



**Northern Village of Kuujjuaq**

**VULNERABILITY ANALYSIS OF  
THE DRINKING WATER  
SOURCE**

WATER INTAKE N°X2114283 OF NV  
KUUJJUAQ

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Project 21-0054

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## **ADVICE TO THE READER**

This document was produced using data collected from municipalities, the Kativik regional administration, the Ministère de l'Environnement et de la Lutte contre les changements climatiques (MELCC), as well as from various actors involved in the protection of natural resources water in Northern Quebec. No data could be collected in the field by our own professionals due to the SARS-CoV-2 pandemic. The analyzes are based on the interpretation of the various articles of law and regulations in force.

The analyzes developed in this document are presented for information purposes only and the final decision concerning the various intervention methods and official protection zones is the responsibility of the Ministère de l'Environnement et de la Lutte contre les changements climatiques. (MELCC) or the municipality concerned.

Consequently, Nuna Resources cannot be held responsible for interventions undertaken in the environment before obtaining the necessary environmental and government authorizations.

## **REFERENCES FOR CITATION**

Nuna Ressources. 2021. Vulnerability Analysis of the drinking water source – Water intake n°X2114283 of NV Kuujuuaq. Rapport du projet 21-0054. 30 pages + appendices.

## ABSTRACT

The environmental firm Nuna Resources was mandated by the Northern Village of Kuujjuaq to carry out the vulnerability analysis of its drinking water source, in compliance with article 75 of the Water Withdrawal and Protection Regulation (WWPR) and following the guidelines in the '*guide de réalisation des analyses de vulnérabilité des sources destinées à l'alimentation en eau potable du Québec*' (MELCC, 2018).

The Northern Village of Kuujjuaq, the largest community in Nunavik, is located on the west shore of the Koksoak River, about 50km upstream from its mouth in Ungava Bay. The northern village is the seat of the Kativik regional government (KRG). Subject to a northern climate and located in an area of discontinuous permafrost, the challenges of protecting the source of drinking water are particularly important. The presence of permafrost and the vagaries of the climate indeed imply development challenges specific to these latitudes.

The source of drinking water for the Northern Village of Kuujjuaq is located in Lake Stewart. The pumping station, located directly on the bank, allows water to be sent to the new water treatment and storage station (construction in 2018), located 4 km further on in the village, on the corner of the road Dog Teamer's. There, the raw water undergoes a nanofiltration treatment, disinfection by UV light and then by addition of chlorine before being stored in a tank. A new addition of residual chlorine is made when the drinking water is distributed by water trucks.

The protection areas for the drinking water source, determined by mapping method, are as follows: the inner protection area includes the waters of the lake within a radius of 300 m around the water intake, as well as the riparian strips of 10 m. The intermediate protection area includes the waters of the lake within a radius of 3 km around the water intake, including riparian strips of 120m. Finally, the outer protection area encompasses the entire watershed of the lake.

Following the assessment of the vulnerability of the water source, one of the six indicators (the physical integrity of the sampling site) was set at "**medium**" because of an oil spill event that took place in the intermediate protection area of the water source in 2019. This event, which took place on the occasion of the displacement of the hydrocarbon reservoir for works, resulted in an environmental study and the excavation of contaminated soil.

The anthropogenic activities that have been listed in the inner and intermediate protection areas are navigation and air transport activities linked respectively to the launching of boats (inner protection area) and to the seaplane base (intermediate area protection). A modestly operating borrow pit is also located in the outer protection zone. However, after evaluating the contaminants and potential events associated with these activities, it was determined that the latter pose only a low or very low threat to the quality / quantity of the water exploited.

Finally, within the limits of the Northern Village of Kuujjuaq, the water source protection areas are mainly included in the "conservation" and "Nuna" land uses, which contribute to the protection of the water source. Small portions of the intermediate protection area are classified as residential area (three residences) and transport and communication area (seaplane base).

Overall, this study shows that the source of drinking water in the Northern Village of Kuujjuaq provides the village with quality water, so far little influenced by human activities. To further improve the monitoring and protection of the drinking water source in the future, the following recommendations have been made:

- Keep a written record of events, even minor ones, which have affected the drinking water production chain and keep this information for inter-annual monitoring. An example of such a register is provided in Appendix 5;
- Create a register in which to record the values of the turbidity of the raw water, particularly during periods of flood (spring melt, heavy rains) when the turbidity is likely to increase;
- During Colilert tests, continue to monitor regularly for the presence of fecal coliforms in raw water;
- Perform a soil contamination analysis at the site of the old borrow pit / dump located near the drinking water source (see map 1 for location);
- Visit of the drinking water sampling and treatment infrastructure by a professional over the next 5 years.

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# 1 INTRODUCTION

## 1.1 MANDATE AND OBJECTIVES

The firm Nuna Ressources was mandated to carry out a vulnerability study of the drinking water source in the Northern Village of Kuujjuaq, which, as responsible for a category 1 surface water withdrawal (supply of more than 500 people) is obliged to provide a vulnerability report before April 1, 2021, under article 75 of the water withdrawal and protection regulation (WWPR). This report is to be renewed every five years.

In accordance with the guidelines of Article 75, this report combines the following information :

- The location of the drinking water sampling site, a description of the water treatment facilities;
- The location plan for inner, intermediate and outer protection areas;
- Water vulnerability levels according to the six indicators presented in Article 69, Appendice IV of the WWPR;
- Human activities, potential events and land uses likely to affect the quantity or quality of water within the protection areas;
- An assessment of the threats posed by the human activities, land uses and potential events listed for the quality or the quantity of the water used for the withdrawal;
- An identification of the probable causes that may explain the medium or high levels of vulnerability concerning the six indicators mentioned in Article 69 Appendice IV of the WWPR;

This report presents a summary of all the information required by the Ministère de l'Environnement et de la Lutte contre les changements climatiques (MELCC), when available, for the Northern Village of Kuujjuaq in accordance with the guidelines provided by the guide for the implementation of vulnerability analyzes of sources intended for drinking water supply in Québec (MELCC, 2018). Section 5.2 presents information that is missing or could not be obtained in the context of this study. If essential elements prove to be missing, this report proposes recommendations, ranked in order of priority, that the municipality could adopt to address the lack of data by 2026, the date of the next vulnerability report.

## 1.2 GENERAL DESCRIPTION OF THE STUDY AREA

The Northern Village of Kuujjuaq (58°06'25.0"N, 68°24'02.7"W) is located on the west shore of the Koksoak River, about 50km upstream from its mouth in Ungava Bay. It is the administrative center of the Nunavik region, seat of the Kativik Regional Government (KRG), in the Northern Québec (10).

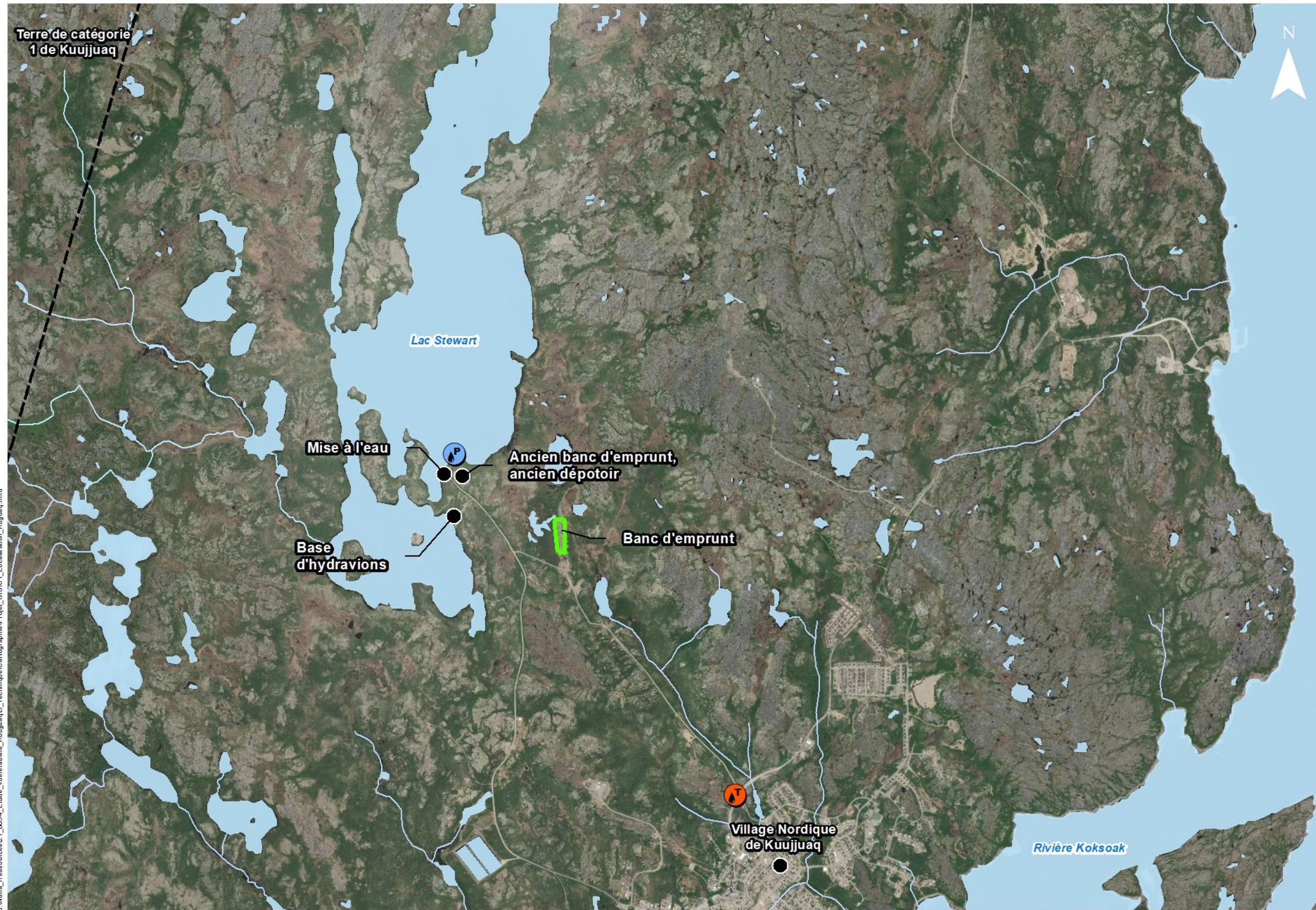
The Northern Village of Kuujjuaq is the largest community in Nunavik, with 2,862 inhabitants over an area of 284.45 km<sup>2</sup> (Affaires municipales et Habitation Québec, 2020).

The village is located in a zone of discontinuous and sporadic permafrost. The area is characterized by a cold climate and forest tundra-type vegetation. Average annual precipitation is around 627 mm/year. Between 2004 and 2018, the annual mean temperature hovered around -3.94°C while the frost season lasted for an average of 198 days (Chiasson et al. 2020).

According to the report by Chiasson and co-authors concerning the permafrost conditions of the Northern Village of Kuujjuaq (Appendice 1), the dominant geological units present on the territory of the village are 5: rocky outcrops (Proterozoic granitic rocks of the province of Churchill), aeolian and alluvial sediments, glacial, marine and organic deposits (peatlands).

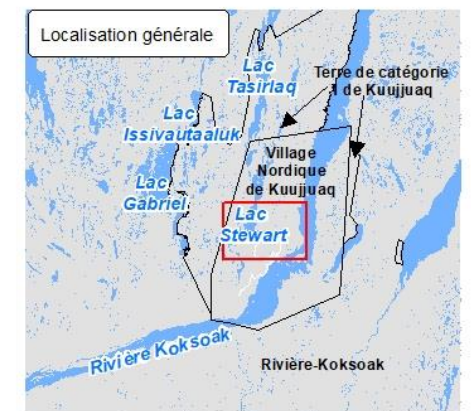
Outside the Northern Village of Kuujjuaq are :

- About 120 km northwest: the Baie-aux-feuilles national park reserve with an area of 386,807.6 hectares, protected area no. 7078;
- About 40 km to the North-West: a mining exploration activity (Diana Property, Azimut exploration);
- About 130 km to the South: mining project (Eldor property, Ashram deposit).



CARTE 1  
Localisation de l'aire d'étude

-  Prise d'eau
  -  Usine de traitement des eaux
  -  Banc d'emprunt
  -  Limite des municipalités
- Hydrographie**
-  Cours d'eau
  -  Plan d'eau



1:35 000  
0 500 1 000 2 000 m

Système de projection cartographique: NAD83 (CSRS) MTM 8

Source des données:  
Fond de carte, cinquième inventaire écoforestier du Québec méridional  
Géobase du réseau hydrographique du Québec (GRHQ) (MERN, 2019);  
Cartographie des milieux humides potentiels du Québec (CMHPQ) (MELCC, 2019);  
Base de données des bassins hydrographiques (MELCC, 2019a)

## 2 CHARACTERIZATION OF WATER WITHDRAWAL

The determination of the water source protection areas, as well as the determination of the vulnerability levels of the water quality indicators presented in sections 2.3 and 2.4 (article 69, Appendice IV of the WWPR), were carried out by consulting the various data transmitted by the Kativik regional administration as well as the data available for the study areas in the open databases mentioned below :

- Geobase of Quebec Hydrographic System / *Géobase du réseau hydrographique du Québec* (GRHQ) (MERN, 2019);
- Hydrographic Basins Data base / *Base de données des bassins hydrographiques* (MELCC, 2019);
- Topographic Data of Canada – CanVec Series (Natural Resources Canada, 2020);
- Image Library of the Northern Villages/ *Imagerie des villages autochtones du Nord* (<https://mern.gouv.qc.ca/repertoire-geographique/imagerie-villages-autochtones-nord/>);
- Cartography of the indigenous Northern Villages at a 1 : 2 000 scale/ *Cartographie des villages autochtones à l'échelle 1/ 2000* (<https://www.donneesquebec.ca/recherche/dataset/cartes-topographiques-des-villages-autochtones-du-nord-a-l-echelle-de-1-2-000>);
- Satellite imagery from Google Earth Pro©.

### 2.1 RAW WATER WITHDRAWAL SITE

The Northern Village of Kuujuaq's water withdrawal site is located in Lake Stewart, north of the village. This water point is a lake with an area of 946.37 ha, which drains a watershed of 6100.51 ha. It stretches for 10 km parallel to the Koksoak River.

The intake, built in 1991, is located at the end of Chemin du Lac Stewart, which ends in a cul-de-sac. The water intake is connected to the water pumping station innerly located on the bank (photo 1).



Photo 1. Aerial photograph adapted from imagery of the Native Villages of the North (MERN). Lake Stewart is the source of drinking water for the Northern Village of Kuujuaq



Photo 2. Pumping station on the shore of Lake Stewart (September 2019, KRG)

The plans presented in Appendice 2 describe in detail the installations at the water intake.

The installations at the water intake are as follows: the water intake is a polyethylene pipe ending in a strainer. The pipe goes to the well of the pumping station where two pumps send water to the treatment station through a sediment screen. Two other pumps allow water to circulate in the recirculation line, which forms a loop between the supply line and the supply line at its outlet from the well (Appendice 2).

**Table 1. Summary of the characteristics of the drinking water intake in the Northern Village of Kuujjuaq**

Sample site element	Description and details
Name of the water intake	Kuujjuaq - Approvisionnement
Water intake number	X2114283
Geographical coordinates	58° 08'24.28"N; 68° 26'46.07"O
Type of use	Permanent
Type de withdrawal	In the lake using a submerged strainer
Depth of sampling	Unknown
Population served	2862 inhabitants
Maximum withdrawal rate per day	1 123 m <sup>3</sup>
Critical water level	Unknown
Number of the most recent authorization issued by the Ministère	Unknown

The supply pipe (250 mm ø) then runs along the access road to the lake for a distance of 3.9 km, until it reaches the new water treatment station in the village, built in 2018/2019 (location map 1). The supply line is made of high-density polyethylene, insulated, and heated to prevent the risk of freezing during winter.

## **2.2 DRINKING WATER TREATMENT INFRASTRUCTURES**

The Northern Village of Kuujjuaq water treatment and distribution station is located in the village at the following coordinates (map 1): 58°6'52.59" N et 68°24'17.94"O

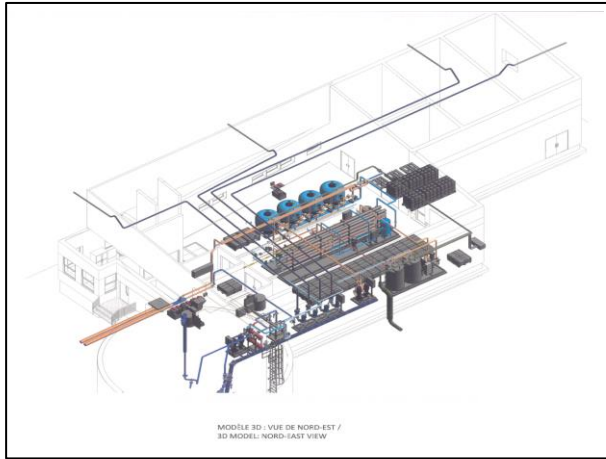


Photo 3. Interior three-dimensional view of the new drinking water treatment plant in the Northern Village of Kuujjuaq, built in 2018 (Source: CIMA+)

Photo 4. Exterior three-dimensional representation of the new drinking water treatment and distribution station (Source: KRG)

Built in 2018/2019 on vacant land, the drinking water treatment and distribution station is located along Dog Teamer's Road, not far from the site of the old drinking water treatment plant.

- Nanofiltration (granular filtration, followed by membrane filtration);
- UV light disinfection (two UV reactors from the Trojan brand);
- Disinfection by adding a chlorine solution;
- pH adjustment and remineralization (addition of sodium bicarbonate and calcium chloride);
- Storage of water in the tank before distribution;
- Further addition of residual chlorine when the water is transferred to the water truck for distribution.

Frequent negative temperatures at this latitude make it difficult if not impossible to install an aqueduct system to supply the village with drinking water (Vincent et al. 2012). Thus, once the water is treated, it is distributed daily by tanker truck to the various infrastructures and to the residents of the village, each with a specific water tank.

A diagram showing in detail the different stages of water treatment, from its withdrawal from Lake Stewart to its distribution by tanker, is provided in Appendice 2.

## 2.3 WATER SOURCE PROTECTION AREAS

Under articles 70, 72 and 74 of the WWPR, category 1 surface water withdrawals are surrounded by 3 protection areas, nested one in the other and which may overlap: the inner protection area, the intermediate protection area and the outer protection area. In the case of a surface water intake installed in a lake, the boundaries of these protection areas follow the following criteria :

**Table 2. Characteristics of protection areas when the surface water source is located in a lake**

Type of environment	Protection areas		
	Inner	Intermediate	Outer
Lake	300 m around the sampling site + 10 m riparian strips	3 km around the sampling site + 120 m riparian strips	The watershed of the withdrawal site and, if applicable, the portion of the intermediate protection area located downstream of the withdrawal site

### General methodology :

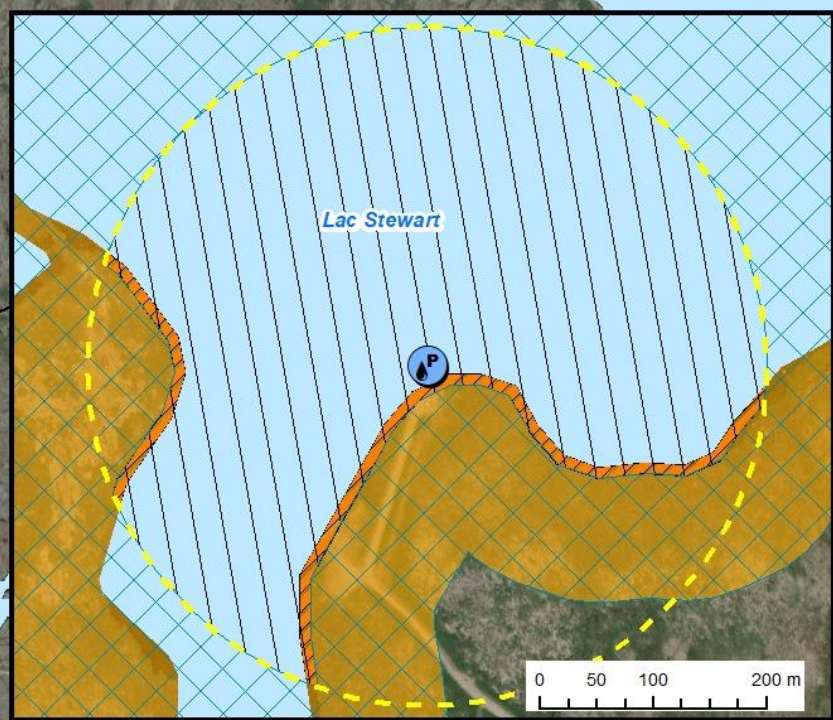
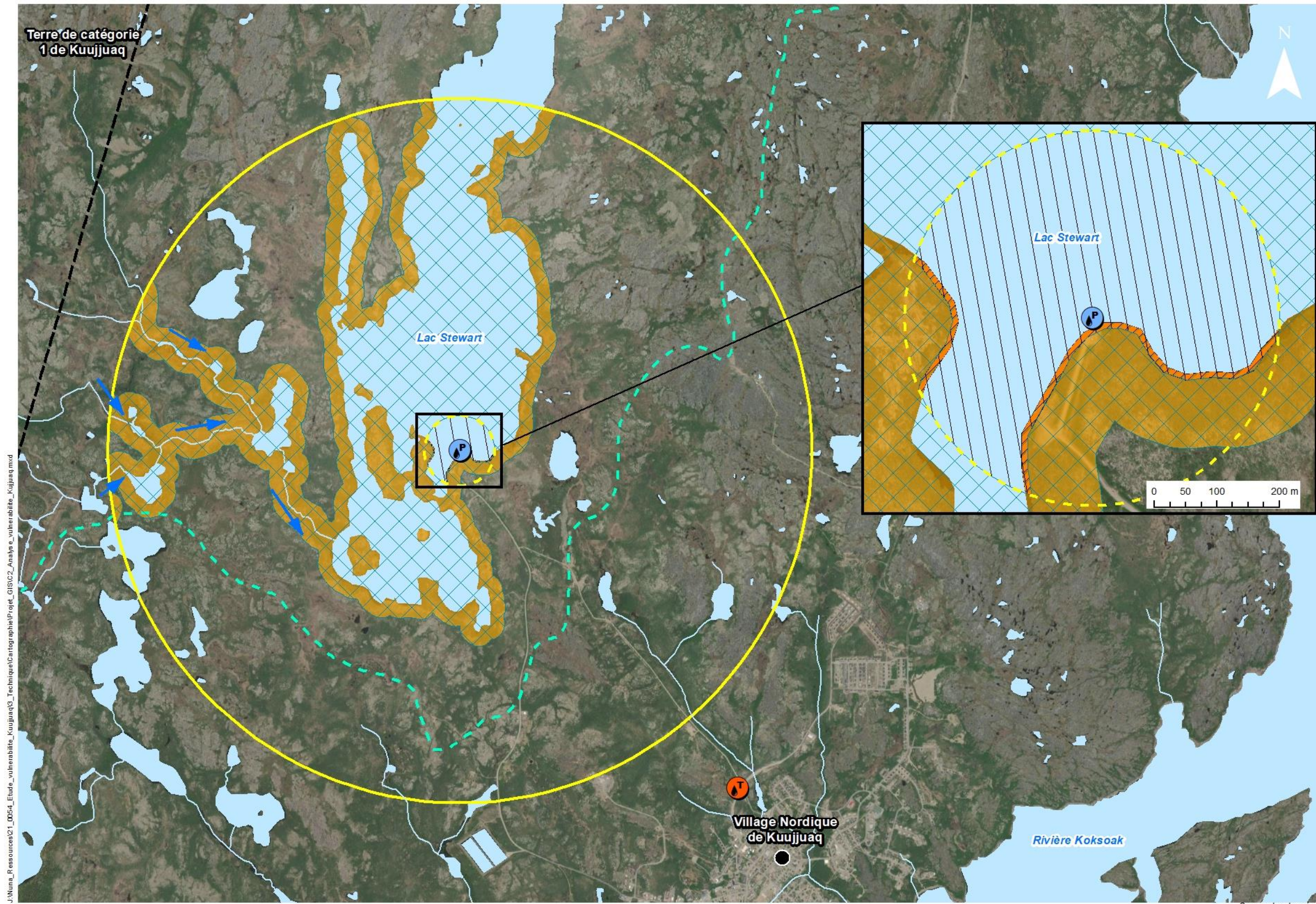
Watershed delimitations were determined using the hydrographic cutting units (HCU) as well as the linear (rivers) and polygon (lakes) geometric networks available from the Geobase of the Quebec Hydrographic System (GQHS or GRHQ in French, 2019). For reference, HCU represent a portion of a bigger watershed or a group of small watersheds delimited by the “Centre d’expertise hydrique du Québec” (CEHQ; now incorporated into the MELCC).

On the one hand, the maximum extension for the water source watershed was determined using the linear (rivers) and polygon (lakes) geometric networks, in particular by the validation of the direction of the water flow and the classification of the linear features according to the Strahler stream order. This operation allows to validate the interconnectivity of the hydrographic system at the HCU limits.

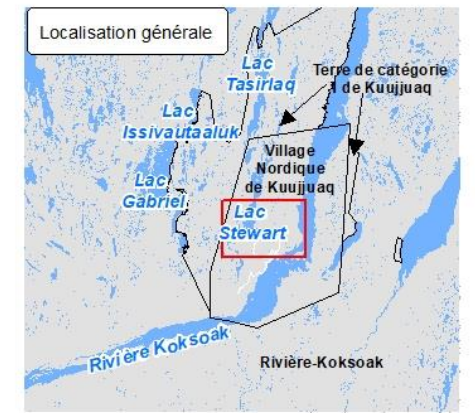
On the other hand, the watershed portion that was downstream the water withdrawal location had to be removed from the lake/ river global watershed when relevant i.e., the portion of the global watershed that has no influence on the exploited waters. The portion upstream the water withdrawal location (watershed delineation) was delimited using level curves at a 1: 50 000 scale available from the topographic data of Canada (CanVec Series, 2020) as well as the linear (rivers) and polygon (lakes) geometric networks available from GQHS. Finally, this whole operation permitted us to properly delimit the water source watershed.

**Maps 2 and 3** show the protection areas for the drinking water source in the Northern Village of Kuujjuaq. As high-water mark data was not available, stream boundaries were determined from existing hydrographic layers for the study site.

## CARTE 2 Aires de protection de la prise d'eau



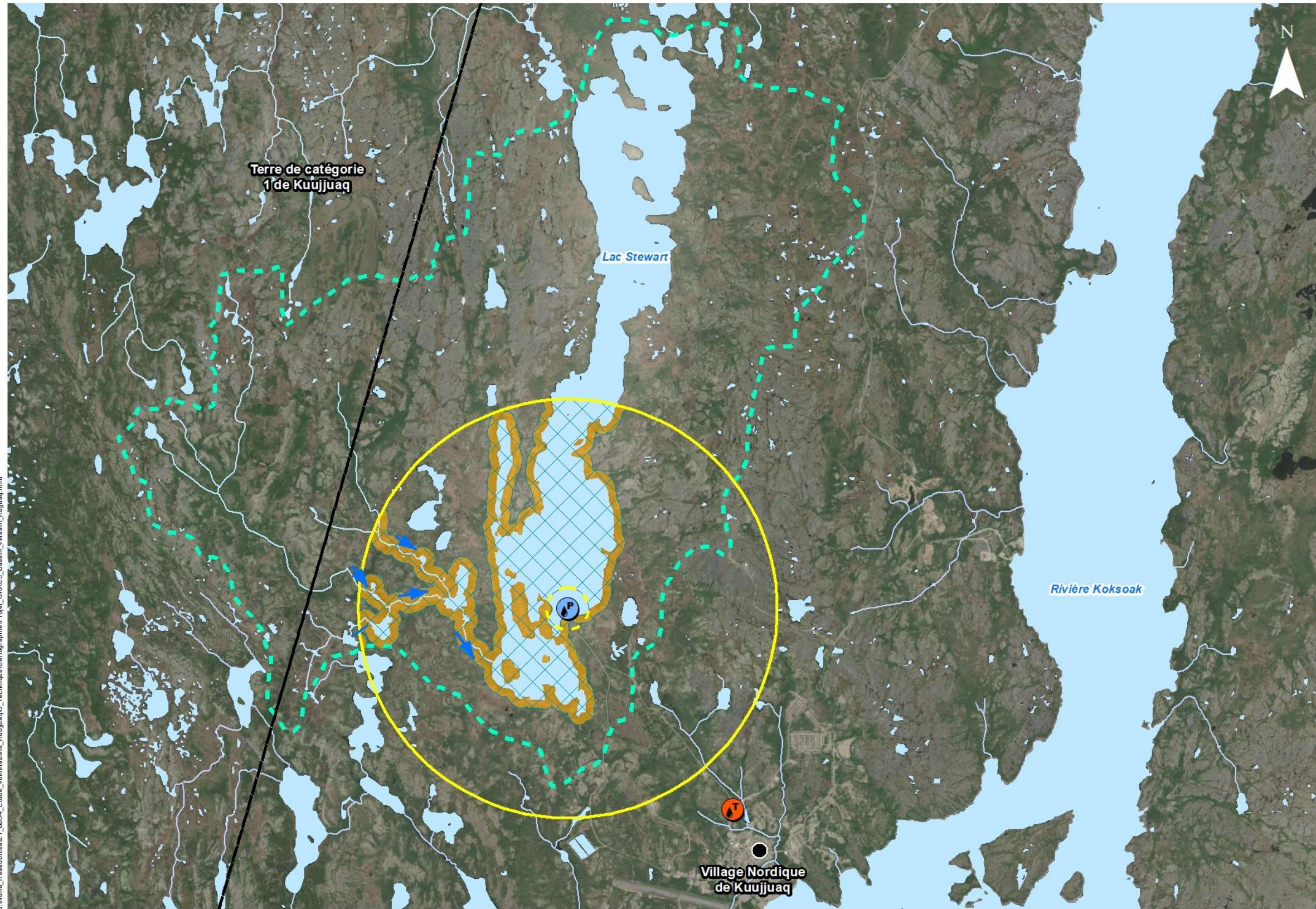
- Prise d'eau
- Usine de traitement des eaux
- Limite des municipalités
- Zone de protection**
  - Rayon de 300m autour de la prise d'eau
  - Rayon de 3km autour de la prise d'eau
  - Bande riveraine de 10m
  - Bande riveraine de 120m
  - Zone de protection immédiate
  - Zone de protection intermédiaire
  - Zone de protection éloignée (bassin versant de la prise d'eau)
- Hydrographie**
  - Cours d'eau
  - Plan d'eau
  - Sens d'écoulement



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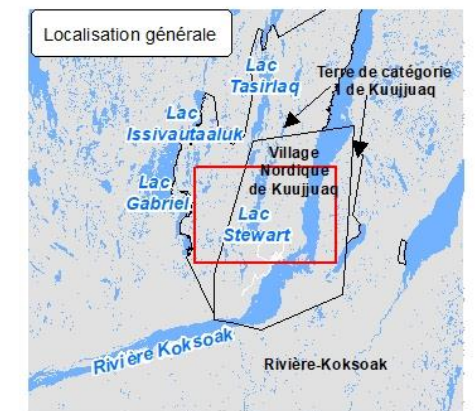
Système de projection cartographique: NAD83 (CSRS) MTM 8

Source des données:  
Fond de carte, cinquième inventaire écoforestier du Québec méridional  
Géobase du réseau hydrographique du Québec (GRHQ) (MERN, 2019);  
Cartographie des milieux humides potentiels du Québec (CMHPO) (MELCC, 2019);  
Base de données des bassins hydrographiques (MELCC, 2019a)



**CARTE 3**  
 Vue d'ensemble du bassin versant du lac Stewart

-  Prise d'eau
-  Usine de traitement des eaux
-  Limite des municipalités
- Zone de protection**
-  Rayon de 300m autour de la prise d'eau
-  Rayon de 3km autour de la prise d'eau
-  Bande riveraine de 120m
-  Zone de protection intermédiaire
-  Zone de protection éloignée (bassin versant de la prise d'eau)
- Hydrographie**
-  Cours d'eau
-  Plan d'eau
-  Sens d'écoulement



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Système de projection cartographique: NAD83 (CSRS) MTM 8

Source des données:  
 Fond de carte, cinquième inventaire écoforestier du Québec méridional  
 Géobase du réseau hydrographique du Québec (GRHQ) (MERN, 2019);  
 Cartographie des milieux humides potentiels du Québec (CMHPQ) (MELCC, 2019);  
 Base de données des bassins hydrographiques (MELCC, 2019a)

## 2.4 VULNERABILITY INDICATORS

As required by Article 69, Appendice IV of the WWPR, the vulnerability of the surface drinking water source is assessed using six indicators which are assigned a low, medium, or high level of vulnerability. These vulnerability levels are determined by following the analysis methods presented in the *guide de réalisation des analyses de vulnérabilité des sources destinées à l'alimentation en eau potable du Québec* (MELCC, 2018) and prescribed in Appendice IV of the WWPR. The following sections present the results of these analyzes for each of the six indicators, as well as the methods employed based on the data available for this assessment.

### 2.4.1 Physical integrity of the site

**Method 1** : Consultation of the register of events. Since August 14, 2014, all those responsible for a category 1 surface water withdrawal are required to keep an up-to-date register of events that have affected, among other things, a water shortage, an obstruction, or a breakage at the water withdrawal site (article 22.0.4 of the WWPR).

An oil spill (approximately 5L) at the pumping station site was listed in November 2019. The soil was then decontaminated according to the standards in force in the intervention guide - Soil protection and contaminated land rehabilitation (MELCC, 2019) and an environmental study was produced (AV19-171-1, Avataani Environmental, December 2019).

**Table 3. Register of events that affected the physical integrity of the withdrawal site**

Event type	Date	Consequences
Oil spill	Autumn 2019	Excavation of contaminated soil and backfillPossible contamination of the water source

According to the Avataani Environmental report dated December 2019, further excavations of contaminated soil at the spill site remained to be undertaken in the spring of 2020. The information provided to us by the Kativik regional administration indicates that this second series of excavations were indeed carried out in 2020. Likewise, it was assumed that the spill resulted from the displacement of the hydrocarbon reservoir during its movement, that the quantity spilled was potentially greater than 5 L and that other similar spills and not listed may have taken place in the past. This event places the physical vulnerability of the water sampling site at an **medium level**. However, if evidence is provided that the excavations in 2019 and 2020 have resulted in optimal soil decontamination and that measures have been taken to prevent such spills at the sampling site in the future, the level of vulnerability of the indicator may be brought down to low.

Since we did not have access to a complete register of events, method 2 was also applied in addition to method 1, to determine the level of vulnerability of this indicator. (Such a proper register does not seem to exist. The municipality has been questioned about this, but no response has yet reached us at the time of writing this report).

**Method 2** : Professional opinion on the condition of the infrastructure.

The context of the pandemic due to COVID-19 since the beginning of 2020 did not allow our professionals to visit the Northern Village of Kuujuaq to meet local stakeholders, to visit the infrastructures and assess their condition since their last upgrade. Having received the mandate to assess the vulnerability of the water source in November 2020, we are therefore relying on the data made available by university research teams (Centre for Northern Studies, Université Laval) and information exchanges with members of the community and the Kativik regional administration in order to issue an opinion on the state of infrastructures and the risk of damage caused by the vagaries of the climate. However, we recommend that this advice be validated in the future by a professional visit to the site of the water sampling and treatment facilities.

### **State of infrastructure**

After consulting the documents sent by the Kativik Regional Government (KRG), it appears that the drinking water treatment facilities in the Northern Village of Kuujuaq were almost completely refurbished in 2018/2019. A new water treatment and distribution station was built on a new site, as well as the entire treatment system was redone at that time. A new tank was installed outside the treatment plant, while the pumping station facilities were upgraded in 2018. The work also included the installation of a fence to restrict the access to the pumping station site for authorized persons only.

### **Risks of natural origin on the integrity of infrastructures**

Since the Northern Village of Kuujuaq is located in a discontinuous permafrost zone, the existing infrastructures are subject to ground movements during periods of frost and thaw and to the vagaries of the arctic climate. An analysis carried out by the Centre for northern studies of Laval University (Chiasson et al. 2020) presents the permafrost conditions according to the surface deposits on which the various infrastructures of the village were built (Appendice 1). The location of the lake's water intake is on glacial deposits (tills) covering more than 2m thick on a rocky base. These unconsolidated deposits can consist of ice up to 30 % of their volume content and are therefore unstable during periods of freezing and thawing. Differential settlements and creep caused by movements of the active layer of permafrost could therefore affect the building of the pumping station, depending on the foundations on which the latter rests. However, no information transmitted leads us to believe that the building may have suffered from such phenomena in the past.

The new water treatment plant is not on the map shown in Appendice 1 because it is too recent to build. However, the deposits located where the latter was built are all thaw-stable deposits (bedrock, sand and gravel cover whose thickness is less than 2 m, sand and stratified gravel whose thickness is greater than at 2 m). New water treatment, storage and distribution facilities are therefore not at risk of damage due to movements and variations in permafrost conditions.

Finally, still according to the report by Chiasson and co-authors, neither the area of the village which hosts the water treatment facilities nor the location of the water intake in the lake is subject to natural and apprehended hazards, which were listed by the team of scientists as part of their research (Appendice 1).

In light of this information, the location of the drinking water collection, treatment and storage infrastructure in the Northern Village of Kuujuaq does not appear to be problematic for the next 5 years. According to this method, the physical vulnerability of these sites is low. A field verification will however be necessary to validate this preliminary opinion.

When two methods are used to determine the level of vulnerability of an indicator, it is necessary to choose the higher level. The level of physical vulnerability of the sampling site is therefore classified as **medium**, as obtained by applying **method 1**.

#### **2.4.2 Vulnerability to microorganisms**

The northern villages, because located north of the 55th parallel (article 22.0.3 of the regulation respecting the quality of drinking water, RRQDW), are not subject to the requirements of article 22.0.1 of the RRQDW, that is, the obligation to test a sample of raw water per week when the distribution system serves between 1001 and 5 000 people.

The sampling of raw water for the detection of microorganisms aims to detect the possible presence of pathogenic microorganisms, particularly *E. Coli* bacteria, which can cause gastroenteritis, the main symptoms of which are: diarrhea, abdominal cramps, nausea, and vomiting (<https://www.quebec.ca/agriculture-environnement-et-ressources-naturelles/eau-potable/contamination-de-l-eau-reseau-de-distribution/e-coli-coliformes-fecaux-or-enterococci/>).

Surface water sources, compared to groundwater sources, are particularly sensitive to the risks of contamination by coliform bacteria (total, fecal) relating to the activities of the surrounding fauna and the impacts of human activities located nearby.

For the Northern Village of Kuujuaq, raw water samples were analyzed from the year 2020. Remember that being north of the 55th parallel, this municipality is not obliged to monitor this parameter on a regular basis. To determine the vulnerability of the water source to microorganisms, we therefore applied method 2.

The latter consists of determining whether, over the entire watershed of the water intake, there is no agglomeration served by a combined or pseudo-domestic sewer network or any industry or activity likely to release pathogenic microorganisms in the water body. Data from Colilert tests for the year 2020 were also used to validate the results of **method 2**.

After examining the land uses and satellite imagery (MERN, Google Earth), it appears that no element likely to reject pathogenic microorganisms is present in the watershed of the water intake (maps 2 and 3; Appendice 3)

In addition, the Colilert test results available between 2016 and 2020 do not indicate the presence of fecal coliforms in raw water. Of course, surface water sources remain particularly sensitive to contamination by surrounding fauna. For this reason, it would be prudent to continue the regular monitoring of raw water started in 2020.

All these elements lead us to set the level of vulnerability of the water intake to microorganisms at "**low**".

### **2.4.3 Vulnerability to fertilizers**

Villages located north of the 55th parallel (article 22.0.3 of the RRQDW) are not subject to the requirements of article 22.0.2 of the RRQDW, i.e. the obligation, for a municipal distribution system serving more than 500 people and at least one residence, to sample and quantify the total phosphorus in raw surface water once a month between May and October.

Methods 2 and 3 will therefore be used for this indicator. The highest vulnerability rating obtained between methods 2 and 3 will be selected as the final rating.

**Method 2** : it consists of listing all the events associated with blooms of algae or cyanobacteria in the water as well as a suspected increase in ammoniacal nitrogen.

No event of this nature has been reported by the Northern Village of Kuujjuaq. The application of this method therefore makes it possible to attribute a **low level** of vulnerability to fertilizers.

**Method 3** : a professional assesses all the activities that represent a potential source of phosphorus or ammoniacal nitrogen in all the protection areas and judges whether they represent a risk.

A seaplane base is located in the intermediate protection zone of the water intake and a small boat launch is located in the inner protection zone (Map 1). These activities could, by the resuspension of lake sediments following turbulence in the water, contribute to the lake's total phosphorus reservoir. However, given the size of the lake (dilution effect), its highly likely oligotrophic waters (northern lakes have generally nutrient poor waters; Hamilton et al. 2001, Michelutti et al. 2002),

and the modest intensity of traffic on the lake, it is unlikely that these activities could significantly affect the concentration of total phosphorus in Lake Stewart.

The level of vulnerability of the water source to fertilizers is therefore set at **low**.

#### **2.4.4 Vulnerability to turbidity**

The villages located north of the 55th parallel (article 22.0.3 of the RRQDW) are not subject to the requirements of article 22.0.2 of the RRQDW, i.e. the obligation to continuously monitor turbidity variations of the raw water once every 4 hours at least and record the values in a register.

As there is no recorded dataset concerning the turbidity of the water exploited for the Northern Village of Kuujuaq, **method 2** is applied to determine the vulnerability rating of the water source. This method consists of issuing a professional opinion following the assessment of the potential impacts of the natural characteristics of the watershed and the human activities taking place there.

As for fertilizers, the turbidity of the lake water could be influenced, to a small extent, by the seaplane base located in the intermediate protection zone and by the small launching set up next to the water pumping station, in the inner protection zone. However, the potential impact of these activities on turbidity is considered minor: the seaplane base is located in a part of the lake isolated from the water intake by a narrow channel (maps 1 and 2), and related activities upon launching are not likely to generate a significant addition of suspended matter to influence turbidity.

In addition, an in-depth analysis of the characteristics of the watershed of the drinking water source carried out by the hydrogeology firm LNA<sup>1</sup> highlights low slopes throughout the watershed (average value of 3.3 %). However, it should be noted that 80 % of the surface deposits present in the watershed are likely to be a source of suspended particles for the exploited water. The analysis also established that 71 % of the watershed (its terrestrial part) is occupied by vegetation which contributes to the protection of the exploited water from turbidity. Full details of the analysis produced by LNA are presented in Appendice 4.

According to the land use map of the Northern Village of Kuujuaq, the edges of the lake are classified as “conservation zones”, the water intake is surrounded by a 60 m buffer zone and the rest of the protection areas of the source of water belongs to the “Nuna” zone, which is mainly dedicated to traditional and recreational activities (see also section 3.3 for more details on land uses). Given these elements, anthropogenic activities in the watershed are not likely to influence the turbidity of the exploited waters.

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<sup>1</sup> Due to the limited data available and in order to validate the level of vulnerability of the water intake to turbidity, an external opinion was requested from LNA

The level of vulnerability of the water source to turbidity is therefore considered to be **low**. In the future, however, it may be prudent to monitor and record changes in this parameter. Consistently high turbidity readings can lead to technical failures in water treatment facilities.

#### **2.4.5 Vulnerability to inorganic substances**

The 11 inorganic substances whose concentrations are to be monitored on an annual basis in drinking water under article 14 of the RRQDW are as follows: antimony, arsenic, barium, boron, cadmium, chromium, cyanides, fluorides, mercury, selenium, uranium. Nitrates and nitrites should be monitored on a quarterly basis.

As the dataset available for the Northern Village of Kuujjuaq does not include 5 years of consecutive values and in accordance with the recommendations of the guide, we first favored method 2. The data available from trace metal analyzes were used as a complement to the main method.

**Method 2** aims to determine whether sectors of industrial, commercial, or agricultural activity are located within the 120 m strip of land of the intermediate protection zone and what percentage of this land area they occupy. The level of vulnerability is low if the percentage is less than or equal to 20 %. No industrial, commercial, or agricultural activity is located in the 120 m riparian strips.

In addition, the concentrations of the 11 inorganic substances, available for the years 2015, 2016 and 2020; as well as the nitrate-nitrite concentrations, available in part for 2015, 2016, 2017, 2019 and 2020, are all well below the applicable standards. In light of this information, the vulnerability index of the drinking water source to inorganic materials is set at **low**.

#### **2.4.6 Vulnerability to organic substances**

As the Northern Village of Kuujjuaq drinking water system does not serve more than 5,000 people, it is not mandatory for this northern village to monitor the 16 pesticides and 16 other organic substances under section 19 of the RRQDW. **Method 2** was therefore applied to determine the level of vulnerability of this indicator. It is identical to method 2 used in section 2.4.5 for inorganic substances.

The level of vulnerability of the drinking water source to organic substances is therefore set at **low**.

## 2.4.7 Summary of vulnerabilities

**Table 4. Summary of the methods used to determine the vulnerability rating of each of the six indicators and the results obtained**

Indicator	Main method used	Vulnerability level
A (physical integrity)	Methods 1 et 2	<b>Medium</b>
B (microorganisms)	Method 2	<b>Low</b>
C (fertilizers)	Methods 2 et 3	<b>Low</b>
D (turbidity)	Method 2	<b>Low</b>
E (inorganic sub.)	Method 2	<b>Low</b>
F (organic sub.)	Method 2	<b>Low</b>

# 3 INVENTORY OF ELEMENTS LIKELY TO AFFECT THE EXPLOITED WATER

## 3.1 ANTHROPIC ACTIVITIES

Due to the context linked to the Covid-19 pandemic, our professionals were unable to go to the Northern Village of Kuujjuaq to take an inventory of human activities in the field. The following sections were therefore carried out thanks to the consultation of the land use map, the development plan of the Northern Village of Kuujjuaq and the consultation of the members of the municipal council, the Nayumivik landholding corporation, and the Kativik regional administration when details were required. Google Earth satellite images and imagery from northern indigenous villages (MERN) were also consulted.

The core of the Northern Village of Kuujjuaq is located approximately 4.3 km as the crow flies from the water intake of Lake Stewart, the latter is isolated from most human activities and its infrastructure. Thus, very few activities take place in its watershed.

### 3.1.1 Inventory of human activities

The anthropogenic activities to be listed are those which, in their usual functioning, are likely to release contaminants that may affect the quantity or quality of surface water exploited.

**Table 5. Activities likely to have an impact on the quality of exploited waters in the watershed of the water source**

Activity type	Protection area	Code and name CUBF	Potential contaminants
Operation of the borrow pit	Outer	89 – exploitation and extraction of other natural resources	inorganic substances
Seaplane base	Intermediate	43 – air transport (infrastructure)	inorganic substances
Launching of boats ramps	Inner	44 – maritime transport (infrastructure)	inorganic substances

### 3.1.2 Threats linked to human activities

The assessment of threats from anthropogenic activities first involves determining how often the activity is likely to release contaminants and the severity associated with that activity and the contaminants released. The combination of the frequency level with the severity level makes it possible to determine the final risk potential, in accordance with the method presented in the drafting guide and under Article 75 of the WWPR.

**Table 6. Risk potential of the listed activities**

Activity type	Protection area	Considered contaminants	Risk potential
Operation of the borrow pit	Outer	Inorganic materials such as trace metals	Low
Operation of the borrow pit	Outer	Particles suspended in water that can affect taste or smell	Low
Air traffic from the seaplane base	Intermediate	Particles suspended in water that can affect taste or smell	Low
Air traffic from the seaplane base	Intermediate	Inorganic materials such as trace metals or phosphorus	Low
Boat launch and navigation	Inner	Particles suspended in water that can affect taste or smell	Low
Boat launch and navigation	Inner	Inorganic materials such as trace metals or phosphorus	Low

The usual activities of the operation of the borrow pit (Dog Teamer's Pit, see also map 1 for the exact location) could produce dust, then influencing the turbidity and inorganic substances in the drinking water drawn from the neighboring lake (like trace metals for example). The vibrations of the machinery could cause the sediment to resuspend in the water and therefore also influence the turbidity and inorganic content. However, none of the water tests reviewed in this study suggest a detectable impact on regulated inorganic materials. In addition, the borrow pit has been in operation since September 2020. Material extraction is scheduled until 2022 for a quantity of material of approximately 50,000 m<sup>2</sup>. These activities are therefore modest. The severity of the consequences of these activities on turbidity and inorganic substances is considered minor. In addition, these activities occur frequently. The risk potential is then set to low.

As explained previously in sections 2.4.3 and 2.4.4 concerning the influence of these activities on turbidity and total phosphorus, the usual activities of the seaplane base and the launching are not likely to represent a serious threat to the quality of the water exploited. By following the guide's criteria, we estimate that the consequences of these activities are minor and that they occur at a

frequent rate (more than once a year but less than once a week when reduced to the year since none of these activities take place during the winter). Air traffic from the seaplane base, as well as navigation activities from the launch, therefore, represent a low-risk potential for the quality or quantity of the water exploited.

It should be noted that a former borrow pit operating site has been listed near the water source, in the intermediate protection zone (see location map 1). After discussion with the Nayumivik Landholding Corporation<sup>2</sup>, it appears that this borrow pit has not been exploited for several decades. Also, the site would have been used as the village's first dumping ground for a short time before the location was quickly abandoned, again several decades ago. After communication with the KRG, no soil contamination data is available for this location, the impact of this former site on the quality of the water exploited therefore remains unknown. However, no anomalies emerged in the analyzes of inorganic substances, so it can be assumed that the site does not affect the quality of the water exploited. Given its close distance from the water sampling site, it might still be relevant to perform some soil contamination analyzes.

### **3.2 POTENTIAL EVENTS**

Potential events linked to human activities correspond to exceptional events caused by accidents or extreme climatic events and which are likely to release contaminants into the surface water exploited or affect the quantity of drinking water available.

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<sup>2</sup> Email communications with M Curtis Mesher, Landuse Administrator, Nayumivik Landholding Corporation

### 3.2.1 Inventory of potential events

**Table 7. Potential events related to the anthropogenic activities inventoried in the watershed of the water intake**

Potential event	Associated activity	CUBF Code and Name	Protection area concerned	Potential contaminants
Spill at the pumping station	Electricity and Heating system at the raw water pumping station	483 – Aqueduct and irrigation	Inner, intermediate	Organic and inorganic substances (oil products)
Machinery spill	Operation of the borrow pit	89 – exploitation and extraction of other natural resources	Outer	Turbidity, organic and inorganic substances
Oil spill	Air traffic from the seaplane base	43 – air transport (infrastructure)	All protection areas	Organic and inorganic substances
Oil spill	Boat launch and navigation	44 – maritime transport (infrastructure)	All protection areas	Organic and inorganic substances
Forest fire	Vegetation in the watershed	91 – undeveloped and unexploited land space	All protection areas	Turbidity (suspended solids)

### 3.2.2 Threats related to potential event

The threat assessment of potential events involves first determining the level of likelihood of the event occurring and then the severity of this event. The combination of the level of probability with the level of severity makes it possible to determine the final risk potential, in accordance with the method presented in the drafting guide and under Article 75 of the WWPR.

**Table 8. Risk potential of the listed events**

Potential event	Protection area	Contaminant considered	Risk potential
Spill at the pumping station	Inner, intermediate	Oil products	<b>Low</b>
Spill / machinery accident at the borrow pit	Outer	Oil products	<b>Very low</b>
Seaplane accident / spill	All areas	Organic matter	<b>Low</b>
Boat accident / spill	All areas	Organic matter	<b>Low</b>
Seaplane accident / spill	All areas	Inorganic matter	<b>Low</b>
Boat accident / spill	All areas	Inorganic matter	<b>Low</b>
Feu de forêt	All areas	Turbidity	<b>Very low</b>

An oil spill at the raw water pumping station located on the shore of the lake immediately beside the water intake, is a potential event that could contaminate the exploited waters. A potential spill following either the filling/ maintenance of the oil tank associated to the pumping station or some instruments malfunctions associated to the oil tank (due to a freezing event, defective/ old parts, etc.) could have **serious** consequences on water quality (aesthetic or organoleptic water quality problem that is not acceptable for the consumer; MELCC 2018). Moreover, it is possible that such an event will occur in the next 5 years. Following the guide's criteria, the associated risk potential is therefore **low**. It should be noted that such an event occurred in Autumn 2019 (see section 2.4.1 and section 4 for more details).

A machinery failure or an accident at the borrow pit operating site represents a potential event during which petroleum-derived substances could be spilled and possibly drained into the body of water. However, in view of the protocols to be applied during such discharges and of the regulations governing the operation of such sites (Regulation respecting quarries and sand pits Q-2, r. 7) and in view of the minimal operation of the site at present, the seriousness of the consequences of such a spill on the exploited waters is considered **minor**. Moreover, it is possible that such an event will occur in the next 5 years. The risk potential associated with such an event is therefore **very low**.

An accidental spill of oil from aviation or maritime activities could release both organic and inorganic contaminants. In both cases, such spills could have serious consequences on the quality of the water exploited if the spill is large (contamination of the water that could influence the health of the population). However, the dilution effect in the waters of the lake, the water treatment facilities, and the location of such an incident on the lake reduce the severity of the consequences of the potential event to "serious". In addition, it is possible that such an event could occur in the next 5 years. The risk potential associated with such an event is therefore classified as **low**.

A forest fire was recorded in 2014 about 10km outside the village (total burn over an area of 95.8 ha, source: Open Forest interactive map). In the worst case, such a fire in the catchment area of the water intake would have minor consequences on the quality of the water (aesthetic or organoleptic water quality problem perceptible by consumers but tolerable). The likelihood of such an event occurring within the next five (5) years is still possible, especially if it occurs in a warm year with little precipitation. The risk potential associated with such an event is therefore classified as **very low**.

Although the melting of permafrost in connection with global warming is an omnipresent challenge in all the protection areas of the water intake, it is difficult, with current data, to assess to what extent this problematic represents a threat, since it is difficult to predict where and when a subsidence or a melt pool will appear and what consequence(s) these will have on the quality of the water exploited. For this reason, potential events related to permafrost melting have not been identified and assessed using the methods applied to the other events above. However, we still consider it essential to mention it here since this type of event could increase in frequency and severity with the ongoing global warming in this region.

### **3.3 LAND USES INVENTORY**

#### **3.3.1 Inventory of land use in protection zones**

As can be seen on the land use map (Appendice 3), the drinking water source protection areas are spread over four different use areas.

- The conservation area (inner protection area);
- The “Nuna” zone (all protection areas);
- The residential zone (intermediate protection area);
- The transport and communication area (intermediate protection area).

The installation of a snow fence or an installation representing an equivalent use, as well as low-impact activities such as hiking trails and snowmobile trails, are the only uses permitted in the conservation zones, which include the banks of the lake.

Most of the rest of the protection areas belong to **the “Nuna” zone**. These lands are mainly used for traditional and recreational purposes but can also accommodate the infrastructure usually installed away from the center of the village, as described in the development plan adopted by the municipal council in 2017 (BY-LAW No. 2017 -03, Northern Village of Kuujjuaq). It should be noted, however, that no development or activity likely to pollute the municipal water source is permitted there.

Small areas, accommodating the seaplane base and some residences are classified as **transport and communication zones** and **residential zones**, respectively.

The portion of the outer protection area that extends beyond the municipal limits represent Category I lands (Schedule 3), i.e. owned by the Nayumivik Landholding Corporation, which manages them for the benefit of his members.

### **3.3.2 Risks related to land use designations for the drinking water sources**

In theory, some of the activities permitted on “Nuna” lands would likely affect the water source such as mineral exploration, solid waste landfills and sewage ponds, cemeteries, and quarries/ borrow pits. However, it should be noted that the waste treatment infrastructure is currently located outside the watershed of the water source. They therefore do not represent any risk for it in the present. If new waste treatment infrastructures were to emerge in the future, the regulations incorporated into the development plan concerning the “Nuna” zone prohibit the establishment of such activities in places where they are likely to affect the water source. In addition, the development plan for the northern village stipulates that any borrow pit or quarry must comply with the by-law governing the operation of such sites for the exploitation of natural resources (Regulation respecting quarries and sand pits Q-2, r. 7) and must hold a certificate of authorization from the Ministry to which it reports (currently the MELCC). These activities, if they take place in the watershed of the water source, should therefore not represent a risk for the quality or quantity of the available drinking water. It should be noted that the use of these territories by the local population for their traditional and recreational activities (hunting and fishing, berries picking, camping, etc.) contributes to the protection of the water source.

Two small portions of the intermediate area are classified as a residential area. The construction of residences and the resulting landscaping can increase soil impermeability and the runoff of drained water to the lake. However, the surface area of the residential area currently in the Intermediate Protection Area is very small and the conservation area that encompasses the lake shores eliminates the risk of water runoff to the lake, however negligible. In addition, the development plan for the Northern Village of Kuujuaq provides for the development of play areas in residential neighbourhoods and the limitation of deforestation during new construction, two elements contributing to the protection of the water source.

The portion of the intermediate protection area which is located in the "communication and transport" zone represents the surface on which the seaplane base is installed on the shore of the lake. Its current size does not represent a high risk for the quality of drinking water and activities related to this infrastructure have been assessed in sections 3.1.2 and 3.2.2.

**Table 10** presented in Appendice 3 summarizes the risks associated with the activities permitted in the four land uses listed in section 3.3.1

## 4 IDENTIFICATION OF PROBLEMS AND PROBABLE CAUSES

Due to the isolated nature of the northern villages, and the pristine nature of the surrounding areas, drinking water sources are not exposed to the risks of chemical/biological contamination from human activities.

Under section 75 of the WWPR, this stage of the analysis seeks to identify the natural or anthropogenic causes behind the medium or high level of vulnerability identified in section 2.4 of this report.

**Table 9. Identification of proven problems linked to the indicator of physical vulnerability of the drinking water withdrawal site**

Problem identification	Associated vulnerability indicator	Identification of causes	Type of cause	Description of the cause	Associated protection zone
Oil spill	Physical indicator	Relocation of the hydrocarbon reservoir	Anthropic	A spill occurred when the tank was disconnected for movement	Intermediate

Following an oil spill incident on the pumping station site (see section 2.4.1, method 1), the physical vulnerability indicator of the water sampling site was set at medium level. The probable cause of this spill is related to the displacement of the oil tank. Normally, this tank is placed on a concrete slab and surrounded by low walls, acting as a retention basin in the event of any spills. However, the tank having been moved for works, the oil spill took place directly on the ground. Thus, this exceptional situation should not occur again. Should such events be a recurring problem, we recommend that the facilities be assessed by a professional so that they can suggest solutions to this problem.

# 5 CONCLUSION

## 5.1 GENERAL CONCLUSIONS

The Northern Village of Kuujjuaq, like the other northern villages in Nunavik, is located in an isolated environment and very little exploited by commercial or industrial activities. For this reason, the drinking water source provides very good quality water, and it is not exposed to the risk of biological or chemical contamination. The main threat to water installations is the vagaries of the arctic climate, linked to the risk of freezing during the winter period and the movement of permafrost, which is undergoing profound changes with global warming.

Following the assessment of the vulnerability of the water source, one of the six indicators (the physical integrity of the sampling site) was set at "medium" because of an oil spill event that took place in the intermediate protection area of the water source in 2019. This event, which took place on the displacement of the hydrocarbon reservoir for works, resulted in an environmental study and the excavation of contaminated soil.

The anthropogenic activities that have been listed in the inner and intermediate protection areas are navigation and air transport activities linked respectively to the launching of boats (inner protection area) and to the seaplane base (area intermediate protection). A borrow pit is also located in the outer protection zone. However, after evaluating the contaminants and potential events associated with these activities, it was determined that the latter pose only a low or very low threat to the quality / quantity of the water exploited.

Finally, within the limits of the Northern Village of Kuujjuaq, the water source protection areas are mainly included in the "conservation" and "Nuna" land uses, which contribute to the protection of the water source. Small portions of the intermediate protection area are classified as residential area (three residences) and transport and communication area (seaplane base).

It emerges from this study that the source of drinking water in the Northern Village of Kuujjuaq provides the northern village with quality water, so far little influenced by human activities.

Recommendations are made in section 5.3 to compensate for the lack of certain data and to further strengthen the monitoring and protection of the drinking water source.

## 5.2 MISSING DATA

There are no data on low water levels and high-water mark. Riparian strips were determined from the cartographic boundaries of the studied watercourses, available on the databases used for mapping. The best available resolution was used.

There is no event log.

The depth of the sample in the lake, the critical water level, as well as the number of the most recent authorization granted by the Ministry are also missing information.

A request for access to water quality data had been made to the regional office of the MELCC for Nord-du-Québec on January 6, 2021 concerning drinking water quality for the Northern Village of Kuujuaq. However, no data had been provided to us at the time of writing this report.

Some data on analyzes of inorganic substances are missing.

## 5.3 RECOMMENDATIONS

Following the analysis of the vulnerability of the drinking water source in the Northern Village of Kuujuaq, here is a list of recommendations, ranked in order of priority to validate certain data discussed in the report and to guarantee the best possible protection of the water source of drinking water.

- During Colilert tests, continue to monitor regularly for the presence of fecal coliforms in raw water;
- Keep a written record of events, even minor ones, which have affected the drinking water production chain and keep this information for inter-annual monitoring. An example of such a register is provided in Appendice 5;
- Create a register in which to record the values of the turbidity of the raw water, particularly during periods of flood (spring melt, heavy rains) when the turbidity is likely to increase sharply;
- Perform a soil contamination analysis at the site of the old borrow pit / dump located near the drinking water source.
- Visit of the drinking water sampling and treatment infrastructure by a professional over the next five (5) years.

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Vincent, W.F., Martin, D., Pienitz, R., Laurion, I., Muir, D. Young, K., and Bégin, Y. 2012. Freshwater resources in a changing environment. Dans: Allard, M. and Lemay, M. (eds) Integrated Regional Impact Studies. p. 137-155.

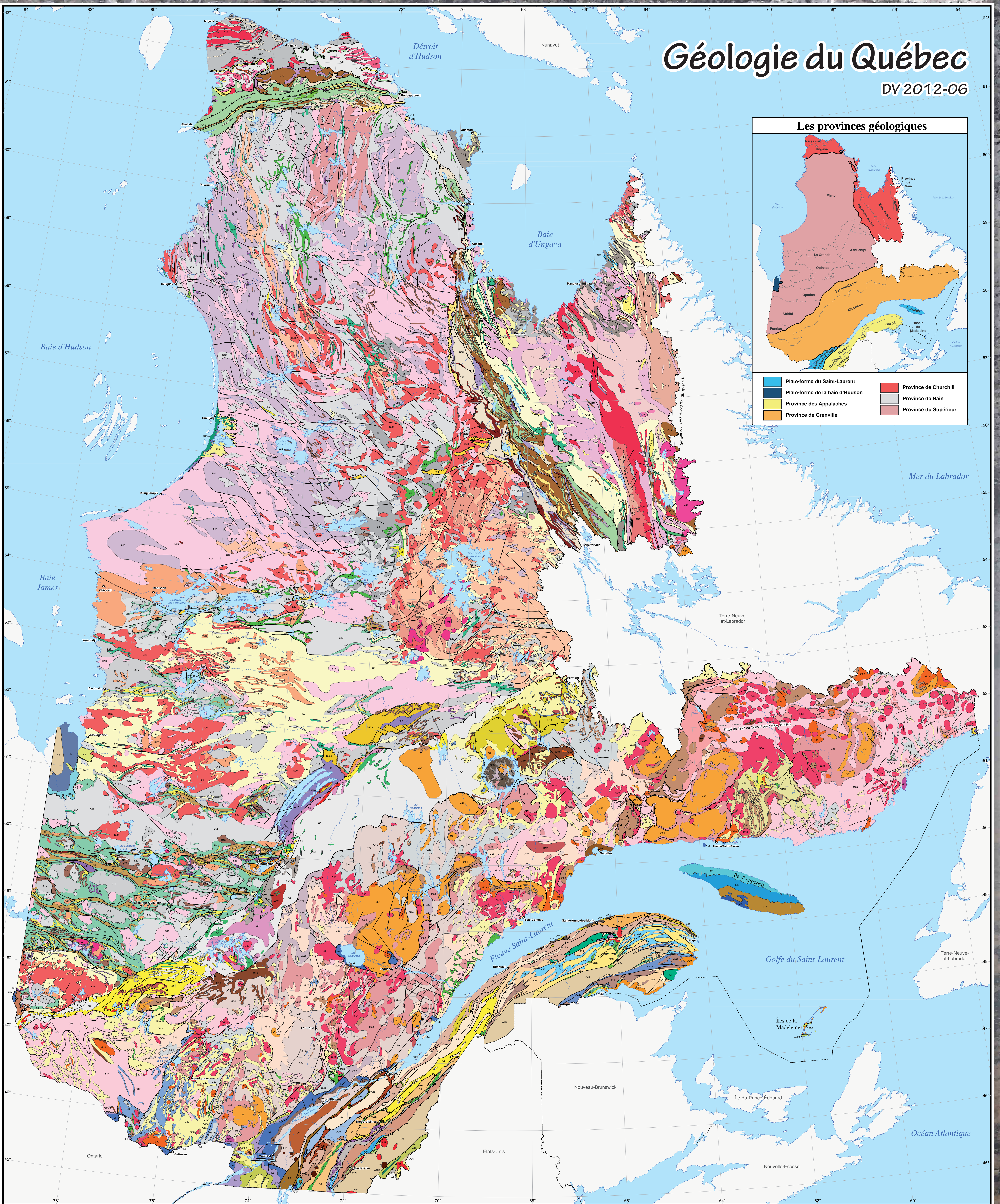
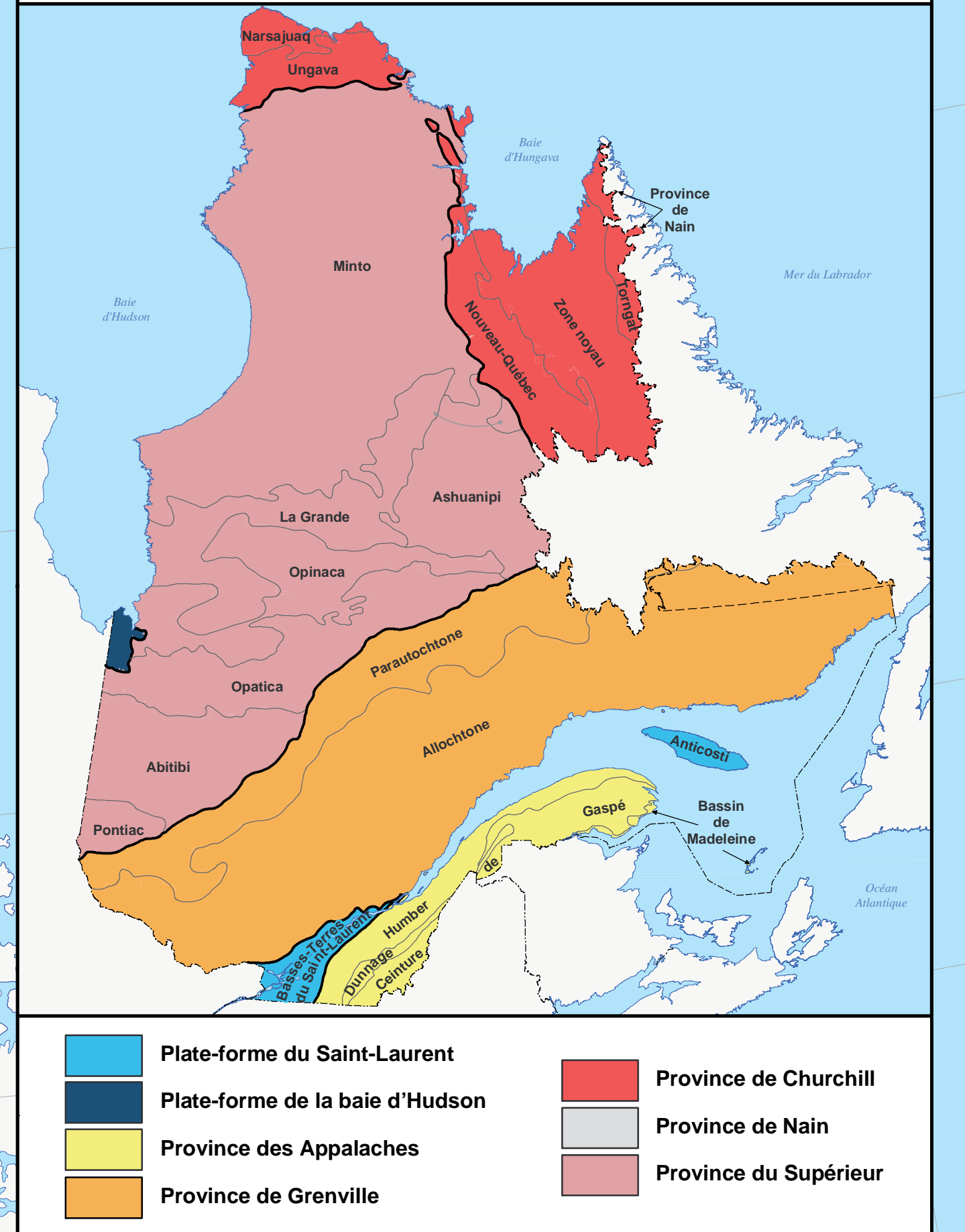
## **ANNEX 1. GEOLOGY AND PERMAFROST**

- A1.1 Geological map of Quebec
- A1.2 Permafrost conditions map (Source : Chiasson et al. 2020)
- A1.3 Map of natural hazards (Source: Chiasson et al. 2020)

# Géologie du Québec

DV 2012-06

## Les provinces géologiques



PROVINCE DES APPALACHES	CAMBRIEN À ORDOVICIEN INFÉRIEUR	PROVINCE DE GRENVILLE	PROVINCE DE CHURCHILL	PROVINCE DE NAIN	PROVINCE DU SUPÉRIEUR
<b>MÉSOZOÏQUE</b> <b>CRÉTACE</b> Roches sédimentaires transmissives à laminaires, brèches de dépense associées et conglomérats (Suite des Montserrat) <b>PALEOZOÏQUE</b> <b>SILURIEN INFÉRIEUR</b> 113 Calcaire à conchilles et calcaire ricéol (Fr. de Châteauguay) 114 Marnes, calcaire et conglomérat calcaire (Fr. de St-Jovite, de Montserrat et de Beauce) <b>ORDOVICIEN SUPÉRIEUR ET MOYEN</b> 112 Calcaire, marnes, schistes et grès (Fr. de St-Jovite, de Montserrat et de Beauce) 111 Grès, schistes, argiles et conglomérats (Fr. de St-Jovite, de Montserrat et de Beauce) <b>ORDOVICIEN INFÉRIEUR</b> 110 Grès, schistes, argiles et conglomérats (Fr. de St-Jovite, de Montserrat et de Beauce) <b>PROVINCE DE CHURCHILL</b> <b>MÉSOZOÏQUE</b> 108 Grès granitique, monzonite quartarite et pegmatite 109 Grès granitique, monzonite quartarite et pegmatite <b>PROVINCE DE NAIN</b> <b>PALEOZOÏQUE</b> 107 Grès granitique, monzonite quartarite et pegmatite <b>PROVINCE DU SUPÉRIEUR</b> <b>PALEOZOÏQUE</b> 106 Grès granitique, monzonite quartarite et pegmatite <b>ARCHÉEN</b> 105 Grès granitique, monzonite quartarite et pegmatite <b>PROVINCE DE GRENVILLE</b> <b>MÉSOZOÏQUE</b> 104 Grès granitique, monzonite quartarite et pegmatite <b>PROVINCE DE CHURCHILL</b> <b>MÉSOZOÏQUE</b> 103 Grès granitique, monzonite quartarite et pegmatite <b>PROVINCE DE NAIN</b> <b>PALEOZOÏQUE</b> 102 Grès granitique, monzonite quartarite et pegmatite <b>PROVINCE DU SUPÉRIEUR</b> <b>PALEOZOÏQUE</b> 101 Grès granitique, monzonite quartarite et pegmatite <b>ARCHÉEN</b> 100 Grès granitique, monzonite quartarite et pegmatite	<b>PROVINCE DE CHURCHILL</b> <b>MÉSOZOÏQUE</b> 108 Grès granitique, monzonite quartarite et pegmatite 109 Grès granitique, monzonite quartarite et pegmatite <b>PROVINCE DE NAIN</b> <b>PALEOZOÏQUE</b> 107 Grès granitique, monzonite quartarite et pegmatite <b>PROVINCE DU SUPÉRIEUR</b> <b>PALEOZOÏQUE</b> 106 Grès granitique, monzonite quartarite et pegmatite <b>ARCHÉEN</b> 105 Grès granitique, monzonite quartarite et pegmatite	<b>PROVINCE DE GRENVILLE</b> <b>MÉSOZOÏQUE</b> 104 Grès granitique, monzonite quartarite et pegmatite <b>PROVINCE DE CHURCHILL</b> <b>MÉSOZOÏQUE</b> 103 Grès granitique, monzonite quartarite et pegmatite <b>PROVINCE DE NAIN</b> <b>PALEOZOÏQUE</b> 102 Grès granitique, monzonite quartarite et pegmatite <b>PROVINCE DU SUPÉRIEUR</b> <b>PALEOZOÏQUE</b> 101 Grès granitique, monzonite quartarite et pegmatite <b>ARCHÉEN</b> 100 Grès granitique, monzonite quartarite et pegmatite	<b>PROVINCE DE CHURCHILL</b> <b>MÉSOZOÏQUE</b> 103 Grès granitique, monzonite quartarite et pegmatite <b>PROVINCE DE NAIN</b> <b>PALEOZOÏQUE</b> 102 Grès granitique, monzonite quartarite et pegmatite <b>PROVINCE DU SUPÉRIEUR</b> <b>PALEOZOÏQUE</b> 101 Grès granitique, monzonite quartarite et pegmatite <b>ARCHÉEN</b> 100 Grès granitique, monzonite quartarite et pegmatite	<b>PROVINCE DE NAIN</b> <b>PALEOZOÏQUE</b> 102 Grès granitique, monzonite quartarite et pegmatite <b>PROVINCE DU SUPÉRIEUR</b> <b>PALEOZOÏQUE</b> 101 Grès granitique, monzonite quartarite et pegmatite <b>ARCHÉEN</b> 100 Grès granitique, monzonite quartarite et pegmatite	<b>PROVINCE DU SUPÉRIEUR</b> <b>PALEOZOÏQUE</b> 101 Grès granitique, monzonite quartarite et pegmatite <b>ARCHÉEN</b> 100 Grès granitique, monzonite quartarite et pegmatite

Missionnaires  
Surface de référence géologique : Ellipsoid GRS 80  
Système de référence géologique : MAD 83 compatible avec le système mondial WGS 84  
Projection cartographique : Courbes de Lambert  
Mézencentris  
68° 30' ouest

0 50 100 150 km

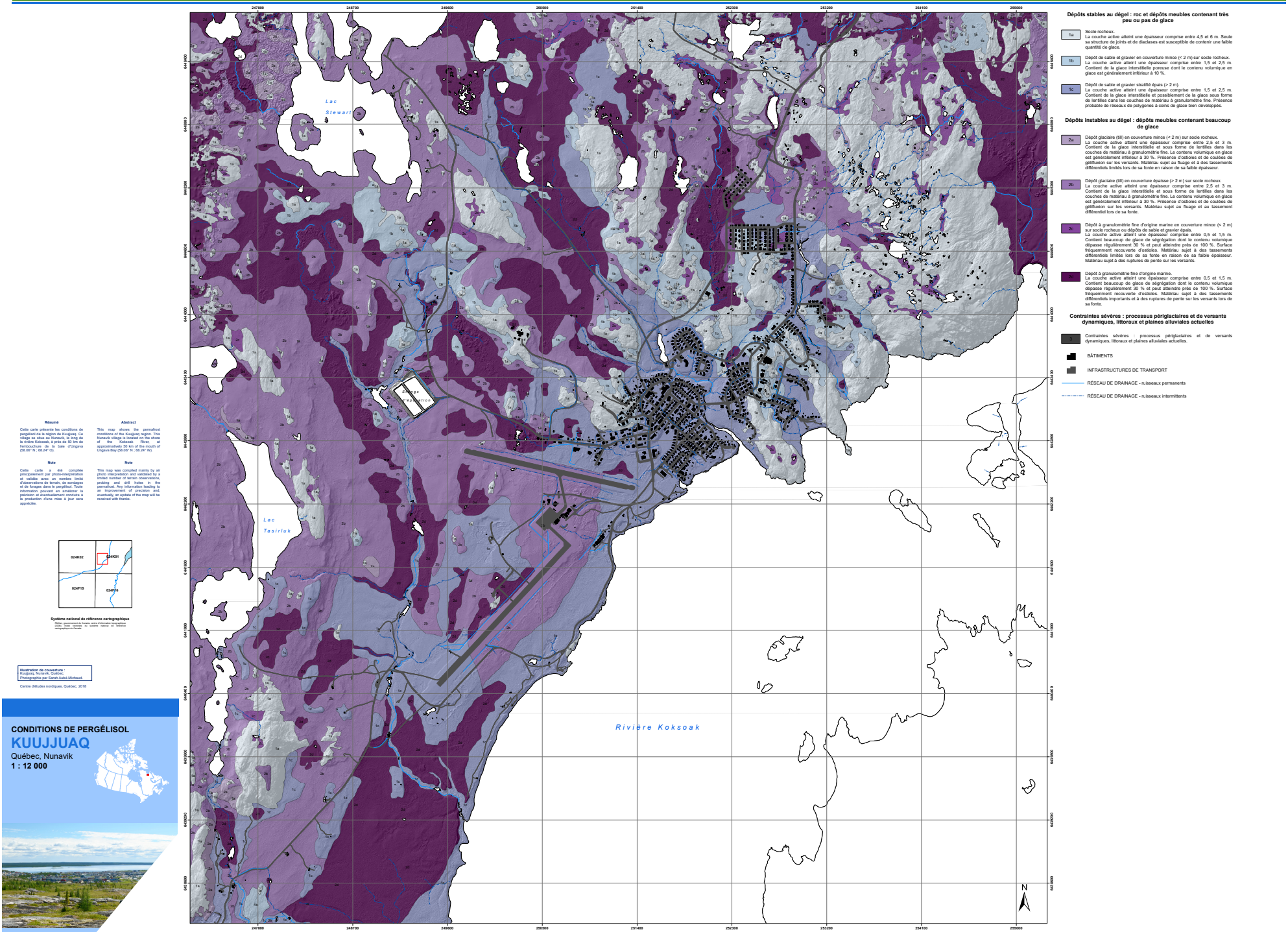
1:2 000 000

Source : Ministère des Ressources naturelles  
Organisation : Direction de l'information géographique du Québec  
Année : 2012  
Topographie : Ministère des Ressources naturelles  
Direction générale de l'information géographique

Réalisation : Robert Thériault, Stéphane Desjardins, André Tremblay  
Assistance technique : Direction des Ressources naturelles  
Ministère des Ressources naturelles  
Production : Direction générale de l'information géographique du Québec  
Diffusion : Ministère des Ressources naturelles  
Direction de l'information géographique du Québec

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**Dépôts stables au dégel : roc et dépôts meubles contenant très peu ou pas de glace**

- 1a Solc rocheux  
La couche active atteint une épaisseur comprise entre 4,5 et 6 m. Seule sa structure de sol et de débris est susceptible de contenir une faible quantité de glace.
- 1b Dépôt de sable et gravier en couverture mince (< 2 m) sur solc rocheux.  
La couche active atteint une épaisseur comprise entre 1,5 et 2,5 m. Contenu de la glace interstitielle possible dont le contenu volumique en glace est généralement inférieur à 10 %.
- 1c Dépôt de sable et gravier stratifié épais (> 2 m).  
La couche active atteint une épaisseur comprise entre 1,5 et 2,5 m. Contenu de la glace interstitielle et possiblement de la glace sous forme de lentilles dans les couches de matériaux à granulométrie fine. Présence probable de réseaux de polygones à coins de glace bien développés.

**Dépôts instables au dégel : dépôts meubles contenant beaucoup de glace**

- 2a Dépôt glaciaire (S) en couverture mince (< 2 m) sur solc rocheux.  
La couche active atteint une épaisseur comprise entre 2,5 et 3 m. Contenu de la glace interstitielle et sous forme de lentilles dans les couches de matériaux à granulométrie fine. Le contenu volumique en glace est généralement inférieur à 30 %. Présence d'oides et de coulées de gélifluxus sur les versants. Matériau sujet au fluage et à des tassements différentiels limités lors de sa fonte en raison de sa faible épaisseur.
- 2b Dépôt glaciaire (S) en couverture épaisse (> 2 m) sur solc rocheux.  
La couche active atteint une épaisseur comprise entre 2,5 et 3 m. Contenu de la glace interstitielle et sous forme de lentilles dans les couches de matériaux à granulométrie fine. Le contenu volumique en glace est généralement inférieur à 30 %. Présence d'oides et de coulées de gélifluxus sur les versants. Matériau sujet au fluage et à des tassements différentiels lors de sa fonte.
- 3a Dépôt à granulométrie fine d'origine marine en couverture mince (< 2 m) sur solc rocheux ou dépôt de sable et gravier épais.  
La couche active atteint une épaisseur comprise entre 0,5 et 1,5 m. Contenu beaucoup de glace de ségrégation dont le contenu volumique dépasse régulièrement 50 % et peut atteindre près de 100 %. Surface fréquemment recouverte d'oides. Matériau sujet à des tassements différentiels limités lors de sa fonte en raison de sa faible épaisseur. Matériau sujet à des ruptures de pente sur les versants.
- 3b Dépôt à granulométrie fine d'origine marine.  
La couche active atteint une épaisseur comprise entre 0,5 et 1,5 m. Contenu beaucoup de glace de ségrégation dont le contenu volumique dépasse régulièrement 30 % et peut atteindre près de 100 %. Surface fréquemment recouverte d'oides. Matériau sujet à des tassements différentiels importants et à des ruptures de pente sur les versants lors de sa fonte.

**Contraintes sévères : processus périglaciaires et de versants dynamiques, littoraux et plaines alluviales actuelles**

- Contraintes sévères : processus périglaciaires et de versants dynamiques, littoraux et plaines alluviales actuelles.
- BÂTIMENTS
- INFRASTRUCTURES DE TRANSPORT
- RÉSEAU DE DRAINAGE - ruisseaux permanents
- RÉSEAU DE DRAINAGE - ruisseaux intermittents

**Résumé**  
Cette carte présente les conditions de congélation de la région de Kuujuuaq. Ce diagramme a été préparé en fonction de la carte de référence de la région de Kuujuuaq (S5 02' N, 68 23' O) et de la carte de référence de la région de Kuujuuaq (S5 02' N, 68 23' O).

**Annexe**  
This map shows the periglacial conditions of the Kuujuuaq region. This diagram was prepared on the basis of the reference map of the Kuujuuaq region (S5 02' N, 68 23' W) and the reference map of the Kuujuuaq region (S5 02' N, 68 23' W).

**Note**  
Cette carte a été compilée à partir de données provenant de diverses sources, notamment de données de terrain, de photographies et de données de télédétection. Toute information présentée en fonction de la précision et de l'exactitude de ces données sera reconnue avec plaisir.

**Note**  
This map was compiled mainly by use of ground information and satellite data. Aerial photographs and other information were used where available. Any information bearing on the accuracy and reliability of the data will be gratefully acknowledged.



**Système national de référence cartographique**  
NAD83 / NAD83  
Projection : MTR zone 6, NAD83  
Échelle : 1 : 12 000

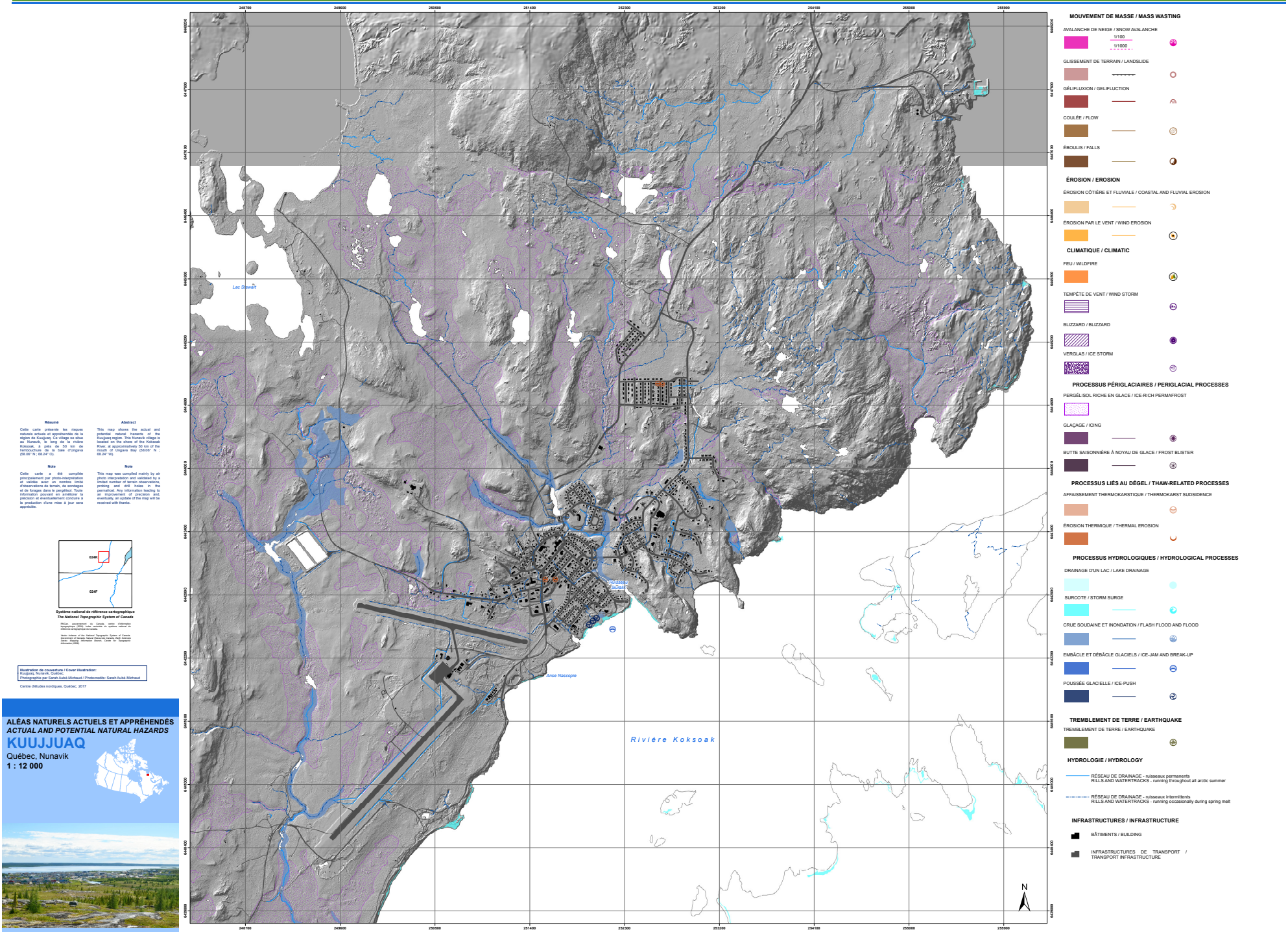
**Illustrations de couverture :**  
Photographie par Sarah Aub-Michaud  
Photographie par Sarah Aub-Michaud

Centre d'études nordiques, Québec, 2018



**CONDITIONS DE PERGÉLISOL**  
**KUUJUUAQ**  
Québec, Nunavik  
1 : 12 000





**Résumé**  
 Cette carte présente les risques naturels actuels et potentiels de la région de Québec. Ce risque est basé sur les données de terrain de la région de Québec, au Nunavik. Elle est basée sur le plan de l'Union St-Jovite (GSDP N° 1-82-01-01).

**Abstract**  
 This map shows the actual and potential natural hazards of the Québec region. This hazard is based on the terrain data of the Québec region at Nunavik. It is based on the Union St-Jovite map (GSDP N° 1-82-01-01).

**Note**  
 Cette carte a été compilée principalement par télédétection et par un nombre limité d'observations de terrain de terrain et de sondage dans le paysage. Toute information supplémentaire est fournie dans le document de référence à la production de cette carte à jour sera ajoutée.

**Note**  
 This map was compiled mainly by satellite remote sensing and a limited number of terrain observations, ground and soil data or the perimeter. Any information regarding to an improvement of production will be available in future of this map will be received with thanks.



**Système national de référence cartographique**  
 The National Geographic System of Canada  
 NAD83  
 UTM  
 Zone 18N  
 Datum: NAD83  
 Spheroid: GRS80  
 Prime Meridian: Greenwich  
 Projection: UTM  
 Units: Metres  
 Authority: ICAO  
 Version: 1.0.0  
 Year: 2011

**Illustration de couverture / Cover illustration:**  
 Photographie par Sarah-Audé Michaud / Photographie: Sarah-Audé Michaud

**ALÉAS NATURELS ACTUELS ET APPRÉHENDÉS**  
**ACTUAL AND POTENTIAL NATURAL HAZARDS**  
**KUUJJUAQ**  
 Québec, Nunavik  
 1 : 12 000

**ALÉAS NATURELS ACTUELS ET APPRÉHENDÉS**  
**ACTUAL AND POTENTIAL NATURAL HAZARDS**  
**KUUJJUAQ**  
 Québec, Nunavik  
 1 : 12 000

- MOUVEMENT DE MASSE / MASS WASTING**
- AVALANCHE DE NEIGE / SNOW AVALANCHE
    - 1/100
    - 1/1000
  - GLISSEMENT DE TERRAIN / LANDSLIDE
  - GELIFLUXION / GELIFLUCTION
  - COULÉE / FLOW
  - ÉBOULIS / FALLS
- ÉROSION / EROSION**
- ÉROSION CÔTIÈRE ET FLUVIALE / COASTAL AND FLUVIAL EROSION
  - ÉROSION PAR LE VENT / WIND EROSION
- CLIMATIQUE / CLIMATIC**
- FEU / WILDFIRE
  - TEMPÊTE DE VENT / WIND STORM
  - BLIZZARD / BLIZZARD
  - VERGLAS / ICE STORM
- PROCESSUS PÉRIGLACIAIRES / PERIGLACIAL PROCESSES**
- PÉRIHELISOL RICHE EN GLACE / ICE-RICH PERMAFROST
  - GLACIAGE / ICING
  - BUTTE SAISONNIÈRE À NOUVEAU DE GLACE / FROST BLISTER
- PROCESSUS LIÉS AU DÉGEL / THAW-RELATED PROCESSES**
- AFFAÎSSEMENT THERMOKARSTIQUE / THERMOKARST SUCSIDENCE
  - ÉROSION THERMIQUE / THERMAL EROSION
- PROCESSUS HYDROLOGIQUES / HYDROLOGICAL PROCESSES**
- DRAINAGE D'UN LAC / LAKE DRAINAGE
  - SURCOTE / STORM SURGE
  - CRUE SUDDAINE ET INONDATION / FLASH FLOOD AND FLOOD
  - EMBAÛLE ET DÉBAÛLE GLACIÈRES / ICE-JAM AND BREAK-UP
  - POUSSEE GLACIÈRE / ICE-PUSH
- TREMBLEMENT DE TERRE / EARTHQUAKE**
- TREMBLEMENT DE TERRE / EARTHQUAKE
- HYDROLOGIE / HYDROLOGY**
- RESEAU DE DRAINAGE - ruisseaux permanents / RILLS AND WATERTRACKS - running throughout all arctic summer
  - RESEAU DE DRAINAGE - ruisseaux intermittents / RILLS AND WATERTRACKS - running occasionally during spring melt
- INFRASTRUCTURES / INFRASTRUCTURE**
- BÂTIMENTS / BUILDING
  - INFRASTRUCTURES DE TRANSPORT / TRANSPORT INFRASTRUCTURE

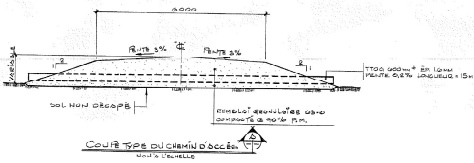
Auteurs : S. Aubé-Michaud, M. Alard et E. L'Hérault, Centre d'études nordiques, Université Laval, décembre 2017.  
 Authors : S. Aubé-Michaud, M. Alard and E. L'Hérault, Centre d'études nordiques, Université Laval, December 2017.

Citation recommandée :  
 Aubé-Michaud, S., Alard, M. et L'Hérault, E., 2017. Aléas naturels actuels et appréhendés, Kuujuaq, Québec, Nunavik, Centre d'études nordiques, échelle 1 : 12 000.

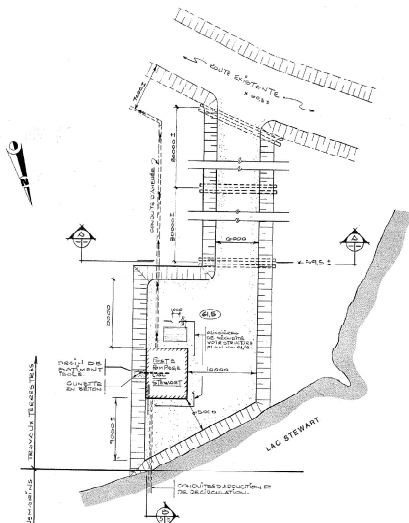
Recommended citation:  
 Aubé-Michaud, S., Alard, M. and L'Hérault, E., 2017. Actual and potential natural hazards, Kuujuaq, Québec, Nunavik, Centre d'études nordiques, scale 1 : 12 000.

## **ANNEX 2. WATER INTAKE CONSTRUCTION DIAGRAMS**

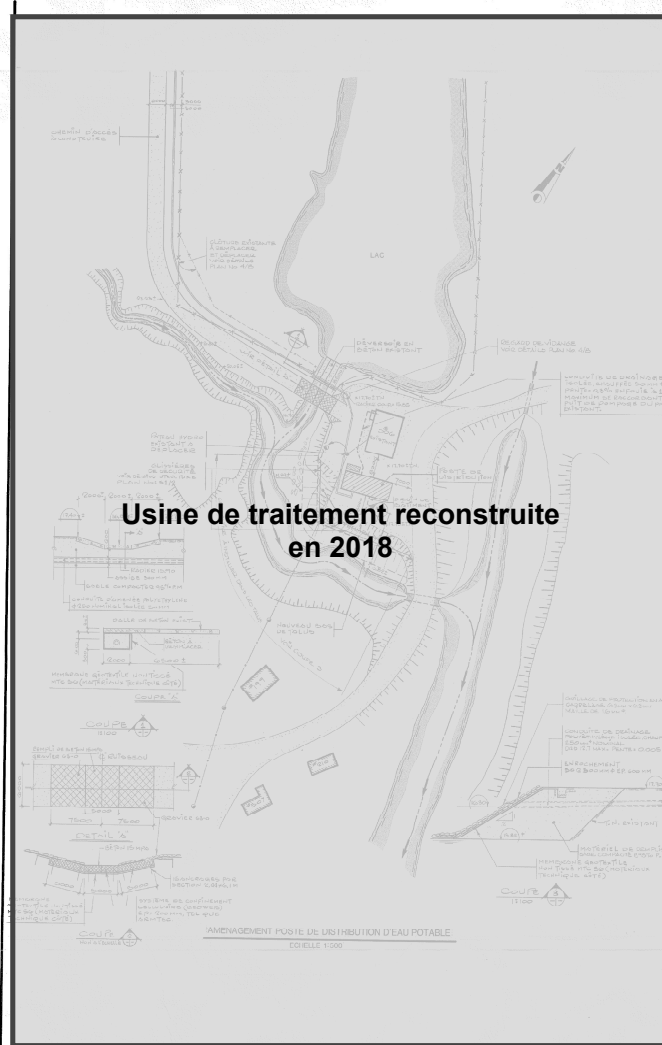
- A2.1, A2.2, A2.3 Diagrams of the installations for withdrawal and treatment of drinking water in the Northern Village of Kuujuaq



Couée type du chemin d'accès  
Nord Océan





AMÉNAGEMENT POSTE DE POMPAGE  
LAC STEWART  
ÉCHELLE 1/200



Usine de traitement reconstruite  
en 2018

AMÉNAGEMENT POSTE DE DISTRIBUTION D'EAU POTABLE  
ÉCHELLE 1/500

No	Date	Modifications	État	Appr.
1	2018	Re-appropriation pour pompage		

Client: ADMINISTRATION REGIONALE KUJUAQ

Projet: ALIMENTATION EN EAU POTABLE KUJUAQ

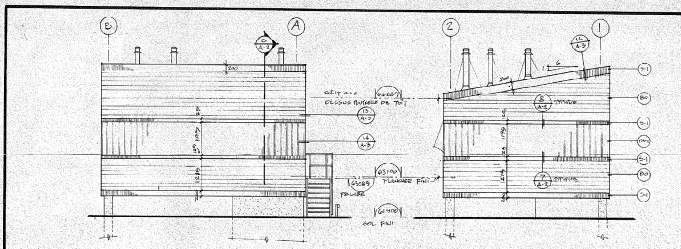
Contractant: GENOR

Titre de plan: AMÉNAGEMENT POSTE DE DISTRIBUTION ET POSTE DE TEMPERE...

Préparé par: Y.D.      Echéché: H. J. Gagnon

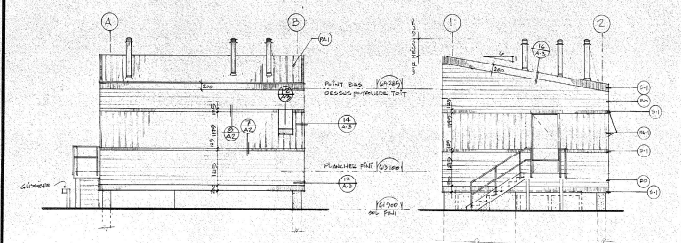
Dessiné par: W.P.S.      Date: NOVEMBRE 1991

Approuvé par: G.P.      Contre: G. Gagnon / H. J. Gagnon



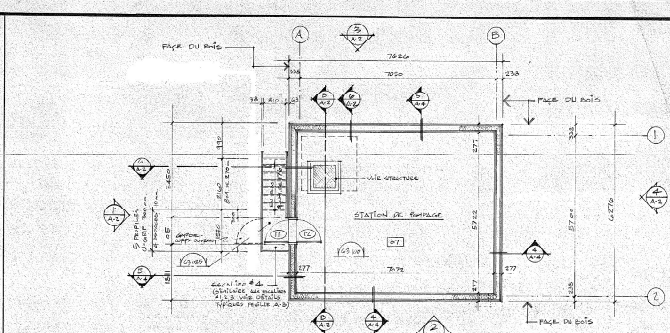
ELEVATION  
Echelle = 1/50

ELEVATION  
Echelle = 1/50

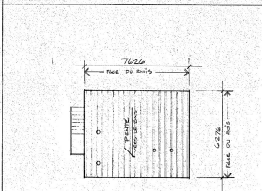


ELEVATION  
Echelle = 1/50

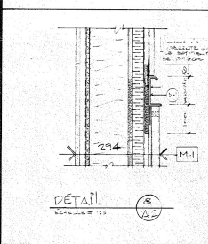
ELEVATION  
Echelle = 1/50



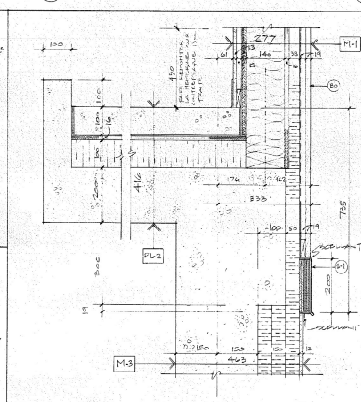
PLAN REZ-DE-CHAUSSEE  
Echelle = 1/50



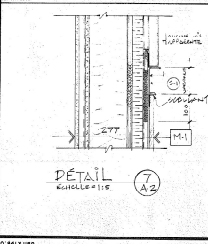
PLAN TOIT  
Echelle = 1/50



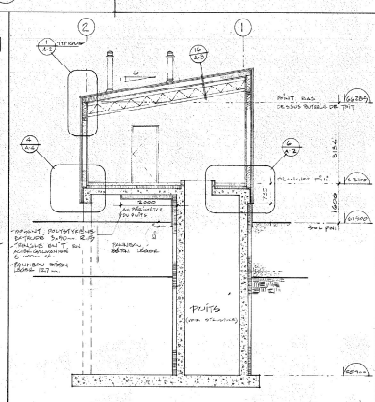
DÉTAIL  
Echelle = 1/5



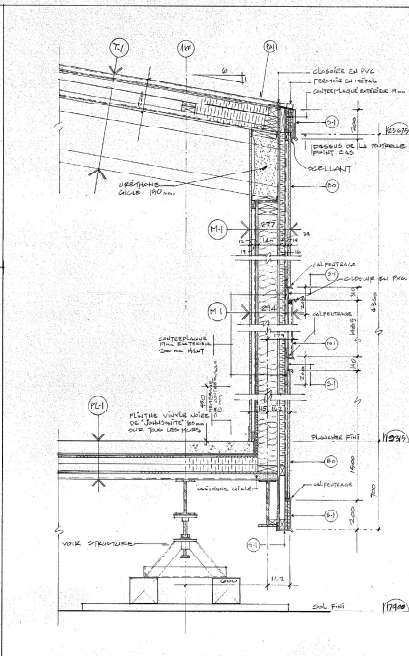
DÉTAIL  
Echelle = 1/5



DÉTAIL  
Echelle = 1/5



COUPE TRANSVERSAL  
Echelle = 1/50



COUPE DE MUR  
Echelle = 1/10

N°	Date	Modification	É	A	V
1					
2					

NOTE : voir simplicité voir feuille A-1

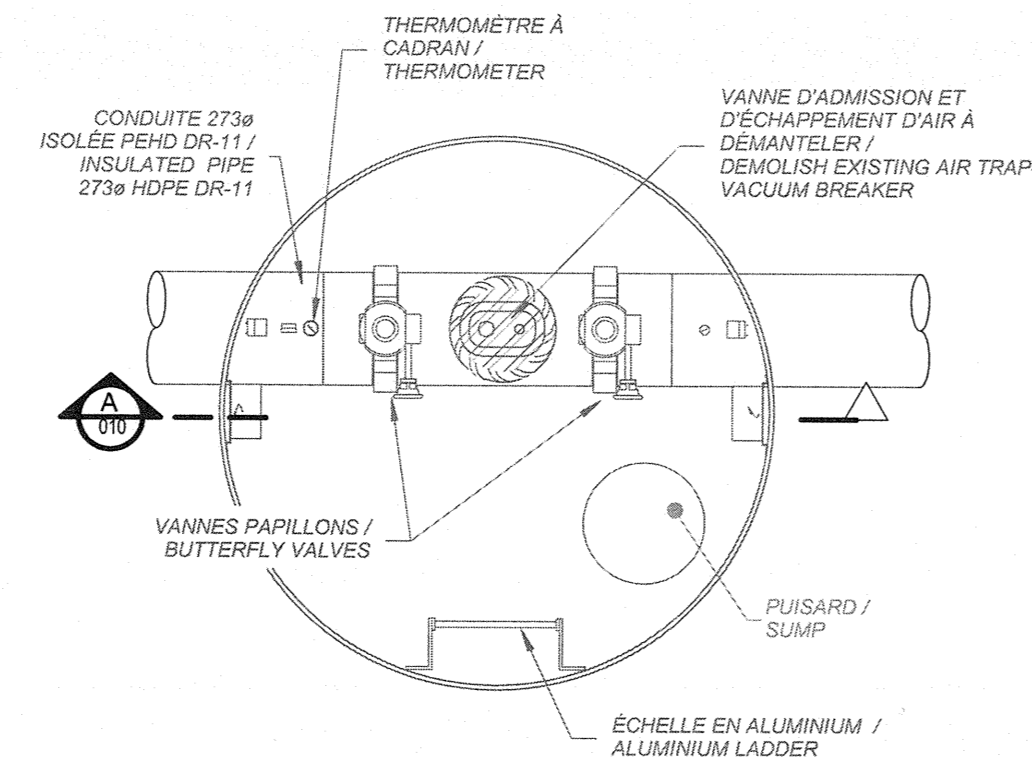
ALIMENTATION EN EAU POTABLE  
A. KUUJJUK

GENOR

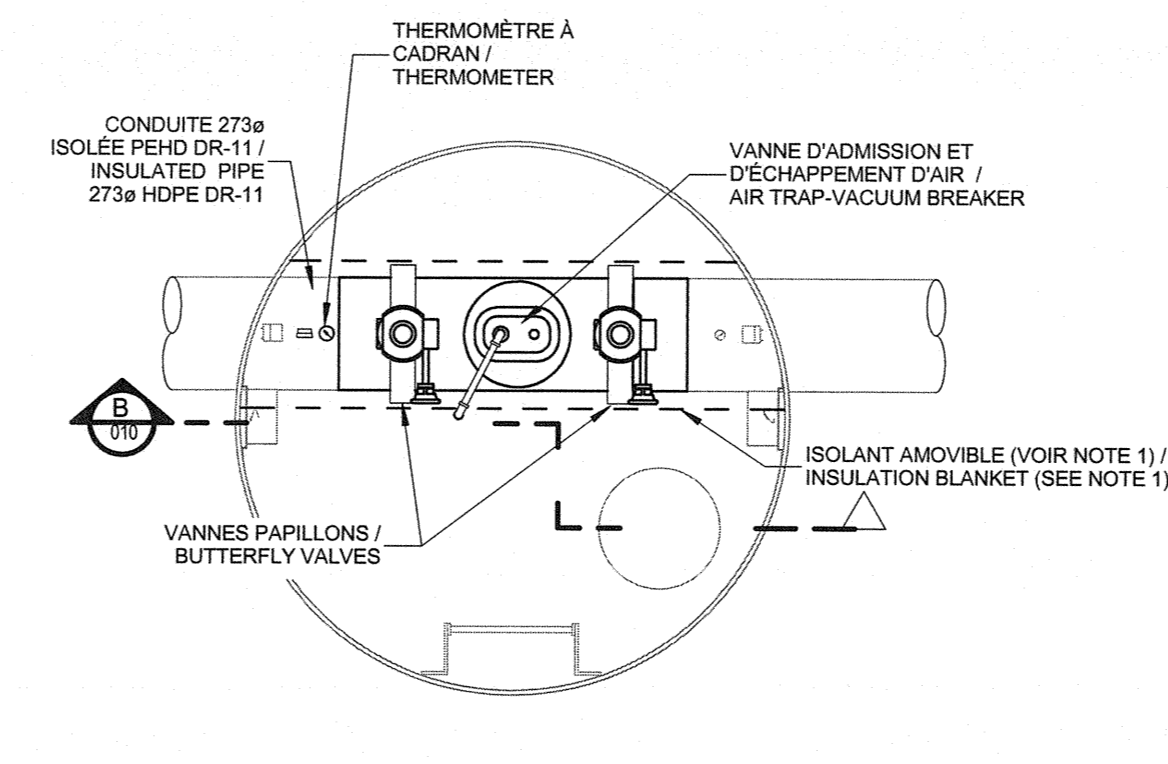
PROJET DE FONDAGE

PLANS, ELEVATIONS, COUPES ET DÉTAILS

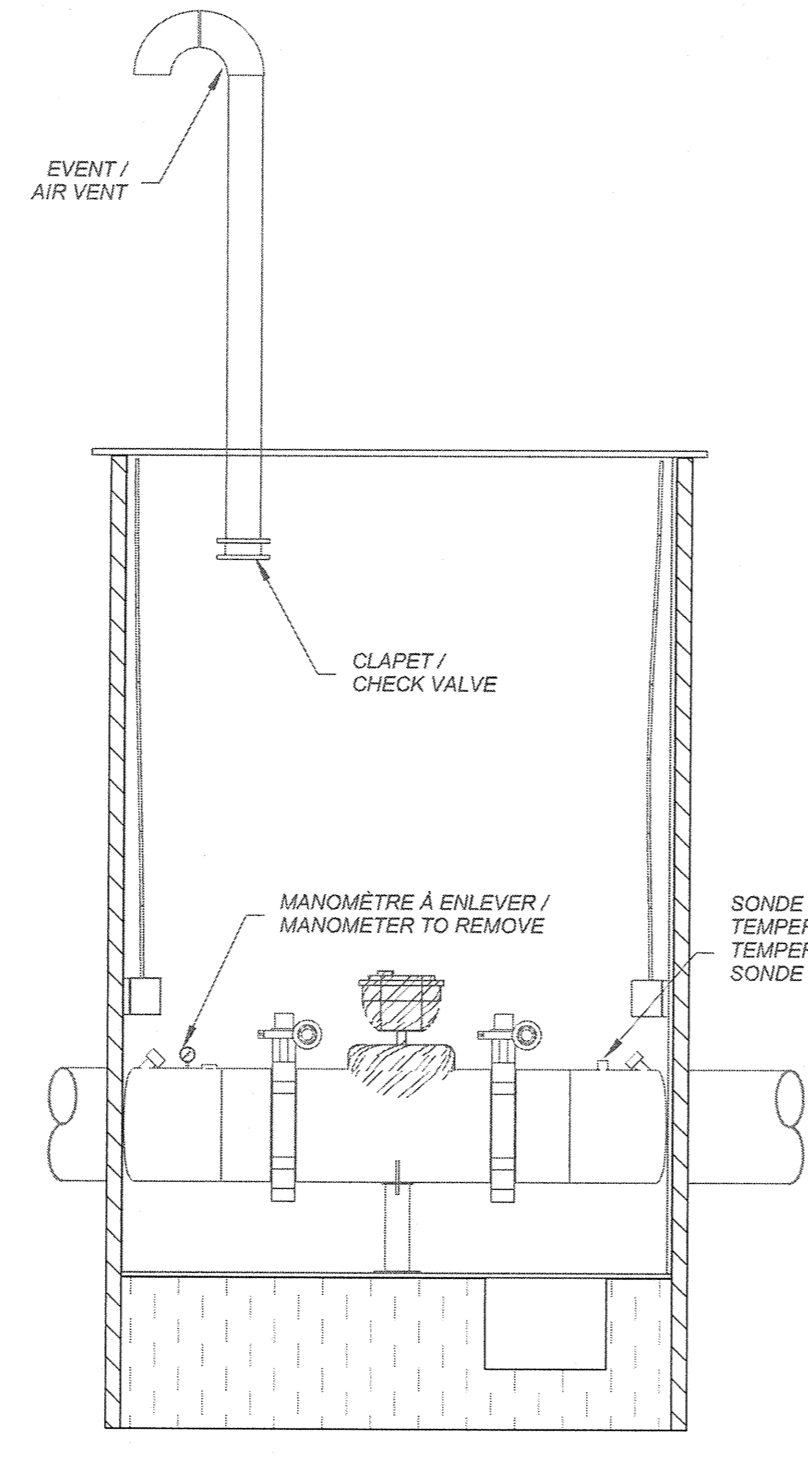
Projeteur: J. Gauthier	Exécuté: J. Gauthier
Approuvé: J. Gauthier	Date: Mars 1971
Approuvé: J. Gauthier	Scale: 277-71
	Page No. A-2



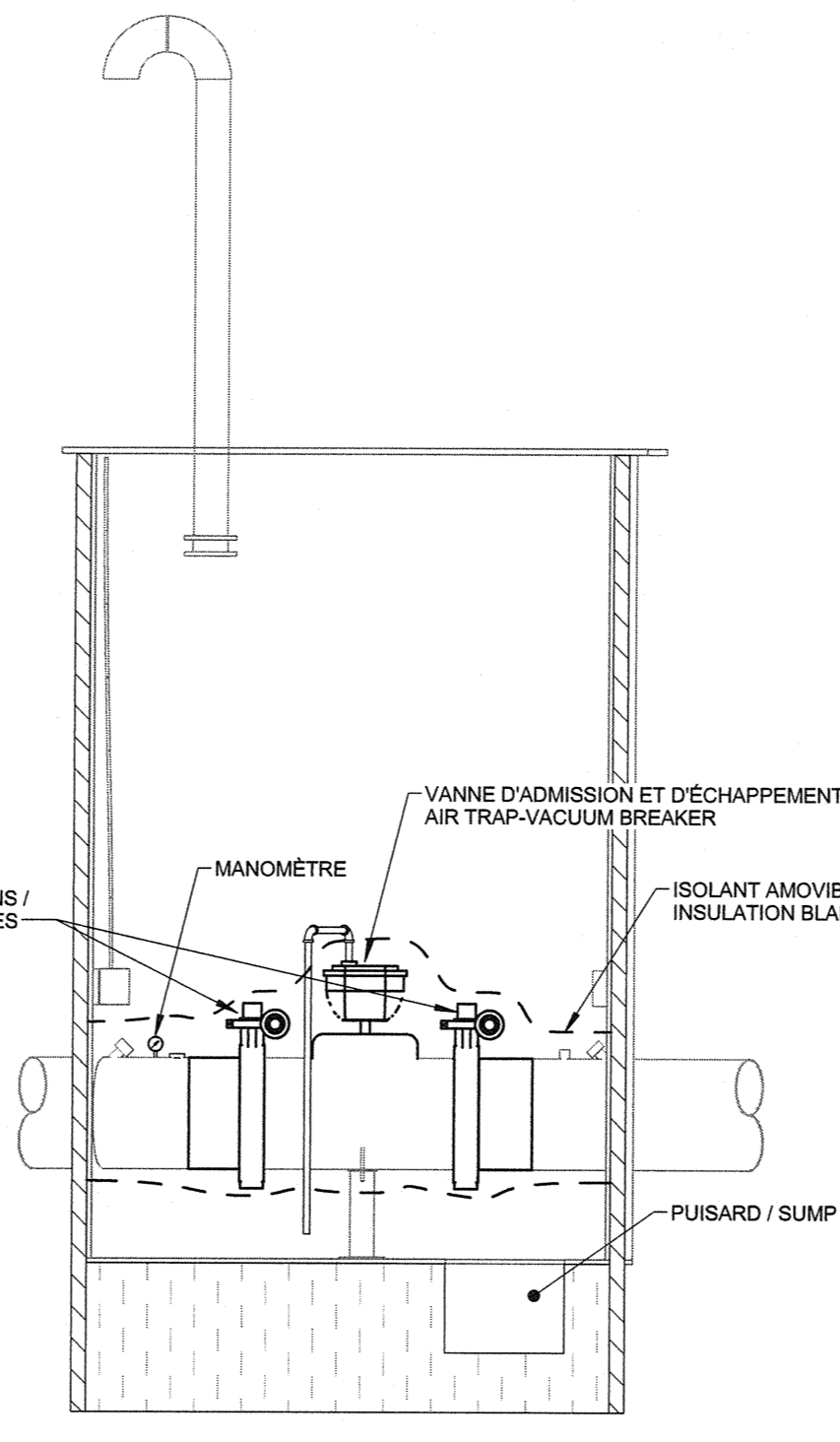
CHAMBRE DE VANNE (TYP.) /  
 MANHOLE (TYP.)  
 Echelle: 1:25



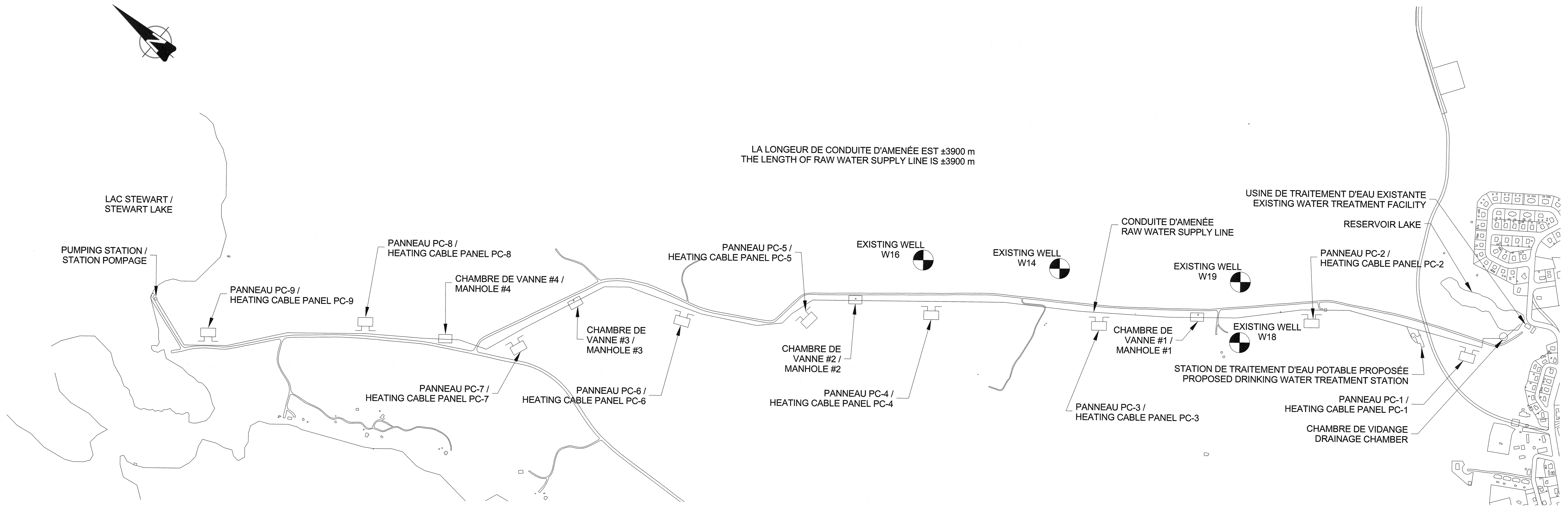
CHAMBRE DE VANNE (TYP.) / TRAVAUX PROPOSÉ /  
 MANHOLE (TYP.) / PROPOSED WORKS  
 Echelle: 1:25



COUPE / SECTION : A-A  
 Echelle: 1:25

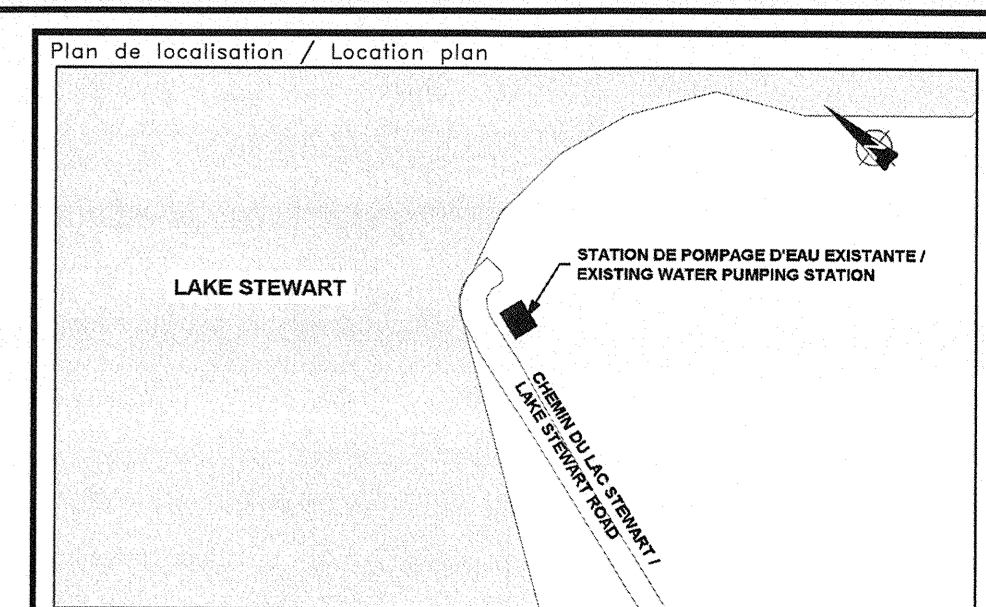


COUPE / SECTION : B-B  
 Echelle: 1:25



LA LONGUEUR DE CONDUITE D'AMENÉE EST ±3900 m  
 THE LENGTH OF RAW WATER SUPPLY LINE IS ±3900 m

VUE D'IMPLANTATION / GENERAL LAYOUT  
 Echelle: 1:5000



- A. B. : L'ENTREPRENEUR DEVAIT, AVANT DE COMMENCER TOUT TRAVAIL :
- VÉRIFIER TOUS LES DIMENSIONS DES DESSINS ET LES CONDITIONS EXISTANTES SUR LE CHANTIER.
  - AVERTIR IMMÉDIATEMENT DE TOUTE ERREUR D'UN DESIGNER.
  - AVANT DE CREUSER, COMMUNIQUER AVEC LA COMMUNAUTÉ DE KUUVUJUAQ.
- A. B. : BEFORE EXECUTING ANY WORK, THE CONTRACTOR WILL HAVE TO :
- VERIFY ALL DESIGN DIMENSIONS AND EXISTING CONDITIONS ON SITE.
  - WARN ENGINEER IMMEDIATELY OF ANY MISTAKES AND/OR MISSING INFORMATION.
  - BEFORE EXCAVATING, CONTACT KUUVUJUAQ AUTHORITY.

LÉGENDE / LEGEND

À ENLEVER / DÉMANTELER / TO REMOVE / DEMOLISH

NOTES :

- COUVERTURES ISOLANTES / INSULATION BLANKETS:
  - COUVERTURES ISOLANTES AMOVIBLES IMPERMÉABLES ET RÉUTILISABLES TELLES QUE ISOTEX-CRYOGEL-1700 CONFECTIONNÉES EN USINE DE TISSU DE FIBRE DE VERRE IMPRÉGNÉ DE SILICONE À L'INTÉRIEUR ET À L'EXTÉRIEUR ET ISOLÉES À L'AIDE DE DEUX COUCHES DE 10 mm D'ÉPAISSEUR DE CRYOGEL-2; CIA ATTACHES VÉLOCRO, PINS ET HOOKS AND SILICONE IMPREGNATED FIBERGLASS STAPS AND INDIVIDUALLY LABELED FOR LOCATION AND REPOSITIONING. INSULATION BLANKETS SUCH AS INDUSTRIALLY CRAFTED ISOTEX-CRYOGEL-1700 OR APPROVED EQUIVALENT.
  - REMOVABLE AND REUSABLE WATERREPELLENT INSULATION BLANKETS SUCH AS MADE INSIDE AND OUT WITH SILICONE IMPREGNATED FIBERGLASS FABRIC AND INSULATED WITH TWO 10 MM LAYERS OF CRYOGEL-2 COMPLETE WITH VELCRO FASTENERS AND STAINLESS STEEL WIREING, PINS AND HOOKS AND SILICONE IMPREGNATED FIBERGLASS STAPS AND INDIVIDUALLY LABELED FOR LOCATION AND REPOSITIONING. INSULATION BLANKETS SUCH AS INDUSTRIALLY CRAFTED ISOTEX-CRYOGEL-1700 OR APPROVED EQUIVALENT.
- COUVERCLES DE PUITS / WELL COVERS:
  - COUVERCLE DE PUITS 150 MM Ø CADENASSABLE VENTILÉ AVEC GRILLAGE ANTI-VERREME TEL QUE SÉRIE WTC SÉRIE BI WATERTITE WEL CAPS - FOR STEEL WELL CASING OUI ÉQUIVALENT APPROUVÉ ET BOUCLIER POTEAU TUBAGE DU PUITS.
  - VENTED 150 MM Ø WELL TUBING COVER WITH PADLOCK RINGS FOR LOCKING PURPOSES SCREENS OPENERS SUCH AS WTC SÉRIE BI WATERTITE WEL CAPS - FOR STEEL WELL CASING MODEL WTC-408-BLUE OR APPROVED EQUIVALENT AND NEW 2 M INDICATOR POST ATTACHED TO WELL TUBING.
- REMPLACEMENT DES PURGEURS / REPLACEMENT OF EXISTING COMBINATION AIR VALVES:
  - REMPLACEMENT DES PURGEURS / RENFLARDS / BRISÉ-VIDE EXISTANTS PAR DE NOUVEAUX DE MARQUE APCO MODÈLE 143C 25MM Ø OUI ÉQUIVALENT APPROUVÉ COMBIS AVEC CONDUITES DE DRAINAGE DIRIGÉES VERS LE BAS DE LA CHAMBRE. /
  - REPLACEMENT OF EXISTING COMBINATION AIR VALVES BY NEW APCO BRAND MODEL 143C 25 MM Ø COMBIS AIR VALVE OR APPROVED EQUIVALENT COMPLETE WITH DISCHARGE TUBING DIRECTED DOWNWARDS.

01	18-04-20	ÉMIS POUR CONSTRUCTION	E.P.
02	17-12-01	ÉMIS POUR SOUMISSION	E.P.

KATIVIK Administration régionale KATIUVIK Regional Government P.O. Box 9 KUUVUJUAQ (QUEBEC) CANADA J0M 1Y0

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scellé / seal  
 19 avr. / 2018

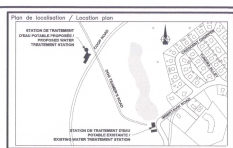
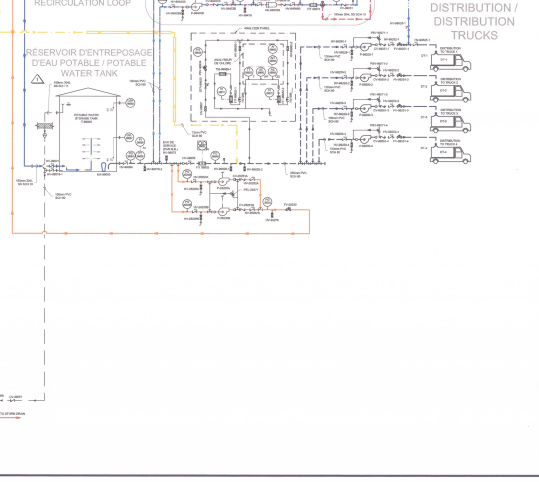
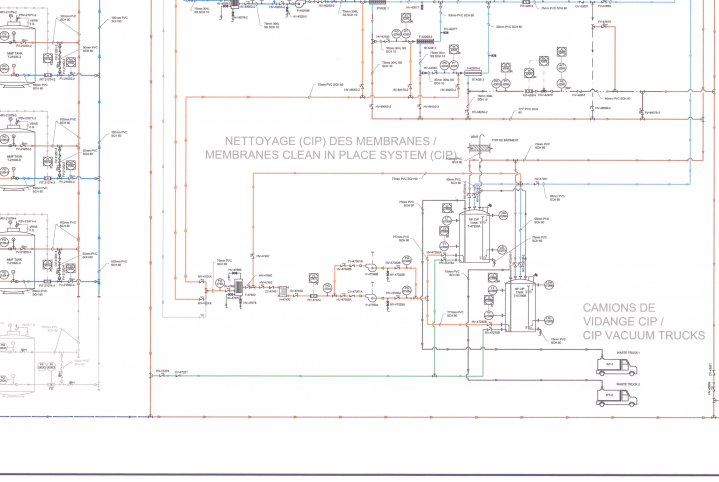
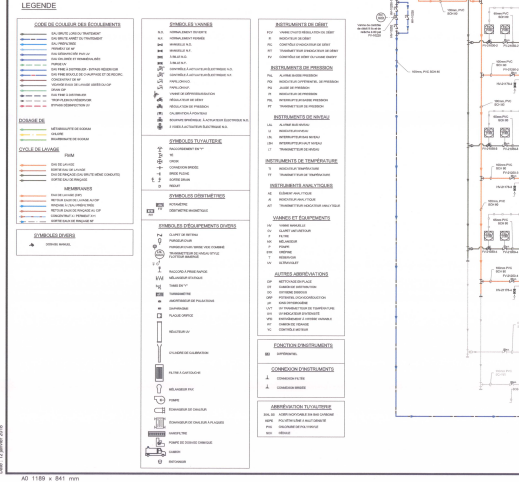
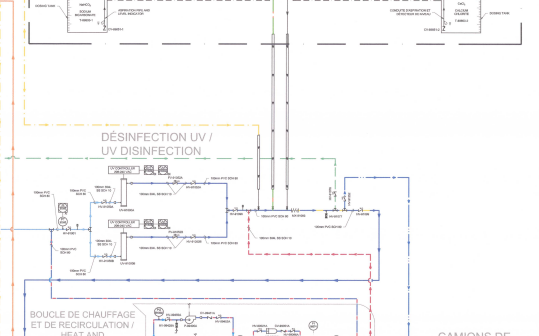
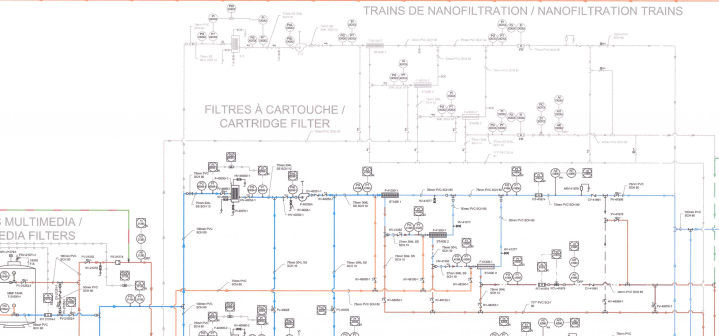
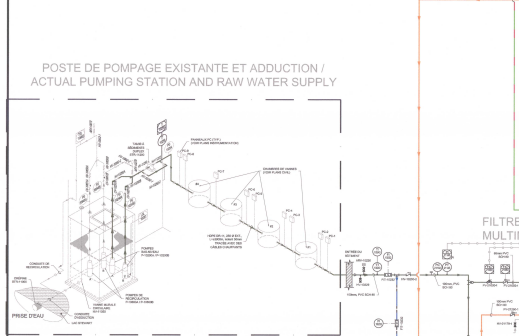
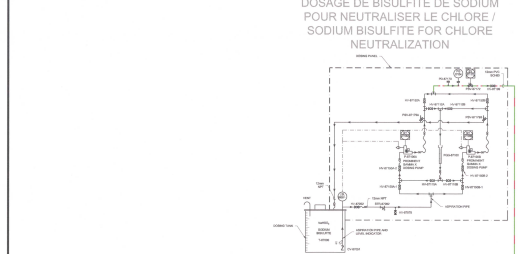
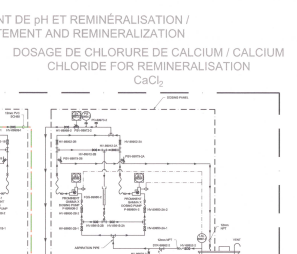
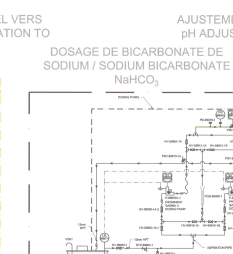
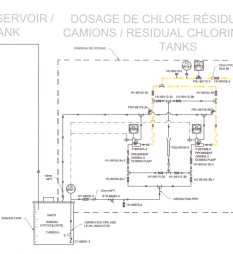
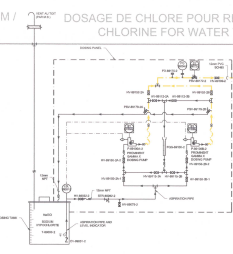
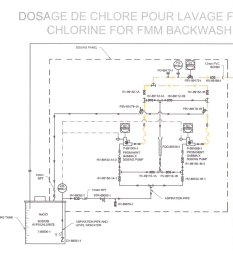
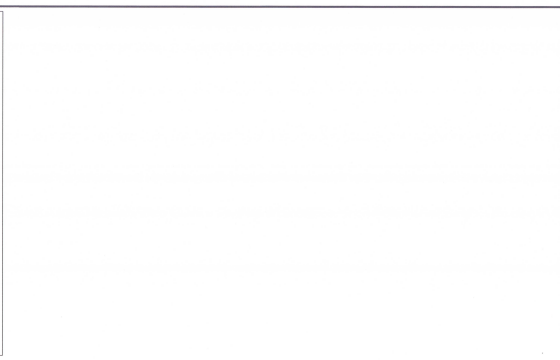
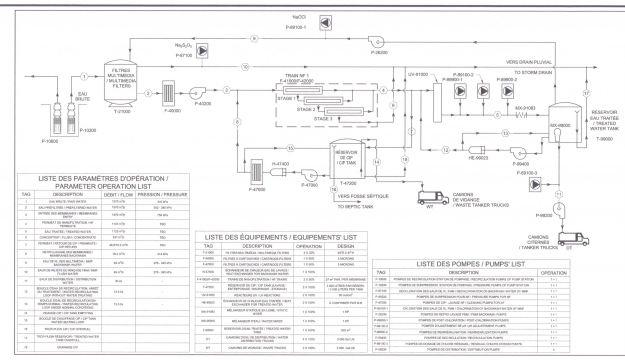
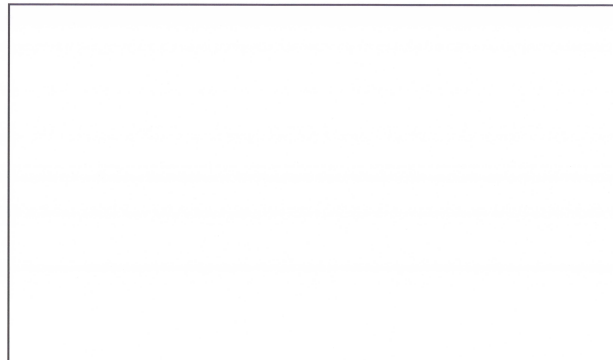
projet / project : MISE À JOUR DES OUVRAGES D'APPROVISIONNEMENT EN EAU POTABLE DE KUUVUJUAQ  
 KUUVUJUAQ DRINKING WATER SUPPLY INFRASTRUCTURE UPGRADE

titre / title : MÉCANIQUE DE PROCÉDÉ / PROCESS MECHANICS

STATION DE POMPAGE D'EAU BRUTE / RAW WATER PUMPING STATION

CHAMBRES SOUTERRAINES - TRAVAUX PROJETÉS / UNDERGROUND MANHOLES - PROJECTED WORKS

dessiné / drafted : Almaz Makhkambaev	échelle / scale : Tel qu'indiquée / As indicated
dessiné / prepared : Sarra Besbes, ing. jr	date : 2016-08
vérifié / verified : Sarra Besbes, ing. jr	référence / reference : P00002375
approuvé / approved : Emile Parent, ing.	dessin vérifié / drawing verified : Almaz Makhkambaev



ÉTAT DE QUÉBEC  
 MINISTÈRE DE L'ÉNERGIE ET DES RESSOURCES NATURELLES  
 DÉPARTEMENT DE L'ÉNERGIE ET DES RESSOURCES NATURELLES  
 DIVISION DE L'ÉNERGIE ET DES RESSOURCES NATURELLES  
 BUREAU DE KULLALUK

NO.	DATE	DESCRIPTION	É.P.
02	18-04-20	EMS POUR CONSTRUCTION	E.P.
01	18-01-18	EMS POUR ADDENDA	E.P.
00	17-12-01	EMS POUR SOUMISSION	E.P.
99	17-06-28	EMS POUR COORDINATION SITE	E.P.
98	17-04-28	EMS POUR COORDINATION SITE	E.P.
00	0000	ÉVALUATION DE RISQUE	007

02	18-04-20	EMS POUR CONSTRUCTION	E.P.
01	18-01-18	EMS POUR ADDENDA	E.P.
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98	17-04-28	EMS POUR COORDINATION SITE	E.P.
00	0000	ÉVALUATION DE RISQUE	007

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### ANNEX 3. LAND USES INVENTORY AND ASSOCIATED RISKS

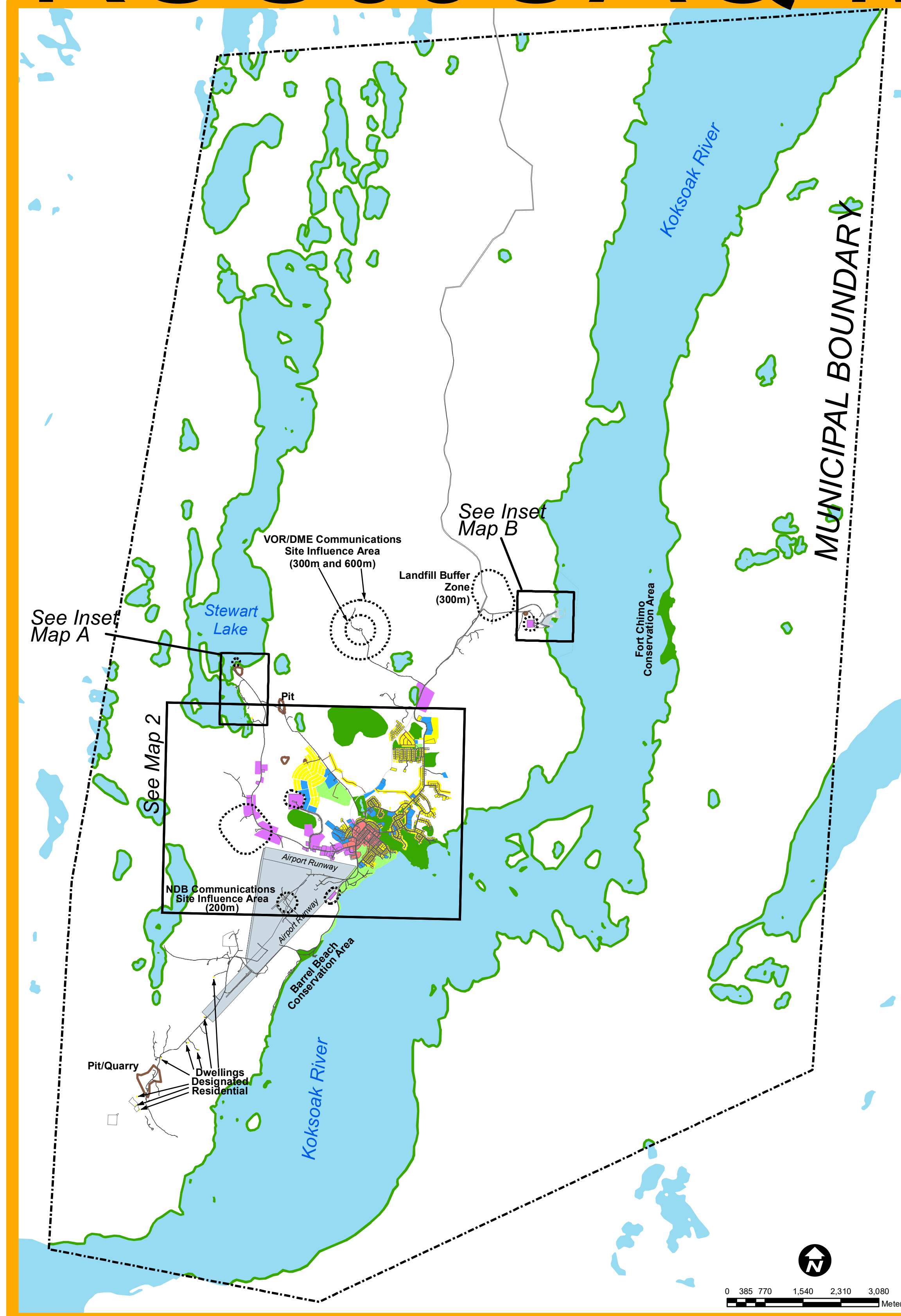
**Table 10. Inventory of activities of land conditions likely to have a positive or negative impact on the water exploited**

Name of condition	Protection areas concerned	Assignment representing risk / protection	Activity representing a risk / protection	Potential contaminants and associated risk
Nuna	All areas	Risk	Mining exploration	Inorganic matter and sediment <b>Very low risk</b>
Nuna	All areas	Risk	Cimetry	Organic matter, micro-organisms <b>Very low risk</b>
Nuna	All areas	Risk	Sewage ponds	Organic matter, micro-organisms <b>Very low risk</b>
Nuna	All areas	Risk	Landfill sites	Organic and inorganic materials, microorganisms <b>Very low risk</b>
Nuna	All areas	Risk	Waste recycling site	Organic and inorganic materials, microorganisms <b>Very low risk</b>
Nuna	All areas	Protection	Hunting and fishing	-
Nuna	All areas	Protection	Berry picking	-
Nuna	All areas	Protection	Camping and outdoors activities	-
Residential	Intermediate	Protection	Creation of play areas	-
Residential	Intermediate	Protection	Limitation of vegetation destruction	-
Transportation and communication	Intermediate	Risk	Airport and associated hydrocarbon storage warehouse	Organic and inorganic matter, suspended matter (turbidity) <b>Very low risk</b>
Transportation and communication	Intermediate	Risk	Quarry and borrow pit	Inorganic matter, suspended matter (turbidity) <b>Very low risk</b>

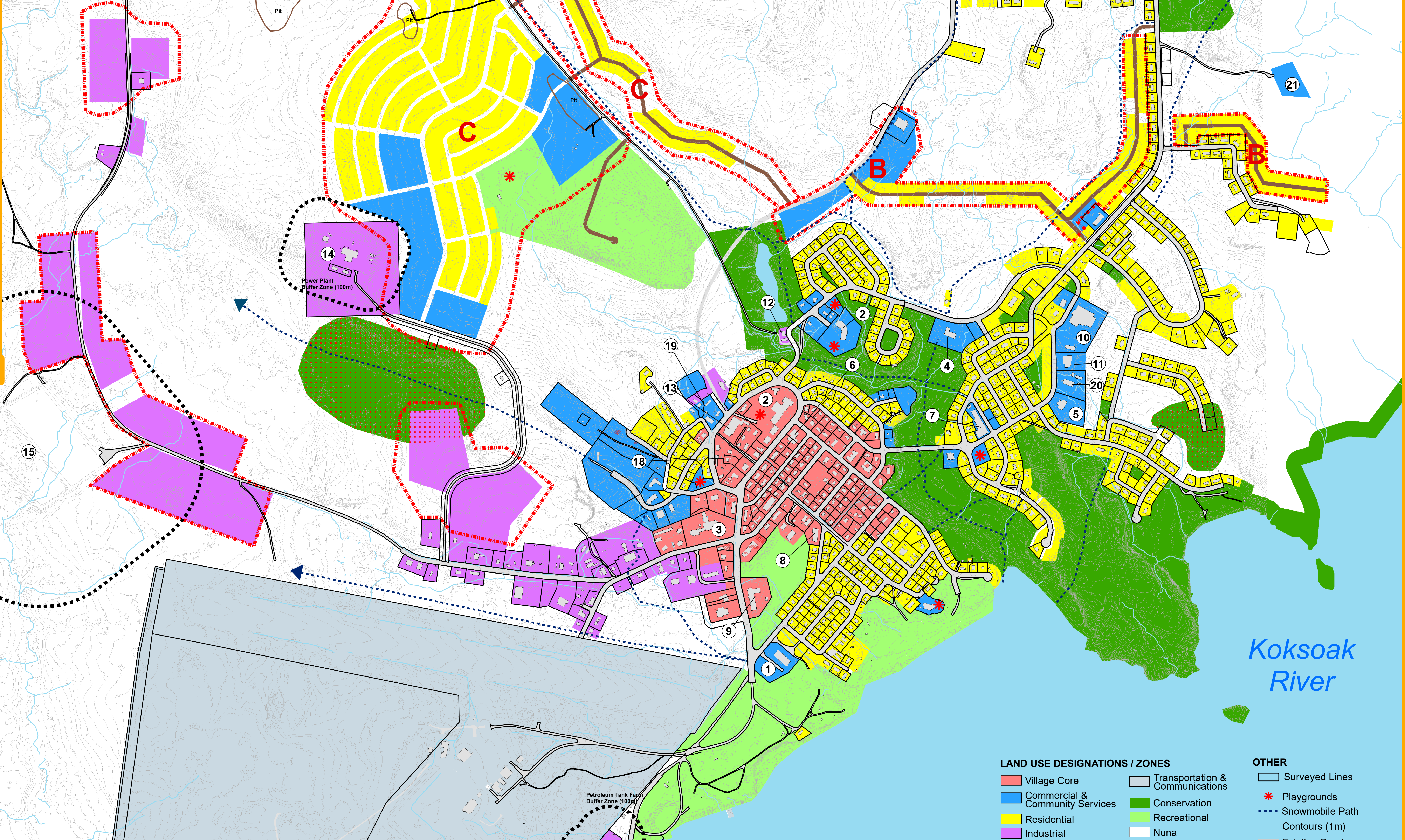
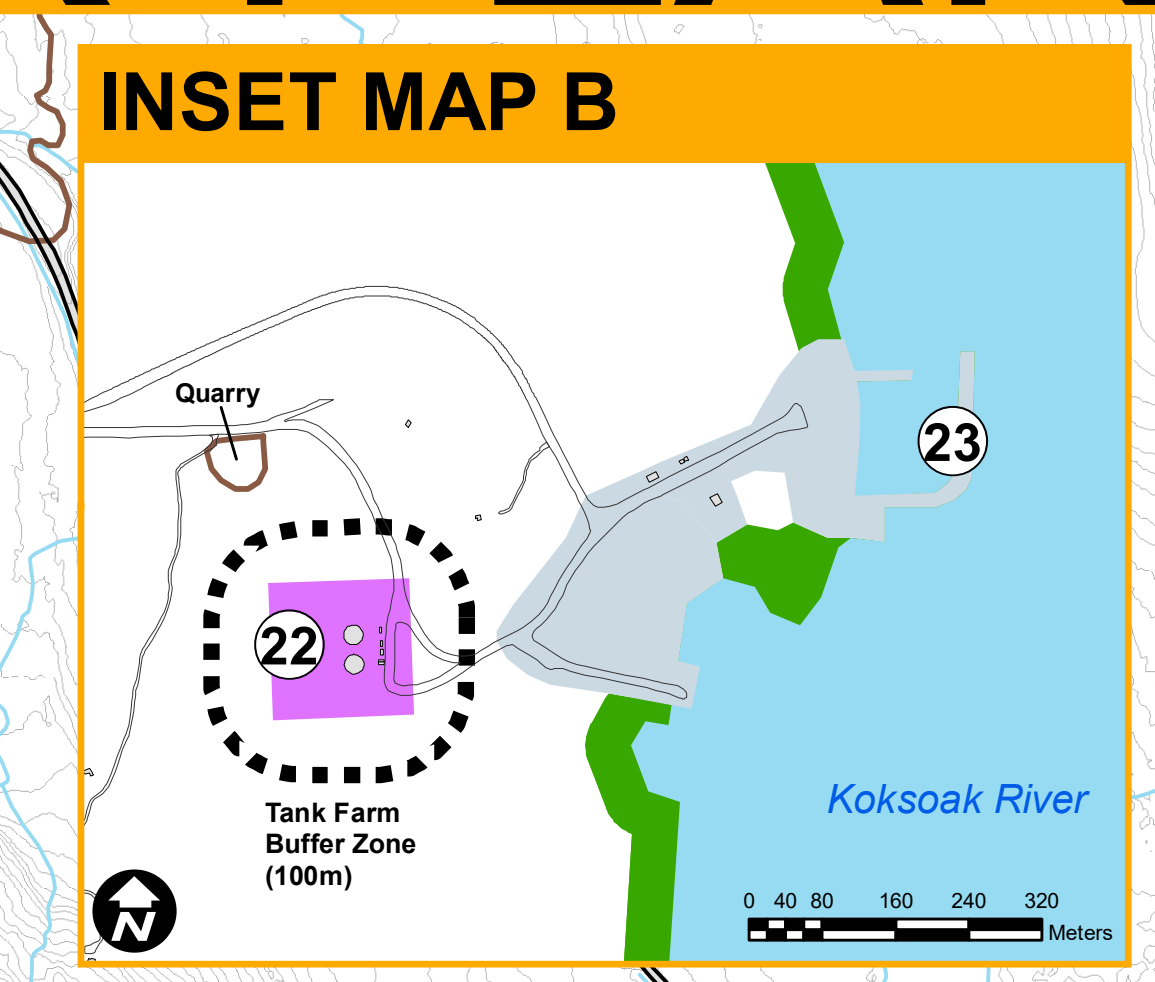
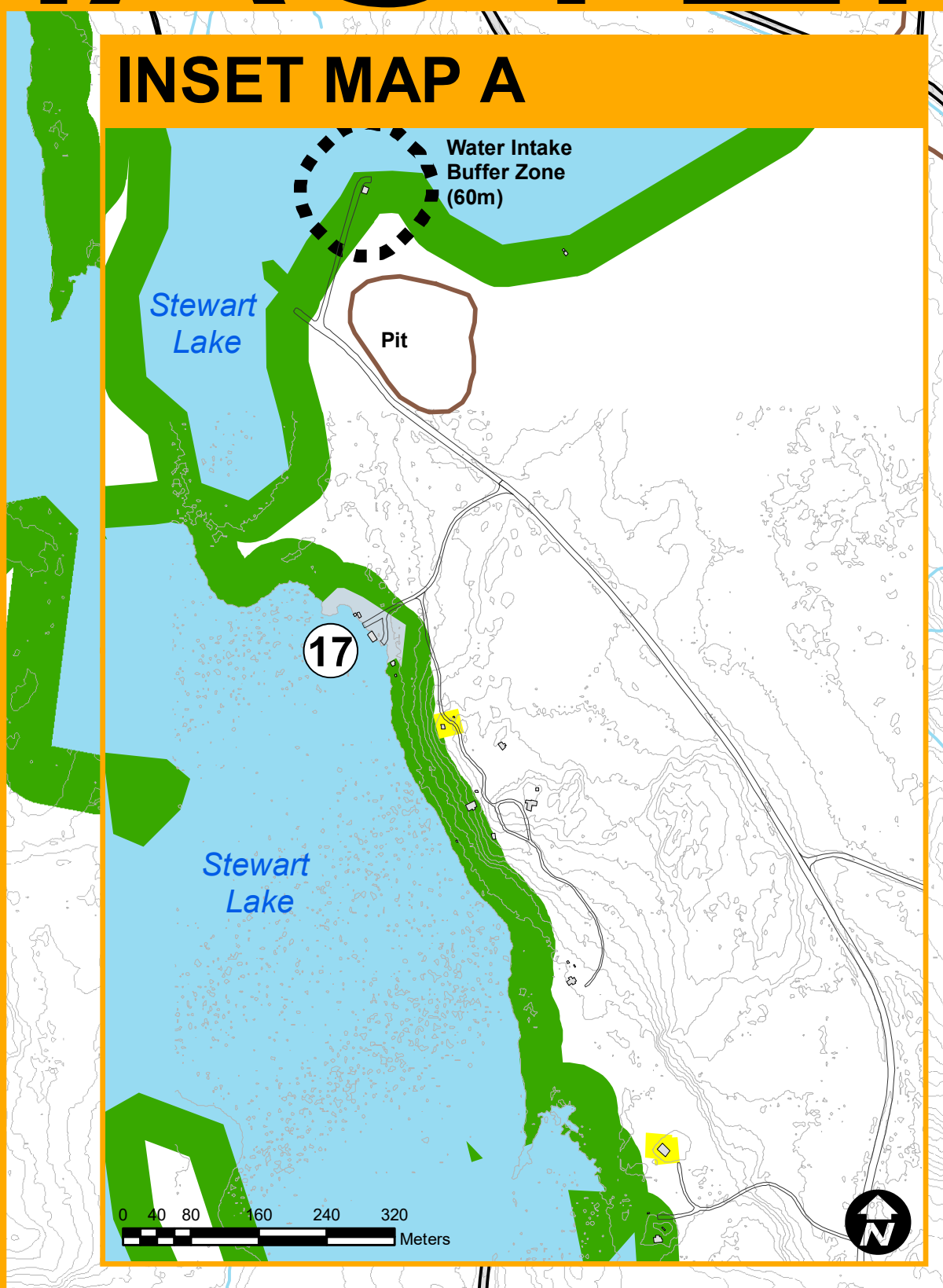
- A3.1 Land use plan for the Northern Village of Kuujjuaq (Source: KRG)
- A3.2 Map of Category I lands of the Northern Village of Kuujjuaq (Source: Nunavik Landholding Corporations Association)

# KUUJJUAQ MASTER PLAN

2015-2035



MAP 1: MUNICIPAL BOUNDARY MAP



**LAND USE DESIGNATIONS / ZONES**

- Village Core
- Commercial & Community Services
- Residential
- Industrial
- Transportation & Communications
- Conservation
- Recreational
- Nuna

**OTHER**

- Surveyed Lines
- Playgrounds
- Snowmobile Path
- Contours (1m)
- Existing Road
- Proposed Road
- Travelled Roadbed
- Pit/Quarry

**OVERLAYS**

- FUTURE DEVELOPMENT AREAS
  - A Short-Term Potential
  - B Mid-Term Potential
  - C Long-Term Potential
- Contaminated Areas (Approximate)
- Berry Picking Areas

**COMMUNITY FEATURES**

- Northern Village Municipal Office Katittavik Town Hall
- Schools
- Health Centre
- CIBC & Landholding Office
- Kativik Municipal Housing Bureau
- Kativik Regional Government Office
- Co-op Store - Newwiq'vi
- Co-op Hotel
- Kuujuaq Inn
- Arena & Swimming Pool
- Kativik School Board
- Water Supply Plant
- Northern Store
- Hydro Quebec Power Plant
- Sewage Lagoon
- Airport
- Float Plane Base
- Catholic Church
- Anglican Church
- Nunavik Regional Health Board
- Cemetery
- Tank Farm
- Marine Infrastructure

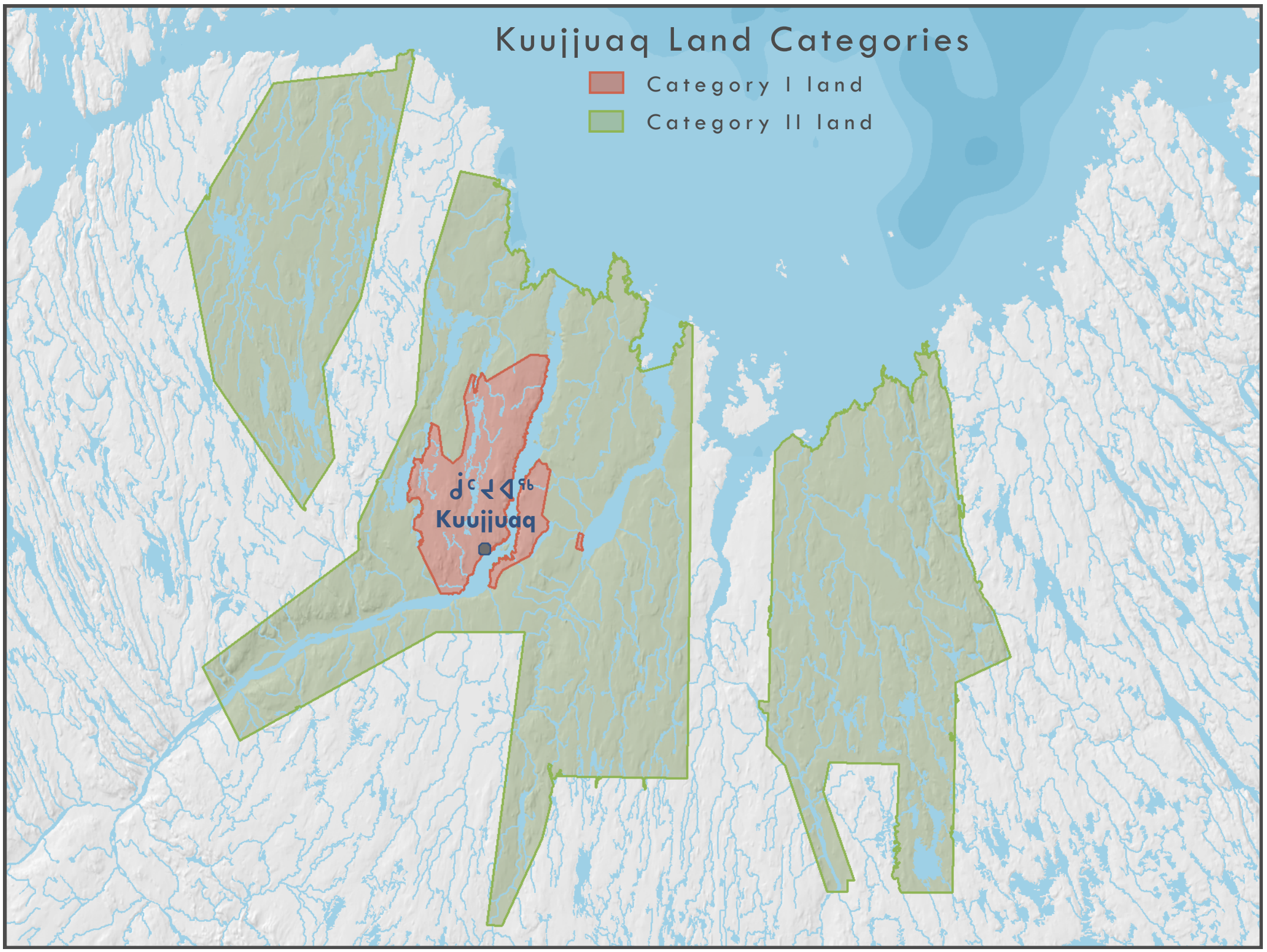
**PERMITTED USES (REFER TO PART 5 - ZONE REGULATIONS - ZONING BY-LAW)**

RESIDENTIAL	VILLAGE CORE	COMMERCIAL & COMMUNITY SERVICES	INDUSTRIAL	RECREATIONAL	CONSERVATION	TRANSPORTATION & COMMUNICATIONS	NUNA
<ul style="list-style-type: none"> <li>Bed and breakfast</li> <li>Craft studio</li> <li>Day care centre</li> <li>Dwelling, detached</li> <li>Dwelling, semi-detached</li> <li>Dwelling, duplex</li> <li>Dwelling, multi-unit</li> <li>Mobile home</li> <li>Elders' facility</li> <li>Group home</li> <li>Home occupation</li> <li>Park or playground</li> <li>Place of worship</li> <li>Secondary suite</li> <li>A use similar to the uses permitted in this zone</li> </ul>	<ul style="list-style-type: none"> <li>Bank</li> <li>Cemetery</li> <li>Community Centre</li> <li>Convenience Store</li> <li>Craft Studio</li> <li>Day care centre</li> <li>Dwelling, multi unit</li> <li>Dwelling row-house</li> <li>Group home</li> <li>Health care facility</li> <li>Home occupation</li> <li>Hotel</li> <li>Municipal/government office</li> <li>Office</li> <li>Park or playground</li> <li>Park or playground</li> <li>Personal or business service</li> <li>Place of Worship</li> <li>Police Station Post office</li> <li>Radio and television station</li> <li>Recreation Facility</li> <li>Restaurant</li> <li>Retail Store</li> <li>Youth Centre</li> <li>A use similar to uses permitted in this zone</li> </ul>	<ul style="list-style-type: none"> <li>Bank</li> <li>Cemetery</li> <li>Community Centre</li> <li>Communications facility</li> <li>Community Hall or Centre</li> <li>Day care centre</li> <li>Dwelling unit(s) in a non-residential building, provided they are either at the back of the building or above the ground floor</li> <li>Educational Facility</li> <li>Elder's Facility</li> <li>Fire hall</li> <li>Gas Station</li> <li>Group home</li> <li>Health Care facility</li> <li>Home occupation</li> <li>Hotel</li> <li>Municipal/government office</li> <li>Office</li> <li>Park or playground</li> <li>Parking Lot</li> <li>Personal or Business Service</li> <li>Place of Worship</li> <li>Police Station</li> <li>Post office</li> <li>Radio and television station</li> <li>Recreation Facility</li> <li>Restaurant</li> <li>Retail Store</li> <li>Youth Centre</li> <li>A use similar to uses permitted in this zone</li> </ul>	<ul style="list-style-type: none"> <li>Agricultural use</li> <li>Automotive repair, sales or rental shop</li> <li>Building supply or contractors' shop</li> <li>Caretaker unit</li> <li>Communications facility</li> <li>Dog team</li> <li>Gas station</li> <li>Hazardous goods storage</li> <li>Outdoor storage</li> <li>Manufacturing and industrial plant</li> <li>Petroleum tanks</li> <li>Power plant</li> <li>Pit</li> <li>Quarry</li> <li>Rental shop</li> <li>Tank farm</li> <li>Warehouse</li> <li>Water intake</li> <li>Water treatment plant</li> <li>Workers' camp (temporary)</li> <li>A use similar to the uses permitted in this zone</li> </ul>	<ul style="list-style-type: none"> <li>Beach shack</li> <li>Boat storage</li> <li>Breakwater</li> <li>Communications facility</li> <li>Dock</li> <li>Monument, cairn, or statue</li> <li>Park or playground</li> <li>Shed to store equipment for traditional, cultural, and recreational activities</li> <li>Sports field</li> <li>Temporary outdoor storage during sealift</li> <li>Washroom facility</li> <li>A use similar to the uses permitted in this zone</li> </ul>	<ul style="list-style-type: none"> <li>Snow fence</li> <li>A use similar to uses permitted in this zone</li> </ul>	<ul style="list-style-type: none"> <li>Airport and related uses</li> <li>Communications facility</li> <li>Flootplane base</li> <li>Pit</li> <li>Quarry</li> <li>Sealift facility and other marine infrastructure</li> <li>A use similar to the uses permitted in this zone</li> </ul>	<ul style="list-style-type: none"> <li>Cabin</li> <li>Cemetery</li> <li>Dog team</li> <li>Commercial harvesting</li> <li>Communications facility</li> <li>Permanent hunting and fishing cabins or camps</li> <li>Pit</li> <li>Quarry</li> <li>Recreation-related development or activities</li> <li>Resource exploration and development</li> <li>Sewage lagoon</li> <li>Snow fence</li> <li>Solid waste disposal site</li> <li>Temporary tenting or camping</li> <li>Water intake</li> <li>Water reservoir</li> <li>Water treatment plant</li> <li>A use similar to the uses permitted in this zone</li> </ul>

MAP 2: LAND USE DESIGNATION AND ZONE MAP

# Kuujuuaq Land Categories

-  Category I land
-  Category II land

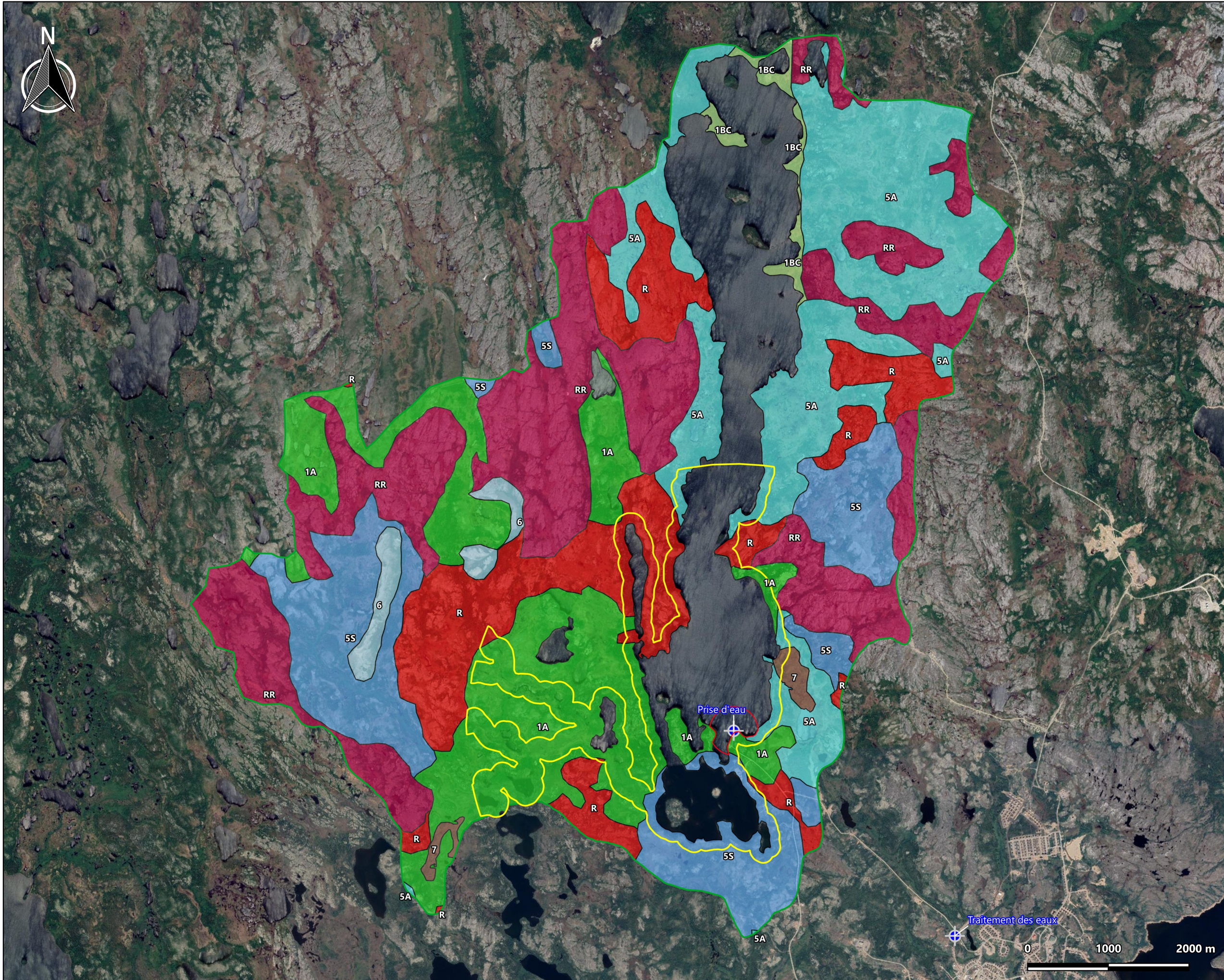


## **ANNEX 4. DETAILS ON THE TURBIDITY VULNERABILITY**

- A4.1 Pdf provided by LNA (4 pages: 1 table and 3 maps)

Caractéristique du milieu	Description	Source des données	Risque associé pour la turbidité
Pédologie	Absence de donnée permettant de conclure dans le rapport car ce dernier se concentre sur le secteur habité du village.	Rapport "Caractérisation géotechnique et cartographie améliorée du pergélisol dans les communautés nordiques du Nunavik - Kuujjuaq"	N/A
Géologie	Environ 20% de la partie terrestre du bassin versant de la prise d'eau est occupée par des dépôts marins d'eau profonde (dépôts silteux/argileux). Ces derniers ne constituent pas une source de turbidité pour les eaux exploitées. Le reste de l'aire (80%) est occupée par des dépôts marins littoraux ou d'eau peu profonde (sableux), du till ou des affleurements rocheux, pouvant apporter des particules en suspension aux eaux de surface.	Ministère des Forêts, de la Faune et des Parcs	Élevé
Relief	Utilisation du MNT pour calculer les pentes dans un logiciel SIG. La valeur de pente moyenne pour le bassin versant du site de prélèvement est de 3,3%. La majorité des pentes sont nulles ou faibles (inférieures à 8%).	MNT (MERN)	Faible
Couvert végétal	Les données de végétation au sein du bassin versant autour de la prise d'eau ont été divisées en deux catégories : couvert végétal représentant une protection vis-à-vis de la turbidité ou non. Ainsi, il apparaît que 71% de la partie terrestre du bassin versant est occupée par un type de végétation participant à la protection des eaux exploitées par rapport à la turbidité.	Ministère des Forêts, de la Faune et des Parcs	Faible
Affectation du territoire	La carte des affectations du territoire du village nordique de Kuujjuaq définit les bordures du lac comme zones de conservation. Le reste des aires de protection de la source d'eau appartient à la zone « Nuna », laquelle est principalement dédiée aux activités traditionnelles et récréatives. À noter la présence d'une base d'hydravion dans la zone de protection intermédiaire et d'une petite mise à l'eau dans l'aire de protection immédiate. Cependant, l'impact de ces activités sur la turbidité des eaux exploitées est jugée négligeable.	Affectations du territoire du village nordique de Kuujjuaq	Faible

**Vulnérabilité retenue pour l'indicateur D** **Faible**



**Groupe Synergis**

**Accompagnement technique pour l'analyse de vulnérabilité des sources d'eau potable du village nordique de Kuujuaq**

**Géologie des dépôts de surface**

**LÉGENDE**

Installation de production d'eau

**Aires de protection**

- Immédiate
- Intermédiaire
- Éloignée

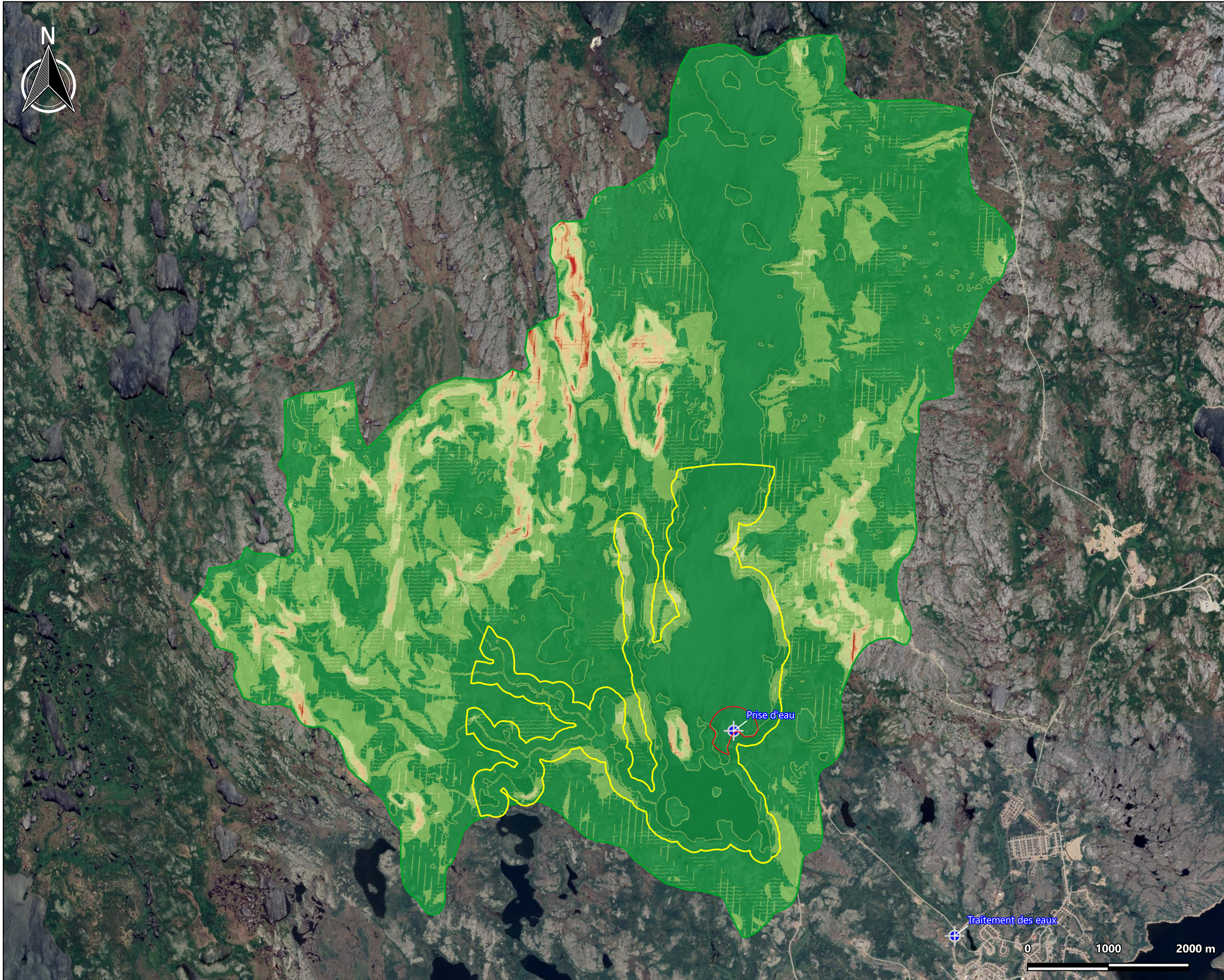
**Dépôts de surface**

- 5A Dépôts marins - Faciès d'eau profonde
- 5S Littoral - Faciès d'eau peu profonde
- 6 Dépôts littoraux
- R Roc
- 1BC Moraine de Rogen, moraine ondulée
- 1A Till indifférenciés
- 7 Organique
- RR Roc à nu

Nom du fichier :  
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Fond cartographique : Google satellite  
Projection MTM zone 6

<b>Échelle :</b>	1 : 45 000	<b>Date :</b>	2021-02-18
<b>Figure :</b>	1	<b>Dossier :</b>	20-6867-4663
<b>Approuvé par :</b>	Jean-Philippe Tremblay, géo., hydrogéologue		
<b>Préparé par :</b>	Jérémy Targosz, chargé de projet		
<b>Dessiné par :</b>	Jérémy Targosz, chargé de projet		

<p><b>LNA</b> HYDROGÉOLOGIE ENVIRONNEMENT</p>	2425, avenue Watt, bur. 210 Québec (Québec) G1P 3X2 Téléphone : 418 657-7999 Sans frais : 1 877 657-7999 Télécopieur : 418 657-5777
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**Groupe Synergis**

**Accompagnement technique pour l'analyse de vulnérabilité des sources d'eau potable du village nordique de Kuujuaq**

**Carte des pentes au sein des aires de protection**

**LÉGENDE**

Installation de production d'eau

**Aires de protection**

Immédiate

Intermédiaire

Éloignée

**Classes de pente**

Pente nulle 0 à 3%

Pente faible 4 à 8%

Pente douce 9 à 15%

Pente modérée 16 à 30%

Pente forte 31 à 40%

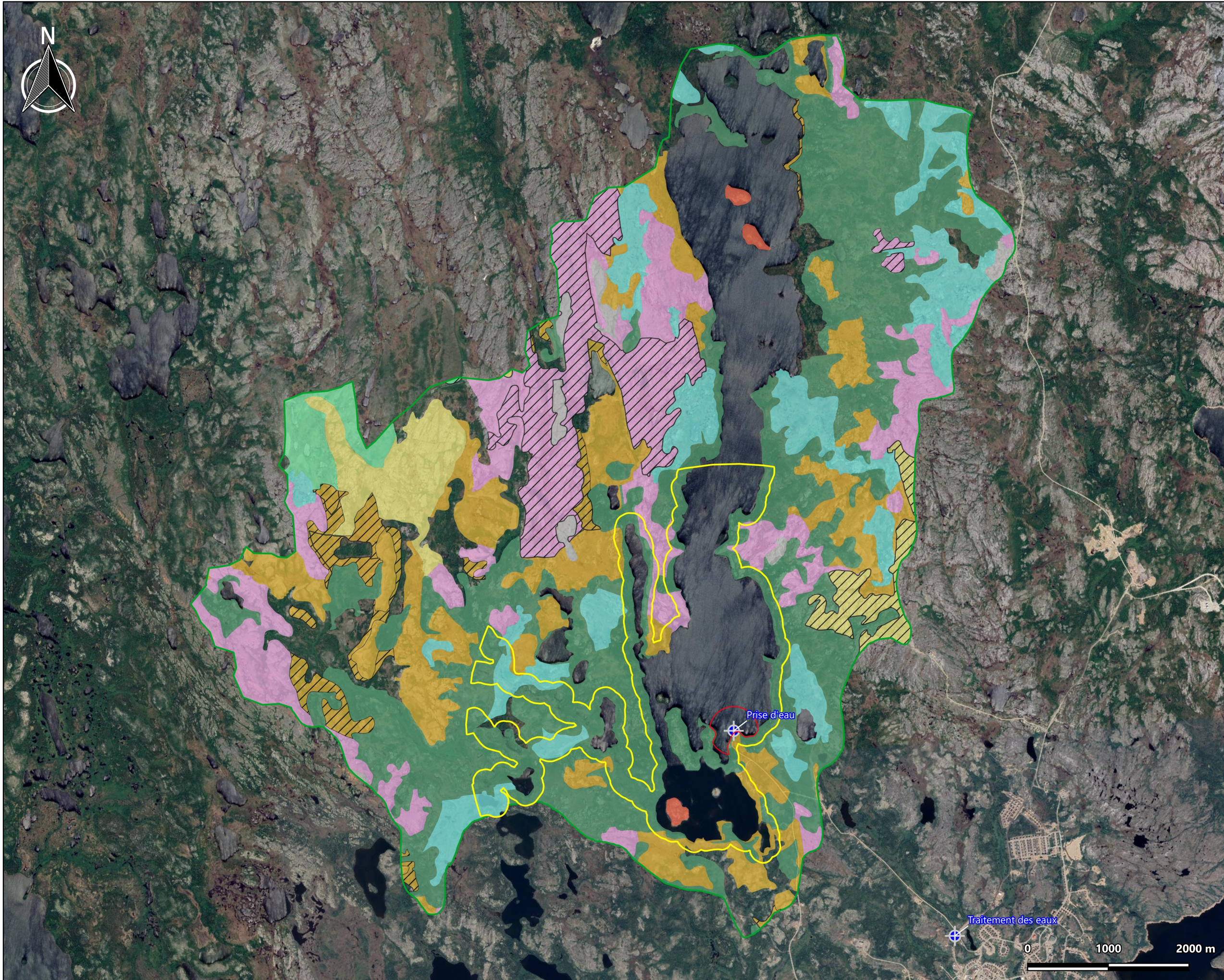
Pente excessive 41% et plus

Nom du fichier :  
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Fond cartographique : Google satellite  
Projection MTM zone 6

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<b>Figure :</b>	2	<b>Dossier :</b>	20-6867-4663
<b>Approuvé par :</b> Jean-Philippe Tremblay, géo., hydrogéologue			
<b>Préparé par :</b> Jérémy Targosz, chargé de projet			
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**Groupe Synergis**

**Accompagnement technique pour l'analyse de vulnérabilité des sources d'eau potable du village nordique de Kuujuaq**

**Cartographie du couvert végétal au sein des aires de protection**

**LÉGENDE**

- Installation de production d'eau
- Aires de protection**
  - Immédiate
  - Intermédiaire
  - Éloignée
- Végétation cartographiée**
  - Affleurements et fragments rocheux
  - Ile de moins de 8 ha
  - Lande subarctique avec 30 à 70 % d'arbustes
  - Lande subarctique
  - Lande subarctique avec 10 à 50 % de substrat rocheux
  - Lande subarctique dominée par le substrat rocheux
  - Résineux
  - Toundra à arbustes dressés
  - Toundra à arbustes dressés avec 30 à 70 % d'arbustes dressés
  - Toundra à arbustes dressés avec 10 à 50 % de substrat rocheux
  - Toundra à arbustes dressés dominée par le substrat rocheux
  - Tourbière minérotrophe uniforme

Nom du fichier : 20-6867-4663\_fig3\_vegetation\_Kuujuaq  
 Fond cartographique : Google satellite  
 Projection MTM zone 6

Échelle :	1 : 45 000	Date :	2021-02-18
Figure :	3	Dossier :	20-6867-4663
Approuvé par :	Jean-Philippe Tremblay, géo., hydrogéologue		
Préparé par :	Jérémy Targosz, chargé de projet		
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**ANNEX 5. MODEL/ TEMPLATE OF AN EVENT LOG**

\* Adapted from the model provided by the MELCC at the following link:  
<http://www.environnement.gouv.qc.ca/eau/potable/registre/modeles-source-provisionnement.htm>

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**Events log occurring throughout the procurement supply chain (article 22.0.4 of RRQDW)\***

**Identification of the withdrawal site**

Location of the potable water production facility: [Northern Village of Kuujjuaq](#)

**Identification of the withdrawal site:**

Name: [Kuujjuaq – Approvisionnement](#)

Number: [X2114283](#)

**Event details**

Description of event: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Start date: \_\_\_\_\_ End date: \_\_\_\_\_

Types of problem encountered:

- Water shortage (strictly linked to a drying up of the water source)
- Obstruction or breakage at the withdrawal site
- Malfunction of the screening, filtration, disinfection system or the entire treatment (validate whether MELCC must be advised in accordance to Article 35.1)
- Other: \_\_\_\_\_

Affected equipments or processes :

- Equipment:  Strainer  Water pipes  Pumping system
- Processes:  Screening  Filtration  Disinfection
- Entire treatment system
- Others: \_\_\_\_\_
- None

Location of occurrence (note if necessary): \_\_\_\_\_  
\_\_\_\_\_

Categories of events to which the observations refer:

- Natural or anthropogenic events that affected the physical integrity of the withdrawal site
- Algae, cyanobacteria or aquatic plants proliferation
- Suspected or measured increases in ammoniacal nitrogen
- Others

Observations made by (name) : \_\_\_\_\_  
Position : \_\_\_\_\_  
Signature : \_\_\_\_\_  
Date : \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

\*Reminders:

- A separate register must be kept for each withdrawal site, ie for each separate water withdrawal installation;
- Each event must be listed separately (one event per page), even if two events occur simultaneously;
- An event whose effect extends over several consecutive days should be recorded as a single event. However, a similar event that occurs periodically must be recorded separately at each occurrence.

**Details of some of the information to be entered in the register**

**Event information**

Types of problem encountered: Check all types of applicable problems according to the classification established in section 22.0.4 of RRQDW.

<b>Types of problems encountered</b>	<b>Examples</b>
Water shortage (strictly linked to a drying up of the water source)	Low flow leading to an exposure of the water intake
	Drainage due to the breaking of a retention dam
Obstruction of the withdrawal site	Silting up
	Frazil
	Proliferation of aquatic plants or zebra mussels
	Accumulation of coarse debris
Breakdown of the withdrawal site	Damages caused by ice
	Subsidence of a retaining wall
	Tearing off / removing of the supply line
Malfunction of the screening, coagulation, settling, filtration, disinfection system or of the entire treatment system	Overgrowth of algae, cyanobacteria or other microorganisms causing taste and odor problems in treated water
	Proliferation of aquatic plants or zebra mussels causing problems with the screening system
	Presence of a contaminant in raw water (for example, ammoniacal nitrogen) which increases the consumption of chemicals (eg. chlorine) and prevents the achievement of treatment goals
Others (any other problem that does not belong to one of the three previous types of problems)	<p>Presence of a contaminant in the raw water which does not affect the operation of existing treatment processes, but which cannot be treated by these processes (eg. chlorides in high concentrations or hydrocarbons).</p> <p><u>Note:</u> Depending on the nature of the contaminant and the risks it represents for human health, its presence could lead to the temporary closure of the water intake.</p>

Place where the event occurred: in some cases, it may be relevant to note the location of the event (eg. the location of the cyanobacteria bloom or the location of a spill).

Categories of events to which the observations refer/relate: Check all the categories concerned.

- Natural or anthropogenic events that have affected the physical integrity of the withdrawal site include events associated with a water shortage, an obstruction or breakage of the sampling site.

The "other" category includes all events that do not correspond to one of the first three categories.

