Budd Inlet Treatment Plant Master Planning Update

Prepared for

LOTT Clean Water Alliance

Olympia, WA

May 6, 2020

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List of Abbreviations

μg/L	micrograms per liter
BIRWP	Budd Inlet Reclaimed Water Plant
BITP	Budd Inlet Treatment Plant
BOD	biological oxygen demand
CEPT	chemically enhanced primary treatment
cf	cubic feet
CARRB	centrate and RAS reaeration basin
CSO	combined sewer overflow
DAF	dissolved air flotation
DAFT	dissolved air flotation tank
EQ	equalization
GBT	gravity belt thickener
gpd	gallons per day
IPS	influent pump station
lb/d	pound(s) per day
$lb/ft^2/d$	pound(s) per square foot per day
$lb/ft^3/d$	pound(s) per cubic foot per day
LM	linear mixing
LOTT	LOTT Clean Water Alliance
MG	million gallons
mgd	million gallons per day
$MgCl_2$	magnesium chloride
ml	milliliter
MWRWP	Martin Way Reclaimed Water Plant
NPDES	National Pollutant Discharge Elimination System
RAS	return activated sludge
RDT	rotary drum thickener
SLR	sea level rise
STEP	septic tank effluent pumping
THP	thermal hydrolysis process
TIN	total inorganic nitrogen
TSS	total suspended solids
UGA	urban growth area
UV	ultraviolet
WAS	waste activated sludge

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, Plant) is LOTT's most valuable capital asset and is the focus of this master planning update. Located in downtown Olympia, BITP is a Type 2 Essential Public Facility (OMC18.04.060) providing wastewater treatment capacity and reclaimed water production for the LOTT service area.

In the 1990s, LOTT adopted a "highly managed" approach to wastewater planning. 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 needs. The assessments fulfill planning requirements, in lieu of periodic Facility or Comprehensive Plans that would typically be required in each regulatory permit cycle.

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 Martin Way Reclaimed Water Facility in Lacey and the Budd Inlet Reclaimed Water Plant 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.

Since 2006, LOTT has undertaken a number of upgrade projects at the BITP that culminated with an ongoing upgrade to the secondary process. LOTT is also undertaking the first comprehensive set of upgrades and replacements at the Martin Way Reclaimed Water Facility. With these developments, and with a changing set of regulatory drivers for both wastewater discharge and reclaimed water disposition, LOTT has commissioned this first phase of work to update master planning. This phase focuses its attention on the BITP and presents a long-term road map to providing wastewater treatment capacity at this location. The Update presents a vision of what the BITP may look like at service area build out, and how the utility will continue to produce a high-quality product given the projected increase in influent flows and loads.

Future phases of master planning will address overall system capacity, with a focus on reclaimed water production capacity at BITP and at the Martin Way Reclaimed Water Plant and options for an updated regional reclaimed water strategy.

Section 2

Background

This section provides background for this Update. It includes details on BITP's history, design, regulatory status, and planning horizon.

2.1 History

The BITP was originally built in 1949 as a primary treatment facility. As a primary plant it removed approximately 50 to 60 percent of incoming pollutants. In the early 1980s, the City of Olympia expanded the plant site and upgraded to secondary treatment, which effectively removed 90 to 95 percent of the incoming pollutants. In 1994, LOTT completed a nutrient removal expansion which, in addition to increasing the removal rate up to 98 percent, also allowed for seasonal nitrogen removal. Tertiary treatment was added in 2004, with the completion of a 1.5 million gallons per day (mgd) Class A Reclaimed Water Facility.

Changes since 2004 include construction of a new primary clarification facility, upgrades to the secondary clarifiers, a new dewatering facility, and a centrate storage and handling facility. Currently, LOTT is completing a major upgrade to its UV disinfection system and is about to begin a major renovation of its secondary biological process.

2.2 Design

The BITP's rated design criteria were established as part of the 1994 nutrient removal upgrades. The design criteria, as listed in its National Pollutant Discharge Elimination System (NPDES) permit, include:

- Maximum month design flow: 28 mgd
- Maximum day design flow: 55 mgd
- Peak hourly design flow: 64 mgd
- Maximum month biological oxygen demand (BOD) load: 37,600 pounds/day (lb/d)
- Maximum month total suspended solids (TSS) load: 35,100 lb/d

The BITP was designed to remove BOD and TSS year-round and remove nitrogen from April through October. A large portion of the sewer system in Olympia consists of combined sewers, which cause very high flows during the winter wet weather season. As part of the 1980s expansion, LOTT constructed a 2.5-million-gallon (MG) flow equalization basin to help buffer peak flows and mitigate their impact on the biological treatment process.

Figure 2-1 presents the current process flow schematic for the BITP. An overview map is provided on Figure 2-2.

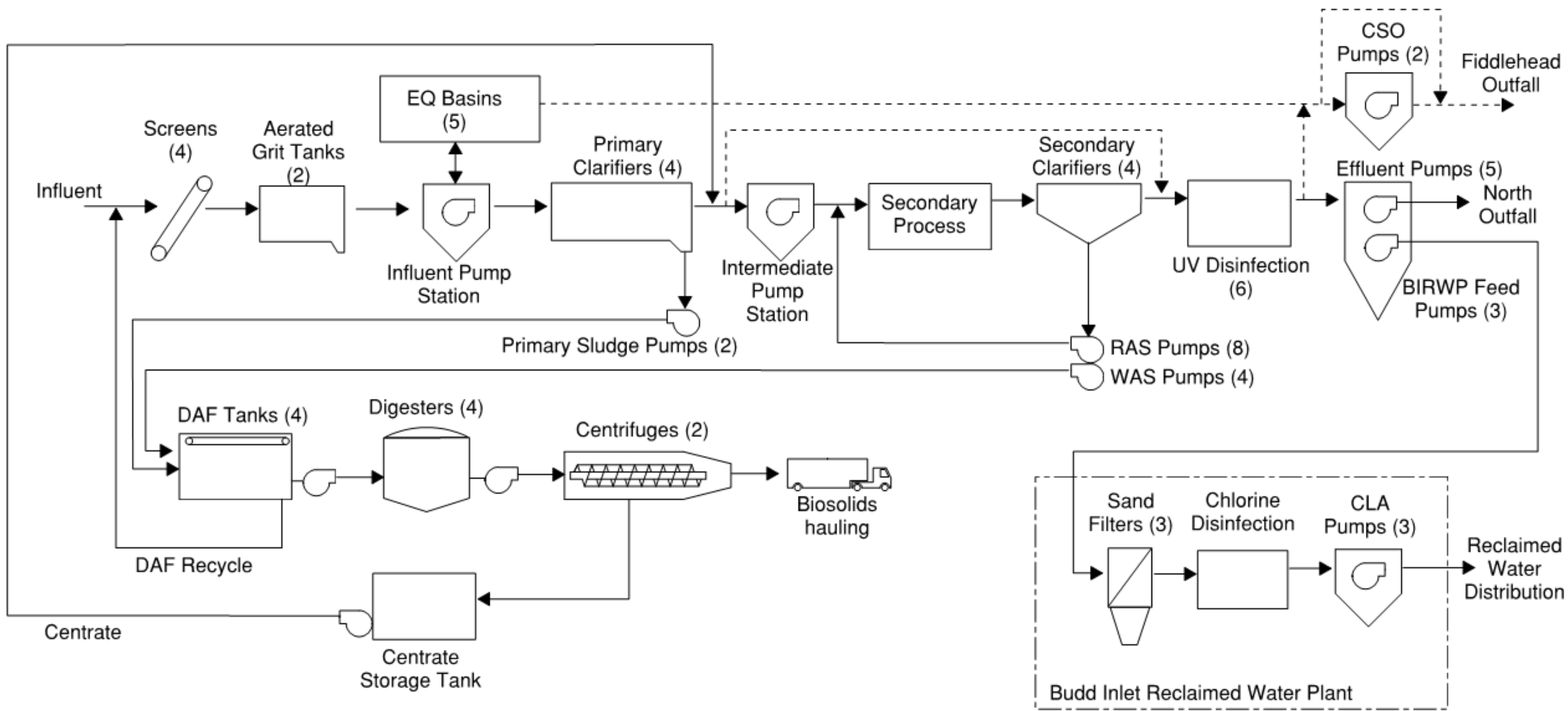


Figure 2-1. Existing process flow schematic of the BITP

Figure 2-2. BITP Facility layout

2.3 Regulatory Status

The Plant's most recent NPDES permit was issued on February 16, 2018. Permit conditions are summarized in Table 2-1.

Table 2-1. 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)		

µg/L = micrograms per liter

mg/L = milligrams per liter

ml = milliliter

TIN = total inorganic nitrogen

Of particular note are the load-based total inorganic nitrogen (TIN) limits. Given the practical limits of secondary wastewater treatment to reliably achieve an effluent TIN of less than 2 to 3 mg/L, the load-based regulation effectively limits the discharge capacity of the BITP to somewhere in the range of 15 mgd during the permit season.

2.4 Planning Horizon

As part of its highly managed plan, LOTT updates its service area flow and load projections every year. Details on those projections may be found in LOTT's annual Flow and Loadings Report. In summary, the LOTT service area consists of three types of parcels:

- Currently developed and sewered
- Currently undeveloped
- Currently developed using onsite wastewater treatment (e.g., septic tanks)

Currently sewered parcels may be expected to generate similar amounts of wastewater in the future. While some of these parcels may be developed further, with increased population and wastewater generation, most are likely to retain current zoning and land use designations and continue to generate similar amounts of wastewater as they currently do.

Undeveloped parcels within the cities of Olympia, Tumwater, Lacey, and their respective urban growth areas (UGA) are expected to be developed per current zoning and land use designations. These parcels will gradually be connected to sewer and contribute the bulk of increased flows and loads observed in the future. LOTT, working in concert with the Thurston County Regional Planning Council, has estimated full build out of the cities and UGAs by 2050. LOTT's planning assumes that by 2050 there will be no undeveloped parcels left in the service area.

Parcels with existing septic tanks are expected to gradually connect to the sewer system. In some cases, this will be driven by regulations. In other cases, it may be incentivized, either by LOTT, the cities, or by other environmental considerations. As existing systems age and reach the end of their expected service life, the likelihood of conversion is expected to increase. Currently, LOTT projects that 35 percent of existing onsite systems will be converted to sewer connections by 2050.

Table 2-2 summarizes the most recent population and flow projections for the LOTT service area. For this Plan Update, two future conditions are considered:

- 2050: projected service area build-out, with full sewering of all developed parcels and conversion of 35 percent of existing onsite treatment systems
- Full connection: the 2050 case with conversion of 100 percent of existing onsite treatment systems

Table 2-2. Service Area Population, Flow, and Load Projection Summary

	Current	2050	Full Connection
Population	175,487	241,237	241,237
Employment	115,190	151,818	151,818
Sewered population	116,743	182,283	241,237
Sewered employment	94,268	138,854	151,818
Summer flow, mgd	12.3	18.5	23.0
Shoulder flow, mgd	14.0	20.4	25.1
Peak month flow, mgd	20.7	27.8	33.2
Average BOD, lb/d	28,126	42,665	52,159
Average TSS, lb/d	27,322	41,444	50,666

The 2050 projection foresees close to 30 percent expansion of the service population, with dry season flows increasing by up to 33 percent and maximum month flows increasing by 25 percent.

The full connection projection brings another 60,000 residents and 13,000 employees onto sewer, with approximately 46 percent increase in wastewater flows and loads compared to the present.

Clearly, the projected loadings and some of the flows are above the BITP's design ratings presented in Section 2.2. Summer and shoulder seasonal flows are also projected to exceed the practical limit of TIN removal consistent with the load-based regulations. One purpose of this Plan Update is to address how LOTT intends to manage these flows and loads.

2.5 Satellite Treatment

In the 2006 Plan, it was projected that up to 13 mgd of flow could be treated at satellite water reclamation facilities by 2025. Currently, satellite treatment remains limited to the original 2-mgd flow brought online at the Martin Way Reclaimed Water Plant (MWRWP) in 2006. The most recent annual capacity assessment projected that the MWRWP would be expanded to 5 mgd capacity by 2050, with the potential to expand to 7 mgd under a full connection scenario.

For this Update, it is assumed that only 3 mgd of satellite treatment is available by 2050, and 5 mgd for the full connection scenario. This is slightly more conservative assumption than that used in the annual capacity report, which adds some flexibility to this master planning effort.

2.6 Expansion of Budd Inlet Treatment Plant Site

Part of this Update includes an evaluation of the BITP's existing 14-acre site, and the potential to expand to nearby properties. This Update will determine whether all necessary processes can fit on the existing site or if not, which properties should be targeted for acquisition.

LOTT has recently acquired one such property at 516 Washington Street NE. This is the former location of the Department of Fish and Wildlife and is located immediately to the west of the BITP across Franklin Street.

2.7 Highly Managed Plan

Under LOTT's Wastewater Resource Management plan, also known as the Highly Managed Plan, LOTT is continuously planning for new system capacity to be built "just in time" to ensure future demands are met. The capacity needs evaluated on an annual basis include wastewater treatment, Budd Inlet discharge, reclaimed water use/recharge, and conveyance capacity in the entire LOTT system. The Flow and Loadings, Capacity, and Infiltration and Inflow Assessment reports are prepared annually and are used to help identify capital projects for inclusion in the annual Capital Improvements Plan (CIP).

The Flow and Loadings Report analyzes residential and employment population projections within the urban growth boundaries of Lacey, Olympia, and Tumwater and estimates the impact on wastewater flows and loadings within the LOTT wastewater system. The Inflow and Infiltration Report uses dry and wet weather sewer flow monitoring results to quantify the amount of unwanted surface (inflow) and subsurface (infiltration) water entering the sewer system and to prioritize sewer line rehabilitation projects. The Capacity Assessment Report uses flow and loadings data and I/I evaluation results to analyze system components (i.e., conveyance, treatment, and discharge), determine when limitations will occur, and provide a timeline for new system components and upgrades. This Update is intended to supplement these annual reports, with a focus on long range strategic planning and site use. For details on the science and engineering behind the flow and loading projections and capacity assessments, please refer to the annual reports.

Section 3

Facility Needs Assessment

Facility needs are tracked and updated each year as part of LOTT's annual capacity assessment and capital planning work. Facility needs are defined based on capacity needs, performance improvements, or repair and replacement work. Needs are developed based on capacity modeling, asset management activities, and staff-directed feedback.

On a biannual basis, LOTT publishes a budget and CIP that summarizes upcoming projects. LOTT maintains a very detailed 6-year CIP, and a longer-range CIP to guide capital management.

This section will summarize process-related facility needs through 2050 and beyond. The purpose of this section is to define the work that will be needed to provide effective wastewater treatment of the projected flows and loads for the two planning scenarios established in Section 2.4 (2050 build out and full connection). In some cases, capacity expansion projects will be required. In other cases, existing facilities will need refurbishment, equipment replacement, and repairs. Finally, in some cases, projects are defined to improve treatment efficiency, reliability, or performance.

For refurbishment, repair, and replacement, near-term projects are defined based on staff prioritization and LOTT's asset management program. Longer-term projects are projected based on industry-standard guidelines of 20 years between renovation events and 75 years for a facility re-build (depending on the type of facility).

The BITP site supports multiple uses/facilities in addition to providing wastewater treatment. The facilities are divided into Process, Administrative, Storage, Public Spaces, and Parking. This Update focuses on process-related needs. The following sections are organized by process area, starting with the Headworks and proceeding to effluent pumping. For each area, facilities are defined and assigned a time frame for completion. Each section includes a zoomed in view of Figure 2-2 and highlights each process in a red box.

3.1 Headworks

The headworks facility consists of preliminary treatment (screens and grit removal) and influent pumping. Raw sewage enters the Plant via a 60-inch pipeline on Adams Street. This pipeline enters the Plant and ultimately directs flow to a four-way splitter. Sluice gates at the head of each channel control the flow to four mechanically cleaned screens that remove large debris from the influent wastewater. Screenings are conveyed to two screenings pits where chopper pumps convey ground-up screenings to two washer/compactor units.

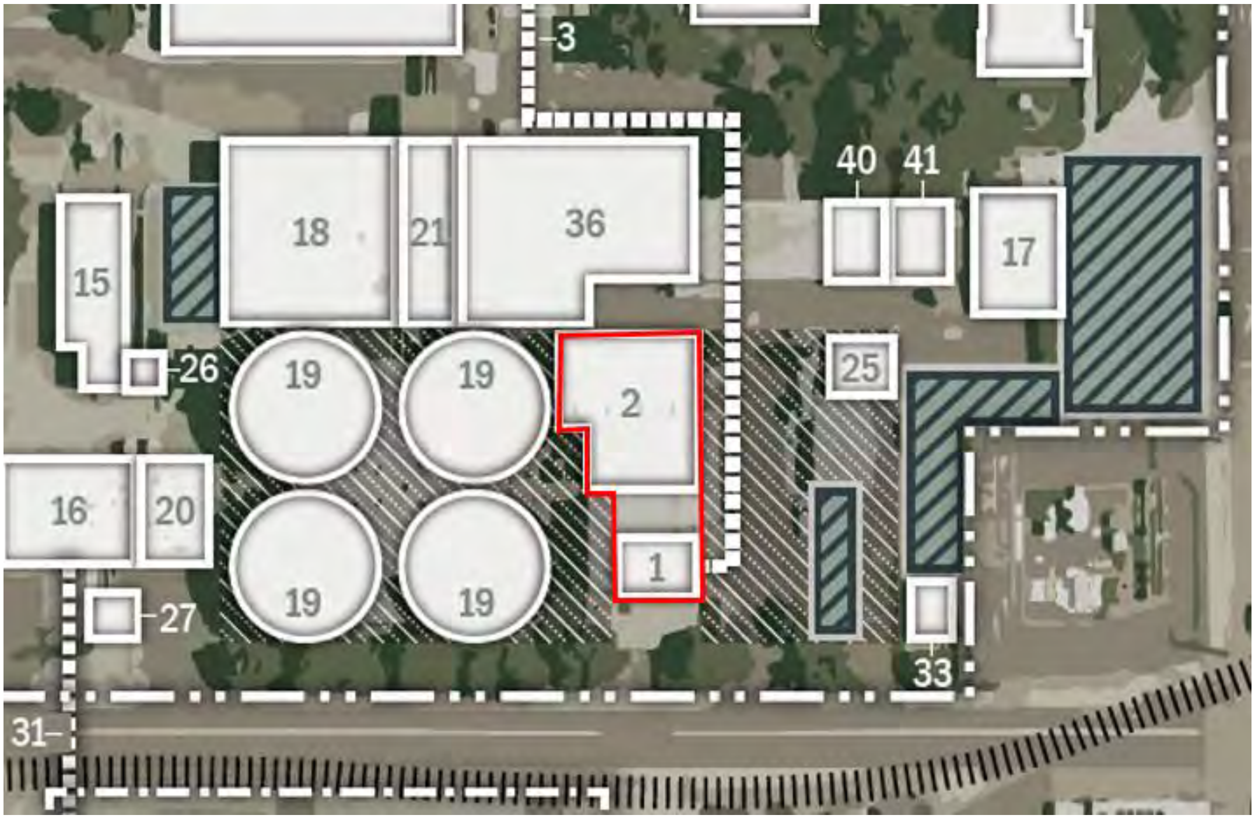


Figure 3-1. Headworks Facility

After screening, wastewater enters two aerated grit channels that remove large inorganic and organic particles. Grit collects in hoppers at the bottom of each tank and is removed by 10 grit pumps. Grit is conveyed to the grit screening/handling room where the grit is processed through two cyclone separators and grit washer/classifiers. Washed grit is stored in hoppers and then hauled offsite. Liquid supernatant from the separator and classifier is recycled to the plant influent splitter box. De-gritted sewage overflows from the grit tanks into two influent wet wells.

The influent pump station pumps flow via a pair of 30-inch force mains to the primary clarifiers.

The only projected capacity limitation in the headworks system is related to the influent pump station. The pump station works in concert with the flow equalization basins to manage peak wet weather flow events. This limitation will be discussed in the following section.

The headworks facility was constructed in 1983, with major upgrades to the screens in 2002 and to the grit tanks in 2016. Replacement of the grit cyclone separators is currently planned for 2020. A large-scale renovation of the headworks is projected for 2038. A more extensive facility re-build is projected for 2058 when the original structure will be 75 years old.

3.2 Equalization Basins

Five equalization (EQ) basins provide up to 2.5 MG of storage. The tanks fill in series as determined by the elevation of the internal weirs. The north EQ basins have the option of filling from the bottom of the wet wells rather than over the weirs. This adds the flexibility to flow pace during the summer months.

The EQ basins were constructed in 1983 and are located deep underground. The digesters, the South Scrubber, and portions of other facilities have been constructed on top of the EQ basins.

The EQ basins shown in Figure 3-2 have been maintained, as needed, since construction. A major renovation is projected in approximately 20 years, with a more expansive re-build required in 2058.

The capacity of the BITP to manage peak wet weather events is currently linked to the operation of the influent pump stations and the EQ basins. As flows increase, these systems will become increasingly limited. Previous studies have estimated that, as currently configured, these systems will not have adequate capacity to manage wet weather flows to an acceptable level of risk in the future. For this reason, a comprehensive assessment of wet weather flows and performance is included in Section 4.3 of this report.

Figure 3-2. EQ basins (hatched)

3.3 Primary Clarifiers

The primary treatment process removes easily settleable material from the screened and de-gritted wastewater. The system includes two sets of primary clarifiers totaling four basins, constructed in 2013. The primary treatment system includes magnetic flow meters that provide an estimate of primary influent flow. All of the primary clarifiers include scum collectors, surface return flight sludge collectors, and primary sludge pumps.

In addition to the primary clarifiers, the 2013 project included an odor control facility and a future chemically enhanced primary treatment (CEPT) chemical building.

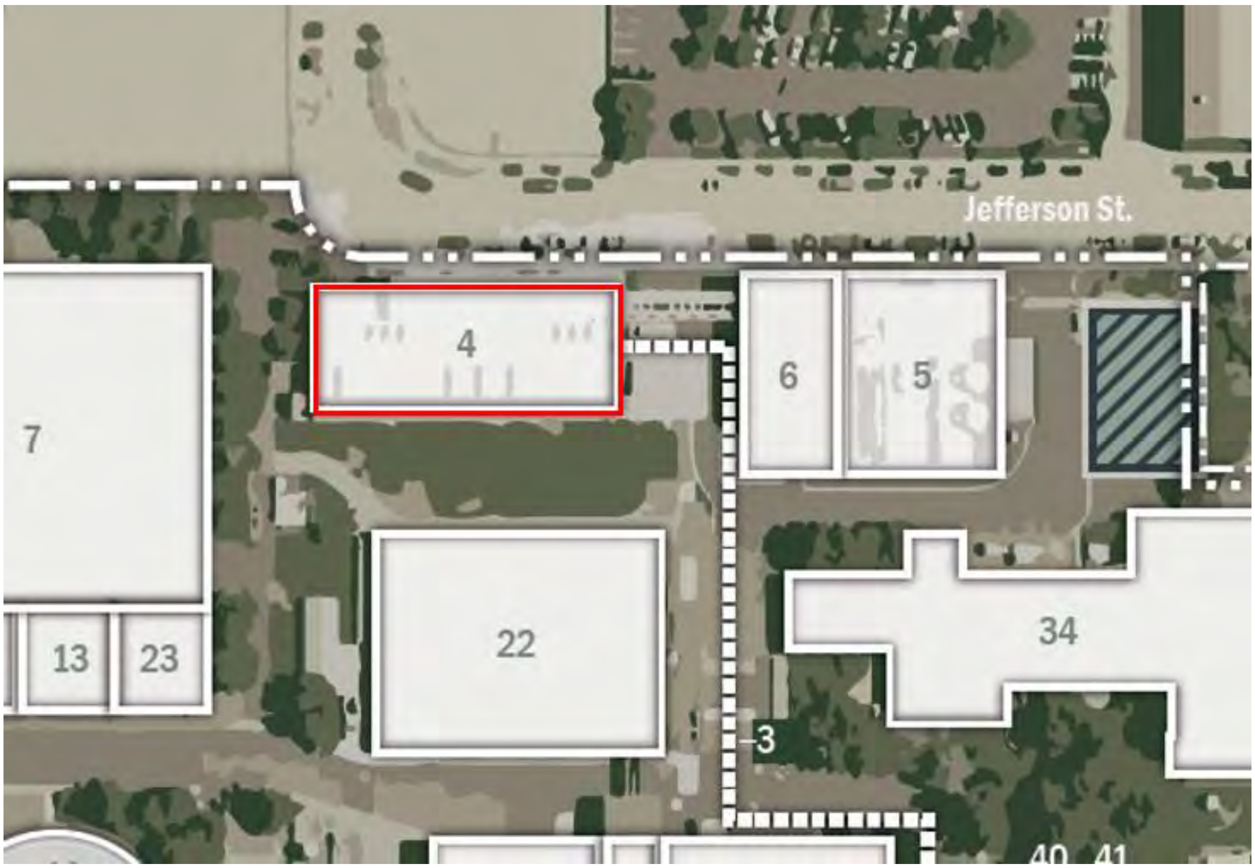


Figure 3-3. Primary clarifiers

20-year renovations are projected for 2033 and 2053, with a full rebuild not needed until 2080.

The capacity of primary clarifiers may be determined through modeling, stress testing, or by using industry-standard indices. These primary clarifiers represent an aggressive design, with very high design loading rates per unit area, and performance to date has been good. Alternatives for capacity-related expansions or upgrades will be developed as part of wet weather assessment in Section 4.3 of this Update.

3.4 Aeration Basins

The LOTT biological treatment system operates a modified four-stage Bardenpho process to optimize TIN removal from the incoming wastewater. Effluent from the primary sedimentation tanks flows through a series of anoxic (low dissolved oxygen) basins and aeration (higher dissolved oxygen) basins. These basins are identified as the first anoxic, first aeration, second anoxic, and final aeration basins.

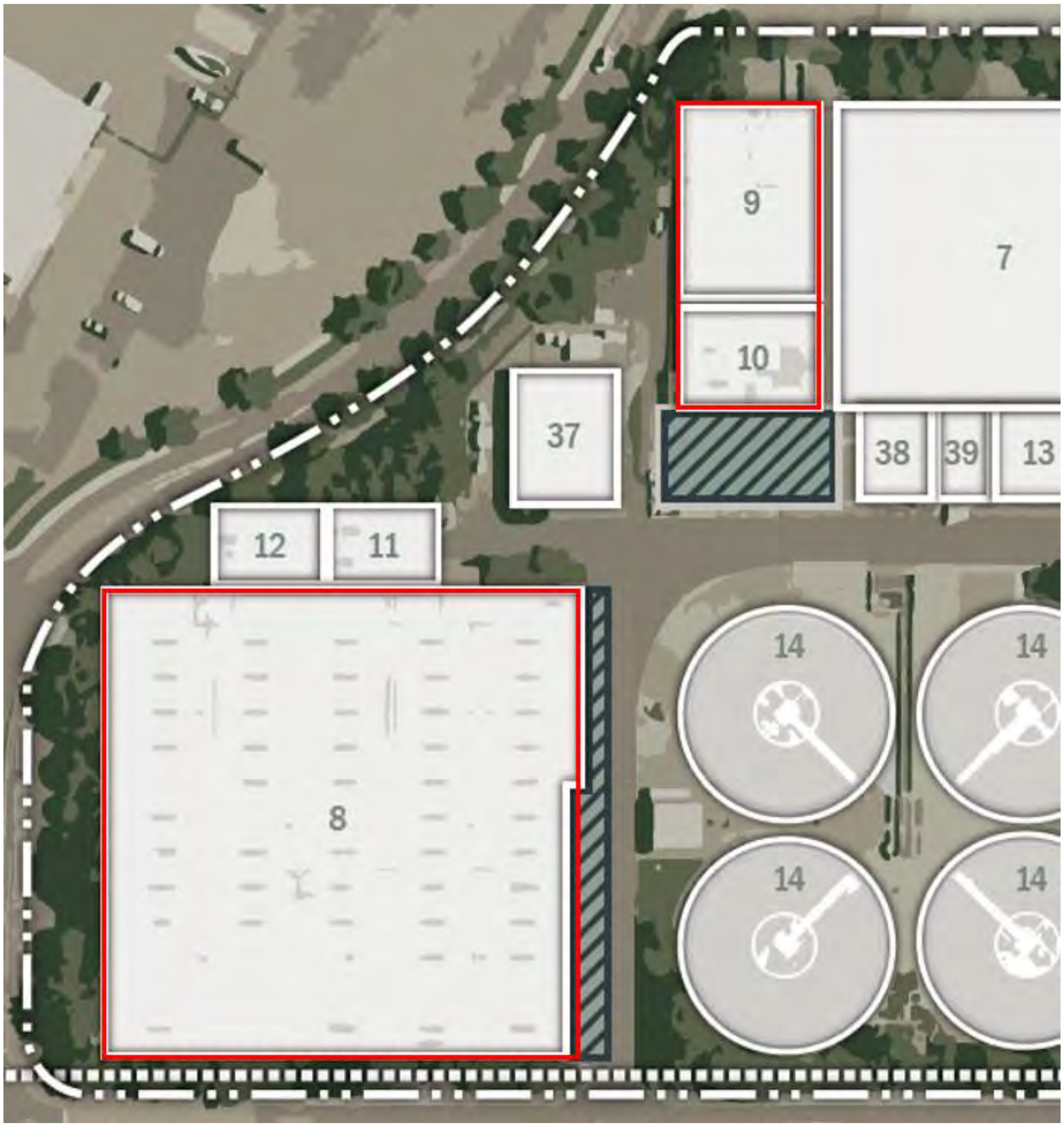


Figure 3-4. Aeration basins

The secondary process was originally designed as a high purity oxygen facility. In the 1990s, this was expanded to nitrogen removal by removing the high purity oxygen aeration system and building a new set of deep basins. The process is currently being renovated again, this time with a more energy-efficient pumping scheme and improved instrumentation and control.

Given the ongoing upgrades, further work on the secondary process is not projected for another 20 years, and a re-build of the main aeration basin should not be required until the 2060s or beyond.

3.5 Blower Building

The process aeration blowers supply the aeration basins with air. In 2011, a new Neuros high-speed turbo blower was installed to add more control and redundancy to the process aeration system. The aeration blower system is being moved to a new facility as part of the Process Improvements project currently underway. This project includes a capacity expansion.

As with the rest of the secondary process, a renovation is projected in approximately 20 years, with a full-scale rebuild not anticipated until the 2060s.

Figure 3-5. Blower building

3.6 Secondary Clarifiers

The purpose of the secondary clarifiers is to separate the biological solids from the clarified mixed liquor and return them to the aeration basins. Clarified effluent is sent to the disinfection facility.

There are four clarifiers at the plant with a diameter of 120 feet and a 14.5-foot side water depth. A project to upgrade the secondary clarifiers was completed in 2007. The project included replacing the clarifier mechanisms, and both the waste activated sludge (WAS) and return activated sludge (RAS) pumping systems.

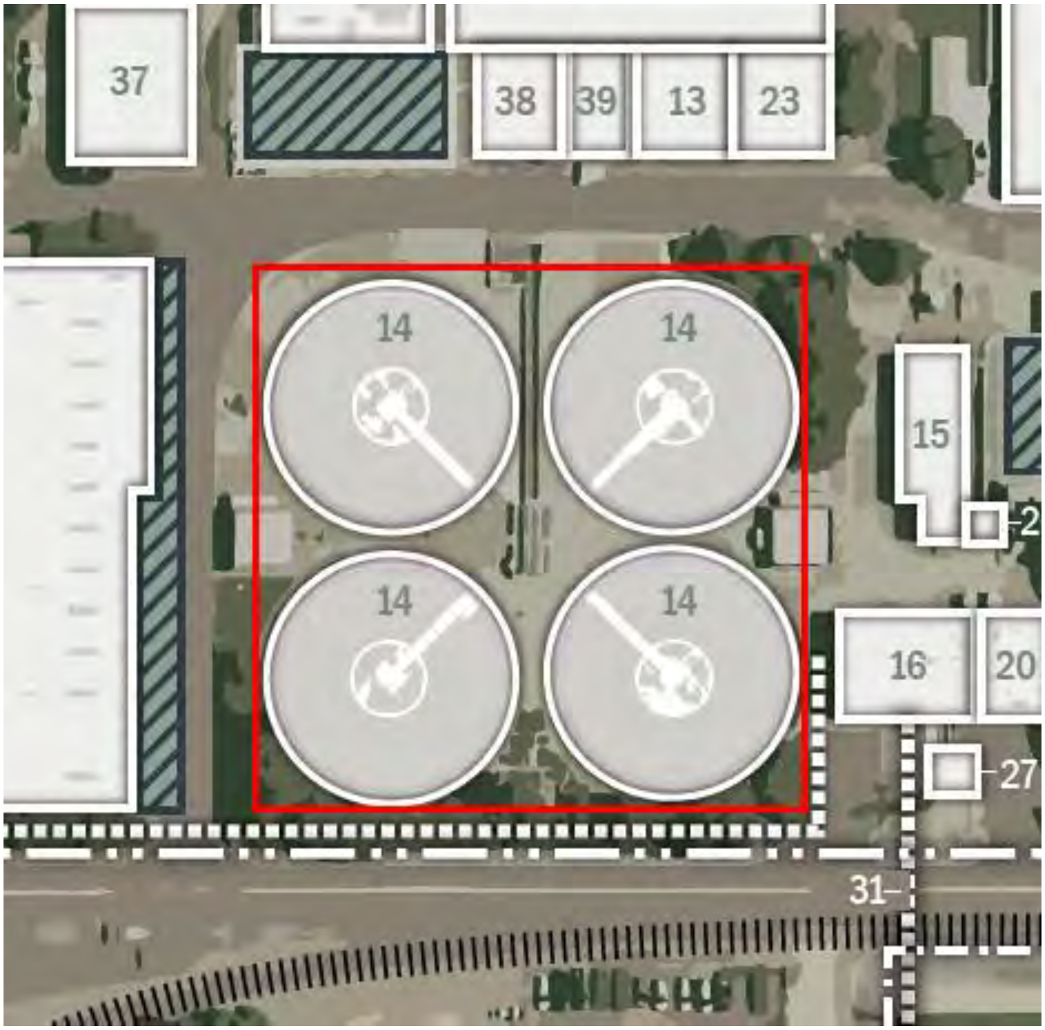


Figure 3-6. Secondary clarifiers

The secondary clarifiers are scheduled for renovation in 2027, with a full rebuild in 2063.

Secondary clarifier capacity may become limited in the future, depending on the performance of the renovated secondary process, as well as influent composition. Historically, the secondary clarifiers have been the BITP's primary capacity limitation, and the 2006 Plan focused on alternatives to provide additional capacity. A similar assessment is provided in Section 4.2 of this Update.

3.7 Disinfection

The ultraviolet (UV) disinfection system is the final liquid stream processing step. Its purpose is to disinfect the effluent from the secondary clarifiers to satisfy the NPDES permit requirements for fecal coliform counts in the final effluent. A UV disinfection system works by exposing the bacteria in the effluent to UV light.

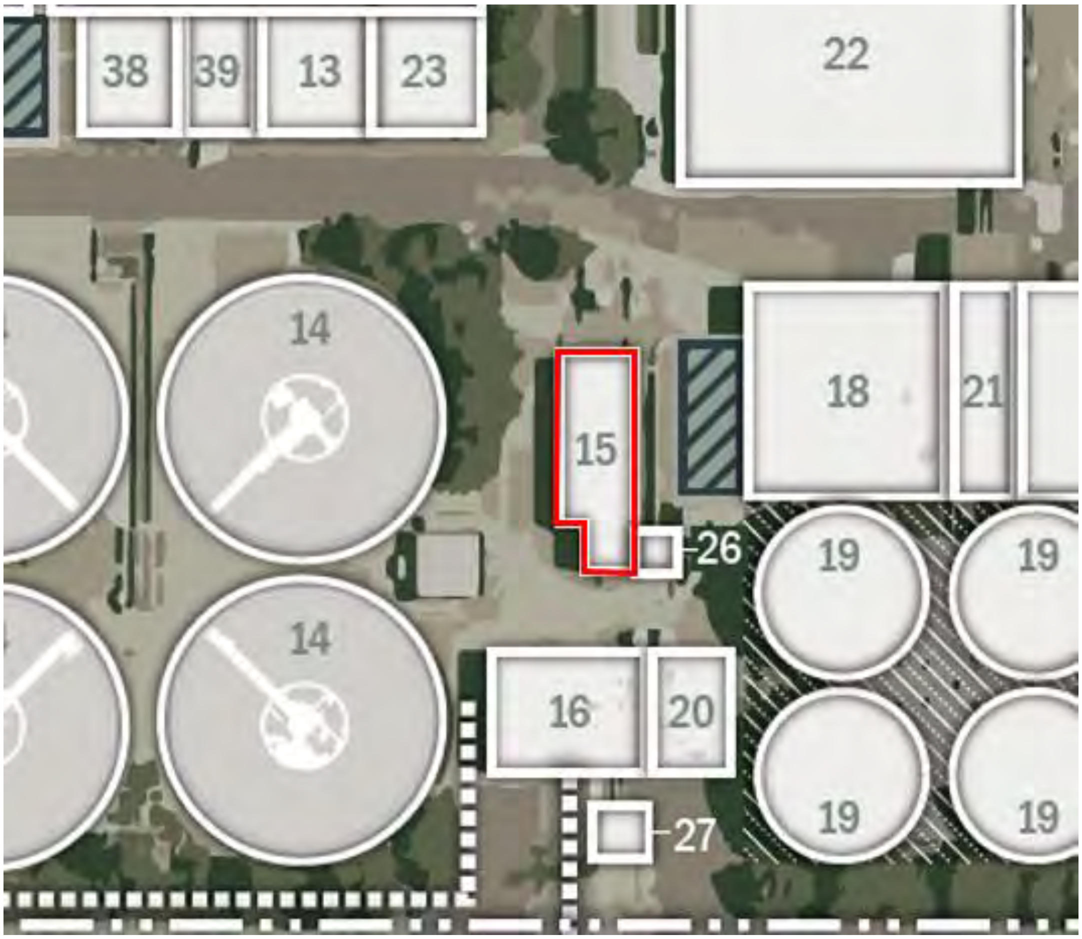


Figure 3-7. UV disinfection

UV disinfection system performance is contingent on the successful performance of the secondary clarifiers, since high suspended solids will block the UV radiation and reduce the amount available for disinfection.

The original UV system was constructed in 1994 and upgraded in 2019, replacing the Trojan 3000 system with the Trojan Sigma system. Five of the seven channels were deepened and equipped with the UV light banks, increasing each channels capacity to 19 MGD. Two channels remain vacant for future expansion if needed. The next major renovation is projected for 2043.

3.8 Budd Inlet Reclaimed Water Plant

The Budd Inlet Reclaimed Water Plant (BIRWP), completed in 2004, produces Class A Reclaimed Water using sand media and sodium hypochlorite to filter and disinfect secondary effluent. Some water is used for internal processes at the BITP and the Capitol Lake Pump Station; the rest is available to end users.

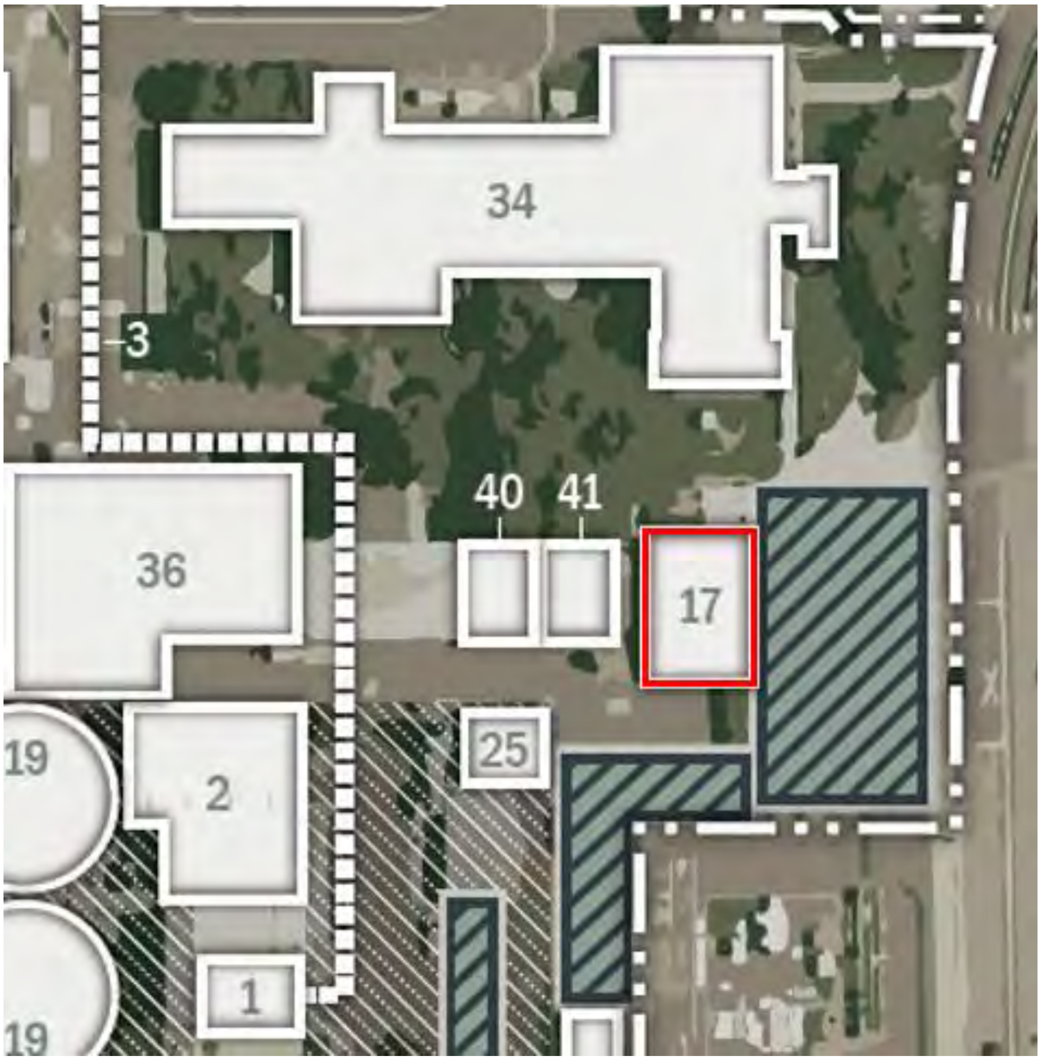


Figure 3-8. BIRWP

The BIRWP is approaching a 20-year service milestone and is projected for renovations in 2025 and 2045. The future of this facility will be evaluated in more detail in Phase 2 of the master planning update, which will focus on LOTT's reclaimed water production and distribution facilities.

3.9 Solids Thickening

The solids thickening process removes excess water from the combined primary sludge and WAS prior to anaerobic digestion. The BITP sludge thickening system consists of four rectangular dissolved air flotation thickener (DAFT) tanks. Bubbles of compressed air are injected into the sludge. With the help of polymer, those bubbles adhere to solids and cause the solids to rise to the surface of the tank, where they are skimmed off.

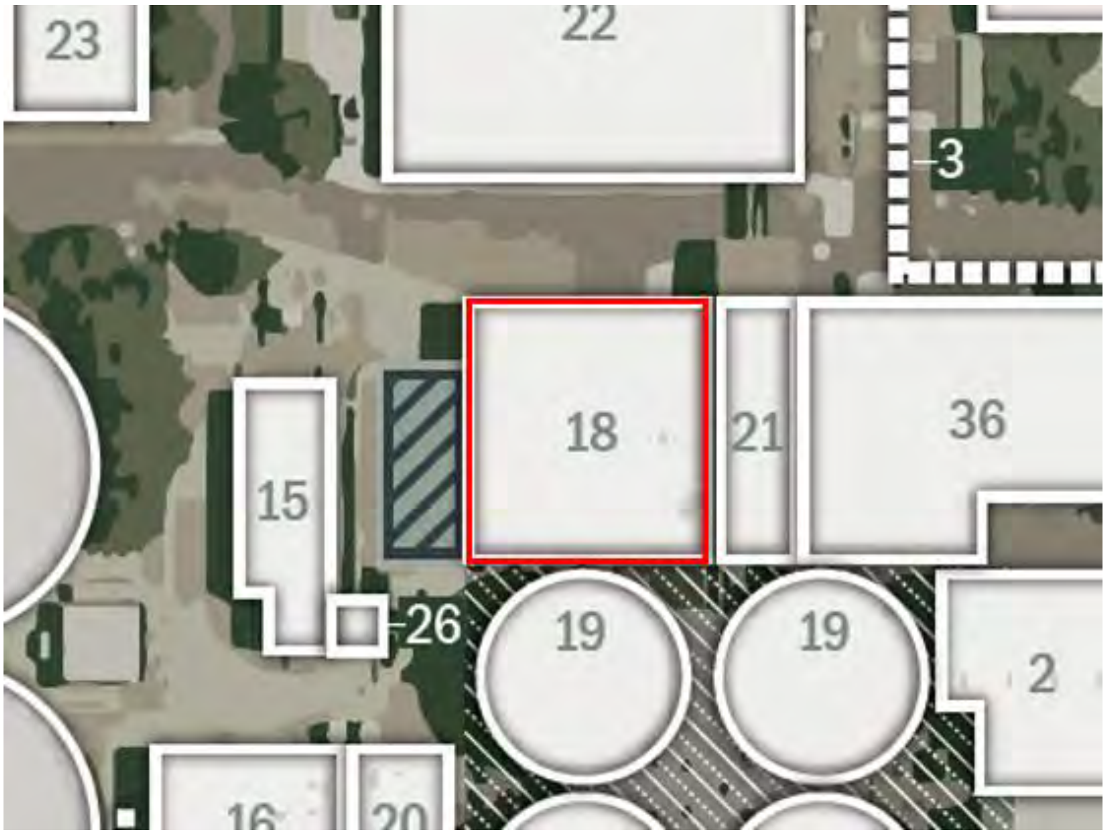


Figure 3-9. Solids thickening

The dissolved air flotation (DAF) system was constructed in 1983 and has historically and has operated at loading rates up to 60 pounds per square foot per day ($lb/ft^2/d$). More recently, however, the system has been stressed due to two of the tanks being out of service for maintenance, and one of the in-service tanks having a new air saturation system. Stress testing in January of 2019 suggested a rating of no more than 45 $lb/ft^2/d$ for the new system. Even with the lower rating, a fully operational four-tank system is projected to have capacity for both the 2050 and full connection scenarios.

A pilot is underway to test a dual aspirating pump configuration to assist in the design of the near-term upgrade planned for 2021. These upgrades are intended to extend the useful life of the DAF system by ten to fifteen years at which time an alternative form of thickening technology may be considered. This will be discussed further in Section 5.

3.10 Digestion

The anaerobic digesters biologically stabilize thickened sludge from the DAFTs by converting portions of the sludge to carbon dioxide, methane, and water. Following anaerobic digestion, the residual material (biosolids) is suitable for land application. Thickened sludge is fed to the digesters through the recirculating sludge system. Recirculating sludge is withdrawn from each digester and pumped to sludge heat exchangers before being returned to the digesters to help ensure complete mixing and maintain mesophilic temperatures.

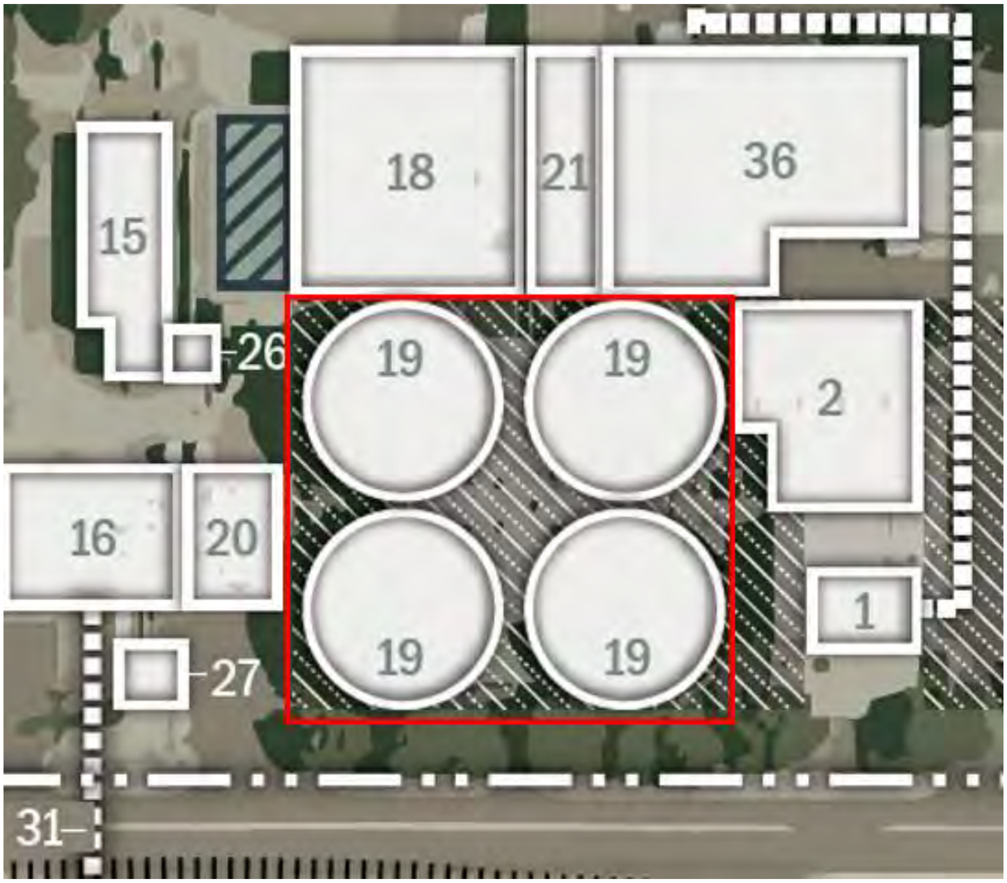


Figure 3-10. Digesters

Methane gas from the digesters is the principle fuel for the high-temperature heat loop system and the cogeneration system. Each digester is equipped with floating gasholder-type covers, which are supported by digester gas pressure. Each digester contains two separate gas-piping systems. The gas utilization system withdraws gas for use as fuel for the high-temperature heat loop system. The second system uses digester gas to continuously mix digester contents. A dedicated gas compressor recirculates digester gas through each digester.

Both the floating covers and gas mixing systems are largely being phased out of the industry. Gas mixing is not as effective as more modern mixing approaches such as draft tubes or linear motion mixers. Floating covers may pose a safety risk and are notably unstable in conditions where biological foaming is present. Recently, corrosion along the edge of one of the digesters was identified and repaired.

Historically, the digesters have performed well, and a capacity expansion was not projected to be needed until the 2030s or 2040s. Recently, however, performance has degraded, and more urgent capacity needs have come to light. While operating with one unit out of service for repairs and another unit providing for storage, operational staff have downgraded the loading capacity of the digesters from an industry-standard range of 0.15 to 0.20 pounds per cubic foot per day (lb/ft^3/d) to

0.08 lb/ft³/d. This downgrade is based on observations of process instability, including increased volatile acids production. These considerations mean that the current system is capacity-limited, and a capacity-related expansion needs to be addressed in the near-term.

An alternatives analysis for expansion is presented in Section 4.4 of this Update.

3.11 Dewatering

The solids dewatering process removes excess moisture from anaerobically digested sludge (2 percent to 3 percent solids) to create biosolids (20 percent to 24 percent solids), which reduces land application hauling costs. Solids dewatering equipment consists of two centrifuges, dewatered sludge conveyance equipment, and loading facilities for sludge hauling trucks. All solids dewatering equipment is contained in the solids handling building. The 1979 facility has been completely overhauled, with a new system put in place in 2018.

Figure 3-11. Dewatering

Dewatered biosolids are discharged from the centrifuges into a screw auger conveyor and transferred to the biosolids hauling trucks for land application. Effluent from the centrifuges (centrate) is drained to a centrate handling facility. Centrate is then metered into the secondary treatment process to control the ammonia loading.

Renovation of the dewatering facility is scheduled at 20 year increments in 2037 and 2057. No capacity needs are projected for either planning scenario.

3.12 Energy Recovery

The energy recovery system uses digester gas to produce energy. The biogas treatment system consists of hydrogen sulfide, siloxane, and moisture removal. The treated gas is primarily utilized in an engine generator, which produces both electricity and heat. If the engine is not available, or if excess gas is being produce, two boilers are available to produce heat. Two natural gas boilers are available as a backup to supplement heat to the system.

The current engine generator is expected to reach the end of its useful life in 2025. It is anticipated that a biogas utilization study will commence in 2023 to develop and evaluate options to continue to beneficially use biogas, which could include continuing with a co-generation unit or scrubbing the gas to a higher level and directing it to the local utilities gas main. Expansion of the treatment system will likely be needed as biogas production increases. Sufficient space around the energy recovery building should be maintained to accommodate a future expansion.

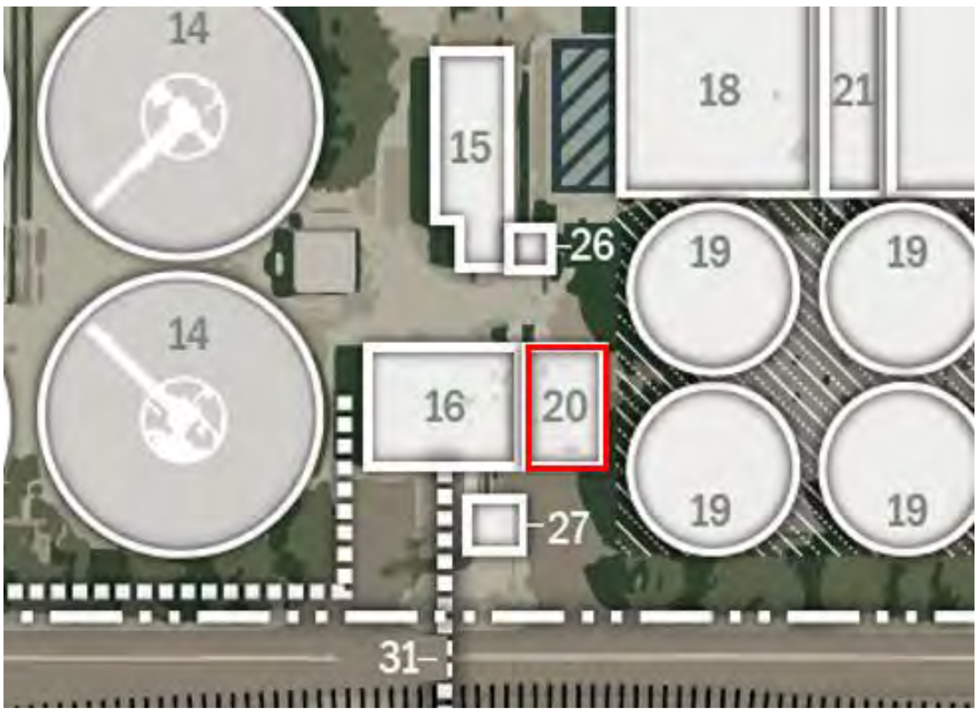


Figure 3-12. Cogeneration

3.13 Odor Control

There are five areas that receive odor control at BITP: primary clarifiers, headworks, EQ basin, centrate storage, and the digesters/solids handling area.

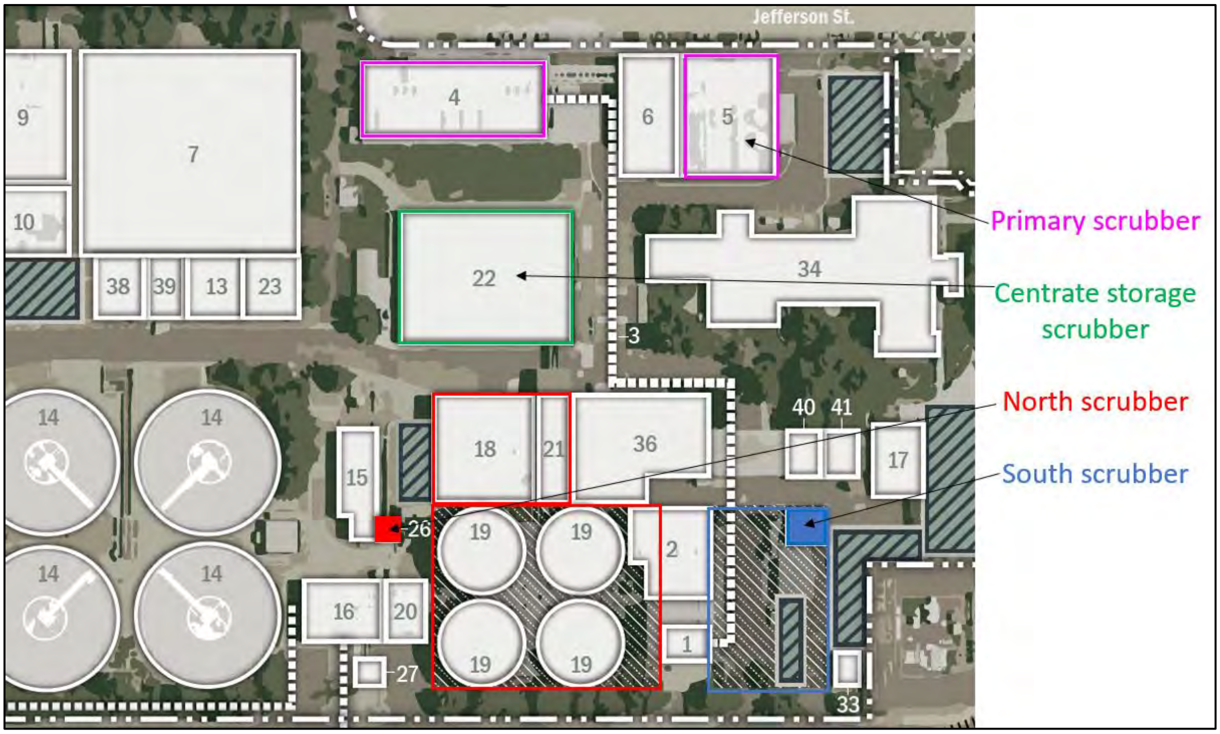


Figure 3-13. North and South scrubbers

The primary clarifiers include an odor control facility and chemical building, which have been sized to accommodate a potential primary sedimentation basins expansion. The primary odor control facility receives foul air from the primary clarifiers and treats it with a chemical (sodium hydroxide) scrubber, followed by a set of carbon scrubbers.

Foul air from the centrifuges and solids handling building is combined with foul air from the northern EQ basins and sent to the North Scrubber (see Figure 3-13). The North Scrubber was designed as a water scrubber with no chemical oxidation, and media cleaning using a soap solution. The North Scrubber largely acts to disperse foul air via its fan and stack.

Foul air from the southern portion of the EQ basins, as well as most of the headworks and influent pump station area, is directed to the South Scrubber. The South Scrubber is a chemical scrubber, which oxidizes odorous compounds using a sodium hypochlorite solution.

Finally, the centrate handling and storage facility houses a water scrubber of similar design and age to the North Scrubber. This was originally used when the building housed the Plant’s primary clarifiers. Currently, it largely acts to disperse foul air via its fan and stack.

A project to replace the North Scrubber has been planned for the near-term but has recently been delayed by more urgent projects. The replacement will likely take place in the mid-2020s.

The South Scrubber, installed in 2004, is projected to need a renovation in 2029. Further renovations to both scrubbers, as well as the new primary scrubber, are projected for the 2040–2050 timeframe.

3.14 Methanol Facility

BITP uses methanol as a supplemental carbon source and doses during the summer and shoulder permit seasons to drive denitrification. Methanol is added to the secondary process.

Given its age (1994 construction), the methanol facility is scheduled for replacement in 2030.

3.15 RAS/WAS Pumping

Each secondary clarifier is equipped with two RAS pumps and one WAS pump. The RAS pumps draw off settled sludge and pump it back to the secondary process. WAS is drawn from each RAS wet well and directed to the DAF thickeners for solids processing. The WAS pumps are operated continuously to even out the load to the dissolved air flotation thickeners.

The RAS and WAS pumps were renovated in 2007 and are scheduled again for renovation in 2027 and replacement in 2054.

3.16 Centrate Treatment

The former primary sedimentation building was repurposed to manage and store centrate in 2018. The centrate handling process removes easily settleable material from the centrate and provides storage for equalizing the ammonia load sent to the biological treatment process. This process includes flow measurement, ammonia concentration monitoring, seven rectangular sedimentation tanks modified to provide settling and storage of centrate, three centrate discharge pumps and two centrate sludge pumps. Centrate is metered into the secondary process via two self-priming centrifugal pumps.

The centrate storage building is more than 70 years old, and a project is scheduled for 2022 to replace the roof structure and odor control system, as well as add covers to the tanks and upgrade the electrical systems. LOTT will continue to store and settle centrate in the centrate handling facility (See Figure 3-14) until a new treatment facility is constructed.

LOTT is considering some form of centrate treatment as a process enhancement. Centrate treatment may also be pursued in the future to expand the capacity of the secondary process, as centrate comprises 15 to 20 percent of the total nitrogen load. A detailed assessment of centrate treatment alternatives is presented in Section 4.1.

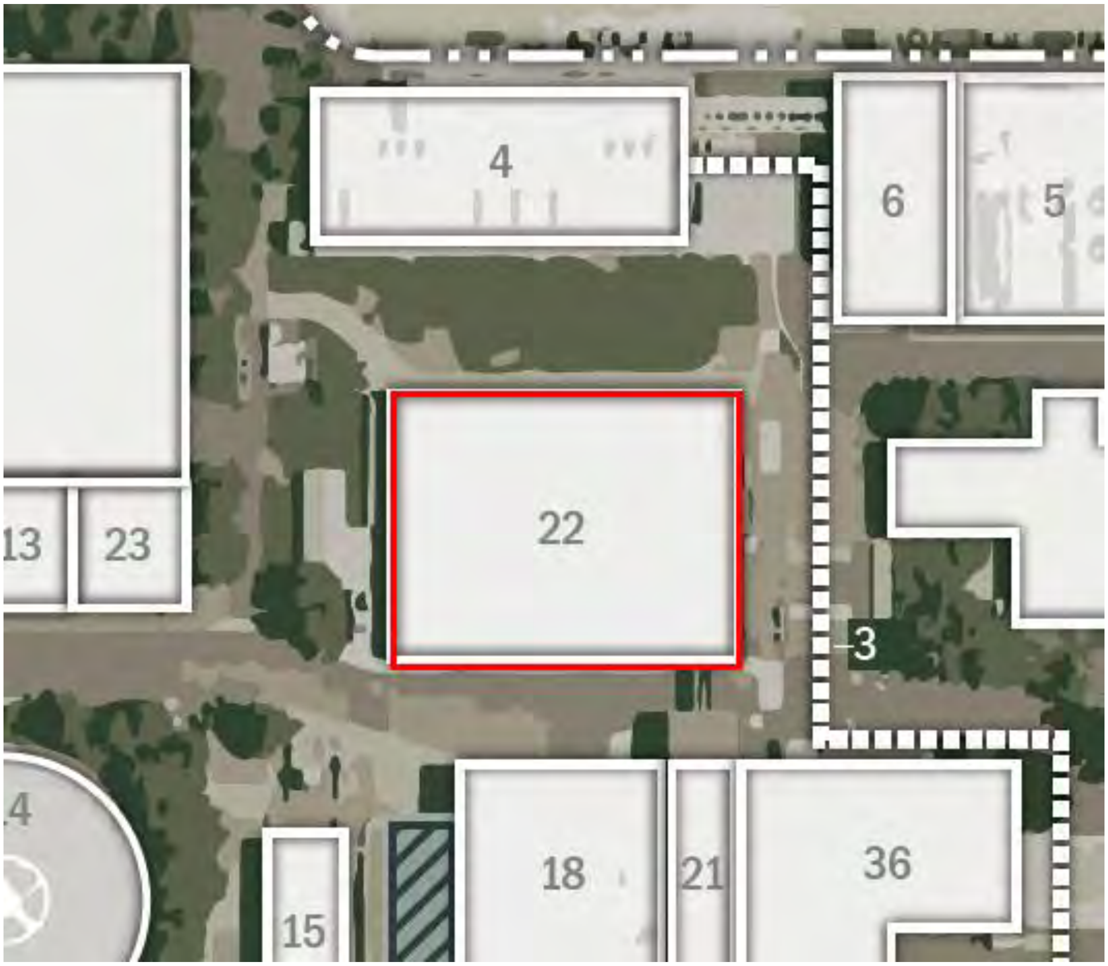


Figure 3-14. Centrate storage and handling

3.17 Septage Receiving

The BITP has a septage receiving facility where trucks may pull up and discharge septage loads. The septage is held in a small tank and pumped to the headworks. The septage loads may be highly variable, and at times may contain chemicals or pollutants that may impair the secondary biological process. This makes holding and equalizing the septage flows especially important.

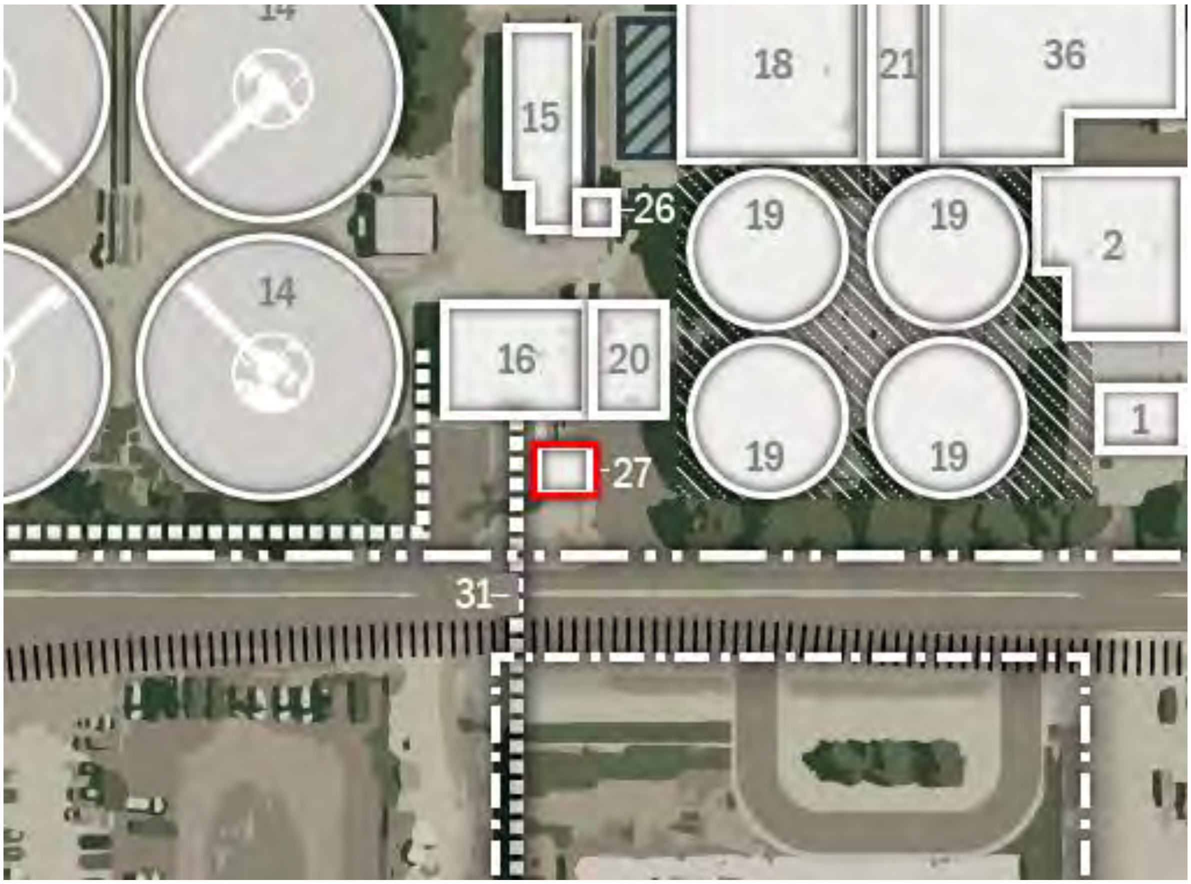


Figure 3-15. Septage receiving

The cities of Lacey and Olympia contain approximately 17,000 parcels using on-site septic tanks for wastewater treatment. Some of these residents use septic tank effluent pumping (STEP) systems, where solids in the sewage are retained onsite within a septic tank, but supernatant in the sewage is pumped by small-diameter pipe to the sewer system. These systems require periodic cleaning to clear out accumulated solids, and the cities typically discharge these solids directly into the sewer system; however, this process has been shown to be damaging to the sewer system (the STEP effluent often contains highly corrosive hydrogen sulfide). In Lacey, this process also poses a danger to the MWRWP, which lacks the capacity to effectively manage the septage loads.

For these reasons, LOTT is considering modifying its septage receiving policies and mechanics. This is discussed in more detail in Section 5 of this report.

3.18 Effluent Pumping

There are three sets of pumps housed in or near the effluent pump station. These include the five effluent pumps, two combined sewer overflow (CSO) pumps, and three reclaimed water filter feed pumps. The effluent pumps direct flow to the North Outfall. This is the Plant's primary form of effluent discharge. Under emergency conditions, flow may also be routed to the Fiddlehead Outfall, either by gravity or via the CSO pumps.

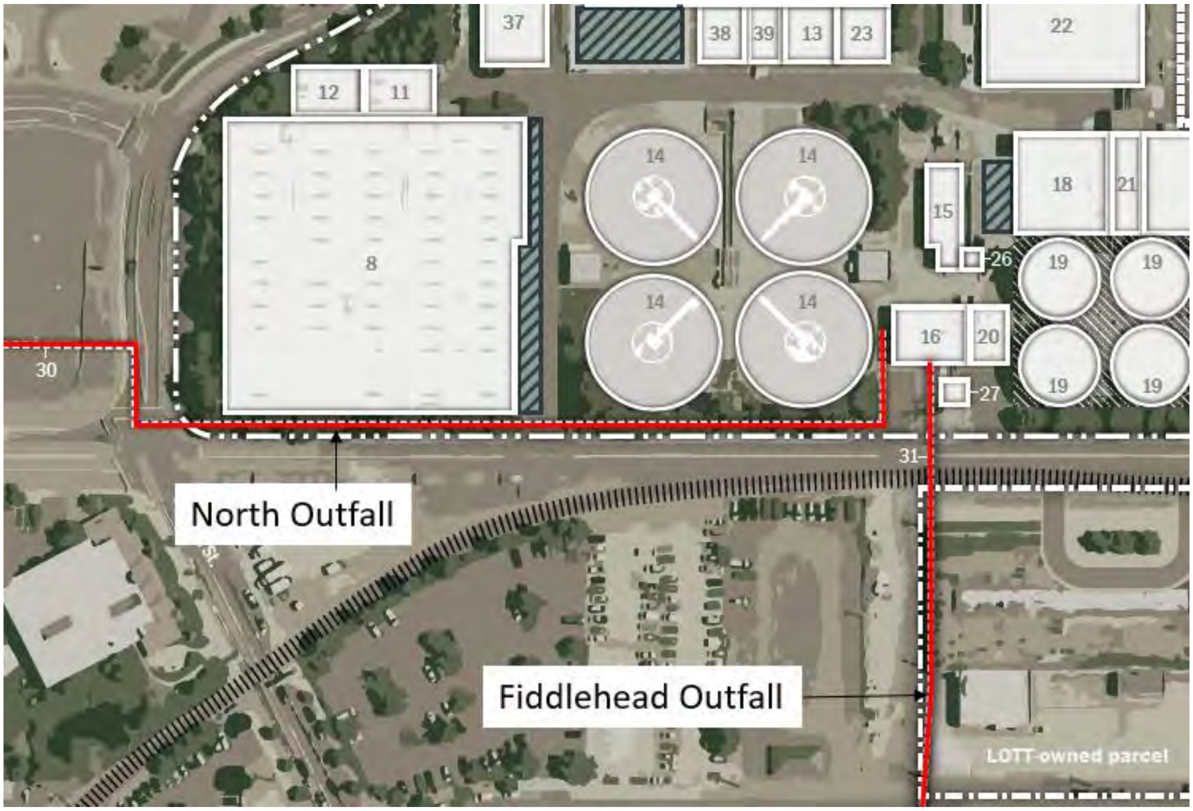


Figure 3-16. BITP outfalls

The capacity of the North Outfall has been estimated to be approximately 72 mgd at the most extreme tidal condition. Flow to the North Outfall is currently limited by a small-diameter section of pipe in the Port of Olympia property.

The Fiddlehead Outfall can convey up to 37 mgd by gravity, or 36 mgd via the CSO pumps.

A project to expand the capacity of the North Outfall by replacing the small-diameter section of pipe is scheduled for 2036. North outfall expansion will reduce reliance on the Fiddlehead Outfall during wet weather events, improving water quality in Budd Inlet.

Given its age, the effluent pump station is projected to need renovations in 2027 and 2057.

3.19 Summary of Existing Facility Process Needs

All of the process facilities at the BITP will require periodic renovation, refurbishment, and replacement. Beyond that, process-related needs fall into two categories: process upgrades and capacity expansion. Table 3-1 summarizes all of the projected upgrade and expansion projects expected to become necessary by 2050.

Table 3-1. Summary of Capacity Expansion and Upgrade Projects Projected for BITP, 2020–2050		
Facility	Need	Timing
Digesters	Capacity expansion	2020
North odor scrubber	Renovation and upgrade	2025
Septage receiving	Capacity expansion and upgrade	2025
Centrate treatment	Capacity expansion and upgrade	2030
Primary clarifiers	Capacity expansion	2035
Wet weather flow	Capacity expansion and upgrade	2035
North outfall	Capacity expansion	2036
Secondary process	Capacity expansion	2040

Alternatives assessments related to these needs will be developed in Sections 4 and 5 of this Update, and recommended capital improvements will be summarized in Section 7.

Table 3-2 summarizes the major renovation needs for process areas. The timing of these renovations will be determined by LOTT's asset management program, which tracks equipment and facility maintenance needs and prioritizes such activities. The following represent renovations, rather than complete facility re-builds. Structural re-builds are projected to be required in the 2060-80 timeframe for most facilities.

Table 3-2. Projected Timing of Major Renovation Needs		
Facility	Last major work	Projected renovation
BIRWP	2005	2025
Cogeneration (every 8–10 years)	2018	2025
Secondary clarifiers (including RAS and WAS pumping)	2007	2027
Effluent pump station	1997	2027
South scrubber	2004	2029
Solids thickening	2018	2030
Methanol facility	1994	2030
Primary clarifiers	2013	2033
Dewatering	2017	2037
Headworks	2016	2038
EQ basins	1983	2038
Secondary process	2021	2041
Blower building	2021	2041
Disinfection	2019	2043

Section 4

Alternatives Assessments

The previous section identified a number of facility needs related either to capacity expansion or performance upgrade. While some needs, such as the North Odor Scrubber and North Outfall, are relatively straightforward to address, others require a more detailed approach, with alternative development and assessment. Detailed alternatives assessments are conducted in this section for:

- Centrate treatment
- Secondary process capacity
- Wet weather management (includes needs related to influent pumping, equalization, and primary treatment)
- Digester capacity

Comparative costs for alternatives will be developed throughout this section. These costs represent an Association for the Advancement of Cost Engineering. Class 5 level of accuracy (-50 to +100 percent), and at times only consider differential costs (costs common to all alternatives are excluded). In Section 7 of this Update, the recommended alternatives are developed into capital projects, and more refined cost estimates are presented.

4.1 Centrate Treatment

Problem

Dewatering centrate has a high load of nutrients, including ammonia and phosphorus. The ammonia in the centrate comprises 15 to 20 percent of the total nitrogen load to the secondary process. The phosphorus in the centrate promotes struvite formation, which historically has led to scaling and plugging of pipes and pumps used to convey centrate. High phosphorus throughout the biosolids system most likely contributes to inefficient dewatering and struvite accumulation in the digesters.

LOTT currently equalizes centrate and meters it back to the process continuously. Load pacing was attempted but proved impractical, particularly during periods when influent flow pacing was practiced. LOTT dilutes the centrate at a 2:1 ratio at the centrifuge to limit struvite potential.

LOTT operations and maintenance staff would prefer to treat the dewatering centrate in a side stream process. The advantages of this approach could include:

- Reduced nitrogen load to the aeration basins, resulting in decreased methanol demands
- Increased nitrification efficiency, which would expand the treatment capacity of the secondary process
- Improved dewatering efficiency
- Eliminating the need to dilute the centrate for struvite control
- Reduced potential for struvite accumulation throughout the BITP

Alternatives and Approach

Unfortunately, no single side stream treatment process is capable of yielding all of the benefits listed above. Processes are specialized toward particular goals. The three main categories of side stream treatment are summarized in Table 4-1 and Figure 4-1, which includes costs and a discussion of the advantages and disadvantages of each with respect to the BITP.

Table 4-1. Comparison of Centrate Treatment Approaches

	Bioaugmentation	Anammox	Struvite Precipitation
Representative brands	• Bioaugmentation reaeration BAR, CARRB (open-source)	• DEMON (World Water Works, Inc.) • Anitamox (Veolia) • AnammoPAQ (Ovivo)	• AirPrex (Centrisys) • NuReSys (Schwing Bioset) • PhosPAQ (Ovivo)
Benefits	• Increase capacity of secondary process by 10-20%	• Reduce methanol demand by 150–500 gpd	• Reduce struvite potential throughout BITP • 15–20% reduction in dewatering polymer demand • 1–2% increased cake thickness
Disadvantages	• Increase methanol demands by 100 gpd	• None	• None
Other considerations		• If influent BOD were to decrease, methanol savings could be much higher • System would not work well with diluted centrate. Struvite precipitation may be required as pretreatment	• Potential to harvest struvite as fertilizer product • Will reduce effluent phosphorus concentrations
Implementation	One train of former first anoxic basin (see Figure 4-1)	Former centrate storage basins (see Figure 4-1)	Parking lot next to north scrubber (see Figure 4-1)
Vendor quote	No vendor involved	\$0.9–\$1.4M	\$1.0–\$1.4M
Total project cost	\$4.7M	\$8.5M	\$7.9M
Operating costs	Similar to existing	Minimal	250 gpd of $MgCl_2$ required \$75,000/year

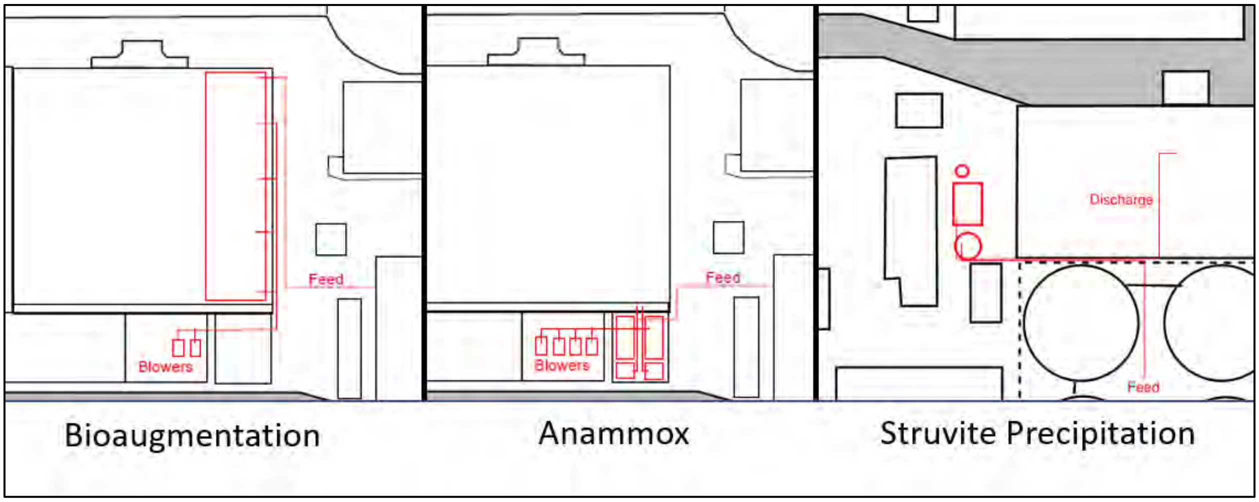
BAR = bioaugmentation reactor

CARRB = centrate and RAS reaeration basin

gpd = gallons per day

$MgCl_2$ = magnesium chloride

Cost assumptions: Contractor costs applied as 15% overhead and profit, 12% general conditions, 35% undesigned contingency (10% for vendor packages), 3.5% bonds and insurance, 9.4% sales tax. Allied costs include 2.5% preliminary engineering, 15% final engineering, 7.5% construction engineering, and 5% legal, administration, and permitting. An estimating contingency has been excluded to avoid biasing the comparison between alternatives. Typically, a 30% contingency would be applied with the allied costs.



Reference the 2050 Site Plan (Figure 6-1 area 23) to see location of centrate treatment at BITP

Figure 4-1. Layout of centrate treatment approaches at BITP

Recommendation

Subjective factors play a large role in this assessment. If future permit-season capacity is prioritized, then bioaugmentation should be implemented. If operational costs and risks related to changing influent characteristics are prioritized, then anammox should be implemented. If the focus is struvite and dewatering, then a struvite precipitation system would be preferred.

Presently, secondary process capacity is not limited, and future limitations are generally linked to peak flow conditions during the winter when the nitrification benefits of a bioaugmentation system may be less relevant. For this reason, implementation of a bioaugmentation process should be reserved as a future upgrade alternative, should permit season capacity become limited.

Anammox systems are most beneficial at facilities with a carbon limitation or with limited alkalinity. The BITP currently has neither limitation. Abundant carbon is currently received from the BOD-rich discharge from the Pepsi bottling facility. In the current condition, an anammox system would not be cost effective; however, influent characteristics can change, and industrial users can leave town or modify their discharge, as was seen when the Olympia Brewery closed in 2002. An anammox facility, though not currently recommended, may become more favorable in the future, and the former centrate storage facility should be maintained as a potential future anammox facility.

A struvite precipitation facility would address several current needs. The dewatering centrate requires heavy dilution (2:1 application at the centrifuge), which limits the storage capacity of the centrate storage facility. Staff have reported struvite scaling throughout the BITP, and it is likely that such precipitation is currently limiting the treatment capacity of the anaerobic digesters.

Looking to the future, a struvite precipitation facility would provide increased flexibility in biosolids options, including an option for future fertilizer recovery. The facility would also remove phosphorus from the BITP discharge, which could have some environmental benefit (a regulatory benefit for phosphorus removal is less likely but still might be considered as a potential benefit).

Of the three alternatives, a struvite precipitation facility would make the most sense in the near-term; however, the $7.9M cost could not be justified solely on the basis of offset costs related to struvite maintenance and mitigation.

The recommended approach is to reserve space for all three approaches and table this decision for future evaluation as needs may change.

4.2 Secondary Clarifiers

Problem

Secondary process capacity is determined by solids loading to the secondary clarifiers. Whether clarifier capacity will become limited depends on many factors, some of which depend on the outcome of the biological process improvements project. In the worst case, it is projected that up to two additional secondary clarifiers may be required by 2050. This assessment evaluates different approaches to addressing this potential capacity limitation.

Alternatives and Approach

The following alternatives were developed to address future secondary clarifier capacity limitations. These alternatives are sketched out on Figure 4-2.

- **Expand with additional clarifiers** by building two identical 120-foot clarifiers on an adjacent parcel.
- **Intensify** the secondary process by adding a ballast. BioMag allows operation at two times the mix liquor suspended solids (MLSS), resulting in a large increase in clarifier capacity.
- **Bypass a portion of the flow around the clarifiers** and remove solids using a membrane filter or similar technology. For the purpose of this investigation, a bypass of 10 mgd was assumed to achieve a similar capacity expansion as adding two secondary clarifiers and would be projected to provide sufficient capacity through 2050.
- **Provide tertiary filtration to overcome overloaded secondary clarifiers.** The system would be designed to overcome short-term clarifier failures by sending 100 percent of the secondary effluent through a downstream filtration step. When clarifiers are operating well, the filters would continue to run, generating a high-quality effluent year-round.
- **Chemically Enhanced Primary Treatment (CEPT)** could be applied year-round or seasonally. CEPT increases primary BOD removal by 10 percent, which translates to a 20-percent reduction in MLSS concentration (the equivalent of building approximately two clarifiers).

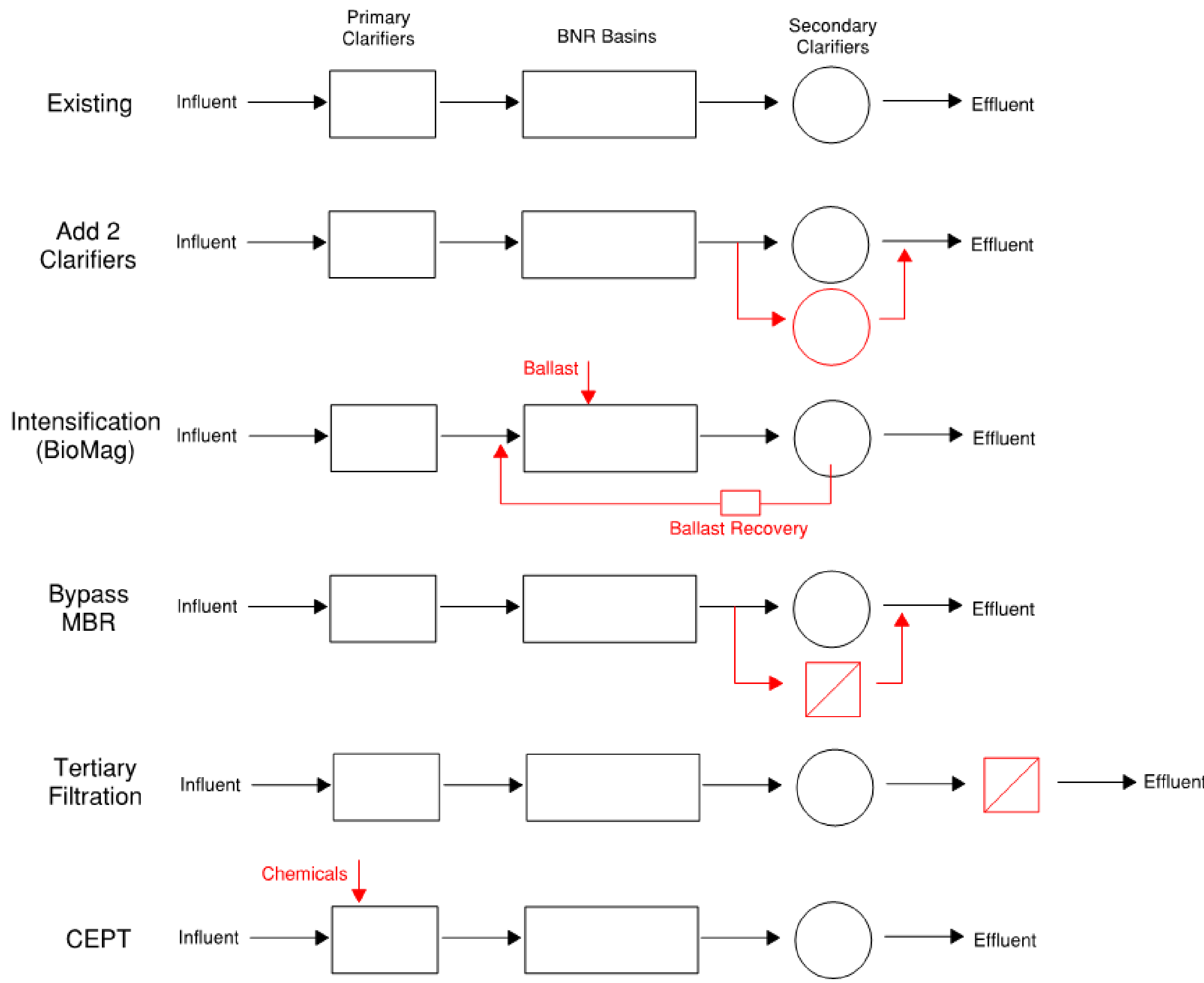


Figure 4-2. Comparison of secondary process capacity expansion alternatives

As discussed in Section 4.1, side stream treatment of the dewatering centrate was estimated to expand the capacity of the secondary process by up to 2.5 mgd (shoulder season basis). This approach was not considered here as this section is mainly concerned with winter season, peak flow capacity.

Cost Summary

Planning-level costs were developed for each alternative based on vendor quotes, estimates for major equipment, and cost curve data for unit processes. Table 4-2 summarizes the capital costs.

Table 4-2. Secondary Clarifier Costs- Comparative Costs	
Alternative	Total project cost (M)
Two additional clarifiers	$22.0
Intensification (BioMag)	$40.2
Bypass MBR	$31.5
Tertiary filtration	$22.6
CEPT	$2.2

Cost assumptions: Contractor costs applied as 15% overhead and profit, 12% general conditions, 35% undesigned contingency (10% for vendor packages), 3.5% bonds and insurance, 9.4% sales tax. Allied costs include 2.5% preliminary engineering, 15% final engineering, 7.5% construction engineering, and 5% legal, administration, and permitting. An estimating contingency has been excluded to avoid biasing the comparison between alternatives. Typically, a 30% contingency would be applied with the allied costs.

Further development of this evaluation was deemed unnecessary, given the capital cost analysis. Provision of CEPT was nearly $20M less expensive than the next-best alternative. CEPT will have a substantial annual cost, however, which is linked to the choice of chemical and the dose applied. Based on historical chemical costs and estimating dosing, the annual cost for seasonal CEPT could vary from $100,000 to $1M.

Risk and Benefit Assumptions

The bypass MBR and tertiary filtration alternatives would generate a large quantity of reclaimed water. Water reclamation of this magnitude would mitigate regulatory risks associated with the BITP's NPDES permit and discharge to Budd Inlet, and could eliminate the need to expand the MWRWP facility. These benefits were not considered in this evaluation since those options would remain viable for future implementation with or without CEPT. The bypass MBR and tertiary filtration alternatives will be developed further as part of a reclaimed water evaluation to be conducted for Phase 2 of this Master Planning Update.

The CEPT alternative could have both positive and negative impacts on wider Plant performance. CEPT will provide phosphorus removal, which would reduce effluent phosphorus and also reduce the potential for struvite formation within the Plant. This would only apply during seasons when CEPT was applied and would not be expected to interfere with any struvite precipitation process installed for treatment of the digester sludge or centrate (it would reduce the yield of such a system).

The increased BOD removal associated with CEPT would need to be compensated for with increased methanol dosing for nitrogen removal if CEPT were applied during nitrogen removal season.

Recommendation

Given that the BITP already has the framework of a CEPT facility in place, CEPT is an obvious "first step" toward expanding secondary process capacity. Other alternatives may be considered as contingencies for the post-2050 timeframe, or as part of regional reclaimed water planning. Also, side stream centrate treatment, such as bioaugmentation, may be used to expand the capacity of the secondary process during the permit season, as needed. **The recommendation is to implement CEPT as-needed based on future capacity needs.**

4.3 Wet Weather

Problem

Combined sewers result in high peak flows at the BITP. These flows are buffered in the existing flow EQ tank and then pumped to the primary clarifiers from the influent pump station (IPS). As flows increase, this system will become limited. The 60-inch influent sewer on Adams Street will also become capacity-limited as flows increase. This limitation may result in flows backing up into downtown Olympia, with subsequent flooding of basements and manholes.

Alternatives were developed that would expand capacity by the equivalent of 10 mgd peak flow. This is based on previous work summarized in the 2010 Equalization Basin Study by Brown and Caldwell and represents the capacity required to reduce CSO likelihood to less than once in 10 years for the 2050 condition.

Alternatives and Approach

Alternatives were developed for both hydraulic and treatment capacity. Alternatives from each group could be paired to provide both hydraulic capacity and treatment.

Hydraulic Options

Do nothing resulting in an increased frequency of CSOs as flows increase.

Upsize the existing IPS. IPS capacity is limited by the force main, which travels across the EQ basins and then underground to the primary clarifiers. If the force main pipes were increased in size from 30 to 36 inches, the pumps would be able to output a higher flow, which would increase IPS capacity by at least 10 mgd.

Linked EQ basin (1.5 MG). A 1.5-MG EQ expansion was determined to be the equivalent of adding 10 mgd of pumping capacity in the 2010 Equalization Basin Study. A hydraulically linked EQ basin would have to be buried 15 feet below ground to have the same hydraulic profile as the existing EQ basins. This type of basin would not require pumps and would improve/extend capacity for flow pacing and provide more opportunity for the BITP to shut off flow to support maintenance activities.

Pumped EQ basin (1.5 MG). A hydraulically separated EQ basin would require pumping but could be built at grade. This type of EQ basin could be fed via a pump station located near the existing EQ basins, or upstream along Adams Street, to relieve the sewer capacity limitation. The latter would require a screening facility to remove large debris from the influent, as such flows would bypass the BITP headworks.

Sewer separation. Separating a portion of the downtown sewer system and replacing old clay sewers on the West Side could remove 10 mgd of peak flow.

Treatment Options

Expand primary clarifiers by adding clarifiers adjacent to the existing clarifiers. Expanding the clarifiers would improve BOD and TSS removal during the winter season but would not relieve any upstream hydraulic risks or reduce the risk of CSOs.

Add CEPT to existing primary clarifiers. Similar to a primary clarifier expansion, CEPT would improve BOD and TSS removal of the existing primary clarifiers during peak flows. By itself, CEPT would not relieve upstream hydraulic conditions or reduce the risk of CSOs.

Wet weather primary clarifiers could be built to treat wet weather flows. A new pump station would direct 10 mgd of flow to this system, which would require its own disinfection system because the flow would bypass further treatment at BITP. The pump station could be located near the IPS or at the Adams Street sewer. The latter would require a screening facility to remove large debris from the influent, as such flows would bypass the BITP headworks. This form of CSO treatment would require regulatory approval.

Wet weather filters. This type of treatment system would be similar to the wet weather primary clarifiers but would use a filter technology to treat the flows.

Cost Summary

Planning-level costs were developed for each alternative based on vendor quotes, estimates for major equipment, and cost curve data for unit processes. Table 4-3 summarizes the capital costs.

Table 4-3. Wet Weather Costs—Comparative Costs

Alternative	Total project cost ($M)
Hydraulic capacity alternatives	
Upsize IPS force mains	$4.7
Linked EQ basin	$16.0
Pumped EQ basin	$10.4
Sewer separation	$50.0
Treatment capacity alternatives	
Expand primary clarifiers	$8.9
CEPT	$2.2
Wet weather primaries	$6.4
Wet weather filters	$20.0
Ancillary systems	
Satellite pump station to feed a pumped EQ basin or a wet weather treatment system	
• Located at existing EQ basin	$9.3
• Located at Adams Street	$16.2

Cost assumptions: Contractor costs applied as 15% overhead and profit, 12% general conditions, 35% undesigned contingency (10% for vendor packages), 3.5% bonds and insurance, 9.4% sales tax. Allied costs include 2.5% preliminary engineering, 15% final engineering, 7.5% construction engineering, and 5% legal, administration, and permitting. An estimating contingency has been excluded to avoid biasing the comparison between alternatives. Typically, a 30% contingency would be applied with the allied costs.

The capital costs range from $2.2M for CEPT to more than $50M for sewer separation. To implement a system that provides both hydraulic and treatment capacity, a matrix of combined alternatives was developed. From this matrix, the following conclusions were drawn:

- To address BITP capacity, upsizing the IPS was much more cost effective than constructing more EQ basin volume
- For treatment, application of CEPT was much more cost effective than constructing more primary clarifiers.
- Alternatives that addressed the Adams Street sewer limitations were more costly, given the need for pumping, screening, treatment, and disinfection. Of those alternatives, however, the combination of an Adams Street pump station and a wet weather primary clarifier would have the lowest capital cost and most flexibility for future expansion.

Risk and Benefit Assumptions

Climate change risks could result in flows which exceed current projections. Of these alternatives, satellite pumping and a dedicated wet weather treatment system would be best positioned to manage such flows.

A linked EQ basin would allow expanded flow pacing—a dry season practice that has been shown to reduce operating costs for nutrient removal.

The sewer limitations at Adams Street are influenced by multiple external factors. One of the most significant is the amount of treatment provided at the LOTT MWRWP. Increased treatment at the MWRWP will reduce the risk of sewer capacity issues in downtown Olympia.

Recommendation

Wet weather treatment is a complicated problem, and one that warrants a staged or phased approach. The recommendation is for three phases of implementation:

Phase 1. CEPT. CEPT will improve primary clarifier performance during wet weather and should preclude the need for primary clarifier expansion. This will also preserve space within the BITP.

Phase 2. IPS Expansion. IPS expansion is the most cost-effective means of expanding BITP's hydraulic capacity and reducing the risk of CSOs. While a linked EQ basin would offer some benefits, including expanded flow pacing, those benefits would not approach the $12M to $13M capital cost difference between the alternatives.

Phase 3. Adams Street pump station linked to wet weather treatment system. The treatment facility would be located at the site of the former Fish and Wildlife Building. This option maximizes flexibility with respect to downtown sewer capacity, climate change and wet weather treatment regulations. With a much higher cost than the recommended Phase 1 and 2 activities, implementation could be delayed until a clearer picture of future requirements is developed.

The recommended approach is diagrammed on Figure 4-3.

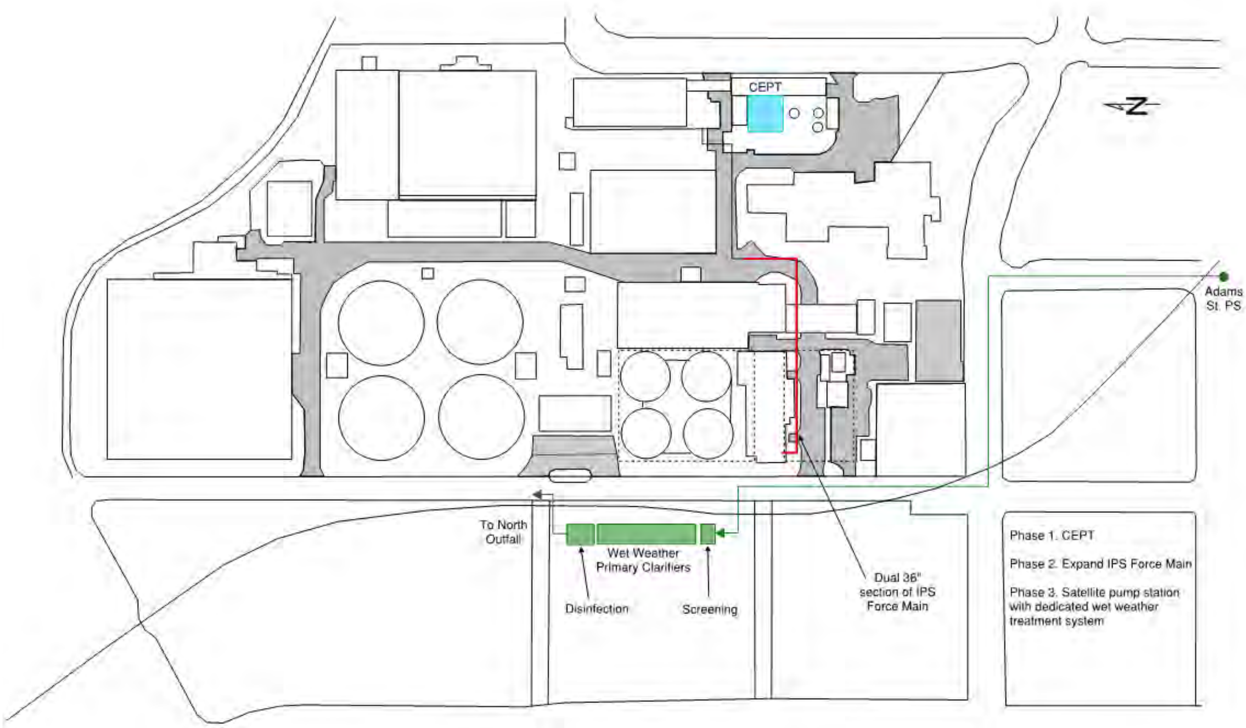


Figure 4-3. Phased implementation of wet weather treatment systems

4.4 Digesters

Problem

The BITP currently has four floating cover, gas-mixed, mesophilic digesters. Digester gas is used for heating and to generate electricity in a cogeneration system.

The digesters are currently limited due to inefficient mixing, which has reduced the operational volatile solids loading limit to 0.08 $lb/ft^3/d$. This loading limit is about half of what would typically be expected.

Aside from inefficient mixing, the digester system is currently undergoing repairs related to a leaking floating cover on one of the units. This has highlighted the need for system redundancy. LOTT staff have defined the service condition to reserve one digester unit to be used for storage and another unit as an offline spare.

Alternatives and Approach

Several preliminary alternatives were developed for long-range digestion planning and are detailed in the bulleted list below. The status quo was determined to be fatally flawed due to existing capacity limitations at the defined service condition. A recent study confirmed the digesters can be retrofitted with fixed covers, and that they can support thermophilic operation. An alternative to raise the height of the digesters was dismissed due to structural concerns. Upgrade projects including expansion, thermophilic operation, and conventional thermophilic hydrolysis process (THP) were investigated are explained below

- **Upgrading existing units with no expansion** involves replacing the floating covers with fixed covers and replacing the gas mixing system with linear motion (LM) mixers.

- **Upgrading existing units with expansion** would build two new 70-foot digesters on the Fish & Wildlife site. All units would have the fixed cover and LM mixer modifications noted above.
- **Upgrading two existing digesters with expansion** would scale back upgrades to just two of the existing units and two new units. The two digesters without upgrades would be used as a storage and spare digester.
- **Upgrading existing digesters and converting two to thermophilic** involves similar upgrades as mentioned above and converting two digesters to thermophilic service. The storage digester would operate at mesophilic temperatures to condition the sludge for dewatering, while the fourth digester would be a spare.
- **THP** includes upgrading existing digesters and installing new THP equipment to increase gas and renewable energy production.

Preliminary Cost Summary

Preliminary costs are summarized in Table 4-4. Costs were developed for each alternative based on vendor quotes, estimates for major equipment, and cost curve data for unit processes.

Table 4-4. Digester Costs—Comparative Costs

Alternative	Total project cost ($M)
Upgrade digesters, no expansion (conventional upgrade)	$9.8
Upgrade digesters with expansion	$25.2
Upgrade two digesters with expansion	$20.4
Upgrade existing and convert two to thermophilic	$10.7
THP	$61.0

Cost assumptions: Contractor costs applied as 15% overhead and profit, 12% general conditions, 35% undesigned contingency (10% for vendor packages), 3.5% bonds and insurance, 9.4% sales tax. Allied costs include 2.5% preliminary engineering, 15% final engineering, 7.5% construction engineering, and 5% legal, administration, and permitting. An estimating contingency has been excluded to avoid biasing the comparison between alternatives. Typically, a 30% contingency would be applied with the allied costs.

Conventional and thermophilic upgrades have similar costs, between $9.8 and $10.7M. The other alternatives were nearly double the cost.

Risk and Benefit Assumptions

All of the alternatives are projected to have sufficient capacity to process 2050 loadings, although the conventional upgrade alternative would be limited for the full connection scenario.

The thermophilic and THP upgrade alternatives would increase the amount of digester gas produced relative to the other alternatives. This would increase the potential for energy recovery through cogeneration.

The thermophilic upgrade and THP alternatives would also produce biosolids compatible with Class A standards, which would increase flexibility in terms of biosolids hauling and disposal options.

Screening Result

Based on the above analysis, two alternatives were carried forward into a more detailed evaluation—conventional and thermophilic upgrades.

Final Evaluation

The final evaluation considers two alternatives, both of which involve upgrading the four existing digesters. Both alternatives include new fixed covers and new LM mixers. The thermophilic alternative includes new heat exchangers, circulation pumps, and hot water pumps. These amount to a base equipment cost of approximately $335,000 per digester.

Capital costs from the screening exercise were developed in more detail, and the thermophilic alternative was expanded to apply to all four digesters. Capital costs for the two final alternatives were:

- Conventional upgrades: $10.6M
- Thermophilic upgrades: $14.0M

The benefit of thermophilic digestion is increased gas production. An analysis of data collected since the installation of the cogeneration system has yielded the following estimates for the value of digester gas:

- $0.002850/cf in electrical value
- $0.000975/cf in heating value

Thermophilic operation is expected to increase the volatile solids destruction by approximately 10 percent. Given projected rates of volatile solids loading, this equates to an average yield of 43,600 cubic feet per day, with a value of $61,000 per year.

A portion of the heating value, however, would be consumed by the added heating demand for the digesters, and a portion of the electrical value would be consumed by the larger pumps and heat exchangers. Ultimately, the thermophilic modifications would generate approximately $50,000 per year in added value. In an evaluation basis, that would not be enough to overcome the initial investment. The net present value difference would be just over $2M favoring a conventional upgrade. There are, however, two more considerations in this evaluation-- capacity and biosolids product.

- **Capacity.** In terms of volatile solids loading, the thermophilic digesters will have 60 percent more capacity than conventional digesters. While the conventional digesters are projected to have capacity to meet the 2050 loading conditions, they will not have capacity to meet the full connection scenario. The thermophilic digesters, on the other hand, would be able to get by with just one lead unit for most of the planning period, and would only be 60 percent utilized in the full connection scenario.
- **Biosolids product.** The thermophilic digesters will generate a Class A-compatible product. That product could be land applied as a Class A product or processed further into a commercial-grade fertilizer (similar to Tacoma's Tagro product).

Recommendation

All of the conventional upgrades (fixed covers, new mixers) would be required for the thermophilic upgrade. The most cost-effective and flexible approach would be to **implement the conventional upgrades immediately**, with a plan in place to shift to thermophilic upgrades in the future. Practically, this would mean reserving space and electrical capacity for future thermophilic heat exchangers and associated equipment. The thermophilic upgrades could then be implemented, as needed, in response to capacity needs or the need for a Class A product.

4.5 Summary

The alternatives assessments in this chapter recommended the following actions:

- Upgrade the four existing digesters with new mixing and fixed covers, reserving space for future thermophilic upgrades
- Defer centrate treatment at the moment, but reserve space for any of the three alternatives to be implemented in the future
- Implement CEPT at the primary clarifiers. CEPT may be used for improved wet weather treatment performance. It may also be used to increase permit season secondary process capacity.
- Expand the capacity of the influent pump station by up-sizing the dual force mains from 30-inch diameter to 36-inch diameter
- Plan for a future satellite IPS near Adams Street to relieve potential wet weather flow limitations in the 60-inch-diameter influent piping.
- Plan for a dedicated wet weather treatment facility to treat flows directed from the new satellite influent pump station.

Section 5

High-Level Assessments

A number of questions were raised during the facility needs assessment and alternatives assessments. These include:

- What can be done at the BITP to mitigate the potential impacts of climate change?
- How can LOTT manage existing and future demands related to septage and STEP receiving?
- What is LOTT's long-range approach to biosolids hauling and disposal?
- What should be LOTT's long-range approach to solids thickening?

These questions are addressed in the following set of high-level assessments. The high-level assessments are intended to provide long-range guidance, rather than discrete recommendations and projects.

5.1 Climate Change

Section 4 recommended a phased approach to managing peak wet weather flows at the BITP. As part of that assessment, one question that repeatedly arose is the potential impact of climate change on the Plant. Climate change has the potential to affect the BITP in several ways. Most notably:

- Climate change may disrupt historical weather patterns, resulting in more severe storm events and increased flows related to infiltration and inflow.
- Climate-change induced sea level rise (SLR) may increase the likelihood and frequency of overland flooding in the downtown Olympia combined sewer system, causing increased wet weather flows at the BITP.
- SLR may increase the likelihood and frequency of flooding at the BITP itself, threatening vulnerable equipment and resources and the ability of the Plant to function.

The City of Olympia is currently working to increase the resilience of its downtown core to the potential impacts of SLR. This may involve using barriers and berms to prevent overland flooding of the peninsula, including the BITP. LOTT will continue to coordinate with the City on SLR response.

Figure 5-1 presents the topography of the BITP and surrounding area, showing areas most susceptible to flooding. This map (Figure A) is also located in Appendix B. Most of the BITP is at an elevation of 15 ft to 18 ft (North American vertical datum of 1988). Normal tides at this location vary from -2 ft to 10 ft elevation, and the highest tide on record (from 1977) was measured at just over 14 ft elevation. Recent projections of SLR, combined with a 100-year return storm tide, have estimated that future peak tidal elevation could be up to 16 ft by the year 2050. As shown on the figure, this could lead to extensive flooding at the BITP. Particularly vulnerable are the Plant's electrical feeds, switchgear, and substations. Also vulnerable are the portions of the BITP located underground. These include the influent pump station and the utilidor.

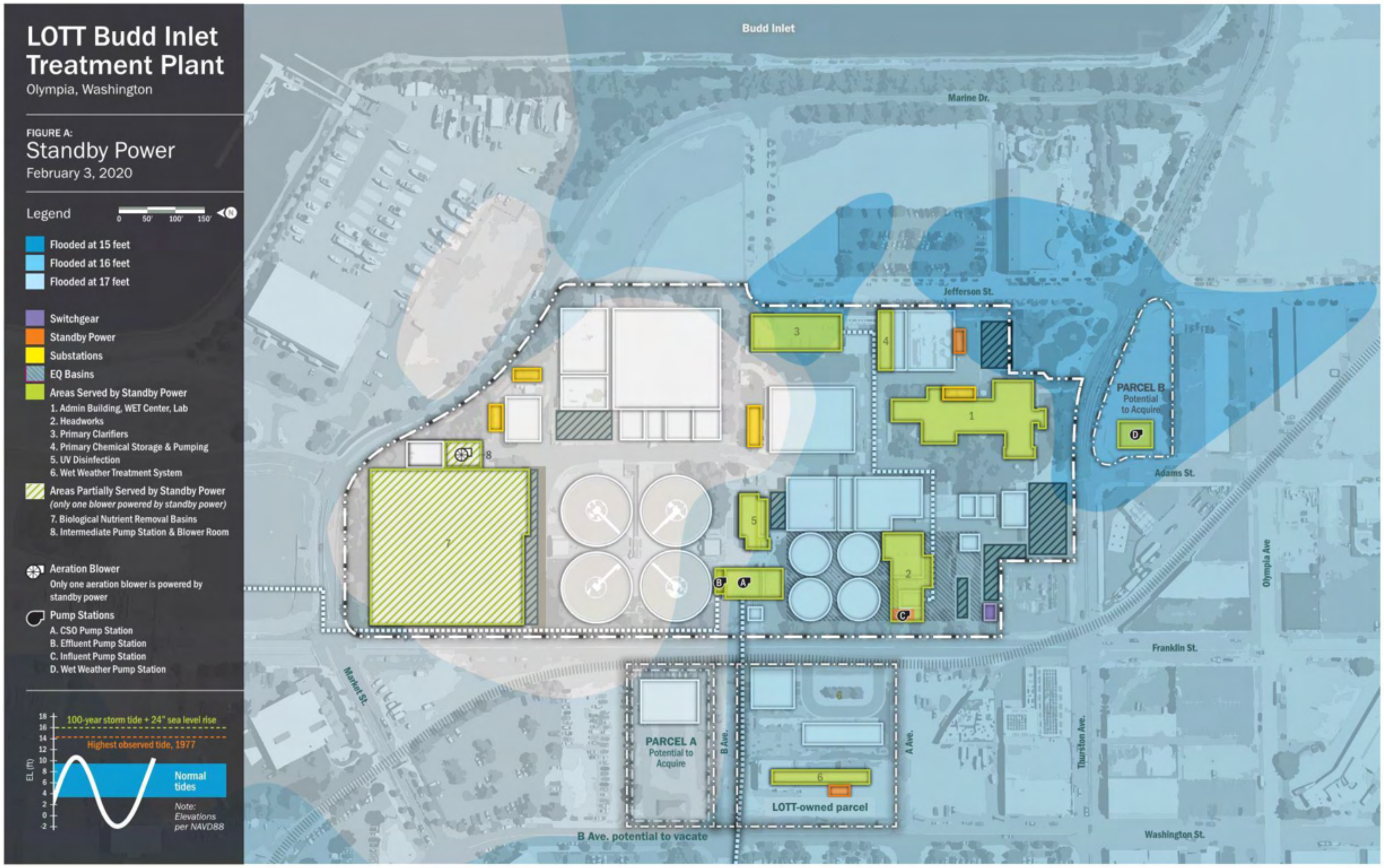


Figure 5-1. Standby power

To mitigate the impacts of flooding, LOTT has adopted a number of guidelines for critical infrastructure. These include:

- Weather-proof critical areas as part of LOTT’s regular replacement schedule.
  - Influent pump station
  - Effluent pump station
  - Service entry switchgear
  - Standby power
  - Substations
- Update design standards and front-end specifications to systematically improve plant resilience over time.
  - Build critical equipment on raised concrete pads
  - Provide waterproof and watertight electrical panels
  - Provide watertight terminal boxes and local hand-operated panels
  - Provide watertight enclosures for substations

LOTT has already implemented these guidelines on its electrical switchgear. The switchgear facility’s most recent renovation included an elevated pad to prevent flooding (Figure 5-2).

Figure 5-2. Renovation of electrical switchgear with elevated pad to reduce flooding risk

With respect to peak flows, LOTT conducted a vulnerability study in 2014. The vulnerability study provided recommendations for how to improve the Plant’s resilience to flooding, as well as guidelines for operating during peak flow events. LOTT’s approach to dealing with high flows has three facets:

- Keep as much flow as possible moving from the influent to the effluent.
- Treat as much of that flow as possible with at least primary treatment and disinfection.
- Protect and preserve the activated sludge biomass in the secondary process.

To keep flow moving, LOTT established emergency power backup for both the influent and effluent pump stations. To provide treatment, emergency power is also provided for primary treatment and UV disinfection. Building on the recommendations in Section 4, standby power would also be provided for a future satellite pump station and a dedicated wet weather treatment facility.

To protect the activated sludge biomass, peak flows to the secondary process would be limited to 55 mgd. Accommodations are included in the biological process improvements project to enable the addition of emergency power for a single aeration blower in the future, ensuring that biomass would not be left unaerated for excessively long periods of time.

Figure 5-3 (also located in Appendix B) presents a long-range approach to managing peak flows. In this figure, up to 100 mgd of flow may be received via the influent piping along Adams Street. A portion of this flow would be removed at the satellite pump station and pumped to a dedicated wet weather treatment facility. For planning purposes, this flow is assumed to be approximately 10 mgd; however, the size of these facilities could be modified as needed. The wet weather treatment system would provide screening, solids separation, and disinfection. Treated effluent would be pumped to the expanded North Outfall.

The remainder of the influent flow would be sent to the headworks for screening and grit removal. The existing EQ basins would act to buffer the peak flow, while the IPS would be capable of pumping up to 80 mgd via the up-sized influent force main. This flow would be treated at the primary clarifiers with CEPT. Up to 55 mgd of primary effluent would be sent for biological treatment in the secondary process, with the remainder of flow being treated with UV disinfection. The various flows would be discharged via the Plant’s two outfalls.

The plan summarized on Figure 5-3 maximizes the degree of treatment and aims to prevent backup of flow in the collection system. All of the key systems are supplied with emergency power, making the scheme resilient to catastrophic flooding and impairment of the local electrical utility.

Figure 5-3. Wet weather

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5.2 STEP/Septage Receiving

As discussed in the facility needs assessment, the BITP currently receives septage from a number of sources. These sources include STEP clean outs managed by the cities of Olympia and Lacey, community STEP and septage clean outs from the City of Lacey, and commercial septage. Table 5-1 summarizes current septage acceptance.

Table 5-1. Septage Receiving Flows

Source	Gallons/year	Average gallons per day	Maximum gallons per month
Lacey STEP	600,000	1,644	120,000
Lacey debris tank	800,000	2,192	180,000
Olympia STEP	600,000	1,644	180,000
Commercial septage[1]	2,000,000	5,479	375,000
Total	4,000,000	10,959	600,000

1. *LOTT is not currently accepting commercial septage*

While the City of Olympia has curtailed future installation of STEP systems, the City of Lacey continues to allow such development and projects an increased amount of septage in the future. In past correspondence, the City of Lacey estimated up to 7,200 gallons per day (gpd) average and 34,000 gpd maximum demands.

The septage received at BITP is highly variable. Random sampling of received loads exhibiting total solids concentration varying from 0.1 to 4.5 percent. The City of Tacoma also receives septage, and their system averages approximately 3 percent solids. The pH of the septage is typically between 5.0 to 7.5, but individual loads may vary.

LOTT and City of Lacey have been in discussions about a potential future septage receiving facility within the City of Lacey to receive all of the City's loads. Conceptual sketches for two different types of facilities have been developed: a stand-alone facility and a facility linked to influent flow equalization at the MWRWP. An alternative concept to expand septage receiving and sludge treatment at the BITP has also been discussed, and that option would resolve/eliminate the need for a separate receiving station in the Lacey area. The facilities would provide screening, pH neutralization, odor control, and security. With a holding volume of 200,000 gallons, the facility could store close to 30 days of septage at the projected average loading. Figure 5-4 presents a schematic of such a facility.

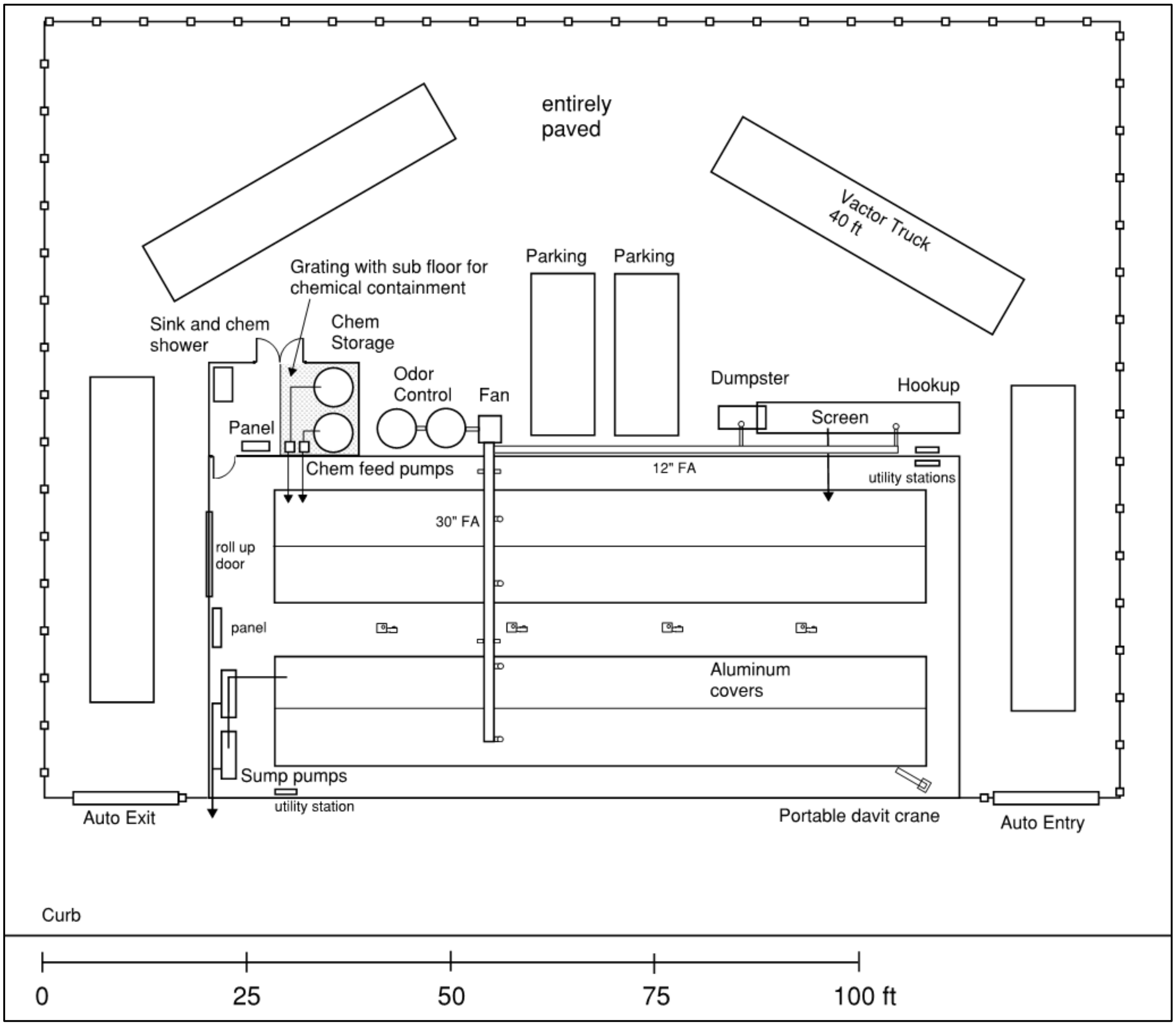

Figure 5-4. Proposed septage receiving facility

The cost of such a facility would be high. The stand-alone facility from Figure 5-4 was estimated to cost $4.3M. A facility integrated with a 500,000-gallon flow EQ basin at MWRWP was estimated to cost $6.7M.

LOTT is currently working with the cities of Lacey and Olympia to sample and characterize STEP loads to better understand their impact on treatment processes. LOTT closed its central receiving station to commercially-hauled septage loads for the foreseeable future to minimize process impacts. Options for managing septage receiving will be further explored in a future phase of master planning.

5.3 Biosolids Disposition

As part of its 2014 Biosolids Master Planning effort, it was concluded that continuing to generate a Class B biosolids product was the most cost-effective approach. A Class B product is suitable for beneficial land application per the requirements of 40 CFR part 503. LOTT currently has its biosolids hauled to a number of permitted land application sites operated by Boulder Park in Douglas County. A Class A biosolids product could increase the number of potential uses and open a market for consumer fertilizer sales; however, the costs of setting up, operating, and managing such a system were too high to consider in light of the marginal advantages, especially as Class B land application is not currently limited.

More recently, LOTT has been exploring the potential for thermal evaporation of its biosolids. The concept is to take a waste stream (for example, digested sludge) and evaporate the liquid content under high heat. Such a process would generate three products:

- Distilled product from the vaporized steam. This would have low solids content but would contain dissolved pollutants, such as ammonia and phosphate, at typical wastewater concentrations.
- A high-strength aqueous product containing the volatile compounds released in the distillation process. This product would contain very high ammonia concentrations but could contain other volatile organic pollutants.
- A dry biosolids product, with more than 90 percent solids content, which may be compatible with Class A biosolids regulations.

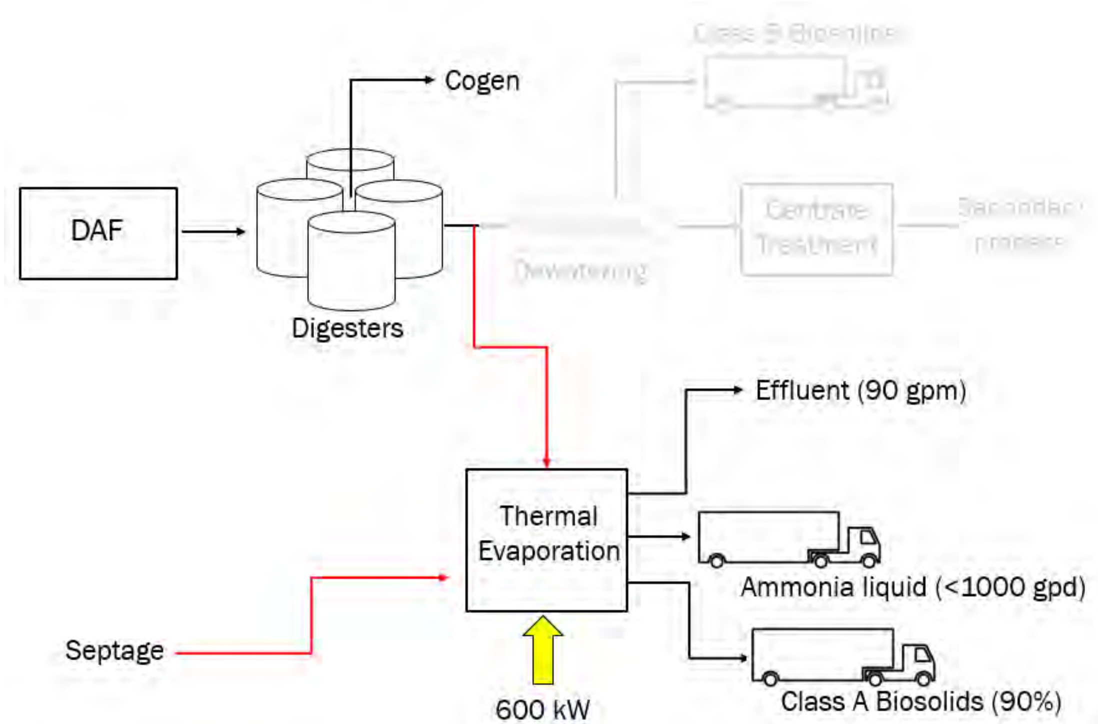

Figure 5-5. Schematic representation of 90 gallons per minute thermal evaporation system

As currently conceived, such a system could treat not only digested solids but a combination of digested solids and septage. A 90-gallons per minute system could treat all of the BITP's digested solids, plus the bulk of the septage itemized in Table 5-1. Because the system treats all of the digested solids, the biosolids dewatering facility would no longer be necessary, and dewatering centrate would no longer be produced. Such a facility would, therefore:

- Eliminate the need for dewatering
- Eliminate the need for centrate treatment
- Eliminate the impacts of septage receiving on the BITP and MWRWP
- Reduce the volume of biosolids product by 4-5X
- May allow for Class A biosolids use

Annual savings from such benefits have been estimated at close to $700,000. That value includes savings of $425,000 per year on dewatering operating and $480,000 per year on biosolids hauling and application, minus the cost to power the evaporation system ($220,000 per year). Capital costs for the system are estimated at approximately $15M to $20M.

The type of system described above is still in its infancy, and a number of questions remain to be resolved before the system would be feasible for application at the BITP. These questions include:

- Will the dry biosolids be compatible with Class A biosolids regulations? If not, will there be another potential end use, such as biofuel?
- Where can the aqueous ammonia liquid be disposed? Currently, such product is applied to livestock farms; however, will a municipally-derived product be contaminated with volatile toxic organics?

LOTT is currently engaged in bench-scale testing, and further pilot work may be required to effectively answer these questions.

5.4 Solids Thickening

Problem

The BITP currently has four DAFTs that provide solids thickening for primary sludge and WAS ahead of anaerobic digestion. Currently, two of the four DAFTs are out of service. Of the two units in service, one has recently been retrofitted with a new form of air saturation that uses a pump instead of a saturation tank system. Recent testing of the system has suggested that the capacity of the tank with the pump saturation system is lower than the capacity of saturation tank system; however, the former system offers a large amount of maintenance savings and simplification and is preferred by staff.

It has been suggested that the DAF technology be evaluated prior to further investment in renovation and replacement. A recent estimate suggested that it would cost $3.2M to complete renovation work on the DAF system.

Alternatives

There are several alternatives available for solids thickening. These include DAF, gravity belt thickeners, centrifuges, and rotary drum thickeners. Of these technologies, DAF requires the most space. It is therefore likely that any of the four technologies would fit within the location of the existing DAF system. A decision on thickening technology, therefore, need not consider capacity or space constraint.

In brief, the advantages and disadvantages of thickening technologies may be expressed as follows.

- **DAF systems** historically have been the most resilient thickening technology. Performance typically has little to do with feed quality, and DAF systems can thicken very thin sludges. For this reason, DAFs have historically been favored for systems with highly variable feed composition, systems wasting mixed liquor, and systems aiming to thicken material with fats, oils, greases, or other scum. DAF systems use relatively low power and require infrequent maintenance. Most of the DAF system maintenance is typically related to the air saturation system, and the self-aspirating pump (as installed in DAF tank 1) has greatly reduced such maintenance. DAF systems are relatively slow to respond to operational changes, however, and failure conditions may be missed if the system is not being watched closely.
- **Gravity belt thickeners (GBT)** come in a variety of sizes and would typically be used to separately thicken primary sludge and WAS. Polymer demand is typically higher than for a DAF system. The

power to operate a GBT is relatively low, but the system requires considerable maintenance. Belts and other wear parts must be periodically replaced, and the system is prone to fouling.

- **Rotary drum thickeners (RDT)** are similar to GBTs but typically require less maintenance. The RDT units keep the sludge enclosed within the drum, which reduces potential for fouling and keeps bearings and other parts away from the sludge and grit. RDT units have high polymer demand but relatively low power. As the newest thickening technology, there is relatively little long-range data on maintenance and replacement. RDTs require that the feed sludge be sufficiently thick; vendors have used 5,000 mg/L as a minimum feed concentration. When lightly loaded, RDTs may struggle to increase cake thickness, increasing the hydraulic load on the digester system. RDTs are more amenable to co-thickening of primary sludge and WAS than GBTs.
- **Centrifuges** have the highest power and maintenance demands of the four technologies but are relatively simple to operate and are more resilient to changes in feed quality than GBTs or RDTs.

LOTT is currently engaged in continued testing and analysis of the self-aspirating pumping system and will continue to evaluate system capacity. A renovation project will be required in the near-term, and this will include a more detailed cost comparison and evaluation. At present, there is no capacity-related need to change course.

Section 6

Future Site Planning

The following figures, located in Appendix B, were developed to provide a long-range road map for future development at the BITP:

- Figure A, introduced in Section 5.1, shows the site topography and susceptibility to flooding. It also presents a summary of the standby power coverage and locations of critical electrical infrastructure. The intent of this map is to show the risks related to climate change and wet weather.
- Figure B, introduced in Section 5.1, provides a conceptual vision of peak wet weather flow routing and treatment. The figure shows how influent flows up to 100 mgd may be managed.
- Figure C, introduced in Section 6.1, presents the future site plan. This Figure shows how the BITP may look in 2050 and beyond, and the facilities required to treat all of the projected flows and loads for both the 2050 and full connection scenarios.
- Figure D, introduced in Section 6.2, presents a transportation map showing the main entrances, exits, and thoroughfares within the BITP. This figure also details parking, deliveries, and other access.

6.1 2050 Site Plan

Based on the results of the facility needs assessment and subsequent assessments in Sections 4 and 5, the future site map on Figure 6-1 (also located in Appendix B) has been developed. While the project was set up with two separate scenarios in mind (2050 and full connection), the scenarios fail to differ in any meaningful way in terms of the facilities and unit processes required at the BITP.

Figure 6-1 uses the following shading to highlight certain areas of the map:

- Facilities shaded in light grey or white are existing facilities, which are not anticipated to change significantly through 2050. These facilities will undergo periodic renovation and replacement cycles but will fundamentally retain the same location and method of treatment.
- Facilities shaded in light blue are either new facilities to be constructed, or existing facilities to be expanded or upgraded.
- Purple shading indicates locations of existing or potential reclaimed water production. The disposition of these locations will be developed further in Phase 2 of this Update.
- Light green shading indicates areas that serve primarily administrative purposes.
- Dark green shading indicates public spaces.
- Orange shading indicates storage facilities.

Three parcels outside of the BITP’s current fence line are shown on Figure 6-1 and are described in the following subsections.

Figure 6-1. 2050 site plan

Washington Street Property

The parcel at 516 Washington Street NE is owned by LOTT. Figure 6-2 shows a close up of the three facilities planned for this space. These include a dedicated wet weather treatment facility intended to treat flows pumped from a satellite influent pump station (#29); an alternative solids processing facility, similar to the thermal evaporation system described in Section 5.3 (#43); and an expanded septage receiving facility (#42), which could be used in conjunction with the alternative solids processing facility.

Figure 6-2. Fish and Wildlife Parcel

The site is large enough to accommodate a truck pull-through driveway off Franklin Street NE, shown above #43.

Parcel A

The parcel located at 608 Washington Street NE was identified as a potential acquisition for LOTT to secure space for secondary process or reclaimed water expansion. This parcel, shown in Figure 6-3, is ideal due to its proximity to the existing secondary clarifiers and final effluent pump station, as well as to the LOTT-owned parcel just south of B Street. Setting aside space for an alternative means of expansion at this location maximizes flexibility to accommodate LOTT's future process needs. Of the various adjacent properties considered for future expansion needs, this parcel is the highest priority for acquisition. LOTT is in discussion with the Port of Olympia about this possible acquisition.

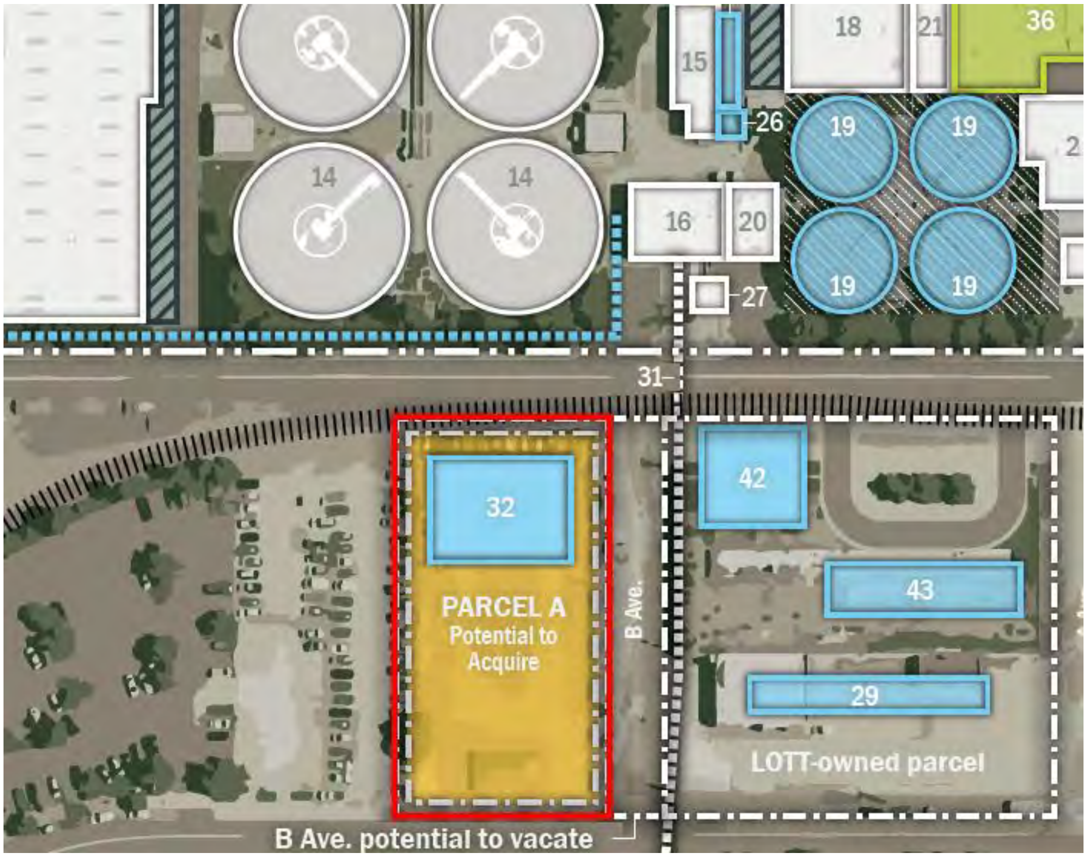

Figure 6-3. Parcel A

B Avenue

LOTT and the City of Olympia have been in initial discussions about the possibility to vacate B Avenue (Figure 6-4). Vacation of this roadway and acquisition of the Port parcel A to the north would provide LOTT with uninterrupted access to 2.6 acres of space for expansion of treatment plant processes.

Figure 6-4. B Avenue

Parcel B

As discussed in Section 4.3, a satellite influent pump station located near Adams Street could reduce peak flow limitations in the 60-inch influent sewer and provide an opportunity for increased wet weather treatment capacity. The optimal location for the pump station would be along State Avenue NE, between Chestnut St. SE and Jefferson St. NE, where the Cherry, Chestnut, and State Street interceptors combine. Given the lack of available land in this area, available parcels within a two block radius should be considered for this pump station. Figure 6-5 highlights a parcel two blocks north, which is known to be currently available. The final selection of a parcel for this pump station will depend on availability at the time of action, cost, and location.

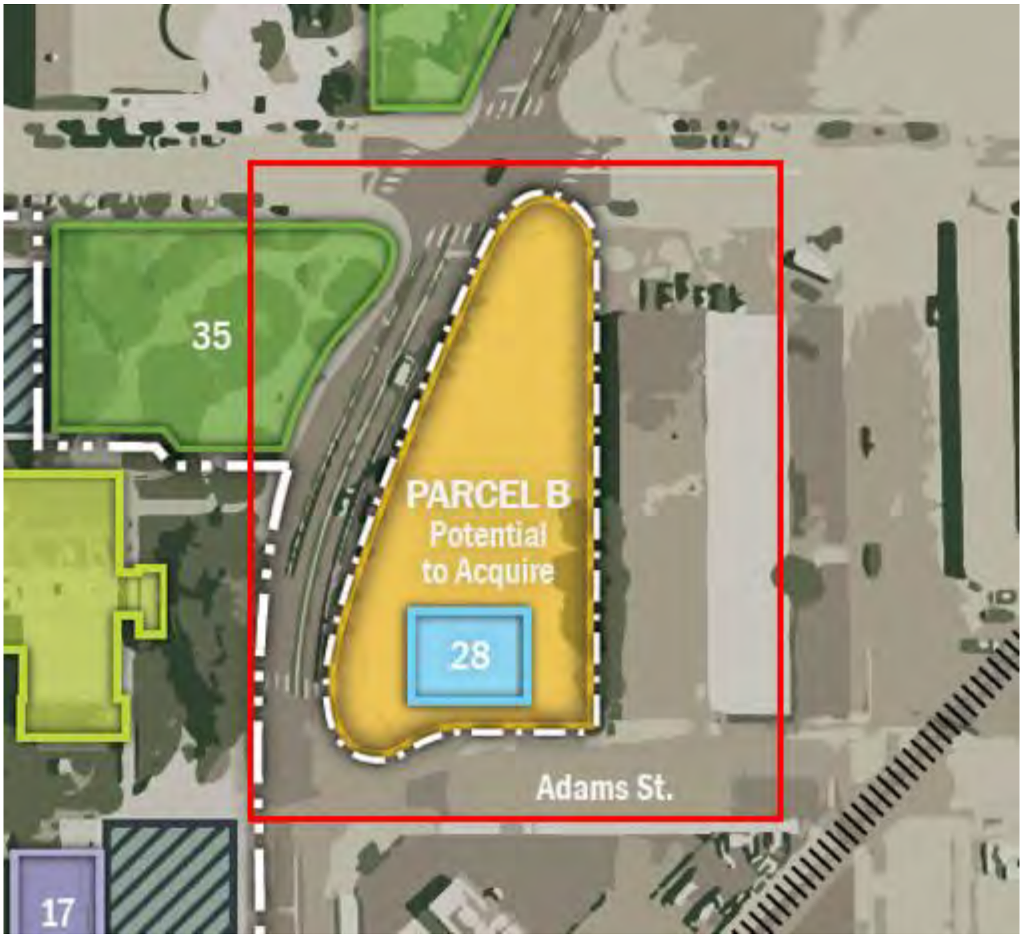

Figure 6-5. Parcel B

6.2 Transportation

Figure 6-6 shows the main roads at BITP, truck loading/unloading areas, and the various employee and visitor parking areas around the plant. This Transportation Map is also located in Appendix B. The map calls out the gates around the plant and the location of the grit dumpster and diesel fuel delivery areas. It also shows the traffic pattern for septage haulers along Franklin Street.

Figure 6-6. Transportation

Section 7

Capital Improvements Plan

LOTT maintains a detailed 6-year CIP to coordinate near-term budgeting, and a high-level long-range program to develop budgetary strategies. These are summarized in each biennial Budget and Capital Improvements Plan report. Table 7-1 summarizes the projects and potential projects which have been developed as part of this Update. 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.

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

Project	Purpose	Timing	Total Cost [1]
Digester upgrades	Digester capacity (Phase 1)	2023	$10,610,000
Digester thermophilic upgrades	Digester capacity (Phase 2)	2045	$3,430,000
CEPT implementation	Secondary process and wet weather capacity (Phase 1)	2025	$2,910,000
Influent pump station expansion	Wet weather capacity (Phase 2)	2035	$3,660,000
Adams Street pump station	Wet weather capacity (Phase 3)	2045	$12,590,000
WW primary clarifiers	Wet weather capacity (Phase 3)	2045	$8,370,000
WW disinfection	Wet weather capacity (Phase 3)	2045	$3,390,000
Screening facility	Wet weather capacity (Phase 3)	2045	$8,520,000
Centrate treatment	TBD	TBD	$3.6–$6.6M
Alternative biosolids processing	TBD	TBD	$15–$20M

1 *Class 5 cost estimates with a range of -50% to +100%*

2 *Estimates include 15% contractor overhead and profit, 12% contractor general conditions, 35% contingency (10% for vendor packages), 3.5% bonds and insurance, 9.4% sales tax, 2.5% preliminary engineering, 15% final engineering, 7.5% construction engineering, and 5% legal, administrative, and permitting costs.*

In addition to the projects listed in Table 7-1, several projects have already been identified in the long-range CIP and have been discussed in Section 3 of this report. These projects are summarized in Table 7-2.

Table 7-2. Capacity or Upgrade Projects already identified in the long-range CIP			
Project	**Purpose**	**Timing**	**Total Cost**
North scrubber	Renovation and upgrade	2025	$6,090,000
Septage receiving	Capacity expansion and upgrade	2025[1]	$2,140,000
North outfall	Capacity expansion	2036	$5,240,000

1 *Septage receiving may be linked to Alternative biosolids processing, as well as to STEP receiving. Project timing and cost are placeholders pending decisions on those facilities.*

2 *Centrate treatment is currently not recommended but may become advantageous if conditions change. The cost of the most expensive alternative from Section 4-1 is carried in this table. Timing at 2030 is a placeholder.*

In addition to the projects in Tables 7-1 and 7-2, a number of renovation and replacement projects were identified in Section 3 of this report. The timing and approximate costs for these projects are summarized in Table 7-3.

Table 7-3. Renovation and Replacement Projects to be Added to the CIP			
Project Area	**Project Type**	**Approximate Time Frame**	**Approximate Cost [1]**
Budd Inlet Reclaimed Water Plant	Renovation	2025	$2,150,000
Secondary clarifiers	Renovation	2027	$6,930,000
Effluent pump station	Renovation	2027	$9,070,000
South scrubber	Replacement	2029	$1,770,000
Solids thickening	Replacement	2030	$4,790,000
Cogeneration	Engine Replacement	2030	$500,000
Methanol facility	Replacement	2030	$1,160,000
Primary clarifiers	Renovation	2033	$4,980,000
Dewatering	Renovation	2037	$4,590,000
Headworks	Renovation	2038	$11,490,000
EQ basins	Renovation	2038	$4,220,000
Secondary process	Renovation	2041	$17,230,000
Blower building	Renovation	2041	$4,310,000
Disinfection	Replacement	2043	$13,970,000

1 *Time frame is based on anticipated average equipment service life (renovations) and facility structural service life (replacement).*

2 *Costs are parametric estimates based on similar projects completed within the past 10 years, adjusted for region and timing using Engineering News Record Construction Cost Index.*

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 October 30, 2018. 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

Estimate 1. Digester Upgrades					
	Quantity	Units	Unit Cost	Total Cost	
				Thermophilic Upgrades	Conventional Upgrades
Demolition					
Digester covers, 70-foot dia	4	ea	$100,000	$400,000	$400,000
Digester mixing systems	4	ea	$1,000	$4,000	$4,000
Heat exchangers	4	ea	$1,500	$6,000	$6,000
Digester equipment					
Covers, 70-foot dia steel fixed	4	ea	$390,000	$1,560,000	$1,560,000
Mixers	4	ea	$325,000	$1,300,000	$1,300,000
Heat exchangers	4	ea	$125,000	$500,000	$0
Digester circulation pumps	4	ea	$95,000	$380,000	$0
Hot water pumps	4	ea	$18,750	$75,000	$0
Mechanical piping and valves	1	ls	$383,350	$383,000	$221,000
Digester coating allowance	20,000	sf	$2	$40,000	$40,000
Electrical and Instrumentation	1	ls	$839,700	$840,000	$616,000
Base cost				$5,488,000	$4,147,000
Contractor overhead and profit	15%			$823,000	$622,000
				$6,311,000	$4,769,000
Contractor general conditions	12%			$757,000	$572,000
				$7,069,000	$5,342,000
Undesigned contingency	35%			$2,474,000	$1,870,000
				$9,543,000	$7,211,000
Bonds and insurance	3.5%			$334,000	$252,000
				$9,877,000	$7,464,000
Tax	9.4%			$928,000	$702,000
Bid cost				$10,805,000	$8,165,000
Preliminary engineering	2.5%			$270,000	$204,000
Final engineering	15%			$1,621,000	$1,225,000
Construction engineering	7.5%			$810,000	$612,000
Legal, admin, permitting	5%			$540,000	$408,000
Total project cost				$14,047,000	$10,615,000

Estimate 2. Influent Pump Station Force Main Expansion				
	Quantity	Units	Unit Cost	Total Cost
Install new 36-inch force mains	420	LF	$2,200	$924,000
Demo 30-inch force mains	420	LF	$100	$42,000
Trenching	250	LF	$1,050	$263,000
EQ work allowance	125	LF	$1,340	$168,000
IPS work allowance	45	LF	$110	$5,000
Site work	1	LS	$30,000	$30,000
Base cost				$1,431,000
Contractor overhead and profit	15%			$215,000
				$1,646,000
Contractor general conditions	12%			$197,000
				$1,843,000
Undesigned contingency	35%			$645,000
				$2,488,000
Bonds and insurance	3.5%			$87,000
				$2,575,000
Tax	9.4%			$242,000
Bid cost				$2,817,000
Preliminary engineering	2.5%			$70,000
Final engineering	15%			$423,000
Construction engineering	7.5%			$211,000
Legal, admin, permitting	5%			$141,000
Total project cost				$3,662,000

Estimate 3. Struvite Removal System				
	Quantity	Units	Unit Cost	Total Cost
Vendor package	1	LS	$1,374,200	$1,374,000
Installation	1	LS	$274,840	$275,000
Piping and valves	1	LS	$233,614	$234,000
Equipment building 18 x 28 ft	600	sf	$250	$150,000
Wet well 8 x 8 x 6 ft LWD	1	LS	$22,900	$23,000
Sludge pumps- 10 HP VX100-90Q Rotary Lobe	1	LS	$49,000	$49,000
Feed piping 8 inches above grade/in buildings	250	LF	$172	$43,000
Sludge piping 8 inches above grade/in buildings	250	LF	$172	$43,000
Electrical and instrumentation	1	LS	$430,000	$430,000
Modulating valves for bypass	2	EA	$10,000	$20,000
Reactor slab	1	EA	$12,720	$13,000
Chemical storage slab	1	EA	$3,450	$3,000
Site work	1	LS	$9,000	$9,000
Base cost				$2,666,000
Vendor package				$1,374,000
Other				$1,292,000
Contractor overhead and profit	15%			$400,000
				$3,066,000
Contractor general conditions	12%			$368,000
				$3,433,000
Undesigned contingency	22.1%[1]			$759,000
				$4,193,000
Bonds and insurance	3.5%			$147,000
				$4,339,000
Tax	9.4%			$408,000
Bid cost				$4,747,000
Preliminary engineering	2.5%			$119,000
Final engineering	15%			$712,000
Construction engineering	7.5%			$356,000
Legal, admin, permitting	5%			$237,000
Total project cost				$6,172,000

1 *10% for vendor package equipment, 35% for everything else*

Estimate 4. Anammox Based Centrate Treatment System					
	Quantity	Units	Unit Cost	Total Cost	
				World Water Works	Veolia
Demolition	1	LS	$40,000	$40,000	$40,000
Rehab	1	LS	$77,500	$78,000	$78,000
Vendor package	1	LS	$1,350,000	$1,350,000	$895,000
Installation	1	LS	$405,000	$405,000	$269,000
Piping and valves	1	LS	$229,500	$230,000	$152,000
Feed pumps: 10 HP VX100-90Q	2	EA	$49,000	$98,000	$98,000
Effluent pumps: 10 HP VX100-90Q	2	EA	$49,000	$98,000	$98,000
Influent pipe: 8 inches below grade	140	LF	$257	$36,000	$36,000
Effluent pipe: 8 inches in outdoor pipe gallery	60	LF	$172	$10,000	$10,000
Air pipe: 8 inches	100	LF	$170	$17,000	$17,000
Electrical and instrumentation	1	LS	$459,600	$460,000	$315,000
Base cost				$2,821,000	$2,007,000
Vendor package				$1,350,000	$895,000
Other				$1,471,000	$1,112,000
Contractor overhead and profit	15%			$423,000	$301,000
				$3,244,000	$2,309,000
Contractor general conditions	12%			$389,000	$277,000
				$3,633,000	$2,586,000
Undesigned contingency	23%[1]			$837,000	$617,000
				$4,470,000	$3,202,000
Bonds and insurance	3.5%			$156,000	$112,000
				$4,627,000	$3,314,000
Tax	9.4%			$435,000	$312,000
Bid cost				$5,062,000	$3,626,000
Preliminary engineering	2.5%			$127,000	$91,000
Final engineering	15%			$759,000	$544,000
Construction engineering	7.5%			$380,000	$272,000
Legal, admin, permitting	5%			$253,000	$181,000
Total project cost				$6,580,000	$4,714,000

1 *10% for vendor package equipment, 35% for everything else*

Estimate 5. Bioaugmentation Centrate Treatment				
	Quantity	Units	Unit Cost	Total Cost
Demo Mixers	4	EA	$1,000	$4,000
Misc. demolition	1	LS	$10,000	$10,000
BAR aeration blower, 4,000 scfm high speed	2	EA	$250,000	$500,000
BAR aeration diffusers	7056	SF	$20	$141,000
8-inch centrate to BAR (Glass lined DI)	250	LF	$172	$43,000
30-inch air (SS)	250	LF	$700	$175,000
24-inch air (SS)	100	LF	$460	$46,000
15-inch air (SS)	50	LF	$615	$31,000
Feed pumps: 10 HP VX100-90Q Rotary Lobe	2	EA	$49,000	$98,000
Mechanical piping and valves	1	LS	$125,650	$126,000
Electrical and instrumentation	1	LS	$259,500	$260,000
Base cost				$1,433,000
Contractor overhead and profit	15%			$215,000
				$1,648,000
Contractor general conditions	12%			$198,000
				$1,846,000
Undesigned contingency	35%			$646,000
				$2,492,000
Bonds and insurance	3.5%			$87,000
				$2,579,000
Tax	9.4%			$242,000
Bid cost				$2,821,000
Preliminary engineering	2.5%			$71,000
Final engineering	15%			$423,000
Construction engineering	7.5%			$212,000
Legal, admin, permitting	5%			$141,000
Total project cost				$3,668,000

Estimate 6. Thermal Evaporative Biosolids Treatment				
	Quantity	Units	Unit Cost	Total Cost
Vendor package	1	LS	$8,000,000	$8,000,000
Building	6,720	sf	$150	$1,008,000
Pipe and conduit				
DS to site	500	LF	$172	$86,000
Septage to site	400	LF	$172	$69,000
NG to site	500	LF	$40	$20,000
Water to site	500	LF	$40	$20,000
Instrument air to site	500	LF	$40	$20,000
Effluent to disinfection	600	LF	$140	$84,000
Asphalt replacement	200	LF	$87	$17,000
12-kV line to substation	300	LF	$200	$60,000
Power to site	150	LF	$30	$5,000
Cable to site	500	LF	$30	$15,000
Site clearing	39,648	sf	$0	$12,000
Grading	4,405	sy	$1	$4,000
Landscaping	1,556	sy	$11	$18,000
Paving	1,333	sy	$53	$71,000
Fence	1,200	LF	$46	$55,000
Motorized gates	2	ea	$3,100	$6,000
Odor control				
Carbon unit	1	ea	$200,000	$200,000
Blower	1	ea	$100,000	$100,000
Enclosure	1	ea	$55,000	$55,000
Grease filter	1	ea	$25,000	$25,000
Electrical substation	1	LS	$1,608,344	$1,608,000
Base cost				$11,558,000
Vendor package				$8,000,000
Other				$3,558,000
Contractor overhead and profit	15%			$534,000
				$4,092,000
Contractor general conditions	12%			$491,000
				$4,583,000
Undesigned contingency	35%			$1,604,000
				$6,187,000
Bonds and insurance	3.5%			$217,000
				$6,403,000
Tax	9.4%			$602,000
Bid cost (non vendor)				$7,005,000

Estimate 6. Thermal Evaporative Biosolids Treatment				
	Quantity	Units	Unit Cost	Total Cost
Preliminary engineering	2.5%			$175,000
Final engineering	5%			$350,000
Construction engineering	7.5%			$525,000
Legal, admin, permitting	5%			$350,000
Total project cost				$16,406,000

Estimate 7. Wet Weather Treatment Systems—Base Costs				
	Quantity	Units	Units Cost	Total Cost
CEPT facility	1	LS	$1,138,274	$1,138,274
Wet weather primary clarifier				
WW primary clarifier	5000	SF	$739	$3,692,750
Disposal of contaminated soil	7868.5	tons	$66	$519,321
				$4,212,071
UV disinfection for WW system				
Disinfection	10,000,000	gpd	$0.1704	$1,704,000
Adams St. pump station				
10 mgd pump station	1	ea	$6,083,649	$6,083,649
Property	0.25	acre	$1,000,000	$250,000
Disposal of contaminated soil	20.5716	tons	$66	$1,358
				$6,335,007
Pretreatment for WW system				
Screenings and grit removal	1	ea	$4,289,116	$4,289,116

Estimate 8. Wet Weather Treatment Systems—Markups and Total Costs					
	CEPT	WWPC	Adams St PS	WW disinfection	WW screening
Base cost	$1,138,000				
Contractor overhead and profit	$171,000				
	$1,309,000				
Contractor general conditions	$157,000				
	$1,466,000	$4,212,000	$6,335,000	$1,704,000	$4,289,000
Undesigned contingency	$513,000	$1,474,000	$2,217,000	$596,000	$1,501,000
	$1,979,000	$5,686,000	$8,552,000	$2,300,000	$5,790,000
Bonds and insurance	$69,000	$199,000	$299,000	$81,000	$203,000
	$2,049,000	$5,885,000	$8,852,000	$2,381,000	$5,993,000
Tax	$193,000	$553,000	$832,000	$224,000	$563,000
Bid cost	$2,241,000	$6,439,000	$9,684,000	$2,605,000	$6,556,000
Preliminary engineering	$56,000	$161,000	$242,000	$65,000	$164,000
Final engineering	$336,000	$966,000	$1,453,000	$391,000	$983,000
Construction engineering	$168,000	$483,000	$726,000	$195,000	$492,000
Legal, admin, permitting	$112,000	$322,000	$484,000	$130,000	$328,000
Total project cost	$2,913,000	$8,370,000	$12,589,000	$3,386,000	$8,523,000

Costs for WWPC, pump station, disinfection, and screening are based on cost curves, which include contractor costs and markups.

Appendix B: Site Maps

LOTT Budd Inlet Treatment Plant

Olympia, Washington

FIGURE A:

Standby Power

February 3, 2020

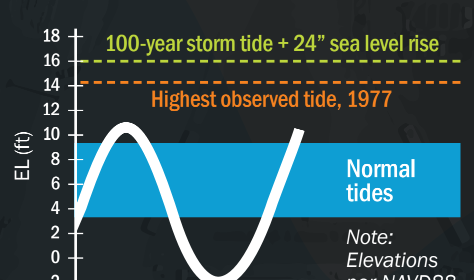
Legend

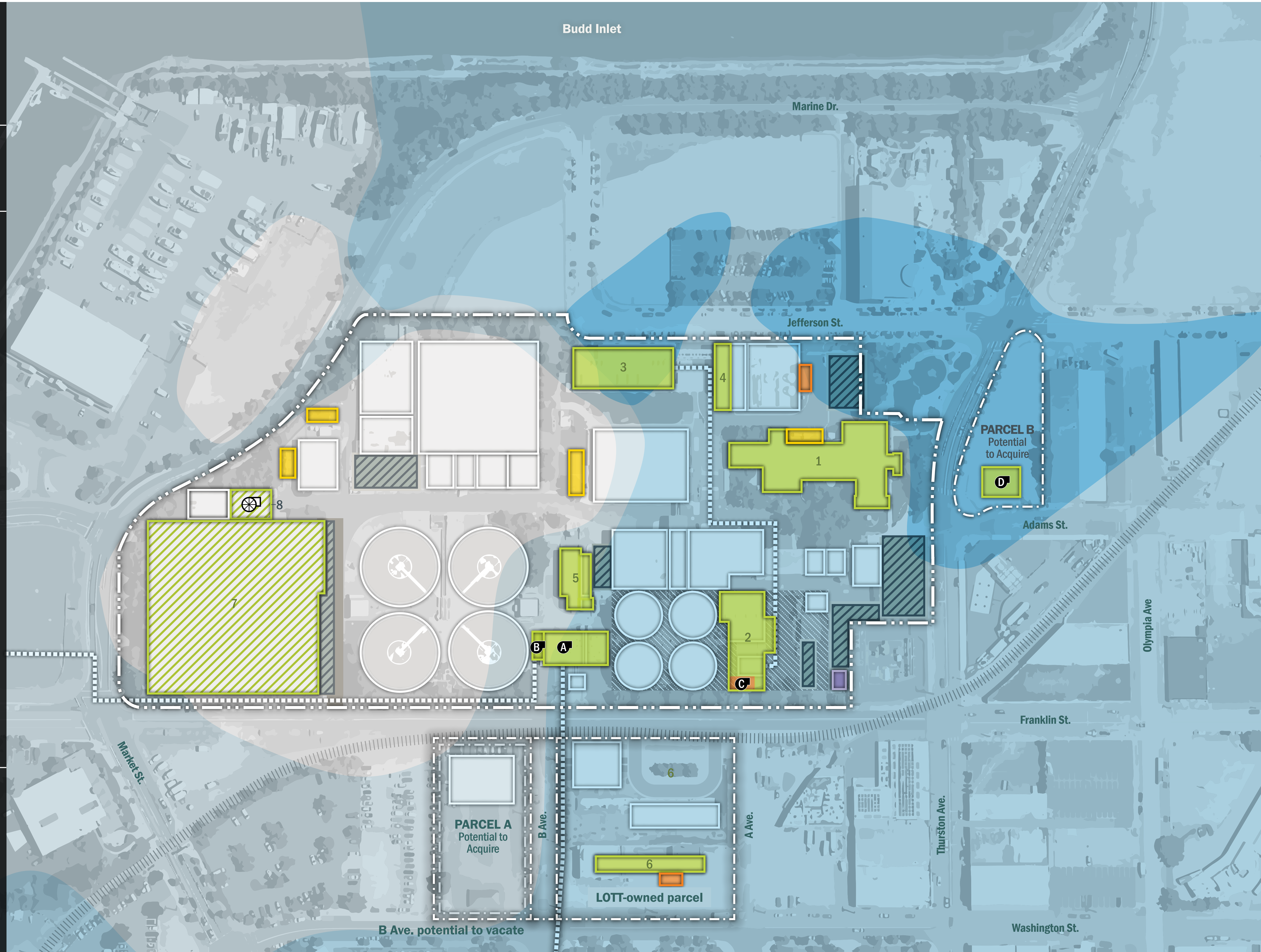
0 50' 100' 150' N

- Flooded at 15 feet
- Flooded at 16 feet
- Flooded at 17 feet

- Switchgear
- Standby Power
- Substations
- EQ Basins
- Areas Served by Standby Power
  1. Admin Building, WET Center, Lab
  2. Headworks
  3. Primary Clarifiers
  4. Primary Chemical Storage & Pumping
  5. UV Disinfection
  6. Wet Weather Treatment System
- Areas Partially Served by Standby Power *(only one blower powered by standby power)*
  7. Biological Nutrient Removal Basins
  8. Intermediate Pump Station & Blower Room

- Aeration Blower
  Only one aeration blower is powered by standby power
- Pump Stations
  - A. CSO Pump Station
  - B. Effluent Pump Station
  - C. Influent Pump Station
  - D. Wet Weather Pump Station





LOTT Budd Inlet Treatment Plant

Olympia, Washington

FIGURE B:

Wet Weather

February 3, 2020

Legend

0 50' 100' 150' N

- Processes involved in wet weather treatment
- EQ Basins
- To secondary process (flow limited to protect process)
- Flow paths

1. Influent Pump Station
2. Headworks
3. Influent Pump Station Forcemain
4. Primary Clarifiers
5. Primary Clarifier Odor Control & Electrical
6. UV Disinfection
7. Effluent Pump Station
8. Wet Weather Pump Station
9. Wet Weather Treatment
10. Forcemain to North Outfall
11. Forcemain to Fiddlehead Outfall

LOTT Budd Inlet Treatment Plant

Olympia, Washington

FIGURE C:

2050 Site Plan

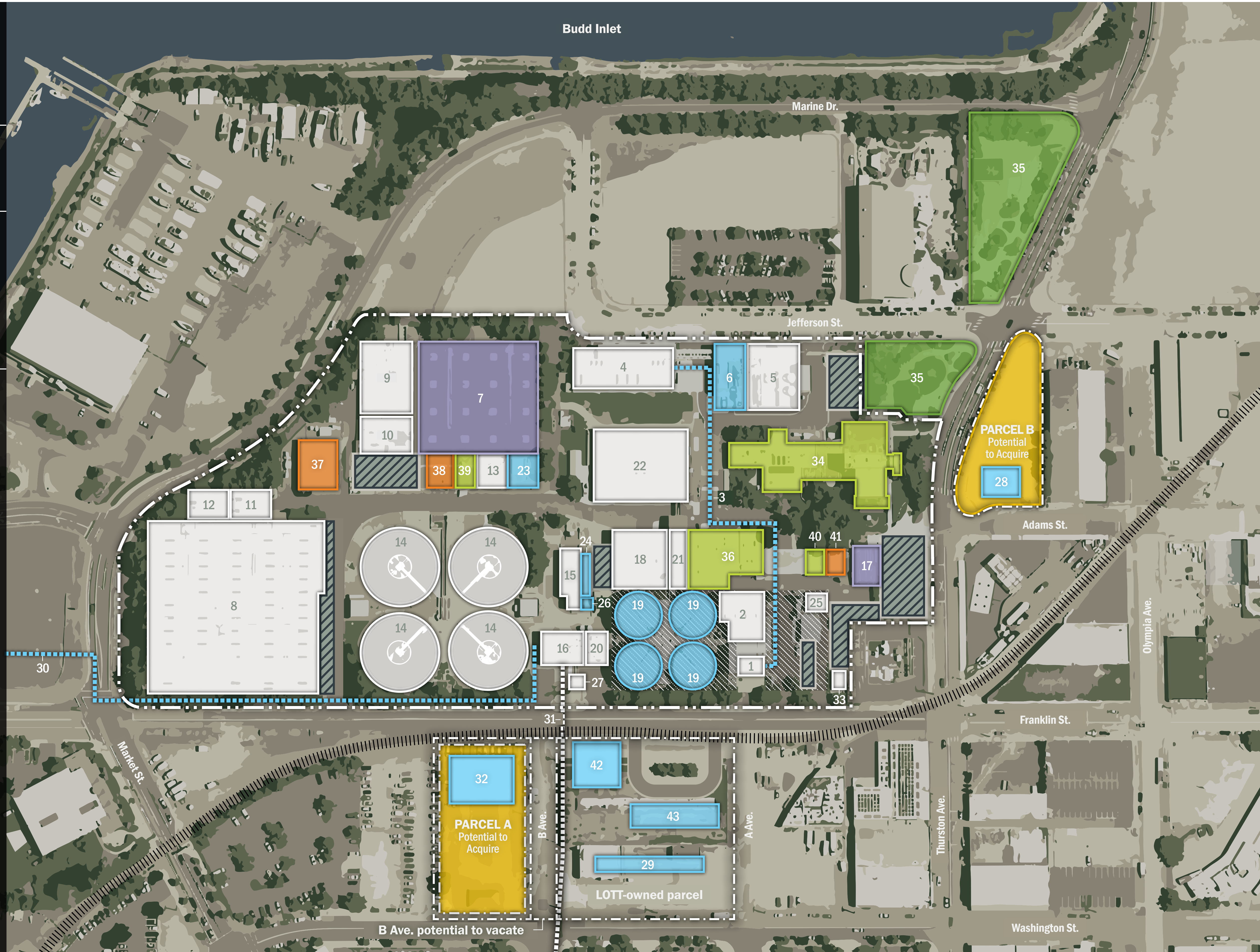
February 3, 2020

Legend

0 50' 100' 150' N

- Existing
- Existing & Potential Reclaimed Water Production Facilities
- Future Capital Project
- Properties Considered for Acquistion
- Administrative
- Public Spaces
- Storage
- Parking Areas
- EQ Basins

1. Influent Pump Station
2. Headworks
3. Influent Pump Station Forcemain Expansion
4. Primary Clarifiers
5. Primary Clarifier Odor Control & Electrical
6. Primary Chemical Storage & Pumping, Potential CEPT
7. Temporary Equalization, Potential Reclaimed Water Expansion
8. Biological Nutrient Removal Basins
9. Second Anoxic Basin
10. Final Aeration Basin
11. Intermediate Pump Station & Blower Room
12. BNR Mechanical/Electrical Building
13. Old Blower Room, Future Use TBD
14. Secondary Clarifiers
15. UV Disinfection
16. Effluent Pump Station
17. Reclaimed Water Filters
18. Solids Thickening
19. Digesters, Potential Conversion to Thermophilic
20. Cogeneration
21. Sludge Dewatering
22. Centrate Storage and Handling
23. Potential Centrate Treatment
24. Potential Struvite Facility
25. South Odor Scrubber
26. North Odor Scrubber
27. Septage Receiving Station
28. Wet Weather Pump Station
29. Wet Weather Treatment
30. Forcemain to North Outfall
31. Forcemain to Fiddlehead Outfall
32. Potential Secondary Process Expansion Area
33. Switchgear
34. Admin Building, WET Center, Lab
35. East Bay Plaza
36. Maintenance
37. Maintenance Storage
38. Parts and Storage Warehouse
39. Outback Control Room
40. Control Systems
41. Storage Building
42. Potential Septage Receiving Expansion
43. Potential Alternative Solids Processing



LOTT Budd Inlet Treatment Plant

Olympia, Washington

FIGURE D:

Transportation

February 3, 2020

Legend

0 50' 100' 150' N

- Parking
- Visitor Parking
- Parts Delivery
- Diesel Fuel Delivery
- Truck pattern for the septage haulers

1. Septage Receiving
2. Visitor Entrance/Exit
3. Biosolids Truck Loading
4. Methanol Delivery
5. Hypochlorite Caustic Soda & CEPT Delivery
6. Odor Scrubber Truck Access
7. South Scrubber Truck Access
8. Hypochlorite Caustic & Polymer Deliveries
9. Grit Dumpster Loading