RECEIVED
By Licensing Administrative Assistant at 10:00 am, Jul 28, 2011

ABANDONMENT AND RESTORATION PLAN FOR THE WATER, SEWAGE AND SOLID WASTE FACILITIES

Licence No. 3BM-BAK1015

Baker Lake, NU

FINAL

Prepared for:

Department of Community and Government Services
Government of Nunavut
P.O. Box 002
Rankin Inlet, NU X0C 0G0

Prepared by:

Nunami Stantec
P.O. Box 188
Rankin Inlet, NU X0C 0G0
Tel: (867) 645-2805 Fax: (867) 645-2063
and
P.O. Box 1680
Yellowknife, NT X1A 2P3
Tel: (867) 920-2216 Fax: (867) 920-2278

Project No.:

123510069

July 2011

NUNAMI STANTEC

NUNAMI STANTEC

EXECUTIVE SUMMARY

This Abandonment and Restoration (A&R) plan has been developed for use at the sewage disposal, water treatment, and solid waste facilities in the community of Baker Lake, Nunavut. The purpose of the A&R plan is to establish and describe standard procedures for proper management of the future abandonment and restoration to be used when the water treatment, sewage disposal and solid waste facilities at Baker Lake are closed. Proper abandonment of these municipal facilities will help ensure environmental contamination or damage is minimized or eliminated and also provide compliance with the Hamlet of Baker Lake's Water License.

This A&R Plan contains the following sections:

1. Introduction
2. Background
3. Sewage Disposal Facility A&R Plan
4. Water Treatment System A&R Plan
5. Solid Waste Facility A&R Plan

An area-wide A&R plan will result in more satisfactory aesthetic and quality improvement results.

A second Abandonment and Restoration Plan, for all previously abandoned water and waste facilities and the previous waste oil pit within the community's boundaries, needs to be prepared and submitted for approval of the Nunavut Water Board, but is beyond the scope of this plan.

TABLE OF CONTENTS

List of Figures

List of Appendices

[File Ref: V:\1102\Yellowknife\Projects\200910Jobs\123510069 Baker Lake Sewage Treatment Improvements\License Compliance\A&R Plan\3BM-BAK1015_BakerLake_A&RPlan_FINAL_18Jul11.docx]

ABBREVIATIONS

A&R..... Abandonment and Restoration

GN-CGS.....Government of Nunavut Department of Community and Government Services

GN-ENV .....Government of Nunavut Department of Environment

Hamlet.....Hamlet of Baker Lake

HHW ..... Household Hazardous Waste

km .....kilometres

L ..... Litres

m ..... metres

m^2..... square metres

m^3.....cubic metres

MSW .....Municipal Solid Waste

NWB.....Nunavut Water Board

O&M.....Operations and Maintenance

SAO ..... Senior Administrative Officer

SCP..... Spill Contingency Plan

1 INTRODUCTION

1.1 Purpose

Item 2 Part G of the Hamlet of Baker Lake's (the Hamlet's) Water License (No. 3BM-BAK1015, located in **Appendix A** of the Operations and Maintenance [O&M] manual), dated June 25, 2010, requires the submission of an Abandonment and Restoration Plan (A&R plan) to the Nunavut Water Board (NWB, the Board) for approval. This A&R plan must be submitted for approval of the Board at least six (6) months prior to abandoning any existing facilities or upon submission of the final design documents for the construction of new facilities to replace existing ones. In 2010, improvements/upgrades were completed on the Hamlet's existing sewage disposal facility; improvements/upgrades are also planned for the Hamlet's water treatment system in mid-2012, including the pumphouse and truck fill station. These completed and scheduled improvements/upgrades do not include abandonment of any municipal facilities however.

This A&R plan has been developed for use for when the existing water treatment, sewage disposal, or solid waste facilities in Baker Lake (Qamani'tuaq), Nunavut, are closed and abandoned. The purpose of the A&R plan is to establish and describe standard procedures for proper closure and abandonment of existing municipal water, sewage and solid waste facilities in Baker Lake. This A&R plan includes information to address the following:

- Water intake facilities
- Water treatment and waste disposal sites and facilities
- Petroleum and chemical storage areas
- Sites affected by waste spills
- Leachate prevention
- An implementations schedule
- Maps delineating disturbed areas and site facilities
- Consideration of altered drainage patterns
- Type and source of cover materials
- Future area use
- Hazardous wastes
- A proposal identifying measures by which restoration costs will be financed by the Licensee upon abandonment.

This A&R plan follows the applicable conditions of Item 2 of Part G of the Hamlet's Water License. The Hamlet will implement the A&R plan when approved by the NWB. This plan is to be used as a guide for the abandonment and restoration of the existing water treatment, sewage disposal, or solid waste facilities in the community.

Under Item 1 Part G of the Hamlet's Water License, a second A&R plan is required for the current facilities which have already been closed or abandoned by the Hamlet (i.e., previous water and waste facilities, previous waste oil pit). These facilities will require additional site work and information prior to development of the site-specific A&R plan and is beyond the scope of this A&R plan. Additional site work should be undertaken soon to facilitate development of the additional A&R plan and assist with the Hamlet's Water License compliance.

1.2 Site Description

The community of Baker Lake is situated on the northwest shore of Baker Lake near the mouth of the Thelon River (64° 18' N, 96° 3' W). The community is situated approximately 283 km inland from the western shore of Hudson Bay in the Kivalliq Region of Nunavut. The community is located approximately 275 km northwest of Rankin Inlet, NU (see inset of Figure 1 in **Appendix A** of this A&R plan).

The community is located in the Wager Bay Plateau Ecoregion of the Northern Arctic Ecozone. The region is characterized by broad sloping uplands, plains and valleys. Soils are primarily silty sand and silty clays overlying boulder till, beach deposits and reworked till. Local topography slopes upward from the lake to a ridge approximately two kilometers to the north. A site overview of the existing conditions is provided on Figure 2 in **Appendix A** of this A&R plan. Permafrost is present, with the active layer established at up to 1.5 meters in depth. Vegetation in the area is typical tundra vegetation consisting of mosses, lichens, grasses, and dwarf shrubs.

The average annual precipitation in the community consists of 156.7 mm of rainfall and 130.7 mm of snowfall, resulting in an annual total of approximately 270.4 mm of precipitation (EC 2010). The July mean high and low temperatures are 16.7°C and 6.0°C, respectively, with the average daily temperature of 11.4 °C. The January mean high and low temperatures are -28.7°C and -35.8°C, respectively. The January average daily temperature is -32.3°C (EC 2010). Winds are commonly from the northwest at an average annual speed of 20.4 km/h (EC 2010).

The Hamlet provides daily trucked services for drinking water delivery and sewage collection. Drinking water is drawn from Baker Lake and distributed to water trucks via the pumphouse truck fill.

Sewage is presently discharged to a natural tundra wetland system, which treats the effluent as it flows to a holding cell which exfiltrates through an outlet, downslope into Lagoon Lake. The effluent then flows east and south, crossing berms, wetland areas and two lakes until it reaches Baker Lake, approximately 2 km east of the water intake. This sewage disposal and treatment wetland system has been in operation since at least 1980 and upgrades to the system were completed in the fall of 2010.

Domestic solid waste is collected five days a week (Monday through Friday) by the Hamlet and disposed of at the municipal solid waste disposal facility.

Locations of the water, sewage disposal, and solid waste disposal facilities are shown in Figure 1 in **Appendix A** of this A&R plan.

2 BACKGROUND

2.1 Sewage Disposal Facility

The sewage disposal facility is discussed in more detail in the O&M manual. However in general, the sewage disposal facility is situated approximately 1.2 km north of the community and consists of a built-out gravel pad dumping station and a natural tundra wetland. The natural tundra wetland consists of a large holding cell, several flow attenuation structures and two lakes. Between the structures and lakes are some small ponds, some small streams and open, boggy, wet tundra areas (natural wetlands) through which overland flow occurs. Upgrades to the sewage disposal facility were completed in the fall of 2010 and included:

- Upgrading of the previous short-term holding cell by strengthening its walls;
- Construction of an additional short-term holding cell to increase the initial retention time of effluent;
- Upgrading of the vacuum truck offloading point into the holding cells;
- Installation of attenuation structures in the wetland area between the holding cells and Lagoon Lake, and between Lagoon Lake and Finger Lake; and,
- Construction of a fence around the sewage and solid waste disposal facilities to keep out wildlife (i.e., caribou).

Sewage is collected from the community's houses and other buildings by vacuum truck and discharged from one of two built out gravel pads. Effluent flows downslope over constructed corrugated metal and riprap spillways into the large holding cell. The holding cell measures approximately 120 m long by 20 m wide with a maximum depth of 1.7 m. The capacity of the holding cell is 1000 m^3 and is designed for a 10-month storage with decanting over the late summer/early fall.

From the holding cell outlet, effluent flows downslope approximately 200 m through a field of flow attenuation riprap into Lagoon Lake. From Lagoon Lake, effluent flows east approximately 300 m towards Finger Lake; the compliance point for effluent quality monitoring has been set immediately prior to Finger Lake. A flow attenuation berm, 150 m long with two 600 mm culverts, is located within the 300 m stretch between Lagoon and Finger Lakes. This attenuation berm is oriented perpendicular to effluent flow, slowing and widening the flow and allowing for better treatment within the wetland.

From Finger Lake, treated effluent then flows an additional 1,000 m southeast into Airplane Lake; Airplane Lake then drains south approximately 1,300 m via Garbage Creek into Baker Lake.

A 2.44 m (8 feet) high by 2.2 km long chain-link fence is also installed around the sewage and solid waste disposal facilities. This fence, completed in 2010, was installed to keep wildlife out of the sewage treatment area and prevent wildlife from feeding within the treatment area.

Drawings for the upgraded sewage disposal facility are included in **Appendix E** the O&M manual. These improvements, with proper operations and maintenance, are intended to ensure this facility is operational through to the year 2029 before abandonment would be considered.

2.2 Water Treatment Facility

The Baker Lake water treatment system is discussed in more detail in the O&M manual. However in general, the water treatment system consists of a water intake, pipeline and pumphouse with truck fill. Potable water is obtained from Baker Lake through an intake and pipeline; the water intake is situated approximately 120 m offshore at a depth of 5 to 6 m below surface.

Water is currently pumped from the intake directly into water distribution trucks. During truck fills, water is chlorinated in the truckfill line from a 15 gallon of chlorine solution tank. Originally the system was designed for chlorination to take place before raw water entered storage tanks in the pumphouse and after leaving the tanks, before entering the water trucks. The storage tanks in the pumphouse were originally meant to fill the water trucks and to supply water to the Health Centre, Nurse's Residence, and the Elder's Facility and Group Home via a small piped distribution system. This piped system was taken off-line after Dillon Consulting Ltd. (2006) observed only batch chlorination occurring for water to the piped system and the free residual chlorine was below the regulated level.

The Hamlet uses trucked services for scheduled water delivery to all houses and other buildings. Water trucks obtain water from Baker Lake via the submersed intake, which pumps water through the pumphouse. The pumphouse accommodates the water intake system, storage tanks, truck fill system, chlorination system, standby generator and associated heating, electrical and alarm systems. The pumphouse and truck fill system are expected to be upgraded in mid- 2012.

2.3 Solid Waste Disposal Facility

Baker Lake's solid waste disposal facilities are discussed in more detail in the O&M manual. However in general, the solid waste disposal facility is situated near the southwest shore of Finger Lake, and adjacent to the sewage disposal facility. The facility was constructed in 1991 and expanded in 1998 to improve compliance. The facility consists of a fenced disposal area for municipal solid waste (MSW) and a separate storage area for bulk metal and hazardous wastes.

The Hamlet collects solid waste from community buildings on a scheduled daily basis (Monday to Friday) with a compactor garbage truck and transports the waste to the MSW disposal area; the MSW disposal area is approximately 25,000 m^2 in size. Open burning occurs at the MSW site on a weekly basis (G. Perkins, *pers. comm.*). Residents currently have access to the MSW and hazardous waste disposal areas and can drop items off at any time. The bulk metal/hazardous waste storage area is situated immediately west of the MSW disposal area; both disposal areas are unlined however and runoff from the solid waste disposal facility drains directly into Finger Lake and the sewage treatment wetland.

Some smaller metal wastes are stored within the MSW disposal area however most large metals wastes are disposed of at the bulk metal/hazardous waste disposal area. The bulk metal wastes typically disposed of by the community include items such as automobiles, heavy equipment, appliances, old fuel tanks, and other bulky metal wastes.

Some hazardous waste management and segregation presently occurs within the solid waste disposal facility. This can be improved upon however to ensure risks to human health and the environment are minimized and the terms of the Hamlet's water license are met. In the community, waste oil is either taken to Baker Lake Contracting and Supplies Ltd. (BLCS) to be burned in their waste oil burners, or is stored in drums at the bulk metal/hazardous waste storage area; these drums are stored in seacans at the solid waste site. Other household hazardous wastes, including, waste batteries, paint, antifreeze and other wastes are also usually stored at the bulk metal/hazardous waste storage area.

Figure 2 in **Appendix A** of this A&R plan illustrates the location of Baker Lake's solid waste disposal facility.

THIS PAGE INTENTIONALLY LEFT BLANK.

3 SEWAGE DISPOSAL FACILITY ABANDONMENT AND RESTORATION PLAN

3.1 Facility

Final upgrades to the sewage disposal facility at Baker Lake were completed in the spring of 2011 and are intended to ensure this facility is operational through to the year 2029 before abandonment will be considered. It is possible that the facility could continue to operate for a significant period of time beyond 2029 though performance of the facility will need to be determined. The two main components of the sewage disposal facility are the holding cell and the sewage treatment tundra wetland.

Six sewage vacuum trucks are available to bring the sewage from the community to the facility. Baker Lake is a residential community with no major heavy industry. The sewage generated and disposed of is a municipal-type waste. Generally, the sewage solids tend to settle in the holding cell and the liquid effluent flows over the tundra wetland.

The sewage is adequately treated at the facility. Due to the uniform characteristics of the domestic wastewater, the steady flow of sewage through the facility, and the holding cell prior to the tundra wetland, the effluent that flows over the tundra wetland has very little solids.

When the facility ceases to be used as a sewage disposal facility, discharge to the holding cell has to cease. It is expected the natural biological processes active in this tundra environment will, over time, help return this area to its original state.

During abandonment and restoration, the public and all personnel working within the sewage disposal facility will be made aware of potential health and safety hazards associated with around sewage wastes. This is imperative so individuals make a conscious effort to perform all necessary safety procedures to protect themselves. The requirements of the Nunavut *Safety Act* will be followed at all times. Additional health and safety precautions for the public and site personnel may be taken during abandonment and restoration.

3.2 Facility Map

The sewage disposal facility is described in more detail in the O&M manual. The facility is shown in Figures 1 and 2 in **Appendix A** of this A&R plan.

3.3 Waste Spills

Prior to abandoning the site or removing any engineered structures, the facility will be inspected for evidence of sewage waste and other spills through an environmental site assessment/investigation; this investigation will be conducted by a qualified professional. Raw sewage can contain infectious bacteria, viruses, fungi and parasites that can cause serious human illnesses and even death. It is imperative to safely and properly clean up all sewage spills to reduce the chance of human infection

and environmental contamination. Any spilled and/or frozen wastewater will be removed and deposited in the holding cell. Petroleum related spills will be collected and deposited at the hazardous waste storage area in appropriate containers. Soils within and adjacent to the sewage disposal facility will be analysed for a suite of parameters to determine any type and extent of contamination.

At the sewage disposal facility, spills may result from any of the following occurrences:

- Leaks or ruptures of fuel tanks;
- Valve or line failure in vehicles or heavy equipment;
- Vehicular accidents;
- Spill during transfer of sewage; or,
- Vandalism.

The Spill Contingency Plan (SCP) is presented in Section 6.2 of the O&M manual and provides a guide to operators and other Hamlet personnel in the event of an accidental release of sewage, or other waste associated with the sewage disposal facility. The SCP is planned to be protective of the local environment and public and personnel health and safety. Every time a spill is identified, the Hamlet's Operations Manager and/or Water Sewage & Solid Waste (WSSW) Foreman will be contacted as soon as possible. The 24-hour NWT/NU Emergency Spills Report Line will be contacted in the event any spill of any amount or substance occurs.

3.4 Implementation Schedule

When the sewage disposal facility is to be abandoned, public access of the area will be restricted. During closure, there is not expected to be a significant amount of heavy equipment activity at the site. This will aid in minimizing disturbance to the existing vegetation and promote restoration of disturbed areas. During abandonment and restoration, the Hamlet will ensure all workers wear the appropriate personal protective equipment (PPE), including waterproof gloves, safety glasses/goggles, rubber boots and disposable protective coveralls. The entire developed area of the facility will be abandoned and restored. This work will include, but not be limited to, the following:

1. Removal of any general debris that has accumulated at the facility. The debris is to be segregated and disposed of at the appropriate solid waste facilities.
2. Prior to removing any engineered structures, the sewage sludge generated by the settling of wastewater solids during primary treatment in the holding cell, considered 'lagoon sludge' (FSC 2001), will need to be addressed as follows:
    a) The amount of sludge accumulation (volume) in the holding cell will be determined.
    b) Sludge in the holding cell will be analysed to determine its physical and chemical characteristics and to ensure the disposal method selected is appropriate, safe and environmentally responsible. Disposal options may include:
        i. Land disposal, if the sludge is of a suitable quality;

ii. If the sludge is not suitable for land disposal, it may be disposed of at the MSW disposal facility if it meets the facility's requirements; or,

iii. The sludge may require additional treatment before disposal (FSC 2001).

3. Removal of the engineered structures placed within the facility. These structures include:

a) The discharge spillways at the dumping stations will be washed and cleaned with a detergent solution and then disinfected using only approved disinfectants, and then disposed of at the solid waste disposal facility, or recycled and incorporated in the future sewage disposal facility design.

b) The metal and concrete filled bollards and wooden traffic barrier stop logs with rebar, placed at the dumping stations will be disposed of at the solid waste disposal facility.

c) The stone riprap will be washed and cleaned with a detergent solution and disinfected using only approved disinfectants, and then disposed of on-site or offsite.

d) Facility signs will be removed, the posts salvaged for use by the Hamlet, and the signs disposed of at the solid waste facility (if not recycled for the future sewage disposal facility).

e) Unless the dumping stations are to be used for another purpose, such as for vehicle parking areas, they will be regraded to match the existing shoulders of the roadway and reseeded so native vegetation can be re-established.

f) The holding cell berm(s) will not be removed until the sludge and effluent are removed. The cell is constructed of sand, gravel and a synthetic liner. The sand and gravel will be analysed for any contamination and, if acceptable, can be reused offsite or disposed of on-site to level the site. A possible use, if acceptable, is as a cover material at the solid waste disposal facility. The sand and gravel will not be placed directly in standing water. The synthetic liner will be disposed of at the appropriate location within the solid waste disposal facility.

g) The liquid effluent in the holding cell will be transported downstream or to another holding cell using the sewage vacuum truck(s) or by other acceptable means.

h) As the attenuation berm is generally constructed with the same materials as the holding cell, the berm will be removed in the same manner, but only after the holding cell has been removed. If not utilized on-site, this material may be very suitable as a cover material at the solid waste disposal facility.

i) All disturbed areas will be regraded to promote natural run-off.

j) All disturbed areas will be reseeded and maintained until native vegetation is re-established.

k) Once the sewage disposal facility has been cleaned up, dispose of disposable PPE (i.e., coveralls, gloves, safety glasses/goggles) in approved area of the MSW disposal facility. Ensure other PPE (i.e. rubber boots) are properly cleaned and disinfected prior to re-use.

3.5 Restoration Costs

The Hamlet will restore their abandoned sewage disposal facility in a manner consistent with the terms and conditions of their Water License and the provisions of this A&R plan. Restoration will be undertaken both in a progressive manner, as components or areas are abandoned, and upon final abandonment of the site. As part of any future sewage expansions and upgrades that may include the abandonment of a section of the existing facility, the engineering evaluation and facility planning will jointly consider the impact and costs associated with abandonment, and what effects the abandonment will have on the discharge parameter limits.

Progressive reclamation will be an activity of regular operations and will be financed through annual operations and maintenance budgets, supervised and undertaken by Hamlet staff. Final abandonment will be an identified component of the capital replacement project and will be funded within the capital budget for the future sewage disposal facility project. Capital projects are typically undertaken by third-party contract which provide for payment upon completion of established activities.

3.6 Future Area Use

The Hamlet will continue to confine sewage disposal to the designated outlet locations and designated treatment route so when the existing sewage disposal facility is abandoned and restored, the area of concern will be easily delineated and monitored as it is allowed to return to its original state, as much as possible.

Only municipal wastewater has been treated at the facility and any contamination would be expected to result not from the sewage disposal, but from the nearby solid waste facility and subsequent leachate. However, future development plans of the sewage disposal facility will not include this area.

4 WATER TREATMENT FACILITY ABANDONMENT AND RESTORATION

4.1 Facility

The GN-CGS is planning to complete upgrades to the pumphouse and truck fill system at Baker Lake in the summer of 2012. These upgrades include a new intake pump, a second pumphouse building housing a new filtration and chlorination system, and two new truck fill lines. No other upgrades are currently planned and no abandonment is expected.

In general, the water treatment system consists of the following equipment used to operate and maintain the water system at Baker Lake:

- Baker Lake to Pumphouse:
  - A permanent intake in Baker Lake, fitted with a screen with 2.5 mm effective openings
  - 100 mm diameter by approximately 111 m long pipeline to the pumphouse, fitted with a Thermon® TC 202a SSR3OA intake line heat trace
- Pumphouse:
  - Detailed equipment lists for the new pumphouse can be found in O&M Manual for the new pumphouse system (expected in mid-2012 concurrent with upgrades to the pumphouse and truck fill system).
- Water Trucks:
  - Six (6) water trucks with an approximately capacity of 11,365 L (2,000 gallon) capacity each. Water trucks bring the water to the community.

When the water treatment system ceases to be used, the existing components will have to be removed. All of the components of the facility are generally located on the land surface and not below ground. It is expected the tundra environment observed in proximity to the water treatment system has not been significantly altered by the water treatment system. When the water treatment system is abandoned, the surrounding area is anticipated to eventually return to its pre-development state over time.

4.2 Facility Map

The general components of the water treatment system are shown in Figure 1 in **Appendix A** of this A&R plan. The pumphouse is located on the shore of Baker Lake.

4.3 Waste Spills

Though any spills would normally be cleaned up as they occur, prior to abandoning the water treatment system or removing any engineered or built-up structures, the areas around the system components will be inspected for evidence of any spills or other contamination through an environmental site assessment/investigation; this investigation will be conducted by a qualified professional. The primary areas of concern for spills will be in and around the pumphouse (e.g., truck fill). The pumphouse has a significant amount of truck traffic and stores and utilizes chlorinated chemicals. It is imperative to safely and properly clean up all vehicle and chlorine-related spills to reduce the chance of environmental contamination. Any contaminated soil or snow will be removed and properly stored in the hazardous waste storage area.

Referencing the water treatment system, spills may result from any of the following occurrences:

- Leaks or ruptures of fuel tanks;
- Valve or line failure in the system, equipment or vehicles;
- Heat expansion due to overfilling or improper storage;
- Improper storage of contaminants;
- Vehicular accidents; or,
- Vandalism.

A SCP has been developed for implementation at the water treatment system in Baker Lake. The SCP is presented in Section 6.2 of the O&M manual and provides a guide to operators and other Hamlet personnel in the event of an accidental release of a hazardous product or other waste at the water treatment system. The SCP is planned to be protective of the local environment and public and personnel health and safety. Every time a spill is identified the Hamlet's Operations Manager and/or WSSW Foreman will be contacted as soon as possible. The 24-hour NWT/NU Emergency Spills Report Line will be contacted in the event any spill of any amount or substance occurs.

4.4 Implementation Schedule

The abandonment of the water treatment system is expected to be simpler in comparison to that of the sewage disposal and solid waste disposal facilities. The water treatment system conveys potable water. At the time of abandonment, the primary area of concern will be the pumphouse and removal of the water intake line.

Structures associated with the water treatment system will be dismantled; these structures include the pumphouse and associated components. Depending on the component and material, structures could either be re-used or disposed of at the MSW disposal area, bulk metal waste disposal area, hazardous waste disposal area, or shipped off-site.

Removal of the intake and pipeline would be expected to increase suspended sediment load of the lake in the vicinity of the removal operations, potentially affecting another drinking water intake (if Baker Lake is re-utilized) and nearby fish and fish habitat. This effect is expected to be limited in

duration however certain mitigation measures may be required, including include monitoring of water quality and installation of silt curtains to prevent transport of suspended sediments,

All compacted built-up areas used for the water treatment facility, including the truck pad of the pumphouse and any abandoned access roads, should be tilled to allow re-growth of vegetation. This should only occur once these areas are confirmed to be clean and free of spills or other contaminants. These areas can be seeded or left for natural restoration.

4.5 Altered Drainage Patterns

The surfaces of the abandoned water treatment system area(s) will be graded to match existing conditions and existing drainage patterns. Runoff will be allowed to flow naturally over the abandoned sites and they will be returned to their pre-development state as much as possible.

4.6 Restoration Costs

The Hamlet will restore the abandoned water treatment system in a manner consistent with the terms and conditions of their license and the provisions of this A&R plan. Restoration will be undertaken both in a progressive manner, as components or areas are abandoned, and upon final abandonment of the system.

Progressive reclamation will be an activity of regular operations and will be financed through annual operations and maintenance budgets, supervised and undertaken by Hamlet staff. Final abandonment will be an identified component of the capital replacement project and will be funded within the capital budget for the project. Capital projects are typically undertaken by third party contract which provide for payment upon completion of established activities.

4.7 Future Area Use

Properly abandoning and restoring the areas used for the water treatment system will allow these areas to return to their pre-development state, as much as possible. Aside from potential spills resulting from vehicle or chlorine chemical use, there is not expected to be any amount of contamination resulting from the water treatment system and future community development plans may include this area.

THIS PAGE INTENTIONALLY LEFT BLANK.

5 SOLID WASTE DISPOSAL FACILITY ABANDONMENT AND RESTORATION

5.1 Facility

There are currently no plans to abandon or upgrade the existing solid waste disposal facilities in Baker Lake.

The solid waste disposal facility is inclusive of the fenced MSW disposal area and the adjacent bulk metal/hazardous waste storage area. The MSW disposal area is approximately 25,000 m^2. The solid waste disposal facility is situated near the southwest shore of Finger Lake, adjacent to the sewage disposal facility; see Figure 2 in **Appendix A** of this A&R plan.

When the facility ceases to be used as the community's solid waste disposal facility, solid waste disposal to it must stop. This assumes a new replacement facility will be functional before the current facility is abandoned. It is expected that the natural biological processes active in this tundra environment will, over time, help return this area to its original state.

During abandonment and restoration, the public and all personnel working within the solid waste disposal facilities will be made aware of potential health and safety hazards associated with municipal solid wastes and hazardous wastes. This is imperative so individuals make a conscious effort to perform all necessary safety procedures to protect themselves. The requirements of the Nunavut *Safety Act* will be followed at all times. Additional health and safety precautions for the public and site personnel may be taken during abandonment and restoration.

Even after the facility is restored, public access to the abandoned facility will be restricted to minimize potential hazards to the public. Public access to the hazardous waste storage area will especially be restricted until it is confirmed the site has been decontaminated to meet residential use requirements. Other uses would generally require less restrictive cleanup provided the contamination is not migrating and the site is capped so that no contact occurs.

5.2 Facility Map

The general location of the solid waste disposal site is shown in Figures 1 and 2 in **Appendix A** of this A&R plan.

5.3 Waste Spills

Prior to abandoning the solid waste facility or capping of any materials, the facility will be inspected for evidence of spills and other contamination spills through an environmental site assessment/investigation; this investigation will be conducted by a qualified professional. A SCP has been developed for implementation at the solid waste disposal facilities in Baker Lake. This SCP is located in Section 6.2 within the O&M manual and should be referenced. All persons involved with

operations at the solid waste disposal facilities should read and be familiar with this SCP. To be effective, it is important that all personnel are familiar with their responsibilities and steps to take in the event of a spill. One of the first criteria of addressing a spill is to identify the spilled material.

At the solid waste disposal facilities, spills may result from any of the following occurrences:

- Leaks or ruptures of fuel storage tanks;
- Valve or line failure in systems, vehicles or heavy equipment;
- Heat expansion due to overfilling or improper storage;
- Improper storage of contaminants;
- Vehicular accidents;
- Spill during transfer of contaminant; or,
- Vandalism.

5.3.1 Municipal Solid Waste (MSW) Disposal Area

The MSW disposal area is fenced. Proper waste segregation will assist in the successful abandonment and restoration of the facility as it helps keep hazardous wastes out of the MSW disposal area, allows the Hamlet to address each waste individually, and reduces, to some degree, the chance of spills.

The MSW disposal area at Baker Lake was likely designed as a natural attenuation landfill. This means that the landfill is not lined and if a spill occurs, contaminants can enter the surrounding environment to be naturally broken down. Natural attenuation landfills rely on permafrost below the landfill to assist in containing spills. However, it is important that when encountered, spills be identified, cleaned up, and contaminated soil or snow disposed of or stored at the proper location in the hazardous waste storage area; this will help ensure harmful contaminants are kept out of the MSW disposal facility and not allowed to move downstream.

The SCP presented in the O&M manual provides a guide to operators and other Hamlet personnel in the event a spill occurs or is discovered at the MSW disposal facility. The SCP is planned to be protective of the local environment and public and personnel health and safety. Every time a spill is identified, the Hamlet's Operations Manager and/or WSSW Foreman will be contacted as soon as possible. The 24-hour NWT/NU Emergency Spills Report Line will be contacted in the event any spill of any amount or substance occurs.

5.3.2 Bulk Metal / Hazardous Waste Storage Area

Prior to and during the abandonment of the bulk metal/hazardous waste storage area, the facility will be inspected for spills. Similar to the MSW disposal area, the bulk metal/hazardous waste storage area is unlined and any contamination resulting from spills or leaks can enter the surrounding environment. It is imperative to safely and properly clean up all spills and leaks to reduce the chance of environmental contamination. Any spilled and/or frozen liquids will be properly addressed.

Depending on the source of contamination, the contaminated soil or snow will be collected and properly stored at the hazardous waste storage area, or sent to an off-site facility.

Any drums stored within the bulk metal/hazardous waste storage area will need to be shipped out of the community. It is presumed this area will continue to be used for some drum storage area until all of the drums are shipped. These containers either previously held or presently hold controlled materials and are very susceptible to spills.

5.4 Implementation Schedule

There are presently no plans to abandon any of the existing solid waste facilities in Baker Lake. The A&R plan for the solid waste facility aims to provide direction to Hamlet personnel involved in the closure of solid waste facility in Baker Lake. The following activities may be expected, but not limited to, during closure of the facility:

- Compaction and contouring of the MSW disposal area landfill
- Removal of any non-landfillable wastes, bulk metals wastes, hazardous wastes and contaminated soils
- Capping of the MSW disposal area and potentially the bulk metal/hazardous waste storage area, with the creation of appropriate drainage systems
- Implementation of a post-closure monitoring and inspection program.

5.4.1 Municipal Solid Waste (MSW) Disposal Area

The current MSW disposal area is being used for municipal waste disposal. Waste will accumulate (be landfilled) in the MSW disposal area until the site reaches its' capacity. Before that point in time, a new MSW disposal site will need to be chosen and the current site closed. Adverse effects to the surrounding environment from the MSW disposal area will be reduced through proper management, operations and maintenance over the life of the facility, consistent with current regulatory requirements, standards, and guidelines. See Section 5 of the O&M manual for information on appropriate operations and maintenance activities at the solid waste disposal facilities.

Regulatory guidelines require sampling of the leachate from the MSW disposal area and the sewage disposal facility to aid in identifying contaminants before they become an issue. The wastes deposited at the MSW disposal area are potential sources of contamination to the surrounding and downstream environment. Potential contaminants originating from the MSW disposal areamay include inorganic compounds (e.g., sulfate, chloride, ammonia), heavy metals, petroleum hydrocarbons, phenols and other dissolved organic matter. These contaminants can end up in the soil, the surface or groundwater, or the air. Contamination of the surrounding environment can add to long-term concerns and consequences and, therefore, sources of contaminants within Hamlet facilities needs to be limited. Contamination from the MSW disposal area can be due to past or present uses, on-going practices, or single events. Analytical results to date seem to indicate only relatively minor levels of contamination from the MSW disposal area, of which are currently effectively treated within the sewage disposal facility.

When the existing MSW disposal area is ready for closure, abandonment activities will consist of consolidating, compacting and leveling the remaining landfillable solid waste on-site into low areas. The entire site will then be capped with at least 0.6 m of sand and gravel, compacted and graded so as to promote drainage away from buried waste. The sand and gravel will be obtained from local pits in the area. Since impermeable materials (i.e., clay) are generally unavailable in Baker Lake, covering the MSW disposal area with an impermeable membrane (e.g., a geomembrane) is recommended. This will prevent water percolation through the waste piles and the creation of more leachate and long-term contamination issues. Final capping operations can be made easier by stockpiling the sand and gravel cover materials close to the MSW disposal area.

Signage will be placed at the abandoned MSW disposal area to inform the public of the abandoned area. Disposal of any other wastes will also be restricted by closing and locking the site. The area will be monitored and inspected to ensure the restrictions are enforced. In addition, the Hamlet will perform any requirements of their Water License, which may eventually include addressing the salvage or removal of the existing fence once the capped MSW disposal site has stabilized.

The capped MSW disposal site will also be covered with compost or soil, and be seeded with an appropriate mix of native grasses and plants to achieve natural vegetation. This covering of the waste will aid in reducing the attraction for birds and other wildlife.

5.4.2 Bulk Metal / Hazardous Waste Storage Area

5.4.2.1 Bulk Metal

The following is a current list of bulk metal materials that are acceptable for disposal in the bulk metal/hazardous waste storage area:

- Large metal wastes (i.e., clean and decommissioned fuel tanks and drums, towers, poles/posts, culverts, etc)
- Tires
- Appliances
- Properly abandoned vehicles, snowmobiles, and all-terrain vehicles (ATVs).

Upon closure of the bulk metal/hazardous waste storage area, all bulk metal waste, including any empty or crushed drums, within the area will be removed from the community through a back haul program and properly disposed of at appropriate receivers. The Hamlet may work with other communities, the GN and a transportation company to establish a backhaul program to remove and dispose of these materials.

5.4.2.2 Hazardous Waste

Hazardous wastes are those that are known to be dangerous due to their chemical, physical or biological properties, are no longer used for their original purpose, and are intended for recycling, treatment, disposal or storage (GNWT 1998, GN-ENV 2002). All hazardous wastes require special handling, storage and disposal methods to prevent human health and environmental exposure.

The Hamlet's solid waste disposal facility (and bulk metal/hazardous waste storage area) is licensed to accept municipal wastes for disposal and should only accept household hazardous wastes for storage. Industrial wastes should not be accepted for storage or disposal. Therefore the majority of materials within the bulk metal/hazardous waste storage area should consist almost entirely of household hazardous wastes (HHW). The Hamlet has restricted storage of HHW and waste fuel to the bulk metal/hazardous waste storage area. The following HHW may be stored at the hazardous waste storage area:

- Pesticides and herbicides
- Paint
- Solvents (e.g., paint cleaners)
- Flammable liquids
- Corrosive cleaners
- Batteries (wet and dry cell)
- Empty contaminant containers (e.g., 205 L fuel drums
- Oil filters
- Antifreeze
- Propane tanks and cylinders
- Aerosol cans (not empty)
- Fire extinguishers
- Used fuel and oil
- Fluorescent light tubes and compact fluorescent light bulbs

Contaminated soil or snow from spill clean-up is the only non-HHW that should be accepted by the Hamlet for storage at the bulk metal/hazardous waste storage area. Contaminated soil or snow should be stored in 205 L steel drums and shipped out of the community every year.

The bulk metal/hazardous waste storage area is intended for storage only, not disposal. It is expected that hazardous wastes will be stored for up to a maximum of five years. This should be sufficient time for the community to build up enough waste to make it economical for a back haul out of the community to a licensed waste receiver. Upon closure of the bulk metal/hazardous waste storage area, all wastes should be removed out of the community for appropriate disposal, or to a new, replacement hazardous waste storage area.

Soils located under and adjacent to the hazardous waste storage area will be analysed for potential contaminants during an environmental site assessment/investigation. Once the extent and type of contamination has been identified, the soils can be removed and disposed of in a manner appropriate for the type of contamination. Excavated soil may need to be sent to an off-site facility for treatment or disposal.

If it can be confirmed that the soil is not contaminated, it may be salvageable and reused for some purpose at the replacement hazardous waste or solid waste facility. Based on the analytical results, the soils could remain on-site, be treated on-site, taken to the replacement hazardous waste storage area, or transported off-site for disposal. Once all materials have been removed from the abandoned hazardous waste storage area and it is established to be free of contaminants, the area should be backfilled with clean materials, tilled and could be seeded with native grasses or allowed to naturally restore.

5.5 Leachate Prevention

Normal operation and maintenance of the MSW disposal area has included burning of burnable waste material. This will restrict some moisture from entering waste media and thus limit leachate production. However, as discussed in Section 5.4.1, it is recommended that the MSW disposal area be covered with an impermeable membrane (e.g., a geomembrane) as this will prevent water percolation through the waste piles and the creation of more leachate and long-term contamination issues. It is anticipated that after covering of the MSW disposal facility, permafrost will move up into the buried waste and further prevent leachate from occurring. Final capping operations can be made easier by stockpiling the sand and gravel cover materials close to the MSW disposal area.

Until the capped MSW disposal site has frozen, some leachate monitoring may need to be undertaken to determine the volume and characteristics of leachate originating from the capped MSW disposal site. Leachate treatment measures may need to be implemented to ensure further contamination to the surrounding and downstream environment is minimized; leachate could be entrained in a holding cell or directed into the adjacent sewage disposal facility. The solid waste facility is underlain by permafrost and bedrock which will act as a barrier in the vertical transport of leachate. However with an impermeable covering and eventual freezing of the MSW disposal site and removal of all wastes and contaminated materials from the bulk metal/hazardous waste storage area, it is expected there will be minimal to no leachate originating from these areas.

5.6 Cover Materials

The entire MSW disposal area will be covered with at least 0.6 m of sand and gravel, compacted and graded so as to promote drainage away from the buried waste. The sand and gravel will be obtained from local pits in the area. Capping operations can be made easier by stockpiling the cover materials close to the MSW disposal facility. After covering the facility, the disturbed areas will be revegetated with native plant species to aid in stabilizing cover materials, reducing erosion, preventing establishment of invasive species, and restoring the area to its pre-development state.

5.7 Altered Drainage Patterns

When the solid waste disposal facility is abandoned and leachate from the site has ceased, it may be beneficial to have the runoff from the capped MSW disposal site and the bulk metal/hazardous waste storage area directed to the adjacent sewage disposal facility.

The surface runoff from the abandoned and reclaimed site(s) will be addressed by grading the areas to direct runoff into the sewage disposal facility, and when that is not possible, to match the original conditions and original drainage patterns. Ideally, final drainage patterns of abandoned sites will match original drainage conditions however this will only occur if the sites have been confirmed clean and surface runoff would not contain any contaminants. Generally, the solid waste disposal facility drains in the northerly direction, towards the existing sewage disposal facility. Any grading during abandonment and restoration work will not change their overall drainage patterns and the areas will be returned to their original state, as much as possible.

Site restoration will be designed to promote growth of native vegetation, reduce erosion and return the site to its pre-development state. Site restoration activities will also encourage minimal long-term maintenance of the abandoned sites. Although somewhat altered and compacted by the development of the solid waste facilities, once tilled, clean soils underlying the non-capped facilities are likely still able to support re-vegetation with minimum maintenance, once established.

The first few years after abandoning or re-seeding are the most crucial for maintenance. During this time and until vegetation has become established, the sites should be regularly inspected for erosion and runoff. Erosion issues should be corrected as soon as possible once identified. The eventual re-vegetation and stabilization of the abandoned sites will create a natural looking site that buffers and slows runoff.

5.8 Restoration Costs

The Hamlet will restore the abandoned solid waste disposal facilities in a manner consistent with the terms and conditions of their license and the provisions of this A&R plan. Restoration will be undertaken both in a progressive manner, as components or areas of certain sections of the facility are abandoned, and upon final abandonment of the facilities.

Progressive reclamation will be an activity of regular operations and will be financed through annual operations and maintenance budgets, supervised and undertaken by Hamlet staff. Final abandonment will be an identified component of the capital replacement project and will be funded within the capital budget for the project. Capital projects are typically undertaken by third party contract which provide for payment upon completion of established activities.

5.9 Future Area Use

The Hamlet will continue to confine their solid waste disposals to the designated locations so when each facility site is abandoned and restored, the area of concern will be easily delineated and monitored. The goal of the abandoning and restoring the solid waste disposal facility will be to allow these areas to return to their original state, as much as possible.

Future community development plans will likely not include these solid waste disposal areas, unless new disposal areas are placed adjacent to or on top of the abandoned areas.

THIS PAGE INTENTIONALLY LEFT BLANK.

6 REFERENCES

6.1 Literature Cited

Dillon Consulting Limited. Water pumphouse and intake system upgrades – Baker Lake, Nunavut. Prepared for Government of Nunavut Department of Community and Government Services, December 2006.

Environment Canada (EC). "Baker Lake A." Canadian Climate Normals 1971-2000. *National Climate Data and Information Archive*. Environment Canada, 2010. Web. 30 March 2011.

Ferguson Simek Clark (FSC). Sewage Treatment Best Available Technology. Prepared for Indian and Northern Affairs Canada, Water Resource Division. Yellowknife, NT: FSC, 2001.

Government of the Northwest Territories (GNWT). 1998. Guideline for the General Management of Hazardous Waste in the NWT. GNWT Department of Resources, Wildlife and Economic Development, Yellowknife, NT.

Government of Nunavut Department of Environment (GN-ENV). Guideline for the General Management of Hazardous Waste. Iqaluit, NU: GN-ENV, 2002.

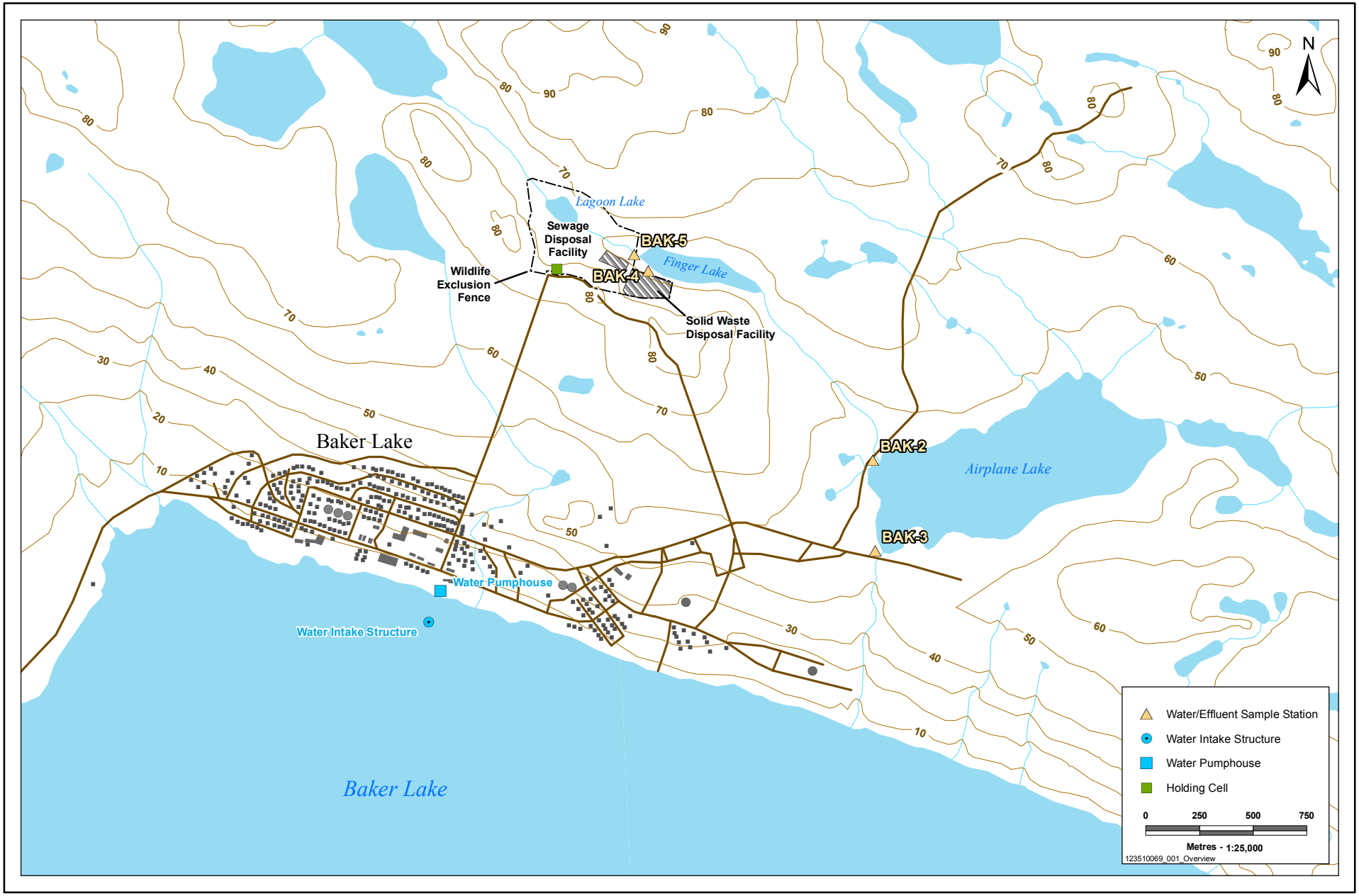
6.2 Personal Communication

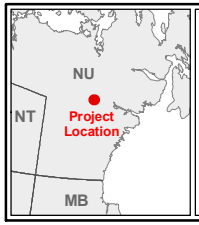
Perkins, G. Operations Manager. Hamlet of Baker Lake. Personal interview. 22 February 2011.

THIS PAGE INTENTIONALLY LEFT BLANK.

APPENDIX A

Figures





Operations and Maintenance Manual for the Water, Sewage and Solid Waste Facilities

Overview of the Water, Sewage and Solid Waste Facilities at Baker Lake, NU

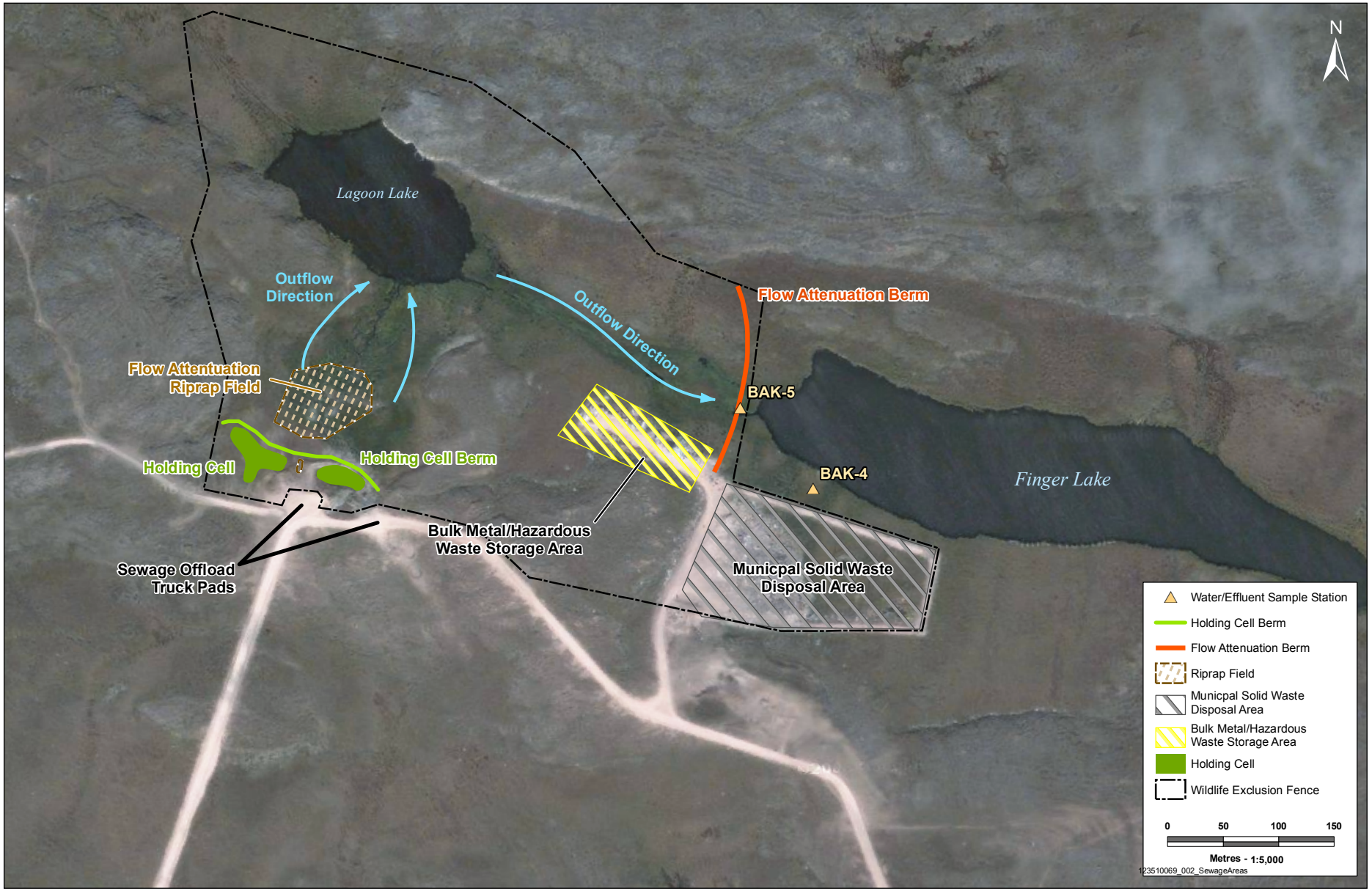
Acknowledgements: Original Drawing by Nunami Stantec

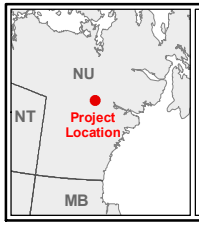
PREPARED FOR NUNAMI STANTEC

PREPARED FOR

FIGURE NO. 1

Last Modified: April 5, 2011 by jastro





Operations and Maintenance Manual for the Water, Sewage and Solid Waste Facilities

Overview of the Sewage and Solid Waste Disposal Facilities at Baker Lake, NU

Acknowledgements: Original Drawing by Nunami Stantec

PREPARED FOR NUNAMI STANTEC

PREPARED FOR

FIGURE NO. **2**

Last Modified: April 5, 2011 by jastro