Snare River Septic Fields Special Study Design

November 2024

Revision History Table

WLWB Version #	Date Received by WLWB	Revised Sections	Description of Revision	Prepared by	Issue Date
1		Not applicable	Not applicable	NTPC	November 6, 2024

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PLAIN LANGUAGE SUMMARY

Northwest Territories Power Corporation (NTPC) owns and operates a series of four hydroelectric power generating systems on the Snare River, about 145 km northwest of Yellowknife, Northwest Territories. Septic systems, which include in-ground septic tanks and septic disposal fields, are used to treat wastewater produced by people (i.e., water that is used in sinks, showers, toilets, etc.) staying at the camps at two of the locations, Snare Rapids and Snare Forks. The Wek'èezhìi Land and Water Board (WLWB) requested that NTPC complete a study to verify that the septic systems are not polluting the Snare River. As part of this study, NTPC proposes to complete inspections of the septic systems and monitoring in the Snare River. The inspections of the septic systems will check that the systems are working as expected. The proposed monitoring in the Snare River will be completed upstream and downstream of the septic systems to verify that wastewater from the septic systems is not impacting the Snare River. After the study is complete, NTPC will prepare a report, where methods and results of the study will be presented; the report will also include an overall assessment of the potential impacts of the septic systems on the Snare River and recommendations for next steps if needed.

ABBREVIATIONS

Acronym	Definition
CALA	Canadian Association for Laboratory Accreditation Inc.
DI	De-ionized
DO	dissolved oxygen
DWGs	Drinking Water Guidelines
E. coli	*Escherichia coli*
GNWT	Government of Northwest Territories
HLR	hydraulic loading rate
LLR	linear loading rate
LWB	Land and Water Boards of the Mackenzie Valley
MTF	Multiple-Tube Fermentation
NT	Northwest Territories
NTPC	Northwest Territories Power Corporation
POPC	Parameters of potential concern
QA	quality assurance
QC	quality control
RPD	relative percent difference
STE	septic tank effluent
the Facility	Snare Hydroelectric Facility
UTM	Universal Transverse Mercator
WLWB	Wek'èezhìi Land and Water Board

UNITS OF MEASURE

Acronym	Definition
°C	degrees Celsius
%	percent
km	kilometre
km^2	square kilometres
L	litre
L/d	litres per day
m	metre
m^2	square metres
m^3/s	cubic metres per second
mg/L	milligrams per litre
mg-P/L	milligrams as phosphorus per litre
mg-N/L	milligrams as nitrogen per litre
MW	megawatts
NTU	nephelometric turbidity units
µg/L	micrograms per litre
MPN/100 mL	most probable number per one hundred millilitre
µS/cm	microsiemens per centimetre.

1 INTRODUCTION

1.1 BACKGROUND

Northwest Territories Power Corporation (NTPC) operates the Snare Hydroelectric Facility (the Facility) located on the Snare River, approximately 145 km northwest of Yellowknife, Northwest Territories (NT). The Facility is a cascade development with four hydro generation stations that span approximately 25 fluvial km, utilizing the difference in elevation between Bigspruce Reservoir (above Snare Rapids) and Strutt Lake (63.3 m difference). These generating stations, in order of upstream to downstream, are Snare Rapids (8.5 megawatts [MW]), Snare Falls (7.4 MW), Snare Cascades (4.3 MW), and Snare Forks (9.2 MW) (Figure 1). The project drainage area supplying the Snare Rapids Generating Stations (Bigspruce Reservoir) is 15,200 km^2, with a mean annual flow of 48.3 m^3/s. The Bigspruce Reservoir represents the main storage for the system. The incremental drainage areas intercepted by each of the three downstream plants are relatively small, such that the increases in intercepted flow are negligible relative to flows received at Snare Rapids. The combined generating stations provide power to the North Slave Electrical System, which provides power to the communities of Yellowknife, Behchokǫ̀, Dettah, and N’Dilo, along with the power generated by the Bluefish Hydroelectric Facility, the Jackfish Generating Plant, and the Frank’s Channel Generating Plant.

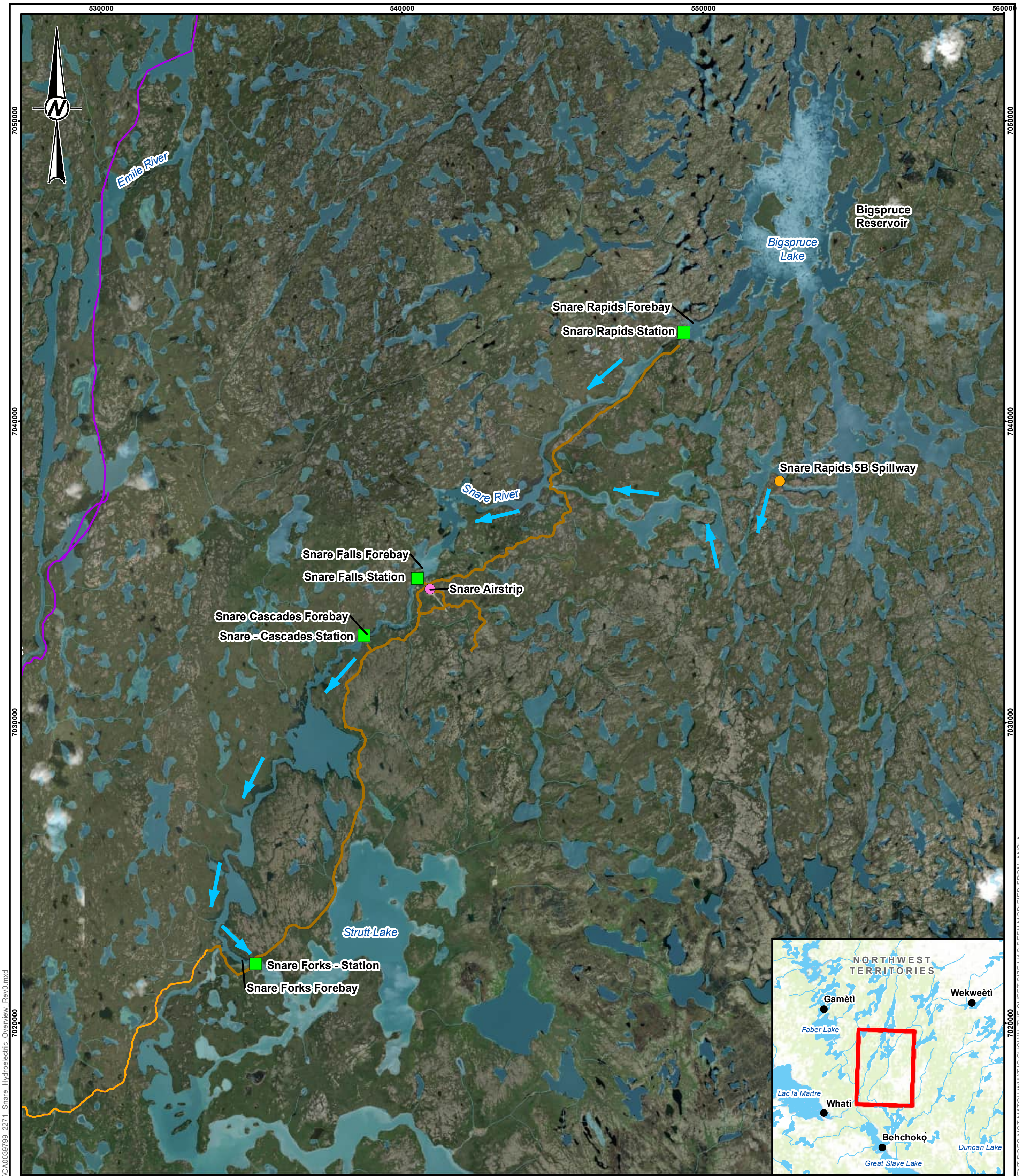
NTPC applied for a new Type A water licence from the Wek'èezhìi Land and Water Board (WLWB) to continue operation of the Facility in 2023; the new Water Licence W2023L4-0001 (Water Licence) was issued in 2024 (WLWB 2024a). During the Water Licence regulatory review process, reviewers raised concerns regarding the potential effects to the Snare River related to effluent from septic systems used to treat domestic wastewater generated at two of the Facility’s camps (i.e., at Snare Rapids and Snare Forks; WLWB 2023a,b, 2024b). A requirement to complete a special study to address these concerns was included in the Water Licence (i.e., Part F, Condition 16 of WLWB 2024a).

1.2 STUDY OBJECTIVES

The objective of the Snare River Septic Fields Special Study is to evaluate if the septic fields at the Snare Rapids and Snare Forks camps have had an effect on the Snare River by completing:

- inspections of the septic systems, including the septic fields, to confirm that they are functioning as expected; and
- monitoring the Snare River to confirm a lack of septic effluent signature in reaches of the Snare River downstream of the septic fields.

The study design is also intended to meet the requirements listed in Schedule 5, Condition 2 in the Water Licence (WLWB 2024a; Table 1).



LEGEND

- GENERATION STATION
- SNARE AIRSTRIP
- SNARE RAPIDS 5B SPILLWAY
- FLOW DIRECTION
- ALL-SEASON ROAD
- SNARE WINTER ROAD
- GNWT WINTER ROAD
- WATERCOURSE
- WATERBODY

0 4 8

1:175,000 KILOMETRES

REFERENCE(S)

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PROJECTION: UTM ZONE 11 DATUM: NAD 83

CLIENT

NORTHWEST TERRITORIES POWER CORPORATION

TITLE

SNARE HYDROELECTRIC FACILITIES OVERVIEW

CONSULTANT

YYYY-MM-DD	2024-10-30
DESIGNED	SP
PREPARED	AB
REVIEWED	AH
APPROVED	AH

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Table 1: Concordance of the Snare River Septic Fields Special Study with the Requirements Specified in the Water Licence W2023L4-0001, Schedule 5, Condition 2

Water Licence Condition		Study Design Section
a)	Description of the septic systems, their locations relative to the Snare River, and operating procedures.	Section 2
b)	Description of downstream receptors that may be impacted by effluent.	Section 3
c)	Identification, with rationale, of parameters of concern that should be used as indicators of potential impacts from the septic systems.	Section 4
d)	A description, with rationale, of the site-specific monitoring activities and anticipated duration of monitoring required to identify impacts from Project-related activities on the Receiving Environment.	Section 5.1
e)	A description of monitoring protocols, methodologies, parameters, and frequencies, including maps or diagrams of the septic systems and monitoring locations.	
f)	A description of the quality assurance and quality control measures followed.	Section 5.3
g)	Reporting schedule.	Section 6

2 DESCRIPTION OF THE SEPTIC SYSTEMS

A description of the design flows, septic tanks, disposal field, proximity of the system to Snare River and maintenance and monitoring activities are provided for the Snare Rapids and Snare Forks septic systems in Sections 2.1 and 2.2, respectively.

2.1 SNARE RAPIDS

2.1.1 Design Flow

Based on the design documents available to NTPC (NTPC 2002, 2017), this septic system was initially intended to service a population of approximately 20 people with a design flow of 4,540 L/d. The Government of Northwest Territories (GNWT) Good Engineering Practice for Northern Water and Sewer Systems recommends 225 L/person/d as a design flow (GNWT 2017), which equates to 4,500 L/d for 20 residents. Maximum occupancy at the Snare Rapids camp has remained at a maximum of 20 people (NTPC 2024a); therefore, the design flow remains in accordance with territory recommendations.

2.1.2 Septic Tank

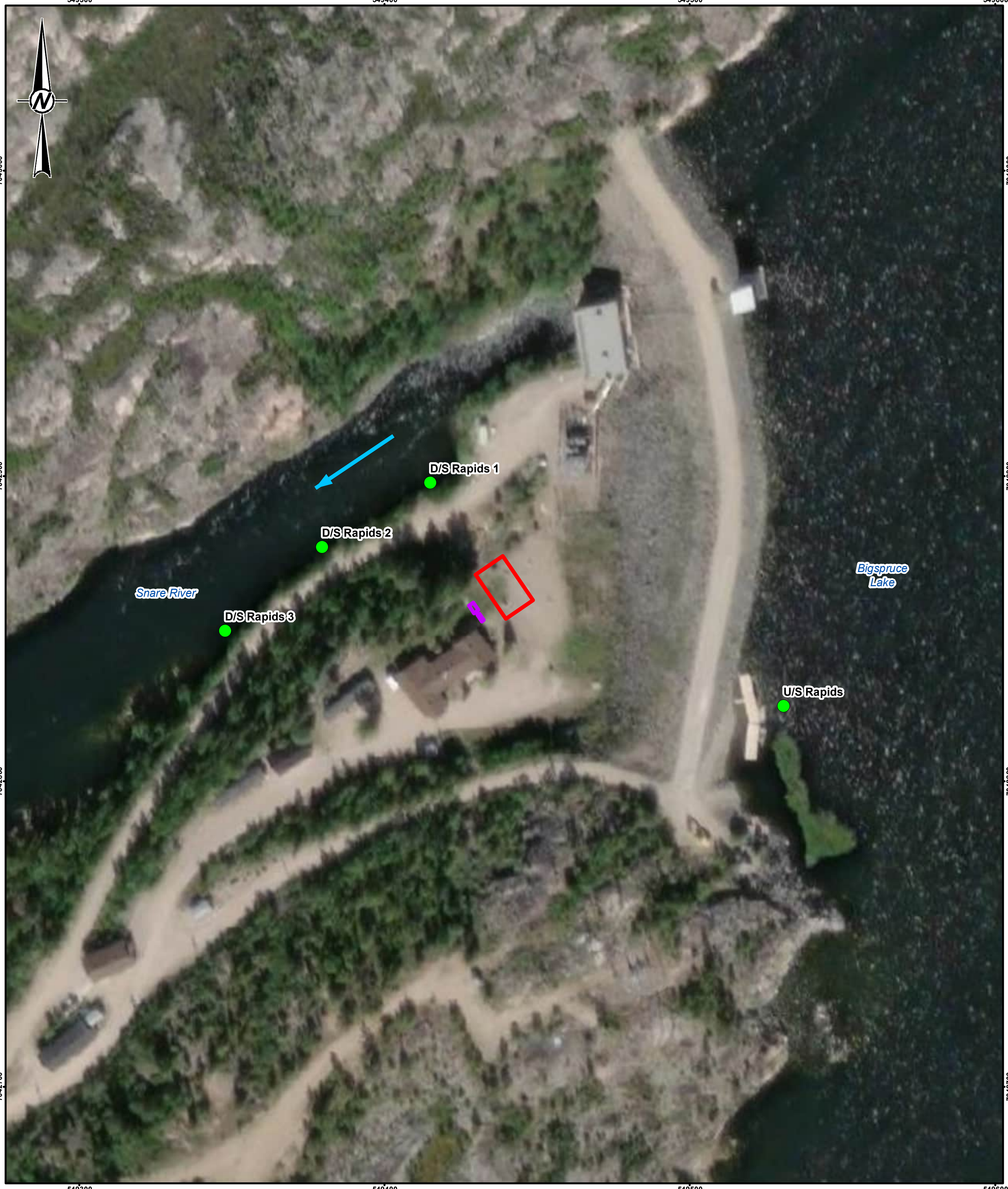
There are two existing septic tanks. The first tank is a single-chamber with a capacity of 10,400 L; the second tank contains a 2,934 L settling chamber, plus a 1,125 L pumping chamber (NTPC 2002, 2017). The combined settling volume is, therefore, 13,334 L.

2.1.3 Disposal Field

The area of the infiltrative surface in the dispersal bed of the Snare Rapids septic system is 190 m^2 based on the record drawings; the effective contour length of the dispersal field is 17.6 m, and the estimated percolation rate was 10 min/in (NTPC 2002, 2017). This information can be used to estimate the hydraulic loading rate (HLR) and linear loading rate (LLR) and compare these loading rates to standards from other relevant territorial or provincial jurisdictions, such as the Yukon Design Specifications for Sewage Disposal Systems (Government of Yukon 2022) or the Alberta Private Sewage Systems Standard of Practice (Alberta Safety Codes Council 2021). The HLR is an estimate of the volume of septic tank effluent (STE) discharged over time per unit area of the infiltrative surface (Alberta Safety Codes Council 2021); estimates of HLR can be used to demonstrate that the permeability of the infiltrative surface and treatment of the STE within the unsaturated sand and soil can be maintained. The LLR measures the volume of STE discharged over time per unit length of the overall system contour (Alberta Safety Codes Council 2021). Estimates of LLR can be used to demonstrate that effluent can travel away from the dispersal field without surfacing, accounting for the long-term groundwater mounding effects that dispersal fields create.

2.1.4 Proximity to Snare River

The location of the septic tanks and disposal field is shown in Figure 2. The septic system is approximately 30 m from the Snare River.



LEGEND

- PROPOSED WATER QUALITY SAMPLING SITE
- FLOW DIRECTION
- APPROXIMATE LOCATION OF SEPTIC FIELD
- APPROXIMATE LOCATION OF SEPTIC TANK

0 25 50

1:1,750 KILOMETRES

REFERENCE(S)

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PROJECTION: UTM ZONE 11 DATUM: NAD 83

CLIENT

NORTHWEST TERRITORIES POWER CORPORATION

TITLE

LOCATIONS OF THE SNARE RAPIDS SEPTIC SYSTEM AND PROPOSED MONITORING STATIONS

CONSULTANT

wsp

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PREPARED	AB
REVIEWED	AH
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2.1.5 Maintenance and Monitoring

The septic tanks are pumped out once per year with a vacuum truck; pumping occurs in the winter months when the ice road is open (NTPC 2024b). Repairs and upgrades were made to the Snare Rapids septic system between August 2016 and July 2017 (NPTC 2024a). NTPC staff complete checks on the tanks every two weeks to make sure the pump is running. Additional routine system monitoring has not occurred; however, NTPC staff have not observed conditions that would indicate a problem with the septic system (e.g., saturated soil in the disposal field; NTPC 2024b).

2.2 SNARE FORKS

2.2.1 Design Flow

The record drawings available to NTPC indicate the design flow is 1,818 L/d (NTPC 2018). This will provide servicing for up to eight people using the NWT design value of 225 L/person/d. The drawing separately notes a design capacity of 682 L/d to service three people; NTPC has confirmed that the design flow was intended for occupancy of three to eight people (NTPC 2024a). The occupancy at this location is low and intermittent (NTPC 2024a,b); therefore, ongoing loadings with eight people do not currently occur, and the design flow remains in accordance with territory recommendations.

2.2.2 Septic Tank

The existing septic tank has two compartments, the first operating as a settling tank and the second as a pump chamber. The total tank volume is 4,540 L, of which at least 3,000 L would likely be contained within the settling compartment.

2.2.3 Disposal Field

The area of the infiltrative surface in the dispersal bed of the Snare Forks septic system is approximately 67 m^2, based on the record drawings. The percolation rate is 55 min/in; the effective contour length of the dispersal field is estimated to be 9.9 m based on the record drawings. The dimensions of the granular bedding material surrounding the laterals are considered for estimating the contour length, with bedding assumed to extend 0.3 m at both ends of the field beyond the 9.3 m laterals.

2.2.4 Proximity to Snare River

The location of the septic tanks and disposal field is shown in Figure 3. The septic system is approximately 70 m from the Snare River.

2.2.5 Maintenance and Monitoring

The septic tank is pumped out once per year with a vacuum truck; pumping occurs in the winter months when the ice road is open (NTPC 2024b). Additional system monitoring has not occurred; however, NTPC staff have not observed conditions indicating a problem with the septic system (e.g., saturated soil in the disposal field; NTPC 2024a).

LEGEND

- PROPOSED WATER QUALITY SAMPLING SITE
- FLOW DIRECTION
- APPROXIMATE LOCATION OF SEPTIC FIELD
- APPROXIMATE LOCATION OF SEPTIC TANK

0 25 50

1:1,750 KILOMETRES

REFERENCE(S)

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PROJECTION: UTM ZONE 11 DATUM: NAD 83

CLIENT

NORTHWEST TERRITORIES POWER CORPORATION

CONSULTANT

wsp

TITLE

LOCATIONS OF THE SNARE FORKS SEPTIC SYSTEM AND PROPOSED MONITORING STATIONS

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REVIEWED	AH
APPROVED	AH

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3 DESCRIPTION OF THE ENVIRONMENT

The Snare River is an important watercourse for the NT, supporting ecological and economic functions, particularly through its role in hydroelectric power generation. Ongoing flow monitoring is required at multiple locations on the Snare River as part of the Water Licence; flows are reported in monthly and annual Water License reports (e.g., NTPC 2024c). The river is characterized by significant seasonal fluctuations in flow, with the highest flows occurring during the spring snowmelt (WSP 2023). This influx of water leads to elevated water levels, gradually declining through the summer and fall as inflows diminish. Lower water levels typically occur later in summer (June and July) and early fall (September and October; Figure 4), which can have critical implications for both the ecosystem and the management of the river (WSP 2023).

Other monitoring programs implemented throughout the Snare River system have focussed on evaluating water quality, fish populations, and habitat conditions (WSP 2023). Overall, monitoring has indicated good water quality in the Snare River, with low levels of pollutants. The river system is characterized by clear, soft, slightly alkaline waters and contains very low concentrations of nutrients and total metals (Rescan 2001). Classified as oligotrophic, the water exhibits low buffering capacity and productivity, typical of Arctic systems. Nutrient levels are consistently low throughout the river, with the only notable trend being higher nitrate concentrations at greater depths. This is likely due to higher phytoplankton biomass in shallower waters, which absorbs a larger proportion of nitrate (Rescan 2001). Total metal concentrations remain similar across different depths, sampling dates, and locations, with concentrations of most metals at or below detection limits (Rescan 2001). Aluminum concentrations were occasionally above the Canadian Water Quality Guideline for the protection of aquatic life, particularly downstream of Snare Forks. Despite these elevated aluminum concentrations, the aquatic ecosystem showed no negative effects, as evidenced by a healthy and diverse aquatic food web (Rescan 2001).

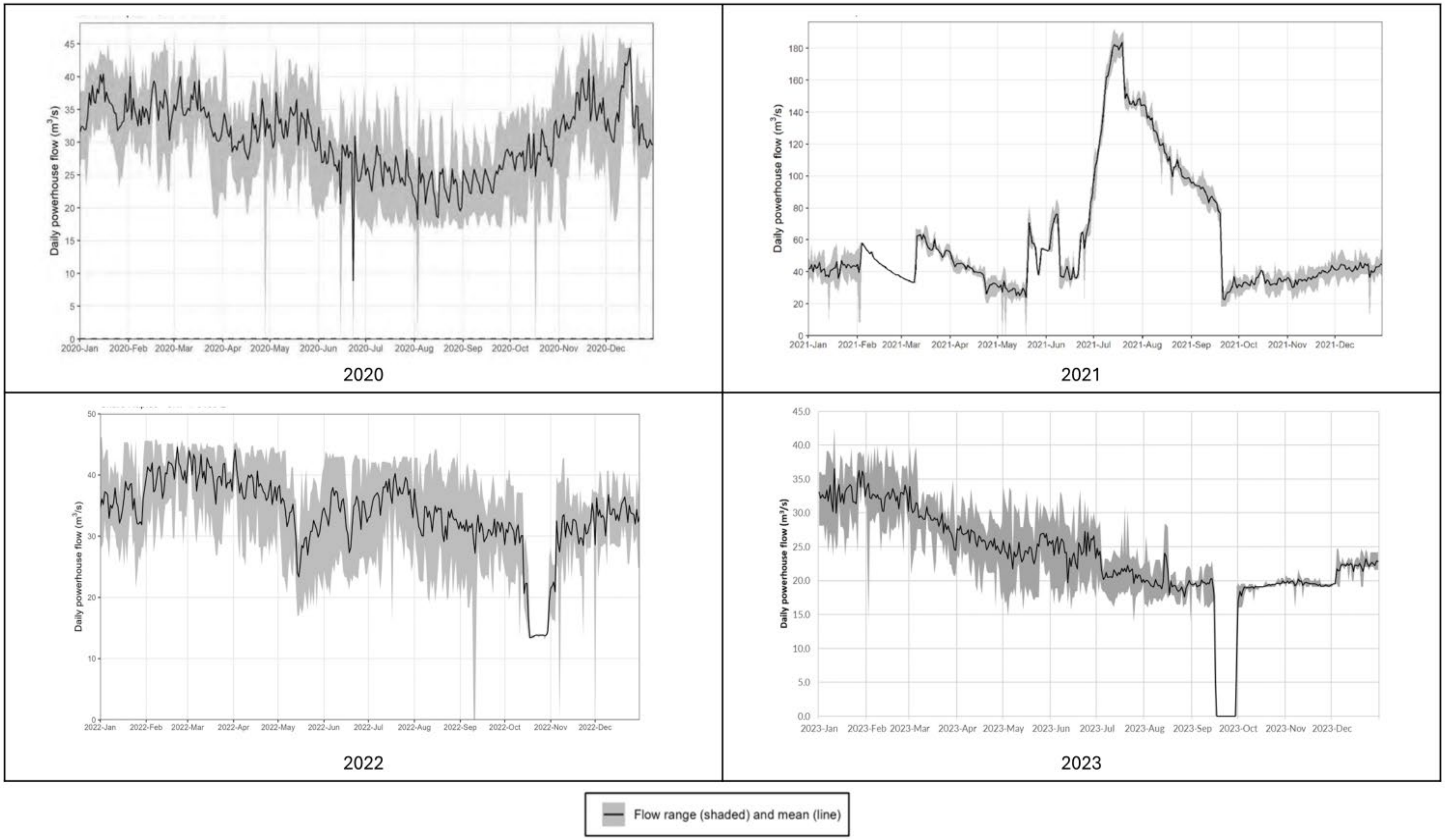
The Snare River aquatic ecosystem supports a diverse range of fish species, with 15 species recorded, including Lake Whitefish, Northern Pike, Walleye, and Arctic Grayling. Notably, Arctic Grayling populations are concentrated downstream of Snare Falls, indicating that the river's flow regimes and water quality are suitable for this species, which is often sensitive to environmental disturbances (Rescan 2000). The river's benthic invertebrate community is equally diverse, dominated by Dipterans, nematodes, and mollusks. These organisms are indicators of the river's overall health and low levels of organic pollution, and they provide a crucial food source for fish populations, helping to sustain the ecological balance within the river system.

The Snare River also serves as an important recreational and subsistence resource for local Indigenous communities, especially the Tłįchǫ people, who use the river and surrounding lakes for fishing, hunting, and trapping. Lake Whitefish and Northern Pike are among the key species targeted in these activities. The river's role as a traditional travel route and resource base highlights its cultural and ecological significance. Recreational fishing is supported by ongoing environmental monitoring to ensure the sustainability of these vital resources (WSP 2023).

The main water use for the Snare River considered in this study is supporting ecological health; therefore, the relevant downstream receptors are the fish and other aquatic life and wildlife living within and adjacent to the Snare River downstream of the septic systems. Human recreational and incidental drinking water[1] uses are limited in the Snare River due to its remoteness; however, these uses are also considered in the study, with humans using the water, either for recreational or drinking water purposes, downstream of the septic systems being the receptor.

[1] NTPC does use water from the Snare River or groundwater for potable water at the Snare Rapids or Snare Forks camps.

Figure 4: Minimum, Maximum and Mean Daily Flows Downstream of Snare Rapids Hydroelectric Facility at Surveillance Network Program Station SNP 0150-2, 2020 to 2023



4 PARAMETERS OF POTENTIAL CONCERN

Parameters of potential concern (POPC) selected for identifying a potential signature of STE in the Snare River were based on three main factors: 1) ability to assess effects on uses (or receptors) of the Snare River downstream of the Snare Rapids and Forks system systems; 2) their prevalence in STE and 3) complexity of monitoring. POPC were grouped into three categories:

- Bacteriological indicators
- Nutrient indicators
- Tracer indicators of chloride, sodium, and conductivity

Bacteriological indicators such as total coliforms, fecal coliforms, and *Escherichia coli* (*E. coli*) are often used as tracers of STE because the presence of these bacteria in rivers can indicate direct input of untreated or partially treated sewage, which can pose a significant risk to human health. Elevated levels can indicate a greater risk of waterborne diseases that can be harmful to human health (Richards et al. 2017). Total coliforms are a group of closely related bacteria that are generally free-living in the environment but are also present in water contaminated with human and animal feces (Government of British Columbia 2007). All coliforms do not necessarily cause human disease; however, their presence in water indicates possible contamination with human or animal wastes. The total coliform group includes fecal coliform and *E. coli*. Fecal coliforms are a group of bacteria associated with human waste, including STE; these bacteria usually live in human or animal intestinal tracts, and their presence in water strongly indicates recent sewage or animal waste contamination (Government of British Columbia 2007). *E. coli* serves as another indicator of fecal contamination (Richards et al. 2017); some strains of *E. coli* are known to cause serious illness in humans (Government of British Columbia 2007). Total coliforms, fecal coliforms, and *E. coli* are standard bacteriological parameters routinely monitored for assessment of recreational uses and drinking water in rivers and lakes.

Nutrient indicators, such as nitrogen and phosphorus, are also used to identify the presence of STE; nutrients have the potential to be a concern from both an ecological and human health perspective. Nitrogen species in STE, including ammonia and nitrate (Digaletos et al. 2023, Richards et al. 2017, Roberton 2021), have the potential to have toxicity effects to aquatic life (CCME 1999) where STE may enter receiving water and increase concentrations of these parameters. Loadings of phosphorus in STE have the potential to increase concentrations of phosphorus in groundwater downgradient and waterbodies downstream of septic systems (Digaletos et al. 2023, Robertson et al. 2019, Lusk et al. 2011), ultimately resulting in nutrient enrichment effects in affected waterbodies. Due to the oligotrophic status of the Snare River, small increases in phosphorus have the potential to result in nutrient enrichment effects, which could lead to excess algae growth and lower dissolved oxygen concentrations that are harmful to aquatic life.

Chloride and sodium, typically elevated in domestic wastewater and STE relative to natural receiving waters, act as conservative tracers due to their relative stability and persistence in the environment (Richards et al. 2017, Roberston 2021). At sufficiently high concentrations, chloride can have toxicity effects on aquatic life (CCME 1999) and impair the aesthetic quality of drinking water (Health Canada 2024). Conductivity, which measures the amount of dissolved material in the water (e.g., chloride and sodium), is also a valuable tracer for STE (Richards et al. 2017, Robertson 2021). Differences in conductivity can be measured in the field, making conductivity a practical and reliable tool for detecting septic system plumes (Robertson 2021).

Pharmaceuticals, artificial sweeteners, and caffeine are known to be present in some STE (Richards et al. 2017, Digaletos et al. 2023) but were not selected as POPC. These parameters are not typically included in water quality monitoring programs for assessing environmental effects and have not been routinely monitored in the Snare River. The presence and typical concentrations of these non-standard parameters are unknown in the STE from the Snare Rapid and Forks camps, which reduces their effectiveness in detecting STE in the Snare River relative to parameters that are known to be elevated in all domestic wastewaters (e.g., bacteria, nutrients, and tracer parameters like chloride). Additionally, laboratory analyses for these parameters required specialized methods, and the results would provide limited information regarding the effects on the uses of the Snare River because aquatic life guidelines and background data in the Snare River are not available for these parameters.

The POPC identified for detecting and assessing potential effects in the Snare River from STE has been included in the parameter list proposed to be monitored during the study; additional information on the full list of parameters selected for the Snare River Septic Fields Special Study can be found in Section 5.2.2.

5 STUDY DESIGN

The design of the Snare River Septic Fields Special Study is comprised of two components: 1) assessing whether the septic systems are functioning as expected, and 2) investigating whether a signature of STE can be detected in the Snare River downstream of the septic systems and if it can, assess the potential for effects on uses of the Snare River. To NTPC's knowledge, formal inspections of the septic systems have not been completed in the last five years; therefore, an inspection of the septic system is proposed to identify deficiencies in the systems that should be mitigated or repaired to reduce the potential risk of STE entering the Snare River. NTPC also proposes to complete sampling in the Snare River upstream and downstream of the septic systems to confirm that a septic effluent signature is not detected in the Snare River or if it is detectable that the potential effects on the uses of the Snare River are negligible. A description of the field methods, including requirements for the septic system inspection, water quality monitoring locations, frequency and parameters, methods to analyze and interpret the data, and quality assurance and control methods, are provided in the subsequent sections (Sections 5.1 to 5.3) of the study design.

5.1 FIELD METHODS

5.1.1 Septic System Inspection

It is understood that the septic tanks are currently pumped out once yearly during the winter months when the ice road is open. The following activities are proposed during the next tank pump-out:

- **Visual inspection of the tankage, looking for risk factors of potential failure including:**
    - Degraded or cracked concrete.
    - Differential settling or heaving that may have made the tank grades uneven.
    - Inspection of the emptied tankage may occur visually from the access risers and be aided by a light source; therefore, the need for confined space entry is not anticipated.
- **Inspection of heat tracing and insulation to verify ongoing freeze protection.**

The following additional inspections are proposed to occur when ambient temperatures are above freezing and the ground is free of snow cover:

- **Visual inspection of the disposal field, looking for risk factors of potential failure including:**
    - Signs of effluent surfacing, such as pooling, saturated ground, or organic films. It is recommended that the disposal field and adjacent downslope areas be inspected.
    - Excessively uneven vegetation growth, which could indicate short-circuiting of effluent to one area of the field.
    - Visual assessment of the prevailing slope of effluent pathway to the Snare River.

- **Camera inspection, if feasible, of disposal field piping, looking for risk factors of potential failure including:**
  - Obstruction of the piping from roots or accumulated debris.
  - Visible cracks or breaks in the piping.
  - Excessive differential settling or heaving that may have altered the intended pipe grading.
  - Laterals flooded with water, indicating a water table or lack of soil drainage.
  - Laterals which are bone dry with cobwebs, which may indicate that no effluent is reaching the lateral.
- **Inspection of groundwater levels:**
  - The record drawings indicate that groundwater monitoring ports were to be installed within the disposal field and downslope of the field. If these are not accessible or installed, it is recommended that new ports be installed in reference to the locations indicated in the record drawings.
  - Measure groundwater levels from the observation ports. The intention is for at least 1.2 m of vertical separation from the lateral elevations to a restrictive layer or water table.

A qualified sewage system maintenance provider may conduct the site inspections. The site inspection scope includes comprehensive record photos and a detailed summary of all observations.

5.1.2 Surface Water Quality Monitoring

5.1.2.1 Sampling Locations

Water quality monitoring will be conducted in the following areas to investigate whether a signature of STE from the septic systems at Snare Rapids and Snare Forks on the Snare River can be identified:

- **Snare Rapids (Figure 2, Table 2):** Sampling stations include U/S Rapids, D/S Rapids 1, D/S Rapids 2, and D/S Rapids 3.
- **Snare Forks (Figure 3, Table 2):** Sampling stations include U/S Forks, D/S Forks 1, D/S Forks 2, and D/S Forks 3.

Water quality at three downstream stations in the Snare River, either adjacent to or downstream of potential STE from the septic systems at both the Snare Rapids and Snare Forks locations, will be monitored to detect a signature of STE in the river. Water quality at one station upstream and upgradient of the septic systems at Snare Rapids and Snare Forks will be monitored to establish water quality conditions that are unimpacted by STE. The target Universal Transverse Mercator (UTM) coordinates for the monitoring locations and sampling requirements for each station are summarized in Table 1; the target locations of the monitoring stations are shown for Snare Rapids and Snare Forks in Figures 2 and 3, respectively.

Table 2: Water Quality Monitoring Station Locations and Sampling Requirements

Sampling Area	Station Name	UTM Coordinates[(a)]		Monitoring Requirements[(b)]
		Easting (m)	Northing (m)	
Snare Rapids	U/S Rapids	549530	7042824	Photo of station Spot or profile WQ field measurements[(c)] WQ samples at surface or surface and bottom depths[(c)]
	D/S Rapids 1	549415	7042897	Photo of station Spot WQ field measurements Surface WQ samples
	D/S Rapids 2	549379	7042876	
	D/S Rapids 3	549347	7042849	
Snare Forks	U/S Forks	535114	7022095	Photo of station Spot or profile WQ field measurements[(c)] WQ samples at surface or surface and bottom depths[(c)]
	D/S Forks 1	535226	7022037	Photo of station Spot WQ field measurements Surface WQ samples
	D/S Forks 2	535252	7022047	
	D/S Forks 3	535293	7022032	

(a) UTMs for the stations are target UTM's based on desktop review and will be confirmed in the field.

(b) Details on sampling requirements for each station are outlined in Section 5.1.2.3.

(c) Spot WQ measurements and surface WQ samples will be collected if the water depth is 5 m or less; profile WQ field measurements will be collected if the water depth is greater than 5 m. If there is a gradient in profile WQ field measurements (i.e., and the depth is greater than 5 m), surface and bottom WQ samples will be collected; if there is no gradient in profile WQ field measurements, only a surface WQ sample will be collected.

UTM = Universal Transverse Mercator; D/S = downstream; U/S = upstream; WQ field measurements = pH, dissolved oxygen, specific conductivity and temperature; WQ samples = water samples for analyses of parameters in Table 3.

5.1.2.2 Sampling Frequency

Water quality monitoring for the Snare River Septic Fields Study will be conducted twice in 2025 during low flow conditions in the Snare River. The monitoring programs are proposed to be completed once in June and again in October, aligning with the expected periods of low water flow in the Snare River (Figure 4). Given the intermittent occupancy at Snare Forks, NTPC proposes to initiate monitoring at the Snare Forks stations only if and when occupancy reaches at least 50% (i.e., four or more people regularly at the camp).

5.1.2.3 Sampling Methods

Sampling stations at both the Snare Rapids and Snare Forks camps will be accessed on foot, with monitoring conducted along the shoreline or off a dock of each watercourse or waterbody.

Field photos will be taken at each sampling site (Table 2). Where safe to do so, water depth will be measured using a measuring tape and recorded on waterproof field notebooks or field datasheets, along with any other field observations. Field physio-chemical spot measurements will be collected with a calibrated water quality multi-parameter meter (e.g., AquaTROLL or equivalent) for the following parameters:

- Temperature (°C);
- Dissolved oxygen (mg/L and %);
- Specific conductivity (referred to herein as conductivity; µS/cm); and
- pH.

The meter will be allowed to stabilize for a minimum of five minutes before the water quality values are recorded and care will be taken to not submerge the sensors of the water quality meter in the sediment.

If water depths are greater than 5 m at the upstream stations, vertical profiles will be collected at 1 m intervals. If a gradient in temperature, dissolved oxygen (DO), or conductivity is observed, samples will be taken from both near the bottom (at least 0.5 m from the bottom to avoid disturbing the sediment) and near the surface (i.e., 0.3 m below the surface), and additional field measurements will be collected at the same depths as the sample depths. If no gradient is present, water quality samples will be collected near the surface at the upstream stations. If the water depth is 5 m or less at the upstream station and at each downstream station in the Snare River, spot field measurements and surface water sampling will occur at 0.3 m below the water surface.

Water quality samples will be collected after the physio-chemical water quality field measurements have been recorded. The sampling depth, date, and time of field data and water chemistry sample collection will be recorded on field data sheets. Sample bottles will be ordered and supplied by the laboratory prior to fieldwork, along with a chain of custody form.

Water for near-surface samples will be collected directly into sample bottles by submerging each bottle to the correct depth until filled, with the mouth of the bottle facing upstream of where the field personnel is standing. Field personnel will avoid disturbing the bottom sediment when collecting the sample. Bottles pre-charged with preservatives will be collected by submerging a spare routine bottle to the correct depth with the mouth facing upstream and then decanting into the pre-charged bottle without overfilling. Sample collection near the bottom will be conducted using Kemmerer or equivalent samplers. Water from the Kemmerer will be decanted into the sample bottles.

Prior to, or immediately after, sampling, the bottles will be labelled with the date and time of collection, station name or sample identification number, and initials of personnel collecting the sample. The bottles will be stored on ice to keep cool (approximately 4°C). At the end of each program, samples will be transported to an analytical laboratory accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) as soon as possible so that analyses can be conducted within the laboratory's recommended hold time, or as close to these hold times as possible. The laboratory will process the samples in accordance with standard methods (e.g., APHA 2012). Water quality samples will be analyzed for the parameter suite and detection limits outlined in Table 3, using the analysis methods and laboratories listed in Table 3.

Table 3: Water Quality Parameters, Target Detection Limits, Units, and Analytical Methods to be Used During the Snare River Septic Fields Special Study

Group	Water Quality Constituents	Detection Limit	Unit	Analytical Method
Physical and Conventional Parameters	Laboratory pH	0.1	unitless	pH meter
	Laboratory conductivity	2	μS/cm	Conductivity meter
	Total dissolved solids, calculated	1	mg/L	Calculation
	Total dissolved solids, measured	10	mg/L	Gravimetric
	Total suspended solids	3	mg/L	Gravimetric
	Turbidity	0.1	NTU	Nephelometric
Major Ions	Bicarbonate, as HCO_3	2	mg/L	Titration
	Calcium	0.02	mg/L	CRC ICP-MS
	Carbonate, as CO_3	2	mg/L	Titration
	Chloride	0.5	mg/L	IC
	Fluoride	0.02	mg/L	IC
	Hardness, as $CaCO_3$	0.5	mg/L	Calculation
	Hydroxide, as OH	2	mg/L	Titration
	Magnesium	0.005	mg/L	CRC ICP-MS
	Potassium	0.05	mg/L	CRC ICP-MS
	Reactive silica, as SiO_2	0.01	mg/L	Colourimetric
	Sodium	0.05	mg/L	CRC ICP-MS
	Sulphate	0.05	mg/L	IC
	Total alkalinity, as $CaCO_3$	2	mg/L	Titration
Nutrients	Dissolved organic carbon	1	mg/L	Combustion
	Total organic carbon	1	mg/L	Combustion
	Nitrate, as N	0.005	mg-N/L	IC
	Nitrate/Nitrite, as N, calculated	0.0051	mg-N/L	Calculation
	Nitrite, as N	0.001	mg-N/L	IC
	ortho-Phosphate, as P	0.001	mg-P/L	Colourimetric
	Total ammonia, as N	0.005	mg-N/L	Fluorescence
	Total dissolved phosphorus	0.001	mg-P/L	Colourimetric
	Total Kjeldahl nitrogen	0.05	mg-N/L	Fluorescence
	Total nitrogen, calculated	0.05	mg-N/L	Calculation
	Total phosphorus	0.001	mg-P/L	Colourimetric
Bacteriological	Total coliforms	1	MPN/100 mL	MTF
	Fecal coliforms	1	MPN/100 mL	MTF
	Escherichia coli	1	MPN/100 mL	MTF

$CaCO_3$ = calcium carbonate; CO_3 = carbonate; CRC ICP-MS = collision/reaction cell inductively coupled mass spectrometry; HCO_3 = bicarbonate; IC = ion chromatography; MTF = Multiple-Tube Fermentation; mg/L = milligrams per litre; mg-P/L = milligrams as phosphorus per litre; mg-N/L = milligrams as nitrogen per litre; N = nitrogen; NTU = nephelometric turbidity units; OH = hydroxide; P = phosphorus; SiO_2 = silica; µg/L = micrograms per litre; MPN/100 mL = most probable number per one hundred millilitre; µS/cm = microsiemens per centimetre.

5.2 DATA ANALYSIS AND INTERPRETATION

5.2.1 Septic System Inspection

Information and data from the septic system inspection will be analyzed to assess the following:

- **Immediate Action Items:** If deficiencies in the system are identified that may impact system performance or result in environmental risk, recommendations will be made for repairing or replacing the components. Examples of actionable deficiencies may include broken piping, compromised tanks, and failed heat tracing.
- **Long Term Risks:** The information gathered during the inspection will be analyzed for the potential of longer-term risks to the receiving environment. Estimates of HLRs and LLRs will be compared to standards from relevant provincial and territorial jurisdictions (e.g., Government of Yukon 2022; Alberta Safety Codes Council 2021). If risks are identified, recommendations will be made for ongoing monitoring and potential mitigations. For example, if observed groundwater levels do not meet recommended regulatory criteria for at least 1.2 m of vertical separation, ongoing monitoring of groundwater levels would be recommended, with replacement or expansion of the field to be undertaken if the ongoing monitoring demonstrates that STE surfacing poses an imminent risk.

5.2.2 Surface Water Quality Monitoring

Water quality data collected during the study will be evaluated to determine whether a signature of STE can be detected in the Snare River downstream of the septic systems and, if so, characterize the potential effect of the STE on uses of the Snare River by completing the following two assessments:

- **Comparisons to Relevant Guidelines:** Water quality data will be compared to guidelines relevant to the potential uses identified for the Snare River:
  - Canadian Water Quality Guidelines for the Protection of Aquatic Life and Livestock Watering (CCME 1999) determine if concentrations upstream or downstream of the septic systems are above recommended thresholds for aquatic life or wildlife[2].
  - Health Canada Drinking Water Guidelines (DWGs, Health Canada 2024) to determine if concentrations upstream or downstream of the septic systems are above health-based DWGs or aesthetic objectives for drinking water.
  - British Columbia's Recreational Water Quality Guidelines (BC MECCS 2019) determine if concentrations upstream or downstream of the septic systems are above thresholds protective of human health for recreational uses.

[2] In the absence of water quality guidelines for wildlife, Canadian Water Quality Guidelines for livestock watering were used as surrogate thresholds for wildlife.

- **Qualitative Spatial Comparisons:** Water quality data will be assessed by comparing concentrations (or values for conductivity) of parameters of potential concern (i.e., bacteriological indicators, nutrients and other tracer parameters that could indicate the presence of STE) collected upstream and downstream of the septic systems. Increases in concentrations between upstream and downstream stations or decreasing concentration gradients with distance downstream of the septic system could indicate a potential signature of STE in the Snare River. All parameters will be reviewed for patterns; however, the focus of this assessment will be on key parameters from each POPC group:
    - Bacteriological indicators:
        - *E. coli* is a key parameter due to its greater specificity in detecting STE relative to fecal and total coliforms and the availability of wildlife health, recreational, and drinking water guidelines for this parameter.
    - Nutrient indicators:
        - Nitrate and ammonia are key parameters due to their presence in STE, potential mobility in groundwater into surface water, and availability of aquatic life, wildlife, recreational, and drinking water guidelines for one or both parameters[3].
        - Total and dissolved phosphorus are key parameters due to their presence in STE and the potential sensitivity of the Snare River to increases in phosphorus due to its oligotrophic status.
    - Other potential tracers of STE:
        - Chloride and sodium are key parameters due to their presence in STE, lack of transformation or degradation in the environment, and the availability of an aquatic life guideline (for chloride only) and aesthetic objectives for drinking water for these parameters.
        - Specific conductivity is a key parameter due to its correlation with dissolved substances in STE (e.g., chloride and sodium) and its ability to be easily measured in the field.

If spatial patterns are identified that indicate a potential signature of STE in the Snare River downstream of the septic systems, the potential effects to ecological, drinking water, and recreational uses of the water in the Snare River will also be evaluated. The combined results of the assessment of spatial patterns that indicate a potential signature of STE in the Snare River and comparisons to relevant guidelines will be used to make recommendations for updates to the Water Licence (e.g., Surveillance Network Program; WLWB 2024a) or management plans required by the Water Licence (e.g., Waste Management Plan; NTPC 2023).

[3] Ammonia has an aquatic life guideline only; all four types of guidelines are available for nitrate.

5.3 QUALITY ASSURANCE AND QUALITY CONTROL

NTPC will adhere to quality assurance (QA) and quality control (QC) protocols to maintain the integrity and reliability of data and reports produced for this monitoring program. Procedures for QA involve a comprehensive set of management and technical procedures aimed at generating high-quality data consistently. Procedures for QC - as a component of QA - include specific measures to assess and verify data quality and procedures for implementing corrective actions if data quality objectives are not achieved.

5.3.1 Septic System Inspection

In the field, the following QA/QC procedures will be applied:

- The checklist of action items is to be pre-approved by reviewing professionals prior to the crew undertaking the fieldwork.
- The crew undertaking the fieldwork to adhere to the checklist and make field notes of all applicable observations.
- Photos of all aspects of the investigation to be taken for records. The photos to include metadata indicating the date and time of the photo along with the GPS coordinates.

Office-based QA/QC procedures include the following:

- All field data to be reviewed against checklist and inspection objectives for completeness and clarity.
- All data to be reviewed against applicable regulations within the Northwest Territory, or where no local regulation exists, against applicable regulations within an adjacent province or territory.
- All reporting to be peer-reviewed by a separate Qualified Professional competent in the area of practice.

5.3.2 Surface Water Quality Monitoring

The following QA/QC procedures should be applied by the qualified field crew:

- Calibrate the water quality meter at least once at the beginning of the program to check the precision and reliability of field measurements.
- During field programs, completion of daily end-of-day checks of the water quality meter by measuring the pH and specific conductivity of known calibration standards to determine if calibration drift occurred throughout the day.
- During field programs, daily Winkler titrations are completed to confirm alignment with dissolved oxygen measurements collected using the water quality meter.

- Collection of equipment blanks, field blanks, travel blanks, and duplicate samples as described below:
  - Equipment blanks are samples prepared using de-ionized (DI) water provided by the analytical laboratory. De-ionized (DI) water is used to rinse the water sampling equipment. Equipment blank samples are filtered and preserved as required, following the same method as the water quality samples. Equipment blank samples are used to detect potential sample contamination due to the sampling equipment.
  - Field blanks are samples prepared in the field using DI water provided by the analytical laboratory. The DI water samples are exposed to the sampling environment at the sample site and handled like the other samples collected. Field blank samples are filtered and preserved as required, following the same method as the water quality samples. Field blanks are used to detect potential sample contamination during sample collection, handling, shipping, and analysis.
  - A travel blank is a complete set of sealed bottles containing DI water, which the analytical laboratory provides. The travel blank is never opened but accompanies sample bottles to and from the field site. Travel blanks are used to detect potential sample contamination during storage and transport.
  - A duplicate sample is the collection of replicate samples from one sample site (i.e. two containers filled in rapid succession at the same sampling location). Duplicate samples are filtered and preserved as required, following the same method as the parent water quality samples. Duplicate samples are used to check within-site variation, and the precision of field sampling methods and laboratory analysis.
- The location where the field blank or duplicate sample is collected will be randomly chosen and recorded in the field notes.
- The QC samples will be submitted blindly to the laboratory for analysis with the other samples and represent a minimum of 10% of the samples submitted to the laboratory.

Office-based QA/QC procedures include the following:

- For field data:
  - Calculation of the percent error between the known calibration standard values and the end-of-day checks, as outlined in the equation below; percent errors greater than 5% represent a notable drift in pH or specific conductivity.

$$Percent\ error = \left|\frac{end-of-day\ check\ measurement - calibration\ solution\ value}{calibration\ solution\ value}\right| \times 100\%$$

  - Calculation of the differences between the field DO measurements, and the corresponding three-stage Winkler titration results from the same station and depth; if the difference is greater than 1.5 mg/L for all titrations from a given station, the difference is considered notable.
  - If percent differences (for calibrations) or differences (for Winkler titrations) are notable, further evaluation of the field data will be conducted to determine if any data should be invalidated (i.e., compare field data against historical and laboratory data).

  - Completion of a 100% review of all field data entries to check for accuracy, completeness, and correct units.
- For laboratory data:
  - Confirm that the laboratory is accredited by CALA.
  - Review of equipment, field, and travel blank data for detectable results; detectable results are considered notable if they are more than five times greater than the detection limit.
  - Calculation of the relative percent difference (RPD) between duplicate samples, as outlined below; RPD are considered notable if they are greater than 20%.

$$RPD = \frac{(Maximum\ Concentration) - (Minimum\ Concentration)}{(Average\ of\ the\ Maximum\ and\ Minimum\ Concentrations)} \times 100\%$$

  - Review of laboratory-stated qualifiers.
  - Check of laboratory data for completeness and that all parameters are analyzed with the correct detection limits, analytical methods, and units.
  - Confirmation that parameter holding times were met.
- For reporting:
  - Data will be stored within the EQuIS Database and maintained in a consistent format for processing and analyses.
  - Completion of a 10% check of all data entered into analysis files, and if errors are identified, completion of a check of all data.
  - Verification of analytical results (e.g., calculations) by qualified personnel not involved in the original analyses.

6 REPORTING

After the Snare River Septic Fields Special Study is completed, a report will be prepared to document methods and results used to verify that effluent from the septic fields is not influencing the Snare River. The study will be considered complete after all laboratory data collected during the study and inspection reports have been received by NTPC. All laboratory and field data collected during the Septic Fields Special Study will be included in the report per submission standards of the Land and Water Boards of the Mackenzie Valley (LWB 2023); copies of the septic system inspection reports will be included as appendices to the report. The report will also include the results of QA/QC procedures to assess the acceptability of the water quality data collected during the study.

Within 90 days following completion of the Septic Fields Special Study, or as directed by the WLWB, NTPC shall submit to the Board, for approval, a Septic Fields Special Study Report in accordance with Schedule 5, Condition 3:

a) Tabular summaries of all data and information generated from the implementation of the Septic Fields Special Study;
b) An interpretation of the results from the Septic Fields Special Study, including an evaluation of whether a release of effluent has occurred; and
c) Recommendations for follow-up and whether any changes to the Water Licence are necessary

An overall summary of the Septic Fields Special study workflow is presented below in Table 4.

Table 4: Septic Fields Special Study and Reporting Schedule, 2024 to 2026

Task	Timing
Submission of Study Design to the WLWB	By November 30, 2024
Regulatory review process for Study Design	December 2024 to February 2025
Implementation of Septic Fields Special Study	Septic system inspections – February or March 2025 and once during the 2025 open-water period (between June and October) Snare River monitoring – 2025 open-water period in 2025 (e.g., June and October)
Submission of the Septic Fields Special Study Report to the WLWB	Submit to WLWB within 90 days of the completion of the Septic Fields Special Study (e.g., February 2026)
Regulatory review of Septic Fields Special Study	Estimated to be between April and June 2026

WLWB = Wek'èezhìi Land and Water Board.

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