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Wastewater Treatment Plant Upgrades Rankin Inlet: Final Report

Process Selection and Design Concept

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Attention: Sarah Collins
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Rankin Inlet Wastewater Treatment Plant Process Selection and Design Concept

This Process Selection and Design Concept report outlines potential secondary treatment alternatives for enhanced treatment at the existing wastewater treatment plant in the community of Rankin Inlet. The purpose of this report is to identify treatment alternatives and provide a high-level technical, performance and cost-based analysis of the main components that correspond to these options. The report has been written with reference to the Wastewater Effluent Characteristic study performed in 2019.

Based on the outcome of our options analysis a moving bed biofilm reactor was identified as the preferred technology for upgrades to the existing wastewater treatment plant.

Should you have any questions of clarifications, please contact the undersigned.

Sincerely,

DILLON CONSULTING LIMITED

A. Williams

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Project Manager

Enclosure
AW:rrk

Our file: 20-2223

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Executive Summary

The Department of Community and Government Services, Nunavut (CGS) has requested that Dillon Consulting (Dillon) analyze treatment alternatives for the upgrade of sanitary treatment at the Rankin Inlet wastewater treatment plant (Rankin WWTP).

From the period of 2017-2019, Dillon completed the “Rankin Inlet Effluent Study”. This study analyzed contaminants of concern in current wastewater effluent that present a potential risk of effluent toxicity and/or noncompliance with applicable regulatory limits. As an outcome of this study, it was recommended that organic content (resulting in dissolved oxygen depletion) and total suspended solids (TSS) be treated through a secondary-level treatment processes. In addition, the Environment and Climate Change Canada (ECCC) has stated that oil and grease removal needs to be addressed in the treatment process.

The 2019 “Rankin Effluent Study” identified that heavy metals such as copper and zinc, as well as phenols, measured high concentrations that could have the potential to contribute to effluent toxicity. ECCC has confirmed that effluent concentrations of the metals and phenols do not warrant treatment, and the metals treatment should be identified as an optional tertiary treatment process.

Dillon has analyzed process alternatives to meet treatment objectives and has presented them in this report. Following a long-list screening exercise, three core biological treatment process alternatives were selected for detailed review. It was determined that the Moving Bed Biofilm Reactor (MBBR) was the most feasible option for secondary treatment. A separate metals precipitation system, common to all considered alternatives was also presented as an optional tertiary treatment method. A sludge management system has been proposed to dewater residuals for disposal at the local landfill. For each of the considered alternatives, preliminary concept-level process schematics and equipment building layouts have been prepared.

1.0 Introduction

Dillon Consulting Limited (Dillon) has been retained by the Department of Community and Government Services, Nunavut (CGS) to review technology alternatives related to the upgrade of wastewater treatment at the Rankin Inlet wastewater treatment plant (Rankin WWTP).

In 2019, Dillon completed the "Rankin Inlet Effluent Study". The focus of this study was to analyze contaminants of concern that present a potential risk of effluent toxicity and/or noncompliance with applicable regulatory limits. From the results of the study, CGS stated organic loading (dissolved oxygen depletion) and Total Suspended Solids (TSS) must be treated through a secondary-level treatment processes. In addition to this, copper, zinc, and phenols were identified to have the potential to contribute to effluent toxicity. Environment Canada and Climate Change has stated that these concentrations do not warrant treatment. Metals precipitation is presented as an optional tertiary treatment process for CGS. In addition to this, the ECCC has stated that oil and grease removal needs to be addressed in the treatment process. Dillon has analyzed three treatment alternative options to manage these parameters and has presented them in this report.

Dillon's approach to evaluating potential secondary treatment alternatives involves: 1) assessing the existing facility and conducting a process review, 2) developing a design basis for the secondary treatment process, and 3) performing a treatment alternatives assessment.

This report has been prepared based upon the present understanding of effluent quality and treatment needs. Recommended technology-based effluent limitations based on research completed by CGS and Dalhousie University between 2010 and 2016 will be used as effluent guidelines.

1.1 General

The Rankin WWTP is located within the community of Rankin Inlet, Nunavut on the northwest coast of the Hudson Bay. Currently the community of Rankin Inlet has a population of approximately 3,046 people.

The water and wastewater infrastructure in Rankin Inlet is operated by CGS. The existing wastewater collection system includes two gravity catchments that feed two lift stations; the Nuvuk Lift Station and Johnson Cove Lift Station. These two lift stations have the capability to accept trucked sewage from nearby homes that are not connected to the collection system; however, only the Johnson Cove is currently used for receiving trucks. Wastewater is pumped from these lift stations to the Rankin WWTP. Both lift stations have the option to bypass the WWTP and discharge directly into the Prairie Bay (Hudson Bay, Artic Ocean).

During the winter months, bleeder water is used in the collection system to prevent freezing. This bleeder water is potable water and results in a dilution of the wastewater.

The current Rankin WWTP consists of the following components: a surge tank which diverts flows to one of two screening augers, an in-channel vertical grinder, overflow tank, and a discharge tank where three self-priming pumps are installed to allow discharge to occur during unusually high tide conditions. Solids collected from the screening systems are transported to the Rankin Inlet Landfill. Effluent is discharged through a diffuser into Prairie Bay via a buried and insulated High Density Polyethylene outfall pipe.

2.0 Background Information

2.1 Existing Documentation

2.1.1 Rankin Inlet Wastewater Effluent Study- 2017- 2019

In 2017, Dillon performed a wastewater effluent study by CGS. The study objectives were to:

- Conduct a municipal wastewater effluent characterization for the Rankin Inlet wastewater
- Assess the extent of the impact of the municipal wastewater effluent discharge on the marine environment in Rankin Inlet.

The wastewater characterization was conducted based on effluent water data collected monthly by CGS from 2017-2019, supplemented by two sets of manual 24 hours composite effluent samples collected by Dillon on October 16 and 17, 2018 and February 21, 2019. Dillon also collected samples for toxicity testing (rainbow trout LC50).

Wastewater characterization identified that Total Suspended Solid (TSS) and Biochemical Oxygen Demand (BOD) exceeded guideline limits under the Canada-wide Strategy for Management of Municipal Wastewater.

Based on the available effluent chemistry for toxicity testing, potential contaminants of concern were identified as: TSS, cBOD (in relation to dissolved oxygen), un-ionized ammonia, copper, zinc and potentially total phenols and total oil and grease (TOG). The ECCC has stated that effluent concentrations of metals and phenols do not warrant treatment. See **Appendix D** for confirmation.

2.2 Current Effluent Quality

Wastewater sampling is undertaken on a monthly basis by CGS using grab sample methodology. Samples are analyzed at ALS Environmental. A summary of the effluent data from 2017- 2019 is shown **Table 2-1**.

Table 2-1: Current Effluent Characteristics

Parameters	Unit	Min	Max	Average	90th Percentile
TSS	mg/L	36.5	765	144	380
BOD5	mg/L	16.7	1490	158	211
CBOD	mg/L	13.8	1460	149	182
Ammonia (as N)	mg/L	1.9	74	10.6	13.5
Nitrate (as N)	mg/L	<0.02	0.168	/	/
Nitrite (as N)	mg/L	<0.01	0.039	/	/
Total Organic Carbon	mg/L	13.4	1670	121	109
Phosphorus (P)	mg/L	0.482	11.1	2.50	3.78
Copper	ug/L	54.9	346	176	257
Iron	ug/L	126	6020	639	1130
Zinc	ug/L	27	446	107	166
Oil and Grease	mg/L	7.4	93.6	30	56

The effluent sampling results demonstrated a wide range of concentrations in TSS, BOD and COD. Design of a treatment process requires anticipating peak sustained concentrations, while avoiding over-designing the process for typical average loads. The 90th percentile of raw effluent concentrations is provided to illustrate a more realistic maximum condition which may be observed with some equalization and blending of raw wastewater.

2.3 Population Projections

The current population of Rankin Inlet is 3,036 people. From 1996 to 2011 the population of Rankin has changed as shown in **Table 2-2**.

Table 2-2: Change in Population, Rankin Inlet

Time Period	Change in Population
1996-2001	+ 5.6%
2001-2006	+ 8.5%
2006-2011	- 9%

Based on Dillon's 2019 study titled *Rankin Inlet Utilidor System Technical Review and Condition Assessment*, an annual growth rate of 2.08% has been identified by the Nunavut Bureau of Statistics. The projected 2040 population using this growth rate is 4,598 individuals.

2.4 Hydraulic Loading

The Municipal and Community Affairs (MACA) design guideline was used to estimate the per-capita wastewater generation for the future design population. This design guideline is appropriate for communities with population between 2,000 and 10,000 people as follows:

Design per capita residential water use (RWU) = 225 L/c.d
Total per capita community use = RWU x [-1.0 + (0.323 x ln(population))]

Using this guideline, the total per capita community use in 2040 is equal to 388 L/cap/day. The following table summarizes the design population and hydraulic loading.

Table 2-3: Hydraulic Loading Design Summary

Parameter	Value	Comment
Current Population:	3,046	Stats Canada
Design Population (2040):	4,598	2.08% annual growth
Estimated Wastewater Generation (2040):	388 L/cap/day	MACA estimation method
Warm Season Daily Average Flow (2040):	1,783 m^3/day	Estimated for Warm Season
Cold Season Measured Wastewater Generation	1,825 m^3/day (599 l/cap/d)	Measured Feb. 20, 2019
	1,625 m^3/day (533 l/cap/d)	Measured Oct. 18, 2018
Harmon Factor (2040 population):	3.3	Harmon equation
Peak Instantaneous Flow (2040):	5,884 m^3/day	Using Harmon equation

Supplementary bleeder water is used throughout the system to prevent freezing in the winter months. Additionally, auger water is added as part of the WWTP operations. Bleeder and auger water are sourced from a potable water source expected to meet drinking water quality. This supplementary potable water may represent 15-40% of the wastewater flow. Bleeder water represents an increase to the hydraulic capacity required for system components, but is not expected to influence the overall mass loading to the system.

A daily average flow of 1,783 m^3/day has been estimated for the wastewater generation in the warm seasons for 2040. This estimation excludes bleeder water. Cold season daily flow average flows have been measured to be 1,625 m^3/day and 1,825 m^3/day when Dillon performed site visits in 2019. We have based peak hydraulic capacity for the system on the instantaneous Harmon peak as this is a conservative value well above the typical average flow. Representing the instantaneous peak flow as the peak day flow provides capacity to accommodate ongoing bleeder water addition.

2.5 Influent Quality

In rural communities, the mass of waste BOD and TSS is estimated to be 75 g/cap/day and 90 g/cap/day, respectively. Rankin Inlet currently has a population of 3,046. Based on the population projection, in 2040 the population of Rankin Inlet will be 4,598. The design loading parameters, using the daily average flow, are summarized in **Table 2-4**.

Table 2-4: Influent Quality Summary

Parameter	Value : (Population 4,598, ADF: 1,783 m^3/day)		Comment
	Mass Loading	Concentration	
BOD Loading Rate:	345 kg/day	193 mg/L	75 g/cap/d estimate
TSS Loading Rate:	414 kg/day	232 mg/L	90g/cap/d estimate
Wastewater Temperature	<4 ^oC		Less than 4^oC should be anticipated in the winter months. Actual value is unknown

2.6 Effluent Criteria

The effluent design criteria used for the wastewater treatment design is presented in the **Table 2-5**. Technology-based effluent limits based on research completed by CGS and Dalhousie University between 2010 and 2016 have been used to establish.

Table 2-5: Effluent Criteria

Parameter	Effluent Design Criteria	Regulation
CBOD	25 mg/L	CGS research
TSS	25 mg/L	CGS research
Un-ionized Ammonia	1.25 mg/L	CGS research
Acute Lethality	Non-toxic effluent	WSER reference guideline*
Total residual chlorine	0.02 mg/L	WSER reference guideline*

* Guideline provided for reference only. WSER standards are not applicable to projects since the Rankin Inlet has deep water discharge, disinfection is not anticipated to be required and has not been considered at this time. The treatment of heavy metals including zinc and copper will be included in the design parameters. Nutrient limits (ammonia and phosphorous) are not included; however, it is assumed that the wastewater treatment options are all capable of providing some degree of nitrification to reduce the impact of ammonia on whole effluent toxicity effects.

3.0 Existing Facility

3.1 Collection System Infrastructure

Two 200 mm HDPE pipelines insulated with 50 mm of polyurethane bring sewage from the two lift stations. Grinder pumps in the lift stations are used to reduce the size of solids in the wastewater. The Johnson Cove force main has the ability to bypass the WWTP and enter the outfall. The Nuvuk force main also has a bypass mechanism that connects to the outfall. The Johnson's Cove lift station handles 60% of the sewage flow from the community, the Nuvuk Lift station Handles 40%.

Inlet pumping stations have not been specifically assessed as part of this report. A cost allowance has been carried for each considered alternative for the potential installation of new pumps at each station to provide additional throughput capacity and lift to integrate with an upgraded downstream treatment system.

3.2 Treatment Plant

Incoming flow is collected in a surge tank where a control valve modulates the flow to the rest of the system. Raw sewage is screened by one of two rotary drum screens. Solids are removed and deposited into a trailer and taken to the local landfill. The remaining effluent moves to an overflow tank prior to discharge into the Prairie Bay. Outfall pumps are used to overcome the tidal forces.

3.3 Building

The treatment building is slab on grade construction and insulated to protect from permafrost. The building has its own generator for emergency power. Two boilers with a day tank and fuel storage tank are used are used to heat the plant.

4.0 New Sewage Treatment Process

Dillon has reviewed the current WWTP site and has evaluated upgrades pertaining to liquid storage, headworks, secondary treatment, and sludge management. Our evaluation of secondary treatment technologies has considered a long list of alternatives and provides a more detailed review of three short-listed processes that could be used to achieve the effluent objectives. Dillon has analyzed each alternative and has presented a recommended process.

4.1 Influent Equalization and Preliminary Treatment

Influent equalization and preliminary treatment is recommended as part of the WWTP upgrade. Based on preliminary data available, it is understood that there may be substantial variation in inlet flow rate and organic strength of incoming wastewater. An equalization tank, capable of buffering these flow variations, and serving as a blending volume for high-strength hauled waste upstream of treatment has been assumed. Volume requirements for this equalization exceed the capacity of the existing surge tank located in the treatment building. Preliminary treatment upgrades may also include a new screening system for enhanced solids removal, particularly if a biological treatment process requiring fine-pore screening is selected. An integrated septage receiving system has been included. This septage receiving system will received hauled waste and provide dedicated screening prior to pumping directly to the Equalization Tank.

4.1.1 Influent Equalization Tank

From the lift stations, wastewater will be pumped into an Equalization Tank. The Equalization Tank is sized based on a measured diurnal flow pattern plus a factor of safety to accommodate peak flow periods. The size of the Equalization Tank has been calculated to be 350 m^3. The purpose of an Equalization Tank is to balance the amount of wastewater entering the facility to reduce the peak hydraulic capacity required, and provide a blending tank upstream of the treatment system to reduce the effect of shock loading by hauled waste delivery. Due to the limited availability of influent flow data, it is recommended to include an Equalization Tank as part of the preliminary design concept at this stage. Equalization sizing should be confirmed as part of the detailed design process.

Two options have been proposed for the Equalization Tank, both using flat bottom tanks. The first option consists of using multiple smaller tanks with a combined storage volume that meets the total equalization volume requirement. This configuration allows for easy transportation and construction as the smaller, pre-built tanks are easily shipped by sea lift. The second option uses one large tank equal to the required equalization volume. These tanks would be shipped in pieces and assembled on site. The tank would be piped such that one can go offline if required (ex. maintenance activities). This configuration allows redundancy, requires a smaller footprint, and reduces the operational complexity.

A feasibility and cost analysis of both options was conducted. Capital Costs of the tank options are summarized in **Table 4-1**.

Table 4-1: Cost Analysis of the Equalization Tanks

Cost	Pre-Built Small Tanks	One Large Tank
Capital Cost Equipment	$640,000	$425,000
Installation	$480,000	$320,000
Process Piping	$150,000	$80,000
Shipping	TBD	TBD
Total	**$1,270,000**	**$825,000**

The advantages and disadvantages of each option were considered. These have been summarized in the **Table 4-2**.

Table 4-2: Advantages and Disadvantages of Tank Options

	Pre-Built Small Tanks	One Large Tank
Advantages	• Designed to fit inside shipping container • Pre-assembled • Does not require specialized team for installation • Simpler foundation design possible	• Simple operation • Installation of one tank only • Less complex system • Smaller footprint
Disadvantages	• Added operational complexity in cleaning and maintaining multiple tanks and interconnecting piping • Large number of tanks (16 total) required to create required volume • More process piping required to connect tanks • Larger footprint and structural foundation • Higher odour risk	• Requires specialized Vendor assembly team • Requires more complex foundation design

Dillon recommends that the one large tank option is the most feasible option for the influent equalization tank. This option is the most cost effective, and does not create operational complexity. The Equalization Tank will be shipped in pieces inside shipping containers and assembled on site by the manufacturer.

4.1.2 Primary Treatment

Wastewater will enter the existing headworks building for screening, then enter the Equalization Tank. After screening, the wastewater will enter the secondary treatment stage.

A rotatory drum screen with 2 mm screen perforations has been included in the cost analysis for the Membrane Bioreactor option. Solids greater than 2mm will be separated from the wastewater and disposed of in the landfill. A new screening system at the same location as the existing screen has been assumed. The new rotary drum screen system would include a dewatering screw press to handle collected material. A screenings bagger has been assumed for ease of screenings disposal and to reduce odour impacts in the screen room.

A dedicated grit removal process has not been included in the preliminary concept. The potential requirement for grit removal should be examined at the detailed design stage.

4.2 Secondary Treatment Process Options

Biological treatment is the secondary treatment process providing organics removal to meet the effluent quality guidelines. Aerobic treatment is the most common and applicable method for the Rankin Inlet application.

The possibility of using physical and chemical treatment, as an alternative to biological treatment was also considered. Chemical treatment systems remove soluble metals (aluminum, copper, zinc, lead, etc.) through chemical reactions. This process precipitates dissolved metals, and coagulates and flocculates suspended solids, such that they settle and can be separated from the wastewater. Chemical treatment has multiple disadvantages including:

- Large operating cost as chemicals will continually need to be replenished and shipped to site
- Increased sludge production relative to biological treatment
- Continuous physiochemical monitoring of effluent is required (pH)
- Additional health and safety concerns with chemical handling.

Physical treatment methods also have high energy costs, maintenance and operation costs, and cannot guarantee BOD removal. For the above reasons, only aerobic biological treatment was considered for further evaluation.

A number of biological treatment technologies are available that are capable of providing the necessary performance to meet the community's treatment objectives. These include:

- Conventional Activated Sludge (CAS)
- Sequencing Batch Reactors (SBR)
- Biological Aerated Filters (BAF)
- Membrane Bioreactors (MBR)
- Rotating Biological Contactors (RBC)
- Moving Bed Biofilm Reactors (MBBR).

4.2.1 Screening of Treatment Alternatives

Screening criteria were developed to identify and eliminate treatment alternatives and process options that would not be applicable, feasible or practical for the Rankin Inlet location. To be considered feasible or practical, alternatives must meet all screening criteria.

The following screening criteria were used to identify the short list of alternative design concepts:

- Operational and Performance Objectives – Can the treatment process reliably perform in a northern environment, considering challenges presented by low ambient and influent wastewater temperature and variable loading?
- Experience and Implementation: Is the process well-established as an accepted treatment alternative for similar locations?
- Constructability: Is the process compact and suitable to a location where all process units must be housed indoors? Is steel tank construction practical for all major process units to minimize concrete requirements?

In **Table 4-3**, 'fail' indicates that the alternative does not meet the criteria and is screened from further consideration.

Table 4-3: Screening of Alternative Treatment Technologies

Alternative	Operational and Performance Objectives	Experience and Implementation	Constructability	Overall
CAS	Pass	Pass	Fail	N
SBR	Pass	Pass	Fail[1]	N
MBR	Pass	Pass	Pass	Y
RBC	Pass	Pass	Pass	Y
BAF	Pass	Fail	Fail	N
MBBR	Pass	Pass	Pass	Y

1 The SBR system has a significantly larger overall footprint and tank volume compared to MBR, RBC, and MBBR.

Alternative design concepts which passed all three screening criteria above were short-listed for further review.

Based on the screening of potential technologies, the following three alternatives were considered for the upgraded facility:

1. Membrane Bioreactor
2. Rotating Biological Contactor
3. Moving Bed Biofilm Reactor

The following sections describe each biological treatment option and highlight the associated advantages and disadvantages. The technical performance, future expandability, capital, operating and maintenance costs, ease of operations, and risk of failure is considered as part the evaluation of each process alternative. Process diagrams and site plan layouts will be referenced for guidance.

4.2.2 Alternative 1: Membrane Bioreactor

A membrane bioreactor (MBR) combines the use of a membrane filtration process with biological wastewater treatment. In this application, the membrane units are submerged in the bioreactor tank. They operate using the same principles as the conventional activated sludge processes, except that the membranes are used instead of a secondary clarifier to separate solids from treated wastewater to achieve a low effluent TSS and BOD. The activated sludge biomass is retained in the treatment tank and is much more concentrated compared to CAS, allowing a smaller treatment tank volume, and eliminating the secondary clarifier, allowing for a more compact system.

For the MBR option at Rankin Inlet, following 2 mm screening and the Equalization Tank, wastewater will enter the first of two outdoor, insulated aeration tanks for biological treatment. The inlet Pre-Anoxic tank is approximately 300 m^3 and the downstream Aerobic tank is 600 m^3. The Pre-Anoxic Tank provides accelerated removal of ammonia and BOD. The anoxic zone also increases the alkalinity into the system, improving the buffering capacity and reducing chemical addition requirements. The wastewater will then travel to the Aerobic zone where biological treatment provides reduction of remaining BOD and converts ammonia in wastewater to nitrate through nitrification. We have assumed that total nitrogen reduction through a denitrification process will not be necessary to meet effluent toxicity requirements.

Following treatment in the bioreactor tank, wastewater will enter an optional heavy metals removal step. Chemical addition is optional to precipitate metals from treated wastewater. After the heavy metal removal step, wastewater will enter the MBR tanks for separation of treated wastewater from suspended-growth biomass and inert solids. Membrane modules are submerged within the prefabricated MBR tanks. The proposed MBR concept consists of three parallel MBR tanks, each containing three membrane modules. Membranes are connected to permeate pumps that draw treated effluent through the membranes under vacuum. Treated effluent will then enter the existing effluent tank for discharge through an optional tertiary metals removal process. Metals removal may be achieved through upstream treatment and not included in the final treatment configuration. Finally, effluent will be discharged to the effluent pumping system and outfall. To maintain a target biomass in the MBR system, mixed liquor must be periodically wasted from the system. Waste activated solids (WAS) will be stored in a holding tank for additional treatment and landfill disposal.

The process block diagram and proposed site layout for the MBR option can be found in **Appendix B.** **Table 4-4** summarizes the key pieces of equipment used in this process.

Table 4-4: Summary of MBR Treatment System Equipment

Stage of Treatment	Equipment	Sizing/Function
Lift Stations	Johnson Lift Station Pump	New pumps (if required)
	Nuvuk Lift Station Pump	New pumps (if required)
Influent Equalization	Equalization Tank	350 m^3
	(2) Equalization Tank Blowers	Maintain dissolved oxygen for odour control
Headworks	Fine screening, dewatering conveyor and screening bagging system	2mm perforated screen Packaged system with control panel
Biological Treatment	Feed pumps (2 duty +1 standby)	35 L/s each
	Anoxic zone Tank	300 m^3 (4h retention at ADF)
	Aerobic zone Tank	600 m^3 HRT (8h retention at ADF)
	(3) MBR Tanks	570 m^3 volume each tank
	(2) Aerobic Blowers	Oxygen supply
	(2) Membrane Scour Blowers	Membrane scouring
	CIP skid and pumps	To clean MBR cassettes

4.2.2.1 Advantages and Disadvantages

High level advantages and disadvantages of the MBR technology are in **Table 4-5**.

Table 4-5: MBR Advantages and Disadvantages Summary

Advantages	Disadvantages
• No need for secondary clarification. • Decreased bioreactor size and lower HRT due to higher biomass concentration. • Higher-quality effluent compared to the other considered alternatives.	• Higher capital cost. • Potential fouling of membranes may incur an ongoing cost for maintenance and replacement. • Chemical cleaning of membranes requires additional consumables. • Increased automation and pumping requirements result in higher utility costs. • Greater level of operator licencing and skill required. • Added cost associated not justified by a need for a high performance treatment package in this application.

4.2.3 Alternative 2: Rotating Biological Contactor

A rotating biological contactor (RBC) is an attached growth treatment process. Microorganisms required for contaminant removal grow on the RBC media disks. These disks are spaced closely together on a shaft to provide a large overall surface area for biomass. Disks are mounted on a rotating shaft that is partially submerged in a tank holding the wastewater. As the disks rotate they are cyclically immersed in wastewater allowing contact with organics and nutrients, followed by exposure to ambient air, removing the need for a mechanical aeration system. As treatment proceeds and biomass grows on the disc surfaces, excess solids are sloughed off as a sludge which must be removed through a downstream secondary clarifier. The RBC system also requires upstream primary clarification to remove settleable solids.

For RBC secondary treatment at the Rankin Inlet WWTP, influent wastewater will be stored in the Equalization Tank prior to treatment and then enter a high rate clarifier. Due to the large footprint of a conventional gravity primary clarifier and the cold climate of Rankin Inlet, high rate clarifiers housed indoors, constructed as modular, steel units have been assumed. These clarifiers can be housed inside the treatment building without the risk of freezing associated with a conventional outdoor clarifier system. Two high rate clarifiers would operate in parallel. The ballasted clarifier would consist of an inlet mixing zone where wastewater is combined with a chemical coagulant and a Microsand that increases the density and settling performance of the solid particles formed. The chemically treated wastewater then enters a lamella-plate clarifier which settles solids in a much smaller area than conventional clarifiers. The settled sludge then passes through a "hydrocyclone" which separates sludge from sand, which is reused.

Following clarification, wastewater is split between three RBC units operating in parallel. After biological treatment in the RBC, effluent will enter a dissolved air floatation (DAF) system which will serve as a compact secondary clarification process for solids separation. The DAF system will be able to provide oil and grease removal along with separating the biomass.

A summary of the key equipment required for this process is listed in the **Table 4-6**: Summary of Key Equipment RBC below. Process diagrams and a proposed site plan can be found in **Appendix B.**

Table 4-6: Summary of Key Equipment RBC

Stage of Treatment	Equipment	Comments
Lift Stations	Johnson Lift Station Pump	New pumps (if required)
	Nuvuk Lift Station Pump	New pumps (if required)
Equalization	Equalization Tank	350 m^3
	(2) Equalization Blowers	
Primary Clarification	(2) High Rate Clarifying Systems	41 m^3
	Coagulant Dosing System	
Biological Treatment	Feed pumps (2 duty +1 standby)	35 L/s each
	(3) Rotating Biological Contactors	505 m^3 /day per RBC 8,299 m^2 total media surface area per
Secondary Clarification	(2) Dissolved Oxygen Flotation (DAF)	Includes air saturation system
	Polymer Dosing System	

4.2.3.1 Advantages and Disadvantages

High-level advantages and disadvantages of the RBC process are outlined in **Table 4-7** below.

Table 4-7: RBC Process Advantages and Disadvantages

Advantages:	Disadvantages:
• Well-established process that has been used in many municipal wastewater treatment applications. • Operation is relatively simple and does not require complex controls or as great a level of operator licensing and skill as MBR treatment. • Low power requirement to drive the rotating shaft and does not require blowers.	• Shafts and bearings may fail, requiring replacement with a major overhaul. • Process must be located indoors in Rankin Inlet to prevent freezing, increasing the potential impact of humidity on the interior of the treatment building. • Potential for odour generation resulting from anaerobic growth along the RBC shaft. • Both primary and secondary clarification are required which increasing building footprint. • Additional process units and larger size of process increase capital costs. • DAF operation for downstream clarification process requires coagulation and chemical use. • RBC tank has detailed HVAC requirements

4.2.4 Alternative 3: Moving Bed Biofilm Reactor

A Moving Bed Biofilm Reactor (MBBR) is an attached growth treatment system. Unlike an RBC, which also contains attached-growth media, the MBBR system is composed of an aerated biological reactor tank filled with small plastic media to support biomass growth. The MBBR media is typically about the size of a Loonie coin, in a honeycomb shape designed to provide a high surface area to volume ratio. The reactor tank is supplied with oxygen to support the biological process through diffusers located at the bottom of the tank, which also mixes the media. The biomass thickness on the media is controlled by the shear forces introduced by mixing within the MBBR tank, as the media pieces contact each other. Media screens are provided on the discharge of the tank to prevent media from leaving, so that the biomass is retained within the reactor. The biomass in an MBBR is self-regulating and does not require return sludge pumping like an MBR.

For the MBBR option at the Rankin Inlet WWTP, flow will pass through a rotary drum screen then be stored in the Equalization Tank prior to treatment. Two MBBR trains operating in parallel are assumed. Each train contains two reactor tanks in series to provide the necessary organic treatment capacity without exceeding the maximum length for a modular steel-tank MBBR system. Wastewater exiting the

MBBR trains will enter a DAF for separation of biomass and treated wastewater. The DAF system will be able to provide oil and grease removal along with separating the biomass.

The proposed site layout and process block flow diagram for the MBBR option can be found in **Appendix A**. A summary of the key equipment components for the MBBR system are summarized in the **Table 4-8** below.

Table 4-8: Key Equipment Required MBBR

Stage of Treatment	Equipment	Comments
Lift Stations	Johnson Lift Station Pump	New pumps (if required)
	Nuvuk Lift Station Pump	New pumps (if required)
Equalization	Equalization Tank	350 m^3
	(2) Equalization Blowers	
Biological Treatment	Feed pumps (2 duty +1 standby)	35 L/s each
	(4) Moving Bed Biofilm Reactors (two reactors per train)	200 m^3 total reactor volume 3.5 hour average day hydraulic retention time 80,000 m^2 total media surface area
	DAF Clarifier (1 per train)	35 L/s capacity
	(2) MBBR Blowers (1 duty, 1 standby)	400 Nm^3/h capacity

4.2.4.1 Advantages and Disadvantages

High level advantages and disadvantages of the MBBR process are highlighted in **Table 4-9** below.

Table 4-9: MBBR Process Advantages and Disadvantages

Advantages	Disadvantages
• Comparatively small footprint compared to the other options, reducing building size • Relatively simple system to operate • Successfully applied to handle low temperature wastewater.	• Less established than the other technologies considered, having gained popularity in the last 20 years • Typically not selected where very high quality effluent is required • DAF operation for downstream clarification requires coagulation and chemical use.

4.2.5 Process Comparison

A summary providing a high-level comparison of each treatment option is shown below in **Table 4-10.** The process components are shown for each biological treatment method.

Table 4-10: Treatment Options Process Stages

Biological Process	Primary Treatment		Secondary Treatment		Metals Removal Process (Optional)	Sludge Handling
	New Screening	Clarifier	Aeration System	Clarification		
MBR	Yes	No	Blowers with fine bubble diffusers	Yes - Membranes included in MBR tank	Yes	Yes
RBC	No	Yes- High Rate Clarifier	No mechanical aeration	Yes- DAF	Yes	Yes
MBBR	No	No	Blowers with coarse or fine bubble diffusers	Yes- DAF	Yes	Yes

All three proposed treatment systems require influent equalization storage, primary screening, metals precipitation (optional) and sludge handling.

4.3 Tertiary Treatment for Metals Removal

All biological treatment alternatives have assumed the option of a dedicated tertiary treatment stage for metals precipitation after the biological secondary treatment stage and prior to discharge. The metals removal process will consist of chemical addition, where pH will be raised to promote the formation of insoluble metals precipitates, which will then be settled from solution using a chemical coagulant. Metals that are precipitated will be co-disposed with the sludge separated from the wastewater. Reacidification will be required to be established after the metals removal process to maintain unionized ammonia below the 1.25 mg/L limit. A Reacidification Tank and chemical feed system has been included as an optional cost and has been excluded in the cost estimate for each biological treatment option.

The need for a metals removal tertiary treatment stage is presented as an optional process, as ECCC has stated that treatment is not warranted. Copper and Zinc content in wastewater may result from the interaction of treated potable water chemistry with water distribution piping. Treatment of potable water to prevent metals leaching from water piping and fixtures should be considered as a holistic approach to controlling the levels of copper and zinc in wastewater. There may be a lower overall capital cost and operating cost to treat the potable water when compared to the tertiary wastewater treatment system proposed. Treating the potable water may have an additional benefit of preventing corrosion of metal in the potable water distribution system. The table below outlines the key equipment involved in the optional metals removal system.

Table 4-11: Metals Removal Key Equipment

	Equipment	Comments
Metals Precipitation	(2) Metal Precipitation and Settling Tanks	33 m^3
	Metals Precipitation Dosing Skids	Pump and chemical storage tanks
Reacidification	Tank and chemical dosing system	Maintain unionized ammonia

Effluent disinfection is not assumed to be necessary for the treatment process due to the deep-water marine discharge arrangement.

4.4 Sludge Management

Sludge produced through secondary treatment will be stored in a sludge tank that is capable of handling a minimum of two days of sludge production. The sludge tank will be aerated to avoid anaerobic conditions and odours.

Stored sludge will be treated with polymer and dewatered using a rotary press. The rotary press process is an established sludge dewatering technology that is more compact than traditional dewatering centrifuges, does not require maintaining a high-speed rotating centrifuge bowl, and it is appropriate for applications where very high solids content in processed sludge (20% or more) is required. The dewatered sludge from the rotary press will be approximately 15-18% solids and will be temporarily stored indoors in a bin for disposal at the landfill. Upon detailed design, an analysis will need to be conducted to determine sludge volumes, and also to confirm if the quantity of solids removed by screens will increase from present levels. The table below outlines the sludge management equipment required.

Table 4-12: Sludge Management Key Equipment

Sludge Handling	Equipment	Comments
	Sludge Handling Tank	50 m^3 able to hold 2 days of sludge
	Sludge Pumps (2)	
	Dewatering System	Rotary press
	Polymer Dosing System	Polymer tank, flocculation tank, and dosing pumps

4.5 Integration with Existing System

The new treatment process will make use of the existing building to house the screening process, effluent chamber and discharge pumps. All other new equipment will be installed in a new structure north west of the existing building. The tanks will be constructed separate from the new structure and north of the existing building. Vehicle access to the new equipment area, including sludge removal will be provided along the east wall of the existing building. An overall site plan and building footprint drawings outlining the configuration of process equipment for each alternative are provided in

Appendix B. Layout diagrams showing potential building configurations for each alternative are provided in **Appendix C**.

4.5.1 Heating and building servicing

The existing wastewater treatment building is heated using a boiler system. Due to the comparatively large size of the proposed new system, a new dedicated system has been assumed to heat the new addition.

Heating services for the new building will be provided by oil-fired boilers and hydronic heating systems. Two boilers have been proposed for the new building that operate at 60% of the building load following typical design practices for boiler heating in similar applications. A dedicated boiler room has been included in the building layout. A fuel tank sized for 2 week supply of fuel has been included in the costing estimate. The annual fuel consumption for heating is approximately 250,000 Litres.

The ventilation system will consist of make-up air units and exhaust fans. The ventilation cost estimates are based on NFPA 820 requirements. Hydronic unit heaters with be used to heat the new building.

5.0 Cost Summary

An opinion of probable cost was developed for each treatment alternative. This cost analysis reviewed capital costs, operational and maintenance costs, and life cycle costs. Capital costs include:

- Site preparation
- WWTP building
- Treatment equipment and tankage
- Process and yard piping
- Building services (heating and electrical) equipment and process connections.

Capital costs consist of direct (cost of assets and construction) and indirect costs (cost of contingency, engineering, insurance, mobilization, and start up).

Indirect cost markups include:

- Mobilization, Demobilization, 5%
- Insurance, Bonds, 3.5%
- Engineering, 15%
- Start-up and trial operation, 2%.

An estimating contingency cost adder of 25% is also assumed in the total price, which is appropriate for conceptual-level costing.

Probable operating costs have been established for each option. Operating costs include:

- Electricity requirements
- Chemical requirements
- Operator labour
- Routine Maintenance
- Allowance for deferred capital replacement expenditure.

A 20-year life cycle for each alternative was also calculated considering capital, operation and maintenance costs. Life cycle costs are presented as a net-present-value. We have selected conservative values (relatively high inflation costs) for the purposes of high-level cost estimation:

- 3.5% discount rate
- 2% annual labour and consumables cost inflation
- 5% annual electricity cost inflation.

A summary of probable costs for each alternative is provided below in **Table 5-1**. A summary of the costs for each facility is shown below. Detailed costed breakouts are shown for each treatment process in **Appendix A**.

Table 5-1: Overall cost Summary

Option	Capital Cost	Annual O&M Cost for Year 1	Total 20 Year Life Cycle Cost
Membrane Bioreactor	$24,630,000	$1,610,000	$51,300,000
Rotating Biological Contactor	$21,800,000	$1,450,000	$45,600,000
Moving Bed Biofilm Reactor	$17,370,000	$1,430,000	$ 40,900,000

Tertiary metals treatment has been presented as an optional cost. A summary of the capital cost (equipment) and operational costs are summarized below.

Table 2: Optional Tertiary Treatment Cost

Option	Capital Cost	O&M Cost
Tertiary Metals Treatment (Optional)	$ 840,000	$350,000

6.0 Evaluation of Alternatives

Each of the alternatives identified above in **Section 5.0** were evaluated for their suitability in serving the community of Rankin Inlet. Alternatives are differentiated by the main treatment process only. The equalization, metals removal and sludge management approaches for all three alternatives are considered to be equivalent and are not independently assessed. The evaluation outlined below represents a holistic, objectives-based assessment of alternative treatment processes with respect to community needs.

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6.1 Evaluation Criteria

Table 6-1: Overview of Evaluation Criteria

Evaluation Criteria	Indicator
Protection of Cultural, Socio-Economic Environment	
Accommodates Planned Future Growth	Ability to meet short and long term growth.
Impacts to archaeological, cultural heritage and built heritage resources	Potential for adverse impacts to archaeological, cultural heritage and built heritage resources
Protection of the Natural Environment	
Impacts on Receiving Water Quality	Potential for adverse impacts to the receiving water quality, particularly in addressing effluent toxicity concerns
Technical Performance	
Performance and Experience	Flexibility of the technology/equipment and ability to adapt to Rankin Inlet needs over the planning period.
Approval Potential	Likelihood of approach receiving Environment Canada approval
Ease of Construction and Operation	Relative ease to implement/construct and maintain/operate the proposed alternative.
	Relative ease with which the alternative could be expanded in the future.
Reliability	Ability of the technology/equipment associated with the alternative to handle variable loadings and flows.
	Ability of the alternative to operate during a power failure.
Feasibility	
System Footprint	Physical site area required and size of treatment system building
Feasibility to Implement	Feasibility and practicality of implementing the alternative
Cost	
Capital Cost	Cost of treatment equipment and buildings
Operating & Maintenance Cost	Annual operating costs including capital reserve allocation

6.2 Summary of Analysis

The evaluation of the three treatment system alternatives has been summarized below in **Table 6-2: Treatment Technology Summary.** Qualitative evaluation criteria are assessed for their alignment with screening criteria with outcomes indicated as follows:

+ Meets evaluation criteria

=	Somewhat meets evaluation criteria
−	Does not meet evaluation criteria

The overall assessment of each alternative is a combination of a holistic review of alignment with the qualitative factors identified in **Table 6-1** as well as system cost.

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Table 6-2: Treatment Technology Summary

Evaluation Criteria	Alternative 1: Do Nothing	Alternative 2: Membrane Bioreactor (MBR)	Alternative 3: Rotating Biological Contactor (RBC)	Alternative 4: Moving Bed Biofilm Reactor (MBBR)
Protection of Cultural, Socio-Economic Environment				
Accommodates Planned Future Growth	Status quo may accommodate future wastewater generation increases but does not address treatment requirements. =	Accommodates future Growth +	Accommodates Future Growth +	Accommodates Future Growth +
Impacts to archaeological, cultural heritage and built heritage resources	No impact +	No impact +	No impact +	No impact +
Protection of the Natural Environment				
Impacts on Receiving Water Quality	Potential for negative impacts to the environment and water quality, particularly through toxicity of effluent −	Sophisticated treatment process with the capability to exceed receiving water quality requirements. +	Sophisticated treatment process with the capability to meet receiving water quality requirements. +	Sophisticated treatment process with the capability to meet receiving water quality requirements. +
Technical Performance				
Performance and Experience	No change. The current facility is simple to operate but does not address requirements for improved performance −	High performance treatment process with use in similar northern applications. Level of treatment exceeds requirements for Rankin Inlet and associated operational and capital cost premium may not be justified in this application. +	High performance treatment process with use in similar northern applications. Capable of meeting requirements for Rankin Inlet. +	High performance treatment process with use in similar northern applications. Capable of meeting requirements for Rankin Inlet. +
Approval Potential	The current facility is subject to ongoing regulatory concerns by Environment Canada. Approval for long term future operation likely would not be provided. −	Established treatment process with relevant reference installations. Approval would likely be provided. +	Established treatment process with relevant reference installations. Approval would likely be provided. +	Established treatment process with relevant reference installations. Approval would likely be provided. +
Ease of Construction and Operation	No construction of new facilities. Minimal operating requirements.	Modular equipment and tank construction. Outdoor bioreactor tank may add complexity compared to other alternatives. More sophisticated process with increased operator skill and training requirements.	Modular equipment and tank construction. Relatively simple operation.	Modular tank construction. Relatively simple operation.

Evaluation Criteria	Alternative 1: Do Nothing	Alternative 2: Membrane Bioreactor (MBR)	Alternative 3: Rotating Biological Contactor (RBC)	Alternative 4: Moving Bed Biofilm Reactor (MBBR)
	=	=	+	+
Reliability	Existing system (pumping and screening) is reliable but does not provide required performance. −	Reliable process able to handle flow and load variations from the community. Limited access to parts or maintenance resources may be a concern. +	Reliable process able to handle flow and load variations from the community. +	Reliable process able to handle flow and load variations from the community. +
Feasibility				
Regulatory and Compliance Requirements	The current facility would not be compliant for the new developments and would face regulatory obstacles. −	Facility will be subject to approval from environmental regulators. +	Facility will be subject to approval from environmental regulators. +	Facility will be subject to approval from environmental regulators. +
System Footprint	Low relative capital cost to municipality; however the current system does not meet requirements =	Relatively small footprint +	Relatively large footprint −	Relatively small footprint +
Feasibility to Implement	Does not meet regulatory policy requirements. −	Feasible alternative. +	Feasible alternative. +	Feasible alternative. +
Cost				
Capital Cost	Low relative capital cost to municipality; however the current system does not meet requirements =	$ 24.6 M =	$ 21.8 M −	$ 17.4 M +
Operating & Maintenance Cost	Low relative operating and maintenance cost. =	$ 1,610,000 −	$ 1,450,000 =	$1 ,430,000 +
Overall Evaluation Ranking	**Not Preferred**	**#2**	**#3**	**#1 (Preferred Option)**

6.3 Recommended Option

Based on the results of the technology assessment and evaluation, construction of a treatment system based on an MBBR biological treatment process is the recommended design concept for upgrades to the existing Rankin Inlet WWTP. The MBBR process is compact, well suited to managing varying hydraulic and organic loads, relatively simple to operate, and cost effective. The MBBR option also integrates easily into the existing WWTP by using the existing screening equipment, with no requirement for additional primary treatment.

6.4 Project Schedule

Dillon has prepared a high-level project schedule for upgrade of the Rankin Inlet WWTP using milestones that have been developed based upon the need to complete engineering design, procurement and shipping of materials via sea lift to Rankin Inlet prior to construction.

Period	Event	Duration
Mid Year 1	Project Detailed Design	9 months
Late Year 1	MBBR system pre-selection	4 month process
Early year 2	Construction tendering and major equipment procurement	7 months
Fall Year 2	Sea Lift to Rankin Inlet	
Early-Mid Year 3	Construction period begins	
Mid Year 3	Second construction materials sea lift	
End Year 3	Construction Completion	

7.0 Conclusion

A wastewater treatment upgrade is required for the Rankin Inlet WWTP to meet effluent toxicity reduction objectives. In 2019, Dillon completed a Wastewater Effluent Characterization study. From the results of the study, organic loading (leading to dissolved oxygen depletion) and Total Suspended Solids (TSS) must be treated through a secondary-level treatment processes. In addition, copper, zinc, phenols, oil and grease and ammonia concentrations can be reduced through an optional treatment process.

Dillon has reviewed the existing facility, and assessed alternative treatment methods meeting performance requirements. An MBBR biological treatment process has been selected as the most feasible option for secondary wastewater treatment. A metals precipitation stage (optional) as well as sludge handling equipment has been described. The need for metals precipitation is optional only, as the ECCC has stated it is not required.

It is recommended that additional effort be made to address some effluent toxicity concerns, particularly those associated with heavy metals content in wastewater, through a review of the community water treatment infrastructure. This further review is recommended prior to the detailed design and implementation of a treatment process but has been excluded from the scope of the present study.

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SAINT JOHN, NEW BRUNSWICK

Appendix A

Treatment Alternative Cost Summaries

MBR Treatment Process Costing

A cost summary on the capital costs including the direct and indirect costs for the MBR process is provided below.

Table A1: MBR Costing Summary

Detailed Capital Cost Summary- MBR		
Item	Item Description	Estimated Cost
	Direct Cost (Equipment Purchase and Construction)	
1	Equipment	
	Lift Stations	$40,000
	Septage Receiving Station	$ 460, 000
	Equalization Tank	$850,000
	Headworks (new screens)	$240,000
	Aerobic Biological Treatment and MBR tank	$7,700,000
	Sludge tank and dewatering	$840,000
	Total Equipment Cost	$10,130,000
2	Direct Construction Cost	$ 6,250,000
	Total Direct Construction Cost	$ **16,380,000**
	Indirect Cost	
1	Mobilization, Demobilization, 5%	$820,000
2	Insurance, Bonds, 3.5%	$570,000
3	Contingency - Estimating, 25%	$4,080,000
4	Engineering, 15%	$2,450,000
5	Start-up and trial operation, 2%	$330,000
	Total Indirect Cost	**$ 8,250,000**
	Total Cost	**$ 24,630,000**

A summary of the operations and maintenance costs for the MBR process is shown below.

Table A2: MBR Operating Cost Summary

Operations and Maintenance Cost- MBR	
Electricity Cost	$70,000
Labour Cost	$200,000
Consumables and Sludge Disposal	$800,000
Routine Maintenance/ Capital Replace Cost	$540,000
Total O&M Cost Annually	**$1,610,000**

RBC Treatment Process Costing

A cost summary on the capital costs including the direct and indirect costs of the RBC process is shown below.

Table A3: RBC Costing Summary

Detailed Capital Cost Summary- RBC		
Item	Item Description	Estimated Cost
	Direct Cost (Equipment Purchase and Construction)	
1	Equipment	
	Lift Stations	$40,000
	Septage Receiving Station	$ 460, 000
	Equalization Tank	$ 850,000
	High Rate Primary Clarifier	$ 1,520,000
	Rotating Biological Contactor units	$ 3,380,000
	DAF Units	$ 1,130,000
	Sludge Tank and dewatering	$1,190,000
	Total Equipment Cost	$ 8,570,000
2	Direct Construction Cost	$ 5,920,000
	Total Direct Construction Cost	**$ 14,490,000**
	Indirect Cost	
1	Mobilization, Demobilization, 5%	$ 730,000
2	Insurance, Bonds, 3.5%	$ 500,000
3	Contingency - Estimating, 25%	$ 3,620,000
4	Engineering, 15%	$ 2,170,000
5	Start-up and trial operation, 2%	$ 290,000
	Total Indirect Cost	**$ 7,310,000**
	Total Cost	**$ 21,800,000**

A summary of the operations and maintenance costs for the RBC process are shown below.

Table A4: RBC Operating Cost Summary

Operations and Maintenance Cost- RBC	
Electricity Cost	$30,000
Labour Cost	$200,000
Consumables and Sludge Disposal	$770,000
Routine Maintenance/ Capital Replace Cost	$450,000
Total O&M Cost Annually	**$1,450,000**

MBBR Treatment Process Costing

A cost summary on the capital costs including the direct and indirect costs of the MBBR are shown in the table below.

Table A5: MBBR Cost Summary

Detailed Capital Cost Summary- MBBR		
Item	Item Description	Estimated Cost
	Direct Cost (Equipment Purchase and Construction)	
1	Equipment	
	Lift Stations	$40,000
	Septage Receiving Station	$460, 000
	Equalization Tank	$850,000
	MBBR System, and DAF	$4,000,000
	Sludge Tank and dewatering	$1,180,000
	Total Equipment Cost	$6,530,000
2	Direct Construction Cost	$5,010,000
	Total Direct Construction Cost	**$ 11,540,000**
	Indirect Cost	
1	Mobilization, Demobilization, 5%	$ 580,000
2	Insurance, Bonds, 3.5%	$ 410,000
3	Contingency - Estimating, 25%	$ 2,880,000
4	Engineering, 15%	$ 1,730,000
5	Start-up and trial operation, 2%	$230,000
	Total Indirect Cost	**$ 5,830,000**
	Total Cost	**$17,370,000**

A summary of the operations and maintenance costs for the MBBR are shown below.

Table A6: MBBR Operating Cost Summary

Operations and Maintenance Cost- MBBR	
Electricity Cost	$ 40,000
Labour Cost	$ 200,000
Consumables and Sludge Disposal	$ 770,000
Routine Maintenance/ Capital Replace Cost	$ 420,000
Total O&M Cost Annually	**$ 1,430,000**

Appendix B

Site Layout

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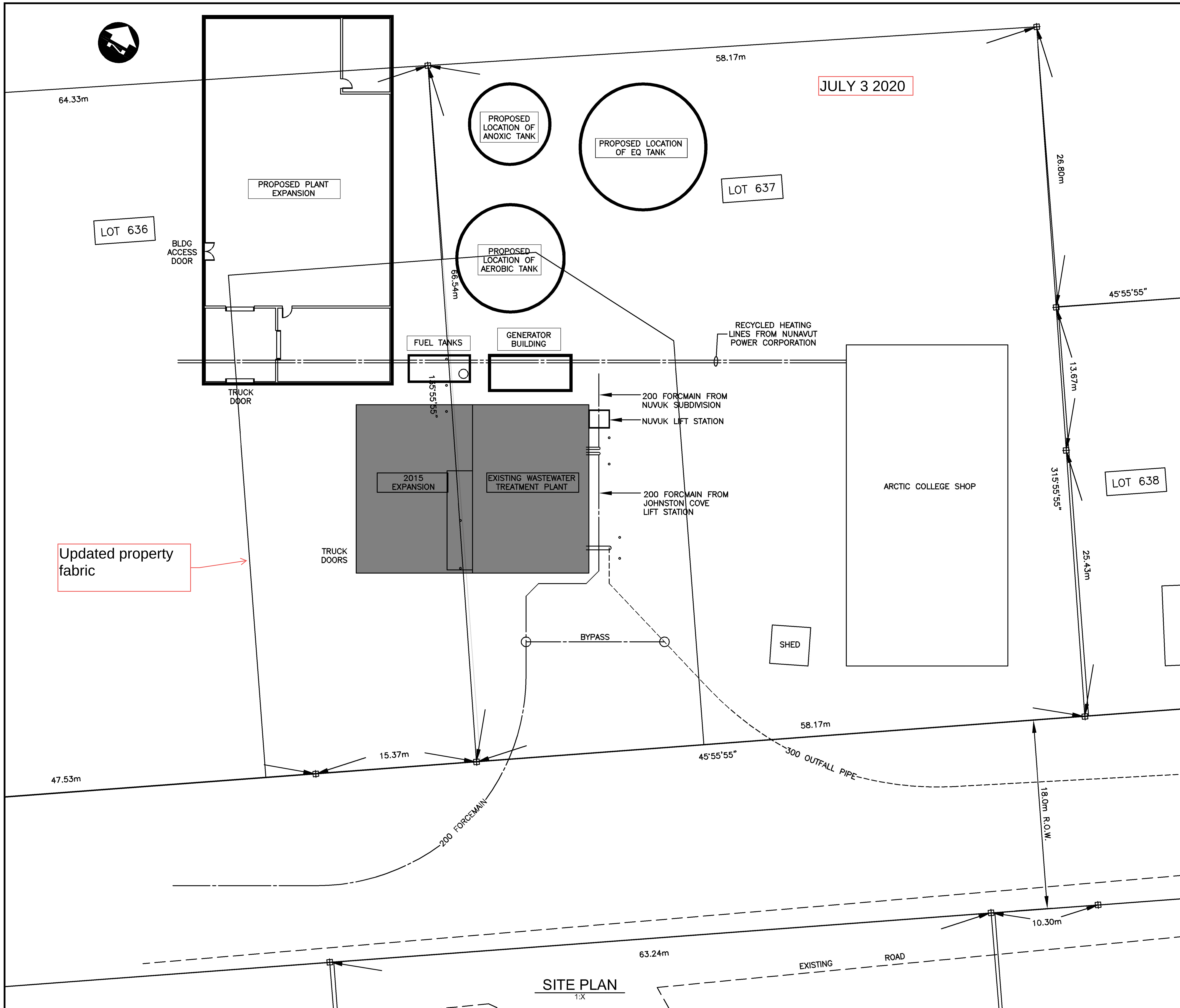

LOCATION MAP

NOTES:

1. EXISTING INFORMATION SHOWN IN THIS PLAN BASED ON TENDER DRAWINGS SUPPLIED TO NORTHWEST TERRITORIES PUBLIC WORKS AND SERVICES DEPARTMENT BY STANLEY CONSULTANTS AUGUST 1995.
2. LOCATION OF EXISTING BUILDINGS IS APPROXIMATE ONLY.

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RANKIN INLET

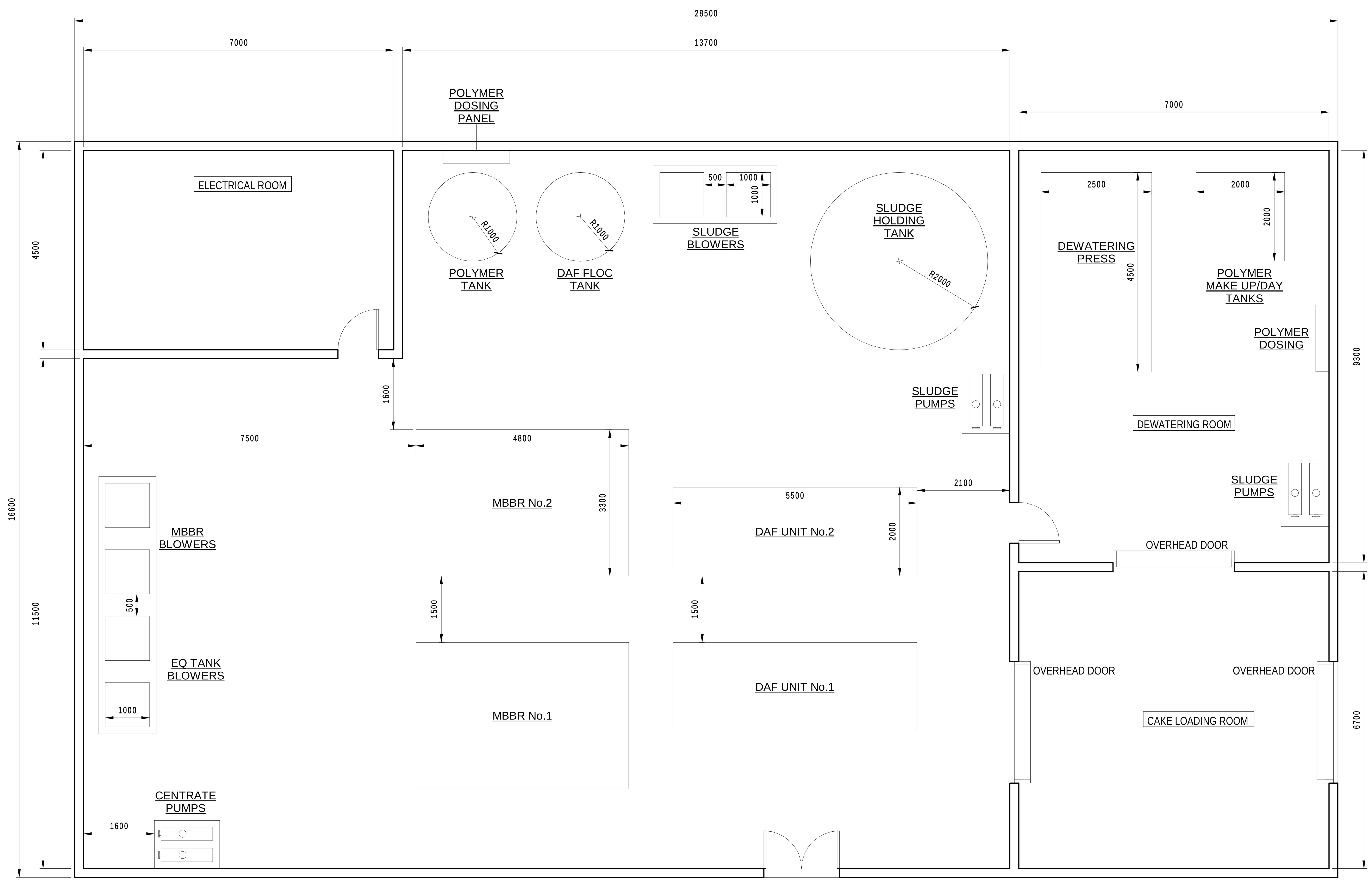
PROJECT NO. 20-2223

CONCEPTUAL SITE PLAN

SHEET NO. C1

Appendix C

Process Block Flow Diagrams and Building Layouts



DILLON CONSULTING LIMITED 130 DUFFERIN AVENUE, SUITE 1400, LONDON, ONTARIO, N6A 5R2, PHONE (519) 438-6192 , FAX (519) 672-8209

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RANKIN INLET

PROCESS

MBBR OPTION

PROJECT NO. 20-2223

SHEET NO. P1

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MBBR

PROJECT NO. 20-2223

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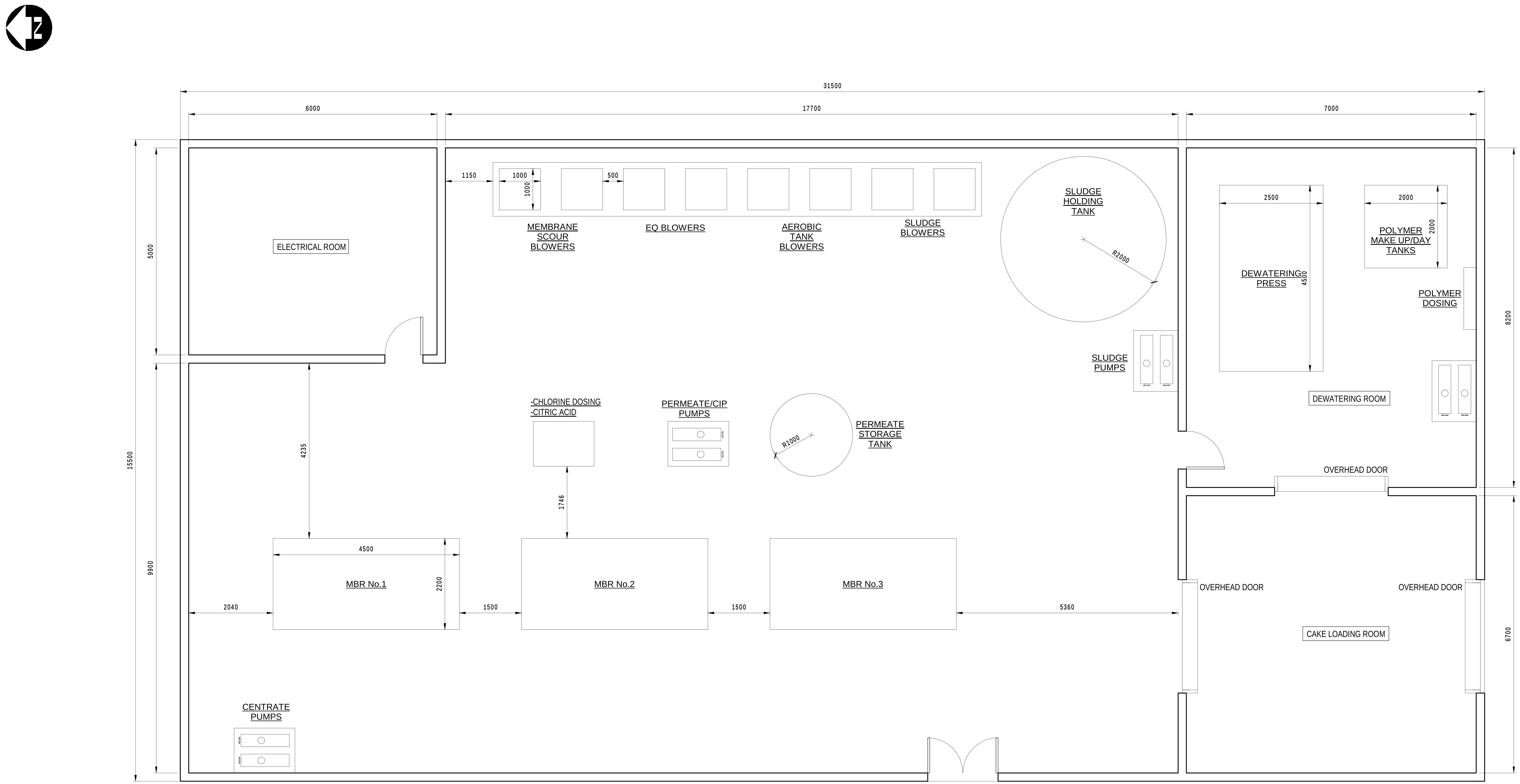

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PROCESS

MBR OPTION

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RANKIN INLET

MBR

PROJECT NO. 20-2223

SHEET NO. PFD2

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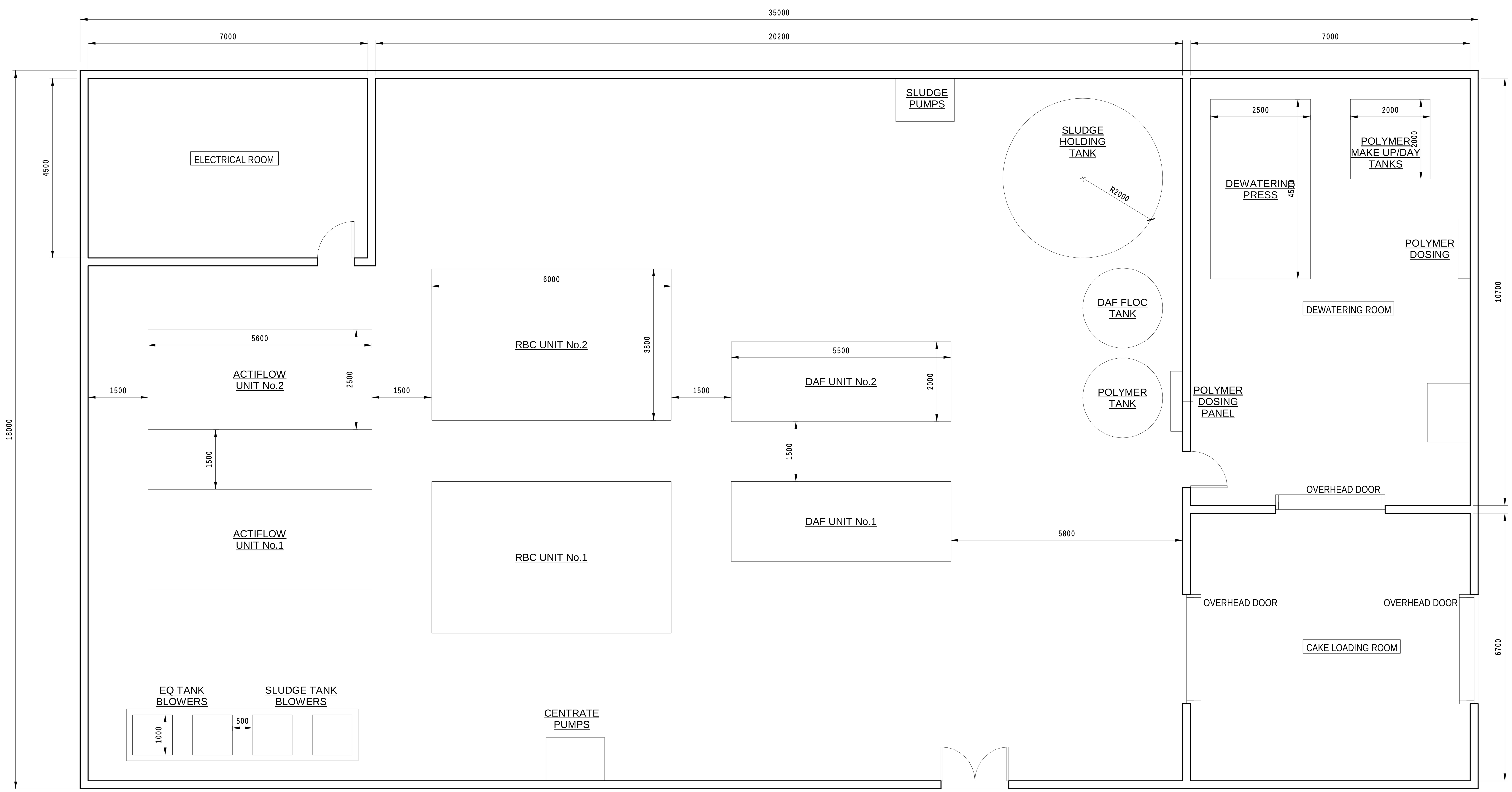

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RANKIN INLET

PROCESS

RBC OPTION

PROJECT NO. 20-2223

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RANKIN INLET

RBC

PROJECT NO. 20-2223

SHEET NO. PFD3

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Appendix D

Letter from ECCC Regarding Metals Removal

Subject: RE: Rankin Inlet Wastewater Treatment Plant Process Selection and Design Concept

Didham, Curtis (EC) <curtis.didham@canada.ca>
to Collins, Sarah, Broome, Craig (EC), Wilson2, Anne (EC), Lusty, Megan, Browne, David

Good Morning Sara,

ECCC confirms that the effluent concentrations of metals and phenols as reviewed in the Wastewater Treatment Plant Upgrades Rankin Inlet: Draft Report Process Selection and Design Concept (Table 2-1) do not warrant treatment.

Regards,

Curtis Didham
Enforcement Officer / Agent d'application de la loi
Enforcement Branch / Direction générale de l'application de la loi
Environment and Climate Change Canada / Environnement et Changement climatique Canada
Government of Canada / Gouvernement du Canada
Iqaluit, Nunavut
Suite 301, 3rd Floor, Qilaut Building
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From: Collins, Sarah <SCollins@GOV.NU.CA>
Sent: May 8, 2020 3:05 PM
To: Didham, Curtis (EC) <curtis.didham@canada.ca>
Cc: Broome, Craig (EC) <craig.broome@canada.ca>; Wilson2, Anne (EC) <anne.wilson2@canada.ca>; Lusty, Megan <MLusty@GOV.NU.CA>; Browne, David <dbrowne@gov.nu.ca>
Subject: RE: Rankin Inlet Wastewater Treatment Plant Process Selection and Design Concept

Good Afternoon Curtis,

Are you able to provide clarity between the email comments sent from ECCC for the Effluent study and the most recent discussion on the Treatment Plant report with regards to treatment for metals?

In the email received on January 17, 2020, the following was stated:
The evaluation of the causes of toxicity attributable to oxygen depletion, TSS, ammonia, copper, zinc, and potentially phenols and oil and grease is reasonable, and these parameters should be encompassed in the treatment process review.

During our call, it was indicated that metals and phenol are below acute toxicity thresholds and would not need to be considered. In their report, Dillon also emphasized that metal concentrations may be more efficiently targeted at a ne

Please confirm if ECCC recommends these items to be considered in the treatment process of the new mechanical plant.

Thank you,

Sarah Collins, P. Eng
Municipal Planning Engineer, Kivalliq Region
Community and Government Services
Government of Nunavut
867-645-8176

From: Didham, Curtis (EC) <curtis.didham@canada.ca>
Sent: April 22, 2020 10:50 AM
To: Collins, Sarah <SCollins@GOV.NU.CA>; Lusty, Megan <MLusty@GOV.NU.CA>; Browne, David <dbrowne@gov.nu.ca>
Cc: Broome, Craig (EC) <craig.broome@canada.ca>; Wilson2, Anne (EC) <anne.wilson2@canada.ca>
Subject: RE: Rankin Inlet Wastewater Treatment Plant Process Selection and Design Concept

Good Morning,

Find attached ECCC review comments that we can discuss during the call.

Regards,

Curtis Didham
Enforcement Officer / Agent d'application de la loi
Enforcement Branch / Direction générale de l'application de la loi
Environment and Climate Change Canada / Environnement et Changement climatique Canada
Government of Canada / Gouvernement du Canada
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