EXHIBIT B

Technical Memorandum

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Prepared for: City of Wilsonville, Oregon

Project Title: WWTP Backup UV System Replacement Predesign

Project No.: 195468

Technical Memorandum

Subject: Preliminary Design Report

Date: August 23, 2024

To: Mike Nacrelli, Plant Manager,
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Limitations:

This document was prepared solely for the City of Wilsonville in accordance with professional standards at the time the services were performed and in accordance with the contract between the City and Brown and Caldwell dated January 29, 2024 This document is governed by the specific scope of work authorized by the City of Wilsonville; 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 City of Wilsonville 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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Section 1: Project Background

The City of Wilsonville (City) Wastewater Treatment Plant (WWTP or plant) treats wastewater with a conventional process, disk filtration, and ultraviolet (UV) light disinfection. Treated water exits the plant and flows to the Willamette River.

As part of a secondary treatment process upgrade constructed in the early 1990s, a TrojanUV4000 disinfection system was installed. In 2014, a second UV channel was added. This new channel contains a Veolia (then Ozonia) Aquaray 3X HO vertical-lamp UV system (Aquaray system). This unit currently operates as the primary disinfection system.

In 2022, Trojan informed the City that the TrojanUV4000 system would no longer be supported. Further, plant staff reports that the system does not currently operate due to a malfunction associated with the human-machine interface (HMI). Given the lack of replacement parts and high costs associated with maintenance-related to the ending of support-the City has not attempted to repair the system. The City plans to replace the TrojanUV4000 with a new UV disinfection system, which is the subject of this preliminary design report.

The City has received a National Pollutant Discharge Elimination System (NPDES) permit from the Oregon Department of Environmental Quality dated August 2020, that includes limits for Escherichia coli (*E. coli*). NPDES permit limits are shown in Table 1-1.

Table 1-1. *E. coli* NPDES Permit Limits

Description	Value
E. coli–Monthly Geometric Mean	126 colony forming units per 100 milliliters (cfu/100 mL)
E. coli-Maximum Single Sample	406 cfu/100 mL

The City is required to sample effluent twice per week. These requirements are consistent for the discharge of Class D quality effluent to the Willamette River. No chlorine is permitted in discharged water, and disinfection is accomplished using UV light.

Section 2: Existing TrojanUV4000 System

The existing TrojanUV4000 UV disinfection system is located on the southeast corner of the Wilsonville WWTP. Immediately adjacent to the TrojanUV4000 channel is the Ozonia/Veolia Aquaray system. The UV systems are downstream of secondary clarification and filtration and immediately precede the outfall.

The TrojanUV4000 system, shown on Figure 2-1, was installed in 1993. The channel is designated as Channel 1 as it was the original UV system on site. The system consists of two banks in the same channel, in series, and it currently operates as the plant's standby UV system. The water level in channel 1 is controlled by a downstream, motorized weir gate. It is 48 inches wide upstream and downstream of the TrojanUV4000, and then narrows to 40 inches around the UV system itself, as shown in Table 2-1. The dimensions of the TrojanUV4000 design, and given that the reactor itself is grouted into the channel, means that extensive demolition will be required to remove the existing system and condition the channel to receive the replacement system. In other words, the existing UV channel was designed to the requirements of the TrojanUV4000, and modifications to the UV channel will be required to install a new UV disinfection system.

Figure 2-1. Existing TrojanUV4000 system

Table 2-1. Existing Channel 1 Dimensions	
Description	Value
Operating floor elevation [a]	96.36 feet (ft)
Available channel length	~56 ft (from inlet to effluent structures)
Channel width	48 inches upstream and downstream of the UV system, 40 inches at the UV system
Channel depth (channel floor to top of grating)	12 ft
Head loss across UV system at 8.0 mgd	25.7 inches

Abbreviation: mgd = million gallons per day

a. Note that in 2014, the plant datum was adjusted from National Geodetic Vertical Datum of 1929 (NGVD 29) datum to North American Vertical Datum of 1988 (NAVD 88) datum. These numbers reflect the elevation relative to the new datum.

The TrojanUV4000 system and the primary Aquaray system were designed according to the parameters listed in Table 2-2.

Table 2-2. Design Basis of Existing UV Systems

Description	TrojanUV4000 (1993)	Aquaray System (2012)
Design UV dose (mJ/cm²)	25	30
UV transmittance (UVT)	55%	55%
Total suspended solids (TSS)	Unknown	5 to 30 mg/L (per the 2012 specifications)
Flow rate (mgd)	8.0 (per hydraulic profile on record drawings, 1995)	8.0 (per the 2012 specifications)

Abbreviations: mg/L = milligrams per liter, mJ/cm² = millijoules per square centimeter

Section 3: Existing UV System Design Parameters

This section details relevant water quality and design parameters to be considered in the design of the replacement UV system.

3.1 Design Basis for UV Transmittance

The WWTP does not use an online ultraviolet transmittance (UVT) monitor, nor does it currently have a protocol for monitoring UVT periodically with grab samples. For this reason, confirmation data related to ongoing UVT is not available. In situations such as this in plants using media filtration upstream, a common conservative design UVT is 55 percent. Given that this was used for previous designs as shown previously in Table 2-2, Brown and Caldwell (BC) recommends retaining 55 percent as the design UVT.

At the site visit in May 2024, BC brought a bench-top UVT monitor (a Real Tech RealUV254 portable unit) to the site to conduct a grab sample UVT check. BC and Jacobs staff collected a 250-mL sample from the effluent in Channel 2 in the overflowing weir trough. This sample was brought into the lab where the test cuvette was rinsed, calibrated, and the water tested for UVT. Milli-Q water was used as the calibration solution (100 percent UVT) and rinse agent. To perform the UVT measurement of the collected effluent, the cuvette was rinsed and filled three times with the sample, and UVT measured for each fill. UVT results of 68.4 percent, 68.3 percent, and 68.2 percent were obtained. The average was 68.3 percent. This UVT was well above the design level of 55 percent Although it represents a single sample and single snapshot of UVT, this water quality value and the fact that the system has remained in compliance with an operator-entered UVT of 65 percent (and subsequently used in the UV system’s calculated dose algorithm) indicates that the upstream processes are producing relatively high UVT water and supports a 55 percent design UVT as appropriate conservatism.

3.2 Design Basis for UV Dose

The original design UV doses for the systems in Channels 1 and 2, listed previously in Table 2-2, note the different design doses. The Aquaray system installed in Channel 2, i.e., the unit treating effluent, operates at a relatively consistent reported UV dose of 33 mJ/cm² based on the monthly reports. BC presumes that this is the 30 mJ/cm² design dose plus an operational safety factor of 10 percent. However, without real-time UVT monitoring, which is not currently in place, the UV dose reported by the HMI is inaccurate. If the UVT is lower than the entered value of 65 percent, then the actual delivered dose is lower. If higher, then the delivered dose is higher.

To understand whether the combination of entered UVT, calculated UV dose, and flow rate consistently resulted in meeting permit limits, BC examined *E. coli* data in monthly reports. Figure 3-1 presents the results of weekly sampling from January 2023 through January 2024. The majority of effluent *E. coli* measurements were below 5 Most Probable Number (MPN)/100 mL. Note that the plant's requirement is not to exceed 126 MPN/100 mL monthly geometric mean, and no single sample is to exceed 406 MPN/100 mL.

There were two exceedances in the period examined, to 893 and 596 MPN/100 mL in April and November 2023, respectively. The first event was considered anomalous as subsequent samples returned to an acceptable level. The second event was correlated with an algae event that was subsequently corrected. Note that TSS was high at the same time as the November sample and may have been a contributing factor (see Section 3.4).

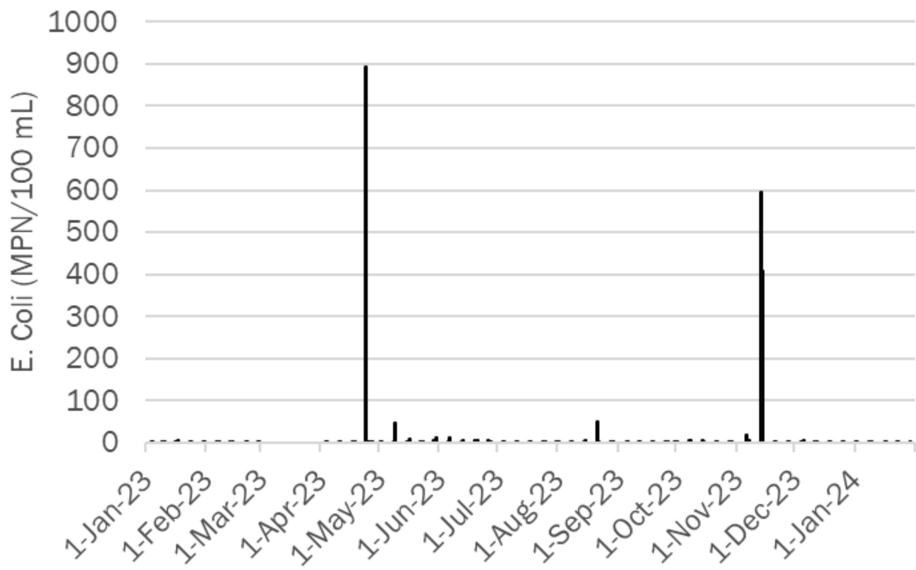

Figure 3-1. *E. coli* results, January 1, 2023, through January 31, 2024

Note that the literature values for the UV dose required to accomplish 1-log reduction of various species of *E.˚coli* ranges between 2.5 and 4 mJ/cm^2. The literature values for UV dose required to accomplish 4-log reduction of similar strains of *E. coli* ranges between 8 and 15 mJ/cm^2 (Malayeri et. al., 2006). Therefore, a design dose of 30 mJ/cm^2 provides a safety factor relative to observed literature dose values for *E. coli.*

From the examination of the previous design and literature doses, the performance of the existing UV system at that design dose, and results of *E. coli* sampling in 2023-2024, BC concludes that a design dose of 30˚mJ/cm^2 is appropriate for the Channel 1 replacement UV system.

3.3 Design Basis for Flow Rate

Figure 3-2 presents recent flow data from the facility. This represents flow that would have passed through the Aquaray-system-equipped Channel 2. The average flow is 2.3 mgd based on the influent flow meter and 2.56 mgd based on the effluent flow meter. Peak flows within the available data set were 4.9 and 5.2 mgd based on the influent and effluent flow meters, respectively, and occurred in January 2024. The Aquaray system installation has a maximum flow rate of 8 mgd per the 2012 specifications. The channel, however, can accept a maximum flow rate of 8.8 mgd per the 2023 master plan. BC recommends that the design flow capacity of the Channel 1 replacement UV system match the flow rate that channel 1 is capable of accepting (i.e., 8.8 mgd).

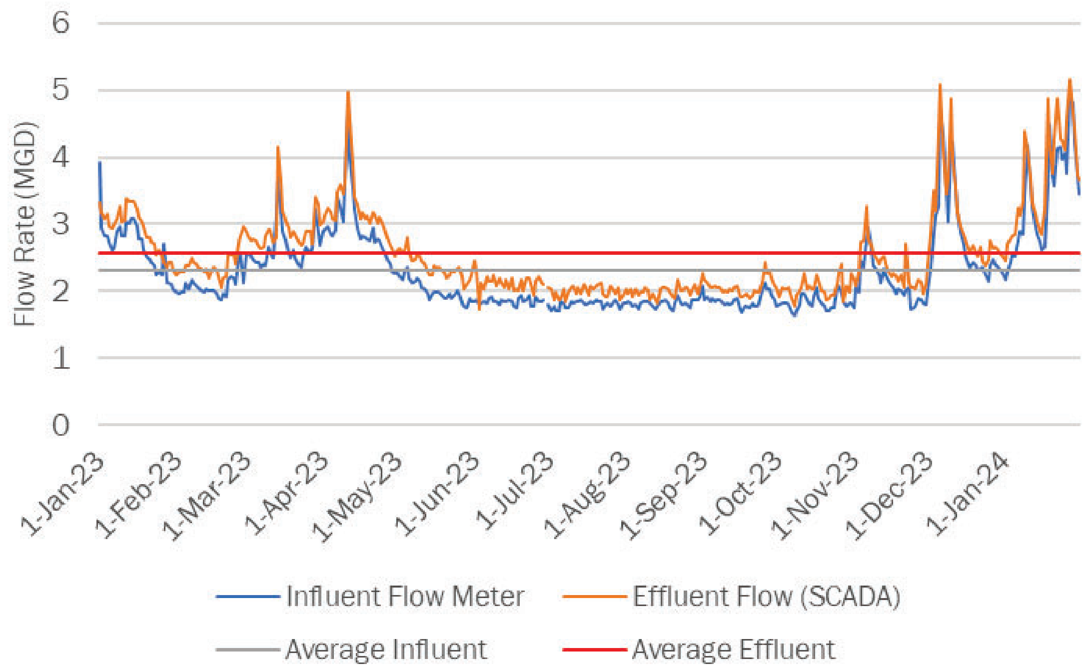

Figure 3-2. Flow rate, January 1, 2023, through January 31, 2024

3.4 Design Basis for Total Suspended Solids

Figure 3-3 presents available data for TSS. The average of all data is 4.9 mg/L, with a peak of 23 mg/L in June 2023. Based on the data, BC recommends a design maximum TSS of 25 mg/L.

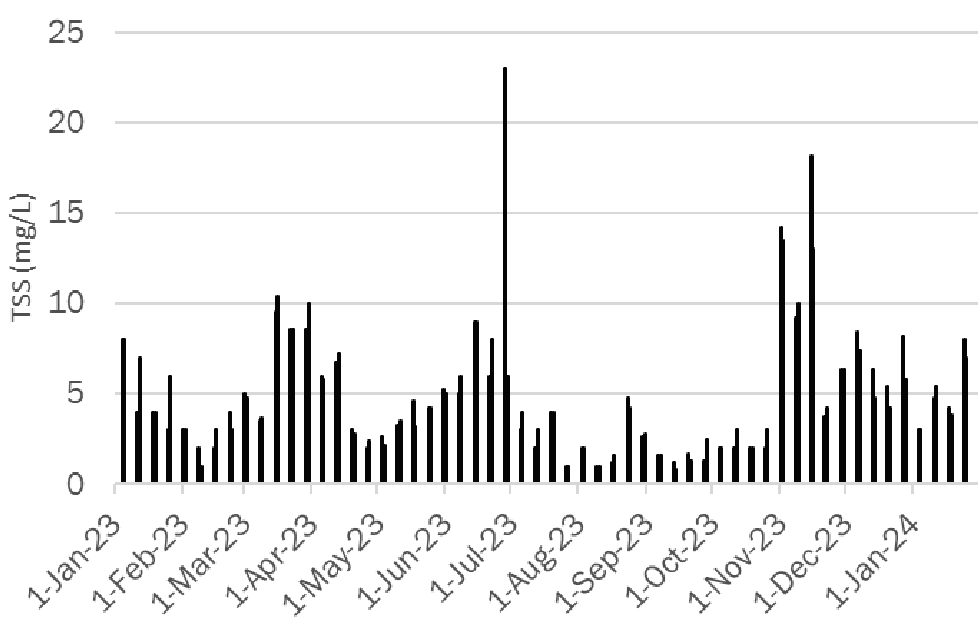

Figure 3-3. Total suspended solids, January 1, 2023, through January 31, 2024

3.5 Hydraulic Profile and Maximum Available Headloss

The hydraulic profile that was updated in 2019 is excerpted and included in Attachment A. This profile suggests that at 8.8 mgd, the existing TrojanUV4000 presents a headloss of 25.7 inches of water (inch H_2O).

The low pressure, high-output UV systems being considered for the retrofit are more sensitive to the water level change from the UV system influent to the effluent, and provide the ability to maintain required water layers and prevent submersion of key electrical components. The water level above the first bank of lamps, for example, must not be of a height (i.e., above the functional arc length of lamps) that creates a low UV dose pathway while, simultaneously, lamps must remain submerged at the downstream end of the UV banks to prevent overheating and operation in air. Therefore, the headloss across the UV system itself is balanced with the allowable water levels at influent and effluent. Designers consider this headloss together with the weir or gate headloss to design a system that works within the context of the UV system/weir and the overall system hydraulic profile. This scenario is different for each UV system configuration. Note that the headloss of the proposed UV systems is much lower than the headloss associated with the existing TrojanUV4000 (i.e., less than 3 inch H_2O). Each manufacturer has proposed a weir/gate/water level combination that will accommodate the flow rates for a replacement system in Channel 1.

3.6 Recommended Design Conditions

Table 3-1 summarizes the recommended design values of flow, UVT, and UV dose, as well as additional water quality parameters, including TSS. These design values provide appropriate conservatism and are supported by historical operational data.

Table 3-1. Recommended Design Conditions for UV System Retrofit

Description	Value	Units
Peak Design Flow	8.8	mgd
Average Flow	2.59	mgd
UVT	55	%
Turbidity	<3.5	Nephelometric turbidity units (NTU)
TSS	<25	mg/L
Fouling Factor and End-of-Lamp-Life Factor	per manufacturer	
Design Dose	≥30	mJ/cm^2 (MS2 reduction equivalent dose [RED] based on an MS2 bioassay validation)
System Configuration, redundancy	Single channel, N+1 bank configuration	
Rated headloss of existing TrojanUV4000 (including fixed weir level control)	25.7	inches (at 8.0 mgd)
Avg. Monthly *E. coli* based on geometric mean	<126	cfu/100 mL
Max Day *E. coli*	<406	cfu/100 mL

3.7 Observations of Mechanical, Structural, and Electrical Site Conditions

A three-person BC team visited the site on May 21, 2024. Flow was observed to be 2,053 gallons per minute (2.96 mgd) through Channel 2. The existing Aquaray system was operational and was disinfecting effluent. There was no flow in Channel 1. Water at a level of approximately 8 ft was stagnant in Channel 1. The TrojanUV4000 system was not operational, and no attempt was made to activate the system. An overall view of the UV area containing both UV systems is shown on Figure 3-4.

Figure 3-4. Existing Wilsonville WWTP UV disinfection area

3.7.1 Mechanical

As noted, the plant operates currently with all flow directed to Channel 2 for disinfection. Plant staff advised that there is a 7.0-mgd threshold value for activation of Channel 1. With recent peak flows significantly less than 7.0 mgd (and less than the 8.8-mgd design flow rate of the Veolia system in Channel 2), plant staff advises that there has been no recent reason to activate Channel 2. The 2023 master plan assumes a 2.9 percent annual population growth rate, resulting in an expected 2045 peak flow rate of 17.6 mgd.

To activate Channel 1, directing flow from Channel 2 to Channel 1 following a 15-minute lamp warm up period of the UV system in Channel 1 is accomplished by operators manually opening an isolation gate at the influent of Channel 1 and manually operating the valve at the inlet to channel 2. The motorized weir gate at the effluent end of Channel 1 is then adjusted incrementally to adjust water level to maintain submergence of lamps. Note that overdosing of UV light may occur under some flow and water quality conditions to maintain submergence of UV lamps.

Note also that the gates are not modulated automatically for flow pacing, and flow is measured in Channel 1 based on position setpoints of the weir gate and an equation in the operation and maintenance (O&M) manual. This manual process is suitable for temporary scenarios only. When flows return to below 7.0 mgd, or when Channel 2 is ready to be returned to service, operators manually actuate the respective isolation valves/gates to return flow to Channel 2. Note that the Channel 2 isolation valve is buried in the yard upstream of the channel and will be open during normal operation when flow is moving through Channel 2.

The Parshall flume shown in the 1993 record drawings was previously removed. The BC team was not able to verify the presence of the Parshall flume foundation shown on Figure 3-5 due to the presence of standing water in the channel. The record drawings are unclear. If this foundation is present, it will need to be removed by the contractor.

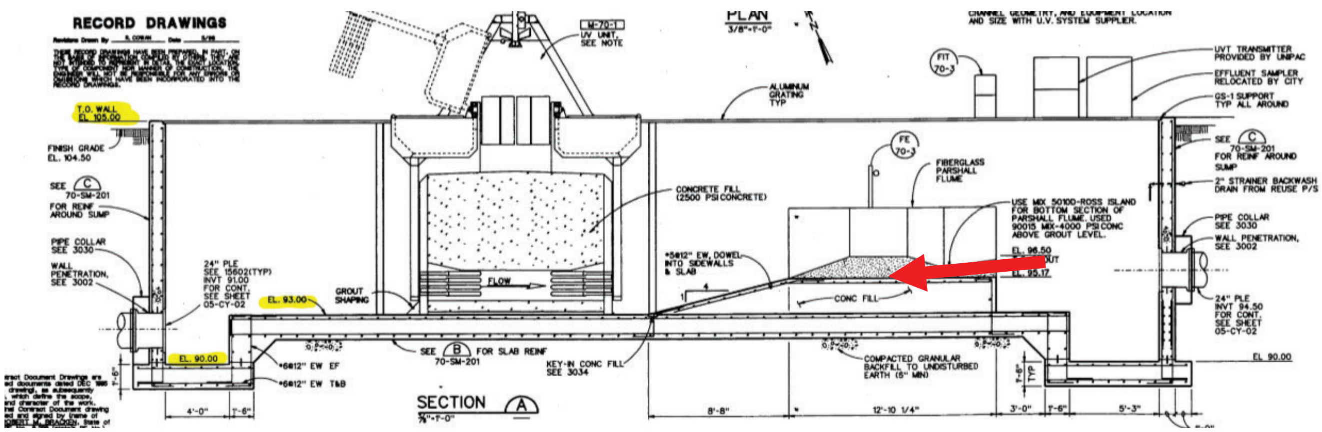

Figure 3-5. Concrete fill supporting the former installation of a Parshall flume

Manual operation of the jib crane during the site visit to evaluate the potential to reach Channel 1revealed that the crane does not have sufficient reach to lift modules out of Channel 1 (in addition to Channel 2, for which it was designed). For this reason, if the Channel 1 replacement UV system requires a crane to lift modules out of the channel, a new jib crane will be required.

While the Channel 2 system is not designed to include in-channel redundancy, the overall system operates with functional redundancy when Channel 1 is available for operation at flows up to 7.0 mgd. As Channel 1 is not operational currently, the only redundancy available is in the non-operating banks of the Channel 2 UV system. Given the relatively low design UVT and the lower average flow relative to design flow, the system typically operates with only one (or possibly two) of the three banks available, leaving at least one as functionally redundant. However, this applies in the scenario where UVT is higher and flow is lower than the design point and will not provide redundancy when flow increases in the future.

3.7.2 Structural

The BC team measured Channel 1 and dimensions were found to match the as-built drawings. The width of the channel in the area of the UV system is 40 inches (48 inches upstream and downstream of the UV system) and 12 ft in depth. A cursory inspection of the channel walls above the water line revealed no obvious deterioration. The contractor should field verify these values.

The existing TrojanUV4000 was grouted into the Channel 1. That is, a grout mixture encases the stainless-steel frame of the UV system as it sits in the channel. The grouting took place after the channel walls were formed and after the UV system itself was placed into the channel. For this reason, a seam exists between the concrete channel walls and the grouting that surrounds the UV system. This seam is shown on Figure 3-6. Removal of the existing TrojanUV4000 is described in a later section.

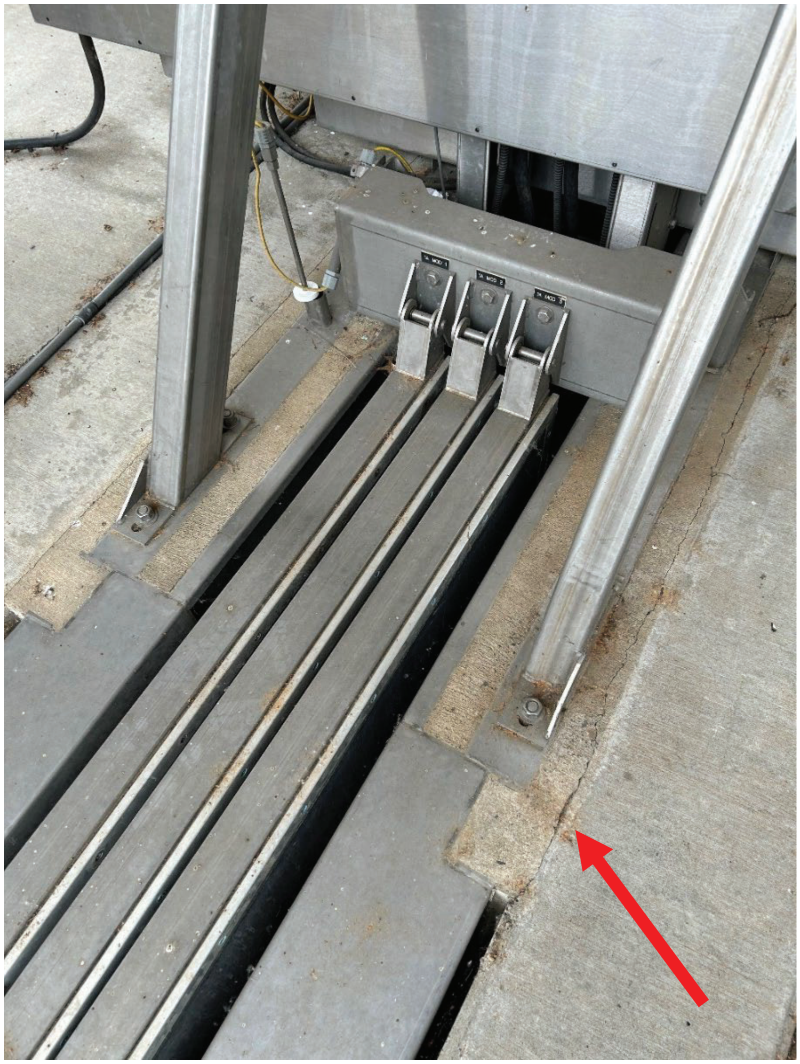

Figure 3-6. Grout-channel interface in the area of the TrojanUV4000

3.7.3 Electrical and Instrumentation

The total connected load of the proposed equipment is lower than the existing TrojanUV4000 equipment. For this reason, BC has made the preliminary conclusion that the existing electrical system is able to support the new equipment with the addition of appropriate transformers. Additional field work during detailed design is needed to confirm specific equipment that can be reused and to resolve record drawing discrepancies in the electrical room. Further, while foundational instrumentation will remain similar (e.g., a level sensor for water detection in channel 1), the updated UV system will use additional UV intensity sensors on each UV bank to monitor operation and control UV dose delivery. A local control panel for the UV equipment will accommodate the additional complexity and connect with the plant SCADA system in the electrical room. Specific electrical and instrumentation (E&I) improvements will, in part, be based on the selected UV manufacturer.

A magnetic flow meter installed upstream of Channel 2 reports flow through the UV channel. This flow rate is entered into the Channel 2 programmable logic controller (PLC) and is input into the UV system control for dose pacing. The flow rate is displayed on a user interface near the influent of Channel 2. The flow meter data display is shown in Figure 3-7.

Figure 3-7. Flow meter display

As discussed above, BC noted that the plant does not currently use a UVT monitor to provide real-time UVT measurement in water passing through the UV system. Rather, plant operators enter a UVT measurement manually. Staff did not indicate that they conducted periodic measurements to check that the UVT was above the entered value (of 65 percent), though on the day of the site visit, UVT was measured at 68.3 percent.

Section 4: UV Equipment Alternatives

4.1 UV Equipment Alternatives Investigated

BC obtained detailed and updated proposal information from Veolia, Trojan, and Wedeco for a replacement UV system for Channel 1. The UV manufacturers provided budget proposals and general arrangement drawings for review (Attachment A). Table 4-1 summarizes the proposed configurations and budget pricing.

Table 4-1. UV System Alternatives Information			
Item	Manufacturer		
	TrojanUVSigna	Veolia Aquaray 3X	Wedeco Duron 600
Number of Channels	1	1	1
Number of Banks/Modules per Channel	4	3	5
Number of Lamps per Bank/Module	8	36	12
Number of Redundant Banks	1	1	1
Total Number of Lamps	40	144	60
Watts per Lamp	1,000	400	600
Lamp Guarantee (hours)	15,000	16,000	14,000
Number of Intensity Sensors	4 (one per bank)	3 (one per bank)	5 (one per bank)
Sleeve Wiping	Yes, chemical/mechanical	Yes, mechanical	Yes, mechanical
Method for Removing Modules from Channel	Automatic Raising Mechanism (integral to system)	Jib crane (not included in budget price)	Automatic Raising Mechanism (integral to system)
System Rating	6P (modules), NEMA 4X (power distribution centers and system control center)	IP68 (modules), NEMA 4X (power supply units)	Quoted as Type 12
Number of Power Supply Units	1	1	1
PLC	Allan-Bradley Compact Logix	Allan-Bradley Compact Logix	Allan-Bradley Compact Logix
Maximum Power Draw (kW)	43.9	58.4	42.1
Power Requirement for Main Power Distribution	480/277V, 3 Phase, 60 Hz, 4 Wire + GND, 36.2 kVA	400V/3 Phase/60 Hz	480V, 3 Phase, 4 Wire + GND (WYE)
Quoted Maximum TSS (mg/L)	20	10	30
Headloss Across UV system including Weir (at 8.8 mgd, without redundancy | with redundancy)	5.0 | 6.3	5.3 | 6.4	19.8 | 20.4
Level Control Proposed	Fixed Weir (finger type, similar to the existing channel 2 weir)	Fixed Weir (finger type, similar to the existing channel 2 weir)	Downward opening gate
Flow Conditioners	2 (included)	1 (included)	None
Quoted Price Without Redundancy	$465,550	$385,000	$345,000 (Type 12)
Quoted Price With Redundancy	$548,500	$435,000	$380,000
Estimated Additional Capital Investment for Jib Crane	NA	$53,000	NA
Additional Capital Investment for UVT Monitor	Est $16,000	Est $16,000	Est $16,000

Abbreviations: GND = ground, Hz = hertz, kVA = kilovolt ampere, kW = kilowatt, NEMA = National Electrical Manufacturers Association, V = volt

Table 4-2 presents details of the required modifications to the existing Channel 1.

<table>
<tr><th colspan="3">Table 4-2. UV System Channel Size and Modification Information</th></tr>
<tr><th>UV Model</th><th>Required Channel Dimensions</th><th>Modification/Impact to Existing Conditions</th></tr>
<tr><td rowspan="3">TrojanUVSigna</td><td>Channel Length Required Without Redundancy: 31.6 feet</td><td rowspan="3">• Channel floor would need to be raised 1.9 ft
• Channel would need to be narrowed 9.3 inches</td></tr>
<tr><td>Channel Width: 30.72 inches</td></tr>
<tr><td>Channel Depth: 93.6 inches</td></tr>
<tr><td rowspan="4">Veolia Aquaray 3X</td><td>Channel Length Required Without Redundancy: 24.5 feet</td><td rowspan="4">• Channel floor would need to be raised 3.38 ft
• Channel would need to be narrowed 10.5 inches</td></tr>
<tr><td>Channel Width: 29.5 inches</td></tr>
<tr><td>Channel Depth: 84 inches</td></tr>
<tr><td>Water Depth: 62 to 69 inches</td></tr>
<tr><td rowspan="4">Wedeco Duron 600</td><td>Channel Length Required Without Redundancy: 40 feet</td><td rowspan="4">• Channel floor would need to be raised approximately 3 ft
• Six total banks (including redundancy) leads to a length that is relatively long; the longer fixed weir will require widening of the channel</td></tr>
<tr><td>Channel Width: 29.5 inches</td></tr>
<tr><td>Channel Depth: 74.8 inches</td></tr>
<tr><td>Water Depth: 42.1 inches (at gate)</td></tr>
</table>

4.2 System Selection Considerations

All three systems presented will fit in the existing Channel 1, will operate within the plant's electrical system capacity, and, with different levels of channel modification, will meet the hydraulic requirements of peak flow conditions. A discussion of the installation requirements, advantages/disadvantages, and O&M requirements of each system is provided in this section.

4.2.1 TrojanUVSigna

Trojan manufactured the original TrojanUV4000 in Channel 1. The City is, therefore, familiar with Trojan as a manufacturer. The TrojanUVSigna is a system Trojan designed to replace the TrojanUV4000 units, and it fits well into the channel at Wilsonville. Required modifications were detailed previously in Table 4-2.

Trojan has recommended four duty banks with a total of 32 lamps. If a redundant bank is selected, an additional 8 lamps will be installed for a total of 40. The system requires a narrower channel than existing (by 9.3 inches). Concrete will be used to adjust the channel width. The length of the installed UV banks themselves require a channel length of approximately 40 ft (with redundancy). The length of the proposed TrojanUVSigna is well within the available length. Designed with fixed weir, the headloss of the UV system (3.2 inches with redundancy) is significantly lower than the existing TrojanUV4000 headloss (estimated at 25.7 inches at 8 mgd).

Trojan has recommended two, 50-percent porosity, flow conditioners at the entrance to the channel. Trojan included these flow conditioners in its proposal.

The Trojan system employs dose pacing control that makes use of sensor readings of UVI in the dose control algorithm. The online intensity measurement measures UVI in the water and accounts for lamp output and sleeve fouling. This is combined with real-time UVT data (measured by an online monitor) to accomplish dose pacing through a range of effluent conditions. The system proposed contains a mechanical-chemical wiping system to clean quartz sleeves. This system will likely reduce the manual cleaning requirements that are currently required by the existing Veolia duty system in Channel 2. In addition, the TrojanUVSigna system incorporates an integral module lifting system that provides module access without the need for a crane.

This provides a simpler footprint and enhanced operator safety while eliminating the requirement of an additional jib crane for Channel 1.

The TrojanUVSigna system uses a 1,000-watt (W) lamp. The relatively high wattage of the lamp leads to a relatively low total lamp count (compared to other low-pressure, high-output lamp-based systems). Trojan warranties the lamp for 15,000 hours.

The UV banks will need a 480-V, 3-phase, 4-wire power supply and will present a total connected load of 43.9 kW. The new TrojanUVSigna system will require a transformer.

All electrical cabinets will be rated NEMA 4X given the outdoor installation. Additionally, the TrojanUVSigna UV module is 6P rated and can withstand submergence for up to 24 hours. This offers system protection should a flooding event occur.

The Trojan system is manufactured in London, Ontario, Canada. Trojan warrants the equipment for 12 months following startup or 18 months after delivery, whichever occurs first.

The TrojanUVSigna meets the design basis treatment requirements. While the system will require some modifications to Channel 1, the lay length of the duty/redundant banks and the recommended fixed weir fits within the existing UV channel's available dimensions. The TrojanUVSigna will consume less energy than the existing TrojanUV4000, and therefore, the existing electrical system will power the new UV unit without substantial modification to the electrical system. Plant staff can expect that equipment maintenance for the TrojanUVSigna will be relatively lower than that required for the existing Veolia system owing to the chemical/mechanical cleaning, fewer lamps, and integral lifting system used to raise the lamps out of the channel. The final design will address additional considerations such as detailed analysis of the existing electrical and structural conditions and requirements for the UV system retrofit.

4.2.2 Veolia Aquaray 3X

Veolia (then Ozonia) manufactured the Aquaray system currently operating in Channel 2. This unit operates as the duty UV system. Installing a similar Veolia Aquaray 3X system in Channel 1 presents advantages, at least in the near term, including familiarity with operations procedures. However, the existing system is more than 10 years old and at the midpoint of its life cycle. The 2023 master plan projects replacement in 2040. Note however, that the proposed replacement system uses a newer-generation ballast and sensor technology. For this reason, the City would need to maintain two separate stores of ballasts and sensors between the two systems. Veolia has proposed an option to provide a new power supply unit and new UV modules for the existing Channel 2 system, which would upgrade the existing system to current technology. This would allow the City to unify parts storage for both systems, but would require an additional capital investment, quoted by Veolia at $100,000 for the new power supply only and $210,000 for new power supplies and new modules. The City would need to hire a contractor to install the new equipment at unknown cost.

A Veolia Aquaray 3X system would fit into the existing Channel 1 with minor modifications. The Aquaray requires a narrower channel than the existing TrojanUV4000 channel (29.5 inches versus 40 inches), and a 3.38-ft-shallower depth. Concrete will be used to adjust channel dimensions. Veolia has recommended three duty banks, each with 36 lamps. The addition of a redundant bank would add 36 lamps and bring the total to 144 lamps. The system uses a lower wattage lamp than TrojanUVSigna (400 W compared to 1,000 W) and for this reason requires more lamps to accomplish disinfection objectives. The length required for the installed UV banks is approximately 33 ft including redundant banks, plus length for the finger weir, which is within the available length. Headloss (6.4 inches) is also significantly lower than the existing TrojanUV4000 (which, as mentioned previously, is estimated at 25.7 inches at 8 mgd).

Veolia has proposed a fixed weir for level control with a length of 624 inches. A fixed weir, or weir trough, presents a robust, low-maintenance method of level control that matches the strategy used by the Aquaray system in Channel 2. Matching the effluent structures would make it more likely that an acceptable passive flow split would be possible. Careful matching of headloss in final design will minimize headloss differences between the channels with the objective of eliminating the need for active flow control between the channels. Veolia has recommended a single flow conditioner at the entrance to the channel to facilitate well-distributed flow across the lamps in the channel.

Like Trojan, Veolia also incorporates features to reduce O&M costs by minimizing energy consumption and extending lamp life. For example, the Aquaray system employs dose pacing algorithms that account for changes in UVT, UVI, and flow rate. The online sensor intensity measurement measures UVI emitted from the lamps in the water and thereby accounts for lamp output and sleeve fouling. This would be combined with real-time UVT data measured by an online monitor to control the number of lamps and the power level of operating lamps with the target of optimizing dose delivery.

Veolia employs a mechanical wiping system to clean quartz sleeves. The existing Veolia Aquaray system in Channel 2 is also equipped with a mechanical wiping system, but operators report that weekly manual cleaning is required to maintain sleeve cleanliness. This procedure includes removal of UV banks, soaking in an acid bath, and reinstallation. It is anticipated that a new Veolia Aquaray in Channel 1 would require a similar cleaning regimen. The new Veolia Aquaray system would also require a new jib crane to remove the modules from the channel. As noted above, the existing crane will not work for both channels. Veolia has not included this crane in its quotation.

The Veolia Aquaray system uses a 400W lamp that is warranted for 16,000 hours. Veolia warrants the equipment for 12 months following startup or 18 months after delivery, whichever occurs first.

The UV banks would be supplied by a 400V, 3-phase, 60-Hz electrical supply and presents a total connected load of 58.4kW. This connected load is approximately 30 percent larger than the TrojanUVSigna. Like the Trojan option, the new UV system would also require a new transformer. All electrical cabinets, given the outdoor installation, will be rated NEMA 4X.

The Veolia Aquaray UV module is IP68 rated and can withstand submergence of 1 meter for up to 24 hours. This offers system protection should a flooding event occur.

The Veolia Aquaray also meets the design basis treatment requirements. While the system will also require some modifications to the channel, including a narrowing, a raising of the floor, and a modification of the effluent structure, the lay length of the duty/redundant banks fits within the Channel 1 available dimensions. The Veolia Aquaray will consume less energy than the existing TrojanUV4000, and therefore, the existing electrical system will power the new UV unit without substantial modification to the electrical system. Plant staff will be familiar with the operation of the Aquaray given their experience with the similar system in Channel 2. The final design will address additional considerations, such as detailed analysis of the existing electrical and structural conditions and requirements for the UV system retrofit.

4.2.3 Wedeco Duron 600

Wedeco has proposed the Duron 600 model for the replacement of the TrojanUV4000 in Channel 1. Required modifications were detailed previously in Table 4-2.

Wedeco has recommended five duty banks with a total of 60 duty lamps. If a redundant bank is selected, an additional 12 lamps will be installed for a total of 72. The system requires a narrower channel than existing (by 10.5 inches). Concrete will be used to adjust the channel width. The length of the installed UV banks themselves require a channel length of approximately 44 ft (with redundancy). The length of the proposed Wedeco Duron 600 is within the available length. However, Wedeco advises that their fixed weir design would require widening of the channel. The headloss of the UV system itself, without the effluent level control, is 3.8 inches with redundancy. Addition of a downward opening gate, as quoted, adds 16.6 inches for a total of 20.4 inches. While this is significantly lower than the existing TrojanUV4000 headloss (estimated at 25.7 inches at 8 mgd), this headloss would be significantly higher than Channel 2 headloss. If Wedeco is selected, additional work to design and cost a low-headloss fixed weir, will be required. Wedeco has not proposed flow conditioners at the entrance to the channel in their initial quotation but would likely be required in final design.

The Wedeco system also employs dose pacing control that makes use of UVT and UVI in the dose control algorithm, with the objective of minimizing operational cost. The system proposed contains a mechanical wiping system to clean quartz sleeves. In addition, the Wedeco Duron system incorporates an integral module lifting system that provides module access without the need for a crane. Like Trojan, this provides a simpler footprint and enhanced operator safety while eliminating the requirement of an additional jib crane for Channel 1.

The Wedeco Duron system uses a 600 W lamp. Wedeco warrants the lamp for 14,000 hours. Wedeco warrants the equipment for 12 months following startup or 18 months after delivery, whichever occurs first.

The UV banks will need a 480-V, 3-phase, 4-wire power supply and will present a total connected load of 42.1 kW. The Wedeco Duron system will require a transformer.

The Wedeco Duron 600 meets the design basis treatment requirements. BC, however, has concerns related to the length of the system and the ability to accommodate a low-headloss fixed weir. The 6 banks (with redundancy) will limit the length of the fixed weir and likely lead to the requirement that the channel be widened in the area of the weir. Given this uncertainty and potential additional installation cost, BC did not proceed with a full Class 4 cost evaluation and NPV of the Wedeco Duron.

4.2.4 Water Analysis to Confirm Design Dose

BC recommends that the plant send water to at least one of the manufacturers to perform collimated beam analyses. This procedure will confirm that the recommended minimum UV dose of 30 mJ/cm^2 is sufficient to accomplish disinfection. UV manufacturers typically do not charge for this service. BC notes that the existing Aquaray system operates at this programmed UV dose, and that as shown on Figure 3-1, *E. coli* inactivation is generally successful. This leads to the observation that this UV dose is sufficient; however, further analysis would benefit the project and give the City added assurance that the design dose is sufficient.

4.2.5 Schedule

BC recommends and anticipates the following schedule for the retrofit. Given that the City currently does not have a functional backup UV system, BC believes that time is of the essence.

- **August 2024–February 2025:** Final design
- **March 2025–July 2025:** Procurement of contracting services
- **July 2025–May 2026:** Long-lead item purchase orders, submittals, and manufacturing/shipping
- **May 2026–August 2026:** Construction
- **August 2026–December 2026:** Commissioning and startup

With immediate start of final design, BC anticipates that the City could complete construction during the summer of 2026, and be operational for the winter treatment season of 2026. To install a new system earlier, the City could purchase the UV equipment in advance of selecting a contractor. This approach comes with risks associated with the contractor taking a minimalist role in the coordination of the assigned equipment contract.

4.2.6 Disinfection During Construction

To address the issue of providing disinfection during the anticipated 3-month construction period, BC recommends that the City continue to use the existing system in Channel 2 during construction. At the site visit in May 2024, BC and the City evaluated the potential for continuing Channel 2 operation during construction. Physically, the channels are separated by the channel's concrete wall. Electrically, each UV system uses different power feeds. If new duct banks are required for Channel 1, a new duct bank would be run in parallel, allowing for continued operation of Channel 2. If existing space/empty duct bank conduits can be used, new cables can be pulled while Channel 2 is operational. No new cables should be pulled in conduits with energized conductors. For these reasons, BC anticipates installation of the new system in Channel 1 could proceed without disruption to Channel 2 operation and that normal UV disinfection could continue during construction with care and protection of the operating Channel 2 (e.g., protecting construction debris from entering the channel). Should a reason arise that requires a contractor to deactivate the UV system in Channel 2 for a prolonged time during construction, the following three options exist:

- Pursue a waiver for disinfection during construction.
- Implement chemical disinfection (and associated quenching of the chemical disinfectant) prior to discharge.
- Implement a temporary UV disinfection system.

Note that Trojan has mobile UV disinfection units available for rent; however, given that piping in the area of the UV systems is underground, temporary above-ground piping between the disk filter effluent and the outfall would require excavation and present a significant cost.

BC observes a regulatory waiver is unlikely to be obtained and both chemical and UV temporary solutions present significant piping difficulties. For these reasons, use of an operating Channel 2 during construction is the best option. Performing construction during the lowest flow period, typically summer, would minimize the volume of water to be disinfected during construction.

Section 5: Mechanical, Structural, and Electrical Considerations

This section describes the mechanical, structural, and electrical considerations investigated during preliminary design.

5.1 Hydraulic Profile with Updated UV Disinfection Systems

The low-pressure, high-output UV systems being considered for the UV Channel 1 retrofit are more sensitive to water level than the existing TrojanUV4000. For this reason, BC performed a hydraulic check to verify that the installation of either candidate manufacturers' systems would maintain acceptable hydraulic conditions.

A parallel objective is to maintain an even flow split between the two channels with retrofitted UV Channel 1 acting as the primary UV system (for flows up to 7.0 mgd). UV Channel 2 will become the secondary UV system activated when flows exceed 7.0 mgd. Under situations where flow exceeds 7.0 mgd, flows will passively split between the two channels.

Using Visual Hydraulics software, BC investigated the hydraulic performance and passive flow splitting potential of the highest headloss replacement UV system. Manufacturers provided the projected maximum headloss presented by the UV system and the flow control weir of 6.3 inches at 8.8 mgd.

Modeling the retrofitted UV Channel 1 with a 43-foot-long fixed weir at 103.85 feet elevation, the model concludes the system maintains an even flow split of 8.8 mgd in each channel (for a total of 17.6 mgd). The existing concrete channel elevations are sufficient, and no upstream limits are exceeded. The long-fixed weir for UV Channel 1 matches the type of weir in UV Channel 2 and therefore would serve as a simpler more reliable and repeatable flow splitting mechanism over a range of wet weather flows. Under lower dry weather flows only one channel (typically UV Channel 1) would be in operation.

The updated hydraulic profile is included in Attachment B.

5.2 Mechanical Considerations

In this section, BC considers several aspects of the mechanical design.

5.2.1 Flow Control

According to the plant's O&M manual, to control flow between Channel 1 and Channel 2, plant staff manually actuate control valves. Channel 2, currently operating as the duty channel, treats flows up to 8.8 mgd. The valve controlling flow to Channel 2 is normally open. If a maintenance scenario arose in Channel 2 and flow needed to be redirected to Channel 1, operators would open the weir gates in Channel 1 and close the valve in Channel 2. This process directs flow to either Channel 1 or Channel 2.

For future flow conditions that exceed 8.8 mgd, plant staff will need to operate both channels simultaneously. To accomplish the flow split with the existing configuration/design, similar manual valve actuation would be required; however, only Channel 1 has a flow meter. In a flow-split scenario, operators are required to calculate the flowrate through Channel 1 using the height of the weir gate and an empirical equation provided in the O&M manual. This scenario related to manual flow measurement in Channel 1 is undesirable for long-term operation. To correct, an additional flow meter is recommended for Channel 1. With flow meters in both channels, differences in flow rates between channels is unimportant if the real-time flow rate is provided to each UV system's respective PLC. Preliminary hydraulic design work by BC's hydraulic team suggests that, with careful selection of a new weir in Channel 1 and matching headloss as closely as possible between the two channels, the system can achieve an even, passive flow split.

Excavation upstream of Channel 1 and installation of a valve and flow meter manhole would accomplish flow split and measurement of flow rate in Channel 1. While automatic flow control/balancing could be postponed, a valve/flow meter manhole is required for this phase of construction. A possible solution is excavation and replacement of approximate 50 ft of piping upstream of Channel 1, as shown on Figure 5-1.

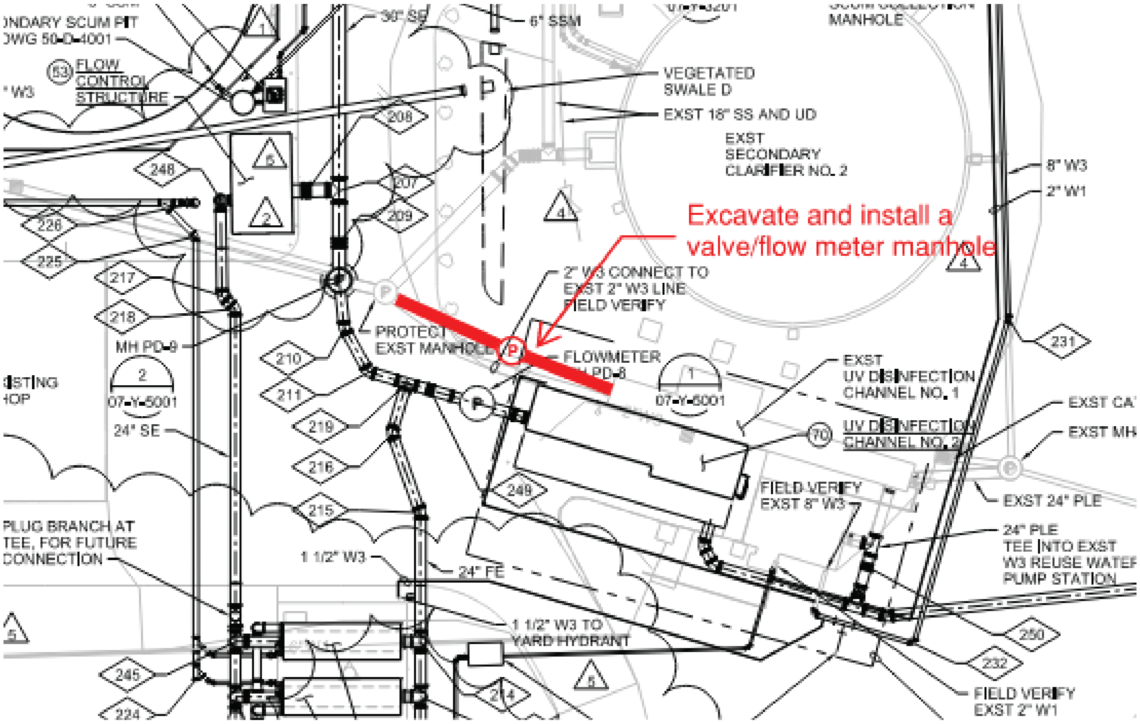

Figure 5-1. Location of proposed upstream valve/flow meter manhole vault

Source: 2012 record drawings pdf, page 63

Flow enters Channel 2 from a pipe near the bottom of the channel. To facilitate well-distributed and even flow across the lamps (eliminating short-circuiting of flow through any one portion of the channel). Flow conditioners will be required.

5.2.2 Redundancy

At full flow of 17.6 mgd (two channels operating at 8.8 mgd), the two UV systems will be required to operate all duty banks. Further, the *Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse* published by the National Water Research Institute (NWRI) in 2012 state that "Standby UV equipment must be available by providing either a complete standby UV reactor train or an additional UV reactor in each reactor train." The City would fulfill these requirements, in Channel 1, with the addition of a redundant bank to the replacement unit. For this reason, BC recommends that the replacement UV system be sized and installed with a redundant bank. The regulator of record will have input in this decision, and this topic should be discussed as the design progresses. If redundancy is not required, this would be an opportunity for value engineering.

5.3 Structural Considerations

The basin will be modified to conform to the requirements of the selected system by adding fill concrete as required to the basin walls and base slab. Resulting dimensions of the channel would be per manufacturer's recommendations. Fill concrete will be reinforced to prevent cracking and will be anchored to the existing basin by drilling and epoxying reinforcing dowels.

The following project standards will be used for the modifications required for the structure during detailed design.

5.3.1 Codes and Standards

The following standards will be followed for the structural design:

- 2022 Oregon Structural Specialty Code with Amendments
- American Society of Civil Engineers (ASCE) 7-16 "Minimum Design Loads and Associate Criteria for Buildings and Other Structures"
- American Concrete Institute (ACI) 318-14 "Building Code Requirements for Structural Concrete" ACI 350-06 "Code Requirements for Environmental Engineering Concrete Structures"

5.3.2 Materials

The following materials will be used for the structural design:

- **Concrete:** 28-day compressive strength, 4,500 pounds per square inch (psi)
- **Reinforcing:** Fy = 60,000 psi

5.3.3 Design Loads

The following criteria will be used for the structural design:

- **Dead Load:** As calculated
- **Equipment Loads:** As provided by manufacturer

5.4 Removal of the Existing UV System

Trojan has provided a step-by-step procedure to remove the existing TrojanUV4000 system (Attachment B). System removal is a multi-day effort by a contractor as the existing stainless-steel reactor body is encased in grout/concrete. Per Trojan, the contractor will need to remove the existing grout/concrete using a jackhammer or saw to gain access to the reactor inserts. The approximate volume of concrete to remove is 15 to 20 cubic yards. Prior to beginning demolition, the contractor should take steps to carefully remove all hydraulic fluid in the TrojanUV4000 to prevent spills. Trojan estimates the time required is 15 to 24 hours (2 to 3 working days) per system.

5.5 Electrical and Instrumentation Considerations

In this section, BC considers several aspects of the electrical and instrumentation design.

5.5.1 Electrical System Modifications

The existing power system distribution was upgraded in 2014 with the addition of Channel 2 UV system. The UV Channel 1 and 2 power feeds originate from switchboard SWBD40, located in the Process Gallery building. Modifications to the switchboard include removal and replacement of existing thermal magnetic circuit breakers for Channel 1 UV system. Breaker ampacity would be determined based on the connected load ampacity.

Although modern UV lamp power supplies are designed to mitigate power system electrical harmonics, it is recommended that an isolation transformer be installed between the switchboard and UV system power supply. Electrical harmonics can cause abnormal operation of sensitive electrical equipment. Isolation transformers mitigate electrical harmonics generated by downstream loads from propagating to the upstream power system. Harmonic content can cause overheating of transformers and therefore the isolation transformer should be K-rated. Transformers that are K-rated are of a robust design to compensate for high load harmonic content without causing premature failure of the transformer itself. Additionally, if operating voltage required by the UV system power supply is less than 480V nominal, such as the Veolia Aquaray system at 400V, a step-down transformer is required.

All power, control, signal, and data cables will route back to the Process Gallery building to the associated electrical switchboard, panelboards, and CP40_2 (Area PLC). During detailed design, it is recommended to determine the available conduits, size, and routing within the existing duct bank is adequate to support the new UV system and associated instrumentation. An additional duct bank is required if additional conduits back to the Process Gallery are necessary. Ideally, it would be routed in parallel with the existing duct bank, as not to disturb operation of Channel 2 UV system, as mentioned in Section 4.2.5.

An alternate to hardwired cables back to CP40_2 is to install a remote input/output (I/O) module and control cabinet at Channel 1 and run RJ45/Ethernet back to CP40_2. All hardwire I/O from the UV system and associated instrumentation would be connected to the remote I/O module. This may eliminate the need to run a new duct bank if there is a spare conduit, sized appropriately, within the existing duct bank.

5.5.2 Instrumentation

An online UVT monitor could be placed upstream of the flow split to monitor UVT in real time. An online unit will allow the UV system to modulate power based on UVT and, assuming that the typical UVT is above 65 percent (the operator-entered UVT), the system will operate at a reduced power when water is of UVT greater than 65 percent and avoid underdosing if UVT drops below 65 percent. While for smaller systems this power savings is not large, it grows linearly with flow rate and also increases as UVT increases. Further, as flow rates to the Wilsonville WWTP increase, the UVT monitor will lead to increased O&M cost savings.

As discussed above, a flow meter upstream of Channel 1 would provide real-time flow data to the upgraded UV system.

Each UV system proposed includes UV intensity (UVI) sensor monitoring. The intensity sensors are part of the UV system. Each UVI sensor reports intensity to the UV system PLC, where the information is used to control operating energy levels of the UV system to accomplish the target UV dose.

Water level sensors will also be included in the upgraded Channel 1. Level control sensors are required to ensure that water is present in the channel at sufficient levels to cool the operating UV lamps. The level sensors also alarm when the water levels are too high (which can create a low-dose pathway above UV lamps and result in undertreatment).

The new UV control panel should include a sun shield and cover to protect the HMI, similar to the existing Aquaray system panel.

To maintain consistency across the plant, it is recommended that PLCs for any remote I/O and UV system controller should be Allen-Bradley CompactLogix or ControlLogix.

Section 6: Cost Estimate and Net Present Value Analysis

This section details BC's construction cost analysis efforts and findings.

6.1 Inputs and Assumptions for Capital Cost Opinion

BC's estimating team performed a Class 4 cost estimate for the Trojan and Veolia options. For the purposes of the evaluation, BC assumed that a redundant bank would be included in the installation.

6.2 Results of the Capital Cost Opinion

The results of the Class 4 cost opinion are presented in Table 6-1. Details and additional description can be found in Attachment E. Note that BC applied a 30 percent contingency.

Table 6-1. Cost Opinion of Two UV Disinfection Options

Description	Trojan	Veolia
Total Construction Cost Estimate	**$2,614,119**	**$2,414,943**
Class 4 Low (-30 percent)	$1,829,683	$1,690,460
Class 4 High (+50 percent)	$3,921,179	$3,622,415

6.3 Net Present Value Analysis Comparing Equipment Options

BC performed a full net present value (NPV) analysis to compare the Trojan and Veolia options, and an annual O&M cost review of Trojan, Veolia, and Wedeco options. While a full cost opinion and NPV analysis was not performed on the Wedeco system, it was included in the O&M cost review. BC believes that results of this analysis helps support the recommendations of the report. Financial inputs, including assumed cost of electricity, are presented in Table 6-2.

Table 6-2. Financial and Energy Cost Assumptions

Item	Value	Notes
Nominal Inflation Rate	6.0 percent	BC assumption
Nominal Discount Rate	8.0 percent	BC assumption
Real Discount Rate	1.89 percent	Calculation
Term	20 years	BC assumption
Cost of Electricity	0.06	$/kilowatt hour

While the electric utility charges different electricity costs at peak and off-peak hours, various surcharges and the weighted average of the different rates led BC to assume the rate presented in Table 6-2.

Replacement parts prices and warranty terms quoted by the manufacturers and used in the NPV calculations are presented in Table 6-3.

Table 6-3. Replacement Parts Warranty Terms and Pricing Used in Annual O&M Calculation				
Guarantees	Trojan	Veolia	Wedeco	Units
Lamp	15,000	16,000	14,000	Hours
Ballast	10	5	5	Years
Sensor	5	5	10	Years
Sleeve	5	10	20	Years
Wiper	1	2	1.5	Years
Prices				
Lamp	$850	$177	$473	
Ballast	$1,300	$840	$1,179	
Sensor	$2,100	$2,000	$1,197	
Sleeve	$350	$96	$641	
Wiper	$55	$8	$51	
Annual Cost for Sensor Calibration	$750	$1,500	$450	
Annual Cost for Cleaning System Consumables	$500	$1,000	$250	
Power Required at Average Flow	7.7	13.39	16.3	kW

The replacement parts pricing and annual costs lead to the calculated annual costs for each consumable/service. The annual costs for each manufacturer are presented in Table 6-4 and Figure 6-1.

Table 6-4. Annual Costs for Consumables and Total Annual Cost			
	Trojan	Veolia	Wedeco
Energy	$4,047	$7,038	$8,567
Lamps	$4,250	$3,546	$10,879
Ballasts	$1,300	$3,360	$4,716
Sensors	$420	$400	$359
Sleeves	$560	$345	$1,154
Wiper Rings	$440	$144	$1,224
Sensor Calibration	$750	$1,500	$450
Cleaning Consumables	$500	$1,000	$250
TOTAL	$12,267	$17,333	$27,599

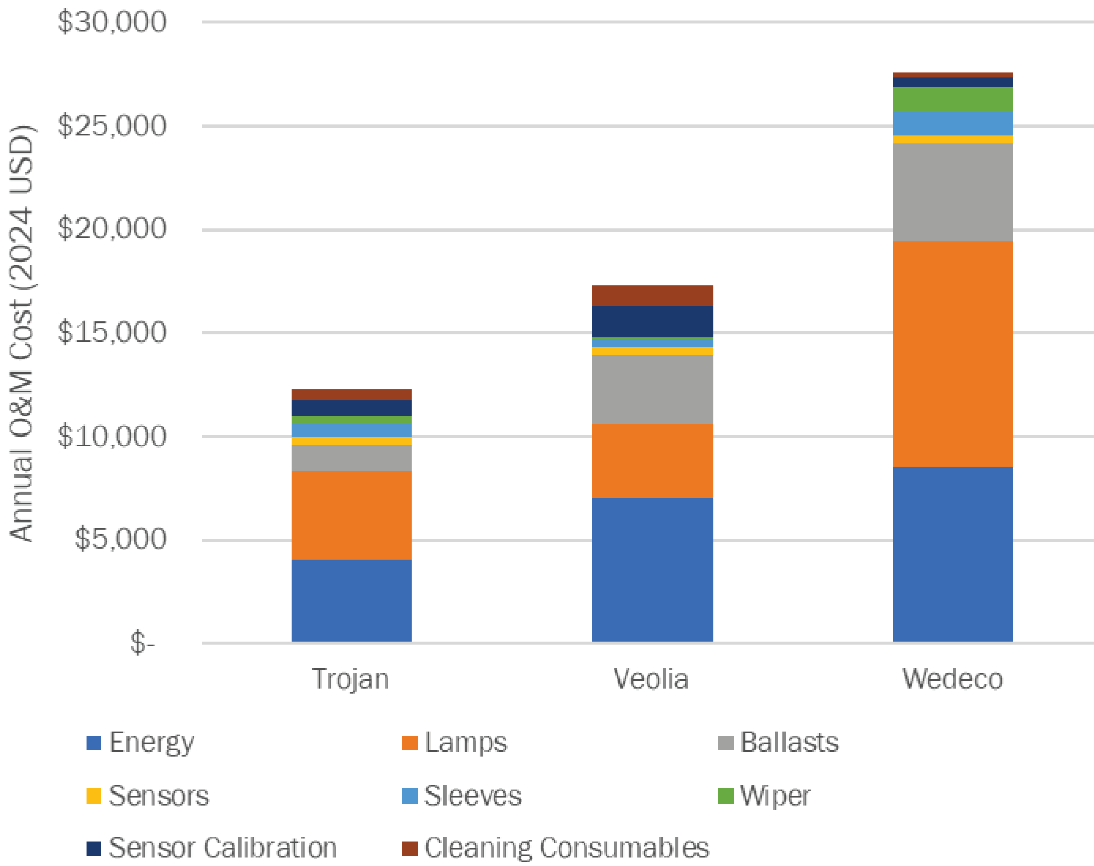

Figure 6-1. Annual O&M costs

Source: BC Calculation with manufacturer input

Using the financial assumptions listed above and the annual costs of each consumable/service, BC calculated a full NPV of the Veolia and Trojan options (Figure 6-2 and Table 6-5) and included the results of the Class 4 cost estimate described above. Results indicate that the total NPV of the Trojan system is higher than the Veolia system given a higher capital purchase price. However, the annual O&M, including electricity usage, is significantly lower. A primary difference in the overall O&M cost is the energy associated with operating the system: the TrojanUVSigna uses approximately 40 percent less energy than the Veolia system to perform the required disinfection.

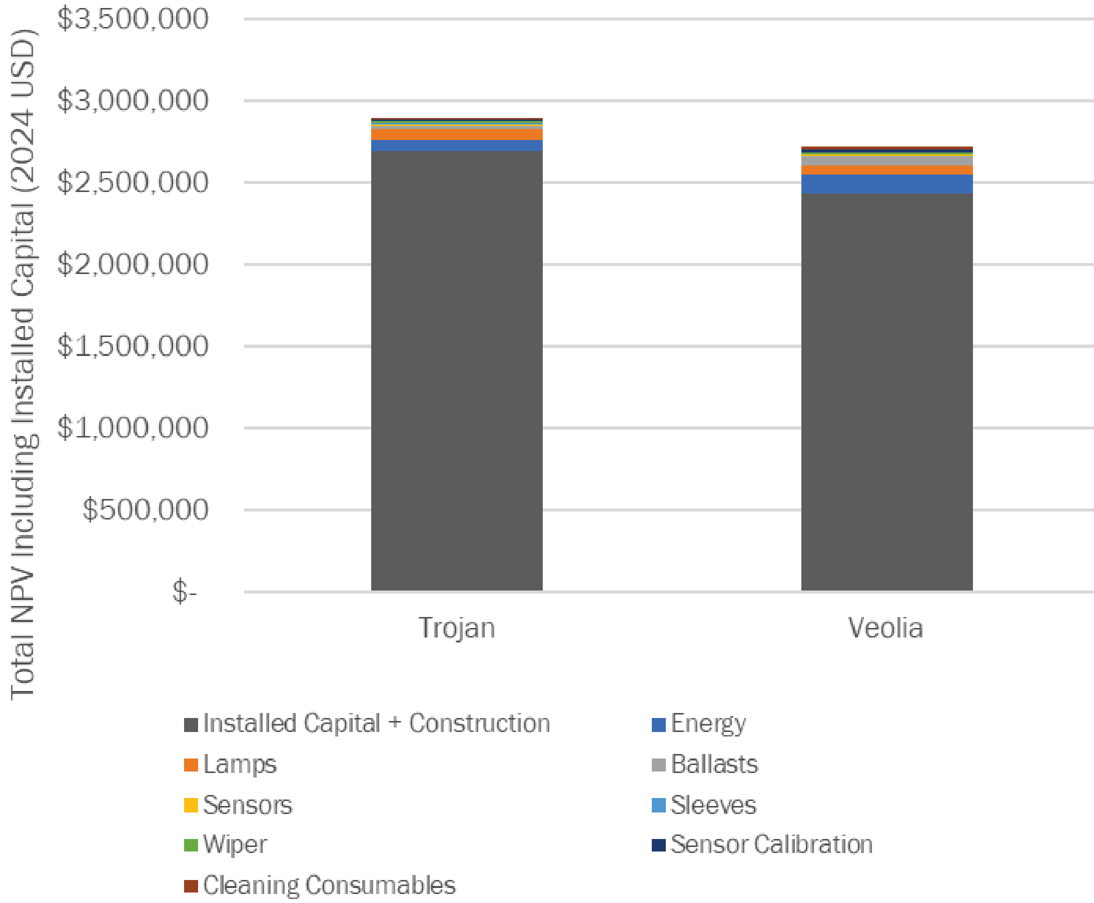

Figure 6-2. Total NPV including installed capital cost for Trojan and Veolia

Table 6-5. Results of NPV Calculations		
Component of Present Value	Trojan	Veolia
Energy	$66,905	$116,345
Lamps	$70,259	$58,617
Ballasts	$21,491	$55,546
Sensors	$6,943	$6,613
Sleeves	$9,258	$5,707
Wiper	$7,274	$2,381
Sensor Calibration	$12,399	$24,797
Cleaning Consumables	$8,266	$16,531
Capital	$2,614,119	$2,414,945
TOTAL	$2,816,913	$2,701,482

Section 7: Recommendations, Future Capacity, and Schedule

This section presents BC's recommendations, summarizes future capacity needs, and presents a proposed project schedule.

7.1 Recommendations

BC recommends the TrojanUVSigna with a redundant bank as the basis of design for a replacement unit for Channel 1. The TrojanUVSigna:

- Is representative of latest-generation technology, has a longer future product lifetime, and is better suited for long-term operation at the plant.
- Has the lowest annual operating cost based on lower operating energy and maintenance costs.
- Expected lower maintenance burden on plant staff given the automatic removal system for lifting UV banks from the channel, fewer lamps to replace, and a more advanced wiper system.
- Has no requirement installation of an additional jib crane and is therefore safer for the plant staff (by eliminating the crane-based removal of UV banks).

Further, if the City were to select Veolia, given the recent change in power supply technology for the Veolia Aquaray, plant staff would need to maintain separate stores of ballasts and sensors which mitigates the system consistency advantage for Veolia.

BC does not recommend that the City carry forward the Wedeco Duron for consideration given uncertainty related to the length of the system, the requirement to widen the channel in the area of the weir, and its significantly higher annual O&M costs.

If the City prefers to avoid sole sourcing the Trojan system, a specification naming both Trojan and Veolia could be developed during detailed design. Encouraging competitive bidding is likely to reduce the system purchase prices listed in Table 5-1.

BC also recommends:

- Adding a UVT monitor to monitor UVT in real time during this upgrade.
- That the UV manufacturer provide flow conditioners at the inlet end of Channel 1 to facilitate well-distributed flow across the channel.
- A K-rated transformer for the UV system to mitigate electrical harmonics.
- A valve and flow meter manhole be installed, as part of this upgrade, upstream of Channel 1 to facilitate flow control and measurement.
- That the final design match the headloss of Channels 1 and 2 as closely as possible to facilitate even flow distribution when flows increase (requiring the use of both channels simultaneously).

7.2 Meeting Disinfection Needs in the Future

The 2023 master plan identifies a 2045 peak flow of 17.6 mgd. The recommended replacement unit adds 8.8 mgd of UV disinfection capacity, to the 8.8 mgd of capacity already in place (in Channel 2). This leads to a combined total disinfection capacity of 17.6 mgd, which meets future requirements.

7.3 Anticipated Schedule for UV System Upgrade

Figure 7-1 presents a potential schedule for the UV system upgrade that includes a 30-week delivery time for the UV system and typical durations for other activities. Note that this schedule is subject to change. BC estimates that under these conditions the City will complete the UV upgrade in mid-2027. The City could accelerate this schedule with pre-procurement of long lead items such as the UV system.

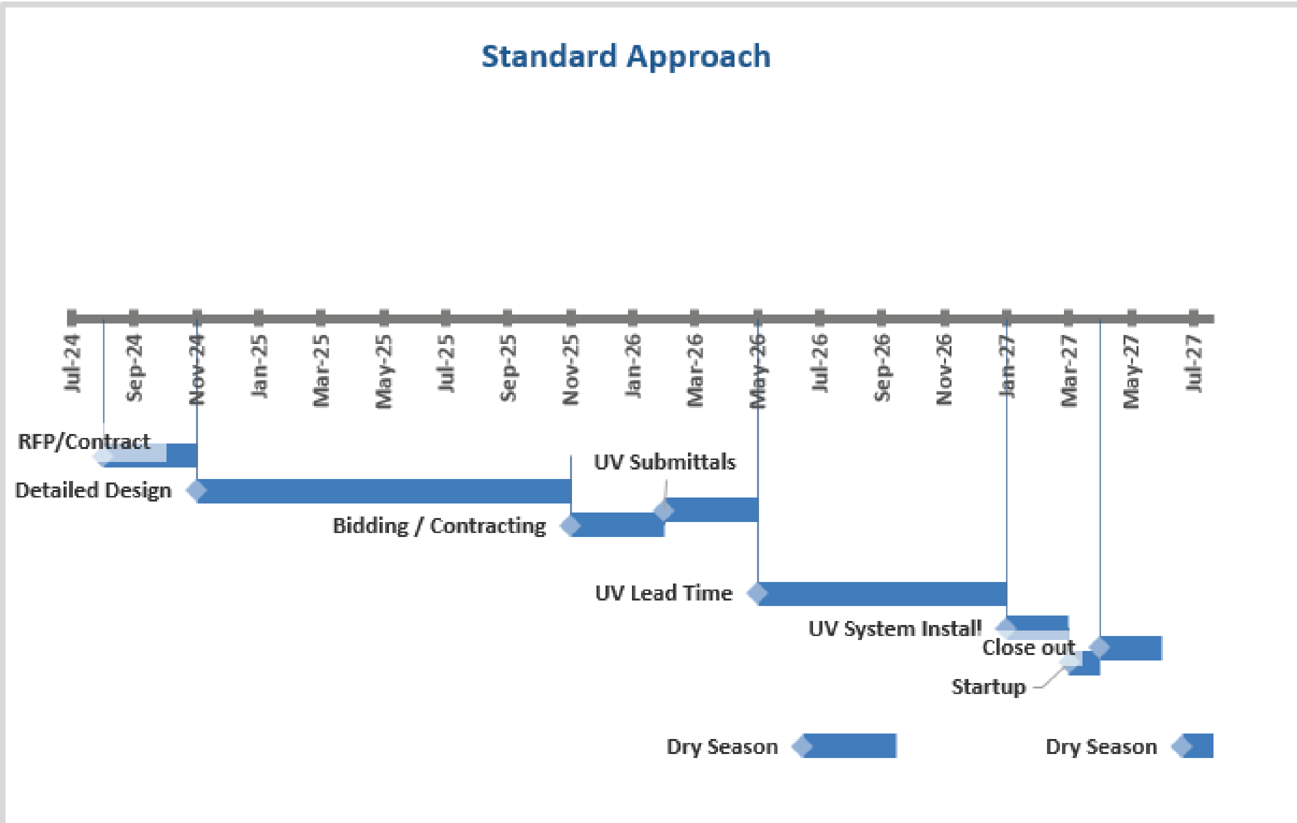

Figure 7-1. Potential schedule for UV system upgrade

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