Phase 2 Master Planning: Capacity Management

Prepared for
LOTT Clean Water Alliance
Olympia, WA
January 2022

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μg/L	micrograms per liter
BIRWP	Budd Inlet Reclaimed Water Plant
BITP	Budd Inlet Treatment Plant
BOD	biochemical oxygen demand
CLA	Class A Reclaimed Water
Ecology	Washington State Department of Ecology
EQ	equalization
gpd	gallons per day
HPRB	Hawks Prairie Groundwater Recharge Basins
lb/d	pound(s) per day
LOTT	LOTT Clean Water Alliance
MBBR	moving bed bioreactor
MG	million gallons
mg/L	milligrams per liter
mgd	million gallons per day
ml	milliliter
MPN	most probable number
MWPS	Martin Way Pump Station
MWRWP	Martin Way Reclaimed Water Plant
N	nitrogen
NPDES	National Pollutant Discharge Elimination System
NTU	nephelometric turbidity unit
RAS	return activated sludge
TIN	total inorganic nitrogen
TKN	total Kjeldahl nitrogen
TMDL	total maximum daily load
TN	total nitrogen
TOC	total organic carbon
TP	total phosphorus
TSS	total suspended solids
TVGC	Tumwater Valley Golf Course
UGA	urban growth area
UV	ultraviolet
WAS	waste activated sludge
WCGRF	Woodland Creek Groundwater Recharge Facility

Section 1

Introduction

The LOTT Clean Water Alliance (LOTT) is responsible for wastewater management services for the urban areas of Lacey, Olympia, and Tumwater in north Thurston County, Washington. The Budd Inlet Treatment Plant (BITP) is LOTT's most valuable capital asset and provides the bulk of wastewater treatment for the service population. Located in downtown Olympia, the BITP is a Type 2 Essential Public Facility (OMC18.04.060) providing wastewater treatment capacity and reclaimed water production for the LOTT service area.

As the result of a long-range planning process in the 1990s, LOTT adopted a "highly managed" approach to wastewater management. The highly managed approach features annual assessments of capacity, performance, and goal setting. These assessments have allowed LOTT to dynamically manage its capital program in response to changes in influent flows, loads, and regulatory requirements. The highly managed plan aimed to decentralize wastewater treatment with the construction of satellite water reclamation facilities. These facilities would treat wastewater to a high standard, Class A Reclaimed Water, which can be reused for beneficial purposes or recharged to groundwater. The first satellite reclaimed water plant—the Martin Way Reclaimed Water Plant (MWRWP)—was constructed in 2006 and has generated over 4 billion gallons of Class A reclaimed water since that time. LOTT reuses the water at the MWRWP and nearby pump station, in addition to recharging groundwater at its Hawks Prairie Recharge Basins (HPRB). The City of Lacey also recharges a portion of this water at the Woodland Creek Groundwater Recharge Facility (WCGRF) for water rights mitigation by the Cities of Olympia and Lacey.

In the same time period, LOTT began to produce reclaimed water at the BITP. The Budd Inlet Reclaimed Water Plant (BIRWP) began operation in 2004. This plant takes final effluent from the BITP and passes it through a filter, generating Class A reclaimed water. This reclaimed water is used for irrigation in downtown Olympia and at the Tumwater Valley Golf Course (TVGC), where a 1-million gallon storage tank was constructed to help manage flows.

In 2006, LOTT published the Budd Inlet Treatment Plant Master Plan. The purpose of the 2006 Master Plan was to recalibrate LOTT's long-range planning direction, given the recent completion of the MWRWP in Lacey and the BIRWP at the BITP. The 2006 Plan envisioned the construction of two additional satellite reclaimed water facilities as a way of reducing discharges to Budd Inlet, reducing the load to the BITP, and reducing flow through sections of the collection system.

Phase 1 of the current master planning effort updates the 2006 plan with respect to facilities at the BITP, and Phase 2 (this document) focuses on overall system capacity, including reclaimed water, satellite facilities, discharge, and end-uses.

Section 2

Background

This section includes details on LOTT's reclaimed water history, original plans, and adjustments over time.

2.1 History

The Highly Managed Plan, adopted in December 1998 and approved by the Department of Ecology in 1999, provided a roadmap for LOTT to manage a new mass-load-based National Pollutant Discharge Elimination System (NPDES) permit. The permit capped effluent discharge of biochemical oxygen demand (BOD), total suspended solids (TSS), and total inorganic nitrogen (TIN) at specific, seasonal masses.

To meet the effluent discharge limits, the BITP was upgraded in 1994 to a secondary nutrient removal facility. The four-stage Bardenpho process implemented at that time was a state-of-the-art secondary treatment process with nitrogen removal—the first treatment plant on Puget Sound and in Washington State to implement nitrogen removal capabilities. Since implementation, the BITP has consistently generated one of the highest-quality effluents of any plant in the state.

To accommodate future growth in the system, the Highly Managed Plan focused on alternative discharge through water recycling, reuse, and groundwater recharge. Class A reclaimed water, the standard for reuse applications such as irrigation and groundwater recharge, requires high removal of suspended solids, typically through a tertiary filter.

LOTT added a tertiary granular media filter (sand filter) to the BITP in 2004 to produce 1.5 million gallons per day (mgd) of Class A reclaimed water at the BIRWP. Initially, reclaimed water from the BIRWP was pumped to irrigate parks and streetscapes in downtown Olympia, East Bay Public Plaza, and for irrigation, process water, cleaning, and toilet flushing at the BITP.

Between 2009 and 2016, LOTT constructed a pipeline and a 1-million gallon reclaimed water storage tank in Tumwater. The storage tank serves the Tumwater Valley Municipal Golf Course, which uses up to 600,000 gallons a day for irrigation. The Reclaimed Water Storage Tank and the Deschutes Valley Park are co-located at the same site. The first phase of work involved building the storage tank and pump station and installing reclaimed water piping and some features of the future park and trailhead. The second phase of work involved completion of the neighborhood park, including restrooms and structures. The storage tank allows the City of Tumwater to distribute Class A reclaimed water to the golf course and other sites in the area.

The BIRWP produced approximately 206.4 million gallons of reclaimed water in 2019. The BIRWP is approaching a 20-year service milestone and is projected to have major renovations in 2025 and 2045.

The MWRWP, constructed in 2006, is a membrane bioreactor plant, which treats raw sewage generated in the City of Lacey and uses a membrane filter to remove solids and create Class A Reclaimed Water. The MWRWP is designed for incremental expansion as the community grows. As part of the initial construction, LOTT built a large wetland pond complex in the Hawks Prairie area of Lacey, as well as a groundwater recharge facility capable of infiltrating 5–8 mgd of reclaimed water into the groundwater.

The Woodland Creek Groundwater Recharge Facility (WCGRF) is jointly owned by Lacey and Olympia and is operated by Lacey. The two cities replenish groundwater at this site as part of their state-approved water rights mitigation plans. By augmenting groundwater in this location, the cities are granted rights to withdraw groundwater in other locations to serve their drinking water systems to support future development in each city.

In 2018, the MWRWP produced 460 million gallons of reclaimed water, of which 239 million gallons were diverted to the Hawks Prairie Ponds and Recharge Basins (HPRB), 111 million gallons to the WCGRF, and the remainder was used for internal processes at the Martin Way treatment plant and pump station.

The MWRWP has undergone a number of major upgrades since its construction. A membrane replacement project is scheduled to take place in the 2023 timeframe.

2.2 Adaptation Over Time

LOTT's Highly Managed Plan originally envisioned a system with the BIRWP and three satellite water reclamation plants. These plants would treat between 3–5 mgd and would effectively divert flows away from the BITP to ensure discharge from the BITP would be consistent with NPDES mass-based permit limits.

More recently, LOTT's approach has shifted away from a network of decentralized satellite water reclamation facilities for the following reasons:

- Wastewater flows have increased more slowly than expected. Flow availability at the MWRWP remains at 2 mgd, and availability at the sites proposed for the other two satellite plants has decreased. Proposed facilities in southeast Lacey and Tumwater would be limited to 2–3 mgd. This delays the timeframe for realizing system-wide capacity benefits and reduces the cost effectiveness of satellite facilities, which have a high up-front cost with economies of scale.
- Additional remote facilities create labor inefficiencies. While originally envisioned as a remote-operated facility, the MWRWP has required a large amount of operational and maintenance attention, with multiple staff frequently on site. Moving staff and equipment between the BITP and MWRWP is inefficient.
- Suitable recharge sites with more than 1-2 mgd of recharge capacity are challenging to find. The MWRWP was constructed with a high-capacity groundwater recharge facility nearby, but that model is unlikely to be repeated for other satellite facilities. Extensive analysis of sites near the proposed locations of future satellite facilities has failed to uncover sites with more than 1–2 mgd of recharge capacity.
- Space is available at the BITP. Phase 1 of the Budd Inlet Treatment Plant master planning effort determined that the BITP and adjacent parcels had sufficient space to expand capacity to meet its projected reclaimed water production needs without the need for satellite treatment facilities.

The approach has shifted to favor reclaimed water production at the two existing facilities—the MWRWP and BITP. LOTT has adequate space to expand the MWRWP to up to 8 mgd and the Hawks Prairie Ponds and Recharge Basins can accept 5-8 mgd for recharge. At the BITP, there is adequate space to greatly expand reclaimed water production, and a system of pumps and distribution piping could convey water to a network of groundwater recharge basins in Tumwater and Thurston County. An assessment completed in 2016 estimated $359M of costs to treat, convey, and discharge up to 20 mgd of flow (escalated to 2021 dollars).

Section 3

Boundary Conditions

This section summarizes the boundary conditions, which are internal and external factors influencing the LOTT master planning effort. Boundary conditions include regulations, stakeholder interests, treatment capacity at the BITP and MWRWP, capacity of the wastewater collection system, expected performance of the BITP treatment process, risk and reserve capacity, and quality objectives for various types of water reuse and recycling.

3.1 Regulatory Constraints

This section discusses current and future regulations.

3.1.1 NPDES Permit

The initial impetus for LOTT's reclaimed water program was the mass-based NPDES permit. The most recent permit was issued on February 16, 2018. Permit conditions are summarized in Table 3-1.

Table 3-1. Current NPDES Limitations at the BITP

	Summer (Jun–Sep)	Shoulder (Apr, May, Oct)	Winter (Nov–Mar)
BOD	7 mg/L 671 lb/d 85% removal	8 mg/L 900 lb/d 85% removal	30 mg/L 5,640 lb/d 85% removal
TSS	30 mg/L 5,265 lb/d 85% removal		
TIN	3 mg/L 288 lb/d	3 mg/L 338 lb/d	No limit
pH	6–9		
Fecal coliform bacteria	200/100 ml (monthly) 400/100 ml (weekly)		
Ammonia-N			26 mg/L (monthly) 36 mg/L (maximum day)
Additional Limits for Fiddlehead Outfall			
Ammonia-N			22 mg/L (monthly) 31 mg/L (maximum day)
Total recoverable copper	6 μg/L (monthly) 7.5 μg/L (maximum day)		

Limits are monthly averages unless stated otherwise

μg/L = micrograms per liter

mg/L = milligrams per liter

ml = milliliter

The permit specifies seasonal mass-based limits for BOD, TSS, and TIN, along with more conventional concentration-based limits and removal requirements. The mass-based limits impact the quantity of flow that may be discharged at the BITP's effluent outfall into Budd Inlet. Figure 3-1 expresses this relationship as it pertains to TIN during the summer season.

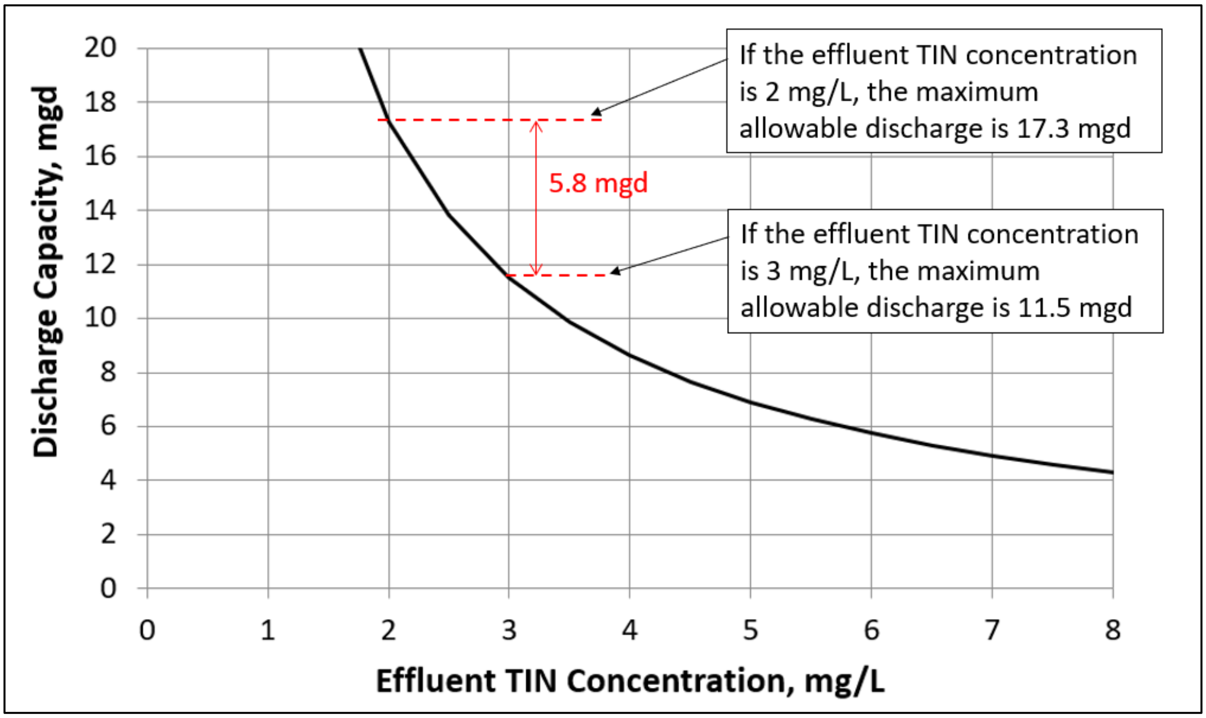


Figure 3-1. Relationship between effluent discharge quantity and concentration given a mass-based limit

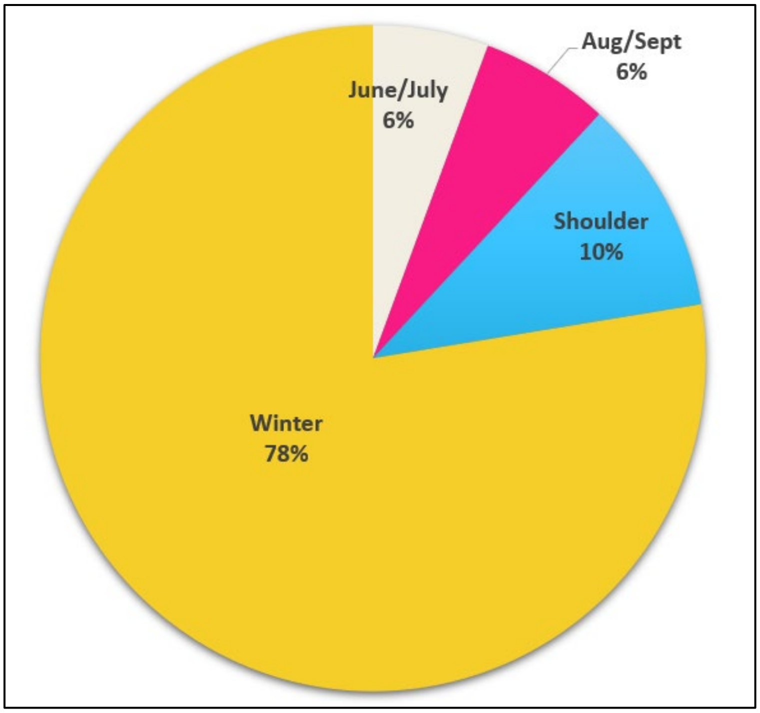
The amount of flow that can be discharged decreases as the effluent concentration increases. With an effluent TIN of 3 milligrams per liter (mg/L), the BITP can discharge 11.5 mgd to Budd Inlet. If performance could be improved to 2 mg/L, the discharge capacity would increase to 17.3 mgd. The 1 mg/L gain in performance would equate to 5.8 mgd of additional discharge capacity.

At current flows (10 mgd or less during the summer), the concentration limit of 3 mg/L is more restrictive than the mass limit. Once summer flows reach 11.5 mgd, the mass limit will become more restrictive. For context, the design criteria for a typical four-stage Bardenpho plant would be a TIN of approximately 3 mg/L.

3.1.2 Puget Sound Nutrient General Permit

The Department of Ecology (Ecology) is currently instituting regulations on nitrogen discharge for treatment plants discharging to Puget Sound. The first stage of this process is the implementation of a general permit, which includes mass-based nitrogen limits. The limits are being applied as annual load limits, so they differ from the seasonal limits present in the NPDES permit.

An annual load limit mostly impacts LOTT's winter discharge. Currently, 78 percent of the nitrogen discharge from the BITP occurs during the winter (Figure 3-2). Summer and shoulder season discharges are low because the BITP actively removes nitrogen during those seasons in order to comply with its NPDES permit.



Shoulder = April, May, October; Winter = November–March

Figure 3-2. Share of annual nitrogen discharge from the BITP

The latest draft of the general permit, issued on December 1, 2021, anticipates an action level of 338,000 pounds per year of TIN for the BITP. The BITP currently averages an annual discharge of 160,400 lb/year.

Although still in discussion, the Department of Ecology has suggested that numerical discharge limits may follow in the future. Values which have been discussed are year-round limits of 3 mg/L and 8 mg/L as TIN.

3.1.3 Capitol Lake / Budd Inlet TMDL

Ecology has been developing a total maximum daily load (TMDL) regulation for Capitol Lake and Budd Inlet. As part of that process, Ecology has indicated that it may reduce the allowable BOD and TIN mass discharge limits in the BITP NPDES permit, as well as add new limits for total nitrogen (TN) and total organic carbon (TOC). Table 3-2 compares the proposed limits to the existing limits.

Table 3-2. Proposed limits associated with Capitol Lake and Budd Inlet TMDL (lb/d)

	Existing Limits		Proposed Limits (changes indicated in red)			
Month	BOD	TIN	BOD	TIN	TOC	TN
January	5,640	None	5,639	1,984	6,054	2,529
February	5,640	None	5,639	1,446	6,054	1,920
March	5,640	None	5,639	661	6,054	1,049
April	900	338	899	337	1,285	683
May	900	338	899	337	1,285	683
June	671	288	670	289	1,056	628
July	671	288	670	289	1,056	628
August	671	288	470	249	853	584
September	671	288	470	249	853	584
October	900	338	899	337	1,285	683
November	5640	None	5639	1874	6054	2405
December	5640	None	5639	2094	6054	2652

The most significant changes are the reductions to BOD and TIN discharge during the August and September period. Figure 3-3 shows how this change would affect TIN discharge.

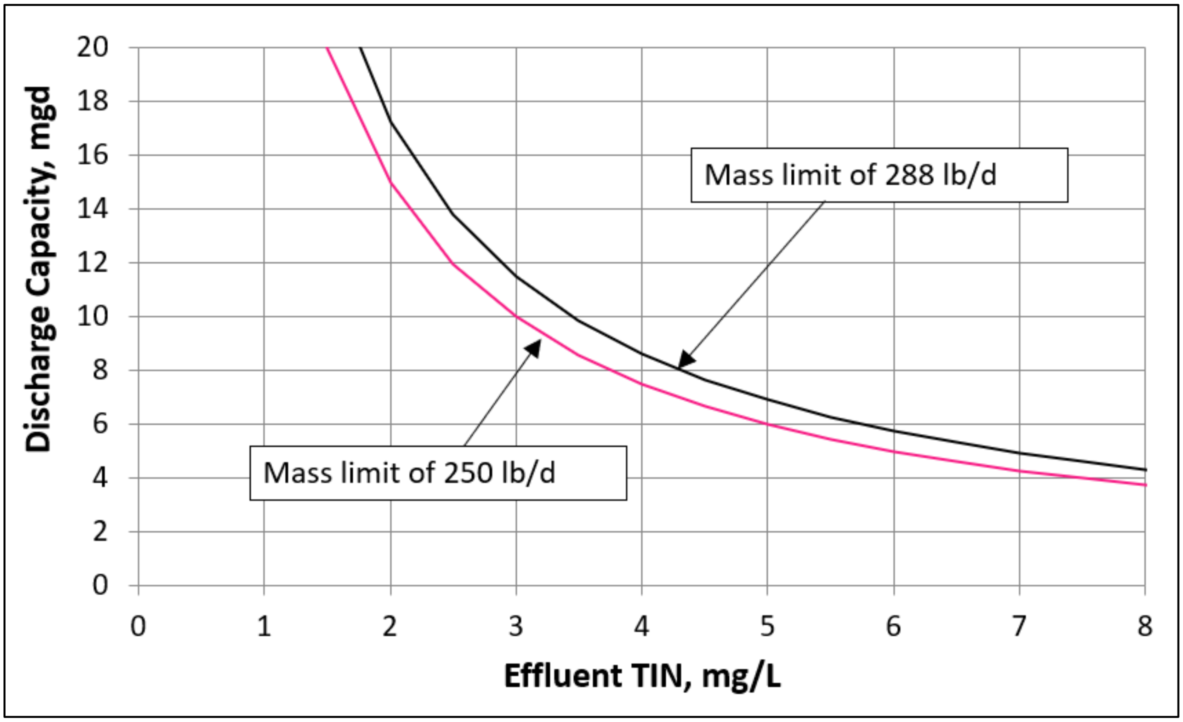


Figure 3-3. Effect of NPDES permit change on summer TIN discharge

The new TIN limit effectively reduces the volume of effluent discharge by 1–2 mgd, depending on the concentration. The BOD revision is even larger, and therefore the volume reduction is also larger, and averages 3–4 mgd.

The winter season TIN limits will require LOTT to monitor nitrogen levels more closely and may require year-round application of methanol to maintain a healthy methalotrophic community. Effectively, the winter season mass limits would require effluent TIN to be maintained below 12-13 mg/L from November through January, with a reduction to 7-8 mg/L in February, and 3-4 mg/L in March.

Total nitrogen is the sum of the TIN and organic nitrogen. Organic nitrogen, which may be present in both dissolved and particulate form, is typically observed at concentrations of 1-3 mg/L. During an August 2021 wastewater characterization at the BITP, the final effluent organic nitrogen averaged 1.4 mg/L, with a range from 0.9 to 2.1 mg/L. The proposed TN limits are 335 to 558 lb/d higher than the proposed TIN limits, meaning that as long as the TIN limits are being met, the plant should be able to discharge 2-3 mg/L of organic nitrogen in most conditions.

TOC is the sum of the BOD plus biologically undegradable carbon, plus carbon which is not capable of being oxidized. TOC and BOD have different units of measure—TOC being an absolute measure of carbon as CO_2, while BOD is a measure of oxygen demand. The proposed TOC limits are based on a regression analysis. Relatively few plants nationwide are regulated for TOC, and correlations between TOC and BOD may differ greatly between plants. Correlations have also been observed to change. A TOC regulation would require active monitoring, and BITP staff would need to treat it as a separate compliance parameter (in other words, BOD compliance alone may not guarantee TOC compliance).

The proposed TMDL-based winter limits for TIN are assumed not to be as restrictive as the summer and shoulder season limits and will only be considered briefly in the subsequent analysis. Likewise, the proposed TMDL-based limits for TN and TOC are only discussed in the context of a sensitivity analysis.

For the purpose of this Plan, the proposed TMDL-based limits for BOD and TIN are assumed to be in place in the August and September season, and all subsequent tables, figures, and calculations incorporate these limits.

3.2 BITP Treatment Performance

The current and expected performance of the BITP provides context for the regulatory limits introduced in Section 3.1.

3.2.1 TSS

The TSS limits in the NPDES permit are applied year-round. The load-based monthly average discharge limit of 5,265 lb/d is most restrictive during the winter when the BITP treats the highest flows. Applied at the monthly average permit concentration limit of 30 mg/L, the mass-based limit would cap discharge at 21 mgd.

Over the past five years, the effluent TSS has averaged 8.2 mg/L (monthly average basis), with a 90th percentile value of 14.2 mg/L. Figure 3-4 presents monthly effluent TSS concentrations for the past 22 winter season months.

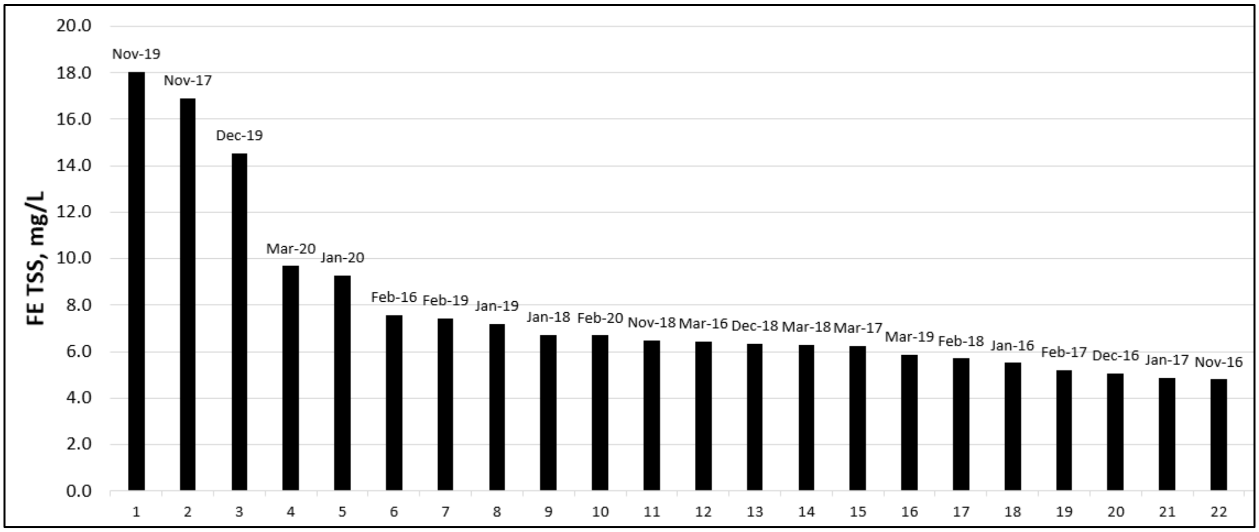


Figure 3-4. Monthly average effluent TSS concentration, winter

Based on past performance, the BITP should be able to maintain an effluent TSS less than 10 mg/L most of the time, with occasional excursions in the 15–20 mg/L range. It would be unusual to experience an effluent TSS concentration higher than 20 mg/L.

3.2.2 BOD

The BITP has an excellent performance record with respect to BOD. The average monthly concentration in the summer is 4.2 mg/L, and in the shoulder season is 4.9 mg/L. 90th percentile values in the two seasons are 6.4 mg/L and 7.5 mg/L, respectively.

The winter season BOD is slightly higher, averaging 7.0 mg/L, with a 90th percentile value of 10.3 mg/L. Standard design of a secondary treatment plant would aim for an effluent BOD between 10-20 mg/L.

Figure 3-5 plots the past 20 months of summer effluent BOD concentrations. Concentrations are typically lower than 7 mg/L, with the exception of a single month in July 2019 with a concentration of 8.6 mg/L. The relatively high concentrations in June through August 2019 are related to testing of an alternative disinfection system, which resulted in the growth of biofilm in the effluent piping and sampler.

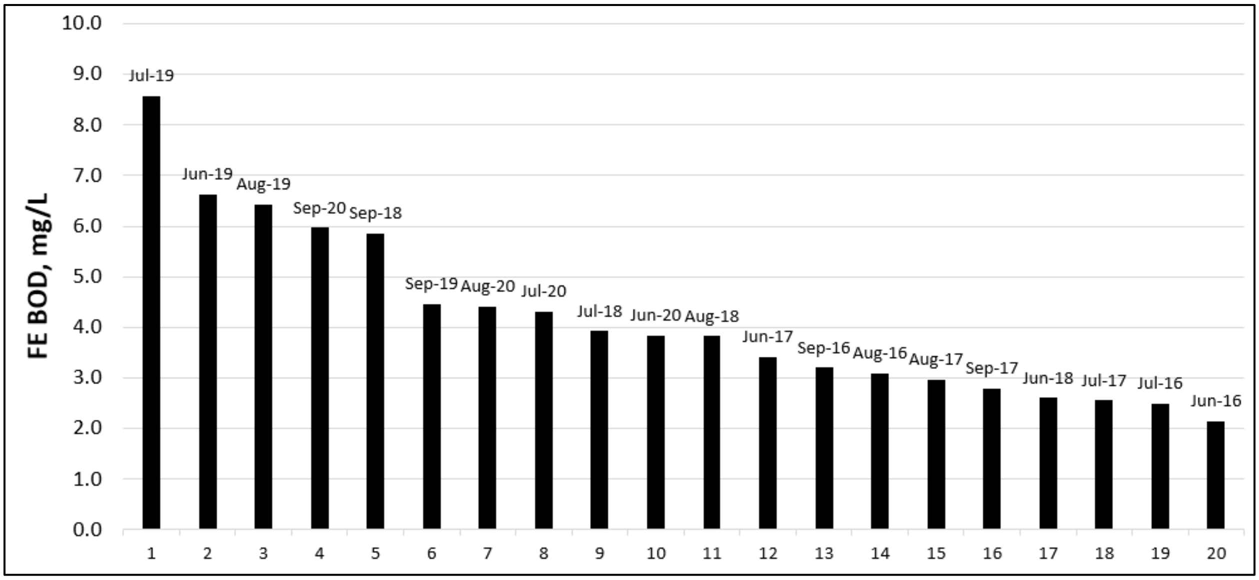


Figure 3-5. Monthly average effluent BOD concentration, summer

Figure 3-6 presents a similar plot for the past 15 shoulder season months. In this case, a typical year might see one month in the 7–8 mg/L range, with the highest concentration recorded at 8.8 mg/L in 2017.

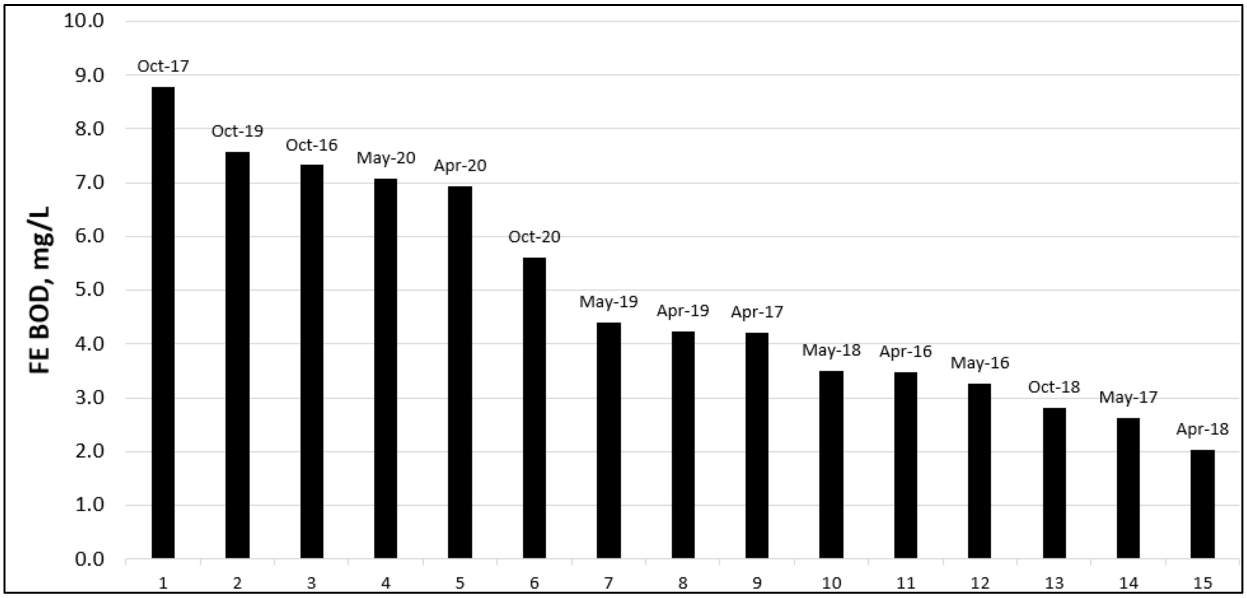


Figure 3-6. Monthly average effluent BOD concentration, shoulder

3.2.3 TIN

Similar to BOD, the TIN regulation is seasonal, with lower concentrations required in the summer and shoulder seasons. The average monthly concentration in the summer is 2.3 mg/L, and in the shoulder season is 2.2 mg/L. 90th percentile values in the two seasons are both 2.7 mg/L. This represents an excellent level of performance for a nitrogen removal plant, where a TIN concentration of 3 mg/L would be considered a typical design criterion.

TIN discharge is not regulated in the winter when the BITP effluent averages 8.1 mg/L.

Figure 3-7 shows the last 20 summer months of TIN performance. Effluent TIN exceeds 2.5 mg/L on a monthly average basis about one month per year. The highest value in the past 5 years was a single month at 3.6 mg/L in September 2019.

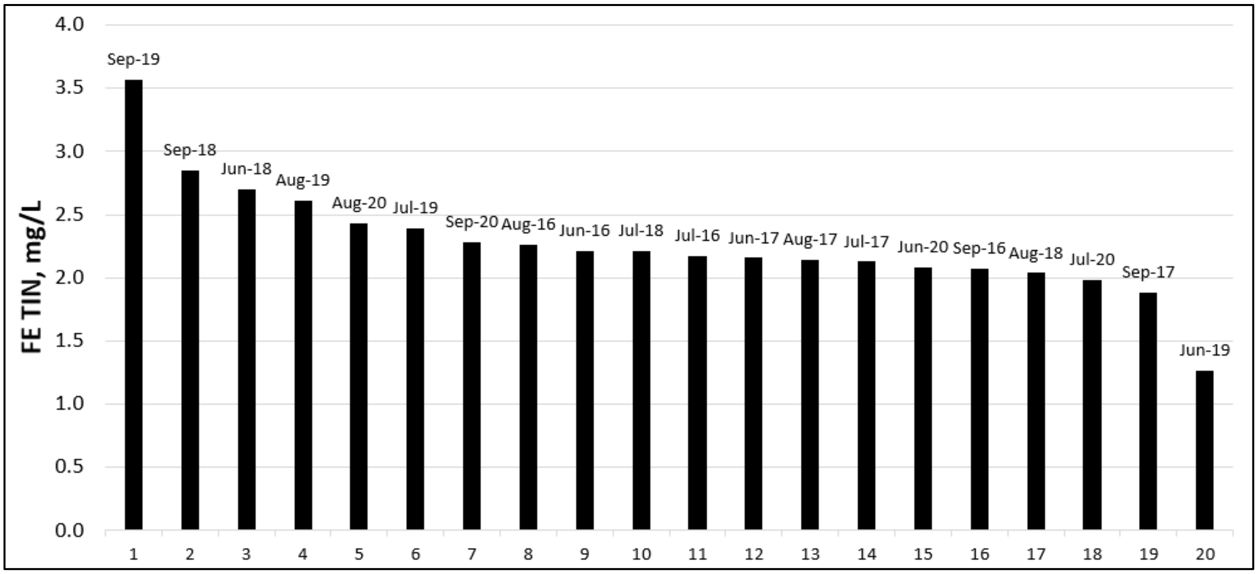


Figure 3-7. Monthly average effluent TIN concentration, summer

The past 15 months of shoulder season effluent TIN concentrations are presented on Figure 3-8. While monthly concentrations periodically exceed 2.5 mg/L, the highest monthly average concentration in the past 5 years was 3.0 mg/L in October 2017.

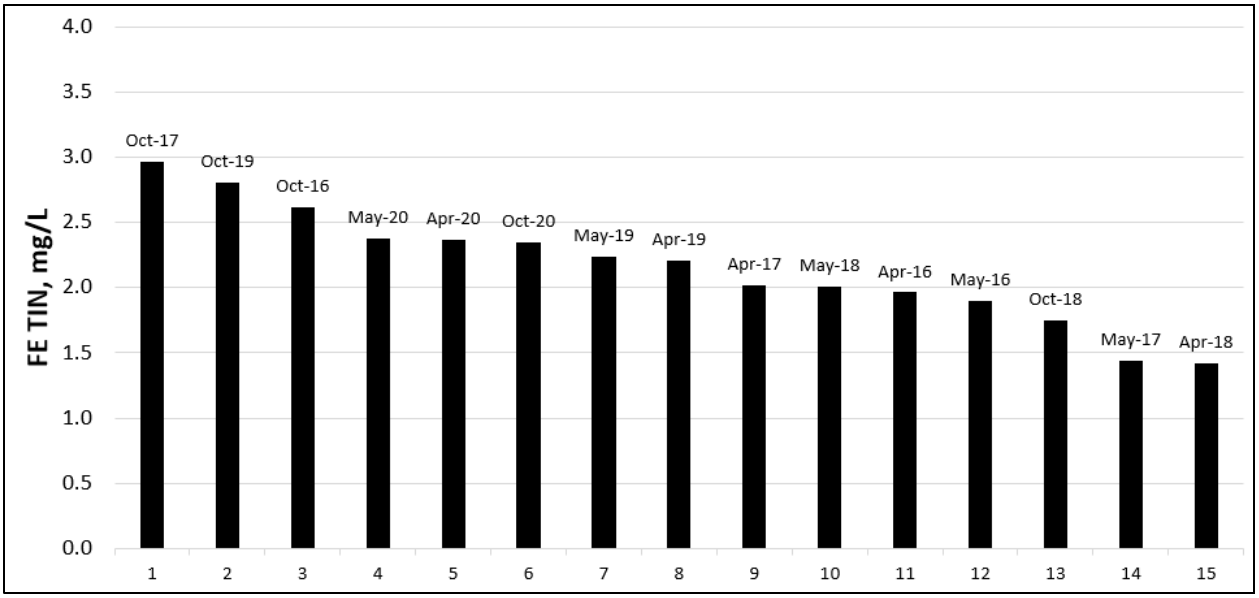


Figure 3-8. Monthly average effluent TIN concentration, shoulder

3.2.4 Performance Summary

Table 3-2 summarizes the performance of the existing system, showing the average, 90th percentile, and maximum monthly concentrations for each constituent during each seasonal condition. The table also shows concentrations measured in 2021, when staff were aiming to reduce concentrations as low as possible.

Table 3-2. Monthly Effluent Concentrations (mg/L), 2016–2020

Constituent	Average	90th Percentile	Maximum	2021 Average [a]
Summer				
TSS	6.6	10.1	14.2	8.7
BOD	4.2	6.4	8.6	4.1
TIN	2.3	2.7	3.6	2.1
Shoulder				
TSS	7.2	13.7	15.5	8.0
BOD	4.9	7.5	8.8	4.6
TIN	2.2	2.7	3.0	2.1
Winter				
TSS	8.2	14.2	18.0	10.9
BOD	7.0	10.3	19.9	5.8
TIN	8.1	14.5	26.0	5.3

[a] *Based on data through October 21, 2021. Winter data represents period from November 2020 through March 2021.*

The 90th percentile performance values mean that performance at this concentration would be expected to occur once every 10 months. Depending on the season, this translates to a recurrence interval of 2–5 years. The 2021 values show some reductions in BOD and TIN concentrations during the summer and shoulder periods. Notably, the BOD and TIN concentrations averaged 3.6 mg/L and 1.4 mg/L in August 2021, respectively.

Table 3-3 translates the concentrations in Table 3-2 into allowable discharge, given the existing and upcoming regulations.

Table 3-3. Maximum Allowable Discharge Flow (mgd), Given the Concentrations Presented in Table 3-2

Constituent	Mass Limit (lb/d)	Average Performance (2016–2020)	90th Percentile Performance (2016–2020)	At Maximum Observed Concentration (2016–2020)	Average Performance (2021) [a]
Aug/Sept					
TSS	5,265	96.1	62.5	44.4	72.3
BOD	470	13.5	8.7	6.6	13.6
TIN	250	13.2	11.0	8.4	14.3
June/July					
TSS	5,265	96.1	62.5	44.4	72.3
BOD	671	19.3	12.5	9.4	19.4
TIN	288	15.2	12.7	9.7	16.4
Shoulder					
TSS	5,265	87.3	45.9	40.7	78.5
BOD	900	21.9	14.4	12.3	23.6
TIN	388	21.5	17.0	15.7	18.9
Winter					
TSS	5,265	76.6	44.5	35.0	58.0
BOD	5,640	96.2	65.6	34.0	117.0
TIN	N/A	N/A	N/A	N/A	N/A

[a] *Based on data through October 21, 2021. Winter data represents period from November 2020 through March 2021.*

Using the 90th percentile performance values as a benchmark, discharge capacity would be limited to 8.7 mgd in August and September; 12.5 mgd in June and July, and 14.4 mgd in the shoulder season. With summer flow averaging 9-10 mgd, and shoulder flows reaching as high as 14-15 mgd, this would suggest that the BITP is currently at risk of violating its mass-based permit at a frequency of at least once every 10 years (particularly with the revised, TMDL-based limits in place).

However, if performance could be maintained at 2021 levels, without excursions, discharge capacity would be much higher. August/September capacity would be 13.6 mgd; June/July capacity would be 16.4 mgd; and shoulder season capacity would be 18.9 mgd. The BITP would still have a cushion of several mgd before capacity would become an issue.

3.2.5 Performance improvement

Two factors which may influence future performance are the effects of new regulations (the revised NPDES permit and the Puget Sound Nutrient General Permit) on operational strategies, and the completion of a major secondary process upgrade currently under construction (Biological Process Improvements project).

The performance summarized in Table 3-2 is based upon maintaining effluent loadings below those in the current NPDES permit. When the TMDL-based limits are applied, one would expect operations to change accordingly. Operational modifications to reduce effluent TIN and BOD could include tighter control of methanol dosing, modifications to dissolved oxygen setpoints in the final aeration stage, and adjustments to the internal mixed liquor recycle flow rate. The General Permit, if applied as an annual limit, could impact the way the BITP is operated in the winter, with more focus on reducing nitrogen discharge.

The Biological Process Improvements project is an upgrade to the existing four-stage Bardenpho system, which includes a revised anoxic/aerobic ratio, upgraded aeration and mixing, and improved flow control. These modifications should allow for more efficient operation, with improved average TIN performance linked to improved control and instrumentation and improved average BOD performance linked to improved aeration and impacts to mixed liquor settleability.

In the long term, one factor which may influence performance in the opposite direction are the impacts of increased flows and loads to the BITP. Increased flows and loads can limit the flexibility of the process and tend to result in a gradual decline in performance as systems throughout the plant approach their capacity limits.

3.3 Flow and Loading Projections

Base and dry weather flows and loads in the LOTT service area are expected to increase by up to 50 percent by 2050 and by approximately 100 percent with full connection of the service area. As flows increase, compliance with the mass-based permit limits will become increasingly difficult without related process expansion or other measures. The following figures show the system-wide flow projections, superimposed with the discharge capacities developed in Table 3-3. In this report, maximum month flows are defined on the basis of a 10-year return frequency, so the maximum month flow would be the 10-year-peak month flow.

3.3.1 August/September

Figure 3-9 presents the August/September condition. During this season, average flows are projected to increase from 11.2 mgd to 16.8 mgd by 2050, with another 5.7 mgd worth of flow potential with full connection and conversion of all septic tanks in the service area. Maximum month flows during the summer typically average 2 mgd higher than average flows.

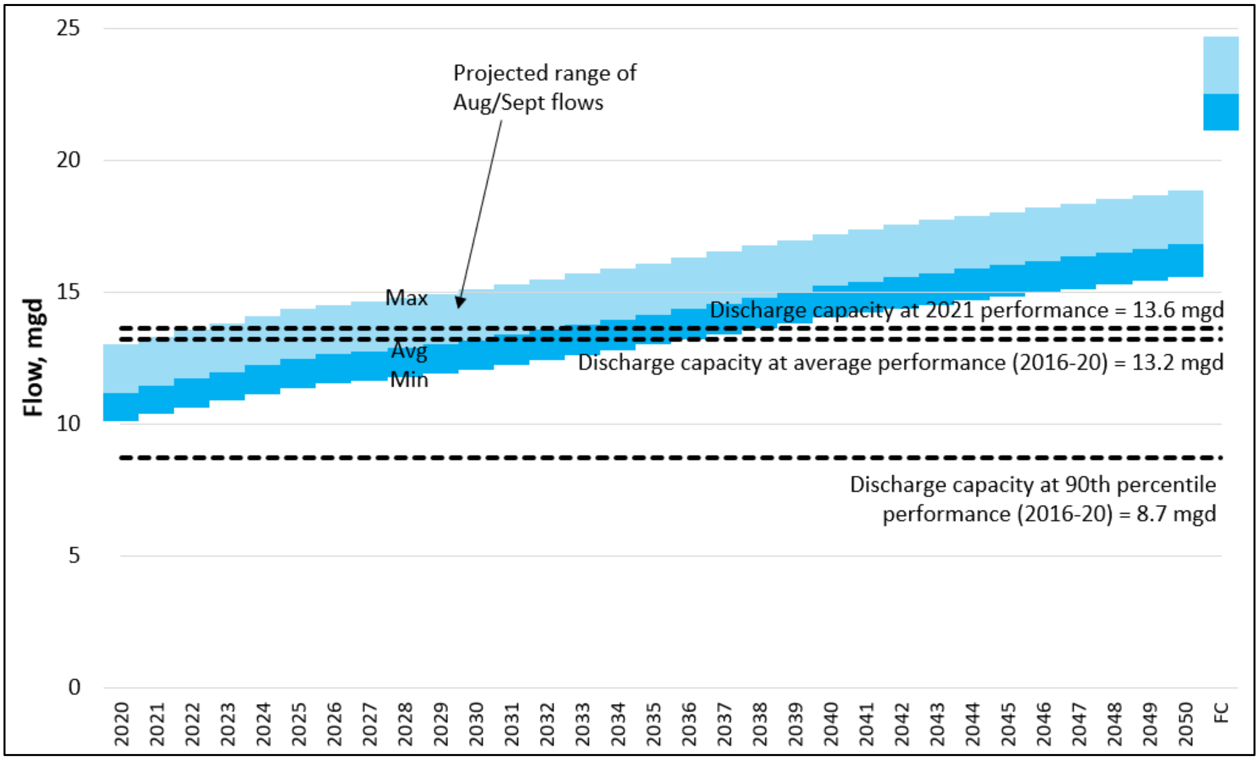


Figure 3-9. System-wide flow projection, August/September, with BITP discharge capacity based on average and 90th percentile performance (2016–2020).

As discussed above, capacity is highly dependent upon performance. There is a spread of 4.9 mgd between capacity at the 90th percentile performance (8.7 mgd) and capacity given the performance recorded in the summer of 2021 (13.6 mgd). Summer season flow currently falls right within that range.

By 2050, there would be a capacity deficit, regardless of which performance assumption is applied, and the deficit would apply regardless of whether it is a high flow or low flow month. Under the most conservative set of assumptions, the capacity deficit in 2050 would be 10.1 mgd, increasing to 16.0 by full connection.

For context, LOTT does not currently discharge all of its flow to Budd Inlet. Currently, 1.4 mgd of flow is treated at MWRWP and applied for beneficial uses; and 0.7 mgd of flow from the BIRWP is applied for beneficial uses during the August/September season. These flows reduce the discharge capacity deficit. This calculation is discussed more in Section 5.1.

3.3.2 June/July

June and July projections are similar to August and September, but the regulations are less strict (Figure 3-10).

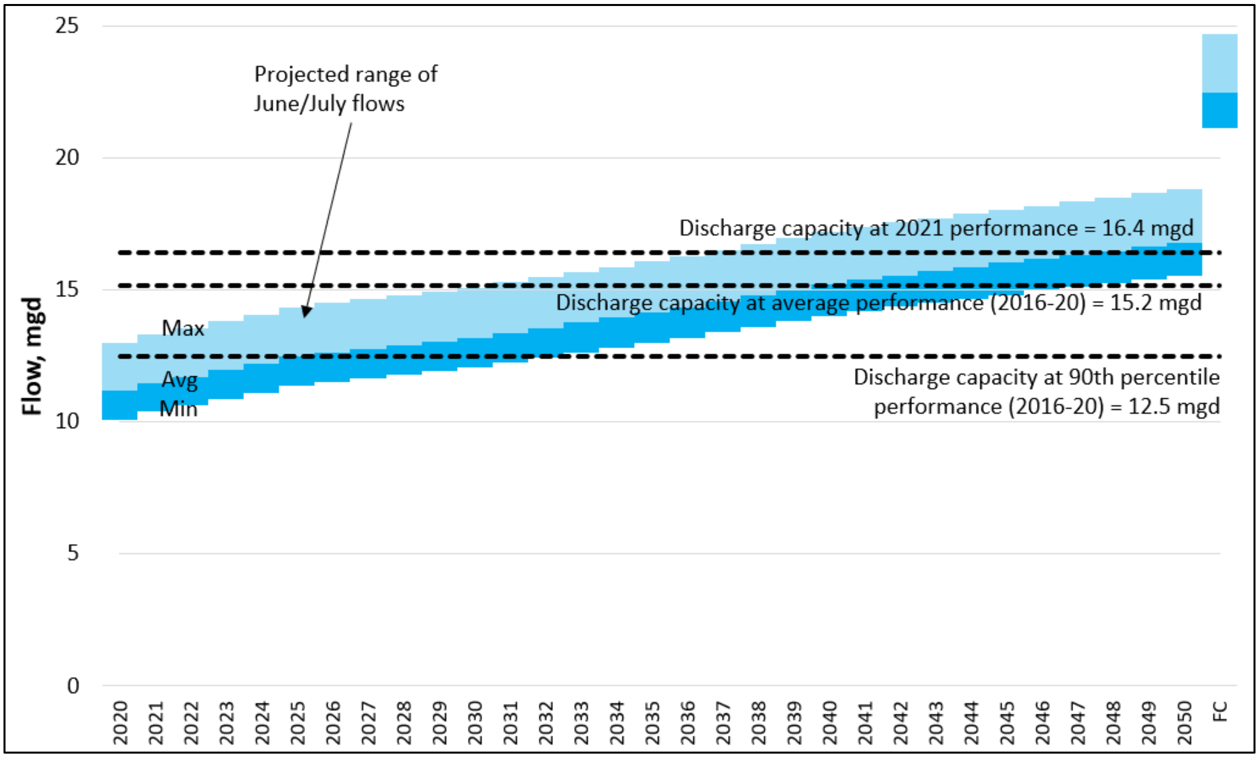


Figure 3-10. System-wide flow projection, June/July, with BITP discharge capacity based on average and 90th percentile performance (2016–2020).

In this case, the current condition is not nearly as limited, the discharge capacity even at the 90th percentile performance is sufficient for most current flows. By 2050, the system would be limited, although not nearly to the degree of the August/September limitation.

3.3.3 Shoulder

The shoulder season has higher limits than summer, but flows are also higher. The system is also more susceptible to peak flows, which can be 4 mgd higher than average flows. Figure 3-11 shows the shoulder projections, along with capacity based on current performance.

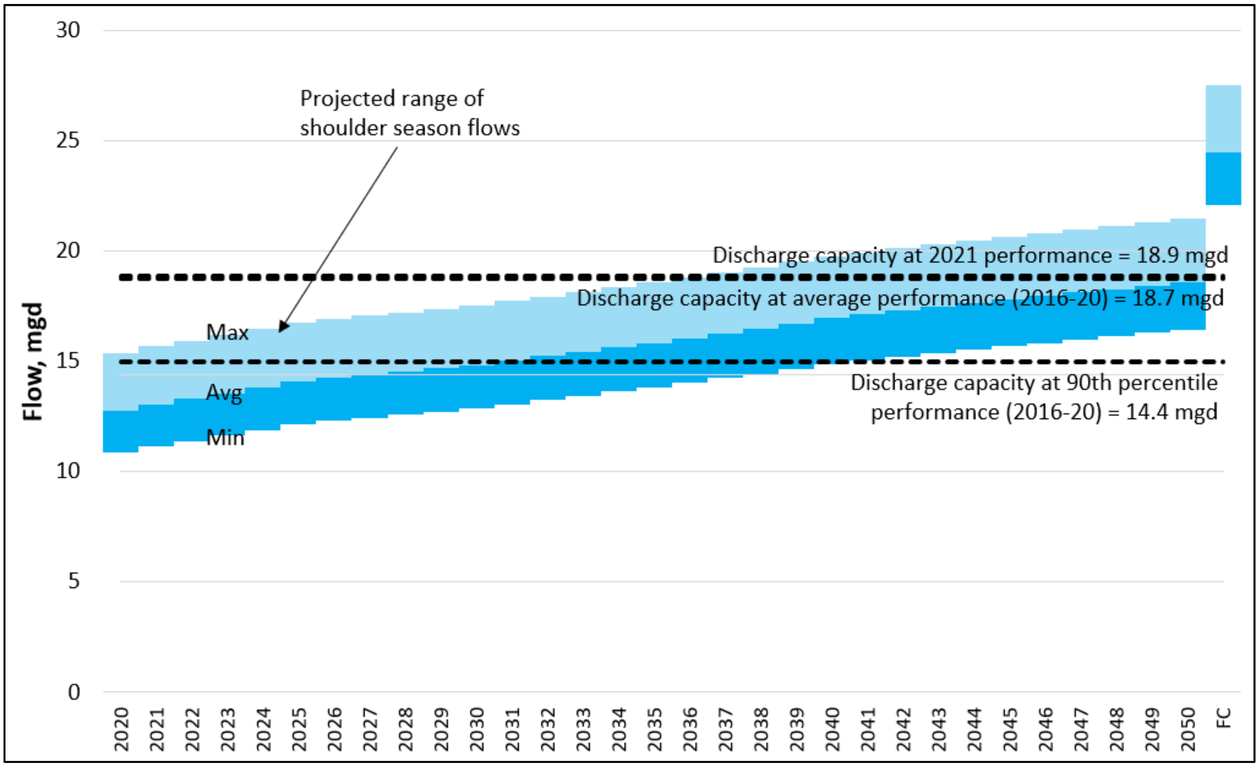


Figure 3-11. System-wide flow projection, shoulder season, with BITP discharge capacity based on average and 90th percentile performance (2016–2020).

In the near-term, the shoulder season regulations are not very limiting. However, there is a much larger spread based on the definition of risk. The shoulder season is typically characterized by good performance with less restrictive limits, but the potential for both high flows and upset conditions is higher.

By 2050, the shoulder season could see capacity deficits of up to 7.0 mgd, depending on the level of performance.

3.3.4 Winter

The winter season is not projected to become capacity-limited for either BOD or TSS removal. Table 3-3 projects the discharge capacity to be up to 80.3 mgd (average) or 44.9 mgd (conservative). The 10-year-peak month flow projections for the system are 26.6 (2050) and 33.1 (full connection).

The TDML-proposed winter limits will require the plant to actively manage nitrogen discharge throughout the winter. However, those limits are less restrictive than the summer and shoulder limits and are not expected to change the overall BITP capacity picture.

The Puget Sound Nutrient General Permit may require year-round nitrogen removal as well. Current action levels would not require a change to BITP operation. Future numerical limits would need to be evaluated against the proposed TMDL-proposed limits.

3.3.5 Summary of Projected Conditions

Table 3-4 summarizes the projected capacity condition at 10-year increments.

Table 3-4. Projected Capacity Deficit Based on Mass-Based NPDES Permit and Maximum Month Flow [a]

Year	2021 average performance [b]	Average performance (2016-2020) [b]	90th Percentile performance (2016-2020) [b]
Current	0.0	0.0	4.3
2030	1.5	1.9	6.3
2040	3.6	4.0	8.5
2050	5.2	5.6	10.1
Full connection	11.1	11.5	16.0

[a] *This table presents the highest deficit for any of the seasonal conditions.*

[b] *All conditions are expressed in terms of the maximum month flow for each seasonal condition.*

Currently, a combination of a peak flow event and 90th percentile treatment performance would lead to capacity deficit of 4.3 mgd at the BITP. This deficit is partially mitigated by the 2.1 mgd of alternative discharge currently in place in the form of groundwater recharge and other beneficial uses for reclaimed water generated at the BIRWP and MWRWP.

In the future, the discharge capacity deficit is projected to increase to 10.1 mgd (2050) and 16.0 mgd (full connection).

If performance could be maintained, consistently, as observed during the summer of 2021, the capacity deficits would not appear until 2030, and future limits would reduce to 5.2 mgd (2050) and 11.1 mgd (full connection).

3.3.6 Planning Contingency

LOTT has historically set aside 1.5 mgd as a factor of safety in its planning. Instead of planning to meet projected limitations (for example, providing up to 10.1 mgd of alternative discharge by 2050), LOTT has planned to provide an additional 1.5 mgd. Theoretically, this safety factor has several functions:

- Protection against process upsets
- Protection against unusually high flow events
- Time for planning and budgeting to react to changes in baseline assumptions
- System redundancy

The 1.5 mgd equates to approximately 7–8 years in terms of flow projections. This period is approximately the time it would take a new project to be planned, budgeted, designed, and constructed.

As protection against upsets, the reserve capacity is only somewhat helpful. In the case of a process upset, the plant would be just as likely to violate the concentration-based limits in its permit as it would be to violate the mass-based limits. The safety factor would offer little protection against a concentration-based limit exceedance.

With respect to high flow events, 1.5 mgd would offer a lot of protection. During the summer, 1.5 mgd represents the difference between a 10-year return flow and a 75-year return flow. During the shoulder season, it represents the difference between a 10-year return flow and a 50-year return flow.

System redundancy refers to the ability to take systems out of service for maintenance, repairs, and upgrades and have enough reserve capacity to manage the temporary outage. In the context of a reclaimed water plan, the systems in question are facilities-- specifically the MWRWP. Flow treated at the MWRWP does not need to be treated (and discharged) at the BITP. Since its construction, the MWRWP has been treated as a fully redundant facility, meaning that the entire facility could be taken out of service, periodically, for repairs and upgrades. As flows throughout the system increase, this policy will become decreasingly feasible, due to limitations in the mass discharge at the BITP.

The LOTT 2021 Capacity Report recommended that the MWRWP be treated as having 1 mgd of redundancy. Upgrades and future work at the MWRWP should be done under the assumption that no more than 1 mgd of MWRWP capacity be taken out of service at any time. To accommodate this policy, LOTT will need to reserve at least 1 mgd of capacity elsewhere in its system. The 1.5 mgd contingency would cover this need.

In summary, LOTT will continue to plan to maintain a planning contingency of 1.5 mgd in its system.

3.4 Reclaimed Water Demand

Since the implementation of the Highly Managed Plan, LOTT has utilized a combination of groundwater recharge and beneficial end uses of reclaimed water to make the most of its discharge capacity. This section discusses current and future reclaimed water demands.

3.4.1 Stakeholder Interests

Key stakeholders with interests in LOTT's reclaimed water include the LOTT partners (the cities of Lacey, Olympia, and Tumwater and Thurston County). The Squaxin Island Tribe and the Washington Department of Fish and Wildlife have also expressed interest in reclaimed water.

LOTT's reclaimed water program was structured such that LOTT's reclaimed water needs are prioritized, followed by LOTT partners, whose access to the resource is roughly proportional to their respective contribution of flow to the system. The LOTT partners are primarily interested in water rights mitigation, irrigation, and industrial uses. Water right mitigation is a priority, as each of the partner cities have existing or planned municipal water rights that require mitigation to offset impacts of groundwater withdrawals. Potential impacts may be effectively mitigated by groundwater recharge.

The Woodland Creek Groundwater Recharge Facility (WCGRF) is an example of this stipulation. The cities of Olympia and Lacey obtained close to 30 mgd of water rights. Hydrogeologic modeling suggested that those rights could be effectively mitigated through up to 1.3 mgd of groundwater recharge at the WCGRF. The recharged flow ends up augmenting Woodland Creek, offsetting the impacts of groundwater withdrawals elsewhere.

Both the Cities of Lacey and Olympia intend to build upon the mitigation at the WCGRF, and the City of Tumwater has expressed interest in mitigating a pair of potential well fields. Mitigation for Tumwater would most likely be linked to the Deschutes River.

LOTT reclaimed water is already being used for irrigation, and the cities expect to expand that in the future. Industrial end uses have also been discussed.

Thurston County has also expressed interest in water rights mitigation to offset impacts from permit-exempt wells through a Watershed Restoration and Enhancement Plan required by the state-level streamflow restoration law (RCW 90.94).

The Squaxin Island Tribe has expressed interest in flow augmentation in the Deschutes River. Reclaimed water could provide this benefit. However, the benefit would be proportional to how far upriver the water could be applied, and the farther upriver the augmentation, the more it would cost to convey the flow.

The Washington Department of Fish and Wildlife has previously expressed interest in using LOTT reclaimed water for fish hatcheries along the Deschutes River.

3.4.2 Current Demands

Current uses of LOTT reclaimed water are summarized in Figure 3-12. These demands include LOTT uses, irrigation (which includes water feature and educational uses at the Hands On Children's Museum), and water rights mitigation.

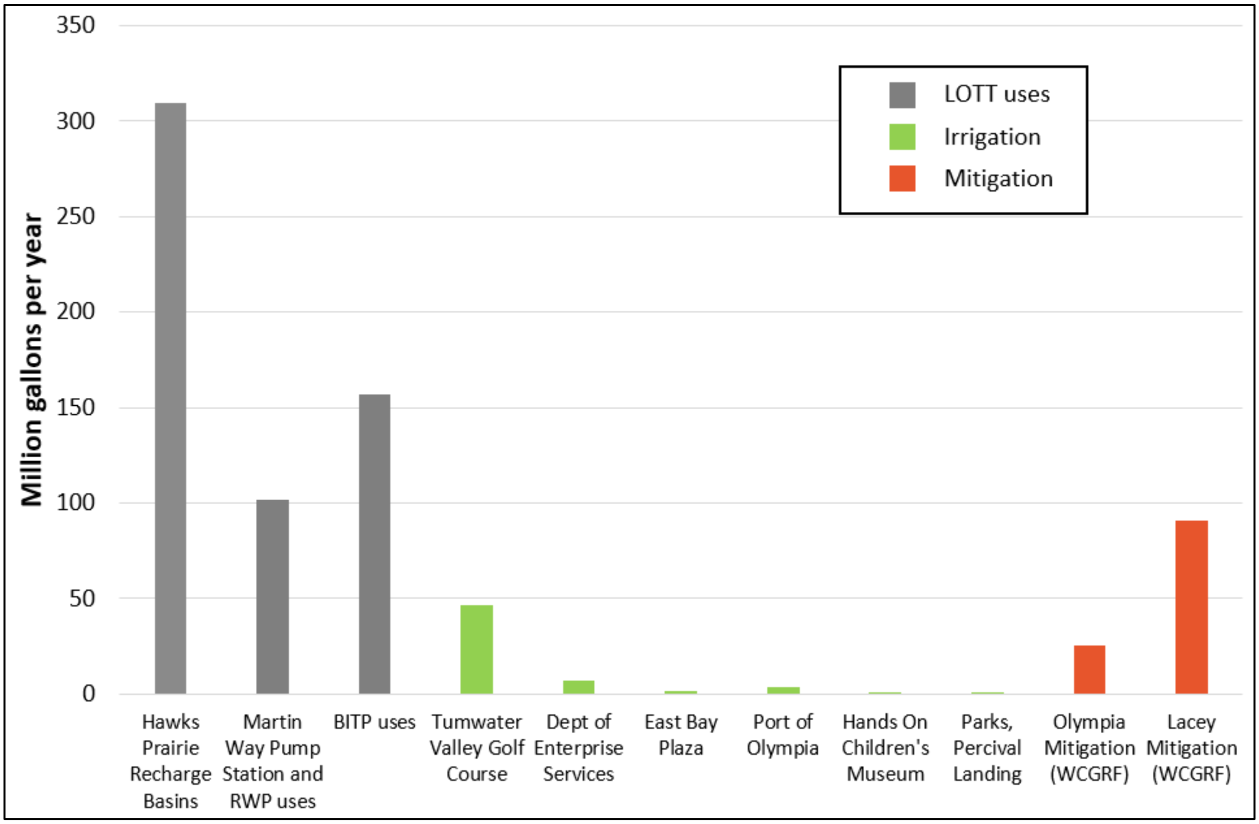
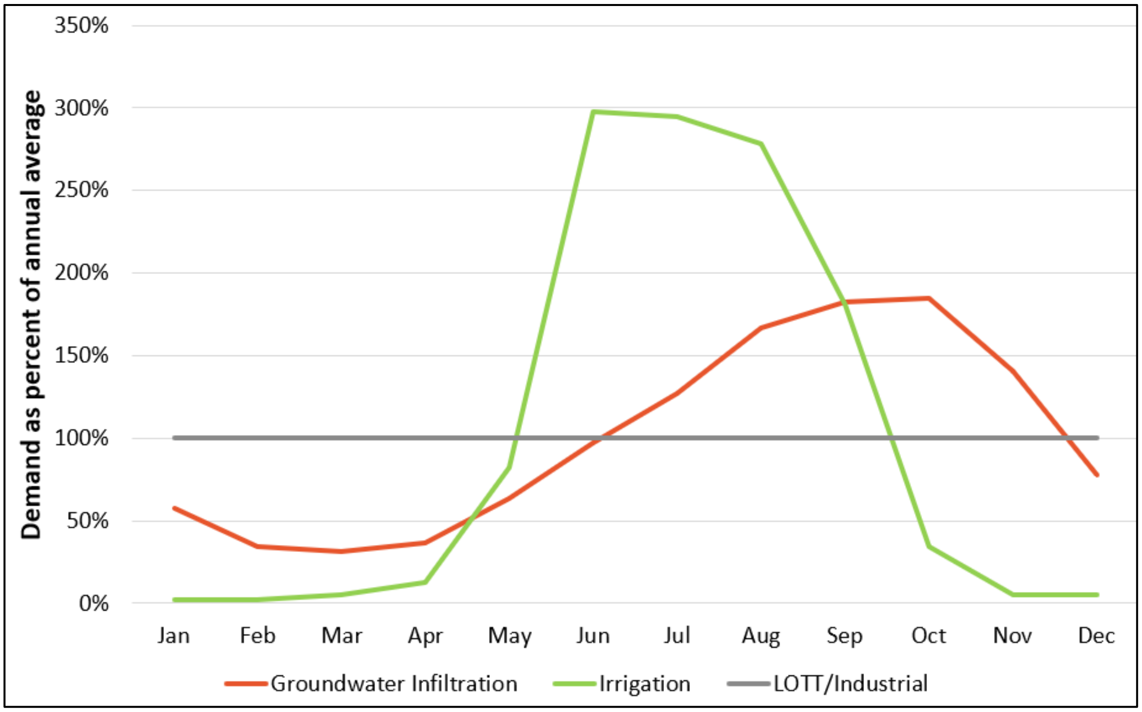


Figure 3-12. Current uses of LOTT reclaimed water

Currently, approximately 129 million gallons per year are sent to the WCGRF for recharge to meet the cities' mitigation goals. The total varies year to year based on MWRWP production, LOTT demands, and groundwater levels at the WCGRF.

The seasonal use pattern varies by the type of demand. LOTT and industrial uses are relatively constant year-round. Irrigation is almost exclusive to the spring and summer period (May through October). Mitigation demand is low in the wet season, and highest in late summer / early fall. Assumed seasonal use patterns are summarized in Figure 3-13.



Infiltration use pattern is based on actual use at the WCGRF, 2020-21

Irrigation pattern is based on City of Lacey irrigation flow records for 2017-2019

Figure 3-13. Seasonal patterns of reclaimed water demand, by end use type

Historical mitigation demand at the WCGRF has been concentrated from May through November, with effectively zero recharge from February through April. In the future, the mitigation pattern is expected to broaden to something similar to what is shown on Figure 3-13.

Figure 3-12 and Figure 3-13 can be combined to show the total current seasonal demand pattern (Figure 3-14). Note that this does not include recharge at the HPRB. The HPRB is a discharge location for reclaimed water and does not constitute a demand.

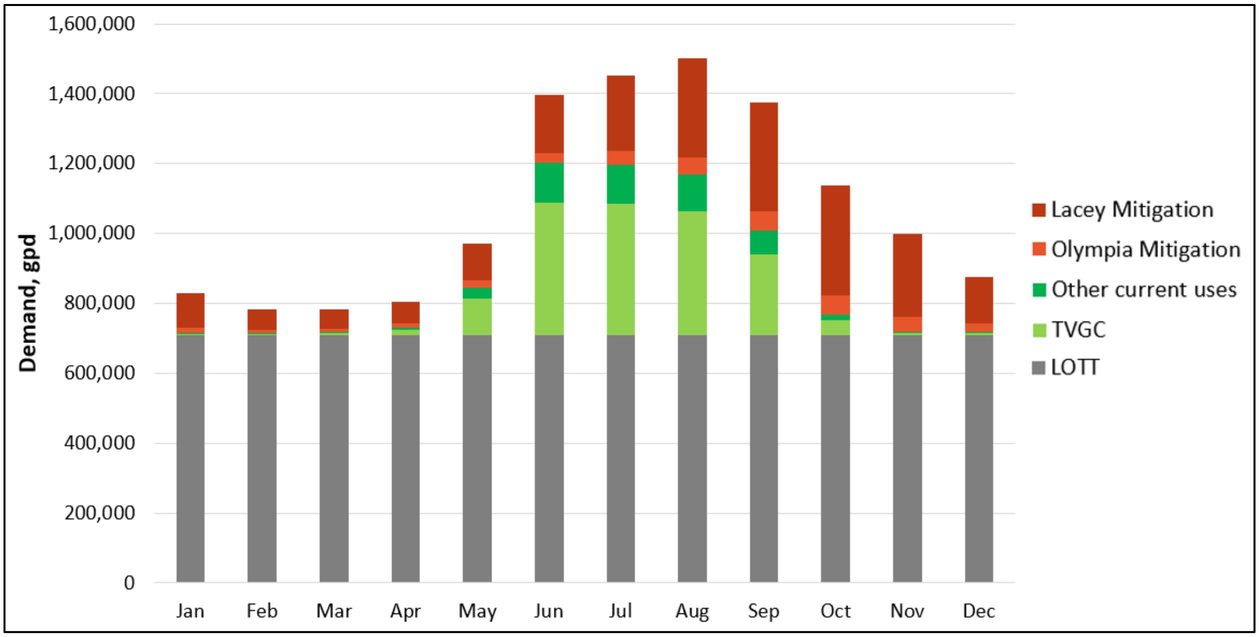


Figure 3-14. Current seasonal demand pattern for LOTT reclaimed water

The demand in Figure 3-14 is dominated by LOTT's in-house uses. These uses, which include water for pumps, spray systems, and cleaning, are relatively constant and compose 66 percent of the total demand. A portion of this flow eventually returns to the treatment process, so this end-use does not entirely mitigate LOTT's discharge capacity.

During the summer, the Tumwater Valley Golf Course and other irrigation uses double the baseline LOTT demand. Mitigation and irrigation uses are minimal from February through April.

In total, demand varies from 0.78 mgd in March to 1.50 mgd in August. Reclaimed water produced in excess of these demands is either recharged to the groundwater at the HPRB or blended with BITP effluent and discharged to Budd Inlet.

3.4.3 Future Demands

The cities of Tumwater, Lacey, and Olympia each provided feedback on projected reclaimed water demands in terms of quantity, quality, seasonality, end use, and location of end use. Table 3-5 below summarizes the feedback received from the cities.

Table 3-5 Partner Future Demands Summary

Use Category	Tumwater	Lacey	Olympia
Industrial	Pepsi 1–2 others Demand up to 15.7 MGY	None	None
Irrigation	Pioneer Park and hatchery Trails project Historical Park Tumwater Falls Park Brewery facility Total demand up to 14.4 MGY	Large number of potential users identified in the Reclaimed Water Plan Demand up to 238 MGY	Demand up to 41.2 MGY
Mitigation	NE wellfield mitigation SW wellfield mitigation (less likely) Projected demand up to 700 MGY	Current demand: 62 MGY Future demand up to 153 MGY	Current demand 10.9 MGY Future demand up to 26.4 MGY

Additional future demands have been estimated from the Reclaimed Water Supply and Demand Analysis Update (HDR, 2015) and the Capitol Campus Reclaimed Water Assessment (Gray & Osborne, 2016). A seasonal plot of projected future demands is presented on Figure 3-15.

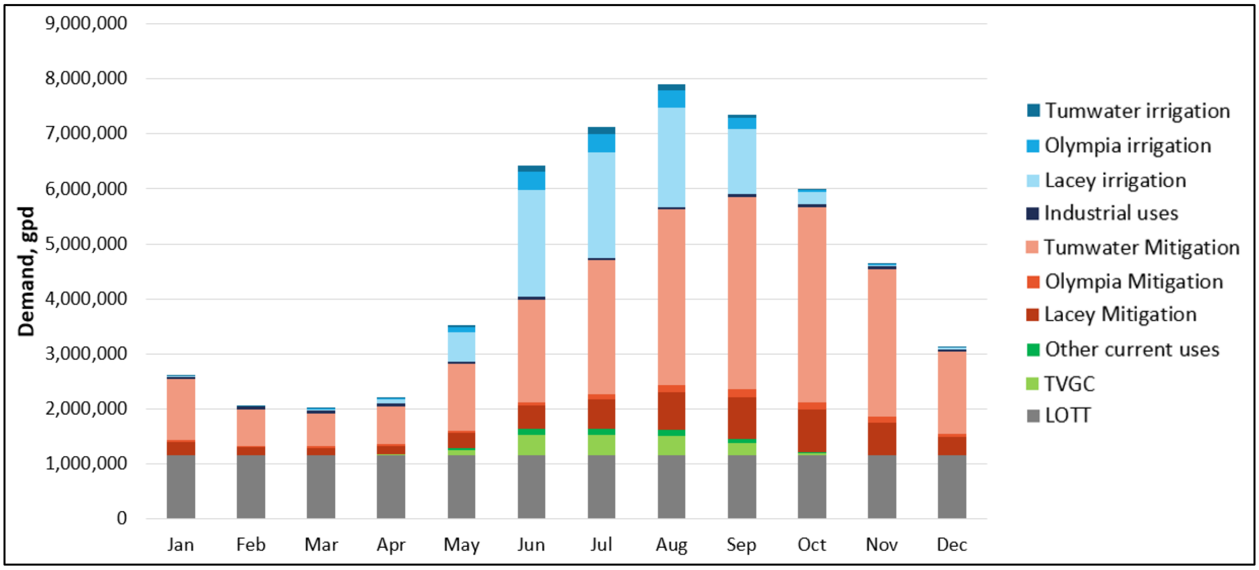


Figure 3-15. Long range future (post-2050) seasonal demand pattern for LOTT reclaimed water

In the future, LOTT end uses comprise a much smaller percentage of the total demand. The largest potential demands are Tumwater mitigation and Lacey irrigation. The Lacey irrigation demands reflect the city's most recent reclaimed water planning effort, which sought to maximize water reuse throughout the city. It is possible that future reclaimed water planning efforts in the other cities will result in increased irrigation demands.

In total, future demands vary from 2.0 mgd in March to 7.9 mgd in August. These demands are projected for 2050 and beyond.

For planning purposes, the values in Figure 3-14 and Figure 3-15 have been extrapolated, assuming 2070 as the time frame for Figure 3-15. These projections are summarized in Table 3-6.

Table 3-6. Minimum Projected End-Use Demands for each Seasonal Condition (Expressed as monthly average demand in mgd) [a b]

Year	Aug/Sept	June/July	Shoulder	Winter
2020	1.2	1.2	0.6	0.6
2030	2.3	2.2	0.8	0.8
2040	3.5	3.1	1.1	1.0
2050	4.7	4.1	1.4	1.2
Full connection	7.0	6.1	1.9	1.7

[a] *Straight line extrapolation from values plotted on Figure 3-14 to those plotted on Figure 3-15, assuming Figure 3-15 represents 2070. This table shows the minimum monthly demand within each seasonal condition.*

[b] *Only 50 percent of the BITP use is credited in this table, as a portion of this flow ultimately returns to the BITP effluent*

3.5 Treatment Objectives for Reuse and Reclamation

This section discusses the treatment objectives and degree of treatment required for groundwater infiltration and other beneficial end-uses.

3.5.1 Class A Reclaimed Water

The current treatment standard for LOTT reclaimed water is the Washington State Class A Reclaimed Water Standard. The alternatives to be developed in this Plan are all based on an assumption that this standard remains the accepted standard for groundwater recharge, irrigation, and other beneficial end-uses described in the previous section. There is a possibility that a more restrictive standard could be applied in the future. Such a standard could require additional unit processes, with higher capital and operating costs those associated with the current standard. This possibility is discussed further in Section 6.3, as it relates to risks associated with planning alternatives.

LOTT currently produces Class A Reclaimed water at the MWRWP and BIRWP. Class A reclaimed water is characterized by low solids content. State regulations are summarized in Table 3-7.

Table 3-7. Washington State Class A Reclaimed Water Standards

Parameter	Unit	Monthly Average	7-day Median	Weekly Average	Sample Maximum
Turbidity					
Sand filter (BIRWP)	NTU	2			5
Membrane filter (MWRWP)	NTU	0.2			0.5
Total coliform	MPN/100 ml		2.2		2,300
Total nitrogen	mg/L	10		15	
Virus removal	4-log inactivation or removal				

MPN = most probable number

NTU = nephelometric turbidity unit

The filtration process removes solids, reducing the turbidity and coliform counts, and disinfection processes take care of the remaining coliforms and virus removal step.

Class A reclaimed water regulates total nitrogen (TN) which is slightly different from the TIN regulation applied to BITP effluent:

- TIN = ammonia (NH_3) + nitrite (NO_2) + nitrate (NO_3)
- TN = TIN + organic nitrogen

Organic nitrogen typically comprises 1–3 mg/L in the effluent, so the TN is typically 1–3 mg/L higher than the corresponding TIN.

The total nitrogen limitations are achieved as part of the biological process upstream of the filtration step. At the BITP, nitrogen removal is achieved in the four-stage Bardenpho system. As summarized in Section 3.2.4, the BITP typically maintains an effluent TIN less than 3 mg/L during summer and shoulder seasons. During the winter, the effluent TIN averages 8–9 mg/L, but there are months when effluent TIN exceeds 10 mg/L, and reclaimed water produced during those periods would not meet the Class A standard. Currently, this is not an issue, as beneficial end-users outside of the BITP have minimal winter season demands. In the future, LOTT can reduce the TIN concentration in the winter by adding supplemental carbon, as it does in the summer and shoulder seasons.

At the MWRWP, the biological process was designed to achieve a year-round effluent TIN less than 10 mg/L and achieving this standard has not been a problem. However, City of Lacey concerns over nitrogen concentrations for water sent to the WCGRF resulted in a goal of less than 5 mg/L TIN for flow sent to the WCGRF. It is challenging to consistently meet this goal at the MWRWP, due to a limitation of available carbon in the influent. However, limiting flow to the MWRWP to a constant flow of about 1.4 mgd allows for more efficient operation capable of meeting the TIN goal of 5 mg/L. This limitation could alternatively be overcome by adding supplemental carbon to the influent, and LOTT is currently investigating this upgrade.

3.5.2 Wetland Augmentation

In the past, LOTT has considered using reclaimed water to augment existing wetlands. The State of Washington has established standards for wetland augmentation, which provide acceptable rates of reclaimed water application based on the wetland classification. Those standards require that reclaimed water meet two additional nutrient standards, beyond the regulations required for Class A Reclaimed Water:

- Total Kjeldahl nitrogen (TKN) < 3 mg/L
- Total phosphorus (TP) < 1 mg/L

TKN is yet another measure of nitrogen, which differs from both TIN and TN.

- TKN = ammonia (NH_3) + organic N

The TKN limitation would be an issue during the winter when the BITP effluent typically has an ammonia concentration of 4–5 mg/L. This concentration could limit the degree to which wetland augmentation could be carried out during the winter.

The TP limit would be a larger concern. LOTT currently does not remove phosphorus at either of its facilities. Achieving a TP < 1 mg/L would require a tertiary step of chemical precipitation and removal, or a renovated biological process.

3.6 Residual Chemicals

LOTT is currently engaged in a long-term study of groundwater infiltration and residual chemicals. There is some potential for future regulations, related to residual chemicals, which could impact treatment requirements for groundwater infiltration. Advanced treatment systems designed to remove residual chemicals would be costly to implement, and costly to operate, increasing the life cycle cost associated with groundwater infiltration. These costs will be discussed as part of the alternatives assessment.

3.7 Collection System Impacts

The regional sewer collection system has a number of projected capacity bottlenecks located between the Martin Way Pump Station (MWPS) and the BITP. These capacity bottlenecks may be relieved by treating and diverting flow at the MWRWP.

Martin Way Interceptor West. The pipes are projected to become full between 2040 and 2050 if MWRWP treatment is limited to 2 mgd. With higher flows treated at MWRWP, the limitation would be extended beyond 2050.

Indian Creek Interceptor. There are three bottleneck locations along this interceptor, with capacity restrictions projected to arise before 2030. Limitations would be pushed back with increased flow to MWRWP. LOTT has $13M budgeted for pipeline replacements in 2035, which assumes MWRWP treatment will increase between 2020 and 2030.

Martin Way Force Main. The force main is projected to reach 85 percent capacity in 2034 and 100 percent capacity in 2039 if MWRWP flow is limited to 2 mgd. With increased treatment at the MWRWP, the 100 percent capacity time frame would be pushed back to 2050. LOTT has budgeted $5.2M for a force main expansion in 2034.

Downtown Interceptors. The downtown interceptors along Cherry, State, and Adams are all projected to become heavily surcharged and capacity-limited by 2040. These limitations would be pushed back past 2050 with increased treatment at the MWRWP. LOTT has budgeted $5M for improvements scheduled for 2037.

In summary, a number of collection system improvements, totaling over $23M, can be delayed if the MWRWP treatment capacity is expanded as quickly as possible. Details on MWRWP expansion and flow availability will be provided in Section 4 of this report.

3.8 Summary of Needs and Demands

The LOTT reclaimed water program is driven primarily by two motivations. The primary driver is to help manage increasing wastewater system capacity needs into the future by diverting flows from the BITP to limit the volume of discharge to Budd Inlet in compliance with NPDES regulations. Where feasible, LOTT also endeavors to provide a renewable resource of reclaimed water for interested stakeholders and community benefit.

Section 3.1 summarized the regulatory situation. The volume of discharge to Budd Inlet is proportional to the degree of treatment. At the current level of treatment performance, LOTT may face a deficit of 10 mgd of discharge capacity by 2050 and 16 mgd with full connection of all septic tanks in the service area. The deficits would be seasonal, with the largest deficit in the August/September period.

Demand for LOTT’s reclaimed water product are summarized in Section 3.4. The demand varies seasonally. Currently, demand varies from 0.8 to 1.5 mgd. In the future, demand is projected to vary from 2.0 to 7.9 mgd.

Considering all of these factors, and organizing them by season, Table 3-8 shows the predicted discharge deficits based on the conservative planning condition of a 90th percentile treatment performance combined with a 10-year peak month flow. The table adds a 1.5 mgd planning contingency and subtracts projected reclaimed water demands, as well as existing infiltration capacity. In short, the table expresses how much additional alternative discharge capacity will be required.

Table 3-8. Projected BITP Discharge Capacity Deficit (mgd), at 10-Year Peak Month Flow and 90th Percentile Treatment Performance [a]

Year	Aug/Sept	June/July	Shoulder	Winter
2020	4.6	0.9	1.9	No deficit
2030	5.5	1.9	3.8	No deficit
2040	6.5	3.1	5.7	No deficit
2050	6.9	3.7	7.2	No deficit
Full Connection	10.4	7.6	12.8	No deficit

[a] *Values calculated as follows:*

10-year peak seasonal month at given year – discharge capacity at 90th percentile performance + 1.5 mgd contingency – minimum projected end-use demand at seasonal condition. For the 2050 Aug/Sept condition, the calculation is 18.8 mgd – 8.7 mgd + 1.5 mgd – 4.7 mgd = 6.9 mgd.

This table predicts the overall BITP discharge capacity deficit if beneficial end-uses were used to their full projected capacity. It does not consider alternative discharge in the form of groundwater infiltration. This table is reporting what the deficit would be before any groundwater infiltration (outside of mitigation demands) takes place. In other words, the table does not include any recharge at the HPRB or future LOTT-managed recharge sites.

The table shows an existing deficit of 4.6 mgd under the August/September condition. However, this assumes the anticipated TMDL-based limits for BOD and TIN in August and September, which have not yet been implemented. Without those limits, the current deficit would be 1.9 mgd, during the shoulder condition.

A deficit of up to 7.2 mgd is projected by 2050. This deficit means that LOTT would need to have 7.2 mgd of alternative discharge in place, outside of beneficial end uses, to meet this demand. This value increases to 12.8 mgd with full connection of septic tanks.

Table 3-8 is based on a conservative level of performance, assuming effluent BOD and TIN concentrations equal to the 90th percentile of concentrations observed from 2016-2020. If performance could be maintained at the level observed in 2021, the capacity deficits would be much more manageable. This condition is summarized in Table 3-9.

Table 3-9. Projected BITP Discharge Capacity Deficit (mgd), at 10-Year Peak Month Flow and 2021 Performance [a]

Year	Aug/Sept	June/July	Shoulder	Winter
2020	No deficit	No deficit	No deficit	No deficit
2030	0.6	No deficit	No deficit	No deficit
2040	1.6	No deficit	1.3	No deficit
2050	2.1	No deficit	2.7	No deficit
Full Connection	5.6	3.7	8.3	No deficit

[a] *Values calculated as follows:*

10-year peak seasonal month at given year – discharge capacity at 2021 performance + 1.5 mgd contingency – minimum projected end-use demand at seasonal condition. For the 2050 Aug/Sept condition, the calculation is 18.8 mgd – 13.6 mgd + 1.5 mgd – 4.7 mgd = 2.1 mgd.

Clearly, treatment performance at the BITP determines the extent of the capacity deficit. As shown earlier in Table 3-3, the difference between the 90th percentile performance and the 2021 performance can equate to several million gallons worth of discharge. In practice, this is the difference between facing a capacity deficit of 7.2 mgd in 2050 versus a deficit of 2.7 mgd.

As time goes by, the gap between best- and worst-case performance should narrow. As the BITP begins to aim for lower effluent BOD and TIN concentrations, and as upgrades such as the biological process improvements are implemented, performance should stabilize, and these projections should become more specific.

Section 4

Existing and Proposed Facilities

This section summarizes the existing and proposed facilities that comprise the LOTT reclaimed water system.

4.1 Treatment Facilities

LOTT has two existing facilities used to generate Class A Reclaimed Water—the MWRWP and BIRWP.

4.1.1 BIRWP

The BIRWP currently has capacity to generate up to 1.5 mgd of Class A Reclaimed Water. The facility was designed to be easily expandable to a capacity of 3.0 mgd. The BIRWP treats secondary effluent from the BITP. Major components of the BIRWP are listed below:

- Three feed pumps located at the Effluent Pump Building, which pump flow to the BIRWP
- Three sand filter modules
- Three chlorine disinfection contact tanks, sized for 30 minutes contact time
- Class A reclaimed water (CLA) clear well with capacity of 140,000 gallons, equating to roughly 5 percent of capacity at 3 mgd
- Three distribution pumps

The 2015 Reclaimed Water Business Case Evaluation determined that, although the facility was designed to be easily expandable as a sand filter, potential cost and space savings could be achieved by changing the technology to either a compressible media filter or a disc filter. The savings were particularly high if the facility needed to expand beyond 3.0 mgd.

4.1.2 MWRWP

The MWRWP treats raw sewage pumped from the MWPS. The facility currently has equipment in place to treat up to 2 mgd. As discussed above, to meet the nitrogen goal for the WCGRF, the facility is limited to treating a relatively constant 24-hour flow. Currently, that limits treatment to an average of 1.4 mgd.

The MWRWP was originally designed to be expandable to a 5-mgd facility. As part of the annual capacity reporting process, LOTT has developed a conceptual plan to expand the MWRWP up to an 8-mgd capacity and has acquired property adjacent to the plant that could accommodate the expansion.

Expanding the MWRWP depends upon the availability of influent flow. The dry season base flow (the lowest weekly average flow of each year) at the MWPS is currently 2.7 mgd. To prevent the MWPS force main and downstream pipes from running dry, LOTT aims to pump a minimum of 0.5 mgd through the force main at all times. The maximum flow currently available for treatment at the MWRWP for two different cases is listed below:

- With carbon limitation requiring constant flow: 1.1 to 1.4 mgd
    - Strictly, the limitation would be 1.1 mgd. In practice, operators have been able to run the system at 1.4 mgd, allowing for periodic reductions in flow on certain nights.

- With an influent equalization basin allowing for flow pacing: 2.2 mgd

Table 4-1 summarizes the maximum treatment capacity based on flow availability, at 10-year increments, for the three cases described above.

Table 4-1. Maximum treatment capacity at the MWRWP based on flow availability (mgd)

Year	Carbon Limitation Requiring Constant Flow	With Influent Flow Equalization and Flow Pacing
Current	1.4	2.2
2030	1.8	2.9
2040	2.3	3.9
2050	2.7	4.6
Full connection	3.6	6.3

4.2 Groundwater Recharge Facilities

The HPRB facility was constructed along with the MWRWP, with the intent of having the capacity to recharge all of the flow produced at the MWRWP. The recharge basins have proven to have a high hydraulic capacity, which has been projected to accommodate up to 8 mgd of flow. The basins have been in operation since the MWRWP started producing flow in 2006.

Since 2006, LOTT has investigated a large number of sites along the Deschutes River corridor. The aim has been to identify a site with a similar capacity as the HPRB, which could accept flow generated at the BIRWP. Sites have been assessed via modeling, open pit tests, falling head tests, and both small and large scale pilot infiltration tests. Table 4-2 summarizes the findings of site investigations to date. Figure 4-1 presents a map of the sites.

Table 4-2. Groundwater Infiltration Site Summary

Location	Initial Projection (mgd)	Distance from BITP (miles)	Current Projection (mgd)	Level of Detail [a] (%)
Henderson South	3–5	4.8	1.5	75
Henderson North	--	3.8	1.3	100
South Deschutes	3–6	8.5	1.5 to 5.0	50
Rixie Road	3–5	5.0	1.0	50
Tumwater Airport	--	5.7	1.0 to 1.65	10
Power line	--	4.0	0.9 to 1.7	10

[a] *Level of detail 10% denotes a paper or modeling study, 50% indicates field work in addition to modeling (falling head tests), 75% indicates small scale pilot infiltration study, 100% indicates large scale pilot infiltration study*

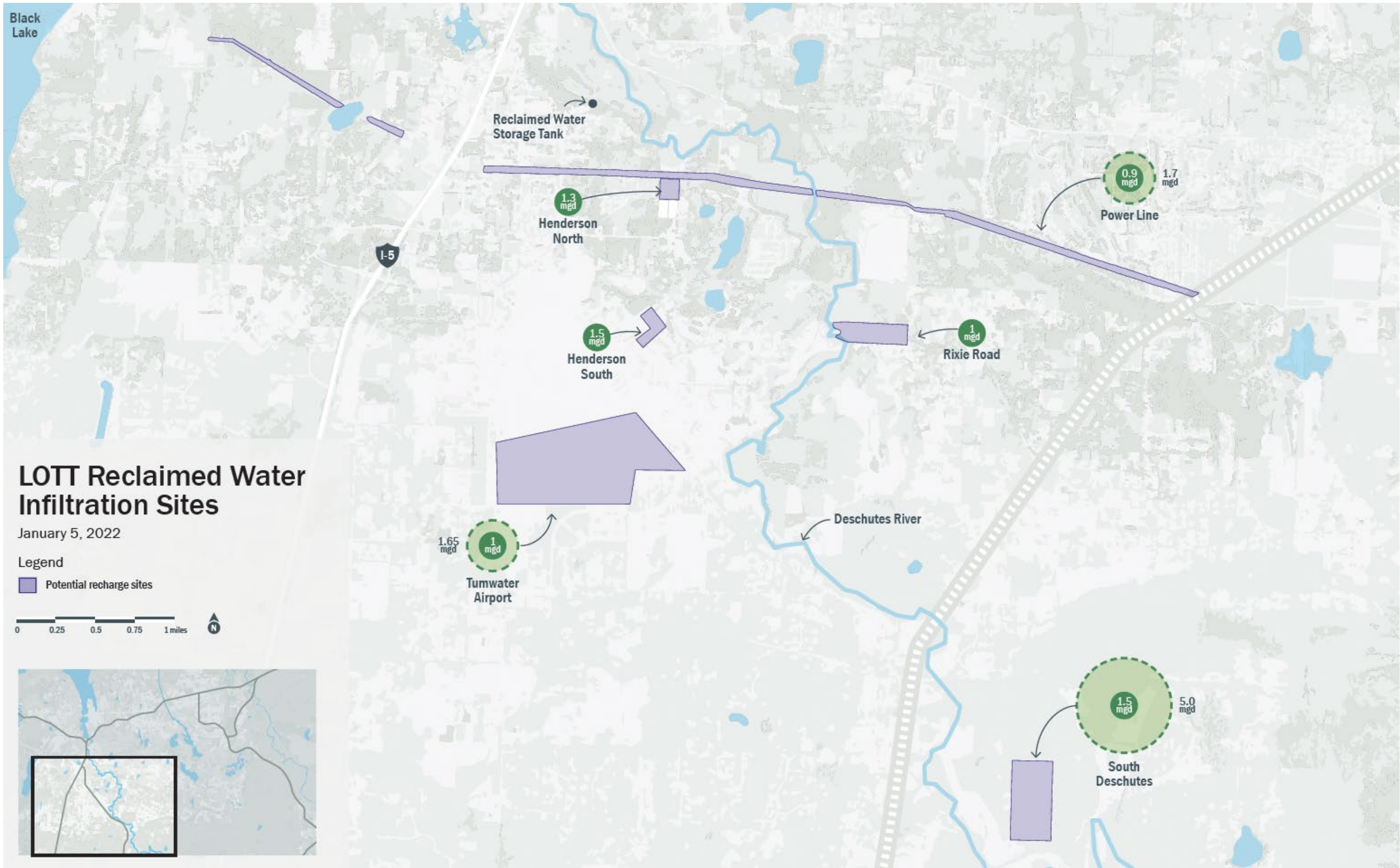


Figure 4-1. Potential groundwater infiltrations sites

LOTT has purchased the two Henderson sites, along with the Rixie Road and South Deschutes sites. All of these sites have undergone field studies along with extensive groundwater modeling. In each case, the estimated infiltration capacity has decreased as additional site-specific investigations have been completed. While the South Deschutes site still appears to have potential for high capacity (up to 5 mgd), the Henderson and Rixie Road sites each appear limited to 1.0 to 1.5 mgd.

LOTT continues to explore opportunities for infiltration at additional sites. A cursory assessment of the south Olympia Airport area estimated an infiltration capacity of 1.0 and 1.65 mgd (PGG, 2019). Due to proximity to the airport, infiltration would need to be subsurface. Any further exploration of this area will require close coordination with the Port of Olympia and the City of Tumwater to assess operational and regulatory feasibility.

A cursory assessment was also completed for a high voltage power line transect in the Tumwater area. Regional data were used to model the infiltration potential for a 6.5-mile long drainpipe installed beneath the Bonneville Power Association power lines crossing between Tumwater and the Chambers Prairie area. The infiltration capacity appears limited to 0.9 to 1.7 mgd. Use of this area would require obtaining easements from numerous property owners, which may limit feasibility.

The Schneider Prairie Wetland, located in southeast Olympia, is the headwaters to Ayer Creek, a tributary of the Deschutes River. The wetland had been identified as a potential location for the use of reclaimed water for wetland enhancement and streamflow augmentation. The wetland's proximity to the Deschutes River raised interests as its upstream location would benefit fish habitat in the river. An initial feasibility report prepared by Skillings (2020) indicated the wetland complex was able to accept 0.3 to 0.5 mgd of reclaimed water application between July and September. A following evaluation performance by Pacific Groundwater Group estimated a range of 0.3 to 0.6 mgd. Additionally, reclaimed water application to wetlands would require phosphorus removal and further treatment at BITP, as discussed in Section 3.5.2.

In general, the site search has been difficult. As the studies have progressed, the projected capacity of each site has decreased, and other factors such as endangered species have come into play. After 15 years of analysis, no sites similar to the HPRB have been identified. Currently, the best prospect for a large-scale site would be the South Deschutes location. The site itself is projected to have 1.5 to 5.0 mgd of capacity, however, there is potential to impact adjacent properties with infiltration in the higher range. There appear to be other potential sites in the general vicinity that could provide additional capacity.

4.3 Reclaimed Water Conveyance

The LOTT reclaimed water conveyance system currently consists of two systems, which are depicted on Figure 4-2. The eastern system conveys flow from the MWRWP to the HPRB. The existing 14-inch diameter pipeline has a capacity of 4 mgd. LOTT currently has plans to add a second pipeline at some point in the 2040s. The City of Lacey has constructed reclaimed water conveyance systems, which draw flow from the LOTT pipeline.

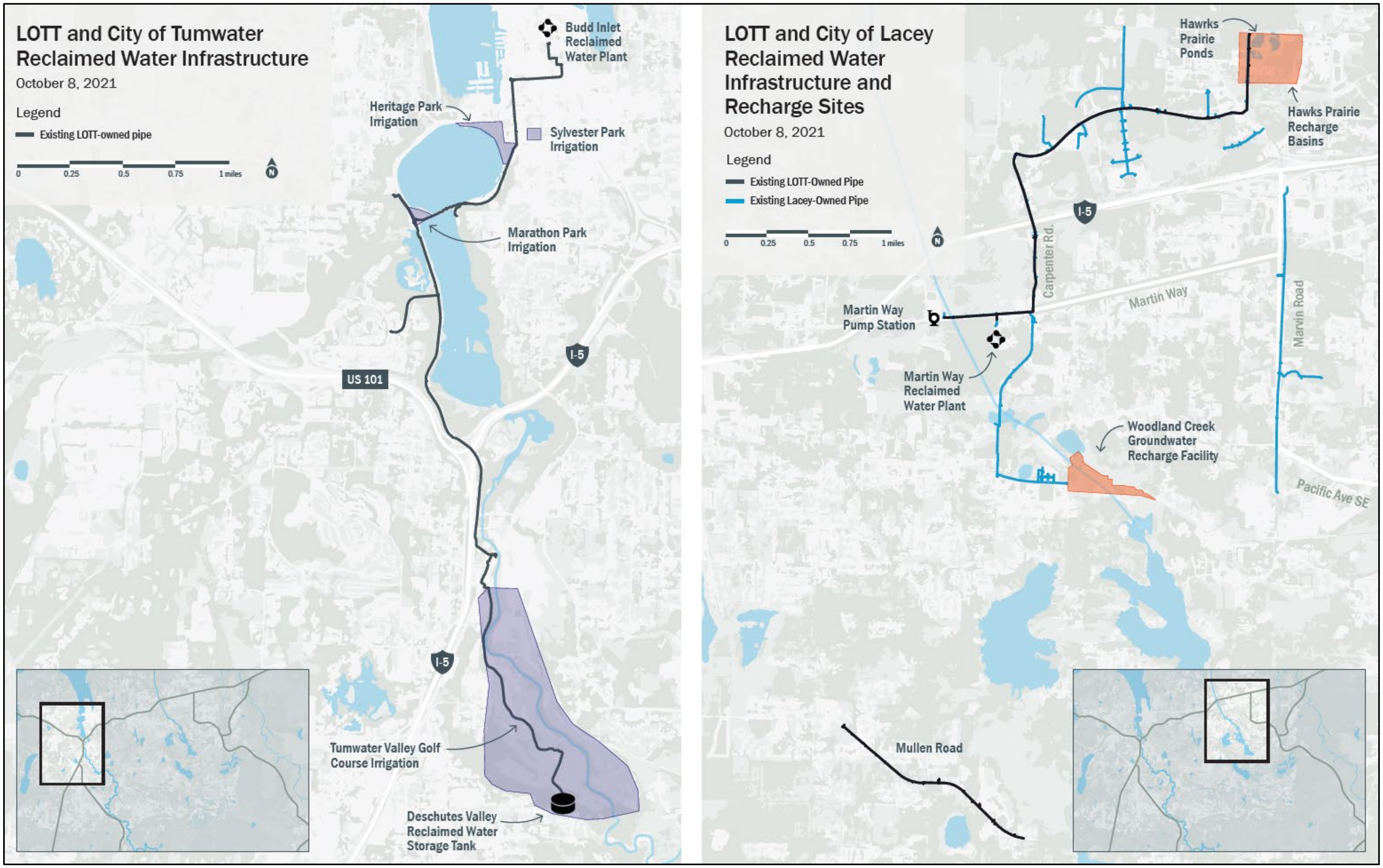


Figure 4-2. LOTT reclaimed water asset summary

The second system conveys flow from the BIRWP to the Reclaimed Water Storage Tank (Figure 4-3). Flow is conveyed by a network of pipes, ranging in size from 12- to 20-inches (average diameter 17.4 inches). The pipeline capacity is limited to 3 mgd, due to pressure limitations in some of the pipes (in particular, an 80-pound per square inch section of piping near Marathon Park). The existing pumps at the BIRWP do not have capacity to pump 3 mgd and would need to be replaced with a larger set of pumps to achieve that flow (65-horsepower pump motor estimate).

The storage tank has the capacity to hold up to 1 million gallons. As part of the original project, a building was also constructed near the storage tank as a potential future pump station.

Section 5

Alternatives Development

LOTT's Highly Managed Plan focused on expansion of satellite reclaimed water production and groundwater infiltration to manage increasing demand for wastewater treatment in the future. LOTT has developed a highly successful reclaimed water program, and demand for the product now exceeds supply. The potential for water rights mitigation has transformed the product into a commodity, with tangible benefits to the LOTT partners.

Beneficial end uses, including water rights mitigation, tend to have a seasonal demand pattern, which does not always match the regulatory seasons. Anticipated changes to the regulation—particularly the TMDL-based reduction in August and September BOD and TIN loadings, will further limit allowable discharge to Budd Inlet. These changes increase the need for alternative discharge. Under the historical approach of satellite production and groundwater recharge, LOTT would need to develop up to 10 mgd of production facilities, and 8 mgd of groundwater recharge facilities before 2050, to meet the anticipated regulatory limits. That could increase to 16 mgd of production and 13 mgd of recharge with full connection of septic tanks within the service area.

LOTT's experience in the past 15 years has shown that high-capacity groundwater infiltration sites are rare and may be located long distances from production facilities. Meanwhile, treatment technologies have advanced to a point where it may be possible to address the mass-based NPDES limits by means other than alternative discharge—for example, by generating a BITP effluent with even lower TIN and BOD concentrations. This section explores alternatives aimed at meeting LOTT's regulatory requirements, including scenarios where alternatives are combined into a strategy that meets the regulatory requirements as well as the projected reclaimed water demands of LOTT's partners.

5.1 Alternative 1. Groundwater Recharge Focus

LOTT's 2016 Capacity Report includes the most recent revision of the satellite treatment and groundwater infiltration concept originally developed as part of the Highly Managed Plan. This alternative envisioned reclaimed water production at two facilities—the MWRWP and the BIRWP. The MWRWP would expand capacity as quickly as possible, using an influent flow equalization basin to maximize capacity. All reclaimed water produced at the MWRWP would be used either for LOTT operational purposes; by the cities of Lacey and Olympia for water rights mitigation or reuse such as irrigation; or discharged for groundwater infiltration at the HPRB. On the west side, the BIRWP would expand, along with the distribution system, with a series of pipes and pump stations conveying reclaimed water from the BIRWP to the reclaimed water storage tank in Tumwater, to the Henderson and Rixie Road groundwater recharge sites, and ultimately, to the South Deschutes groundwater recharge site. Alternative 1 represents the evolution of this plan.

As developed in Section 4.1, the MWRWP capacity is limited by the availability of wastewater flow. Without equalization, production capacity would be limited to 2.7 mgd by 2050. With influent flow equalization, the MWRWP could generate 2 mgd of product in 2030, 3 mgd of product in 2040, 4 mgd of product in 2050, and 6 mgd of product with full connection. These production capacities are larger than projected stakeholder demands in the MWRWP area (WCGRF mitigation plus Lacey irrigation), which are limited to a maximum of 1.8 mgd during the June/July period and only 0.5 mgd during the shoulder season. Excess flow would be recharged at either the WCGRF or HPRB.

Allowing for treatment at the MWRWP, Table 5-1 summarizes the remaining capacity deficit in the system for each seasonal condition.

Table 5-1. Projected BITP Discharge Capacity Deficit, at 10-Year Peak Month Flow and 90th Percentile Treatment Performance, Excluding Projected MWRWP Treatment (mgd) [a]

Year	Aug/Sept	June/July	Shoulder	Winter
2020	4.4	0.6	1.0	No deficit
2030	5.8	2.1	2.6	No deficit
2040	7.0	3.2	3.8	No deficit
2050	7.6	3.9	4.5	No deficit
Full connection	11.5	7.7	8.6	No deficit

[a] *Values calculated as follows:*

10-year peak seasonal month at given year – discharge capacity at 90th percentile performance + 1.5 mgd reserve capacity – projected MWRWP production. For the 2050 Aug/Sept condition, the calculation is 18.8 mgd – 8.7 mgd + 1.5 mgd – 4 mgd = 7.6 mgd.

With the MWRWP expanded as quickly as possible, Table 5-1 expresses how much additional reclaimed water production would be required across the system. Production of an additional 7.6 mgd would be required by 2050 and 11.5 mgd with full connection.

Table 5-2 takes the analysis a step further, subtracting the projected end-use demands in Olympia and Tumwater. This table expresses the capacity deficit that remains with MWRWP expanded to its full potential and given all projected end uses throughout the system.

Table 5-2. Projected BITP Discharge Capacity Deficit, at 10-Year Peak Month Flow and 90th Percentile Treatment Performance, Excluding Projected MWRWP Treatment (mgd) [a]

Year	Aug/Sept	June/July	Shoulder	Winter
2020	3.9	No deficit	0.8	No deficit
2030	4.5	0.9	2.2	No deficit
2040	4.9	1.5	3.2	No deficit
2050	4.7	1.7	3.8	No deficit
Full connection	7.0	4.5	7.5	No deficit

[a] *Values calculated as follows:*

10-year peak seasonal month at given year – discharge capacity at 90th percentile performance + 1.5 mgd reserve capacity – projected MWRWP production – minimum projected end-use at seasonal condition (outside of MWRWP zone). For the 2050 Aug/Sept condition, the calculation is 18.8 mgd – 8.7 mgd + 1.5 mgd – 4 mgd – 2.8 mgd = 4.7 mgd. In this case, the 2.8 mgd end use demand excludes demands supplied via the MWRWP. It also assumes that 50% of the BITP uses would end up back in the plant effluent.

With MWRWP expanded as quickly as possible, and with the projected seasonal end-use demands as summarized in Section 3.5, Table 5-2 expresses how much additional discharge (i.e., groundwater infiltration) would be required across the system. The table projects a need for up to 4.7 mgd by 2050 and 7.5 mgd with full connection.

The implication for this alternative is that LOTT would need to develop 7.6 mgd of CLA treatment and 4.7 mgd of recharge capacity on the west (BIRWP) side of the system by 2050. Those needs would increase to 11.5 mgd of treatment and 7.5 mgd of recharge capacity with full connection.

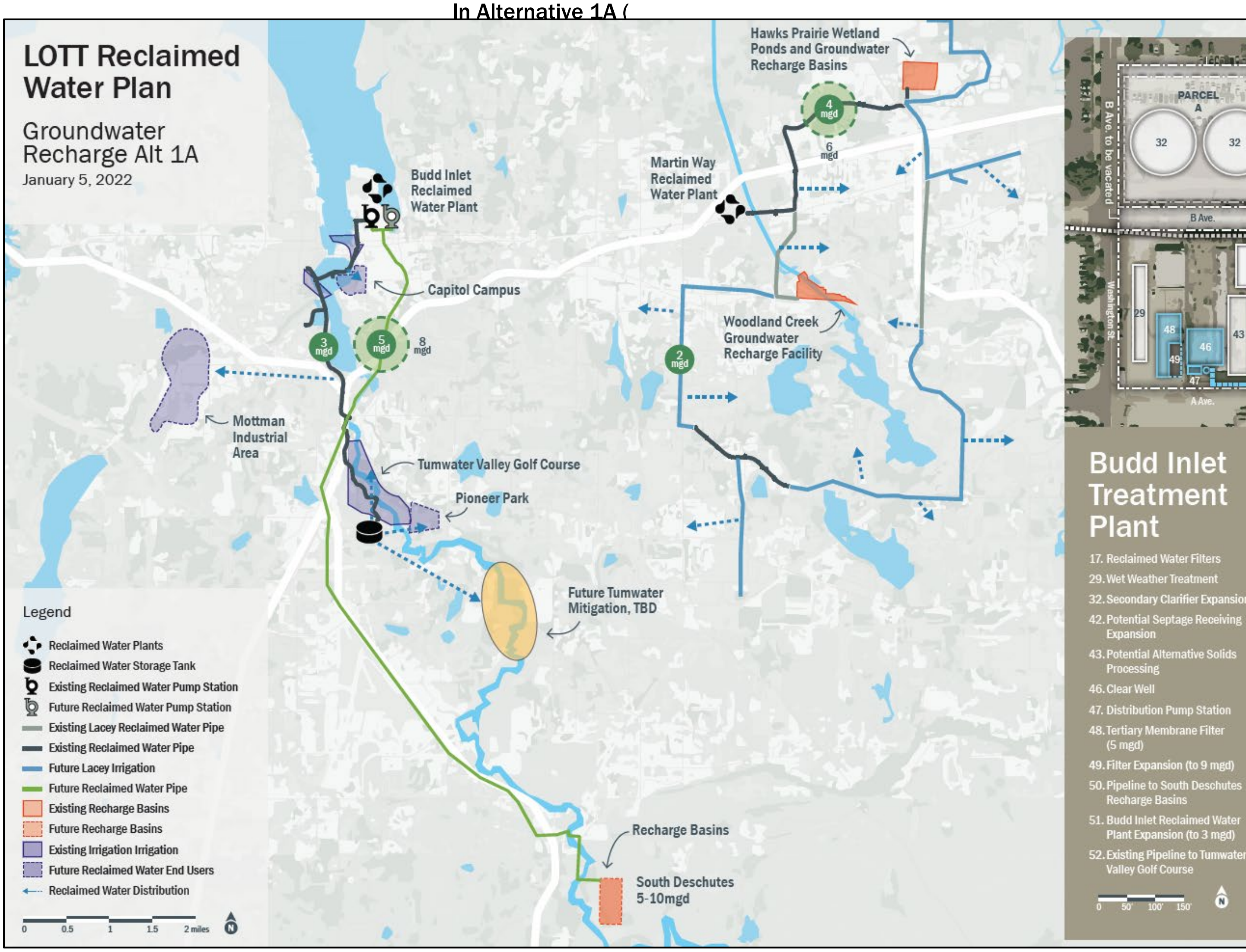
Such is the scenario given performance at the 90th percentile of 2016-2020 performance. If performance could be sustained at the level observed in 2021, the situation would look much different. Table 5-2 would not project any recharge need on the west side until after 2050, with only 3 mgd of recharge capacity needed at full connection. The alternatives assessment is generally focused on the worst-case scenario (performance at the 90th percentile level), but the implications of improved performance are an important part of the analysis. At the end of the alternatives assessment a sensitivity analysis will assess how treatment performance could impact the outcome of the assessment and the recommended plan.

Three alternatives were developed to provide the necessary treatment and discharge. Alternatives 1A and 1B include the MWRWP expanding as quickly as possible. Both alternatives locate 8 mgd of production at the BITP by 2050. Production would be achieved by expanding the existing BIRWP sand filtration system to 3 mgd and by constructing a new 5-mgd treatment facility.

The BIRWP was designed to be easily expandable to 3 mgd, and existing infrastructure is in place to convey up to 3 mgd to the Reclaimed Water Storage Tank in Tumwater. This flow could support all of the projected end-use and mitigation demands of Tumwater and Olympia through 2050.

A new treatment facility would treat 5 mgd of BITP secondary effluent to Class A reclaimed water standards. This facility could employ a variety of treatment technologies—sand filtration, compressible media, cloth discs, or membranes. The facility would require a disinfection process, along with a clear well and vertical turbine pump station. To accommodate full connection demands, the facility would be designed for 5 mgd but expandable to 9 mgd.

Alternatives 1A and 1B would differ in their approach to groundwater infiltration.



In Alternative 1A (Figure 5-1), the pump station would send flow along a 10-mile pipeline to the South Deschutes Recharge Basin site. This site has a projected capacity of 1.5 to 5.0 mgd, and additional properties located in the same general area appear to have infiltration potential. For the purpose of this plan, it is assumed that an initial 5 mgd of recharge capacity, scaling up to 8 mgd capacity after 2050, could be implemented in this vicinity. Note that this may require discovery of up to 6.5 mgd of recharge sites in the area, if the South Deschutes site is limited to only 1.5 mgd.

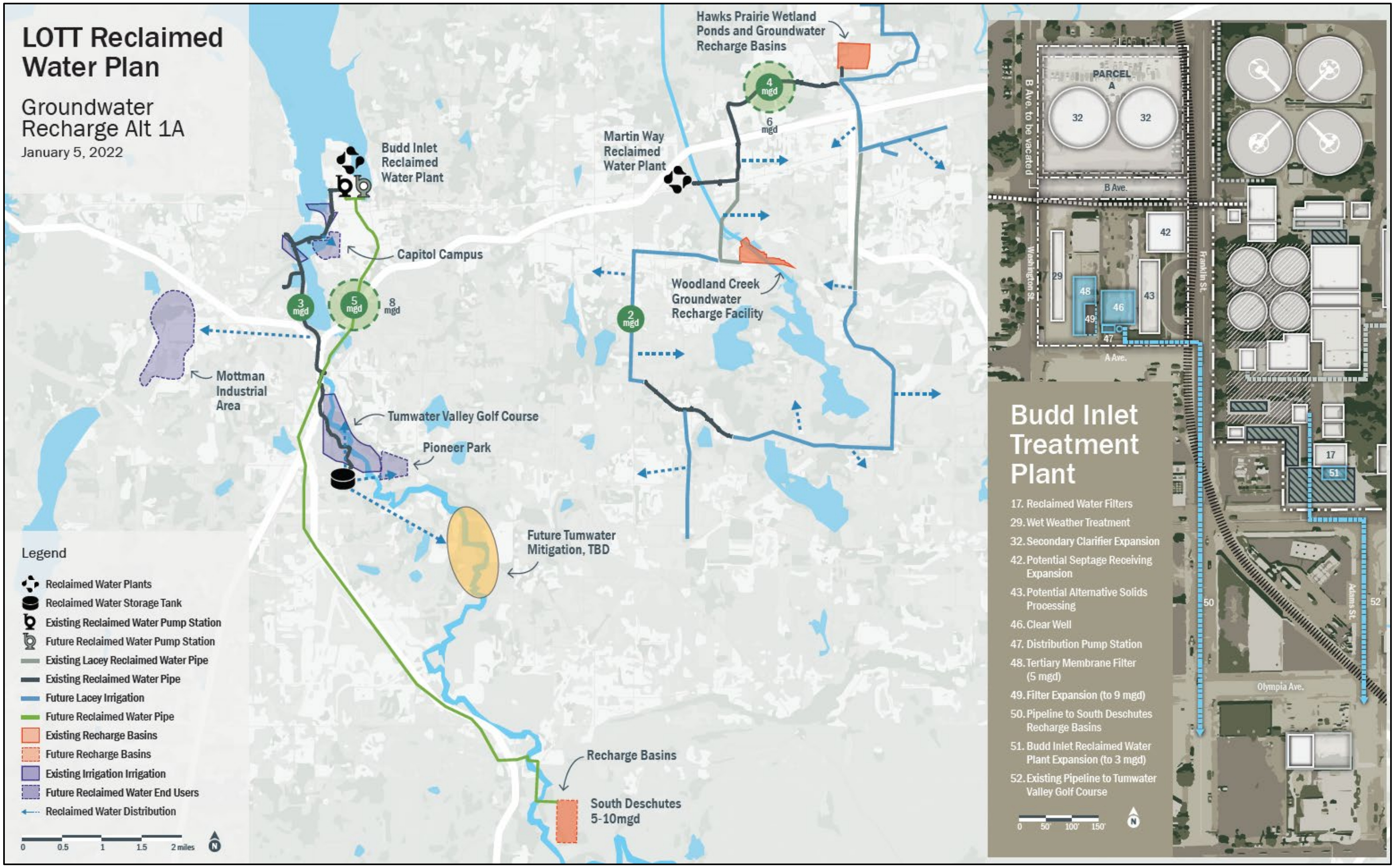


Figure 5-1. Alternative 1A

In Alternative 1B (Figure 5-2), the pump station would send flow to three smaller, closer sites. The Henderson South, Henderson North, and Rixie Road sites have a combined capacity of 3.8 mgd. This capacity could be increased to 5.0 mgd by supplementing those sites with additional recharge at yet-to-be-determined sites. Beyond 2050, the additional 3 mgd of recharge required to accommodate full connection would require a pipeline to the South Deschutes Recharge Basin site.

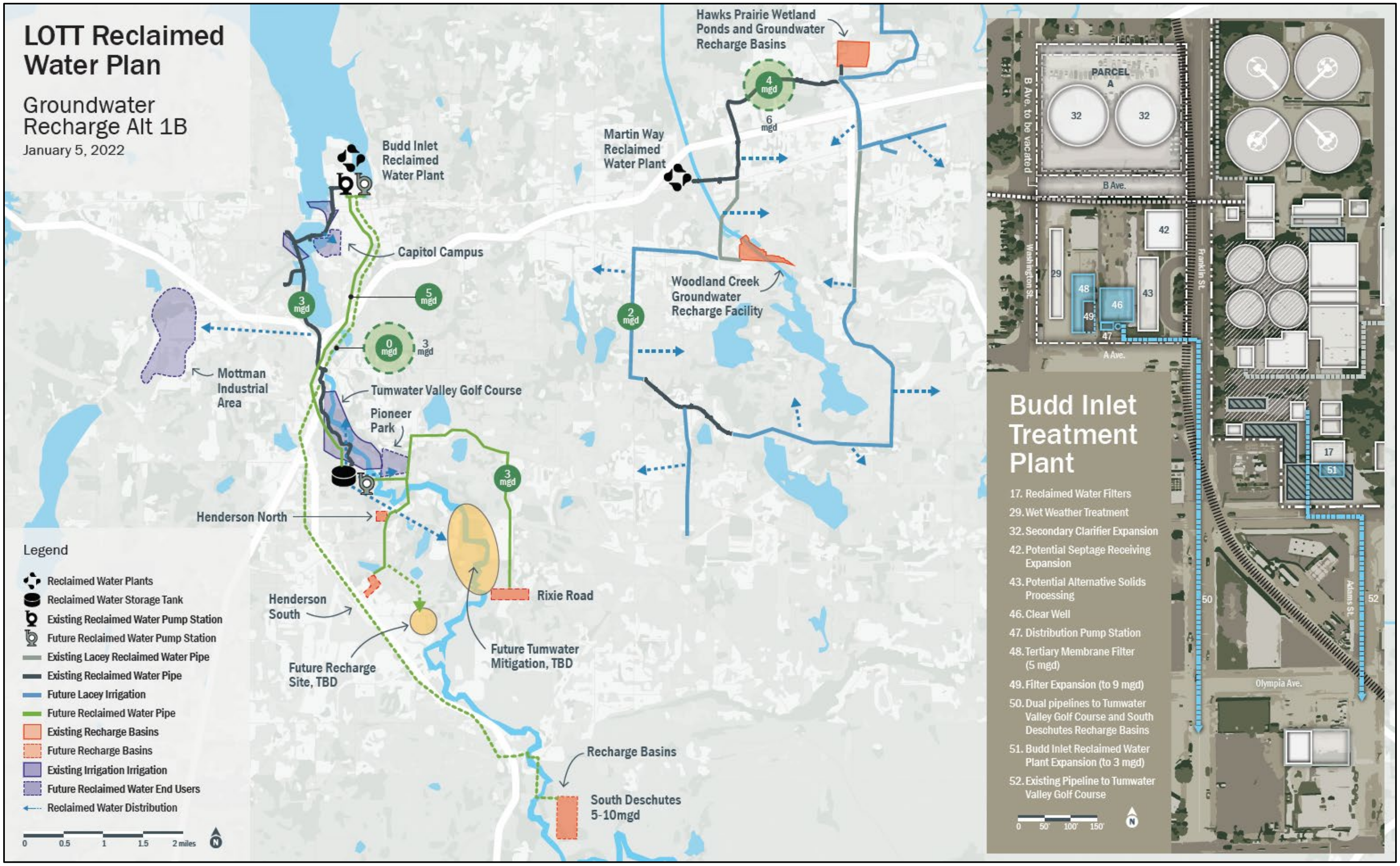


Figure 5-2. Alternative 1B

The third alternative (1C) maximizes the use of the MWRWP by pumping flow from the BITP (Figure 5-3). This alternative expands the MWRWP to an 8-mgd capacity by 2050 and includes a pipeline pumping 3 mgd of raw sewage. This alternative changes the treatment and recharge demands in Table 4-1 and Table 4-2. Under this alternative, treatment demands at the BITP are reduced, with no recharge needed on the west side until nearly 2050.

An expanded BIRWP (3 mgd) could provide most of the treatment demand through 2050. Ultimately, a 6-mgd capacity treatment system would be needed to supplement the BIRWP. Recharge could be provided at one of the Henderson sites, with a 4-mgd pipeline to South Deschutes needed for the full connection scenario.

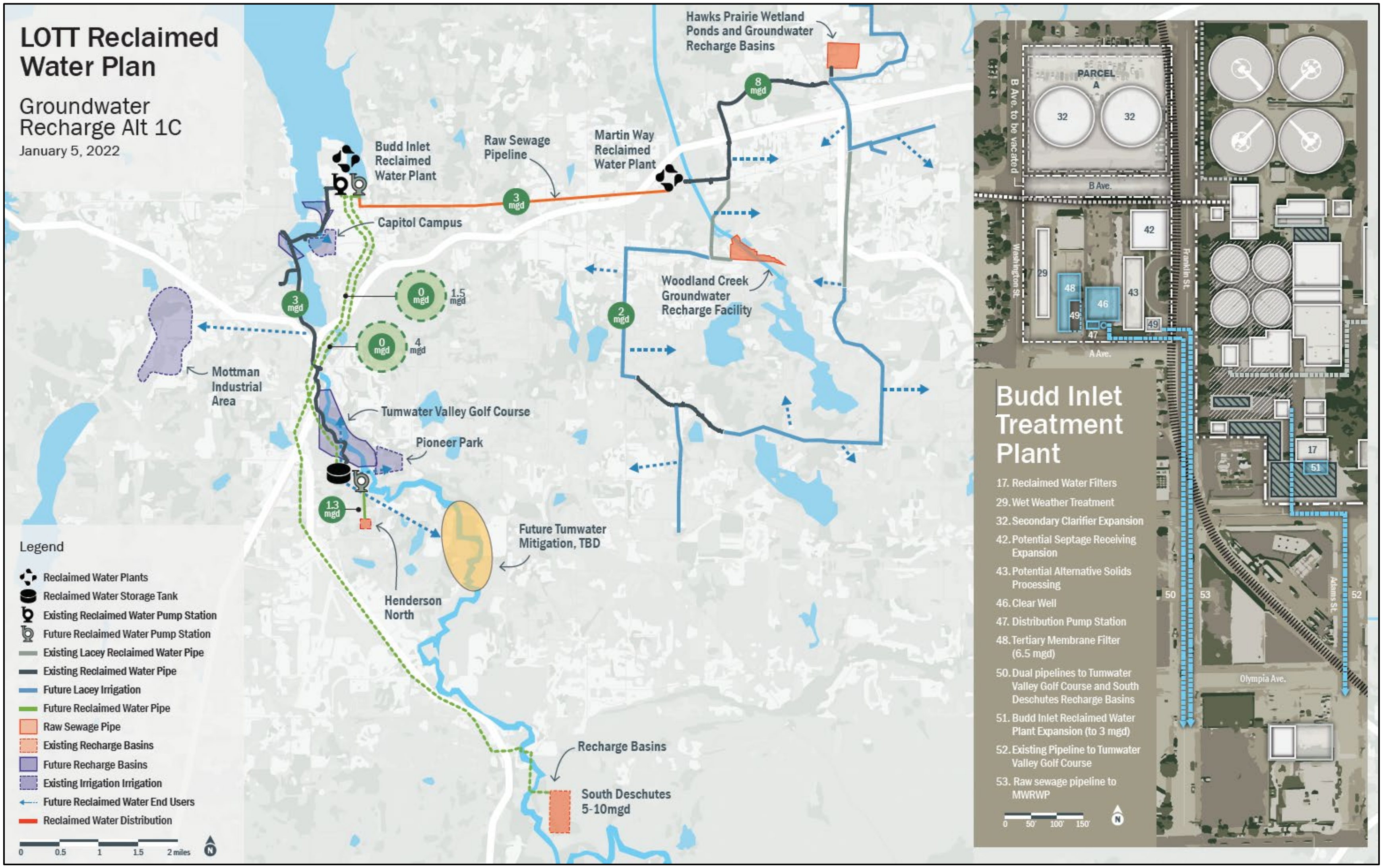


Figure 5-3. Alternative 1C

Table 5-3 summarizes alternatives 1A, 1B, and 1C, and Table 5-4 compares the costs of Alternatives 1A, 1B, and 1C.

Table 5-3. Comparison of Groundwater Recharge Alternatives (all values in mgd)

	Alt 1A	Alt 1B	Alt 1C
2050			
CLA production at MWRWP	4.0	4.0	8.0
CLA production at BITP	7.6	7.6	3.6
Recharge capacity at HPRB	4.0	4.0	8.0
Recharge capacity on west side	4.7	4.7	0.7
Full Connection			
CLA production at MWRWP	6.0	6.0	8.0
CLA production at BITP	11.5	11.5	9.5
Recharge capacity at HP RB	6.0	6.0	8.0
Recharge capacity on west side	7.5	7.5	5.5

Table 5-4. Cost Comparison Between Groundwater Recharge Alternatives [a]

	1A	1B	1C
Phase 1 costs (2050)			
BIRWP expansion to 3 mgd	$7,185,000	$7,185,000	$7,185,000
MWRWP expansion by 3 mgd [b]			$50,045,000
New production facilities	$33,963,000	$33,963,000	
Pipeline costs	$55,938,000	$46,994,000	$35,471,000
Recharge facility costs	$18,854,000	$7,259,000	$4,697,000
Total Phase 1	$115,939,000	$95,401,000	$97,398,000
Phase 2 costs (full connection)			
New production facilities	$22,221,000	$22,221,000	$31,509,000
Pipeline costs	$27,969,000	$55,938,000	$76,221,000
Recharge facility costs	$15,083,000	$15,083,000	$18,854,000
Credit for MWRWP expansion in Phase 1 [b]			-$16,682,000
Total Phase 2	$65,272,000	$93,242,000	$109,901,000
Total	$181,212,000	$188,642,000	$207,299,000

[a] *Costs are total project costs, which include direct costs, bid costs (12% contractor overhead and markup; 15% contractor general conditions; 2% startup, training, and manuals; 35% contingency; 3.5% bonds and insurance; and 9.4% sales tax), and allied costs (2.5% preliminary engineering, 15% final engineering, 7.5% construction engineering, and 5% legal, administration, and permitting).*

[b] *Alternatives 1A and 1B assume that MWRWP will expand to a capacity of 5 mgd in 2050, with an ultimate capacity of 6 mgd. These costs are not estimated in the table and are assumed to be a baseline condition. Alternative 1C expands to 8 mgd by 2050, with an ultimate capacity of 8 mgd. To equate this alternative with the other two, 3 mgd of incremental capacity cost must be added to the 2050 condition, and 1 mgd of incremental capacity cost must be removed from the full connection condition.*

While Alternative 1B has the lowest near-term cost, the long-range cost favors Alternative 1A. Both alternatives end up with a 10-mile pipeline from the BITP to the South Deschutes Recharge Basins. Alternative 1B has additional costs associated with pipelines to the smaller-capacity, closer sites, but those costs are partially offset by lower recharge basin costs due to the higher infiltration capacity of those sites compared to South Deschutes. Alternative 1C, which sends flow from the BITP to the MWRWP, has the highest long-range cost.

Operationally, Alternative 1B would have much higher costs to operate and maintain a large number of distributed facilities. LOTT would need to maintain four separate sites, each of which would require security and landscaping, in addition to mechanical maintenance activities, sampling, testing, and groundwater monitoring. Development continues to expand closer to the sites associated with Alternative 1B, increasing the risk associated with neighboring properties.

Alternative 1A offers some ecological advantage, given that recharge takes place farther upstream along the course of the Deschutes River. The farther upstream the recharge, the more benefit in terms of flow augmentation.

Alternative 1A will be the primary focus for comparing the Groundwater Recharge Alternative to other alternatives in this assessment. The alternative bypasses the small, nearby sites, sending reclaimed water directly to the South Deschutes recharge site. Projected end-use demands would be met by expanding the BIRWP sand filtration system and pumping 3 mgd to the Reclaimed Water Storage Tank. The MWRWP would expand as quickly as possible, using influent flow equalization to increase flow availability.

5.2 Alternative 2. Enhanced Effluent Quality Focus

While there is clearly demand for a reclaimed water product, the principal driver of LOTT's reclaimed water program is compliance with the BITP's NPDES permit. At current levels of treatment performance, LOTT could need to develop up to 16 mgd of alternative discharge (Table 3-4) to ensure compliance.

However, there are technologies that could improve the effluent quality of the BITP to such a level that significantly more flow could be discharged while remaining in compliance with the mass-based permit. With enhanced effluent quality, the need for alternative discharge could be eliminated, and further development of LOTT's reclaimed water program could be driven solely by stakeholder demand.

5.2.1 Projected Performance

Tertiary treatment involves adding a layer of treatment downstream of existing secondary processes. To comply with the mass-based NPDES limits, treatment would be applied for both BOD and TIN removal.

During the summer and shoulder permit seasons, the BITP effluent typically has an ammonia concentration near zero, and, as summarized in Section 3.2.3, a TIN concentration between 2–3 mg/L (90th percentile value of 2.7 mg/L). Tertiary nitrogen removal systems would target an effluent TIN of 1 mg/L. With respect to the mass-based regulation, reducing the effluent TIN concentration from 2.7 mg/L to 1.0 mg/L would increase the allowable discharge volume by 270 percent. In the August/September period, the volume would increase from 11.0 mgd (Table 3-3) to 30.0 mgd. With a projected 10-year maximum summer month flow of only 19.0 mgd (2050) or 24.8 mgd (full connection), there would be ample capacity for nitrogen discharge throughout the planning horizon.

With respect to BOD, the BITP effluent concentration is typically less than 5 mg/L, with 90th percentile values of 6.4 mg/L in the summer and 7.5 mg/L in the shoulder season. The effluent BOD is typically composed of two elements: particulate BOD present in effluent solids and soluble BOD related to overdosing of methanol. A tertiary treatment system with nitrogen removal, reaeration, and filtration would remove both sources of BOD. A target effluent BOD for such systems would be 3 mg/L. In the August/September period, the allowable discharge volume would increase from 8.7 mgd (Table 3-3) to 18.8 mgd.

Table 5-3 compares performance and discharge capacity under current conditions and with tertiary treatment.

Table 5-3. Effect of tertiary treatment on performance and mass-based discharge capacity

Constituent	Performance (mg/L)		Allowable Discharge (mgd)	
	Current 90th Percentile	Tertiary	Current 90th Percentile	Tertiary
June/July				
TSS	10.1	4	62.5	157.7
BOD	6.4	3	12.5	26.8
TIN	2.7	1	12.7	34.5
Aug/Sept				
TSS	10.1	4	62.5	157.7
BOD	6.4	3	8.7	18.8
TIN	2.7	1	11.0	30.0
Shoulder				
TSS	13.7	4	45.9	157.7
BOD	7.5	3	14.4	35.9
TIN	2.7	1	17.0	46.5

5.2.2 Design and Technologies

Figure 5-4 presents a process flow diagram of the tertiary treatment systems. The systems would include a nitrogen (N) removal step, a filtration step (which could be combined with the N removal step in some systems), disinfection to meet Class A standards, and effluent pumping. Variations on this process flow will be explored in the sub-alternative evaluation below.

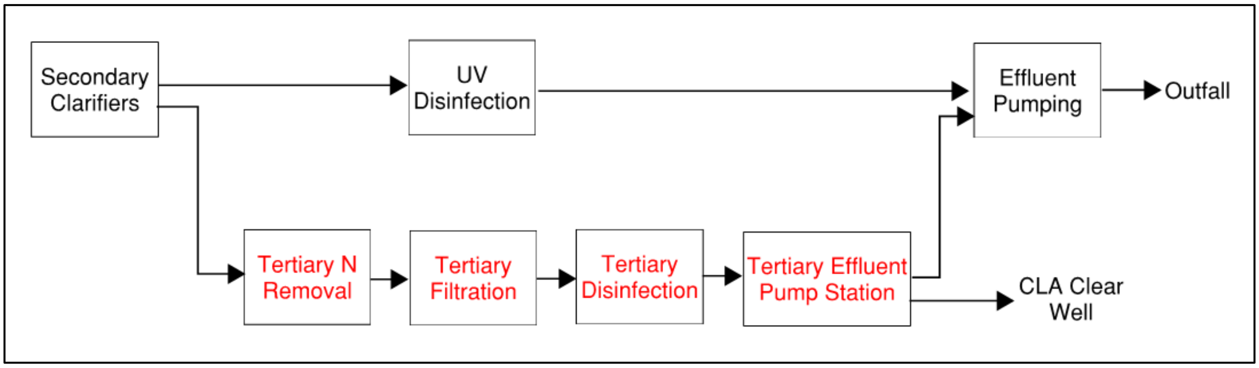


Figure 5-4. Process flow schematic of tertiary systems

The tertiary systems would operate year-round but would only be required during the summer and shoulder seasons. The systems should therefore be designed to treat only a portion of the secondary effluent. Assuming that BITP secondary process performance remains constant, with the 90th percentile values listed in Table 3-2, the tertiary systems would need to treat up to 8.8 mgd by 2050 and 13.1 mgd for the full connection scenario. For the purpose of this evaluation, tertiary treatment systems have been sized to treat an average flow of 15 mgd, with diurnal peaks to 20 mgd. It would be possible to phase implementation, installing only half of such a system to provide capacity through the mid-2030s and subsequently expanding the facility as needed, based on performance.

Figure 5-5 shows what the plant flows would look like, for the maximum month August/September 2050 condition, with this system in place.

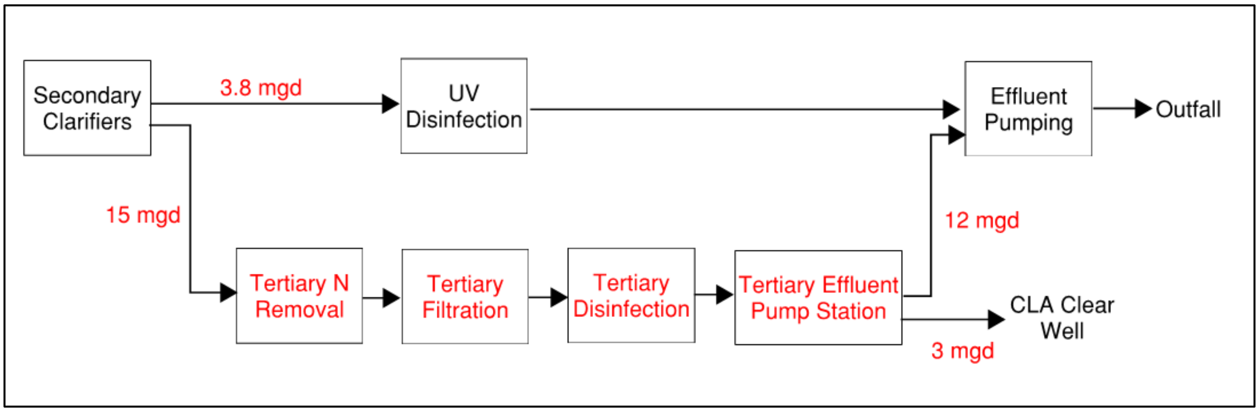
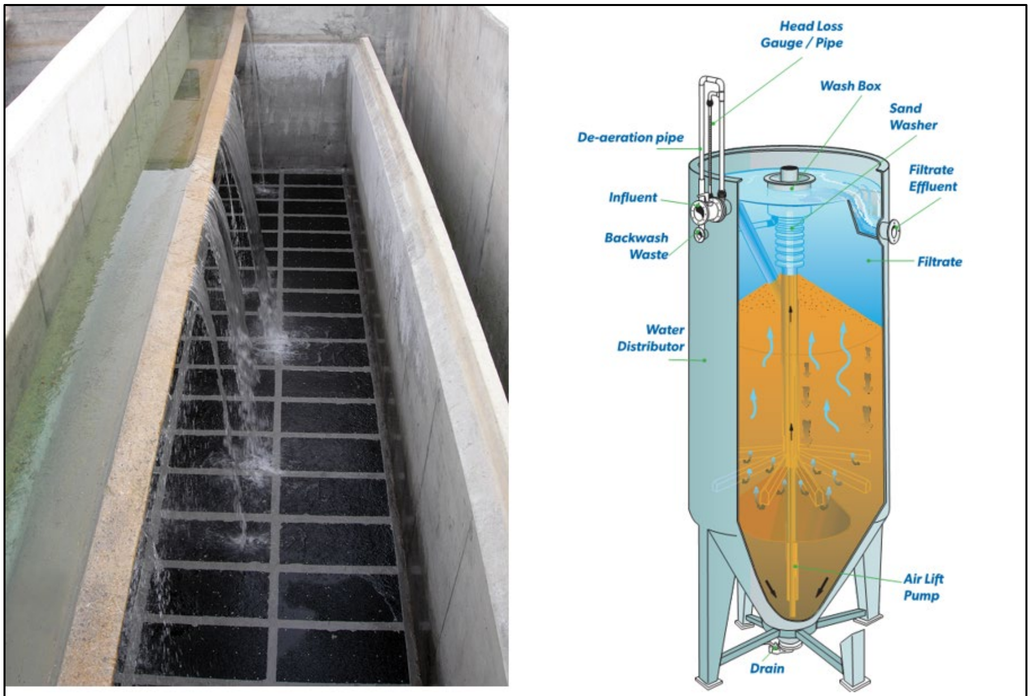


Figure 5-5. Process flow schematic of tertiary systems, with maximum month 2050 Aug/Sept flows

During the summer period, most of the plant flow would be treated. The existing disinfection facility would be lightly loaded and would have regular periods of zero flow. Even during the winter, outside of storm events and rainy days, the tertiary system could be treating the full plant flow. In large part, the existing ultraviolet (UV) disinfection would be reduced to treating peak flows.

Several technologies are currently being used for tertiary nitrogen removal and include denitrification filters, moving bed bioreactors (MBBRs), biologically active filtration, and ion exchange.

Denitrification filters have a long history and are typically used at plants where the secondary process does not include a denitrification step. For example, they are often found at trickling filter plants where the trickling filter provides both BOD and ammonia removal, generating an effluent with a high nitrate concentration. There are several vendors offering denitrification filter products, which vary from deep bed granular media filters to upflow media filters similar to the Dynasand system in place at the BIRWP. The difference is that the denitrification filter has a biological component. A denitrifying bacteria community grows as a biofilm on the filter particles. The filter is fed with a carbon source (methanol, acetate, or Micro-C) and nitrate is removed as the flow passes through the filter. Because the technology is itself a filtration process, there is typically no need for any downstream filtration. In this application, the denitrification filter would typically be followed by a re-aeration step to ensure all the supplemental carbon is used up, minimize the effluent BOD, and ensure that effluent dissolved oxygen is high enough for marine plants and aquatic life.



Deep bed filter (De Nora Tetra)

Upflow filter (Westech Supersand)

Figure 5-6. Denitrification filters

Source: De Nora, Westech

Biologically active filters are effectively the same concept as the denitrification filter—a filter system with biofilm-coated media. Suez markets the BioFOR process, which uses a proprietary media instead of sand. The BioFOR system is an upflow filter but laid out like a deep bed (Figure 5-7). Veolia offers a BIOSTYR process with a similar layout, using polystyrene media.

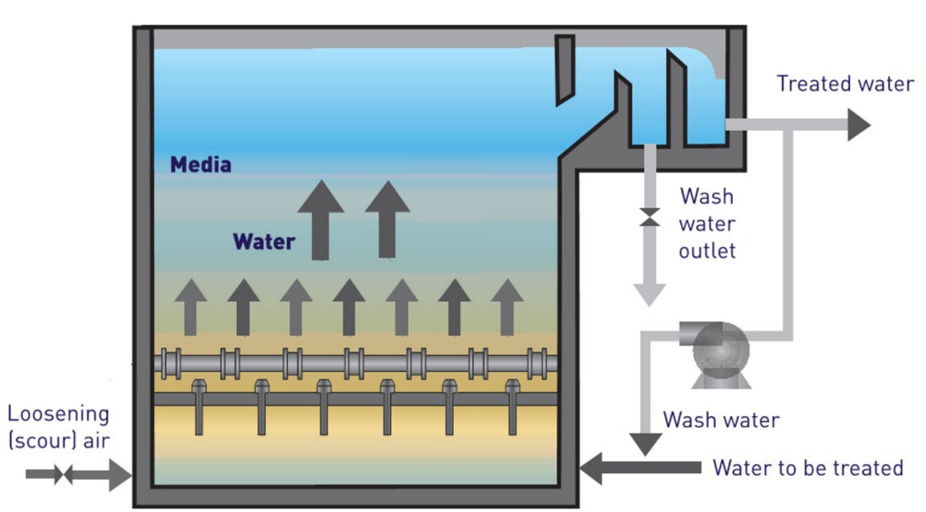


Figure 5-7. BioFOR denitrification system

Source: Suez

Tomorrow Water offers another approach to biologically active denitrification filters. Its product features an upflow filter with vertical segregation of anoxic and reaeration zones, with a proprietary plastic media (Figure 5-8).

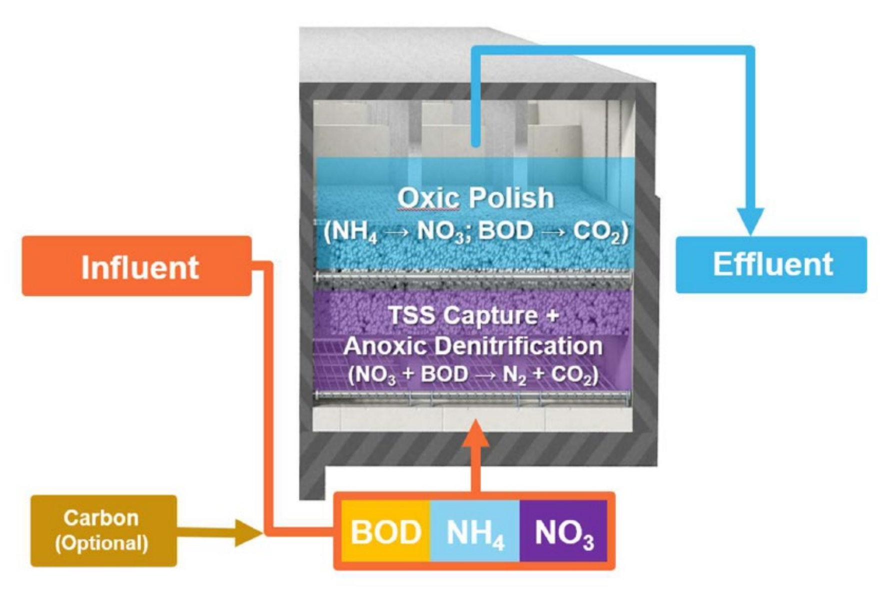


Figure 5-8. Tomorrow Water Proteus System

Source: Tomorrow Water

The MBBR system is a similar concept, passing flow across a media-filled reactor. In this case, the media are Kaldness chips, and the reactors are laid out in series, similar to a set of aeration basins. Flow would pass across three basins—two anoxic denitrifying basins and one aerobic reaeration basin. Flow passes across large-pore cylindrical screens, which retain the plastic media in each reactor (Figure 5-9). The MBBR system is not a filter and will create some solids particles that can get into the effluent. For that reason, the MBBR system would need a tertiary filtration system to treat its effluent.

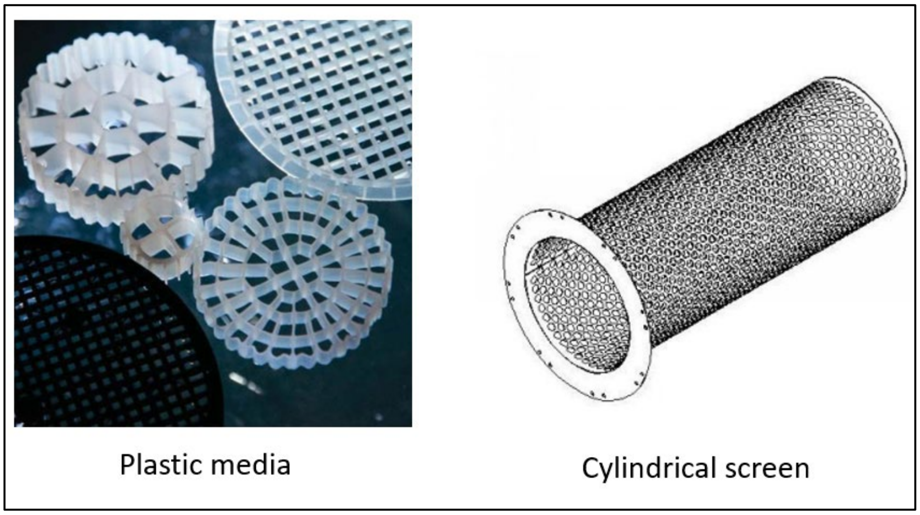


Figure 5-9. MBBR media and screens

Source: Veolia

Each of these systems should be able to meet the TIN target of 1 mg/L. Some of the systems may be able to achieve the BOD target of 3 mg/L on their own—the denitrification filters and the Tomorrow Water system in particular—while others would require a tertiary filter on the back end. The systems are similar in size, and all would require similar amounts of carbon supplementation. Based on preliminary calculations, the methanol (or equivalent carbon source) demand is projected to be 200–300 gpd.

Tertiary filtration can be achieved through similar technologies used to generate reclaimed water. In fact, with appropriate disinfection, the tertiary product would be classified as Class A reclaimed water. Filtration technologies could include sand filters, compressible media, cloth discs, or membranes. These systems would remove TSS, along with the particulate BOD associated with it.

For the purpose of this evaluation, site plans and cost information are based on the MBBR system with a cloth disc tertiary filter. This system is conservatively sized, and any of the other systems should be able to fit within the system footprint.

The alternatives assessment for Alternative 2 is primarily focused on how these facilities would fit into the existing BITP site plan. Ideally, tertiary facilities could fit into the existing hydraulic profile between the secondary clarifiers and the existing UV disinfection system. In such a case, a tertiary disinfection and tertiary effluent pumping system would not be needed. A review of the existing hydraulic profile found that the secondary clarifier effluent weirs are located at an elevation of 114.23 ft. The UV disinfection system is designed to operate with a maximum regulated water surface elevation of 112.15 ft. The level control weir at the downstream end of the UV system has an elevation of 111.57 ft. The available head between the secondary clarifiers and UV disinfection system is therefore 2.1 to 2.7 ft. The tertiary filtration system requires a minimum of approximately 1 ft of head loss. The tertiary MBBR system projected 3 inches of head loss across each of three proposed basins, with a little less than 1 ft of head loss across the entire system. That would leave less than 1 ft of head loss for secondary flow diversion and routing to, from, and within the tertiary system. While additional assessment would be required to assess feasibility, there is a high likelihood that this would be not be feasible without additional pumping.

5.2.3 Alternative 2A. Two New Secondary Clarifiers

Alternative 2A aims to stay within the hydraulic profile by locating the tertiary treatment facilities as close as possible to the secondary clarifiers and UV disinfection system. Figure 5-10 presents a process flow schematic, and Figure 5-11 presents a sketch of the alternative.

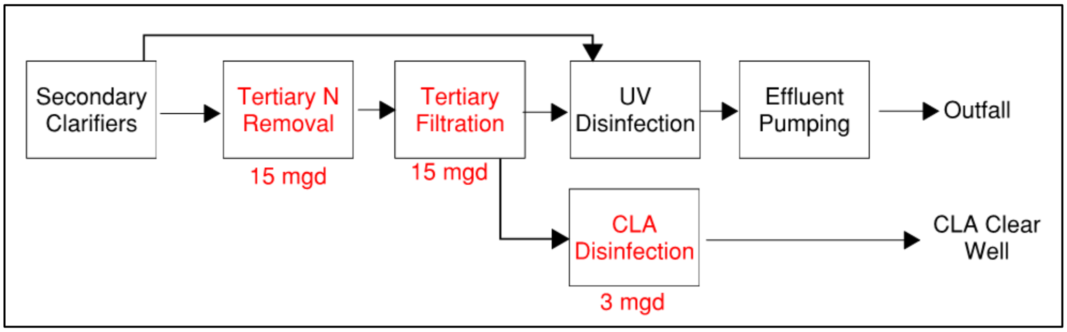


Figure 5-10. Process flow schematic for Alternative 2A

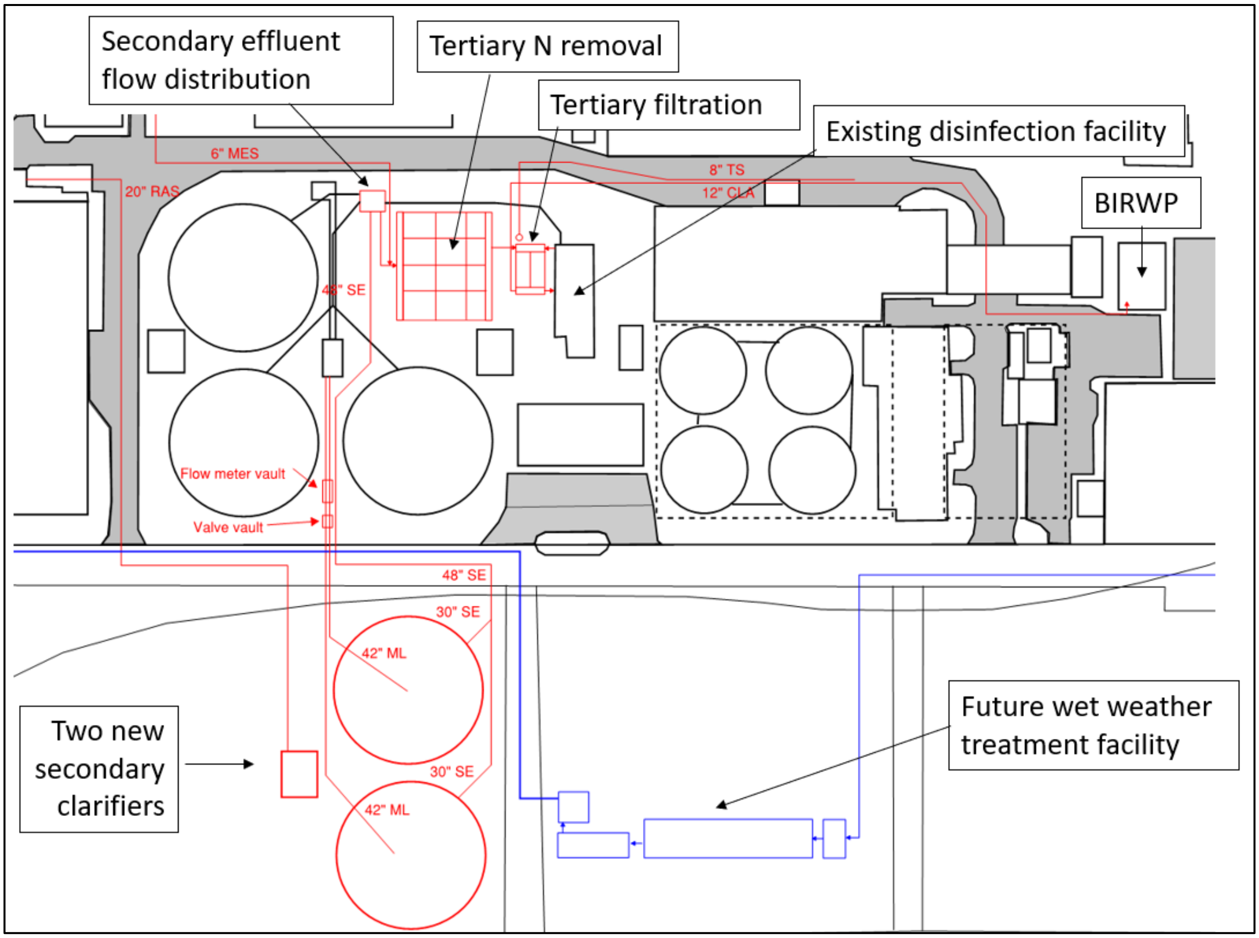


Figure 5-11. Alternative 2A. Two New Secondary Clarifiers

Space for the tertiary facilities would be obtained by demolishing one of the existing secondary clarifiers. Two new secondary clarifiers would be constructed west of the BITP. The system would consist of the tertiary nitrogen removal facility and the tertiary membrane. The tertiary membrane would discharge to the existing UV disinfection facility. No tertiary disinfection or pumping would be required. A portion of the tertiary effluent (3 mgd) would be routed to the existing BIRWP, which would be re-purposed as a CLA disinfection facility. The disinfected flow would be routed to the existing clear well for distribution. This alternative would therefore send 3 mgd of Class A reclaimed water to the Reclaimed Water Storage Tank to satisfy projected end uses. End use demand is projected to be 2.9 mgd in 2050 and 4.4 mgd beyond 2050. This demand includes water rights mitigation for the City of Tumwater.

Alternative 2A presents several challenges. First, in order to route flow to and from the two new secondary clarifiers, three large diameter pipelines need to be threaded between two existing clarifiers. Second, the existing UV disinfection facility is bounded on one side (to the south) by a medium-voltage duct bank and on the other side (to the north) by a large 30–40 cable low-voltage duct bank. As shown on Figure 5-11, the low-voltage duct bank would need to be relocated to accommodate the tertiary filtration facility and its connections to the disinfection facility. Finally, there is some risk that even with the close location, the facilities will not fit within the existing hydraulic profile.

5.2.4 Alternative 2B. Facilities on Adjacent Parcel

Alternative 2B would not attempt to stay within the hydraulic profile and would site the tertiary facilities on an adjacent parcel to the west. A process flow schematic for Alternative 2B is presented on Figure 5-12. This schematic includes tertiary disinfection and pumping but presents those facilities as dual-use, linked to a future wet weather treatment facility. LOTT plans to construct a wet weather treatment facility, capable of treating 10 mgd of flow pumped from downtown Olympia. The facility would include preliminary treatment, solids separation, disinfection, and pumping. The Alternative 2B concept would link the tertiary disinfection and pumping facilities to the future wet weather facility. Since the wet weather facility would only be operated during major storm events (during the winter), the tertiary treatment facilities could be turned down (or turned off) to accommodate wet weather treatment.

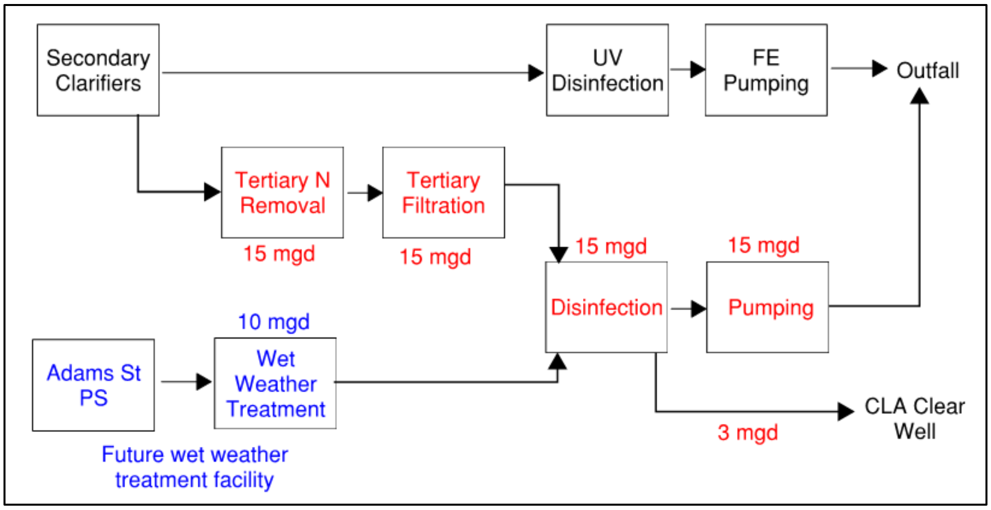


Figure 5-12. Process flow schematic for Alternative 2B

Figure 5-13 presents an overall site layout for Alternative 2B.

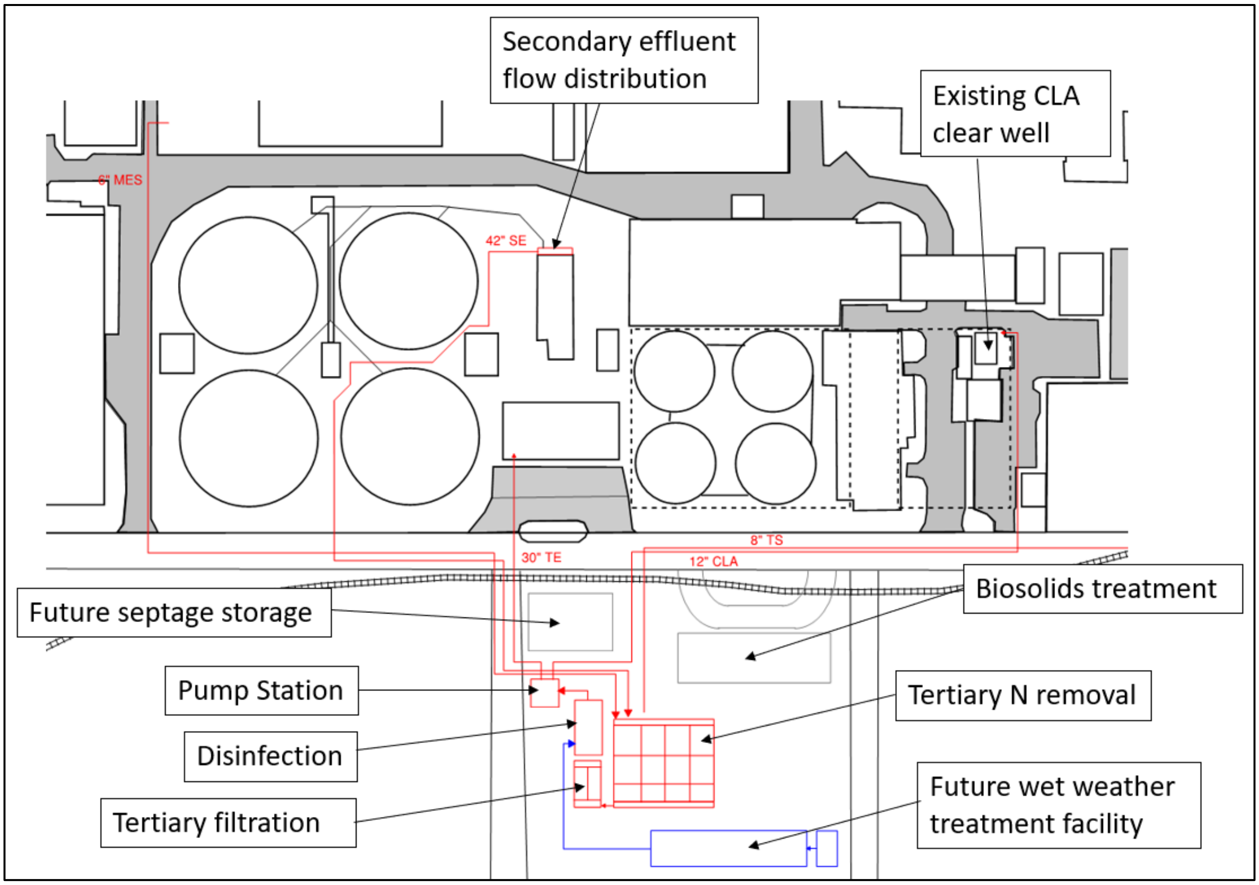


Figure 5-13. Alternative 2A. Facilities on Adjacent Parcel

Facilities already planned for the adjacent parcel include the wet weather treatment facility, a relocated septage receiving station and storage, and a septage storage tank, and a biosolids treatment facility. The tertiary treatment facilities still have ample room to fit into the site plan. In this case, a single large diameter pipe would need to weave its way through the existing secondary clarifiers to get to the adjacent parcel. It is likely that the low-voltage duct bank could be avoided with this pipe run. Effluent from the tertiary facility would be pumped to the Effluent Pump Building, where it would be mixed with secondary effluent and pumped to the North Outfall. Since Alternative 2B would have a tertiary disinfection facility, operation of the existing sand filter BIRWP would no longer be necessary. The existing clear well and distribution pumps could be used for storage and distribution. The rest of the facility could be decommissioned. As with Alternative 2A, this alternative would send 3 mgd of CLA to the Reclaimed Water Storage Tank for distribution to beneficial end uses.

5.2.5 Alternatives Comparison

Alternatives 2A and 2B are compared in Table 5-4. The capital cost comparison is detailed in Table 5-5.

Table 5-4. Relative Comparison of Alternatives 2A and 2B

Factor	Alternative 2A	Alternative 2B
Advantages	• Increased clarifier capacity • End up with one more secondary clarifier than Alternative 2B	• Disconnects tertiary facilities from existing hydraulic profile (more flexibility on design)
Disadvantages	• Effectively paying the cost of one secondary clarifier for space • Not possible if adjacent parcel is not available • Some risk that hydraulics will not work without pumping • More pipe routing complexity through congested areas	• May require construction of disinfection facility and effluent pump station right away (although both could be dual-use with future wet weather facility)
Cost	$54.2M	$37.9M

Table 5-5. Cost Comparison between Alternatives 2A and 2B [a,b]

Element	A	B
Southeast secondary clarifier demolition	$835,000	$0
Effluent distribution box	$3,273,000	$2,418,000
Yard piping to tertiary system	$889,000	$3,250,000
Mixed liquor distribution box	$450,000	$0
Yard piping to/from new clarifiers	$3,889,000	$0
Two new secondary clarifiers	$25,562,000	$0
Tertiary N removal	$15,748,000	$15,748,000
Tertiary filtration	$6,639,000	$6,639,000
CLA piping	$279,000	$346,000
Piping within tertiary site	$3,270,000	$151,000
Disinfection facility	$0	$8,480,000
Effluent pump station	$0	$4,570,000
Total	$60,834,000	$41,602,000

[a] *Costs are total project costs, which include direct costs, bid costs (12% contractor overhead and markup; 15% contractor general conditions; 2% startup, training, and manuals; 35% contingency; 3.5% bonds and insurance; and 9.4% sales tax), and allied costs (2.5% preliminary engineering, 15% final engineering, 7.5% construction engineering, and 5% legal, administration, and permitting).*

[b] *Hauling and disposal costs assume that 50 percent of the excavated soil is contaminated.*

While Alternative 2A offers the big advantage of an additional secondary clarifier, it carries high costs associated with pipe routing and modifications to existing electrical infrastructure. Alternative 2B is less expensive and carries less risk. It is more easily expandable and is less dependent upon the acquisition of additional property to the west of the BITP. Further, the $13.0M in disinfection and effluent pumping could represent savings against the future cost of a wet weather facility.

Alternatively, it may be possible to remove the disinfection facility from this alternative and pump the tertiary effluent back to the existing disinfection facility. That option would reduce the cost of Alternative 2B by approximately $7–8M.

Alternative 2B will be the primary focus for comparing the Enhanced Effluent Quality Alternative to other alternatives in this assessment.

5.2.6 Implementation

The Enhanced Effluent Quality Alternative is projected to require 8.5 mgd of treatment by 2030, 8.8 mgd of treatment by 2050, and 13.1 mgd of treatment with full connection. The costs presented to this point represent a 15 mgd system, sized for the full connection scenario. Realistically, a 15 mgd system is unlikely to be necessary, and certainly not in the near term. Given the uncertainty over future performance, the actual need may range from close to zero (if the BITP can perform the way it did in 2021) to the 13.1 mgd mentioned above.

There are reasons to suggest that performance might improve. These include the natural operational adjustments associated with lower effluent targets, anticipated optimization and performance improvements associated with the biological process improvements project, and a number of other potential adjustments:

- Limiting discharge of septic tank solids during the August/September time frame
- Providing alkalinity supplementation to support nitrification under slug load conditions
- Implementing side stream treatment of dewatering centrate

Depending on the outcome of these modifications, they may be able to allow for a delay in implementation or reduce the scope of implementation.

For cost-saving purposes, it might make sense to construct only half of the 15-mgd facility in the near-term. A near-term implementation might cost as little as $26.8M, including the elements in Table 5-6.

Table 5-6. Elements Needed for Near-Term Implementation of High Quality Effluent Alternative

Element	Cost
Tertiary nitrogen removal facility 7.5 mgd	$9,418,000
Tertiary filtration facility built to 15 mgd but with 7.5 mgd of equipment	$5,059,000
Tertiary effluent pump station	$4,570,000
Tertiary yard piping, including $1M allowance for effluent pipeline to existing disinfection	$7,164,000
BIRWP modifications for CLA disinfection	$600,000
Total	$26,812,000

[a] Costs are total project costs, which include direct costs, bid costs (12% contractor overhead and markup; 15% contractor general conditions; 2% startup, training, and manuals; 35% contingency; 3.5% bonds and insurance; and 9.4% sales tax), and allied costs (2.5% preliminary engineering, 15% final engineering, 7.5% construction engineering, and 5% legal, administration, and permitting).

Ultimately, the system could be built out to 15 mgd, and linked to the future wet weather facility, as needed.

Additional costs for this alternative include upgrading the CLA distribution pumps to send 3 mgd of flow to the Reclaimed Water Storage Tank. No additional pipelines would be required, nor would any groundwater recharge basins need to be constructed. The 3 mgd of reclaimed water would satisfy all projected stakeholder demands through 2050 but might need to be supplemented after 2050.

A system-wide view of Alternative 2 is provided on Figure 5-14.

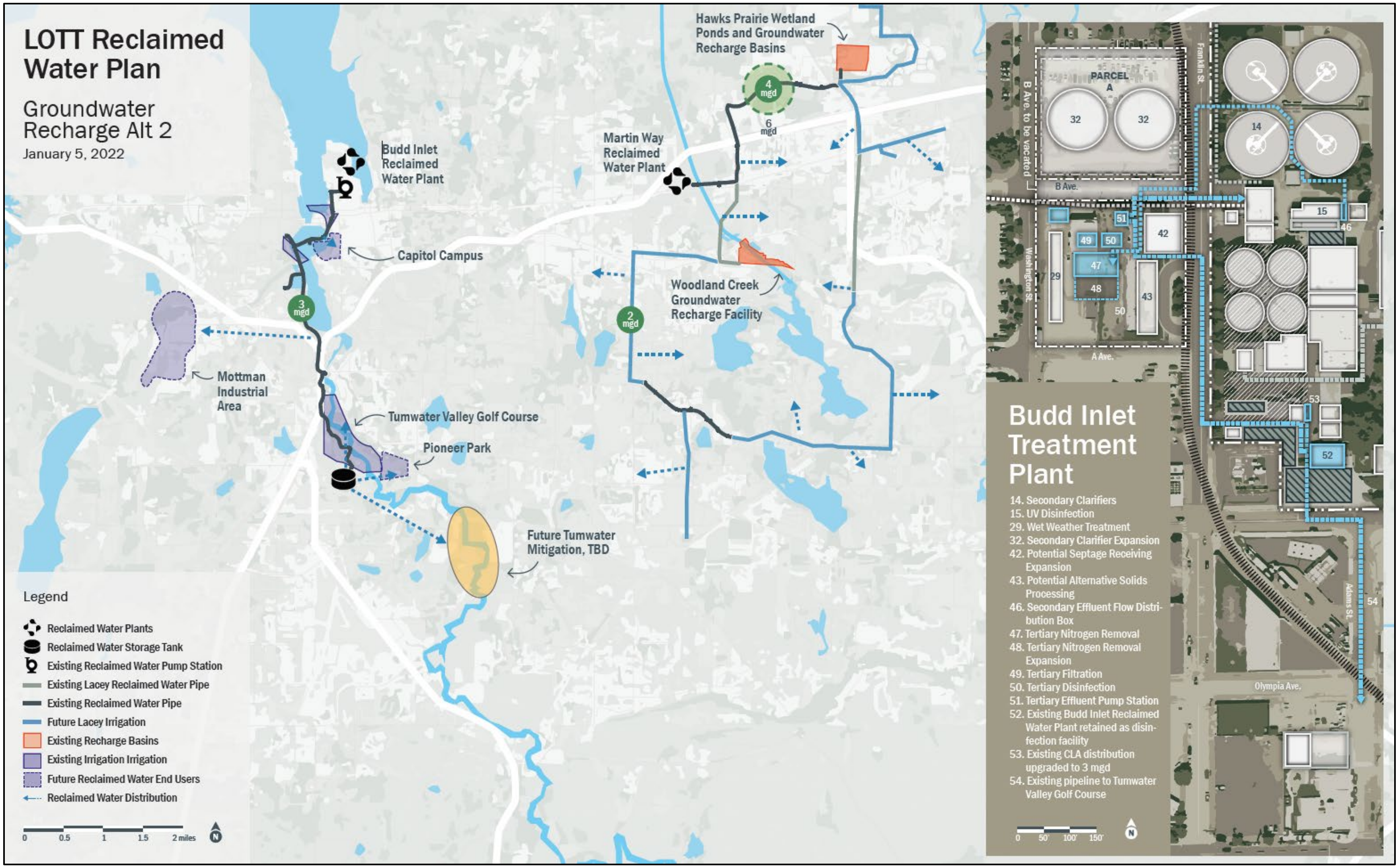


Figure 5-14. Alternative 2

5.3 Reuse Product Extension

Demand and/or future regulatory requirements may lead to treatment of reclaimed products to higher than Class A standards. Higher levels of treatment remove additional constituents from the water product and allow for more types of end uses, up to and potentially including potable reuse.

Alternative 2, with tertiary nitrogen removal, provides a potential pathway to a higher quality product, particularly if a membrane filtration system is used as the tertiary filter. This produces a tertiary effluent which would be compatible with more advanced treatment processes, such as reverse osmosis.

In the near term, a pilot system could include a small, advanced treatment facility, with either reverse osmosis or some combination of biologically activated carbon, granular activated carbon, and advanced oxidation processes. The facility would generate potable-quality water. This water could initially be used for demonstration purposes and be designed to be expandable, with expansion and distribution linked to demand.

Figure 5-15 presents a process flow schematic for this concept.

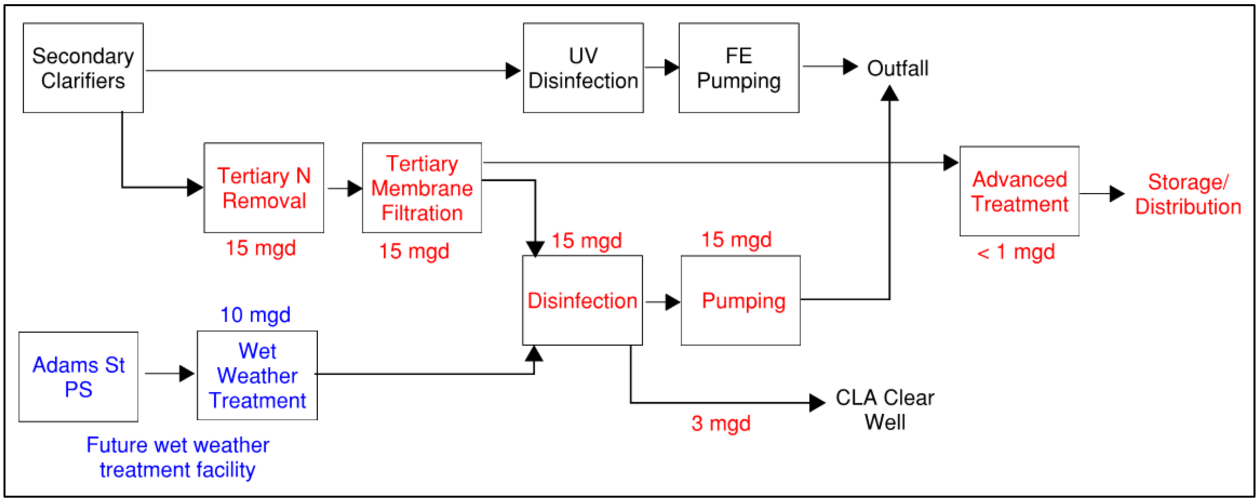


Figure 5-15. Process flow schematic for Alternative 3

Section 6

Alternatives Comparison

The alternatives developed in Section 5 provide two different pathways for LOTT to manage its discharge capacity regulation and its water reclamation program. Alternative 1 is focused on alternative discharge through groundwater recharge and Alternative 2 maximizes Budd Inlet discharge by improving the BITP effluent quality. Alternative 2 provides the flexibility to add additional treatment processes should demand for a higher quality water product develop, or be required, in the future. The alternatives already overlap in many key areas. All continue to expand the MWRWP as quickly as possible, with water rights mitigation at the WCGRF, beneficial end uses throughout the service area, groundwater recharge at the HPRBs, and 3 mgd of Class A reclaimed water for distribution through the Reclaimed Water Storage Tank in Tumwater to meet projected demands in that area.

The alternatives are designed such that the plan may shift from one to the other, as demands develop and needs change. The purpose of this section is to compare the costs and relative benefits of the alternatives.

6.1 Treatment, Supply, and Performance Comparison

Table 6-1 presents a comparison of the two alternatives at the 2050 condition.

Table 6-1. Comparison of alternatives, 2050 condition

Title	Alternative 1 Groundwater Recharge	Alternative 2 Enhanced Effluent Quality
Class A reclaimed water production		
MWRWP	4 mgd	4 mgd
BITP	8 mgd	15 mgd
Total	12 mgd	19 mgd
Class A reclaimed water distribution		
MWRWP	4 mgd	4 mgd
Reclaimed Water Storage Tank	3 mgd	3 mgd
Groundwater recharge		
HPRB	Up to 4 mgd	Up to 4 mgd
WCGRF	Up to 1.3 mgd	Up to 1.3 mgd
South Deschutes	5 mgd	–
Annual mass discharge to Budd Inlet		
BOD	162,000	155,000
TIN	152,000	135,000

As summarized above, the alternatives are similar in many respects. The key difference is that Alternative 1 aims to keep reclaimed water production to the minimum level required to meet the discharge limit, pumping 5 mgd of product to the South Deschutes Recharge Basins. Alternative 2 produces an enhanced quality effluent, allowing for discharge of more flow to Budd Inlet, while maintaining compliance with mass-based discharge limits. By nature of the tertiary technology, the discharge from Alternative 2 would be consistent with Class A reclaimed water standards, so Alternative 2 would end up generating a large amount of reclaimed-quality effluent, which could be directed to a variety of end-uses should the demand arise (additional reclaimed water distribution would be needed to convey more than 3 mgd from the BITP to the Reclaimed Water Storage Tank).

Ecologically, annual mass loadings to Budd Inlet would be similar. Alternative 2 would offer a slight advantage, with approximately 4 percent less BOD loading and 11 percent less TIN loading. Because the tertiary treatment system would be sized to treat 10-year peak month flows during the shoulder season, the system would actually have the capacity to treat 100 percent of the BITP flow for most of the year. The only times when the system could not treat full flow would be during wet weather events. The advantage would shift to Alternative 1 in the full connection scenario, due to the increased groundwater recharge volumes.

6.2 Cost Comparison

A capital cost comparison of the alternatives is presented in Table 6-2. The table excludes certain costs which are common to both alternatives, such as expansion of the MWRWP.

Table 6-2. Capital cost comparison [a]

Component	Alternative 1 Groundwater Recharge	Alternative 2 High Effluent Quality
2050 costs		
Tertiary nitrogen removal	$0	$15,748,000
Tertiary filtration	$22,270,000	$6,639,000
Tertiary disinfection	$3,540,000	$8,480,000
Tertiary pumping	$8,153,000	$4,570,000
BIRWP modifications	$7,185,000	$1,754,000
Pipelines	$55,938,000	$6,164,000
Recharge basins [b]	$18,854,000	$0
Advanced treatment facilities	$0	$0
2050 total	**$115,939,000**	**$43,355,000**
Full connection costs		
Treatment expansion	$20,491,000	$0
Pumping expansion	$1,730,000	$0
Pipeline expansion	$27,969,000	$0
Recharge expansion	$15,083,000	$0
Advanced treatment facilities	$0	$0
Full connection total	**$65,273,000**	**$0**
Total	**$181,213,000**	**$43,355,000**

[a] *Costs are total project costs, which include direct costs, bid costs (12% contractor overhead and markup; 15% contractor general conditions; 2% startup, training, and manuals; 35% contingency; 3.5% bonds and insurance; and 9.4% sales tax), and allied costs (2.5% preliminary engineering, 15% final engineering, 7.5% construction engineering, and 5% legal, administration, and permitting).*

[b] *Recharge basin cost does not include addition site investigations and land purchase for sites beyond the South Deschutes site, which will almost certainly be required.*

There is a wide spread in capital costs, particularly if one considers the full connection scenario. While the tertiary modifications present in Alternative 2 would provide ample discharge capacity, even with full connection, Alternative 1 would require successive stages of implementation, with $65M projected in costs after 2050.

Even without considering such costs, and only looking at the 2050 scenario, there is a $73M difference between Alternatives 1 and 2. Alternative 2 is clearly the less expensive option, by a wide margin.

Table 6-3 compares the alternatives on the basis of annual operating costs. As with Table 6-2, this comparison excludes certain items common to both alternatives, such as treatment at the MWRWP.

Table 6-3. Annual Operating Cost Comparison [a]

Component	Alternative 1 Groundwater Recharge	Alternative 2 High Effluent Quality
Treatment power	$140,000	$150,000
Pumping power	$281,000	$121,000
Carbon	$0	$184,000
Hypochlorite	$123,000	$10,000
Polymer	$90,000	$0
Labor	$158,000	$158,000
Total	**$792,000**	**$623,000**

[a] *Cost assumptions include power cost of $0.09/kwh (includes demand charge), labor cost of $150,000/year, methanol cost of $2.00/gal, hypochlorite cost of $1.50/gallon, and polymer cost scalable to the $30,000/year spent in 2016 at the BIRWP.*

Alternative 2 is projected to have slightly lower annual operating costs compared to Alternative 1. The largest cost associated with Alternative 1 is pumping from the BITP to the South Deschutes Recharge Basins ($207,000 per year). The largest cost associated with Alternative 2 is supplemental carbon for the tertiary nitrogen removal step. The $184,000 annual cost assumes methanol priced at $2.00 per gallon. Alternative carbon sources such as sodium acetate or MicroC could be more expensive. Alternative 2 also includes $125,000 in disinfection. However, that cost would be offset by savings at the existing disinfection facility, so the values in Table 6-2 should be viewed as conservative in that respect.

Clearly, the annual costs reported in Table 6-2 do not change the life cycle cost comparison. With up to $142M in savings compared to Alternative 1, and a lower annual operating cost, Alternative 2 is the most cost-efficient alternative.

6.3 Sensitivity Analysis

One of the largest uncertainties in this analysis is future performance of the BITP. As discussed several times throughout this plan, there is a wide spread in historical performance, comparing the 90th percentile performance from 2016-2020 against the excellent performance observed in 2021 when operations staff were actively trying to reduce effluent BOD and TIN concentration as low as possible. Further complicating the matter are planned improvements which should increase the reliability of process operation. If performance improves, how would that affect the alternatives analysis? In general, Alternative 2 is the more flexible alternative. Tertiary systems could be implemented relatively quickly, and the size of such systems could be modified to match future conditions. Alternative 1 incudes more long-term investments such as pipelines and pump stations, and includes property acquisition and investigation tasks which can take years to develop. Further, Alternative 2 is more likely to benefit from advances in technology, making tertiary systems less expensive and easier to integrate into the site, while Alternative 1 is more dependent on infrastructure.

A key variable in this analysis is end-use demand. If demand increases beyond the projection (either for water rights mitigation or other end-uses), how do the alternatives compare? The limiting factor for supply would be the reclaimed water pipeline from the BITP to the Reclaimed Water Storage Tank, which has a conveyance capacity of 3 mgd. This limitation is common to both alternatives. If demand were to increase on that side of the system, a new pipeline would be required. For

Alternative 1, it may be possible to design the BITP to South Deschutes pipeline in a way that a flow diversion point exists near the golf course, allowing for future diversion of a portion of the flow. Alternative 2 would require a new pipeline from the BITP to the storage tank ($10–15M, depending on the capacity). Neither alternative would be likely to require more treatment, as Alternative 1 would have a surplus of 5 mgd of reclaimed water, and Alternative 2 would have a surplus of 12 mgd of reclaimed water.

Alternative 1 carries some risk related to groundwater infiltration. Class A reclaimed water contains a variety of residual chemicals. The degree to which these chemicals are removed by soil percolation varies, and some chemicals may get into the groundwater. There is some risk that future regulations may require more advanced levels of treatment for groundwater recharge, such as reverse osmosis, biologically activated carbon, granular activated carbon, and/or advanced oxidation processes. This treatment could easily double or triple the life cycle cost of Alternative 1. Similar treatment would be required for reclaimed water produced for groundwater infiltration or reuse under Alternative 2, although the volume of such flow would be lower (including flows at the MWRWP, Alternative 1 would generate 11.7 mgd of reuse and/or recharge flow, while Alternative 2 would generate 6.9 mgd of such flow).

Another risk related to Alternative 1 is locating applicable sites for groundwater recharge. Although the geology near the South Deschutes site appears favorable to infiltration, the South Deschutes site itself may only offer 1.5 mgd of capacity, and additional sites have not yet been identified.

Alternative 2 carries some risk that NPDES regulations will change. Historically, Ecology has tightened limits as BITP performance has improved. Further reduction of either the TIN or BOD mass limits would reduce the benefit of tertiary treatment and could create new discharge limitations. Alternative 1 would carry a similar risk; the difference is that the high standard of performance achieved with tertiary treatment might spur additional regulations that would otherwise be deemed too restrictive. If Alternative 2 is implemented, it will be in LOTT's best interest to make sure that the Department of Ecology is familiar with the decision-making process, and with this particular aspect of it. If possible, it would be beneficial to seek assurance with Ecology, in written form, or perhaps as part of the SEPA process.

Demand for higher quality product could increase dramatically in the future, with the possibility of water shortages and climate change. Alternative 2 can transition to a higher quality product fairly easily, with tertiary membrane filtration and an advanced treatment facility placed downstream of the tertiary treatment facility. For Alternative 1, a change in the quality of demand would be a major paradigm shift. There would be a risk that the pipelines and groundwater recharge basins could become a sunk investment

The proposed Budd Inlet / Capitol Lake TMDL includes new limits for TN and TOC, and monthly winter limits for TIN. While these new limits do not change the plan in terms of what is presented in Tables 6-1 through 6-3, they may influence the risk assessment. Alternative 2 would provide a facility offering year-round effluent nitrogen removal. While the plant, as currently designed, should be able to meet the proposed winter TIN limits, a tertiary system would make it easier to meet those limits, and provide for more operational control. Likewise, the tertiary filtration associated with Alternative 2 would reduce risk with respect to effluent TOC.

6.4 Recommendation

Historically, LOTT's reclaimed water program, and the Highly Managed Plan, has been on the path of Alternative 1. Long-range capital planning has envisioned spending well over $100M in infrastructure to send Class A reclaimed water to a network of groundwater recharge basins.

Innovations in tertiary treatment have shown that plants can achieve very low effluent TIN and BOD concentrations with the appropriate technology. These technologies have the potential to effectively negate the limit of discharge volume that is currently in place due to the mass-based NPDES permit limits. This could eliminate the need for alternative discharge. As envisioned in Section 5 of this report, the Enhanced Effluent Quality Alternative, discharging 56 percent more annual flow to Budd Inlet, would actually have lower effluent mass loadings of BOD and TIN than Alternative 1 through 2050. Shifting its program to one emphasizing tertiary treatment, while still providing enough reclaimed water to meet community and stakeholder needs, has the potential to save $76M in capital costs over the next 30 years and $142M into the future. Alternative 2, Enhanced Effluent Quality, is the recommended alternative.

Implementation of Alternative 2 should be accomplished using the philosophy of just-in-time planning established as part of the Highly Managed Plan. Just-in-time planning allows for the size and scope of upgrades to match actual needs. Currently, there is a large uncertainty over how well the BITP will perform after the biological process improvements project is complete, and after other process modifications and upgrades have been implemented. As time passes, and more data are collected on operation with those improvements in place, the uncertainty will gradually decrease. The following factors all contribute to the size and scope of tertiary improvements associated with Enhanced Effluent Quality:

- Performance of the BITP in terms of effluent BOD
- Performance of the BITP in terms of effluent TIN
- Flow and load projections
- End-use demands from the LOTT partners and stakeholders
- Implementation schedule for the Capitol Lake and Budd Inlet TMDL
- Implementation of the Puget Sound Nutrient General Permit
- Expansion schedule for the MWRWP

Each of these factors should be tracked and reviewed annually, and the implications for risk should determine the timing of implementation.

In the meantime, it is recommended that enhanced treatment technologies be piloted at the BITP to better understand the relative advantages and disadvantages of the competing technologies.

Section 7

Capital Improvements Plan

New, more restrictive TMDL-based limits for BOD and TIN are likely to be applied within the next 5 years. Once imposed, LOTT will immediately face some risk of a mass-based effluent violation for BOD. Under a worst-case risk scenario, LOTT would need to apply 8.5 mgd of tertiary treatment by 2030. The following projects are planned within the next 10 years:

- Finishing the process improvements project (2023)
- Digester improvements (2025): $30M
- Air handling improvements (2026): $4.8M
- Centrate Building rehabilitation (2024): $4.3M
- Collection system rehabilitation (2023): $4.6M
- MWRWP improvements (2026): $7.0M
- North Outfall upgrades (2027–33): $7.9M
- Sludge thickening upgrades (2027–33): $4.3M
- Biogas treatment upgrades (2027–33): $6.3M
- Electrical replacements (2027–33): $11.2M
- MWRWP membrane replacement (2027–33): $20.8M

The following other projects are currently under consideration for this same time frame:

- Centrate treatment: $5.8M
- Advanced biosolids treatment: $15–20M
- BIRWP expansion: $8.1M
- MWRWP expansion to 3 mgd: $8.5M
- MWPS flow equalization basin: $10M

With so many projects in the near-term horizon, full implementation of Alternative 2 does not appear reasonable. A more practical approach would be to phase implementation, as outlined in Table 5-6. A phase 1 project would provide 7.5 mgd of treatment and cost $26.8M. The timing of this project would be determined by performance of the BITP and the factors described at the end of Section 6.

The partially implemented Alternative 2 would differ from full implementation in the following ways:

- Build only two out of the four trains for the tertiary N removal system
- Build the entire tertiary filtration system, but only install half the equipment
- Do not build the tertiary disinfection system
- Pump 1.5 mgd of tertiary effluent to the existing BIRWP for Class A disinfection
- Pump the rest of the tertiary flow back to the BITP disinfection facility, using the same pipe routing as the 42-inch secondary effluent piping

In the future, if the facility needs to double its capacity, that could be accomplished in the following ways:

- Building the second half of the tertiary N removal facility
- Installing equipment for the second half of the tertiary filtration facility
- Either installing the tertiary disinfection facility (which will service double-duty as the wet weather disinfection facility) or expanding class A disinfection capacity at the former BIRWP

LOTT maintains a detailed 6-year Capital Improvement Plan to coordinate near-term budgeting and a high-level long-range program to develop budgetary strategies. These strategies are summarized in each biennial Budget and Capital Improvements Plan report. Table 7-1 summarizes the projects and potential projects that have been developed as part of this update. The list includes the projects under consideration listed above. The only project from that list that doesn't appear below is advanced biosolids treatment. The advanced biosolids treatment system is still under investigation. If the decision is made to implement, that project could replace the centrate treatment project in the same time frame.

Details on these estimates are provided in Appendix A. Note that some of these estimates have been developed further beyond the estimates reported in Section 4 and 5 of this report, and therefore may appear different in this table. The timing of the projects in Table 8-1 will depend on operational performance, and on the TMDL implementation.

Table 7-1. Projects to be Added to the CIP

Project	Purpose	Total Cost [a, b]
First half of tertiary treatment facility	NPDES compliance	$26.8M
Second half of tertiary treatment facility	As needed, for NPDES compliance	$16.4M
MWPS flow equalization facility	To allow MWRWP expansion	TBD
MWRWP expansion to 3 mgd	NPDES compliance	$8.5M
CLA distribution pumping expansion	To meet stakeholder demands for reclaimed water	$1.2M
Centrate treatment (if advanced biosolids treatment is NOT implemented)	BITP capacity expansion	$5.8M
MWRWP expansion to 4 mgd	NPDES compliance	$8.5M
MWRWP expansion to 5 mgd	NPDES compliance	$31.4M
MWRWP distribution pipeline expansion	The pipeline is currently limited to 4 mgd	$12.7M
MWRWP expansion to 6 mgd	NPDES compliance	$8.5M

[a] *Class 5 cost estimates with a range of -50% to +100%.*

[b] *Costs are total project costs, which include direct costs, bid costs (12% contractor overhead and markup; 15% contractor general conditions; 2% startup, training, and manuals; 35% contingency; 3.5% bonds and insurance; and 9.4% sales tax), and allied costs (2.5% preliminary engineering, 15% final engineering, 7.5% construction engineering, and 5% legal, administration, and permitting).*

Table 7-2 lists projects to be removed from the long-range Capital Improvements Plan, including the catch-all Southern Recharge Conveyance and Development, which comprises a variety of treatment systems, pipelines, and groundwater recharge basins along the Deschutes River Corridor.

Table 7-2. Projects to be Removed from the CIP

Project	Total Cost
BIRWP expansion	$8.1M
Henderson recharge basins	$9.9M
Southern recharge conveyance and development	$332M

Given that groundwater recharge would not be necessary beyond that at the HPRBs, the WCGRF, and potential future sites developed by the partners, LOTT would be free to sell off some of its properties. Specifically, the Henderson South, Henderson North, Rixie Road, South Deschutes, and the Deschutes Valley Property. While none of these sites is projected to be necessary per the recommended alternative, there may be some advantage to maintaining possession of certain sites from a risk management perspective. Of the currently-owned sites, the South Deschutes property has the most potential for groundwater recharge, and would be the most favorable for streamflow augmentation of the Deschutes River. Of the smaller sites to the north, the Henderson North site is the closest to the Reclaimed Water Storage Tank and would be best-positioned to accept surplus from the existing distribution system. Both of these sites could provide LOTT with flexibility for future planning, and could also, potentially, contribute to future water rights mitigation for the City of Tumwater. For these reasons, the recommendation is to sell the Henderson South, Rixie Road, and Deschutes Valley Properties as part of implementation of the recommended alternative. The Mullen Road property, which was a part of a previous plan to develop a satellite reclaimed water plant in southern Lacey, has no relationship to any of the alternatives presented in this plan, and may also be sold.

Section 8

Limitations

This document was prepared solely for LOTT in accordance with professional standards at the time the services were performed and in accordance with the contract between LOTT and Brown and Caldwell dated July 6, 2020. This document is governed by the specific scope of work authorized by LOTT; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by LOTT and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

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Appendix A: Cost Estimates

Appendix B: Site Maps