City of Hamilton
PUBLIC WORKS COMMITTEE
AGENDA

Meeting #:	24-008
Date:	June 17, 2024
Time:	1:30 p.m.
Location:	Council Chambers Hamilton City Hall 71 Main Street West

Carrie McIntosh, Legislative Coordinator (905) 546-2424 ext. 2729

Members of the public can contact the Clerk’s Office to acquire the documents considered at this meeting, in an alternate format.

8. STAFF PRESENTATIONS

9. CONSENT ITEMS

10. PUBLIC HEARINGS

11. DISCUSSION ITEMS

12. MOTIONS

13. NOTICES OF MOTION

14. GENERAL INFORMATION / OTHER BUSINESS

15. PRIVATE AND CONFIDENTIAL

16. ADJOURNMENT

Submitted on Tue, 06/11/2024 - 19:35

Submitted by: Anonymous

Submitted values are:

Committee Requested

Committee
Public Works Committee

Will you be delegating in-person or virtually?
In-person

Will you be delegating via a pre-recorded video?
No

Requestor Information

Requestor Information
Jake Maurice
[redacted]

Preferred Pronoun
he/him

Reason(s) for delegation request
HSR Front Boarding Policy

Will you be requesting funds from the City?
No

Will you be submitting a formal presentation?
No

CITY OF HAMILTON
PUBLIC WORKS DEPARTMENT
Hamilton Water Division

TO:	Chair and Members Public Works Committee
COMMITTEE DATE:	June 17, 2024
SUBJECT/REPORT NO:	Woodward Water Treatment Plant Phase 2 Upgrades (PW22078(a)) (City Wide)
WARD(S) AFFECTED:	City Wide
PREPARED BY:	Stuart Leitch (905) 546-2424 Ext. 7808
SUBMITTED BY: **SIGNATURE**	Nick Winters Director, Hamilton Water Public Works Department

RECOMMENDATION

(a) That the Hamilton Water Divisional staff complement be increased by four new permanent Full-Time Equivalents as detailed in Appendix "A" to Report PW22078(a) to deliver the Woodward Water Treatment Plant Phase 2 Upgrades Capital Program;

(b) That the four Full-Time Equivalents identified in recommendation (a) to Report PW22078(a) be funded from the Water, Wastewater and Stormwater Rate Capital Program (Project ID No. 5142166110 and 5143066110) at an approximate annual cost of $622K;

(c) That three permanent Full-Time Equivalents be included in the recommended 2025 Water, Wastewater and Stormwater Rate Budget to provide operational support for the Woodward Water Treatment Plant Phase 2 Upgrades and other large capital upgrades occurring at the City's two wastewater treatment facilities.

EXECUTIVE SUMMARY

Report PW22078 received by Public Works Committee on September 19, 2022, updated Council about the Woodward Water Treatment Plant (Water Treatment Plant) Phase 2 upgrades. The report identified that staff would submit a recommendation report to the Public Works Committee once a Third-Party Review Assignment (Review Assignment) had been completed.

The Review Assignment, attached as Appendices "B", "C", "D" and "E" to Report PW22078(a) includes key areas that are deemed critical to the success of the Water Treatment Plant Phase 2 upgrades with a focus on reviewing the Phase 2 Conceptual Design components developed in 2022. The Review Assignment considered whether certain portions of the work could be deferred as a future phase to reduce project scope or to defer capital expenditures. The Review Assignment concluded that the Water Treatment Plant Phase 2 Capital Program should be split into Phases 2A and 2B which will provide project staff the ability to prioritize key process upgrades that protect public health ahead of a capacity expansion to support Hamilton's growth and development.

The City's Waterworks Asset Management Plan (2022) identified that the condition of the Water Treatment Plant is rated as Poor, largely due to the deficiencies that will be addressed by the Water Treatment Plant Phase 2 Capital Program. The key goals of this capital program are to address the poor asset condition, resolve process capacity restrictions, provide a resilient water treatment system and robust production process, while utilizing best available technologies. The estimated capital cost for the Water Treatment Plant Phase 2A and 2B Projects is $335M and $208M respectively, including engineering, construction, contingency and inflation.

The Review Assignment investigated the project team structures for the design and construction of major water treatment plants and plant rehabilitation programs across other major Canadian municipalities. The recommendations in Report PW22078(a) will ensure that Hamilton Water has the required staff resources to successfully design, construct, and commission an extremely complex capital rehabilitation and upgrade program at the City's most critical water facility.

Alternatives for Consideration – See Page 10

FINANCIAL – STAFFING – LEGAL IMPLICATIONS

Financial: The recommendations in Report PW22078(a) do not require any additional budget approvals.

The staffing additions in recommendation (a) will be funded through the existing approved water, wastewater, and stormwater capital program, specifically the Water Treatment Plant Phase 2A and 2B Capital Project ID No. 5142166110 and 5143066110. The approximate annual cost of these positions is $622K. Individual position costs are identified in Appendix "A" to Report PW22078(a).

The financial implications of recommendation (c) will be detailed during the 2025 Water, Wastewater and Stormwater Rate Budget process.

Staffing: The recommendations in this report will increase the Hamilton Water Divisional staffing complement by four permanent full-time equivalents.

Legal: N/A

HISTORICAL BACKGROUND

The Woodward Water Treatment Plant (Water Treatment Plant) is a conventional drinking water treatment plant with a rated capacity of 909 million litres per day, providing potable drinking water and fire protection to the Hamilton community. It is the only Water Treatment Plant servicing the City's greater urban area and as a result it provides potable drinking water for close to 570,000 residents, industrial, commercial, and institutional properties, and there are also service connections to limited areas of Halton Region and Haldimand County.

The plant was originally constructed in 1931 and expanded in the late 1950s with various improvements occurring over the decades. The treatment process includes intake chlorination (for zebra mussel control and pathogen inactivation), screening, pre-chlorination (for pathogen inactivation), coagulation, flocculation, conventional gravity sedimentation, granular activated carbon filtration, post-filter followed by fluoridation (for the reduction of dental caries), and ortho-phosphate addition (for corrosion control).

Over the last several years, the Hamilton Water Division completed a Best Available Technologies and Feasibility Study (CH2M Hill 2016) and a Conceptual Design (AECOM 2022) for the Water Treatment Plant Phase 2 Process upgrades. Concurrently, Hamilton Water completed the Water Treatment Plant Phase 1 Process upgrades through a $25M construction project that involved large capital upgrades. The key goals of the Water Treatment Plant Phase 2 Process upgrades are to address the poor asset condition, resolve process capacity restrictions, provide a resilient water treatment system and robust production process, while utilizing best available technologies.

The estimated capital cost for the Water Treatment Plant Phase 2A and 2B Projects is $335M and $208M respectively, including engineering, construction, contingency and inflation. Phase 2 has been split up into Phase 2A (water quality improvements) which requires priority completion and a future Phase 2B (growth-related upgrades) which targets completion by 2035.

In 2023, Hamilton Water completed a Third-Party Review Assignment (Review Assignment) that provided recommendations for key areas that are deemed critical to the success of the Water Treatment Plant Phase 2 upgrades. The Review Assignment was completed utilizing a due diligence approach, focusing on a review of the 2022 Phase 2 Conceptual Design components. The following is a summary of the Review Assignment findings:

1. Staff Resourcing Requirements - Dedicated City staff resources are required for the delivery of the Water Treatment Plant Phase 2 upgrades including the support of successful project management, design, and construction administration. These resources include positions to create and staff a capital project team, and operations and maintenance positions that will provide critical support throughout all phases of the capital program.

2. Process Risk During Construction - Risks associated with the proposed upgrades were highlighted and preferred alternatives/technologies identified for suitability to achieve the desired objectives for the Water Treatment Plant Phase 2 upgrades. In addition, the proposed construction staging, overall schedule, and potential impact to Water Treatment Plant operations during the course of construction were reviewed with respect to maintaining water production and treatment objectives. An evaluation was used to compare proposed technologies and their rated treatment capacity to the overall rated capacity for the Water Treatment Plant to confirm that existing hydraulic restrictions at the Water Treatment Plant will be addressed with the capital upgrades.

3. Constructability and Construction Phasing - The constructability and construction sequencing was considered, and risks were identified and accounted for in the project planning. The Review Assignment concluded that the construction activity is suitable for the Water Treatment Plant. In addition, the Review Assignment considered whether certain portions of the work could be deferred as a future phase to reduce project scope or to defer capital expenditures. The Review Assignment concluded that the Water Treatment Plant Phase 2 Capital Program should be split into Phases 2A and 2B which will provide project staff the ability to prioritize key process upgrades that protect public health ahead of a capacity expansion to support Hamilton's growth and development.

4. Capital Construction Cost - Following the recommendation that the construction program be split into two distinct contracts for Phase 2A and 2B, the review of the conceptual cost estimate resulted in the following capital cost and timeline breakdown:

Woodward Water Treatment Plant Upgrades Phase	Capital Cost Estimate	Schedule Estimate

Phase 2A (assuming construction start 2028, including inflation, engineering, construction and continency)	$335M	Design - 2025 to 2027 Construction - 2028 to 2032
Phase 2B (assuming construction start 2032, including inflation, engineering, construction and continency)	$208M	Design: 2029 to 2031 Construction: 2032 to 2035

The Water Treatment Plant Phase 2A and 2B upgrades include the following major scope items:

Phase 2A Upgrades	Description
Filter Building Components:	
Filter to Waste	Currently the plant does not include a filter to waste process. A new system will allow for filter 'ripening' after backwash prior to finished water production. This process will mitigate water quality challenges after a backwash cycle and will address Ministry of the Environment, Conservation and Parks design concerns.
Filter Underdrains	Replace the filter underdrains in 22 out of 24 filters (two filter underdrains were previously replaced due to failure). The works will ensure reliable filtration redundancy and capacity is maintained.
Replace Filter Media	This is necessary to ensure maintenance of filtered water quality. This is a recurring activity approximately every four years in order to meet water quality objectives.
Ultra-violet Disinfection / Filter Backwash System Building Components:	
Ultra-violet (UV) Disinfection	Adding post-filter UV will address Ministry of the Environment, Conservation and Parks concerns regarding disinfection credits, reduce the quantity of chlorine needed for disinfection, and address concerns over degradation of process equipment and filter media due to the current practice of pre-treatment with chlorine. In addition, UV will provide an extra barrier against pathogens.

Phase 2A Upgrades	Description
Filter Backwash System	The filter backwash pumping equipment will be housed in the new ultra-violet building. The new backwash system will use non-chlorinated water which will prolong the service life of the filter media and reduce replacement frequency.
Chlorine Disinfection Building:	
Chlorine Disinfection	A new Chlorine Disinfection Building is required to replace the existing aged facility and ensure security of supply with growing demands from both the Water and Wastewater treatment processes. The new building will incorporate the ability to use two alternate chlorine supply strategies.
Ancillary Requirements:	
Miscellaneous	Other ancillary works required such as landscaping, yard piping, drain piping, clearwell tank concrete restoration, excess soils management, etc.
Phase 2B Upgrades	Description
Low Lift Pumping Station	Upgrades are anticipated as a result of changes to the hydraulics through the new Water Treatment Plant pre-treatment process.
Pre-Treatment Process & Superstructure	New process technology housed in a new superstructure is required to reduce the hydraulic bottleneck in the existing sedimentation tanks and increase production capacity. This will also improve pre-treatment water quality and filter performance.
Ancillary Requirements	Other ancillary works required such as landscaping, yard piping, drain piping, excess soils management, etc.

A 10-year forecasted budget (cash flowed) for the Water Treatment Plant Phase 2 Process upgrades of $353M (excluding contingencies and inflation) was included in the

2023 Water, Wastewater and Storm Rate Budget. In the 2024 Water, Wastewater and Stormwater Rate Budget the 10-year forecast budget was updated and increased to $543M (including contingencies and inflation), and to reflect the Water Treatment Plant Phase 2A ($335M) and 2B ($208M) projects. Phase 2A is the non-growth component of the upgrades and is 100% funded from the City's water revenues. Phase 2B is the growth component of the upgrades and is 100% funded by Development Charges.

POLICY IMPLICATIONS AND LEGISLATED REQUIREMENTS

The Water Treatment Plant Phase 2 Upgrades are required to ensure the City's ability to produce potable drinking water the meets or exceeds the regulatory requirements stipulated by the *Ontario Safe Drinking Water Act Safe Drinking Water Act*, 2002, S.O. 2002, c. 32, and regulations.

The Water Treatment Plant Phase 2 Upgrade are also required to ensure that the City has potable drinking water production capacity to support the City's growth to the year 2051 as identified in Ontario by the Greater Golden Horseshoe: Growth Forecasts to 2051 Technical Report, August 26, 2020.

RELEVANT CONSULTATION

The following groups have been consulted and are supportive of the recommendations in this report:

- Financial Planning Administration and Policy Division, Corporate Services Department
- Hamilton Water Division, Public Works Department

ANALYSIS AND RATIONALE FOR RECOMMENDATION

The Third-Party Review Assignment (Review Assignment), attached as Appendices "B", "C", "D" and "E" to Report PW22078(a) includes the investigation of project team structures for the design and construction of major water treatment plants and plant rehabilitation programs across other major Canadian municipalities. The staffing recommendations in Report PWS22078(a) are supported by the results of that investigation and will ensure that Hamilton Water has the required staff resources to successfully design, construct, and commission an extremely complex capital rehabilitation and upgrade program at the City's most critical water facility.

The recommended resource structure for the Water Treatment Plant Phase 2 Upgrade includes dedicated Capital staff with project support from Operations, Supervisory Control and Data Acquisition (SCADA) and Maintenance. This resource structure will significantly minimize risks including schedule and budget variances for the program which has project timelines that are estimated to carry through to 2035 for the design and construction of both Phases 2A and 2B. In addition, there will be a requirement in the future for additional staff to operate and maintain the new process once the equipment is commissioned roughly around 2032 (Phase 2A) to 2035 (Phase 2B). The future staffing requests will be better understood once the design commences for Phases 2A and 2B and the level of operational and maintenance effort is assessed considering the type of new process infrastructure.

The following provides details regarding each position that is encompassed by the recommendation (a) in Report PW22078(a):

Manager, Capital Delivery, Water Treatment Plant Program:

There is currently no dedicated Manager resource for the management of the Water Treatment Plant large capital program. The responsibilities of the Manager will be to oversee the overall project management of the Phase 2A and 2B Water Treatment Plant upgrades along with the overall Capital Program and staffing management. The Manager will also be responsible for the sponsorship oversight for the Senior Project Manager led capital projects within the Water Treatment Plant Capital Program.

Senior Project Manager, Capital Delivery, Water Treatment Plant Program:

There is currently no dedicated Senior Project Manager resource for the Water Treatment Plant Capital Projects. The responsibilities of the Senior Project Manager will be to provide oversight for the investigative, design, construction, commissioning, and warranty services for the Filter Building components within the Water Treatment Plant Phase 2A and 2B upgrades. This position will require the qualifications and experience to project manage complex, large capital projects. The Senior Project Manager will also be responsible for the sponsorship oversight for the Project Manager led capital projects within the Water Treatment Plant Capital Program.

Project Manager, Capital Delivery, Water Treatment Plant Program:

There is currently no dedicated Project Manager resource for the Water Treatment Plant Capital Projects. The responsibilities of the Project Manager will be to provide oversight for the investigative, design, construction, commissioning, and warranty services for the Chlorine Building components within the Water Treatment Plant Phase 2A and 2B upgrades.

Engineering Technologist, Capital Delivery, Water Treatment Plant Program:

There is currently no dedicated Engineering Technologist resource for assisting with the Water Treatment Plant Capital Projects. The responsibilities of the Engineering

Technologist will be to address the number of day-to-day requests received. This position is also required to provide project and program support, maintain a document management system, and provide project controls for the various capital projects within the Water Treatment Plant Phase 2A and 2B upgrades and Program related tasks.

The following provides details regarding each position that is encompassed by the recommendation (c) in Report PW22078(a) which will be referred to the 2025 Water, Wastewater and Stormwater Budget:

Treatment Plant Senior Process Engineer:

Currently operational input into the design of large capital projects at the Water and Wastewater Treatment Plants is provided by the Manager of Plant Operations and the Overall Responsible Operator (ORO) for the Water Treatment system and the ORO for the Wastewater Treatment systems. Given that the Water Treatment Plant Phase 2 project is planned to occur simultaneously with the Woodward Wastewater Treatment Plant Phase 2 Expansion project and the Dundas Wastewater Treatment Plant replacement project, the current structure for operational input will create significant project risks. The Senior Process Engineer will provide regulatory and process operational requirements to the engineering design teams and provide coordination throughout the construction period for these projects.

SCADA Project Manager:

There is currently no dedicated SCADA Project Manager for assisting Water Treatment Plant Capital Projects. The SCADA Project Manager will play a crucial role in overseeing and supporting automation and SCADA-related tasks throughout the lifecycle of the project, including design, construction, training, and commissioning phases. This position will also support the Woodward Wastewater Treatment Plant Phase 2 Expansion project and the Dundas Wastewater Treatment Plant replacement project.

Maintenance Supervisor:

There is currently no dedicated maintenance support for assisting Water Treatment Plant Capital Projects. The Maintenance Supervisor will offer technical and field support in mechanical, electrical, instrumentation aspects throughout the project lifecycle. This role will serve as the primary representative of Plant Maintenance throughout the design, construction, training, commissioning, and warranty phases. This position will also support the Woodward Wastewater Treatment Plant Phase 2 Expansion project and the Dundas Wastewater Treatment Plant replacement project.

ALTERNATIVES FOR CONSIDERATION

Alternative 1:

Staff could be directed to resource the Water Treatment Plant Phase 2 Capital Program by re-allocating existing Hamilton Water capital program staff. This alternative is not recommended because it would impact the existing water, wastewater and stormwater capital program resulting in increased risk of infrastructure failures, loss of water, wastewater or stormwater services, adverse public health impacts, adverse environmental impacts, and requiring expensive and unplanned emergency interventions.

Council has received several reports since 2021 that identify the poor overall condition of the City's water, wastewater, and stormwater assets, and the need to increase spending across the water, wastewater, and stormwater capital program to reduce risk, support community growth and development, and improve environmental outcomes. Council has also supported this critical infrastructure deficit through increasing investments through the 2022, 2023, and 2024 Water, Wastewater and Stormwater Rate Budgets.

FINANCIAL – STAFFING – LEGAL IMPLICATIONS

Financial: The annual estimated staffing costs for the four full-time equivalents estimate at $622K would be avoided.

In addition, Hamilton Water would have to analyse the 10-year water, wastewater and stormwater capital program and identify projects for deferral in order to free-up the necessary staff resources to support the Water Treatment Plant Phase 2 Capital Program.

Staffing: The Hamilton Water Divisional Complement would not increase.

Legal: Increased risk of infrastructure failure is accompanied by increased risk of regulatory non-compliance, fines, and exposes the City to significant liability. Mayor and Council, and senior members of City staff may also be exposed to personal liability under the Standard of Care Provisions within the Ontario Safe Drinking Water Act.

Alternative 2:

The four full-time equivalents identified in recommendation (a) could be approved on a temporary basis expiring at the end of the Water Treatment Plant Phase 2 Capital

Program. This alternative is not recommended because it adds significant risk to the capital program resulting from increased staff turn-over. The Water Treatment Plant Phase 2 Capital Program represents a $543M investment in the City's most critical water asset, with an accompanying 10-year program schedule. There is ample evidence across municipalities that capital projects and programs with higher levels of staff turn-over result in projects that experience delays, increased overall project costs, and increased operational risk.

FINANCIAL – STAFFING – LEGAL IMPLICATIONS

Financial: There is increased risk that project costs will exceed estimates because of delays and change orders required to respond to operational issues that develop through the course of the capital program.

Staffing: The Hamilton Water Divisional staffing complement by four full-time equivalents for the duration of the Water Treatment Phase 2 Capital Program, currently estimated for completion in 2035.

Legal: N/A

APPENDICES AND SCHEDULES ATTACHED

Appendix "A" to Report PW22078(a) – Breakdown of Full-Time Equivalents

Appendix "B" to Report PW22078(a) – Woodward Water Treatment Plant Phase 2 Upgrades Third-Party Review (Stantec 2023) – Constructability and Construction Phasing Review

Appendix "C" to Report PW22078(a) – Woodward Water Treatment Plant Phase 2 Upgrades Third-Party Review (Stantec 2023) Process Risk Review

Appendix "D" to Report PW22078(a) – Woodward Water Treatment Plant Phase 2 Upgrades Third-Party Review (Stantec 2023) Resourcing Review

Appendix "E" to Report PW22078(a) – Woodward Water Treatment Plant Phase 2 Upgrades Third-Party Review (Stantec 2023) – Capital Construction Cost Review

Woodward Water Treatment Plant Capital Program - Business Case Summary

Department: Public Works

Capital Delivery Staff	Description of Program Enhancement	Total Expenditure	Net	FTE Impact	Annualized Amount
Manager	Oversee the capital delivery of Phase 2A and 2B WTP upgrades, other active/future capital projects, program and staffing management.	$ 46,250	$ -	1	$ 185,000
Senior Project Manager	Provide project management for the capital delivery services for the Filter Building components within the Phase 2A and 2B upgrades and other active and future capital projects at the plant. Duties will also include supervisory role for both Project Manager and Engineering Technologist.	$ 42,250	$ -	1	$ 169,000
Project Manager	Provide project management for the capital delivery services for the Chlorine Building components within the WTP Phase 2A and 2B upgrades and other active and future capital projects at the Water Treatment Plant.	$ 39,250	$ -	1	$ 157,000
Engineering Technologist	Address multiple day-to-day requests received and provide project/program support, maintain a document management system and provide project controls for the various capital projects.	$ 27,750	$ -	1	$ 111,000
	TOTAL	**$ 155,500**		**4**	**$ 622,000**

CITY OF HAMILTON

Woodward Water Treatment Plant Capital Program

BUSINESS CASE #1

BUSINESS CASE OVERVIEW		
Request Title	Manager, Capital Delivery, Woodward Water Treatment Plant Program	
Department/Division	Public Works - Hamilton Water - Capital Delivery	
Request Driver	Woodward Water Treatment Plant Phase 2 Capital Program	
Funding Source	Project ID No. 5142166110 and 5143066110	
Proposed Start Date	Q4 2024	
Strategic Plan Priorities	Built Environment & Infrastructure	y
Do you Require the Use of External Consultants?	no	

2024 OPERATING BUDGET FINANCIAL IMPACTS		
DESCRIPTION	2024 AMOUNT	ANNUALIZED AMOUNT
Salary/Wages	$37,500	$150,000
Benefits	$8,750	$35,000
Total Expenditures	$46,250	$185,000
Capital Funding	$46,250	$185,000
Total Revenue	$46,250	$185,000
Net Impact	$0	$0
Full Time Equivalent (FTE)	1.0	1.0
Capital Budget Impact	$46,250	$185,000

BUSINESS CASE DETAILS

1. Reason for Request:

There is currently no dedicated Manager resource for the management of the Water Treatment Plant large capital program. The responsibilities of the Manager will be to oversee the overall project management of the Phase 2A and 2B Water Treatment Plant upgrades along with the overall Capital Program and staffing management. The Manager will also be responsible for the sponsorship oversight for the Senior Project Manager led capital projects within the Water Treatment Plant Capital Program.

 What are the objectives of the request? The recommended resource structure for the Water Treatment Plant Phase 2 Upgrade for the staffing request will provide a dedicated Capital staff.

 What are the expected outcomes of the request and the actions that will create these expected outcomes? - A new Manager will provide a dedicated focus on further advancing this large capital project into the next phase of the project, including issuing the RFP for engineering design and contract administration service.

 What is the challenge or opportunity that this request proposes to solve? The staffing recommendations will ensure that Hamilton Water has the required staff resources to successfully design, construct, and commission an extremely complex capital rehabilitation and upgrade program at the City's most critical water facility.

 What value will the City gain from this request? The recommendations in Report PW22078(a) will ensure that Hamilton Water has the required staff resources to successfully design, construct, and commission an extremely complex capital rehabilitation and upgrade program at the City's most critical water facility.

 Does the request provide value for money (efficiency and effectiveness) to a program or service? There is ample evidence across municipalities that capital projects and programs with higher levels of staff turn-over result in projects that experience delays, increased overall project costs, and increased operational risk.

2. Implications if Request not permitted:

Not having this dedicated position will significantly increase risks including schedule and variances for the program, which has project timelines that are estimated to carry through to 2035 for the construction of both WTP Phases 2A & 2B.

 What impacts will this request have on the community or organization, in terms of service delivery, legal or policy requirements, daily operations or customer service? Increased risk of infrastructure failure is accompanied by increased risk of regulatory non-compliance, fines, and exposes the City to significant liability. Mayor and Council, and senior members of City staff may also be exposed to personal liability under the Standard of Care Provisions within the Ontario Safe Drinking Water Act.

 What will be the risk, impact or consequence if the request is not approved? if this request is not permitted, it would impact the existing water, wastewater and stormwater capital program resulting in increased risk of infrastructure failures, loss of water, wastewater or stormwater services, adverse public health impacts, adverse environmental impacts, and requiring expensive and unplanned emergency interventions.

3. Alternatives (if any):

Alternative 1: Staff could be directed to resource the Water Treatment Plant Phase 2 Capital Program by re-allocating existing Hamilton Water capital program staff. This alternative is not recommended because it would impact the existing water, wastewater and stormwater capital program resulting in increased risk of infrastructure failures, loss of water, wastewater or stormwater services, adverse public health impacts, adverse environmental impacts, and requiring expensive and unplanned emergency interventions.

Alternative 2: the new position could be approved on a temporary basis expiring at the end of the Water Treatment Plant Phase 2 Capital Program. This alternative is not recommended because it adds significant risk to the capital program resulting from increased staff turn-over. The Water Treatment Plant Phase 2 Capital Program represents a $543M investment in the City's most critical water asset, with an accompanying 10-year program schedule. There is ample evidence across municipalities that capital projects and programs with higher levels of staff turn-over result in projects that experience delays, increased overall project costs, and increased operational risk.

4. Performance Measures:

Performance Measures will be based on the following:

 Is there baseline data available? KPI targets for monitoring cashflows, schedules and budgets are currently in place.

 What target(s) in relation to a baseline demonstrate progress in achieving the expected outcome(s) of the request? Established KPI targets and outcomes include meeting the estimated project schedule and budget established in 2024 rate budget process. The performance will be measured, tracked and updated on a monthly basis.

 How will the performance of this request be measured and evaluated? The performance of the Manager will be measured on the overall success of the Water Treatment Plant Capital program KPI target expectations, along with successful management of the staffing complement.

CITY OF HAMILTON

Woodward Water Treatment Plant Capital Program

BUSINESS CASE #2

BUSINESS CASE OVERVIEW		
Request Title	Senior Project Manager, Capital Delivery, Woodward Water Treatment Plant Program	
Department/Division	Public Works - Hamilton Water - Capital Delivery	
Request Driver	Woodward Water Treatment Plant Phase 2 Capital Program	
Funding Source	Project ID No. 5142166110 and 5143066110	
Proposed Start Date	Q4 2024	
Strategic Plan Priorities	Built Environment & Infrastructure	y
Do you Require the Use of External Consultants?	no	

2024 OPERATING BUDGET FINANCIAL IMPACTS		
DESCRIPTION	**2024 AMOUNT**	**ANNUALIZED AMOUNT**
Salary/Wages	**$34,100**	**$136,400**
Benefits	**$8,150**	**$32,600**
Add item here		
Total Expenditures	**$42,250**	**$169,000**
Capital Funding	**$42,250**	**$169,000**
Total Revenue	**$42,250**	**$169,000**
Net Impact	**$0**	**$0**
Full Time Equivalent (FTE)	**1.0**	**1.0**
Capital Budget Impact	**$42,250**	**$169,000**

BUSINESS CASE DETAILS

1. Reason for Request:

There is currently no dedicated Senior Project Manager resource for the Water Treatment Plant Capital Projects. The responsibilities of the Senior Project Manager will be to provide oversight for the investigative, design, construction, commissioning, and warranty services for the Filter Building components within the Water Treatment Plant Phase 2A and 2B upgrades. This position will require the qualifications and experience to project manage complex, large capital projects. The Senior Project Manager will also be responsible for the sponsorship oversight for the Project Manager led capital projects within the Water Treatment Plant Capital Program.

- **What are the objectives of the request?** The recommended resource structure for the Water Treatment Plant Phase 2 Upgrade for the staffing request will provide a dedicated Capital staff.
- **What are the expected outcomes of the request and the actions that will create these expected outcomes?** - A new Senior Project Manager will provide a dedicated focus on further advancing this large capital project into the next phase of the project, including issuing the RFP for engineering design and contract administration service.
- **What is the challenge or opportunity that this request proposes to solve?** The staffing recommendations will ensure that Hamilton Water has the required staff resources to successfully design, construct, and commission an extremely complex capital rehabilitation and upgrade program at the City’s most critical water facility.
- **What value will the City gain from this request?** The recommendations in Report PW22078(a) will ensure that Hamilton Water has the required staff resources to successfully design, construct, and commission an extremely complex capital rehabilitation and upgrade program at the City’s most critical water facility.
- **Does the request provide value for money (efficiency and effectiveness) to a program or service?** There is ample evidence across municipalities that capital projects and programs with higher levels of staff turn-over result in projects that experience delays, increased overall project costs, and increased operational risk.

2. Implications if Request not permitted:

Not having this dedicated position will significantly increase risks including schedule and variances for the program, which has project timelines that are estimated to carry through to 2035 for the construction of both WTP Phases 2A & 2B.

 What impacts will this request have on the community or organization, in terms of service delivery, legal or policy requirements, daily operations or customer service? Increased risk of infrastructure failure is accompanied by increased risk of regulatory non-compliance, fines, and exposes the City to significant liability. Mayor and Council, and senior members of City staff may also be exposed to personal liability under the Standard of Care Provisions within the Ontario Safe Drinking Water Act.

 What will be the risk, impact or consequence if the request is not approved? if this request is not permitted, it would impact the existing water, wastewater and stormwater capital program resulting in increased risk of infrastructure failures, loss of water, wastewater or stormwater services, adverse public health impacts, adverse environmental impacts, and requiring expensive and unplanned emergency interventions.

3. Alternatives (if any):

Alternative 1: Staff could be directed to resource the Water Treatment Plant Phase 2 Capital Program by re-allocating existing Hamilton Water capital program staff. This alternative is not recommended because it would impact the existing water, wastewater and stormwater capital program resulting in increased risk of infrastructure failures, loss of water, wastewater or stormwater services, adverse public health impacts, adverse environmental impacts, and requiring expensive and unplanned emergency interventions.

Alternative 2: the new position could be approved on a temporary basis expiring at the end of the Water Treatment Plant Phase 2 Capital Program. This alternative is not recommended because it adds significant risk to the capital program resulting from increased staff turn-over. The Water Treatment Plant Phase 2 Capital Program represents a $543M investment in the City’s most critical water asset, with an accompanying 10-year program schedule. There is ample evidence across municipalities that capital projects and programs with higher levels of staff turn-over result in projects that experience delays, increased overall project costs, and increased operational risk.

4. Performance Measures:

Performance Measures will be based on the following:

 Is there baseline data available? KPI targets for monitoring cashflows, schedules and budgets are currently in place.

 What target(s) in relation to a baseline demonstrate progress in achieving the expected outcome(s) of the request? Established KPI targets and outcomes include meeting the estimated project schedule and budget established in 2024 rate budget process. The performance will be measured, tracked and updated on a monthly basis.

 How will the performance of this request be measured and evaluated? The performance of the Manager will be measured on the overall success of the Water Treatment Plant Capital program KPI target expectations, along with successful management of the staffing complement.

CITY OF HAMILTON

Woodward Water Treatment Plant Capital Program

BUSINESS CASE #3

BUSINESS CASE OVERVIEW		
Request Title	Project Manager, Capital Delivery, Woodward Water Treatment Plant Program	
Department/Division	Public Works - Hamilton Water - Capital Delivery	
Request Driver	Woodward Water Treatment Plant Phase 2 Capital Program	
Funding Source	Project ID No. 5142166110 and 5143066110	
Proposed Start Date	Q4 2024	
Strategic Plan Priorities	Built Environment & Infrastructure	y
Do you Require the Use of External Consultants?	no	

2024 OPERATING BUDGET FINANCIAL IMPACTS		
DESCRIPTION	**2024 AMOUNT**	**ANNUALIZED AMOUNT**
Salary/Wages	**$31,625**	**$126,500**
Benefits	**$7,625**	**$30,500**
Add item here		
Total Expenditures	**$39,250**	**$157,000**
Capital Funding	**$39,250**	**$157,000**
Total Revenue	**$39,250**	**$157,000**
Net Impact	**$0**	**$0**
Full Time Equivalent (FTE)	**1.0**	**1.0**
Capital Budget Impact	**$39,250**	**$157,000**

BUSINESS CASE DETAILS

1. Reason for Request:

There is currently no dedicated Project Manager resource for the Water Treatment Plant Capital Projects. The responsibilities of the Project Manager will be to provide oversight for the investigative, design, construction, commissioning, and warranty services for the Chlorine Building components within the Water Treatment Plant Phase 2A and 2B upgrades.

 What are the objectives of the request? The recommended resource structure for the Water Treatment Plant Phase 2 Upgrade for the staffing request will provide a dedicated Capital staff.

 What are the expected outcomes of the request and the actions that will create these expected outcomes? - A new Project Manager will provide a dedicated focus on further advancing this large capital project into the next phase of the project, including issuing the RFP for engineering design and contract administration service.

 What is the challenge or opportunity that this request proposes to solve? The staffing recommendations will ensure that Hamilton Water has the required staff resources to successfully design, construct, and commission an extremely complex capital rehabilitation and upgrade program at the City's most critical water facility.

 What value will the City gain from this request? The recommendations in Report PW22078(a) will ensure that Hamilton Water has the required staff resources to successfully design, construct, and commission an extremely complex capital rehabilitation and upgrade program at the City's most critical water facility.

 Does the request provide value for money (efficiency and effectiveness) to a program or service? There is ample evidence across municipalities that capital projects and programs with higher levels of staff turn-over result in projects that experience delays, increased overall project costs, and increased operational risk.

2. Implications if Request not permitted:

Not having this dedicated position will significantly increase risks including schedule and variances for the program, which has project timelines that are estimated to carry through to 2035 for the construction of both WTP Phases 2A & 2B.

 What impacts will this request have on the community or organization, in terms of service delivery, legal or policy requirements, daily operations or customer service? Increased risk of infrastructure failure is accompanied by increased risk of regulatory non-compliance, fines, and exposes the City to significant liability. Mayor and Council, and senior members of City staff may also be exposed to personal liability under the Standard of Care Provisions within the Ontario Safe Drinking Water Act.

 What will be the risk, impact or consequence if the request is not approved? if this request is not permitted, it would impact the existing water, wastewater and stormwater capital program resulting in increased risk of infrastructure failures, loss of water, wastewater or stormwater services, adverse public health impacts, adverse environmental impacts, and requiring expensive and unplanned emergency interventions.

3. Alternatives (if any):

Alternative 1: Staff could be directed to resource the Water Treatment Plant Phase 2 Capital Program by re-allocating existing Hamilton Water capital program staff. This alternative is not recommended because it would impact the existing water, wastewater and stormwater capital program resulting in increased risk of infrastructure failures, loss of water, wastewater or stormwater services, adverse public health impacts, adverse environmental impacts, and requiring expensive and unplanned emergency interventions.

Alternative 2: the new position could be approved on a temporary basis expiring at the end of the Water Treatment Plant Phase 2 Capital Program. This alternative is not recommended because it adds significant risk to the capital program resulting from increased staff turn-over. The Water Treatment Plant Phase 2 Capital Program represents a $543M investment in the City’s most critical water asset, with an accompanying 10-year program schedule. There is ample evidence across municipalities that capital projects and programs with higher levels of staff turn-over result in projects that experience delays, increased overall project costs, and increased operational risk.

4. Performance Measures:

Performance Measures will be based on the following:

 Is there baseline data available? KPI targets for monitoring cashflows, schedules and budgets are currently in place.

 What target(s) in relation to a baseline demonstrate progress in achieving the expected outcome(s) of the request? Established KPI targets and outcomes include meeting the estimated project schedule and budget established in 2024 rate budget process. The performance will be measured, tracked and updated on a monthly basis.

 How will the performance of this request be measured and evaluated? The performance of the Manager will be measured on the overall success of the Water Treatment Plant Capital program KPI target expectations, along with successful management of the staffing complement.

CITY OF HAMILTON

Woodward Water Treatment Plant Capital Program

BUSINESS CASE #4

BUSINESS CASE OVERVIEW

Request Title	Engineering Technologist, Capital Delivery, Woodward Water Treatment Plant Program	
Department/Division	Public Works - Hamilton Water - Capital Delivery	
Request Driver	Woodward Water Treatment Plant Phase 2 Capital Program	
Funding Source	Project ID No. 5142166110 and 5143066110	
Proposed Start Date	Q4 2024	
Strategic Plan Priorities	Built Environment & Infrastructure	y
Do you Require the Use of External Consultants?	no	

2024 OPERATING BUDGET FINANCIAL IMPACTS

DESCRIPTION	2024 AMOUNT	ANNUALIZED AMOUNT
Salary/Wages	**$21,925**	**$87,700**
Benefits	**$5,825**	**$23,300**
Add item here		
Total Expenditures	**$27,750**	**$111,000**
Add item here		
Capital Funding	**$27,750**	**$111,000**
Add item here		
Total Revenue	**$27,750**	**$111,000**
Net Impact	**$0**	**$0**
Full Time Equivalent (FTE)	**1.0**	**1.0**
Capital Budget Impact	**$27,750**	**$111,000**

BUSINESS CASE DETAILS

1. Reason for Request:

There is currently no dedicated Engineering Technologist resource for assisting with the Water Treatment Plant Capital Projects. The responsibilities of the Engineering Technologist will be to address the number of day-to-day requests received. This position is also required to provide project and program support, maintain a document management system and provide project controls for the various capital projects within the Water Treatment Plant Phase 2A and 2B upgrades and Program related tasks.

 What are the objectives of the request? The recommended resource structure for the Water Treatment Plant Phase 2 Upgrade for the staffing request will provide a dedicated Capital staff.

 What are the expected outcomes of the request and the actions that will create these expected outcomes? - A new Engineering Technologist will provide a dedicated focus on further advancing this large capital project into the next phase of the project, including issuing the RFP for engineering design and contract administration service.

 What is the challenge or opportunity that this request proposes to solve? The staffing recommendations will ensure that Hamilton Water has the required staff resources to successfully design, construct, and commission an extremely complex capital rehabilitation and upgrade program at the City's most critical water facility.

 What value will the City gain from this request? The recommendations in Report PW22078(a) will ensure that Hamilton Water has the required staff resources to successfully design, construct, and commission an extremely complex capital rehabilitation and upgrade program at the City's most critical water facility.

 Does the request provide value for money (efficiency and effectiveness) to a program or service? There is ample evidence across municipalities that capital projects and programs with higher levels of staff turn-over result in projects that experience delays, increased overall project costs, and increased operational risk.

2. Implications if Request not permitted:

Not having this position will delay the implementation of Capital Projects currently budgeted for issuance and ensure our capital investment for water/wastewater/storm infrastructure renewal into the future.

 What impacts will this request have on the community or organization, in terms of service delivery, legal or policy requirements, daily operations or customer service? This position will assist in supporting the needs maintaining our capital program, ensuring our facilities meet regulatory compliance expectations, create more reliable assets to provide drinking water, wastewater and storm services to the public.

 What will be the risk, impact or consequence if the request is not approved? If the Capital SPM position is not approved, the program will not be able to operate as planned, resulting in these delay of the implementation, and certain aspects of this program will be not be supported. Not having this support, there is the potential for HW's capital improvements to vertical infrastructure would be at risk, resulting in stations failing unexpectedly.

3. Alternatives (if any):

Not having this dedicated position will significantly increase risks including schedule and variances for the program, which has project timelines that are estimated to carry through to 2035 for the construction of both WTP Phases 2A & 2B.

 What impacts will this request have on the community or organization, in terms of service delivery, legal or policy requirements, daily operations or customer service? Increased risk of infrastructure failure is accompanied by increased risk of regulatory non-compliance, fines, and exposes the City to significant liability. Mayor and Council, and senior members of City staff may also be exposed to personal liability under the Standard of Care Provisions within the Ontario Safe Drinking Water Act.

 What will be the risk, impact or consequence if the request is not approved? if this request is not permitted, it would impact the existing water, wastewater and stormwater capital program resulting in increased risk of infrastructure failures, loss of water, wastewater or stormwater services, adverse public health impacts, adverse environmental impacts, and requiring expensive and unplanned emergency interventions.

4. Performance Measures:

Performance Measures will be based on the following:

- **Is there baseline data available?** KPI targets for monitoring cashflows, schedules and budgets are currently in place.
- **What target(s) in relation to a baseline demonstrate progress in achieving the expected outcome(s) of the request?** Established KPI targets and outcomes include meeting the estimated project schedule and budget established in 2024 rate budget process. The performance will be measured, tracked and updated on a monthly basis.
- **How will the performance of this request be measured and evaluated?** The performance of the Manager will be measured on the overall success of the Water Treatment Plant Capital program KPI target expectations, along with successful management of the staffing complement.

Woodward 3rd Party Review – Constructability and Construction Phasing Review

June 19, 2023

Prepared for:

City of Hamilton

Prepared by:

Stantec Consulting Ltd.
100-300 Hagey Boulevard
Waterloo ON   N2L 0A4

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Revision	Description	Author		Quality Check		Approved By	
0	Draft	HH BW PK	3/20/2023	DP NM	3/21/2023	MK	4/6/2023
1	Final	HH	5/5/2023	BW NM	6/2/2023	MK	6/19/2023

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

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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.

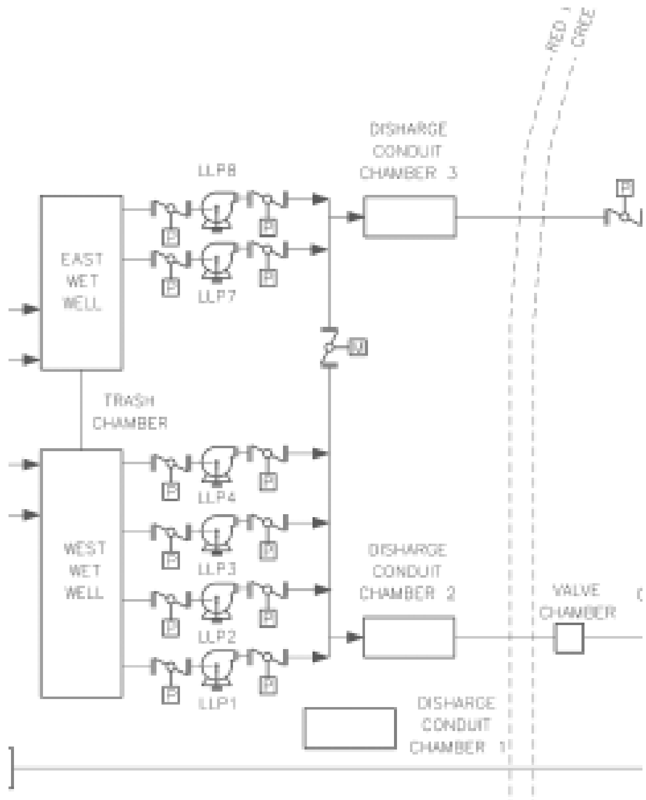

Figure 2-1: Low Lift Pump Configuration

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

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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.

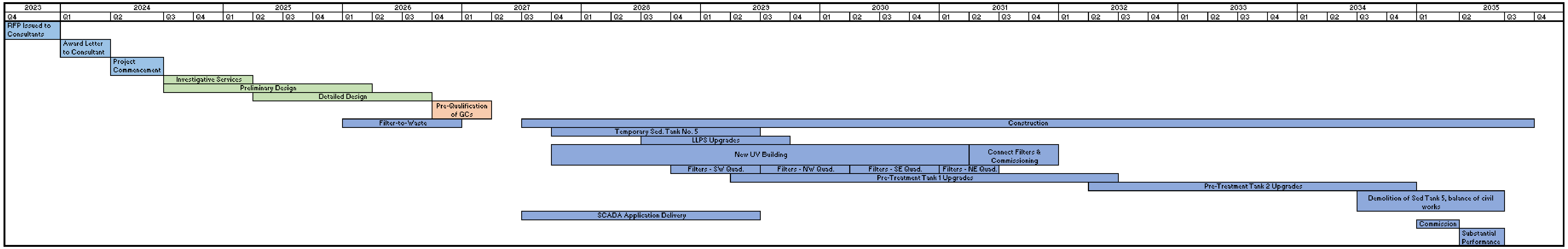

Figure 2-2: Summary of Existing Construction Schedule

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

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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**.

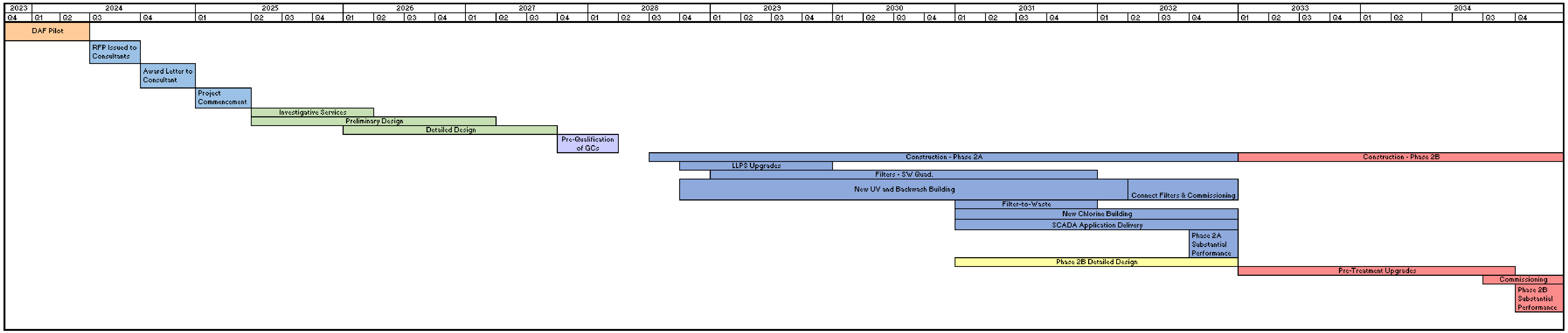


Figure 3-1: Possible Optimized Phase 2 Construction Schedule

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 5th 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 5th 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.

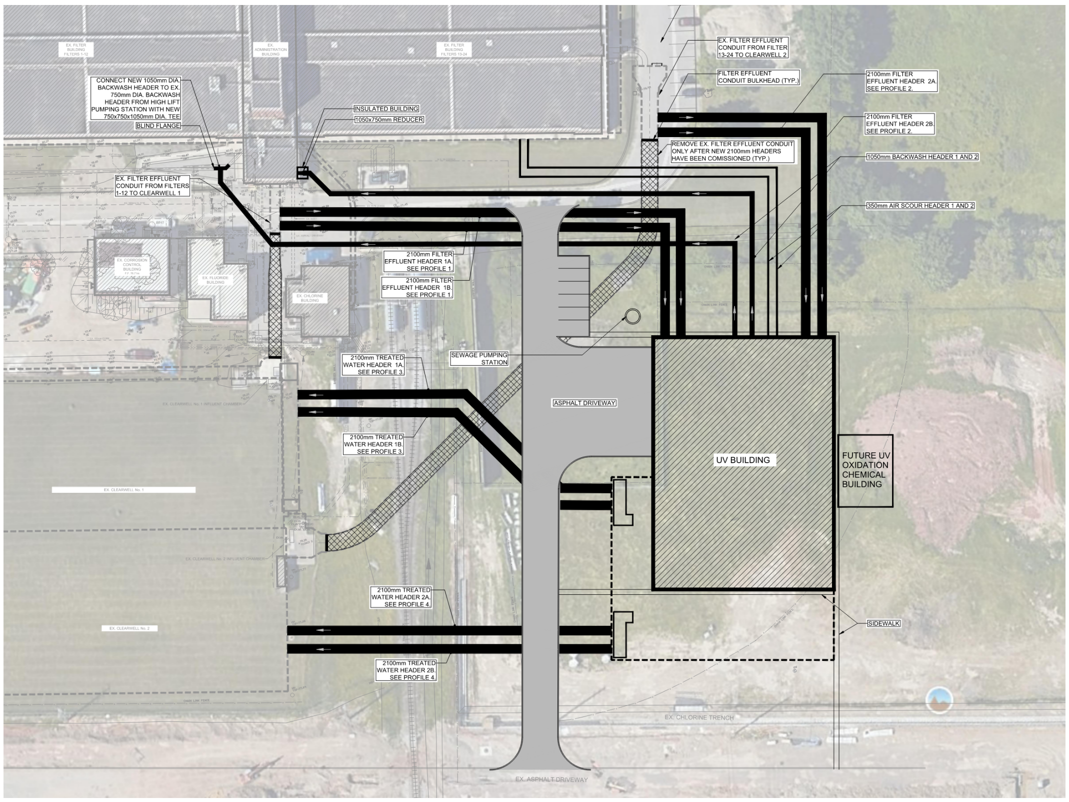


Figure 4-1: Proposed UV Building Infrastructure and Layout (Source: AECOM Conceptual Design, 2021)

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.

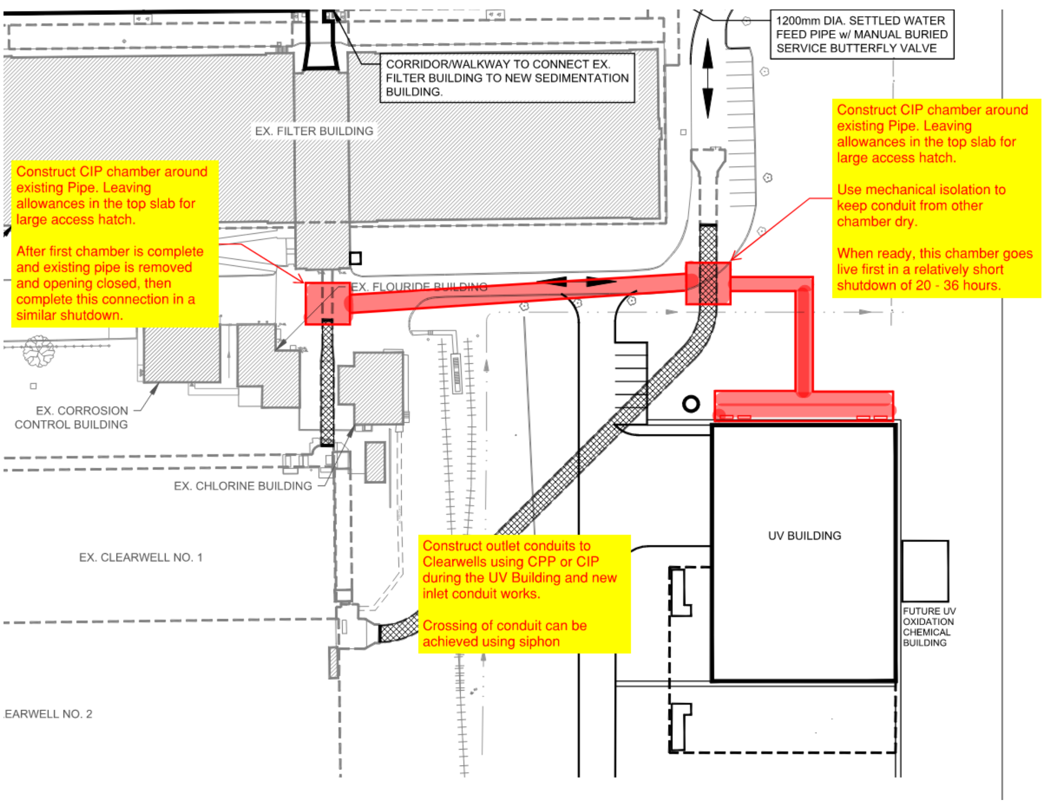


Figure 4-2: Alternative Conduit Connections (Drawing Source: AECOM Conceptual Design, 2021)

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.

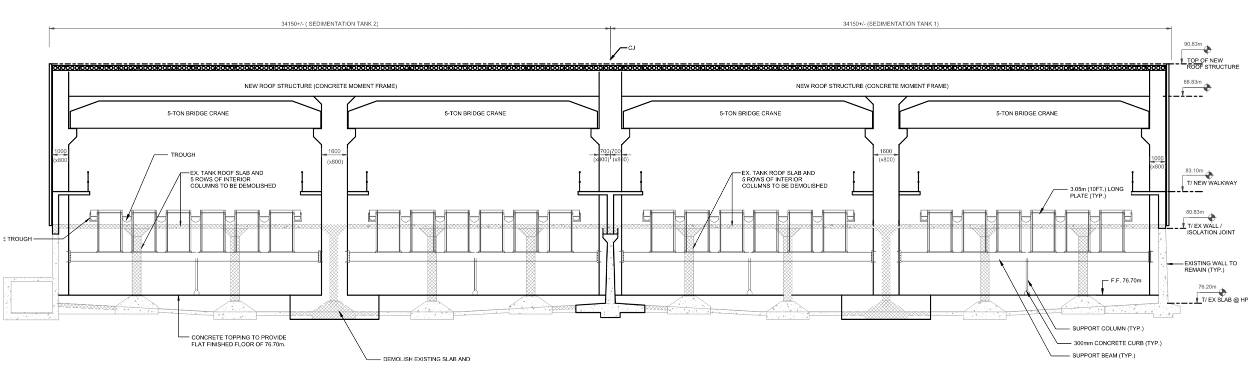


Figure 4-3: Proposed Sedimentation Tank Structural Works (Source: AECOM Conceptual Design, 2021)

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.

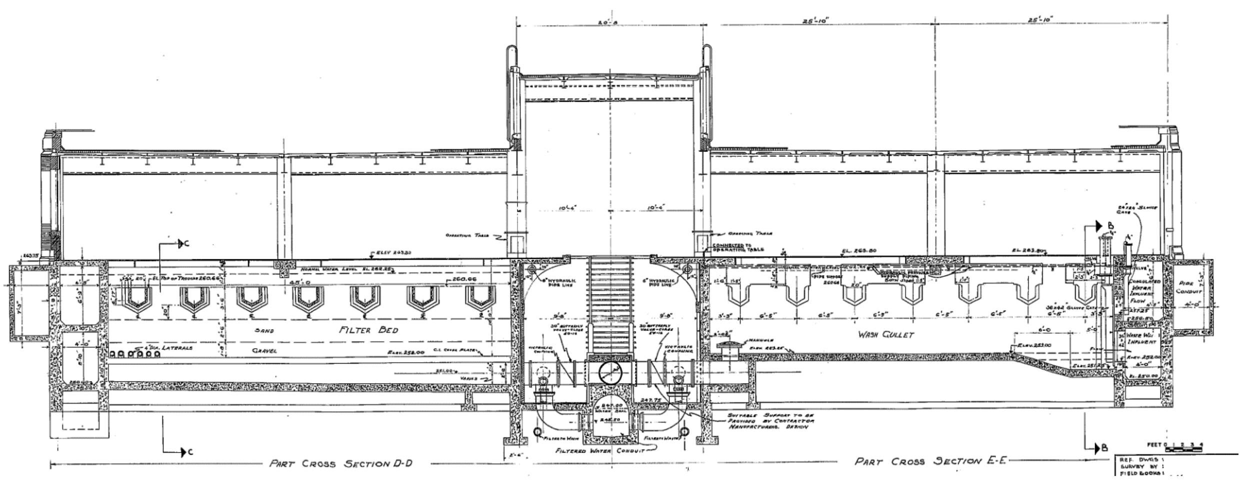


Figure 4-4: Filter and Lower Pipe Gallery Drawing (Source: Woodward WTP: 1931 and 1957 drawing set)

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.

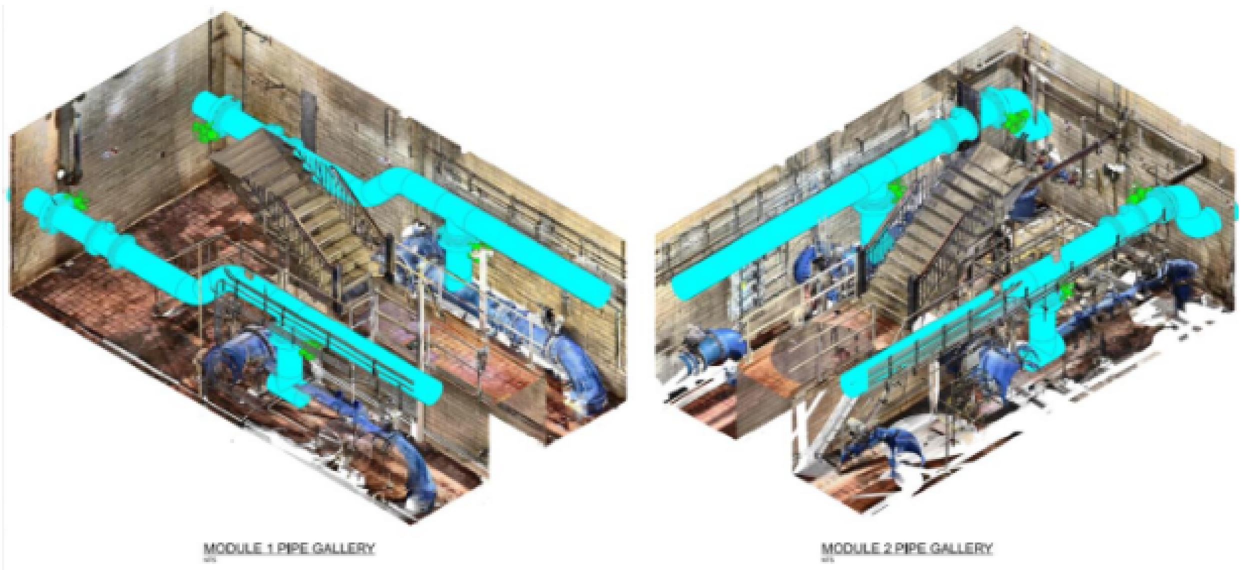


Figure 4-5: FTW Piping Conceptual Design (Source: CH2M Filter-to-Waste report, 2021)

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

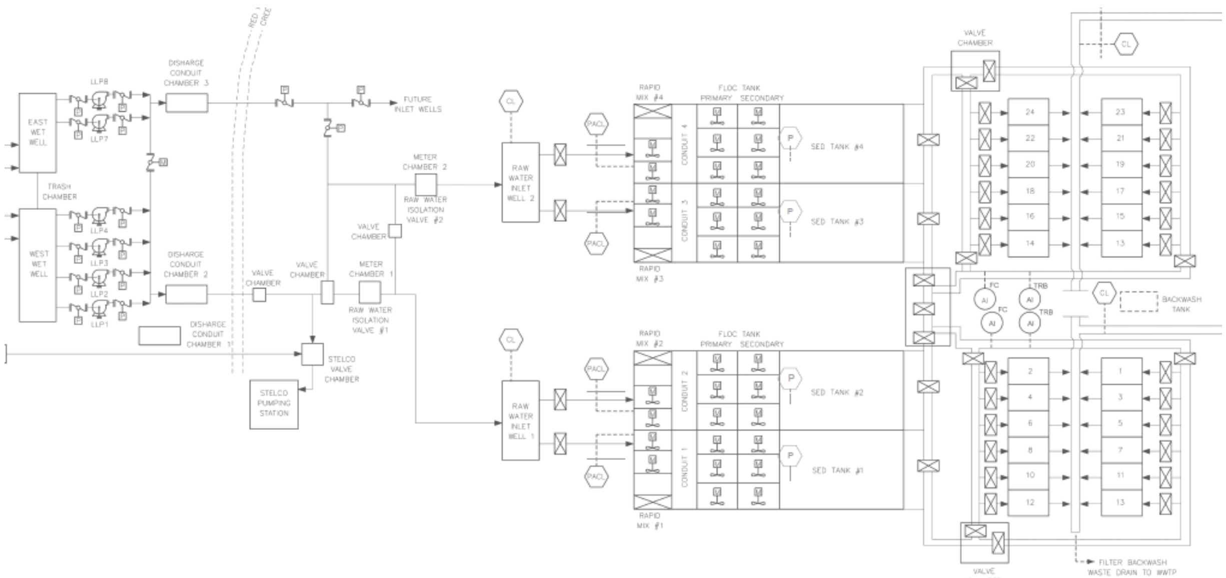
- Task 1 - Construction phasing opportunities and key constructability considerations **(today's workshop)**
- Task 2 - Risks analysis of process / construction activities, concurrent large capital projects at the Woodward WTP and Woodward WWTP **(early February)**
- Task 3 - Capital construction cost 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



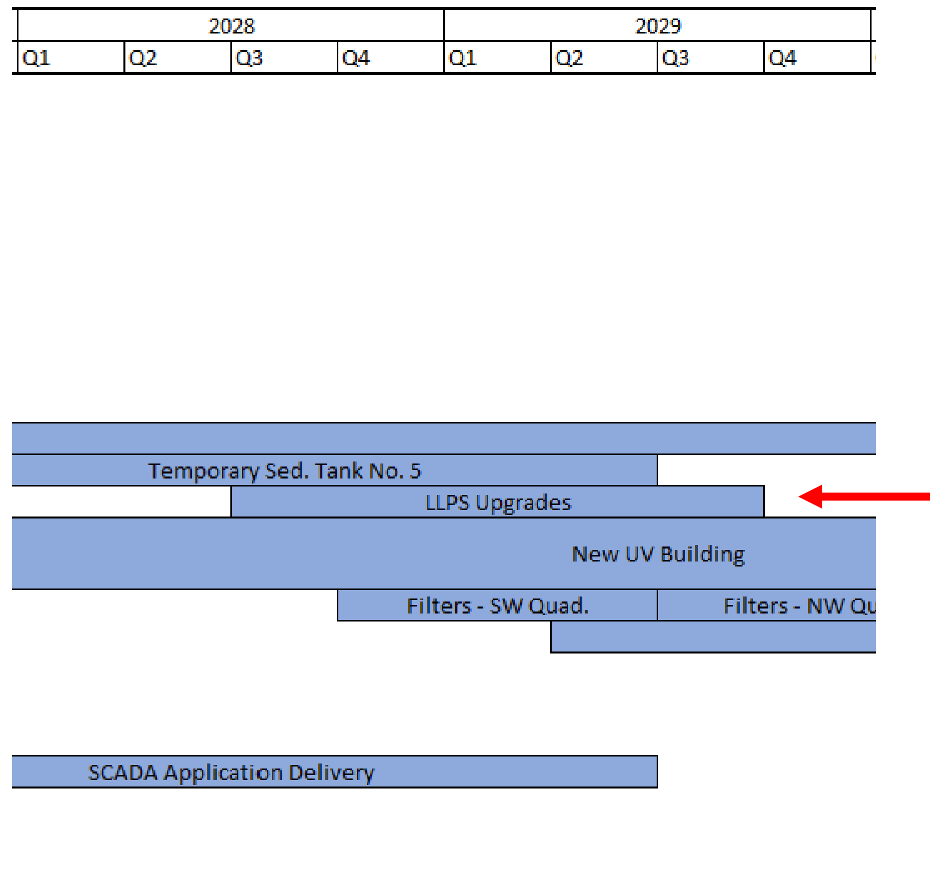
Primary Driver for LLPS Upgrades

- 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

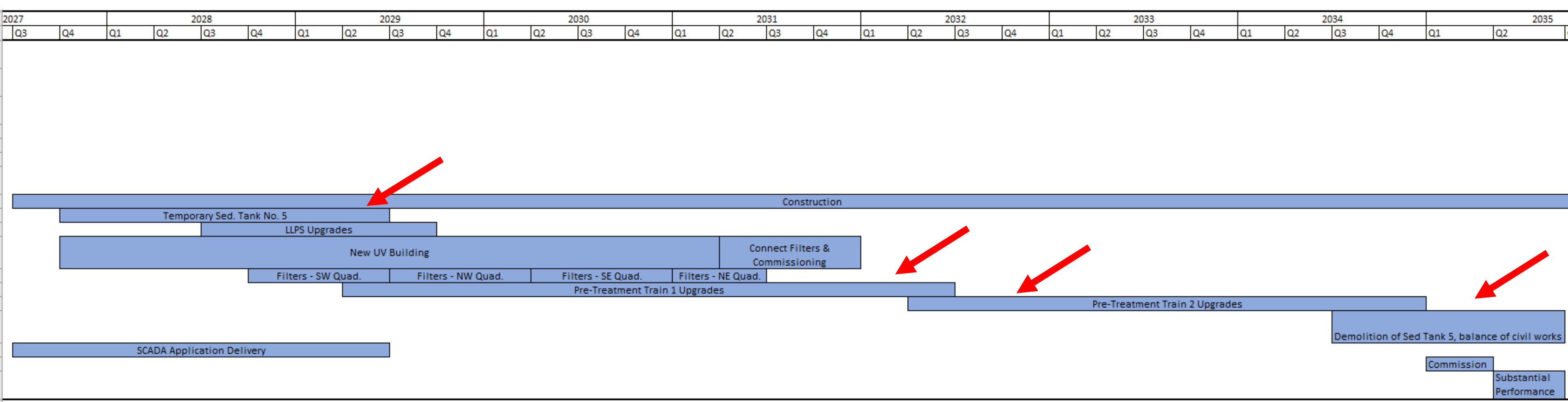
Primary Drivers for Upgrades

- 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

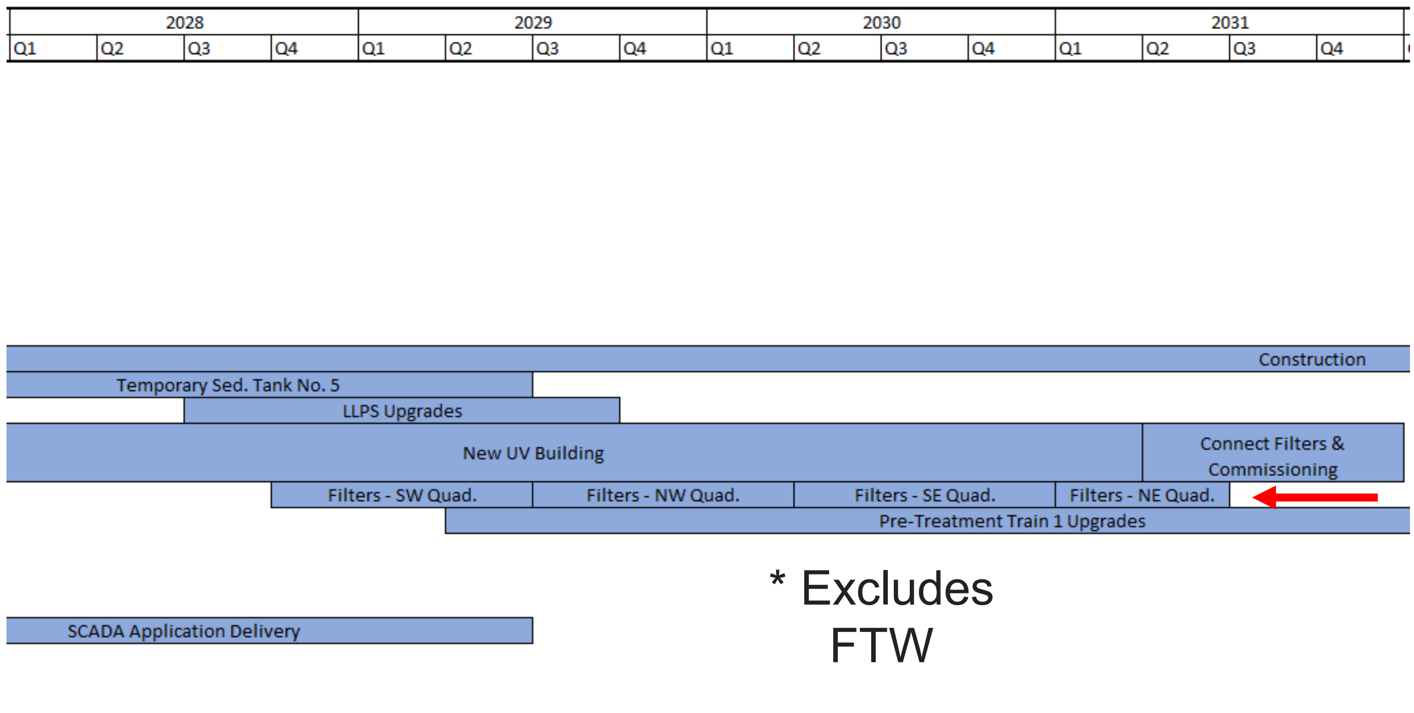
Primary Driver for Upgrades

- 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



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

Filter Building 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

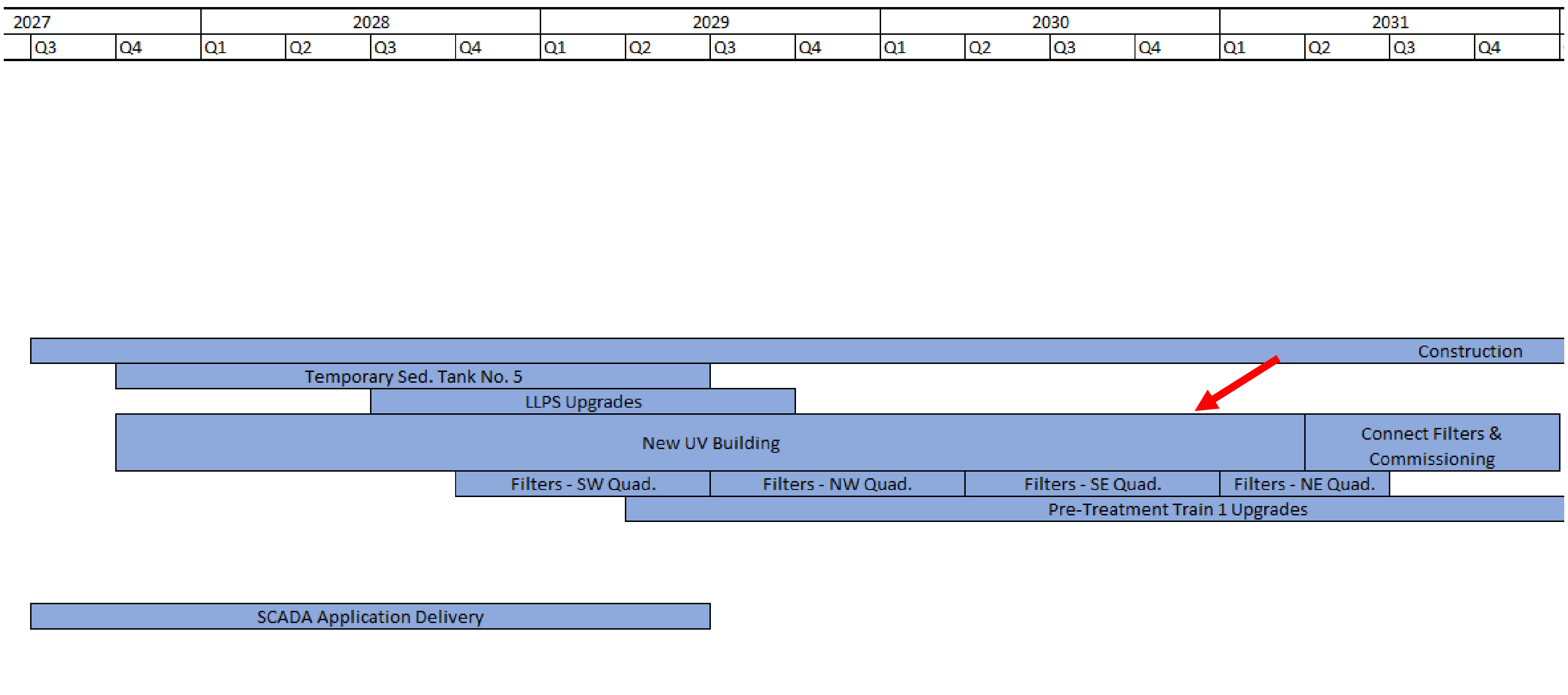
- In the event of a pre-chlorination failure, the plant is not able to rely on post-filter chlorination to provide adequate CT
- Disinfection goals:

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

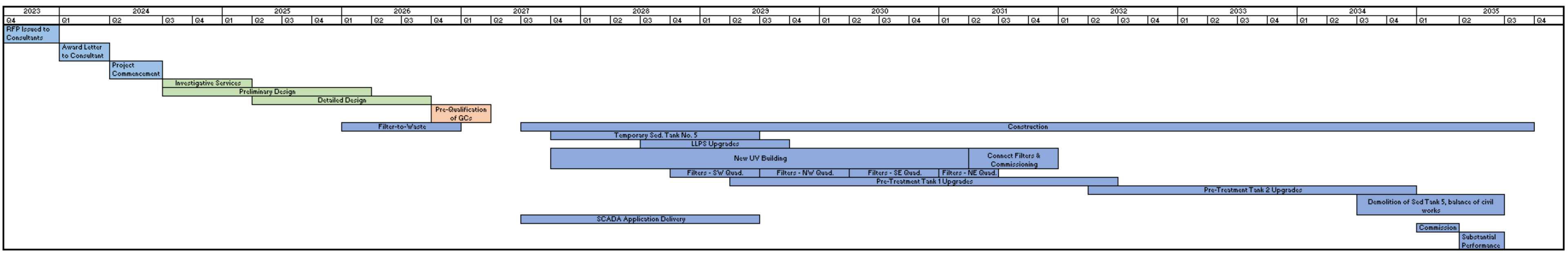
UV Building Schedule

- 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.

Pre-Treatment
&
Sedimentation

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

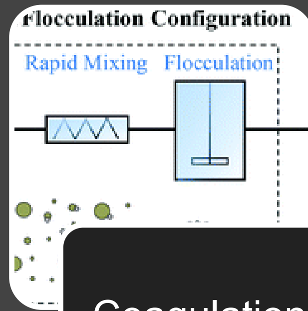
Optimize Public Health Protection

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.

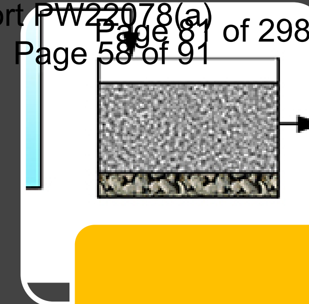
Filters are the most important process for pathogen removal.

Technical Perspective



Coagulation / Flocculation

Sedimentation



Filtration

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

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

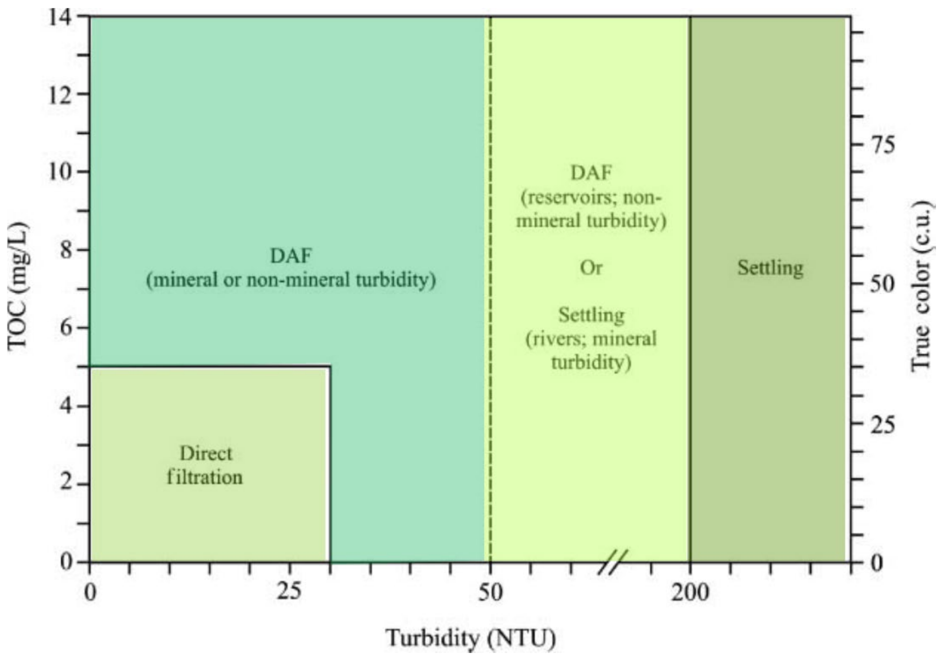
Preferred Sedimentation Technology Continued:

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



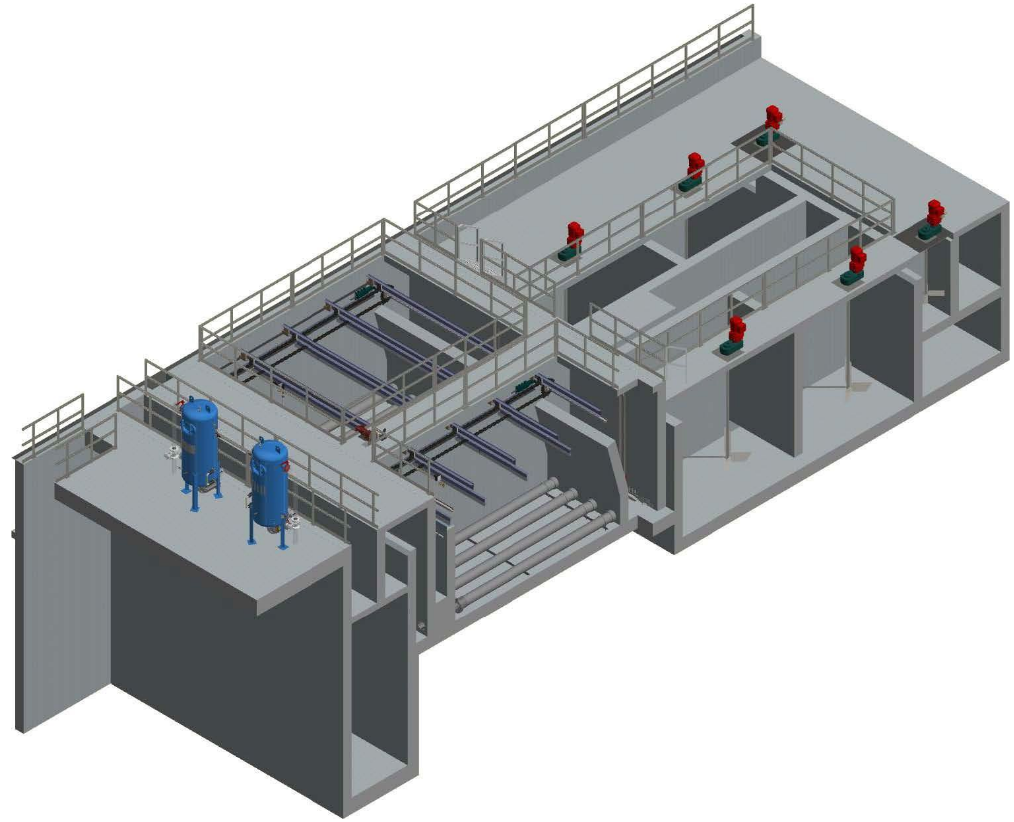
Valade, M. T., W. C. Becker, and J. K. Edzwald. "Treatment selection guidelines for particle and NOM removal." Journal of Water Supply: Research and Technology—AQUA 58.6 (2009): 424-432.

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)

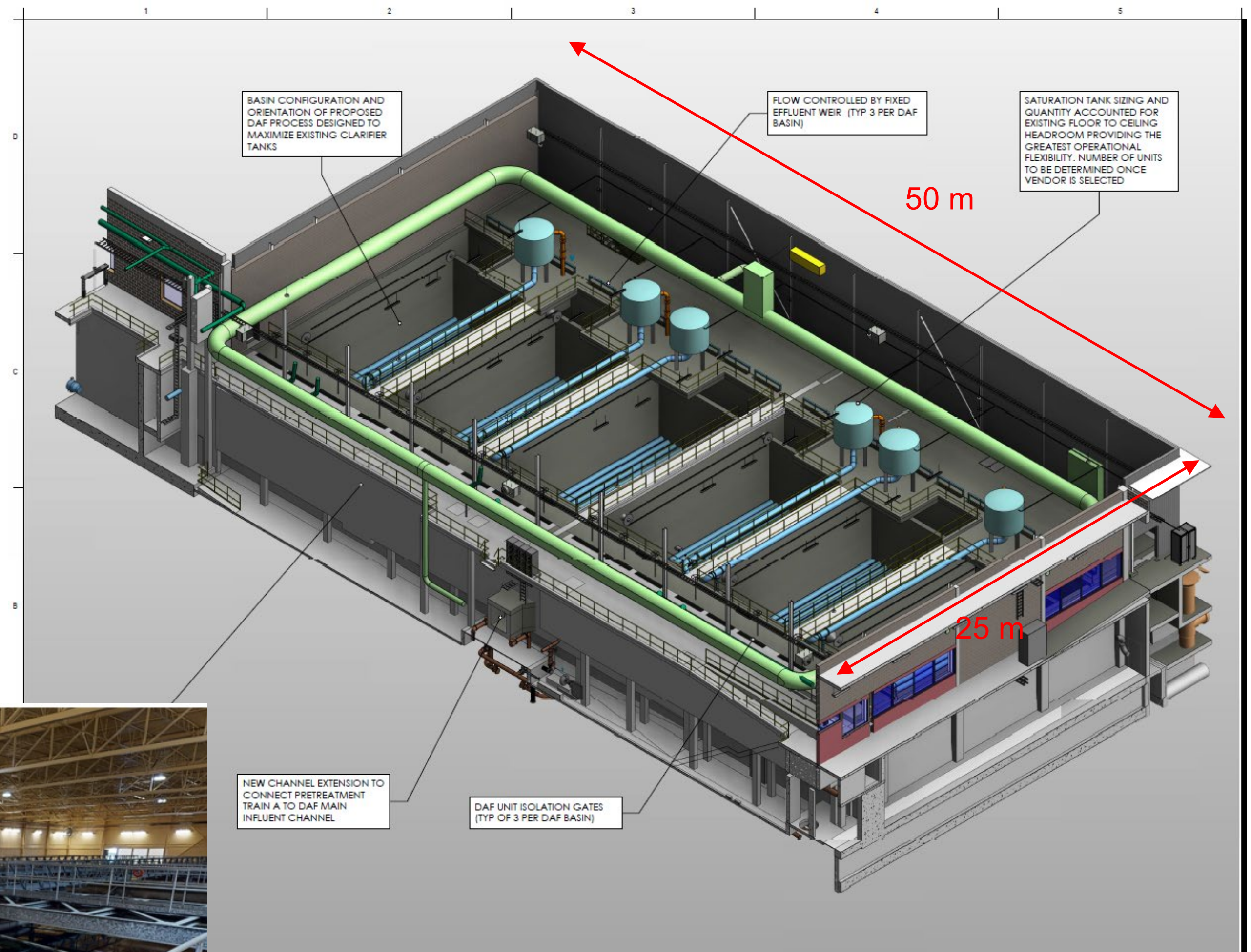
Case Study

Buffalo Pound SK: DAF Retrofit

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

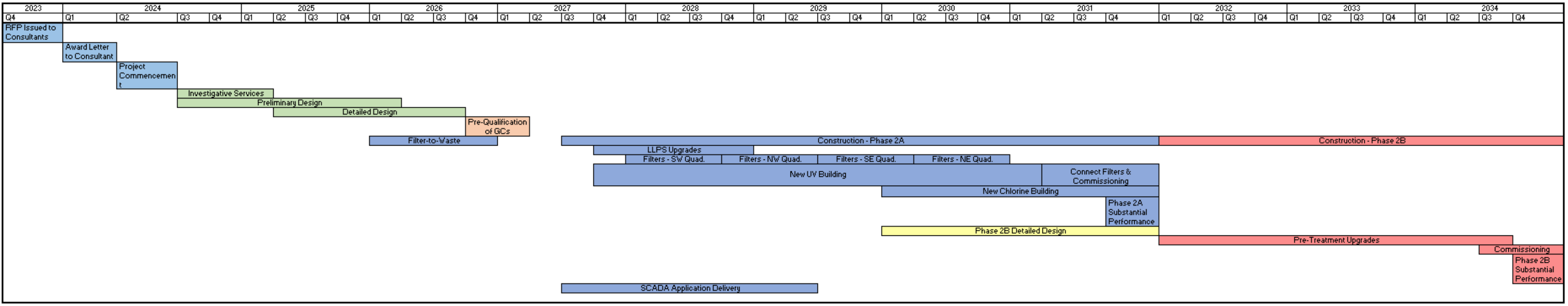
Summary

- 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



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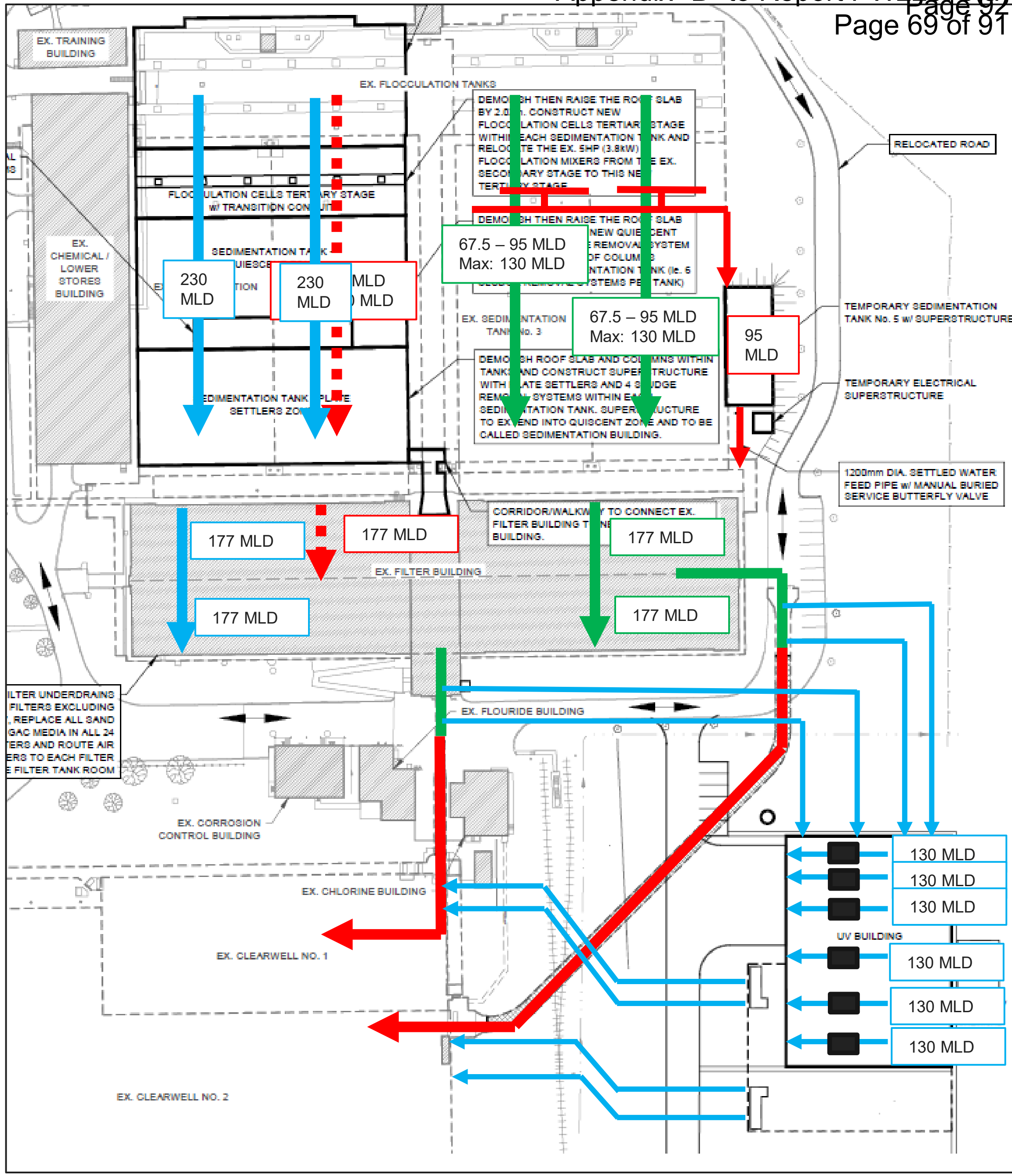
Hydraulic Stress Testing Options

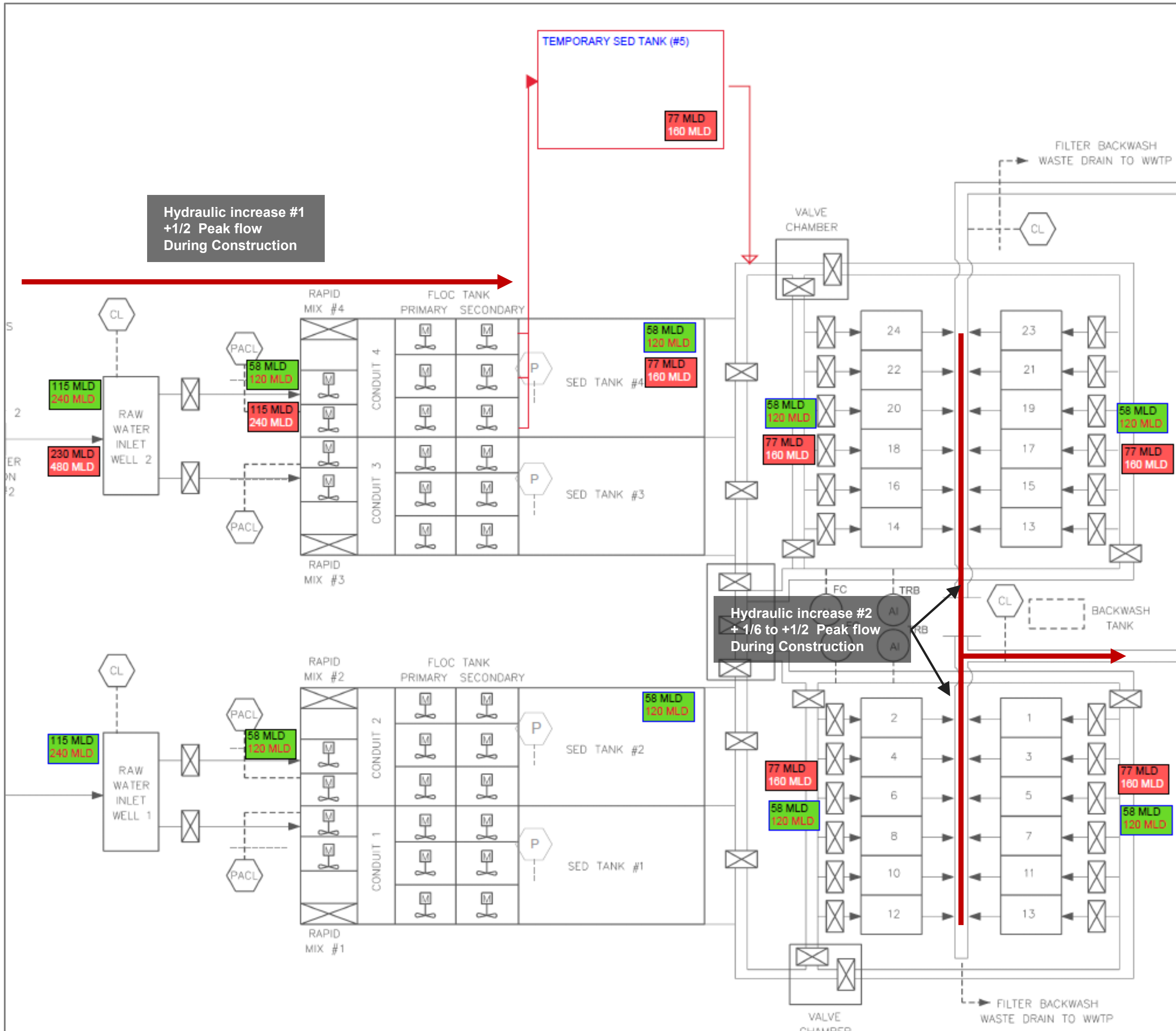
Stress Testing *Hydraulic Capacities*



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.

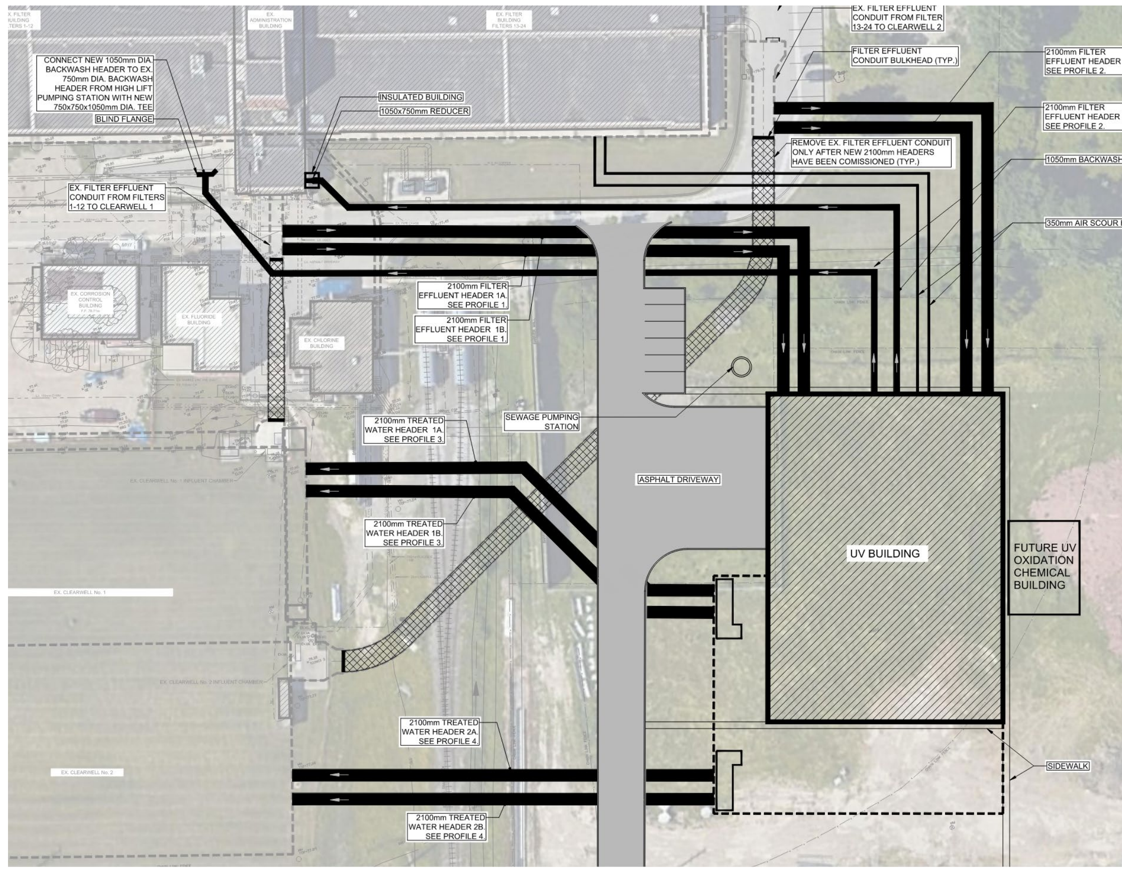
Constructability Considerations

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

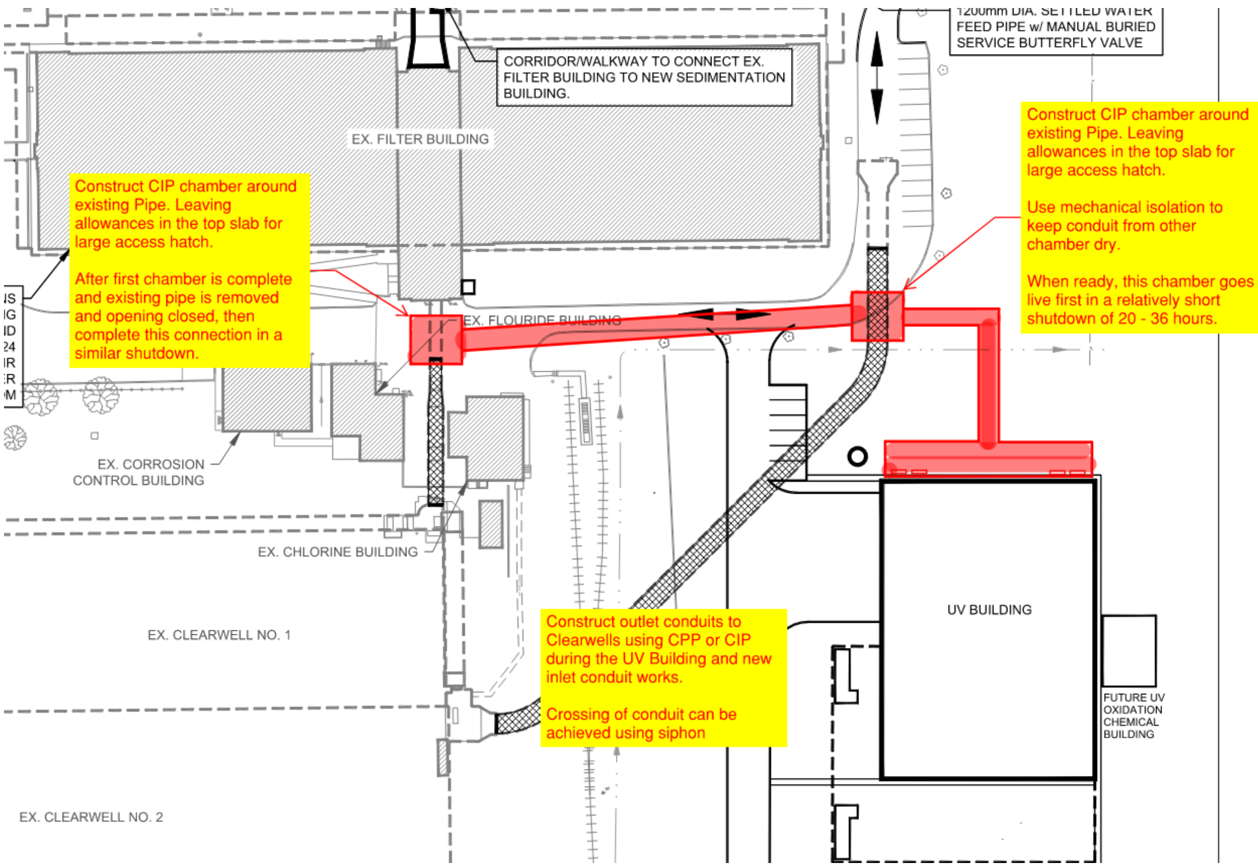
- Is there an Owner driven requirement to have two flow conduits from each tie-in location versus one at each?
  - Confirmation of this helps steer the direction the City will be required to build
  - Specifically, if possible, is there a rule of no single point of failure stipulated?
  - One CIP conduit 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.



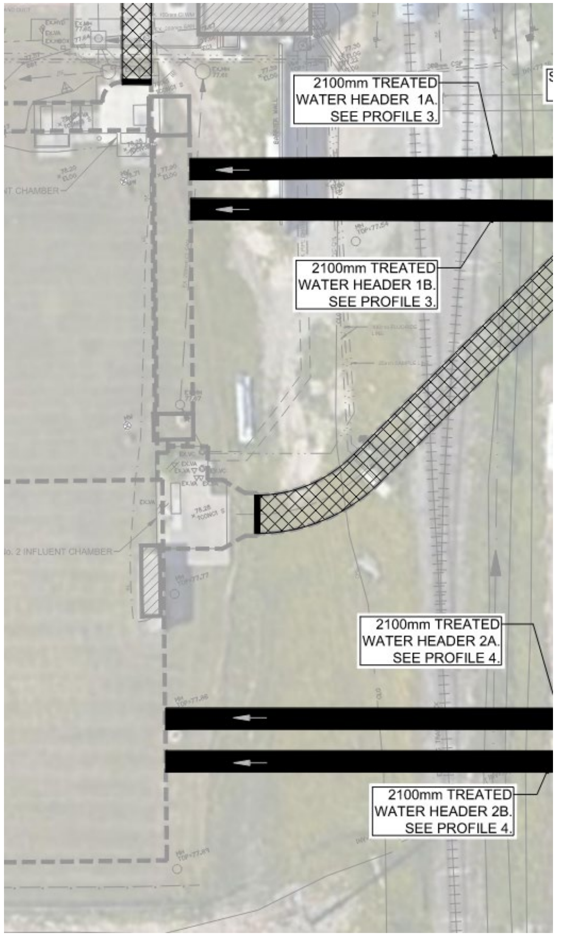
Constructability

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.

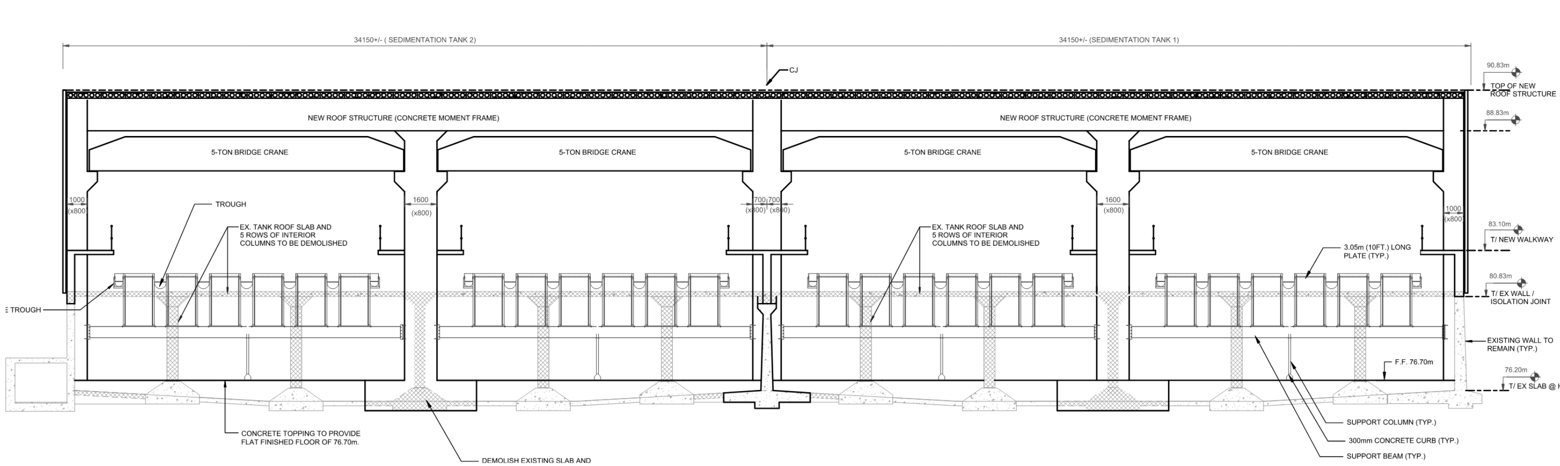


Constructability

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

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

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

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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.

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	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.	

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	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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Environmental Designer
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Attachment: Workshop presentation

Woodward 3rd Party Review – Process Risks Review

June 22, 2023

Prepared for:

City of Hamilton

Prepared by:

Stantec Consulting Ltd.
100-300 Hagey Boulevard
Waterloo ON N2L 0A4

165640394

Revision	Description	Author		Quality Check		Approved By	
0	Draft	HH NM BW	4/4/2023	DP SH	4/5/2023	MK	4/6/2023
1	Final	HH	6/20/2023			MK	6/20/2023

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 associated with the proposed upgrades and preferred alternatives / technologies in terms of their suitability to achieve the desired objectives for the Phase 2 WTP Upgrades. In addition, the proposed construction staging, overall schedule, and potential impact to plant operations during the course of construction were reviewed with respect to maintaining water production and treatment objectives. Stantec's Comprehensive Performance Evaluation (CPE) approach was used to compare proposed technologies and their rated capacity to the overall rated capacity for the WTP to confirm that existing treatment bottlenecks are anticipated to be alleviated with the proposed upgrades.

The report concludes the following:

Table E-1: Risks and Recommendations

Problem / Risk	Recommendation	Report Section
The plant operates with frequent start-stop cycles, resulting in increased peak flows. During construction, these flows will result in elevated loading rates through sedimentation and filtration while trains are offline.	There is an opportunity to evaluate the total plant production requirements in an effort to peak-shave high plant flow operating scenarios to minimize performance and production risks during construction and operate the plant more in line with best practices.	2.1 – 2.3
Tertiary flocculation stage considered unnecessary	Remove tertiary flocculation stage from the Phase 2 upgrades scope.	2.3.1
The capacity risk of having one or two sedimentation basins offline is expected to be moderate. With two sedimentation basins offline, performance is expected to decline at flowrates greater than 130 – 260 MLD, dependent upon temperature. Higher settled water turbidity could result in shorter filter run times and greater risk of turbidity breakthrough.	Perform an extended full-scale stress test at a sedimentation loading rate between 1.2 and 2.0 m/h and filtration loading rate of 12 m/hr, and complete a full-scale trial using a sedimentation polymer aid. The polymer aid may allow sedimentation to operate at a higher loading rate. Additional details for process stress testing are included in Appendix F.	2.3.1
The capacity risk of having one filter quadrant offline during construction is expected to be minimal, however, having two filter quadrants offline could reduce plant capacity to 321 – 386 MLD.	Prioritize upgrades to the filtration process including upgraded underdrains and backwash technology, optimize the filter backwash sequence, and implement FTW infrastructure. Develop an SOP for operating the Woodward WTP with only two (2) filter quadrants (or 10 filters in service with 2 standby) where the potential plant capacity may be limited to approximately 320 MLD.	2.3.2

Problem / Risk	Recommendation	Report Section
At current loading rates, individual filter effluent turbidity goals are not always achieved.	Plant performance is in line with the AWWA Partnership for Safe Water Goals for the most part; however, there exists an opportunity to address the frequency of elevated average hourly filter effluent turbidity.	2.3.2
Disinfection credits may be limited under worst-case conditions during construction when one or two sedimentation basins are offline. Currently, the plant relies on CT through sedimentation for the majority of its disinfection credits.	Raise minimum pre-chlorine residuals through pre-treatment such that sufficient contact time is provided under cold water conditions with reduced sedimentation capacity. UV upgrades could be moved ahead in the schedule.	2.3.3
Concerns were presented regarding potential surcharging of the filter effluent channel access hatch during potential elevated flow scenarios during construction.	Stress testing, conducted in March 2023, with one filter quadrant offline demonstrated an operational bottleneck between 575 – 600 MLD due to chemical dosing restrictions. Surcharging in the filter effluent hatch was not observed during the stress test.	4

A risk matrix was developed to summarize the risks identified in this review, and present potential remediation strategies in Section 5.0.

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LIST OF TABLES

LIST OF FIGURES WITHIN THE REPORT

LIST OF APPENDICES

1.0 INTRODUCTION

1.1 BACKGROUND

The Woodward Water Treatment Plant (WTP) provides potable water for the City of Hamilton and some communities in Halton and Haldimand. The plant was originally constructed in 1931 and expanded in the late 1950s. The treatment process includes intake chlorination for seasonal zebra mussel control and year-round pathogen inactivation, screening, pre-chlorination for pathogen inactivation ahead of pre-treatment, coagulation with polyaluminum chloride (PACl), flocculation, conventional gravity sedimentation, granular activated carbon (GAC) filtration, post-filter chlorination for primary and residual disinfection, ammoniation to form chloramines for residual maintenance, and fluoridation. The current rated capacity of the WTP is 909 MLD, though the current expected maximum capacity is approximately 500 MLD.

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

- **Pre-Treatment and Sedimentation**: It was expected that process performance could not be maintained or sustained at plant flowrates above 250 MLD or during high raw water turbidity events. Operations' existing 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 regulatory criterion for the filters of ≤ 0.3 NTU 95% of the time in individual filter effluent turbidity readings; however, not all filters are able to meet ≤ 0.1 NTU in 100% of individual filter effluent turbidity readings in a calendar month, suggesting compliance with future regulations may be challenging. Existing plants flowrates were well below the 2041 projected maximum day flows of 650 MLD, and it is anticipated that future higher flow rates (and changing turbidity profile of the source water) will challenge filtered water quality due to the combined risks of declining sedimentation process performance and higher filter loading rates.
- **Disinfection**: year-round pre-chlorination is required to achieve *Giardia* inactivation. Post-filter inactivation alone for primary disinfection is not feasible due to the limited capacity of the existing clearwells.

In general, the 2016 report concluded that that the 2041 target plant production of 650 MLD could be achieved only under low source water turbidity (≤ 5 NTU) conditions. At sustained moderate raw water turbidity levels (5 – 15 NTU), the plant capacity was expected to be 500 MLD or less, and at sustained high raw water turbidity levels (≥ 30 NTU) the plant capacity was expected to be 300 MLD or less.

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

1.2 PROBLEM STATEMENT

The proposed construction sequencing associated with Phase 2 upgrades at the Woodward WTP means some process units will experience elevated loading rates for several months. The ability of the WTP to continue to meet water quality and production requirements under high loading conditions requires review.

1.3 OBJECTIVES

This report reviews the proposed upgrades and preferred alternatives in terms of their ability to suit the desired objectives for the Phase 2 Upgrades. In addition, proposed construction staging, overall schedule, and potential impact to plant operations during the course of construction with respect to maintaining water production and achieving treatment objectives are presented.

1.4 APPROACH

An evaluation of flow sequencing and process risks associated with the pre-treatment, filtration, and disinfection upgrades is presented in Section 2.

The possibility of a temporary mobile system for additional sedimentation capacity was reviewed in Section 3.

An evaluation of flow scenarios associated with upgrades, including preliminary stress testing, is provided in Section 4.

A risk matrix was developed and is shown in Section 5.

Recommendations and conclusions are provided in Section 6.

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2.0 EVALUATION OF FLOW SEQUENCING AND PROCESS RISKS ASSOCIATED WITH UPGRADES

This section presents a review of three (3) years of flow data (2019 to 2022) for each major WTP process unit, with the aim of evaluating process unit loading rates during future construction activities.

By defining process unit loading requirements during construction, process bottlenecks and associated performance and operational risks associated with the proposed construction sequencing can be identified and flagged for mitigation.

2.1 FLOW ANALYSIS (SCADA DATA)

Stantec reviewed hourly SCADA low lift pumping (LLP) and individual filter flow data from 2019 through 2022 as detailed below.

2.1.1 Determination of WTP Flowrates

Raw water low lift pump flow metering SCADA data and filtered water flow metering SCADA data were reviewed to assess WTP flows.

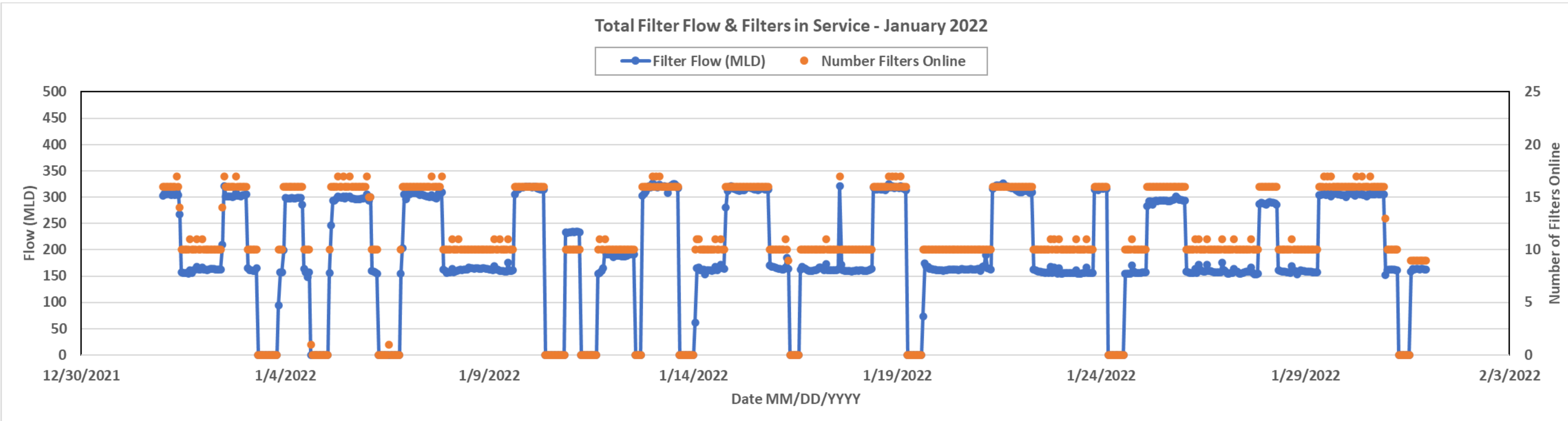
During the data evaluation, a discrepancy between total raw water flow and total filter flow was identified whereby total filter effluent flow values were higher than total raw water flow values. In consultation with the City, it was identified that there are known problems with the accuracy of the raw water flow metering (refer to Appendix B for additional supporting information).

In response to this observation, filter flows were used to evaluate flow conditions and associated process loading rates for all unit processes at Woodward WTP. For this reason, the following review focuses on filtered water SCADA data. Seasonal filter flow data for the period 2019 through 2022 was analyzed to assess the total number of filters online at any one time and the corresponding total filtered flow rate; this data is in Figure 2-1 for one month per season in 2022.

In addition to the data presented in Figure 2-1, the following observations were also noted form the review:

- The WTP was routinely offline, which occurred at a higher frequency in July and October,
- The WTP operates at a series of somewhat fixed flow set-points of 150, 250, 350 and 400 L/s.

Given that the plant operates in frequent start-stop flow sequences suggests that the WTP flow is responding to an equalization feedback signal from downstream storage and demand requirements.


Total Filter Flow & Filters in Service - January 2022
Filter Flow (MLD)
Number Filters Online
Flow (MLD)
Number of Filters Online
Date MM/DD/YYYY
500
450
400
350
300
250
200
150
100
50
0
25
20
15
10
5
0
12/30/2021
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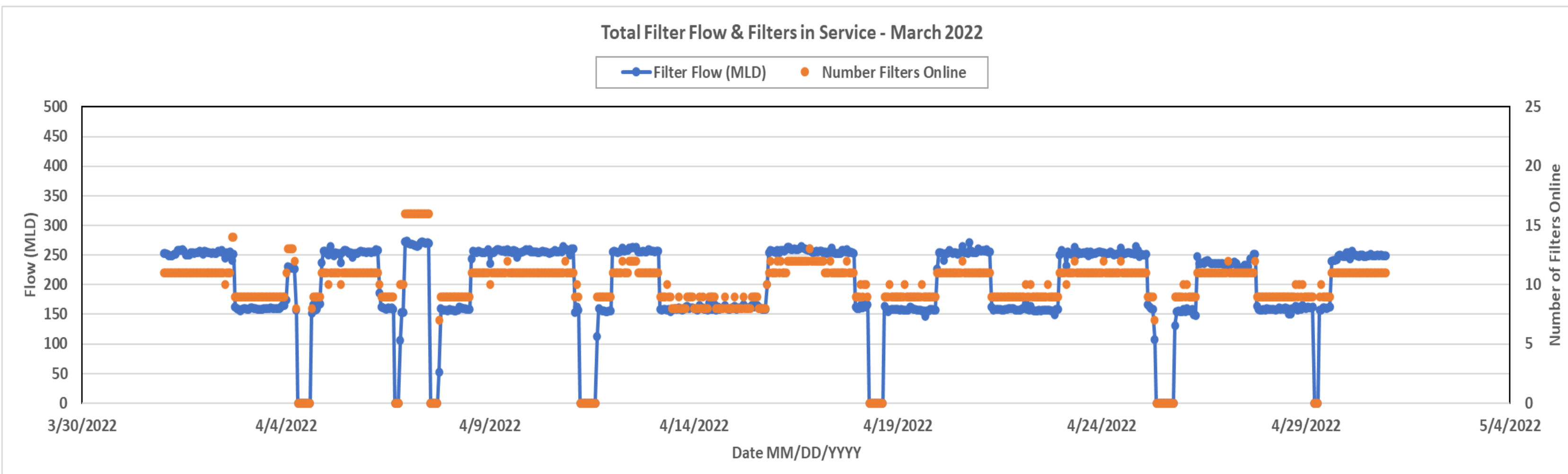
2/3/2022


Total Filter Flow & Filters in Service - March 2022
Filter Flow (MLD)
Number Filters Online
Flow (MLD)
Number of Filters Online
Date MM/DD/YYYY
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0
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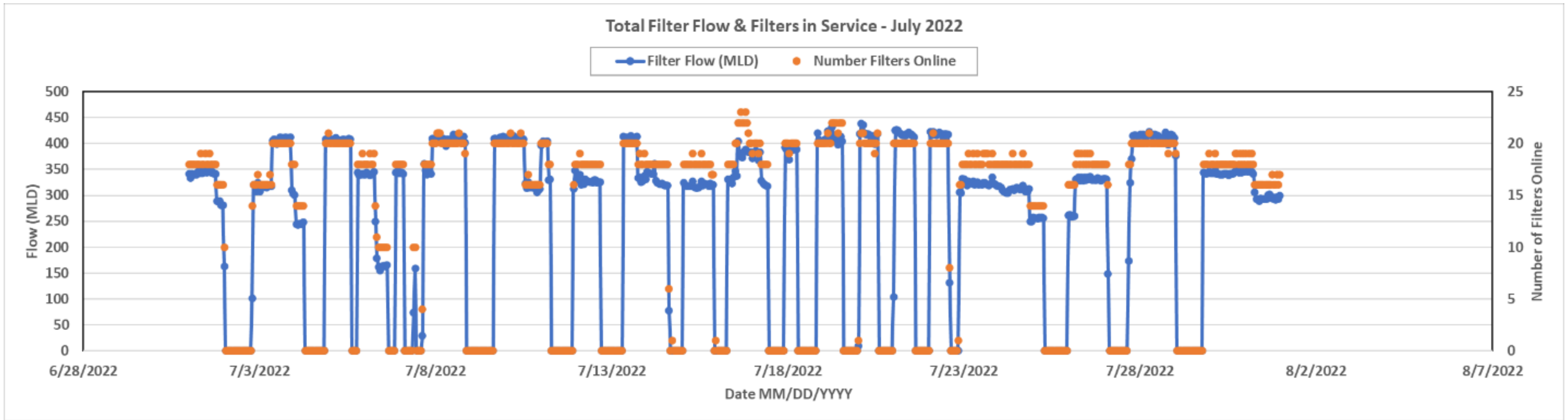
5/4/2022



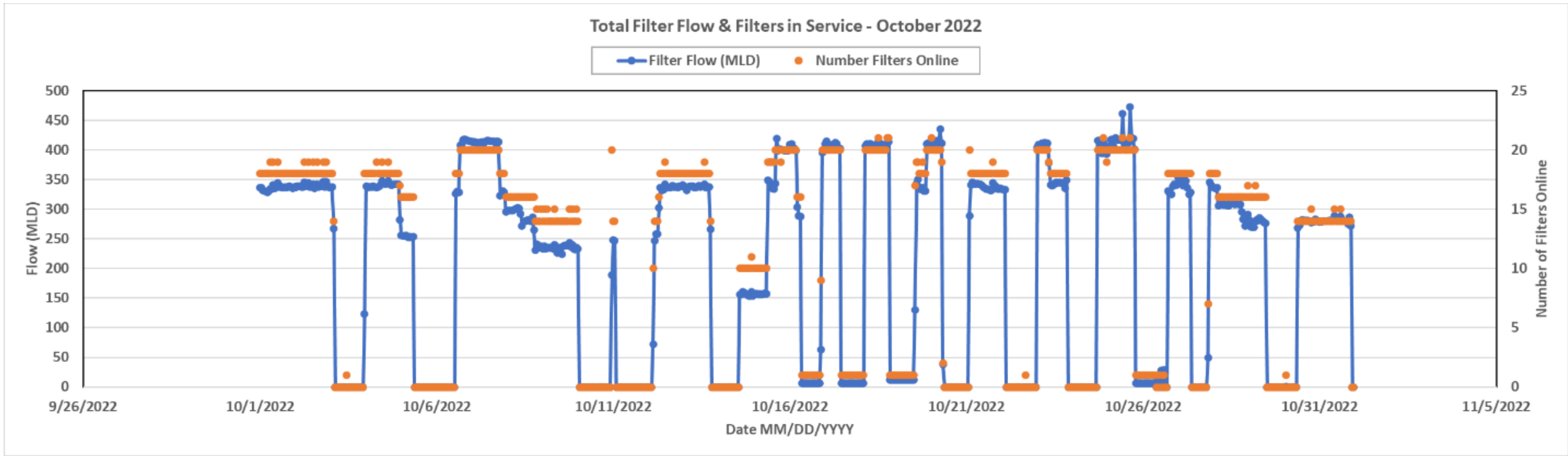


Figure 2-1: Seasonal Total Filter Flow and Number of Filters in Service for January, March, July and October 2022, respectively

To further evaluate seasonal flow operation, a scatter plot of average monthly flows and maximum monthly flows was created against raw water temperature for data provided from 2019 through 2022 as shown in Figure 2-2.

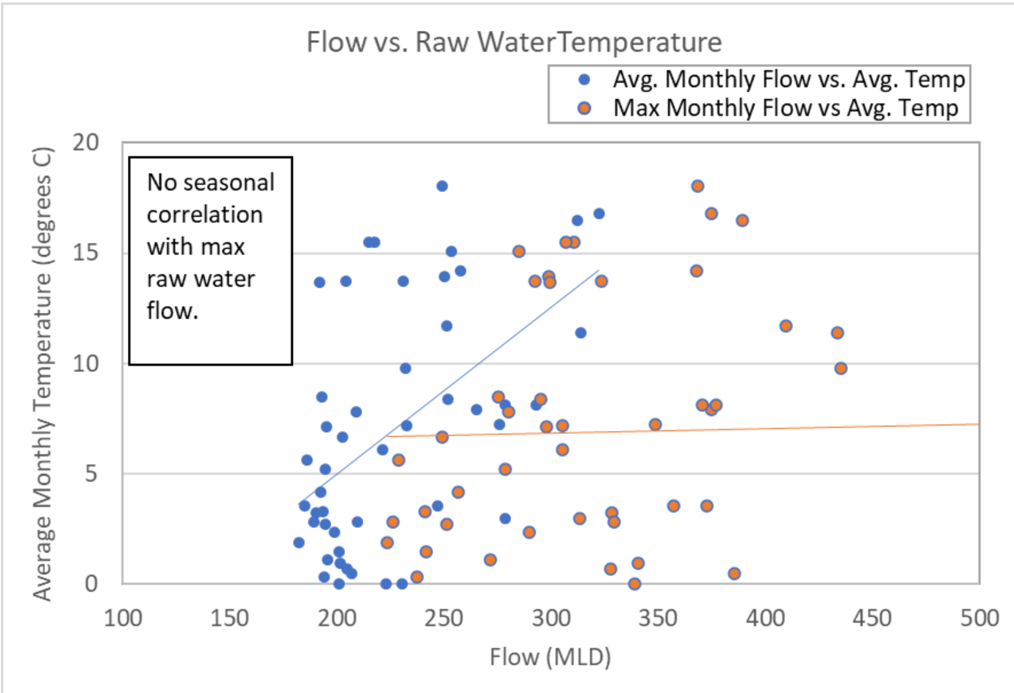


Figure 2-2: Average and Maximum Monthly Flows Relative to Raw Water Temperature (2019 - 2022)

Figure 2-2 suggests that higher average monthly flows are slightly correlated with warmer temperatures, and maximum monthly flows are not correlated with temperature.

In considering future construction sequencing, the flow data indicates that it may be possible to reduce peak production flows and associated peak process loading rates during construction by operating the WTP for longer periods of time at a lower flow rate, to provide the same net production of water over time.

The data also suggests that there may be an opportunity to extend construction activities into the summer months, given higher flows may not be necessary during the months from May through August.

2.1.2 Flow Selection for Risk Evaluation

For the purposes of evaluating process and operational risks during the proposed construction activities, Stantec's aim was to identify a projected peak demand flow.

Initially, the City provided draft projected demands for Woodward WTP showing that the peak historical day was approximately 490 MLD, the historic maximum day demand (MDD) was approximately 400 MLD or less, and the historic average day demand (ADD) was approximately 225 to 250 MLD. Additionally, the projected demands figure shows stabilized demand since 2012.

Stantec understands the WTP operates with frequent on/off cycles due to chloramine residual decay issues within the distribution system that occur when the system runs continuously. Shutting down for long drain cycles was reported to facilitate better mixing and water quality in the distribution system – this strategy has been adopted by Operations within the past few years. The plant also operates in this manner to take advantage of energy tariffs during the summer by shutting down when possible.

It is recommended to further investigate the chloramine residual issues within the distribution system that occur when the system runs continuously. Peak shaving current WTP flows would be beneficial to many aspects of the proposed upgrades, including plant hydraulics, temporary sedimentation measures, and the design approach for the upgrades. Peak shaving would be possible if the system were to be run continuously.

Given the potential opportunity for minimizing peak flows, Stantec used a peak demand flow of 425 MLD for the purpose of the analysis of risks to process performance during construction. This value represents the MDD * 1.25 and the 99th percentile of total filter flow in 2022.

2.2 PLANT PERFORMANCE DESKTOP REVIEW

2.2.1 Risks and Opportunities with Filter Operation

Given filtration is a critical pathogen barrier for the Woodward WTP in addition to downstream disinfection, a focus on risks and opportunities associated with filter operation was conducted. Granular media filtration performs best with consistent operation rather than in a start-stop approach. Therefore, the current operational approach may be hard on the filters and require more backwashing, resulting in higher filter headloss or turbidity breakthrough therefore impacting performance and efficiency, and potential damage to underdrains.

The filter flow observations present an opportunity to evaluate the total plant production needs over a longer time-period in an effort to peak-shave high plant flow operating scenarios to minimize risks during construction and in an effort to operate the plant more in line with best practices.

2.2.2 Plant Performance Review

A desktop evaluation of existing plant performance (process water quality under alternative loading rates) was conducted to baseline how the WTP currently performs at different flow rates. Findings from this review inform considerations for operating the plant at the selected peak demand flow rate of 425 MLD during the construction period.

Stantec reviewed plant performance and applied the American Water Works Association (AWWA) Partnership for Safe Water Goals which primarily focus on turbidity of settled water and filter effluent (refer to Table 2-1). Additionally, Stantec evaluated potential operational factors that may impact turbidity performance to understand performance risks during construction.

Table 2-1: AWWA Partnership for Safe Water Turbidity Optimization Goals

Unit Process	Goal Description	Partnership Optimization Performance Goal
Sedimentation	Continuous, stable performance regardless of variation in raw water quality	• When raw water average ≤10 NTU, <1.0 NTU 95th percentile • (When raw water average >10 NTU, <2 NTU 95th percentile)
Filtration – Combined Filter Effluent (CFE) Turbidity	Continuous, stable performance regardless of variations in raw and settled water quality	• <0.10 NTU, 95th percentile • <0.30 NTU, maximum
Filtration – Individual Filter Effluent (IFE) Turbidity	Continuous, stable performance regardless of variations in raw and settled water quality	• <0.10 NTU, 95th percentile • <0.30 NTU maximum
Filtration – Backwash Recovery	Minimize passage of elevated turbidity water into treated water stream	• Return to service when IFE turbidity <0.1 NTU after filter-to-waste

The goals presented in the table above serve as high-level performance objectives for a well optimized plant to provide reliable treatment and public health protection. It is recommended to strive to maintain these performance objectives even during construction activities.

Raw water turbidity data was reviewed, as presented graphically in Figures 2-3 through 2-6.

A review of raw water turbidity values produced the following general findings:

- Average hourly raw water turbidity recorded at the LLPS was <10 NTU more than 95% of the time.
- Settled water turbidity on side 1 and side 2 were <1 NTU 95% of the time.
- Filter effluent turbidity was <0.1 NTU 85% of the time; however, the 95th percentile was 1.1 NTU and the maximum was 2.0 NTU.

These results confirm that raw water turbidity is low and settled water turbidity is generally low and well managed. However, the occurrence of elevated average hourly filter effluent turbidity is a notable consideration for construction sequencing; specifically, the absence of filter-to-waste (FTW) and optimized filter backwashing infrastructure likely has an impact on average filter effluent turbidity and therefore it is recommended to prioritize these upgrades to filtration to minimize filtration performance risks during construction.

The trendline for raw water turbidity from 2019 through 2022 indicates that elevated turbidity events >50 NTU occur sporadically and are not common for Woodward WTP; they occur approximately four times per year and typically last for less than 5 days. Occasionally, an elevated raw water turbidity event will extend to the 5 – 10 day timeframe. The maximum average hourly raw water turbidity value observed during this timeframe was 180 NTU. This raw water turbidity data suggests that suitable clarification processes for this water type may include enhanced sedimentation with lamella plates (possibly with a settling aid polymer) or dissolved air flotation (DAF).

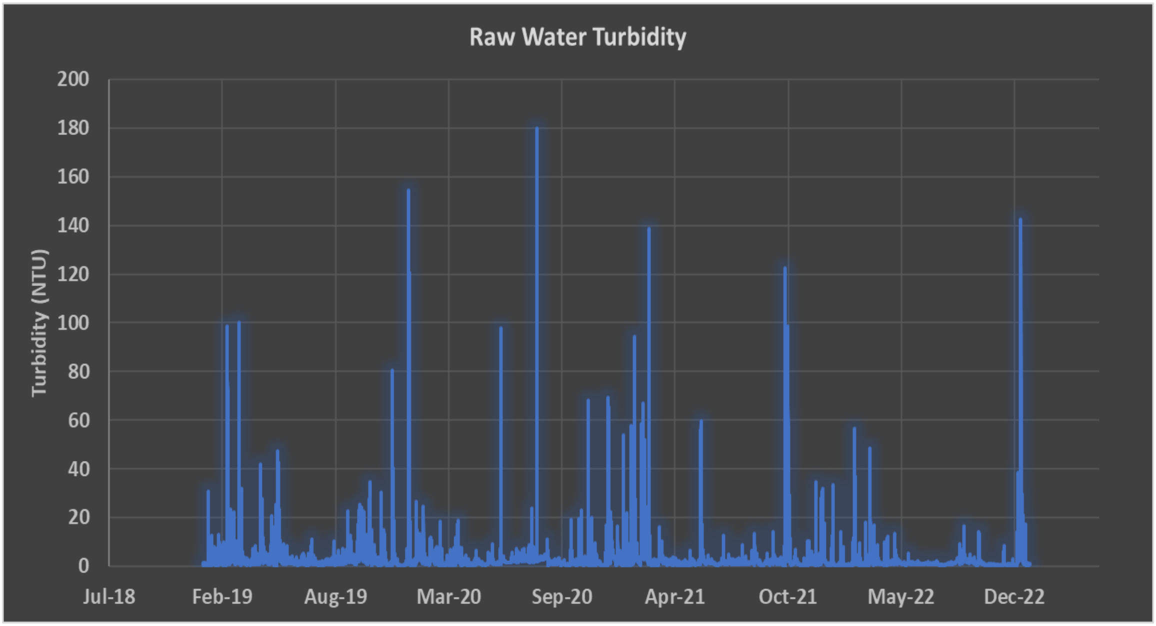


Figure 2-3: Trendline of Raw Water Turbidity (2019 - 2022)

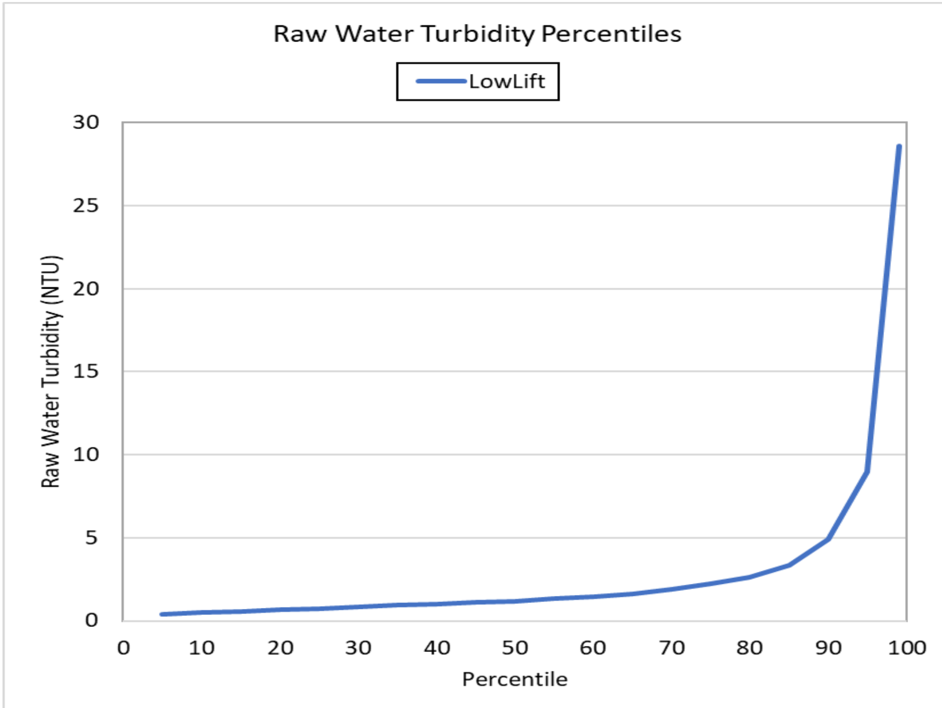


Figure 2-4: Percentile Plot of Raw Water Turbidity (2019 - 2022)

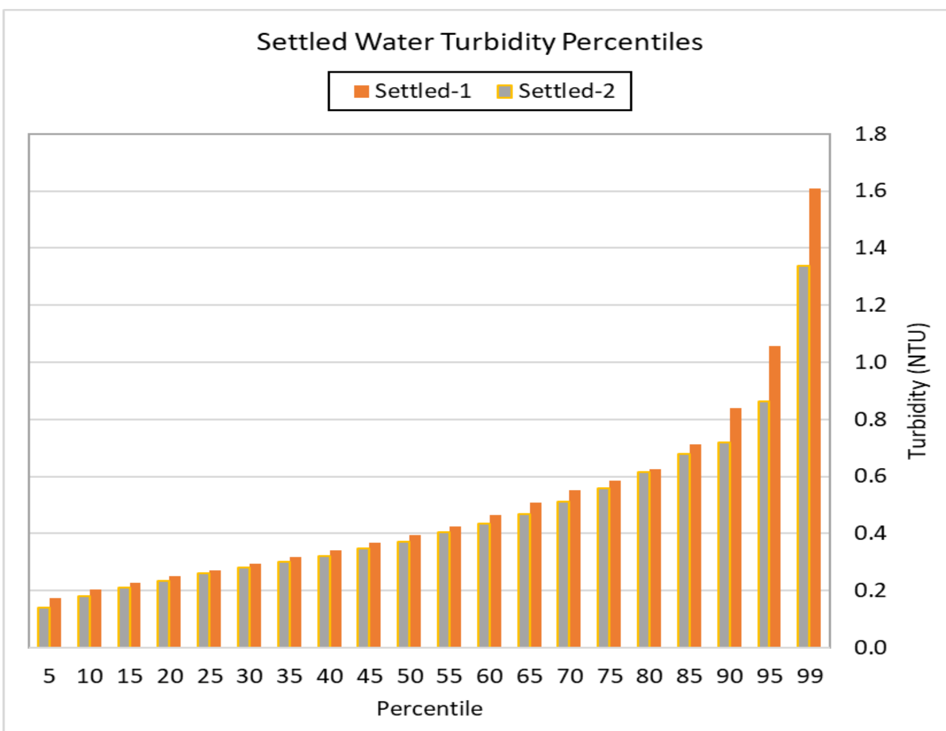


Figure 2-5: Percentile Plot of Settled Water Turbidity (2019 - 2022)

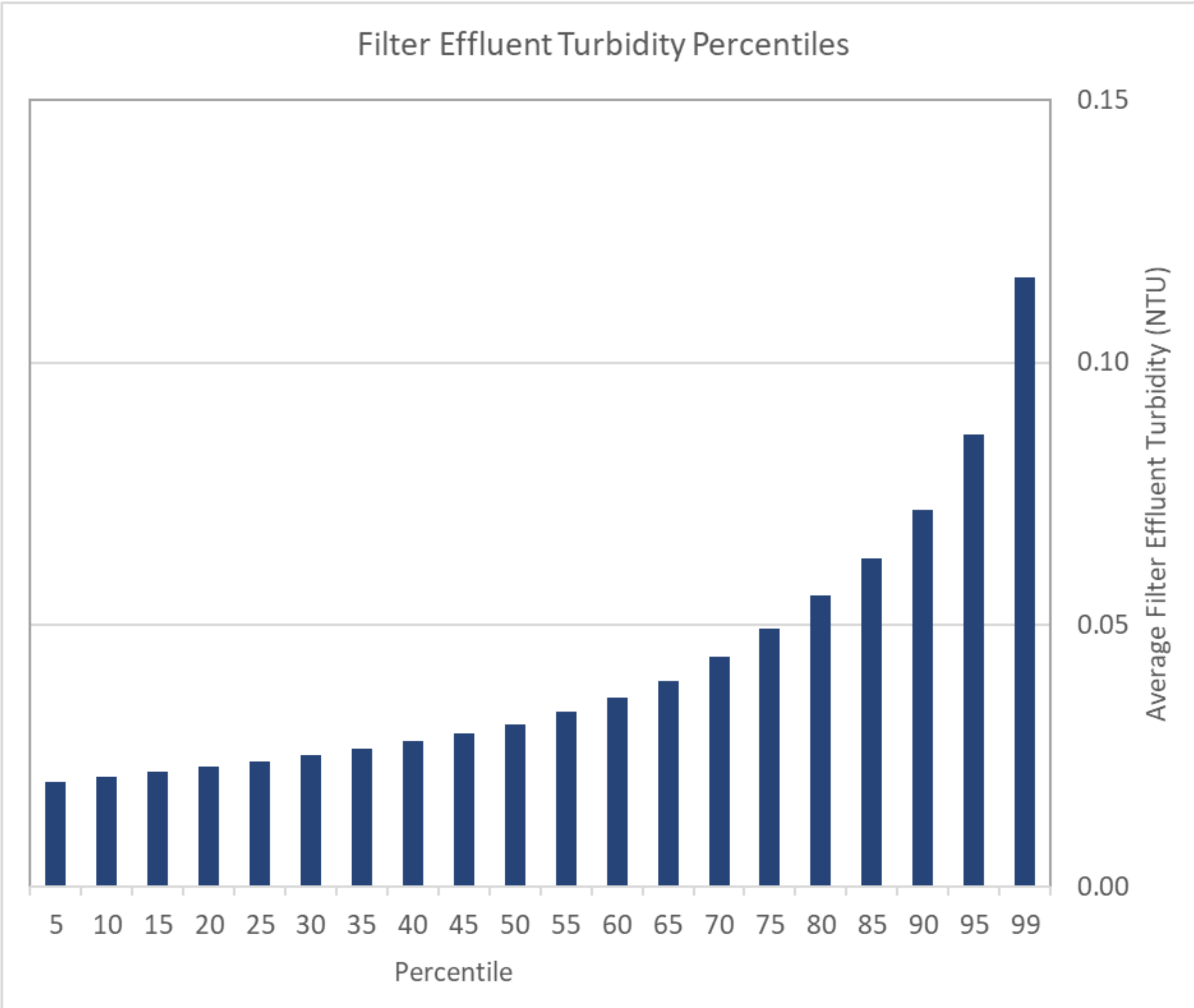


Figure 2-6: Percentile Plot of Filter Effluent Turbidity (2021 - 2022)

A review of the frequency of filter surface overflow rates (SOR) was undertaken, as presented in Figure 2-7. The data presented highlights that the filters have not been operated at loading rates above 9 m/h in the last three years.

In order to operate for extended periods of time at a higher filtration loading rate (e.g., the design loading rate of 12 m/h), it would be recommended to perform an extended full-scale stress test at 12 m/h and to also evaluate a full-scale trial using a sedimentation polymer aid. The polymer aid may allow the sedimentation process to operate at a higher loading rate as well. It is not recommended to operate the filters at a loading rate beyond the design loading rate of 12 m/h under any operating conditions; and in the winter when raw water turbidity is low and sedimentation provides low turbidity removal (i.e., the plant operates similar to a direct filtration plant), it is not recommended to operate the filters at a loading rate >10 m/h unless demonstrated through stress testing.

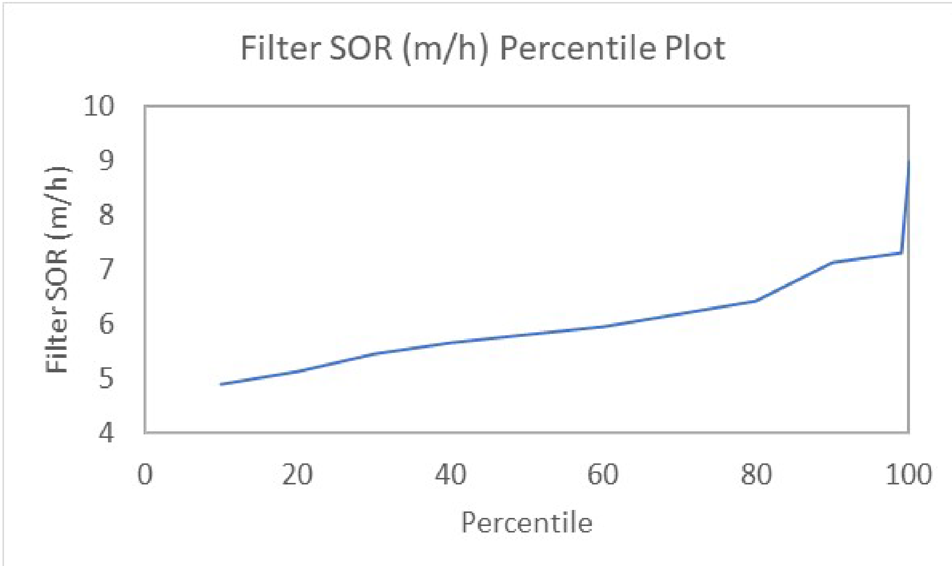


Figure 2-7: Percentile Plot of Filter Surface Overflow Rate (SOR) in Practice (2019 - 2022)

The figures below present an evaluation of potential factors impacting settled water turbidity.

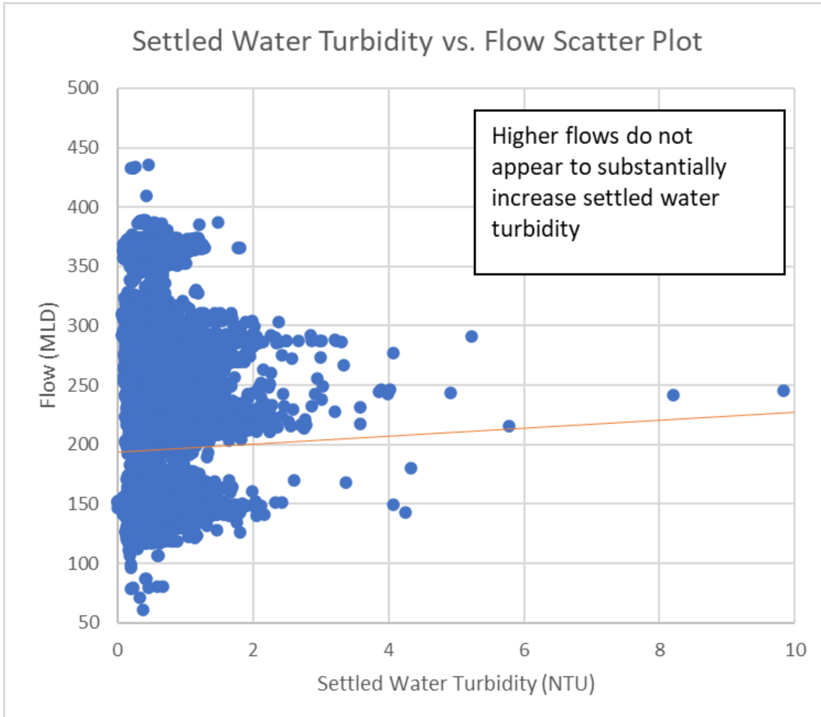


Figure 2-8: Scatter Plot of Settled Water Turbidity and Flow (2022)

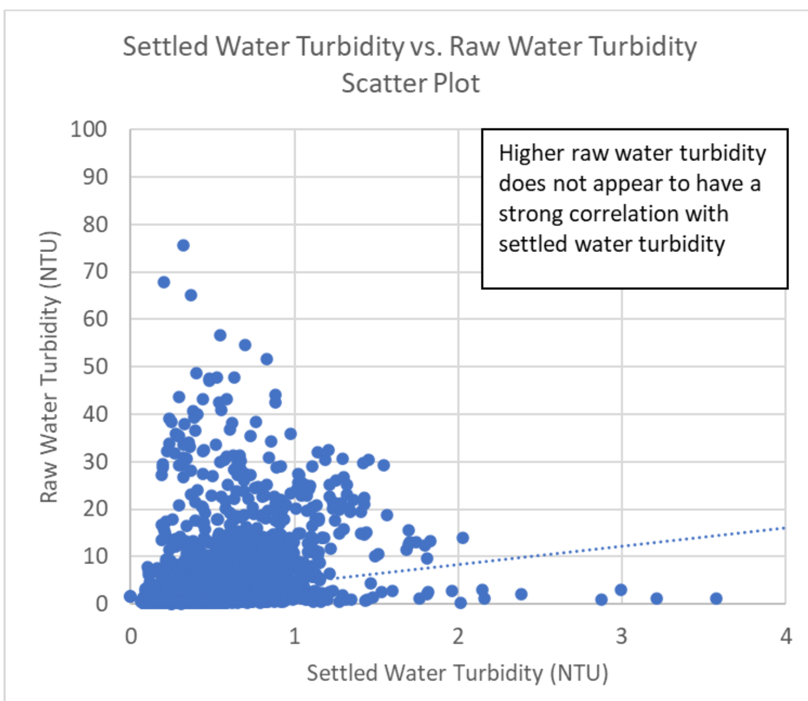


Figure 2-9: Scatter Plot of Settled Water Turbidity and Raw Water Turbidity (2022)

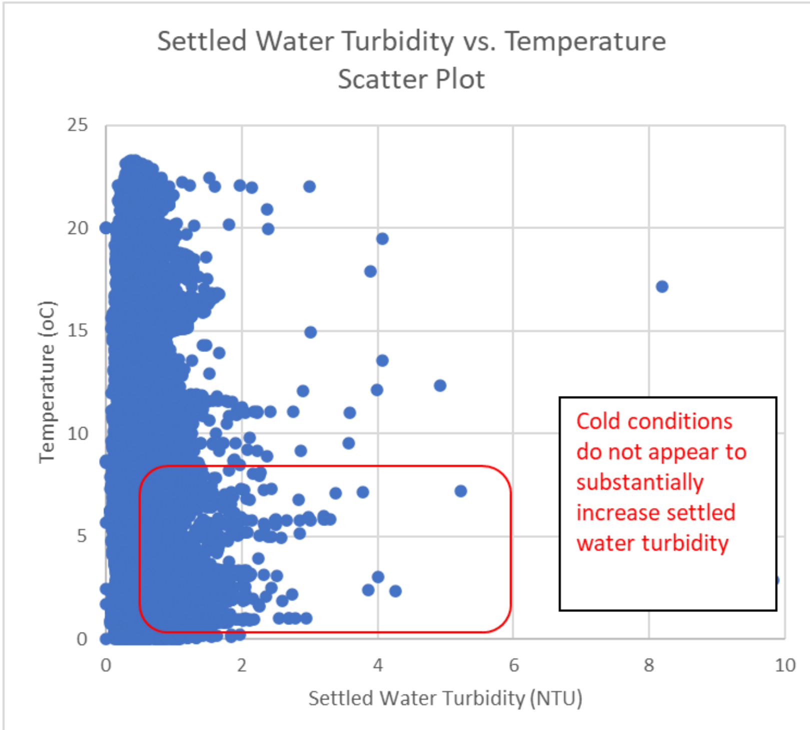


Figure 2-10: Scatt Plot of Settled Water Turbidity and Temperature (2022)

A correlation between higher flows and elevated settled water turbidity was not observed in 2022, with settled water turbidity maintained at <2 NTU at flows up to 425 MLD (Figure 2-8).

Additionally, elevated raw water turbidity was not associated with elevated settled water turbidity, suggesting that the existing sedimentation basins were able to effectively manage raw water turbidity events in 2022 (Figure 2-9).

Finally, settled water turbidity was not found to correlate with raw water temperature or show higher turbidity values during cold water conditions (Figure 2-10).

The above observations suggest that pre-treatment and sedimentation processes are currently operating well at current loading rates, but call into question the limitations on plant operation during high raw water turbidity events.

2.3 PLANT CAPACITY RISKS

To understand the capacity risks during construction, a desktop evaluation of the baseline and future (relating to the construction period) unit process capacities – including consideration for pre-treatment trains being out of service during the construction period – was undertaken. This analysis used guideline values for respective contact times and loading rates provided by the Ontario Ministry of Conservation and Parks (MECP), and the design assumptions for the original construction of Woodward WTP.

The detailed results of this analysis that support the values discussed in the subsequent process summaries are provided in the **Appendix A and B**.

A review of the likelihood and consequence of identified potential process risks during the proposed construction activities is provided in Section 5.0.

It is noted that a full-scale flow stress test was also performed in March 2023 to validate findings from the desktop review. These results are presented in Section 4.0 (4.3 and 4.4), and a review of the unit process performance during this testing is provided in **Appendix D**. To further understand the practical capacity limitations associated with pre-treatment unit processes, an extended full-scale capacity test on one train of the process is recommended.

2.3.1 Pre-Treatment / Sedimentation

Flocculation design and performance is affected by the retention time through flocculation basins. Based on the MECP guidance value of a contact time of 30 minutes, flocculation capacity is expected to be reduced to 402 MLD with two trains offline, and 603 MLD with one train offline. However, Stantec has experience with flocculation basins designed with contact times as low as 15 to 20 minutes in cold water conditions that perform well and therefore this process is expected to be able to meet the rated plant capacity of 909 MLD with a 20-minute contact time. Therefore, it is recommended to defer capital upgrades to increase flocculation capacity as the plant is expected to be able to meet AWWA and MECP performance criteria with the existing flocculation basins. Alternatively, it is recommended that the City invest in opportunities to optimize consistent pre-treatment chemistry such as the use of online streaming current to ensure good charge neutralization is achieved by accurate coagulant dosing through all raw water quality conditions.

Sedimentation performance is affected by the sedimentation area available at a given flow rate – i.e., the sedimentation loading rate. When sedimentation basins are taken offline, the treatment capacity is decreased, as shown in Figure 2-12.

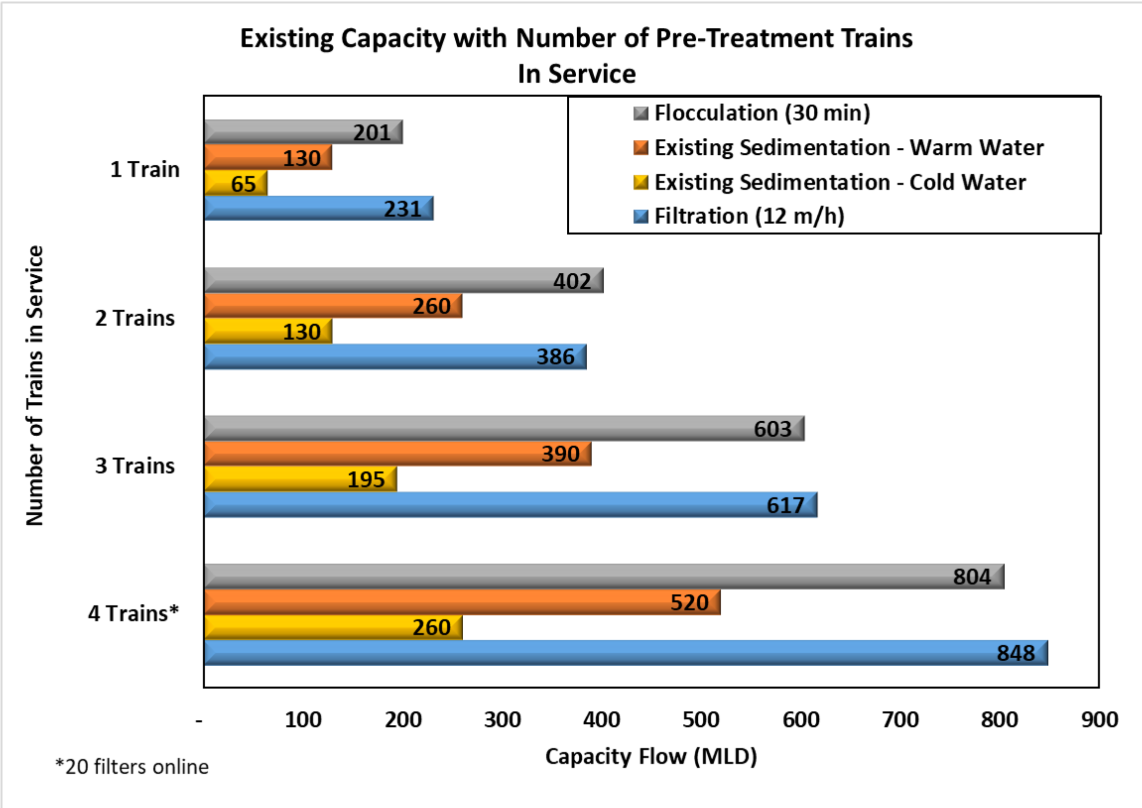


Figure 2-11: Existing Estimated Unit Process Capacities with Number of Trains Out of Service

With all sedimentation basins operating, based on guideline performance criteria, the existing treatment process is expected to be able to perform well up to approximately 520 MLD, which corresponds to an SOR of 2.16 m/hr with all four trains in service. Allowable sedimentation loading rates are generally reduced under cold water conditions, so there is the potential for declining sedimentation performance in cold water conditions at flows >260 MLD (corresponding to 1 m/hr). With one train offline, performance of sedimentation is expected to decline at plant flow rates higher than 390 MLD and 195 MLD for warm water and cold water conditions, respectively.

It should be noted that with two (2) sedimentation basins offline, sedimentation performance is expected to decline at flow rates greater than 260 MLD (1 m/hr) and 130 MLD (2 m/hr) in cold water and warm water conditions, respectively.

Given that sedimentation performance is expected to be negatively impacted by cold water conditions, it may be worthwhile to review the construction schedule to explore opportunities for sedimentation upgrades to occur in the spring and summer months when sedimentation capacity is expected to be higher with one or two trains out of service. Lower water temperatures result in higher viscosity and lower sedimentation velocities. Furthermore, there is an opportunity to complete a coagulation optimization study to determine optimal coagulant doses for varying raw water conditions.

While sedimentation is not a key unit process barrier for Woodward WTP for pathogen control, higher settled water turbidity could result in shorter filter run times as a result of either higher rates of headloss accumulation or greater risk of turbidity breakthrough. This could result in more filters out of service at a given time than anticipated and potentially negatively impact the ability of the WTP to reliably meet demands until sufficient filters can be backwashed and brought back into service. This risk presents further support to evaluate the potential benefits to a settling aid polymer.

An additional evaluation of the plant capacities achieved by alternative clarification technologies is provided in **Appendix C**.

2.3.2 Filtration

It should be noted that Woodward WTP is suspected of operating similarly to a direct filtration plant under certain operating conditions such as when raw water turbidity is very low and water temperatures are cold. Under these conditions, poor flocculation and sedimentation may be achieved with respect to particle removal and therefore the majority of particle loading to the plant must be managed by filtration. When operating under these conditions, a maximum filter loading rate of 10 m/h is recommended to maintain filtration efficiency and acceptable unit filter run volumes (UFRVs).

Based on this desktop evaluation, filtration performance is expected to be acceptable up to a potential plant flow rate of 514 MLD with only 16 filters in service (equivalent to a loading rate of 10 m/h per filter), and this could potentially be increased to 617 MLD with only 16 filters in service if a loading rate of 12 m/h can be demonstrated. This is shown in Table 2-2.

Table 2-2: Filtration Conditions with Number of Filter Quadrants Offline

	Evaluation Scenarios			
No. Filter Beds	**22**	**16**	**10**	**6**
SOR (m/h)	6.31	8.68	13.89	23.14
	9.65	13.27	21.24	35.40
	13.50	18.56	29.70	49.50
Capacity - MLD (10 m/h):	707	514	321	193
Capacity - MLD (12 m/h)	848	617	386	231
Capacity - MLD (15 m/h)	1,060	771	482	289
No. Standby Filters	2	8	14	18
Quads Online	4	3	2	1

The capacity risk of having one of the four filter quadrants (i.e., set of 6 filters) offline during construction is anticipated to be minimal. The capacity risk of having two (2) filter quadrants offline at a given time during construction could reduce plant capacity to 321 MLD (at 10 m/hr), which could potentially be increased to 386 MLD if a filter loading rate of 12 m/h can be demonstrated. It is recommended to develop a standard operating procedure for the construction periods that require two (2) filter quadrants to be offline at a given time.

It should be noted that potentially increasing the filtration loading rate to 12 m/h results in a maximum plant capacity of 848 MLD with 22 filters in service, and the capacity declines to 707 MLD at a loading rate of 10 m/h with 22 filters in service. Therefore, the overall WTP capacity will be limited to approximately 848 MLD long-term provided no expansion to the filtration process. This is not expected to be an issue with respect to projected demands to 2050 (with peak historical day of <800 MLD); however, it is not in line with the current DWWP for a rated capacity of 909 MLD.

Another opportunity to optimize coagulation, flocculation and sedimentation, particularly during construction but also in terms of general optimization, would be to evaluate the use of online streaming current or bench-scale zeta potential measurements to validate adequate coagulation chemistry to optimize filtration run times.

This review demonstrates that flocculation is not a limiting unit process for the Woodward WTP based on projected demands of 425 MLD and 650 MLD under the assumption that a 20-minute contact time would be sufficient and optimized coagulation would be practiced routinely. In general, Stantec does not support prioritizing or capital expenditures associated with additional flocculation capacity at Woodward WTP.

2.3.3 Disinfection

To evaluate the disinfection capacity of the plant, the following criteria were used:

- For a WTP with a surface raw water source, a minimum 2-log removal of *Cryptosporidium*, 3-log removal/inactivation of *Giardia*, and a 4-log removal/inactivation of viruses must be achieved at all times when the plant is supplying water to the distribution system.
- The conventional filtration system of the water treatment plant is capable of providing disinfection removal credits of 2-log for *Cryptosporidium*, 2.5-log for *Giardia* and 2-log removal for viruses. Since *Giardia* requires the longest contact time with chlorine for inactivation (as compared to viruses), a 0.5-log *Giardia* inactivation was used to determine the required chlorine contact time.
- The required concentration multiplied by time (CT) values for inactivation of *Giardia* were calculated from the US EPA equation for free chlorine, $CT_{required}$,

$$CT_{required} = 0.2828(pH)^{2.69} (C_{Cl\ residual})^{0.15} (0.933)^{(T-5)}$$

where:

$C_{Cl\ residual}$ = Free chlorine residual, mg/L

pH = Water pH at Point of Entry into distribution system, S.U.

T = Water temperature, °C

- Consideration is only given to the effective volume of the clearwells.
- Cold water conditions were used to evaluate the disinfection capacity.

- The effective contact volume of the process units was determined by using the target water level and baffling factor used in the Woodward WTP CT calculator. This factor is assigned based on the configuration of the inlet and outlet piping, operating water levels, and the degree of baffling. The baffling factor is multiplied by the operating volume to determine the effective volume for chlorine contact.

- 5th percentile raw and treated chlorine residual, 1st percentile settled water chlorine residual, 95th percentile pH and 5th percentile temperature were selected as the worst-case conditions, reflected through actual operating values.

Table 2-3 presents a summary of the data used for CT calculations.

Table 2-3: Conditions Used for Disinfection Capacity Evaluation at 450 MLD

Parameter	Chlorine Residual (mg/L)	pH	Temperature (degrees C)	Actual CT (mg-min/L) (2)	*Giardia* log-inactivation (2)	Notes (1)
Pre-Chlorination Cold Water Conditions						
Intake Pipe 1	0.51	8.25	0.2	8	0.07	5th percentile LLP intake residual, 95th percentile LLP sample pH, 5th percentile raw water temperature
Intake Pipe 2	0.5	8.4	0.2	12	0.11	5th percentile LLP intake chlorine residual, 95th percentile LLP sample pH, 5th percentile raw water temperature
Pre-Treatment (Module 1)	0.9	7.7	0.2	44	0.45	1st percentile settled water chlorine residual, 95th percentile settled water pH, 5th percentile raw water temperature
Pre-Treatment (Module 2)	0.84	7.8	0.2	41	0.42	1st percentile settled water chlorine residual, 95th percentile settled water pH, 5th percentile raw water temperature
Post-Chlorination Cold Water Conditions						
Clearwell 1	1.2	7.5	0.2	15	0.09	5th percentile clearwell 1 chlorine residual, 95th percentile HWHLP pH, 1st percentile raw water temperature
Clearwell 2	0.9	7.5	0.2	12	0.14	5th percentile clearwell 2 chlorine residual, 95th percentile HWHLP pH, 1st percentile raw water temperature
Sum, excluding post-chlorination				**61**	**0.49**	Intake 1, Module 2 only
Sum, including post-chlorination				**73**	**0.72**	Intake 1, Module 2 only

(1) Daily average SCADA data from January 1, 2019 through December 31, 2022.
(2) CT and *Giardia* inactivation calculated at current peak capacity – 450 MLD.

Based on these conditions, the disinfection process at the Woodward WTP would be able to achieve 0.5-log *Giardia* inactivation (regulatory requirement) at current peak flows of 450 MLD under worst-case conditions with all sedimentation tanks in service. Pre-chlorination contributes 0.49-log *Giardia* inactivation, while post-chlorination contributes 0.23-log *Giardia* inactivated, for a total of 0.72, which meets the 0.5-log *Giardia* inactivation requirement. If CT provided in the clearwells is not counted, then the plant would not be able to achieve 0.5-log *Giardia* inactivation at 450 MLD under worst-case conditions.

The figure below shows *Giardia* inactivation provided through each module based on plant flow and number of sedimentation basins available. It is Stantec's understanding that the current CT calculators do not account for contact time in the clearwells, this figure therefore does not account for CT provided in the clearwells.

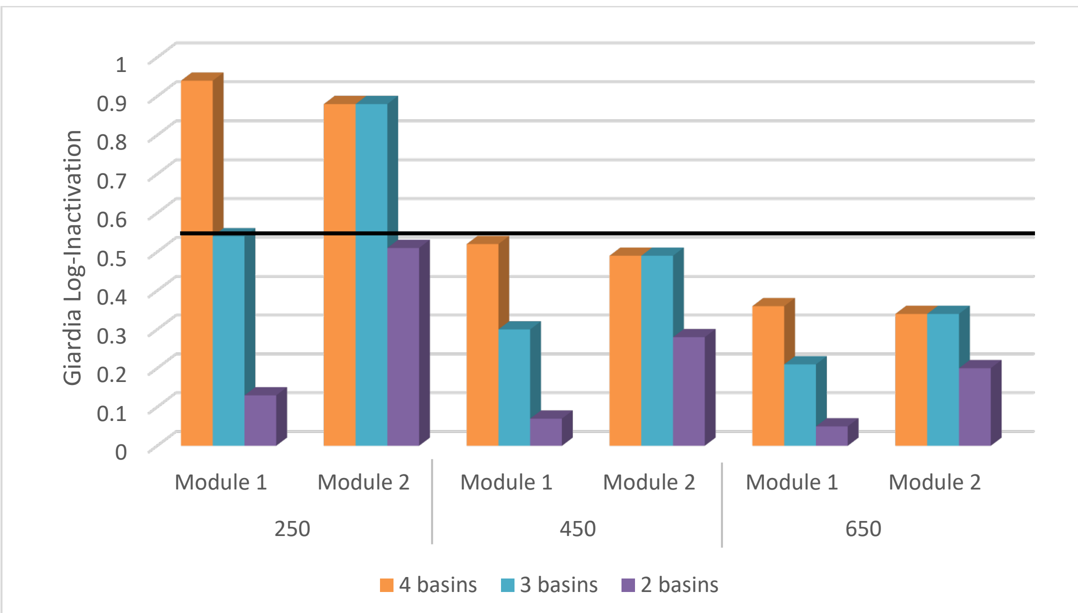


Figure 2-12: Giardia Log-Inactivation with Increasing Flow and Reduced Sedimentation Capacity

Based on the available CT, under worst-case conditions the plant would be limited to the flows shown in **Figure 2-13**, dependent upon the number of sedimentation tanks in service and whether the clearwells are counted.

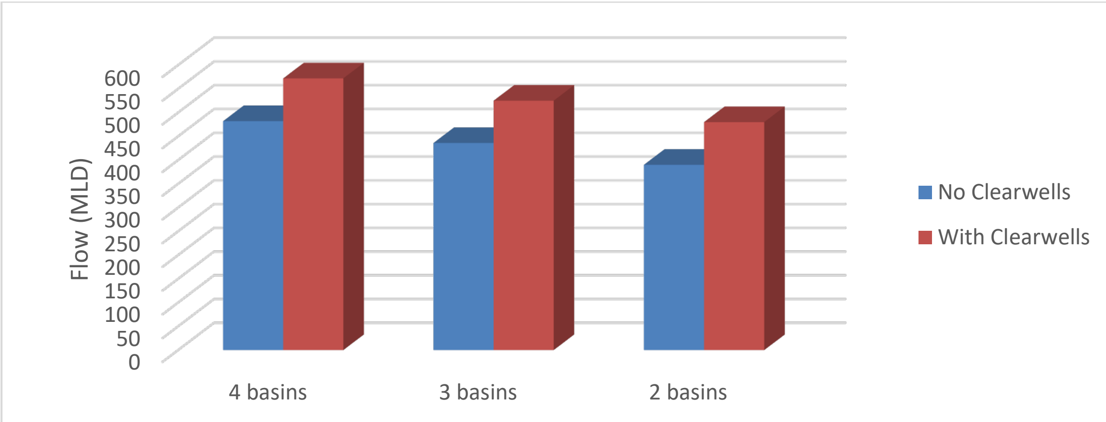


Figure 2-13: Plant Flow Capacity Based on CT Restrictions

3.0 OPPORTUNITIES / OPTIONS FOR POTENTIAL BACKUP SYSTEMS

Stantec contacted Suez to inquire about use of their MPAK mobile system for provision of temporary supplemental treatment capacity during construction works.

The systems offer various treatment technologies including Actiflo^{TM}, ultrafiltration, and ion exchange. Suez offers temporary trailers that can mobilize to site to provide treatment capacity during maintenance and construction activities.

Based on discussions, it was concluded that the Suez mobile systems would not be able to supply sufficient capacity to replace a 95 MLD sedimentation tank and are therefore not a suitable alternative to a temporary 5th sedimentation tank.

4.0 EVALUATION OF FLOW SCENARIOS ASSOCIATED WITH UPGRADES

4.1 FLOW SEQUENCING DURING VARIOUS CONSTRUCTION STAGES

The proposed construction schedule requires the plant to operate in a non-typical flow configuration, which is anticipated to result in higher than typical flowrates in portions of the plant. Stantec has identified two hydraulic increase cases (detailed in Technical Memo #1) as summarized below.

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.

Given the recommendations within this document and by other firms, Stantec has prioritized hydraulic increase #2 for preliminary assessment and investigation.

4.2 PRELIMINARY HYDRAULIC MODEL

Stantec constructed a preliminary hydraulic model in the Stantec Hydraulic Analysis and Design System (HADeS v. 4.3) using existing hydraulic grade line (HGL) and plant design information for the west (Filters 1 through 12) and east (Filters 13 through 24) filter galleries. We have noted that, due to a bulkhead installed in the filter effluent channels, all of the west side filter effluent flows through the original channel into clearwell 1, while all of the eastern effluent will flow through the larger channel into clearwell 2.

The results of our analysis are shown in **Figure 4-1** and **Figure 4-2**. Our preliminary model predicts that, under typical conditions, the filter effluent channels will operate under a partially filled condition. Under a partially filled condition, filter backpressure at the effluent valve will be effectively decoupled from the clearwell level and hydraulic resistance within the effluent channel. Above certain combinations of clearwell levels and channel flowrates, the water level is predicted to rise to the top of the effluent channel. Beyond this point, the hydraulic resistance of both the effluent channel and clearwell level will add to that of the filter. This will result in further opening of the filter effluent valve for comparable flowrates, which may reduce maximum filter runtimes due to built-up headloss compared to lower flow rates.

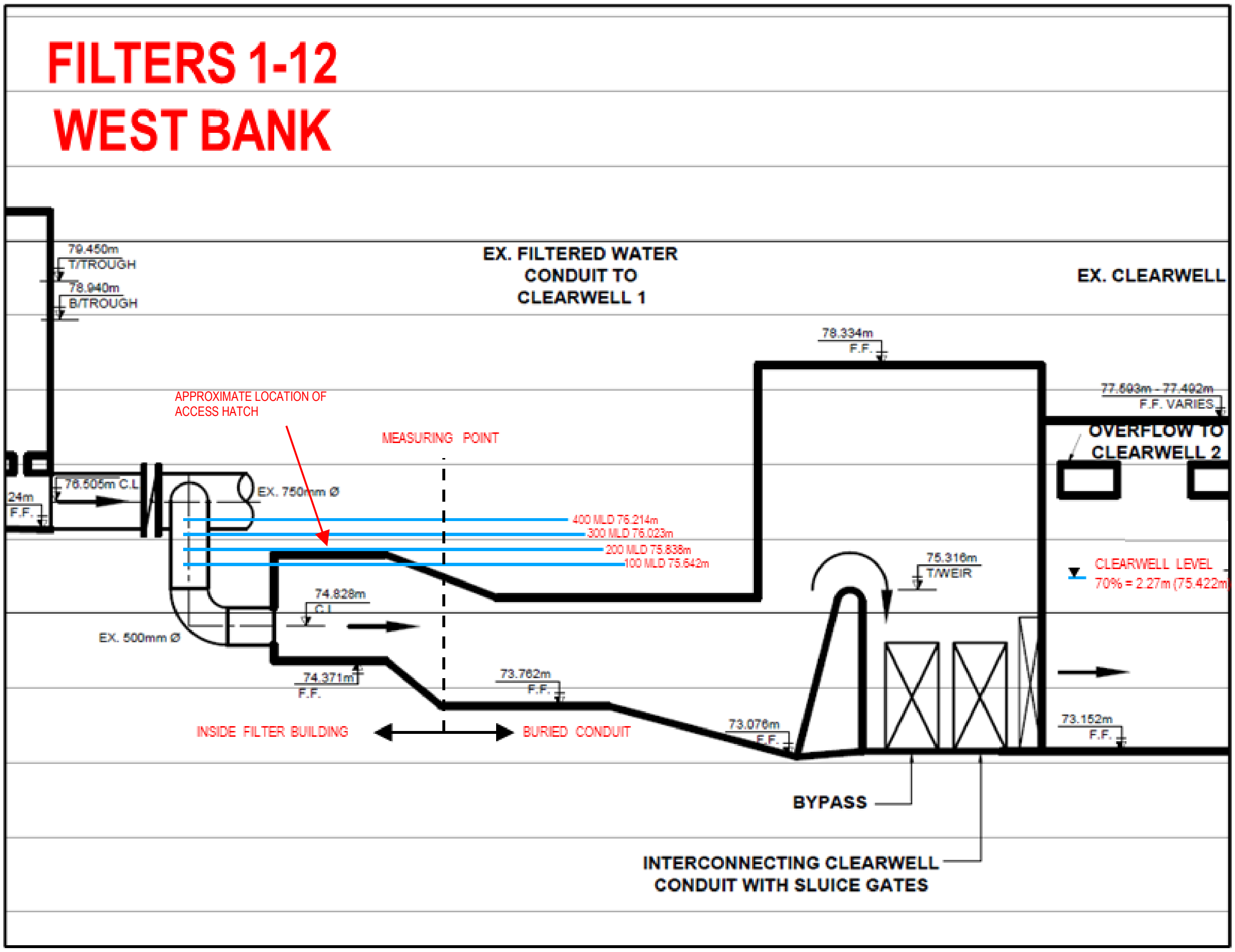


Figure 4-1 Predicted running water depths in the west filter bank (filters 1 through 12) effluent channel under various flowrates with a clearwell depth of 2.27 m.

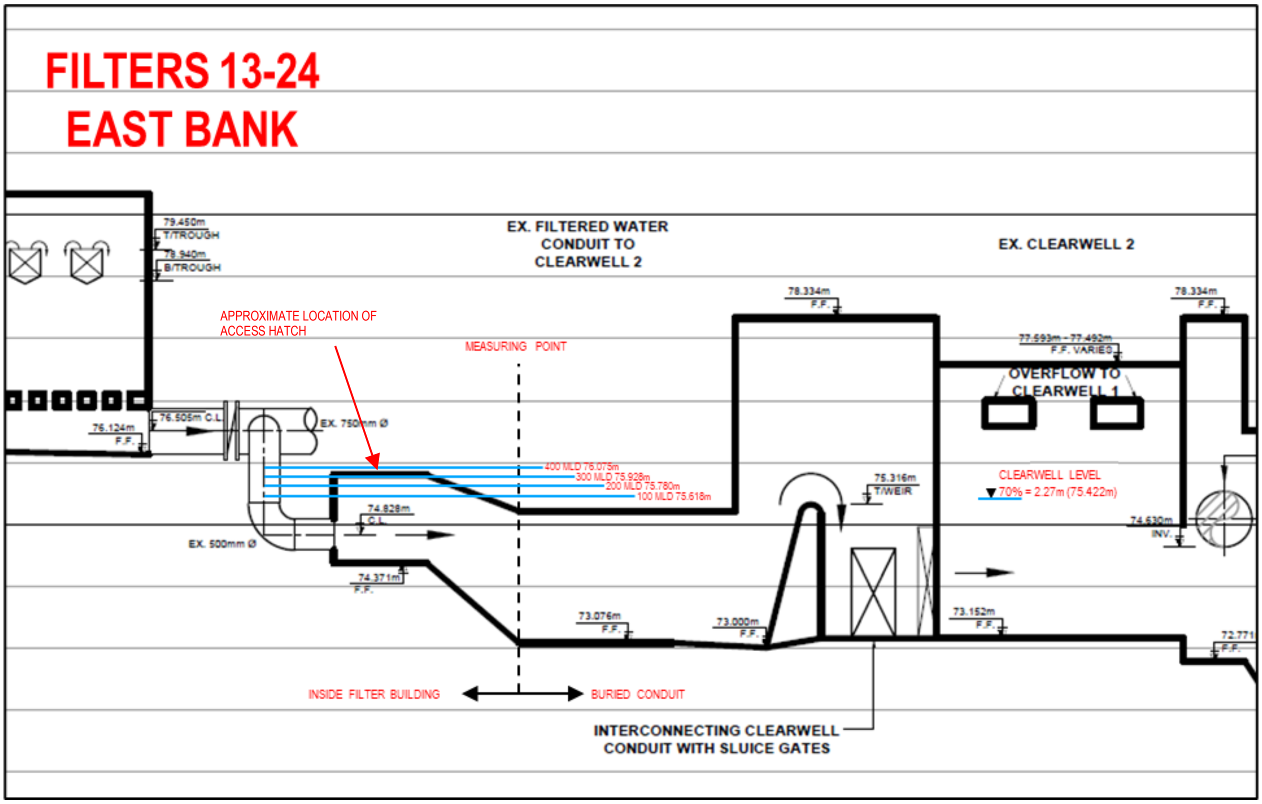


Figure 4-2 Predicted running water depths in the east filter bank (filters 13 through 24) effluent channel under various flowrates with a clearwell depth of 2.27 m.

4.3 HYDRAULIC STRESS TESTING

Stantec participated in plant stress testing on March 27, 2023 at the Woodward WTP, which aimed to:

1. Understand the effect of higher than typical flowrates on the plant with a single filter quadrant out of service.
2. Verify and validate any hydraulic bottleneck within the system, specifically downstream from the filters as described within Section 4.2.

To do this, plant operators adjusted the flow at western and eastern sections of the plant according to **Table 4-1**, which simulated the flow that would be seen in each effluent channel if one quadrant on the west side of the plant was out of service. This is analogous to what is expected during the filter upgrade portions of the proposed construction scope.

Table 4-1: Stress Testing Scenarios

Low Lift pump flowrate (MLD)	**Scenario: Western Bank (filters 1-6 of 7-12) out of service**		**Notes**
	Western Effluent Channel Flowrate (MLD)	*Eastern Effluent Channel Flowrate (MLD)*	
250	83	167	
300	100	200	
350	117	233	
400	133	267	
450	150	300	
480	160	320	Filters 1 through 6 placed out of service
500	167	333	Filters 1 through 6 placed out of service
600	200	400	Filters 1 through 6 placed out of service

It should be noted that during the stress test, the flowrate balance between each side was achieved by taking various filters out of service, to keep filters operating at nearly the same loading rate as was seen during the 250 MLD run. Above the 480 MLD influent flowrate run, filters 1 through 6 were taken out of service and the flowrate balanced amongst the remaining filters to simulate conditions expected during the retrofit. Due to existing conditions, filters 21 and 22 were out of service for the duration of the test.

Two filters from each bank were chosen for analysis as these were online for the length of the test. These filters were filter 11 (west bank) and Filter 13 (east bank) and are situated in similar locations with respect to the effluent channel. Graphs of the pressure drop across the effluent valve and the clearwell (for the respective filter) level are shown as

Figure 4-3 and **Figure 4-4**. Pressure drop was calculated using manufacturing Cv versus % open graphs. The pressure drop across the valve is a direct result of the valve open position.

Filter #11, in the west bank, shows two distinct regions of pressure drop, termed **low slope** (loss of 0.124 kPa of headloss per MLD) and **high slope** (0.282 kPa of headloss per MLD). Thus, in the high slope region, the valve must open further than in the low slope region to maintain a desired flowrate. The transition between the regions is thought to occur because of additional resistance downstream of the valve above ~130 MLD and a clearwell #1 level of 2.55 m. This added resistance is likely due to the channel being surcharged, as indicated from the HADeS simulations in **Figure 4-1** described earlier. Note that the flowrates mentioned here refer to the flow within the filter effluent channel, rather than the full plant flowrate.

As a result of these distinct regions, the operation margin to a 100% open valve will be reduced to a greater extent than what may be expected at lower channel flows. For the data shown for filter #11, the reduction in margin is in the order of 7%. Thus, operating in the **high slope** range, the valve for filter #11 is expected to reach 100% open 7% faster than in the low slope range. Filter #11 had a filter age of approximately 25 hours during this test (nearly 50% of the time to backwash). Under these conditions, the effluent valve is expected to be open to 78% with a channel flowrate of 200 MLD. Further, given this filter age, the valve is predicted to be 100% open at a flowrate of 266 MLD in the western effluent channel.

In contrast, filter #13 in the eastern bank (**Figure 4-4**) shows a single slope region for entirety of the flow range studied. It is Stantec's opinion that this is because the filter effluent channel is not surcharged, effectively de-coupling the filter effluent from the hydraulic resistance effects of the effluent channel or clearwell level. Note that the surcharge level for clearwell #2 is predicted to be ~350-375 MLD (**Figure 4-2**). These results suggest that there is no hydraulic impact of running the east side channel to 400 MLD.

Given the age of filter #13 (19.7 hours at the end of the filter test), it is expected that the effluent valve will be 100% open at an eastern channel flowrate of 639 MLD.

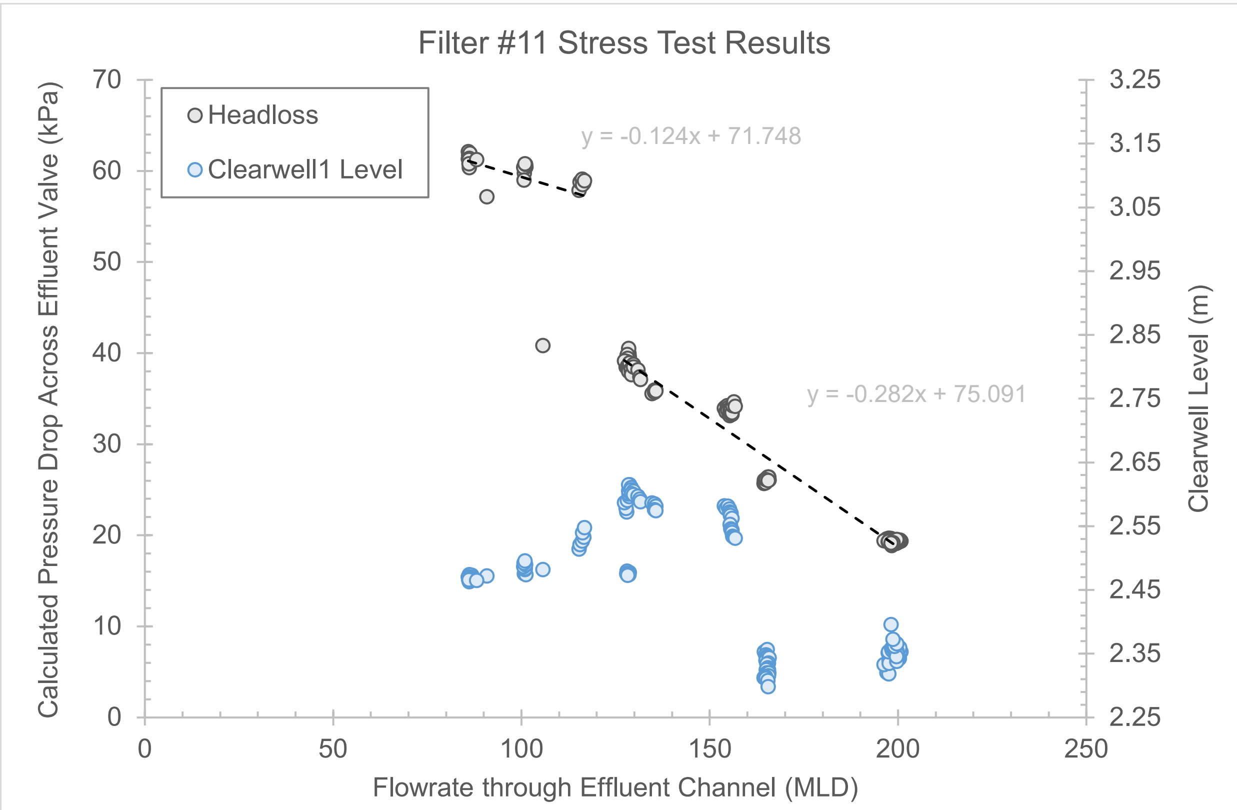


Figure 4-3: Filter 11 (West Bank) Stress Test Results

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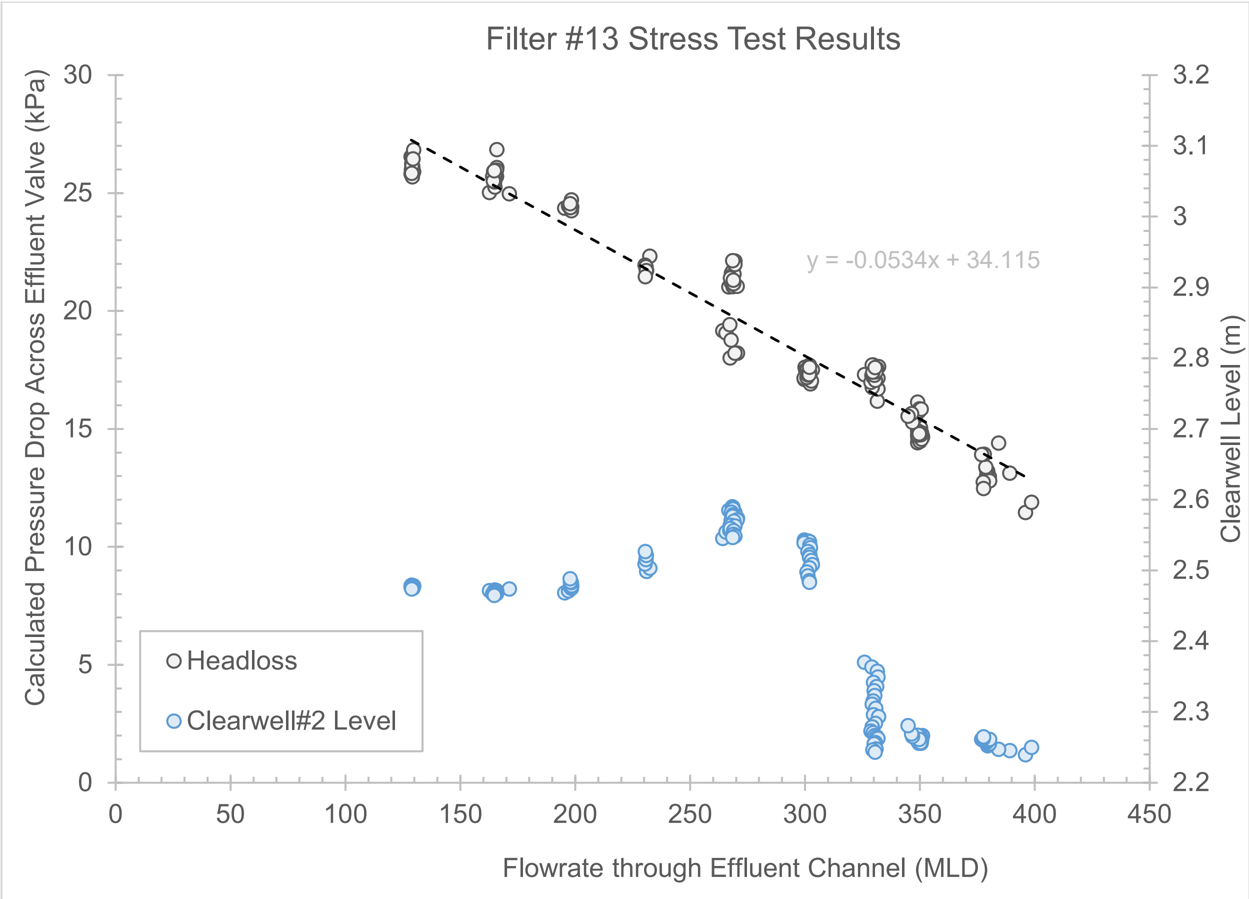

Figure 4-4: Filter 13 (East Bank) Stress Test Results

4.4 SECONDARY STRESS TESTING RESULTS

During the stress test, it was observed that an operational bottleneck occurred between 575 and 600 MLD total plant flow. At these plant flowrates, chemical system high flow alarms were received, suggesting that the chlorine dosing could not be increased without investigation. It was understood that one pre-chlorinator and one post-chlorinator were operating at maximum capacity in this range, precluding further increases in total plant flowrate without sacrificing CT.

Surcharging of the filter effluent channel hatch was not observed. Anecdotally, it is understood that this has happened in the past. Stantec believes that this may have been caused by bolts not tightened to specification, as the watertight hatch is designed to withstand water pressure.

We further understand that the stress test may not have been able to proceed during periods of warmer ambient temperatures. Stantec was informed that the VFD room for the high lift pumps contains a potentially inadequate HVAC system and cannot accommodate high flowrates for extended periods of time due to temperature rejection issues.

Finally, we understand that there have been concerns regarding cavitation of the high lift pumps limiting their capacity. Stantec observed the high lift pumps operating between 550 and 575 MLD during the stress test. On site, staff noted the presence of characteristic sounds of cavitation coming from the intake of the pump, as well as discharge pump pressures oscillating by roughly +/-10 psi(g). Based on operator discussions, we understand that this concern is not present at lower flowrates (below 400 MLD discharge). Although the characteristic sound of cavitation is present, it is most noticeable at the intake of the pump, rather than at the pump casing.

We recommend further testing and investigation on VFD temperature reduction, chemical line flowrates, and cavitation to understand impacts on discharge flowrates.

5.0 RISK MATRIX

A list of potential risks and consequences was identified for the proposed construction activities with respect to plant performance and potential flow rates. The hazardous events were then ranked according to their associated risk. The two main elements considered for ranking were the likelihood of occurrence and the severity of occurrence. **Table 5-1** and **Table 5-2** (from the MECP DWQMS[2] Guide) elucidate the rating system.

Table 5-1: Risk Scoring for Event Likelihood

Description	Likelihood of hazardous event occurring	Rating
Rare	May occur in exceptional circumstances; rarely expected to occur or have an impact.	1
Unlikely	Could occur during certain operating conditions.	2
Possible	Potential to occur or have an impact at one or more times during construction.	3
Likely	Expected to occur on a regular basis (monthly to quarterly) during construction.	4
Very Likely	Expected to have an impact throughout the construction activities.	5

Table 5-2: Risk Scoring for Event Consequence

Description	Consequences of hazardous event occurring	Rating
Insignificant	Insignificant performance impact; little or no health risk	1
Minor	Limited performance impact; minor health risk	2
Moderate	Potential for performance impact at some operating conditions; health impact on small part of the population	3
Major	Large or expected performance impacts through construction schedule; part of population at risk	4
Catastrophic	Major or continuous performance impacts; or potential for complete system failure	5

Risk is the lack of certainty about the outcome of a particular choice. Statistically, the level of negative risk can be calculated as the product of the probability that the harm occurs multiplied by the severity of that harm. In practice, a risk matrix is a useful approach when either the probability or the harm severity cannot be estimated with accuracy and precision. Considering this approach, a risk matrix rating risks according to the likelihood of an event occurring and the consequence of this event occurring was developed as shown in **Table 5-3**.

[2] https://www.ontario.ca/page/ontarios-drinking-water-quality-management-standard-pocket-guide

Table 5-3: Woodward WTP Risk Matrix

		Consequence				
		Catastrophic (5)	Major (4)	Moderate (3)	Minor (2)	Insignificant (1)
Likelihood	Almost Certain (5)	25	20	15	10	5
	Likely (4)	20	16	12	8	4
	Moderate (3)	15	12	9	6	3
	Unlikely (2)	10	8	6	4	2
	Rare (1)	5	4	3	2	1

Risk Rating	
15 - 25	**High** - Constitutes a Significant Risk. Managing this risk is a priority and additional risk control measures are needed. Interim steps may be needed prior to implementing permanent solutions
5 - 14	**Medium** - Constitutes a Moderate Risk with Caution. Investigate if additional measures can reduce risk even further.
1 - 4	**Low** - Constitutes a Tolerable Risk. Monitoring is required to ensure controls are maintained and effective.

Table 5-4 describes the risk rating for the Woodward WTP Phase 2 Upgrades based on the consequence and likelihood of an event. The risk matrix summarizes the likelihood and consequences of risks associated with major component upgrades and existing conditions for the WTP.

Table 5-4: Woodward WTP Phase 2 Upgrades Risk Matrix Results

Item #	Component	Root Cause	Risk	Likelihood	Consequence	Risk Rating	Remediation
1	Typical Operating Flow Regime • Frequent on/off cycles • No equalization of filter flows	Distribution system residual issues	Increased stress on major unit processes; unoptimized filter operation – frequent start-stop is hard on infrastructure and filter underdrains and can minimize filter run-times; without optimization plant required to run at higher peak flows through construction with capacity restrictions	4	3	12	Complete a study to address distribution system residual issues to enable the plant to run continuously at lower flows. Opportunity to operate at lower peak flows during construction activities that require pre-treatment processes to be offline.
2	Flocculation • Existing flocculation capacity appears to be adequate for ≥900 MLD	Design	Flocculation upgrades increases complexity of construction and extend schedule, unsupported capital expenditure. **Financial risk** with no demonstrated performance or regulatory benefit. The AECOM construction cost estimate for the flocculation upgrades is $5M.	4	4	16	Remove tertiary flocculation stage from Phase 2 Upgrades scope

Item #	Component	Root Cause	Risk	Likelihood	Consequence	Risk Rating	Remediation
3a	Sedimentation • 1 – 2 tanks offline for extended period	Capacity limitation	Potential to impact CT calculation with sludge accumulation in sedimentation basins, and potential for floc accumulation and carry-over into filtration at higher flow rates. Potential for overlap of scheduled sedimentation basin maintenance when only 2 trains are in service.	5	3	15	Investigate possibility of implementing DAF and locating in lower stores footprint to expedite clarifier upgrades construction staging and increase sedimentation capacity in smaller footprint. Evaluate opportunities to have sedimentation tanks offline in warm water conditions when sedimentation performance is expected to be more robust.
3b	Sedimentation • Incomplete evaluation for best available technology	Design	Selected technology may be susceptible to organics and algae upsets. Capacity achieved by proposed upgrades will not provide rated capacity with one train offline. Proposed technology could require substantial labor and maintenance for plate cleaning and/or operation and maintenance of an aeration system for plate cleaning which may not reduce labor burden associated with existing maintenance of sedimentation basins.	4	3	12	Potential to improve management of algae and organics with high-rate clarification technology. Potential to increase clarification capacity in smaller footprint making land available for other future potential uses (e.g., treatment of emerging contaminants). Potential to minimize and/or streamline future maintenance and operational procedures associated labor burden relative to existing process.

Item #	Component	Root Cause	Risk	Likelihood	Consequence	Risk Rating	Remediation
3c	Sedimentation • Cost risk regarding potential for significant concrete work	Age	There is a financial risk associated with the potential for significant concrete rehabilitation work within the existing sedimentation basins.	2	3	6	Complete recommended testing to confirm structural integrity of concrete including carbonation testing and pH testing.
3d	Temporary 5th Sedimentation Tank • Reuse of lamella plates	Complexity	Damage to plates in transport preventing reuse; financial	3	2	6	Plan for loss of 10-15% of modules in transport; set aside $240k for replacement.
4a	Filtration • 2 filter quadrants offline for a 1-month period	Capacity limitation	Desktop evaluation suggests capacity could be limited to 320 MLD. Could result in short filter run times or additional capacity restrictions if several filters in two quadrants enter backwashing at the same time.	5	4	20	Modify construction plan to reduce amount of time with two filter quadrants offline. Push filter upgrades ahead in schedule to allow for operation of modern filter beds and backwash systems during filter capacity restrictions. Develop SOP for operating plant at a 320MLD restriction with 2 filter quadrants online.
4b	Filtration • Backwash limitations during filter upgrades	Capacity Limitation	If a backwash is called for while a single quadrant is out of service and the plant is running at a high flowrate, the filter design loading rate may be exceeded.	5	4	20	Monitor operations for periods where this condition is expected to occur, if possible, increase plant throughput to increase supply in clearwells and reduce low lift pump rates to allow backwashing to occur without exceeding filter loading rates.

Item #	Component	Root Cause	Risk	Likelihood	Consequence	Risk Rating	Remediation
5	Disinfection • Plant relies on pre-chlorination disinfection for CT	Capacity limitation	Reduced disinfection capacity due to sedimentation upgrades	4	5	20	Increase minimum chlorine residuals, count disinfection credits from filtration and clearwells. Push UV upgrades ahead in schedule.
6a	High lift pumps • Cavitation occurs at flows over 450 MLD	Reported to be influent pipe size	Inability for plant to pump expected flows. Note flow testing was conducted 03/27/2023 and pumps were able to pump 600 MLD though cavitation was occurring.	4	4	16	Confirm root cause is size of influent pipes and correct as part of upgrades. Address on/off cycles, allowing the plant to run consistently at lower flow rates. Understand nature and location of noise – perform risk and maintenance analysis for continued and extended operation.
6b	High lift pumps • High lift VFDs unable to operate at top capacity during summer months	Inadequate HVAC	Potential forced reduction in high lift capacity during warmer months	5	2	10	Investigate temperature effects within VFD room and upgrade the HVAC system if determined cause. Potentially use temporary air conditioners if required. It is Stantec's understanding that this is currently in design with a consultant.
7	Complexity of Overall Conceptual Design	Construction plan and schedule	Delays to schedule, financial risk	4	3	12	Separate construction into two phases, prioritizing protection of public health.

6.0 RECOMMENDATIONS AND CONCLUSIONS

The Stantec team has evaluated the process risks associated with the current proposed Phase 2 upgrades.

Raw water and filtered water flow rates were reviewed. It was noted that there was a significant flow discrepancy between raw water and filtered water flow, likely due to the Module 1 raw water flow meter issues. Design for the replacement of the flow meter is in progress. Frequent start-stop cycles were observed in the flow data. Granular media filtration performs best with consistent operation rather than in a start-stop approach. This type of operation may be hard on filters and require more backwashing, resulting in higher filter headloss or turbidity breakthrough impacting performance and efficiency. The flow evaluation presents an opportunity to evaluate the total plant production needs in an effort to peak-shave high plant flow operating scenarios to minimize risks during construction and operate the plant more in line with best practices.

Plant performance using the AWWA Partnership for Safe Water Goals was reviewed. The results indicate that raw water turbidity is low and settled water turbidity and filtered water turbidity are generally low and well managed. However, there is an opportunity to minimize risks of potentially elevated filter effluent turbidity events by constructing FTW piping and optimizing filter backwashing to minimize filter ripening spikes and improve filter cleaning during backwashing. It was noted that filtration has not been operated at a loading rate > 9 m/hr in the past three years; in order to operate for extended periods at higher loading rates during construction, an extended full-scale stress test at 12 m/hr is recommended. It may be of interest to approach this stress testing in stepwise manner, by initially testing 10 m/h, followed by 11 m/h and finally 12 m/h should the first two tests demonstrate the ability to maintain unit filter run volumes at greater than 250 m^3/m^2.

The existing sedimentation treatment process is expected to perform well up to approximately 520 MLD, with the potential for declining performance in cold water conditions at flows greater than 260 MLD. With two sedimentation basins offline, performance is expected to decline at flowrates greater than 130 MLD and 260 MLD in cold and warm water conditions, respectively. Higher settled water turbidity could result in shorter filter run times as a result of higher headloss accumulation rates and greater risk of turbidity breakthrough. Filtration performance is expected to be robust to a potential plant flow rate of 514 MLD with only 16 filters in service; this could potentially be increased to 617 MLD with only 16 filters in service if a loading rate of 12 m/hr can be demonstrated. The capacity risk of having one filter quadrant offline during construction is expected to be minimal, however, having two filter quadrants offline could reduce plant capacity to 321 MLD – or potentially 386 MLD if a filter loading rate of 12 m/hr can be demonstrated. The sedimentation basins provide the majority of the CT required for 0.5-log *Giardia* inactivation. With the potential for two sedimentation basins offline during construction, CT could limit plant production under worst-case conditions. It was noted that CT provided through the clearwell is not included in the current CT calculator.

Plant stress testing was conducted on March 27, 2023 to understand the hydraulic limitations associated with higher flowrates with one quadrant out of service, and verify and validate any hydraulic bottlenecks within the system downstream of the filters. The results of the stress test demonstrated an operational bottleneck between 575 – 600 MLD due to chemical dosing high flow alarms; the final chlorinator was operating at maximum capacity precluding further increases in plant flowrate. Surcharging in the filter effluent channel hatch was not observed during the stress test. Some characteristic sounds of cavitation were observed at the high lift pump intake when operating at these flows. Additional analysis of the treatment performance response during this stress testing is provided in **Appendix D**.

A risk matrix was developed to evaluate the likelihood and consequence of the risks identified in this evaluation. The following recommendations have been developed:

- Backwashing during filter upgrades may result in design filter loading rate exceedances. Operations should be monitored for periods where this condition is expected to occur.
- Raise minimum pre-chlorine residuals through pre-treatment such that sufficient contact time is provided under cold water conditions with reduced sedimentation capacity. UV upgrades could be moved ahead in the schedule.
- Prioritize upgrades to the filtration process including upgraded underdrains and backwash technology, optimize the filter backwash sequence, and implement FTW infrastructure ahead of sedimentation upgrades.
- Perform an extended full-scale stress test at a filtration loading rate of 12 m/hr, and complete a full-scale trial using a sedimentation polymer aid. The polymer aid may allow sedimentation to operate at a higher loading rate, which will be beneficial for the construction period when capacities are limited.
- Develop an SOP for operating the Woodward WTP with only two (2) filter quadrants (or 10 filters in service with 2 standby) where the potential plant capacity may be limited to approximately 320 MLD.
- Remove tertiary flocculation stage from the Phase 2 upgrades scope.
- Conduct further testing and investigation of VFD temperature reduction, chemical flowrates, and cavitation to understand impacts on discharge flowrates.
- Evaluate the use of online streaming current or bench-scale zeta potential measurements to validate adequate coagulation chemistry to optimize filtration run times.
- Given the City is considering DAF as an alternative clarification process, evaluate the feasibility and cost-benefit relative to sedimentation with lamella plates, and conduct pilot testing to validate design loading rate.
- Complete a detailed evaluation of sedimentation/clarification technologies. Investigate the possibility of implementing DAF and locating in the lower stores footprint. Stantec understands this is currently under review with a consultant, including structural integrity of the sedimentation tanks and soil bearing capacity.

- Review the construction schedule to explore opportunities for sedimentation upgrades to occur in the spring and summer months when sedimentation capacity is expected to be higher with one or two trains out of service.
- Investigate opportunities to equalize total filter flow rates to reduce high WTP flow conditions, and minimize plant shut-downs and filter start-stop operation. With flow peak shaving, the construction schedule could be modified if higher capacity is not required through the summer as has been observed in recent years.
- Replace Module 1 Flow Meter (underway) and validate that SCADA total raw water flows are in line with total filter flows.
- Complete recommended testing to confirm structural integrity of concrete including carbonation testing and pH testing.
- Plan for loss of 10-15% of plate modules in transport between temporary sedimentation tank and tank 2; set aside $240k for replacement.

APPENDIX A
PLANT CAPACITY ANALYSIS WORKBOOK

WOODWARD – FULL-SCALE WATER TREATMENT PLANT STRESS TESTING

Objectives

The objective of the full-scale stress testing is to evaluate capacity limitations associated with the existing filtration process in its pre-construction condition to understand potential flow restrictions during Phase II upgrades. The objective of this testing is not to optimize filter UFRV although this could be investigated using a similar protocol / approach, following filter upgrades with modern underdrains and air scour equipment, in concert with optimize coagulation chemistry.

Each stress test will be trialed with all existing four (4) clarification trains in service- but only two filter quadrants of the process (i.e. 12 filters).

The preferred filter quadrants for testing are at the discretion of plant operations. It is recommended to test quadrants that have representative performance of the filtration process and no known filter condition or operating issues. The other quadrants can either be taken offline, maintained at a low flow-rate or other configuration as pre-determined by the City and operations to accommodate distribution demands and storage levels, clearwell levels, or other supply considerations.

The full-scale flow capacities planned to be tested at Woodward WTP include the following:

1. **370 MLD** (185 MLD per quadrant), representing current predicted process potential performance limitation for filtration with two filter quadrants out of service and a target loading rate of 11 m/hr.
    - **To achieve these target filtration loading rates, it is recommended to run the testing with 11 filters online and 1 in standby.**

2. **405 MLD** (202.5 MLD per train), representing a filter loading rate of 12 m/h (with 11 filters online and 1 in standby); to be tested should Trial 1 at 370 MLD be successful.
    - **To achieve these target filtration loading rates, it is recommended to run the testing with 11 filters online and 1 in standby.**

Stress testing at approximately 370 MLD and 405 MLD

This component of the stress test requires that the plant is operated at a constant flow rate of 370 MLD for a duration of as long as possible (e.g., until 2 of the 11 filters enter backwash), or for a minimum period of 24 hours, whichever is shorter. Prior to initiating the test, filters in the test quadrants should be backwashed to allow for the most robust testing conditions possible. Should one filter enter backwash during the testing, the standby filter in the test quadrant could be brought online in an effort to extend the testing.

Should testing at 370 MLD with two filter quadrants prove successful in terms of maintaining filter UFRV > 200 m^3/m^2, then the testing is to be repeated at a flow condition of 405 MLD.

It is preferred to conduct the testing during typical raw water quality conditions and not during a raw water quality event (e.g., lake turnover, elevated turbidity). All monitoring and performance evaluations are to be repeated for this set of testing as described below.

Protocol for Full-Scale Testing

Guidance for Operations and Conditions for Terminating the Test:

- Submission of a Form 2 to the MECP is recommended prior to testing to notify the MECP of the intent to test a higher flow condition on one train than current average day flows but well within the DWWP flow rate. If additional testing is completed with a filter aid polymer, the Form 2 will be required to notify the MECP of a process change to be trialed on two filter quadrants of the full-scale process with the addition of the polymer to the stage-2 flocculation basin (dose to be informed by jar-testing).

- Cleaning of sedimentation basins is recommended prior to the test.
- Calibration of instrumentation (turbidity meters, temperature probes, pH probes) to be completed prior to testing.
- Filter effluent turbidity set-point programming could be increased to 0.20 NTU
    - This will allow for an evaluation of the rise in headloss accumulation and/or filter effluent turbidity during the test to 0.15 NTU (half the MAC of 0.3 NTU).
- The test is to be initiated with 11 filters online and one (1) filter on stand-by
    - All filters to be backwashed prior to initiating testing
    - The stand-by filter is to be brought online should one (1) filter go out of service.
- Target flow rates should be achieved in a step-wise approach (e.g., by increasing plant flows by 50 MLD at a time before achieving steady state operation at the given test flow rate) so as not to disrupt process performance due to a flux in plant flow rate
- The test is to be terminated should one of the following conditions arise:
    - If two (2) of the initial in-service filters are offline (or three [3] filters offline in total) / backwashing AND the filter effluent turbidity reaches 0.15 NTU
    - CT calculations are not met

Zeta-Potential Monitoring and Coagulant Dose Adjustments to be Completed by Operations Staff

It is also recommended to use zeta-potential to uphold appropriate coagulation chemistry through sedimentation during testing.

During the testing, zeta-potential parameters should be monitored three times a day (e.g. every 4 hours at 8 am, 12PM, and 4 PM) in the <u>post-coagulated water</u> (downstream of flash mixing) of the Test Train. A set point of >-8 mV is recommended to be upheld during testing.

During the testing, coagulant doses should be adjusted to maintain the optimal post-coagulation zeta potential set-point.

Response action:

- Should zeta potential measurements in the raw water decline, or post-coagulation decline to become more negative than the set-point or approximately -5 mV, coagulant dose should be increased.
- Should zeta potential measurements in the raw water increase, or post-coagulation increase to become more positive than the set-point, or approximately +3 mV, coagulant dose should be decreased.

Evaluation of Results

Following the testing, Stantec will submit a request for SCADA data including the following parameters:

- Raw water

- Turbidity
- Temperature
- pH

- Coagulation
  - Chemical Doses
  - pH
- Settled water turbidity
- Filtration (for filters in service):
  - Flows
  - Runtime
  - UFRV
  - Effluent Turbidity
  - Headloss
- Operations log containing observations made during the course of each trial and particularly during backwashing events – a description of the reason for terminating each filter run (e.g., headloss, turbidity breakthrough, time, other).

The preferred increment for SCADA data will be determined following observations made during full-scale testing.

Laboratory parameters to be requested include:

- Grab sampling for raw water, settled water, and filter effluent UVA

Reliable performance will be evaluated against the following criteria:

- UFRVs greater than 200 m^3/m^2 while maintaining filter effluent turbidity <0.1 NTU.

Should the stress test need to be terminated prior to achieving the target UFRV condition, a review of the rate of filter headloss accumulation, and increased settled water turbidity conditions will be completed.

APPENDIX B
FLOW ANALYSIS

APPENDIX B

The City communicated that the accuracy of the Module 1 Raw Water Flow Meter is poor at high flow rates. Operations staff have observed that this flow meter it is often off by 10 to 40 MLD due to heavy turbulence upstream of the flowmeter; accuracy is improved at lower flow rates. This magnetic flow meter has a butterfly valve and a proximal pipe elbow which are known to be problematic for accurate flow readings. It is understood that the Module 2 flow meter is a Venturi and has better accuracy, and that there is an ongoing project to replace the Module 1 Raw Water Flow Meter.

Table B-1: Seasonal Maximum and Average Raw Water and Total Filter Flow Rates (2022)

Process Flows (MLD)		Raw Water (MLD)		Filtration (MLD)	
Year	Month	Maximum	Average	Maximum	Average
2022	January	340	201	326	194
2022	March	241	194	274	199
2022	July	433	314	439	243
2022	October	370	293	472	206

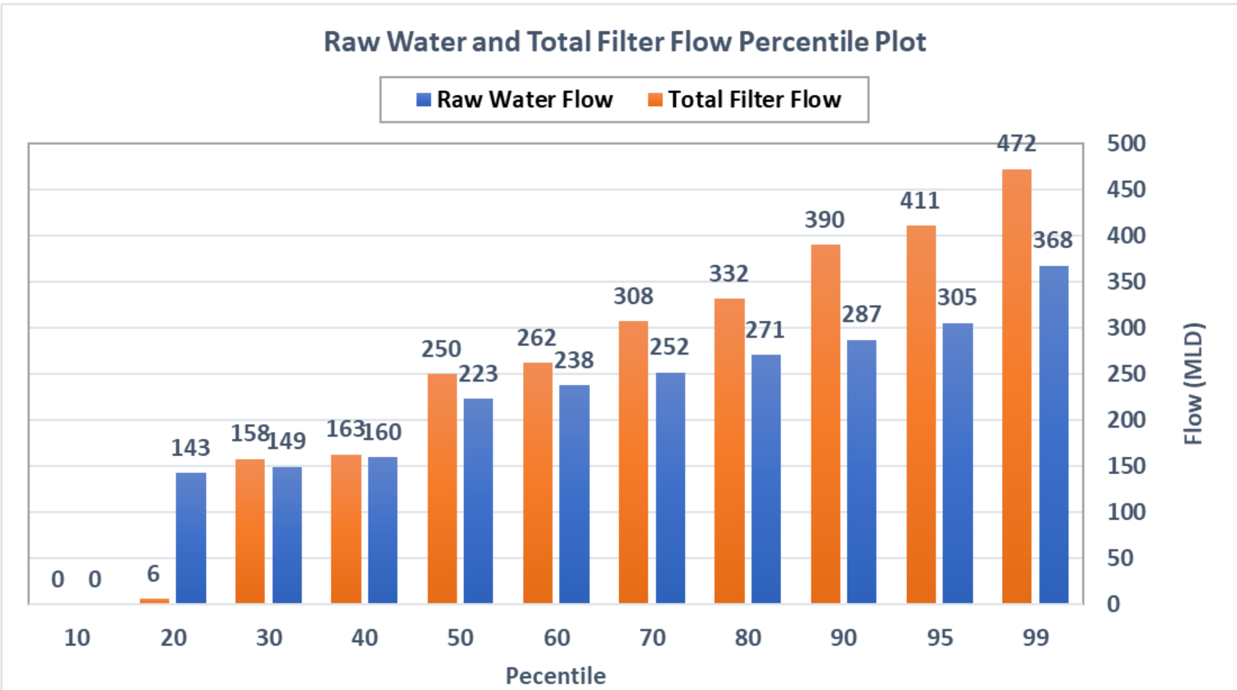

Figure B-1: Raw Water Flow and Total Filter Flow Percentile Plot Demonstrating Discrepancy Between SCADA Flow Values

APPENDIX C
DISSOLVED AIR FLOTATION EVALUATION

APPENDIX C

PRELIMINARY REVIEW OF ALTERNATIVE CLARIFICATION TECHNOLOGIES FOR WOODWARD WTP

Stantec reviewed the potential unit process capacity that could be achieved by upgrades for either enhanced sedimentation basins with lamella plates or dissolved air flotation (DAF).

Enhanced Sedimentation with Lamella Plates

The proposed upgrades for sedimentation with lamella plates were assumed to have a plate coverage area of 45% (conservatively). With two (2) or three (3) upgraded trains in service, the estimated capacity would increase to approximately 572 MLD and 859 MLD, respectively. This is expected to meet projected demands beyond 2050. However, upgrading only two (2) trains, as planned for the Phase 2 Upgrades, will not enable the plant to achieve the targeted 650 MLD maximum capacity.

If the goal of the upcoming construction activities is to achieve a reliable process capacity of 909 MLD long-term, then the capital costs for sedimentation upgrades with lamella plates may be misplaced. As the capacity graph below indicates, with one train out of service (e.g., for maintenance), the plant capacity would be reduced to 286 MLD after the Phase 2 upgrades, or 859 MLD long-term, which may not meet the objective of the construction activities. There may be other, high-rate, technologies that can achieve the same or higher capacity in a lower footprint.

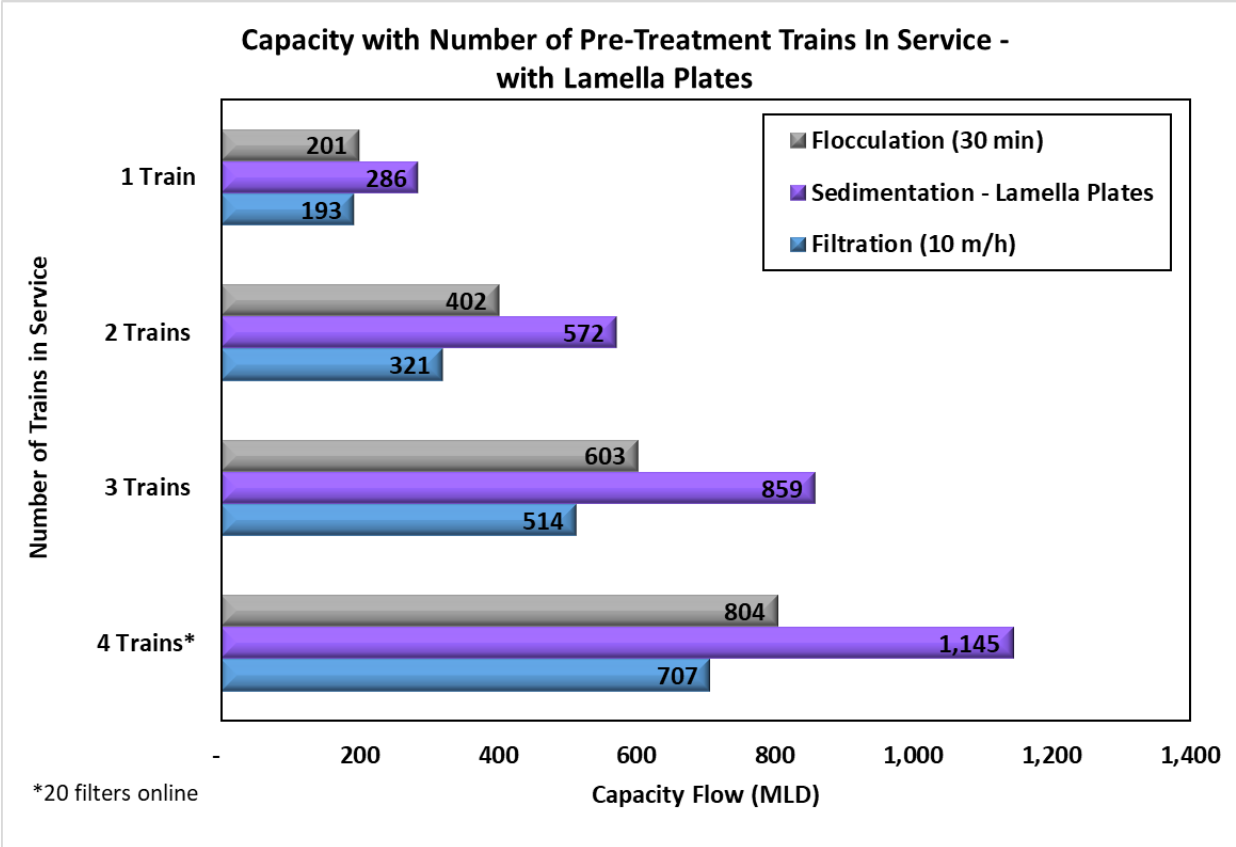

Figure C-1: Unit process capacity potential with number of pre-treatment trains out of service with Woodward WTP upgraded sedimentation with lamella plates

Table C-1: Unit process capacity potential and risks for sedimentation upgrades with lamella plates

Sedimentation Evaluation - Lamella Plates - Plate Coverage Area Calculation					Sedimentation - Lamella Plates: Evaluation Scenarios			
Flow Condition	Flow Rate (m^3/d)		Flow (MLD)	No. Trains:	4	3	2	1
PEAK (2022)	459,000	m^3/d	425	SOR (m/h) - Plate Coverage SA	3.92	5.23	7.84	15.68
PHASE 1 (PHD GROWTH)	702,000	m^3/d	650		6.00	8.00	11.99	23.99
Rated Capacity	981,720	m^3/d	909		8.39	11.18	16.77	33.54
Downstream Losses:	8%			Capacity - MLD (5 m/h):	1,145	859	572	286

Dissolved Air Flotation Retrofit

A preliminary conceptual evaluation of the potential unit process capacity for DAF at Woodward required a preliminary markup of alternative process unit configurations. Understanding that typically 11 m is the maximum approximate acceptable width of a DAF basin, the following conceptual layouts were prepared to either consider DAF upgrades within the existing sedimentation basins or in the footprint of the lower stores. This preliminary evaluation assumed a conservative DAF loading rate of 18 m/h, although many installations with comparable raw water quality have demonstrated good performance at loading rates of 26 m/h or higher.

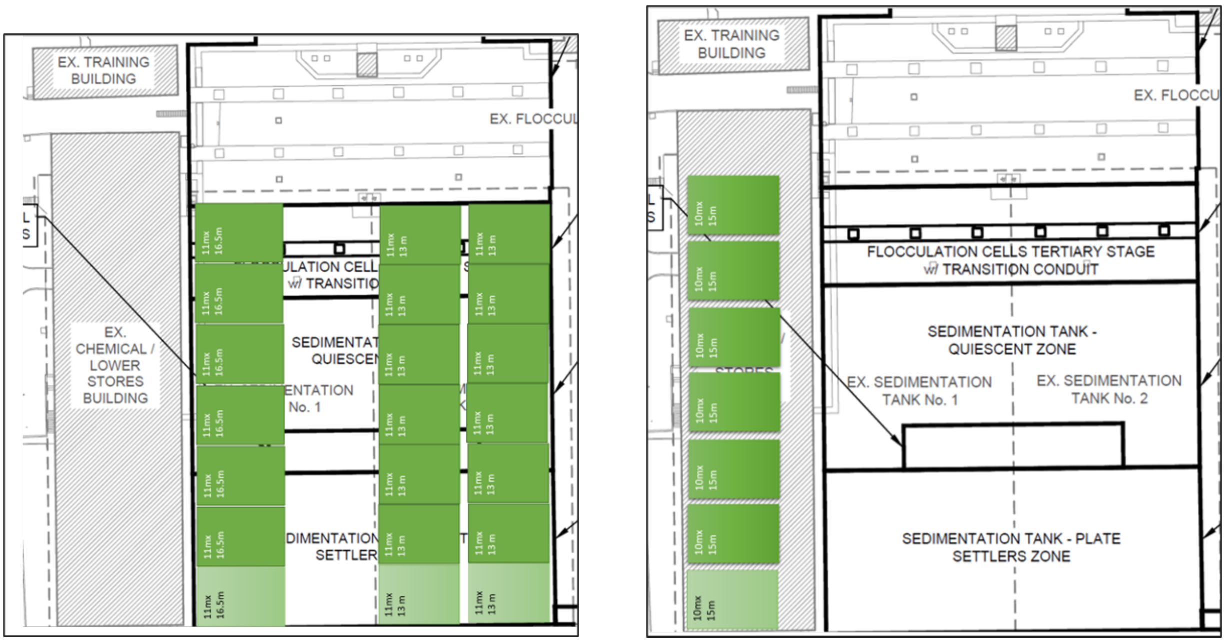

Figure C-2: Preliminary conceptual schematic of DAF unit process layouts; retrofit into existing sedimentation basins (LEFT) and greenfield construction in location of existing lower stores (RIGHT).

The results of this review suggest that, conservatively, 13 DAF units (11x16 m each with 1 standby) could achieve the plant rated capacity of 909 MLD, while nine (9) units could achieve the capacity of 608 MLD, and seven (7) units could achieve 456 MLD. Higher loading rates could reduce these estimates by 20% or more.

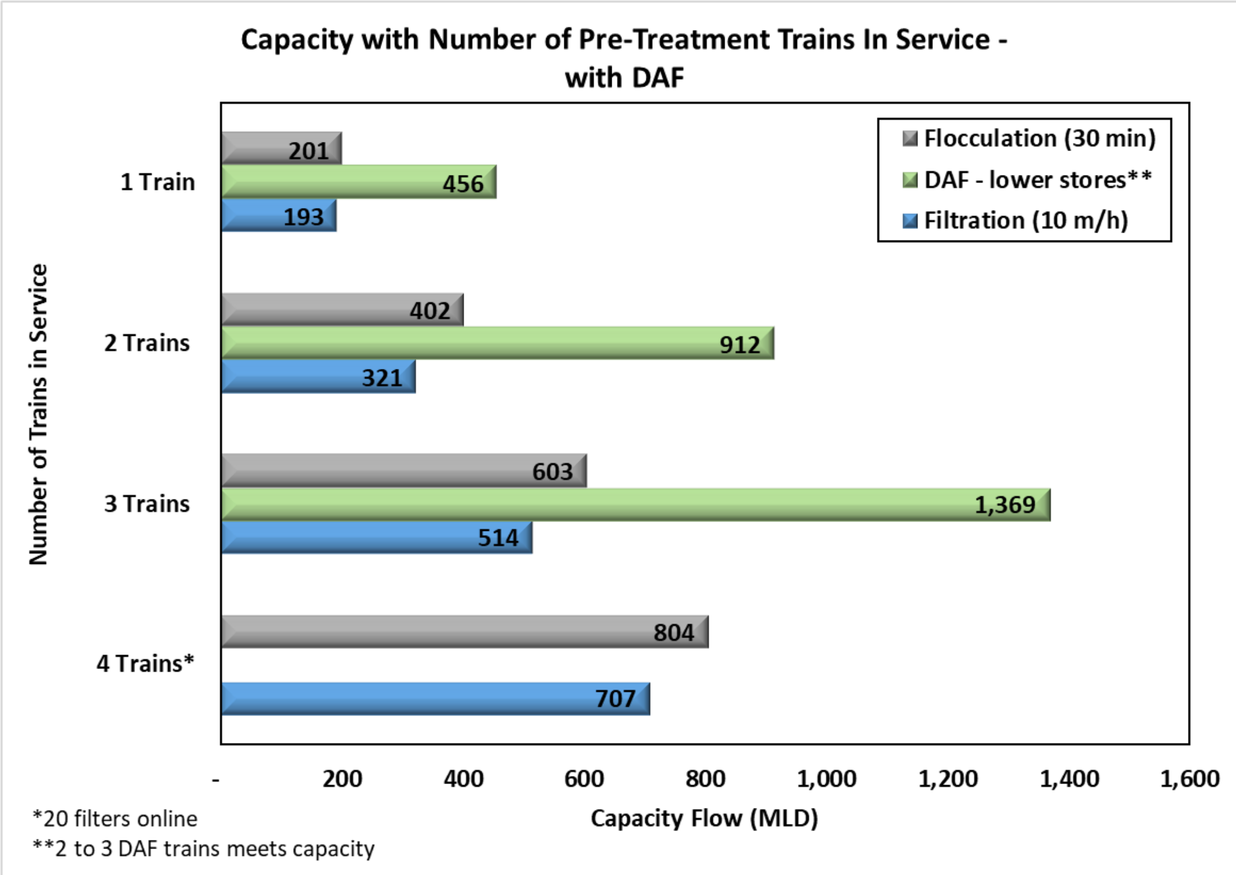

Figure C-3: Conceptual unit process capacity potential for dissolved air flotation upgrades at Woodward WTP (6 units per train)

EVALUATION OF ALTERATIVE CLARIFICATION TECHNOLOGIES

To evaluate the best available technology for upgrading the clarification process at Woodward WTP with respect to the existing treatment processes in place (coagulation, flocculation, filtration) and the raw water quality, Stantec conceptually reviewed and scored evaluation criteria associated with sedimentation upgrades with lamella plates and DAF upgrades (either retrofit or at the lower stores). The details of that analysis are summarized in Table C-2 and Figure C-4 below.

Overall, the results of this conceptual review suggest that DAF is expected to provide operational and performance benefits over enhanced sedimentation with lamella plates. The potential advantages for a DAF upgrade at Woodward WTP may include:

- Higher rate process able to achieve a higher loading rate and capacity in a given footprint, potentially minimizing construction activities and leaving land available for potential future uses (e.g., treatment for emerging contaminants, filter backwash recycle holding tanks)
- A more robust technology process for the management of potential algae blooms

- Potential for minimizing chemical consumption where the use of a sedimentation polymer aid would not be required, but could benefit operation of enhanced sedimentation
- Potential for more streamlined operations and maintenance burden. While DAF would have higher energy costs and maintenance associated with saturators and compressors which require annual maintenance shut-downs, lamella plates could require routine washing of the plate and/or operation of an automated aeration cleaning system which would also require maintenance and operation in itself.

It is understood that the City has plans underway to conduct pilot testing for DAF at Woodward WTP and conceptual layouts for DAF retrofitting, and Stantec is in support of this approach to understanding the best approach to addressing sedimentation shortfalls for Woodward WTP.

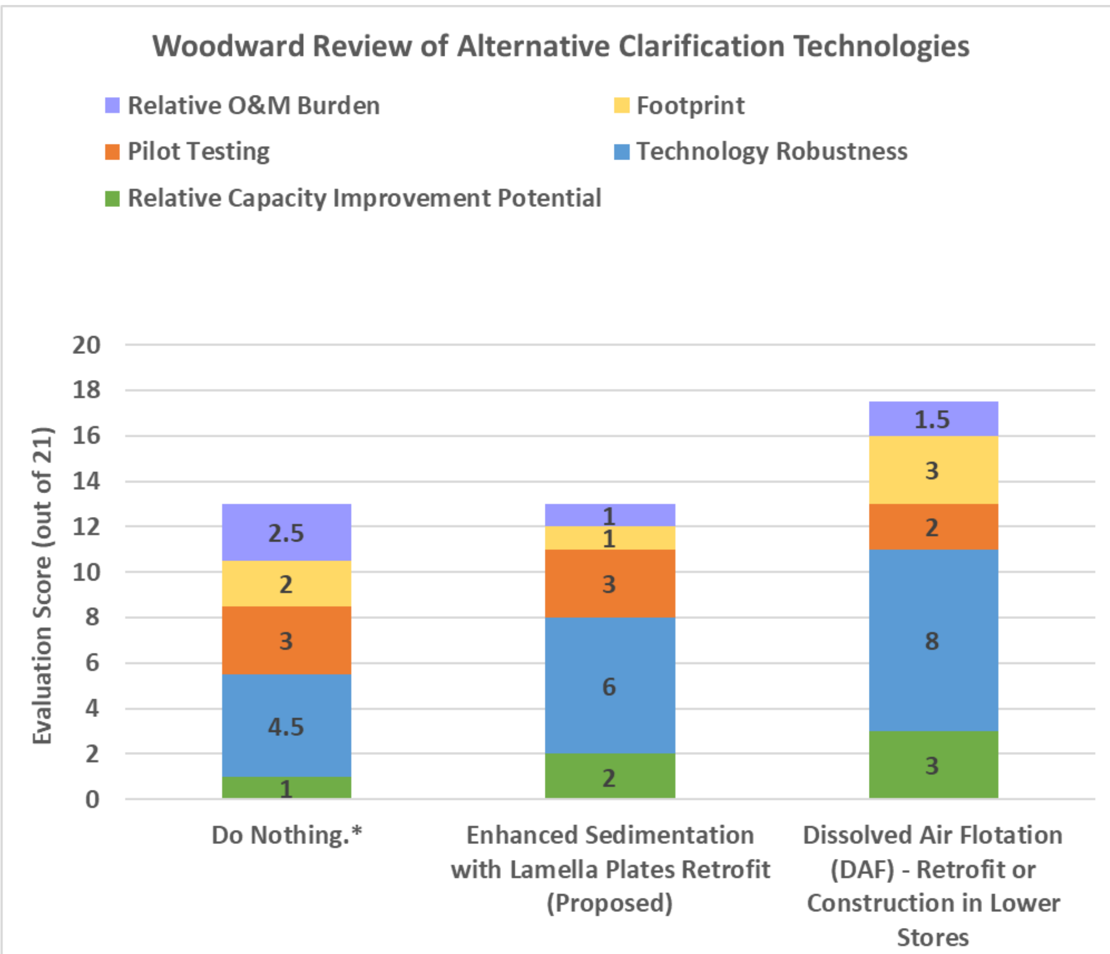

Figure C-4: Conceptual evaluation of alternative clarification technologies for Woodward WTP.

Table C-2: Summary of results of conceptual evaluation of alternative clarification technologies for Woodward WTP.

Evaluation Scores	Alternatives			
	1	**2**	**3**	
Evaluation Criteria	**Do Nothing.***	**Enhanced Sedimentation with Lamella Plates Retrofit (Proposed)**	**Dissolved Air Flotation (DAF) - Retrofit or Construction in Lower Stores**	**Total Potential score**
Relative Capacity Improvement Potential	1	2	3	3
Technology Robustness	4.5	6	8	9
Turbidity	2	2.5	3	
Organics	1.5	2	2	
Algae	1	1.5	3	
Pilot Testing	3	3	2	3
Footprint	2	1	3	3
Relative O&M Burden	2.5	1	1.5	3
GRAND TOTAL SCORE	**13**	**13**	**17.5**	**21**

APPENDIX D
STRESS TESTING ANALYSIS

APPENDIX D

SUMMARY OF PROCESS PERFORMANCE DURING STRESS TESTING

Introduction

As described in Sections 4.3 and 4.4, a brief stress test was performed at Woodward WTP in March 2023. A review of the pre-treatment unit process performance in response to that testing is provided below. It is noted that during the testing, Filters 1 through 6, 21, and 22 were offline. SCADA data was provided in 1 minute increments to support this analysis.

A summary of the raw water temperature and pH conditions through the plant is provided below in **Table D-1**. In general, the test was performed at cold water conditions which are theorized to produce more challenging conditions for sedimentation performance.

Table D-1. Summary of Raw Water Temperature and Plant pH Values During Testing

Test Conditions	Value	Stdev	Count (*n*)
Temperature, Raw Water (degrees C)	2.15	0.007	10
pH, Raw Water	8.11	0.039	20
pH, Settled Water (1)	7.52	0.018	300
pH, Settled Water (2)	7.48	0.022	300
pH, HLPS (1)	7.37	0.037	300
pH, HLPS (2)	7.29	0.007	300

Raw Water Turbidity

Raw water turbidity was found to increase during the test as flow rate was increased as shown in **Figure D-1**., and a correlation between plant flow (total filter flow as this is known to be more accurate) and raw water turbidity was identified as shown in **Figure D-2**.

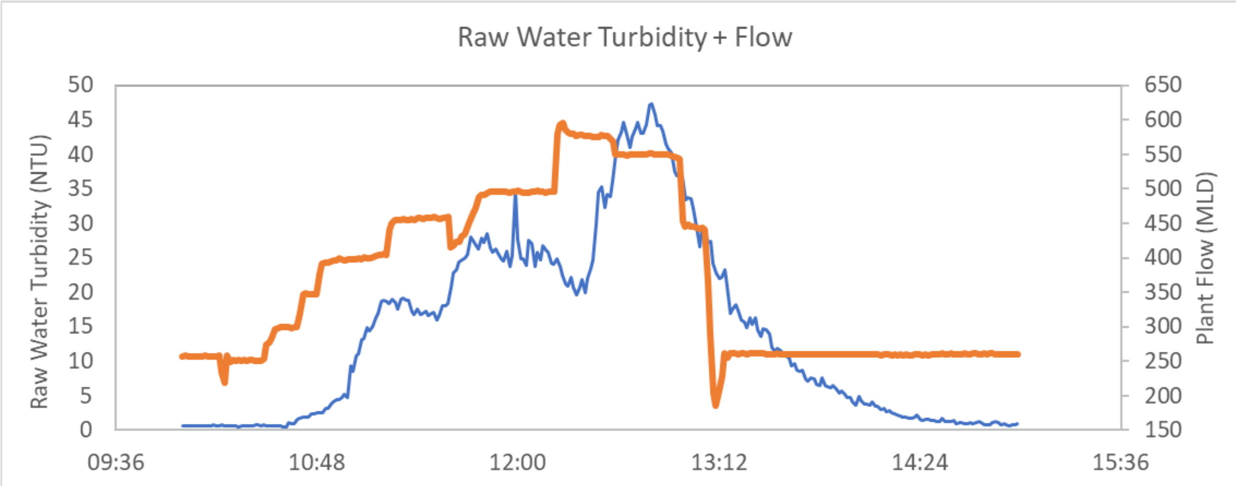

Figure D-1. Trendline of raw water turbidity and plant flow during stress testing.

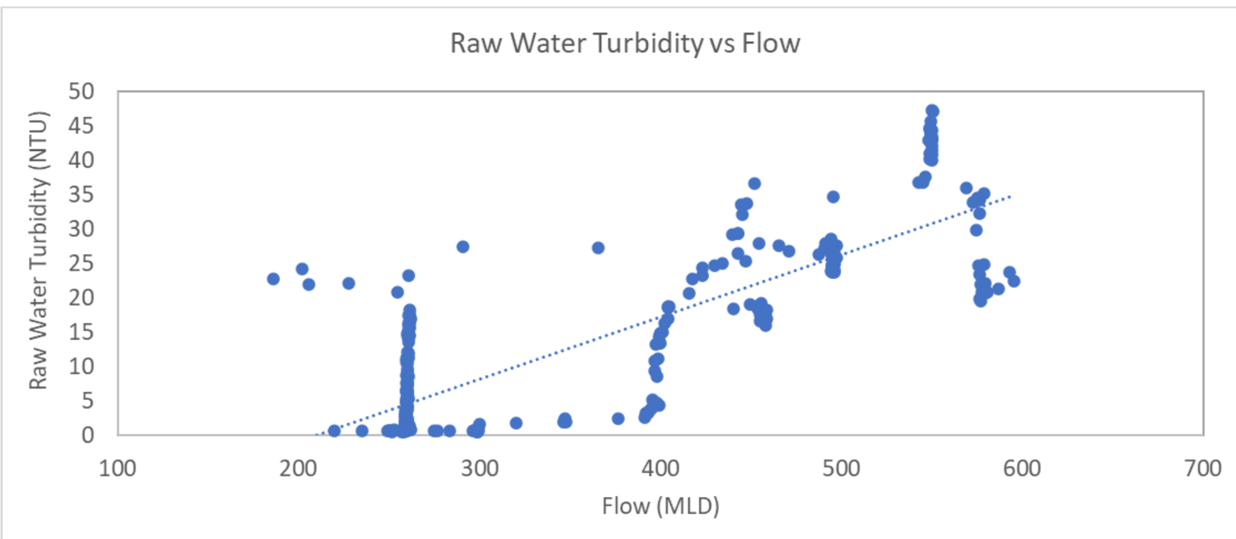

Figure D-2. Relationship between raw water turbidity and total plant flow during testing.

PACl Dosing

During testing, operators reported that there were issues with the coagulant pumps maintaining the target flow pacing for continuous, sustained coagulant dosing. The trend for the ratio of plant flow rate to PACl pump discharge flow during the testing is presented in **Figure D-3**. This demonstrates that the ratio significantly declined once the plant was running above about 400 MLD and all four (4) PACl pumps followed the same declining trend at the higher flow rates. Additionally, the maximum PACl pump speed feedback approached 80% once flows were greater than or equal to 550 MLD (**Figure D-4**).

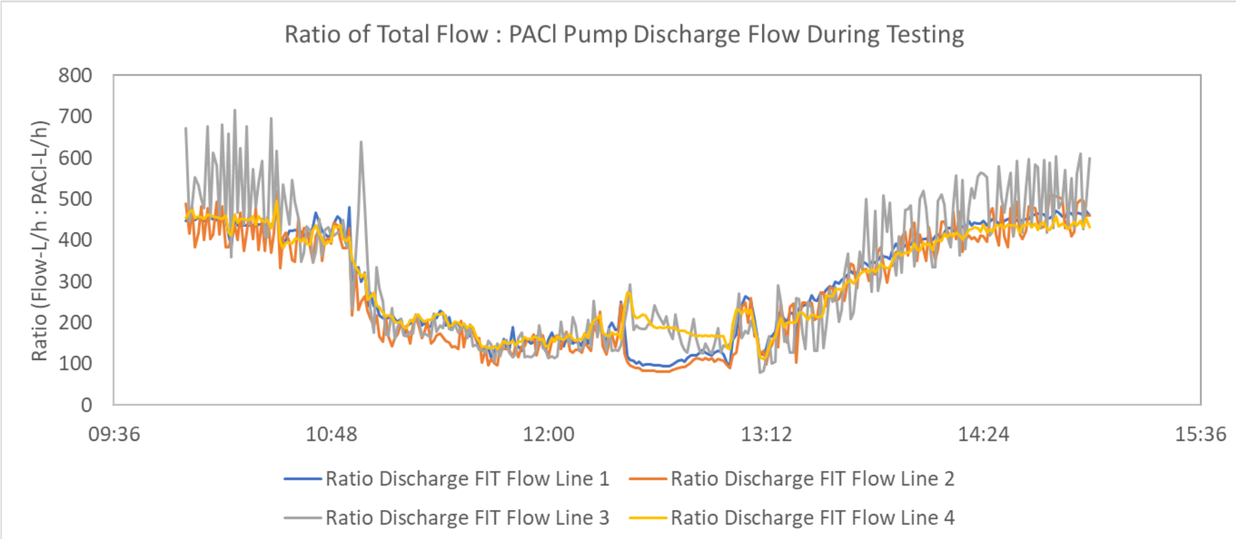

Figure D-3. Ratio of Plant Flow to PACl Pump Flow during stress testing.

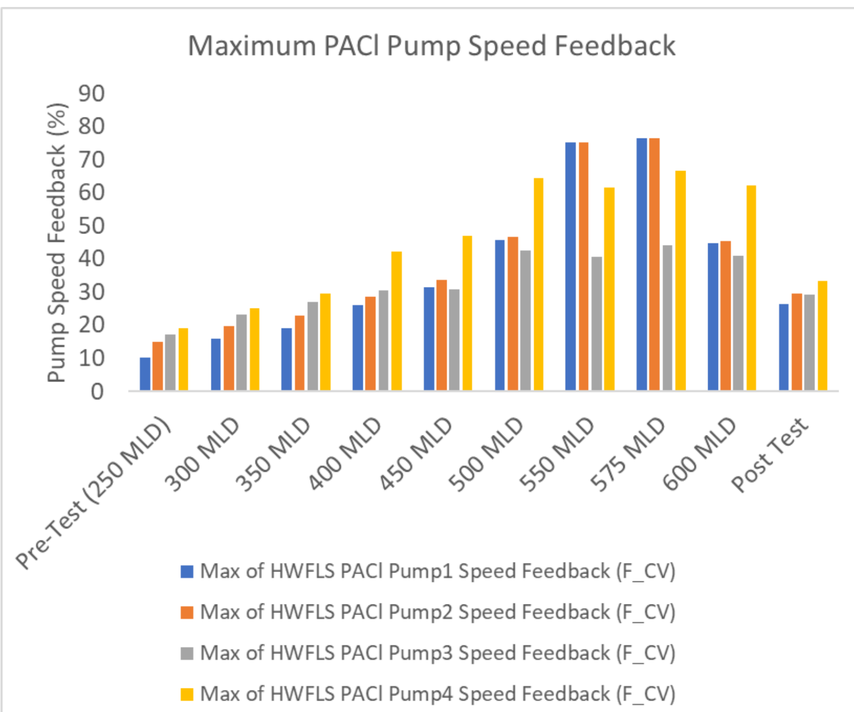

Figure D-4. Maximum PACl pump speed feedback during stress testing.

Sedimentation

Throughout the testing, the loading rate of sedimentation was increased in a step-wise approach from approximately 1.0 m/h to briefly above 2.0 m/h which is the maximum sedimentation surface overflow rate

(SOR) recommended by the MECP (**Figure C-5**) (based on the value of a surface area of 2,710 m^2 per train).

While average settled water turbidity did rise for both sedimentation basins over the course of the brief test, the maximum turbidity value observed was <0.8 NTU as shown in **Figure D-6**. The scatter plot in Figure C-5 shows a gradual increase in the trend of settled water turbidity at higher plant flows. Therefore, extended operation at future projected demands anticipated during construction is recommended to understand the longer term robustness of sedimentation when one or more trains are scheduled to be offline.

Finally, higher settled water turbidity was observed on Side 2 than on Side 1 which may be the result of the accuracy of the instrumentation sample line, instrument maintenance (e.g., potential clogging of the line), a difference in sludge blanket at the test initiation, or represent a true difference in performance between the two sides (**Figure D-7**).

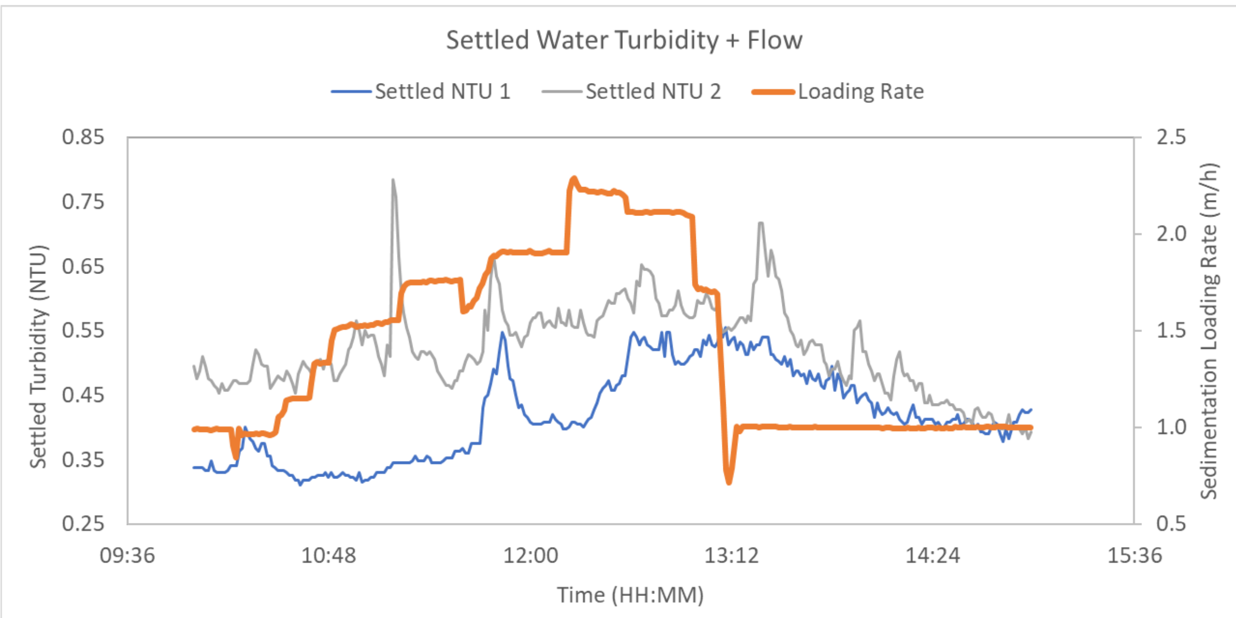

Figure D-5. Settled water turbidity trends during testing while increasing plant flow and sedimentation loading rate.

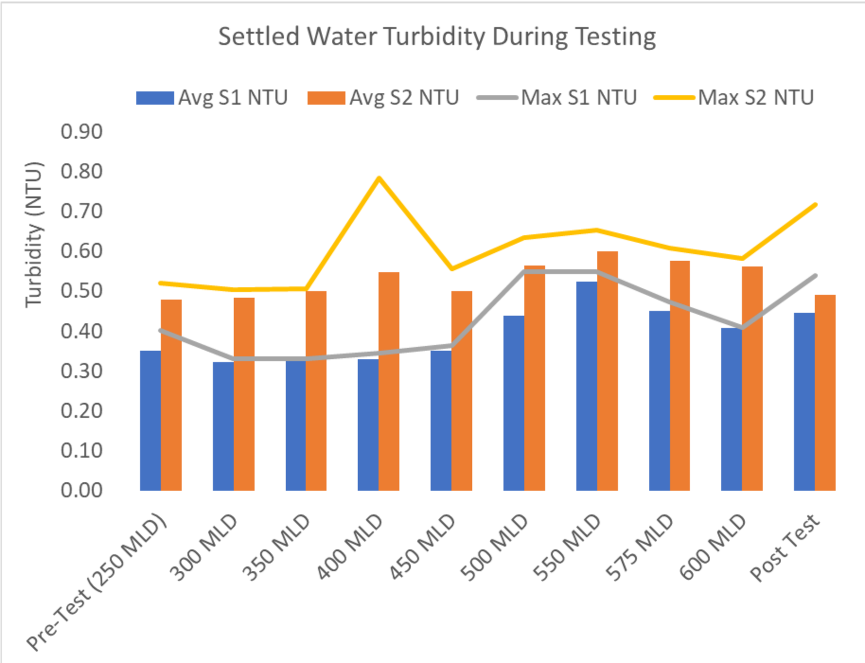

Figure D-6. Average and maximum settled water turbidity observed during brief stress test modes.

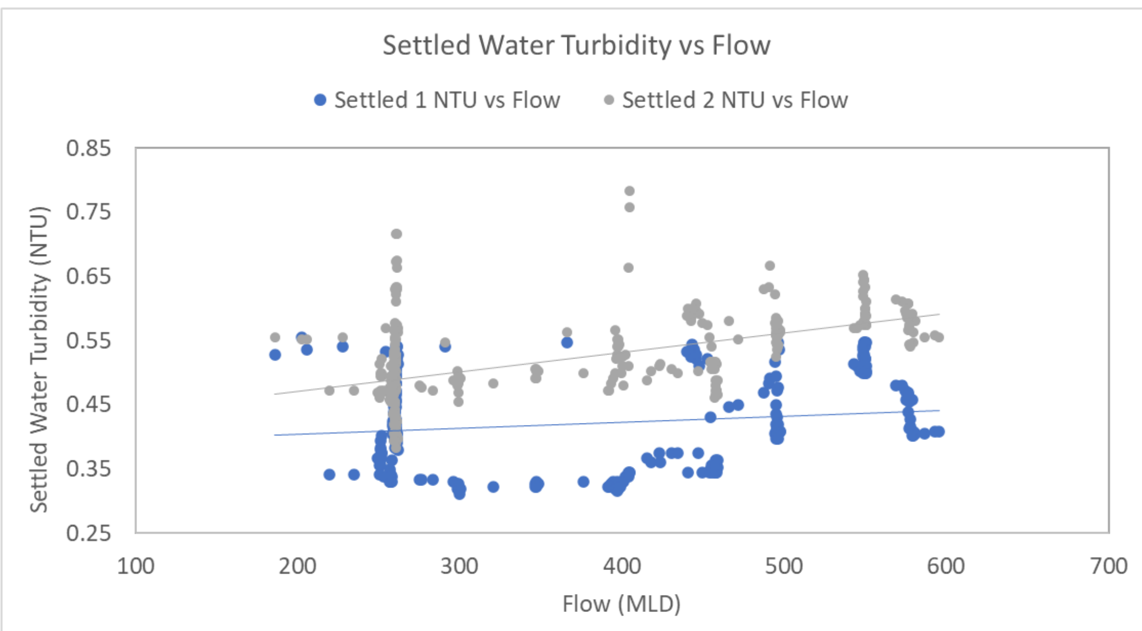

Figure D-7. Scatter plot of settled water turbidity and plant flow during stress testing.

Filtration

Due to the short duration of this stress testing, an evaluation of filter efficiency, robustness, or unit filter run volume (UFRV) is not practical. To further evaluate these process capabilities, a longer and sustained stress test is recommended. Overall, due to filtration programming controls, filter effluent turbidities were maintained below 0.1 NTU (radar **Figure D-8** showing the results only for even numbered filters in service).

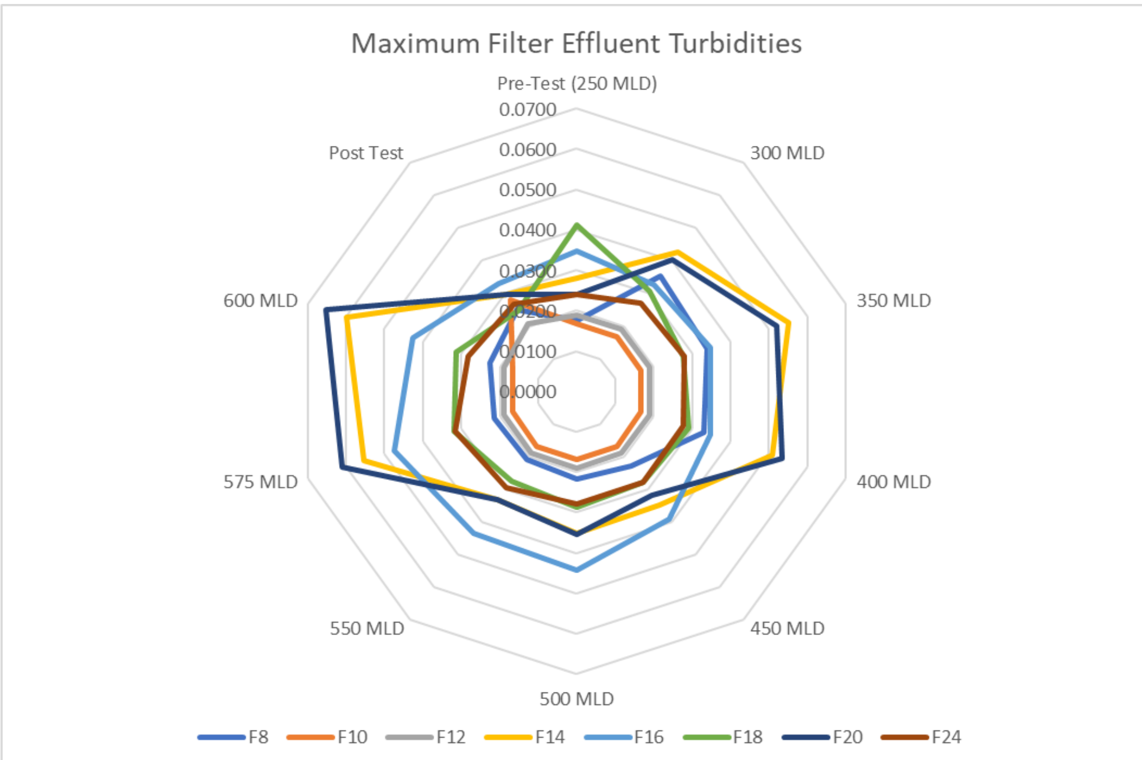

Figure D-8. Maximum Filter Effluent Turbidity During Stress Testing (even numbered filters in service only)

A marked increase in filter effluent turbidity was observed particularly for Filters 14 16, 19, 20, and 23, when flow was transitioned from 500 MLD to 600 MLD (**Figure D-9**).

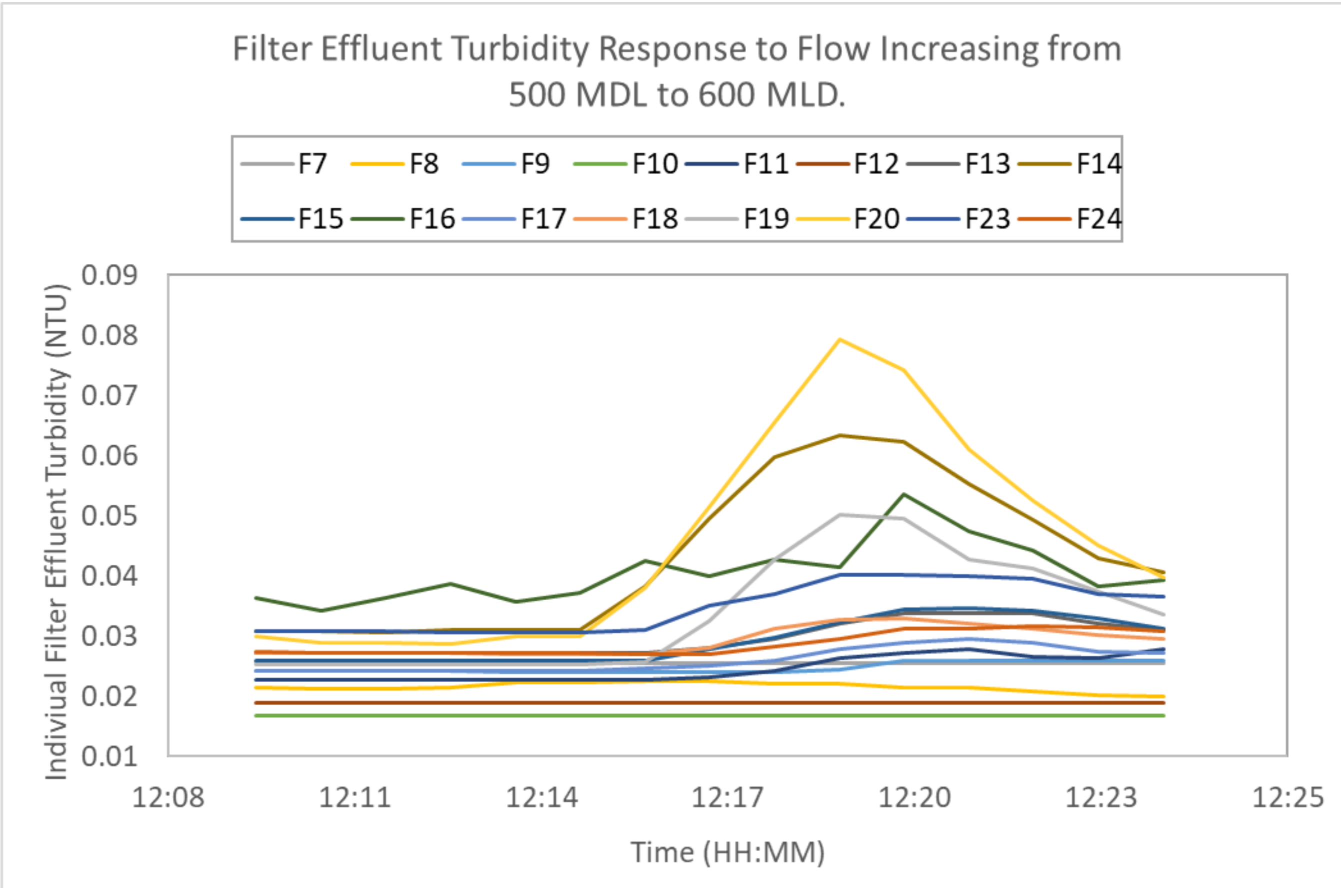

Figure D-9. Individual filter effluent turbidity response to flow increasing from 500 MLD to 600 MLD.

Finally, a review of filter loading rates practiced during the stress testing was conducted based on the total filter flow, the number of filters in service and the individual filter bed surface area (134 m^2). The maximum filter loading rate testing at full-scale was 11.6 m/h for a duration of approximately 12 minutes (**Figure D-10**).

A scatter plot of the correlation between average and maximum filter effluent turbidity against filter loading rate is provided in **Figure D-11**. This data suggests a potential trend of higher maximum filter effluent turbidity and higher filter effluent turbidity variability at higher flow rates.

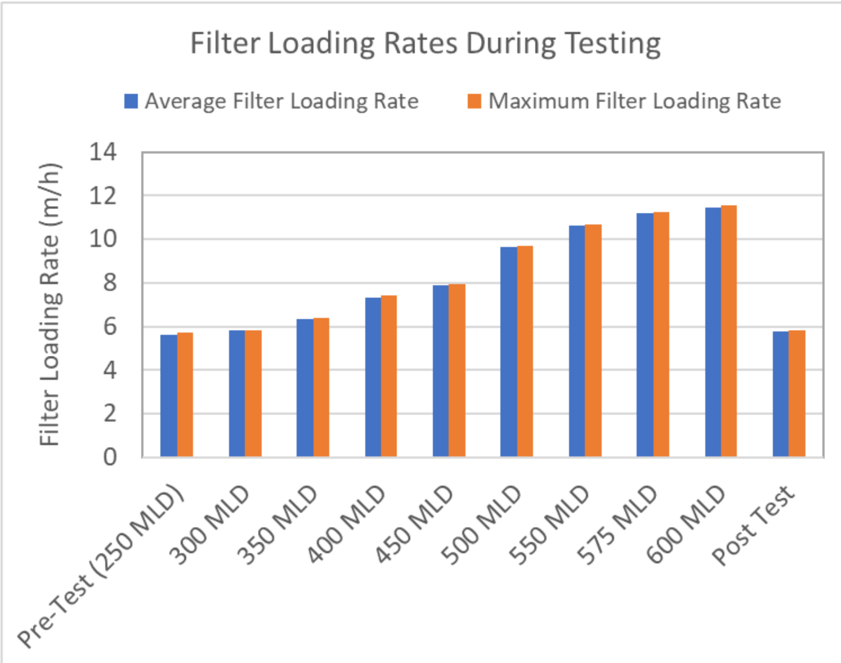

Figure D-10. Filter Loading Rates Experienced During Stress Testing

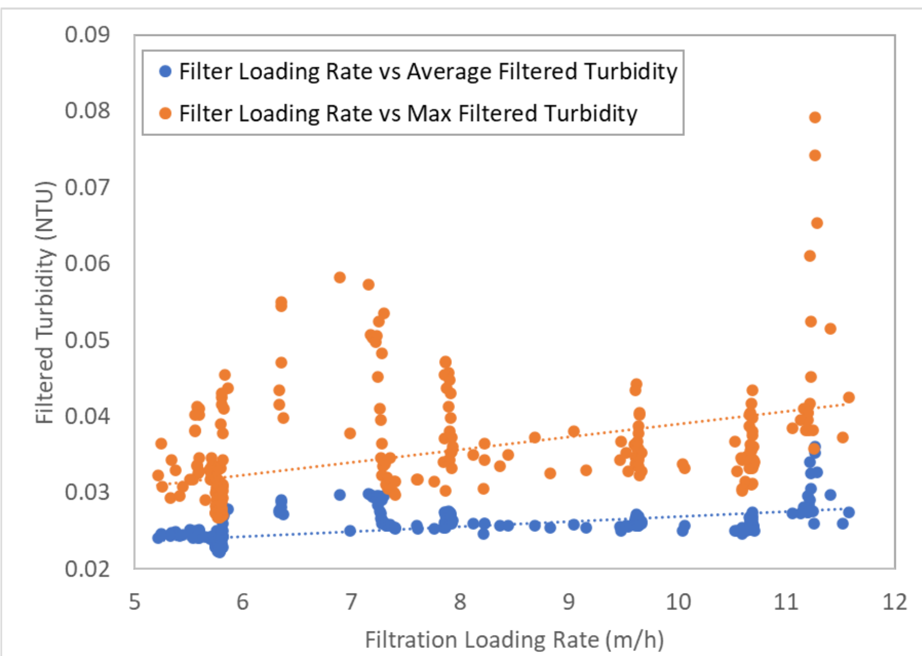

Figure D-11. Scatter plot of average (blue) and maximum (orange) filter effluent turbidity and filter loading rate.

Based on these observations, a sustained stress test could further elucidate the potential capacity for the filtration process to maintain good unit filter run volume performance values at higher flows.

SUMMARY OF OBSERVATIONS AND RECOMMENDATIONS

A summary of the process performance observations during stress testing is provided below:

1. Raw water turbidity was found to increase with increasing plant flow rate.
   a. It is recommended to investigate the cause of this observation.
   b. Potential causes could be uptake of sand off of the bottom of the lake near the intake; sloughing of biofilm from within the intake pipe; natural raw water turbidity event.
   c. Potential remediation could involve an SOP or programming to minimize flux at the intake when increasing the plant flow rate; routinely clean intake pipe walls.
2. PACl pumps were unable to maintain flow-pacing at higher flows.
   a. Recommend to review programming and pump sizing.
3. Consider repeating sedimentation loading rate test for an extended duration at an elevated flow rate representative of future projected demands during construction to understand potential performance limitations with extended operation at higher loading rates.
4. There is a potential trend of higher maximum filter effluent turbidity and higher filter effluent turbidity variability at higher flow rates.
   a. Consider conducting a sustained stress test at a higher plant capacity to elucidate the expected UFRV that can be maintained at higher flow rates and identify the practical process capacity limitation with respect to the current filters.

APPENDIX E
PRELIMINARY REVIEW OF BACKWASH OPTIMIZATION

APPENDIX E

REVIEW OF OPTIMIZED FILTER BACKWASHING

Woodward WTP operates 24 filters in the absence of filter-to-waste (FTW) and optimized backwash equipment. Stantec has reviewed the filer design and media specifications to provide a recommended backwash sequence incorporating an Extended Terminal Subfluidization Wash (ETSW) to minimize filter-to-waste and optimize filter out of service time. The aim of this recommendation is to provide a framework for which to design filter backwash pump upgrades for optimized filter backwashing.

It is recommended to initially add an ETSW step after the high-rate wash step. The recommended ETSW wash settings are as follows:

- ETSW Step: 10 MLD for a duration of 15 minutes.

No media fluidization (suspension) should be observed during this step if performed correctly.

Success of this testing would be determined based on minimizing the filter ripening spike. Should the filter ripening spike persist with the implementation of the ETSW step, then lengthening the ETSW step to a duration of 17 minutes or increasing the ETSW flow rate up to a maximum of 70 MLD could be trialed. An effective ETSW rate for Woodward WTP based on the media specifications available should not exceed 70 MLD.

To further optimize this step, the ETSW step could be reduced to a duration of 10 minutes at temperatures greater than 15 degrees C.

Further backwash optimization can be achieved by optimizing the low-rate and high-rate wash steps to the following settings:

- Low-Rate Wash Step: 70 MLD for 0.5 minutes (or 1 minute if programming does not allow less than 1 minute)
- High-Rate Wash Step: 125 MLD for 3 minutes.

The recommended ETSW Backwash Sequence is as follows:

Initial Recommended Backwash Sequence with ETSW Step.

Step	Description	Rate (MLD)	Duration (min)
1	Close Filter Inlet Valve		
2	Drain water to low level (16" or 1.5 ft from top of filter media) through filter to waste valve (FTW).		
3	Close FTW valve.		
4	Open outlet valve, backwash pump starts		
5	Low Wash (from filter wash inlet)	72	0.5

Initial Recommended Backwash Sequence with ETSW Step.

Step	Description	Rate (MLD)	Duration (min)
6	High Wash (aka FLUIDIZATION) - transition occurs within 10 seconds	125	3
7	ETSW (Low wash) - transition occurs immediately; within 10 seconds	10	15
8	Wash outlet valve closes and low wash fills the filter up to normal operating level.		
9	Low wash turns off (backwash pump off) and wash inlet valve closes		
10	Filter sits for stratification time	0	10
11	Filter Inlet valve opens (and FTW valve opens if available)	200	5
12	FTW valve closes, if available.		
13	Filter effluent opens to return filter to service.		

Summary of assumptions:

Parameter	Description	Value	Units
Effective Size (**ES**)	sand	**0.50**	mm
Uniformity Coefficient (**UC**)	sand	**1.70**	d60/d10
Media Density	sand	**2.65**	g/cm^3
Media Depth **(D)**	sand	**1.65**	feet
Effective Size (**ES**)	gac	**1.00**	mm
Uniformity Coefficient (**UC**)	gac	**2.10**	d60/d10
Media Density	gac	**1.55**	g/cm^3
Media Depth **(D)**	gac	**2.30**	feet
Freeboard (top of media to overflow)	filter at rest	**2.80**	feet
Surface Area of Filter (or one side)	basis for flows	**720**	sq. ft.

APPENDIX F
PROCESS STRESS TESTING PRELIMINARY GUIDE

WOODWARD – FULL-SCALE WATER TREATMENT PLANT STRESS TESTING

Objectives

The objective of the full-scale stress testing is to evaluate capacity limitations associated with the existing filtration process in its pre-construction condition to understand potential flow restrictions during Phase II upgrades. The objective of this testing is not to optimize filter UFRV although this could be investigated using a similar protocol / approach, following filter upgrades with modern underdrains and air scour equipment, in concert with optimize coagulation chemistry.

Each stress test will be trialed with all existing four (4) clarification trains in service- but only two filter quadrants of the process (i.e. 12 filters).

The preferred filter quadrants for testing are at the discretion of plant operations. It is recommended to test quadrants that have representative performance of the filtration process and no known filter condition or operating issues. The other quadrants can either be taken offline, maintained at a low flow-rate or other configuration as pre-determined by the City and operations to accommodate distribution demands and storage levels, clearwell levels, or other supply considerations.

The full-scale flow capacities planned to be tested at Woodward WTP include the following:

1. **370 MLD** (185 MLD per quadrant), representing current predicted process potential performance limitation for filtration with two filter quadrants out of service and a target loading rate of 11 m/hr.
   - **To achieve these target filtration loading rates, it is recommended to run the testing with 11 filters online and 1 in standby.**

2. **405 MLD** (202.5 MLD per train), representing a filter loading rate of 12 m/h (with 11 filters online and 1 in standby); to be tested should Trial 1 at 370 MLD be successful.
   - **To achieve these target filtration loading rates, it is recommended to run the testing with 11 filters online and 1 in standby.**

Stress testing at approximately 370 MLD and 405 MLD

This component of the stress test requires that the plant is operated at a constant flow rate of 370 MLD for a duration of as long as possible (e.g., until 2 of the 11 filters enter backwash), or for a minimum period of 24 hours, whichever is shorter. Prior to initiating the test, filters in the test quadrants should be backwashed to allow for the most robust testing conditions possible. Should one filter enter backwash during the testing, the standby filter in the test quadrant could be brought online in an effort to extend the testing.

Should testing at 370 MLD with two filter quadrants prove successful in terms of maintaining filter UFRV > 200 m^3/m^2, then the testing is to be repeated at a flow condition of 405 MLD.

It is preferred to conduct the testing during typical raw water quality conditions and not during a raw water quality event (e.g., lake turnover, elevated turbidity). All monitoring and performance evaluations are to be repeated for this set of testing as described below.

Protocol for Full-Scale Testing

Guidance for Operations and Conditions for Terminating the Test:

- Submission of a Form 2 to the MECP is recommended prior to testing to notify the MECP of the intent to test a higher flow condition on one train than current average day flows but well within the DWWP flow rate. If additional testing is completed with a filter aid polymer, the Form 2 will be required to notify the MECP of a process change to be trialed on two filter quadrants of the full-scale process with the addition of the polymer to the stage-2 flocculation basin (dose to be informed by jar-testing).

- Cleaning of sedimentation basins is recommended prior to the test.
- Calibration of instrumentation (turbidity meters, temperature probes, pH probes) to be completed prior to testing.
- Filter effluent turbidity set-point programming could be increased to 0.20 NTU
  - This will allow for an evaluation of the rise in headloss accumulation and/or filter effluent turbidity during the test to 0.15 NTU (half the MAC of 0.3 NTU).
- The test is to be initiated with 11 filters online and one (1) filter on stand-by
  - All filters to be backwashed prior to initiating testing
  - The stand-by filter is to be brought online should one (1) filter go out of service.
- Target flow rates should be achieved in a step-wise approach (e.g., by increasing plant flows by 50 MLD at a time before achieving steady state operation at the given test flow rate) so as not to disrupt process performance due to a flux in plant flow rate
- The test is to be terminated should one of the following conditions arise:
  - If two (2) of the initial in-service filters are offline (or three [3] filters offline in total) / backwashing AND the filter effluent turbidity reaches 0.15 NTU
  - CT calculations are not met

Zeta-Potential Monitoring and Coagulant Dose Adjustments to be Completed by Operations Staff

It is also recommended to use zeta-potential to uphold appropriate coagulation chemistry through sedimentation during testing.

During the testing, zeta-potential parameters should be monitored three times a day (e.g. every 4 hours at 8 am, 12PM, and 4 PM) in the post-coagulated water (downstream of flash mixing) of the Test Train. A set point of >-8 mV is recommended to be upheld during testing.

During the testing, coagulant doses should be adjusted to maintain the optimal post-coagulation zeta potential set-point.

Response action:

- Should zeta potential measurements in the raw water decline, or post-coagulation decline to become more negative than the set-point or approximately -5 mV, coagulant dose should be increased.
- Should zeta potential measurements in the raw water increase, or post-coagulation increase to become more positive than the set-point, or approximately +3 mV, coagulant dose should be decreased.

Evaluation of Results

Following the testing, Stantec will submit a request for SCADA data including the following parameters:

- Raw water

  - Turbidity
  - Temperature
  - pH
- Coagulation
  - Chemical Doses
  - pH
- Settled water turbidity
- Filtration (for filters in service):
  - Flows
  - Runtime
  - UFRV
  - Effluent Turbidity
  - Headloss
- Operations log containing observations made during the course of each trial and particularly during backwashing events – a description of the reason for terminating each filter run (e.g., headloss, turbidity breakthrough, time, other).

The preferred increment for SCADA data will be determined following observations made during full-scale testing.

Laboratory parameters to be requested include:

- Grab sampling for raw water, settled water, and filter effluent UVA

Reliable performance will be evaluated against the following criteria:

- UFRVs greater than 200 m^3/m^2 while maintaining filter effluent turbidity <0.1 NTU.

Should the stress test need to be terminated prior to achieving the target UFRV condition, a review of the rate of filter headloss accumulation, and increased settled water turbidity conditions will be completed.

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Woodward 3rd Party Review – Resourcing Review

November 21, 2023

Prepared for:

City of Hamilton

Prepared by:

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Waterloo ON   N2L 0A4

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WOODWARD 3RD PARTY REVIEW – PROCESS RISKS REVIEW

Revision	Description	Author		Quality Check		Approved By	
0	Draft	HH	4/25/2023	JT	4/26/2023	MK	6/20/2023
1	Draft v. 2	HH	10/03/2023	MK	10/4/2023		
2	Draft v. 3	HH	10/13/2023				
3	Final	HH	11/20/2023			MK	11/20/2023

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 presents a review and recommendations for dedicated City staff resources for the delivery of the Woodward Phase 2 upgrades project, both from a project management, design, and construction management perspective. An organization chart was developed to demonstrate a potential team structure, with a Gantt chart illustrating timeline for onboarding team members. The recommendations presented center around new positions that will need to be created to support the Phase 2 Upgrades project.

It is anticipated that the City will require the following support during the design period of the Phase 2 upgrades project (2024 – 2026):

Table E-1: Staff Requests for Phase 2 Upgrades (Design: 2024 - 2026)

Role	Availability During Design	Year Position Required
Manager / Project Sponsor	100%	2024
Senior Project Manager	100%	2024
Project Manager	100%	2025
Engineering Technologist	100%	2025
Operations Supervisor	50%	2025
Maintenance Supervisor	50%	2025
SCADA	50%	2025

It is recommended that the City request additional staff to support the design phase of the Phase 2 upgrades project for the roles in Table E-1.

Following design, it is anticipated that the City will require the following support during the construction phase of the Phase 2 upgrades project (2027 – 2034). The majority of these positions would have been created during the design phase and roles can be carried through construction.

Table E-2: Staff Requests for Phase 2 Upgrades (Construction: 2027 - 2034)

Role	Availability During Construction	Year Position Required
Manager / Project Sponsor	100%	Same as Design
Senior Project Manager	100%	Same as Design
Project Manager (Phase 2A)	100%	Same as Design

Role	Availability During Construction	Year Position Required
Project Manager (Phase 2B)	100%	To be determined by City at later date
Engineering Technologist	100%	Same as Design
Operations Supervisor	50%	Same as Design
Operations Support Staff	100%	2027
Maintenance Supervisor	50%	Same as Design
Maintenance Support Staff	50%	2027
SCADA	50%	Same as Design

During the construction phase, based on the assumptions on staff continuity from the design phase as outlined above, it is that the City will not require additional project management and engineering staff with the exception of a Phase 2B project manager. Operations and maintenance impacts during the course of construction to support planned shutdowns, equipment start-ups and commissioning, operation of valves, training sessions, change requests, technical input, etc. have been considered. It is recommended that the City request additional staff to support the construction period (2027 – 2034) of the Phase 2 upgrades project as follows: one (1) full time-equivalent (FTE) operations support staff, and one (1) FTE maintenance support staff, in addition to their current work force as summarized in Table E-2.

Operations and maintenance staff hired for the design and construction of the Phase 2 upgrades project can be retained to operate and maintain the plant post-construction. The number of staff required to operate and maintain the plant will be determined during detailed design.

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1.0 INTRODUCTION

1.1 BACKGROUND

The Woodward Water Treatment Plant (WTP) provides potable water for the City of Hamilton and some communities in Halton and Haldimand. The plant was originally constructed in 1931 and expanded in the late 1950s. The treatment process includes intake chlorination for seasonal zebra mussel control and year-round pathogen inactivation, screening, pre-chlorination for pathogen inactivation ahead of pre-treatment, coagulation with polyaluminum chloride (PACl), flocculation, conventional gravity sedimentation, granular activated carbon (GAC) filtration, post-filter chlorination for primary and residual disinfection, ammoniation to form chloramines for residual maintenance, and fluoridation. The current rated capacity of the WTP is 909 MLD, though the current expected maximum capacity is approximately 500 MLD.

The AECOM 2022 Conceptual Design Report for Phase 2 of the upgrades includes 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 23 filters, replace the GAC and sand media in 24 filters, refurbish 23 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.

1.2 PROBLEM STATEMENT

The proposed design and construction effort associated with Phase 2 upgrades at the Woodward WTP will put additional burden on the engineering, operations and maintenance teams. A review of the structure of the engineering, operations and maintenance teams and flexibility for involvement with the Phase 2 Upgrades project is required.

1.3 OBJECTIVES

This report focuses on a review and recommendations for dedicated City staff resources for the delivery of the Woodward WTP Phase 2 Upgrades project, from a project management, design, construction management, and operational resources perspective. Operational impacts during the course of construction to support planned shutdowns, equipment start-ups and commissioning, training sessions, etc. were reviewed. The overall operational support available (Full Time Equivalent) for the WTP post-construction is presented, recognizing the new facilities and technologies integrated into the plant following completion of the project.

1.4 APPROACH

Projects of a similar scale at other Canadian WTPs are reviewed in Section 2.

A summary of the resourcing survey results is presented in Section 3.

A review of the expected impacts of the Phase 2 Upgrades project to engineering is presented in Section 4.

A review of the expected impacts of the Phase 2 Upgrades project to operations and maintenance, including post-construction effort, is summarized in Section 5.

Recommendations, including an overall resourcing chart and Gantt chart, are provided in Section 6.

Conclusions are provided in Section 7.

2.0 PROJECTS AT OTHER CANADIAN WTPS

This section presents a review of the project management, engineering, and operations structuring for the design and construction of three major water treatment plants or plant rehabilitation programs in Canada. Each project is unique in terms of staffing needs and complexity; staffing resources will vary based on the project scope. The examples listed below are not directly comparable to the Woodward Phase 2 Upgrades project, however, can be used to gain insight into how other municipalities have structured their teams for major water treatment plant construction and/or rehabilitation.

2.1 MONTREAL WTP REHABILITATION PROGRAM

The Montreal WTP Rehabilitation Program occurred between 2005 and 2013 and involved the rehabilitation of the City's three WTPs. The approximate capital investment for the project was $300M.

The project was conducted using the Engineering, Procurement, and Construction Management (EPCM) delivery model, in which the EPCM contractor provides a professional service to undertake the design, plan the overall project, and then to procure and manage other contractors to implement the construction works. Within this model, the project was divided into multiple contracts with multiple engineers and contractors.

The City hired 5-6 dedicated full-time staff for the project, including the following:

- One (1) project manager
- One (1) construction manager
- One (1) financial officer
- Three (3) sub-project managers, overseeing engineering and construction at each of the three plants.

The project was also supported by approximately eight (8) technical resources who were not dedicated to the project full-time.

2.2 LAVAL CHOMEDEY WTP REHABILITATION

The Laval Chomedey WTP Rehabilitation occurred between 2007 – 2016. The approximate capital investment for the project was $110M.

The project was also conducted using the EPCM delivery model, and separated into various design and construction projects per sector of the WTP (9 in total).

The City hired 3-4 dedicated full-time staff for the project, including the following:

- One (1) project manager

- One (1) construction manager
- Sub-PMs overseeing the process for each contract.

The project was also supported by several technical resources who were not dedicated to the project full-time.

2.3 HAMILTON WUP

The Hamilton Woodward Wastewater Treatment Plant Upgrades Project (WUP) is a $340M total budget project, consisting of upgrades to the main wastewater pump station, the power centre, chlorination upgrades, tertiary treatment, and biosolids management.

The City is currently preparing for the Phase 2 expansion and north secondary treatment plant rehabilitation. The Phase 2 expansion includes addition of a new third secondary treatment plant, expansion of the tertiary treatment facilities, upgrades to solids management through additional gravity belt thickeners, modifications to the south and north digester complexes, digester boiling system upgrades, electrical system upgrades, relocation or removal of some existing works, and a major renovation to the existing north secondary treatment plant.

The organization structure for the project management and operations staff is depicted in Table 2-1 below.

Table 2-1: Hamilton WUP Roles and Budgeted FTE

Role	Budgeted FTE
Director	1
Manager – Process Transition	1
Process Supervisor	1
Water/Wastewater Operator	3
Sr. Project Manager – Capital Works	2
Project Manager Construction	2
Technician	1

3.0 SUMMARY OF WOODWARD WTP SURVEY RESULTS

Stantec prepared a survey (Appendix A) that was distributed to the City project management and engineering team, as well as the Woodward WTP operations and maintenance team, to review current projected opinions on the resourcing demand for the Woodward WTP. The results of the survey, completed by representatives from Capital Delivery, Operations, and Maintenance teams, are summarized below.

3.1 ENGINEERING

There are currently four (4) staff expected to be heavily involved with the Phase 2 upgrades: Manager / Project Sponsor, Senior Project Manager, Project Manager, Engineering Technologist. The Senior Project Manager is expected to be dedicated 100% full-time to the project by Q3/Q4 2024 pending resource plan approval by council.

3.2 OPERATIONS

There are two (2) operators on-shift at all times at the WTP, and one (1) process supervisor available as required 24/7 from a remote location. During day shifts, there is one (1) process supervisor located at the WTP and one (1) superintendent available as required from a remote location. It is expected that the superintendent would have 10% availability, process supervisor 20% availability, operator 10% availability, and manager 10% availability during the Phase 2 Upgrades.

3.3 MAINTENANCE

The maintenance group services the WTP, WWTP (both Woodward and Dundas) and outstations – there are no trades dedicated to the WTP. The maintenance group is comprised of the following:

- 10 millwrights
- 7 instrument technicians
- 6 electricians
- 6 SCADA staff

In the past, the design phase has put a strain on maintenance supervisors to attend meetings and review drawings. Construction support can generally be accommodated if planned in advance.

4.0 STAFFING REQUIREMENTS TO SUPPORT PHASE 2 UPGRADES DESIGN AND CONSTRUCTION

The following roles are expected to be heavily involved with the design phase of the Phase 2 upgrades project (2024 – 2026). The percentage burdens are viewed as commitment above and beyond current responsibilities.

Table 4-1: Recommended Roles for the Phase 2 Upgrades Project – Design Phase (2024 – 2026)

Role	Responsibility	Availability During Design	Year Position Required
Manager / Project Sponsor	Oversees overall program management, attends all meetings, fills in for PM when required	100%	2024
Senior Project Manager	Oversees project management	100%	2024
Project Manager	Based on-site, heavy construction experience required	100%	2025
Engineering Technologist	Works with the Operations Supervisor to review procedures during abnormal operating conditions, provide RFIs and site tours, liaises with stakeholders and agencies for approvals and permitting, liaises with various City departments. This team member should be very familiar with the plant.	100%	2025
Operations Supervisor	Acts as a go-between for engineering and operations, helps plan upcoming activities requiring Operational support. This team member should be a Process Supervisor.	50%	2025
Maintenance Supervisor	Acts as a go-between for engineering and operations, helps plan upcoming activities requiring Maintenance support. This team member should be a Maintenance Supervisor.	50%	2025
SCADA	Acts as a go-between for engineering and operations, helps plan upcoming activities requiring SCADA support. This team member should be a SCADA Technologist	50%	2025

The following roles are expected to be heavily involved with the construction phase of the Phase 2 upgrades project (2027 – 2034). The percentage burdens are viewed as commitment above and beyond current responsibilities. The breakdown of maintenance support by is expected to be as follows:

- SCADA: 16 hours weekly
- Electrician: 8 hours weekly
- Millwright: 8 hours weekly
- Instrument Technician: 8 hours weekly

Table 4-2: Recommended Roles for the Phase 2 Upgrades Project – Construction Phase (2027 – 2034)

Role	Responsibility	Availability During Construction	Year Position Required
Manager / Project Sponsor	Oversees overall program management, attends all meetings, fills in for PM when required	100%	Same as Design
Senior Project Manager	Oversees project management	100%	Same as Design
Project Manager (Phase 2A)	Based on-site, heavy construction experience required	100%	Same as Design
Project Manager (Phase 2B)	Based on-site, heavy construction experience required	100%	To Be Determined by City at Later Date
Engineering Technologist	Works with the Operations Supervisor to review procedures during abnormal operating conditions, provide RFIs and site tours, liaises with stakeholders and agencies for approvals and permitting, liaises with various City departments. This team member should be very familiar with the plant.	100%	Same as Design
Operations Supervisor	Acts as a go-between for engineering and operations, helps plan upcoming activities requiring Operational support. This team member should be a Process Supervisor.	50%	Same as Design
Operations Support Staff	Operate valves, respond to questions and RFI requests, attend workshops, additional effort required to maintain plant operations with reduced sedimentation and filtration capacity, training.	100%	2027

Role	Responsibility	Availability During Construction	Year Position Required
Maintenance Supervisor	Acts as a go-between for engineering and operations, helps plan upcoming activities requiring Maintenance support. This team member should be a Maintenance Supervisor.	50%	Same as Design
Maintenance Support Staff	Attend workshops, review drawings, respond to questions and RFI requests, support electrical shutdowns and SCADA upgrades, training. Maintain upgraded processes post-construction.	50%	To Be Determined by City
SCADA	Acts as a go-between for engineering and operations, helps plan upcoming activities requiring SCADA support. This team member should be a SCADA Technologist	50%	Same as Design

5.0 REVIEW OF PHASE 2 IMPACTS TO OPERATIONS AND MAINTENANCE

5.1 STRATEGIES TO MANAGE DESIGN PHASE O&M EFFORTS

There are several strategies available to manage design phase operations and maintenance efforts. “OPMAN”, operability and maintainability, can be implemented to improve efficiency of O&M reviews throughout the design process.

The OPMAN process involves four (4) main steps:

1. Follow P&ID (3D model, or other drawing) using a five-question checklist.
2. Answer on a scale of 1-5.
3. Identify concerns that are not acceptable.
4. Assign unacceptable concerns to an individual on the design team.

Typically, the review is most effective when completed as a group study. Following completion of the review, an OPMAN report is generated with the following concerns:

- Acceptable but could be improved.
- Unacceptable, requires modification.
- Totally unacceptable, requires redesign.

An example of an OPMAN evaluation table is provided below (Table 5-1). The review team would review the drawings, determine how acceptable the situation is, and whether the design could place staff at risk of developing long term problems. A rating between 1 to 5 is then selected for each category and populated in the table, with explanation as to why the design may place staff at risk. If evident, the review team could provide the design team with a recommendation on how the concern may be addressed. A pre-populated worksheet could also be developed, with dropdown menus for selection of scoring and criteria (Figure 5-1).

Table 5-1: Example OPMAN Table

	INDEX →	1	2	3	4	5
		ACCEPTABLE	ACCEPTABLE but could be improved	UNACCEPTABLE requires some design modifications	UNACCEPTABLE requires significant redesign	INSUFFICIENT INFORMATION needs further investigation
A	*Access for Operation*	Acceptable and appropriate access for operators.	Access possible but could be improved.	Access for operation very difficult. Some minor modifications required.	No access for operation of plant.	
B	*Access for Maintenace*	Acceptable and appropriate access provided for plant maintenance, including lifting facilities	Access possible but could be improved	Access for maintenance unacceptable. Impossible to remove/replace plant.	Access for maintenance unacceptable. No facilities to remove/replace plant	
C	*Mechanical Isolation of individual components*	Acceptable provision has been made for mechanical isolation. Standby/ duplicate system installed.	Mechanical isolation possible but causes disruption to process.	Mechanical isolation not possible. Design modification required	Mechanical isolation not possible. Significant redesign required.	
D	*Electrical Isolation*	Electrical isolator provided suitable for application.	Electrical isolator provided but inconveniently located. Acceptable disruption to process.	Electrical isolator provided but common to other plant or poorly labelled. Design modification required.	Electrical isolator provided but completely unsuitable for application.	
E	*Equipment removal*	Acceptable and approriate removal	Acceptable removal but could be improved	Difficult removal. Minor design changes required.	Removal not feasible.	
F	*Process Implication*	Process unaffected by isolation.	Process can continue to operate but at reduced capacity or difficult reconfiguration required.	Isolation causes unacceptable disruption to process. Design modification required.	Isolation causes significant disruption to process. Possible safety implications.	

NODE NUMBER	1			
NODE NAME	WAS Tank System			
AREA OF PLANT				
DRAWING REF	P&IDs	IT100 WAS Tank System P&ID	<Not Used>	<Not Used>
	Process Flow	MT000 Process Flow Diagram - WAS Withdrawal Network	<Not Used>	<Not Used>
	Piping	<Not Used>	<Not Used>	<Not Used>
	Mechanical	<Not Used>	<Not Used>	<Not Used>

			A	B	C	D	E	F
OpMan Ref	Plant Ref	Item Description	Access for operation commensurate with intended mode of operation? i.e. manual or auto	Access for maintenance including lifting arrangements.	Provision of mechanical isolation	Provision of electrical isolation	Removal from building	Process implication of isolation
1	TAB-STR-V-5012	Manual isolation valve	<Blank>	<Blank>	<Blank>	<Blank>	<Blank>	<Not used>

Dropdown Menu

Access for Operation
<Blank>
Not Applicable
1. Acceptable/Appropriate access for operators.
2. Access possible/Could be improved.
3. Access difficult/Minor modifications required.
4. No access
5. Insufficient information

Figure 5-1: OPMAN Process Worksheet Example

5.2 REQUIRED O&M SUPPORT FOR UPGRADED PROCESSES

A high-level estimate of operations and maintenance support required to operate and maintain the upgraded processes at the Woodward WTP is provided. These estimates should be re-assessed and confirm during detailed design. Team members added during the design and construction phases of the project may continue in their roles to support operations and maintenance of the plant post-construction.

5.2.1 Sedimentation – Plate Settlers

If designed and installed correctly, the O&M effort associated with plate settlers is expected to be minimal. Automatic bubbler systems could be considered during the detailed design phase; the bubbler system can improve performance by keeping plates clean. A bubbler system would, however, be expected to require additional mechanical maintenance and annual cleaning.

The use of plate settlers may require an additional chemical operating system for polymer dosing to optimize plate settler performance, particularly in cold water conditions. Additional O&M effort would be associated with the polymer system.

Semi-annual plate and basin cleaning, conducted by industrial cleaners, is recommended. There is an estimated $50k fee associated with the industrial cleaning service.

It is expected that plate settlers could result in an additional eight (8) hours of operations effort weekly, and eight (8) hours of maintenance effort weekly. The majority of the maintenance effort is expected to fall on millwrights.

5.2.2 Sedimentation – Dissolved Air Flotation

DAF is likely to require additional operator support when compared to plate settlers. Operators will be required to perform additional duties such as adjustment of saturator nozzles. However, DAF is not expected to require polymer dosing.

DAF is likely to require additional maintenance support to maintain additional mechanical equipment, including but not limited to saturators and compressors. Annual maintenance shutdowns for each train are expected.

It is expected that DAF could result in an additional 12 hours of operations effort weekly, and 12 hours of maintenance effort weekly. The majority of the maintenance effort is expected to fall on millwrights.

5.2.3 Filtration

The filtration upgrades are not expected to result in significant changes to current O&M effort. In general, there is expected to be improved operational flexibility as a result of more reliable filter technology, longer filter run times and reduced concern regarding condition of filter underdrains. Additional maintenance can be expected for the air scour and filter-to-waste equipment.

It is expected that the filtration upgrades could result in an additional four (4) hours of operations effort weekly, and eight (8) hours of maintenance effort weekly. The majority of the maintenance effort is expected to fall on millwrights.

5.2.4 Chlorination

The current conceptual design for the new chlorine building consists of a railcar and tonner hybrid system. Railcars are expected to be the primary source of chlorine the majority of the time, however, regular use of tonners (1 week per quarter) is recommended to maintain a supply contract with the vendor and increase operator comfort level. The railcar system is automated, and does not require significant operator involvement. When the tonner system is operational under average flows at both the WTP and WWTP, a bank of four (4) tonners is expected to last approximately two (2) days. Every other day, two (2) operators would be required to change out a bank of tonners. Under peak flow events or wet weather conditions, the frequency at which tonner replacement and delivery are required would increase.

It is expected that the new chlorine building would result in an additional 24 hours of operations effort weekly, and eight (8) hours of maintenance effort weekly. The majority of the maintenance effort is expected to fall on millwrights.

5.2.5 UV Disinfection

The UV building will consist of the filter backwash pumps and UV disinfection system. The backwash pumps are expected to operate automatically, and it is anticipated that they will require annual maintenance. The UV system is also expected to operate automatically, with automatic lamp cleaning, however bulb breaks will occur and lamps will require replacement as necessary. The City should plan for 30% of lamps to require replacement annually. There is the potential for additional instrumentation burden associated with the UV system as it is likely that UVT analyzer(s) will be installed.

It is expected that the UV building would result in an additional 12 hours of operations effort weekly, and 12 hours of maintenance effort weekly. The majority of the maintenance effort is expected to fall on millwrights and electricians.

During the workshop, it was requested that Stantec investigate further the maintenance requirements for UV systems. Stantec consulted with Operations at Region of Peel to request an estimate of maintenance support requirements for the in-line UV system at the Arthur P. Kennedy Lakeview WTP. The OCWA operator informed Stantec that typical maintenance requirements are as follows:

- Monthly reference sensor checks – two days for two electricians to complete eight reactors
- Semi-annual maintenance – completed by Trojan Technologies, including inspection, replacement of gel, gaskets, etc.
- Lamps and quartz sleeves replaced as necessary. The WTP bulbs are rated for 15,000 hours; failures are uncommon, estimated at 2 – 5 lamps and 1 – 3 quartz sleeves per year.

5.2.6 Summary

Table 5-2 presents a summary of the anticipated O&M effort required by the plant, on top of current operations and maintenance requirements, following completion of the Phase 2 upgrades based on estimated additional weekly effort by Operations and Maintenance. It is anticipated that Operations will require an additional two (2) FTE, while maintenance will require an additional one (1) FTE. The majority of the maintenance effort is expected to fall on millwrights and electricians.

Table 5-2: Anticipated Phase 2 Post-Construction O&M Effort

Process	Operations (hrs/week)	Maintenance (hrs/week)
DAF	12	12
Filtration	4	8
Chlorine Building	24	8
UV Building	12	12
Total	**52**	**40**
Total as FTE	**2 FTE**	**1 FTE**

6.0 RECOMMENDATIONS

The Stantec team has evaluated the resourcing opportunities associated with the current proposed Phase 2 upgrades. An organization chart has been developed that proposes a management and support staff structure for the design and construction phases of the project (Figure 6-1) based on the current conceptual design schedule (AECOM, 2022).

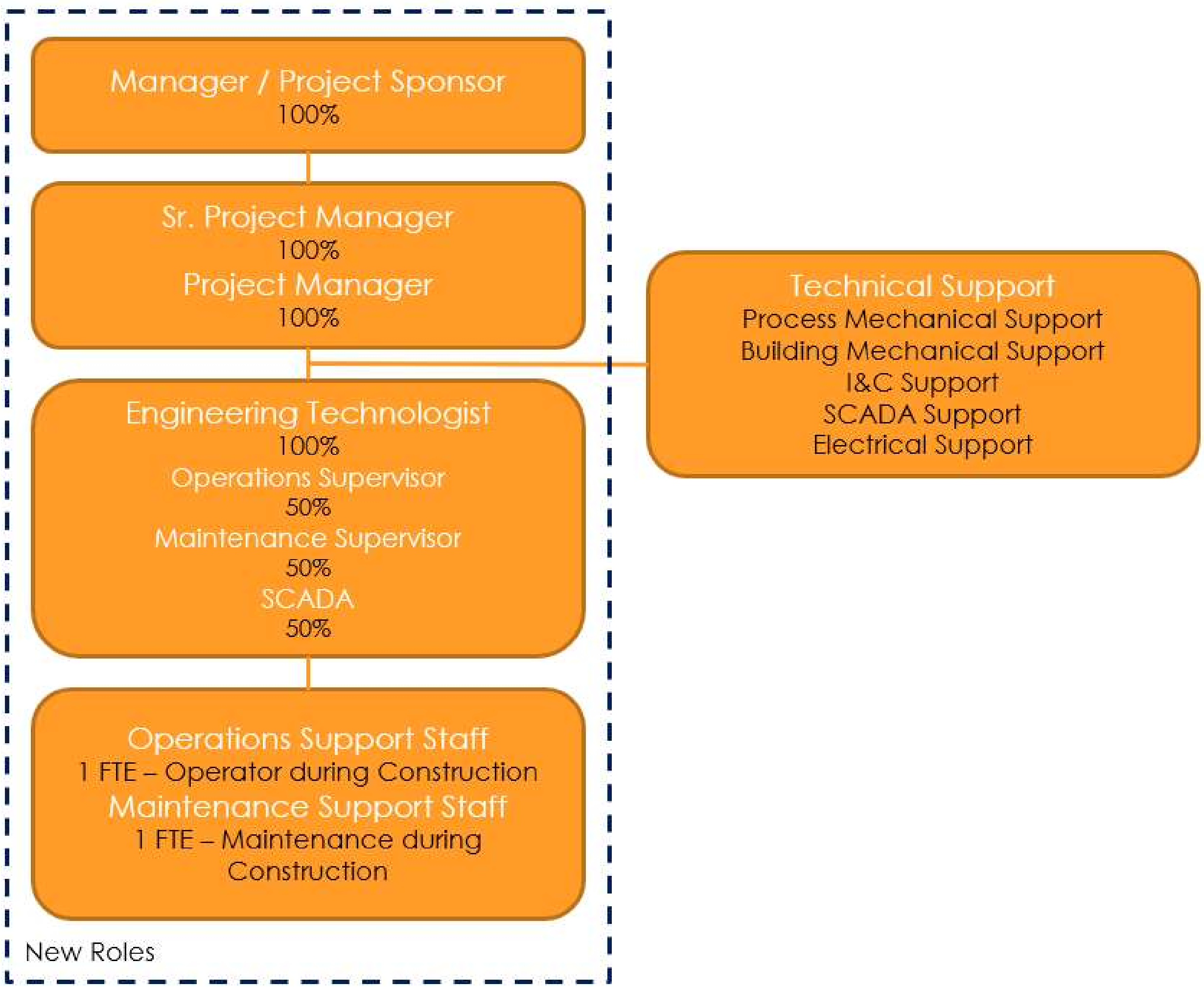

Figure 6-1: Organization Chart; One Construction Contract

It is recommended that the City split the construction contracts into two phases, a Phase 2A and a Phase 2B. An alternative organization chart was developed based on this structure. Generally, the support required by liaisons, discipline technical support and operations and maintenance is not expected to change significantly compared to structuring the project under one contract, however, the project management structure will vary. With a split construction contract, the City may wish to consider one construction manager for each phase, with shared technical and O&M resources.

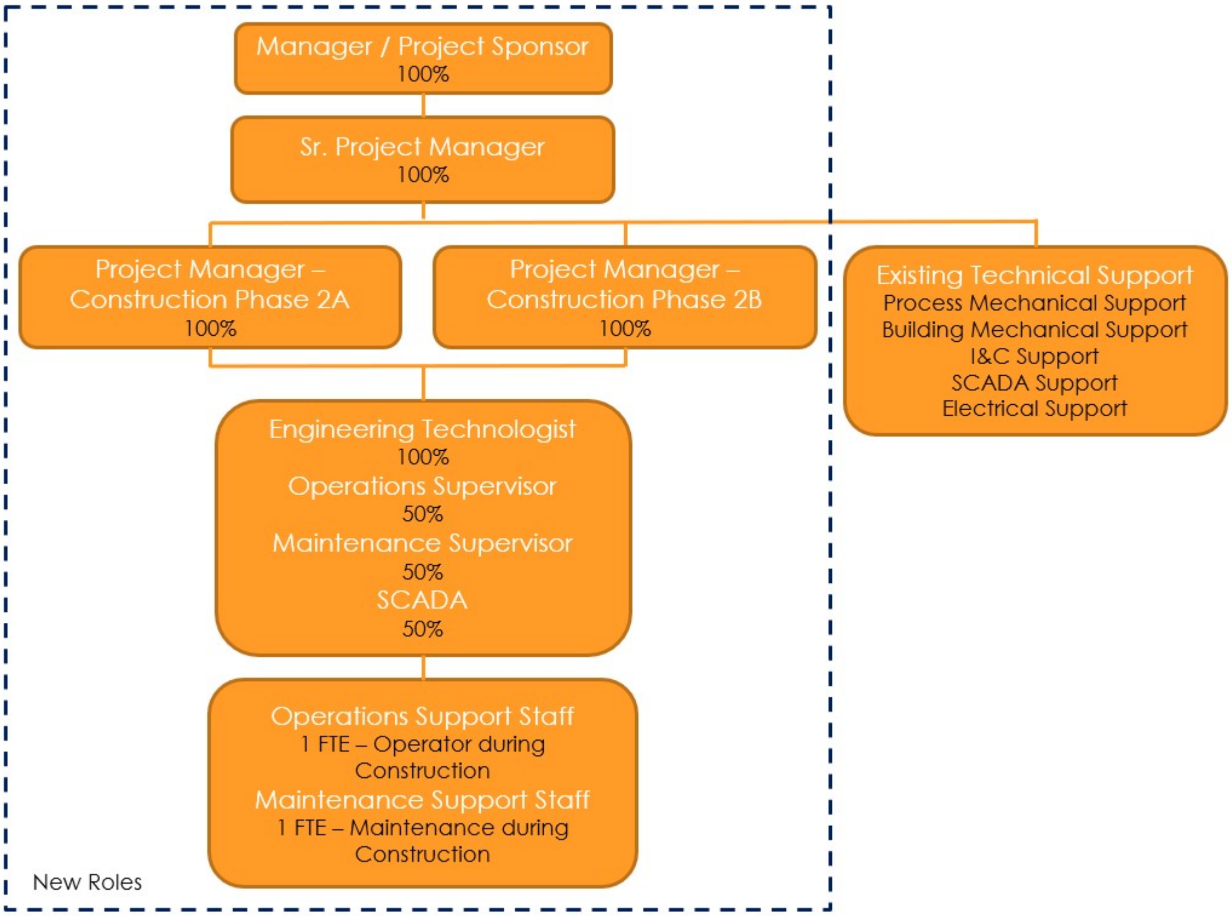

Figure 6-2: Organization Chart; Two Construction Contracts

The amount of support required by each role will vary throughout the phases of the project. The Gantt chart provided below recommends a timeline for onboarding staff to the project team.

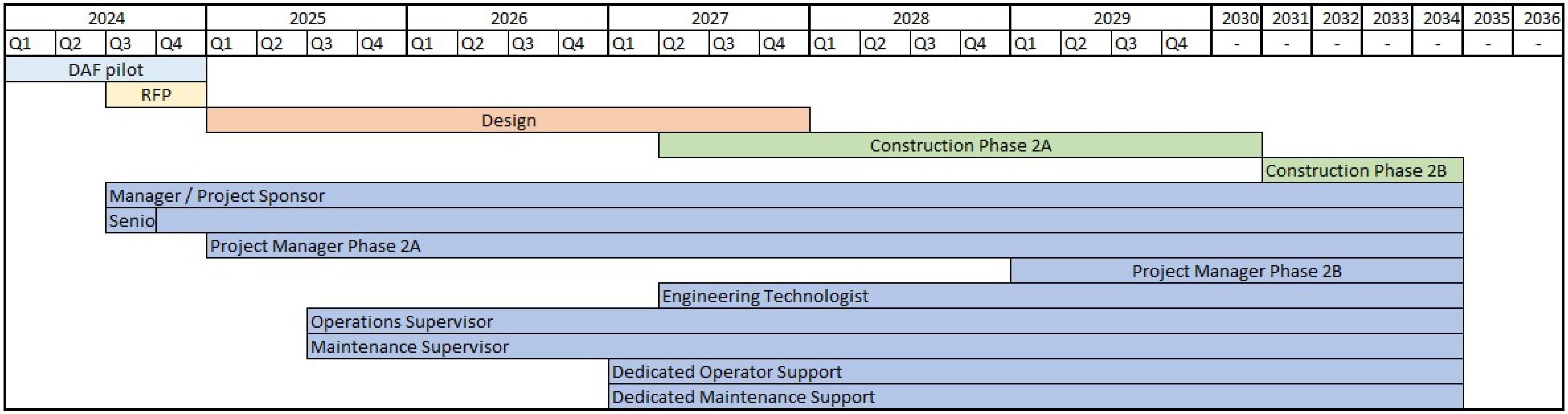

Figure 6-3: Resourcing Gantt Chart; Two Construction Contracts

7.0 CONCLUSIONS

The Stantec team has evaluated the resourcing requirements associated with the Phase 2 upgrades project at Woodward WTP.

This report presents a review and recommendations for dedicated City staff resources for the delivery of the Woodward Phase 2 upgrades project, both from a project management, design, and construction management perspective. An organization chart was developed to demonstrate a potential team structure, with a Gantt chart illustrating timeline for onboarding team members. The recommendations presented center around new positions that will need to be created to support the Phase 2 Upgrades project.

It is anticipated that the City will require the following support during the design period of the Phase 2 upgrades project (2024 – 2026):

Table 7-1: Staff Requests for Phase 2 Upgrades (Design: 2024 - 2026)

Role	Availability During Design	Year Position Required
Manager / Project Sponsor	100%	2024
Senior Project Manager	100%	2024
Project Manager	100%	2025
Engineering Technologist	100%	2025
Operations Supervisor	50%	2025
Maintenance Supervisor	50%	2025
SCADA	50%	2025

It is recommended that the City request additional staff to support the design phase of the Phase 2 upgrades project for the roles in Table 7-1.

Following design, it is anticipated that the City will require the following support during the construction phase of the Phase 2 upgrades project (2027 – 2034). The majority of these positions would have been created during the design phase and roles can be carried through construction.

Table 7-2: Staff Requests for Phase 2 Upgrades (Construction: 2027 - 2034)

Role	Availability During Construction	Year Position Required
Manager / Project Sponsor	100%	Same as Design
Senior Project Manager	100%	Same as Design
Project Manager (Phase 2A)	100%	Same as Design
Project Manager (Phase 2B)	100%	To be determined by City at later date

Role	Availability During Construction	Year Position Required
Engineering Technologist	100%	Same as Design
Operations Supervisor	50%	Same as Design
Operations Support Staff	100%	2027
Maintenance Supervisor	50%	Same as Design
Maintenance Support Staff	50%	2027
SCADA	50%	Same as Design

During the construction phase, based on the assumptions on staff continuity from the design phase as outlined above, it is that the City will not require additional project management and engineering staff with the exception of a Phase 2B Project Manager. Operations and maintenance impacts during the course of construction to support planned shutdowns, equipment start-ups and commissioning, operation of valves, training sessions, change requests, technical input, etc. have been considered. It is recommended that the City request additional staff to support the construction period (2027 – 2034) of the Phase 2 upgrades project as follows: one (1) full time-equivalent (FTE) operations support staff, and one (1) FTE maintenance support staff, in addition to their current work force as summarized in Table 7-2.

Operations and maintenance staff hired for the design and construction of the Phase 2 upgrades project can be retained to operate and maintain the plant post-construction. The number of staff required to operate and maintain the plant will be determined during detailed design.

APPENDIX A
RESOURCING REVIEW WORKSHOP MEETING MINUTES

Stantec

Meeting Notes

Woodward WTP 3rd Party Review – Resourcing Review Worksop

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

Location: MS Teams

Next Meeting: April 21, 2023 / 10:00 am – 12:00 pm

Attendees:

City of Hamilton
Stuart Leitch (SL)
Bill Docherty (BD)
Deborah Goudreau (DG)
Trevor Marks (TM)
Danny Locco (DL)

Stantec
Michael Kocher (MK)
Hailey Holmes (HH)
Joel Thompson (JT)

Absentees: None

Distribution: Attendees

	Item	Action
1	• Personnel and the assignment were introduced.	

2	Stantec reviewed large capital projects over the past 10 years to share project management and engineering structure.
	• Montreal WTP Rehabilitation program
	  ○ City hired 5-6 dedicated full-time staff including, PM, construction manager, financial officer, and sub-PMs.
	  ○ SL inquired whether the financial officer was dedicated solely to the project. MK confirmed that in	

	Item	Action

	this case, it was a dedicated role and required additional effort due to EPCM delivery.
	• Laval WTP Rehabilitation was presented.
	  ○ City developed 9 contracts by area of the WTP, and hired 3-4 dedicated full-time staff.
	• Hamilton WUP org chart was presented. Project structure has a director and three sub-PMs.
	  ○ SL NOTED WUP was three separate projects, with each having a separate PM.	

3	The resourcing survey results were reviewed, grouped according to engineering, operations, and maintenance. • DG noted that the two operators on shift are also watching the SCADA screens for all of the outstations. If there is an issue at an outstation, the outstation operator would be mobilized. If issue occurs after day-shift, process supervisor would likely send a wastewater operator to respond (who also carry water licenses). • MK inquired whether hydro shutdowns are planned to continue for the future. DG confirmed that the energy office notifies the plant when there is a suspected hydro peak to avoid running the HLPs during the peak hours. The plant is run overnight instead. This operating strategy is expected to continue until demand cannot be met. • JT inquired whether the plant sees an effect on the filters from the shutdowns/start-ups. DG noted filters are conventional, and not seeing an impact of the frequent start/stops on filtration. • MK noted a filter quadrant will be offline for significant periods of time during the upgrades, shutdown strategy may not be feasible. DG noted they understand that during construction operating strategy may need to change, and that they have excess storage in the distribution system which helps provide a buffer. • Shutdowns are not overly resource intensive – occur very frequently. • Maintenance services are shared between the water and wastewater systems. Noted design phase can put some strain on the supervisors but construction can generally be accommodated as long as there are no maintenance emergencies. • MK noted strategies are available to manage the effort required from O&M for the design phase; these will be	Stantec to share Pat Coleman OPMAN webinar with the City

	Item	Action
	provided to the City in the TM, along with a recorded webinar prepared by Stantec in 2022.	
4	The suggested engineering roles for the Phase 2 upgrades project was reviewed. • SL noted that their project management structure already has time dedication suggestions for alternate PMs on large capital projects. • SL noted the Operations Liaison role could potentially report through DG. • SL noted the Sr. Construction PM could be a consultant activity – dedicated staff approved for the role if the City is not able to accommodate so many staff dedicated to the project. • SL requested to review what the consultant team on-site looked like for the example projects shared. • The anticipated percentage burdens were reviewed as commitment above and beyond current responsibilities. • SL noted currently alternate PM would be expected to have 20% availability, but could be increased for a project of this size. • DG inquired whether the Operations Liaison should be two different people during design and construction. To support design, 50% time from a superintendent would likely be required, but more support would be required from an operator for construction, with some support from supervisors. Maintenance requirements during design would likely be more from a supervisor, but more heavily relying on trades during construction. • DL noted primary maintenance support is SCADA with some electrical support required for electrical shutdowns for WUP. • MK clarified that the Liaison role is expected to be more like a supervisor or superintendent role. Feedback on City's terminology is useful and will be incorporated into the report. • JT noted importance of involving supervisors from the design stage. DG noted experience with WUP has helped get acceptance and buy-in from the operators on the various work associated with large projects.	Stantec to request consultant team structure on-site in example projects – key roles for consultant
5	• SL noted they are doing 3D modelling for WUP and worked with consultant to develop an approach for reviews of 3D models. This has improved the reviewing process.	

	Item	Action
6	O&M support during design and construction was reviewed. • DG noted the design phase support may be more ad-hoc – 0.2 FTE may be high. DG agrees with 1 FTE during construction, but expects training may have a higher burden on supervisors than front-line operators. For WUP, the City hired 4 additional operators so that one additional per shift is available. An attempt was made to hire was a year before commissioning started to provide ample training time. • DG expects bigger impact on maintenance side with the UV building. DL expects a dedicated SCADA support for both WUP and this project. • MK inquired whether Stantec should develop an overall staffing table showing the timeline for hiring these individuals. SL is expecting design phase to occur between Q4 2024 – Q2 2027. SL requested Stantec develop a resourcing schedule for the project and post-construction operations. DG noted restriction of who can be hired and when hiring may occur will need to be approved by council. • DG noted contracts are renewed every 2 years – the City cannot hire for an 8-year contract. Operational support during the project needs to be someone who knows the plant well. • SL requested Stantec prepare org charts showing which roles are new, which are existing and the overall structure. Provide a Gantt chart for hiring and resourcing.	Stantec to prepare org charts and Gantt charts
7	• DG noted bulb breaks and lamp replacements should be specified as a maintenance activity. • DG noted maintenance estimate for UV seems lower than expected. • MK noted Stantec could confirm maintenance performed at Region of Peel WTP to gain a potentially more accurate estimate.	Stantec to request UV maintenance estimate from Region of Peel
8	• DG clarified that if each shift needs an additional FTE – then that is 5 FTE total. • When operating tonners – additional operator support would likely be covered by overtime. ○ MK noted additional support would only be required during deliveries, and switching between banks of tonners • SL requested Stantec put DAF into the resourcing summary table as O&M effort is higher than plates.	Stantec to update summary table with DAF Stantec to provide additional detail for maintenance requirements

	Item	Action
	• DG and DL requested additional granularity for maintenance requirements – i.e. what type of trade will be required	

The meeting adjourned at 10:40AM.

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

Woodward 3rd Party Review – Capital Construction Cost Review

September 25, 2023

Prepared for:

City of Hamilton

Prepared by:

Stantec Consulting Ltd.
100-300 Hagey Boulevard
Waterloo ON N2L 0A4

165640394

Revision	Description	Author		Quality Check		Approved By	
0	Draft	HH PK		MK		MK	
1	Final	HH				MK	

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Prepared by ____

(signature)

Hailey Holmes, M.E.Sc., E.I.T., Stantec

Prepared by ____

(signature)

Paul Kusiar, C.E.T., Kusiar Project Services

Approved by ____

(signature)

Mike Kocher, P.Eng., Stantec

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 presents a review of the conceptual cost estimate developed by Stantec and Kusiar Project Services (KPS) for the Woodward WTP Phase 2 Upgrades.

Using the City's previous council report as a guideline for reporting, the following table summarizes the overall cost estimate for the Phase 2 Upgrades at Woodward WTP:

Table E-1-1: Cost Estimate for Woodward WTP Phase 2 Upgrades (excluding engineering, inflation and contingencies)

Process	**Opinion of Cost**
Low Lift	$18,100,000
Temporary Pre-Treatment	$17,100,000
Pre-Treatment	$62,486,000
Filter to Waste	$16,100,000
Backwash System	$15,100,000
Filter Underdrains	$7,100,000
Filter Media	$15,100,000
UV Disinfection	$110,223,000
Chlorine Building	$21,100,000
Miscellaneous	$5,100,000
Total (2023 Dollars, not including inflation, engineering, and contingency)	***$287,509,000***

The total opinion of cost comes to $287.5M and does not include contingency, engineering or inflation, assuming one construction contract at current 2023 rates. Based on the current stage of the project, it is expected that this estimate will be refined and change over time as the scope of the project is better defined. There is no current indication that construction cost increases will slow, but if stabilized they will continue to be subject to inflation which is difficult to accurately forecast. This initial capital cost estimate was then input into the City of Hamilton's CCE Vertical Project Cost Estimate Worksheet V1.2, which provided a final total project cost of $514.6M.

Stantec provided a recommendation to split the construction contract into two phases, a phase 2A and a phase 2B. Phase 2A prioritizes upgrades that improve protection of public health, including filter upgrades and the UV building. Two construction contracts would result in the following capital cost breakdown:

Table E-1-2: Phase 2A Capital Cost Estimate

Process	Opinion of Cost
Filter to Waste	$16,100,000
Backwash System	$15,100,000
Filter Underdrains	$7,100,000
Filter Media	$15,100,000
UV Disinfection	$110,223,000
Chlorine Building	$21,100,000
Miscellaneous	$2,550,000
Sub-total Phase 2A (2023 Dollars, not including inflation, engineering, and contingency)	***$187,273,000***
Total Phase 2A (2027 Dollars, including inflation, engineering, and contingency)	**$335,200,000**

Table E-1-3: Phase 2B Capital Cost Estimate

Process	Opinion of Cost
Low Lift	$18,100,000
Temporary Pre-Treatment	$17,100,000
Pre-Treatment	$62,486,000
Miscellaneous	$2,550,000
Sub-total Phase 2B (2023 Dollars, not including inflation, engineering, and contingency)	**$100,236,000**
Total Phase 2B (2032 Dollars, including inflation, engineering, and contingency)	**$208,800,000**

Including the City of Hamilton’s CCE Vertical Project Cost Estimate Worksheet V1.2 factors for inflation, engineering, and contingency, the total Phase 2A cost estimate is $335.2M assuming construction start date of 2027, and total Phase 2B cost estimate is $208.8M assuming construction start date of 2032.

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1.0 INTRODUCTION

1.1 BACKGROUND

The Woodward Water Treatment Plant (WTP) provides potable water for the City of Hamilton and some communities in Halton and Haldimand. The plant was originally constructed in 1931 and expanded in the late 1950s. The treatment process includes intake chlorination for seasonal zebra mussel control and year-round pathogen inactivation, screening, pre-chlorination for pathogen inactivation ahead of pre-treatment, coagulation with polyaluminum chloride (PACl), flocculation, conventional gravity sedimentation, granular activated carbon (GAC) filtration, post-filter chlorination for primary and residual disinfection, ammoniation to form chloramines for residual maintenance, and fluoridation. The current rated capacity of the WTP is 909 MLD.

The AECOM 2022 Conceptual Design Report for Phase 2 of the upgrades includes 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 23 filters, replace the GAC and sand media in 24 filters, refurbish 23 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 de-chlorination 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.

1.2 PROBLEM STATEMENT

The construction cost estimate for the Phase 2 Upgrades project had previously increased from $165M (CH2M HILL, 2016, pre-conceptual design) to the recent estimate of $385M (AECOM, 2022). Stantec will provide an independent review and update to the overall capital cost estimate, incorporating additional project scope, market factors (inflation), and considering timing of construction.

1.3 OBJECTIVES

The 3rd party review of the conceptual design capital cost estimate is intended to assist the City with the capital cost budgeting and planning. The purpose of this review is to assess if there are major gaps or assumptions that can be identified within the conceptual design estimate that could significantly impact final construction costs.

1.4 APPROACH

The conceptual design cost estimate is presented in Section 2.0.

Stantec and Kusiar Project Services’ review of the existing cost estimate is presented in Section 3.0.

Construction inflation is discussed in Section 4.0.

CCE workshop review is discussed in Section 5.0.

Conclusions are presented in Section 6.0.

2.0 REVIEW OF PREVIOUS COST ESTIMATES

The AECOM conceptual design report (2022) included a construction cost estimate of $242M before engineering, contingency, and level-of-accuracy impacts (30%). With the addition of contingencies and level-of-accuracy impacts, the estimate rose to $368M, excluding engineering and inflation. There were several other major exclusions regarding the 2022 cost estimate. These include but are not limited to:

- Additional LLPS works (i.e. replacement of the remaining 3 large pumps, upgrades to the facility). Additional study and pump testing was recommended.
- New chlorine building works (conceptual design completed by Stantec, 2022).
- Filter-to-Waste works (conceptual design completed by Jacobs, 2022).
- Any works related to effluent pump station improvements (known hydraulic bottleneck).
- Major concrete rehabilitation / repairs to sedimentation tanks.

The Council Report (PW22078) cost estimate, dated September 2022, included line items for the chlorine building, miscellaneous upgrades, and engineering, but excluded contingencies and inflation. The cost estimate was a total of $348M.

3.0 STANTEC/KPS REVIEW OF COST ESTIMATE

3.1 BACKGROUND

KPS assembled the Opinion of Cost based on information provided within the previous conceptual designs completed by Jacobs and AECOM. Where information was deemed insufficient to sufficiently prepare costing estimates, assumptions were made based on a variety of previous projects in similar size and scope.

Further, the “construction community” typically working on these types of projects was consulted to gain a better understanding of current pricing on large scale multi-year projects, gather current information on materials specific to inflation, and gather current vendor pricing for as many items as possible. It is not currently known whether the City will elect to issue this project as one large contract or if it will be split in two smaller projects, however, for the purposes of this exercise an estimate was developed based on one construction contract from start to finish using today’s market value pricing.

High prices were observed in all areas of the estimate, with some signs of stabilizing but no signs of any significant reductions in the near future. Significant price increases worth noting include concrete, which has risen in price significantly more quickly recently than has been historically observed. Stainless steel pricing has stabilized somewhat due to the Euro conversion rate; stainless steel pricing has an influence specifically on the plate settlers. Stainless steel pricing could become more volatile again when this project reaches the tender stage – it is recommended to update the estimate frequently. The City could gather updated costing information or engage a consultant to provide quarterly updates as construction draws closer and the design evolves. As the detailed design progresses, an estimation team could update all quantities and track the market for current pricing. Additionally, the contractor community should be engaged for current market pricing regularly as part of this undertaking.

3.2 UV BUILDING

KPS has previously recommended the City move away from large diameter CPP and construct a CIP conduit system for water conveyance. The UV Building cost estimate was developed assuming the City has accepted this recommendation. While the UV building design will not result in a complicated build, the scope is complex considering the amount of buried services in the surrounding area that will need to be relocated or managed prior to or during construction. The civil works portion of the estimate was quantified by calculating excavation quantities, concrete volumes, backfilling and disposal quantities and the complexity of concrete forming types. The wall areas of the super-structure were used to determine an accurate quantity of concrete and values were factored in. Overall pricing was straight forward to estimate, however, assumptions were required for the electrical portion of the cost as limited detail was provided in the conceptual design. Assumptions included minor adjustments to the main incoming high voltage service in terms of fuse sizing at the 27.6 kV level, a new sub-station/switchgear, and 600V distribution throughout. The primary process equipment was quoted by Trojan UV’s local representative

Jeff Dobbin of H2Flow Equipment Inc. The pricing is current as of April 2023 and the high level quotation for the UV equipment is included in Appendix B.

The cost estimate for the UV building, excluding engineering, inflation and contingencies, is $110.2M.

3.3 SEDIMENTATION

The sedimentation tank upgrade is a large undertaking with many associated unknowns. The cost estimate was developed under the assumption that plate settlers would be installed in the existing sedimentation basins, per the AECOM conceptual design report and drawings. The number of removals was quantified, and demolition values from other projects were used to develop a demolition cost estimate. For the modifications to occur as planned, both sedimentation tanks must be removed from service - this assumption was carried through the cost estimate development. If the City proceeds with the tank modification as detailed in the conceptual design, it is recommended to engage a professional demolition contractor to prepare a formal quotation and scope of work for inclusion in the tender documents. There will be strategic removals that must be made while maintaining the integrity of the remaining structure; it is highly recommended to engage an independent firm local to the Greater Toronto Area (GTA) and capable of managing a demotion of this size and complexity.

In addition to current pricing from local contractors, a quotation from a local vendor for the plate settler system was included in the quotation. Scott Lenhardt, P. Eng. of Pro-Aqua Inc. provided a budgetary quotation for the plate settler system, included in Appendix B.

The budgetary estimate for the sedimentation tank works was prepared based on major sub tasks including demolition & removals, excavation, concrete, process, mechanical and electrical. The total estimate for the sedimentation tanks (including temporary pre-treatment system and a new super structure) is $79.6M, excluding contingency, engineering and inflation.

3.4 FILTRATION

The filter building estimate includes a full replacement of all underdrains, media, and a significant amount of surficial concrete restoration. Recent restoration pricing from other active projects was used as a basis for the cost estimate. A contractor and vendor were consulted to confirm the construction approach in terms of pricing and schedule. Bennet Mechanical (Bennett) and Continental Carbon (Continental) provided budgetary quotations for the materials. Bennett confirmed the approach referenced previous work in the filter building at Woodward WTP while Continental quoted the media and underdrain replacement including labour and material. Jacobs was retained to complete a preliminary design for installation of filter-to-waste within the filter building; their conceptual cost estimate was updated and included in the overall estimate.

The budgetary estimate for filter underdrain replacement and concrete restoration is $7.1M, for filter media replacement is $15.1M, and for filter-to-waste is $16.1M.

3.5 CHLORINE BUILDING

The new chlorine building conceptual design and cost estimate were previously prepared by Stantec. The cost estimate included in the overall Phase 2 upgrades is $21.1M.

3.6 OVERALL ESTIMATE

Using the City's previous council report as a guideline for reporting, the following table summarizes the overall cost estimate for the Phase 2 Upgrades at Woodward WTP:

Table 3-1: Cost Estimate for Woodward WTP Phase 2 Upgrades, excluding engineering, inflation and contingencies

Process	Opinion of Cost
Low Lift	$18,100,000
Temporary Pre-Treatment	$17,100,000
Pre-Treatment	$62,486,000
Filter to Waste	$16,100,000
Backwash System	$15,100,000
Filter Underdrains	$7,100,000
Filter Media	$15,100,000
UV Disinfection	$110,223,000
Chlorine Building	$21,100,000
Miscellaneous	$5,100,000
Total (2023 Dollars, not including inflation, engineering, and contingency)	***$287,509,000***

The total opinion of cost comes to $287.5M and does not include contingencies, engineering and inflation, assuming one construction contract at current 2023 rates. It is expected that this estimate will change over time. There is no current indication that construction cost increases will slow, but even if stabilized they will continue to be subject to inflation which is difficult to accurately forecast. This initial estimate was used in the City of Hamilton's CCE Vertical Project Cost Estimate Worksheet V1.2, which provided a final total project cost of $514.6M.

The CCE spreadsheet factors in project contingencies, inflation, engineering costs, and land costs where applicable. An inflation factor of 3% was assumed; refer to Section 4 for further information.

3.7 TWO CONSTRUCTION CONTRACTS

Stantec provided a recommendation to split the construction contract into two phases, a phase 2A and a phase 2B. Phase 2A prioritizes upgrades that improve protection of public health, including filter upgrades and the UV building. Two construction contracts would result in the following capital cost breakdown:

Table 3-2: Phase 2A Capital Cost Estimate

Process	Opinion of Cost
Filter to Waste	$16,100,000
Backwash System	$15,100,000
Filter Underdrains	$7,100,000
Filter Media	$15,100,000
UV Disinfection	$110,223,000
Chlorine Building	$21,100,000
Miscellaneous	$2,550,000
Sub-total (2023 Dollars, not including inflation, engineering, and contingency)	***$187,273,000***
Total Phase 2A (2027 Dollars, including inflation, engineering, and contingency)	**$335,200,000**

Table 3-3: Phase 2B Capital Cost Estimate

Process	Opinion of Cost
Low Lift	$18,100,000
Temporary Pre-Treatment	$17,100,000
Pre-Treatment	$62,486,000
Miscellaneous	$2,550,000
Sub-total (2023 Dollars, not including inflation, engineering, and contingency)	**$100,236,000**
Total (2023 Dollars, including inflation, engineering, and contingency)	**$208,800,000**

Including the City of Hamilton's CCE Vertical Project Cost Estimate Worksheet V1.2 factors for inflation, engineering, and contingency, the total Phase 2A cost estimate is $335.2M assuming a construction start date of 2027, and total Phase 2B cost estimate is $208.8M assuming a construction start date of 2032. Stantec strongly recommends prioritizing upgrades that improve protection of public health, including filtration upgrades and the new UV building. Discussion surrounding the possibility of delaying the UV building occurred during the final workshop with the City of Hamilton. Careful consideration should be given to delaying the UV building upgrades from both constructability and process risk perspectives; the process risks associated with the UV building are well documented in previous technical memos. Should the UV building be delayed to Phase 2B, a new location for the backwash pumps and air scour equipment required for the filter upgrades would be needed as the current conceptual design places the equipment in the UV building. Consideration needs to be given to buildings and equipment with overlapping functionality.

4.0 CONSTRUCTION INFLATION

Non-residential construction inflation is significant. The 11-census metropolitan area (CMA) composite for non-residential construction cost increased 12.5% in 2022 compared to 2021, representing the highest annual increase since the beginning of the Non-Residential Building Construction Price Index in 1981[1].

Higher costs for steel and concrete have primarily led the non-residual construction price growth. Structural steel framing alone increased by 2.5% in Q4 2022, compared to Q3 2022, followed by concrete and metal fabrications which were both up by 2.3%. The cost to build bus depots with maintenance and repair facilities and factors rose the most in the 11-CMA composite (up by 1.9%).

Supply chain disruptions that started during the COVID-19 pandemic continued to impact the construction industry in 2022. The generalized increase in fuel prices has also impacted the industry. Wood, plastics, and composites recorded one of the largest year-over-year increases. These factors, along with the growth in prices of structural steel framing, concrete, and metal fabrications, led the rise in construction material costs.

[1] Statistics Canada. *Building construction price indexes, fourth quarter 2022*. February, 2023. The Daily — Building construction price indexes, fourth quarter 2022 (statcan.gc.ca)

5.0 CCE WORKSHOP REVIEW & DISCUSSION

The City of Hamilton Construction Cost Estimating (CCE) worksheet was reviewed and its impact on the construction cost estimate assessed.

Using a starting point of a construction inflation rate of 3% and engineering inflation rate of 3% per the City's current inflation factors, in addition to the allowances and contingencies referenced in the worksheet, the overall total cost estimate increased to $514.6M.

The largest contributors to the increased costs produced with the CCE worksheet relative to AECOM estimate included project contingency (construction) at $72M, construction inflation (3 years at 3%) at $51M, and the overall consultant costs (including permits/approvals, contingencies, etc.) at $61.6M.

The CCE worksheet includes a Construction Contingency allowance of 25%. Although this may seem high for a project of this size and magnitude, based on the current conceptual level design, this is an appropriate amount to carry until the scope of the project is further refined and detailed design progress. Typically, a conceptual or schematic level design cost estimate (Class D) is considered to have a +/- 20 – 25% level of accuracy.

5.1 PREVIOUS COST ESTIMATES

Previous estimates have been provided to the City by CH2MHill (2015) and AECOM (2022). Works included in each of the estimates is summarized in Table 5-1. The scope of the work was expanded between the CH2M Hill analysis in 2016 and AECOM's conceptual design in 2022, as well as further detail provided resulting in expected increases in estimated capital cost.

Table 5-1: Woodward WTP Phase 2 Upgrades Consultant Comparison

Works	CH2M Hill	AECOM	Stantec
LLPS		X	X
Rapid Mixers and Flocculation Mixers		X	X
Flocculation Tank Tertiary Stage		X	X
Sedimentation Tank 1 and 2 Plate Settlers	X	X	X
Sedimentation Tank 1 and 2 Superstructure	X	X	X
Temporary 5th Sedimentation Tank		X	X
Backwash Pumps and Aeration for 24 Filters	X	X	X
Refurbishment of 23 Filters	X	X	X
Filter Underdrain Replacement of 23 Filters	X	X	X
Filter Media Replacement of 23 Filters	X	X	X
Filter Effluent Headers and Treated Water Headers		X	X
UV Building	X	X	X

Works	CH2M Hill	AECOM	Stantec
New Backwash Pumps and Tanks		X	x
New Chlorine Contact Tanks	X	X	X
Yard Piping		X	X
Miscellaneous	X	X	X

A comparison of the previous estimates, with Stantec's estimate, is provided in **Table 5-2**. Additional contingency and inflation factors are included in the Stantec estimate per the City's CCE worksheet.

Table 5-2: Consultant Cost Estimate Comparison

Conditions	CH2M Hill ($M)[2]	AECOM ($M)[3]	Stantec ($M)
	Not provided	242 (2022 $)	287.5 (2022 $)
Estimate with contingency and/or inflation	93.8 (2015 $) 112.8 (2022 $)	368 (2022 $)	514.6 (2022 $)
Contingency and/or inflation included	• 15% contractor fees • 20% design contingency • 10% construction contingency	• 2% provisional cash allowance • 15% tender contingency • 30% level of accuracy contingency	• 3% construction inflation annually through 2027 • 3% engineering inflation annually through 2027 • 25% construction continency • 15% design and contract administration

[2] Final Summary Report, Woodward WTP Capital Works Implementation Plan. CH2M Hill. April 2016.
[3] Woodward WTP Upgrades Conceptual Design Report. AECOM. September 2022.

6.0 CONCLUSIONS

In conclusion, the Stantec team has evaluated the construction cost estimate associated with the Phase 2 upgrades project at the Woodward WTP.

It is anticipated that the construction cost will rise to $514.6M, including engineering, contingencies and inflation. If the construction contracts are split into Phase 2A and Phase 2B as recommended by Stantec, the anticipated constructions costs are $335.2M and $208.8M, respectively.

APPENDIX A
CAPITAL COST REVIEW WORKSHOP MEETING MINUTES

Stantec

Meeting Notes

Woodward WTP 3rd Party Review – Capital Cost Review Worksop

Project/File: 165640394
Date/Time: April 21, 2023 / 11:00 am – 1:00 pm

Location: MS Teams

Next Meeting: TBD

Attendees:

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

Stantec
Michael Kocher (MK)
Hailey Holmes (HH)

KPS
Paul Kusiar (PK)

Absentees: None

Distribution: Attendees

	Item	Action
1	• The AECOM conceptual design report cost estimate was reviewed. • SL confirmed that the cost estimate presented at the council meeting in September 2022 did not include contingencies and inflation, only the total estimate for engineering and construction.	Info
2	• The cost estimate developed by Stantec and KPS was reviewed.	Info

	Item	**Action**
	• MK noted that this estimate is assuming plate settlers move forward as the sedimentation technology. • PK noted that soils costs could be reduced by developing a soil management plan in advance of construction as soil disposal costs are currently very high. • PK noted that estimate was prepared separately from AECOM's estimate. • PK noted concrete costs have doubled in recent years and accounts approximately $47M for the full project. • KPS consulted with Bennett, Continental Carbon, etc for updated costing for updates in the filter building including underdrains and media. • SL inquired whether the underdrain style quoted was AWI SS style. PK confirmed. PK clarified the media costing was $2.5M per quad (set of 4 filters) to purchase and install new media. SL requested to view the quotation from Continental Carbon. • The total cost estimation was determined to be $287.6M. With contingency, and construction and consultant inflation, the total project cost is estimated at $554.7M. • SL noted the high contingency is standard for City of Hamilton project management. Through pre-design and detailed design, the City carries lower contingency values as estimate precision increases. • SL noted FTW and LLPS changes included in cost and inquired whether other exclusions included in costs such as rehabilitation work in sed tanks and clearwells. MK clarified those costs have not yet been included. SL requested costs to be included to provide a full complete estimate. • MK noted the biggest cost difference between Stantec and AECOM estimate is pre-treatment and UV disinfection building costs. • SL inquired whether Stantec could provide a high level understanding of lifecycle comparison of DAF and plate settlers with a decision matrix using contingency.	KPS Stantec
3	• MK presented a discussion on construction inflation. • Non-residential construction cost increases have been > 10% year over year since 2020, with biggest increases in structural steel framing, followed by concrete and metal fabrications. • SL noted the contingency and inflation will be included when presenting project to council this coming summer.	Info

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	Item	Action
4	• SL inquired about the low inflation cost carried for consultant. MK noted this is fairly standard for the industry and not expecting to see large increases in coming years. • SL noted that based on recent construction contracts, it does appear the industry may be slowly calming down. MK noted these are 1-2 year contracts which may skew the trend. PK noted that with they have seem some stabilization recently. • MK recommends engagement with large GCs, informing and updates, until tender goes out. • MK inquired whether there are ways to include material fluctuation clauses into a traditional design, bid, build contract. PK noted there are. SL noted this would need to be done carefully – not issuing a blank cheque. • TM requested clarification for exclusions: high lift pumps, concrete restoration on sedimentation tanks and clearwells. PK clarified 2000 m^2 of surficial repairs was included in the filter estimate.	Info
	• SL requested the breakdown of cost estimate. PK confirmed this can be provided.	Stantec/KPS

The meeting adjourned at 11:55AM.

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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Environmental Designer
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Attachment: Workshop presentation, cost estimate breakdown

Stantec

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

Workshop 4 – Capital Cost Estimate Review for Woodward Phase 2 Works

Agenda

1. Introductions
2. Review Previous Estimates (AECOM, PW22078)
3. Stantec / KPS review of Cost Estimate
4. Construction Inflation Discussion
5. CCE Workshop Review & Discussion
6. Next Steps

Introductions

Stantec Team

- Mike Kocher: Project Manager
- Paul Kusiar: Constructability Lead
- Hailey Holmes: Process Engineering Support

Recent Estimates

Recent
Estimates

AECOM Concept Design Report

- $242M before Engineering, Contingences, and Level-of-Accuracy Impact (30%)
- Inflation not included
- $368M including Contingencies and Level-of-Accuracy Impact. Did not include Engineering or Inflation.
- Major exclusions from AECOM estimate:
  - Additional LLPS works (i.e. replacement of remaining Large 3 pumps, upgrades to facility). Additional study and pump testing were recommended.
  - New Chlorine Building works (Stantec concept design)
  - Filter-to-Waste works (Jacobs concept design).
  - Any works related to Effluent Pump Station improvements (known bottleneck)
  - Major concrete rehabilitation / repairs to sedimentation tanks

Recent
Estimates

PW22078 – Sept 19, 2022

- Built further off the AECOM concept design estimate
- Included line items for Chlorine Building, Misc. Upgrades, and Engineering (?)
- Excluded Contingencies and Inflation
- $348M total estimate
- Notes within PWC report:

HW is undertaking a third-party review of key areas that are deemed critical to the success of this project as part of a due diligence approach. The main project scope of this review includes:

- *Capital Construction Cost Review of the WTP Phase 2 Process Upgrades capital budget evolution from the CH2M Hill 2016 Study to the current AECOM 2022 conceptual design. The review will focus on additional scope identified during the AECOM 2022 conceptual design. Other factors will also be assessed including labour shortages, complex project sequencing, supply chain challenges, excess soil regulations, material costs and escalating inflation.*

Stantec / KPS Cost Estimate Review

Stantec / KPS Cost Estimate Review

Cost Estimate Development Review

- Paul Kusiar from KPS to walk through cost estimate development
- Focus of bottom-up cost estimate development was primarily on Sedimentation Tank Upgrades (Plate Settlers), Filter Building Upgrades, and UV Building Upgrades.
- Used combination of take-offs for Concrete, Steel, and Civil Works, discussions with large Contractors on current material cost rates, as well as updated vendor quotations for key components (i.e. Plate Settlers, Filter Media)
- Electrical / I&C represent approx. 15% of cost estimate.
- Additional items also added for recently completed cost estimates from other supporting studies (i.e. Chlorine Building, Filter-to-Waste).

Stantec / KPS Cost Estimate Review

Summary of Results

- Current estimate sits at $287.5M, before contingencies, allowances, inflation, and engineering.
- Approx. 19% higher base capital cost estimate compared with AECOM concept design ($287.5M vs $242M).
- The following items are still in progress / not yet included in the estimate:
  - Seeking updated vendor quotation for UV process equipment. Currently have allowance within Detailed Cost Estimate.
  - Does not yet include any Sed Tank concrete rehabilitation work (that may be required following Jacobs concrete testing).
  - Does not include any works associated with Effluent PS (known bottleneck).
  - Engineering, contingencies, allowances etc. have been assessed using City of Hamilton CCE Worksheet (next section).

Construction Inflation Discussion

Construction Inflation

Construction Inflation

Year-over-Year Non-Residential Construction Inflation Increase (%)				
	4th Quarter 2022	**4th Quarter 2021**	**4th Quarter 2020**	**4th Quarter 2019**
Toronto Metro Area	**14.5**	**11.2**	**2.6**	**2.9**

Non-residential construction costs register record increase (2022 4th Quarter - Statistics Canada)

https://www150.statcan.gc.ca/n1/daily-quotidien/230208/dq230208d-eng.htm

> The 11-CMA composite for non-residential construction cost increased 12.5% in 2022 compared with 2021. This was the highest annual increase since the beginning of the Non-Residential Building Construction Price Index in 1981.

> Higher costs for steel and concrete led non-residential construction price growth

> Non-residential building construction cost growth was led by cost increases in structural steel framing (+2.5%), followed by concrete and metal fabrications (both up by 2.3%). Of all non-residential buildings surveyed, the cost to build bus depots with maintenance and repair facilities and factories (both up by 1.9%) rose the most in the 11-CMA composite.

CCE Worksheet Review

CCE Worksheet Review

City of Hamilton CCE Worksheet Review

- CCE Worksheet to be shared and discussed.
- Using a starting point of a Construction Inflation Rate of 7% and Engineering Inflation Rate of 3%, plus allowances and contingencies from the Worksheet, overall total increases substantially to $554M
- Largest contributors to increases using CCE worksheet:
  - Project Contingency (Construction): $72M
  - Construction Inflation (3 years @ 7%): $90M
  - Overall Consultant Costs (inc. Permits/Approvals, Contingencies, etc.): $61M

Next Steps

Next Steps

Next Steps

- Updates to TM1 and TM2 based on City comments.
- Submission of draft TM3 – Resourcing for WTP Phase 2 Works
- Submission of draft TM4 – 3rd Party Review of Conceptual Design Cost Estimate
- Submission of draft TM5 – Woodward WTP Phase 2 Funding Opportunities

APPENDIX B
CAPITAL COST QUOTATIONS

Filter Media Replacement Quote

To: Paul Kusiar- KPS
Re: Budget Pricing for Filter Media Replacement
At: Woodward Water Treatment Plant

SCOPE: REMOVAL AND DISPOSAL OF FILTER MEDIA
-CCG will remove and dispose of all existing GAC and sand in each of the 24 filters. All filter media will be removed via industrial vacuum and disposed offsite.

SCOPE: SUPPLY & DELIVERY OF FILTER MEDIA
-CCG will supply and install 305mm of 0.45-0.55 UC 1.50 Sand in each of the 24 filters. All sand is NSF 61 Certified. Supply includes extra volume for skimming of fines and void fill of stainless-steel underdrains. All sand will be installed through slurry induction system and will be in accordance with AWWA B100. Owner to supply water for installation.
-Upon completion of sand installation, CCG will disinfect each of the 12 filters in accordance with AWWA C653-13.
-CCG will supply and install 914mm of FILTRASORB 300 8X30 GAC in each of the 24 filters. CCG will install all GAC in accordance with AWW B604.
-CCG will work with Owner to properly backwash and commission each of the filters.
-Prior to shipment of all filter media, both sand and GAC will be sampled and sent to independent laboratory for testing. 1 sample for ever 25m3 of each filter media type.
-Once the filter media is delivered CCG will once again sample both the sand and GAC and send of to independent labs for testing. 1 sample for ever 50m3.
-CCG will also come in and sample 3 months and 12 months after commissioning of filters. All samples will be tested at independent labs.
-All the above scope was based on having access to one quadrant (6 filters) at a time.

PER QUADRANT BUDGETARY PRICING

REMOVAL & DISPOSAL OF EXISTING FILTER MEDIA	$308,480.00
SUPPLY AND INSTALLATION OF FILTER MEDIA	$2,190,820.00

CLARIFICATIONS:
-HST is extra. All amounts are in CAD dollars.
-Quotation is budgetary and based on current market conditions.

Should you have any questions concerning this quote please contact me at 905-645-4916 or 905-643-7615 ext 221.
CONTINENTAL CARBON GROUP INC

Michael Massis Date: April 18, 2023
Vice President Marketing and Sales

UV Cost Estimate

From: Paul Kusiar
To: Holmes, Hailey
Subject: Fwd: WTP - UV Estimate
Date: Thursday, July 6, 2023 3:15:14 PM
Attachments: image001.jpg

FYI

Get Outlook for iOS

From: Jeff Dobbin <Jeff@h2flow.com>
Sent: Friday, April 21, 2023 11:24:58 AM
To: Paul Kusiar <paul.kusiar@kps.ca>
Subject: RE: WTP - UV Estimate

Hi Paul,

Thanks for the email!

I remember working with you on the Mid-Halton upgrade.

Good luck at your meeting, and please let us know if you need anything else.

Best regards

Jeff

Jeff Dobbin
Municipal Sales Manager & Municipal Area Manager – Ontario Central
H2Flow Equipment Inc.
580 Oster Lane, Vaughan, Ontario, Canada L4K 2C1
Tel: (905) 660-9775 x31 Fax: (905) 660-9744 Cell: (416) 500-5388
jeff@h2flow.com www.h2flow.com

From: Paul Kusiar <paul.kusiar@kps.ca>
Sent: April 21, 2023 10:12 AM
To: Jeff Dobbin <Jeff@h2flow.com>
Subject: WTP - UV Estimate

Hi Jeff,

Thanks again for taking my call earlier this morning. As I get more details that I can share with you I will, but for now as discussed, six (6) reactors at 1.2 m diameter each complete with all controls/panels et al is what is being considered for Woodward WTP.

Construction start is currently expected as early as 2026, and I am carrying $6M for supply of your full system. If you have any questions or further comments, please do not hesitate to let me know.

Respectfully,

Paul Kusiar, C.E.T
Kusiar Project Services Inc.
163 Long Dr., Stratford, ON, N5A 7Y8
paul.kusiar@kps.ca
p. 519-273-7631
f. 519-273-6263
c. 519-949-3791

Plate Settler Cost Estimate

From: Paul Kusiar
To: Holmes, Hailey; Kocher, Michael
Subject: Fwd: Hamilton WTP - quote
Date: Tuesday, July 11, 2023 10:51:57 AM
Attachments: image001.png

FYI Gang,

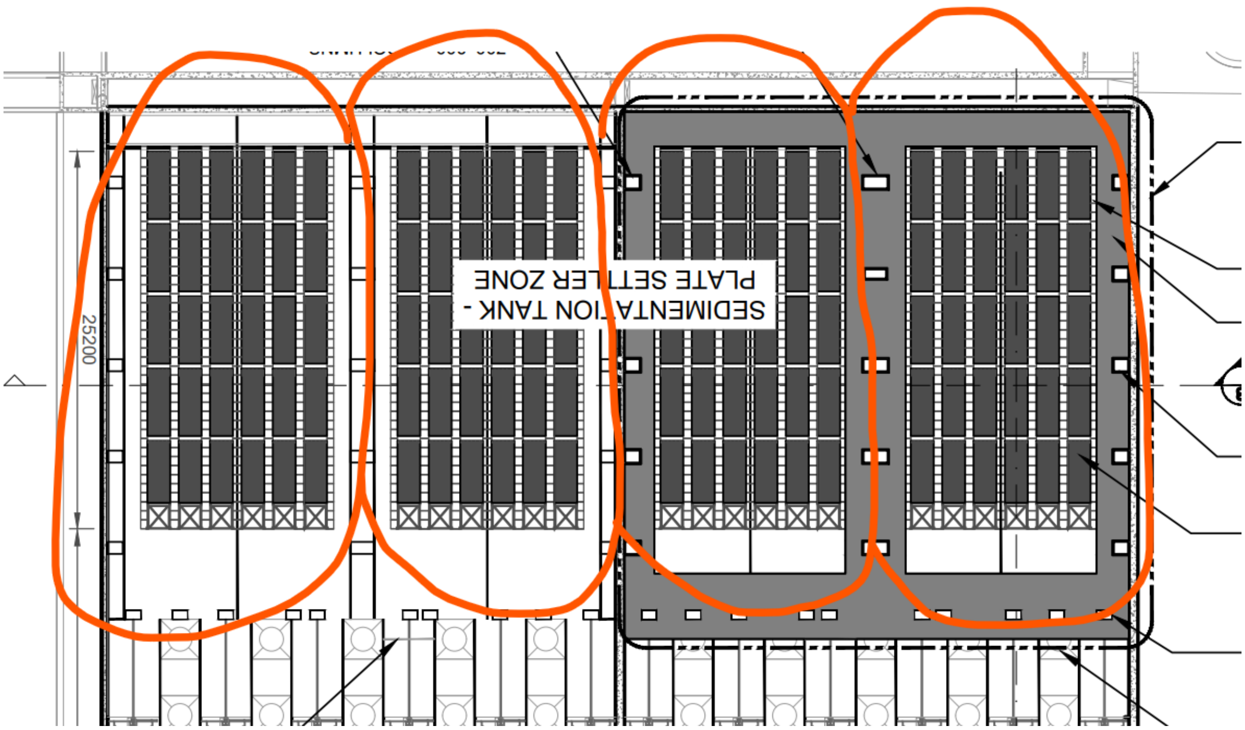
I'll tidy up estimate when I get to office.

Regards,
Paul
Get Outlook for iOS

From: Scott Lenhardt <Scott@proaquasales.com>
Sent: Tuesday, July 11, 2023 10:50:33 AM
To: Paul Kusiar <paul.kusiar@kps.ca>
Subject: RE: Hamilton WTP - quote

Paul,

Confirming the price of 20-25MM in CAD for :



Scott Lenhardt, P.Eng.

Pro Aqua, Inc.
264 Bronte Street South
Unit #7
Milton, ON
L9T 5A3

905-864-9311 x228 Office (rare)
905-864-8469 Fax
905-330-9244 Cell (best)

scott@proaquasales.com
www.proaquasales.com

From: Scott Lenhardt
Sent: Thursday, April 20, 2023 9:10 AM
To: Paul Kusiar <paul.kusiar@kps.ca>
Subject: RE: Hamilton WTP - quote

For more detail:

Budget Price for Two (2) Sedimentation Tanks: Safer number if a couple years out, to allow for some material and currency fluctuation - $20,000,000-$25,000,000 CAD Plate Settler Units and Supports

Assumptions: Two (2) Sedimentation Tanks, twelve (12) rows of plate settlers per tank, 5 plate modules per row, 60 modules per basin, 120 plate modules total. Plate totals, 98 plates per module, 11,760 plates total. Type 304 SS.

Supports: To be designed and made of stainless steel. Type 304 SS.

Scott Lenhardt, P.Eng.

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905-330-9244 Cell (best)

scott@proaquasales.com
www.proaquasales.com

From: Scott Lenhardt
Sent: April 20, 2023 9:06 AM
To: Paul Kusiar <paul.kusiar@kps.ca>
Subject: RE: Hamilton WTP - quote
Importance: High

Paul,

Based on today's exchange rate and SS pricing, we would be C$16-18MM for the plates and C$2-4MM for the supports (these vary wildly form job to job depending on how crazy the structural requirements become) in 304SS for two tanks.

I'll send you a bit more detail shortly, but I know you wanted an order of magnitude price sooner than this morning!

Scott Lenhardt, P.Eng.

Pro Aqua, Inc.
264 Bronte Street South
Unit #7
Milton, ON
L9T 5A3

905-864-9311 x228 Office (rare)
905-864-8469 Fax
905-330-9244 Cell (best)

scott@proaquasales.com
www.proaquasales.com

From: Paul Kusiar <paul.kusiar@kps.ca>
Sent: April 17, 2023 2:39 PM
To: Scott Lenhardt <Scott@proaquasales.com>
Subject: Hamilton WTP - quote

Hi Scott,

As discussed, looking for high level budgetary number for potential works project. Hoping to have by Thursday night, but I would accept a rough number from the back of your bar napkin tonight. Its all budgetary right now Scott so I don't want to waste your time.

Objective is to retrofit the existing sed tanks and add in plate settlers capable of 230MLD each cell. Drawings are attached for your reference, but please do not share.

Regards,

Paul Kusiar, C.E.T

Kusiar Project Services Inc.
163 Long Dr., Stratford, ON, N5A 7Y8
paul.kusiar@kps.ca
p. 519-273-7631
f. 519-273-6263
c. 519-949-3791

Hamilton

INFORMATION REPORT

TO:	Chair and Members Public Works Committee
COMMITTEE DATE:	June 17, 2024
SUBJECT/REPORT NO:	2023 Year End Report on Community Bookings at Tim Hortons Field (PW18075(c)) (Ward 3)
WARD(S) AFFECTED:	Ward 3
PREPARED BY:	Rob Gatto (905) 546-2424 Ext. 5448
SUBMITTED BY: **SIGNATURE:**	Indra Maharjan Director of Corporate Facilities & Energy Management Public Works Indra Maharjan

COUNCIL DIRECTION

The purpose of this Information Report is to provide Council with a 2023 Year-End Report on 'Community Use' at Tim Hortons Field.

The Facility Agreement between Toronto 2015 Organizing Committee and the City of Hamilton calls for Tim Hortons Field to be made available for high performance athletes and community sports use for 1,100 hours per year, with an associated obligation to report on such use on an annual basis.

Utilization of the stadium is measured on two categories of use: (1) Field of Play Usage and (2) Room & Space Bookings. Appendix "A" to Report PW18075(c) provides a 5-year history as well as the current year-end report of 'Community Use' at the stadium.

INFORMATION

Tim Hortons Field continues to be showcased as a premier stadium, hosting international, national, and high-profile local community events.
Field of Play Bookings (2023):

At Tim Hortons Field, the field of play is typically available for bookings from March to November, available 7 days a week from 7:00 a.m. – 11:00 p.m. Available extended hours are based on 'non-prime' time hours are defined as Monday to Friday 5:00 p.m. – 11:00 p.m.., and weekends 8:00 a.m. – 11:00 p.m. During the winter months, the field of play is typically closed due to inclement weather conditions. However, in 2022 and 2023 we had winter events at the stadium, operating eleven months of the year for the field of play. Such events January through March were the FIFA World Cup Qualifier, the CONCACAF Champions League Finals, NHL Heritage Outdoor Classic, OHL Outdoor Showcase, & the 110th Grey Cup.

Room and Space Bookings (2023):

Tim Hortons Field offers several interior spaces for small meeting and conferences, trade shows and private lounge set ups. This space is ideal for, rehearsals, dinners, and presentations. In addition, there are interior rooms of various sizes that may be configured to serve smaller functions, meetings or larger events in the club suites which converts from five smaller room to one larger banquet room.

In 2023 Tim Hortons Field has increased 'community usage' by 39% percent, in comparison to 2022. The success has been the collaboration between a wide range of partners, including the stadium's anchor tenant, the Hamilton Sports Group organization, and their support engaging and promoting community use. Other strategic partners include the two major School Boards in Hamilton, Colleges and Universities, various community sporting organizations, neighbourhood associations, non-profit and profit organizations, which collectively has made a tangible difference on how the stadium, is utilized.

To close out the 2023 season, the City of Hamilton, and Tim Hortons Field hosted the 110th Grey Cup Game, in front of 30,000 spectators, which was a successful national event.

APPENDICES AND SCHEDULES ATTACHED

Appendix "A" to Report PW18075(c) – 5-year History on Community Usage

Year Over Year

[1] Community Use of Tim Hortons Field

Field of Play				Room Space Bookings				Total Hours
Year	Bookings	Hours		Year	Bookings	Hours		
2019	243	564.0		2019	83	473.0		[2] 1037.0
[3] 2020	14	38.0		2020	10	38.0		76.0
[3] 2021	10	22.5		2021	0	0.0		22.5
[4] 2022	299	795.5		2022	18	67.0		862.5
[5] 2023	381	937.25		2023	76	347		1284.25

Footnotes:

1 Data provided in this report represents only ‘community use’ at Tim Hortons Field. Excluded in this review is the professional sports use and major events i.e., concerts.

2 April 2019 marked the inaugural season of the Canadian Premier League (Hamilton Forge). Noticeable decrease of ‘community use’ to make way for professional soccer.

3 Pandemic COVID-19 period.

4 January - December 2022 - 862.50 total ‘community use’ hours.

5 January - December 2023 – 1284.25 total ‘community use’ hours. This is a 39% Increase from 2022.

Hamilton

WASTE MANAGEMENT SUB-COMMITTEE
REPORT 24-002

Thursday, May 30, 2024
1:30 p.m.
Room 264, 2nd Floor
City Hall, Hamilton

Present: Councillor M. Francis (Chair), Councillor A. Wilson (Vice Chair), Councillor M. Tadeson, H. Govender, P. Hargreave, K. Hunt, L. Nielsen

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THE WASTE MANAGEMENT SUB-COMMITTEE PRESENTATION REPORT 24-002 FOR INFORMATION:

(a) APPROVAL OF AGENDA (Item 1)

The Committee Clerk advised that there were no changes to the agenda.

The agenda for the May 30, 2024 meeting of Waste Management Sub-Committee was approved, as presented.

(b) DECLARATIONS OF INTEREST (Item 2)

There were no declarations of interest.

(c) APPROVAL OF MINUTES OF PREVIOUS MEETING (Item 3)

(i) February 12, 2024 (Item 3.1)

The Minutes of the February 12, 2024, meeting of the Waste Management Sub-Committee were approved, as presented.

(d) STAFF PRESENTATIONS (Item 7)

(i) Asset Management Plan (Item 7.1)

Dan Leake, Senior Program Analyst, Corporate Asset Management, addressed the Committee, respecting the Asset Management Plan, with the aid of a PowerPoint presentation.

(ii) 2024 Compost Giveaways (Item 7.2)

Rob Conley, Manager, Recycling and Waste Disposal, addressed the Committee respecting 2024 Compost Giveaways, with the aid of a PowerPoint presentation.

(iii) Multi-Residential Cart Implementation (Item 7.3)

Ryan Kent, Manager of Waste Policy and Planning, addressed the Committee, respecting Multi-Residential Cart Implementation, with the aid of a PowerPoint presentation.

(iv) Blue Box Transition Update (Item 7.4)

Ryan Kent, Manager of Waste Policy and Planning, addressed the Committee, respecting the Blue Box Transition Update, with the aid of a PowerPoint presentation.

(v) Promotion and Education Update (Item 7.5)

Ryan Kent, Manager of Waste Policy and Planning, addressed the Committee, respecting the Promotion and Education Update, with the aid of a PowerPoint presentation.

(vi) Litter Enhancement Program (Item 7.6)

Joel McCormick, Manager, Waste Collections, addressed the Committee, respecting the Litter Enhancement Program, with the aid of a PowerPoint presentation.

(vii) Dog Waste in Public Spaces (Item 7.7)

Joel McCormick, Manager, Waste Collections, addressed the Committee respecting Dog Waste in Public Spaces, with the aid of a PowerPoint presentation.

(viii) (Hunt/Tadeson)
The staff presentations respecting the following matters, were received:

(1) Asset Management Plan (Item 7.1)

(2) 2024 Compost Giveaways (Item 7.2)

(3) Multi-Residential Cart Implementation (Item 7.3)

(4) Blue Box Transition Update (Item 7.4)

(5) Promotion and Education Update (Item 7.5)

(6) Litter Enhancement Program (Item 7.6)

(7) Dog Waste in Public Spaces (Item 7.7)

(e) CONSENT ITEMS (Item 8)

(i) Solid Waste Management Master Plan Action Items (Item 8.1)

The Consent Item respecting Solid Waste Management Master Plan Action Items, was received.

(f) ADJOURNMENT (Item 13)

There being no further business, the Waste Management Sub-Committee adjourned at 2:59 p.m.

Respectfully submitted,

____
Councillor M. Francis
Chair, Waste Management Sub-Committee

____
Carrie McIntosh
Legislative Coordinator
Office of the City Clerk

CITY OF HAMILTON
PUBLIC WORKS DEPARTMENT
Hamilton Water Division

TO:	Chair and Members Public Works Committee
COMMITTEE DATE:	June 17, 2024
SUBJECT/REPORT NO:	Housing-Enabling Water Systems Fund (PW24038)
WARD(S) AFFECTED:	Wards 1 and 2
PREPARED BY:	Mike Christie (905) 546-2424 Ext. 6194
SUBMITTED BY: **SIGNATURE:**	Nick Winters Director, Hamilton Water Public Works Department

RECOMMENDATION

(a) That the General Manager, Finance and Corporate Services, and the General Manager, Public Works, be authorized to delegate the appropriate person to be duly authorized to submit all necessary documentation to support the City of Hamilton's application, attached as Appendix "A" to Report PW24038, for the Housing-Enabling Water Systems Fund.

(b) That the Mayor and City Clerk be authorized to execute and/or amend all necessary documentation, including Funding Agreements, to receive funding under the Housing-Enabling Water Systems Fund with content satisfactory to the General Manager, Finance and Corporate Services, and in a form satisfactory to the City Solicitor, provided the City's application is successful;

(c) That the City Solicitor be authorized and directed to prepare any necessary by-laws for Council approval, for the purpose of giving effect to the City's acceptance of funding from the Housing-Enabling Water Systems Fund.

EXECUTIVE SUMMARY

The Housing-Enabling Water Systems Fund is a provincial application-based funding program that supports the repair, rehabilitation, and expansion of core water infrastructure to enable new housing development. The fund is intended to complement the Ministry of Municipal Affairs and Housing's Building Faster Fund. All municipalities that own water/wastewater/stormwater infrastructure were able to submit an application for one project within this competitive funding program.

As this funding program exclusively focuses on projects that support housing and growth, all the City water/wastewater/stormwater projects that were considered are either fully or substantially funded by development charges. This represents a significant change from historical funding applications submitted by the City that were focused on large rehabilitation/replacement projects within the rate funded capital program (as opposed to the development charges funded capital program).

Most large capital projects in the City's 10-year water, wastewater and stormwater capital program were ineligible primarily due to project schedules that did not align with the Housing-Enabling Water Systems Fund's eligibility criteria (e.g., the projects had already commenced construction, or the planned completion dates were beyond March 31, 2027), or the projects were focused on infrastructure renewal that had little or no impact on enabling new housing units.

The City's Housing-Enabling Water Systems Fund application bundles two watermain replacement projects in Wards 1 and 2 that support additional housing units, the City's Water and Wastewater Master Plan, intensification within the urban boundary, and improves overall fire flow and system reliability within Pressure District 2 of Hamilton's Woodward Drinking Water Subsystem.

The Ontario Ministry of Infrastructure has communicated that successful and unsuccessful applicants will be notified in summer 2024. A future communication update will be provided to the Mayor and Council that advises whether the City's application was successful or unsuccessful.

Alternatives for Consideration – N/A

FINANCIAL – STAFFING – LEGAL IMPLICATIONS

Financial: The gross project cost for the two bundled watermain upgrade projects submitted under the Housing-Enabling Water Systems Fund totals $12.92M, where the maximum Provincial contribution of 73% represents $9.43M in potential funding, with a remaining municipal contribution of $3.49M. See Appendix "A" to Report PW24038 for a breakdown of the share of funding for the two watermain projects.

Staffing: N/A

Legal: If the City's applications are successful, it is expected that there will be a requirement to enter into a funding agreement to receive funding from the

Housing-Enabling Water Systems Fund and there may be requirements for other ancillary agreements or associated by-laws

HISTORICAL BACKGROUND

The Housing-Enabling Water Systems Fund application intake launched on January 29, 2024, and closed on April 19, 2024. Municipalities that are successful in obtaining funding from the Housing-Enabling Water Systems Fund will be able to fund their projects as early as fall 2024. Water, wastewater, and stormwater projects are all eligible for funding. The Ontario Ministry of Infrastructure will fund a maximum of 73% of the project costs up to $35M, with the municipality required to fund the remaining 27% of the project costs. Funded projects must not have already started construction and must be completed by March 31, 2027.

The original funding announcement in November 2023 was for $200M in total available funding across all Ontario municipalities, but on March 21, 2024, the province announced $625M in additional program funding bringing the total available to $825M. Given that the change in available funding was so close to the April 19, 2024 application deadline, the City was expecting that there would be a second round of applications for the newly added $625M, or that municipalities would have the ability to submit multiple projects for funding. However, and despite being engaged very closely with the provincial staff administering the funding program, the City only learned on April 12, 2024 (via an e-mail communication received by the Mayor’s office), that the applications due by April 19, 2024 would be considered for the full $825M program, and that there would be no opportunity to submit additional projects.

POLICY IMPLICATIONS AND LEGISLATED REQUIREMENTS

N/A

RELEVANT CONSULTATION

Collectively, the Hamilton Water Division, Growth Management Division (Planning & Economic Development), and Engineering Services Division reviewed a very broad list of planned projects and analysed them against the funding conditions and criteria. The Budgets and Fiscal Policy Section (Corporate Services) also reviewed this report.

ANALYSIS AND RATIONALE FOR RECOMMENDATION

Based on information from the Ontario Ministry of Infrastructure, submissions will be evaluated based on the following criteria:

- New housing units enabled/created;

- Cost per housing unit enabled/created
- Environmental benefits, including climate resiliency
- Current utilization of water/wastewater/stormwater infrastructure capacity
- Financial capacity of municipality to support the project (including funding sources such as debt, reserves, loans, development charges)
- Status of proposed housing development and alignment to provincial policies (e.g., provincial policy, official plan, plans of subdivision and/or condominium)
- Alignment with asset management regulations
- Regulatory compliance
- Project benefits
- Critical health and safety risks
- Project status - project must be in the process or completed the design and planning phases
- Construction must not have commenced, and must be completed by March 31, 2027

Upon consideration of the criteria above, along with evaluating projects within the rate and development charge supported capital plan, the bundled watermain upgrade projects at York Boulevard/Cannon Street West and Locke Street/Margaret Street were selected as the best candidates for the Housing-Enabling Water Systems Fund application.

Project details are as follows:

York Boulevard and Cannon Street West Watermain Upgrades

700m of a new 500mm watermain and valve chambers on York Boulevard at Locke to Cannon at Caroline.

Locke Street and Margaret Street Watermain Upgrades

Upsized watermains on Locke Street (from King to York), Margaret Street (King to Main), King Street (Locke to Margaret), new 300mm watermain interconnected with future Locke Street 500mm watermain, new 500mm watermain on Locke Street (Main to York).

Based on the increase in water capacity of this infrastructure and typical residential water consumption, these proposed upgrades could enable an estimated 24,450 new housing units across Pressure District 2. However, this estimate does not incorporate other key considerations required to approve this scale of development (e.g., local watermain upgrades required to service a specific development within Pressure District 2, wastewater servicing, other utilities, transportation planning and traffic, etc.).

ALTERNATIVES FOR CONSIDERATION

N/A

APPENDICES AND SCHEDULES ATTACHED

Appendix “A” to Report PW24038 – Housing-Enabling Water Systems Fund Project Submission - Financials

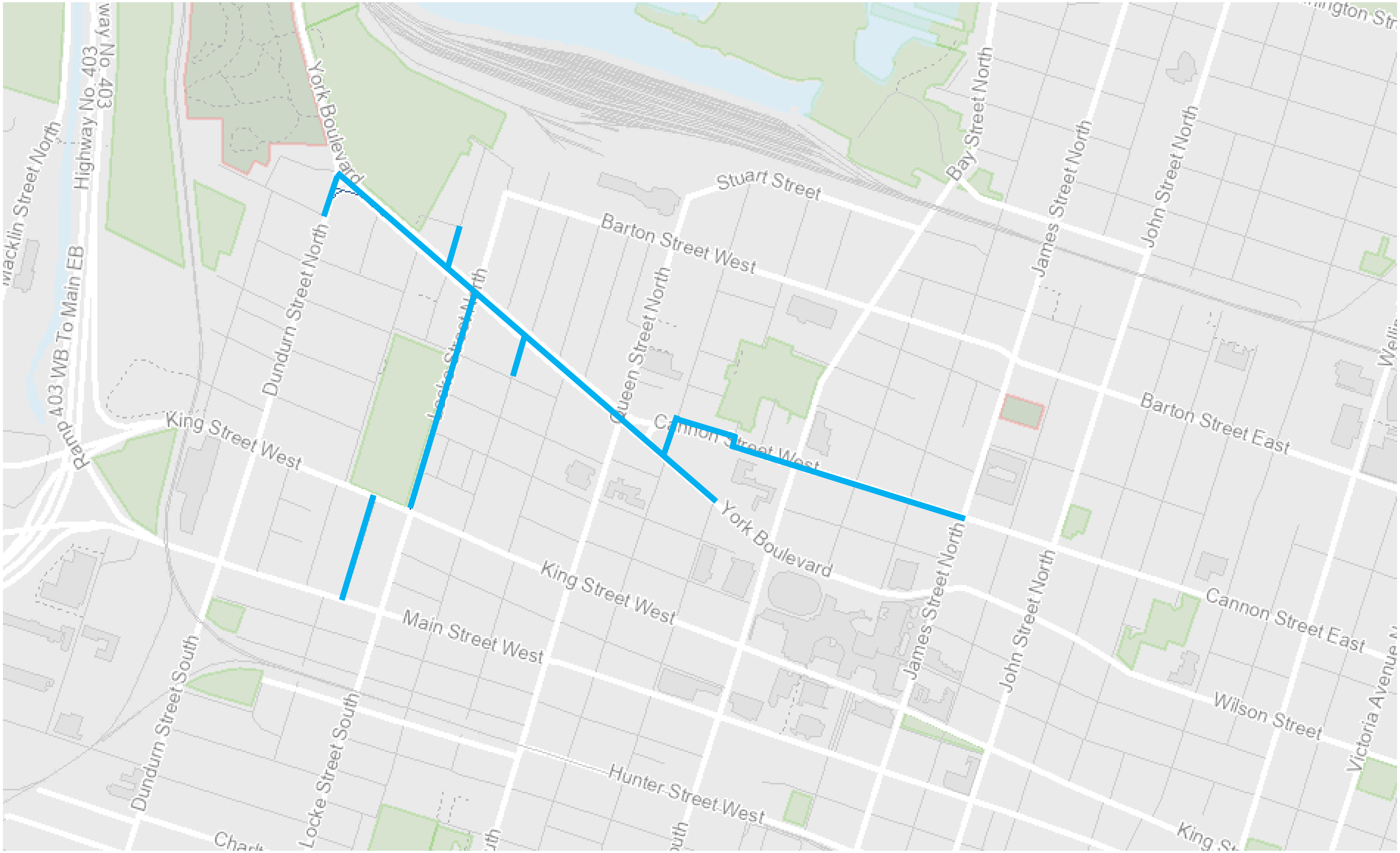
Appendix “B” to Report PW24038 – Housing-Enabling Water Systems Fund - Watermain Upgrade Locations

Appendix “C” to Report PW24038 – Bylaw to authorize the signing of a municipal funding agreement for the transfer of the Housing-Enabling Water Systems Fund Program Between the Ministry of Infrastructure and the City of Hamilton

Housing-Enabling Water Systems Fund Project Submission – Financials

Project Title and Description	Eligible Budget	Maximum Provincial Contribution	Minimum Municipal Contribution
York Boulevard and Cannon Street West Watermain Upgrades 700m of a new 500mm watermain and valve chambers on York Blvd at Locke to Cannon at Caroline	$5.82M	$4.25M	$1.57M
Locke St and Margaret Street Watermain Upgrades Upsized watermains on Locke St (from King to York), Margaret St (King to Main), King St (Locke to Margaret), new 300mm watermain interconnected with future Locke St 500mm watermain, new 500mm watermain on Locke St (Main to York)	$7.10M	$5.18M	$1.92M
Total	**$12.92M**	**$9.43M**	**$3.49M**

Housing-Enabling Water Systems Fund
Watermain Upgrade Locations



Watermain

0.4km

Authority: Item , Public Works Committee Report
CM:
Wards: 1 and 2

Bill No.

CITY OF HAMILTON
BY-LAW NO.

To Authorize the Signing of a Municipal funding agreement for the Transfer of the Housing-Enabling Water Systems Fund Program Between the Ministry of Infastructure and the City of Hamilton

WHEREAS the Council of the City of Hamilton wishes to enter into a Municipal Funding Agreement in order to participate in the Municipal Funding Agreement for the Transfer of the Housing-Enabling Water Systems Fund;

NOW THEREFORE the Council of the City of Hamilton enacts as follows:

1. The Mayor and City Clerk are hereby authorized to execute a municipal funding agreement for the transfer of Housing-Enabling Water Systems Fund between the Ministry of Infrastructure and the City of Hamilton, in a form satisfactory to the City Solicitor and with content acceptable to the General Manager of Finance and Corporate Services.
2. That Mayor and City Clerk are hereby authorized to execute any other funding extensions, agreements or documentation required to receive funding from the Housing-Enabling Water Systems Fund in a form satisfactory to the City Solicitor and with content acceptable to the General Manager of Finance and Corporate Services.
3. This by-law shall come into force on the day it is passed.

PASSED this day of June 2024.

A. Horwath Mayor	J. Pilon Acting City Clerk

CITY OF HAMILTON
PUBLIC WORKS DEPARTMENT
Waste Management Division

TO:	Chair and Members Public Works Committee
COMMITTEE DATE:	June 17, 2024
SUBJECT/REPORT NO:	Urban Waste Vacuum Cleaner Manufacturer Standardization (PW24042) (City Wide)
WARD(S) AFFECTED:	City Wide
PREPARED BY:	Joel McCormick (905) 546-2424 Extension 4770
SUBMITTED BY: **SIGNATURE:**	Angela Storey Director, Waste Management Public Works Department AStorey

RECOMMENDATIONS

(a) Pursuant to Procurement Policy #14 – Standardization and Policy #11 – Non-Competitive Procurement, that Council approve the standardization of the Glutton Urban Waste Vacuum Cleaner manufactured by Glutton and the single sourcing of the supply, parts, and maintenance for the equipment with the licensed distributor Joe Johnson Equipment until May 1, 2029 for the Waste Management Division;

(b) That the General Manager, Public Works, or their designate, be authorized to negotiate, enter into, and execute any required contract and ancillary documents required to give effect thereto with licensed distributor Joe Johnson Equipment, in a form satisfactory to the City Solicitor; and

(c) That the General Manager, Public Works, or their designate, be authorized to amend any contracts executed and any ancillary documents as required if the manufacturer or licensed distributor identified in this Report undergoes a name change, in a form satisfactory to the City Solicitor.

EXECUTIVE SUMMARY

The purpose of Report PW24042 is to obtain approval to use Glutton as the standard for stand-alone, mobile urban waste vacuum cleaners and replacement parts pursuant to Procurement Policy #14 – Standardization as well as seeking approval to single source the purchase of this equipment, replacement parts, and equipment maintenance from Joe Johnson Equipment pursuant to Procurement Policy #11 – Non-competitive Procurement for a five-year period expiring May 1, 2029.

Glutton urban waste vacuum cleaners (Glutton) are currently being used successfully within the Downtown Cleanliness Program of the Waste Management Division. This equipment is used for litter management in public areas such as on sidewalks. The Waste Management Division currently owns and operates four Gluttons and has plans to expand its inventory to support the enhanced litter management program approved with the 2024 Tax Operating and Capital Budget.

Prior to purchasing the first Glutton, staff performed their due diligence by researching and testing different types of urban waste vacuum cleaners. Through this, it was determined that Glutton is better suited for litter management downtown. In preparation for this report, staff completed a second market scan of similar urban waste vacuums and determined that Glutton is still the preferred equipment based on the location of its quick access emergency stop function.

Staff recommend the single source purchase of this equipment, replacement parts and equipment maintenance to Joe Johnson Equipment as they are the North American distributor for Glutton. In addition to this, Joe Johnson Equipment is local which results in speedy response times.

Alternatives for Consideration – See Page 4

FINANCIAL – STAFFING – LEGAL IMPLICATIONS

Financial: The cost associated with the purchase of an urban waste vacuum cleaner manufactured by Glutton is approximately $30,000. Purchase of additional units for the Waste Management Division will be included in its future capital budget request. The estimated annual operating cost for each unit is approximately $2,000 and would be requested through the budget approval process as an operating impact from capital.

The number of Gluttons to be purchased over the span of the standardization is dependent on budget approval and program growth. The Waste Management Division would like to double its fleet of Gluttons over the course of the standardization which equates to four additional Gluttons to be purchased and operated in the downtown core for litter management. The estimate cost to purchase four Gluttons is approximately $120,000 with a total operating budget impact of approximately $8,000.

Staffing: N/A

Legal: N/A

HISTORICAL BACKGROUND

The Downtown Cleanliness Program within the Waste Management Division is responsible for litter management in the downtown core (excluding roadways). The Division currently owns and operates four Gluttons that contribute to efficient litter management.

The first Glutton went into operation in 2018 following an in-depth review of available equipment, with all four Gluttons in operation by the third quarter of 2023. The four Gluttons were originally purchased through Procurement Policy #11 – Non-competitive Procurement. Standardization of this unit and single sourcing the future purchase through Joe Johnson Equipment will ensure staff can efficiently and consistently increase the inventory of urban waste vacuum cleaners that meet staff’s requirements for use in the litter maintenance program.

Trained Downtown Cleanliness staff can perform minor equipment repair such as cleaning and replacing filters. Standardizing the maintenance and repair function will help return malfunctioning equipment back to working order quickly.

POLICY IMPLICATIONS AND LEGISLATED REQUIREMENTS

The recommendations in this Report are in accordance with the following:

- Procurement Policy By-law 20-205 as amended, Policy #14 – Standardization
- Procurement Policy By-law 20-205 as amended, Policy #11 – Non-competitive Procurement
- Clean & Green Hamilton Strategy – Litter Prevention
- 2022 – 2026 Council Priorities – Priority 2: Safe & Thriving Neighbourhoods; Outcome 3: Provide vibrant parks, recreation, and public space
- Hamilton’s Climate Action Strategy
- City of Hamilton’s Green Fleet Policy

RELEVANT CONSULTATION

The Procurement Section has been consulted with respect to adherence to the Procurement Policy.

ANALYSIS AND RATIONALE FOR RECOMMENDATION

Prior to purchasing the initial Gluttons, staff completed their due diligence by researching and testing different types of urban waste vacuum cleaners. More recently, staff completed a second market scan of similar urban waste vacuum cleaners where it was determined that the urban waste vacuum cleaner manufactured by Glutton still meets staff's requirements, specifically due to the location of its quick access emergency stop function which is located on the handle next to the operator's hand. Similar equipment from other manufactures offers this function but in locations that are not ideal for quick reactions.

In addition to this, the urban waste vacuum cleaners manufactured by Glutton are compact in size, intuitive to use and have low noise and dust impact. The Glutton is also battery powered and supports Hamilton's Climate Action Strategy.

There are several benefits to standardizing and single sourcing this equipment:

- Expansion of the urban waste vacuum cleaner inventory with units that have been proven to successfully manage litter.
- Standardization allows staff to streamline time requirements for equipment procurement, inventory maintenance and stocking supplies.
- Familiarity by staff due to the same functions and operations.
- Staff who operate this equipment for their work must complete mandatory safety training so they can operate it safely and efficiently. It is more efficient to facilitate the equipment training by having a consistent equipment brand.
- Reduction of inventory on stocking parts for simple maintenance.
- Local availability of parts and service.

The only North American distributor for this equipment is Joe Johnson Equipment. Approving the single source option as outlined in this Report will allow the purchase of the equipment and parts, and equipment maintenance through the only North American distributor, eliminating the need to issue a formal procurement process such as a Request for Tender or Request for Quotation.

ALTERNATIVES FOR CONSIDERATION

Should the recommendations in this report not be approved, staff would undertake the competitive procurement process. As staff from the Waste Management and Fleet

Services have already investigated similar equipment in the market, this option could lead to less familiar, ergonomic, environmentally-friendly equipment being purchased.

Financial: The financial implications for this alternative would not be known until the procurement process is complete.

Staffing: N/A

Legal: N/A

APPENDICES AND SCHEDULES ATTACHED

N/A

CITY OF HAMILTON
PUBLIC WORKS DEPARTMENT
Corporate Asset Management

TO:	Chair and Members Public Works Committee
COMMITTEE DATE:	June 17, 2024
SUBJECT/REPORT NO:	Policy 11 - Compressed Natural Gas Mobile Refuelling Equipment (PW22003(a)) (City Wide)
WARD(S) AFFECTED:	City Wide
PREPARED BY:	Tom Kagianis (905) 546-2424 Ext. 5105
SUBMITTED BY: **SIGNATURE:**	Andrea Vargas Acting Director of Corporate Asset Management Public Works

RECOMMENDATION

(a) That Council approves the expansion of the Policy #11 – Non-competitive Procurement, previously approved through Report PW22003, for the supply, installation, and management of compressed natural gas and mobile refuelling equipment. This expansion is estimated to cost $300K annually for a three-year period for a total of $900K and will support the operational requirements of the Compressed Natural Gas Waste Collection Trucks;

(b) That the General Manager, Public Works, or their designate, be authorized to negotiate, enter into, and execute a contract and any ancillary documents required to give effect thereto with Compression Technology Corporation, in a form satisfactory to the City Solicitor;

(c) That the General Manager, Public Works, or their designate, be authorized and directed to submit and sign an application with supporting documentation relating to applicable grant funding opportunities, including but not limited to the Green Initiative grant funding application with supporting documentation including an application attestation and final agreement, on behalf of the City of Hamilton;

(d) That the General Manager of Finance and Corporate Services, or their designate, be authorized and directed to confirm the City of Hamilton's funding contribution, on behalf of the City of Hamilton and sign the required proof of funding forms related to Green Initiative grant funding; and any resulting funding agreements and associated ancillary documents that may also include a contribution to funding, in a form acceptable to the City Solicitor; and,

(e) That the City Solicitor be authorized and directed to prepare any necessary by-laws for Council approval, for the purpose of giving effect to the City's acceptance of grant funding opportunities.

EXECUTIVE SUMMARY

The purpose of this report is to seek approval for expanding the existing single-source agreement with Compression Technology Corporation.

The temporary mobile Compressed Natural Gas Fuelling Station at 1579 Burlington Street East was previously approved in Report PW22003 to fuel compressed natural gas waste collection trucks. Report PW22003(a) is requesting to expand the single source approval to support compressed natural gas fuelling for the approved compressed natural gas waste collection trucks. The existing diesel-powered trucks reached their full life expectancy and were approved for replacement with compressed natural gas trucks through the 2023 Tax Capital Budget process.

In August 2022 City Council approved Hamilton's Climate Action Strategy that includes the 'ReCharge Hamilton – Our Community Energy and Emissions Plan. The Community Energy and Emissions Plan provides a low-carbon scenario to help achieve net zero by 2050.

The City's waste collections section currently operates 37 diesel-powered trucks. The purchase of 19 compressed natural gas trucks (ten approved in 2022 and nine approved in 2023) represents 51% of waste collection vehicles powered by compressed natural gas by 2025. This initiative will result in an 1190-tonne reduction of greenhouse gas emissions over the seven-year life of these waste collection trucks.

The expanded single-source approval to utilize Compression Technology Corporation for the temporary mobile fuelling station will enable the fuelling of nine compressed natural gas waste collection trucks until the new compressed natural gas station at Hamilton Transit Maintenance and Storage Facility, 281 Birch Avenue adjoining 330 Wentworth Street North is operational with permanent, fast flow natural gas dispensers.

The compressed natural gas waste collection trucks align with Low-Carbon Transformation #3: Changing How We Move, which will help incrementally decrease greenhouse gas emissions from our transportation sector until cleaner forms of heavy-duty vehicle technology become economically available such as clean hydrogen.

Compression Technology Corporation is the only known company in Canada that offers this combination of equipment for a compressed natural gas mobile refuelling solution with an approximate cost of $300K annually. This is for the supply of 100% renewable natural gas which is the most economical option offered. This expense will continue until the compressed natural gas station at the new Hamilton Transit Maintenance and Storage Facility is in service where the cost to fuel the waste collection trucks will be reduced and is estimated at $110-$130K annually.

Currently, there are grant funding opportunities available through the Federation of Canadian Municipalities - Green Municipal Fund to assist with green initiative projects. Staff will review these and any future submission requirements of the offered funding programs and submit application(s) for consideration and approval.

Recently, Term of Council priorities have accelerated the City’s current Climate Change Action Strategy goal of a 50% reduction in total corporate greenhouse gas emissions from the 2005 baseline by 2030, to achieve a 55% reduction by the end of 2026.

Alternatives for Consideration – See Page 6

FINANCIAL – STAFFING – LEGAL IMPLICATIONS

Financial: The recommended single-source procurement for the compressed natural gas and mobile refuelling equipment required to fuel the compressed natural gas waste collection trucks is estimated to cost $300K annually for up to three years until the Hamilton Transit Maintenance and Storage Facilities’ Compressed Natural Gas Station is operational. Fuel use estimates are based on a historical annual average fuel consumption rate. This figure can fluctuate due to operational changes.

There are no budget impacts as the fuel cost to operate the waste management fleet is pre-established as part of the 2024 operating budget. The cost for the delivery of fuel and equipment was included in the 2024 capital budget request in ProjectID 5120051501 - Waste Collection Fleet Replacement.

Future refuelling at the Hamilton Maintenance and Storage Facility Natural Gas Station based on the best available information today is expected to cost $100K-$130K annually over the remaining life of the vehicles which would result in savings to the current base operating budget for fuel estimated to be in 2027.

Staffing: N/A

Legal: Fleet Services/Energy staff will work with Legal to draft a Compressed Natural Gas Supply Agreement with Compression Technology Corporation in a form satisfactory to the City Solicitor.

HISTORICAL BACKGROUND

In July 2019 Marathon Technical Services was contracted to perform a Compressed Natural Gas Packer Truck Fuelling Study in consideration of replacing all City-owned waste collection trucks from diesel-powered to compressed natural gas powered as they became due for replacement.

The analysis included an evaluation of several compressed natural gas refuelling scenarios, a cost analysis, an estimated reduction of greenhouse gases and some commentary on other chassis power options that are currently available in the industry.

In January 2022 Fleet Services previously received single source approval under Report (PW22003) (City Wide) to utilize Compression Technology Corporation for the supply, installation and management of the temporary compressed natural gas and mobile refuelling equipment, and operational requirements for the life of the nine compressed natural gas waste collection trucks.

Currently, the City has one compressed natural gas fuel site located at 2200 Upper James Street. This location is used to refuel transit buses. A previous site at 330 Wentworth Street North, was installed in the mid-1990’s with a Pro Logic Controller and compressors that were no longer supported by the manufacturer for parts supply therefore the site was decommissioned.

Ten diesel-powered trucks reached their full life expectancy and were approved for replacement with compressed natural gas trucks in the 2022 Capital Budget process. In addition, nine diesel-powered trucks reached their full life expectancy and were approved for replacement with compressed natural gas trucks through the 2023 Tax Capital Budget process.

POLICY IMPLICATIONS AND LEGISLATED REQUIREMENTS

RELEVANT CONSULTATION

The following departments provided input into the development of this report:

- Corporate Services Department, Financial Planning Division.
- Corporate Services Department, Procurement Division.
- Public Works Department, Waste Management Division.
- Public Works Department, Energy and Facilities Management Division.

- External Consultation: Marathon Technical Services

ANALYSIS AND RATIONALE FOR RECOMMENDATION

The recommended option is provided by Compression Technology Corporation. This is the lowest cost for a short-term solution.

If successful, the grant funding opportunities of the Federation of Canadian Municipalities - Green Municipal Fund would result in reducing the funding contribution from the City.

The Federation of Canadian Municipalities Capital offers a program that focuses on alternative fueled vehicles and the required infrastructure. The Federation of Canadian Municipalities program is structured as a loan or grant depending on how the application is approved. The City may qualify to receive a low-interest loan of up to $5 Million and/or a grant worth up to 15% of the loan, covering up to 80% of eligible costs.

ALTERNATIVES FOR CONSIDERATION

Alternative 1 – Dedicated Station
Option to install a dedicated compress natural gas compressor station at 1579 Burlington Street. This option would require the retention of a consultant, engineered specification, and tender issuance. By pursuing this option, the compressed natural gas waste collection trucks will be required to fuel at an alternate location or install a temporary mobile refuelling station until a dedicated station can be installed at 1575 Burlington Street.

Fleet does not recommend investigating the option to install a dedicated compressed natural gas compressor station at 1579 Burlington Street due to extensive lead times, and significant increase in cost. Additionally waste collection operations would incur additional cost and operating impacts as they would be forced to fuel at an alternative site such as 2200 Upper James Street in the time period between the arrival of new trucks and the building of the permanent station at 1579 Burlington Street.

Financial: New station estimates approximately $5 Million

Staffing: Additional resources are required to investigate options and feasibility

Legal: N/A

Alternative 2 – Hamilton Street Railway Location

Fuel new compressed natural gas waste collection trucks at the 2200 Upper James Hamilton Street Railway location. The round-trip distance from 1579 Burlington Street to 2200 Upper James is 46km with a drive time of 42 minutes.

Financial: Additional cost of approximately $430,000 annually to drive to 2200 Upper James. The cost of both the driver time and the truck cost per km were included for a one-year period from Wentworth to Mount Hope. This was included as a 23.2 km round trip (at $1.88 inflation-adjusted per km).

Staffing: This option adds 42 minutes of unproductive staff time each operating day and may impact waste collection operations

Legal: N/A

APPENDICES AND SCHEDULES ATTACHED

N/A

12.1

CITY OF HAMILTON

MOTION

Public Works Committee: June 17, 2024

MOVED BY COUNCILLOR C. KROETSCH……..………….………………..….

SECONDED BY COUNCILLOR……………………………………………..

Strachan Open Space Redevelopment (Ward 2)

WHEREAS the Strachan Open Space located along the south side of Strachan Street West between Bay Street North and Ferguson Avenue North, provides a valuable asset for the community as a green corridor of mature trees and sod areas;

WHEREAS this area contains an underutilized surface parking lot that could be repurposed for much needed public amenities;

WHEREAS, as the site is adjacent to an active rail line, the Ward Councillor has met with representatives from CN Railway to discuss any requirements they may have;

WHEREAS the community is supportive of maintaining this space for public use subject to consultation with the Ward Councillor;

WHEREAS there are city wide parks in the area and the neighbours would benefit from a more community focused park area with amenities;

WHEREAS there is an active transportation route through the site allowing ease of movement through the space;

WHEREAS there are some activations that can commence without added Capital funds such as benches, picnic tables, and parkland signs and staff will work with the Ward Councillor for these additions; and

WHEREAS future improvements that would enhance the space for more neighbourhood uses would require budget and work prioritization.

THEREFORE, BE IT RESOLVED:

(a) That staff be directed to submit a capital detail sheet for the first phase of the Strachan Open Space improvement project for Council consideration as part of an upcoming budget process.

12.2

CITY OF HAMILTON

MOTION

Public Works Committee: June 17, 2024

MOVED BY COUNCILLOR N. NANN …….. ……..………..……………....

SECONDED BY COUNCILLOR……………………………………………..

Fencing Installation for Gage Park Community Garden Located at 1000 Main Street East, Hamilton (Ward 3)

WHEREAS, the Gage Park Community Garden located at 1000 Main Street East Hamilton, has been operating in its current location since 2011 and provides opportunities for residents to grown their own food, beautify an area of the park and gather and make connections with fellow community members;

WHEREAS, the recent construction activities at the adjacent Rosedale Tennis Club has reconfigured the existing fencing that borders the community garden; and

WHEREAS, the existing garden fencing is in disrepair and needs to be replaced and reconfigured to connect to the new tennis club fencing.

THEREFORE, BE IT RESOLVED THAT:

(a) An allocation of $6,749 be made from the Ward 3 Discretionary Funds (Project ID#3302309300) to fund the installation of new fencing along the southern portion of the Gage Park Community Garden located at 1000 Main Street East, Hamilton.

12.3

CITY OF HAMILTON

M O T I O N

Public Works Committee: June 17, 2024

MOVED BY COUNCILLOR J. BEATTIE……....…....…………..…………….

SECONDED BY COUNCILLOR ……………….…………………………….

Installation of Speed Cushions as a Traffic Calming Measure on Various Roadways in Ward 10 (Ward 10)

WHEREAS, the City of Hamilton has adopted Vision Zero approach which considers human error as part of the roadway safety equation; and

WHEREAS, Ward 10 residents on a number of roadways have repeatedly advocated for traffic calming measures in their neighbourhoods to address roadway safety concerns as a result of speeding and cut-through traffic.

THEREFORE, BE IT RESOLVED:

(a) That the Transportation Division be authorized and directed to install 2 speed cushions on Grays Road between Frances Avenue and Lakepointe Place as part of Transportation's 2024 Traffic Calming program for fall implementation, to be funded through the Ward 10 Capital Re-Investment Reserve #108070 at an upset limit, including contingency, not to exceed $10,000;

(b) That the Transportation Division be authorized and directed to install 4 speed cushions on Memorial Avenue between Glen Castle Drive and Birchlawn Drive as part of Transportation's 2024 Traffic Calming program for fall implementation, to be funded through the Ward 10 CP Minor Maintenance #4031911610 at an upset limit, including contingency, not to exceed $20,000; and

(c) That the General Manager of Public Works and City Clerk be authorized and directed to execute any required agreement(s) and ancillary documents, with such terms and conditions in a form satisfactory to the City Solicitor.

12.4

CITY OF HAMILTON

M O T I O N

Public Works Committee: June 17, 2024

MOVED BY COUNCILLOR T. MCMEEKIN......…....………..……………

SECONDED BY COUNCILLOR ………………….…………………………….

Installation of Speed Cushions as a Traffic Calming Measure on Howard Boulevard (Ward 15)

WHEREAS, the City of Hamilton has adopted a Vision Zero approach which considers human error as part of the roadway safety equation; and

WHEREAS, Ward 15 residents on Howard Boulevard have repeatedly advocated for traffic calming in their neighbourhood to address roadway safety concerns as a result of speeding and cut-through traffic;

THEREFORE, BE IT RESOLVED:

(a) That the Transportation Division be authorized and directed to install 1 speed cushion on Howard Boulevard between Orchard Avenue and Mays Crescent as part of Transportation's 2024 Traffic Calming program for fall implementation;

(b) That all costs associated with the installation of traffic calming measures be completed through Ward 15 CP Minor Maintenance #4031911615 at an upset limit, including contingency, not to exceed $5,000; and

(c) That the General Manager of Public Works and City Clerk be authorized and directed to execute any required agreement(s) and ancillary documents, with such terms and conditions in a form satisfactory to the City Solicitor.

12.5

CITY OF HAMILTON

M O T I O N

Public Works Committee: June 17, 2024

MOVED BY COUNCILLOR T. HWANG……......…....…………..……………

SECONDED BY COUNCILLOR ……………………..……………………………

Installation of Speed Cushions as a Traffic Calming Measure on Frederick Avenue (Ward 4)

WHEREAS, the City of Hamilton has adopted a Vision Zero approach which considers human error as part of the roadway safety equation; and

WHEREAS, Ward 4 residents on Frederick Avenue have advocated for traffic calming in their neighbourhood to address roadway safety concerns as a result of speeding and cut-through traffic.

THEREFORE, BE IT RESOLVED:

(a) That the Transportation Division be authorized and directed to install up to 2 speed cushions on Frederick Avenue between Roxborough Avenue and Cannon Street East as part of the Transportation's 2024 Traffic Calming program for fall implementation;

(b) That all costs associated with the installation of traffic calming measures be funded from the Ward 4 Capital Re-Investment Reserve #108054 at an upset limit, including contingency, not to exceed $10,000; and

(c) That the General Manager of Public Works and City Clerk be authorized and directed to execute any required agreement(s) and ancillary documents, with such terms and conditions in a form satisfactory to the City Solicitor.

12.6

CITY OF HAMILTON

M O T I O N

Public Works Committee: June 17, 2024

MOVED BY COUNCILLOR T. JACKSON…………………………………….

SECONDED BY COUNCILLOR……………………………………………..

Installation of Speed Cushions as a Traffic Calming Measure on Huntington Avenue (Ward 6)

WHEREAS, residents on Huntington Avenue in Ward 6 have advocated for the installation of speed cushions to address roadway safety concerns as a result of speeding; and

WHEREAS, signatures were collected from residents resulting in support by 19 of 34 (56%) homes on Huntington Avenue for the installation of speed cushions as a traffic calming measure.

THEREFORE, BE IT RESOLVED:

(a) That the Transportation Division be authorized and directed to install up to 2 speed cushions as a traffic calming measure on Huntington Avenue between Brentwood Drive and Kingslea Drive as part of Transportation’s 2024 Traffic Calming Program for fall implementation;

(b) That all costs associated with the installation of traffic calming measures at be completed through the Ward 6 Capital Re-Investment Reserve #108056 at an upset limit, including contingency, not to exceed $10,000; and

(c) That the General Manager of Public Works and City Clerk be authorized and directed to execute any required agreement(s) and ancillary documents, with such terms and conditions in a form satisfactory to the City Solicitor.

12.7

CITY OF HAMILTON

M O T I O N

Public Works Committee: June 17, 2024

MOVED BY COUNCILLOR M. SPADAFORA...…....………..……………

SECONDED BY COUNCILLOR ……………….……………………………

Installation of Speed Cushions as a Traffic Calming Measure Around Chedoke Elementary School and Mountview Elementary School (Ward 14)

WHEREAS, the City of Hamilton has adopted a Vision Zero approach which considers human error as part of the roadway safety equation; and

WHEREAS, Ward 14 residents have advocated for traffic calming in their neighbourhoods in proximity to Chedoke and Mountview Elementary Schools to address roadway safety concerns as a result of speeding and cut-through traffic.

THEREFORE, BE IT RESOLVED:

(a) That the Transportation Division be authorized and directed to install 2 speed cushions on Bendemere Avenue between W 25th Street and W 27th Street and 2 speed cushions on W 27th Street between Bendamere Avenue and Leslie Avenue as part of Transportation's 2024 Traffic Calming program for fall implementation;

(b) That the Transportation Division be authorized and directed to install 1 speed cushion on San Antonio Drive between Argo Street and Karen Crescent and 2 speed cushions on Karen Crescent between San Antonio Drive and San Pedro Drive as part of Transportation's 2024 Traffic Calming program for fall implementation;

(c) That all costs associated with the installation of traffic calming measures be completed through the Ward 14 Capital Re-Investment Reserve#108064 at an upset limit, including contingency, not to exceed $35,000; and

(d) That the General Manager of Public Works and City Clerk be authorized and directed to execute any required agreement(s) and ancillary documents, with such terms and conditions in a form satisfactory to the City Solicitor.

12.8

CITY OF HAMILTON

MOTION

Public Works Committee: June 17, 2024

MOVED BY COUNCILLOR M. FRANCIS……………………......………………

SECONDED BY COUNCILLOR……………….……………………………………...

Hamilton Beach Strip Open Space, Adjacent to Lakeside Avenue (Ward 5)

WHEREAS, the Hamilton Beach Rescue unit previously operated from the area at the Hamilton Beach Strip, adjacent to Lakeside Avenue;

WHEREAS, an aged boat lift is a remnant from previous operations of this group, and is no longer needed and at its end of life;

WHEREAS, Voluntary Hamilton Beach Rescue Unit are not able assist with the removal of this infrastructure;

WHEREAS, a motion was approved at the October 16, 2023 Public Works Committee to fund the removal, to the amount of $4,000.00;

WHEREAS, a further procurement process was undertaken after the original contractor declined the proposed removal work; and

WHEREAS, an additional $5,900 to remove the structure is required to complete the works. The total cost for the removal will be $9,900.

THEREFORE, BE IT RESOLVED:

(a) That additional funding for the removal of the Hamilton Beach Rescue Lift located at the Hamilton Beach Strip, adjacent to Lakeside Avenue, be approved from Hamilton Beach Rescue Reserve #110005 at an upset limit, including contingency, not to exceed $5,900; and

(b) That the General Manager of Public Works or designate be authorized and directed to approve and execute any and all required agreements and ancillary documents, with such terms and conditions in a form satisfactory to the City Solicitor.