ATTACHMENT 20

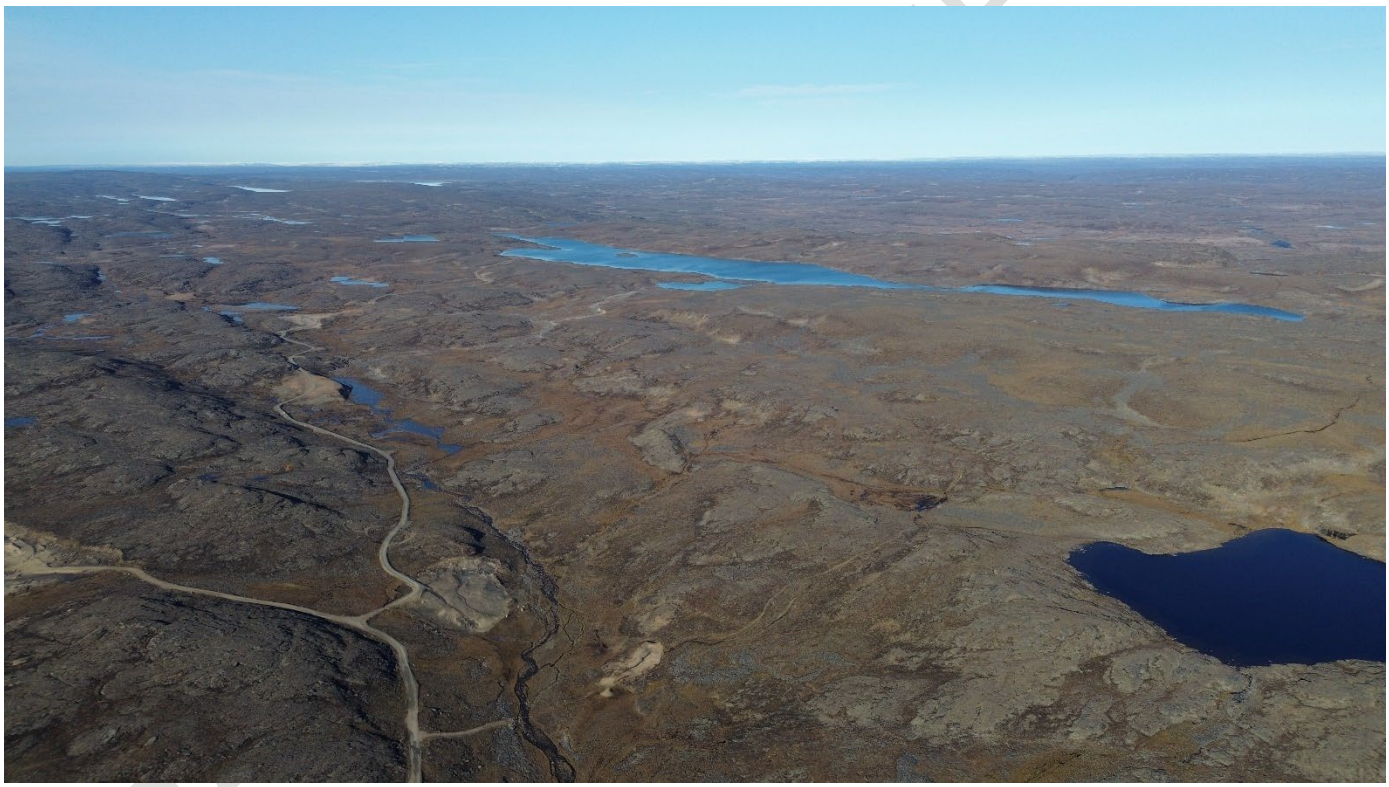
LTWP Preliminary Design Report – Appendix K – Preliminary Systems Operation Manual

City of Iqaluit

System Operations Manual

Long Term Water Program – Supply and Storage

March 2024



System Operations Manual

Long Term Water Program – Supply and Storage

March 22, 2024

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1 Introduction

Background

As the City of Iqaluit (City) is considered the newest Capital City in Canada and is rapidly developing into a regional center for the Territory with many northern businesses in Nunavut making it their base of operations, this has led to a rapid growth in population (3% - 4% growth rate expected annually). As a result, the Lake Geraldine raw water reservoir is no longer sufficient to supply or store the required amount of water needed to support potable water needs for the projected growth rate of the City. Additional water resources and storage are needed to sustain expected future demand. Based on feasibility studies (by others) for the new reservoir, the amount of water required by the City is expected to increase by 65% which represents an additional 1,824,500 m^3 of raw water storage required.

Over the last few years, the City has pumped water from the Apex River to Lake Geraldine as an emergency measure to augment the over-winter storage requirements for the City. In 2021 the City also used Unnamed Lake (UNL) (now known as Lake Qikiqtalik) for emergency supply as well. Given the variability of flows within the Apex River and water-taking license constraints, seasonal pumping from Apex River is considered a temporary interim solution until a long-term water supply and storage solution is implemented. The long term water supply project will utilize water from Lake Qikiqtalik in a new reservoir adjacent to Lake Geraldine to augment storage in Lake Geraldine.

Lake Qikiqtalik has a larger catchment basin than Lake Geraldine with an estimated storage capacity of approximately 5,500,000 m^3 of freshwater. Preliminary studies (by others) on Lake Qikiqtalik have indicated that seasonal pumping from Lake Qikiqtalik is viable to supply Lake Geraldine and the new reservoir. The planned approach is to take advantage of the greater amount of water available during the Spring freshet followed by continuous pumping for an additional period during the open water season to fill the new reservoir in preparation for winter. An ongoing study being completed (by others) show preliminary results that indicate Lake Qikiqtalik does not have sufficient water supply for the long-term projections. Therefore, following this preliminary design, additional project scope may be added and/or the project scope changed to access supplemental water supply from the Apex River, through two options that are currently being considered by the City. This preliminary design report addresses only the original project solution as described herein. A supplementary report or addendum to this report may be issued in future to address the supplemental water supply when a final approach is confirmed.

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System Overview

The City of Iqaluit has a drinking water system that is comprised of the Lake Geraldine reservoir, a water treatment plant, and a water distribution system. Expansion of that system was completed through the Long Term Water Program – Supply and Storage (LTWP – S&S) project which included addition of a raw water pump station, conveyance pipeline, new reservoir and service corridor connecting the two reservoirs.

An overview of the LTWP – S&S project is provided in Appendix A.

This manual services as a system operation manual for the components of the expanded system constructed as part of the LTWP – S&S.

This manual is broken down into chapters covering the raw water pump station, the conveyance pipeline, and the new reservoir (including the service corridor).

Municipal Address

Iqaluit, Nunavut X0A 0H0 (will be updated in future with new addresses when assigned).

Pump Station

Layout

The Raw Water Pump Station (RWPS) is located on the east shore of Lake Qikiqtalik, approximately 4.5 km northwest of the City of Iqaluit, Nunavut.

Design Features

The RWPS is designed as a wet well pump station that includes:

- A raw water intake screen in Lake Qikiqtalik with a 750 mm diameter intake pipe running along the bed of Lake Qikiqtalik to the raw water intake well (wet well). The Electrical Control Room houses electrical for the intake heat tracing.
- An intake airburst system consisting of two (one duty, one standby) compressors, a compressed air tank, air receivers, and piping connected to the intake used to clear of ice and debris from the intake screens.
- Sub-grade wet well for three submersible centrifugal pumps (two duty and one standby).
- Ultrasonic level system that monitors the wet well water levels.
- Back-up float alarm system to alert operations staff in the event of low wet well water level.
- Isolated Valve Room adjacent to the wet well to house valves, piping, and electromagnetic flow meter on the discharge header.
- Wet well with lighting, heating, and ventilation and a manually operated two tonne hoist and trolley to remove the pumps.
- Valve Room with lighting, heating and ventilation and a sump with a submersible pump to lift the wastewater to the wastewater tank at grade level inside electrical room. The valves can be lifted and moved to the floor of the valve chamber using the monorail, then lifted to the electrical and control room using a hoist, with a hook in the ceiling over the hatch.

- At grade Electrical and Control Room for the MCC panels, Programmable Logic Controller (PLC) and control panels, variable frequency drives (VFDs) for the raw water pumps, compressors, electric heating units, ventilation, and lighting.
- Supervisory Control and Data Acquisition (SCADA) system to communicate between the RWPS and the City's Control Centre.
- Outdoor standby diesel-powered generator set with an automatic transfer switch.
- Three phase primary hydro supply to the pump station building complete with a pole mounted transformer (to be determined by Utility) for 600 V supply to the motor control centre.
- A potable water tank with booster pump will service the washroom fixtures and hose bibs (washroom will be accessed from electrical room). An electric point of use water heater will be provided for the hand sink hot water connection.
- A wastewater tank and grinder/pump to service the washroom fixtures and floor drains in each space.
- An indoor air handling unit will provide ventilation air into all spaces except the wet well, serviced by a separate blow heater and exhaust fan.
- Additional electric heaters will be provided in each space, one baseboard heater will be provided inside the washroom.

Refer to pump station plans in **Appendix A**.

Capacity

To meet the City's current and future water needs up to an additional 1,824,500 m^3 of raw water storage is necessary annually, with a working available volume of XXX m^3. This water is only pumped during the open water season at Lake Qikiqtalik. Annual open water season can last up to five months each year however, it can be as short as three months. For this reason, the design for pumping assumes a conservative scenario of open water season length (i.e., three months, 92 days between June and September). The RWPS is designed to take advantage of the large available volume of water in the lake during the Spring freshet (during which two pumps will be utilized), with remainder of the water pump (using one pump) during the remainder of the season. Table 2-1 summarizes the design criteria for the RWPS.

Table 2-1 – RWPS Design Criteria

Description	Value	Reference
Pump Capacity (Design)	556 L/s	Design review meetings with the Project Team

Intake

Pipe

The raw water intake at Lake Qikiqtalik is on the west shore of Lake Qikiqtalik and is a nominal 750 mm high density polyethylene (HDPE) DR 11 (inside diameter of 615.1 mm) raw water inlet line extending out into Lake Qikiqtalik. It will has been placed at a minimum of 8 m water depth and runs along the lakebed to the wet well. The water intake is set two metres from the bottom of Lake Qikiqtalik, to minimize silt and sand from entering the pipe. The intake is at a minimum depth of six metres below the water surface allowing for two metres of ice and four metres of water over the intake when the water level in the lake is at the lakes' outlet channel invert of 202.10 m.

The intake pipe is insulated and heat traced for freeze protection.

The flow velocity in the 750 mm diameter intake pipe with a pump flow of 556 L/s is 1.9 m/s.

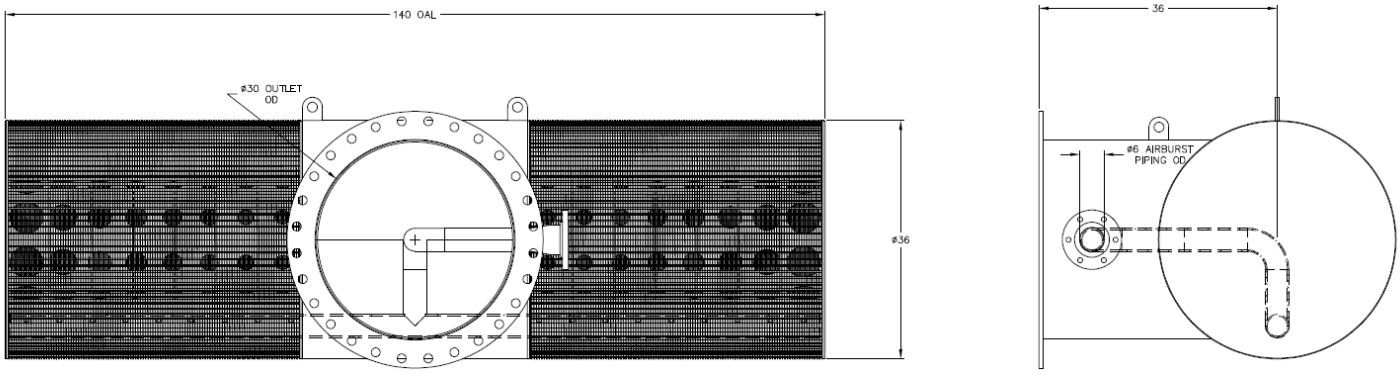
Screen

The intake screen is sized in accordance with the Department of Fisheries and Oceans (DFO) Freshwater Intake End-of-Pipe Fish Screen Guidelines for the fish that may be present in Lake Qikiqtalik. Previous studies identified the presence of Arctic Char however, Ninespine Stickleback may also be present. Arctic Char and Ninespine Stickleback have a subcarangiform mode of swimming. To accommodate fish with a subcarangiform mode of swimming the intake is designed with a maximum approach velocity of 0.11 m/s per the DFO guidelines. Consequently, a screen with a clear area of 8.02 m^2 is required for a flow rate of 556 L/s to prevent entrainment and impingement. The screen openings will be no larger than 2.54 mm in accordance with the DFO guidelines.

The screen is fitted with an air scour that is operated by an airline running in parallel with the raw water line and connected to a compressor located in the electrical and control room of the pump station. The air scour can be run continuously in winter to mitigate frazil ice or in bursts to control biofouling.

The raw water intake screen is designed for a flow of 556 L/s with an inlet flow velocity of 0.11 m/s (0.36 fps). The screen is a “TEE” type, 914 mm (36 in.) in diameter, with an overall length of approximately 3.56 m (140 in.) long with #69 wire screen providing a slot size of 2.54 mm (0.1 in.). The screen is equipped with a 750 mm (30 in.) flanged outlet and a 150 mm (6 in.) airburst connection. All material is 316 stainless steel (SS). Refer to Figure 2-2 for a general layout of the intake screen.

Figure 2-2 – RWPS Intake Screen



Airburst System

The airburst system consists of two (one duty, one standby) 141.0 L/s (299 cfm) rotary screw compressors each with 575/3/60, 55.9 kW (75 hp) TEFC motor, aftercooler, oil/moisture separator, graphic controller, and sound attenuating enclosure. Each compressor is sized to charge the 8330 L (2200 gallon) receiver from 0 kPa to 1035 kPa (0 psi to 150 psi) in 10 minutes. The receiver is equipped with a pressure switch, pressure gauge, safety valve and auto drain valve and one – 18.9 L (five gallon) 1379 kPa (200 psi) rated horizontal receiver with check valve, pressure gauge, safety valve and manual drain valve. The receiver will have a 150 mm (6") lug style butterfly valve ductile iron body, SS disc & stem, BUNA rubber seat with pneumatic rack and pinion fail close actuator with limit switches, visual position cone, direct mounted solenoid with manual override.

The air system package includes a control panel that will be connected to the RWPS control system for monitoring.

Process Mechanical

Discharge Pipe Size and Class

The pumps are sized for the design flow of 556 L/s. The discharge pipe is a 600 mm diameter HDPE DR 11 (inside diameter of 492.1 mm). The flow velocity with a pump flow of 556 L/s is 2.8 m/s.

Discharge Pipe Drain Line

In the case of pipe failure, it may be necessary to drain a portion of the discharge pipe back into the wet well. The portion of the discharge pipe within the valve room is equipped with a 150 mm diameter drain line complete with an isolation valve to drain the discharge pipe back into the wet well. The isolation drain valve is equipped with a manual handwheel operator accessed from the valve room.

As an alternative method to drain the discharge piping, the swing flex check valve on the pump discharge can be manually opened to allow flow reversal. When draining the discharge pipe through a pump, the pump must be removed from automatic control to ensure it does not turn on.

Internal Piping

Each pump discharge line is 450 mm diameter and is equipped with a swing flex check valve and a knife gate valve. The common discharge header is equipped with a 450 mm diameter magnetic flow meter, pressure sensor and transmitter and a combination air valve. All piping within the building is 304L stainless steel with stainless steel flanges. The header transitions from 450 mm stainless steel to 600 mm HDPE as it leaves the building.

Combination Air and Vacuum Release Valve

Short-lived full-vacuum or sub-atmospheric pressure may occur at the discharge side of the pump station.

A 100 mm diameter combination air and vacuum (CAV) release valve for raw water is installed on the 450 mm diameter common pump discharge header to release entrapped air and provide pipeline vacuum protection. Due to the nature of raw water, the CAV must be cleaned and maintained regularly by the operation staff.

Wet Well

The Wet Well consists of a rectangular structure and houses the 750 mm diameter inlet pipe with an isolation slide gate; three (3) submersible centrifugal pumps, three (3) 450 mm diameter pump discharge piping; an ultrasonic level sensor that monitors the level of the water in the wet well. A back-up float alarm provides a secondary alarm to alert operations staff in the event of low liquid level.

Intake Slide Gate

An inlet slide gate is provided on the wall of the wet well to isolate the wet well from the intake pipe in LAKE QIKIQTALIK for ease of maintenance of the wet well.

Wet Well Access Room

The Wet Well Access Room is located above the wet well. Lifting equipment for pump removal is provided, consisting of a monorail, trolley and manual hoist.

Entry of personnel into the Wet Well, wearing a retrieval equipment harness, can be made through a 1000 mm by 1000 mm access hatch. Ingress into the Wet Well is via a vertical, non-slip ladder. Refer to **Figure 2.2-4**, **Figure 2.2-5**, and **Figure 2.2-6**.

Operation

Detailed information related to the operation of the pump station and individual equipment is provided in this section.

Pump Control Philosophy

Control of the raw water pumps will be by a programmable logic controller (PLC) using local flow meter and system pressure as its primary input.

A discharge header pressure transmitter is used to provide the discharge pipe pressure input. A discharge header flow meter is used to provide the flow input.

Pumps will be started by operation staff to transfer the water from Lake Qikiqtalik to the reservoir. The pumps will then run automatically until operations staff turn them off or a low level in the wet well is detected. If a low level in the wet well is detected the pump will automatically shut down.

The pumps will operate with rotating duty/stand-by cycles to maintain similar operating hours for each pump. If one of the duty pumps fails or needs to be removed from service for maintenance, the stand-by pump will be activated.

The pumps will operate continuously, modulating between 75% - 100% of its rated speed, based on a distribution pressure continuous feedback loop. During the commissioning phase, it is anticipated that the Systems Integrator will adjust the variable frequency drive (VFD) control loop parameters and the start and stop setpoints to reflect actual flow requirements and conditions in the pipeline to achieve the desired flow velocity (i.e., to maintain full flow) in the conveyance pipeline system.

Emergency Standby Power

The pump station will operate on utility power while such power is available. When operating on utility power, operation of pumps and motors shall be controlled by the pump control system. During a failure of utility power, operation of the pump with the standby engine shall be controlled by the pump control system and engine control system.

Equipment

Process flow diagrams, Drawings XXX in Appendix A, outline the equipment provided for the pump station. The following tables list the process mechanical equipment and tag numbers.

Table 2-2 – RWPS Process Pump Specifications

Qty	Tag	Type / Description	Voltage / Phase / Hertz (V/Ph/Hz)	Motor Size (kW/hp)	Location
3	WW1-RWSP1 WW1-RWSP2 WW1-RWSP3	Flygt Submersible Pump, Model NP 3202 LT 3-615 (VFD) rated at 265.0 L/s at 11.4 m TDH	600/3/60	44.8/60	Wet Well
1	VCH1-SP1	Submersible Sump Pump			

Table 2-3 – RWPS Valve and Gate Specifications

Qty	Tag	Type / Description	Operator*	Mode	Location	Size (mm)
1	SP1-CV1	Swing Check Valve			Valve Room - Sump Pump 1 Discharge	50
	SP1-PV1	Plug Valve	N/O	Manual	Valve Room – Sump Pump Discharge	50
1	VCH1_BV1	Ball Valve	N/O	Manual	Valve Room – Pump Common Header - Air Relief Valve Inlet	100
1	VCH1_AV1	Combination Air Vacuum Release Valve	N/O		Pump Common Discharge Header Air Release	100
1	VCH1_GV1	Gate Valve	N/C	Manual	Valve Room – Forcemain Drain	150
1	SLP1_CV1	Swing Check Valve			Valve Room - Pump 1 Discharge	450
1	SLP2_CV1	Swing Check Valve			Valve Room - Pump 2 Discharge	450
1	SLP3_CV1	Swing Check Valve			Valve Room - Pump 3 Discharge	450
1	SLP1_BV1	Butterfly Valve	N/O	Manual	Valve Room - Pump 1 Discharge	450
1	SLP2_BV1	Butterfly Valve	N/O	Manual	Valve Room - Pump 2 Discharge	450
1	SLP3_BV1	Butterfly Valve	N/O	Manual	Valve Room - Pump 3 Discharge	450
1	WW1-SG1	Slide Gate	N/O	Manual	Wet Well Inlet	900
* “N/O” refers to “Normally Open”, “N/C” refers to “Normally Closed”						

Table 2-4 – RWPS Other Equipment

Qty	Tag	Typ / Description	Operator*	Mode	Location	Size (mm)
1	VCH1_FM1	Electromagnetic Flow Meter			Valve Chamber – Common Pump Discharge Header	450

Process Operation

The process and instrumentation control diagrams (P&IDs) for the RWPS are included in **Appendix A**, Drawings XXX. These diagrams outline all process equipment and instrumentation that will be used to control the station.

System Description

Raw water is drawn from the Wet Well through each of the three submersible wet well pumps (two duty, one standby), located in the Wet Well.

The pumps discharge individually through 450 mm diameter pipes which enter the Valve Room. Each individual pump discharge line is equipped with a check valve and butterfly valve. The individual pump discharge lines combine into a common 450 mm diameter pipe.

The common discharge header travels through the Valve Room exiting through the east wall of the Valve Room as a 600 mm diameter forcemain. The common pump discharge pipe is equipped with, a 450 mm electromagnetic

flow meter, a 100 mm combination air release valve, pressure indicator and transmitter setup, and a forcemain drain line.

Control

The pumps in the Wet Well are driven by motors equipped with variable frequency drives (VFD).

The pumps are controlled by a Programmable Logic Controller (PLC), located in the MCC. The PLC is programmed to make all automatic decisions and commands, monitor all process and alarm inputs, and communicates with the City's monitoring system. There are three equipment control modes of operation:

1. Hand (HAND)
2. Off (OFF)
3. Automatic (AUTO)

Equipment with the capability for automatic control is equipped with a HAND/OFF/AUTO (H/O/A) selector switch. An H/O/A switch allows the operator to place equipment in either Local or Remote modes, in addition to OFF. HAND corresponds to Local control; in HAND mode, the equipment can be controlled directly from the control station where the H/O/A switch is located. AUTO corresponds to Remote control.

In HAND mode, the device may be controlled from a local control panel or from the MCC. In both cases, the device operates without control requiring the PLC. In HAND mode, all software interlocks are bypassed. The hardwired interlocks, such as overloads, emergency stops, and pump control relays are still active. This mode is only intended to be used in an emergency or during maintenance and requires constant operator presence and supervision within the station. The back-up floats will not control the pumps when the pumps are operating in HAND mode.

The AUTO mode is the normal mode of operation for a device. In this mode, the PLC controls all aspects of the process, adjusting the process based upon predefined algorithms and current process feedback.

- To set a pump to Remote control, perform the following steps:
  1. Go to the pump's corresponding control panel located in the MCC.
  2. Turn the H/O/A selector switch to AUTO.
- To start a pump via Local control, perform the following steps:
  0. Go to the pump's corresponding control panel located in the MCC.
  1. Turn the H/O/A selector switch to HAND the pump will begin running.
  2. If desired, adjust speed using the VFD 'HIM' Module.
- To stop a pump via Local control, perform the following steps:
  0. Go to the pump's corresponding control panel located in the MCC.
  1. Turn the HAND/OFF/AUTO selector switch to OFF.
  2. During maintenance procedures where the local control is set to OFF, the Operator shall also ensure all lock-out procedures are completed before work proceeds.

Normal Operation (Discuss and Coordinate with I/C)

In AUTO mode, each of the pumps are controlled based on analog feedback from the ultrasonic level transmitter installed in the Wet Well. The analog level is sent from the Wet Well transmitter to the PLC via a hardwired 4-20 mA signal which is scaled according to the Wet Well size (metres). If the ultrasonic level transmitter fails, the pumps will be controlled by the pressure transmitter and hardwired low level float switch-. Wet Well control setpoints are shown in Table 2-5.

Operations enter the operating setpoints for the well level, and pump duty arrangement for all the pumps at the OIT control screen.

Table 2-5 – RWPS Wet Well Level Setpoints

Description	Level (m)	Ultrasonic Control	Float Control
Invert of Inlet Raw Water Intake Pipe	198.85		
Low Level Alarm and Stop Duty Pump (Backup)	200.69	•	•
Wet Well Floor	198.645		

Process and Equipment Troubleshooting

The following table shows typical troubleshooting actions for potential process issues.

Table 2-6 – RWPS Troubleshooting

Problem	Probable Cause	Action
Pump does not start automatically	H/O/A switch at MCC	• Ensure that the HAND/OFF/Auto switch for the pump is in AUTO.
	PLC	• Check the PLC for power and normal function. • If defective, refer to the equipment manual or call for service.
	Pump	• Check the power supply to the pump. • Check the pump, refer to the equipment manual or call for service.
	Floats	• Confirm Low Level Lockout Float is not stuck
Pump shuts off immediately after start-up	Discharge Valves	• Check operation of valves to ensure they are in the normal operation mode (open/closed).
Flow meter does not register flow	Valves	• Check position of all manual valves.
	Flowmeter	• Check if pumps are running. • Check signal from flowmeter to PLC. • Check flowmeter unit. If defective, refer to equipment manual or call for service.

Instrumentation and Control (I&C)

Operation

The Process Control Narrative is a written description of key control system elements for the facility. It details all of the manual and automatic modes of process control including software control functions, hardwired interlocks,

alarms and historical data collection requirements. Detailed process descriptions and tabular charts are used to define the process control requirements.

The Operator Interface Terminal (OIT) is located on the PLC control panel and allows operators to remotely monitor and control the equipment within the facility.

List of Equipment

A list of the main instrumentation at the facility is provided in this section.

Table 2-7 – RWPS Flow Control and Measurement

Qty.	Tag	Type/Description	Location
1	VCH1_FT1	Flowmeter on Pump Discharge Header	MCC in Control Room

Table 2-8 – RWPS Pressure Measurement

Qty.	Tag	Type/Description	Location
1	VCH1_PT1	Discharge Forcemain Pressure Transmitter	MCC in Control Room

Table 2-9 - RWPS Level Measurement

Qty.	Tag	Type/Description	Location
1	WWL1_LT1	Ultrasonic Level Transmitter	Wet Well
	WWL1_LS1	Low Float Switch	Wet Well

Building Services

List of Mechanical Equipment

A list of the main mechanical equipment at the facility is provided in this section.

Table 2-10 – RWPS Heating and ventilation equipment

Qty.	Tag	Type/Description	Location
1	AHU-01	Air handling unit	Wet well access room
1	DH-01	Duct heater	Wet well access room
1	EF-01	Washroom ceiling mounted exhaust fan	Washroom
1	EF-02	Wet well inline vertical mounted exhaust fan	Wet well access room
1	EF-03	Valve room & wet well access room exhaust fan	Electrical room
1	BHT-01	Blow heater wet well	Wet well access room
1	BBH-01	Washroom baseboard heater	Washroom
1	EUH-01	Electrical unit heater electrical room	Electrical room
1	EUH-02	Electrical unit heater electrical room	Electrical room
1	EUH-03	Electrical unit heater wet well access room	Wet well access room
1	EUH-04	Electrical unit heater wet well access room	Wet well access room
1	EUH-05	Electrical unit heater valve room	Valve room

1	EUH-06	Electrical unit heater valve room	Valve room
1	EUH-07	Electrical unit heater wet well	Wet well
4	MD-01 to MD-04	Air compressors EA connections	Electrical room
1	MD-05	AHU-01 fresh air intake	Wet well access room
2	MD-06&07	EF-02 & 03	Electrical room & wet well access room

Table 2-11 – RWPS Plumbing and drainage equipment

Qty.	Tag	Type/Description	Location
1	T-01	Potable water storage tank	Electrical room
1	T-02	Raw wastewater storage tank	Electrical room
1	P-01	Potable water pump	Electrical room
1	P-02	Submersible sanitary drainage pump	Valve room
1	SG-01	Raw wastewater grinding system	Washroom
1	DWHTR-01	Domestic water heater	Washroom

Sanitary Drainage System Description

The valve room area will be provided with a sump pit for drainage purpose. The submersible pump will be activated by a float system and wastewater will be directed to the raw wastewater storage tank located inside electrical room at ground level. A Sani grind system will pump raw wastewater from toilet and hand sink directly into the same storage tank.

Sanitary Drainage System Controls Logic

Submersible pump P-02, runs to empty sump pit, when high level is reached inside the pit, a high-level alarm is sent to RWSP PLC.

Submersible pump control panel and controller shall include the following functionality:

- Float failure alarm detection
- Float failure logic compensation
- Exterior strobe with fuses
- Reset float failure through the operator interface terminal screen or a push button
- Voltage and phase monitor one for each power feed
- Pump motor winding thermistor bimetal over temperature switch with shutdown alarm
- Audible horn
- One reset button and one lamp test button
- Pump start counters to display through the operator interface terminal screen
- Record log and display alarm history and currently active alarms through operator interface terminal screen
- Three floats control system for single pump operation that shall have 24 volt intrinsically safe circuits, high level alarm, phase failure relay trips at: low voltage, phase loss, phase unbalance, and phase reversal

Floats shall sequence the submersible pump as follows:

- Float 1: - Stop pump (Lowest fluid level)

- Float 2: - Start pump
- Float 3: - High level alarm

The following status signals shall be transmitted to PLC system.

- Pump (P-02) – fault
- Float 3 - activated - high level alarm
- Loss of pump power or loss of control power

Potable Water System Description

A storage tank will provide the water for RWSP facility. A pressurized tank and booster pump will deliver water at plumbing fixtures inside the washroom, water heater and hose bibs. A low pressure switch will ensure pump operation to maintain pressure in water lines to all fixtures.

Potable Water System Controls Logic

Water booster pump P-01, runs to maintain tank T-03 pressure at pre-set value. When water level in storage tank T-01 low level is reached, pump P-1 will stop, and a low-level alarm will be sent to RWSP PLC system. Pump P-01 stops when water pressure line reaches 413 kPa (60 psi).

Water storage tank T-01 is filled periodically by truck based on City operating schedule.

System OEM control panel shall include the following functionality:

- Starter for motor.
- Push-to-test pilot lights for motor: Green (running), amber (power on) and red (fault or low suction pressure).
- “Off" time delay relay.
- Terminal strip for wiring connections of remote mounted devices.
- Summary alarm contacts for PLC system.
- Control circuit transformer.
- Pressure gauges to indicate suction and discharge for booster pump and booster pump system discharge pressure mounted in panel cover.
- Audible horn
- One reset button and one lamp test button
- Pump start counters to display through the operator interface terminal screen
- Record log and display alarm history and currently active alarms through operator interface terminal screen

The following status signals shall be transmitted to PLC system.

- Pump (P-01) – fault
- Level sensor 1 - low level tank T-01 alarm
- Level sensor 2 – high level tank T-01 alarm
- Loss of pump power or loss of control power

Heating and Ventilation System Description

The station building temperature is controlled automatically through hardwired temperature high and low switches. The PLC will not control the building temperature. High and low temperature alarm switches are wired into the PLC for monitoring and generating alarms. The PLC will also receive general fault alarms from all HVAC equipment.

Electrical room temperature is being maintained at 15°C year-round by ventilation air unit AHU-01. The unit will be controlled by a remote temperature sensor located inside electrical room. Heated air from air compressors will be used to pre-heat fresh air, motorized dampers MD-01 to MD-05 will modulate to maintain room temperature. An electric duct heater, DH-01 will be provided on the fresh air intake connection of the air handling unit for pre-heating of outside air.

An electric blow heater will be used to maintain wet well space temperature at 7°C. Blow heater BHT-01 will be located above the wet well and ducted to supply the air into the wet well space. The heater will be controlled by a temperature sensor remotely located in wet well room.

Exhaust air will be extracted from the valve room and wet well access room by EF-03. Exhaust air will be extracted from the wet well by EF-02, and from washroom by EF-01. MD-06 and 07 will be interlocked with EF-02 and EF-03 and will be closed when fans are not operational.

Additional electric heaters, EUH-01 to EUH-07 and BBH-01 controlled by room temperature sensors are located in electrical room, valve room, wet well, wet well access room and washroom to maintain room temperature.

Heating and Ventilation System Controls Logic

1. Outdoor temp. < 15°C:

Occupied mode: EF-1,2,3 run unit AHU-01 operated at 1,175 l/s (2,500 cfm) if air compressors are off or 4,935 l/s (10,500 cfm) if one air compressor is on; Unoccupied mode: EF-1 and EF-3 are off, EF-2 is operational, unit AHU-01 runs at 600 l/s (1,280 cfm) if air compressors are off and at 4,360 l/s (9,280 cfm) if one air compressor is on. MDs on air compressor exhaust air connections modulate to maintain room temp. at 15C.

2. Outdoor temp. >15°C

Occupied mode: EF-1,2,3 run unit AHU-01 operates at 1,175 l/s (2,500 cfm) if air compressors are off or 4,935 l/s (10,500 cfm) if one air compressor is on, MDs modulate to maintain room temp at ambient temperature; in Unoccupied mode: EF-1&3 are off, EF-2 is operational, unit AHU-01 runs at 600 l/s (1,280 cfm) if air compressors are off and at 4,360 l/s (9,280 cfm) if one air compressor is on.

The following status signals shall be transmitted to PLC system.

- Low temperature alarm for each space
- High differential pressure AHU-01 filters
- Common fault alarm from all equipment
- Loss of pump power or loss of control power

Electrical

Information related to the primary power supply, appurtenances, MCC, and various operational scenarios is presented in this section. Power will be from the local utility, Qulliq Energy Corporation (QEC) which is diesel supplied through a local independent grid in Iqaluit.

List of Electrical Equipment

A list of the main electrical equipment at the facility is provided in this section.

Table 2-12 – RWPS Primary Power Supply

Location	Outside, Pole
Power Company	QEC
Power	4.16 kV

Table 2-13 – RWPS Pole Mounted Transformer

Location	Outside, Pole
Serial Number	TBD
????? PO	TBD
????? Stock Code	TBD
Primary/Secondary Voltage	Primary Voltage: 4.16 kV, Secondary Voltage: 600 V
Capacity	??? kVA, 3 PH, 3 W, 4.16 kV – 347/600 V

The emergency standby generator is a diesel powered; liquid cooled four (4) cylinder engine with suitable horsepower requirements to run the wastewater pump station.

Table 2-14 – RWPS Emergency Standby Generator

Location	Outdoors in an acoustic enclosure
Manufacturer/Model	TBD
Standby Type	Diesel
Standby Engine Capacity	??? kW / ??? kVA, 600 V, 3 PH, 4 W
Generator Breaker	600 V, ??? A, 3 PH
Load Bank	N/A

Table 2-15 – RWPS Automatic Transfer Switch

Location	MCC Shelter
Capacity	600 V, 100 A, 3 PH

Safety

Electrical safety information is available through governing CSA Codes and Standards and the Nunavut Electrical Protection Act. Electrical equipment is to be maintained and operated only by qualified persons who are familiar with the proper use of personal protective equipment and tools.

The basic rule for safe operation and maintenance electrical work is “Isolate First”. Prior to starting any electrical maintenance or repair work, the affected area should be electrically isolated and locked out.

Whenever possible, visually inspect the isolating apparatus to confirm the contacts have indeed been opened and the equipment on which maintenance is to be performed is isolated from its power supply(s). In addition to visually inspecting the isolating apparatus to positively confirm that the equipment has been isolated, use an adequately rated voltmeter to test the potential of each phase conductor or circuit part to ensure the equipment is de-energized.

Arc Flash is an unexpected release of heat and energy produced by electricity traveling through air. It is usually caused by accidental contact between live conductors. Arc Flash can occur where there is energized electrical equipment, and the explosion can result in electrocution, burns, blindness, and other physical injuries. Potential tasks that can result in arc flash, include, but are not limited to:

- Operating a switch or circuit breaker
- Inserting or removing a circuit breaker
- Opening an enclosure door
- Removing a cover (bolted or hinged)

- Testing for voltage

Emergency Operation

Emergency pump operation is provided by a diesel generator, located outside in an acoustic enclosure. The generator is controlled by a control panel located in the MCC.

The PLC will monitor the process of transfer from normal to emergency power supply and from emergency power to normal power. The following generator hardwired signals are wired to the PLC and available for monitoring and alarming at the local OIT:

Generator Run Status

- Generator Auto Status
- Battery Charger Fault
- Battery Voltage Low
- Generator Door Open
- Generator Enclosure Temperature

Health and Safety

Hazards

Physical Hazards

A summary of possible physical hazards at this facility includes, but are not limited to:

- Machinery (e.g. pump motor drives, etc.) which are not guarded, or inadequately guarded.
- Walking surfaces which have been compromised (e.g. loose gratings, damaged railings, slippery walkways, tripping hazards, etc.).
- Confined spaces (e.g. maintenance holes, vaults, etc.).
- Noise from running equipment.
- Handling of heavy equipment (e.g. pump/drive maintenance, change of chemical drums, etc.).

Electrical Hazards

The electrical equipment, control panels, and wiring contained in this facility are a potential electrical hazard to all personnel in this facility. Potential causes of hazards include but are not limited to:

- Improper grounding
- Exposed electrical parts
- Inadequate wiring
- Overhead power lines
- Damaged insulation
- Overloaded circuits

- Wet conditions
- Damaged tools and equipment
- Battery acid
- Arc Flash

Electrical repairs are to be carried out by a qualified electrician only.

Prevention

Specific electrical safety guidelines include, but are not limited to:

- Follow lock-out procedures and de-energize equipment before working on it; check if the task of operating the disconnect switch requires arc flash protection.
- Wear proper arc flash personal protective equipment and clothing.
- Do not remove the ground pin from power tools or other equipment.
- Report suspected exposed electrical parts, damaged insulation, and damaged equipment to the Team Lead.
- Do not perform maintenance or repairs or operate electrical equipment in wet areas.
- Wear acid-proof gloves and face protection when working with chemicals or on storage batteries.

Conveyance

System Overview

Description of the system, overall site plan

Pipeline Operations

Seasonal Startup

- Describe startup procedure (see Shelley's draft notes)
- Outline the need for inspection at the beginning of the season
- Discuss use of pressure gauges, and/or pressure transmitters (at top and bottom end of pipe)

Normal Operations

- Discuss day-to-day operations
- Use of manual pressure gauges (do they have a purpose during normal ops or just startup?)
- How often to inspect?
- Signs of issues? Pressure gauges, etc.
- Describe use of automated valves (for isolation?)

Seasonal Shut Down

- Describe shut down procedure
- Use of drain valves
- Draining end of pipe at reservoir, use of sediment control (permit needed for removing sediment?)

Inspection and Maintenance

- What things need to be inspected? How often?
- Regular maintenance (periodic cleaning pipeline every 5 years? 10 years? How??)
- How do we know when it needs cleaning?
- What needs maintenance? Valves? Valve chamber cleanout?
- Refer to Contractor O&M Manual for instructions on maintaining air valves, drain valves, etc. etc.

Reservoir

Introduction

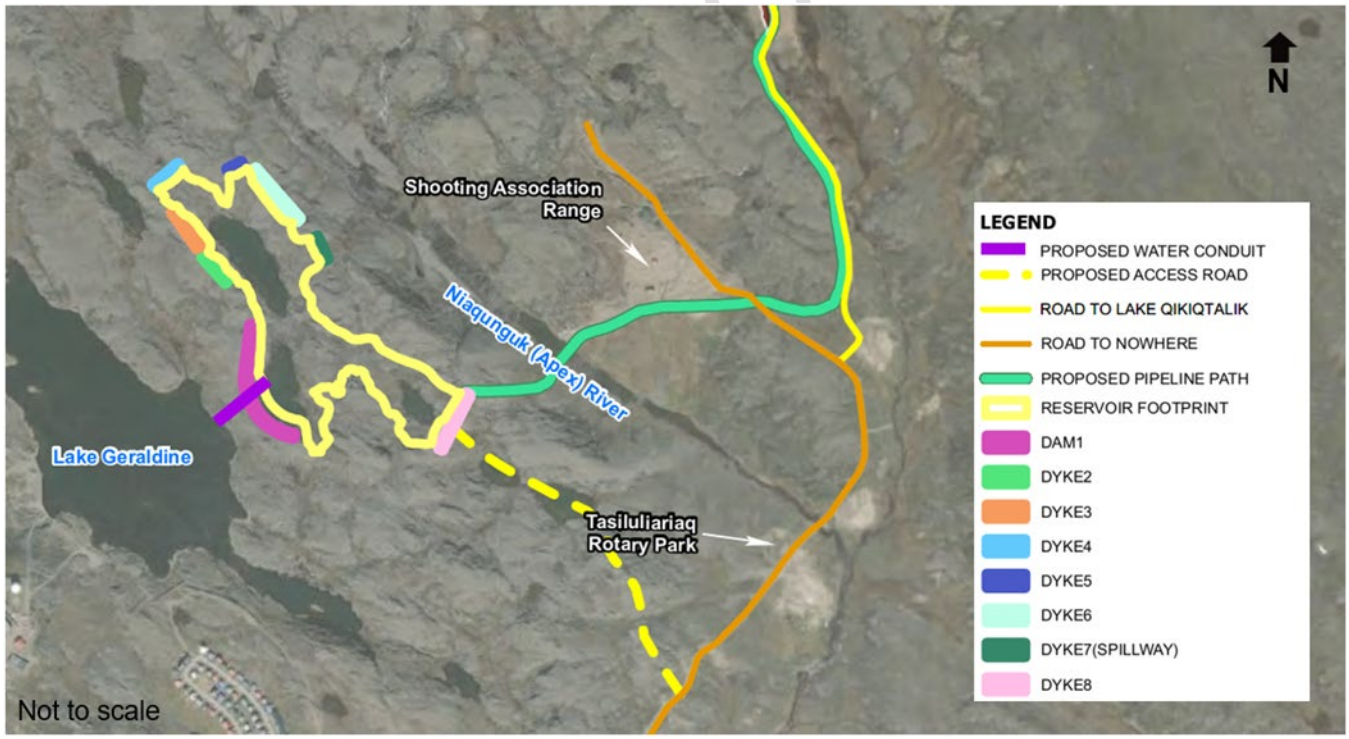
In accordance with the Canadian Dam Association (CDA) Dam Safety Guidelines (2013), an Operation, Maintenance, and Surveillance Manual (OMS Manual) is required to provide both experienced and new staff with the information they need to safely operate the reservoir.

The instructions and information found in the following sections provide preliminary OMS practices for the reservoir.

Infrastructure Overview

The reservoir system comprises eight retention structures (one dam and seven dykes) in addition to peripheral utilities (e.g., access roads). The dam and dyke structures are similar in design. The key differences between the dam and the dykes being: the larger size of the structure, the presence of an additional buttress at the rear of the dam, and the water conveyance under the dam allowing water transit from the reservoir to Lake Geraldine. The general dam/dyke structure will consist of a homogenous rock-fill embankment with internal filter-graded cushion layers to support a geosynthetic liner, and riprap armouring on the upstream side to protect against ice impacts. The reservoir currently incorporates one spillway located at Dyke 7. The general locations of the retention structures associated with the reservoir are shown in Figure 4-1.

Figure 4-1 – Components of Proposed Reservoir



As the reservoir design progresses, this section will be updated to further detail the reservoir retention structures and infrastructure associated with communications, access route, public safety, and site security.

Roles and Responsibilities

The Lake Geraldine Dam OMS Manual currently identifies eight staff positions at the City of Iqaluit Water Utility with responsibilities associated with the dam at Lake Geraldine. These responsibilities are expected to expand to include the reservoir with the addition of qualified personnel as needed. In accordance with the responsibility structure for the Lake Geraldine Dam, the following roles and responsibility structure is :

- The Chief Administrative Officer (CAO) be responsible for safe operation, maintenance, and surveillance of the reservoir.
- The Director of Engineering and Public Works be responsible for the management in support of the safe operation of the reservoir.
- The Superintendent of Water/Wastewater be responsible for infrastructure in operation of the reservoir.
- The Public Works Operation Superintendent be responsible for assignment and operation of the dam intake line and water conveyance between the reservoir and Lake Geraldine.
- The Utilidor Foreman be responsible for maintenance, preventative maintenance and inspection activities at the site.
- A selected number of operators be responsible for operation of the reservoir, intake control valves and supply line that provides water to Lake Geraldine, site inspections, public access, incident reporting, general record keeping, and maintaining a Permanent Record File (PRF).

Operations

This section outlines the general guidelines for the operation of the reservoir. The procedures identified in the following subsections do not represent or include detailed operating procedures related to specific utilities and instruments associated with the reservoir. Where required, these operating procedures will be developed and included in the OMS Manual after the detailed design of the reservoir is completed.

Operating Procedures

Operating procedures have been divided into the five activation levels. Table 4-1 will be updated with key water level elevations and detailed hydrological event conditions as the reservoir design progresses.

Table 4-1 – Activation Levels for Proposed Reservoir

Activation Level	Condition	
	Hydrological Event	Other Events
NORMAL CONDITION (**Green**)	Reservoir is at or below maximum operating level. No weather events of concern forecasted.	Not Applicable
FLOOD SITUATION (**Blue**) Out-of-bank water levels	a) Reservoir level at maximum operating level with heavy snowpack. Rain forecasted for an amount of concern in the next 24 hours. b) Reservoir level at or above maximum operating level.	Not Applicable

Activation Level	Condition	
	Hydrological Event	Other Events
DAM OR DYKE ALERT (Yellow) Abnormal condition poses a threat	a) Reservoir level is slightly above maximum operating level due to snowmelt only. Rain forecasted in the next 24 hours. b) Annual snowfall 2.0x more than normal and reservoir is at operating level.	Abnormal condition that may affect dam or dyke performance has been identified, for example: Beaching erosion at the crest, either upstream or downstream; New leakage, or recurring leakage, observed to be increased and/or silt laden; Minor structural deformation or deterioration.
DAM OR DYKE EMERGENCY (Orange) Potential dam or dyke failure is developing	a) Reservoir level is above maximum operating level and rain and/or snowmelt may result in water level reaching close to crest. b) At elevated reservoir levels but is not eroding the slope and level is expected to recede.	Leakage downstream of dam or dyke is escalating and is brown and silt laden. Dam or dyke has suddenly deformed and sinkholes and depressions are observed, associated with leakage. Abnormal condition creates threat to dam or dyke safety, requiring immediate attention. If implemented, remediation is expected to be effective.
DAM OR DYKE FAILURE (Red) Dam or dyke failure is imminent or has occurred	a) Reservoir level is expected to overtop dam or dyke. b) Dam or dyke overtopping is occurring or imminent.	Upstream water level is decreasing rapidly, indicating an internal dam or dyke failure. Leakage is overwhelming the spillway channel. Dam or dyke is deforming and leakage is excessive and escalating. Failure of dam or dyke is occurring or imminent.

Normal Operations

The reservoir will require limited attention from staff during normal operations. Normal operation conditions will be fully defined once an emergency preparedness plan is developed. However, in general, normal operating conditions would mean the reservoir water level is below the maximum operating level and all retention structures are performing as intended.

Components to facilitate the release of water from the reservoir are limited to the water conveyance connection to Lake Geraldine and its control valves. The ability to safely release water from the reservoir will depend on the water level and conditions in Lake Geraldine. In the event water level rise in the reservoir cannot be mitigated by a controlled release into Lake Geraldine, the water will either flow over the concrete spillway or be stored in the reservoir if the reservoir water level is below the spillway sill.

Unusual Operations

The reservoir may require more active attention from staff during unusual operations. Unusual operations are defined as (1) Flood Operations - the retention structures are spilling with the reservoir water level slightly above the maximum operational level and (2) Dam or Dyke Alert – an abnormal condition that poses a threat to the dam or a dyke. Unusual periods do not include emergency operations.

Flood Conditions

Specific flood conditions will be defined as the reservoir design progresses. In general, flooding is anticipated to occur when there is an above average snowpack in the reservoir and a rain event with heavy precipitation is forecasted when the reservoir is at or above its maximum operating level.

In periods of higher-than-normal reservoir levels, especially when there is considerable snow cover, increased frequency of inspections and subsequent site maintenance procedures may be required. The following actions may be necessary:

- Site access roads may require grading and/or clearing to allow for access and debris removal.
- The inlet for the water conveyance to Lake Geraldine may require snow removal/clearing.
- The spillway channel may need to be cleared to control flood discharge and for visual observation.
- Ice build-up in the reservoir may require slotting to promote brake-up.

Dam or Dyke Alert

A dam or dyke alert will occur when an abnormal observation has the potential to threaten the security of the dam or a dyke. Abnormal conditions, other than flooding, can occur at any time and may be observed by operators or reported by the public. These conditions are not weather dependent and may include:

- Beaching erosion at the crest, either upstream or downstream.
- New leakage, or recurring leakage, observed to be increased and/or silt-laden.
- Minor structural deformation or deterioration of the rockfill slope.
- Sinkholes in the downstream fill at the dam or dyke.
- Increased flow in the spillway channel while the reservoir is below the spillway sill.
- As sudden drop in the reservoir water level.

When abnormal conditions are observed, increased frequency of inspections and subsequent site maintenance procedures may be required. The following actions are considered appropriate:

- Refer to the emergency response plan that will be developed for the reservoir to establish the response protocol.
- Conduct independent investigations of the incident to qualify the risk to dam or dyke failure.
- Prepare a remedial plan to address the observed condition and restore the dam or dyke.
- Review emergency procedures to prepare for a potential escalation to emergency operations.

Emergency Operations

Emergency periods are defined as periods when one or more of the retention structures are under duress or an incident has occurred that places dam or dyke integrity at risk. An Emergency Response Plan (ERP) for the reservoir will be developed for the City of Iqaluit that outlines the decision-making framework for emergency operations. The objective of the ERP will be to outline how to operate the reservoir in a manner that reduces the

risk of a dam or dyke collapse. Recommended emergency preparedness measures will be established as the reservoir design progresses. These measures may include:

- A readily available and accessible stockpile of rock fill for re-enforcing the existing rockfill embankments in the event of slumping and material movement.
- A source of construction equipment to haul and place rock material, as well as open and upgrade access roads, if necessary.
- A source for sandbags or other type of material that can be used to raise and buttress the rockfill core wall expeditiously.
- Tools to remove debris buildup / cut / break ice.

Flow Control

The reservoir will rely on a dual pipe water conveyance connection to Lake Geraldine to control flow out of the reservoir. Details on flow control operations will be added to this section as the reservoir design progresses.

Records (Logs)

The reservoir operator or team is expected to be responsible for documenting reservoir operating conditions (e.g., water level) on a weekly basis and submitting these conditions to their supervisors for review. Details on where and how to record measurements will be added as the reservoir design progresses. In general, a standardized log sheet is recommended for recordkeeping purposes. The log would include basic key information (e.g., the date, weather, observations) and be signed after each inspection.

Maintenance

This section outlines the general guidelines for maintenance of the reservoir. The procedures detailed below do not represent or include detailed procedures related to specific maintenance activities. Where required, detailed maintenance procedures will be developed in a manner that is consistent with recommended manufacturers operating and maintenance procedures and/or accepted industry safe work practices.

Maintenance Program

Maintenance activities consist of two types: (1) planned preventative maintenance and (2) unplanned incident maintenance. Preventative maintenance programs consist of regularly scheduled activities which occur on a repetitive basis, whereas incident maintenance activities are derived in response to an observed unusual or unexplained condition that requires an unplanned action. The City of Iqaluit will be required to provide both types of maintenance. Records of all maintenance activities shall be maintained within the established PRF with a copy issued to the Director of Public Works as is currently done for the Lake Geraldine Dam.

Preventative maintenance activities will be detailed in this section as the reservoir design progresses.

Incident maintenance actions are generated as needed and based on operator and annual dam safety inspections. Typical examples include the following:

- Any depressions in the crest surface should be filled and regraded for freeboard maintenance.
- Riprap on the upstream slope is reinstated and regraded to protect integrity of blanket.
- Slumps or depressions are investigated and re-filled.

Spillway

Preventative maintenance activities at the spillway are expected to include the following:

- Removal of floating debris from the reservoir during open water season in the area around the spillway entrance, and disposal of the debris off-site.
- Removal of any debris from the winter ice on the reservoir.
- Slot-cutting of ice build-up on the upstream side of the reservoir.

Intake Structure

Preventative maintenance activities at the intake structure for the water conveyance connection to Lake Geraldine are expected to include the removal of any buildup of sediment and debris around the intake structure and its screen. Additional details will be added to this section as the reservoir design progresses.

Flow Control

The reservoir will rely on a dual pipe water conveyance connection to Lake Geraldine to control flow out of the reservoir. Details on flow control maintenance activities will be added to this section as the reservoir design progresses.

Infrastructure (Access, Utilities)

A ring access road that runs along the crest of the retention structures has been for the reservoir. This ring access road along with the access road that connects it to the Road to Nowhere may sustain damage from spring runoff and will likely require regrading each spring. It should be expected that all access roads associated with the reservoir will require regular grading and maintenance. Inspection and maintenance reports are to be included in the permanent record file.

Maintenance Schedule

This section will be updated to include a maintenance schedule for the reservoir as the design progresses. Table 4-2 provides an example of a possible maintenance schedule that would align with the maintenance schedule for the Lake Geraldine Dam.

Table 4-2 - Maintenance Schedule for Proposed Reservoir

Structure	Action Item	Occurrence	Maintenance Type
Dam	Remove Floating Debris from Reservoir	As Required	Preventative
	Removal of Debris from Ice	As Required	Preventative
	Slot-Cut Ice	As Required	Preventative
Dykes	Removal of upstream debris	As Required	Preventative
	Grade crest	Semi -Annual	Preventative
Intake	Clean trash rack, remove build-up	As Required	Incident
	Exercise valves through full operating cycle.	Annual	Preventative
		Annual	Preventative

Structure	Action Item	Occurrence	Maintenance Type
	Inspect valve chambers and components.		
Outlet to Lake Geraldine	TBD		

Maintenance Records

Maintenance activities will be recorded in the established PRF including work order output summaries. Entries shall include, time and date, weather condition, description of the maintenance activity and supervisory sign-off that the work was completed satisfactorily. For convenience, both the operation and maintenance activities should be recorded in the same PRF.

Surveillance

Similar to the Lake Geraldine Dam, a performance-based surveillance program that includes inspection and monitoring instrumentation will be established for the reservoir. The goal of performance-based surveillance is to identify deviations in performance conditions so corrective or risk mitigation measures can be implemented before adverse consequences result. Observations from inspections coupled with assessment of records from instrumentation monitoring can be used to:

1. Observe performance of known anomalies;
2. Predict future performance;
3. Establish baseline data; and
4. Refine future designs.

Inspections

The reservoir components shall be inspected regularly so that deficiencies can be identified at an early stage and corrective actions can be taken in a timely manner. Inspections are to be conducted at different times of the year and under different reservoir levels. Table 4-3 provides an example of possible inspection frequencies that would align with inspections of the Lake Geraldine Dam under its current surveillance program.

Table 4-3 – Surveillance Inspection Type and Frequency

Inspection Type	Frequency
Routine Visual Inspection	Monthly
Formal Inspection	Annually
Special Inspection	As required
Dam Safety Review (DSR)	Every 5 years or more

Similar to the Lake Geraldine Dam, it is expected that the Director of Public Works will be responsible for ensuring that inspections of the components are completed and that all reports are reviewed by a competent engineer. Additionally, the Facilities Coordinator would be responsible for preparing action plans for any maintenance work required, or additional monitoring. These plans would then be approved by the Director of Public Works or CAO.

Routine Visual Inspections

Routine inspections are expected to be performed by the reservoir operator or team.

A routine inspection consists of observations of the general appearance and functioning of the dam, dykes, and spillway. Items of interest include changes at known leakage locations, erosion, sinkholes, boils, seepage, slope slumping or sliding, settlement, displacements or cracking of structural components.

Routine inspections are generally not as comprehensive as a formal inspection but should always include a review of past inspection reports and collection of monitoring data. Particular attention should be paid to items noted in past reports.

Reporting for routine inspections will involve completing an inspection checklist. A checklist will be developed and added to the OMS manual once the detailed design of the reservoir is completed. It is expected that the Superintendent of Operations will be responsible for reviewing and signing off the routine inspection reports.

Formal Dam Safety Inspections

A formal Dam Safety Inspection (DSI) will be performed annually by a third-party professional engineer. The formal inspections will include a detailed visual examination of the dam as well as review of past inspection reports, monitoring data, photographs, maintenance records, or other pertinent data as required. The formal inspection documents observations regarding the condition of the dam and dykes with any significant condition changes from previous inspections being highlighted. During field examination of the dam, dikes, spillway and selected features and components, attention shall be paid to any issues outlined in previous reports.

A DSI report shall be completed summarizing the findings of the inspection, describing in detail any issues of concern noted during the inspection, identify new observations when compared with previous completed DSI reports, and identify actions required. The report should also include photos and an assessment of the severity of the observed anomalies as well as recommendations for maintenance, repairs, investigation or additional surveillance. Similar to the Lake Geraldine Dam, it is anticipated that all DFI reports will be reviewed and signed off by the Director of Public Works and be included in the PRF.

Dam Safety Review

A Dam Safety Review (DSR) is a formal procedure defined in the CDA Dam Safety Guidelines (2013) which is typically completed by independent professional engineers with specific training in dam safety. It will be the responsibility of the Director of Public Works and Superintendent of Operations to review the DSR for the reservoir and develop a maintenance plan for any items requiring repair or monitoring.

A DSR will include a review of past inspection reports, monitoring data, photographs, maintenance records, or other pertinent data or compilation of an information database if it is the first formal technical inspection, or if files do not exist or are inadequate. The DSR may include a number of analyses that may be generated as a result of observations made during the field inspection, changes in the watershed conditions, or regulatory changes.

The DSR report should also include some assessment of the level of severity of the observed anomalies as well as recommendations for maintenance, repairs, investigation or further surveillance. The details of the DSR Inspection and the receipt of the final report shall be recorded in the PRF.

Special Inspections (Unusual Conditions)

In addition to regularly scheduled inspections, it is recommended that special inspections of the reservoir retention structures occur after any unusual or extreme event such as a flood event, an unexplained anomaly, abnormal icing, rapid snowmelt, earthquakes, and exceedance of the maximum operating level. In particular, rainfall in combination with warm temperatures and wind can create increased inflow conditions.

Following the inspection, procedures for a dam or dyke alert should be followed, as will be outlined in the ERP for the reservoir. In these conditions, monitoring reservoir levels at appropriate intervals will help ensure that the EPP/ERP plans are deployed prior to a crisis.

In the event anomalies are identified during routine or formal inspections that may constitute a possible dam or dyke safety issue, an inspection will be conducted immediately by a professional engineer trained in surveillance. Special Inspections may or may not require a detailed report depending on the results of the inspection. At a minimum, the inspection details shall be recorded including observations, photographs, and recommendations.

Instrumentation and Monitoring

Instrumentation will be installed in the reservoir dam and dykes to monitor, at minimum, porewater pressure, horizontal/vertical displacement, seepage, and temperatures in the subsurface. This section will be updated to include details on the instrument locations and monitoring requirements as the design process progresses.

Inspection of Reservoir Components

Inspections are anticipated to be conducted as outlined below. An inspection checklist and observation sheet for the reservoir will be developed to facilitate effective surveillance. The Nunavut Environment publication on inspection of dams may also be included in the final OMS manual to guide operators performing routine inspections.

Routine Visual Inspections

The reservoir dam and dykes will be investigated for evidence of displacement, sinkholes, springs and wet spots. The following components of the dam and dykes will be inspected:

Crest

- Longitudinal Cracking: indication of local instability, differential settlement and movement between adjacent segments of the dam or dyke.
- Transverse Cracking: indication of differential settlement or movement between adjacent segments of the dam or dyke.
- Misalignment: can indicate movement between adjacent portions of the dam or dyke in directions perpendicular to the axis of the dam or dyke.
- Narrowing of the crest width through erosion or undermining of the upstream crest.
- Low areas caused by erosion or settlement.
- Sinkholes or any unexplained hole or cavity, which might indicate internal erosion.

Upstream Slope

- Beaching.
- Deterioration of riprap.
- Displacement of riprap.
- Sliding of the embankment.

Downstream Slope

- Cracks - can indicate settlement, or a slide developing.
- Slides - require immediate evaluation by a Professional Engineer.
- Bulges - an indicator of potential sliding.
- Seepage - occurs at all dams or dykes in varying degrees. The most potentially dangerous condition is the appearance of seepage on the downstream face at the toe of the dam or dyke. The concentration and rate of the flow will be noted. The presence of fines in the seepage flow, making it appear murky would indicate the possibility of internal erosion (piping).

- Depressions: might indicate internal erosion.
- Erosion caused by runoff.
- Standing or ponding water at the downstream toe, which can cause slope instability.

Abutments

- Seepage - especially at the abutment/embankment contact zone (groin).
- Any indication of abutment instability such as cracking or material displacement.

Downstream Toe

- Sinkhole depressions.
- Wet or marshy ground or standing water.
- Seepage areas - mark and document areas dimensions to use for comparison in future inspections.

Spillway

The spillway surfaces will be visually inspected for cracks, settling, obstructions, erosion, vandalism or other destructive forces.

The spillway channel may be obstructed by excessive accumulation of debris, ice movement, and snowdrifts. An obstructed spillway will have substantially reduced discharge capacity and can create problems including overtopping of adjacent rockfill structures.

Degradation of the spillway channel erosion protection can result in undermining and structural destabilization of the spillway. Spillway channel erosion protection will be observed, reported on, and repaired as required.

Surveillance Records

All surveillance activities shall be recorded in the PRF. Entries shall include, time and date, weather condition, and description of any deficiencies or changes to reservoir structures. For convenience, the operation and maintenance, and surveillance activities should be recorded in the same PRF.

Permanent Record File

A Permanent Record File (PRF) will need to be started by the City of Iqaluit once the reservoir is completed to document activities related to the reservoir dam and dykes. The primary purpose of this PRF will be to ensure OMS activities and associated decisions are recorded. It will also provide a means of ensuring conformance to established procedures. It is anticipated that the reservoir PRF will be updated weekly with the following information related to OMS activities.

- Date/Time.
- Operator/staff on duty.
- Weather.
- Discharges (spillway, dam, and/or dykes) and reservoir levels.
- Equipment testing.
- Planned and unplanned maintenance activities.
- Incident details (Incidents that possibly impact reservoir safety and will be considered in future inspections).
- Reports dispatched and received.
- Notification of receipt of changes to established operation procedures.
- Record of communication with respect to any dam and dyke OMS issues.

Appendix A

A – Design Drawings

Appendix B

B – Standard Operation Procedures (SOPs)

RWPS Operational Checks – Regular Maintenance

1.1 Purpose

The purpose of this Standard Operating Procedure (SOP) is to:

- describe the operational checks that require to be completed as part of regular station maintenance.

1.2 Precautions

Known precautions include:

- Review supplier Operation and Maintenance Manuals for precautions

1.3 Equipment

Major equipment that will assist with this procedure includes:

- N/A

1.4 Advance Preparation

Advance preparations that assist this procedure include:

- N/A

1.5 Procedure

List of checks provided is as follows:

Weekly Station Checks

- Inspect external areas of station for any signs of vandalism/damage/deficiencies.
- Check Wet Well hatches and covers to ensure locks are maintained. Access station and disable entry alarm.
- Check oil and coolant level, battery levels, belts and hoses of genset.
- Start and operate genset for 30 minutes.
- Record pumping system operational readings such as flows, number of starts, and elapsed time, in an ongoing log book. Compare these to identify any abnormalities.
- Set off alarms, verify transmittal and acknowledge receiving of alarms. Ensure alarms are registered and then reset.
- Operate each pump manually to monitor amperage.
- Perform general housekeeping of the interior of the station.
- Perform visual check of process piping for leaks.
- Confirm operation of ventilation system.

Monthly Station Checks

- Perform confined space entry of Wet Well.
- Tip floats to confirm operation.

- Simulate station power failure to automatically start standby generator. Start and run each pump during this run period.
- Verify that check valves are operating properly.
- Verify that air releases are working and not leaking.
- Record all activities performed.

1.6 Maintenance

Refer to the supplier Operation and Maintenance Manual for maintenance procedures.

1.7 References

- Supplier Operation and Maintenance Manuals
- Facility drawings

1.8 Attachments

None.

1.9 Approvals

Date Created				Signature
Date Approved:		Approved By:		
Date Amended:		Approved By:		
Date Amended:		Approved By:		
Date Next Review		Reviewed By:		
Supersedes:				

RWPS Emergency Standby Generator Operation

1.1 Purpose

The purpose of this Standard Operating Procedure (SOP) is to:

- describe normal operation of the backup standby generator Operation.

1.2 Precautions

Known precautions include:

- The exhaust pipes from the diesel engine can become hot, and operators should be careful not to touch the exhaust manifold and pipes.
- Review of safety hazards such as moving parts, extreme heat, shock or electrocution that are present during operation.

1.3 Equipment

Major equipment that will assist with this procedure includes:

- N/A

1.4 Advance Preparation

Advance preparations that assist this procedure include:

- Operators should read and be familiar with the supplier Maintenance and Operation Manual for the generator.
- Review records of regular genset run testing to ensure operability.

1.5 Prestart Checklist

To ensure continued satisfactory operation, perform the following checks or inspections before or at each startup, as designated, and at the intervals specified in the service schedule. In addition, some checks require verification after the unit starts.

DANGER: Hazardous voltage. Moving parts. Will cause severe injury or death.

Operate the generator set only when all guards and electrical enclosures are in place.

- **Air Cleaner**. Check for a clean and installed air cleaner element to prevent unfiltered air from entering engine.
- **Air Inlets**. Check for clean and unobstructed air inlets.
- **Battery**. Check for tight battery connections. Consult the battery manufacturer's instructions regarding battery care and maintenance.
- **Controller**. After reconnecting the battery, set the controller time and date.
- **Coolant Level**. Check the coolant level according to the cooling system maintenance information.

Note: Block Heater Damage. The block heater will fail if the energized heater element is not immersed in coolant.

Fill the cooling system before turning on the block heater. Run the engine until it is warm and refill the radiator to purge the air from the system before energizing the block heater.

- Drive Belts. Check the belt condition and tension of the radiator fan, water pump, and battery charging alternator belt(s) according to the drive belt system maintenance information.
- Exhaust System. Check for exhaust leaks and blockages. Check the silencer and piping condition and check for tight exhaust system connections. Inspect the exhaust system components (exhaust manifold, exhaust line, flexible exhaust, clamps, silencer, and outlet pipe) for cracks, leaks, and corrosion.
  - Check for corroded or broken metal parts and replace them as needed.
  - Check for loose, corroded, or missing clamps and hangers. Tighten or replace the exhaust clamps and/or hangers as needed.
  - Check that the exhaust outlet is unobstructed.
  - Visually inspect for exhaust leaks (blowby). Check for carbon or soot residue on exhaust components. Carbon and soot residue indicate an exhaust leak. Seal leaks as needed.
- Oil Level. Maintain the oil level at or near, not over, the full mark on the dipstick.
- Operating Area. Check for obstructions that could block the flow of cooling air. Keep the air intake area clean. Do not leave rags, tools, or debris on or near the generator set.

1.6 Procedures

The following steps should be followed for these procedures.

These steps should be modified as needed as operating experience is gained with the facility.

1.6.1 Starting

1.6.1.1 Local Manual Starting

Move the diesel engine Hand-Off-Auto switch to Hand and Idle-Rated Switch to Idle and press engine start push button. These switches are located in PLC Panel.

For additional details, refer to the generator set supplier's operation and maintenance manual.

1.6.1.2 Auto Starting

Move the diesel engine Hand-Off Auto Switch to Auto mode and engine Idle – Rated switch to Idle mode the system is set for auto operation.

Note:

The controller provides up to 30 seconds of programmable cyclic cranking and up to 60 seconds rest with up to 6 cycles. The default setting is 15 seconds cranking and 15 seconds rest for 3cycles. Make cyclic cranking adjustments using the keypad.

For additional details, refer to the generator set supplier's operation and maintenance manual.

1.6.2 Stopping

1.6.2.1 Manual Stopping (Master Switch in OFF)

Run the diesel operated engine without load for 5 minutes prior to shutdown to ensure adequate engine cooldown. To manually stop the engine, simply move the Hand-Off-Auto Switch to Off position.

For additional details, refer to the generator set supplier's operation and maintenance manual.

1.6.2.2 Automatic Stopping (Master Switch in Auto)

To stop the engine set that was started by activating the remote start input when the master switch is in AUTO, simple deactivate the remote start input by opening the contacts of this input. The engine set will transition to the

Cooldown state. The engine set will run at normal speed until the engine coolant temperature falls below the preprogrammed cooldown threshold or until the programmable cooldown time delay expires, whichever occurs first. If the Cooldown Override parameter is set to TRUE, the coolant temperature will be ignored, and the cooldown will continue for the full cooldown delay. If the remote start input is re-activated during the cooldown cycle, the cooldown will abort, and normal generator set operation will resume.

For additional details, refer to the generator set supplier's operation and maintenance manual.

1.6.2.3 Emergency Stopping

Use the emergency stop switch located at engine for immediate shutdown. The emergency stop switch bypasses the time delay engine cooldown and immediately shuts down the generator set.

Note:

Use the emergency stop switch(es) for emergency shutdowns only

For additional details, refer to the generator set supplier's operation and maintenance manual.

1.7 References

- Supplier Operation and Maintenance Manuals

1.8 Attachments

None.

1.9 Approvals

Date Created				Signature
Date Approved:		Approved By:		
Date Amended:		Approved By:		
Date Amended:		Approved By:		
Date Next Review		Reviewed By:		
Supersedes:				

RWPS Start Up and Shut Down

1.1 Purpose

The purpose of this Standard Operating Procedure (SOP) is to:

- describe the general procedures to start up the RWPS and shut it down.

1.2 Precautions

Known precautions include:

- The pump station should operate normally only during Lake Qikiqtalik open water season.
- Operators should be aware of which areas of the RWPS are Confined Spaces and should follow confined space entry procedures if it is necessary to enter those areas.

1.3 Equipment

Major equipment that will assist with this procedure includes:

- N/A

1.4 Advance Preparation

- N/A

1.5 Start Up Procedure

The following steps should be followed for pump station start up.

It should be noted that this procedure should be considered as a general start up procedure. The steps taken to start up the pump station should be reviewed and modified as needed to adjust the start up procedures. These steps should be modified as operating experience is gained with the facility.

1. Confirm position and operation of the station discharge valves:
    - Confirm the conveyance pipes discharge valves are closed.
    - Confirm the conveyance pipes isolation valves in the high point splitting chamber are open.
    - Confirm the drain valve for the pump discharge piping is closed.
    - Confirm the isolation valves for the pumps are open.
    - Confirm the isolation valves for the air-release valves are open.
    - Confirm the gate on the inlet pipe is open.
    - Ensure minimum wastewater level in the Wet Well is met to allow pumps to prime.
2. Engage power supply to a single pump and start pump on minimal speed in HAND:
    - Fill the discharge piping and forcemain.
    - Fill the conveyance pipe with water from the pump.
    - Open the discharge valve on Conveyance Pipe 1 and ramp up speed of pump to full speed.
    - Turn the pump from HAND to AUTO.

3. Monitor pump station operations to confirm proper operation.
4. If additional water is needed:
    - Open the discharge valve on the Conveyance Pipe 2 and start the second pump in HAND and ramp up speed of pump to full speed.
    - Turn the pump from HAND to AUTO.
5. Monitor pump station operations to confirm proper operation.

1.6 Shut Down Procedure

The following steps should be followed for pump station shut down.

It should be noted that this procedure should be considered as a general shut down procedure. The steps taken to shut the pump station down should be reviewed and modified as needed to adjust the shutdown procedures to the specific reason why the pump station is being shut down. These steps should be modified as operating experience is gained with the facility.

1. Turn all the pumps OFF.
    - If needed, lock out power to the pumps.
    - Open the forcemain drain valve and drain to the wet well.

1.7 Abnormal Operating Conditions

Emergency Stop:

- The pumps have emergency stop buttons that can be activated to stop their operation.

1.8 References

- Refer to pump station and equipment operation and maintenance manuals and/or drawings as appropriate.

1.9 Attachments

None.

1.10 Approvals

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RWPS Pump Removal, Reinstall and Maintenance

1.1 Purpose

The purpose of this Standard Operating Procedure (SOP) is to:

- describe the general procedures to remove and reinstall the pump station pumps

1.2 Precautions

Known precautions include:

- Pumps are very heavy and should always be fully supported during the removal and reinstallation process.
- Refer to the Operation and Maintenance manuals for the pumps for weights and information on lifting points and how to support the pumps.
- Pumps should be fully isolated from power supply, from the control system and from the wastewater piping before removal.

1.3 Equipment

Major equipment that will assist with this procedure includes:

- Pump removal monorail, trolley, and hoist

1.4 Advance Preparation

Advance preparations that assist this procedure include:

- Operators should read and be familiar with the equipment Operation and Maintenance manuals for the pumps, for the monitoring panels and for the removal davit and hoist.
- Confirm the other remaining pumps can handle the expected flows with the subject pump(s) removed.
- Ensure isolation valves located upstream and downstream of the pump(s) to be removed are closed before removal activities occur.
- Prepare a hoisting and rigging plan for pump hoisting and removal.
- Prepare landing locations for each pump.
- Supply new gaskets for the inlet and outlet flanges for the pump as it may not be possible to re-use the existing gaskets.

1.5 General

Contact the pump supplier and/or contractor to perform any pump removal, replacement, and re-installation procedures.

1.6 References

- Pump and Supplier Operation and Maintenance Manuals
- Monorail Operation and Maintenance Manuals
- Facility drawings

1.7 Attachments

None.

1.8 Approvals

Date Created				Signature
Date Approved:		Approved By:		
Date Amended:		Approved By:		
Date Amended:		Approved By:		
Date Next Review		Reviewed By:		
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RWPS – Wet Well Cleaning

1.1 Purpose

The purpose of this Standard Operating Procedure (SOP) is to:

- describe the general procedures for cleaning the Wet Well.

1.2 Precautions

Known precautions include:

- Operators should be aware of which areas of the pump station are Confined Spaces and should follow confined space entry procedures if it is necessary to enter those areas.
- The Wet Well is a higher hazard area and operators should provide ventilation and ensure the ventilation system is operating at full capacity during Wet Well cleaning. Cleaning procedures should not be initiated if the portable ventilation system is not available.
- Wet Well cleaning shall only occur during periods when water transfer is not required or during non-open water period on Lake Qikiqtalik.

1.3 Equipment

Major equipment that will assist with this procedure includes:

- Portable Ventilation equipment

1.4 Advance Preparation

Advance preparations that assist this procedure include:

- Cleaning should be conducted during periods when water transfer is not required or during non-open water period on Lake Qikiqtalik.
- Confirm that the inlet slide gate is closed.

1.5 Cleaning Procedure

The following steps should be followed for Wet Well cleaning.

1.5.1 Manual Hose Down

- Lower the Wet Well level below the normal operating level to expose the walls within the Wet Well.

1.5.2 Wastewater Wet Well Cleaning

- Turn the station into manual operating mode and turn pumps off.
- Close inlet slide gate to stop the flow to the Wet Well.
- Start Pump 1 or Pump 2 in manual mode to minimum speed to draw down the Wet Well level.
- When the pump loses prime the cleaning cycle stops.
- Open the inlet slide gate and allow the Wet Well to fill again.

1.6 References

- Supplier Operation and Maintenance Manuals

- Facility drawings

1.7 Attachments

None.

1.8 Approvals

Date Created				Signature
Date Approved:		Approved By:		
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Date Next Review		Reviewed By:		
Supersedes:				

RWPS Transducer and Float Maintenance

1.1 Purpose

The purpose of this Standard Operating Procedure (SOP) is to:

- Discuss the procedures for maintenance of the transducer and floats in the Wet Well.

1.2 Precautions

Known precautions include:

- Potential exposure to lake water.

1.3 Equipment

Major equipment that will assist with this procedure includes:

- N/A

1.4 Advance Preparation

- N/A

1.5 Procedure

The transducer and float devices in the Wet Well shall be maintained on an operator determined basis. Refer to the supplier operation and maintenance manuals for the maintenance procedures to be followed or contact the equipment supplier directly for specific questions.

1.6 References

- Supplier Operation and Maintenance Manuals

1.7 Attachments

None.

1.8 Approvals

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RWPS Forcemain Maintenance

1.1 Purpose

The purpose of this Standard Operating Procedure (SOP) is to:

- Describe the procedure for performing maintenance on the forcemain.

1.2 Precautions

Known precautions include:

- Be aware of potential for a pressurized forcemain.
- Be aware of potential confined spaces.

1.3 Equipment

Major equipment that will assist with this procedure includes:

- N/A

1.4 Advance Preparation

- N/A

1.5 Procedure

- Close isolation valve to isolate the forcemain from the pump station.

1.6 References

- Facility drawings

1.7 Attachments

None.

1.8 Approvals

Date Created				Signature
Date Approved:		Approved By:		
Date Amended:		Approved By:		
Date Amended:		Approved By:		
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RWPS Flow Meter Maintenance, Removal and Reinstallation

1.1 Purpose

The purpose of this Standard Operating Procedure (SOP) is to:

- describe the general procedures to perform maintenance, remove, and re-install the station flow meter.

1.2 Precautions

Known precautions include:

- Potential exposure to lake water.

1.3 Equipment

Major equipment that will assist with this procedure includes:

- N/A

1.4 Advance Preparation

- N/A

1.5 Procedure

1.5.1 Removal and Re-installation

The following procedure shall only be completed during periods when water transfer is not required or during non-open water period on Lake Qikiqtalik.

The following steps should be followed for performing removing and re-installing the station discharge flow meter.

- Shut off and lock out the raw water pumps.
- Drain the forcemain and piping into the wet well by opening the drain valve.
- Perform removal and re-installation procedures per the supplier operation and maintenance manual.
- Follow the SOP for start up of the RWPS.

1.5.2 Maintenance

Perform maintenance on the flow meter per the supplier operation and maintenance manual or contact the supplier directly. If the flowmeter must be removed for maintenance activities, refer to the above section for removal and re-installation procedures.

1.6 References

- Supplier Operation and Maintenance Manuals
- Facility drawings

1.7 Attachments

None.

1.8 Approvals

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RWPS Alarms

1.1 Purpose

The purpose of this Standard Operating Procedure (SOP) is to:

- All station alarms and resolution procedures

1.2 Precautions

Known precautions include:

- N/A

1.3 Equipment

Major equipment that will assist with this procedure includes:

- N/A

1.4 Advance Preparation

- N/A

1.5 General

Refer to a list of station alarms and respective resolution procedures below:

Tag	Description	Resolution Procedure
	Pump 1 Failure	Check the pump, refer to the equipment manual or call for service.
	Pump 2 Failure	Check the pump, refer to the equipment manual or call for service.
	Pump 3 Failure	Check the pump, refer to the equipment manual or call for service.
	PLC Power Alarm	Refer to the PLC operation and maintenance manual or contact the PLC supplier directly.
LT-1	Loss of Echo Alarm to Auto Dialer	Refer to the Hydroranger operation and maintenance manual or contact the supplier directly.
	Illegal Entry Alarm	Call Police
	Pump Station Door Limit Switch Alarm to Auto Dialer	Call Police
	Utility Power Failure	Check station and ensure standby power generator is operating and has sufficient fuel.

1.6 References

- Supplier Operation and Maintenance Manuals

- Facility drawings

1.7 Attachments

None.

1.8 Approvals

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