

Town of Deep River

Deep River Water Treatment Plant Phase 1: Trihalomethanes Reduction Study

Technical Memorandum 2: Re-Evaluation of THM Reduction Technologies

Monday, July 8, 2024

A001332 / 370

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Engineering for **people**



Technical Memorandum 2: Re-Evaluation of THM Reduction Technologies

Deep River Water Treatment Plant
Phase 1: Trihalomethanes Reduction Study
Project no. A001332 | File no. 370

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Table of Contents

1	Introduction.....	4
1.1	Background.....	4
1.2	Purpose.....	5
2	Water Quality.....	6
3	Proposed Methods for Reducing THMs.....	9
3.1	Short Term Options.....	9
3.1.1.1	Deep River WTP	9
3.1.1.2	CNL Reservoir.....	10
3.2	Long Term THM Reduction Alternatives	10
3.3	Preferred THM Reduction Alternative	14
4	Implementation Plan.....	18
5	Summary and Recommendations	20
	References.....	21

List of Tables

Table 1:	DOC and TOC Concentrations (2021, 2023 & 2024).....	7
Table 2:	GAC Filter Media Replacement Benefits, Challenges, and Costs	9
Table 3:	Long Term THM Reduction Alternatives Benefits, Challenges, and Costs	12
Table 4:	Chloramination Implementation Risk Mitigation.....	14

List of Figures

Figure 1:	CNL Reservoir THM Concentration	6
Figure 2:	Monthly Average of Free Chlorine Residual (2019 – 2023).....	8
Figure 3:	Residence Time to CNL Reservoir.....	10
Figure 4:	PAC vs. Chloramination O&M Cost Comparison	13
Figure 5:	Proposed Ammonium Sulfate Dosing Location	16
Figure 6:	Proposed Ammonium Sulfate Piping Route	16

Figure 7: Proposed Ammonium Sulfate Storage Building Site Layout 17

List of Appendices

Appendix A: GAC Budgetary Proposal

Appendix B: Opinion of Probable Cost for PAC THM Reduction Alternative

Appendix C: Opinion of Probable Cost for Chloramination THM Reduction Alternative

1 Introduction

1.1 Background

The Deep River Water Treatment Plant (WTP) is located at 177 River Rd., Deep River, County of Renfrew, Ontario. It is owned by the Corporation of the Town of Deep River (Town) and operated by the Ontario Clean Water Agency (OCWA). The Deep River WTP has a Design Capacity of 13,638 m³/d and Maximum Daily Water Taking of 15,911 m³/d.

The WTP serves a population of approximately 4,109 people within the Town with a network of watermains and an elevated storage tank (water tower). In 2019, a booster pumping station and an approximately 9 km long watermain were constructed to connect the Deep River distribution system to the Canadian Nuclear Lab (CNL) facility, which contains an on-site reservoir.

The Town retained CIMA+ to address the elevated concentrations of disinfection by-products (DBPs), especially trihalomethanes (THMs), in the Town's treated drinking water tower and in the CNL reservoir. In June 2023, CIMA+ prepared Technical Memorandum (TM) 1 which evaluated feasible technologies for THM reduction based on water quality and quantity data provided between 2017-2021. A preferred THM reduction technology to implement at the Deep River WTP, Powdered Activated Carbon (PAC), was identified in TM1 and further developed in a Conceptual Design Report (CIMA+, September 2023).

Concurrently, CNL retained an engineering firm for the design of an in-tank aeration system to reduce THMs at their on-site reservoir. This project is in collaboration with the Town and under the same overall scope to reduce THMs from the municipally generated water. The two projects are complimentary with the end objective to achieve THM compliance throughout the distribution system. CNL completed detailed design for the reservoir aeration system in early 2024; however, costs and timeline for implementation of aeration in the reservoir were higher and longer than expected.

In March 2024, CIMA+ assessed recent water quality data (2022-2024). Prior to 2023, THM formation was elevated seasonally (typically in late summer and early fall), which signified that PAC could operate intermittently (i.e. 3-4 months per year) when peak Total Organic Carbon (TOC) and Dissolved Organic Carbon (DOC) levels in the river were observed to mitigate THM formation and reduce the Running Annual Average (RAA) values. In 2023, a presumed reduction in the river water quality led to consistently high THM levels in the CNL reservoir (Section 2) while chlorine residuals remained relatively consistent from previous years. This new data suggests that PAC

would need to operate significantly longer each year to reduce the potential for THM formation, which may impact the feasibility and economics of PAC for the WTP. As well, PAC alone may not be sufficient to mitigate elevated THM levels in the CNL reservoir due to the longer residence time in the CNL transmission line and reservoir, necessitating the CNL Reservoir Aeration project to proceed. The combination of continuous use of PAC at the WTP as well as aeration at the CNL reservoir would result in costly annual operation and maintenance burdens for the Town and CNL.

1.2 Purpose

The purpose of Technical Memorandum (TM) 2 is to:

- Re-evaluate feasible alternatives and technologies that could provide a more cost-efficient, long-term, and robust solution in light of recent water quality trends to mitigate THM formation in both the Town's and CNL's distribution network; and,
- Assess the possibility of implementing short-term solutions and optimization strategies to provide sufficient THM precursor removal at existing WTP flows as well as provide new data for design basis development for the long-term THM reduction upgrades.

2 Water Quality

The Town and OCWA provided updated water quality data from ongoing CNL reservoir THM sampling (Figure 1), TOC and DOC sampling (Table 1), and average monthly chlorine residual (Figure 2). Figure 1 shows that the Running Annual Average (RAA) THM concentrations in the CNL reservoir have surpassed the regulated Maximum Acceptable Concentration (MAC) of 100 µg/L consistently, mainly attributed to elevated THM concentrations in July-September each year. However, since May 2023 THM concentrations have measured consistently above 100 µg/L, resulting in increasing RAAs.

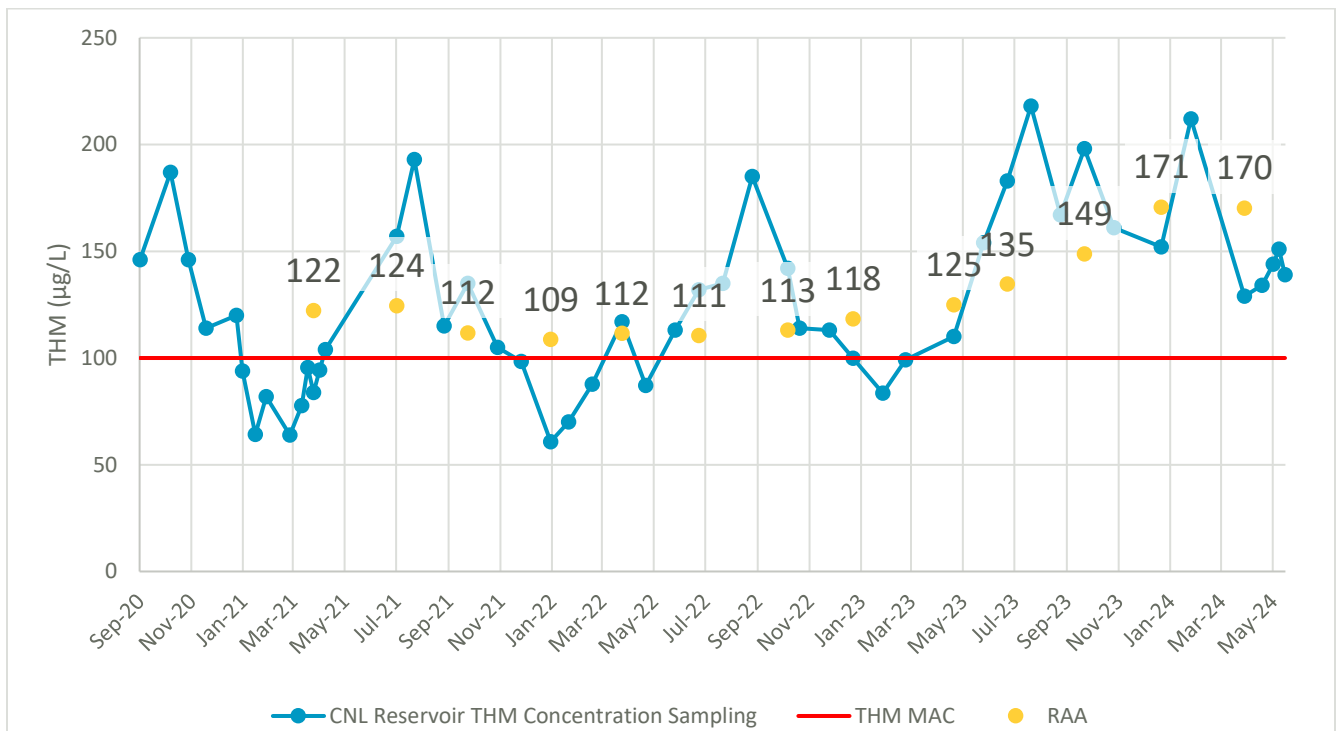


Figure 1: CNL Reservoir THM Concentration

As discussed in TM1, key factors in THM formation include:

- Precursor concentration (i.e. high TOC/DOC prior to primary disinfection):
 - As shown in Table 1, elevated concentrations of TOC/DOC’s have been measured in the raw water between 2021-2024.
- Elevated chlorine residuals:
 - As shown in Figure 2, the levels of chlorine residual in the treated water (clearwell) and distribution system remained relatively consistent or have slightly decreased between 2019-2023.
- Residence time following disinfection:

- The Town’s water tower was offline in 2022 for rehabilitation, which decreased the residence time of water in the distribution system.
- No other known operational changes have occurred to increase residence time in the distribution system.

This data suggests that increasing TOC/DOC concentrations in the raw water and increased residence time in the Town’s water tower are contributing to recent elevated THM concentrations.

Table 1: DOC and TOC Concentrations (2021, 2023 & 2024)

Year	Month, Day	DOC			TOC		
		Raw Water (mg/L)	Filter Effluent (mg/L)	Distribution (mg/L)	Raw Water (mg/L)	Filter Effluent (mg/L)	Distribution (mg/L)
2021 ⁽¹⁾	Mar 16	7.90	3.4	3.10	8.00	3.8	3.10
	Mar 23	7.60	3.3	3.30	7.60	3.3	3.10
	Mar 30	7.80	3.3	3.20	7.70	3.4	3.10
	Apr 6	7.80	3.8	3.20	7.50	3.3	3.20
	Apr 13	7.70	3.0	3.00	7.40	3.2	3.00
	Apr 20	7.40	3.0	2.80	7.20	3.0	2.80
2023 ⁽²⁾	Feb 2	8.65	-	-	8.05	-	-
2024 ⁽³⁾	Jun 4	9.1	3.6	-	9.5	3.9	-

Table Notes:

- (1) Based on figures presented by OCWA in DBP Report (OCWA, 2021)
- (2) Based on figures presented in Veolia laboratory testing. (Veolia, 2023)
- (3) Based on OCWA Laboratory Report for June 2024

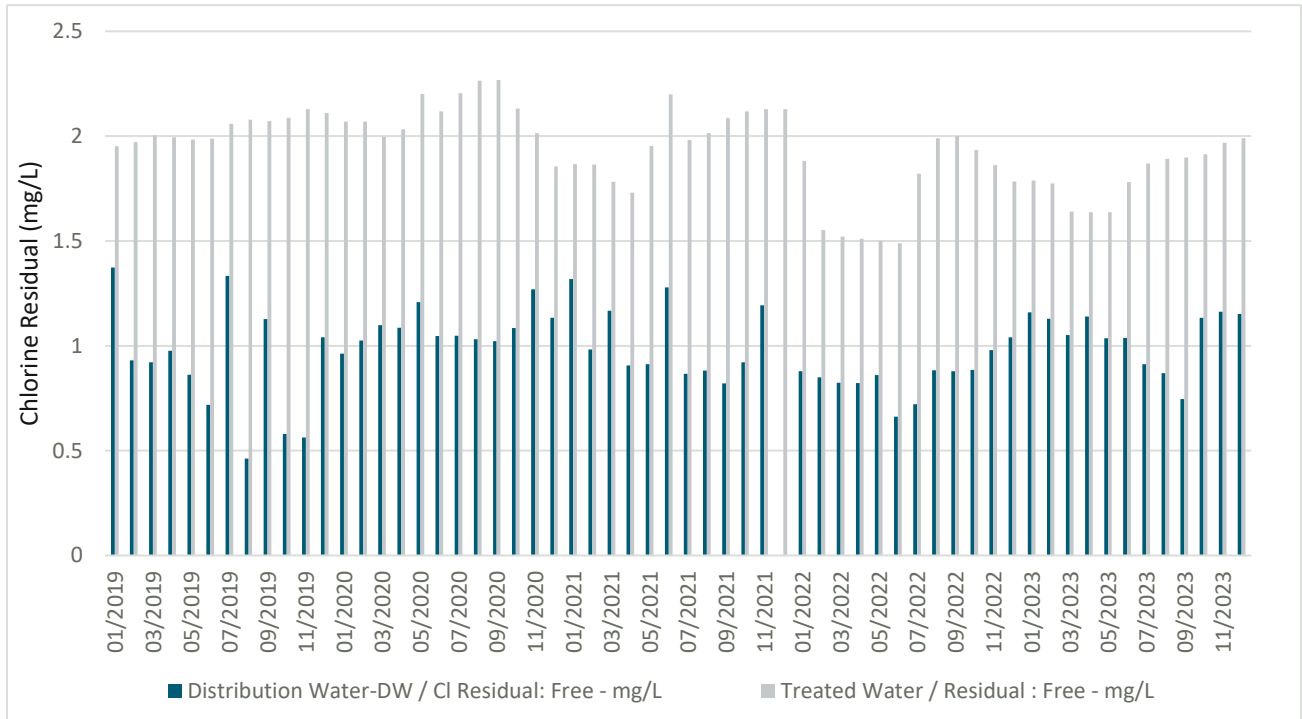


Figure 2: Monthly Average of Free Chlorine Residual (2019 – 2023)

3 Proposed Methods for Reducing THMs

3.1 Short Term Options

3.1.1.1 Deep River WTP

Given the source water quality issues (Section 2) that have been identified in the past 2-3 years that are exacerbating the issue of THM formation at the CNL reservoir, the Town is considering implementing a short-term THM reduction strategy. This strategy is needed to remove sufficient precursors (TOC/DOC) prior to primary disinfection at the current average daily flows to mitigate THM formation. However, a long-term option will also be required to meet the WTP’s Design Capacity (13,638 m³/d).

The preferred short-term option for THM reduction is to replace anthracite media in existing gravity filters with granular activated carbon (GAC) to provide TOC/DOC reduction benefits prior to primary disinfection. The benefits, challenges and costs of this short-term strategy are presented in Table 2.

Table 2: GAC Filter Media Replacement Benefits, Challenges, and Costs

Benefits	Challenges	Costs
<ul style="list-style-type: none"> • TOC/DOC removal for the current average daily flow. • Can be quickly implemented to mitigate the current THM formation issues. • Will benefit any long-term preferred solution with continuous and passive TOC/DOC reduction. 	<ul style="list-style-type: none"> • Insufficient empty bed contact time in the existing gravity filters to meet the required TOC/DOC removal rate at the WTP’s Design Capacity (i.e. long-term solution sized for the plant’s Design Capacity still required). • No guarantee that precursors will be removed to levels that mitigate THM formation to acceptable levels in the CNL reservoir. 	<ul style="list-style-type: none"> • Capital cost estimate for GAC and sand media replacement (material and labour) for three (3) existing gravity filters: <u>\$788K + HST</u>, including (full scope provided in Appendix A): <ul style="list-style-type: none"> • Removal and disposal of all existing filter media, • Inspection and reporting on condition of underdrains (repairs can be made on time and materials basis), • Installation of new sand and GAC media, • Initial backwash to remove fines and disinfection, and • 15% contingency.

Benefits	Challenges	Costs
<ul style="list-style-type: none"> No direct short-term O&M costs. 	<ul style="list-style-type: none"> Unknown media performing life expectancy and replacement timing. 	<ul style="list-style-type: none"> Excludes: Operations (OCWA) and Town support services, including BAC-T testing, on-site support.

3.1.1.2 CNL Reservoir

As noted in Figure 3, one of the challenges with the Deep River supply of potable water to the CNL site is the long residence time (RT) within the distribution system and storage tanks.

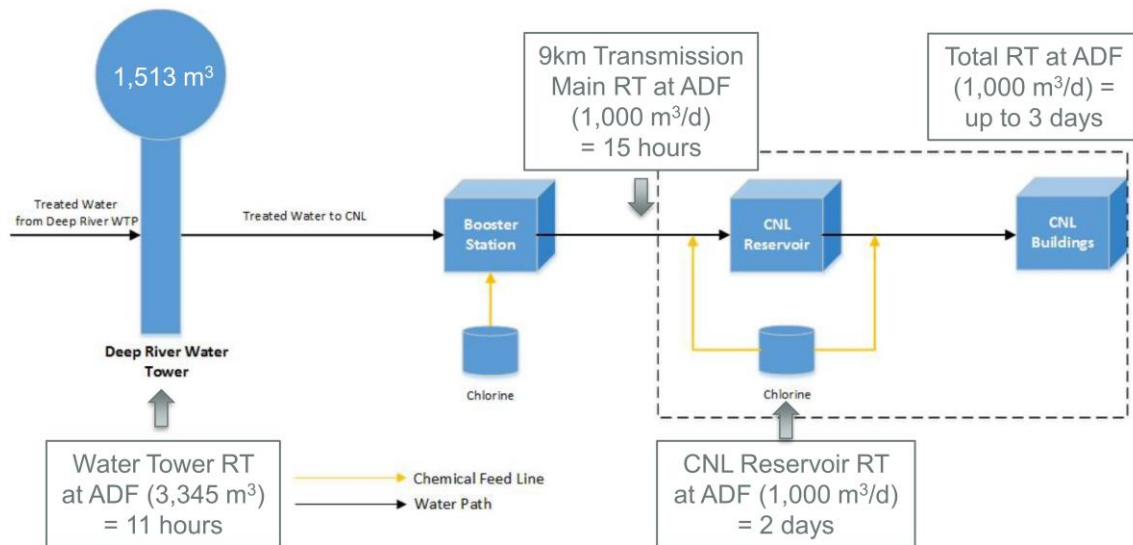


Figure 3: Residence Time to CNL Reservoir

The following action is recommended in the short-term to mitigate THM formation in the CNL reservoir:

- Reduce the active volume of the CNL reservoir, by lowering the high water level in the tank and/or by using only one of two reservoir cells, to decrease residence time (CNL noted that the reservoir is not used for fire flow).

3.2 Long Term THM Reduction Alternatives

TM1 reviewed various long-term options to implement at the Deep River WTP to reduce THMs, including ion exchange, PAC, and GAC pressure filters, with a preference for methods that removed precursors (TOCs/DOCs). PAC was found to be the most feasible due to its compatibility with the existing Actiflo® units, lower capital cost, and

ability to operate intermittently. However, given the latest water quality data (Section 2), a re-evaluation of PAC's feasibility as a long-term solution is warranted.

Another long-term option for THM reduction that will be considered is implementing chloramination for secondary disinfection. Chloramination involves adding ammonia following chlorine addition for secondary disinfection, which forms a chloramine residual (principally monochloramine). Chloramines form low THMs and HAAs, so their use as a secondary disinfectant in place of chlorine is an effective way to reduce DBPs. Chlorination would still be required for primary disinfection prior to the clearwell as chloramines have less oxidation capacity. Furthermore, chloramines are usually much more stable than free chlorine, so challenges related to maintaining a disinfectant residual at remote areas of the distribution system are often resolved.

Chloramination as secondary disinfection was considered in conjunction with UV for primary disinfection and aeration at the water tower as a feasible recommendation to reduce THM formation as part of OCWA's 2021 "Feasibility Review to Manage the Formation of DBP" Report. OCWA noted that the existing chlorine gas system can be maintained to feed chlorine. An additional ammonia storage and dosing system is required to complete the system. Due to health and safety concerns associated with gaseous ammonia, OCWA recommended a liquid ammonia system (typically ammonium sulfate solution).

Due to the space constraints of the existing Deep River WTP building, either long-term alternative will require a separate building for storage and dosing equipment. Either long-term strategy will also work in conjunction with the short-term strategies of WTP optimization and GAC media replacement to reduce TOC/DOC prior to primary disinfection.

The benefits, challenges, and costs of PAC vs. chloramination as long-term THM reduction strategies are presented in Table 3. Based on this evaluation, the preferred long-term option for THM reduction is to implement chloramination to provide a cost-efficient and robust solution for both Deep River and CNL.

Table 3: Long Term THM Reduction Alternatives Benefits, Challenges, and Costs

Enhanced Treatment Process	Benefits	Challenges	Costs
Powdered Activated Carbon (PAC)	<ul style="list-style-type: none"> • Effective removal of TOC/DOC using adsorption. • Can be easily integrated as an additional tank ahead of the existing Actiflo® units. • Can be used seasonally/intermittently during high TOC/DOC concentration periods in raw water. 	<ul style="list-style-type: none"> • PAC can be a safety hazard if not handled properly. • Requires a classified building for PAC slurry generation and conveyance equipment. • Requires new hydrocyclones for Actiflo® units to separate PAC from microsand. • Additional THM treatment at the CNL Reservoir (aeration) would be required in conjunction with PAC treatment at the WTP to reduce THM below MAC (100 µg/L). • High cost for prolonged operation (6 to 12 months/year). • Once no longer usable PAC media requires landfill disposal. 	<ul style="list-style-type: none"> • Capital Cost Estimate: <u>\$4M</u>, (see Appendix B for detailed breakdown) • O&M Cost Estimate: \$10K - \$118K (See Figure 4 below for 1 month, 3 months, 6 months, 12 months of PAC usage) • CNL Reservoir Aeration Upgrades Capital Cost Estimate: <u>\$3M</u>
Chloramination	<ul style="list-style-type: none"> • Low THM formation potential with chloramine residual. • Chloramine residual is more stable and long lasting than free chlorine. • Dosage can be increased or decreased with flow. • Lower estimated capital and operating costs than PAC + CNL Reservoir Aeration Upgrades. 	<ul style="list-style-type: none"> • Potential for lead solubility in the distribution system if lead pipes are present. However, Town and CNL have indicated that their distribution systems do not contain lead pipes. Increased sampling for lead solubility may be required following commissioning of chloramination. • Elevated bromide levels in raw water can accelerate chloramine residual decay in the distribution system. Bromide is present in the Deep River WTP raw water based on the presence of Bromodichloromethane and Bromoform in the treated water, although it is likely that bromide concentrations in the raw water are not sufficient to measurably decay chloramine residual. Ongoing raw water testing for bromide is recommended to inform the chloramine residual dose at the WTP and boosting requirements for the distribution system (as required). • N-Nitrosodimethylamine (NDMA) (Ontario DWQS = 9 ng/L) has been shown to form with chloramination. Prior to switching to chloramination, lab scale or pilot scale studies are recommended to confirm the production of NDMA and alternative DBPs. • Nitrification can occur in distribution system if chloramine residual is insufficient, chlorine to ammonia ratio is reduced, or distribution detention times are excessive. Distribution system monitoring and periodic flushing of areas of low flow or dead-ends are recommended to maintain chloramine residual and mitigate nitrification. • Requires careful commissioning strategy to switch from chlorination to chloramination. 	<ul style="list-style-type: none"> • Capital Cost Estimate: <u>\$1M</u>, (see Appendix C for detailed breakdown) • O&M Cost Estimate: \$13K (See Figure 4 below)

Figure 4 presents the estimated operation and maintenance costs (O&M) for PAC, if used for 1, 3, 6, or 12 months, compared to chloramination, which involves dosing chlorine and ammonium sulfate continuously for secondary disinfection. As shown, the feasibility of implementing PAC at the Deep River WTP decreases as length of annual operation increases, whereas chloramination has a more predictable annual O&M cost. Furthermore, these O&M costs do not include the required operation of the CNL reservoir aeration if PAC were to be implemented at the WTP.

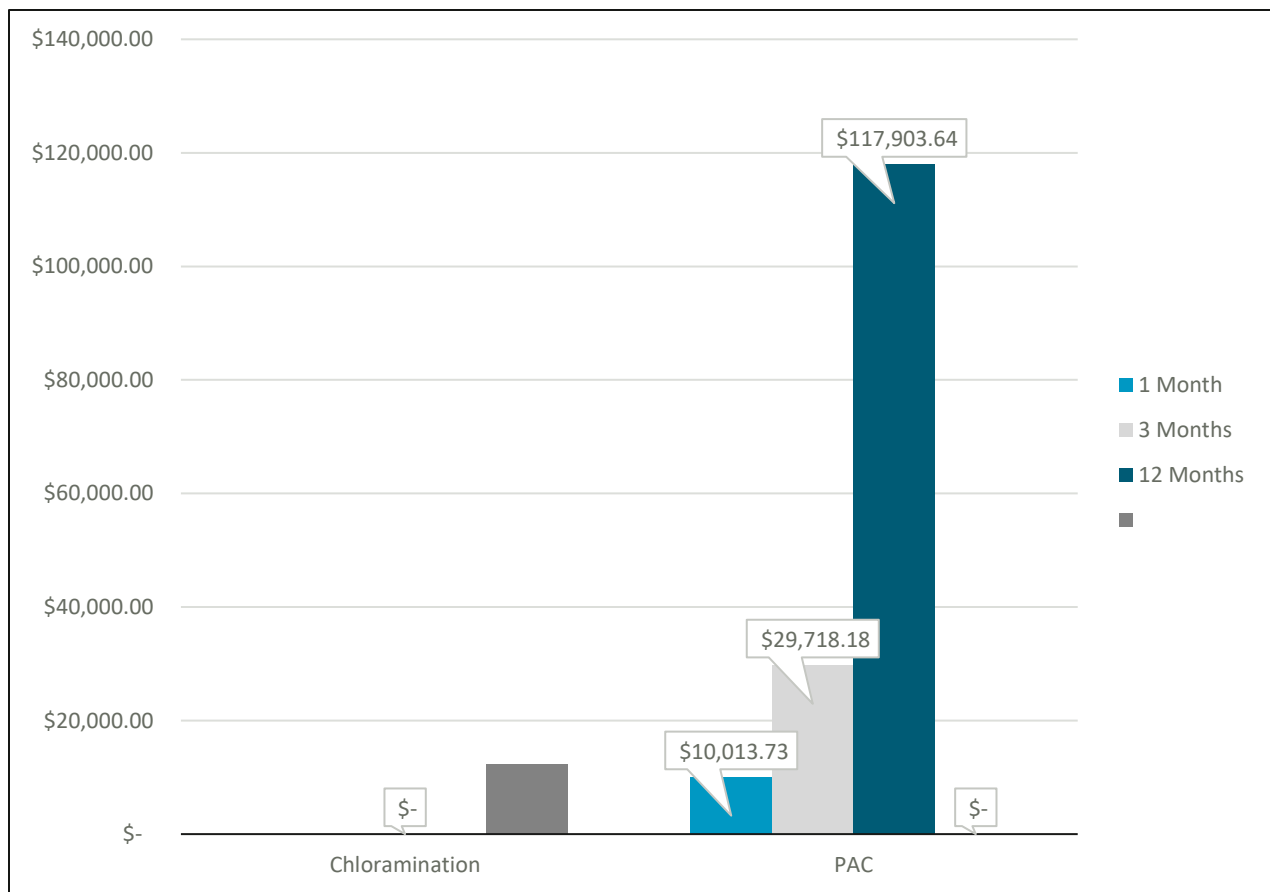


Figure 4: PAC vs. Chloramination O&M Cost Comparison

3.3 Preferred THM Reduction Alternative

The preferred THM reduction alternative for the Deep River WTP is to implement a new chloramination system by dosing ammonium sulfate after chlorine to provide a chloramine residual for secondary disinfection. The challenges and risk mitigation approach is identified in Table 4.

Table 4: Chloramination Implementation Risk Mitigation

Risk	Action	Comment
Lead pipe compatibility with Chloramination	Eliminate	<ul style="list-style-type: none"> Deep River: Confirmed no lead pipes in the system CNL: Confirmed no lead pipes in the system
THM Formation	Mitigate	<ul style="list-style-type: none"> GAC media will reduce pre-cursors Chlorine is used as primary disinfection which will generate a base level of THMs. Chloramination cuts the further production.
DBP (NDMA) Formation	Mitigate	<ul style="list-style-type: none"> Raw water quality was reviewed and a review of existing facilities with chloramination along the Ottawa River. Ongoing testing of raw water quality and NDMA formation potential recommended.
Compatibility with existing users	Mitigate	<ul style="list-style-type: none"> Communication plan will be developed to advise residents and commercial users of the change.
Change requiring new operations strategy	Mitigate	<ul style="list-style-type: none"> Increase operator familiarity with chloramination and gain buy-in during detailed design stage. Ammonium sulphate and chlorine dosage calculation tool to be developed and shared with operators.

Figure 5 illustrates the proposed dosing location for the new ammonium sulfate line in the existing treated water pipe gallery. A spare injection tap is shown on the WTP as-built drawings that may offer a suitable dosing location for ammonium sulfate.

Due to space constraints within the existing WTP building, construction of a separate storage building for ammonium sulfate totes and pumping equipment will be required.

The preferred location for the new building and the new ammonium sulfate line are shown in Figure 6 and Figure 7.

Key considerations that will be addressed in future design and construction phases of the upgrades include:

- Confirm the feasibility of the ammonium sulfate dosing location shown in Figure 5 and the total chlorine sampling location for the treated water,
- Provide access for delivery of ammonium sulfate,
- Design a separate, well-ventilated building for the ammonium sulfate storage and dosing system to meet health and safety standards, and
- Design of a detailed commissioning and implementation plan for switching the distribution system from chlorination (free chlorine) to chloramination (total chlorine). This plan will involve careful planning and coordination with operations and residents to flush chloraminated water quickly throughout the distribution. The flushing is predicted to take approximately two (2) days, during which residences will have access to water. It is recommended that the water tower and CNL reservoir are drained prior to chloramination implementation, then filled with chloraminated water once the distribution system has been converted to chloramine residual.

In addition to proposed long-term chloramination upgrades, the following plant processes should be considered in the upcoming major capital project:

- Implementation of an Actiflo® coagulant to optimize TOC/DOC removal through the Actiflo® units,
- Automation of polymer makeup system to ensure the Actiflo® system is operating efficiently to remove TOC/DOC,
- Replacement of the assets within the Actiflo® units that are approaching the end of their useful life, including the lamella plates,
- Replacement of the Actiflo® control system, which OCWA has noted is unable to be reprogrammed, and
- Replacement or repair of WTP stainless steel piping that is showing signs of corrosion.

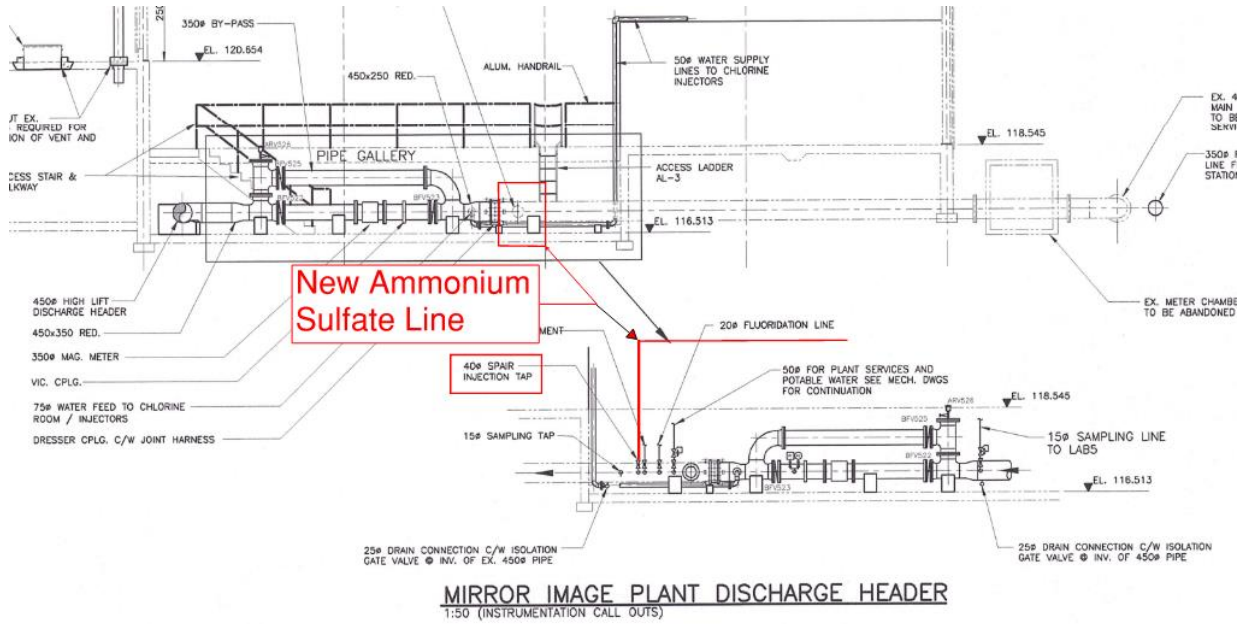


Figure 5: Proposed Ammonium Sulfate Dosing Location

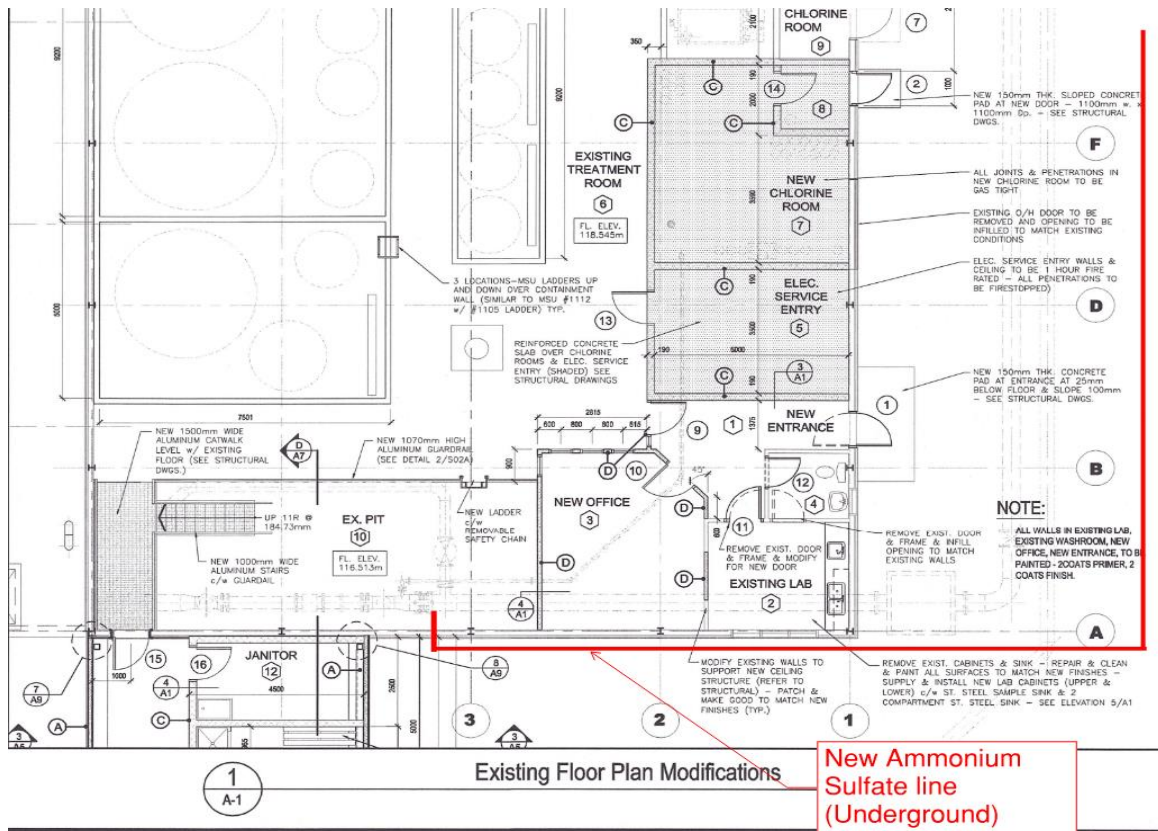


Figure 6: Proposed Ammonium Sulfate Piping Route

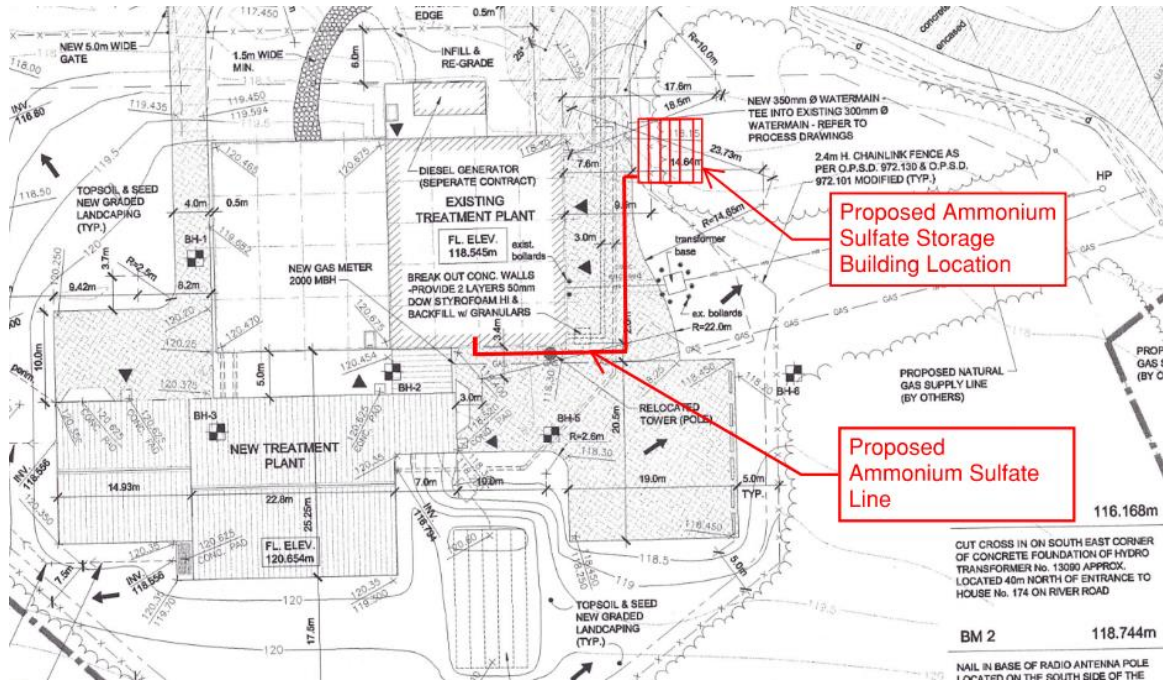
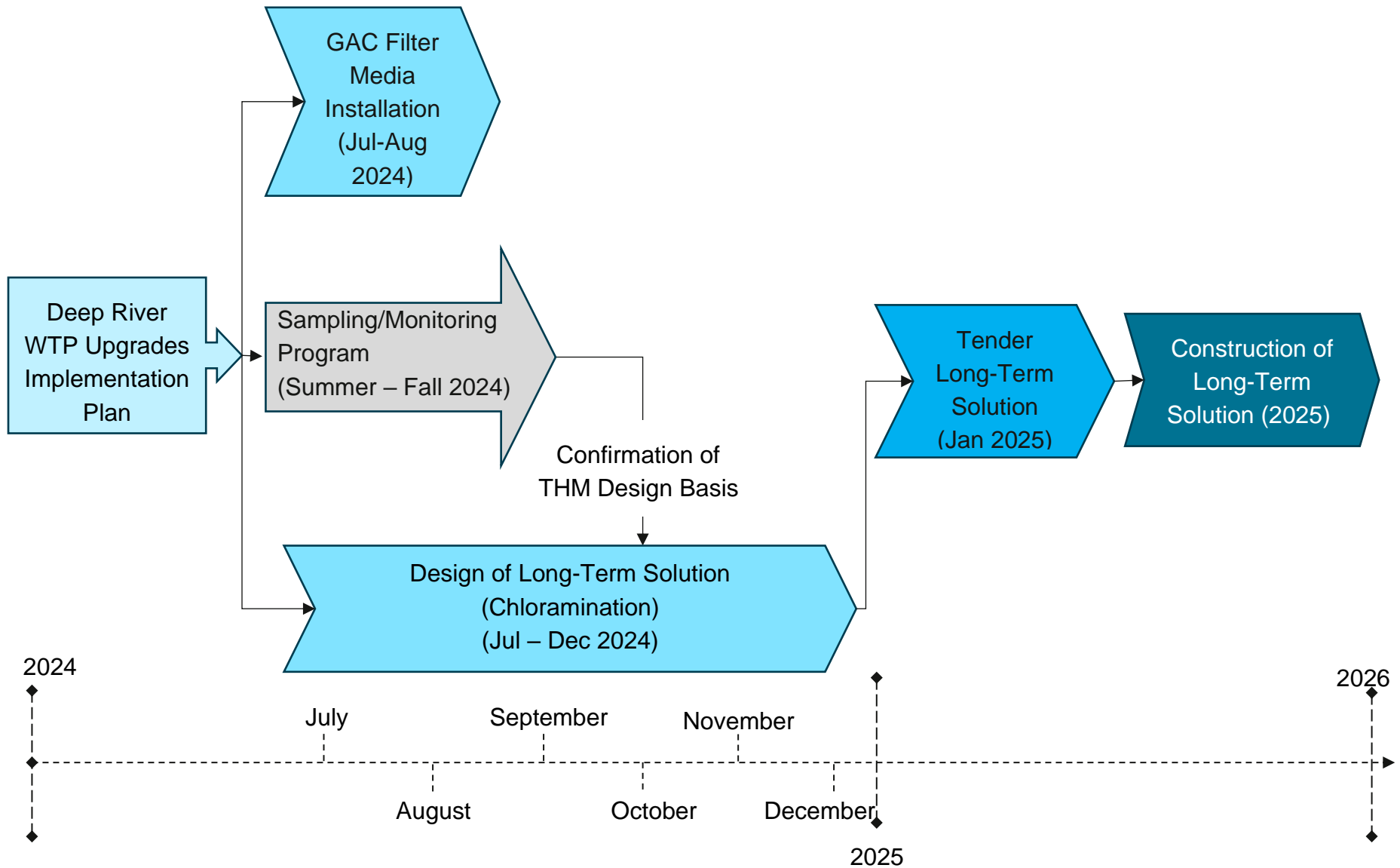


Figure 7: Proposed Ammonium Sulfate Storage Building Site Layout

4 Implementation Plan

The following timeline presents the proposed implementation plan for the Deep River WTP THM reduction short- and long-term upgrades.



5 Summary and Recommendations

The following summarizes the findings and recommendations from TM2:

- Sustained elevated concentrations of THMs in the CNL reservoir in 2023 are causing concern. High TOC/DOC concentrations in the raw water and increased residence times in the water tower may have contributed to elevated THMs.
- A short-term solution of installing GAC in the existing gravity filters is proposed to be implemented in Summer 2024.
- Implement a sampling/monitoring program for key raw water (TOC/DOC, bromine, etc.) and treated water (THMs, chlorine residual, etc.) parameters as well as formation potential for NDMA and nitrification in the distribution system to inform the long-term upgrades design basis.
- PAC and chloramination were considered for long-term options for THM reduction for the Deep River WTP. Ultimately, chloramination was determined to be the preferred option given the newly obtained water quality data and estimated PAC O&M costs.
- Key considerations that will be addressed in future design and construction phases of the chloramination upgrades include:
 - Confirm the feasibility of the ammonium sulfate dosing location and the total chlorine sampling location for the treated water,
 - Provide access for delivery of ammonium sulfate,
 - Design a separate, well-ventilated building for the ammonium sulfate storage and dosing system to meet health and safety standards, and
 - Design of a detailed commissioning and implementation plan for switching the distribution system from chlorination (free chlorine) to chloramination (total chlorine).
- Additional plant processes should be considered for the upcoming upgrades:
 - Implementation of an Actiflo® coagulant to optimize TOC/DOC removal through the Actiflo® units,
 - Automation of polymer makeup system to ensure the Actiflo® system is operating efficiently to remove TOC/DOC,
 - Replacement of the assets within the Actiflo® units that are approaching the end of their useful life,
 - Replacement of the Actiflo® control system, and
 - Replacement or repair of WTP stainless steel piping.

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A

Appendix A: GAC Budgetary Proposal

Continental Carbon Group

To: Amy Langford/CIMA
Re: Filter Media Replacement
At: Deep River Water Treatment Plant

SCOPE OF WORK:

- CCG will remove and dispose of all existing filter media in all (3) filters. All filter media will be removed via industrial vacuum and disposed offsite.
- CCG will perform an inspection on existing underdrains. Any findings will be reported to Owner. CCG can make any necessary repairs to underdrain on a time and material basis.
- CCG will then install 150mm of 0.45-0.55 UC 1.40 Sand in each of the (3) filters. Installation of sand will adhere to AWWA B100-16. CCG will slurry educt all sand media.
- As per AWWA B100-16, CCG will skim and remove all fines after initial backwash. CCG may need to repeat this backwash/skim procedure as many times necessary to ensure all fines are removed from the sand layer.
- Upon completion of sand media installation, CCG will disinfect each of the (3) filters as per AWWA C653-13. Owner is responsible for dichlorination of water used for disinfection along with BAC-Ts.
- CCG will then install 800mm of FILTRASORB 12X40 Granular Activated Carbon as manufactured by Calgon Carbon in each of the (3) filters.
- All installation will adhere to AWWA B604-18. Similar to sand installation, CCG will slurry educt all GAC.
- CCG will allow newly installed GAC to soak overnight. CCG will work with the Owner to backwash and commission each of the (3) filters.

COST PER FILTER FOR THE ABOVE SCOPE

\$228,420.00

CLARIFICATIONS:

- HST is extra. All amounts are in Canadian dollars.
- Water for installation of filter media supplied by Owner at no cost to Continental.
- Quotation above assumes that Owner will take BAC-T after GAC installation.
- Quotation is valid for 60 days.

CONTINENTAL CARBON GROUP INC



Michael Massis

Date: April 24, 2024

Vice President Marketing and Sales

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B

Appendix B: Opinion of Probable Cost for PAC THM Reduction Alternative

Deep River WTP Upgrade - THM - PAC
Conceptual Design Class D Cost Estimate (-40% to +50%)
A001332

Drafted by AL
Reviewed by BY & IP

Component Description	Quantity	Unit	Unit Cost	Material Cost	Installation		Total Cost
					% of Matl	Cost	
Site Works (Division 2)							\$ 155,000
Excavation/Backfill/Disposal	800	m ³	\$ 75	\$ 60,000	incl.	\$ -	\$ 60,000
New Fencing and Gate Relocation	50	m	\$ 500	\$ 25,000	incl.	\$ -	\$ 25,000
Landscaping (tree planting)	1	L.S.	\$ 30,000	\$ 30,000	incl.	\$ -	\$ 30,000
Removal & Miscellaneous	1	L.S.	\$ 40,000	\$ 40,000	incl.	\$ -	\$ 40,000
Structural and Architectural (Division 3 - 10)							\$ 409,000
New PAC Equipment and Electrical Building	42	m ²	\$ 3,000	\$ 126,000	50%	\$ 63,000	\$ 189,000
New Concrete PAC Tank and Intermediate Pump Station	60	m ³	\$ 2,000	\$ 120,000	incl.	\$ -	\$ 120,000
Miscellaneous (doors, hatches, etc)	1	L.S.	\$ 100,000	\$ 100,000	incl.	\$ -	\$ 100,000
Process Equipment (Division 11)							\$ 1,423,500
PAC preparation and dosing equipment	1	L.S.	\$ 527,000	\$ 527,000	50%	\$ 263,500	\$ 790,500
Intermediate pumping low lift pumps	2	ea	\$ 60,000	\$ 120,000	50%	\$ 60,000	\$ 180,000
Isolation valves - motorized (350mm)	3	ea	\$ 15,000	\$ 45,000	50%	\$ 23,000	\$ 68,000
Check valves (350mm)	3	ea	\$ 10,000	\$ 30,000	50%	\$ 15,000	\$ 45,000
Automated Polymer Preparation System	1	L.S.	\$ 180,000	\$ 180,000	50%	\$ 90,000	\$ 270,000
Miscellaneous	1	L.S.	\$ 70,000	\$ 70,000	incl.	\$ -	\$ 70,000
Instrumentation and Controls (Division 13)		L.S.	10%	\$ 1,423,500	incl.	\$ -	\$ 150,000
HVAC & Plumbing (Division 15)		L.S.	30%	\$ 409,000	incl.	\$ -	\$ 130,000
Electrical (Division 16)		L.S.	20%	\$ 1,423,500	incl.	\$ -	\$ 290,000
Sub-Total							\$ 2,557,500
Sub-Total Costs (A)							\$ 2,557,500
Division 1 - General Contractor's Overhead & Profit, Mob., bond		% of A	10.0%				\$ 260,000
Sub-Total Costs (B)							\$ 2,817,500
Contingency		% of B	20.0%				\$ 570,000
Estimating Allowance		% of B	10.0%				\$ 290,000
Detailed Design Engineering and Contract Administration		% of B	10.0%				\$ 290,000
Total Estimated Construction Costs (C) - Excluding Escalation & HST							\$ 3,967,500
Provisional Items							
Component Description	Quantity	Unit	Unit Cost	Material Cost	Installation		Total Cost
					% of Matl	Cost	
THM analyser	2	ea	\$ 75,000.00	\$ 150,000.00	incl.	\$ -	\$ 150,000.00
Actiflo® lamella plate replacement (Provisional)	3	ea	\$ 20,000	\$ 60,000	50%	\$ 30,000	\$ 90,000
Actiflo® air scouring installation (Provisional)	3	ea	\$ 106,000	\$ 318,000	50%	\$ 159,000	\$ 477,000
Actiflo® microsand dosing (Provisional)	1	L.S.	\$ 166,000	\$ 166,000	50%	\$ 83,000	\$ 249,000
Actiflo® control panel replacement (Provisional)	1	L.S.	\$ 50,000	\$ 50,000	50%	\$ 25,000	\$ 75,000
Replacement of SS piping (Provisional)	1	L.S.	\$ 75,000	\$ 75,000	50%	\$ 37,500	\$ 112,500
							\$ 1,150,000
Total Estimated Construction Costs (C) with Provisional Items - Excluding Escalation & HST							\$ 5,117,500

C

Appendix C: Opinion of Probable Cost for Chloramination THM Reduction Alternative

Deep River WTP Upgrade - THM - Chloramination
Conceptual Design Class D Cost Estimate (-40% to +50%)
A001332

Drafted by AM
Reviewed by AS & BY

Component Description	Quantity	Unit	Unit Cost	Material Cost	Installation		Total Cost
					% of Matl	Cost	
Site Works (Division 2)							
Excavation/Backfill/Disposal	250	m ³	\$ 75	\$ 18,750	incl.	\$ -	\$ 18,750
New Fencing and Gate Relocation	50	m	\$ 500	\$ 25,000	incl.	\$ -	\$ 25,000
Landscaping (tree planting/site restoration)	1	L.S.	\$ 30,000	\$ 30,000	incl.	\$ -	\$ 30,000
Removal & Miscellaneous	1	L.S.	\$ 30,000	\$ 30,000	incl.	\$ -	\$ 30,000
Structural and Architectural (Division 3 - 10)							
New Ammonium Sulfate Equipment and Electrical Building	25	m ²	\$ 3,500	\$ 87,500	50%	\$ 43,750	\$ 131,250
Miscellaneous (doors, hatches, etc)	1	L.S.	\$ 10,000	\$ 10,000	incl.	\$ -	\$ 10,000
Process Equipment (Division 11)							
Liquid Chemical feed systems for Sodium Hypo pump skid with Auto switchover control panel	1	L.S.	\$ 31,000	\$ 31,000	50%	\$ 15,500	\$ 46,500
Diaphragm Dosing Pumps	2	incl.	\$ -	\$ -	incl.	\$ -	\$ -
Pre-piped and pre-wired system mounted on a corrosion resistance wall mounted skid	1	incl.	\$ -	\$ -	incl.	\$ -	\$ -
Lot true-union ball valves		incl.	\$ -	\$ -	incl.	\$ -	\$ -
PVC Piping		incl.	\$ -	\$ -	incl.	\$ -	\$ -
Local control panel for Auto switch over option.	1	incl.	\$ -	\$ -	incl.	\$ -	\$ -
Piping and connection	50	l.m	\$ 1,000	\$ 50,000	incl.	\$ -	\$ 50,000
Miscellaneous	1	L.S.	\$ 10,000	\$ 10,000	incl.	\$ -	\$ 10,000
Instrumentation and Controls (Division 13)		L.S.	10%	\$ 106,500	incl.	\$ -	\$ 20,000
HVAC & Plumbing (Division 15)		L.S.	30%	\$ 141,250	incl.	\$ -	\$ 50,000
Electrical (Division 16)		L.S.	20%	\$ 106,500	incl.	\$ -	\$ 30,000
Sub-Total							\$ 451,500
Sub-Total Costs (A)							
\$ 451,500							
Division 1 - General Contractor's Overhead & Profit, Mob., bond		% of A	10.0%				\$ 50,000
Sub-Total Costs (B)							
\$ 501,500							
Contingency		% of B	20.0%				\$ 110,000
Estimating Allowance		% of B	10.0%				\$ 60,000
Detailed Design Engineering and Contract Administration		% of B	10.0%				\$ 60,000
Total Estimated Construction Costs (C) - Excluding Escalation & HST							
\$ 731,500							
Provisional Items							
Component Description	Quantity	Unit	Unit Cost	Material Cost	Installation		Total Cost
					% of Matl	Cost	
THM analyser (Provisional)	1	ea	\$ 75,000	\$ 75,000	incl.	\$ -	\$ 75,000
Actiflo® lamella plate replacement (Provisional)	3	ea	\$ 20,000	\$ 60,000	50%	\$ 30,000	\$ 90,000
Actiflo® air scouring installation (Provisional)	3	ea	\$ 106,000	\$ 318,000	50%	\$ 159,000	\$ 477,000
Actiflo® microsand dosing (Provisional)	1	L.S.	\$ 166,000	\$ 166,000	50%	\$ 83,000	\$ 249,000
Actiflo® control panel replacement (Provisional)	1	L.S.	\$ 50,000	\$ 50,000	50%	\$ 25,000	\$ 75,000
Replacement of SS piping (Provisional)	1	L.S.	\$ 75,000	\$ 75,000	50%	\$ 37,500	\$ 112,500
\$ 1,080,000							
Total Estimated Construction Costs (C) with Provisional Items - Excluding Escalation & HST							
\$ 1,811,500							



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