ATTACHMENT 44

WWTP Redesign Development Report

Rev 1
April 24, 2026

IQALUIT WWTP UPGRADE

City of Iqaluit

REDESIGN DEVELOPMENT REPORT

Prepared for:

City of Iqaluit
Building 901 (City Hall)
Nunavut Drive
Iqaluit, NU X0A OHO

Prepared by:

Nunami Stantec
4910 – 53 Street, PO Box 1777
Yellowknife, NT X1A 2p4
Tel: (867) 920-2882 Fax: (867) 920-4319

Project No.:

110126045

November 27, 2017

NUNAMI STANTEC

NUNAMI STANTEC

EXECUTIVE SUMMARY

The City of Iqaluit's Wastewater Treatment Plant (WWTP) requires upgrading to meet both a growing population and the requirements of their renewed water licence. Under the licence conditions, the upgrading is required by December 31, 2018. This Design Development Report outlines the basis of design and presents the main features of the upgrade that will be expanded upon during detailed design.

Effluent Discharge Limits

The upgraded WWTP will meet effluent discharge limits as set out by the Canadian Council of Ministers of the Environment (CCME) Wastewater Systems Effluent Regulation (WSER) regulated federally under the Fisheries Act. The key limits to be met are an effluent concentration of cBOD less than or equal to 20 mg/L and TSS less than or equal to 20 mg/L. It was reviewed and agreed during the Value Engineering (VE) Session that the plant will not be designed for nitrification because of limitations on the available capital funding, and therefore the un-ionized ammonia limit in the water licence will not be met.

Design Flows and Loads

The latest population projection was established by the VE Session. A 2016 base population of 8,220 was the benchmark for the population projection. The design population for the new facility of 10,870 was agreed to at the VE Session. With an anticipated population growth rate of 1.15%, this population will be reached in 2041, which gives the proposed facility a 25-year design horizon. A 25 year design horizon is a reasonable and typical operating period for a facility of this type. The average annual flow (AAF) based upon 10,870 and a per capital flow rate of 400 L/c/day is 50.3 L/s, the maximum month flow (MMF) is 60.4 L/s and the peak hour flow is 151 L/s.

Unit Processes

The following upgrades to the treatment process were agreed to during the VE Session:

- Preliminary Treatment: Three new chopper pumps will be installed in the existing wet well pumping station. The pumps will be sized so that two pumps operate together with capacity to handle the peak hour flow of 151 L/s while the third pump is in standby. New 6 mm shaftless spiral fine screens will capture and clean coarse materials for disposal. The new screens will be installed in the same location where the existing screens are located on the upper level of the headworks building.
- Primary Treatment: Two Primary Filters with capacity to handle the 121 L/s each will be installed on the upper level of the headworks building. The installation of two filters (duty/assist) will provide the appropriate flexibility that was identified during the VE Session.
- Secondary Treatment: The existing concrete aeration tanks on site will be modified and repurposed into Moving Bed Biofilm Reactors (MBBR) for secondary treatment. The tanks will be filled with carrier media which provides a surface for attached biological growth and treatment to take place. New process aeration blowers will provide the oxygen required for the aerobic treatment. The MBBR will be followed by high rate secondary clarification using

Dissolved Air Flotation (DAF) units. Dissolved air is added to the mixed liquor and suspended particles are removed from the liquid stream by bringing the solids to the surface. Treated effluent from the DAF units will be discharged to the existing outfall that flows in to Koojesse Inlet.

- Solids Handling: Thickened Waste Activated Sludge (TWAS) from the DAF units will be stored prior to being dewatered by a belt filter press. A belt filter press uses a perforated belt and mechanical compression to filter and separate the liquid fraction in the sludge from the solids fraction. A dry polymer make-up system will be used to aid in the dewatering process. Dewatered solids will be deposited in a trailer for disposal.

Construction Staging and Schedule

The construction of the project is anticipated to take approximately 20 months to complete with anticipated need to pre-order major pieces of equipment. This will allow the final sealift in 2018 to mobilize the required equipment to continue construction through the 2018/2019 winter season. Detailed planning of the construction phase will be necessary to minimize the diversion of the wastewater to the adjacent primary sewage lagoon, which is a contingency treatment system.

TABLE OF CONTENTS

List of Tables

List of Figures

List of Appendices

[File Ref: U:\110126045\design\Redesign Report\rpt_iqaluit_redesign_development_2017_10_30_FINAL.docx]

1 INTRODUCTION

1.1 Background

The City of Iqaluit's Wastewater Treatment Plant (WWTP) requires upgrading to meet both a growing population and as well as to meet the requirements of their renewed water license. Under the license conditions, the upgrading is currently required by December 31, 2018. The existing WWTP currently provides a primary level of treatment and cannot achieve sufficient reduction of contaminants to meet the effluent quality objectives outlined in the City's renewed water license. A secondary treatment process must be added to the existing facility to achieve an effluent quality that is compliant with the water license result.

To date, Stantec has completed a field review of the existing WWTP, a feasibility study evaluating secondary treatment options, initial "Issued for Tender" package, Value Engineering Report and this Redesign Development Report.

1.2 Objective

The purpose of this Redesign Development Report is to outline the basis of the redesign and present the main features of the upgrade that will be expanded upon during the detailed design phase.

Specific objectives of this report include:

- Finalize design criteria for 20 year design horizon beginning in 2018
- Present major process treatment equipment selections
- Present initial civil, architectural, structural, electrical, mechanical and instrumentation design criteria
- Present initial drawing package
- Provide discussion on construction staging and schedule

2 DESIGN CRITERIA

2.1 Effluent Discharge Limits

The upgraded WWTP will be subject to territorial and federal requirements for effluent discharge. The City's current Water License (#3AM-IQA1626) and Reasons for Decision document issued by the Nunavut Water Board (NWB) in 2016 include requirements for treatment at the upgraded WWTP. The Water License does not contain any discrete regulated effluent quality parameters. The rationale for the NWB removing the effluent quality parameters in the issuance of the Water License is based on *"the recognition that the effluent final discharge points for both facilities are located in the marine environment, Koojesse Inlet, which is outside the NWB's jurisdiction in terms of establishing discharge criteria for a deposit of waste to fresh water. The removal of the effluent quality parameters is supported by both Environment and Climate Change Canada (ECCC) and Indigenous and Northern Affairs Canada (INAC)".*

At the federal level, the Canadian Council of Ministers of the Environment (CCME) has established the Wastewater Systems Effluent Regulations (WSER) under the Fisheries Act. The WSER are intended to provide harmonized wastewater effluent criteria across Canada. The Government of Nunavut has not formally adopted these limits, however the Reasons for Decision document indicates "*With respect to implementation of secondary treatment of sewage effluent, ECCC recommended that the wastewater treatment upgrade design specifications must ensure that discharge is compliant with the Fisheries Act. In this regard, ECCC submitted that it is satisfied with the City's progress to investigate treatment system options to improve wastewater quality and recommended that the upgrade design specifications ensure that appropriate effluent quality is achieved such that discharge is compliant with s. 36(3) of the Fisheries Act.28. While recognizing that the Wastewater Systems Effluent Regulations (WSER) do not apply in Nunavut, ECCC recommended that the WSER provide due diligence guidance for Fisheries Act compliance. ECCC also recommended that the City should strive to meet or exceed WSER effluent quality standards at the end of the treatment system and rely on the WSER for monitoring of effluent quality criteria."*

Discharge limits for the upgraded WWTP were discussed and defined during the VE Session. It was agreed that the upgraded WWTP will need to meet the WSER limits with exception of un-ionized ammonia limit. **Table 1** presents a summary of the design criteria for treated effluent discharge limits that resulted from the VE Session.

Table 1: Summary of Treated Effluent Discharge Limits for the Iqaluit WWTP

Parameter	Federal Limit (WSER)	Proposed Design Criteria
BOD	Not specified	N/A
cBOD	≤ 25 mg/L	≤ 20 mg/L
TSS	≤ 25 mg/L	≤ 20 mg/L
Un-Ionized Ammonia	≤ 1.25 mg/L	Not specified
Total Ammonia	Not specified	N/A
Total Residual Chlorine	≤ 0.02 mg/L	≤ 0.02 mg/L
pH	Not specified	6 to 9
Oil and Grease	Not specified	No visible sheen
Toxicity	Non-acutely lethal	Non Toxic

NOTE:

(1) Federal Limits for cBOD and TSS are based on a quarterly arithmetic mean of biweekly composite samples for a facility of this size. The proposed 2016 design objectives also refer to mean results based on composite samples (with the exception of un-ionized ammonia, which is an absolute maximum value).

(2) Toxicity refers to non-acutely toxic undiluted effluent under the "Rainbow Trout, Oncorhynchus mykiss (as per Environment Canada's Environmental Protection Series Biological Test Method EPS/1/RN/13)". Samples are to be taken quarterly for a facility of this size. An allowance should also be made to allow for the use of the pH stabilized testing protocol, EPS1/RM/50.

2.2 Design Population Flows and Loads

2.2.1 Population Projections

The two main sources for population projections related to the City of Iqaluit, are the Nunavut Bureau of Statistics and the City of Iqaluit's General Plan (2010). At the VE Session, the City requested that the population projections follow the Nunavut Bureau of Statistics projections instead of the General Plan projections. The City's Planning and Development Department indicated that they expect the population will grow at a slower rate than listed in the General Plan. Based on this direction, an average annual population growth rate of 1.15% per year was chosen. The VE Session used a 2016 population of 8,220 to begin the population projections. The design population for the new facility was selected to be 10,870. This population would be reached in 2041 at a population growth rate of 1.15%.

2.2.2 Design Flows and Loads

The design flows and loads were discussed and defined during the VE Session. A summary of these design flows and loads are summarized in **Table 2**.

Table 2: Summary of Design Flows and Loads

		2017 Current	2041Future
Population			
Population	PE	8,315	10,870
Flows			
Average per Capita Flow	m^3/cap/d	0.4	0.4
Average Annual Flow	m^3/d	3,326	4,348
Maximum Month Flow (PF=1.2)	m^3/d	3,991	5,218
Maximum Day Flow (PF=2.0)	m^3/d	6,652	8,696
Peak Hour Flow (PF=3.0)	m^3/d	9,978	13,044
Peak Hour Flow (PF=3.0)	L/s	115	151
Biological Oxygen Demand (BOD)			
Average Day Per Capita Load	kg/cap/d	0.08	0.08
Average Annual Load	kg/d	665	870
Average Annual Concentration	mg/L	200	200
Maximum Month Load (PF=1.2)	kg/d	798	1,044
Chemical Oxygen Demand (COD)			
Average Day Per Capita Load	kg/cap/d	0.16	0.16
Average Annual Load	kg/d	1,315	1,739
Average Annual Concentration	mg/L	400	400
Maximum Month Load (PF=1.2)	kg/d	1,578	2,087
Total Suspended Solids (TSS)			
Average Day Per Capita Load	kg/cap/d	0.08	0.08
Average Annual Load	kg/d	658	870
Average Annual Concentration	mg/L	200	200
Maximum Month Load (PF=1.2)	kg/d	789	1,044
Total Kjeldahl Nitrogen (TKN)			
Average Day Per Capita Load	kg/cap/d	0.017	0.017
Average Annual Load	kg/d	140	185
Average Annual Concentration	mg/L	43	43
Maximum Month Load (PF=1.2)	kg/d	168	222
Total Phosphorus (TP)			
Average Day Per Capita Load	kg/cap/d	0.0025	0.0025
Average Annual Load	kg/d	21	27
Average Annual Concentration	mg/L	6	6
Maximum Month Load (PF=1.2)	kg/d	25	33

2.3 Mass Balance

A mass balance showing the distribution of flow and loading at year 2041 for the average annual flow and maximum month flow design conditions throughout the treatment process is shown in **Figure 1 and Figure 2**

	Raw Wastewater			Screenings		Grit		Dewatered Primary Solids		Primary Effluent		Treated Effluent		Thickened Waste Activated Sludge		Dewatered Solids		Filtrate	
Plant Influent																			
Flow	4,348	m^3/d	m^3/d	0.11	m^3/d	0.00	m^3/d	2.45	m^3/d	4,345	m^3/d	4,327	m^3/d	18.0	m^3/d	3.24	m^3/d	14.8	m^3/d
	50	L/s	L/s	0	L/s	0	L/s	0	L/s	50	L/s	50	L/s	0.21	L/s	0.038	L/s	0.17	L/s
BOD	870	kg/d	kg/d		kg/d		kg/d	200	kg/d	670	kg/d	87	kg/d		kg/d		kg/d		kg/d
COD	1,739	kg/d	kg/d		kg/d		kg/d		kg/d		kg/d		kg/d		kg/d		kg/d		kg/d
TSS	870	kg/d	kg/d	35	kg/d	0	kg/d	392	kg/d	442	kg/d	87	kg/d	540	kg/d	486	kg/d	54.0	kg/d
TKN	185	kg/d	kg/d		kg/d		kg/d		kg/d		kg/d		kg/d		kg/d		kg/d		kg/d
TP	27	kg/d	kg/d		kg/d		kg/d		kg/d		kg/d		kg/d		kg/d		kg/d		kg/d
BOD	200	mg/l	mg/l		mg/l		mg/l	81,560	mg/l	154	mg/l	20	mg/l	0	mg/l		mg/l		mg/l
COD	400	mg/l	mg/l		mg/l		mg/l		mg/l		mg/l		mg/l		mg/l		mg/l		mg/l
TSS	200	mg/l	mg/l		mg/l		mg/l	160,000	mg/l	102	mg/l	20	mg/l	30,000	mg/l		mg/l	3,659	mg/l
TKN	43	mg/l	mg/l		mg/l		mg/l		mg/l		mg/l		mg/l		mg/l		mg/l		mg/l
TP	6	mg/l	mg/l		mg/l		mg/l		mg/l		mg/l		mg/l		mg/l		mg/l		mg/l

Figure 1: Mass Balance at Annual Average Flow Condition for the year 2041

	Raw Wastewater		Screenings			Grit		Dewatered Primary Solids		Primary Effluent		Treated Effluent		Thickened Waste Activated Sludge		Dewatered Solids		Filtrate	
Plant Influent																			
Flow	5,218	m^3/d	m^3/d	0.13	m^3/d	0.00	m^3/d	2.94	m^3/d	5,215	m^3/d	5,193	m^3/d	21.8	m^3/d	3.93	m^3/d	17.9	m^3/d
	60	L/s	L/s	0	L/s	0	L/s	0	L/s	60	L/s	60	L/s	0.25	L/s	0.045	L/s	0.21	L/s
BOD	1,044	kg/d	kg/d		kg/d		kg/d	240	kg/d	804	kg/d	104	kg/d		kg/d		kg/d		kg/d
COD	2,087	kg/d	kg/d		kg/d		kg/d		kg/d		kg/d		kg/d		kg/d		kg/d		kg/d
TSS	1,044	kg/d	kg/d	42	kg/d	0	kg/d	471	kg/d	531	kg/d	104	kg/d	655	kg/d	590	kg/d	65.5	kg/d
TKN	222	kg/d	kg/d		kg/d		kg/d		kg/d		kg/d		kg/d		kg/d		kg/d		kg/d
TP	33	kg/d	kg/d		kg/d		kg/d		kg/d		kg/d		kg/d		kg/d		kg/d		kg/d
BOD	200	mg/l	mg/l		mg/l		mg/l	81,560	mg/l	154	mg/l	20	mg/l	0	mg/l		mg/l		mg/l
COD	400	mg/l	mg/l		mg/l		mg/l		mg/l		mg/l		mg/l		mg/l		mg/l		mg/l
TSS	200	mg/l	mg/l		mg/l		mg/l	160,000	mg/l	102	mg/l	20	mg/l	30,000	mg/l	150,000	mg/l	3,659	mg/l
TKN	43	mg/l	mg/l		mg/l		mg/l		mg/l		mg/l		mg/l		mg/l		mg/l		mg/l
TP	6	mg/l	mg/l		mg/l		mg/l		mg/l		mg/l		mg/l		mg/l		mg/l		mg/l

Figure 2: Mass Balance at Maximum Month Flow Condition for the year 2041

3 PROCESS EQUIPMENT DESIGN

3.1 Primary Treatment

3.1.1 Hauled Wastewater Receiving

The City provides wastewater holding tank hauling services to residences which are not connected to the piped wastewater collection system. Holding tanks are pumped out regularly and the wastewater is currently transported to a rudimentary dump station located upstream of the WWTP, where the wastewater flows by gravity into the WWTP wet well.

The addition of hauled wastewater receiving equipment was discussed at the VE Session and it was agreed that adding hauled wastewater receiving to the existing building footprint would not be feasible unless the building was expanded and major civil works were completed. An appropriate location for haulers to discharge at the WWTP itself is not currently available. However, improvements to the wet well pumping operations will help mitigate issues with cloths and rags clogging the existing pumps. No improvements were recommended for the existing hauled wastewater receiving station.

3.1.2 Raw Wastewater Pumping

The existing wet well is located deep below grade and receives flow from two lift stations in the City, which have macerators, and a gravity line which services downtown (including a connection to the jail) and holding tank wastewater. From this existing wet well, raw wastewater will be pumped to the screening system by three new submersible solids handling, chopper pumps. These three new pumps are required to increase the pumping capacity to meet future growth. Raw wastewater pumping will be greatly improved compared to the existing system because of the use of more robust pumps. **Table 3** provides a summary of the design criteria for the new raw wastewater pumps.

Table 3: Raw Wastewater Pump Design Criteria

Parameter	Design Value
Number of Units, Total/Duty	3/2
Type	Submersible Solids Handling Chopper Pump
Design Flow, each, L/s	75.5
Peak Capacity, (two pumps operating) L/s	151
Power, each, kW	19

3.1.3 Fine Screens

Raw wastewater will be pumped from the wet well to one of two new fine screens to be located on the upper level of the existing Headworks Building. Screening equipment functions to remove coarse solids and other large materials in wastewater to enhance downstream treatment and protect equipment. The screens will be shaftless spiral type with 6 mm diameter openings and integrated with washers/compactors in the same structure. A hot water spray system will be included with the screens to allow for the better management of fats, oils and grease that are present in the collection system. Screenings removed from the screens, will be washed, and compacted and then transferred to the existing hopper and deposited in the screenings trailer for disposal off site. **Table 4** provides a summary of the design criteria for the new fine screens. Each screen will have a peak capacity of 151 L/s, which is the design peak hourly flow of the plant. This peak hour capacity on each screen will provide increased operating flexibility for the WWTP, maintaining capacity and allowing one screen to be out of service. The screens will operate duty/standby at any given flow.

Table 4: Fine Screen Design Criteria

Parameter	Design Value
Number of Units, Total/Duty	2/1
Type	Shaftless Spiral
Design Flow, Annual Average, L/s	50.3
Peak Capacity, each, L/s	151
Opening size, mm	6
Power, kW	1.5

3.1.4 Grit Removal

The grit removal system was removed from the design as agreed at the VE Session. The rationale for excluding grit removal at the time of construction was that the grit load in Iqaluit was expected to be low due to nominal infiltration to the sewer system and no significant grit contributing sources in the City. Even though the grit issue is a cause of excessive wear and increased replacement of parts of the primary treatment equipment, the VE Session decided to eliminate the grit removal system from the current design. Removing grit removal eliminates the need for expanding the plant building footprint because there is currently no available space to install the system.

3.1.5 Primary Filtration

Primary filters will be used for ultra-fine screening and solids retention, and will provide approximately the same level of treatment as conventional primary sedimentation but in a much smaller footprint. The primary filters will be located on the upper level of the Headworks Building and will receive flow from shaftless spiral screens. The primary filter unit contains a filter belt which captures influent TSS and particulate BOD on a filter mat, increasing the removal of TSS and BOD as the thickness of the filter mat increases. Filtered primary effluent will flow by gravity to the MBBR tanks. Solids are thickened on the mat and removed by an air knife. The primary filters will require a dedicated blower or air compressor to supply the air knife with pressurized air. Solids are dewatered on an integral screw press/compaction zone in the filter and discharged through a chute to a disposal trailer located on the lower level of the Headworks Building.

Table 5 provides a summary of the design criteria for the primary filters. The primary filters have a peak treatment capacity of 121 L/s and will operate in a duty/assist configuration at average and maximum month flows. At peak hour flows of 151 L/s for the year 2041 both units will need to be in operation.

Table 5: Primary Filter Design Criteria

Parameter	Design Value
Number of Units, Total/Assist (2041 peak hour flow)	2/1
Design Flow, Average Annual, L/s	50.3
Peak Capacity, L/s	121 L/s
Opening size, microns	350
Auger Power, kW	0.37
Bower Power, kW	7.5

3.2 Secondary Treatment

3.2.1 MBBR

The existing concrete aeration tanks on site will be repaired and repurposed into Moving Bed Biofilm Reactors (MBBR) for secondary treatment. MBBR is a submerged attached growth process which uses a conventional bioreactor filled with carrier media suspended in the tank. The carrier media provides a surface for attached growth to take place, while the media is kept suspended and in continuous movement with aeration. A sieve is used to retain the carrier media in the bioreactor tanks, while allowing the treated effluent to flow downstream for further processing. The MBBR system is a single pass system with no return activated sludge (RAS) from the solids separation process.

Each of the two existing aeration tanks will be divided in half to create two MBBR trains with two aeration cells each. Each train will be designed to treat 75% of the maximum month ultimate design flow or 45.3 L/s per train. It is expected that both MBBR trains operate continuously at the same time. Aeration to the MBBRs will be provided by three new positive displacement aeration blowers (2 duty/1 stand by) to be located in the secondary treatment area of the building. 600 m^3/hr of air at 46 kPa are required for each MBBR train. **Table 6** provides a summary of the design criteria for the MBBRs.

Table 6: MBBR Design Criteria

Parameter	Design Value
Number of Units	2 MBBR trains (2 aeration cells per train)
Reactor Volume, two trains, m^3	392
Freeboard, mm	600
Design Flow, Average Annual, L/s	50.3
Peak Capacity, two trains, L/s	90.6
Air Requirement per MBBR Train, Nm3/hr.	600

3.2.2 Dissolved Air Flotation (DAF)

The MBBR will be followed by high rate secondary clarification using a (DAF) unit. Dissolved air is added to the mixed liquor and suspended particles are removed from the liquid stream by bringing the particles to the surface, from where they are skimmed off to a collection tank. The DAF will thicken MBBR sludge up to approximately 3% dry solids content in a compact foot print. The DAF units are intended to operate continuously in parallel receiving mixed liquor from the MBBR trains. Each DAF unit will have capacity to treat half (75.5 L/s) of the PHF to be received at the plant by 2041. One DAF unit will have hydraulic capacity to pass the PHF (151 L/s) if the other unit is not in operation but there would be a degradation of the treated effluent quality during the period that only one DAF unit is operating. **Table 7** provides a summary of the design criteria for the DAF units.

Table 7: DAF Design Criteria

Parameter	Design Value
Number of Units, Duty/Assist	2/1
Type	Dissolved Air Floatation
Surface Area, m^2	TBD
Design Flow, Annual Average, L/s	50.3 L/s
Design Flow Each DAF Unit, (two DAF units operating), L/s	75.5 L/s
Hydraulic Capacity Each DAF Unit, (with deterioration of the final effluent quality when only one DAF unit is operational), L/s	151 L/s

3.3 Solids Handling

3.3.1 Belt Filter Press

Thickened Waste Activated Sludge (TWAS) from the DAF will be stored in a TWAS storage tank prior to being dewatered by a belt filter press. The TWAS storage tank will have coarse bubble aeration to keep the solids in suspension and prevent it from turning anaerobic while being stored. Air will be supplied to the TWAS Storage Tanks by the process aeration blowers that will also provide air to the MBBR trains. Each process aeration blower will be sized with capacity of 784 Nm^3/hr to be able to supply air to one MBBR train (600 Nm^3/hr.) plus one TWAS Storage Tank (184 Nm^3/hr maximum). Two blowers will operate supplying air to both MBBR trains and both TWAS Storage Tanks while the third one will be on standby.

Duty/standby solids handling pumps will transfer TWAS from the storage tank to be dewatered. Sludge dewatering reduces the volume of solids for disposal, which ultimately reduces costs of storage and transportation to final disposal. Dewatering produces a “cake” material which can vary in total solids content based on the type of sludge processed and the amount of polymer used. A belt filter press uses a perforated belt and mechanical compression to filter and separate the liquid fraction in the sludge from the solids fraction. To accomplish the filtering action under compression, a fabric belt is wound through a series of rollers, in which sludge is fed at the beginning of the belt and “squeezed” by the successive rollers. Once the dewatered cake is scraped from the end of the press, the belt is washed with water to remove residual solids before the belt is returned to the first roller. Liquid waste is returned to the process for treatment. A dry polymer make-up system will be used to aid in the dewatering process.

The belt filter press will be sized for flows up to 7.3 m^3/hr. (2 L/s). The belt filter press will be used for dewatering three days a week for 7 hours a day (21 hours total of dewatering per week). This method of operation will avoid the dewatering on weekends. Dewatered sludge will discharge directly into a dewatered solids disposal trailer located on the lower floor of the secondary treatment area of the building. The centrate (waste liquid from the dewatering process) will be returned to the headworks of the plant for primary treatment. **Table 8** provides a summary of the design criteria for the Belt Filter Press.

Table 8: Belt Filter Press Design Criteria

Parameter	Design Value
Number of Units, Duty/Total	1/1
Feed Solids Concentration, %TS	3
Discharge Solids Concentration, %TS	15 – 19 (estimated)
Design Dry Solids Loading, kg/h	218
Design Flow, m^3/h	7.3
Polymer Dosage, kg/tonne dry solids	3 to 10
Motor, kW	2.2

4 HYDRAULIC DESIGN

The hydraulic design is governed by existing infrastructure and hydraulic control points within the WWTP. All plant modifications will be designed to accommodate existing hydraulic conditions and controls, and minimize the requirement for intermediate pumping. The main control point of the plant is:

- Fine screens (invert el. 15.0 m): The fine shaftless spiral screen elevation has been set to allow for enough head to flow from gravity from these screens through the primary filters prior to discharge into the MBBR reactors. The raw wastewater pumps will lift the liquid from the wet well to the fine screen elevation.

5 CIVIL DESIGN

The existing site is located north of the Koojesse Inlet of Frobisher Bay and south of an above ground fuel pipeline. An access road runs east of the WWTP and along the lagoon. The existing site grading runs from north to south with the existing building sitting between 10.0m and 7.5m above sea level. The land has generally been developed with some natural features of tundra and rock outcrops remaining. A drainage ditch runs northeast to southwest. The existing access vault connected to the outfall line is located at 7.0m.

The site includes buried sanitary lines, one leading to the WWTP plant from a sanitary truck dumping station and City collection system north east of the site, and another outfall line leading south to an access vault and discharge. All existing underground sanitary services will remain in existing locations and will not be affected by the WWTP redesign or access road. A new outflow line will be installed leading from the south side of the building to the existing access vault. The exact location of the new outflow line has not yet been identified and will be included with the next engineering submission. Underground water services are currently not provided to this building.

Any potable water required for building and process operations has previously been delivered by truck. As part of an anticipated improvement to the systems, Nunami submitted a conceptual water servicing study in May 2017. This study included

- Project background on the existing water and sanitary services in the area;
- Population and demand projections;
- Development of servicing options, stating limitations and design criteria (including thermal analysis);
- Estimate of probable cost for each option; and
- Option recommendation.

Option 1 was sized to consider servicing of the WWTP and future servicing of the West 40 part of Iqaluit. This option involved a continuation of the entire municipal loop as far as the WWTP along the south side of the airport runway with supply and return lines equally sized at 200 mm. The total cost of this option was estimated at $1,955,000, including a 30% contingency.

Option 2 was sized with a to consider servicing of the WWTP and future servicing of West 40. The option involved a continuation of the 200 mm supply line with return line of 75 mm. Though sizing of the recirculation line and pump at the WWTP should prevent line freeze, O&M requirements will be higher. Any connecting services in the West 40 area must consider the WWTP recirculation and span to AV213. The total cost of this option was estimated at $1,715,000, including a 30% contingency.

Option 3 was sized to consider servicing only the WWTP without the potential future servicing of West 40. The option involved running a 100 mm supply line branch from the municipal loop at Mivvik Street with a 75 mm return line. An external water storage tank and associated pumping infrastructure will be required to maintain service during peak demand. The total cost of this option was estimated at $1,387,000, including a 30% contingency.

Nunami recommended Option 1 if potential future servicing of West 40 was a priority and Option 3 if only servicing of the WWTP is to be considered. Final selection of the servicing option is pending City direction. Once determined, Nunami will proceed forward with the detailed design of direct connected water services.

6 ARCHITECTURAL DESIGN

6.1 Design Process

The existing two story wastewater treatment facility in its current configuration lacks sufficient floor area to function effectively with the proposed new systems. A new stairwell at the South side of the building is necessary to provide adequate entry and exit from the Southwest corner of the second story of the facility. This addition will allow adequate access to this area of the facility without removing critical floor space that is required for the facilities operational equipment. Looking at the existing wall and roof assemblies, we plan to design similar systems and finishes that are durable and low maintenance.

The existing cladding in a state of disrepair in various locations and it is recommended that the City consider replacing all of the existing cladding so it will match the proposed new metal cladding.

6.2 Exterior Systems Description

The building envelope will be designed to meet the RFP Project Brief requirements, Government of Nunavut's 'Good Building Practices Guidelines – Second Edition 2005' and the National Building Code of Canada 2015's (NBCC 2015) performance criteria as best as practically feasible. Should the City of Iqaluit have additional recommendations we would be open to reviewing and implementing those recommendations for this project.

In terms of thermal resistance for the construction assemblies the RSI values (nominal) noted assume consistent thickness and/or application but are not dependent on placement or method of installation.

We are recommending the proposed construction assemblies for the wastewater treatment plant expansion follow the specifications below, which are established on northern best building practices for this type of facility. Proven, easily constructed and durable assemblies will provide a cost-effective means of addressing space constraints and efficient energy use for the facility.

- Roof Assembly RSI 7.0 (R40):
  - Metal Roofing (standing seam) c/w snow guards
  - 250mm semi-rigid mineral wool insulation (two layers – fully adhered system)
  - Self-adhered Air/Vapour Barrier
  - 16 mm exterior grade gypsum sheathing (optional if adhered insulation requires solid backing)
  - Metal decking per structural
  - OWSJ per structural
  - Ceiling finish

- Wall Assembly RSI 4.75 (R32): OPTION 1
  - Metal Cladding
  - Metal Strapping Channel
  - 200mm semi-rigid mineral wool insulation
  - Standoff fiberglass clips (Cascadia clips)
  - Self-adhered Air / Vapour Barrier
  - 16mm exterior grade gypsum sheathing
  - 203mm Wind load-bearing light gauge metal framing
  - Structural steel columns and bracing
  - Finish as specified (metal liner / gypsum / plywood - TBD)

- Wall Assembly RSI 4.75 (R32): OPTION 2
  - 150mm Insulated Metal Panels (IMP)
  - Horizontal metal furring channels
  - 203mm Wind load-bearing light gauge metal framing
  - Structural steel columns and bracing
  - Finish as specified (metal liner / gypsum / plywood -TBD)

At areas requiring a two-hour fire resistant rated assembly all columns will require two layers of gypsum board (Type 'X') on metal furring as per NBCC 2015.

- Exterior Doors
  - Entry Systems
    - Insulated 1.9mm (14 gauge) pressed steel doors in thermally broken 1.9mm (14 gauge) hollow metal frames, utilizing institutional hardware and continuous hinges.
  - Overhead Doors
    - Thickness = 50mm, high performance insulated sectional steel overhead doors to RSI 3.08 (R17.5) with PVC thermal break. Low air infiltration rating for high wind load conditions. Galvanized, painted finish. (Thermacore Sectional Steel Doors)

- Roof Coverings
  - 'Enerstar' rated metal roofing, standing seam profile, zinc / pre-finished, 24 gauge.
  - Alternative roofing product

- Two ply MBM (modified bitumen membrane) system can be used employing minimum 250 gram granular cap-sheet with 180 gram sanded base sheet on exterior grade gypsum sheathing / protection board.

- Exterior Cladding
  - Exterior cladding to be 22mm corrugated metal siding in 'Galvalume Plus' finish, 22 gauge thickness.
  - Exterior cladding is chosen on its merits of exceptional integrity, cost, longevity and ability to sustain its finish with little to no maintenance. Overall, this is a system which will hold up well to abuse during inclement weather and seasonal maintenance such as snow removal.
  - A portion of the existing cladding finishes are damaged or in a state of disrepair and replacement is highly recommended and indicated in the attached elevation drawings. Replacement allows for a homogeneous overlap between existing and new portions of the building, preventing a piecemeal look to the phased renovations.

6.3 Stairs

Interior stair construction:

- Steel pan and concrete
- Proprietary rubber tile treads and risers employing non-slip finishes with edge warning strips and nosing's

6.4 Interior Systems Description

Interior wall framing will be 22 gauge 92 mm, 152 mm or 203 mm galvanized metal stud with scheduled finishes as required. Interior rated partitions to terminate at the underside of metal deck and finished with appropriate fire stopping systems.

- General Interior Wall Assembly 0hr & 1hr FRR:
  - Metal liner or painted wall finish
  - 16mm Type 'X' Impact resistant gypsum board
  - 152mm light gauge metal framing
  - 16mm Type 'X' Impact resistant gypsum board
  - Metal liner or painted wall finish

- Interior Wall Assembly 2hr FRR:
  - Metal liner wall finish
  - 2 Layers 16mm Type 'X' Impact resistant gypsum board
  - 152mm light gauge metal framing

- 2 Layers 16mm Type 'X' Impact resistant gypsum board
- Metal liner wall finish

6.5 Interior Doors

All interior doors, including any fire rated doors, will be 16 gauge hollow metal in fully welded 16 gauge pressed steel frames.

6.6 Interior Finishes

Interior finishes are to be easily maintained and durable for use in an industrial application. Care will be taken to specify the appropriate paint product for areas with humid conditions.

- Walls: In light use applications such as Mechanical and Electrical rooms: Painted 16mm abuse resistant gypsum board on light metal framing. Backboards for mounting electrical and mechanical to be 19mm plywood treated with fire resistant paint coating on all sides.
- Ceilings: Exposed, painted structural steel. Where required spray applied cementitious fire proofing over any exposed structure requiring a fire resistance rating.
- Floor: Sealed exposed concrete with non-slip surface additive.

6.7 Interior Catwalk

With the removal of the grating above the DAF's we are adding a new steel grating catwalk with handrail. This will allow for direct access to the nearest exit for emergency escape purposes.

- Floor: 38mm Steel Grating on Steel Members as per structural.
- Handrails: 38mm Steel Pipe. Painted

7 STRUCTURAL DESIGN

7.1 Vertical & Lateral Loading

The structural design of this wastewater treatment facility will conform to the latest edition of the National Building Code of Canada (NBCC), which at the time of this report and the scheduled construction is the 2015 edition. The following loads will be applied to the existing structure (where/if modifications are required) and to the new stairwell addition in accordance with the Codes and Standards referenced below.

7.1.1 Specified Vertical Loading

In addition to structures self-weight, loads to be used in the design will be as follows:

- Roofs
  - Snow(SL): 2.94 kPa (Typical)
    Drift loading is not anticipated.
  - Superimposed Dead (SDL): 1.50 kPa
- Main Floor
  - Live (LL): 6.00 kPa
  - Superimposed Dead (SDL): 1.00 kPa
  - Partition Load: 1.00 kPa
- Stairs/Landings
  - Live (LL): 4.80 kPa
  - Superimposed Dead (SDL): 1.00 kPa
  - Partition Load: 1.00 kPa

7.1.2 Wind, Snow & Rain Loading

Wind and snow loads to be used in the design will be as follows:

- Ground snow load:
  - Ss (snow) = 2.90 kPa
  - Sr (rain) = 0.20 kPa
- Hourly wind pressure:
  - (1/50 years) = 0.58 kPa
  - (1/10 years) = 0.45 kPa

- 24 Hour Rain (1/50 years)
  - 58mm

7.1.3 Seismic Loading

One of the key components in determining the seismic requirements is the site/soil classification, which requires the involvement of a qualified geotechnical engineer. A geotechnical evaluation has been conducted by the Stantec Geotechnical Team and a site classification as been determined as Class C.

- Sa (T) = 5% damped spectral response acceleration value for given building structure period:
  - Sa (0.2) = 0.087
  - Sa (0.5) = 0.065
  - Sa (1.0) = 0.043
  - Sa (2.0) = 0.023
  - Sa (5.0) = 0.0058
  - Sa (10.0) = 0.0025
  - PGA (peak ground acceleration) = 0.051
  - PGV (peak ground velocity) = 0.052

As per the new requirements of NBCC 2015, all structures must be designed for seismic loading. Given the building Importance Factor, the Sa (0.2) value, and the site Class of C, seismic design must follow the extensive requirements set out in Articles 4.1.8.2 to 4.1.8.22 of NBCC 2015.

7.2 Building Importance Category

The NBCC 2015 sets importance categories for various building functions. A wastewater treatment plant must remain fully functional in the event of disaster. Therefore, Stantec has designated this building as “Post Disaster” as set out in the NBCC. This designation requires an increase in loading factors to be applied to environmental loading during design. **Table 9** gives the Importance Factors at the four different levels of importance for comparison.

Table 9: Building Importance Factors

Loading Type	Importance Factor, I			
	Low Importance	Normal Importance	High Importance	Post Disaster
Dead Load	1.00	1.00	1.00	**1.00**
Live Load	1.00	1.00	1.00	**1.00**
Snow / Rain Load	0.80	1.00	1.15	**1.25**
Wind Load	0.80	1.00	1.15	**1.25**
Seismic Load	0.80	1.00	1.30	**1.50**

7.3 Building Systems

7.3.1 Foundation & Main Floor

- 219mm diameter rock-socketed steel piles to bedrock.
- Concrete grade beams. Approximate sizing of 600x400mm.
- 200mm concrete suspended slab with void form insulation to minimize frost heave.

7.3.2 Stairwell / Landings

- Steel HSS columns ranging from approx. 102x102mm to 152x152mm.
- Steel W-Section beams and joists.
- Steel C-Channel stair stringers
- Composite steel deck landings with concrete topping, totaling 115mm in thickness.

7.3.3 Roof

- Steel HSS columns ranging from approx. 102x102mm to 152x152mm.
- Steel W-Section beams and joists.
- 38mm corrugated steel deck roof fastened to the supporting structure.

7.3.4 Lateral Resistance

- The lateral resistance system of the superstructure will be HSS bracing.
- The main floor and foundation will resist lateral loads through bending capacity of the steel piles.

7.4 Building Systems - Major Modifications to Existing

7.4.1 Second Level Floor & MBBR Tank End Wall

One of the largest demolitions in this project is the removal of the existing Level 2 slab which is located between Grids 5 & 6 and D & F. This slab will be demolished and a new slab will be installed back at the same location except at a higher elevation. The current elevation of the existing slab in that area is approx.1500mm lower than the remainder of Level 2.

Coinciding with this floor removal and rebuild, the concrete end wall of the current MBBR tanks at Grid 5 will be removed to make room for the new DAF units on the lower level. This will include the removal of the Upper Level steel column supporting the roof and the Lower Level concrete pier at Grid 5E which is integrated into the existing wall. A new foundation and full-height steel column will be constructed at Grid 5E to support the new Level 2 floor and existing roof along with the remaining existing structural components. Also, as part of the DAF unit placement, the existing MBBR divider wall on Grid E will be removed form Grid 4 to 5.

7.4.2 New MBBR Tank End & Divider Walls

With the removal of the existing MBBR tank end wall, new end walls will be constructed to reduce the volume of the tanks. The new end walls will be placed plan-west of Grid 4. These new walls will consist of reinforced concrete and some steel framing to provide sufficient anchorage into the existing concrete. The additional layers of post-pour Xypex which were added after the original construction will need to be removed to access the original concrete walls for proper anchorage. A new coating of Xypex will be installed after the construction of the new end walls. Similarly, the resized MBBR tanks will also be divided with new dividing walls plan-west of Grid 3.

7.4.3 Headworks Gantry Crane

As noted in the following section, the existing monorail crane located on Level 2 of the headworks extension will be removed. A new gantry crane will be installed for improved mobility in the space. The new crane and rails will be supported by the existing steel structure with some new steel components.

7.4.4 Air Handling Unit (AHU) Platform / New Catwalk

A new structural steel platform will be constructed above MBBR #1 – Cell #1 to support a new air handling unit (AHU). The platform will cover the area from Grids 2 to 3 and D to E in order to support the AHU and have sufficient space around the AHU for maintenance. It will consist of steel W-Sections and open steel or fiberglass grating. The framework will span from Grids D to E and rest on top of the existing concrete floor and MBBR tank divider.

Similarly, a new steel framed catwalk will be constructed immediately plan-west or Grid 4. The construction will also be steel W-Sections spanning from Grid D to E with open steel or fiberglass grating.

7.4.5 New Mechanical / Boiler Room

A new mechanical room will be located between Grids B to D and 4 to 5 on the Lower Level. The current equipment and tankage in this space will be removed but no significant structural demolition is anticipated. The existing opening in the floor directly above this space will be framed with structural steel from below and the floor infilled with composite steel deck and concrete. A small mezzanine may be required in this space for miscellaneous mechanical equipment.

7.4.6 DAF Unit Installation

One item that is still under review is the logistics of installing the DAF units which are extremely large and heavy. At this time, the most likely scenario will require a large opening be cut out of the Lower Level concrete wall on Grid 6, somewhere between Grids D and F in order for the units to enter the design locations. This will result in a loss in lateral capacity of that shear wall which will be replaced by a stiff moment or braced steel frame.

7.5 2015 Condition Assessment Requirements

- ***The roof structure above the MBBR tanks shows signs of corrosion and staining.*** The current design and specifications will address this issue through cleaning of the structure and application of a zinc rich compound or epoxy based sealant. If/where corrosion is too severe; the steel member may need to be replaced.
- ***The roof structure above the MBBR tanks contains several bracing gussets which do not have bracing attached. This indicates that there may be missing roof braces.*** New roof bracing will be installed across the entire roof where bracing appears to be missing and ***it will match the profile of the existing bracing.***
- ***Much of the structure contains HSS tubing used for columns and bracing. In a corrosive environment, this is considered "bad practice" as corrosive gases/substances could potentially get inside of the members and corrode from the inside out which would go undetected. HSS members are acceptable when proper ventilation is provided.*** Further review of the existing facility as it relates to the overall new design with proposed additional to the building suggest that HSS members are acceptable. Proper ventilation will be provided and much of the new structure will be HSS framed.
- ***Web stiffeners in many of the roof beams were missing at column locations. It is possible that they may not have been required from a capacity perspective but it is general/good practice to install stiffeners in on the webs of W-Section beams at all concentrated load and support locations.*** The new design will incorporate the installation of web stiffeners at all standard locations.
- ***The monorail hoist is not located properly causing maintenance difficulties. The roof structure consists of Open Web Steel Joists (OWSJ) which are not capable of supporting concentrated loads between nodes (intersections of chords and web members). The monorail was installed at the nodes closest to the ideal location. Poor location of the monorail creates difficulty in maintaining the primary filter.*** The position and need for this hoist at the current location will be reviewed. The current hoist may be removed and replaced with a small gantry crane to allow full mobility in the room.

7.6 Codes, Standards & Acceptable Products

- Design Criteria, Loading and Methodology - Limit Stated Design (LSD) / NBCC 2015
- Design of Structural Concrete – Latest Edition of CSA A23.3.
- Design of Structural Steel – Latest Edition of CSA S16.
- Reinforcing Steel Quality - Latest Edition of CAN/CSA G30.18
- Structural Steel Quality – Latest Edition of CSA G40.21
- Anchorage / Fastening – Simpson Strong-Tie and/or Hilti Systems.
- OWSJs & Steel Deck – Canam Canada Standards / Design Literature.

8 BUILDING MECHANICAL DESIGN

8.1 Introduction

The mechanical HVAC systems for the WWTP building will be designed to meet or exceed requirements of the Government of Nunavut "Good Building Practice Guidelines, 2nd edition, December 2005, (referred herein as "Good Building Practice (GBP)"), applicable ASHRAE standards and guidelines, normal industry practice for similar facilities, and other applicable codes and standards. These include, but are not necessarily limited to:

- National Building Code of Canada – latest edition;
- National Fire Code of Canada – latest edition;
- National Plumbing Code of Canada – latest edition;
- CSA B139-15, Installation Code for Oil-Burning Equipment;
- Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products;
- Applicable ASPE standards;
- NFPA 10 Standard for Portable Fire Extinguishers;
- NFPA-37 – Standard for Installation and Use of Stationary Engines and Gas Turbines
- NFPA-91 – Standard for Exhaust Systems for Air Conveying of vapors, Gases, Mists and Particulate Solids.
- NFPA-101 – Life Safety Code.
- NFPA-820 – Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
- Industrial Ventilation Handbook
- Canadian Occupational Health and Safety (CCOHS) Act
- SMACNA Duct Construction Methods
- Applicable SMACNA Design and Construction Guidelines;
- ASHRAE Guideline 0-05 The Commissioning Process;
- ASHRAE Guideline 4 for O&M Manuals;
- ASHRAE 90.1-2007, Energy Standard for Buildings except Low-Rise Residential Buildings;
- ASHRAE 62.1-2010, Ventilation for Acceptable Air Quality; and
- Other applicable codes and standards.

8.2 HVAC Design Considerations

8.2.1 Outdoor Design Conditions

Design conditions for the WWTP will be based on the National Building Code of Canada statistical 1% January and 2.5% July norms as follows:

- Winter design Temperature: -41°C
- Summer: 17°C db/12°C wb

8.2.2 Indoor Design Requirements

The design criteria of the HVAC systems will be as shown below in **Table 10.**

Table 10: HVAC Design Criteria

Building Room	Design Indoor Temp.		Vent Rate (ACH)	Haz. Classification (NFPA Group D)	Room Pressure
	Max. (°C)	Min. (°C)			
LOWER PLAN					
Headworks Bldg	24	10	6 to 12	Class 1, Div 2	Negative
Wet Well	24	10	6 to 12	Class 1, Div 2	Negative
Stair No. 1 (headworks)	24	16	1	1 hr Rated	Positive
Mech Room	24	10	To ASHRAE	Class 1, Div 2	Neutral
Sludge Trailer	24	10	3 to 6	Class 1, Div 2	Negative
DAF Tank area	24	10	To ASHRAE	Unclassified	Positive
New exterior Stair	24	16	To ASHRAE	Unclassified	Positive
Generator Room	30	10	N/A	2 hr rated	Neutral
UPPER PLAN					
Headworks Bldg	24	10	6 to 12	Class 1, div 2	Negative
MBBR area (above tks)	24	10	3 to 6	Class 1, Div 2	Negative
Exist Elect Rm (GL C/3)	24	10	N/A	1 hr rated	N/A
Exist Office/Lab	24	20	To ASHRAE	Unclassified	Positive
Exist Washroom	24	20	To ASHRAE	Unclassified	Negative
Exist Office	24	20	To ASHRAE	Unclassified	Positive
Polymer Mixing Area	24	10	To ASHRAE	Unclassified	Positive
Hallway	24	10	3 to 6	Class 1, Div 2	Negative
Pos. Displ. Blower area	24	10	3 to 6	Class 1, Div 2	Negative
Belt Filter Press	24	10	3 to 6	Class 1, Div 2	Negative
Electrical Room	30	18	N/A	1 hr rated	Neutral

8.3 HVAC Systems

8.3.1 Heating

8.3.1.1 Heating Plant

Building heating shall be provided from high efficient cast iron sectional fuel oil fired boilers installed in the repurposed mechanical room located on the main floor at about grid C/4-5. Capacity of boiler system shall be such that peak heating can be maintained with largest heat recovery device failed or one boiler out of service. Based on our calculations, the estimated total boiler plant output is about 665 kW. All HVAC equipment sizing will be confirmed during detailed design.

The hot water load for process operation is NOT included in the total boiler plant load calculation.

Boilers will be monitored by the Direct Digital Control (DDC) system.

A three (3) boiler system is proposed for this plant with each boiler sized at 50% peak heating load.

A two-pipe reverse/return primary/secondary distribution system shall be provided to serve the buildings terminal units.

Heating media shall be a factory premixed 60%-40% water/glycol Dowfrost HD, with high-temperature inhibited propylene glycol (no substitutes will be allowed).

Duplex secondary heating water pumps will be equipped with variable flow drives (VFD's) on circulation pumps to reduce energy consumption.

A small packaged automatic heating media makeup system with pump, tank and pressure reducing valve shall be provided. In addition, a chemical pot feeder and glycol side stream filters shall be provided.

All HW equipment in the mechanical room including pipe, valves, fittings and heating equipment, e.g. air separator and heat exchanger) shall be insulated.

Subject to detailed design, a separate chimney shall be provided for each oil-burning appliance. The length of exposed chimney lengths outdoors shall be minimized to reduce the risk of condensation. A barometric draft regulator shall be installed on each oil-burning appliance if natural draft. A cleanout shall be provided at all vent piping changes of direction.

8.3.1.2 Terminal Heat

Unclassified areas will be heated using commercial hydronic unit heaters or hydronic base finned radiation in the offices. In the classified areas, explosion proof hydronic unit heaters will be used for space heating. Vestibules and stairways will be heated using hydronic wall mounted cabinet unit heaters. Each terminal heating unit will have thermostatic control to provide individual space temperature control.

Heat piping shall be Schedule 40 black iron or Type L copper. Grooved mechanical joints are not permitted. A means of isolation, balancing and flow measurement at all pieces of major equipment and at major circuits shall be provided.

Isolation ball valves shall be provided on the supply and return of every heating unit. Isolation ball valves shall be provided on each side of all zone valves.

Globe valves or characterized ball valves shall be used for balancing: butterfly valves are not acceptable. A balancing valve shall be provided at the return connection of each terminal unit. A drain valve with cap and chain shall be provided at all system low points, and manual vents at all system high points.

Appropriate maintenance access shall be provided for all valves, drains, system vents and equipment.

Adequately-sized sleeves shall be provided for all heating piping passing through walls or floors.

Insulation on all HVAC piping and ductwork shall be provided to the requirements of National Energy Code for Buildings, in order to maintain water temperature, minimize heat loss and to prevent condensation.

Distribution to the ventilation coils shall be direct return with circuit flow balancing valves, modulating 2- way control valves complete with a Coil Loop Pump for pre-heat coils and modulating 2-way control valves for re-heat coils. Distribution to the main building terminal heating units shall be a reverse return piping loop.

8.3.2 Ventilation

All unclassified areas will need to be physically separated from classified areas in accordance with NFPA 820. No air will be allowed to transfer from classified space into an unclassified space or vice versa.

Air System #1 (AS-1) is an existing air handling unit that will remain in operation and will continue to serve the classified Headwork area of the plant that requires 6 to 12 air changes. See the table M-1 above.

Air System #2 (AS-2) is a new ventilation unit that will serve the process areas of the plant outside of the area served by AS-1. The equipment will meet the electrical requirements for Class 1 Div. 2 operation and be installed on a platform above the MBBR cells at approximately grid D/2-3. The unit will provide 100% fresh air to remove explosive and corrosive sewer gases. The exhaust will include a 100 mm polypropylene filter to remove organic volatiles, a 50mm MERV 8 filter to remove most other particles, a polypropylene flat plate heat exchanger to assist in the heating of the fresh air, and then the exhaust fan. The fresh air supply will include a summer position for a MERV 8 filter, a pre-heating coil, a winter position for a MERV 8 filter, the polypropylene flat plate heat exchanger, a final heating coil, and the supply fan. The flat plate heat exchanger will recover about 50% of the heat down to 0°C. The exhaust air temperature will be limited to 0°C to avoid frosting of the heat exchanger core. There will be a face and bypass damper installed at the heat exchanger to provide free cooling during the summer. A flat plate heat exchanger is proposed, rather than a heat wheel heat exchanger because the flat plate heat exchanger is a more robust system and has a proven history of operation in this application. The equipment will be supplied with a spare polypropylene filter and heat exchanger core so that the dirty equipment can be replaced with a clean set while the dirty set is being cleaned. Fans will have VFD controllers to modulate the fan speeds to maintain differential air static pressure between the classified area served by AS-1 and the unclassified area served by AS-2.

Air System #3 (AS-3) is a new unit that will serve the office area of the plant including the office, washroom, and lab. This will provide a fresh air supply to these rooms to minimize contamination from the plant. These spaces will be pressurized to reduce contamination. See the table M-1 above. AS-3 equipment will be located on the mezzanine above the office area. The unit will provide 100% fresh air and exhaust from the washroom and the lab. The exhaust will include a filter to remove most dust particles, a flat plate heat exchanger to assist in the heating of the fresh air, and then the exhaust fan. The fresh air supply will include a summer position for a filter, a pre-heating coil, a winter position for a filter, the flat plate heat exchanger, a heating coil and the supply fan. The flat plate heat exchanger will recover about 50% of the heat down to 0°C. The exhaust air temperature will be limited to 0°C to avoid frosting of the heat exchanger core. The unit will be a heat recovery ventilator, similar to that used for residential applications.

Air System #4 (AS-4) is a service cooling air for the mechanical room. Cooling will be accomplished through economizer cooling using a small single supply fan system and modulating return/exhaust air.

Air System #5 (AS-5) is a service cooling air for the new electrical room. Cooling will be accomplished through economizer cooling using a small single supply fan system and modulating return/exhaust air.

The mechanical room will also have a combustion air intake duct.

A standby generator will be provided for the facility. Subject to detailed design, the existing generator is remaining in service in its own dedicated room. The room will be heated with unit heaters and motorized dampers will be provided to allow for air exchange in the room to prevent overheating. The exhaust piping and muffler will be thermally insulated.

Air distribution will be low velocity galvanized sheet metal and the supply ductwork will be insulated.

8.4 Fuel System

Heating energy shall be by ultra-low Sulphur Arctic Grade diesel fuel supplied from a new above ground secondary contained fuel oil holding tank installed at the exterior of the building. Capacity shall be sufficient for two weeks of operation at peak load and will be monitored by the DDC system. In addition, the tank will be sized to provide for 3 days of continuous operation of the standby generator. This is an allowance for power outages during blizzard conditions.

Fuel oil transfer shall be through duplex (Main/Standby) positive displacement pumps. The transfer pumps will be located in the generator room.

Fuel oil warming for the oil-fired boilers and the generator will be from separate interior auxiliary double walled steel or fiberglass fuel oil day tanks in each room. Level switches shall be used to provide low/high level alarms and to start/stop the fuel oil transfer pumps.

A normally closed solenoid valve will be installed on the fuel oil supply line to each auxiliary fuel tank. On call for fuel from either tank, the solenoid valve will be energized open, and fuel will be pumped to the appropriate tank. The generator system will take precedence over the boiler system. The day tank for the generator shall be sized to hold a minimum of 4 hours of oil for the unit. Use of auxiliary high safety limit in lieu of day tank overflow/return line to the main tank is not acceptable.

Fuel transfer pumps and auxiliary indoor tank shall be installed in a steel containment with additional level safety control to monitor liquid level inside the containment pan.

Fuel system to be designed to meet the requirements of GBP. The oil supply from the day tanks to the oil-burning appliances shall be by gravity with a return line to the appropriate day tank. The supplies to the boilers shall have an oil safety valve.

Exterior fuel piping (supply and return) shall have braided steel flexible pipe connectors when entering the building and to the emergency generator.

8.5 Plumbing

Potable water will be provided to the WWTP building via a new insulated water service connected to the City of Iqaluit water system. The proposed tie-point between building plumbing and municipal water service will be set at 3m outside of building footprint. A water service backflow preventer will be installed in the WWTP to protect the public water system. As well, a duplex recirculation pump system will be provided to provide freeze protection for the water service.

Subject to detailed design of the potable water service, a heat injection system consisting of an injection pump(s) and a double walled plate heat exchanger is proposed to reheat the domestic water recirculation line if required.

Insulated domestic hot and cold water will be piped to the building plumbing fixtures and to the new process equipment as required.

Domestic hot water will be produced via a commercial oil fired domestic hot water heater installed in the mechanical room.

The existing plumbing fixtures will remain as is except that a thermostatic tempering valve will be provided to temper the water supply to the drench shower. A hot water recirculation pump will ensure that hot water is supplied to the fixtures quickly. DCW and DHW will be piped to the fixtures.

All pipe will be insulated and identified.

Domestic hot water circulation will be provided on the main DHW piping. The domestic hot water system will be fitted with only 45 degree elbows and will be hydraulically balanced to eliminate concerns over fitting erosion corrosion failures reported to be occurring on DHW recirculation systems.

The existing drainage system will be left as is and any new drainage from the non-potable system connected to it.

Table 11 below is a preliminary summary of the proposed process DCW & DHW requirements.

Table 11: Process/Filter Water Equipment Supply

Location	Process/Fixture	Hot Water	Cold Water
Headworks Bldg	Fine Screen 1	No	Yes
	Fine Screen 2	No	Yes
	Primary Filter 1	No	Yes
	Primary Filter 2	No	Yes
	Hose Station - Upper floor	No	Yes
	Hose Station – Lower floor	No	Yes
Secondary Bldg Upper	Hose Station - MBBR	No	Yes
	Hose Station - Belt Filter Press	No	Yes
	Belt Filter Press	No	Yes
	Polymer mixing area	Yes	Yes
	Existing Lab	Yes	Yes
	Existing washroom – WC/Lav	Yes	Yes
	Eye wash/drench shower	Yes	Yes
Secondary Bldg Lower	Hose Station – DAF tanks	No	Yes
	Hose Station – Sludge Trailer	No	Yes

Where equipment drains are required, they will drain into a sump with duplex sump pumps operated by liquid level controllers, c/w a high-level alarm. The underground piping will be high density polyethylene piping complete with 50mm of urethane insulation and an exterior polyethylene jacket. The above grade piping will be PVC DWG. This piping will be similar to Ipex System 15 which is suitable for most applications in non-combustible construction.

The Belt Filter Press filtrate will be piped directly to the incoming wet well in the Headworks building. Refer to Process System description.

8.6 Fire Protection

The building is not sprinklered. In lieu, passive and active fire protection systems will be provided.

Passive mechanical protection systems will include rated fire stopping, fire dampers and the use of low flame and smoke spread rated material. To provide the highest level of passive protection the facility will be of non-combustible construction throughout.

Fire extinguishers will be installed to the requirements of NFPA 10 and the Authority having jurisdiction. For general service, multi-purpose use extinguishers will be Type ABC dry chemical. For electrical and equipment rooms, clean extinguishing agent extinguishers will be provided. Fire extinguishers will be hanger mounted.

8.7 Controls

A complete automatic control and alarm system will be provided. Control will be from the latest generation of web browser based Building Management System (BMS) that will use open protocol communications making it suitable for interface to any third-party vendor equipment controls. The system will have a fail-safe design to ensure continued system operation regardless of the BMS status using manufacturer proprietary controllers wherever possible with the BMS used for initiating control and monitoring only.

Controllers on the BMS will be capable of standalone operation and will communicate over a peerless network. Located on the LAN will be a web server PC that will operate both as the system server and as a web based Internet server that will allow control functions, report functions, all data base generation and modification functions as described for typical BMS work-stations to be completed via the Internet from any remote site with Internet access.

Control for packaged equipment will be through the unit manufacturer supplied and programmed PCU's. For all equipment, open protocol BACNet communications will be provided between the PCU's and the BMS.

For on-site diagnostics and control, an industrial type touch-screen PC workstation located in the mechanical room connected to the BMS will be supplied. After hours monitoring and alarm system trouble will be reported through digital pager or email connections to allow after hours communications to maintenance personnel for critical system trouble, e.g. heating system failure. The BMS will also allow remote monitoring and control of the buildings through Internet based communications. As a requirement of the project closeout, the BMS contractor will verify successful communications from the site using the Internet based communications. Output to an autodialer provided by Electrical or to a process system PLC for critical alarms will also be provided.

Make Up Air unit control will include supply air temperature reset, fan speed control, economizer cooling, energy recovery control and full status and alarm. Terminal unit control on the air systems will include programmable occupancy scheduled ventilation along with manual override and occupied/unoccupied set back.

AS-1 will operate at 50% capacity unless the ambient air temperature is above 10 °C, whenever the ventilated space is occupied, or whenever activated by approved combustible gas detectors set to function at 10% of the lower flammable limit (LFL). Whenever any of the above characteristics apply, AS-1 will operate at 100% capacity.

AS-2 will also operate at 50% capacity unless the ambient air temperature is above 10 °C, whenever the ventilated space is occupied, or whenever activated by approved combustible gas detectors set to function at 10% of the lower flammable limit (LFL). Whenever any of the above characteristics apply, AS-2 will operate at 100% capacity.

AS-3 will operate when programmed and with a manual override.

The air systems for the mechanical room and for the electrical room will operate to maintain the room temperature set-points.

Heating plant control will include boiler staging and water temperature reset. Heating pump control will include automatic pump sequencing and pump speed control to provide improved energy efficiency and equipment life cycle.

Heating terminal unit control will be on/off. All terminal unit control will be resident on the BMS and include night set back and after hours override temperature control and be capable of the control of operation ranges from the BMS.

Critical alarms will be reported through the BMS using digital pager or email connections. In addition, connection to auto dialers, where supplied by electrical, will also be included for critical alarms.

Draft control descriptor logic for the systems is as follows:

8.7.1 Plumbing Control Logic

1. The water service recirculation pumps will automatically switch lead pump based on a pre-set schedule. In event of lead pump failure, stand-by pump will automatically start and alarm will be set to OWS.
2. The DHWH burner will cycle to maintain the DHWH temperatures. If DHW exceeds or is below set points, alarms will be generated.
3. The DHW recirculation pump will operate whenever any of the main AS units is on full speed. If the pump fails, a critical alarm will be generated.

8.7.2 Fuel System Control Logic

1. The fuel oil transfer pumps will cycle to maintain the auxiliary tank levels.
2. The transfer pumps will operate as lead/standby with auto transfer after each duty cycle.
3. On Lead pump failure, standby pump enabled and alarm sent to OWS.
4. On low fuel oil at the main tank, a critical alarm will be generated.
5. On high fuel oil at one of the auxiliary oil tanks a hard-wired alarm will be generated and the pumps will stop. The pumps will not restart until reset.
6. On low fuel oil at one of the auxiliary oil tanks an alarm will be generated and both oil pumps will start.

8.7.3 Heating System Control Logic

1. The building heating provides heat for space and air heating through the heating terminal units and ventilation air heating coils. The building heating system will run continuously.
2. Three high efficiency fuel oil boilers will provide peak load heating. The fuel oil boilers will operate lead/lag. When any of the boilers is on, the associated primary circulation pump is to be on.
3. The fuel oil boilers are to be staged on and the burners are to operate to meet demand. The primary heating system glycol temperature will be reset based on outdoor air and DHW heating demands.

4. The secondary pumps are to operate lead/standby with auto transfer on failure and with lead rotating weekly. If both pumps fail a critical alarm will be generated. Pump speed is to be controlled based on the internal IVS controller.
5. Zone heating for all radiators is to be 2 position solenoid type valves.
6. Space heating thermostats are to start the unit heaters, cabinet unit heaters, and baseboard radiation as required to maintain the temperature.

8.7.4 Ventilation System Control Logic

8.7.4.1 AS-1

1. The system will consist of the air system that will run continuously. It will operate at 2 speeds at times as noted above.
2. Supply air temperature is to be reset based on outdoor air using proportional control to the reheat coil and “free” cooling economizer to maintain set point. The face and bypass damper at the heat exchanger will provide the economizer cooling.
3. The heating coil pumps are to operate whenever the outdoor air temperature is less than -10°C and to never operate less than 1hr.
4. AS-1 supply speed to be modulated based on duct static pressure. AS-1 exhaust fan speed to be adjusted to maintain building pressurization.
5. Fresh air will be conditioned by the preheat coil, heating the air to 0°C and then the flat plate heat exchanger. Preheating the fresh air will provide the frost control and permit continuous supply air.
6. A low temperature override and alarm will be provided for AS-1. Alarms on high filter pressure drop and fan failure will be provided.

8.7.4.2 AS-2

1. The system will consist of the air system that will run continuously. It will operate at 2 speeds at times as noted above.
2. Supply air temperature is to be reset based on outdoor air using proportional control to the reheat coil and “free” cooling economizer to maintain set point. Free cooling will be provided by modulating and finally stopping the heat wheel to reduce and then stop the heat exchange process.
3. The heating coil pumps are to operate whenever the outdoor air temperature is less than -10°C and to never operate less than 1hr.
4. AS-2 supply speed to be modulated based on duct static pressure. AS-2 exhaust fan speed to be adjusted to maintain building pressurization.
5. Fresh air will be conditioned by the preheat coil, heating the air to -15°C and then the heat wheel heat exchanger. Preheating the fresh air will provide the frost control and permit continuous supply air.
6. A low temperature override and alarm will be provided for AS-2. Alarms on high filter pressure drop, heat recovery failure and fan failure will be provided.

8.7.4.3 AS-3

1. The system will consist of the air system that will run as scheduled or as per the manual override.
2. Supply air temperature is to be reset based on outdoor air using proportional control to the reheat coil to maintain set point.
3. The heating coil pumps are to operate whenever the outdoor air temperature is less than -10°C and to never operate less than 1hr.
4. Fresh air will be conditioned by the preheat coil, heating the air to 0°C and then the flat plate heat exchanger. Preheating the fresh air will provide the frost control and permit continuous supply air.
5. A low temperature override and alarm will be provided for AS-1. Alarms on high filter pressure drop and fan failure will be provided.

8.7.4.4 Mechanical/Electrical Rooms

1. Supply fan on/off by a cooling demand.
2. Supply air temperature is to be reset based on space demand using proportional control to economizer to maintain temperature set point.
3. When the cooling fans are on, any space heating equipment is to be locked out.

8.7.4.5 Generator Room

1. When the emergency generator starts, the corresponding minimum outdoor air damper is to open for combustion air.
2. As the space temperature changes, the room space sensor and generator exhaust temperature via the BMS are to modulate the outdoor air, exhaust air and recirculation air dampers and cycle the unit heater fan and valve to maintain temperature set points.

8.7.4.6 UH and CUH

1. On a drop in space temperature, the fan is started.

8.7.4.7 Radiators

1. On a drop in space temperature, the heating coil valve is opened to maintain set point using 2 position control valves.

8.8 Other

8.8.1 Testing, Adjusting and Balancing

Testing, Adjusting and Air Balancing of all air and water systems will be included.

8.8.2 Commissioning and Training

Construction commissioning services will be provided for the WWTP. Commissioning is necessary to ensure installation and operation of the mechanical equipment to the requirements of the contract documents, reducing start-up problems and failures common during the warranty period.

Training of maintenance staff as an element of the commissioning process is also included.

9 ELECTRICAL DESIGN

9.1 Introduction

9.1.1 General

The following section outlines specific strategies for the electrical systems of the proposed facility and will form the basis for further development during detailed design. The electrical requirements for the project are directly related to and affected by the process, instrumentation, and mechanical design.

The design goals are to provide electrical systems that are operational, efficient, and flexible. In all cases, electrical systems must be robust and reliable or they immediately affect the intended functions of the facility and well-being of the occupants. The electrical systems will contribute to the building's energy efficiency and sustainability.

The electrical systems will be designed to facilitate cable replacement, renewal and removal as the needs and activities of the users change over the life of the building. The electrical systems will be designed to provide energy efficient solutions to achieve low operating and maintenance costs while supporting the facility functions.

Other factors in the overall design of the facility will include:

- Reliability including backup power providing continuity of the electrical systems.
- Flexibility as well as simplicity of operation and maintenance.
- Consideration of maintenance of major system components with negligible down time.
- Life safety systems to meet applicable code requirements.

The electrical systems addressed hereinafter in this report include:

- Electrical Service and Power Distribution
- Standby Power Supply
- Branch Circuit Wiring
- Lighting
- Emergency and Exit Lighting
- Fire Alarm System
- Structured Wiring System
- Security Systems
- Motor Control

9.1.2 Basis of Electrical Design

The electrical systems will be designed in accordance with the current edition of the following Codes and Standards:

- Canadian Electrical Code Part-1 2015 Edition
- Illumination Engineering Society (IES) Standards
- Telecommunication Industries Association (TIA)
- CAN-ULC-S524-14- Standard for Installation of Fire Alarm Systems
- CAN-ULC-S537-13- Verification of Fire Alarm Systems
- Local Ordinances and Authorities Having Jurisdiction

9.2 Electrical Services and Distribution

9.2.1 Electrical Distribution

The existing electrical service at the WWTP site is a 400A, 347/600V, underground service from a 300kVA utility pad mounted transformer. The goal of the project is to maintain the existing service; however, this will be dependent on the loads of the new and replaced process equipment. In the next stage of design when the process equipment selection is refined, it should be determined whether the existing service is to increase to accommodate the upgrades.

The main service entrance is located in the second-floor Electrical Room. It is the design intent to maintain this location as the main service entrance and location of main distribution board. As design progresses, consideration will need to be given to potential phasing or staging of construction which may result in temporary electrical services. The WWTP will continue to be serviced from the existing 347/600V, 3P, 4-wire distribution system.

The main switchboard, rated for 400A 600V 3-phase 4-wire, consists of a main 100% rated 400A circuit breaker with solid state trip unit, a current transformer section for utility metering and a distribution section for the feeder circuit breakers. This switchboard sub-feeds two Motor Control Centres (MCC), MCC-1 and MCC-2, and three transformers. There are two 600/120/208V transformers, each feeding a single 120/208V, 3-phase panelboard, and one 600/277/460V, 3-phase transformer feeding a single panelboard. The primary distribution voltage throughout the facility is 600V with localized 208 and 480V as required.

Large mechanical motors and process equipment with high electrical loads will be fed at 600 volts. There is some equipment that will be fed from the existing 277/480V system in the Headworks.

Lighting will be predominantly fed from 208 volts supply as well as small miscellaneous mechanical equipment. All communication systems and building receptacles will be fed from 120/208V, 3-phase 4-wire distribution systems.

The MCCs will house all the necessary breakers, motor starters, soft-starters etc., for the equipment installed, in addition to retaining the necessary spare capacity required for any additional loads to be installed under future developments.

All distribution and branch circuit breakers will be automatic, molded-case type. Uniformity of manufacturer would be maintained for all panelboards and circuit breakers specified. Transient voltage surge suppression (TVSS) protection will be provided at the main 600V switchboard and selected distribution panels.

Short circuit and protective coordination/Arc flash studies shall be included in the project by a professional employed by the contractor.

9.3 Standby Power Supply

A 250kW diesel driven electric generator unit currently provides back-up power as a standby source to the normal utility power service through an automatic transfer switch. The standby generator system will be designed to automatically energize on utility failure with a delayed shutdown on return to normal power.

The standby MCC panel will supply power to designated motors required for process treatment as well as to selected mechanical building systems and general lighting. The ventilation systems power requirements will be coordinated with mechanical to insure hazardous areas continue to be ventilated during a utility power outage. Also, generator back up will be provided to an Uninterrupted Power Supply (UPS) where required. The UPS in turn will provide power to the Programmable Logic Center (PLC) and other critical circuit systems.

It is recommended that a load bank be provided to facilitate annual testing of the generator. The load bank shall be capable of accommodating 100% of the generator load and will have multi-step controls. The provision of a load bank reduces complication of annual testing and improves reliability.

Part of the value engineering discussions included keeping the existing generator and revising the distribution via load shedding if loads are greater than the capacity of the existing generator. This will be the goal of the design going forward but needs to be confirmed.

Further discussions with the facility operators and the design team are required in order to confirm the WWTP generator size. As the design progresses the generator size may need to be increased.

9.4 Branch Circuit Wiring

All power wiring for the process areas in general will be installed in exposed rigid metallic conduit (RMC). Electrical metallic tubing (EMT) will be used only in areas with general building functions such as administration areas, lab areas etc. at locations where conduits are not subject to mechanical injuries. Conduit size to be a minimum of 21mm. Electrical non-metallic tubing (ENT) may be used for concealed wiring in poured concrete walls or block walls filled with concrete. Any external underground ducts will be PVC schedule 40. Conduit runs in concrete slabs and floors shall be rigid PVC. Empty conduits will be complete with nylon pull wire. All flexible conduit connections to motors and motor controls will be flexible metallic type with liquid tight connectors. Raceways and cables passing through floors and fire-rated walls will have sleeves filled with fire-rated sealing compound. Metal clad cables or flexible metallic raceways may be used for connections to transformers and connection drops from ceiling junction boxes to luminaires.

All building wiring larger than #10AWG, unless otherwise noted will be stranded copper, 600V insulation. Insulation resistance and resistance to ground tests will be performed on all feeders prior to being energized. No conductors smaller than No.12 gauge to be used for branch circuit wiring. All wiring will be complete with permanent markers identified at each splice and pull box and will be color coded.

All feeders will consist of copper conductors pulled in conduits, with separate grounding conductors for interior distribution equipment and Teck 90 armored cable for all process and exterior feeders. All Teck cables will either be installed in the cable trays or in the underground duct banks

Overhead wire mesh cable trays may be used on accessible ceiling areas to accommodate cabling for data, telephone, security, and other low-tension systems. A two-tier system will be provided to maintain separation between low tensions cables and power conductors.

9.5 Lighting

It is the intent that all lighting within the facility shall be replaced and upgraded. The following summarizes the lighting design and lighting systems to be implemented for the WWTP upgrade:

- Lighting systems will be designed as energy efficient, quality artificial lighting, and low maintenance systems.
- Lighting design will be in accordance with IESNA lighting handbook.
- The design includes luminaires in all administration area rooms, corridors, and process areas. Luminaires will include LED systems for process interior and exterior areas.
- All luminaires will be suitable and rated for the environment where they are located.
- All light fixtures provided will be LED-type. In general, fixtures will have a minimum CRI of 85, 4100K colour temperature.
- Lighting control systems for exterior fixtures will include a contactor from an “On Off Auto” switch with photocell and time clock control.

9.6 Emergency and Exit Lighting

It is the intent that all existing battery packs, remote heads and exit signs will be removed, and new devices provided. All emergency lighting in the building will be accomplished by using battery packs and double remote heads with low voltage LED lamps. The battery packs will also supply DC power to the exit lights for illumination under the condition of normal power failure.

AC light emitting diode (LED) type exit lights, that conform to CAN/CSA-C860 will be used to provide energy efficiency and to meet the proposed CSA/NBCC standard.

Emergency battery packs will be located outside of any corrosive or hazardous areas. Remote heads and exit signs will be specified to suit the environment in which they are located.

The exit signs specified will meet the National Building Code requirement that exit signs consist of a green pictogram and a white or lighted tinted graphical symbol, commonly referred to as the “running man”.

9.7 Fire Alarm System

A single stage, non-coded, fully addressable fire alarm system, designed to meet the requirements of the National Building Code of Canada, will be included. The system will include the provision of pull stations, smoke detectors, heat detectors, duct detectors, and audio-visual signaling devices, as required. Interfaces between the fire alarm system, building management system and process controls system will be provided as per applicable codes and standards, and client requirements.

The system will include a main control panel with integral annunciator in the electrical room and remote annunciator(s) at other designated fire-fighting entrances.

Smoke detectors will be of the photoelectric type. Heat detectors shall be of both the fixed temperature and fixed temperature/rate-of-rise type as determined by the location. Ancillary devices such as fan shutdown and autodialer/communicator activation shall be incorporated as required.

Connection to a digital autodialer and programmed to notify on-call or maintenance staff as determined by the client.

Uniformity of manufacturer shall be maintained for all fire alarm system components.

9.8 Structured Wiring System

Data distribution throughout the WWTP building will originate at the demarcation point in the electrical room. The final arrangement will be discussed with the owner and telecommunication utility provider and details will be incorporated in the subsequent construction documents.

The communication common works will meet all relevant TIA/EIA standards. This will be a Cat 6 rated cable plant and facility. A 25 year manufacturer's warranty will be specified for the plant.

The intention for the offices and labs is that there will be two (2) Cat 6 cables terminated to two (2) Cat 6 rated RJ 45 outlets at each work station for voice and data.

There will be network points for PLC communication at every location identified by the instrumentation and controls division.

All data switches, servers and wireless access points (if required) will be provided by the owner.

9.9 Access Control System

An access control system (ACS) shall be installed at all main exterior entrance points of the WWTP building.

ACS shall be of proximity technology. Proximity cards and/ or fobs may be used on the system based on the discretion of owner.

Staff and custodial staff will be issued proximity cards to enter the building. Restriction of access to key areas may be implemented using hierarchy based security access control. This information is to be provided by the owner very early in the project to allow for setting up of infrastructure/programming of the system.

ACS door controller panel will be installed in the main electrical room.

Electrified door locking devices with required exit hardware such as electric locksets or electric strikes shall be specified and supplied under the doors and windows specification.

9.10 Intrusion Alarm System

An Intrusion Alarm (IAS) system will be installed to monitor the entire WWTP facility building. Main IAS controller panel will be installed in the main electrical room.

A telephone outlet shall be provided for intrusion alarm panel connection for alarm monitoring. IAS panel shall be equipped with remote access (modem) capability to allow panel to be programmed and tested remotely.

Dual technology motion detectors (PIR) shall be installed on the main entrance/exit.

Door alarm contacts to be installed on all exterior perimeter doors. Door alarm contacts to connect and report as individual inputs on the intrusion panel.

9.11 Commissioning and Testing

In a project of this nature it is imperative that the commissioning and testing of major electrical equipment and systems be undertaken by a commissioning and testing agency employed by the contractor. This work will include necessary verification and start-up procedures. Operation and maintenance manuals incorporating copies of shop drawings, complete schematic diagrams, recommended maintenance schedules and logs, system operation write-ups test results and safety procedures would also form part of the electrical contractor’s scope of work.

10 INSTRUMENTATION AND CONTROL DESIGN

10.1 Introduction

The upgraded WWTP will be fitted with a completely integrated instrumentation and controls system. The system will be configured to ensure the reliable operation of the treatment process in a continuous automatic mode.

The instrumentation and control section outlines the general process control philosophy, key system components, guidelines for recommended instruments, the requirements for integration of vendor supplied packaged equipment, and the proposed configuration of the process control network.

In general, the process control philosophy for the WWTP will see the plant controlled by two Programmable Logic Controllers (PLCs) that communicate with the field devices required to monitor and control each individual aspect of the treatment process. Plant systems will operate in Automatic, Manual Remote, or Local modes.

10.2 Operation Modes

10.2.1 Automatic

Automatic control will be performed by programmed logic within the PLC that controls the respective segments of the process. The automatic mode is invoked by placing the local selector switch or switches in the automatic position and enabling the programmed logic within the PLC network to provide control. Where local PLCs and operator interface terminals are utilized (with vendor supplied packaged equipment) the onboard interface terminal will be provided with a local/remote select via the operator interface.

10.2.2 Remote Manual

With the local switch in the automatic mode, the operator will have the option to manually control the equipment from the main operator work station or the plant floor operator interface terminals.

10.2.3 Local

Equipment can be manually controlled by placing the local selector switch in the hand or off position. Vendor supplied packaged equipment will be locally operable on manual mode by selecting local control and interacting with this equipment from the onboard interface terminal.

10.2.4 Plant Alarms

Plant alarms will be categorized into three groups – Safety, Major and Minor. The categories are defined as follows:

- Safety alarms are conditions that are dangerous to personnel or property and require immediate response.
- Major alarms are conditions that require immediate attention.
- Minor alarms are conditions that do not require immediate attention.

Each category of alarm will have a resulting outcome with operator actions to manage the alarm condition (e.g. major alarms require immediate attention; minor alarm conditions should be noted but are non-urgent). The WWTP will be fitted with an audible alarm system to advise operational personnel to go to the nearest plant computer system workstation or operator interface terminal to determine the source of alarm and to take the appropriate action depending upon the alarm priority.

For vendor supplied packaged equipment, such as blowers, a separate discrete visual warning display, provided with the package, will be located at the equipment but integrated with the plant computer alarm system.

A safety alarm can be defined as a condition that could cause danger to life if not given the appropriate attention immediately. The alarm could be generated from; process equipment, combustible gas detection systems or fire detection systems. Safety alarms will be wired directly from the primary initiating device to the audible and visual warning devices installed at key locations around the plant (e.g. bells or horns, and warning units including access points in process areas). A discrete status contact will be taken from the primary sensor to the plant computer system to warn that a safety alarm has been initiated.

10.3 Plant Trend Data and Information Archive

The control system computing will be configured to allow the trending of pre-determined process variables. These trends will be operator configurable to allow the selection of trend variables, trend time bases, and the trend scale. The data required for process trending will be stored in a historian database for archive purposes. Archive data can also be retrieved and compiled to provide daily, weekly, or monthly reports.

10.4 Plant Control System (PCS)

The plant control system (PCS) will utilize two PLCs and vendor package supplied PLC based subsystems connected on an industrial control network to form a single integrated PCS. The PLCs, software, and communications network components will all be of a uniform manufacturer to ensure that the system will not require physical media or software protocol converters to operate.

10.4.1 System Hardware

The WWTP is currently fitted with Allen Bradley (Rockwell Automation) PLC and corresponding software systems. The design intent for the new WWTP is to standardize the entire site to Allen Bradley (Rockwell Automation) PLCs and corresponding software systems. This uniformity of technology manufacturer provides advantages in that both operations and maintenance personnel will need to train on, and be familiar with, only one technology platform. Two new operator machines will be provided as part of this work to provide redundant SCADA PCs for the operators.

10.4.2 System Software

The PCS will utilize several different pieces of software to provide the various system functions. New PLC logic will be developed and implemented using Rockwell Automation RSLogix 5000 whereas the existing logic will continue to utilize RSLogix 500. It is proposed that the existing RSView32 software be upgraded to the Rockwell Automation FactoryTalk platform, to ensure compatibility with the installed PLC hardware and keep the system up to date with current operating systems. This compatibility minimizes effort required to integrate the operator interface with the process control, allowing for better operator tools.

It is anticipated that the complete PCS will consist of several PLCs installed at the following locations (controls for all vendor packaged equipment to be confirmed during detailed design):

- Headworks (new PLC)
- Screens / screenings conveyor/ washer compactor (Vendor package)
- Primary filter (Vendor package)
- Secondary treatment (new PLC)
- Blower control (Vendor package)

PLC hardware and system software packages will be standardized to ensure all systems can communicate and share equipment status and control information over a common platform. Where packaged equipment vendors cannot provide PLC based controls that are appropriately compatible with the plant PCS other alternatives will be pursued.

10.4.3 System Communications

Individual PLCs will be networked together to form a complete plant automation system. The design approach will be to provide the control systems network using an Ethernet/IP protocol. This control network will be configured in a star topology using copper based Category 6 Cabling, as the size of the plant foot print will not require other media to address transmission distance restrictions. The PCS will also be connected to a plant information network. The plant information network will provide data connections for operator interface computers, operator interface terminals on the plant floor, engineering workstations, and the plant data historian.

10.5 Motor Control and Variable Frequency Drives

A large portion of the plant control will be provided through the control of electric drive motors. These motors will be fed from Motor Control Centers (MCCs) located in the headworks and the secondary treatment areas of the plant. Where variable frequency drives (VFD) are required to provide a variable pumping or treatment equipment speed, they will be located within the MCCs to avoid the harsh environment of the plant floor. The control system interface for fixed speed motor starters and the variable frequency drives within the MCCs will be via Ethernet/IP communications protocol.

10.6 Process Instruments and Control Devices

Process measurement and control devices will be specified to provide rugged, reliable, industrial quality components. These devices will be selected with the intent to ensure that they have local vendor service and support. Where possible devices such as flow meters, pressure, temperature, and level instruments will be selected to correspond with the manufacturers/types that are currently installed in the WWTP. Where the owner has device preferences those instrument and control components will be specified.

Where instruments and control devices are to be installed in areas classified as hazardous atmospheres the devices will be rated and installed to meet the appropriate code requirements. Rated spaces such as the headworks area will, where at all possible, have only the essential devices installed within the space.

The rated spaces will also be fitted with gas detection systems which will provide local visual and audible alarm signaling. The gas detection system will be provided as a complete certified system, and will not rely on the plant PLCs or control network to operate. The gas detection system will however provide alarm information to the plant PCS so that operations staff will have all required alarm location information available without having to enter the space.

11 CONSTRUCTION STAGING AND SCHEDULE

11.1 Construction Staging

With the restricted floor space available, it will be a significant challenge to minimize the necessary diversion of wastewater flow from the existing primary treatment system to the adjacent primary lagoon, which is the contingency treatment system. New floor space is not being created to allow the new construction to be completed prior to abandoning the existing fine screens and primary filter.

To minimize the amount of diversion to the lagoon, it is anticipated that a new primary filter can be installed while the existing system remains in operation. Unfortunately, this is not the case with the fine screens as they will require replacement in the same foot print. It will be stressed to the General Contractor to remove and replace these screens as efficiently as possible with minimal downtime.

In general, the other challenges with modifying the plant are less of a concern. The existing electrical system will provide some challenges and it will be necessary to interrupt the generator operation for installation of the DAF units. To counteract this potential loss of power, it is suggested that through additional protocols and attention, the flow can be diverted to the lagoon in the event of a power outage.

To summarize the efforts anticipated this time, it is suggested that the project proceed in the following construction stages:

- Stage 1
  - Existing preliminary and primary treatment remains in operation
  - Remove equipment not in use
  - Relocation of electrical items serviced in existing electrical room
  - Temporary provisions for generator service
  - Install one new primary filter
  - Commence secondary demolition and installation

- Stage 2
  - Receive, stage and prepare new fine screens for installation
  - Divert flow to lagoon
  - Remove and replace existing fine screens
  - Start-up, commission and place primary system into operation through one new primary filter and with flow through secondary bypass to outfall
  - Commence second primary filter installation
  - Continue secondary construction

- Stage 3
  - Upgrade influent pumps (with minimal diversion to lagoon)
  - Complete second primary filter installation, start-up and commission
  - Complete secondary construction while primary remains in operation
  - Start-up and commission secondary systems

11.2 Construction Schedule

There are several significant constraints that will dictate the milestone goals of the project schedule. These include:

- Funding goal to expend significant funds in year 2018
- Tender in spring to take advantage of summer 2018 construction season
- Negotiate and enter into Novation agreement for MBBR and DAF supply, in order to make fall sealift.
- If necessary, prepare price inquiries and enter in to Novation Agreements for other long term delivery items, in order to make fall sealift

A detailed schedule is included in **Appendix B** and the major milestones are summarized as shown in **Table 12.** Note that this schedule is highly dependent on the Contractor’s means and methods and should be considered for planning purposes only. The estimated construction schedule will be refined further during detailed design.

Table 12: Estimated Construction Schedule

Critical Task	Start Date	End Date
Execute Veolia Novation Agreement	November 7, 2017	January 3, 2018
Pre-purchase Equipment Quote & Award (if necessary)	February 16, 2018	April 2, 2018
WWTP Upgrade Construction Tender & Award	April 2, 2018	May 11, 2018
WWTP Construction	May 21, 2018	August 28, 2019
Commissioning	August 29, 2019	October 9, 2019
Project Complete		December 18, 2019

12 CLOSING

Respectfully submitted,

Nunami Stantec Limited

Submitted by:

Glenn Prosko, P.Eng
Senior Project Manager

Reviewed by:

Alejandro Rojas
Senior Process Engineer

NUNAMI STANTEC

APPENDIX A

Conceptual Review Drawings
(Under Separate Cover)

APPENDIX B

Estimated Construction Schedule