Appendix E Carleton Place Wastewater Treatment Plant Expansion Options Evaluation Memo

Stantec **Memo**

To:	Guy Bourgon, P.Eng. Town of Carleton Place	From:	Pierre Wilder, P.Eng. and Jean Hébert, P.Eng. Stantec Consulting, Ottawa, ON
Project/File:	163401646	Date:	November 17, 2022

Reference: Carleton Place Water Treatment Plant Expansion Options Evaluation

1 Introduction

The Town of Carleton Place's water & wastewater infrastructure will require expansion to accommodate planned growth to 2041. Stantec Consulting Ltd. (Stantec) was retained by the Town of Carleton Place (Town) to prepare a Master Plan and undertake Schedule 'C' Municipal Class Environmental Assessments (MCEA) and to identify problems & opportunities, identify alternative solutions, and define implementation plans for the expansion of the Town's water treatment plant (WTP) and wastewater treatment plant (WWTP). The 30-day public review period for the Master Plan was completed July 5, 2022, and contained the following preferred alternatives:

- To expand the existing WTP on the existing site at John St.;
- To add water storage at the WTP site as part of the expansion; and,
- To expand the existing WWTP on the existing site off Patterson Cres. and partially into the neighbouring property (Town's household hazardous waste and compost depot).

The Master Plan was undertaken in accordance with the Master Plan process, which generally addresses Phases 1 and 2 of the Class EA process. The Town is proceeding with Phases 3 and 4 of the Class EA process to complete the planning and preliminary design for these recommended projects, which generally includes identifying and evaluating a range of alternative design concepts, identifying a preferred design, and documenting the decision-making process within an Environmental Study Report. The Schedule 'C' MCEA projects are now underway for the above noted preferred alternatives to complete the planning and preliminary design, including phasing and planning level costing, which were presented in the Master Plan.

1.1 Purpose

The purpose of this memorandum is to present and evaluate the feasible alternative design concepts to determine the preferred alternative to expand the WTP, add water storage on the existing WTP site and develop a strategy for implementation. This memorandum satisfies steps 1 to 4 of Phase 3 of the Municipal Class Environmental Assessment Planning process and will form the basis for upcoming consultation with review agencies and the public prior to confirmation of the preferred design solution.

2 Water Treatment Plant Expansion Needs and Constraints

The WTP has a rated capacity of 12,000 m^3/day, including drinking water demand and process wastewater. As discussed in the **Phase 1 Report**, the plant can deliver treated water at a rate of 8,400 m^3/d. An operational benchmark of 7,700 m^3/d is monitored by Ontario Clean Water Agency (OCWA) for water use by-law considerations.

The plant consists of two buildings. The original building, constructed in 1914, has been modified several times and is dedicated to raw water intake, screening, pumping and coagulant storage and injection. It also houses the water-cooled standby diesel generator and a portion of the motor control centre. Most of the treatment equipment (two Actiflo clarifiers, three steel tank filters, and chemical feed systems) is in the 1984 plant expansion building, located adjacent to the original building. Disinfection is provided through chlorine contact time in two underground clearwell reservoirs, followed by the high lift pump well. The high lift pumps transfer treated water into the Town's potable water distribution system. As the high lift pump well is a single cell, there is no way to isolate it without shutting down water supply to the Town.

The preferred alternative solution to accommodate the future servicing needs for the WTP up to 2041, based on the evaluation performed in the Master Plan, consists of expanding the WTP within the existing site. **Figure 1** illustrates the high-level expansion footprint that was assumed in the Master Plan evaluations. This footprint is further defined within the preliminary site plans of the expansion options, presented in **Figure 2** and **Figure 3**. This option seeks to maintain use of the existing processes, where practical, while providing the necessary treatment capacity to accommodate future growth.

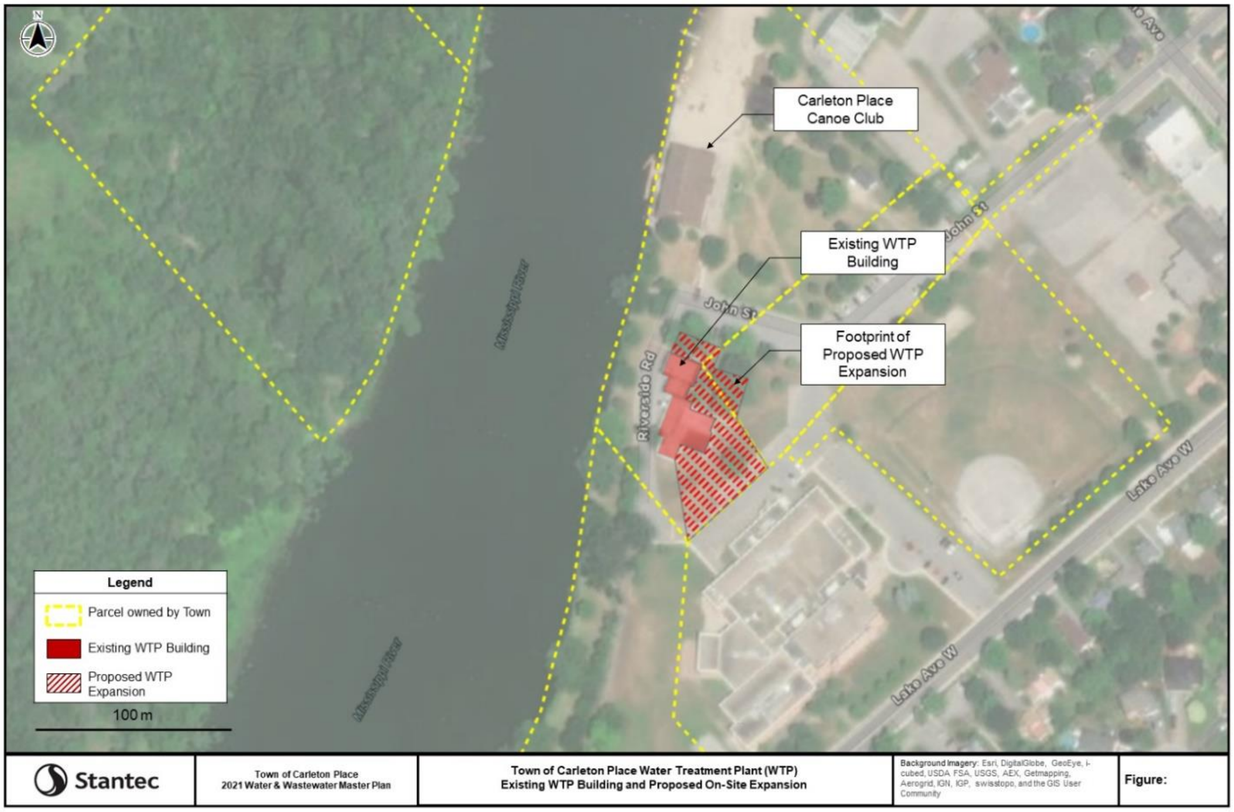

Figure 1: Potential Footprint for WTP Expansion

The following is a summary of WTP planning constraints and needs, some of which are discussed in the **Phase 1 and Phase 2 Reports**:

- A WTP expansion to approximately 20,700 m^3/d (i.e., 72% increase of current capacity) is needed in the long-term to accommodate population growth over a 20-year planning horizon. As the existing facility is approaching its current rated capacity, some expansion is already required to meet the maximum day demand without consuming any emergency storage from the facility's clearwells or from the existing water tower.
- The plant's existing low-lift raw water pumps are currently under capacity for the maximum day demand due to operational limitations. The existing wet well is not deep enough to upgrade these pumps to meet the future flow due to net positive suction head requirements. Thus, a new wet well and low lift pumping station is likely required in any expansion option.
- The high-lift pumps technically have sufficient firm capacity to meet the next 10 years of Town growth, however, the configuration of the clearwells (with two largest pumps in one tank) make it difficult for operators to take the larger clearwell out of service. The pump will eventually need to be upgraded to meet the 20-year maximum day demand of 208.5 L/s (18,000 m^3/d) on a regular basis, and the peak hour demand of 313 L/s (27,000 m^3/d) under extreme condition, when the elevated water storage tank is isolated for repair or maintenance purpose.

Some key features of the existing WTP site that relate to the evaluation criteria and were considered in the evaluation of alternatives include:

- The existing water intake pipe is near the deepest part of the Mississippi River between the Mississippi Lake and the Mississippi Dam in downtown Carleton Place. A 2022 water availability study concluded that it is unlikely there will be issues with insufficient water supply or exposed water intake following expansion of the WTP to meet the 20-year capacity requirements (20,700 m^3/d).
- A geotechnical investigation was not completed at the existing site, however based on background document review and the proximity to the river, it is expected that any deep excavations would encounter both rock conditions and high groundwater levels. A previous subsurface soil analysis was conducted by others in 2009 for the removal of an underground storage tank on the property. The soil verification report did not indicate any evidence of contaminated soil.
- A Species At-Risk (SAR) review was completed at the existing site and did not identify any SAR on the existing property but found several potentially suitable habitats for Blanding's Turtles and SAR Bats. These should be considered at the design stage.
- A Stage 1 Archaeological Assessment was completed at the existing site and evaluated the site as having no archaeological potential, with no need for further investigation recommended.
- The original WTP building (constructed in 1914) was registered locally by the Town in 2021 as a "property of cultural heritage value or interest" and should be preserved and protected in all alternatives. This building currently houses the intake screens, low lift pumps and backup generator.
- Some opportunities for improvement or optimization of the existing facility have been identified by the operators, specifically related to existing process efficiency and health and safety concerns (i.e., chemical storage and handling capacity). Expansion construction should consider these issues during design.
- The circular steel tank filters installed in 1984 may reach the end of their service life over the next 10 years.

3 Long List of Expansion Options and Screening

3.1 Expansion Options Long List Development

A long list of water treatment options potentially suited to expand the existing WTP has been developed. **Table 1** provides a general process description for each treatment option, based on process area (clarification, filtration, and disinfection), as well as relative advantages/disadvantages.

Table 1: Long List of WTP Expansion Options

Treatment	Process Description	Advantages	Disadvantages
Clarification Options			
Actiflo	• Coagulant, polymer, and micro-sand are injected to create a larger, heavier floc that settle more rapidly than floc generated through conventional clarifier system	• Robust system, capable of treating a wide range of raw water characteristics • Occupies a smaller footprint than conventional clarifier process and DAF (see below) • Can remove algae • Operator is already familiar with this system	• Proprietary system, which means Town could only deal with one supplier • Requires a specific combination of coagulant, polymer, and micro-sand to work well • Micro-sand handling process should be addressed properly
Dissolved Air Flotation (DAF)	• A portion of water is diverted into a tank with compressed air. Small air bubbles are generated when diverted water is returned into main tank at atmospheric pressure. Flocs capture bubbles and float.	• Smaller footprint system than conventional clarifier • Efficient removal of high color, low turbidity river water • Can remove algae	• Larger footprint than the Actiflo system already in place
Conventional Clarifier	• Coagulant and polymer are injected, then water is mixed gently to promote formation of floc, before transferring to the clarifier	• Most common technology • Lowest reagent costs • Many suppliers, more competitive costs, as this is not a proprietary system	• The largest footprint solution • Not as effective as other systems when removing algae
Miox	• Mixed-oxidant system, using salt to create strong oxidant for disinfection purpose	• Enhanced oxidation power • Excellent at destroying biological contaminants	• Not a stand-alone solution, needs other treatment steps upstream

Treatment	Process Description	Advantages	Disadvantages
Filtration Options			
Steel Tanks	• Circular welded steel tank, existing system in place has two sets of automated valves per tank (2 filters per tank)	• More cost efficient for smaller municipal plants • Backwash reserve mounted on top of the filter tank, no need for a backwash pump • Smaller wastewater volume per filter backwash cycle means smaller backwash settling tank volume	• Requires larger footprint filter room for a given rated capacity • Available only in standardized diameters • Not cost efficient for larger plants, as the number of automated valves is too high • Backwash flow difficult to adjust on an automated butterfly valve • Both filters within same steel tanks are taken off service when one side is in backwash mode reducing the plant capacity
Concrete Tanks	• Cast-in-place concrete rectangular basins with automated valves on the side	• Can be built to any dimension to fit the plant expansion needs • More filtering area and capacity per set of automated valves • Better usage of filter room area, avoiding loss of filtering area associated to a circular tank in a rectangular room, so future filter room footprint would be reduced • Backwash flow rate and volume can be optimized for each season (as water density and viscosity vary with water temperature) • Reduced number of filters means reduced number of filtered water turbidity analyzers and overall number of I/Os, with associated savings under the SCADA & Instrumentation budget	• Needs a separate backwash reserve and duplex backwash pump system with associated costs

Reference: Carleton Place Water Treatment Plant Expansion Options Evaluation

Treatment	Process Description	Advantages	Disadvantages
Disinfection Options			
Chlorine Gas	• Gaseous chlorine in pressurized metal containers • Gaseous feed system	• Very compact installation • Upgrading current installation to meet future needs would be relatively easy	• Very toxic gas, Operator must wear protective mask • Chlorine room shall be isolated from the rest of the building • Any leakage along the feed line up to the injection point represents a risk • Technology abandoned by most municipal plants in Canada, even the larger ones
Sodium Hypochlorite Solution	• 12% solution delivered to site either by a tanker truck or in 45-gallon barrels depending on demand and frequency • Duplex feed pump system feeding from a day tank	• Much safer than gaseous chlorine • Meets all the Ontario provincial requirements for disinfection of drinking water, for primary and secondary disinfection purpose	• Solution occupies much more room than compressed chlorine gas containers • A large portion of the on-site water reservoir is dedicated to chlorine contact
Ultraviolet (UV)	• UV light applied into a stainless vessel, with UV lamp isolated from water into a quartz tube	• Extremely efficient at deactivating some biological contaminants for primary disinfection purpose. • Contact time within the UV vessel itself avoiding the need for dedicating a portion of the water reservoir for chlorine contact	• Does not leave any residual for secondary disinfection purpose, so chlorine injection (without contact time requirement) is still mandatory

3.2 Long List Options Screening

A series of critical “YES / NO” type questions can be asked to screen the various expansion options described in **Table 2** to help identify a short-list of treatment process options for further evaluation. The questions selected for screening the options are as follows:

1. Is there sufficient space for a new process?
2. Does the option improve health and safety (H&S) conditions for operators and/or the public?
3. Will MECP approve the new process and issue a letter of conformance?
4. Are there other proven installations in Ontario?
5. Does the process maximize and optimize the use of existing infrastructure?

Reference: Carleton Place Water Treatment Plant Expansion Options Evaluation

Table 2: Long List Options Screening

Process	Sufficient Space?	Improve H&S?	MECP Approval?	Proven Installs?	Use Existing Infrastructure?	PASS / FAIL - Comments
Clarification Options						
Actiflo	YES	N/A	YES	YES	YES	PASS – carried forward for further evaluation
DAF	NO	N/A	YES	YES	NO	FAIL – much larger footprint requirement, poor use of existing treatment plant infrastructure
Clarifier	NO	N/A	YES	YES	NO	FAIL – much larger footprint requirement, poor use of existing treatment plant infrastructure
Miox	YES	N/A	YES	YES	NO	FAIL – poor use of existing treatment plant infrastructure, would need costly additional steps
Filtration Options						
Steel Tanks	YES	N/A	YES	YES	YES	PASS – carried forward for further evaluation
Concrete Tanks	YES	N/A	YES	YES	YES	PASS – carried forward for further evaluation
Disinfection Options						
Chlorine Gas	YES	NO	YES	YES	YES	FAIL – technically, keeping the existing gaseous chlorine system would not increase the risk to the public and the operator, but that risk is high. Most municipalities have abandoned this technology to reduce the risk. On this basis, Stantec considers this as FAIL.
Sodium Hypochlorite	YES	YES	YES	YES	YES	PASS – carried forward for further evaluation
UV	YES	NO	YES	YES	YES and NO	FAIL – Does not provide any substantial benefit, as chlorine injection would still be required for secondary disinfection purpose. Volume dedicated to chlorine contact will be used as emergency volume, and be made available under emergency conditions, using a sluice gate at bottom of water reservoir compartment.

The initial screening of Clarification and Disinfection options resulted in the selection of Actiflo clarifiers and sodium hypochlorite disinfection as the preferred alternatives for those unit processes. The short-list of options identified based on the results of the screening assessment for the Filtration process are:

- **Alternative 1** – New circular steel tank filters; and
- **Alternative 2** – New concrete tank filters.

These alternatives will be further explored and evaluated in the following sections.

4 Short Listed Options

4.1 Upgrades Common to both Alternative Options

Both proposed alternatives would maintain the existing WTP site footprint and involve expanding processes to meet planned growth. A high-level review of the required process expansion footprints indicates that the 2041 demand could be met by expanding the existing facility on the current property.

Both options seek to maintain use of the existing processes, including the existing raw water intake, Actiflo clarifiers, and steel filter tanks, while providing new infrastructure where necessary to increase treatment capacity to accommodate future growth. It is recommended that the condition of existing infrastructure be inspected prior to the planned upgrades regardless of the preferred alternative option.

For both alternative designs, the following upgrades will be required to meet the 20-year WTP capacity:

- New low lift pumps with a larger and deeper basin than the existing one, within a new chemical feed building to safely store process chemicals. An extension to the raw water intake line will direct raw water to the new low lift pumping and chemical building, situated north of the original plant building, to minimize pumping requirements for the expanded plant. The proposed location for the new low lift pumping and chemical building is directly adjacent to the Mississippi Valley Conservation Authority (MVCA) regulation limit and may require consultation during detailed design.
- New Actiflo clarifiers, installed adjacent to the existing Actiflo clarifiers.
- A new below-grade backwash settling tank with a small above-grade process room for pumping. Options may be investigated during preliminary design to determine whether this can be placed beneath the filter room or Actiflo room to save space on site.
- A new backup generator to meet increased demand for the expanded WTP.
- Additional below-grade clearwell cells and increased high lift pump capacity to meet peak water demands, which results in the temporary loss of parking spaces for the Carleton Place High School during construction. A new above-grade high lift pump room will be required above the clearwells.
- Preservation of the original 1914 building, which has cultural heritage value. This building may continue to be used for chemical storage, maintenance activities and administrative purposes.
- All new buildings and tanks are proposed to be detached from the original building and will match the height of existing buildings or have a lower profile to minimize visual impact changes to the site.

- Chloramination may also be required with the upgrades to the WTP pending raw water quality analysis to be performed during future design stages.

4.2 Alternative 1 – New Circular Steel Tank Filters

In addition to the upgrades noted in **Section 4.1**, Alternative 1 involves expanding the WTP with similar treatment technology to the existing, including the addition of new circular steel tank filters. A preliminary site plan of this alternative is shown in **Figure 2**.

As reported by the Operating Authority (OCWA), the net rating of each of the three steel vessels is 3,000 m^3/d. As plant rated capacity is to be increased to 20,700 m^3/d, at least seven such vessels are required, and an eight one is required for redundancy. The total number of filters would therefore be 16, with 10 of them new as part of the expansion (5 new dual tanks). The existing steel filter tanks may need replacement within the existing filter room within the 10-year planning period as they approach the end of their useful life.

This alternative takes up a smaller footprint on the existing site, as compared to the other feasible alternative, because of the steel filters having their own built-in backwash reserve and requiring a smaller overall backwash settling tank volume (due to the smaller filter units). However, operating and maintaining steel filters is labour intensive and generally provides less process control. The sheer number of filters presents a high operational and monitoring burden. Also, the filter backwash flow rate and duration cannot be controlled with the steel tanks and the dual-filter system requires both filters to be taken offline during backwash. Although initial capital expenditure for this alternative is low, it has increased operation and maintenance (O&M) costs and more frequent filter replacement requirements.

Table 3 provides a summary of the advantages and disadvantages of a circular steel tank filter expansion.

Table 3: Summary of Advantages and Disadvantages of Alternative 1 – New Circular Steel Tank Filters

Advantages	Disadvantages
• Smaller expansion footprint; • Makes use of remaining life of existing steel tanks; • Lower initial capital cost (See Section 4.4); • Proven technology; • Well understood capital and long-term O&M requirements; and • New infrastructure can be constructed offline while the existing WTP remains in operation, reducing complexity of maintaining service during construction.	• Higher O&M requirements and reduced longevity of steel tank vs concrete tank; • Steel tanks are only available in standardized diameters which limits customization of new infrastructure to match future plant capacity; • Circular tanks do not optimize footprint of new filter room (circular tanks within rectangular building); • Overall number of filter valve set and filtered turbidity meters (16) is much higher than number at the concrete tank filters (only 4). • New filter room may need to be separated from the existing one, on opposite side of the ACTIFLO room • Limited operator flexibility and control for process optimization (as backwash reserve and flow rate cannot be adjusted); and • Increased compliance deviation risk based on the addition of several smaller filters.

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Client/Project
TOWN OF CARLETON PLACE

CLASS ENVIRONMENTAL ASSESSMENTS FOR WATER AND SEWAGE FACILITY EXPANSIONS

Project No.
1634-01646

Title
OPTION 1: ACTIFLO CLARIFIERS WITH NEW CIRCULAR STEEL TANK FILTERS

Revision
C

Date
2022.10.26

Reference Sheet
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Figure No.
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4.3 Alternative 2 – New Concrete Tank Filters

In addition to the upgrades noted in **Section 4.1**, Alternative 2 involves expanding the WTP with new concrete tank filters, including new filter backwash and backwash water reserve tanks. A preliminary site plan of this alternative is shown in **Figure 3**. The new concrete filter tanks would be sized to treat the full capacity of the plant. Existing steel tank filters will be decommissioned and abandoned in place after new concrete tank filters would be operational.

This alternative improves plant operator control and decreases maintenance requirements as compared to Alternative 1, since it requires only a quarter of the automated valves and turbidity meters to maintain with four concrete filters than with eight steel tank (each with two filters). However, concrete filter tanks do not have a built-in backwash water reserve, unlike the steel filter vessels, and thus will require an expanded clearwell volume with dedicated pumps to supply this reserve water, resulting in a larger overall footprint and further temporary loss of Carleton Place High School parking spaces during construction. An advantage of this is greater operational flexibility and the ability to control backwash flowrate and duration to each unit. The rectangular shape also makes it possible to optimize distribution piping for more efficient backwashing, which is more difficult in circular steel tanks.

The new concrete filter room would be larger than supplemental steel filter room (as in Option 1) as they need to be sized for the full plant capacity to compensate for decommissioning the existing steel tank filters. The new concrete filters would be side by side, to optimize footprint, but this imposes some limitations for the rest of the site. In addition, more recreational space on the WTP site will be lost to allow for the installation of the new filter backwash settling tank; this one would be larger than the one for steel tank filter, because each concrete filter unit would generate about four times more backwash wastewater at every cycle compared to the smaller steel tank filters.

Having four concrete filters as opposed to eight steel filter vessels also makes it possible to allocate more time between consecutive backwash cycles, which means more time for settling and transferring clarified water to the river and transferring sludge to the communal sewage collection system. This would provide overall flexibility not possible with steel tank filters, which have more intensive backwash sequences during some periods of the year, as reported by OCWA.

Table *4* provides a summary of the advantages and disadvantages of a concrete tank filter expansion.

Table 4: Summary of Advantages and Disadvantages of Alternative 2 – New Concrete Tank Filters

Advantages	Disadvantages
• Proven technology; • Well understood capital and long-term O&M requirements; • Lower O&M requirements (due to reduced number of automated valves and other instruments) and increased longevity of concrete vs. steel tank; • Can be built to any dimension to fit the plant expansion needs; • Opportunity to repurpose existing filter room area in the future; • Improved operator flexibility and control for process optimization, particularly at filter backwash process; and • New infrastructure can be constructed offline while the existing WTP remains in operation, reducing complexity of maintaining service during construction.	• Higher initial capital cost, attributed mainly to requirement for a separate backwash reserve and duplex backwash pump system (See Section 4.4); • Temporary loss of additional parking spaces for Carleton Place High School during construction; • Larger expansion footprint due to additional clearwell volume and larger backwash settling tank needed; and • Does not makes use of remaining service life of existing steel tanks.

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Client/Project	TOWN OF CARLETON PLACE CLASS ENVIRONMENTAL ASSESSMENTS FOR WATER AND SEWAGE FACILITY EXPANSIONS
Project No.	1634-01646
Title	OPTION 2: ACTIFLO CLARIFIERS WITH NEW CONCRETE TANK FILTERS
Revision	C
Date	2022.10.26
Reference Sheet	-
Figure No.	3

4.4 Life Cycle Cost Analysis

An opinion of probable construction cost (Class 4 estimate (-30% to +50%) in $CAD 2022) and preliminary 20-year life cycle cost analysis were developed for both alternatives, including associated upgrades as described in **Section 4.1**. The result is shown in **Table 5**. Detailed calculations and assumptions for the life cycle cost analysis are provided in **Appendix A**. This table assumes that expansion is completed in 2025.

Reference: Carleton Place Water Treatment Plant Expansion Options Evaluation

Table 5: Life Cycle Cost Analysis

Process System	Opinion of Probable Cost (2022 $CAN)		Proposed Upgrades and Notes
	Alternative 1 – New Circular Steel Tank Filters	Alternative 2 – New Concrete Tank Filters	
WTP Expansion 2023 – 2025: Increase WTP capacity to 20,700 m^3/d to support population growth up to 2041			
Power Supply, Generator & SCADA	$2,100,000	$1,700,000	• Upgrading the plant's standby power system, including replacing the water-cooled diesel generator with an air-cooled diesel or natural gas generator within a sound attenuating, weatherproof enclosure, having rated capacity sufficient to meet the 2041 standby power needs. • Upgrading the plant's SCADA system. Cost is proportional to number of I/O points required (higher for Option 1).
Low Lift Pump & Chemical Feed Building	$2,640,000	$2,640,000	• Installing a new Chemical Feed and Low Lift Pumping Building adjacent to the existing Low Lift Pumping Building. • Replace low lift pumps and install in new building. • Upgraded chemical feed systems to resolve 30-day chemical storage issue. • Replacing the gaseous chlorine feed system with a sodium hypochlorite solution feed system. • Relocating the fluoride feed system to the existing gaseous chlorine feed room. • Demolishing the lime feeder. • Implementing a carry water-based sand transfer system in the existing chemical storage room, to carry ACTIFLO sand to the ACTIFLO basins.
ACTIFLO Basins with Chemical Feed System Upgrades	$2,750,000	$2,750,000	• Install two (2) new ACTIFLO basins and extend chemical feed systems to new basins. Existing and new ACTIFLO basins to discharge to a new common splitter box so clarified water would be blended prior to be sent to filters. This will improve reliability and simplify monitoring. • Existing ACTIFLO basins to be rehabilitated
Gravity Filters	$3,780,000	$3,760,000	• Alternative 1 includes installing five (5) new circular steel gravity filters, including backwash reserve. • Alternative 2 includes installing four (4) new concrete gravity filters and new backwash pumps in clearwell. • Both alternatives include installing anew splitter box combining flow from existing and new ACTIFLO basins, before to distribute flow to filters

Reference: Carleton Place Water Treatment Plant Expansion Options Evaluation

Process System	Opinion of Probable Cost (2022 $CAN)		Proposed Upgrades and Notes
	Alternative 1 – New Circular Steel Tank Filters	Alternative 2 – New Concrete Tank Filters	
Backwash Settling Tank	$440,000	$860,000	• Tank to collect filter backwash wastewater, to clarify it, to discharge clarified water to the River, and concentrated sludge to the communal sewage collection system. Size required is proportional to filter unit sizes.
Clearwell Expansion	$2,200,000	$2,890,000	• Expanding the clearwells to meet chlorine contact and additional emergency storage requirements to meet 2041 projected water demand. • Clearwell expansion for Option 2 includes additional filter backwash reserve volume
High Lift Pump Upgrades	$600,000	$600,000	• Replacing high lift pumps to meet 2041 peak hour demand flow rate. • Upgrading the HVAC system in the High Lift Pump Room.
Site Piping and Other Civil Works	$450,000	$250,000	• Includes connecting the raw water intake pipe to the new Low Lift Pumping Building. • Option 1 cost includes additional piping and pumps to split flow between the new and existing filter rooms
Sub-Total	**$14,960,000**	**$15,540,000**	
Contingency, Engineering, & Additional General Contract Costs	**$6,280,000**	**$6,490,000**	• Includes contingency (20%), engineering (10% - includes design and contract administration), additional general contract costs that are significant factors of construction contracts, including mobilization/demobilization/bonds/insurance (2%), and contract contingency/cash allowance (10%). Contractor's overhead and profit is assumed to be included in items above.
Total Construction Cost	**$21,200,000**	**$21,900,000**	• Class 4 estimate (-30% to +50%) in $CAD 2022.
Present Value 20-Year O&M Cost	**$22,640,000**	**$19,270,000**	• See **Appendix A** for model assumptions.
20-Year Life Cycle Cost	**$43,900,000**	**$41,200,000**	

5 Alternatives Evaluation Criteria & Rating System

The criteria for the evaluation of the alternatives fall into four main categories as presented in **Table 6**:

- Natural environment;
- Cultural environment;
- Socio-Economic environment; and
- Technical environment.

Table 6 presents the criteria and the related key considerations and impacts to assess. Both alternatives are then qualitatively assessed against each criteria using a reasoned argument approach, resulting in a determination identifying each option as preferred or least preferred.

Table 6: Alternatives Evaluation Criteria

Category	Criteria
Natural Environment	**Aquatic Environment** • Potential to impact fish and fish habitat; and • Potential to impact surface water quality and quantity.
	Terrestrial Environment • Potential to impact wildlife/habitat (i.e., Species-at-Risk, spawning areas, significant ecological areas, etc.); • Potential to affect vegetation (i.e., wooded areas, wetlands, conservation areas, etc.); and • Potential to impact individual trees or landscaped features.
Cultural Environment	**Archaeological Resources** • Potential to impact undisturbed lands.
	Built Heritage Resources / Cultural Landscape • Potential to impact known built heritage resources or cultural landscapes/features.
Socio-Economic Environment	**Noise/Vibration & Air Quality** • Potential to impact noise sensitive areas (i.e., residential dwellings, daycares, etc.) during construction; • Potential to affect local air quality during construction; and • Potential to affect local air quality during operational phase.
	Property Requirements • Requires acquisition of private property.
	Aesthetics • Potential to impact visual aesthetics of study area.
	Land Use • Potential to impact existing and future designated land use and/or community use.
	Consistency with Municipal Planning Objectives and Existing/Proposed Development • Satisfies the goals and objectives of the Town's Official Plan. • Consistency with municipal/regional policies. • Potential to support existing and future development within the area.
	Health & Safety • Potential to impact health and safety of residents; • Potential to impact health and safety of employees; • Potential impacts to groundwater quality (i.e., wells, effect Source Water Protection area, etc.); and • Potential to encounter contaminated subsurface conditions.
	Community Access • Disruption to existing traffic, private property and business access during construction; and • Disruption to existing traffic, private property and business access during operation.

Category	Criteria
Technical Environment	**Functionality/Reliability of Water Treatment** • Quality of source water at intake; • Treated potable water quality; and • Reliability of the treatment process.
	Monitoring Requirements & Efficiencies • Impacts to operational monitoring requirements and efficiency.
	Cost • Relative capital, operational and maintenance costs ($).
	Utilities • Potential to impact existing utilities.
	Constructability & Feasibility • Potential to disrupt existing traffic, property access or functionality of existing facilities during construction; and • Location, depth of excavation, soil conditions, rock removal, groundwater control, in-water works, workable construction area, construction duration.
	Expandability • Potential to be expanded or flexible to meet future population needs.
	Climate Change • Ability to increase resilience to climate change (i.e., severe weather events) within the study area; and • Impacts to known climate change contributors (i.e., GHG emissions).

6 Alternatives Evaluation

Table *7* shows the summary of the evaluation of the alternatives for the WTP expansion.

Table 7: Evaluation Summary for WTP Expansion

Evaluation Criteria		Alternative Design Solutions	
Factors	**Measures**	**Alternative 1: New circular steel filters**	**Alternative 2: New concrete tank filters**
Natural Environment			
Aquatic Environment	• Potential to impact fish and fish habitat. • Potential to impact water quality and quantity.	• High potential to impact fish and fish habitat through increased water-taking due to population growth. • Low potential to impact water quality and quantity due to extent of construction footprint and potential for runoff during construction and due to site's proximity to the Mississippi River. However, impacts may be mitigated through design and construction management measures. • Low potential to impact water quantity during low flow conditions (resulting from increased extraction rate) based on findings of Water Availability Assessment.	
Terrestrial Environment	• Potential to impact wildlife/habitat (i.e., Species-at-Risk, spawning areas, significant ecological areas, etc.). • Potential to affect vegetation (i.e., wooded areas, wetlands, conservation areas, etc.). • Potential to impact individual trees or landscaped features.	• Low potential to impact wildlife/habitat, including migratory bird nests. • Low potential to affect vegetation. • High potential to significantly impact individual mature trees that would require removal to accommodate expansion, however impact can be mitigated post-construction by planting new trees nearby.	
Natural Environment Summary		**No significant difference between net effects for each alternative**	
Cultural Environment			
Archaeological Resources	• Potential to impact undisturbed lands.	• Low potential to impact undisturbed lands as expansion can be accommodated within previously disturbed lands (i.e., existing ROW/parking lots).	
Built Heritage Resources / Cultural Landscape	• Potential to impact known built heritage resources or cultural landscapes / features.	• Moderate potential to impact built heritage resources. Although the original WTP building has Cultural Heritage Value, there is no impact to this building. The new Low Lift Pumps and Chemical Feed Building adjacent to the original building will include a buffer and additional mitigation measures to avoid impacts. Public visibility of two of three sides of the original building will be diminished. All new buildings will require architectural design considerations to ensure compatibility with existing WTP buildings.	
Cultural Environment Summary		**No significant difference between net effects for each alternative**	
Socio Economic Environment			
Noise/Vibration & Air Quality	• Potential to impact noise sensitive areas (i.e., residential dwellings, daycares, etc.) during construction. • Potential to affect local air quality during construction. • Potential to affect local air quality during operational phase.	• Moderate potential for increased noise disturbance near adjacent high school and park land temporarily during construction. Construction noise bylaws will be adhered to. • Low potential to affect local air quality besides temporary construction dust and vehicle exhaust.	• Moderate-High potential for increased noise disturbance near adjacent high school and park land temporarily during construction as larger clearwell footprint requires lengthier construction periods. Construction noise bylaws will be adhered to. • Low potential to affect local air quality besides temporary construction dust and vehicle exhaust.
Property Requirements	• Requires acquisition of private property.	• Low potential to impact private property as expansion would remain within Town owned ROW/existing parking lots.	

Evaluation Criteria		Alternative Design Solutions	
Factors	**Measures**	**Alternative 1: New circular steel filters**	**Alternative 2: New concrete tank filters**
Aesthetics	• Potential to impact visual aesthetics of study area.	• Moderate potential for visual aesthetic impacts through reduction of park land and construction of new WTP structures which will change the existing views/landscape of the area. Also, potential impacts to the visual aspect of the heritage attributes of the existing WTP structure.	
Land Use	• Potential to impact existing and future designated land use and/or community use.	• High impact to existing land use and use of open space for recreation; temporary loss of few parking spaces during construction	• Higher impact to existing land use and use of open space for recreation; temporary loss of many parking spaces during construction
Consistency with Municipal Planning Objectives & Existing / Proposed Development within the Area	• Satisfies the goals and objectives of the Town's Water and Wastewater Master Plan. • Consistency with municipal/regional policies.	• Satisfies the goals of the Town's Water and Wastewater Master Plan to support future projected population growth in the 20-year planning horizon (to 2041). • Not consistent with local policy to appreciate built heritage due to blocking two of three sides of heritage building. However, mitigation measures could be implemented during design and construction to protect the cultural heritage value of the existing WTP.	
Health & Safety	• Potential to impact health and safety of residents. • Potential to impact health and safety of employees. • Potential impacts to groundwater quality (i.e., wells, effect Source Water Protection area, etc.). • Potential to encounter contaminated subsurface conditions.	• Low potential to affect the health and safety of Town residents. • Improves health and safety of employees through improvement in chemical storage and transfer processes. • Low potential to impact groundwater quality including private wells. • Low potential to encounter contaminated subsurface conditions.	
Community Access	• Disruption to existing traffic, private property and business access during construction. • Disruption to existing traffic, private property and business access during operation.	• High potential to increase existing traffic near adjacent high school and Canoe Club during construction, which can be mitigated by working with local stakeholders to locate appropriate laydown and parking areas for contractor. • No impact during operation of the new facilities.	
Socio-Economic Environment Summary		**Preferred**	**Moderately Preferred**
Technical			
Functionality/Reliability of Water Treatment	• Quality of source water at intake. • Treated potable water quality. • Reliability of the treatment process.	• No impact to source water quality as existing intake will be kept. • No impact to treated water quality as expansion processes will maintain existing potable water quality. • Low improvement in functionality/reliability of treatment plant through optimization of some operation processes (disinfection). However, maintaining circular steel filters limits operational control and process optimization.	• No impact to source water quality as existing intake will be kept. • No impact to treated water quality as expansion processes will maintain existing potable water quality. • High improvement in functionality/reliability of treatment plant through optimization of some operation processes (disinfection and filtration).
Monitoring Requirements & Efficiencies	• Impacts to operational monitoring requirements and efficiency.	• Moderate impact to operational monitoring requirements as the addition of several steel filters will add sampling points that require compliance monitoring and reporting. • Low improvement in efficiency of treatment with limited control of backwash flows through steel filters.	• Low impact to operational monitoring requirements as the addition of concrete filters will add minimal sampling points that require compliance monitoring and reporting. • High improvement in efficiency of treatment with the addition of concrete filters with backwash pumping to control backwash flows.
Cost	• Relative capital, operational and maintenance costs ($).	• Moderate 20-year lifecycle cost. Costs are comparable but slightly higher for Alternative 1.	
Utilities	• Potential to impact existing utilities.	• Low impact. Sufficient potable water supply to residences. Upgraded hydro connection may be needed at the site.	

Reference: Carleton Place Water Treatment Plant Expansion Options Evaluation

Evaluation Criteria		Alternative Design Solutions	
Factors	**Measures**	**Alternative 1: New circular steel filters**	**Alternative 2: New concrete tank filters**
Constructability & Feasibility	• Potential to disrupt existing traffic, property access or functionality of existing facilities during construction. • Location, depth of excavation, soil conditions, rock removal, groundwater control, in-water works, workable construction area, construction duration.	• Moderate impacts to functionality of existing facilities are anticipated during construction to dismantle existing equipment and begin operations of new equipment, which can be mitigated with specification of construction sequencing and constraints of continuous plant operation. • Geotechnical investigation of site will be required, likely rock removal and groundwater will be encountered during construction due to site proximity to the river. However, no in-river works needed as existing intake pipe has capacity to serve future flow rates.	
Expandability	• Potential to be expanded or flexible to meet future population needs.	• Limited potential to expand beyond projected 20-year population horizon. Future expansion area or new plant would need to be identified and secured before 2041 horizon.	
Climate Change	• Ability to increase resilience to climate change (i.e., severe weather events) within the study area • Impacts to known climate change contributors (i.e., GHG emissions)	• Moderate improvement in resiliency to climate change through increased chemical storage, generator capacity, and flood-resistant facility design. • Moderate potential to increase known climate change contributors through increased energy consumption, although there are opportunities to implement more energy efficient processes.	• Moderate-high improvement in resiliency to climate change through implementation more robust and efficient treatment processes, increased chemical storage and generator capacity, and flood-resistant facility design. • Moderate-high potential to increase known climate change contributors through the use of concrete tank filters and increased energy consumption, although there are opportunities to implement more energy efficient processes.
TECHNICAL SUMMARY		**Least Preferred**	**Preferred**
Overall Conclusion		**MODERATELY PREFERRED**	**PREFERRED**

LEGEND
Preferred
Moderately Preferred
Least Preferred

Reference: Carleton Place Water Treatment Plant Expansion Options Evaluation

7 Conclusions and Next Steps

The preliminary preferred alternative for WTP expansion based on the detailed evaluation is ***Alternative 2: New concrete tank filters***, with the following key advantages:

- Lower O&M requirements and costs;
- Increased longevity of concrete vs. steel tank will reduce future infrastructure replacement requirements;
- Ability to customize new concrete filters' size to match future plant capacity needs; and
- Improved operator flexibility and control for process optimization.

It is recommended that the Town inspect the existing infrastructure that is proposed to be reused, including the water intake, existing Actiflo clarifiers, and existing steel filters, to confirm their condition is adequate for future use.

The preliminary preferred alternative will be presented in an upcoming online Public Information Centre to solicit comment and input from stakeholders, including review agencies, the public, and those who previously expressed interest in the Master Plan. Input from review agencies and the public is necessary and important at this stage to assist the Town by providing additional information, in reviewing the evaluation and in arriving at the preferred decision. The study will be fully documented in the ESR, to which this memo will be appended.

Regards,

STANTEC CONSULTING LTD.

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Attachment: Appendix A:Life Cycle Cost Analysis

Appendix A: Life Cycle Cost Analysis

Life Cycle Cost Analysis for Carleton Place Water Treatment Plant Upgrading Options

General Assumptions

Period of the life cycle cost analysis	20 years	
Expansion Completed in Year	2025	
Costs proportional to daily drinking water production rate:	\$ per m³ produced	
Chemicals	0.119	
Services, supplies and equipment	0.034	
Production & Pumping of Water	0.038	
Cost proportional to building footprint		
HVAC and Controls	\$ 110,000 /year for current building footprint	
Based on	702 m²	
	0.13 \$/kWh	
Costs increasing on an annual basis independent from water demand increase		
Management Fee	\$ 184,000 in 2021	
Annual increase rate	2% to consider additional regulatory requirements	
Labor Costs associated to treatment technology		
Base Labor Costs	\$ 212,310 as of 2021	
Associated to new ACTIFLO Tanks	10% net increase	
Associated to new steel tank filters	25% net increase	
Associated to new concrete filters	10% net increase	
End of service life of current steel tank filters	**2030**	
Cost for replacing current steel tank filters	\$ 3,912,300	75% of new steel filter construction costs
End of service life of SCADA & Instrumentation	**2034**	
Cost for replacing SCADA & instrucmentation	\$ 500,000	
Social Discount Rate:	3.0 %	https://muse.jhu.edu/article/396282/pdf

Option 1 - New ACTIFLO Basins and New Circular Steel Tank Filters, with Current Steel Filters Replaced in Year 2030

1326 m² total building footprint **Labor net increase 35%**

Year	Serviced Population (p)	Average Daily Flow (m3/d)	HVAC & Controls (\$/yr)	Chemicals (\$/yr)	Production & Pumping (\$/yr)	Labour (\$/yr)	Management (\$/yr)	Services, sup & repl (\$/yr)	Other Costs (\$/yr)	Total (\$/yr)	Present Value (\$/yr)
2021	13,500	5,633	\$110,000	\$122,339	\$78,132	\$ 212,310	\$184,000	\$69,908	\$ -	\$776,690	\$776,690
2022	14,137	5,899	\$110,000	\$256,223	\$81,819	\$ 212,310	\$187,680	\$73,207	\$ -	\$921,239	\$921,239
2023	14,804	6,177	\$110,000	\$268,312	\$85,680	\$ 212,310	\$191,434	\$76,661	\$ -	\$944,396	\$916,889
2024	15,503	6,469	\$110,000	\$280,981	\$89,725	\$ 212,310	\$195,262	\$80,280	\$ -	\$968,559	\$912,959
2025	16,235	6,774	\$207,778	\$294,248	\$93,962	\$ 286,619	\$199,168	\$84,071	\$ -	\$1,165,844	\$1,066,913
2026	17,000	7,094	\$207,778	\$308,113	\$98,389	\$ 286,619	\$203,151	\$88,032	\$ -	\$1,192,082	\$1,059,149
2027	17,649	7,364	\$207,778	\$319,876	\$102,145	\$ 286,619	\$207,214	\$91,393	\$ -	\$1,215,024	\$1,048,091
2028	18,322	7,645	\$207,778	\$332,073	\$106,040	\$ 286,619	\$211,358	\$94,878	\$ -	\$1,238,746	\$1,037,430
2029	19,021	7,937	\$207,778	\$344,742	\$110,086	\$ 286,619	\$215,585	\$98,498	\$ -	\$1,263,307	\$1,027,185
2030	19,747	8,240	\$207,778	\$357,901	\$114,288	\$ 286,619	\$219,897	\$102,257	\$ 3,912,300	\$5,201,039	\$4,105,748
2031	20,500	8,554	\$207,778	\$371,548	\$118,646	\$ 286,619	\$224,295	\$106,157	\$ -	\$1,315,042	\$1,007,870
2032	20,911	8,726	\$207,778	\$378,997	\$121,024	\$ 286,619	\$228,781	\$108,285	\$ -	\$1,331,484	\$990,749
2033	21,330	8,900	\$207,778	\$386,591	\$123,449	\$ 286,619	\$233,356	\$110,455	\$ -	\$1,348,248	\$974,003
2034	21,757	9,079	\$207,778	\$394,330	\$125,921	\$ 286,619	\$238,024	\$112,666	\$ 500,000	\$1,865,337	\$1,308,310
2035	22,193	9,261	\$207,778	\$402,233	\$128,444	\$ 286,619	\$242,784	\$114,924	\$ -	\$1,382,781	\$941,606
2036	22,638	9,446	\$207,778	\$410,298	\$131,019	\$ 286,619	\$247,640	\$117,228	\$ -	\$1,400,581	\$925,949
2037	23,092	9,636	\$207,778	\$418,526	\$133,647	\$ 286,619	\$252,593	\$119,579	\$ -	\$1,418,741	\$910,636
2038	23,555	9,829	\$207,778	\$426,918	\$136,327	\$ 286,619	\$257,644	\$121,977	\$ -	\$1,437,262	\$895,654
2039	24,027	10,026	\$207,778	\$435,473	\$139,058	\$ 286,619	\$262,797	\$124,421	\$ -	\$1,456,145	\$880,992
2040	24,509	10,227	\$207,778	\$444,208	\$141,848	\$ 286,619	\$268,053	\$126,917	\$ -	\$1,475,423	\$866,655
2041	25,000	10,432	\$207,778	\$453,107	\$144,690	\$ 286,619	\$273,414	\$129,459	\$ -	\$1,495,067	\$852,616
										Total PV=	**\$22,650,643**
										Equiv. AV=	**\$1,522,479**
	Construction Costs (see Table 5 in memo)										
2022	\$CAD									\$ 21,244,000.00	\$21,244,000
										Total PV=	**\$43,895,000**

Option 2 - New ACTIFLO Basins and Current Circular Steel Tank Filter Replaced by Rectangular Concrete Tank Filters

1446 m² total building footprint **Labor net increase 20%**

Year	Serviced Population (p)	Average Daily Flow (m3/d)	HVAC & Controls (\$/yr)	Chemicals (\$/yr)	Production & Pumping (\$/yr)	Labour (\$/yr)	Management (\$/yr)	Services, sup & repl (\$/yr)	Other Costs (\$/yr)	Total (\$/yr)	Present Value (\$/yr)
2021	13,500	5,633	\$110,000	\$122,339	\$78,132	\$212,310	\$184,000	\$69,908	\$ -	\$776,690	\$776,690
2022	14,137	5,899	\$110,000	\$128,112	\$81,819	\$212,310	\$187,680	\$73,207	\$ -	\$793,127	\$793,127
2023	14,804	6,177	\$110,000	\$268,312	\$85,680	\$212,310	\$191,434	\$76,661	\$ -	\$944,396	\$916,889
2024	15,503	6,469	\$110,000	\$280,981	\$89,725	\$212,310	\$195,262	\$80,280	\$ -	\$968,559	\$912,959
2025	16,235	6,774	\$226,581	\$294,248	\$93,962	\$ 254,772	\$199,168	\$84,071	\$ -	\$1,152,801	\$1,054,976
2026	17,000	7,094	\$226,581	\$308,113	\$98,389	\$ 254,772	\$203,151	\$88,032	\$ -	\$1,179,039	\$1,047,560
2027	17,649	7,364	\$226,581	\$319,876	\$102,145	\$ 254,772	\$207,214	\$91,393	\$ -	\$1,201,981	\$1,036,839
2028	18,322	7,645	\$226,581	\$332,073	\$106,040	\$ 254,772	\$211,358	\$94,878	\$ -	\$1,225,703	\$1,026,507
2029	19,021	7,937	\$226,581	\$344,742	\$110,086	\$ 254,772	\$215,585	\$98,498	\$ -	\$1,250,264	\$1,016,579
2030	19,747	8,240	\$226,581	\$357,901	\$114,288	\$ 254,772	\$219,897	\$102,257	\$ -	\$1,275,696	\$1,007,046
2031	20,500	8,554	\$226,581	\$371,548	\$118,646	\$ 254,772	\$224,295	\$106,157	\$ -	\$1,301,999	\$997,873
2032	20,911	8,726	\$226,581	\$378,997	\$121,024	\$ 254,772	\$228,781	\$108,285	\$ -	\$1,318,441	\$981,044
2033	21,330	8,900	\$226,581	\$386,591	\$123,449	\$ 254,772	\$233,356	\$110,455	\$ -	\$1,335,205	\$964,580
2034	21,757	9,079	\$226,581	\$394,330	\$125,921	\$ 254,772	\$238,024	\$112,666	\$ 500,000	\$1,852,294	\$1,299,161
2035	22,193	9,261	\$226,581	\$402,233	\$128,444	\$ 254,772	\$242,784	\$114,924	\$ -	\$1,369,737	\$932,725
2036	22,638	9,446	\$226,581	\$410,298	\$131,019	\$ 254,772	\$247,640	\$117,228	\$ -	\$1,387,538	\$917,326
2037	23,092	9,636	\$226,581	\$418,526	\$133,647	\$ 254,772	\$252,593	\$119,579	\$ -	\$1,405,698	\$902,264
2038	23,555	9,829	\$226,581	\$426,918	\$136,327	\$ 254,772	\$257,644	\$121,977	\$ -	\$1,424,219	\$887,526
2039	24,027	10,026	\$226,581	\$435,473	\$139,058	\$ 254,772	\$262,797	\$124,421	\$ -	\$1,443,102	\$873,101
2040	24,509	10,227	\$226,581	\$444,208	\$141,848	\$ 254,772	\$268,053	\$126,917	\$ -	\$1,462,380	\$858,994
2041	25,000	10,432	\$226,581	\$453,107	\$144,690	\$ 254,772	\$273,414	\$129,459	\$ -	\$1,482,024	\$845,178
										Total PV=	**\$19,272,257**
										Equiv. AV=	**\$1,295,398**
	Construction Costs (see Table 5 in memo)										
2022	\$CAD									\$ 21,939,000.00	\$21,939,000
										Total PV=	**\$41,212,000**

Notes:

1. Unit costs per water production rate are derived based on 2021 costs and 2022 budgeted amounts
2. Chemical costs beyond 2022 expected to increase substantially based on discussions with operators