5600
TSS	30 mg/L	45 mg/L	3400	5100	6800
Other Parameter Limitations:					
E. coli Bacteria	Shall not exceed 126 organisms per 100 ml geometric mean. No single sample shall exceed 406 organisms per 100 mL.				
Total Chlorine Residual	Shall not exceed a monthly average concentration of 0.02 mg/L and a daily maximum concentration of 0.04 mg/L.				
Ammonia	The interim limit no longer applies as WES fulfilled the MAO requirements.				
pH	Shall be within the range of 6.0-9.0.				
BOD_5 Removal Efficiency	Shall not be less than 85 percent monthly average.				
TSS Removal Efficiency	Shall not be less than 85 percent monthly average.				

Notes:
(1) The daily mass load limit is suspended on any day that the flow exceeds 23.8 mgd (twice the design average dry weather flow).
Abbreviations: BOD_5 - five-day biochemical oxygen demand; $CBOD_5$ - five-day carbonaceous biochemical oxygen demand; lbs/day - pounds per day; MAO - Mutual Agreement and Order; mg/L - milligrams per liter; ml - milliliter; TSS - total suspended solids; WES - Clackamas Water Environment Services.

During the last permit cycle DEQ increased the level of treatment required during the dry season to integrate the basin standard of 10 mg/L for both BOD and TSS. The mass load limits that were based on previous permit limits and design flow were not changed.

The current administratively extended permit included an ammonia limit that limited the discharge to a monthly average of 15 mg/L. The District also received a Mutual Agreement and Order (MAO) that required the District to make improvements to the existing outfall to increase mixing. A duckbill diffuser was added to one of the existing discharge pipes and a report entitled "Tri-City Water Pollution Control Plant Compliance with MAO WQ/M-NWR-11-046" was submitted to DEQ in February 2012. In a letter dated December 3, 2012, DEQ responded that the District fulfilled the requirements of the MAO and the ammonia limit no longer applies. A copy of the DEQ MAO and letter are included in Appendix 4A.

4.3.2 Outfall Status

The existing Tri-City WRRF outfall has a hydraulic capacity of 75 mgd which has been reached during peak flow events. A second outfall is needed, and the District has initiated development of the predesign and design of the second outfall. It is anticipated that the new outfall diffuser will be designed to provide improved mixing compared to the existing outfall.

Siting and preliminary mixing conditions have been addressed in the draft technical memorandum "Willamette River Outfall Diffuser Siting Alternatives Evaluation" dated October 18, 2019, Jacobs Engineering. The proposed location for the new outfall diffuser is just downstream of the I-205 bridge across the Willamette River. According to this technical memorandum, under 2040 conditions the dilution factors (DF) would be 33 at the Zone of Initial Dilution (ZID) and 83 at the Regulated Mixing Zone (RMZ) for an effluent flow of 23.8 mgd and 18 mgd respectively.

4.3.3 Toxicity Evaluation

One advantage of the new outfall and diffuser is that mixing will be improved. The draft technical Memorandum entitled "Willamette River Outfall Diffuser Siting Alternatives Evaluation" includes an evaluation of the dilution required to meet the ammonia water quality criteria. The results of this study indicate that the governing condition for ammonia toxicity is the chronic 30-day ammonia criteria at the RMZ. A minimum dry season DF of 50 will be required at the RMZ to meet the 30-day chronic toxicity criterion while DF of 83 is estimated to be available at the RMZ. Mixing criteria for the new diffuser will continue to be refined during design.

4.3.4 Temperature Requirements

The long-term temperature requirements are uncertain, but the 2006 temperature TMDL that is currently under revision provides an indication on the likely future discharge requirements. Figure 4.2 shows the thermal load discharged by the Tri-City WRRF during the summers of 2017. It is noteworthy that the highest thermal discharge in occurred on September 10th in 2017 and August 17th in 2015. Neither of these thermal loads correlate with storm events, but high effluent temperatures.

The thermal load is directly proportional to the plant flow so the thermal load discharged in the future will increase as the flows increase. Currently there appears to be about 30-percent room for growth with the existing TMDL allocation.

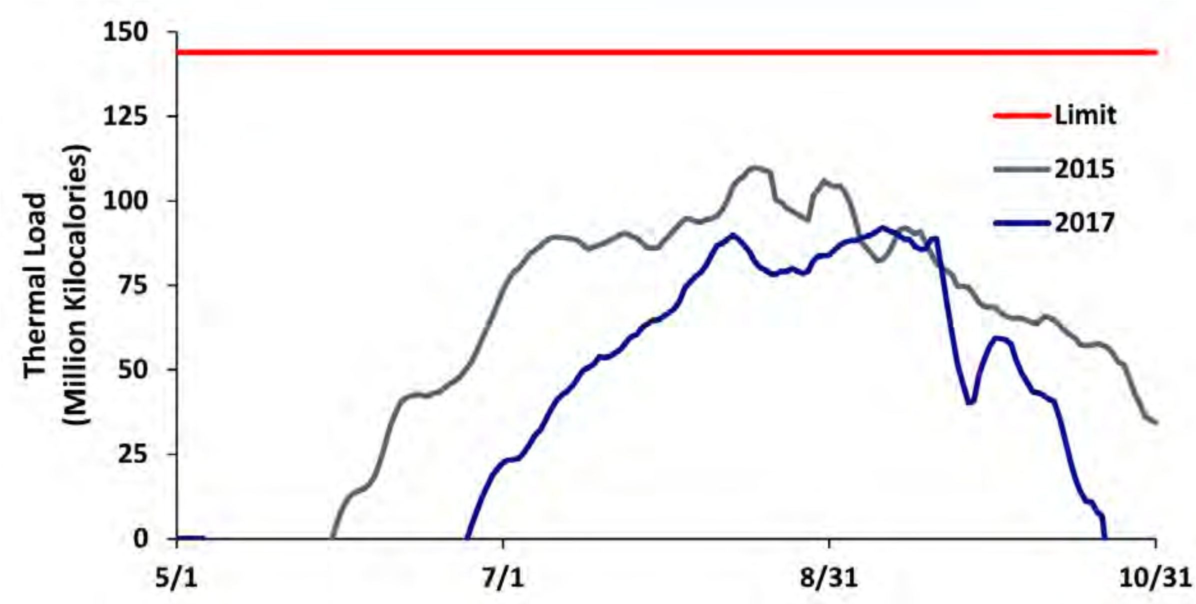


Figure 4.2 Tri-City WRRF 2017 Thermal Load Discharges to the Willamette River

4.3.5 Select Treatment

Tri-City WRRF has secondary treatment capacity for 35 mgd and during major storm events, flows to the plant exceed this capacity. During such events, primary effluent is routed to the disinfection system and combined with secondary treated effluent for disinfection.

Select treatment should be employed when the secondary treatment process could be compromised by the high flows. Permit limits need to be met whenever select treatment is employed. DEQ has accepted select treatment as a legitimate means to address exceptionally high flows. EPA has at time questioned the practice but has not taken formal action at a national level.

In 2016 through 2018, select treatment was used on nearly 100 days but the total volume receiving select treatment was relatively small as shown in Table 4.4. The impact of select treatment on final effluent quality was not significant for most events except when the select treatment flow exceeded 14 mgd. However, the elevated suspended solids concentrations associated with this event were also due to poor secondary clarifier performance during peak flow conditions cause by solids washout. The final effluent TSS discharged for days with select treatment is shown in Figure 4.3. As shown in the figure, effluent suspended solids typically remain low during peak flow events.

Table 4.4 Select Treat Summary

Year	Days/year	Total Volume (million gallons)
2016	39	62
2017	48	191
2018	12	18

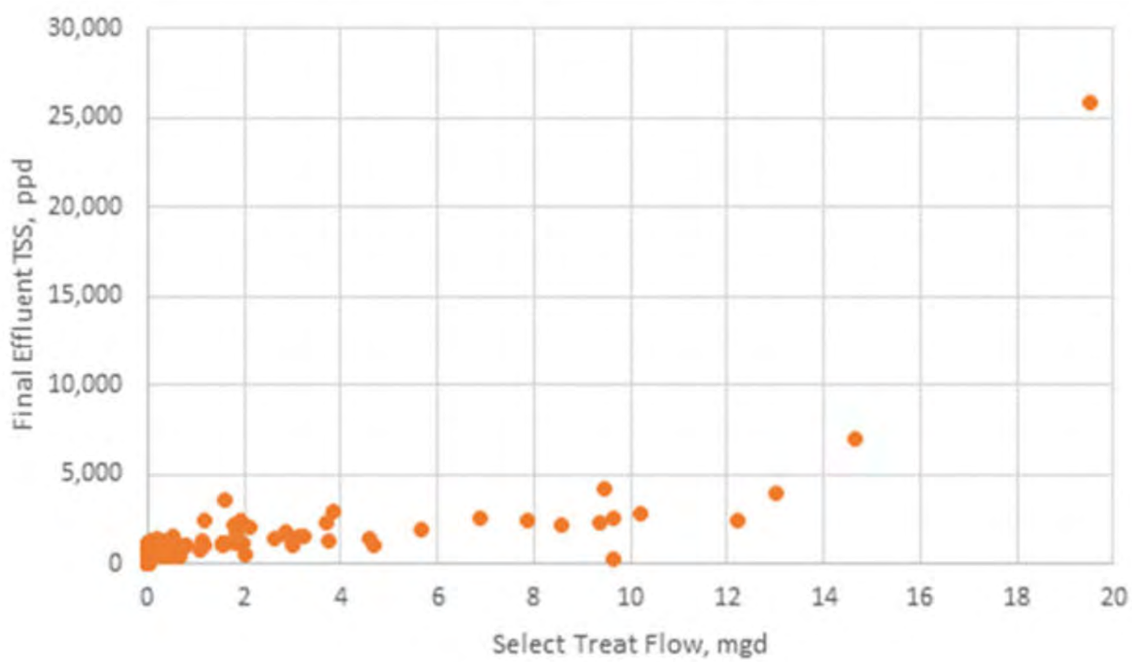


Figure 4.3 Effluent TSS on Days with Select Treatment

4.4 Existing Kellogg Creek WRRF Considerations

The Kellogg Creek WRRF discharges to the Willamette River just upstream of the Milwaukie Bay Park and the confluence of the Willamette River and Kellogg Creek.

4.4.1 Existing NPDES Permit Limits

The existing permit limits for the Kellogg Creek WRRF are shown in Table 4.5.

Table 4.5 Kellogg Creek WRRF Effluent Permit Limits

Parameter	Average Effluent Concentration		Monthly Average (lbs/day)	Weekly Average (lbs/day)	Daily Maximum (lbs)
	Monthly	Weekly			
May 1 - October 31:					
$CBOD_5$	15 mg/L	25 mg/L	1300	2000	2600
TSS	20 mg/L	30 mg/L	1700	2600	3400
November 1 - April 30:					
BOD_5	25 mg/L	40 mg/L	2100	3200	4200
TSS	30 mg/L	45 mg/L	2500	3800	5000
Other Parameter Limitations:					
E. coli Bacteria	Shall not exceed 126 organisms per 100 ml geometric mean. No single sample shall exceed 406 organisms per 100 ml.				
Total Chlorine Residual	Shall not exceed a monthly average concentration of 0.03 mg/L and a daily maximum concentration of 0.07 mg/L.				
Ammonia - May 1 to October 31	Shall not exceed a maximum daily limit of 60.1 mg/L or an average monthly limit of 33.9 mg/L.				

Parameter	Average Effluent Concentration		Monthly Average (lbs/day)	Weekly Average (lbs/day)	Daily Maximum (lbs)
	Monthly	Weekly			
Ammonia - May 1 to October 31	Shall not exceed a maximum daily limit of 60.1 mg/L or an average monthly limit of 33.9 mg/L.				
Ammonia - November 1 to April 30	Shall not exceed a maximum daily limit of 41.9mg/L or an average monthly limit of 25.4 mg/L.				
pH	Shall be within the range of 6.0-9.0.				
BOD_5 Removal Efficiency	Shall not be less than 85 percent monthly average.				
TSS Removal Efficiency	Shall not be less than 85 percent monthly average.				

The mass loads included in the permit are based on the average dry weather design flow of 10 mgd.

The ammonia and chlorine residual limits shown in Table 5 are based on the permit modification issued by DEQ on August 21, 2007.

The permit includes a note that states that the State of Oregon had adopted the EPA 1999 ammonia criteria and upon approval of the new standard by the EPA, there would be no ammonia limit. EPA did note approve that standard and Oregon adopted new ammonia standards in 2015 which EPA has now approved. For the time that the existing permit is in effect, the ammonia limit is in effect.

4.4.2 Outfall Status

In 2016 the District constructed an outfall diffuser at the end of the existing outfall to improve mixing in the river. The diffuser is the last 120 feet of the outfall and has seven 20-inch vertical risers with Tideflex elastomeric check valve ports. A comprehensive mixing zone study was completed entitled "Outfall Mixing Zone Study for the Kellogg Creek Water Resource Recovery Facility, Outfall 001", (January 2018, CH2M Hill) (Kellogg Creek Mixing Zone Study). This study demonstrated that excellent mixing is achieved with the new outfall diffuser as summarized below:

Discharge Condition:	Dilution Factor:
Existing Flow 1Q10 ZID	27
Buildout Flow 1Q10 ZID	22
Existing Flow 7Q10 RMZ	179
Buildout Flow 7Q10 RMZ	142

With the changed conditions associated with the new diffuser, the study recommends that the definition of the mixing zone be changed from the existing mixing zone defined in the NPDES permit. The recommended RMZ is as follows:

- "Rectangle that has a 280-foot width centered on the diffuser Port No. 5 and a length of 200 feet upstream and downstream from the diffuser alignment and aligned with the diffuser alignment."

The ZID is recommended to remain as:

- "That portion of the allowable mixing zone that is 20 feet from the discharge ports."

The mixing zone study has been submitted to DEQ.

4.4.3 Toxicity Evaluation

The Kellogg Creek Mixing Zone Study evaluated toxicity based on the improved mixing conditions following construction of the new diffuser. Based on the current Oregon ammonia water quality standard, the reasonable potential analysis (RPA) for ammonia showed that there is no reasonable potential to exceed the ammonia water quality criteria. It is reasonable that the ammonia limit for toxicity be eliminated in the next permit.

As part of the Kellogg Creek Mixing Zone Study, RPAs were developed for both aquatic toxicity and for the human health criteria. The study concluded that the effluent discharges do not have a reasonable potential to exceed either the aquatic life or human health water quality criteria.

4.4.4 Temperature Requirements

The long-term temperature requirements are uncertain, but the 2006 temperature TMDL that is currently under revision provides an indication on the likely future discharge requirements. Figure 4.4 shows the thermal load discharged by the Kellogg Creek WRRF during the summer of 2017. Currently there appears to be about 50-percent room for growth with the existing TMDL allocation.

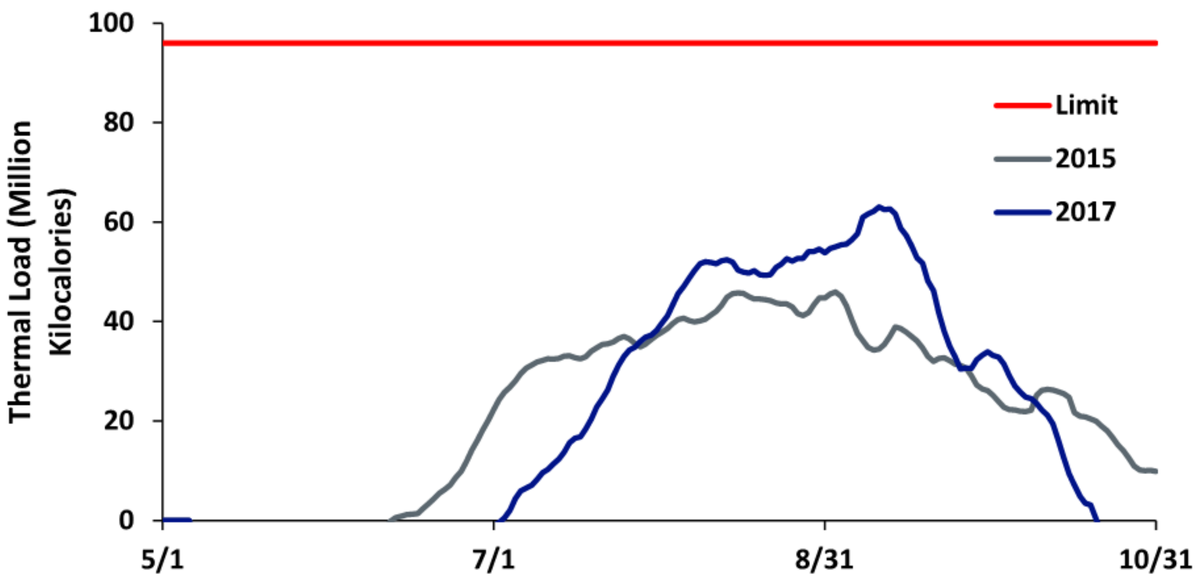


Figure 4.4 Kellogg Creek WRRF 2017 Thermal Load Discharges to the Willamette River

4.4.5 Select Treatment

Kellogg Creek WRRF has secondary treatment capacity for 17 mgd and during major storm events, flows to the plant could exceed this capacity. During such events, primary effluent could be sent directly to the disinfection system and combined with secondary treated effluent for disinfection. Select treatment has only recently been used at the plant and the impact of select treatment on plant performance is not available.

4.5 Anticipated Future Treatment Requirements

Both the Tri-City and Kellogg Creek WRRFs are scheduled to receive a revised NPDES permit in 2022 and it is unlikely that any new TMDLs will be promulgated by DEQ in the interim. Improvements that have been made to the existing outfalls and the proposed new outfall for the Tri-City WRRF provide excellent mixing and comply with the ammonia criteria. As a result of these mixing improvements, elimination of permitted effluent ammonia limits at the two plants is anticipated. In addition, the mixing provides for compliance with the aquatic life and human health criteria based on the RPA completed as part of the mixing zone studies.

4.5.1 Tri-City WRRF Permit

For the Tri-City WRRF, the current permit incorporated the basin standards for the technology-based limits for CBOD5 and TSS and no change is warranted. Planning should be based on the limits shown in Table 4.6.

Table 4.6 Anticipated Tri-City WRRF Effluent Permit Limits

Parameter	Average Effluent Concentration		Monthly Average (lbs/day)	Weekly Average (lbs/day)	Daily Maximum (lbs)(1)
	Monthly	Weekly			
May 1 - October 31:					
$CBOD_5$	10 mg/L	15 mg/L	1050	1750	2100
TSS	10 mg/L	15 mg/L	1400	2100	2800
November 1 - April 30:					
BOD_5	25 mg/L	40 mg/L	2800	4500	5600
TSS	30 mg/L	45 mg/L	3400	5100	6800
Other Parameter Limitations:					
E. coli Bacteria	Shall not exceed 126 organisms per 100 ml geometric mean. No single sample shall exceed 406 organisms per 100 ml.				
Total Chlorine Residual	Shall not exceed a monthly average concentration of 0.02 mg/L and a daily maximum concentration of 0.04 mg/L.				
Ammonia	The interim limit no longer applies as WES fulfilled the MAO requirements.				
pH	Shall be within the range of 6.0-9.0.				
BOD_5 Removal Efficiency	Shall not be less than 85 percent monthly average.				
TSS Removal Efficiency	Shall not be less than 85 percent monthly average.				

Note:
(1) The daily mass load limit is suspended on any day that the flow exceeds 23.8 mgd (twice the design average dry weather flow).

A factor that will become important is the monthly and weekly CBOD5 load limits in the May 1 to October 31 period. Based on the projected flow for the Tri-City service area, the allowable concentration that can be discharged by 2040 will be less than the permitted 10 mg/L. Table 4.7 shows the concentration limits for the average, maximum week and maximum month dry weather flows based on the permitted mass load.

Table 4.7 Effluent Concentration Limits based on Mass Load Limits

	Tri-City Service Area Flow (mgd)		CBOD Concentration (mg/L)	
	2018	2040	2018	2040
ADWF	7.1	8.5	17.7	14.8
MMDWF	12.7	17.1	9.9	7.3
MWDWF	18.3	23.6	11.5	8.9

Note:
Abbreviations: ADWF - average dry weather flow; MMDWF - maximum month dry weather flow; MWDWF - maximum week dry weather flow.

Since influent flow and load transfers from the Kellogg Creek service area to the Tri-City Service area are taking place and will continue to increase, it is important that the mass load limits be assessed to ensure long-term compliance.

Capacity at the Tri-City WRRF has been increased since 1992 and the plant is subject to OAR 240-041-0061(9)(b) which states the following:

- *(b)For new sewage treatment facilities or treatment facilities expanding the average dry weather treatment capacity and receiving engineering plans and specifications approval from the department after June 30, 1992, the mass load limits must be calculated by the department based on the proposed treatment facility capabilities and the highest and best practicable treatment to minimize the discharge of pollutants.*

The Tri-City WRRF does not have the capability to meet daily mass loads that occur during unusually high peak flows that are experienced during major storm events. Some to the facility service areas were constructed with combined sewers that were later separated. The District has adopted an aggressive infiltration and inflow control strategy but even with this strategy, peak day mass loads will be high. The facilities plan will identify the highest and best practicable treatment that can be achieved by the plant.

4.5.2 Kellogg Creek WRRF Permit

The Kellogg Creek WWRF effluent limits should remain the same as the 2006 permit with the exception that no ammonia limit is warranted. An interim limit was included in the existing permit pending revision of the water quality standard. With the newly approved standard and the improved mixing, there is no reasonable potential that the discharge will exceed water quality standards. The anticipated limits are shown in Table 4.8.

Table 4.8 Anticipated Kellogg Creek WRRF Effluent Permit Limits

Parameter	Average Effluent Concentration		Monthly Average (lbs/day)	Weekly Average (lbs/day)	Daily Maximum (lbs)
	Monthly	Weekly			
May 1 - October 31:					
$CBOD_5$	15 mg/L	25 mg/L	1300	2000	2600
TSS	20 mg/L	30 mg/L	1700	2600	3400
November 1 - April 30:					
BOD_5	25 mg/L	40 mg/L	2100	3200	4200
TSS	30 mg/L	45 mg/L	2500	3800	5000
Other Parameter Limitations:					
E. coli Bacteria	Shall not exceed 126 organisms per 100 ml geometric mean. No single sample shall exceed 406 organisms per 100 ml.				
Total Chlorine Residual	Shall not exceed a monthly average concentration of 0.03 mg/L and a daily maximum concentration of 0.08 mg/L.				
Ammonia	The interim limit no longer applies as WES fulfilled the MAO requirements.				
pH	Shall be within the range of 6.0-9.0.				
BOD_5 Removal Efficiency	Shall not be less than 85 percent monthly average.				
TSS Removal Efficiency	Shall not be less than 85 percent monthly average.				

The capacity of the plant has not been increased so there is no basis for changing the discharge limits to the basin standard.

Based on OAR 340-041-0061 (9) (a) (D), The design average wet weather flow is defined as the average flow between November 1 and April 30 when the sewage treatment facility is projected to be at design capacity for that portion of the year. The current recognized ADWF design capacity is 10 mgd as stipulated in Schedule A of the NPDES permit. Based on Table 3.7 of Chapter 3, the existing ADWF is 8.0 mgd and the existing average wet weather flow (AWWF) is 11.9 mgd. If the ADWF increases to 10 mgd, the corresponding AWWF would be 14.9 mgd. If this logic is sound, we should be able to make the case that the daily mass load be suspended when the daily flow exceeds 14.9 mgd. These are the provisions set forth in the rule:

- *(c) On any day that the daily flow to a sewage treatment facility exceeds the lesser hydraulic capacity of the secondary treatment portion of the facility or twice the design average dry weather flow, the daily mass load limit does not apply. The permittee must operate the treatment facility at highest and best practicable treatment and control.*
- *(d) The design average wet weather flow used in calculating mass loads must be approved by the department in accordance with prudent engineering practice and must be based on a facility plan approved by the department, engineering plans and specifications approved by the department, or an engineering evaluation. The permittee must submit documentation describing and supporting the design average wet weather flow with the permit application, application for permit renewal, or modification request or upon request by the department. The design average wet weather flow is defined as the average flow between November 1 and April 30 when the sewage treatment facility is projected to be at design capacity for that portion of the year.*

Based on these rules, a change needs to be reflected in the renewed NPDES permit. The hydraulic capacity of the secondary treatment system for the Kellogg Creek WWRF is 18 mgd, and the permit should suspend the daily mass load whenever the flow to the plant exceeds 18 mgd.

Chapter 5

EXISTING WRRF CAPACITY AND CONDITION SUMMARY

5.1 Introduction

This chapter summarizes the existing capacity and condition of the liquid and solids stream treatment processes at the Kellogg Creek and Tri-City Water Resource Recovery Facilities (WRRF), and the key design criteria and the treatment plant flow and load projections that are used to develop alternatives needed to address deficiencies through the planning period.

The chapter also summarizes recommended improvements to assets based on a condition assessment completed at each WRRF, including the methodology and prioritization approach used for the condition assessment.

Detailed capacity analyses (including the unit process and hydraulic capacities), and condition assessments can be found in the Kellogg Creek and Tri-City WRRF Facilities Plans.

5.2 WRRF Capacity Summary

5.2.1 Design Criteria

Major unit process design criteria were developed for both the Tri-City and Kellogg Creek WRRFs. Design criteria recommended for the Tri-City WRRF are summarized in Table 5.1, and the design criteria recommended for the Kellogg Creek WRRF are summarized in Table 5.2.

Table 5.1 Tri-City Unit Process Design Criteria

Unit Process	Design Parameter	Design Criteria(1)	Redundancy Criteria
Influent pumping	**PHF**	**100% of PHF**	**Largest pump OOS**
Screening	PHF **PDF**	Hydraulically pass flow **Hydraulically pass flow**	All units in service **All mechanically cleaned screens in service**
Grit Removal	**PHF**	**HRT = 2 min**	**All units in service**
Primary Treatment	**PHF** MMWWF ADWF	**Hydraulically pass flow** 1,500-2,000 gpd/sf(2) 1,500 gpd/sf	**All units in service** All units in service Largest unit OOS
Secondary Treatment			
Aeration Basins (CAS non nitrifying)	**MMWWF** ADWF	**aSRT = 2.5 days** aSRT = 2.5 days	**All units in service** Largest units OOS
Aeration Basin (MBR Train)	**MMWWF**	aSRT = 10 days	**All units in service**
Secondary Clarifiers	**PHF** ADWF	**SOR = 1,200 gpd/sf** SOR = 1,200 gpd/sf	**All units in service** Largest unit OOS
Membrane Tanks	**PHF**	**Flux = 19.2 gpd/sf**	**All units in service**

Unit Process	Design Parameter	Design Criteria(1)	Redundancy Criteria
Disinfection			
Chlorine Contact Basin	**PHF** PDF ADWF	**HRT=15 min** HRT=20 min HRT=60 min	**All units in service** All units in service Largest units OOS
UV Channels	**PHF** ADWF	**30 mJ/cm²** 30 mJ/cm²	**All units in service** Largest unit OOS
Thickening GBT	Max Week Load **Max Month Load**	400 gpm; 900 lb/m/hr **400 gpm; 900 lb/m/hr**	All units in service **Largest unit OOS**
Anaerobic Digestion(3)	Max Month Load **Max Month Load** Max Month Load	SRT = 20 days **SRT = 15 days** SVSLR = 0.15 lb VS/d-lb VS inventory(4)	All units in service **Largest unit OOS** Largest unit OOS
Dewatering Centrifuge	Max Week Load **Max Month Load**	2,200 lb/hr **2,200 lb/hr**	All units in service **Largest unit OOS**

Notes:
(1) Bold text denotes the capacity-limiting criteria for each unit process.
(2) At 1,500 gpd/sf SOR, TSS removal in primary clarifiers is assumed to be 60 percent; at 2,000 gpd/sf, TSS removal is assumed to be 54 percent.
(3) Anaerobic digestion criteria assume 90 percent of the total digester volume is utilized for digestion.
(4) Design criteria for the most recent Tri-City solids expansion project was for a SVSLR of 0.16 lb VS/d-lb VS inventory under max two-week loads. This value was related to a maximum month SVSLR of 0.15 lb VS/d-lb VS inventory using the relationship between max-two week and maximum loads defined in that project.
Abbreviations: ADWF - average dry weather flow; aSRT - aerobic solids retention time; CAS - conventional activated sludge; GBT - gravity belt thickener; gpd/sf - gallons per day per square foot; gpm - gallons per minute; HRT - hydraulic retention time; lb/hr - pounds per hour; lb/m/hr - pounds per meter per hour; lb VS/d-lb VS - pounds per day of volatile solids fed per pound of volatile solids; max - maximum; MBR - membrane bioreactor; min - minute(s); mJ/cm² - millijoules per square centimeter; MMWWF - maximum month wet weather flow; OOS - out of service; PDF - peak day flow; PHF - peak hour flow; SOR - surface overflow rate; SRT - solids residence time; SVSLR - specific volatile solids loading rate; TSS - total suspended solids; UV - ultraviolet.

Table 5.2 Kellogg Creek Unit Process Design Criteria

Unit Process	Design Parameter	Design Criteria	Redundancy Criteria
Influent pumping	**PHF**	**100% of PHF**	**Largest pump OOS**
Screening	**PHF**	**Hydraulically pass flow**	**Largest screen OOS**
Grit Removal	**PHF**	**SOR = 43,000 gpd/sf**	**All units in service**
Primary Treatment	**PHF** MMWWF ADWF	**Hydraulically pass flow** 1,420 gpd/sf(5) 1,620 gpd/sf(6)	**All units in service** All units in service Largest unit OOS
Secondary Treatment			
Aeration Basins	**MMWWF** ADWF	**aSRT = 2.5 days** aSRT = 2 days	**All units in service** Largest unit OOS
Secondary Clarifiers	**PHF** ADWF	**SOR = 1,200 gpd/sf** SOR = 1,200 gpd/sf	**All units in service** Largest unit OOS
Disinfection			
UV Channels	**PHF**	**30 mJ/cm²**	**All units in service**
Chlorine Contact Basin	**PHF**	HRT=15 min	All units in service
DAFT Thickening	**Max Week Load**	**24 ppd/sf**	**All units in service**

Unit Process	Design Parameter	Design Criteria	Redundancy Criteria
Anaerobic Digestion(3)	**Max Month Load** Max Month Load	**SRT = 20 days** SVSLR = 0.15 lb VS/d-lb VS inventory(4)	**All units in service** All units in service
Dewatering Centrifuge	**Max Month Load**	**90 gpm(7)**	**All units in service**

Notes:
(1) Bold text denotes the capacity-limiting criteria for each unit process.
(2) Disinfection criteria assume chlorine contact basin is only used as backup to the UV channels, whether for redundancy purposes or to treat flow exceeding the rated capacity of the UV channels.
(3) Anaerobic digestion criteria assume 90 percent of the total digester volume is utilized for digestion. Assumed that excess solids will be transferred to Tri-City if a digester needs to be taken out of service for maintenance.
(4) Design criteria for the most recent Tri-City solids expansion project was for a SVSLR of 0.16 lb VS/d-lb VS inventory under max two-week loads. This value was related to a maximum month SVSLR of 0.15 lb VS/d-lb VS inventory using the relationship between max-two week and maximum loads defined in that project.
(5) Projected TSS removal at 1420 gpd/sf is 59 percent.
(6) Projected TSS removal at 1660 gpd/sf is 55 percent.
(7) Assumes six days per week, 20 hours per day operation.
Abbreviations: DAFT - dissolved air flotation thickener; ppd/sf - pounds per day per square foot.

5.2.2 Treatment Plant Flow and Load Projections

Flow and load projections for the Tri-City and Kellogg Creek service areas are summarized in Chapter 3. The Tri-City WRRF currently treats wastewater generated within the Tri-City service area, along with a portion of the wastewater generated in the Kellogg Creek service area that is transferred to the Tri-City WRRF through the Intertie 2 Pump Station. Expansion at Kellogg Creek is not possible, and WRRF capacity analyses assume the practice of inter-basin flow transfer to optimize the capacity at both facilities will continue. Accordingly, peak day and peak hour flows at the Kellogg Creek WRRF are capped at 25 million gallons per day (mgd), with any flow (and associated load) above 25 mgd transferred to the Tri-City WRRF. Additionally, since the secondary treatment process at Kellogg Creek is limited to 18 mgd, the capacity analysis assumed that peak flow transfers will be managed to limit maximum month and maximum week flows through the Kellogg Creek WRRF to less than 18 mgd.

The practice of optimizing treatment capacity by transferring flow between Kellogg and Tri-City on a seasonal basis must also be considered when evaluating the solids stream capacity at both WRRFs. Overall, Kellogg Creek solids stream improvements are based on treating the maximum month wet weather flow of 18 mgd. The load associated with 18 mgd of wet weather flow is less than the load associated with 18 mgd of dry weather flow, because solids concentrations are reduced in the wet weather season (relative to dry weather load concentrations). Therefore, additional dry weather season flow (and load) is transferred to the Tri-City WRRF to optimize the use of existing and new solids treatment facilities. It should be noted that Tri-City has excess dry weather capacity for both flow and load (as outlined in Chapter 5 of the Tri-City WRRF Facilities Plan).

Table 5.3 summarizes the 2040 flow projections for the Kellogg Creek WRRF that result from these flow transfer assumptions.

Table 5.3 Kellogg Creek WRRF Flow Projections

Flow Component	2018			2040		
	Kellogg Creek service area, mgd	Transfer from Kellogg Creek to Tri-City WRRF, mgd(1)	Kellogg Creek WRRF, mgd	Kellogg Creek service area, mgd	Transfer from Kellogg Creek to Tri-City WRRF, mgd(1)	Kellogg Creek WRRF, mgd
ADWF	8.0	0.0	8.0	10.3	0.0	10.3
MMDWF	11.5	0.0	11.5	14.8	2.7	12.1
MWDWF	15.4	2.1	13.3	19.9	5.9	14.0
PDDWF	19.7	1.7	18.0	25.5	7.5	18.0
MMWWF	17.1	0.0	17.1	22.1	4.1	18.0
MWWWF	23.2	5.2	18.0	29.9	11.9	18.0
PDWWF	33.5	8.5	25.0	46.6	21.6	25.0
PHF	41.2	16.2	25.0	57.2	32.2	25.0

Note:
(1) Transfer requirement based on the capacity of Kellogg Creek WRRF as defined in Chapter 5 of the Kellogg Creek WRRF Facilities Plan.

5.2.3 Available and Required Capacity

The results of the process capacity analysis for the Tri-City and Kellogg Creek WRRFs are summarized in Figures 5.1 through 5.4, with additional information on each unit process presented in Tables 5.4 and 5.5. The detailed process and hydraulic capacity analyses for both WRRFs can be found in their respective Facilities Plans.

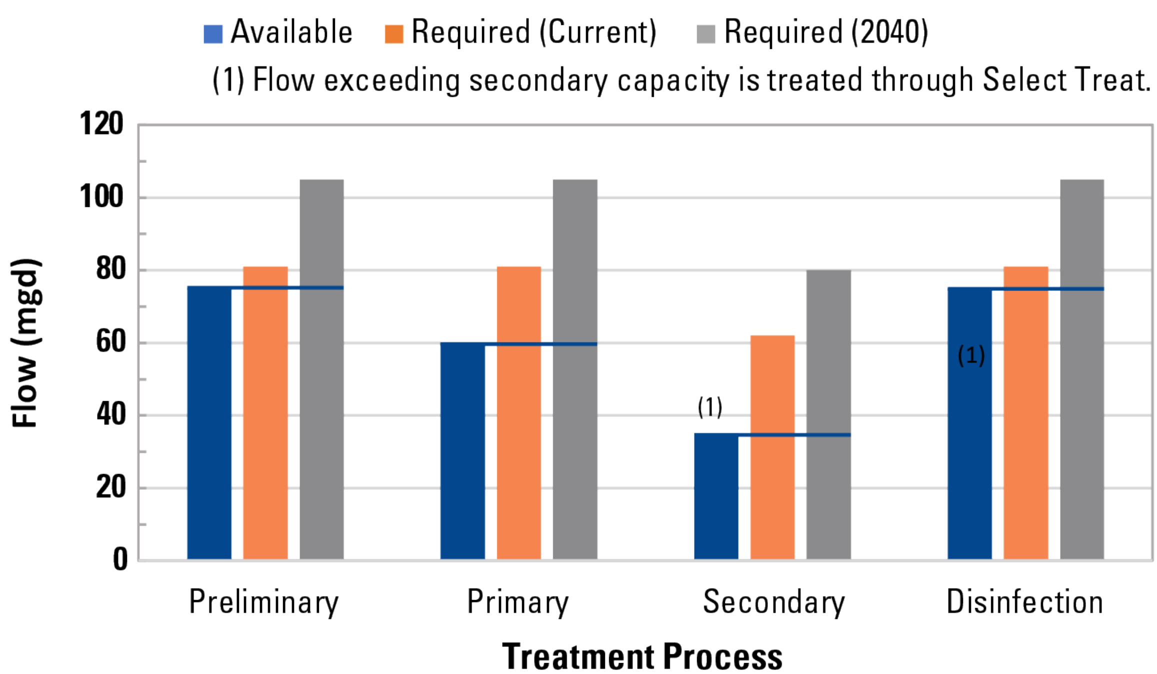


Figure 5.1 Tri-City WRRF Liquid Stream Capacity

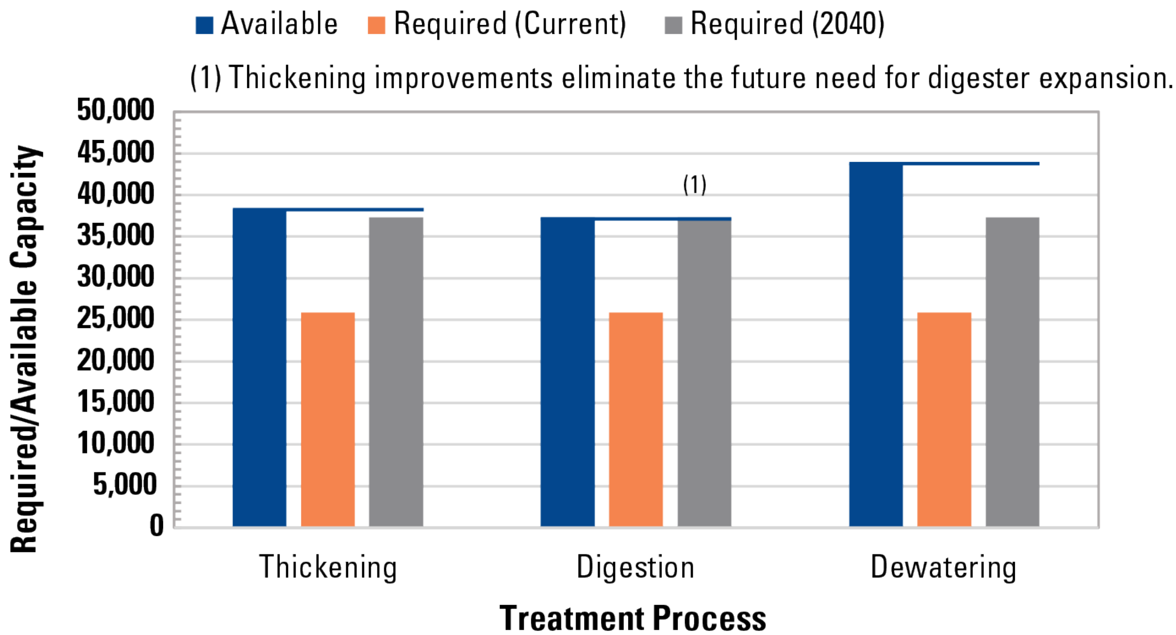


Figure 5.2 Tri-City WRRF Solid Stream Capacity

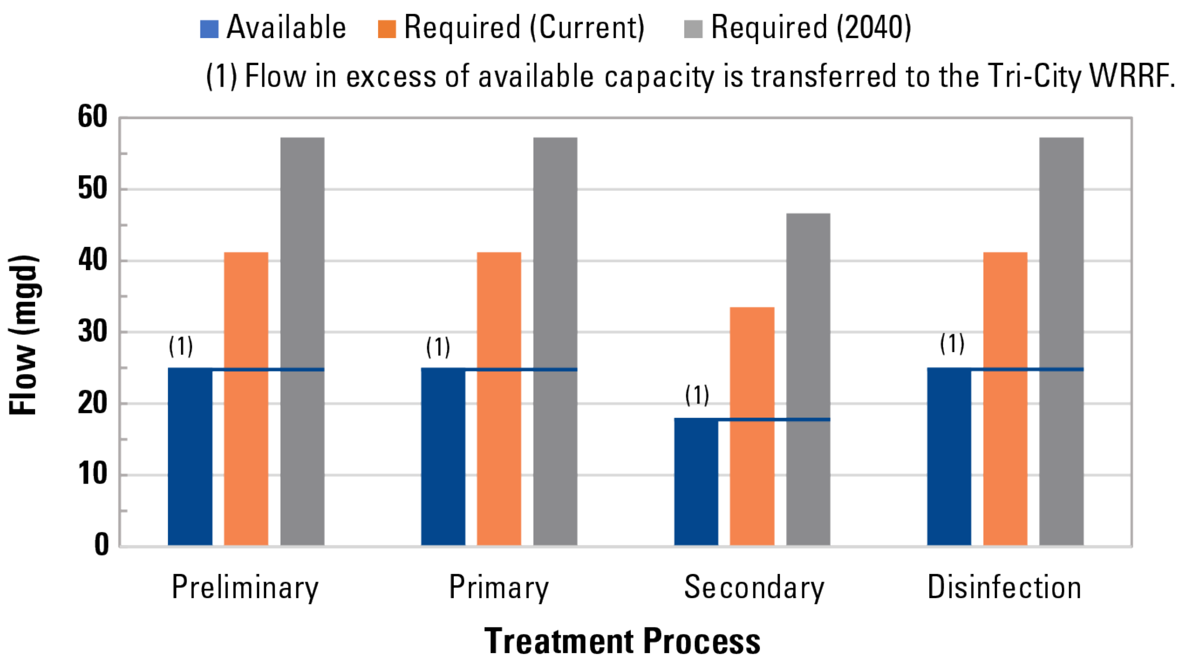


Figure 5.3 Kellogg Creek WRRF Liquid Stream Capacity

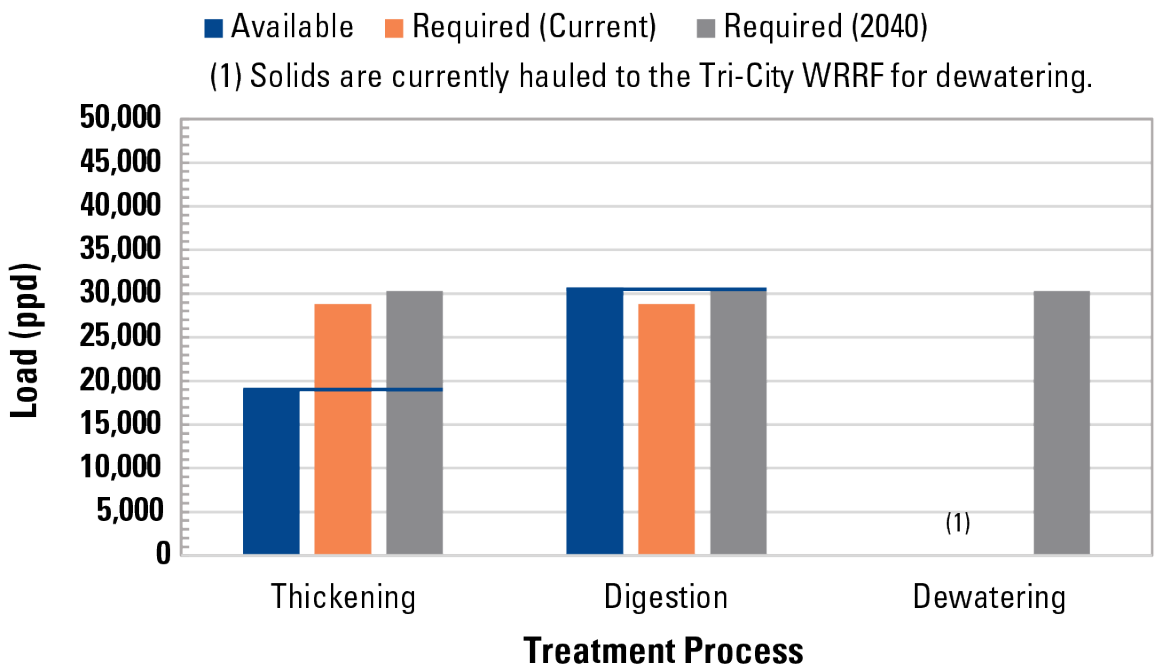


Figure 5.4 Kellogg Creek WRRF Solid Stream Capacity

Table 5.4 Tri-City WRRF Capacity Analysis Summary

Unit Process	Limiting Flow Parameter	Capacity Summary			Notes
		Currently Available	Currently Required (2018)(1)	Future Required (2040)(1)	
Influent Pumps	PHF, mgd	50	65	72	The available pumping capacity at Tri-City is 68 mgd, which exceeds the current PHF of 65 mgd. However, the available firm pumping capacity (largest unit OOS) is 50 mgd, which is less than the current PHF and will be exceeded within the planning period. Accordingly, pumping improvements are required at Tri-City to increase the firm pumping capacity from 50 mgd to 72 mgd.
Influent Screens	PHF, mgd	85	81	104	The available total screening capacity (including the manually cleaned bar rack) is 85 mgd, which is exceeds the current PHF but I less than the capacity required by buildout. less than the required capacity (55 mgd) today. Accordingly, improvements are required at Tri-City to increase the screening capacity to meet the projected PHF.
Grit Basins	PHF, mgd	75	81	104	The existing grit basins have a rated capacity of 50 mgd but have passed flows of up to 75 mgd. This capacity is less than the projected current and 2040 PHF and thus additional girt removal capacity will be required to meet the projected 2040 flows.
Primary Clarifiers	PHF, mgd	60	81	104	The existing primary clarifiers have a peak capacity of approximately 60 mgd, which is less than the required capacity under current conditions as well as projected future (2040) conditions. Accordingly, improvements are required at Tri-City to increase the total primary treatment capacity from 60 mgd to 104 mgd.
Aeration Basins	MMWWF, mgd	30	22	31(2)	The existing aeration basins in the CAS and MBR systems have a combined maximum month capacity of approximately 30 mgd when the MLSS inventory in the CAS system is maintained at a level that produces a 2.5-day SRT throughout the wet weather season. With this level of process control, additional aeration basins are not necessary. However, additional aeration basin capacity may be considered to reduce the necessary level of process control and add reliability to the process.
Secondary Clarifiers / Membrane Tanks	PHF, mgd	35(4)	58(5)	79(5)	When the secondary process is operated at a 2.5-day SRT, the combined peak capacity of the existing secondary clarifiers and membranes is 35 mgd. Assuming 25 mgd of select treat and additional 44 mgd PHF capacity is required by the year 2040.
Disinfection	PHF, mgd	65	71(6)	94(6)	The existing chlorine contact chamber provides sufficient contact time to disinfect a peak flow of 65 mgd, which is less than both the current and projected 2040 PHF. Additional capacity is required to meet the projected 2040 PHF.
WAS Thickening	MMWW WAS load, ppd	43,000(7)	23,700	41,500	The existing two GBTs have sufficient capacity to thicken the projected WAS loads for current and projected future loads.
Digestion	MMWW Digester SRT, days	15(7)	18	13 (without PS thickening) 21 (with PS thickening)	Without primary sludge thickening, the anaerobic digestion process does not have sufficient firm capacity for the projected 2040 MMWW loads. Assuming the addition of a process to thicken the primary sludge to 5 percent total solids by the year 2040, the current digestion capacity (including the new digester) has sufficient capacity through the year 2040.
Dewatering	Maximum Month Dewatering Feed Load	53,000(7)	31,000	45,000	Assuming a 9.5 hour per day, 7 day per week operational schedule, the new centrifuges have sufficient firm capacity to dewater projected MMWW load in the year 2040.

Notes:
(1) For all processes except Influent Pumps, the required capacity includes transfer flow from Kellogg Creek.
(2) Includes 5 mgd of transfer flow from Kellogg Creek.
(3) Includes 25 mgd through CAS, and 5 mgd through MBR aeration basins.
(4) Includes 25 mgd through CAS, 10 mgd through MBR.
(5) Excludes 25 mgd through select treat.
(6) Excludes 10 mgd treated through UV disinfection.
(7) Firm capacity.
Abbreviations: MLSS - mixed liquor suspended solids; MMWW - maximum month wet weather; PS - primary sludge; WAS - primary sludge.
RED - Capacity improvements are recommended.
YELLOW - Capacity improvements may be desirable.
GREEN - Capacity improvements are not required.

Table 5.5 Kellogg Creek WRRF Capacity Analysis Summary

Unit Process	Limiting Flow/Load Parameter	Capacity Summary			Notes
		Currently Available	Currently Required (2018)(1)	Future Required (2040)(1)	
Influent Pumps	PHF, mgd	25(2)	25	25	The total available pumping capacity at Kellogg exceeds the required capacity, which is capped at 25 mgd, and the available firm pumping capacity (largest unit out of service) matches the cap. Accordingly, no pumping capacity improvements are required at Kellogg Creek.
Influent Screens	PHF, mgd	25	25	25	The total available pumping capacity at Kellogg exceeds the required capacity, which is capped at 25 mgd, and the available firm capacity (largest unit out of service) matches the cap. Accordingly, no screening capacity improvements are required at Kellogg Creek.
Grit Basins	PHF, mgd	25	25	25	While the existing grit basins have a total capacity of approximately 25mgd based on past experience, it is anticipated that at these flows grit removal deteriorates. These high flows are likely causing additional grit to be transferred to downstream processes under high-flow conditions.
Primary Clarifiers	PHF, mgd	25	25	25	The available primary clarifier capacity (25 mgd) matches the PHF cap. Accordingly, no primary treatment capacity improvements are required.
Secondary Treatment	MMWWF, mgd	18	17	18	The current maximum month aeration basin capacity is 18 mgd, which slightly exceeds the 2018 MMWWF and equals the capped flow through secondary treatment of 18 mgd.
Disinfection	PHF, mgd	25 (combined UV and CCB)	25	25	The current combined capacity of the UV disinfection system and CCB exceeds 25 mgd, which provides sufficient capacity for the peak hydraulic flow of 25 mgd. However since UV system does not provide the full 25 mgd of capacity due to condition issues associated with the UV disinfection process discussed in TM 5B, the District may desire to address the condition issues and provide the full 25 mgd of disinfection capacity through a new UV system.
WAS Thickening	Max Week WAS Load, mgd	9,700	14,700	15,400	The current capacity of the is less than the current and projected 2040 maximum week WAS loads. Staff typically operate the DAFT at SLR rates exceeding typical design points. Additional thickening capacity is required to meet projected 2040 loads.
Anaerobic Digestion	Max Month SRT, days(3)	20	22.4	20.5	With modifications to the current digester sludge holding tank to provide for mixing, the current anaerobic digestion system provides sufficient capacity for the projected year 2040 maximum month loads. With only two anaerobic digesters, providing firm capacity for the projected 2040 maximum month solids loads would require the one remaining digester to be operated with significant recuperative thickening flows and digester total solids concentrations exceeding 3 percent. For this reason, it is recommended that excess solids are routed to Tri-City if a digester needs to be taken out of service for maintenance.
Dewatering	Maximum month Dewatering Feed Flow, gpm(4)	90	78	81	While the auxiliary centrifuge located at the Tri City plant has sufficient capacity to dewater the digested sludge from Kellogg Creek, District staff desires a more permanent solution for dewatering at Kellogg Creek.

Notes:
(1) For all processes, the difference between the required capacity and the flow cap (25 mgd) is transferred to Tri-City.
(2) It is assumed that improvements are made to the influent pump station to allow the influent pumps to operate at their rated capacities.
(3) Capacities are listed assuming typical operation at two percent total solids in the digester.
(4) Capacities are listed assuming six days per week, 20 hours per day operation.
Abbreviations: CCB - chlorine contact basin; TM - technical memorandum.
RED - Capacity improvements are recommended.
YELLOW - Capacity improvements may be desirable.
GREEN - Capacity improvements are not required.

5.3 WRRF Condition Assessment

5.3.1 Overview

This section summarizes the process used to perform the condition assessment of the Kellogg Creek and Tri-City WRRF. The assessment was based on visual inspection; invasive equipment testing procedures were not utilized.

5.3.2 Protocol and Deployment

The condition assessment was conducted by a multi-discipline team of mechanical, structural, and electrical/ instrumentation engineers. Exterior corrosion, weathering, and deterioration issues along with discipline-specific condition and performance issues, such as temperature, noise, vibration, leakage, wiring, foundational, and component issues were all considered under the purview of the assessment effort. The assessment began with staff interviews to compile a list of known deficiencies, identify operating limitations, and discuss maintenance and operations history of each location. In addition to what was described by plant staff, the assessment team looked for potential problems such as structural deterioration, electrical and instrumentation issues, and mechanical degradation.

5.3.3 Scoring

The condition of assets was ranked using a one-through-five scale at both a general level and across a series of discipline specific questions. A score of 1 represents the best condition assets, while a score of 5 represents the worst condition assets. The purpose of scoring is to provide a common scale to rate assets so they can be compared to one another. The general condition scoring was reviewed and confirmed by Clackamas Water Environment Services (WES) before the commencement of the condition assessment effort. Table 5.6 provides the general description of the condition associated with each score.

Table 5.6 General Condition Score Descriptions

Condition Score	General Description[1]
1 (Best)	**Excellent** Installed with very little wear. Fully operable, well maintained, and consistent with current standards. Little wear shown and no further action required.
2	**Good** Sound and well maintained but may be showing slight signs of wear. Delivering full efficiency with little or no performance deterioration. Only minor renewal or rehabilitation may be needed.
3	**Moderate** Functionally sound and acceptable and showing normal signs of wear. May have minor failures or diminished efficiency and with some performance deterioration or increase in maintenance cost. Moderate renewal or rehabilitation needed.
4	**Poor** Functions but requires a high level of maintenance to remain operational. Shows abnormal wear and is likely to cause significant performance deterioration in the near term. Replacement or major rehabilitation needed.

Condition Score	General Description[1]
5 (Worst)	**Very Poor** Effective life exceeded and/or excessive maintenance cost incurred. A high risk of breakdown or imminent failure with serious impact on performance. No additional life expectancy with immediate replacement required.

Note:
(1) Discipline-specific score are described in the Appendix 5a-A - WES Condition Scoring of TM5A: Existing Tri-City Water Resource Recovery Facility Condition.

Discipline specific condition scores are utilized to provide further insight into the specific area(s) in which an asset is deficient and gives measure to the repair(s) that is needed to bring an asset to like-new condition. Table 5.7 provides the condition questions categories prompted by a specific asset discipline.

Table 5.7 Summary of Condition Questions Categories by Discipline

Discipline	Condition Question Categories[1,2]
Mechanical	• Corrosion/ Exterior. • Vibration. • Temperature. • Leakage. • Components.
Structural	• Surface Deterioration. • Coating/ Lining/ Paint. • Leakage. • Foundation/ Supports. • Components.
Electrical	• Equipment. • Enclosure. • Temperature/ Noise. • Wiring/ Cable Condition. • Components.
Instrumentation & Controls	• Equipment/ Transmitter. • Display/ Enclosure/ Mount. • Wiring/ Cable Condition. • Components.
HVAC	• Corrosion/ Exterior. • Vibration. • Temperature. • Components.

Notes:
(1) A more detailed description of the discipline-specific score can be found in Appendix 5a-A - WES Condition Scoring of TM5A: Existing Tri-City Water Resource Recovery Facility Condition.
(2) Excludes general condition question, which is asked across all asset discipline types.

5.3.4 Results and Estimated Costs

The Tri-City WRRF Facilities Plan and the Kellogg Creek WRRF Facilities Plan include condition assessment summaries by location and asset type, and a summary of recommended improvements based on the results of the condition assessment.

This section contains a summary of the estimated costs by asset location for the recommendations contained in Tri-City WRRF Facilities Plan and the Kellogg Creek WRRF Facilities Plan. The cost estimates are based on a combination of information provided by WES, quotes from vendors, and Carollo's experience on similar projects.

The costs estimates provided only assume direct (material (assets), labor, and equipment) costs and in February 2021 dollars (Engineering News Record Construction Cost Index: 11699). Costs in the summary are rounded to the nearest ten thousand dollars. No project cost markups are assumed or included in this cost estimating effort. The expected accuracy of this estimating effort provided herein is assumed to be 50 percent over to 30 percent under the actual direct cost incurred.

The following tables summarize the costs by the recommended time frame for planning and budgetary purpose as to when renewal efforts should be performed. Table 5.8 shows costs for the 0-to-2-year time period, Table 5.9 shows costs for the 3-to-5-year time period, and Table 5.10 shows costs for the 6-to-10-year time period.

Table 5.8 Cost Estimate Summary - Rehabilitation and Replacement in Next 0 to 2 Years

Facility	Estimated Cost
Tri-City WRRF	
Primary Sedimentation Basins	$4,101,000
Primary Pump Station	$678,000
CAS Aeration Basins	$95,000
Digesters	$2,689,000
Total Estimated Project Cost for Tri-City WRRF	**$7,563,000**
Kellogg Creek WRRF	
IPS	$350,000
Aeration Basin Air	$123,000
Secondary Clarifier Gates and Skimmers	$43,000
Total Estimated Project Cost for Kellogg Creek WRRF	**$516,000**

Table 5.9 Cost Estimate Summary - Rehabilitation and Replacement in Next 3 to 5 Years

Facility	Estimated Cost
Tri-City WRRF	
IPS / Headworks	$834,000
Primary Sedimentation Basins	$347,000
CAS Aeration Basins	$1,913,000
RAS Pump Station	$261,000
MBRs	$12,000
Backup Centrifuge	$26,000

Facility	Estimated Cost
Chlorine Contact Basin	$637,000
Digesters	$26,000
Chemical Building	$15,000
General Site	$154,000
Total Estimated Project Cost for Tri-City WRRF	**$4,225,000**
Kellogg Creek WRRF	
Headworks	$1,243,000
Biofilters	$106,000
Primary Clarifier 2 and Primary Sludge Pump Station	$604,000
Aeration Basin Gates and Structural	$4,010,000
Misc. Building Improvements	$190,000
Total Estimated Project Cost for Kellogg Creek WRRF	**$6,153,000**

Table 5.10 Cost Estimate Summary - Rehabilitation and Replacement in Next 6 to 10 Years

Facility	Estimated Cost
Tri-City WRRF	
IPS / Headworks	$2,223,000
Primary Sedimentation Basins	$333,000
Primary Pump Station	$56,000
CAS Aeration Basins	$496,000
Blower Building	$305,000
Secondary Clarifiers	$293,000
RAS Pump Station	$352,000
MBRs	$652,000
Backup Centrifuge	$51,000
Chlorine Contact Basin	$25,000
Digesters	$203,000
Chemical Building	$104,000
Lab	$31,000
General Site	$7,000
Total Estimated Project Cost for Tri-City WRRF	**$5,131,000**
Kellogg Creek WRRF	
Primary Clarifier 1	$550,000
Secondary Clarifier Drives and Structural	$412,000
Carbon Filter	$45,000
Total Estimated Project Cost for Kellogg Creek WRRF	**$1,007,000**

Chapter 6
BASIN-WIDE SCENARIOS

6.1 Introduction

This chapter presents the basin-wide scenarios that were developed as part of the Willamette Facilities Plan (WFP). Basin-wide scenarios were explored to identify improvements needed to meet projected wastewater flows and loads within the District's Kellogg Creek and Tri-City service areas as well as potential future regulatory requirements. In particular, the process evaluated the following questions:

- **During the wet weather season:** Should peak flows be treated and discharged at a remote facility located at the Blue Heron property on the West side of the Willamette River, or conveyed to the Tri-City WRRF for treatment and discharge?
- **During the dry weather season:** If regulatory requirements become more stringent in the future, what combination of Kellogg Creek and Tri-City Water Resource Recovery Facility (WRRF) capacity provides the most cost-effective means of protecting Willamette River water quality?

The chapter describes scenario development, presents the basis for estimating project costs, and outlines the scenario evaluation methodology. A description of each scenario, including National Pollutant Discharge Elimination System (NPDES) permitting assumptions, basin-wide conveyance and treatment, seasonal WRRF treatment capacities, potential WRRF treatment schematics, and estimated project costs for comparison, is also provided.

Basin-wide scenarios presented herein were evaluated using comparative costs and non-cost considerations that account for site-specific conditions. The results of water quality modeling in the Lower Willamette River, completed as part of the planning process, were also considered. With respect to the location of treatment and discharge during the regulatory dry weather season, the modeling demonstrated that water quality changes are not measurable as the location of treated effluent discharge varies between the Kellogg Creek and Tri-City WRRF outfalls.

6.2 Basin-Wide Scenario Overview

This section provides an overview of the District's basin-wide scenario development and evaluation process. Current and projected flows and loads throughout the District's service area are summarized in Chapter 3. Existing conveyance capacities summarized in the *Sanitary Sewer Master Plan for Water Environment Services* (2019, Jacobs) and the capacities of the existing WRRFs (summarized in Chapter 5) were all considered.

6.2.1 Scenario Components

Each scenario described in this chapter includes the same common components: the Kellogg Creek WRRF, Tri-City WRRF, and the Blue Heron Site, as well as major gravity sewers, pump stations, and force mains. These components were combined into various scenarios to determine the most effective approach to meeting current treatment requirements while setting the District up to provide capacity for future growth and potential NPDES permit limits.

6.2.1.1 Treatment Facilities

Currently the Kellogg Creek and Tri-City WRRFs treat all flow generated within the District's overall service area, utilizing the ability to optimize treatment by transferring flow from Kellogg Creek to Tri-City. The District also owns the former outfall from the Blue Heron Paper Mill (at River Mile 27.8) and the load allocations associated with the NPDES permit for this facility. There is currently no active discharge at the Blue Heron site, but the District retains a valid NPDES Permit. The District acquired non-certificated, pre-1901 water rights previously used by the Blue Heron paper mill site, which were transferred to the Blue Heron lagoon side and recharacterized from industrial to municipal use.

The basin-wide scenarios evaluated herein consider the use of the Blue Heron site for seasonal wet weather treatment and year-round satellite treatment and discharge. Such a strategy would reduce the cost of peak flow conveyance to the Tri-City WRRF, as well as the cost of treating peak flows at the Tri-City WRRF.

6.2.1.2 Conveyance Infrastructure

In 2013, the District constructed the Intertie 2 Pump Station (IT2 PS) to provide the ability to pump up to 10 million gallons per day (mgd) to the Tri-City WRRF. Together with the Clackamas Pump Station, the District can pump up to approximately 13 mgd of flow previously flowing to the Kellogg Creek WRRF to the Tri-City WRRF. Currently, during the dry weather season, the Kellogg Creek and Tri-City WRRFs are operatively relatively independently with flow (including an industrial component) diverted to Tri-City WRRF as needed to accommodate maintenance and construction at Kellogg Creek WRRF. During the wet season, flow that exceeds the capacity of Kellogg Creek WRRF is diverted to Tri-City WRRF.

The current practice of inter-basin flow transfer will continue in the future, which provides the District with substantial flexibility to provide sufficient capacity on a seasonal basis while also protecting water quality by meeting current and potential future NPDES permit limits. As discussed within this chapter, basin-wide scenarios all include improvements to regional conveyance that are needed to deliver flow to the treatment facilities owned and operated by the District. The conveyance improvements presented herein are based on the recommended improvement projects outlined in the *Sanitary Sewer Master Plan for Water Environment Services* (2019, Jacobs).

6.2.2 NPDES Permit Assumptions

Multiple regulatory scenarios were also evaluated as part of the WFP, considering different ways to utilize existing Clackamas Water Environment Services (WES) treatment and conveyance infrastructure to meet current and potential flow and load limitations, as well as potential future NPDES permit limits in the Lower Willamette River.

Some basin-wide scenarios were developed considering the existing NPDES permit limits for the Tri-City WRRF and Kellogg Creek WRRF, which are presented in Chapter 4. Other scenarios were developed assuming future NPDES permit limits on effluent ammonia and total phosphorus, which may result from the development of future total maximum daily load (TMDL) allocations in the Lower Willamette River. These scenarios were primarily developed to assess how potential future NPDES permit limits may impact the long-term cost-effectiveness of near-term improvements needed to address existing facility capacity or condition limitations.

6.2.3 WRRF Treatment Schematics

WRRF treatment schematics were developed for both the Tri-City and Kellogg Creek WRRFs for each basin-wide scenario. The schematics - presented in this chapter with existing facilities shown in grayscale and the new facilities are shown in color - represent initial planning assumptions for the number, size, and type of treatment components to provide the necessary capacity and performance associated with each scenario. A more detailed evaluation of specific alternatives for liquid stream and solid stream improvements at both WRRF was completed based on the results of the basin-wide analysis. These detailed evaluations can be found in the Tri-City and Kellogg Creek WRRF Facilities Plans.

6.3 Cost Evaluation Methodology

Project cost estimates for each basin-wide scenario were developed based on estimating principles and assumptions outlined in this section.

6.3.1 Cost Estimate Class

Project costs were developed to compare scenarios following industry standards published by the Association for the Advancement of Cost Engineering (AACE), which include five classes of cost estimates.

Costs presented in this chapter are Class 5 estimates, which are commonly referred to as conceptual level estimates and are used to compare a broad range of alternatives based on limited engineering detail (less than two percent design completion). The expected accuracy range for Class 5 estimates is -50 percent to + 100 percent, which means that actual bids for the completed project can fall within a range of 50 percent below the estimate to 100 percent above the estimate.

6.3.2 Project Cost Details

Previously prepared detailed design cost estimates or actual construction costs for similar process units were used as a basis for some of the scenario cost components. For the purpose of comparing scenarios, Engineering News Record's (ENR) historical 20-city construction cost index (CCI) was used to adjust these estimates to April 2020 dollars (ENR CCI: 11413). Additionally, an RS Means location factor was applied to address cost differences between Oregon City and the location of the reference project used as a basis to develop costs, if applicable.

Project costs are presented in current dollars to be consistent with costs presented in the recent *Sanitary Sewer Master Plan for Water Environment Services* (2019, Jacobs) and have not been adjusted to the mid-point of constructions. More detailed cost estimates for the recommended scenarios can be found in the Tri-City WRRF Facilities Plan and the Kellogg Creek WRRF Facilities Plan.

6.3.3 Cost Assumptions and Mark-ups

Table 6.1 presents the cost assumptions and mark-ups that were used to develop the project costs.

Table 6.1 Cost Assumptions and Mark-ups

Component	Value
Electrical, Instrumentation, and Control	25 percent of direct costs.
General Conditions	12 percent.
Builders Rick and GL Insurance	1.25 percent.
Overhead and Profit	15 percent.
Continency	30 percent.
Oregon Corporate Activity Tax	0.57 percent.
Yard Pipe / Site Civil	20 percent of construction costs for plant site.
Engineering, Legal, Admin, Public Involvement	38 percent applied to construction costs.

Note:
(1) Cost assumptions and mark-up were revised when developing the Kellogg Creek WRRF Facilities Plan and Tri-City WRRF Facilities Plan.

The costs presented in this chapter are comparative costs to assist with evaluating the basin-wide scenarios and identifying the recommended scenario and are not intended for capital improvement program (CIP) development. The costs include capacity improvements only and do not include Repair and Replacement (R&R) costs, or the cost of improvements that are and common to all scenarios. Major cost categories include:

- Basin-wide conveyance improvements (e.g., major conveyance and outfall improvements) that are unique to each alternative.
- Kellogg Creek WRRF capacity improvements.
- Tri-City WRRF capacity improvements.
- A new peak wet weather treatment facility at the Blue Heron site.

6.4 Non-Cost Evaluation Methodology

This section describes the methodology used to evaluate scenarios based on non-cost criteria that, in addition to other factors, consider site-specific conditions and water quality modeling results. As previously noted, the water quality modeling demonstrated that water quality changes are not measurable as the location of treated effluent discharge varies between the Kellogg Creek and Tri-City WRRF outfalls.

6.4.1 Site Constraints

6.4.1.1 Kellogg Creek WRRF

The Kellogg Creek WRRF site has limited space for expansion, and the District has signed agreements that prohibit expansion of treatment capacity. For these reasons, basin-wide scenarios all assume the Kellogg Creek WRRF capacity is capped at current levels, with additional capacity provided at the Tri-City WRRF.

6.4.1.2 Tri-City WRRF

The property adjacent to and south of the existing Tri-City WRRF offers room for expansion. Because this property was home to a former landfill, expansion onto this property will require the appropriate level of permitting and remediation.

6.4.1.3 Blue Heron Site

Environmental and land use was evaluated for scenarios utilizing the Blue Heron site, as summarized in Sections 6.4.2 and 6.4.3. Constructability and site access issues at Blue Heron is limited, which may impact construction cost; however building a remote treatment facility at the site was assumed to be feasible for the purposes of developing and evaluating basin-wide scenarios.

6.4.2 Environmental Requirements

Environmental Science Associates (ESA) evaluated the environmental permitting considerations for the potential construction of a new wastewater treatment facility at the Blue Heron Site and prepared memorandum to summarize the evaluation, which is included in Appendix B.

ESA mapped environmental resources in the area of the Blue Heron site, including streams, wetlands, fish and wildlife habitat, and floodplains, which are shown in Figure 1 in the memorandum. ESA also identified 17 potential cultural resources within a 0.5-mile radius of the site and noted that the project areas is knowns for early historic development and settlement, lending to the consideration of the site as high-probability for the presence of historical cultural resources.

The following local, state, and federal environmental regulatory considerations would need to be addressed:

- Federal and State Agency Permits:
  - U.S. Army Corps of Engineers Section 404 Permit.
  - National Marine Fisheries Services Endangered Species Act Section 7 Consultation, including a Biological Assessment.
  - Oregon DEQ Section 401 Water Quality Certification.
  - Oregon State Historic Preservation Office National Historic Preservation Act Section 106 Consultation.
  - Oregon Department of State Lands Removal-Fill Permit.
- Local Agency Permits from the City of West Linn Community Development Code (CDC):
  - Chapter 27: Flood Management Areas.
  - Chapter 28: Willamette and Tualatin River Protection.
  - Chapter 32: Water Resource Area Protection.

6.4.3 Land Use

Winterbrook performed a high-level land use assessment of the requirements for a potential new wastewater treatment facility at the Blue Heron site and prepared a memorandum to summarize the results, which is included in Appendix C.

Winterbrook reviewed each of the main land use and zoning designations that apply to the Blue Heron site and summarized the applicability, review process, timelines, and key criteria for each land use/zoning designation. Based on review of the information, Winterbrook believes that the proposed District treatment facility can be designed to meet the West Linn CDC regulations at the subject site. Key findings of the high-level review include:

- The proposed treatment facility is an outright permitted use in the General Industrial base zone.
- A new facility will require Design Review, with a public hearing and decision by the City Planning Commission.

- Willamette River Greenway and Flood Management Area permits will also be needed for future site development.
- A Water Resources Area (WRA) permit can and should be avoided since WRA riparian and wetland buffers are located at the edges of or outside of the planned facility site.

6.4.4 Non-Cost Criteria

A summary of the non-cost criteria used by the planning team to evaluate scenarios is included below:

6.4.4.1 Operational Complexity

The basin-wide scenarios were assigned a score for operational complexity. A score of "5" is the least complex (e.g., the scenario uses current process technology at existing WRRF). A score of "1" is the most complex (e.g., the scenario uses new process technology at remote site).

6.4.4.2 Reliability / Flexibility

Reliability and flexibility of the scenarios were also considered. Scenarios were assigned scored based on the reliability and flexibility of operations where a score of "5" is the most reliable/flexible (e.g., the scenario adds a new treatment facility or options) and a score of "1" is the least reliable/flexible (e.g., the scenario does not provide operators with additional treatment options).

6.4.4.3 Water Quality

The scenarios were assigned a score for water quality considerations. A score of "5" indicates that the scenario improves water quality relative to the existing conditions. A score of "1" indicates that the scenario degrades water quality relative to the existing conditions.

6.4.4.4 NPDES Permitting

NPDES permitting challenges were also considered during the non-cost analysis. Scenarios were assigned scores based on NPDES permitting complexity where a score of "5" is the least complex strategy (e.g., the scenario uses individual discharge permits at Tri-City WRRF and Kellogg Creek WRRF that meet basin standards) and a score of "1" is the most complex strategy (e.g., the scenario uses a buddle permit approach and/or remote wet weather treatment).

6.4.4.5 Environmental and Land Use

The basin-wide scenarios were assigned a score for environmental and land use considerations. A score of "5" has no environmental or land use challenges (e.g., the scenario required no environmental approvals, land use permits, etc.). A score of "1" has significant environmental and/or land use challenges (e.g., the scenario requires numerous approvals and permits with uncertain outcome).

6.4.4.6 Community Benefit/Impact

The basin-wide scenarios have the potential for community benefit, so the scenarios were assigned a score for community considerations. Scenarios that create community benefits, such as open public spaces and/or other community assets, were assigned a score of "5". Scenarios that have the potential to impact the community negatively, such as options that require mitigation and/or extensive outreach, were assigned a score of "1".

6.5 Basin-Wide Scenarios

Table 6.2 and Figure 6.1 summarize the basin-wide scenarios that were developed for evaluation. In Figure 6.1, flows shown in the left side of the box represent the 2040 dry weather maximum month (MM) flows, which were used to develop the regulatory dry weather strategy. Flows shown on the right side of the box represent 2040 wet weather peak hour (PH) flows, which were used to develop the wet weather strategy. The figure also shows if the scenario is based on existing NPDES permit limits or potential future NPDES permit limits.

Table 6.2 Basin-Wide Scenarios

Scenario	Description
Scenario 1 (Base case)	Existing NPDES permit limits; peak flow transfer from Kellogg Creek to Tri-City; no treatment at Blue Heron.
Scenario 1.5	Existing NPDES permit limits at Kellogg Creek; future seasonal nutrient limits at Tri-City; peak flow transfer from Kellogg Creek to Tri-City; no treatment at Blue Heron.
Scenario 2	Future seasonal nutrient limits at both WRRFs; peak flow transfer from Kellogg Creek to Tri-City; no treatment at Blue Heron.
Scenario 3	Future seasonal nutrient limits at both WRRFs; seasonal "intensification" at Kellogg Creek; peak flow transfer from Kellogg Creek to Tri-City; no treatment at Blue Heron.
Scenario 4	Existing NPDES permit limits; peak flow transfer from Kellogg Creek to Tri-City, peak flow treatment at Blue Heron.
Scenario 5	Future seasonal nutrient limits at both WRRFs, peak flow transfer from Kellogg Creek to Tri-City; year-round treatment at Blue Heron.

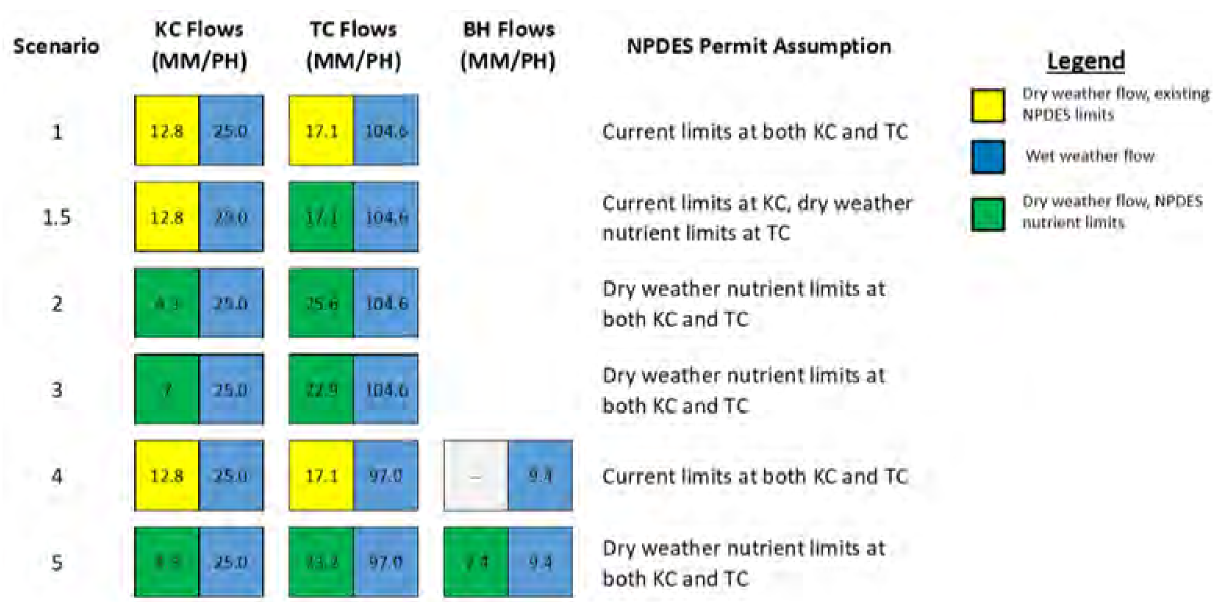


Figure 6.1 Basin-Wide Scenarios Summary of Flows and Permit Assumptions

Once developed, Scenarios were compared to answer fundamental questions about the use of basin-wide infrastructure and system optimization. Specific scenarios were compared to answer key questions as described below:

- Scenario 1 versus Scenario 4:
  - Should a wet weather treatment facility be constructed at Blue Heron?
- Scenario 2 versus Scenario 3:
  - If future nutrient limits are imposed at both Kellogg Creek and Tri-City, should the Kellogg Creek process be "intensified"?
- Scenario 2 versus Scenario 5:
  - If future nutrient limits are imposed at both Kellogg Creek and Tri-City, should a year-round treatment facility be constructed at Blue Heron?

6.5.1 Scenario 1

Scenario 1 is based on existing NPDES limits. The scenario assumes the current practice of transferring peak flow from Kellogg Creek WRRF to Tri-City WRRF will continue, and does not include a remote, peak flow wet weather treatment facility at the Blue Heron site.

6.5.1.1 NPDES Permit Assumption

The existing NPDES permit limits in place at the Tri-City and Kellogg Creek WRRFs will remain in place throughout the planning period.

6.5.1.2 Conveyance and Treatment Schematics

The basin-wide conveyance and treatment schematic for Scenario 1 is shown in Figure 6.2. The schematic shows the amount of flow that will be treated at each facility in both the dry weather (DW) and wet weather (WW) seasons for the estimated 2018 flows and projected 2040 flows. Basin-wide conveyance components required for Scenario 1 include:

- Expansion of the Willamette Pump Station.
- New infrastructure to convey peak flow from the Blue Heron Site to the Tri-City WRRF.
- Upsizing of the Tri-City WRRF outfall pipe.

6.5.1.3 Seasonal WRRF Treatment Capacities

For the dry weather season, Scenario 1 assumes the Kellogg Creek and Tri-City WRRFs will continue to treat average and MM flows from their respective service areas. Minimal capacity improvements are required for dry weather flow conditions.

For the wet weather season, Scenario 1 assumes that peak flows to the Kellogg Creek WRRF will continue to be capped at 25 mgd, with the balance of flow (in excess of 25 mgd) transferred to the Tri-City WRRF. This requires improvements to the Intertie Pump Station and associated conveyance facilities, as well as improvements to the Tri-City WRRF, which will increase the peak flow hydraulic capacity to 105 mgd (the projected 2040 peak hour wet weather flow that includes excess flow transfer from the Kellogg Creek Service Area).

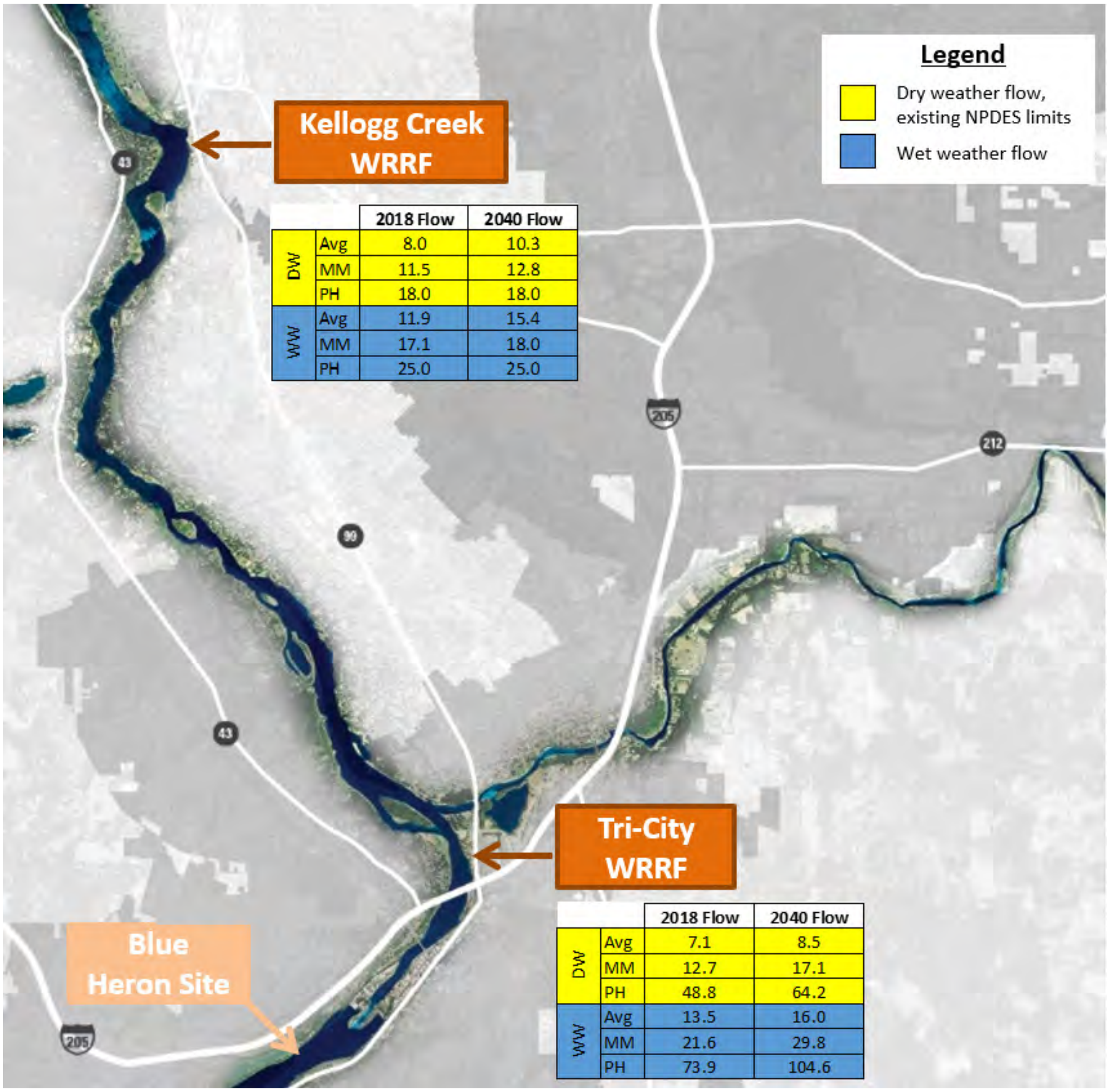


Figure 6.2 Scenario 1: Basin-wide Conveyance and Treatment Schematic

6.5.1.4 WRRF Treatment Schematics

Figures 6.3 and 6.4 show the preliminary Scenario 1 treatment schematics for the Kellogg Creek and Tri-City WRRF liquid streams, respectively.

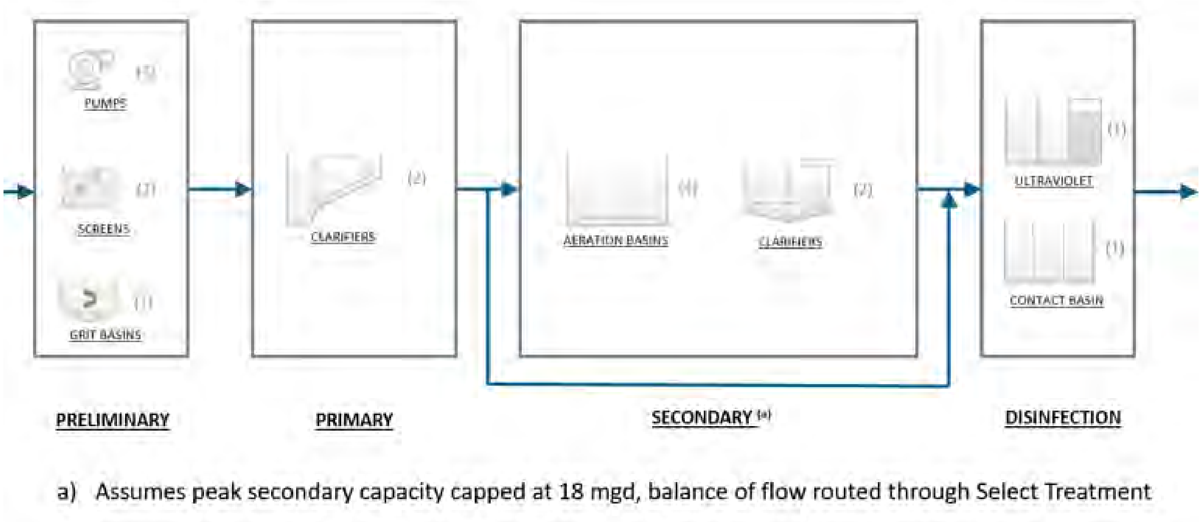


Figure 6.3 Scenario 1: Kellogg Creek WRRF Liquid Stream Schematic

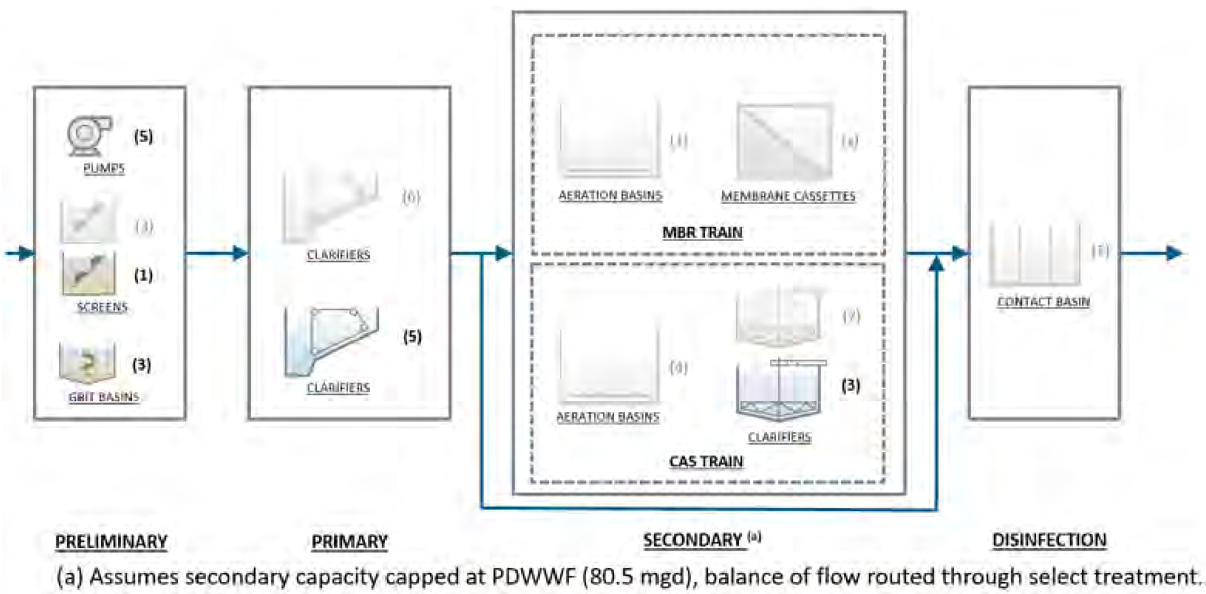


Figure 6.4 Scenario 1: Tri-City WRRF Liquid Stream Schematic

As shown in Figure 6.3, Scenario 1 does not trigger capacity-related improvements for the Kellogg Creek WRRF liquid stream within the planning period. The recommended improvements for the Tri-City WRRF liquid stream for Scenario 1 are summarized below:

- **Influent Pumping and Preliminary Treatment:**
  - Influent pumping, screening, and grit removal, including five new influent pumps, one new screen, and three new grit basins.
- **Primary Treatment:**
  - Five new primary clarifiers.
- **Secondary Treatment:**
  - Three new secondary clarifiers in the conventional activated sludge (CAS) train.

6.5.1.5 Estimated costs

The estimated, comparative costs for Scenario 1 are shown in Table 6.3.

Table 6.3 Scenario 1 Estimated Costs

Component		Cost Estimate(1)
Basin-Wide Conveyance Components	• Willamette Pump Station expansion. • Conveyance from Blue Heron to Tri-City WRRF.(2) • Upsize Tri-City WRRF outfall pipe.	$19,730,000
Kellogg Creek WRRF Capacity Components	-	$0
Tri-City WRRF Capacity Components	• Influent pumping, screening, grit removal. • New primary clarifiers (five). • New secondary clarifiers (three). • Yard/Site/Civil.	$78,790,000
Blue Heron Facility	-	$0
Total Construction Cost		**$98,520,000**
Engineering, Legal, Administration (38%)		$37,440,000
Total Project Cost		**$135,960,000**

Notes:
(1) Costs presented are comparative costs and are not intended for CIP development.
(2) Conveyance improvements needed if Blue Heron site is not developed as a treatment facility.

6.5.2 Scenario 1.5

Scenario 1.5 is based on existing NDPES permit limits at the Kellogg Creek WRRF but assumes that future summertime nutrient (ammonia and phosphorus) limits are imposed at the Tri-City WRRF. The scenario assumes the current practice of transferring peak flow from Kellogg Creek WRRF to Tri-City WRRF will continue, and does not include a remote, peak flow wet weather treatment facility at the Blue Heron site.

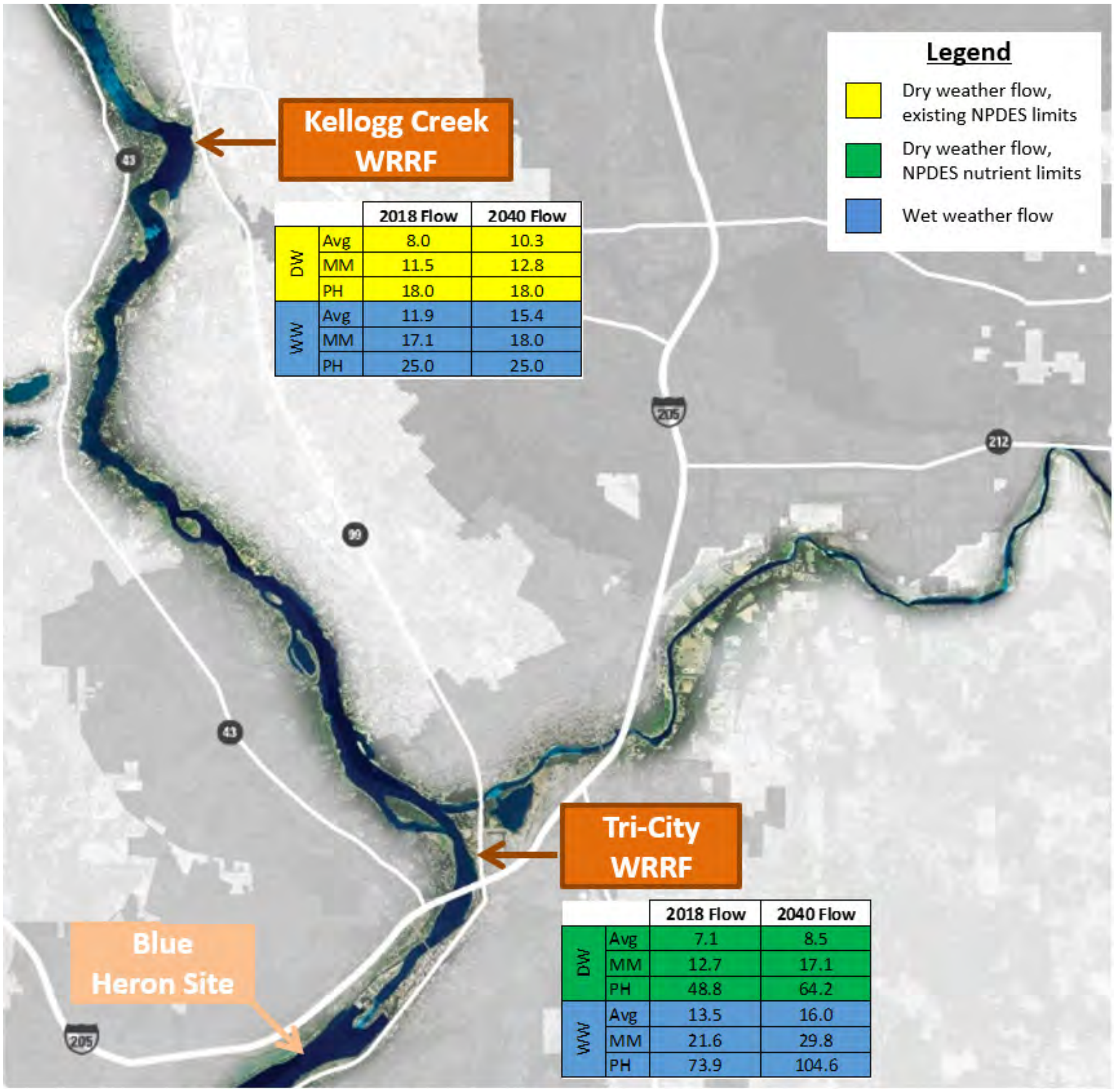
6.5.2.1 NPDES Permit Assumption

The existing NPDES permit limits in place at the Kellogg Creek WRRF will remain in place throughout the planning period, and future NDPES permit limits on ammonia and phosphorus will be imposed at the Tri-City WRRF during the regulatory, dry-weather season.

6.5.2.2 Basin-Wide Conveyance and Treatment Schematics

The basin-wide conveyance and treatment schematic for Scenario 1.5 is shown in Figure 6.5. Basin-wide conveyance components required for Scenario 1.5 include:

- Expansion of the Willamette Pump Station.
- New infrastructure to convey peak flow from the Blue Heron Site to the Tri-City WRRF.
- Upsizing of the Tri-City WRRF outfall pipe.



		2018 Flow	2040 Flow
DW	Avg	8.0	10.3
	MM	11.5	12.8
	PH	18.0	18.0
WW	Avg	11.9	15.4
	MM	17.1	18.0
	PH	25.0	25.0

		2018 Flow	2040 Flow
DW	Avg	7.1	8.5
	MM	12.7	17.1
	PH	48.8	64.2
WW	Avg	13.5	16.0
	MM	21.6	29.8
	PH	73.9	104.6

Figure 6.5 Scenario 1.5: Basin-Wide Conveyance and Treatment Schematic

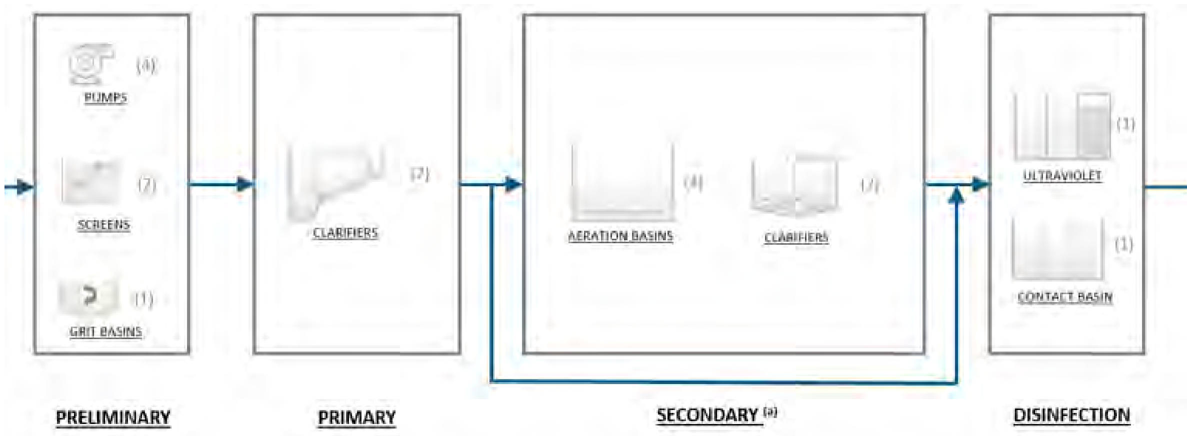
6.5.2.3 Seasonal WRRF Treatment Capacities

For the dry weather season, Scenario 1.5 assumes the Kellogg Creek and Tri-City WRRFs will continue to treat average and MM flows from their respective service areas. Minimal capacity improvements are required for dry weather flow conditions; however, improvements to remove nutrients are required at the Tri-City WRRF.

For the wet weather season, Scenario 1.5 assumes that peak flows to the Kellogg Creek WRRF will continue to be capped at 25 mgd, with the balance of flow (in excess of 25 mgd) transferred to the Tri-City WRRF. This requires improvements to the Intertie Pump Station and associated conveyance facilities, as well as improvements to the Tri-City WRRF, which will increase the peak flow hydraulic capacity to 105 mgd.

6.5.2.4 WRRF Treatment Schematics

Figures 6.6 and 6.7 show the preliminary Scenario 1.5 treatment schematics for the Kellogg Creek and Tri-City WRRF liquid streams, respectively.

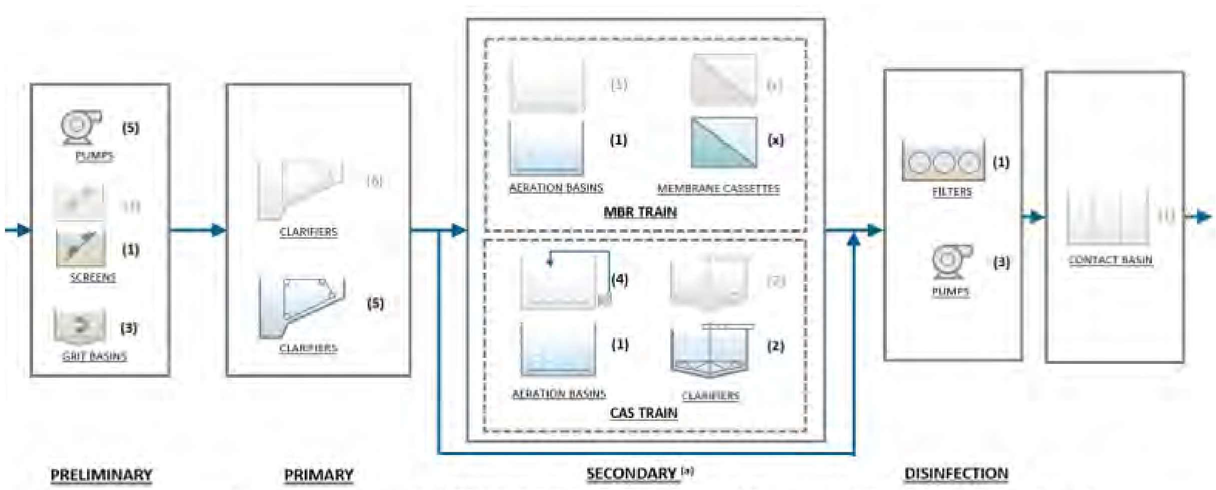


a) Assumes peak secondary capacity capped at 18 mgd, balance of flow routed through Select Treatment

Figure 6.6 Scenario 1.5: Kellogg Creek WRRF Liquid Stream Schematic

Scenario 1.5 does not trigger capacity-related improvements for the Kellogg Creek WRRF liquid stream within the planning period. The recommended improvements for the Tri-City WRRF liquid stream for Scenario 1.5 are summarized below:

- **Influent Pumping and Preliminary Treatment:**
  - Influent pumping, screening, and grit removal, including five new influent pumps, one new screen, and three new grit basins.
- **Primary Treatment:**
  - Five new primary clarifiers.
- **Secondary Treatment:**
  - Membrane Bioreactor (MBR) Train: one new aeration basin and new membrane cassettes.
  - CAS Train: CAS aeration basin modifications on all four existing aeration basins, one new aeration basin, and two new secondary clarifiers.
- **Tertiary Treatment:**
  - New tertiary filtration and pump station.



a) Assumes secondary capacity capped at PDWWF (80.5 mgd), balance of flow routed through select treatment. CAS Train operated in BNR mode during dry weather season.

Figure 6.7 Scenario 1.5: Tri-City WRRF Liquid Stream Schematic

6.5.2.5 Estimated costs

The estimated, comparative costs for Scenario 1.5 are shown in Table 6.4.

Table 6.4 Scenario 1.5 Estimated Costs

Component		Cost Estimate[1]
Basin-Wide Conveyance Components	• Willamette Pump Station expansion. • Conveyance from Blue Heron to Tri-City WRRF.[2] • Upsize Tri-City WRRF outfall pipe.	$19,730,000
Kellogg Creek WRRF Capacity Components	-	$0
Tri-City WRRF Capacity Components	• Influent pumping, screening, grit removal. • New primary clarifiers (five). • CAS aeration basin modifications (four). • New CAS Aeration Basins (one). • New MBR aeration basins (one). • New membrane cassettes. • New secondary clarifiers (two). • Tertiary filters. • Yard/Site/Civil.	$129,190,000
Blue Heron Facility	-	$0
Total Construction Cost		**$148,920,000**
Engineering, Legal, Administration (38%)		$56,590,000
Total Project Cost		**$205,150,000**

Notes:
(1) Costs presented are comparative costs and are not intended for CIP development.
(2) Conveyance improvements needed if Blue Heron site is not developed as a treatment facility.

6.5.3 Scenario 2

Scenario 2 assumes that future summertime nutrient (ammonia and phosphorus) limits are imposed at both the Tri-City and Kellogg Creek WRRF. The scenario assumes the current practice of transferring peak flow from Kellogg Creek WRRF to Tri-City WRRF will continue, and does not include a remote, peak flow wet weather treatment facility at the Blue Heron site.

6.5.3.1 NPDES Permit Assumption

Future NDPES permit limits on ammonia and phosphorus will be imposed at the Kellogg Creek and Tri-City WRRFs during the regulatory, dry-weather season.

6.5.3.2 Basin-Wide Conveyance and Treatment Schematics

The basin-wide conveyance and treatment schematic for Scenario 2 is shown in Figure 6.8. Basin-wide conveyance components required for Scenario 2 include:

- Expansion of the Willamette Pump Station.
- New infrastructure to convey peak flow from the Blue Heron Site to the Tri-City WRRF.
- Upsizing of the Tri-City WRRF outfall pipe.

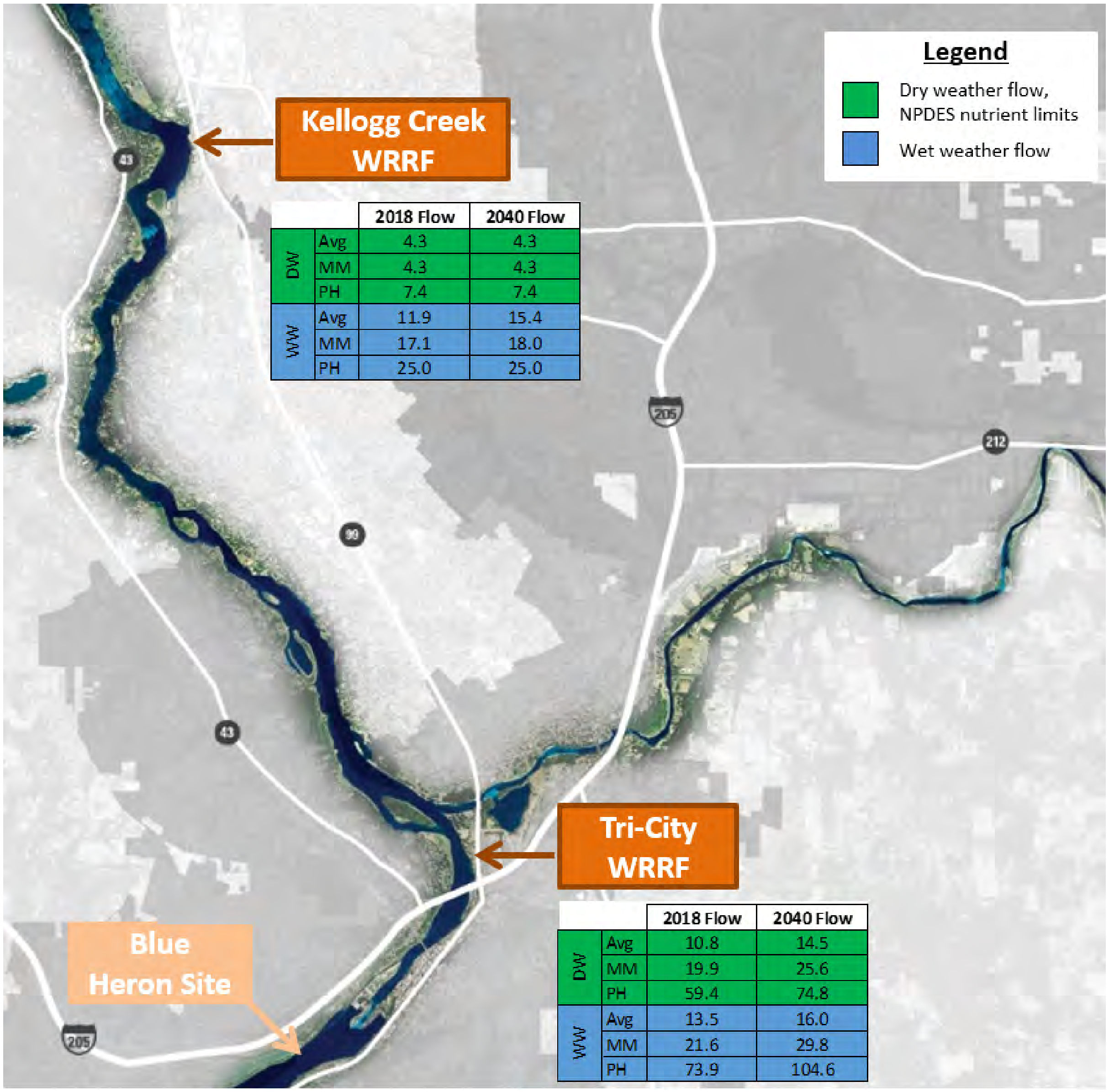
6.5.3.3 Seasonal WRRF Treatment Capacities

For the dry weather season, Scenario 2 assumes that the Kellogg Creek WRRF is de-rated to achieve nutrient removal, which caps its capacity at approximately 4 mgd. The balance of dry weather flow is transferred from the Kellogg Creek Service Area to the Tri-City WRRF for treatment, where improvements to remove nutrients are required.

For the wet weather season, Scenario 2 assumes that peak flows to the Kellogg Creek WRRF will continue to be capped at 25 mgd, with the balance of flow (in excess of 25 mgd) transferred to the Tri-City WRRF. This requires improvements to the Intertie Pump Station and associated conveyance facilities, as well as improvements to the Tri-City WRRF, which will increase the peak flow hydraulic capacity to 105 mgd.

6.5.3.4 WRRF Treatment Schematics

Figures 6.9 and 6.10 show the preliminary Scenario 2 treatment schematics for the Kellogg Creek and Tri-City WRRF liquid streams, respectively.



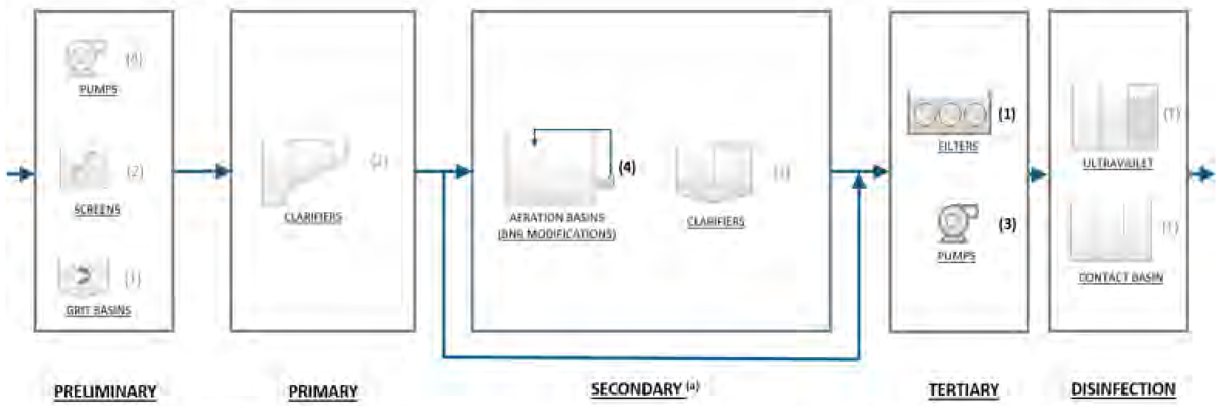
Kellogg Creek WRRF

		2018 Flow	2040 Flow
DW	Avg	4.3	4.3
	MM	4.3	4.3
	PH	7.4	7.4
WW	Avg	11.9	15.4
	MM	17.1	18.0
	PH	25.0	25.0

Tri-City WRRF

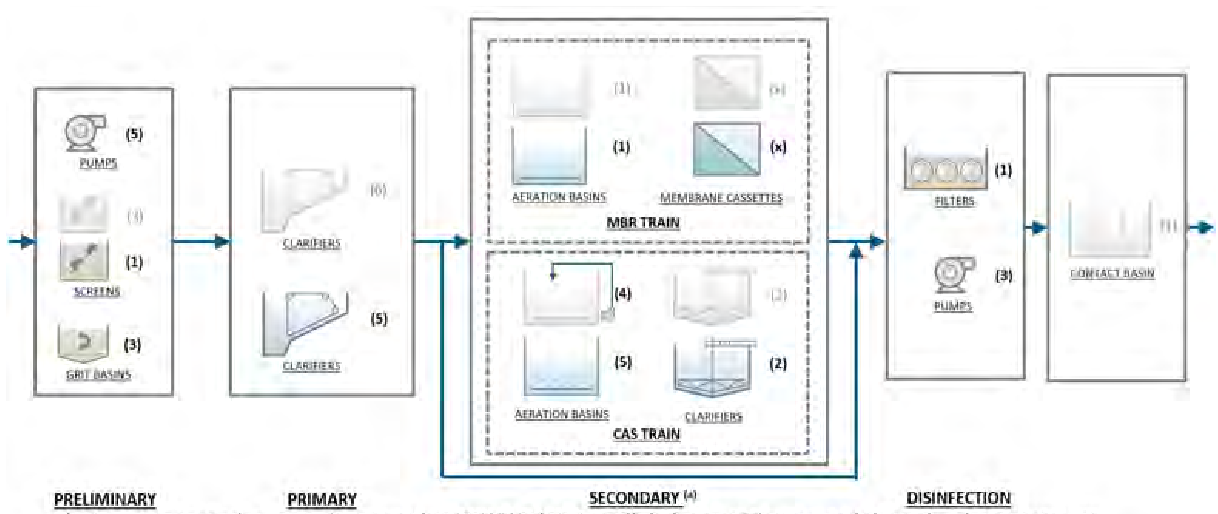
		2018 Flow	2040 Flow
DW	Avg	10.8	14.5
	MM	19.9	25.6
	PH	59.4	74.8
WW	Avg	13.5	16.0
	MM	21.6	29.8
	PH	73.9	104.6

Figure 6.8 Scenario 2: Basin-Wide Conveyance and Treatment Schematic



a) Dry weather season: BNR modifications to achieve 4.3 mgd max month dry weather secondary capacity, peak secondary capacity capped at 7.4 mgd. Wet weather season: peak secondary capacity capped at 18 mgd, balance of flow routed through Select Treatment, remainder of flow transferred to Tri-City.

Figure 6.9 Scenario 2: Kellogg Creek WRRF Liquid Stream Schematic



a) Assumes secondary capacity capped at PDWWF (80.5 mgd), balance of flow routed through select treatment. CAS Train operated in BNR mode during dry weather season.

Figure 6.10 Scenario 2: Tri-City WRRF Liquid Stream Schematic

The recommended improvements for the Kellogg Creek WRRF liquid stream for Scenario 2 are summarized below:

- **Secondary Treatment:**
  - CAS aeration basin modifications on all four existing aeration basins.
- **Tertiary Treatment:**
  - New tertiary filtration and pump station.

The recommended improvements for the Tri-City WRRF liquid stream for Scenario 2 are summarized below:

- **Preliminary Treatment:**
  - Influent pumping, screening, and grit removal, including five new influent pumps, one new screen, and three new grit basins.
- **Primary Treatment:**
  - Five new primary clarifiers.
- **Secondary Treatment:**
  - MBR Train: one new aeration basin and new membrane cassettes.
  - CAS Train: CAS aeration basin modifications on all four existing aeration basins, five new aeration basin, and two new secondary clarifiers.
- **Tertiary Treatment:** New tertiary filtration and pump station.

6.5.3.5 Estimated costs

The estimated, comparative costs for Scenario 2 are shown in Table 6.5.

Table 6.5 Scenario 2 Estimated Costs

Component		Cost Estimate[1]
Basin-Wide Conveyance Components	• Willamette Pump Station expansion. • Conveyance from Blue Heron to Tri-City WRRF.[2] • Upsize Tri-City WRRF outfall pipe.	$19,730,000
Kellogg Creek WRRF Capacity Components	• CAS aeration basin modifications (four). • Tertiary filters. • Yard/Site/Civil.	$20,560,000
Tri-City WRRF Capacity Components	• Influent pumping, screening, grit removal. • New primary clarifiers (five). • CAS aeration basin modifications (four). • New CAS aeration basins (five). • New MBR aeration basins (one). • New membrane cassettes. • New secondary clarifiers (two). • Tertiary filters. • Yard/Site/Civil.	$145,990,000
Blue Heron Facility	-	$0
Total Construction Cost		**$186,280,000**
Engineering, Legal, Administration (38%)		$70,790,000
Total Project Cost		**$257,070,000**

Notes:
(1) Costs presented are comparative costs and are not intended for CIP development.
(2) Conveyance improvements needed if Blue Heron site is not developed as a treatment facility.

6.5.4 Scenario 3

Scenario 3 assumes that future summertime nutrient limits are imposed at both the Tri-City and Kellogg Creek WRRF. While Scenario 2 assumed the Kellogg WRRF would be de-rated to approximately to 4.0 mgd meet potential future dry weather effluent limits, Scenario 3 assumes the process would be modified through intensification to meet these limits. The intensification process assumed for Scenario 3 and the resulting Kellogg Creek capacity is described more fully in the Kellogg Creek WRRF Facilities Pan. The scenario also assumes the current practice of transferring peak flow from Kellogg Creek WRRF to Tri-City WRRF will continue, and does not include a remote, peak flow wet weather treatment facility at the Blue Heron site.

6.5.4.1 NPDES Permit Assumption

Future NDPES permit limits on ammonia and phosphorus will be imposed at the Kellogg Creek and Tri-City WRRFs during the regulatory, dry-weather season.

6.5.4.2 Basin-Wide Conveyance and Treatment Schematics

The basin-wide conveyance and treatment schematic for Scenario 3 is shown in Figure 6.8. The basin-wide conveyance components required for Scenario 3 include the following:

- Expansion of the Willamette Pump Station.
- Conveyance from the Blue Heron Site to the Tri-City WRRF.
- Upsizing of the Tri-City WRRF outfall pipe.

6.5.4.3 Seasonal WRRF Treatment Capacities

For the dry weather season, Scenario 3 assumes that the secondary process at the Kellogg Creek WRRF is intensified to achieve nutrient removal, which caps its capacity at approximately 7.4 mgd. The balance of dry weather flow is transferred from the Kellogg Creek Service Area to the Tri-City WRRF for treatment, where improvements to remove nutrients are required.

For the wet weather season, Scenario 3 assumes that peak flows to the Kellogg Creek WRRF will continue to be capped at 25 mgd, with the balance of flow (in excess of 25 mgd) transferred to the Tri-City WRRF. This requires improvements to the Intertie Pump Station and associated conveyance facilities, as well as improvements to the Tri-City WRRF, which will increase the peak flow hydraulic capacity to 105 mgd.

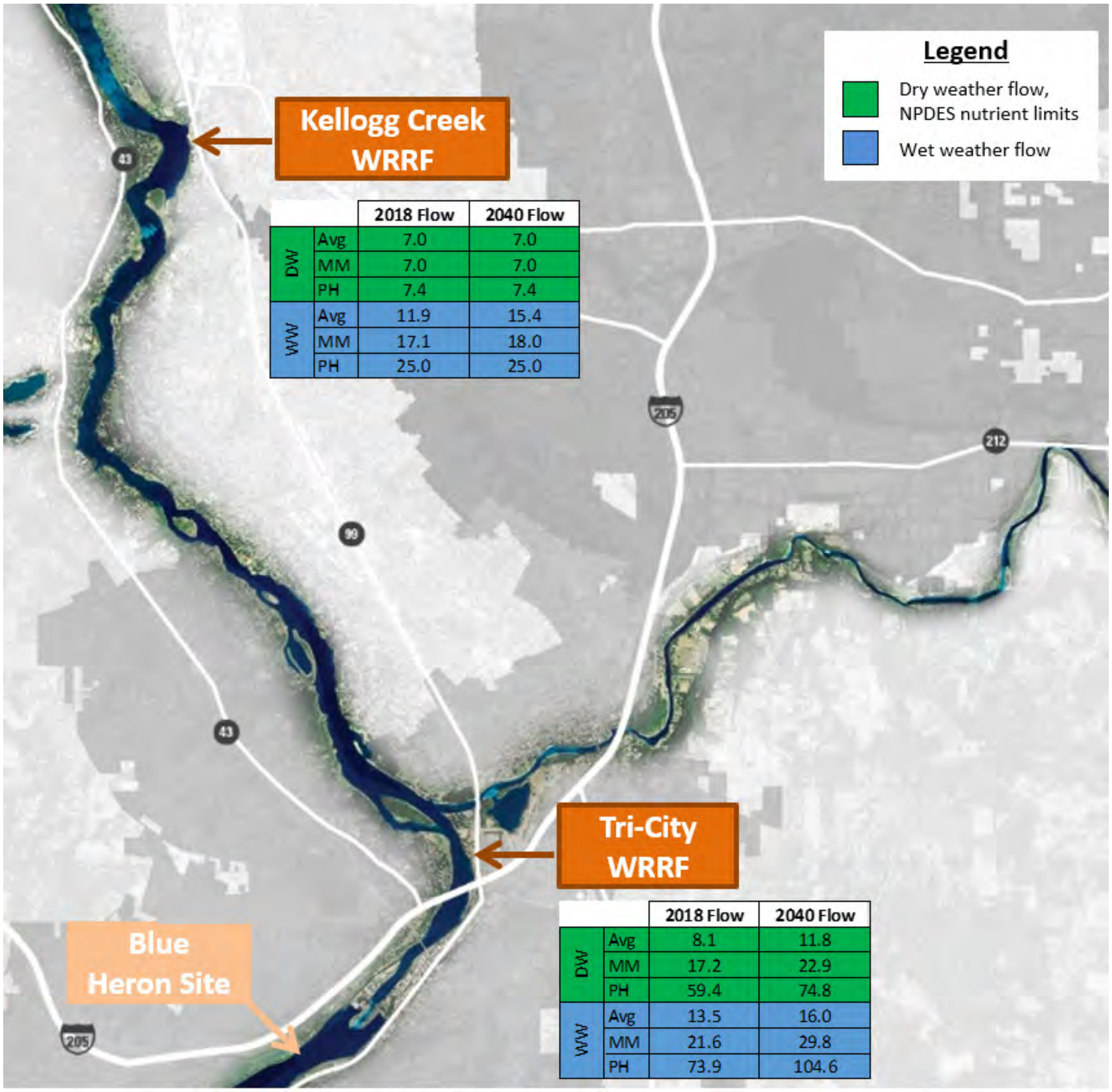
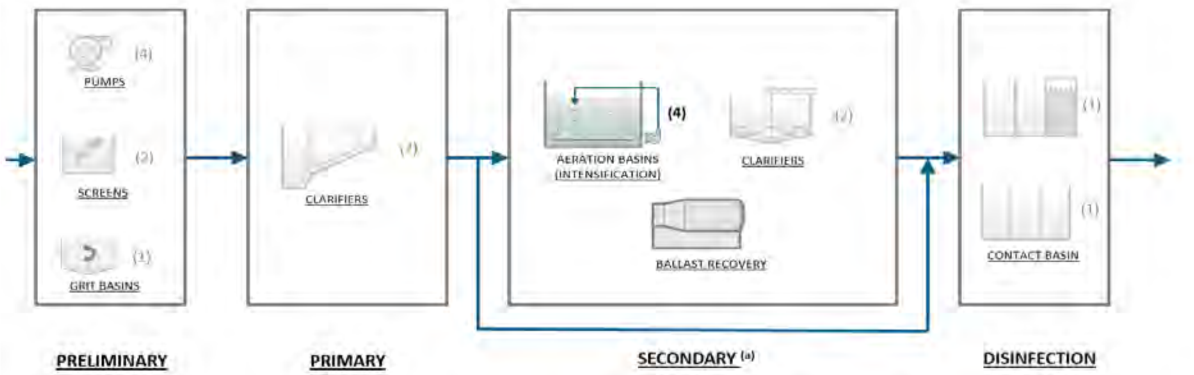


Figure 6.11 Scenario 3: Basin-wide Conveyance and Treatment Schematic

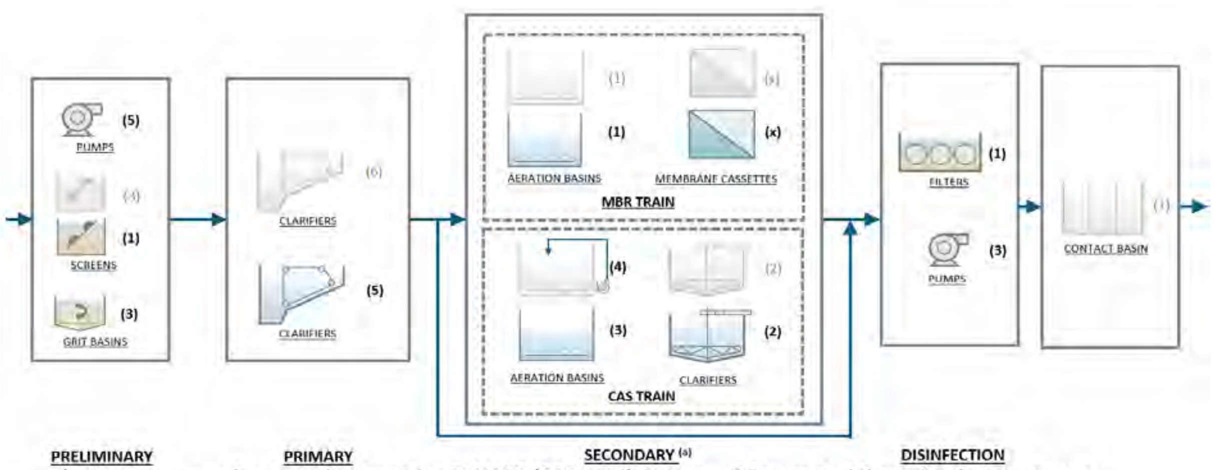
6.5.4.4 WRRF Treatment Schematics

Figures 6.12 and 6.13 show the preliminary Scenario 3 treatment schematics for the Kellogg Creek WRRF liquid stream and the Tri-City WRRF liquid stream, respectively.



a) Dry weather season: BNR modifications to achieve 7.4 mgd max month dry weather secondary capacity, peak secondary capacity capped at 7.4 mgd. Wet weather season: peak secondary capacity capped at 18 mgd, balance of flow routed through Select Treatment, remainder of flow transferred to Tri-City.

Figure 6.12 Scenario 3: Kellogg Creek WRRF Liquid Stream Schematic



a) Assumes secondary capacity capped at PDWWF (80.5 mgd), balance of flow routed through select treatment. CAS Train operated in BNR mode during dry weather season.

Figure 6.13 Scenario 3: Tri-City WRRF Liquid Stream Schematic

The recommended improvements for the Kellogg Creek WRRF liquid stream for Scenario 3 are summarized below:

- **Secondary Treatment:**
  - Intensification and CAS aeration basin modifications on all four existing aeration basins.

The recommended improvements for the Tri-City WRRF liquid stream for Scenario 3 are summarized below:

- **Preliminary Treatment:**
  - Influent pumping, screening, and grit removal, including five new influent pumps, one new screen, and three new grit basins.
- **Primary Treatment:**
  - Five new primary clarifiers.
- **Secondary Treatment:**
  - MBR Train: one new aeration basin and new membrane cassettes.
  - CAS Train: CAS aeration basin modifications on all four existing aeration basins, three new aeration basin, and two new secondary clarifiers.
- **Tertiary Treatment:** New tertiary filtration and pump station.

6.5.4.5 Estimated costs

The estimated, comparative costs for Scenario 3 are shown in Table 6.6.

Table 6.6 Scenario 3 Estimated Costs

Component		Cost Estimate(1)
Basin-Wide Conveyance Components	• Willamette Pump Station expansion. • Conveyance from Blue Heron to Tri-City WRRF.(2) • Upsize Tri-City WRRF outfall pipe.	$19,730,000
Kellogg Creek WRRF Capacity Components	• CAS aeration basin modifications (four). • Secondary Intensification. • Yard/Site/Civil.	$20,300,000
Tri-City WRRF Capacity Components	• Influent pumping, screening, grit removal. • New primary clarifiers (five). • CAS aeration basin modifications (four). • New CAS aeration basins (three). • New MBR aeration basins (one). • New membrane cassettes. • New secondary clarifiers (two). • Tertiary filters. • Yard/Site/Civil.	$136,480,000
Blue Heron Facility		$0
Total Construction Cost		**$176,510,000**
Engineering, Legal, Administration (38%)		$67,070,000
Total Project Cost		**$243,580,000**

Notes:
(1) Costs presented are comparative costs and are not intended for CIP development.
(2) Conveyance improvements needed if Blue Heron site is not developed as a treatment facility.

6.5.5 Scenario 4

Scenario 4 is based on existing NPDES limits. The scenario assumes the current practice of transferring peak flow from Kellogg Creek WRRF to Tri-City WRRF will continue with the addition of a remote, peak flow wet weather treatment facility at the Blue Heron site, which would eliminate the need for peak flow conveyance improvements from west of the Willamette River to the Tri-City WRRF.

6.5.5.1 NPDES Permit Assumption

Existing NPDES permit limits in place at the Tri-City and Kellogg Creek WRRFs will remain in place throughout the planning period.

6.5.5.2 Basin-Wide Conveyance and Treatment Schematics

The basin-wide conveyance and treatment schematic for Scenario 4 is shown in Figure 6.14. Since this scenario includes a peak-flow treatment facility at the Blue Heron site, conveyance improvements to increase capacity from the Willamette Pump Station to the Tri-City WRRF are not required.

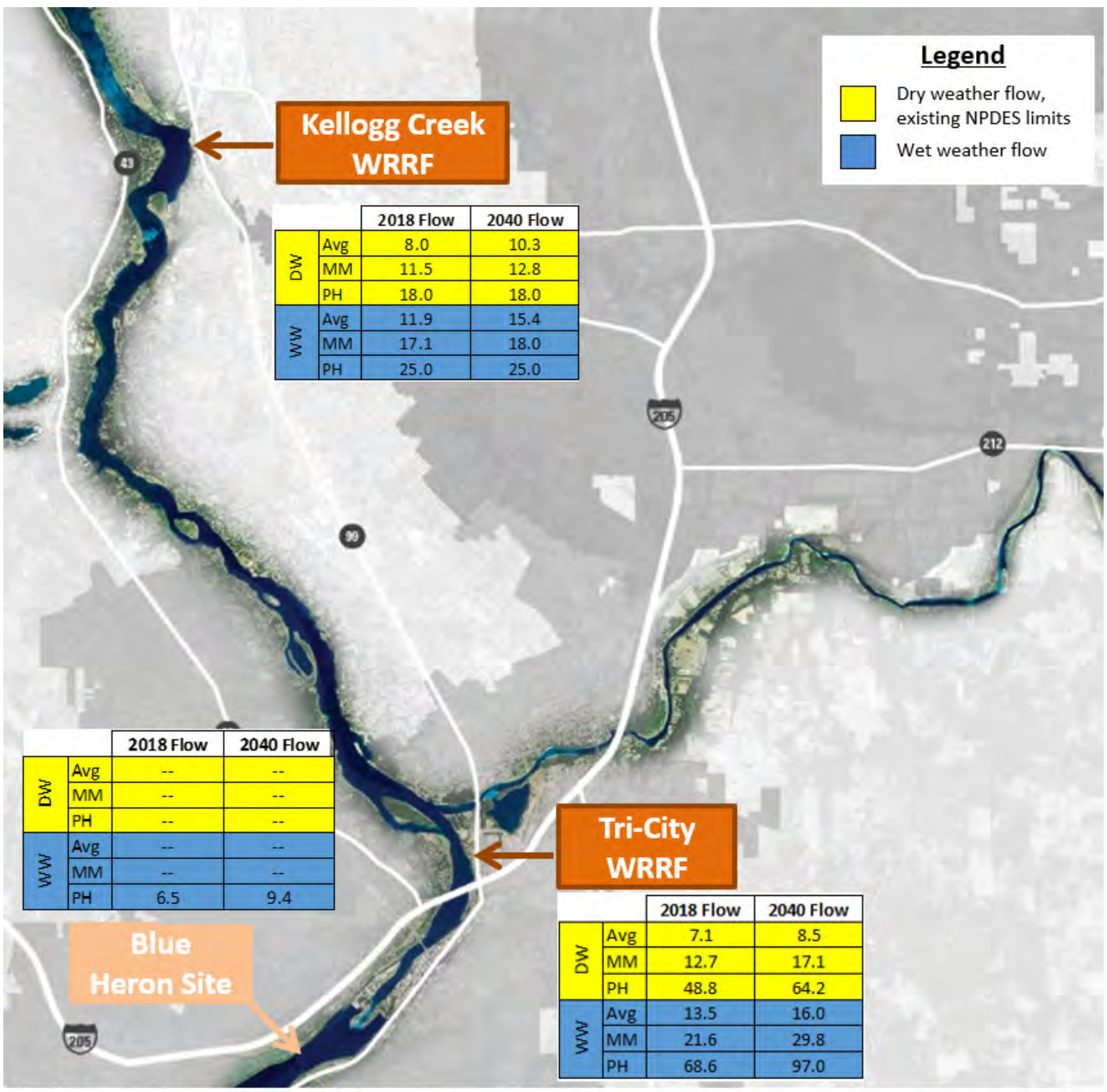


Figure 6.14 Scenario 4: Basin-wide Conveyance and Treatment Schematic

6.5.5.3 Seasonal WRRF Treatment Capacities

For the dry weather season, Scenario 4 assumes the Kellogg Creek and Tri-City WRRFs will continue to treat average and MM flows from their respective service areas. Minimal capacity improvements are required for dry weather flow conditions.

For the wet weather season, Scenario 4 assumes that peak flows to the Kellogg Creek WRRF will continue to be capped at 25 mgd, with the balance of flow (in excess of 25 mgd) transferred to the Tri-City WRRF. This requires improvements to the Intertie Pump Station and associated conveyance facilities, as well as improvements to the Tri-City WRRF. However, construction of a 10 mgd wet weather treatment facility at Blue Heron reduces the total peak flow capacity requirement at Tri-City from 105 mgd to approximately 97 mgd.

6.5.5.4 WRRF Treatment Schematics

Figures 6.15 and 6.16 show the preliminary Scenario 4 treatment schematics for the Kellogg Creek WRRF liquid stream and the Tri-City WRRF liquid stream, respectively.

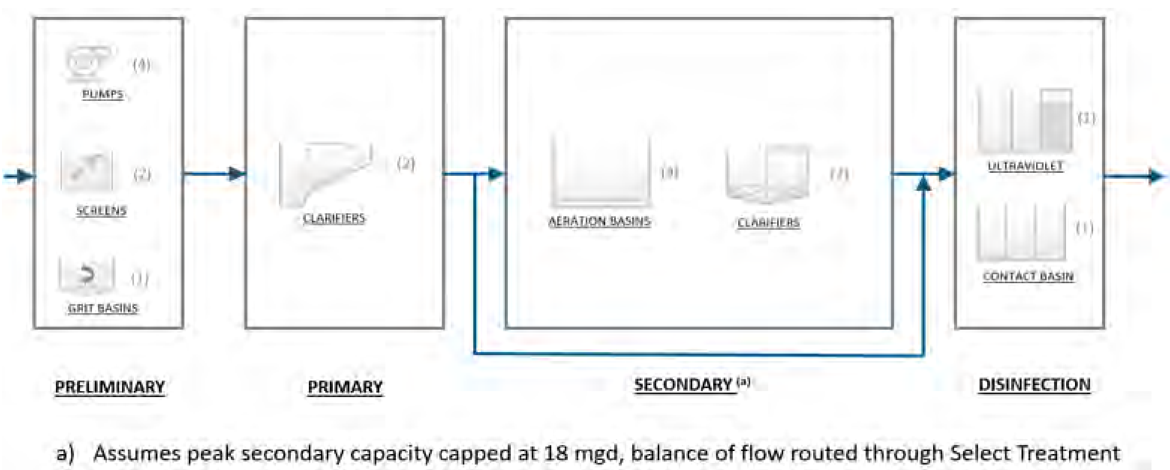


Figure 6.15 Scenario 4: Kellogg Creek WRRF Liquid Stream Schematic

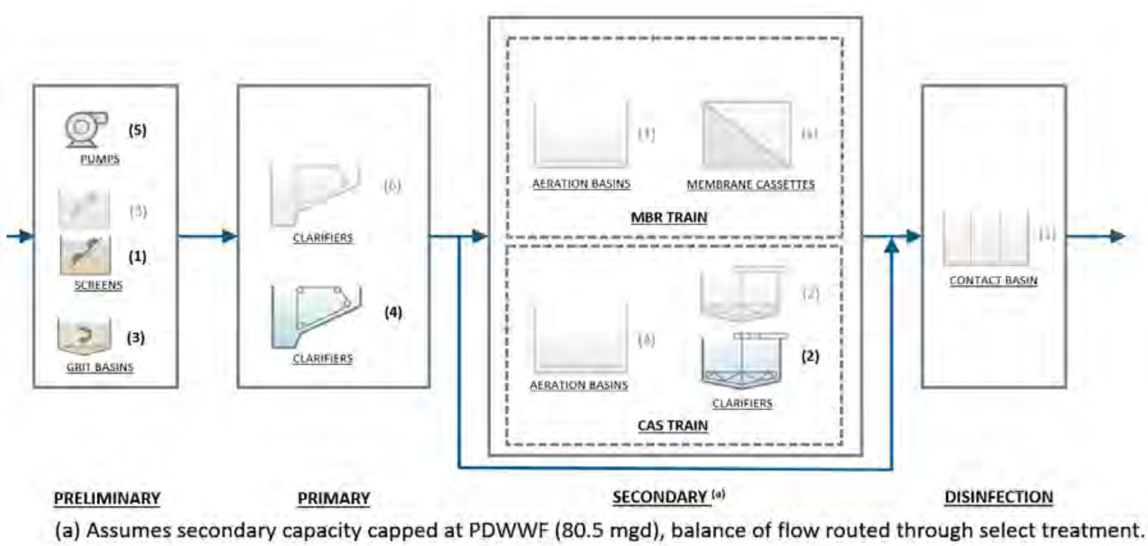


Figure 6.16 Scenario 4: Tri-City WRRF Liquid Stream Schematic

Scenario 4 does not trigger capacity-related improvements for the Kellogg Creek WRRF liquid stream within the planning period. The recommended improvements for the Tri-City WRRF liquid stream for Scenario 4 are summarized below:

- **Influent Pumping and Preliminary Treatment:**
  - Influent pumping, screening, and grit removal, including five new influent pumps, one new screen, and three new grit basins.
- **Primary Treatment:**
  - Four new primary clarifiers.
- **Secondary Treatment:**
  - Three new secondary clarifiers in the CAS train.

The recommended components of a Blue Heron Wet Weather Facility include an expansion of the Willamette Pump Station expansion, influent screening, High-rate clarification (HRC) trains, and ultraviolet (UV) disinfection. Figure 6.17 shows the treatment schematic for such a wet weather treatment facility, and Figure 6.18 shows the potential site layout adjacent to the existing Willamette Pump Station.

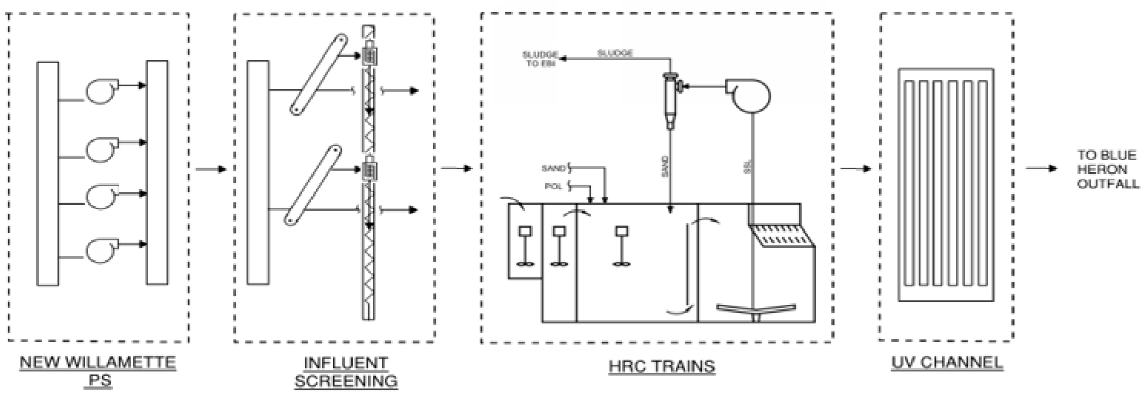


Figure 6.17 Scenario 4: Blue Heron Wet Weather Facility Schematic

Figure 6.18 Scenario 4: Blue Heron Wet Weather Facility Potential Layout

6.5.5.5 Estimated costs

The estimated, comparative costs for Scenario 4 are shown in Table 6.7.

Table 6.7 Scenario 4 Estimated Costs

Component		Cost Estimate(1)
Basin-Wide Conveyance Components	-	$0
Kellogg Creek WRRF Capacity Components	-	$0
Tri-City WRRF Capacity Components	• Influent pumping, screening, grit removal. • New primary clarifiers (four). • New secondary clarifiers (two). • Yard/Site/Civil.	$65,870,000
Blue Heron Facility	• 10-mgd wet weather treatment facility	$29,180,000
Total Construction Cost		**$95,805,000**
Engineering, Legal, Administration (38%)		$36,120,000
Total Project Cost		**$131,170,000**

Note:
(1) Costs presented are comparative costs and are not intended for CIP development.

6.5.6 Scenario 5

Scenario 5 assumes that future summertime nutrient (ammonia and phosphorus) limits are imposed at the Tri-City and Kellogg Creek WRRF. The scenario assumes the current practice of transferring peak flow from Kellogg Creek WRRF to Tri-City WRRF will continue with the addition of a remote treatment facility at the Blue Heron site that would operate on a year-round basis.

6.5.6.1 NPDES Permit Assumption

Future NDPES permit limits on ammonia and phosphorus will be imposed at the Kellogg Creek and Tri-City WRRFs during the regulatory, dry-weather season.

6.5.6.2 Basin-Wide Conveyance and Treatment Schematics

The basin-wide conveyance and treatment schematic for Scenario 4 is shown in Figure 6.14. Since this scenario includes a peak-flow treatment facility at the Blue Heron site, conveyance improvements to increase capacity from the Willamette Pump Station to the Tri-City WRRF are not required.

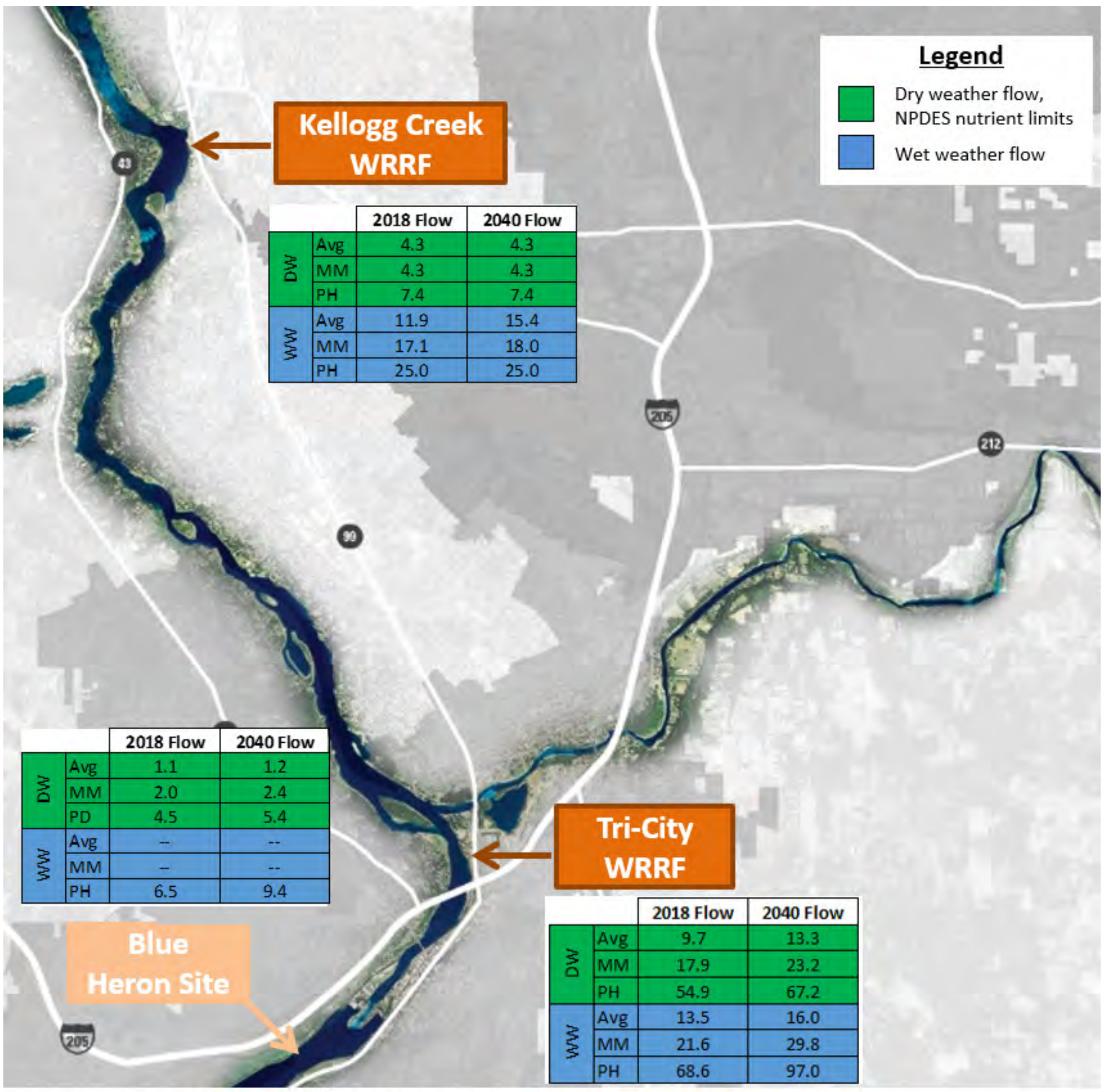


Figure 6.19 Scenario 5: Basin-Wide Conveyance and Treatment Schematic

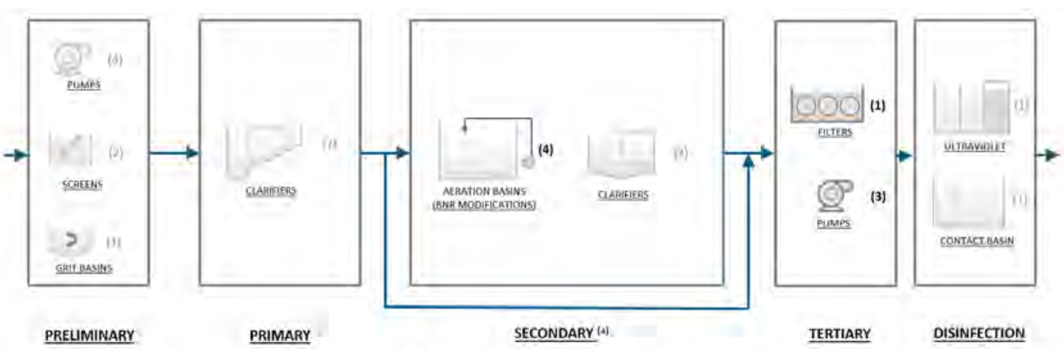
6.5.6.3 Seasonal WRRF Treatment Capacities

For the dry weather season, Scenario 5 assumes that the Kellogg Creek WRRF is de-rated to achieve nutrient removal, which caps its capacity at approximately 4 mgd. The balance of dry weather flow is transferred from the Kellogg Creek Service Area to the Tri-City WRRF for treatment, where improvements to remove nutrients are required. A new membrane bioreactor (MBR) facility constructed at Blue Heron would be used to offload a portion of the dry weather flow that would otherwise need to be treated at the Tri-City WRRF.

For the wet weather season, Scenario 4 assumes that peak flows to the Kellogg Creek WRRF will continue to be capped at 25 mgd, with the balance of flow (in excess of 25 mgd) transferred to the Tri-City WRRF. This requires improvements to the Intertie Pump Station and associated conveyance facilities, as well as improvements to the Tri-City WRRF. However, construction of a 10 mgd wet weather treatment facility at Blue Heron reduces the total peak flow capacity requirement at Tri-City from 105 mgd to approximately 97 mgd.

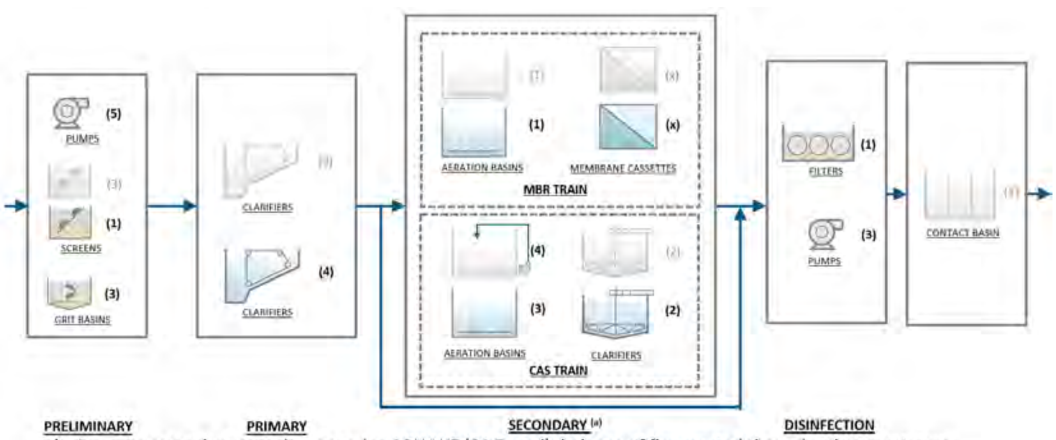
6.5.6.4 WRRF Treatment Schematics

Figures 6.20 and 6.21 show the preliminary Scenario 5 treatment schematics for the Kellogg Creek WRRF liquid stream and the Tri-City WRRF liquid stream, respectively.



a) Dry weather season: BNR modifications to achieve 4.3 mgd max month dry weather secondary capacity, peak secondary capacity capped at 7.4 mgd. Wet weather season: peak secondary capacity capped at 18 mgd, balance of flow routed through Select Treatment, remainder of flow transferred to Tri-City.

Figure 6.20 Scenario 5: Kellogg Creek WRRF Liquid Stream Schematic



a) Assumes secondary capacity capped at PDWWF (80.5 mgd), balance of flow routed through select treatment. CAS Train operated in BNR mode during dry weather season.

Figure 6.21 Scenario 5: Tri-City WRRF Liquid Stream Schematic

The recommended improvements for the Kellogg Creek WRRF liquid stream for Scenario 5 are summarized below:

- **Secondary Treatment:**
  - CAS aeration basin modifications on all four existing aeration basins.
- **Tertiary Treatment:**
  - New tertiary filtration and effluent pump station.

The recommended improvements for the Tri-City WRRF liquid stream for Scenario 5 are summarized below:

- **Preliminary Treatment:**
  - Influent pumping, screening, and grit removal, including five new influent pumps, one new screen, and three new grit basins.
- **Primary Treatment:**
  - Four new primary clarifiers.
- **Secondary Treatment:**
  - MBR Train: One new aeration basin and new membrane cassettes.
  - CAS Train: CAS aeration basin modifications on all four existing aeration basins, three new aeration basin, and two new secondary clarifiers.
- **Tertiary Treatment:**
  - New tertiary filtration and pump station.

6.5.6.5 Estimated costs

The estimated, comparative costs for Scenario 5 are shown in Table 6.8.

Table 6.8 Scenario 5 Estimated Costs

Component		Cost Estimate[1]
Basin-Wide Conveyance Components	-	$0
Kellogg Creek WRRF Capacity Components	• CAS aeration basin modifications (four). • Tertiary filters. • Yard/Site/Civil.	$20,560,000
Tri-City WRRF Capacity Components	• Influent pumping, screening, grit removal. • New primary clarifiers (four). • CAS aeration basin modifications (four). • New CAS aeration basins (three). • New MBR aeration basins (one). • New membrane cassettes. • New secondary clarifiers (two). • Tertiary filters. • Yard/Site/Civil.	$125,730,000
Blue Heron Facility	• Year-round MBR treatment with 10 mgd HRC capacity.	$67,340,000
Total Construction Cost		**$213,630,000**
Engineering, Legal, Administration (38%)		$81,180,000
Total Project Cost		**$294,810,000**

Note:
(1) Costs presented are comparative costs and are not intended for CIP development.

6.6 Summary of Comparative Costs

Table 6.9 summarizes the comparative project costs for each of the five basin-wide scenarios developed by the planning team.

Scenario 1 and Scenario 4 can be compared to address the question of where to increase peak flow capacity in the basins served by WES. As shown in Table XXX, increasing conveyance capacity between the Willamette Pump Station and the Tri-City WRRF and increasing peak flow treatment capacity at Tri-City (Scenario 1) is similar in cost to building a 10 mgd wet weather treatment facility at the Blue Heron site (Scenario 4).

Scenarios 1.5, 2, 3, and 5 can be compared to address the question of where to increase treatment capabilities if limits on ammonia or phosphorus are included in future NPDES permits. As shown in Table 6.9, centralizing nutrient removal capability at Tri-City has a much lower cost than other scenarios that would also provide nutrient removal capacity at Kellogg Creek (Scenarios 2 and 3) or at Kellogg Creek and Blue Heron (Scenario 5).

Table 6.9 Comparative Project Costs

	Scenario 1	Scenario 1.5	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Basin-Wide Conveyance	$19.7	$19.7	$19.7	$19.7	$0	$0
Kellogg Creek Improvements	$0	$0	$20.6	$20.3	$0	$20.6
Tri-City Improvements	$78.8	$129.2	$146.0	$136.5	$65.9	$125.7
Blue Heron Facility	$0	$0	$0	$0	$29.2	$67.3
Subtotal Construction	$98.5	$148.9	$186.3	$176.5	$95.8	$213.6
Engineering, Legal, Admin.	$37.4	$56.6	$70.8	$67.1	$36.1	$81.2
Total Project	**$136.0**	**$205.2**	**$257.1**	**$243.6**	**$131.2**	**$294.8**

6.7 Non-Cost Evaluation

Figures 6.22 and 6.23 illustrate the results of the non-cost evaluation of each scenario compared to the "ideal condition" (i.e., the scenario that would receive the highest score of in all non-cost categories).

Figure 6.22 compares scenarios that address the question of where to increase peak flow capacity in the basins served by WES. As shown in Figure 6.22, Scenario 1 is preferred over Scenario 4. This is primarily due to the complexity of operating a remote treatment facility, and the potential permitting, environmental, and land use challenges associated with constructing a treatment facility at the Blue Heron site.

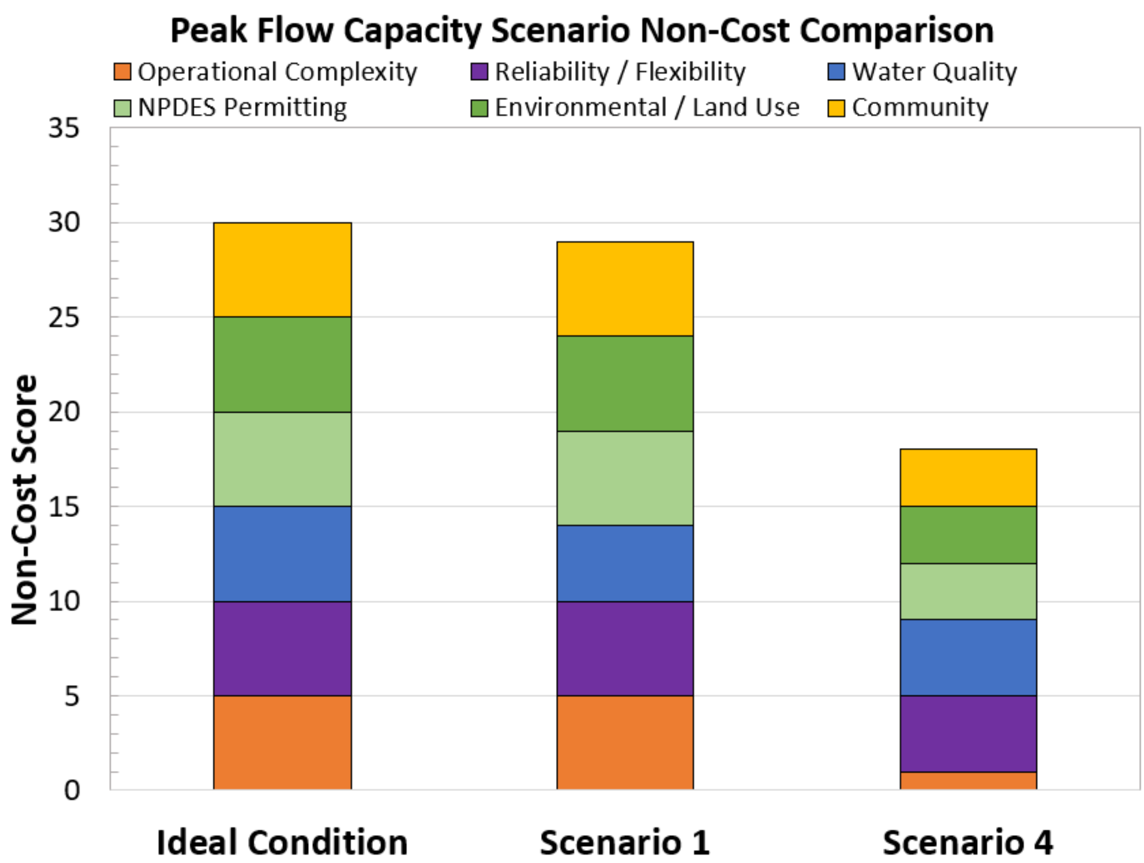


Figure 6.22 Basin-Wide Scenario Non-Cost Comparison - Peak Flow Hydraulic Capacity

Figure 6.23 compares scenarios that address the question of where to increase treatment capabilities if limits on ammonia or phosphorus are included in future NPDES permits. As shown in Figure 6.23, centralizing nutrient removal capability at the Tri-City WRRF alone (Scenario 1.5) is preferred. In the event that nutrient removal capabilities would also be required at the Kellogg Creek WRRF, Scenario 3 (intensification of the Kellogg Creek process) is preferred over other alternatives.

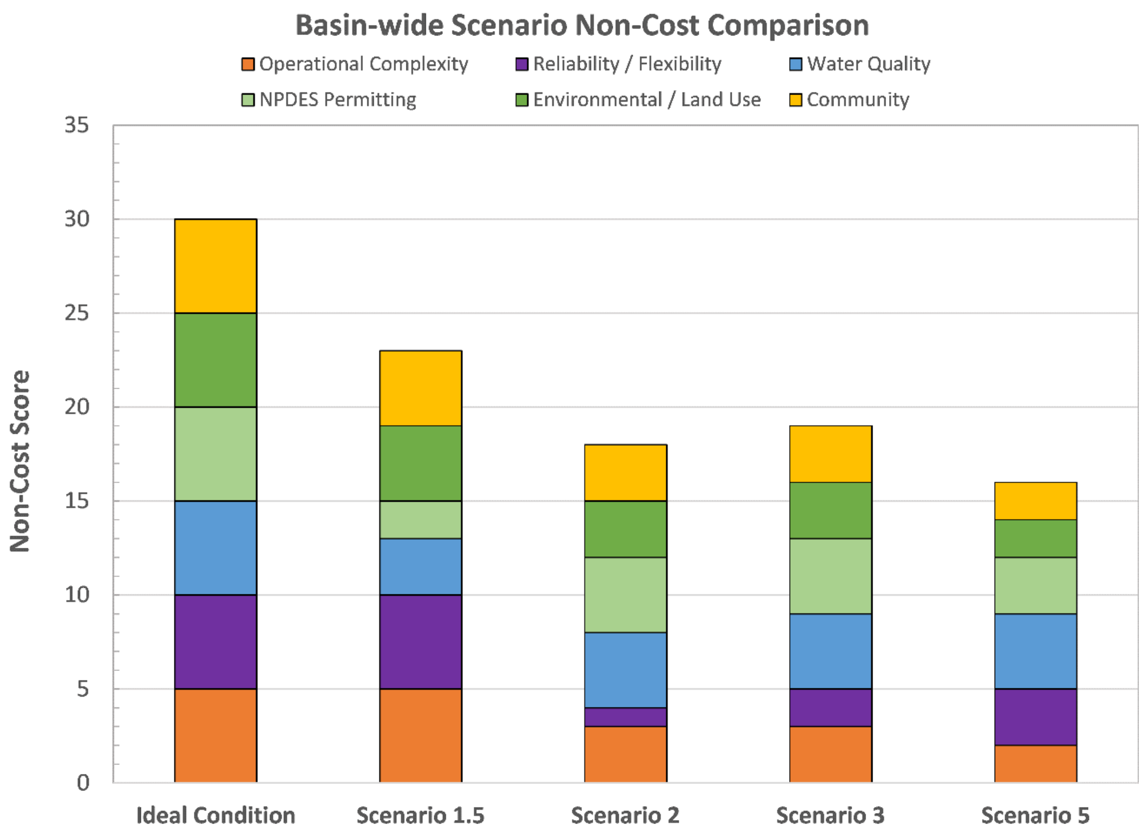


Figure 6.23 Basin-Wide Scenario Non-Cost Comparison - Future Nutrient Removal

6.8 Summary and Recommendation

Basin-wide scenarios were explored to identify improvements needed to meet projected wastewater flows and loads within the District's Kellogg Creek and Tri-City service areas as well as potential future regulatory requirements. In particular, the process evaluated key questions related to increasing peak flow hydraulic capacity in the wet weather season and providing nutrient removal during the dry weather season if future NPDES permits required such limits.

6.8.1 Approach to Increasing Peak Flow Capacity

Based on the evaluation of cost and non-cost criteria, increasing the conveyance capacity between the Willamette Pump Station to the Tri-City WRRF and increasing peak flow treatment capacity at Tri-City (Scenario 1) is preferred. The total estimated project cost of Scenario 1 is similar to Scenario 4; however, Scenario 1 scored significantly higher when considering non-cost criteria.

6.8.2 Approach to Providing Future Nutrient Removal if Required

Based on the evaluation of cost and non-cost criteria, centralizing nutrient removal capability at the Tri-City WRRF alone (Scenario 1.5) is preferred. This scenario has the lowest comparative cost, and scores he highest considering non-cost criteria. In the event that nutrient removal capabilities would also be required at the Kellogg Creek WRRF, Scenario 3 (intensification of the Kellogg Creek process) is preferred over other alternatives.

Chapter 7

IMPLEMENTATION PLAN

7.1 Introduction

This chapter outlines the implementation plan for improvements for the Kellogg Creek Water Resource Recovery Facility (WRRF) and Tri-City WRRF based on the recommended scenarios defined in Chapter 6 of this Plan.

Detailed information about the recommended improvement projects can be found in Chapter 7 of the Kellogg Creek WRRF Facilities Plan and Chapter 7 of the Tri-City WRRF Facilities Plan.

7.2 Planning Level Cost Estimate

Summaries of project costs for the recommended improvements are provided in Tables 7.1 and 7.2, respectively.

Table 7.1 Kellogg Creek WRRF - Recommended Plan Project Cost Summary

Project(1)	Category(2)	Estimated Project Cost(3)
Near-term (0 - 2 year) R&R Improvements	Condition	$516,000
Mid-term (3 - 5 years) R&R Improvements	Condition	$6,153,000
Long-term (6 - 10 year) R&R Improvements	Condition	$1,007,000
UV Disinfection System	Condition	$2,700,000
Solids Thickening, Digestion, and Dewatering Improvements	Condition / Capacity	$24,000,000
Gas Utilization	Condition	$5,900,000
	TOTAL	**$40,276,000**

Notes:
(1) Details of each project can be found in Chapter 7 of the Kellogg Creek WRRF Facilities Plan.
(2) Condition projects are driven by the need to maintain existing reliable treatment capacity. Capacity projects are driven by the need to increase reliable treatment capacity.
(3) The estimated project costs are the construct costs for the repair and replacement (R&R) Improvement projects. The estimated project costs for all other projects include the construct costs plus Engineering, legal and administration fees (ELA). Details on the estimated project costs can be found in Chapter 7 of the Kellogg Creek WRRF Facilities Plan and Chapter 7 of the Tri-City WRRF Facilities Plan.

Table 7.2 Tri-City WRRF - Recommended Plan Project Cost Summary

Project[(1)]	Category[(2)]	Estimated Project Cost[(3)]
Near-term (0 - 2 year) R&R Improvements	Condition	$7,563,000
Mid-term (3 - 5 years) R&R Improvements	Condition	$4,225,000
Long-term (6 - 10 year) R&R Improvements	Condition	$5,131,000
Peak Flow Hydraulic Improvements	Capacity	$53,685,000
Primary Sludge Thickening	Capacity	$7,565,000
	TOTAL	**$78,169,000**

Notes:
(1) Details of each project can be found in Chapter 7 of the Tri-City WRRF Facilities Plan.
(2) Condition projects are driven by the need to maintain existing reliable treatment capacity. Capacity projects are driven by the need to increase reliable treatment capacity.
(3) The estimated project costs are the construct costs for the R&R Improvement projects. The estimated project costs for all other projects include the construct costs plus ELA.

7.3 Project Triggers

Project triggers were developed based on the capacity analysis and condition assessment. Capacity-related triggers were developed based on unit process design criteria as presented in Chapter 5 and the flow and load projections presented in Chapter 3. Triggers for Repair and Rehabilitation (R&R) projects to address the condition of assets at the WRRFs are based on the results of the condition assessment as shown in Chapter 6 of the Kellogg Creek WRRF Facilities Plan and Chapter 6 of the Tri-City WRRF Facilities Plan.

Tables 7.3 and 7.4 summarizes the recommended improvements based on the triggers for the Kellogg Creek WRRF and Tri-City WRRF, respectively.

Table 7.3 Kellogg Creek WRRF - Recommended Improvements Triggers

Category	Process Description	Trigger			Approximate Trigger Date
		Description	Value	Units	
Condition	Near-term (0 - 2 year) R&R Improvements	Address condition deficiencies			2022
Condition	Mid-term (3 - 5 years) R&R Improvements	Address condition deficiencies			2024
Condition	Long-term (6 - 10 year) R&R Improvements	Address condition deficiencies			2028
Condition	UV Disinfection System	Address condition deficiencies			2022
Condition / Capacity	Solids Thickening, Digestion, and Dewatering Improvements	Max week WAS Max month SRT	9700 20	ppd days	2026
Condition	Gas Utilization	Provide a means to utilize the digester gas			2026

Note:
Abbreviations: ppd - pounds per day; SRT - solids residence time; WAS - waste activated sludge.

Table 7.4 Tri-City WRRF - Recommended Improvements Triggers

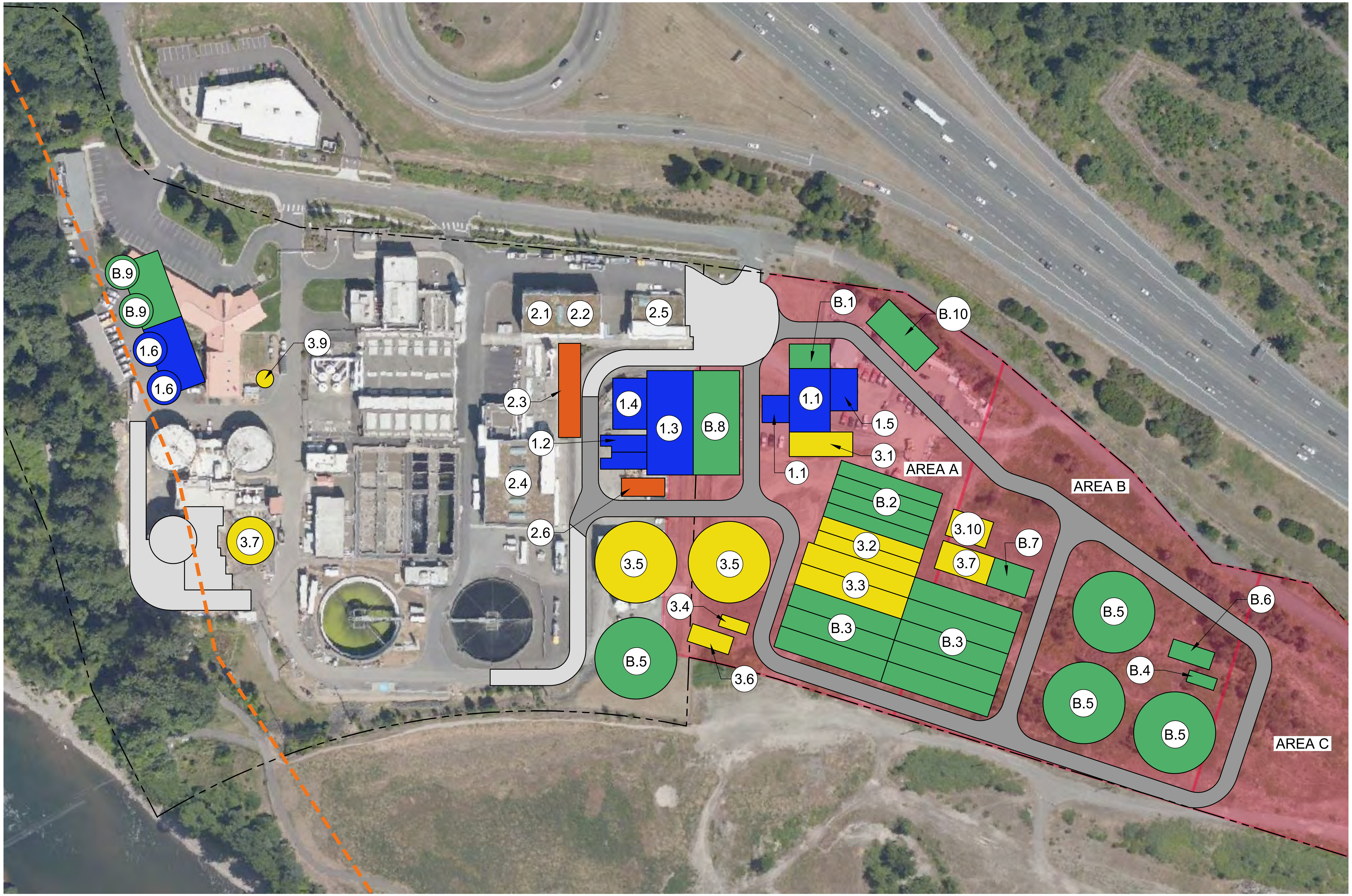
Category	Process Description	Trigger			Approximate Trigger Date
		Description	Value	Units	
Condition	Near-term (0 - 2 year) R&R Improvements	Address condition deficiencies			2022
Condition	Mid-term (3 - 5 years) R&R Improvements	Address condition deficiencies			2024
Condition	Long-term (6 - 10 year) R&R Improvements	Address condition deficiencies			2028
Capacity	Peak Flow Hydraulic Improvements	PHF	60[1]	mgd	2022
Capacity	Primary Sludge Thickening	MM firm digestion SRT	15	days	2038

Notes:
(1) 60 mgd represents the PHF capacity of the primary and secondary process.
Abbreviations: mgd - million gallons per day; MM - maximum month; PHF- peak hour flow.

7.4 WRRF Site Plans

Site plans for the recommended improvements, excluding the R&R Improvements, were developed for the Kellogg Creek WRRF and Tri-City WRRF. The site plans show the recommended improvements through buildout and include more improvements than are listed in the previous sections. Figure 7.1 and Figure 7.2 illustrate the recommended improvements at the Kellogg Creek WRRF and Tri-City WRRF, respectively.

Figure 7.1 Kellogg Creek WRRF Site Plan



LEGEND:

SCENARIO 1
- 1.1 - SOUTH PLANT SCREENINGS BUILDING
- 1.2 - BALLASTED SEDIMENTATION
- 1.3 - SOUTH CHLORINE CONTACT BASIN
- 1.4 - SOUTH CHEMICAL BUILDING
- 1.5 - SOUTH HEADWORKS ODOR CONTROL
- 1.6 - GRAVITY THICKENERS 1-2 *

SCENARIO 1.5
- 2.1 - MBR PUMP STATION EXPANSION
- 2.2 - MBR FINE SCREEN EXPANSION
- 2.3 - MBR AERATION BASIN 2
- 2.4 - MEMBRANE EXPANSION
- 2.5 - UV DISINFECTION EXPANSION
- 2.6 - TERTIARY PUMP STATION

SCENARIO 3
- 3.1 - SOUTH GRIT BASIN
- 3.2 - SOUTH PRIMARY SEDIMENTATION BASINS 7-8
- 3.3 - SOUTH CAS AERATION BASINS 5-6
- 3.4 - ML SPLITTER BOX 1
- 3.5 - SOUTH SECONDARY CLARIFIERS 3-4
- 3.6 - SOUTH RAS PUMP STATION 2
- 3.7 - SOUTH BLOWER BUILDING
- 3.8 - ANAEROBIC DIGESTER 4
- 3.9 - RELOCATED DIGESTER GAS HOLDING TANK
- 3.10 - SOUTH PLANT ODOR BUILDING

BUILDOUT
- B.1 - SOUTH INFLUENT PUMP STATION
- B.2 - SOUTH PRIMARY SEDIMENTATION BASINS 9-12
- B.3 - SOUTH CAS AERATION BASINS 7-14
- B.4 - ML SPLITTER STRUCTURE 2
- B.5 - SECONDARY CLARIFIERS 5-8
- B.6 - RAS PUMP STATION 3
- B.7 - SOUTH BLOWER BUILDING EXPANSION
- B.8 - SOUTH CHLORINE CONTACT BASIN EXPANSION
- B.9 - GRAVITY THICKENERS 3-4 *
- B.10 - MAINTENANCE BUILDING / GARAGE

EXISTING FACILITIES / ROAD
PROPOSED ROAD
APPROXIMATE LANDFILL BOUNDARIES
PROPERTY LINE
ENVIRONMENTALLY SENSITIVE AREA BOUNDARIES

* NEED FOR NEW SOLIDS THICKENING TO BE DETERMINED, AS WELL AS PROJECT TIMING, LOCATION, AND PROCESS TYPE.

0 37.5' 75' 150'
SCALE: 1" = 75'

Figure No. 7.2
PROPOSED TRI-CITY WRRF SITE PLAN
CLACKAMAS WATER ENVIRONMENT SERVICES

carollo

LAST SAVED BY: bhawes
FILE NAME: 11636A00_FIGURE_SEED.DWG
Plot Date: 11/15/2021 8:25:29 AM

7.5 Project Schedule

Recommended projects for the upcoming five-year capital improvement plan (CIP) are summarized below:

- Kellogg Creek WRRF: Disinfection System Improvements.
- Kellogg Creek WRRF: Near-term (0 - 2 year) R&R Improvements.
- Kellogg Creek WRRF: Mid-term (3 - 5 years) R&R Improvements.
- Tri-City WRRF: Peak Flow Hydraulic Improvements.
- Tri-City WRRF: Near-term (0 - 2 year) R&R Improvements.
- Tri-City WRRF: Mid-term (3 - 5 years) R&R Improvements.

Figure 7.3 presents a summary of the recommended project schedule for the 20-year CIP. All projects except R&R Improvements include a design period and construction period.

7.6 Financial Analysis - Capital Improvement Plan

The anticipated cash flow to complete recommended improvements throughout the planning period was determined for the recommended improvements summarized in Tables 7.1 and 7.2. The cash flow over the 20-year planning horizon, which includes a 3 percent escalation rate, is shown in Figure 7.4 and summarized in Table 7.5. Costs presented in Figure 7.4 and Table 7.5 have been escalated to the mid-point of construction. The peak expenditure is approximately $25.5 million in planning year 2026.

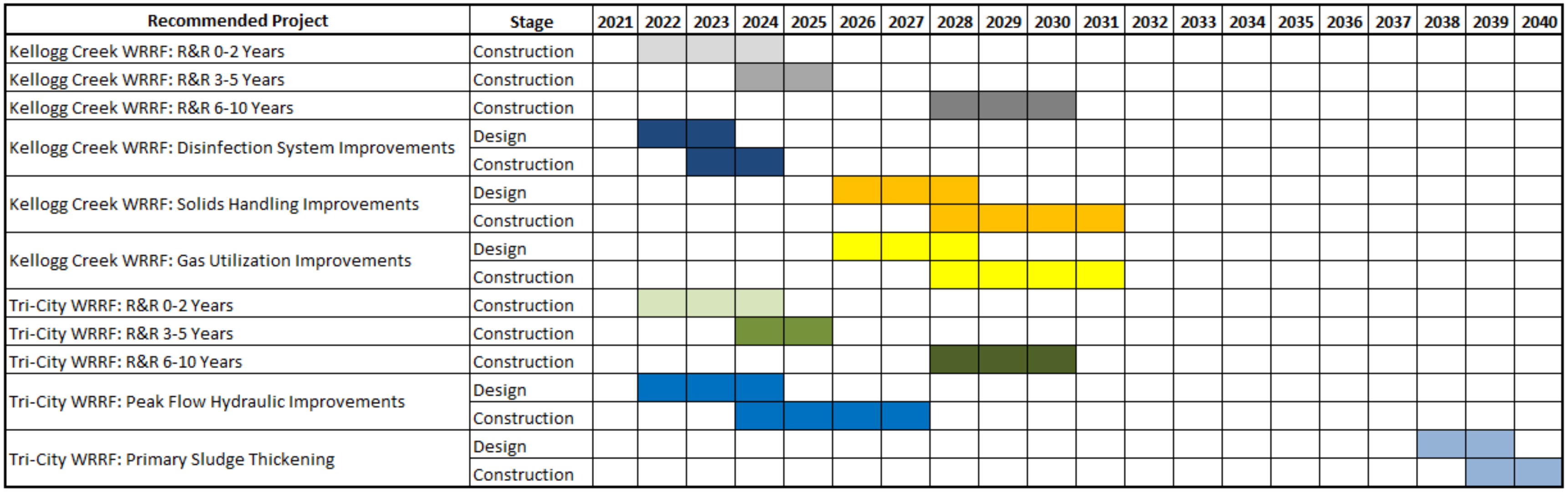


Figure 7.3 Project Schedule for Recommended Improvements

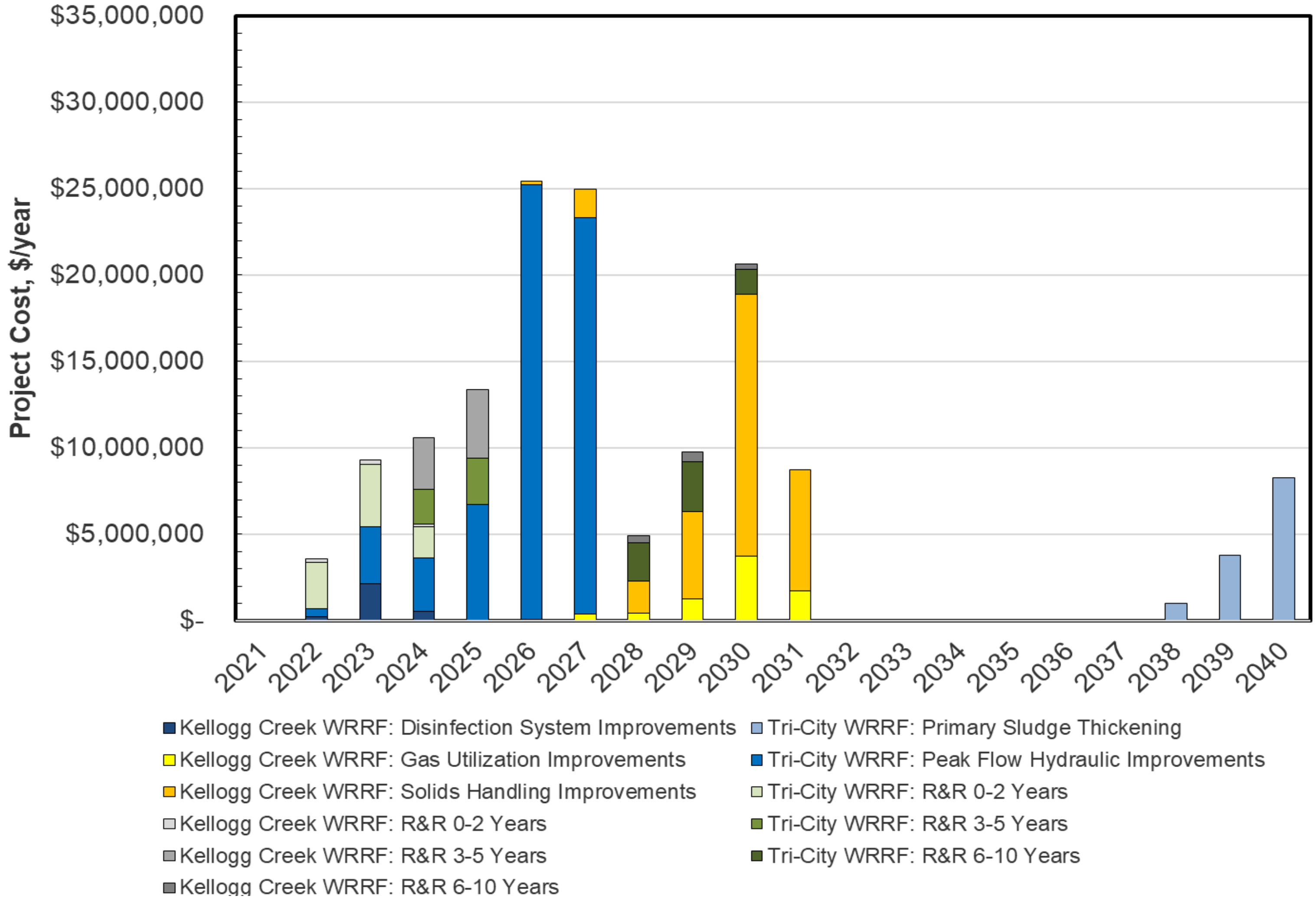


Figure 7.4 Cash Flow Summary

Table 7.5 Cash Flow Summary

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Kellogg Creek WRRF: Disinfection System Improvements	$-	$227,000	$2,150,000	$523,000	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Kellogg Creek WRRF: Solids Handling Improvements	$-	$-	$-	$-	$-	$232,000	$1,650,000	$1,854,000	$5,048,000	$15,143,000	$7,011,000	$-	$-	$-	$-	$-	$-	$-	$-	$-
Kellogg Creek WRRF: Gas Utilization Improvements	$-	$-	$-	$-	$-	$57,000	$406,000	$456,000	$1,241,000	$3,723,000	$1,723,000	$-	$-	$-	$-	$-	$-	$-	$-	$-
Kellogg Creek WRRF: R&R 0-2 Years	$-	$184,000	$246,000	$123,000	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Kellogg Creek WRRF: R&R 3-5 Years	$-	$-	$-	$2,975,000	$3,967,000	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Kellogg Creek WRRF: R&R 6-10 Years	$-	$-	$-	$-	$-	$-	$-	$429,000	$573,000	$286,000	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Tri-City WRRF: Peak Flow Hydraulic Improvements	$-	$460,000	$3,278,000	$3,130,000	$6,704,000	$25,141,000	$22,906,000	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Tri-City WRRF: Primary Sludge Thickening	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$1,013,000	$3,801,000	$8,277,000
Tri-City WRRF: R&R 0-2 Years	$-	$2,701,000	$3,601,000	$1,800,000	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Tri-City WRRF: R&R 3-5 Years	$-	$-	$-	$2,043,000	$2,724,000	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Tri-City WRRF: R&R 6-10 Years	$-	$-	$-	$-	$-	$-	$-	$2,188,000	$2,917,000	$1,459,000	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
TOTAL	**$-**	**$3,572,000**	**$9,274,000**	**$10,594,000**	**$13,394,000**	**$25,430,000**	**$24,962,000**	**$4,928,000**	**$9,779,000**	**$20,611,000**	**$8,734,000**	**$-**	**$-**	**$-**	**$-**	**$-**	**$-**	**$1,013,000**	**$3,801,000**	**$8,277,000**

Appendix A

LAND USE COMPATIBILITY STATEMENT FROM LOCAL GOVERNMENT

~~Will be included at a later date. ~

Appendix B

DRAFT PERMITTING ISSUES MEMO BLUE HERON SITE 06032020

ESA 50 YEARS 1969-2019

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draft memorandum

date	June 3, 2020
to	Brian Matson, PE, Carollo
from	John Vlastelicia, ESA
subject	Environmental Permitting Issues Summary: Blue Heron Mill Site Clackamas County Water Environment Services Willamette Facilities Plan

Thank you for asking Environmental Science Associates (ESA) to support Carollo's work for Clackamas County Water Environment Services (WES) on the Willamette Facilities Plan (WFP). This memorandum summarizes our evaluation of environmental permitting considerations for the potential construction of a new wastewater treatment plant at the former Blue Heron mill site in West Linn.

UNDERSTANDING AND SCOPE OF REVIEW

Carollo is assisting WES with the evaluation of "basin-wide" alternatives for the WFP. One of the alternatives under consideration involves constructing a new treatment plant on a portion of the former Blue Heron mill property, which is now owned by WES.

The 39-acre former mill site is located at 1317 Willamette Falls Drive in West Linn, and it extends from Volpp Street on the north bank of the Willamette River north to 5th Avenue. The potential location for the treatment facility comprises an approximately 1-acre portion of Tax Lot No. 31E01BB0100, adjacent to WES's existing Willamette Pump Station at 1185 SE 4th Ave (refer to Figure 1, attached). WES also owns an outfall from the former paper mill to the Willamette River at River Mile 27.8, but does not actively discharge from that outfall.

ESA understands that the potential treatment facility considered for the Blue Heron mill site would include the following components:

- Modifications to/expansion of the existing Willamette Pump Station
- Influent screening
- Actiflo® high-rate clarification units
- UV disinfection
- Connection to existing outfall at Blue Heron Mill Site

ESA's review considered the anticipated environmental permitting requirements and potential issues associated with this alternative, along with an initial assessment of what would be required to address them. The evaluation documented in this memorandum is based on our reviews of existing available information and our understanding of environmental regulatory requirements. ESA has not performed any field investigations related to environmental resources at the site and has not contacted any regulatory agency to discuss project permitting considerations.

MAPPED ENVIRONMENTAL RESOURCES

ESA reviewed existing maps, reports, and databases to identify the following environmental resources in the area of the Blue Heron mill site and the potential treatment facility improvements. Refer also to the attached Figure 1.

Streams

An unnamed tributary of Bernert Creek flows in an easterly direction through the Blue Heron property, just north of the potential treatment plant location. Historic aerial photographs from 1936 suggest the stream was present along approximately its current course in the project area (east of 4th Street) at that time. The stream discharges to Bernert Creek off-site, approximately 600 feet east of the potential treatment facility. Bernert Creek flows in a southerly direction into the Willamette River approximately 500 feet downstream of the confluence with the unnamed tributary.

Wetlands

The City of West Linn's Local Wetlands Inventory (LWI) identifies an approximately 2.8-acre wetland adjacent to both sides of the unnamed tributary of Bernert Creek on the subject property. The wetland, identified as WI-3 in the LWI, is classified as "Significant" by the City based on assessment factors including diverse wildlife habitat, intact fish habitat, and intact hydrological control (Winterbrook Planning, 2003). Wetland hydrology for WI-3 is provided by the unnamed tributary of Bernert Creek described above.

Fish and Wildlife Habitat

The City of West Linn's Goal 5 Significant Natural Resource Inventory identifies lands adjacent to the Willamette River and the unnamed tributary to Bernert Creek as "Significant Riparian Habitat". The mapped width of the riparian habitat corridors is 120 feet on each side of the river/stream, based on the potential tree height of the dominant tree species in the area, which typically include black cottonwood, Douglas fir, and western red cedar. Additionally, the entirety of Tax Lot No. 31E01BB00100, including the proposed treatment plant location, is mapped by Metro as Habitat Conservation Area (HCA). The HCA designation as mapped excludes WES's Willamette Pump Station on the adjacent Taxlot No. 31E01BB00102.

Floodplains

The majority of Tax Lot No. 31E01BB00100, including the proposed treatment plant location, is mapped by the Federal Emergency Management Agency (FEMA) as Zone AE Special Flood Hazard Area, which is an area of 1% annual chance flooding with base flood elevations determined (i.e., the 100-year floodplain). The southernmost portion of the site is mapped as an area of 0.2% annual chance flooding, or 500-year floodplain. FEMA Flood Insurance Rate Map (FIRM) Panel No. 41005C0257D identifies 100-year water surface elevations at the project site to be between about 74.9 and 75.0 feet NAVD88. City of West Linn mapping identifies the majority of the site as being inundated by the 1996 flood. The entire Tax Lot No. 31E01BB00100 including the site of the potential treatment facility is within the City's Flood Management Area Overlay Zone.

Cultural Resources

Archaeological Resources

A preliminary review of the Oregon State Historic Preservation Office (SHPO) Oregon Archaeological Records Remote Access on May 28, 2020 shows that there are 17 completed cultural resource survey studies within a 0.5-mile radius of the project, resulting in the identification of one archaeological site and one archaeological isolate from the historic era, one archaeological isolate from the precontact era, and one Traditional Cultural Property (TCP). Within 1 mile are additional historic-era and precontact archaeological sites, largely documented along the river shoreline.

One prior pedestrian survey, completed for Federal Energy Regulatory Commission licensing (Oetting 2001), crosses over a small portion of the project site; otherwise, no prior surveys overlap with the project area. A TCP study (Hajda, French, Ellis 2004) identified a TCP bordering the mill site to the south along the shoreline. On December 23, 2004, the TCP was determined by SHPO to be Eligible for listing on the National Register of Historic Places (NRHP).

Precontact materials have a high probability of being found adjacent to the Willamette River and the bank terraces upslope of the river. The TCP and significance assigned to its presence also lends to the high-probability concerns for the area.

Built Environment Resources

A preliminary review of SHPO Historic Sites Database May 28, 2020, shows a total of 118 built environment resources documented within a 0.5-mile radius of the project. Of these, 54 are considered eligible for NRHP-listing and 64 are considered not eligible. None appear within the project site, but several are adjacent to the mill site.

Historic materials have a high probability of being found in areas of historic settlement and development, in this case also adjacent to the Willamette River and upslope. The project area is known for early historic development and settlement, lending to the consideration of the site as high-probability for the presence of historic cultural resources.

ENVIRONMENTAL PERMITTING CONSIDERATIONS

The construction of new treatment facilities at the Blue Heron mill site would require site-specific investigations to further delineate and characterize environmental resources. Permits would be required from the City of West Linn and potentially federal and state agencies depending on resource impacts. The following environmental regulatory considerations would need to be addressed.

Federal and State Agency Permits

U.S. Army Corps of Engineers (USACE) Section 404 Permit

The unnamed tributary of Bernert Creek that transects the Blue Heron property, as well as the adjacent wetlands (LWI Wetland No. WI-3), would very likely be considered "waters of the United States" subject to USACE jurisdiction and permitting requirements under Section 404 of the federal Clean Water Act. Project-related discharges of dredged or fill material below the OHW level of the stream or within the boundaries of adjacent wetlands would require Section 404 permit coverage from USACE.

The stream and wetland boundaries shown on LWI and other mapping should be considered approximate. A wetland delineation following USACE Wetland Delineation Manual methods is recommended if this alternative is advanced and would be needed to support a permit application to USACE if there are wetland impacts. If the treatment facilities at the Blue Heron site can be sited to avoid stream and wetland fill entirely, based on an accurate determination of site wetland boundaries, then no permit from USACE would be needed. If the alternative would require wetland fill, then a permit application to USACE would be needed.

An application for USACE Section 404 permit coverage would need to demonstrate a clear purpose and need for the project and document an evaluation of alternatives that would avoid and minimize stream and wetland impacts. Mitigation would be required by USACE for adverse impacts to jurisdictional waters/wetlands, either through purchase of mitigation credits from a mitigation bank or through permittee-proposed on-site or off-site mitigation (e.g., wetland creation, restoration, or enhancement). The site is within the service area of the Mud Slough Mitigation Bank, if purchase of mitigation credits is pursued.

If USACE Section 404 permit coverage is needed and wetland impacts total less than 0.5 acres, the project may qualify for coverage under a USACE Nationwide Permit(s), such as NWP#12 (Utility Lines) and/or NWP#39 (Commercial and Institutional Developments) if all Nationwide Permit conditions can be met. Qualifying for coverage under a Nationwide Permit would streamline the review process and avoid the need for a public comment process. If the project does not qualify for Nationwide Permit coverage, an Individual Permit would be needed, which would require a more substantial alternatives analysis and a USACE public comment process.

The need for a federal permit from USACE would trigger related reviews by and consultations with other federal and state agencies, including the National Marine Fisheries Service (NMFS), SHPO, and the Oregon Department of Environmental Quality (DEQ). Additionally, excavation or fill activities in the stream or wetland would require a permit from the Oregon Department of State Lands (DSL) pursuant to Oregon's Removal-Fill Law. Those agency reviews and related considerations are described in the following subsections.

NMFS Endangered Species Act Section 7 Consultation

Prior to issuing a Section 404 permit, the USACE would be required to consult with NMFS and/or U.S. Fish and Wildlife Service (USFWS) on actions that "may affect" a species listed as Threatened or Endangered under the federal Endangered Species Act. Development along this reach of the Willamette River that would have a federal nexus, such as a Section 404 permit, would require an assessment of potential project impacts to listed Upper Willamette River (UWR) Chinook salmon and UWR steelhead in the Willamette River, and require consultation with NMFS, which has jurisdiction over anadromous fish species. Impacts to listed terrestrial wildlife and plant species managed by USFWS are less likely, and there is no designated Critical Habitat for USFWS species in the project area, but a site visit should be conducted to confirm the absence of listed species and suitable habitat.

A Biological Assessment (BA) would need to be prepared that evaluates the effects of the proposed new treatment facilities on listed salmon and steelhead. The BA would need to consider potential effects from both construction and operation of the facilities, including physical impacts to the floodplain and the potential for water quality-related impacts from a new outfall discharge and stormwater runoff from new site development. NMFS would review the BA and determine whether the project is likely (or not likely) to adversely affect listed fish. If adverse effects are likely, NMFS would need to issue a Biological Opinion (BO) with an Incidental Take Statement to authorize project construction. The BO would specify conservation measures intended to avoid and minimize adverse impacts that would ultimately be made part of the USACE permit.

If stream and wetland impacts can be avoided and no USACE permit is needed for the project, but there is still a federal nexus (such as funding for the project), Endangered Species Act consultation requirements would still need to be addressed by the lead federal agency.

Oregon Department of Environmental Quality (DEQ) Section 401 Water Quality Certification

A USACE Section 404 permit would trigger the need for 401 Water Quality Certification coverage for the project, to document the state's determination that the project can meet water quality standards. DEQ is the state agency responsible for issuing 401 Water Quality Certifications for federal permits.

The Joint Permit Application submitted to the USACE for the Section 404 permit would also need to be submitted to DEQ for 401 certification review. The application would need to include information on water quality considerations for the proposed construction and operation of the treatment facilities, including related wastewater and stormwater discharges to the Willamette River. Water quality-related information developed to support WES's National Pollutant Discharge Elimination System (NPDES) Permit compliance for the outfall discharge to the Willamette River (e.g., modeling, mixing zone study, Reasonable Potential Analysis) could be used to support the 401 certification review.

Oregon SHPO National Historic Preservation Act (NHPA) Section 106 Consultation

Section 106 of the NHPA would require the USACE, prior to issuing a permit for the project, to consider the potential impacts to historic resources and consult with SHPO and affected tribes. Because of the high-probability concerns for the area, the USACE, SHPO, and tribes would likely request site-specific survey for cultural resources in the area of the potential treatment facilities. ESA recommends that a pedestrian survey and built environment assessment be performed prior to submittal of the Joint Permit Application. Pedestrian survey should entail subsurface probing for presence/absence of archaeological materials. A report documenting the survey and findings should be submitted for SHPO, USACE, and tribe review in support of the USACE's Section 106 consultation process.

Prior to performing surveys, an Area of Potential Effect (APE) would need to be defined, and consultation with SHPO should occur to determine their expectations for cultural resources compliance and potential impacts to historic properties. Permits from SHPO would be required for subsurface probing. If a cultural site is identified through pedestrian survey or probing, SHPO would request delineation of the site through further subsurface excavation and findings that provide an initial statement of significance. If a pre-contact site is identified through survey, the report would also need to be submitted to the appropriate tribes for review (in addition to SHPO).

Because the adjacent TCP is considered eligible for NRHP listing, project impacts to eligibility would likely need to be assessed. Other requirements may be included in permitting regarding recovered artifact review, but specifics on that are difficult to predict at this stage.

If stream and wetland impacts can be avoided and no USACE permit is needed for the project, but there is another federal nexus for the project (e.g., federal funding), NHPA Section 106 consultation requirements would need to be completed by the lead federal agency.

Oregon Department of State Lands (DSL) Removal-Fill Permit

In addition to the USACE Section 404 permit, excavation or fill placement below the OHW level of the stream or within the boundaries of adjacent wetlands would require a Removal-Fill Permit from DSL. A wetland delineation would need to be conducted to accurately determine the stream and wetland boundaries on the site and quantify impacts (if any). If the treatment facilities at the Blue Heron site can be sited to avoid stream and wetland fill entirely, based on an accurate determination of site wetland boundaries, then no permit from DSL would be needed. If the alternative would require wetland fill, then a permit application would need to be submitted to DSL.

DSL and the USACE accept a common Joint Permit Application (JPA) form when reviewing projects for Oregon Removal-Fill Law and Section 404 Clean Water Act permits. As described above, the JPA needs to demonstrate a clear purpose and need for the project and document an evaluation of alternatives that would avoid and minimize stream and wetland impacts. Mitigation would be required by DSL for adverse impacts to jurisdictional waters/wetlands, either through purchase of mitigation credits from a mitigation bank or through permittee-proposed on-site or off-site mitigation (e.g., wetland creation, restoration, or enhancement).

Local Agency Permits

Construction of treatment facilities at the Blue Heron mill site would require land use approval from the City of West Linn. ESA understands that land use issues for this alternatives are being addressed separately and in more detail by another member of the Carollo team. Environmental overlay zones and associated City Community Development Code (CDC) chapters that would need to be considered in the City land use review process are briefly described below.

- Chapter 27: Flood Management Areas

  A flood management area permit is required for all development in the Flood Management Overlay Zone, which includes the entirety of the potential treatment plant location. In general, the regulations of Chapter 27 are intended to site development outside of the Special Flood Hazard Area (SFHA) to the greatest extent possible. Permitting development within the SFHA would require the project to demonstrate compliance with several approval criteria, including not causing an increase in flood elevations and balancing any floodplain fill with an equal amount of excavation (i.e., no net fill). Depending on project details and floodplain impacts, coordination with and submittals to FEMA may be needed to comply with National Flood Insurance Program (NFIP) requirements (e.g., Conditional Letter of Map Revision based on Fill [CLOMR-F]).

- Chapter 28: Willamette and Tualatin River Protection

  A Willamette and Tualatin River Protection Area permit is required for development within HCA on properties within the Willamette Greenway, which includes the entirety of the potential treatment plant location. The City uses the HCA maps to delineate where development should or should not occur, with the intent to avoid or minimize disturbance of HCAs. Permitting development within HCA would require the project to demonstrate compliance with several approval criteria, and mitigation would be required for HCA impacts. Public wastewater treatment facilities are not on the list of "Prohibited Uses" identified in CDC Section 28.050.

- Chapter 32: Water Resource Area Protection

  The vegetated riparian buffer adjacent to the stream on the north side of the potential treatment facility is mapped as a Water Resource Area (WRA) on the City's WRA Map. Permitting development within WRA would require the project to demonstrate compliance with Chapter 32 approval criteria, which include avoiding WRA impacts to the extent possible and mitigating for unavoidable impacts. A field assessment would need to be conducted to verify WRA boundaries and characterize WRA conditions for the land use application.

CONCLUSIONS AND RECOMMENDATIONS

The construction of a new wastewater treatment facility at the Blue Heron mill site would require WES to address a number of environmental resource issues and permitting requirements, as described in this memorandum. The following summary observations and recommendations are provided to highlight key considerations as the alternatives analysis moves forward.

- The need for some federal and state permits including a USACE Section 404 Permit, DEQ 401 Water Quality Certification, and DSL Removal-Fill Permit is dependent on whether or not the construction of the treatment facility would physically impact areas below the OHW level of the site stream or within wetland boundaries. Based on the LWI mapping and on the map of the potential treatment facility footprint provided to ESA by Carollo, it appears that there may be some potential to design the facility to avoid excavation/fill in stream and wetland areas. However, the LWI mapping was completed many years ago (2003) and should be considered an approximation of wetland boundaries. Conducting a formal wetland delineation of Tax Lot No. 31E01BB0100 relatively early in the planning/design process is recommended to determine if there will be stream/wetland impacts and thus determine federal and state permitting needs.

- The potential treatment facility site along the Willamette River is in close proximity to previously documented historic resources and is in an area generally considered to have a high probability for encountering historic resources. If there will be a need for a USACE Section 404 permit and/or if there will be federal funding for the project, ESA recommends that a pedestrian survey and built environment assessment be performed relatively early in the planning/design process to identify potential concerns. A Cultural Resources Assessment Report would ultimately need to be submitted as part of the federal permitting/funding process.

- The potential treatment facility site is located almost entirely within the SFHA (i.e., 100-year floodplain) of the Willamette River, and the entire site is mapped as HCA. City of West Linn CDC regulations are written to prevent and minimize development within SFHA and HCA unless other alternatives are not feasible. Permitting development within SFHA and HCA would require a number of approval criteria to be met and impacts to be mitigated. ESA recommends preliminary coordination with the City of West Linn Planning Department relatively early in the planning process to discuss the feasibility of permitting a treatment facility within SFHA and HCA, in particular.

Thank you again for asking ESA to support your alternatives analysis for WES for the potential construction of a new treatment plant at the Blue Heron mill site. Please let me know any questions, comments, or follow-up information needs you have related to this work.

REFERENCES

City of West Linn, 2019. Community Development Code, Chapters 27, 28, and 32. Reviewed at https://www.codepublishing.com/OR/WestLinn/#!/WestLinnCDC/WestLinnCDCNT.html

City of West Linn, 2020. MapOptix. Reviewed for land use, aerial photographs, environmental resource boundaries, and other information at https://westlinnoregon.gov/maps/mapoptix

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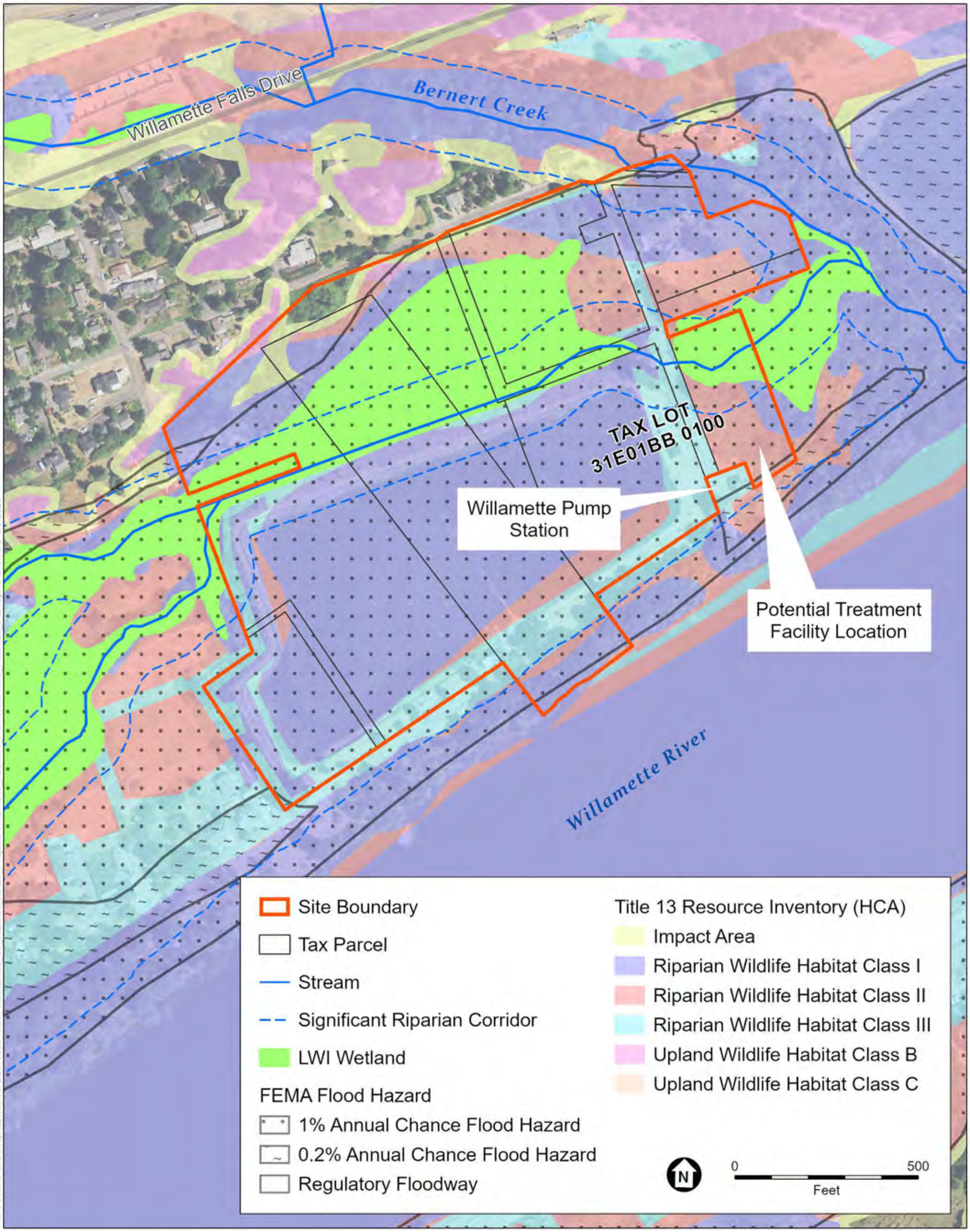
Winterbrook Planning, 2003. City of West Linn Wetland, Riparian and Wildlife Habitat Inventory.



SOURCE: City of West Linn, METRO RLIS, DSL LWI, FEMA

D201900319.00

Figure 1
Environmental Mapping
Blue Heron Paper Mill Site, West Linn, OR

ESA

Appendix C

DRAFT MEMORANDUM - REVIEW OF WES 4TH STREET FACILTIY PERMIT NEEDS

DRAFT MEMORANDUM

To: Brian Matson PE, Carollo Engineers, Inc.
From: Tim Brooks
Date: May 29, 2020
Subject: Draft Review of WES 4th Street Facility Permit Needs

Contents

Introduction

This memo provides a high-level land use assessment of the requirements for a potential new treatment facility in West Linn, Oregon. The review is part of Clackamas County Water Environmental Services' (District) Willamette Facilities Plan Project (#1029-08). This review was requested by Carollo Engineers, Inc., the prime consultant leading the District's Facility Plan project. The subject site is located immediately north of the District's existing Willamette Pump Station at 1185 SE 4th Street in West Linn. The work scope provides for an assessment of local zoning and land use requirements at the site, including potential environmental regulations related to the wetlands, riparian corridors, floodplains, and the Willamette River Greenway.

The memo begins with a brief project description and then reviews each of the main land use and zoning designations that apply to the proposed study site. Table 1 (page 3) summarizes the applicability, review process, timelines, and key criteria for each of the land use/zoning designations. Additional information can be found in the West Linn Community Development Code (CDC) at:
https://www.codepublishing.com/OR/WestLinn/#!/WestLinnCDC/WestLinnCDCNT.html

Project Description

The District is investigating siting options for an "off-site" facility that would be used to treat wastewater on an intermittent basis (ca. 30 days per year). The subject site for the purposes of this memo is part of the old Blue Heron Mill property owned by the District. The proposed facility would provide peak wastewater flow treatment including pumping, screening, solids removal, and disinfection.

Figure 1. Site Location in West Linn

The facility would consist of an above-grade structure that is similar in scale and appearance to the District pump station located south of the site. Limited on-site parking (2-3 vehicles) is expected, but the facility will not be staffed on a regular basis.

Base Zone Use & Development Standards

The proposed facility site at 4th Street is in the General Industrial (GI) base zone. A "sewerage treatment plant" is classified as a major utility in the West Linn CDC. Major utilities are allowed uses in the GI zone. However, while the use is permitted outright, all above-ground development within the zone is subject to the City's Design Review process.

Figure 2. Detail Site Map ("Subject Site")

Development standards applicable to a proposed treatment facility in the GI zone are summarized in Attachment 1. The applicable standards provide minimal setbacks and much flexibility for use of the site but should be reviewed closely and incorporated into any future site design. Parking area and landscape standards will influence the design and layout of the facility. Parking areas must be screened with landscaping and are intended to be less visually prominent in general. Under landscaping standards (CDC Chapter 54), outdoor storage areas, delivery areas, and above-ground utility facilities shall be buffered and screened to obscure their view from adjoining properties and to reduce noise levels.

Table 1. WES Facility at 4th Street – Summary of Key Land Use Permits

Designation	Applicability	Review process/timing	Key Standards/Criteria	Remarks
Base Zone – General Industrial (CDC Chapter 23)	A treatment plant is a Major Utility, which is an outright allowed use.	• Permitted use • Use subject to Design Review per CDC 23.090.B	• See Attachment 1: Development Standards for dimensional standards and additional applicable code (Accessory Uses, Parking, Landscaping, etc.)	Zone well suited to use; this is conditional use in most zones.
Design Review (CDC Chapter 55)	- Applies to Major Utility uses (CDC 23.090.B) and specifically to above-ground improvements - WES project is therefore subject to Design Review	• Pre-app required • Deemed Class II Design Review • Decision by Planning Commission • 3-4 month review	• Approval standards (CDC 55.100) involve: Tree preservation; topography/drainage preservation; architecture standards; pedestrian-oriented design • Public facilities have functional constraints making full compliance difficult, but WES should make its "design sympathetic to surrounding properties by landscaping, setbacks, buffers, and all reasonable architectural means" • Compliance with related Chapters such as parking and landscaping is triggered by CDC 55.100.A	Typically processed concurrent with lower (Planning Director) permits, below
Willamette and Tualatin River Protection (CDC Chapter 28)	- All development within the Willamette and Tualatin River Greenways - The subject site is entirely within the Willamette River Greenway and the regulated Habitat Conservation Area (HCA)	• Pre-app required • Decision by Planning Director • Typically processed together with other permit reviews • Concurrent review (with Design Review): 3-4 months • Separate review: 2-3 months	• Study area is largely within "Medium" HCA designation, with some nearby "High" HCA • Development must be kept within Medium HCA • Mitigation required for HCA disturbance • Structures should be screened/colored/surfaced to blend with riparian environment (CDC 28.110.M) • Water-permeable surfaces required at this site • Minimal/non-direct lighting & other standards apply	City staff interpreted Chapter 28 to impose a 5,000 sq. ft. cap on development within all HCAs. We argued that industrial uses are not subject to cap and staff agrees, only applies in High HCA
Water Resource Area Protection (CDC Chapter 32)	- All development within WRA areas, which include riparian corridors, wetlands, and a 65 ft. buffer from site wetland - WES facility can avoid WRA impact and permit	• Pre-app required • Decision by Planning Director • Same process as above (see remarks)	• Very few allowances for encroachment in WRAs • Development shall be conducted in a manner that will avoid or, if avoidance is not possible, minimize adverse impact on WRAs • Mitigation and re-vegetation of disturbed WRAs required	TBD - There may be advantages to separating the Director reviews from the Planning Commission Design Review
Flood Management Areas (CDC Chapter 27)	- All development in FMA - Project site is within FMA, so permit applies to entire project	• Pre-app required • Decision by Planning Director • Same process as above	• Maintain flood storage and conveyance capacity, no increase to design flood elevations • No net fill increase in floodplain • Lowest floor 1 foot above base flood, or flood-proof	Site was completely flooded during 1996 flood.

Design Review

The proposed facility is classified as a Class II Design Review because it is a new, non-residential use with above ground buildings and/or structures. Only the above-ground improvements are subject to the review. (Note that below ground utility work will be reviewed by the Public Works Department, and both above and below-ground work will be reviewed in Greenway, Water Resource and Flood Management permits, described below.)

Design Review approval standards focus on tree preservation; topography/drainage preservation; architecture standards; and pedestrian-oriented design. The City code acknowledges that certain uses like public facilities have functional constraints that may make full compliance with architectural standards difficult, but promotes public facility design that is "sympathetic to surrounding properties by landscaping, setbacks, buffers, and all reasonable architectural means." Additional standards in other CDC Chapters, such as parking and landscaping, must also be met (CDC 55.100.A).

Class II Design Reviews are reviewed by the City Planning Commission and require a public hearing. The Design Review process and timeline are described in the Review Procedures section, below. In short, it is an approximately three to four-month process following submittal of a complete application. A pre-application is required prior to submittal.

Typically, this Design Review would be processed concurrently with the other required permits described below. As noted below, there may be strategic reasons to consider separating the Planning Commission and Planning Director permit reviews.

Willamette River Greenway

The proposed facility site is located entirely within the Willamette River Greenway zone and the related Habitat Conservation Area (HCA), which is linked to Metro's Title 3 and 13 natural resource plans. Based on a combination of City and Metro mapping, the proposed facility site is largely within a "Medium" HCA designation, with some nearby areas to the north and east mapped as "High" HCA. The existing District pump station and the 4th Street right of way have no HCA designation.

Since the site has both Medium and High HCA, all development must be kept within the lower (Medium) sensitivity habitat area. Given the location of the facility site in Figure 2, this should not be difficult to do. The permit review will look at impacts to identified resource functions and mitigation for any impacts will be required. WRG standards include the following:

- Proposed structures in the HCA should be screened, colored, and/or surfaced to blend in

Figure 3. HCA Map (Class II = Medium HCA)

with the riparian environment. Surfaces must be non-polished/reflective or at least expected to lose their luster within a year.

- Water-permeable materials must be used for surfaces such as parking lots, driveways, patios, and paths (some exceptions apply).
- Lighting must be the minimum necessary and must not create off-site glare or be omni-directional (screens and covers will be required).

City planning staff had previously interpreted Chapter 28 to impose a 5,000 sq. ft. cap on development within all HCAs. We argued that this standard applied to residential uses and industrial uses were not subject to such a cap. In a recent communication, staff agreed and believes that the 5,000 sq. ft. threshold only applies in High HCA areas.

Willamette River Greenway permits are reviewed by the Planning Director who makes an administrative decision. The Greenway process and timeline are described in the Review Procedures section, below. A Director review is an approximately two to three-month process but this permit would typically be processed concurrent with the Design Review (with a slightly longer review process. A pre-application is required prior to submittal.

Note that the Willamette Greenway Trail is located south of the proposed facility site. Since the site does not have frontage on the waterfront or on the trail property, there are no regulatory or incentive-based provisions for trail connections or improvements that apply the development of the District site.

Water Resource Area

Water Resource Areas (WRA) at the site include City-mapped riparian corridors, wetlands and WRA buffer areas, as identified in Chapter 32 and Chapter 2 (Definitions) of the CDC. The site's riparian corridors, wetlands, and a 65 ft. WRA buffer from site wetland are depicted in Figure 4. The buffer is based on the gentle slopes adjacent to the wetland. As evident in the figure, the mapped WRA areas are at the periphery of the proposed development area and the District facility can likely avoid a WRA permit.

Figure 4. Water Resource Areas and buffers

In general, development activities are quite restricted in the WRA, with only limited allowances for encroachment in WRA resource and buffer areas. For unavoidable impacts, mitigation and re-vegetation of disturbed WRAs is required.

WRA permits are reviewed by the Planning Director, following the same process as the Greenway review, above. The Director review process and timeline are described in the Review Procedures section, below. A pre-application is required prior to submittal.

Flood Management Areas

Flood Management Areas (CDC Chapter 27) place limitations on development within the floodplain. The proposed facility site is located entirely within the FMA.

Key development standards that apply to the site include the following:

- Development, excavation, and fill shall be performed in a manner to maintain or increase flood storage and conveyance capacity and not increase design flood elevations
- No net fill increase in any floodplain is allowed. All fill placed in a floodplain shall be balanced with an equal amount of soil material removal. Excavation areas shall not exceed fill areas by more than 50 percent of the square footage.

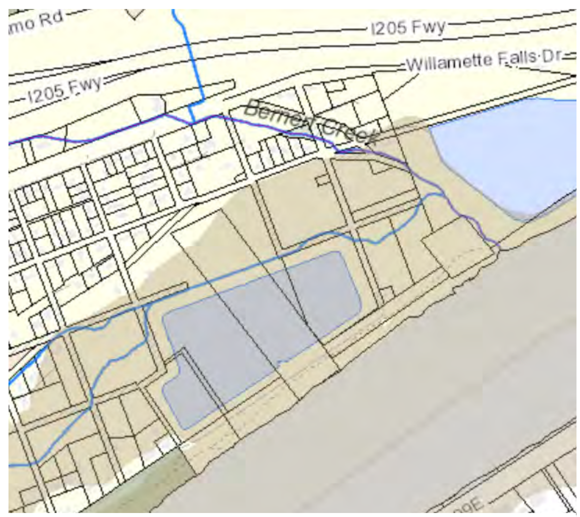


Figure 5. Flood Management Areas (in brown)

- All proposed improvements to the floodplain or floodway which might impact the flood-carrying capacity of the river shall be designed by a professional civil engineer licensed to practice in the State of Oregon.
- The lowest floor shall be elevated to at least one foot above the level of the base flood elevation; or shall meet additional requirements, including that they be flood-proofed and have structural components capable of resisting hydrostatic and hydrodynamic loads and effects of buoyancy.

This site was completely flooded during the 1996 flood. As noted on District facility planning maps, the large lagoon to the west of this site did not flood in 1996.

FMA permits are reviewed by the Planning Director, following the same process as the Greenway and WRA reviews, above. The Director review process and timeline are described in the Review Procedures section, below. A pre-application is required prior to submittal.

Review Procedures

Pre-application Conference

A pre-application conference will be required for the proposed project (the Design Review and each of the permits trigger this, but only one meeting is necessary). At the pre-app, City planning staff will review project plans and provide feedback on the zoning and policy related requirements for the project.

West Linn's pre-application conferences are scheduled on the first and third Thursday of every month, and it takes about two weeks to get on the schedule. City notes from the meeting will be issued within two weeks of the pre-app. The land use application must be filed within 18 months of the pre-app, or a new pre-app will be needed.

Community Meeting

Community outreach is important for any public facility project, even a smaller scale treatment facility that will be operated infrequently. The goal is to solicit feedback and respond to comments and concerns from area neighbors, local neighborhood organizations, and other interest groups.

Any time a project such as this will trigger a land use proceeding, with public notice and a public hearing, it is all the more important to get out in front on potential community concerns since these could affect the outcome of the land use decision. Generally, it is wise to reach out to neighbors beyond the typical land use notice area, which in this case is 500 feet from the site boundary.

Notwithstanding, neighborhood contact is only *required* for certain applications, and the most relevant of these would be for proposals that include a non-residential building of more than 1,500 sq. ft. (CDC 99.038). This is a neighbor and neighborhood association contact requirement and a site posting requirement. Documentation of neighborhood contact is required to be submitted with the land use application.

Review Process

The land use review process is described in CDC 99.060. The "Class II" Design Review is the higher-level of the multiple permits needed; it is reviewed by the City Planning Commission. The FMA, WTPA and the WRA permits are all subject to Planning Director review. Typically, these would be consolidated in one concurrent review with the Design Review application.

Once submitted, the City has 30 days to review the application for "completeness." The Planning Director review takes about two to three months from complete application. The Planning Commission review involves a public hearing and takes a bit longer, from 2.5 to 4 months. A concurrent review would follow the Planning Commission timeline.

The West Linn Planning Commission has sometimes been known for digging into the weeds on projects, and this can have mixed results depending on the project. When the time comes to prepare permit applications and develop a submittal strategy, the project team may want to assess the pros and cons of a combined submittal (the norm) versus potentially applying separately for the Design Review (by Planning Commission) and Planning Director review of the other permits.

The Planning Commission is currently in the process of redefining what constitutes Major and Minor Utilities with the aim of improving impact mitigation. Since the WES facility is already treated as a Major Utility, we do not believe this will impact the WES project in any significant way. A Planning Commission meeting on the subject is scheduled for the first week of June, 2020.

Conclusion

Based on a review of the information provided by Carollo Engineers, Inc., we believe that the proposed District treatment facility can be designed to meet the West Linn CDC regulations at the subject site. Key findings of this high-level review include:

- The proposed treatment facility is an outright permitted use in the GI base zone.
- A new facility will require Design Review, with a public hearing and decision by the City Planning Commission.
- Willamette River Greenway and Flood Management Area permits will also be needed for future site development. These are administrative permits (reviewed by the Planning Director) but may be combined with the Design Review and processed concurrently.
- A Water Resource Area permit can and should be avoided since WRA riparian and wetland buffers are located at the edges of or outside of the planned facility site.

Thank you for reaching out to us with this short-notice request, we are pleased to be of service. Please let us know if you have any questions or comments on this draft memo.

Attachment 1. Selected General Industrial (GI) Development Standards

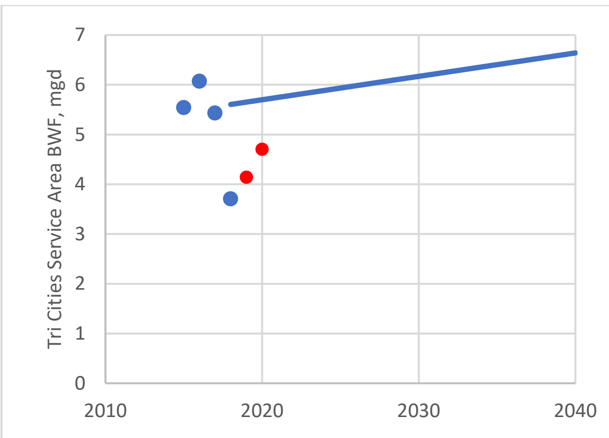
CDC Chapter	Code Reference	Standard	Requirement
Base Zone – General Industrial (Ch. 23)	**CDC 23.070.A.4**	Setbacks	No setbacks under base zone, but subject to Chapter 38 (see below, effective front setback is 5 ft and side/rear setback is 3 ft)
	CDC 23.070.A.5	Maximum lot coverage	50%
	CDC 23.070.A.6	Maximum building height	Since subject site/structure is more than 100 feet from a residential zone: 3.5 stories or 45 feet
Additional Yard Required (Ch. 38)	**CDC 38.020**	Rear/side yard setback the structure will not be built on property line	3 feet
	CDC 38.030	Setback from street centerline	25 feet plus yard required by zone. Since 4th Ave. ROW is 40 ft wide, 25 ft. setback from centerline would mean 5 ft. front setback at site
Off-street Parking (Ch. 46)	**CDC 46.070**	Maximum distance allowed between parking area and use	Not farther than 200 feet from an entryway to the building or use they are required to serve
	CDC 46.150.A.18	Parking design standards	Commercial, office, industrial, and public parking lots may not occupy more than 50 percent of the main lot frontage of a development site. The remaining frontage shall comprise buildings or landscaping. If over 50 percent of the lineal frontage comprises parking lot, the landscape strip between the right-of-way and parking lot shall be increased to 15 feet wide and shall include terrain variations (e.g., one-foot-high berm) plus landscaping.
Landscaping (Ch. 54)	**CDC 54.020.E.2**	Minimum required landscaping	20% of gross site area; parking lot landscaping may be counted
	CDC 54.020.E.3.b	Minimum landscaped area width	5 feet
	CDC 54.020.E.3.d	Perimeter landscaping	When parking abuts ROW: 10-foot strip When parking/loading/driveway abuts adjoining lot: 5-foot strip
	CDC 54.020.E.3.e	Perimeter landscaping when 50% of lineal frontage is parking lot	15-foot strip
	CDC 54.020.E.3.f	Additional landscaped areas	All areas not used for parking, maneuvering, or circulation
	CDC 54.020.E.3.i	Buffering and screening	Outdoor storage areas, service areas (incl. delivery areas), and above-ground utility facilities shall be buffered and screened to obscure their view from adjoining properties and to reduce noise levels to acceptable levels at the property line.

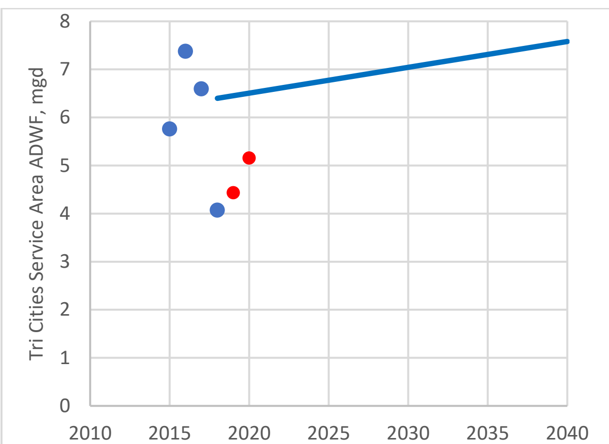
Appendix D

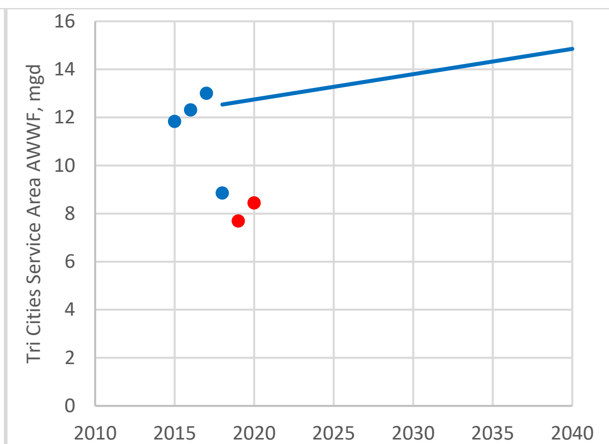
HISTORICAL FLOWS AND LOADS UPDATE

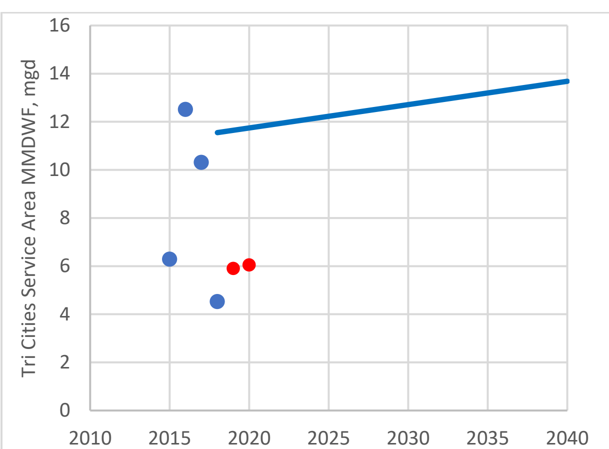
The flows and loads analysis presented in Chapter 3 includes an evaluation of influent flow and load data through the year 2018. Since the analysis was completed, influent flow and load data for the years 2019 and 2020 became available. The flow and load graphs were updated with this new data to determine whether the projected need to be refined. An analysis found that the original projections were sufficient and did not need to be updated. This appendix includes the updated flow and load graphs. The red data points are the next data from 2019 and 2020.

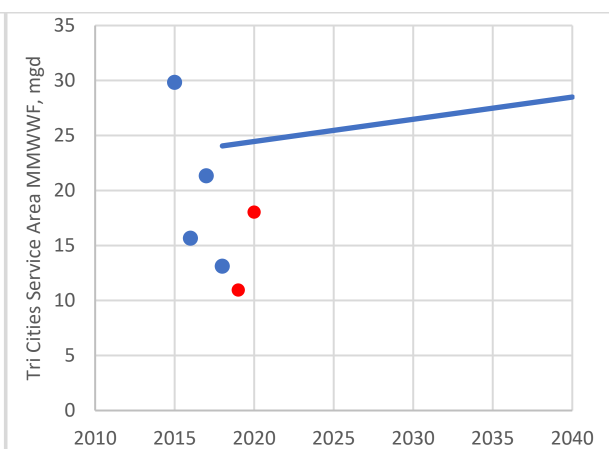
<u>Tri-City Service Area Flows</u>

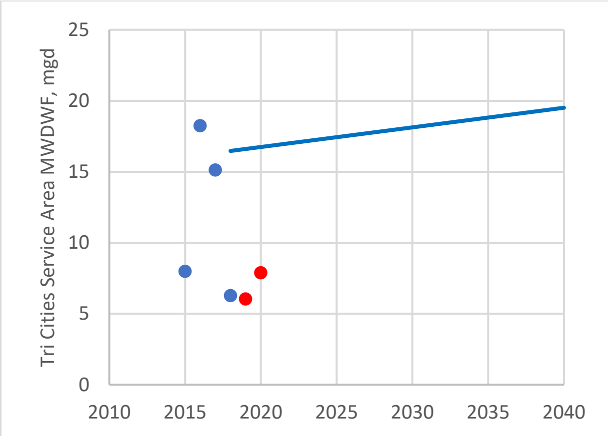








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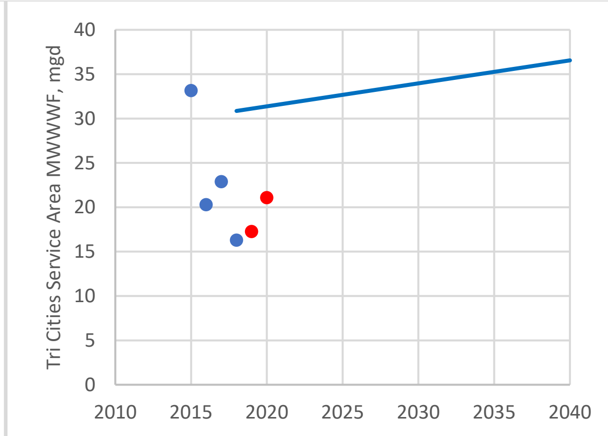
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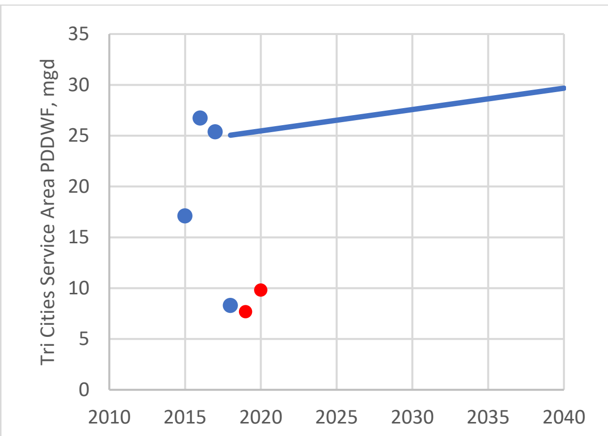
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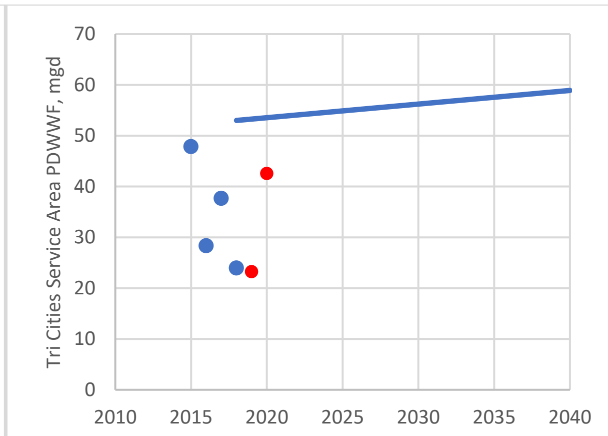
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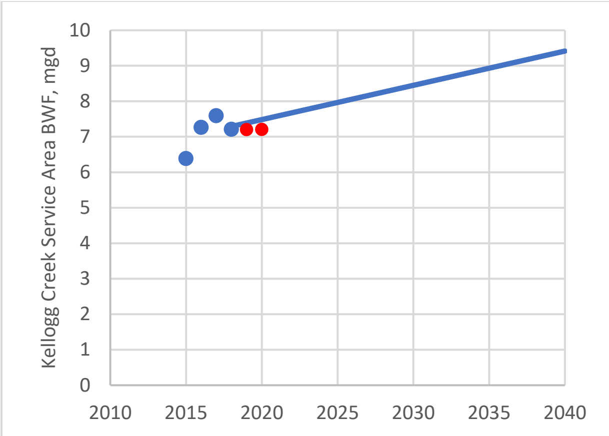

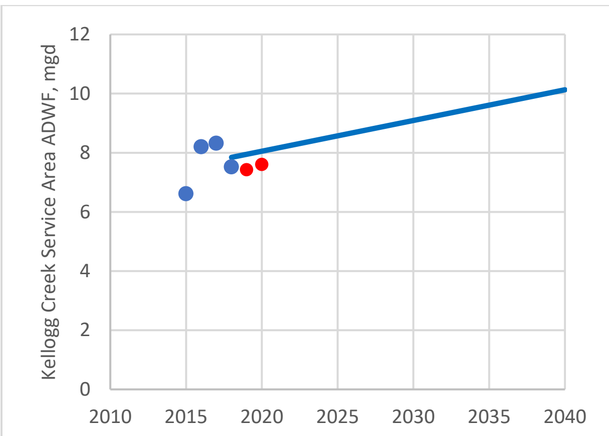

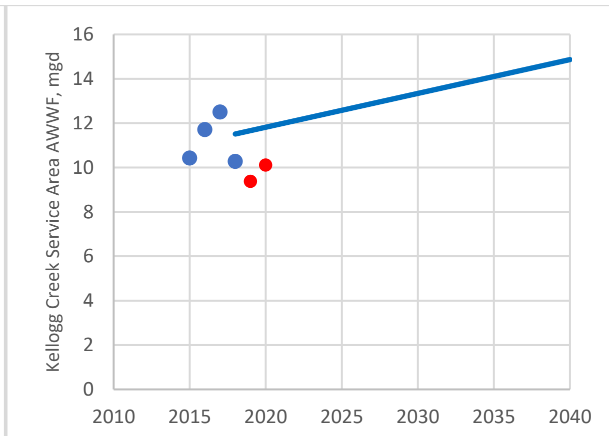

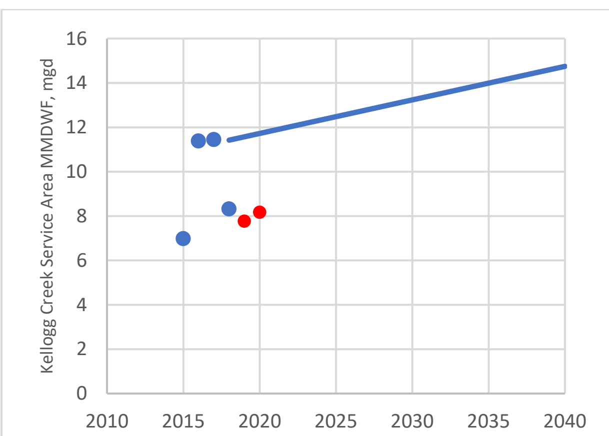

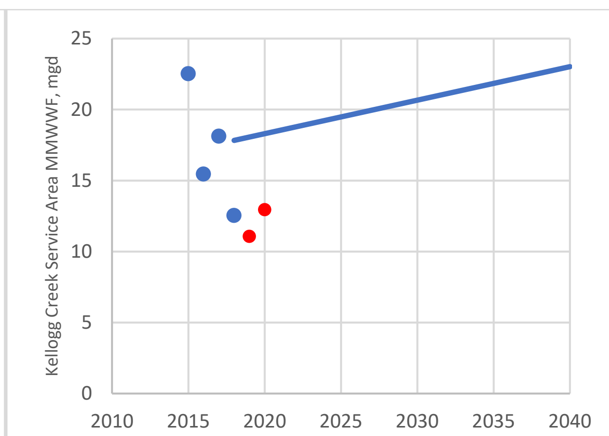

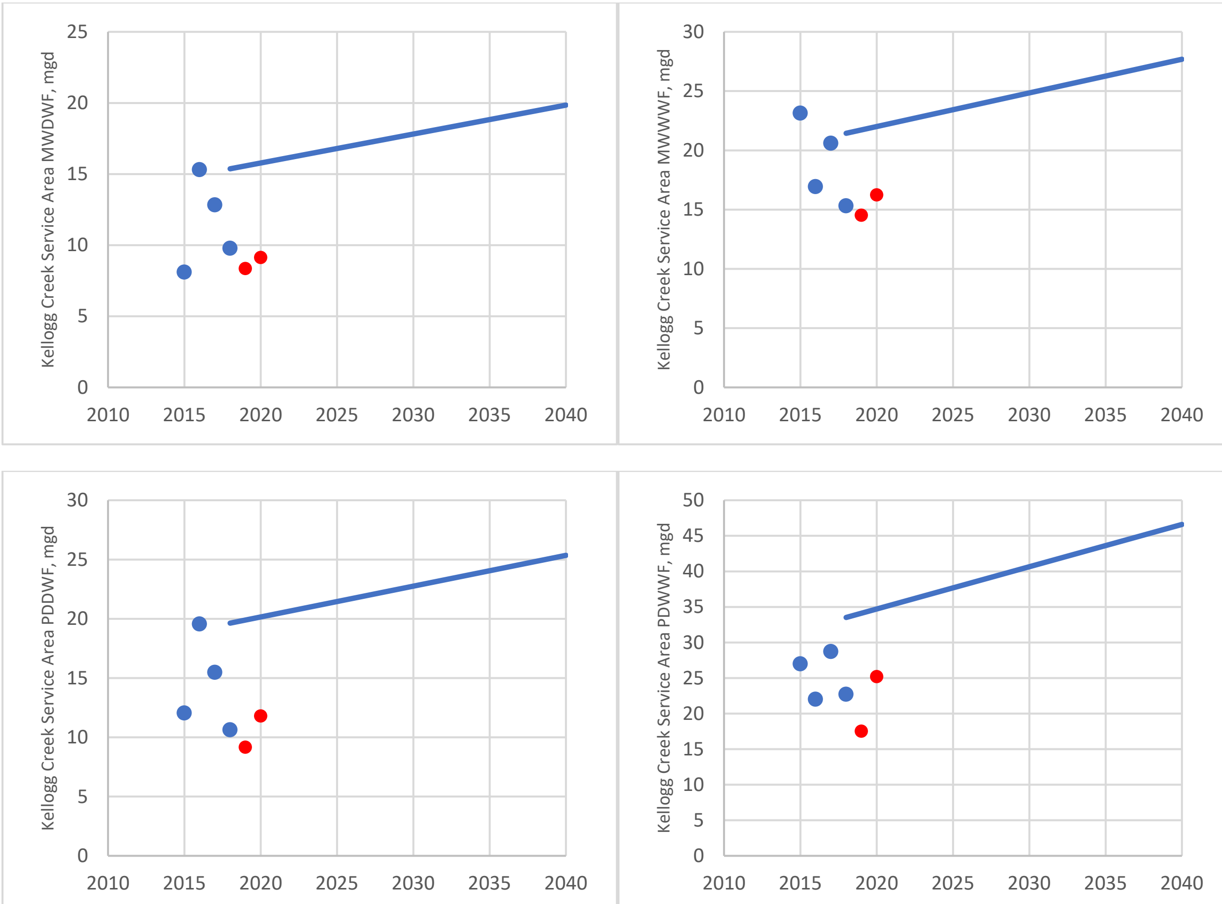
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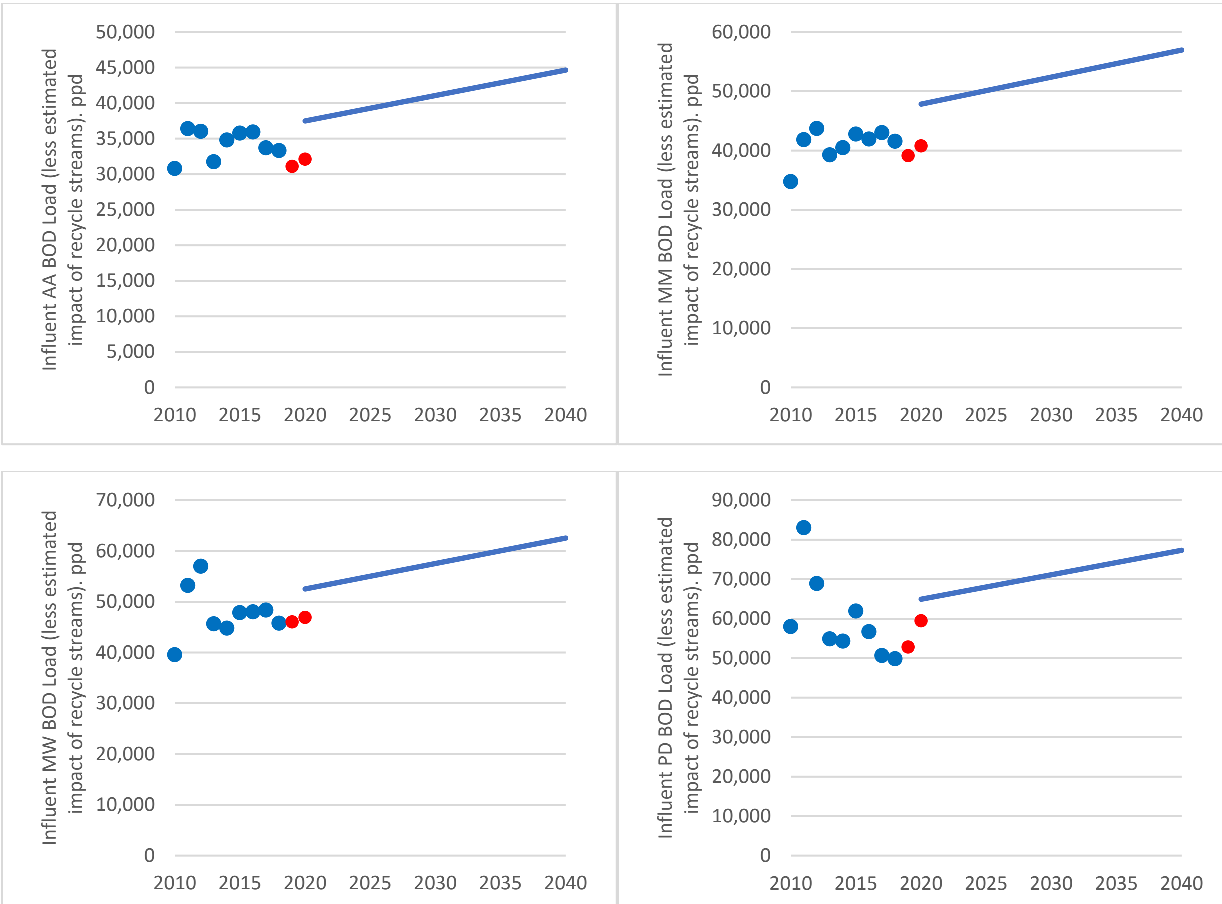
Combined System BOD Loads



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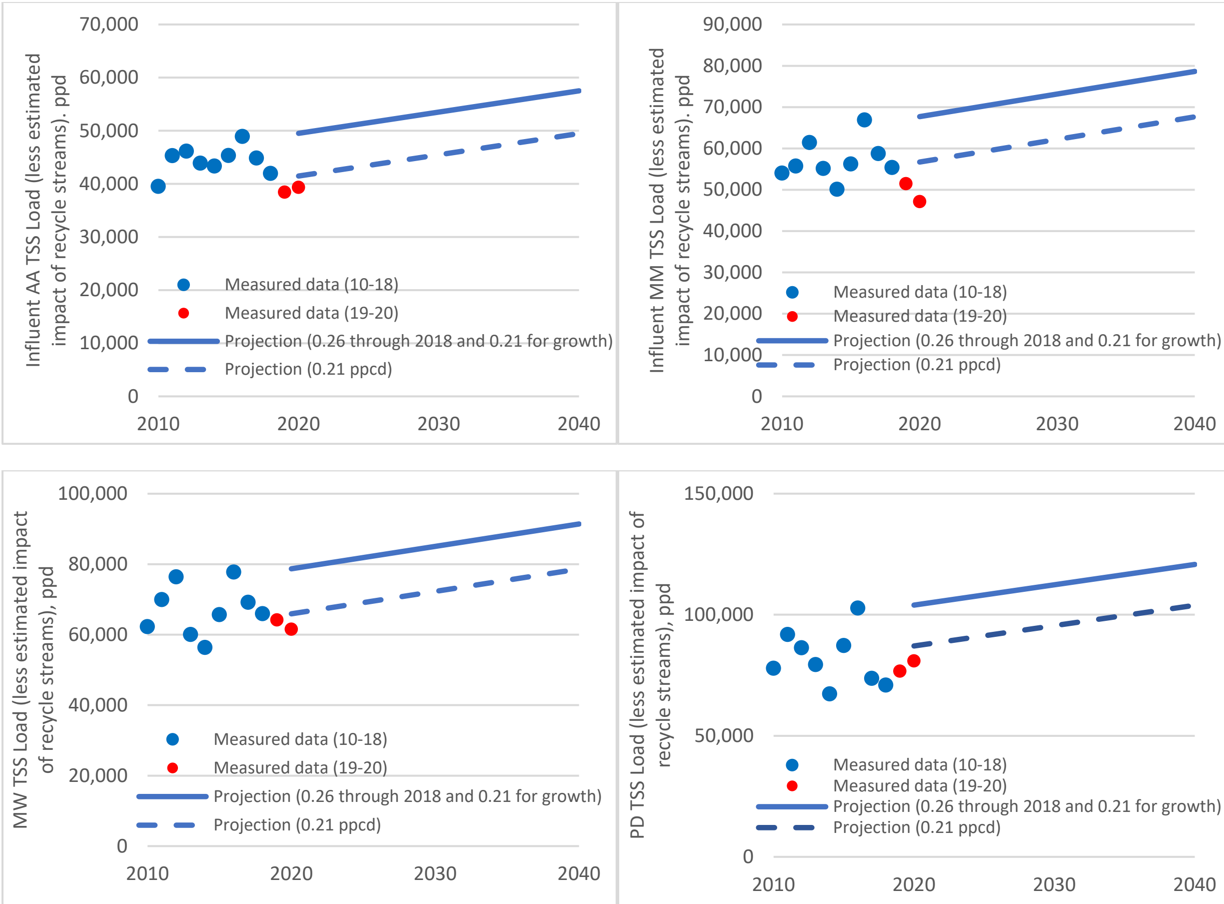

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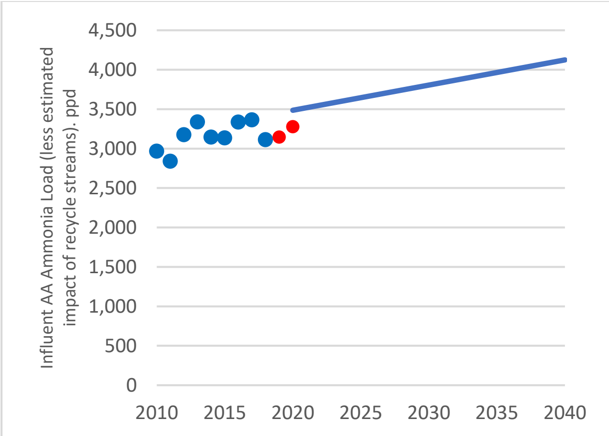

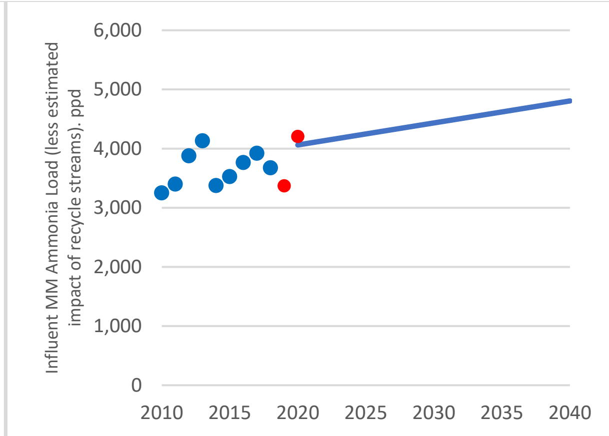

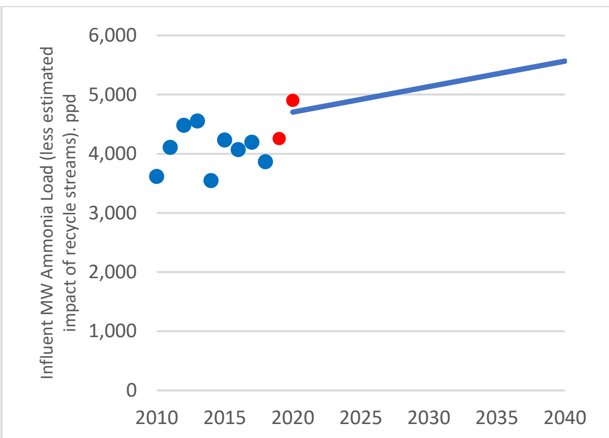

TRI-CITY
FACILITIES PLAN

CLACKAMAS WATER ENVIRONMENT SERVICES

Clackamas Water Environment Services

TRI-CITY FACILITIES PLAN

DRAFT | August 2022

carollo

Clackamas Water Environment Services

TRI-CITY FACILITIES PLAN

DRAFT | August 2022

This document is released for the purpose of information exchange review and planning only under the authority of Brian R. Matson, August 5, 2022, State of Oregon PE No. 66976.

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Abbreviations

°C	degrees Celsius
A2O	anaerobic, anoxic, oxic
AA	average annual
AACE	Association for the Advancement of Cost Engineering
AB	Aeration Basin
ACS	American community survey
ADW	average dry weather
ADWF	average dry weather flow
AO	Anaerobic, Oxic
aSRT	aerobic solids retention time
aSRT	aerobic solids retention time
AWWF	average wet weather flow
BOD	biochemical oxygen demand
BOD_5	five-day biochemical oxygen demand
BWF	base wastewater flow
CAS	conventional activated sludge
CCB	chlorine contact basin
CCSD No. 1	Clackamas County Service District No. 1
CIP	capital improvement plan
CSZ	cascadia subduction zone
CWR	Cold Water Refugia
DAFT	dissolved air flotation thickener
DEQ	Department of Environmental Quality
DF	dilution factors
District	Clackamas Water Environment Services
DMA	designated management agencies
DOGAMI	Department of Geology and Mineral Industries
DS	digested sludge
ELA	engineering, legal, and administration
ENR	Engineering News-Record
FEMA	Federal Emergency Management Agency
ft/hr	feet per hour
GBT	gravity belt thickeners
GDP	gross domestic product
gfd	gallons per square foot per day
gpcpd	gallons per capita per day
gpd	gallons per day
gpd/sf	gallons per day per square foot
gpm	gallons per minute
gpm/sf	gallons per minute per square foot

Guide	Wastewater Facility Planning Guide
hp	horsepower
HRC	high-rate clarification
HRT	hydraulic retention time
I/I	infiltration and inflow
IPS	influent pump station
IWRS	Integrated Water Resources Strategy
lb VS/d-lb VS	pounds per day of volatile solids fed per pound of volatile solids
lbs/day	pounds per day
MAO	Mutual Agreement and Order
MBR	membrane bioreactor
mg/L	milligrams per liter
mgd	million gallons per day
min	minute(s)
mJ/cm2	millijoules per square centimeter
ml	milliliter
mL/g	milliliters per gram
MLE	modified Ludzack-Ettinger
MLR	mixed liquor recycle
MLSS	mixed liquor suspended solids
MLTR	mixed liquor transfer
MM	maximum month
MMDW	maximum month dry weather
MMDWF	maximum month dry weather flow
MMWW	maximum month wet weather
MMWWF	maximum month wet weather flow
MW	maximum week
MWDWF	maximum week dry weather flow
MWWWF	maximum week wet weather flow
N/A	not applicable
NO_3	nitrate
NPDES	National Pollutant Discharge Elimination System
NPV	net present value
O&M	operations and maintenance
OAR	Oregon Administrative Rules
ODFW	Oregon Department of Fish and Wildlife
OH&P	overhead and profit
OOS	out of service
ORS	Oregon Revised Statute
PDDWF	peak day dry weather flow
PDF	peak day flow
PDWWF	peak day wet weather flow

PHF	peak hour flow
Plan	Tri-City Water Resource Recovery Facility Plan
ppd	pounds per day
ppd/sf	pounds per day per square foot
PS	primary sludge
PSB	primary sedimentation basin
PSU	Portland State University
R&R	repair and replacement
RAS	return activated sludge
RMZ	Regulated Mixing Zone
sf	square foot
SOR	surface overflow rate
SPA	state-point analysis
SRF	State Revolving Fund
SRT	solids residence time
ST	select treat
SVI	sludge volume index
SVSLR	specific volatile solids loading rate
SWMACC	Surface Water Management Agency of Clackamas County
TAZ	Transportation Analysis Zones
TCSD	Tri-City Service District
TDH	total dynamic head
TM	technical memorandum
TMDL	total maximum daily loads
TS	total solids
TSS	total suspended solids
TWAS	thickened waste activated sludge
UV	ultraviolet
VFD	variable frequency drive
WAS	waste activated sludge
WES	Clackamas Water Environment Services
WFP	Willamette Facilities Plan
WRRF	Water Resource Recovery Facility
WSE	water surface elevation

Chapter 1

INTRODUCTION

1.1 Introduction

Clackamas Water Environment Services (WES), also referred to as the “District,” prepared three facilities plans for its two wastewater treatment facilities that discharge to the Willamette River. The Willamette Facilities Plan (WFP) describes basin-wide scenarios and recommended treatment and conveyance facilities throughout the District’s service area. The Tri-City Water Resource Recovery Facility (WRRF) Facilities Plan (Plan) defines the implementation of projects that are specific to the Tri-City WRRF. The Kellogg Creek WRRF Plan defines the implementation of projects that are specific to the Kellogg Creek WRRF.

The goal of the Tri-City WRRF Plan is to develop a 20-year capital plan that identifies improvements to the District’s Tri-City WRRF. These improvements are designed to provide the best value to the District's ratepayers by maximizing the use of existing infrastructure and optimizing system operation while continuing to protect water quality and human health and supporting economic development.

1.1.1 Background

WES is an intergovernmental partnership formed pursuant to Oregon Revised Statute (ORS) 190 and owns and operates over 340 miles of conveyance infrastructure and three wastewater facilities that can or do discharge to the Willamette River. The Kellogg Creek WRRF discharges up to 25 million gallons per day (mgd) at River Mile 18.5. The remaining flow is treated at, and discharged from, the Tri-City WRRF at River Mile 25.5.

The District was created in 2016 under ORS 190 as a governmental partnership between Clackamas County Service District No. 1 (CCSD No. 1) and Tri-City Service District (TCSD). WES is managed by the County Department of the same name in a coordinated effort within the overall county organization to provide long-term certainty and stability for its customers.

In June 2017, the Surface Water Management Agency of Clackamas County (SWMACC) joined the partnership. On July 1, 2017, the District began providing wastewater treatment services at the Tri-City and surface water management services to the SWMACC service area. On July 1, 2018, the District began providing wastewater collection and treatment services to the CCSD No. 1 service area and surface water management services within the City of Happy Valley and unincorporated Clackamas County. That same year, the permits for Kellogg Creek, Tri-City, and Blue Heron Paper Mill were integrated under a single entity.

WES now serves as an independent municipal corporation authorized to provide specific services within specified boundaries within Clackamas County. The consolidation associated with the District’s formation creates regulatory and operational opportunities, which the Plan will address.

1.1.2 Purpose

The purpose of the Tri-City WRRF Facilities Plan is to develop, evaluate, and recommend improvements at the Tri-City WRRF as part of the selected basin-wide scenario described in the Willamette Facilities Plan and resulting from condition and capacity assessments.

The Plan was developed in a manner consistent with the District's regional approach to planning and operating its conveyance and treatment facilities, and in accordance with requirements for wastewater planning documents set forth by the Oregon Department of Environmental Quality (DEQ) that support subsequent Clean Water State Revolving Fund (SRF) funding.

1.1.3 Additional Plan Documents

The Tri-City WRRF Facilities Plan was developed simultaneously with the Willamette Facilities Plan and the Kellogg Creek WRRF Facilities Plan, which are considered as supporting planning documents.

The WFP describes the basin-wide scenarios and recommended treatment and conveyance facilities throughout the District's planning area, while the Tri-City WRRF Facilities Plan and the Kellogg Creek WRRF Facilities Plan define the projects that are specific to each facility.

1.1.4 Related Documents

The following sources were used to develop this Plan:

- Portland State University College of Urban & Public Affairs Population Research Center.
- US Census Bureau American Community Surveys, Clackamas County, 2009-2017.
- The Oregon Conservation Strategy, Oregon Department of Fish and Wildlife, 2016.

The following Clackamas County and District reports and plans were also referenced:

- Population Forecasts for Clackamas County Service Districts, August 2016, EcoNorthwest.
- Clackamas County Economic Landscape, Emerging Trends Update, 2017 Update, FCS Group.
- Sanitary Sewer System Master Plan for Water Environment Services, January 2019.
- Tri-City Solids Handling Improvements (TCSHI), 2018.
- Tri-City Site Master Plan, 2013 Update.
- 2018- 2023 WES Capital Improvement Plan, 2018.
- Proposed 2019-2020 WES Fiscal Year Budget, 2019.
- Watershed Action Plan Kellogg-Mt. Scott Watershed, June 2009.
- Watershed Action Plan Rock Creek Watershed, June 2009.

1.2 Plan Requirements

This Plan meetings the requirements of three documents, which are briefly described in this section.

1.2.1 Oregon DEQ Wastewater Facility Planning Guide, July 2019

The Oregon DEQ developed a Wastewater Facility Planning Guide (Guide) to help communities develop and evaluate wastewater alternatives to meet their long-term needs. The Oregon DEQ administers the SRF, which provides below-market rate loads to public agencies for preparing planning and environmental review documents, designing and constructing wastewater facilities, and completing other water quality improvement design and construction projects.

The Guidelines for Preparing Wastewater Planning Documents and Environmental Reports for Public Utilities, last revised in July 2019, outline the required contents of a wastewater planning document. The Tri-City WRRF Facilities Plan, as well as the Kellogg Creek WRRF Facilities Plan and the Willamette Facilities Plan, were prepared in accordance with this Guide.

1.2.2 Oregon's Integrated Water Resources Strategy, 2017 Update

In 2012, the State of Oregon's Water Resource Commission adopted the Integrated Water Resources Strategy (IWRS). The goal was to bring various sectors and interests together to work toward the common goal of maintaining healthy water resources for Oregonians and the environment for generations to come.

The IWRS provides a blueprint to help the state focus its efforts on two key goals: improving the understanding of Oregon's water resources and meeting Oregon's water resources needs. The document discusses critical issues facing the state and recommends actions to address the issues, including meeting its instream and out-of-stream water needs relative to water quantity, water quality, and ecosystem needs. In 2017, the IWRS was updated and introduced nine new recommended actions.

The IWRS-recommended actions applicable to wastewater planning and the District's fulfillment of the actions can be found in the WFP.

1.2.3 Statewide Land Use Goal 11, 2005 Update

In Oregon, the foundation for the statewide program for land use planning is a set of 19 statewide land use planning goals. The objective of Goal 11 is to plan and develop a timely, orderly, and efficient arrangement of public facilities and services to serve as a framework for urban and rural development. This goal directs local governments to establish an urban growth boundary and provide sewer services inside it.

Associated planning documents must describe the boundary and show compliance with Goal 11 and the local comprehensive plan. Wastewater planning documents must also include an affirmative land use compatibility statement from the local government to demonstrate compatibility with the comprehensive plan. The District's fulfillment of this requirement can be found in the WFP.

1.3 Plan Organization

The following is a summary of the Tri-City WRRF Facilities Plan organization by chapter:

- **Chapter 1 - Introduction:** Describes the purpose and need for the Tri-City WRRF Facilities Plan, the Plan requirements, and the Plan scope and organization.
- **Chapter 2 - Planning Area Characteristics:** Describes the Tri-City Service Area and the population and employment trends and projections in the service area.
- **Chapter 3 - Wastewater Flows and Loads:** Presents a summary of the projected wastewater flows and loads for the Tri-City Service Area.
- **Chapter 4 - Permitting and Regulatory Considerations:** Presents information on the regulatory elements that are the primary driver for the immediate and potential future improvements to the Tri-City WRRF.
- **Chapter 5 - Existing WRRF Capacity:** Summarizes the existing capacity at the Tri-City WRRF, including the unit process design criteria.

- **Chapter 6 – Existing WRRF Condition Assessment:** Presents the condition assessment results and recommendations for improvements resulting from field investigations at the Tri-City WRRF.
- **Chapter 7 – Treatment Alternatives:** Summarizes the process to develop, evaluate, and recommend improvements as the Tri-City WRRF as part of the selected basin-wide scenario, and includes the recommended alternatives to improve the WRRF within the planning period.
- **Chapter 8 - Implementation Plan:** Presents the proposed project sequencing, construction schedule and estimated total project cost through the planning year (2040).

Chapter 2

TRI-CITY SERVICE AREA CHARACTERISTICS

2.1 Introduction

This chapter documents key planning area characteristics of the District's Tri-City Service Area. These characteristics are summarized in a manner consistent with the District's regional approach to planning and operating its conveyance and treatment facilities, and in accordance with requirements for wastewater planning documents set forth by the Oregon Department of Environmental Quality (DEQ) that support subsequent Clean Water State Revolving Fund (SFR) funding.

Details of the District's entire planning area, which was used to compare and select basin-wide scenarios, can be found in the Willamette Facilities Plan. This includes land use information and physical characteristics of the District's planning area.

2.2 Tri-City Service Area

This section defines the Tri-City Service Area and briefly describes the Tri-City Water Resource Recovery Facility (WRRF).

2.2.1 Service Area Definition

The Tri-City Service Area is one of three service areas considered by the Willamette Facilities Plan, which are consistent with the planning area considered in the Sanitary Sewer System Master Plan for Water Environment Services (January 2019). The Tri-City Service Area was originally the Tri-City Service District (TCSD) and was renamed Rate Zone 1 when the District began providing services to the area in 2017. Rate Zone 1 will be referred to as the "Tri=City Service Area" in this plan. Figure 2.1 shows the Tri-City Service Area.

The Tri-City Service Area includes the cities of Gladstone, Oregon City, and West Linn, as well as a small number of retail customers. Flow generated within the Tri-City service area is tributary to the Tri-City WRRF.

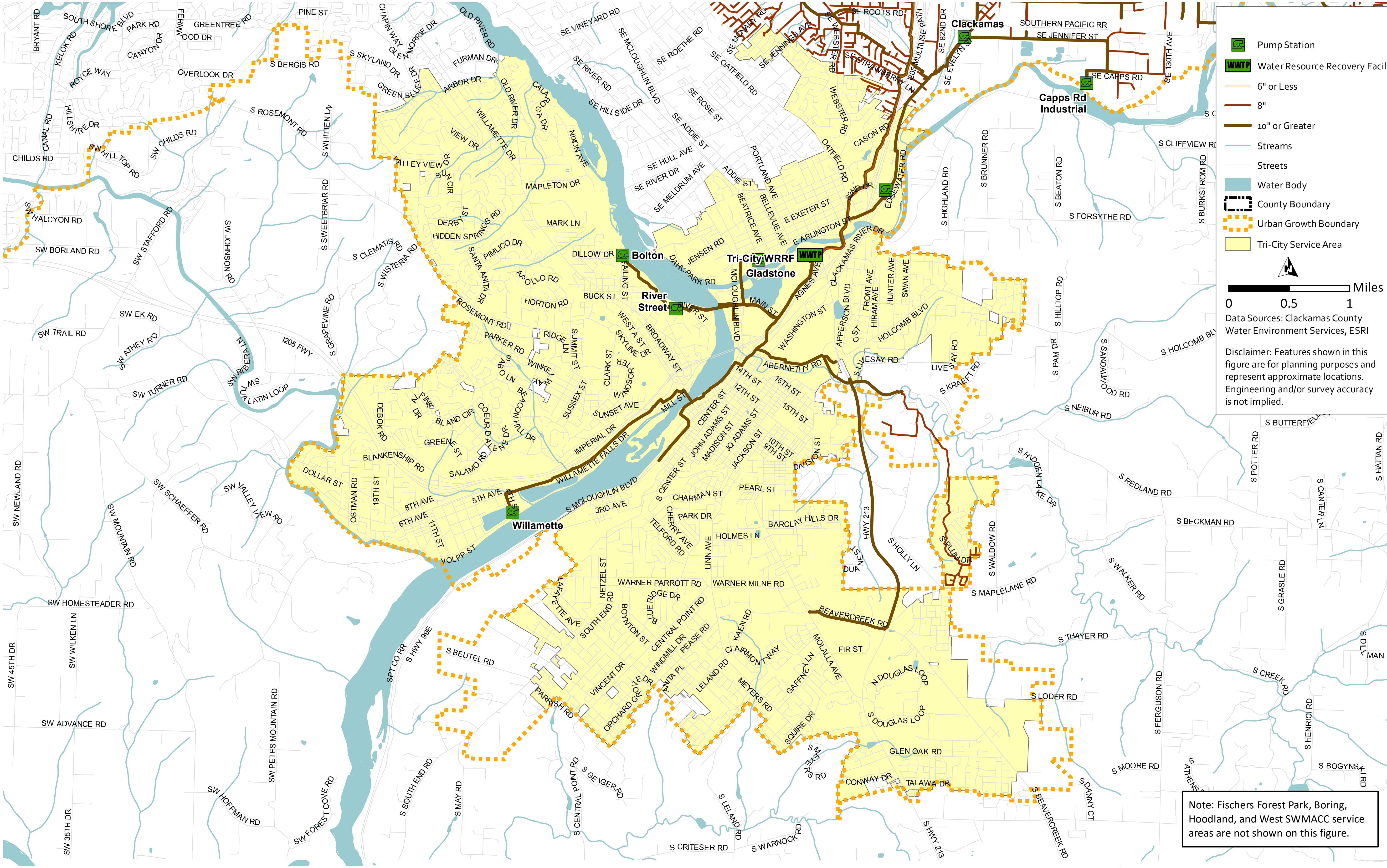


Figure 2.1 Tri-City Service Area Conveyance Infrastructure

2.2.2 Tri-City WRRF Existing Facilities

The Tri-City WRRF is located at 15941 South Agnes Avenue in Oregon City, Oregon. The facility was brought online in 1987 and has a dry weather flow capacity of 11.9 million gallons per day (mgd).

2.2.3 Tri-City Surrounding Area

As shown in Figure 2.2, the Tri-City WRRF is located in Oregon City at the confluence of the Clackamas River and the Willamette River. The facility is bounded by I-205 to the south and east, and the Clackamas River to the north and west.

Clackamette Cove, which was once a gravel quarry, is located directly west of the facility. The Old Rossman Landfill, which used to be a municipal garbage landfill, is located directly south of the facility.

The site is approximately 40 to 50 ft above sea level. The facility is located within FEMA's 100-year floodplain for the Clackamas River, creating a flood hazard for the site.

Metro classifies the Tri-City WRRF site as a Riparian Class I habitat, which is an area supporting three or more riparian functions. Directly north of the facility, between the site and the Clackamas River, is a designated wetlands area. According to Oregon Department of Fish and Wildlife's (ODFW) Conservation Strategy, this site is a strategy habitat because of the wetlands and because the site contains a flowing river and riparian habitat.

ODFW identified the Willamette River and the Clackamas River as habitat for the following native fish that are endangered, threatened, or vulnerable species:

- Fall and spring chinook.
- Coho.
- Pacific lamprey.
- Summer and winter steelhead.
- Coastal cutthroat trout.

The dominant soils at the site include Quaternary surficial deposits, alluvial deposits, and mixed grained sediments. According to Department of Geology and Mineral Industries (DOGAMI), a Cascadia Subduction Zone (CSZ) earthquake could produce severe shaking at the facility and the potential landslide hazard is high.

Figure 2.2 Tri-City WRRF Vicinity Map

2.3 Population and Employment

Population and employment trends are significant factors in the planning for wastewater conveyance and treatment facilities. This section describes the trends and projections used to determine future flows and loads as part of this plan.

2.3.1 Local Industry

Clackamas County's principal economic activities include agriculture, timber, manufacturing, and commerce. According to the Clackamas County Economic Landscape Emerging Trends Update from 2017, the gross domestic product (GDP) for 2015 was $18.8 billion. The 2015 GDP was up from $17.6 billion in 2014 and $18.1 billion in 2013. The top industries in Clackamas County, in order of annual GDP contribution to Clackamas County, are as follows:

- Professional business services.
- High-tech manufacturing.
- Wholesale trade.
- Healthcare.
- Advanced manufacturing – metals and machinery.
- Software & media production.
- Transportation & distribution.
- Agriculture & food production.
- Food & beverage processing.
- Nurseries and greenhouses.
- Wood manufacturing.

2.3.2 Socio-Economic Trends

The US Census Bureau conducted an annual American community survey (ACS) to help local officials and businesses understand changes in their communities. The ACS provides data on jobs and occupations, educational attainment, and homeownership, in addition to other population trends. Table 2.1 summarizes socio-economic statistics and trends from 2009 to 2017 for Clackamas County.

Table 2.1 Clackamas County Socio-Economic Trends

Clackamas County	2009	2013	2017
Unemployment(1)	11.3%	7.2%	3.8%
Median household income (dollars)(2,3)	$74,905	$76,549	$72,408
Median nonfamily income (dollars)(2,3)	$36,266	$37,812	$42,366
Education: high school graduate or higher(2)	91.9%	93.1%	93.9%
Education: Bachelor's degree or Higher(2)	30.0%	30.9%	34.9%
Below poverty level(2)	No data	9.8%	9.0%

Notes:
(1) Source: WES 2019-2020 Fiscal Year Budget.
(2) Source: U.S. Census Bureau American Community Surveys.
(3) Due to lack of 2009 data, 2010 data is shown.

According to Table 2.1, the economic trend for Clackamas County was generally positive from 2009 to 2017, with the unemployment rate steadily decreasing since 2009. Although the median household income decreased between 2013 and 2017, the median nonfamily income increased by approximately 18 percent from 2010 to 2017. Also, education levels increased from 2009 to 2017, and poverty decreased between 2013 and 2017.

2.3.3 Current Tri-City Service Area Populations

As of 2018, the estimated population for the District's Tri-City Service Area is approximately 72,145 people (Source: WES 2019-2020 Fiscal Year Budget).

2.3.4 Household and Employment

Table 2.2 summarizes the household and employee projections for the District's planning area, per the Sanitary Sewer System Master Plan for Water Environment Services. Note, a separate projection of the number of households and employees in the Tri-City Service was not determined.

Table 2.2 Planning Area Household and Employee Projections

	2015	2040
Number of households	76,200	84,700
Number of employees	102,600	123,000

Notes:
(1) Source of data is the Sanitary Sewer System Master Plan for Water Environment Services.
(2) Projections are for the District's entire planning area and are not specific to the Tri-City Service Area.

2.3.5 Tri-City Service Area Population Projections

In 2016, EcoNorthwest completed growth estimates for the various jurisdiction within the District's planning area (Population Forecasts for Clackamas County Service Districts, August 2016). The 20-year population forecasting efforts started with Portland State University (PSU) Population Research Center 2015 certified population estimates and the 2018 Oregon Metro Regional Transportation Plan.

Region-wide forecasts were allocated into Metro Transportation Analysis Zones (TAZ). Population projections included in this chapter were previously reviewed by local jurisdictions. Projections were prepared separately for the Tri-City Service Area.

The EcoNorthwest population projections by jurisdiction for the Tri-City Service Area through the year 2040 are summarized in Table 2.3. Figure 2.3 shows the population projections graphically. The Tri-City Service Area population is forecasted to increase approximately 28 percent from 2015 through 2040. As shown in Figure 2.3, Oregon City will have the largest percent increase in population growth in the Tri-City Service Area between 2015 and 2040.

Table 2.3 Tri-City Service Area Population Projections

Jurisdiction	2015	2020	2025	2030	2035	2040
Gladstone(1)	11,505(1)	11,703	11,723	11,765	11,737	11,714
Oregon City(1)	33,940(1)	38,599	41,711	44,529	46,201	47,534
West Linn(1)	25,605(1)	27,794	28,559	29,068	29,185	30,087
Tri-City Service Area Total(2)	**69,406**	**76,565**	**80,621**	**84,185**	**86,308**	**88,766**

Notes:
(1) Certified Population Estimate, Portland State University, December 2015.
(2) EcoNorthwest growth estimate refers to the Tri-City Service Area as TCSD.

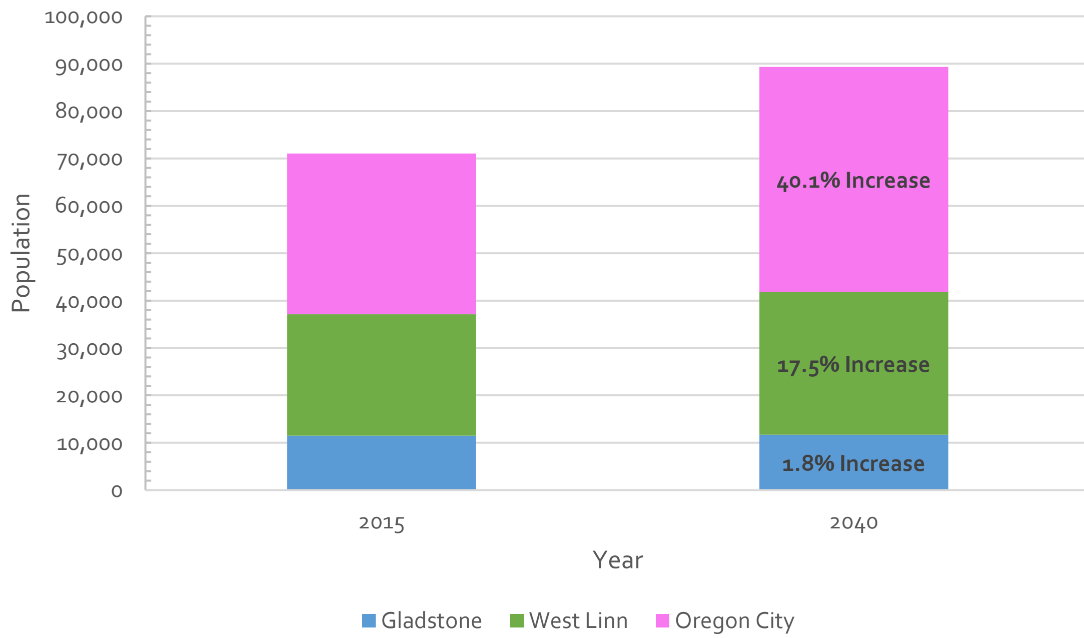


Figure 2.3 Tri-City Service Area Population Projection

2.3.6 Buildout Projections

According to the Sanitary Sewer System Master Plan for Water Environment Services (Master Plan), buildout for the District's planning area is projected to occur in 2087 when the population is anticipated to reach 360,900 people. Buildout utilized per capita dry flows at the lower end of the range reported in Table 3-6 of the Master Plan (approximately 54 gallons per capita per day [gpcpd]). By 2087, 44 percent of the District's service area population is projected to be in the Tri-City Service Area and 56 percent in the Kellogg Creek Service Area (approximately 43 percent upstream of Intertie 2 Pump Station and 13 percent downstream of the Intertie 2 Pump Station).

When buildout is reached in 2087, employment in the District's service area is anticipated to reach 206,500 employees. The buildout utilized per employee dry flows at the lower end of the range reported in Table 3-6 of the Master Plan (approximately 40 gpcpd). By 2087, 37 percent of employees are projected to be in the Tri-City Service Area and 63 percent in the Kellogg Creek Service Area (53 percent upstream of Intertie 2 Pump Station and 10 percent downstream of the Intertie 2 Pump Station).

Chapter 3

WASTEWATER FLOWS AND LOADS

3.1 Introduction

This chapter summarizes the wastewater flow and loads projections for the Tri-City Service Area. The Willamette Facilities Plan provides a more detailed evaluation of the historical wastewater flows and loads generated in the Tri-City service area and the development of the flow and load projections.

3.2 Flow and Load Parameters

The flow parameters of primary interest for planning purposes are defined below. With the exception of base wastewater flow and peak day dry weather flow, which were determined through analysis of historical plant records, two methods were used to define existing flows: 1) analysis of historical plant records; and 2) Oregon State DEQ Guidelines for Making Wet-Weather and Peak Flow Projections for Sewage Treatment in Western Oregon, herein described as the DEQ methodology. In each case, the most reasonable and conservative value was selected as the bases for determining the capacity of the Tri-City WRRF and was used for subsequent alternatives evaluation:

1. **Base Wastewater Flow (BWF):** The average daily flow in the months of July and August.
2. **Average Dry Weather Flow (ADWF):**
   a. The average of daily flows over the six-month dry weather season, May 1 through October 31.
   b. The average flow during May through October corresponding to long-term average rainfall for the period from May through October.
3. **Average Wet Weather Flow (AWWF):**
   a. The average flow at the plant during the wet weather season, November 1 through April 30.
   b. The average flow during November through April corresponding to long-term average wet weather rainfall.
4. **Maximum Month Dry Weather Flow (MMDWF):**
   a. The maximum 30-day running average flow occurring during the months of May through October.
   b. The average monthly flow corresponding to the wettest dry weather month of high groundwater (May) with a 10 percent probability of occurrence in any given year.
5. **Maximum Month Wet Weather Flow (MMWWF):**
   a. The maximum 30-day running average flow occurring during the months of November through April.
   b. The anticipated monthly average flow corresponding to the wettest wet weather month of high groundwater (January) with a 20 percent probability of occurrence in any given year.
6. **Maximum Week Dry Weather Flow (MWDWF)**: The maximum 7-day running average flow from May through October.
7. **Maximum Week Wet Weather Flow (MWWWF):** The maximum 7-day running average flow from November through April.
8. **Peak Day Dry Weather Flow (PDDWF):** The maximum daily flow from May through October.

9. **Peak Day Wet Weather Flow (PDWWF):**
   a. The maximum daily flow from November through April.
   b. The anticipated daily flow resulting from a 24-hour storm with a 1-in-5-year recurrence interval during a period of high groundwater and saturated soils.
10. **Peak Hour Flow (PHF):** The peak flow sustained for a one-hour period during the 24-hour, five-year return frequency storm, at a time when groundwater levels are high, and soils are saturated by previous storms.

In addition to these flow parameters this chapter considered the following parameters for BOD and TSS loads:

1. **Average Annual (AA):** The average load over a calendar year.
2. **Maximum Month (MM):** The maximum 30-day running average load.
3. **Maximum Week (MW):** The maximum 7-day running average load.

3.3 Summary of Flow Projections

Table 3.1 summarizes the base BWF for 2018, 2040, and buildout based on the projected population growth, as shown in Chapter 2.

Table 3.2 summarizes the projected flows for the Tri-City Service Area. ADWF, AWWF, MMDWF, MMWWF, MWDWF, MWWWF, and PDDWF were projected by multiplying the resulting BWF projection by the peaking factors developed for each parameter, as presented in the Willamette Facilities Plan. Since the peak flows (PDWWF and PHF) are more related to collection system age and ground water infiltration than population growth, the collection system model developed during the Sanitary Sewer Master Plan (2019, Jacobs) was used to project PDWWF and PHF.

Table 3.1 Tri-City Service Area BWF Projection

	2018	2040	Buildout
Population	73,700	88,800	158,800
Per capita flow	76	76	76
Residential BWF, mgd	5.6	6.8	12.1
Industrial Flow, mgd(1)	0.55	0.55	0.55
Septage Flow, mgd(2)	0.008	0.01	0.01
Total BWF, mgd	6.2	7.3	12.7

Notes:
(1) Industry flow projections taken from the Tri-City Water Resource Recovery Facility Solids Handling Improvement Project TM3 Projected Future Flows and Loads (2016, Stantec). Since the 2015 and 2020 values were both 0.55 mgd, the 2018 industrial flow was set equal to 0.55 mgd.
(2) Septage flow projections taken from the Tri-City Water Resource Recovery Facility Solids Handling Improvement Project TM3 Projected Future Flows and Loads (2016, Stantec). 2018 value is a linear interpolation between the 2015 value of 0.005 and the 2020 value of 0.01.

Table 3.2 Tri-City Service Area Flow Projection Summary

Flow Component	2018	2040	Buildout
BWF	6.2	7.3	12.7
ADWF	7.1	8.5	14.6
MMDWF	12.7	15.1	26.1
MWDWF	18.3	21.7	37.4
PDDWF	28.0	33.2	57.4
AWWF	13.5	16.0	27.7
MMWWF	21.5	25.5	44.0
MWWWF	34.7	41.2	54.0
PDWWF	53.0	58.2	65.2
PHF	65.1	72.2	80.0

3.4 Summary of Combined Load Projection

A detailed analysis of the historical and existing loads for the District's Tri-City and Kellogg Creek services areas can be found in the Willamette Facilities Plan. Unlike flows, which can be highly variable depending on the age and condition of the service area collection system, residential loads are typically similar between different service areas. For this reason, loads for both the Tri-City and Kellogg Creek service areas were developed together for planning purposes.

Table 3.3 summarizes the results of the per capita analysis for each load parameter, and shows the per capita value used for the load projections. Projected loads were developed by first projecting the average load from 2018 to current accounting for the anticipated growth in the residential population, industry, and septage. Table 3.4 summarizes the average annual, maximum month, and maximum week load projections for 2018, 2040, and buildout conditions. Note, the projected average annual loads and load projections are for both the Tri-City and Kellogg Creek service areas.

Table 3.3 Projected AA Loads for District's Planning Area

	Population	Per Capita Load, ppcd	Residential AA, ppd	Industrial Load, ppd	Septage Load, ppd	Total AA, ppd
BOD						
2018	174,100	0.19	32,700	3,000	600	36,300
2040	218,400	0.19	41,000	3,000	600	44,600
Buildout	360,900	0.19	67,800	3,000	600	71,400
TSS						
2018	174,100	0.21	36,600	2,000	1,500	40,000
2040	218,400	0.21	45,900	2,000	1,600	49,500
Buildout	360,900	0.21	75,800	2,000	1,600	79,400
Ammonia						
2018	174,100	0.017	2,920	400	66	3,380
2040	218,400	0.017	3,360	400	66	4,120
Buildout	360,900	0.017	6,050	400	66	6,510

	Population	Per Capita Load, ppcd	Residential AA, ppd	Industrial Load, ppd	Septage Load, ppd	Total AA, ppd
Total Phosphorus						
2018	174,100	0.007	1,220	NA	NA	1,220
2040	218,400	0.007	1,530	NA	NA	1,530
Buildout	360,900	0.007	2,530	NA	NA	2,530

Notes:

(1) Industry load projections taken from the *Tri-City Water Resource Recovery Facility Solids Handling Improvement Project TM3 Projected Future Flows and Loads* (2016, Stantec). Since there was no change in the load between 2015 and 2020, these values were assumed for 2018 as well.

(2) Septage flow projections taken from the *Tri-City Water Resource Recovery Facility Solids Handling Improvement Project TM3 Projected Future Flows and Loads* (2016, Stantec). 2018 value is a linear interpolation between the 2015 and the 2020.

Table 3.4 Load Projections for District's Planning Area

Load Parameter	2018	2040	Buildout
TSS			
AA	40,000	49,500	79,400
MM	54,800	67,600	108,600
MW	63,700	78,600	126,200
BOD			
AA	36,300	44,600	71,400
MM	46,300	57,000	91,100
MW	50,900	62,500	100,000
Ammonia			
AA	3,380	4,120	6,510
MM	3,940	4,810	7,590
MW	4,560	5,570	8,790
Total Phosphorus			
AA	1,220	1,530	2,530
MM	1,420	1,780	2,940
MW	1,640	2,060	3,410

3.5 Summary of Treatment Flows and Loads

With the District's existing permit, the Kellogg Creek WRRF can treat up to its hydraulic limit of 18 million gallons per day (mgd) through secondary treatment and 25 mgd with select treat. The remainder of the Kellogg Creek service area flows and loads are diverted to the Tri-City WRRF through the Intertie 2 Pump Station. Tables 3.5 through 3.7 summarize the anticipated flow distribution between the District's two facilities with the existing permit and assuming that the Kellogg Creek WRRF treats as much of the Kellogg Creek service area flows and loads as it has capacity to treat, with the exception that dry weather flows are capped such that the solids loads to the Kellogg Creek WRRF do not exceed the projected wet weather solids loads. This exception minimizes the necessary solids improvements at the Kellogg Creek WRRF while taking advantage of excess dry weather capacity at the Tri-City WRRF.

Table 3.5 2018 Existing Permit Condition Treatment Plant Flows and Loads

	Kellogg Creek	Tri-City	Total
Flows			
BWF	7.3	6.2	13.5
ADWF	8.0	7.1	15.1
MMDWF	11.5	12.7	24.2
MWDWF	13.3	20.4	33.7
PDDWF	18.0	29.7	47.7
AWWF	11.9	13.5	25.4
MMWWF	17.1	21.5	38.6
MWWWF	18.0	39.9	57.9
PDWWF	25.0	61.5	86.5
PHF	25.0	81.3	106.3
BOD			
ADW	18,900	17,400	36,300
MMDW	24,100	22,300	46,300
MWDW	22,700	28,100	50,900
AWW	18,900	17,400	36,300
MMWW	24,100	22,300	46,300
MWWW	20,500	30,400	50,900
TSS			
ADW	21,100	19,000	40,000
MMDW	28,800	25,900	54,800
MWDW	28,800	34,800	63,700
AWW	21,100	19,000	40,000
MMWW	28,800	25,900	54,800
MWWW	26,000	37,600	63,700
Ammonia			
ADW	1,700	1,700	3,400
MMDW	2,000	2,000	3,900
MWDW	2,000	2,600	4,600
AWW	1,700	1,700	3,400
MMWW	2,000	2,000	3,900
MWWW	1,800	2,800	4,600
Total Phosphorus			
ADW	700	500	1,200
MMDW	800	600	1,400
MWDW	800	800	1,600
AWW	700	500	1,200
MMWW	800	600	1,400
MWWW	700	900	1,600

Table 3.6 2040 Existing Permit Condition Treatment Plant Flows and Loads

	Kellogg Creek	Tri-City	Total
Flows			
BWF	9.5	7.3	16.8
ADWF	10.3	8.5	18.7
MMDWF	12.1	17.8	29.9
MWDWF	14.0	27.6	41.6
PDDWF	18.0	40.7	58.7
AWWF	15.4	16.0	31.4
MMWWF	18.0	29.6	47.6
MWWWF	18.0	53.1	71.1
PDWWF	25.0	80.5	105.5
PHF	25.0	104.4	129.4
BOD			
ADW	24,400	20,300	44,600
MMDW	25,300	31,600	57,000
MWDW	23,900	38,600	62,500
AWW	24,400	20,300	44,600
MMWW	25,300	31,700	57,000
MWWW	20,500	42,000	62,500
TSS			
ADW	27,200	22,200	49,500
MMDW	30,300	37,300	67,600
MWDW	30,300	48,300	78,600
AWW	27,200	22,200	49,500
MMWW	30,300	37,300	67,600
MWWW	26,000	52,600	78,600
Ammonia			
ADW	2,200	2,000	4,100
MMDW	2,100	2,700	4,800
MWDW	2,100	3,500	5,600
AWW	2,200	2,000	4,100
MMWW	2,100	2,700	4,800
MWWW	1,800	3,800	5,600
Total Phosphorus			
ADW	900	600	1,500
MMDW	900	900	1,800
MWDW	900	1,200	2,100
AWW	900	600	1,500
MMWW	900	900	1,800
MWWW	700	1,300	2,100

Table 3.7 Buildout Existing Permit Condition Treatment Plant Flows and Loads

	Kellogg Creek	Tri-City	Total
Flows			
BWF	12.0	15.4	27.4
ADWF	12.0	18.6	30.6
MMDWF	12.7	36.5	49.1
MWDWF	14.7	53.9	68.5
PDDWF	18.0	79.1	97.1
AWWF	18.0	33.7	51.7
MMWWF	18.0	60.5	78.5
MWWWF	18.0	82.7	100.7
PDWWF	25.0	128.1	153.1
PHF	25.0	162.8	187.8
BOD			
ADW	28,500	42,900	71,400
MMDW	26,600	64,600	91,100
MWDW	25,100	74,900	100,000
AWW	28,500	43,000	71,400
MMWW	25,300	65,800	91,100
MWWW	20,500	79,500	100,000
TSS			
ADW	31,800	47,600	79,400
MMDW	31,800	76,700	108,600
MWDW	31,800	94,400	126,200
AWW	31,800	47,600	79,400
MMWW	30,300	78,300	108,600
MWWW	26,000	100,200	126,200
Ammonia			
ADW	2,500	4,000	6,500
MMDW	2,200	5,400	7,600
MWDW	2,200	6,600	8,800
AWW	2,500	4,000	6,500
MMWW	2,100	5,500	7,600
MWWW	1,800	7,000	8,800
Total Phosphorus			
ADW	1,100	1,500	2,500
MMDW	900	2,000	2,900
MWDW	900	2,500	3,400
AWW	1,100	1,500	2,500
MMWW	900	2,100	2,900
MWWW	700	2,700	3,400

Chapter 4

PERMITTING AND REGULATORY CONSIDERATIONS

4.1 Introduction

This chapter summarizes the permitting and regulatory considerations that were considered when developing, evaluating, and selecting near-term and potential future improvements to the Tri-City WRRF.

4.2 Framework

It is the responsibility of the Oregon DEQ to establish and enforce water quality standards that preserve the Willamette River's beneficial uses. The DEQ's general policy is one of antidegradation of surface water quality. Discharges from wastewater treatment plants are regulated through the National Pollutant Discharge Elimination System (NPDES). All discharges of treated wastewater to a receiving stream must comply with the conditions of an NPDES permit. The Environmental Protection Agency (EPA) oversees state regulatory agencies and can intervene if the state agencies do not successfully protect water quality.

The Tri-City WRRF discharges to the Willamette River at River Mile 25.5 just upstream of the confluence with the confluence of the Willamette River and the Clackamas River.

4.2.1 Beneficial Uses

To assist in the development of water quality standards, a list of beneficial uses is established for each water body in the state. Oregon Administrative Rule (OAR) 340-041-0340 lists the beneficial uses for the Willamette River in the vicinity of the District's treatment plants as shown in Table 4.1.

Table 4.1 Designated Beneficial Uses for the Willamette River from the Mouth to the Willamette Falls

Beneficial Uses
Public Domestic Water Supply(1)
Private Domestic Water Supply(1)
Industrial Water Supply
Irrigation
Livestock Watering
Fish and Aquatic Life
Wildlife & Hunting
Fishing
Boating
Water Contact Recreation
Aesthetic Quality
Hydro Power
Commercial Navigation and Transportation

Notes:
(1) With adequate pretreatment (filtration & disinfection) and natural quality to meet drinking water standards. Source: OAR 340-041-0340.

4.2.2 Oregon Administrative Rules for Wastewater Treatment

The state surface water quality and waste treatment standards for the Willamette Basin are detailed in the following sections of the Oregon Administrative Rules (OAR):

- OAR 340-041-0004 lists policies and guidelines applicable to all basins. DEQ's policy of antidegradation of surface waters is set forth in this section.
- OAR 340-041-0007 through 340-041-0036 describes the standards that are applicable to all basins.
- OAR 340-041-0061 describes the basis for establishing mass load limits.
- OAR 340-041-0340 through 340-041-0345 contain requirements specific to the Willamette Basin including beneficial uses, approved total maximum daily loads (TMDL) in the basin, and water quality standards and policies.

The surface water quality and waste treatment standards in the OARs are viewed as minimum requirements. Additionally, more stringent limits developed through the TMDL process would supersede the basin standards.

4.2.2.1 Total Daily Maximum Loads

The Clean Water Act requires DEQ to establish TMDLs and corresponding waste load allocations for all water bodies on the 303 (d) list. DEQ prepared a TMDL for mercury in 2006 and issued the revised draft TMDL in June 2019. The draft DEQ TMDL was rejected by EPA. In November of 2019 DEQ issued a revised TMDL which EPA disapproved. EPA established the Willamette Basin TMDL on December 30, 2019. It is anticipated that a waste minimization strategy will be used along with a variance since the mercury targets may not be attainable in the near term.

DEQ also issued the temperature TMDL in 2006 which was initially approved by EPA. However, EPA's approval was challenged in Federal Court which ruled that the TMDL should not have been approved. DEQ will need to update the Willamette Basin TMDL. It is unlikely that the load allocations in the 2006 TMDL will be increased since the allocation is based in part on the human health allowance in the regulations. For dry season discharges to the Willamette River, DEQ allocated the following temperature loads to Tri-City WRRF:

- Temperature increase: 0.0108 degrees Celsius (°C).
- Thermal load: 144 million Kcal/day.

The thermal load allocations outlined above are fixed by the TMDL. To calculate the actual thermal load being discharged, the following calculation is required:

$$ETL = QE \times (TE - TR) \times Cf$$

Where:

- QE = Effluent flow in mgd
- TE = Temperature of the Effluent in °C
- TR = River temperature criterion (20°C)
- Cf = Conversion factor (2,446,665)

As is evident from this equation, the river temperature at the time of discharge is not a factor. The NPDES permit will set a thermal load limit expressed in million kilocalories and the actual load discharged will be calculated daily using the seven-day moving average of the plant's maximum daily effluent temperature.

4.2.3 Cold Water Refuge

DEQ published the "Draft Lower Willamette River Cold-Water Refuge Narrative Criterion Implementation Study", January 2020, for submittal to the National Marine Fisheries Service. This study identifies cold-water refuge (CWR) sites including Kellogg Creek and Johnson Creek near the Kellogg Creek WRRF. DEQ did not find enough evidence to recommend the creation of additional CWR in the migration corridor of the Willamette River. However, there are data gaps and USGS is also doing similar work which could add potential sites. Implementation of the cold-water refuge is outlined in the draft report and the three proposed steps are listed below:

1. DEQ will implement existing temperature TMDLs to address temperature reductions in the main stem and cold-water tributaries to maintain and enhance the CWRs identified in this report. For example, implementing the Clackamas Basin TMDL will protect the quality of cold-water refuge provided by the Clackamas River confluence.
2. Designated management agencies (DMA) along the mainstem Willamette River are required to address Cold Water Refugia (CWR) according to the 5-year Willamette Basin TMDL Implementation Plans. The Implementation Plans require DMAs to evaluate impacts to existing CWR, now identified in this study, identify additional CWR if applicable, and provide options for protecting or enhancing such areas.
3. NPDES permits for discharges are required to evaluate and prohibit thermal impacts to CWR under the authority of OAR 340-041-0053 (d). When permits are issued for discharges within the migration corridor, potential for impacts to the CWR identified in this report or by DMAs must be evaluated and thermal plume limitations applied as necessary.

4.2.4 Clean Water Act 303 (d) Listing

The federal Clean Water Act requires that the responsible regulatory agency establish a list of water bodies that do not meet applicable water quality standards. In Oregon, this responsibility falls to the DEQ. This list, known as the 303 (d) list, is updated every three years. In April of 2020, DEQ submitted the Oregon 2018-20 Integrated Report to EPA. EPA approved the report on November 12, 2020 and this report is now effect. DEQ is now beginning work on the 2020-2022 integrated report.

DEQ's assessment is divided into river segments that are designated as assessment units. Figure 4.1 shows the extent of the assessment units that are relevant to the District's facilities.

The Tri-City WRRF discharges to the Willamette River assessment unit that spans from Champoeg Creek to the Clackamas River. The causes of impaired uses for the Willamette River for this part of the river are listed below:

- Temperature.
- Aquatic Weeds.
- Dissolved Oxygen.
- Biocriteria.
- Methylmercury.
- Dieldrin.
- PCBs.
- DDT and derivatives.
- Dioxin.
- Aldrin.

Willamette River Water Quality Assessment Units

Willamette River assessment units in the proximity of the Tri-City Water Resource Recovery Facility and the Kellogg Creek Water Resource Recovery Facility.

Kellogg Creek WRRF outfall

Tri-City WRRF outfall

Legend:

	DEQ ID	Reach
(yellow line)	OR_SR_1709000704_88_104020	Champoeg Creek to Clackamas River
(orange line)	OR_SR_1709000704_88_104019	Clackamas River to Johnson Creek
(green line)	OR_SR_1709001202_88_104175	Johnson Creek to Columbia River

Kellogg Creek Outfall

Tri-City Outfall

N

Figure 4.1

Willamette River Water Quality Assessment Units

Water Environment Services Regulatory Considerations

The Willamette River assessment unit immediately downstream of Milwaukie is known as the Johnson Creek to the Columbia River assessment unit. In addition to the causes for impairment shown above, Johnson Creek to the Columbia River assessment unit includes the following causes of impairment:

- Chlorophyll – a.
- Aquatic Weeds.
- Dissolved Oxygen.
- Harmful Algal Blooms.
- Iron.
- E. coli.
- Chlordane.

Aquatic weeds, harmful algal blooms, chlorophyll-a and the biocriteria could all be related to the nutrient loading in the river. Aquatic growth is stimulated by nutrients that are available in the water. DEQ has not evaluated the conditions in the river to determine if the river is either nitrogen or phosphorous limited. However, upstream tributaries have been found to be phosphorous limited. Dissolved oxygen is primarily influence by oxygen demand exerted by organic loading. A TMDL process will be necessary to establish future treatment requirements. Long-term planning should include provision of footprint at the plant for nutrient removal.

4.3 Current Tri-City WRRF Treatment and Discharge Requirements

The Tri-City WRRF discharges to the Willamette River at Clackamette Park just upstream of the confluence of the Willamette and Clackamas Rivers.

4.3.1 Existing NPDES Permit Limits

The existing permit limits for the Tri-City WRRF are shown in Table 4.2.

Table 4.2 Tri-City Effluent Permit Limits

Parameter	Average Effluent Concentration		Monthly Average (lbs/day)	Weekly Average (lbs/day)	Daily Maximum (lbs)(1)
	Monthly	Weekly			
May 1 - October 31					
$CBOD_5$	10 mg/L	15 mg/L	1050	1750	2100
TSS	10 mg/L	15 mg/L	1400	2100	2800
November 1 - April 30					
BOD_5	25 mg/L	40 mg/L	2800	4500	5600
TSS	30 mg/L	45 mg/L	3400	5100	6800
Other Parameter Limitations					
E. coli Bacteria	Shall not exceed 126 organisms per 100 ml geometric mean. No single sample shall exceed 406 organisms per 100 ml.				
Total Chlorine Residual	Shall not exceed a monthly average concentration of 0.02 mg/L and a daily maximum concentration of 0.04 mg/L.				
Ammonia	The interim limit no longer applies as WES fulfilled the MAO requirements.				
pH	Shall be within the range of 6.0-9.0.				
BOD_5 Removal Efficiency	Shall not be less than 85 percent monthly average.				
TSS Removal Efficiency	Shall not be less than 85 percent monthly average.				

Notes:
(1) The daily mass load limit is suspended on any day that the flow exceeds 23.8 mgd (twice the design average dry weather flow).

During the last permit cycle DEQ increased the level of treatment required during the dry season to integrate the basin standard of 10 mg/l for both biochemical oxygen demand (BOD) and total suspended solids (TSS). The mass load limits that were based on previous permit limits and design flow were not changed.

The current administratively extended permit included an ammonia limit that limited the discharge to a monthly average of 15 mg/L. The District also received a Mutual Agreement and Order (MAO) that required the District to make improvements to the existing outfall to increase mixing. A duckbill diffuser was added to one of the existing discharge pipes and a report entitled "Tri-City Water Pollution Control Plant Compliance with MAO WQ/M-NWR-11-046" was submitted to DEQ in February 2012. In a letter dated December 3, 2012, DEQ responded that the District fulfilled the requirements of the MAO and the ammonia limit no longer applies. A copy of the DEQ MAO and letter are included in Appendix A.

4.3.2 Outfall

The existing Tri-City WRRF outfall has a hydraulic capacity of 75 mgd which has been reached during peak flow events. A second outfall is needed, and the District has initiated development of the predesign and design of the second outfall. It is anticipated that the new outfall diffuser will be designed to provide improved mixing compared to the existing outfall.

Siting and preliminary mixing conditions have been addressed in the draft technical memorandum "Willamette River Outfall Diffuser Siting Alternatives Evaluation" dated October 18, 2019, Jacobs Engineering. The proposed location for the new outfall diffuser is just downstream of the I-205 bridge across the Willamette River. According to this technical memorandum, under 2040 conditions the dilution factors (DF) would be 33 at the Zone of Initial Dilution (ZID) and 83 at the Regulated Mixing Zone (RMZ) for an effluent flow of 23.8 mgd and 18 mgd respectively.

4.3.3 Toxicity

One advantage of the new outfall and diffuser is that mixing will be improved. The draft technical Memorandum entitled "Willamette River Outfall Diffuser Siting Alternatives Evaluation" includes an evaluation of the dilution required to meet the ammonia water quality criteria. The results of this study indicate that the governing condition for ammonia toxicity is the chronic 30-day ammonia criteria at the RMZ. A minimum dry season DF of 50 will be required at the RMZ to meet the 30-day chronic toxicity criterion while DF of 83 is estimated to be available at the RMZ. Mixing criteria for the new diffuser will continue to be refined during design.

4.3.4 Temperature

The long-term temperature requirements are uncertain, but the 2006 temperature TMDL that is currently under revision provides an indication on the likely future discharge requirements. Figure 4.2 shows the thermal load discharged by the Tri-City WRRF during the summers of 2017. It is noteworthy that the highest thermal discharge in occurred on September 10th in 2017 and August 17th in 2015. Neither of these thermal loads correlate with storm events, but high effluent temperatures.

The thermal load is directly proportional to the plant flow so the thermal load discharged in the future will increase as the flows increase. Currently there appears to be about 30-percent room for growth with the existing TMDL allocation.

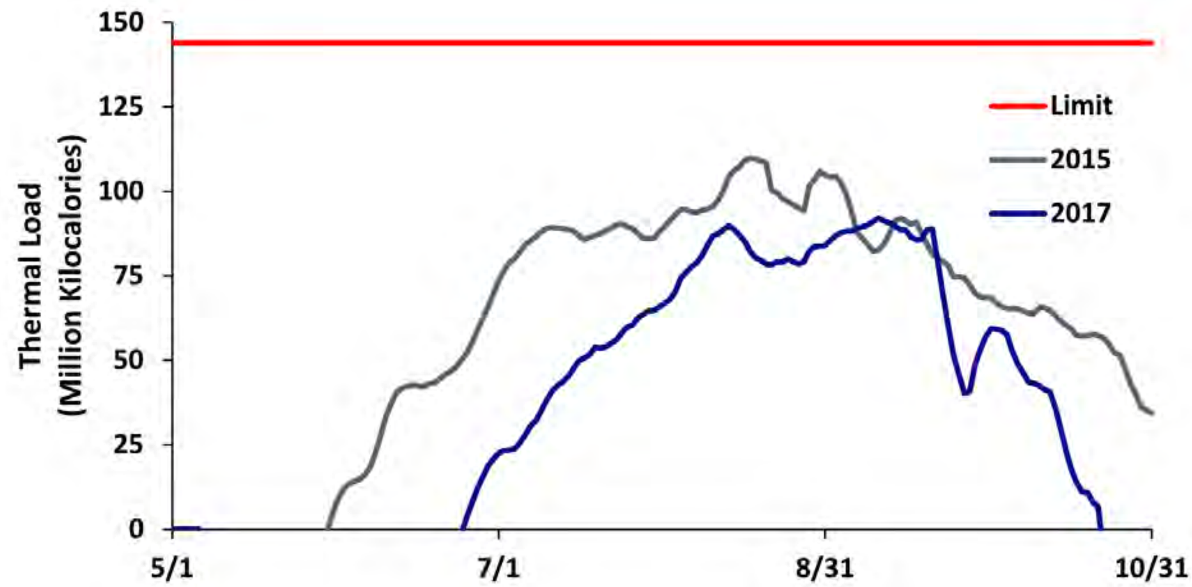


Figure 4.2 Tri-City WRRF 2017 Thermal Load Discharges to the Willamette River

4.3.5 Select Treatment

Tri-City WRRF has secondary treatment capacity for 35 mgd and during major storm events, flows to the plant exceed this capacity. During such events, primary effluent is routed to the disinfection system and combined with secondary treated effluent for disinfection.

Select treatment should be employed when the secondary treatment process could be compromised by the high flows. Permit limits need to be met whenever select treatment is employed. DEQ has accepted select treatment as a legitimate means to address exceptionally high flows. EPA has at time questioned the practice but has not taken formal action at a national level.

In 2016 through 2018, select treatment was used on nearly 100 days but the total volume receiving select treatment was relatively small as shown in Table 4.3. The impact of select treatment on final effluent quality was not significant for most events except when the select treatment flow exceeded 14 mgd. However, the elevated suspended solids concentrations associated with this event were also due to poor secondary clarifier performance during peak flow conditions cause by solids washout. The final effluent TSS discharged for days with select treatment is shown in Figure 4.3. As shown in the figure, effluent suspended solids typically remain low during peak flow events.

Table 4.3 Select Treat Summary

Year	Days/year	Total Volume (million gallons)
2016	39	62
2017	48	191
2018	12	18

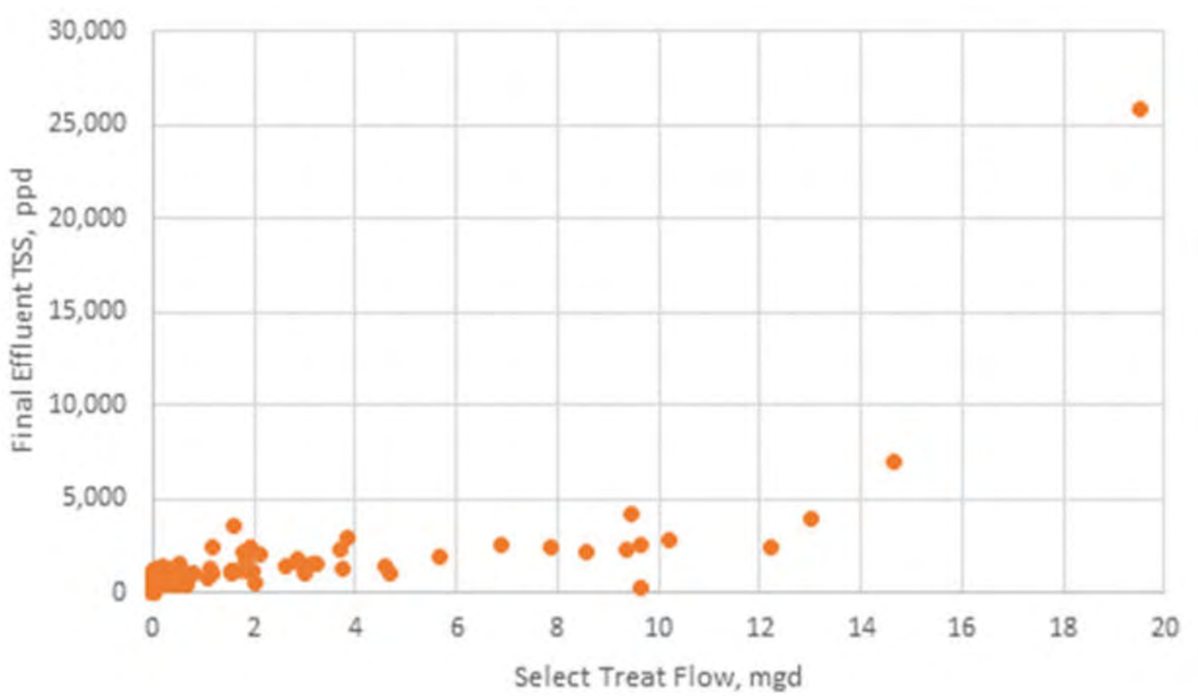


Figure 4.3 Effluent TSS on Days with Select Treatment

4.4 Potential Future Tri-City WRRF Treatment Requirements

The Tri-City WRRF, along with the Kellogg Creek WRRF, are scheduled to receive a revised NPDES permit in 2022, and it is unlikely that any new TMDLs will be promulgated by DEQ in the interim. Improvements that have been made to the existing outfalls and the proposed new outfall for the Tri-City WRRF provide excellent mixing and comply with the ammonia criteria. As a result of these mixing improvements, elimination of permitted effluent ammonia limits at the two plants is anticipated. In addition, the mixing provides for compliance with the aquatic life and human health criteria based on the RPA completed as part of the mixing zone studies.

For the Tri-City WRRF, the current permit incorporated the basin standards for the technology-based limits for five-day carbonaceous biochemical oxygen demand ($CBOD_5$) and TSS and no change is warranted. Planning should be based on the limits shown in Table 4.4.

Table 4.4 Anticipated Tri-City WRRF Effluent Permit Limits

Parameter	Average Effluent Concentration		Monthly Average (lbs/day)	Weekly Average (lbs/day)	Daily Maximum (lbs)(1)
	Monthly	Weekly			
May 1 – October 31					
$CBOD_5$	10 mg/L	15 mg/L	1050	1750	2100
TSS	10 mg/L	15 mg/L	1400	2100	2800
November 1 – April 30					
BOD_5	25 mg/L	40 mg/L	2800	4500	5600
TSS	30 mg/L	45 mg/L	3400	5100	6800

Parameter	Average Effluent Concentration		Monthly Average (lbs/day)	Weekly Average (lbs/day)	Daily Maximum (lbs)[(1)]
	Monthly	Weekly			
Other Parameter Limitations					
E. coli Bacteria	Shall not exceed 126 organisms per 100 ml geometric mean. No single sample shall exceed 406 organisms per 100 ml.				
Total Chlorine Residual	Shall not exceed a monthly average concentration of 0.02 mg/L and a daily maximum concentration of 0.04 mg/L.				
Ammonia	The interim limit no longer applies as WES fulfilled the MAO requirements.				
pH	Shall be within the range of 6.0-9.0.				
BOD_5 Removal Efficiency	Shall not be less than 85 percent monthly average.				
TSS Removal Efficiency	Shall not be less than 85 percent monthly average.				

Notes:
(1) The daily mass load limit is suspended on any day that the flow exceeds 23.8 mgd (twice the design average dry weather flow).

A factor that will become important is the monthly and weekly CBOD5 load limits in the May 1 to October 31 period. Based on the projected flow for the Tri-City service area, the allowable concentration that can be discharged by 2040 will be less than the permitted 10 mg/L. Table 4.5 shows the concentration limits for the average, maximum week and maximum month dry weather flows based on the permitted mass load.

Table 4.5 Effluent Concentration Limits based on Mass Load Limits

	Tri-City Service Area Flow (mgd)		CBOD Concentration (mg/L)	
	2018	2040	2018	2040
ADWF	7.1	8.5	17.7	14.8
MMDWF	12.7	17.1	9.9	7.3
MWDWF	18.3	23.6	11.5	8.9

Since influent flow and load transfers from the Kellogg Creek service area to the Tri-City Service area are taking place and will continue to increase, it is important that the mass load limits be assessed to ensure long-term compliance.

Capacity at the Tri-City WRRF has been increased since 1992 and the plant is subject to OAR 240-041-0061(9)(b) which states the following:

> *(b)For new sewage treatment facilities or treatment facilities expanding the average dry weather treatment capacity and receiving engineering plans and specifications approval from the department after June 30, 1992, the mass load limits must be calculated by the department based on the proposed treatment facility capabilities and the highest and best practicable treatment to minimize the discharge of pollutants.*

The Tri-City WRRF does not have the capability to meet daily mass loads that occur during unusually high peak flows that are experienced during major storm events. Some to the facility service areas were constructed with combined sewers that were later separated. The District has adopted an aggressive infiltration and inflow control strategy but even with this strategy, peak day mass loads will be high. The facilities plan will identify the highest and best practicable treatment that can be achieved by the plant.

Chapter 5

CAPACITY ANALYSIS

5.1 Introduction

This chapter identifies existing capacity ratings and deficiencies for the various liquid and solids stream treatment processes at the Tri-City WRRF. The hydraulic capacity of the WRRF under peak flow conditions is also defined. Analyses are based on current operational practices and effluent limits. Alternatives to address capacity limitations identified herein, and/or to meet potential future effluent limits, will be developed and evaluated in Chapters 7 and 8. Assessments and recommendations for improving systems that support each major unit processes (e.g., aeration blowers, solids pumps, chemical systems) will be also included as part of the subsequent alternatives development and evaluation.

5.2 Design Criteria

The Tri-City WRRF consists of influent pumping, screening, grit removal, primary treatment and secondary treatment and disinfection. Solids generated through the primary and secondary treatment processes are thickened, anaerobically digested and dewatered prior to disposal. A process flow diagram for the plan in included in Appendix B. When possible, unit process design criteria were jointly developed for both the Tri-City and Kellogg Creek WRRFs. Design criteria recommended for the Tri-City WRRF are summarized in Table 5.1.

Table 5.1 Tri-City Unit Process Design Criteria

Unit Process	Design Parameter	Design Criteria(1)	Redundancy Criteria
Influent Pumping	**PHF**	**100% of PHF**	**Largest pump OOS**
Screening	PHF **PDF**	Hydraulically pass flow **Hydraulically pass flow**	All units in service **All mechanically cleaned screens in service**
Grit Removal	**PHF**	**HRT = 2 min**	**All units in service**
Primary Treatment	**PHF** MMWWF ADWF	**Hydraulically pass flow** 1,500-2,000 gpd/sf(2) 1,500 gpd/sf	**All units in service** All units in service Largest unit OOS
Secondary Treatment			
Aeration Basins (CAS non nitrifying)	**MMWWF** ADWF	**aSRT = 2.5 days** aSRT = 2.5 days	**All units in service** Largest units OOS
Aeration Basin (MBR Train)	**MMWWF**	aSRT = 10 days	**All units in service**
Secondary Clarifiers	**PHF** ADWF	**SOR = 1,200 gpd/sf** SOR = 1,200 gpd/sf	**All units in service** Largest unit OOS
Membrane Tanks	**PHF**	**Flux = 19.2 gpd/sf**	**All units in service**

Unit Process	Design Parameter	Design Criteria[1]	Redundancy Criteria
Disinfection			
Chlorine Contact Basin	**PHF**	**HRT=15 min**	**All units in service**
	PDF	HRT=20 min	All units in service
	ADWF	HRT=60 min	Largest units OOS
UV Channels	**PHF**	**30 mJ/cm^2**	**All units in service**
	ADWF	30 mJ/cm^2	Largest unit OOS
Thickening GBT	Max Week Load	400 gpm; 900 lb/m/hr	All units in service
	Max Month Load	**400 gpm; 900 lb/m/hr**	**Largest unit OOS**
Anaerobic Digestion[3]	Max Month Load	SRT = 20 days	All units in service
	Max Month Load	**SRT = 15 days**	**Largest unit OOS**
	Max Month Load	SVSLR = 0.15 lb VS/d-lb VS inventory[4]	Largest unit OOS
Dewatering Centrifuge	Max Week Load	2,200 lb/hr	All units in service
	Max Month Load	**2,200 lb/hr**	**Largest unit OOS**

Note:
(1) Bold text denotes the capacity-limiting criteria for each unit process.
(2) At 1,500 gpd/sf SOR, TSS removal in primary clarifiers is assumed to be 60 percent; at 2,000 gpd/sf, TSS removal is assumed to be 54 percent.
(3) Anaerobic digestion criteria assume 90 percent of the total digester volume is utilized for digestion.
(4) Design criteria for the most recent Tri-City solids expansion project was for a SVSLR of 0.16 lb VS/d-lb VS inventory under max two-week loads. This value was related to a maximum month SVSLR of 0.15 lb VS/d-lb VS inventory using the relationship between max-two week and maximum loads defined in that project.

5.3 Treatment Plant Flow Projections

Flow and load projections for the Tri-City and Kellogg Creek service areas are summarized in Chapter 3. The Tri-City WRRF treats all wastewater generated within the Tri-City service area, along with a portion of the wastewater generated in the Kellogg Creek service area and transferred to the Tri-City WRRF through the Intertie 2 Pump Station. Analysis in this chapter assumes that, during PDWWF and PHF, the Kellogg Creek WRRF will treat up to 25 mgd. Any flow (and associated load) above 25 mgd will be transferred to the Tri-City WRRF. Additionally, since the secondary treatment process at Kellogg Creek WRRF is limited to 18 mgd, analysis in this chapter assumes that, maximum month and maximum week flows in excess of 18 mgd are diverted from the Kellogg Creek service area to the Tri City WRRF. Since the projected solids concentrations are lower in the wet weather seasons, the projected load associated with the 18 mgd secondary treatment hydraulic cap is less during the wet weather season than during the dry weather season. Since the Tri-City WRRF has excess dry weather capacity (discussed later in this chapter), additional loads are transferred from the Kellogg Creek WRRF to the Tri-City WRRF to limit the solids loading to the Kellogg Creek WRRF during the dry season. Table 5.2 summarizes the 2040 flow projections for the Tri-City WRRF that result from these flow transfer assumptions.

Table 5.2 Tri-City WRRF Flow Projections

Flow Component	2018			2040		
	Tri-City service area, mgd	Transfer from Kellogg Creek to Tri-City WRRF, mgd(1)	Tri-City WRRF Influent, mgd	Tri-City service area, mgd	Transfer from Kellogg Creek to Tri-City WRRF, mgd(1)	Tri-City WRRF Influent, mgd
ADWF	7.1	0.0	7.1	8.5	0.0	8.5
MMDWF	12.7	0.0	12.7	15.1	2.7	17.8
MWDWF	18.3	2.1	20.4	21.7	5.9	27.6
PDDWF	28.0	1.7	29.7	33.2	7.5	40.7
MMWWF	21.5	0.0	21.5	25.5	4.1	29.6
MWWWF	34.7	5.2	39.9	41.2	11.9	53.1
PDWWF	53.0	8.5	61.5	58.2	21.6	80.5
PHF	65.1	16.2	81.3	72.2	32.2	104.4

Note:
(1) Transfer requirement based on the capacity of Kellogg Creek WRRF as defined in Chapter 5 of the Kellogg Creek WRRF Facilities Plan.

5.4 Unit Process Capacity

5.4.1 Influent Pump Station

The Influent Pump Station at the Tri-City WRRF pumps wastewater collected from the Tri-City service area and internal plant drains (including the thickening return flows) to the influent screens. The Influent Pump Station includes five pumps. Two are small variable-speed pumps, each with a rated capacity of 5,000 gpm (7.2 mgd) at 49 feet (ft) of total dynamic head (TDH). Three are larger pumps, each with a rated capacity of 12,500 gpm (18 mgd) at 48 ft of TDH; two of these three pumps are variable speed, while the third is run at a constant speed. The pump station has a total capacity of 68.4 mgd and a firm capacity (single largest unit out of service [OOS]) of 50.4 mgd. Design data for the influent pump station are summarized in Table 5.3.

Table 5.3 Influent Pump Station Design Data

Process / Criterion	Unit	Value
Number of Pumps		5
Total Capacity	mgd	68.4
Firm Capacity	mgd	50.4
High-Flow Pumps		
Number		2
Power, each	hp	200
Control		2 at variable speed, 1 at constant speed
Capacity, each	mgd	18
TDH	feet	48

Process / Criterion	Unit	Value
Low-Flow Pumps		
Number		2
Power, each	hp	100
Control		Variable speed
Capacity, each	mgd	7.2
TDH	feet	49

The Kellogg Creek WRRF is hydraulically limited to 25 mgd; therefore, all flow exceeding this cap is transferred from the Kellogg Creek service area to the Tri-City WRRF via Intertie 2 Pump Station. Transferred flow enters the WRRF downstream of the influent pump station; therefore, the influent pump station only needs to pump the projected 2040 PHF in the Tri-City service area (72.2 mgd) with the largest pump out of service. As shown in Figure 5.1, an additional 21.8 mgd of reliable pumping capacity is required to meet the 2040 PHF projection.

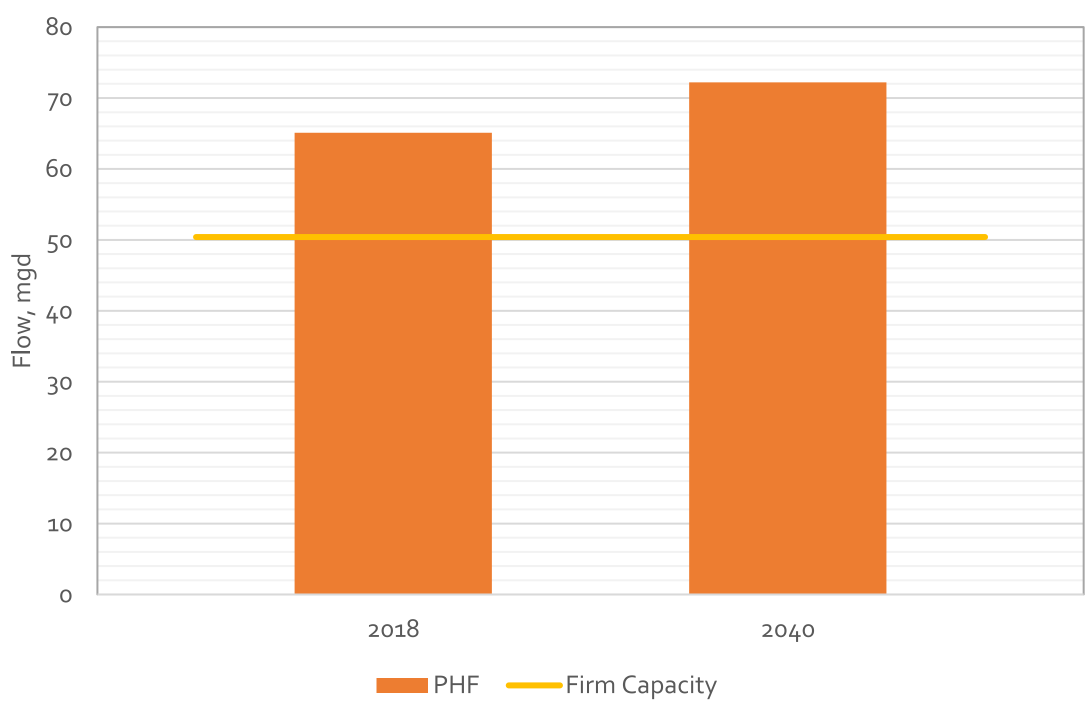


Figure 5.1 Influent Pump Station Capacity

5.4.2 Screening

The Tri-City WRRF headworks has three mechanically-cleaned bar screens and one manually-cleaned bar screen. Two of the mechanically-cleaned screens are 7 feet wide with 3/8-inch openings between bars, and are each rated for 25 mgd. The third mechanically-cleaned screen is 4 ft wide with 5/8-inch openings between bars, and is rated for 10.4 mgd. It is understood that the bars of this 4-foot screen are to be replaced with 3/8-inch openings between bars – however, this capacity analysis assumes the current bar spacing is maintained. A 7-foot wide manually-cleaned bar rack with 1-inch openings is used to screen excess flows greater than approximately 60 mgd. Design data for the screens are summarized in Table 5.4

Table 5.4 Screening Design Data

Process / Criterion	Unit	Value
Number of Screens		3 mechanically-raked bar screens, 1 manually-raked rack
Mechanical Screens		
Number		2
Channel Width	ft	2 at 7; 1 at 4
Capacity, each	mgd	2 at 25; 1 at 10.4
Bar Spacing	inch	2 at 3/8, 1 at 5/8
Manual Bar Rack		
Number		1
Channel Width	ft	7
Capacity	mgd	25
Bar Spacing	inch	1
Total capacity (including manual bar rack)	mgd	85.4
Total capacity of mechanically cleaned screens	mgd	60.4

The total capacity of the screening facility is 85.4 mgd including the manual bar rack and is 60.4 mgd excluding the manual bar rack.

Currently, flow transferred from the Kellogg Creek service area enters the Tri-City WRRF upstream of the screening facility; thus, the screens must be capable of treating both the flows from the Influent Pump Station and the transfer flows from the Kellogg Creek service area. These flows are summarized in Table 5.2.

As is shown in Figure 5.2, currently, the existing headworks has sufficient capacity through their mechanically cleaned screens to treat approximately the current PDF. Flows that exceed this are treated with the manual bar rack. By 2040, additional mechanically cleaned screen capacity will be required to continue to treat flows up to the PDF without using the manual bar rack.

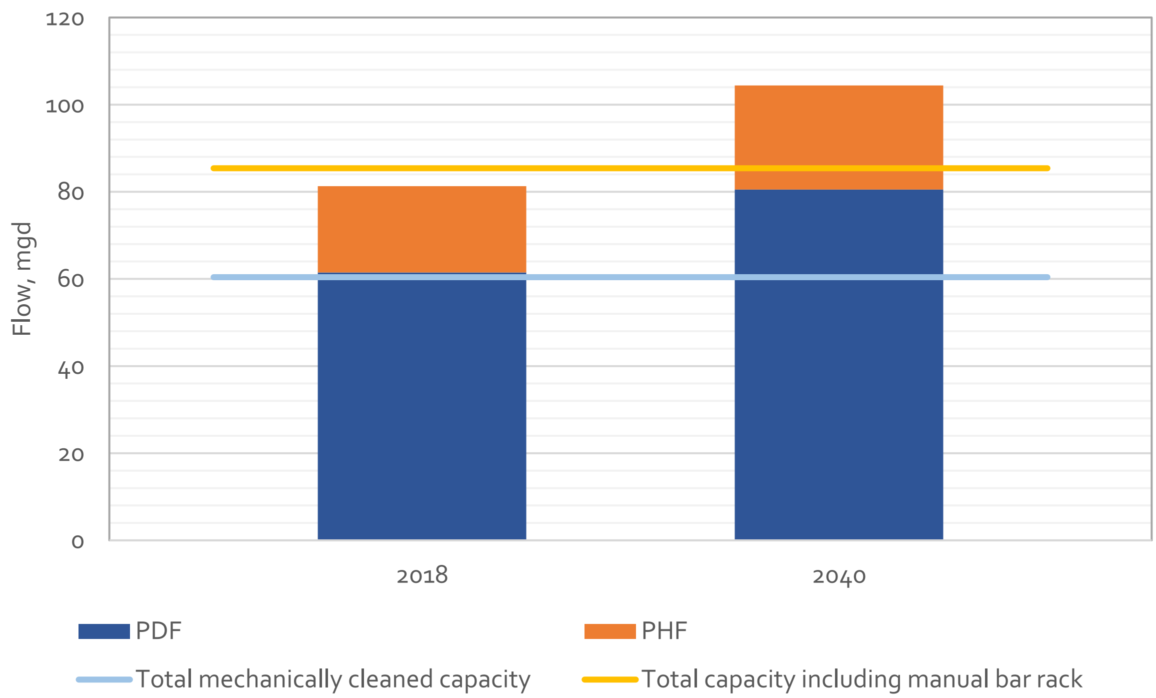


Figure 5.2 Screening Capacity

5.4.3 Grit Removal

Denser and more rapidly settleable solids that are suspended in raw wastewater are removed downstream of the screening process via two aerated grit chambers. The grit chambers are configured such that coarse bubble diffusers introduce air into one side of the chamber, which induces a spiral flow pattern that maintains lighter particles in suspension. Settled grit is collected into one of three grit bays (per chamber), while lighter solids are passed on to downstream treatment processes.

Each grit chamber is hydraulically rated for 25 mgd, which corresponds to an HRT of 3.1 minutes. However, on December 7, 2015 peak flows to the Tri-City WRRF were recorded as high as 75.5 mgd suggesting that hydraulically, the Tri-City grit removal process can pass flows up to this value. During this peak event, the SOR at the recorded PHF was approximately two minutes which is on the low side of the recommended range of two to five minutes from *Wastewater Engineering: Treatment and Resource Recovery* by Metcalf & Eddy. Design data for the grit chambers are summarized Table 5.5.

As shown in Figure 5.3, the hydraulic capacity of the grit removal system is approximately equal to the current PHF. Additional grit removal capacity will be required to treat the projected 2040 PHF.

Table 5.5 Grit Removal Design Data

Process / Criterion	Unit	Value
Type		Aerated Grit Vortex
Number of Units		2
Total Rated Capacity	mgd	50
Total Hydraulic Capacity(1)	mgd	75

Process / Criterion	Unit	Value
Firm Capacity	mgd	25
Volume, each	cubic feet	7,356
Detention Time at Rated Capacity	min	3.1
Detention Time at Hydraulic Capacity	min	2.1

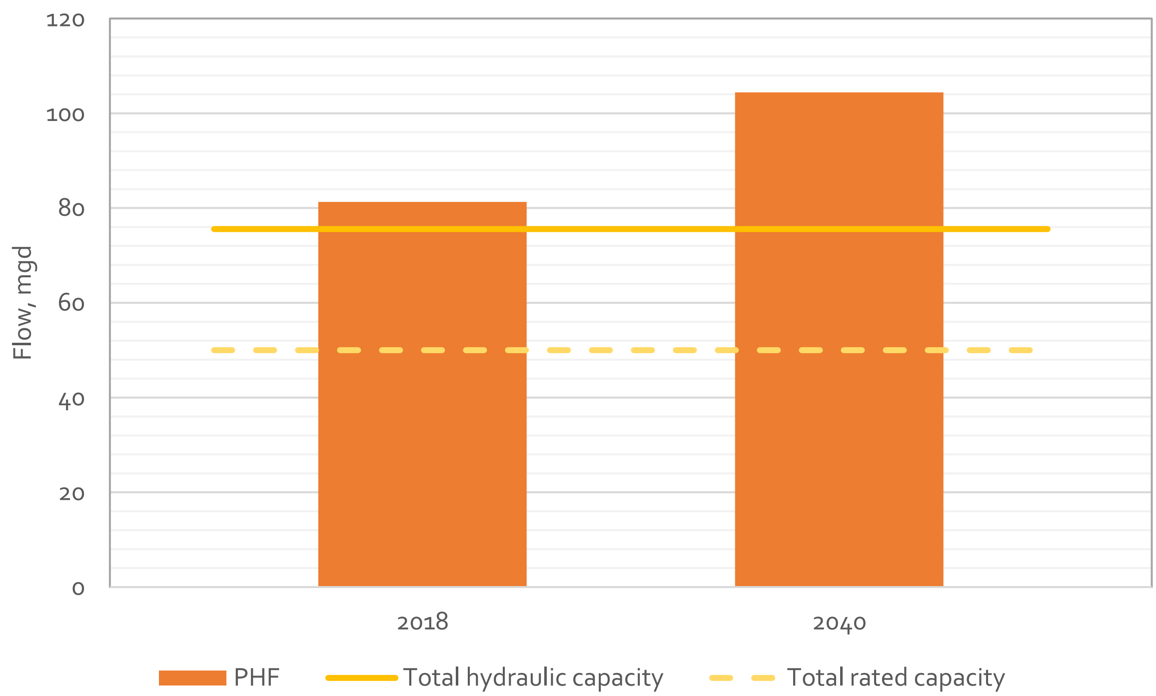


Figure 5.3 Grit Removal Capacity

5.4.4 Primary Treatment

Primary treatment is provided through six, 125-ft long by 20-ft-wide by 11-foot-deep rectangular primary clarifiers. These units remove surface scum and suspended solids, including non-soluble BOD, prior to secondary treatment. Design data for the primary clarifiers are summarized in Table 5.6.

Table 5.6 Primary Clarifier Design Data

Process / Criterion	Unit	Value
Number of Units		6
Capacity, each	mgd	10
Total Capacity	mgd	60
Firm Capacity	mgd	50
Dimensions		
Length	ft	125
Width, each	ft	20
Sidewater depth, average	ft	11

The performance of the primary treatment system is linked to the capacity of the secondary system since lower primary clarifier removal rates result in higher loads (and thus reduced capacity) to the secondary process. Primary TSS removal percentages correlate with the clarifier SOR, with higher removal rates typically seen at lower SORs. Figure 5.4 shows historical primary TSS removal plotted against SOR, which generally supports this observation.

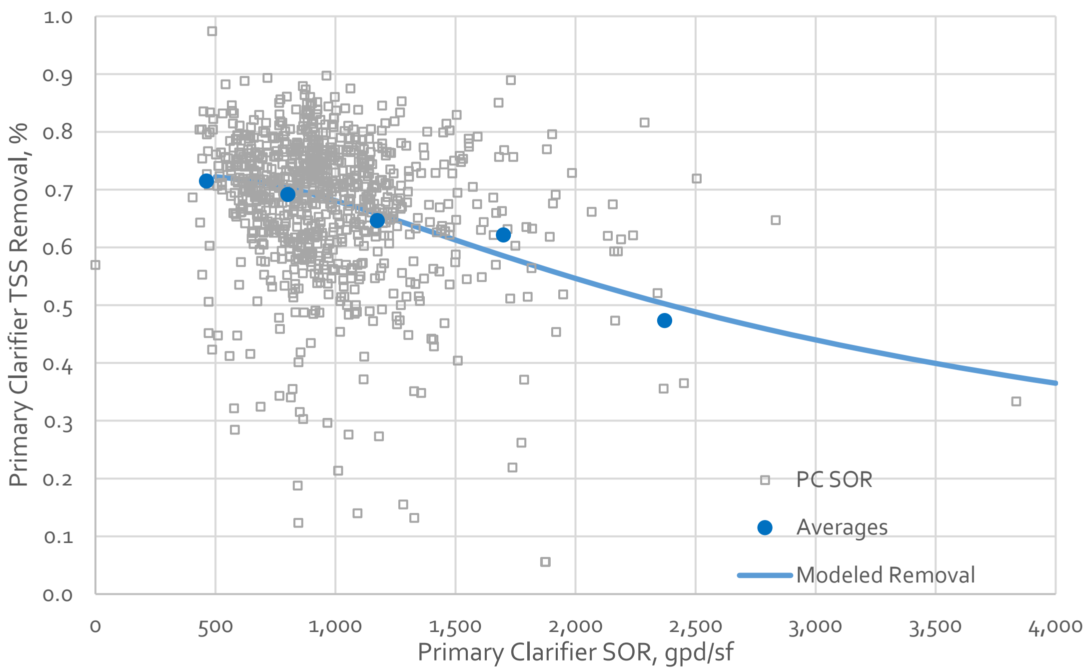


Figure 5.4 Primary Clarifier TSS Removal vs. Surface Overflow Rate

Typical MMWWF SORs are in the range of approximately 1500 to 1600 gpd/sf. This MMWWF SOR is applied for the redundancy criterion which is ADWF with one clarifier out of service. At a SOR of 1500 gpd/sf with one primary clarifier out of service, the existing primary process capacity for a flow of approximately 19 mgd. As is shown in Figure 5.5, this capacity exceeds the projected 2040 ADWF.

At typical MMWWF SORs, the MMWWF capacity of the primary clarification process is between approximately 22 and 24 mgd. As is shown in Figure 5.5, this capacity is slightly greater than the current MMWWF and is less than the projected 2040 MMWWF. The primary clarifier SOR corresponding to the projected MMWWF is projected to be higher than this range at approximately 2000 gpd/sf. Based on the relationship shown in Figure 5.4, this high of a SOR correlates to a primary clarifier TSS removal of approximately 54 percent. As is shown in the subsequent section, the secondary system has sufficient capacity to treat the projected MMWWF with a 54 percent TSS removal through the primary clarifiers. However, given the high anticipated MMWWF SOR, either additional primary treatment capacity is recommended or a system to separately treat the peak flows (thereby limiting the MMWWF through primary treatment).

The existing Tri-City primary clarifiers can treat a PHF of 60 mgd which corresponds to a surface overflow rate of 4,000 gpd/sf. As is shown in Figure 5.5, this capacity is less than the current PHF. Part of the reason for this is that up to 10 mgd of the peak flow can bypasses primary treatment and flow directly to the membrane bioreactor (MBR) fine screening process. By the year 2040 either additional primary treatment capacity will be required to treat the projected or a separate peak flow treatment system will be required.

Figure 5.5 Primary Treatment Capacity

5.4.5 Membrane Bioreactors

The Tri-City WRRF has two parallel secondary treatment trains: a conventional activated sludge (CAS) treatment train and a MBR treatment train.

5.4.5.1 Intermediate Pump Station

Downstream of the influent pump station, an intermediate pump station pumps either primary influent or primary effluent to the MBR process which has an existing capacity of 10 mgd. This pump station consists of two 60 hp pumps rated for 6,950 gpm (10 mgd) at 15 ft TDH, and one 10 hp pump rated for 3,500 gpm (5.0 mgd) at 7 ft TDH. All three pumps are variable speed, and the speed of the pumps is typically based on diurnal flow and/or maintaining a base-loading to MBR process. Currently the MBR train is limited to a PHF of 10 mgd, so the firm capacity of the intermediate pump station (approximately 15 mgd) is adequate. Design data for the intermediate pump station are summarized in Table 5.7.

Table 5.7 Intermediate Pump Station Design Data

Process / Criterion	Unit	Value
Number		3
Type		Axial Flow / Non-Clog
Power, each	hp	2 at 60, 1 at 10
Control		Variable speed
Capacity, each	mgd	2 at 10.0; 1 at 5.0
TDH	ft	2 at 15; 1 at 7
Total Capacity	mgd	25.0
Firm Capacity	mgd	15.0

5.4.5.2 Fine Screening

In addition to the influent screens, flow to the MBR process is passed through two center-fed band screens in the Fine Screening building. These 7.5-ft wide screens can each treat up to 15 mgd and have 2-millimeter (mm) screen openings. Screened effluent subsequently flows by gravity to the MBR aeration basin. These screens have sufficient capacity for handling the design MBR peak hour flows of 10 mgd. Design data for the fine screens are summarized in Table 5.8.

Table 5.8 Fine Screening Design Data

Process / Criterion	Unit	Value
Number		2
Type		Center feed band screen
Width	ft	7.5
Opening size	mm	2
Capacity, each	mgd	15
Firm capacity	mgd	15
Total capacity	mgd	30

5.4.5.3 Membrane Bioreactors

The MBR treatment train consists of a single aeration basin (AB5), and multiple membrane tanks. AB5 consists of four small anoxic zones (each with a volume of 8,330 cubic feet) and four larger aerobic zones (each with a volume of 16,660 cubic feet). While the anoxic zones are separated by baffle walls, the aerobic zones are not baffled. Two wall-mounted mixed liquor recycle (MLR) propeller pumps recirculate mixed liquor from the final zone (Zone 6) to the first zone (Zone 1A). Flow from AB5 subsequently enters the MBR basins, where filtrate permeates through 527,680 square feet (sf) of membrane surface area, and is then pumped to UV disinfection via four 25 hp filtrate pumps, rated for 2,031 gpm at 35 ft TDH. There are four membrane tanks, each 10 ft wide by 70 ft long and 10.25 ft deep. Each tank contains ten membrane cassettes. Each cassette contains 43 installed membrane modules, except for two half-cassettes and a single cassette with "blank" modules – thus, there are effectively only eight active membrane cassettes per tank, in total. Excess flow is returned to AB5 via two 100 hp mixed liquor transfer (MLTR) pumps, rated for 14,400 gpm at 10 ft TDH. The maximum allowable membrane flux of 19.2 gpd/sf corresponds to an overall process flow rate of 10 mgd. For purposes of anticipating plant operations and flow splits between the two parallel secondary treatment processes, it is assumed that the MBR process handles 3.2 mgd under ADWFs, 5.0 mgd under max month flows, and 10.0 under peak hour and peak day flows. Design data for the membrane bioreactors are summarized in Table 5.9.

Table 5.9 Membrane Bioreactor Design Data

Process / Criterion	Unit	Value
Aeration Basin		
Number		1
Length	ft	272
Width	ft	15
Sidewater Depth	ft	24.5
Volume		
Unaerated Volume	cubic feet	18,700
Aerobic Volume	cubic feet	66,700
Total Volume	cubic feet	83,300
Membranes		
Number of tanks		4
Membrane type		Hollow Fiber
Total membrane area	sf	527,700
Maximum flux	gpd/sf	19.2
Filtrate Pumps		
Number		4
Type		Horizontal centrifugal
Power, each	hp	25
Control		Variable speed
Capacity, each	gpm	2,031
TDH	ft	35
MLTR Pumps		
Number		2
Type		Horizontal centrifugal
Power, each	hp	100
Control		Variable speed
Capacity, each	gpm	14,400
TDH	ft	10
MLR Pumps		
Number		2
Type		Wall-mounted fan
Power, each	hp	10
Control		Variable speed
Capacity, each	gpm	5,555
TDH	ft	1

For the MBR treatment train, the maximum allowable mixed liquor suspended solids (MLSS) concentration in the aeration basins is set to approximately 8,000 milligrams per liter (mg/L) based on the requirements of the membrane system. MBR systems require full nitrification to promote a filterable floc. Figure 5.6 shows the historical aSRT for the MBR treatment train which has ranged from 4 to 12 days. To ensure full nitrification during the winter an aSRT of 10 days was selected for this analysis. At the design aSRT of 10 days and a maximum month MLSS concentration of 8,000 mg/L, the calibrated BioWin model (described in Appendix C) predicts that the MBR aeration basin is limited to 5 mgd of primary effluent MMWWF. Higher concentrations from dry weather conditions or from flow bypassing primary treatment limit the MBR treatment to less than 5 mgd during maximum month conditions.

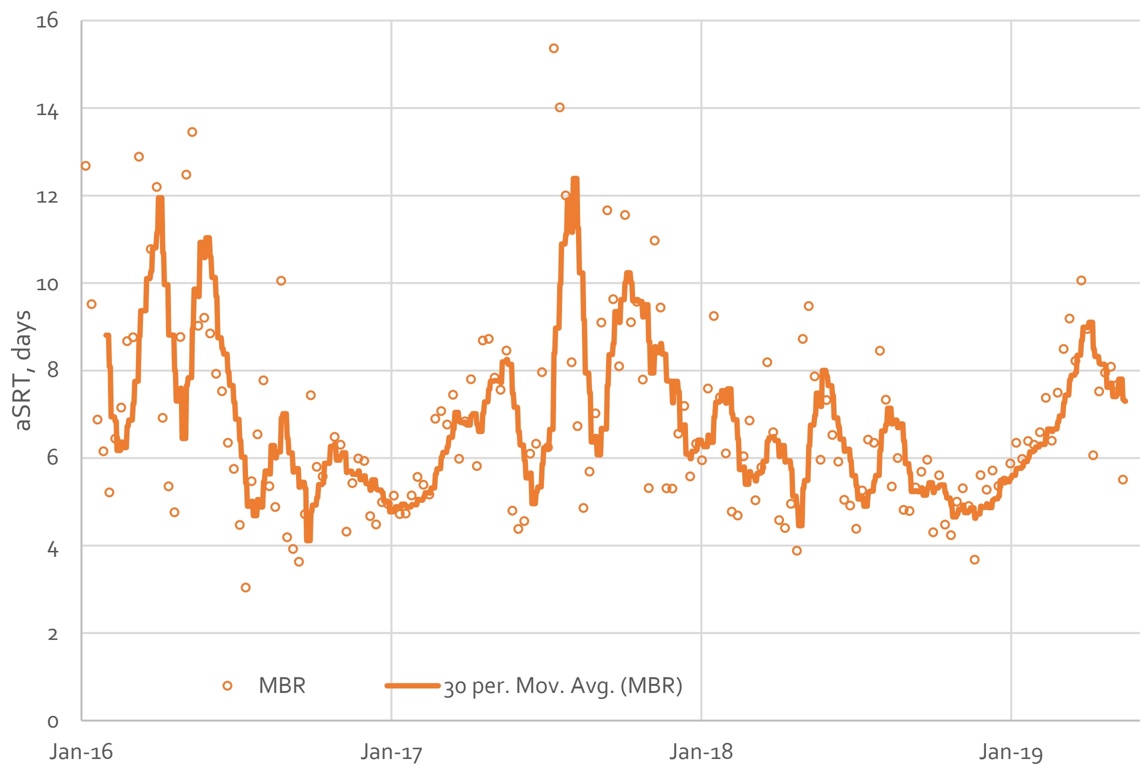


Figure 5.6 Historical MBR Aeration Basin aSRT

5.4.5.4 UV Disinfection

MBR filtrate is treated via UV disinfection. The UV disinfection process is comprised of two parallel channels containing two banks of forty UV lamps each. Each channel is rated for disinfection of 5 mgd each at a design dose of 30 millijoules per square centimeter (mJ/cm^2). Thus, UV disinfection capacity is adequate for handling the MBR peak flow of 10 mgd with all units in service and is adequate for average flows with a train out of service so long as no more than 5 mgd is sent through the MBR treatment process when a UV channel is out of service for maintenance. Design data for the UV channels are summarized in Table 5.10.

Table 5.10 UV Disinfection Design Data

Process / Criterion	Unit	Value
Number of Channels		2
Type		Low-pressure, high output
Design Dosage	mJ/cm^2	30
Number of modules per channel		2
Number of lamps per module		40
Capacity per Channel	mgd	5
Firm Capacity	mgd	5
Total Capacity	mgd	10

5.4.6 Conventional Activated Sludge Treatment

In evaluating the capacity of the CAS system, it is assumed that 3.2 mgd primary effluent is sent to the MBRs under average dry weather conditions, 5.0 mgd under maximum month conditions, 6.0 mgd under maximum week conditions and 10 mgd during PDDWF, PDF and PHF. Additionally, during peak storm events, approximately 25 mgd of primary effluent is routed directly to disinfection to protect the secondary process from solids washout. This mode of operation is referred to as select treatment.

The CAS treatment train consists of four aeration basins (AB1 – AB4) and two secondary clarifiers. The aeration basins contain baffle walls that divide each aeration basin into distinct zones. The CAS aeration basins are configured to allow operation in multiple configurations, but operators typically operate in a plug-flow configuration. Zones 1A and 1B are unaerated selector zones, each 8,330 cubic feet; Zones 2-5 are aerobic, each 17,850 cubic feet. Each zone is approximately 20 ft deep and separated by concrete baffle walls; the exceptions are Zones 3-5, which are not separated by any physical barrier. Within each CAS aeration basin, a single dedicated MLR pump returns flow from the final Zone 5 to Zone 1B, Zone 2, or Zone 3, depending on the operating configuration. These are generally not used but may be required for future permit conditions necessitating biological nutrient removal.

Mixed liquor from the CAS aeration basins combines in the aeration basin effluent channel and flows through two three-foot Parshall flumes which divide flow between two secondary clarifiers. The secondary clarifiers are each 120 feet in diameter and 18 feet deep. Sludge is withdrawn from the bottom of the secondary clarifiers and pumped back to Zone 1A of the CAS aeration basins through the return activated sludge (RAS) pump station. This pump station is comprised of two 15 hp RAS pumps rated for 1500 gpm at 18 feet TDH, and three 50 hp RAS pumps rated for 4700 gpm at 28 feet TDH. Each pump is equipped with a variable frequency drive (VFD) and paced according to the flow through the CAS secondary process. Design data for the conventional activated sludge process are summarized in Table 5.11.

Table 5.11 Conventional Activated Sludge Design Data

Process / Criterion	Unit	Value
Aeration Basins		
Number		4
Length	feet	150
Width	feet	29.75
Depth	feet	19.5

Process / Criterion	Unit	Value
Volume		
Unaerated Volume, each	cubic feet	16,660
Aerobic Volume, each	cubic feet	71,400
Total Volume, each	cubic feet	88,060
Secondary Clarifiers		
Number		2
Diameter	feet	120
Sidewater Depth	feet	18
RAS Pumps		
Number		5
Control		Variable Speed
Power, each	hp	2 at 15; 3 at 50
Capacity, each	gpm	2 at 1,500; 3 at 4,700
TDH	feet	2 at 18; 3 at 28
MLR Pumps		
Number		4
Power, each	hp	20
Control		Variable Speed
Capacity, each	gpm	5,000

The capacity of the CAS aeration basins is closely tied to the process capacity of the secondary clarifiers, which is determined via state-point analysis (SPA). The maximum allowable maximum month MLSS concentration in the aeration basins is defined by the ability for MLSS to settle in the secondary clarifiers. The SPA determines the maximum allowable MLSS concentration based on the peak flow rate, the RAS flow rate, and the speed at which the MLSS settles as quantified by measurement of the sludge volume index (SVI).

Figure 5.7 shows the historical SVI in the Tri-City WRRF CAS process alongside a 30-day running average value. During the period of record, the average 30-day SVI ranged from approximately 100 milliliters per gram (mL/g) to 390 mL/g, with an overall average of 175 mL/g between January 2016 and May 2019. These SVI values are relatively high for domestic wastewater treatment, with well settling sludge typically having a SVI of 150 mL/g or less. Since planning around a SVI as high as 390 mL/g, would significantly limit the capacity of the CAS process, the capacity analysis in this TM assumes a more typical design SVI value of 150 mL/g. Operation and process modifications may be necessary to consistently achieve this SVI value.

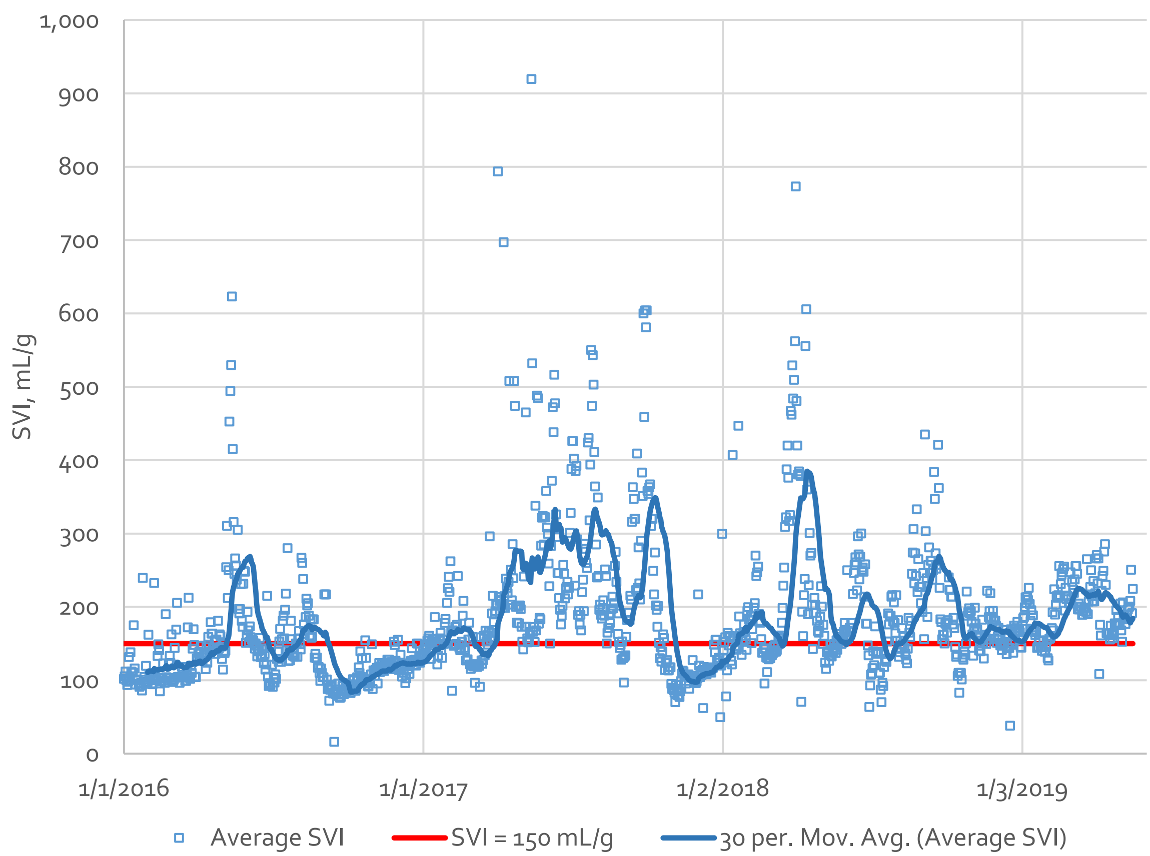


Figure 5.7 Historical CAS SVI

The SOR defines the overflow line on the SPA curve. With an SVI of 150 mL/g (Vesilind coefficients are : v_0 = 21.31 feet per hour [ft/hr], k = 0.403 liters per gram [L/g]) and a clarification safety factor of 1.2, the Vesilind curve intersects the overflow line at a MLSS concentration of approximately 2,600 mg/L, indicating that the max month MLSS concentration must be 2,600 mg/L or less at PHF for the clarifiers to effectively settle the sludge. The SPA curves for max month MLSS at peak hour flow with all units in service is shown in Figure 5.8. The RAS rate indicated in this figure reflects the minimum flow rate necessary for operating at a constant sludge blanket depth. A minimum RAS rate of 32 percent of the maximum CAS influent flow rate of 25 mgd is 8 mgd, or 5,600 gpm. This is well below the RAS pumping capacity, indicating that the RAS pumping capacity of the CAS process is sufficient through the planning period.

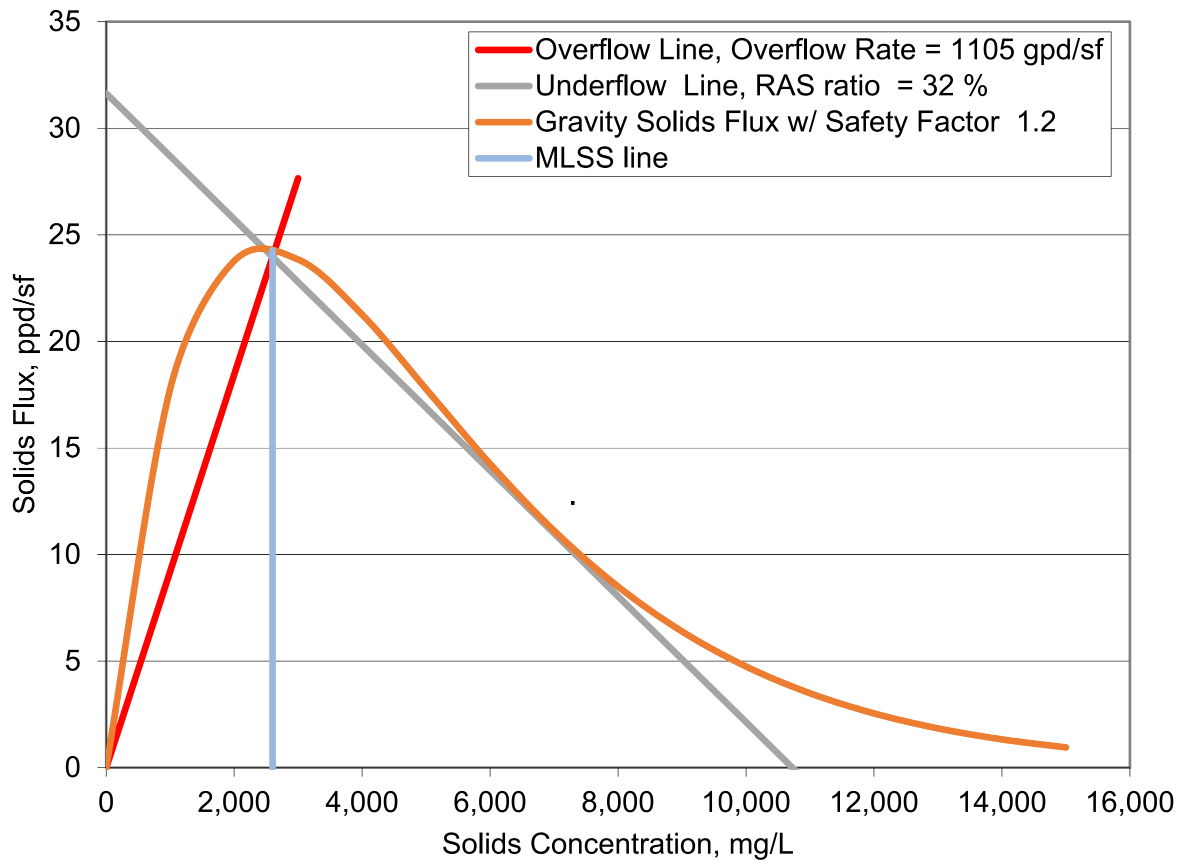


Figure 5.8 SPA for Max Month MLSS at Peak Hour Flow

The capacity of the CAS aeration basins is defined by the maximum allowable MLSS concentration and the design aSRT. For the CAS aeration basins, the maximum allowable MLSS concentration was determined using the SPA to be 2,600 mg/L The design aSRT was set based on an analysis of historical data. Plant operations data shown in Figure 5.9 indicate that, for the CAS process, the monthly average operating aerobic aSRT has ranged from 1.5 to 6 days. Thus, the design aSRT for the CAS process was set to 2.5 days, which is a typical minimum value that allows for the growth of microorganisms that promote sludge settleability.

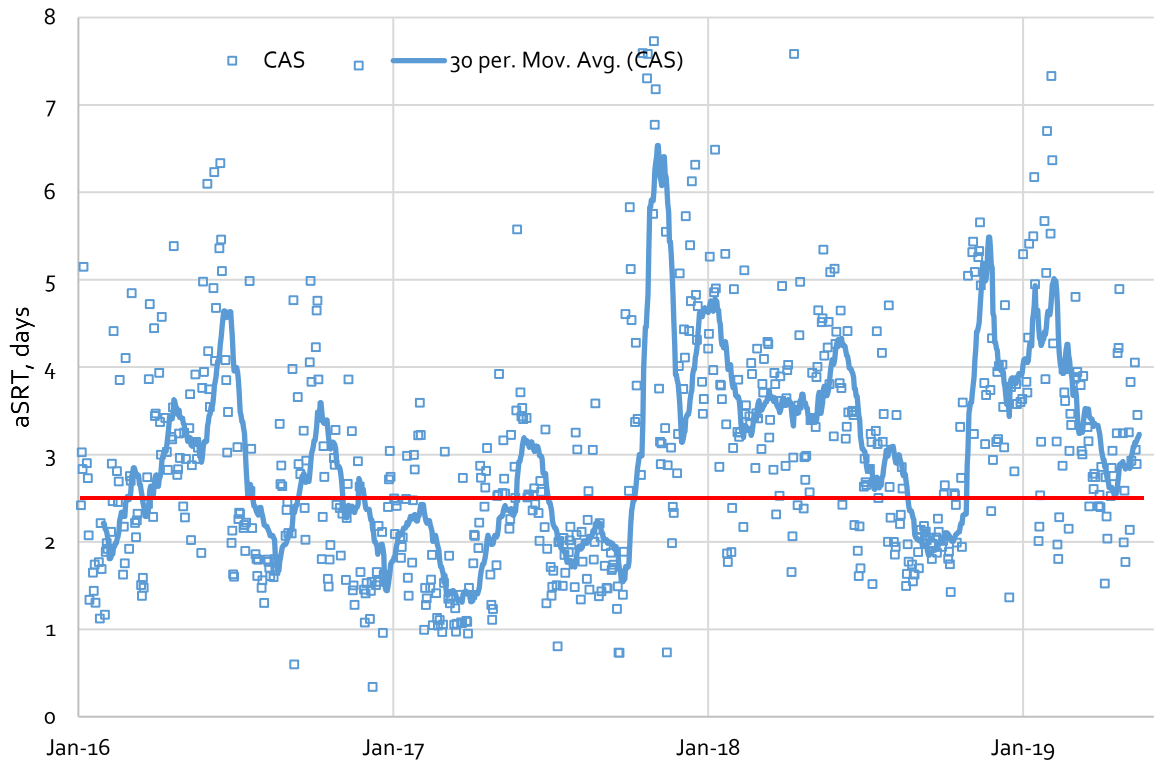
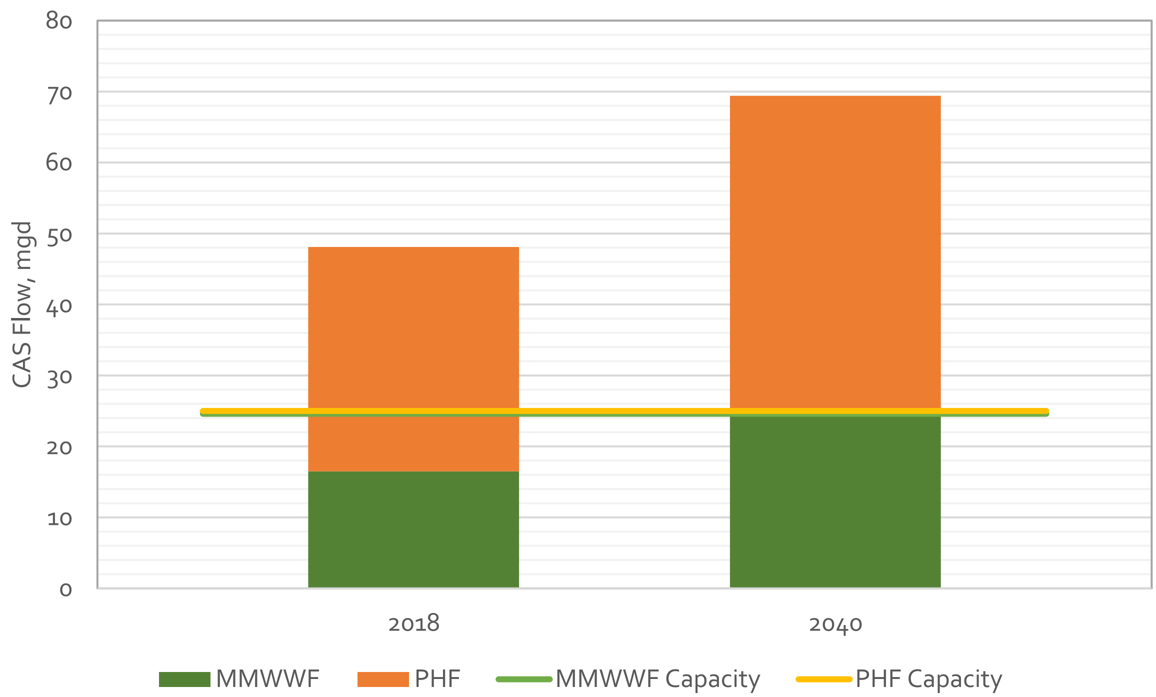


Figure 5.9 Historical CAS Aeration Basin aSRT

Based on the maximum allowable MLSS concentration and the design aSRTs, the capacity of the secondary system was determined through a calibrated BioWin model. The model calibration is described in Appendix C and Appendix D summarizes the solids mass balance for the MMWW condition. At the design aSRT of 2.5 days, a maximum month MLSS concentration of 2,600 mg/L and 54 percent removal of TSS through the primary clarifiers, the CAS aeration basins are limited to 2040 CAS MMWWF of approximately24.6 mgd. As is shown in Figure 5.10, the secondary system has sufficient MMWWF capacity for the current and projected 2040 CAS MMWWFs.

Under average dry weather conditions, one secondary clarifier or one aeration basin must be able to be removed from service to allow for maintenance. Assuming that a clarifier or an aeration basin are removed during the dry periods of June through September, these redundancy criteria do not limit the Tri-City secondary treatment capacity.

In addition to the capacity limitations posed by the secondary clarifiers on the aeration basins, the secondary clarifiers also have a maximum flow capacity criterion. The plant operates their secondary clarifiers at peak SORs of 1,200 gpd/sf, which are within the typical range for peak SORs. At a SOR of 1,200 gpd/sf, the secondary clarifiers have a theoretical maximum flow capacity of 27 mgd, but hydraulic limitations downstream limit the secondary process capacity to 25 mgd, as explained in Section 5.5. Figure 5.10 compares the available peak capacity with all clarifiers in service against the current and projected CAS PHF. Including the allowed select treat flow, the plant has sufficient capacity for the current PHF, but additional peak flow capacity will be required in the near future. By 2040, the deficit between the available secondary treatment PHF capacity and the projected PHF is 44.4 mgd.



Note: Both the 2018 and 2040 PHF bars in this figure include neither the 10 mgd sent to the MBR facility nor 25 mgd through select treatment.

Figure 5.10 Secondary Clarifier Capacity

5.4.7 Sodium Hypochlorite Disinfection

Secondary effluent from the CAS treatment train flows to the chlorine contact basin, where it is mixed with select treat flow and disinfected with sodium hypochlorite. Combined disinfected CAS secondary effluent and MBR filtrate are dosed with sodium bisulfite for dechlorination in the effluent mixing box, and flow by gravity to the outfall in the Willamette River.

The chlorine contact basin consists of two parallel contact chambers, each 36,700 cubic feet in volume and with a length-to-width ratio of 40 to 1. The Oregon DEQ, in *Preparing Wastewater Planning Documents and Environmental Reports for Public Utilities* (July 2019), the contact chamber should be sized for at least 15 minutes of contact time at PHF, 20 minutes at PDF, and 60 minutes at ADWF. Because of the location of the bisulfite dosing point in the effluent mixing box, the volume of the 72-inch effluent pipe is considered in determining these contact times – the segment of pipe between the chlorine contact basin and the effluent mixing box is approximately 600 ft long, corresponding to an additional contact volume of 17,000 cubic feet under all flow conditions. Design data for sodium hypochlorite disinfection are summarized in Table 5.12.

Table 5.12 Sodium Hypochlorite Disinfection Design Data

Process / Criterion	Unit	Value
Chlorine Contact Basins		
Number		2
Volume, each	cubic feet	36,700
Length to Width Ratio		40:1

Process / Criterion	Unit	Value
Pipe to Effluent Mixing Box		
Length	feet	600
Nominal diameter	inches	72
Volume	cubic feet	17,000
ADWF contact time	min	60
ADWF capacity (1 basin out of service)	mgd	9.7
PDF contact time	min	20
PDF capacity (all basins in service)	mgd	38.2
PHF contact time	min	15
PHF capacity (all basins in service)	mgd	50.8

These combined contact times of the contact chambers and the effluent pipe correspond to a PHF capacity of 50.8 mgd, PDF capacity of 38.2 mgd, and ADWF capacity with one unit out of service of 9.7 mgd, respectively. Figure 5.11 shows the capacity of the existing chlorine contact basin to meet the disinfection criteria prescribed by DEQ in 2018 and 2040. While there is sufficient capacity to meet the requirement for the disinfection process to provide a 60-minute contact time with a basin out of service, the basins lack capacity to provide a full 20-minute contact time under PDF conditions and 15 minutes under PHF conditions.

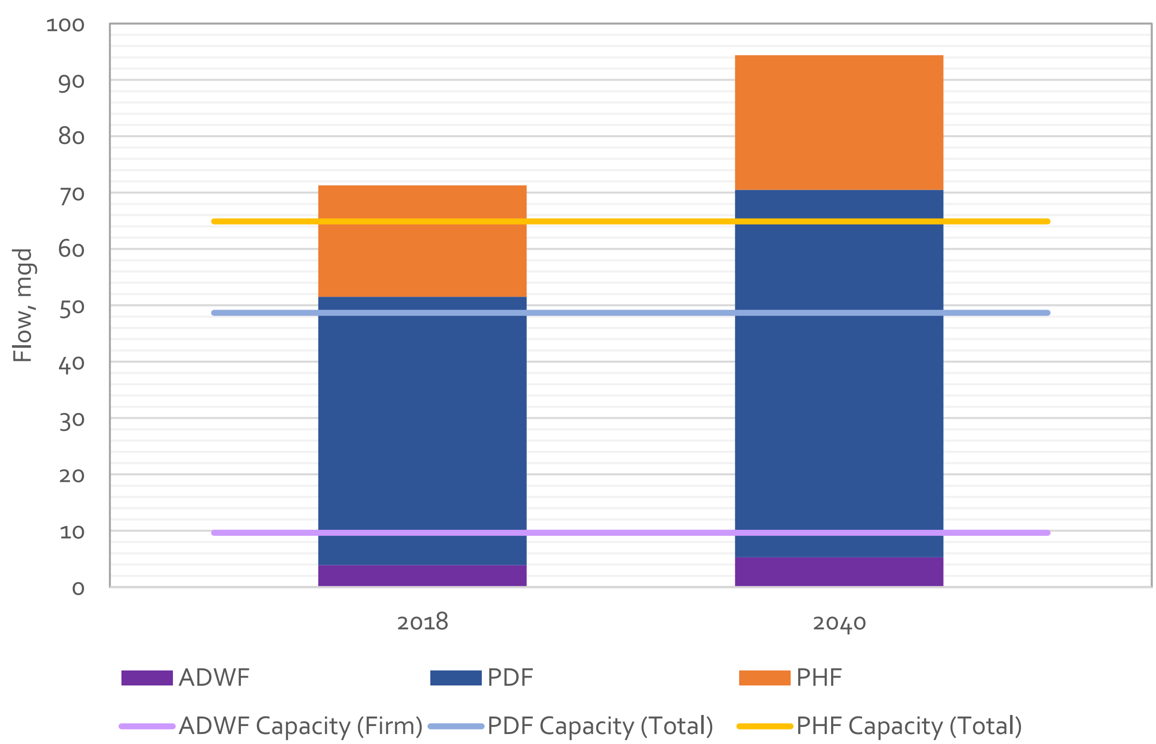


Figure 5.11 Sodium Hypochlorite Disinfection Capacity

5.4.8 Thickening

Waste activated sludge (WAS) is diverted from the CAS train RAS system and pumped to the thickening process by two 7.5 hp pumps, each rated for 400 gpm at 0.8 percent solids. WAS is also diverted from the MBRs in the mixed liquor channel and pumped to the gravity belt thickeners (GBT) by two 10 hp pumps, each rated for 400 gpm at 40 ft TDH.

WAS from both the MBR and CAS treatment trains is thickened on two, 2-meter GBTs and subsequently pumped to the anaerobic digesters. The GBT is limited to a hydraulic loading rate of 200 gpm per meter, corresponding to a WAS rate of 400 gpm per GBT. The GBT is also limited to a solids loading rate of 900 lb/m/hr, corresponding to 1,800 lb/hr per GBT. The design minimum solids concentration of the thickened WAS (TWAS) is 5 percent. TWAS from the end of the belts is collected in sludge hoppers and pumped to the anaerobic digesters via two 15 hp progressive cavity pumps, rated for 120 gpm at 50 pounds per square inch. Design data for the solids thickening process are summarized in Table 5.13.

Table 5.13 WAS Thickening Design Data

Process / Criterion	Unit	Value
Type		Gravity belt thickeners
Number		2
Belt width	meter	2
Hours of Operation		
Hours per day		10
Days per week		7
Hydraulic loading rate, each	gpm	400
Firm hydraulic capacity	mgd	0.58
Total hydraulic capacity	mgd	1.15
Solids loading rate, each	lb/hr	1,800
Firm solids loading capacity	ppd	43,200
Total solids loading capacity	ppd	86,400

Prior to installation of the GBTs, WAS thickening was accomplished using a pair of dissolved air flotation thickeners (DAFT). These have been decommissioned, but one of the East DAFT tanks is still used to collect filtrate. GBT filtrate flows by gravity to the influent pump station wet well, though the ability also exists for it to be pumped back to the primary clarifiers or the CAS aeration basins.

Using the calibrated plant model, the capacity of the GBTs was compared to the projected future flows and loads. Based on this analysis, the current GBTs have sufficient total capacity to thicken the WAS generated from the projected 2040 maximum week wet weather (MWWW) flows and loads and sufficient firm capacity to thicken the WAS generated from the 2040 MMWW flows and loads (Figure 5.12) assuming they can be operated for up to 11.5 hours per day, seven days per week.

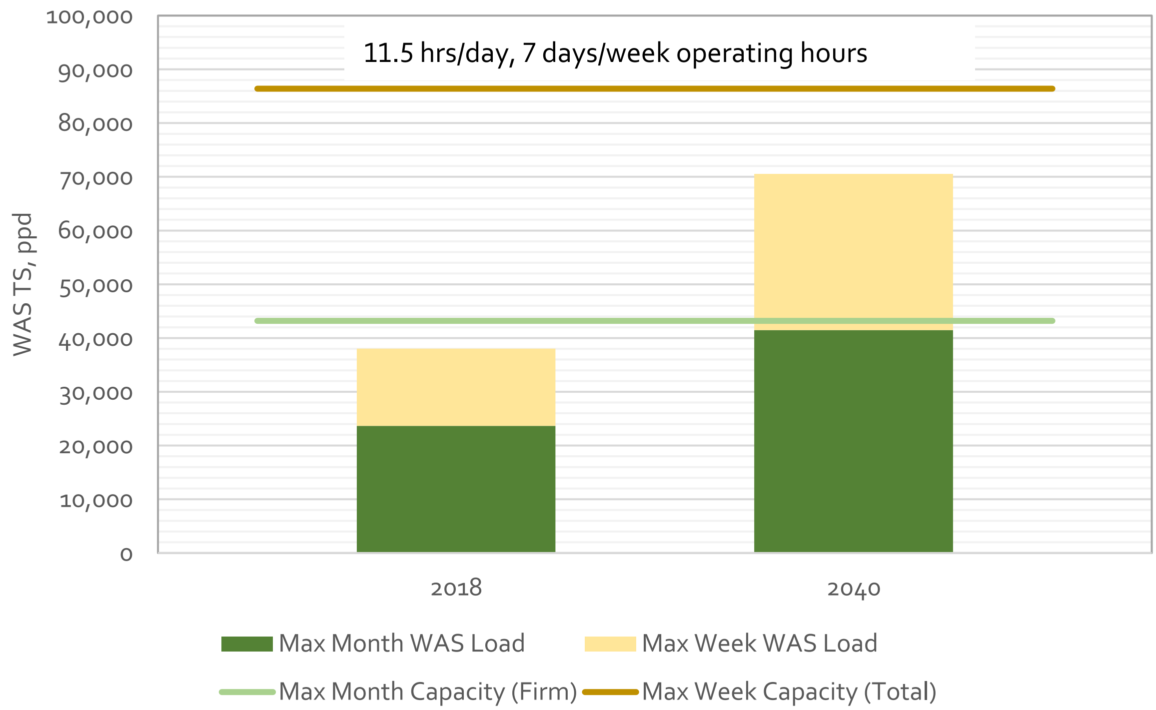


Figure 5.12 WAS Thickening Solids Loading Capacity

5.4.9 Anaerobic Digestion

The Tri-City WRRF currently has three anaerobic digesters; two are each 65 feet in diameter, 41 feet deep, and containing 1,020,000 gallons in volume, and a newly constructed digester is 70 feet in diameter, 45 feet deep, and containing 1,300,000 gallons.

The anaerobic digesters require the capacity to treat the maximum month solids load with a 20-day solids residence time (SRT) with all units in service, and a 15-day SRT with one digester out of service (Table 5.1). The capacity rating for the anaerobic digesters is based on the following assumptions:

- Digesters are operated up to their maximum sidewater depth.
- 90 percent of the digester volume is used for active digestion.
- The primary sludge (PS) thickness is approximately 2.5 percent and TWAS thickness is approximately 5 percent.

Both hydraulic and solids loading can control the anaerobic digestion process. For the most recent solids upgrade project at Tri-City, the anaerobic digestion hydraulic loading was limited to a minimum SRT of 15 days with one digester out of service. No specific SRT criterion was set for all digesters in service from this project. For this reason, a target SRT of 20 days under maximum month conditions with all digesters in service was selected to provide stable digestion. Figure 5.13 reflects the anticipated digester SRTs. Note that unlike previous capacity figures, the digester capacity is exceeded if the vertical bars representing digester SRT at max month loads fall below the horizontal lines representing design digester SRT values. Based on these assumptions, the anaerobic digesters currently have sufficient firm and total capacity to treat the current MMWW solids loads. By 2040 without additional primary sludge thickening, the firm SRT is projected to drop to 13 days while the total SRT is projected to drop to 21 days. If primary sludge thickening is provided (shown in Figure 5.13 in the hatched area) which can thicken the primary sludge to 5 percent total solids, the projected firm anaerobic digestion SRT is projected to increase to 21 days while the projected total SRT is projected to increase to 30 days.

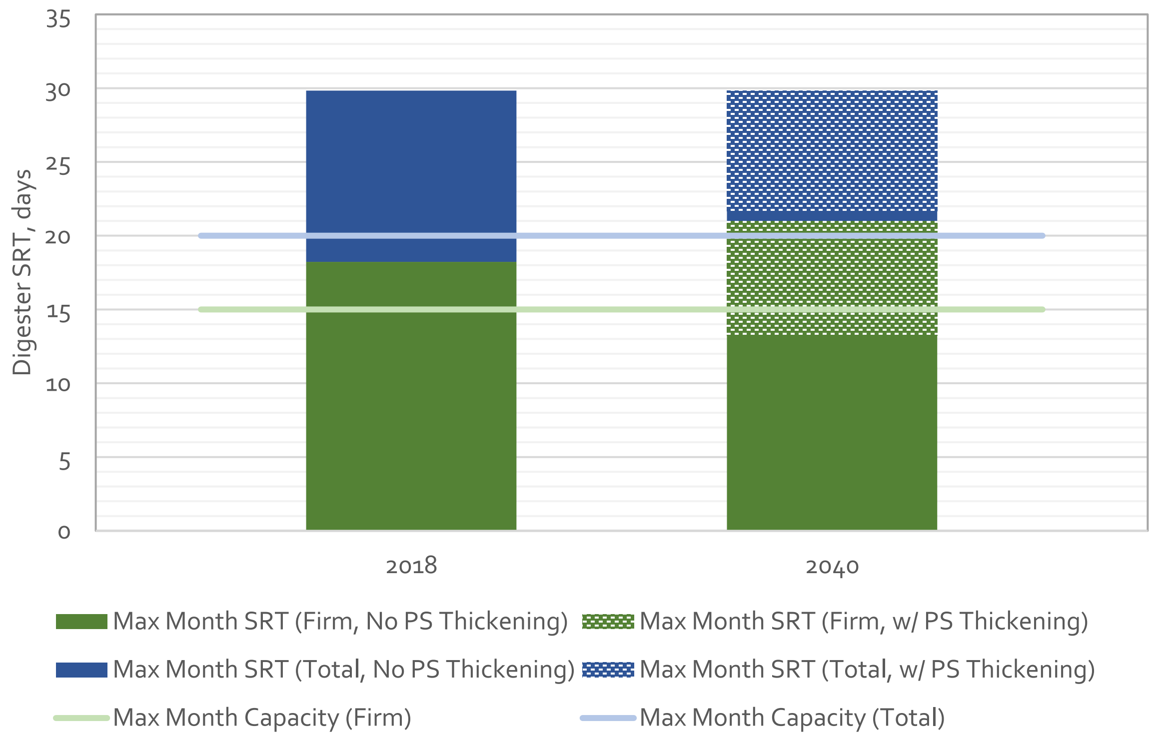


Figure 5.13 Digestion Capacity

The most recent solids project at Tri-City limited the anaerobic digestion specific volatile solids loading rate (SVSLR) to 0.16 pounds per day of volatile solids fed per pound of volatile solids (lb VS/d-lb VS) inventory under maximum two-week loads with one digester out of service. Since maximum two-week loads were not projected as part of this project, the 0.16 lb VS/d-lb VS inventory was converted to a maximum month value of 0.15 lb VS/d-lb VS inventory using the relationship between maximum month and maximum two-week loads from the Tri-City solids expansion project. Figure 5.14 represents the anticipated digester SVSLR, which is defined as the volatile solids load to the anaerobic digesters divided by the total mass of volatile solids within the digesters. There is sufficient digestion capacity to meet the 0.15 lb VS/d-lb VS inventory even without primary sludge thickening for the entire planning period.

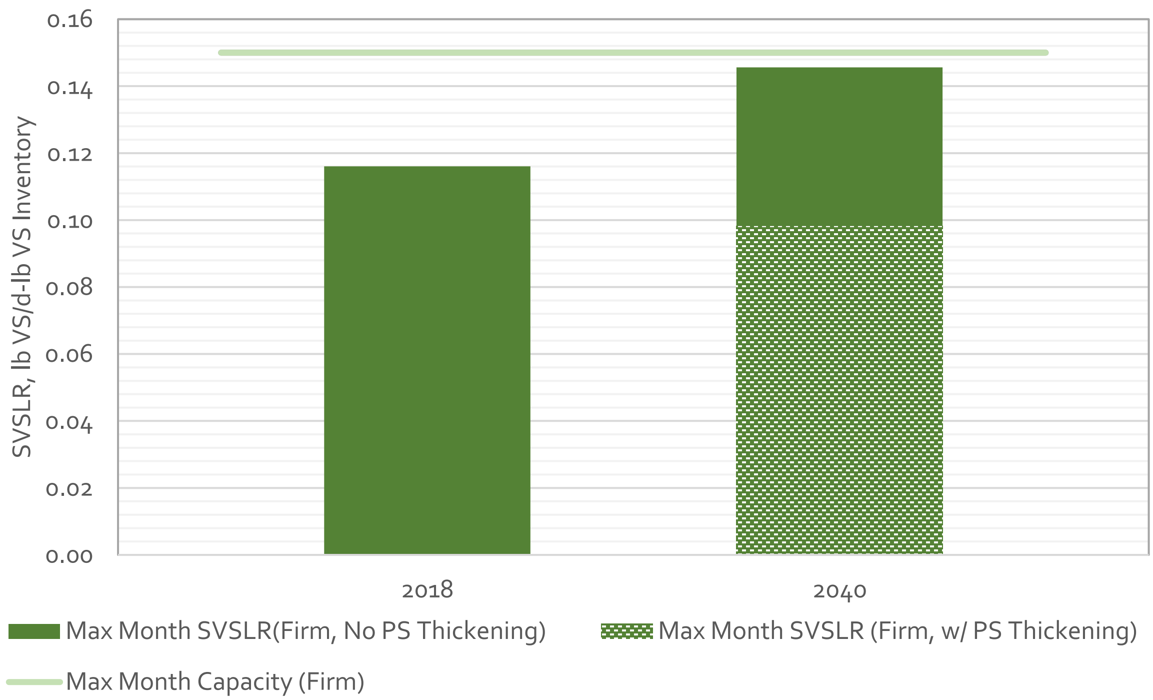


Figure 5.14 Digestion Capacity

5.4.10 Dewatering

Digested sludge (DS) is pumped to two recently constructed dewatering centrifuges. The centrifuges are each rated for 2,200 lb/hr of dry solids at 175 gpm and 2.5 percent feed solids. The design cake concentration is 23 percent total solids. Centrate from the dewatering centrifuge can be stored in the decommissioned west DAFT tank prior to pumping to the MBR influent.

The overall solids loading capacity of the dewatering process, along with current and projected digested solids loads, is shown in Figure 5.15, assuming the centrifuges can be operated 9.5 hours per day, 7 days per week . Figure 5.16 shows the hydraulic capacity of the dewatering centrifuges assuming these same operating hours. It is assumed in this analysis that primary sludge thickening will be implemented within the planning period, which is why the hydraulic loading rate to the centrifuges is reduced in 2040. Assuming these operating hours are allowable under maximum month conditions, the centrifuges have adequate capacity through the planning period, though the hydraulic loading rate under current conditions require the longest operating hours to maintain sufficient capacity.

Digested sludge from the Kellogg Creek WRRF is shipped to the Tri-City WRRF for dewatering on an auxiliary dewatering centrifuge. Since this centrifuge is dedicated to dewatering sludge from the Kellogg Creek WRRF, its capacity is discussed in Chapter 5 of the Kellogg Creek WRRF Facilities Plan.

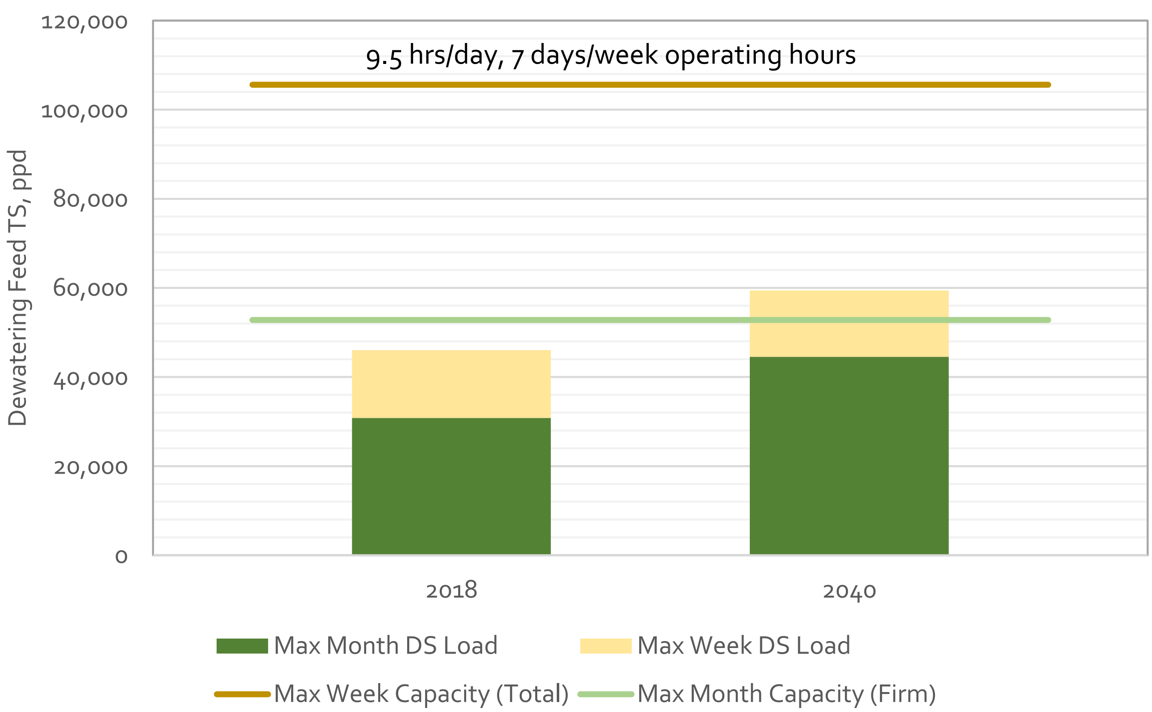


Figure 5.15 Dewatering Centrifuge Solids Loading Capacity

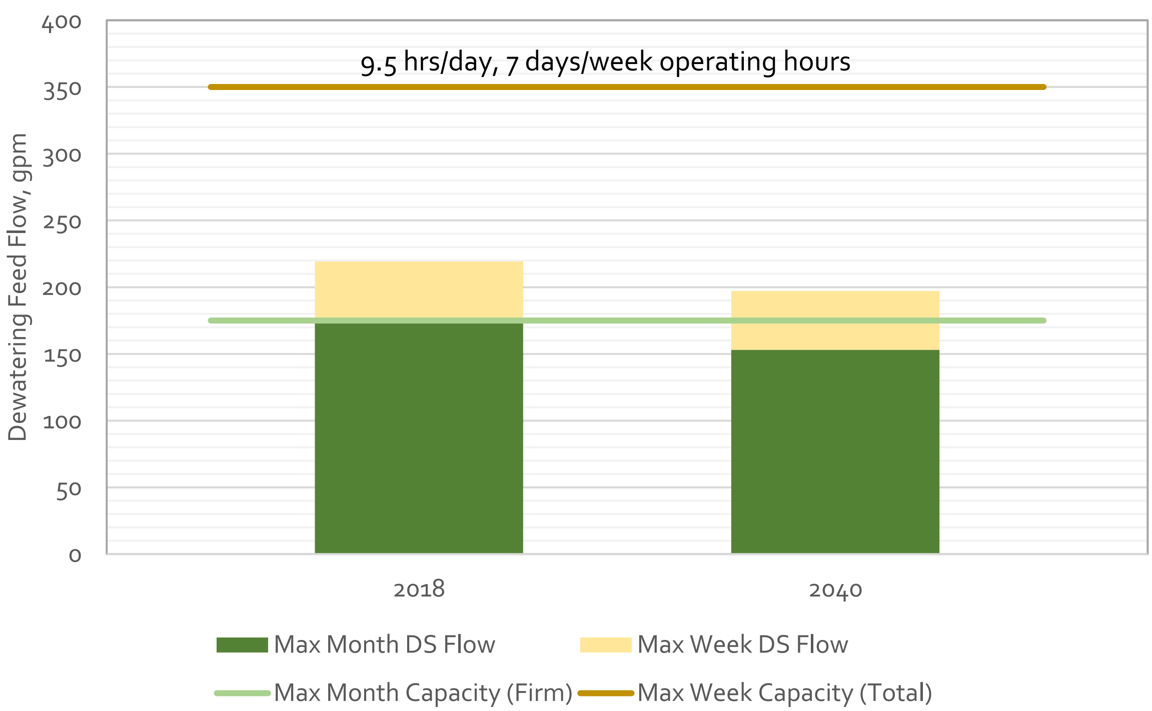


Figure 5.16 Dewatering Centrifuge Hydraulic Loading Capacity

5.5 Hydraulic Capacity

A hydraulic profile was developed for the Tri-City WRRF using the original outfall drawings from February 1984, and the original plant record drawings from September 1986 though the most recent Phase 1 Expansion drawings from February 2012. The limits of the analysis extend from the influent pump station discharge to the outfall in the Willamette River, including flow from the fine screens to the MLTR channel, through the UV disinfection system, and through the Select Treat Parshall flume and diversion structure.

5.5.1 Approach and Assumptions

A model was used to develop individual unit process hydraulic capacities as well as an overall peak hydraulic capacity (i.e., hydraulic profile) through the Tri-City WRRF at the PHF condition, with the Willamette River at the 25-year flood stage at stream gauge ID 14207770, which corresponds to a water surface elevation of 38 ft per National Geodetic Vertical Datum of 1929 (NGVD 29). The following criteria were used to define hydraulic capacity:

- Weir Submergence. A six-inch minimum elevation should be maintained between the weir crest and the downstream water surface elevation.
- Freeboard. Freeboard was defined as the distance between the water surface elevation and the top of a structure wall and/or bottom of concrete slab or adjacent walkway (in the event of a covered basin). The required freeboard to establish capacity was assumed to be 18-inches, and plant hydraulic capacity was defined as the flow that can be passed through the WRRF without violating the minimum freeboard criterion at any processes structure.
- Flume Submergence. Parshall flumes cannot accurately measure flow when the flume submergence exceeds 90 percent. This criterion was used to define the upper limit of the WRRF flow measurement capabilities in locations where Parshall flumes are used to measure flow.

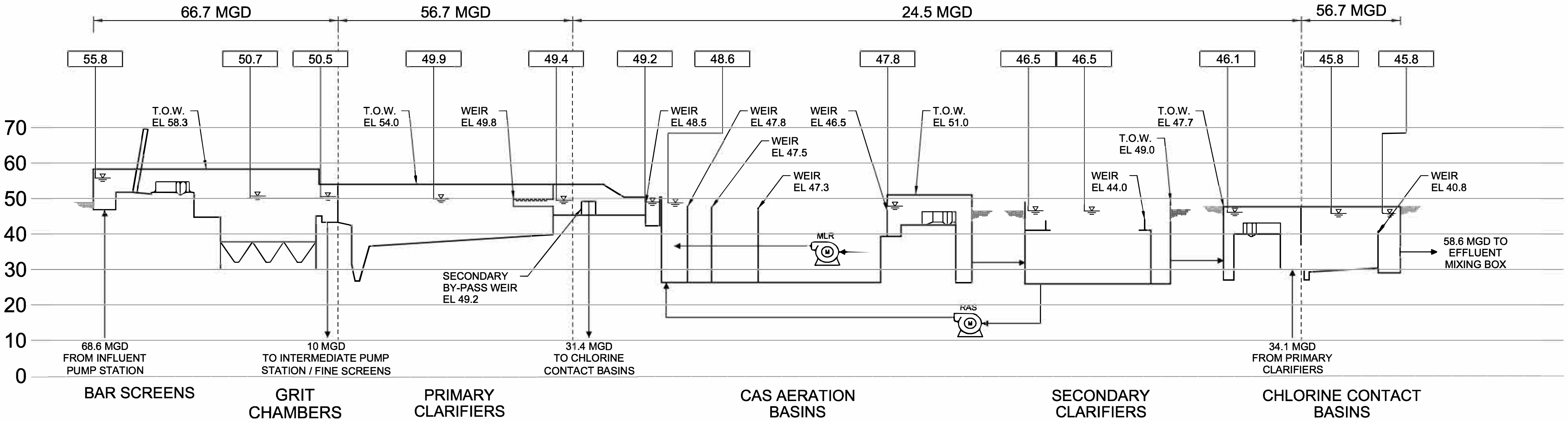
In most cases, a unit process' hydraulic capacity was defined by a submerged weir condition, although in some cases the freeboard criterion was exceeded first.

The following general assumptions were made in evaluating the capacity of each unit process:

- All flow that exceeds the combined capacity of the CAS and MBR treatment trains (35 mgd) receives select treatment.
- The MBR WAS pump station is operating at its total capacity of 1.15 mgd. No CAS WAS pumps are operating.
- Plant drain flows, membrane backwash flows, primary sludge flows, and non-potable water flows are not accounted for in this analysis.

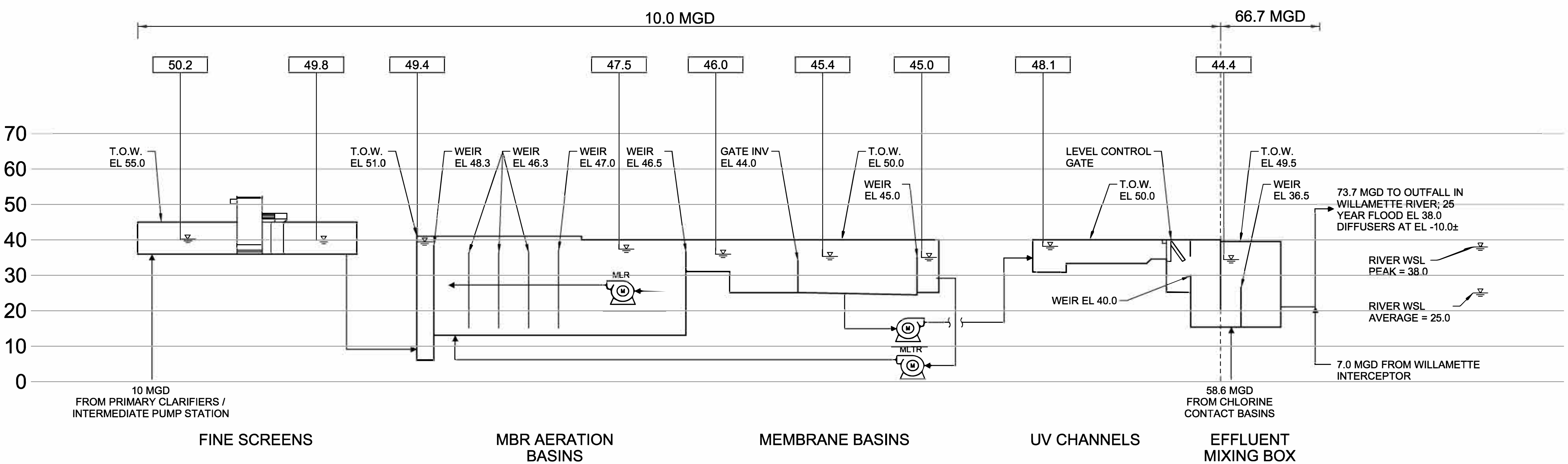
5.5.2 Results and Limitations

The hydraulic capacity of the Tri-City WRRF when the Willamette River is at the 25-year flood elevation is estimated to be 67 mgd, which is the condition that causes freeboard requirements to be exceeded in downstream structures (e.g., chlorine contact basin effluent channels, select treatment Parshall flume). This condition is reflected on the hydraulic profile shown in Figure 5.17 and is considered to be the maximum hydraulic capacity of the WRRF. Similarly, the hydraulic capacity of the CAS secondary treatment process was determined to be the main capacity limitation at approximately 25 mgd, which matches observations of peak flow capacity through the CAS process by plant staff.



	BAR SCREENS	GRIT CHAMBERS	PRIMARY CLARIFIERS	CAS AERATION BASINS	SECONDARY CLARIFIERS	CHLORINE CONTACT BASINS
UNITS IN SERVICE: PEAK / AVERAGE (TOTAL)	3 / 2 (4)	2 / 2 (2)	6 / 6 (6)	4 / 4 (4)	2 / 2 (2)	2 / 2 (2)

	PHF
MLR	28.8 MGD
RAS	12.6 MGD



	FINE SCREENS	MBR AERATION BASINS	MEMBRANE BASINS	UV CHANNELS
UNITS IN SERVICE: PEAK / AVERAGE (TOTAL)	3 / 2 (4)	2 / 2 (2)	6 / 6 (6)	4 / 4 (4)

	PHF
MLR	16.0 MGD
RAS	21.0 MGD

Figure 5.17
TRI-CITY WRRF HYDRAULIC PROFILE

carollo

The following limitations should be addressed when considering alternatives to increase the hydraulic capacity of the Tri-City WRRF:

- Outfall Pipeline. The pipeline connecting the outfall transition structure near the confluence of the Clackamas and Willamette Rivers to the Tri-City WRRF is nearly a mile long and contains 14 manholes. Hydraulic modeling at peak flows indicates this pipeline produces several feet of headloss, which severely limits peak hydraulic capacity. A project to install a new, parallel outfall pipeline is underway. A draft memorandum (Jacobs, July 2019) was used to assess the likely impact of using this new outfall in parallel with the original outfall under peak flow conditions. Assuming the new outfall consists of an 84-inch pipe that is approximately 6,150 ft long, and assuming 1.5 ft of headloss is induced at the new outfall diffusers, the water surface elevation (WSE) in the effluent mixing box at the Tri-City WRRF is significantly reduced. With this outfall in place, the model predicts that the Tri-City WRRF hydraulic capacity may be increased to the 2040 PHF condition (estimated to be 104.6 mgd), although the freeboard criterion may be violated in certain structures and other in-plant improvements (e.g., additional process units and hydraulic interconnections) will be required.
- Select Treatment Parshall Flume. Depending on future flow splits, the Parshall flume that measures Select Treat may become submerged and/or may produce a hydraulic bottleneck that creates freeboard issues in upstream structures.
- Primary Effluent Collection Channel. The CAS aeration basins are separated from the primary effluent collection channel by a weir wall, which is approximately 19 ft wide. The crest of this weir is only 0.7 ft below the overflow weir into the Select Treatment channel, which is downstream of the primary clarifiers. At high flows, the WSE in the primary effluent collection channel backs up to within 0.7 ft of this bypass weir. As a result, it is possible that Select Treatment may occur at flows that are close to (or slightly less than) the rated secondary capacity of the CAS and MBR systems.

5.6 Capacity Summary

The results of the process capacity analysis presented in this chapter are summarized in Table 5.14.

Table 5.14 Tri-City WRRF Capacity Analysis Summary

Unit Process	Limiting Flow Parameter	Capacity Summary			Notes
		Currently Available	Currently Required (2018)(1)	Future Required (2040)(1)	
Influent Pumps	PHF, mgd	50	65	72	The available pumping capacity at Tri-City is 68 mgd, which exceeds the current PHF of 65 mgd. However, the available firm pumping capacity (largest unit OOS) is 50 mgd, which is less than the current PHF and will be exceeded within the planning period. Accordingly, pumping improvements are required at Tri-City to increase the firm pumping capacity from 50 mgd to 72 mgd.
Influent Screens	PHF, mgd	85	81	104	The available total screening capacity (including the manually cleaned bar rack) is 85 mgd, which is exceeds the current PHF but I less than the capacity required by buildout. less than the required capacity (55 mgd) today. Accordingly, improvements are required at Tri-City to increase the screening capacity to meet the projected PHF.
Grit Basins	PHF, mgd	75	81	104	The existing grit basins have a rated capacity of 50 mgd but have passed flows of up to 75 mgd. This capacity is less than the projected current and 2040 PHF and thus additional girt removal capacity will be required to meet the projected 2040 flows.
Primary Clarifiers	PHF, mgd	60	81	104	The existing primary clarifiers have a peak capacity of approximately 60 mgd, which is less than the required capacity under current conditions as well as projected future (2040) conditions. Accordingly, improvements are required at Tri-City to increase the total primary treatment capacity from 60 mgd to 104 mgd.
Aeration Basins	MMWWF, mgd	30	22	31(2)	The existing aeration basins in the CAS and MBR systems have a combined maximum month capacity of approximately 30 mgd when the MLSS inventory in the CAS system is maintained at a level that produces a 2.5-day SRT throughout the wet weather season. With this level of process control, additional aeration basins are not necessary. However, additional aeration basin capacity may be considered to reduce the necessary level of process control and add reliability to the process.
Secondary Clarifiers / Membrane Tanks	PHF, mgd	35(4)	58(5)	79(5)	When the secondary process is operated at a 2.5-day SRT, the combined peak capacity of the existing secondary clarifiers and membranes is 35 mgd. Assuming 25 mgd of select treat and additional 44 mgd PHF capacity is required by the year 2040.
Disinfection	PHF, mgd	65	71(6)	94(6)	The existing chlorine contact chamber provides sufficient contact time to disinfect a peak flow of 65 mgd, which is less than both the current and projected 2040 PHF. Additional capacity is required to meet the projected 2040 PHF.
WAS Thickening	MMWW WAS load, ppd	43,000(7)	23,700	41,500	The existing two GBTs have sufficient capacity to thicken the projected WAS loads for current and projected future loads.
Digestion	MMWW Digester SRT, days	15(7)	18	13 (without PS thickening) 21 (with PS thickening)	Without primary sludge thickening, the anaerobic digestion process does not have sufficient firm capacity for the projected 2040 MMWW loads. Assuming the addition of a process to thicken the primary sludge to 5 percent total solids by the year 2040, the current digestion capacity (including the new digester) has sufficient capacity through the year 2040.
Dewatering	Maximum Month Dewatering Feed Load	53,000(7)	31,000	45,000	Assuming a 9.5 hour per day, 7 day per week operational schedule, the new centrifuges have sufficient firm capacity to dewater projected MMWW load in the year 2040.

Notes:
(1) For all processes except Influent Pumps, the required capacity includes transfer flow from Kellogg Creek.
(2) Includes 5 mgd of transfer flow from Kellogg Creek.
(3) Includes 25 mgd through CAS, and 5 mgd through MBR aeration basins.
(4) Includes 25 mgd through CAS, 10 mgd through MBR.
(5) Excludes 25 mgd through select treat.
(6) Excludes 10 mgd treated through UV disinfection.
(7) Firm capacity.
RED – Capacity improvements are recommended.
YELLOW – Capacity improvements may be desirable.
GREEN – Capacity improvements are not required.

Chapter 6

CONDITION ASSESSMENT

6.1 Introduction and Purpose

The purpose of this chapter is to present the condition assessment results and recommendations for improvements resulting from field investigations conducted at the Tri-City (WRRF. Although a thorough review of all assets was completed, this chapter only highlights assets that were deemed to be in moderate (score of 3) to severe (score of 5) condition and describes the rehabilitation or replacement actions necessary to address the condition of these assets.

6.2 Overview of Facility

The Tri-City WRRF is one of three wastewater treatment facilities owned and operated by WES. The Tri-City facility is located at 15941 South Agnes Avenue in Oregon City, Oregon and has been in operation since 1986. The plant is currently designed to treat up to 60 mgd, but averages around 12 mgd. Major renovation and improvements to the facility include the addition of membrane bioreactor and appurtenances constructed in 2012 and solids handling improvements instituted in 2018. At the time of the condition assessment effort construction was still underway at various portion of the solids/ digester complex and are reflected in the condition assessment results to follow.

6.3 Condition Assessment

The process used to perform the condition assessment of the Tri-City facility assets is summarized in this section. The assessment was based on visual inspection; invasive equipment test procedures were not utilized.

Protocol and Deployment

The condition assessment took place over the course of roughly four days (November 18th through 21st, 2019) and was conducted by a multi-discipline team of mechanical, structural, and electrical/instrumentation engineers. Exterior corrosion, weathering, and deterioration issues along with discipline-specific condition and performance issues, such as temperature, noise, vibration, leakage, wiring, foundational, and component issues were all considered under the purview of the assessment effort. The assessment began with staff interviews to compile a list of known deficiencies, identify operating limitations, and discuss maintenance and operations history of each location. In addition to what was described by plant staff, the assessment team looked for potential problems such as structural deterioration, electrical and instrumentation issues, and mechanical degradation.

Scoring

The condition of assets was ranked using a one-through-five scale at both a general level and across a series of discipline specific questions. A score of 1 represents the best condition assets, while a score of 5 represents the worst condition assets. The purpose of scoring is to provide a common scale to rate assets so they can be compared to one another. The general condition scoring was reviewed and confirmed by WES before the commencement of the condition assessment effort. Table 6.1 provides the general description of the condition associated with each score.

Table 6.1 General Condition Score Descriptions

Condition Score	General Description [1]
1 (Best)	**Excellent** Installed with very little wear. Fully operable, well maintained, and consistent with current standards. Little wear shown and no further action required.
2	**Good** Sound and well maintained but may be showing slight signs of wear. Delivering full efficiency with little or no performance deterioration. Only minor renewal or rehabilitation may be needed.
3	**Moderate** Functionally sound and acceptable and showing normal signs of wear. May have minor failures or diminished efficiency and with some performance deterioration or increase in maintenance cost. Moderate renewal or rehabilitation needed.
4	**Poor** Functions but requires a high level of maintenance to remain operational. Shows abnormal wear and is likely to cause significant performance deterioration in the near term. Replacement or major rehabilitation needed.
5 (Worst)	**Very Poor** Effective life exceeded and/or excessive maintenance cost incurred. A high risk of breakdown or imminent failure with serious impact on performance. No additional life expectancy with immediate replacement required.

Notes:
(1) Discipline-specific score are described in the Appendix 5a-A – WES Condition Scoring of TM5A: Existing Tri-City Water Resource Recovery Facility Condition.

Discipline specific condition scores are utilized to provide further insight into the specific area(s) in which an asset is deficient and gives measure to the repair(s) that is needed to bring an asset to like-new condition. Table 6.2 provides the condition questions categories prompted by a specific asset discipline.

Table 6.2 Summary of Condition Questions Categories by Discipline

Discipline	Condition Question Categories [1]
Mechanical	• General Condition • Corrosion/ Exterior • Vibration • Temperature • Leakage • Components
Structural	• General Condition • Surface Deterioration • Coating/ Lining/ Paint • Leakage • Foundation/ Supports • Components

Discipline	Condition Question Categories (1)
Electrical	• General Condition • Equipment • Enclosure • Temperature/ Noise • Wiring/ Cable Condition • Components
Instrumentation and Controls	• General Condition • Equipment/ Transmitter • Display/ Enclosure/ Mount • Wiring/ Cable Condition • Components
HVAC	• General Condition • Corrosion/ Exterior • Vibration • Temperature • Components

Notes:
(1) A more detailed description of the discipline-specific score can be found in Appendix 5a-A – WES Condition Scoring of TM5A: Existing Tri-City Water Resource Recovery Facility Condition.

Observations and Findings

The assessment results are separated into sixteen distinct locations as presented in the WES computerized maintenance management system (CMMS): influent pump station, primary basins, primary pump station, aeration basins, blower building, secondary clarifiers, secondary pump station, chlorine contact basin, membrane bioreactor, backup centrifuge, digester complex, chemical building, lime silos, administration building, laboratory, and buildings and grounds. The locations are geographical in nature with a few exceptions.

Figure 6.1 shows the locations included in the condition assessment.

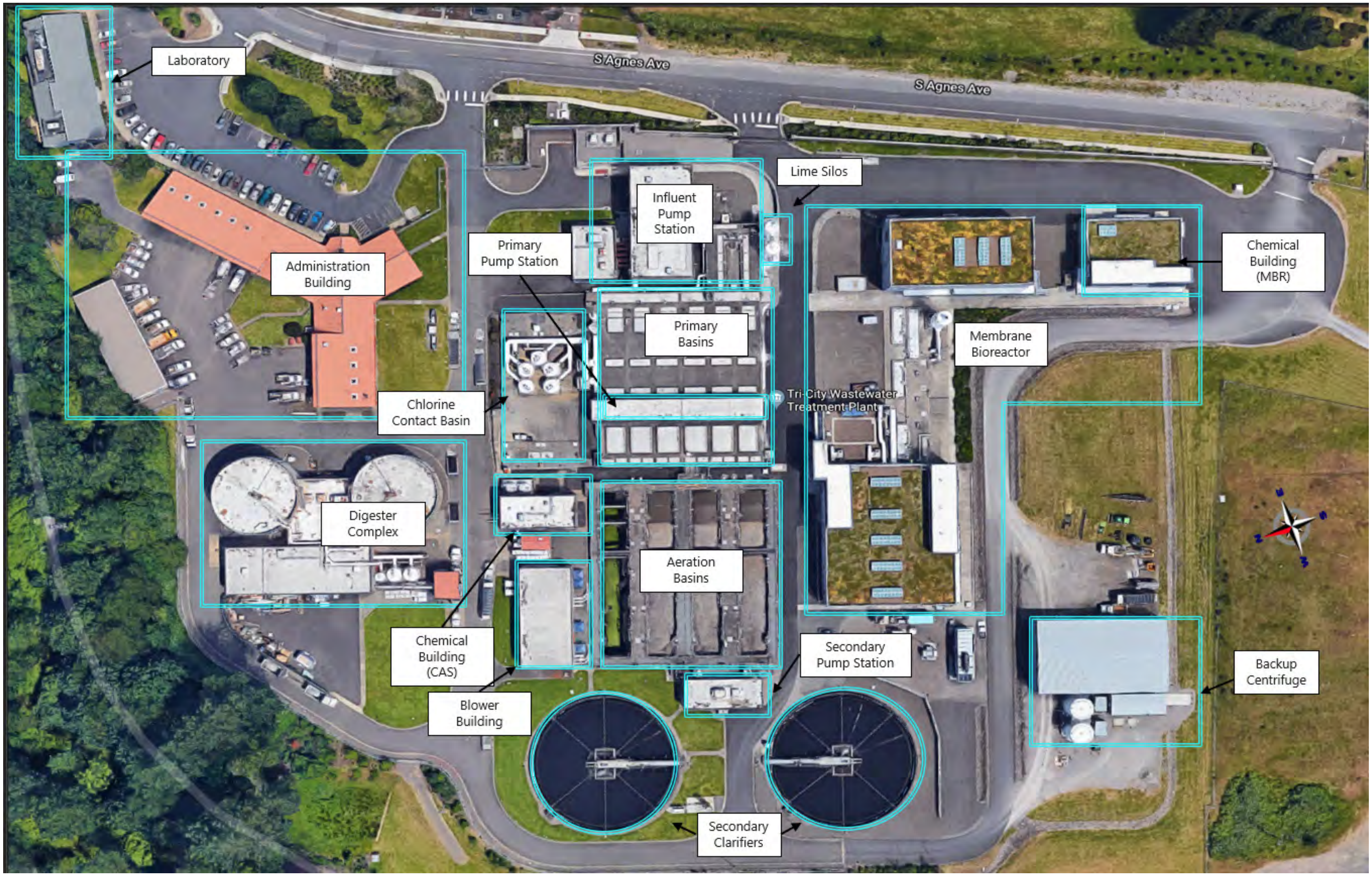


Figure 6.1 Condition Assessment Areas

The follow section provides an overview of each location and its relative geographical position within the grounds of the Tri-City WRRF. A summary of asset types present, along with notable observations, a summary condition scoring, and general corrective actions follows. The summary condition table sorts assets by the maximum condition score received, asset name, and lists the deficient score category attributing to the maximum condition score as the reason. The maximum value from both the general and discipline-specific questions scored one-through-five represents the overall asset condition score for that discrete asset and is what is present in the findings below. Lastly corrective actions are described for all assets receiving a score of 3 (moderate) or higher.

Recommendations for asset improvement were classified as either replacement or rehabilitation. Replacement in this case was assumed to mean the action or process of substituting an existing asset with a newly acquired unit at cost. Rehabilitation was assumed to be the action of restoring something that has been damaged to its former condition.

6.3.1 Influent Pump Station

The influent pump station location resides centrally along the eastern boundary of the Tri-City facility grounds and is comprised of two buildings, an enclosed basin structure, and a septage handling area. The influent pump station building is the furthermost north (~ 30 feet. by 40 feet.) followed by the screening building to the south (~ 50 feet. by 95 feet.) and grit chamber basin. Directly east of the grit chamber basins resides the septage handling.

Assets designated to the influent pump station location include: basins, channels, launders, troughs, hoppers, piping, tanks, wet wells, blowers, conveyors, gates, hoists, trolleys, cranes, pumps, screens, strainers, skimmers, samplers, valves, meters, transmitters, programmable logic controllers, switches, sensors, exhaust fans, supply fans, motors, motor control centers, solid state starters, switchboards, and variable frequency drives.

The following notable observations were made about condition deficient assets at the influent pump station location:

- Grit Pumps 2, 3, 4, and 5 – were evaluated to be in overall poor condition. Pumps show significant wear and components need to be replaced. Some associated pump valves leak.
- Influent Pump 1 – was evaluated to be in overall poor condition. Replaced temporary rotating assembly (from returned activated sludge (RAS) pump) with refurbished original rotating assembly in April 2019. Problems with vibration ever since. Now waiting for parts to remedy. Pump only runs when necessary. Pump suction piping is likely to be heavily corroded (based on pump 2 piping failure). Should be inspected and/or replaced. Pump discharge piping within building shows evidence if corrosion and/or leakage. OandM staff concerned with integrity of pipe. Should be inspected. Isolation valve (knife gate) on pump discharge should be added as asset. Appears to be moderately maintained. Isolation valve (bonneted knife gate) on pump suction should be added as asset. Appears to be moderately maintained but is corroded and is reported to leak.
- Influent Pump 3 and 4 – were evaluated to be in overall poor condition. Pump suction piping is likely to be heavily corroded (based on pump 2 piping failure). Should be inspected and/or replaced.
- Influent Pump 5 – was evaluated to be in overall poor condition. Current rotating assembly is in shop for repair (installed unit is from RAS pump). Recently refurbished driveline due to vibration issues. Works well.

- Influent Pump Station Piping General – was evaluated to be in overall poor condition. Raw sewage pipes (5 of them). Coating appears to be in good condition, but corrosion is evident at Victaulic™ joints. Evidence of small leaks at joints. Active leaks at pump 2 (1 most west) at knife gate. Corrosion between flanges and at knife gate. Knife gate 5 is in poor condition with severe component corrosion, not leaking though. Pipes at exterior have minor coating failures with minor corrosion observed. Have had recent failures at (2) of the dismantling joints within the dry well. Concerned about localized corrosion and leak evidence at the couplings on the effluent pipes.
- Grit Basin 1 – was evaluated to be in overall moderate condition. Minor leaks in stairwell to the south of Screenings Building. Piping appears moderate with some local corrosion at Victaulic™ joints. Local corrosion on NPW pipe at west end of grit gallery. Concrete walls inside grit gallery have some cracks with most having precipitate, but no active leaks. Expansion joint at west interface with primary gallery has minor weeping.
- Grit Basin 2 – was evaluated to be in overall moderate condition. No coating observed. Possibly air treated. Couple of rebar spalls, but no exposed aggregate. Influent channel looks good. Lichen covering a pipe in the channel.
- Grit Chamber 1 Effluent Gate – was evaluated to be in overall moderate condition. Seals well but is in worse shape. Difficult to open/shut. Oil leak.
- Grit Hoppers 1 and 2 – were evaluated to be in overall moderate condition. Grit hoppers are coated steel with minor corrosion and coating failure. Hoppers are lined with stainless steel and in good condition. Conveyor supports have minor to moderate corrosion at the top of the hopper wall.
- Grit Pump 1 and 6 – were evaluated to be in overall moderate condition. Wear components need to be replaced. Will likely replace pumps. Some valves leak.
- Influent Pump 1, 2, 3, 4, and 5 Motors – were evaluated to be in overall moderate condition. Nameplate does not indicate Inverter Duty Motor, which is the type of motor that should be used with VFDs. Motor No. 5 was rebuilt in 1998.
- Influent Pump 2 – was evaluated to be in overall moderate condition. Pump suction piping is likely to be heavily corroded (based on RAS Pump 1 piping failure). Should be inspected and/or replaced. Isolation valves (knife gate) on pump suction and discharge appears to be moderately maintained but is corroded and is reported to leak. Packing can be maintained, but valves cannot be refurbished without an extended header outage.
- Influent Wet Well Isolation Gate Valve – was evaluated to be in overall moderate condition. WES staff indicated that valve infrequently used. Gate nut stripped in late 90 and no flow could get into plant. Sluice Gate. Not sure why it is in place, no bypass. Critical that it stays open. Gate was not visible.
- Mechanical Bar Screens 1, 2, and 3 – were evaluated to be in overall moderate condition. Bar No. 1 screen is the only remaining motorized screen with original bar screen spacing of 5/8. WES intends to replace bar screen bars in the next year or two with 3/8 inch to match the other screens. Bar screens bars for unit No. 3 replaced in 2013, WES hired contractor to replace the bar screen bars of screen #2 in 2018. Overall, the screens operate as intended with as expected O&M requirements. Staff has had to replace carrier bearings occasionally and motor brakes on screens No. 2 and No. 3. Bar screens have redundancy through other screens. SCADA monitors level upstream of the screens and if necessary, will open gates to allow additional screens to come online to meet flow requirements. Staff pointed out some corrosion issues with the screen framing and expressed concerns about long term structural integrity. Hydraulic capacity of

screens after installation of smaller bar screens was not known per discussions with WES staff, should be evaluated during future headworks evaluation.

- Screening Building – was evaluated to be in overall moderate condition. Concrete double tee roof framing with precast concrete beams with precast concrete wall panels. North panel to the west of the west roll up door has numerous cracks and the joint to the west side has completely failed (torn open). Appears that the joint is too wide for the sealant. Expansion joint runs through building to isolate grit load-out. Joint at interior door has failed. Minor door frame corrosion at north side of load-out. Concrete spall at septage receiving. South side wall panels have similar joint sealant issue. Joint appears to be too wide. It is greater than 2.0 inches wide. No direct exit to grade at the south side. Overall concrete exterior condition is good to moderate. Steel tie plates appear to have been a seismic retrofit to tie panels together. Seen throughout the interior. Building has a split level. Concrete spalling at the grit hopper room floor at a few locations due to shallow rebar coverage. Two locations in the bar screen room have concrete floor spall due to shallow rebar coverage.
- Screening Piping General – was evaluated to be in overall moderate condition. Piping in grit load-out area (grit and process drain) appears to be in good condition with no obvious corrosion or coating failures or leaks. Appears to be minor corrosion at Victaulic™ couplings. Piping in grit room is good to moderate with localized replacement of pipe sections at the floor interface due to corrosion. One pipe was observed with corrosion at the floor and requiring a section replacement and protection.
- Screenings Channel 1, 2, 3, and 4 Influent and Effluent Gates – were evaluated to be in overall moderate condition. In general, both influent and effluent gates in the screening area have worked as expected. WES staff recently noted that the fiberglass is showing signs of aging and that their replacement should be considered in future years. They sometimes have issues with rags getting stuck in the gate when they are closed, which allows some leakage to occur. Influent gates are viewed by staff as being more critical than the effluent gates in that the influent gates are required to isolate a screen. The effluent gates are not as critical in isolating channels because the Parshall flumes after the screens prevent flow from backing into the screen channel during normal flow conditions. Actuator equipment from one of the effluent gates was used to repair the internals of an influent actuator. Condition input was coordinated with plant staff.
- Screenings Conveyor – was evaluated to be in overall moderate condition. Entire belt is replaced about every 7 years and is special made for WES. The small rollers are repaired as needed, about 6 per year (or roughly ¼) of the small rollers. One or two of the larger rollers are replaced annually (there are only 5 to 7 of these). The drive roller delaminated a few years ago and they had to replace it. The drive motor shows some wear. When they work on the conveyor, they temporarily drop screenings on downside of screen and have the conveyor down for 3 to 4 hours.
- Screenings Effluent Channel – was evaluated to be in overall moderate condition. Minor exposed aggregate visible through view hatches. Concrete in channels is not coated but is treated with air.
- Screenings Influent Channel – was evaluated to be in overall moderate condition. Concrete channels were visible through gate penetrations and at small view hatches. Concrete surfaces in channel have minor surface wear with minor exposed aggregate and appear to be in good to moderate condition. Channels are treated with air. The channels are not coated or lined.
- Screenings Influent Channel 1, 2, 3, and 4 – were evaluated to be in overall moderate condition. Concrete channels have minor exposed aggregate. Channels are not lined or coated.

Picture 1.
Grit Pump 2

Picture 2.
Influent Pump 1

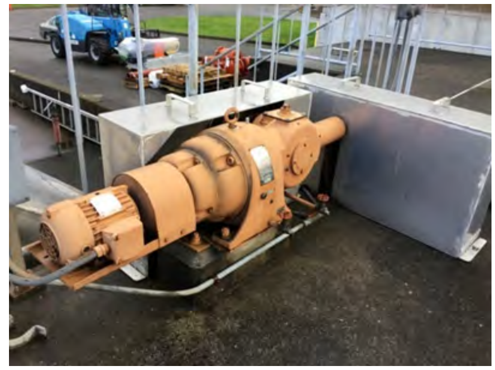
Picture 3.
Influent Pump Station Piping General

Picture 4.
Influent Pump Station Switchboard

Picture 5.
Influent Wet Well Odor Air Fan

Picture 6.
Grit Basin 1

Picture 7.
Screening Building



Picture 8.
Primary Basin 1 Sludge Collector

Table 6.3 summarizes the condition scores for condition deficient assets at the influent pump station location.

Table 6.3 Condition Assessment Summary – Influent Pump Station Location

Condition Score	Asset Name	Reason
4 – Poor	Grit Pump 2	• Components
4 – Poor	Grit Pump 3	• Components
4 – Poor	Grit Pump 4	• Components
4 – Poor	Grit Pump 5	• Components
4 – Poor	Influent Pump 1	• General Condition • Corrosion/ Exterior • Vibration • Components
4 – Poor	Influent Pump 1 Motor	• General Condition • Equipment • Enclosure • Temperature/ Noise • Wiring/ Cable Condition
4 – Poor	Influent Pump 1 VFD	• Enclosure
4 – Poor	Influent Pump 2	• General Condition • Corrosion/ Exterior
4 – Poor	Influent Pump 2 Motor	• General Condition • Equipment • Enclosure
4 – Poor	Influent Pump 2 VFD	• General Condition
4 – Poor	Influent Pump 3	• Components

Condition Score	Asset Name	Reason
4 – Poor	Influent Pump 3 Motor	• General Condition • Equipment • Enclosure
4 – Poor	Influent Pump 3 VFD	• General Condition • Equipment • Enclosure
4 – Poor	Influent Pump 4	• Components
4 – Poor	Influent Pump 4 Motor	• General Condition
4 – Poor	Influent Pump 4 VFD	• General Condition • Equipment • Enclosure
4 – Poor	Influent Pump 5	• Components
4 – Poor	Influent Pump 5 Motor	• General Condition • Enclosure
4 – Poor	Influent Pump 5 VFD	• General Condition • Equipment • Enclosure
4 – Poor	Programmable Logic Controller (CP01; IPS)	• General Condition • Equipment/ Transmitter • Display/ Enclosure/ Mount • Wiring/ Cable Condition
4 – Poor	Influent Pump Station Piping General	• Leakage
4 – Poor	Influent Pump Station Switchboard	• Components
4 – Poor	Influent Wet Well Odor Air Fan	• General Condition • Components
4 – Poor	Manhole J Level Switch High	• General Condition
3 – Moderate	Grit Basin 1	• General Condition • Leakage
3 – Moderate	Grit Basin 2	• General Condition • Surface Deterioration • Leakage
3 – Moderate	Grit Blower Room Supply Air Fan	• General Condition
3 – Moderate	Grit Chamber 1 Effluent Gate	• General Condition • Corrosion/ Exterior • Leakage
3 – Moderate	Grit Gallery Supply Fan	• General Condition
3 – Moderate	Grit Hopper 1	• Coating/ Lining/ Paint
3 – Moderate	Grit Hopper 2	• Coating/ Lining/ Paint
3 – Moderate	Grit Pump 1	• General Condition • Components

Condition Score	Asset Name	Reason
3 – Moderate	Grit Pump 6	• General Condition • Components
3 – Moderate	Grit/ Septage Gallery Exhaust Fan	• General Condition • Corrosion/ Exterior
3 – Moderate	Influent Building Inter Level Supply Fan	• General Condition
3 – Moderate	Influent Building Roof Supply Fan 1	• General Condition • Corrosion/ Exterior
3 – Moderate	Influent Roof Building Air Supply Unit	• General Condition • Corrosion/ Exterior
3 – Moderate	Influent Roof Building Supply Fan 2	• General Condition • Corrosion/ Exterior
3 – Moderate	Influent Wet Well Combustible Gas Analyzer	• General Condition
3 – Moderate	Influent Wet Well Isolation Gate Valve	• General Condition
3 – Moderate	Influent Wet Well Level Switch High	• General Condition
3 – Moderate	MCC-1A/1B	• General Condition • Enclosure
3 – Moderate	MCC-2A/2B	• General Condition • Enclosure • Temperature/ Noise
3 – Moderate	MCC-3A/3B	• General Condition • Enclosure
3 – Moderate	Mechanical Bar Screen 1	• General Condition • Corrosion/ Exterior
3 – Moderate	Mechanical Bar Screen 2	• General Condition • Corrosion/ Exterior
3 – Moderate	Mechanical Bar Screen 3	• General Condition • Corrosion/ Exterior
3 – Moderate	Screening Building	• General Condition • Surface Deterioration
3 – Moderate	Screening Piping General	• General Condition • Surface Deterioration
3 – Moderate	Screenings Building Combustible Gas Analyzer	• General Condition
3 – Moderate	Screenings Building Supply Fan 2	• General Condition • Corrosion/ Exterior
3 – Moderate	Screenings Building Supply Fan 3	• General Condition • Corrosion/ Exterior
3 – Moderate	Screenings Building Supply Fan 4	• General Condition • Corrosion/ Exterior
3 – Moderate	Screenings Channel 1 Effluent Gate	• General Condition

Condition Score	Asset Name	Reason
		• Leakage
3 – Moderate	Screenings Channel 1 Influent Gate	• General Condition • Leakage
3 – Moderate	Screenings Channel 2 Effluent Gate	• General Condition • Leakage
3 – Moderate	Screenings Channel 2 Influent Gate	• General Condition • Leakage
3 – Moderate	Screenings Channel 3 Effluent Gate	• General Condition • Leakage
3 – Moderate	Screenings Channel 3 Influent Gate	• General Condition • Leakage
3 – Moderate	Screenings Channel 4 Effluent Gate	• General Condition • Leakage
3 – Moderate	Screenings Channel 4 Influent Gate	• General Condition • Leakage
3 – Moderate	Screenings Conveyor	• General Condition
3 – Moderate	Screenings Effluent Channel	• General Condition
3 – Moderate	Screenings Influent Channel	• General Condition
3 – Moderate	Screenings Influent Channel 1	• General Condition
3 – Moderate	Screenings Influent Channel 2	• General Condition
3 – Moderate	Screenings Influent Channel 3	• General Condition
3 – Moderate	Screenings Influent Channel 4	• General Condition
3 – Moderate	Septage Tank Level Transmitter	• General Condition

Based on the observations and findings described above, the following actions are recommended for the influent pump station location.:

1. Rehabilitate Grit Pumps 1, 2, 3, 4, 5 and 6; consider replacement if either unit has been rehabilitated more than twice in the past.
2. Rehabilitate Influent Pumps 1, 2, 3, 4, and 5; consider replacement if either unit has been rehabilitated more than twice in the past.
3. Rehabilitate Influent Pump 1, 2, 3, 4, and 5 Motor; consider replacement if either unit has been rehabilitated more than twice in the past.
4. Rehabilitate Influent Pump 1, 2, 3, 4, and 5 VFD; consider replacement if either unit has been rehabilitated more than twice in the past.
5. Rehabilitate Influent Pump Station Piping General; strip and re-coat piping/ joints with a protective paint or polymer to prevent continued corrosion and wear. Replace select sections of piping and Victaulic™ joints found to be severely corroded. Address active leak at pump 2.
6. Rehabilitate Influent Pump Station Switchboard; consider replacement if cost of rehabilitation is too high.
7. Replace Influent Wet Well Odor Air Fan.

8. Rehabilitate Grit Basin 1 and 2; address corrosion and spalling of concrete at specific areas where they occur in the basins through a process of sandblasting and mortar repair. Injection grouting should be utilized to fill cracks observed. Urethane resin injection or application of an external water stop, such as Sika Combiflex™, can be used to seal leaking expansion joints that were observed.
9. Replace Grit Blower 1 High Temperature Switch.
10. Replace Grit Blower Room Supply Air Fan.
11. Rehabilitate Grit Chamber 1 Effluent Gate.
12. Replace Grit Gallery Supply Fan.
13. Rehabilitate Grit Hopper 1 and 2.
14. Replace Grit/ Septage Gallery Exhaust Fan.
15. Replace Influent Building Inter Level Supply Fan.
16. Replace Influent Building Roof Supply Fan 1 and 2.
17. Rehabilitate Influent Pump Station Control Panel 1 (CP-1); replace components, wirings, and connections as necessary.
18. Replace Influent Roof Building Air Supply Unit.
19. Replace Influent Wet Well Combustible Gas Analyzer.
20. Replace Influent Wet Well Isolation Gate Valve.
21. Replace Influent Wet Well Level Switch High.
22. Replace Manhole J Level Switch High.
23. Rehabilitate MCC-1A/1B, MCC-2A/2B, and MCC-3A/3B; replace components, wirings, and connections as necessary.
24. Replace Mechanical Bar Screen 1, 2, and 3.
25. Rehabilitate Screening Building; address spalling of concrete in grit hopper room and bar screen rooms through local spall repairs. Injection grouting should be utilized to fill cracks observed in the north wall panel. Replace filler and sealant materials at the wide wall panel joints located on the north and south sides of the building.
26. Rehabilitate Screening Piping General; strip and re-coat piping/ joints with a protective paint or polymer to prevent continued corrosion and wear. Replace select sections of piping and Victaulic™ joints found to be severely corroded.
27. Replace Screenings Building Combustible Gas Analyzer.
28. Replace Screenings Building Supply Fan 2, 3, and 4.
29. Rehabilitate Screenings Channel 1, 2, 3, and 4 Effluent Gates.
30. Rehabilitate Screenings Channel 1, 2, 3, and 4 Influent Gates.
31. Rehabilitate Screenings Conveyor.
32. Rehabilitate Screenings Influent and Effluent Channel; address corrosion of concrete within channels through a process of sandblasting and application of protective coating.
33. Replace Septage Tank Level Transmitter.

6.3.2 Primary Basins

The primary basins location resides roughly in the center along the eastern boundary of the Tri-City facility grounds, immediately west of the influent pump station location, and is comprised predominantly of 6 rectangular basins numbered sequential from north to south.

Assets designated to the primary basins location include: basins, channels, launders, troughs, piping, drive assemblies, gates, pumps, skimmers, samplers, vales, switches, and sensors.

The following notable observations were made about condition deficient assets at the primary basins location:

- Primary Basin 1, 2, 3, 4, 5, and 6 Sludge Collectors – were evaluated to be in overall very poor condition. Chains replaced every 10 years. Maintenance performed on collector drives every year. All original equipment. Components replaced every so often. Shear pins break 1 per basin per year. Underwater components are near end of useful life. Maintenance is afraid of these drives failing at any time.
- Primary Sedimentation Basins 1, 2, 3, 4, 5, and 6 – were evaluated to be in overall very poor condition. Primary sedimentation basins No. 2, No. 5, and No. 6 were offline at the time of field assessment and viewed from the walkway at top. Overall concrete condition is moderate to poor with exposed aggregate typical throughout. Staff reports surface is soft and crumbles when agitated. Odor control is run through the Primary Building. Should investigate if there is a potential for short circuiting as the intake appears to occur near the large basin openings that are also inside the building. Localized spalling observed at No. 2. Effluent troughs leak water back into the clarifier. Water leaks from the effluent channel into the troughs where flap gates provide isolation. Minor aluminum beam corrosion observed at covers. Joint sealants within the clarifier have deteriorated and require replacement. Flushing pipes have severe corrosion and require replacement. Typical cracking and evidence of previous leaks in walls within the galleries. Conditions are consistent across observed clarifiers.
- Primary Influent Channel – was evaluated to be in overall poor condition. Concrete is in moderate condition. Valves in poor condition. Chamber to number 1 is in moderate condition with minor exposed aggregate. Number 6 inlet chamber looks a little worse with exposed aggregate that appears soft. Not clear where air treatment is coming from but is likely from the primary building. Condition is still moderate but approaching poor.
- Primary Influent Channel Isolation Gates No. 1 and 2 – were evaluated to be in overall poor condition. Large manual gates for isolating basins. Gate No. 1 isolates basins No. 1 through 4. Gate No. 2 isolates basins No. 5 through 6. Major cracks observed in both FRP plates.
- Primary Basins 1, 2, 3, 4, 5, and 6 Flow Control Gates – were evaluated to be in overall moderate condition. Oil leaks from actuators on valves No. 1, No. 4, and No. 5. Valve No. 5 had water seep into actuator 3-4 years ago and froze in winter, manual selector housing had to be placed as a result. Gates seals properly.
- Primary Effluent Channel – was evaluated to be in overall moderate condition. Concrete appears to be moderate with minor conc surface corrosion. Valve stem in very poor condition, used for flushing lines. Air treated from Primary Building. The effluent end of the troughs leaks back into the clarifier, some profusely. The effluent end of the troughs is isolated from the effluent channel by hinged flap gates. When a clarifier is offline, the effluent troughs are remaining filled with water due to flap gate leaks. Flushing valve appears to be severely corroded and in need of replacement (inoperable). Concrete spall and joint sealant failure in the exterior channel wall between basins No. 3 and No. 4.
- Primary Effluent Diversion Control Gate – was evaluated to be in overall moderate condition. Exterior wear but works fine for now.
- Primary Effluent Sampler – was evaluated to be in overall moderate condition. New sampler, old fridge. Operations regularly replaces tubing.

Picture 9.
Primary Basin 1 Sludge Collector

Picture 10.
Primary Sedimentation Basin 1

Picture 11.
Primary Sedimentation Basin 1

Picture 12.
Primary Sedimentation Basin 1

Picture 13.
Primary Influent Channel Isolation Gate No. 1

Picture 14.
Primary Helical Skimmer Basin 1

Table 6.4 summarizes the condition scores for condition deficient assets at the primary basins location.

Table 6.4 Condition Assessment Summary – Primary Basin Location

Condition Score	Asset Name	Reason
5 – Very Poor	Primary Basin 1 Sludge Collector	• General Condition
5 – Very Poor	Primary Basin 2 Sludge Collector	• General Condition
5 – Very Poor	Primary Basin 3 Sludge Collector	• General Condition
5 – Very Poor	Primary Basin 4 Sludge Collector	• General Condition
5 – Very Poor	Primary Basin 5 Sludge Collector	• General Condition
5 – Very Poor	Primary Basin 6 Sludge Collector	• General Condition
5 – Very Poor	Primary Sedimentation Basin 1	• Components
5 – Very Poor	Primary Sedimentation Basin 2	• Components
5 – Very Poor	Primary Sedimentation Basin 3	• Components
5 – Very Poor	Primary Sedimentation Basin 4	• Components
5 – Very Poor	Primary Sedimentation Basin 5	• Components
5 – Very Poor	Primary Sedimentation Basin 6	• Components
4 – Poor	Primary Influent Channel	• General Condition • Surface Deterioration
4 – Poor	Primary Influent Channel Isolation Gate No. 1	• General Condition • Corrosion/ Exterior • Components
4 – Poor	Primary Influent Channel Isolation Gate No. 2	• General Condition • Corrosion/ Exterior • Components
3 – Moderate	Primary Basin 1 Flow Control Gate	• General Condition • Leakage • Components
3 – Moderate	Primary Basin 2 Flow Control Gate	• General Condition • Components
3 – Moderate	Primary Basin 3 Flow Control Gate	• General Condition • Components
3 – Moderate	Primary Basin 4 Flow Control Gate	• General Condition • Leakage • Components
3 – Moderate	Primary Basin 5 Flow Control Gate	• General Condition • Leakage • Components
3 – Moderate	Primary Basin 6 Flow Control Gate	• General Condition • Leakage • Components
3 – Moderate	Primary Central Gallery Piping General	• General Condition • Surface Deterioration

Condition Score	Asset Name	Reason
3 – Moderate	Primary Dewatering Pump	• Leakage
3 – Moderate	Primary East Gallery Piping General	• General Condition • Surface Deterioration
3 – Moderate	Primary Effluent Channel	• General Condition • Surface Deterioration
3 – Moderate	Primary Effluent Diversion Control Gate	• General Condition • Corrosion/ Exterior
3 – Moderate	Primary Effluent Sampler	• General Condition
3 – Moderate	Primary Influent Channel Level Switch High	• General Condition • Display/ Enclosure/ Mount • Wiring/ Cable Condition
3 – Moderate	Primary North Gallery Piping General	• General Condition • Surface Deterioration

Based on the observations and findings described above, the following actions are recommended for the primary basins location:

1. Replace Primary Basin 1, 2, 3, 4, 5, and 6 Sludge Collectors.
2. Rehabilitate Primary Sedimentation Basins 1, 2, 3, 4, 5, and 6; address corrosion of concrete within the basins through a process of sandblasting, mortar repair, and application of protective coating. Injection grouting should be utilized to fill cracks where they occur.
3. Rehabilitate Primary Influent Channel; address corrosion of concrete within channels through a process of sandblasting, mortar repair, and application of protective coating. Injection grouting should be utilized to fill cracks where they occur.
4. Replace Primary Influent Channel Isolation Gates No. 1 and 2.
5. Rehabilitate Primary Basin 1, 2, 3, 4, 5, and 6 Flow Control Gates; replace motorized actuators.
6. Rehabilitate Primary Central Gallery Piping General; strip and re-coat piping/ joints with a protective paint or polymer to prevent continued corrosion and wear. Replace select sections of piping and Victaulic™ joints found to be severely corroded.
7. Rehabilitate Primary Dewatering Pump; consider replacement if either unit has been rehabilitated more than twice in the past.
8. Rehabilitate Primary East Gallery Piping General; strip and re-coat piping/ joints with a protective paint or polymer to prevent continued corrosion and wear. Replace select sections of piping and Victaulic™ joints found to be severely corroded.
9. Rehabilitate Primary Effluent Channel; address corrosion of concrete within channels through a process of sandblasting and application of protective coating. Injection grouting should be utilized to fill cracks where they occur. Flap gates should be replaced with something that seals properly. The flushing valve and piping should be replaced.
10. Rehabilitate Primary Effluent Diversion Control Gate.
11. Replace Primary Effluent Sampler.

12. Replace Primary Influent Channel Level Switch High.
13. Rehabilitate Primary North Gallery Piping General; strip and re-coat piping/ joints with a protective paint or polymer to prevent continued corrosion and wear. Replace select sections of piping and Victaulic™ joints found to be severely corroded. Injection grouting should be utilized to fill cracks observed.

6.3.3 Primary Pump Station

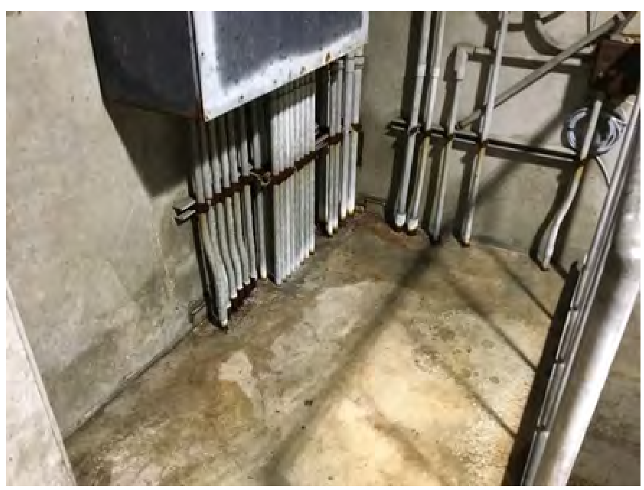
The primary pump station location resides atop the primary clarifiers location, found centrally along the eastern boundary of the Tri-City facility grounds, immediately west of the influent pump station location. The primary pump station location is comprised primarily of single rectangular building approximately 20 feet by 135 feet.

Assets designated to the primary pump station location include: piping, traps, pumps, skimmers, samplers, meters, and transmitters.

The following notable observations were made about condition deficient assets at the primary pump station location:

- Primary Helical Skimmer Basin 1, 2, 3, 4, 5, and 6 – were evaluated to be in overall very poor condition. Drives in good shape. Skimmers corroded, squeegee needs replacement, trough corroded, shaft bearings require replacement. Further condition assessment recommended.
- Primary Building – was evaluated to be in overall moderate condition. Very long and narrow. Suspect seismic vulnerability. Roof is precast concrete double tees with precast concrete wall panels. No evidence of seismic retrofit, except the building does have transverse concrete frames at 4 locations and is split with an expansion joint across the middle. Very corrosive environment with unprotected metals have moderate to severe corrosion. Roof drain piping requires replacement above water. Minor spalling at panel joint bases. In general, building is in moderate condition. Piping appears to be in moderate condition, except for the roof drains and hot water supply. Wall panel cracking is typical throughout and more pronounced than elsewhere.

Picture 15.
Primary Helical Skimmer Basin 2



Picture 16.
Primary Building

Table 6.5 summarizes the condition scores for condition deficient assets at the primary pump station location.

Table 6.5 Condition Assessment Summary – Primary Pump Station Location

Condition Score	Asset Name	Reason
5 – Very Poor	Primary Helical Skimmer Basin 1	• Corrosion/ Exterior • Components
5 – Very Poor	Primary Helical Skimmer Basin 2	• Corrosion/ Exterior • Components
5 – Very Poor	Primary Helical Skimmer Basin 3	• Corrosion/ Exterior • Components
5 – Very Poor	Primary Helical Skimmer Basin 4	• Corrosion/ Exterior • Components
5 – Very Poor	Primary Helical Skimmer Basin 5	• Corrosion/ Exterior • Components
5 – Very Poor	Primary Helical Skimmer Basin 6	• Corrosion/ Exterior • Components
3 – Moderate	Primary Building	• General Condition • Surface Deterioration
3 – Moderate	Primary Scum Box Level Transmitter	• General Condition

Based on the observations and findings described above, the following actions are recommended for the primary pump station location:

1. Replace Primary Helical Skimmer Basins 1, 2, 3, 4, 5, and 6.
2. Rehabilitate Primary Building; replace roof drain and hot water supply piping. Address corrosion and spalling of concrete at panel joints with local spall repairs. Perform seismic evaluation of the building.
3. Replace Primary Scum Box Level Transmitter.

6.3.4 Aeration Basins

The aeration basins location resides centrally in the Tri-City facility grounds east of the primary basins and west of the secondary clarifiers. The aeration basin location is predominately structural in nature and consist of four large rectangular basins numbered sequentially from north to south. Basin No. 1 was noted to non-operational at the time of the field assessment effort.

Assets designated to the aeration basins location include: basins, vaults, gates, mixers, pumps, valves, meters, transmitters, switches, sensors, and supply fans.

The following notable observations were made about condition deficient assets at the aeration basins location:

- CAS AB1, AB2, AB3, and AB4 Complete Mix Effluent Channel Isolation Gates – were evaluated to be in overall very poor condition. Classified as an asset because otherwise flow will sit stagnant in the "complete mix" effluent channel. This gate has never been opened. Doesn't look like it would open. Looks like it is sealed shut, so at least it doesn't leak!

- CAS AB1-2 and AB3-4 Dewatering Pumps – were evaluated to be in overall poor condition. Seal leaks. Isolation valves are frozen due to age. Works fine otherwise, protected from elements and only used a few times a year, if that.
- CAS Aeration Basins 1, 2, 3, and 4 – were evaluated to be in overall poor condition. Basins were observed previously (see Appendix 5a-B WES - STRUCTURAL SITE VISIT ON 9-19-19 of TM5A: Existing Tri-City Water Resource Recovery Facility Condition). Basins No. 1 and 2 were online, and Basins No. 3 and 4 were offline. Concrete surfaces below the water level have exposed aggregate, but staff reports that the surface is not soft or loose. Flushing pipe valves have seized up. Step feed gates are difficult to operate. Guardrail is not consistent throughout. Walkway bridges have minimal concrete bearing and spalling at the supported edges. Moss growth is common at the aeration basin effluent channel walls. The west expansion joint that separates the RAS pump station from the aeration basins leaks profusely into the gallery below when it rains.
- ML Flume No. 2 Bypass Gate – was evaluated to be in overall poor condition. Critical to operate for clarifier isolation, unknown if maintenance does anything on these. Good seal though.
- CAS AB Effluent Isolation Gate – was evaluated to be in overall moderate condition. Isolates north and south halves of aeration basins so they can run independently. Original gates maintained but infrequently used. Somewhat worn but functional and seals well per operators.
- CAS AB1, AB2, AB3, and AB4 Effluent Gates – were evaluated to be in overall moderate condition. Normally not any water on either side of closed gate. Easy to turn by hand. Seem well-maintained.
- CAS AB1, AB2, AB3, and AB4 Mixers 1 and 2 – were evaluated to be in overall moderate condition. Submerged. Near end of useful life. Put in circa 2005-2006. Replacement of components is getting very expensive. Mixers likely oversized.
- CAS AB1, AB2, AB3, and AB4 Zone A, B, and C Flow Control Valves – were evaluated to be in overall moderate condition. Long time in service, work OK but exposure to elements is taking its toll. Gaskets need replacement sometimes.
- CAS AB4 Actuated Wall Valves No. 1, 2, and 3 – were evaluated to be in overall moderate condition. Exercised frequently. Battery powered; battery runs out sometimes. Modulated based on foaming. All valves in identical shape.
- CAS AB4 Effluent Gate – was evaluated to be in overall moderate condition. This is the only one where there was evidence that the gate seated correctly. Normally not any water on either side of closed gate. Easy to turn by hand. Seem well-maintained.
- CAS/MBR AB4 Isolation Valve – was evaluated to be in overall moderate condition. Oil leak onto handwheel. Only operated to send flow from membrane bioreactor (MBR) to AB4.
- ML Flume No. 1 and 2 Effluent Gates – were evaluated to be in overall moderate condition. Redundant due to ability to use effluent gates to split flows instead of flumes. Gate No. 1 was actively leaking into SC1, but recently fixed.

Picture 17.
CAS AB3 Complete Mix Effluent Channel Isolation Gate

Picture 18.
CAS Aeration Basin 1

Picture 19.
CAS Aeration Basin 1

Picture 20.
CAS Aeration Basin 1

Picture 21.
CAS AB1-2 Dewatering Pump

Picture 22.
ML Flume No. 2 Bypass Gate

Table 6.6 summarizes the condition scores for condition deficient assets at the aeration basins location.

Table 6.6 Condition Assessment Summary – Aeration Basin Location

Condition Score	Asset Name	Reason
5 – Very Poor	CAS AB1 Complete Mix Effluent Channel Isolation Gate	• Corrosion/ Exterior • Components
5 – Very Poor	CAS AB2 Complete Mix Effluent Channel Isolation Gate	• Corrosion/ Exterior • Components
5 – Very Poor	CAS AB3 Complete Mix Effluent Channel Isolation Gate	• Corrosion/ Exterior • Components
5 – Very Poor	CAS AB4 Complete Mix Effluent Channel Isolation Gate	• Corrosion/ Exterior • Components
5 – Very Poor	CAS AB1 Zone A Dissolved Oxygen Transmitter	• General Condition • Equipment/ Transmitter • Display/ Enclosure/ Mount • Wiring/ Cable Condition • Components
5 – Very Poor	CAS AB1 Zone B Dissolved Oxygen Transmitter	• General Condition • Equipment/ Transmitter • Display/ Enclosure/ Mount • Wiring/ Cable Condition • Components
5 – Very Poor	CAS AB1 Zone C Dissolved Oxygen Transmitter	• General Condition • Equipment/ Transmitter • Display/ Enclosure/ Mount • Wiring/ Cable Condition • Components
5 – Very Poor	CAS AB1 Zone D Dissolved Oxygen Transmitter	• General Condition • Equipment/ Transmitter • Display/ Enclosure/ Mount • Wiring/ Cable Condition • Components
5 – Very Poor	CAS AB2 Zone A Dissolved Oxygen Transmitter	• General Condition • Equipment/ Transmitter • Display/ Enclosure/ Mount • Wiring/ Cable Condition • Components
5 – Very Poor	CAS AB2 Zone B Dissolved Oxygen Transmitter	• General Condition • Equipment/ Transmitter • Display/ Enclosure/ Mount • Wiring/ Cable Condition • Components

Condition Score	Asset Name	Reason
5 – Very Poor	CAS AB2 Zone C Dissolved Oxygen Transmitter	• General Condition • Equipment/ Transmitter • Display/ Enclosure/ Mount • Wiring/ Cable Condition • Components
5 – Very Poor	CAS AB2 Zone D Dissolved Oxygen Transmitter	• General Condition • Equipment/ Transmitter • Display/ Enclosure/ Mount • Wiring/ Cable Condition • Components
5 – Very Poor	CAS AB3 Zone A Dissolved Oxygen Transmitter	• General Condition • Equipment/ Transmitter • Display/ Enclosure/ Mount • Wiring/ Cable Condition • Components
5 – Very Poor	CAS AB3 Zone B Dissolved Oxygen Transmitter	• General Condition • Equipment/ Transmitter • Display/ Enclosure/ Mount • Wiring/ Cable Condition • Components
5 – Very Poor	CAS AB3 Zone C Dissolved Oxygen Transmitter	• General Condition • Equipment/ Transmitter • Display/ Enclosure/ Mount • Wiring/ Cable Condition • Components
5 – Very Poor	CAS AB3 Zone D Dissolved Oxygen Transmitter	• General Condition • Equipment/ Transmitter • Display/ Enclosure/ Mount • Wiring/ Cable Condition • Components
5 – Very Poor	CAS AB4 Zone A Dissolved Oxygen Transmitter	• General Condition • Equipment/ Transmitter • Display/ Enclosure/ Mount • Wiring/ Cable Condition • Components
5 – Very Poor	CAS AB4 Zone B Dissolved Oxygen Transmitter	• General Condition • Equipment/ Transmitter • Display/ Enclosure/ Mount • Wiring/ Cable Condition • Components

Condition Score	Asset Name	Reason
5 – Very Poor	CAS AB4 Zone C Dissolved Oxygen Transmitter	• General Condition • Equipment/ Transmitter • Display/ Enclosure/ Mount • Wiring/ Cable Condition • Components
5 – Very Poor	CAS AB4 Zone D Dissolved Oxygen Transmitter	• General Condition • Equipment/ Transmitter • Display/ Enclosure/ Mount • Wiring/ Cable Condition • Components
4 – Poor	CAS AB1-2 Dewatering Pump	• Leakage
4 – Poor	CAS AB3-4 Dewatering Pump	• Leakage
4 – Poor	CAS Aeration Basin 1	• Leakage
4 – Poor	CAS Aeration Basin 2	• Leakage
4 – Poor	CAS Aeration Basin 3	• Leakage
4 – Poor	CAS Aeration Basin 4	• Leakage
4 – Poor	ML Flume No. 2 Bypass (Select Treat) Gate	• Corrosion/ Exterior
4 – Poor	CAS AB1 Zone A Flow Indicating Transmitter	• General Condition • Equipment/ Transmitter • Display/ Enclosure/ Mount • Wiring/ Cable Condition
4 – Poor	CAS AB1 Zone B Flow Indicating Transmitter	• General Condition • Equipment/ Transmitter • Display/ Enclosure/ Mount • Wiring/ Cable Condition
4 – Poor	CAS AB1 Zone C Flow Indicating Transmitter	• General Condition • Equipment/ Transmitter • Display/ Enclosure/ Mount • Wiring/ Cable Condition • Components
4 – Poor	CAS AB2 Zone A Flow Indicating Transmitter	• General Condition
4 – Poor	CAS AB2 Zone B Flow Indicating Transmitter	• General Condition
4 – Poor	CAS AB2 Zone C Flow Indicating Transmitter	• General Condition
4 – Poor	CAS AB3 Zone A Flow Indicating Transmitter	• General Condition
4 – Poor	CAS AB3 Zone B Flow Indicating Transmitter	• General Condition
4 – Poor	CAS AB3 Zone C Flow Indicating Transmitter	• General Condition
4 – Poor	CAS AB4 Zone A Flow Indicating Transmitter	• General Condition
4 – Poor	CAS AB4 Zone B Flow Indicating Transmitter	• General Condition
4 – Poor	CAS AB4 Zone C Flow Indicating Transmitter	• General Condition

Condition Score	Asset Name	Reason
3 – Moderate	CAS AB Effluent Isolation Gate	• General Condition • Corrosion/ Exterior • Leakage • Components
3 – Moderate	CAS AB1 Effluent Gate	• Corrosion/ Exterior
3 – Moderate	CAS AB1 Mixer 1	• General Condition • Corrosion/ Exterior • Components
3 – Moderate	CAS AB1 Mixer 2	• General Condition • Corrosion/ Exterior • Components
3 – Moderate	CAS AB1 Zone A Flow Control Valve	• General Condition • Leakage
3 – Moderate	CAS AB1 Zone B Flow Control Valve	• General Condition • Leakage
3 – Moderate	CAS AB1 Zone C Flow Control Valve	• General Condition • Leakage
3 – Moderate	CAS AB2 Effluent Gate	• Corrosion/ Exterior
3 – Moderate	CAS AB2 Mixer 1	• General Condition • Corrosion/ Exterior • Components
3 – Moderate	CAS AB2 Mixer 2	• General Condition • Corrosion/ Exterior • Components
3 – Moderate	CAS AB2 Zone A Flow Control Valve	• General Condition • Leakage
3 – Moderate	CAS AB2 Zone B Flow Control Valve	• General Condition • Leakage
3 – Moderate	CAS AB2 Zone C Flow Control Valve	• General Condition • Leakage
3 – Moderate	CAS AB3 Effluent Gate	• Corrosion/ Exterior
3 – Moderate	CAS AB3 Mixer 1	• General Condition • Corrosion/ Exterior • Components
3 – Moderate	CAS AB3 Mixer 2	• General Condition • Corrosion/ Exterior • Components
3 – Moderate	CAS AB3 Zone A Flow Control Valve	• General Condition • Leakage

Condition Score	Asset Name	Reason
3 – Moderate	CAS AB3 Zone B Flow Control Valve	• General Condition • Leakage
3 – Moderate	CAS AB3 Zone C Flow Control Valve	• General Condition • Leakage
3 – Moderate	CAS AB4 Actuated Wall Valve No. 1	• Corrosion/ Exterior
3 – Moderate	CAS AB4 Actuated Wall Valve No. 2	• Corrosion/ Exterior
3 – Moderate	CAS AB4 Actuated Wall Valve No. 3	• Corrosion/ Exterior
3 – Moderate	CAS AB4 Effluent Gate	• Corrosion/ Exterior
3 – Moderate	CAS AB4 Mixer 1	• General Condition • Corrosion/ Exterior • Components
3 – Moderate	CAS AB4 Mixer 2	• General Condition • Corrosion/ Exterior • Components
3 – Moderate	CAS AB4 Zone A Flow Control Valve	• General Condition • Leakage
3 – Moderate	CAS AB4 Zone B Flow Control Valve	• General Condition • Leakage
3 – Moderate	CAS AB4 Zone C Flow Control Valve	• General Condition • Leakage
3 – Moderate	CAS Channel Blower 1 Temp Switch High	• General Condition • Display/ Enclosure/ Mount • Wiring/ Cable Condition • Components
3 – Moderate	CAS Channel Blower 3 Temp Switch High	• General Condition • Equipment/ Transmitter • Display/ Enclosure/ Mount • Wiring/ Cable Condition • Components
3 – Moderate	CAS Primary Effluent Channel Level Indicating Transmitter	• General Condition • Equipment/ Transmitter • Display/ Enclosure/ Mount • Wiring/ Cable Condition • Components
3 – Moderate	CAS/MBR AB4 Isolation Valve	• Leakage
3 – Moderate	ML Flume Box Influent Gate	• General Condition • Corrosion/ Exterior • Components
3 – Moderate	ML Flume No. 1 Effluent Gate	• Leakage
3 – Moderate	ML Flume No. 2 Effluent Gate	• Leakage

Based on the observations and findings described above, the following actions are recommended for the aeration basin location:

1. Rehabilitate CAS AB1, AB2, AB3, and AB4 Complete Mix Effluent Channel Isolation Gates.
2. Replace CAS AB1, AB2, AB3, and AB4 Zone A, B, C, and D Dissolved Oxygen Transmitters.
3. Rehabilitate CAS AB1-2 and AB3-4 Dewatering Pumps; replace isolation valves.
4. Rehabilitate CAS Aeration Basins 1, 2, 3, and 4; address corrosion of concrete within basins through a process of sandblasting and application of protective coating. Injection grouting should be utilized to fill cracks where they occur. Organic debris should be removed from the surfaces of the effluent channel. Leakage from the expansion joints into the RAS Building and pipe galleries below should be repaired with replacement of the joint sealants and with the application of a surface-applied water stop, such as Sika Combiflex™. Attempts to seal the leaks using urethane resin injection have failed and the joint continues to leak. The end supports for the walkway bridges should be secured with stainless steel hardware and anchors and gaps should be filled with flexible joint material and sealants as required to ensure a safe walking surface is provided.
5. Replace ML Flume No. 2 (Select Treat) Bypass Gate.
6. Rehabilitate CAS AB Effluent Isolation Gate.
7. Rehabilitate CAS AB1, AB2, AB3, and AB4 Effluent Gates.
8. Replace CAS AB1, AB2, AB3, and AB4 Mixers 1 and 2.
9. Replace CAS AB1, AB2, AB3, and AB4 Zone A, B, C, and D Flow Control Valves.
10. Replace CAS AB1, AB2, AB3, and AB4 Zone A, B, C, and D Flow Indicating Transmitters.
11. Rehabilitate CAS AB4 Actuated Wall Valves No. 1, 2, and 3.
12. Replace CAS Channel Blowers 1 and 3 Temp Switch High.
13. Replace CAS Primary Effluent Channel Level Indicating Transmitter.
14. Rehabilitate CAS/MBR AB4 Isolation Valve.
15. Rehabilitate ML Flume Box Influent Gate.
16. Rehabilitate ML Flume No. 1 and 2Effluent Gates.

6.3.5 Blower Building

The blower building location resides in the northwest portion of the Tri-City facility grounds, north of the aeration basins location, and consists predominantly of single building approximately 40 feet by 95 feet.

Assets designated to the blower building location include: piping, tanks, blowers, compressors, dryers, programmable logic controllers, air handling units, supply fans, motor control centers, switchboards, and variable frequency drives.

The following notable observations were made about condition deficient assets at the blower building location:

- CAS Blower Building Air Supply Unit 1, 2, and 3 – were evaluated to be in overall moderate condition. Controls are very outdated (and problematic). Temperature controlled (doesn't work). Auto redundancy not functional.
- CAS Blower Building Control Panel 2 (CP-2) – was evaluated to be in overall moderate condition. Indicators on front of panel are not functional and obsolete.
- Blower Building – was evaluated to be in overall moderate condition. Evidence of seismic retrofit with tie plates connecting the wall panels to the floor slab. Joint sealant at the wall panels at the building corners is in poor condition.

Picture 23.
MCC-5A

Picture 24.
CAS Channel Blower 2

Picture 25.
CAS Plant Service Air Compressor 1

Picture 26.
CAS Blower Building Air Supply Unit 2

Picture 27.
CAS Blower MCC Room Duct Heater

Picture 28.
CAS Plant Service Air Compressor 1 PLC

Table 6.7 summarizes the condition scores for condition deficient assets at the blower building location.

Table 6.7 Condition Assessment Summary – Blower Building Location

Condition Score	Asset Name	Reason
3 – Moderate	Blower Building	• General Condition
3 – Moderate	Blower Building Switchboard	• General Condition • Equipment • Enclosure • Wiring/ Cable Condition • Components
3 – Moderate	CAS Blower Building Air Supply Unit 1	• General Condition
3 – Moderate	CAS Blower Building Air Supply Unit 2	• General Condition
3 – Moderate	CAS Blower Building Air Supply Unit 3	• General Condition
3 – Moderate	CAS Blower Building Control Panel 2 (CP-2)	• General Condition • Display/ Enclosure/ Mount • Wiring/ Cable Condition
3 – Moderate	CAS Blower MCC Room Duct Heater	• General Condition
3 – Moderate	MCC-5A	• General Condition • Equipment • Enclosure • Components
3 – Moderate	MCC-5B	• General Condition • Equipment • Enclosure • Components
3 – Moderate	MCC-5E	• General Condition • Equipment • Enclosure • Components

Based on the observations and findings described above, the following actions are recommended for the blower building location:

1. Rehabilitate Blower Building Switchboard; replace components, wirings, and connections as necessary.
2. Rehabilitate CAS Blower Building Air Supply Unit 1, 2, and 3; replace controls.
3. Rehabilitate CAS Blower Building Control Panel 2 (CP-2); replace components, wirings, and connections as necessary.
4. Replace CAS Blower MCC Room Duct Heater.
5. Rehabilitate Blower Building; reseal wall panels at the exterior of the building.
6. Rehabilitate MCC-5A, MCC-5B, and MCC-5E; replace components, wirings, and connections as necessary.

6.3.6 Secondary Clarifiers

The secondary pump station location resides centrally along the western boundary of the Tri-City facility grounds and is comprised mainly of two circular clarifier structures approximately 120′ in diameter. Clarifiers are numbered sequentially north to south.

Assets designated to the secondary clarifiers location include: basins, drive assemblies, screens, strainers, skimmers, samplers, meters, and transmitters.

The following notable observations were made about condition deficient assets at the secondary clarifiers location:

- CAS Secondary Clarifier 1 Rotating Scum Pipe – was evaluated to be in overall moderate condition. Support rollers recently replaced in 2019.
- Secondary Clarifier Basin 1 and 2 – were evaluated to be in overall moderate condition. No. 1 is the north clarifier and was offline. No. 2 was online, minor concrete spall observed at the effluent box. Overall condition is good to moderate. The effluent launder is coated with localized coating failure throughout. Minor corrosion of scum deflectors at the bridge. Staff reported that the bottom side of the effluent channel has exposed aggregate similar to the aeration basins. The clarifier drive was repaired in 2017 due to failure caused by unbalanced rake arm. The concrete sidewalk at the effluent box has settled about 2 to 3 inches and sounds like there is a void beneath the sidewalk.

Picture 29.
CAS Secondary Effluent Sampler

Picture 30.
Secondary Clarifier Basin 1

Picture 31.
Secondary Clarifier Basin 1

Picture 32.
Secondary Clarifier Basin 1

Table 6.8 summarizes the condition scores for condition deficient assets at the secondary clarifiers location.

Table 6.8 Condition Assessment Summary – Secondary Clarifiers Location

Condition Score	Asset Name	Reason
3 – Moderate	CAS Secondary Clarifier 1 Flow Indicating Transmitter	• General Condition
3 – Moderate	CAS Secondary Clarifier 1 Rotating Scum Pipe	• General Condition • Corrosion/ Exterior
3 – Moderate	CAS Secondary Clarifier 2 Flow Indicating Transmitter	• General Condition
3 – Moderate	CAS Secondary Clarifier 2 Rotating Scum Pipe	• General Condition • Corrosion/ Exterior
3 – Moderate	Secondary Clarifier Basin 1	• General Condition • Surface Deterioration • Coating/ Lining/ Paint • Components
3 – Moderate	Secondary Clarifier Basin 2	• General Condition • Surface Deterioration • Coating/ Lining/ Paint • Components

Based on the observations and findings described above, the following actions are recommended for the secondary clarifiers location:

1. Replace CAS Secondary Clarifier 1 and 2 Flow Indicating Transmitters.
2. Rehabilitate CAS Secondary Clarifier 1 and 2 Rotating Scum Pipes.
3. Rehabilitate Secondary Clarifier Basins 1 and 2; address coating failure within effluent launders/ channels through a process of sandblasting and application of protective coating. Injection grouting should be utilized to fill cracks where they occur.

6.3.7 Secondary Pump Station

The secondary pump station location resides centrally along the western boundary of the Tri-City facility grounds, directly east of the secondary clarifiers and is comprised mainly by a single building approximately 35 feet by 60 feet.

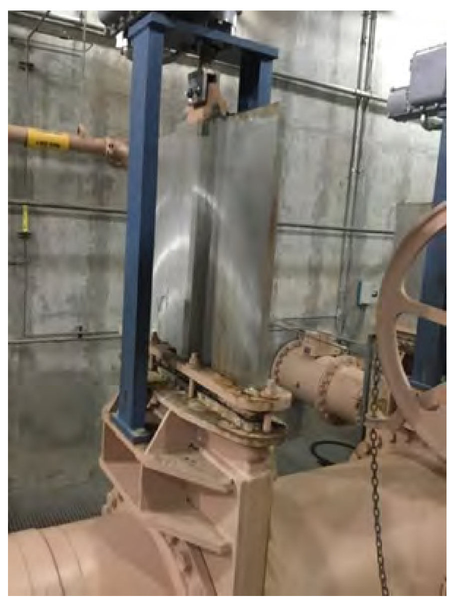
Assets designated to the secondary pump station location include: piping, traps, pumps, valves, meters, transmitters, programmable logic controllers, supply fans, unit heaters, motors, motor control centers, and variable frequency drives.

The following notable observations were made about condition deficient assets at the secondary pump station location:

- CAS RAS Pumps 2, 3, and 4 – were evaluated to be in overall poor condition. Pump suction piping is likely to be heavily corroded (based on RAS Pumps 1 and 5 piping failure). Should be inspected and/or replaced. Isolation valves (knife gate) on pump suction and discharge appears to be moderately maintained but is corroded and is reported to leak. Packing can be maintained, but valves cannot be refurbished without an extended header outage. Pump No. 3 bearing frame is currently being used as IPS.

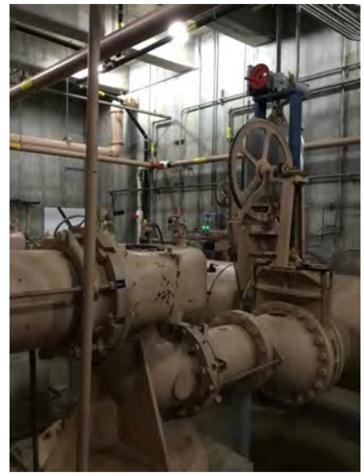
- Suction Header Actuated Valves 1 and 2 – were evaluated to be in overall poor condition. Valves (knife gate) on pump suction appears to be moderately maintained but are corroded and leaks. Packing can be maintained, but valves cannot be refurbished without an extended header outage.
- CAS (CP-3) PLC Control Panel 3 – was evaluated to be in overall moderate condition. Indicators located on front of panel are obsolete.
- CAS RAS Building Air Supply Unit – was evaluated to be in overall moderate condition. Controls are very outdated (and problematic).
- CAS RAS Pumps 1 and 5 – were evaluated to be in overall moderate condition. Suction piping was already replaced due to excessive corrosion.
- CAS RAS Pump 1, 2, 4, and 5 Motors – were evaluated to be in overall moderate condition. Motors are not inverter duty rated, should be since they are operated by VFDs.
- CAS Secondary Scum Pump – was evaluated to be in overall moderate condition. Pump serves as a backup to adjacent (centrifugal type) scum pump.
- CAS Secondary Scum Underflow Pump – was evaluated to be in overall moderate condition. Occasionally air locks.
- CAS WAS Pumps 1 and 2 – were evaluated to be in overall moderate condition. Pump suction piping is likely to be heavily corroded (based on RAS Pumps 1 and 5 piping failure). Should be inspected and/or replaced.
- RAS Building – was evaluated to be in overall moderate condition. Seismic retrofit with steel tie plates at interior panels. Water is leaking through the building joint to the east and into the building. Active leaks through the joint allow rainwater to leak profusely into the pump station in the basement.
- RAS Piping General – was evaluated to be in overall moderate condition. Joint leakage from above is causing localized damage of coating and corrosion of pipes that cross below the joint. Corrosion of knife gates is typical on RAS lines and leakage was observed.

Picture 33.
Suction Header Actuated Valve 1



Picture 34.
Suction Header Actuated Valve 2

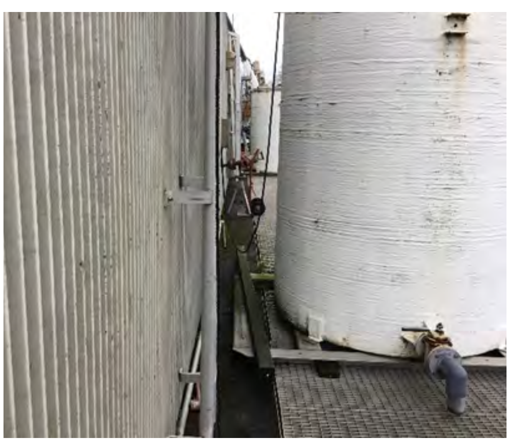
Picture 35.
CAS RAS Pump 2



Picture 36.
CAS RAS Pump 3

Picture 37.
CAS Secondary Scum Underflow Pump

Picture 38.
RAS Piping General



Picture 39.
RAS Building

Picture 40.
CCB 2 Isolation Gate

Table 6.9 summarizes the condition scores for condition deficient assets at the secondary pump station location.

Table 6.9 Condition Assessment Summary – Secondary Pump Station Location

Condition Score	Asset Name	Reason
4 – Poor	CAS RAS Pump 1	• General Condition
4 – Poor	CAS RAS Pump 1 Motor	• General Condition • Equipment • Enclosure • Temperature/ Noise • Wiring/ Cable Condition • Components
4 – Poor	CAS RAS Pump 2	• Components
4 – Poor	CAS RAS Pump 2 Motor	• General Condition • Equipment • Enclosure • Temperature/ Noise • Wiring/ Cable Condition • Components
4 – Poor	CAS RAS Pump 4	• Components
4 – Poor	CAS RAS Pump 4 Motor	• General Condition • Equipment • Enclosure • Temperature/ Noise • Wiring/ Cable Condition • Components
4 – Poor	CAS RAS Pump 5	• General Condition
4 – Poor	CAS RAS Pump 5 Motor	• General Condition • Equipment • Enclosure • Temperature/ Noise • Wiring/ Cable Condition • Components
4 – Poor	RAS Piping General	• General Condition • Surface Deterioration • Coating/ Lining/ Paint • Leakage • Components
4 – Poor	Suction Header Actuated Valve 1	• Leakage
4 – Poor	Suction Header Actuated Valve 2	• Leakage
4 – Poor	CAS Secondary Scum Underflow Pump	• Corrosion/ Exterior • Leakage

Condition Score	Asset Name	Reason
3 – Moderate	CAS (CP-3) PLC Control Panel 3	• Equipment/ Transmitter • Display/ Enclosure/ Mount • Wiring/ Cable Condition • Components
3 – Moderate	CAS RAS Building Air Supply Unit	• General Condition • Corrosion/ Exterior
3 – Moderate	CAS RAS Building Supply Fan	• General Condition • Corrosion/ Exterior
3 – Moderate	CAS RAS Control Room NG Unit Heater 1	• General Condition
3 – Moderate	CAS RAS Control Room NG Unit Heater 2	• General Condition • Corrosion/ Exterior
3 – Moderate	CAS RAS Control Room NG Unit Heater 3	• General Condition
3 – Moderate	CAS RAS Control Room NG Unit Heater 4	• General Condition • Corrosion/ Exterior
3 – Moderate	CAS Secondary Scum Pump	• General Condition • Corrosion/ Exterior • Leakage
3 – Moderate	CAS WAS Pump 1	• General Condition
3 – Moderate	CAS WAS Pump 2	• General Condition
3 – Moderate	MCC-6A	• General Condition • Equipment • Enclosure • Components
3 – Moderate	MCC-6B	• General Condition • Equipment • Enclosure • Components
3 – Moderate	MCC-6E	• General Condition • Equipment • Enclosure • Components
3 – Moderate	RAS Building	• General Condition • Leakage

Based on the observations and findings described above, the following actions are recommended for the secondary pump station location:

1. Replace Suction Header Actuated Valves 1 and 2.
2. Rehabilitate CAS (CP-3) PLC Control Panel 3; replace components, wirings, and connections as necessary.
3. Replace CAS AB1, AB2, AB3, and AB4 RAS Flow Indicating Transmitters.
4. Replace CAS RAS Building Air Supply Unit.

5. Replace CAS RAS Building Supply Fan.
6. Replace CAS RAS Control Room NG Unit Heaters 1, 2, 3, and 4.
7. Rehabilitate CAS RAS Pumps 1, 2, 3, 4, and 5; consider replacement if any unit has been rehabilitated more than twice in the past.
8. Replace CAS RAS Pump 1, 2, 4, and 5 Motors; not rated for VFDs.
9. Rehabilitate CAS Secondary Scum Pump; consider replacement if either unit has been rehabilitated more than twice in the past.
10. Rehabilitate CAS Secondary Scum Underflow Pump; consider replacement if either unit has been rehabilitated more than twice in the past.
11. Rehabilitate CAS WAS Pump 1 and 2; consider replacement if either unit has been rehabilitated more than twice in the past.
12. Rehabilitate MCC-6A, MCC-6B, and MCC-6E; replace components, wirings, and connections as necessary.
13. Replace RAS Piping General; strip and re-coat piping/ joints with a protective paint or polymer to prevent continued corrosion and wear. Replace select sections of piping and joints found to be severely corroded, specifically RAS suction piping.
14. Rehabilitate RAS Building; address water infiltration issues as recommended at the aeration basins, as the expansion joints are located at the east side of the building and within the aeration basins.

6.3.8 Chlorine Contact Basin

The chlorine contact basins location resides directly north of the primary basins location beneath the odor control structures. The chlorine contact basin location is predominately below grade with the rough dimensions of 65 feet by 135 feet.

Assets designated to the contact basins location include: basins, channels, launders, troughs, gates, mixers, pumps, screens, strainers, skimmers, samplers, exhaust fans, supply fans, and unit heaters.

The following notable observations were made about condition deficient assets at the chlorine contact basin location:

- CAS Chlorine Contact Basin – was evaluated to be in overall poor condition. No entry was made into the basin. Contractors were working inside one of the 2 CCBs during the site visit. Joint sealants are exuding out of the joints inside the basin and need to be replaced. Interior concrete surfaces are reported by staff to be OK. Exterior surfaces are damaged by condensate/leakage from the odor control scrubbers and foul air ducts.
- CCB 1 and 2 Isolation Gates – was evaluated to be in overall poor condition. Both gates leak badly. Unclear if they were designed to leak.
- CAS CCB Ventilation Exhaust Fan – was evaluated to be in overall moderate condition. Only odor air fan for entire CCB. Original, looks like it has seen better days.

Picture 41.
CAS Chlorine Contact Basin

Picture 42.
CAS CCB De-chlorination Room Exhaust Fan

Table 6.10 summarizes the condition scores for condition deficient assets at the chlorine contact basin location.

Table 6.10 Condition Assessment Summary – Chlorine Contact Basin Location

Condition Score	Asset Name	Reason
4 – Poor	CAS Chlorine Contact Basin	• Surface Deterioration
4 – Poor	CCB 1 Isolation Gate	• Leakage
4 – Poor	CCB 2 Isolation Gate	• Leakage
3 – Moderate	CAS CCB De-chlorination Room Exhaust Fan	• General Condition • Vibration
3 – Moderate	CAS CCB Ventilation Exhaust Fan	• General Condition • Corrosion/ Exterior
3 – Moderate	CAS Chlorine Building MCC Room Supply Fan	• General Condition

Based on the observations and findings described above, the following actions are recommended for the chlorine contact basin location:

1. Rehabilitate CAS Chlorine Contact Basin; address corrosion of concrete at the top side of the basin by sandblasting and surface mortar repair, and application of a non-skid protective coating. Replace joint sealants within the basin. Injection grouting should be utilized to fill cracks where they occur.
2. Rehabilitate CCB 1 and 2 Isolation Gates.
3. Replace CAS CCB De-chlorination Room Exhaust Fan.
4. Replace CAS CCB Ventilation Exhaust Fan.
5. Replace CAS Chlorine Building MCC Room Supply Fan.

6.3.9 Membrane Bioreactor

The membrane bioreactor location resides in the southeastern portion of the Tri-City facility grounds and consists of four buildings and a slew of structures and appurtenances found below grade. The UV disinfection building (60 feet by 80 feet) is the southernmost structure with the fine screening building located directly to the north. The membrane bioreactor electrical building (50 feet by 50 feet.) is directly east of the screening building with the main membrane bioreactor building (100 feet by 135 feet) slightly further to the east.

Assets designated to the membrane bioreactor location include: basins, channels, launders, troughs, piping, tanks, bio reactors, contactors, compressors, conveyors, dryers, gates, hoists, trolleys, cranes, mixers, pumps, rollup doors, screens, strainers, skimmers, samplers, UV reactors, valves, meters, transmitters, programmable logic controllers, air condition units, air handling unit, exhaust fans, louvers, dampers, supply fans, unit heaters, control panels, motor control centers, switchgears, transformers, and variable frequency drives.

The following notable observations were made about condition deficient assets at the membrane bioreactor location:

- UVT Sampler – was evaluated to be in overall very poor condition. Bad, new one has been ordered. Fails a lot. Pump has been changed multiple times to no avail. Has never worked reliably. Compensate by overdosing.
- MBR Intermediate Pump 3 – was evaluated to be in overall poor condition. Lime builds up on impeller, needs to be cleaned frequently (inspected quarterly). Motor rattles a lot and has been placed on a stand to minimize vibrations. Spare parts available.
- MBR MLTR Pumps 1 and 2 – were evaluated to be in overall poor condition. Have had problems with motor bearings (stray current). Evidence of vibration at varying flow rates. Have had problems with pump No. 2 motor bearings (stray current). Replaced outboard bearings multiple times. Recently replaced with grounding ring.
- MBR AB5 Zone 3, 4, 5, and 6 Diffuser Air Control Valves – were evaluated to be in overall moderate condition. Oil leaks at valve stems, however still operable. No routine maintenance performed.
- MBR Filtrate Pump 1B and 2B Discharge Valves – were evaluated to be in overall moderate condition. Starting to see failures on valve stem seals. These ones are replaced outright. Actuators are also starting to fail. Maintenance frequently rebuilds these.
- MBR Fine Screens 1 and 2 – were evaluated to be in overall moderate condition. Lime deposits plug the screens. Previous seals leaked all over the floor. New ones are better but still leaking slightly. Stuff still gets through the screen and into the MBR, can damage the membranes. Operators don't trust them to remove everything.
- MBR Intermediate Pumps 1 and2 – were evaluated to be in overall moderate condition. These faults are due to lime buildup on impeller. This is a problem.

Picture 43.
UVT Sampler

Picture 44.
MBR MLTR Pump 2

Picture 45.
MBR Intermediate Pump 3

Picture 46.
MBR Fine Screen 1

Picture 47.
MBR AB5 Aerobic Zone 6

Picture 48.
BUC Day Tank 2

Table 6.11 summarizes the condition scores for condition deficient assets at the membrane bioreactor location.

Table 6.11 Condition Assessment Summary – Membrane Bioreactor Location

Condition Score	Asset Name	Reason
5 – Very Poor	UVT Sampler	• General Condition • Components
4 – Poor	MBR Intermediate Pump 3	• Vibration
4 – Poor	MBR MLTR Pump 1	• Vibration
4 – Poor	MBR MLTR Pump 2	• Vibration
3 – Moderate	MBR AB5 Aerobic Zone 3	• General Condition
3 – Moderate	MBR AB5 Aerobic Zone 4	• General Condition
3 – Moderate	MBR AB5 Aerobic Zone 5	• General Condition
3 – Moderate	MBR AB5 Aerobic Zone 6	• General Condition
3 – Moderate	MBR AB5 Zone 3 Diffuser Air Control Valve	• General Condition • Leakage • Components
3 – Moderate	MBR AB5 Zone 4 Diffuser Air Control Valve	• General Condition • Temperature • Leakage
3 – Moderate	MBR AB5 Zone 5 Diffuser Air Control Valve	• General Condition • Leakage • Components
3 – Moderate	MBR AB5 Zone 6 Diffuser Air Control Valve	• General Condition • Leakage • Components
3 – Moderate	MBR Filtrate Pump 1B Discharge Valve	• General Condition • Components
3 – Moderate	MBR Filtrate Pump 2B Discharge Valve	• General Condition • Components
3 – Moderate	MBR Fine Screen 1	• Leakage
3 – Moderate	MBR Fine Screen 2	• Leakage
3 – Moderate	MBR Intermediate Pump 1	• General Condition
3 – Moderate	MBR Intermediate Pump 2	• General Condition

Based on the observations and findings described above, the following actions are recommended for the membrane bioreactor location:

1. NO ACTION UVT Sampler; WES staff addressing.
2. Rehabilitate MBR Intermediate Pump 3; consider replacement if unit has been rehabilitated more than twice in the past.
3. Rehabilitate MBR MLTR Pumps 1 and 2; consider replacement if either unit has been rehabilitated more than twice in the past.

4. Replace MBR AB5 Aerobic Zone 3, 4, 5, and 6 Meters.
5. Rehabilitate MBR AB5 Zone 3, 4, 5, and 6 Diffuser Air Control Valves.
6. Replace MBR Filtrate Pump 1B and 2B Discharge Valves.
7. Replace MBR Fine Screen 1 and 2.
8. Rehabilitate MBR Intermediate Pumps 1 and 2; consider replacement if either unit has been rehabilitated more than twice in the past.

6.3.10 Backup Centrifuge

The backup centrifuge location resides in the southeast portion of the Tri-City facility grounds and consists of four superstructures and two circular tanks. The main superstructure 110 feet by 60 feet contains the primary centrifuge and biosolids with the three remaining superstructures housing the assessor asset such as pumps and conveyors.

Assets designated to the backup centrifuge location include: buildings, piping, tanks, vaults, wet wells, centrifuge, conveyors, dispensing units, grinders, hoists, trolleys, cranes, pumps, meters, transmitters, programmable logic controllers, control panels, motors, motor control centers, and variable frequency drives.

The following notable observations were made about condition deficient assets at the backup centrifuge location:

- BUC Day Tank 2 – was evaluated to be in overall poor condition. West tank. Severe corrosion of the tank bottom plate was observed at the southeast quadrant. The bottom plate is delaminating. The conc pad has shallow horizontal cracks near the surface with evidence of leakage. Spalling is imminent.
- Backup Centrifuge Building – All interior non-protected surfaces or surfaces where the coating has failed have moderate to severe corrosion (see base of stud framing around the door). Bolts in frames have minor to moderate corrosion.

Picture 49.
BUC Day Tank 2

Picture 50.
BUC Day Tank 2

Table 6.12 summarizes the condition scores for condition deficient assets at the backup centrifuge location.

Table 6.12 Condition Assessment Summary – Backup Centrifuge Location

Condition Score	Asset Name	Reason
4 – Poor	BUC Day Tank 2	• Surface Deterioration • Components
3 – Moderate	Backup Centrifuge Building	• General Condition

Based on the observations and findings described above, the following actions are recommended for the backup centrifuge location:

1. Rehabilitate BUC Day Tank 2; address corrosion of steel tank with removal of damaged steel, provision of supplemental weld repairs, and application of a protective coating. Address concrete corrosion of the supporting pad through a process of sandblasting, chipping, and surface mortar repair. Injection grouting should be utilized to fill cracks where they occur.
2. Rehabilitate Backup Centrifuge Building; replace heavily corroded surface and coat minor areas with protective coating.

6.3.11 Digester Complex

The digester complex location resides in the northeast corner of the Tri-City facility grounds and consists primarily of a large L shaped building roughly 100 by 100 feet along the longer ends with two solids storage tanks approximately 60' in diameter flanking opposite ends of the complex. Accessory assets are exteriorly located on grounds to the south.

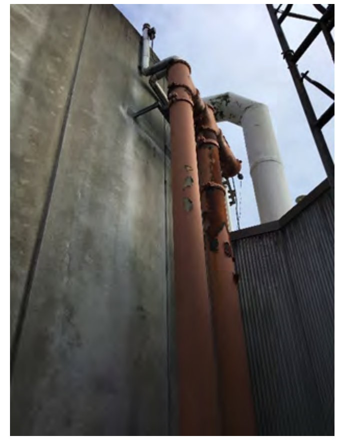
Assets designated to the digester complex location include: piping, tanks, traps, drive assemblies, grinders, heat exchangers, pumps, meters, transmitters, programmable logic controllers, motor control centers, and variable frequency drives.

It should be noted that digester complex was under construction during the condition assessment effort and many assets to be decommissioned and replaced as part of the construction efforts were not evaluated as directed by WES staff.

The following notable observations were made about condition deficient assets at the digester complex location:

- CAS Anaerobic Digester Tank 1 – was evaluated to be in overall very poor condition. Digester No. 1 is the north digester. Evidence of leakage from behind the wall panels. The roof insulation is in very poor condition and is in need of replacement. The concrete dome could not be viewed but is assumed to be in poor condition. Gas piping/appurtenances have severe corrosion and require replacement.
- CAS Anaerobic Digester Tank 2 – was evaluated to be in overall very poor condition. South digester. The roof insulation is in very poor condition and in need of replacement. The gas piping/appurtenances have severe corrosion with gas leakage. Parapet panels have corrosion at the joints and require repair.
- Digester Piping General – was evaluated to be in overall poor condition. Local coating failures are frequent. Piping at generator is in very poor condition with active leaks.
- CAS Gravity Belt Thickener 1 and 2 – were evaluated to be in overall moderate condition. Drive roller is delaminating.

Picture 51.
CAS Anaerobic Digester Tank 1



Picture 52.
CAS Anaerobic Digester Tank 1

Picture 53.
CAS Anaerobic Digester Tank 1

Picture 54.
CAS Anaerobic Digester Tank 1

Picture 55.
CAS Anaerobic Digester Tank 2

Picture 56.
CAS Anaerobic Digester Tank 1

Table 6.13 summarizes the condition scores for condition deficient assets at the digester complex location.

Table 6.13 Condition Assessment Summary – Digester Complex Location

Condition Score	Asset Name	Reason
5 – Very Poor	CAS Anaerobic Digester Tank 1	• Components
5 – Very Poor	CAS Anaerobic Digester Tank 2	• Components
5 – Very Poor	CAS Flare Digester Gas Flow Meter	• General Condition
5 – Very Poor	CAS Thickened Sludge Flow Indicating Transmitter	• General Condition • Equipment/ Transmitter • Display/ Enclosure/ Mount • Wiring/ Cable Condition • Components
5 – Very Poor	WAS 1 Flow Indicating Transmitter	• General Condition
5 – Very Poor	WAS 2 Flow Indicating Transmitter	• General Condition
4 – Poor	Digester Piping General	• Leakage
3 – Moderate	CAS Centrate Pump Flow Indicating Transmitter	• General Condition • Equipment/ Transmitter • Display/ Enclosure/ Mount • Wiring/ Cable Condition • Components
3 – Moderate	CAS Gravity Belt Thickener 1	• General Condition
3 – Moderate	CAS Gravity Belt Thickener 2	• General Condition
3 – Moderate	CAS Heat Exchanger 1 Temp Element	• General Condition
3 – Moderate	CAS Natural Gas Flow Meter	• General Condition
3 – Moderate	CAS Sludge Circulation Pump 1 Temp Element/Trans	• General Condition
3 – Moderate	CAS Sludge Circulation Pump 2 Temp Element/Trans	• General Condition
3 – Moderate	CAS Sludge Feed Pump 2 Grinder	• General Condition
3 – Moderate	CAS Thickened Sludge Hopper 1 Level Indicating Transmitter	• General Condition • Equipment/ Transmitter • Display/ Enclosure/ Mount • Wiring/ Cable Condition • Components
3 – Moderate	CAS Thickened Sludge Hopper 2 Level Indicating Transmitter	• General Condition • Equipment/ Transmitter • Display/ Enclosure/ Mount • Wiring/ Cable Condition • Components

Condition Score	Asset Name	Reason
3 – Moderate	CAS Transfer Sludge Pump 1	• General Condition
3 – Moderate	Centrifuge/GBT Feed Pump 1	• Components
3 – Moderate	Centrifuge/GBT Feed Pump 2	• General Condition • Equipment • Enclosure • Wiring/ Cable Condition • Components
3 – Moderate	Digester 1 Gas Pressure Indicating Transmitter	• General Condition
3 – Moderate	Digester 2 Gas Pressure Indicating Transmitter	• General Condition
3 – Moderate	MCC 8A-8E-8B	• General Condition • Equipment • Enclosure • Wiring/ Cable Condition • Components
3 – Moderate	MCC 9A-9B	• General Condition • Equipment • Enclosure • Wiring/ Cable Condition • Components
3 – Moderate	Sludge Loading Flow Indicating Transmitter	• Display/ Enclosure/ Mount • Wiring/ Cable Condition
3 – Moderate	Thickened Sludge Underflow Level Transmitter	• General Condition • Equipment/ Transmitter • Display/ Enclosure/ Mount • Wiring/ Cable Condition • Components
3 – Moderate	TWAS PUMP 1 VFD	• General Condition
3 – Moderate	TWAS PUMP 2 VFD	• Equipment • Enclosure

Based on the observations and findings described above, the following actions are recommended for the digester complex location:

1. Rehabilitate CAS Anaerobic Digester Tank 1 and 2; replace roofing. Include contingency for repairing cracks and/or spalls in the concrete roof. Repairs at the concrete roof may be expected to include injection of cracks where they occur and localized mortar repairs. The interior of the digesters was not observed, but interior surfaces above the low liquid level may also require sandblasting, a concrete mortar repair, and application of a protective coating.
2. Rehabilitate Digester Piping General; replace deficient section of piping, specifically near generator, and recoat/ paint peeling and slightly corded sections.
3. Replace CAS Centrate Pump Flow Indicating Transmitter.

4. Replace CAS Flare Digester Gas Flow Meter.
5. Rehabilitate CAS Gravity Belt Thickeners 1 and 2; replace drive rollers.
6. Replace CAS Heat Exchanger 1 Temp Element.
7. Replace CAS Natural Gas Flow Meter.
8. Replace CAS Sludge Circulation Pumps 1 and 2 Temp Element/Trans.
9. Rehabilitate CAS Sludge Feed Pump 2 Grinder.
10. Replace CAS Thickened Sludge Flow Indicating Transmitter.
11. Replace CAS Thickened Sludge Hopper 1 and 2 Level Indicating Transmitters.
12. Rehabilitate CAS Transfer Sludge Pump 1; consider replacement if unit has been rehabilitated more than twice in the past.
13. Rehabilitate Centrifuge/GBT Feed Pumps 1 and 2; consider replacement if unit has been rehabilitated more than twice in the past.
14. Replace Digester 1 and 2 Gas Pressure Indicating Transmitters.
15. Rehabilitate MCC 8A-8E-8B and MCC 9A-9B; replace components, wiring, and connections as necessary.
16. Replace Sludge Loading Flow Indicating Transmitter.
17. Replace Thickened Sludge Underflow Level Transmitter.
18. Rehabilitate TWAS PUMP 1 and 2 VFDs; replace components, wiring, and connections as necessary.
19. Replace WAS 1 and 2 Flow Indicating Transmitters.

6.3.12 Chemical Building

The chemical building location consists of two separate location one which resides roughly in the middle of the Tri-City facility grounds, west of the blower building and east of the chlorine contact basins and odor control structures. This chemical building location serves the CAS system and consists primarily of single building 30 feet by 60 feet with a few accessory assets exterior to the structure. The other location consists of 90 feet by 120 feet building located in the southeast corner of the plant and serves the membrane bioreactor process.

Assets designated to the chemical building location include: piping, pumps, rollup doors, programmable logic controllers, switches, sensors, exhaust fans, supply fans, control panels, motor control centers, and variable frequency drives.

The following notable observations were made about condition deficient assets at the chemical building location:

- Building HVAC – was evaluated to be in overall poor condition. Staff suggested that both the ductwork and AC unit are inadequate.
- MBR Citric Acid Feed Pump 1 – was evaluated to be in overall moderate condition. Probably needs to be rebuilt sooner than later. Seal looks fairly compromised.

Picture 57.
MBR Citric Acid Feed Pump 1

Picture 58.
CAS MCC 7A-7B

Table 6.14 summarizes the condition scores for condition deficient assets at the chemical building location.

Table 6.14 Condition Assessment Summary – Chemical Building Location

Condition Score	Asset Name	Reason
4 – Poor	Building HVAC	• General Condition
3 – Moderate	CAS MCC 4A-4B	• General Condition • Equipment • Enclosure • Temperature/ Noise • Wiring/ Cable Condition • Components
3 – Moderate	CAS MCC 7A-7B	• General Condition • Equipment • Enclosure • Temperature/ Noise • Wiring/ Cable Condition • Components
3 – Moderate	CAS Sodium Bisulfite Room SO2 Gas Detector	• General Condition
3 – Moderate	CP-2 REMOTE	• Display/ Enclosure/ Mount
3 – Moderate	MBR Citric Acid Feed Pump 1	• Leakage

Based on the observations and findings described above, the following actions are recommended for the chemical building location:

1. Rehabilitate Building HVAC; consider replacement of the AC unit and sections of deficient duct work.
2. Rehabilitate MBR Citric Acid Feed Pump 1; consider replacement if unit has been rehabilitated more than twice in the past.

3. Rehabilitate CAS MCC 4A-4B and CAS MCC 7A-7B; replace components, wiring, and connections as necessary.
4. Replace CAS Sodium Bisulfite Room SO2 Gas Detector.
5. Rehabilitate CP-2 REMOTE; replace components, wiring, and connections as necessary.

6.3.13 Lime Silos

The lime silos location resides centrally along the eastern boundary of the Tri-City facility, south of the grit basins in the influent basin location and is comprised of two silos roughly 10 ft in diameter.

Assets designated to the lime silos location include: silos, exhaust fans, and control panels.

Note that no condition deficient assets were observed.

6.3.14 Administration Building

The administration building location resides in the northeast corner of the Tri-City facility grounds and is comprised primarily of single building that is roughly 45 feet by 200 feet

Assets designated to the administration building location include: piping.

Note that no condition deficient assets were observed.

6.3.15 Laboratory

The laboratory location resides the northeast corner of the Tri-City facility grounds and consists of single building roughly 50 feet by 100 feet.

Assets designated to the laboratory location include: piping, compressors, dryers, and exhaust fans.

The following notable observations were made about condition deficient assets at the laboratory location:

- WQL Fume Hood 1, 2, 3, and 4 – were evaluated to be in overall moderate condition. Controls are outdated.

Picture 59.
WQL Fume Hood 1

Picture 60.
WQL Fume Hood 2

Table 6.15 summarizes the condition scores for condition deficient assets at the laboratory location.

Table 6.15 Condition Assessment Summary – Laboratory Location

Condition Score	Asset Name	Reason
3 – Moderate	WQL Fume Hood 1	• General Condition
3 – Moderate	WQL Fume Hood 2	• General Condition
3 – Moderate	WQL Fume Hood 3	• General Condition
3 – Moderate	WQL Fume Hood 4	• General Condition

Based on the observations and findings described above, the following actions are recommended for the laboratory location:

1. Replace WQL Fume Hoods 1, 2, 3, and 4.

6.3.16 Buildings and Grounds

The buildings and grounds location include assets across the Tri-City facility grounds and resides in no specific area.

Assets designated to the buildings and grounds location include: buildings, towers, pumps, safety eye washes, screens, strainers, meters, transmitters, exhaust fans, supply fans, lighting, motors, switchgears, transformer, and variable frequency drives.

The following notable observations were made about condition deficient assets at the buildings and grounds location:

- RAS Building - was evaluated to be in overall moderate condition. Seismic retrofit with steel tie plates at interior panels. Water is leaking through the building joint to the east and into the building. Active leaks through the joint allow rainwater to leak profusely into the pump station in the basement.

Picture 61.
Backup Centrifuge Building

Picture 62.
Backup Centrifuge Building

Picture 63.
High Voltage Transformer 1A

Table 6.16 summarizes the condition scores for condition deficient assets at the buildings and grounds location.

Table 6.16 Condition Assessment Summary – Buildings and Grounds Location

Condition Score	Asset Name	Reason
4 – Poor	Tri-City CAS Emergency Lighting	• General Condition • Equipment • Enclosure • Temperature/ Noise • Wiring/ Cable Condition • Components
3 – Moderate	CAS Non-Pot Station Supply Air Fan 1	• General Condition
3 – Moderate	High Voltage Transformer 1A	• General Condition • Enclosure • Temperature/ Noise • Wiring/ Cable Condition • Components
3 – Moderate	High Voltage Transformer 1B	• General Condition • Enclosure • Temperature/ Noise • Wiring/ Cable Condition • Components

Based on the observations and findings described above, the following actions are recommended for the buildings and grounds location:

- Rehabilitate Tri-City CAS Emergency Lighting; replace large sections of deficient lighting across facility.
- Replace CAS Non-Pot Station Supply Air Fan 1.
- CONTACT Portland General Electric (PGE) about replacing High Voltage Transformer 1A and 1B.

6.4 Cost Estimates

This section contains a summary of the estimated costs by asset location for the recommendations contained in the previous questions. The cost estimates are based on a combination of information provided by WES, quotes from vendors, and Carollo's experience on similar projects.

The costs estimates provided only assumes direct (material (assets), labor, and equipment) costs and in February 2021 dollars (Engineering News Record Construction Cost Index: 11699). Costs in the summary are rounded to the nearest ten thousand dollars. No project cost markups are assumed or included in this cost estimating effort. The expected accuracy of this estimating effort provided herein is assumed to be 50 percent over to 30 percent under the actual direct cost incurred.

The following tables summarize the costs by the recommended time frame for planning and budgetary purpose as to when renewal efforts should be performed. Table 6.16 shows costs for the 0-to-2-year time period, Table 6.17 shows costs for the 3-to-5-year time period, and Table 6.18 shows costs for the 6-to-10-year time period.

Detailed cost estimates, including each asset name, the condition score, and recommended action, can be found in *TM 5A: Existing Tri-City Water Resource Recovery Facility Condition*.

Table 6.17 Cost Estimate Summary – Rehabilitation and Replacement in Next 0 to 2 Years

Facility	Estimated Cost
Primary Sedimentation Basins	$4,101,000
Primary Pump Station	$678,000
CAS Aeration Basins	$95,000
Digesters	$2,689,000
Total Estimated Project Cost	**$7,563,000**

Table 6.18 Cost Estimate Summary – Rehabilitation and Replacement in Next 3 to 5 Years

Facility	Estimated Cost
IPS / Headworks	$834,000
Primary Sedimentation Basins	$347,000
CAS Aeration Basins	$1,913,000
RAS Pump Station	$261,000
MBRs	$12,000
Backup Centrifuge	$26,000
Chlorine Contact Basin	$637,000
Digesters	$26,000
Chemical Building	$15,000
General Site	$154,000
Total Estimated Project Cost	**$4,225,000**

Table 6.19 Cost Estimate Summary – Rehabilitation and Replacement in Next 6 to 10 Years

Facility	Estimated Cost
IPS / Headworks	$2,223,000
Primary Sedimentation Basins	$333,000
Primary Pump Station	$56,000
CAS Aeration Basins	$496,000
Blower Building	$305,000
Secondary Clarifiers	$293,000
RAS Pump Station	$352,000
MBRs	$652,000
Backup Centrifuge	$51,000
Chlorine Contact Basin	$25,000
Digesters	$203,000
Chemical Building	$104,000
Lab	$31,000
General Site	$7,000
Total Estimated Project Cost	**$5,131,000**

Chapter 7

TRI-CITY WRRF ALTERNATIVES

7.1 Introduction

This chapter documents improvements needed to address deficiencies at the Tri-City WRRF over a 20-year planning period. The analyses and recommendations presented in this chapter build on a series of evaluations, which are summarized in the following documents:

- Chapter 2 - Tri-City Service Area Characteristics.
- Chapter 3 - Wastewater Flows and Loads.
- Chapter 4 - Permitting and Regulatory Considerations.
- Chapter 5 - Capacity Assessment.
- Chapter 6 - Condition Assessment.

Capacity limitations at the WRRF are described in Chapter 4. The condition of various assets within the WRRF, and recommendations for R&R of those assets, are defined in Chapter 6. Improvements presented herein address capacity and condition limitations in the liquid and solids stream treatment processes, in accordance with the recommended basin-wide scenarios developed as part of the WFP. The schedule for recommended improvements and the associated 20-year CIP for the WRRF will be documented in the Tri-City WRRF Facilities Plan.

7.1.1 Basin-Wide Treatment Scenarios

The analyses and recommendations presented in this chapter are part of an overall WFP, which considers the District's regional treatment facilities and associated conveyance infrastructure. Scenarios evaluated as part of the WFP each considered different ways to utilize existing WES treatment and conveyance infrastructure to meet current and potential flow and load limitations, and potential future NPDES permit limits in the Lower Willamette River. The pertinent WFP scenarios vis-à-vis the alternatives presented in this chapter include:

- **WFP Scenario 1:** Existing NPDES permit limits, with peak flows to the Kellogg Creek WRRF (i.e., flows in excess of 25 million gallons per day [mgd]) transferred to the Tri-City WRRF. A more detailed description of the NPDES permit assumptions for Scenario 1 is included in Chapter 4.
- **WFP Scenario 1.5:** Future NPDES summertime permit limits on effluent ammonia and total phosphorus, which may result from DEQ's Total Maximum Daily Load (TMDL) process on the Lower Willamette River and require some flow and load transfer from Kellogg Creek to Tri-City during the regulatory dry weather season via a basin-wide permit. DEQ would allow all nutrient removal to be provided at Tri-City and Kellogg Creek current permit limits would remain.

- **WFP Scenario 3:** Future NPDES summertime permit limits on effluent ammonia and total phosphorus, which may result from DEQ's TMDL process on the Lower Willamette River and require some flow and load transfer from Kellogg Creek to Tri-City during the regulatory dry weather season. This Scenario assumes DEQ would require individual permits for Tri-City and Kellogg Creek, so that nutrient removal would be required at both Kellogg Creek and Tri-City facilities.

7.1.2 Tri-City WRRF Influent Flow Assumptions

the Tri-City WRRF must treat influent flows generated within the Tri-City service area along with flows transferred from the Kellogg Creek WRRF. Flow treated at the Tri-City WRRF The amount of flow being transferred from the Kellogg Creek service area to the Tri-City WRRF would change depending on the basin-wide scenario. Table 7.1 summarizes the flow transfer assumptions used to develop the Tri-City WRRF alternatives presented in this chapter.

Table 7.1 Tri-City WRRF: Flow Transfer Assumptions for Basin-Wide Treatment Scenarios

Basin-wide Scenario	Flow Component	2040		
		Tri-City service area, mgd	Transfer from Kellogg Creek to Tri-City WRRF, mgd(1)	Tri-City WRRF Influent, mgd
Scenario 1	MMDWF	15.1	2.7	17.8
	PHF	72.2	32.2	104.4
Scenario 1.5	MMDWF	15.1	2.7	17.8
	PHF	72.2	32.2	104.4
Scenario 3	MMDWF	15.1	6.4	21.5
	PHF	72.2	32.2	104.4

Notes:
(1) Transfer requirement based on the capacity of Kellogg Creek WRRF as defined in TM 4B.

Due to rainfall-induced infiltration and inflow (I/I) and increasing flow transfers, peak flows at the Tri-City WRRF are much higher than flows associated with average or even maximum month conditions. The District plans to reduce I/I in priority basins throughout the regional system, and the peak flow projections in this chapter assume that these I/I reduction projects have been completed. However, future peak flows at the Tri-City WRRF will continue to grow, in part because the amount of flow transferred from the Kellogg Creek service area increases over time. This is due to the fact that the capacity of the Kellogg Creek WRRF is capped at 25 mgd, so up to 33 mgd of peak flows generated in the Kellogg Creek service must be transferred to Tri-City by the year 2040.

Figures 7.3 and 7.4 below show existing and projected peak flows at the Tri-City WRRF. Figure 7.3 shows the data throughout the calendar year. As shown, flow is typically less than 10 mgd in the dry weather season, and the facility's 35 mgd secondary capacity is rarely exceeded throughout the year. Figure 7.4 is a probability plot of these same flow data, which shows that future peak flows are predicted to exceed secondary capacity only about two percent of the time (approximately seven to 10 days per year). The infrequent need for peak flow treatment is a substantial consideration when developing alternatives to increase peak flow capacity and is accounted for in the analysis of alternatives.

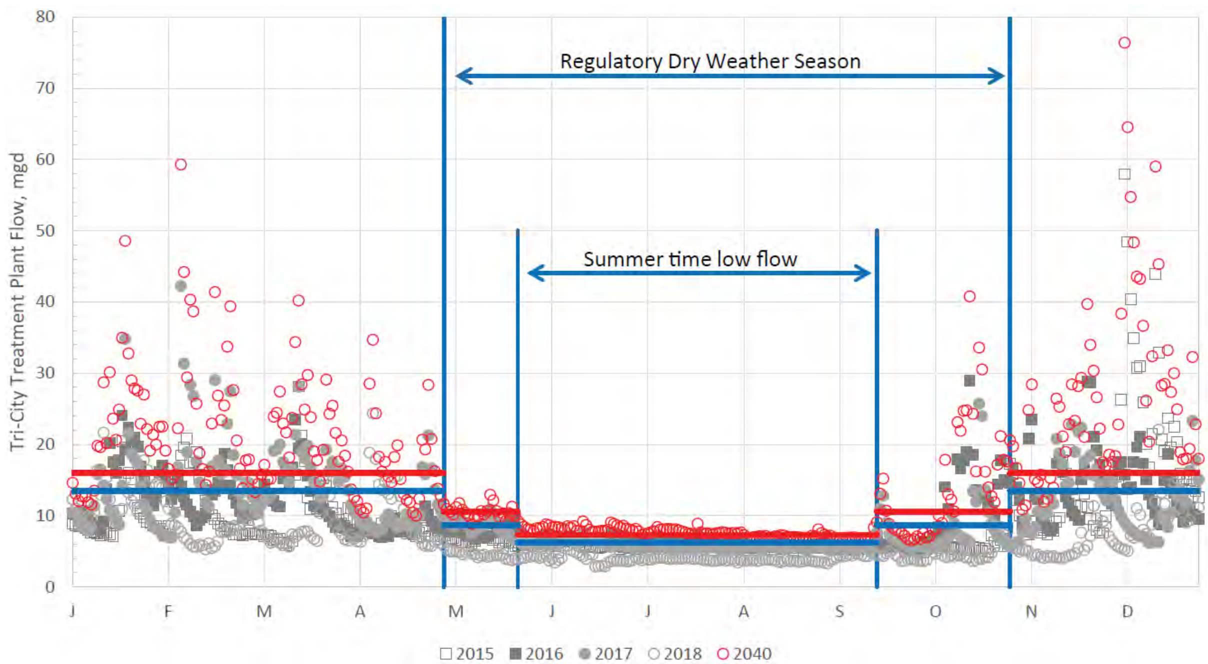


Figure 7.1 Existing and Projected Tri-City WRRF Peak Flows

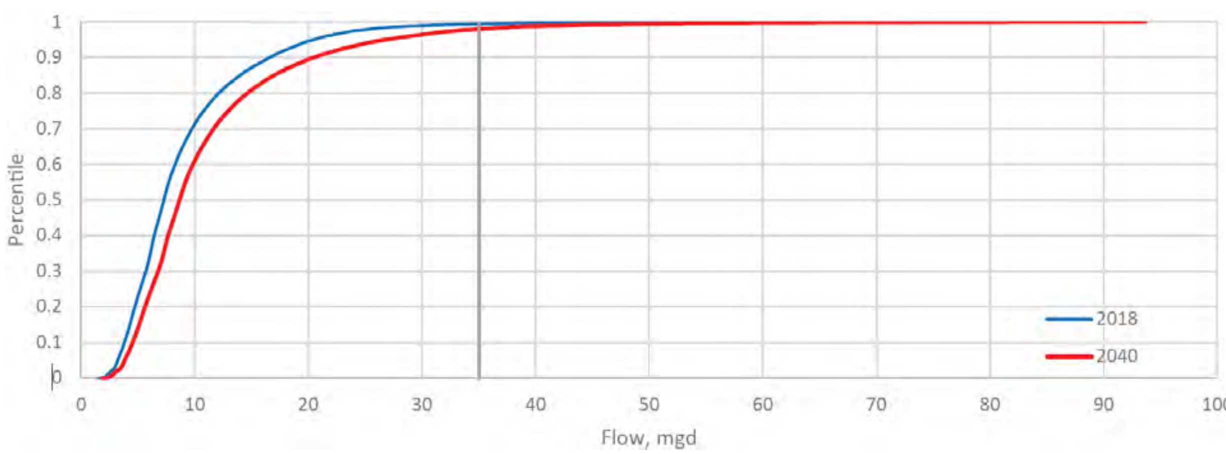


Figure 7.2 Existing Projected Tri-City WRRF Peak Flow Probability

7.2 Alternatives Evaluation Methodology

For each basin-wide scenario, alternatives to address capacity and condition limitations were evaluated by the planning team using cost and non-cost factors that are consistent with the District's decision-making criteria for capital and planning projects. Specific cost assumptions and non-cost criteria are presented in this section.

7.2.1 Cost Assumptions

Capital and life-cycle cost estimates were developed to compare alternatives on a financial basis as well as for CIP development. These cost estimates follow industry standards published by the Association for the Advancement of Cost Engineering (AACE), which include five classes of cost estimates:

- Class 5 (Order of Magnitude Estimates). These are commonly referred to as conceptual level estimates and are used to compare a broad range of alternatives based on limited engineering detail (less than 2 percent design completion). The expected accuracy range for Class 5 estimates is +50 percent to -30 percent, which means that actual bids for the completed project can fall within a range of 50 percent over the estimate to 30 percent below the estimate.
- Class 4 and Class 3 (Budget Estimates). These estimates are used to establish the Owner's budget for a project. The expected accuracy range for both classes is +30 to -15 percent. Class 4 estimates rely on engineering detail ranging from 1 to 15 percent; Class 3 estimates rely on engineering detail between 10 and 40 percent.
- Class 2 and Class 1 (Definitive Estimates). These estimates are used to track project costs during design, and to compare actual bids with Engineer's Estimates. The expected accuracy range for both classes is +15 to -5 percent. Class 2 estimates rely on engineering detail ranging from 50 to 100 percent; Class 1 estimates rely on engineering detail beyond 100 percent (such as conformed drawings).

Class 5 cost estimates were developed and used to compare various liquid and solids stream alternatives. Class 4 Budgetary Estimates were then developed for the recommended improvement alternatives.

7.2.1.1 Capital Cost Assumptions

Capital cost include construction costs (e.g., materials, labor, equipment, subcontractor costs, and indirect costs such as contractor mobilization, demobilization, temporary contractor facilities, testing commissioning, and cleanup), plus indirect costs that would not be a physical element of the project (e.g., engineering, legal, and administrative costs, taxes, and fees).

Estimated project costs are presented in February 2021 dollars consistent with a 20 cities Engineering News-Record (ENR) value of 11699. The following assumptions and markups were used to develop construction and total project costs:

- Design Contingency: 30 percent.
- General Conditions: 10 percent.
- Contractor Overhead and Profit (OH&P): 15 percent.
- Engineering, Legal, and Administration (ELA): 25 percent.

7.2.1.2 Life Cycle Cost Assumptions

Annual and life-cycle cost estimates were prepared for certain alternatives to account for relative difference in annual operations and maintenance (O&M) costs. Annual O&M cost estimates presented herein account for the cost of labor, consumables, power, and chemicals, and were developed under annual average operating conditions based on costs from similar and recent projects, vendor-supplied costs, and costs supplied by District staff (e.g., power, labor, chemicals).

Life-cycle costs were calculated over a 20-year period for certain alternatives, with a discount rate of three percent. These costs are presented as Net Present Value (NPV) costs, which include the NPV of annual O&M costs plus the total estimated project costs, in February 2021 dollars.

7.2.2 Non-Cost Considerations

In addition to cost, alternatives to increase the Tri-City WRRF hydraulic capacity (under Scenario 1) and to provide additional nutrient removal capability (under Scenarios 1.5 and 3) were also evaluated based on a set of qualitative criteria. These criteria, or guiding principles, were presented to DEQ at a meeting on March 31, 2021, and include:

- Protect water quality by meeting NPDES Permit limits.
- Match the investment in treatment capacity with a demonstrated water quality benefit, considering both capital and life-cycle costs.
- Consider the operational impacts associated with each alternative:
  - Select technologies with a proven history of performance in similar applications.
  - Minimize treatment process and flow splitting complexity.
- Control cost and reduce risk by avoiding complex and/or difficult construction.
- Maximize the use of existing treatment assets, but minimize interties between the North and South areas of the Tri-City site to:
  - Facilitate ease of operation.
  - Reduce or eliminate the need for intermediate/effluent pumping.
- Plan for the future:
  - Plan for potential future regulatory scenarios and "Buildout" conditions on the Tri-City site.
  - Minimize or avoid stranded assets.

7.3 Process Design Criteria and Assumptions

As shown in Table 7.1, each of the three basin-wide scenarios considered by the planning team will require an increase of the Tri-City WRRF peak hydraulic capacity to approximately 105 mgd by the year 2040. Additionally, Scenarios 1.5 and 3 require improvements to increase Tri-City's nutrient removal capabilities in the regulatory dry weather season. This section summarizes the criteria used to size the unit processes to provide the required additional hydraulic and nutrient removal capacity. Criteria are provided for each liquid stream process needed to increase hydraulic or nutrient removal capacity at some point within the planning period. A process flow diagram of the existing liquid stream processes for Tri-City WRRF is shown in Figure 7.2, for reference. Process flow diagrams for each alternative that show how existing processes are expanded and new processes are added is included in Section 7.4.

7.3.1 Influent Pumping and Preliminary Treatment

The 2018 document from DEQ titled *Preparing Wastewater Planning Documents and Environmental Reports for Public Utilities* (DEQ Planning Document) provides redundancy criteria for influent pumping and preliminary treatment processes. This document requires influent pumping be sized to pump the projected PHF with the largest unit out of service. The firm capacity of the existing Tri-City influent pump station (IPS) is 50.4 mgd. Each Tri-City alternative will require upgrades to the existing IPS pumps and piping to increase the firm capacity to 72.2 mgd.

Per the DEQ Planning Document, screening processes must have multiple units and need to be sized to convey the PHF with all units in service. The capacity of the existing mechanically cleaned bar screens at the Tri-City WRRF is approximately 60 mgd. Flow in excess of 60 mgd is currently treated through a manually cleaned bar rack. Several alternatives presented herein require expanding the existing bar screen facility's capacity to 105 mgd, while others assume that the peak flow transfer from the Kellogg Creek service area, which is currently passed through the existing screens, would be re-routed to a new bar screen facility. Modifications to the existing screening facility are not required for these alternatives;

however, a new screening facility would be required to treat approximately 35 mgd of transfer flow from the Kellogg Creek service area.

The DEQ Planning Document does not specify redundancy criteria for grit removal processes. The rated process capacity of the existing Tri-City WRRF grit basins is 50 mgd; however, the basins can hydraulically pass up to 75 mgd. Several alternatives presented herein require expanding the Tri-City grit removal capacity to 105 mgd through modifications adjacent to the existing grit basins. Others assume that the peak flow transfer from the Kellogg Creek service area (currently routed to the existing grit basins) would be re-routed to a new peak flow treatment facility, which obviates the need to increase grit removal capacity.

The redundancy requirements for the influent pumping and preliminary treatment processes are summarized in Table 7.2.

Table 7.2 Influent Pumping and Preliminary Treatment Design Criteria

Redundancy Criteria	PHF	PDF
Influent Pumping	Largest unit out of service	NA
Screening	All units in service	Manual bar rack out of service
Grit Removal	All units in service	NA

7.3.2 Primary Treatment

The current Tri-City WRRF provides primary treatment for all flows, and primary treatment is needed ahead of all future secondary processes. This section summarizes the criteria used to size required additional primary treatment capacity.

The DEQ Planning Document does not list specific redundancy criteria for primary treatment. However, the District has identified that they would like to be able to take a primary clarifier out of service for maintenance during ADWF conditions.

Future requirements for primary treatment are based on the performance and hydraulic limitations of the District's existing primary clarifiers. Currently the District is able to hydraulically pass a total of 60 mgd through their six primary clarifiers which correlates to a PHF surface overflow rate (SOR) of 4,000 gallons per day per square foot (gpd/sf). This SOR is higher than typical guidelines for peak flow – Metcalf and Eddy (4th Edition) suggests up to 3,000 gpd/sf. However, given the District's successful operation of their primary clarifiers at this SOR, future primary clarifiers will be sized for a PHF SOR of 4,000 gpd/sf.

In addition to passing peak flows, primary clarifiers must have a sufficient surface area to remove the desired percentage of BOD and TSS at less extreme flow conditions. The performance of the primary treatment system is linked to the planned MMWW capacity of the secondary system (i.e., lower primary clarifier removal rates result in higher loads (and thus reduced capacity) to the secondary process). Primary TSS removal percentages correlate with the SOR, with higher removal rates typically seen at lower SORs. Figure 7.1 shows the historical primary clarifier TSS removal plotted against SOR. This correlation was used in Chapter 4 to develop a range of target SORs coupled with planned TSS removals for MMWW conditions. At more typical SOR of 1,500 gpd/sf, the average TSS removal from the historic data is approximately 60 percent. At higher SORs of 2,000 gpd/sf associated with passing the full 2040 influent flow of 29.6 mgd through the existing secondary process, the average TSS removal from the historic data is approximately 54 percent. For planning future processes, the target MMWW SOR was assumed to be in the middle of this range at 1,650 gpd/sf.

Table 7.3 summarizes the design criteria used to size future primary clarification processes.

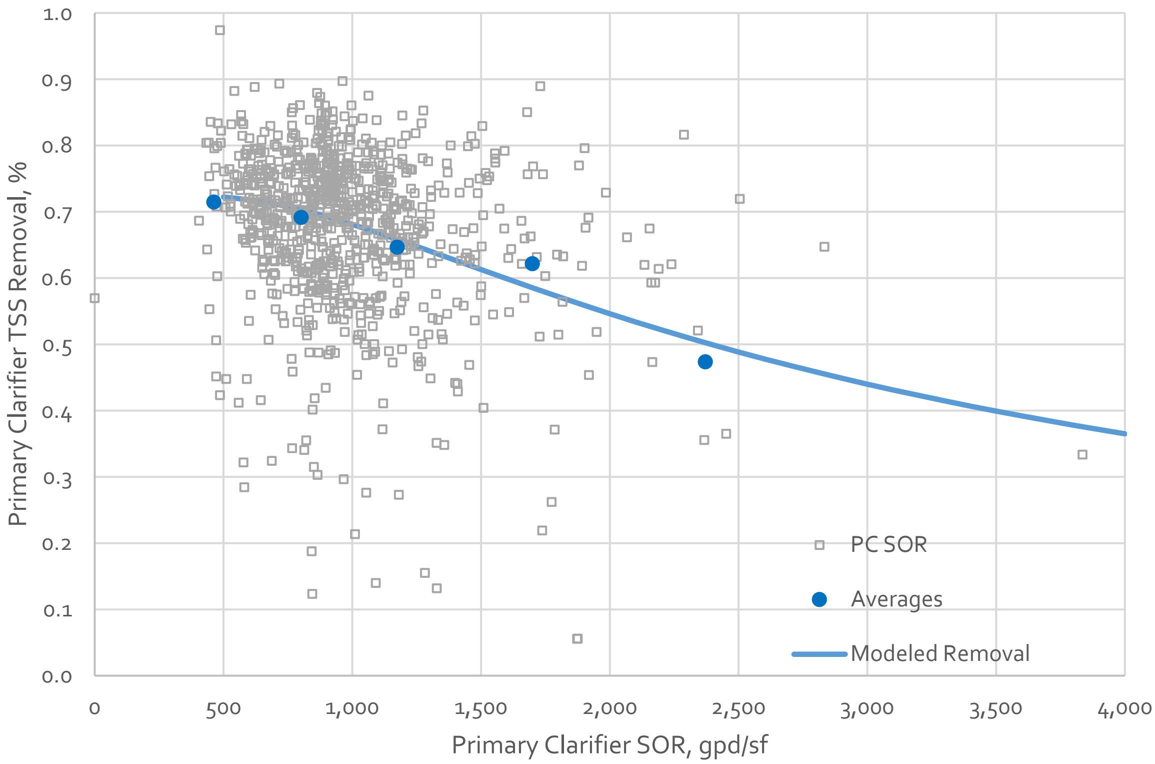


Figure 7.3 Primary Clarifier TSS Removal vs. Surface Overflow Rate

Table 7.3 Primary Clarifier Design Criteria

Design Criteria	PHF	MMWWF	ADWF
Redundancy Criteria	All units in service	All units in service	1 unit out of service
SOR, gpd/sf	4,000	1,650	1,500
Planned TSS removal at selected SOR, %	NA	59%	60%

7.3.3 High-Rate Primary Treatment (Ballasted Sedimentation)

Several alternatives to increase the peak flow hydraulic capacity at the Tri-City WRRF are based on the addition of a high-rate treatment, or ballasted sedimentation process, such as Actiflo®. Actiflo® has been accepted as a treatment for peak flows in the Pacific Northwest region and throughout the United States. In this process, coagulant and polymer are added to screened wastewater, which is then routed into a flocculation tank where sand is added to the process. The sand provides a ballast allowing the particles in the raw wastewater to settle rapidly. The coagulated/flocculated mixture is then sent to a high-rate lamella clarifier. In addition to being able to treat peak flows in a smaller footprint, this type of process can be rapidly started up in response to a peak flow event and could also be used as a tertiary process in the dry-weather season (if needed) to remove phosphorus.

To achieve an effluent total phosphorus concentration of 0.3 mg/L for Scenarios 1.5 and 3, it was assumed that the ballasted sedimentation would be required for the conventional side of the plant. A mass balance was performed to determine how much of the conventional secondary effluent would need tertiary treatment with the remainder of the flow bypassing the ballasted sedimentation process. Daily current summer-time flows were projected to the year 2040 and buildout and blended effluent qualities were projected assuming that the MBR process could achieve an effluent total phosphorus concentration of 0.3 mg/L, the CAS tertiary process could achieve an effluent total phosphorus concentration of 0.15 mg/L, and secondary effluent bypassing tertiary treatment could achieve a total phosphorus concentration of 1 mg/L. These assumptions result in a required tertiary treatment capacity of approximately 15 mgd by Year 2040, and approximately 37 mgd by Buildout.

Table 7.4 summarizes the design criteria for the Actiflo® process.

Table 7.4 Actiflo® Design Criteria

Design Criteria	PHF – Actiflo®	MMDW – Actiflo®
Operational mode	Peak Flow Treatment	Tertiary Phosphorus Removal
SOR	38 gpm/sf	25 gpm/sf

7.3.4 Conventional Secondary Treatment

Primary effluent flows up to 35 mgd currently receive secondary treatment through either the existing CAS process or the membrane bioreactor (MBR). This section summarizes the criteria used to size additional CAS capacity, and the following section summarizes the criteria used to size additional MBR capacity.

The DEQ Planning Document does not list specific redundancy criteria for aeration basins but requires a minimum of two units. The District prefers to be able to take one aeration basin out of service for maintenance during ADWF conditions. Additionally, the DEQ guidelines suggest that a secondary clarifier needs to be able to be removed from service during MMDWF conditions.

The sizing of future conventional aeration basins and secondary clarifiers is linked to and depends on the flow entering secondary treatment, the required aSRT, and the settleability of the MLSS. A state point curve is used to determine the maximum allowable MLSS concentration for a given clarifier surface area, MLSS settleability (as measured by the SVI), and peak flow. Effluent quality goals are used to set the planned minimum aSRT.

7.3.4.1 Scenario 1 - Current Permit Limits

No nitrification is required for Scenario 1, and the planned minimum maximum month aSRT was assumed to be 2.5 days. The maximum allowable MLSS concentration was determined to be 2,600 mg/L assuming an SVI of 150 mL/g and 12.5 mgd of peak flow per secondary clarifier. For Scenario 1, if all secondary clarifiers were in operation, one aeration basin could be taken out of service during average load conditions coupled with PDDWF. Additionally, it was assumed that if all aeration basins were in service, a secondary clarifier could be taken out of service during average load conditions for flows less than 22.5 mgd (12.5 mgd to the conventional process and 10 mgd to the MBR process). These conditions meet the guidance provided by DEQ and District preferences. No secondary treatment expansion is required for Scenario 1.

7.3.4.2 Scenarios 1.5 and 3 - Nutrient Removal

For Scenarios 1.5 and 3, nitrification and phosphorus removal would be required during the summer period when minimum month temperatures are expected to be 13 degrees Celsius (C). During this condition a minimum aSRT of eight days was assumed to provide complete nitrification. A SVI of 150 mL/g was assumed, and the state point was run using the projected PDDWF through secondary treatment.

Secondary capacity expansion would be required for this scenario, and since the MBR process was designed to be doubled, it was assumed that an expanded MBR process would treat a PDDWF of 20 mgd, with the balance of PDDWF treated through existing and new CAS, with future aeration basins and secondary clarifiers replicating the existing units. The aeration basins were assumed to operate in an Anaerobic/Anoxic/Oxic (A2O) mode to biologically remove phosphorus and to provide sufficient denitrification to avoid rising sludge in the secondary clarifiers. The basins were assumed to be configured to allow for 11 to 22 percent of the volume to be anaerobic, 11 to 22 percent of the volume to be anoxic, and 67 to 78 percent of the volume to be aerated. A mixed liquor recycle (MLR) flow of approximately 2Q was assumed to be returned to either the second or third unaerated zone to provide a moderate level of denitrification.

The expansion was assumed to result in separated north (existing) and south (new) CAS processes, with the flow split between north and south determined such that each side of the process would treat peak flow proportional to the planned maximum month flow. The maximum allowable MLSS concentration for the north and south side was then determined based on the north and south flow split. Generally, the resulting maximum allowable MLSS concentration ranged between 3,500 to 4,000 mg/L.

For Scenarios 1.5 and 3, three redundancy criteria were reviewed assuming ADW loads coupled with PDDWFs:

- One conventional aeration basin out of service, and all MBR trains and secondary clarifiers in service.
- One secondary clarifier out of service and all conventional aeration basins and MBR trains in service.
- One MBR train out of service, all conventional aeration basins and secondary clarifiers in service.

Table 7.5 summarizes the design criteria used to size future conventional secondary treatment processes.

Table 7.5 Conventional Aeration Basin Design Criteria for Scenarios 1, 1.5 and 3

Design Criteria	MMWWF	MMDWF	ADWF
Redundancy Criteria	All units in service	All units in service	1 unit out of service(1)
Scenario 1 configuration	AO	AO	AO
Scenario 1 aSRT	2.5	2.5	3.0
Scenario 1 MLSS, mg/L(2)	2,600	2,600	2,600
Scenario 1.5 and 3 configuration	AO	A2O	A2O
Scenario 1.5 and 3 aSRT	2.5	8	8
Scenario 1.5 and 3 MLSS, mg/L	2,600(2)	3,500 - 4,000(3)	3,500 - 4,000(3,4) 1,800 - 3,000(3,5) 2,750 - 3,900(6)

Notes:
(1) Either an aeration basin OR a secondary clarifier out of service.
(2) State point analysis assuming a maximum of 12.5 mgd per secondary clarifier and an SVI of 150 mL/g.
(3) State point analysis was run for each individual flow split condition assuming the PDDWF with 20 mgd through the MBR system and an SVI of 150 mL/g.
(4) One conventional aeration basin out of service and all secondary clarifiers in service.
(5) One secondary clarifier out of service and all conventional aeration basins in service.
(6) One half of the MBR train (consisting of one MBR aeration basin, 1 MBR tank and 1 ultraviolet [UV] channel) out of service, all conventional aeration basins and secondary clarifiers in service. State point analysis was run for each individual flow split condition assuming the PDDWF with 10 mgd through the MBR system and an SVI of 150 mL/g.

7.3.5 Membrane Bioreactor

The MBR system was designed to treat either primary effluent or primary influent; however, the District prefers to treat primary effluent through the MBR so it was assumed this would continue in the future. The MBRs are designed to nitrify. For the summer season, the minimum aSRT to achieve nitrifications was assumed to be eight days, while during the winter, the minimum aSRT was assumed to be 10 days. MBR systems are designed to operate at a higher MLSS concentration of around 8,000 mg/L in the aeration basin and 10,000 mg/L in the membrane tank. The current MBR system is designed with a maximum month flux of up to 9.6 gallons per square foot per day (gfd) and a peak flux of up to 19.2 mgd. For the alternative analysis, it was assumed that the future expansions to the MBR process would resemble the current configuration.

For Scenarios 1.5 and 3, phosphorus removal would be required in addition to nitrification during the regulatory dry-weather season. Although biological phosphorus removal is possible with a MBR system, due to the high recycle load of Nitrate (NO_3) and oxygen, achieving this is difficult and requires additional pumping. For this reason, it was assumed that chemical phosphorus removal would be required for the MBR side of the process. To achieve an assumed effluent goal of 0.3 mg/L total phosphorus, a two-point chemical dosing system was assumed, alum dosing to primary clarifiers dedicated to the MBR process and additional chemical dosing in the MBR aeration basin. The chemical dose in the primary clarifiers was set to achieve a primary effluent ortho phosphorus concentration of approximately 1 mg/L to ensure that the downstream biological process does not become phosphorus limited. The dosing of chemicals to the MBR aeration basin was then set to achieve a final effluent total phosphors concentration of 0.3 mg/L.

Table 7.6 summarizes the MBR process design criteria used to size additional MBR process.

Table 7.6 Membrane Bioreactor Design Criteria for Scenarios 1.5 and 3

Design Criteria	PHF	MMWWF	MMDWF
Redundancy Criteria	All units in service	All units in service	All units in service
MBR Aeration basin configuration	MLE	MLE	MLE
aSRT	NA	10	8
MBR Aeration basin MLSS, mg/L	NA	8,000/10,000	8,000/10,000
Flux, gpd	19.2	9.6	9.6

7.3.6 Disinfection

CAS effluent and Select Treat (flow that receives primary treatment and disinfection) are disinfected through chlorine contact basins, and MBR effluent is disinfected with UV. The Oregon DEQ Facility Planning Document require that chlorine disinfection processes achieve a contact time of at least 15 minutes during PHF condition, 20 minutes during PDF conditions, and 60 minutes during ADWF conditions. Additionally, the District would like the ability to operate with the largest chlorine contact basin out of service during ADWF conditions. Table 7.7 summarizes the chlorine disinfection design criteria used to size additional processes.

Table 7.7 Chlorine Disinfection Design Criteria

Design Criteria	PHF	PDF	ADWF
Redundancy Criteria	All units in service	All units in service	Largest Unit Out of Service
Contact Time, min	15	20	60

The Oregon DEQ Facility Planning Document requires a minimum of two ultraviolet (UV) disinfection systems sized for a minimum dose of 30 millijoules per square centimeter (mJ/cm^2) at either the PHF condition or the MDDWF condition with one unit out of service.

7.4 Liquid Stream Alternatives Development

This section describes the liquid stream alternatives to expand and improve the Tri-City WRRF to meet 2040 and Buildout flows and loads for Basin-Wide Scenarios 1, 1.5, and 3. Since dry-weather nutrient limits are not imposed with Scenario 1, the wet weather season controls and alternatives are required to increase peak hour flow capacity. The approach used to develop, evaluate, and select Tri-City alternatives consisted of the following steps:

1. Determine improvements needed to provide flow and load capacity for Year 2040 under Scenario 1 (specifically, improvements to increase peak hydraulic capacity to 105 mgd under existing NPDES permit conditions). These improvements are shown in blue on the WRRF treatment schematics presented later in this section in Figures 7.5 – 7.9, 7.11 and 7.12.
2. Determine additional improvements needed to provide nutrient removal capability in the regulatory dry-weather season under Scenarios 1.5 and 3. These improvements are shown in orange (for Scenario 1.5) and yellow (for Scenario 3) on the WRRF treatment schematics presented later in this section.
3. Compare the cost and non-cost considerations of the alternatives.
4. Select the preferred alternative to achieve Scenario 1 capacity while also considering Scenario 1.5 and 3 phasing requirements.

Figure 7.2 is a schematic of the existing treatment processes at the Tri-City WRRF, and shows flow routing when the facility is operated at peak hydraulic capacity. As shown in the figure, the current peak wet weather flow capacity is approximately 70 mgd, which must be increased to approximately 105 mgd by 2040 for all scenarios. Alternatives to increase peak flow capacity through existing and new treatment processes use the following nomenclature:

- Existing treatment processes north of the MBR Train are referred to "North Plant" processes.
- The existing MBR Train (screens, aeration basins, membranes, and UV disinfection) is referred to as the "MBR Train."
- New processes to increase treatment capacity and constructed to the south of the MBR Train are referred to as "South Plant" processes.

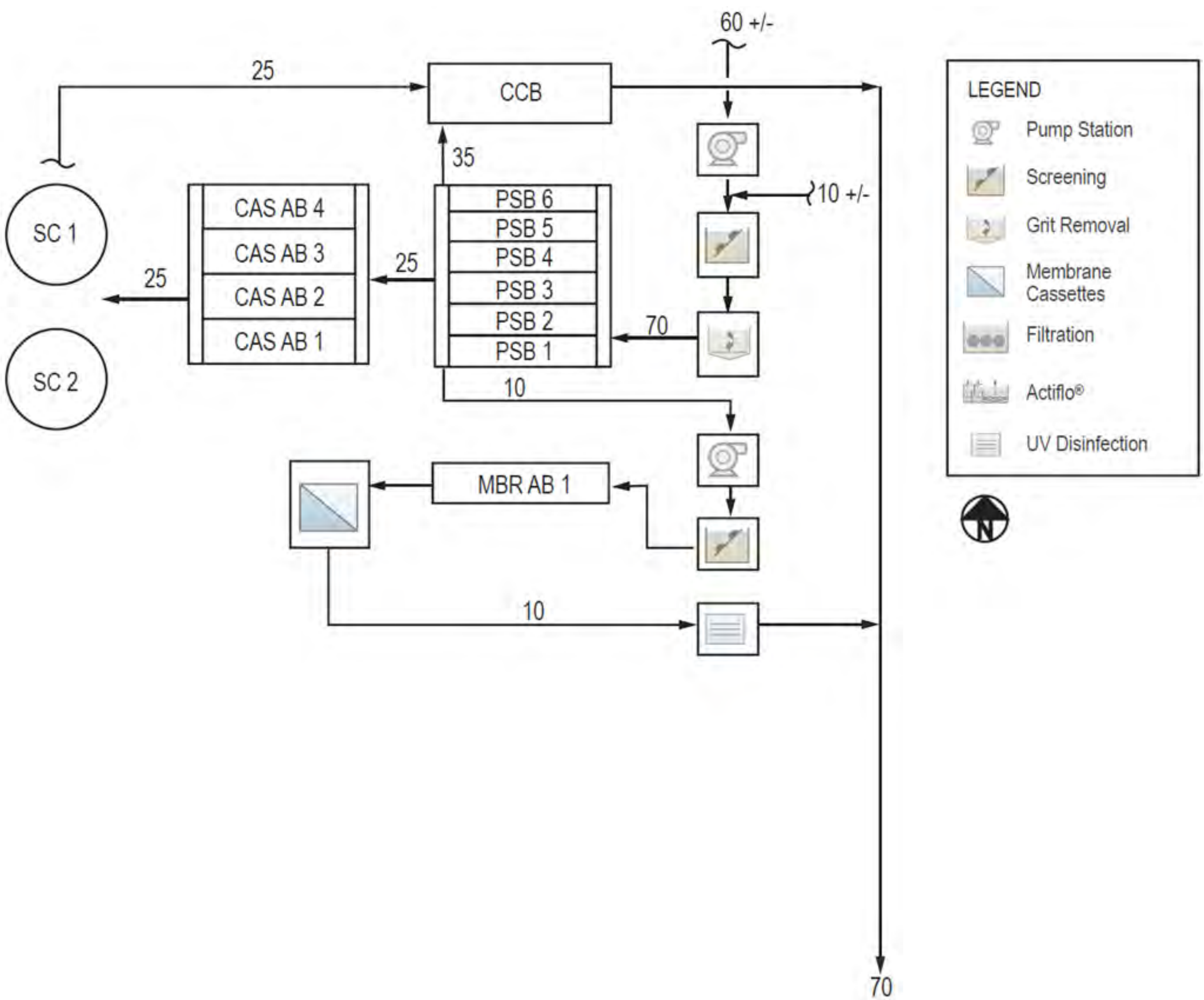


Figure 7.4 Existing Tri-City WRRF Schematic

The following alternatives were evaluated to meet the planning year and buildout flows and loads:

- **Alternative 1**: Expand wet weather treatment capacity with primary and secondary clarifiers on the south side of the plant.
- **Alternative 2**: Expand wet weather treatment capacity with primary clarifiers on the north side of the plant along with additional wet weather capacity provided with a new peak flow treatment facility.
- **Alternative 3**: Expand wet weather treatment capacity with an expanded MBR process along with a new peak flow treatment facility.
- **Alternative 4:** Expand wet weather treatment capacity with a new CAS process on the south side of the plant.
- **Alternative 5:** Expand wet weather treatment capacity with a new peak flow treatment facility.

7.4.1 Alternative 1

Alternative 1 (shown in Figure 7.5) increases Tri-City peak flow capacity as required in Scenario 1 by building additional primary and secondary clarifiers to the south and connecting those new processes to the North Plant and addresses nutrient removal required in Scenarios 1.5 and 3 as described below.

Alternative Description

Process improvements needed to increase peak hydraulic capacity (shown in blue on Figure 7.5) include:

- Improvements to increase influent pumping, screening, and grit removal capacity in the existing IPS and headworks.
- Five new primary sedimentation basins (PSBs) to increase primary treatment capacity to 105 mgd. Due to space limitations, these clarifiers would need to be constructed south of the existing MBR train, so approximately 40 percent of the de-gritted primary influent during peak flows would be routed to these new PSBs.
- A new Primary Influent Pump Station would be needed to allow primary effluent from these new PSBs to flow by gravity back to the existing CAS aeration basins in the North Plant for secondary treatment.
- Three new secondary clarifiers would be needed to provide adequate secondary treatment capacity. Due to space limitations, these clarifiers would need to be constructed south of the existing MBR train, so approximately 60 percent of the mixed liquor during peak flows would be routed to these new clarifiers.
- A new chlorine contact basin (CCB) would also be needed to disinfect effluent from the new South Plant secondary clarifiers.
- Because of the hydraulic connection between the existing CAS aeration basins and new secondary clarifiers, Alternative 1 also requires a new effluent pump station downstream of the new South Plant CCB.
- The area set aside for Tri-City WRRF expansion was formally home to a landfill. A line item for landfill remediation is required for each alternative that expands into this area and is a function of how much space is required within the landfill site.

Other improvements to achieve potential future nutrient limits in the regulatory dry weather season are also shown in Figure 7.5. Improvements shown in orange are associated with Scenario 1.5 and include:

- Improvements to the existing MBR Train, including primary effluent pumping, screening, a new aeration basin, and additional membrane cassettes.
- New tertiary facilities (pump station, chemical dosing, and filters) to remove phosphorous from a portion of the CAS secondary effluent.

Improvements shown in yellow are associated with Scenario 3 and include a new CAS aeration basin.

For Alternative 1, the estimated capital cost to increase peak hydraulic capacity to meet existing NPDES permit limits (Scenario 1) is $131 million. Table 7.8 summarizes the major cost components of Alternative 1 for each of the three Basin-Wide Scenarios.

Table 7.8 Alternative 1 Estimated Total Project Cost

Cost Component	Scenario 1	Scenario 1.5	Scenario 3
Preliminary Treatment	$13.6	$13.6	$13.6
Primary Treatment	$17.6	$17.6	$17.6
Ballasted Sedimentation	$0.0	$0.0	$0.0
MBR/UV Expansion	$0.0	$21.2	$21.2
CAS ABs	$0.0	$0.0	$4.4
CAS Secondary Clarifiers	$17.8	$17.8	$17.8
Tertiary Treatment	$0.0	$5.1	$5.1
Disinfection	$5.3	$5.3	$5.3
Intermediate/Effluent PS	$18.3	$18.3	$18.3
Process Support Facilities	$10.4	$17.4	$34.2
Yard/Site/Civil	$14.5	$17.8	$20.8
Landfill Remediation	$7.3	$7.3	$8.1
ELA (25%)	$26.2	$35.4	$41.6
Total	**$131.0**	**$176.8**	**$208.0**

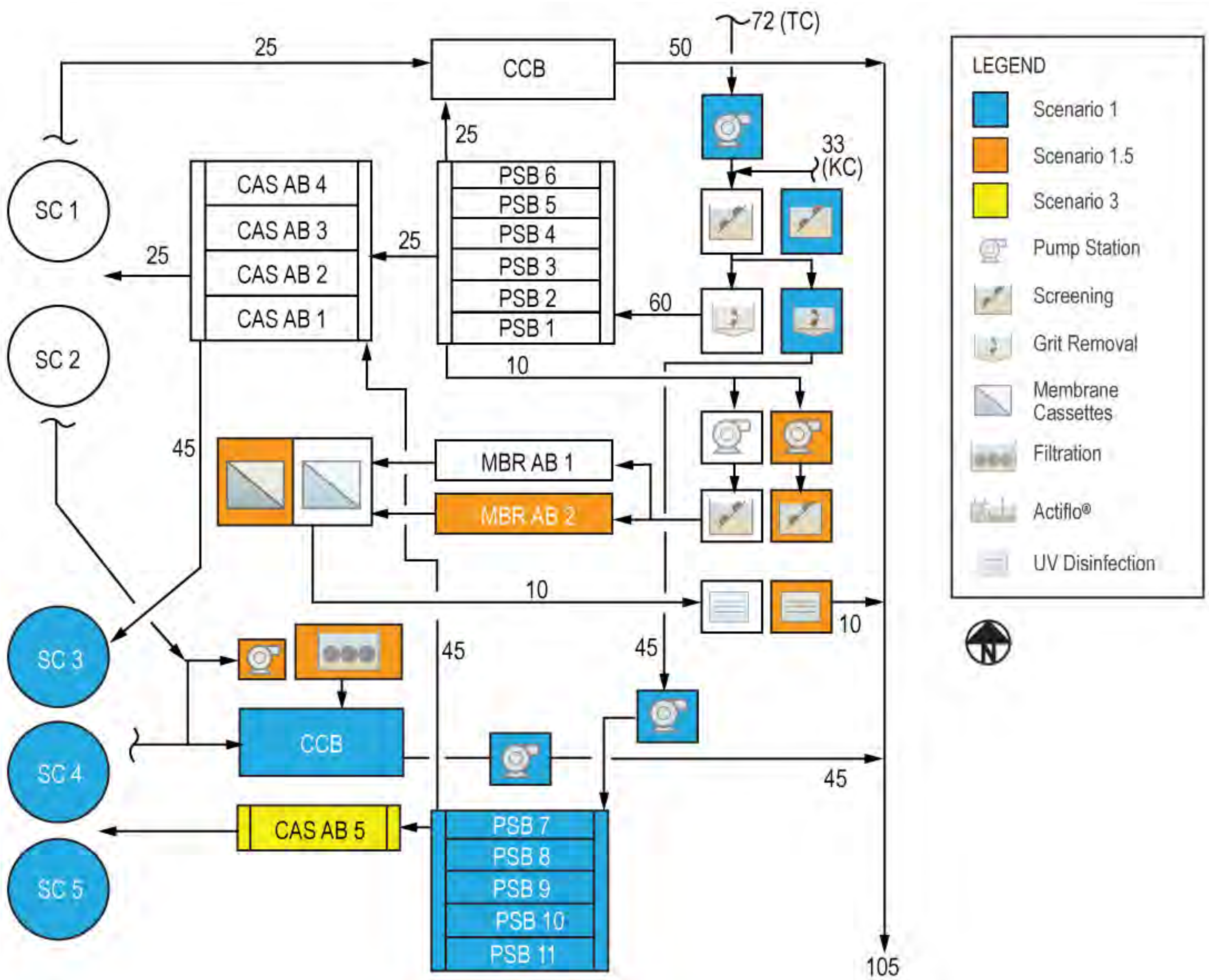


Figure 7.5 Tri-City WRRF Alternative 1 Schematic

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Non-cost considerations for Alternative 1 are summarized in Table 7.9 below.

Table 7.9 Alternative 1 Non-Cost Summary

Non-Cost Consideration	Summary
Protect Water Quality	Meets current and potential future NPDES limits.
Match Investment to Water Quality Benefit	Has a high estimated project cost but does provide a measurable difference in water quality (relative to the lowest cost alternative).
Consider Operational Impacts	Requires complex flow splitting/routing and the need to quickly bring biological processes into operation to treat intermittent peak flows.
Avoid Complex/Difficult Construction	Requires significant (costly and risky) interconnecting yard piping between existing North Plant and new South Plant facilities.
Minimize North/South Interties	Requires extensive North/South interties and (as a result) requires primary influent and final effluent pumping to meet future hydraulic profile conditions.
Plan for the Future	Reserves space to build future improvements for Scenarios 1.5, 3 under "Buildout" conditions.

7.4.2 Alternative 2

To reduce the flow splitting complexity of Alternative 1, Alternative 2 (shown in Figure 7.6) maximizes flow through the existing North Plant by building new primary clarifiers to the north. The balance of peak flow capacity is then provided through a new peak flow treatment facility (Actiflo®) constructed south of the existing MBR Train.

Alternative Description

Process improvements needed to increase peak hydraulic capacity (shown in blue on Figure 7.6) include:

- Improvements to increase influent pumping, screening, and grit removal capacity in the existing IPS and headworks.
- Two new PSBs to increase primary treatment capacity to 80 mgd. Due to space limitations, these clarifiers would be constructed in the footprint of the existing CCB, which would then need to be replaced with a new CCB located in the South Plant.
- A new Actiflo® process to treat the balance of peak flow (105 mgd – 80 mgd = 25 mgd).
- Three new secondary clarifiers to provide adequate secondary treatment capacity. Due to space limitations, these clarifiers would need to be constructed south of the existing MBR train, so approximately 60 percent of the mixed liquor during peak flows would be routed to these new clarifiers.
- A new CCB to replace the existing CCB, with capacity to disinfect up to 95 mgd.
- Because of the hydraulic connection between the existing CAS aeration basins and new secondary clarifiers, Alternative 1 also requires a new effluent pump station downstream of the new South Plant CCB.
- The area set aside for Tri-City WRRF expansion was formally home to a landfill. A line item for landfill remediation is required for each alternative that expands into this area and is a function of how much space is required within the landfill site.

Other improvements to achieve potential future nutrient limits in the regulatory dry weather season are also shown in Figure 7.6. Improvements shown in orange are associated with Scenario 1.5 and include:

- Improvements to the existing MBR Train, including primary effluent pumping, screening, a new aeration basin, and additional membrane cassettes.
- A tertiary pump station and chemical dosing to pump and condition secondary effluent upstream of the Actiflo® process, which would be operated in the dry weather season to remove phosphorous from a portion of the CAS secondary effluent.

Improvements shown in yellow are associated with Scenario 3 and include a new CAS aeration basin, and potentially the need for additional pumping capacity to convey primary effluent to a new South Plant CAS basin.

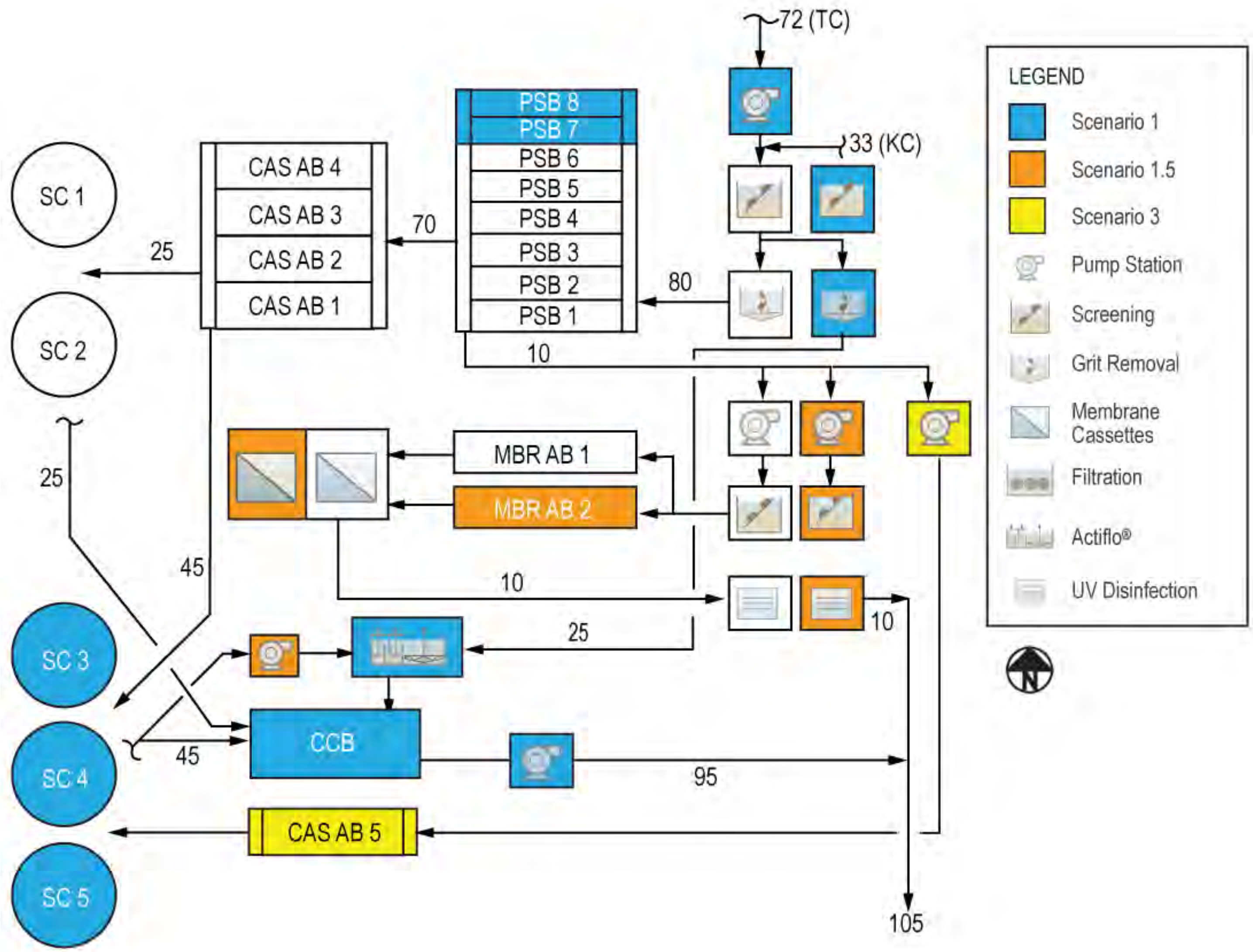


Figure 7.6 Tri-City WRRF Alternative 2 Schematic

For Alternative 2, the estimated capital cost to increase peak hydraulic capacity to meet existing NPDES permit limits (Scenario 1) is $115 million. Table 7.10 summarizes the major cost components of Alternative 2 for each of the three Basin-Wide Scenarios.

Table 7.10 Estimated Total Project Cost, Alternative 2

Component	Scenario 1	Scenario 1.5		Scenario 3
Preliminary Treatment	$13.6	$13.6		$13.6
Primary Treatment	$8.5	$8.5		$8.5
Ballasted Sedimentation	$6.1	$6.1		$6.1
MBR/UV Expansion	$0.0	$21.2		$21.2
CAS ABs	$0.0	$0.0		$4.4
CAS SCs	$17.8	$17.8		$17.8
Tertiary Treatment	$0.0	$0.0		$0.0
Disinfection	$11.2	$11.2		$11.2
Intermediate/Effluent PS	$12.2	$12.2		$16.6
Process Support Facilities	$9.6	$16.6		$33.3
Yard/Site/Civil	$11.8	$14.6		$18.3
Landfill Remediation	$1.4	$1.4		$1.6
ELA (25%)	$23.1	$30.9		$38.2
Total	**$115.3**	**$154.1**		**$191.0**

Non-cost considerations for Alternative 2 are summarized in Table 7.11 below.

Table 7.11 Alternative 2 Non-Cost Summary

Non-Cost Consideration	Summary
Protect Water Quality	Meets current and potential future NPDES limits.
Match Investment to Water Quality Benefit	Has a high estimated project cost but does provide a measurable difference in water quality (relative to the lowest cost alternative).
Consider Operational Impacts	Reduces flow splitting/routing complexity; reduces the need to quickly bring biological processes into operation to treat intermittent peak flows.
Avoid Complex/Difficult Construction	Requires costly and risky interconnecting yard piping between existing North Plant and new South Plant facilities.
Minimize North/South Interties	Requires North/South interties and (as a result) requires final effluent pumping to meet future hydraulic profile conditions.
Plan for the Future	Reserves space to build future improvements for Scenarios 1.5, 3 under "Buildout" conditions.

7.4.3 Alternative 3

Alternative 3 (shown in Figure 7.7) leaves the North Plant capacity at existing levels and increases overall peak flow capacity by: 1) increasing the capacity of the MBR Train to 20 mgd; and 2) installing 45 mgd of Actiflo® capacity in the South Plant. This alternative further reduces flow splitting complexity by eliminating the connection of the North Plant CAS train to new South Plant facilities under Scenario 1, although connections between North Plant SCs and South Plant tertiary (dry-weather Actiflo®) are required for Scenarios 1.5 and 3.

Alternative Description

Process improvements needed to increase peak hydraulic capacity (shown in blue on Figure 7.7) include:

- Improvements to increase influent pumping, screening, and grit removal capacity in the existing IPS and headworks.
- Improvements to the existing MBR Train, including primary effluent pumping, screening, a new aeration basin, and additional membrane cassettes.
- A new Actiflo® process to treat the balance of peak flow (105 mgd – 60 mgd = 45 mgd).
- A new CCB to disinfect Actiflo® effluent.
- The area set aside for Tri-City WRRF expansion was formally home to a landfill. A line item for landfill remediation is required for each alternative that expands into this area and is a function of how much space is required within the landfill site.

Other improvements to achieve potential future nutrient limits in the regulatory dry weather season (Scenarios 1.5 and 3) are also shown in Figure 7.7. Improvements shown in orange are associated with Scenario 1.5 and include a new SC, tertiary pump station, and chemical dosing to pump and condition secondary effluent upstream of the Actiflo® process, which would be operated in the dry weather season to remove phosphorous from a portion of the CAS secondary effluent.

Improvements shown in yellow are associated with Scenario 3 and include a new CAS aeration basin, and two additional secondary clarifiers. To function in this mode, a portion of the Actiflo® process would need to be operated to provide primary clarification upstream of the South Plant CAS process, which adds to the operational complexity of this alternative.

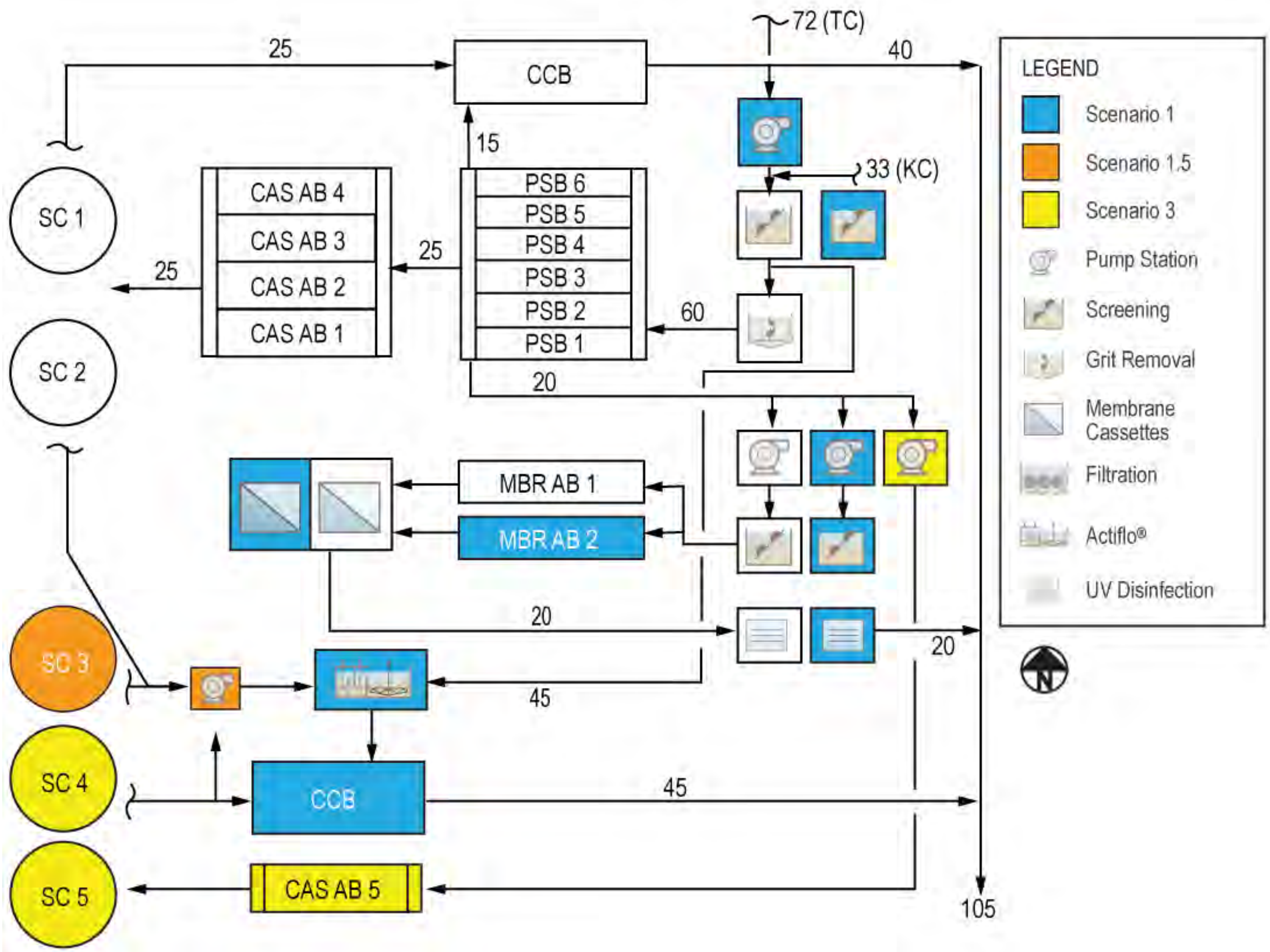


Figure 7.7 Tri-City WRRF Alternative 3 Schematic

For Alternative 3, the estimated capital cost to increase peak hydraulic capacity to meet existing NPDES permit limits (Scenario 1) is $66 million. Table 7.12 summarizes the major cost components of Alternative 3 for each of the three Basin-Wide Scenarios.

Table 7.12 Estimated Total Project Cost, Alternative 3

Component	Scenario 1	Scenario 1.5	Scenario 3
Preliminary Treatment	$5.1	$5.1	$5.1
Primary Treatment	$0.0	$0.0	$0.0
Ballasted Sedimentation	$9.8	$9.8	$9.8
MBR/UV Expansion	$21.2	$21.2	$21.2
CAS ABs	$0.0	$0.0	$8.9
CAS SCs	$0.0	$5.9	$17.8
Tertiary Treatment	$0.0	$0.0	$0.0
Disinfection	$4.6	$4.6	$4.6
Intermediate/Effluent PS	$0.0	$5.0	$9.5
Process Support Facilities	$3.4	$10.4	$32.3
Yard/Site/Civil	$8.4	$10.2	$16.2
Landfill Remediation	$0.2	$0.4	$2.2
ELA (25%)	$13.2	$18.4	$31.9
Total	**$66.0**	**$25.0**	**$159.7**

Non-cost considerations for Alternative 3 are summarized in Table 7.13 below.

Table 7.13 Alternative 3 Non-Cost Summary

Non-Cost Consideration	Summary
Protect Water Quality	Meets current and potential future NPDES limits.
Match Investment to Water Quality Benefit	Has a lower estimated project cost and increases production of membrane quality effluent, but at a significantly increased annual O&M cost.
Consider Operational Impacts	Reduces flow splitting/routing complexity but increases the peak flow requirements of the MBR process (not well suited for treating peak flow).
Avoid Complex/Difficult Construction	Reduces the need for costly and risky interconnecting yard piping between existing North Plant and new South Plant facilities.
Minimize North/South Interties	Requires North/South interties but eliminates the need for a final effluent pumping to meet future hydraulic profile conditions.
Plan for the Future	Reserves space to build future improvements for Scenarios 1.5, 3 under "Buildout" conditions.

7.4.4 Alternative 4

Alternative 4 (shown in Figure 7.8) leaves the North Plant and MBR Train capacity at existing levels and increases overall peak flow capacity by installing new CAS capacity in the South Plant. This alternative has a similar level of flow splitting complexity to Alternative 3, and also retains the need to connect North Plant SCs to South Plant tertiary (dry-weather Actiflo®) facilities for Scenarios 1.5 and 3.

Alternative Description

Process improvements needed to increase peak hydraulic capacity (shown in blue on Figure 7.8) include:

- Improvements to increase screening and grit removal capacity in a new headworks constructed to the south.
- Five new PSBs to increase primary treatment capacity to 105 mgd. Due to space limitations, these clarifiers would need to be constructed south of the existing MBR train. Approximately 17 percent of the de-gritted North Plant primary influent during peak flows would be routed to these new PSBs, which would treat 100 percent of the flow transferred from the Kellogg Creek WRRF during peak flow events.
- Due to headloss in the existing and future piping, a new Primary Effluent Pump Station would be needed to pump degritted primary effluent from the North Plant into the new South Plant PSBs.
- Two new CAS aeration basins and three new SCs to treat South Plant primary effluent.
- A new CCB to disinfect effluent from the new South Plant secondary clarifiers.
- The area set aside for Tri-City WRRF expansion was formally home to a landfill. A line item for landfill remediation is required for each alternative that expands into this area and is a function of how much space is required within the landfill site.

Other improvements to achieve potential future nutrient limits in the regulatory dry weather season are also shown in Figure 7.8. Improvements shown in orange are associated with Scenario 1.5 and include a pump station, chemical dosing, and filters to remove phosphorous from a portion of the CAS secondary effluent.

Improvements shown in yellow are associated with Scenario 3 and include MBR Train modifications (primary effluent pumping, screening, a new aeration basin, and additional membrane cassettes).

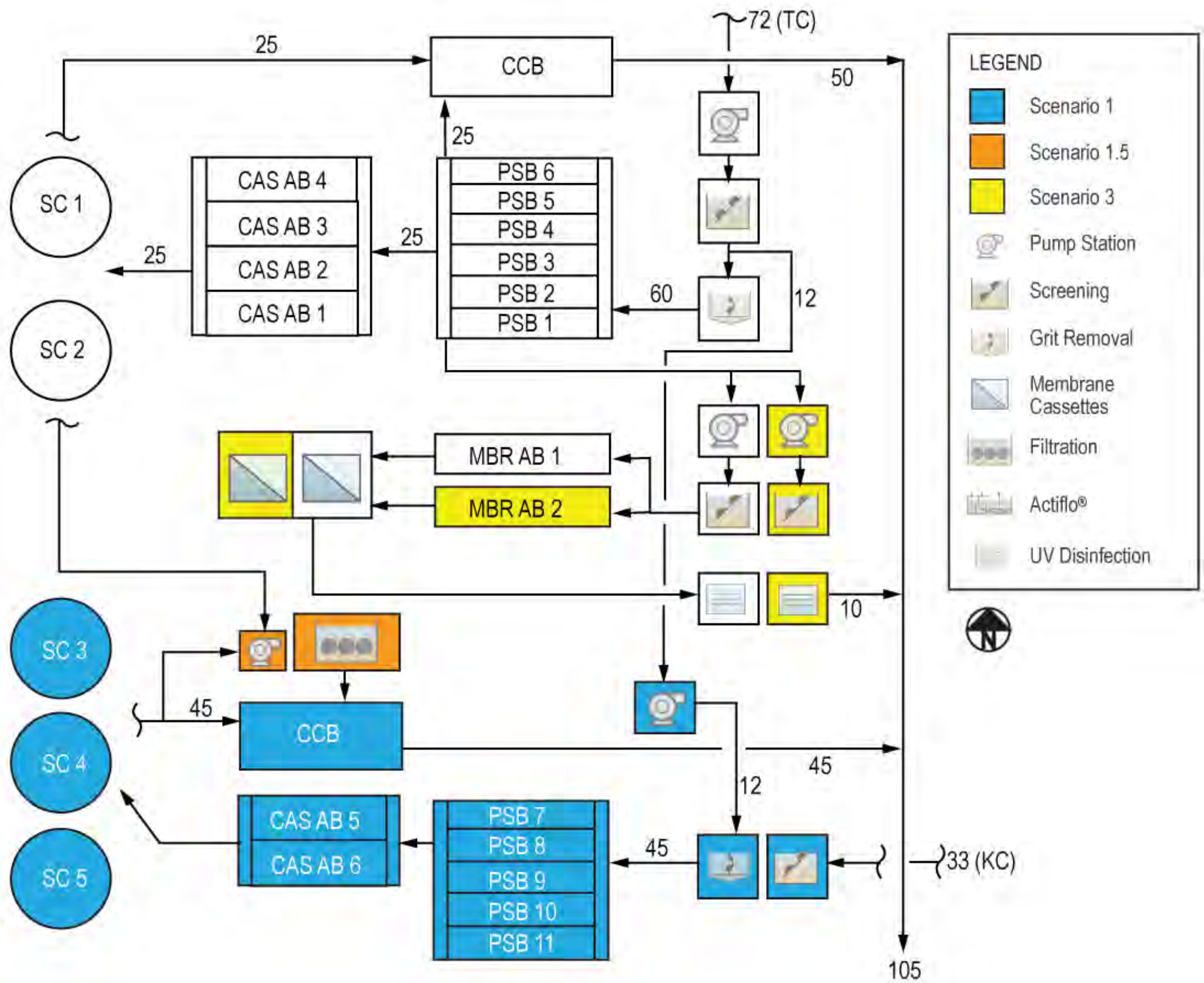


Figure 7.8 Tri-City WRRF Alternative 4 Schematic

For Alternative 4, the estimated capital cost to increase peak hydraulic capacity to meet existing NPDES permit limits (Scenario 1) is $137 million. Table 7.14 summarizes the major cost components of Alternative 4 for each of the three Basin-Wide Scenarios.

Table 7.14 Estimated Total Project Cost, Alternative 4

Component	Scenario 1	Scenario 1.5	Scenario 3
Preliminary Treatment	$20.4	$20.4	$20.4
Primary Treatment	$17.6	$17.6	$17.6
Ballasted Sedimentation	$0.0	$0.0	$0.0
MBR/UV Expansion	$0.0	$0.0	$21.2
CAS ABs	$8.9	$8.9	$8.9
CAS SCs	$17.8	$17.8	$17.8
Tertiary Treatment	$0.0	$5.1	$5.1
Disinfection	$4.6	$4.6	$4.6
Intermediate/Effluent PS	$4.5	$9.5	$9.5
Process Support Facilities	$17.1	$24.1	$32.5
Yard/Site/Civil	$12.0	$13.7	$16.6
Landfill Remediation	$6.7	$6.7	$6.7
ELA (25%)	$27.4	$32.1	$40.2
Total	**$136.9**	**$160.5**	**$201.2**

Non-cost considerations for Alternative 4 are summarized in Table 7.15 below.

Table 7.15 Alternative 4 Non-Cost Summary

Non-Cost Consideration	Summary
Protect Water Quality	Meets current and potential future NPDES limits.
Match Investment to Water Quality Benefit	Has the highest estimated project cost but does provide a measurable difference in water quality (relative to the lowest cost alternative).
Consider Operational Impacts	Reduces flow splitting/routing complexity but maximizes the need to quickly bring biological processes into operation to treat intermittent peak flows.
Avoid Complex/Difficult Construction	Reduces the need for costly and risky interconnecting yard piping between existing North Plant and new South Plant facilities.
Minimize North/South Interties	Requires North/South interties but eliminates the need for a final effluent pumping to meet future hydraulic profile conditions.
Plan for the Future	Reserves space to build future improvements for Scenarios 1.5, 3 under "Buildout" conditions.

7.4.5 Alternative 5

Alternative 5 (shown in Figure 7.9) leaves the North Plant and MBR Train capacity at existing levels and increases overall peak flow capacity by installing new Actiflo® capacity in the South Plant. This alternative has a similar level of flow splitting complexity to Alternative 4, and also retains the need to connect North Plant SCs to South Plant tertiary (dry-weather Actiflo®) facilities for Scenarios 1.5 and 3.

Alternative Description

Process improvements needed to increase peak hydraulic capacity (shown in blue on Figure 7.9) include:

- Improvements to increase screening in a new headworks constructed to the south.
- A new Actiflo® process to treat the balance of peak flow (105 mgd – 60 mgd = 45 mgd).
- A new CCB to disinfect effluent from the new South Plant secondary clarifiers.
- The area set aside for Tri-City WRRF expansion was formally home to a landfill. A line item for landfill remediation is required for each alternative that expands into this area and is a function of how much space is required within the landfill site.

Other improvements to achieve potential future nutrient limits in the regulatory dry weather season are also shown in Figure 7.9. Improvements shown in orange are associated with Scenario 1.5 and include:

- Improvements to the existing MBR Train, including primary effluent pumping, screening, a new aeration basin, and additional membrane cassettes.
- A tertiary pump station and chemical dosing to pump and condition secondary effluent upstream of the high-rate clarification (HRC) process, which would be operated in the dry weather season to remove phosphorous from a portion of the CAS secondary effluent.

Improvements shown in yellow are associated with Scenario 3 and include degritting improvements in the new South Plant headworks, two new PSBs, two new CAS aeration basin, and two additional secondary clarifiers.

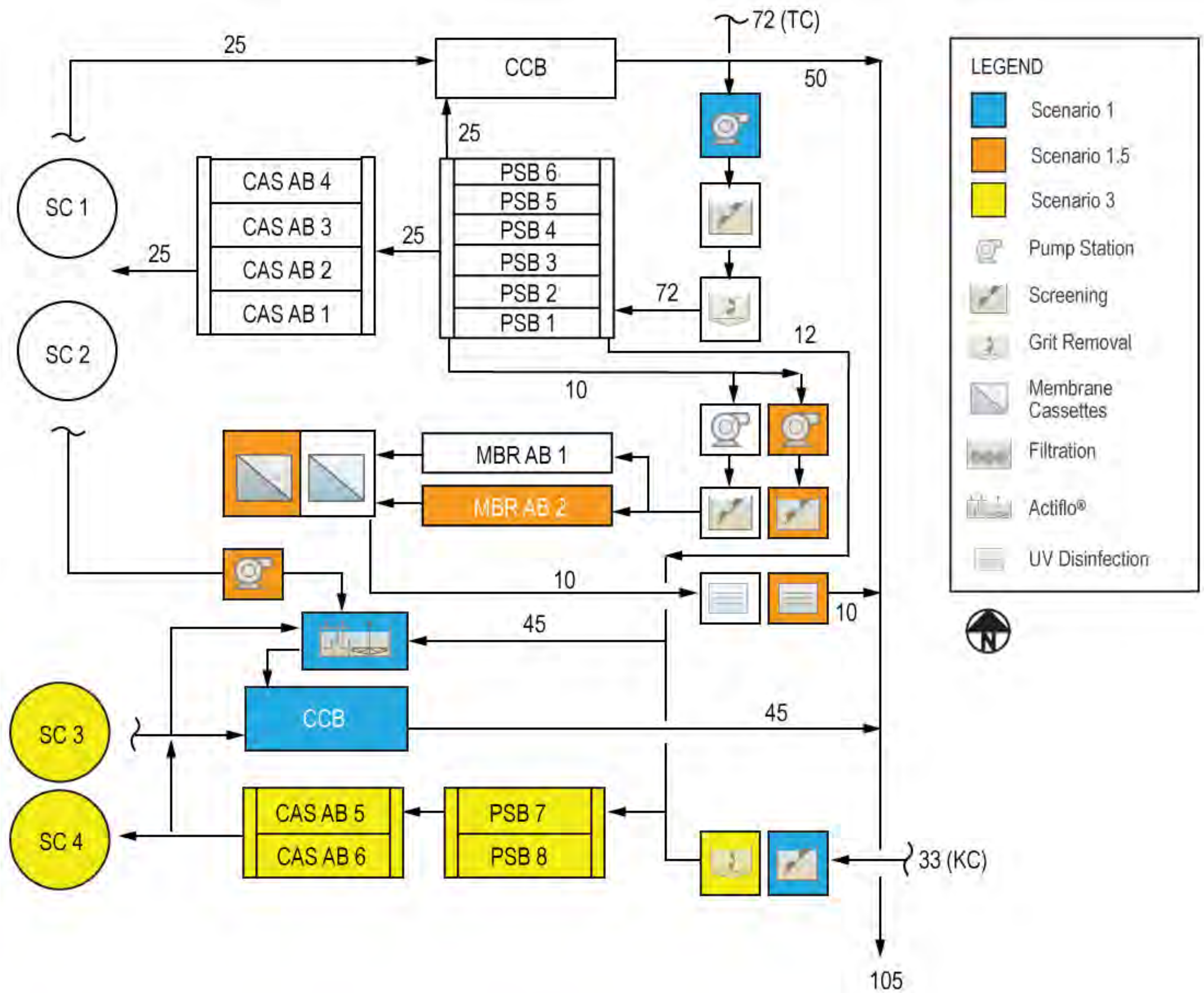


Figure 7.9 Tri-City WRRF Alternative 5 Schematic

For Alternative 5, the estimated capital cost to increase peak hydraulic capacity to meet existing NPDES permit limits (Scenario 1) is $49.4 million. Table 7.16 summarizes the major cost components of Alternative 4 for each of the three Basin-Wide Scenarios.

Table 7.16 Estimated Total Project Cost, Alternative 5

Component	Scenario 1	Scenario 1.5	Scenario 3
Preliminary Treatment	$14.7	$14.7	$20.8
Primary Treatment	$0.0	$0.0	$7.0
Ballasted Sedimentation	$9.8	$9.8	$9.8
MBR/UV Expansion	$0.0	$21.2	$21.2
CAS ABs	$0.0	$0.0	$8.9
CAS SCs	$0.0	$0.0	$11.9
Tertiary Treatment	$0.0	$0.0	$0.0
Disinfection	$4.6	$4.6	$4.6
Intermediate/Effluent PS	$0.0	$5.0	$5.0
Process Support Facilities	$3.6	$10.6	$32.8
Yard/Site/Civil	$6.7	$10.6	$17.7
Landfill Remediation	$0.2	$0.0	$1.7
ELA (25%)	$9.9	$19.2	$35.4
Total	**$49.4**	**$95.8**	**$176.9**

Non-cost considerations for Alternative 5 are summarized in Table 7.17 below.

Table 7.17 Alternative 5 Non-Cost Summary

Non-Cost Consideration	Summary
Protect Water Quality	Meets current and potential future NPDES limits.
Match Investment to Water Quality Benefit	Has the lowest estimated project cost and protects Willamette River water quality.
Consider Operational Impacts	Reduces flow splitting/routing complexity and eliminates the need to quickly bring biological processes into operation to treat intermittent peak flows.
Avoid Complex/Difficult Construction	Reduces the need for costly and risky interconnecting yard piping between existing North Plant and new South Plant facilities.
Minimize North/South Interties	Requires North/South interties but eliminates the need for a final effluent pumping to meet future hydraulic profile conditions.
Plan for the Future	Reserves space to build future improvements for Scenarios 1.5, 3 under "Buildout" conditions.

7.4.6 Summary of Preliminary Alternatives

The Tri-City improvements alternatives presented in this chapter were primarily evaluated based on their to increase peak hydraulic capacity to 105 mgd under existing NPDES permit conditions (Scenario 1), considering both cost and non-cost factors. Figure 7.10 summarizes the estimated project cost of five Tri-City WRRF improvement alternatives. While each of the five alternatives achieve the technical and performance criteria to add capacity and meet NPDES permit limits, the estimated total project cost to increase peak hydraulic capacity, represented by the blue bar in the figure, is significantly lower for Alternative 5. The estimated total project cost of Alternative 5 to meet potential future NPDES limits on nutrients (associated with Scenarios 1.5 and 3) is lower than several other alternatives and is within approximately 11 percent of the lowest cost alternative (Alternative 3) considering these scenarios.

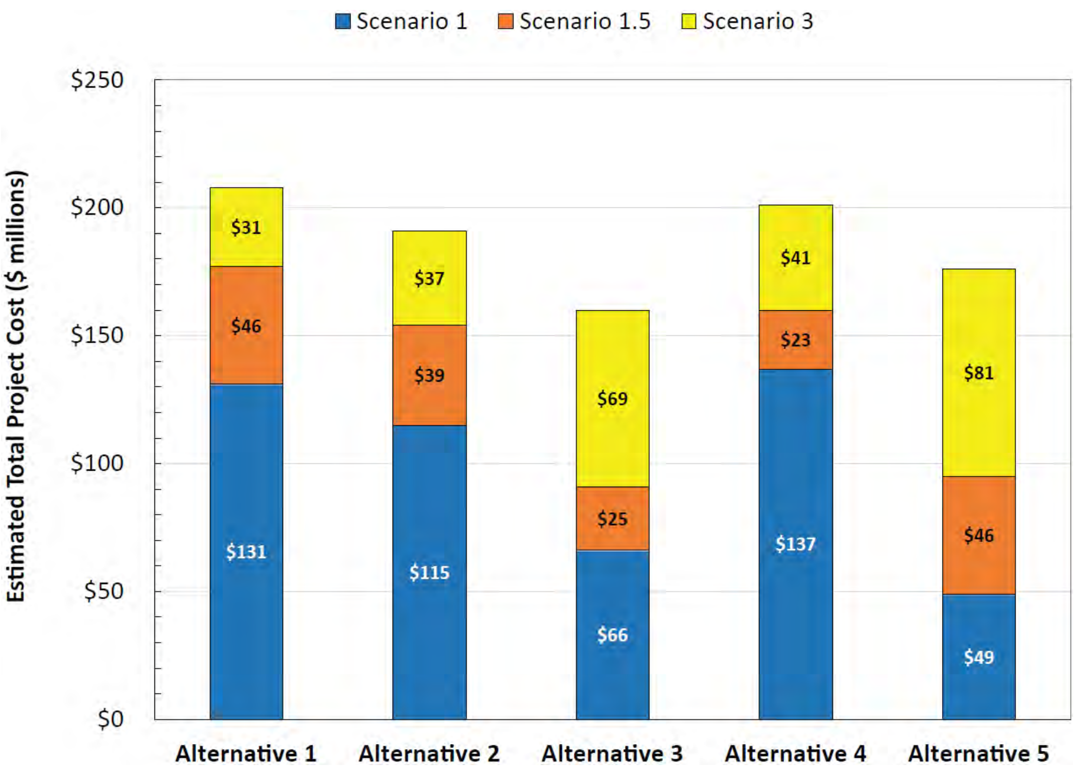


Figure 7.10 Tri-City WRRF Alternative Total Project Cost Summary

Table 7.18 summarizes the non-cost considerations for each alternative. As shown in the table, Alternative 5 best addresses the non-cost considerations used for the analysis of alternatives.

Table 7.18 Summary of Non-Cost Considerations

Alternative	Water Quality	Benefit to Investment	Operational Complexity	Construction Complexity	Minimal Interties	Plan for Future
1	+	-	-	-	-	+
2	+	-	-	-	0	+
3	+	0	-	+	0	+
4	+	-	-	-	0	+
5	+	+	+	+	0	+

Legend:
+ = positive 0 = neutral - = negative

Alternative 5 (Actiflo®) is the recommended alternative to increase the peak hydraulic capacity of the Tri-City WRRF. Refinements to the recommended alternative, including a summary of water quality modeling demonstrating that the alternative will protect water quality, are provided in the following section.

7.5 Liquid Stream Recommended Plan Refinement

Process design criteria presented in Section 7.3 provide the information needed to size the process components associated with the recommended alternative. Additional development of this alternative was completed to refine the regulatory considerations, site plan, and hydraulic profile.

7.5.1 NPDES Permit Considerations

Chapter 4 summarizes existing and anticipated NPDES limits for the Tri-City WRRF. For Scenario 1 the existing concentration limits and other effluent parameters (e.g., disinfection limits, chlorine residual, pH, and removal efficiencies) are not expected to change. However, Chapter 4 notes that the mass load limits must be assessed and increased, with the calculation based on the *"proposed treatment facility capabilities and the highest and best practicable treatment to minimize the discharge of pollutants."*

WES performed water quality modeling to determine the potential impact of increasing BOD and ammonia mass load discharges, which will result from growth in the Tri-City service area and increases in the flow being transferred from the Kellogg Creek service area over the planning period. The mass loads used in the modeling are based on the recommended alternative, with the Actiflo® process operated to treat peak flows that exceed existing secondary capacity (35 mgd), and the existing Select Treat process used to treat the balance of peak flows up to 105 mgd. Table 7.19 reflects the flow split under this 2040 PHF. The corresponding daily, weekly, and monthly averages that result are indicative of this flow split and consistent with the definition of "*the highest and best practicable treatment to minimize the discharge of pollutants* "

It is important to note that, the percentage of flow through select treat drops from its existing level (50 percent) to approximately 25 percent by implementing the recommended alternative. Based on the projected flow probability, the frequency of select treat use will decline from current levels (approximately 36 hours per year) to approximately 4 hours per year.

Although the Actiflo®® process will only be called on to operate during peak conditions, water quality modeling was completed for the calculated maximum week wet weather flow (MWWWF) load condition, as this was determined to be the most conservative condition from a water quality standpoint. The results of the water quality modeling provided to DEQ demonstrate that there is no measurable impact associated with the increased mass load.

Table 7.19 Process Flow Split for Mass Load Calculations

Unit Process	PHF (105 mgd)	PDF (80.5 mgd)	MWWWF(1) (53.1 mgd)	MMWWF (29.6 mgd)
Existing CAS	23.8%	31.1%	46.0%	59.6%
Actiflo®Actiflo®	42.8%	45.7%	33.6%	16.2%
Existing ST	23.8%	10.8%	2.0%	0%

Notes:
(1) Water quality modeling completed for this flow condition.

7.5.2 Disinfection Approach

As noted in Chapter 5, the capacity of the existing disinfection system (65 mgd) will be exceeded within the planning period. Given this, and the fact that the recommended Tri-City alternative provides for treatment capacity of peak flows to the south, the recommended alternative would include a 45 mgd disinfection process to treat Actiflo® effluent.

Chlorine and UV disinfection were evaluated as alternatives and presented to WES during a June 14, 2021, workshop. Chlorine is the recommended disinfection approach based on cost and non-cost considerations. Key considerations supporting this recommendation include:

- Both chlorine disinfection and UV fit well on the site for 2040 and buildout flow conditions.
- The estimated total project cost is higher for chlorination (approximately $9.0M) than for UV ($7.6M). However, the estimated NPV of annual O&M cost for Scenario 1 (2040 flows and loads) is lower for chlorination (approximately $660,000) than it is for UV (approximately $1.5M). As a result, the total estimated NPV of the two disinfection options is effectively the same, under Scenario 1 conditions.
- The headloss for chlorine disinfection is lower than for UV, which is a significant advantage considering the need to connect the existing North Plant (at a fixed hydraulic elevation) to the new South Plant peak flow processes.
- Due to the intermittent use of this facility, chlorination is also favored over UV from an O&M standpoint.

7.5.3 Flow Schematic and Project Components

A process flow schematic for the recommended plan is presented in Figure 7.11. The schematic includes the following components:

- Influent Pump Station Modifications. Flow from the Tri-City service area arrives by gravity and must be pumped. The current PHF entering the IPS from the Tri-City service areas is estimated at approximately 62 mgd. By 2040, PHF from the Tri-City service area will increase to approximately 72 mgd. The firm capacity of the existing IPS must therefore be increased from its current firm capacity (50 mgd) to 72 mgd. These improvements can be made within the existing IPS structure; however, modeling should be performed to confirm adequate wet well and inlet conditions for the selected pumps. Additional improvements to the mechanical, electrical, and instrumentation components are also required.
- Flow Diversion from Existing PSBs to Actiflo®. Flow would be routed from the existing PSB influent channel to the new Actiflo® process to the south. A preliminary alignment through the existing MBR utility tunnel was identified during planning and should be verified during preliminary design. A new flow meter and control valve would be required to control this flow up to approximately 20 mgd.
- Influent Screening. A new bar screen facility is required to screen up to 33 mgd of flow transferred from the Kellogg Creek service area.
- Ballasted Sedimentation (Actiflo®). A new Actiflo® process with chemical storage and feed, is needed to treat up to 45 mgd.
- Disinfection Facilities. A new CCB and chemical storage facilities are needed for chlorination and de-chlorination of up to 45 mgd.

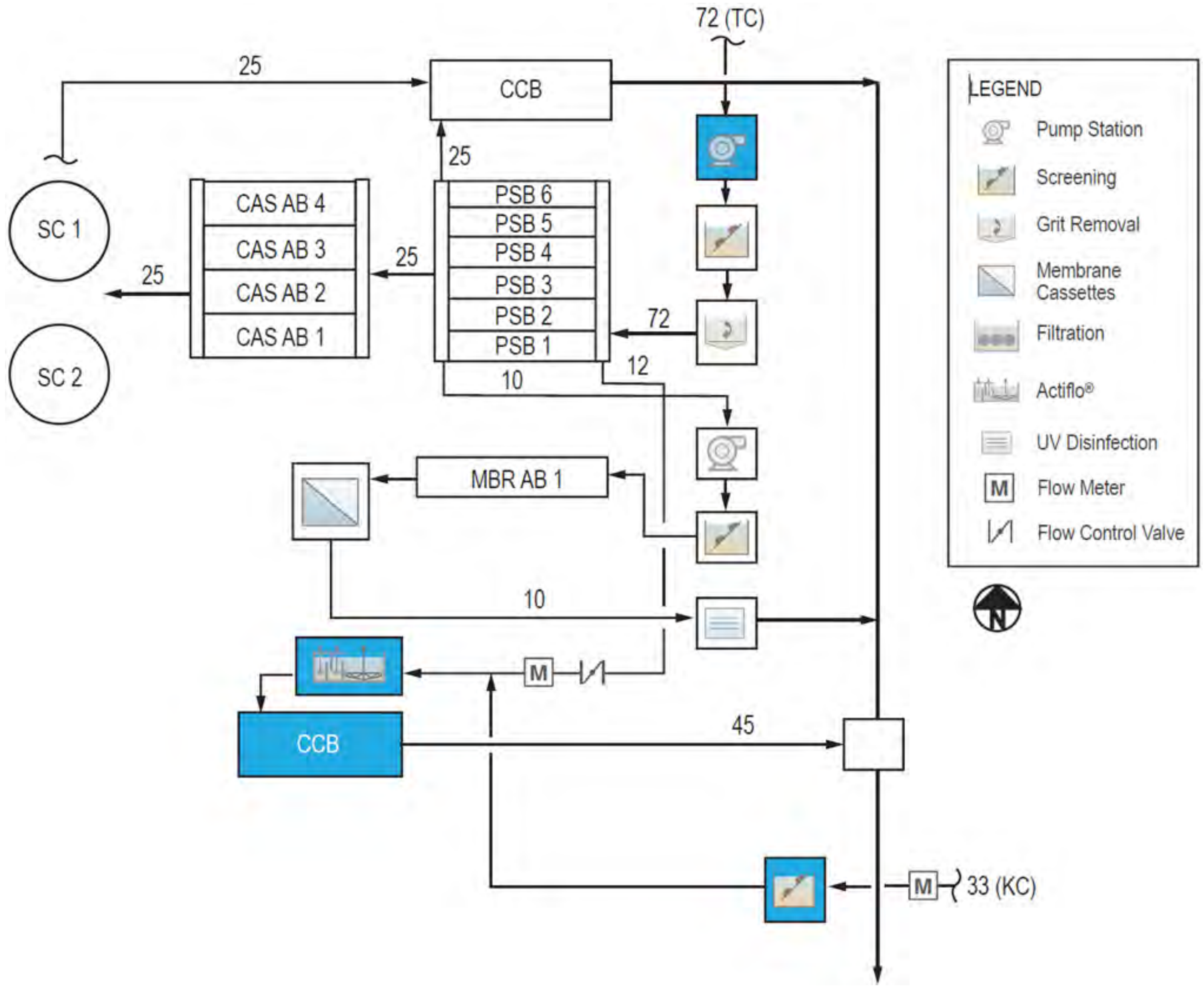


Figure 7.11 Tri-City WRRF Recommended Alternative Scenario 1 Process Schematic

A process flow schematic for the recommended alternative showing facilities for Scenario 1.5, Scenario 3, and Buildout is presented in Figure 7.12. The number of unit processes for the Buildout condition is based on Scenario 3 assumptions for NPDES permit limits – the most conservative scenario evaluated.

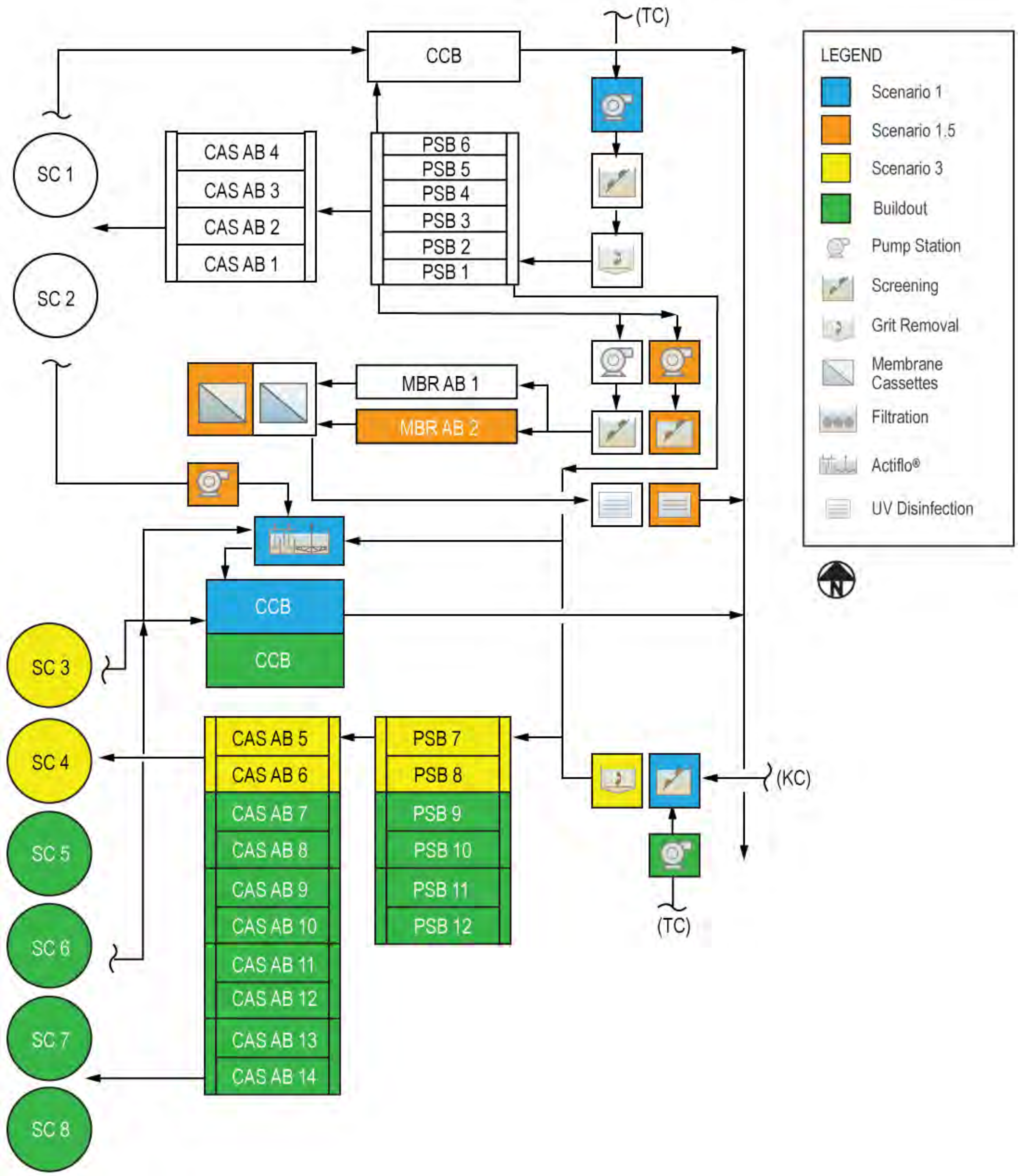


Figure 7.12 Tri-City WRRF Recommended Alternative Buildout Process Schematic

7.5.4 Site Plan

The proposed site plan for the recommended alternative is presented in Figure 7.13. Facilities needed for Scenario 1, Scenario 1.5, Scenario 3, and Buildout are shown.

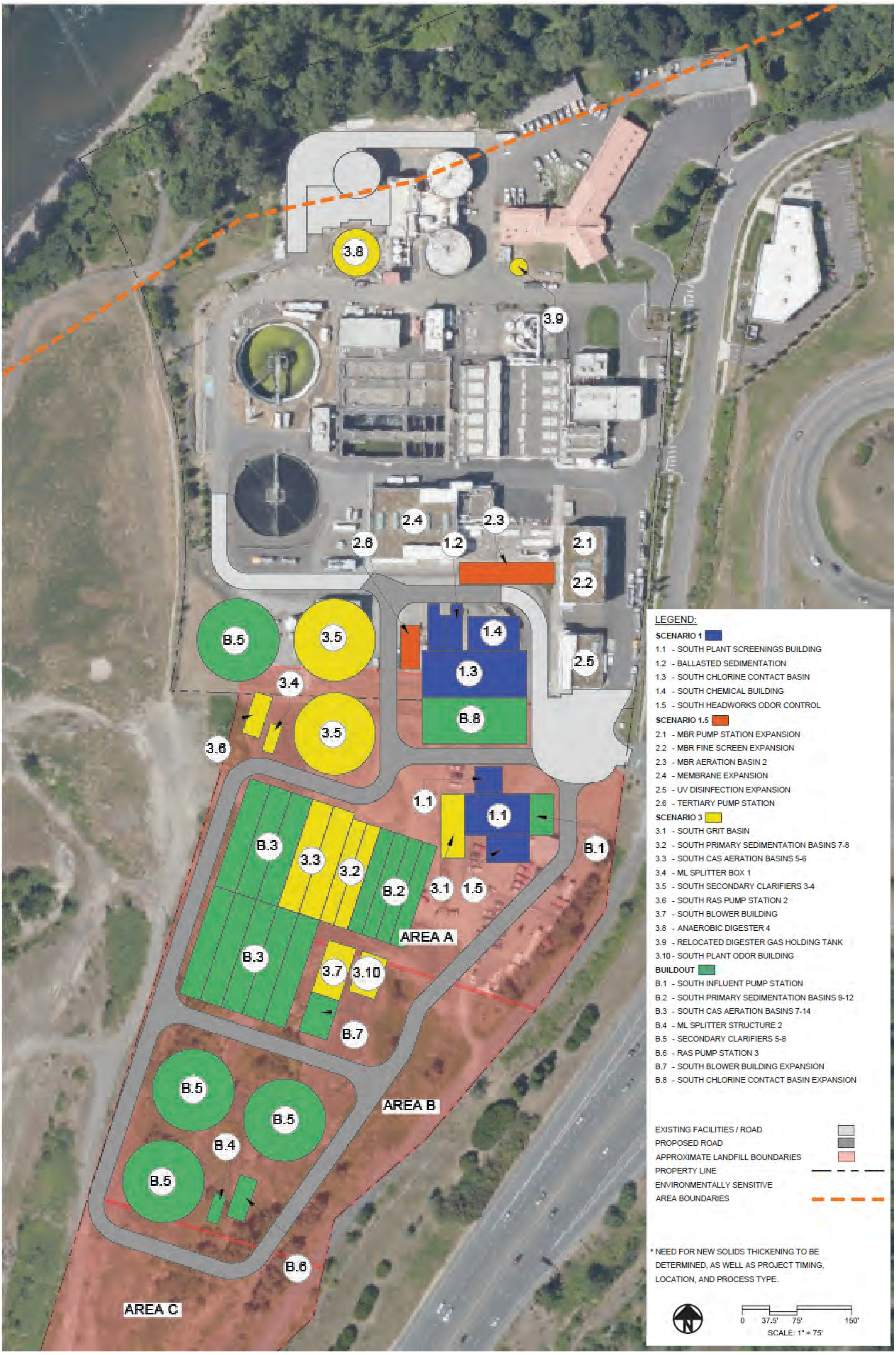


Figure 7.13 Tri-City WRRF Recommended Alternative Buildout Site Plan

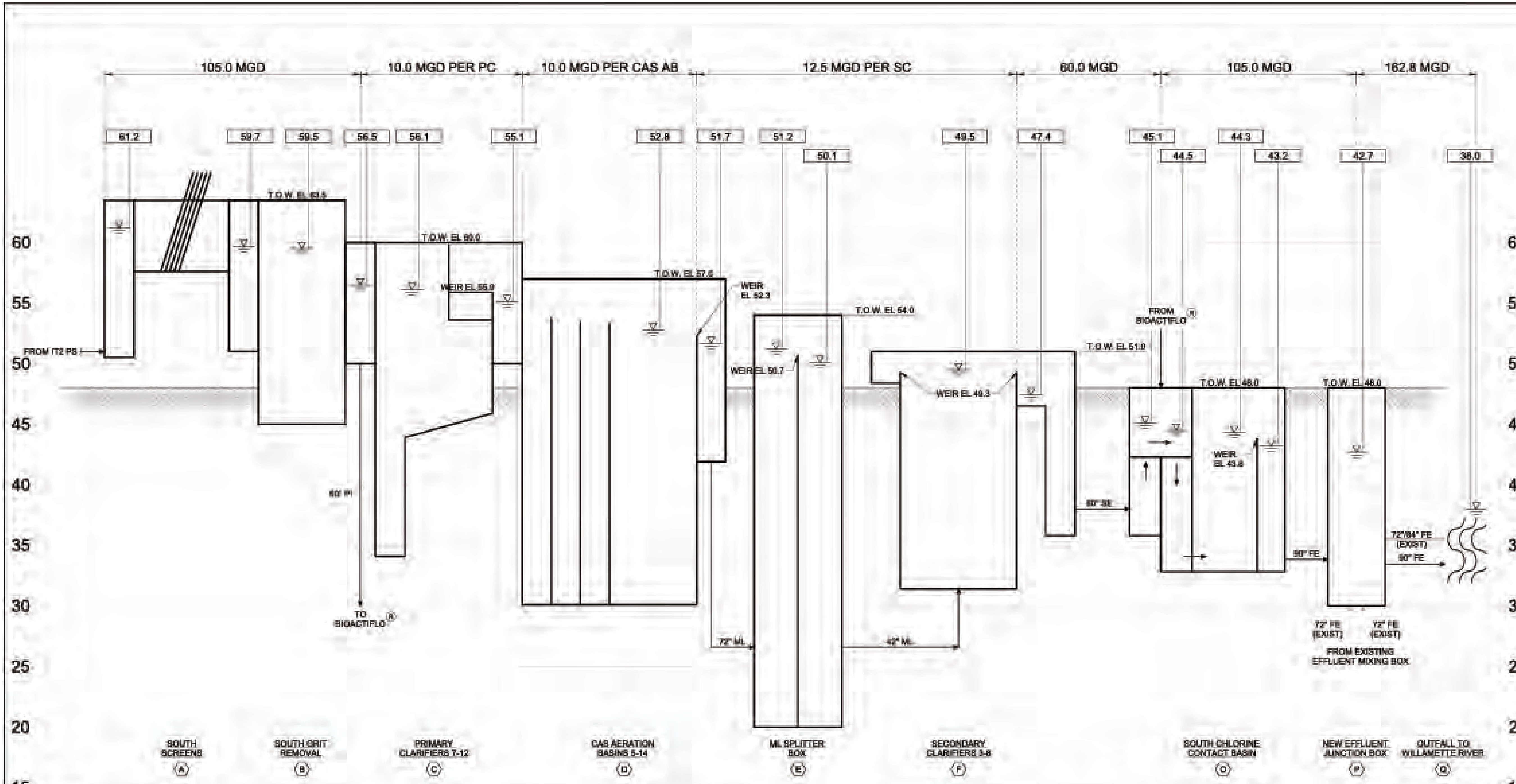
7.5.5 Hydraulic Profile

The planning team established the hydraulic profile for the proposed improvements to the Tri-City WRRF, with the goal of maximizing gravity flow through all new South Plant processes. The steps required to achieve this are described below.

Step 1: Set the hydraulic profile of new South Plant processes to allow gravity discharge for Buildout Conditions. Figure 7.14 illustrates the hydraulic profile through new South Plant improvements under Buildout conditions. The controlling downstream water surface elevation (WSE) is an effluent junction box that will tie into new and existing outfall pipes that convey treated effluent to the Willamette River outfalls. Under Buildout PHF conditions and at the 25-year flood elevation, this WSE is 42.7. Providing adequate capacity for each unit process between the future bar screens and this structure require the future bar screen WSE to be 61.2.

Step 2: Determine the gravity transfer flow capacity between North Plant and the South Plant. Figure 7.15 illustrates the hydraulic profile between the existing North Plant and new South Plant improvements. The controlling downstream WSE is in the South Plant CCB, and was established during Step 1 at 45.1. The WSE in the existing North Plant PSBs (the most likely location to divert flow to the South Plant) is approximately 50.5. This provides approximately five feet of driving head to convey flow from the North Plant PSBs to the Actiflo® process. Hydraulic modeling shows approximately 20 mgd could be conveyed by gravity under these conditions. However, if the transfer flow must first pass through an aeration basin, the driving head is reduced to the point that a pump station between the North Plant PSBs and the aeration basin is needed. An intermediate pump station may be desirable to increase operations and maintenance flexibility and is shown Figure 7.15 for reference.

Step 3: Confirm future dry-weather tertiary capacity. Under Scenario 1.5 and 3, a portion of the future secondary effluent must be treated through the Actiflo® process operating in a tertiary mode to remove phosphorous. Figure 7.16 shows the hydraulic profile under Buildout PDDWF conditions. The figure demonstrates that the WSE in future South Plant secondary clarifiers must be set at approximately 49.5 to allow for dry weather gravity flow through the tertiary Actiflo®.



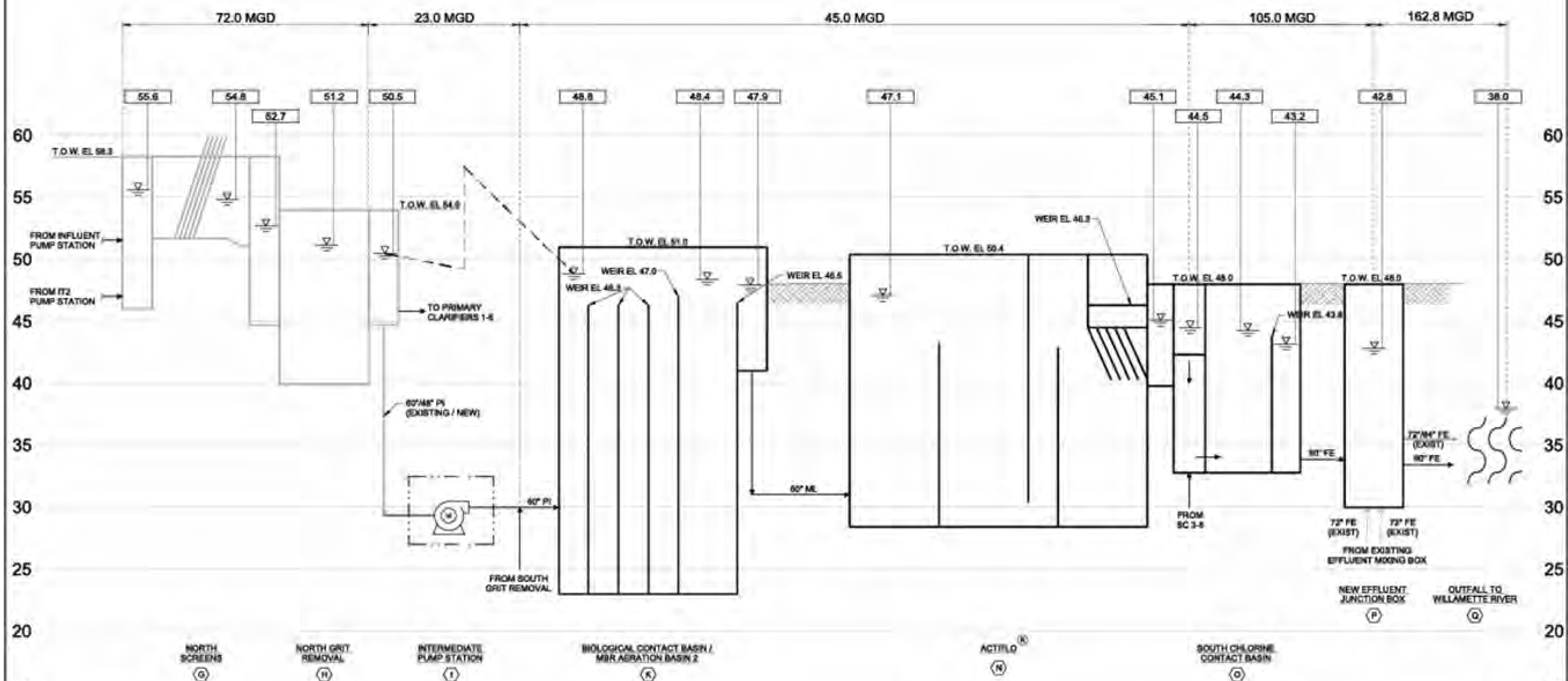
NOTES:

1. CAS AERATION BASINS, ML SPLITTER BOXES, AND SECONDARY CLARIFIERS ARE ALL ASSUMED TO INCLUDE RAS FLOW EQUAL TO 50 PERCENT OF THE INDICATED INFLUENT FLOW.
2. CAS AERATION BASINS ARE ASSUMED TO INCLUDE MIXED LIQUOR RECYCLE FLOW EQUAL TO 400 PERCENT OF THE INDICATED INFLUENT FLOW.
3. THE HYDRAULIC PROFILE ASSUMES A MAXIMUM FLOW RATE OF 10 MGD THROUGH EACH AERATION BASIN, NOT THE OVERALL BUILDOUT PHF DISTRIBUTED AMONG AERATION BASINS 5-14. UNDER SCENARIO 3 IN 2040, CAS AERATION BASINS 5 AND 6 WILL RECEIVE 10 MGD EACH, RESULTING IN A HIGHER UPSTREAM WSE THAN UNDER THE BUILDOUT PHF, IN WHICH EACH CAS AERATION BASIN ONLY RECEIVES 8 MGD OF PRIMARY EFFLUENT.
4. THE HYDRAULIC PROFILE ASSUMES A MAXIMUM FLOW RATE OF 12.5 MGD THROUGH EACH CLARIFIER (AND, SUBSEQUENTLY, 37.5 MGD THROUGH THE MIXED LIQUOR SPLITTER BOX), NOT THE OVERALL BUILDOUT PHF DISTRIBUTED AMONG SECONDARY CLARIFIERS 3-8. IT IS ASSUMED THAT EACH CLARIFIER HAS CAPACITY TO PRODUCE 12.5 MGD OF CLARIFIED EFFLUENT, AND THAT A NEW CLARIFIER WOULD ONLY BE CONSTRUCTED ONCE THIS HYDRAULIC LIMIT IS REACHED. THIS ASSUMPTION RESULTS IN A HIGHER UPSTREAM WSE THAN UNDER THE BUILDOUT PHF, IN WHICH EACH SECONDARY CLARIFIER ONLY PRODUCES 10 MGD OF CLARIFIED EFFLUENT.
5. THE DOWNSTREAM WATER SURFACE ELEVATION, INTERPOLATED FROM A JA NUARY 2019 CLACKAMAS COUNTY FLOOD INSURANCE COMPANY.
6. ALL ELEVATIONS IN THIS HYDRAULIC PROFILE ARE SHOWN ACCORDING TO THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD 29).

LEGEND:

- XX.X — HYDRAULIC GRADE AT BUILDOUT PEAK DAY DRY WEATHER FLOW (PDDWF), UNLESS NOTED OTHERWISE
- (X) — PROCESS IDENTIFICATION TAG (CORRESPONDS TO ALTERNATIVE 5 SCHEMATIC IN FIGURE X)
- FINISHED GRADE
- XX.X — OVERALL PROCESS FLOW AT BUILDOUT PEAK DAY DRY WEATHER FLOW (PDDWF), OR INDIVIDUAL PROCESS FLOW WHERE INDICATED

Figure 7.14 Tri-City WRRF Recommended Alternative South Plant Hydraulic Profile



NOTES:

1. INTERMEDIATE PUMP STATION ADDED TO ALLOW OPERATIONS TO MAXIMIZE FLOWS THROUGH THE PROCESS AND TO PROVIDE OPERATIONAL FLEXIBILITY.
2. WATER SURFACE ELEVATION DOWNSTREAM OF NORTH GRIT REMOVAL BASED ON THE CALCULATED HYDRAULIC GRADE UPSTREAM OF PRIMARY CLARIFIERS 1-6 (NOT SHOWN). THIS HYDRAULIC GRADE ASSUMES THE PRIMARY EFFLUENT WEIRS ARE UNSUBMERGED AND THAT ALL SIX OF THESE PRIMARY CLARIFIERS ARE ONLINE, TREATING A TOTAL FLOW OF 49.0 MGD PER THE FLOW SPLIT INDICATED IN THIS PROFILE.
3. THE DOWNSTREAM WATER SURFACE ELEVATION AT THE OUTFALL IN THE WILLAMETTE RIVER REFLECTS THE RIVER LEVEL AT THE 25-YEAR FLOOD ELEVATION, INTERPOLATED FROM A JANUARY 2019 CLACKAMAS COUNTY FLOOD INSURANCE STUDY.
4. ALL ELEVATIONS IN THIS HYDRAULIC PROFILE ARE SHOWN ACCORDING TO THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD 29).

LEGEND:

- XX.X — HYDRAULIC GRADE AT BUILDOUT PEAK HOUR FLOW (PHF), UNLESS NOTED OTHERWISE.
- (X) — PROCESS IDENTIFICATION TAG (CORRESPONDS TO ALTERNATIVE 5 SCHEMATIC IN FIGURE X)
- FINISHED GRADE
- XX.X — OVERALL PROCESS FLOW AT BUILDOUT PEAK HOUR FLOW (PHF), OR INDIVIDUAL PROCESS FLOW WHERE INDICATED

Figure 7.15 Tri-City WRRF Recommended Alternative North/South Plant Transfer Hydraulic Profile

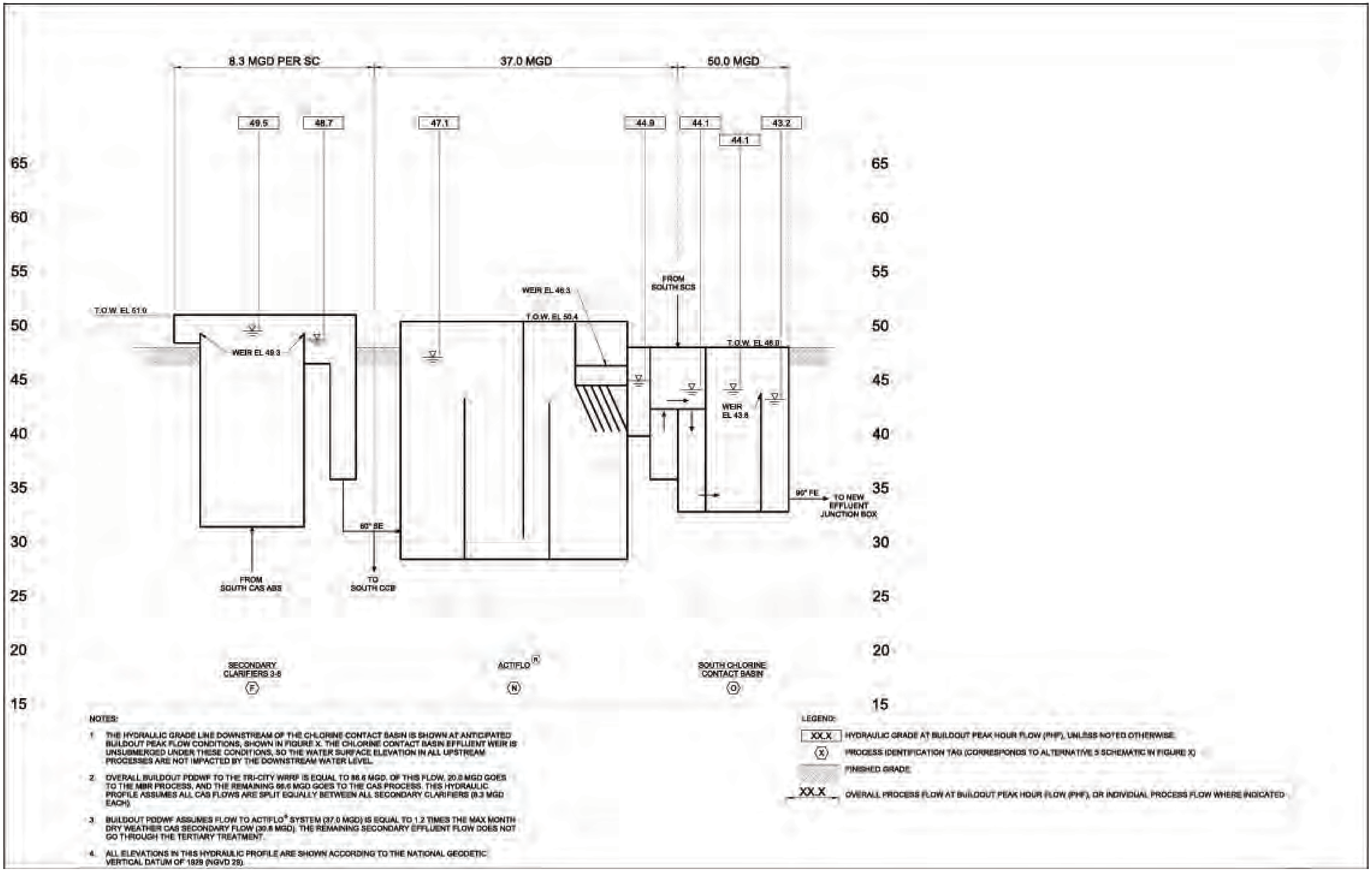


Figure 7.16 Tri-City WRRF Recommended Alternative South Plant Tertiary Hydraulic Profile

7.5.6 Estimated Costs

Table 7.20 summarizes the estimated total project cost for the recommended alternative. The costs in this table differ from those comparative cost estimates previously presented in Section 7.4 and have been updated to include all the anticipated project cost components. The costs shown are for project components associated with Scenario 1, which provide peak flow hydraulic capacity under existing NPDES limits through the year 2040.

Table 7.20 Recommended Plan Estimated Total Project Cost

Project Components	Estimated Total Cost (1) (Millions)
Existing IPS Modifications	$3.7
South Plant Bar Screens	$12.4
Peak Flow Treatment (Actiflo®)	$14.4
South Plant CCB	$6.0
Chemical Facilities	$3.2
Effluent Junction/Sampling Structure	$4.1
ELA (25%)	$10.7
Total Estimated Project Cost	**$53.7**

7.6 Solids Stream Alternatives

Chapter 5 identified that, late in the planning period, additional primary sludge thickening capacity could be required to provide sufficient capacity in the anaerobic digestion process under the current permit conditions. Analysis also determined the need for additional thickening would be increased if either Scenario 1.5 and/or Scenario 3 are implemented. This section summarizes the design criteria and expansion requirements for the primary sludge thickening and anaerobic digestion processes.

7.6.1 Solids Thickening

Gravity and mechanical thickening were evaluated as alternatives to increase solids thickening capacity at the Tri-City WRRF. Table 7.22 summarizes the advantages and challenges of these two alternatives.

Table 7.21 Advantages and Challenges of Primary Sludge Thickening Alternatives

	Advantages	Challenges
Gravity Thickening	• Proven "low-tech" process with low O&M costs. • Can provide a reliable source of readily degradable carbon for a future biological phosphorus removal process. • Allows foul air to be covered and scrubbed with minimal exposure.	• Largest space requirement on a limited site.. • Variable return flow quality can impact secondary treatment capacity.
Mechanical Thickening	• Small footprint • Could combine the thickening of primary sludge and WAS in one process	• Requires more O&M costs. • For some mechanical processes, foul air within the building can be difficult to extract and treat

Gravity thickening is the more conservative alternative from the standpoint of site footprint and cost. Therefore, the proposed CIP includes a line item for new gravity thickeners late in the planning period.

The gravity thickeners were sized for a maximum week solids loading rate of 25 pounds per day per square foot (ppd/sf) with one unit out of service. With both units in service, one of the thickeners could be operated as a fermenter with the second unit operating as a thickener. In this mode, the fermenter/thickeners could provide soluble BOD and volatile fatty acids to help with a future biological phosphorus removal process. If one unit needed to be out of service for maintenance, the remaining unit would be operated as a thickener. Based on this design criteria, two units could be required for 2040 loads, and four units would be required for Buildout.

The need for and timing of this project should continue to be evaluated. Should additional thickening be required, a more extensive analysis of the thickening alternatives to select the technology and location of these improvements should be conducted. For the basis of developing a CIP, the estimated cost for gravity thickeners is $7.6 million.

7.6.2 Digestion

Chapter 5 established the design criteria for the anaerobic digestion process based on the SRT and SVSLR summarized in Table 7.23. Based on these design criteria and assuming that the primary sludge can be thickened to 5.5 percent, one additional anaerobic digester could be required by the year 2040 if Scenario 3 NPDES permitting conditions materialize. This fourth digester would be located adjacent to the three existing digesters as shown in Figure 7.13. Siting the digester in this location would also require a relocation of the existing gas storage system. Because of the uncertainty of the Scenario 3 trigger, the cost for these improvements is not included in the CIP.

Table 7.22 Anaerobic Digestion Design Criteria

Design Criteria	Max Month All Units in Service	Max Month One Unit Out of Service
Primary Sludge Concentration[1]	5.5%	5.5%
Thickened WAS Concentration	5%	5%
SRT/HRT	20 days	15 days
SVSLR	0.15 lb VS/d-lb VS inventory	0.15 lb VS/d-lb VS inventory

Note:
(1) Assumes a primary sludge thickening process in service.

7.7 Repair and Replacement Improvements

In addition to the capacity-related improvements at the Tri-City WRRF, there are a number of improvements required to address the condition of existing equipment. A detailed description of these R&R projects is included in Chapter 6. The recommended improvements, presented in order of priority (i.e., Near-Term, Mid-Term, Long-Term) are summarized in the tables below.

Table 7.23 Recommended Near-Term (0 – 2 Years) R&R Improvements

R&R Project	Estimated Capital Cost
IPS / Headworks	-
Primary Sedimentation Basins	$4,101,000
Primary Pump Station	$678,000
CAS Aeration Basins	$95,000
Digesters	$2,689,000
Total Estimated Cost	**$7,563,000**

Table 7.24 Recommended Mid-Term (3 – 5 Years) R&R Improvements

Facility	Estimated Capital Cost
IPS / Headworks	$834,000
Primary Sedimentation Basins	$347,000
CAS Aeration Basins	$1,913,000
RAS Pump Station	$261,000
MBRs	$12,000
Backup Centrifuge	$26,000
Chlorine Contact Basin	$637,000
Digesters	$26,000
Chemical Building	$15,000
General Site	$154,000
Total Estimated Cost	**$4,225,000**

Table 7.25 Recommended Long-Term (6 – 10 Years) R&R Improvements

Facility	Estimated Capital Cost
IPS / Headworks	$2,223,000
Primary Sedimentation Basins	$333,000
Primary Pump Station	$56,000
CAS Aeration Basins	$496,000
Blower Building	$305,000
Secondary Clarifiers	$293,000
RAS Pump Station	$352,000
MBRs	$652,000
Backup Centrifuge	$51,000
Chlorine Contact Basin	$25,000
Digesters	$203,000
Chemical Building	$104,000
Lab	$31,000
General Site	$7,000
Total Estimated Cost	**$5,131,000**

Chapter 8

IMPLEMENTATION PLAN

8.1 Introduction

This chapter outlines the implementation plan for improvements at the Tri-City WRRF. Improvements are based on the Rehabilitation and Repair (R&R) projects identified in Chapter 6, and the recommended alternative presented in Chapter 7 of this Facilities Plan.

8.2 Planning Level Cost Estimate

The project costs (including construction and Engineering, Legal, and Administrative costs) for the recommended improvements are summarized in Table 8.1.

Table 8.1 Tri-City WRRF – Recommended Plan Project Cost Summary

Project(1)	Category(2)	Estimated Project Cost(3)
Near-term (0 – 2 year) R&R Improvements	Condition	$7,563,000
Mid-term (3 – 5 years) R&R Improvements	Condition	$4,225,000
Long-term (6 – 10 year) R&R Improvements	Condition	$5,131,000
Peak Flow Hydraulic Improvements	Capacity	$53,685,000
Primary Sludge Thickening	Capacity	$7,565,000
	TOTAL	**$78,169,000**

Notes:
(1) Details of each project can be found in Chapter 7.
(2) Condition projects are driven by the need to maintain existing reliable treatment capacity. Capacity projects are driven by the need to increase reliable treatment capacity.
(3) The estimated project costs are the construct costs for the repair and replacement (R&R) Improvement projects. The estimated project costs for all other projects include the construct costs plus engineering, legal and administration fees (ELA). Details on the estimated project costs can be found in Chapter 7.

8.3 Project Triggers

Project triggers were developed based on the capacity analysis and condition assessment. Capacity-related triggers for each capacity project were developed based on unit process design criteria as presented in Chapter 5 and the flow and load projections presented in Chapter 3. Triggers for Repair and Replacement (R&R) projects to address the condition of assets at the WRRF are based on the results of the condition assessment as shown in Chapter 6.

Table 8.2 summarizes the recommended improvements based on the triggers for the Tri-City WRRF.

Table 8.2 Tri-City WRRF - Recommended Improvements Triggers

Category	Process Description	Trigger			Approximate Trigger Date
		Description	Value	Units	
Condition	Near-term (0 - 2 year) R&R Improvements	Address condition deficiencies			2022
Condition	Mid-term (3 - 5 years) R&R Improvements	Address condition deficiencies			2024
Condition	Long-term (6 - 10 year) R&R Improvements	Address condition deficiencies			2028
Capacity	Peak Flow Hydraulic Improvements	PHF	60(1)	mgd	2022
Capacity	Primary Sludge Thickening	MM firm digestion SRT	15	days	2038

Notes:
(1) 60 mgd represents the PHF capacity of the primary and secondary process.

8.4 Project Schedule

Recommended projects for the upcoming five-year capital improvement plan (CIP) for the Tri-City WRRF are summarized below:

- Peak Flow Hydraulic Improvements.
- Near-term (0 - 2 year) R&R Improvements.
- Mid-term (3 - 5 years) R&R Improvements.

Figure 8.1 presents a summary of the recommended project schedule for the 20-year CIP for the Tri-City WRRF. All projects except R&R Improvements include a design period and construction period.

8.5 Financial Analysis – Capital Improvement Plan

The anticipated cash flow to complete the recommended projects throughout the planning period was determined for the recommended improvements at Tri-City WRRF summarized in Table 8.1. The cash flow over the 20-year planning horizon for the Tri-City WRRF, which includes a 3 percent escalation rate, is shown in Figure 8.2 and summarized in Table 8.3. Costs presented in Figure 8.2 and Table 8.3 have been escalated to the mid-point of construction. The peak expenditure for improvements at the Tri-City WRRF is approximately $25.1M in planning year 2026.

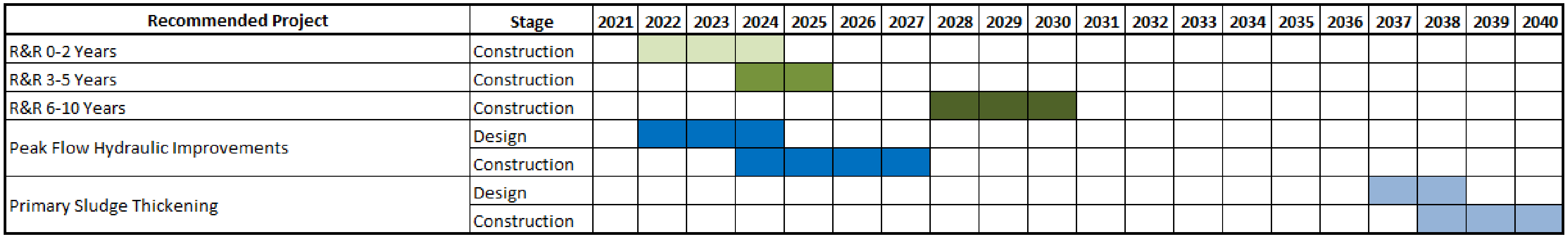


Figure 8.1 Project Schedule for Recommended Tri-City WRRF Improvements

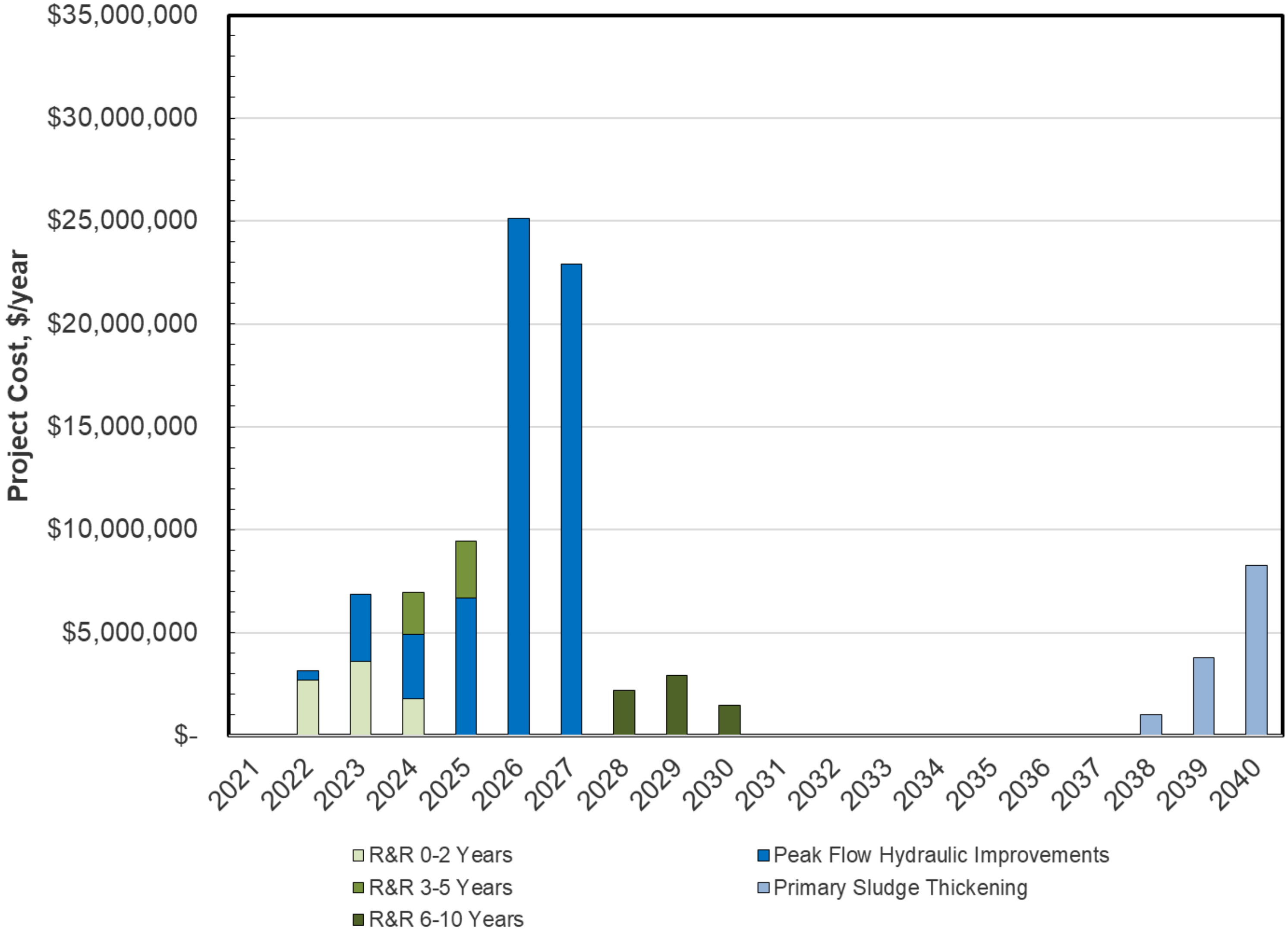


Figure 8.2 Tri-City WRRF Cash Flow Summary

Table 8.3 Tri-City WRRF Cash Flow Summary

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Peak Flow Hydraulic Improvements	$-	$460,000	$3,278,000	$3,130,000	$6,704,000	$25,141,000	$22,906,000	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Primary Sludge Thickening	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$1,013,000	$3,801,000	$8,277,000
R&R 0-2 Years	$-	$2,701,000	$3,601,000	$1,800,000	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
R&R 3-5 Years	$-	$-	$-	$2,043,000	$2,724,000	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
R&R 6-10 Years	$-	$-	$-	$-	$-	$-	$-	$2,188,000	$2,917,000	$1,459,000	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
TOTAL	**$-**	**$3,161,00**	**$6,879,000**	**$6,973,000**	**$9,428,000**	**$25,141,000**	**$22,906,000**	**$2,188,000**	**$2,917,000**	**$1,459,000**	**$-**	**$-**	**$-**	**$-**	**$-**	**$-**	**$-**	**$1,013,000**	**$3,801,000**	**$8,277,000**

Appendix A

DEQ MUTUAL AGREEMENT AND ORDER (MAO NO. WQ/M-NWR-11-046 DECEMBER 3, 2012 DEQ LETTER)

Appendix A

MAO No. WQ/M-NWR-11-046

December 3, 2012 DEQ Letter

BEFORE THE ENVIRONMENTAL QUALITY COMMISSION

OF THE STATE OF OREGON

IN THE MATTER OF: TRI-CITY SERVICE DISTRICT, Permittee	)))))	MUTUAL AGREEMENT AND ORDER NO. WQ/M-NWR-11-046 CLACKAMAS COUNTY

WHEREAS:

1. The Department of Environmental Quality (Department or DEQ) expects to issue a National Pollutant Discharge Elimination System (NPDES) Waste Discharge Permit (Permit) to Tri-City Service District (Permittee) in April, 2011. The Permit will authorize the Permittee to construct, install, modify or operate wastewater treatment control and disposal facilities (facilities) and discharge adequately treated wastewaters into the Willamette River, waters of the state, in conformance with the requirements, limitations and conditions set forth in the Permit. The Permit will expire five years from the date issued.

2. In 2010, Permittee undertook a mixing zone study to collect data needed for promulgation of the permit. That data indicates that the Permittee's current discharge dilution is less than determined by previous studies. This results in the need for Permittee to improve the dilution or provide additional treatment, or both.

3. DEQ and the Permittee recognize that until new or modified facilities are constructed and put into full operation, Permittee will not be able to meet water quality based effluent limits based on the dilution available for ammonia.

4. The proposed Permit includes ammonia interim effluent limitations in Schedule A that will apply until new facilities are constructed and put into full operation, and also more stringent ammonia effluent limitations if the new facilities are not constructed and put into full

operation as required below.

5. This MAO is not intended to limit, in any way, the Department's right to proceed against Permittee in any forum for any past or future violations.

NOW THEREFORE, it is stipulated and agreed that:

6. The Environmental Quality Commission shall issue a final order:

A. Requiring Permittee to undertake the following:

a. By no later than December 1, 2011, Permittee shall submit for DEQ approval, written plans and specifications of the selected approach for the Tri-City WWTP capital improvements relating to ammonia discharge. The plans and specifications must fully explain the administrative and engineering feasibility of the approach.

b. Within 360 days after the Department's approval of the plans and specifications, but no later than December 1, 2012, Permittee shall complete construction and start up of ammonia-related capital improvements according to the approved plans and specifications.

c. Within 374 days after the Department's approval of the plans and specifications, but no later than December 15, 2012, Permittee shall submit to the Department a report on the completion of the construction and startup of the improvements.

B. Requiring Permittee, upon receipt of a written Penalty Demand Notice from the Department, to pay $250 for each day of each violation of the compliance schedule set forth in Paragraph 6A.

7. If any event occurs that is beyond Permittee's reasonable control and that causes or may cause a delay or deviation in performance of the requirements of this MAO, Permittee shall immediately notify the Department verbally of the cause of delay or deviation and its anticipated

duration, the measures that have been or will be taken to prevent or minimize the delay or deviation, and the timetable by which Permittee proposes to carry out such measures. Permittee shall confirm in writing this information within five (5) working days of the onset of the event. It is Permittee's responsibility in the written notification to demonstrate to the Department's satisfaction that the delay or deviation has been or will be caused by circumstances beyond the control and despite due diligence of Permittee. If Permittee so demonstrates, the Department shall extend times of performance of related activities under this MAO as appropriate. Circumstances or events beyond Permittee's control include, but are not limited to, acts of nature, unforeseen strikes, work stoppages, fires, explosion, riot, sabotage, or war. Increased cost of performance or consultant's failure to provide timely reports may not be considered circumstances beyond Permittee's control.

8. Permittee and the Department hereby waive any and all of their rights to any and all notices, hearing, judicial review, and to service of a copy of the final order herein. The Department reserves the right to enforce this order through appropriate administrative and judicial proceedings.

9. Regarding the schedule set forth in Paragraph 6A above, Permittee acknowledges that Permittee is responsible for complying with that schedule regardless of the availability of any federal or state grant monies.

10. The terms of this MAO may be amended by the mutual agreement of the Department and Permittee.

11. The Department may amend the compliance schedule and conditions in this MAO upon finding that such modification is necessary because of changed circumstances or to protect public health and the environment. The Department shall provide Permittee a minimum of thirty

(30) days written notice prior to issuing an Amended Order modifying any compliance schedules or conditions. If Permittee contests the Amended Order, the applicable procedures for conduct of contested cases in such matters shall apply.

12. This MAO shall be binding on the parties and their respective successors, agents, and assigns. The undersigned representative of each party certifies that he or she is fully authorized to execute and bind such party to this MAO. No change in ownership or corporate or partnership status relating to the facility shall in any way alter Permittee's obligations under this MAO, unless otherwise approved in writing by DEQ.

13. All reports, notices and other communications required under or relating to this MAO should be directed to Greg Geist, DEQ Northwest Region, 2020 SW 4th Avenue, Suite 400, Portland OR 97201. The contact person for Permittee shall be Dan Henninger, 150 Beavercreek Road, Suite 430, Oregon City OR 97045

14. Permittee acknowledges that it has actual notice of the contents and requirements of the MAO and that failure to fulfill any of the requirements hereof would constitute a violation of this MAO and subject Permittee to payment of civil penalties pursuant to Paragraph 6B above.

15. Any stipulated civil penalty imposed pursuant to Paragraph 6B shall be due upon written demand. Stipulated civil penalties shall be paid by check or money order made payable to the "Oregon State Treasurer" and sent to: Business Office, Department of Environmental Quality, 811 S.W. Sixth Avenue, Portland, Oregon 97204. Within 21 days of receipt of a "Demand for Payment of Stipulated Civil Penalty" Notice from the Department, Permittee may request a hearing to contest the Demand Notice. At any such hearing, the issue shall be limited to Permittee's compliance or non-compliance with this MAO. The amount of each stipulated civil penalty for each violation and/or day of violation is established in advance by this MAO

and shall not be a contestable issue.

16. Providing Permittee has paid in full all stipulated civil penalties pursuant to Paragraph 15 above, this MAO shall terminate 60 days after Permittee demonstrates full compliance with the requirements of the schedule set forth in Paragraph 6A above.

PERMITTEE

4/27/11
Date

Michael S. Kuenzi, District Director
Tri-City Service District

DEPARTMENT OF ENVIRONMENTAL QUALITY

4·29·11
Date

Leah Koss
Manager, Office of Compliance and Enforcement

FINAL ORDER

IT IS SO ORDERED:

ENVIRONMENTAL QUALITY COMMISSION

4·29·11
Date

Leah Koss, Manager, Office of Compliance and Enforcement
Department of Environmental Quality
Pursuant to OAR 340-011-0136(1)

Oregon
John A. Kitzhaber, MD, Governor

Department of Environmental Quality
Headquarters
811 SW Sixth Avenue
Portland, OR 97204-1390
(503) 229-5696
FAX (503) 229-6124
TTY 711

December 3, 2012

Mr. Michael S. Kuenzi, P.E., Director
Tri-City Service District
150 Beavercreek Road
Oregon City, Oregon 97045

RE: Compliance with Mutual Agreement and Order (MAO) No. WQ/M-NWR-11-046
WQ- Clackamas County / File No. 89700

Dear Mr. Kuenzi:

I am writing to you today to congratulate and thank you for completing the installation of the duckbill diffuser valve on the Tri-City WPCP outfall. This was the final step in the overall project that addressed ammonia toxicity. With completion of this project, the Tri-City Service District's obligations under MAO No. WQ/M-NWR-11-046 have been fulfilled. I appreciate the Service District's efforts to see it through to an on-time, successful completion.

Municipal wastewater treatment facilities play a very important role in protecting water quality and helping to achieve our goal of having all waters fishable and swim-able. By constructing the new MBR wastewater treatment system, configuring the outfall flow control structure for and instigating seasonal outfall operations, and adding the duckbill diffuser the Service District has resolved the ammonia toxicity issue and I commend you for your efforts.

I thank The Tri-City Service District and WES for assembling a team of the highest quality professionals who collaboratively with you designed and then completed this crucial project.

Again, congratulations on the successful completion of an ambitious project and thank you for your continued efforts in improving the environment.

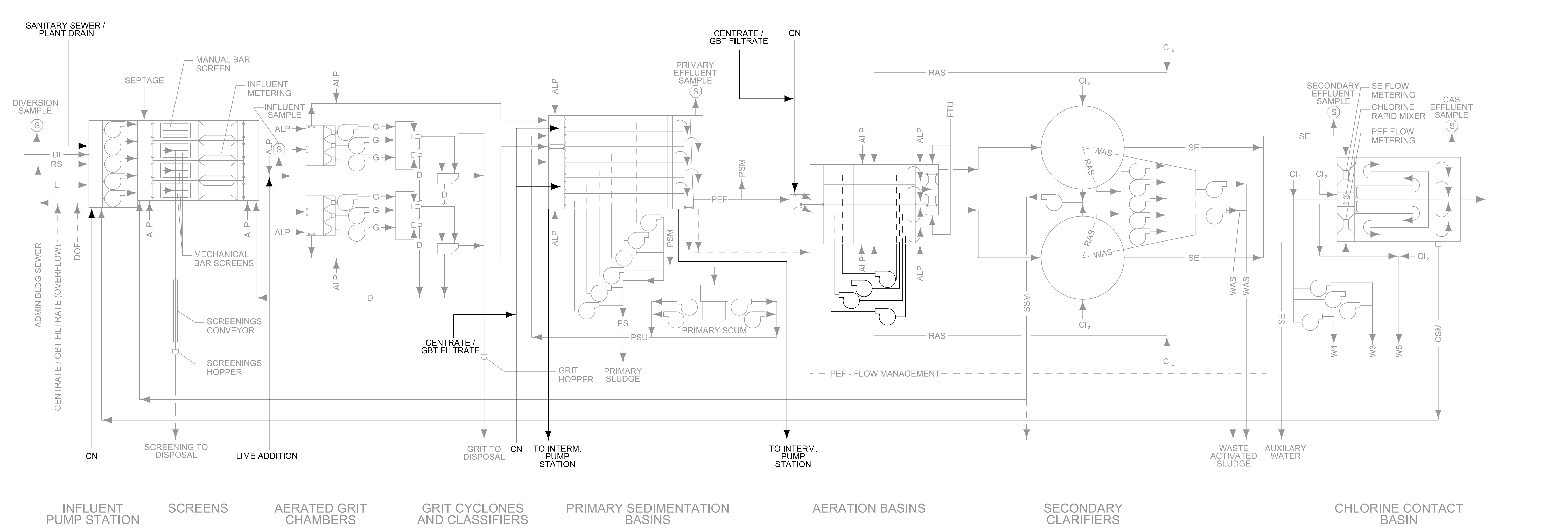
Sincerely,

Dick Pedersen
Director

cc: Nina DeConcini, ODEQ NWR Office
Tiffany Yelton-Bram, ODEQ NWR Office
Chris Storey, Clackamas County Counsel

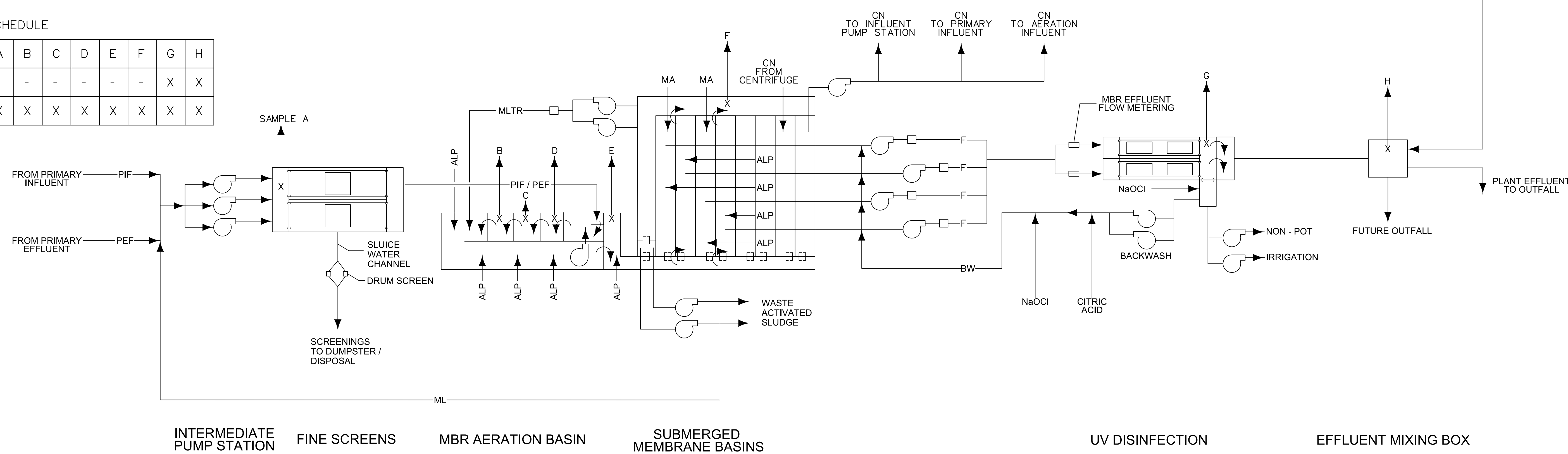
Appendix B

PROCESS FLOW DIAGRAM



SAMPLE POINT SCHEDULE

SAMPLE POINT	A	B	C	D	E	F	G	H
COMPOSITE	-	-	-	-	-	-	X	X
GRAB	X	X	X	X	X	X	X	X



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REV	DATE	BY	DESCRIPTION
	2/1/12	JDG	RECORD DRAWING

SCALE: NONE

WARNING: 0 ½ 1 — IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED MWH
DRAWN MWH
CHECKED MWH

RECORD DRAWING

This record drawing has been prepared, entirely or in part on the basis of unverified information compiled and furnished by others to the preparer who is not responsible for any inaccuracies, errors or omissions which may have been incorporated into the document as a result

MWH Portland Oregon

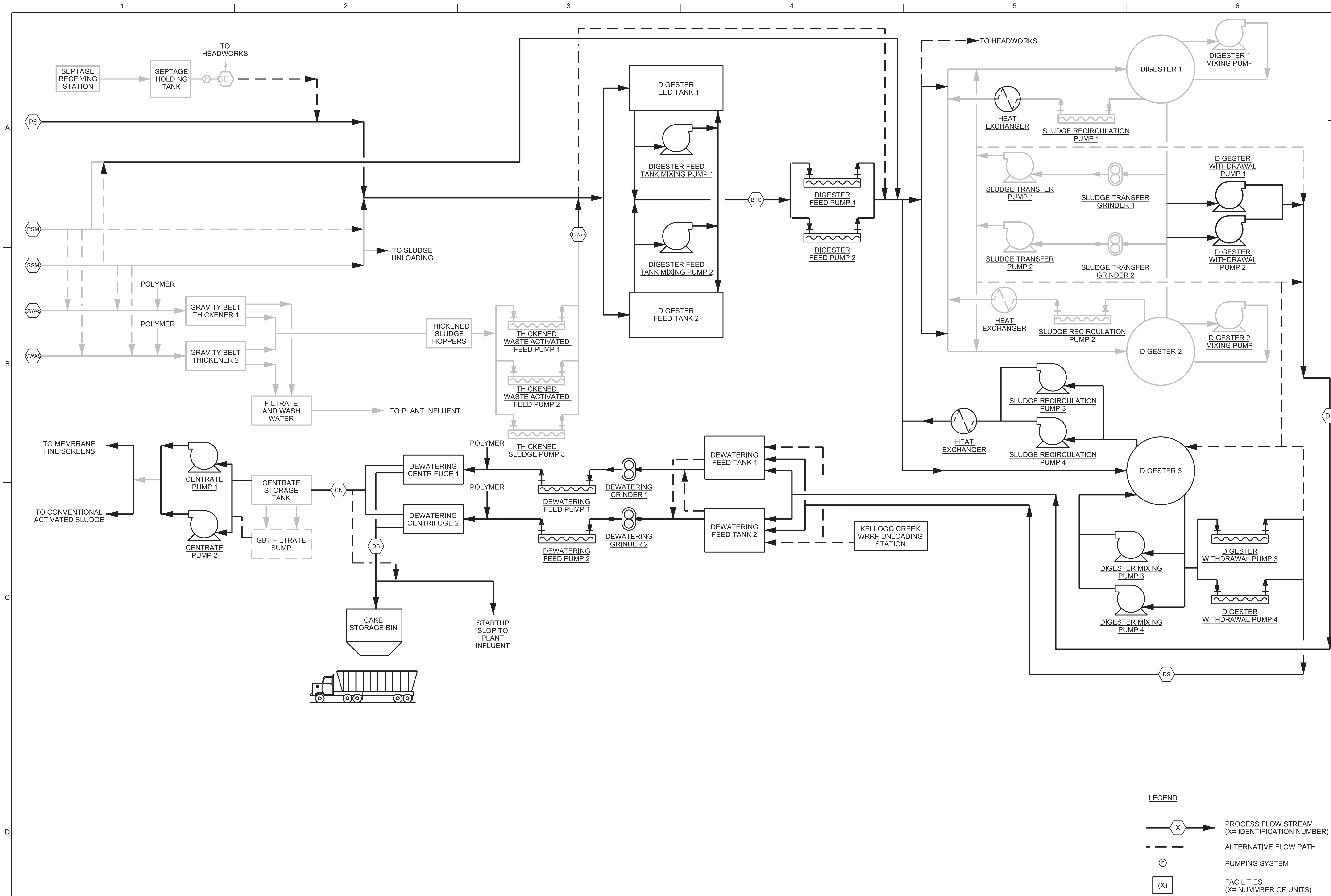
WATER ENVIRONMENT SERVICES — A Department of Clackamas County

TRI-CITY WPCP PHASE 1 EXPANSION

GENERAL PROCESS FLOW DIAGRAM

SHEET 10-G-10

1530666



DIGITALLY SIGNED ON APRIL 11, 2018

06/30/2019

NO.	DATE	REVISION	BY	APVD

DSGN M HATZIGEORGIOU | DR GS JAMROS | CHK TL BAUER | APVD RB FULLER

WATER ENVIRONMENT SERVICES

TRI-CITY WRRF
SOLIDS HANDLING IMPROVEMENTS
WATER ENVIRONMENT SERVICES
CLACKAMAS COUNTY, OREGON

ch2m

GENERAL
SOLIDS PROCESS FLOW DIAGRAM

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	APRIL 2018
PROJ	692260
DWG	10-G-023B
SHEET	24 of 335

ISSUED FOR BID

Appendix C

PROCESS MODEL DOCUMENTATION

PROJECT MEMORANDUM

WILLAMETTE FACILITIES PLAN

Clackamas Water Environment Services

Date:	January 14, 2020
Project No.:	11636A.00

Prepared By:	Anne Conklin
Reviewed By:	Brian Graham
Subject:	Process Model Documentation

Purpose

The purpose of this memorandum is to document the process model calibration for the Clackamas Water Environment Services (WES) Tri Cities and Kellogg Creek treatment plants. Since the peak flow capacity of the Kellogg Creek plant is capped at 25 million gallons per day (mgd), the District constructed the Intertie 2 pump station to divert flows from the Kellogg Creek service area to the Tri Cities plant which can be expanded. In addition to the flow transfers, the digested sludge generated at Kellogg Creek is hauled to the Tri Cities plant where it is dewatered. The dewatering return flows from the Kellogg Creek digested sludge are treated at the Tri Cities Plant. Since these two models are interconnected, one process model was developed for both plants.

Influent Data Issues at Kellogg Creek

The influent measurement at Kellogg Creek includes recycle from the thickening process and is upstream of grit removal. No other recycle streams enter the plant between the influent sample location and the primary clarifiers. The measured influent total suspended solids (TSS) concentrations are highly variable and are sometimes measured at concentrations above 1,000 milligrams per liter (mg/L). For this reason an outlier analysis was performed and any influent loads measured that were greater than 1.5 times the interquartile range greater than the 75th percentile load (or less than 1.5 times the interquartile range less than the 25th percentile load) were excluded.

As is shown in Figure 1, a solids mass balance around the primary clarifiers does not close even including an estimate for how much solids are removed in grit[1]. For this reason, four different draft model calibrations were developed to determine which one best matched the measured data through the plant:

1. Trust the measured influent and primary effluent (PE) influent biochemical oxygen demand (BOD) and TSS concentrations:
   a. Due to the super high influent TSS concentrations, calculated primary sludge and cake loads were much higher than were measured. Additionally, the per capita TSS load was higher than is typical for a residential system.
   b. Due to the high influent TSS/BOD ratio, the required Fup was high, resulting in a high observed yield and higher modeled thickened waste activated sludge (TWAS) loads.

[1] Kellogg Creek plant staff indicate that they remove 6 cy/wk of grit. Assuming a middle of the range moisture content of 39% from Metcalf and Eddy, a specific gravity of 2.65 and an ISS/TSS ratio of 1, I get that the influent TSS sample could contain up to 1,882 ppd of grit.

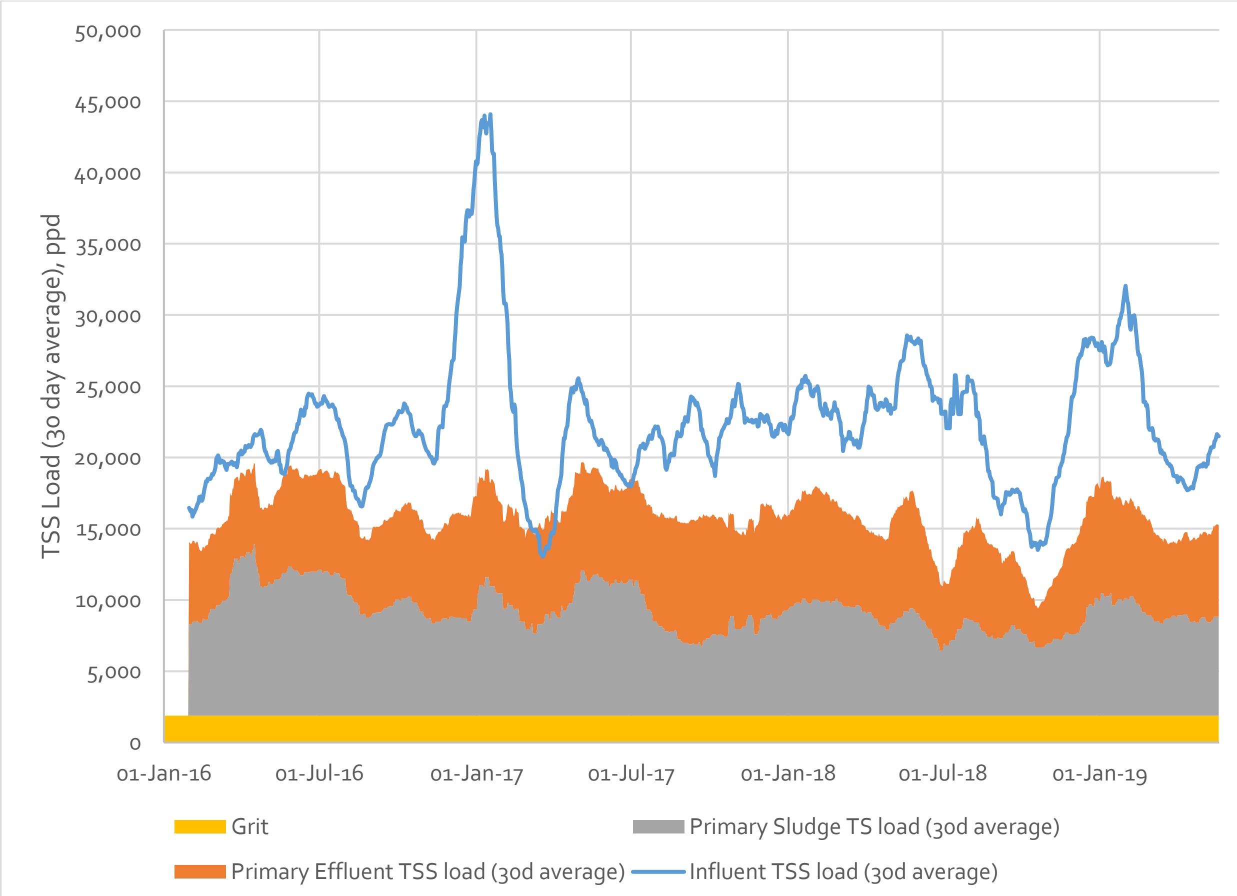


Figure 1 Kellogg Creek Primary Clarifier Mass Balance

2. Trust the measured influent BOD concentration, PE BOD and TSS concentrations and primary sludge load:
    a. By ignoring the measured influent TSS concentrations, the model could predict the measured primary sludge (PS) loads and thus better predict the measured cake loads.
    b. However, by reducing the influent TSS concentrations to match what would be required based on the estimated grit production, PE and primary sludge loads, the calculated primary clarifier TSS and BOD removal percentages are very close to each other. In order for this to happen, the predicted influent sBOD percentage would have to be impossibly low.
    c. I could not generate any influent wastewater characteristics to match this scenario.
3. Trust the measured PE BOD and TSS concentrations and primary sludge load. Using the measured primary effluent and primary sludge loads, I recalculated what the influent TSS load needed to be and then what influent BOD load would make sense based on the wastewater characteristics.
    a. This resulted in modeled sludge loads that reasonably matched the measured values and more reasonable wastewater characteristics.
    b. However, the resultant influent BOD per capita was lower than would be expected for residential wastewater.
4. Trust the measured PE BOD and TSS concentrations. In this model, the PE concentrations are trusted and all other are modeled assuming reasonable influent characteristics and per capita loads.

a. This model most closely matches the measured solids production while not being too far off the measured influent BOD concentration, and calculated influent TSS concentration (based on the primary clarifier mass balance). Additionally, the per capita loads are very close to what would be expected for residential wastewater.

Table 1 summarizes the results of these four draft model calibrations. Since model calibration 4 more closely matched the measured solids loads and resulted in a reasonable influent wastewater characteristic and per capita loads, I chose to move forward with draft model calibration 4.

Table 1 Kellogg Creek Model Calibration Summary

	KC Measured	Model 1	Model 2	Model 3	Model 4
COD Fractionation	(Default)				
Fbs	0.1600	0.1300	Not feasible	0.1400	0.1300
Fxsp	0.7500	0.8660	Not feasible	0.7500	0.8400
Fup	0.1300	0.3140	Not feasible	0.2490	0.1690
Influent BOD					
Concentration (mg/L)	260	260	260	198	218
Per capita (ppcd)	0.202	0.202	0.202	0.153	0.169
Influent TSS					
Concentration (mg/L)	372	372	241	241	250
Per capita (ppcd)	0.288	0.288	0.187	0.187	0.194
Primary Effluent BOD					
Concentration (mg/L)	141	141	141	141	141
Removal, %	46%	46%	46%	30%	36%
Primary Effluent TSS					
Concentration (mg/L)	106	106	106	106	106
Removal, %	69%	69%	51%	51%	53%
Primary Sludge, ppd	6,453	13,632	6,453	6,316	6,824
TWAS, ppd	6,232	7,361	Not feasible	7,174	6,534
Anaerobic Digestion VSR, %	67%	45%	Not feasible	50%	61%
Cake, ppd	4,761	10,401	Not feasible	6,172	5,028

Notes:
Measured value (scrubbed data, concentrations calculated from average loads from calibration period.
Calculated value (based on measured primary sludge and measured primary effluent.
Delta < 6% Delta < 20% Delta < 30% Delta > 100%

Influent Data Issues at Tri Cities

The data uncertainties at Tri Cities were different than those at the Kellogg plant. Interestingly at Tri Cities the influent loads have been dropping. The average influent TSS per capita loads was 0.27 ppcd in 2017 (similar to Kellogg Creek), 0.19 ppcd in 2017 (10% less than typical residential values) and 0.15 ppcd in 2018

(30 percent less than typical residential values). Plant staff have indicated that the influent TSS loads were again low in 2019.

However while the influent loads have dropped, solids loads have remained fairly stable (Table 2). Although the influent per capita loads are considerably lower than expected, the influent loads do match the measured primary effluent and primary sludge loads in 2018 (Figure 2).

Table 2 Tri Cities Solids Loads

	2016	2017	2018
Influent TSS Load, ppd (per capita)	28,590 (0.27)	25,189 (0.19)	20,503 (0.15)
Primary Sludge Load, ppd	10,349	10,238	11,526
TWAS load, ppd	7,085	6,799	7,219

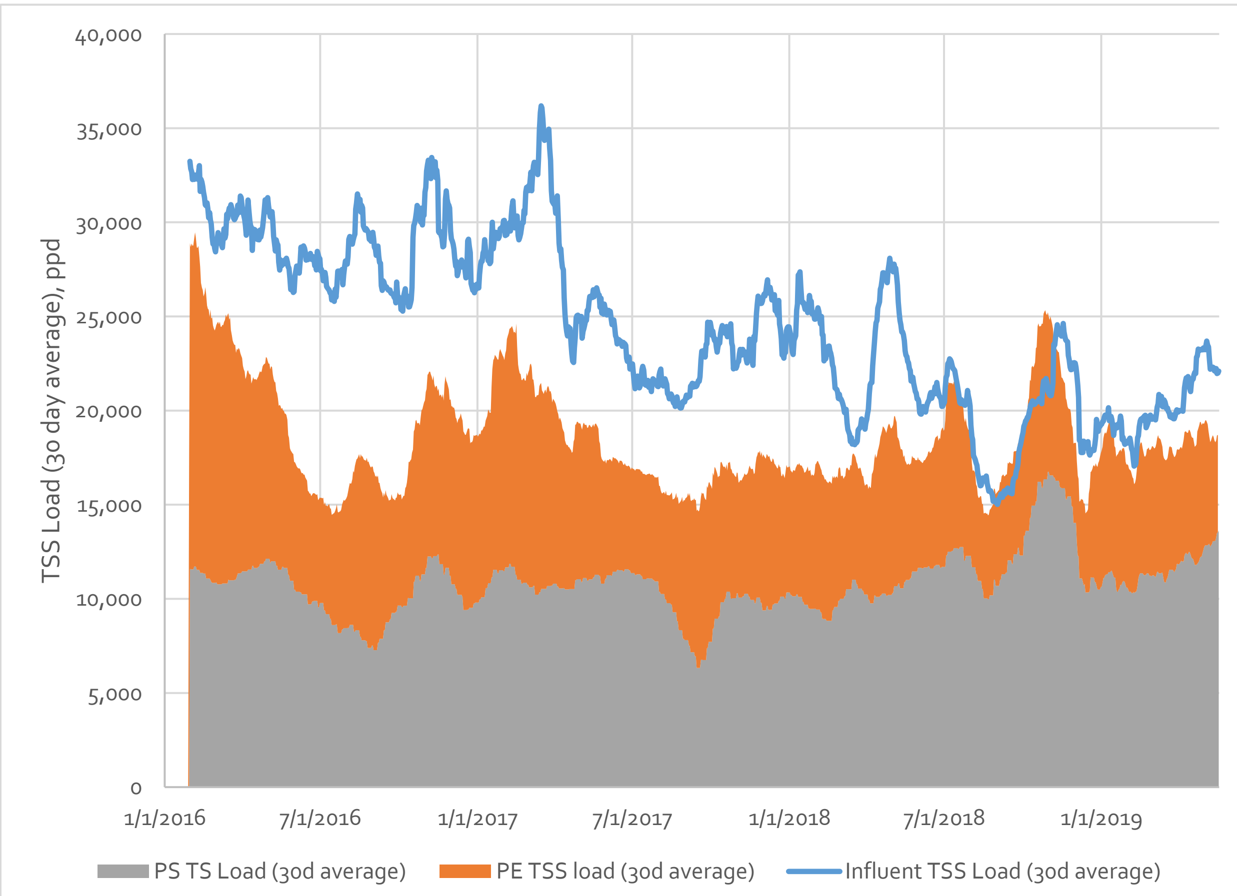


Figure 2 Tri Cities Primary Clarifier Mass Balance

Model Calibration

A steady state process model was developed in BioWin 6 and calibrated to one year of influent data (the most recent data available, 5/10/18 – 5/9/19): WES Whole Plant Model4b.bwc. At this point in the process, the aeration modeling has not been calibrated or evaluated. A dynamic calibration was evaluated however, due to the uncertainty in the influent data at Kellogg Creek and the number of times throughout the year that the Tri Cities plant took aeration basins on and off line, the dynamic calibration was quite difficult.

During the calibration period the Tri Cities plant operated with their one MBR aeration basin online and 3.2 of their 4 CAS aeration basins online. Table 3 summarizes the calibration results for Tri Cities. I think that the WAS flows from the WAS flows from the MBR plant are over predicted by a factor of 2. As can be seen in Table 3, the model over predicts primary sludge loads by about 9 percent, under predicts secondary solids by about 13-14 percent, under predicts combined TWAS by about 9 percent and over predicts hauled solids by about 9 percent.

Table 3 Tri Cities Calibration Summary

	Measured	Modeled	Delta
Influent			
Flow, mgd	8.29	8.29	0%
BOD load, ppd	17,497	17,498	0%
NH3, mg/L	27	28	2%
NH3/TKN	0.58	0.58	0%
TSS load, ppd	19,882	19,514	2%
Primary Clarification			
PE BOD, mg/L	141	141	0%
PE TSS, mg/L	101	101	0%
Secondary Treatment			
CAS MLSS, mg/L	1,575	1,364	13%
CAS MLVSS, mg/L	1,217	1,092	10%
CAS WAS, ppd	6,866	5,945	13%
CAS aSRT, days	3.13	3.13	0%
SE_FLOW, mgd	6.15	5.70	7%
MBR AB MLSS, mg/L	6,891	5,930	14%
MBR AB MLVSS, mg/L	5,487	4,491	18%
MBR RAS TSS, mg/L	8,614	7,405	14%
MBR RAS VSS, mg/L	6,859	5,607	18%
MBR WAS, ppd	4,272	1,886	56%
MBR aSRT, days	6.5	12.6	95%
Solids			
PS TS, ppd	11,917	12,972	9%
TWAS, ppd	7,713	7,047	9%
Centrifuge Feed TS, ppd	11,757	10,483	11%
Land applied solids, dry tons/year	1,589	1,779	12%

During the calibration period, the Kellogg Creek plant was operating with 3 out of their 4 aeration basins in service. Table 4 summarizes the results of the calibration. The plant measures RAS and WAS TSS concentrations and they are different by almost a factor of 2. They feel that their WAS concentrations are more accurate but we have discussed with them taking spins of the solids every hour during their intermittent wasting cycle to see over the entire course of a WAS wasting, is the average WAS TSS concentration closer to the RAS or initial WAS measurement. As can be seen in Table 4, the measured influent TSS and BOD concentrations were ignored and the model calibrated around other parameters in the plant. The model over predicts primary and TWAS solids by about 6 percent, under predicts centrifuge feed solids by about 14 percent and over predicts hauled biosolids by about 5 percent.

Table 4 Kellogg Creek Calibration Summary

	Measured	Modeled	Delta
Influent			
Flow	6.85	6.84	0%
Scrubbed TSS load, ppd	21,649	14,716	32%
Scrubbed BOD load, ppd	14,935	12,538	16%
NH3, mg/L	28	24	13%
NH3/TKN	0.65	0.61	6%
Grit, ppd	1,882	1,841	2%
Primary Clarification			
PE BOD, mg/L	141	140	0%
PE TSS, mg/L	106	106	1%
Secondary Treatment			
MLSS, mg/L	1,680	1,830	9%
MLVSS, mg/L	1,473	1,570	7%
WAS load, ppd (based on WAS TSS)	9,367	6,860	27%
WAS load, ppd (based on RAS TSS)	6,081	6,860	13%
aSRT, days	2.60	2.56	2%
Solids			
PS TS, ppd	6,453	6,824	6%
TWAS, ppd	6,232	6,534	5%
Centrifuge feed TS, ppd	5,982	5,121	14%
Hauled biosolids, dry tons/year	869	912	5%

Prepared by:

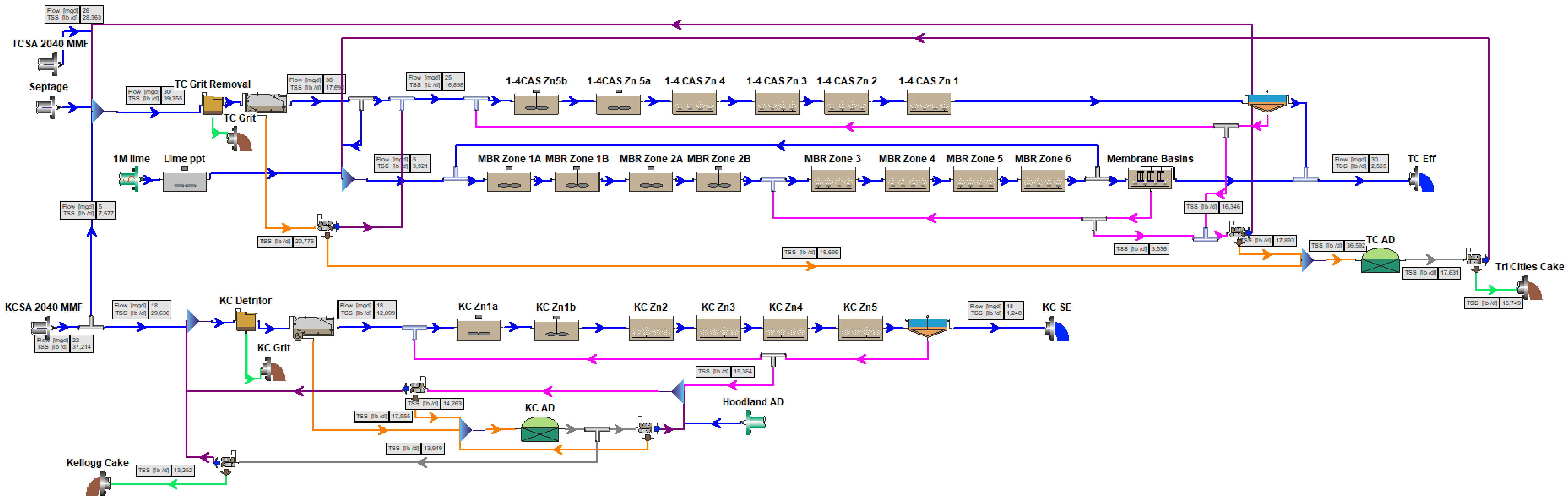
Anne Conklin:

AC:sm

Appendix D

MASS BALANCE

2040 MMWWF


TCSA 2040 MMF
Septage
TC Grit Removal
TC Grit
1M lime
Lime ppt
1-4CAS Zn5b
1-4CAS Zn 5a
1-4 CAS Zn 4
1-4 CAS Zn 3
1-4 CAS Zn 2
1-4 CAS Zn 1
MBR Zone 1A
MBR Zone 1B
MBR Zone 2A
MBR Zone 2B
MBR Zone 3
MBR Zone 4
MBR Zone 5
MBR Zone 6
Membrane Basins
TC Eff
TC AD
Tri Cities Cake
KCSA 2040 MMF
KC Detritor
KC Grit
KC Zn1a
KC Zn1b
KC Zn2
KC Zn3
KC Zn4
KC Zn5
KC SE
KC AD
Hoodland AD
Kellogg Cake

KELLOGG CREEK
FACILITIES PLAN

Clackamas Water Environment Services

KELLOGG CREEK FACILITIES PLAN

DRAFT | July 2022

CLACKAMAS WATER ENVIRONMENT SERVICES

Clackamas Water Environment Services

KELLOGG CREEK FACILITIES PLAN

DRAFT | July 2022

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Abbreviations

°C	degrees Celsius
°F	degrees Fahrenheit
A2O	Anaerobic-Anoxic-Oxic
AA	Average Annual
AACE	Advancement of Cost Engineering
ACS	American Community Survey
ADWF	average dry weather flow
AHF	Active Harmonic Filters
AO	anaerobic-oxic
AOB	ammonia-oxidizing bacteria
aSRT	aerobic solids retention time
AWWF	average wet weather flow
BOD	biochemical oxygen demand
BOD_5	five-day biochemical oxygen demand
BPR	Biological phosphorus removal
Btu	British thermal unit
BWF	base wastewater flow
$CBOD_5$	five-day carbonaceous biochemical oxygen demand
CCB	chlorine contact basin
CCSD No. 1	Clackamas County Service District No. 1
CEPT	Chemically enhanced primary treatment
cf	cubic feet
CFU	colony-forming unit
CHP	Combined Heat and Power
CIP	capital improvement plan
CMMS	computerized maintenance management system
CO	carbon monoxide
CSZ	Cascadia Subduction Zone
CWR	Cold Water Refugia
DAFT	dissolved air flotation thickener
DAR	dissolved air recycle
dBA	decibel.
DDT	dichlorodiphenyltrichloroethane
DEQ	Department of Environmental Quality
District	Clackamas Water Environment Services
DMA	designated management agencies

DOGAMI	Department of Geology and Mineral Industries
ELA	engineering, legal and administration fees
ENR	Engineering News Record
EPA	Environmental Protection Agency
F&P	Fischer & Porter
FEMA	Federal Emergency Management Agency
ft	feet
ft/hr	feet per hour
gal	gallon(s)
GBT	gravity belt thickeners
GDP	gross domestic product
gpcpd	gallons per capita per day
gpd/sf	gallons per day per square foot
gpm	gallons per minute
Guide	Wastewater Facility Planning Guide
H2S	hydrogen sulfide
hp	horsepower
hr	hour
HRT	hydraulic retention time
IPS	influent pump station
IUVA	International Ultraviolet Association, Inc
IWRS	Integrated Water Resources Strategy
kcal/day	kilocalories per day
kW	kW - kilowatt
kWe	kilowatt-electric
kWh	kilowatt-hour
L/g	liters per gram
lb VS/d-lb VS	pounds per day of volatile solids fed per pound of volatile solids
lbs	pounds
lbs/day	pounds per day
LHV	low heating value
LPHO	low-pressure, high-output
MAO	methyl aluminoxane
Max	maximum
MCC	Motor Control Center
METRO	Oregon Metro
mg/L	milligrams per liter
mgd	million gallons per day

min	minute
mJ/cm	millijoules per square centimeter
mJ/cm2	millijoules per square centimeter
mL	milliliter
mL/g	milliliters per gram
MLE	Modified Ludzack-Ettinger
MLR	mixed liquor recycle
MLSS	mixed liquor suspended solids
MLSS	mixed liquor suspended solids
MM	maximum month
MMDW	maximum month dry weather
MMDWF	maximum month dry weather flow
MMWWF	maximum month wet weather flow
MW	maximum week
MWDWF	maximum week dry weather flow
MWWWF	maximum week wet weather flow
N/A	not applicable
NaHSO3	sodium bisulfite
NaOCl	sodium hypochlorite
NEMA	National Electrical Manufacturers Association
NOB	nitrite-oxidizing bacteria
NOx	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NPV	net present value
NWRI	National Water Research Institute
O&M	operations and maintenance
OAR	Oregon Administrative Rule
ODFW	Oregon Department of Fish and Wildlife
OH&P	Contractor Overhead and Profit
OOS	out of service
ORS	Oregon Revised Statute
PAH	polycyclic aromatic hydrocarbons
PAO	phosphorus-accumulating organisms
PCB	polychlorinated biphenyls
PDDWF	Peak Day Dry Weather Flow
PDWWF	Peak Day Wet Weather Flow
PHF	Peak Hour Flow
Plan	Kellogg Creek Water Resource Recovery Facility Plan

ppcd	pounds per capita per day
ppd	pounds per day
ppd/sf	pounds per day per square foot
PS	pump station
psig	pounds per square inch gauge
PSU	Portland State University
R&R	repair & replacement
RAS	return activated sludge
RDT	rotary drum thickener
RMZ	regulated mixing zone
RPA	reasonable potential analysis
rpm	revolutions per minute
scfm	standard cubic feet per minute
sf	square foot
SOR	surface overflow rate
SPA	state-point analysis
SRF	State Revolving Fund
SRT	solids residence time
SVI	sludge volume index
SVSLR	specific volatile solids loading rate
SWD	side water depth
SWMACC	Surface Water Management Agency of Clackamas County
TAZ	Transportation Analysis Zones
TBD	to be determined
TCSD	Tri-City Service District
TCSHI	Tri-City Solids Handling Improvements
TDH	total dynamic head
TDML	total maximum daily load
TP	Total phosphorus
TPS	Thickened Sludge Pump
TS	Total Solids
TS	total solids
TSS	total suspended solids
TSS	total suspended solid
TWAS	thickened waste activated sludge
UV	ultraviolet
VFA	volatile fatty acids
VFD	variable frequency drive

VOC	volatile organic compounds
W	watt
w.c.g.	water column gauge
WAS	waste activated sludge
WES	Clackamas Water Environment Services
WFP	Willamette Facilities Plan
WRRF	Water Resource Recovery Facility
WSE	water surface elevations
ZID	zone of immediate dilution

Chapter 1

INTRODUCTION

1.1 Introduction

Clackamas Water Environment Services (WES), also referred to as the "District," prepared three facilities plans for its two main wastewater treatment facilities, The Kellogg Creek Water Resource Recovery Facility (WRRF) and the Tri-City WRRF, which both discharge to the Willamette River. The Willamette Facilities Plan (WFP) develops scenarios that consider the District's basin that serve the Kellogg Creek and Tri-City WRRFs, which are referred to as 'basin-wide scenarios'. The WFP describes basin-wide scenarios and recommended treatment and conveyance facilities throughout the District's service area. The Kellogg Creek WRRF Plan (Plan) defines the implementation of projects that are specific to the Kellogg Creek WRRF. The Tri-City WRRF Facilities Plan defines the implementation of projects that are specific to the Tri-City WRRF.

The goal of this document, the Plan, is to develop a 20-year capital plan that identifies improvements to the District's Kellogg Creek WRRF. These improvements are designed to provide the best value to the District's ratepayers by maximizing the use of existing infrastructure and optimizing system operation while continuing to protect water quality and human health and supporting economic development.

1.1.1 Background

WES is an intergovernmental partnership formed pursuant to Oregon Revised Statute (ORS) 190 and owns and operates over 340 miles of conveyance infrastructure and three wastewater facilities that can or do discharge to the Willamette River. The Kellogg Creek WRRF discharges up to 25 million gallons per day (mgd) at River Mile 18.5. The remaining flow is treated at, and discharged from, the Tri-City WRRF, at River Mile 25.5. The District also owns the former outfall from the Blue Heron Paper Mill (at River Mile 27.8) and the load allocations associated with the National Pollutant Discharge Elimination System (NPDES) permit for this facility. There is no active discharge at the Blue Heron site, but WES retains a valid NPDES permit.

The District was created in 2016 under ORS 190 as a governmental partnership between Clackamas County Service District No. 1 (CCSD No. 1) and Tri-City Service District (TCSD). WES is managed by the County Department of the same name in a coordinated effort within the overall county organization to provide long-term certainty and stability for its customers. A brief history of the District partnership is provided below:

- In June 2017, the Surface Water Management Agency of Clackamas County (SWMACC) joined the partnership.
- On July 1, 2017, the District began providing wastewater treatment services at the Tri-City and surface water management services to the SWMACC service area.

- On July 1, 2018, the District began providing wastewater collection and treatment services to the CCSD No. 1 service area and surface water management services within the City of Happy Valley and unincorporated Clackamas County.
- In 2018, the permits for Kellogg Creek, Tri-City, and Blue Heron Paper Mill were integrated under a single entity.

WES now serves as an independent municipal corporation authorized to provide specific services within specified boundaries within Clackamas County. The consolidation associated with the District's formation creates regulatory and operational opportunities, which the Plan will address.

1.1.2 Purpose

The purpose of the Kellogg Creek WRRF Facilities Plan is to develop, evaluate, and recommend improvements at the Kellogg Creek WRRF as part of the selected basin-wide scenario described in the Willamette Facilities Plan and resulting from condition and capacity assessments.

The Plan was developed in a manner consistent with the District's regional approach to planning and operating its conveyance and treatment facilities, and in accordance with requirements for wastewater planning documents set forth by the Oregon Department of Environmental Quality (DEQ) that support subsequent Clean Water State Revolving Fund (SRF) funding.

1.1.3 Additional Plan Documents

The Kellogg Creek WRRF Facilities Plan was developed simultaneously with the Willamette Facilities Plan and the Tri-City WRRF Facilities Plan, which are considered as supporting planning documents.

The Willamette Facilities Plan describes the basin-wide scenarios and recommended treatment and conveyance facilities throughout the District's planning area, while the Kellogg Creek WRRF Facilities Plan and the Tri-City WRRF Facilities Plan define the projects that are specific to each facility.

1.1.4 Related Documents

The following sources were used to develop this Plan:

- Portland State University College of Urban & Public Affairs Population Research Center.
- US Census Bureau American Community Surveys, Clackamas County, 2009-2017.
- The Oregon Conservation Strategy, Oregon Department of Fish and Wildlife, 2016.

The following Clackamas County and District reports and plans were also referenced:

- Population Forecasts for Clackamas County Service Districts, August 2016, EcoNorthwest.
- Clackamas County Economic Landscape, Emerging Trends Update, 2017 Update, FCS Group.
- Sanitary Sewer System Master Plan for Water Environment Services, January 2019.
- Tri-City Solids Handling Improvements (TCSHI), 2018.
- Tri-City Site Master Plan, 2013 Update.
- 2018- 2023 WES Capital Improvement Plan, 2018.
- Proposed 2019-2020 WES Fiscal Year Budget, 2019.
- Watershed Action Plan Kellogg-Mt. Scott Watershed, June 2009.
- Watershed Action Plan Rock Creek Watershed, June 2009.

1.2 Plan Requirements

This Plan meets the requirements of the following three documents, which are briefly described in this section:

- Oregon DEQ Wastewater Facility Planning Guide, July 2019.
- Oregon's Integrated Water Resources Strategy, 2017 Update.
- Statewide Land Use Goal 11, 2005 Update.

1.2.1 Oregon DEQ Wastewater Facility Planning Guide, July 2019

The Oregon DEQ developed a Wastewater Facility Planning Guide (Guide) to help communities develop and evaluate wastewater alternatives to meet their long-term needs. The Oregon DEQ administers the SRF, which provides below-market rate loads to public agencies for preparing planning and environmental review documents, designing and constructing wastewater facilities, and completing other water quality improvement design and construction projects.

The Guidelines for Preparing Wastewater Planning Documents and Environmental Reports for Public Utilities, last revised in July 2019, outline the required contents of a wastewater planning document. The Kellogg Creek WRRF Facilities Plan, as well as the Tri-City WRRF Facilities Plan and the Willamette Facilities Plan, were prepared in accordance with this Guide.

1.2.2 Oregon's Integrated Water Resources Strategy, 2017 Update

In 2012, the State of Oregon's Water Resource Commission adopted the Integrated Water Resources Strategy (IWRS). The goal was to bring various sectors and interests together to work toward the common goal of maintaining healthy water resources for Oregonians and the environment for generations to come.

The IWRS provides a blueprint to help the state focus its efforts on two key goals: improving the understanding of Oregon's water resources and meeting Oregon's water resources needs. The document discusses critical issues facing the state and recommends actions to address the issues, including meeting its instream and out-of-stream water needs relative to water quantity, water quality, and ecosystem needs. In 2017, the IWRS was updated and introduced nine new recommended actions.

The IWRS-recommended actions applicable to wastewater planning and the District's fulfillment of the actions can be found in the WFP.

1.2.3 Statewide Land Use Goal 11, 2005 Update

In Oregon, the foundation for the statewide program for land use planning is a set of 19 statewide land use planning goals. The objective of Goal 11 is to plan and develop a timely, orderly, and efficient arrangement of public facilities and services to serve as a framework for urban and rural development. This goal directs local governments to establish an urban growth boundary and provide sewer services inside it.

Associated planning documents must describe the boundary and show compliance with Goal 11 and the local comprehensive plan. Wastewater planning documents must also include an affirmative land use compatibility statement from the local government to demonstrate compatibility with the comprehensive plan. The District's fulfillment of this requirement can be found in the WFP.

1.3 Plan Organization

The following is a summary of the Kellogg Creek WRRF Facilities Plan organization by chapter:

- **Chapter 1 - Introduction:** Describes the purpose and need for the Kellogg Creek WRRF Facilities Plan, the Plan requirements, and the Plan scope and organization.
- **Chapter 2 - Planning Area Characteristics:** Describes the Kellogg Creek Service Area and the population and employment trends and projections in the service area.
- **Chapter 3 - Wastewater Flows and Loads:** Presents a summary of the projected wastewater flows and loads for the Kellogg Creek Service Area.
- **Chapter 4 - Permitting and Regulatory Considerations:** Presents information on the regulatory elements that are the primary driver for the immediate and potential future improvements to the Kellogg Creek WRRF.
- **Chapter 5 - Existing WRRF Capacity:** Summarizes the existing capacity at the Kellogg Creek WRRF, including the unit process design criteria.
- **Chapter 6 - Existing WRRF Condition Assessment:** Presents the condition assessment results and recommendations for improvements resulting from field investigations at the Kellogg Creek WRRF.
- **Chapter 7 - Treatment Alternatives:** Summarizes the process to develop, evaluate, and recommend improvements at the Kellogg Creek WRRF as part of the selected basin-wide scenario, and includes the recommended alternatives to improve the WRRF within the planning period.
- **Chapter 8 - Implementation Plan:** Presents the proposed project sequencing, construction schedule and estimated total project cost through the planning year (2040).

Chapter 2

KELLOGG CREEK SERVICE AREA CHARACTERISTICS

2.1 Introduction

This chapter documents key planning area characteristics of Clackamas Water Environment Services (District) Kellogg Creek Service Area. These characteristics are summarized in a manner consistent with the District's regional approach to planning and operating its conveyance and treatment facilities, and in accordance with requirements for wastewater planning documents set forth by the Oregon Department of Environmental Quality (DEQ) that support subsequent Clean Water State Revolving Fund (SFR) funding.

Details of the District's entire planning area, which was used to compare and select basin-wide scenarios, can be found in the Willamette Facilities Plan. This includes land use information and physical characteristics of the District's planning area.

2.2 Kellogg Creek Service Area

This section defines the Kellogg Creek Service Area and briefly describes the Kellogg Creek Water Resource Recovery Facility (WRRF).

2.2.1 Service Area Definition

The Kellogg Creek Service Area is one of three service areas considered by the Willamette Facilities Plan, which are consistent with the planning area considered in the Sanitary Sewer System Master Plan for Water Environment Services (January 2019). The Kellogg Creek Service Area was originally the Clackamas County Service District No. 1 (CCSD No. 1) and was renamed Rate Zone 2 when the District began providing services to the area in 2018. Rate Zone 2 will be referred to as the "Kellogg Creek Service Area" in this plan. Figure 2.1 shows the Kellogg Creek Service Area.

The Kellogg Creek Service Area includes four separate, noncontiguous sewer service areas encompassing the areas listed below:

- Unincorporated areas of Clackamas County.
- The City of Happy Valley.
- The western edges of Damascus.
- The communities of Hoodland, Boring, and Fischer's Forest Park.
- Surface water management service area within the City of Happy Valley and in unincorporated Clackamas County.
- The City of Milwaukie and Johnson City.

Except for flow that is transferred to the Tri-City WRRF via the Intertie 2 Pump Station, flow generated within the Kellogg Creek Service Area is tributary to the Kellogg Creek WRRF.

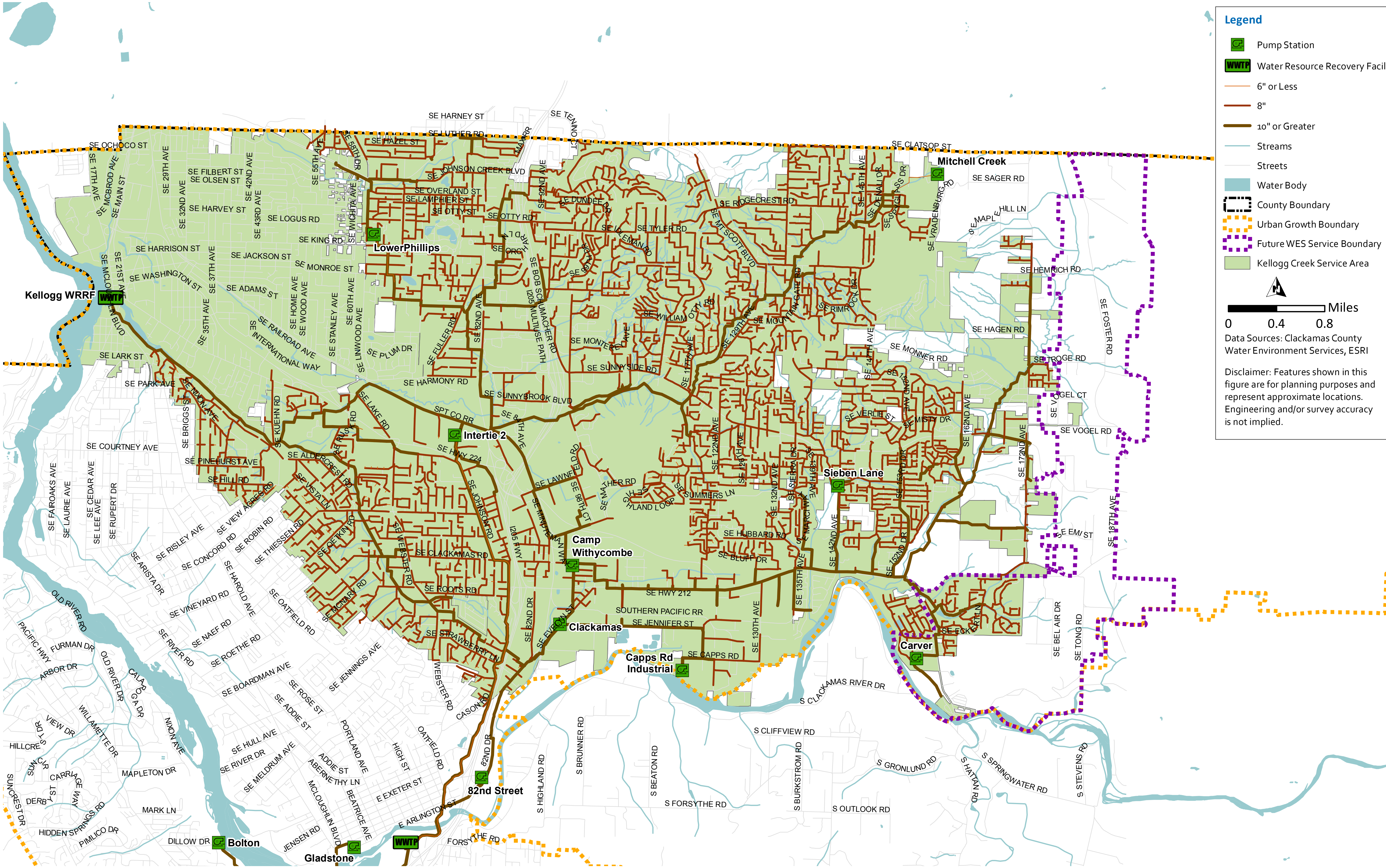

Figure 2.1 Kellogg Creek Service Area Conveyance Infrastructure

2.2.2 Kellogg Creek WRRF Existing Facilities

The Kellogg Creek WRRF is located at 11525 SE McLoughlin Blvd in Milwaukie, Oregon. The facility was brought online in 1974 and has a dry weather flow capacity of 10 million gallons per day (mgd).

2.2.3 Kellogg Creek Surrounding Area

As shown in Figure 2.2, the Kellogg Creek WRRF is located in Milwaukie at the confluence of Kellogg Creek and the Willamette River. The facility is bounded by Highway 99E to the east and the Willamette River to the west. Milwaukie Bay Park and downtown Milwaukie are directly north of the facility site. Directly south of the site is a residential area.

The site is approximately 30 to 40 feet above sea level. The facility is located within the Federal Emergency Management Agency's (FEMA) 100-year floodplain for the Willamette River, creating a flood hazard and potential for interruption of treatment services during storm events.

According to Oregon Metro (Metro), a Riparian Class II habitat is an area supporting one or two primary riparian functions. Metro classifies the Kellogg Creek WRRF site as a Riparian Class II habitat but does not classify it as a wetland.

According to the Oregon Department of Fish and Wildlife (ODFW's) Conservation Strategy, the site is a strategy habitat because it contains a flowing river and is a riparian habitat. ODFW has identified the Willamette River and Kellogg Creek as habitat for the following endangered, threatened, or vulnerable species of native fish:

- Fall and spring chinook.
- Coho.
- Pacific lamprey.
- Summer and winter steelhead.
- White sturgeon.
- Coastal cutthroat trout.

The dominant soils at the site include Quaternary surficial deposits, alluvial deposits, mixed grained sediments, and outburst flood deposits left by the Missoula floods. According to the Oregon Department of Geology and Mineral Industries (DOGAMI), a Cascade Subduction Zone (CSZ) earthquake could produce severe shaking at the Kellogg Creek WRRF, and the potential landslide hazard is high.

Figure 2.2 Kellogg Creek WRRF Vicinity Map

2.3 Population and Employment

Population and employment trends are significant factors in the planning for wastewater conveyance and treatment facilities. This section describes the trends and projections used to determine future flows and loads as part of this plan.

2.3.1 Local Industry

Clackamas County's principal economic activities include agriculture, timber, manufacturing, and commerce. According to the Clackamas County Economic Landscape Emerging Trends Update from 2017, the gross domestic product (GDP) for 2015 was $18.8 billion. The 2015 GDP was up from $17.6 billion in 2014 and $18.1 billion in 2013. The top industries in Clackamas County, in order of annual GDP contribution to Clackamas County, are as follows:

- Professional business services.
- High-tech manufacturing.
- Wholesale trade.
- Healthcare.
- Advanced manufacturing - metals and machinery.
- Software and media production.
- Transportation and distribution.
- Agriculture and food production.
- Food and beverage processing.
- Nurseries and greenhouses.
- Wood manufacturing.

2.3.2 Socio-Economic Trends

The US Census Bureau conducted an annual American community survey (ACS) to help local officials and businesses understand changes in their communities. The ACS provides data on jobs and occupations, educational attainment, and homeownership, in addition to other population trends. Table 2.1 summarizes socio-economic statistics and trends from 2009 to 2017 for Clackamas County.

Table 2.1 Clackamas County Socio-Economic Trends

Clackamas County	2009	2013	2017
Unemployment(1)	11.3%	7.2%	3.8%
Median household income (dollars)(2,3)	$74,905	$76,549	$72,408
Median nonfamily income (dollars)(2,3)	$36,266	$37,812	$42,366
Education: high school graduate or higher(2)	91.9%	93.1%	93.9%
Education: Bachelor's degree or Higher(2)	30.0%	30.9%	34.9%
Below poverty level(2)	No data	9.8%	9.0%

Notes:
(1) Source: WES 2019-2020 Fiscal Year Budget.
(2) Source: U.S. Census Bureau American Community Surveys.
(3) Due to lack of 2009 data, 2010 data is shown.

According to Table 2.1, the economic trend for Clackamas County was generally positive from 2009 to 2017, with the unemployment rate steadily decreasing since 2009. Although the median household income decreased between 2013 and 2017, the median nonfamily income increased by approximately 18 percent from 2010 to 2017. Also, education levels increased from 2009 to 2017, and poverty decreased between 2013 and 2017.

2.3.3 Current Kellogg Creek Service Area Populations

As of 2018, the estimated population for the District's Kellogg Creek Service Area is approximately 100,905 people (Source: WES 2019-2020 Fiscal Year Budget).

2.3.4 Households and Employment

Table 2.2 summarizes the household and employee projections for the District's planning area, per the Sanitary Sewer System Master Plan for Water Environment Services. Note, a separate projection of the number of households and employees in the Kellogg Creek Service was not determined.

Table 2.2 Planning Area Household and Employee Projections

	2015	2040
Number of households	76,200	84,700
Number of employees	102,600	123,000

Notes:
(1) Source of data is the Sanitary Sewer System Master Plan for Water Environment Services.
(2) Projections are for the District's entire planning area and are not specific to the Kellogg Creek Service Area.

2.3.5 Kellogg Creek Service Area Population Projections

In 2016, EcoNorthwest completed growth estimates for the various jurisdiction within the District's planning area (Population Forecasts for Clackamas County Service Districts, August 2016). The 20-year population forecasting efforts started with Portland State University (PSU) Population Research Center 2015 certified population estimates and the 2018 Oregon Metro Regional Transportation Plan.

Region-wide forecasts were allocated into Metro Transportation Analysis Zones (TAZs). Population projections included in this chapter were previously reviewed by local jurisdictions. Projections were prepared separately for the Kellogg Creek Service Area and include proposed extensions of the District's service areas, as shown in Figure 2.1. The 2040 estimates for the Kellogg Creek Service Area include the District's expansion in the Happy Valley/Former Damascus area.

The EcoNorthwest population projections by jurisdiction for the Kellogg Creek Service Area through the year 2040 are summarized in Table 2.3. Figure 2.3 shows the population projections graphically. The Kellogg Creek Service Area population is forecasted to increase approximately 36 percent from 2015 through 2040. As shown in Figure 2.3, Happy Valley will have the largest percent increase in population growth in the Kellogg Creek Service Area between 2015 and 2040.

Table 2.3 Kellogg Creek Service Area Population Projection

Jurisdiction	2015	2020	2025	2030	2035	2040
Unincorporated Clackamas County	74,294	81,944	87,236	94,996	101,625	107,236
Milwaukie(1)	20,505(1)	21,291	21,973	22,241	22,076	21,914
Johnson City(1)	565(1)	556	545	536	526	520
Kellogg Creek Service Area(2)	**95,364**	**103,791**	**109,754**	**117,730**	**124,227**	**129,670**

Notes:
(1) Certified Population Estimate, Portland State University, December 2015.
(2) EcoNorthwest growth estimate refers to the Kellogg Creek Service Area as CCSD No. 1.

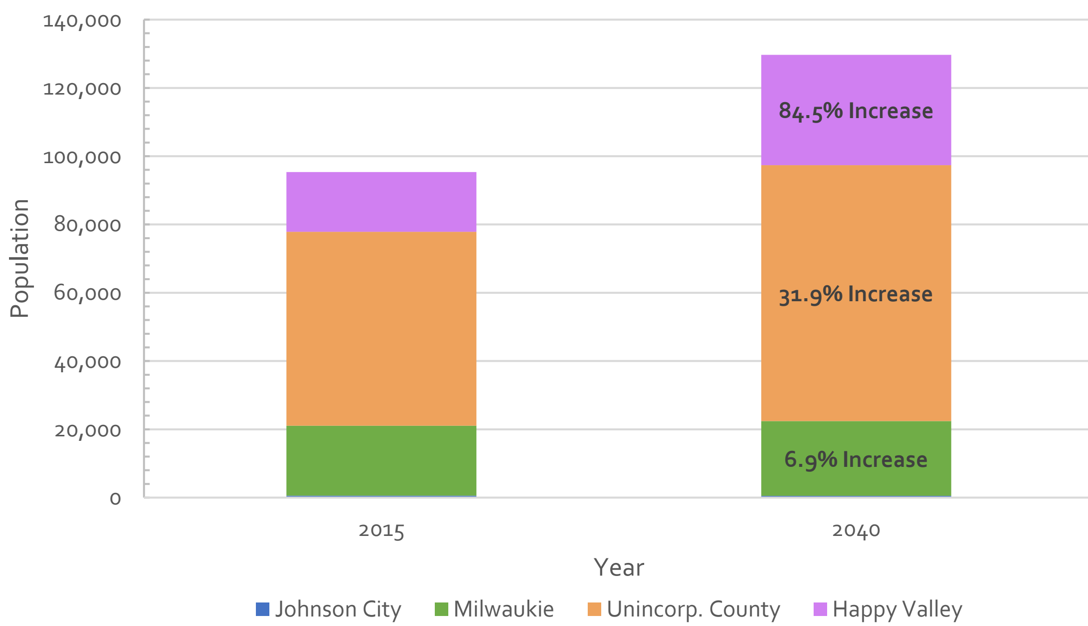

Figure 2.3 Kellogg Creek Service Area Population Projection

Note: Johnson City population is projected to decrease from 2015 to 2040.

2.3.6 Buildout Projections

According to the Sanitary Sewer System Master Plan for Water Environment Services (Master Plan), buildout for the District's planning area is projected to occur in 2087 when the population is anticipated to reach 360,900 people. Buildout utilized per capita dry flows at the lower end of the range reported in Table 3-6 of the Master Plan (approximately 54 gallons per capita per day [gpcpd]). By 2087, 44 percent of the District's service area population is projected to be in the Tri-City Service Area and 56 percent in the Kellogg Creek Service Area (approximately 43 percent upstream of Intertie 2 Pump Station and 13 percent downstream of the Intertie 2 Pump Station).

When buildout is reached in 2087, employment in the District's service area is anticipated to reach 206,500 employees. The buildout utilized per employee dry flows at the lower end of the range reported in Table 3-6 of the Master Plan (approximately 40 gpcpd). By 2087, 37 percent of employees are projected to be in the Tri-City Service Area and 63 percent in the Kellogg Creek Service Area (53 percent upstream of Intertie 2 Pump Station and 10 percent downstream of the Intertie 2 Pump Station).

2.4 Conclusion

Details of the Kellogg Creek Service Area and the Kellogg Creek WRRF surrounding area were considered when developing the basin-wide scenarios and Kellogg Creek WRRF-specific alternatives. The population and employment projections presented in this chapter provide the basis for developing flow and load projections.

Chapter 3

WASTEWATER FLOWS AND LOADS

3.1 Introduction

This chapter summarizes the wastewater flow and load projections for the Kellogg Creek Service Area. The Willamette Facilities Plan provides a more detailed evaluation of the historical wastewater flows and loads generated in the Kellogg Creek service area and the development of the flow and load projections.

3.2 Flow and Load Parameters

The flow parameters of primary interest for planning purposes are defined below. Two methods were used to define existing flows: 1) analysis of historical plant records; and 2) Oregon State Department of Environmental Quality (DEQ) Guidelines for Making Wet-Weather and Peak Flow Projections for Sewage Treatment in Western Oregon, herein described as the DEQ methodology. Base wastewater flow and peak day dry weather flow were determined through analysis of historical plant records.

In each case, the most reasonable and conservative value was selected as the basis for determining the capacity of the Kellogg Creek Water Resource Recovery Facility (WRRF) and was used for subsequent alternatives evaluation. Kellogg Creek historical service area flows were calculated by adding the flow recorded from the Intertie 2 pump station to the influent flow measured at the Kellogg Creek WRRF.

1. **Base Wastewater Flow (BWF):**
   a. The average daily flow in the months of July and August.
2. **Average Dry Weather Flow (ADWF):**
   a. The average of daily flows over the six-month dry weather season, May 1 through October 31.
   b. The average flow during May through October corresponding to long-term average rainfall for the period from May through October.
3. **Average Wet Weather Flow (AWWF):**
   a. The average of daily flows during the wet weather season, November 1 through April 30.
   b. The average flow during November through April corresponding to long-term average wet weather rainfall.
4. **Maximum Month Dry Weather Flow (MMDWF):**
   a. The maximum 30-day running average flow occurring during the months of May through October.
   b. The average monthly flow corresponding to the wettest dry weather month of high groundwater (May) with a 10 percent probability of occurrence in any given year.
5. **Maximum Month Wet Weather Flow (MMWWF):**
   a. The maximum 30-day running average flow occurring during the months of November through April.
   b. The anticipated monthly average flow corresponding to the wettest wet weather month of high groundwater (January) with a 20 percent probability of occurrence in any given year.
6. **Maximum Week Dry Weather Flow (MWDWF):**
   a. The maximum seven-day running average flow from May through October.

7. **Maximum Week Wet Weather Flow (MWWWF):**
   a. The maximum seven-day running average flow from November through April.
8. **Peak Day Dry Weather Flow (PDDWF):**
   a. The maximum daily flow from May through October.
9. **Peak Day Wet Weather Flow (PDWWF):**
   a. The maximum daily flow from November through April.
   b. The anticipated daily flow resulting from a 24-hour storm with a 1-in-5-year recurrence interval during a period of high groundwater and saturated soils.
10. **Peak Hour Flow (PHF):**
   a. The peak flow sustained for a one-hour period during the 24-hour, five-year return frequency storm, at a time when groundwater levels are high, and soils are saturated by previous storms as determined through hydraulic modeling of the collection system.
   b. The anticipated peak hourly flow resulting from linear extrapolation on a log-normal plot of the average annual, maximum month and peak day flows plotted against their respective recurrence intervals.

In addition to these flow parameters this chapter considered the following parameters for biochemical oxygen demand (BOD) and total suspended solids (TSS) loads:

1. **Average Annual (AA):** The average load over a calendar year.
2. **Maximum Month (MM):** The maximum 30-day running average load.
3. **Maximum Week (MW):** The maximum 7-day running average load.

3.3 Summary of Flow Projections

Table 3.1 summarizes the base BWF for 2018, 2040, and buildout based on the projected population growth, as shown in Chapter 2.

Table 3.2 summarizes the projected flows for the Kellogg Creek Service Area. ADWF, AWWF, MMDWF, MMWWF, MWDWF, MWWWF, and PDDWF were projected by multiplying the resulting BWF projection by the peaking factors developed for each parameter, as presented in the Willamette Facilities Plan. Since the peak flows (PDWWF and PHF) are more related to collection system age and ground water infiltration than population growth, the collection system model developed during the Sanitary Sewer Master Plan (2019, Jacobs) was used to project PDWWF and PHF.

Table 3.1 Kellogg Creek Service Area BWF Projection

	2018	2040	Buildout
Population	100,400	129,700	202,100
Per capita flow	73	73	73
Residential BWF, mgd	7.3	9.5	14.7
Total BWF, mgd	7.3	9.5	14.7

Notes:
Abbreviations: mgd - million gallons per day.

Table 3.2 Kellogg Creek Service Area Flow Projection Summary

Flow Component	2018	2040	Buildout
BWF	7.3	9.5	14.7
ADWF	8.0	10.3	16.0
MMDWF	11.5	14.8	23.1
MWDWF	15.4	19.9	31.1
PDDWF	19.7	25.5	39.7
AWWF	11.9	15.4	24.0
MMWWF	17.1	22.1	34.5
MWWWF	23.2	29.9	46.7
PDWWF	33.5	46.6	87.9
PHF	41.2	57.2	107.8

3.4 Summary of Combined Load Projection

A detailed analysis of the historical and existing loads for the District's Tri-City and Kellogg Creek service areas can be found in the Willamette Facilities Plan. Unlike flows, which can be highly variable depending on the age and condition of the service area collection system, residential loads are typically similar between different service areas. For this reason, loads for both the Tri-City and Kellogg Creek service areas were developed together for planning purposes.

Table 3.3 summarizes the results of the per capita analysis for each load parameter, and shows the per capita value used for the load projections. Projected loads were developed by first projecting the average load from 2018 to future conditions accounting for the anticipated growth in the residential population, industry, and septage. Table 3.4 summarizes the average annual, maximum month, and maximum week load projections for 2018, 2040, and buildout conditions. Note, the projected average annual loads shown in Table 3.3 and the load projections shown in Table 3.4 are for both the Tri-City and Kellogg Creek service areas.

Table 3.3 Projected AA Loads for District's Planning Area

	Population	Per Capita Load, ppcd	Residential AA, ppd	Industrial Load, ppd	Septage Load, ppd	Total AA, ppd
BOD						
2018	174,100	0.19	32,700	3,000	600	36,300
2040	218,400	0.19	41,000	3,000	600	44,600
Buildout	360,900	0.19	67,800	3,000	600	71,400
TSS						
2018	174,100	0.21	36,600	2,000	1,500	40,000
2040	218,400	0.21	45,900	2,000	1,600	49,500
Buildout	360,900	0.21	75,800	2,000	1,600	79,400

	Population	Per Capita Load, ppcd	Residential AA, ppd	Industrial Load, ppd	Septage Load, ppd	Total AA, ppd
Ammonia						
2018	174,100	0.017	2,920	400	66	3,380
2040	218,400	0.017	3,360	400	66	4,120
Buildout	360,900	0.017	6,050	400	66	6,510
Total Phosphorus						
2018	174,100	0.007	1,220	NA	NA	1,220
2040	218,400	0.007	1,530	NA	NA	1,530
Buildout	360,900	0.007	2,530	NA	NA	2,530

Notes:
(1) Industry load projections taken from the *Tri-City Water Resource Recovery Facility Solids Handling Improvement Project TM3 Projected Future Flows and Loads* (2016, Stantec). Since there was no change in the load between 2015 and 2020, these values were assumed for 2018 as well.
(2) Septage flow projections taken from the *Tri-City Water Resource Recovery Facility Solids Handling Improvement Project TM3 Projected Future Flows and Loads* (2016, Stantec). 2018 value is a linear interpolation between the 2015 and the 2020.
Abbreviations: ppcd - pounds per capita per day; ppd - pounds per day.

Table 3.4 Load Projections for District's Planning Area

Load Parameter	2018	2040	Buildout
TSS			
AA	40,000	49,500	79,400
MM	54,800	67,600	108,600
MW	63,700	78,600	126,200
BOD			
AA	36,300	44,600	71,400
MM	46,300	57,000	91,100
MW	50,900	62,500	100,000
Ammonia			
AA	3,380	4,120	6,510
MM	3,940	4,810	7,590
MW	4,560	5,570	8,790
Total Phosphorus			
AA	1,220	1,530	2,530
MM	1,420	1,780	2,940
MW	1,640	2,060	3,410

3.5 Summary of Treatment Flows and Loads

With the District's existing permit, the Kellogg Creek WRRF can treat up to its hydraulic limit of 18 mgd through secondary treatment and 25 mgd with select treat. The remainder of the Kellogg Creek service area flows and loads are diverted to the Tri-City WRRF through the Intertie 2 Pump Station. Table 3.5 summarizes the anticipated flows and loads at the Kellogg Creek WRRF with the existing permit and assuming that the Kellogg Creek WRRF treats as much of the Kellogg Creek service area flows and loads as it has capacity to treat, with the exception that dry weather flows are capped such that the solids loads to the Kellogg Creek WRRF do not exceed the projected wet weather solids loads. This exception minimizes the necessary solids improvements at the Kellogg Creek WRRF while taking advantage of excess dry weather capacity at the Tri-City WRRF.

Table 3.5 Existing Permit Condition Flows and Loads at Kellogg Creek WRRF

	2018	2040	Buildout
Flows			
BWF	7.3	9.5	12.0
ADWF	8.0	10.3	12.0
MMDWF	11.5	12.1	12.7
MWDWF	13.3	14.0	14.7
PDDWF	18.0	18.0	18.0
AWWF	11.9	15.4	18.0
MMWWF	17.1	18.0	18.0
MWWWF	18.0	18.0	18.0
PDWWF	25.0	25.0	25.0
PHF	25.0	25.0	25.0
BOD			
ADW	18,900	24,400	28,500
MMDW	24,100	25,300	26,600
MWDW	22,700	23,900	25,100
AWW	18,900	24,400	28,500
MMWW	24,100	25,300	25,300
MWWW	20,500	20,500	20,500
TSS			
ADW	21,100	27,200	31,800
MMDW	28,800	30,300	31,800
MWDW	28,800	30,300	31,800
AWW	21,100	27,200	31,800
MMWW	28,800	30,300	30,300
MWWW	26,000	26,000	26,000

	2018	2040	Buildout
Ammonia			
ADW	1,700	2,200	2,500
MMDW	2,000	2,100	2,200
MWDW	2,000	2,100	2,200
AWW	1,700	2,200	2,500
MMWW	2,000	2,100	2,100
MWWW	1,800	1,800	1,800
Total Phosphorus			
ADW	700	900	1,100
MMDW	800	900	900
MWDW	800	900	900
AWW	700	900	1,100
MMWW	800	900	900
MWWW	700	700	700

Chapter 4

PERMITTING AND REGULATORY CONSIDERATIONS

4.1 Introduction

This chapter summarizes the permitting and regulatory considerations that were considered when developing, evaluating, and selecting near-term and potential future improvements to the Kellogg Creek Water Resources Recovery Facility (WRRF).

4.2 Framework

It is the responsibility of the Oregon Department of Environmental Quality (DEQ) to establish and enforce water quality standards that preserve the Willamette River's beneficial uses. The DEQ's general policy is one of antidegradation of surface water quality. Discharges from wastewater treatment plants are regulated through the National Pollutant Discharge Elimination System (NPDES). All discharges of treated wastewater to a receiving stream must comply with the conditions of an NPDES permit. The Environmental Protection Agency (EPA) oversees state regulatory agencies and can intervene if the state agencies do not successfully protect water quality.

The Kellogg Creek WRRF, which is regulated by NPDES, discharges to the Willamette River at River Mile 18.5 near the confluence with Kellogg Creek.

4.2.1 Beneficial Uses

To assist in the development of water quality standards, a list of beneficial uses is established for each water body in the state. Oregon Administrative Rule (OAR) 340-041-0340 lists the beneficial uses for the Willamette River in the vicinity of the District's treatment plants as shown in Table 4.1.

Table 4.1 Designated Beneficial Uses for the Willamette River from the Mouth to the Willamette Falls

Beneficial Uses
Public Domestic Water Supply(1)
Private Domestic Water Supply(1)
Industrial Water Supply
Irrigation
Livestock Watering
Fish & Aquatic Life
Wildlife & Hunting
Fishing
Boating
Water Contact Recreation
Aesthetic Quality
Hydro Power
Commercial Navigation & Transportation

Note:
(1) With adequate pretreatment (filtration & disinfection) and natural quality to meet drinking water standards.
Source: OAR 340-041-0340.

4.2.2 Oregon Administrative Rules for Wastewater Treatment

The state surface water quality and waste treatment standards for the Willamette Basin are detailed in the following sections of the OAR:

- OAR 340-041-0004 lists policies and guidelines applicable to all basins. DEQ's policy of antidegradation of surface waters is set forth in this section.
- OAR 340-041-0007 through 340-041-0036 describes the standards that are applicable to all basins.
- OAR 340-041-0061 describes the basis for establishing mass load limits.
- OAR 340-041-0340 through 340-041-0345 contain requirements specific to the Willamette Basin including beneficial uses, approved Total Maximum Daily Loads (TMDL) in the basin, and water quality standards and policies.

The surface water quality and waste treatment standards in the OARs are viewed as minimum requirements. Additionally, more stringent limits developed through the TMDL process would supersede the basin standards.

4.2.2.1 Total Daily Maximum Loads

The Clean Water Act requires DEQ to establish TMDLs and corresponding waste load allocations for all water bodies on the 303 (d) list. DEQ prepared a TMDL for mercury in 2006 and issued the revised draft TMDL in June 2019. The draft DEQ TMDL was rejected by EPA. In November of 2019 DEQ issued a revised TMDL which EPA disapproved. EPA established the Willamette Basin TMDL on December 30, 2019. It is anticipated that a waste minimization strategy will be used along with a variance since the mercury targets may not be attainable in the near term.

DEQ also issued the temperature TMDL in 2006 which was initially approved by EPA. However, EPA's approval was challenged in Federal Court which ruled that the TMDL should not have been approved. DEQ will need to update the Willamette Basin TMDL. It is unlikely that the load allocations in the 2006 TMDL will be increased since the allocation is based in part on the human health allowance in the regulations. For dry season discharges to the Willamette River, DEQ allocated the following temperature loads to Kellogg Creek WRRF:

- Temperature increase: 0.0062 degrees Celsius.
- Thermal load: 96 million kilocalories per day (kcal/day).

The thermal load allocations outlined above are fixed by the TMDL. To calculate the actual thermal load being discharged, the following calculation is required:

$$ETL = QE \times (TE - TR) \times Cf$$

Where:

- ETL = excess thermal load.
- QE = Effluent flow in million gallons per day (mgd).
- TE = Temperature of the Effluent in degrees Celsius (°C).
- TR = River temperature criterion (20°C).
- Cf = Conversion factor (2,446,665).

As is evident from this equation, the river temperature at the time of discharge is not a factor. The NPDES permit will set a thermal load limit expressed in million kilocalories and the actual load discharged will be calculated daily using the seven-day moving average of the plant's maximum daily effluent temperature.

4.2.3 Cold Water Refuge

DEQ published the "Draft Lower Willamette River Cold-Water Refuge Narrative Criterion Implementation Study", January 2020, for submittal to the National Marine Fisheries Service. This study identifies cold-water refuge (CWR) sites including Kellogg Creek and Johnson Creek near the Kellogg Creek WRRF. DEQ did not find enough evidence to recommend the creation of additional CWR in the migration corridor of the Willamette River. However, there are data gaps and United States Geological Survey is also doing similar work which could add potential sites. Implementation of the cold-water refuge is outlined in the draft report and the three proposed steps are listed below:

1. DEQ will implement existing temperature TMDLs to address temperature reductions in the main stem and cold-water tributaries to maintain and enhance the CWRs identified in this report. For example, implementing the Clackamas Basin TMDL will protect the quality of cold-water refuge provided by the Clackamas River confluence.
2. Designated management agencies (DMAs) along the mainstem Willamette River are required to address Cold Water Refugia (CWR) according to the 5-year Willamette Basin TMDL Implementation Plans. The Implementation Plans require DMAs to evaluate impacts to existing CWR, now identified in this study, identify additional CWR if applicable, and provide options for protecting or enhancing such areas.
3. NPDES permits for discharges are required to evaluate and prohibit thermal impacts to CWR under the authority of OAR 340-041-0053 (d). When permits are issued for discharges within the migration corridor, potential for impacts to the CWR identified in this report or by DMAs must be evaluated and thermal plume limitations applied as necessary.

4.2.4 Clean Water Act 303 (d) Listing

The federal Clean Water Act requires that the responsible regulatory agency establish a list of water bodies that do not meet applicable water quality standards. In Oregon, this responsibility falls to the DEQ. This list, known as the 303 (d) list, is updated every three years. In April of 2020, DEQ submitted the Oregon 2018-20 Integrated Report to EPA. EPA approved the report on November 12, 2020 and this report is now in effect. DEQ is now beginning work on the 2020-2022 integrated report.

DEQ's assessment is divided into river segments that are designated as assessment units. Figure 4.1 shows the extent of the assessment units that are relevant to the District's facilities.

The Kellogg Creek WRRF discharges to the Willamette River just upstream of the Milwaukie Bay Park into the Clackamas River to Johnson Creek Assessment Unit. The following are the causes for impaired uses for this reach of the Willamette River:

- Temperature.
- Cyanide.
- Hexachlorobenzene.
- Ethylbenzene.
- Pentachlorophenol.
- polycyclic aromatic hydrocarbons (PAH).

- Dieldrin.
- polychlorinated biphenyls (PCB).
- dichlorodiphenyltrichloroethane (DDT) and derivatives.
- Aldrin.
- Biocriteria.

The Willamette River assessment unit immediately downstream of Milwaukie is known as the Johnson Creek to the Columbia River assessment unit. In addition to the causes for impairment shown above, Johnson Creek to the Columbia River assessment unit includes the following causes of impairment:

- Chlorophyll - a.
- Aquatic Weeds.
- Dissolved Oxygen.
- Harmful Algal Blooms.
- Iron.
- E. coli.
- Chlordane.

Aquatic weeds, harmful algal blooms, chlorophyll-a and the biocriteria could all be related to the nutrient loading in the river. Aquatic growth is stimulated by nutrients that are available in the water. DEQ has not evaluated the conditions in the river to determine if the river is either nitrogen or phosphorous limited. However, upstream tributaries have been found to be phosphorous limited. Dissolved oxygen is primarily influence by oxygen demand exerted by organic loading. A TMDL process will be necessary to establish future treatment requirements. Long-term planning should include provision of footprint at the plant for nitrification and phosphorus removal.

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Willamette River Water Quality Assessment Units

Willamette River assessment units in the proximity of the Tri-City Water Resource Recovery Facility and the Kellogg Creek Water Resource Recovery Facility.

Kellogg Creek WRRF outfall

Tri-City WRRF outfall

Legend:

	DEQ ID	Reach
(yellow line)	OR_SR_1709000704_88_104020	Champoeg Creek to Clackamas River
(orange line)	OR_SR_1709000704_88_104019	Clackamas River to Johnson Creek
(green line)	OR_SR_1709001202_88_104175	Johnson Creek to Columbia River

Kellogg Creek Outfall

Tri-City Outfall

N

Figure 4.1

Willamette River Water Quality Assessment Units

Water Environment Services Regulatory Considerations

4.3 Current Kellogg Creek WRRF Treatment and Discharge Requirements

The Kellogg Creek WRRF discharges to the Willamette River just upstream of the Milwaukie Bay Park and the confluence of the Willamette River and Kellogg Creek.

4.3.1 Existing NPDES Permit Limits

The existing permit limits for the Kellogg Creek WRRF are shown in Table 4.2.

Table 4.2 Kellogg Creek WRRF Effluent Permit Limits

Parameter	Average Effluent Concentration		Monthly Average (lbs/day)	Weekly Average (lbs/day)	Daily Maximum (lbs)
	Monthly	Weekly			
May 1 - October 31					
$CBOD_5$	15 mg/L	25 mg/L	1300	2000	2600
TSS	20 mg/L	30 mg/L	1700	2600	3400
November 1 - April 30					
BOD_5	25 mg/L	40 mg/L	2100	3200	4200
TSS	30 mg/L	45 mg/L	2500	3800	5000
Other Parameter Limitations					
E. coli Bacteria	Shall not exceed 126 organisms per 100 ml geometric mean. No single sample shall exceed 406 organisms per 100 ml.				
Total Chlorine Residual	Shall not exceed a monthly average concentration of 0.03 mg/l and a daily maximum concentration of 0.07 mg/L.				
Ammonia: May 1 to October 31	Shall not exceed a maximum daily limit of 60.1 mg/L or an average monthly limit of 33.9 mg/L.				
Ammonia November 1 to April 30	Shall not exceed a maximum daily limit of 41.9mg/L or an average monthly limit of 25.4 mg/L.				
pH	Shall be within the range of 6.0-9.0.				
BOD_5 Removal Efficiency	Shall not be less than 85 percent monthly average.				
TSS Removal Efficiency	Shall not be less than 85 percent monthly average.				

Note:
Abbreviations: BOD_5 - five-day biochemical oxygen demand; $CBOD_5$ - five-day carbonaceous biochemical oxygen demand; lbs - pounds; lbs/day - ponds per day; mg/L - milligrams per liter; ml - milliliter; TSS - total suspended solids.

The mass loads included in the permit are based on the average dry weather design flow of 10 mgd.

The ammonia and chlorine residual limits shown in Table 4.1 are based on the permit modification issued by DEQ on August 21, 2007.

The permit includes a note that states that the State of Oregon had adopted the EPA 1999 ammonia criteria and upon approval of the new standard by the EPA, there would be no ammonia limit. EPA did not approve that standard and Oregon adopted new ammonia standards in 2015 which EPA has now approved. For the time that the existing permit is in effect, the ammonia limit is in effect.

4.3.2 Outfall

In 2016 the District constructed an outfall diffuser at the end of the existing outfall to improve mixing in the river. The diffuser is the last 120 feet of the outfall and has seven 20-inch vertical risers with Tideflex elastomeric check valve ports. A comprehensive mixing zone study was completed entitled "Outfall Mixing Zone Study for the Kellogg Creek Water Resource Recovery Facility, Outfall 001", (January 2018, CH2M Hill) (Kellogg Creek Mixing Zone Study). This study demonstrated that excellent mixing is achieved with the new outfall diffuser as summarized below:

Discharge Condition:	Dilution Factor:
Existing Flow 1Q10 zone of immediate dilution (ZID)	27
Buildout Flow 1Q10 ZID	22
Existing Flow 7Q10 regulated mixing zone (RMZ)	179
Buildout Flow 7Q10 RMZ	142

With the changed conditions associated with the new diffuser, the study recommends that the definition of the mixing zone be changed from the existing mixing zone defined in the NPDES permit. The recommended RMZ is as follows:

- "Rectangle that has a 280-foot width centered on the diffuser Port No. 5 and a length of 200 feet upstream and downstream from the diffuser alignment and aligned with the diffuser alignment."

The ZID is recommended to remain as:

- "That portion of the allowable mixing zone that is 20 feet from the discharge ports."

The mixing zone study has been submitted to DEQ.

4.3.3 Toxicity

The Kellogg Creek Mixing Zone Study evaluated toxicity based on the improved mixing conditions following construction of the new diffuser. Based on the current Oregon ammonia water quality standard, the reasonable potential analysis (RPA) for ammonia showed that there is no reasonable potential to exceed the ammonia water quality criteria. It is reasonable that the ammonia limit for toxicity be eliminated in the next permit.

As part of the Kellogg Creek Mixing Zone Study, RPAs were developed for both aquatic toxicity and for the human health criteria. The study concluded that the effluent discharges do not have a reasonable potential to exceed either the aquatic life or human health water quality criteria.

4.3.4 Temperature

The long-term temperature requirements are uncertain, but the 2006 temperature TMDL that is currently under revision provides an indication on the likely future discharge requirements. Figure 4.2 shows the thermal load discharged by the Kellogg Creek WRRF during the summer of 2017. Currently there appears to be about 50-percent room for growth with the existing TMDL allocation.

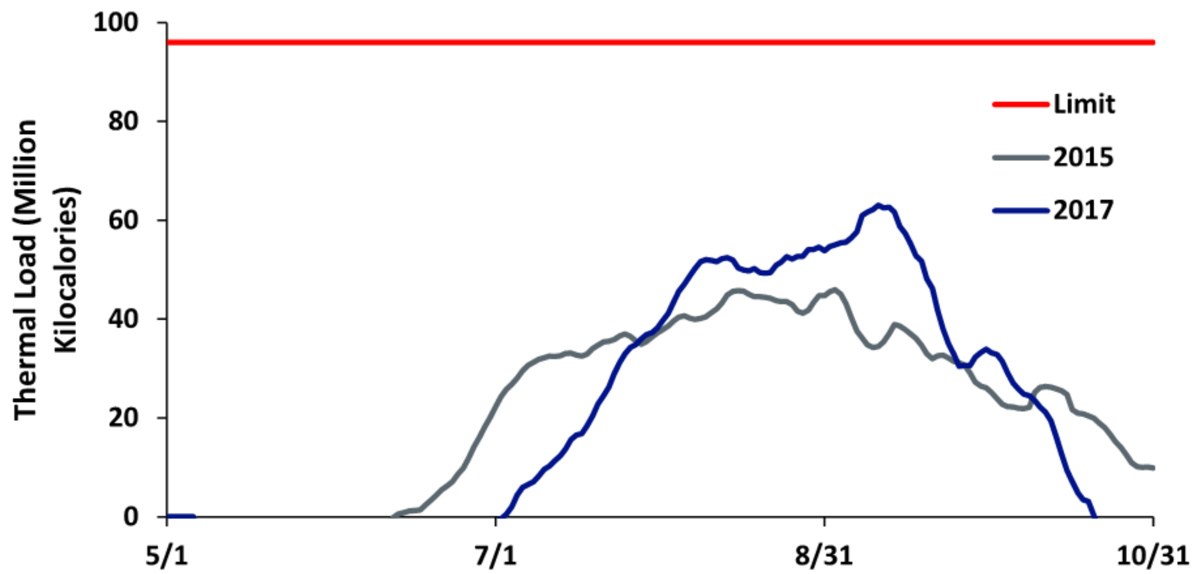


Figure 4.2 Kellogg Creek WRRF 2017 Thermal Load Discharges to the Willamette River

4.3.5 Select Treatment

Kellogg Creek WRRF has secondary treatment capacity for 18 mgd and during major storm events, flows to the plant could exceed this capacity. During such high flow events, primary effluent could be sent directly to the disinfection system and combined with secondary treated effluent for disinfection. This process is called select treatment which has only recently been used at the plant. As a result, the impact of select treatment on plant performance is not available.

4.4 Potential Future Kellogg Creek WRRF Treatment Requirements

The Kellogg Creek WRRF, along with the Tri-City WRRF, are scheduled to receive a revised NPDES permit in 2022, and it is unlikely that any new TMDLs will be promulgated by DEQ in the interim. Improvements that have been made to the existing outfalls and the proposed new outfall for the Tri-City WRRF provide excellent mixing and comply with the ammonia criteria. As a result of these mixing improvements, elimination of permitted effluent ammonia limits at the two plants is anticipated. In addition, the mixing provides for compliance with the aquatic life and human health criteria based on the RPA completed as part of the mixing zone studies.

The Kellogg Creek WWRF effluent limits should remain the same as the 2006 permit with the exception that no ammonia limit is warranted. An interim limit was included in the existing permit pending revision of the water quality standard. With the newly approved standard and the improved mixing, there is no reasonable potential that the discharge will exceed water quality standards. The anticipated limits are shown in Table 4.3.

The capacity of the plant has not been increased so there is no basis for changing the discharge limits to the basin standard.

Table 4.3 Anticipated Kellogg Creek WRRF Effluent Permit Limits

Parameter	Average Effluent Concentration		Monthly Average (lbs/day)	Weekly Average (lbs/day)	Daily Maximum (lbs)
	Monthly	Weekly			
May 1 - October 31					
$CBOD_5$	15 mg/L	25 mg/L	1300	2000	2600
TSS	20 mg/L	30 mg/L	1700	2600	3400
November 1 - April 30					
BOD_5	25 mg/L	40 mg/L	2100	3200	4200
TSS	30 mg/L	45 mg/L	2500	3800	5000
Other Parameter Limitations					
E. coli Bacteria	Shall not exceed 126 organisms per 100 ml geometric mean. No single sample shall exceed 406 organisms per 100 ml.				
Total Chlorine Residual	Shall not exceed a monthly average concentration of 0.03 mg/L and a daily maximum concentration of 0.08 mg/L.				
Ammonia	The interim limit no longer applies as WES fulfilled the Methyl Aluminoxane (MAO) requirements.				
pH	Shall be within the range of 6.0-9.0.				
BOD_5 Removal Efficiency	Shall not be less than 85 percent monthly average.				
TSS Removal Efficiency	Shall not be less than 85 percent monthly average.				

Based on OAR 340-041-0061 (9) (a) (D), The design average wet weather flow is defined as the average flow between November 1 and April 30 when the sewage treatment facility is projected to be at design capacity for that portion of the year. The current recognized average dry weather flow (ADWF) design capacity is 10 mgd as stipulated in Schedule A of the NPDES permit. Based on Table 3.7 of Chapter 3, the existing ADWF is 8.0 mgd and the existing average wet weather flow (AWWF) is 11.9 mgd. If the ADWF increases to 10 mgd, the corresponding AWWF would be 14.9 mgd. If this logic is sound, we should be able to make the case that the daily mass load be suspended when the daily flow exceeds 14.9 mgd. These are the provisions set forth in the rule:

- *(C) On any day that the daily flow to a sewage treatment facility exceeds the lesser hydraulic capacity of the secondary treatment portion of the facility or twice the design average dry weather flow, the daily mass load limit does not apply. The permittee must operate the treatment facility at highest and best practicable treatment and control.*
- *(D) The design average wet weather flow used in calculating mass loads must be approved by the department in accordance with prudent engineering practice and must be based on a facility plan approved by the department, engineering plans and specifications approved by the department, or an engineering evaluation. The permittee must submit documentation describing and supporting the design average wet weather flow with the permit application, application for permit renewal, or modification request or upon request by the department. The design average wet weather flow is defined as the average flow between November 1 and April 30 when the sewage treatment facility is projected to be at design capacity for that portion of the year.*

Based on these rules, a change needs to be reflected in the renewed NPDES permit. The hydraulic capacity of the secondary treatment system for the Kellogg Creek WWRF is 18 mgd, and the permit should suspend the daily mass load whenever the flow to the plant exceeds 18 mgd.

Chapter 5

CAPACITY ANALYSIS

5.1 Introduction

This chapter identifies existing capacity ratings and deficiencies for the various liquid and solids stream treatment processes at the Kellogg Creek Water Resource Recovery Facility (WRRF). The hydraulic capacity of the WRRF under peak flow conditions is also defined. Analyses are based on current operational practices and effluent limits. Alternatives to address capacity limitations identified herein, and/or to meet potential future effluent limits, will be developed and evaluated in Chapters 7 and 8. Assessments and recommendations for improving systems that support major unit processes (e.g., aeration blowers, solids pumps, chemical systems) will be included as part of the subsequent alternatives development and evaluation.

5.2 Design Criteria

The Kellogg Creek WRRF consists of influent pumping, screening, grit removal, primary treatment, secondary treatment, and disinfection. Solids generated through the primary and secondary treatment processes are thickened and anaerobically digested. Digested solids are hauled to the Tri-City WRRF for dewatering prior to disposal. A process flow diagram for the facility in included in Appendix 5A. When possible, unit process design criteria were jointly developed for both the Tri-City and Kellogg Creek WRRFs. Design criteria recommended for the Kellogg Creek WRRF are summarized in Table 5.1.

Table 5.1 Kellogg Creek Unit Process Design Criteria

Unit Process	Design Parameter	Design Criteria	Redundancy Criteria
Influent pumping	**PHF**	**100% of PHF**	**Largest pump OOS**
Screening	**PHF**	**Hydraulically pass flow**	**Largest screen OOS**
Grit Removal	**PHF**	**SOR = 43,000 gpd/sf**	**All units in service**
Primary Treatment	**PHF** MMWWF ADWF	**Hydraulically pass flow** 1,420 gpd/sf(5) 1,620 gpd/sf(6)	**All units in service** All units in service Largest unit OOS
Secondary Treatment			
Aeration Basins	**MMWWF** ADWF	**aSRT = 2.5 days** aSRT = 2 days	**All units in service** Largest unit OOS
Secondary Clarifiers	**PHF** ADWF	**SOR = 1,200 gpd/sf** SOR = 1,200 gpd/sf	**All units in service** Largest unit OOS
Disinfection			
UV Channels	**PHF**	**30 mJ/cm^2**	**All units in service**
Chlorine Contact Basin	**PHF**	HRT=15 min	All units in service

Unit Process	Design Parameter	Design Criteria	Redundancy Criteria
DAFT Thickening	**Max Week Load**	**24 ppd/sf**	**All units in service**
Anaerobic Digestion[3]	**Max Month Load** Max Month Load	**SRT = 20 days** SVSLR = 0.15 lb VS/d-lb VS inventory[4]	**All units in service** All units in service
Dewatering Centrifuge	**Max Month Load**	**90 gpm[7]**	**All units in service**

Notes:
(1) Bold text denotes the capacity-limiting criteria for each unit process.
(2) Disinfection criteria assume chlorine contact basin is only used as backup to the UV channels, whether for redundancy purposes or to treat flow exceeding the rated capacity of the UV channels.
(3) Anaerobic digestion criteria assume 90 percent of the total digester volume is utilized for digestion. Assumed that excess solids will be transferred to Tri-City if a digester needs to be taken out of service for maintenance.
(4) Design criteria for the most recent Tri-City solids expansion project was for a SVSLR of 0.16 lb VS/d-lb VS inventory under max two-week loads. This value was related to a maximum month SVSLR of 0.15 lb VS/d-lb VS inventory using the relationship between max-two week and maximum loads defined in that project.
(5) Projected TSS removal at 1420 gpd/sf is 59 percent.
(6) Projected TSS removal at 1660 gpd/sf is 55 percent.
(7) Assumes 6 days per week, 20 hours per day operation.
Abbreviations: aSRT - aerobic solids retention time; ADWF - average dry weather flow; DAFT - dissolved air flotation thickener; gpd/sf - gallons per day per square foot; gpm - gallons per minute; HRT - hydraulic retention time; lb VS/d-lb VS - pounds per day of volatile solids fed per pound of volatile solids; Max - maximum; min - minute(s); mJ/cm^2 - millijoules per square centimeter; MMWWF - maximum month wet weather flow; OOS - out of service; ppd/sf - pounds per day per square foot; PHF - peak hour flow; SOR - surface overflow rate; SRT - solids residence time; SVSLR - specific volatile solids loading rate; UV - ultraviolet.

5.3 Treatment Plant Flow and Load Projections

Flow and load projections for the Kellogg Creek Service Area are summarized in Chapter 3.

The Tri-City WRRF treats all wastewater generated within the Tri-City service area, along with a portion of the wastewater generated in the Kellogg Creek service area and transferred to the Tri-City WRRF through the Intertie 2 Pump Station. Analysis in this chapter assumes that, during peak day wet weather flows (PDWWF) and PHF, the Kellogg Creek WRRF will treat up to 25 million gallons per day (mgd). Any flow (and associated load) above 25 mgd will be transferred to the Tri-City WRRF. Additionally, since the secondary treatment process at Kellogg Creek WRRF is limited to 18 mgd, analysis in this chapter assumes that maximum month and maximum week flows in excess of 18 mgd are diverted from the Kellogg Creek service area to the Tri-City WRRF. Since the projected solids concentrations are lower in the wet weather seasons, the projected load associated with the 18 mgd secondary treatment hydraulic cap is less during the wet weather season than during the dry weather season. Since the Tri-City WRRF has excess dry weather capacity (see Chapter 5 of the Tri-City WRRF Facilities Plan), additional loads are transferred from the Kellogg Creek WRRF to the Tri-City WRRF to limit the solids loading to the Kellogg Creek WRRF during the dry season. Table 5.2 summarizes the 2040 flow projections for the Kellogg Creek WRRF that result from these flow transfer assumptions.

Table 5.2 Kellogg Creek WRRF Flow Projections

Flow Component	2018			2040		
	Kellogg Creek Service Area, mgd	Transfer from Kellogg Creek to Tri-City WRRF, mgd[1]	Kellogg Creek WRRF, mgd	Kellogg Creek Service Area, mgd	Transfer from Kellogg Creek to Tri-City WRRF, mgd[1]	Kellogg Creek WRRF, mgd
ADWF	8.0	0.0	8.0	10.3	0.0	10.3
MMDWF	11.5	0.0	11.5	14.8	2.7	12.1
MWDWF	15.4	2.1	13.3	19.9	5.9	14.0

Flow Component	2018			2040		
	Kellogg Creek Service Area, mgd	Transfer from Kellogg Creek to Tri-City WRRF, mgd(1)	Kellogg Creek WRRF, mgd	Kellogg Creek Service Area, mgd	Transfer from Kellogg Creek to Tri-City WRRF, mgd(1)	Kellogg Creek WRRF, mgd
PDDWF	19.7	1.7	18.0	25.5	7.5	18.0
MMWWF	17.1	0.0	17.1	22.1	4.1	18.0
MWWWF	23.2	5.2	18.0	29.9	11.9	18.0
PDWWF	33.5	8.5	25.0	46.6	21.6	25.0
PHF	41.2	16.2	25.0	57.2	32.2	25.0

Notes:
(1) Transfer requirement based on the capacity of Kellogg Creek WRRF as defined in this Chapter.
Abbreviations: MMDWF - maximum month dry weather flow; MWWWF - maximum week wet weather flow; MWDWF - maximum week dry weather flow; PDDWF - peak day dry weather flow.

5.4 Unit Process Capacity

5.4.1 Influent Pump Station

The Influent Pump Station at the Kellogg Creek WRRF pumps wastewater collected in the Kellogg Creek service area and internal plant drains. The Influent Pump Station includes four pumps. Two are 200 horsepower (hp) variable-speed pumps, each with a rated capacity of 14 mgd (10,000 gpm) at 45 feet (ft) of total dynamic head (TDH). Two are 60 hp variable speed pumps, each with a rated capacity of 5.5 mgd (3,819 gpm) at 42 ft TDH. The pump station has a total capacity of 39.0 mgd and a firm capacity (single largest unit OOS) of 25.0 mgd. In practice, however, operators have been unable to operate the influent pumps at their rated capacity. It is assumed for the purposes of this evaluation that improvements will be made to the pump station so that the pumps operate at their rated capacities. Design data for the influent pump station are summarized in Table 5.3.

Table 5.3 Influent Pump Station Design Data

Process / Criterion	Unit	Value
Number of Pumps		4
Control		2 at Constant Speed 2 at Variable Speed
Total Capacity	mgd	39
Firm Capacity	mgd	25
Constant Speed Pumps		
Power	hp	200
Number		2
Capacity, each	mgd	14
TDH	ft	45
Variable Speed Pumps		
Number		2
Power	hp	60
Capacity, each	mgd	5.5
TDH	ft	42

Figure 5.1 plots the firm capacity of the Influent Pump Station alongside the current and projected 2040 PHF for the Kellogg Creek WRRF. This figure illustrates that the station has sufficient firm capacity to pump the WRRF cap of 25 mgd.

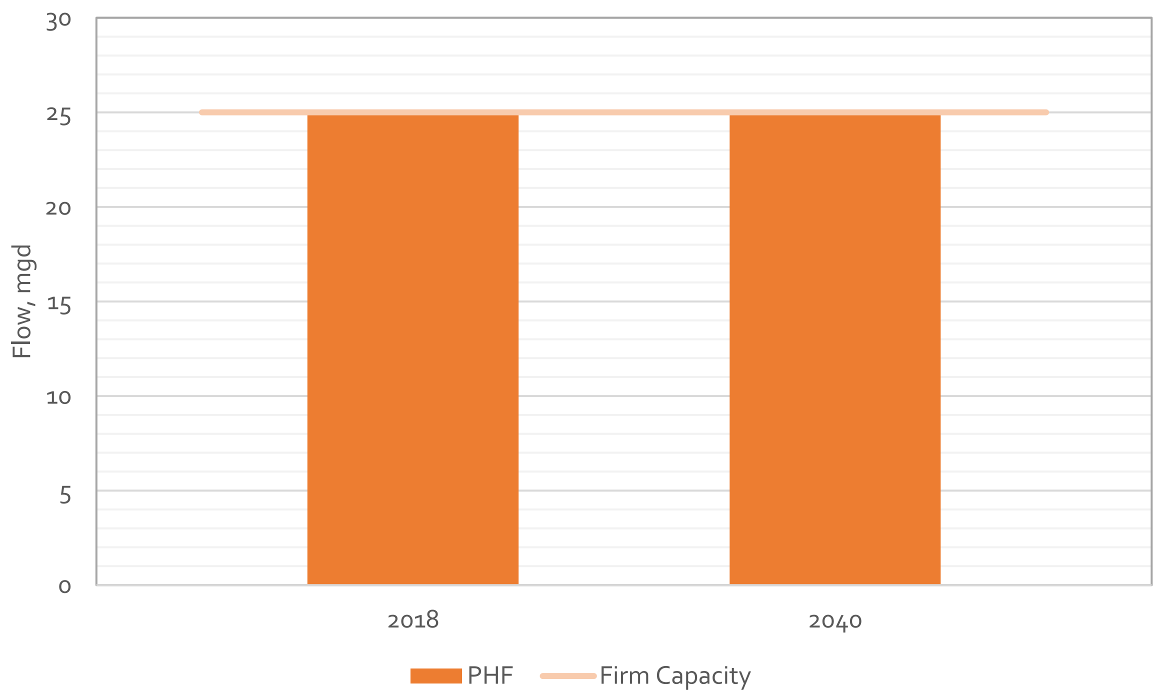


Figure 5.1 Influent Pump Station Capacity

5.4.2 Screening

The Kellogg Creek headworks has two mechanically-cleaned bar screens, each four-foot wide with 3/8-inch openings between bars. A four-foot wide manually-cleaned bar rack with one-inch openings is used to accommodate excess flow. Each mechanically-raked screen is rated for 25 mgd, per the plant Operations and Maintenance manual. This provides sufficient firm capacity to match the plant's hydraulic limit. Design data for the screens are summarized in Table 5.4.

Table 5.4 Screening Design Data

Process / Criterion	Unit	Value
Number of Screens		Two mechanically raked bar screens, one manually-raked rack.
Firm Capacity	mgd	25
Total Capacity	mgd	50
Mechanical Screens		
Number		2
Firm Capacity	mgd	25
Total Capacity	mgd	50
Bar Spacing	inch	3/8

Process / Criterion	Unit	Value
Manual Bar Rack		
Number		1
Capacity	mgd	25
Bar Spacing	inch	1

Figure 5.2 illustrates the screening capacity relative to the hydraulic capacity and current and projected flows for the Kellogg Creek WRRF. As shown by the figure, screening capacity is sufficient for the hydraulic cap of 25 mgd.

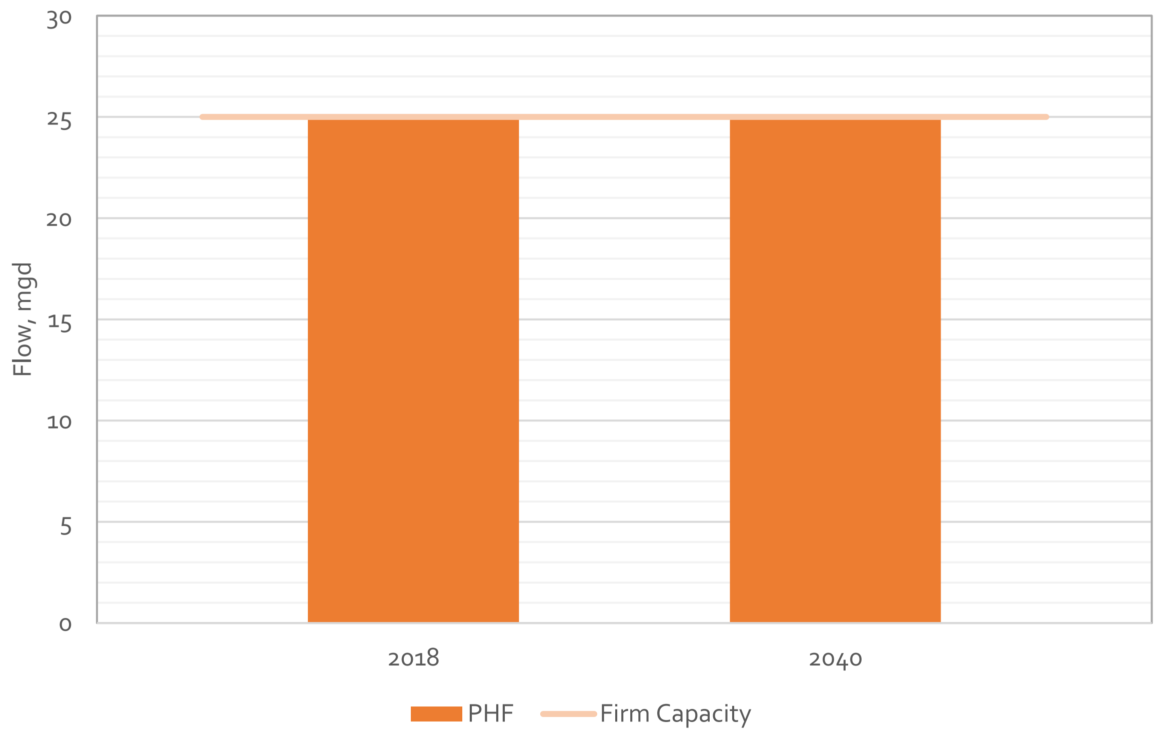


Figure 5.2 Screening Capacity

5.4.3 Grit Removal

Denser and more rapidly settling solids that are suspended in the wastewater influent are removed downstream of the screening process via a detritor tank. In the detritor tank, the velocity of flow is significantly reduced to allow heavier solids to settle. These heavier solids are collected from the bottom of the tank while lighter solids remain in suspension and pass over the discharge weir. The Kellogg Creek detritor tank is 24-ft by 24-ft square, with the grit collection mechanism sweeping a 12-ft radius from the center of the tank. Design data for grit removal are summarized in Table 5.5.

Table 5.5 Grit Removal Design Data

Process / Criterion	Unit	Value
Type		Detritor
Number of Units		1
Tank Dimensions		
Length	ft	24
Width	ft	24
Surface Area	sf	576

Notes:
Abbreviations: sf - square foot.

According to *Sewerage and Sewage Treatment* (Babbitt and Baumann, 1958), a SOR less than 51,000 gpd/sf is recommended to remove grit particles 0.36 millimeter (mm) or larger in a detritor tank, and 25,000 gpd/sf is required to remove particles 0.17 mm or larger (historically "grit" is defined as particles larger than 0.21 mm in diameter). At the hydraulic maximum flow of 25 mgd, the SOR in the detritor will be approximately 43,000 gpd/sf and it is anticipated that at this SOR, only the larger grit particles will be effectively removed. It is assumed for purposes of this evaluation that since Clackamas Water Environment Services (the District) has been able to successfully operate at flows of 25 mgd, the capacity of the detritor tank will be 25 mgd.

Figure 5.3 illustrates the grit removal capacity relative to the current and projected 2040 plant flows, as well as the 25 mgd cap. As shown by the figure, the detritor tank has sufficient capacity for the 25 mgd cap. However, as discussed above, at this flow, it is anticipated that grit removal performance will be reduced.

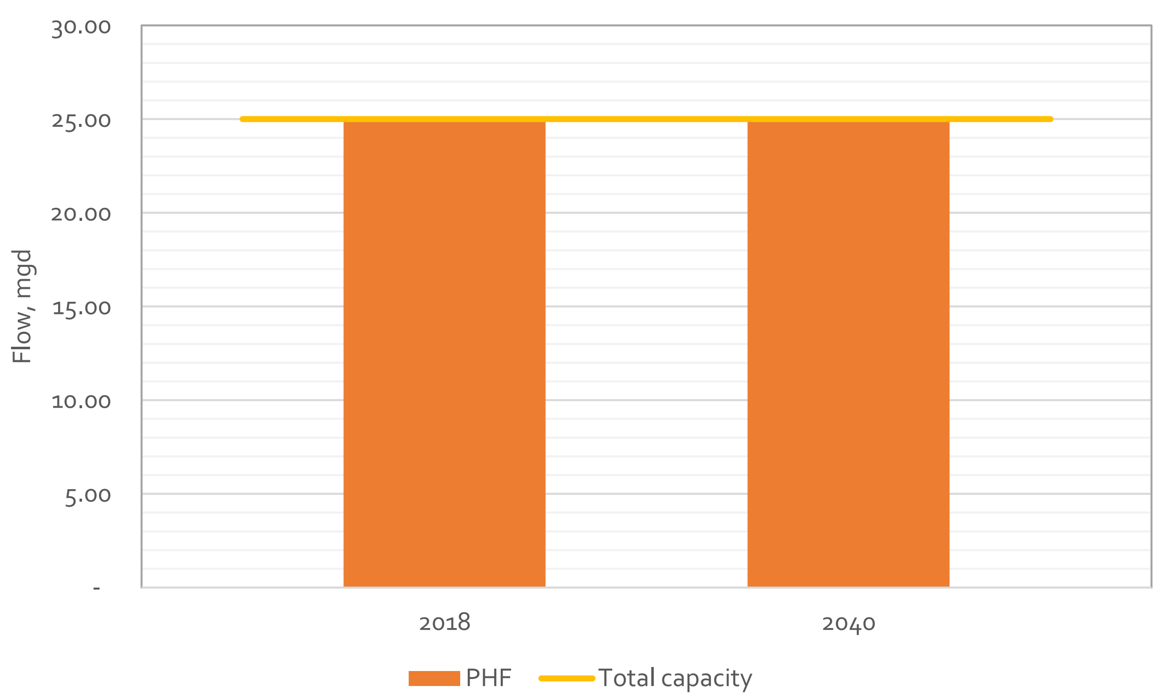


Figure 5.3 Grit Removal Capacity

5.4.4 Primary Clarification

Primary treatment is provided by two 90-ft diameter circular clarifiers with a 10-ft side water depth (SWD). These units remove surface scum, biochemical oxygen demand (BOD), and total suspended solids (TSS) prior to secondary treatment. Design data for the primary clarifiers are summarized in Table 5.6.

Table 5.6 Primary Clarifier Design Data

Process / Criterion	Unit	Value
Number of Units		2
Diameter	ft	90
SWD	ft	10

The performance of the primary treatment system is linked to the capacity of the secondary system since lower primary clarifier removal rates result in higher loads (and thus reduced capacity) to the secondary process. Primary TSS removal percentages correlate with the clarifier SOR, with higher removal rates typically seen at lower SORs. Figure 5.4 shows historical primary TSS removal plotted against SOR, which generally supports this observation.

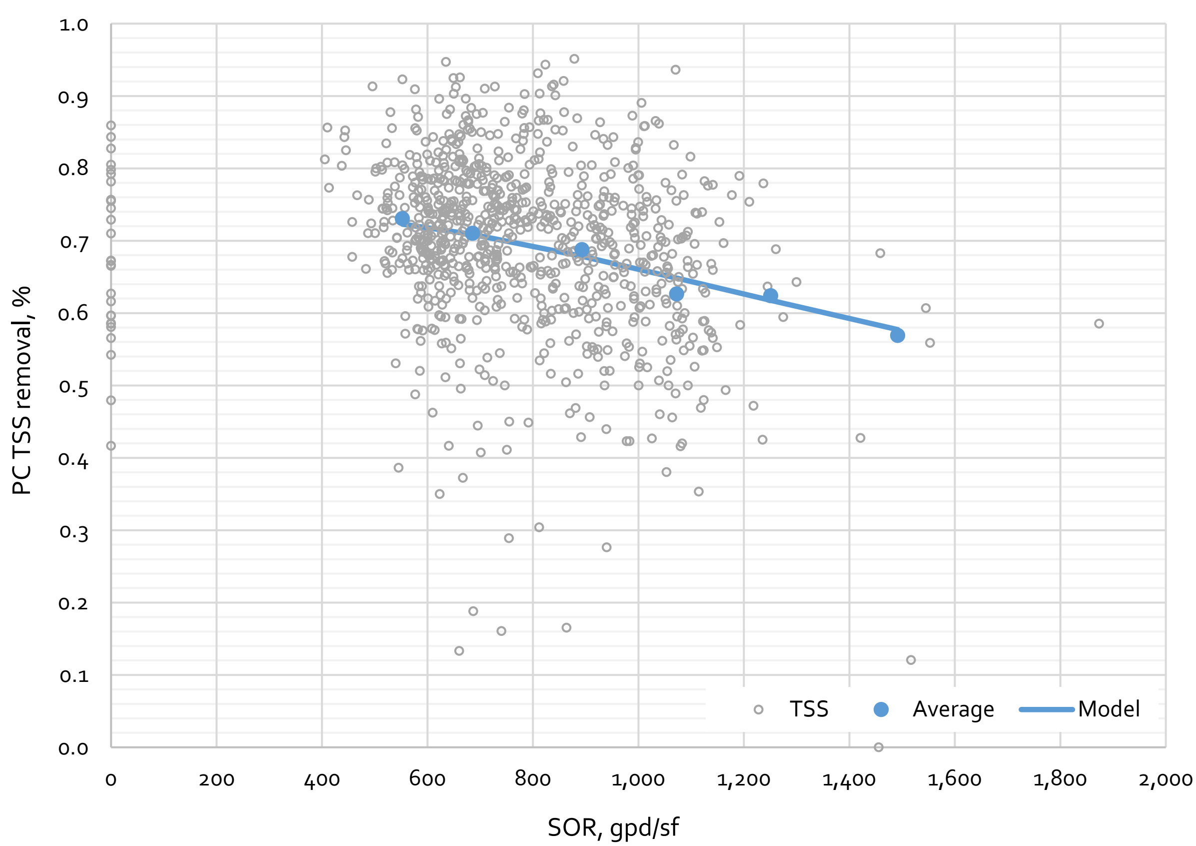


Figure 5.4 Primary Clarifier TSS Removal vs. Surface Overflow Rate

With one primary clarifier out of service during ADWFs, the SOR is expected to be approximately 1620 gpd/sf which correlates to a primary clarifier TSS removal of approximately 55 percent (based on the relationship shown in Figure 5.4). As is shown in the subsequent section, during average dry weather flows and loads, the secondary system has sufficient capacity to treat the projected ADWF of 10.3 mgd with a 55 percent TSS removal through the primary clarifiers assuming that all the aeration basins and secondary clarifiers are online and the minimum aSRT drops to two days. Based on this analysis, the firm capacity of the primary clarifiers is 10.3 mgd.

The primary clarifier SOR corresponding to the maximum secondary treatment flow of 18 mgd is approximately 1,420 gpd/sf which, based on the relationship shown in Figure 5.4, correlates to a primary clarifier TSS removal of approximately 59 percent. As is shown in the subsequent section, the secondary system has sufficient capacity to treat 18 mgd of MMWWF with a 59 percent TSS removal through the primary clarifiers and thus, the MMWWF capacity of the primary clarifiers is 18 mgd.

Under PHF conditions, the primary clarifiers need to be able to hydraulically pass the PHF event. Historically, the primary clarifiers at the Kellogg Facility have been unable to pass the design plant capacity of 25 mgd because of a hydraulic bottleneck in the secondary treatment process, which backed up flow and flooded the primary clarifier effluent weirs. Recent construction at Kellogg Creek has eliminated this bottleneck, reducing the hydraulic grade in the primary clarifiers by providing a select treatment flow path for flows between 18 mgd and 25 mgd. This project has increased the peak hydraulic capacity of the primary clarifiers to 25 mgd.

Figure 5.5 shows the Kellogg Creek primary treatment capacity relative to the current and projected primary flows. The chart shows that the primary clarifiers have sufficient capacity to treat the projected year 2040 ADWF with one primary clarifier out of service, and the projected 2040 MMWWF and PHF with all units in service.

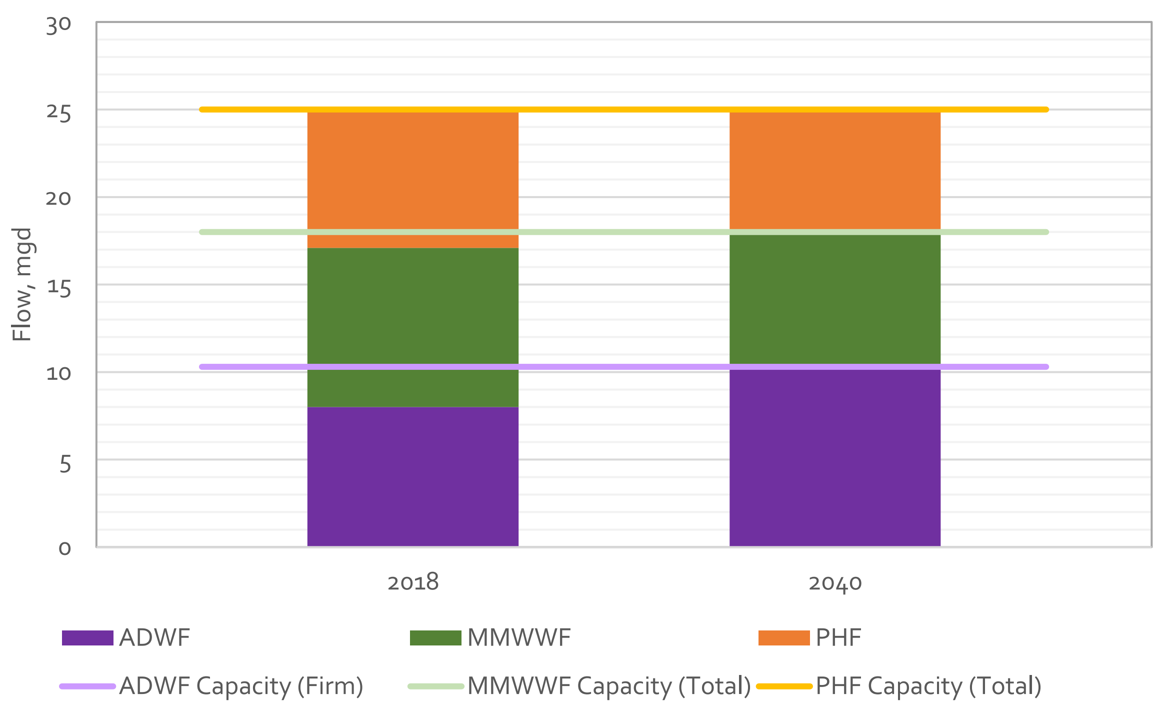


Figure 5.5 Primary Treatment Capacity

5.4.5 Secondary Treatment

The secondary treatment process at the Kellogg Creek WRRF is comprised of four aeration basins and two secondary clarifiers. The aeration basins contain baffle walls which divide each basin into distinct zones, including anaerobic selectors. The aeration basins are configured to allow operation in multiple configurations, but operators typically operate in a plug-flow configuration. Zone 1A is 4,500 cubic feet, Zone 1B is 8,800 cubic feet and Zones 2 through 5 are each between 13,000 and 14,000 cubic feet. The basins are 15 ft deep and Zones 1, 2 and 3 are separated by concrete baffle walls. Zones 3 through 5 are not baffled. All zones are aerated with fine bubble membrane disc diffusers except for Zones 1A and 1B.

Mixed liquor from the aeration basins is combined in the aeration basin effluent channel and flows through two 2-ft Parshall flumes (now submerged) to two secondary clarifiers. The secondary clarifiers are each 105 ft in diameter and have SWD of 15 ft.

Sludge is withdrawn from the bottom of the secondary clarifiers and pumped back to Zone 1A of the aeration basins through the return activated sludge (RAS) pump station. This pump station is comprised of three 20 hp RAS pumps, each rated for 2,777 gpm (4 mgd) at 15 ft TDH. Each pump is equipped with a variable frequency drive (VFD) and paced according to the flow through the secondary process. Design data for secondary treatment are provided in Table 5.7.

Table 5.7 Secondary Treatment Design Data

Process / Criterion	Unit	Value
Aeration Basins		
Number		4
Length	ft	151
Width, each	ft	30
Depth	ft	17.5
Volume		
Anaerobic Volume, each	cubic feet	14,400
Aerobic Volume, each	cubic feet	58,700
Total Volume, each	cubic feet	73,100
Secondary Clarifiers		
Number		2
Diameter	ft	105
SWD	ft	15
RAS Pumps		
Number		3
Control		Variable Speed
Flow Rate, each	gpm	2,777
TDH	ft	15

Notably, the weirs in both secondary clarifiers were raised as part of a 1994 plant improvements project due to the installation of UV disinfection downstream requiring a higher hydraulic grade. This caused the Parshall flumes in the mixed liquor suspended solids (MLSS) splitter box to become submerged, such that they no longer create an even flow split. Operators currently adjust the flow split between duty clarifiers by modulating the position of isolation gates upstream of the flumes. Without this flow balancing, mixed liquor preferentially flows to Secondary Clarifier 1.

The capacity of the aeration basins is closely tied to the process capacity of the secondary clarifiers, which is determined via state-point analysis (SPA). The maximum allowable maximum month MLSS concentration in the aeration basins is selected to promote settling in the secondary clarifiers. The SPA determines the maximum allowable MLSS concentration based on the peak flow rate, the RAS flow rate, and the speed at which the MLSS settles, which is a function of the sludge volume index (SVI).

Figure 5.6 shows the historical SVI at the Kellogg Creek WRRF alongside a 30-day running average value. During the period of record, the average 30-day SVI ranged from approximately 110 milliliters per gram (mL/g) to 390 mL/g, with an overall average of 250 mL/g between January 2016 and May 2019. These SVI values are relatively high for domestic wastewater treatment, with more typical values for well settling sludge around 150 mL/g. Since planning around a SVI as high as 250 mL/g, would significantly limit the capacity of the Kellogg Creek WRRF, the capacity analysis in this chapter assumes a more typical design SVI value of 150 mL/g. Operation and process modifications may be necessary to consistently achieve this SVI value.

The SOR defines the overflow line on the SPA curve. With an SVI of 150 mL/g (Vesilind coefficients are as follows: v_0 = 21.31 feet per hour [ft/hr], k = 0.403 liters per gram [L/g]) and a clarification safety factor of 1.2, the solids flux curve intersects the overflow line at a MLSS concentration of approximately 2,800 milligrams per liter (mg/L), indicating that the max month MLSS concentration must be 2,800 mg/L or less at PHF for the clarifiers to effectively settle the sludge. The SPA curves for max month MLSS at peak hour flow with all units in service is shown in Figure 5.7. Note that this SPA curve shows a RAS flow rate of 36 percent of the influent flow to the aeration basins - this flow reflects the minimum rate at which RAS must be removed to maintain a consistent sludge blanket, or approximately 3.2 mgd per clarifier under peak conditions. This minimum RAS rate is well below the rated 4 mgd capacity of each RAS pump, indicating that the existing RAS pumps are adequately sized for anticipated conditions through 2040.

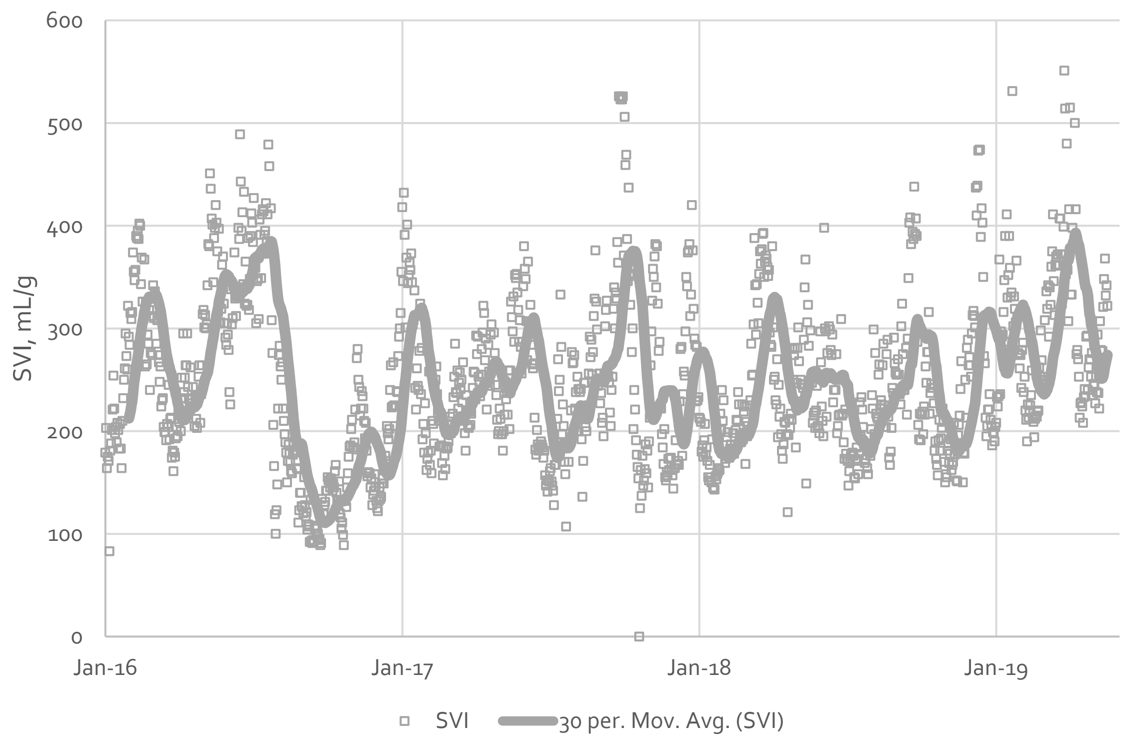


Figure 5.6 Historical SVI

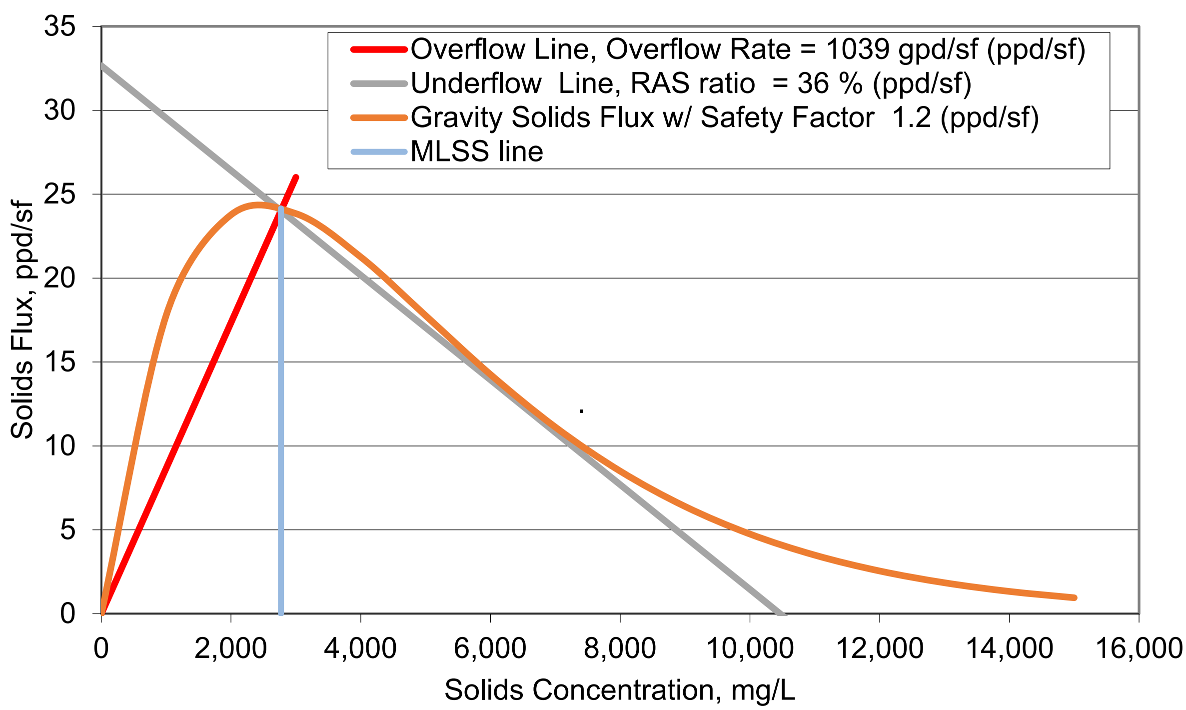


Figure 5.7 SPA for Max Month MLSS at Peak Hour Flow

The aSRT necessary to provide effective secondary treatment was determined through examination of historic data and process modeling in BioWin. Information relating to the calibration of the BioWin model is described in Appendix 5B. Appendix 5C includes a solids mass balance for the MMWWF condition. Plant data shown in Figure 5.8 indicate that the aSRT at Kellogg Creek has ranged from 1.5 to 5 days. As is shown in Figure 5.8, the aSRT does not typically decrease below 2.5 days during the winter; therefore, a minimum aSRT value of 2.5 days was selected for process analysis.

During maximum month wet weather flows and loads, at the design aSRT of 2.5 days, a maximum month MLSS concentration of 2,800 mg/L, and a primary clarifier removal rate of 59 percent, the aeration basins are limited to approximately 18 mgd.

Under average dry weather flow and load conditions, three redundancy criteria were evaluated:

- **One primary clarifier out of service:** Under this condition it was assumed that all the aeration basins and secondary clarifiers are in service and the primary clarifier TSS removal would be 55 percent. During dry weather conditions it was assumed that the aSRT could drop to a minimum of two days.
- **One aeration basin out of service:** Under this condition it was assumed that both primary clarifiers would be in service with a TSS removal rate of 65 percent. Additionally, both secondary clarifiers would be in service and the aSRT could drop to a minimum of two days during the warmer summer temperatures.
- **One secondary clarifier out of service:** Under this condition it was assumed that both primary clarifiers would be in service with a TSS removal rate of 65 percent. Additionally, all aeration basins would be in service and the aSRT could drop to a minimum of two days during the warmer summer temperatures.

Figure 5.9 compares the firm secondary treatment capacity to the current and projected Kellogg Creek ADWFs along with the total secondary treatment capacity to the current and projected MMWWFs. As shown by Figure 5.9, the secondary system has sufficient capacity to treat the projected 2040 flows. Additionally, at the projected 2040 ADWFs, the secondary system had sufficient capacity to handle either a primary clarifier, aeration basin or secondary clarifier out of service.

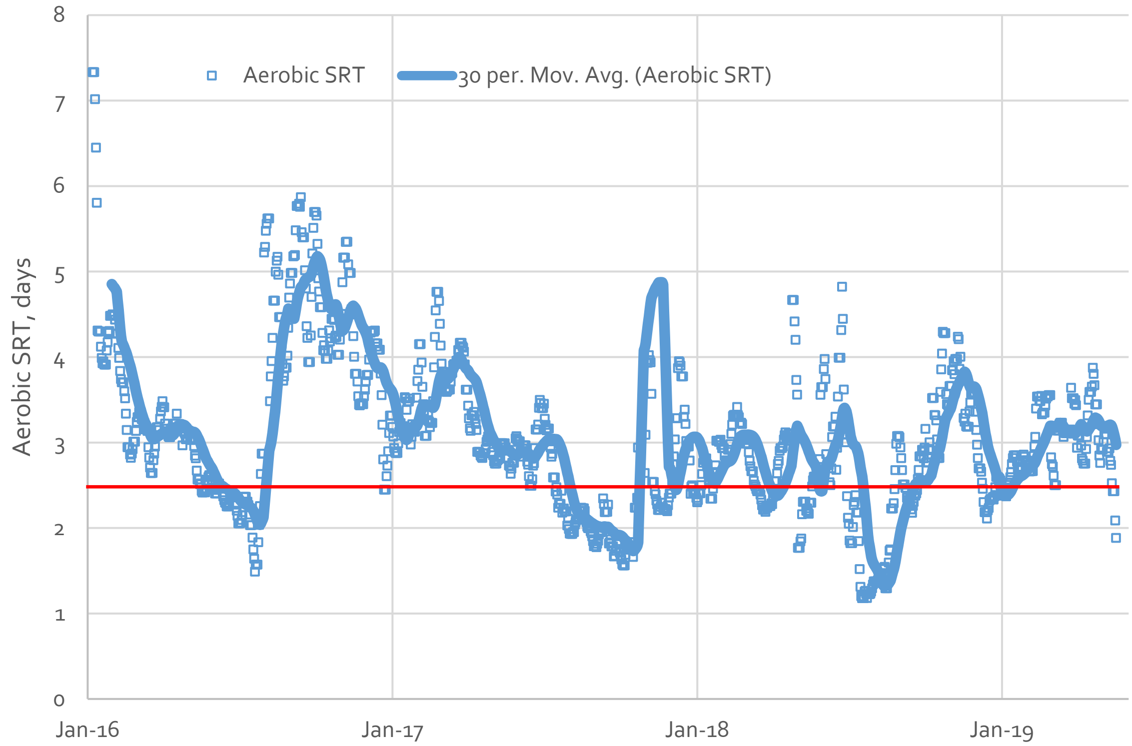


Figure 5.8 Historical Aerobic Solids Retention Time

Note: aSRT calculated using the RAS TSS concentrations.

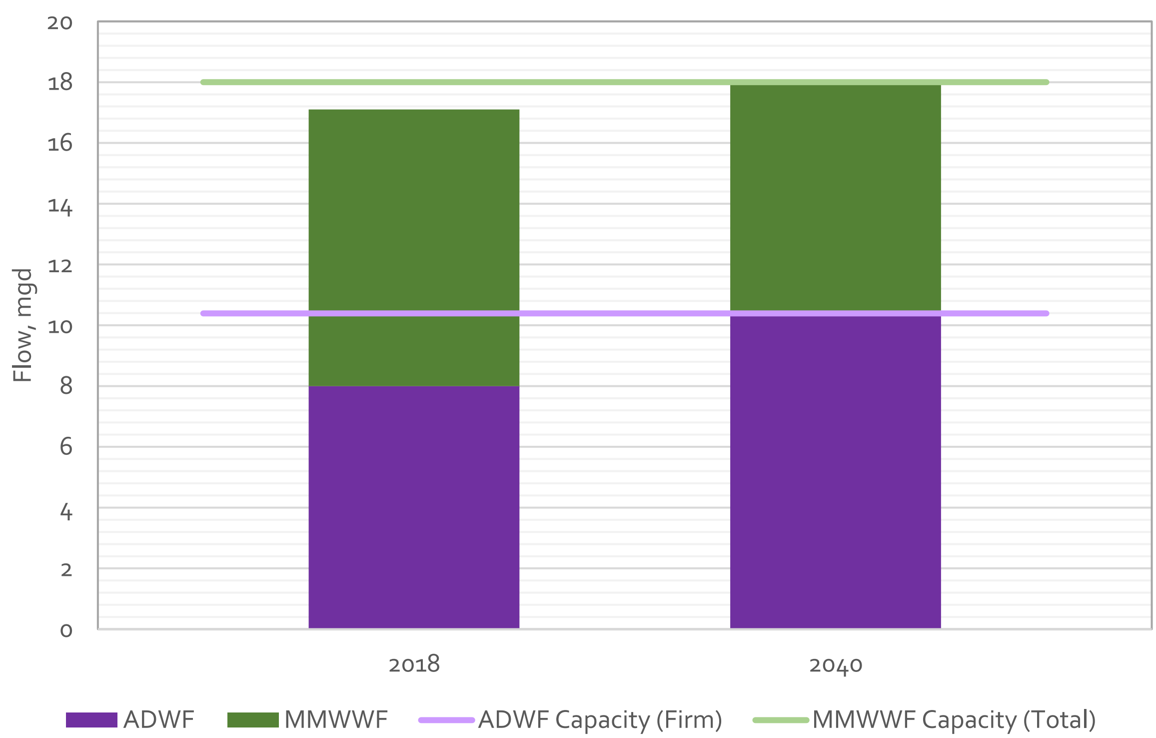


Figure 5.9 Secondary Treatment Capacity

5.4.6 Disinfection

Secondary effluent from the secondary treatment train flows to the UV disinfection channels, where it is exposed to ultraviolet light to inactivate pathogens. There are two UV channels, each with three banks of lamps. In the current configuration, the flow through the UV disinfection process is hydraulically limited to 18 mgd. The UV channels were constructed above one of two trains in an existing chlorine contact basin (CCB). This CCB is used for chlorine disinfection of select treatment flow when the total plant flow exceeds 18 mgd. Disinfected effluent flows are dosed with sodium bisulfite for dechlorination (when chlorination is used) in the discharge box, and flow by gravity to the outfall in the Willamette River. Design data for disinfection are summarized in Table 5.8.

Table 5.8 Disinfection Design Data

Process / Criterion	Unit	Value
UV Channels		
Number		2
Firm Capacity	mgd	9
Total Capacity	mgd	18
Design Dose	mJ/cm^2	30
Chlorine Contact Basins		
Number		2 (1 used during peak flows)
Chamber No. 1 Volume	gallons	293,000

Figure 5.10 illustrates the UV disinfection capacity relative to the current and projected 2040 flows, as well as the 18 mgd cap onflows through UV disinfection.

Select treat flows between the 18 mgd flow treated through UV disinfection and the 25 mgd hydraulic cap, are disinfected through one of the CCBs. Assuming an HRT of 15 minutes during PHF conditions, one of the CCB trains has a capacity of 13.3 mgd, which is sufficient to handle the anticipated select treat flow of 7 mgd (Figure 5.11).

The combined firm capacity of the disinfection system at Kellogg Creek is 22.3 mgd (9 mgd from UV plus 13.3 mgd from one of the CCB trains). Since this exceeds the projected PDDWF of 18 mgd, the plant would be able to treat the projected PDDWF with a UV train out of service through a combination of CCB and UV disinfection.

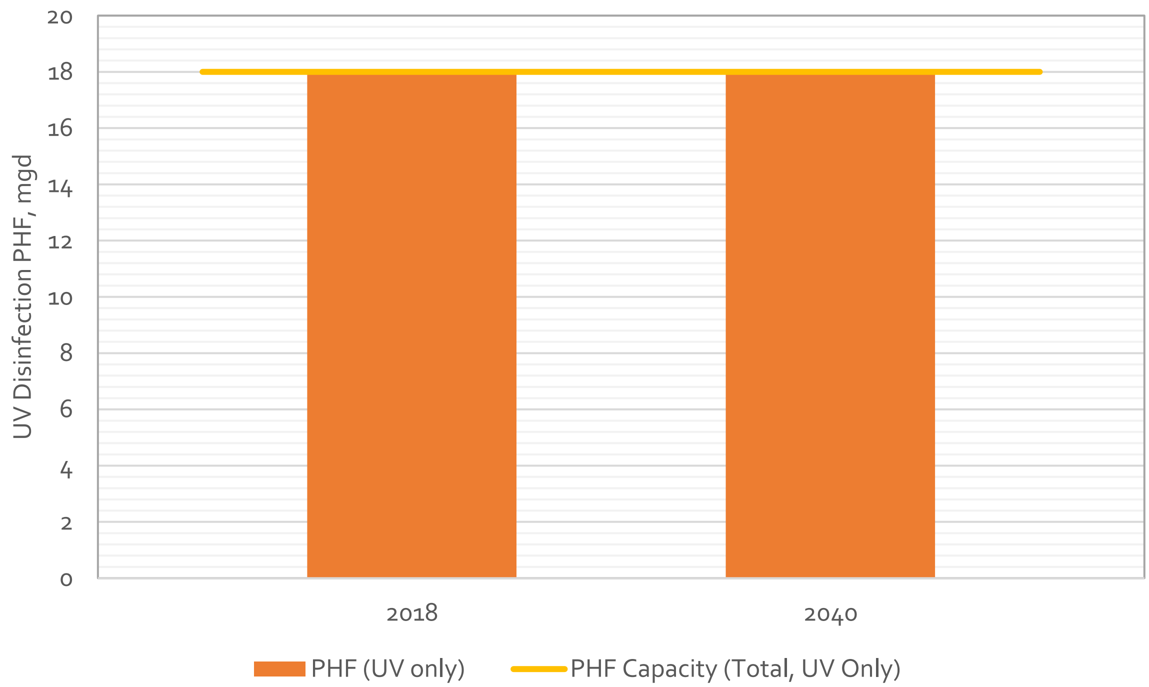


Figure 5.10 UV Disinfection Capacity

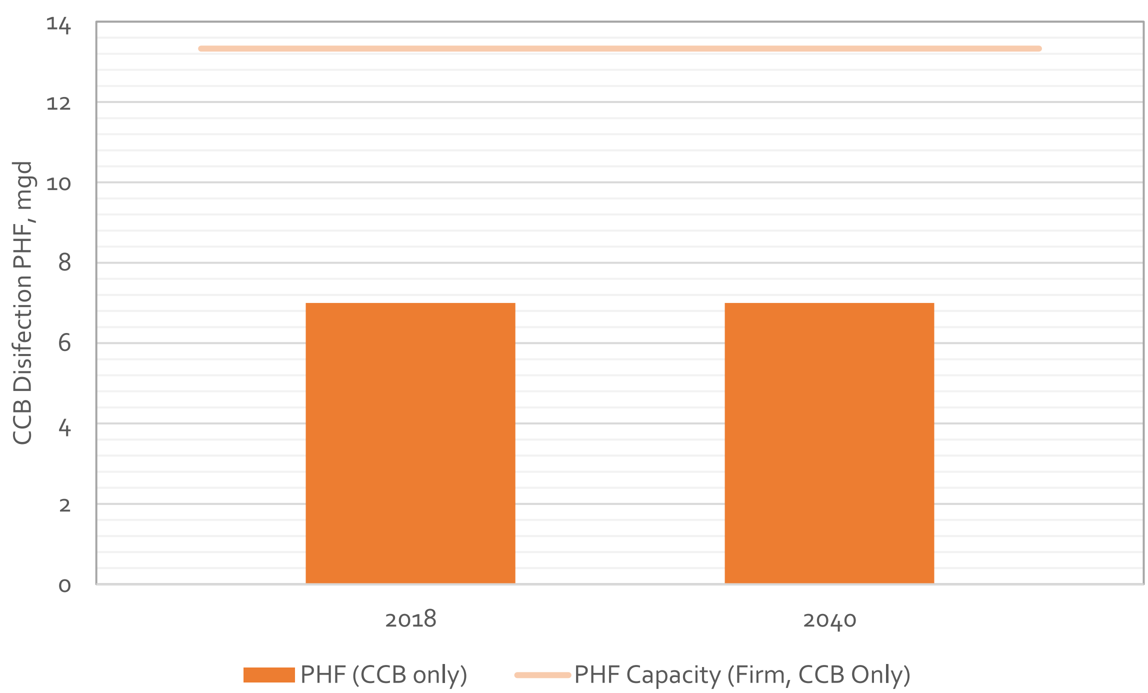


Figure 5.11 CCB Disinfection Capacity

5.4.7 Thickening

Waste activated sludge (WAS) is diverted from the secondary clarifier RAS system and pumped to a single dissolved air flotation thickener (DAFT) to be thickened and then pumped to the anaerobic digesters. The WAS pumps which feed the DAFT are each rated for 200 gpm at 23 ft TDH. The thickened waste activated sludge (TWAS) pumps are each rated for 70 gpm at 40 psi TDH. The DAFT is approximately 42 ft long and 10 ft wide, and has a SWD of 12 ft. When polymer is used, typical DAFT design criteria limit the maximum week solids loading rate (SLR) to 24 ppd/sf. Design data for WAS thickening are summarized in Table 5.9.

Table 5.9 WAS Thickening Design Data

Process / Criterion	Unit	Value
Type		Dissolved Air Flotation
Number		1
Dimensions		
Width	ft	10
Length	ft	42
Surface Area	sf	420

Currently the Kellogg Creek WRRF measures quite different RAS and WAS concentrations. WAS loads calculated using the measured WAS concentrations are higher than the calculated TWAS loads and the WAS loads calculated using the RAS concentrations. Figure 5.12 plots historical solids loading rates calculated three ways (using the WAS flow and WAS concentration, the WAS flow and RAS concentration, and the TWAS load). Based on the historical data shown in Figure 5.12, the DAFT has experienced maximum week SLRs as high as 25, 30 and 35 ppd/sf based on the RAS concentration, TWAS loads and WAS concentrations, respectively. This indicates that DAFT is currently operating at SLRs that exceed recommended design criteria.

A DAFT SLR of 24 ppd/sf corresponds to a WAS load of 9,700 ppd. This WAS load capacity is significantly lower than the current and projected WAS loads, as reflected in Figure 5.13. This indicates a capacity limitation in the current Kellogg Creek sludge thickening process.

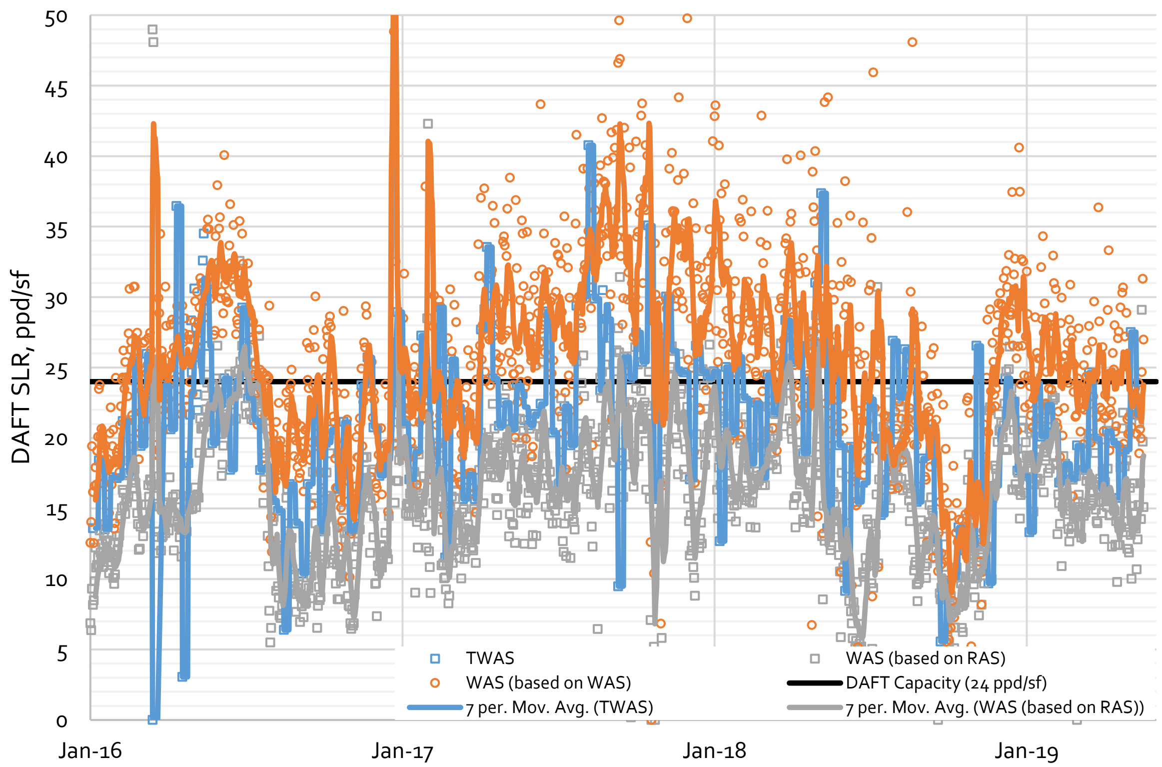


Figure 5.12 DAFT Solids Loading Rate

Note: Due to the large differences in WAS loads as calculated based on the WAS flow and WAS concentration, WAS flow and RAS concentration, and TWAS flow and TWAS concentration, there is a great deal of uncertainty about the actual solids loading rate to the DAFT. For the purposes of this analysis, the "correct" value is irrelevant, as all three methods for estimating the true WAS load indicate that the DAFT is already overloaded under maximum week conditions.

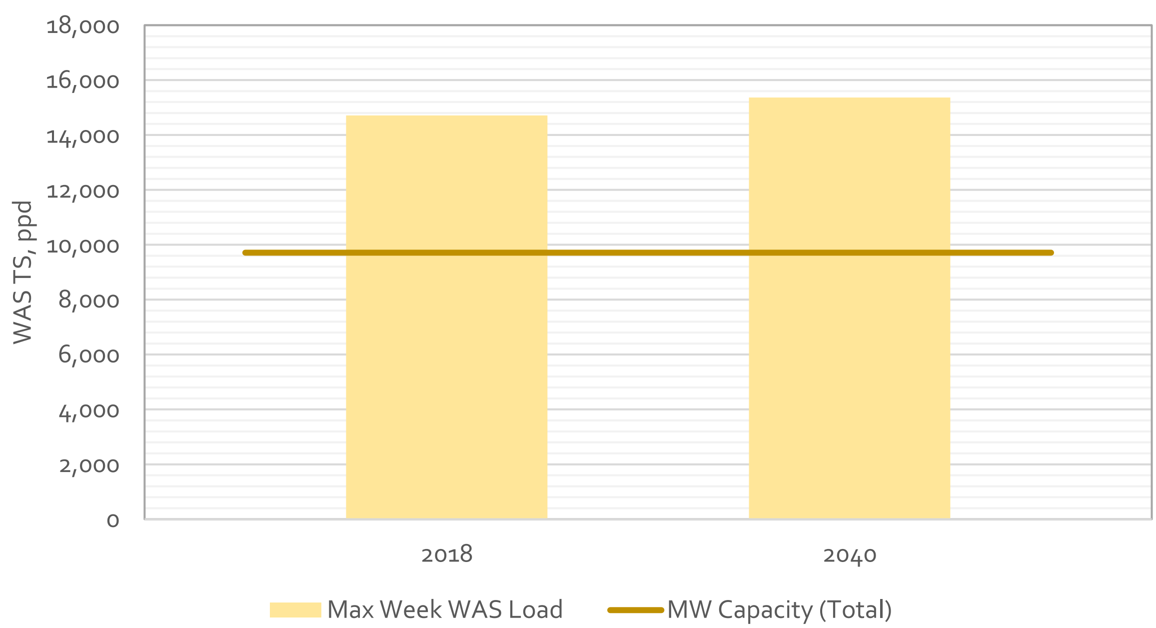


Figure 5.13 DAFT Capacity

5.4.8 Anaerobic Digestion

Primary sludge is thickened in the primary clarifiers, combined with TWAS, and pumped to one of two anaerobic digesters. Each digester is 65 ft in diameter and 41 ft tall. Assuming 90 percent of the digester volume is available, the active volume of each digester is 916,000 gallons. District staff notes that the digesters are currently operated at a maximum SWD of 33 ft. However, for the purposes of this analysis, it is assumed that the operating level can be increased to the full SWD as necessary to meet capacity needs. Both digesters are heated but only one of the digesters is mixed. Flow is pumped out of the unmixed digester five to six days per week and is hauled to the Tri-City WRRF for dewatering. A rotary drum thickener (RDT) in the thickening complex is used for recuperative thickening of digester sludge. The RDT is rated for a maximum hydraulic loading rate of 125 gpm.

The capacity rating for the anaerobic digesters is based the following assumptions:

- Both digesters are operational, heated, and mixed, and can be operated up to a SWD of 41 ft. Although only one digester is currently mixed, the unmixed digester can maintain the target Class B biosolids temperature of 95 degrees Fahrenheit, which suggests adequate mixing for process performance.
- Primary sludge and TWAS are thickened to a concentration of 4 percent, which is a relatively conservative minimum monthly value.
- The RDT is operated to recuperatively thicken up to 125 gpm of digested sludge to a solids concentration of six percent. The operation of recuperative thickening allows for a slight separation between HRT and SRT, with measured SRTs about three days greater than HRT. With the RDT recuperatively thickening, the current digested sludge concentration stays around two percent. For the purposes of this analysis, it is assumed that under typical conditions, the RDT will be operated to maintain a digester total solids (TS) concentration of two percent. However, if necessary, the recuperative thickening flow could be increased to maintain a maximum digester solids concentration of three percent.

Design data for anaerobic digestion and recuperative thickening are summarized in Table 5.10.

Table 5.10 Anaerobic Digestion Design Data

Process / Criterion	Unit	Value
Anaerobic Digesters		
Number		2
Total active volume	gallons	1,832,000
Temperature	°F	95
Dimensions		
Diameter	ft	65
SWD	ft	41
Active volume	%	90
Active volume, each	gallons	916,000

Process / Criterion	Unit	Value
Recuperative Thickening		
Type		Rotary Drum Thickener
Number		1
Flow	gpm	125
Thickened Sludge TS	% TS	6.0
Hours of Operation		
Hours per Day		24
Days per Week		7

Both hydraulic and solids loading can control the anaerobic digestion process. For the most recent solids upgrade project at Tri-City, the anaerobic digestion hydraulic loading was limited to a SRT of 15 days under maximum two-week conditions with one digester out of service. For Kellogg Creek, when a digester needs to be taken out of service for planned maintenance, it is assumed that excess solids will be diverted to Tri-City. For this reason, a target SRT of 20 days under maximum month conditions with all digesters in service was selected to provide stable digestion. Figure 5.14 shows that the District has been able to operate their anaerobic digestion at HRTs above these criteria, with historical HRTs ranging from 20 to 50 days (assuming the volume of both digesters).

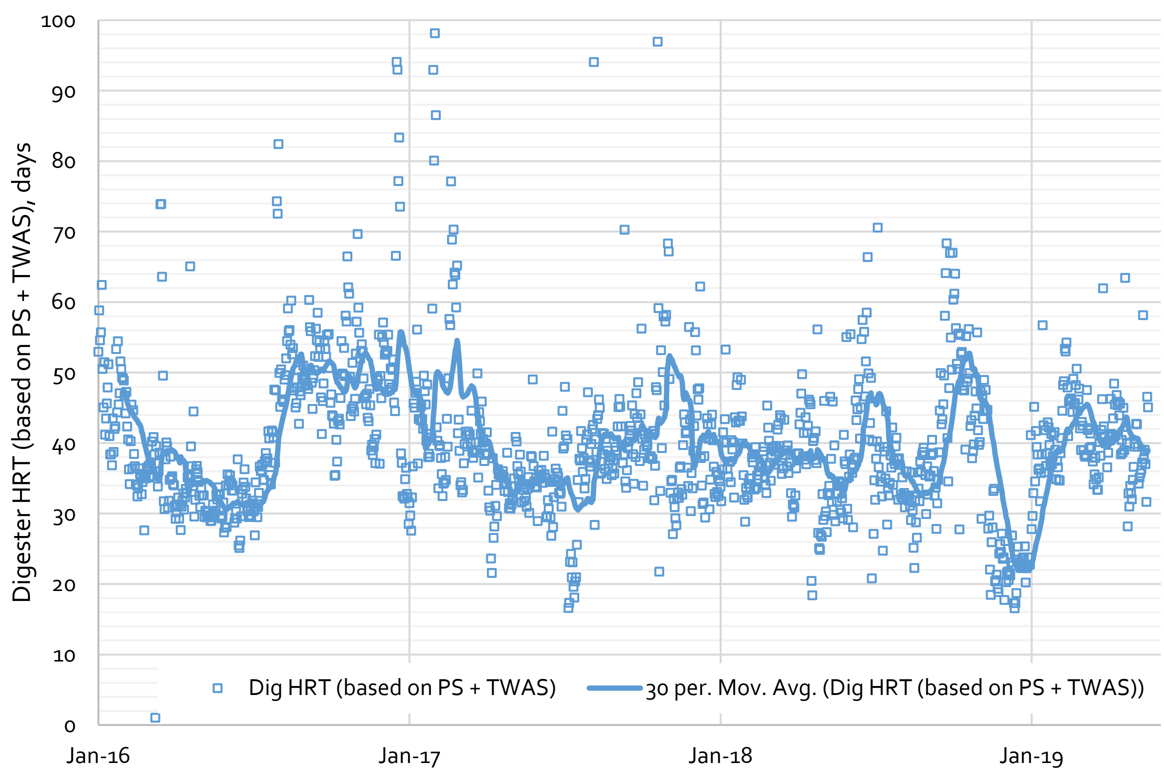


Figure 5.14 Anaerobic Digestion HRT

Note: Abbreviation: PS - primary sludge.

The most recent solids project at Tri-City limited the anaerobic digestion SVSLR to 0.16 lb VS/d-lb VS inventory under maximum two-week loads with one digester out of service. As was mentioned previously, when a digester at Kellogg Creek is taken out of service for planned maintenance, it is assumed that excess solids will be diverted to Tri-City. Since maximum two-week loads were not projected as part of this project, the 0.16 lb VS/d-lb VS inventory was converted to a maximum month value of 0.15 lb VS/d-lb VS inventory using the relationship between maximum month and maximum two-week loads from the Tri-City solids expansion project.

The capacity of the anaerobic digestion process is shown in Figures 5.15 and 5.16. Note that unlike other capacity figures throughout this document, Figure 5.15 shows the capacity based on SRT, in which a digester is out of capacity when the SRT falls below the target criterion, and thus the vertical bar representing the anticipated SRT falls below the horizontal capacity line. Based on the stated assumptions regarding digester operation, the anaerobic digestion process at Kellogg Creek has approximately sufficient capacity with both digesters in service under maximum month conditions. Figure 5.16 shows that the anaerobic digestion process has sufficient capacity to meet a SVSLR of 0.15 lbVS/d-lb VS inventory with both digesters in service under maximum month conditions.

If one digester were used to treat the entire projected maximum month load, the projected total solids concentration in the one remaining digester would need to be approximately 3.3 percent in order to maintain a SRT of 15 days. It is assumed that rather than stress the one remaining digester, excess solids will be transferred to Tri-City.

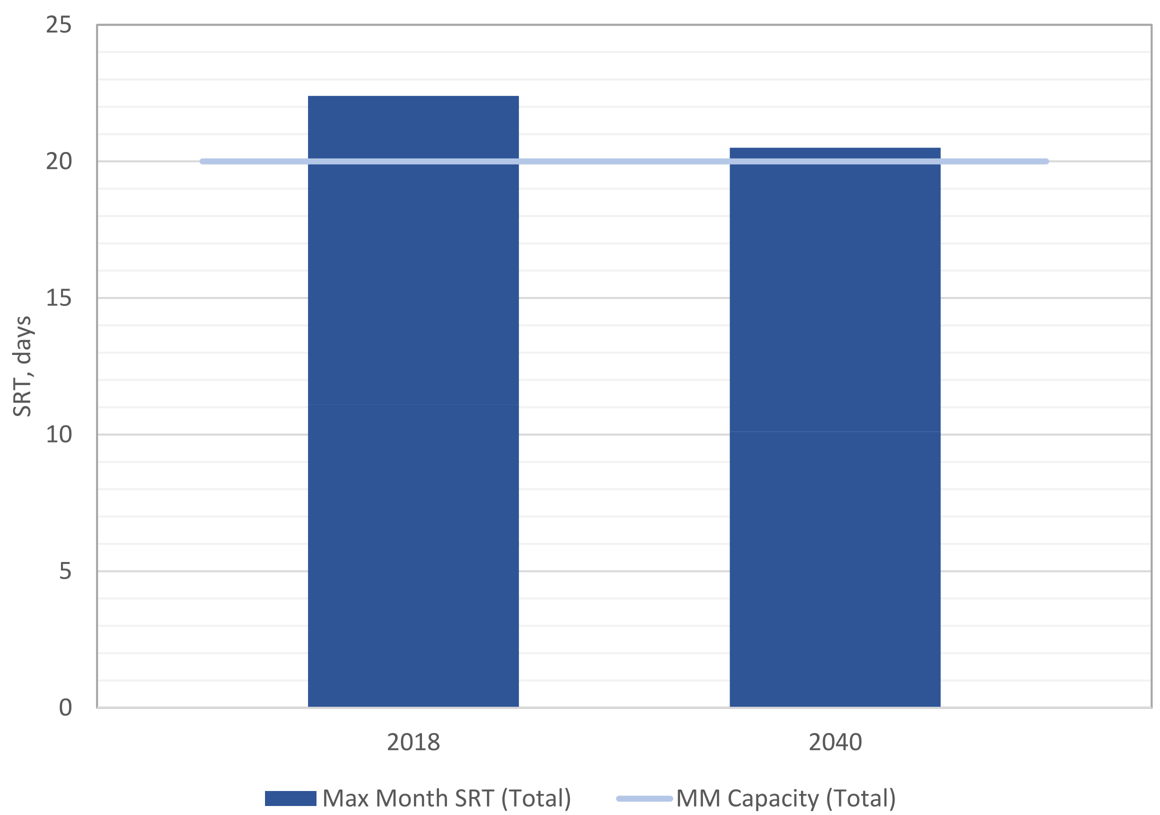


Figure 5.15 Anaerobic Digestion Capacity - Solids Retention Time

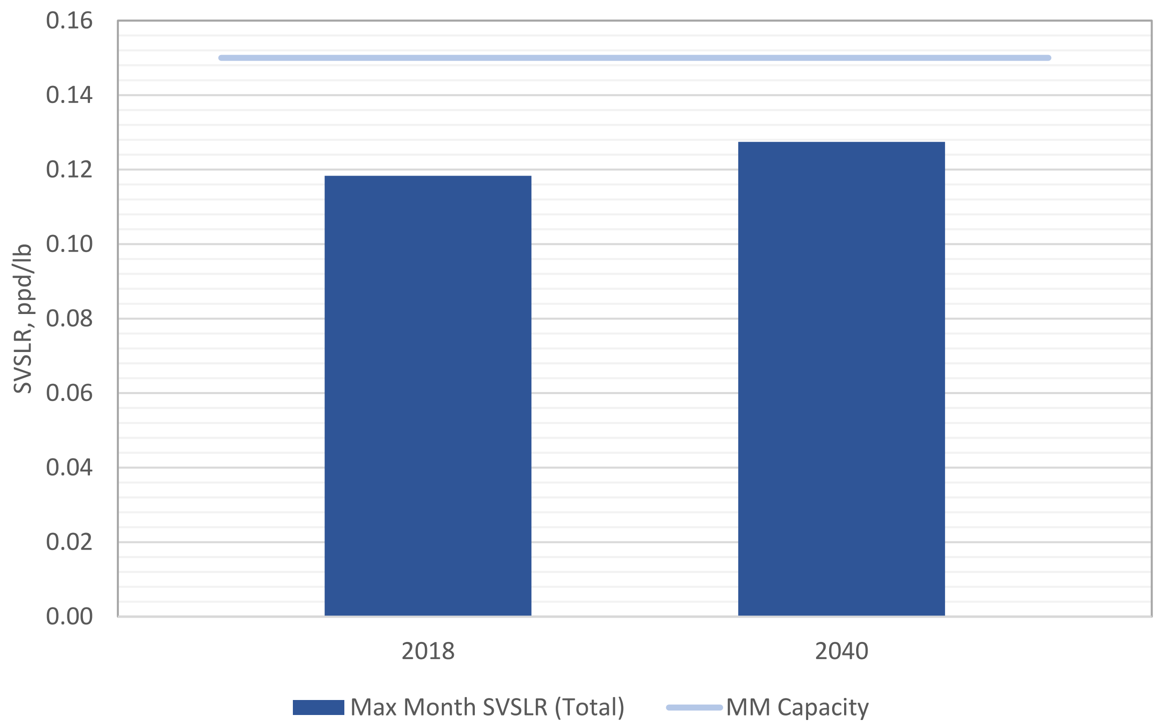


Figure 5.16 Anaerobic Digestion Capacity - Specific Volatile Solids Loading Rate

5.4.9 Dewatering

Digested sludge from the Kellogg Creek WRRF is hauled to the Tri-City WRRF, to be dewatered by an auxiliary dewatering centrifuge.

The Andritz D5LX centrifuge used to dewater digested sludge from the Kellogg Creek WRRF was originally rated for a peak HLR of 150 gpm or at 1,500 lb/hr at a concentration of two percent TS. Within the last year, the District has operated this centrifuge at between 60 and 100 gpm with an average flow rate of 80 gpm. Based on conversations with the District, for planning purposes, the HLR will be assumed to be 90 gpm. However, with optimization, it's possible that the centrifuge could be operated at its full design HLR. During the past year, the District has operated the centrifuge on average 5 days per week for approximately 10 hours per day. However, under peak loading conditions, the District has increased this operating schedule to 6 days per week with an operating time of up to 20 hours per day. For planning purposes for peak week loads, the centrifuge operating schedule will be assumed to be 6 days per week, 20 hour per day. Design data for the dewatering process are summarized in Table 5.11.

Table 5.11 Dewatering Design Data

Process / Criterion	Unit	Value
Type		Centrifuge
Number		1
Hydraulic Loading Rate	gpm	90
Dewatered Sludge TS	% TS	18%
Hours of Operation		
Hours per Day		20
Days per Week		6

The overall capacity of the dewatering process is compared to the current and projected 2040 hydraulic loading rates in Figure 5.17. Per the operating schedule described above, the centrifuge has sufficient capacity to dewater the digested sludge from the Kellogg Creek WRRF digesters. If the centrifuge used to dewater the Kellogg Creek solids were to be taken out of service for maintenance, the Kellogg Creek solids would need to be dewatered using the centrifuges used to dewater the Tri-City solids.

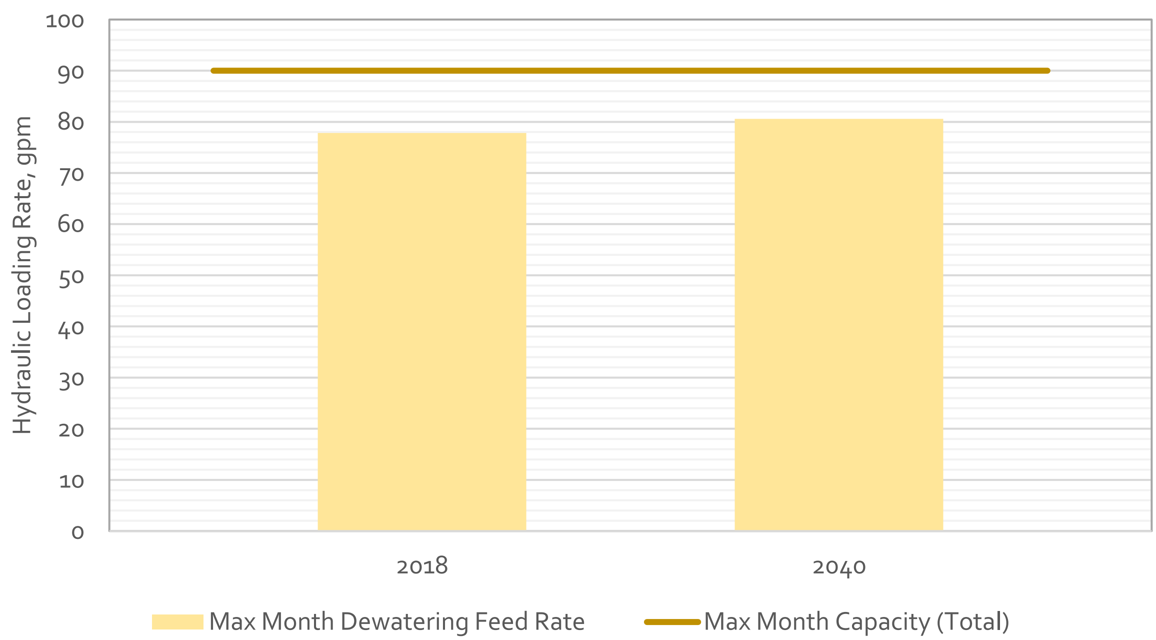


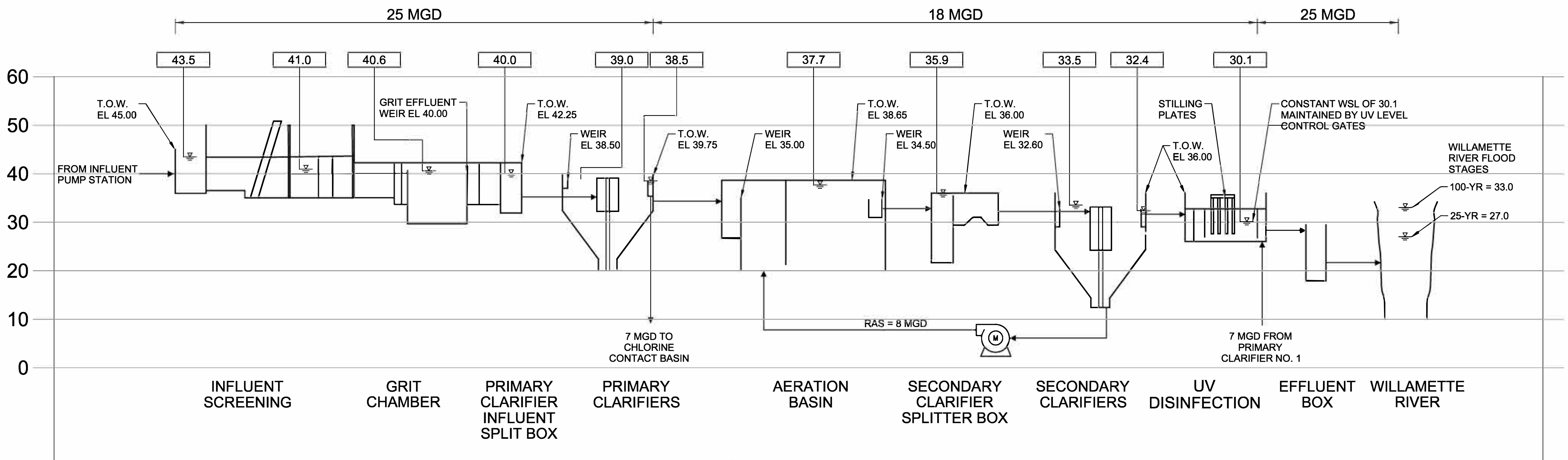
Figure 5.17 Dewatering Hydraulic Loading Capacity

5.5 Hydraulic Capacity

The design hydraulic capacity of the Kellogg Creek WRRF is 25 mgd, with recent improvements intended to ensure that this flow rate can be effectively passed through the plant. Future flows above 25 mgd are expected to be pumped to the Tri-City WRRF, so the hydraulic capacity of Kellogg Creek WRRF will not change over the planning period. A hydraulic profile is shown in Figure 5.18, based on hydraulic calculations performed as part of the recent facility improvements project (Brown and Caldwell, 2018). This profile shows water surface elevations (WSE) in each process structure when the Willamette River is at the 25-year flood stage of 27 ft.

5.6 Capacity Summary

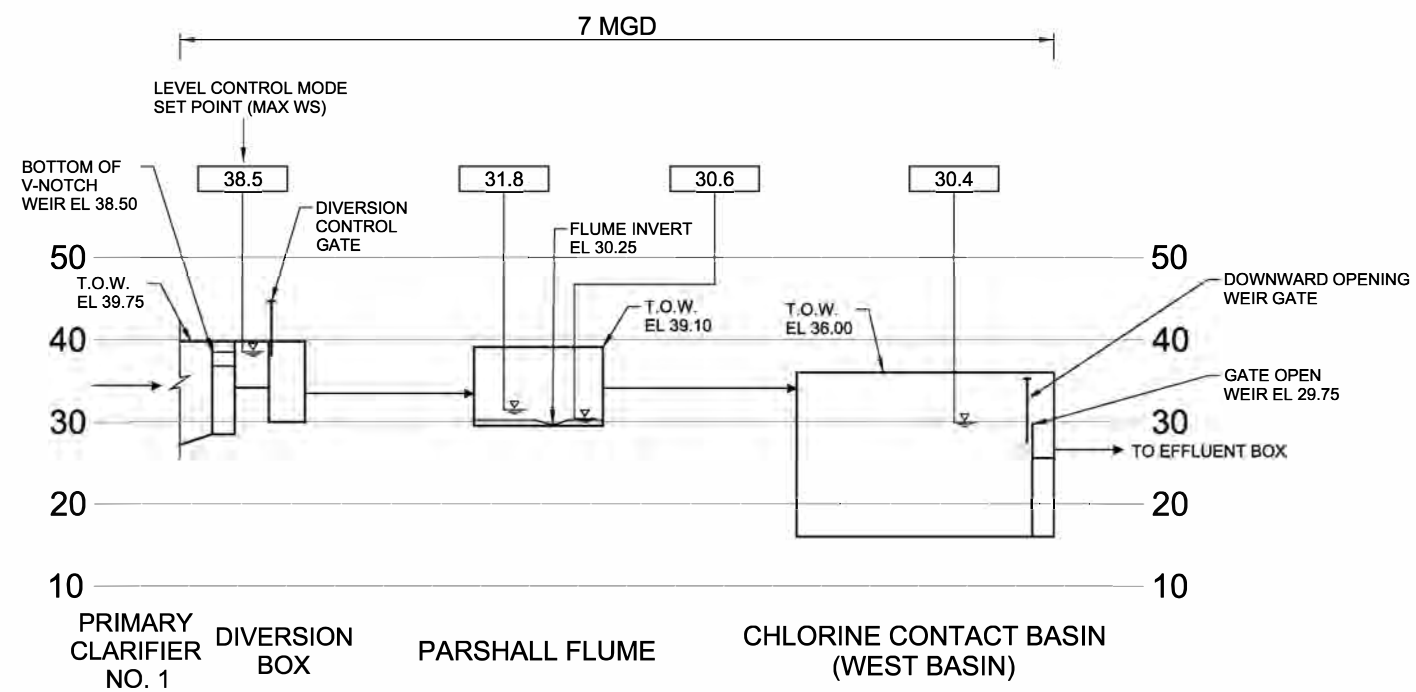
The process capacity limitations discussed above are summarized in Table 5.12.



NOTE:

(1) INFORMATION SHOWN ABOVE IS FROM PLANT FACILITY HYDRAULIC ANALYSIS DATED JUNE 2007.

(1) EXISTING PLANT HYDRAULIC PROFILE
(THROUGH UV DISINFECTION CHANNELS)



FLOW MANAGEMENT SYSTEM HYDRAULIC PROFILE
(THROUGH UV DISINFECTION CHANNELS)

Figure 5.18

KELLOGG CREEK WRRF HYDRAULIC PROFILE

Table 5.12 Kellogg Creek WRRF Capacity Analysis Summary

Unit Process	Limiting Flow/Load Parameter	Capacity Summary			Notes
		Currently Available	Currently Required (2018)(1)	Future Required (2040)(1)	
Influent Pumps	PHF, mgd	25(2)	25	25	The total available pumping capacity at Kellogg exceeds the required capacity, which is capped at 25 mgd, and the available firm pumping capacity (largest unit out of service) matches the cap. Accordingly, no pumping capacity improvements are required at Kellogg Creek.
Influent Screens	PHF, mgd	25	25	25	The total available pumping capacity at Kellogg exceeds the required capacity, which is capped at 25 mgd, and the available firm capacity (largest unit out of service) matches the cap. Accordingly, no screening capacity improvements are required at Kellogg Creek.
Grit Basins	PHF, mgd	25	25	25	While the existing grit basins have a total capacity of approximately 25mgd based on past experience, it is anticipated that at these flows grit removal deteriorates. These high flows are likely causing additional grit to be transferred to downstream processes under high-flow conditions.
Primary Clarifiers	PHF, mgd	25	25	25	The available primary clarifier capacity (25 mgd) matches the PHF cap. Accordingly, no primary treatment capacity improvements are required.
Secondary Treatment	MMWWF, mgd	18	17	18	The current maximum month aeration basin capacity is 18 mgd, which slightly exceeds the 2018 MMWWF and equals the capped flow through secondary treatment of 18 mgd.
Disinfection	PHF, mgd	25 (combined UV and CCB)	25	25	The current combined capacity of the UV disinfection system and CCB exceeds 25 mgd, which provides sufficient capacity for the peak hydraulic flow of 25 mgd. However, since UV system does not provide the full 25 mgd of capacity due to condition issues associated with the UV disinfection process discussed in Chapter 6, the District may desire to address the condition issues and provide the full 25 mgd of disinfection capacity through a new UV system.
WAS Thickening	Max Week WAS Load, mgd	9,700	14,700	15,400	The current capacity of the is less than the current and projected 2040 maximum week WAS loads. Staff typically operate the DAFT at SLR rates exceeding typical design points. Additional thickening capacity is required to meet projected 2040 loads.
Anaerobic Digestion	Max Month SRT, days(3)	20	22.4	20.5	With modifications to the current digester sludge holding tank to provide for mixing, the current anaerobic digestion system provides sufficient capacity for the projected year 2040 maximum month loads. With only two anaerobic digesters, providing firm capacity for the projected 2040 maximum month solids loads would require the one remaining digester to be operated with significant recuperative thickening flows and digester total solids concentrations exceeding 3 percent. For this reason, it is recommended that excess solids are routed to Tri-City if a digester needs to be taken out of service for maintenance.
Dewatering	Maximum month Dewatering Feed Flow, gpm(4)	90	78	81	While the auxiliary centrifuge located at the Tri City plant has sufficient capacity to dewater the digested sludge from Kellogg Creek, District staff desires a more permanent solution for dewatering at Kellogg Creek.

Notes:
(1) For all processes, the difference between the required capacity and the flow cap (25 mgd) is transferred to Tri-City.
(2) It is assumed that improvements are made to the influent pump station to allow the influent pumps to operate at their rated capacities.
(3) Capacities are listed assuming typical operation at two percent total solids in the digester.
(4) Capacities are listed assuming 6 days per week, 20 hours per day operation.
RED - Capacity improvements are recommended.
YELLOW - Capacity improvements may be desirable.
GREEN - Capacity improvements are not required.

Chapter 6

CONDITION ASSESSMENT

6.1 Introduction and Purpose

The purpose of this chapter is to present the condition assessment results and recommendations for improvements resulting from field investigations conducted at the Kellogg Creek Water Resource Recovery Facility (WRRF). Although a thorough review of all assets was completed, this chapter only highlights assets that were deemed to be in moderate (score of 3) to severe (score of 5) condition and describes the rehabilitation or replacement actions necessary to address the condition of these assets.

6.2 Overview of facility

The Kellogg Creek WRRF is one of three wastewater treatment facilities owned and operated by Clackamas Water Environment Services (WES). Kellogg Creek, located 11525 Southeast McLoughlin Boulevard in Milwaukie Oregon, was originally constructed in 1974 and treats up to 25 million gallons per day (mgd). The Kellogg Creek WRRF has had some improvement performed over the years, but no large-scale renovation to date.

6.3 Condition Assessment

The process used to perform the condition assessment of the Kellogg Creek facility assets is summarized in this section. The assessment was based on visual inspection; invasive equipment testing procedures were not utilized.

6.3.1 Protocol and Deployment

The condition assessment took place over the course of three days (November 13th through 15th, 2019) and was conducted by a multi-discipline team of mechanical, structural, and electrical/ instrumentation engineers. Exterior corrosion, weathering, and deterioration issues along with discipline-specific condition and performance issues, such as temperature, noise, vibration, leakage, wiring, foundational, and component issues were all considered under the purview of the assessment effort. The assessment began with staff interviews to compile a list of known deficiencies, identify operating limitations, and discuss maintenance and operations history of each location. In addition to what was described by plant staff, the assessment team looked for potential problems such as structural deterioration, electrical and instrumentation issues, and mechanical degradation.

6.3.2 Scoring

The condition of assets was ranked using a one-through-five scale at both a general level and across a series of discipline specific questions. A score of 1 represents the best condition assets, while a score of 5 represents the worst condition assets. The purpose of scoring is to provide a common scale to rate assets so they can be compared to one another. The general condition scoring was reviewed and confirmed by WES before the commencement of the condition assessment effort. Table 6.1 provides the general description of the condition associated with each score.

Table 6.1 General Condition Score Descriptions

Condition Score	General Description [1]
1 (Best)	**Excellent** Installed with very little wear. Fully operable, well maintained, and consistent with current standards. Little wear shown and no further action required.
2	**Good** Sound and well maintained but may be showing slight signs of wear. Delivering full efficiency with little or no performance deterioration. Only minor renewal or rehabilitation may be needed.
3	**Moderate** Functionally sound and acceptable and showing normal signs of wear. May have minor failures or diminished efficiency and with some performance deterioration or increase in maintenance cost. Moderate renewal or rehabilitation needed.
4	**Poor** Functions but requires a high level of maintenance to remain operational. Shows abnormal wear and is likely to cause significant performance deterioration in the near term. Replacement or major rehabilitation needed.
5 (Worst)	**Very Poor** Effective life exceeded and/or excessive maintenance cost incurred. A high risk of breakdown or imminent failure with serious impact on performance. No additional life expectancy with immediate replacement required.

Notes:
(1) Discipline-specific score are described in the Appendix 5b-A - WES Condition Scoring of TM5B: Existing Kellogg Creek Water Resource Recovery Facility Condition.

Discipline specific condition scores are utilized to provide further insight into the specific area(s) in which an asset is deficient and gives measure to the repair(s) that is needed to bring an asset to like-new condition. Table 6.2 provides the condition questions categories prompted by a specific asset discipline.

Table 6.2 Summary of Condition Questions Categories by Discipline

Discipline	Condition Question Categories [1,2]
Mechanical	• Corrosion/ Exterior. • Vibration. • Temperature. • Leakage. • Components.
Structural	• Surface Deterioration. • Coating/ Lining/ Paint. • Leakage. • Foundation/ Supports. • Components.
Electrical	• Equipment. • Enclosure. • Temperature/ Noise. • Wiring/ Cable Condition. • Components.

Discipline	Condition Question Categories (1,2)
Instrumentation & Controls	• Equipment/ Transmitter. • Display/ Enclosure/ Mount. • Wiring/ Cable Condition. • Components.
HVAC	• Corrosion/ Exterior. • Vibration. • Temperature. • Components.

Notes:
(1) A more detailed description of the discipline-specific score can be found in Appendix 5b-A - WES Condition Scoring of TM5B: Existing Kellogg Creek Water Resource Recovery Facility Condition.
(2) Excludes general condition question, which is asked across all asset discipline types.

6.3.3 Observations and Findings

The assessment results are separated into thirteen distinct locations as presented in the WES computerized maintenance management system (CMMS): influent pump station, primary basins, primary pump station, aeration basins, blower building, secondary clarifiers, secondary pump station, chlorine contact basin, digester complex, thickening complex, chemical building, administration building, and building and grounds. The locations are geographical in nature with a few exceptions.

Figure 6.1 shows the locations included in the condition assessment.

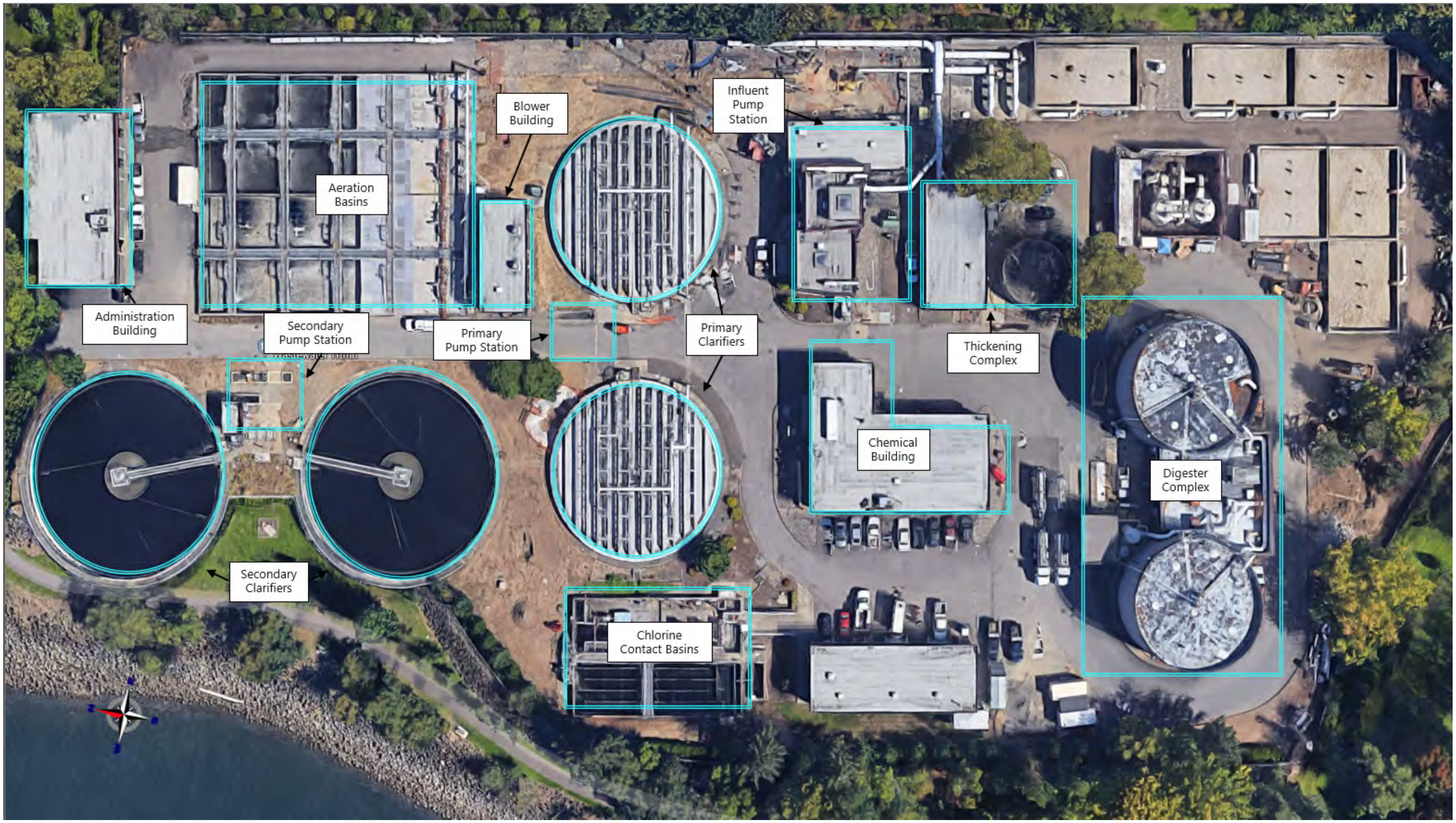


Figure 6.1 Condition Assessment Areas

Note: The Buildings and grounds location are non-point specific and includes several assets at various areas across the Kellogg Creek WRRF.

The following section provides an overview of each location and its relative geographical position within the grounds of the Kellogg Creek WRRF. A summary of asset types present, along with notable observations, a summary condition scoring, and general corrective actions follows. The summary condition table sorts assets by the maximum condition score received, asset name, and lists the deficient score category attributing to the maximum condition score as the reason. The maximum value from both the general and discipline-specific questions scored one-through-five represents the overall asset condition score for that discrete asset and is what is present in the findings below. Lastly corrective actions are described for all assets receiving a score of 3 (moderate) or higher.

Recommendations for asset improvement were classified as either replacement or rehabilitation. Replacement in this case was assumed to mean the action or process of substituting an existing asset with a newly acquired unit at cost. Rehabilitation was assumed to be the action of restoring something that has been damaged to its former condition.

6.3.1 Influent Pump Station

The influent pump station location resides in the south-central portion of the facility grounds. Three separate buildings make up the influent pump station location, each with a separate exterior access point. All influent flow is first directed to the receiving wet well in the 60 feet (ft) by 25 ft. pump house building located the closest to McLoughlin Boulevard before being transferred through flanking building and into the 30 ft. by 30 ft. screening building which contains the grit chambers and appurtenances. Assets designated to the influent pump station location consist of piping, basins, hoppers, screens, strainers, buildings, channels, launders, troughs, pumps, rollup doors, drive assemblies, grit classifiers, rake arm assemblies, valves, hosts, trolleys, cranes, skimmers, samplers, supply fans, programmable logic controls, meters, transmitters, motor control centers, variable frequency drives, motors, switchgears, and control panels.

The following notable observations were made about condition deficient assets within the influent pumping system:

- **Main Lift Influent Pump 2:** Evaluated to be in overall very poor condition. The pump exhibited active leaking at the stuffing box. It appears that the unit's seals are worn, which is allowing for the extent of leakage present. Duct tape was used as a temporary management strategy to control the rate of leaking. Staff indicated that the unit had previously been refurbished and is scheduled to be again once Pumps 1 and 3 are placed back into service.
- **Influent Pumps 2 and 4 Variable Frequency Drives (VFD):** Evaluated to be in overall poor and very poor condition. The VFD represents technology that is greatly outdated, for which there is no replacement parts readily available. The control panel assembly operates sufficiently.
- **Blower 1 and 2 Variable Frequency Drives:** Located inside Motor Control Center 7 (MCC) and were evaluated to be in overall poor condition. MCC-7 is located in Influent Pump Station Building. Wiring, display enclosure, and components exhibited moderate discoloration and apparent wear overall indicating heavy use. There is a concern that if not addressed the variable frequency drives will unexpectedly fail with the potential to render additional electronic equipment inoperable and or cause bystander shock potential. Equipment is becoming out of date and nearing the end of estimated useful operational life.

- **Blower Motor Control Center - MCC 7:** Evaluated to be in overall poor condition. According to staff the Blower 2 variable frequency drive has been problematic in the past and consequently replaced with a soft start. Blower 1 cooling fan has failed a few times over the past several years and during the time of inspection was not observed to be working. Lugs and cables for the main exhibit significant heat/ electrical related wear and should be address in the near term.
- **Headworks Building:** Evaluated to be in overall poor condition. Walls and roof added to facility post original to enclose. Corrosion of panel connections at floor is moderate and requires rehab. Grout topping at floor failing. Screenings channels have minor surface abrasion/loss. Current standby bypass in place from IPS. Scoring for building is on Screenings Channel 1. Guardrail post spalls typical. Wall panel base joint is porous and leaks through north side when washing down grit clarifier. Could not view roof framing. In general, building is in poor condition. Roof is due to be replaced and in poor condition, but with only minor leakage. Roof has moss growth at locations. IPS roof is similar. Influent pipes reported to have recent leaks, but not actively leaking, they are conc encased and partially buried with cracking in the encasement. Primary influent splitter box conc surface has a grit film but appears to without obvious defects. Sludge pipe is in poor condition with leak repairs.
- **Local Control Panel 1 - PLC01:** Evaluated to be in overall poor condition. The control panel is showing significant signs of wear and deterioration indicative of age and frequent operation. Programmable logic controller's input/output cards have reached obsolescence, meaning that replacement parts and maintenance/ service are no longer provided by the manufacturer.
- **Main Lift Influent Pump 2 and 4 - Motors:** Evaluated to be in overall poor condition. The motor casing exhibited signs of corrosion, discoloring, and general wear. It is suspected that the motor is at least 15 to 20 years old and nearing the end of its useful life. The electrical conduit connection at the base of the motor appears to be insecure and allowing the potential for shorting of the exposed high voltage wiring.
- **Main Lift Influent Pump 4:** Evaluated to be in overall poor condition. Pump 4, similarly, to Pump 2, exhibited active leaking most likely attributable to worn seals. Leaking was observed at casing joints. Staff indicated that the unit had previously been refurbished in the past and is scheduled to be rebuilt once Pumps 1 and 3 are commissioned.
- **Screenings Building:** Evaluated to be in overall poor condition. Walls and roof added to facility post original to enclose. Corrosion of panel connections at floor is moderate and requires rehab. Grout topping at floor is failing. Screenings channels have minor surface abrasion/loss. Current standby bypass in place from IPS. Scoring for building is on Screenings Channel 2. Guardrail post spalls typical. Wall panel base joint is porous and leaks through north side when washing down grit clarifier. Could not view roof framing. In general, building is in poor condition. Roof is due to be replaced and in poor condition, but with only minor leakage. Roof has moss growth at locations. IPS roof is similar. Influent pipes reported to have recent leaks, but not actively leaking, they are conc encased and partially buried with cracking in the encasement. Primary influent splitter box conc surface has a grit film but does not appear to have any obvious defects. Sludge pipe is in poor condition with leak repairs.
- **Blower Motors 1 and 2:** Evaluated to be in overall moderate condition. Wiring, display enclosure, and components exhibited moderate discoloration and apparent wear overall indicating heavy use. There is a concern that if not addressed the blower motors will unexpectedly fail with the potential to render additional electronic equipment inoperable and or cause bystander shock potential. Equipment is becoming out of date and nearing the end of estimated useful operational life.

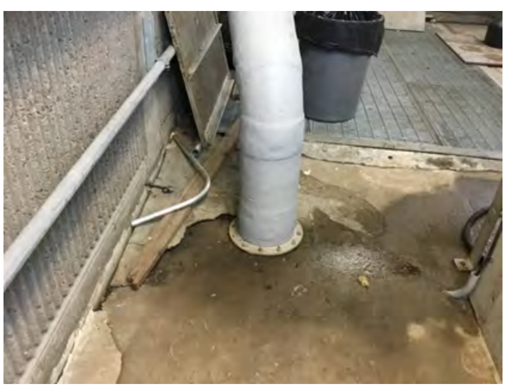
Picture 1.
Main Lift Influent Pump 2

Picture 2.
Influent Pump 4 Variable Frequency Drive

Picture 3.
Main Lift Influent Pump 2 – Motor

Picture 4.
Local Control Panel 1 - PLC01

Picture 5.
Blower Motor Control Center MCC 7



Picture 6.
Screenings Building

Picture 7.
Screenings Building

Table 6.3 summarizes the condition scores received and reason for deficient assets within the influent pump station location.

Table 6.3 Condition Assessment Summary - Influent Pump Station

Condition Score	Asset Name	Reason
5 – Very Poor	Influent Pump 4 Variable Frequency Drive	• General Condition. • Enclosure. • Temperature/ Noise. • Wiring/ Cable Condition.
5 – Very Poor	Main Lift Influent Pump 2	• Leakage.
4 – Poor	Bar Screen 1 Control Panel	• Equipment. • Wiring/ Cable Condition. • Components.
4 – Poor	Bar Screen 2 Control Panel	• Components.
4 – Poor	Blower 1 Variable Frequency Drive (Located in MCC-7 in Influent Pump Station Building)	• General Condition. • Equipment. • Enclosure. • Wiring/ Cable Condition. • Components.
4 – Poor	Blower 2 Variable Frequency Drive (Located in MCC-7 in Influent Pump Station Building)	• General Condition. • Equipment. • Enclosure. • Wiring/ Cable Condition. • Components.
4 – Poor	Blower Motor Control Center MCC 7	• General Condition. • Equipment. • Enclosure. • Wiring/ Cable Condition. • Components.
4 – Poor	Grit Removal Drive Assembly	• General Condition.
4 – Poor	Headworks Building	• General Condition. • Surface Deterioration. • Components.
4 – Poor	Influent Pump 2 Variable Frequency Drive	• General Condition. • Equipment. • Wiring/ Cable Condition. • Components.
4 – Poor	Local Control Panel 1 - PLC01	• General Condition Equipment/ Transmitter. • Display/ Enclosure/ Mount. • Wiring/ Cable Condition. • Components.
4 – Poor	Main Lift Influent Pump 2 - Motor	• Wiring/ Cable Condition.
4 – Poor	Main Lift Influent Pump 4	• Leakage.

Condition Score	Asset Name	Reason
4 – Poor	Main Lift Influent Pump 4 - Motor	• Wiring/ Cable Condition.
4 – Poor	Screenings Building	• General Condition. • Surface Deterioration. • Components.
4 – Poor	Screenings Channel 2	• General Condition. • Surface Deterioration.
4 – Poor	Screenings Channel 3	• General Condition. • Surface Deterioration.
3 – Moderate	Bar Screen 1	• General Condition.
3 – Moderate	Bar Screen 2	• General Condition.
3 – Moderate	Blower Motor 1	• General Condition. • Equipment. • Enclosure. • Temperature/ Noise. • Wiring/ Cable Condition. • Components.
3 – Moderate	Blower Motor 2	• General Condition. • Equipment. • Enclosure. • Temperature/ Noise. • Wiring/ Cable Condition. • Components.
3 – Moderate	Grit Removal Basin Rake Arm Assembly	• General Condition. • Corrosion/ Exterior.
3 – Moderate	Influent Pump 2 Flow Transmitter	• General Condition. • Equipment/ Transmitter. • Display/ Enclosure/ Mount. • Wiring/ Cable Condition. • Components.
3 – Moderate	Influent Pump 4 Flow Transmitter	• General Condition. • Equipment/Transmitter. • Display/Enclosure/Mount. • Wiring/Cable Condition. • Components.
3 – Moderate	Screenings Compactor	• Components

Based on the observations and findings described above, the following actions are recommended for the influent pump station location:

1. Rehabilitate Main Lift Influent Pump 2 and 4; consider replacement if either unit has been rehabilitated more than twice in the past.
2. Replace Main Lift Influent Pumps 2 and 4 - Motors with new units.

3. Replace Influent Pump 2 and 4 Variable Frequency Drives with new units.
4. Replace Influent Pumps 2 and 4 Flow Transmitters with new units.
5. Rehabilitate Local Control Panel 1 - PLC01; replace input/output cards with new cards.
6. Replace Blower Motor Control Center MCC-7 including blower 1 and 2 Variable Frequency Drives.
7. Rehabilitate Headworks Building; replace roofing on building (screening building already allocated, along w/ grit channels) and exterior. Address corrosion of concrete across headworks through a process of sandblasting, mortar repair, and application of protective coating. Injection grouting should be utilized to fill cracks observed.
8. Replace Bar Screens 1 and 2 with new units.
9. Replace Bar Screen 1 and 2 Control Panels with new units.
10. Rehabilitate Grit Removal Basin Rake Arm Assembly.
11. Rehabilitate Grit Removal Drive Assembly; consider replacement if it has been rehabilitated more than twice in the past.
12. Replace Screenings Compactor.
13. Rehabilitate Screenings Channels 2 and 3; address corrosion of concrete within channels through a process of sandblasting and application of protective coating.
14. Rehabilitate Screenings Building; address corrosion of concrete at panel connections to floor through a process of sandblasting and application of protective coating. Replace building roof. Make repairs to miscellaneous concrete spalls and cracks.
15. Rehabilitate Blower Motor 1 and 2; consider replacement if they have been rehabilitated more than twice in the past.

6.3.2 Primary Basins

The primary basins location resides in the center of the Kellogg Creek facility grounds and is comprised of two 100-ft diameter aluminum covered clarifiers and support appurtenances. Assets designated to the primary basins location consist of piping, basins, weirs, baffles, skimmers, samplers, drive assemblies, and rake arm assemblies.

The following notable observations were made about condition deficient assets within the primary basins location.

- **Primary Basin 2:** Evaluated to be in overall poor condition. Primary Basin 2 is approximately 50 feet due East of basin 1. At the time of assessment, the clarifier was out of service and all water was drained, exposing the concrete structure for a more thorough investigation. Sidewalk settlement was recorded at the south side of the clarifier, about 1.5 inches. Support posts at launder appear to have minor to moderate corrosion. Launder was last coated in 2014 for both clarifiers. Mechanism was replaced with stainless steel. The bottom grout is delaminating from the concrete bottom slab throughout much of the basin. Exposed aggregate at the base of the wall was also noted. Cracking in the bottom grout appears to reflect the locations of expansion joints that occur in the bottom slab. Bottom grout is buckled upward at the southeast zone at the perimeter expansion joint. Delamination of grout is typical around expansion joints and pronounced at southeast zone over an area that is about 200 square feet in size. Staff also reported cracking at base slab and grout, along with multiple utility leak repairs to the south of the basin.

- **Primary Basin 1:** Evaluated to be in overall moderate condition. The basin had previously undergone rehabilitation in 2014 as noted from staff. Overall, the condition was observed to be like that of Primary Basin 2, except that no utility leak repairs were reported from staff. Grout pads at cover columns are in poor condition. Support posts at launders appear to have minor to moderate corrosion.

Picture 8.
Primary Basin 2

Picture 9.
Primary Basin 1

Picture 10.
Primary Basin 2

Picture 11.
Primary Pump Station Piping General

Table 6.4 summarizes the condition scores received and reason for deficient assets within the primary basins location.

Table 6.4 Condition Assessment Summary - Primary Basins

Condition Score	Asset Name	Reason
4 – Poor	Primary Basin 2	• Surface Deterioration.
3 – Moderate	Primary Basin 1	• General Condition. • Surface Deterioration.

Based on the observations and findings described above, the following actions are recommended for the primary basins location over the following generalized timeframes:

1. Rehabilitate Primary Basins 1 and 2; address corrosion of concrete within basins through a process of sandblasting and application of a protective coating. Support posts at launder need fresh application of protective coating. The bottom basin grout should be removed and replaced at about 50 percent of the floor area. Expansion joints should be inspected and sealed. Injection grouting should be utilized to fill cracks in the base slab where they occur.

6.3.3 Primary Pump Station

The primary pump station location resides in the center of the Kellogg Creek WRRF grounds, just north of Primary Basin No. 2 and south of the blower building. The access stairs to the pump room run parallel along the paved utility road that cuts through the plant. Assets designated to the primary pump station location consist of sludge and scum pumps, grinders, traps, piping, and control panels. Select support assets to the primary clarifiers (PC) are also included under the hierarchal location designation and include skimmers, samplers, weirs, and baffles.

The following notable observations were made about condition deficient assets within the primary pump station location:

- **Primary Pump Station Piping General:** Evaluated to be in overall moderate condition. Flaking and weathering of paint and coating was present along numerous pipe sections within the pump room, specifically at sweeps and joints. Seismic bracing of pipes was not observed during inspection and is required by code. Bracing restraints for the compression tank were also absent and should be installed to ensure asset stability and security in the event of seismic occurrence.
- **Primary Scum Pump, Primary Sludge Pumps 1 and 2:** Evaluated to be in overall moderate condition. Significant corrosion was observed at various locations on pump casings, most notably at joints and on the heads of bolts. Leakage was also present around pump seals and likely contributed to the extent of corrosion noted.
- **Primary Sludge Grinder 1 Local Control Panel:** Evaluated to be in overall moderate condition. Wiring exhibited moderate discoloration and apparent wear overall indicating heavy use. There is concern that if not addressed the panel will unexpectedly fail with the potential to render additional electronic equipment inoperable and or cause bystander shock potential.

Picture 12.
Primary Pump Station Piping General

Picture 13.
Primary Sludge Pump 2

Table 6.5 summarizes the condition scores for condition deficient assets within the primary pump station.

Table 6.5 Condition Assessment Summary - Primary Pump Station

Condition Score	Asset Name	Reason
3 – Moderate	Primary Pump Station Piping General	• General Condition. • Coating/ Lining/ Paint.
3 – Moderate	Primary Scum Pump	• General Condition. • Corrosion/ Exterior. • Components.
3 – Moderate	Primary Sludge Grinder 1 Local Control Panel	• Wiring/ Cable Condition.
3 – Moderate	Primary Sludge Pump 1	• General Condition. • Corrosion/ Exterior. • Leakage. • Components.
3 – Moderate	Primary Sludge Pump 2	• General Condition. • Corrosion/ Exterior. • Leakage. • Components.

Based on the above observations and findings, the following actions are recommended for the primary pump station location:

1. Rehabilitate Primary Pump Station Piping General; strip and re-coat piping/ joints with a protective paint or polymer to prevent continued corrosion and wear. Replace select joints found to be severely corroded. Add seismic bracing to pipes and compression tank.
2. Rehabilitate Primary Scum Pump; consider replacement if it has been rehabilitated more than twice in the past.
3. Replace Primary Sludge Grinder 1 Local Control Panel.
4. Rehabilitate Primary Sludge Pump 1 and 2; consider replacement if it has been rehabilitated more than twice in the past.

6.3.4 Aeration Basins

The aeration basins location resides in the northeast corner of the facility grounds, just south of the administration building. Assets designated to the aeration basins location consist of the structural basins themselves, channels, launders, troughs, valves, gates, piping, mixers, meters, transmitters and control panels. Four separate rectangular basins roughly 135 ft. by 32 ft., for an overall footprint of approximately 135 ft. by 140 ft., consume the bulk of the area.

The following notable observations were made about condition deficient assets at the aeration basins location:

- **AB1, AB2, AB3, and AB4 Step Feed Gates:** Evaluated to be in overall very poor condition. Step feed gates are manually operated and are left in a closed position under normal operating conditions. As noted from staff, due to the excessive leaking around the gates by incumbent flow, measures have been taken to shim the sides of the gates in a closed position since 2018.

Corrosion and exterior wear are present across many of the step feed gates along with active paint peeling, however this is secondary to the above-mentioned operational issues noted.

- **AB4 Zone 2 and 4 Air Flow Control Valves:** Evaluated to be in overall very poor condition. Control valves are electronically operated using actuators. Actuators show significant wear and deterioration from ultraviolet (UV) exposure and were recorded to not work during the time of inspection. Oil leakage from actuators was also detected along with moisture present behind sight glasses.
- **Influent Channel (combined):** Evaluated to be in overall very poor condition. Moderate to severe concrete surface corrosion of up to a 1 inch of surface loss was observed next to aeration basin 2. No discernible protective coating was recorded along the channel. The influent channel can isolate Aeration Basins 1 and 2. Basin 1 gate support connect to influent well appears to be moderately to severally corroded in and in need of repair.
- **Aeration Basins 1, 2, 3, and 4 (AB1, AB2, AB3, and AB4):** Evaluated to be in overall poor condition. All basins were in service during the time of assessment and interior inspection of the structural basins was limited. Significant concrete corrosion and spalling was present at Aeration Basins 3 and 4 along the exterior walkway at the north end. Similar concrete degradation and spalling patterns were noted at Aeration Basin 1 and 2. Overall exposed concrete appears worn with exposed aggregate common. Basins were covered over the anoxic zones at the south end and could not be easily inspected. Joint sealant at walkways has failed across all the basins as evident by foliage growth out of joint at Aeration Basin 2. High water levels in the basins were observed to cause the leaking of water into the pipe chase between basins, causing stagnant water conditions in the chase.
- **Aeration Basins Piping General:** Evaluated to be in overall poor condition. The spray water piping system at the south end of the basins was noted to be defunct. Air lines are generally stainless steel, polyvinyl chloride in the basin, and steel in the pipe chases. Piping for step feed pumps were observed to be nonoperational. WES staff noted that non-operational piping systems had leaks and or frozen vales attributed to their abandonment. Overall, the observed stainless-steel piping was in good and operable condition.
- **AB1 Zones 1 and 3 Air Flow Transmitters:** Evaluated to be in overall moderate condition. Meter and transmitter casings and electrical conduit connections show significant signs of exterior deterioration. Equipment is becoming out of date and nearing the end of estimated useful operational life.
- **AB2 Zones 3 and 4/ AB 3 Zones 2 and 4 Air Quality Meters:** Evaluated to be in overall moderate condition. Wiring exhibited moderate discoloration and apparent wear overall indicating heavy use. There is concern that if not addressed the panel will unexpectedly fail with the potential to render additional electronic equipment inoperable and or cause bystander shock potential. Equipment is becoming out of date and nearing the end of estimated useful operational life.
- **Effluent Channel (combined):** Evaluated to be in overall moderate condition. Drain holes were drilled in troughs throughout the channel. Flow springs through the drain holes and empties into one of two drop boxes from the wall. Flow into the troughs is highly uneven. Surfaces are covered with algae and mussels.

Picture 14.
AB1 Main Step Feed Gate

Picture 15.
AB4 Zone 4 Air Flow Control Valve

Picture 16.
Influent Channel (combined)

Picture 17.
Blower Building (Acoustic Panels)

Table 6.6 summarizes the condition scores for condition deficient assets at the aeration basins location.

Table 6.6 Condition Assessment Summary - Aeration Basins

Condition Score	Asset Name	Reason
5 – Very Poor	AB1 Main Step Feed Gate	• General Condition. • Leakage. • Components.
5 – Very Poor	AB2 Main Step Feed Gate	• General Condition. • Leakage. • Components.
5 – Very Poor	AB3 Main Step Feed Gate	• General Condition. • Leakage. • Components.

Condition Score	Asset Name	Reason
5 – Very Poor	AB4 Main Step Feed Gate	• General Condition. • Leakage. • Components.
5 – Very Poor	AB4 Zone 2 Air Flow Control Valve	• Leakage.
5 – Very Poor	AB4 Zone 4 Air Flow Control Valve	• General Condition. • Components.
5 – Very Poor	Influent Channel (combined)	• Coating/ Lining/ Paint.
4 – Poor	Aeration Basin 1 (AB1)	• Leakage.
4 – Poor	Aeration Basin 2 (AB2)	• Leakage.
4 – Poor	Aeration Basin 3 (AB3)	• Leakage.
4 – Poor	Aeration Basin 4 (AB4)	• Leakage.
4 – Poor	Aeration Basins Piping General	• General Condition.
3 – Moderate	AB1 Zone 1 Air Flow Transmitter	• General Condition.
3 – Moderate	AB1 Zone 3 Air Flow Transmitter	• General Condition. • Display/ Enclosure/ Mount.
3 – Moderate	AB2 Zone 3 Air Quality Meter	• General Condition.
3 – Moderate	AB2 Zone 4 Air Quality Meter	• General Condition. • Wiring/ Cable Condition.
3 – Moderate	AB3 Zone 2 Air Quality Meter	• Wiring/ Cable Condition.
3 – Moderate	AB3 Zone 4 Air Quality Meter	• Wiring/ Cable Condition.
3 – Moderate	Effluent Channel (combined)	• General Condition.

Based on the above observations and findings, the following actions are recommended for the aeration basins location:

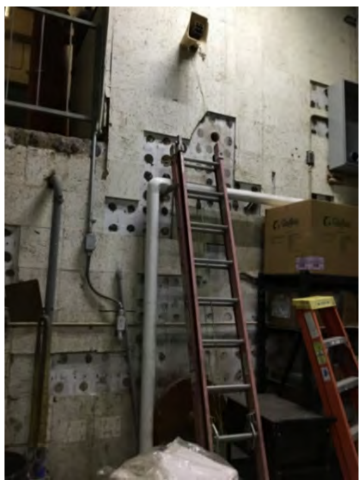
1. Replace AB1, AB2, AB3, and AB4 Main Step Feed Gates.
2. Rehabilitate AB4 Zone 2 and 4 Air Flow Control Valves; replace motorized actuators with new units.
3. Rehabilitate Aeration Basin 1, 2, 3, and 4 (AB1, AB2, AB3, and AB4); drain, power blast, and apply protective coating to concrete. Consider raise the chase isolation walls to reduce incumbent spillage.
4. Replace Aeration Basins Piping General; portions of airlines; entire spray water system and step feed pump system.
5. Replace AB1 Zone 1 and 3 Air Flow Transmitters.
6. Replace AB2 Zone 3 and 4 Air Quality Meters.
7. Replace AB3 Zone 2 and 4 Air Quality Meters.
8. Rehabilitate Influent and Effluent Channels (combined); drain, power blast, mortar repair, and apply protective coating to concrete. Address gate support connection in basin 1 of the influent channel and drain holes specifically in effluent troughs.

6.3.5 Blower Building

The blower building location resides in the center of the facility grounds, just south of the aeration basins and north of primary clarifier No. 2. The building is roughly 30 ft. by 60 ft. Assets designated to the blower building location consist of the superstructure, blowers, actuators, piping, exhaust fans, supply fans, meters, transmitters, programmable logic controllers, solid state starters, motor control centers, and control panels. Mechanical and electrical/ instrumentation discipline assets are assumed to have undergone at least one round of rehabilitation or replacement.

The following notable observations were made about condition deficient assets at the blower building location:

- **Blower Building:** Evaluated to be in overall poor condition. Missing acoustical wall panels over 20 percent. Concrete spall at the southeast corner at the exterior. Large gap in walkway at north side of building.
- **Active Harmonic Filters (AHF) 1 and 2:** Evaluated to be in overall moderate condition. AHF enclosure and electrical connections show significant signs of deterioration. AHF Wiring exhibited moderate discoloration and apparent wear overall indicating heavy use. There is concern that if not addressed the panel will unexpectedly fail with the potential to render additional electronic equipment inoperable and or cause bystander shock potential. AHF is becoming out of date and nearing the end of estimated useful operational life.



Picture 18.
Blower Building (Acoustic Panels)

Picture 19.
Blower Building

Picture 20.
AHF-2 Active Harmonic Filter

Picture 21.
Motor Control Center MCC-2A

Table 6.7 summarizes the condition scores for condition deficient assets at the blower building location.

Table 6.7 Condition Assessment Summary - Blower Building

Condition Score	Asset Name	Reason
4 – Poor	Blower Building	• Components.
3 – Moderate	AHF-1 Active Harmonic Filter Control Panel	• General Condition. • Equipment. • Wiring/ Cable Condition. • Components.
3 – Moderate	AHF-2 Active Harmonic Filter Control Panel	• General Condition. • Enclosure. • Wiring/ Cable Condition.
3 – Moderate	Motor Control Center MCC-2A	• General Condition. • Enclosure. • Temperature/ Noise.

Based on the above observations and findings, the following actions are recommended for the blower building location:

1. Replace AHF-1 and AHF-2 Active Harmonic Filter Control Panels.
2. Rehabilitate Blower Building; replace missing acoustical wall panels, address concrete spall at the southeast corner with local repair. Fill gap observed at north side of building walkway with a flexible joint and sealant material.
3. Rehabilitate Motor Control Center MCC-2A; replace lugs, wiring, and cable connections.

6.3.6 Secondary Clarifiers

The secondary clarifiers location resides in the northwest corner of the Kellogg Creek WRRF grounds and is comprised of two 120 ft. diameter circular clarifiers and support appurtenances. Secondary Clarifier No. 1 is the furthermost north of the two clarifiers, due west of the administration building. Clarifier No. 2 is 40 ft. south of Clarifier No. 1, due west of the aeration basins. Assets designated to the secondary clarifier's location include clarifier basins, underdrain pumps, splitter boxes, wet wells, gates, rake arm and drive assemblies, piping, and control panels. Mechanical and electrical/ instrumentation discipline assets are assumed to have undergone at least one round of rehabilitation or replacement.

The following notable observations were made about condition deficient assets at the secondary clarifier's location:

- **Secondary Clarifier 1 and 2 Motorized Actuated Influent Gate:** Evaluated to be in overall very poor condition. Gate are constructed of cast aluminum and due to corrosion and general deterioration have become thin and structurally deficient which has resulting in general flexing from incumbent flow when operated in the closed position. The pressure created by the flow can easily cause leakage around the edges of the gate into an empty clarifier in an isolation scenario. WES staff reported that they have needed to use sump pumps in the past to drain out the mixed liquor that leaks into offline clarifier due to the ineffective sealing around isolation gate. The gate height is low, WES staff currently attaches a piece of metal on top of the gates when closed to prevent flow from overtopping the gate.

- **Secondary Clarifier Basin 1 and 2:** Evaluated to be in overall moderate condition. Clarifier No. 1 has unequal weir flow split that is high flow on the north side and low on the south side. Clarifier No. 2 has the same issues, but somewhat more pronounced. Site subsidence/ settlement maybe attributable to the unequal flow. Despite the observed operational issues, stated above, both clarifiers appear to be in good working condition with minor to moderate wear and deterioration.
- **Secondary Clarifier Basin 1 and 2 Drive Assemblies:** Evaluated to be in overall moderate condition. WES staff instructed condition assessment team to reference condition assessment report Rebuild-It Services Group - 2019 (Appendix 5b-B of TM5B: Existing Kellogg Creek Water Resource Recovery Facility Condition).
- **Secondary Clarifier Basin 2 Rake Arm:** Evaluated to be in overall moderate condition. clarifiers both in operation and rake arms could not be observed during time of assessment. WES staff instructed condition assessment team to reference condition assessment report Rebuild-It Services Group - 2019 (Appendix 5b-B of TM5B: Existing Kellogg Creek Water Resource Recovery Facility Condition).
- **Secondary Influent Splitter Box:** Evaluated to be in overall moderate condition. Flow split is uneven with most of the flow going to Secondary Clarifier No. 1. The gate to Secondary Clarifier No. 1 is lowered to help even flow split. Site subsidence/ settlement maybe attributable to the unequal flow. Channel is concrete with minor aggregate exposure.

Picture 22.
Secondary Clarifier 1 Motorized Actuated Influent Gate

Picture 23.
Secondary Clarifier Basin 1 Drive Assembly

Picture 24.
Secondary Influent Splitter Box

Picture 25.
Secondary Clarifier Basin 1 Rake Arm

Table 6.8 summarizes the condition scores for condition deficient assets at the secondary clarifiers location.

Table 6.8 Condition Assessment Summary - Secondary Clarifiers

Condition Score	Asset Name	Reason
5 – Very Poor	Secondary Clarifier 1 Motorized Actuated Influent Gate	• Leakage.
5 – Very Poor	Secondary Clarifier 2 Motorized Actuated Influent Gate	• Leakage.
5 – Very Poor	Secondary Clarifier Basin 2 Rake Arm	• General Condition.
3 – Moderate	Secondary Clarifier Basin 1	• General Condition.
3 – Moderate	Secondary Clarifier Basin 1 Drive Assembly	• General Condition. • Components.
3 – Moderate	Secondary Clarifier Basin 2	• General Condition.
3 – Moderate	Secondary Clarifier Basin 2 Drive Assembly	• General Condition. • Components.
3 – Moderate	Secondary Influent Splitter Box	• General Condition.

Based on the above observations and findings, the following actions are recommended for the secondary clarifier location:

1. Rehabilitate secondary Clarifier 1 and 2 Motorized Actuated Influent Gates; replace actuators and ensure new gates seal properly when closed.
2. Rehabilitate Secondary Clarifier Basin 2 Rake Arms; reference condition assessment report Rebuild-It Services Group - 2019 (Appendix 5b-B of TM5B: Existing Kellogg Creek Water Resource Recovery Facility Condition). The scum beach should be replaced, the launders coated, and other miscellaneous rehab work.
3. Rehabilitate Secondary Clarifier Basin 1 and 2; drain, power blast, and apply protective coating to concrete. Investigate weir flow split; may be indicative of larger settlement problem. Cost included to further investigate uneven flow over the weirs and potential settlement.

4. Rehabilitate Secondary Clarifier Basin 1 and 2 Drive Assemblies; reference condition assessment report Rebuild-It Services Group - 2019 (Appendix 5b-B of TM5B: Existing Kellogg Creek Water Resource Recovery Facility Condition).
5. Rehabilitate Secondary Influent Splitter Box; drain, power blast, mortar, and apply waterproof sealer/ protective coating to concrete. Investigate weir flow split; may be indicative of larger problem.

6.3.7 Secondary Pump Station

The secondary pump station resides in the northwest of the facility grounds, in between secondary clarifiers No. 1 and No. 2. Assets designated to the secondary pump station location include pumps, wet wells, traps, channels, launders, troughs, weirs, baffles, skimmers, samplers, piping, meters, transmitters, motor control centers, variable frequency drives, programmable logic controls, and control panels.

The following notable observations were made about condition deficient assets at the secondary pump station location:

- **Secondary Clarifier Basin 1 and 2 Scum Skimmers:** Evaluated to be in overall very poor condition. Scum rake showed significant corrosion and wear. Trough bars were heavily worn/eroded. WES staff instructed condition assessment team to reference condition assessment report (Rebuild-It Services Group - 2019).

- **Secondary Clarifier Basin 1 and 2 Scum Baffles, Boxes, and Troughs:** Evaluated to be in overall poor to moderate condition. WES staff instructed condition assessment team to reference condition assessment report (Rebuild-It Services Group - 2019).

- **Activated Sludge Recirculation Pump Station Building:** Evaluated to be in overall poor condition. Basement has active leaks in the west wall and cracks at pipe penetration. The piping appears to be seismically braced and in excellent condition. Scum piping is still old and one support lacks anchorage.

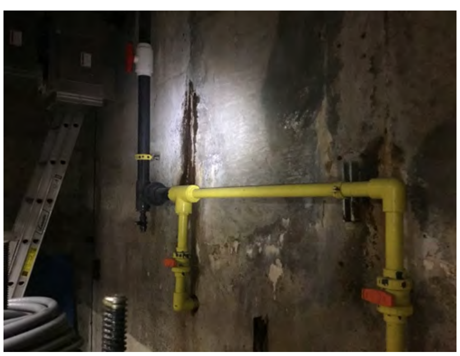
- **Secondary Scum Pump:** Evaluated to be in overall moderate condition. Significant corrosion and exterior deterioration observed at various locations on pump casing, most notably at joints and on the heads of bolts. Leakage was also present around pump seals and likely contributed to the extent of corrosion noted.

Picture 26.
Secondary Clarifier Basin 2 Scum Skimmer

Picture 27.
Secondary Clarifier Basin 2 Scum Skimmer

Picture 28.
Secondary Scum Pump

Picture 29.
Activated Sludge Recirculation Pump Station Building



Picture 30.
Activated Sludge Recirculation Pump Station Building

Picture 31.
Non-Potable Water Pump 2

Table 6.9 summarizes the condition scores for condition deficient assets at the secondary pump station location.

Table 6.9 Condition Assessment Summary - Secondary Pump Station

Condition Score	Asset Name	Reason
5 – Very Poor	Secondary Clarifier Basin 1 Scum Skimmer	• General Condition. • Corrosion/ Exterior. • Components.
5 – Very Poor	Secondary Clarifier Basin 2 Scum Skimmer	• General Condition. • Corrosion/ Exterior. • Components.
4 – Poor	Activated Sludge Recirculation Pump Station Building	• Leakage.
4 – Poor	Secondary Clarifier Basin 2 Scum Trough	• General Condition.
3 – Moderate	Secondary Clarifier Basin 1 Scum Baffle	• General Condition.
3 – Moderate	Secondary Clarifier Basin 1 Scum Box	• General Condition.
3 – Moderate	Secondary Clarifier Basin 1 Scum Trough	• General Condition.
3 – Moderate	Secondary Clarifier Basin 2 Scum Baffle	• General Condition.
3 – Moderate	Secondary Clarifier Basin 2 Scum Box	• General Condition.
3 – Moderate	Secondary Scum Pump	• General Condition. • Corrosion/ Exterior. • Leakage.

Based on the above observations and findings, the following actions are recommended for the secondary pump station location:

1. Replace Secondary Clarifier Basin 1 and 2 Scum Skimmers.
2. Rehabilitate Activated Sludge Recirculation Pump Station Building; Injection hydro grouting should be utilized to fill cracks/ active leaks observed along basement wall and cracks at pipe penetration.
3. Rehabilitate Secondary Clarifier Basin 1 and 2 Scum Baffle, Boxes, and Troughs; drain power blast, and apply protective coating to concrete.
4. Rehabilitate Secondary Scum Pump; consider replacement if it has been rehabilitated more than twice in the past.

6.3.8 Chlorine Contact Basin

The chlorine contact basin location resides near the center of facility grounds at the western extremity of plant, adjacent to the Willamette River. The location is mainly comprised of two 30 ft. by 40 ft. rectangular contact chambers and appurtenances. Assets designated to the chorine contact basin location include basins, channels, launders, troughs, gates, pumps, blowers, piping, skimmers, samplers, screens, strainers, injector, educator, hoists, trolleys, cranes, UV reactors, meters, transmitters, and control panels.

The following notable observations were made about condition deficient assets at the chlorine contact basin location:

- **Non-Potable Water Pump 2 and Non-Potable Water Strainer:** Evaluated to be in overall very poor condition. Significant discoloration, corrosion, and exterior deterioration noted at various locations on pump, motor, and strainer casing. Joints and bolt connection appear to be the most susceptible. Despite extensive corrosion all units seem to be meeting design flows.

- **UV Channel 1 and 2 Cassettes 1 and 2 A/B/C:** Evaluated to be in overall very poor condition. Ultraviolet cassette banks and associated control panels overheat frequently during the summer and end up shorting out ballasts as noted by WES staff. Operators end up having to spray water on the cabinets to keep them cool. Due to the equipment running hot much of the time, specifically in the summer, the reliability of the treatment and units is questionable. UV cassettes and ballasts end up having to purchased and replaced frequently.
- **Effluent Flow Transmitter:** Evaluated to be in overall poor condition. Wiring, display enclosure, and components exhibited moderate discoloration and apparent wear overall indicating heavy use. There is a concern that if not addressed the panel will unexpectedly fail with the potential to render additional electronic equipment inoperable and or cause bystander shock potential. Equipment is becoming out of date and nearing the end of estimated useful operational life.
- **UV Channel 1 and 2 Disinfection Systems:** Evaluated to be in overall poor condition. Ultraviolet control panels overheat frequently during the summer and end up causing strain and damage to the electrical components as noted by WES staff. Operators end up having to spray water on the cabinets to keep them cool. Due to the equipment running hot much of the time, specifically in the summer, the reliability of the treatment and units is questionable. There is a concern that if not addressed the panel will unexpectedly fail with the potential to render additional electronic equipment inoperable and or cause bystander shock potential.
- **UV Channel 1 and 2 Motorized Influent Gates:** Evaluated to be in overall poor condition. Due to corrosion and general deterioration influent gates have become thin and structurally deficient. Seals around the periphery of the gates have leaked since installation as noted by WES staff.
- **UV Cleaning Blower:** Evaluated to be in overall poor condition. Significant corrosion and exterior wear observed at various locations on pump casing, most notably at joints and on the heads of bolts. Leakage was also present around pump seals and likely contributed to the extent of corrosion noted. Despite extensive corrosion units seems to be meeting operational requirements.
- **Chlorine Contact Chamber Secondary Effluent Basin:** Evaluated to be in overall moderate condition. The north expansion joint that traverses the structure in the east-west direction is opened up to nearly two inches at the middle walkway. The joint in the gap should be filled. Other joint locations appear to be wider than normal. Devin indicated that they believe the basin is settling differentially at the north end, which is adjacent to the river park grassy knoll that is also adjacent to the west ends of both secondary clarifiers. The concrete wall surfaces below the water line have exposed aggregate.
- **UV Channel 1 and 2 Level Control Gates:** Evaluated to be in overall moderate condition. Due to corrosion and general deterioration level control gates have become thin and structurally deficient. Levels in channel are at visibly different elevations - do not appear to be achieving a perfect flow split.
- **UV Gantry Crane:** Evaluated to be in overall moderate condition. Moderate discoloration, corrosion, and exterior deterioration noted across the gantry crane unit. Due to coating loss and damage the gantry crane requires further inspection and evaluation.
- **UV Influent Gate No. 2 and 3:** Evaluated to be in overall moderate condition. Moderate corrosion, coating loss, and damage was observed on the influent gates. Despite corrosion units seems to be meeting operational requirements.

Picture 32.
UV Gantry Crane

Picture 33.
UV Channel 1 Cassette 1A Control Cabinet

Picture 34.
UV Influent Gate No. 2

Picture 35.
Digester Building Exhaust Fan 5

Table 6.10 summarizes the condition scores for condition deficient assets at the chlorine contact basin location.

Table 6.10 Condition Assessment Summary - Chlorine Contact Basin

Condition Score	Asset Name	Reason
5 – Very Poor	Non-Potable Water Pump 2	• Corrosion/ Exterior.
5 – Very Poor	UV Channel 1 Disinfection System	• Components.
5 – Very Poor	UV Channel 2 Disinfection System	• Components.
4 – Poor	CCB No. 1 Influent Gate	• Leakage.
4 – Poor	Effluent flow transmitter	• General Condition. • Equipment/ Transmitter. • Display/ Enclosure/ Mount. • Wiring/ Cable Condition. • Components.
4 – Poor	UV Channel 1 Motorized Influent Gate	• General Condition. • Leakage. • Components.
4 – Poor	UV Channel 2 Motorized Influent Gate	• General Condition.

Condition Score	Asset Name	Reason
4 – Poor	UV Cleaning Blower	• Leakage.
3 – Moderate	Chlorine Contact Chamber Secondary Effluent Basin	• Corrosion/ Exterior.
3 – Moderate	UV Channel 1 Level Control Gate	• Components.
3 – Moderate	UV Channel 2 Level Control Gate	• Corrosion/ Exterior.
3 – Moderate	UV Gantry Crane	• General Condition.
3 – Moderate	UV Influent Gate No. 2	• Corrosion/ Exterior.
3 – Moderate	UV Influent Gate No. 3	• General Condition.

Abbreviation: CCB - Chlorine Contact Basin.

Based on the above observations and findings, the following actions are recommended for the chlorine contact basin location:

1. Rehabilitate Non-Potable Water Pump 2; consider replacement if it has been rehabilitated more than twice in the past.
2. Replace UV Channel 1 and 2 Disinfection Systems; consider upgrading to newer UV technology.
3. Rehabilitate CCB No. 1 Influent Gate.
4. Replace Effluent flow transmitter.
5. Rehabilitate UV Channel 1 and 2 Motorized Influent Gates.
6. Rehabilitate UV Cleaning Blower; consider replacement if it has been rehabilitated more than twice in the past.
7. Rehabilitate Chlorine Contact Chamber Secondary Effluent Basin; drain, power blast, mortar, and apply waterproof sealer/ protective coating to concrete.
8. Rehabilitate UV Channel 1 and 2 Level Control Gates; ensure that seals are properly seated.
9. Rehabilitate UV Influent Gates 2 and 3; ensure that seals are properly seated.
10. Rehabilitate UV Gantry Crane; paint and replace electrical components. Investigate further to determine if structural integrity is compromised.

6.3.9 Digester Complex

The digester complex location resides at the southeast corner of treatment facility grounds, due south of the chemical building. Two circular tanks roughly 80 feet in diameter flank a 60 ft. by 60 ft. superstructure. Assets designated to the digester complex location include buildings, traps, tanks, piping, boilers, valves, filter, generator, heat exchanger, pump, separator, tank, grinder, air handling units, supply and exhaust fans, programmable logic controllers, meters, transmitters, motor control centers, variable frequency drives, motors, and control panels.

The following notable observations were made about condition deficient assets at the chlorine contact basin location:

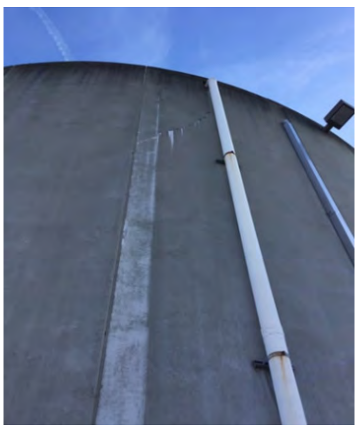
- **Carbon Vessel Digester 1 Exhaust Fan:** Evaluated to be of overall very poor condition. Expected life exceeded and high likelihood of breakdown or failure. Carbon vessel digester No. 1 exhaust fan was inoperable at the time of condition assessment.

- **Carbon Vessel Digester 1 and 2 Exhaust and Building Pressure Indicator:** Evaluated to be in overall poor condition. Mechanical pressure gauge has significant wear and degradation. Requires a high level of maintenance to remain operational and should be replaced.

- **Carbon Vessel Digester 2 Exhaust Fan:** Evaluated to be in overall poor condition. Exhaust fan has significant wide-spread corrosion. Operation not affected.
- **Carbon Vessel Digester Building:** Evaluated to be in overall poor condition. Tank is anchored. One support has fractured laminates at the top of the reinforcing band. Significant concrete surface corrosion due to leachate from ducts and tank.
- **Digester Building:** Evaluated to be in overall poor condition. Building adjoins to digester walls with no apparent separation joints. Evidence of roof leaks at electrical room. Some concrete cracking observed in walls. Piping lacks seismic bracing throughout. Pipes appear to be in poor condition with evidence of corrosion and leakage at Boiler Room. The roof mounted metals have moderate to severe corrosion. The heat exchanger framing is in poor condition and at the end of its useful life. Spalled concrete at stair tower wall at roof, five locations. Minor cracking in building walls, but no associated corrosion or spalling.
- **Digester No. 1:** Evaluated to be in overall very poor condition. Located to the east of Digester No. 2. The digester roof is covered with insulation foam that is in very poor condition with most of the insulation failed, bubbling, missing, and irregular. Strong smell of hydrogen sulfide gas at the center. Gas cover lid has pitting. Minor cracking at wall access. Walls appear to have exterior panels for insulation and/or aesthetics. Wall panel crack at north side with evidence of past leakage.
- **Digester No. 2:** Evaluated to be in overall very poor condition. Roof insulation is in similarly poor condition as Digester No. 1 roof, but to a slightly lesser degree. Flange of access hatch at center of roof has evidence of moderate corrosion. Strong smell of hydrogen sulfide (H_2S) gas at the center of the roof, likely from the pressure relief valve. Gas cover lid has pitting. Gas piping has severe corrosion, suspected source of leakage as well. Wall panel cracking observed at north side.
- **Digester 1 and 2 Foam Separators:** Evaluated to be in overall very poor condition. Severely corroded valves for isolating tanks, but apparently still functional. WES staff have not used the foam separators in 5 years.
- **Digester Building Air Supply Unit:** Evaluated to be in overall very poor condition. Fan works. Heating component out of service. Used for ventilation only.
- **Digester Complex Piping General:** Evaluated to be in overall poor condition. Building adjoins to digester walls with no apparent separation joints. Evidence of roof leaks at electrical room. Some concrete cracking observed in walls. Piping lacks seismic bracing throughout. Pipes appear to be in poor condition with evidence of corrosion and leakage at Boiler Room.
- **Sludge Filling Station:** Evaluated to be in overall moderate condition. Sludge is loaded here and hauled to Tri-City for dewatering. Concrete construction with lateral bracing on three sides. Steel panel roof deck with some minor corrosion. Pipe support on fill line appears to have very corroded weld to roof beam flange.
- **Engine Generator:** Evaluated to be in overall moderate condition. Rebuilt 10-15 years ago. Minor leaks of jacket water during startup. Minor oil leaks. Full spare located at Tri-City WRRF. Knocks due to gas quality.

Picture 36.
Digester 1 Foam Separator

Picture 37.
Digester Building Air Supply Unit



Picture 38.
Digester 1

Picture 39.
Digester 1

Picture 40.
Digester 1

Picture 41.
Digester 2

Picture 42.
Digester 1

Picture 43.
Heat Exchanger Hot Water Circulation Pump 2

Picture 44.
Digester Complex Piping General

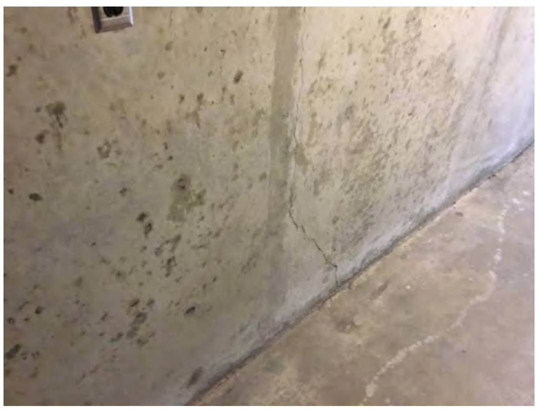
Picture 45.
Carbon Vessel Digester 1 Exhaust Fan

Picture 46.
Carbon Vessel Digester 1 Exhaust Fan

Picture 47.
Carbon Vessel 1

Picture 48.
Digester Building (roof)

Picture 49.
Digester Building (roof)



Picture 48.
Digester Building

Picture 49.
Sludge Holding Tank Flame Arrestor 1

Table 6.11 summarizes the condition scores for condition deficient assets at the chlorine contact basin location.

Table 6.11 Condition Assessment Summary - Digester Complex

Condition Score	Asset Name	Reason
5 – Very Poor	Carbon Vessel Digester 1 Exhaust Fan	• General Condition.
5 – Very Poor	Digester 1	• Coating/ Lining/ Paint.
5 – Very Poor	Digester 1 Foam Separator	• Corrosion/ Exterior.
5 – Very Poor	Digester 2	• Coating/ Lining/ Paint.
5 – Very Poor	Digester 2 Foam Separator	• Corrosion/ Exterior.
5 – Very Poor	Digester Building Air Supply Unit	• Components.
5 – Very Poor	Digester Building Exhaust Fan 5	• General Condition. • Corrosion/ Exterior.
4 – Poor	Boiler Bypass Flow Control Valve	• General Condition. • Corrosion/ Exterior. • Components.

Condition Score	Asset Name	Reason
4 – Poor	Bypass Flow Control Valve 1	• General Condition.
4 – Poor	Bypass Flow Control Valve 2	• General Condition.
4 – Poor	Carbon Vessel Digester 1 Exhaust Pressure Indicator	• General Condition.
4 – Poor	Carbon Vessel Digester 2 Exhaust Fan	• General Condition. • Corrosion/ Exterior.
4 – Poor	Carbon Vessel Digester 2 Exhaust Pressure Indicator	• General Condition.
4 – Poor	Carbon Vessel Digester Building	• Surface Deterioration.
4 – Poor	Carbon Vessel Digester Building Pressure Indicator	• General Condition.
4 – Poor	Digester Building	• Components.
4 – Poor	Digester 2 Level	• General Condition. • Equipment/ Transmitter. • Display/ Enclosure/ Mount. • Wiring/ Cable Condition. • Components.
4 – Poor	Digester Complex Piping General	• General Condition. • Coating/ Lining/ Paint.
4 – Poor	Engine/ Boiler Room Supply Fan 1	• General Condition. • Components.
4 – Poor	Motor Control Center MCC-6	• Wiring/ Cable Condition.
4 – Poor	Motor Control Center MCC-6E	• Wiring/ Cable Condition.
4 – Poor	Plant Effluent Meter	• General Condition. • Equipment/ Transmitter. • Display/ Enclosure/ Mount. • Wiring/ Cable Condition. • Components.
4 – Poor	Engine Generator	• General Condition. • Corrosion/ Exterior. • Vibration. • Leakage.
4 – Poor	Programmable Logic Controller 03 (PLC03)	• General Condition. • Equipment/ Transmitter. • Wiring/ Cable Condition. • Components.
3 – Moderate	Digested Sludge Loading Pump 1	• General Condition. • Corrosion/ Exterior.
3 – Moderate	Digested Sludge Loading Pump 2	• General Condition. • Corrosion/ Exterior.

Condition Score	Asset Name	Reason
3 – Moderate	Digester 1 Gas Pressure	• General Condition. • Equipment/ Transmitter. • Display/ Enclosure/ Mount. • Wiring/ Cable Condition.
3 – Moderate	Digester 2 Gas Pressure	• General Condition. • Equipment/ Transmitter. • Display/ Enclosure/ Mount. • Wiring/ Cable Condition.
3 – Moderate	Heat Exchanger Hot Water Circulation Pump 2	• Corrosion/ Exterior. • Leakage.
3 – Moderate	Incinerator Digester Gas Usage Meter	• Equipment/ Transmitter.
3 – Moderate	Motor Control Center Square D	• General Condition. • Enclosure. • Wiring/ Cable Condition.
3 – Moderate	Sludge Filling Station	• General Condition.
3 – Moderate	Sludge Transfer Pump 1	• General Condition.
3 – Moderate	Sludge Transfer Pump 2	• General Condition.

Based on the above observations and findings, the following actions are recommended for the digester complex location:

1. Replace Carbon Vessel Digester 1 and 2 Exhaust Fans.
2. Rehabilitate Digester 1 and 2; replace roofing, insulation paneling, and include contingency for repairing cracks and/or spalls in the concrete roof. Repairs at the concrete roof may be expected to include injection of cracks where they occur and localized mortar repairs. The interior of the digesters was not observed, but interior surfaces above the low liquid level may also require sandblasting, a concrete mortar repair, and application of a protective coating.
3. Rehabilitate Digester 1 and 2 Foam Separators; replace valves and repaint/ coat exterior.
4. Replace Digester Building Air Supply Unit.
5. Replace Digester Building Exhaust Fan 5.
6. Replace Boiler Bypass Flow Control Valve.
7. Replace Bypass Flow Control Valves 1 and 2.
8. Replace Carbon Vessel Digester 1 and 2 Exhaust Pressure Indicators.
9. Rehabilitate Carbon Vessel at Digester Building, address corrosion of concrete through a process of sandblasting, mortar repair, and application of a non-skid protective coating.
10. Replace Carbon Vessel Digester Building Pressure Indicator.
11. Rehabilitate Digester Building; address concrete spalls at the roof stair tower with local concrete repairs and repair leakage at the roof deck with injection grouting using a urethane resin.
12. Replace Digester 2 Level Meter.
13. Rehabilitate Digester Complex Piping General; add seismic bracing and strip/ coat piping suffering from corrosion.
14. Replace Engine/ Boiler Room Supply Fan 1.
15. Replace Motor Control Center MCC-6.
16. Replace Motor Control Center MCC-6E.
17. Replace Motor Control Center Square D.

18. Replace Plant Effluent Meter.
19. Rehabilitate Programmable Logic Controller 03 (PLC03); replace obsolete components, wiring and connections.
20. Rehabilitate Digested Sludge Loading Pump 1 and 2; consider replacement if it has been rehabilitated more than twice in the past.
21. Replace Digester 1 and 2 Gas Pressures meters.
22. Rehabilitate Engine Generator; consider replacement if it has been rehabilitated more than twice in the past.
23. Rehabilitate Heat Exchanger Hot Water Circulation Pump 2; consider replacement if it has been rehabilitated more than twice in the past.
24. Replace Incinerator Digester Gas Usage Meter.
25. Rehabilitate Sludge Filling Station; perform minor steel repairs at damaged welds.
26. Rehabilitate Sludge Transfer Pump 1 and 2; consider replacement if it has been rehabilitated more than twice in the past.

6.3.10 Thickening Complex

The digester complex location resides at the southeast corner of treatment facility grounds, due south of the chemical building. Two circular carbon tanks roughly 80 ft. in diameter flank a 60 ft. by 60 ft. superstructure. Assets designated to the digester complex location include buildings, traps, tanks, piping, boilers, valves, filter, generator, heat exchanger, pump, separator, tank, grinder, air handling units, supply and exhaust fans, programmable logic controllers, meters, transmitters, motor control centers, variable frequency drives, motors, and control panels.

The following notable observations were made about condition deficient assets at the Thickening Complex basin location:

- **Dissolved Air Flotation Treatment (DAFT) Air Saturation Tank:** Evaluated to be in overall very poor condition. Replacement tank purchased and ready to be installed. Waiting to schedule a DAFT shutdown. Very corroded.
- **Sludge Holding Tank Flame Arrestor 1:** Evaluated to be in overall very poor condition. Exterior OK but under the cover the casing is severely corroded. Apparently took maintenance three hours to open the cartridge because it was rusted shut. Handle broke off. Interior is stainless steel, but judging from condition of exterior, adequate performance is not guaranteed.
- **Thickening Building Air Handling Unit:** Evaluated to be in overall very poor condition. Heating element is broken, so building stays generally cold. Suction for this unit is in an area that naturally collects a lot of leaves in the fall. Leaves plug up the suction very quickly, so air flow is poor. Maintenance is unsure what to do about this beyond constantly rake the area.
- **DAFT Flotation Thickener Sludge Hopper:** Evaluated to be in overall poor condition. Sludge hopper is covered with cake but framing supporting tread plate is corroded and in poor condition. Coating deterioration only at top. Cake covering conceals the coating surface.
- **DAFT Sludge Skimmer Drive Mechanism:** Evaluated to be in overall poor condition. Flights and chain replaced, Reeves drive replaced five years ago, they have a shelf spare motor. Lower flights for scraper are not used, probably don't work. Reeves drive for skimmer may not be capable of speeding up.

- **Compressor Room Exhaust Fan:** Evaluated to be in overall moderate condition. On the roof. Operators have noticed no problems, but plant doesn't do much to maintain them beyond checking that they still work.
- **DAFT Pressure Regulating Valve:** Evaluated to be in overall moderate condition. Pressure Reducing Valve performs critical function of controlling the air circulation flow into the DAFT. Big and expensive, per operators.
- **DAFT Recirculation Pump 1 and 2:** Evaluated to be in overall moderate condition. Casing need replacement once in 10 years due to wear from grit/impeller.
- **Rotary Drum Thickener:** Evaluated to be in overall moderate condition. Uses a lot of polymer. Some leakage at wall panels. Nameplate unreadable. Anchorage to the structure may be inadequate.
- **Sludge Holding Tank:** Evaluated to be in overall moderate condition. Sludge is stored in the holding tank. Serves as inlet for imported sludge. Roof slab has moss and leaves. Concrete looks worn, but not a lot of cracking or spalling. One active leaking crack on the east side (weeping).
- **Sludge Holding Tank Flame Arrestor 2:** Evaluated to be in overall moderate condition. Not as thoroughly rusted through as the other Flame Arrestor on the sludge holding tank. But still the same age.
- **Thickened Sludge Pump (TPS) 1, 2, and 3:** Evaluated to be in overall moderate condition. The stator and rotor are replaced roughly every 3-4 years. Pumps have run dry on accident or clogs every other year or so, causing overheating. TPS No. 2 and No. 3 run more than TPS No. 1, as they are also used to pump RDT thickened sludge to digesters. Used to leak badly, but new mechanical seals fixed leakage.
- **Motor Control Center - MCC 4:** Evaluated to be in overall poor condition. Enclosure and electrical connections show significant signs of deterioration. Wiring exhibited moderate discoloration and apparent wear overall indicating heavy use. There is a concern that if not addressed the panel will unexpectedly fail with the potential to render additional equipment inoperable and or cause bystander shock potential. Equipment is becoming out of date and nearing the end of estimated useful operational life.
- **Thickening Complex Piping General:** Evaluated to be in overall moderate condition. Piping in general has no lateral bracing for seismic. In general piping in the basement is in good condition. One dripping leak at a dissolved air recycle (DAR) valve was observed.

Picture 50.
DAFT Flotation Thickener Sludge Hopper

Picture 51.
DAFT Sludge Skimmer Drive Mechanism

Picture 52.
DAFT Air Saturation Tank

Picture 53.
DAFT Recirculation Pump 2

Table 6.12 summarizes the condition scores for condition deficient assets at the Thickening Complex location.

Table 6.12 Condition Assessment Summary - Thickening Complex

Condition Score	Asset Name	Reason
5 – Very Poor	DAFT Air Saturation Tank	• General Condition. • Corrosion/ Exterior. • Leakage. • Components.
5 – Very Poor	Sludge Holding Tank Flame Arrestor 1	• General Condition. • Corrosion/ Exterior. • Components.
5 – Very Poor	Thickening Building Air Handling Unit	• Components.
4 – Poor	DAFT Flotation Thickener Sludge Hopper	• General Condition. • Components.
4 – Poor	DAFT Sludge Skimmer Drive Mechanism	• General Condition.
4 – Poor	Motor Control Center (MCC-4)	• General Condition. • Equipment. • Wiring/ Cable Condition. • Components.
4 – Poor	Thickened Sludge Pump 1 Local Control Panel	• General Condition. • Equipment. • Enclosure. • Wiring/ Cable Condition. • Components.
3 – Moderate	Compressor Room Exhaust Fan	• General Condition.
3 – Moderate	DAFT Circulation Pump 1 Seal Water Screen	• General Condition.
3 – Moderate	DAFT Circulation Pump 2 Seal Water Screen	• General Condition.

Condition Score	Asset Name	Reason
3 – Moderate	DAFT Pressure Regulating Valve	• Leakage.
3 – Moderate	DAFT Recirculation Pump 1	• Corrosion/ Exterior. • Components.
3 – Moderate	DAFT Recirculation Pump 2	• Corrosion/ Exterior. • Components.
3 – Moderate	Local Control Panel 4 (Remote Base to PLC03)	• Components.
3 – Moderate	Plant Air Receiver 1	• General Condition.
3 – Moderate	Plant Air Receiver 2	• General Condition.
3 – Moderate	Sludge Holding Tank	• General Condition. • Surface Deterioration.
3 – Moderate	Sludge Holding Tank Flame Arrestor 2	• General Condition. • Corrosion/ Exterior. • Components.
3 – Moderate	Thickened Sludge Pump 1	• Temperature. • Components.
3 – Moderate	Thickened Sludge Pump 1 Seal Water Screen	• General Condition.
3 – Moderate	Thickened Sludge Pump 2	• Temperature.
3 – Moderate	Thickened Sludge Pump 2 Local Control Panel	• General Condition. • Equipment. • Enclosure. • Wiring/ Cable Condition.
3 – Moderate	Thickened Sludge Pump 2 Seal Water Screen	• General Condition.
3 – Moderate	Thickened Sludge Pump 3	• Temperature.
3 – Moderate	Thickened Sludge Pump 3 Local Control Panel	• General Condition. • Enclosure. • Wiring/ Cable Condition.
3 – Moderate	Thickened Sludge Pump 3 Seal Water Screen	• General Condition.
3 – Moderate	Thickening Complex Piping General	• Leakage.

Based on the above observations and findings, the following actions are recommended for the Thickening Complex location:

1. NO ACTION DAFT Air Saturation Tank; WES currently addressing.
2. NO ACTION DAFT Circulation Pump 1 and 2 Seal Water Screens; WES currently addressing.
3. NO ACTION Thickened Sludge Pump 1, 2, and 3 Seal Water Screens; WES currently addressing.
4. Replace Sludge Holding Tank Flame Arrestors 1 and 2.
5. Replace Thickening Building Air Handling Unit.
6. Replace DAFT Pressure Regulating Valve.
7. Replace DAFT Flotation Thickener Sludge Hopper.
8. Rehabilitate DAFT Sludge Skimmer Drive Mechanism; replace with spare motor on shelf, replace lower flights for scraper and reeves drive for skimmers.

9. Rehabilitate DAFT Recirculation Pumps 1 and 2; consider replacement if they have been rehabilitated more than twice in the past.
10. Rehabilitate Local Control Panel 4 (Remote Base to PLC03); replace obsolete components, wiring and connections.
11. Rehabilitate Motor Control Center (MCC-4); replace obsolete components, wiring and connections.
12. Replace Compressor Room Exhaust Fan.
13. Replace Plant Air Receivers 1 and 2.
14. Rehabilitate Sludge Holding Tank; address corrosion of concrete within tank through a process of sandblasting, mortar repair, and application of protective coating. Expansion joint grouting should be removed and replaced around tank. Injection grouting should be utilized to fill cracks observed in base slab.
15. Rehabilitate Thickened Sludge Pumps 1, 2, and 3; consider replacement if they have been rehabilitated more than twice in the past.
16. Replace Thickened Sludge Pump 1 Panel.
17. Rehabilitate Thickening Complex Piping General; add seismic bracing.

6.3.11 Chemical Building

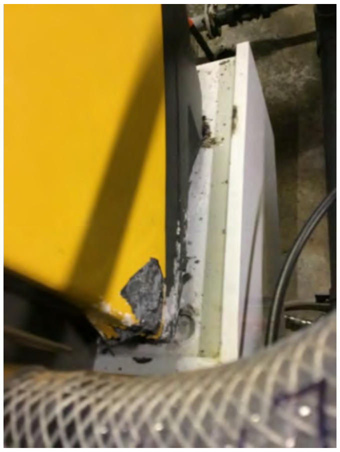
The chemical building location resides in the center of the treatment facility grounds, due south of primary clarifier No. 1, and is made up mainly of 70 ft. by 100 ft. building. Assets designated to the chemical building location include tanks, piping, pumps, generators, switchboards, programmable logic controllers, meters, transmitters, and control panels.

The following notable observations were made about condition deficient assets at the chemical building location:

- **Chlorine Building Piping General:** Evaluated to be in overall moderate condition. Tank drain piping has significant corrosion and leakage. Corrosion and leakage present at both tanks. Repairs recommended. Other metal pipes in the tank room are in poor condition. Off gassing from sodium hypochlorite is corrosive to metals. Suspected that ventilation in the hypochlorite room is insufficient, maybe due to inadequate air flow circulation.
- **Sodium Hypochlorite Metering Pump 2:** Evaluated to be in overall moderate condition. Chlorine was observed to be leaking from a pump feed piping, causing moderate corrosion across pump casing.

Picture 54.
Sodium Bisulfate Tank Level

Picture 55.
Chlorine Building Piping General



Picture 56.
Sodium Hypochlorite Metering Pump 2

Picture 57.
Biofilter 1

Table 6.13 summarizes the condition scores for condition deficient assets at the chemical building location.

Table 6.13 Condition Assessment Summary - Chemical Building

Condition Score	Asset Name	Reason
3 – Moderate	Chlorine Building Piping General	• General Condition. • Surface Deterioration. • Leakage. • Components.
3 – Moderate	Sodium Hypochlorite Metering Pump 2	• General Condition. • Corrosion/ Exterior. • Leakage. • Components.

Based on the above observations and findings, the following actions are recommended for the chlorine contact basin location:

1. Rehabilitate Chlorine Building Piping General; replace deficient section of piping and recoat/ paint peeling and slightly corroded sections.
2. Rehabilitate Sodium Hypochlorite Metering Pump 2; consider replacement if they have been rehabilitated more than twice in the past.

6.3.12 Administration Building

The administration building location resides at the northwest corner of treatment facility grounds, due north of the aeration basins, and is comprised of a single 45 ft. by 90 ft. building. Assets designated to the administration building location were limited to the building and piping at the time that the condition assessment was conducted.

The following notable observations were made about condition deficient assets at the chlorine contact basin location:

- **Air Condition Unit:** Evaluated to be of overall very poor condition. Expected life exceeded and high likelihood of breakdown or failure.
- **Administration Building Piping General:** Evaluated to be in overall moderate condition. The hot water piping system east of the restrooms is defunct due to failure of hot water piping in the building. Hot water is now supplied on-demand by dedicated hot-water units.

Table 6.14 summarizes the condition scores for condition deficient assets at the administration building location.

Table 6.14 Condition Assessment Summary - Administration Building

Condition Score	Asset Name	Reason
5 – Very Poor	Air Condition Unit	• General Condition. • Corrosion/ Exterior. • Vibration. • Temperature. • Components.
3 – Moderate	Administration Building Piping General	• General Condition.

Based on the above observations and findings, the following actions are recommended for the Administration location:

1. Replace Air Condition Unit.

Rehabilitate Administration Building Piping General; replace deficient section of piping and recoat/ paint peeling and slightly corroded sections.

6.3.13 Building and Grounds

The building and grounds location encompass the entirety of Kellogg Creek facility. Assets designated to the building and digester location include piping, buildings, containment areas, tanks, generators, compressors, filters, air condition units, blowers, exhaust fans, meters, transmitters, lighting, switchgears, transformers, variable frequency drives, motors, and control panels.

The following notable observations were made about condition deficient assets at the chlorine contact basin location:

- **Biofilter 1:** Evaluated to be in overall poor condition. Significant corrosion, damage, and wear across unit that appears to not be affecting operation. Isolation valve handle is bent but still turns. No odors.

- **Activated Carbon Filters 1, 2, and 3:** Evaluated to be overall moderate condition. Pressure gauge is non-operational and subject to freezing. New carbon filters installed in 2018. WES has proactively replaced carbon filters to avoid plugging since pressure cannot be tracked back with the pressure gauge.

Table 6.15 summarizes the condition scores for condition deficient assets at the Building and Grounds location.

Table 6.15 Condition Assessment Summary - Building and Grounds

Condition Score	Asset Name	Reason
4 – Poor	Biofilter 1	• Corrosion/ Exterior.
4 – Poor	Kellogg Creek Emergency Lighting	• General Condition. • Equipment. • Enclosure. • Temperature/ Noise. • Wiring/ Cable Condition. • Components.
4 – Poor	Odor Air Blower 1	• General Condition.
4 – Poor	Odor Air Blower 2	• General Condition.
3 – Moderate	Activated Carbon Filter 1	• General Condition. • Components.
3 – Moderate	Activated Carbon Filter 2	• General Condition. • Components.
3 – Moderate	Activated Carbon Filter 3	• General Condition. • Components.

Based on the above observations and findings, the following actions are recommended for the Building and Grounds location:

1. Rehabilitate Biofilter 1; replace bent valve.
2. Rehabilitate Kellogg Creek Emergency Lighting; replace large sections of deficient lighting across facility.
3. Rehabilitate Odor Air Blowers 1 and 2; consider replacement if they have been rehabilitated more than twice in the past.
4. Replace Activated Carbon Filters 1, 2, and 3.

6.4 Cost Estimates

This section contains a summary of the estimated costs by asset location for the recommendations contained in the previous questions. The cost estimates are based on a combination of information provided by WES, quotes from vendors, and Carollo's experience on similar projects.

The costs estimates provided only assume direct (material (assets), labor, and equipment) costs and in February 2021 dollar (Engineering News Record Construction Cost Index: 11699). Costs in the summary are rounded to the nearest ten thousand dollars. No project cost markups are assumed or included in this cost estimating effort. The expected accuracy of this estimating effort provided herein is assumed to be 50 percent over to 30 percent under the actual direct cost incurred.

The following tables summarize the costs by the recommended time frame for planning and budgetary purpose as to when renewal efforts should be performed. Table 6.16 shows costs for the 0-to-2-year time period, Table 6.17 shows costs for the 3-to-5-year time period, and Table 6.18 shows costs for the 6-to-10-year time period.

When preparing a summary of the rehabilitation and replacement costs, the planning team reviewed the detailed information from the condition assessment. The cost estimate summaries in Tables 6.16 through 6.18 reflect costs that prioritize the needs at the Kellogg Creek WRRF and avoid overlap with other recommended improvement projects. Detailed cost estimates, including each asset name, the condition score, and recommended action, can be found in *TM 5B: Existing Kellogg Creek Water Resource Recovery Facility Condition*.

Table 6.16 Cost Estimate Summary - Rehabilitation and Replacement in Next 0 to 2 Years

R&R Project	Estimated Capital Cost
Influent Pump Station	$100,000
Aeration Basin	$526,000
Secondary Clarifier Gates and Skimmers	$29,000
Secondary Pump Station	$10,000
Total	$665,000

Table 6.17 Cost Estimate Summary - Rehabilitation and Replacement in Next 3 to 5 Years

R&R Project	Estimated Capital Cost
Influent Pump Station and Headworks	$886,000
Primary Clarifier No. 2	$550,000
Aeration Basin Gates and Structural Improvements	$3,250,000
Blower Building	$35,000
Miscellaneous Building Improvements	$106,000
Secondary Pump Station	$14,000
Total	$4,841,000

Table 6.18 Cost Estimate Summary - Rehabilitation and Replacement in Next 6 to 10 Years

R&R Project	Estimated Capital Cost
Influent Pump Station and Headworks	$752,000
Primary Clarifier No. 1	$550,000
Primary Pump Station	$54,000
Aeration Basins	$264,000
Secondary Clarifier Drives and Structural Improvements	$326,000
Blower Building	$93,000
Miscellaneous Building Improvements	$45,000
Secondary Pump Station	$86,000
Total	$2,170,000

Chapter 7

KELLOGG CREEK WRRF ALTERNATIVES

7.1 Introduction

This Chapter documents improvements needed to address deficiencies at the Kellogg Creek Water Resource Recovery Facility (WRRF) over a 20-year planning period. The analyses and recommendations presented in this chapter build on a series of evaluations, which are summarized in the following:

- Chapter 2 – Kellogg Creek Service Area Characteristics.
- Chapter 3 – Wastewater Flows and Loads.
- Chapter 4 – Permitting and Regulatory Considerations.
- Chapter 5 – Capacity Analysis.
- Chapter 6 – Condition Assessment.

Capacity limitations at the WRRF are described in Chapter 5. The condition of various assets within the WRRF, and recommendations for repair and replacement (R&R) of those assets, are defined in Chapter 6. Improvements presented herein address capacity and condition limitations in the liquid and solids stream treatment processes, including:

- Liquid Stream: Improvements to the existing disinfection system and associated components.
- Solids Stream: Improvements to the existing thickening, digestion, and dewatering processes and associated components.

Improvements to meet future regulatory scenarios are also discussed in this chapter. The schedule for recommended improvements and the associated 20-year Capital Improvement Plan for the WRRF will be documented in the Kellogg Creek WRRF Facilities Plan.

7.1.1 Basin-Wide Treatment Scenarios

The analyses and recommendations presented in this chapter are part of an overall Willamette Facilities Plan (WFP), which considers the District's regional treatment facilities and associated conveyance infrastructure. Multiple regulatory scenarios were evaluated as part of the WFP. These scenarios each considered different ways to utilize existing Clackamas Water Environment Services (WES) treatment and conveyance infrastructure to meet current and potential flow and load limitations, and potential future National Pollutant Discharge Elimination System (NPDES) permit limits in the Lower Willamette River. The pertinent WFP scenarios vis-à-vis the alternatives presented in this chapter include:

- **WFP Scenario 1:** Existing NPDES permit limits, with peak flows to the Kellogg Creek WRRF (i.e., flows in excess of 25 million gallons per day [mgd]) transferred to the Tri-City WRRF. A more detailed description of the NPDES permit assumptions for Scenario 1 is included in Chapter 4.

- **WFP Scenario 1.5:** Future NPDES summertime permit limits on effluent ammonia and total phosphorus, which may result from DEQ's Total Maximum Daily Load (TMDL) process on the Lower Willamette River and require some flow and load transfer from Kellogg Creek to Tri-City during the regulatory dry weather season via a basin-wide permit. DEQ would allow all nutrient removal to be provided at Tri-City and Kellogg Creek current permit limits would remain.
- **WFP Scenario 3:** Future NPDES summertime permit limits on effluent ammonia and total phosphorus, which may result from DEQ's TMDL process on the Lower Willamette River and require some flow and load transfer from Kellogg Creek to Tri-City during the regulatory dry weather season. This Scenario assumes DEQ would require individual permits for Tri-City and Kellogg Creek, so that nutrient removal would be required at both Kellogg Creek and Tri-City facilities.

7.2 Alternatives Evaluation Methodology

Alternatives to address capacity and condition limitations were evaluated by the planning team using cost and non-cost factors that are consistent with the District's decision-making criteria for capital and planning projects. Specific cost assumptions and non-cost criteria are presented in this section.

7.2.1 Cost Assumptions

Capital and life-cycle cost estimates were developed to compare alternatives on a financial basis as well as for capital improvement plan (CIP) development. These cost estimates follow industry standards published by the Association for the Advancement of Cost Engineering (AACE), which include five classes of cost estimates:

- Class 5 (Order of Magnitude Estimates). These are commonly referred to as conceptual level estimates and are used to compare a broad range of alternatives based on limited engineering detail (less than two percent design completion). The expected accuracy range for Class 5 estimates is +50 percent to -30 percent, which means that actual bids for the completed project can fall within a range of 50 percent over the estimate to 30 percent below the estimate.
- Class 4 and Class 3 (Budget Estimates). These estimates are used to establish the Owner's budget for a project. The expected accuracy range for both classes is +30 to -15 percent. Class 4 estimates rely on engineering detail ranging from 1 to 15 percent; Class 3 estimates rely on engineering detail between 10 and 40 percent.
- Class 2 and Class 1 (Definitive Estimates). These estimates are used to track project costs during design, and to compare actual bids with Engineer's Estimates. The expected accuracy range for both classes is +15 to -5 percent. Class 2 estimates rely on engineering detail ranging from 50 to 100 percent; Class 1 estimates rely on engineering detail beyond 100 percent (such as conformed drawings).

Class 5 cost estimates were developed and used to compare various liquid and solids stream alternatives. Class 4 Budgetary Estimates were then developed for the recommended improvement alternatives.

7.2.1.1 Capital Cost Assumptions

Capital cost includes construction costs (e.g., materials, labor, equipment, subcontractor costs, indirect costs such as contractor mobilization, demobilization, temporary contractor facilities, testing commissioning, and cleanup), and indirect costs that would not be a physical element of the project (e.g., engineering, legal, and administrative costs, taxes, and fees).

Estimated project costs are presented in February 2021 dollars consistent with a 20 cities Engineering News-Record (ENR) Index value of 11699. Capital costs presented in this chapter have not been adjusted to the mid-point of construction – these adjustments will be made as part of the CIP. The following assumptions and markups were used to develop construction and total project costs:

- Design Contingency: 30 percent.
- General Conditions: 10 percent.
- Contractor Overhead and Profit (OH&P): 15 percent.
- Engineering, Legal, and Administration (ELA): 25 percent.

7.2.1.2 Life Cycle Cost Assumptions

Annual and life-cycle cost estimates were prepared for certain alternatives to account for relative difference in annual operations and maintenance (O&M) costs. Annual O&M cost estimates presented herein account for the cost of labor, consumables, power, and chemicals, and were developed under annual average operating conditions based on costs from similar and recent projects, vendor-supplied costs, and costs supplied by District staff (e.g., power, labor, chemicals).

Life-cycle costs were calculated over a 20-year period, with a discount rate of three percent. These costs are presented as Net Present Value (NPV) costs, which include the NPV of annual O&M costs plus the total estimated project costs, in February 2021 dollars.

7.2.2 Non-Cost Criteria

Equally weighted non-cost criteria were used to account for the differences between various disinfection alternatives, and were scored 1 through 5 as follows:

- Operational Complexity:
  - 5 = least complex (e.g., uses current processes technology at an existing WRRF).
  - 1 = most complex (e.g., uses new process technology at a remote site).
- Water Quality:
  - 5 = improves water quality relative to existing conditions.
  - 1 = degrades water quality relative to existing conditions.
- NPDES Permitting Challenges:
  - 5 = least complex (e.g., individual discharge permits at Kellogg Creek meeting basin standards).
  - 1 = most complex (e.g., bubble permit approach and/or remote wet weather treatment).
- Environmental/Land Use Challenges:
  - 5 = no challenges (e.g., requires no environmental approvals, land use permits, etc.).
  - 1 = significant challenges (e.g., requires numerous approvals and permits with uncertain outcome).
- Community Benefit/Impact:
  - 5 = benefit (e.g., creates open public spaces and/or other community assets).
  - 1 = potential impact (e.g., requires mitigation and/or extensive outreach).

7.3 Scenario 1 Liquid Stream Alternatives

Scenario 1 assumes that the capacity of the Kellogg Creek WRRF remains the same, and that existing NPDES permit limits documented in Chapter 4 remain in effect. All flow generated in the Kellogg Creek service area in excess of 25 mgd will continue to be transferred to the Tri-City WRRF. Therefore, liquid stream improvements are to address R&R and are summarized in Section 6B.6. Required improvements to the disinfection system are addressed below.

7.3.1 Disinfection Improvements

The WRRF currently has a hybrid disinfection process. The existing Fischer & Porter (F&P) 70UV6000 ultraviolet (UV) disinfection system, installed in 1994 has a rated capacity of 18 mgd, although plant staff have been able to successfully disinfect flows up to 22 mgd through this system. Periodic peak flows that exceed UV system capacity are disinfected with sodium hypochlorite. Based on the condition assessment completed and documented in Chapter 6, the existing UV disinfection system is at the end of its useful life and must be replaced with a more reliable system. Table 7.1 summarizes the design criteria used to evaluate disinfection alternatives.

Table 7.1 Disinfection Alternative Design Criteria

Parameter	Value
Peak Flow Rate (mgd)	25.0
Average Flow Rate - Current (mgd)	9.9
Average Flow Rate – Future (mgd)	12.5
Total Suspended Solids	
Dry Weather (mg/L)	10
Wet Weather (mg/L)	30
NPDES Permit Limits	
E. coli, 30-day geometric mean	126 organisms/100 mL
E. coli, maximum single grab sample	406 organisms/100 mL
Chlorine Residual, average monthly limit	0.03 mg/L
Chlorine Residual, maximum day limit	0.08 mg/L
Disinfection By-products	N/A

Notes:
Abbreviations: mg/L – milligrams per liter; mL – milliliter; N/A – not applicable.

Two alternatives were considered for replacing the existing system:

- Alternative 1 – Hybrid Disinfection System: Replace the existing UV system with a new system capable of disinfecting flow up to 18 mgd and continue to disinfect flow in excess of 18 mgd with sodium hypochlorite and dechlorinate with sodium bisulfite.
- Alternative 2 – Chlorination/Dechlorination System: Replace the existing hybrid system with a new system capable of disinfecting all flow with sodium hypochlorite and dechlorinate with sodium bisulfite.

7.3.1.1 Alternative 1 – Hybrid Disinfection System

This alternative includes replacing the existing UV system with new equipment designed to fit within the existing footprint with relatively minor channel modifications. Design criteria specific to Alternative 1 are summarized in Table 7.2.

Table 7.2 UV System Design Criteria

Parameter	Value
Peak Flow Rate (mgd)	18.0
Average Flow Rate (mgd)	11.0
Design UV Transmittance (%)	60
Average UV Transmittance (%)	75
Minimum T1 RED (mJ/cm2), per IUVA protocol	19.0
Redundancy	N + 1 Channels at Average Flow

Notes:
Abbreviations: IUVA – International Ultraviolet Association, Inc.; mJ/cm2 - millijoules per square centimeter.

Disinfection layouts and preliminary cost proposals for two UV systems (Xylem (WEDECO) Duron, and De Nore [formerly Calgon Carbon] $C^3$500D) were developed for this evaluation based on the design parameters detailed in Tables 6B.1 and 6B.2. Both of these systems utilize low-pressure, high-output (LPHO) amalgam UV lamps, and both have system validations that comply with the National Water Research Institute (NWRI) 2012 UV Guidelines and the IUVA Protocol. If Alternative 1 is the preferred disinfection system alternative, UV systems by other manufacturers should be considered as part of the subsequent design process.

While both UV systems operate on the same principles, they have different configurations, maintenance, and replacement needs. The WEDECO Duron utilizes 600 watt (W) lamps whereas the De Nora $C^3$500D utilizes 520W lamps. The De Nora system is similar to the existing horizontal UV system, with lamps that are evenly spaced and parallel to the flow. The WEDECO Duron has the lamps in a staggered arrangement at a 45-degree inclination. Both systems have a design water level of approximately 42 inches, which would require the channel floor to be raised by approximately 6 inches. Both systems would also require that new channel walls be poured or installed in the existing channels to reduce the channel width where the new UV banks will be located. The inclined system requires more substantial channel modifications as the available freeboard will need to be increased by approximately nine inches to ensure that the grating properly covers the UV equipment; however, both systems will fit within the existing hydraulic profile.

Basic system configurations information including total lamp counts and total power consumption for both systems are shown in Table 7.3.

Table 7.3 Summary of UV System Configurations

Parameters	WEDECO Duron	De Nora $C^3$500D
Number of Channels	2	2
Number of Banks/Channel	4	2
Number of Modules/Bank	1	4
Number of Lamps/Module	12	7
Total Number of Lamps	**96**	**112**
Number of UV Sensors	8	4
Number of Power Distribution Centers	4	4
Number of Master Control Panels	1	1
Total Power Consumption (kW)	**66.6**	**71.1**

Parameters	WEDECO Duron	De Nora $C^3$500D
Minimum Channel Length (feet)	35.4	33.0
Channel Width (inches)	29.5	24.3
Minimum Channel Depth (inches) (1)	74.8	66.0
Water Depth (inches)	42.1	42.0
Water depth references upstream or downstream of UV banks?	upstream	downstream

Notes:
(1) Existing channel floor for both UV systems needs to be raised by approximately 6 inches to fit the existing hydraulic profile. The channel depth listed is from the new channel floor elevation.
Abbreviations: kW = kilowatt.

7.3.1.2 Alternative 2 – Chlorination/Dechlorination System

This alternative includes demolishing the existing UV system and minor modifications to restore the chlorine contact basin to provide sufficient contact time to disinfect all 25 mgd with sodium hypochlorite. Dechlorination for this alternative would be provided by dosing sodium bisulfite. Key design criteria for Alternative 2 are summarized in Table 7.4.

Table 7.4 Chlorination/Dechlorination System Design Criteria

Parameter	Value
Peak Flow Rate (mgd)	25.0
Average Flow Rate (mgd)	11.0
Minimum Contact Time at Peak Flow (min)	20 min
Target Chlorine Residual (mg/L)	2.0 – 3.0
Range of Chlorine Dose (mg/L)	4.0 – 9.0
Range of Chlorine Demand (mg/L)	2.0 – 6.0
Range of Bisulfite Dose (mg/L)	5.0 – 8.0

7.3.1.3 Disinfection Alternative Capital Costs

Equipment costs were requested from the two UV suppliers to develop capital cost estimates for Alternative 1. UV system costs included UV reactor components, motorized level control gates, level sensors, auxiliary equipment, UV transmittance analyzer, spare parts, start-up and commissioning services and training. Estimated construction costs included decommissioning of the existing UV system, adding a roof structure for the UV equipment, structural/mechanical additions or modifications to the existing UV channel, electrical and instrumentation modifications, contingency, general conditions, contractor overhead and profit.

The capital cost estimate for Alternative 2 was based on relatively minor modifications to the existing chlorine contact basin, and new chemical feed equipment and controls (e.g., feed pumps, chlorine residual analyzers, National Electrical Manufacturers Association (NEMA) 4X cabinets, and other related components).

Equipment, construction, and total project cost for both alternatives – including both UV system suppliers – are summarized in Table 7.5.

Table 7.5 Disinfection Alternative Capital Cost Summary

Description	Alternative 1 (WEDECO + Hypo)	Alternative 1 (Calgon Carbon + Hypo)	Alternative 2 (Chlorination/ Dechlorination)
Equipment Costs			
UV Disinfection System (Complete)	$455,000	$757,000	
Chlorination/Dechlorination System	$100,000	$100,000	$100,000
Total Equipment Costs	**$555,000**	**$857,000**	**$100,000**
Construction Costs			
Civil/Mechanical/Structural	$273,000	$221,000	$10,000
Electrical & Instrumentation	$114,000	$99,000	$34,000
Roof Shelter/Davit Crane	$25,000	$25,000	--
Miscellaneous/Demolition	$50,000	$50,000	$25,000
Sub-Total	**$1,017,000**	**$1,252,000**	**$169,000**
Contingency (30%)(1)	$169,000	$149,000	$51,000
General Conditions (10%)	$119,000	$140,000	$23,000
Contractor Overhead & Profit (15%)	$196,000	$231,000	$36,000
Total Estimated Construction Cost	**$1,500,000**	**$1,772,000**	**$278,000**
Total Estimated Project Cost	**$1,874,000**	**$2,215,000**	**$347,000**

Notes:
(1) Contingency was not applied to the UV equipment costs.

7.3.1.4 Disinfection Alternative Annual O&M Costs

The estimated annual O&M costs for each alternative – including both UV system suppliers – are summarized in Table 7.6. UV system replacement costs were provided by the UV vendors. Chemical costs for Alternative 2 assume a chlorine dose of 9 mg/L and a bisulfite dose of 7 mg/L. All costs are based on a projected mid-point flow rate of 11 mgd. Costs in the table assume a power cost of $0.08 per kilowatt-hour (kWh), an O&M labor rate of $75 per hour, and bulk costs for sodium hypochlorite (NaOCL) and sodium bisulfite (NaHSO3) of $1.09 and $0.70, respectively.

Table 7.6 Disinfection Alternative Annual O&M Cost Summary

Description	Alternative 1 (WEDECO)	Alternative 1 (Calgon Carbon)	Alternative 2
Lamp Replacement (Cost/Unit)	$310	$272	--
Ballast Replacement (Cost/Unit)	$775	$585	--
Wiper Replacement (Cost/Unit)	$18	$100	--
Sleeve Replacement (Cost/Unit)	$180	$104	--
UV Sensor Replacement (Cost/Unit)	$750	$1,622	--
Sensor Calibration (Annual Cost)	$412	$492	--
Chemical Cost	$9,400	$9,400	$226,000
Parts Replacement Cost	$22,100	$23,800	--
Labor Cost	$22,400	$14,500	$27,000
Power Cost	$15,000	$16,000	--
Total Estimated Annual O&M Cost	**$69,000**	**$64,000**	**$253,000**

7.3.1.5 Disinfection Alternative NPV

Table 7.7 summarizes the estimated NPV of each Alternative. As shown, the NPV of Alternative 1 ranges from approximately $2.9 to $3.2 million, depending on the UV system that is used for the basis of cost. Most of this cost is associated with the capital cost of installing a new UV system.

The estimated NPV of Alternative 2 ranges from $3.4 to $6.4 million, depending on the assumed chemical (sodium hypochlorite and sodium bisulfite) doses needed to achieve adequate disinfection and dechlorination, and the cost of those chemicals. Given the extreme sensitivity of the NPV cost to the required chemical doses, and the relative lack of dose information under current operation, additional testing is recommended to confirm these important parameters.

Table 7.7 Summary of Disinfection Alternative NPV

Cost Component	Alternative 1 (WEDECO)	Alternative 1 (Calgon Carbon)	Alternative 2
Capital Cost	$1.87 M	$2.22 M	$350,000
Annual O&M Cost	$69,000	$64,000	$180,000 - $380,000
NPV of Annual O&M	$1.03 M	$0.95 M	$3.0 M - $6.0 M
Total NPV	$2.90 M	$3.17 N	$3.4 M - $6.4 M

7.3.1.6 Disinfection Alternative Non-Cost Considerations

Disinfection alternatives were compared on a non-cost basis as part of the evaluation. The results of this comparison are summarized below:

- Operational Complexity: Alternative 1 was scored lower (2) than Alternative 2 (4) due to the need to maintain and operate two different disinfection processes.
- Reliability/Flexibility: Alternative 1 was scored higher (5) than Alternative 2 (4) due to the reliability and flexibility associated with being able to operate the chemical disinfection system as a backup to the UV disinfection system.
- Water Quality: Alternative 1 was scored higher than Alternative 2 because UV provides a more effective form of pathogen (particularly virus) inactivation relative to chlorine when ammonia is present in the secondary effluent (as would be the case at the WRRF).
- NPDES Permitting: Alternative 1 was scored higher than Alternative 2 because chlorine byproducts – a potential future regulatory concern – are not formed through UV disinfection.
- Environmental/Land Use: Neither alternative was scored because there are no differentiating affects associated with this criterion.
- Community: Alternative 1 was scored higher than Alternative 2 because UV disinfection systems significantly reduce the number of chemical truck deliveries to the WRRF site on an annual basis.

7.3.1.7 Disinfection System Summary and Recommendation

The cost and non-cost analysis of disinfection alternatives summarized in this chapter suggests that a hybrid disinfection system (Alternative 1, with UV disinfection for flow ≤ 18 mgd and chlorine disinfection for flow up to 25 mgd) is the preferred alternative for improving the existing disinfection system at the Kellogg Creek WRRF. Although Alternative 1 does have the higher total capital cost, the relatively lower annual O&M cost makes it attractive from a NPV basis. Also, Alternative 1 scores slightly higher than Alternative 2 on a non-cost basis.

Alternative 1 is the recommended disinfection alternative for the purposes of establishing the Kellogg Creek WRRF CIP. As noted above, the NPV benefit of Alternative 1 is heavily influenced by the assumed chemical doses and costs needed for Alternative 2. Validation of the actual chlorine dose required for disinfection (i.e., confirmation of the chlorine demand and necessary chlorine residual to achieve disinfection over a range of flows and operational conditions) as well as the sodium bisulfite dose required for dechlorination, is recommended to confirm this decision prior to proceeding with design.

7.4 Scenario 1 Solids Stream Improvements

This section describes recommended improvements to the Kellogg Creek WRRF solids stream. A process flow diagram of the solids stream showing both the existing system and the recommended upgrades is shown in Figure 7.1. New solids thickening, solids dewatering, and cake loadout facilities are recommended, as well as upgrades to the digester gas system and anaerobic digestion. Alternatives for each of these components were evaluated by the planning team, as summarized in this section.

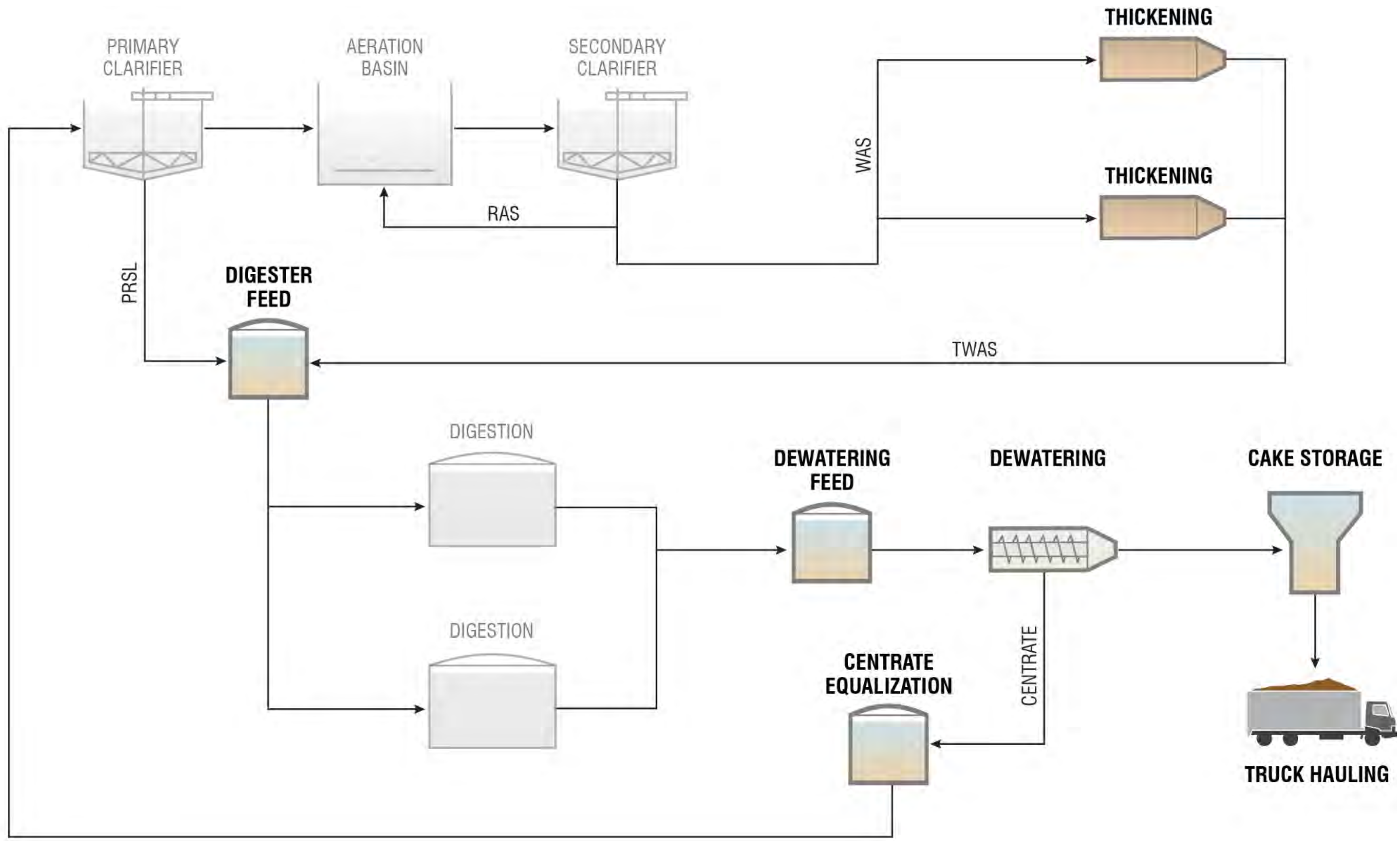


Figure 7.1 Solids Process Flow Diagram and Recommended Improvements

7.4.1 Solids Thickening

Currently, primary and secondary solids are thickened separately before digestion. Primary sludge is thickened to approximately four percent Total Solids (TS) in the primary clarifiers. The practice of thickening primary sludge in the primary clarifiers occasionally results in primary clarifier upsets during warm months due to fermentation and floating sludge.

Waste activated sludge (WAS) is pumped directly from the secondary clarifier sludge hopper to a dissolved air flotation thickener (DAFT). Thickened waste activated sludge (TWAS) can be stored in a holding tank and pumped to the digesters but is typically pumped from the TWAS hopper straight to the digester. Primary sludge is combined with thickened WAS and primary and secondary scum in the digester feed piping before entering the digester. A rotary drum thickener (RDT) is used for recuperative thickening of digester sludge.

As discussed in Chapter 5, the existing DAFT process is operating at solids loading rates that exceed recommended design criteria. Additionally, the major components of the DAFT system (e.g., the sludge hopper and skimmer drive mechanism) are in very poor condition. Replacement of the DAFT process is therefore recommended to provide reliable WAS thickening capacity through the planning period.

Although primary and secondary solids are currently thickened separately, co-thickening of primary and secondary solids is an alternative that could be explored during subsequent design of the recommended improvements if digestion capacity becomes an issue.

7.4.1.1 Solids Thickening Considerations

The following considerations were used to guide the analysis of thickening improvements at the WRRF:

1. **Operating assumptions.** Primary solids will continue to be thickened in the primary clarifiers, thickening units for the WAS stream will operate 20 hours per day, 7 days per week, and
2. **Equipment type.** New RDTs will be used as the basis of planning for WAS thickening. WAS thickening can also be accomplished with new gravity belt thickeners (GBTs), so the type of thickening equipment should be further evaluated and confirmed during preliminary design.
3. **Number and unit capacity (size) of equipment.** The RDTs would be specified to meet capture and thickened solids concentrations at the design capacity, with adequate hydraulic capacity to pass the maximum capacity, although performance (solids capture and thickened solids concentrations) would be reduced under the maximum capacity condition.
4. **Thickening equipment location and configuration.** Because of the space constraints and the condition of the existing DAFT building, it is recommended that new thickening equipment be located in a new building regardless of the equipment type that is selected. This will allow the existing DAFT to stay in service during construction, reducing construction complexity and operational risk. The new facility could also be sized to allow for an accessible and efficient configuration.

During preliminary design, further consideration should be given to the following items:

- The number of units desired for optimal operation for the technology that is ultimately selected.
- Eliminating the existing recuperative thickening process. The RDT used for recuperative thickening is in moderate condition and may need to be replaced before 2040, and recuperative thickening is less efficient (compared to pre-thickening) and creates a higher digester heat demand due to the increased hydraulic load on the digesters.

7.4.1.2 Solids Thickening Design Criteria

Design criteria for thickening improvements at the WRRF are summarized in Table 7.8. and assumes separate primary and WAS thickening.

Table 7.8 Solids Thickening Design Criteria

Parameter	WAS Only
Number of Units	2 (1 duty, 1 standby)
Design Solids Load	800 lb TS/hr
Design Solids Flow	200 gpm
Maximum Solids Load	1,200 lb TS/hr
Maximum Solids Flow	300 gpm
Thickened Solids Concentration at Design Conditions	4.4% TS
Capture at Design Conditions	95%
Primary/Secondary Solids Ratio by Mass	58% Primary/ 42% Secondary
Raw Sludge Volatile Solids Concentration	86%
Maximum Polymer Demand at Design Conditions	20 lb active/dry ton feed solids

Notes:
Abbreviations: hr – hour; lb – pound(s).

7.4.1.3 Solids Thickening Capital Costs

The estimated total project costs for new thickening improvements range from $4.1 million (WAS only) to $4.4 million (co-thickening). These costs include two RDTs, thickened sludge pumping, and space in a new building. Table 7.9 summarizes the estimated capital cost of the improvements.

Table 7.9 Thickening Capital Cost Summary

Description	Base Alternative (WAS Only)	Alternative 1 (Co-thickening)
Equipment Costs		
Thickening Equipment - RDT	$455,000	$517,000
Thickened Sludge Pumping	$165,000	$165,000
Total Equipment Costs	$620,000	$682,000
Construction Costs		
Building	$945,000	$945,000
Odor Control	$210,000	$210,000
Civil/Site Work	$177,000	$275,000
Miscellaneous/Demolition	$0	$0
Sub-Total	$1,952,000	$2,112,000
Contingency (30%)(1)	$586,000	$634,000
General Conditions (10%)	$254,000	$275,000
Contractor Overhead & Profit (15%)	$419,000	$453,000
Total Estimated Construction Cost	$3,211,000	$3,474,000
Total Estimated Project Cost	$4,100,000	$4,400,000

7.4.2 Digestion

Based on the condition and capacity of the existing facilities, improvements are recommended to a number of Kellogg Creek digestion system components, including: a new digester feed tank, digester feed piping modifications, digester mixing, digested solids withdrawal, and emergency digester overflow. This section summarizes recommendations for each of these components.

7.4.2.1 Digester Feed Tank

TWAS and thickened primary solids are currently independently pumped to the digesters. A new digester feed tank is recommended to enhance digester performance by increasing feed sludge homogenization prior to digestion, and to provide storage within the solids handling process. Table 7.10 contains preliminary design criteria for the digester feed tanks sized to provide 8 hours of storage at the year 2040 maximum day design flows. A rectangular concrete tank (approximately 42,400 gallons) divided into two compartments is recommended to provide adequate storage and some level of redundancy. Pumped mixing is recommended to maintain solids in suspension and increase homogenization prior to digester feed.

Table 7.10 Digester Feed Tank Design Criteria

Parameter	Value
Storage Period	8 hours at 2040 maximum day flow
Number of Digester Feed Tanks	1 (with baffle)
Total Storage Volume	42,400 gallons
Freeboard Depth (from High Water Level to Bottom of Cover)	2.0 feet
Mixing System	Chopper-type pumped mixing

The estimated project cost of the digester feed tank is $2.2 million, which includes a divided concrete tank, pumped mixing systems, digester feed pumps, gas safety equipment, and appurtenances.

Table 7.11 summarizes the estimated capital cost of the improvements.

Table 7.11 Digester Feed Tank Capital Cost Summary

Description	Alternative (WAS Only)
Equipment Costs	
Digester Feed Tank Mixers	$169,000
Digester Feed Pumps	$165,000
Digester Gas Safety Appurtenances	$153,000
Total Equipment Costs	$487,000
Construction Costs	
Digester Feed Tank and Civil/Mechanical	$536,000
Miscellaneous/Demolition	$25,000
Sub-Total	$1,048,000
Contingency (30%)	$314,000
General Conditions (10%)	$136,000
Contractor Overhead & Profit (15%)	$225,000

Description	Alternative (WAS Only)
Total Estimated Construction Cost	$1,723,000
Total Estimated Project Cost	$2,200,000

7.4.2.2 Digester Feed Piping

The Kellogg Creek digesters are currently operated in parallel, and the second-stage digester is effectively used as a sludge storage tank prior to biosolids loadout. As discussed in Chapter 5, the existing configuration does not provide sufficient capacity or redundancy for projected 2040 loads. Digester modifications are needed to allow for parallel feed with sufficient capacity for current and future loads. Currently, if one digester is taken out of service, excess loads must be routed to the Tri-City WRRF to protect digester stability and ensure Class B Biosolids are achieved.

The existing digester piping appears to provide a pathway for parallel digester operation, as shown in Figure 7.2. The primary and secondary sludge lines are equipped with pneumatically operated valves to control which digester receives raw sludge; however, these valves have not been used in many years and would need replaced/rebuilt, with proper controls for programing. If the condition of these valves is addressed, they could be programmed to distribute sludge flows equally to each digester and create a parallel digester configuration.

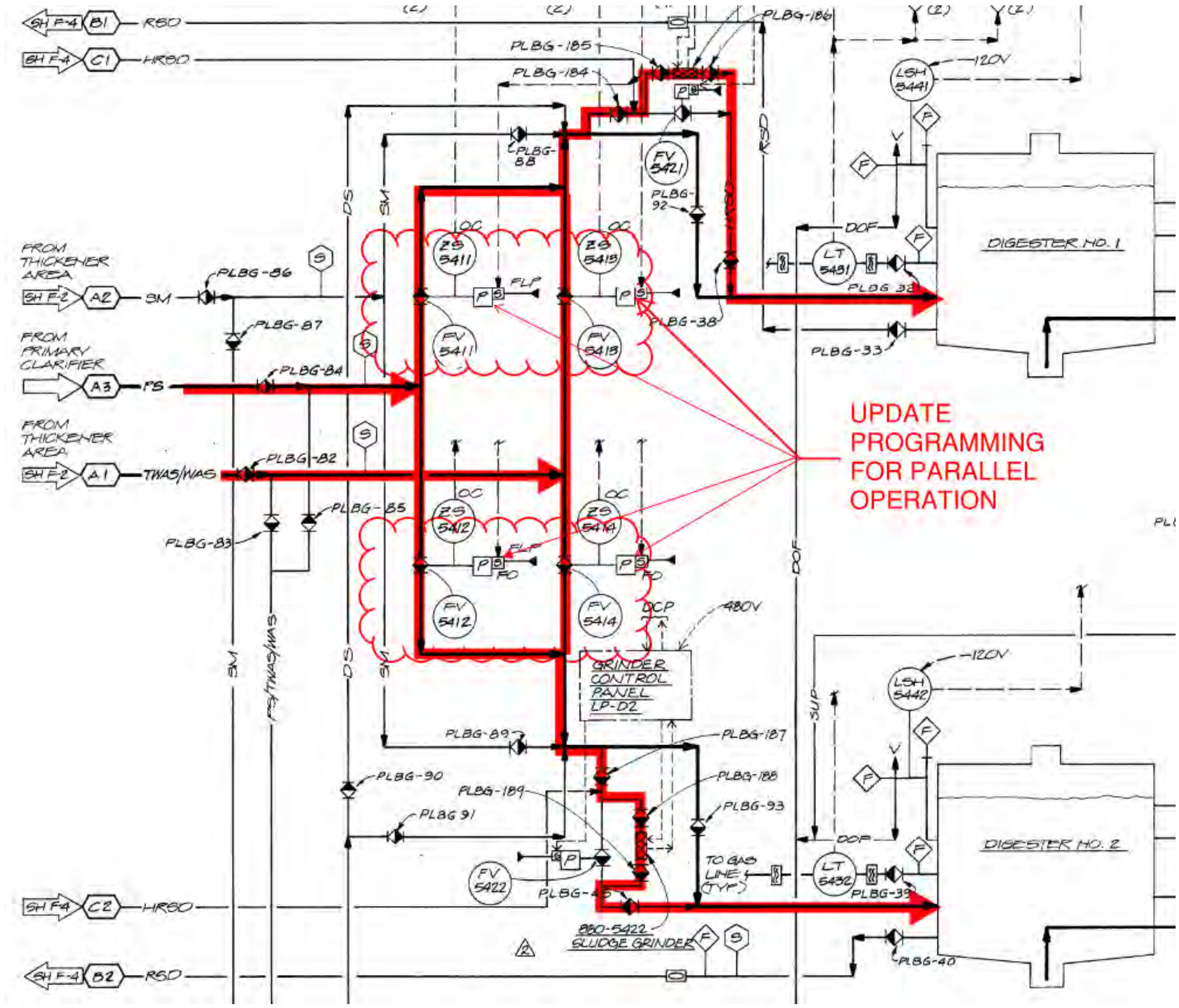


Figure 7.2 Potential Digester Feed Piping Modifications

The cost of pipe and valve revisions is relatively minor relative to other recommended improvements. Further investigation into the existing piping and programming should be performed to determine the scope of services required for the recommended revisions.

7.4.2.3 Digester Mixing

Digester 2 is equipped with a pumped mixing system manufactured by Vaughan and installed in 2012. Digester 1 was originally equipped with gas cannon mixing system, which has since been decommissioned due to equipment age and poor performance. To use Digester 1 as an active digester, a new mixing system is required. It is assumed that a pumped mixing system would be installed, similar to the one installed in Digester 2.

Table 7.12 Digester 1 Mixing System Design Criteria

Parameter	Value
Type	Non-Clog Horizontal Chopper
Duty Pumps	1
Standby Pumps	0
Design Flow per Pump	4,700 gpm
Maximum Pump Rated TDH	Per Manufacturer's Recommendations
TS Concentration	1% - 4%
Motor Speed	1,750 rpm
Maximum Motor Size	75 hp
Drive Type	Variable Frequency

Notes:
Abbreviations: hp – horsepower; rpm – revolutions per minute; TDH – total dynamic head.

The estimated capital cost for a new digester mixing system, assumes that only one additional pump is installed to mix Digester 1, and that redundancy is provided by having key spare parts (e.g., a spare rotor, motor, and appurtenances) on hand, and is included in the overall cost of digester improvements summarized later in this chapter.

7.4.2.4 Digested Solids Withdrawal

The existing digester withdrawal piping allows for manual selection of several withdrawal points located on the side of each digester, including one withdrawal point from the center of the cone. Withdrawal lines from each digester are combined into a header that feeds two sludge loading pumps and two sludge transfer pumps. The sludge loading pumps are used to transfer digested solids to trucks and the transfer pumps are used for transferring solids between the digesters.

Although the existing withdrawal should be retained for maintenance and/or for other uses, surface withdrawal is recommended to reduce digester foaming and increase digester control flexibility. When similar surface withdrawal was added to one of the Tri-City WRRF digesters, the foam level was observed to decrease from several feet to a several inches.

Withdrawing predominantly from the surface, with occasional (one day per week) withdrawal from the cone, is recommended. Figure 7.3 shows a new surface withdrawal and standpipe. In this configuration, a gravity overflow line will discharge to a stainless steel digester standpipe adjacent to the digester, which enhances control of the digester withdrawal pumps.

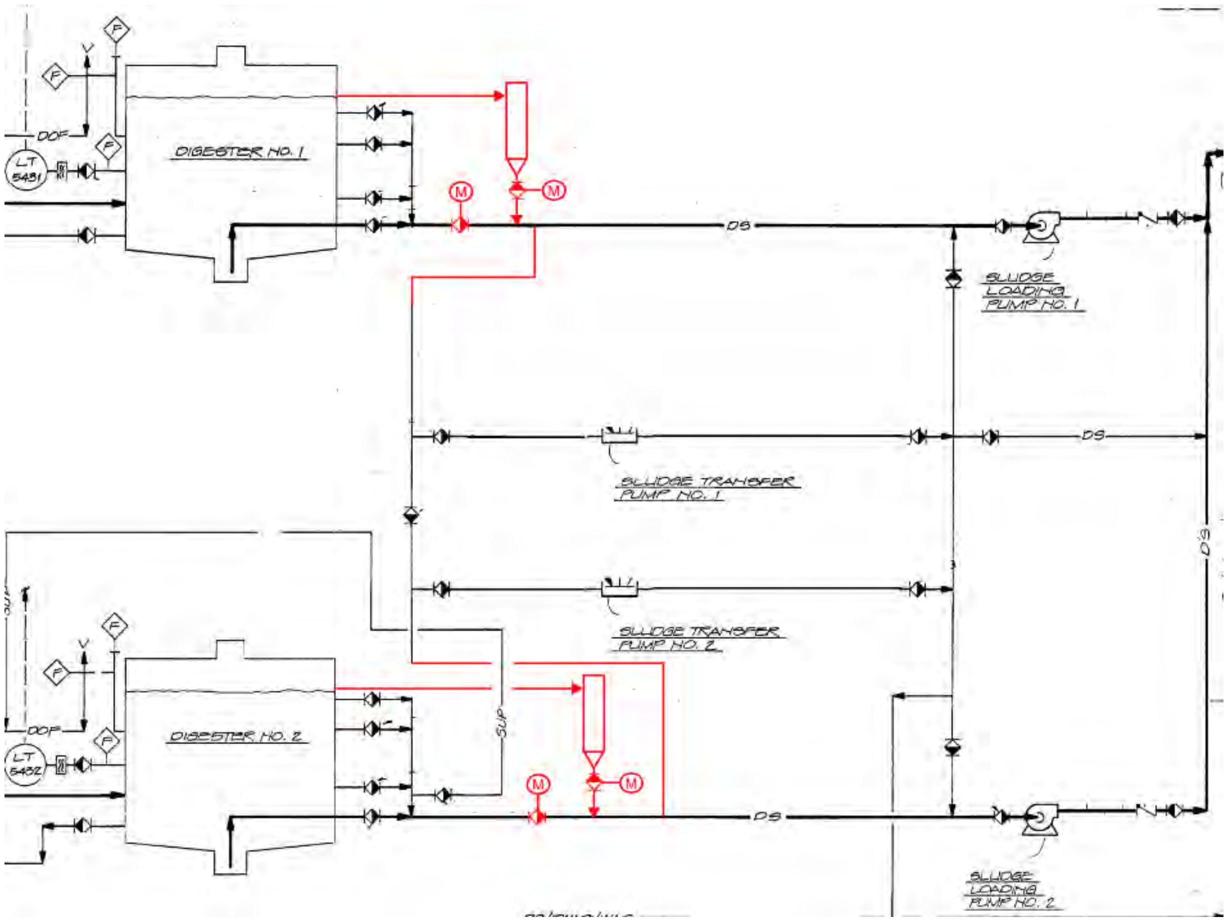


Figure 7.3 Proposed Digested Sludge Withdrawal Modifications

7.4.2.5 Digester Emergency Overflow

The existing Kellogg Creek digesters are equipped with emergency overflow mechanisms. This piping and associated controls should be inspected to ensure that they are in functional condition. If the systems are non-functional or have been disconnected (as was the case at the Tri-City WRRF), a new digester emergency overflow system is recommended. The costs presented herein reflect the cost of new emergency overflow systems, as illustrated in the schematic above.

If new digester emergency overflow systems are installed, a true surface overflow similar to the Tri-City WWRF is recommended. The elevation of the of each emergency overflow should be located approximately three feet above the elevation of the of the normal full tank withdrawal line in the digesters. This location will allow free discharge of the emergency overflow, such that levels and pressures in the digesters do not impact the structural integrity of the fixed cover systems.

The digester overflows should be piped through a U-shaped trap with its vertical leg taller than the maximum operating pressure of the digester. The trap should be filled with water to provide a gas seal and an option to add antifreeze. The U-trap feature will prevent digester gas from escaping the tank.

The overflow systems should be constructed from 316L stainless steel for all piping components that will regularly be exposed to digester gas. Downstream of the water trap, the remainder of the overflow can be constructed of carbon steel or other material. The emergency overflow should be sized to relieve the combination of maximum day sludge flows and digester gas production rates. Emergency overflow events should flow by gravity to the plant headworks or primary clarifiers. Valves or other pipe restrictions should not be provided on the emergency overflow line.

Table 7.13 summarizes the estimated capital cost of the recommended Kellogg Creek digester improvements presented in this section.

Table 7.13 Digester Improvement Costs

Description	Estimated Costs
Equipment Costs	
Digester 1 Mixing System	$268,000
Total Equipment Costs	$268,000
Construction Costs	
Digester Withdrawal Revisions	$170,000
Emergency Overflow Piping	$160,000
Repair and Rehabilitation	$731,000
Sub-Total	$1,329,000
Contingency (30%)	$399,000
General Conditions (10%)	$173,000
Contractor Overhead & Profit (15%)	$285,000
Total Estimated Construction Cost	$2,186,000
Total Estimated Project Cost	$2,700,000

7.4.3 Solids Dewatering

After anaerobic digestion, biosolids are generally dewatered to reduce the water content in the solids, which reduces the cost of transportation and beneficial use. Digested solids from Kellogg Creek WRRF are currently hauled to the Tri-City WRRF for dewatering. The Planning Team evaluated multiple dewatering alternatives, including keeping the dewatering process at the Tri-City WRRF, moving the dewatering process to the Kellogg Creek WRRF and hauling thickened (undigested sludge) to the Tri-City WRRF. These alternatives are described in Appendix 7A. Due to the expense and operational impact associated with hauling liquid sludge and operating the temporary dewatering facility at Tri-City WRRF, a new dewatering facility located at the Kellogg WWRF is recommended.

Moving the location of the dewatering process, and its associated return stream to the Kellogg Creek WRRF will increase the ammonia load on the Kellogg Creek WRRF. Currently the Kellogg Creek WRRF has a monthly effluent ammonia limit of 33.9 mg/L and a daily limit and 60.1 mg/L. These limits are based on dilution provided by an older outfall which was replaced in 2016. With the new outfall, the 2018 *Outfall Mixing Zone Study for the Kellogg Creek Water Resource Recovery Facility* (CH2M) found no reasonable potential for the Kellogg Creek WRRF to exceed ammonia water quality criteria even if dewatering processes were located at the Kellogg Creek facility. Based on this memorandum and the newly adopted water quality standards, Chapter 4 recommended that these ammonia limits should be removed from future permits.

The analysis in this chapter is comprised of three components: the dewatering equipment, the dewatered biosolids storage and loadout facilities, and a polymer system (which can be shared with the thickening system previously presented).

7.4.3.1 Dewatering Equipment

The primary technologies used for municipal biosolids dewatering are belter filter presses, rotary presses, screw presses, and centrifuges. Centrifuges are currently used at the Tri-City WRRF. These machines rotate at a high speed to apply a centrifugal force to the solids slurry, forcing the heavier solids to separate from the water fraction and collect along the bowl wall. Centrate discharge weirs, located at one end of the unit, control the water depth within the unit, while the solids are conveyed from the bowl up the conical section (the "beach") where the cake is discharged.

Centrifuges provide the highest dewatered cake solids of the dewatering technologies, albeit with a higher power demand. Centrifuges are well proven and have been used extensively in municipal wastewater dewatering applications since the 1930s. Centrifuges are the recommended dewatering technology at the Kellogg Creek WRRF, as they are a proven process that provides consistency with the equipment currently used at the Tri-City WRRF.

Recommended design criteria for the dewatering centrifuge is shown in Table 7.14. To minimize capital costs, one dewatering unit is recommended, with back-up dewatering provided at the Tri-City WRRF. The new building for housing the dewatering equipment could be sized to allow a second unit to be added in the future, if the District would like to consider having redundant equipment installed at the Kellogg Creek WRRF.

Table 7.14 Centrifuge Dewatering Design Criteria

Parameter	Value
Technology	Decanter Centrifuge
Number of Units	1
Operation	7 hours/day, 6 days/week
Design Flow	200 gpm
Design Solids Load	2,600 lb TS/hr
Max Flow	260 gpm
Max Solids Load	3,420 lb TS/hr
Minimum Capture at Design Conditions	95%
Minimum Cake Solids at Design Conditions	22%
Maximum Polymer Dose	40 lb active/dry ton feed solids

The recommended dewatering centrifuge design criteria is consistent with a Westfalia CF6000, which is the same dewatering unit used by the Tri-City WRRF. Figure 7.4 shows the projected solids flows to dewatering under the stated design conditions, and Figure 7.5 shows the projected solids loads. Both the hydraulic and solids capacity of a single centrifuge would be exceeded under maximum 3-day and higher loading conditions at startup. Likewise, a single centrifuge would be overloaded at maximum week and higher conditions near the end of the planning period. This condition could be addressed in a number of ways: 1) by operating the centrifuge longer; 2) by installing a larger centrifuge; 3) by installing a second centrifuge; and/or 4) by diverting additional raw wastewater to the Tri-City WRRF. The recommended design basis in Table 7.14 above maintains size consistency with the Tri-City WRRF, providing for shared use of common spare parts, which is particularly important for the bowl, scroll, and tile assemblies on the centrifuges.

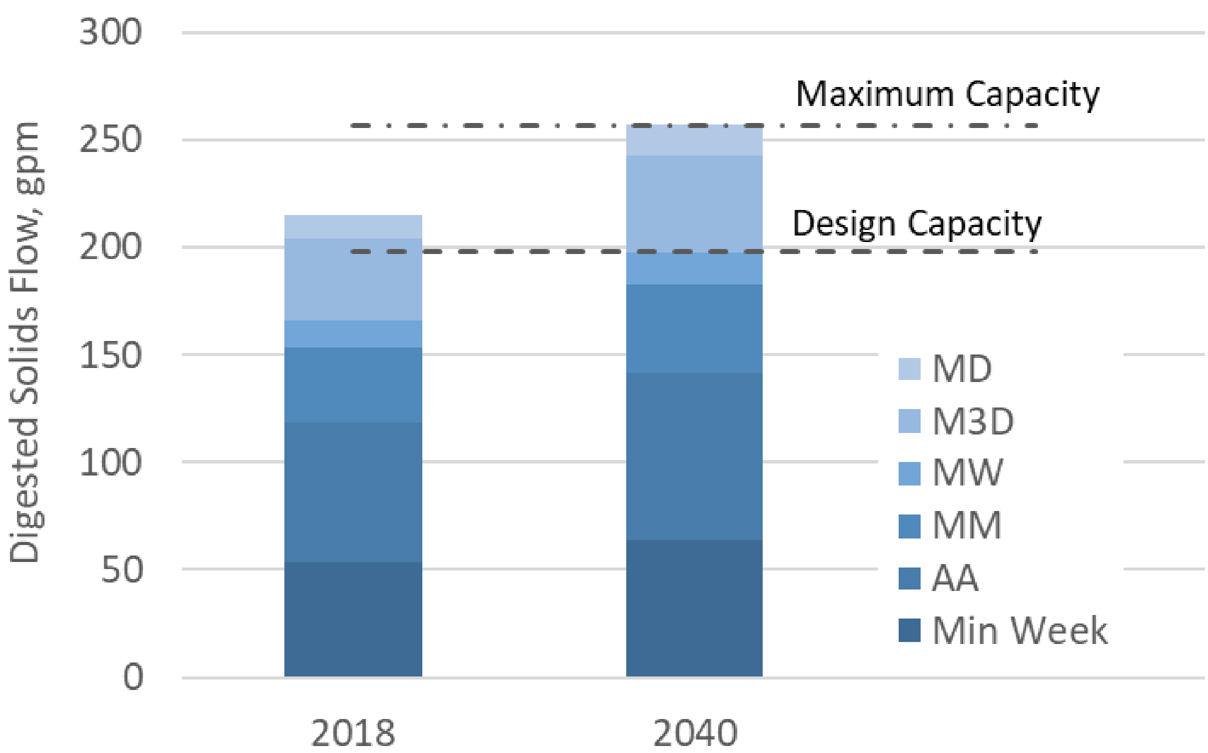


Figure 7.4 Centrifuge Capacity Based on Flow Criteria

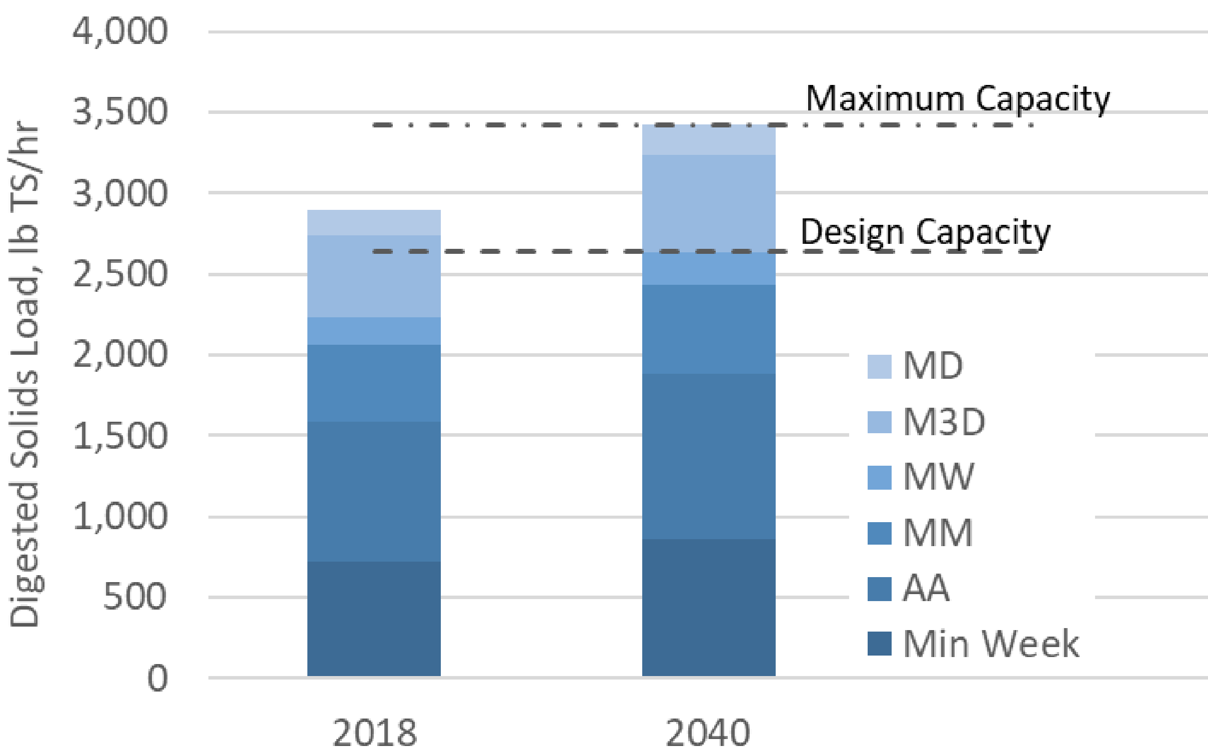


Figure 7.5 Centrifuge Capacity Based on Load Criteria

The estimated project cost of the dewatering system is $7.3 million, which includes the dewatering units, dewatering building (space for a single centrifuge), and odor control. The size and configuration of the new dewatering building should be further evaluated and optimized during design.

7.4.3.2 Dewatered Biosolids Storage and Loadout

Dewatered biosolids will be conveyed to a dewatered biosolids storage bin for temporary storage prior to truck loadout. The storage bin will be equipped with load cells to monitor available storage capacity. Open-flight conveyors will level the cake within the storage bin and ensure complete filling. The discharge mechanism will be a sliding frame. Table 7.15 provides the dewatered biosolids storage bin design criteria.

Table 7.15 Dewatered Biosolids Storage Bin Design Criteria

Parameter	Value
Number of Units	1
Storage at 2040 Average Annual Loading	1.0 days (2 days total)
Type	Sliding-Frame
Capacity	1,600 cf 100,000 wet pounds

Notes:
Abbreviations: cf – cubic feet.

The estimated project cost of the dewatered biosolids storage and loadout system is $6.2 million, and includes screw cake conveyance, a cake storage bin, cake loadout shelter, and odor control.

7.4.3.3 Thickening and Dewatering Polymer

The existing liquid polymer emulsion system for the thickeners was installed in 2018. The polymer system consists of two duty polymer trains with a mix tank, polymer feed pump, and post-dilution control for each tank. One train is dedicated to WAS thickening and the other train is dedicated to recuperative thickening. It is recommended that these units be relocated and used for the new thickening system. A new liquid polymer emulsion system is recommended for the dewatering process. The system will be similar to the existing thickening polymer trains. If co-thickening is implemented in the future, the existing WAS-only thickening train could be re-purposed for co-thickening and the recuperative thickening train could be used as standby.

Table 7.16 Dewatering Polymer Design Criteria

Parameter	Value
Polymer Type	Emulsion
Neat Polymer Active Percentage	36%
Polymer Batch Solution	0.5%
Polymer Process Solution	0.15%
Maximum Dewatering Polymer Dose	40 lb active/dry ton feed solids
Batch Preparation Time	15-20 minutes
Aging Time at 2040 Maximum Week	55 minutes
Drive	Variable Speed

The estimated project cost of the polymer system is $0.9 million. This cost includes the new dewatering polymer train and relocating the existing trains from the current thickening building to the new dewatering building. The cost of the building, odor control, and associated costs are included in the thickening and dewatering system costs.

7.4.4 Summary of Recommended Thickening, Digestion, and Dewatering Improvement Costs

Table 7.17 summarizes the estimated capital cost of the recommended improvements to the solids thickening, digestion, and dewatering systems at the Kellogg Creek WRRF. The cost of centrate equalization, which may be beneficial in future phases of the project, is not included in Table 7.17. The decision on whether to add centrate equalization can be evaluated as part of the pre-design of the solids improvement project. Space has been set aside on the site plan should the District desire to include centrate equalization.

Table 7.17 Summary of Thickening, Digestion, and Dewatering Capital Costs

Project	Estimated Capital Cost(1)
Thickening	$4,100,000
Digestion Upgrades	$2,700,000
Digester Feed Tank	$1,900,000
Dewatering Feed Tank(2)	$900,000
Dewatering System	$7,300,000
Cake Storage	$6,200,000
Polymer Upgrades	$900,000
Total	**$24,000,000**

Notes:
(1) Capital costs include construction costs plus ELA.
(2) The costs shown for the dewatering feed tank are to repurpose the existing Hoodland storage tank for use as a dewatering feed tank.

7.4.5 Combined Heat and Power (CHP)

It is intended that the District will update the CHP system at KC WRRF to capture the methane produced in the digesters to create heat and power for use at the facility. The CHP system will include gas storage, gas conditioning and an engine-generator.

7.4.5.1 Digester Gas Storage

Low pressure digester gas storage is recommended to provide an operating buffer between the digester gas production rate and the digester gas usage rate. The buffer provides time for digester gas use in the cogeneration engine or boilers to match production. A new digester gas holder would allow the plant to operate in a level-based mode for digester gas handling, rather than the current pressure-based mode, and maximize digester gas utilization.

Options for low-pressure gas storage include a floating-lid gas holder and a dual-membrane system (a digester gas membrane inside an air membrane). The gas storage system is usually maintained around half-full. If gas production exceeds gas demand, the stored volume will increase up to the full capacity of the storage system. At this point, the gas pressure in the system will increase until the gas flare pressure is reached and the gas will automatically be flared until the pressure drops. If gas consumption exceeds gas production, the stored volume will decrease to the minimum capacity of the system.

Digester gas storage is usually sized for 5 to 30 minutes of storage, which provides enough time for the cogeneration engines and boilers to adjust their gas consumption rate to match production. A 5,250 cubic foot membrane system is recommended to meet the recommended storage guidelines. For reference, the size matches the size of gas holder installed at Tri-City.

Table 7.18 contains design criteria for the digester gas holder.

Table 7.18 Digester Gas Holder Design Criteria

Parameter	Value
Size	5,250 cf
Type	Dual-Membrane, Low Pressure
Mounting	Concrete Pad
Height	20 feet
Air Blower	1 duty + 1 standby
Normal Operating Pressure	14 in w.c.g.
Pressure Relief Setting	18 in w.c.g.
Design Maximum Pressure	20 in w.c.g.

Notes:
Abbreviations: w.c.g. – water column gauge.

The estimated project cost of the digester gas holder system is $0.9 million. A dual membrane holder is assumed for pricing. A final decision as to the type of holder can be made in design.

7.4.5.2 Digester Gas Conditioning

Raw digester gas includes hydrogen sulfide (H_2S), moisture, siloxanes, and volatile organic compounds (VOCs). These contaminants inhibit heat transfer surfaces, increase maintenance frequency, and decrease service life of engines. Digester gas conditioning removes these contaminants and pressurizes the gas to levels needed at the cogeneration system. The existing digester gas handling system does not include gas treatment. New engines operate with tighter tolerances and are subject to more stringent air regulations. Therefore, a new digester gas conditioning system will be required for future cogeneration. Digester gas conditioning prior to use in the boilers is also a beneficial practice and significantly reduces maintenance. A digester gas conditioning system consisting of H_2S removal, compression, moisture removal, and activated carbon siloxane treatment is recommended. Figure 7.6 shows a schematic of the digester gas treatment system.

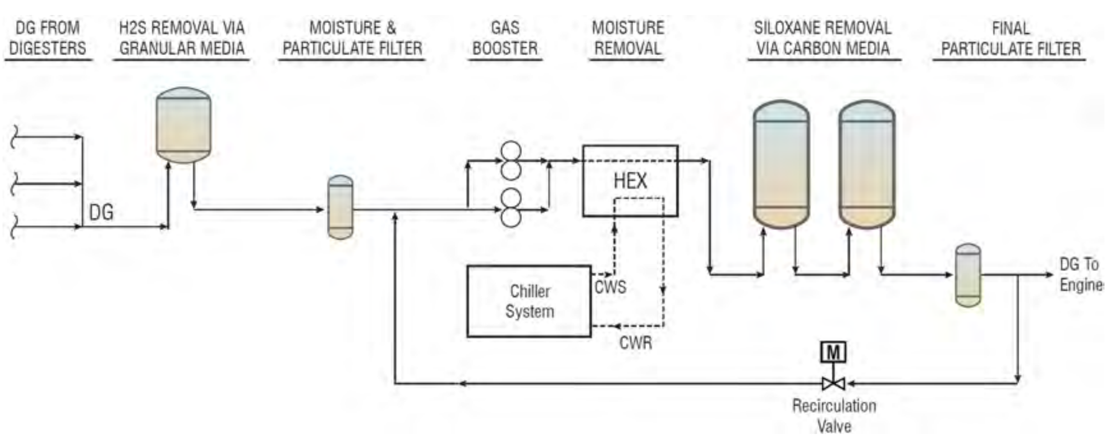


Figure 7.6 Digester Gas Treatment System Schematic

For H_2S reduction, raw digester gas is conveyed through a vessel filled with iron-adsorbing media, such as iron sponge media or SulfaTreat. Iron sponge media consists of wood chips and shavings coated with iron oxide. SulfaTreat uses a clay-based media rather than wood chips and shavings. Spent SulfaTreat media is easier to withdraw from the vessel, and avoids the flammability issues associated with iron sponge, but it is more expensive. H2S removal is followed by moisture and siloxane removal using activated carbon.

Design criteria for the digester gas handling system is shown in Table 7.19. The system was sized to match the digester gas quality and quantity from the Tri-City WWRF, for cost estimating. Further research on the Kellogg Creek WRRF digester gas quality and production is required during design to appropriately size the system

Table 7.19 Digester Gas Conditioning System Design Criteria

Parameter	Value
System Rated Flow	250 scfm
Flow for Calculating Media Design Life	175 scfm
H_2S Removal Vessels	
Number	1
Size	TBD
Material of Construction	304L Stainless Steel
Media Type	Pelletized Ferric Hydroxide (SulfaTreat)
Media Design Life	6 months
Gas Handling	
Gas Booster Number	2 (1 duty, 1 standby)
Gas Booster Capacity	250 scfm each
Gas Booster Type	Rotary Lobe, Belt-Driven
Gas Booster Motor	TBD
Gas Booster Drive	Adjustable Speed Drive
Moisture Removal	Dual-Core Heat Exchanger with Chilled Water and Gas Reheat
Chiller System	Packaged System with Dual Pumps and Dual Refrigerant Compressors, Air Cooled
Siloxane Removal Vessels	
Number	2 (1 lead, 1 lag)
Size	TBD
Material of Construction	304L Stainless Steel
Media Type	Pelletized Activated Carbon

Notes:
Abbreviations: scfm – standard cubic feet per minute; TBD – to be determined.

The estimated capital cost of the digester gas conditioning system is $2.5 million.

7.4.5.3 Combined Heat and Power

The existing cogeneration engine is a 250-kilowatt (kW) induction unit that is nearing the end of its useful life. To continue combined heat and power production, a new cogeneration engine is recommended. The projected 2040 digester gas production rate under average annual conditions is 150 scfm. Assuming a typical digester gas lower heating value of 570 BTU/scf and an engine electrical efficiency of 34 percent, this gas flowrate corresponds to 510 kW of electrical output and up to 2.2 million BTU/hr of heat recovery. To ensure that the maximum amount of digester gas is beneficially used, a 600-630 kW output cogeneration engine is recommended. This size is consistent with the standard size offered by the two main cogeneration engine manufacturers, Caterpillar and Innio (Jenbacher) and will be used for estimating. However, engine sizing should be refined during design.

The new engine will be tuned for digester gas consumption only and will not be provided with natural gas supplementation, thus providing the ability to enter into a net-metering agreement with PGE. Electrical power from the generator will be synchronized with the plant electrical system via the engine switchgear. Heat from the engine jacket, lube oil, first-stage intercooler, and engine exhaust will be transferred into the existing heating water loop to heat the digestion process. In addition, currently heat is returned to the treatment process, so this will remove heat energy from the effluent.

The new engine and associated components can likely fit in the location of the existing engine, but extensive building upgrades will likely be required to meet the current National Electrical Code. These upgrades may include new entryways, sealing wall penetrations, and relocating digester gas piping and equipment. The location of the engine should be finalized during design.

Design criteria for the cogeneration engine is shown in Table 7.20.

Table 7.20 Cogeneration Engine Design Criteria

Parameter	Value
Nominal Output Rating	600 to 630 kW
Engine Type	Lean-Burn, Turbocharged
Engine Speed	1,800 rpm (No Gearbox)
Number of Cylinders	12
Fuel Type	Digester Gas Only
Fuel Pressure Required	2-3 psig
Minimum Fuel Efficiency	34% Input Fuel Energy to Electrical Power Output, LHV Basis
Heat Recovery Rate	40% Input Fuel Energy

Notes:
Abbreviations: LHV – low heating value; psig – pounds per square inch gauge.

The estimated project cost of the cogeneration engine system is $2.5 million.

7.4.5.4 Waste Gas Burner

Waste gas burners safely combust excess digester gas during normal and transient operational events, and also prevent methane and odor emissions from the site. The Kellogg Creek WRRF currently has a waste gas burner with a nominal rating of 150 scfm, which was installed in 2013. The proposed digester gas upgrades would allow the Kellogg Creek WRRF to beneficially use most of the digester gas produced at the facility. Under normal conditions, the existing waste gas burner would not be used and would be employed only under emergency or extenuating circumstances.

Table 7.21 contains design criteria for a potential future waste gas burner that would provide a 1.3 peaking factor on the projected year 2040 peak day digester gas flow. Although this redundant waste gas burner is not required, criteria are shown in case the District desires to install a redundant burner in the future.

Table 7.21 Waste Gas Burner Design Criteria

Parameter	Value
Waste Gas Burner Type	Enclosed
Number of Units	1
Maximum Digester Gas Flowrate	350 scfm
Burner Turndown Ratio	Infinite
Minimum Inlet Pressure	>0 inches w.c.g.
Minimum Destruction Efficiency	99.5%
Maximum Noise Level	85 dBA at 10 feet

Notes:
Abbreviations: dBA - decibel.

7.4.5.5 Summary of Recommended CHP Improvement Costs

Table 7.22 summarizes the estimated capital cost of the recommended improvements to the digester gas systems at the Kellogg Creek WRRF.

Table 7.22 Summary of Digester Gas System Capital Costs

Project	Estimated Capital Cost (1)
Gas Storage	$900,000
Gas Conditioning	$2,500,000
Cogen Improvements	$2,500,000
Total	$5,900,000

Notes:
(1) Project costs include construction costs plus ELA.

7.5 Scenario 3 Treatment Alternatives

As detailed in the WFP, the planning team evaluated several treatment scenarios to determine the most cost-effective approach to addressing potential future nutrient limits. Should nutrient limits be imposed on the Lower Willamette during the regulatory dry weather season, and if Kellogg Creek and Tri-City continue to hold individual NPDES permits, treatment modifications at the Kellogg Creek WRRF would be required to mitigate the reduction of dry-weather capacity. These modifications would primarily be required to: 1) remove ammonia-nitrogen through secondary modifications, and 2) remove total phosphorus (TP) through a combination of chemical treatment and secondary modifications.

As described in this section, intensification is recommended to meet Scenario 3 permit limits at Kellogg Creek while preserving as much carbonaceous biological oxygen demand (CBOD) capacity at Kellogg Creek as possible. However, even with intensification the Kellogg Creek capacity would be reduced from its current capacity of about 18 mgd under Scenario 3, so the amount of dry-weather flow conveyed from the Kellogg Creek service area to the Tri-City WRRF for treatment would increase. Table 7.23 summarizes the Scenario 3 dry weather assumptions for how much flow can be treated at Kellogg Creek with and without intensification and how much needs to be transferred to Tri-City. Since nutrient removal is not required in the wet weather, the Scenario 3 wet weather flows treated through Kellogg Creek and transferred to Tri-City remain the same as in Scenario 1.

Table 7.23 Kellogg Creek WRRF: Scenario 3 Flow Transfer Assumptions

Dry Weather Flow Component	2040		
	Kellogg Creek Service Area, mgd	Kellogg Creek WRRF Flow, mgd	Transfer from Kellogg Creek to Tri-City WRRF, mgd
Without Intensification			
ADW	10.3	5.0	5.3
MMDW	14.8	5.3	9.5
MWDW	19.9	6.0	13.9
PDDW	25.5	13	12.5
With Intensification			
ADW	10.3	8.0	2.3
MMDW	14.8	8.4	6.4
MWDW	19.9	9.5	10.4
PDDW	25.5	10.5	15.0

Notes:
Abbreviations: ADW - average dry weather; MMDW - maximum month dry weather; MWDW - maximum week dry weather; PDDW - peak day dry weather.

Recommended modifications to the existing Kellogg Creek WRRF treatment processes to accommodate a future Scenario 3 are presented in this section.

7.5.1 Primary Treatment Modifications

Chemical treatment is recommended to achieve TP limits under Scenario 3. Multiple chemical addition points are recommended through the treatment process to minimize coagulant consumption and the loss of capacity in the aeration basins associated with the increase in solids yield.

Chemical addition to the primary clarifiers is recommended as a component of this strategy. This would require coagulant addition and mixing upstream of the primary clarifiers, with the most likely coagulant addition and mixing point being downstream of the existing detritor, upstream of the flow split between the two primary clarifiers. Alum would be the most likely coagulant. Ferric chloride should not be used due to the downstream UV disinfection system.

7.5.2 Aeration Basin Modifications

Under Scenario 3, the existing aeration basins would need to be modified, with the most likely configuration being a Modified Ludzack Ettinger (MLE) process for nitrification. This will likely require installation of mixed liquor recycle (MLR) pumps, provisions for sufficient anoxic volume to restore alkalinity and maintain sludge settleability, and reconfiguration of the existing diffuser grid to ensure adequate aeration for full nitrification. A planning-level analysis of dry-season oxygen demands suggests that new aeration blowers would not be needed.

A conceptual set of modifications required to convert the aeration basins to operate in an MLE configuration is shown red in Figure 7.7. These modifications would include the addition of wet wells for MLR pumps, piping connecting the MLR pumps to the ends of the existing step feed piping, and reorientation of the existing step feed piping to direct MLR flow to the first zone in the aeration basins. Note that these modifications would still allow for the basins to operate under the current anaerobic-oxic (AO) configuration with step feed / contact stabilization capabilities during the wet weather season, when nitrification is not needed for permit compliance. Depending on the degree of denitrification achieved, alkalinity addition may be required.

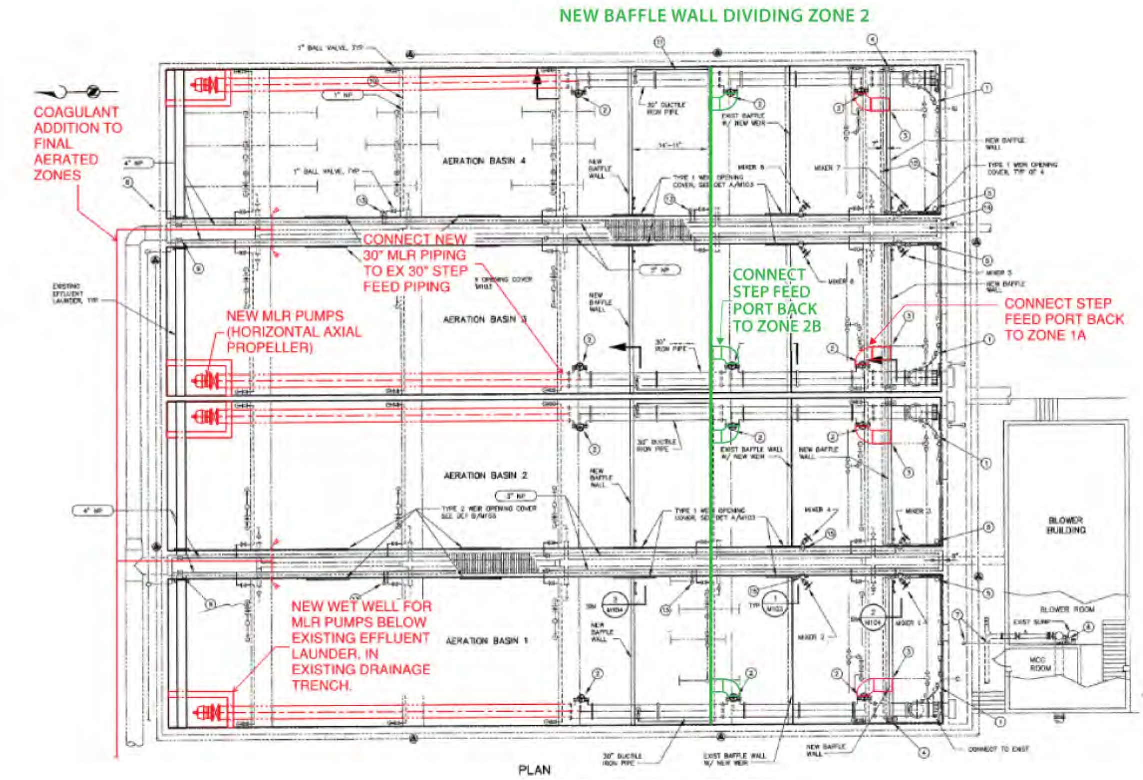


Figure 7.7 Conceptual Aeration Basin Modifications Plan for MLE Process (Red) and A2O Process (Green) Configuration

Biological phosphorus removal (BPR) would reduce the amount of coagulant required for chemical phosphorus removal. BPR is attained by selecting for phosphorus-accumulating organisms (PAOs). The effectiveness of BPR depends on a variety of factors, and a full characterization of the influent wastewater was not performed as part of this planning effort. If BPR is implemented along with chemical phosphorus removal, the basin would need to be modified to provide adequate anaerobic volume required for phosphorus release upstream of the anoxic zone required for denitrification, while still maintaining sufficient aerobic volume for CBOD removal, phosphorus uptake, and nitrification. This configuration is called the Anaerobic-Anoxic-Oxic (A2O) configuration. New MLR pumps would still be required for denitrification, and some of the existing baffle walls would likely need to be modified to provide appropriate zone volumes. Modifications to the existing basin to allow for operation in an A2O mode are shown in green in Figure 7.7.

7.5.3 Intensification

Due to the limited aeration basin volume available, the current basins do not have sufficient nitrification capacity for the rated capacity of 18 mgd. Additionally, due to site constraints, expanding the aeration basins at the Kellogg Creek WRRF is not feasible. Therefore, intensifying the secondary treatment process at the Kellogg Creek WRRF by modifying the process to operate at higher mixed liquor suspended solids (MLSS) concentrations is recommended to meet Scenario 3 NPDES permit limits.

Several technologies are available for intensifying the secondary treatment process, including a process called BioMag®. This process adds a ballast material to the activated sludge process which induces rapid sludge settling in the secondary clarifiers and allows for stable operation of the aeration basins with higher MLSS concentrations. Additionally, the rapid settling in the secondary clarifiers results in a lower effluent total suspended solids (TSS) than is typical for conventional activated sludge. With BPR sequestering phosphorus into the biomass in the MLSS, improved TSS removal also helps to achieve lower effluent TP.

Intensification using BioMag® requires recovery of the ballast from the WAS. A new set of WAS pumps, a WAS sump, and means of conveying the recovered ballast back to the mixing tank would be provided along with equipment associated with the separation process. The BioMag® system also requires fine sludge screens (where influent screening is insufficient), shear mills to separate the magnetite ballast from the floc, and rotating magnetic drums which would pull the magnetite particles out of the liquid, return them to the ballast mix tank and simultaneously discharge WAS to the WAS sump. A schematic of the BioMag® process at the Kellogg Creek WRRF is illustrated in Figure 7.8. It is assumed that the BioMag system (or equal) would be located in a new building located east of the digester complex.

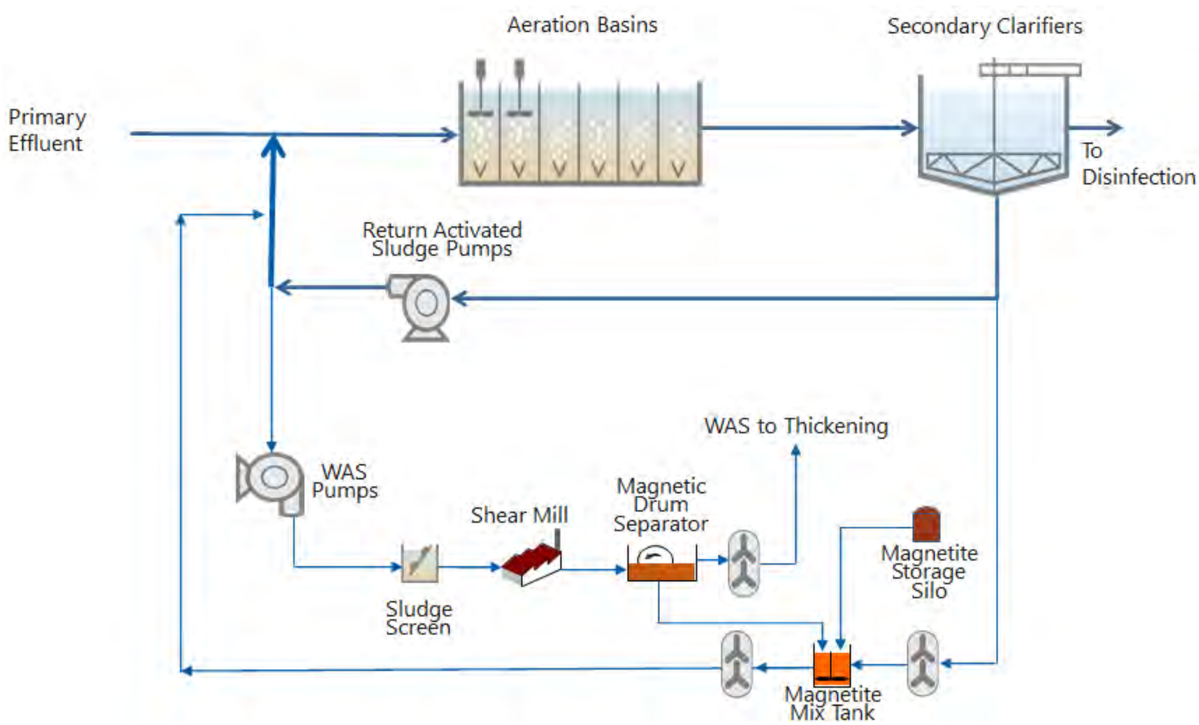


Figure 7.8 Sample BioMag® Process Flow Diagram

7.5.4 Odor Control

Construction of the ballast recovery facilities would require demolition of some of the existing biofilters and odorous air blowers, so additional odor treatment capacity would need to be provided to compensate for the loss of biofilters.

For planning purposes, biotowers are assumed, as they provide odor control with a relatively small footprint. They could be installed adjacent to the ballast recovery building.

For planning purposes, biotowers are assumed, as they provide odor control with a relatively small footprint. They could be installed adjacent to the ballast recovery building.

7.6 Repair and Replacement Improvements

In addition to the recommended improvements to the Kellogg Creek WRRF disinfection and solids handling systems, there are a number of improvements that are necessary to address the condition of existing equipment. A detailed description of these R&R improvements is presented in Chapter 6, and the recommended improvements, presented in order of priority (i.e., Near-Term, Mid-Term, and Long-Term) are summarized in the tables below.

Table 7.24 Recommended Near-Term (0 - 2 Years) R&R Improvements

R&R Project	Estimated Capital Cost
Influent Pump Station	$100,000
Aeration Basin	$526,000
Secondary Clarifier Gates and Skimmers	$29,000
Secondary Pump Station	$10,000
Total	$665,000

Table 7.25 Recommended Mid-Term (3 - 5 Year) R&R Improvements

R&R Project	Estimated Capital Cost
Influent Pump Station and Headworks	$886,000
Primary Clarifier No. 2	$550,000
Aeration Basin Gates and Structural Improvements	$3,250,000
Blower Building	$35,000
Miscellaneous Building Improvements	$106,000
Secondary Pump Station	$14,000
Total	$4,841,000

Table 7.26 Recommended Long-Term (6 - 10 Year) R&R Improvements

R&R Project	Estimated Capital Cost
Influent Pump Station and Headworks	$752,000
Primary Clarifier No. 1	$550,000
Primary Pump Station	$54,000
Aeration Basins	$264,000
Secondary Clarifier Drives and Structural Improvements	$326,000
Blower Building	$93,000
Miscellaneous Building Improvements	$45,000
Secondary Pump Station	$86,000
Total	$2,170,000

Table 7.27 Summary of Recommended Improvements

Project	Category[1]	Estimated Capital Cost[2]
Near-term (0 – 2 year) R&R Improvements	Condition	$665,000
Mid-term (3 – 5 year) R&R Improvements	Condition	$4,841,000
Long-term (6 – 10 year) R&R Improvements	Condition	$2,170,000
UV Disinfection System	Condition	$2,700,000
Solids Thickening, Digestion, and Dewatering Improvements	Condition / Capacity	$24,000,000
Gas Utilization	Condition	$5,900,000

Notes:
(1) Condition projects are driven by the need to maintain existing reliable treatment capacity. Capacity projects are driven by the need to increase reliable treatment capacity.
(2) Project cost includes construction plus ELA.

Figure 7.9 Kellogg Creek WRRF Site Plan

Chapter 8

IMPLEMENTATION PLAN

8.1 Introduction

This chapter outlines the implementation plan for improvements at the Kellogg Creek Water Resource Recovery Facility (WRRF), Improvements are based on the Rehabilitation and Repair (R&R) projects identified in Chapter 6, and the recommended alternative presented in Chapter 7 of this Facilities Plan.

8.2 Planning Level Cost Estimate

The project costs, including Construction and Engineering, Legal, and Administrative (ELA) costs for the recommended improvements are summarized in Table 8.1.

Table 8.1 Kellogg Creek WRRF - Recommended Plan Project Cost Summary

Project(1)	Category(2)	Estimated Project Cost(3)
Near-term (0 - 2 year) R&R Improvements	Condition	$665,000
Mid-term (3 - 5 years) R&R Improvements	Condition	$4,841,000
Long-term (6 - 10 year) R&R Improvements	Condition	$2,170,000
UV Disinfection System	Condition	$2,700,000
Solids Thickening, Digestion, and Dewatering Improvements	Condition / Capacity	$24,000,000
Gas Utilization	Condition	$5,900,000
	TOTAL	**$40,276,000**

Notes:
(1) Details of each project can be found in Chapter 7.
(2) Condition projects are driven by the need to maintain existing reliable treatment capacity. Capacity projects are driven by the need to increase reliable treatment capacity.
(3) The estimated project costs are the construct costs for the repair and replacement (R&R) Improvement projects. The estimated project costs for all other projects include the construct costs plus engineering, legal and administration fees (ELA). Details on the estimated project costs can be found in Chapter 7.

8.3 Project Triggers

Project triggers were developed based on the capacity analysis and condition assessment. Capacity-related triggers were developed based on unit process design criteria as presented in Chapter 5 and the flow and load projections presented in Chapter 3. Triggers for Repair and Rehabilitation (R&R) projects to address the condition of assets are based on the results of the condition assessment as shown in Chapter 6.

Table 8.2 summarizes the recommended improvements based on the triggers for the Kellogg Creek WRRF.

Table 8.2 Kellogg Creek WRRF - Recommended Improvements Triggers

Category	Process Description	Trigger			Approximate Trigger Date
		Description	Value	Units	
Condition	Near-term (0 - 2 year) R&R Improvements	Address condition deficiencies			2022
Condition	Mid-term (3 - 5 years) R&R Improvements	Address condition deficiencies			2024
Condition	Long-term (6 - 10 year) R&R Improvements	Address condition deficiencies			2028
Condition	UV Disinfection System				2022
Condition / Capacity	Solids Thickening, Digestion, and Dewatering Improvements	Max Week WAS Max Month SRT	9700 20	ppd days	2026
Condition	Gas Utilization	Provide a means to utilize the digester gas			2026

Notes:
Abbreviations: mgd - million gallons per day; ppd - pounds per day; SRT - solids residence time; WAS - waste activated sludge.

8.4 Project Schedule

Recommended projects for the upcoming five-year capital improvement plan (CIP) for the Kellogg Creek WRRF are summarized below:

- Disinfection System Improvements.
- Near-term (0 - 2 year) R&R Improvements.
- Mid-term (3 - 5 years) R&R Improvements.

Figure 8.1 presents a summary of the recommended project schedule for the 20-year CIP for the Kellogg Creek WRRF. All projects except R&R Improvements include a design period and construction period.

8.5 Financial Analysis - Capital Improvement Plan

The anticipated cash flow to complete recommended improvements throughout the planning period was determined for the recommended improvements at Kellogg Creek WRRF summarized in Table 8.1. The cash flow over the 20-year planning horizon for the Kellogg Creek WRRF, which includes a 3 percent escalation rate, is shown in Figure 8.2 and summarized in Table 8.3. Costs presented in Figure 8.2 and Table 8.3 have been escalated to the mid-point of construction. The peak expenditure for improvements at the Kellogg Creek WRRF is approximately $19.2 million in planning year 2030.

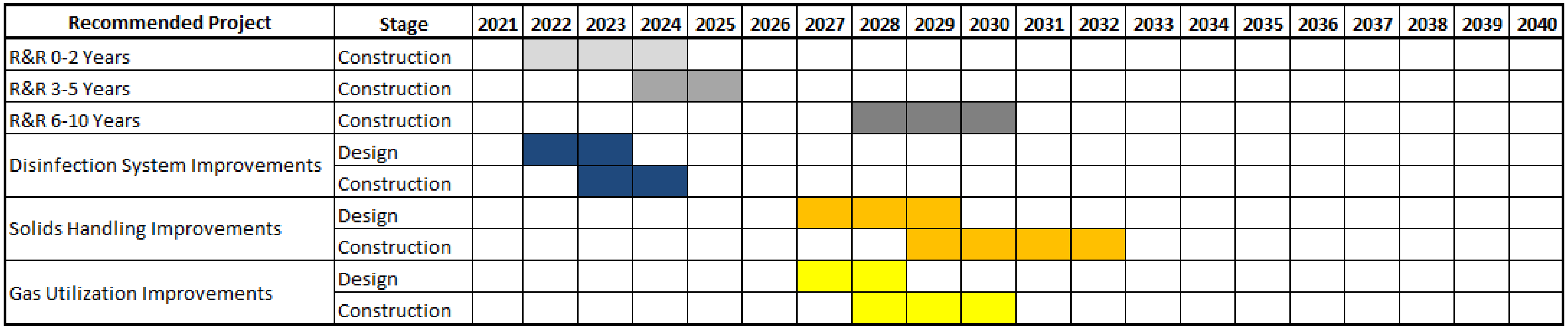


Figure 8.1 Kellogg Creek WRRF Project Schedule for Recommended Improvements

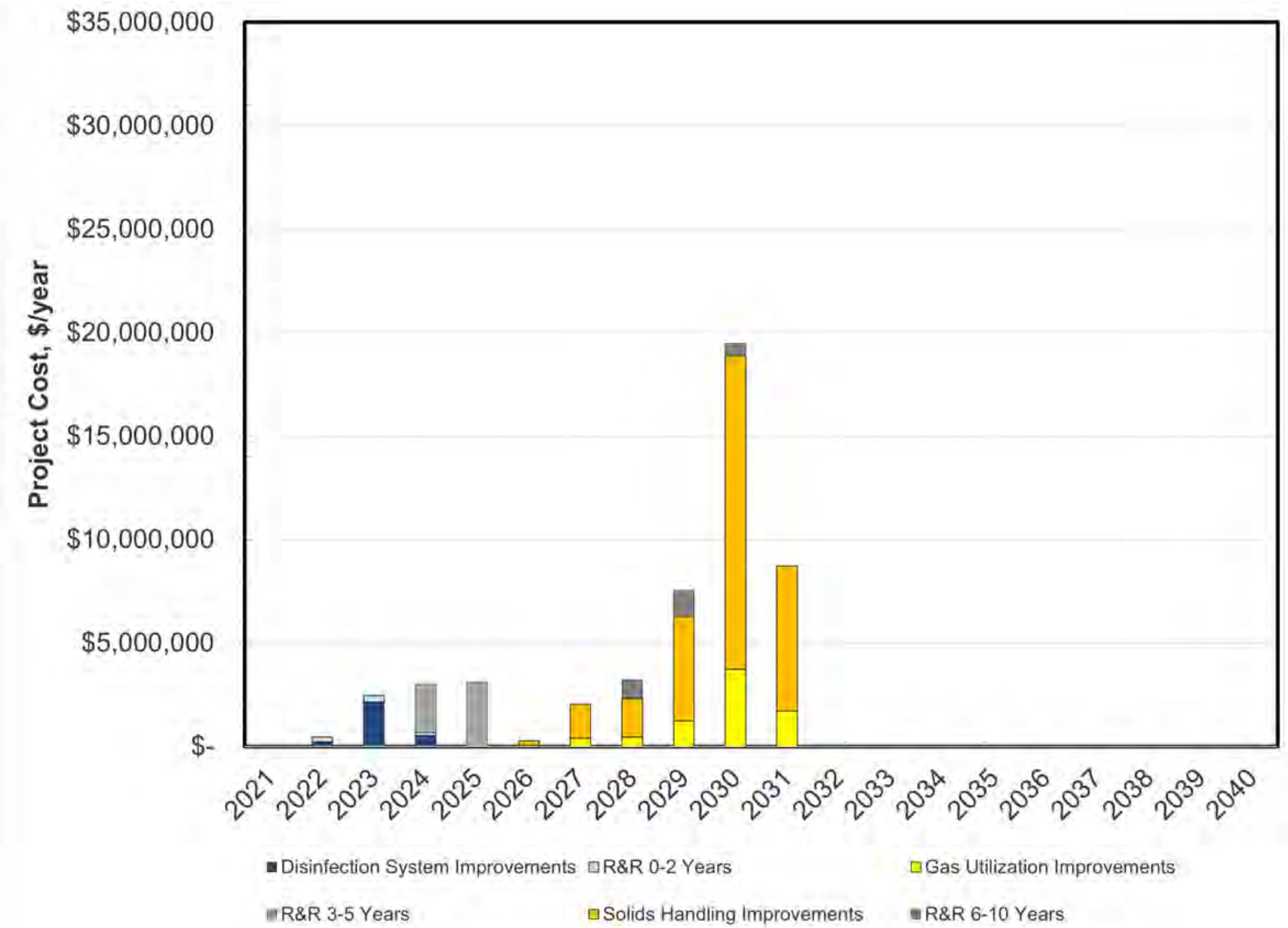


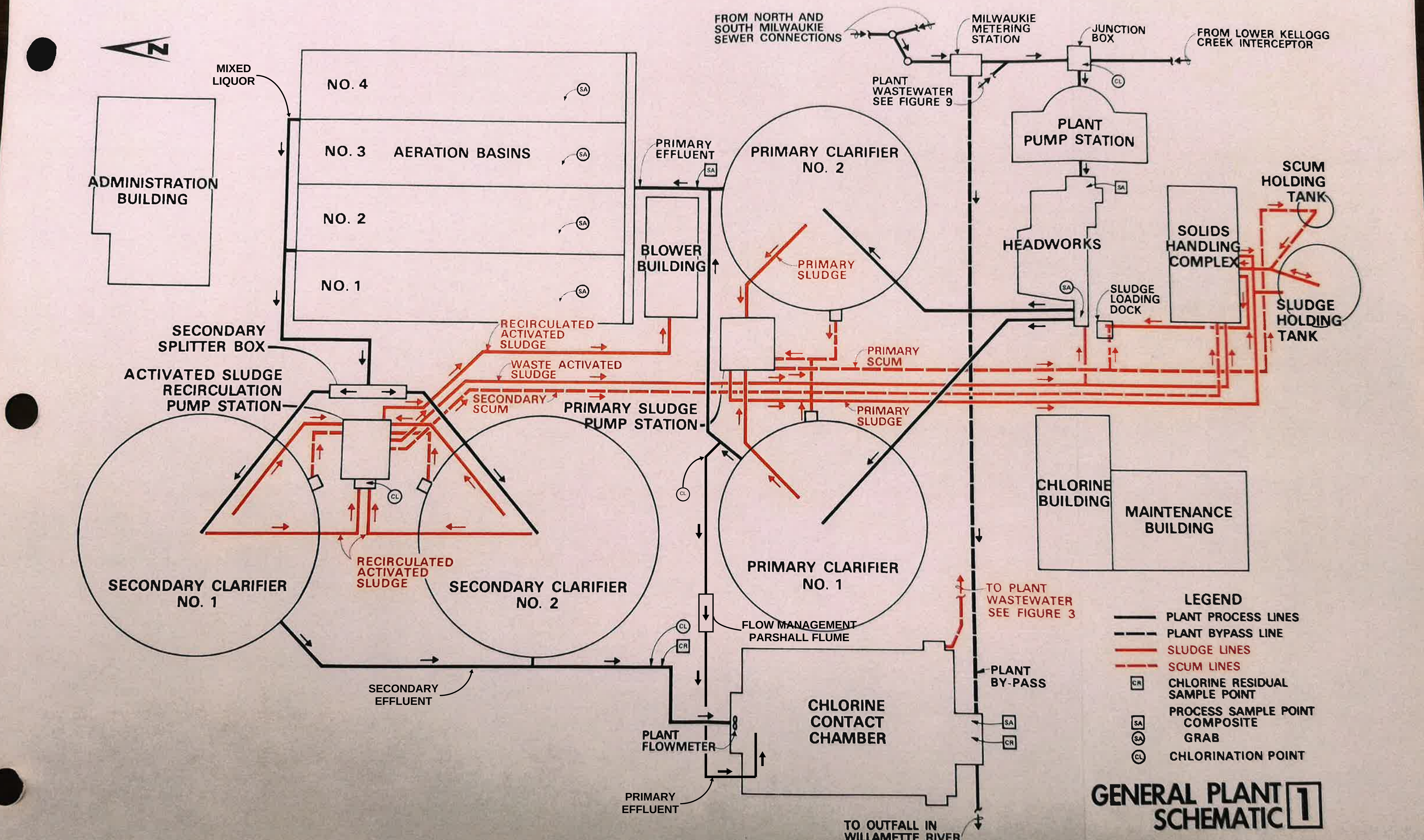
Figure 8.2 Kellogg Creek WRRF Cash Flow Summary

Table 8.3 Kellogg Creek WRRF Cash Flow Summary

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Disinfection System Improvements	$-	$227,000	$2,150,000	$523,000	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Solids Handling Improvements	$-	$-	$-	$-	$-	$232,000	$1,650,000	$1,854,000	$5,048,000	$15,143,000	$7,011,000	$-	$-	$-	$-	$-	$-	$-	$-	$-
Gas Utilization Improvements	$-	$-	$-	$-	$-	$57,000	$406,000	$456,000	$1,241,000	$3,723,000	$1,723,000	$-	$-	$-	$-	$-	$-	$-	$-	$-
R&R 0-2 Years	$-	$237,000	$317,000	$158,000	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
R&R 3-5 Years	$-	$-	$-	$2,341,000	$3,121,000	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
R&R 6-10 Years	$-	$-	$-	$-	$-	$-	$-	$925,000	$1,234,000	$617,000	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
TOTAL	**$-**	**$464,000**	**$2,466,000**	**$3,022,000**	**$3,121,000**	**$288,000**	**$2,055,000**	**$3,235,000**	**$7,523,000**	**$19,483,000**	**$8,734,000**	**$-**	**$-**	**$-**	**$-**	**$-**	**$-**	**$-**	**$-**	**$-**

Appendix 5A

PROCESS FLOW DIAGRAM



GENERAL PLANT SCHEMATIC 1

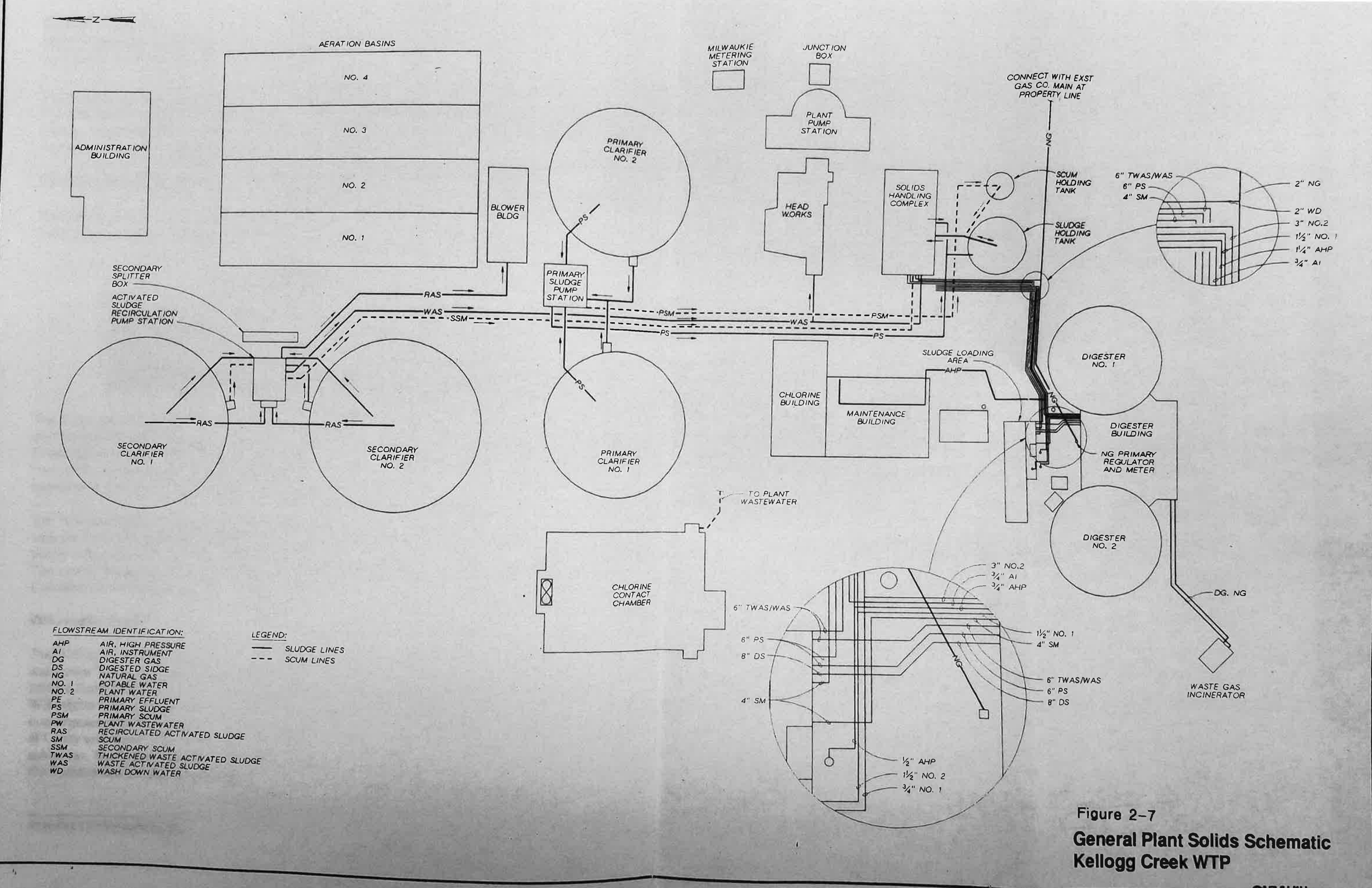


Figure 2-7

General Plant Solids Schematic Kellogg Creek WTP

Appendix 5B

MODEL DOCUMENTATION

PROJECT MEMORANDUM

WILLAMETTE FACILITIES PLAN

Clackamas Water Environment Services

Date: January 14, 2020
Project No.: 11636A.00

Prepared By:	Anne Conklin
Reviewed By:	Brian Graham
Subject:	Process Model Documentation

Purpose

The purpose of this memorandum is to document the process model calibration for the Clackamas Water Environment Services (WES) Tri Cities and Kellogg Creek treatment plants. Since the peak flow capacity of the Kellogg Creek plant is capped at 25 million gallons per day (mgd), the District constructed the Intertie 2 pump station to divert flows from the Kellogg Creek service area to the Tri Cities plant which can be expanded. In addition to the flow transfers, the digested sludge generated at Kellogg Creek is hauled to the Tri Cities plant where it is dewatered. The dewatering return flows from the Kellogg Creek digested sludge are treated at the Tri Cities Plant. Since these two models are interconnected, one process model was developed for both plants.

Influent Data Issues at Kellogg Creek

The influent measurement at Kellogg Creek includes recycle from the thickening process and is upstream of grit removal. No other recycle streams enter the plant between the influent sample location and the primary clarifiers. The measured influent total suspended solids (TSS) concentrations are highly variable and are sometimes measured at concentrations above 1,000 milligrams per liter (mg/L). For this reason an outlier analysis was performed and any influent loads measured that were greater than 1.5 times the interquartile range greater than the 75th percentile load (or less than 1.5 times the interquartile range less than the 25th percentile load) were excluded.

As is shown in Figure 1, a solids mass balance around the primary clarifiers does not close even including an estimate for how much solids are removed in grit[1]. For this reason, four different draft model calibrations were developed to determine which one best matched the measured data through the plant:

1. Trust the measured influent and primary effluent (PE) influent biochemical oxygen demand (BOD) and TSS concentrations:
    a. Due to the super high influent TSS concentrations, calculated primary sludge and cake loads were much higher than were measured. Additionally, the per capita TSS load was higher than is typical for a residential system.
    b. Due to the high influent TSS/BOD ratio, the required Fup was high, resulting in a high observed yield and higher modeled thickened waste activated sludge (TWAS) loads.

[1] Kellogg Creek plant staff indicate that they remove 6 cy/wk of grit. Assuming a middle of the range moisture content of 39% from Metcalf and Eddy, a specific gravity of 2.65 and an ISS/TSS ratio of 1, I get that the influent TSS sample could contain up to 1,882 ppd of grit.

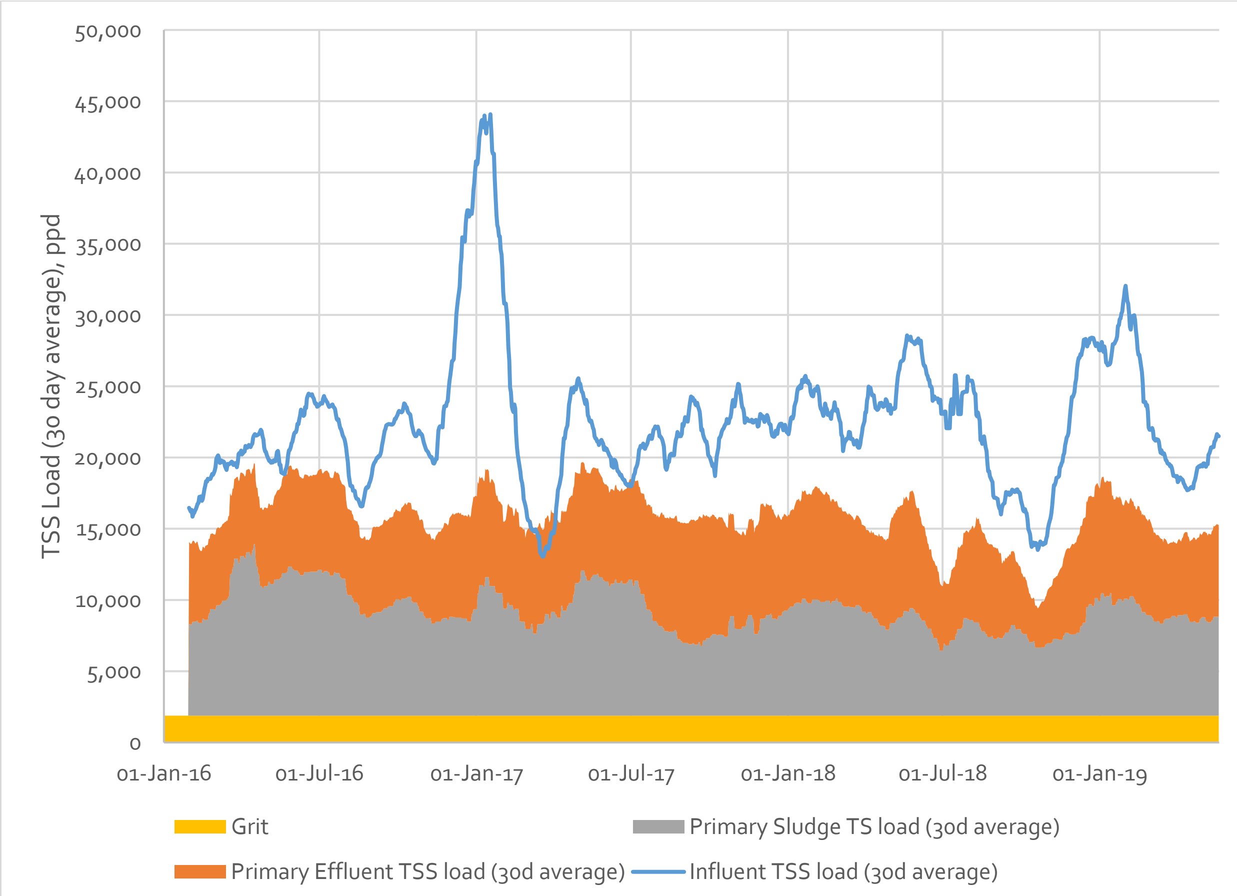


Figure 1 Kellogg Creek Primary Clarifier Mass Balance

2. Trust the measured influent BOD concentration, PE BOD and TSS concentrations and primary sludge load:
    a. By ignoring the measured influent TSS concentrations, the model could predict the measured primary sludge (PS) loads and thus better predict the measured cake loads.
    b. However, by reducing the influent TSS concentrations to match what would be required based on the estimated grit production, PE and primary sludge loads, the calculated primary clarifier TSS and BOD removal percentages are very close to each other. In order for this to happen, the predicted influent sBOD percentage would have to be impossibly low.
    c. I could not generate any influent wastewater characteristics to match this scenario.
3. Trust the measured PE BOD and TSS concentrations and primary sludge load. Using the measured primary effluent and primary sludge loads, I recalculated what the influent TSS load needed to be and then what influent BOD load would make sense based on the wastewater characteristics.
    a. This resulted in modeled sludge loads that reasonably matched the measured values and more reasonable wastewater characteristics.
    b. However, the resultant influent BOD per capita was lower than would be expected for residential wastewater.
4. Trust the measured PE BOD and TSS concentrations. In this model, the PE concentrations are trusted and all other are modeled assuming reasonable influent characteristics and per capita loads.

a. This model most closely matches the measured solids production while not being too far off the measured influent BOD concentration, and calculated influent TSS concentration (based on the primary clarifier mass balance). Additionally, the per capita loads are very close to what would be expected for residential wastewater.

Table 1 summarizes the results of these four draft model calibrations. Since model calibration 4 more closely matched the measured solids loads and resulted in a reasonable influent wastewater characteristic and per capita loads, I chose to move forward with draft model calibration 4.

Table 1 Kellogg Creek Model Calibration Summary

	KC Measured	Model 1	Model 2	Model 3	Model 4
COD Fractionation	(Default)				
Fbs	0.1600	0.1300	Not feasible	0.1400	0.1300
Fxsp	0.7500	0.8660	Not feasible	0.7500	0.8400
Fup	0.1300	0.3140	Not feasible	0.2490	0.1690
Influent BOD					
Concentration (mg/L)	260	260	260	198	218
Per capita (ppcd)	0.202	0.202	0.202	0.153	0.169
Influent TSS					
Concentration (mg/L)	372	372	241	241	250
Per capita (ppcd)	0.288	0.288	0.187	0.187	0.194
Primary Effluent BOD					
Concentration (mg/L)	141	141	141	141	141
Removal, %	46%	46%	46%	30%	36%
Primary Effluent TSS					
Concentration (mg/L)	106	106	106	106	106
Removal, %	69%	69%	51%	51%	53%
Primary Sludge, ppd	6,453	13,632	6,453	6,316	6,824
TWAS, ppd	6,232	7,361	Not feasible	7,174	6,534
Anaerobic Digestion VSR, %	67%	45%	Not feasible	50%	61%
Cake, ppd	4,761	10,401	Not feasible	6,172	5,028

Notes:
Measured value (scrubbed data, concentrations calculated from average loads from calibration period.
Calculated value (based on measured primary sludge and measured primary effluent.
Delta < 6% Delta < 20% Delta < 30% Delta > 100%

Influent Data Issues at Tri Cities

The data uncertainties at Tri Cities were different than those at the Kellogg plant. Interestingly at Tri Cities the influent loads have been dropping. The average influent TSS per capita loads was 0.27 ppcd in 2017 (similar to Kellogg Creek), 0.19 ppcd in 2017 (10% less than typical residential values) and 0.15 ppcd in 2018

(30 percent less than typical residential values). Plant staff have indicated that the influent TSS loads were again low in 2019.

However while the influent loads have dropped, solids loads have remained fairly stable (Table 2). Although the influent per capita loads are considerably lower than expected, the influent loads do match the measured primary effluent and primary sludge loads in 2018 (Figure 2).

Table 2 Tri Cities Solids Loads

	2016	2017	2018
Influent TSS Load, ppd (per capita)	28,590 (0.27)	25,189 (0.19)	20,503 (0.15)
Primary Sludge Load, ppd	10,349	10,238	11,526
TWAS load, ppd	7,085	6,799	7,219

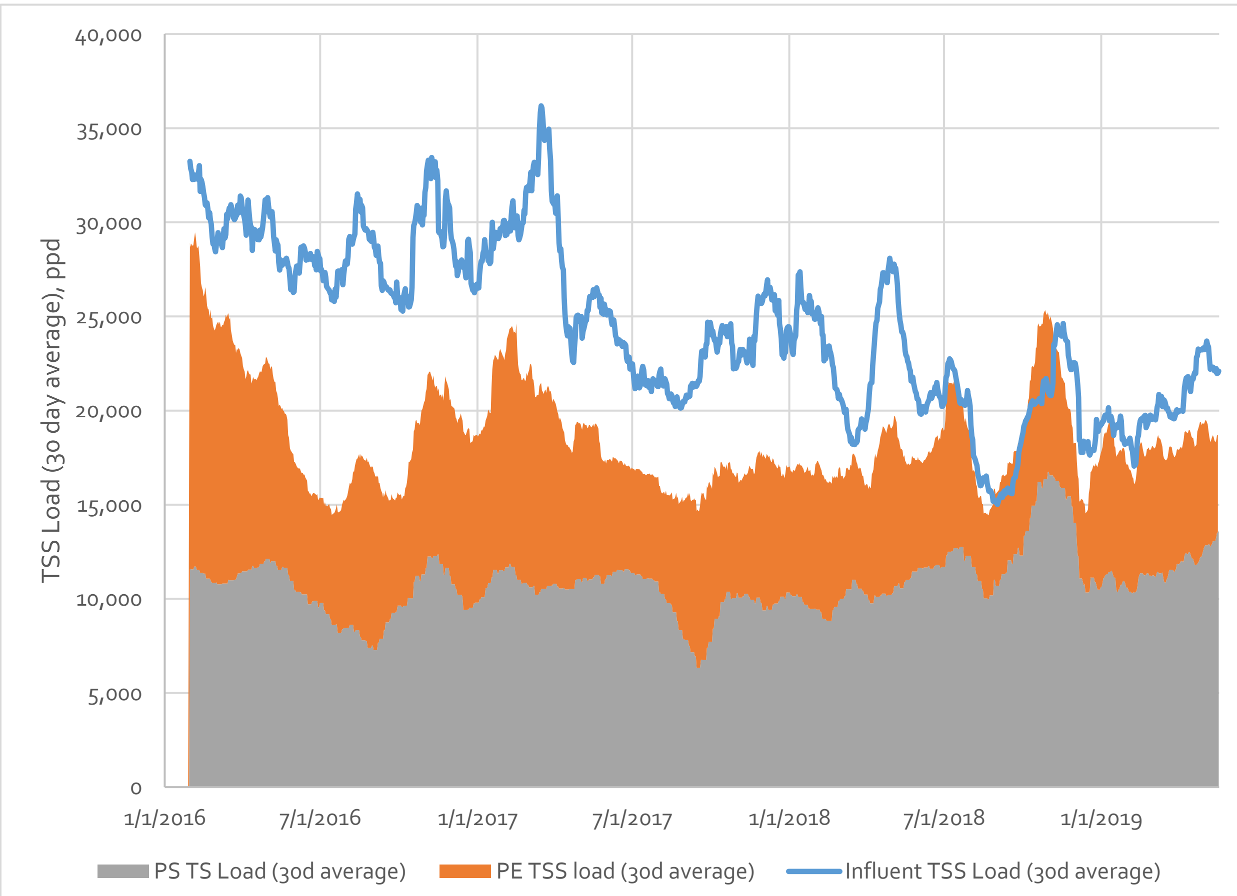


Figure 2 Tri Cities Primary Clarifier Mass Balance

Model Calibration

A steady state process model was developed in BioWin 6 and calibrated to one year of influent data (the most recent data available, 5/10/18 – 5/9/19): WES Whole Plant Model4b.bwc. At this point in the process, the aeration modeling has not been calibrated or evaluated. A dynamic calibration was evaluated however, due to the uncertainty in the influent data at Kellogg Creek and the number of times throughout the year that the Tri Cities plant took aeration basins on and off line, the dynamic calibration was quite difficult.

During the calibration period the Tri Cities plant operated with their one MBR aeration basin online and 3.2 of their 4 CAS aeration basins online. Table 3 summarizes the calibration results for Tri Cities. I think that the WAS flows from the WAS flows from the MBR plant are over predicted by a factor of 2. As can be seen in Table 3, the model over predicts primary sludge loads by about 9 percent, under predicts secondary solids by about 13-14 percent, under predicts combined TWAS by about 9 percent and over predicts hauled solids by about 9 percent.

Table 3 Tri Cities Calibration Summary

	Measured	Modeled	Delta
Influent			
Flow, mgd	8.29	8.29	0%
BOD load, ppd	17,497	17,498	0%
NH3, mg/L	27	28	2%
NH3/TKN	0.58	0.58	0%
TSS load, ppd	19,882	19,514	2%
Primary Clarification			
PE BOD, mg/L	141	141	0%
PE TSS, mg/L	101	101	0%
Secondary Treatment			
CAS MLSS, mg/L	1,575	1,364	13%
CAS MLVSS, mg/L	1,217	1,092	10%
CAS WAS, ppd	6,866	5,945	13%
CAS aSRT, days	3.13	3.13	0%
SE_FLOW, mgd	6.15	5.70	7%
MBR AB MLSS, mg/L	6,891	5,930	14%
MBR AB MLVSS, mg/L	5,487	4,491	18%
MBR RAS TSS, mg/L	8,614	7,405	14%
MBR RAS VSS, mg/L	6,859	5,607	18%
MBR WAS, ppd	4,272	1,886	56%
MBR aSRT, days	6.5	12.6	95%
Solids			
PS TS, ppd	11,917	12,972	9%
TWAS, ppd	7,713	7,047	9%
Centrifuge Feed TS, ppd	11,757	10,483	11%
Land applied solids, dry tons/year	1,589	1,779	12%

During the calibration period, the Kellogg Creek plant was operating with 3 out of their 4 aeration basins in service. Table 4 summarizes the results of the calibration. The plant measures RAS and WAS TSS concentrations and they are different by almost a factor of 2. They feel that their WAS concentrations are more accurate but we have discussed with them taking spins of the solids every hour during their intermittent wasting cycle to see over the entire course of a WAS wasting, is the average WAS TSS concentration closer to the RAS or initial WAS measurement. As can be seen in Table 4, the measured influent TSS and BOD concentrations were ignored and the model calibrated around other parameters in the plant. The model over predicts primary and TWAS solids by about 6 percent, under predicts centrifuge feed solids by about 14 percent and over predicts hauled biosolids by about 5 percent.

Table 4 Kellogg Creek Calibration Summary

	Measured	Modeled	Delta
Influent			
Flow	6.85	6.84	0%
Scrubbed TSS load, ppd	21,649	14,716	32%
Scrubbed BOD load, ppd	14,935	12,538	16%
NH3, mg/L	28	24	13%
NH3/TKN	0.65	0.61	6%
Grit, ppd	1,882	1,841	2%
Primary Clarification			
PE BOD, mg/L	141	140	0%
PE TSS, mg/L	106	106	1%
Secondary Treatment			
MLSS, mg/L	1,680	1,830	9%
MLVSS, mg/L	1,473	1,570	7%
WAS load, ppd (based on WAS TSS)	9,367	6,860	27%
WAS load, ppd (based on RAS TSS)	6,081	6,860	13%
aSRT, days	2.60	2.56	2%
Solids			
PS TS, ppd	6,453	6,824	6%
TWAS, ppd	6,232	6,534	5%
Centrifuge feed TS, ppd	5,982	5,121	14%
Hauled biosolids, dry tons/year	869	912	5%

Prepared by:

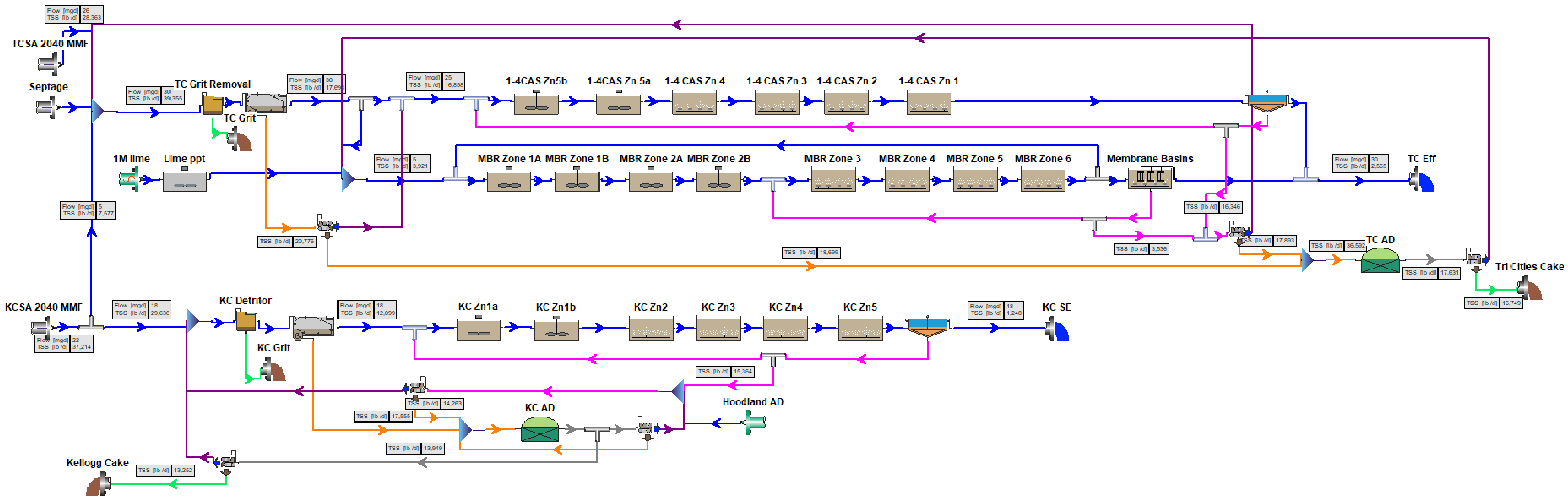
Anne Conklin:

AC:sm

Appendix 5C

MASS BALANCE

2040 MMWWF



TCSA 2040 MMF
Septage
TC Grit Removal
TC Grit
1M lime
Lime ppt
1-4CAS Zn5b
1-4CAS Zn 5a
1-4 CAS Zn 4
1-4 CAS Zn 3
1-4 CAS Zn 2
1-4 CAS Zn 1
MBR Zone 1A
MBR Zone 1B
MBR Zone 2A
MBR Zone 2B
MBR Zone 3
MBR Zone 4
MBR Zone 5
MBR Zone 6
Membrane Basins
TC Eff
TC AD
Tri Cities Cake
KCSA 2040 MMF
KC Detritor
KC Grit
KC Zn1a
KC Zn1b
KC Zn2
KC Zn3
KC Zn4
KC Zn5
KC SE
KC AD
Hoodland AD
Kellogg Cake

Appendix 7A

DEWATERING ALTERNATIVES FOR THE KELLOGG CREEK WWRF

PROJECT MEMORANDUM

WILLAMETTE FACILITIES PLAN

Water Environment Services

Date: November 17, 2021

Project No.: 11636A00

Prepared By:	Anne Conklin
Reviewed By:	Brian R. Matson
Subject:	Dewatering Alternatives for the Kellogg Creek Water Resource Recovery Facility (WRRF)

Background

Digested biosolids from the Kellogg Creek WRRF (KC) is currently hauled to the Tri-City WRRF (TC) for dewatering using a backup centrifuge (BUC). The District has historically viewed this as a temporary solution, assuming that a permanent biosolids dewatering process would be installed at KC within the planning period (year 2040). The initial round of KC treatment improvements developed as part of the Willamette Facilities Plan (WFP) included new solids thickening, digestion, and dewatering facilities at KC. This alternative is hereafter referred to as the "Facilities Plan Alternative." In an effort to confirm the most reliable and cost-effective use of existing and new infrastructure, the project team evaluated two additional alternatives, which are described in this memorandum. Alternative 1 assumed that digested biosolids from KC would continue to be dewatered at TC using the BUC. Alternative 2 assumed that thickened sludge would be hauled from KC to TC for digestion and dewatering.

Alternatives Analysis

Solids handling alternatives, including capital, operation and maintenance (O&M), and net present value (NPV) costs are described below and summarized in Table 1.

- **Facilities Plan Alternative**: The Facilities Plan Alternative assumes solids generated at KC are processed at KC. This results in the following capital investments at KC:
  - Solids thickening improvements to provide adequate capacity and to address the condition of existing equipment.
  - Digester improvements to improve the reliable digester capacity.
  - Dewatering improvements to eliminate the need to haul digested biosolids to TC.

  Although the Facilities Plan Alternative has the highest capital cost, it reduces annual O&M costs by eliminating the need to haul digested biosolids to TC for dewatering.
- **Alternative 1**: Alternative 1 assumes solids generated at KC are thickened and digested at KC before being hauled to TC for dewatering. This results in the following capital investments at KC and TC:
  - Solids thickening improvements to provide adequate capacity and to address the condition of existing equipment.
  - Digester improvements to improve the reliable digester capacity.

  - Alternative 1 assumes digested biosolids are hauled to TC for dewatering using the BUC. Therefore, costs to replace the existing BUC with a new centrifuge unit are included in Alternative 1 capital costs.

  Alternative 1 has a lower capital cost relative to the Facilities Plan Alternative; however annual O&M costs are higher for two primary reasons. The first reason is related to the cost of process aeration at TC. Currently, centrate (with a high ammonia concentration) produced at the TC facility is routed directly to the membrane bioreactor (MBR) process, which is a nitrifying process. Therefore, additional centrate produced by dewatering KC biosolids at TC will increase the ammonia load to the TC MBR, which will increase aeration costs. The second reason is the annual cost of hauling digested biosolids from KC to TC for dewatering.

- **Alternative 2**: Alternative 2 assumes thickened solids from KC are hauled to TC for digestion and dewatering. This results in the following capital investments at KC and TC:
  - Solids thickening improvements to provide adequate capacity and to address the condition of existing equipment.
  - Minimal repair and rehabilitation (R&R) improvements to the KC digesters, allowing them to operate as sludge storage.
  - Expansion of TC digestion and dewatering capacity by 2040.

  As with Alternative 1, Alternative 2 results in lower capital improvements through the planning period, but higher annual O&M costs due to the need to nitrify the centrate in the TC MBR, and the need to haul thickened sludge from KC to TC.

Table 1 summarizes the estimated capital, annual O&M, and NPV costs for the three alternatives. As shown, the 20-year NPV of the Facilities Plan Alternative is essentially the same as Alternative 1.

Table 1 Alternative Analysis Summary

Solids Handling Improvement	Facilities Plan Alternative	Alternative 1 (Dewatering at TC)	Alternative 2 (Digestion & Dewatering at TC)
Estimated Capital Cost of Improvements at KC(1)			
• Thickening	$4,400,000	$4,400,000	$4,400,000
• Dewatering	$7,300,000		
• Cake Storage and Truck Loadout	$6,200,000		
• Polymer System	$870,000		
• Digester Feed Tank	$1,900,000	$1,900,000	
• Dewatering Feed Tank	$900,000	$900,000	
• Digester R&R	$1,500,000	$1,500,000	$250,000
• Digester Mixing Upgrades	$1,233,000	$1,233,000	
Estimated Capital Cost of Improvements at TC(1)			
• Digester Number 4			$7,582,000
• Dewatering Expansion		$1,500,000	$1,500,000
Total Estimated Capital Cost	**$24,000,000**	**$11,000,000**	**$14,000,000**

Solids Handling Improvement	Facilities Plan Alternative	Alternative 1 (Dewatering at TC)	Alternative 2 (Digestion & Dewatering at TC)
O&M Costs, Dollars per Year(2)			
• Additional Aeration Cost(3)		$29,000	$22,000
• Liquid Sludge Hauling(4)		$819,000	$973,000
Total Annual O&M Costs	**$0**	**$948,000**	**$995,000**
Total NPV(5)	**$24,000,000**	**$24,000,000**	**$29,000,000**

Notes:
(1) Capital costs presented as Project Costs which include construction, engineering, legal and administration costs.
(2) O&M costs shown in present day dollars based on projected loads for the year 2030.
(3) Assumes an energy cost of $0.15 per kilowatt-hour (kWh).
(4) Assumes 5,600-gallon tanker truck, $110/hour; 15 miles round trip, 50 minutes per round trip, 0.8 hours to load and unload the truck, $0.2 per mile for truck maintenance, $40,000, per year for eventual truck replacement.
(5) Assumes a 20-year payback period and a 3% net discount rate.

Recommendations

Because the 20-year NPV of the three alternatives is essentially the same, the District may elect to implement whichever alternative best suits their preference. The Facilities Plan Alternative is recommended if the District wishes to construct reliable solids handling facilities at KC and minimize the annual O&M cost of hauling biosolids to TC. Alternative 1 is recommended if the District would prefer to defer or avoid the capital expense associated with improving solids processes at KC.

This document is released for the purpose of information exchange review and planning only under the authority of Brian R. Matson, November 15, 2021, State of Oregon PE License No.66976.

Prepared by:

Anne Conklin, Ph.D., P.E.

Reviewed by:

Brian R. Matson, P.E.

AC:mm

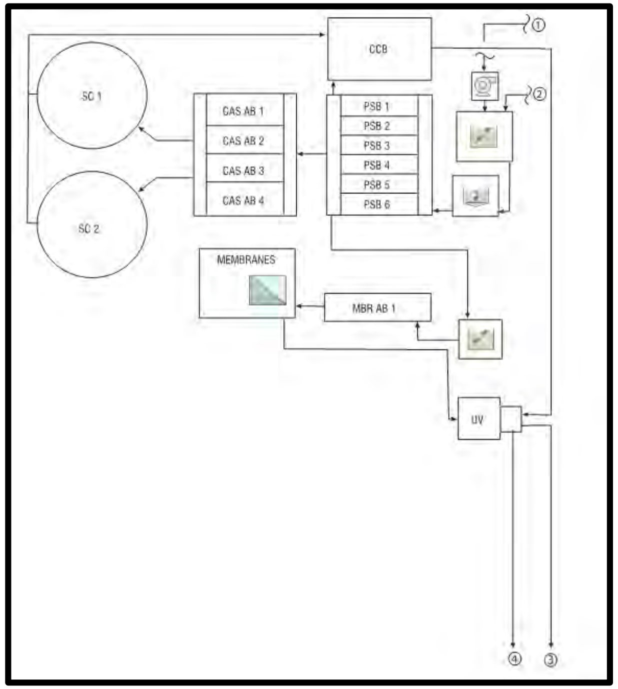
CLACKAMAS
WATER ENVIRONMENT SERVICES

Clackamas County
Board of Commissioners Meeting
1 November 2022

Willamette Facilities Plan

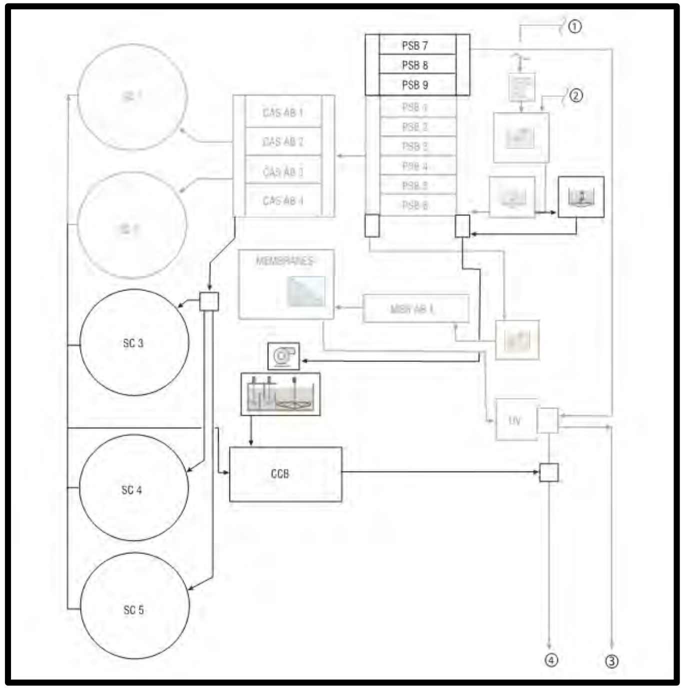
Lynne Chicoine, PE, BCEE
Consultant

What is a Facilities Planning Process



Existing Facilities - 2020

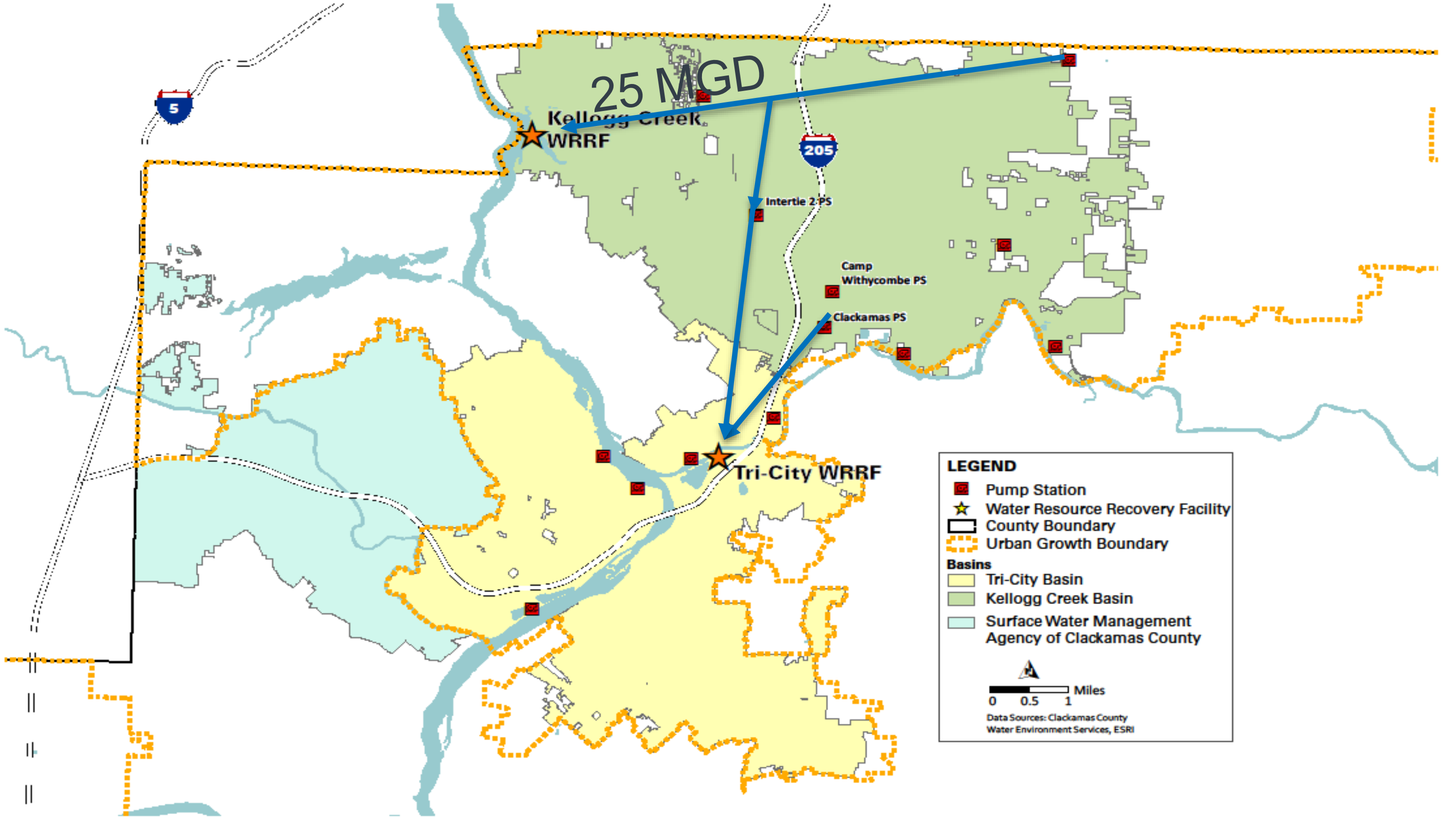
- Regulatory
- Capacity
- Condition



Required Facilities - 2040

CLACKAMAS WATER ENVIRONMENT SERVICES

WFP Looked at Best Way to Integrate Treatment Across Service Basins



CLACKAMAS WATER ENVIRONMENT SERVICES

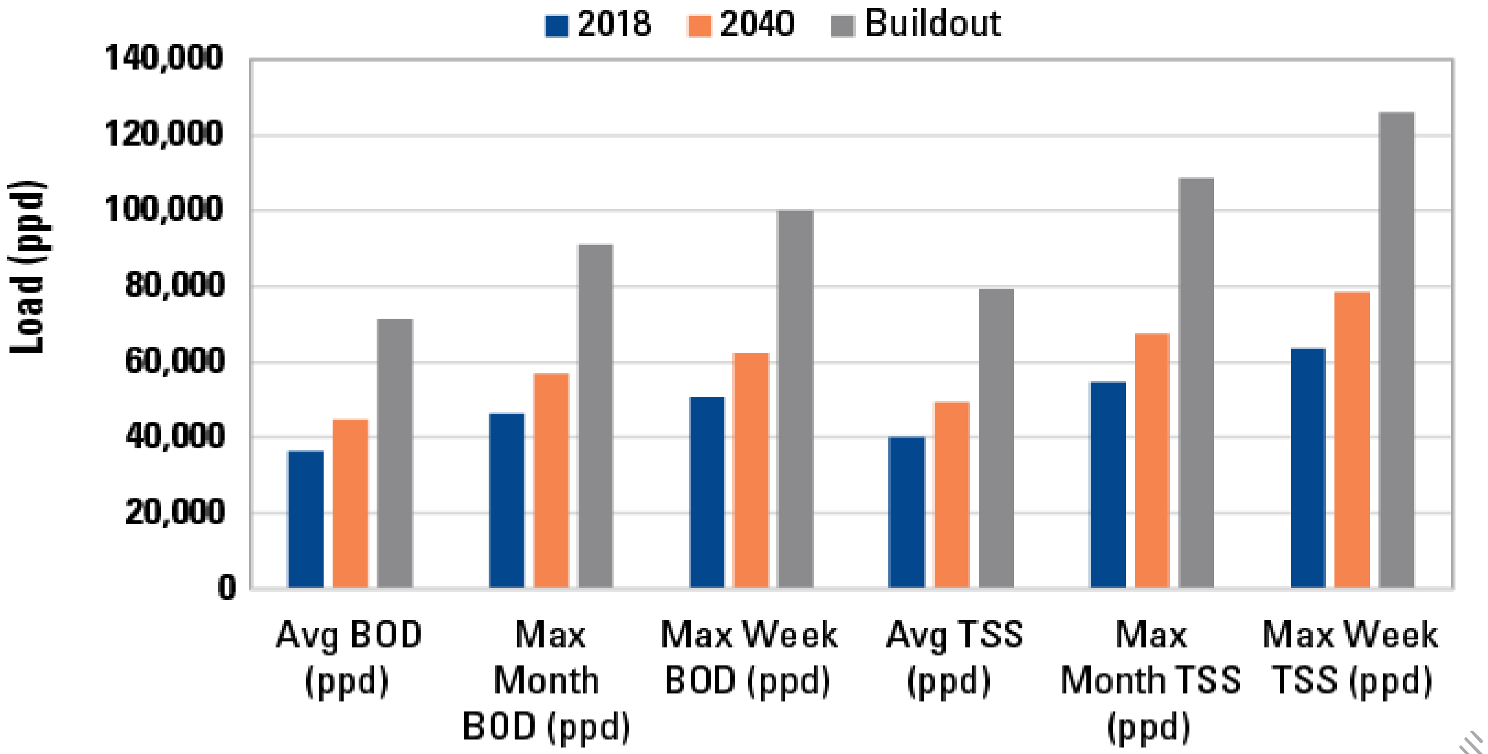
Wastewater Treatment Has Two Regulatory Seasons

Dry Season: May - October

Wet Season: November - April

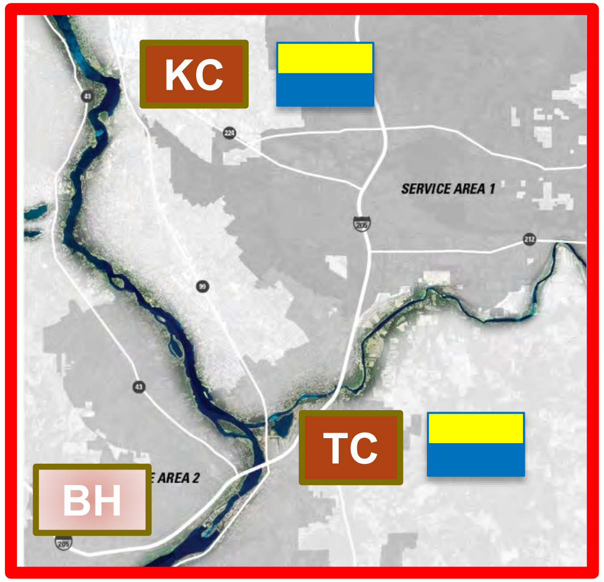
Dry Season

Dry Weather: 2040 Population (=Load) Projection

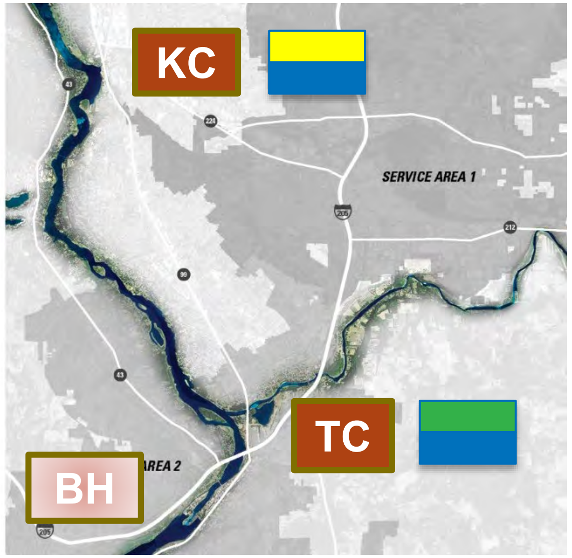


CLACKAMAS WATER ENVIRONMENT SERVICES

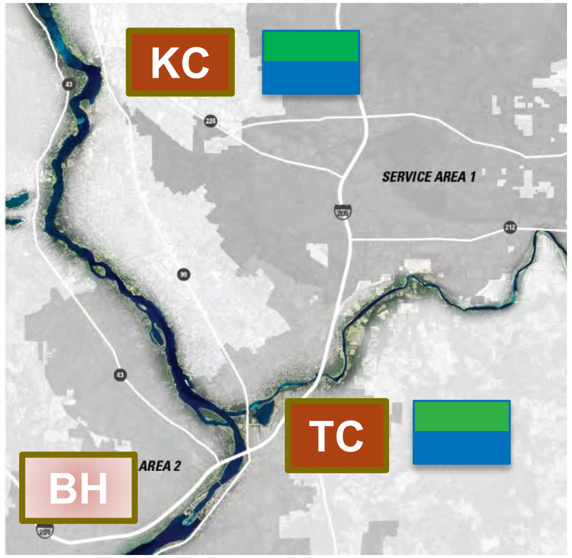
Dry Weather (DW) Scenarios



Scenario 1
Current Permit Limits



Scenario 1.5
Nutrient Removal
Combined Permit



Scenario 3
Nutrient Removal
Individual Permits

Water Quality →

Cost →

DW Current Permit | DW Nutrient Removal | Wet Weather

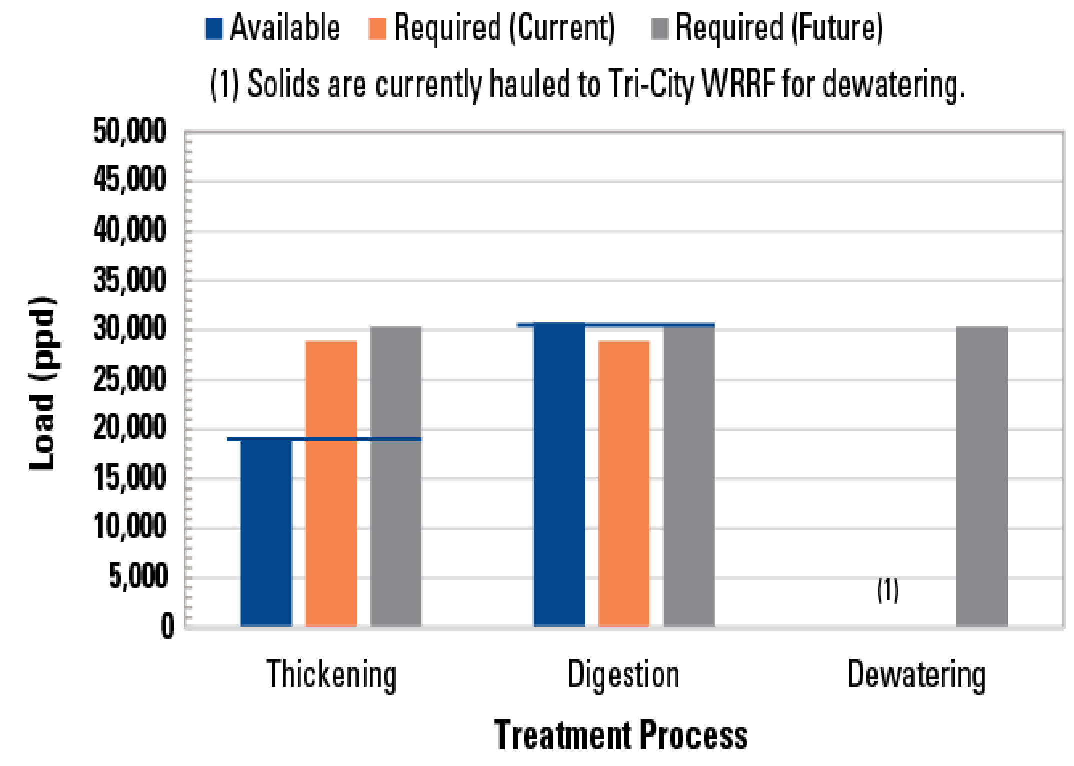
CLACKAMAS WATER ENVIRONMENT SERVICES

Dry Weather Capacity Needs

TC WRRF ($7.6M)

- Add Primary Sludge Thickening (2030+/-)

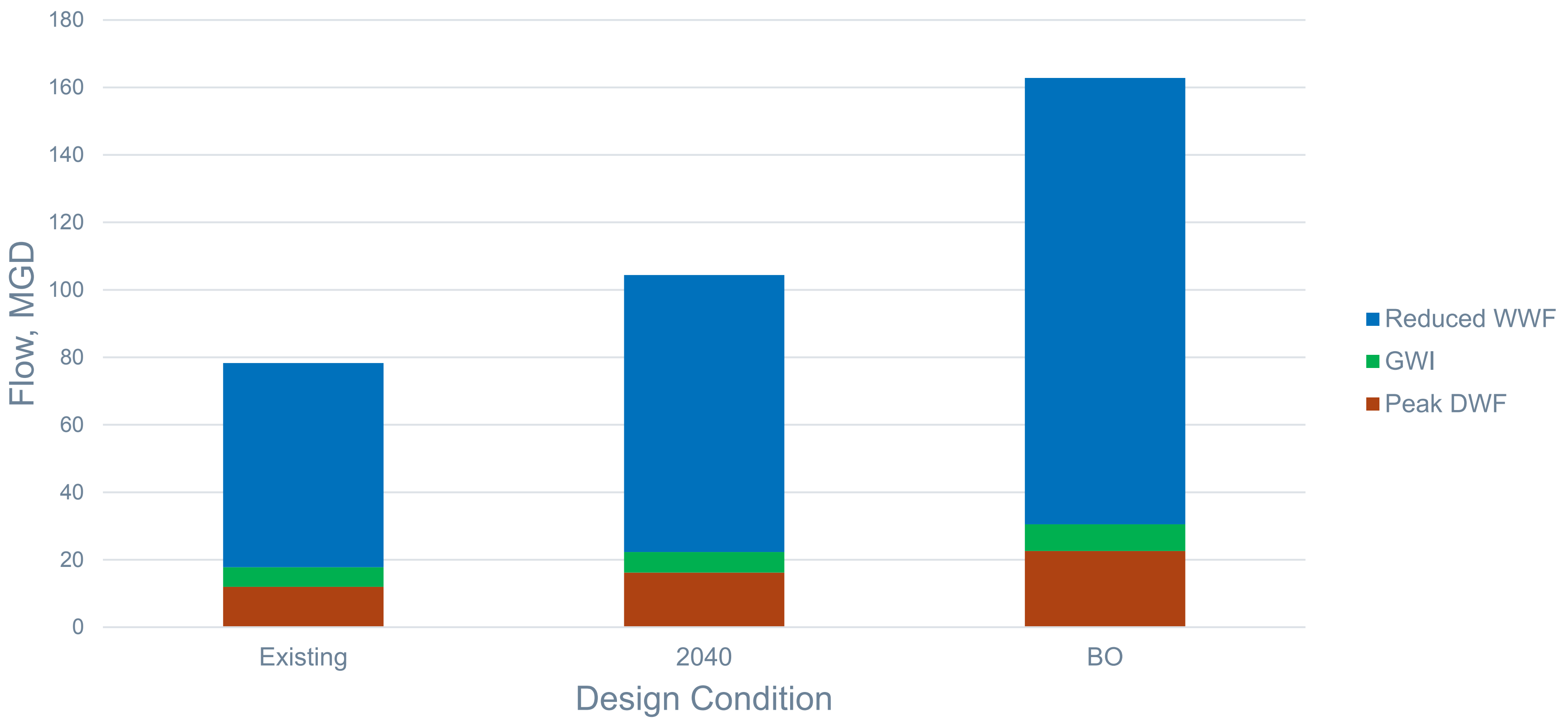
KC WRRF



CLACKAMAS WATER ENVIRONMENT SERVICES

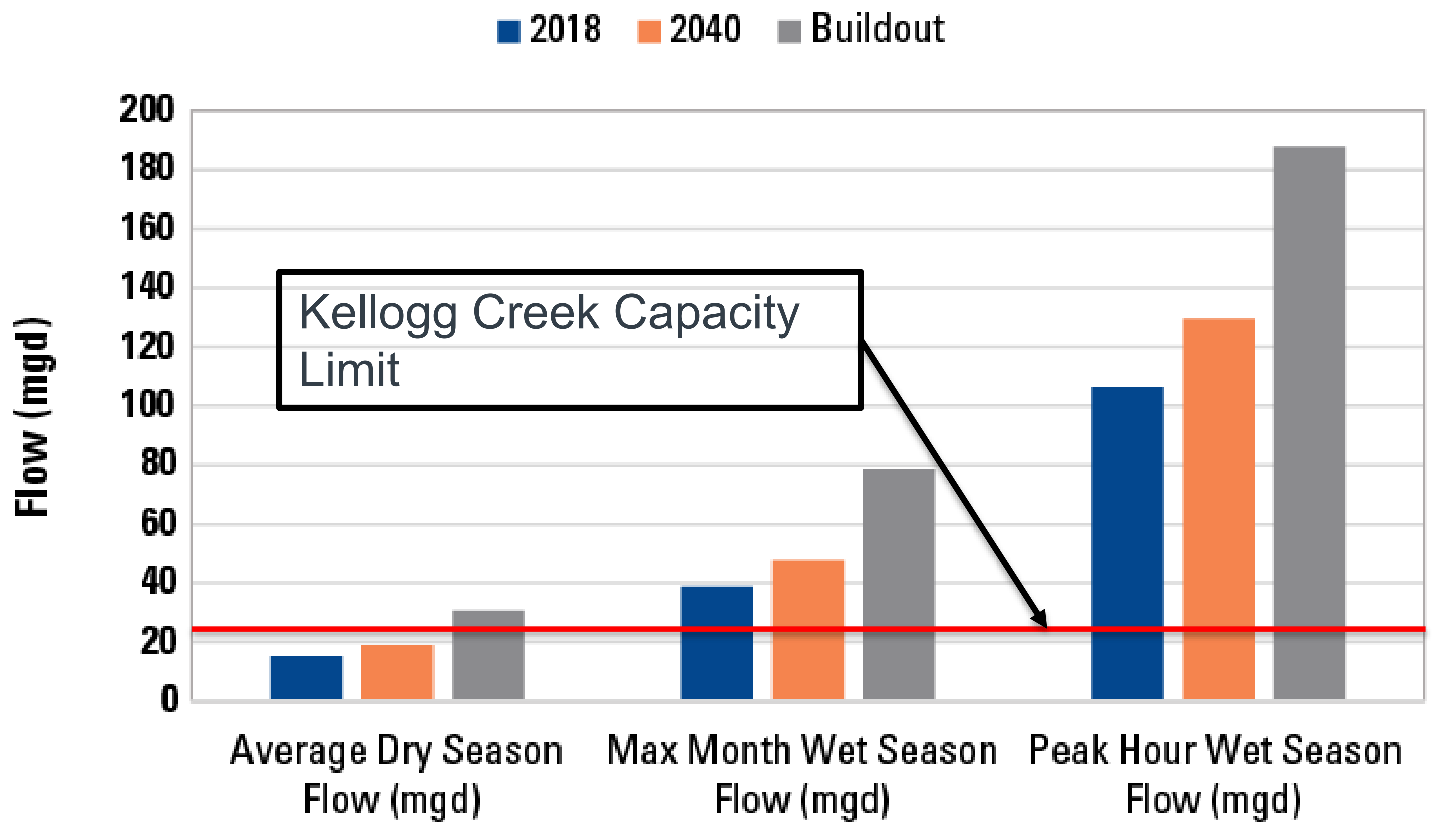
Wet Season

Current and Projected TC WRRF Flows (with I/I Reduction)



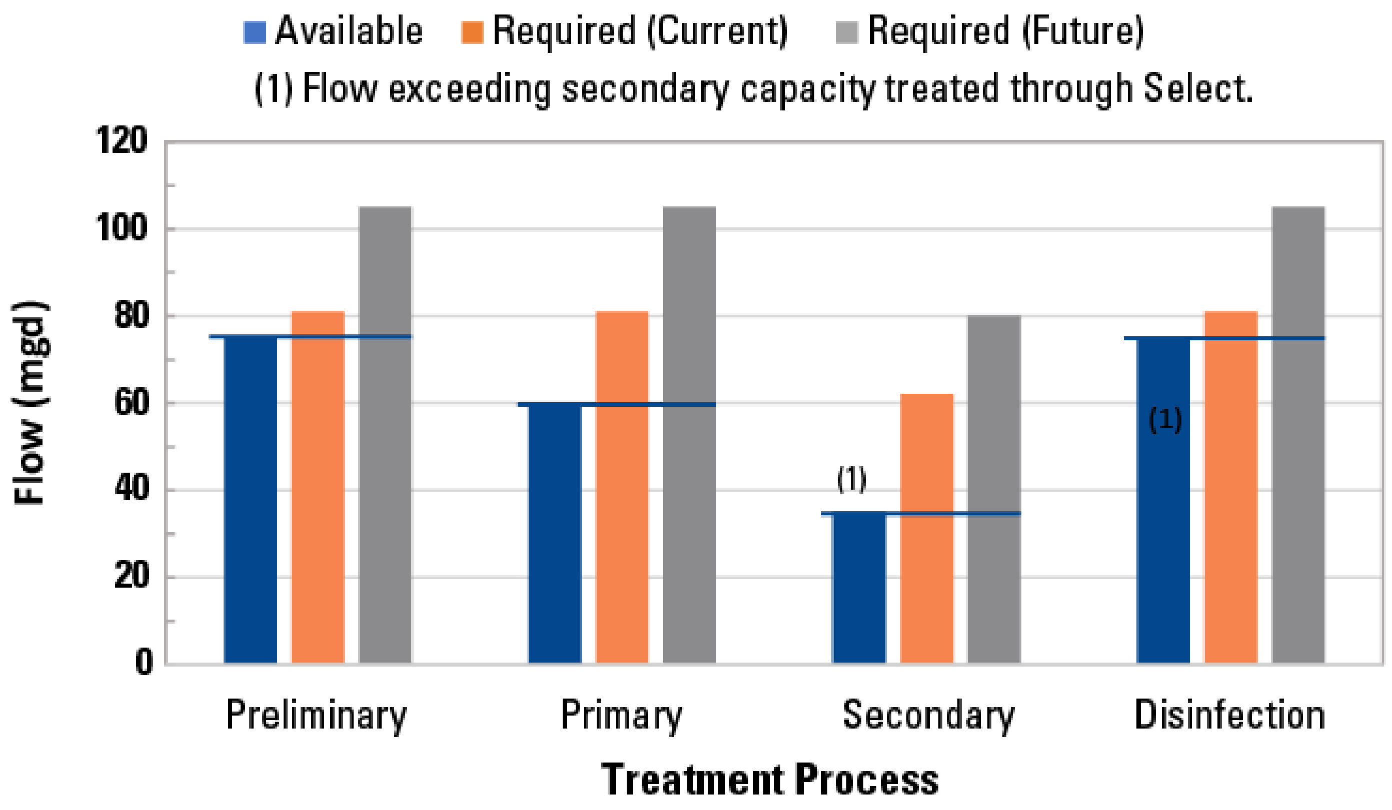
CLACKAMAS
WATER ENVIRONMENT SERVICES

Total Flow Projection (with I/I Reduction)

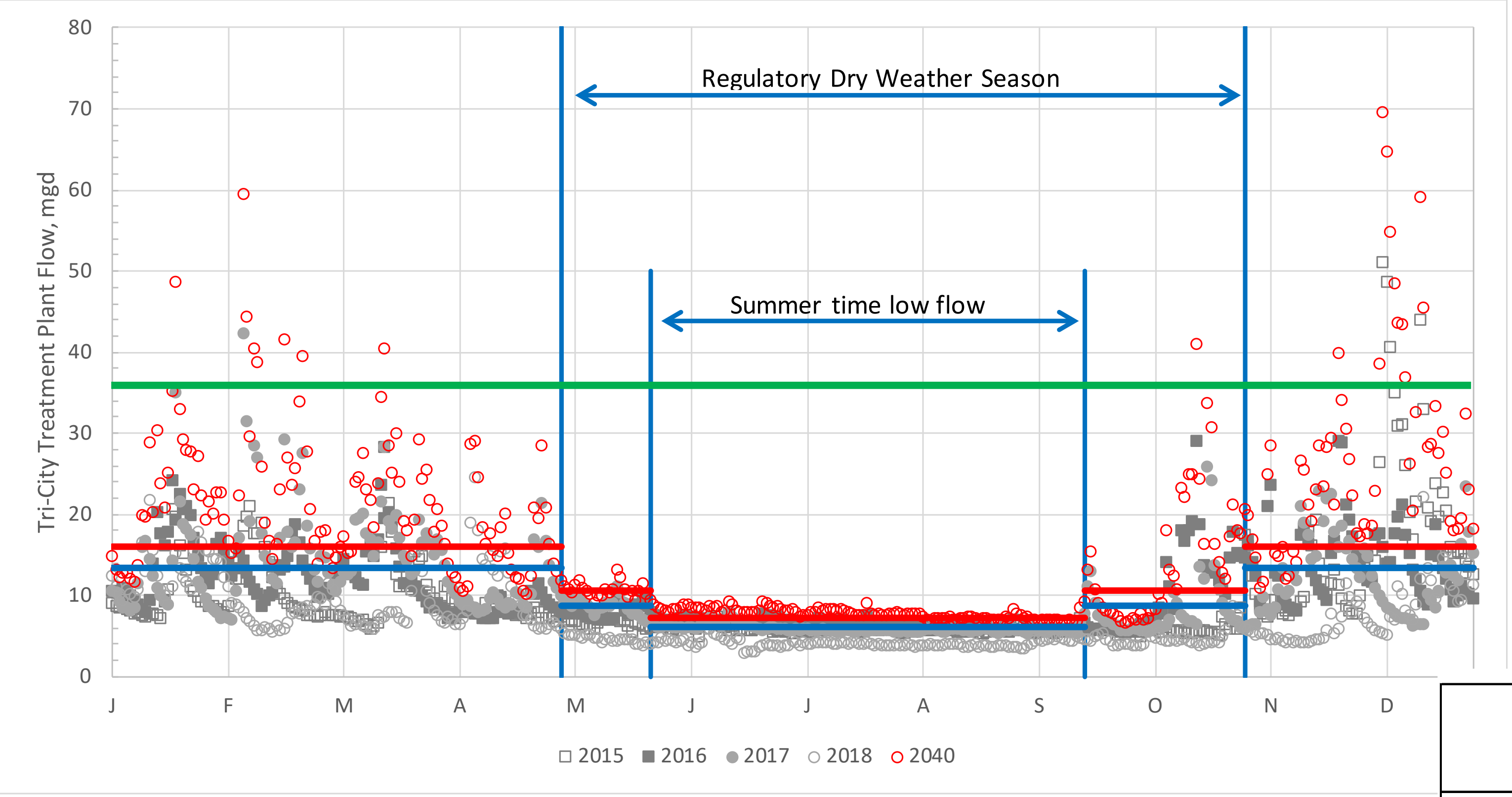


CLACKAMAS WATER ENVIRONMENT SERVICES

Tri-City WRRF Wet Weather Capacity Needs (with I/I Reduction)



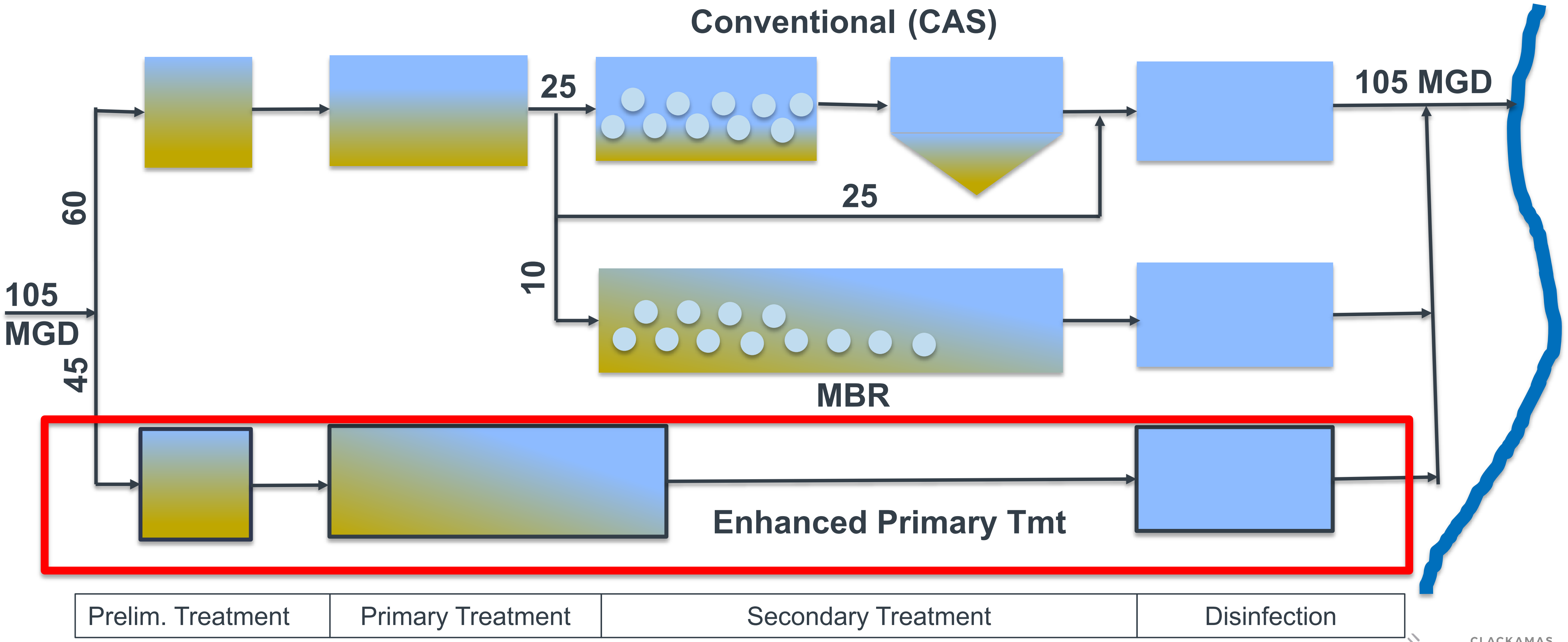
Infrequent Peak Flow at Tri-City Presents Challenges



Estimated Value	Current [(1)]	Projected (2040)
% of Time Q ≤ 35 mgd	99%	98%
No. of ST Events per Year	3	9
Average Annual ST Duration (hrs)	50	180
% of Annual Flow Discharged as ST	1%	3%
(1) Average of 2015 - 2018 data		

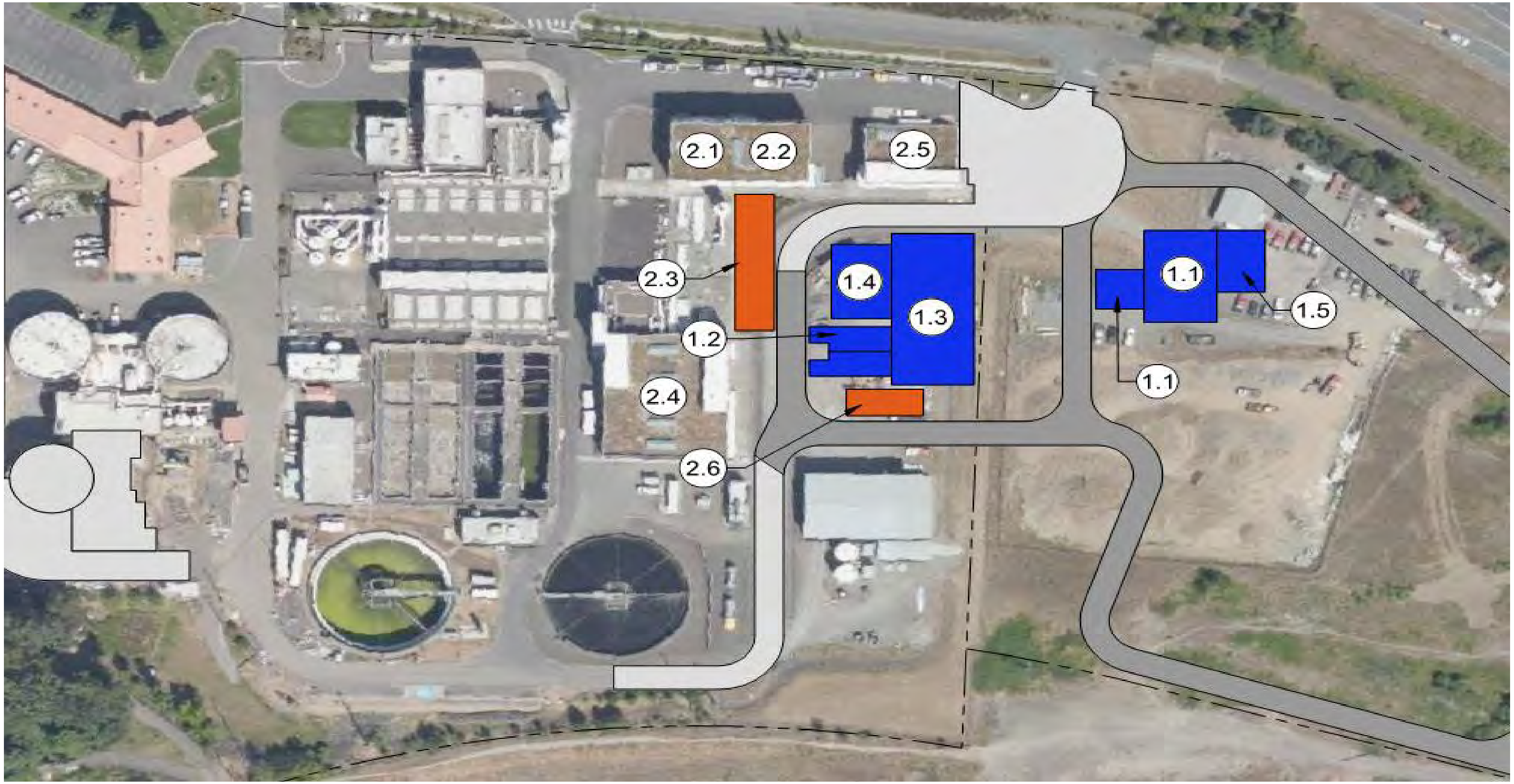
Recommended Plan

Recommended Tri-City WRRF Wet Weather Expansion – Estimated $54M



CLACKAMAS WATER ENVIRONMENT SERVICES

Recommended 2040 Tri-City Site Layout



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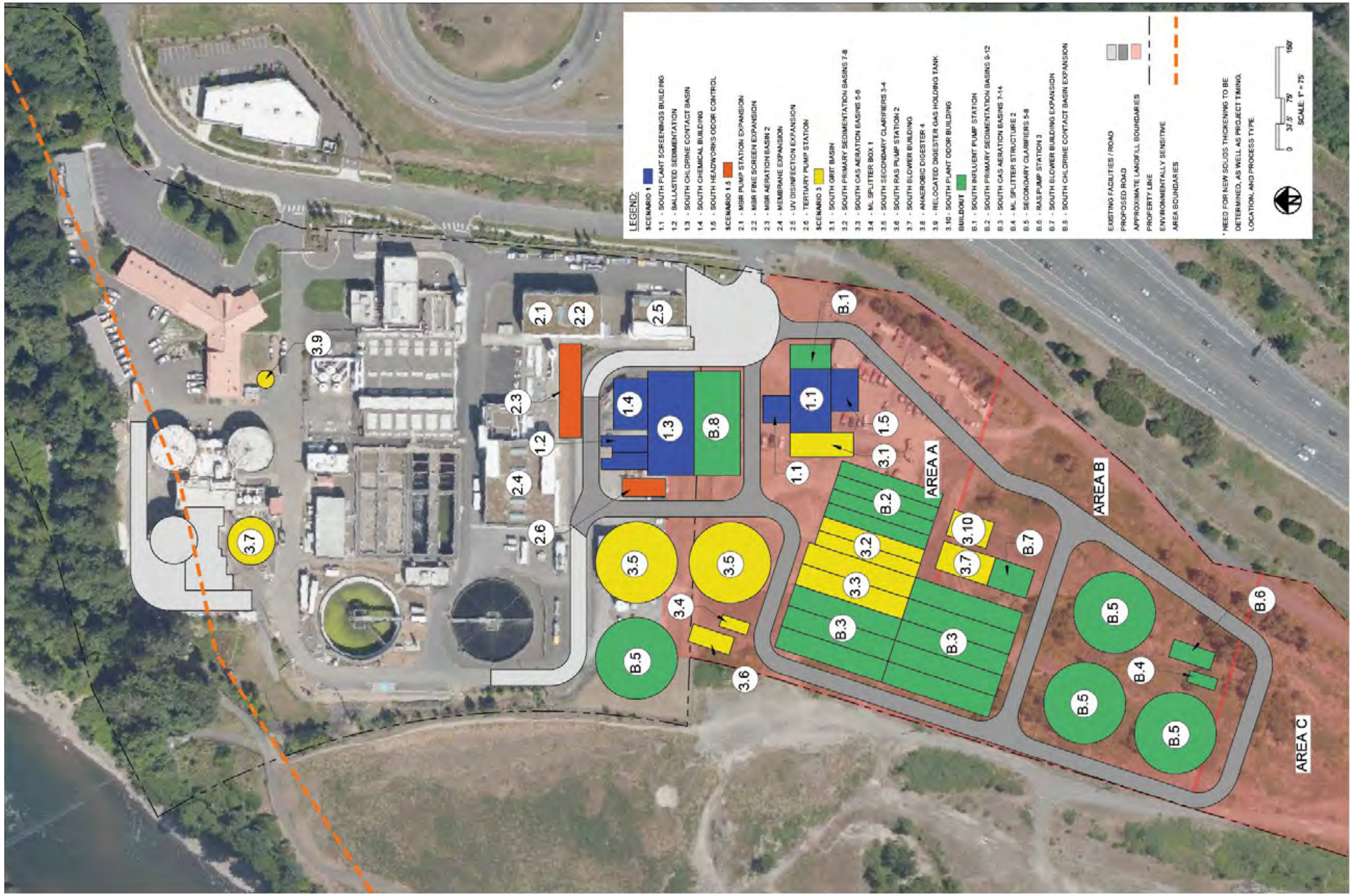
Recommended Conceptual Tri-City Site Plan at Buildout



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Summary and Next Steps

- Willamette Facilities Plan recommends $119 for capacity and condition improvements
- Endorsed by WES Advisory Committee (Feb 2022)
- Tri-City WRRF Weather Expansion is largest project
  - Estimated Capital Cost $54M
  - WES to begin negotiation with DEQ
  - Design/Construction planned for 2026 - 2031

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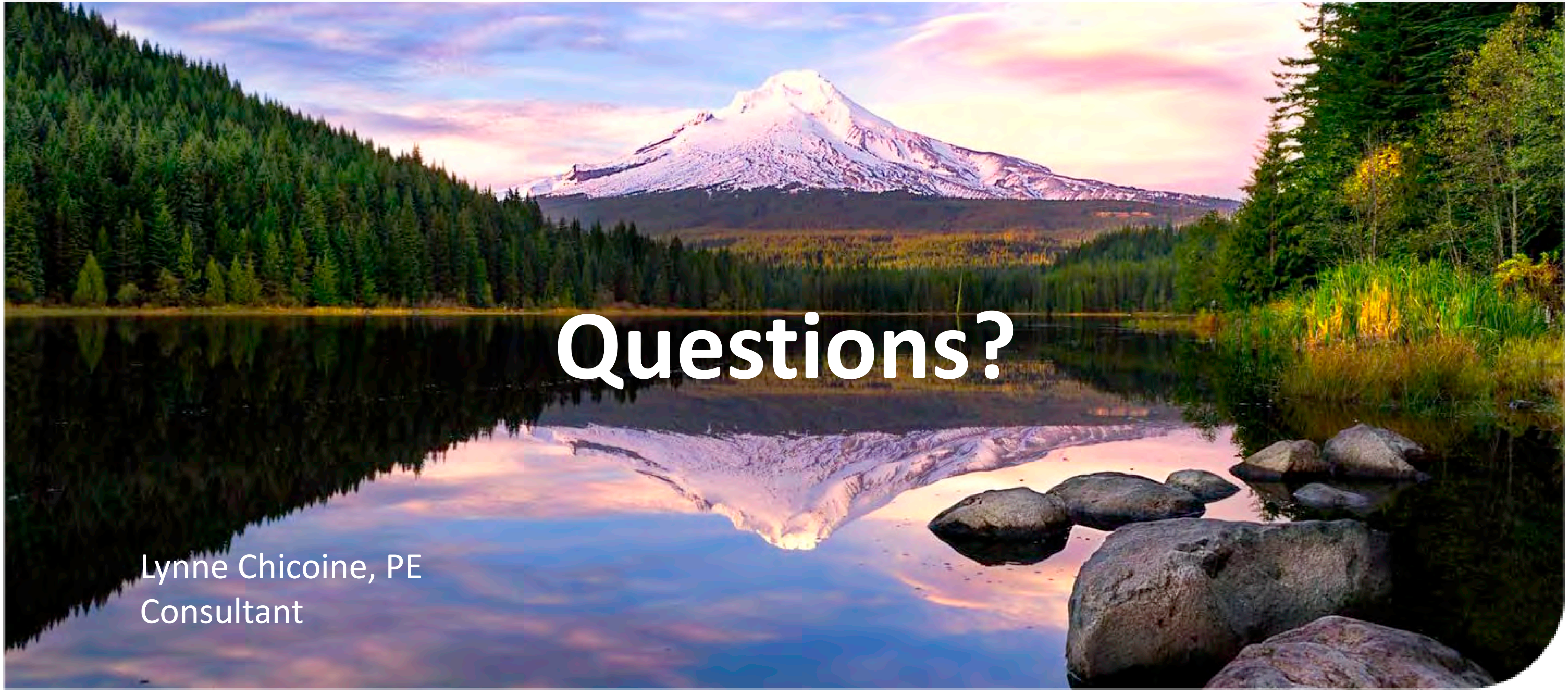

Questions?

Lynne Chicoine, PE
Consultant