Preliminary Design Report

IQALUIT WWTP

Conversion & Expansion

May 2004

Iqaluit

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EARTH TECH

A Tyco Infrastructure Services Company

Conversion and Expansion of the Iqaluit Wastewater Treatment Plant

Preliminary Design Report

Prepared for:

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City of Iqaluit
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Prepared by:

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May, 2004

Project # 75360

Earth Tech Canada Inc.
17203 – 103 Avenue, Edmonton, Alberta T5S 1J4 Canada

May 26, 2004

Refer to File: 75360-03

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City of Iqaluit
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Attention: Mr. Brad Sokach, P.Eng.

Dear Brad:

Re: DRAFT - Preliminary Design Report

Earth Tech is pleased to submit our Draft Preliminary Design Report for the Conversion and Expansion of the Iqaluit Wastewater Treatment Plant (WWTP). We look forward to the City's comments on this draft report, and we are available at your convenience to discuss the contents of the report in further detail.

Very truly yours,

EARTH TECH (CANADA) INC.
Per:

Glenn Prosko, P.Eng.
Project Manager

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1.0 BACKGROUND

Earth Tech (Canada) Inc. (ET) was retained by the City of Iqaluit to undertake the design of improvements/upgrades to the Iqaluit WWTP, and provide inspection services during the construction of the improvements/upgrades.

There are numerous issues associated with the existing WWTP and they have been documented in the following reports:

• Structural Review of the Process Tanks at the Iqaluit Reclamation Facility	CH_2M Gore & Storrie
• Sewage Treatment Plant Investigation	Earth Tech (Canada) Inc.
• Completion Study for the Iqaluit Wastewater	CH_2M Hill

As part of this project, it is the City's intention to address the deficiencies and issues identified in these previous reports. Furthermore, it is the City's desire to convert the existing facility to a conventional activated sludge secondary treatment plant to meet the projected flows and loadings for a 20-year design horizon.

The objectives of the design team are as follows:

- To provide a complete operating system that not only meets the needs of the community, but which also suits the specific characteristics of its location;
- To provide optimal design and operational features suited to the community and avoid processes or equipment that require highly specialized technical skills or sophisticated maintenance procedures;
- Where practical, remove features of the existing plant which would have been awkward to operate or even unworkable;
- Maximize the re-use and integration of salvageable components within the existing facility; and
- Minimize life cycle costs of the facility, while meeting the technical requirements of the approval.

2.0 DESIGN CRITERIA – RAW WASTEWATER CHARACTERISTICS

The design of the Iqaluit WWTP is to be based on a Phase 1 population of 8,000 with consideration and provisions included in the design for a Phase 2 population of 12,000. However, some unit processes have been designed for the Phase 2 service population, because the additional cost of installing the equipment for Phase 2 is minimal, or because of space limitations for a second unit.

The assumed raw wastewater characteristics are detailed in **Table 2-1** below. The design criteria have been developed based on the requirements set out in Table 2 of the City's RFP. The design criteria has been augmented with Total Kjeldahl Nitrogen (TKN) loadings, and both flow and peaking factors, based on Earth Tech's experience at other communities in Canada.

Table 2-1 – Raw Wastewater Design Criteria

Raw Wastewater Characteristics	Design Criteria
Phase 1 Design Population	8,000
Phase 2 Design Population	12,000
Per Capita BOD Load	80 g/c/d
Per Capita COD Load	160 g/c/d
Per Capita TSS Load	80 g/c/d
Per Capital TKN Load	15 g/c/d
Phase 1 - Average Annual Flow (AAF)	3,200 m^3/d
Phase 2 – Average Annual Flow (AAF)	4,800 m^3/d
Peak Hour Load Peaking Factor (PF)	1.5
Maximum Month Load Peaking Factor (PF)	1.2
Maximum Day Flow Peaking Factor (PF)	2.0
Peak Hour Flow Factor (PF)	3.0

The raw wastewater characteristics listed in **Table 2-1** are typical of values found in communities across North America and are considered to be reasonable and prudent design assumptions.

The Iqaluit WWTP will be designed to nitrify on a year-round basis and two additional parameters are of particular concern:

- Alkalinity; and
- Temperature.

The alkalinity of the raw wastewater is expected to be low, as the water supply in the City has little alkalinity. Alkalinity is added to wastewater from detergents and raises the alkalinity of raw wastewater by approximately 80 mg/L over water (measured as $CaCO_3$). As discussed later in this report, the nitrification process consumes alkalinity and the denitrification process releases alkalinity. However, the resulting alkalinity in the wastewater effluent will be lower than desired and an alkalinity supplement will be required. The alkalinity supplement will take the form of soda ash, lime, or caustic. For the purposes of this report, it assumed that the raw wastewater would have a 'natural' alkalinity of 100 mg/L (as $CaCO_3$), of which 20 mg/L is residual from the City's Water Treatment Plant, and the remaining 80 mg/L from detergent.

The effects of cold ambient air temperatures in Iqaluit on the temperature of the raw wastewater are ameliorated by the fact that the raw water supply in Iqaluit is heated using a series of 'reheat' stations. To assist in developing a temperature profile during the winter for raw wastewater, the City staff measured the temperature of raw wastewater over a 24 hour period from Wednesday, March 10 to Thursday, March 11. The ambient air temperature at the time of sampling was –35ºC.

The results of the sampling program are summarized in **Table 2-2** below.

Table 2-2 – Temperature Measurements

Sampling Time	Temperature ºC
9:30 a.m.	15
9:40 a.m.	13.5 (Truck 41 dumping)
11:30 a.m.	14
1:30 p.m.	14
3:30 p.m.	14.5 (Truck 39 dumping)
5:30 p.m.	15
12:20 a.m.	12.5
4:00 a.m.	10
8:00 a.m.	13.5

The arithmetic average of the nine temperature data points is 13.6ºC. For the purposes of this report, a more conservative design temperature of 12ºC will be used to allow for future expansions of the collection system, which could cause a somewhat lower raw wastewater temperature.

The design flows and loads for the Nunavut WWTP are summarized in **Table 2-3** below.

Table 2-3 – Design Flows and Loads

		Stage 1	Stage 2
		8,000	12,000
Flow			
Average annual flow	m^3/d	3,200	4,800
Maximum month flow (PF 1.2)	m^3/d	3,840	5,760
Maximum week flow (PF 1.35)	m^3/d	4,320	6,480
Maximum day flow (PF 2.0)[1]	m^3/d	6,400	9,600
Peak hour flow (PF 3.0)	m^3/d	9,600	14,400
Peak hour flow (PF 3.0)	L/s	111	167
BOD			
Average annual per capita load	kg/c/d	0.080	0.080
Average annual load	kg/day	640	960
Maximum month load (PF 1.2)	kg/day	704	1,056
Maximum week load (PF 1.35)	kg/day	864	1,296
Maximum day load (PF 1.5)	kg/day	960	1,440
COD			
Average annual per capita load	kg/c/d	0.160	0.160
Average annual load	kg/day	1,280	1,920
Maximum month load (PF 1.2)	kg/day	1,408	2,112
Maximum week load (PF 1.35)	kg/day	1,728	2,592
Maximum day load (PF 1.5)	kg/day	1,920	2,880

[1] It is noted that the Maximum Day Flow PF used in Earth Tech's Water Treatment Plant Pre-Design Brief, dated March 2002 is 2.0 and the Peak hour factor is 3.0.

Table 2-3 – Design Flows and Loads Cont'd

		Stage 1	**Stage 2**
		8,000	12,000
TSS			
Average annual per capita load	kg/c/d	0.080	0.080
Average annual load	kg/day	640	960
Maximum month load (PF 1.2)	kg/day	704	1,056
Maximum week load (PF 1.35)	kg/day	864	1,296
Maximum day load (PF 1.5)	kg/day	960	1,440
TKN			
Average annual per capita load	kg/c/d	0.015	0.015
Average annual load	kg/day	120	180
Maximum month load (PF 1.2)	kg/day	132	198
Maximum week load (PF 1.35)	kg/day	162	243
Maximum day load (PF 1.5)	kg/day	180	270

3.0 DESIGN CRITERIA – EFFLUENT REQUIREMENTS

Earth Tech initiated discussions with regulatory authorities concerning appropriate effluent requirements for the secondary treatment plant. The parameter of particular concern is ammonia, as the requirement to reduce ammonia in the raw wastewater has a significant impact on both the construction cost and operating cost of the WWTP. Based on the discussions with regulatory agencies, **Table 3-1** below presents the proposed effluent limits for the WWTP (Refer to correspondence in **Appendix A**).

Table 3-1 – Effluent Requirements

Effluent Requirements	Effluent Criteria[2]	Design Objective
BOD	45 mg/L	20 mg/L
TSS	45 mg/L	20 mg/L
Ammonia	10 mg/L	10 mg/L

The proposed effluent requirements for BOD and TSS of 45 mg/L are typical of requirements set in jurisdictions across North America for coastal discharges. The effluent limit of 10 mg/L for ammonia is reasonable for a secondary treatment plant designed to reduce ammonia in a cold weather climate.

Notwithstanding the regulatory effluent requirements in Iqaluit, the design objective for BOD and TSS will be 20 mg/L, based on a monthly average of daily 24-hour composite samples. The activated sludge process is able to meet the more stringent BOD and TSS design objectives of 20 mg/L, and will therefore be used as the basis of design.

The design objective for ammonia will remain at 10 mg/L and the WWTP process will be designed to nitrify on a year round basis.

It is noted that many jurisdictions do not impose an ammonia effluent limit for discharge to a marine environment. However, based on discussions with regulatory authorities having jurisdiction in Iqaluit, it is evident that ammonia toxicity is a concern, and therefore ammonia will need to be treated and reduced.

To date, the Nunavut Department of Health and Social Services and Environment Canada have responded to the proposed effluent limits and agreed to the limits, as proposed (Refer to correspondence in **Appendix A**). The Nunavut Department of Health and Social Services has agreed to the effluent limits as proposed and Environment Canada has acknowledge that the proposed effluent limits of 45, 45, 10 (BOD, TSS, Ammonia) are a significant improvement over the effluent quality guidelines for marine embayed areas that are being followed in Nunavut. Environment Canada suggested that the limits of 45, 45, 10 should be set as the maximum allowable concentrations, and that lower objectives of 20 to 30 mg/L should be used for BOD and TSS. The design objectives detailed in **Table 3-1** meet the objectives suggested by Environment Canada.

[2] Based on monthly averages of 24-hour daily composite samples

4.0 PROCESS ALTERNATIVES

The preferred biological process for Iqaluit is conventional activated sludge, which will be designed to nitrify on a year-round basis. The requirement to nitrify in Iqaluit has been confirmed from our discussions with regulatory agencies in Nunavut. As conventional activated sludge is a proven process with numerous applications throughout the world, the process is adaptable to changing flow and load conditions, an alternative biological process will not be considered for Iqaluit. However, several alternative unit processes will be considered as detailed below.

The conceptual process design proposed by CH_2M Hill was based on the following unit processes:

- Raw wastewater pumping;
- Screening;
- Biological Process
    - Aerobic zones for BOD and ammonia reduction;
    - Anoxic zones for denitrification;
- Secondary clarification;
- Waste Activated Sludge (WAS) thickening (Dissolved Air Flotation – DAF);
- Thickened WAS Storage;
- Dewatering (centrifuge).

The following unit process alternatives will be considered for Iqaluit:

- Incorporation of grit removal after fine screening;
- Incorporation of primary clarification;
- Gravity belt / rotary drum WAS thickening in lieu of DAF WAS thickening; and
- Belt filter press dewatering in lieu of centrifuge dewatering.

4.1 Incorporation of Grit Removal

A grit removal system removes sand and silt that enter a WWTP and reduces wear and abrasion on downstream rotating equipment, such as pumps and mixers. Grit removal was not included in CH_2M Hill's process design and there are many smaller WWTPs where grit removal is not provided.

One of the most common types of grit removal systems used today is the vortex style. The system consists of a cylindrical tank and impeller. Flow enters the chamber tangentially in a downward spiral, and the impeller rotates to create a slight upward density current to separate the more dense grit from the less dense organic material. The grit falls to the bottom of the tank and is removed, and the organics are allowed to continue downstream for further treatment.

The grit that settles to the bottom of the tank is removed with a pump, such as an airlift pump, and conveyed to a grit classifier. The classifier washes the grit and a screw conveyor dewaters the grit and discharges it into a bin for final disposal.

The grit removal system itself has a high level of operational simplicity, as there is one small drive on the top of the tank, an air lift pump, an air compressor, and one drive on the grit classifier. Similarly, the maintenance requirements are low, as Operations Staff may be required to grease a set of bearings and add oil to a gear box periodically. The life expectancy before a major repair is required, is dependent on the grit loading in Iqaluit, however it is expected that a major repair will not be required for at least 10-years.

Based on our discussions with people knowledgeable of raw wastewater characteristics in Iqaluit, and more generally within Nunavut, it was suggested that the grit load in Iqaluit will be low, as compared to communities in the south. The rationale for this observation being that there is virtually no infiltration to the sewer system, there are no car washes discharging to the sewer system, cross-connections between the storm and sanitary sewers, nor are there any other sources that could contribute grit to raw wastewater.

Although grit is not expected to be an issue in Iqaluit, it is prudent to include provisions for the unit process in the Headworks Building. Should grit ever prove to be a problem in the future, the additional wear and maintenance requirements on pumps, and mixers could be significant. With space allotted and provisions included in the design, a grit removal system could be added in the future. Furthermore, the incorporation of a Salsnes Filter into the process design will assist in the removal of grit. This is discussed further in the next section.

4.2 Incorporation of Primary Clarification

Primary clarification is a unit process that removes a portion of the Total Suspended Solids (TSS) fraction in the raw wastewater. In removing a portion of the TSS fraction, a portion of the BOD fraction is also removed, which reduces the sizing requirements of the bioreactor, aeration system, secondary clarification and sludge train.

For smaller WWTPs, such as Iqaluit, it is common not to provide a primary clarification unit process, as the cost and complexity of constructing and operating primary clarifiers is not offset by the savings of having a primary clarifier. Also, for smaller WWTPs it is not uncommon to employ extended aeration activated sludge, which utilizes extremely long SRTs of 15 to 30 days. Therefore, removing additional organic matter in a primary clarifier provides little benefit, when the activated sludge process is designed for long SRTs.

A technology developed in Norway is now being marketed in North America as a substitute for 'traditional' primary clarification. The technology is marketed as the 'Salsnes Filter' and uses a moving fabric belt with a nominal opening size of 300 microns. Wastewater is introduced on one side of the belt, and debris is retained on the wet side of the belt. Clarified wastewater passes through the belt and continues to downstream unit processes for further treatment. As the belt clogs, the belt advances and is washed, and the screened material discharges to a dewatering conveyor, that compacts the material to a solids content of 25 to 35%.

The Salsnes Filter is a simple, low cost and robust alternative to conventional primary clarification, and it is finding a niche in the marketplace as a means of reducing the organic loading to secondary treatment processes.

The Salsnes Filter is simple to operate and robust, and there is no reason to exclude the process from consideration. Therefore, this option will be carried forward and considered in further detail in Section 5 to determine if the added cost of the unit is warranted, based on savings in capital and operating costs.

4.3 Gravity Belt / Rotary Drum Thickening versus DAF

WAS thickening is a unit process that concentrates the mixed liquor that is wasted from the biological process. The advantage of WAS wasting and thickening is that it provides a relatively simple means of controlling the SRT of the biological process, which is the single most important process control parameter for an activated sludge process that is designed to nitrify. Also, thickening reduces the sizing of downstream dewatering equipment.

The most common WAS thickening technologies are Dissolved Air Flotation (DAF), gravity belt thickeners, and rotary drum thickeners. All three technologies are relatively simple and have been proven on many installations throughout the world. A comparative assessment of these three technologies is summarized in **Table 4-1** below.

Table 4-1: Comparison of Thickening Options

Parameter	DAF	Gravity Belt	Rotary Drum
Operational Simplicity	Satisfactory	Good	Good
Low Labour Requirement	Good	Satisfactory	Satisfactory
Process Control Simplicity	Good	Satisfactory	Satisfactory
Robustness of Equipment	Satisfactory	Good	Good
Minimal Repair and Maintenance	Satisfactory	Good	Good
Low Frequency of Major Repair	Good	Good	Good
Low Capital Cost	Satisfactory	Good	Good
Low Operating Cost	Good	Good	Good
Specialist Services Not Required for Repair/Maintenance	Good	Good	Good

The gravity belt thickener and rotary drum thickener have a marginal advantage over DAF for the parameters of operational simplicity, robustness of equipment, minimal repair and maintenance, low capital cost and low operating cost. However, the DAF has the advantage of a high level of process control simplicity, because wasting can be accomplished directly from the bioreactor, rather than from the RAS line as required by the other two thickening options. The advantage of mixed liquor wasting is that SRT control is simple, because it can be controlled simply by varying the WAS flow. For the alternative of RAS wasting, SRT is dependent on both the flow and concentration of mixed liquor, therefore process control is more complex.

The single largest factor contributing to the operating cost of a DAF is the recirculation pump, which returns effluent from the back of the DAF to the front of the DAF. The annual operating cost of the recirculation pump is estimated to be $2,700 (exclusive of taxes), based on the following assumptions:

- Recirculation Flow 100m^3/d
- Backpressure 50m
- Cost of electricity $0.27/kW-hr
- Pump efficiency 50%

Annual Cost = 100m^3/d / 3600 / 24 x 365 x 24 x 9.81 x 50 / 50% x $0.27/kW-hr
= $2,685

An advantage of the DAF is that polymer is not required to achieve a suspended solids concentration of 2.5%. Both the gravity belt and rotary drum alternatives require polymer and the annual cost of polymer is estimated to be $2,900:

- Daily WAS TSS 392 kg/d
- Cost of polymer $10/kg
- Polymer dosage 2 kg/tonne of dry solids

Annual Cost = 392 kg/d x 365 / 1000 x 2 x $10
= $2,860

It is noted that with polymer addition, both the gravity belt and rotary drum thickeners can achieve solids concentrations greater than 5%, whereas a DAF without polymer can achieve a solids concentration in the range of 2.5 to 3.0%. With polymer addition, a DAF can achieve a solids concentration of 5 to 6%, which is comparable to gravity belt and rotary drum thickeners.

The premium cost of purchasing a DAF over the alternatives of gravity belt or rotary drum thickening, is estimated to be approximately $30,000.

The high process simplicity and lower labour requirements of a DAF provide more benefit to the City, than the gravity belt / rotary drum thickening benefits of lower capital cost, operational complexity, and maintenance repair requirements. It is therefore recommended that DAF be used for WAS thickening.

4.4 Belt Filter Press Versus Centrifuge

The conceptual design report for the Iqaluit WWTP indicated that centrifuge technology is to be utilized for thickened WAS (TWAS) dewatering. Centrifuge dewatering is a well established technology and suitable for the service in Iqaluit, however other technologies, such as a Belt Filter Press (BFP), are available and provide some advantages over the centrifuge.

The following paragraphs provide a brief summary of the centrifuge and BFP technologies, then discusses the respective advantages and disadvantages of using the technologies in Iqaluit.

Centrifuge technology utilizes gravitational forces to separate the liquid fraction of the sludge from the solids fraction. The available gravitational force is enhanced by spinning a bowl at high speed (3,000 to 5,000), which dramatically increases the gravitational force and capacity of a machine.

Belt filter press technology 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 and sludge is fed at the beginning of the belt and 'squeezed' by 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.

Both centrifuge and presses require polymer to successfully dewater TWAS and the polymer performs two functions. The first is to neutralize the charge on the TWAS to reduce the natural tendency of sludge particles to repel each other, and the second is to enhance the formation of the 'floc' particles during the dewatering process.

A comparison of the advantages and disadvantages of centrifuge versus BFP is detailed in **Table 4-2** below.

Table 4-2: Comparison of Dewatering Options

Parameter	Centrifuge	Belt Filter Press
Operational Simplicity	Satisfactory	Good
Low Labour Requirement	Good	Satisfactory
Process Control Simplicity	Good	Good
Robustness of Equipment	Satisfactory	Good
Minimal Repair and Maintenance	Satisfactory	Good
Low Frequency of Major Repair	Good	Good
Low Capital Cost	Satisfactory	Good
Low Operating Cost	Satisfactory	Good
Low Odour Emissions	Good	Poor/Satisfactory
Specialist Services Not Required for Repair/Maintenance	Poor	Good

Overall, the centrifuge has a slight advantage over the BFP for the parameters of Low Labour Requirement, and Low Odour Emissions. BFP has a slight advantage over centrifuge in the areas of Operational Simplicity, Robustness of Equipment, Minimal Repair and Maintenance, Low Capital Cost, and Low Operating Cost. Of particular note given the service in Iqaluit, is the parameter of 'Specialist Services Not Required for Repair / Maintenance' and a BFP is far superior to a centrifuge. Given the complexity of the centrifuge in terms of mechanical, electrical and instrumentation equipment, a factory trained technician will be required to 'trouble shoot' virtually any problem. The BFP on the other hand is considerably less complex, fewer moving parts, and moving parts rotate at a considerably lower RPM, than a centrifuge.

Based on the preceding discussion, and recognizing that the centrifuge does provide some advantages, we believe the BFP technology is better suited for Iqaluit, and we therefore recommend the process for dewatering.

5.0 PROCESS DESIGN

This section of the report provides the rationale for sizing the major unit processes for the Iqaluit WWTP. Two options are considered in this section: Option 1 and Option 2. The process flow configurations for Options 1 and 2 are illustrated in **Figures 1 and 2**, respectively, on the following pages. The configurations are identical, except that Option 2 incorporates a Salsnes Filter, which is equivalent to a primary clarification unit process.

The process design for each configuration (Option 1 and 2) is developed based on two loading conditions:

- Maximum month flow and loading conditions in summer at 16^{o}C; and
- Average month flow and loading conditions in winter at 12^{o}C.

In addition to each configuration and loading condition, mass balances were completed for the Phase 1 and Phase 2 service populations of 8,000 and 12,000, respectively. In total, eight mass balances were prepared to cover the scenarios under consideration and are presented in **Appendix B**.

Each unit process is discussed in further detail in the following sections.

5.1 Option 1

5.1.1 Raw Wastewater Pumping

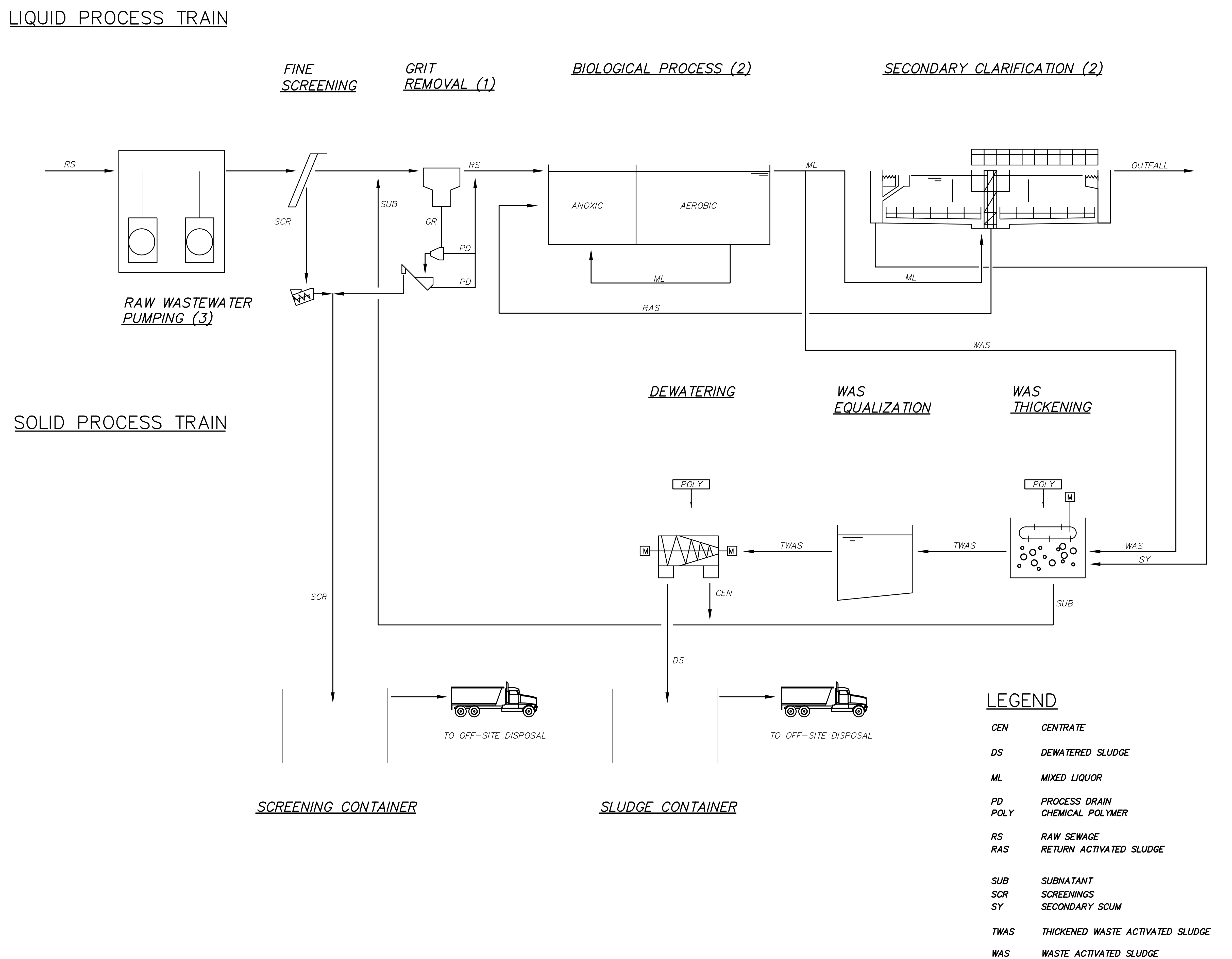
The existing raw wastewater pumping station is required to lift wastewater from below ground to the fine screens and downstream treatment processes. From the screens, wastewater will flow through the plant by gravity.

The existing pumping station consists of three submersible centrifugal pumps. The lift station building is ~ 48 m^3 and extends approximately 2.1 m above grade.

The pump station will need to be inspected to determine if the existing pumps have been damaged by freezing with standing water in the wet well. As a result, new raw wastewater pumps may be required. If possible, the existing raw wastewater pumping station will be retained and used in the new works. The approximate sizing of the raw wastewater pumps is as follows:

Number of Pumps	3
Configuration	2 duty and 1 standby
Capacity	56 L/s @ 10m TDH
Type	Submersible, centrifugal, solids passing

The pumps will operate in a lead lag arrangement, which will spread wear and tear evenly across all three pumps.



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No.	Date	Description
A	APR. 04 2004	REVISIONS

REVISIONS

Iqaluit
CITY of IQALUIT, Nunavut

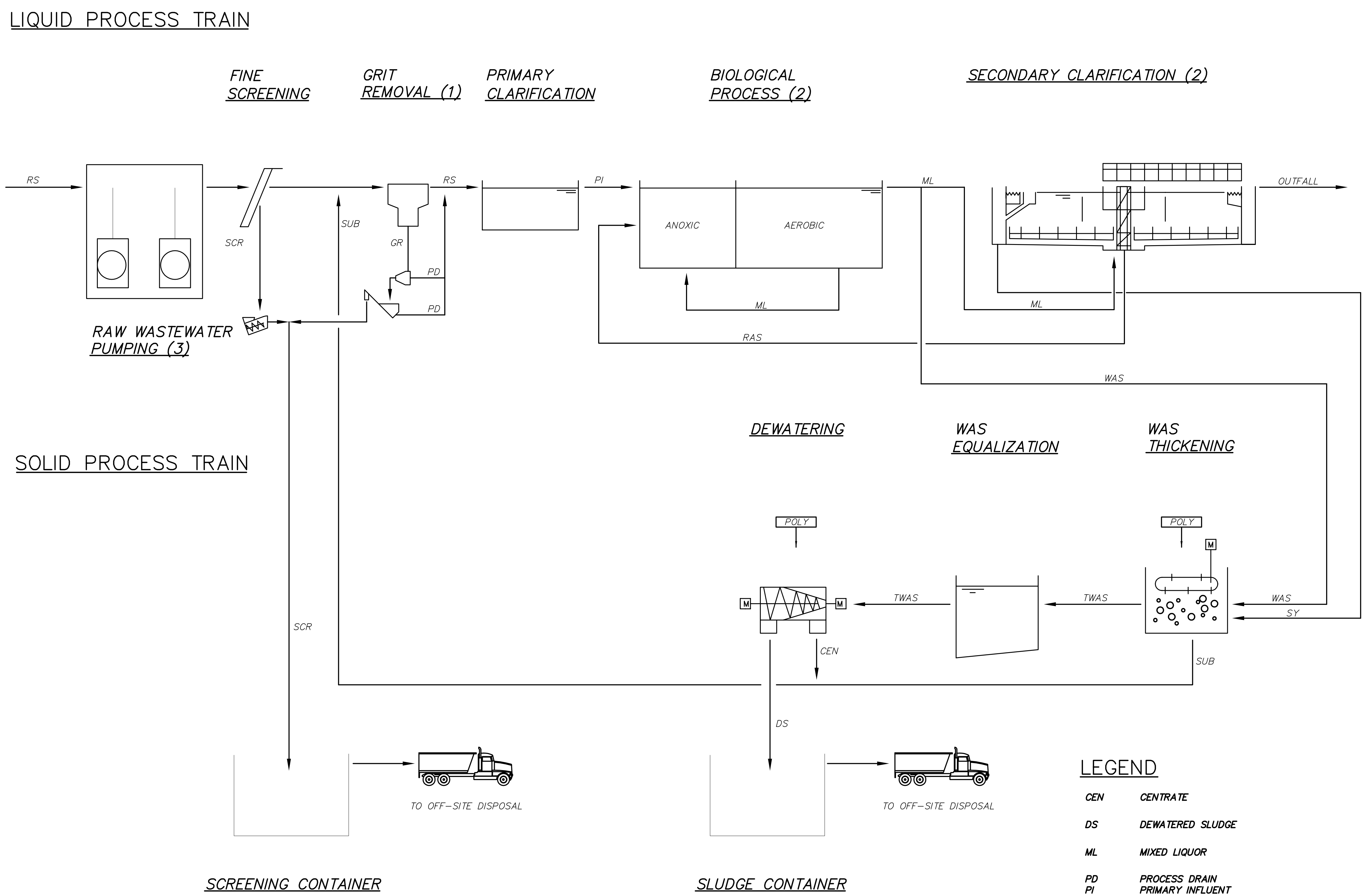
Design RDB
Drawn SEB
Approved Chief
Director

Project Title
CITY OF IQALUIT WASTE WATER TREATMENT PLANT

Drawing Title
PROCESS FLOW DIAGRAM - OPTION 1

Scale N.T.S
Project No. 75360
Date 08.04.04
Drawing No. **FIG. 1**
Revision **0**

PLOT DATE: 2004.04.19 07:40 PLOT SCALE: 1:1 PS BY: SUSAN.BALOGH



LEGEND

CEN	CENTRATE
DS	DEWATERED SLUDGE
ML	MIXED LIQUOR
PD	PROCESS DRAIN
PI	PRIMARY INFLUENT
POLY	CHEMICAL POLYMER
RS	RAW SEWAGE
RAS	RETURN ACTIVATED SLUDGE
SUB	SUBNATANT
SCR	SCREENINGS
SY	SECONDARY SCUM
TWAS	THICKENED WASTE ACTIVATED SLUDGE
WAS	WASTE ACTIVATED SLUDGE

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No.	Date	Description

REVISIONS

Iqaluit

CITY of IQALUIT, Nunavut

Design RDB

Drawn SEB

Approved

Chief

Director

Project Title

CITY OF IQALUIT WASTE WATER TREATMENT PLANT

Drawing Title

PROCESS FLOW DIAGRAM - OPTION 2

Scale N.T.S

Project No. 75360

Date 08.04.04

Drawing No. FIG. 2

Revision 0

PLOT DATE: 2004.04.19 07:40 PLOT SCALE: 1:1 PS BY: SUSAN.BALOGH

Two of the pumps will be equipped with VFDs to allow the flow to the treatment plant to be equalized. In addition, a level transmitter will be provided in the lift station, and the speed of the pumps will be modulated to maintain the desired water level setpoint.

For Phase 2, the pumps will be replaced with larger pumps having a capacity of 84 L/s.

Based on our discussions with people knowledgeable about raw wastewater characteristics in the North, it was suggested that the trucked wastewater will pose a challenge for the WWTP and most particularly the raw wastewater pumps. In particular, trucked wastewater will contain large amounts of debris, such as clothing and shoes, that will obstruct and disable the pumps. It is expected that the pumping station will require a significant amount of maintenance and operator attention.

The characteristics of trucked waste will be similar to 'portable outhouse' wastes collected in the south. Portable outhouse waste includes a large amount of debris, such as diapers, clothing, pop and beer bottles, and other debris. This type of waste stream is problematic and extremely difficult to deal with at a WWTP, as the debris blocks screens and pumps.

To address the concern of debris in the raw wastewater in Iqaluit, we recommend that the existing raw wastewater pumping station be incorporated into the new Headworks Building and the following additional provisions be incorporated into the design of the pumping station:

- Provide a manual 'basket' screen immediately downstream of the inlet sewer pipe to remove large debris before it enters the pump station. The basket screen will be equipped with rails similar to a submersible pump to facilitate the removal and cleaning of the basket;
- Include lifting provisions to allow the pumps to be removed and 'landed' in the Headworks Building for maintenance and to remove blockages;
- Provide direct access to the working platform in the pump station either from the 1st floor or by a stairwell from the 2nd floor; and
- Ventilate the wetwell at 6 & 12 air changes per hour.

A flowmeter will be installed on the raw wastewater forcemain inside the new Headworks Building. It may be possible to re-use the existing 200 mm magnetic flowmeter on the outfall pipe, and this will be considered further during detail design.

An issue that will need to be addressed with the regulatory authorities is whether a WWTP bypass can be incorporated into the design of the raw wastewater pumping station. A bypass located just below the working platform in the wet well would prevent the wet well from flooding in the event of a pump failure, or emergency and direct the flow to the outfall.

Alternatively, the re-use of the existing sewage lagoon as an emergency storage cell could be considered. In the event of a pump failure, and a bypass is not provided, the City would need to divert sewage to the existing lagoons, or raw sewage would overflow at the pump station.

The issue of a bypass will be considered further during detailed design but it appears that the elevation of the diversion manhole at the sewage lagoon, is well above the lift station platform. This means that in an emergency event, the City must respond quickly to close the gate at the diversion manhole or alternatively, the lift station must be structured so that a higher level of flooding may be accommodated.

Other implications with using the existing lagoons include:

- What extent of remediation is required to bring the lagoon to an acceptable level of use for an emergency bypass.

- The use of the lagoon would required temporary overland pumping back into the system without the installation of a permanent structure.

Again, further research is required and this item will be addressed during detailed design.

5.1.2 Screening

The screenings room is a Class I Group D Division 2[3] area and the existing fiberglass wall and method of sealing between the areas is inadequate to separate the non-classified areas of the bioreactors and Administration Area from the headworks area. We therefore recommend that a new Headworks Building be constructed adjacent to the WWTP. The new Headworks Building will include new concrete channels on the second floor for two screens and a bypass channel equipped with a manual screen.

The first floor of the Headworks Building will be used to store screenings, and a chute will be provided to connect the upper and lower floors and facilitate the removal of debris for disposal at a landfill. The lower floor will be equipped with an overhead door to allow a utility trailer to be parked at the lower level.

A tee will be cut into the existing forcemain from the lift station, and valve installed on the downstream side of the tee. In normal operation, the tee will be closed and wastewater will flow to the inlet channel. However, the existing WWTP bypass to the outfall will remain as constructed. To operate the bypass, the new valve installed in the forcemain will need to be opened, and both flanges installed on the existing bypass line (in the Boiler Room) will need to be removed and a spool piece inserted in the line.

Both floors of the Headworks Building will be equipped with combustible gas and H_2S detectors. In the event that combustible gas is detected, ventilation in the room will be increased from 6 air changes / hour to 12 air changes / hour. In the event that combustible gas continues to accumulate in the room, the raw wastewater lift pumps will be disabled and a call-out alarm will be initiated and Operations Staff will be required to respond to the alarm.

The new Headworks Building will be equipped with an alarm panel consisting of a flashing light, an audible alarm, and disable buttons. The panel will be located near the entrance to the building.

The design criteria for the screens is summarized below:

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[3] Classification designated by National Fire Protection Association (NFPA) Code 820

Number of Duty Screens	2
Standby	1 manual bypass
Total capacity	167 L/s
Capacity per screen	84 L/s
Type	3mm perforated screen basket with auger
Screenings container	garbage bag

The existing screening system consists of three screening channels each having dimensions of ~ 0.61m W by 3.25mL x 1.20m D (two screening channels and one bypass channel equipped with a manual screen). The channels are pre-fabricated of stainless steel and are located in a room adjacent to the office and washroom. The channels are equipped with slide gates and a Milltronics level transmitter on the inlet side of the screens.

The existing screens are 'auger' style screens, which utilize a perforated basket for screening, and an inclined auger to convey screenings from the channel to above the floor. The screens each have a nominal rating of 77 L/s each and with both in service have a nominal rating of 154 L/s. The nominal flow rating with both screens in service is marginally below the Phase 2 peak flow of 167 L/s. However, the screens should be able to accommodate the marginally higher Phase 2 peak flow without compromising the efficiency of the screening process.

The existing screens will be retained for the new WWTP and will be moved into a new Headworks Building and installed in the new concrete channels. If feasible, the existing manual screen will be relocated to the new bypass channel. Assuming the existing Milltronics level transmitter is operable, it will be re-located to the inlet side of the screens. Hand slide gates will be provided on both the upstream and downstream side of the screens, which will allow a unit to be taken out of service.

The operation of the screens will be controlled by the water level on the upstream side of the screen.

5.1.3 Grit Removal

Grit removal will not be provided in Phase 1, however provisions will be allowed in the design for a grit removal system, should the City choose to install one at a future date. The grit removal unit process will be located downstream of the fine screens. As grit removal is not a 'critical' unit process and given that the unit process is robust and not prone to 'catastrophic' failure, a redundant unit will not be provided. The grit removal unit will be sized based on the Phase 2 service population of 12,000. The sizing of the grit separator and grit classifier, are as follows:

- Phase 2 average day flow — 4,800m^3/d
- Average grit loading rate — 0.013m^3/ML
- Grit peaking factor — 10
- Number of duty units — 1
- Number of standby units — 0
- Maximum grit loading/day — 0.624m^3

- Concentration of slurry 1%
- Diameter of separator tank 2.6 m
- Grit pump Air lift, or recessed impeller
- Drive motor 0.5 kW
- Grit classifier/dewatering unit capacity 10 L/s
- Grit classifier drive 0.75 kW

The grit classifier would be located on the second floor of the Headworks Building and dewatered grit will discharge to a garbage bag on the floor. Periodically, staff will tie off the bag and dispose of the bag through a chute to a utility trailer on the first floor below.

A channel will be provided to bypass the grit separator and slide gates will be installed upstream and downstream of the grit separator. A baffling arrangement will be incorporated into the channel immediately downstream of the grit separator to retain combustible liquids within the Headworks Building. With this provision, the Headworks Area will be rated as a Class I Group D Division 2 electrical area, but downstream processes, such as the bioreactors and Main Building will remain unclassified. Additional safety features will be incorporated into the design, such as the inclusion of a combustible gas detector in the room, which in the event that combustible gas is detected will activate a call-out alarm, initiate high ventilation rates in the room, and shut-down the influent pumps.

The baffling arrangement will also act as a barrier to remove floatable material that passes through the fine screens, such as grease. If not for the baffles, floatable material would enter the bioreactors and accumulate in the anoxic zones, as the outlet from the tanks is submerged at the bottom of the tanks. Even though the baffles will remove most of the floatable material, some material will accumulate in the anoxic tanks and will have to be removed from time to time.

A flow splitting weir will be provided on the downstream side of the overflow weir to evenly split the flows between the two bioreactor trains. The flow splitting weir will be located perpendicular to the overflow weir.

The channels in the Headworks Building will be equipped with a coarse bubble aeration system to allow Operations Staff to aerate the channels periodically to remove any organic material that may accumulate in the channel.

Provisions will be included in the design of the outlet channel to split 50% of the flow to the future Phase 2 bioreactors.

5.1.4 Primary Clarification

Primary clarification, or an equivalent unit process, is not included in the Option 1 process flow configuration.

5.1.5 Biological Process

The biological process for the Iqaluit will be designed to serve two primary functions:

- Reduce organic carbon loading (BOD and TSS); and
- Reduce ammonia (NH_4^+) loading.

Organic carbon and ammonia (referred to as substrates) in the raw wastewater are reduced by bacteria in the bioreactors. The bacteria in the bioreactors are referred to as Mixed Liquor Suspended Solids (MLSS) or activated sludge. The activated sludge uses these substrates for a variety of functions, including producing energy and producing more cells. The bacteria that grow in the bioreactor are 'harvested' and removed from the biological process. The harvesting of bacteria is referred to as 'wasting' and the stream is referred to as Waste Activated Sludge (WAS).

The important reactions that govern the above two process are shown below:

Bacterial cell growth $\underset{\text{Organic matter}}{COHNS} + O_2 + \text{bacteria} + \text{energy} \rightarrow C_5H_7NO_2$

Nitrification $NH_4^+ + 3O_2 \rightarrow NO_3^- + 2H^+ + H_2O$

The requirement to reduce ammonia levels in the raw wastewater governs the sizing of the activated sludge basins (referred to as "bioreactors"), because the bacteria that reduce ammonia grow much slower than the bacteria that reduce organic carbon. As a result, more bacteria needs to be retained in the biological process to ensure ammonia can be treated and the effluent limits are achieved.

In addition to removing the organic carbon and ammonia loading, the bioreactors for Iqaluit will be designed to remove nitrate, which is produced in the nitrification process. The process of removing nitrate is referred to as denitrification and the end product is nitrogen gas. The chemical reaction for denitrification is shown below:

Denitrification $NO_3- \rightarrow NO_2- \rightarrow NO \rightarrow N_2O \rightarrow N_2$

In the bioreactor, denitrification is accomplished by returning nitrified mixed liquor from the end of the aerobic zone to the front of the anoxic zone. The denitrification process takes place in the anoxic zones of the bioreactor.

The denitrification is not strictly necessary to meet the effluent limits set out in Section 3. However, there are many benefits to denitrification:

- Incorporating the process into the liquid train will reduce the potential for filamentous bacteria to proliferate and create foaming problems;
- The process will reduce the amount of air required in the downstream aerobic cells; and
- The denitrification step creates alkalinity, thereby minimizing the alkalinity supplement required to allow the nitrification process to proceed to completion.

5.1.6 Bioreactor Configuration

The existing bioreactor configuration of anoxic zones followed by aerobic zones will be retained for the Iqaluit WWTP. The WWTP concept design report suggested that an SRT of 12 days should be used as the basis of the process design for Iqaluit. However, such a design SRT will result in a mixed liquor concentration of almost 5,500 mg/L, which is high and not usual for conventional activated sludge. As a result of the high solids load, the secondary clarifiers will need to be larger. Also, at a higher mixed liquor concentration of 5,500 mg/L, the bioreactor may be subject to foaming, which can be an operational issue.

The raw wastewater temperature data gathered by Operations Staff suggests that the wastewater temperature in the winter will be between 13 and 14ºC, and that the temperature will increase slightly in the bioreactors, as the room is heated. Given that the wastewater temperature is expected to be above 12ºC, and that there will be no temperature loss in the WWTP, it is recommended that the design SRT be lowered to 10 days in the winter, and 8 days in the summer. With operating experience, the design assumptions used for Phase 1 can be re-evaluated for Phase 2.

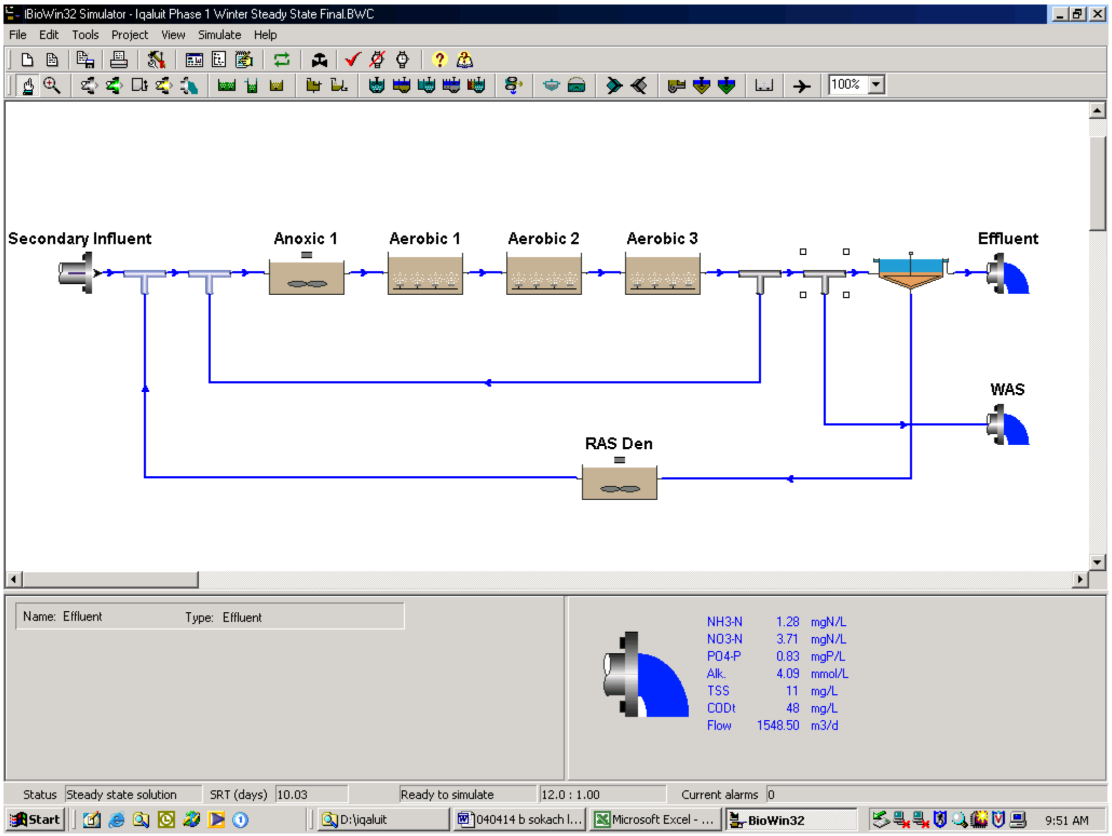
To assist with the design of the expansion for Phase 2, it is recommended that a flowmeter and temperature probe be installed on the raw wastewater forcemain to measure flows, and raw wastewater temperature. The data from the these instruments will be important for the planning of the Phase 2 upgrade, and will ensure that the new bioreactor is sized appropriately.

The bioreactor configuration was modeled in a process simulation package called BioWin. This software package is used throughout the wastewater industry for modeling nutrient removal plants and developing process designs.

Under the Phase 1 design flow and loading conditions, at a temperature of 12ºC and with a total bioreactor volume of 515m^3 per train (132m^3 in anoxic zones, and 389m^3 in aerobic zones) the steady state simulation predicts an effluent ammonia concentration of less than 1.5 mg/L. Even allowing for a wide diurnal ammonia load variation during the day (peak loading in the morning and low loadings at night), the process should be capable of meeting the ammonia effluent requirement of 10 mg/L (based on monthly average of 24-hour daily composites).

The effluent nitrate concentration is less than 4 mg/L with the Nitrified Mixed Liquor Recycle (NMLR) set at three times the average day flow of 3,200m^3/d. This level of denitrification is adequate to ensure that 'rising sludge' does not pose a problem in the operation of the secondary clarifiers. The results from the BioWin simulation of the Phase 1 winter flow and loading condition is illustrated in **Figure 3** below.

Figure 3 – BioWin Simulation of Phase 1 Winter Loading Condition



The sizing of the bioreactors for Phase 1 is summarized as follows:

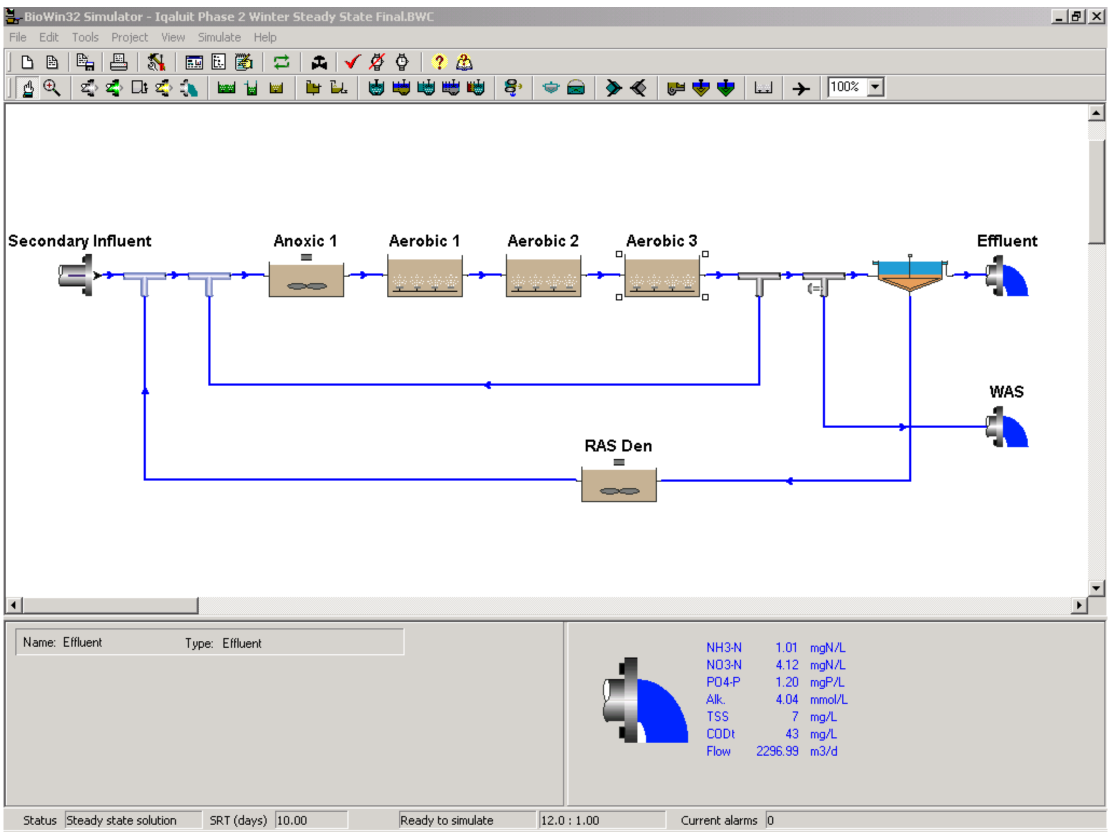
- Volume of Anoxic 1[4] — 126m^3 (2.442m W x 11.815m L x 4.377 H)
- Volume of Anoxic 2 (Swing Zone) — 126m^3 (2.442m W x 11.815m L x 4.377 H)
- Volume of Aerobic 1 — 389m^3 (4.931m W x 18.038m L x 4.377 H)
- Volume of Aerobic 2 — 389m^3 (2.442m W x 11.815m L x 4.377 H)
- Nitrified Mixed Liquor Recycle — 4,800m^3/d

[4] Note: Assumes 500mm freeboard between the liquid surface and top of bioreactor.

The existing bioreactor will need to be doubled to accommodate the Phase 2 service population of 12,000 and lower the mixed liquor concentration in the bioreactors to less than 4,000 mg/L. The new bioreactor will have a volume of 1,030m^3 to match the existing bioreactor and bringing to the total bioreactor volume to 2,060m^3. For Phase 2, the bioreactors will have a mixed liquor concentration of 3,500 mg/L at a design SRT of 10 days (refer to mass balances).

The steady state BioWin simulation shows the process is able to achieve an ammonia concentration of approximately 1 mg/L and nitrates of less than 4 mg/L. The results from the BioWin simulation of the Phase 2 winter flow and loading condition is illustrated in **Figure 4** below.

Figure 4 – BioWin Simulation of Phase 2 Winter Loading Condition



The sizing of the bioreactors for Phase 2 is summarized as follows:

- Volume of Anoxic 1 126m^3
- Volume of Anoxic 2 126m^3
- Volume of Aerobic 1 389m^3
- Volume of Aerobic 2 389m^3
- Nitrified Mixed Liquor Recycle 3,600m^3/d

The existing bioreactors have been configured to operate as parallel trains and provisions were not provided to operate the trains in a 'plug flow' configuration. In plug flow mode, wastewater proceeds in series through each zone (Anoxic 1 → Anoxic 2 → Aerobic 1 → Aerobic 2). To optimize the efficiency of the biological process it would be preferable to operate the bioreactors in a 'plug flow' configuration. However, to retrofit the bioreactors now would be an expensive undertaking, and it is possible that a significant amount of coring and hammering in the existing walls could cause further cracking. Therefore, the existing configuration will be retained and baffles will be installed in the existing bioreactors to facilitate plug flow in both aerobic zones. Two sets of baffles will be installed in the aerobic zones to divide the bioreactor into 3 zones.

The existing bioreactors have provisions to allow a single train (i.e. one anoxic zone and one aerobic zone) to be taken out of service, while the other train remains in service. This feature will be retained for the new WWTP.

The last aerobic zone in each bioreactor includes a Nitrified Mixed Liquor Return pump, which discharges through a 200 mm pipe to the front of the anoxic zones. The 200 mm pipes are somewhat small for the service, however should still be suitable. The existing pumps are Flygt submersible centrifugal style and may be suitable for the intended duty. This will be confirmed during detail design.

Each NMLR line will require a flowmeter to allow operations staff to monitor and adjust the flow rate. The existing 100 mm flowmeters on the discharge side of the existing Durco Process Pumps may be suitable for the service and this will be confirmed during detail design.

Submersible mixers will be required for each of the anoxic zones to ensure the mixed liquor does not stratify and settle in the tank. The mixers will be sized to provide at least 2 to 4 W of mixing energy per m^3 of tank volume. There are two existing Flygt submersible mixers at the WWTP and each is rated at 1.8 kW. The nominal mixing energy provided by the mixers is 14 W/m^3 and considerably more than the required mixing energy of 2 to 4 W/m^3.[5] Therefore the existing mixers will be retained and used for the WWTP. The rails for the mixers have not yet been installed nor could they be located at the WWTP. A provisional item will be included in the construction contract for the provision of new rails.

In the Phase 2 expansion, it is assumed that the new bioreactors will be constructed in a plug flow configuration. Once the new Phase 2 bioreactors are constructed, the existing bioreactor may be converted to plug flow, or the retained in their present configuration.

The water level in the bioreactors will need to be controlled with an outlet weir. As the Zeeweed process would have utilized pumps to convey mixed liquor from the bioreactor and through the membranes, new hydraulic weir structures will be required. New concrete or stainless steel structures will be constructed at the end of each bioreactor, and control weirs will be installed either on the outside wall of the bioreactor or inside the new structure. New mixed liquor pipes will be installed to convey mixed liquor from the new structures to the new secondary clarifiers. The mixed liquor pipes will be interconnected (valve to be installed on interconnection) to allow both clarifiers to be used in the event a bioreactor is taken out of service.

[5] Mixing energy = 1,800 W per mixer / 126 m^3 per anoxic tank = 14.3 W/m^3

In Phase 2, the mixed liquor pipe from the new bioreactors will need to be connected to the pipe feeding the clarifiers. To facilitate the future connection, tees and blind flanges will be provided on the mixed liquor piping.

During detailed design, consideration will be given to using two 300 mm mixed liquor pipes at the outlet of the bioreactors, then increasing the pipes to 500 mm downstream of the isolation valves. If 300 mm piping is used, then the existing knife gate valves in the bioreactors may be reused.

The aerobic zones of the bioreactor will be covered with checker plate covers and the headspace below will be ventilated with an exhaust fan to maintain a slight negative pressure in the bioreactors. Similarly, the anoxic zones will be ventilated with an exhaust fan to maintain a slight negative pressure. The headspaces will be ventilated at 6 air changes / hour under normal operating conditions, and 12 air changes per hour in the event that combustible gas is detected.

The covers over the bioreactors will serve two functions:

1. Eliminate aerosol emissions from the aerobic zones into the main building; and
2. Provide an additional safety precaution in the event that combustible fluid carries over from the Headworks Building.

As an added safety precaution, a second combustible gas detector will be installed in the Main Building and alarm stations will be installed at the entrances.

5.1.7 Aeration System Design

Each aerobic zone will be equipped with a fine bubble aeration system to deliver oxygen necessary for the biological process. Dissolved Oxygen (DO) probes will be installed in the third zone of each bioreactor, which will be used to modulate actuated butterfly valves on the aeration piping and the speed of the 25 HP blowers. The functioning of the DO probes is explained further in the following paragraphs.

The design of the aeration system for Phase 1 is summarized in **Table 5-1** below.

Table 5-1 – Option 1 Aeration Analysis

AERATION ANALYSIS								
PROJECT:	Iqaluit WWTP				**DATE:**	30-Apr-2004		
DESCRIPTION:	PRELIMINARY AERATION DESIGN - SINGLE TRAIN				PROJ. #:	75360		
	Phase 1 Service Population 8,000 - Maximum Load				BY:	RDB		
CONDITION	UNITS	Aerobic 1 Peak	Aerobic 2 Peak	Aerobic 3 Peak	Aerobic 1 Average	Aerobic 2 Average	Aerobic 3 Average	
TANK PARAMETERS								
Tank Depth	m	4.38	4.38	4.38	4.38	4.38	4.38	
Diffuser Depth	m	4.08	4.08	4.08	4.08	4.08	4.08	
Saturation Depth Factor	ratio	0.25	0.25	0.25	0.25	0.25	0.25	
Tank Width	m	4.931	4.931	4.931	4.931	4.931	4.931	
Tank Length	m	6.0	6.0	6.0	6.0	6.0	6.0	
Tank Volume	m3	130	130	130	130	130	130	
Diffuser diameter	m	0.225	0.225	0.225	0.225	0.225	0.225	
Flow	m3/d	3200	3200	3200	3200	3200	3200	
HRT	h	1.0	1.0	1.0	1.0	1.0	1.0	
Temperature	C	14	14	14	14	14	14	
OXYGEN UPTAKE RATE								
Heterotrophic OUR	g/m3/h							
Autotrophic OUR	g/m3/h							
Total OUR	g/m3/h	113.40	103.05	88.43	50.4	45.8	39.3	
AOR	kg O2/d	353	320	275	157	142	122	
Alpha		0.5	0.55	0.60	0.50	0.55	0.60	
Beta		0.95	0.95	0.95	0.95	0.95	0.95	
Atmospheric Pressure	kPa	90	90.00	90.00	90.00	90.00	90.00	
Residual O2 Conc.	mg/L	1.00	1.00	1.00	2.00	2.00	2.00	
Cs	mg/L	10.31	10.31	10.31	10.31	10.31	10.31	
Csw	mg/L	9.66	9.66	9.66	9.66	9.66	9.66	
Css	mg/L	8.97	8.97	8.97	8.97	8.97	8.97	
AOR/SOTR		0.419	0.461	0.502	0.370	0.407	0.444	
SOTR	kg O2/d	842	696	547	423	350	275	
SOTR per m2	kgO2/d/m2	28.47	23.52	18.50	14.31	11.82	9.30	
Density	kg/m3	1.20145	1.20145	1.20145	1.20145	1.20145	1.20145	
O2 fraction	kg O2/kg air	0.232	0.232	0.232	0.232	0.232	0.232	
AT/AD, estimate		10	13	15	10	13	15	
Number of Diffusers		74	57	50	74	57	50	
Flux/diffuser	m3/h	7.474	8.204	7.396	3.419	3.752	3.383	
SOTE, calculated		0.226	0.222	0.223	0.249	0.243	0.245	
kLa, calculated	m3/d	2850.7	2355.1	1852.4	1432.4	1183.3	930.8	
Vg, calculated	m/d	451.1	380.9	297.6	206.3	174.2	136.1	
AIR REQUIREMENT	nm3/min	9.3	7.8	6.1	4.2	3.6	2.8	
	nm3/h	556	470	367	254	215	168	

Much of the existing aeration equipment in the WWTP, although covered with dust, appears to be satisfactory and can be reused for this project. The original aeration equipment was supplied by Sanitaire and they will be contacted during the detail design phase to confirm the original basis of design, and scope of supply.

At this time, we have not confirmed the number of diffusers that are presently being stored in the WWTP, nor what existing equipment is suitable to be reused. We will therefore include a provisional sum in the contract for the supply and installation of new diffusers, should it be necessary.

It appears that 'Royce' dissolved oxygen probes were supplied as part of Zenon's original contract, or at least a controller is mounted across from the dewatering room. If the probes can be relocated, they will be used for the treatment plant. Similar to the diffusers, provisional items will be included in the construction contract for new dissolved oxygen probes in the event they are required.

One DO probe will be provided in the last (third) aerobic zone of each bioreactor and the feedback signal from the probe will be used to control the flow of air to each bioreactor. Process control will be accomplished by modulating the position of a butterfly valve on each drop leg to maintain a desired DO setpoint. Manual butterfly valves will be provided on each drop leg to the first and second aerobic zones in each bioreactor. The manual valves will be setup to ensure that adequate air is provided to these zones.

5.1.8 Blower

For Phase 1, the bioreactors will have a peak air demand of 46.4 m^3/min and an average air demand of 21.2 m^3/min. For Phase 2, the bioreactor will have a peak air demand of 69.6 m^3/min and an average air demand of 31.8 m^3/min.

There are two existing sets of Aerzan Blowers: 1) three 50 HP, and 2) three 25 HP. The 50 HP blowers have a nameplate rated capacity of 37.9 m^3/min and the 25 HP blowers are rated at 16.9 m^3/min. Both blowers have a discharge rating of approximately 48 kPA (7 psi), which is adequate for the intended service in Iqaluit. Also, the three 25 HP blowers are equipped with variable speed drives located in the MCC.

Subject to confirmation by the manufacturer, it appears that the existing complement of blowers are adequate to meet the intended service. The rating of the 50HP is marginally below the Phase 1 peak air requirement of 46.4 m^3/min. However, one 50 HP blower and one 25 HP blower will certainly meet the air requirement.

It is recommended that two of the existing 50 HP blowers and two of the existing 25 HP blowers be retained as installed equipment. In this configuration, the Iqaluit WWTP will have sufficient firm capacity to meet the Phase 2 air requirement with the largest unit (50 HP) out of service. The remaining two blowers (one 50 HP and one 25 HP) will be retained as shelf spares and/or for parts for the blowers that will remain in service.

A new stairway will be built from the vestibule on the first floor to the second floor which will take up the space made available by removing the 50 HP and 25 HP blowers.

The supply air for the existing blowers is provided from the main HVAC unit adjacent to the existing electrical room. The air required for the blowers is significant with peak air demands for Phase 2 of 63.2 m^3/min (2,230 cfm) and constitutes a significant load on the HVAC unit. It is recommended that the air supply for the blowers be provided directly from outside using the existing louvre in the generator room. The new ducting would be routed through the generator room and existing opening between the generator and blower rooms. Drop legs from the ducting would attach to the filter elements on the blowers using flexible hoses and hose clamps.

The inlet of the duct will be fitted with a hood or louvre and bird screen. To minimize the potential for frost to accumulate on the screen, a 25mm line from the discharge side of the blowers will discharge back to a mixing box located immediately downstream of the inlet louvre. A relief damper will be installed on the mixing box to allow supply air to be provided from the blower room in the event that frost should cover the screen and block the air supply.

The supply ducting will be insulated to minimize heat losses in the rooms, and two low pressure safety switches will be installed in the ducting to shut-down the blowers, when vacuum conditions develop in the supply ducting. The blower shut-down sequence will be initiated when either switch is in alarm condition.

The blowers will be controlled using pressure transmitters installed on the main process air discharge header. The feedback signal from the pressure transmitter will be used to modulate the speed of the blowers to maintain a desired pressure setpoint. In the event that a single blower is unable to meet the desired pressure setpoint, then a second blower will be started. The desired blower operating sequence will be selected from the computer screen.

There are two existing 'Bailey Fisher & Porter' pressure transmitters at the WWTP that have a nameplate rating of –15 to 15 psi (-100 to 100 kPa) and appear suitable for the intended service. Both pressure transmitters will be installed on the main discharge header to provide redundancy in the event that one of the transmitters should fail.

The existing 25 HP blowers are equipped with VFDs, whereas the 50 HP blowers are not equipped with VFD. The VFD configuration of the blowers will remain unchanged, and the small blowers will be used during low load periods and for trimming. In the event that the air demand is greater than what can be supplied by two 25 HP blowers, then the lead 50 HP blower will be utilized with trimming provided by the speed control on one of the 25 HP blowers.

A branch line from the main process air blower will be extended to the TWAS vault and used to aerate and mix the sludge (see Section 5.1.11 for more details). An actuated butterfly valve will be installed on the branch line to allow Operations Staff to turn off or cycle the air to minimize energy consumption.

In Phase 2, the City may give consideration to installing VFDs on the larger blowers, as the air demand will be higher and the larger blowers will see more service. For Phase 1, the 50 HP will remain as fixed speed blowers.

The existing 200 mm process air headers are suitable for reuse and will be incorporated into the design of the aeration piping. Presently, the air headers terminate at the downstream end of the bioreactors, and will simply be extended as required for the drop legs to the new aeration system.

The 200 mm process air headers are not insulated, and as a safety precaution should be insulated to prevent Operations Staff from touching the hot surface of the pipe.

5.1.9 Alkalinity Adjustment

Chemical will need to be added to the wastewater to supplement the alkalinity to ensure that nitrification can be maintained. Theoretically, 7.14 kg of alkalinity (as $CaCO_3$) will be required per kg of ammonia (as N) oxidized by the WWTP. A portion of the alkalinity consumed during nitrification will be recovered during denitrification (in anoxic zone).

Chemicals which may be used to supplement the alkalinity in Iqaluit are soda ash, caustic and lime. The preferred chemical will be confirmed during detail design.

5.1.10 Secondary Clarification

The primary purpose of secondary clarification is to separate the bacteria in the mixed liquor from the water. Once separated, the bacteria at the bottom of the clarifier are pumped back to the bioreactor, and the water flows upward over a weir and discharges to the receiving water body. In Iqaluit, the receiving water body is Frobisher Bay

Secondary clarifiers are essential for conventional secondary treatment, and as a critical unit process and given the remote setting in Iqaluit, we recommend that two clarifiers be provided. In this configuration, a clarifier will be available for service in the event one clarifier is taken out of service.

Secondary clarifiers are designed to meet two governing criteria:

- Hydraulic criteria to meet a specified Surface Overflow Rate (SOR); and
- Solids thickening capacity.

The sizing of bioreactors and secondary clarifiers are interrelated, as the concentration of mixed liquor in the bioreactor affects the solids loading to the secondary clarifier and hence the thickening capacity of the clarifier may be a governing design criteria. Both the hydraulic and thickening criteria are discussed in the following paragraphs.

The sizing of the secondary clarifiers, based on hydraulic criteria is as follows:

- Phase 2 peak hour flow — 9,600m^3/d
- No. of clarifiers in service — 2
- No. of standby clarifiers — 0
- Design surface overflow rate — 35m^3/m^2/d
- Required area of each clarifier — 137m^2
- Diameter of each clarifier — 13.2m
- Side Water Depth (SWD) — 4.5 to 5.0m
- RAS rate — 80% of Average Annual Flow (3840 m^3/day)

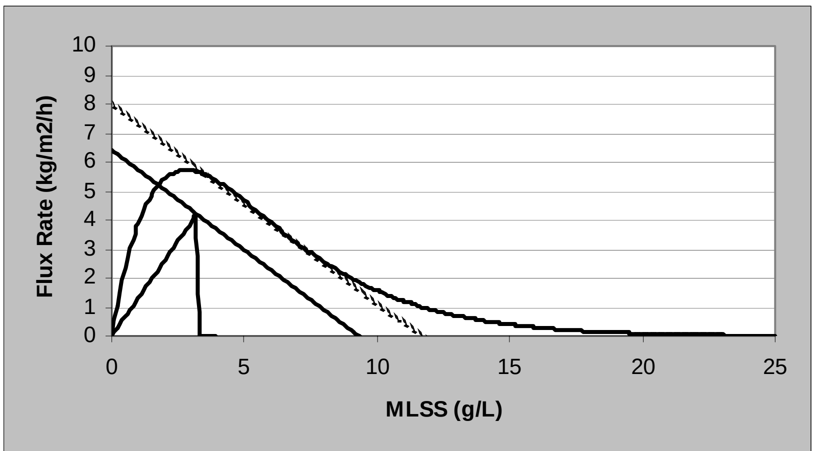
Based on the foregoing, to meet the Phase 1 peak hour flow of 9,600m^3/d, two 13.2m diameter secondary clarifiers will be required for the Iqaluit WWTP to meet the design SOR.

The second consideration in the design of a secondary clarifier is the thickening capability of the clarifier. This design condition is important because it dictates what mass of solids can be returned from the bottom of the clarifier to the bioreactor. The term ‘thickening failure’ refers to the condition where the mass of solids being returned from the bottom of the clarifier to the bioreactor is less than the mass of solids being discharged to the clarifier(s) from the bioreactor(s). When a failure occurs, solids build-up in the clarifier and eventually wash-out over the weirs.

A measure of the ability of mixed liquor solids to settle and thicken in a secondary clarifier is the Sludge Volume Index (SVI). Generally, for a conventional activated sludge process with appropriate sized selectors a design SVI is in the range of 150 to 250 mL/g is used. For Iqaluit, an SVI of 200 mL/g with a 20% safety factor will be used as the basis of design for the secondary clarifiers.

A state point analysis of the secondary clarifiers for Iqaluit is presented in **Figure 5** below, based on an SVI of 200 mL/g. This analysis shows the thickening capacity of a secondary clarifier, based on the settleability of the mixed liquor sludge. The governing maximum solids loading rate (referred to as "Flux Rate") is 6.4 kg/m^2/h.

Figure 5 – Solids Flux Analysis



For Option 1, the maximum Solids Loading Rate (SLR) assuming both secondary clarifiers are in service is as follows:

- Phase 1 peak flow 9,600m^3/d
- No. of units in service 2
- No. of standby units 0
- Phase 1 RAS flow 2,560m^3/d
- Mixed liquor solids concentration (winter) 4,634mg/L
- Maximum Allowable SLR 6.4 kg/m^2/h
- Required secondary clarification area 367m^2
- Diameter of each clarifier 15.3m

The solids flux of the clarifiers is the governing design condition for Iqaluit and 15.3m diameter clarifiers are required for Phase 1. For Phase 2, 16.2m diameter clarifiers are required with a new bioreactor. Therefore, it would be prudent to construct the larger 16.2m diameter clarifiers in Phase 1.

5.1.11 WAS Thickening

The incremental cost of upsizing a DAF, especially for smaller units, is minimal, therefore the new DAF WAS thickening system for Iqaluit will be sized based on the Phase 2 service population of 12,000. The sizing of the DAF for Iqaluit is as follows:

- Peak TSS loading 719 kg/d
- Flow $227m^3/d$
- No. of units in service 1
- No. of standby units 0
- Maximum design solids loading $3\ kg/m^2/hr$
- Concentration of thickened WAS 2.5%
- Required (minimum) area of DAF $10m^2$
- TWAS flow $28m^3/d$

An equalization vault will be required to store Thickened Waste Activated Sludge (TWAS) to allow it to be fed to the dewatering unit process intermittently. The TWAS vault will be sized to allow for 3 days of active TWAS storage at the Phase 2 design population of 12,000 people. The sizing of the TWAS vault is as follows:

- Peak TWAS volume $28m^3/d$
- Days of storage 3
- Active TWAS storage volume $84m^3$

The TWAS vault will be constructed in the new Secondary Clarifier Building and it will be equipped with an aeration system to allow the sludge to be mixed before it is fed to the dewatering process. The existing Blowers will supply the air to the TWAS Vault aeration system as described in the paragraphs above.

The DAF will be fed on continuous basis, that is 24 hours per day and 7 days per week, with mixed liquor drawn directly from the surface of the bioreactor. This will provide the best control of the biological process to ensure that nitrification is maintained on a year round basis. It is assumed that polymer will not be added to the DAF, which will provide a TWAS concentration of approximately 2.5% solids. The City could add a polymer addition system at any time in the future, which will increase the TWAS concentration to approximately 4 to 5%, and will increase the solids recovery efficiency of the unit.

The basis for sizing the WAS pumps is as follows:

- Maximum day flow 227m^3/d
- Number of duty units 2
- Number of standby units 1
- Operation continuous 24 hours/day
- Rating per pump 1.3 L/s
- TDH Approximately 5m

A wasting box will be constructed in each of the bioreactors to facilitate 'selective' wasting, or in other words to waste mixed liquor from the top of the bioreactor. This method of wasting will facilitate the removal of poor settling sludge and provide a simple means of controlling the SRT. The wasting box will include a 'buoyant weir' that will move with changing water levels in the bioreactor.

The wasting pumps will be located either in the WAS boxes (submersible), or on the recessed floor immediately adjacent to the existing electrical room. Flowmeters will be required to measure the volume of WAS discharged from each bioreactor to ensure that an appropriate SRT is being maintained for the biological process. The existing 100mm flowmeters on the discharge side of the existing 'Durco' Process Pumps appear to be too large for the intended service, however this will be confirmed during detailed design. If the flowmeters are too large for the WAS service, they may be suitable for the Nitrified Mixed Liquor Return Line.

Provisions will be included in the design of the RAS and BFP systems to allow RAS to be wasted directly to the BFP. This feature will only be used in the event that the DAF needs to be taken out of service for an extended period of time. Each RAS line will have a branch line equipped with a flowmeter and butterfly flow control valve. The flow control valve will maintain a desired flow setpoint input by Operations Staff. The RAS lines will combine downstream of the flow control valves and discharge to the BFP feed line.

There are numerous existing butterfly valves and actuators at the WWTP that should be suitable for reuse in the RAS dewatering system. However, new magnetic flowmeters will be required for each of the RAS branch lines.

5.1.12 Dewatering

Similar to the design rationale for the DAF, the incremental cost of upsizing a dewatering unit process, especially for smaller units, is minimal. Therefore, the dewatering unit will be sized for the Phase 2 service population of 12,000. The sizing of the dewatering equipment for Iqaluit will be sized based on the Phase 2 service population of 12,000.

The dewatering equipment will be sized to be able to process two days worth of TWAS in 6 hours over a single day. In this way, the BFP will not need to be operated on the weekend. In the event of a long weekend, the accumulated inventory of TWAS can be drawn down by operating the BFP for additional time each day during the week.

The new BFP will be sized for the governing of two design conditions:

1. TWAS dewatering; and
2. RAS dewatering (emergency only).

The new BFP will be located in the existing Dewatering Room and dewatered cake will discharge through a chute to a Utility Trailer located below in the Solids Handling Room.

The sizing of the BFP for dewatering is as follows:

- Phase 2 peak solids loading 704 kg/d
- Flow 28m^3/d
- Number of duty units 1
- Number of standby units 0
- Minimum cake solids 16%
- Operation once every 2 days
- Hours of operation / day 6
- Design solids loading rate 235 kg/hr
- Volumetric loading 9.3m^3/hr

The sizing of the BFP for RAS dewatering will be investigated and confirmed during detailed design.

The BFP feed pump will be sized to accommodate the peak volumetric loading rate of 9.3m^3/hr and a progressive cavity style pump will be used for the service. A second standby feed pump will be provided for the Iqaluit WWTP.

The sizing of the BFP sludge feed pump for Iqaluit is as follows:

- Number of duty units 1
- Number of standby units 1
- Design flow 2.6 L/s
- TDH 10m (approximate)
- Type of pump Progressing cavity
- Power 5 kW

The existing Moyno feed pump has a nameplate rated capacity of 2.7 L/s (10m^3/hr) at a TDH of 15m. The rated capacity of the sludge feed pump is 2.7 L/s and virtually identical to the required capacity of 2.6 L/s. The details of the pump will be confirmed with the manufacturer during detailed design. If possible, the existing progressing cavity pump will be used. The suitability of the existing pump will be confirmed during detailed design.

The BFP sludge feed pump will have a relatively high maintenance requirement, therefore it is recommended that a second pump be provided as standby to the existing pump. In the event, a new rotor and/or stator is required, the second pump can be put into service while the new parts are being shipped.

The BFP feed pump(s) will be located either in the old generator room, if the room can accommodate the pumps. As the width of the Generator Room is only 2.4m, this poses a concern for providing adequate clearances around the pumps for access and maintenance. In the event the room is not suitable as a pump room, the pumps will be re-located to the new Secondary Clarifier Building.

The existing 'ACS Poly Mixer' system utilizes liquid polymer, which is blended with water to the required concentration. Generally, liquid polymer is blended to approximately 0.15 to 0.25% by weight. Our experience with polymer systems has shown that liquid systems have a lower capital cost, but a somewhat higher operating cost.

Given the choice between dry and liquid polymer systems for Iqaluit, a dry polymer system is more appropriate due to the following considerations:

- Lower shipping costs; and
- Ease of storage and longer shelf life.

The dry polymer system will be sized based on the following criteria:

- Phase 2 peak solids 704 kg/d
- Polymer dosage 8 kg/tonne dry solids
- Operation once every 2 days
- Hours of operation per day 6
- Polymer consumption / day of operation 11.3 kg/d
- Polymer volume / day of operation 2,260 L
- Polymer make-up concentration 0.5%
- No. of batch tanks 2
- Volume of each tank 1,200 L/hr
- Mixers 2

The sizing of the polymer feed pump for Iqaluit is as follows:

- Number of duty units 1
- Number of standby units 1
- Design flow 38 L/hr
- TDH 10 m (approximate)
- Type of pump Mechanical diaphragm or progressive cavity

- Power 1 kW with VFD

5.1.13 Outfall

The existing outfall consists of 70 m of 300mm diameter pipe at a slope of approximately 4%. Assuming full pipe flow, the theoretical capacity of the existing outfall is 193 L/s, which is greater than the Stage 2 peak hour flow of 167 L/s (or 14,400m^3/d) (see **Table 5-2** below for details).

As the outlet of the pipe discharges above high water level and is therefore open to atmosphere, there should not be a concern for 'air locking' of the outfall pipe.

Table 5-2: Capacity of Outfall

ROUND PIPE FLOW CALCULATIONS		
Pipe Diameter (D):	**300**	mm
Pipe Slope:	**4.00%**	
Manning's 'n':	**0.013**	
Full Velocity (Vf):	2.736	m/s
Pipe Capacity (Qf):	0.193	c.m./s
Design Q (Qd, cms):	**0.1666**	c.m./s
Qd/Qf:	86.14%	
Depth Ratio:	71.57%	
Vd/Vf:	112.48%	
Flow Depth (d):	215	mm
Flow Velocity (Vd):	3.08	m/s
Slope for full flow:	2.97%	

We have not had an opportunity to confirm the as-built conditions of the outfall, but the actual invert elevations of the sewer should be confirmed during construction, when the pipe is exposed for the construction of the new secondary clarifiers.

5.1.14 Effluent Water System

The existing WWTP does not have a potable water service, therefore a domestic water storage tank has been provided in the Boiler Room. The existing potable water system provides water to the washroom and laboratory and various locations within the plant.

Water will be required for the chemical systems, as well as for the Belt Filter Press. It is not considered practical to use potable water for these applications given the amount of water required. Therefore, an effluent water system will be provided.

The existing recycle flush effluent water system is fed from either of the existing CIP Backpulse tanks located on the second floor. The CIP Backpulse tanks have a volume of 7,575 L (2,000 US gals). The recycle effluent water is then fed to two Jacuzzi pumps via a 50mm (2") PVC pipe, which are located in the Mechanical Room located on the first floor. The two Jacuzzi pumps then discharge the effluent water to a UV Sterilizer unit for disinfection. The UV Sterilizer was supplied by R-Can Environmental Inc and its model number is SUV-40P. Following the UV Sterilizer there is a pressure tank. There is a pressure switch upstream and a pressure indicator downstream of the pressure tank.

The recycle effluent water is discharged to various locations in the WWTP for various uses as listed below:

- To the Fournier Rotary Press via two 25mm (1") PVC pipes. There are two locations that the recycle effluent water is added to the press.
- To the ACS Polymixer located in the Fournier Press Room via 12.5mm (1/2") PVC pipe.
- To a tap and ball valve located on the second floor just above Aerobic Tank #1 downstream of the Filter Area via a 19mm (3/4") PVC line.
- To a tap and ball valve located on second floor next to the stairs leading to the process pump and electrical room area via a 12.5mm (1/2") PVC pipe.
- To a tap and ball valve on the second floor located in the middle of the aerobic tanks downstream of the filters via a 19mm (3/4") PVC pipe.
- To Screening Room cleaning water system for the screens. The recycle effluent water ties into two solenoid valves via a 25mm (1") PVC pipe, which discharge water to the screens upon start-up to clean the screens.
- To a tap and ball valve located in the Screening Room via a 25mm (1") PVC pipe.

The details of the effluent water system will be confirmed during the detailed design phase, once the water requirements for the various unit processes are finalized.

5.1.15 Secondary Effluent Disinfection

It is anticipated that secondary effluent disinfection will not be required as part of the Phase 1 project. Notwithstanding, there is sufficient difference in elevation between the outlet of the secondary clarifiers and the receiving water body to easily accommodate a UV disinfection system. Provisions will be included in the design to allow a UV disinfection to be added in the future.

It is anticipated that the a new UV room would be constructed adjacent to the Secondary Clarifier Building.

5.1.16 Chemical Storage

Storage will be required for polymer, alkalinity adjustment chemical and sodium hypochlorite. Storage space will be provided in the Sludge Loading Room on the first floor of the new Headworks Building. If additional storage is required, space may be provided in the Secondary Clarifier Building.

The space requirements for chemical storage will be confirmed during the detailed design phase.

5.2 Option 2

Option 2 is similar to Option 1, except that a Salsnes Filter is installed downstream of the fine screens and upstream of the bioreactors. The Salsnes Filter will serve the same purpose as a primary clarifier and will remove suspended organic material that otherwise flows to the bioreactors for treatment. Also, the filter will remove debris and material that passes through the upstream fine screens and provides an added level of protection to downstream equipment. In the case of Iqaluit, the underflow piping between the anoxic and aerobic zones will allow debris and material to accumulate at the top of the bioreactor. Therefore, removing additional material in the Headworks Building will reduce the quantity of debris that will accumulate in the anoxic zones of the bioreactors.

A significant advantage of the Salsnes Filter is that by removing suspended organic material, the sizing of downstream unit processes, such as bioreactors, secondary clarifiers and sludge handling equipment, can be reduced.

In addition to savings in capital costs, the Salsnes Filter will reduce aeration costs, as less organic matter will need to be oxidized in the bioreactor. Also, the filter will lower the quantity of polymer required for the Belt Filter Press, as less WAS will be generated.

5.2.1 Raw Wastewater Pumping

The raw wastewater pumping station will be identical to what was proposed under Option 1.

5.2.2 Screening

Screening will be the same as what was proposed under Option 1.

5.2.3 Grit Removal

Grit removal will not be provided for Phase 1, however provisions will be incorporated into the design of the Headworks Building to allow it to be added later should grit removal ever be required in the future.

5.2.4 Primary Clarification

A single Salnes Filter will be provided in the Headworks Building immediately downstream of the screens. The Salsnes Filter would be fed by gravity from the screens and flow by gravity to the bioreactors.

The Salsnes Filter will be sized to accommodate the Phase 2 peak flow of 167 L/s. The dewatered cake from the Filter will discharge through a chute to a utility trailer on the 1st floor of the Headworks Building.

An underflow / overflow baffling arrangement will be provided downstream together with a weir to split flow to the bioreactors.

5.2.5 Bioreactor Configuration

The configuration of the bioreactor will be the same as Option 1 with anoxic zones followed by aerobic zones. The design SRT of 10 days in the winter and 8 days in the summer will remain the same as Option 1. The design mixed liquor concentrations in the winter and summer are 3,660 mg/L and 3,330 mg/L, respectively.

To accommodate the Phase 2 flows and loadings, a third bioreactor identical to the existing bioreactors will be required. The bioreactors will continue to operate in a parallel configuration similar to the existing bioreactors. For Phase 2, the total bioreactor volume is 1,545m^3 and mixed liquor concentrations in the summer and winter are the same as Phase 1 at 3,660 mg/L and 3,330 mg/L, respectively.

Similar to Phase 1, a NMLR pump will be required to return mixed liquor from the third aerobic zone to the first anoxic zone. A submersible mixers will be required for the anoxic zone to ensure the mixed liquor stays in suspension.

Similar to Phase 1, the Phase 2 bioreactor will be covered with checker plate covers and the headspace below will be ventilated with an exhaust fan to maintain a slight negative pressure. Also, the anoxic zone will also be ventilated to maintain a slight negative pressure.

5.2.6 Aeration System Design

The aeration system for Option 2 will be somewhat smaller than Option 1, because the oxygen uptake rate is lower. The design of the aeration system is summarized in **Table 5-3** below.

The control of the aeration system will be identical to Option 1 with DO probes in the third aerobic zone used to modulate the air flow between the bioreactors.

5.2.7 Blower Design

The same complement of blowers described for Option 1 will be used for Option 2. However, less power will be consumed in Option 2, as less organic matter will be oxidized in the bioreactors.

Table 5-3: Option 2 Aeration Analysis

AERATION ANALYSIS							
PROJECT:	Iqaluit WWTP				**DATE:**	30-Apr-2004	
DESCRIPTION:	PRELIMINARY AERATION DESIGN - SINGLE TRAIN				PROJ. #:	75360	
	Phase 1 Service Population 8,000 - Maximum Load				BY:	RDB	
CONDITION	UNITS	Aerobic 1 Peak	Aerobic 2 Peak	Aerobic 3 Peak	Aerobic 1 Average	Aerobic 2 Average	Aerobic 3 Average
TANK PARAMETERS							
Tank Depth	m	4.38	4.38	4.38	4.38	4.38	4.38
Diffuser Depth	m	4.08	4.08	4.08	4.08	4.08	4.08
Saturation Depth Factor	ratio	0.25	0.25	0.25	0.25	0.25	0.25
Tank Width	m	4.931	4.931	4.931	4.931	4.931	4.931
Tank Length	m	6.0	6.0	6.0	6.0	6.0	6.0
Tank Volume	m3	130	130	130	130	130	130
Diffuser diameter	m	0.225	0.225	0.225	0.225	0.225	0.225
Flow	m3/d	3200	3200	3200	3200	3200	3200
HRT	h	1.0	1.0	1.0	1.0	1.0	1.0
Temperature	C	14	14	14	14	14	14
OXYGEN UPTAKE RATE							
Heterotrophic OUR	g/m3/h						
Autotrophic OUR	g/m3/h						
Total OUR	g/m3/h	109.35	90.90	65.48	48.6	40.4	29.1
AOR	kg O2/d	340	283	204	151	126	91
Alpha		0.5	0.55	0.60	0.50	0.55	0.60
Beta		0.95	0.95	0.95	0.95	0.95	0.95
Atmospheric Pressure	kPa	90	90.00	90.00	90.00	90.00	90.00
Residual O2 Conc.	mg/L	1.00	1.00	1.00	2.00	2.00	2.00
Cs	mg/L	10.31	10.31	10.31	10.31	10.31	10.31
Csw	mg/L	9.66	9.66	9.66	9.66	9.66	9.66
Css	mg/L	8.97	8.97	8.97	8.97	8.97	8.97
AOR/SOTR		0.419	0.461	0.502	0.370	0.407	0.444
SOTR	kg O2/d	812	614	405	408	308	204
SOTR per m2	kgO2/d/m2	27.46	20.75	13.70	13.80	10.43	6.88
Density	kg/m3	1.20145	1.20145	1.20145	1.20145	1.20145	1.20145
O2 fraction	kg O2/kg air	0.232	0.232	0.232	0.232	0.232	0.232
AT/AD, estimate		10	13	15	10	13	15
Number of Diffusers		74	57	50	74	57	50
Flux/diffuser	m3/h	7.171	7.113	5.256	3.280	3.254	2.404
SOTE, calculated		0.228	0.225	0.232	0.250	0.248	0.255
kLa, calculated	m3/d	2748.9	2077.4	1371.6	1381.2	1043.8	689.2
Vg, calculated	m/d	432.9	330.3	211.5	198.0	151.1	96.8
AIR REQUIREMENT	nm3/min	8.9	6.8	4.3	4.1	3.1	2.0
	nm3/h	534	407	261	244	186	119

5.2.8 Alkalinity Adjustment

The alkalinity requirement for Option 2 is the same as Option 1. The sizing of the chemical feed system will be confirmed during the detailed design phase.

5.2.9 Secondary Clarification

The sizing of the secondary clarifiers differs between Option 1 and Option 2. In Option 1, the governing design condition was the thickening capacity of the clarifiers, which required clarifiers having a diameter of 16.2m. For Option 2, the governing design condition is still the thickening capacity of the clarifiers, however the clarifiers are smaller at 13.6 m in diameter.

The sizing of the secondary clarifiers, based on hydraulic criteria is as follows:

- Phase 1 peak hour flow 9,600m^3/d
- No. of clarifiers in service 2
- No. of standby clarifiers 0
- Area of each clarifier 145m^2
- Diameter of each clarifier 13.6m
- Maximum surface overflow rate 35m^3/m^2/d
- Actual surface overflow rate 33m^3/m^2/d
- Side Water Depth (SWD) 4.5 to 5.0m
- RAS rate 80% of Average Annual Flow

Assuming an SVI of 200 mL/g, the solids flux of the 13.6m diameter clarifiers is adequate to meet the Phase 1 requirement.

- Phase 1 peak flow 9,600m^3/d
- Phase 1 RAS flow 2,560m^3/d
- Mixed liquor solids concentration (winter) 3,664 mg/L
- Secondary clarification area 290m^2
- Maximum Allowable SLR 6.4 kg/m^2/h
- Actual solids Loading Rate (SLR) 6.4 kg/m^2/h

For Phase 2, a third 13.6m diameter clarifier will be required together with a new bioreactor.

5.2.10 WAS Thickening

The incremental cost of upsizing a DAF, especially for the smaller units, is minimal, therefore the new DAF WAS thickening system for Iqaluit will be sized based on the Phase 2 service population of 12,000. The sizing of the DAF for Iqaluit under Option 2 is as follows:

- Peak TSS loading 547 kg/d
- Flow 164m^3/d
- Maximum design solids loading 3 kg/m^2/hr
- No. of units in service 1

- No. of standby units 0
- Concentration of thickened WAS 2.5%
- Required (minimum) area of DAF 7.6m^2

An equalization vault will be required to store Thickened Waste Activated Sludge (TWAS) to allow it to be fed to the dewatering unit process intermittently. The TWAS vault will be sized to allow for three days of active TWAS storage at the Phase 2 design population of 12,000 people. The sizing of the TWAS vault is as follows:

- Peak TWAS volume 21.4m^3/d
- Days of storage 3
- Active TWAS storage volume 64m^3

The TWAS vault will be constructed in the new Secondary Clarifier Building and it will be equipped with an aeration system to allow the sludge to be mixed before it is fed to the dewatering process.

The basis for sizing the WAS feed pumps is as follows:

- Maximum day flow 164m^3/d
- Number of duty pumps 2
- Number of standby pumps 1
- Operation continuous 24 hours/day
- Rating per pump 1.0 L/s
- TDH Approximately 5m

Provisions for selective wasting will be included in the design as detailed under Option 1. Also, provisions will be included to allow RAS to be wasted directly to the BFP.

5.2.11 Dewatering

In this Option, the Belt Filter Press will be smaller, as less WAS is generated in the bioreactors. The sizing of the Belt Filter Press is as follows:

The sizing of the BFP for TWAS dewatering is as follows:

- Number of duty units 1
- Number of standby units 0
- Phase 2 peak solids 536 kg/d
- Phase 2 flow 21.4m^3/d
- Operation Once every 2 days

- Hours of operation/day 6
- Design solids load rate 178 kg/hr
- Volumetric loading 7.1m^3/hr

The sizing of the BFP for RAS thickening and dewatering will be confirmed during detailed design.

The sizing of the BFP sludge feed pump for Iqaluit is as follows:

- Number of duty units 1
- Number of standby units 1
- Design flow 2.0 L/s
- TDH 10m (approximate)
- Type of pump Progressing cavity
- Power 5 kW

Similar to Option 1, a new dry polymer system will be required for Iqaluit. The sizing of the polymer system is as follows:

- Phase 2 peak solids 536 kg/d
- Polymer dosage 8 kg/tonne dry solids
- Operation every 2 days
- Hours of operation 6
- Polymer consumption / operating day 8.6 kg/d
- Polymer make-up concentration 0.5%
- Polymer volume / operating day 1,720 L/d
- Polymer feed 286 L/hr
- No. of batch tanks 2
- Volume per tank 1,000 L
- No. of Mixers 2

The sizing of the polymer feed pump for Iqaluit is as follows:

- Number of duty units 1
- Number of standby units 1
- Design flow 286 L/hr (4.8 L/min)
- TDH 10m (approximate)
- Type of pump Mechanical diaphragm or progressive cavity
- Power 1 kW with VFD

The existing Moyno centrifuge feed pump has a nameplate rated capacity of 2.7 L/s ($10m^3/hr$) at a TDH of 15m. The rated capacity of the sludge feed pump is 2.7 L/s, which is adequate for the service. The details of the pump will be confirmed with the manufacturer during detailed design.

The BFP feed pump will have a relatively high maintenance requirement, therefore it is recommended that a second pump be provided as standby to the existing pump. In the event, a new rotor and/or stator is required, the second pump can be put into service while the new parts are being shipped.

5.2.12 Outfall

The requirements for the outfall under Option 2 are the same as Option 1.

5.2.13 Effluent Water System

The requirements for the effluent water system will be somewhat lower under Option 2, as the BFP will be smaller. The details of the system will be confirmed during detailed design.

5.2.14 Secondary Effluent Disinfection

Similar to Option 1, provisions will be included in the design to allow secondary effluent disinfection to be added at a later date.

5.2.15 Chemical Storage

The chemical storage requirements for Option 2 will be similar to Option 1. Storage space requirements will be developed during detailed design.

5.3 Recommended Option

Of the two options under consideration, Option 2 is recommended for Iqaluit. The addition of a Salsnes Filter into the WWTP provides many benefits, including the following:

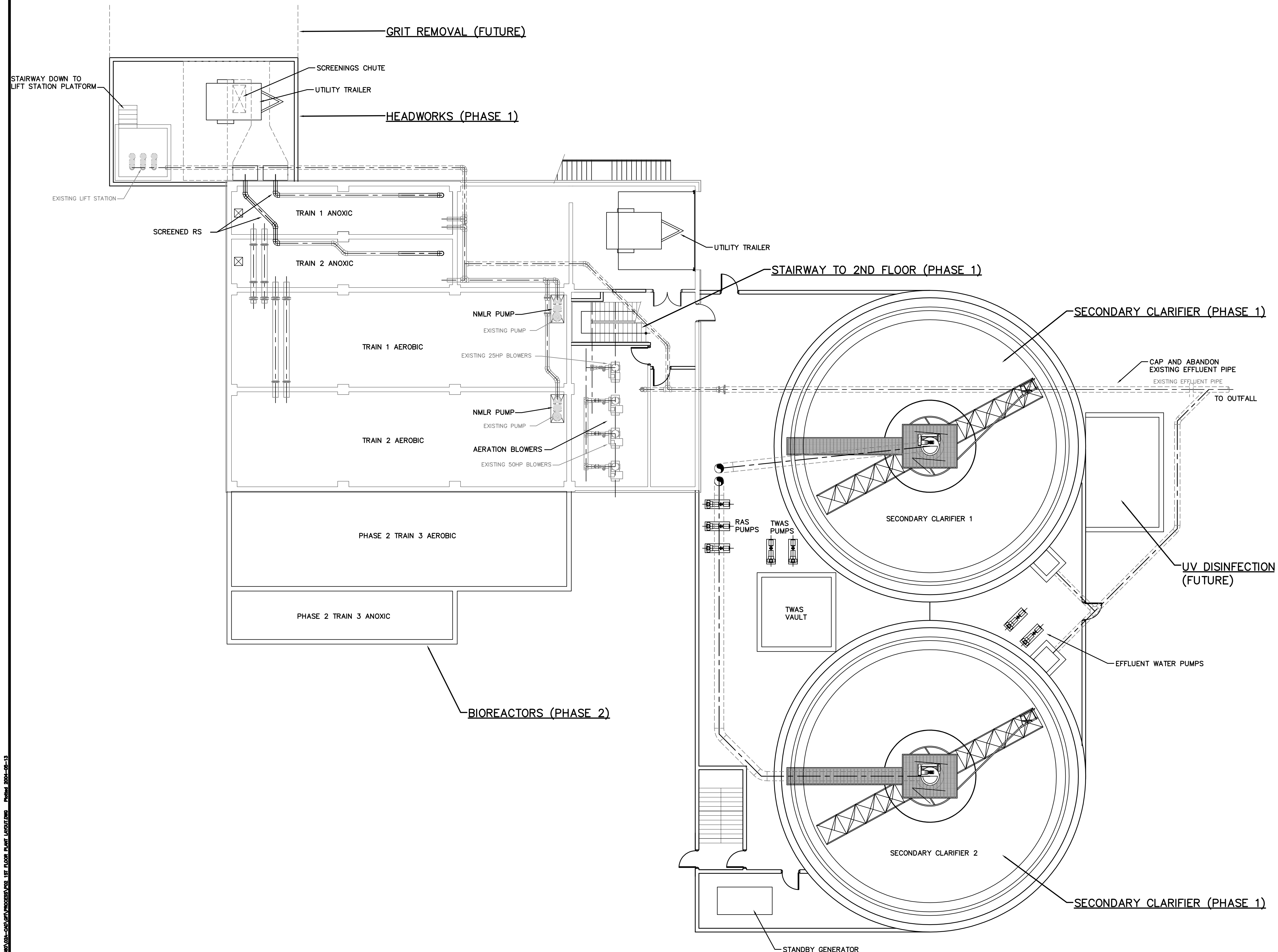
- In Phase 1, the mixed liquor concentration in the bioreactors will be lower and will reduce the potential for foaming to be a problem;
- Further reduces the accumulation of debris in the anoxic zones;
- Reduces grit loadings to downstream unit processes;
- Reduces the size of the secondary clarifiers required for Phase 1;
- Reduces the size of the bioreactors required for Phase 2;
- Reduces the sizing of all equipment in the solids train; and
- Reduces operating costs with lower power and chemical consumption.

The equipment itself is robust, simple to operate and well-suited for the requirements in Iqaluit. The capital cost of $200,000 will be more than offset by savings in equipment, building footprint and operating costs.

Based on the preceding, Option 2 is recommended for Iqaluit.

5.4 Preliminary Floor Plans

Preliminary floor plans for the upgrades in Iqaluit are shown in **Figures 6 and 7** and a preliminary hydraulic profile is presented in **Figure 8** on the following pages**.**



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No.	Date	Description

REVISIONS

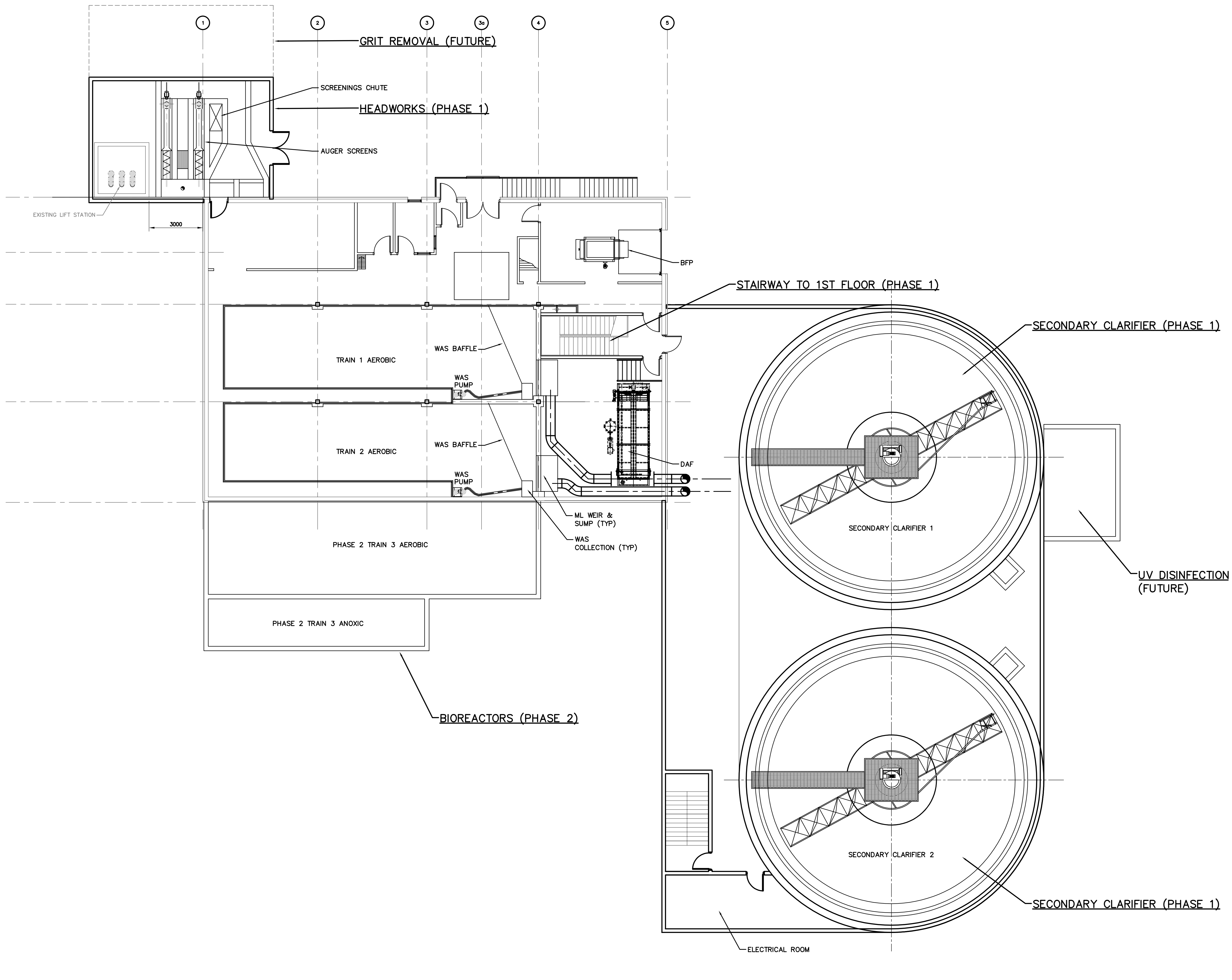
Iqaluit
CITY of IQALUIT, Nunavut

Design RDB
Drawn DKB/KJW
Approved Chief
Director

Project Title
CITY OF IQALUIT WASTE WATER TREATMENT PLANT

Drawing Title
PROCESS PRELIMINARY FIRST FLOOR LAYOUT

Scale N.T.S.
Project No. 75360
Date 22/04/04
Drawing No. **FIG. 6**
Revision



EARTH TECH
Earth Tech (Canada) Inc. Edmonton, AB (780) 488-6800

DRAFT COPY

No.	Date	Description

REVISIONS

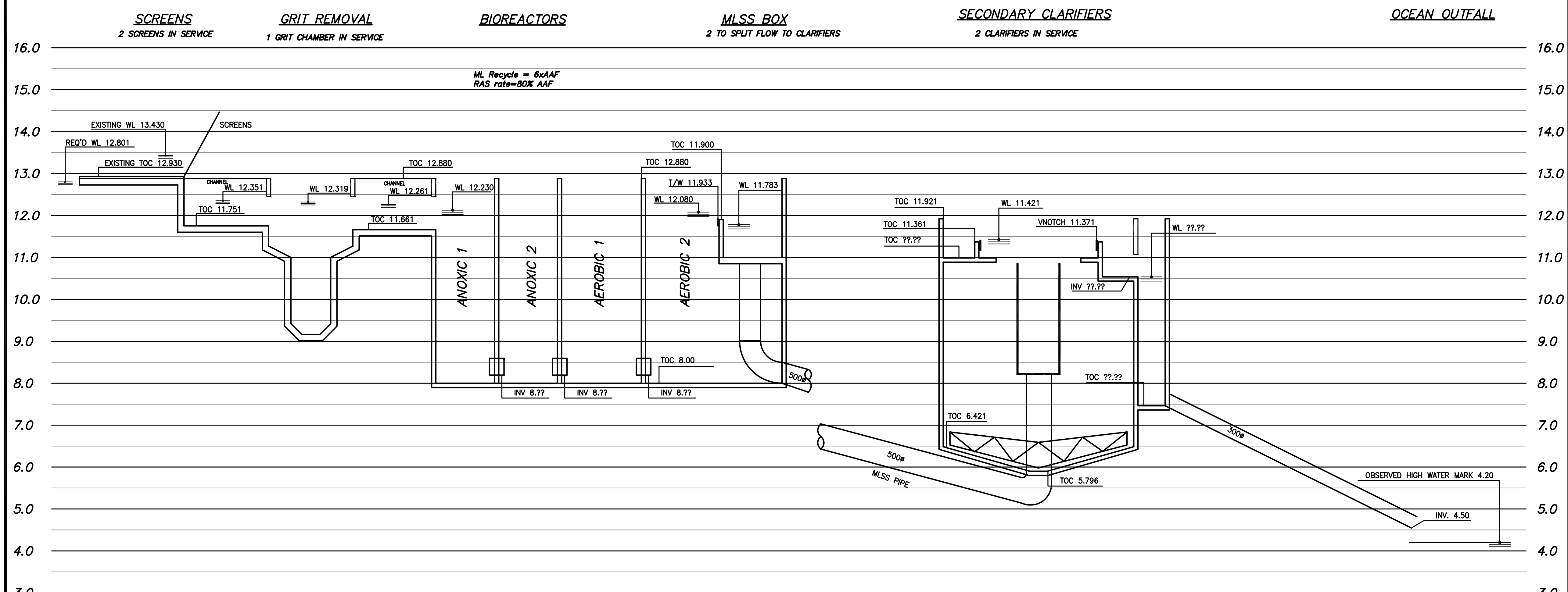
Iqaluit
CITY of IQALUIT, Nunavut

Design RDB
Drawn DKB/KJW
Approved Chief
Director

Project Title
CITY OF IQALUIT WASTE WATER TREATMENT PLANT

Drawing Title
PROCESS PRELIM. SECOND FLOOR LAYOUT

Scale N.T.S.
Project No. 75360
Date 22/04/04
Drawing No. FIG. 7
Revision



PHASE 2 FLOWS

Q AAF = AVERAGE ANNUAL FLOW = 4800 m3/d

Q PK_{hour}= AFF x 3.0 PEAKING FACTOR = 14400 m3/d

PLOT DATE: 2004.04.23 14:42 PLOT SCALE: 1:1 PS BY: DAVID.BENKE

L:\WORK\75000\75360\02A-CAD\GFX\PROCESS\DWGS\PLANT HYDRO PROFILE.DWG

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Earth Tech (Canada) Inc. Edmonton, AB (780) 488-6800

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No.	Date	Description

REVISIONS

Iqaluit

CITY of IQALUIT, Nunavut

Design SNO

Drawn DKB

Approved Chief

Director

Project Title

CITY OF IQALUIT WASTE WATER TREATMENT PLANT

Drawing Title

HYDRAULIC PROFILE Q = 14400 m3/d

Scale N.T.S.

Project No. 75360

Date 19/04/04

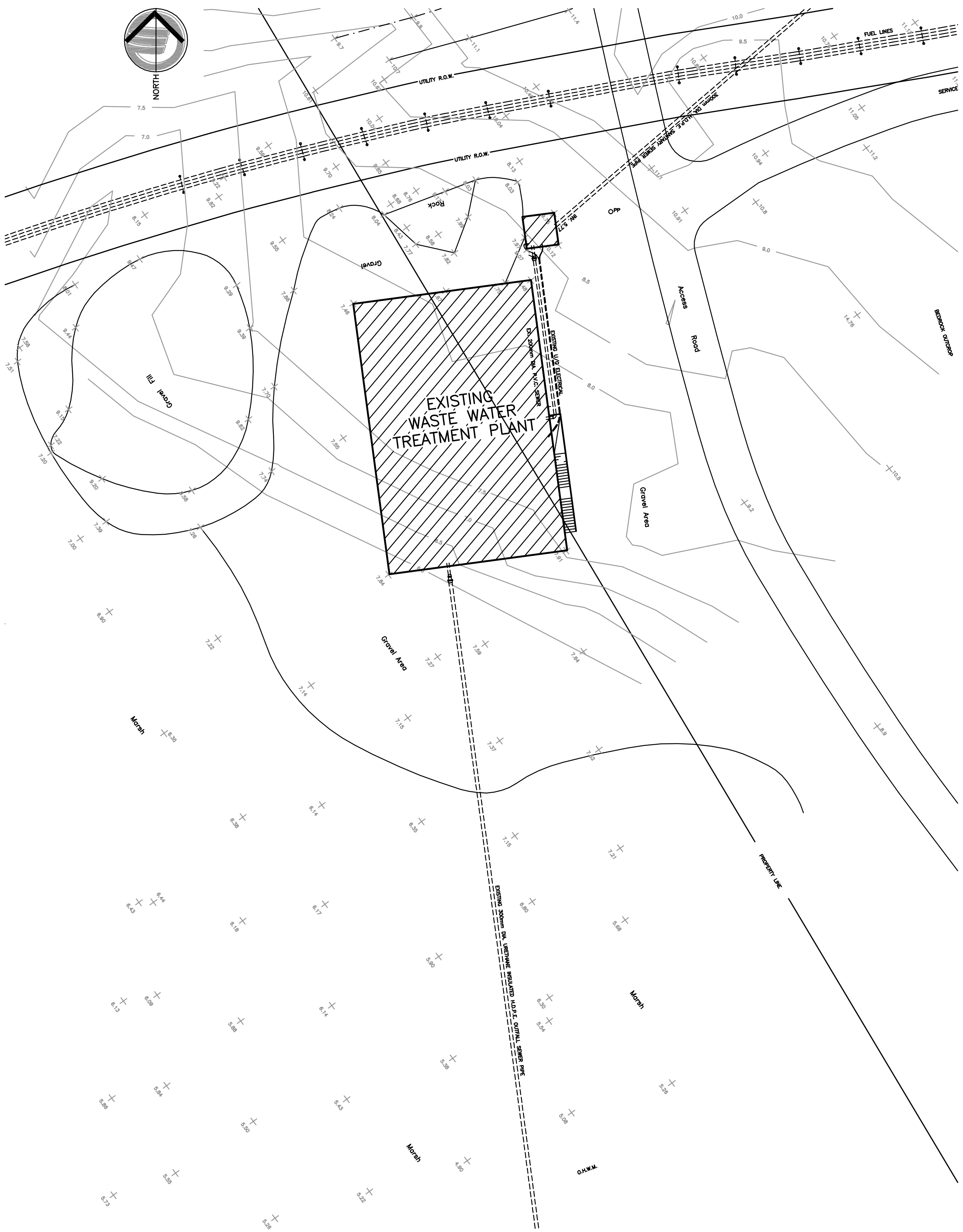
Drawing No. FIG. 8

Revision

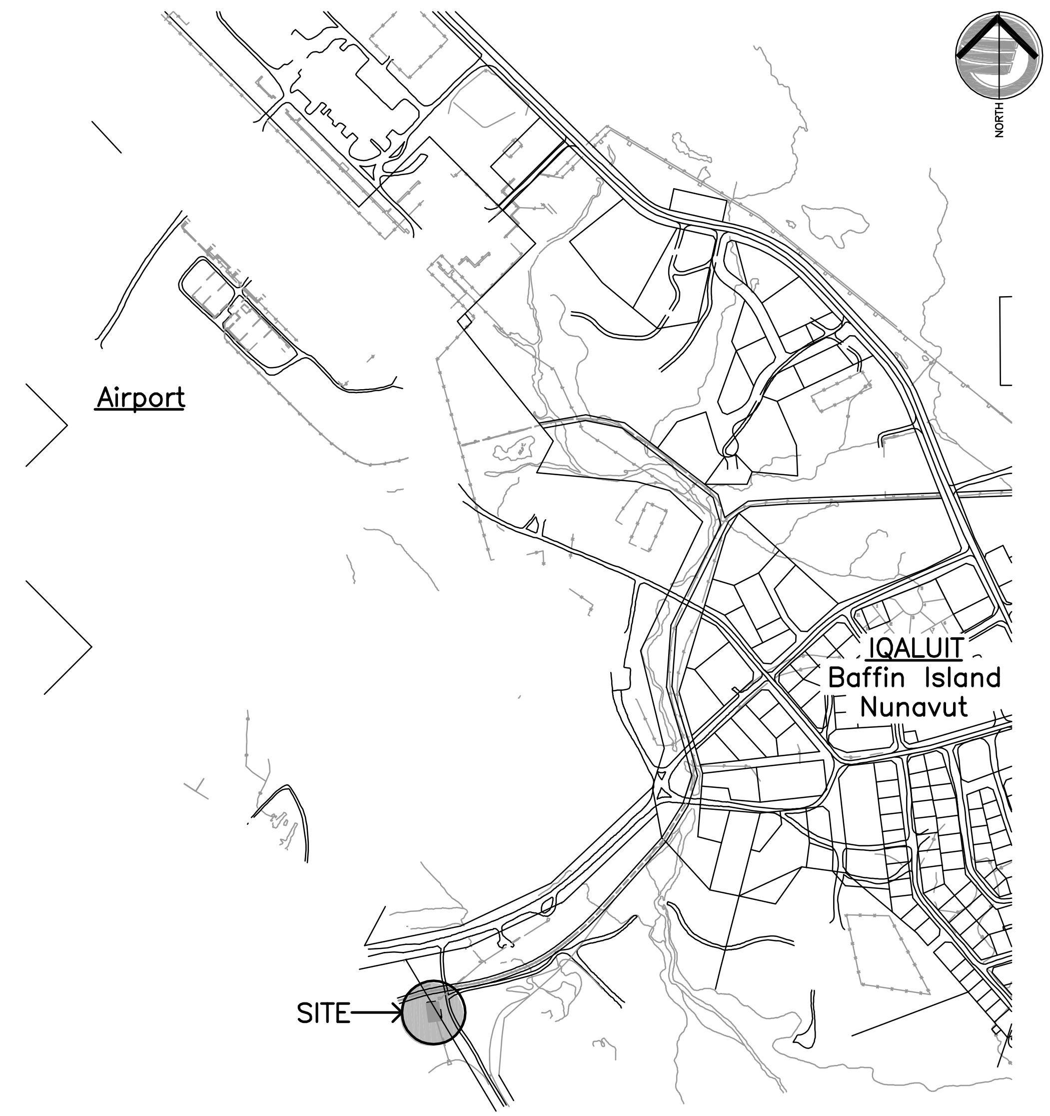
6.0 CIVIL WORKS AND SITE PLAN

The civil works for the WWTP will include improvements to the existing grading and surfacing of parking or service areas immediately surrounding the existing plant building and the new additions. Vehicular access will be required routinely for removal of the screenings, the dewatered sludge and for fuel oil. A permanent access will not likely be constructed to the outer generator door, as this door should only required access on rare occasions.

Preliminary location and existing site plans as well as a proposed site plan are shown in **Figures 9 and 10,** respectively, on the following pages.



EXISTING SITE PLAN
0 5 10 15 20m
Scale 1:250



LOCATION PLAN
0 5 10 20 30 40
Scale 1:5000

EARTH TECH
Earth Tech (Canada) Inc. Yellowknife, NT 867-873-6316

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PRELIMINARY
Not For Construction
2004/05/20

No.	Date	Description
1	2004 5/20	ISSUED FOR REVIEW

REVISIONS

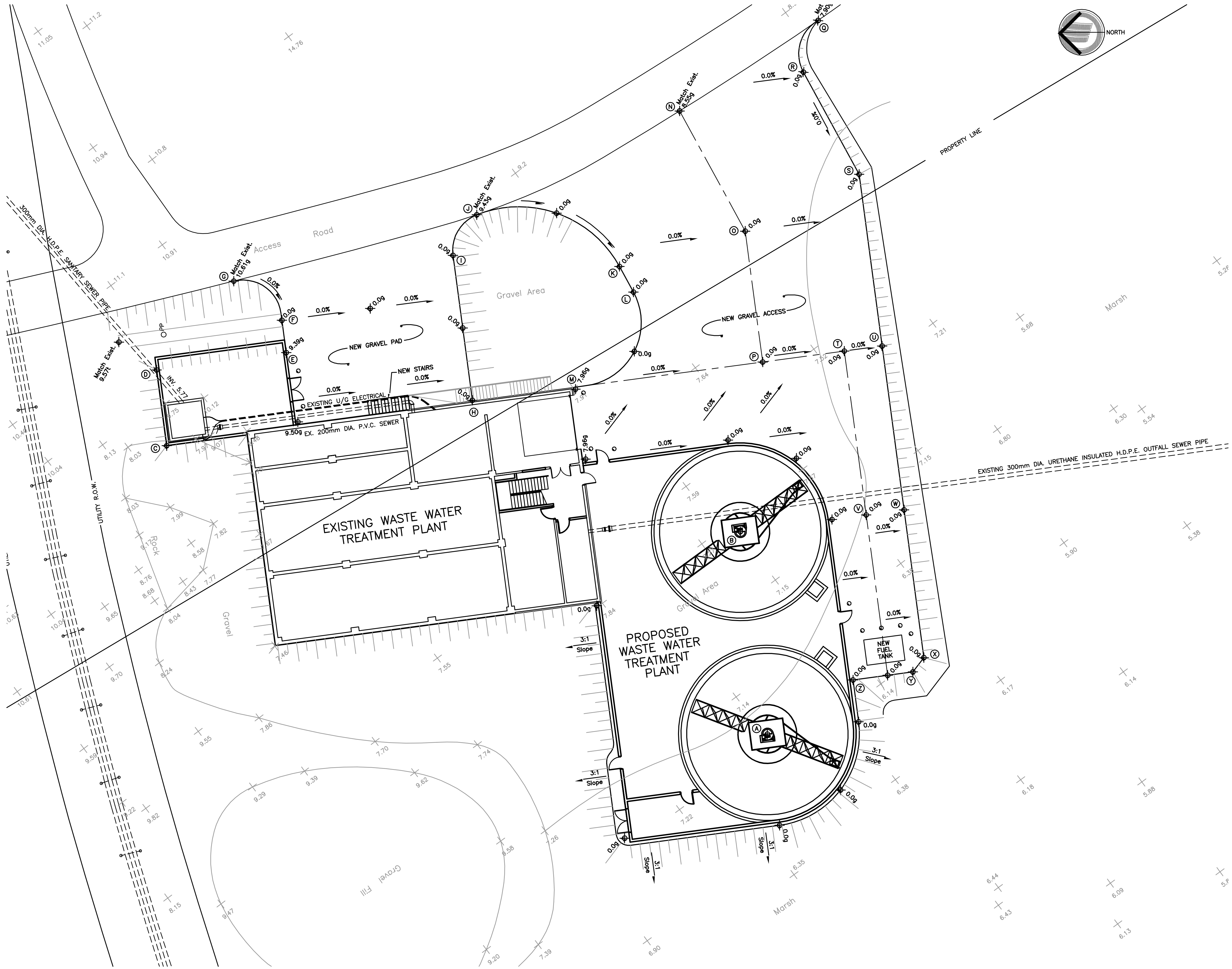
Iqaluit
CITY of IQALUIT, Nunavut

Design
Drawn R.J.H.
Approved
Chief
Director

Project Title
CITY OF IQALUIT WASTE WATER TREATMENT PLANT

Drawing Title
LOCATION PLAN and EXISTING SITE PLAN

Scale AS SHOWN
Project No. 75360
Date 2004-05-20
Drawing No. **Figure 9**
Revision **0**



PROPOSED SITE LAYOUT and GRADING PLAN

Scale 1:125 (0 5 10)

EARTH TECH

Earth Tech (Canada) Inc. Yellowknife, NT 867-873-6316

COORDINATE DATA		
IDENT.	NORTHING	EASTING
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B	7068513.900	522690.878
C	7068560.139	522698.982
D	7068560.396	522704.928
E	7068550.750	522706.292
F	7068551.090	522708.833
G	7068554.874	522711.907
H	7068536.123	522702.548
I	7068537.648	522713.933
J	7068535.779	522717.120
K	7068524.564	522713.062
L	7068523.465	522711.047
M	7068528.208	522703.560
N	7068519.835	522725.276
O	7068514.686	522715.835
P	7068513.309	522705.555
Q	7068508.957	522732.384
R	7068510.110	522728.330
S	7068505.731	522720.302
T	7068506.898	522706.414
U	7068503.925	522706.812
V	7068505.175	522693.545
W	7068502.202	522693.943
X	7068500.648	522682.334
Y	7068501.507	522681.210
Z	7068506.215	522680.579

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PRELIMINARY
Not For Construction
2004/05/26

No.	Date	Description
1	2004 5/26	ISSUED FOR REPORT

REVISIONS

Iqaluit
CITY of IQALUIT, Nunavut

Design
Drawn R.J.H.
Approved Chief
Director

Project Title
CITY OF IQALUIT WASTE WATER TREATMENT PLANT

Drawing Title
PROPOSED SITE LAYOUT and GRADING PLAN

Scale AS SHOWN
Project No. 75360
Date 2004-05-26
Drawing No. Figure 10
Revision 0

7.0 MECHANICAL SYSTEMS

7.1 Heating

The existing heating system consists of two glycol heating boilers with pumps circulating glycol through each. Heating water supply consists of two mains with a single pump on each. One pump supplies glycol to unit heaters throughout the building, the other serves the heating coils in the air handling unit. Distribution is via supply/return headers located on the mezzanine above the office/washroom (Lab). Distribution piping is copper within the mechanical room and Kitec (semi-rigid) throughout the rest of the facility. Electric baseboard heaters with integral thermostats provide heating for the Washroom and Office.

It is anticipated that the boilers and pumps will be reused but this will need to be confirmed during detailed design. Since the building size and ventilation are increasing from the original building, it is possible this equipment will not have sufficient capacity. The status of the glycol in the system is not known but has likely deteriorated over time. The heating media should be tested and reused if appropriate. Pumps and distribution piping will be reused where possible. New glycol unit heaters will be provided to heat the expanded building. The majority of the existing heating piping is not insulated. It is recommended that all heating piping be insulated throughout the building in order to promote better heating efficiency and occupant safety.

7.2 Ventilation

One air handling unit provides tempered ventilation air to the entire Second Floor and to the Blower Room on the First Floor. This unit consists of the following components: two supply fans, one return fan, preheat coil, heating coil, heat recovery section, filter sections and mixing sections. One supply fan serves the Second Floor, the other serves the Blower Room. A small exhaust fan is provided in the washroom, which discharges into the Bioreactor Room. Ventilation for the Generator Room is provided via openings in the exterior wall and Blower Room demising wall. Motorized dampers are modulated based on the temperature setpoint (local thermostat). No ventilation air is currently provided for the Office, Trash Auger Room or the Cake Bin Room.

Press Room – Ventilation air will be provided to this area at a rate of ten air changes per hour from the existing air handling unit.

Cake Bin Room – Ventilation air will be provided to this area at a rate of six air changes per hour. Preliminary calculations indicate that a new air handling unit will be required to serve this area and any others on the First Floor.

Headworks – A new two speed makeup air unit coupled with a two speed exhaust fan will provide six and twelve air changes per hour on LOW and HIGH speed respectively. Since this area is a Class I Div. II area, all motors will be explosion proof. The air system will normally operate on LOW speed, but upon sensing occupancy or H_2S gas, the air system will switch to HIGH. This is the only classified space in the building.

Aerobic Tanks – Continuous exhaust is required to keep the tanks at a negative pressure with respect to the main room. This will help to prevent odors, potentially hazardous gas and humid air from escaping to the rest of the building.

Generator Room – Motorized dampers in the out door air, exhaust and recirculating air openings will modulate to maintain the temperature set point when the generator is operating. When the generator is not running, no mechanical ventilation will be provided to this space, which is standard industry practice.

Electrical Room – A new transfer fan will be provided to ventilate this room based on local temperature set point.

Secondary Clarifier Tank Room – A new make up air unit and exhaust fan will be provided to ventilate the space at two air changes per hour on a continuous basis. General ventilation only is required in this space due to low occupancy level and lack of odours and gases to be removed.

Blower Room – Make-up air for the blowers will be provided via the existing outdoor air opening in the Generator Room wall and the opening in the Generator Room/Blower Room demising wall. The openings are oversized for the current application but easily adapted. New insulated ductwork will be provided.

Provisions for Future – Additional air volume will be required to ventilate the future Aeration Tanks. The existing air handling unit does not have capacity to handle this load. If the future expansion occurs, an additional air handling unit will be required.

7.3 Domestic Water

The domestic water system consists of a water storage tank and pressure system (expansion tank and jet pump) located in the Mechanical Room on the First Floor and electric domestic water heater located on the mezzanine above the office/washroom. Distribution piping is copper throughout and serves the washroom and a hand sink and hose bibs in the Lab. The equipment appears to be in good working condition and aside from modifications to pipe work, it is anticipated that the sizes will be adequate for reuse.

7.4 Plumbing

The plumbing system consists of one washroom with water closet, lavatory and shower, and floor drains located throughout the building. It appears that rough-in has been provided in the Lab area for a domestic clothes washer. Sanitary waste is piped out the wall to a sewage holding tank located under the main stair outdoors. It appears that this was a temporary setup which is now not in service. The sewage tank is disconnected and the main sanitary drain pipe terminates just outside the wall allowing drainage to flow freely to the ground. A sump located in the Cake Bin room collects drainage from floor drains in the Pump Room, Press Room and all of the First Floor. Waste water is pumped up and out of the building beside the main sanitary discharge. The pumps are controlled by a series of float switches and monitored by a control panel located in the Cake Bin Room. Floor drains above the Anoxic

Tanks are not piped but contain pipe stubs only and are designed to drain directly to the Anoxic Tanks.

The sump pumps were tested and appear to be in working order, though the status of alarms and float switches is not known. Drainage piping will need to be connected to the floor drains above the Anoxic Tank 2 as the current configuration would compromise the containment of the tanks. Piping will be reconfigured so that discharge from all fixtures is to the Aerobic Tank I. Drainage from the Secondary Clarifier Tank Room will be collected in a sump and pumped to the discharge piping from the rest of the building.

7.5 Fuel Oil

The fuel oil system consists of one doubled walled 9600 L storage tank located directly outside the Generator Room. A wall mounted 450 L daytank is located in the Generator Room. Fuel oil piping (copper tubing) runs under the floor in PVC conduit to the Mechanical Room to feed the boilers. The main fuel storage tank appears to rely on a vacuum seal for monitoring of the secondary containment. This type of tank is notorious for containment monitoring difficulties and should be replaced with a conventional double walled steal tank. The size of this new tank will be determined based on building heating and generator requirements. The proposed location of the tank is on south side of Secondary Clarifier Room.

8.0 STRUCTURAL

8.1 Introduction

It is proposed to upgrade the existing Iqaluit wastewater treatment plant utilizing as much of the existing plant as possible. Revision to the process flow and storage requirements, will involve numerous small modifications to the existing structure as well as two new building additions.

There will be a new 600 m2 building addition on the south elevation to enclose the two new 13.6m concrete clarifiers. A 62 m2 new screens building will be added to the northeast corner of the existing building. The new combined total footprint of the facility will encompass an area of approximately 1115 m2.

The foundation and lower floor will be constructed of cast-in-place concrete where as the super structure will be framed with steel and metal cladding.

8.2 Site Considerations

The existing building is located on a bedrock outcrop that slopes toward the north-west. Generally the site slopes downward toward the ocean to the south and to a marsh on the west. The clarifier building will be located on the south west corner of the existing building. A portion of the existing marshland will be infringed upon.

The new screens building is situated between the existing building and the existing road on the east. The northeast corner of the existing building will have to be backfilled and surface drainage re-directed. The east side of the existing building will be backfilled by approximately 2.5m so that the equipment door on the upper level can be accessible by the town's loader.

A geotechnical investigation of the site still has not been carried out to date, however it is understood from the original construction that the bedrock is close to the surface. The bedrock will be used as the bearing surface for the proposed structures. It is also understood that the rock profile in the building area is well above the level required by the clarifier depth and consequently blasting will be required to bring the bedrock to below the clarifier floors.

8.3 Foundations

Foundation loads from the superstructure are anticipated to be approximately 150 kN. Loads of this magnitude may be transferred directly to the bedrock via drilled anchors.

Grade supported concrete slabs for the occupied spaces of the lower level will be placed over a sand / gravel layer isolating the slab from direct contact with the bedrock surface. Lower floor slabs on grade are anticipated to be approximately 150 mm thick and reinforced to provide lateral restraint to the clarifier walls and to accommodate temperature and shrinkage of the slab concrete.

All concrete specified for the foundation components will contain normal – type 10 - cement as negligible amounts of water soluble sulphates are anticipated in the soil in the vicinity of the proposed building. Concrete exposed to freeze thaw cycles will be air entrained to CSA Standards.

8.4 Existing Building Modifications

There are several items from the existing construction that need to be repaired or completed. These include bracing to the roof purlins and missing anchor bolts.

Around the existing aerobic cells, all the handrails and ladders will be removed. A removable aluminum plate floor will be added to completely close off the aerobic tanks. Small concrete weirs will be added to the south end of the cells.

A new internal stair core will be added to the south side of the building to replace the existing non-code compliant ship ladder.

8.5 Clarifier Building Main Floor

The main floor of the clarifier building will be a concrete slab on grade providing a support for the process equipment. The slab will be approximately 150 mm thick and will be reinforced to carry the loads imposed both from the equipment as well as the reactions from the clarifier walls.

8.6 Clarifier Building Second Floor

The second floor of the clarifier will mostly be constructed of FRP (fiber reinforced plastic) grating on a steel substructure. There will only be catwalks created as needed to access equipment. There will be localized concrete floor areas under the second floor electrical room.

8.7 Clarifier Building Roof

The roof structure for the new buildings will be framed with light steel framing, and metal deck. The roof structure will be mono-sloped to the south so that the existing roof profiles are maintained. The resulting clear spans will therefore not encumber the process floor space with columns. A new roof structure will be added overtop of the existing building at a shallower slope, so that there are no changes in roof elevation between the existing and new building.

All design loads, for roofs will be in compliance with the requirements of the National Building Code and specific requirements of the project.

8.8 Building Columns

All columns will be located along exterior walls and each will be enclosed within the building envelope. It is anticipated that the columns will be hollow structural sections and will be sized and detailed to work with the wall system design and minimize projections into occupied spaces.

8.9 Lateral Stability

The exterior walls of the new buildings will be wind bearing. Wall sections will be designed to carry the wind loads to the columns or directly to the ground or roof diaphragm.

Lateral stability will be achieved by the use of cross bracing or rigid shear walls in selected structural bays and will be located to have minimal effect on operations.

The roof of the building will be designed to act as a diaphragm. The metal roof deck, joists and beams, despite being nominally sloped for drainage, will be detailed to provide the necessary diaphragm action to deal with the wind and seismic loads imposed on the structure.

8.10 Codes And Standards

The following Codes and Standards will apply to the structural components of this building:

- The National Building Code of Canada 1995
- Design of Concrete Structures for Buildings CSA A23.3
- Cold Formed Steel Structural Members CSA S136
- Limit States Design of Steel Structures CAN/CSA S16.1
- ACI 350R Environmental engineering Concrete structures

Other codes and standards may apply and will be specified in the construction documents.

9.0 INSTRUMENTATION AND CONTROLS

9.1 Plant Control System (SCADA)

The upgraded wastewater treatment plant facility control scheme will be provided using a Supervisory Control and Data Acquisition (SCADA) system. The SCADA system will consist of a Programmable Logic Controller (PLC's) installed at the WWTP as the primary control platform.

The configuration of the SCADA system is outlined in the attached SCADA Schematic drawing. As shown in the drawing, the system consists of several functional blocks including: PLC, operator interface Video Display Terminal (VDT), Field devices, alarm dialer, printer, horn and beacon, operator PC terminal and printer. All SCADA system components are powered by Uninterruptible Power Supplies (UPS) to ensure that the power to this equipment is both uninterrupted and protected from any under/over voltage conditions.

Each of the functional blocks are defined in greater detail in **Table 9-1** below.

Table 9-1 Plant Control System Functional Blocks

TYPE	APPLICATION	ACCEPTABLE PRODUCTS
PLC	Plant Controller	Allen Bradley (Existing Equipment, to be reused)
PLC Software	Configuration and run programs for PLC's	Rockwell RSLogix
Modem	PC to outside link	By PC vendor
Network Switch	Facility Ethernet Hub	Alied Telesyn
Operator Interface	Plant floor operator interface and system display terminal	Rockwell Panelview
PC	Operator interface and system configuration terminal	Dell
HMI Software	Operator Interface Software	Rockwell RS View
Autodialer	Alarm Dialout	Barrnet Engineering

9.2 Programmable Logic Controller

The PLC selected for this application will be specified as Allen Bradley SLC series Model 505. This product matches both the equipment currently installed in the facility and the equipment installed at the wastewater treatment plant. The existing Allen Bradley PLC equipment will be re-used where ever possible and supplemented with currently missing components to form a complete and operational system. The Allen Bradley is considered to be a manufacturer with a track record of rugged and reliable technology and this PLC has the following features.

Be of modular design. Modular design will allow for the removal/replacement of modules with the system on-line without causing disruption to cabinet wiring or other operating modules.

Be equipped with power supply, processor, memory, analog input/output, and discrete input/output modules.

Be expandable to incorporate a sufficient number of modules to allow for a maximum of 250 input/output signals (in any mix of analog or discrete signals).

Be 120 volt AC powered and have an internal battery back-up for the memory module.

9.3 Operator Terminal (Hardware)

The operator terminal will provide single or multiple plant floor locations for the operator to interact with the entire control system. The operator interface video display terminal will be configured to provide both graphic and text based system status information. The operator will interact with the system using both the touch screen and the front panel keypad. The information provided on the operator interface video display terminal will be real time and represent the current plant status. Trending, alarm logs and reports will not be available on this device. The operator will also be able to monitor the entire system from the system PC located at the wastewater treatment plant. Trending, alarm logs and reports will be available at this PC location.

9.4 System Communications

The PLC will communicate with the operator interface video display terminals, the operator PC, printers and the Packaged Equipment PLC's using Ethernet protocol. The Ethernet protocol has been selected, as it is a current, well established protocol that is flexible and easily configured.

Both the new wastewater treatment plant and the upgraded existing reservoir will use a similar Ethernet configuration with all devices wired to a single network switch.

The PLC control system at the wastewater treatment plant location will be fitted with it's own auto dialer. This will ensure that in event of plant alarms the facility will be able to generate and transmit alarms to the system operator.

9.5 Connections to Field Devices

Field devices will be wired to the main PLC location from three (3) main sources; the MCC, field instruments located throughout the facilities, and from the controls systems provided with packaged equipment. MCC signals will be discrete information such as motor status (running, stopped, tripped) or control signals to motor starters (stop, start).

The field devices located throughout the facilities will generate or require both analog and discrete signals. Analog devices will generate inputs to the PLC such as temperature, pressure, flow, and level values or require outputs such as control valve position signals. Discrete signals from field devices located throughout the facilities will include equipment status, valve position, flow status, and alarm switches(temperature, pressure, level). Where there are large numbers of field devices it is more efficient to install a marshalling panel in the area, and wire each device to the marshalling panel. A single multi-conductor cable is then routed to the main PLC cabinet. All multi-conductor cables will be provided with spare conductors to allow the addition of new field instruments.

9.6 Connections to Packaged Equipment

At the time of this report the inclusion of packaged equipment has not been determined. The following paragraph details the interconnection of control systems should packaged equipment be supplied.

Some of the packaged equipment may be provided with its own control system. In order to interface with this equipment, control ties will be made in one of two ways. If the packaged equipment is to be provided with its' own PLC, the equipment will be specified to ensure that an Ethernet interface can be wired between the packaged equipment and the wastewater treatment plant PLC. If the packaged equipment is not provided with its' own PLC, individual status and control signals from with the equipment will be wired directly to/from the wastewater treatment plant PLC.

9.7 Human Machine Interface (HMI) Software

All operator interface terminals and the operator office PC will run the facilities HMI software. This software provides a graphic and text based operator screens that are laid out to mimic segments of the treatment, storage, and distribution pumping segments of the process. From the video display terminals the real time plant operating and alarm values or status are presented to the operator. The VDT's also allow the operator to change all process variables or equipment status (for example: pump start/stop). The operator PC will provide a view only location from which to monitor the plants operation, process changes cannot be initiated from this computer.

The HMI software also includes a data collection function that allows the operator to view trends, generate reports, or review alarm logs in order to trouble shoot process upsets. Reporting, trends and alarm logs can all be customized to provide information for operations as well as to generate audit tracking information for regulatory purposes.

It is important to note that the PLC control system equipment does not rely on the HMI software to operate. In event of an HMI failure, the PLC will continue to control the plant and all related safety systems. Using the last entered operations settings. When the HMI is offline all viewing of plant status, changes to process control, data recording and reporting ability is lost. All acceptable manufactures of HMI software listed above have a proven track record of reliable systems installed in major municipal and industrial settings.

10.0 ELECTRICAL

10.1 General

The existing wastewater treatment plant has yet to be commissioned or operated due to a number of deficiencies. The existing wastewater treatment plant services are to run until construction of upgraded wastewater treatment plant is completed, commissioned and placed into service. Electrical systems installed within the new facility will be both code compliant and energy efficient. Electrical distribution will be sized to accommodate the facilities as-built requirements, and future expansion of the facilities treatment systems and/or pumping requirements.

This section of the report is intended to provide a consolidated outline of the electrical systems design for the new wastewater treatment plant. The report will cover the following items:

- Power Distribution Systems
- Standby Power Generation and Distribution
- Building Wiring
- Lighting and Emergency Lighting Systems
- Power for Mechanical Equipment
- Telephone and Communications systems
- Control Systems are discussed in the following section of this report

This report is intended to define the scope, material and quality of installation and provide sufficient information to enable the Project Team to establish a realistic estimate of probable cost for the project.

The electrical design and installation will conform to the following codes, regulations and standards:

- National Building Code of Canada 1995
- Canadian Electrical Code, CSA C22.1-98
- Nunavut Power Corporation Utility Requirements
-

The selected electrical systems will:

- Provide a wastewater treatment plant that is safe, efficient, easily maintained, well lit, and has the capacity to allow for future changes to the treatment and/or distribution systems.
- Meet the capital budget requirements
- Minimize operating costs by utilizing low maintenance energy efficient systems where practical within the project budget.
- Provide reliable system operation by incorporating known proven technologies backed by reputable vendors and their associated service agencies.

10.2 Site Services

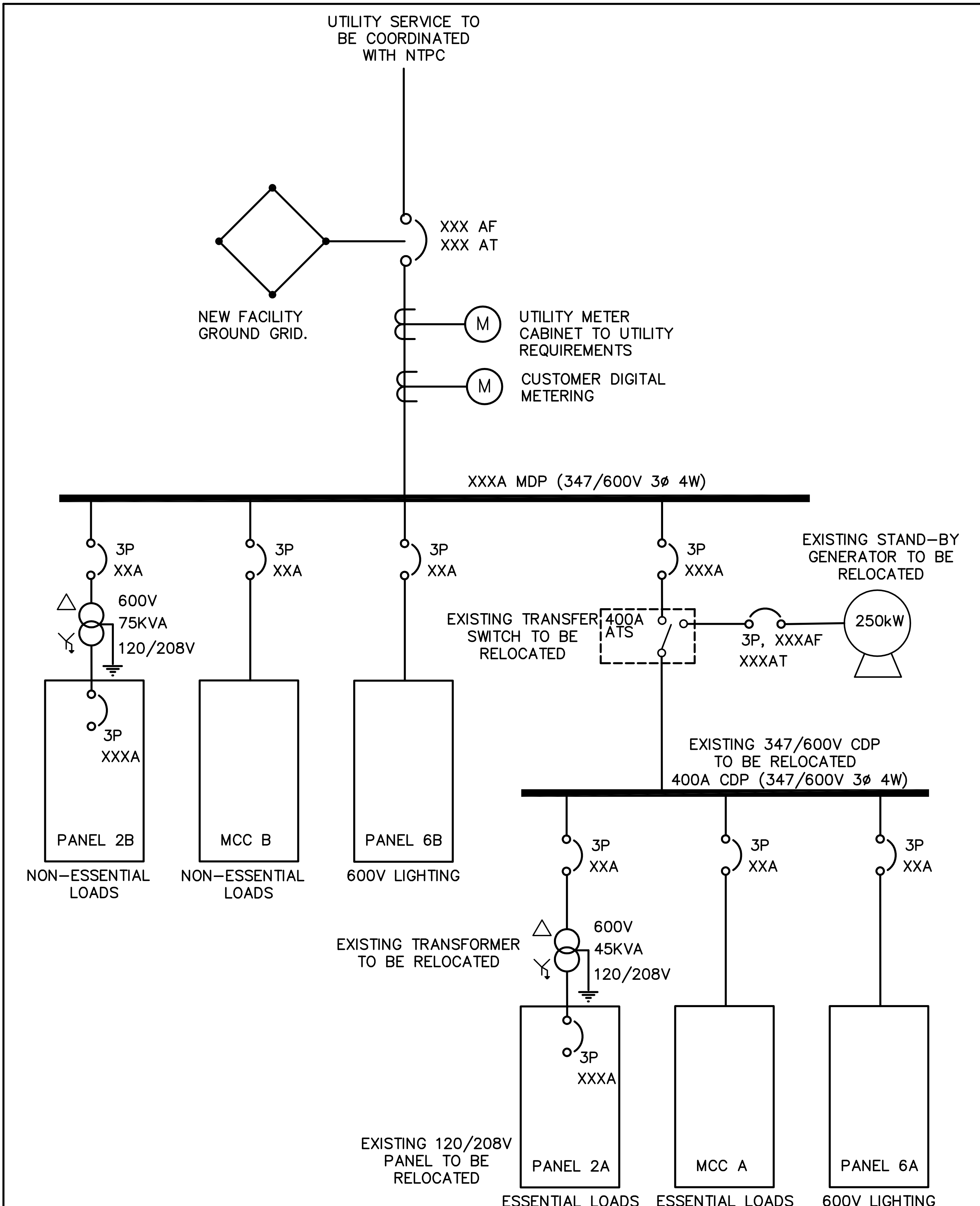
The power service for the new wastewater treatment plant will be co-ordinated with the Nunavut Power Corporation. We are currently assuming the facility service requirements will be greater than 400amps and will require a padmounted utility transformer located outside of the electrical room building wall. Incoming service conductors will be routed underground to the electrical room and subsequently to the MDP. The installation of the incoming power lines and metering requirements for the service to the new wastewater treatment plant is to be coordinated with the Nunavut Power Corporation.

The installation of phone service to the new wastewater treatment plant will also be provided overhead building electrical room. Incoming telephone will be routed to small telephone backboard located in the electrical room. Installation of the new telephone service is to be coordinated with Northwestel.

10.3 Power Distribution

The new wastewater treatment plant power distribution is to be configured as indicated on the attached Single Line Diagram shown on Figure 11. Figure 11. also indicates the components of the existing facility power distribution system that are to be re-used for the upgraded facility. The main electrical service will be sized at XXX amperes, 347/600 volts, 3 phase, 4 wire. (Presently the sizing of the facility incoming service equipment has not been undertaken as the size, number, and type of electrical motors has not been determined.) The main power distribution will configured as follows:

- Utility provided 3 phase transformer.
- A main circuit breaker with adjustable solid state tripping.
- The facility system ground will be provided by an exposed copper conductor grid routed around the new building perimeter and tied to copper clad ground rods located at each corner of the building.
- A single Main Distribution Panel (MDP) utilizing molded case thermal/magnetic trip circuit breakers. The MDP will feed both the utility only , and standby power distribution systems.
- The standby power branch of the distribution will be fed via the relocated Automatic Transfer Switch (ATS). The ATS will be fed from the MDP and the relocated stand-by generator.
- Motor Control Centers (MCC) fed from the MDP and the standby power generation distribution . The MCCs will feed all motor loads over 0.56 kW. The Motor Control Centers will contain all motor starters for process motors including magnetic starters, reduced voltage starters, and Variable Frequency Drives as required. Critical facility motor loads will be fed from the stand powered MCC’s to ensure the essential facility motor loads are operational during a utility power failure
- 347/600 volt distribution panels will provide power for new facility lighting circuits.
- 120/208 volt distribution panels will each be fed via an individual transformers. These panels will provide branch circuit wiring to the wastewater treatment plant.



DRAWN BY: LL	IQALUIT WWTP	EARTH TECH Earth Tech (Canada) Inc. Yellowknife, NWT 867-873-6316
CKD. BY: TDC	DESIGN REPORT SINGLE LINE DIAGRAM	SCALE: N.T.S. DATE: MAY/04 DWG No. FIGURE 11

Acceptable manufacturers for power distribution, motor control centers, motor starters distribution transformers, panel boards and equipment disconnect switches are Cuttler Hammer, or Allen Bradley.

10.4 Stand-by Power System

As a key component of the design process, the facility standby power requirements will be calculated to ensure that the existing Caterpillar 250kW generator can be re-used. If required the motor start sequence will be managed to ensure the capacity of the existing generator can be maximized and the capital cost of upgrading the generator can be avoided. The stand-by power system will also ensure that the plant control systems, building heating and essential pumping systems remain in operation at all times.

In the event of utility power loss, under voltage or loss of a single phase, the automatic transfer switch will detect the utility problem and start the generator. Once up to temperature and operating voltage the automatic transfer switch will transfer all facility loads onto the generator. At this stage in the design the generator is anticipated to be 250 kW.The Automatic transfer switch will also sense the resumption of utility power and monitor the utility for stability. Once the utility power is proven stable for an adjustable amount of time (0-30min) the transfer switch will re-transfer the load back to the utility and initiate the generator cool down/stop sequence. Re-transfer time would be set in the 15 to 20 min range.

10.5 Special Electrical Requirements

Hazardous area classification will be required for a portion of the electrical installation in the Facility. This classification will apply to the facility headworks as a minimum, per NFPA 820 and the Canadian Electrical Code. All equipment installed in this portion of the plant will need to be rated for installation in a Class 1 Zone 2 Group D locations and the corresponding wiring methods must be used to connect this equipment.

10.6 Mechanical Equipment Connection

All new motors .56 kW or larger will be fed from starters housed in one of the MCC lineups. Each motor would also be fitted with new isolation disconnects mounted next to the motors for service disconnect purposes.

Power connections to mechanical equipment will be completed as detailed in the **Table 10-1** below:

Table 10-1: Power Connections to Mechanical Equipment

Mechanical Load	Power Connection Type
Motors .373 kW and less	Manual motor starter. A relay will be provided if automatic operation is required.
Motors .56 kW or more	A magnetic motor starter installed in the Motor Control Centre (MCC) and isolation disconnects at the equipment.
Packaged Units c/w integral controls/motor starters.	Circuit breakers installed in the MCC or panel 6A

The new wastewater treatment plant MCC will incorporate low voltage and single phase protection relays that will disconnect equipment under poor power conditions.

10.7 Branch Circuit Wiring

In order to address the numerous code compliance issues with the existing facility branch circuit wiring, work under this project will include replacement of existing and installation of all new required branch circuits. All new wastewater treatment plant conductors will be copper, RW-90 insulation, minimum size # 12 AWG. Wiring methods will be as follows:

- Rigid Galvanized Conduit — Exposed conduit within the treatment area
- EMT Conduit — General surface runs within the electrical room
- PVC Conduit — Power and control signals to and from chemical treatment systems.
- Liquid Seal Flexible Conduit — Connections to mechanical equipment and transformers.
- Teck Cable — Connections to mechanical equipment, panelboards and exterior devices

Electrical devices installed in specific use areas will be recessed or protected with wire guards or lexan shields.

Generally, building utilization voltages will be as follows:

- 120 volts single phase — Small motors .373 kW or less, duplex receptacles, specific lighting types.
- 240 volts single phase — Specific supplied equipment.
- 347 volts single phase — Facility Lighting.
- 600 volts three phase — Motors .56 kW and larger specific supplied equipment.

Additional electrical conduit will be installed in the new wastewater treatment plant for future use devices, if required.

10.8 Lighting

Interior lighting will be provided by fluorescent fixtures mounted throughout the facility. All fixtures will be installed with T-8 lamps and electronic ballast's. The fixtures in the treatment area will be totally enclosed and gasketed which will prohibit the entrance of moisture or environmental contaminants. These lights provide an "instant on" illumination. All luminaries are to be located in service accessible locations, therefore lighting will not be located over open tanks or treatment vessels. Additional task lighting will be provided to increase illumination levels in the lab, over workbenches and in the chemical treatment area.

Exterior lighting fixtures are to be provided to illuminate the building entries, truck loading bays and the building perimeter. Exterior lighting is to be provided by surface mounted High Pressure Sodium fixtures with lexan shields to deter vandalism. The exterior lighting is detailed in **Table 10-2** below.

Table 10-2 Exterior Lighting Lamp Source and Utilization Areas

Exterior Lamp Source	Areas of Utilization
HID-High Pressure Sodium (70 watts)	At the building entrances
HID-High Pressure Sodium (150 watts)	Building perimeter

To ensure an energy efficient installation that meets the functional requirements of the facility, **Table 10-3** below shows the light sources that will be used:

Table 10-3 Light Sources

Lamp Source	Areas of Utilization
Fluorescent-Standard T-8 lamp	Throughout the building interior
HID-High Pressure Sodium	Exterior lighting

Lighting control is outlined in **Table 10-4** below:

Table 10-4 Lighting Control

Exterior:	Photocell/timer, exterior lighting, contactor cabinet c/w hand-off-auto selector
Interior:	Line voltage switches in smaller rooms Switched lighting contactors in treatment areas

10.9 Emergency Lighting Units

Emergency lighting units are provided to ensure the required coverage when the electrical service is interrupted and the generator has not yet transferred into use, or in event of a generator failure. Battery packs and additional remote heads will be installed to ensure proper coverage throughout the building.

Emergency lighting will be provided by self contained, battery operated emergency lighting units to illuminate access to exits. Where required this equipment will meet the construction and installation criteria for hazardous area classification.

10.10 Exit Signs

Exit signs will operate from the power supply of the emergency lighting battery packs in order to ensure that the exit signs are illuminated normally and in event of a power failure.

Illuminated exit signs will be provided at all exit doors and as required by the National Building Code. Exit signs will be constructed of extruded aluminum and utilize LED type lamps.

10.11 Fire Alarm System

As dictated by the NFPA 820 code the headworks and sludge handling/storage areas are to be equipped with a fire alarm system. Other areas such as the office, lab, shop, and storage areas will also be fitted with the fire alarm system.

10.12 Communication System

The telephone system will originate at the telephone backboard located in the electrical room and be routed from this location to the various points of use within the facility. The telephone wiring system will consist of outlet boxes, conduit, Cat 5E cabling, and single jack outlets at the point of use. All telephone wiring will be run in conduit and telephone conduit will be fitted with ground bushings and bonded to ground.

The upgraded wastewater treatment plant will have the following installations:

- A telephone line dedicated to the operators voice phone.
- A telephone line dedicated for computer communications to allow the operations staff and others remote access to the facilities Supervisory Control and Data Acquisition (SCADA) system.
- A telephone line dedicated to the facilities alarm dialer

11.0 COST ESTIMATE

For the purpose of this report, a preliminary capital cost for the recommended design (Option 2) has been estimated for budgetary purposes. Option 1 has not been estimated because it is higher in capital costs. Refer to **Appendix C** for a breakdown of the preliminary capital cost estimate.

The total estimated capital cost is $6,122,000 (GST not included). The recommended allowance for a contingency is shown in **Table 11-1** below. This has been included for budget purposes.

Table 11-1: Preliminary Capital Cost Estimate

Total Cost	$5,142,285
Contingency at (20%)	$979,485
Total Estimated Capital Cost	**$6,122,000**

APPENDIX A
Earth Tech Records of Discussion
Correspondence from Earth Tech
Correspondence from Nunavut Department of Health and Social Services
Correspondence from Nunavut Water Board, Environmental Protection Branch
Correspondence from Environment Canada

Environment Canada Environnement Canada

Environmental Protection Branch
Qimugjuk Building 969 P.O. Box 1870
Iqaluit, NU X0A 0H0
Tel: (867) 975-4639
Fax: (867) 975-4645

April 15, 2004 Our file: 4782 012

Mr. Jim Wall
Technical Advisor
Nunavut Water Board
P.O. Box 119
Gjoa Haven, NU X0B 1J0
Tel: (867) 983-2214
Fax: (867) 360-6369 *Via Email at Tech1@nwb.nunavut.ca*

Dear Mr. Wall:

RE: NWB3IQA04 - Earth Tech Canada Inc. Effluent Quality Criteria for the Iqaluit Water Treatment Plant

Thank-you for your letter dated April 5, 2004 requesting specific guidance as to the likelihood of Earth Tech Canada Inc.'s proposed effluent quality criteria for the Iqaluit Waste Water Treatment Plant meeting Section 36(3) of the *Fisheries Act*. The following specialist advice has been provided pursuant to Environment Canada's mandated responsibilities for the enforcement of the *Canadian Environmental Protection Act*, Section 36(3) of the *Fisheries Act*, the *Migratory Birds Convention Act,* and the *Species at Risk Act*.

Environment Canada's current thinking on dealing with Section 36(3) of the *Fisheries Act* and municipal wastewater effluent is to have non-acutely lethal effluent. The courts have ruled that non-acutely lethal effluent can be determined by conducting the 96 hour Rainbow Trout Bioassay LC50 Toxicity Test for the wastewater effluent (it should be noted that in the near future there will be a pH-drift adjustment for this test that will make testing for ammonia toxicity more accurate; it is hoped this test will be available in 2005).

The proposed effluent quality for the Iqaluit wastewater treatment discharge (45 mg/L BOD5, 45 mg/L Suspended Solids, 10 mg/L Ammonia) are a significant improvement over the effluent quality guidelines for marine embayed areas that are currently being followed in Nunavut (120/180 BOD/TSS) and a step in the right direction towards meeting the requirements of Section 36(3) of the *Fisheries Act*. These limits are consistent with Environment Canada's current thinking on a long term strategy for maximum allowable limits for BOD5 and TSS in municipal wastewater effluent. Environment Canada's current thinking is to have the target design of 20-30 mg/L BOD5 and 20-30 mg/L TSS to allow for a factor of safety to ensure maximum limits of 45 mg/L BOD5 and 45 mg/L TSS are never to be exceeded. Environment Canada is working with the Canadian Council of Ministers of the Environment (CCME) to establish national criteria for wastewater effluent quality which will address the *Fisheries Act* requirements. The above noted position is the part of the discussion points the Department will be taking to CCME in the near future.

Environment Canada cannot at this time provide specific guidance as to the likelihood of the proposed effluent meeting the requirements of 36(3) of the Fisheries Act as it is not possible to determine whether the proposed effluent based on **these three criteria alone** will be deleterious or not. This said, the following points provide some direction to assist in addressing *Fisheries Act* Section 36(3) responsibilities for your consideration:

- Testing the effluent for toxicity, as referenced in the beginning of this letter, will help to confirm if toxicity is an issue related to the *Fisheries Act* Section 36(3);
- Reducing the existing design criteria effluent guidelines is consistent with due diligence strategies to reduce liabilities from potential Section 36(3) *Fisheries Act* violations;
- Understanding, updating and maintaining upstream source control and pollution prevention strategies (such as pretreatment at industries discharging to the municipal wastewater treatment plant) will also reduce Fisheries Act liabilities;
- Additional due diligence strategies may also include, but are not limited to, optimizing wastewater treatment facility operation/maintenance and designing facilities to a minimum baseline of secondary treatment effluent quality (and potentially higher treatment depending on site specific sensitivity).

Environment Canada hopes that this information is of use to the Nunavut Water Board in your discussions with the City of Iqaluit and Earth Tech Canada Inc. If you have any further questions regarding this issue, please feel free to contact me at (867) 975-4639, or Christina Ruiu, Project Engineer, at (306) 780-7365.

Yours truly,

Original signed by

Colette Meloche
Environmental Assessment Specialist

cc: (Stephen Harbicht, Head, Assessment and Monitoring, Environment Canada, Yellowknife)
(Craig Broome, Head, Enforcement, Environment Canada, Yellowknife)
(Christina Ruiu, Project Engineer, Environment Canada, Saskatoon)

P.O. BOX 119
GJOA HAVEN, NU X0B 1J0 kNK5 wmoEp5 vtmpq
TEL: (867) 360-6338 NUNAVUT WATER BOARD
FAX: (867) 360-6369 NUNAVUT IMALIRIYIN KATIMAYINGI

April 5, 2004 File No. NWB3IQA04

Colette Meloche, M.Sc.
Environmental Assessment Specialist
Environmental Protection Branch
Environment Canada
Qimugjuk Building 968, P/O Box 1870
Iqaluit, NU X0A 0H0

Dear. Ms. Meloche:

In response to the attached letter from Earth Tech Canada Inc. regarding effluent quality criteria for the Iqaluit Waste Water Treatment Plant, the Nunavut Water Board would like to seek expert advice on recommended pre-design effluent quality criteria proposed.

In the absence of established regulations to address the deposit of waste water associated with municipal waste treatment facilities, the NWB requests that Environment Canada provide specific guidance as to the likelihood of the proposed effluent meeting the requirements of S 36(3) of the *Fisheries Act*.

Please provide any comments and/or recommendations to the Board by April 15, if possible, in order that the Board may provide a timely response to this request.

Sincerely,

Original signed by:

Jim Wall
Technical Advisor
Nunavut Water Board

Attachment 1: Earth Tech correspondence, dated March 29, 2004

CC. Iqaluit distribution list

Department of Health & Social Services: Baffin
WoE=x5]x8ixc8NqgoEp4f5 xJ3n6goEp4f9l: er3bl4
Okoa Kavamat Monakhikakvilikiot Olasilikiot
Ministère de la Santé et des Services Sociaux
P.O. Box 1000 Stn 1046; tt6v4f=4 1000; C.P. 1000 Stn 1046
Iqaluit, NU wclw5, kNK5 X0A 0H0
Phone: s]cMs5: Fonia (867) 979-4800 Fax: h4vJ4f5: Faxkot:(867) 979-4833

Environmental Health

April 2, 2004

Brad L. Sokach, P.Eng.
Director of Engineering, Lands, and Planning
City of Iqaluit
P.O. Box 460
Iqaluit, NU X0A 0H0

Re: Effluent Quality Guidelines for Iqaluit Waste Water Treatment Plant

Dear Mr. Sokach:

This letter is in response to your e-mail and the attached letter from Earth Tech Canada Inc. regarding the suitability of the recommended effluent quality criteria for the Iqaluit Waste Water Treatment Plant.

The Nunavut Public Health Act and Regulations do not provide specific guidelines for sewage effluent quality. In general, section 6(1) of the Public Sewerage System Regulations states:

> "No final disposal of effluent from a sewerage system shall be carried out in a manner that creates
> (a) a health hazard with respect to water supplies, swimming beaches or any body of water in the area; or
> (b) aesthetically unacceptable conditions with respect to temperature, turbidity, colour, taste or odour of any stream or body of flowing water in the area."

Provided that the recommended effluent quality guidelines meet the approval of all other applicable regulatory authorities and the Iqaluit Waste Water Treatment Plant is in compliance with the Nunavut Public Health Act and Regulations, Environmental Health, Department of Health and Social Services, will be satisfied with the recommendations proposed by Earth Tech Canada Inc. in their letter dated March 29, 2004.

We look forward to further discussion and communication regarding the Iqaluit Waste Water Treatment Plant as development progresses.

Should you have any questions or concerns, please do not hesitate to contact me at (867) 975-4817.

Yours truly,

Tracey Hewitt, BSc, BEH(AD), CPHI(C)
Environmental Health Officer

Cc Bruce Trotter, Environmental Health Specialist, GN

Earth Tech Canada Inc. 17203 – 103 Avenue, Edmonton, Alberta T5S 1J4 Canada

March 29, 2004 Refer to File: 75360
Document6

City of Iqaluit
P. O. Box 460
Iqaluit, NU X0A 0H0
Attention: Brad Sokach, P.Eng.

Dear Brad:

Re: Effluent Quality Guidelines for Iqaluit WWTP

We have had discussions and exchanges over the past two weeks with a variety of individuals seeking to clarify the effluent quality criteria for the Iqaluit Waster Water Treatment Plant (WWTP).

Our conclusions of these discussions, regarding the effluent quality criteria, are as follows.

1. The current draft effluent quality guidelines for municipal wastewater discharges in marine embayed areas in Nunavut (120/180 - BOD/SS with 150 to 600 L/c/d water consumption) are not appropriate to Iqaluit .
2. Ammonia reduction is required in order to produce an effluent that is "not acutely lethal" to fish.

In responding to these conclusions to establish design criteria upon which to proceed with the process pre-design of the Iqaluit WWTP improvements, we are recommending the following effluent quality guidelines.

A. 45 mg/L BOD_5.
B. 45 mg/L Suspended Solids.
C. 10 mg/L Ammonia.

We recommend that this letter be circulated to the regulatory authorities, namely the Nunavut Water Board, Environment Canada, Fisheries and Oceans Canada, and the Nunavut Health Authority in order to obtain their feedback on this recommendation as soon as possible.

Very truly yours,

EARTH TECH (CANADA) INC.

Per:

Ken Johnson, M.A.Sc., MCIP, P.Eng.
Senior Environmental Planner

Telephone
780.488.6800
Facsimile

Discussion with Jim Wall Technical Advisor, Nunavut Water Board, regarding Nunavut Water Board expectations for sewage effluent parameters

2004 03 18

Prepared by Ken Johnson

Fisheries Act is the legislation of prime interest or concern, and specifically the clause associated with "discharge of deleterious substances". The associated phrase being used by DFO for sewage effluent quality is "non acutely lethal". The problem in the application of this phrase is that there are no associated effluent quality parameters in the north at this time. Water licences are worded such that the water licence does not exclude responsibility for a community to meet "other" legislation, in this case the Fisheries Act.

The application of Fisheries Act has a potential weakness in that it provides a fuzzy benchmark of what is a "fail" in terms of effluent quality, but it does not provide a benchmark for a "pass".

Bill C33 Section 75 is the descriptive information for interpreting the potential effluent criteria demands. An effort is underway to try and "mesh" Bill C33 with the Fisheries Act.

The only potential guidelines that may have merit to address "non acutely lethal" are the guidelines applied in the operation of sewage treatment facilities on Federal Lands. For these operations the effluent criteria are 20/20 (SS/BOD5).

The 1993 report by UMA Engineering Ltd. entitled Municipal Wastewater Treatment Technologies Capable of Achieving Compliance with the Fisheries Act in the Northwest Territories is a reference document for the consideration of various technologies.

The discussion amongst regulators is proceeding but it is only at the "information sharing" stage with a series of presentations on March 24 and 25, and a meeting on March 26. Nothing definitive is expected to emerge from the meeting.

Pathogens are not a particular issue from an effluent criteria perspective for the Water Board technical staff. However, the "public hearing" requirement creates the opportunity for community input, and this input usually revolves to some degree around fecal coliforms, and the potential impacts on marine species that the community may harvest. This suggests that effluent disinfection may emerge as a requirement in the treatment process.

Sludge disposal in Iqaluit may only have three options from the NWB's perspective

1. incineration
2. composting (windrow or vessel applications)
3. landfilling to a secure site (lined landfill cell)

Discussion with Anne Wilson, Senior Scientist, Environment Canada, Yellowknife, regarding sewage effluent parameters for future northern facilities in Nunavut and the NWT

2004 03 15

Prepared by Ken Johnson

EC's position concerns the enforcement of the Fisheries Act and the discharge of "deleterious" substances. More specifically, the sewage treatment process in Iqaluit is expected the address the issue of "acute toxicity" to fish.

Environment Canada, Indian and Northern Affairs Canada, Community Government and Transportation – Government of Nunavut and the Nunavut Water Board are meeting on March 26th to discuss the municipal waste discharge criteria.

Recommended a discussion with Jim Wall of the Nunavut Water Board to potentially provide more specific information on effluent quality criteria.

Discussion with Richard Johnson, Sales Rep, Sanitherm Engineering regarding sewage effluent parameters for existing northern facilities in Nunavut and the NWT

2004 03 12

Prepared by Ken Johnson

Sanitherm has assisted with WWTP's in Pangnitung and at camp facilities in the Beaufort Delta and the Ekati, and Diavik diamond mines. .

In Pangnirtung, the effluent quality required by the existing Muncipal Wastewater Guidelines of the Nunavut Water Board is 100/110 (SS/BOD5), but Sanitherm committed to 45/45, without disinfection, in the final system process.

In the Beaufort Delta, the design standards for camp installations are 25/25, with disinfection. A facility for PetroCan planned to utilize a tablet-type chlorinator, the this process was dropped in favour of UV disinfection.

At the Ekati mine the effluent standard is 25/25, without disinfection. At the Diavik mine the effluent standard is 10/10, with a very low P limit (0.5 mg/L) and UV disinfection (15 CFU's/100 mL). At the Snap Lake mine site, the effluent standard is 25/25, with UV disinfection.

What's reasonable - 45/45 is easy to accomplish and it's a target that will be more forgiving to the operator's actions; 25/25 is a reasonable figure, possibly in conjunction with disinfection, but that won't ensure nitrification, especially if the water temperature is low. Another consideration is the cleaner the effluent, the more sludge you'll produce.

APPENDIX B
Eight Mass Balances for Expected Scenarios at Iqaluit WWTP

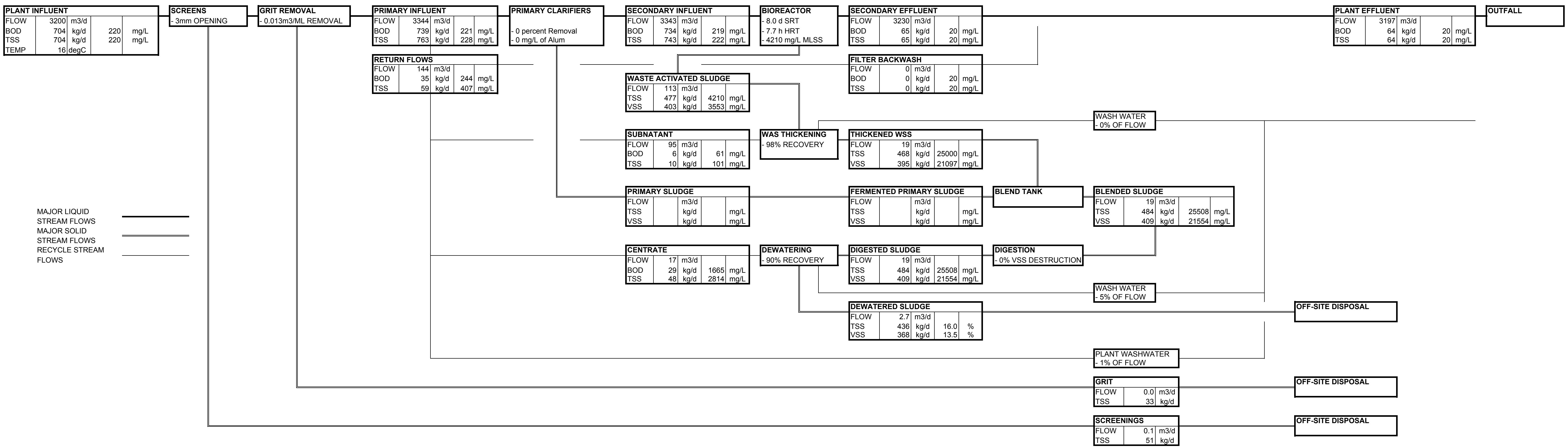


FIGURE 3
MASS BALANCE
Iqaluit WWTP
Service Population of 8000 Summer Conditions

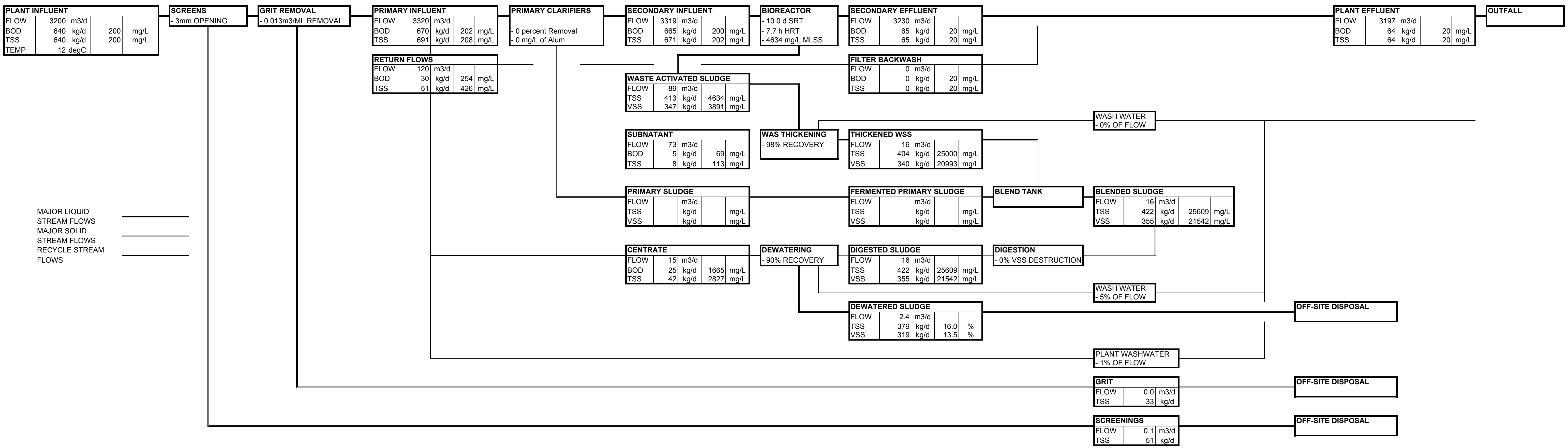


FIGURE 4
MASS BALANCE
Iqaluit WWTP - Option 1
Service Population of 8000 Winter Conditions

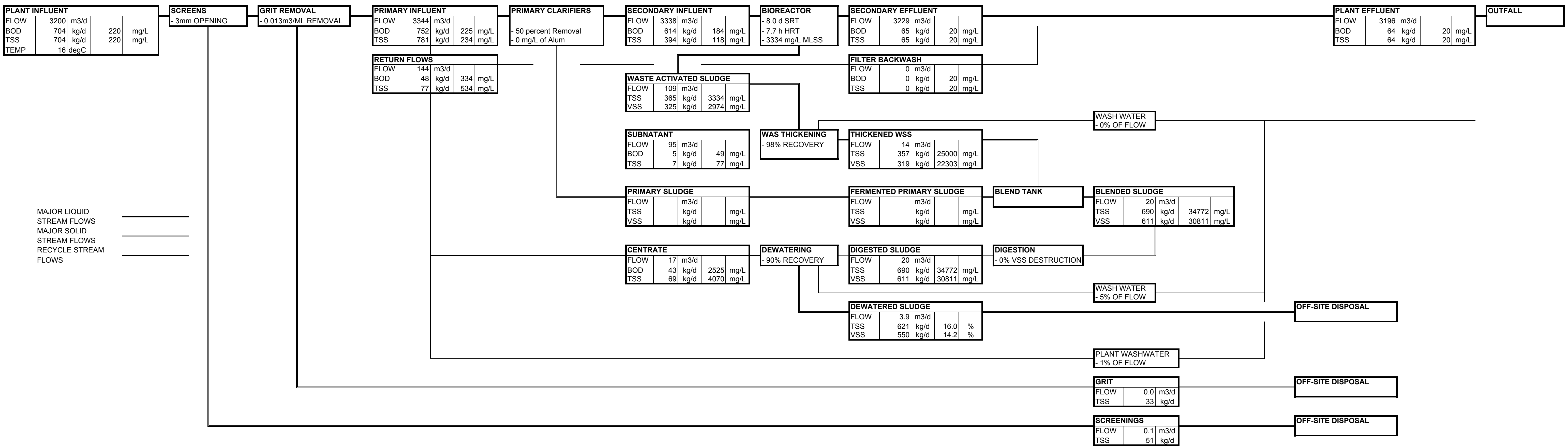


FIGURE 5
MASS BALANCE
Iqaluit WWTP - Option 2
Service Population of 8000 Summer Conditions

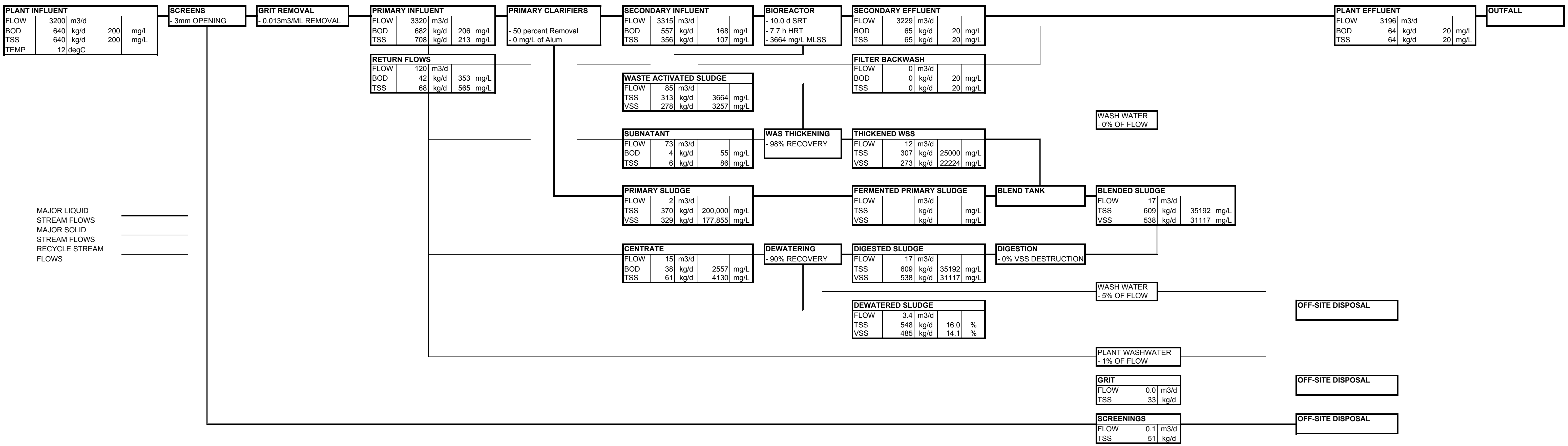


FIGURE 6
MASS BALANCE
Iqaluit WWTP - Option 2
Service Population of 8000 Winter Conditions

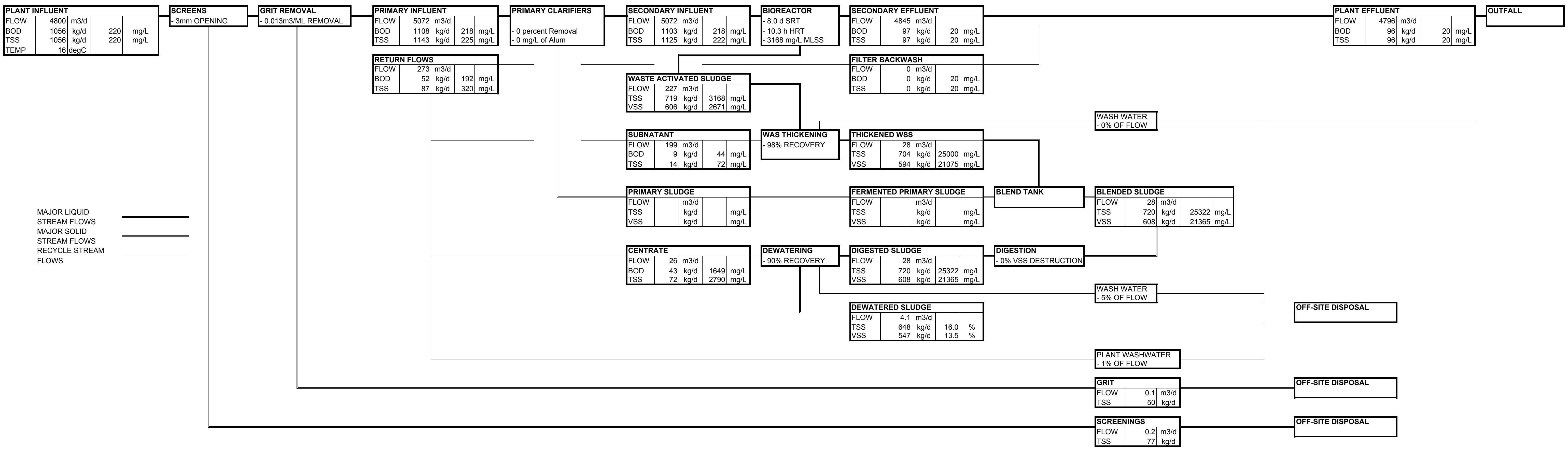


FIGURE 7
MASS BALANCE
Iqaluit WWTP - Option 1
Service Population of 12000 Summer Conditions

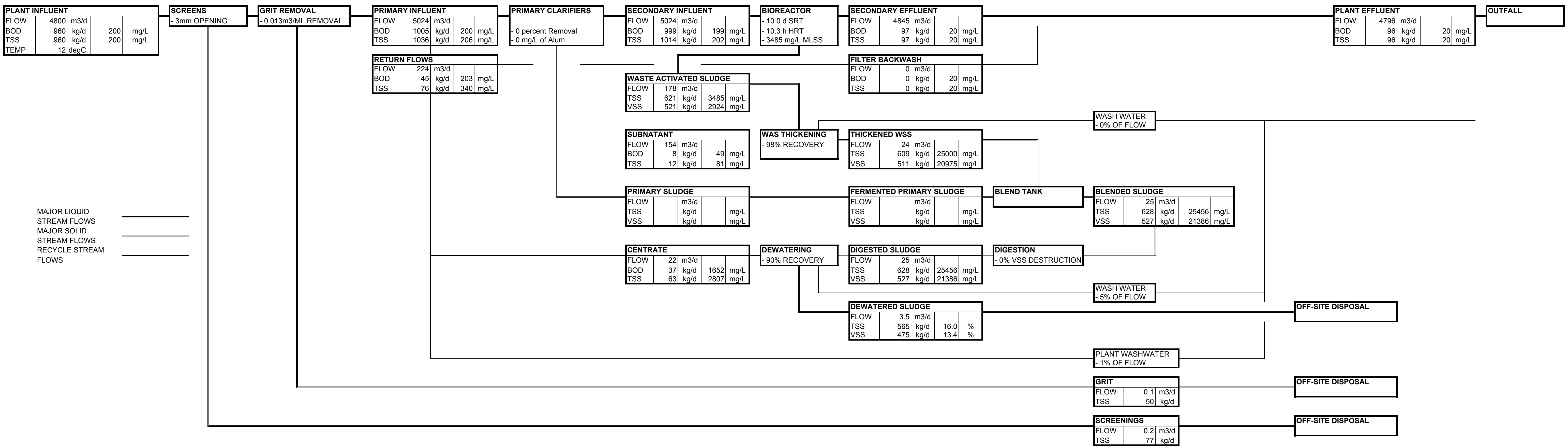


FIGURE 8
MASS BALANCE
Iqaluit WWTP - Option 1
Service Population of 12000 Winter Conditions

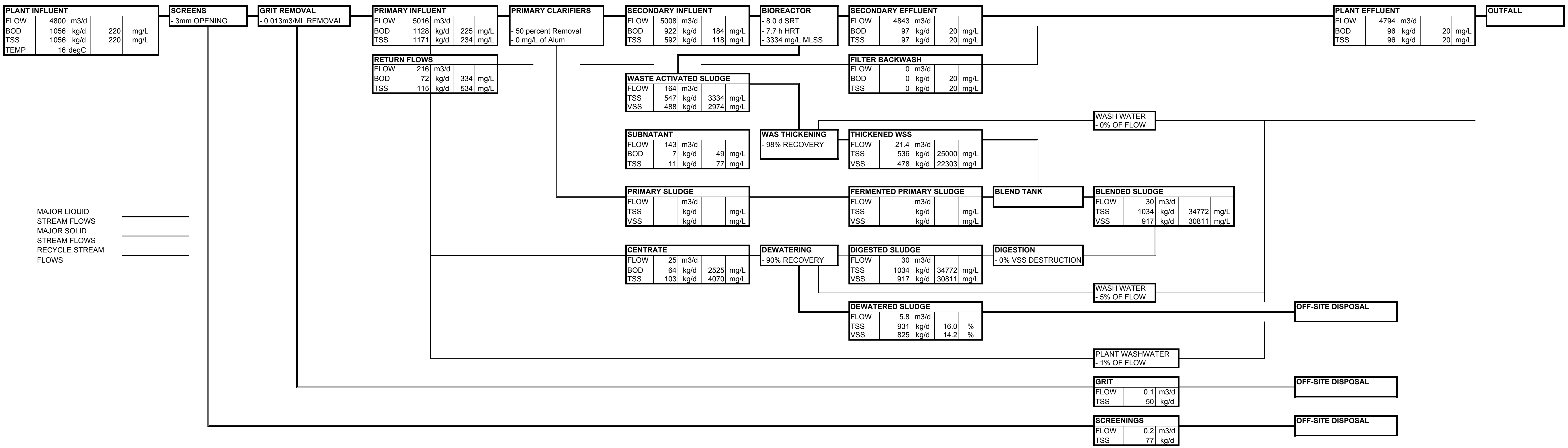


FIGURE 9
MASS BALANCE
Iqaluit WWTP - Option 2
Service Population of 12000 Summer Conditions

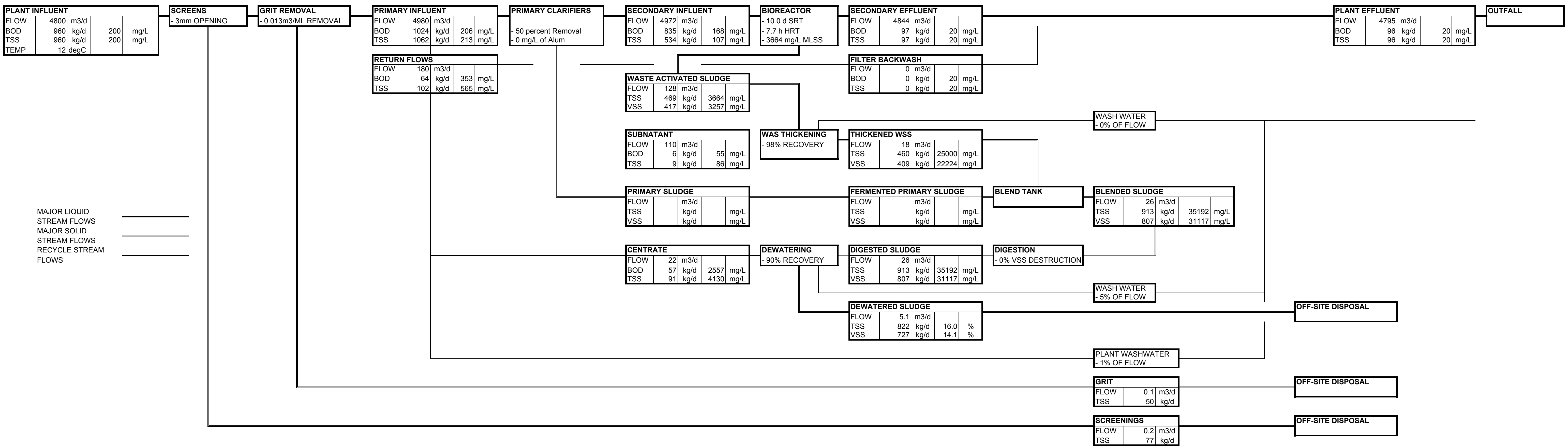


FIGURE 10
MASS BALANCE
Iqaluit WWTP - Option 2
Service Population of 12000 Winter Conditions

APPENDIX C
Preliminary Capital Cost Estimate

Iqaluit Wastewater Reclamation Facility

Date: 26-May-04

APPENDIX C: Preliminary Capital Cost Estimate - Option 2

Table C-1: Preliminary Capital Cost Estimate

Description	Quan.	UofM	Unit Price	Material/Labour Cost $	Northern Cost Allowance [1] $	Total Cost $
CIVIL/SITEWORKS						
building backfilling	75	cum	$35	$2,625	$2,494	$5,119
building demolition	200	sqm	$150	$30,000	$28,500	$58,500
rock blasting	1000	cum	$36	$36,000	$34,200	$70,200
excavation	200	cum	$15	$3,000	$2,850	$5,850
gravel fill	215	cum	$50	$10,750	$10,213	$20,963
Final Grading	75	cum	$25	$1,875	$1,781	$3,656
			subtotal >	**$84,250**	**$80,038**	**$164,288**
PROCESS						
Headworks						
Raw Wastewater Pumps	3	ea	$22,000	$66,000	$62,700	$128,700
Basket Screen	1	ls	$16,500	$16,500	$15,675	$32,175
Screening/Grit Utility Trailer	1	ls	$10,500	$10,500	$9,975	$20,475
Salsnes Filter	1	ls	$180,000	$180,000	$50,000	$230,000
Piping/Channels	1	ls	$19,000	$19,000	$18,050	$37,050
Gates/Weirs	1	ls	$12,000	$12,000	$11,400	$23,400
Bioreactors						
Piping, Aeration, SS	1	ls	$25,000	$25,000	$23,750	$48,750
WAS Pump-new	3	ea	$5,300	$15,900	$15,105	$31,005
Guide Rails	2	ea	$3,400	$6,800	$6,460	$13,260
ML Weir & Sump	1	ls	$15,000	$15,000	$14,250	$29,250
Alkalinity Adjustment	1	ls	$26,000	$26,000	$24,700	$50,700
Secondary Clarifier						
Mechanism	2	ea	$86,000	$172,000	$45,000	$217,000
RAS Pumps	3	ea	$13,500	$40,500	$38,475	$78,975
Effluent Water Pumps	2	ea	$10,250	$20,500	$19,475	$39,975
Secondary Clarifier Piping	1	ls	$61,000	$61,000	$57,950	$118,950
Dewatering System						
DAF Unit	1	ls	$110,000	$110,000	$25,000	$135,000
TWAS Vault	1	ls	$13,000	$13,000	$12,350	$25,350
TWAS Pumps	1	ls	$22,000	$22,000	$20,900	$42,900
Polymer System	1	ls	$33,000	$33,000	$31,350	$64,350
Belt Filter Press	1	ls	$252,000	$252,000	$65,000	$317,000
Utility Trailer for Sludge	1	ls	$11,000	$11,000	$10,450	$21,450
Dewatering System Piping	1	ls	$20,000	$20,000	$19,000	$39,000
Demolition	1	ls	25,000	$25,000	$23,750	$48,750
General Subcontractor Mark-up (10% of Process)				$114,770	$59,702	$174,472
			subtotal >	**$1,194,470**	**$592,117**	**$1,786,587**

Iqaluit Wastewater Reclamation Facility

Date: 26-May-04

APPENDIX C: Preliminary Capital Cost Estimate - Option 2

Table C-1: Preliminary Capital Cost Estimate

Description	Quan.	UofM	Unit Price	Material/Labour Cost $	Northern Cost Allowance [1] $	Total Cost $
STRUCTURAL						
Concrete						
foundation wall	250	cum	$400	$100,000	$95,000	$195,000
grade beams	50	cum	$325	$16,250	$15,438	$31,688
interior pad footings	50	cum	$450	$22,500	$21,375	$43,875
concrete walls	50	cum	$350	$17,500	$16,625	$34,125
125 slab on grade - area	625	sqm	$75	$46,875	$44,531	$91,406
patch small area conc floor	100	sqm	$35	$3,475	$3,301	$6,776
Metals						
beams	7	tnes	$3,500	$24,500	$23,275	$47,775
columns	6	tnes	$2,750	$16,500	$15,675	$32,175
bollards	8	each	$350	$2,800	$2,660	$5,460
miscellaneous steel	3.5	tnes	$5,000	$17,500	$16,625	$34,125
Open web steel joists	25	tnes	$2,875	$71,875	$68,281	$140,156
aeration tank lids	1	each	$80,000	$80,000	$76,000	$156,000
38 metal deck	625	sqm	$20	$12,500	$11,875	$24,375
handrail	200	m	$100	$20,000	$19,000	$39,000
grating plain black	150	sqm	$110	$16,500	$15,675	$32,175
stair treads	48	riser	$400	$19,200	$18,240	$37,440
Woods and Plastics						
exterior stud walls	600	sqm	$12	$7,200	$6,840	$14,040
millwork general	5	m	$590	$2,950	$2,803	$5,753
Thermal and Moisture Protection						
R20 - 140 batt walls	620	sqm	$22	$13,640	$12,958	$26,598
R20 - 140 batt roof	625	sqm	$22	$13,750	$13,063	$26,813
vapour barrier	1225	sqm	$13	$16,293	$15,478	$31,770
metal wall liner	620	sqm	$30	$18,600	$17,670	$36,270
metal roof cladding	625	sqm	$49	$30,469	$28,945	$59,414
metal wall cladding	620	sqm	$49	$30,225	$28,714	$58,939
sprayed fire proofing - 1 hour	200	sqm	$35	$7,000	$6,650	$13,650
Doors and Windows						
hollow metal complete	12	each	$900	$10,800	$10,260	$21,060
Finishes						
acoustic ceiling tiles	66	sqm	$25	$1,650	$1,568	$3,218
12 gypsum b/s of steel stud wall	50	sqm	$45	$2,250	$2,138	$4,388
Demolition	1	ls	15,000	$15,000	$14,250	$29,250
			subtotal >	**$657,801**	**$624,911**	**$1,282,712**

Iqaluit Wastewater Reclamation Facility

Date: 26-May-04

APPENDIX C: Preliminary Capital Cost Estimate - Option 2

Table C-1: Preliminary Capital Cost Estimate

Description	Quan.	UofM	Unit Price	Material/Labour Cost $	Northern Cost Allowance [1] $	Total Cost $
MECHANICAL						
Fuel System	1	ls	13,500	$13,500	$12,825	$26,325
Headworks Ventilation	1	ls	21,500	$21,500	$20,425	$41,925
Secondary Clarifier Ventilation	1	ls	18,000	$18,000	$17,100	$35,100
First Floor Ventilation	1	ls	8,000	$8,000	$7,600	$15,600
Miscellaneous Ventilation	1	ls	16,000	$16,000	$15,200	$31,200
Heating	1	ls	25,000	$25,000	$23,750	$48,750
Plumbing Systems	1	ls	4,500	$4,500	$4,275	$8,775
Piping Insulation	1	ls	20,000	$20,000	$19,000	$39,000
HVAC Controls	1	ls	11,000	$11,000	$10,450	$21,450
Demolition	1	ls	10,000	$10,000	$9,500	$19,500
General Subcontractor Mark-up (10% of Mechanical)				$13,750	$13,063	$26,813
			subtotal >	**$161,250**	**$153,188**	**$314,438**
ELECTRICAL						
Headworks	1	ls	52,000	$52,000	$49,400	$101,400
Existing building	1	ls	37,000	$37,000	$35,150	$72,150
Clarifier building	1	ls	78,000	$78,000	$74,100	$152,100
Demolition	1	ls	10,000	$10,000	$9,500	$19,500
General Subcontractor Mark-up (10% of Electrical)				$16,700	$15,865	$32,565
			subtotal >	**$193,700**	**$184,015**	**$377,715**
CONTROLS						
Headworks	1	ls	78,000	$78,000	$74,100	$152,100
Existing building	1	ls	55,000	$55,000	$52,250	$107,250
Clarifier building	1	ls	310,000	$310,000	$294,500	$604,500
Demolition	1	ls	10,000	$10,000	$9,500	$19,500
General Subcontractor Mark-up (10% of Controls)				$45,300	$43,035	$88,335
			subtotal >	**$498,300**	**$473,385**	**$971,685**
Sub-Total						**$4,897,424**
General Contractor Requirements (5%)						$244,871
Sub-Total						$5,142,295
20% Contingency						$979,485
Total Estimated Capital Cost						**$6,122,000**

GST Excluded

Notes:

1. In general, the costs to Iqaluit are approximately 30 % more than the cost in Yellowknife. The costs in Yellowknife are approximately 50 % more than the costs in Edmonton. Therefore the Northern Allowance from Edmonton to Iqaluit utilized for this estimate is 95% (1.3*1.5).