Stantec

Woodward 3rd Party Review – Constructability and Construction Phasing Review

June 19, 2023

Prepared for:

City of Hamilton

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EXECUTIVE SUMMARY

Stantec Consulting Ltd. was retained by the City of Hamilton (City) to conduct a 3rd party review of the proposed Phase 2 upgrades at the Woodward WTP. Recently, the City has undertaken a number of studies related to the Phase 2 upgrades project.

This report focuses on the risks and considerations associated with the large-scale construction activities and heavy civil construction related to the Woodward WTP Phase 2 project, particularly on the major construction areas including the sedimentation tanks and pre-treatment system, filter building, and new UV building. In addition, the team considered whether certain portions of the work could be deferred to a future phase to reduce the scope of the Phase 2 upgrades or defer capital expenditures. The report concludes the following:

1. The conceptual design development was completed with consideration for a pre-treatment clarification process. A thorough review of alternative pre-treatment technology (Dissolved Air Flotation) is currently underway and will be completed prior to issuing an engineering request for proposal for the Phase 2 upgrades.
2. The contract should be split into a Phase 2A and Phase 2B. This will allow additional time to evaluate and design the appropriate pre-treatment system and provide Operations with the ability to prioritize the UV and filter upgrades which ultimately protect public health most.
3. A hydraulic stress test prior to construction was recommended. The City and Stantec completed this testing on March 27, 2023. This testing provides the plant with information to quantify the ability of the various filter effluent channels to accommodate higher flowrates that may be seen during the proposed construction sequence.
4. Several constructability considerations should be further reviewed by the City, including UV conduit tie-in points, sedimentation tank structural works, and filter-to-waste (FTW) piping. The UV conduit and sedimentation tank structural works in particular will require long periods of downtime at the plant.

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1.0 INTRODUCTION AND BACKGROUND INFORMATION

The Woodward Water Treatment Plant (WTP) provides potable water for the City of Hamilton and some communities of Halton and Haldimand. The plant was originally constructed in 1931 and expanded in the late 1950s. The treatment process includes intake chlorination for zebra mussel control and pathogen inactivation, screening, pre-chlorination for pathogen inactivation, coagulation with polyaluminum chloride (PACl), flocculation, conventional gravity sedimentation, granular activated carbon (GAC) filtration, post-filter chlorination/ammoniation for residual maintenance by chloramination, and fluoridation.

In 2016, CH2M HILL (now Jacobs) completed a process unit performance review of the Woodward WTP to review performance of the existing unit processes, identify operational constraints and identify capacity or hydraulic restraints[1]. The review found the following:

- **Pre-Treatment and Sedimentation**: performance as measured by settled water turbidity appeared to be adequate. The sedimentation tanks were operating at an average flow of 250 MLD and it was expected that this performance could not be maintained or sustained at higher plant flows or during high raw water turbidity events. Operations strategy is to shut down the plant when raw water turbidity is elevated.
- **Filtration**: based on historical data from 2013, the plant is meeting the treatment criterion for the filters of ≤ 0.3 NTU 95% of the time in individual filter effluent turbidity readings, but not all filters are able to meet the performance objective of ≤ 0.1 NTU in 100% of individual filter effluent turbidity readings in a calendar month suggesting compliance with future regulations may be a vulnerability. Filter loading rates were well below the 2014 max day flows of 650 MLD; the filters will be increasingly vulnerable due to increasing water demands and resulting filter loading rates, increasingly poor performance of sedimentation tanks as production rates increase and changing turbidity profile of the source water.
- **Disinfection**: pre-chlorination is required to achieve *Giardia* inactivation. Post-filter inactivation for primary disinfection is not feasible due to the limited capacity of the existing clearwells.

In general, it is expected that the estimated 2041 target plant production of 650 MLD could be achieved at low source water turbidity (≤ 5 NTU). At sustained moderate raw water turbidity levels (5 – 15 NTU), the plant capacity was expected to be 500 MLD or less. At sustained high raw water turbidity levels (≥ 30 NTU), the plant capacity is expected to be 300 MLD or less.

The 2016 report recommended the priority be upgrades to sedimentation, filtration and primary disinfection based on physical condition, capacity and design/performance limitations.

[1] Woodward Avenue WTP Final Summary Report – WTP Capital Works Implementation Plan. CH2M. April 2016.

In 2017, the City commenced the engineering and construction to complete Contract 1 of the upgrades to the WTP by completing immediate needs works, including the following:

- Replacement of rapid and flocculation mixers for both modules
- Installation of PACl injection points to the rapid mixing tanks
- Replacement of GAC media in all filters
- Installation of new filter underdrains and provision for future air scour capabilities in Filter No. 7, and new sand and GAC media for Filter No. 7
- Replacement of filter inlet and waste drain gates for all filters
- Replacement of clearwell gates
- Rehabilitation of the chemical/stores building
- Construction of an interconnecting conduit between Clearwell No. 1 and Clearwell No. 2

2.0 SUMMARY OF PLANNED PHASE 2 UPGRADES

Section 2 of this report summarizes plant upgrades recommended by AECOM and Jacobs in prior reports.

The AECOM 2022 Conceptual Design Report for Contract 2 of the upgrades reported a substantially increased opinion of capital cost. The AECOM report indicates the reason for the high cost is due to the size of the plant, not the number of processes requiring improvements[2]. The Contract 2 upgrades include the following:

- Low lift pumps: replace three of the four existing pumps in low lift pump spots #1 – 4 with three (two variable speed, one constant speed) pumps, replace the starters for the two existing large constant speed pumps with VFDs, relocate existing pump 1 to pump 5 or 6.
- Rapid mixing and flocculation tanks: raise the roof slab of the rapid mixing tanks and flocculation tanks No. 1 and 2, construct an additional third-stage flocculation tank within the sedimentation tank, relocate starters and mixers; install VFDs for all flocculation mixers.
- Sedimentation tanks: install plate settlers within sedimentation tanks no. 1 and 2, demolish roof slab of sedimentation tanks no. 1 and 2 and construct a superstructure above the plate settler zone, install automated sludge removal systems, construct and demolish a temporary sedimentation tank No. 5 with temporary relocation of existing access road.
- Filtration: replace the underdrains in 22 filters, replace the GAC and sand media in 24 filters, refurbish 22 filters, construct two backwash tanks and install backwash pumps within the UV building, install duty blowers within the UV building and air scour headers to the filter building, install a dechlorination system within the UV building.
- UV Building: construct a UV building to house a UV vault with up to six 1200 mm diameter UV trains, sized for future UV oxidation reactors, but installed with disinfection reactors, construct two new chlorine contact tanks with serpentine baffles, and incorporate the backwash and air scour systems within the new building.

2.1 LOW LIFT PUMPS

The AECOM 2020 hydraulic analysis of the low lift pumping station[3] indicated that the existing low lift pumps would be sufficient to supply the 2041 maximum flow demand of 650 MLD, even if the hydraulic water level in the sedimentation tanks were to increase by 3 m. However, additional duty pumps would need to be installed to guarantee the water supply for the ultimate maximum flow scenario. The pumping capacity assessment was conducted using the supplier pump curves; the pumps were not field tested.

[2] Woodward Avenue WTP Upgrades Conceptual Design Report Rev. 1. AECOM. September 2, 2022.
[3] Woodward Avenue WTP – LLP Capacity Assessment Technical Memorandum. AECOM. December 8, 2020.

The current pump configuration (four pumps available on the west side but only two pumps available on the east side as per Figure 2-1) does not allow maximum flows to be pumped through both the east and west raw water pipes. The upgrades will provide an even flow split capability between each side of the WTP. According to the conceptual design schedule, the LLPS upgrades are scheduled to be completed between August 2028 through July 2029.

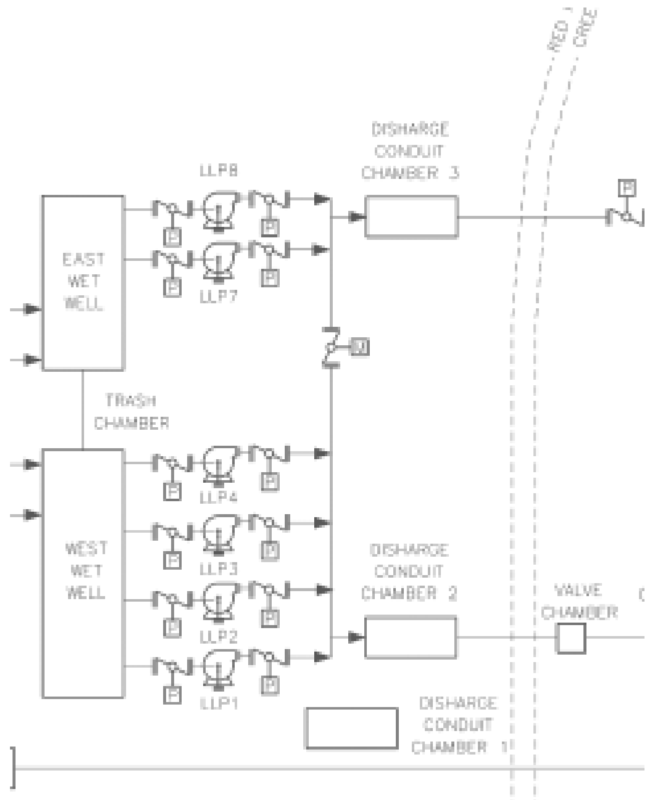


Figure 2-1: Low Lift Pump Configuration

2.2 PRE-TREATMENT

2.2.1 Rapid Mixing and Flocculation

According to the Jacobs capacity assessment, the flocculation tanks do not have capacity for max flows under cold weather conditions for the flowrates projected through 2041. Jacobs recommended a tertiary stage be added to the two existing stages to achieve at least 30 minutes of detention time year-round. Raising the roof in the rapid mix / flocculation area is also required to accommodate the changing hydraulic grade line associated with the sedimentation upgrades.

2.2.2 Sedimentation

Jacobs also noted that the sedimentation process at the Woodward WTP is significantly undersized and limits production capacity. Adverse raw water quality events cannot be effectively treated, leading to a downstream impact and increased stress on filtration. Lamella plates were selected as the preferred technology to increase sedimentation capacity. A 5th temporary sedimentation tank was proposed by Jacobs to maintain capacity during construction. It is proposed to construct a temporary 5th underground sedimentation tank with plates, with a capacity of 95 MLD. To construct the tank, the current access road will need to be rerouted. There will be significant periods of time during which sedimentation tanks 1 and 2 will both need to be shutdown to accommodate the proposed works to tank 1.

The sedimentation tank work is scheduled to occur between November 2027 and December 2034, with the balance of civil works bringing the projected completion date to March 2035. The overall sedimentation tank upgrades are the critical path and will take approximately eight (8) years based on the current approach.

2.3 FILTRATION

CH2M (now Jacobs) noted that the current filters have sufficient capacity to achieve max day flows through 2041, but the existing underdrains are in increasingly poor condition and are resulting in a reduced treatment capacity[4]. The GAC media is to be replaced every 4 years as pre-chlorination is exhausting the GAC more quickly, having the potential to compromise the taste and odour (T&O) control strategy. Refurbishment of the filters and underdrains should address the honeycombing, cracks, spalling, stains and surface erosion occurring. Implementation of air scour will improve the limited filter media cleaning during backwashes. The current filter upgrades schedule has periods of time during which two filter quadrants will be offline for an extended period. The filter upgrades are currently scheduled to occur between October 2028 and June 2031.

Filter-to-Waste has been proposed for diversion of initial high-turbidity spike in filtered water after a conventional backwash and to reduce the risk of water quality breaches after a backwash or longer periods of filter inactivity. Filter-to-Waste is not currently included in the conceptual design or schedule for the Phase 2 upgrades, but should be completed in conjunction with the filter upgrades and UV building.

2.4 DISINFECTION

The primary driver for disinfection upgrades is capacity; in the event of a pre-chlorination failure, the plant is not able to rely on post-filter chlorination to provide adequate CT. The UV building and two new chlorine contact tanks are currently scheduled to be completed between December 2027 through December 2031.

2.5 SUMMARY OF EXISTING SCHEDULE

A high-level summary of the existing schedule as presented in the AECOM CDR is presented in Figure 2-2. Significant overlapping works are likely to increase complexity of construction and increase constructability risks.

[4] Woodward Avenue WTP Study Final Summary Report – WTP Capital Works Implementation Plan. CH2M. April 2016.

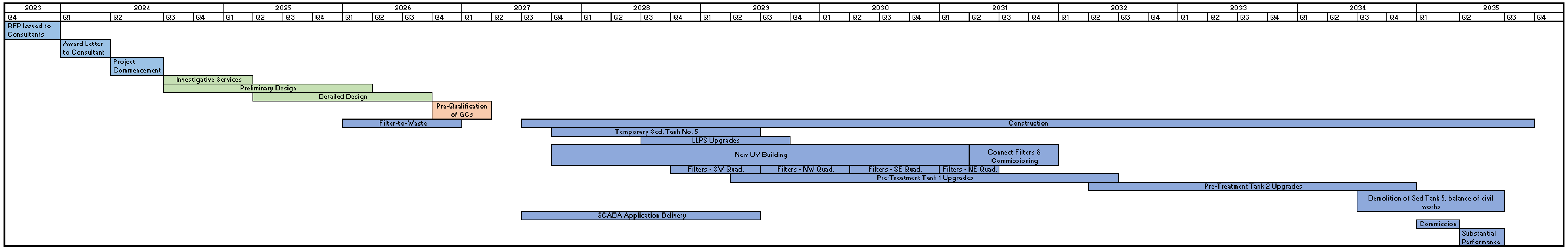


Figure 2-2: Summary of Existing Construction Schedule

3.0 INITIAL EVALUATION OF UPGRADES

3.1 EVALUATION

Based on an initial review of the proposed upgrades, Stantec agrees with the requirement for upgrades to low lift pumping, sedimentation, filtration, and disinfection as outlined in Table 3-1.

Table 3-1: Initial Evaluation of Upgrades

Process Upgrade	**Justification**				**Stantec Review**
	Capacity	**Regulation**	**Operational / Risk to Treatment**	**Level of Agreement (1 – 3)**	**General Review Comments**
Low Lift Pumping			√	3	Agreement with proposed changes to improve operational flexibility.
Sedimentation	√	√	√	3	Required for future capacity and flexibility given current MECP restriction and demands. Requires further evaluation of optimization versus new technology and staging.
Filtration	√	√	√	3	Prioritize upgrades to help meet regulatory filter turbidity requirements and public health protection.
Disinfection		√	√	3	Prioritize upgrades for public health protection and operational flexibility.

√	Moderate level of agreement
√	Strong level of agreement

3.1.1 Low Lift Pumping

The current pump configuration (four pumps available on the west side but only two pumps available on the east side) does not allow maximum flows to be pumped through both the east and west raw water pipes. The upgrades will provide an even flow split capability between each side of the WTP, allowing the full 2041 peak flows of 650 MLD to be pumped through a single water delivery pipe and treated through Module 1. However, plate settler upgrades to Tanks 1 and 2 in Module 1 will continue to limit flow through Module 1 to a maximum instantaneous flow rate of 548 MLD. Without the pumping upgrades, flow through Module 1 is limited to 500 MLD, assuming the flowmeter control valve is 100% open and Lake Ontario water levels are low. The LLP upgrades will also provide the capacity required to treat the ultimate maximum day flows of 909 MLD.

Stantec agrees with the recommendation made by AECOM to complete pump performance testing to determine the actual pump curves. The LLP assessment by AECOM was completed based on theoretical expected pump performance. The LL pumping requirements will vary depending on the final solution for the pre-treatment upgrades. It is Stantec's understanding that the City intends to complete this testing under a separate roster assignment.

3.1.2 Sedimentation

Stantec agrees that the existing sedimentation process presents a performance and operational bottleneck at the Woodward WTP. The existing sedimentation process is undersized based on the projected capacity of 650 MLD and the current system design with no use of polymer to enhance settling time, no sludge collection, and possibly non-optimized coagulation process.

However, the preferred alternative approach to addressing these limitations with the existing sedimentation process requires further evaluation. There are other alternative technologies to increasing the capacity and performance of sedimentation for Woodward WTP and these may include modified coagulation processes, additional enhanced sedimentation, dissolved air flotation (DAF), and ballasted flocculation (e.g., Actiflo™). While it is understood that a very high-level evaluation of these alternative processes has been presented in the past for Woodward WTP[5], a more detailed cost-benefit and feasibility analysis is recommended. The pre-treatment upgrades section of the pre-screening evaluation table is shown in **Table 3-2** below. It is Stantec's understanding that the City is currently initiating a pilot test for DAF, and will be completing a life-cycle analysis and decision matrix to determine the optimal clarification technology for Woodward WTP.

It is important to note that while MECP provides guidance values for sedimentation loading rate, there are no regulatory criteria associated with settled water quality data (e.g., turbidity, organics). The primary reason for this is that the filtration process, and downstream disinfection processes, are the main barriers for pathogen removal through conventional drinking water treatment processes. The key objectives for the coagulation / flocculation / sedimentation process are to achieve charge neutralization of raw water particles and conversion of raw water NOM to a particulate form so that the resulting floc particles can be removed by clarification and filtration. Clarification is included to reduce the solids loading to the filters

[5] CH2M HILL, WTP Capital Works Implementation Plan Final Summary Report, 2016

and ensure reasonable filter run times and UFRVs. When raw water turbidity and organics concentrations are low and therefore coagulant doses are low, the sedimentation step becomes less important to the overall treatment scheme. The removal of solids through sedimentation may be less critical at certain times of the year at Woodward WTP which may operate in a de-facto direction filtration mode for better parts of the year. Additionally, the performance of sedimentation processes can often be enhanced by ensuring frequent and thorough removal of sludge from the basins so that it is not scoured and carried over by hydraulic surges and when high molecular weight flocculant polymers are used to produce large, rapidly settling floc particles.

Furthermore, a WTP with well-operating filters with modern underdrains and backwash procedures is more resilient overall than a WTP with adequate sedimentation time but filters that need upgrading. Therefore, while Stantec agrees that there are potential bottlenecks with the existing sedimentation process, the priority of upgrades should be emphasized for filtration and downstream disinfection to implement key public health protection barriers at the outset of construction activities.

Table 3-2: 2016 CH2M Capital Implementation Plan Summary Report Pre-Treatment Evaluation

Alternative Technology	Overall Water Quality Benefit and Seasonal Use	Relative Capital Cost	Relative O&M Cost	Site Footprint Requirements	Recommended for Shortlist & Justification
"Like for Like" Expansion	Low	Very high	Medium	High	N – high capital cost and footprint requirement, provides additional capacity but low additional water quality benefit.
Extend intake	Low	Very high	Low	Low	N – Environmental Canada Study concluded expected marginal to moderate improvement with 5 km extension.
Lamella Plate Settlers	High	Medium	Low	Low	Y – high water quality benefit, small footprint, low operating costs.
Actiflo	Medium – High	High	High	Medium	N – potential for T&O control but significant mechanical equipment and more suitable clarification options are available.
DAF	Low – High	High	High	Medium	N – provides T&O and algal control; smaller footprint (though significantly more mechanical equipment than plate settlers); high operating costs year-round, not practical for seasonal variation only.

3.1.3 Filtration

The existing filtration process, underdrains, and backwash equipment at Woodward present a significant bottleneck with respect to operational and treatment risks due to the media surface cracking, aging underdrain system and lack of air-scour. These issues could potentially translate into regulatory issues and/or capacity issues should filtration performance and condition continue to decline. Regulatory compliance for filtration can be strictly based on the controls in place to achieve filter effluent turbidity performance objectives in line with regulatory criteria and therefore this is less of a concern, particularly when the plant is equipped with several filtration modules providing sufficient redundancy should several filters enter into backwash simultaneously. Therefore, Stantec supports that the existing filtration system presents a bottleneck with respect to operational and treatment risks.

Stantec supports the proposed upgrades in concept in terms of the upgrades to the underdrain technologies, the addition of air scour, and media replacement. However, there are concerns with the construction staging of the filtration upgrades where several modules of filtration are proposed to be offline simultaneously. Therefore, a detailed review of performance risks associated with filtration capacity during construction is recommended.

3.1.4 Disinfection

The existing disinfection process consists of pre- and post-chlorination. The proposed upgrades include two new chlorine contact tanks, sized for 2-log virus removal and an instantaneous flowrate of 936 ML, and a UV disinfection system sized for 1.0-log *Cryptosporidium* (UVT 90%) inactivation and 0.5-log *Giardia* inactivation. The existing clearwells will continue to provide flow balancing and redundancy for operational flexibility, with the new chlorine contact tanks to provide the required virus inactivation. The City plans to reduce or eliminate pre-chlorination in order to promote biological filtration following the upgrades. The addition of UV will provide multi-barrier disinfection and more robust public health protection. To increase flows under the current design and provide consistent disinfection, pre- and post-chlorination chlorine residuals would need to be further increased. Stantec supports the existing disinfection system presents an operational / risk to treatment; these upgrades are required and should be prioritized.

Currently, provincial regulations require pathogen control to achieve 3-log reduction of *Giardia* (with 0.5-log achieved by inactivation) and 2-log reduction in *Cryptosporidium*; however, the Health Canada protozoa guidance is to achieve ≥ 3-log *Cryptosporidium* removal and/or inactivation, and the Ontario Procedure for Disinfection is currently under review and could increase pathogen management requirements. Therefore, it is in the best interest of the Woodward WTP to implement multi-barrier disinfection to increase protozoa inactivation.

3.2 OPPORTUNITIES TO DELAY OR MODIFY CERTAIN PROPOSED UPGRADES

There exists an opportunity to modify the order of construction for the Phase 2 Upgrades to optimize public health protection, improve resiliency during construction, and allow time for the selection of a preferred, robust technology to address the sedimentation bottlenecks. The order of upgrades is therefore proposed to be modified to:

1. Disinfection upgrades
2. Filtration upgrades
3. LLP upgrades
4. Staged pre-treatment upgrades

Modifying the order of upgrades to complete disinfection upgrades first will increase critical barriers that provide public health protection. The new UV building will be greenfield construction, and filter upgrades are well-proven technologies with feasible implementation as demonstrated with filter 7 upgrades. Filters are a critical process for pathogen removal at the WTP; the existing filters are susceptible to turbidity non-compliance in the event of flow surges, non-optimized coagulation chemistry and sedimentation upsets, all of which are more likely during pre-treatment construction work. Providing full capacity disinfection, upgraded and robust filters, and optimized coagulation systems first will provide operators with a resilient system and will help to mitigate compliance and operational risks during the sedimentation upgrades.

Sedimentation and pre-treatment processes are not tied to regulatory parameters or analyzers. Rather, pre-treatment chemistry (i.e. coagulation charge neutralization) and filtration processes work together to protect public health. Optimized coagulant dosing may allow upgraded filters to reliably meet plant capacity, even during elevated raw or settled water turbidity events. Optimized coagulant dosing could improve the performance of filtration during construction when capacity is limited and the filters are running at a higher loading rate. The existing filter underdrains and backwash processes are old and unreliable. With optimized filtration design and backwash technology, filtration will become a robust treatment process and effective barrier for pathogens and other contaminants with extended run-times and improved efficiency.

Modifying the phasing plan and completing pre-treatment upgrades after disinfection and filtration upgrades will allow more time for selection of the preferred sedimentation technology. It is critical to select the preferred pre-treatment technology and develop a feasible conceptual design prior to initiating detailed design in order to allow for accurate cost estimates, detailed proposal submissions, and selection of an appropriate experienced design firm. The existing design for enhanced sedimentation upgrades with plate settlers requires complex and substantial construction, costs, and staging for a technology that may not be the best fit for this facility and budget. A possible optimized schedule for the Phase 2 Upgrades is shown in **Figure 3-1**.

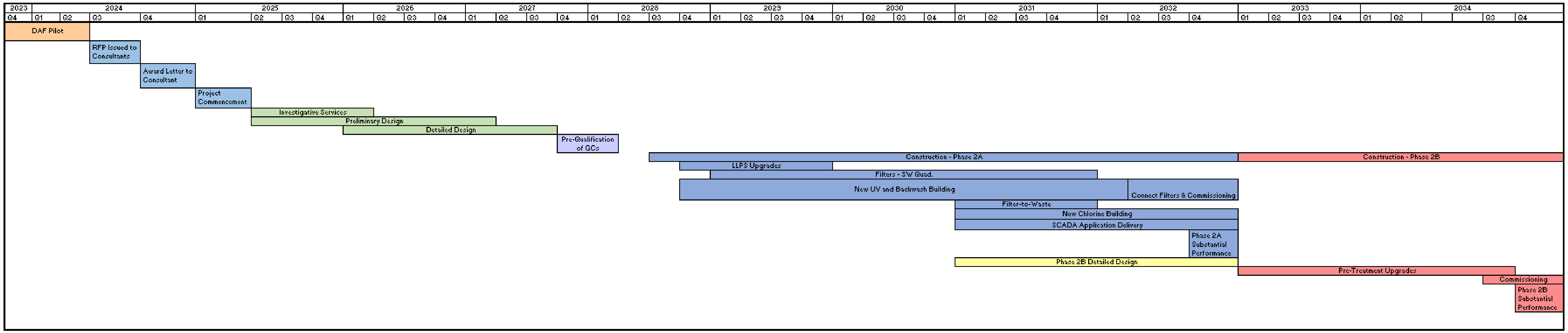


Figure 3-1: Possible Optimized Phase 2 Construction Schedule

3.2.1 Preliminary Review of Dissolved Air Flotation

Dissolved Air Floatation (DAF) may be the best available technology for pre-treatment given the raw water quality and footprint available at Woodward, and this option may provide additional benefits including:

- Alleviate the need for a 5^{th} or temporary pre-treatment train during construction, as well as associated civil works, if the Lower Stores facility footprint can be used for DAF, and the City decides an even flow split ability between both pre-treatment sides is no longer required for Phase 2.
- Improved clarified water quality.
- Reduced building capital construction costs.
- More robust treatment for emerging contaminants such as harmful algal blooms.
- No need to modify existing flocculator cells.
- Lower process footprint.
- Minimized need to retrofit all sedimentation basins.
- Provides available space in sedimentation basins for a potential future process.
- Opportunity for more flexibility during upgrades given substantially higher capacity in one “train".
- Potential to delay low lift pump upgrades.

It is important the City have time to complete pilot testing of DAF, particularly at a reasonable proposed loading rate (e.g. 20 m/hr) and through extended elevated turbidity events (e.g. > 100 NTU) to understand how robust the technology can be for Woodward, to inform design decisions (e.g., the need for polymer addition), and to provide preliminary operator training and exposure to an alternative pre-treatment technology.

The low lift pumping station upgrades, flocculation, and sedimentation tank upgrades including temporary sedimentation tank no. 5 can be optimized or shifted in the schedule if DAF were to be implemented. Moving the disinfection and filtration upgrades ahead in the schedule may provide more operational flexibility during the pre-treatment upgrades. A possible optimized schedule is shown in Figure 3-1. The schedule splits the design and construction assignments into two phases, Phase 2A and Phase 2B, to provide additional time to select a preferred sedimentation technology. Phase 2A involves the LLPS, disinfection and filtration upgrades. Detailed design for the pre-treatment upgrades (Phase 2B) can then occur concurrently with the final two years of Phase 2A. The pre-treatment upgrades schedule can be significantly optimized with an alternative technology such as DAF, eliminating the need for a 5^{th} temporary sedimentation tank, road relocation and associated civil works. Pre-treatment upgrades are shown to occur over a 3-year period, resulting in completion of the Phase 2 project 1 year earlier than originally scheduled. The optimized schedule will prevent multiple sedimentation tanks from being offline concurrently with one or two filter quadrants down, prioritizing protection of public health and decreasing likelihood of non-compliance events.

3.3 HYDRAULIC STRESS TESTING

The proposed construction schedule (**Figure 2-2**) requires the plant to operate in an off-normal flow configuration, resulting in higher than typical flowrates expected in portions of the plant. Stantec has identified two hydraulic increase cases that we recommend be investigated for the presence of bottle necks and mitigation methods elucidated before construction starts.

1. Hydraulic Increase #1 – Sedimentation upgrades

   Removal of a single sedimentation train will increase the flow to the other trains by 8.3% of the influent plant flow. At a peak flow of 480 MLD, this represents an increase per train of 40 MLD.

2. Hydraulic Increase #2 – Filter Upgrades.

   The proposed schedule shows the filters being upgraded in quadrants (6 filters to be upgraded at once). During this upgrade, the flow will increase to the other filters by 8.3% of the influent plant flow. At a peak flow of 480 MLD, this represents an increase of 40 MLD per filter quadrant.

The above assessment assumes that the flowrate from all sedimentation trains can be distributed equally between all quadrants. If this is incorrect, then flowrate implications can increase as much as 50%.

We further understand that a bulkhead fitting is installed between the outlet piping from filters 1 - 12 and 13 - 24, such that they may not be combined. We further understand that there are concerns from plant staff that the outlet channel leading from filters 1 - 12 to the clearwell may be hydraulically limited under some scenarios. With the inability to ferry water from one quadrant discharge channel to another under construction flow scenarios, the opportunity to mitigate flow changes may be reduced.

We recommend hydraulic stress testing prior to construction to quantify the ability of the various filter effluent channels to accommodate flowrates that may be seen during the proposed construction sequence. We propose the following scenarios:

Scenario 1 – Flowrate through Filters 1 – 12 = 320 MLD

This scenario will test the hydraulic capacity of the effluent channel from filters 1 through 12 under the condition that six of filters 13 through 24 (e.g. one quadrant) are out of service at a plant peak flowrate of 480 MLD. We recommend monitoring the level in the effluent channel, level in the filter gallery and flowrate through all the filters during this test.

Scenario 2 – Flowrate through Filters 13 – 24 = 320 MLD

This scenario will test the hydraulic capacity of the effluent channel from filters 13 through 24 under the condition that six of filters 1 through 12 (e.g. one quadrant) are out of service at a plant peak flowrate of 480 MLD. We recommend monitoring the level in the effluent channel, level in the filter gallery and flowrate through all the filters during this test.

4.0 CONSTRUCTABILITY CONSIDERATIONS

The conceptual design results in significant construction efforts at three (3) main locations within the Woodward WTP for the new UV Building, the Sedimentation Tanks, and the existing Filter Building. Although a great deal more detail will be required during the detailed design portion of this project prior to construction, it is worthwhile raising concerns observed at the conceptual level that, if addressed early, would result in more efficient construction phasing.

4.1 UV BUILDING

The new proposed UV Building will be in the south-east portion of the WTP site, and be south of the existing Filter Building, whilst east of the existing Clearwells. This is an open area in terms of having no other buildings in the immediate location but is also a congested area with existing underground utilities.

The below image (**Figure 4-1**) is the UV Building in the proposed location complete with all major new infrastructure connecting it to the existing treatment train. At first glance, the piping arrangement appears to be convoluted, where portions can be deleted in full, and others simplified. It is worthwhile clarifying that we have assumed that all major pipe systems have been twinned to eliminate single points of failure concerns the City might have within the treatment process.

A main concern with the piping system as shown is the concept shows 2100 mm diameter pipes connected to existing conduits where the condition of this conduit is unrealized until fully excavated and inspected during construction, posing risk that the exterior concrete may require additional structural restoration efforts. Additionally, connecting 2100 mm diameter pipes as shown, presumably CPP, would require significant downtime to the existing system, further complicating the running of the plant during construction.

When using CPP or Blue Brute PVC, the only reasonable method of installation on a critical pipeline such as this would be in one direction. The one directional construction method presents new obstacles for this area as follows:

- Only one installation crew can work on one pipeline at a time.
- Excavation, pipeline installation, and backfill is duplicated for each run, increasing the risk at each existing infrastructure crossing.
- Connections must be made at one end of the pipe and then completed at the second. If installed as shown, the pipe would first be connected at the UV Building, run to the existing conduit, then left exposed until ready for final go-live connection. This would apply at all pipe locations.
- The final connection would be a manufactured closure piece that can only be field fit when the final piece of pipe is installed up to the existing conduit. Any imperfections in this specialty closure piece would result in a significantly longer downtime to the WTP Operation.

The UV outlet at the southerly portion of the building connecting to existing Clearwell No. 2 results in an unnecessarily long downtime to Clearwell No. 2. The City has already completed modifications that permit flow into either clearwell through one common influent channel. It should be noted that based on the current CT calculator, the City does not count CT provided through the clearwells, therefore without clearwell 2 in operation, there is no impact to plant capacity.

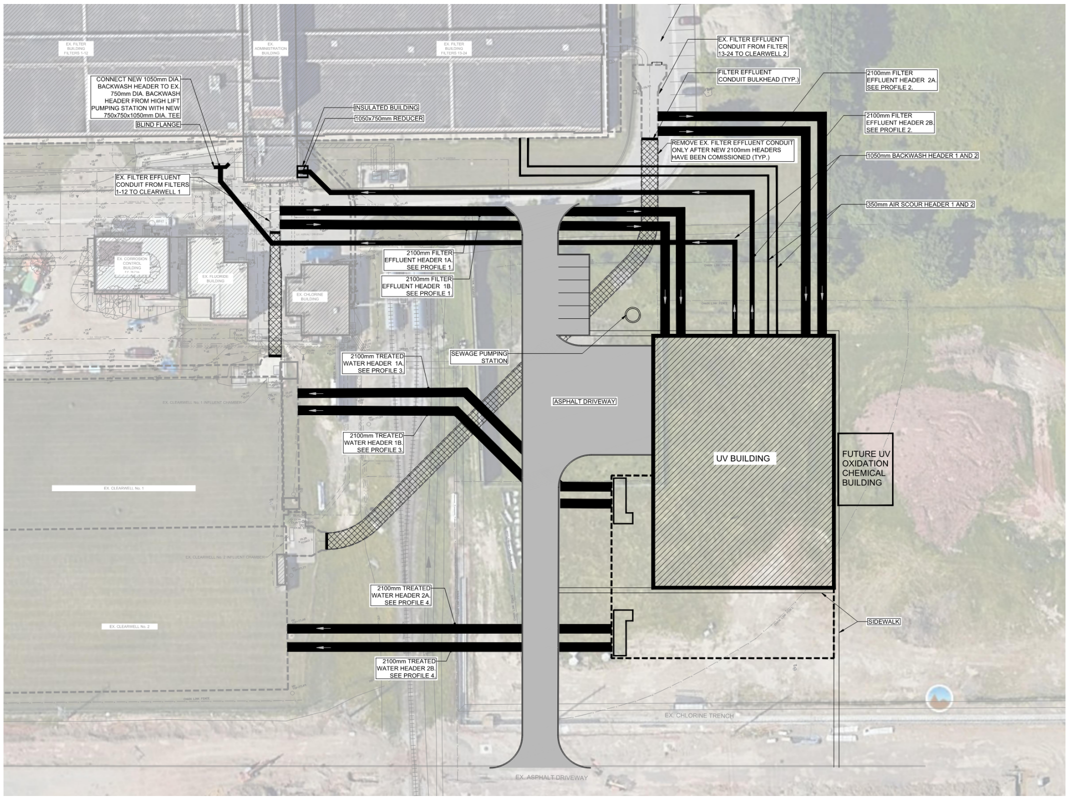


Figure 4-1: Proposed UV Building Infrastructure and Layout (Source: AECOM Conceptual Design, 2021)

After having reviewed the site piping layout, we believe replacing the pipe system with a cast-in-place (CIP) concrete split conduit would better serve the City by minimizing the amount of downtime required for connections.

A CIP split conduit would permit the contractor to construct in many locations without the concerns associated with one directional construction methods. Two or more crews could be working on the same conduit, reducing the overall duration and making critical infrastructure crossings just once.

Flexibility could also be realized when connecting to the existing conduit systems by first constructing a CIP chamber around the existing conduits whilst they remain in service, uninterrupted by the construction process as shown in **Figure 4-2** below. This would allow all final connections to be made and backfilled before the system is connected live.

Within the connecting chambers, the use of slide gates or large diameter valves on pipe embeds would permit the selection of one or both conduits to be in service.

The final connection would be a simple short duration shut down to remove a section of existing conduit, making the system live. This is a critical part of the project and careful consideration should be given to the ease of removal of these existing conduits during detailed design. Room for wire saws, and concrete removal should be considered to keep the overall tie-in between 20 and 36 hours of downtime.

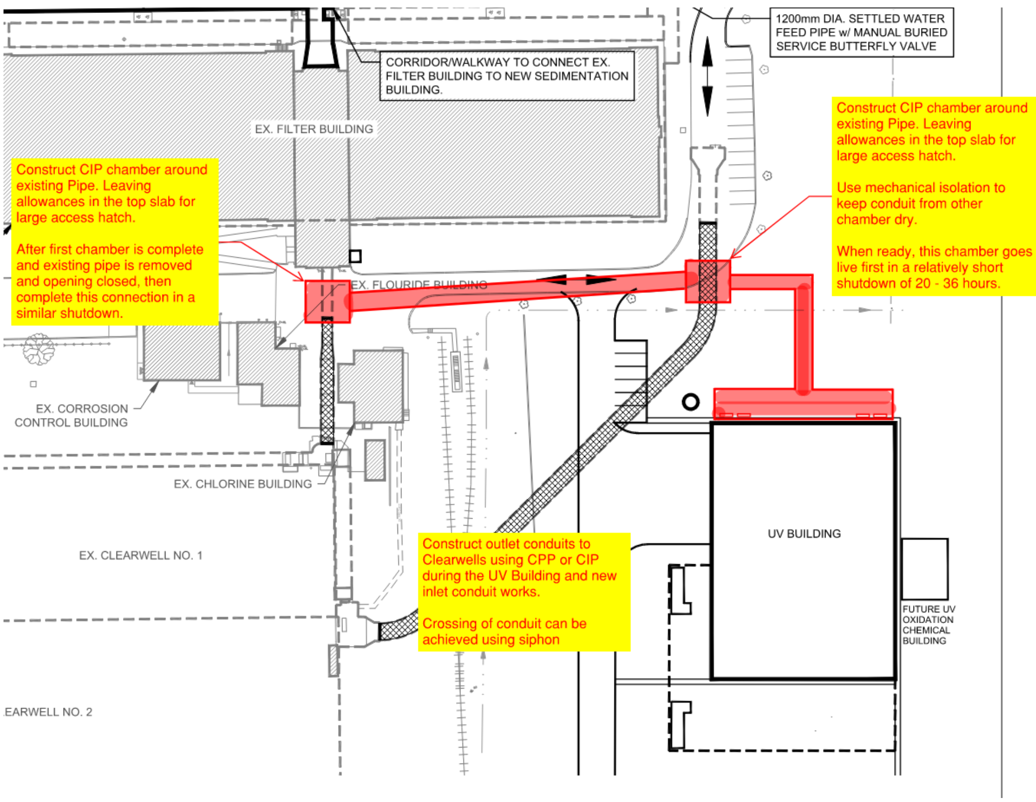


Figure 4-2: Alternative Conduit Connections (Drawing Source: AECOM Conceptual Design, 2021)

The outlet piping system could be CIP or CPP if for some reason the designer felt it better served the project. It is, however, our experience that CIP construction is more flexible and efficient in that it allows multiple crews working from each end toward each other.

By completing all CIP channel works and leaving final connections as the last step in the process, the entire UV Building can be constructed and commissioned in a single phase. The conceptual report spoke to staging the commissioning of this facility, but we do not see that as necessary.

The building itself is not a difficult build, but it is a complex one having internal intermediate suspended slabs that are typically built after the top suspended slab is constructed. Additionally, there is a great deal of interior wall construction that can be achieved using a pre-engineered gang-form system as opposed to conventional wood form construction. The building superstructure is also shown as CIP, but we assume this will be masonry wall construction made up of structural block walls and brick façade.

For a building of this significance, it may be worthwhile for the City to consider in its tender document stipulating minimum crew sizes and have schedule milestones with financial incentives built in. It would not be unreasonable to state a minimum of two CIP crews on each inlet and outlet conduit plus two to three CIP crews on the UV Building at the same time. Minimizing the window on the civil portion of the work should provide the City with the comfort that critical connection around live conduits, excluding two, are complete, and the below ground works around existing infrastructure is complete. This approach would minimize the window of risk for all stakeholders.

4.2 SEDIMENTATION TANKS

The conceptual plans indicate that Sedimentation Tanks 1 and 2 will undergo significant structural modifications that will expose all stakeholders to an equal amount of unforeseen risk. This will also result in an extended downtime of both tanks at the same time to complete the works as shown.

Consideration should be given to an alternate construction method that does not require such invasive structural modifications. It is our understanding from discussion with the Woodward WTP staff that the maximum allowable interruption to the Sedimentation Tanks 1 & 2 would be one out of service at any one time. As shown now, the center wall isolating Tanks 1 & 2 requires full roof removal, wall extension upwards, and new roof sections constructed before one of these two tanks could see temporary service.

The level of effort getting one tank back into service is likely to exceed one year of construction where two tanks would be out of service, assuming no unforeseen issues arise during construction. It should be noted there are many unknowns that will have to be fully investigated before a construction schedule could be produced. These unknown items include but are not limited to: existing concrete condition, existing soil bearing capacity to withstand the additional pressure of a raised tank and water volume weight, and the existing water table depth and fluctuations as this design shows many large penetrations through the tank floors to construct large concrete column supports. The Stantec team understands the City has retained a consultant to complete this review.

Figure 4-3 provides a visual of the large slab penetrations, raised walls, and new roof construction in the current conceptual design.

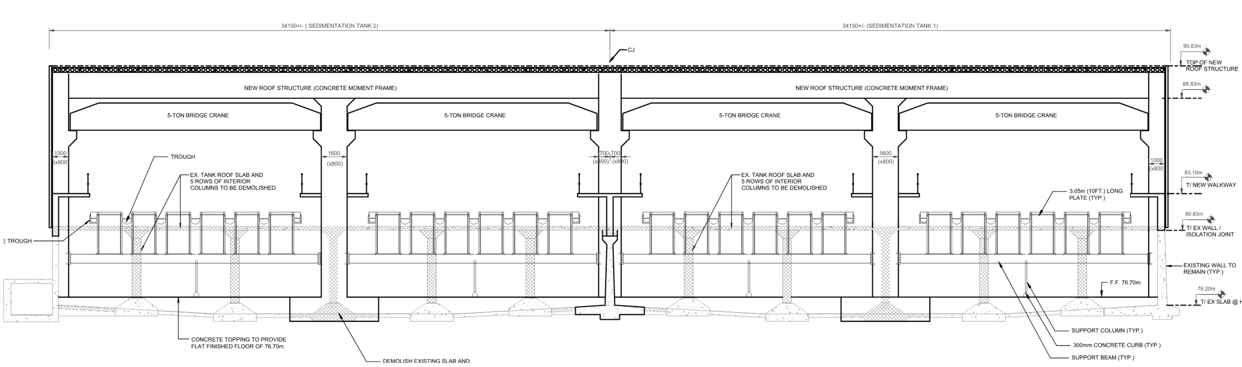


Figure 4-3: Proposed Sedimentation Tank Structural Works (Source: AECOM Conceptual Design, 2021)

Further design related discussions are recommended with this task to ensure the City can accommodate calculated interruptions to more appropriate portion of this facility.

4.3 FILTER MODIFICATIONS

The existing Filter Building conceptual design integrates a Filter-To-Waste (FTW) system designed to flow off-spec water post-backwash into the on-site waste stream. The FTW addition will be gravity driven and requires pipe modification into the existing lower pipe gallery.

A section of the filters and lower pipe gallery is shown below, from the 1931 and 1957 drawing set provided by the City. At the center of the building is the lower pipe gallery showing three flow streams including backwash supply, filtered effluent, and filter drain lines.

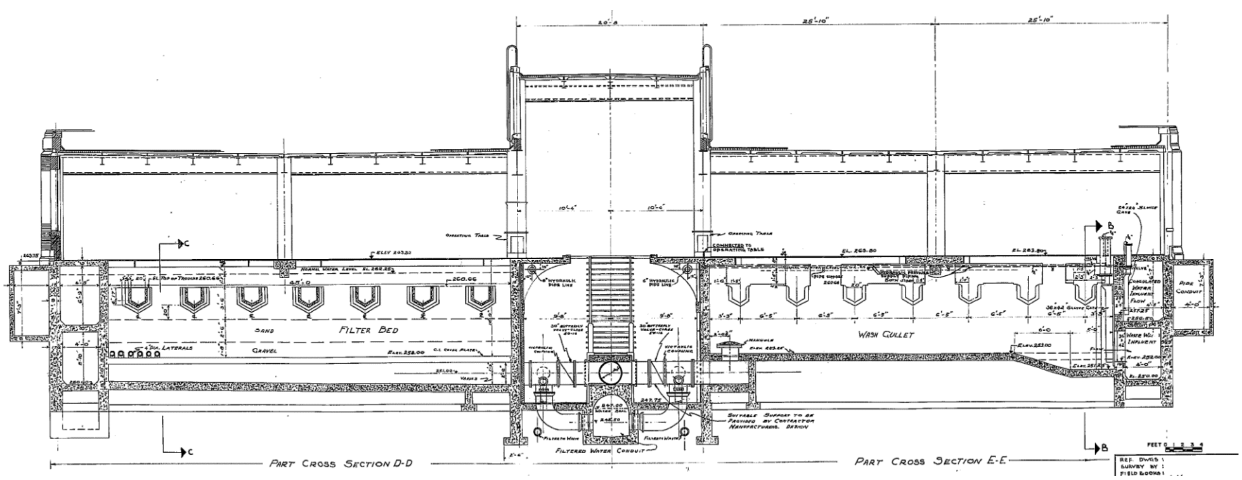


Figure 4-4: Filter and Lower Pipe Gallery Drawing (Source: Woodward WTP: 1931 and 1957 drawing set)

The intent of the FTW addition is to connect piping to the existing filter effluent line and when the filter completes its backwash and returns to filter service, it would first run filtering to waste to eliminate any possible off-spec water. **Figure 4-5**, from the Jacobs FTW conceptual design report, shows the proposed piping installation layout.

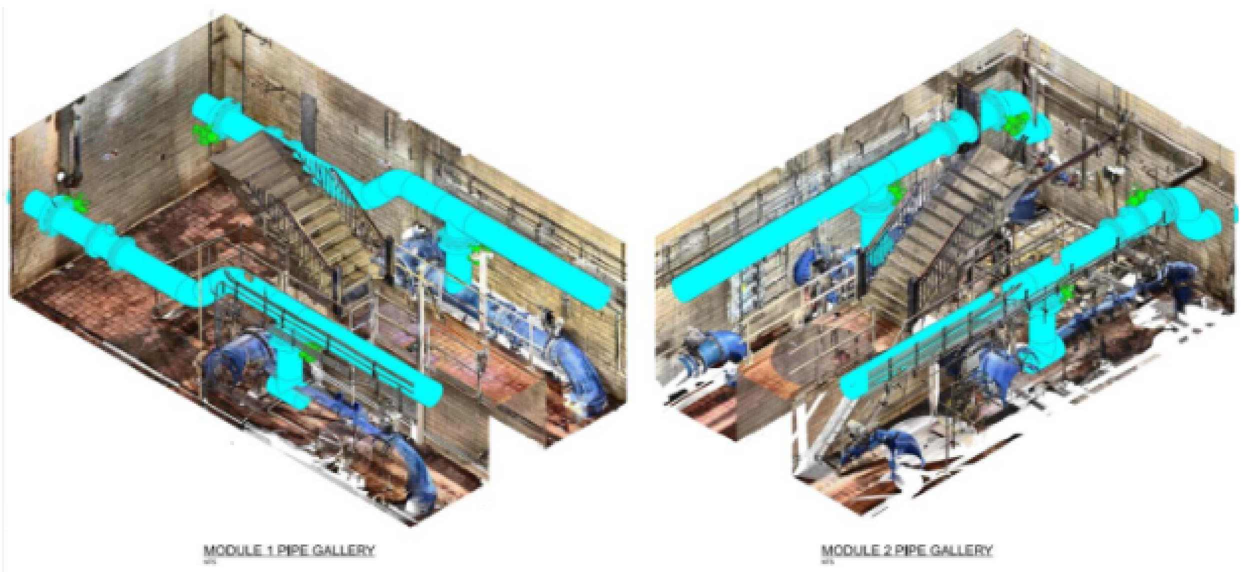


Figure 4-5: FTW Piping Conceptual Design (Source: CH2M Filter-to-Waste report, 2021)

There are concerns regarding how this piping would integrate into this area of the plant that is already a very old build and having its own degradation issues. During our November 18, 2022 site visit, there were signs of water weeping up through the floor tiles, hollow sounding floor tiles indicating issues below, concrete spalling, and reinforcing steel corrosion.

At face value, integrating the FTW piping within this pipe gallery may appear to be the easiest way to implement the system, but it will not be without careful staging within a congested area as shown in the photo in **Figure 4-6**.

Figure 4-6: Filter Gallery Congestion

The FTW system proposed in the Jacobs report is the least invasive with respect to the structural integrity, however, if there are options to consider an alternate means of dealing with the filtrate during the return to service, the City stands to reduce project risks related to construction within this facility. This should be further explored during detailed design.

5.0 RECOMMENDATIONS AND CONCLUSIONS

The Stantec team has evaluated the construction phasing opportunities and constructability risks associated with the current proposed Phase 2 upgrades. The following recommendations have been developed:

- More time is required for a proper evaluation of pre-treatment technology alternatives prior to release of the consultant RFP in late 2023/early 2024. Pre-treatment alternatives were not assessed in the level of detail required for upgrades of this size during the conceptual design development. A lifecycle assessment of DAF and plate settlers should be completed.
- Conduct an optimization study for pre-treatment with respect to coagulant dosing and potential to improve performance when capacity is limited during construction.
- Conduct a detailed review of performance risks associated with filtration capacity during construction.
- Conduct pump testing on the LLPs and HLPs.
- Split the Phase 2 upgrades contract into two separate contracts, as Phase 2A and Phase 2B. This will allow the City to prioritize critical upgrades protecting public health, being filtration and disinfection, as well as provide additional time for a DAF pilot, and pre-treatment conceptual and detailed design. Splitting the contracts will also reduce the amount of construction occurring concurrently, decreasing constructability complexity. Hydraulic stress testing prior to construction is recommended. This would allow the plant to quantify the ability of the various filter effluent channels to accommodate higher flowrates that may be seen during the proposed construction sequence.
- Complete further testing on the sedimentation basins to determine existing concrete condition, existing soil bearing capacity, and existing water table depth and fluctuations. Stantec understands a consultant has been retained to complete this work.
- Several constructability considerations should be addressed relating to the UV building conduit tie-in points, sedimentation tank structural works, and FTW piping location. These concerns could be addressed during pre- and detailed design. Consideration should be given to the UV building piping layout and material and stipulating minimum crew sizes and schedule milestones with financial incentives in tender documents.

6.0 REFERENCES

AECOM. (2020, December 8). *Woodward Avenue WTP – LLP Capacity Assessment Technical Memorandum*.

AECOM. (2022, September 2). *Woodward Avenue WTP Upgrades Conceptual Design Report Rev. 1*.

CH2M HILL. (2010, February). *Woodward Avenue WTP Alternatives Evaluation*.

CH2M HILL. (2016, April 29). *Woodward Avenue WTP Study Capital Works Implementation Plan Final Summary Report*.

Jacobs. (2022, April 11). *Filter-to-Waste Conceptual Design Technical Memorandum*.

APPENDIX A
WORKSHOP NO. 1 POWERPOINT SLIDES

Stantec

City of Hamilton
Woodward WTP Phase 2 Upgrades
3rd Party Review

Workshop 1 – Construction Phasing Opportunities & Constructability Risks

Agenda

1. Stantec 3rd Party Review Scope
2. Summary of Planned Phase 2 Upgrades
    - LLPS Upgrades
    - Pre-Treatment / Sedimentation Tank Upgrades
    - Filter Building Upgrades
    - UV Upgrades
    - Current Phase 2 Construction Schedule (overall)
3. Initial Evaluation of Upgrades
4. Opportunities to Delay or Modify Certain Proposed Upgrades
5. Hydraulic Stress Testing Options
6. Constructability Considerations (Key Tie-in Points)
7. Open Discussion
8. Next Steps

Stantec Team

- Mike Kocher: Project Manager
- Dave Pernitsky: Senior Advisor
- Nicole McLellan: Water Quality Specialist
- Brad Wilson: Process Engineer
- Hailey Holmes: Process Engineering Support
- Paul Kusiar (Kusiar Project Services): Constructability

Project Overview

Overview of 3rd Party Review Assignment Scope

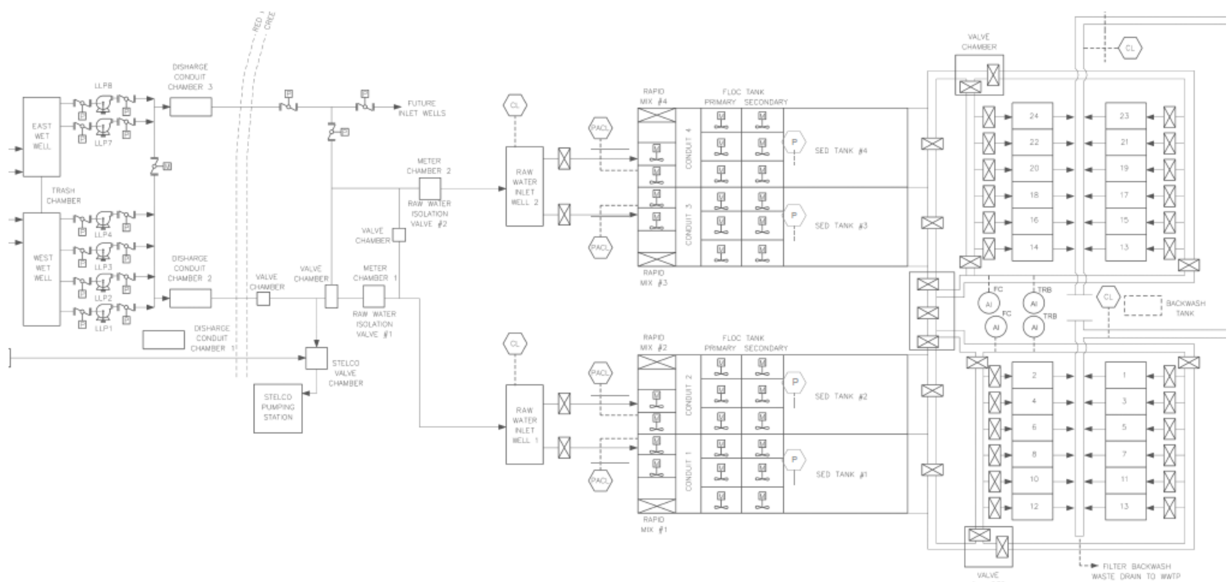
- Task 1 - Construction phasing opportunities and key constructability considerations **(today's workshop)**
- Task 2 - Risks analysis of process / construction activities, concurrent large capital projects at the Woodward WTP and Woodward WWTP **(early February)**
- Task 3 - Capital construction cost estimate review
- Task 4 - Resourcing assessment, organizational structure for the large capital projects
- Task 5 – Review of Available Grant Funding Opportunities

Low Lift Pumping Station

LLPS

Overview of Phase 2 Scope

- Relocation of a LLP from west to east side
- Removal and disposal of LLPs 2 and 4; installation of new LLPs with motors, VFDs, associated pipes, valves, instruments
- New LLP 1 with motor, soft starter, and associated discharge pipe, valves and instruments
- Replacement of starters with VFDs for LLPs 7 and 8; replacement of associated discharge pipes, valves, instruments
- Replacement of transformers with larger size



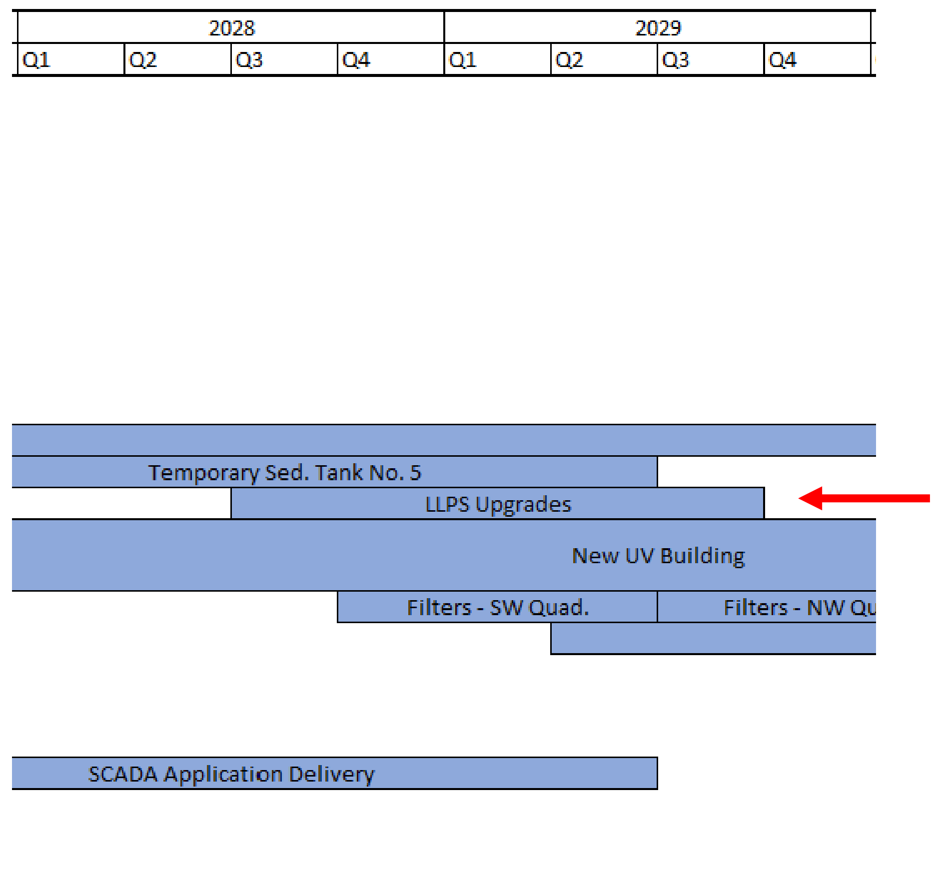
Primary Driver for LLPS Upgrades

- Meet capacity for ultimate max. flow scenario at varying Lake Ontario water levels
- Meet capacity for 2041 max. flows assuming 1 LLP fails in each module
- Provide even flow split capability between each side of the WTP (East, West)

LLPS

LLPS Upgrades Schedule

- Overall LLPS upgrades: Aug. 2028 – July 2029



Pre-Treatment & Sedimentation

Overview of Phase 2 Scope

Rapid Mix and Flocculation:

- Raise the roof for tanks 1 and 2
- Construct additional flocculation tank tertiary stage within sedimentation tank
- Relocate starters for existing rapid mixers
- Install new flocculation mixers for primary stage, relocate existing mixers from primary stage to secondary stage, and from secondary stage to tertiary; install VFDs

Sedimentation

- Install plate settlers within tanks 1 and 2
- Demolish and raise the roof
- Construct superstructure above plate settlers zone
- Install concrete topping and automated sludge removal systems
- Relocate existing access road
- Construct temporary sedimentation tank no. 5 with plate settlers; demolish the temporary sed tank and reconstruct the access road

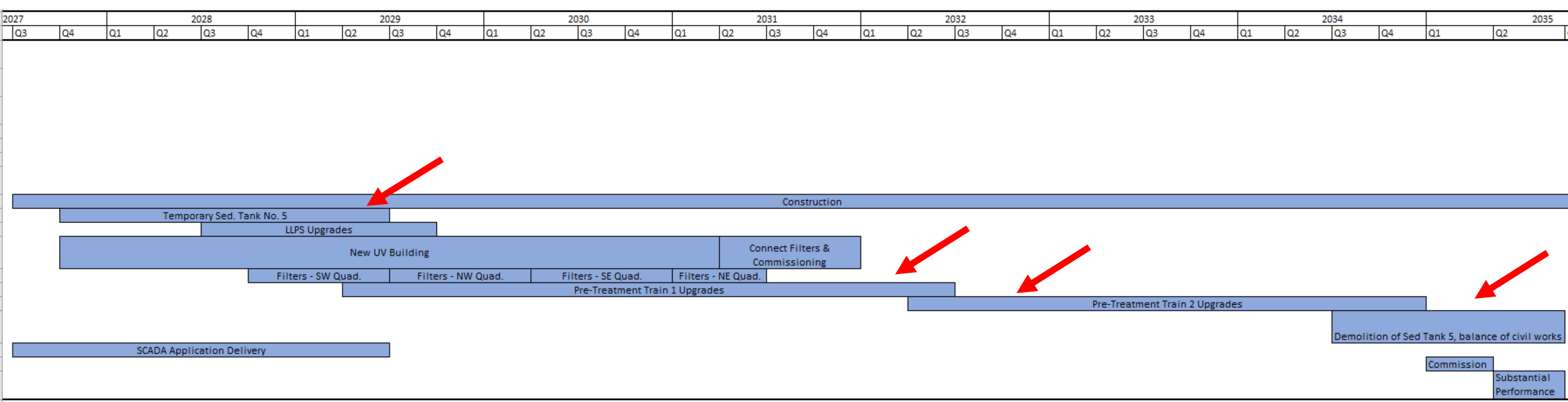
Primary Drivers for Upgrades

- Flocculation:
  - Roof raise: changing hydraulic grade line with sedimentation upgrades
  - Tertiary stage: to achieve at least 30 minutes detention time year-round.
  - Note: modifications may not be necessary if sedimentation upgrade is DAF
- Sedimentation:
  - Limited production capacity, low design rate for conventional settling tanks
  - Adverse raw water events cannot be effectively treated, leading to downstream impact on filtration and treated water quality
  - Plant shutdowns during turbidity events
  - Quarterly manual cleaning of sludge in tanks requires confined space entry

Pre-Treatment
&
Sedimentation

Sedimentation Upgrade Schedule

- Temporary sedimentation tank 5: Nov. 2027 – June 2029
- Pre-treatment train 1 upgrades: June 2029 – April 2032
- Pre-treatment train 2 upgrades: April 2032 to Dec. 2034
- Demolition of temporary sedimentation tank no.5 and balance of civil works: Aug. 2034 – March 2035
- **Key Takeaway – overall Sed Tank Upgrades are critical path and will last approx. 8 years based on current approach**



Filter Building Upgrades

Overview of Phase 2 Scope

- Replace all filter underdrains (except Filter 7)
- Replace media in all filters
- Refurbish all filters (except Filter 7)
- Construct two new backwash tanks and install new pumps within UV building, with two backwash headers to the filter building
- Install two duty blowers and air scour headers within the UV building and routed to the filter building
- Install a dechlorination system within the UV building
- Conversion to biological filtration, once post-filter UV is in place and prechlorination is discontinued

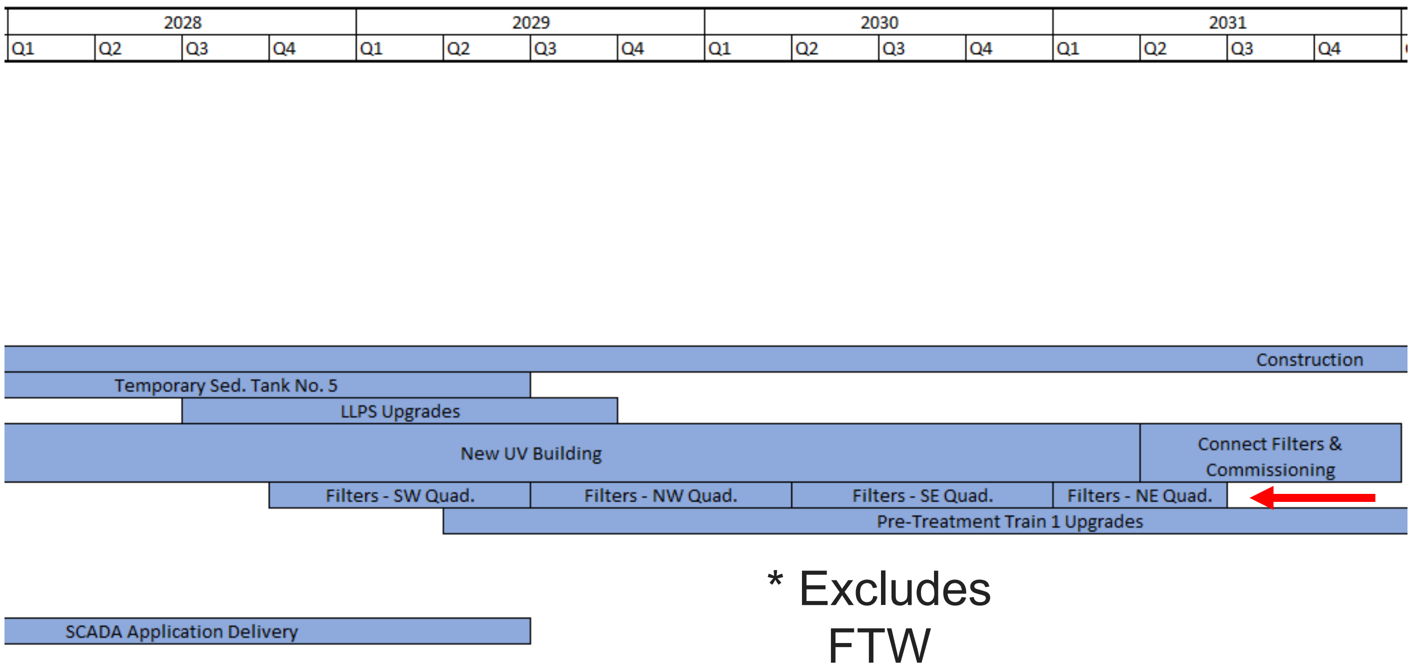
Primary Driver for Upgrades

- Reduced capacity due to poor physical condition of old clay tile underdrains; failures in recent years
- GAC media to be replaced every 2-4 years; prechlorination exhausting GAC more quickly. T&O control strategy compromised.
- Air scour: limited filter media cleaning during backwash with no surface wash system.
- Filter refurbishment: filters exhibit honeycombing, cracks, spalling, stains and surface erosion

Filter Building Upgrades

Filter Upgrades Schedule

- Filter upgrades to be completed between Oct. 2028 to June 2031



* Excludes FTW

Addition of Filter-to-Waste

- FTW recommended for:
  - Diversion of initial high-turbidity spike in filtered water after a conventional backwash
  - Risk of water quality breaches after a backwash or longer periods of filter inactivity
  - Best practice
- CDR recommends construction Jan. 2026 – Jan. 2027
- Q for City – Has ETWS been investigated as possible alternative to FTW?

UV Upgrades

Overview of Phase 2 Scope

- Construct a UV building to house a UV vault with up to 6 1200 mm DIA UV trains, sized for future UV oxidation reactors, but installed with disinfection reactors for now
- Construct two new chlorine contact tanks with serpentine baffles
- Incorporate backwash and air scour systems within UV building

Filter Building Upgrades

Primary Driver for Upgrades

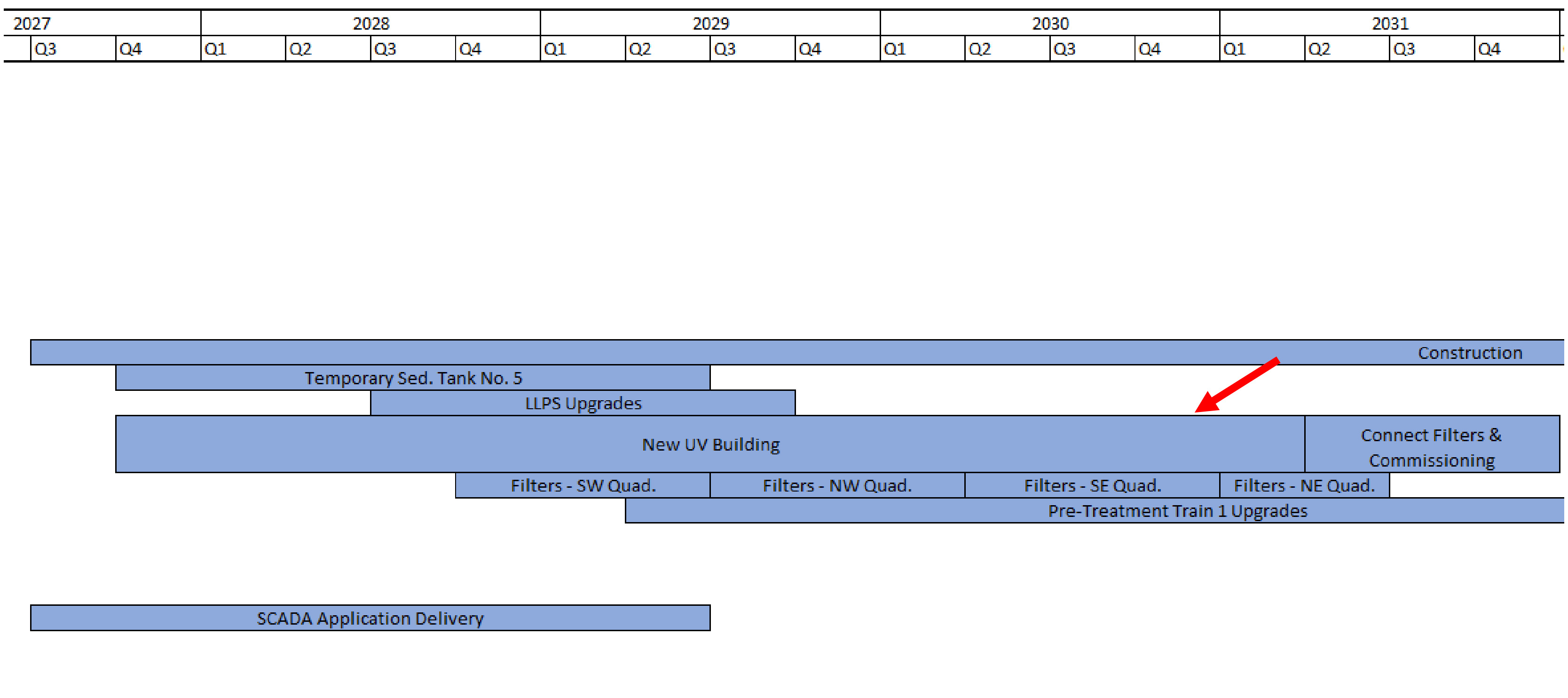
- In the event of a pre-chlorination failure, the plant is not able to rely on post-filter chlorination to provide adequate CT
- Disinfection goals:

Parameter	Water Quality Treatment Objectives	Disinfection to be Achieved					
		Intake and Pre-treatment Tanks[1]	Conventional Filtration[2]	UV Disinfection	Chlorine Disinfection within Chlorine Contact Tanks (CCTs)	Chlorine Disinfection within Existing Clearwells[5]	Total
Crypto-sporidium	2	-	2[3]	> 1.0[4]	-	-	> 3[3,4]
Giardia	3 including 0.5-inactviation	-	2.5	> 0.5	-	-	> 3
Viruses	4 including 2-inactviation	-	2	-	> 2	-	> 4

Aecom, 2022

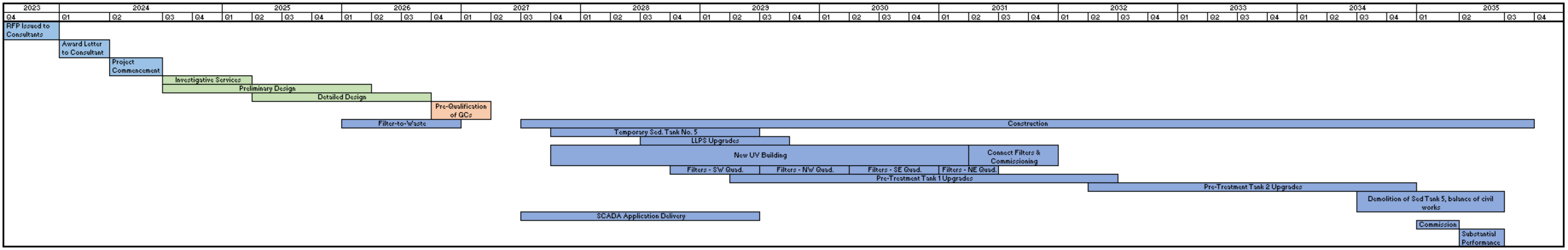
UV Building Schedule

- Construction between Dec. 2027 – Dec. 2031
  - UV building, including equipment: Dec. 2027 – Mar. 2031
  - Filter and treated water headers: Feb. 2029 – Aug. 2029



Summary of Existing Schedule

Summary of Schedule



Initial Evaluation of Upgrades

Initial Evaluation

Initial Review Summary (Major Process Area)

Process Upgrade	Justification			Stantec Review	
	Capacity	Regulation	Operational / Risk to Treatment	Level of Agreement (1-3)	General Review Comments
Low Lift Pumping			√	3	• Strongly agree with proposed changes to improve operational flexibility.
Sedimentation	√	√	√	3	• Required for future capacity and flexibility given current MECP restriction and demands • Requires further evaluation of preferred technology and staging
Filtration		√	√	3	• Prioritize upgrades; Will help meet regulatory filter turbidity requirement
UV + Chlorination Disinfection		√	√	3	• Prioritize upgrades for public health protection and operational flexibility.

Opportunities to Modify Phasing Plan

Stantec is exploring the opportunity to modify the order of construction to:

- Optimize public health protection
- Improve resiliency during construction
- Allow time for the selection of a preferred, robust technology to address sedimentation bottlenecks

Therefore, Stantec is evaluating proposing upgrades in the following order:

1. Disinfection Upgrades
2. Filtration Upgrades
3. Staged Pre-Treatment Upgrades

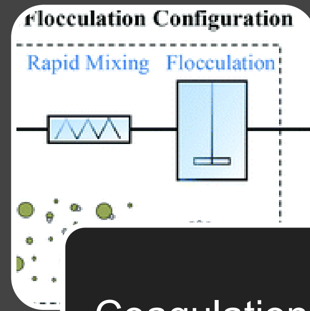
Optimize Public Health Protection

Barriers that provide greatest public health protection → UV + Chlorine Disinfection → Filtration

- These process upgrades involve low to moderate complexity.
- New UV Building to be constructed on greenfield.
- Filter upgrades are well-proven technologies and feasibility of implementation already demonstrated on Filter #7.
- **Therefore, it is recommended to prioritize upgrades for UV Disinfection and Filtration Optimization.**

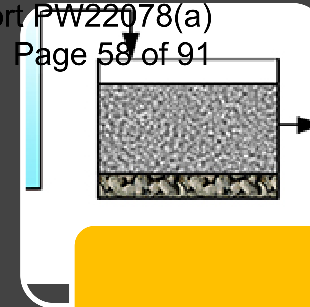
Filters are the most important process for pathogen removal.

Technical Perspective



Coagulation / Flocculation

Sedimentation



Filtration

<u>Sedimentation and pre-treatment processes are **not** tied to regulatory parameters or analyzers (e.g., turbidity, *E. coli*).</u>

Rather, pre-treatment chemistry (i.e., coagulation charge neutralization) and Filtration processes work together to protect public health. Optimized coagulant dosing may allow upgraded filters to reliably meet plant capacity, even during elevated raw or settled water turbidity events.

Existing filters are susceptible to turbidity non-compliance in the event of flow surges, non-optimized coagulation chemistry, sedimentation upsets, all of which are more likely during pre-treatment upgrades. Providing upgraded and robust filters and coagulant systems first will provide resiliency and mitigate these risks.

Existing filtration underdrains and backwash processes are old and unreliable. With optimized filtration design and backwash technology, filtration will become a robust treatment process and effective barrier for pathogens and other contaminants with extended run-times and improved efficiency.

Allow More Time for Selection of Preferred Sedimentation Technology

At present, the preferred sedimentation technology is undecided.

It is critical to select the preferred pre-treatment technology and develop a feasible conceptual design prior to initiating detailed design in order to allow for accurate cost estimates, detailed proposal submissions, and selection of an appropriate experienced design firm.

Stantec notes the existing design for sedimentation upgrades with plate settlers requires complex and substantial construction, costs, and staging for a technology that may not be the best fit for this facility

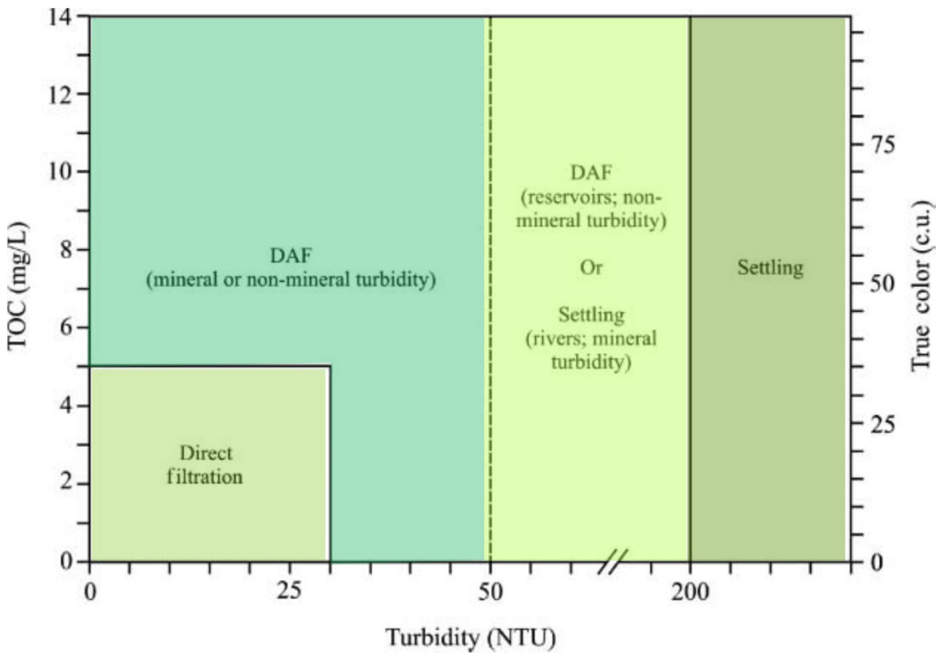
Preferred Sedimentation Technology Continued:

Further, Stantec notes that Dissolved Air Flotation (DAF) may be the best available technology for pre-treatment in the given footprint at Woodward, and this option may provide additional benefits, such as:

- Alleviate the need for a 5th or temporary pre-treatment train during construction
- Improved settled water quality
- Reduced building capital construction costs
- More robust treatment for emerging contaminants such as potential algal blooms
- No need to modify existing flocculator cells

It is important that the City has time to complete pilot testing of DAF, particularly at a reasonable proposed loading rate (e.g., 20 m/h) and through extended elevated turbidity events (e.g., >100 NTU) to understand:

- How robust this technology can be for Woodward,
- inform design decisions, and
- Provide preliminary operator training and exposure to an alternative pre-treatment technology



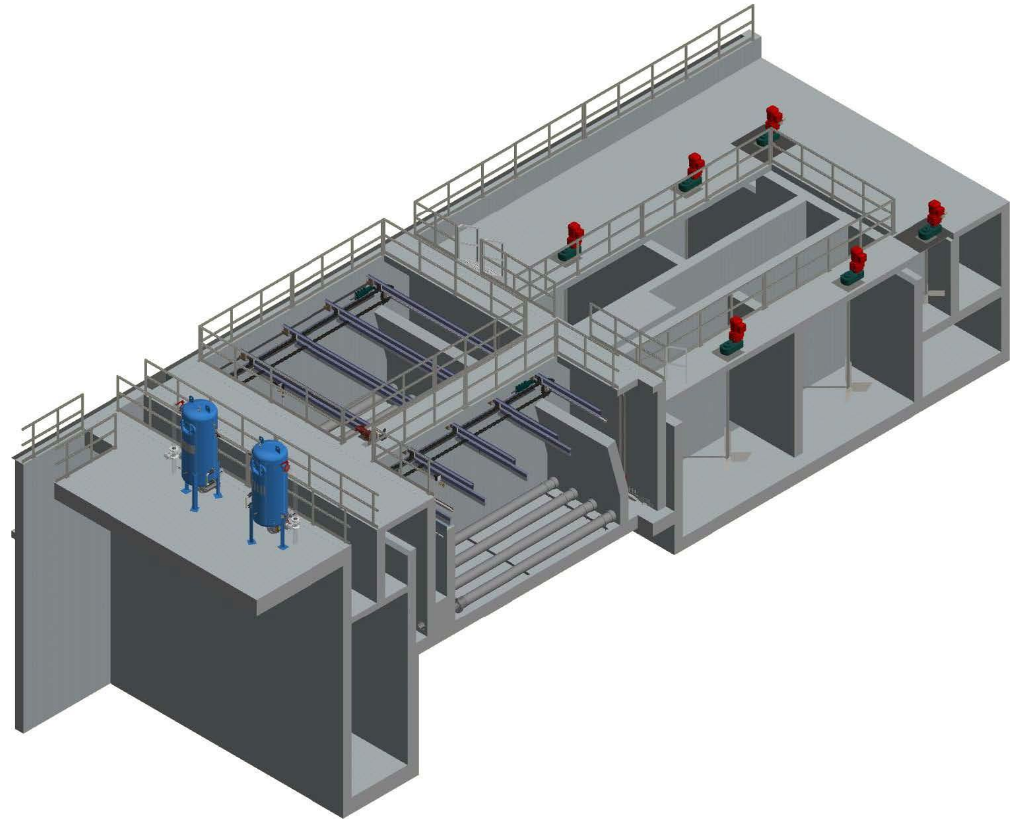
Valade, M. T., W. C. Becker, and J. K. Edzwald. "Treatment selection guidelines for particle and NOM removal." Journal of Water Supply: Research and Technology—AQUA 58.6 (2009): 424-432.

DAF Upgrade Considerations

5th pre-treatment train:
- not necessary long-term
- may not be necessary during construction

Requires conceptual evaluation – design and cost estimate

Potential to construct DAF train in existing location of lower stores (Jacobs)
- Minimal impacts on staging of other construction activities



2-train concrete DAF (provided by AWC)

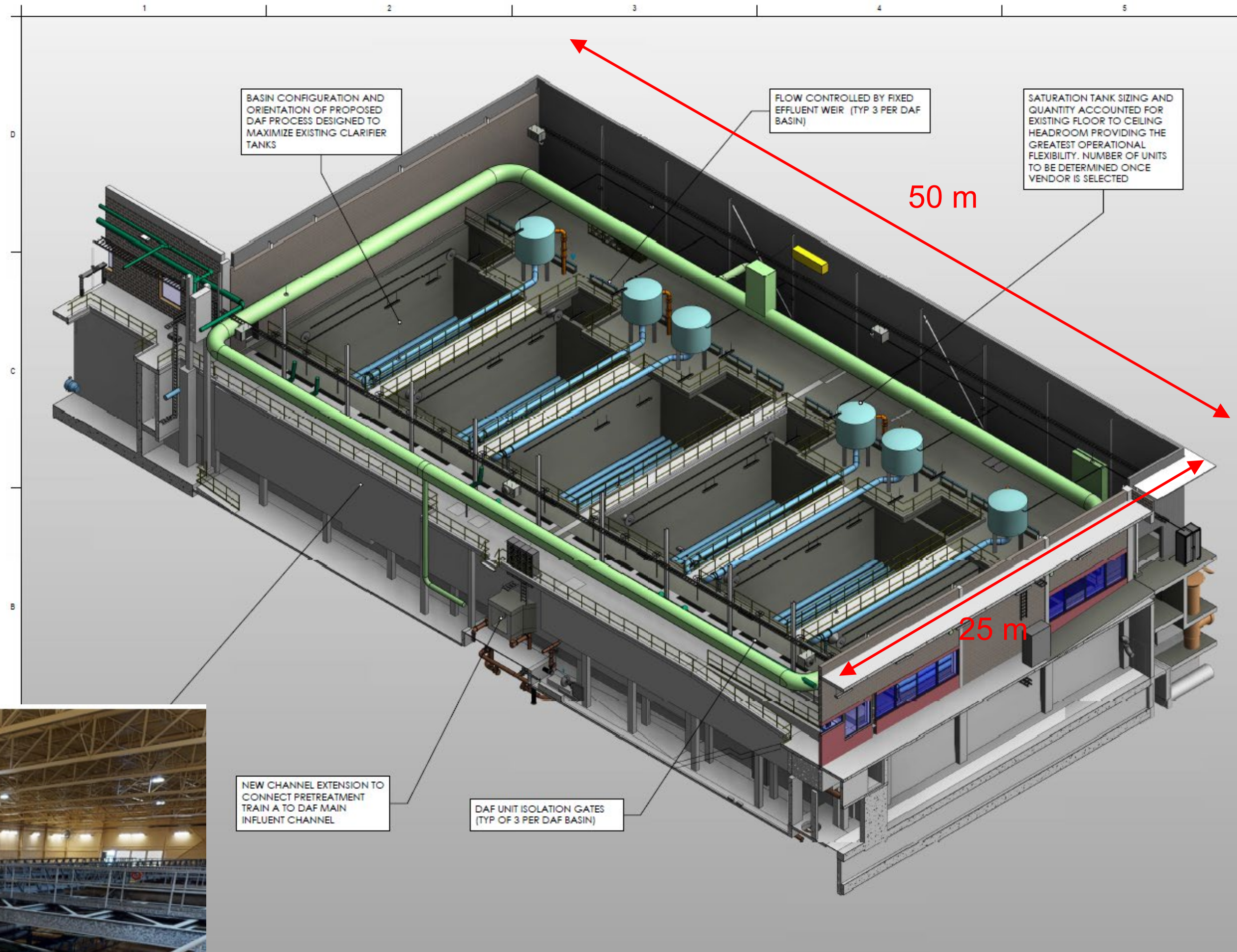
Buffalo Pound SK: DAF Retrofit

Case Study

6 DAF units retrofitted into 2 square clarifiers

First 3 DAF constructed over winter low demand season

Each DAF 57 MLD with flotation area 7.8 x 13 m



Case Study

Buffalo Pound SK: DAF Retrofit

Isolate 1 clarifier for winter construction.

Case Study

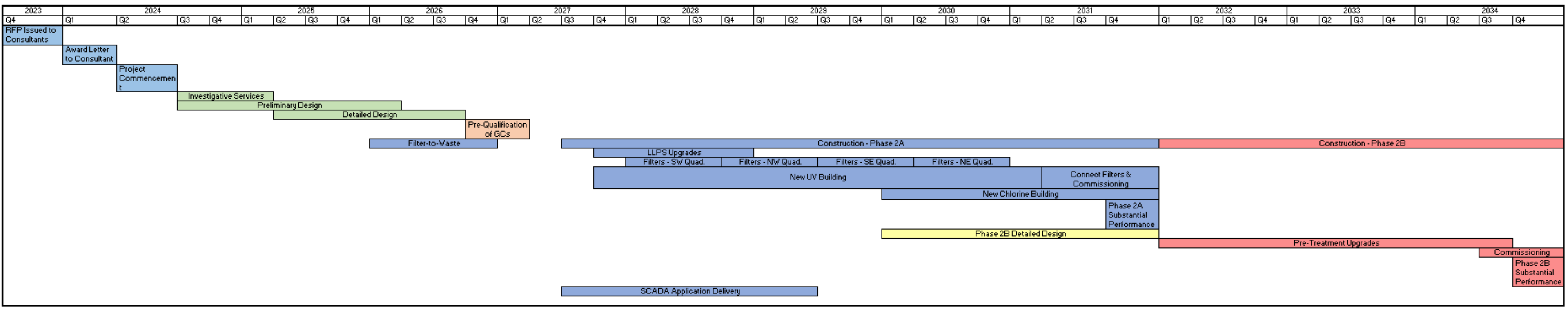
Buffalo Pound SK: DAF Retrofit

Summary

- Unit processes that can be optimized or shifted in the schedule if DAF were to be implemented:
  - LLPS
  - Flocculation
  - Sedimentation, including temporary tank 5
- Recommend investigation of ETSW as alternative to FTW

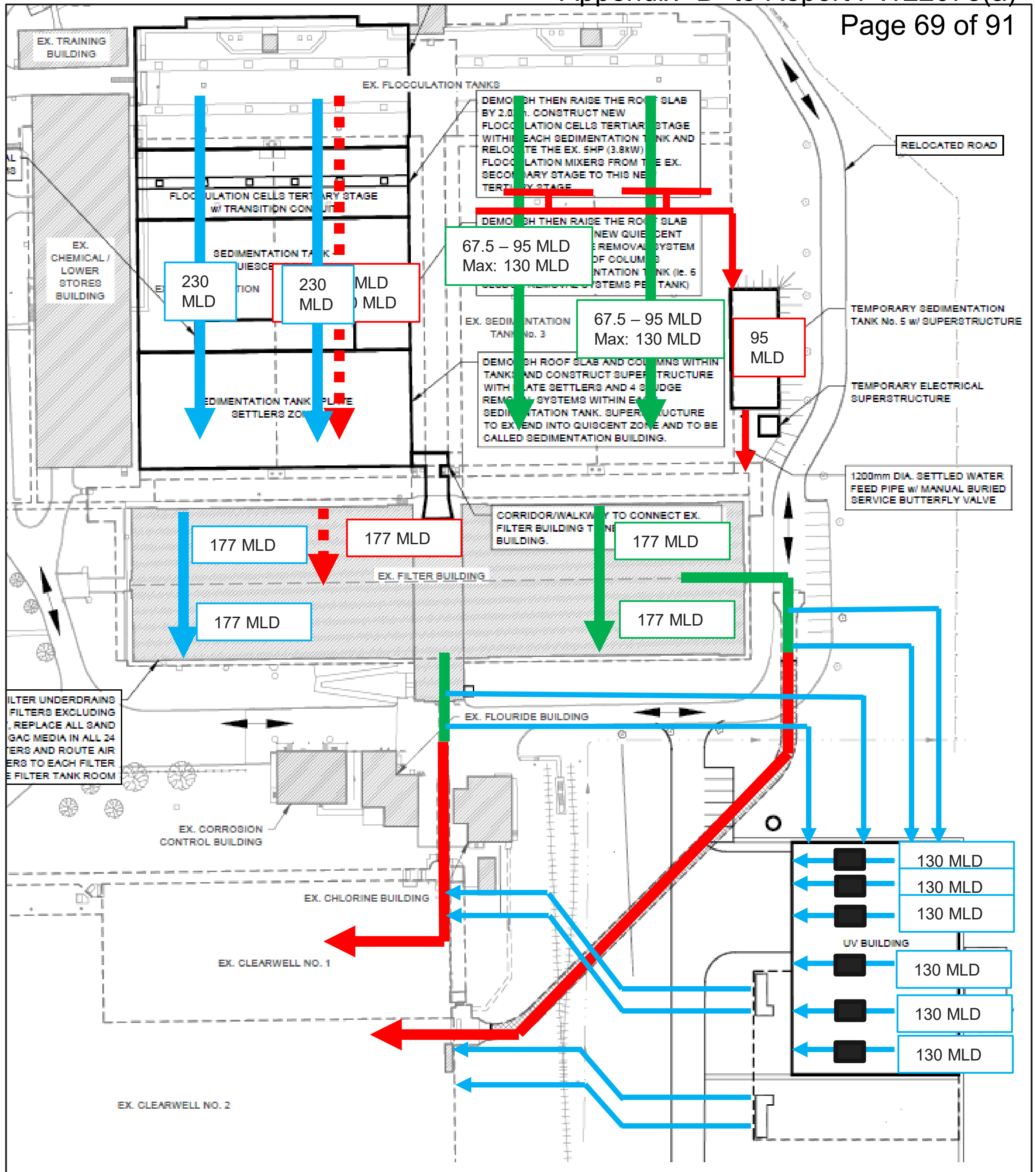
Possible New Schedule

Possible New Schedule



Hydraulic Stress Testing Options

Stress Testing *Hydraulic Capacities*



LEGEND

Current + Unchanging Flow

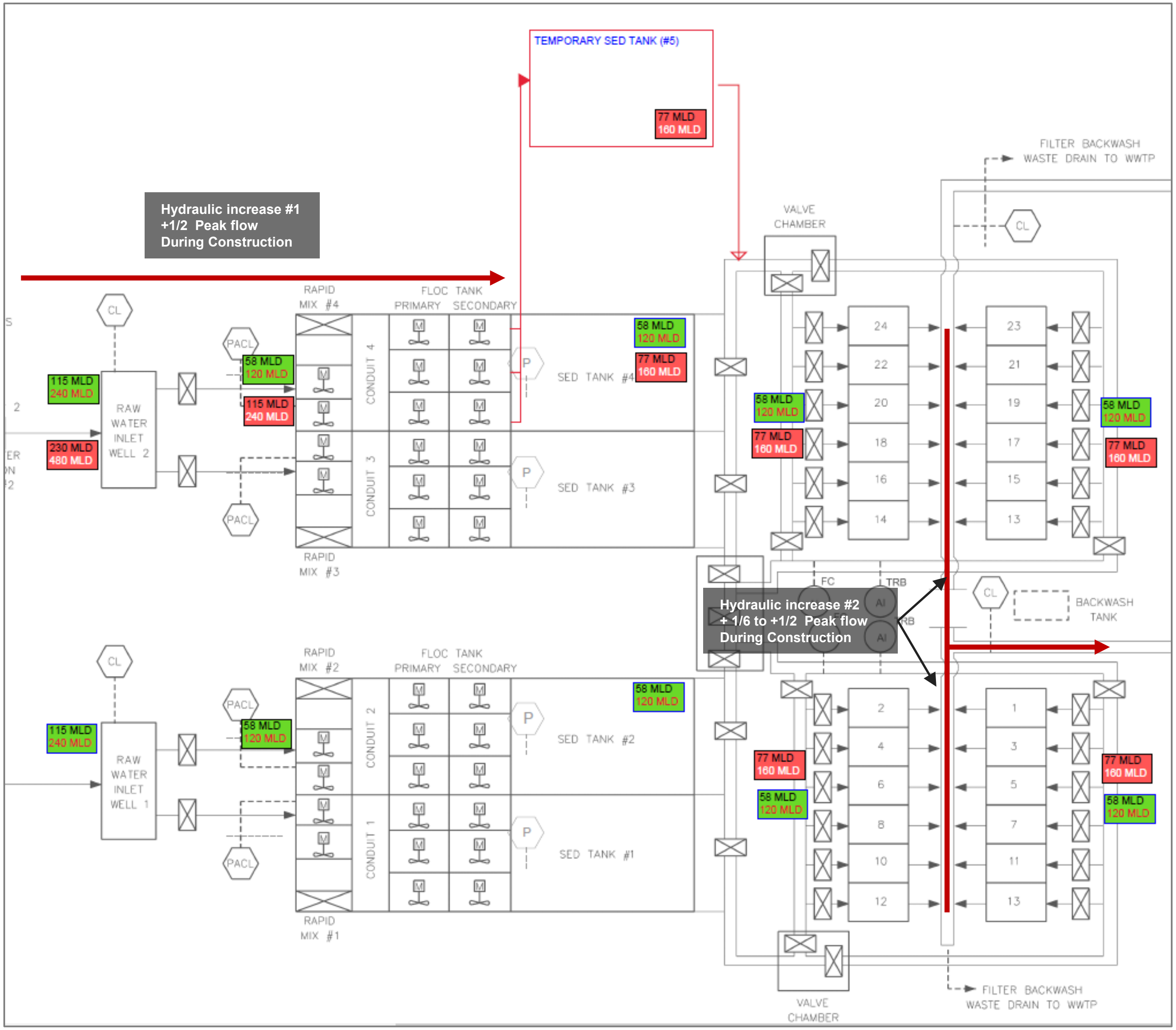
Flows During Construction

Post Construction

Potential to be Impacted by Construction

Process Capacity — xxx MLD

Stress Testing *Forecast Flowrates*



LEGEND

Current Configuration (all trains in service)	AVG FLOW / PEAK FLOW
Construction Configuration (train 1&2 (tank 1&2) offline)	AVG FLOW / PEAK FLOW

Notes:

1. *Average Flow: 230 MLD at Intake*
2. *Peak Flow: 480 MLD at Intake*

Stress Testing – Hydraulic Limitations

- Objectives
  - Simulate the hydraulic conditions of the filter effluent piping during peak flow conditions
- Key Data Points
  - Flowrate.
  - Filter water level
  - Level in water channel
- Starting Plant operating configuration
  - All pre-treatment trains running at typical condition.
  - Filters freshly backwashed.
  - Room in clearwells for excess water.
  - New channel to clearwell closed.
- Recommended Procedure
  - Note current plant flow and level in effluent channel (or clear well 1 if not possible)
  - Proceed with step increase in plant flowrate (30 to 50 MLD)
  - Note level increase in chosen measurement level spot)
  - Increase flow in another step (30 to 50 MLD)
- Analysis
  - Trend flowrate and level and use hydraulic relations to predict surcharge Flowrate.

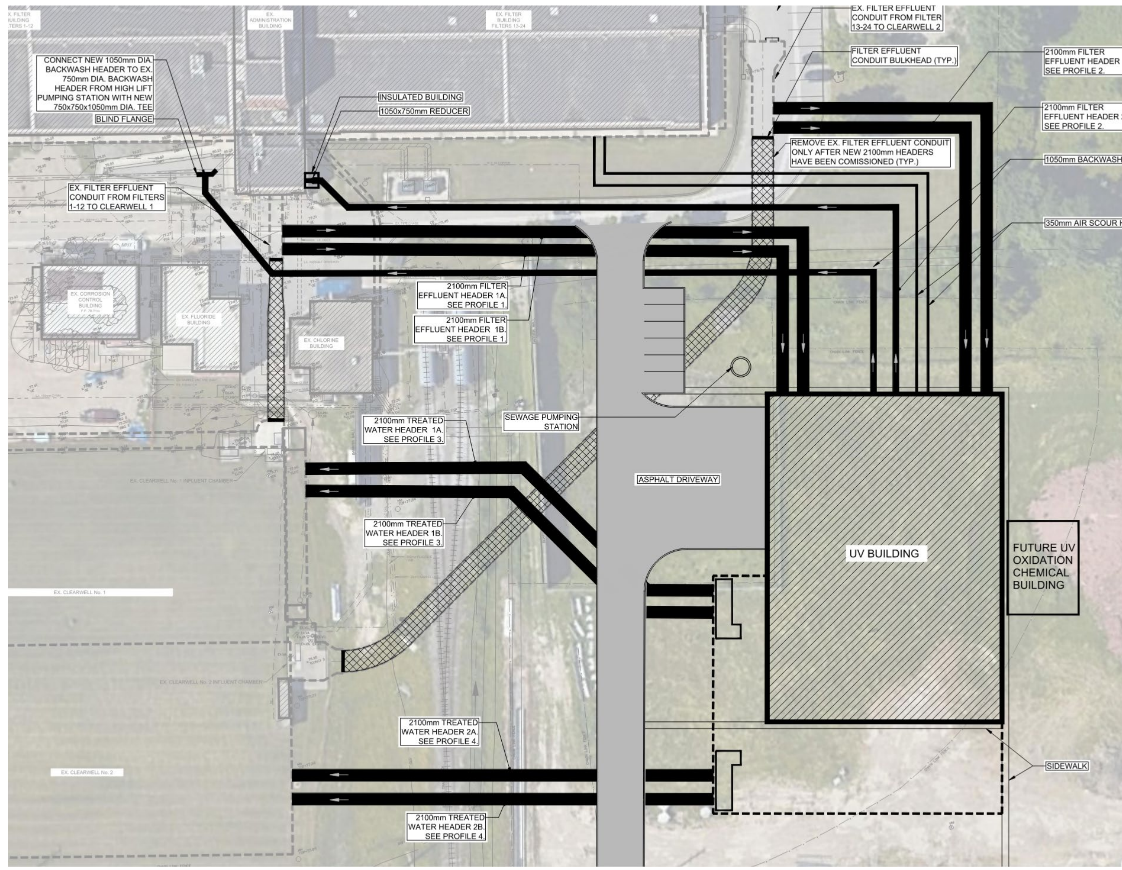
Constructability Considerations

Constructability

Critical Tie-Ins

Current conceptual design

- Duplicate large pipes
- Difficult possibly custom connections to existing conduits
- Connections require longer shut down of clearwells



Constructability

Critical Tie-Ins

Existing Filter To UV Flow Path

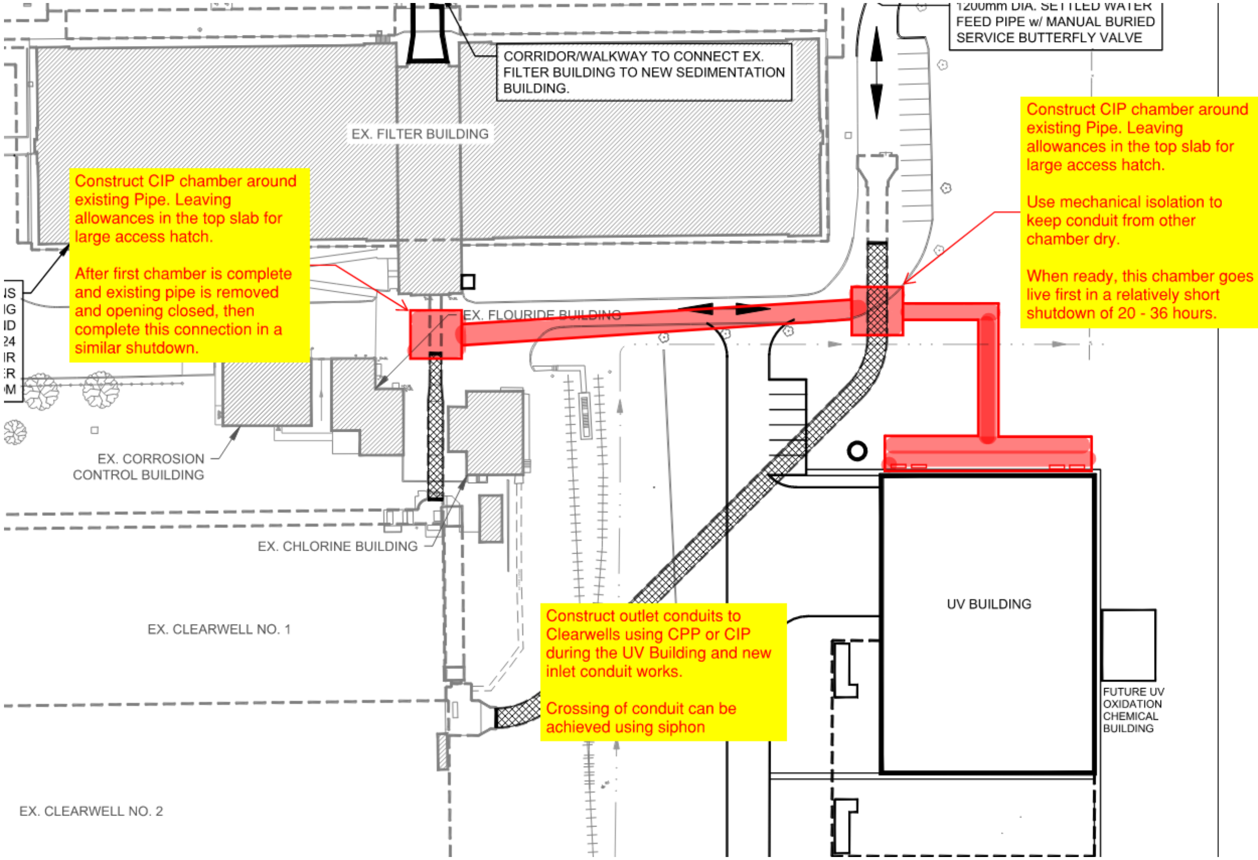
- Is there an Owner driven requirement to have two flow conduits from each tie-in location versus one at each?
    - Confirmation of this helps steer the direction the City will be required to build
    - Specifically, if possible, is there a rule of no single point of failure stipulated?
    - One CIP conduit is more suited to this project
- One CIP conduit is easier to construct that large diameter
- Consider using CIP structures at connection points

Constructability

Critical Tie-Ins – Alternate Option

Filter feeds to clearwell remain in service during all construction of new infrastructure and UV until connections are made.

Will however require careful construction around existing conduits.



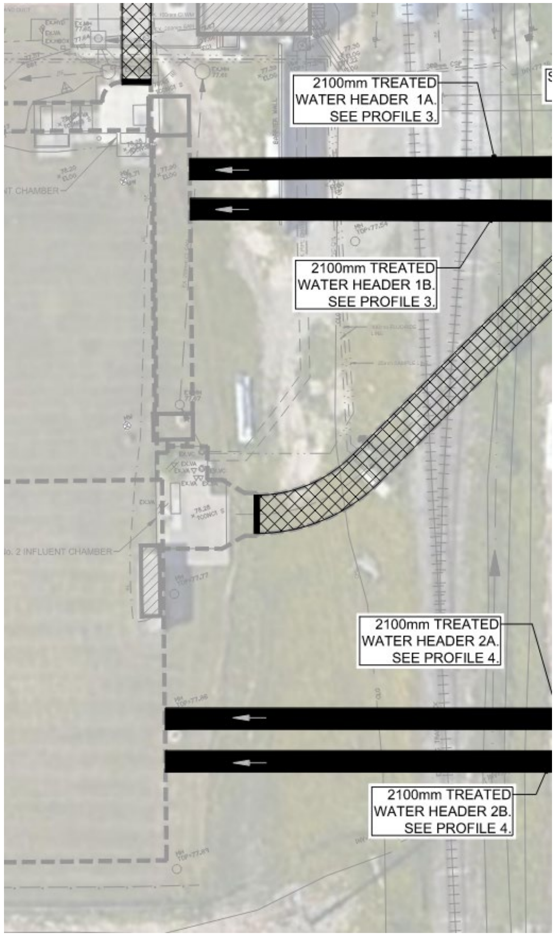
Constructability

Critical Tie-Ins – Alternate Option

Shutdowns of each Clearwell will be required to complete these final connections.

How long can one Clearwell be down for?

If the material of choice is CPP, then suggest these shutdowns be done as early as possible when construction of UV Building commences. Install embeds complete with direct burry valves or add on a valve chamber.

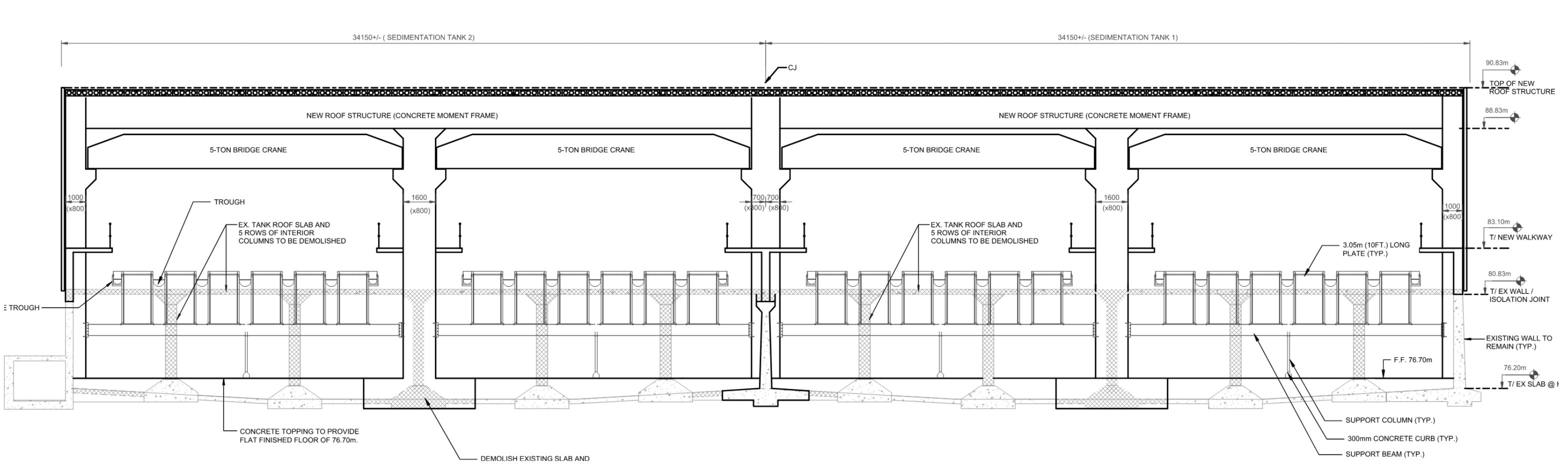


Constructability

Sedimentation Tank Works

Proposed Conceptual Design

Extensive works shown here raising some questions that should be considered



Constructability

Sedimentation Tank Works

Proposed Conceptual Design

- Can two sed tanks be down this length of time? Must be to complete works as shown.
- If empty, is hydraulic uplift a concern due to groundwater?
- Is structure capable of supporting new loads?
- Is existing soil condition capable of supporting new loads?
- Access limitations require use of one or more likely two tower cranes. Using RT or Mobile cranes is expensive and possibly not possible to complete all areas of work. Plan on having two dedicated locations for Towers.

Open Discussion

Open
Discussion

General Considerations

- Reuse of plates from Temporary Sedimentation Tank 5 to Sedimentation Tank 2 is not recommended.
- Center dividing wall of sedimentation tanks 1 & 2 will limit ability to have sedimentation tank 2 online while 1 is under construction
- Filter upgrades – 2 quadrants offline during effluent connections may provide process risks

Open
Discussion

Additional Minor-Changes / Low-Capital Recommendations

1. Polymer addition

2. Recommend alternatives review for Filter-to-Waste
   - Optimize filtration backwashing with Extended Terminal Subfluidization Wash (ETSW) i.e., superwash.

Plant Operations Q&A

Q&A

Operational Questions

- Please confirm capacity of each individual sedimentation basin – information in reports is conflicting. 130 MLD per basin?
- Please confirm peak flows through the plant. Range appears to be 450 – 520 MLD?

Next Steps

Upcoming Deliverables

1. Constructability and Construction Phasing tech memo – late January
2. Workshop 2 – Process Risks – early February
3. Process Risks tech memo – late February
4. Workshop 3 – Resourcing Review – late February
5. Resourcing Review tech memo – early March
6. Workshop 4 – Capital Construction Cost – early March
7. Capital Construction Cost comments – mid March

APPENDIX B
WORKSHOP NO. 1 MEETING SUMMARY

Stantec

Meeting Notes

Woodward WTP 3rd Party Review - Constructability and Construction Staging Worksop

Project/File: 165640394
Date/Time: January 12, 2023 / 9:00 am – 11:00 am

Location: MS Teams

Next Meeting: TBD

Attendees:

City of Hamilton
Stuart Leitch (SL)
Richard Fee (RF)
Jason Fox (JF)
Deborah Goudreau (DG)
Trevor Marks (TM)

Stantec
Michael Kocher (MK)
Hailey Holmes (HH)
Nicole McLellan (NM)
David Pernitsky (DP)
Brad Wilson (BW)

Kusiar Project Services (KPS)
Paul Kusiar (PK)

Absentees: Danny Locco

Distribution: Attendees

Safety Moment: Candle + Fire Safety: make sure candles are away from flammable locations. Ensure candles are blown out before leaving a room and/or falling asleep.

	Item	Action
1	Personnel were introduced and the assignment was introduced.	
2	An overview of the Phase 2 scope was presented.	
3	An overview of the originally proposed schedule was presented.	

	Item	**Action**
4	Extended Terminal Subfluidization Wash (ETSW) was discussed as a possible alternative to filter-to-waste (FTW). It was noted that FTW has been investigated as part of a study completed by Jacobs, however it is not currently included in the overall Phase 2 schedule (AECOM). The City is interested in learning more about ETSW and potential for implementation at the Woodward WTP.	Stantec to provide additional documentation and carry informal conversation about the implementation of ETSW
5	It was discussed that Stantec believes that there are optimization opportunities for the current schedule that protect and mitigate project risk.	
6	Phasing plan modification opportunities were presented.	
7	The City noted that the construction of the project is a complex undertaking, though the processes may be common and aren't expected to have a high complexity for installation.	
8	Preferred sedimentation technologies were discussed, including the advantages of DAF.	
9	JF confirmed the raw water turbidity meter caps at 180 NTU.	
10	The City noted that they are currently looking at DAF as an alternative sedimentation technology to lamella plates. SL inquired about typical loading rates for DAF. NM indicated MECP suggests as low as 12 m/h should be used. DP noted 20 m/h is used in many WTPs across Canada as the design loading rate.	
11	SL noted that the Region of Durham is currently undergoing a DAF project that did not require piloting. NM noted that Union WTP is retrofitting DAF within their circular clarifiers, and did not conduct a pilot study.	
12	A case study of the Buffalo Pound WTP in Moosejaw SK. was presented. DP noted that this plant will have a loading rate of nearly 20 m/h. The staged constructability approach was discussed. It took 6 months to install 3 DAF units into the existing sedimentation tanks at the Buffalo Pound WTP.	
13	The City noted issues with their filter backwash system, including: • An informal ETSW trial was previously conducted by JF and was difficult and did not achieve good results.	City to provide trial results of previous testing (configurations, results) to Stantec for review; as well as current backwash pumping capabilities and

	Item	Action
	• Control of backwash was flow is difficult due to a PRV and control valve being in series. Tuning was noted as difficult. NM noted that the correct protocol and coagulation strategy is needed to minimize or eliminate the ripening spike. JF was interested in ETSW procedure.	limitations. Note – these have now been provided.
14	SL inquired whether the MECP would accept ETSW as an alternative to FTW. JF noted the MECP has just stated that something better than the current procedure is required. NM noted there are other WTPs in Ontario without FTW who have implanted ETSW to satisfy MECP.	
15	It was noted that typically, due to clean raw water, there is not a significant ripening peak. However, when there are peaks of high inlet turbidity, there can be a significant ripening peak, and JF has the program setup to take a filter offline if the effluent turbidity increases beyond 0.9 NTU regardless of reason. At times, these peaks occur even under low raw water turbidity conditions and approaching non-compliance. JF noted the plant cannot manage long periods of high turbidity due to filter issues.	
16	The City noted that the FTW piping was preferred regardless of ETSW, though would be open to ETSW as an optimization opportunity. JF noted the backwash system is very unreliable and significantly limits Operations flexibility.	
17	DG noted that an IJC report was released that showed a correlation between City GI illness and storm events – irrespective of filter effluent spikes. JF noted public health issues are not being identified through turbidity spikes. Woodward is 1 of only 2 Great Lake-sourced WTPs with this issue.	
18	It was noted that filter to waste piping would add to an already congested filter gallery basement. NM noted that ETSW, without FTW, would drain via backwash waste piping. TM indicated the new backwash pumps and piping located in the UV building would further support completing the UV/filter upgrades first.	
19	Schedule optimization was discussed. • SL noted that separation of construction contracts carries a risk due to potential schedule over runs – they have asked for clarity of schedule analysis due to potential for delays.	City to send the latest capacity and demand projections to Stantec when they are available. Note – these have now been provided.

	Item	Action
	• The City noted that the hydraulic bottleneck is the sedimentation basins. They have noted the risk associated with pushing their perceived hydraulic bottleneck down the road as demand increases. • Stantec requested confirmation of projected future flowrates and demands. • TM noted that the master plan and growth projection updates are ongoing; any current values and projections available will be provided.	
20	SL noted that contract separation is being considered solely from a budgetary perspective.	
21	A discussion about construction staging was presented.	
22	DG noted that 1% of customer base is responsible for 50% of the water usage.	
23	Stantec presented a discussion about a hydraulic stress test. The City was amenable to increased flowrate test as presented, and noted that it was possible to note the level within the filter effluent channels. JF is interested in proceeding with the hydraulic step tests and noted previously overflowing filters into the hallway and overflowing filter effluent channel into the basement during periods of high flow. BW identified two main hydraulic pinch points: the sedimentation basins when tanks 1 and 2 are offline, and the filters when 1 and/or 2 quadrants are taken offline as currently scheduled in the AECOM CDR.	
24	Constructability staging was presented.	
25	Confining the contractor to a smaller location would be useful.	
26	A discussion of an alternative construction tie-in plans was presented.	
27	A discussion about the extensive work to the sedimentation basins was presented. It was noted that nearly 50% of the concrete would need to be replaced to modify the existing basins for the plate settler modification. Stantec clarified that in order to conduct the upgrades to the sedimentation basins as currently planned, sed tanks 1 and 2 would both need to be offline for a considerable period of time, simultaneously with the filter upgrades.	

	Item	Action
28	PK noted that one or two tower cranes would be required for the upgrades.	
29	SL requested Stantec add the receiving capacity of the clear wells to any hydraulic stress tests	Stantec to add the hydraulic receiving capacity of the clearwells to the hydraulic stress testing.
30	SL requested Stantec create and maintain an Action Log for the project.	Stantec to create Action Log

The meeting adjourned at 10:57AM.

The foregoing is considered to be a true and accurate record of all items discussed. If any discrepancies or inconsistencies are noted, please contact the writer immediately.

Best regards,

STANTEC CONSULTING LTD.

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Attachment: Workshop presentation