Report on

LAKE GERALDINE DAM

Operations, Maintenance & Surveillance Manual

Iqaluit, Nunavut

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Meco Project Number: 10486

LAKE GERALDINE DAM

OPERATIONS, MAINTENANCE & SURVEILLANCE MANUAL

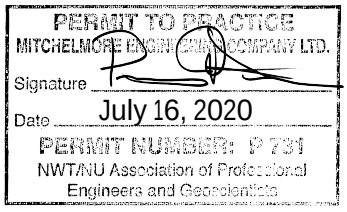
Prepared for

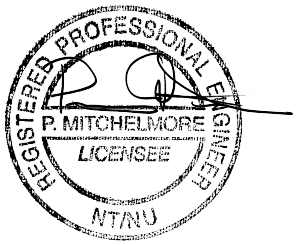
CITY OF IQALUIT

901 Nunavut Drive
P.O. Box 460
Iqaluit, Nunavut X0A 0H0

Tel: (867) 979-5600

Attention : Amy Elgersma
Email: A.Elgersma@city.iqaluit.ca





Prepared by

MITCHELMORE ENGINEERING COMPANY LIMITED

109 Ilsley Avenue, Unit 14
Dartmouth, NS | B3B 1S8

Tel: (902) 444-3131
Fax: (902) 404-7777

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Reviewed By:	Perry Mitchelmore, P.Eng.		

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PURPOSE

The instructions and information found in this manual are intended to document safe operation, maintenance and surveillance (OMS) practices for Lake Geraldine Dam. This manual is a component of the Lake Geraldine Dam Safety Management Plan (DSMP) and should be read in conjunction with the DSMP.

The OMS manual is not a comprehensive overview of structural safety at the facility. Unusual or unanticipated events may occur that impact the safety and integrity of Lake Geraldine Dam. The OMS manual provides tools to manage both anticipated and unanticipated events through planned activities. It is the responsibility of the City of Iqaluit Water Utility to monitor such events and to take timely and appropriate actions to minimize risk to the dam and related structures.

This manual is a component of the Lake Geraldine Dam Safety Management Plan.

The OMS manual will establish a framework with respect to management of Lake Geraldine Dam through effective procedures. To this end, the OMS manual will detail the following:

- **Identify roles and responsibilities of dam safety and operational personnel**
- **Procedures for operation, maintenance and surveillance**
- **Requirements for analysis and documentation of performance**

1 INTRODUCTION

Operations, maintenance and surveillance activities are an integral part ensuring safe dam performance consistent with design intent. An effective OMS program will improve overall safety of a dam and its associated structures while improper operation and inadequate maintenance may result in conditions that impact the life expectancy of a dam, its ability to respond to extreme events or increase the likelihood of dam failure. Inadequate surveillance may result in lost opportunities for early identification of potential problems at the dam.

Procedures minimize the impact of operations on the public, the environment, other stakeholders and licensed users of the water system. Maintenance activities described are prioritized, completed and documented. Surveillance includes visual inspections and instrumentation monitoring, used as a means to check whether the dam is performing satisfactorily against criteria established during the dam design. Operations, maintenance and surveillance records are retained in such a way that they can be periodically reviewed for trends related to potential issues or impacts.

This manual provides a management system framework that will be applied to ensure ongoing planning, implementation, and improvement of operation, maintenance and surveillance activities. The City of Iqaluit water supply is located at Lake Geraldine, as presented in Figure 1.1.

Lake Geraldine is retained by a reinforced concrete central core wall rockfill dam with a central, reinforced concrete spillway for flood dissipation. The original dam was constructed in 1958 for the Department of National Defense but the structure has been raised four times already as a means of increasing capacity (available storage). The original dam had a crest elevation of 107.88 m compared with the current crest elevation of 112.28 m. The current reservoir volume is 1.3 Mm^3 with a 15.3 m long spillway at sill elevation 111.33 m. Reservoir data is summarized in Table 1.1. Basic dam geometry is summarized in Table 1.2. Raw water is supplied from the reservoir through a 450 mm diameter pipe which feeds the water treatment plant approximately 200 metres downstream.

Figure 1.1 Location of Dam

Table 1.1 Lake Geraldine Storage at Selected Lake Level Elevations

Lake Level Elevation (m)	Storage (1000 m^3)	Remark
101.30	55	Bedrock at Base of Concrete Dam and Spillway
106.50	611	Bedrock at North and Central Berm
106.68	644	1985 Spillway Elevation
107.60	839	Bedrock at South Berm
108.00	930	Central Berm Base Elevation
109.33	1280	1995 Spillway Elevation
111.33	1963	2006 (existing) Spillway Elevation
111.40	1993	Sunny Day Concrete Dam Failure
112.28	2349	North and South Concrete Dam Crest Elevation
112.50	2442	North, Central, and South Berm Crest Elevation
112.58	2479	Wet Weather Failure - Concrete Dam Failure

Table 1.2 Berm and Dam Segment Geometry

Berm/Dam Segment	Length (m)	Crest Elevation (m)	Base Elevation (m)	Bedrock Elevation (m)	Height of Berm/Dam (m)
North Berm	55.5	112.5	108.3	106.5	4.3
Central Berm	78.0	112.5	108.0	106.5	4.5
North Dam	13.3	112.3	102.6	101.3	11.0
Spillway	15.3	111.3	101.6	101.3	10.0
South Dam	39.1	112.3	102.6	101.3	11.0
South Berm	68.5	112.5	111.5	107.6	1.0

The components of the dam are shown in Figure 1.2.

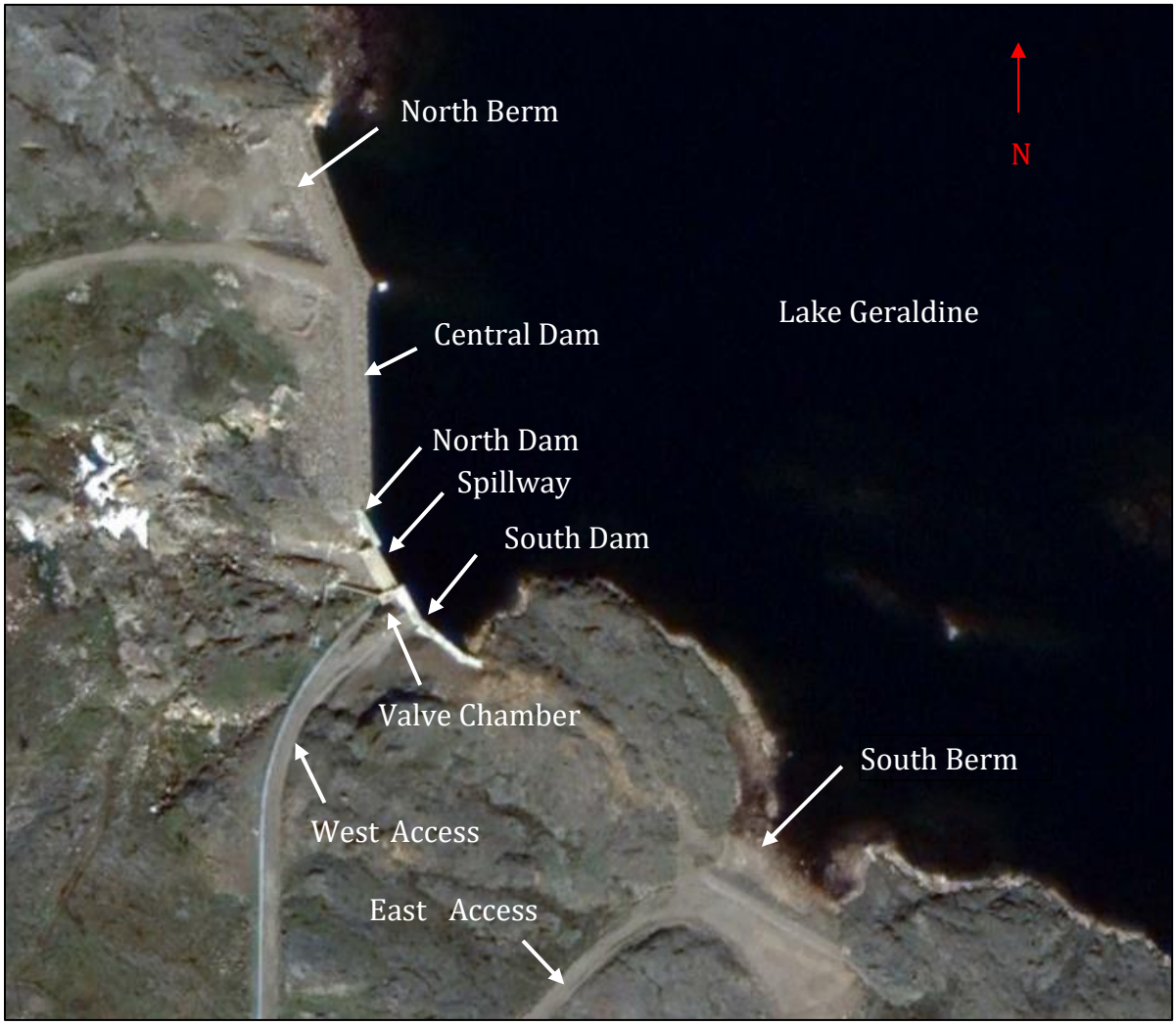


Figure 1.2 – Dam Components

2 OPERATIONS

2.1 GENERAL

The following represents general guidelines for operation of the dam and associated appurtenances at Lake Geraldine Dam. The procedures identified below do not represent or include detailed operating procedures related to specific equipment associated with operations. Where required, detailed operating procedures are developed in a manner that is consistent with recommended manufacturers' operating and maintenance procedures/manuals and industry accepted safe work practices and performed by properly trained staff.

2.2 STANDARD OPERATING PROCEDURES (SOPS)

Elements that support the proper function of the dam require general operational activities and procedures. Procedures to be developed address:

- Access roads to the dam (general grading and stability)
- Grating at inlet to water supply line to be clear of debris
- Confined space access to valve chamber (access port) which controls flow to WTP
- Valve operation
- Hot water return line to reservoir
- CCTV acquisition of submerged inlet
- Transmission main ventilation valves

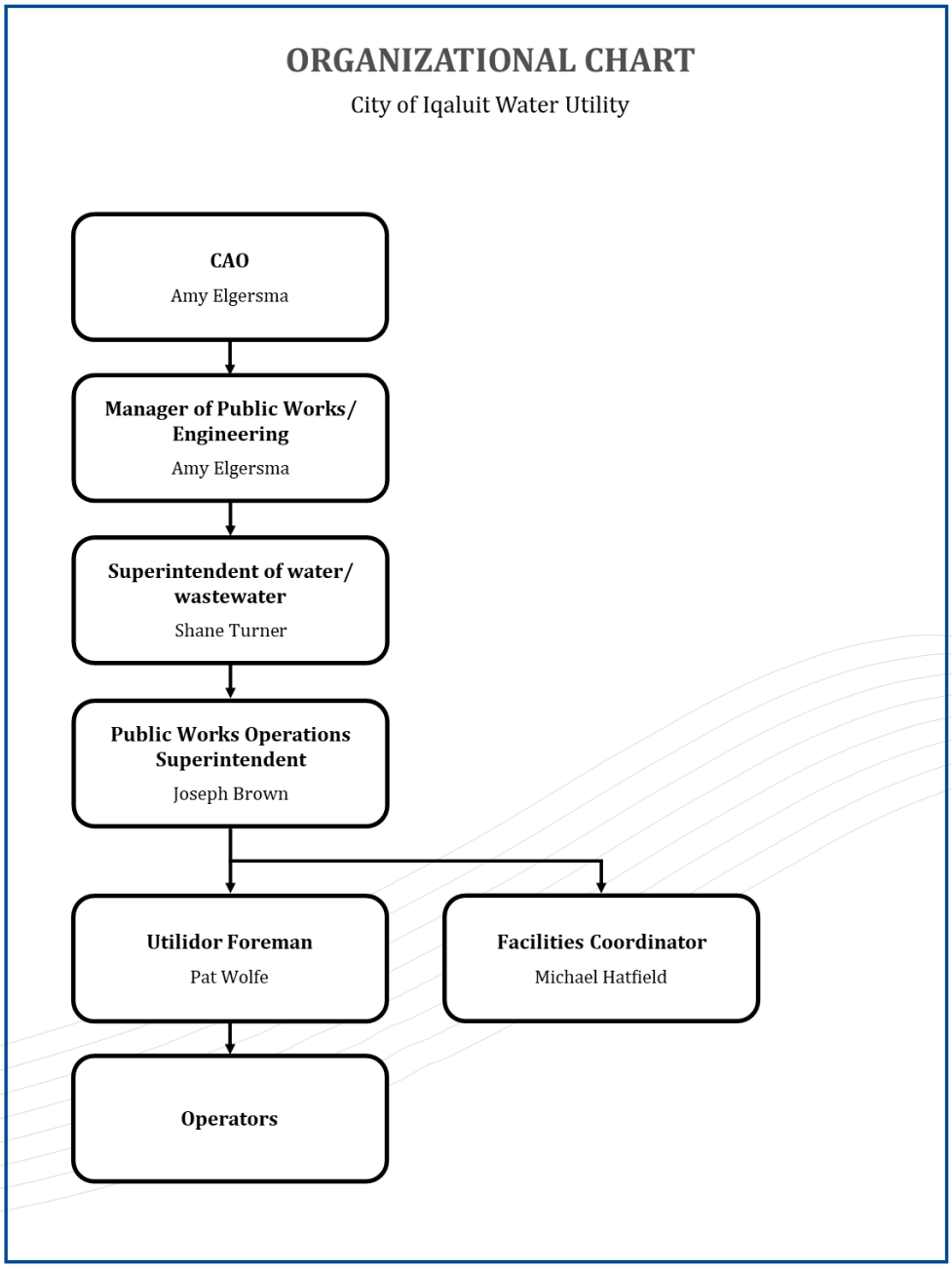
2.3 ROLES AND RESPONSIBILITIES

There are eight (8) staff positions identified at the City of Iqaluit Water Utility with the following responsibilities.

- The Chief Administrative Officer is responsible for safe operation, maintenance and surveillance of the Lake Geraldine Dam
- The Director of Engineering and Public Works is responsible for the management in support of the safe operation of the Lake Geraldine Dam
- The Superintendent of Water/Wastewater is responsible for infrastructure in operation of the Lake Geraldine Dam.
- The Public Works Operation Superintendent is responsible for assignment and operation of the dam, intake line and WTP.

- The Utilidor Foreman is responsible for maintenance, preventative maintenance and inspection activities at the site.
- The four (4) plant operators are responsible for operation of the dam, intake control valve and supply line that provides raw water to the water treatment plant and day to day operation, site inspections, public access, incident reporting, general record keeping and maintaining the permanent record file.

Figure 2.1 City of Iqaluit Utility Organizational Chart



The City of Iqaluit Water Utility is licensed for water withdrawal of up to 3013 m^3/day. The current withdraw rate is closer to 2,500 m^3/day (M. Hatfield, Nov 26, 2019). There is no regulatory requirement for an environmental flow from the reservoir to the downstream drainage channel. A copy of the Water Withdrawal Permit as issued by the Government of Nunavut is located in Appendix B. The City of Iqaluit Water Utility's purpose is to provide raw water to the treatment plant, provide treatment in accordance with the Federal Guidelines for CDWQ and to provide a potable supply to City users.

2.4 OPERATING PROCEDURES

Operating procedures are recommended for five (5) activation levels as outlined in Table 2.1.

2.4.1 NORMAL OPERATIONS

The Lake Geraldine dam requires limited attention from staff during normal operations. Normal operations are defined in the emergency preparedness plan (EPP) as when the structure is performing as intended and the reservoir water level is below elevation 111.40 m, or approximately 0.07 m or surcharge in the reservoir.

Components to facilitate release of raw water are limited to a control valve at the inlet chamber to the transmission main that feeds the water treatment plant. Inflow that exceeds this capacity will flow over the concrete spillway or be stored in the reservoir if the reservoir water level is below the spillway sill.

The gate valve is maintained in an open position to provide flow for the water treatment plant. The gate valve controls supply to the water treatment plant and is normally in the fully open position. The valve position can only be adjusted manually at the chamber adjacent to the spillway. The valve chamber is a confined space and all entries require an entry plan.

In the condition where the valve is to be closed, the operator will verify there is adequate ventilation capacity downstream of the valve to prevent a vacuum in the pipe. Prior to operation of the valve, operators will visually inspect the reservoir and intake area for debris or ice buildup, remove debris and open any vents.

Table 2.1 Reservoir Operation Activation levels

Activation Level	Condition	
	Hydrologic Event	**Other Events**
NORMAL CONDITION (Green)	Reservoir is at or below Elev. 111.33 m. No weather events forecast.	Not Applicable
FLOOD SITUATION (Blue) Out-of-bank water levels	a) Reservoir level at Elev 111.33 m with heavy snowpack. Rain forecast for 15 mm or more in 24 hours. b) Reservoir level at or above Elev 111.40 m.	Not applicable.
DAM ALERT (Yellow) Abnormal condition poses a threat	a) Reservoir Level at or above Elev 111.60 m due to snowmelt only. Rain forecast for 15 mm or more in 24 hours. b) Annual snowfall 2.0x more than normal. Reservoir at (111.33 m).	Abnormal condition that may affect dam performance has been identified, e.g.: • 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 EMERGENCY (Orange) Potential dam failure is developing	a) Reservoir Level at or above Elev 111.90 m. Rain and/or snowmelt may result in additional flow. b) At elevated reservoir levels but is not eroding the slope and level is expected to recede.	Leakage downstream of the rockfill dam is escalating and is brown and silt laden. Rockfill dam has suddenly deformed and sinkholes and depressions are observed, associated with leakage. Minor displacement of the concrete dam/spillway and associated leakage. Abnormal condition creates threat to dam safety, requiring immediate attention. If implemented, remediation is expected to be effective.
DAM FAILURE (Red) Dam failure is imminent or has occurred	a) Reservoir level is expected to overtop concrete at the gravity dam, i.e., Elev 112.33 m. b) Rockfill Dam overtopping is occurring or imminent.	Upstream water level is decreasing rapidly, indicating an internal dam failure. Concrete dam has actively displaced and leakage is overwhelming the spillway channel. Rockfill dam is deforming and leakage is excessive and escalating. Failure of dam is occurring or imminent.

2.4.2 UNUSUAL OPERATIONS

The Lake Geraldine dam may require more active attention from staff during unusual operations. Unusual operations are defined as (1) Flood Operations - the structure is spilling with the reservoir water level up to elevation 111.50 m, and (2) Dam Alert – an abnormal condition that poses a threat to the dam. Unusual periods do not include emergency operations.

2.4.2.1 FLOOD CONDITION

Flood operations is nominally defined as the downstream flow when the reservoir elevation exceeds elevation 111.40 m (AMEC 2012). Flooding may also be anticipated with there is an above average snowpack in the watershed. The hydrological environment indicates that an annual snowfall about two-times the average annual snow, or about 400 cm, is likely to cause flooding.

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 are considered appropriate:

- Site access roads may require grading and/or clearing to allow for access and debris removal;
- The valve chamber will require snow removal/clearing;
- The spillway channel may need to be cleared to control flood discharge and for visual observation;
- Snow and ice removal at the spillway to reinstate the discharge capacity; and
- Ice build-up in the reservoir may require slotting to promote brake-up.

2.4.2.2 DAM ALERT

A dam alert will occur when an abnormal observation has the potential to threat the security of the dam. Abnormal conditions, other than flooding, can occur at any time and may be observed by operators or reported by the public. These 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 rockfill dam;
- Increased flow in the spillway channel while the reservoir is below the spillway sill;

- Displacement, cracking and/or deformation of the concrete dam; and
- 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 (ERP) for Lake Geraldine to establish the response protocol;
- Conduct independent investigations of the incident to qualify the risk to dm failure;
- Prepare a remedial plan to address the observed condition and restore the dam;
- Site access roads may require grading and/or clearing to allow for access and debris removal;
- Review the EPP and ERP to prepare for a potential escalation to emergency operations.

2.4.3 EMERGENCY OPERATIONS

Emergency periods are defined as periods when the dam is under duress or an incident has occurred that places the dam integrity at risk. The Emergency Response Plan (ERP) for the City of Iqaluit outlines the decision-making framework for emergency operations. The objective of the ERP is to operate the dam in a manner that manages the risk in a manner that reduces the risk of a dam collapse. Under these conditions, measures will be in place to undertake the following:

- A readily available and accessible stockpile of rock fill for re-enforcing the existing rockfill embankment 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;
- Access to monitoring equipment for lake levels (CCTV and staff gauge);
- Tools to remove debris buildup / cut / break ice;
- Equipment to move material for berm construction around WTP and on access road.

2.5 FLOW CONTROL

The water treatment plant receives water from Lake Geraldine via a 375 mm diameter line that extends from the dam, through an access chamber to the plant. There are no controls at the intake structure. There are valves situated within the valve chamber situated at the base of the dam. The inline gate valve is operated manually by accessing the chamber. Operations staff indicate that in the event of poor raw water quality in the reservoir they have the ability to close off the valve. It is also understood that the water treatment plant also has an automatic valve that can be closed when requirements arise. This is done through the HTML and plant operations.

There are no staff gauges at the dam to observe levels within the lake. Facilities Management has indicated that a SCADA based monitoring system linked with the WTP will incorporate a camera positioned at the Dam to observe the levels at a newly placed staff gauge. It is also understood that automation may employ a level sensor to provide real time water level measurement. These activities are planned for the near future.

For the past two years the City of Iqaluit has relied on the diversion of water from the adjacent Apex River watershed to supplement low reservoir lake levels such that water supply is sustained over the winter months. There are procedures in place to monitor, report and act on events related to reservoir high water levels and dam overtopping. These procedures are outlined in the Emergency Response Plan and directly follow the CDA guidelines for response in the event of Normal, Flood, Dam Alert, Dam Emergency and Dam Failure operating levels.

2.6 RECORDS (LOGS)

The water treatment plant operator(s) is responsible to document/record weekly reservoir levels and submit to supervisors for review. Currently, measurements are manually taken at the reservoir to determine levels. A standardized log sheet with the date, weather, and observations will be signed and logged after each inspection.

3 MAINTENANCE

The following represents general guidelines for maintenance of the dam and associated appurtenances at Lake Geraldine. The procedures detailed below do not represent or include detailed procedures related to specific maintenance activities. Where required, detailed maintenance procedures are developed in a manner that is consistent with recommended manufacturers operating and maintenance procedures/manuals and/or accepted industry safe work practices and performed by properly trained staff. All structures, machinery, and equipment necessary for the safe and reliable operation of the Lake Geraldine Dam shall be maintained in good working order.

3.1 MAINTENANCE PROGRAMS

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 provides both types of maintenance. Records of all maintenance activities are maintained within a permanent record file with a copy issued to the Director of Public Works.

3.2 CONCRETE DAM & SPILLWAY

Preventative maintenance items at the concrete spillway will 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 away from the dam and above the flood water level;
- Removal of any debris from winter ice that has been placed by the public when using the reservoir for recreational activities; and
- Slot-cutting of ice build-up on the upstream side of the dam.

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

- Maintenance of the concrete finish, filling of leaks with grout;
- Removal of snow and ice build-up at the spillway crest; and
- Removal of any obstructions on the upstream or downstream channel systems.

3.3 EMBANKMENT STRUCTURES

Preventative maintenance items will include the following:

- The crest is regularly graded to provide positive drainage off the crest. Care is taken to ensure that successive grading operations do not cause a lowering of the crest elevation; and
- Debris is removed from the upstream slope of the dam semi-annually.

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; and
- Slumps or depressions are investigated and re-filled.

3.4 INTAKE STRUCTURE

Preventative maintenance items will include the following:

- Remove any buildup of sediment and debris around intake structure
- Remove scale and buildup on intake screen

3.5 FLOW CONTROL

Maintenance at the inline valve control chamber, the transmission line and at the WTP inlet control valve require:

- Maintain access to valve chamber at all times, including snow removal at chamber and equipment access road.
- A safe and permanent access ladder on site for use at the chamber
- Access hatch opening tools (pry bar and lifting device) at the site within a dry enclosed container.
- Cleaning at the 375 mm diameter valve which includes
    - Stem and wheel will be lubricated to allow free movement
    - Removal and treatment of rust buildup
- Operating the valve through its full operating range (fully closed to fully open to fully closed).

- Visually inspecting the valve with care taken to check the following:
    - Inspect stem threads and lift nut threads for wear. Replace the thrust nut as soon as excessive wear is noted.
    - Valve stem will be cleaned and greased on a regular schedule.
    - All fasteners will be checked for correct tightening.
    - The valve chamber access hatch will be cleaned, have handles installed and security locking bolts to keep the cover in place while avoiding vandalism.
- At the water treatment plant conduct maintenance on inlet control valves in accordance with manufacturer recommendations.
- Perform regular calibration checks on flow monitoring devices in accordance with manufacturer specifications or as noted in supplier O&M Manual.
- Conduct regular maintenance checks on transmission line including observation and repair of any noted leaks and drips observed at pipe joints.
- Check daily, the functionality of hot water re-circulating line.
- Repair or replace damaged pipe shield as necessary.

3.6 INFRASTRUCTURE (ACCESS, UTILITIES)

The only utility at the Geraldine Dam site is the heated water line which keeps the inflow pipe from freezing. Both the transmission main and heated water line are situated at grade adjacent the easterly dam access road. A galvanized surround covers both lines.

The westerly access road may sustain damage from spring runoff and will be regraded each spring. This access road is situated adjacent the floodplain, which during flooding conditions may be inundated. The easterly access road to the heat plant and WTP is outside of the floodplain, however prone to local runoff. Both access roads will be graded and maintained regularly. Inspection and maintenance reports are to be included in Permanent Record File.

3.7 MAINTENANCE SCHEDULE

The following table identifies the components of the Dam infrastructure, actions required and when maintenance should occur.

Table 3.1 Maintenance Schedule

Item	Action Item	Occurrence	Type
Concrete Dam	Remove Floating Debris from Reservoir	As Required	PM
	Removal of Debris from Ice	As Required	PM
	Slot-Cut Ice	As Required	PM
Embankment Dam	Removal of upstream debris	As Required	PM
	Grade crest	Semi -Annual	PM
Intake	Clean trash rack, remove build-up	As Required	Incident
Control Valve	Exercise Valve through full operating cycle.	Annual	PM
	Inspect Valve chamber and components.	Annual	PM
Control Valve	Clean, treat, lubricate	Annual	PM
Flow Meter	Calibrate	As Specified	PM
Transmission Main	Maintain access, replace or repair shield, check hot-water circulation	As Required	Incident

3.8 MAINTENANCE RECORDS

Maintenance activities are recorded in a Permanent Record File (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, maintenance and surveillance activities are to be recorded in the PRF.

4 SURVEILLANCE

The City of Iqaluit uses a performance-based surveillance program that includes inspection and monitoring instrumentation. 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 are used to:

1. Observing performance of known anomalies;
2. Predicting future performance;
3. Establishing baseline data; and
4. Refining future designs.

4.1 INSPECTIONS

Lake Geraldine dams are inspected regularly so that deficiencies can be identified at an early stage and corrective actions are taken in a timely manner. Inspections are to be conducted at different times of the year and under different reservoir levels. The City of Iqaluit uses four (4) levels of inspection, as outlined in Table 4.1.

Table 4.4.1 Lake Geraldine Dam – Inspection Schedule

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

It is the responsibility of the Director of Public Works to ensure that inspection of the Lake Geraldine Dam is completed and that all reports are reviewed by a competent engineer. The Facilities Coordinator will prepare an action plan for any maintenance work required, or additional monitoring which is to be approved by the Director of Public Works or CAO.

Currently, the existing work order process is being used for maintenance work designation, with the anticipation of a new process being developed by the Superintendent of Water /Wastewater. This plan is to be approved by the Director of Public Works.

4.1.1 ROUTINE VISUAL INSPECTIONS

Routine inspections are performed by the Plant Operator.

A routine inspection consists of observations of the general appearance and functioning of the dam and spillway and is intended to identify conditions which might indicate changes in a dam's performance. 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 will be paid to items noted in past reports.

Reporting for routine inspections involves completing the Inspection Checklist in Appendix A. It is the responsibility of the Superintendent of Operations to review and sign off the inspection report.

4.1.2 FORMAL DAM SAFETY INSPECTIONS (DSI'S)

Formal inspections are performed by the Director of Engineering, their designate or an outside 3rd party professional engineer. In general, a formal inspection will be conducted by a professional engineer, or a technically trained person of similar ability.

Formal inspections will be performed annually and 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 with any significant condition changes from previous inspections being highlighted. During field examination of the dam, its spillway and intake, or selected features and components, attention shall be paid to any issues outlined in previous reports.

A Dam Safety Inspection (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's, and identify actions required. The

report shall be supplemented with photos. It should also include an assessment of the severity of the observed anomalies as well as recommendations for maintenance, repairs, investigation or additional surveillance. The report will be reviewed and signed off by the Director of Public Works and then filed in the appropriate location. The inspection details shall be included in the Permanent Record File.

4.1.3 DAM SAFETY REVIEW

A Dam Safety Review (DSR) is a formal procedure defined in the Canadian Dam Association (CDA) and Dam Safety Guidelines (2013) which is typically completed by independent professional engineers with specific training in dam safety. It is the responsibility of the Director of Public Works and Superintendent of Operations to review the DSR 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.

4.1.4 SPECIAL INSPECTIONS (UNUSUAL CONDITIONS)

In addition to regularly scheduled inspections, dams are inspected during, if possible, and after an unusual or extreme event such as flood event approaching the IDF, 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 alert should be followed, as outlined in the emergency response plan (RRP) for Lake Geraldine. 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 that anomalies are identified during routine or formal inspections that may constitute a possible dam safety issue, an inspection will be conducted immediately by a professional engineer trained in dam 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.

4.2 INSTRUMENTATION AND MONITORING

The City of Iqaluit recently installed instrumentation at Lake Geraldine Dam to monitor porewater pressures and temperatures in the subsurface. Instrumentation locations are identified in Figure 4-1. Instrumentation details are summarized in Table 4.2.

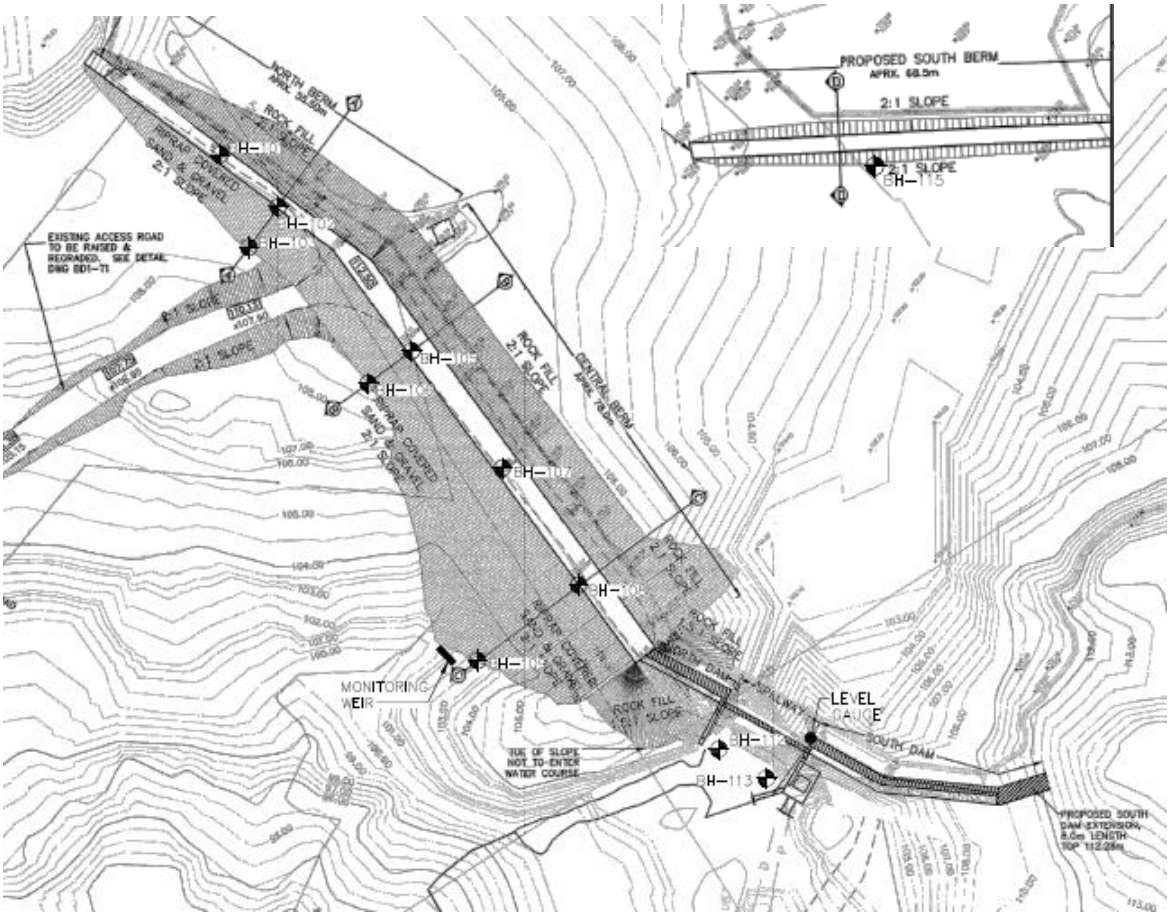


Figure 4-1 Borehole/Instrumentation Locations

Otherwise, the City of Iqaluit does not have a water level staff gauge at the reservoir but there is a water level gauge at the Environment Canada station located in the reservoir which may be

accessible. The EPP recommends that automated equipment be installed to monitor (flow rate, water level and CCTV). These are being considered but have not been installed to date.

Table 4.2 Instrumentation Installation Details

Location	Instrumentation Type	Elevation (m)	
		Top	Bottom
BH101	Piezometer P101-1	106.3	105.9
BH102	Thermistor T102-1	112.4	97.1
BH103	Thermistor T103-1	108.5	100.6
BH105	Thermistor T105-1	112.5	97.3
BH106	Thermistor T106-1	108.1	100.2
BH107	Piezometer P107-1	103.7	103.2
BH108	Thermistor T108-1	112.5	97.2
BH109	Thermistor T109-1	103.0	95.1
BH112	Piezometer P112-1	99.3	98.8
BH113	Piezometer P113-1	99.4	98.9
	Piezometer P113-2	98.2	97.7
BH115	Thermistor T115-1	112.1	104.1

4.3 INSPECTION OF DAM COMPONENTS

Inspections are to be conducted as outlined below. An inspection sheet for the Lake Geraldine Dam is included in Appendix A, to facilitate effective surveillance. Also included in Appendix A is a Nunavut Environment publication on inspection of dams, which can be used as guidance for operators performing routine inspections.

4.3.1 ROCKFILL DAM INSPECTION

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

Crest

- Longitudinal Cracking: indication of local instability, differential settlement and movement between adjacent segments of the dam;

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

Upstream Slope

- Beaching;
- Deterioration of riprap;
- Displacement of riprap; and
- 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 in varying degrees. The most potentially dangerous condition is the appearance of seepage on the downstream face at the toe of the dam. 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; and
- Standing or ponding water at the downstream toe, which can cause slope instability.

Abutments

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

Downstream Toe

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

4.3.2 CONCRETE SPILLWAY

Concrete surfaces will be visually inspected for spalling and/or deterioration due to weathering, leaking at repaired cracks, unusual or extreme stresses, alkali or other chemical attack, erosion, vandalism or other destructive forces. Structural problems may be indicated by cracking, exposure of reinforcing bars, large areas of broken out concrete, misalignment at joints, undermining and settlement in the structure. Rust stains that are noted on the concrete may indicate the internal corrosion and deterioration of reinforcing steel is occurring.

Obstruction

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.

Spillway Channel Erosion Protection

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.

4.3.3 VALVE INSPECTION

The inlet vertical bar screen and concrete control chamber/valve will be inspected annually. The bar screen can be inspected using a GoPro watertight camera attached to a rod which can be submerged from the side of a small boat. The main items of inspection are:

- Lack of readily accessible operating controls;
- Rusted or non-lubricated valve stem;
- Debris lodged in the intake bar structure;
- Vandalism of the valve chamber and valve components; and
- Ice damage.

4.4 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 the structure. For convenience, both the operation and maintenance and surveillance activities will be recorded in the PRF.

5 PERMANENT RECORD FILE

A Permanent Record File (PRF) has been developed by others which has historical information on the dam and the related activities that have occurred since construction. The primary purpose of the PRF is to ensure operations, maintenance and surveillance activities and associated decisions are recorded. It also provides a means of ensuring conformance to established procedures. The dam PRF shall be updated weekly with the following information related to dam operation, maintenance and surveillance activities.

- Date/Time.
- Operator/staff on duty.
- Weather.
- Discharges (spillway and embankments) and reservoir levels.
- Equipment testing.
- Planned and unplanned maintenance activities.
- Incident details (Incidents that possibly impact dam 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 dam OMS issues.
- Handwritten notes shall be legible and well organized.

Appendix A

Inspection Documents

Lake Geraldine Dam Routine Inspection Checklist

Name of Inspector: **Date of Inspection:**
Weather:

Instruction to Inspector:
Inspector to walk the crest and the base on the concrete dam, north, centre and south berms to visually inspect and record findings below. Where changes are observed, record observations and recover a photograph. Report and photograph conditions highlighting anything that seems new or unusual.

Description	Yes	No	Comment
General Observations			
Presence of snow/ ice on ground			
Presence of snow/ ice on Lake			
Vandalism/garbage			
Gates locked			
Concrete Dam			
New cracking / spalling visible along the top of the concrete dam			
New cracking / spalling visible along the downstream side of the concrete dam			
Presence of active leaks through concrete			
Deteriorated/leaking sealant			
Presence of active leaks beneath concrete dam			
Misalignment of sections of the concrete wall and spillway			
Centre Berm			
Upstream Slope- Slough, slides or bulges			
Upstream Slope- Gravel washout			
Upstream Slope- Displaced Riprap			

Lake Geraldine Dam Routine Inspection Checklist

Description	Yes	No	Comment
Downstream Slope- Slough, slides or bulges			
Downstream Slope- Gravel washout			
Downstream Slope- Displaced Riprap			
Downstream Slope- Wet area of seepage at base of slope			
Top of Berm- Sinkhole			
Top of Berm- Gravel washout			
North Berm			
Upstream Slope- Slough, slides or bulges			
Upstream Slope- Gravel washout			
Upstream Slope- Displaced Riprap			
Downstream Slope- Slough, slides or bulges			
Downstream Slope- Gravel washout			
Downstream Slope- Displaced Riprap			
Downstream Slope- Wet area of seepage at base of slope			
Top of Berm- Sinkhole			
Top of Berm- Gravel washout			
South Berm			
Upstream Slope- Slough, slides or bulges			
Upstream Slope- Gravel washout			
Upstream Slope- Displaced Riprap			

Lake Geraldine Dam Routine Inspection Checklist

Description	Yes	No	Comment
Downstream Slope- Slough, slides or bulges			
Downstream Slope- Gravel washout			
Downstream Slope- Displaced Riprap			
Downstream Slope- Wet area of seepage at base of slope			
Top of Berm- Sinkhole			
Top of Berm- Gravel washout			

Table 1 Piezometer Data

Date Inspector

Piezometer ID	Water Depth (m)	Comment
BH107		
BH101		
BH112		
BH113 (s)		
BH113 (d)		

Lake Geraldine Dam Routine Inspection Checklist

Table 2 Thermistor Data

Date Inspector: Reviewer Date

Thermistor Bulb	Thermistor ID						
	T1	T2	T3	T4	T5	T6	T7
Air							
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							

Lake Geraldine Dam Routine Inspection Checklist

Lake Geraldine Dam Routine Inspection Checklist

Appendix B

Water Withdrawal Permit

NUNAVUT WATER BOARD

TYPE "A" WATER LICENCE NO. 3AM-IQA1626

TABLE OF CONTENTS

Licence No. 3AM-IQA1626

Pursuant to the Nunavut Waters and Nunavut Surface Rights Tribunal Act and the Agreement Between the Inuit of the Nunavut Settlement Area and Her Majesty the Queen in Right of Canada, the Nunavut Water Board, hereinafter referred to as the Board, hereby grants to the

CITY OF IQALUIT

(Licensee)

P.O. BOX 460 IQALUIT, NU X0A OHO

(Mailing Address)

hereinafter called the Licensee, the right to alter, divert or otherwise use Water or deposit Waste for a period subject to restrictions and conditions contained within this Licence:

Licence Number / Type:	**3AM-IQA1626 / TYPE "A"**
Water Management Area:	**FROBISHER BAY WATERSHED (53)**
Location:	**WITHIN CITY OF IQALUIT'S MUNICIPAL BOUNDARIES, QIKIQTANI REGION, NUNAVUT**
Classification:	**MUNICIPAL UNDERTAKING**
Purpose:	**USE OF WATERS AND DEPOSIT OF WASTE**
Quantity of Water not to be Exceeded:	**1,100,000 CUBIC METRES ANNUALLY**
Date Licence Issuance:	**JUNE 17, 2016**
Expiry of Licence:	**JUNE 16, 2026**

This Licence issued **(Motion Number: 2016-02-P6-14)** and recorded at Goji Haven, Nunavut, includes and is subject to the annexed conditions.

Norman Mike
Nunavut Water Board,
Hearing Chair

APPROVED BY: Minister of Indigenous and Northern Affairs Canada

APPROVAL DATE:

PART A: SCOPE, DEFINITIONS, AND ENFORCEMENT

1. SCOPE

a. This Type "A" Water Licence No. 3AM-IQA1626 ("Replacement and Amended Licence" or "Licence") authorizes the City of Iqaluit ("Licensee" or the "City") to use Water and deposit Waste in support of a Municipal undertaking, as classified under Schedule 1 of the *Regulations*, within the City's municipal boundaries at the following approximate geographic coordinates:

Undertaking	Latitude	Longitude
Overall Extents	63° 50' 56.31" N	68° 39' 49.87" W
	63° 50' 57.30" N	68° 33' 41.94" W
	63° 43' 48.91" N	68° 18' 12.53" W
	63° 41' 06.60" N	68° 18' 18.82" W
	63° 41' 04.08" N	68° 32' 44.20" W
	63° 44' 46.02" N	68° 39' 43.1 0" W
West 40 Landfill	63° 43' 58.15" N	68° 32' 08.54" W
Water Treatment Plant	63° 45' 12.24" N	68° 30' 22.79" W
Wastewater Treatment Plant	63° 44' 45.15" N	68° 32' 19.80" W

The scope of activities, works, and undertakings authorized in accordance with the terms and conditions of this Replacement and Amended Licence is as follows:

a. Use, management, and protection of the Lake Geraldine drainage basin;
b. Management and protection of Waters surrounding the West 40 Landfill site;
c. Management, collection, and monitoring of leachate from the West 40 Landfill site and adjacent Sludge Management Facility;
d. Management of improved drainage works at the West 40 Landfill site;
e. Management, operation, and eventual closure and reclamation of the current West 40 Landfill site and associated solid waste disposal facilities;
f. Upgrades, operation, maintenance, monitoring, and eventual closure and reclamation of a Wastewater Treatment Plant (WWTP);
g. Operation, maintenance, monitoring, and eventual closure and reclamation of a Sludge Management Facility;
h. Operation, maintenance, monitoring and eventual closure and reclamation of a Sewage Lagoon Facility;
i. Implementation of contingency measures for the Wastewater and Landfill management facilities; and
j. Implementation of changes to the monitoring requirements including frequency, parameters, and stations being monitored.

b. This Licence is issued subject to conditions contained herein with respect to the taking of Waters and the depositing of Waste of any type in any Waters or in any place under any

conditions where such Waste or any other Waste that results from the deposits of such Waste may enter any Waters. Whenever new Regulations are made or existing Regulations are amended by the Governor in Council under the Act, or other statutes imposing more stringent conditions relating to the quantity, type or manner under which any such Waste may be so deposited, this Licence shall be deemed to be subject to such requirements; and

c. Compliance with the terms and conditions of this Licence does not absolve the Licensee from the responsibility for compliance with all applicable legislation, guidelines, and directives.

2. DEFINITIONS

a. The Licensee shall refer to Schedule A for definitions of terms used in this Licence.

3. ENFORCEMENT

a. Failure to comply with this Licence shall be a violation of the Act, subjecting the Licensee to the enforcement measures and the penalties provided for in the Act.

b. All inspection and enforcement services regarding this Licence will be provided by Inspectors appointed under the Act.

c. For the purpose of enforcing the terms and conditions of this Licence with respect to the use of Water and deposit or Discharge of Waste in Waters, Inspectors appointed under the Act, hold all powers, privileges, and protections that are conferred upon them by the Act or by other applicable laws.

PART B: GENERAL CONDITIONS

1. The Licensee shall file, with the Board for review, no later than the 31st of March of the year following the calendar year being reported, an Annual Report formulated in accordance with the requirements under Schedule B of this Licence.

2. The Licensee shall maintain a copy of this Licence at the Municipal Office, potable Water Treatment Facility, and the Waste Treatment Facilities at all times.

3. The Licensee shall file an application for renewal of this Licence at least one (1) year prior to the Licence expiry.

4. The Licensee shall, to the satisfaction of an Inspector, install, operate, and maintain metres, devices or other appropriate methods for measuring the volumes of Water used and Waste Discharged or deposited.

5. The Licensee shall post the necessary signs to identify the stations of the Monitoring Program included under Schedule I of this Licence. All signage shall be in the Official Languages of Nunavut.

6. The Licensee shall, for all Plans submitted under this Licence, include a proposed timetable for implementation. Plans submitted cannot be undertaken without subsequent written approval and/or directions from the Board. The Board may alter or modify a Plan if necessary to achieve legislative objectives and will notify the Licensee in writing of acceptance, rejection, or alteration of the Plan.

7. The Licensee shall, for all Plans submitted under this Licence, implement the Plan as approved by the Board in writing.

8. The Licensee shall, within thirty (30) days of notification or within the timeframe specified by the Board, submit for review and/or Board's approval revisions for any plan found to be unacceptable to the Board.

9. Every Plan to be carried out pursuant to the terms and conditions of this Licence shall become a part of the Licence, and any additional terms and conditions imposed upon approval of a Plan by the Board shall also become part of the Licence. All relevant terms and conditions of the Licence should be contemplated in the development of a Plan where appropriate.

10. The Licensee shall review the Plans referred to in this Licence as required by changes in operation and/or technology and modify the Plans accordingly. Revisions to any Plan shall be submitted in the form of an addendum to be included within the Annual Report required under Part B, Item 1, complete with the lists of revisions detailing where significant content changes are made.

11. The Licensee shall immediately report to the NWT/NU 24-Hour Spill Report Line (867-920-8130) any spills of Waste associated with the Undertakings under this Licence including the potable Water Treatment Facility and Waste Treatment Facilities, which are reported to or observed by the Licensee.

12. Any communication with respect to this Licence shall be made in writing to the attention of:

Manager of Licensing
Nunavut Water Board
P. O. Box 119
Goji Haven, NU X0B 1J0
Telephone: (867) 360-6338
Fax: (867) 360-6369
Email: licensing@nwb-oen.ca

13. Any notice made to an Inspector shall be made in writing to the attention of:

Water Resources Officer
Nunavut District, Nunavut Region
P.O. Box 100
Iqaluit, NU X0A 0H0
Telephone: (867) 975-4295
Fax: (867) 979-6445

14. The Licensee shall submit, to the Board for information or as otherwise directed, one (1) paper copy and one (1) electronic copy of all reports, studies, and Plans generated for the works, activities, and undertakings under this Licence. All Reports, studies or Plans submitted to the Board by the Licensee shall include an executive summary in English, Inuktitut, and French.

15. The Licensee shall ensure that any document(s) or correspondence submitted by the Licensee to the Board is received by the Board and maintain on file a copy of the acknowledgment of receipt issued by the Manager of Licensing or his/her designate.

16. This Licence is assignable as provided for in section 44 of the Act.

17. The expiry or cancellation of this Licence does not relieve the Licensee from any obligation imposed by the Licence, or any other regulatory requirement.

PART C: CONDITIONS APPLYING TO SECURITY

1. The Licensee is not required to post reclamation security for the activities, works, and undertakings authorized under this Licence.

PART D: CONDITIONS APPLYING TO THE USE OF WATERS AND WATER MANAGEMENT PLANS

1. The Licensee is authorized to withdraw, from the Lake Geraldine Reservoir at Monitoring Station No. IQA-01, up to 1,100,000 cubic metres of Water annually for the relevant activities, works, and undertakings authorized under the scope of this Licence.

2. The Licensee shall submit to the Board for approval, within sixty (60) days of the Effective Date of the Licence, an updated manual for the potable Water Treatment Facility. The Manual shall be prepared in accordance with relevant aspects of the format outlined in the *Guidelines for the Preparation of an Operation and Maintenance Manual for Sewage and Solid Waste Disposal Facilities in the Northwest Territories* (GNWT, 1996). The manual shall, address among other items, the following:

    a. Purpose of facility;
    b. Site setting;

c. Operational procedures for storage, treatment and distribution of potable Water; Waste generated and hazardous substances associated with the facility; site inspections; and personnel training;
d. Maintenance procedures including equipment servicing;
e. Sampling and monitoring requirements; and
f. Emergency response measures.

3. The Licensee shall equip all freshwater intake structures with screens of appropriate mesh size that meet the requirements of Fisheries and Oceans (DFO) Canada's *Freshwater Intake End-of-Pipe Fish Screen Guidelines* (1995 or the most current) so as to prevent the entrainment of fish and control Water withdrawal rates such that fish do not become impinged within the screens.

4. The Licensee shall undertake Dam Safety Inspections (DSI) and/or Dam Safety Reviews (DSR) of the Lake Geraldine water supply facility in accordance with requirements of the Canadian Dam Association (CDA), *Dam Safety Guidelines* (2007, or the most current version). The Licensee shall submit for the Board's review, within the Annual Report required under Part B, Item 1, the report generated for the DSIs or DSRs along with the Licensee's recommended actions to address any deficiencies identified in the inspections and/or reviews.

5. The Licensee shall not remove any material from below the ordinary High Water Mark of any Water body unless otherwise approved by the Board in writing.

6. The Licensee shall not cause erosion to the banks of any body of Water and shall provide the necessary controls to prevent such erosion.

7. The Licensee shall implement necessary measures to control sediment and erosion prior to and during operations to prevent entry of sediments into Water.

8. The Licensee shall maintain the potable Water Treatment Facility in accordance with applicable guidelines, procedures, and regulations and to the satisfaction of an Inspector.

9. The Licensee shall, as part of any proposal to supplement the Lake Geraldine Reservoir, evaluate the potential impact on freshwater resources, including fish and fish habitat. The results of the evaluation must be included as part of any application to augment the Lake Geraldine Reservoir with Water from proximal water bodies.

PART E: CONDITIONS APPLYING TO THE DEPOSIT OF WASTE AND WASTE MANAGEMENT PLANS

1. The Licensee is authorized to use the Sewage Lagoon Facility and the Wastewater Treatment Plant to treat and dispose of Wastewater generated by the Undertaking authorized under this Licence until such time that the Upgraded Wastewater Treatment Plant authorized by the

Licensee is constructed and commissioned, or as otherwise approved by the Board in writing.

2. The Licensee shall provide written notice to an Inspector and the Board at least ten (10) days prior to any planned Discharges from the Solid Waste Facility, Sewage Lagoon Facility, Wastewater Treatment Plant, and the Upgraded Wastewater Treatment Plant once commissioned.

3. The Licensee shall establish the relevant monitoring stations for the facilities authorized under this Licence in accordance with Schedule I.

4. The Licensee shall ensure that Surface Drainage or surface Water runoff associated with site activities or generated during the construction of any facility designed to withhold, divert, or retain Water or Waste, does not exceed the following Effluent criteria:

Parameter	Maximum Average Concentration	Maximum concentration of Any Grab Sample
Total Suspended Solids (TSS)	50.0 mg/L	100.0 mg/L
pH	Between 6 and 9.	

5. Upon commissioning of the Upgraded Wastewater Treatment Plant, the Sewage Lagoon Facility shall be used as a back-up facility or closed and reclaimed in accordance in Part J, Item 4.

6. The Licensee shall submit to the Board for approval in writing, within four (4) months of the Effective Date of the Licence, an Operation and Maintenance Manual for the Sewage Lagoon Facility that addresses requirements for both the Sewage Lagoon and Sludge Management Facilities. The manual shall be prepared in accordance with the *Guidelines for the Preparation of an Operation and Maintenance Manual for Sewage and Solid Waste Disposal Facilities in the Northwest Territories* (GNWT, 1996).

7. The Licence shall submit to the Board for approval in writing, by December 21, 2018 or as otherwise directed by the Board in writing, an Operations and Maintenance Manual for the Upgraded Wastewater Treatment Plant that incorporates the requirements of Part E, Item 6. The manual shall be prepared in accordance with the *Guidelines for the Preparation of an Operation and Maintenance Manual for Sewage and Solid Waste Disposal Facilities in the Northwest Territories* (GNWT, 1996).

8. The manual referred to in Part E, Item 7 shall supersede the manual referenced in Part E, Item 6, following approval by the Board in writing.

9. The Licensee shall submit to the Board for approval in writing, by December 31, 2018, an updated version of the plan entitled *City of Iqaluit Solid Waste Management Plan*, dated January 2014 that addresses relevant intervener's comments and recommendations made during the licensing process, such as inclusion of details related to future uses of the landfill, timeframe for closure, and ongoing activities within the scope of this Licence.

10. The Licensee shall undertake Dam Safety Inspections (DSI) and/or Dam Safety Reviews (DSR) of the Wastewater Treatment Facilities in accordance with requirements of the Canadian Dam Association (CDA), *Dam Safety Guidelines* (2007, or most current version). The Licensee shall submit for the Board's review, within the Annual Report required under Part B, Item 1, the report generated for the DSIs or DSRs along with the Licensee's recommended actions to address any deficiencies identified in the inspections and/or reviews.

11. The Licensee shall dispose of and contain all municipal solid waste generated by the City at the West 40 Landfill as associated site(s) authorized under this licence or as otherwise approved by the Board in writing.

12. The Licensee shall submit to the Board for approval, within sixty (60) days of the Effective Date of the Licence, an updated Landfill Operation and Maintenance Manual that addresses concerns raised by intervening parties during the licensing process including the following:

    a. Management of Leachate from the facility;
    b. Updated sampling and monitoring requirements; and
    c. Open burning practices.
    d. Ongoing activities within

13. The Licensee shall collect and contain all leachate generated by the West 40 Landfill within the Landfill.

14. The Licensee shall submit to the Board for review, by December 31, 2017, an updated version of the document entitled *West 40 Landfill Drainage Management Review*, dated September 16, 2011, that addresses the concerns raised by intervening parties including information on the absence of permafrost related data.

15. The Inspector may authorize an emergency Discharge ,following the Licensee's written submission to the Inspector and to the Board, at least fifteen (15) days prior to discharge or as instructed by the Inspector, that includes the following information:

    a. Proposed quantity of discharge;
    b. Reason for discharge;
    c. Identification of the Final Discharge Location;
    d. Proposed sampling and analysis to be conducted; and
    e. Proposed mitigation measures to implemented.

16. The Licensee shall submit to the Board and the Inspector for review, within sixty (60) days following any emergency Discharge authorized by the Inspector, a report that includes, among other items, an analysis of results for the emergency Discharge.

17. The Licensee shall maintain the Licensed Facilities to the satisfaction of an Inspector.

18. The Licensee shall remove from the site associated with the undertaking, all Hazardous Wastes, waste oil and non-combustible waste generated through the course of the operation, for disposal at a licensed waste disposal facility.

19. The Licensee shall maintain records of all Waste removed from site and records of confirmation of proper disposal of removed Waste. These records shall be made available to an Inspector or the Board upon request.

PART F: CONDITIONS APPLYING TO CONSTRUCTION

1. The Licensee shall, submit to the Board for review, within thirty (30) days prior to commencing construction of any facilities or infrastructure authorized under this Licence, for-construction designs and drawings, signed and stamped by an Engineer.

2. The Licensee shall ensure that all relevant approved facilities are designed and constructed to engineering standards such that, at a minimum, they comply with the most current version of the *Canadian Dam Safety Guidelines*.

3. The Licensee shall implement measures to ensure that all materials used in the construction of relevant facilities or infrastructure included under the scope of this Licence are free of contaminants, to the extent that they do not cause harmful or significant effects to Water.

4. The Licensee shall maintain shoreline stability during construction.

5. The Licensee shall ensure that all final designs and drawings are qualified by an Engineer confirming that:

    a. Works are designed under sound engineering principles;
    b. Design limitations are understood and communicated within the report; and
    c. Measures are implemented to minimize impact to Water.

6. The Licensee shall, submit to the Board for review, within ninety (90) days of completion of any structure authorized under this licence, to contain, withhold, divert or retain Water or Wastes; a construction summary report prepared by an Engineer that includes, among other relevant information, as-built drawings, documentation of field decisions that deviated from original plans, and any data used to support these decisions.

7. The Licensee shall, if contamination of surface and/or ground water is encountered during construction and excavation, notify the Inspector immediately and implement the Spill Contingency Plan.

8. The Licensee shall develop and implement measures necessary to prevent and mitigate erosion and/or the release of sediment into Water during the construction of the Upgraded Wastewater Treatment Plant or during any construction activities associated with the Undertaking.

PART G: CONDITIONS APPLYING TO MODIFICATIONS

1. The Licensee may, without written consent from the Board, carry out Modifications to the potable Water Treatment Facility and Waste Treatment Facilities provided that such Modifications are consistent with the terms of this Licence and the following requirements are met:

    a. the Licensee has notified the Board in writing of such proposed Modifications at least sixty (60) days prior to beginning the Modifications;
    b. Such Modifications are consistent with the NPC Land Use Planning (NPC) Conformity Determination and the NIRB Screening Decision;
    c. such Modifications do not place the Licensee in contravention of the Licence or the *Act*;
    d. the Board has not, during the sixty (60) days following notification of the proposed Modifications, informed the Licensee that review of the proposal will require more than sixty (60) days; and
    e. The Board has not rejected the proposed Modifications.

2. Modifications for which all of the conditions referred to in Part G, Item 1 have not been met can be carried out only with written approval from the Board.

3. The Licensee shall provide as-built plans and drawings of the Modifications referred to in this Licence within ninety (90) days of completion of the Modifications. These plans and drawings shall be stamped by an Engineer.

PART H: CONDITIONS APPLYING TO SPILL CONTINGENCY PLANNING

1. The Licensee shall, submit to the Board for approval in writing, within thirty (30) days of the Effective Date of this Licence, an amalgamated and updated Spill Contingency Plan. The Plan shall address spill contingency planning requirements for all relevant aspects of works, activities, and undertakings associated with the scope of this Licence including the Sewage Lift Station.

2. The Licensee shall, subject to section 16 of the Regulations, report any unauthorized deposits of Waste or foreseeable unauthorized deposits of waste and/or Discharges of Effluent, and:

    a Employ, as required, the approved Spill Contingency Plan;
    b Report the incident immediately via the NWT/NU 24-Hour Spill Reporting Line (867) 920-8130 and to the Inspector at (867) 975-4295; and
    c For each spill occurrence, submit a detailed report to the Inspector, no later than thirty (30) days after initially reporting the event. The report shall include the amount and

type of spilled product, the GPS location of the spill, and the measures taken to contain, clean up and restore the spill site.

3. The Licensee shall, in addition to Part H, Item 2, regardless of the quantity of release of a harmful substance, report to the NWT/NU Spill Line if the release is near or into a Water body.

PART I: CONDITIONS APPLYING TO MONITORING

1. The Licensee shall monitor the relevant potable Water Treatment Facility and Waste Treatment Facilities authorized under this Licence in accordance with requirements included under Schedule I.

2. The Licensee shall, submit Board for approval in writing, within sixty (60) days of the Effective Date of this Licence, an updated Monitoring Program that addresses monitoring requirements for the Water Treatment Facility and Waste Treatment Facilities. The Monitoring Program shall address, among other items, the requirements outlined in Schedule I.

3. All analyses required under Schedule I shall be conducted using methods as described in the most recent edition of "*Standard Methods for the Examination of Water and Wastewater*", or by such other methods as approved by the Board in writing.

4. All laboratory analyses shall be performed at a laboratory accredited according to ISO/IEC Standard 17025. The accreditation shall be current and in good standing.

5. The Licensee shall, submit to the Board for review, within sixty (60) days of the Effective Date of the Licence, an updated Quality Assurance/Quality Control (QA/QC) Plan prepared in accordance with *Quality Assurance (QA) and Quality Control (QC) Guidelines for Use by Class "A" Licensees in Meeting SNP Requirements and for Submission of a QA/QC Plan* (INAC, 1996 or most current version). The updated plan shall be accompanied by a letter from an Analyst of an accredited laboratory confirming acceptability of the Plan.

6. The Licensee shall measure by instrument and record in cubic metres, the monthly quantities of freshwater extracted from the Lake Geraldine Reservoir, at Monitoring Program Station No. IQA-01, used for all purposes under this Licence.

7. The Licensee shall measure, by instrument and record in cubic metres, the quantities of Effluent released from the Sewage Lagoon Facility at Monitoring Station No. IQA-02, Wastewater Treatment Plant and/or Upgraded Wastewater Treatment Plant at Monitoring Station No. IQA-04 and the West 40 Landfill at Monitoring Station No. IQA-08.

8. The Licensee shall measure and record in cubic metres, the monthly and annual volumes of sludge removed from the Wastewater Treatment Facilities.

9. The Licensee shall provide the GPS co-ordinates (in degrees, minutes and seconds of latitude and longitude) of all locations of sources of Water utilized and Waste deposited under this Licence.

10. The Licensee shall include all of the data and information required by the Monitoring Program under Schedule I within the Annual Report required under Part B, Item 1 of the Licence or as otherwise requested by an Inspector and/or the Board.

11. Additional Monitoring may be requested by the Board and/or the Inspector.

12. The Monitoring Program and compliance dates specified in the Licence may be modified at the discretion of the Board in writing and do not constitute an application for Amendment as defined in the *Act*.

PART J: CONDITIONS APPLYING TO CLOSURE AND RECLAMATION

1. The Board has accepted the document entitled *Iqaluit Solid Waste Management Plan West 40 Landfill Decommissioning Technical Memorandum*, dated January 2014, submitted as additional information with the Application.

2. The Licensee shall submit to the Board for approval in writing, at least one (1) year prior to commencing the decommissioning of the West 40 Landfill, a Final Closure and Reclamation Plan prepared by an Engineer in accordance with industry's best practices and relevant guidelines.

3. The Licensee shall, for the Plan required under Part J, Item 2, include a presentation of data and a discussion of environmental conditions existing before the use of the site by the Licensee as a municipal landfill, as well as remediation objectives.

4. The Licensee shall notify the Board in writing, at least one year prior to the implementation of final closure, of its intentions to proceed with final closure of any Water use or Waste disposal facilities included within the scope of this Licence, excluding the Facility under Part J, Item 2.

SCHEDULES

Schedule A: Definitions

In this Licence, 3AM-IQA1626:

"**Act**" means the *Nunavut Waters and Nunavut Surface Rights Tribunal Act*;

"**Addendum**" means the supplemental text that is added to a full plan, manual, or report, usually included at the end of the document and is not intended to require a full resubmission of the revised report. It may also be considered as an appendix or supplement;

"**Amendment**" means a change to any terms and conditions of this Licence through application to the NWB, requiring a change, addition, or deletion of specific terms and conditions of the Licence not considered as a modification;

"**Analyst**" means an Analyst designated by the Minister under section 85 (1) of the *Act*;

"**Annually**" means, in the context of monitoring frequency, one sampling event occurring every 365 days with a minimum of 200 days between sampling events;

"**Application**" means, for the purposes of this License, the totality of the NWB Public Register opened as a result of the filing of the application to replace and amend expired Water Licence 3AM-IQA0611(3AM-IQA0612);

"**Biannually**" means, in the context of the monitoring frequency, two sampling events occurring per calendar year, with a minimum of 150 days and a maximum of 210 days between sampling events;

"**Board**" means the Nunavut Water Board established under Article 13 of the *Nunavut Land Claims Agreement* and under section 14 of the Act;

"**Discharge**" means the release of any Water or Waste to the receiving environment;

"**Effective Date**" means the date on which the Minister of Indigenous and Northern Affairs Canada approves the Licence;

"**Effluent**" means treated or untreated liquid Waste material that is Discharged into the environment from the site water management facilities such as a settling pond or a treatment plant;

"**Engineer**" means a professional engineer registered to practice in Nunavut in accordance with the *Consolidation of Engineers and Geoscientists Act S. Nu 2008, c.2* and the *Engineering and Geoscience Professions Act S.N.W.T. 2006, c.16 Amended by S.N.W.T. 2009, c.12*;

"**Engineered Structure**" means any facility, designed and approved by a Professional Engineer who is registered with the Association of Professional Engineers, Geologists and Geophysicists of Nunavut;

"**Grab Sample**" means an undiluted quantity of material collected at a particular time and place that may be representative of the total substance being sampled at the time and place it was collected;

"**Greywater**" means the component of Effluent produced from domestic use (i.e. washing, bathing, food preparation and laundering), excluding Sewage;

"**Hazardous Waste**" means materials or contaminants categorized as dangerous goods under the *Transportation of Dangerous Good Act* (1992), no longer used for their original purpose and intended for recycling, treatment, disposal or storage at appropriate facilities;

"**High Water Mark**" means the usual or average level to which a body of water rises at its highest point and remains for sufficient time so as to change the characteristics of the land (ref. *Department of Fisheries and Oceans Canada, Operational Statement: Mineral Exploration Activities*);

"**Inspector**" means an Inspector designated by the Minister under section 85 (1) of the Act;

"**Licence**" means this Type "A" Water Licence No. 3AM-IQA1626, issued by the Nunavut Water Board to the City of Iqaluit in accordance with the Act;

"**Licensee**" means the entity to whom Licence No. 3AM-IQA1626 is issued or assigned;

"**Minister**" means the Minister of Indigenous and Northern Affairs Canada (INAC);

"**Modification**" means an alteration to a physical work that may introduce a new structure or eliminates an existing structure and does not alter the purpose or function of the work;

"**Monitoring Program**" means the program to collect data on surface water and groundwater quality to assess impacts to the environment of an appurtenant undertaking;

"**Monthly**" means, in the context of monitoring frequency, one sampling event occurring within calendar month with a minimum of twenty-one (21) days between sampling events;

"**Nunavut Land Claims Agreement**" (NLCA) means the "*Agreement Between the Inuit of the Nunavut Settlement Area and Her Majesty the Queen in Right of Canada*," including its preamble and schedules, and any Amendments to that agreement made pursuant to it;

"**Quality Assurance / Quality Control (QA/QC)**" Quality Assurance means the system of activities designed to better ensure that quality control is done effectively; Quality Control means the use of established procedures to achieve standards of measurement for the three principle components of quality: precision, accuracy and reliability;

"**Quarterly**" means divisions of the calendar year, comprised of three month intervals from January to December, inclusive (January – March, April – June, July – September and October – December);

"**Regulations**" means the *Nunavut Waters Regulations* (SOR/2013/669 18th April, 2013);

"**Sewage**" means all toilet wastes and greywater;

"**Sewage Lagoon Facility**" refers to the waste disposal facility and associated structures designed and constructed to treat Sewage in the City of Iqaluit since 1978, which has also been upgraded in subsequent years;

"**Sludge Management Facility**" means the facility located within the West 40 Landfill that is used for the disposal and treatment of sludge generated by the Wastewater Treatment Plant;

"**Solid Waste Facility**" means the West 40 Landfill, Sludge Management Facility and all other facilities identified in the Application that are designed and constructed to manage solid waste generated by the City of Iqaluit;

"**Surface Drainage**" means all surface waters resulting from the flow over, through or out of an operations area and is collected by means of Engineered structures;

"**Undertaking or Undertakings**" means an undertaking or undertakings in respect of which Water is to be used or Waste is to be deposited, as classified in Schedule 1 of the *Regulations*;

"**Upgraded Wastewater Treatment Plant (UWWTP)**" means the current Wastewater Treatment Plant, which was designed, constructed, and commissioned under Phase 1, for the preliminary treatment of Wastewater, in addition to the infrastructure scheduled for construction and commissioning by December 2018, under Phase 2, for the secondary treatment of Wastewater as described in the Application;

"**Use**" means use as defined in section 4 of the Act;

"**Waste**" means Water as defined in section 4 of the Act;

"**Waste Treatment Facilities**" refers to all facilities constructed and operated by the City of Iqaluit to manage solid and liquid Waste associated with this licence.

"**Wastewater**" means the water generated by site activities or originates on-site that requires treatment or any other water management activity;

"**Wastewater Treatment Facilities**" means the Sewage Lagoon, Wastewater Treatment Plant, Upgraded Wastewater Treatment Plant and associated facilities authorized under this Licence;

"**Wastewater Treatment Plant**" means the engineered system, located adjacent to the Sewage Lagoon Facility that is designed for the containment and preliminary treatment of Sewage generated by the City of Iqaluit as described in the Application;

"**Water or Waters**" means water as defined in section 4 of the *Act*;

"**Water Treatment Facility**" means the engineered facilities and appurtenances designed and constructed for the withdrawal storage treatment and distribution of fresh water for domestic purposes, described in the Application; and

"**West 40 Landfill**" means the Solid Waste Facility or original landfill facility along with its Northern Expansion and Sludge Management Facility that is designed to manage solid waste generated by the City of Iqaluit.

Schedule B: Annual Reporting Requirements

The Annual Report referred to in Part B, Item 1, shall include the following:

a. The monthly and annual quantities in cubic metres of fresh Water withdrawn from the Lake Geraldine Reservoir at Monitoring Station No. IQA-01;
b. The monthly and annual quantities in cubic metres of any Discharges from the Wastewater Treatment Facilities at Monitoring Stations IQA-02, IQA-04, and IQA-08;
c. Copy of reports generated from Dam Safety Inspections and Dam Safety Reviews along with the Licensee's proposed actions to address issues identified and/or updates on continuing actions to address issues;
d. The monthly and annual quantities in cubic metres of sludge removed from the Wastewater Treatment Facilities;
e. The monthly and annual quantities of Wastes disposed of at the West 40 landfill;
f. A summary report which includes all data and information generated under the Monitoring Program, including the QA/QC program, in electronic and printed formats acceptable to the Board;
g. A summary of all construction activities carried out for facilities under the Licence;
h. A summary of modifications and/or major maintenance work carried out on the potable Water Treatment and Waste Treatment Facilities, including all associated structures;
i. A progress report and revisions (if applicable) to any studies requested by the Board that relate to Waste management, Water use or reclamation and a brief description of any future studies planned by the Licensee including, a non-technical executive summary for the general public, translated into Inuktitut;
j. Any revisions required, in the form of addenda, to Plans, Manuals and Reports approved under the Licence;
k. A list and description, including volumes and Spill Report Line Identification Number, of all un-authorized Discharges, spills and summaries of follow-up action taken;
l. A summary of any closure and reclamation work undertaken and an outline of any work anticipated for the next year, including any changes to implementation and scheduling;
m. A summary of actions taken to address concerns or deficiencies listed in the inspection reports and/or compliance reports filed by an Inspector;
n. A brief update on the implementation plan of all facilities within the scope of this Licence including changes projected implementation and status of the Upgraded Wastewater Treatment Plant;
o. A summary of any studies, reports and plans requested by the Board that relate to Waste disposal, Water use or reclamation and a brief description of any future studies planned; and
p. Any other details on the use of Water or Waste disposal requested by the Board by November 1st of the year being reported.

Schedule I: Condition Applying to Monitoring

Table 1 – Water Quality Parameters		
Test Groups	**Analytical Parameters**	**Units**
Routine (R)	Alkalinity, Acidity, Chloride, Carbonate, Bicarbonate, Total Hardness, Hydroxide, Sulphate, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Total Organic Carbon (TOC), Total Inorganic Carbon (TIC)	mg/L
	pH (field and lab)	pH units
	Oxidation-Reduction Potential (ORP) (field)	mV
	Conductivity (field and lab)	uS/cm
	Temperature (field)	°C
	Turbidity	NTU
Effluent (E)	Total Suspended Solids (TSS)	mg/L
	Temperature (field)	°C
	Conductivity (field and lab)	uS/cm
	pH (field and lab)	pH units
Acute Lethality (AL)	Based on Environment Canada's *Procedure for pH Stabilization During the Testing of Acute Lethality of Wastewater Effluent to Rainbow Trout* (EPS 1/RM/50, March 2008), if single concentration test fails and un-ionized ammonia concentration is less than or equal to 1.25 mg/L	"Pass" / "Fail"
ICP- Metals Scan (Total)	Al, Sb, As, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Li, Mn, Mo, Ni, Se, Sn, Ag, Sr, Tl, Ti, U, V, Zn, Hg	mg/L
Nutrients (N)	Ammonia-N, Nitrate-N, Nitrite-N	mg N/L
	Total Phosphorus, Orthophosphate	mg/L
Biological (B)	Biochemical Oxygen Demand	mg/L
	Total and Fecal Coliform	CFU/100 mL
Potable Water (PW)	Fecal Coliform	CFU/100 mL
	ICP Metals (Total and dissolved)	mg/L
	Total Suspended Solids –TSS	mg/L
Flow (F)	Volume	m^3
Landfill Specific (LS)	Polychlorinated Biphenyls (PCBs) Benzene, Toluene, Ethylbenzene and Xylene (BTEX)	mg/L

Table 2[1] - Water Quality Monitoring Criteria

Station ID	Description	Status	Parameter	Testing / Measurement Frequency	Reporting Frequency
IQA-01	Lake Geraldine Reservoir – Raw Water	Active	R, PW	Monthly	Biannually
			F	Monthly	
IQA-01(#)	Based on Part I, Item 4 of Expired Licence	Inactive	N/A	N/A	N/A
IQA-02	Sewage Lagoon – Effluent Discharge Point	Active	B, N, E, ICP	Once prior to discharge; once during discharge; and once prior to the completion of discharge	Annually
			F	During decant	
IQA-03	Sewage Lagoon – Influent	Inactive	N/A	N/A	N/A
IQA-04	Wastewater Treatment Plant - Effluent	Active	B, N, E, ICP	Quarterly – Prior to commissioning of the WWTP	Annually
			B, N, E, ICP	Monthly – Following commissioning of the WWTP	
			AL	Annually – following commissioning of the WWTP	
			F	During Discharge	
IQA-05	Wastewater Treatment Plant - Influent	Active	B, E, N, ICP	Biannually – Prior to commissioning of the WWTP	Annually
				No testing requirements following commissioning of the WWTP	N/A
IQA-06	Sludge – From WWTP	Active	B, E, N, ICP	Quarterly	Annually
IQA-07	Surface Water entering West 40 Landfill – Based on Part E, Item 4 of the Expired Licence	Inactive	N/A	N/A	N/A

Station ID	Description	Status	Parameter	Testing / Measurement Frequency	Reporting Frequency
IQA-08	West 40 Landfill – Effluent Discharge Point, Based on Part E, Item 4 of the Expired Licence	Active	B, E, N, ICP, F, LS	Once prior to discharge; once during discharge; and once prior to the completion of discharge	Annually
			F	During Discharge	
IQA-08(#)	Based on E, Item 17, Part F, Item 10 & Part I, Item 4 of the Expired Licence	Inactive	N/A[2]	N/A	N/A
IQA-08A	Station situated up-gradient of West 40 Landfill	Active	B, E, N, ICP, F, LS	Annually	Annually
IQA-08B	Station situated down-gradient of West 40 Landfill	Active			
IQA-09	Contaminated soil accepted at the West 40 Landfill	Inactive	NA	N/A	N/A

[1] Table 2 may be modified by the Board and re-issued where necessary. Re-issuance is not considered an Amendment to the application or Licence as defined in the *Act*.
[2] Means not applicable