ARVIAT SEWAGE TREATMENT FACILITY OPERATION AND MAINTENANCE PLAN

Water Licence No. 3AM-ARV1016

Updated By:
Government of Nunavut
Community & Government Services
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1.0 Introduction

1.1 Site Description

The Hamlet of Arviat is located within the Kivalliq Region, Nunavut (61°06'N, 94°3W Figure 1). The community has a population of approximately 2514 (2016 Census). Like the rest of Nunavut, Arviat is only accessible by air and for a limited season by boat.

Figure 1 The Hamlet of Arviat, Google Earth 2019

The topography is relatively flat with a sight rise when moving inland away from Hudson Bay. Local bedrock is generally overlain by glacial fluvial sediments. Arviat is in the physiographic region of the Hudson Bay lowlands, characterized by low topographic relief, occasional bedrock outcrops and glacial and glaciofluvial overburden sediments. Boulder fields and eskers are common. Approximately 20 to 30 % of the land is shallow ponds with depths of 1 m or less. Land between the ponds is marshy, vegetated by grasses and sedges.

1.2 Wastewater Treatment Facility

The Wastewater Treatment Facility (WWTF) includes:

- An exfiltration sewage lagoon (commissioned in 2005) which receives trucked sewage collected from holding tanks in each building
- A wetland treatment area (WTA) that discharges to Hudson Bay
- Two abandoned lagoon cells

Wastewater is transported by truck from sewage holding tanks to the active lagoon for disposal. The current lagoon holds approximately 38, 000 m^3 and has an exfiltration berm that allows effluent to passively enter the estimated 7.3 ha WTA down a 100 m flow path during summer months (Figure 2). The final receiving area is Hudson Bay. The as-built drawings are in Appendix A.

Figure 2 Arviat Sewage Lagoon, Google Earth 2019

1.3 Nunavut Board Water Licence

The Nunavut Water Board (NWB) licence 3AM-ARV1016 authorizes the water withdrawal and waste disposal at the sewage and solid waste facilities. The Hamlet of Arviat holds the water licence and owns and operates the sewage and solid waste assets, and the Government of Nunavut owns and operates the water treatment infrastructure. The licence dated June 16, 2015 expired on February 27, 2016. The Hamlet is currently in the process of renewing and amending the licence to account for changes to the water infrastructure and increased raw water pumping volumes from the water source to account for the 20-year design horizon of water consumption.

2.0 Staff and Safety

Staff training is an important aspect of the operation of a WWTF. Staff must be adequately trained to follow this O&M Plan and operate the facility. This O&M Plan is dependent on sufficient site-specific training to allow staff to understand and operate the facility.

The Senior Administrative Officer (SAO) is responsible for all aspects of municipal infrastructure and programing, as well as fiscal responsibilities. All Hamlet employees report to the SAO, and the SAO reports to the municipal council. The two staff that work directly with the WWTF are the Water Clerk, who is responsible for sampling and reporting, and the Foreman who ensures sewage pickup and disposal occurs as required and inspects the lagoon fencing and related infrastructure.

The health and safety of workers and the public is the priority while operating the WWTF. The requirements of the Nunavut Safety Act must be always followed. All actions and operations must be undertaken with safety as the priority.

3.0 Security and Control

The lagoon is fenced, and warning signs are posted. A 450-metre setback surrounding the lagoons is designated in the Community Land Use plan as restrictive development.

4.0 Wastewater Conveyance

The WWTF, operated by the Hamlet of Arviat, is located approximately 2.8 km south-west from the Hamlet. Sewage is collected daily by truck from all the houses and occupied buildings with holding tanks. The sewage is collected from the holding tanks via external discharge ports on the exterior wall of these buildings. The trucks discharge the sewage into the lagoon by way of a long flume that prevents bank erosion during the discharge of the sewage into the lagoon.

The lagoon is designed to receive municipal sewage only. The discharge of other liquid wastes is prohibited unless it can be demonstrated that the waste will have not have deleterious impact on the WWTF. The 2011 document entitled: Environmental Guideline for Industrial Waste Discharges into Municipal Solid Waste and Sewage Treatment Facilities describes the criteria and process for disposing liquids that are considered industrial or construction waste streams. Liquid wastes meeting the criteria detailed in the document are acceptable for discharge into the WWTF. Liquid wastes that do not meet the criteria must be pre-treated until they do or be stored in barrels as hazardous waste for future disposal at a licensed facility located outside of the community.

5.0 System Capacity and Design

Limited information on the original design of the facility is available, therefore the calculations and assumptions used in the 2010 Operations and Maintenance Plan have been used in conjunction with more recent field investigations. There are three lagoons in Arviat, two of which are not active, and the third, furthest east, being the only active lagoon.

The WWTF consists of two components:

- Lagoon: A facultative lagoon, which provides retention time for the settlement of solids as well as aerobic and anaerobic processes, which decomposes the sewage through microbial activity

- WTA: Receives the discharge of the treated effluent from the lagoon for final treatment via filtering and biological digestion by plants and micro-organisms in a designated wetland

Figure 3 Sewage Disposal Facility, Nuna Burnside 2010

The lagoon discharges into the WTA through the exfiltration berm during the non-frozen months, as shown in Figure 3. During the months where the exfiltration berm is frozen, the lagoon fills to near the top of berm. Throughout the melted season, the lagoon drains down from the top of the berm to allow space for the upcoming frozen season.

During the years 2017, 2018, and 2019 a manual decant was required in the late spring due to a risk of the berms overtopping prior to the exfiltration berm becoming active. These decants were done with written approval from CIRNAC. Photos of the decant can be seen in Appendix B. This indicates that the lagoon is over-capacity. A new and upgraded lagoon is currently in the schematic design phase, with expected commissioning in 2024. The schematic design report will be shared in 2021 followed by the developing design documents in 2022.

5.1 Influent Volumes

In municipalities with trucked service, it is normally assumed that the sewage generated is equivalent to water consumption. Accordingly, the daily and annual sewage generation rates for the Hamlet of Arviat are conservatively assumed to be equal to the water consumption rates. Table 2 summarizes the monthly volumes that are estimated to be deposited at the sewage lagoon each year. Based on the last 7 years, there is an average 3.9% yearly increase in sewage generation.

Table 1 Wastewater Generation Estimates

	Estimated Wastewater (m^3)						
Month	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
January	7,141	7,035	7,597	8,229	8,551	8,870	8,774
February	6,460	6,470	7,009	7,824	7,527	7,917	8,184
March	6,928	7,327	7,355	8,384	7,707	8,542	8,654
April	6,620	6,903	7,227	7,961	8,006	8,311	8,388
May	6,777	7,978	7,791	8,131	8,216	8,656	8,887
June	6,607	7,518	7,666	7,966	8,086	8,287	8,175
July	6,854	7,237	7,901	8,205	8,500	8,910	9,096
August	6,943	6,944	7,947	8,414	8,538	9,042	9,219
September	6,768	7,360	7,657	7,956	8,353	8,582	8,743
October	7,189	7,711	8,072	8,270	8,553	8,881	9,026
November	7,256	7,422	7,509	8,059	8,283	8,709	8,694
December	7,536	7,612	7,762	8,285	8,431	8,815	8,768
Yearly Total	83,079	87,516	91,493	97,685	98,751	103,521	104,606
Difference	**-**	**5.3%**	**4.5%**	**6.8%**	**1.1%**	**4.8%**	**1.0%**

5.2 Storage Capacity

The lagoon covers an area of approximately 18,980 m^2. Using an estimated usable depth of approximately 2.0 m, the capacity of the lagoon is approximately 38,000 m^3.

5.3 Wetland Treatment Area

There is approximately 100 m of land between the sewage lagoon and the ocean which is identified as the WTA in Figure 2. The WTA is a secondary treatment system from the primary treatment system (the facultative lagoon). Wetland systems operate by dispersing sewage lagoon treated effluent over an area of sufficient size, to allow natural processes such as:

- Sedimentation
- Adsorption by soil particles
- Uptake, and digestion of nutrient components by plants
- Microbial decomposition of complex molecules
- Physical entrainment in changing flow regimes
- Dilution by intermixing with the natural water system

The WTA is designed as a part of the WWTF, and the land area is formally set aside for this land use. All other land use that could be a conflict with this use is prohibited in the designated WTA.

6.0 Sludge Management

Sludge has not been removed from the lagoon since it was commissioned in 2005. The height of the sludge accumulation in the lagoon will be monitored at intervals to ensure accumulation does not exceed a certain percent volume of the lagoon. This height is presently set at 0.4 m from the bottom of the lagoon floor, which is 20 percent volume of the lagoon. At this time, the removal of sludge should be considered to maintain the capacity of the lagoon.

It has been recommended that sludge removal occur at the lagoon to improve capacity and eradicate the need for manual decanting each spring. Although the lagoon will be upgraded soon, the removal of sludge is still recommended and planned to take place in 2021.

7.0 Surface Water Management

Surface water and snow melt that occur within the catchment area to the lagoon are accounted for within the flow in and out of the lagoon and contribute to dilution of the effluent. This includes meltwater from the entrance road, surrounding berms, and directly within the lagoon. Surface water and snow melt that occurs outside of the facility follow drainage paths/ditches around the border of the lagoon and drain independently to the bay.

8.0 Sewage Lagoon Operational Procedures

8.1 Sewage Collection Procedures

The following sewage collection operational procedures shall be carried out by the staff of the Hamlet of Arviat daily dependent upon weather conditions:

- Household and commercial sewage holding tanks will be pumped out using a vacuum truck and hauled to the WWTF
- Sewage from the vacuum truck will be discharged to the sewage lagoon into a long flume spillway that prevents bank erosion during the discharge of the sewage into the lagoon
- Daily waste volumes deposited to the Sewage Lagoon (and trip counts) shall be recorded
- In the event of an accident, a spill of sewage or petroleum products or a fire during sewage collection operations, the Environmental Emergency Contingency Plan, Hamlet of Arviat shall be implemented (separate document)
- Any non-sewage liquid wastes must be properly assessed prior to discharge to the lagoon.

8.2 Sewage Lagoon Operational Procedures

The following procedures shall be undertaken by the staff of the Hamlet of Arviat during periodic and seasonal maintenance operations at the WWTF:

- The roadway and truck pad shall be maintained by snow clearing in the winter and surface grading in the summer, with any defects repaired as necessary .
- Berms shall be inspected monthly.
- Site warning signage, which identifies the boundaries of the WWTF (i.e. Sewage Lagoon and the WTA) shall be inspected monthly, and repaired or replaced as necessary.
- Any airborne litter shall be removed from the WWTF to the Hamlet landfill as required.

- The Sewage Lagoon shall be inspected annually to determine the thickness of sludge (from a small boat in the summer or through a hole in the ice in the winter) Desludging of the lagoon shall be conducted, based on the sludge thickness in the lagoon. A trigger sludge depth of 0.4 m (average) is recommended to determine the need for desludging.

- Monitoring and inspections will occur as outlined in the NWB Water License and described in this O&M Plan. Refer to the Environmental Monitoring and Quality Assessment/Quality Control Plan for details (separate document).

The activities described above shall be completed by the staff of the Hamlet and details of any repairs shall be reported in the Annual Report submitted to the NWB, in compliance with the Hamlet's Water License.

9.0 Monitoring Program

As outlined in the NWB water license, regular monitoring of the effluent from the WWTF is required. Sampling shall be in accordance with the Hamlet of Arviat Environmental Monitoring Program and Quality Assurance/Quality Control (QA/QC) Plan, which is being prepared as a separate document. Monitoring stations for the WWTF are displayed on Table 3.

Table 2 Monitoring Program Stations

Monitoring Station	**Description**	**Frequency**	**Analysis Requirements**
ARV-2a	Effluent from the Solid Waste Site	Quality: Monthly during the months of May to August and prior to discharge of accumulated impacted water Acute Toxicity Annually	Active (Quality and Acute Toxicity)
ARV-2b	Effluent from the discharge point of the New Solid Waste Disposal Facility.	Quality Monthly during the months of May to August and prior to discharge of accumulated impacted water. Acute Toxicity Annually	Not Active (Quality and Acute Toxicity)
ARV-3	Raw Sewage at truck offload point.	Monthly	Not active

ARV-4	Effluent from the discharge point of the Sewage Disposal Facility (end of Wetland).	Quality Monthly during the months of May to August. Acute Toxicity Annually	Active (Quality and Acute Toxicity)
ARV-5	Discharge from the Bulky Metal Waste Area.	Monthly during periods of observed flow.	Active (Quality)
ARV-6	Discharge from the Hazardous Waste Storage Area.	Monthly during periods of observed flow.	Active (Quality)
ARV-8	Water level in Sewage Disposal Facility lagoon	Monthly during thawed conditions.	Active (Sewage level)
ARV-9	Sewage Sludge removed from the Sewage Disposal Facility	Monthly	Active (Volume)

Table 4 provides a description of the current effluent parameters required by ARV1016 as well as the newly requested effluent parameters that are based on several years of research by Dalhousie University Center for Water Resources Studies.

Table 3 Effluent Parameters

Parameter	**Maximum Concentration of any Grab Sample**	**Requested change to effluent parameter**
Fecal Coliform	1 x 10^4 CFU/dl	-
CBOD	80 mg/L	100 mg/L
Total Suspended Solids	100 mg/L	120 mg/L
Oil and Grease	No visible Sheen	-
pH	Between 6 and 9	-

The NWB license Part B: General Conditions include the requirement to file an Annual Report with the NWB no later than March 31st of each calendar year. The report shall include:

- Tabular summaries of all data generated under the “Monitoring Program”.
- The monthly and annual quantities in cubic metres of freshwater obtained from all sources.
- The monthly and annual quantities in cubic metres of each and all waste discharged.
- A summary of modifications and/or major maintenance work carried out on the Water Supply and Waste Disposal Facilities, including all associated structures.

- A list of unauthorized discharges and summary of follow-up action taken.
- A summary of any abandonment and restoration work completed during the year and an outline of any work anticipated for the next year.
- A summary of any studies, reports and plans (i.e. Operation and Maintenance, Abandonment and Restoration, QA/QC) requested by the Board that relate to waste disposal, water use or reclamation, and a brief description of any future studies planned.
- Any other details on water use or waste disposal requested by the Board by November 1st of the reporting year.

10.0 Closure Plan

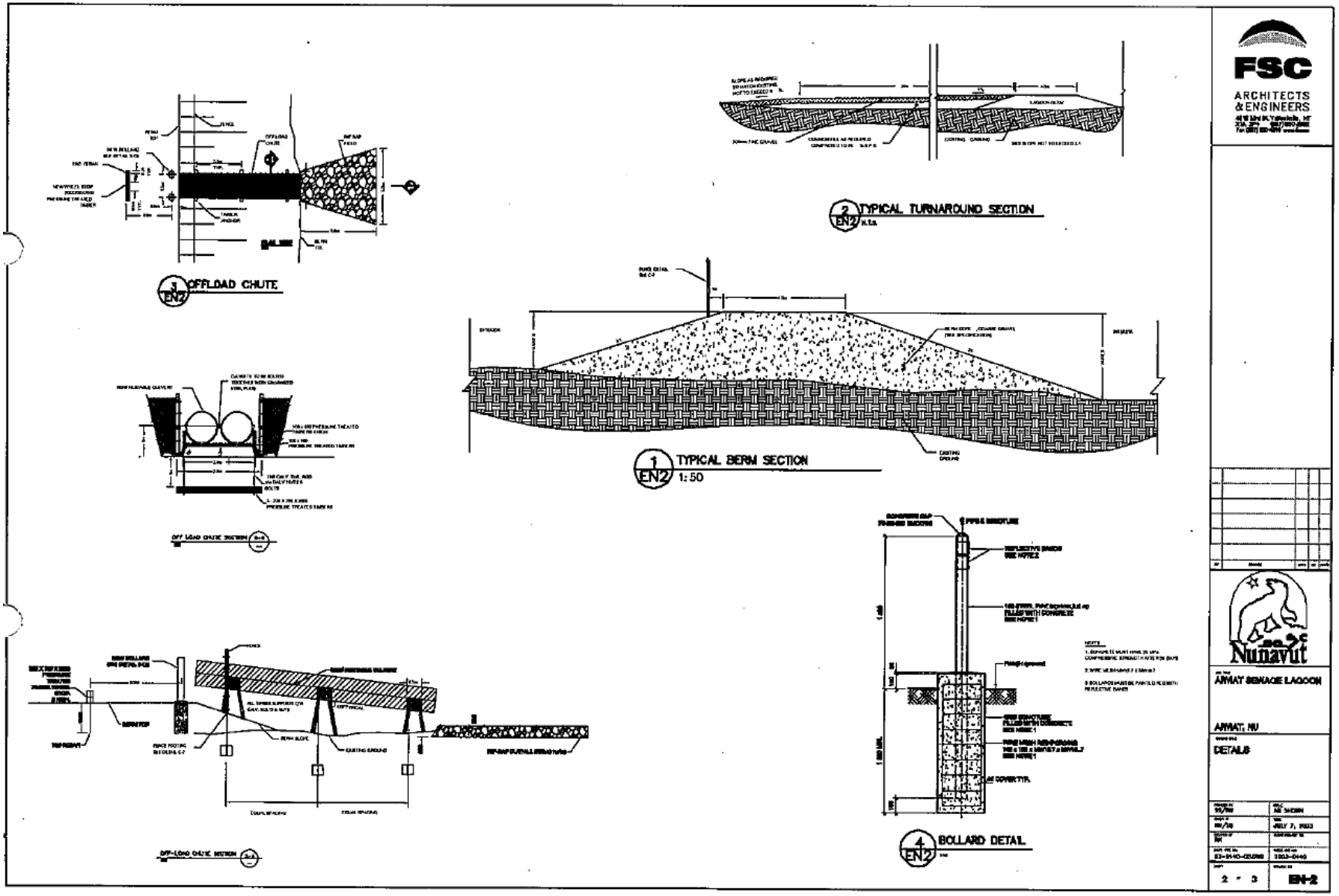
Part G of the Water License requires the submission of Abandonment and Restoration Plan at least six months prior to abandoning any facilities and construction of new facilities to replace existing ones.

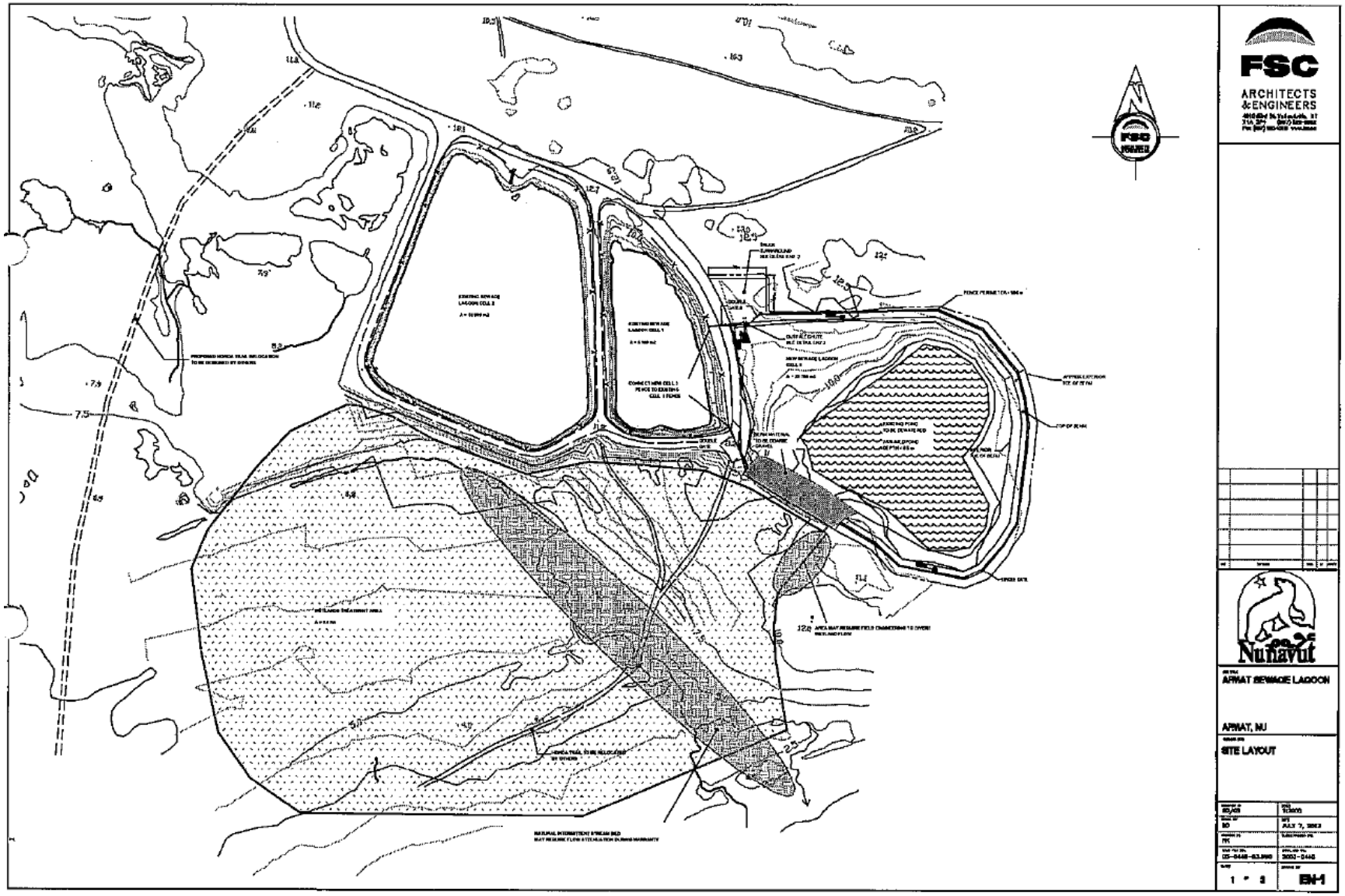
A new facility is currently in the schematic design phase with estimated construction in 2022-23. If the existing lagoon is abandoned as part of the new/upgraded facility, an abandonment and restoration plan is required to be submitted to the NWB as part of this licence. The restoration of the two non-active cells should also be included in this plan.

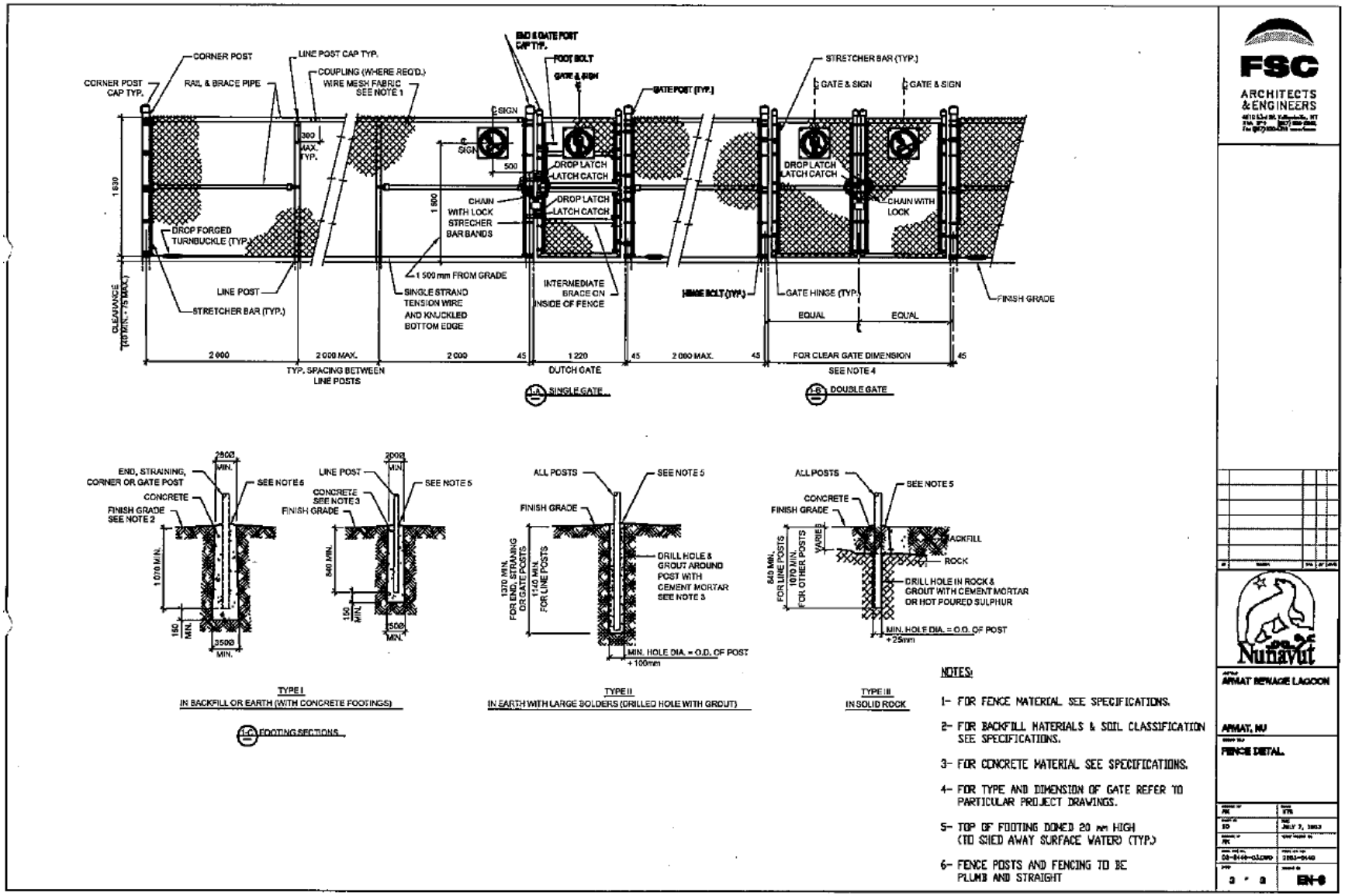
11.0 Modifications and Upgrades

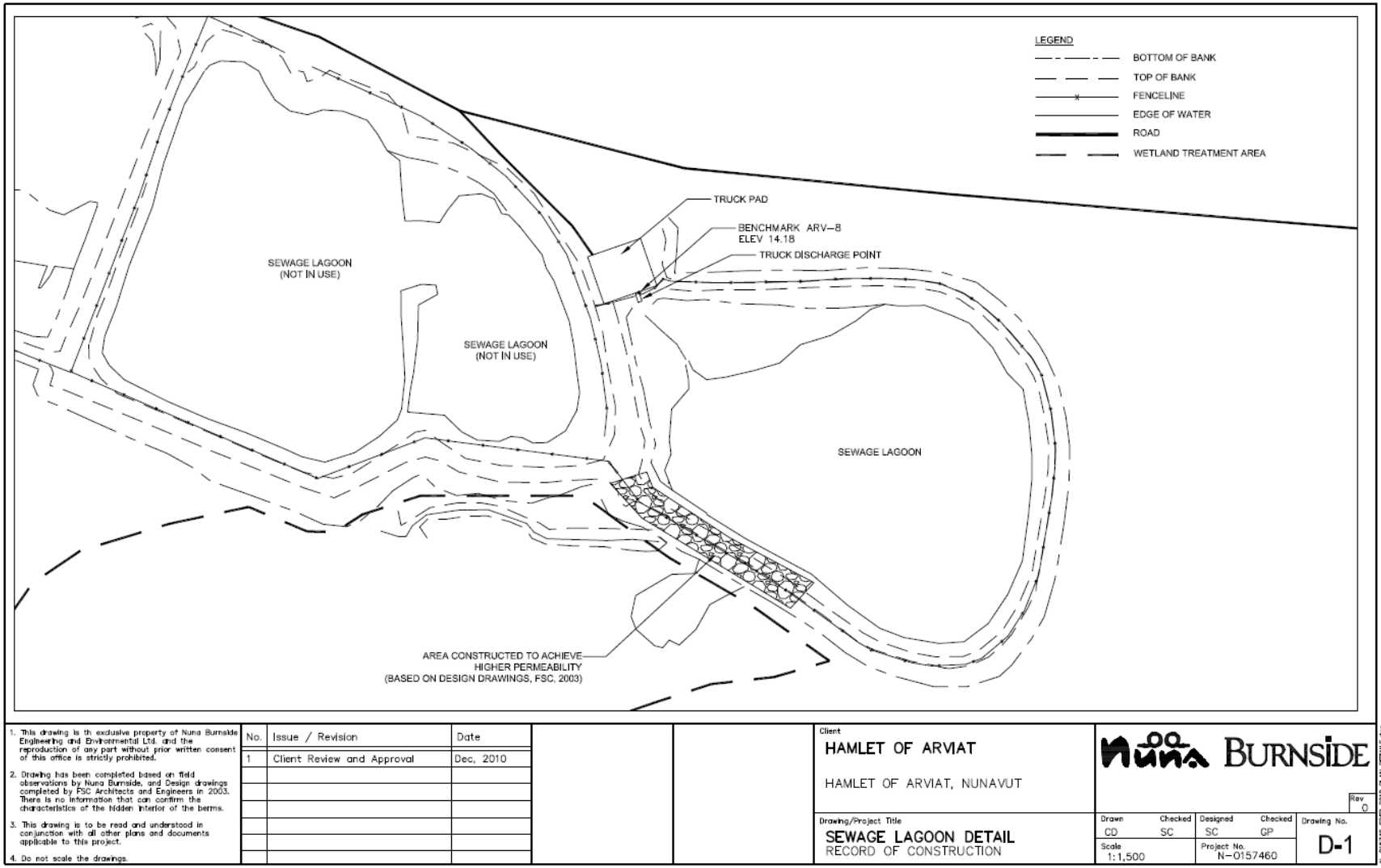
The existing facility is under capacity and a new facility is the in schematic design phase. All design documents relating to the upgrades site will be made available to the NWB as they are finalized and an amendment to the licence requested. An upgrades O&M plan will be submitted with the design documents for the upgraded infrastructure.

Appendix A Design Concept and As-Built Drawing


FSC
ARCHITECTS
&ENGINEERS
3 EN2 OFFLOAD CHUTE
2 EN2 TYPICAL TURNAROUND SECTION
1 EN2 TYPICAL BERM SECTION
1:50
4 EN2 BOLLARD DETAIL
Nunavut
ARVIAT SEWAGE LAGOON
ARVIAT, NU
DETAILS
JULY 7, 2021
EN-2


FSC
ARCHITECTS
&ENGINEERS
Nunavut
ARVIAT SEWAGE LAGOON
ARVIAT, NU
SITE LAYOUT


CORNER POST
CORNER POST CAP TYP.
RAIL & BRACE PIPE
LINE POST CAP TYP.
COUPLING (WHERE REQ'D.)
WIRE MESH FABRIC SEE NOTE 1
END & GATE POST CAP TYP.
FOOT BOLT
GATE & SIGN
GATE POST (TYP.)
STRETCHER BAR (TYP.)
℄ GATE & SIGN
℄ SIGN
DROP LATCH
LATCH CATCH
CHAIN WITH LOCK
STRECHER BAR BANDS
DROP FORGED TURNBUCKLE (TYP.)
LINE POST
STRETCHER BAR (TYP.)
1 500 mm FROM GRADE
SINGLE STRAND TENSION WIRE AND KNUCKLED BOTTOM EDGE
INTERMEDIATE BRACE ON INSIDE OF FENCE
HINGE BOLT (TYP.)
GATE HINGE (TYP.)
FINISH GRADE
CLEARANCE (100 MIN. - 75 MAX.)
1 830
1 500
300 MAX. TYP.
500
2 000
2 000 MAX.
TYP. SPACING BETWEEN LINE POSTS
45
1 220
DUTCH GATE
2 000 MAX.
EQUAL
FOR CLEAR GATE DIMENSION
SEE NOTE 4
1-A SINGLE GATE
1-B DOUBLE GATE
END, STRAINING, CORNER OR GATE POST
LINE POST
CONCRETE
CONCRETE SEE NOTE 3
FINISH GRADE
SEE NOTE 2
SEE NOTE 5
2800 MIN.
1 070 MIN.
840 MIN.
150 MIN.
3500 MIN.
500 MIN.
ALL POSTS
1370 MIN. FOR END, STRAINING OR GATE POSTS
1140 MIN. FOR LINE POSTS
DRILL HOLE & GROUT AROUND POST WITH CEMENT MORTAR SEE NOTE 3
MIN. HOLE DIA. = O.D. OF POST +100mm
BACKFILL
ROCK
VARIES
840 MIN. FOR LINE POSTS
1070 MIN. FOR OTHER POSTS
DRILL HOLE IN ROCK & GROUT WITH CEMENT MORTAR OR HOT POURED SULPHUR
MIN. HOLE DIA. = O.D. OF POST +25mm
TYPE I
IN BACKFILL OR EARTH (WITH CONCRETE FOOTINGS)
1-C FOOTING SECTIONS
TYPE II
IN EARTH WITH LARGE BOLDERS (DRILLED HOLE WITH GROUT)
TYPE III
IN SOLID ROCK
NOTES:
1- FOR FENCE MATERIAL SEE SPECIFICATIONS.
2- FOR BACKFILL MATERIALS & SOIL CLASSIFICATION SEE SPECIFICATIONS.
3- FOR CONCRETE MATERIAL SEE SPECIFICATIONS.
4- FOR TYPE AND DIMENSION OF GATE REFER TO PARTICULAR PROJECT DRAWINGS.
5- TOP OF FOOTING DOMED 20 mm HIGH (TO SHED AWAY SURFACE WATER) (TYP.)
6- FENCE POSTS AND FENCING TO BE PLUMB AND STRAIGHT
FSC
ARCHITECTS & ENGINEERS
Nunavut
ARVIAT SEWAGE LAGOON
ARVIAT, NU
FENCE DETAIL
JULY 7, 2003
EN-8



1. This drawing is th exclusive property of Nuna Burnside Engineering and Environmental Ltd. and the reproduction of any part without prior written consent of this office is strictly prohibited.
2. Drawing has been completed based on field observations by Nuna Burnside, and Design drawings completed by FSC Architects and Engineers in 2003. There is no information that can confirm the characteristics of the hidden interior of the berms.
3. This drawing is to be read and understood in conjunction with all other plans and documents applicable to this project.
4. Do not scale the drawings.

No.	Issue / Revision	Date
1	Client Review and Approval	Dec, 2010

Client: HAMLET OF ARVIAT
HAMLET OF ARVIAT, NUNAVUT

Drawing/Project Title: SEWAGE LAGOON DETAIL
RECORD OF CONSTRUCTION

NUNA BURNSIDE

Rev 0

Drawn	Checked	Designed	Checked	Drawing No.
CD	SC	SC	GP	D-1

Scale: 1:1,500
Project No.: N-0157460

N-0157460 SGFR 2010 PLAN DETAILS.dwg
Date Plotted: Dec 22, 2010–11:00pm

Appendix B: Photographs

Raw sewage being disposed at offload flume, September 10,2010

Benchmark use to survey lagoon level, September 10, 2010

Condition of Lagoon, June 4, 2018

Condition of Lagoon, June 4, 2018

Condition of Lagoon, June 4, 2018

Decanting, June 4, 2018