Government of Nunavut

Wastewater Treatment Plant – Design Brief

Type of Document
Final

Project Name
New Utilidor Design, Resolute Bay, NU

Project Number
OTT-00206333-A0

Prepared By:

exp Services Inc.
100-2650 Queensview Drive
Ottawa, ON   K2B 8H6
Canada

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exp Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 8H6
Canada
T: 613 688-1899
F: 613 225-7337
www.exp.com

Stephen G. Bliss, M.Sc.E., P.Eng.
Water and Wastewater Services

Steven L. Burden, P.Eng.
Manager – Municipal
Infrastructure Services

Date Submitted:
December 2012

Table of Contents

List of Appendices

List of Tables

1 Introduction

1.1 General

The following design brief summarizes the design parameters that will be utilized for the addition of a wastewater treatment plant to service the Hamlet of Resolute Bay. While Resolute Bay has been served by a piped water and sewer system since the late 1970's, wastewater treatment has been non-existent.

The Hamlet is a small, isolated community in Northern Nunavut with a combination of challenges with respect to wastewater treatment. The Hamlet requires a wastewater treatment facility that can service the future permanent population as well as seasonal temporary population. The Hamlet requires a system that is simple to operate while being reliable and compact.

1.2 Community Description

Resolute Bay is located on Cornwallis Island at N74°42' and W94°52'. Resolute Bay has a reported population of approximately 250. The climate is especially challenging in this community. Average annual temperature is -16.7°C and average annual wind speed is 21 km/hour. The lowest temperature recorded at this site is -52.2°C and the highest recorded hourly wind speed is 142 km/hr. A wind chill temperature as low as -72°C has been observed. The extremely low temperatures are combined with a protracted period of dark during the winter. The sun does not rise above the horizon between early November and early February. The combination of temperature, high wind and lack of daylight create challenging operating conditions for much of the year.

The Hamlet of Resolute Bay is made up of two development areas: the town site and the airport area. In the late 1970's, the majority of the permanent population of the community were relocated to the current town site area. The town site area was developed with piped water distribution and sewage collection networks. The needs of the Airport area is currently met using a truck service delivery system. There is no current intention to modify this servicing scheme.

1.3 Project Scope

The basis of the design of the new wastewater treatment facility will focus on a mechanical treatment system. The Pre-Design Report for this project reviewed several options and the form wastewater treatment would take. While lagoons are the favoured wastewater treatment process in the north, a suitable site for a lagoon system would be too far from the Hamlet to make such a system feasible on a piped sewage system. Given the climatic conditions experienced here, a mechanical (biological) treatment system would have to be enclosed to allow for proper biological operation. The cost of construction in the north is very high and this will require that the treatment system be as compact as possible. The membrane bioreactor (MBR) process, as recommended in the Pre-Design Report, will provide a high-quality effluent in a relatively small footprint.

It is planned that the new works be commissioned and in service prior to April 1, 2017. The design life that has been set for these works will vary but the expected design life for the civil works is 30 years; the design life for the rotating (mechanical) equipment is expected to be in the 10-15 year range. Thus, the planning horizon for the project is 2047.

2 Design Criteria and Background Data

2.1 Service Conditions

Due to the location of the Hamlet, weather and remoteness present the biggest challenges for the wastewater treatment system both in terms of design and operation. These factors create periods of time when the community cannot be accessed from the outside for deliveries of supplies. This poses a challenge for wastewater treatment whereby sufficient storage must be provided for stockpiling of spare parts/equipment and consumable products such as chemicals.

As defined in the Pre-design Report, there is a significant temporary population in the Hamlet that can approach the permanent population in numbers. This temporary population can create a situation where the average daily flow increases significantly for periods of several weeks during the year. The wastewater treatment system must manage streams from both the piped collection network serving the town site, as well as sewage trucked from the airport area of the community.

2.1.1 Existing Facilities

The existing water treatment/distribution and wastewater collection infrastructure for the Hamlet has been a part of the community for many years. Historically wastewater "treatment" consisted of a macerator; its purpose was to grind up the solids in the wastewater stream prior to discharging to the ocean. The unit was not operating during the site visit of May 30, 2012, and it did not appear to have been operational for some time. As a result, solid materials (primarily paper products) are building up at the mouth of the outfall. The new wastewater treatment system will generate a clean effluent free of the solids that are now evident.

The effluent is discharged at the edge of the ocean above the high tide limit. The existing outfall location will continue to be used for the new treatment system. Relocating/extending the outfall to achieve a submerged discharge would require approvals from Transport Canada (Navigable Waters Protection Act) and the Department of Fisheries and Oceans (Fisheries Act). Also, relocating the outfall in such a manner would substantially add to the overall project costs.

2.1.2 Design Flows

The design flows for the wastewater treatment system were developed based on the population to be served over a 30-year design period, both permanent and transitory (the discussion on the serviced population can be found in the Pre-Design Report).

Design flows (based on design year 2047) are:

- Average daily flow: 4.7 L/s
- Maximum flow: 7.6 L/s
- Peak flow: 8.9 L/s

2.2 Wastewater Characteristics

The wastewater characteristics for design of the wastewater treatment facility were developed as part of the pre-design study. In summary, the design characteristics on a concentration basis are significantly higher than current wastewater test results indicate. The design characteristics take into account future initiatives by the hamlet to reduce bleed water flow into the collection system which would significantly increase the wastewater concentrations. The wastewater characteristics that have been developed for design are presented in Table 2.1.

Table 2.1 - Recommended Influent Wastewater Characteristics for Design

Parameter	Unit	Influent	Effluent Limits[1]
Carbonaceous BOD_5 Concentration (BOD_5)	mg/L	110	80
Total Suspended Solids (TSS)	mg/L	125	70
Chemical Oxygen Demand (COD)	mg/L	250	
Ammonia-N (NH_3-N)	mg/L	12	
Total Kjeldahl Nitrogen (TKN)	mg/L	20	
Total Phosphorous (TP)	mg/L	4	

Table 2.2 lists the projected effluent characteristics. While the limits shown do not yet officially apply to northern communities, they are consistent with what would be expected of secondary wastewater treatment.

Table 2.2: Projected Effluent Characteristics

Parameter	Unit	Value[2]
Carbonaceous BOD_5 Concentration (BOD_5)	mg/L	<25
Total Suspended Solids (TSS)	mg/L	<25
Ammonia-N (NH_3-N)	mg/L	<1.25

[1] *Guidelines for Treated Municipal Wastewater in the Northwest Territories*
[2] Fisheries Act "*Wastewater Systems Effluent Regulations"*, SOR/2012-139

3 WWTP Design Considerations

3.1 Wastewater Treatment

In general, the wastewater treatment system will consist of a packaged membrane bioreactor system with aeration and anoxic biological treatment tanks to provide the bulk of the treatment. A number of additional processes and process units will be required to form a complete wastewater treatment system for the Hamlet. The following paragraphs provide a description of each of these processes and provide a description of how each unit fits into the overall treatment system. Also refer to Drawing P-401 "Resolute Bay WWTP Flow Diagram" and Drawing P-402 "Resolute Bay WWTP P&ID" in Appendix A.

3.1.1 Screening

Preliminary treatment will consist of coarse and fine screening. Coarse screening will consist of an automatically-cleaned bar screen with openings in the 6-12 mm range. The purpose is to remove large inorganic debris that cannot be biodegraded in the biological treatment system and may create maintenance issues for downstream pumps and equipment. All wastewater will initially flow through this screen and into the first of two wastewater sumps. The wastewater will then be pumped through a drum screen with a screen element having 2-3 mm openings. The purpose of secondary fine screening is to provide protection for the membranes further downstream. Particles larger than 2-3 mm (ultimate fine screen pore size depends on the specific membrane manufacturer) can potentially damage the membranes by tearing the membrane material. The fine-screened wastewater will flow to a second sump where it will be pumped to the Equalization Tank.

Screened material collected from the drum screen will be washed, compacted and dewatered prior to being discharged into a bagging collection system. Screened material from the coarse screen will be collected in a separate lined bin. All screenings will ultimately be disposed of in the solid waste landfill site.

3.1.2 Pumping

Pumping of the raw wastewater will be required to first move the liquid from the initial receiving sump (via a duplex submersible pump system) through the drum screen. A second duplex submersible pump system will transport the wastewater from the screening area to the Equalization Tank via. These two sets of duplex pumps will be located in sumps in the floor of the screening/dewatering room. Submersible pumps will be designed to handle raw wastewater and will be non-clogging to assist with passage of larger solids particles. Pumps will be supplied complete with lifting davits or other lifting devices and guide rails to allow retrieval of the pump for maintenance without entering the sump. Pumps will be designed for duty/standby operation, that is, each pump will be sized to handle the design peak flow. Pump operation within the sumps will be on/off, controlled by the PLC as required based on sump level, and will allow for alternating duty to avoid excessive wear on a single pump.

From the equalization tank, raw wastewater will be fed to the biological treatment system using duplex, centrifugal, end-suction pumps that will be installed on a concrete housekeeping pad on the building floor near the equalization tank. These pumps will be controlled by variable frequency drives (VFD) to allow for steady inflow to the biological system (anoxic tank). These pumps will be designed for continuous duty operation to allow for consistent inflow to the biological system over 24 hours. Pumps will be of the close-coupled design (as opposed to belt-driven) and will be supplied as a complete package pre-installed with the motor on a common steel base.

A duplex pump system will be required to extract permeate (treated effluent) from the membrane system. These pumps will both operate as duty pumps with one pump dedicated to each membrane tank. Provision will be made within the permeate piping to allow for each pump to service both tanks in the event of a pump failure. These pumps will be supplied by the membrane equipment supplier as part of a packaged skid-mounted assembly and will be centrifugal, end-suction, self-priming pumps with VFD control to allow for precise flow control.

Additional duplex pumps will be required to provide a constant recycle of mixed liquor suspended solids (MLSS) from the membrane tank to the anoxic tank. The discharge piping from these pumps will be configured to allow for a portion of the recycle MLSS to be diverted to the sludge storage tank for wasting. A final set of duplex pumps will be required to transfer sludge from the storage tank to the dewatering system. Both sets of pumps will be centrifugal, end-suction pumps. The recycle pumps will be supplied by the membrane equipment supplier and should be supplied pre-installed as part of a packaged assembly. The recycle pumps will be equipped with VFD control to allow variation of the recycle flow rate. The sludge pumps will operate with on/off control.

Treatment process bypasses will be included at four points: a complete plant bypass, a bypass after coarse screening (from the raw wastewater sump) and two after fine screening (either from the screened wastewater sump or from the Equalization Tank as a tank overflow).

3.1.3 Equalization

An Equalization (EQ) Tank will be required in order to absorb the “peak flows” associated with the trucking of wastewater from the airport area. These peaks will be more pronounced in the summer months when activity increases in the airport area and the population increases. The EQ tank provides attenuation within the system to help promote a steady delivery of flow and organic loading to the downstream biological treatment system. Sharp spikes in either flow or organic load can lead to instability and reduced treatment performance within any biological system and an EQ tank helps to minimize these potential impacts. The preliminary sizing of the EQ Tank is approximately 190 m^3; the usable volume will be in the order of 160 m^3.

The EQ Tank will be constructed of bolted steel, gasketed panels. The tank will be enclosed and vented to the exterior of the building. Screened wastewater will be pumped from this tank to the MBR system. The tank will generally operate at its lowest level in order to have containment volume available when needed.

3.1.4 Membrane Bioreactor (MBR)

The Membrane Bioreactor (MBR) will provide the majority of the wastewater treatment. The biological treatment system consists of three main zones within the system, identified as the anoxic tank, the aeration tank and the membrane tanks. The anoxic tank is the first zone in the process and consists of a mixed tank with relatively low levels of dissolved oxygen (DO). Bacteria in the presence of low oxygen levels are able to perform biological nitrogen removal which also can reduce the amount of chemical required for alkalinity addition. The aeration tank follows the anoxic tank and it is here that most of the biological treatment occurs within the system. The aeration tank operates at a higher DO concentration allowing the aerobic bacteria to consume the organic material in the wastewater, eliminating most of the influent BOD_5 concentration. The mixed liquor from the aeration tank flows to the membrane tanks.

Some organic removal continues within the membrane tanks but the primary purpose is to house the submerged membranes that provide virtually 100% removal of TSS from the effluent. Dual membrane tanks are proposed to allow for one tank to be out of service for periodic membrane cleaning as required without a need to stop flow to the system. It is also proposed that the anoxic and aeration tanks be designed as a single structure with common-wall construction to make efficient use of materials and floor space. It is anticipated that the membrane tanks will be skid-mounted packaged systems complete with main equipment items such as permeate pumps and scour blowers pre-installed and pre-piped.

The MBR system will be supplied as a packaged treatment system by a single supplier and will include a number of key equipment items including pumps, aeration blowers, mixers, chemical feed systems, instrumentation, and controls. The extent of the supply as part of the membrane package will be better defined in the detailed design phase of this project. The intent is to have the membrane equipment supplier provide as much of the equipment as possible to promote single-source accountability. It is also the intent to have as much of the equipment as possible supplied as skid-mounted, packaged assemblies complete with piping, valves, and instrumentation pre-installed. This will help reduce the cost and complexity of the installation of this equipment and may also allow for more efficient use of space within the plant.

3.1.5 Ultraviolet (UV) Disinfection

A final step in the treatment process is UV disinfection for deactivation of pathogens within the effluent discharged from the membrane system. The UV system will likely be a stainless steel channel bolted to a concrete housekeeping pad on the building floor. The stainless steel channel will house the UV lights that perform the pathogen deactivation. The UV system will be supplied as a complete unit including an outlet weir to maintain a minimum level of treated effluent in the channel. This minimum level ensures that the bulbs are always submerged even under low flow conditions. The UV system will include provision in the piping configuration including valves to allow for bypass of the system if maintenance is required. An additional advantage of the high quality effluent produced from the membrane system is that the effluent has a high UV transmittance which can allow for the use of a smaller UV system to achieve the same effectiveness. The disinfected effluent will be utilized as plant service water for chemical and polymer dilution requirements.

3.1.6 Residuals Management

Due to the continuous growth of the active biomass in the system, production of waste activated sludge (WAS) from any biological treatment system is inevitable. A waste sludge storage tank will be used to retain the waste sludge prior to dewatering. This allows for the operator to thicken the WAS and periodically direct WAS to the dewatering operation at convenient times. Dewatering is required to reduce the overall volume of waste sludge sent for disposal. There are many different operations available for dewatering, but given the remoteness of the Hamlet and the inherent challenges of sourcing spare parts, a simple but effective option is to handle the waste sludge using GeoTubes®. A GeoTube® is constructed from geomembrane fibers as a large enclosed tube. The sludge is pumped into the tube until the tube is full. The flow of sludge is then stopped allowing the tube to relax and the water in the sludge naturally leave through the permeable membrane. This process is repeated until the GeoTube® is full.

The GeoTube® will be housed in a roll off bin or trailer in an enclosed room of the treatment plant adjacent to the raw wastewater sumps and screening. The water draining from the GeoTube® (identified as filtrate) would be directed from the roll off bin/trailer to the screened wastewater sump and recycled back to the EQ tank. The sludge would collect in the GeoTube® until such time as it is full, then the roll off bin/trailer would be removed from the plant, hauled to the landfill site, emptied of the GeoTube® and returned to have a new GeoTube® installed. A filled GeoTube® would be in the order of 2.5m wide by 7m long, and weigh in the order of 20 tonnes. Preliminary calculations indicate that the treatment system would fill up to 6 units per year in the early years, increasing to 8 units per year as the population increases through to 2047.

3.1.7 Chemical Systems

Various chemical systems will be required for the proper operation of the plant. The MBR system will require cleaning chemicals to keep the membranes functioning properly. The membranes can be fouled by both organic and inorganic material. The membranes operate by having the water pass from the outside to the inside of the membrane structures. Generally, organic fouling can be addressed by continuously applying an air scour over the face of the membranes and, on a regular basis, apply a backpulsing (reversing the flow of effluent) or relaxing the membranes (halt the permeate pumps) while the air scour continues. This removes the majority of the organic build-up. Over time, however, the organic build-up is such that the regular cleaning method becomes ineffective.

Organic fouling that cannot be removed by the above method of cleaning can be effectively controlled through the use of a chlorine compound, usually sodium hydroxide. A solution of sodium hydroxide is introduced into the effluent side of the membranes and allowed to drain through the membranes from the inside out dislodging the organic growth. A weak acid (e.g., citric acid) is similarly introduced into the membranes to remove inorganic material (e.g., scale). The chemical cleaning, for both organic and inorganic fouling, should be a relatively infrequent event – 1 to 2 times per year for each.

The chemical cleaning systems will consist of simple duplex metering pumps, piping and valving mounted on a panel. The cleaning chemicals would be shipped in a concentrated liquid form or as a powder so a dilution tank (with a mixer) will be required for each system. The chemical dosing system for membrane cleaning will be supplied by the membrane equipment supplier as a packaged, skid-mounted system.

A chemical (polymer) feed system consisting of duplex metering pumps, piping and valving will also be required for the dewatering system. The polymer would be shipped in powder form; therefore, a mix (make-down) tank will be required. Further dilution will be necessary before the polymer is used in the dewatering system; final effluent will be used for the dilution water.

An additional consideration for this plant will be chemical addition to the biological treatment system for alkalinity control. Aerobic treatment systems generally undergo a process called nitrification in the presence of sufficient ammonia-nitrogen (from the raw wastewater) and oxygen (from the aeration blowers). This process consumes alkalinity which can leave the system vulnerable to an alkalinity deficiency. Having sufficient alkalinity in the system is critical for buffering in the reactor to maintain a neutral pH balance required for proper system operation. The addition of a denitrification step (anoxic zone) provides recovery of roughly half of the alkalinity lost through nitrification. However, in some cases, chemical addition such as soda ash or sodium bicarbonate is required to maintain proper alkalinity levels in the biological system. Preliminary investigation for the Resolute Bay facility indicates that alkalinity chemical addition likely will not be required but this will require more analysis during the detailed design phase of the project.

3.2 Process Support Requirements

The additional equipment that is proposed for the new Resolute Bay wastewater treatment plant includes:

- Washroom/Shower Facility – Shower stall, single sink, toilet and storage vanity
- Laboratory Facility – Sampling sink, counter top, storage cupboards
- Laboratory Equipment – Laboratory equipment will include all necessary glassware, testing apparatus, chemicals, etc., to perform the tests required for proper monitoring of the treatment system.
- Safety Shower – eyewash and safety shower in case of chemical exposure
- Maintenance room with storage and workbench – an area has been included for equipment repair, spare parts and other storage requirements.

- Boiler room
- Genset room
- Chemical storage appropriate for storing chemicals in a cool, dark and dry location.

3.3 Instrumentation and Control

The water supply, distribution, and wastewater treatment systems will require a singular controls system that will integrate the Char Lake Pump House, the Signal Hill Water Treatment Plant (WTP) and the new wastewater treatment plant (WWTP). Each location will be interconnected with an Ethernet network.

At each of the separate facilities, a standalone Programmable Logic Controller (PLC) will be required. The PLC will control functions as well as monitor online instrumentation. It is proposed that Allan Bradley PLC controllers be used throughout the various sites, each site with a touchscreen control interface. It has been reported that Allan Bradley controllers are utilized in the Resolute Fuel tank farm, so this would be a good selection based on trouble shooting and spare parts availability. Each PLC will have a local operator interface running Allen Bradley Factory View Software (or equivalent). The programming of the PLC would be done using RS Logix software and the Operator interface programming would be done with Allen Bradley Software that is not proprietary in nature. An additional copy of Factory Talk View would be installed on a Personal Computer (PC). This PC would act as a server to collect and display data from all locations that are connected to the Ethernet network. Additional Factory Talk View Clients for additional PC users can be added as long as they are connected to the Ethernet network.

The following is a preliminary list of functions that the wastewater treatment PLC will control:

- Flow measurement (inlet of plant, plant effluent and waste sludge);
- Operation of the raw wastewater pumps feeding the MBR system;
- Monitoring the MBR system for status/alarms;
- Various “FAULT” and “STATUS” indications for auxiliary equipment:
    - Pumps (Circulation and Chemical Feed)
    - Diesel Generator
    - Boilers
    - HVAC

It is proposed that a combination of wireless Ethernet radios and buried fiber optic communication lines be utilized for communication between the Char Lake, WTP and WWTP sites. To increase the reliability of the system licensed frequency radios such as Cal amp Viper SC UHF shall be utilized as they can be operated up to 10 watts power output. This should negate the loss of line-of-sight and the weather related communication issues.

3.4 Controls Narrative for Wastewater Treatment System

The following is a preliminary list of functions that the wastewater treatment PLC would control:

- On/off and speed control for all pumps based on online flow and/or level instrumentation
- On/off and speed control for all blowers based on online flow and/or dissolved oxygen (DO) instrumentation
- Chemical metering for pH adjustment

- Timing of backpulse operations (if required for specific membrane system)
- Clean-in-place routines for periodic membrane cleaning including chemical metering
- Control of waste sludge flow to waste sludge storage tank.

The following is the proposed preliminary instrumentation required for the wastewater treatment plant:

- Level indicating transmitters for all tanks and sumps
- Flow transmitters for raw influent, permeate (effluent), recycle sludge, and waste sludge
- Dissolved oxygen instrumentation for aeration, anoxic, membrane, EQ, and sludge storage tanks
- Trans-membrane pressure transmitter for each membrane tank
- Online temperature monitoring for aeration tank
- Various faults and alarms based on set-points for instrumentation listed above.

3.5 Building Space Requirements

A new structure will be required to house the wastewater treatment process. The building will be located in the vicinity of the existing macerator building close to the existing sewer pipe.

At present, the building size has been set at 600 m^2 (20m X 30m) – refer to Drawing P-403 “WWTP Layout” in Appendix A. The building will house all components of the wastewater treatment system as well as the office, sludge dewatering and the Support Requirements (refer to Section 3.2). All rooms are to be located on the ground floor; initial space allotments for the various rooms are as follows:

- Office/lab: 24 m^2 (4m X 6m);
- MCC: 20 m^2 (4m X 5m);
- Gen-set Room: 15 m^2 (3m X 5m);
- Boiler Room: 25 m^2 (5m X 5m);
- Chemical Storage: 20 m^2 (4m X 5m);
- Maintenance: 30 m^2 (5m X 6m);
- Washroom /w shower: 6 m^2 (2m X 3m); and,
- Sludge Dewatering: 50 m^2 (5m X 10m).

Room arrangement will be such that the office/lab room will be separated from the gen-set room by other spaces to minimize noise.

Good engineering practice would have the areas in which the raw wastewater sump, the screened effluent sump and the sludge dewatering are to be located to be “classified” as outlined in the NFPA 820 “Standard for Fire protection in Wastewater Treatment and Collection Facilities”, 2012 Edition. The sumps and dewatering process would be located in a common room that would be sealed off from the rest of the building; access would be from the outside. All electrical components within this area would be rated as Class I, Division 2 as a minimum. Appropriate gas detection equipment (e.g. combustible gases, H_2S) will also be required for safety and monitoring purposes.

3.5.1 Building Design Criteria

Reference Codes and Standards

Design will be in accordance with requirements of following standards and to requirements of local authority having jurisdiction. Where conflict occurs, the most stringent shall apply.

- National Building Code of Canada 2010 edition, errata, revisions and supplements.
- CSA-A23.1-09/A23.2-09, Concrete Material and Methods of Concrete Construction / Methods of Test for Concrete.
- CSA-A23.3-04 (R2010), Design of Concrete Structures.
- CSA-S16-09, Limit States Design of Steel Structures.
- CSA-S136-07, North American Specification for the Design of Cold Formed Steel Structural Members.

Structural Loading

Design loads will be in accordance with the 2010 edition of the National Building Code of Canada (NBCC) for Resolute Bay. The Importance Category = ‘Post-Disaster’, per Table 4.1.2.1 of the NBCC.

- Dead load:
    - Roof and walls: dead loads will be based on the pre-engineered building preliminary design.
    - Mezzanine floor: based on final design for mezzanine concrete/metal deck floor structure.
- Live load:
    - Mezzanine floor: 4.8 kPa + equipment load.
    - Main floor slab: 4.8 kPa + equipment load.
- Snow and rain (1/50):
    - S_s = 1.7 kPa.
    - S_r = 0.1 kPa.
- Wind:
    - $q_{1/10}$ = 0.54 kPa.
    - $q_{1/50}$ = 0.69 kPa.
- Seismic:
    - S_a (0.2) = 0.30.
    - S_a (0.5) = 0.15.
    - Sa (1.0) = 0.083.
    - Sa (2.0) = 0.025.
    - PGA = 0.15.

Foundations

The building foundation design will be carried out in accordance with the geotechnical report recommendations (supplied under separate cover). It is anticipated that the foundation will be a cast-in-place concrete mat with rigid insulation, granular base and thermosyphon system.

Structure

The building structure will be a steel pre-engineered building system which is well suited and commonly used in the north. The framing will consist of steel rigid frames spanning the narrow dimension of the building which will support cold formed roof purlins, liner, insulation and metal roofing. The wall structure will consist of horizontal cold formed girts, liner, insulation and exterior metal cladding.

The lateral load resisting system will consist of rigid frames along with X-braced endwalls for loads parallel to the building narrow dimension, and X-braced sidewalls for loads parallel to the building long dimension.

Building Envelope

The building envelope will consist of the following:

- Walls:
    - Pre-finished metal cladding.
    - Air barrier.
    - RSI 4.4 minimum semi-rigid insulation.
    - Thermal sub-girts.
    - Structural cold formed girts.
    - Interior vapour barrier/metal liner.
- Roof:
    - Standing seam metal roof cladding.
    - Thermal support clips.
    - Air barrier.
    - RSI 7.0 minimum semi-rigid insulation.
    - Structural cold formed purlins.
    - Interior vapour barrier/metal liner.

3.6 Building and Site Services

3.6.1 Building Mechanical Services

Fire Protection

Fire Protection will be in conformance with the National Fire Code 2005 and conform to NFPA 820 “Standard for Fire Protection in Wastewater Treatment and Collection Facilities”, 2012, with the exception of sprinklers.

Due to the limited availability of Fire Protection Water in the vicinity of the building the building will not be sprinklered. Water supply will be provided by the local fire department for fire suppression.

The building will be divided off into two areas:

The classified area will be designed under the Liquid Stream Treatment Process Requirements to the Coarse and Fine Screen Facilities as a Class 1, Div 2 area. This area houses the sludge dewatering, raw sewage sump and screened sewage sump. Fire Extinguishers and a Combustible Gas Detector will be required. The area will be physically separated and sealed from the unclassified area.

The unclassified area will be designed under the Liquid Stream Treatment Process Requirements to the Enclosed Aeration preceded by Primary Treatment. Fire Extinguishers and a Fire Alarm System will be included. The area will be physically separated and sealed from the classified area.

Plumbing

Plumbing will be in conformance with The National Building Code of Canada 2005. A non-accessible washroom will be provided on site with lavatory, water closet and shower. A lab sink will be provided in the Lab/Office. Domestic water will stored on site in a domestic water tank and distributed throughout the building with a duplex pumping system. Water will be heated in a diesel-fired hot water storage tank. A combination emergency shower and eyewash with tempered water will be provided close to the chemical storage area.

Heating

Heat will be provided by two sectional cast iron boilers pumping through a duplex pumping system to unit heaters located throughout the plant. Redundancy will be provided for all units heaters. Hydronic baseboards will be utilized for smaller areas. The system will be filled with food grade glycol to prevent freeze-up.

The use of water-to-air heat pumps for capturing heat from the process waste stream to use as building heat was reviewed. The high cost of electricity for operating the heat pumps does not make this an economically viable option.

Ventilation

Areas will be ventilated in accordance with the National Building Code, ASHRAE 62-2007 “Guidelines for Acceptable Indoor Air Quality”, and NFPA 820.

Ventilation Unclassified Area: The space can be continuously ventilating at the rate of six (6) air changes per hour. This flow rate may further be reduced to three (3) air changes per hour when the outdoor air temperature is below 10^{o}C. The use of a heat recovery type supply and exhaust air unit will further reduce energy consumption. Return air from the building will be heated before it passes through the heat recovery unit by a hydronic heating coil to prevent frost up of the coil. All controls will be tied to the process PLC and the system powered by both normal and back-up power sources. The use of variable frequency drives will permit accurate flow setting which will be verified by a balancing contractor. Temperatures will be controlled and monitored digitally and setback for further energy saving. Point of source humidity control will be utilized at the aeration tank with the use of clear curtains to contain the vapour. The aeration tank will be kept under a slight negative pressure and exhausted through the heat recovery unit.

Ventilation Classified Area: The Classified Area must be ventilated at a rate of twelve (12) air changes per hour to achieve an electrical rating of Class 1, Group D, Division 2. The system requires combustible gas detection to ensure fans are operating when a hazard is detected. The ventilation equipment will employ both supply and exhaust fans. The fans may run at 50% when the outdoor air temperature is below 10^{o}C and the combustible gas detection system permits. The use of variable frequency drives will permit accurate flow setting which should be verified by a balancing contractor. A heat-pipe heat recovery device will be utilized. Return air from the building will be heated before it passes through the heat pipe to prevent frost up of the coil. Process water conditions will be monitored and room temperature maintained at approximately 5^{o}C above process water temperature to reduce condensation in the area. Heating will be achieved with explosion-proof hydronic unit heater(s).

Ventilation Generator Space: Heated generator exhaust air will be sent to the main space via duct work ducted up through the generator space ceiling. Intake cooling air will enter the space via ductwork through the wall connecting the main and generator spaces. This will allow the generator heat to be recovered during periods of cold outside air temperatures. Due to the volume of the main space, heat exhaust air from the generator should not affect indoor environment when outside air temperatures are higher. If it is determined during the detailed design phase that this does cause a major effect in the main space environment, a temperature controlled exhaust fan will be utilized. A temperature controller will maintain the generator space by controlling intake and exhaust air dampers on the generator ventilation ductwork.

Ventilation Boiler Room: Heat from the boilers will be rejected to the main space of the plant. Again this will allow capturing of heat during cold periods and during warmer periods an exhaust fan in the main are of the plant could be used to reject the heat if required. Combustion air to the boilers will be supplied through a motorized damper from the building exterior.

Ventilation MCC Room: Heat from the MCC will be rejected to the main space of the plant via an exhaust fan and duct work through the ceiling into the main space. Supply air will be cooler air from the main space entering the room at a lower elevation. The temperature is to be controlled by a reverse acting thermostat.

Chemical Storage Area Ventilation: Stored in the Chemical Storage Room is Sodium Hypochlorite in liquid form, Citric Acid in power form, and Polymers. Ventilation will be through a continuous exhaust fan to keep the room under a slight negative pressure at all times.

3.6.2 Building Electrical Services

General

Wherever possible the design will meet all applicable codes and standards for the region including:

- Canadian Electrical Code of Canada 2012
- National Building Code of Canada 2010
- National Energy Code for Buildings 2011
- Government of Nunavut – Structured Cabling Guidelines
- Government of Nunavut – Electrical/Mechanical Safety Section - Electrical Bulletins
- Government of Nunavut – Office of the Fire Marshall (OFM) - Technical Bulletins

As much as possible and practical the electrical design will maintain uniformity of manufacturer.

Power Distribution

A 600 volt, 200 amp service entrance will be fed from the local utility (Qullig Energy Corporation) and will meet the utility service entrance standards. A service-rated fusible main disconnect will be used in order to protect the system from utility power surges. Spare fuses will be required on site to minimize plant interruptions. A diesel standby generator, complete with an automatic transfer switch, will be installed within the wastewater treatment plant in order to maintain total plant operation during a utility power outage.

Due to the high cost of purchasing electrical power from the local utility an investigation is currently ongoing in to the feasibility of replacing the standby generator with a prime generator. This generator would run continuously, as much as possible, and would turn the wastewater treatment plant into a co-generation facility. The majority of the time this facility would operate totally independent of the local electric utility. The plant would be equipped with automatic switching to minimize disruption in the event of a generator failure.

A motor control center will be installed in the plant electrical room which will contain all of the feeders, motor starters and circuit breakers for the 600 volt loads. Variable frequency drives will be installed on some motors in order to improve control functionality as well as energy efficiency. In order to reduce cost, the variable frequency drives will be wall mounted and not installed in the motor control center. Each variable frequency drive will be equipped with a line side reactor in order to minimize the harmonics that are placed back on to a relatively small electrical system. Local motor disconnects will be installed, where feasible, to make motor maintenance as simple as possible.

The sump/dewatering area of the wastewater treatment building will be a “Classified” area and will, therefore, require that all electrical components installed in this area be explosion-proof. Explosion-proof components come with a significant cost increase. The components installed in this classified area will be kept to a minimum in order to minimize any unnecessary cost.

Lighting & Building Services

One feed from the motor control center will power a 600V:120/208V transformer. This transformer will directly feed the mains of a distribution panel located in the building’s electrical room. The distribution panel will be used to power the lighting and building service loads as well as any miscellaneous 120/208V loads required in the building.

Due to the high cost of electricity the reduction of energy consumption is of great importance. The plant will be equipped with occupancy sensors which will control the interior lighting and photocells that will control the exterior lighting. Though fluorescent lighting fixtures are the standard industrial, **exp** will continue to investigate the energy savings as well as the increased life cycle associated with LED lighting and will weigh that against the higher initial cost of installation. The design will also include exit lights and emergency lights within the plant. Lighting will be designed to conform to the National Energy Code. Standard building services such as receptacles and switches will be included in this design. Controlled outdoor receptacles will be provided for parking stall use.

SCADA & Controls

A PLC panel will be installed in the plant electrical room which will be used for process control and monitoring. An Allen Bradley SLC 500 PLC will be used in order to maintain the current standard in the area. An Allen Bradley Panelview Plus graphic terminal will be mounted on the front of the PLC panel to provide local process monitoring and control. A desktop PC will be placed in the wastewater treatment plant office which will be used for remote process monitoring and control. This computer will be networked with the water treatment plant as well as the Char Lake water pumping station in order to make data from both of these stations available at the wastewater treatment facility. This network design will likely utilize both wired and wireless communication between the stations and will make it possible to add a SCADA computer at a municipal office for process monitoring and control of all three stations. Remote alarming will be used to provide off-site operators with both critical and non-critical alarms from each station.

Reliability

In order to make the facility reliable, hand/off/auto switches will be installed on all of the motors in the motor control center. If the PLC is lost for any reason, the operator will be able to run all of the motors manually to maintain plant operation until the PLC issue can be resolved. **Exp** is investigating the possibility of a remote connection from the **exp** offices. This would allow for remote assistance and troubleshooting, and would allow **exp** to make process modifications when required to improve operation.

4 Cost Estimate

A detailed opinion of probable cost has been developed for the wastewater treatment system. This probable cost is presented in Appendix A of this report. The following table summarizes the probable capital costs.

Table 4.1 – Wastewater Treatment Probable Capital Costs

Item	Estimated Cost
Building	$2,235,700
Wastewater treatment process	$2,782,500
Mechanical and electrical	$1,263,000
Site development	$210,000
Sub-total	**$6,491,200**
General requirements	$1,298,200
Freight and accommodations	$1,635,800
Design and pricing allowance	$942,500
Construction Allowance	$518,400
Subtotal allowances and contingencies	**$4,394,900**
Total	**$10,886,100**

5 Summary

5.1 Summary

The findings and recommendations of this design brief may be summarized as follows:

- Design flows, based on both the permanent and transitory population and the design year of 2047, are:
    - Average daily flow: 4.7 L/s
    - Maximum flow: 7.6 L/s
    - Peak flow: 8.9 L/s
- The design characteristics of the raw wastewater take into account future initiatives by the hamlet to reduce bleed water into the collection system.
- A mechanical wastewater treatment system best fits the needs of the Hamlet.
- The design service life will be: civil works: 30 years; mechanical components: 15 years.
- The recommended wastewater treatment process is a membrane bioreactor (MBR). The MBR minimizes unit processes and requires a small footprint.
- Additional unit processes include screening, ultraviolet (UV) disinfection and solids management.
- The recommended ultimate destination of the waste biosolids is the community solid waste landfill.
- A GeoTube® dewatering system is the recommended dewatering process.
- A new building will be required to house the wastewater treatment system. Preliminary sizing for the building is 20m X 30m.
- The building will be located adjacent to the existing macerator building near the shoreline.
- It is anticipated that the building will be a pre-engineered structure on a cast-in-place concrete mat foundation.
- The building will also include rooms/space for:
    - Office/laboratory;
    - Maintenance room;
    - Washroom c/w shower;
    - Boiler/genset room;
    - Chemical storage;
    - Motor control center.
- The space containing the raw wastewater sumps and the sludge dewatering equipment will require particular attention to the electrical, heating and ventilation equipment due to the possible presence of hazardous gases.

- The treatment process will be controlled by a Programmable Logic Controller (PLC) that can be monitored both locally and remotely on a personal computer (PC). This will be interconnected with the SCADA system monitoring the Char Lake Pumphouse, the Signal Hill Water Treatment Plant and the Utilidor system.
- A Class C cost estimate has been developed for the proposed works. This estimate may be as follows.

Construction costs	$6,491,200
Allowances and contingencies	$4,394,900
Total	$10,886,100

Appendix A – Figures

Appendix B – Cost Estimates