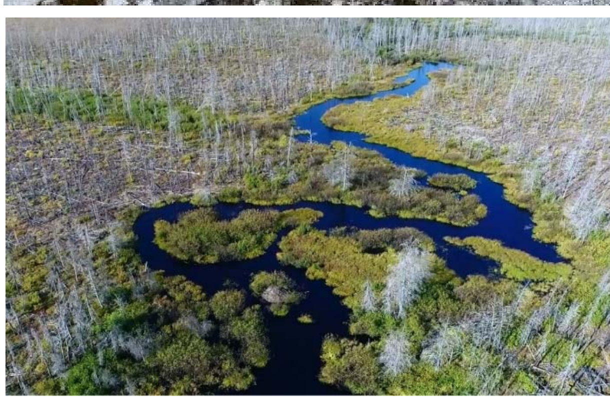
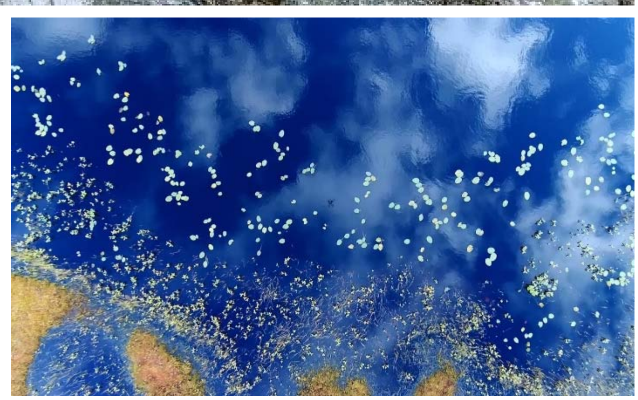
# JAMES BAY LITHIUM MINE

## ENVIRONMENTAL IMPACT ASSESSMENT

### CHAPTER 6: DESCRIPTION OF THE RECEIVING ENVIRONMENT

JULY 2021 (VERSION 2)





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# 6 DESCRIPTION OF THE RECEIVING ENVIRONMENT

## 6.1 GEOGRAPHIC FRAMEWORKS AND PROJECT STUDY AREAS

### *6.1.1 GEOGRAPHIC FRAMEWORK*

The James Bay Lithium Mine project is in the Nord-du-Québec administrative region, on the territory of the Eeyou Istchee James Bay Regional Government. It is located approximately 10 km to the south of the Eastmain River, 100 km east from James Bay, and the Eastmain Cree village (Map 1-1). The project is on Category III lands of the JBNQA.

The central geographical coordinates in UTM (zone 18, NAD83) of the project site are presented below:

— X: 358,891
— Y: 5,789,180

The lands subject to the mining claims of the James Bay Lithium Mine project (Project Property) are easily accessed by the Billy-Diamond highway that connects Matagami and Radisson. This road crosses the project property at kilometre 381 of the road, close to the km 381 truck stop managed by the SDBJ **(Map 2-1)**.

### *6.1.2 LOCAL STUDY AREA*

The local study area primarily consists of the mine operating site**, including the footprint of all infrastructure planned under the project, as well as the** right-of-way within which certain components may be influenced by the project. **These components are**, more specifically, **those related to the** physical and biological environments such as soils, water, sediments and flora, to name a few. **Looking at the entire mine site as well as the nearby subwatersheds, we see that the study area encompasses and is centred on all elements that should be considered.**

**The local study area** is located on both sides of **Billy-Diamond highway, at** kilometre 381 of the road, in the same location as the km 381 truck stop. This stop is well known to visitors who take **this** road **and is located** at 52° north latitude.

The local study area covers an area of 36.9 km$^2$, 6.7 km from east to west and 5.5 km from north to south. Map 6-1 shows this area.

### *6.1.3 OTHER STUDY AREAS*

To precisely analyze the impacts of the project, other study areas have been delimited for certain environmental components. The need to consider other study areas is justified by the fact that, in some cases, the project will only influence components that are located near the proposed mine, while for other aspects, the effects will instead be felt on a broader scale than the local study area.

In these specific cases, **for example, for human environmental components or to assess cumulative effects,** the new study areas are presented and justified in **the corresponding sections**.

# 6.2 PHYSICAL ENVIRONMENT

## 6.2.1 CLIMATE

The climate of the study area is of subarctic continental type according to Köppen's classification of climates. It is characterized by a very cold and long winter and a short and cool summer with limited precipitation, but which lasts all year long.

The most representative and complete weather station to characterize the climatic conditions of the study area is La Grande Rivière Airport (code: 71827) positioned at coordinates 53° 38' 00'' N, 77° 42' 00'' W, at an elevation of 195 m and located approximately 162 km to the north of the proposed mining facilities. The climate data presented below are taken from the Environment Canada (EC) climate normals directory for the period 1981-2010 (EC, **2021**). Climate normals are averages of weather variables over a predetermined period of 30 years established by the World Meteorological Organization (WMO) providing a consistent and objective comparison of the climate between different regions.

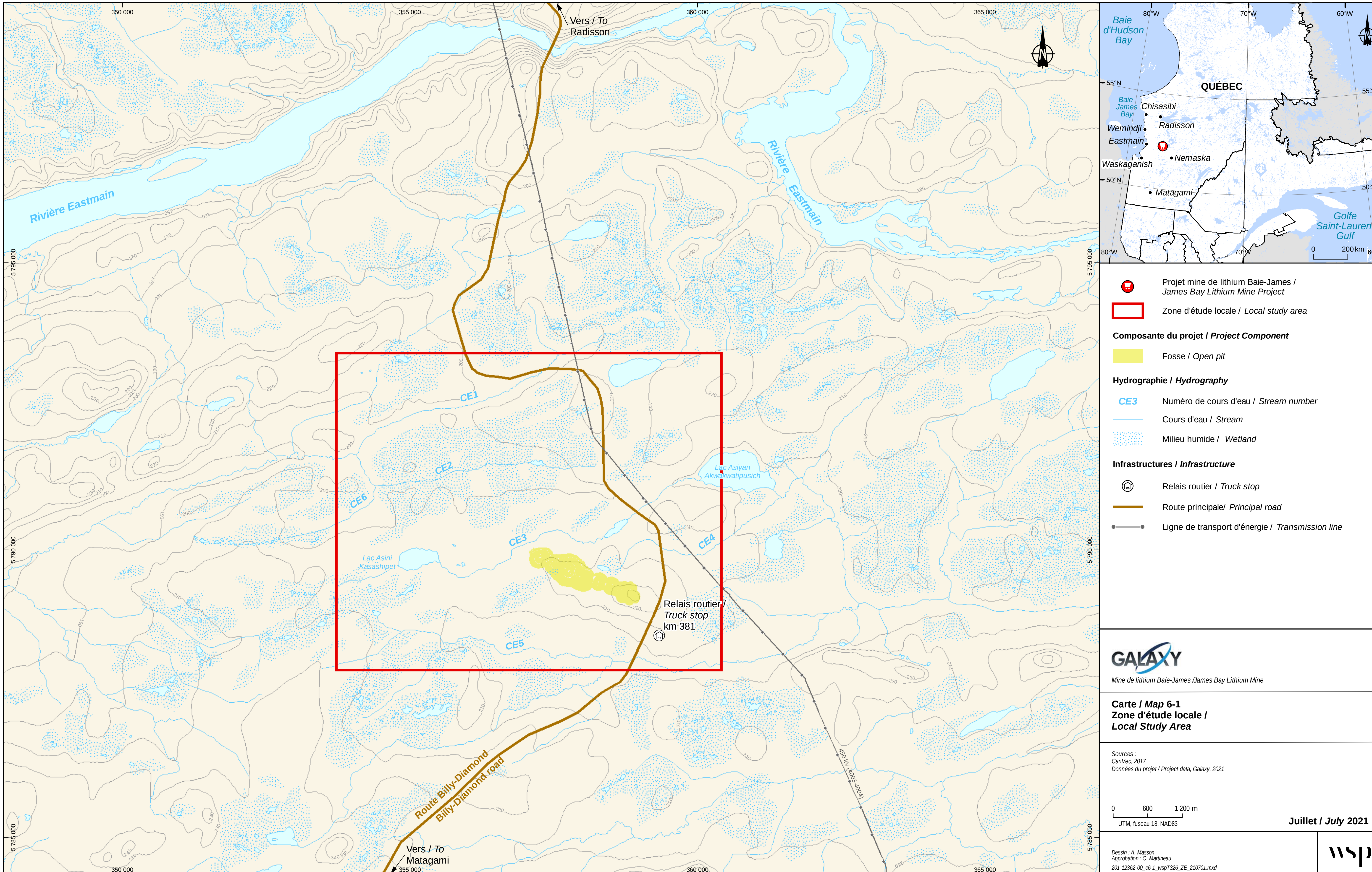
### 6.2.1.1 TEMPERATURE

The mean, maximum and minimum monthly average temperatures are presented in Table 6-1. The coldest month is January with an average temperature of -23.2°C, and July is the warmest month with an average temperature of 14.2°C. The monthly temperature ranges vary from 6 to 12.5°C, where March is the month with the greatest temperature range.

The extreme temperatures (record) having been recorded at La Grande Rivière Airport station are -44.6°C in February 1979 and 37.3°C in July 2015.

**Table 6-1 Monthly average mean, maximum and minimum daily air temperatures at La Grande Rivière Airport station (1981 to 2010 period)**

| Month | Mean (°C) | Maximum (°C) | Minimum (°C) | Temperature range (°C) |
|---|---|---|---|---|
| January | -23.2 | -18.5 | -28.0 | 9.5 |
| February | -21.6 | -15.9 | -27.3 | 11.4 |
| March | -14.5 | -8.2 | -20.7 | 12.5 |
| April | -5.0 | 0.6 | -10.6 | 11.2 |
| May | 4.3 | 10.3 | -1.6 | 11.9 |
| June | 10.8 | 17.3 | 4.2 | 13.1 |
| July | 14.2 | 20.4 | 8.0 | 12.4 |
| August | 13.1 | 18.6 | 7.6 | 11.0 |
| September | 8.1 | 12.3 | 3.8 | 8.5 |
| October | 1.7 | 4.8 | -1.5 | 6.3 |
| November | -6.1 | -3.1 | -9.1 | 6.0 |
| December | -16.0 | -12.0 | -19.9 | 7.9 |
| **Annual (average)** | **-2.9** | **2.2** | **-7.9** | **10.1** |



Vers / To Radisson
Rivière Eastmain
Rivière Eastmain
CE1
CE2
CE3
CE4
CE5
CE6
Lac Asiyan Akwakwatipusich
Lac Asini Kasashipet
Relais routier / Truck stop km 381
Route Billy-Diamond
Billy-Diamond road
Vers / To Matagami
450 kV (4003-4004)
350 000
355 000
360 000
365 000
5 795 000
5 790 000
5 785 000
Baie d'Hudson Bay
QUÉBEC
Baie James Bay
Chisasibi
Radisson
Wemindji
Eastmain
Nemaska
Waskaganish
Matagami
Golfe Saint-Laurent Gulf
80°W
70°W
60°W
55°N
50°N
0
200 km
Projet mine de lithium Baie-James / James Bay Lithium Mine Project
Zone d'étude locale / Local study area
Composante du projet / Project Component
Fosse / Open pit
Hydrographie / Hydrography
CE3 Numéro de cours d'eau / Stream number
Cours d'eau / Stream
Milieu humide / Wetland
Infrastructures / Infrastructure
Relais routier / Truck stop
Route principale/ Principal road
Ligne de transport d'énergie / Transmission line
GALAXY
Mine de lithium Baie-James /James Bay Lithium Mine
Carte / Map 6-1
Zone d'étude locale /
Local Study Area
Sources :
CanVec, 2017
Données du projet / Project data, Galaxy, 2021
0 600 1 200 m
UTM, fuseau 18, NAD83
Juillet / July 2021
Dessin : A. Masson
Approbation : C. Martineau
201-12362-00_c6-1_wspT326_ZE_210701.mxd
wsp

Table 6-2 shows the average number of days for each month when the maximum temperature is equal to or below and the minimum temperature is above the freezing point. These measurements show that for the period from December to February, on average, only two days are reported with a minimum temperature above 0°C. In turn, the months of June, July, August and September do not show any days with a maximum temperature less than or equal to the freezing point. The proportion of days when a negative temperature has been recorded is 43%.

**Table 6-2 Average number of days with temperatures above and below/equal to the freezing point at the La Grande Rivière Airport station (1981 to 2010 period)**

| | Number of days | |
|---|---|---|
| | Maximum temperature | Minimum temperature |
| Month | <=0°C | >0°C |
| January | 31 | 0 |
| February | 27 | 1 |
| March | 26 | 5 |
| April | 14 | 16 |
| May | 2 | 29 |
| June | 0 | 30 |
| July | 0 | 31 |
| August | 0 | 31 |
| September | 0 | 30 |
| October | 4 | 27 |
| November | 22 | 8 |
| December | 30 | 1 |
| **Annual (total)** | **156** | **209** |

### 6.2.1.2 PRECIPITATION

The monthly average precipitation is presented in Table 6-3. The annual precipitation at EC's La Grande Rivière Airport station is 697.2 mm, of which 453.8 mm is rain and 261.3 mm is snow. The month of September is the wettest with 110.6 mm of equivalent precipitation (rain and snow). The least rainy month is February with a total average of 21.9 mm. It is also noted that there can be snowfall on average throughout the entire year, except in July and August.

The maximum daily precipitation recorded at this station is 66.4 mm of rain in August 2000 and 25.8 cm of snow in November 1985. The recurrence of rainfall 1:1000 year (24 h) was assessed at 101.6 mm, whereas the melt 1:100 year (30 days) is 388.5 mm.

### 6.2.1.3 WIND

Table 6-4 shows the average monthly speeds and prevailing direction of wind between 1981 and 2010 at La Grande Rivière Airport station. The average annual wind speed is 14.5 km/h. The month of September is the windiest with an average speed of 15.9 km/h. The least windy month is January with a speed of 13.6 km/h. The direction of prevailing wind is primarily from a western sector throughout the entire year, except for October, November and December when the prevailing direction is from a southern sector.

The maximum hourly wind speed recorded at La Grande Rivière Airport station is 93 km/h with a southwesterly direction, while the maximum recorded gust is 122 km/h. These values were recorded during October 1984.

**Table 6-3 Monthly mean precipitation averages at La Grande Rivière Airport station (1981-2010 period)**

| Month | Rainfall (mm) | Snowfall (cm) | Total precipitation (mm) |
|---|---|---|---|
| January | 0.1 | 33.1 | 30.9 |
| February | 1.2 | 23.0 | 21.9 |
| March | 3.4 | 28.6 | 29.4 |
| April | 12.7 | 21.0 | 32.7 |
| May | 27.9 | 11.9 | 39.0 |
| June | 62.6 | 2.6 | 65.3 |
| July | 78.5 | 0.0 | 78.5 |
| August | 91.0 | 0.1 | 91.1 |
| September | 106.9 | 4.0 | 110.6 |
| October | 56.2 | 32.4 | 87.3 |
| November | 11.6 | 60.3 | 67.9 |
| December | 1.7 | 44.4 | 42.6 |
| **Annual (total)** | **453.8** | **261.3** | **697.2** |

* The total in mm represents the water equivalent of the melted snow and the rain.

**Table 6-4 Monthly source of wind and average speed at La Grande Rivière Airport station (period from 1981 to 2010)**

| Month | Average speed (km/h) | Prevailing source | Maximum hourly speed (km/h) | Maximum speed direction |
|---|---|---|---|---|
| January | 13.6 | West | 57 | Northwest |
| February | 13.7 | West | 56 | West |
| March | 14.2 | West | 72 | West |
| April | 14.4 | West | 63 | Southeast |
| May | 14.9 | West | 61 | Southwest |
| June | 15.1 | West | 65 | Southeast |
| July | 13.7 | West | 65 | South |
| August | 14.3 | West | 65 | Southwest |
| September | 15.9 | West | 74 | West |
| October | 15.4 | South | 93 | Southwest |
| November | 15.3 | South | 74 | West |
| December | 13.8 | South | 67 | West |
| **Year (average)** | 14.5 | **West** | - | - |

The seasonal distribution and total wind direction frequencies between 1981 and 2010 are shown in Figure 6-1 as a histogram. Analysis of the histogram indicates that more than 48 % of wind, regardless of the time of the year, varies in direction in a sector from south to west. Winter and summer are the seasons with the greatest wind frequency from the west with values of 22 % and 21 % respectively. The northeastern sector has the lowest total wind frequency with a percentage of 7.6 %. The other wind directions have relatively similar frequencies and do not show much variability. Figure 6-2 presents the wind rose generated from weather data generated using the WRF model (Weather Research and Forecast) and ERA-Interim climate reanalysis generated by ECMWF (European Centre for Medium-Range Weather Forecasts) for the 2011 to 2015 years.

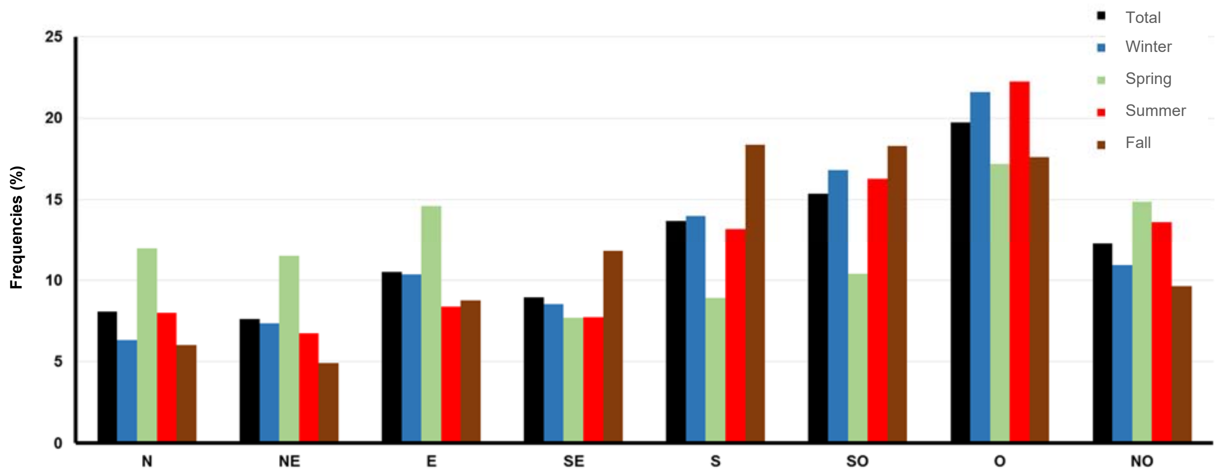



**Figure 6-1 Histogram of wind direction frequencies at La Grande Rivière Airport station (period from 1981 to 2010)**

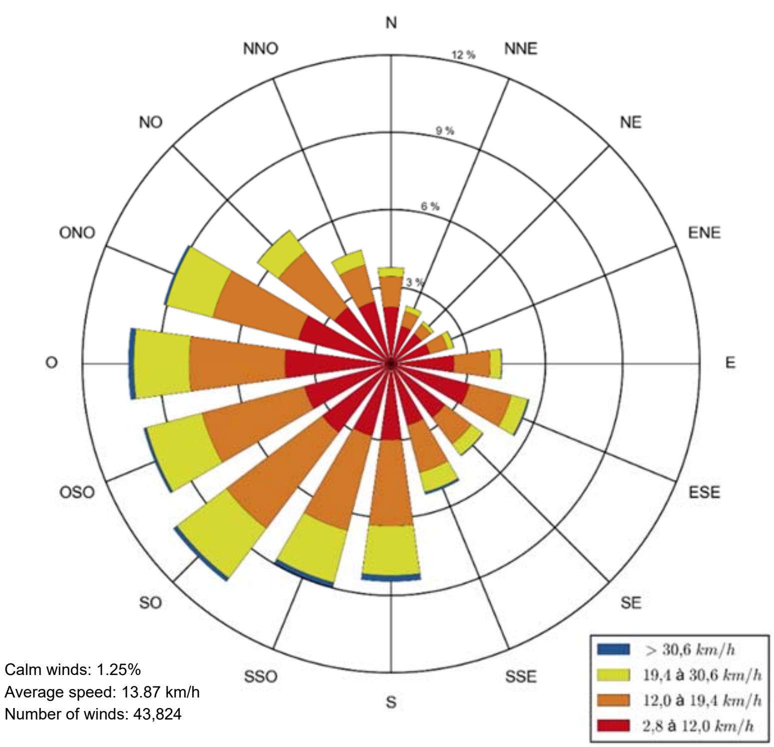



**Figure 6-2 Wind rose**

## 6.2.2 GEOLOGY

Located in the heart of the Canadian Shield, the study area is in the northeastern part of the Superior Geological Province and is part of the volcano-plutonic La Grande subprovince (MRNF, 2004) (Map 6-2). This area includes a volcano-sedimentary assemblage assigned to the Eastmain Group.

The study area is part of the Eastmain greenstone belt and, more specifically, lies within the Lower Eastmain Group. It is dominated by metavolcanic rocks (amphibolites of mafic to felsic grade associated with Komo formation), metasedimentary rocks and minor gabbroic intrusions (Broad Oak, 2009 in SRK Consulting, 2010).

The chronology of the assemblage that led to La Grande Subprovince dates back to the Archaean era (4.0 to 2.5 Ga). During this period, two phases of volcanic and tectonic deformation occurred. Between the two, the basins of the Auclair formation were formed (> 2,546 ± 50 Ma). A third more recent phase of retrograde metamorphism during the Proterozoic era (2.5 Ga to 0.541 ± 0.1 Ga) left abundant flecks and dykes. In the study area, the formation is said to date from the second deformation phase, during late-stage or post-tectonic intrusions, at the end of the Archean era (> 2.697 Ma) (Broad Oak, 2009 in SRK Consulting, 2010).

The Auclair formation dominates the surface geology of the study area (Broad Oak, 2009 in SRK Consulting, 2010). In fact, a paragneiss with metamorphic minerals (probably sedimentary in origin) occupies a large part of this area (Map 6-3). Amphibolized and amphibolite basalts belonging to the Komo Formation outcrop on both sides of the Billy-Diamond highway. Immediately to the south of the basalts is a spodumene pegmatite dyke. More specifically, it is mineralized lithium in solid phase in the form of spodumene, of igneous origin. It is in the Lithium-Cesium-Tantalum (LCT) family and of albite-spodumene type (SRK Consulting, 2010).

In the northeastern portion of the study area, a monogenic to polygenic conglomerate and sandstone denotes belonging to the greenstone belt (Broad Oak, 2009 in SRK Consulting, 2010). Also, a diabase dyke crosses the central portion of the study area on a north-south axis. Finally, we note the presence of felsic and intermediate tuffs at the northern limit border of the study area. Lastly, spodumene consists of white to green prismatic and striated crystals and in the form of lithium-containing mica in pseudomorphic flat aggregates (Broad Oak, 2009 in SRK Consulting, 2010).

## 6.2.3 STRUCTURE AND SEISMIC ACTIVITY

Eastern Canada is a stable continental region of the North American plate, therefore, has relatively low seismic activity. The Superior Province, in which the study area is located, has overall experienced tectonic stability since 2.6 **Ga (Percival, 2007; NRCan, 2017a)**.

Seismic hazard is the most violent ground motion likely to occur in a region, based on a given probability. Ground motions are defined by spectral-acceleration values of the soil that is used in the design of foundations. In the study area, the *National Building Code 2015* establishes the probability of an occurrence at 0.000404 per year. This means that for a 50-year recurrence period, there is a 2% chance that an earthquake will cause greater than expected ground motion (NRCan, 2017*b*). The site is in a very low seismic hazard area. In this regard, there is no issue regarding the geological aspects of the soil that are discriminating in the study area.

## 6.2.4 PHYSICAL GEOGRAPHY

The study area is in the James subregion of the Canadian Shield (NRCan, 2006). It occupies the northern part of the Abitibi lowlands and James Bay natural province, near the intersection with the Grande Rivière low hills and Mistassini highland provinces. This natural province has a plain relief slightly inclined toward James Bay (MDDELCC, 2017*a*).

The topography of Abitibi and James Bay lowlands is low and softened, and elevation ranges from 200 to 350 m. Rocky outcrops are common and often correspond to striated spodumene hills or ridges of dykes rising up to 30 m above the surrounding plain. They are separated by depressions varying from a few hundred meters to more than 10 km. Within the study area, the elevation varies by some tens of metres at the most.

## 6.2.5 GEOMORPHOLOGY

The study area experienced a complex sequence of quaternary episodes: glaciation, regional readvances, marine and lacustrine invasions. This dynamic left thick fine deposits (clay, silt and fine sand) in the depressions, occupied by peat bogs. The project site is located near organic deposits, rocky outcrops and fluvial deposits (Map 6-4). Moreover, a large part of the surface is covered with peat bogs.

The territory was completely covered by the Wisconsinan glacier during the last glacial episode. This ice cover has led to the planing of summits in the region, the overdeepening of valleys and the establishment of glacial deposits in the valleys.

At the project site, the bedrock can be found from a depth of 1.8 m. The rocky surface is covered in some places, with sandy units approximately 3 m thick and whose granulometry varies from fine to coarse. These units are interlayered with gravel beds. In other places, some exploratory trenches have silt and clay beds at the base. These sandy units are covered with a peaty horizon with a thickness varying between 0 and 0.8 m. Also, some areas may be characterized by the presence of isolated islets of permafrost, since the area is in the sporadic permafrost zone. These islets can be found mainly in peat bogs. Given the little difference in elevation in the study area, there is no particular problem regarding the stability of surface deposits.

## 6.2.6 HYDROGEOLOGY

The assessment of hydrogeological conditions at the project site was carried out using data collected in 2017**,** 2018**, 2020 and 2021** during the investigation campaigns. Compiling data made it possible to determine the different hydrogeological units, to assess the hydraulic properties and to assess the piezometry as well as the quality of the groundwater. Details of the methods used and results are presented in the expert survey on hydrogeology **and in the SNC-Lavalin studies** (WSP, 2018*a*, ***SNC-Lavalin, 2020 and SNC-Lavalin 2021 (report in progress)***). This section summarizes the content of **these studies**.

### 6.2.6.1 METHODOLOGY

During the hydrogeological and geotechnical work in the fall of 2017 and winter of 2018, 77 drillings were done, including three open-rock wells. Of these, 36 were built into observation wells or piezometers. **A second geotechnical survey was conducted in summer 2020 and winter 2021. As part of this survey, 26 boreholes were drilled and 11 were built into observation wells.** Also, additional stratigraphic surveys (trenches) provided information on the stratigraphy of the study area. The location of the different surveys carried out in the study area is shown on Map 6-5.

During the **2017 and 2018** field campaigns, 36 groundwater samples were taken at 20 wells or piezometers in order to establish the initial environmental state. Soil samples were also collected from the drilling and trench sites **in 2017, 2018, 2020 and 2021**. In addition, the results of surface water samples were used to determine the characteristics of the receiving environments for readjusting the criteria for metals. Finally, permeability tests and a pumping test were performed to obtain the hydraulic properties of different hydrostratigraphic units.

### 6.2.6.2 HYDROSTRATIGRAPHIC UNITS

The following hydrostratigraphic units were identified, during drilling, from the surface:

— Peat: Several peatlands have developed on the poorly drained surface of very compact marine deposits. They are vast and very numerous, so that they cover the deposits on approximately 72% of the territory. Some peatlands have also developed in the rock and till depressions. The abundance of these wetlands shows poor soil drainage conditions. The peat unit is characterized by organic deposits capable of reaching **4** m in thickness.

— Littoral sand: In some areas, there are sandy deposits established during the retreat of the Tyrell Sea. These littoral deposits cover the marine deposits. During investigative work, they were rarely identified, except for one area to the south of the pit (PO1 and PO2).

— Clay: A layer of clay deposits (marine deposits) is found on the lower grounds between the rock ridges and till. The thickness of clay deposits can reach 10 m depending on the drilling performed. In the study area, this unit is completely covered by the peat unit.

— Till: In the region, the cover of glacial materials is rather discontinuous. These shapes are elongated and oriented along a WSW-ENE axis that indicates the direction of the regional ice flow. The till of the area is characterized by a very dense material with no apparent structure and by the sporadic presence of sand and gravel lenses. This till consists mainly of silty and gravelly sands with traces of clay. The drillings suggest a thickness of up to 20 m.

— Rock: This unit consists mainly of metasedimentary rocks such as paragneisses and schists as well as mafic and intermediate volcanic rocks such as basalts, andesites, volcaniclastic rocks and, locally, alkaline volcanic rocks.

### 6.2.6.3 GRANULOMETRIC ANALYSIS

Soil samples were taken during drilling for granulometric analysis. As mentioned earlier, the surface soils identified in the study area are mainly till and clay deposits. Till consists mainly of silty sand with varying proportions of gravel. The clay deposit consists of silt and clay including traces of sand. Table 6-5 presents the results summary for the granulometric analysis performed.

**Table 6-5 Summary of results for the granulometric analysis performed**

| Unit | Number of samples | Average interval (m) | Lithology | Average granulometric results (%) |
|---|---|---|---|---|
| Clay deposits | **25** | **2.71** to 3.**38** | Silt and clay, traces of sand | Silt **58.6** |
| | | | | Clay **36.8** |
| | | | | Sand **4.6** |
| Sandy deposits (till) | **85** | **2.61** to 3.**3** | Silty and gravelly sand, traces of clay | Sand **50.3** |
| | | | | Silt **29.4** |
| | | | | Gravel **18.2** |
| | | | | Clay 2.**1** |

### 6.2.6.4 HYDRAULIC PROPERTIES OF MATERIALS

The hydraulic properties of the materials were determined for each unit from the work carried out in the study area, namely:

- granulometric analysis (**110** analyses);
- pumping test (one test at well WSP-PW03);
- permeability tests (**64** tests on **30** wells).

All these analyses make it possible to determine parameters, such as the hydraulic conductivity and the storage coefficient depending on the different units encountered.

The permeability contrast between the different units will influence the groundwater flow patterns. Table 6-6 presents the compilation of hydraulic conductivity data per unit determined. The rock unit was subdivided into three entities following field observations and from the geology of the site.

**Table 6-6 Compilation of hydraulic conductivity data (m/s)**

| Lithostratigraphic unit | Minimum | Maximum | Average |
|---|---|---|---|
| Clay deposits | 3.56 x $10^{-12}$ | **1.28** x $10^{-8}$ | **7.45** x $10^{-10}$ |
| Sandy deposits (till) | 4.29 x $10^{-9}$ | 1.05 x $10^{-3}$ | **4.90** x $10^{-6}$ |
| Rock (paragneiss) | 1.76 x $10^{-7}$ | **2.27** x $10^{-4}$ | **1.2** x $10^{-5}$ |
| Rock (spodumene pegmatite) | **7.77** x $10^{-9}$ | **6.07** x $10^{-7}$ | **9.4** x $10^{-8}$ |
| Rock (amphibolitized and amphibolite basalt) | 2.72 x $10^{-8}$ | **4.70** x $10^{-5}$ | 2.**85** x $10^{-6}$ |

### 6.2.6.5 PIEZOMETRIC LEVELS

As part of the work, **49** drillings, including **34** observation wells, were subject to water level measurements on one or more occasions between August 2017, May 2018**, September 2020 and March 2021**. A piezometric map (Map 6-6) was generated using the measurements taken in all wells intercepting the rock in May 2018. All surveys are shown in Table 6-7.

The pit sector represents a piezometric head. Groundwater flow would occur radially from this piezometric head toward the surrounding watercourses. Water levels recorded prior to snowmelt in February 2018 are between 0.03 m and 0.84 m lower than those recorded at the beginning of May 2018, for an average variation of 0.36 m. Surveys carried out at different times of the year (**February, March, May, July and August**) show seasonal variations in water levels.

In the future pit sector, the water depth levels of the bedrock aquifer range from 0.40 to 4.98 m, and the piezometric elevation ranges from 213.03 to 224.89 m. A variation of -0.03 to 0.84 m was observed between August 2017 and May 2018 and a variation of -0.67 to 0.13 m between February 2018 and May 2018 in the wells of this sector.

In the area south of the pit, the water depth levels of the bedrock aquifer range from -0.25 to 1.16 m, whereas the piezometric elevation ranges from 205.6 to 212.98 m. A variation of 0.19 to 0.73 m was observed between February and May 2018 in the wells of this sector.

**In the future plant, east stockpile and nearby basin sector, the water depth levels of the bedrock aquifer range from 1.1 to 4.65 m, and the piezometric elevation ranges from 209.15 to 211.74 m. The water depth levels of the surface aquifer were measured in July 2020 at 2.74 m, for a piezometric elevation of 213.31 m. The plant sector is located on a topographic high, which explains the higher water depth levels and higher piezometric level (BH20-P-06 and BH20-P-07).**

**In the area of the future southwest stockpile, located near pit JB-1, the water depth level measured was measured in March 2021 at 1.26 m, for a piezometric elevation of 209.99 m. This value is similar to the levels measured in the pit sector.**

**In the future west stockpile and basin sector (located to the north of creek CE3), the water depth levels of the bedrock aquifer range from -0.04 to 1.34 m, and the piezometric elevation ranges from 201.01 to 207.23 m. The water depth levels of the surface aquifer range from -0.04 to 0.99 m and the piezometric elevation varies from 199.64 to 211.93 m. A variation of 0.02 m was observed between February and May 2018 in the WSP-MW8R well.**

Finally, in the future **north waste rock** stockpile sector **(located to the north of the plant and CE3 creek)**, the water depth levels of the bedrock aquifer range from -0.**03** to **0.86** m, whereas the piezometric elevation ranges from **205.11** to **209.31** m. **The water depth levels of the surface aquifer range from -0.11 to 1.92 m and the piezometric elevation varies from 204.62 to 209.50 m.** A variation of 0.26 to 0.58 m was observed between February and May 2018 in the wells of this sector.

The horizontal gradient in the study area ranges from 0.03 to 0.001.

#### *6.2.6.6 AQUIFER CLASSIFICATION*

According to the MDDELCC's *Système de classification des eaux souterraines* (MDDEFP, 2012), groundwater bodies can be class I, II or III based on their hydrogeological properties, quality and use potential. A class I groundwater body is an irreplaceable source of drinking water. A class II hydrogeological formation is a current or potential source of drinking water. Class II formations have an acceptable water quality of sufficient quantity. Lastly, a class III hydrogeological formation cannot be used as a source of drinking water (poor quality and insufficient quantity).

Based on the information collected as part of the investigations for this study, the rock corresponds to a class II fractured aquifer, meaning the aquifer is a potential source of drinking water. The extent of the glaciofluvial deposits (till unit) naturally has good potential as an aquifer. Therefore, it is considered a class II aquifer.

## Table 6-7 Piezometric readings

| Well number | Well depth (m) | Elevation of the middle of the screen (m) | Height of the rim above ground level (m) | Screened unit | Campaigns 1 and 2 | | | Campaign 3 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Depth of water level wrt ground level (m) | Piezometric elevation (m) | Date | Depth of water level wrt ground level (m) | Piezometric elevation (m) | Date |
| WSP-PW01 | 126.2 | - | 0.28 | Rock | - | - | - | 2.70 | 224.89 | May 6, 2018 |
| WSP-PW03 | 169.5 | - | 0.80 | Rock | 4.25 | 213.01 | February 2018 | 4.22 | 213.04 | May 5, 2018 |
| WSP-MW1R | 6.1 | 200.62 | 0.86 | Rock | - | - | - | 0.86 | 205.11 | May 3, 2018 |
| WSP-MW2R | 10.8 | 196.97 | 1.03 | Rock | - | - | - | 9.20* | 197.82 | May 5, 2018 |
| WSP-MW3R | 12.2 | 199.48 | 0.92 | Rock | 0.68 | 209.05 | February 2018 | 0.42 | 209.31 | May 3, 2018 |
| WSP-MW4R | 7.6 | 210.32 | 0.57 | Rock | 1.09 | 215.33 | August 2017 | 0.40 | 216.02 | May 3, 2018 |
| WSP-MW5R | 13.1 | 201.12 | 0.80 | Rock | 1.21 | 212.26 | February 2018 | 0.48 | 212.99 | May 5, 2018 |
| WSP-MW6R | 10.7 | 220.62 | 0.62 | Rock | 4.91 | 224.91 | August 2017 | 4.98 | 224.84 | May 4, 2018 |
| WSP-MW7R | 7.8 | 201.21 | 0.79 | Rock | 1.16 | 207.10 | February 2018 | 0.97 | 207.29 | May 3, 2018 |
| WSP-MW8R | 12.2 | 192.62 | 0.86 | Rock | 0.74 | 202.73 | February 2018 | 0.72 | 202.75 | May 3, 2018 |
| WSP-MW9R | 18.9 | 187.20 | 0.97 | Rock | - | - | - | -0.25 | 205.60 | May 4, 2018 |
| BH-3A | 8.23 | 194.35 | 0.56 | Rock | - | - | - | 0.12 | 201.70 | May 2, 2018 |
| BH-10A | 11.5 | 189.24 | 0.48 | Rock | - | - | - | -0.04 | 200.23 | May 1, 2018 |
| BH-15 | 9.56 | 195.12 | 1.08 | Rock | - | - | - | 0.10 | 202.03 | May 1, 2018 |
| BH-45 | 4.62 | 205.82 | 1.35 | Rock | - | - | - | -0.03 | 208.94 | May 1, 2018 |
| BH-47 | 12.83 | 205.05 | 1.36 | Rock | - | - | - | 1.65 | 210.09 | May 1, 2018 |
| BH21-N-03 | 10.93 | 200.86 | 0.85 | Rock | 1.11 | 209.15 | March 2021 | - | - | - |
| BH21-O-05 | 9.05 | 200.1 | 0.85 | Rock | 1.02 | 207.23 | March 2021 | - | - | - |
| BH21-P-04 | 5.85 | 205.66 | 0.98 | Rock | 1.26 | 208.85 | March 2021 | - | - | - |
| BH21-R-01 | 8.8 | 200.16 | 0.94 | Rock | 1.05 | 206.41 | March 2021 | - | - | - |
| BH21-W-03 | 9.05 | 196.33 | 0.92 | Rock | 1.07 | 202.81 | March 2021 | - | - | - |
| BH21-W-04 | 8.85 | 193.81 | 0.94 | Rock | 0.90 | 201.01 | March 2021 | - | - | - |

## Table 6-8 Piezometric readings (cont.)

| Well number | Well depth (m) | Elevation of the middle of the screen (m) | Height of the rim above ground level (m) | Screened unit | Campaigns 1 and 2 – Depth of water level wrt ground level (m) | Campaigns 1 and 2 – Piezometric elevation (m) | Campaigns 1 and 2 – Date | Campaign 3 – Depth of water level wrt ground level (m) | Campaign 3 – Piezometric elevation (m) | Campaign 3 – Date |
|---|---|---|---|---|---|---|---|---|---|---|
| BH21-W-06 | 8.8 | 198.98 | 0.93 | Rock | 1.34 | 205.49 | March 2021 | - | - | - |
| BH21-SW-03 | 5.95 | 206.80 | 0.98 | Rock | 1.26 | 209.99 | March 2021 | - | - | - |
| BH20-P-07 | 19.71 | 198.43 | - | Rock | 4.54 | 211.74 | September 2020 | - | - | - |
| WSP-MW2S | 4.57 | 204.15 | 0.81 | Surface deposits | 0.34 | 206.85 | February 2018 | 0.21 | 206.98 | May 5, 2018 |
| WSP-MW3S | 4.3 | 206.90 | 0.85 | Surface deposits | 0.75 | 208.92 | February 2018 | 0.17 | 209.50 | May 3, 2018 |
| WSP-MW4S | 4.4 | 213.51 | 0.63 | Surface deposits | 1.17 | 215.23 | August 2017 | 0.33 | 216.07 | May 5, 2018 |
| WSP-MW5S | 4.6 | 210.32 | 0.71 | Surface deposits | 0.80 | 212.59 | February 2018 | 0.30 | 213.09 | May 5, 2018 |
| WSP-MW8S | 4.3 | 200.41 | 0.99 | Surface deposits | - | - | - | 0.40 | 202.78 | May 3, 2018 |
| WSP-MW9S | 4.6 | 202.28 | 0.95 | Surface deposits | - | - | - | 0.10 | 205.26 | May 4, 2018 |
| PO-1 | 7.28 | 215.89 | 0.56 | Surface deposits | - | - | - | 5.44 | 216.17 | May 4, 2018 |
| PO-2 | 8.5 | 214.01 | 0.57 | Surface deposits | 5.07 | 215.36 | February 2018 | 5.74 | 214.69 | May 4, 2018 |
| BH-1 | 11.43 | 210.78 | 0.99 | Surface deposits | - | - | - | 5.01 | 215.07 | May 1, 2018 |
| BH-10B | 8 | 193.11 | 0.23 | Surface deposits | - | - | - | 0.72 | 199.64 | May 1, 2018 |
| BH-14 | 16 | 203.86 | 1.09 | Surface deposits | - | - | - | 1.23 | 211.93 | May 1, 2018 |
| BH-18 | 6.32 | 201.38 | 0.24 | Surface deposits | - | - | - | -0.04 | 203.72 | May 1, 2018 |
| BH-23 | 11.05 | 204.75 | 1.07 | Surface deposits | - | - | - | 0.66 | 208.99 | May 1, 2018 |
| BH-27 | 8.18 | 202.46 | 1.17 | Surface deposits | - | - | - | 0.14 | 204.62 | May 1, 2018 |
| BH-29 | 14.02 | 202.90 | 1.30 | Surface deposits | - | - | - | 1.92 | 206.68 | May 1, 2018 |
| BH-3B | 8.23 | 197.66 | 0.61 | Surface deposits | - | - | - | 0.28 | 201.66 | May 2, 2018 |
| BH-31 | 8.84 | 205.33 | 1.36 | Surface deposits | - | - | - | 0.12 | 207.91 | May 1, 2018 |
| BH-36 | 8.18 | 205.84 | 1.59 | Surface deposits | - | - | - | 0.57 | 208.17 | May 1, 2018 |
| BH-37 | 6.63 | 204.15 | 1.40 | Surface deposits | - | - | - | 0.08 | 208.58 | May 1, 2018 |

**Table 6-9 Piezometric readings (cont.)**

| Well number | Well depth (m) | Elevation of the middle of the screen (m) | Height of the rim above ground level (m) | Screened unit | Campaigns 1 and 2 | | | Campaign 3 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Depth of water level wrt ground level (m) | Piezometric elevation (m) | Date | Depth of water level wrt ground level (m) | Piezometric elevation (m) | Date |
| BH-41 | 6.22 | 205.38 | 1.41 | Surface deposits | - | - | - | -0.11 | 207.18 | May 1, 2018 |
| BH-49 | 17.96 | 199.90 | 1.40 | Surface deposits | - | - | - | 4.50 | 206.90 | May 1, 2018 |
| BH-50 | 5.28 | 206.32 | 1.43 | Surface deposits | - | - | - | 0.39 | 206.93 | May 1, 2018 |
| BH20-P-06 | 16.21 | 206.05 | - | Surface deposits | 2.74 | 213.31 | July 2020 | - | - | - |
| BH21-O-06 | 13.15 | 205.75 | 0.63 | Surface deposits | 3.5 | 211.85 | March 2021 | - | - | - |
| * Value not stabilized. | | | | | | | | | | |

### 6.2.6.7 AQUIFER VULNERABILITY

The till in the study area is mainly comprised of silty and gravelly sand with traces of clay. It is moderately permeable and has low aquifer potential. The rock is a fractured aquifer, with low potential. The rock aquifer is most vulnerable where the rock is outcropping, in fracture zones or where the granular deposits are thin. Metamorphic rock does not have strong filtering properties. Overall, the rock aquifer should be considered vulnerable, but with a weak potential.

The DRASTIC[1] system for measuring the vulnerability of groundwater reflects the level of contamination risk based on hydrogeological properties. This evaluation method was developed by the United States Environmental Protection Agency (US EPA). The DRASTIC system is based on three basic assumptions:

— the sources of contamination are at ground surface level;
— contaminants move from ground surface level to the aquifer with seepage water;
— contaminants have the same mobility as water.

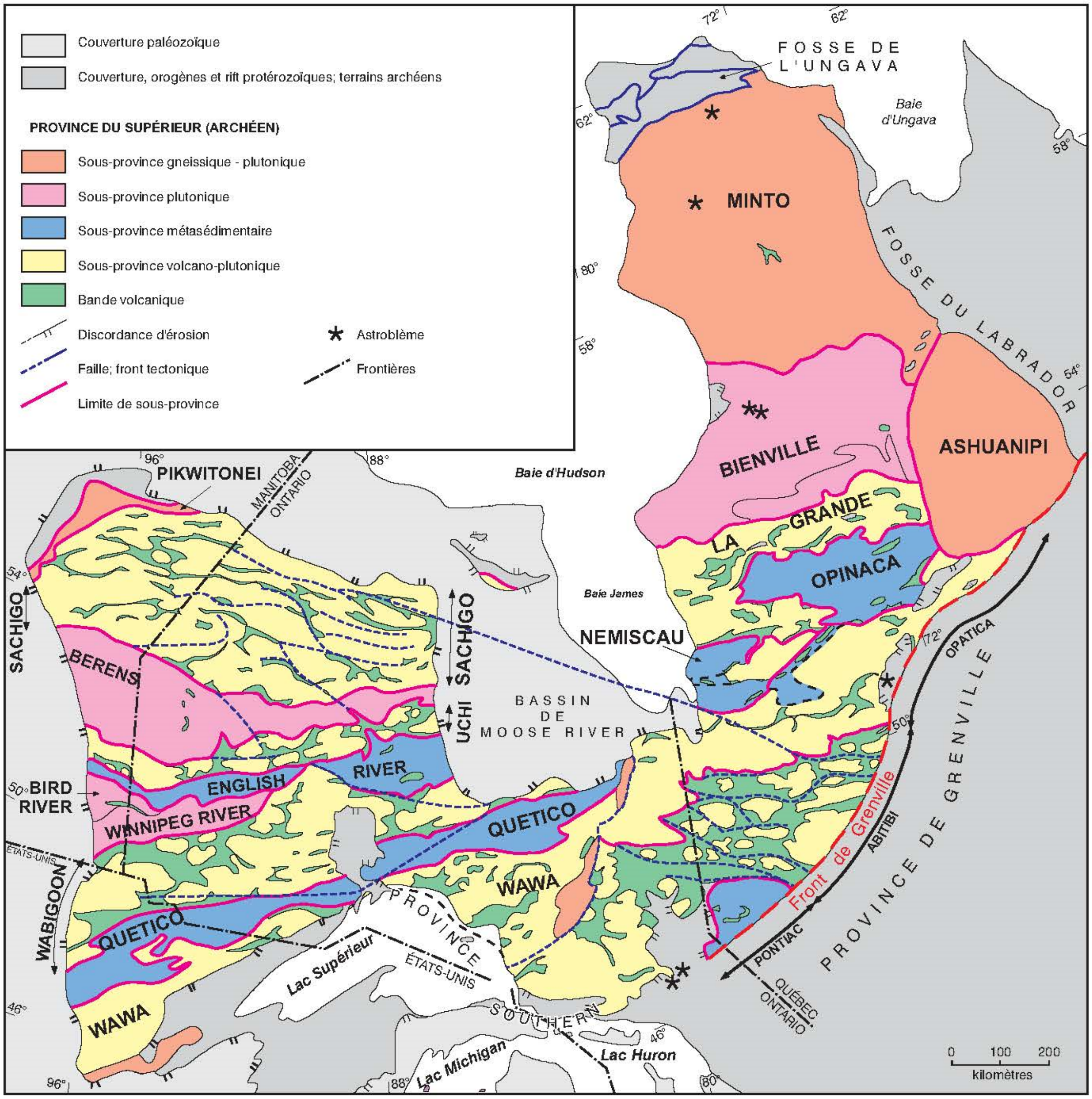
Based on the hydrogeological properties of the site, a groundwater vulnerability index of 137 was assessed for surface deposits and of 105 for the upper portion of the rock, which equates to a medium[2] level of vulnerability based on the levels described in the *Water Withdrawal and Protection Regulation* (WWPR, section 53). Table 6-8 shows the details of the weighting for each factor.

**Table 6-10 Aquifer vulnerability**

| Unit | Physical parameters | Typical value or interval | Weight | Associated weight | Subtotal | DRASTIC per unit |
|---|---|---|---|---|---|---|
| Till unit | D – Depth to water table | Between 0.0 and 5.7 m | 5 | 9 | 45 | 137 |
| | R – Recharge | Between 10 and 30 cm per year | 4 | 7 | 28 | |
| | A – Aquifer media | Till | 3 | 5 | 15 | |
| | S – Soil media | Till / clay silt | 2 | 4 | 8 | |
| | T – Topography (slope) | Slope between 2 and 12% | 1 | 7 | 7 | |
| | I – Impact of vadose zone | Till or clay | 5 | 5 | 25 | |
| | C – Aquifer conductivity | Between 0.02 and 29 m/d | 3 | 3 | 9 | |
| Rock unit | D – Depth to water table | Between 0 and 4.9 m | 5 | 6 | 30 | 105 |
| | R – Recharge | Between 0.1 and 15 cm per year | 4 | 5 | 20 | |
| | A – Aquifer media | Rock: igneous or altered metamorphic/basalt rock | 3 | 4 | 12 | |
| | S – Soil media | Till / clay silt | 2 | 4 | 8 | |
| | T – Topography (slope) | Slope between 2 and 12% | 1 | 7 | 7 | |
| | I – Impact of vadose zone | Till or clay | 5 | 5 | 25 | |
| | C – Aquifer conductivity | Between 0.0008 and 0.83 m/d | 3 | 1 | 3 | |

1 Aquifer vulnerability index: D=Depth to water; R=Recharge, A=Aquifer media, S=Soil media, T=Topography (slope), I=Impact of the vadose zone media, C=Hydraulic conductivity

2 Vulnerability ratings: Low: a rating equal to or less than 100 for the entire protection zone; Medium: a rating less than 180 for the entire protection zone, unless a low rating has been assigned; High: a rating equal to or greater than 180 in any part of the protection zone (WWPR, section 53).




*Source: MRNF, 2004*

**Map 6-2 Superior Province**

## 6.2.7 HYDROGRAPHY

**The local study area is located at the head of subwatersheds with watercourses that flow westward to the north and eastward to the south of the study area (Map 6-7A). This section describes the work done to characterize the hydrography of the sector.**

### 6.2.7.1 WORK COMPLETED

A field campaign was completed in summer 2017 to characterize the five watercourses in the study area, which were named creeks CE1 to CE5 (Map 6-7**B**). A pluviometer was installed and water level probes were placed in each watercourse to take continuous measurements over the course of slightly more than three months.

Moreover, stream gauging (measurement of flow) took place on three occasions opposite the water level probes. Finally, some bathymetric surveys were completed on creeks CE3 and CE5 as well as in lakes in the study area. Following the evolution of the project and associated studies, a second field campaign was carried out in the summer of 2018 to carry out cross sectional surveys of the creeks CE2, CE3 and CE4 as well as additional gaugings on the six watercourses under study (including CE6).

The characteristic flows of the six watercourses, which are flood flow, monthly and low-water means, were calculated in theory and compared with the measurements taken during the field campaign. The mean monthly flows were estimated using interbasin transfer at the Rivière à l'Eau Claire reference station (090605). The rational method**, as described in the Manuel de conception des ponceaux (MTQ, 2014),** was used on the pluviometer data from the Grande Rivière A station (7093715) to estimate the flood flow. **The basic equation for this method is as follows:**

$$Q = 0.278 * C * F_L * I * A$$

**Where:**

**Q is peak flow ($m^3/s$)**

**C is the runoff coefficient**

**FL is a flood buffer coefficient**

**I is rainfall intensity (mm/h)**

**A is the surface area of the watershed ($km^2$)**

**The runoff coefficient is determined from the average slope of the main watercourse and/or watershed, type of soil and plant cover. In this case, the hydrological soil classification was determined according to ecoforestry maps of the area and the corresponding values published in the Manuel de conception des ponceaux (MTQ, 2014). Consequently, it was determined to be class B soil. Plant cover (woodland, grassland, cropland, urban) was determined from aerial photos. In this case, the watershed is primarily made up of woodland, with many lakes. The average slope of the watershed was determined from digital topographic maps. The flood buffer coefficient reproduces the effect of flood attenuation (lower intensity, but longer duration) by wetlands. It reduces the runoff hydrograph peak by factoring in the proportion of lakes and swamps in the watershed, as well as their location in relation to the watercourse. The duration and intensity of rainfall to be used in the rational method depends on watershed concentration time. IDF (Intensity-Duration-Frequency) data from the La Grande Rivière Airport station was used.**

The interbasin transfer method was also used on the Rivière à l'Eau Claire station data **and the Rivière Saint-Louis station (040212)** data for comparative purposes. Low-water flow was estimated using the linear regression method developed by the MDDELCC, adapted for the Nord-du-Québec region. The methodology used to calculate the characteristic flows is provided in detail in the Hydrological technical study (*Étude spécialisée sur l'hydrologie)* (WSP, 2018*b*).

Finally, the characteristic water levels in the creeks CE2, CE3 and CE4 were estimated by one-dimensional hydraulic modeling using the HEC-RAS software. A total of 54 cross sections were identified and modeled. The models were calibrated using water level and flow data measured in the field in June 2018. More details on the methodology used to mount and calibrate the models are available in the Hydrological technical study (Étude spécialisée sur l'hydrologie*)* (WSP, 2018*b*).

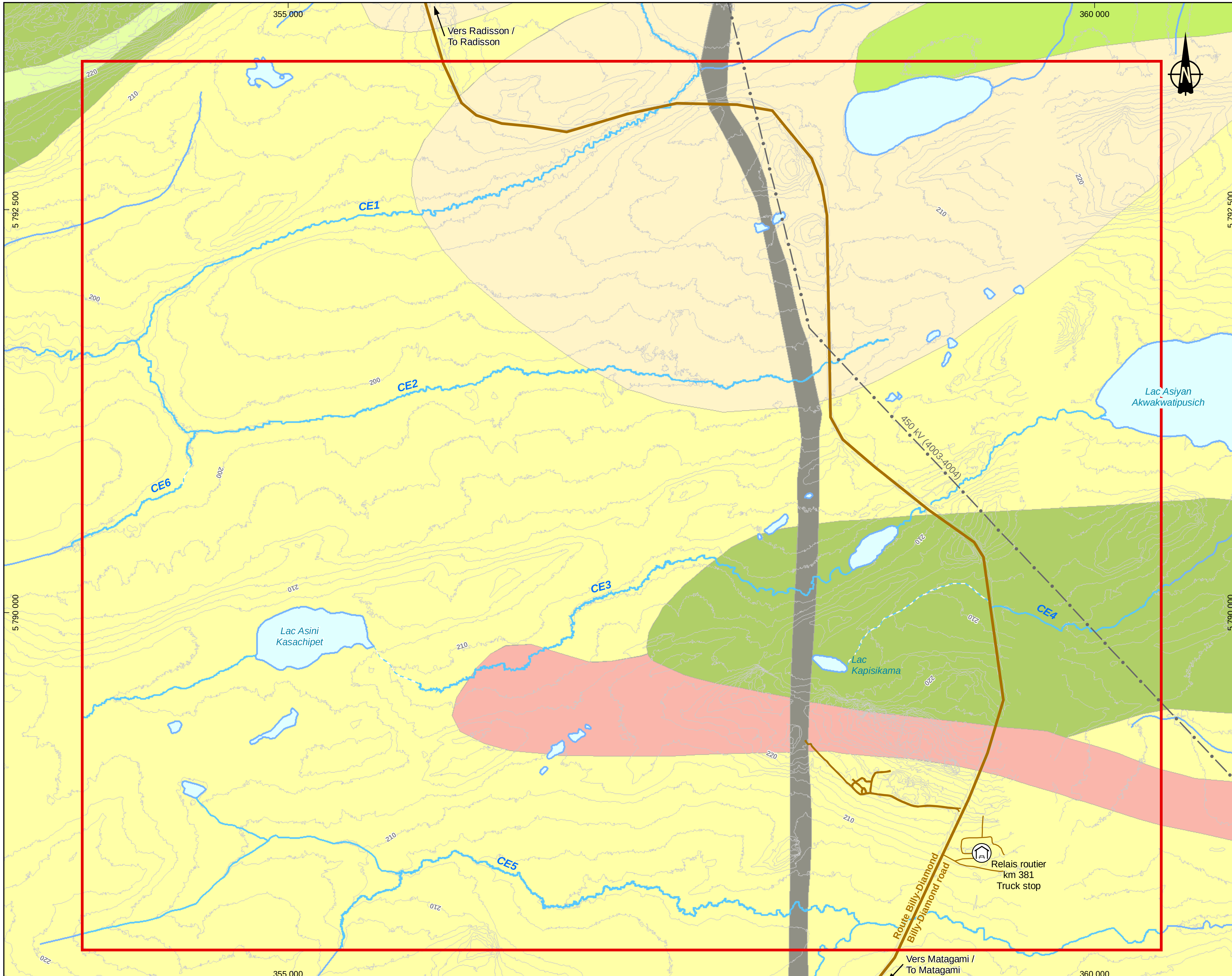
### *6.2.7.2 WATERSHEDS*

The study area is located inside the Eastmain River watershed. It has an area of approximately 46,000 km² and drains water from several lakes and rivers. In the study area, creeks CE1, CE2 and CE6 flow to the west, towards the Miskimatao River, and then join the Eastmain River. Creeks CE3, CE4 and CE5 flow to the east and also join the Eastmain River. **Map 6-7A shows the boundary of the Eastmain River watershed, as well as the boundaries of the local study area subwatersheds.** Note that the study area drainage system represents a very small percentage of the Eastmain River watershed (total of 0.1%).

Map 6-7**B** shows the watersheds of the watercourses in the study area **in more detail**. Table 6-9 shows the surface areas of these watersheds. These are undeveloped, very small and negligibly sloped watersheds as well as many wetlands that cause a significant reduction in watercourse flow. Photos of the watercourses are available in the Hydrological technical study (Étude spécialisée sur l'hydrologie*)* (WSP, 2018b).

### Table 6-11 Surface area of the watersheds of the watercourses studied

| Name | Surface area ($km^2$) |
|---|---|
| **North side (CE1, CE2 and CE6)** | **20.36** |
| CE1 | 7.63 |
| CE2 | 9.07 |
| CE6 | 3.11 |
| **South side (CE3, CE4 and CE5)** | **48.76** |
| CE3 | **10.33** |
| CE4 | 3.03 |
| CE5 | 27.01 |




Zone d'étude locale / *Local study area*

Courbe de niveau (équidistances 2 m) / *Contour (interval 2 m)*

**Infrastructures / *Infrastructure***

Route principale / *Main road*

Route d'accès / *Access road*

Ligne de transport d'énergie / *Transmission line*

**Géologie / *Geology***

Pegmatite à spodumène / *Pegmatite with spodumene*

Conglomérat monogénique à polygénique et grès / *Monogenic to polygenic and sandstone conglomerate*

Paragneiss à minéraux métamorphiques / *Paragneiss with metamorphic minerals*

Basalte amphibolitisé et amphibolite / *Amphibolitized basalt and amphibolite*

Tuf intermédiaire / *Intermediate tuff*

Tuf felsique à intermédiaire / *Felsic to intermediate tuff*

Diabase / *Diabase*

**Hydrographie / *Hydrography***

CE2 Numéro du cours d'eau / *Stream number*

Cours d'eau permanent / *Permanent stream*

Cours d'eau à écoulement diffus ou intermittent / *Intermittent or diffused flow stream*

GALAXY

*Mine de lithium Baie-James /James Bay Lithium Mine*

**Carte / *Map* 6-3**
**Géologie /**
***Geology***

*Sources :*
*Canvec : 1 : 50 000, RNCan, 2015*
*BDGA : 1 : 1 000 000, RNCan, 2011*
*Géologie / Goelogy : Sigeom, 2017*

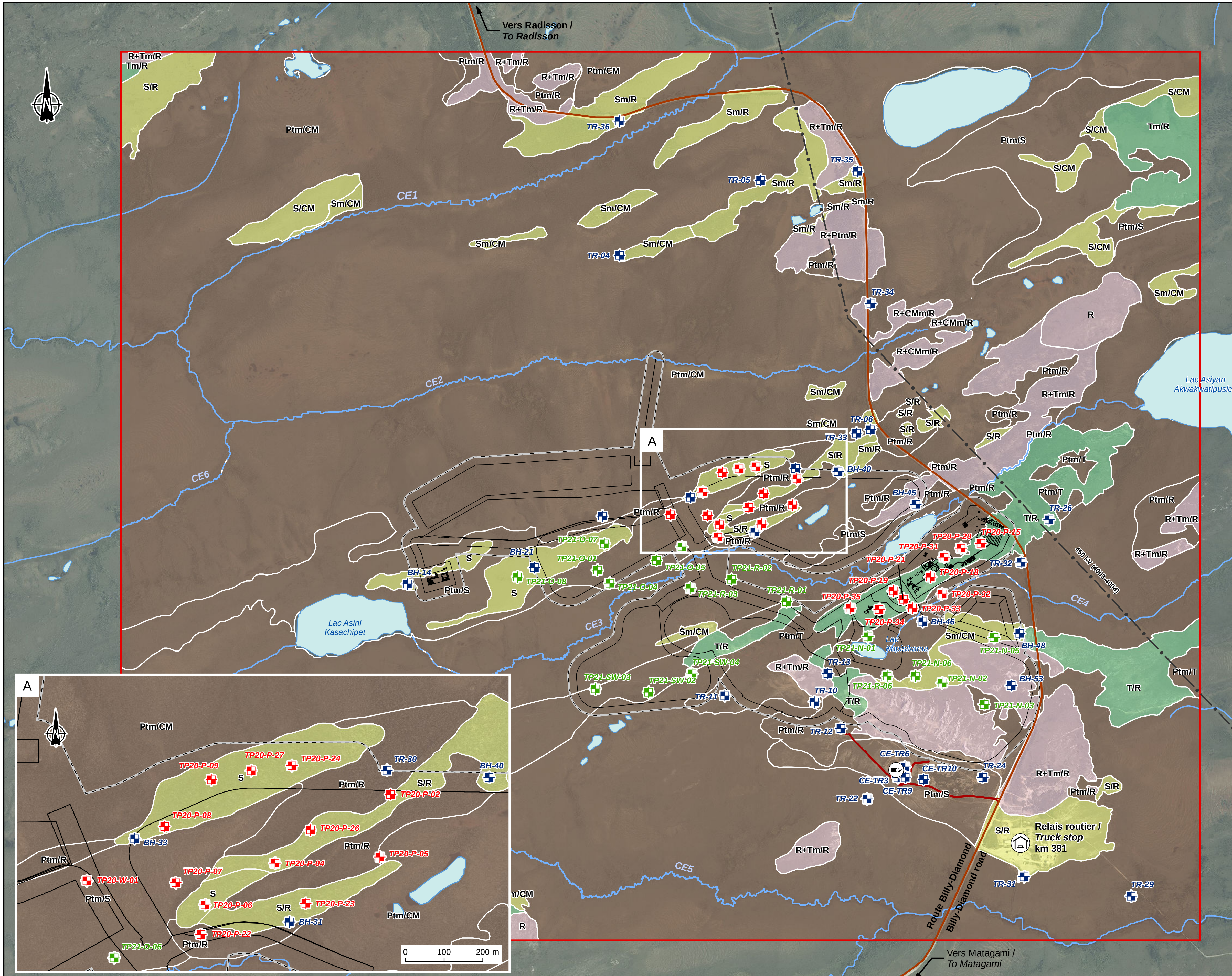
0 240 480 m

UTM, fuseau 18, NAD83

**Juillet / *July* 2021**

*Dessin : A. Masson*
*Approbation : C. Martineau*
*201-12362-00_c6-3_wspT327_geologie_210701.mxd*

wsp




Infrastructures minières / *Mining infrastructure*

Empreinte de la mine (zone tampon de 50 mètres) / *Mine footprint (buffer 50 meters)*

Zone d'étude locale / *Local study area*

**Site d'échantillonnage des sols / *Soil sampling site***

- Antérieur / *Previous*
- 2020
- 2021

**Infrastructures / *Infrastructure***

- Route / *Road*
- Ligne de transport d'énergie / *Transmission line*
- Lieu d'enfouissement en territoire isolé (LETI) / *Remote landfill*

**Dépôts de surface / *Superficial Deposits***

| | |
|---|---|
| R | Roc / *Rock* |
| R+CMm/R | Roc avec placage d'argile mince ( <2 m) et discontinu / *Rock with veneer of thin (<2 m) and discontinuous clay* |
| R+Tm/R | Roc avec placage de till mince ( <2 m) et discontinu / *Rock with veneer of thin (<2m) and discontinuous till* |
| R+Ptm/R | Roc avec placage de tourbe mince (<2 m) et discontinu / *Rock with veneer of thin (<2m) and discontinuous peat* |
| S | Sable / *Sand* |
| S/CM | Sable (2 à 6 m) sur argile / *Sand (2 to 6 m) on clay* |
| S/R | Sable (2 à 6 m) sur roc / *Sand (2 to 6 m) on rock* |
| Sm/CM | Sable mince (<2 m) sur argile / *Thin sand (<2 m) on clay* |
| Sm/R | Sable mince (<2 m) sur roc / Thin sand (<2 m) on rock |
| T/R | Till (2 à 6 m) / *Till (2 to 6 m) on rock* |
| Tm/R | Till mince (<2 m) sur roc / *Thin till (<2 m) on rock* |
| Ptm/CM | Tourbe mince (<2 m) sur argile / *Thin peat (<2 m) on clay* |
| Ptm/R | Tourbe mince (<2 m) sur roc / *Thin peat (<2 m) on roc* |
| Ptm/S | Tourbe mince (<2 m) sur sable / *Thin peat (<2 m) on sand* |
| Ptm/T | Tourbe mince (<2 m) sur till / Thin peat (<2 m) on till |

**Hydrographie / *Hydrography***

- Cours d'eau permanent / *Permanent stream*
- Cours d'eau à écoulement diffus ou intermittent / *Intermittent or diffused flow stream*

GALAXY

*Mine de lithium Baie-James /James Bay Lithium Mine*

**Carte / *Map* 6-4**
**Géomorphologie et sites d'échantillonnage des sols /**
***Geomorphology and Soil Sampling Sites***

*Sources :*
*Orthoimage : Galaxy, août / august 2017*
*Photo interpretation : WSP 2018*
*Données du projet / Project data : Galaxy, 2021*

0 240 480 m
UTM, fuseau 18, NAD83

**Juillet / *July* 2021**

*Dessin : A. Masson*
*Approbation : C. Martineau*
*201-12362-00_c6-4_wspT090_sols_210701.mxd*

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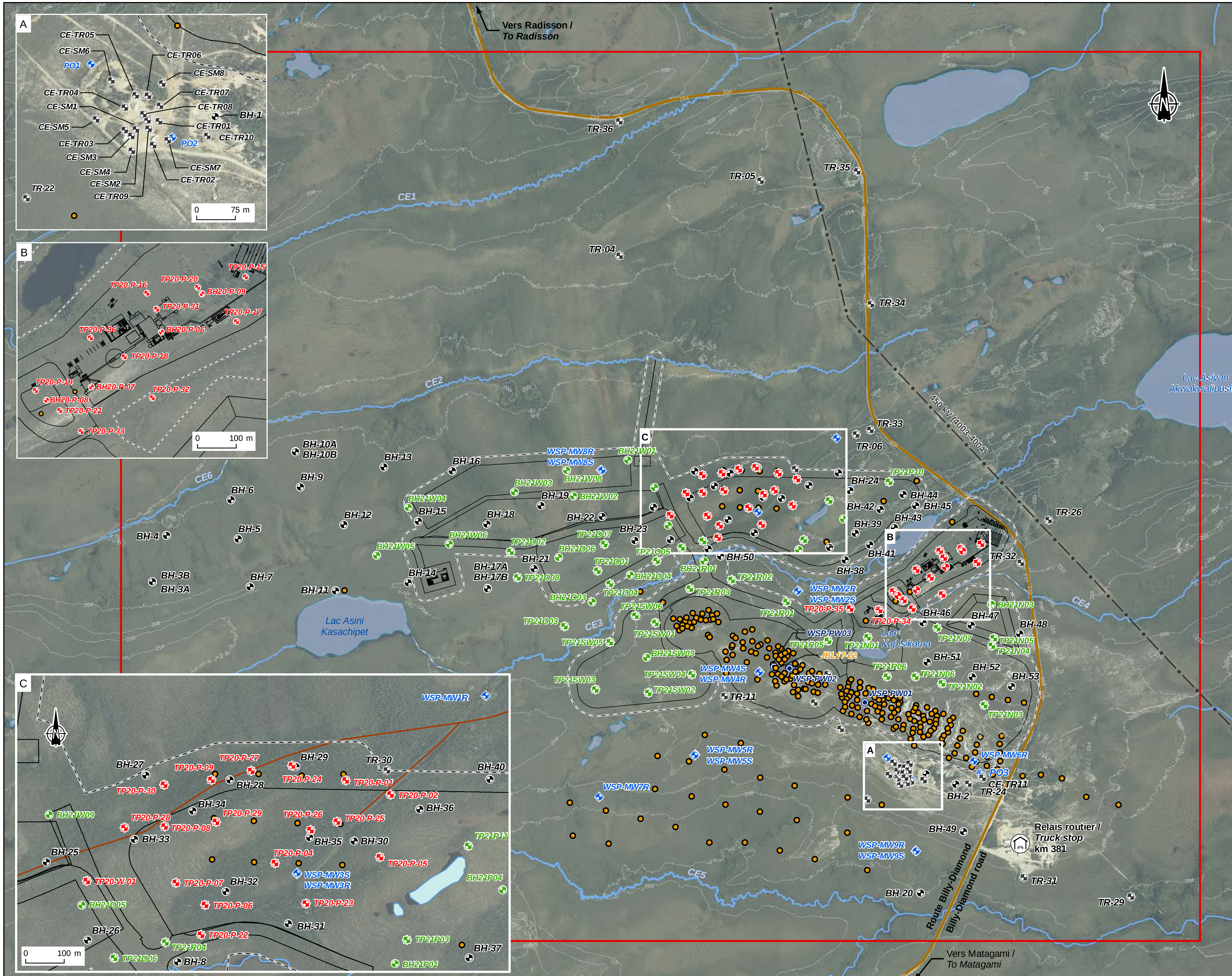


Infrastructures minières / *Mining infrastructure*

Empreinte de la mine (zone tampon de 50 mètres) / *Mine footprint (buffer 50 meters)*

Zone d'étude locale / *Local study area*

Courbe de niveau (équidistance des courbes 2 m) / *Contour (interval 2 m)*

Forage d'exploration / *Exploration drill hole*

Puits d'observation / *Observation well*

Puits de pompage / *Pumping well*

Tranchée antérieure / *Previous trench*

Tranchée 2020 / *Trench 2020*

Tranchée 2021 / *Trench 2021*

Sondage géotechnique antérieur / *Previous geotechnical borehole*

Sondage géotechnique 2020 / *Geotechnical borehole 2020*

Sondage géotechnique 2021 / *Geotechnical borehole 2021*

**Infrastructures / *Infrastructure***

Route principale / *Main road*

Route d'accès / *Access road*

Ligne de transport d'énergie / *Transmission line*

**Hydrographie / *Hydrography***

CE3 Numéro de cours d'eau / *Stream number*

Cours d'eau permanent / *Permanent stream*

Cours d'eau à écoulement diffus ou intermittent / *Intermittent or diffused flow stream*

Plan d'eau / *Waterbody*

GALAXY

*Mine de lithium Baie-James /James Bay Lithium Mine*

**Carte / *Map* 6-5**
**Sondages hydrogéologiques /**
***Hydrogeological Boreholes***

Sources :
Orthoimage : Galaxy, août / august 2017
Données du projet / Project data : Galaxy, 2021

0 240 480 m
UTM, fuseau 18, NAD83

**Juillet / *July* 2021**

Dessin : A. Masson
Approbation : C. Martineau
201-12362-00_c6-5_wspT111_hg_sondage_210701.mxd

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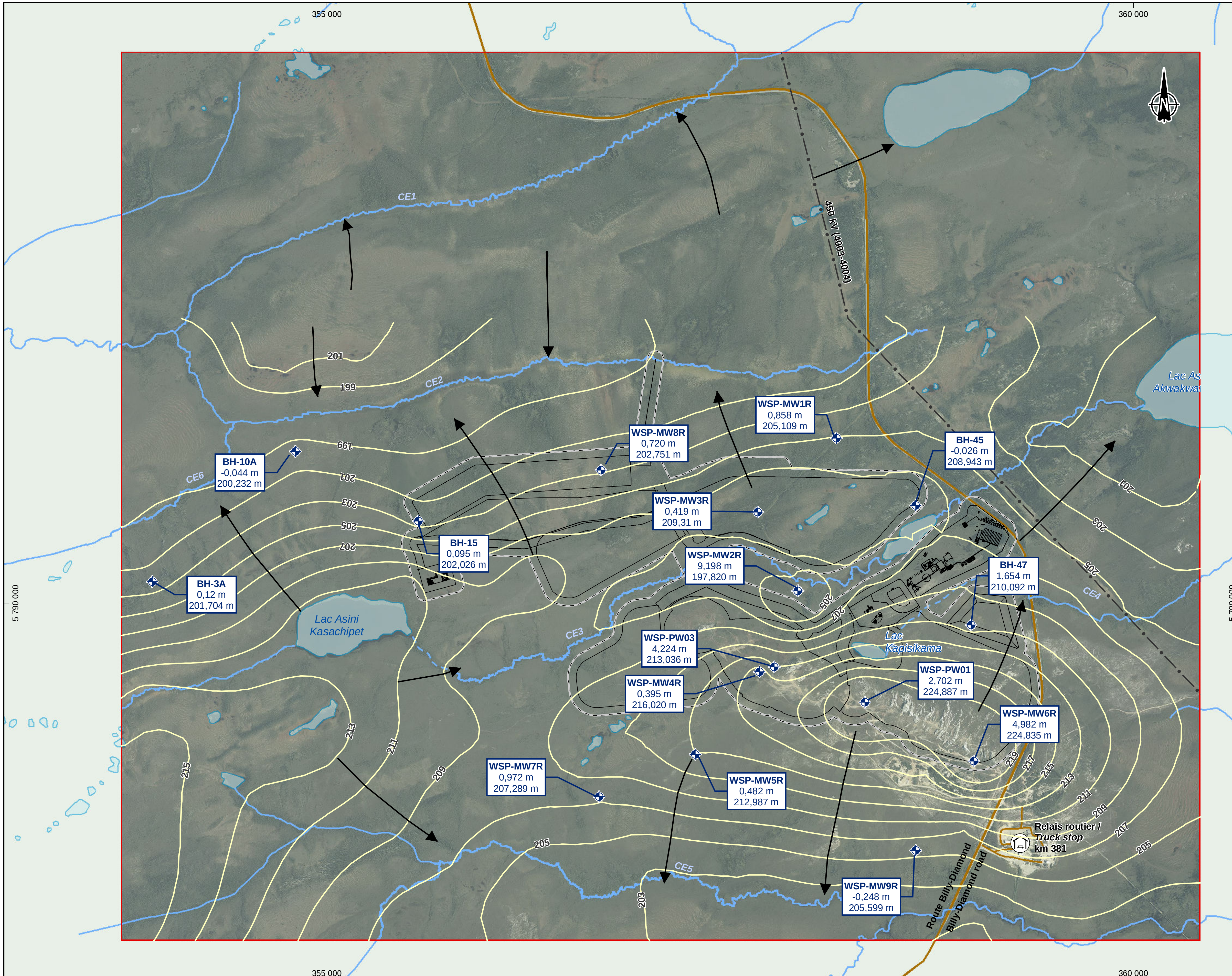



Zone d'étude locale / *Local study area*

Infrastructures minières / *Mining infrastructure*

Empreinte de la mine (zone tampon de 50 mètres) / *Mine footprint (buffer 50 meters)*

Puits d'observation / *Observation well*

BH-45 / -0,026 / 208,943 m — Nom du puits d'observation / *Name of observation well*; Profondeur du niveau d'eau p/r sol / *Water level depth from ground*; Élévation piézométrique (m) / *Piezometric elevation (m)*

Courbe piézométrique / *Piezometric contour*

Sens d'écoulement de l'eau / *Direction of water flow*

**Infrastructures / *Infrastructure***

Route principale / *Main road*

Route d'accès / *Access road*

Ligne de transport d'énergie / *Transmission line*

**Hydrographie / *Hydrography***

CE3 Numéro de cours d'eau/ *Stream number*

Cours d'eau permanent / *Permanent stream*

Cours d'eau à écoulement diffus ou intermittent / *Intermittent or diffused flow stream*

Plan d'eau / *Waterbody*

GALAXY

*Mine de lithium Baie-James /James Bay Lithium Mine*

**Carte / *Map* 6-6**
**Piézométrie / *Piezometry***

*Sources :*
*Orthoimage : Galaxy, août / august 2017*
*Piézométrie, WSP 2018*
*Données du projet / Project data : Galaxy, 2021*

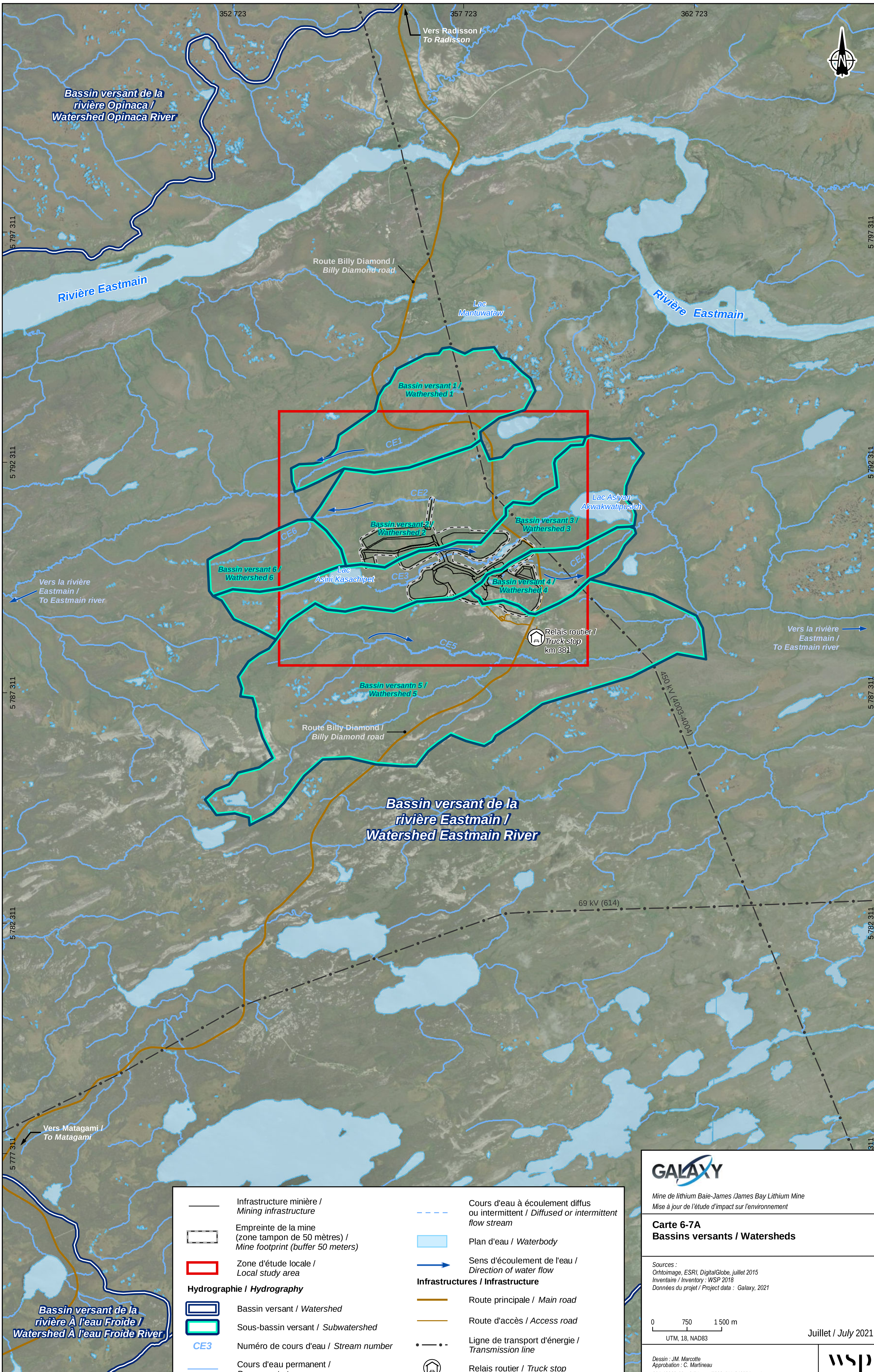
0 240 480 m

UTM, fuseau 18, NAD83

**Juillet / *July* 2021**

*Dessin : A. Masson*
*Approbation : C. Martineau*
*201-12362-00_c6-6_wspT113_hg_piezo_210701.mxd*

wsp



352 723
357 723
362 723
5 797 311
5 792 311
5 787 311
5 782 311
5 777 311
Vers Radisson / To Radisson
Bassin versant de la rivière Opinaca / Watershed Opinaca River
Rivière Eastmain
Route Billy Diamond / Billy Diamond road
Lac Mantuwataw
Rivière Eastmain
Bassin versant 1 / Wathershed 1
CE1
CE2
Lac Asiyan Akwakwatipusich
Bassin versant 2 / Wathershed 2
Bassin versant 3 / Wathershed 3
CE6
Bassin versant 6 / Wathershed 6
Lac Asini Kasachipet
CE3
CE4
Bassin versant 4 / Wathershed 4
Vers la rivière Eastmain / To Eastmain river
Relais routier / Truck stop km 381
CE5
Vers la rivière Eastmain / To Eastmain river
450 kV (4003-4004)
Bassin versantn 5 / Wathershed 5
Route Billy Diamond / Billy Diamond road
Bassin versant de la rivière Eastmain / Watershed Eastmain River
69 kV (614)
Vers Matagami / To Matagami
Bassin versant de la rivière À l'eau Froide / Watershed À l'eau Froide River
Infrastructure minière / Mining infrastructure
Empreinte de la mine (zone tampon de 50 mètres) / Mine footprint (buffer 50 meters)
Zone d'étude locale / Local study area
Hydrographie / Hydrography
Bassin versant / Watershed
Sous-bassin versant / Subwatershed
CE3 Numéro de cours d'eau / Stream number
Cours d'eau permanent / Permanent stream
Cours d'eau à écoulement diffus ou intermittent / Diffused or intermittent flow stream
Plan d'eau / Waterbody
Sens d'écoulement de l'eau / Direction of water flow
Infrastructures / Infrastructure
Route principale / Main road
Route d'accès / Access road
Ligne de transport d'énergie / Transmission line
Relais routier / Truck stop
GALAXY
Mine de lithium Baie-James /James Bay Lithium Mine
Mise à jour de l'étude d'impact sur l'environnement
Carte 6-7A
Bassins versants / Watersheds
Sources :
Orhtoimage, ESRI, DigitalGlobe, juillet 2015
Inventaire / Inventory : WSP 2018
Données du projet / Project data : Galaxy, 2021
0 750 1 500 m
UTM, 18, NAD83
Juillet / July 2021
Dessin : JM. Marcotte
Approbation : C. Martineau
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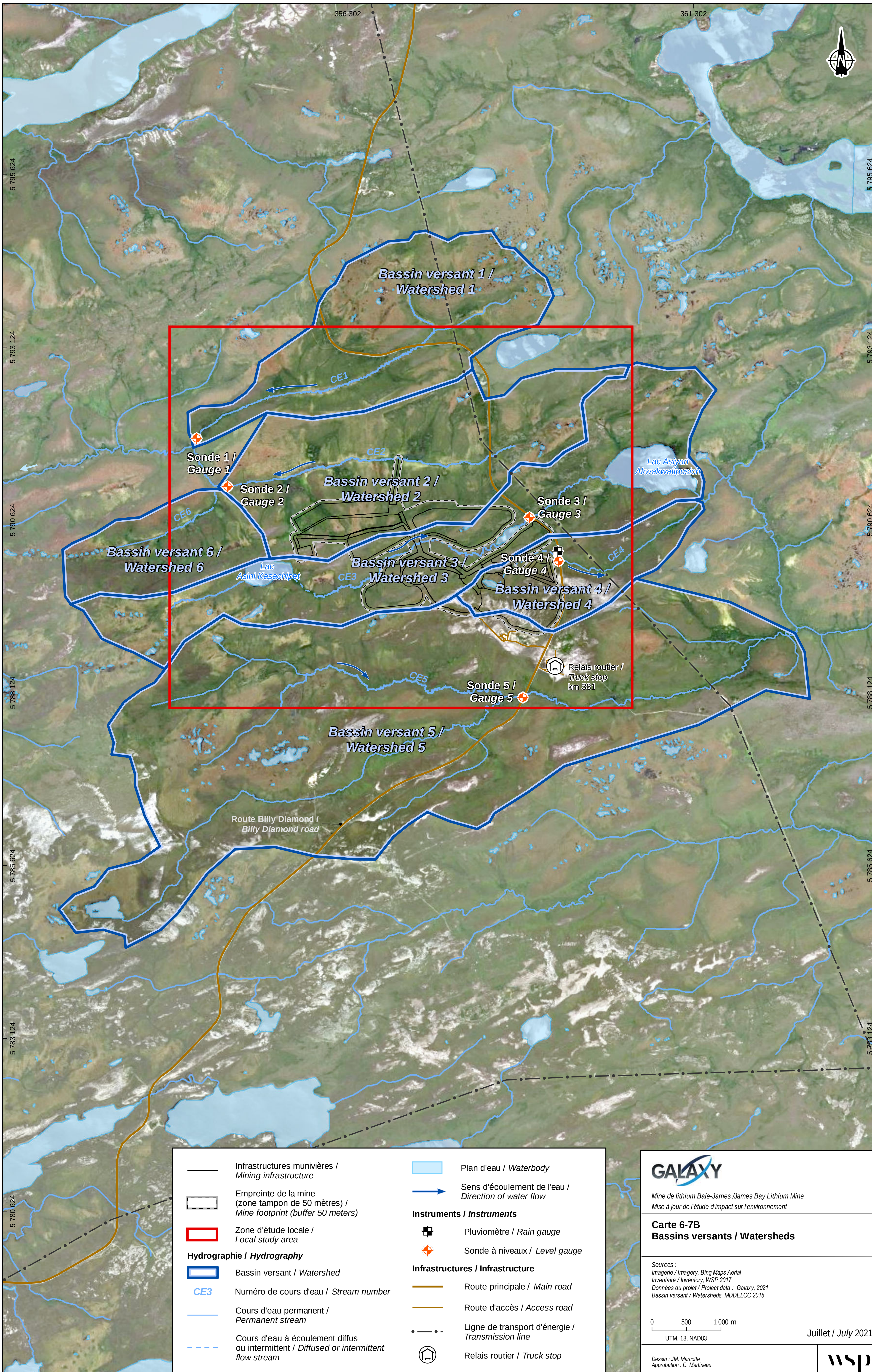
wsp



356 302
361 302
5 795 624
5 793 124
5 790 624
5 788 124
5 785 624
5 783 124
5 780 624
Bassin versant 1 / Watershed 1
Bassin versant 2 / Watershed 2
Bassin versant 3 / Watershed 3
Bassin versant 4 / Watershed 4
Bassin versant 5 / Watershed 5
Bassin versant 6 / Watershed 6
CE1
CE2
CE3
CE4
CE5
CE6
Sonde 1 / Gauge 1
Sonde 2 / Gauge 2
Sonde 3 / Gauge 3
Sonde 4 / Gauge 4
Sonde 5 / Gauge 5
Lac Asiyan Akwakwatipusich
Lac Asini Kasachipet
Relais routier / Truck stop km 381
Route Billy Diamond / Billy Diamond road
Infrastructures munivières / Mining infrastructure
Empreinte de la mine (zone tampon de 50 mètres) / Mine footprint (buffer 50 meters)
Zone d'étude locale / Local study area
Hydrographie / Hydrography
Bassin versant / Watershed
Numéro de cours d'eau / Stream number
Cours d'eau permanent / Permanent stream
Cours d'eau à écoulement diffus ou intermittent / Diffused or intermittent flow stream
Plan d'eau / Waterbody
Sens d'écoulement de l'eau / Direction of water flow
Instruments / Instruments
Pluviomètre / Rain gauge
Sonde à niveaux / Level gauge
Infrastructures / Infrastructure
Route principale / Main road
Route d'accès / Access road
Ligne de transport d'énergie / Transmission line
Relais routier / Truck stop
GALAXY
Mine de lithium Baie-James /James Bay Lithium Mine
Mise à jour de l'étude d'impact sur l'environnement
Carte 6-7B
Bassins versants / Watersheds
Sources :
Imagerie / Imagery, Bing Maps Aerial
Inventaire / Inventory, WSP 2017
Données du projet / Project data : Galaxy, 2021
Bassin versant / Watersheds, MDDELCC 2018
0 500 1 000 m
UTM, 18, NAD83
Juillet / July 2021
Dessin : JM. Marcotte
Approbation : C. Martineau
201-12362-00_c6-7B_wspT289_BV_210701.mxd
wsp

### 6.2.7.3 CHARACTERISTIC FLOW RATES AND WATER LEVELS

This section presents the estimated characteristic flow rates downstream of the six watercourses in the study area. Table 6-10**a** shows the mean monthly flow estimated by interbasin transfer. The annual specific flow of watercourses in the study area is estimated to be 18.7 L/s/km².

**Table 6-12a Mean monthly flow in the studied watercourses estimated by interbasin transfer**

| Month | Watercourse flow rate (L/s) | | | | | |
|---|---|---|---|---|---|---|
| | CE1 | CE2 | CE3 | CE4 | CE5 | CE6 |
| January | 72 | 85 | 97 | 29 | 254 | 29 |
| February | 55 | 65 | 75 | 22 | 195 | 22 |
| March | 47 | 55 | 63 | 18 | 165 | 19 |
| April | 56 | 66 | 75 | 22 | 196 | 23 |
| May | 243 | 288 | 329 | 97 | 859 | 99 |
| June | 246 | 292 | 332 | 98 | 869 | 100 |
| July | 168 | 199 | 227 | 67 | 594 | 68 |
| August | 174 | 207 | 236 | 69 | 617 | 71 |
| September | 171 | 203 | 231 | 68 | 605 | 70 |
| October | 195 | 232 | 264 | 78 | 690 | 79 |
| November | 173 | 206 | 234 | 69 | 612 | 70 |
| December | 115 | 137 | 156 | 46 | 407 | 47 |

**Table 6-10b below shows the values of the main factors used in rational method calculations under current conditions. Note that the runoff coefficient Cp may seem low, because it is the mean coefficient for the entire watershed, including lake and wetland areas.**

**Table 6-10b Factors considered for the rational method – current conditions**

| | CE2 | CE3 | CE4 | CE5 | CE6 |
|---|---|---|---|---|---|
| % lakes and wetlands | 58 | 29 | 7.4 | 28 | 27 |
| Mean $C_p$ | 0.09 | 0.12 | 0.14 | 0.12 | 0.12 |
| $T_c$ (h) | 5.0 | 7.6 | 4.4 | 9.7 | 4.6 |
| I 25 years (mm/h) | 10.2 | 7.3 | 11.4 | 6.0 | 10.9 |
| $F_L$ | 0.58 | 0.78 | 0.63 | 0.59 | 0.59 |

**Note: The goal of the study was to obtain flow rates to compare current conditions and projected conditions, to assess the effects of the project, and not to be used to size structures (dikes, pits, ponds, pumping stations). These values should therefore not be considered absolute, but used for comparison purposes.**

Table 6-11 shows the flood flow as estimated by the rational method. This method was used because it considers the physical characteristics of the watershed, such as the watercourse slope and the buffering due to wetlands and lakes, unlike the interbasin transfer method. The flood flow varied between 0.3 and 1.7 $m^3$/s in the study area over the two-year return period.

**Table 6-11 Flood flow in the studied watercourses estimated using the rational method**

| Return period | Watercourse flow rate (m³/s) | | | | | |
|---|---|---|---|---|---|---|
| | CE1 | CE2 | CE3 | CE4 | CE5 | CE6 |
| 2 year | 0.62 | 0.67 | 1.02 | 0.41 | 1.71 | 0.33 |
| 10 years | 1.00 | 1.14 | 1.67 | 0.71 | 2.72 | 0.56 |
| 25 years | 1.19 | 1.37 | 1.99 | 0.86 | 3.22 | 0.68 |
| 50 years | 1.33 | 1.54 | 2.23 | 0.97 | 3.60 | 0.76 |
| 100 years | 1.47 | 1.71 | 2.46 | 1.08 | 3.98 | 0.85 |

The low-water flows estimated using the linear regression method are presented in Table 6-12. This method was used because it seems to be perfectly adapted for the small watersheds in the Nord-du-Québec region, while still being conservative, and the order of magnitude of the results was validated using the interbasin transfer method (details provided in the sector study).

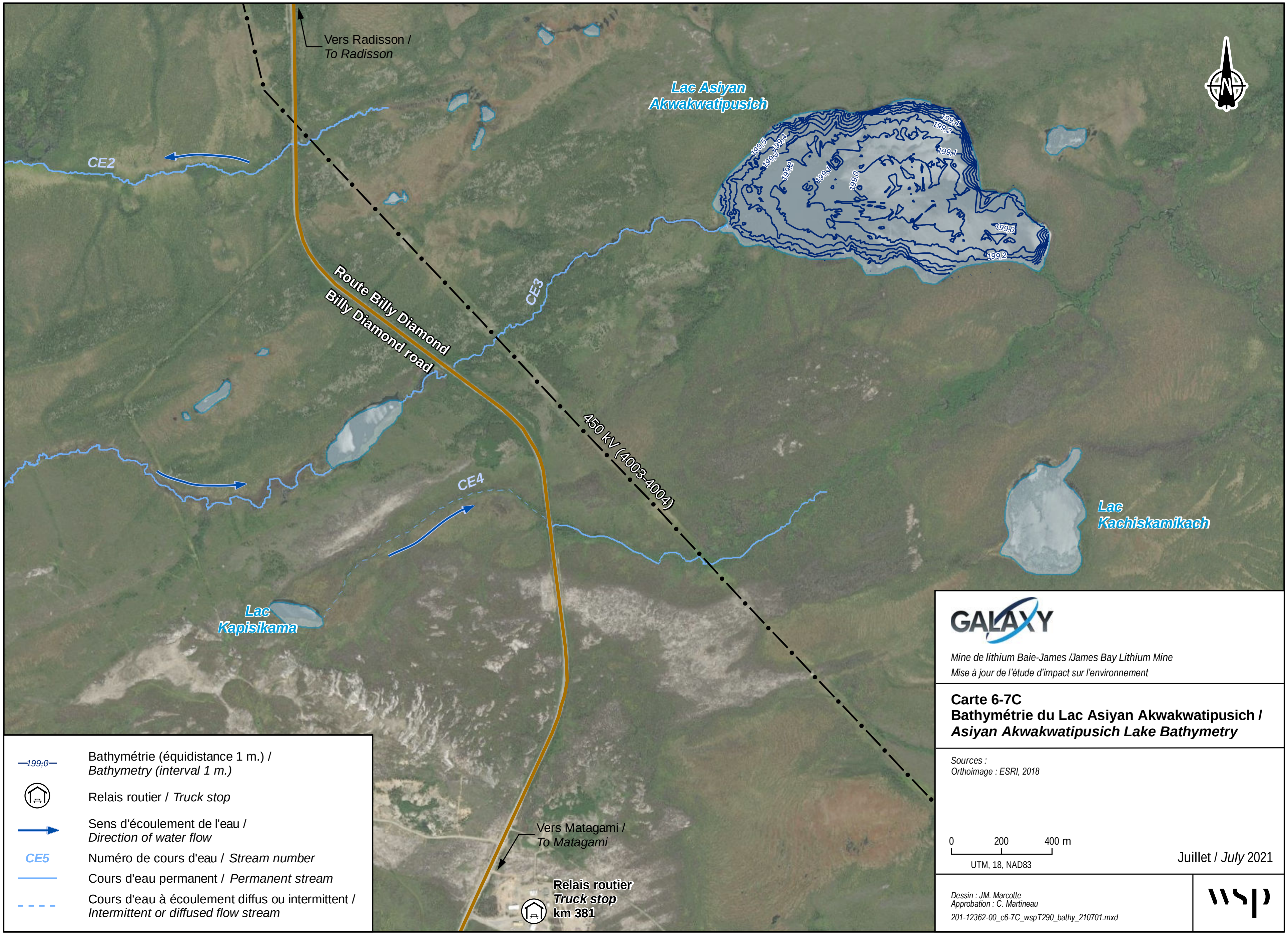
**Table 6-12 Low-water flow rates in the studied watercourses estimated using the linear regression method**

| Period | Watercourse flow rate (L/s) | | | | | |
|---|---|---|---|---|---|---|
| | CE1 | CE2 | CE3 | CE4 | CE5 | CE6 |
| $Q_{2,7}$ annual | 13 | 15 | 17 | 5 | 45 | 5 |
| $Q_{10,7}$ annual | 6 | 7 | 8 | 2 | 22 | 3 |
| $Q_{5,30}$ annual | 8 | 10 | 11 | 3 | 30 | 3 |
| $Q_{2,7}$ summer | 31 | 37 | 42 | 12 | 110 | 13 |
| $Q_{10,7}$ summer | 14 | 16 | 19 | 5 | 49 | 6 |
| $Q_{5,30}$ summer | 29 | 35 | 40 | 12 | 104 | 12 |

The above-mentioned characteristic flow rates were then entered as a limiting condition upstream of the hydraulic models, to obtain an estimate of the characteristic water levels in creeks CE2, CE3 and CE4. The results of these simulations are presented in the Hydrological technical study (Étude spécialisée sur l'hydrologie) in the form of hydraulic profiles and characteristic waterlines (WSP, 2018*b*).

#### 6.2.7.4 BATHYMETRY

**Basic bathymetry, consisting of one-time measurements taken with an echo sounder, was done in Asiyan Akwakwatipusich, Asini Kasachipet and Kapisikama Lakes and Unnamed Pond 1. These measurements helped determine the mean and maximum depth of the bodies of water surveyed. This data is shown in Tables 27 to 31, as well as in Table 33 of the sector study Aquatic Inventory and Baseline Study (WSP, 2018c). Precision bathymetry was, however, done for Asiyan Akwakwatipusich Lake and the result of these measurements is shown in Map 6-7C below.**




GALAXY

*Mine de lithium Baie-James /James Bay Lithium Mine*
*Mise à jour de l'étude d'impact sur l'environnement*

**Carte 6-7C**
**Bathymétrie du Lac Asiyan Akwakwatipusich /**
***Asiyan Akwakwatipusich Lake Bathymetry***

*Sources :*
*Orthoimage : ESRI, 2018*

0 200 400 m
UTM, 18, NAD83

Juillet / *July* 2021

*Dessin : JM. Marcotte*
*Approbation : C. Martineau*
*201-12362-00_c6-7C_wspT290_bathy_210701.mxd*

wsp

| | |
|---|---|
| 199,0 | Bathymétrie (équidistance 1 m.) / *Bathymetry (interval 1 m.)* |
| | Relais routier / *Truck stop* |
| | Sens d'écoulement de l'eau / *Direction of water flow* |
| CE5 | Numéro de cours d'eau / *Stream number* |
| | Cours d'eau permanent / *Permanent stream* |
| | Cours d'eau à écoulement diffus ou intermittent / *Intermittent or diffused flow stream* |

## 6.2.8 SURFACE WATER AND GROUNDWATER QUALITY

### 6.2.8.1 SURFACE WATER

This section presents the main characteristics of the water quality of watercourses in the study area. The comparison between the results obtained and the surface water quality criteria recognized by provincial and federal governments established a reference point for surface water quality in the study area. The Aquatic Inventory and Baseline Study (*L'étude spécialisée sur l'habitat aquatique*) (WSP, 2018*c*) provides details on the methodology used, the work carried out and the results obtained.

**METHODOLOGY**

Surface water sampling took place monthly for nine stations six times between June and November 2017 to have a representation of annual variation. The stations were selected to present representative information on the aquatic environment. The locations of the surface water sampling stations are shown on Map 6-8.

Surface water quality was measured using physiochemical measurements *in situ* and chemical analyses in the lab.

The following *in situ* measurements were taken at each sampling station:

- physiochemical data of the water: temperature (°C), dissolved oxygen (% and mg/L), conductivity (µS/cm) and pH;
- description and photos of the watercourse or body of water at the sampling site.

As for the chemical analyses completed in the laboratory, Table 6-13 shows the median and standard deviation for each parameter for each of the six samples from each station.


Zone d'étude locale / *Local study area*
Effluent minier / *Mining effluent*
Effluent sanitaire / *Sanitary effluent*
Infrastructures minières / *Mining infrastructure*
Empreinte de la mine (zone tampon de 50 mètres) / *Mine footprint (buffer 50 meters)*

**Sites d'échantillonnage / *Sampling Sites***
Pêche électrique / *Electrofishing*
Seine / *Beach seine*
Filet à grandes mailles / *Large mesh experimental gill net*
Filet à petites mailles / *Small mesh net*
Filet expérimental / *Multi mesh experimental gill net*
Grand verveux / *Big fyke*
Petit verveux / *Little fyke*
Filet expérimental / *Multi mesh experimental gill net* (Hg poisson / Hg fish - 2019)
Grand verveux / *Big fyke* (Hg poisson / Hg fish - 2019)
Petit verveux / *Little fyke* (Hg poisson / Hg fish - 2019)
Bourolle / *Bait trap* (Hg poisson / Hg fish - 2019)
Benthos / *Benthos*
Eau et sédiments / *Water and sediments*
Sédiments / *Sediments*
Station de pêche / *Fishing station* (2012)
Barrage de castor / *Beaver dam*

**Hydrographie / *Hydrography***
CE3 Numéro de cours d'eau / *Stream number*
Cours d'eau permanent / *Permanent stream*
Cours d'eau à écoulement diffus ou intermittent / *Intermittent or diffused flow stream*
Sens d'écoulement de l'eau / *Direction of water flow*
Littoral des cours d'eau / *Watercourses shoreline*
CE1-S1 Section de cours d'eau / *Stream section*

**Infrastructures / *Infrastructure***
Route principale / *Main road*
Route d'accès / *Access road*
Ligne de transport d'énergie / *Transmission line*
Relais routier / *Truck stop*

GALAXY
*Mine de lithium Baie-James / James Bay Lithium Mine*

**Carte 6-8**
**Stations de pêche, de qualité de l'eau et des sédiments /**
***Fishing, water and sediment sampling sites***

*Sources :*
*Orthoimage : Galaxy, août / august 2017*
*Données du projet / Project data : Galaxy, 2021*
*Fosse, carrière et entreposage des explosifs / Pit, quarry and explosives magasine : Mining Plus, 2018*
*Secteur administratif et industriel et aire de minerai / Administrative and industrial sector and ROM pad : Primero, 2018*
*Banc d'emprunt / Borrow pit, Stantec, 2019*

0 240 480 m
UTM, 18, NAD83

Juillet / *July* 2021

*Dessin : JM. Marcotte*
*Approbation : C. Martineau*
*201-12362-00_c6-8_wspT291_stations_210701.mxd*

## Table 6-13 Median and standard deviation for each parameter analyzed over six inventory campaigns

| Parameters | Units | Station | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1A | | 1B | | 2A | | 2B | | 3A | | 3B | | 4A | | 5A | | 5B | |
| | | Median | Deviation | Median | Deviation | Median | Deviation | Median | Deviation | Median | Deviation | Median | Deviation | Median | Deviation | Median | Deviation | Median | Deviation |
| **Basic descriptors** | | | | | | | | | | | | | | | | | | | |
| Total alkalinity (in $CaCO_3$) | mg $L^{-1}$ | 0.5 | 1.6 | 4 | 2 | 0.5 | 1.1 | 1.25 | 2.16 | 0.5 | 2.0 | 0.75 | 4.21 | 2.05 | 11.09 | 0.5 | 2.8 | 3.5 | 4.8 |
| Dissolved organic carbon | mg $L^{-1}$ | 31.125 | 6.155 | 28.3 | 5.3 | 23.4 | 4.7 | 28.05 | 6.28 | 20.9 | 8.7 | 25.7 | 7.2 | 22.8 | 7.3 | 24 | 8.6 | 26.3 | 5.6 |
| Suspended solids (SS) | mg $L^{-1}$ | 1.125 | 1.047 | 1.5 | 2.0 | 3 | 3.8 | 1.5 | 1.3 | 3 | 1.1 | 3 | 1.0 | 4 | 1.8 | 2 | 2.3 | 4 | 3.1 |
| Total dissolved solids | mg $L^{-1}$ | 56 | 16.2 | 78 | 13.4 | 68 | 14.5 | 74 | 13.7 | 58 | 7.1 | 60 | 13.8 | 68 | 13.4 | 68 | 12.3 | 68 | 11.6 |
| Turbidity | NTU | 0.4 | 0.2 | 0.65 | 1.15 | 0.9 | 0.4 | 0.65 | 0.79 | 1 | 1.0 | 0.85 | 0.26 | 1 | 2.8 | 1.4 | 2.4 | 1.25 | 1.02 |
| Hardness (in $CaCO_3$) | mg $L^{-1}$ | 3.82 | 1.77 | 6.01 | 1.10 | 6.61 | 1.49 | 5.625 | 0.857 | 3.7 | 1.4 | 4.07 | 0.61 | 6.27 | 3.14 | 4.765 | 1.269 | 6.37 | 1.27 |
| **Nutrients** | | | | | | | | | | | | | | | | | | | |
| Ammonia nitrogen ($NH_3$-$NH_4$) | mg N $L^{-1}$ | 0.01 | 0 | 0.015 | 0.008 | 0.01 | 0.002 | 0.01 | 0.008 | 0.01 | 0.010 | 0.01 | 0 | 0.01 | 0.02 | 0.0175 | 0.010 | 0.01 | 0.01 |
| Total nitrogen | mg N $L^{-1}$ | 0.312 | 0.190 | 0.491 | 0.184 | 0.38775 | 0.127 | 0.344 | 0.188 | 0.329 | 0.145 | 0.426 | 0.101 | 0.337 | 0.119 | 0.15 | 0.163 | 0.397 | 0.135 |
| Nitrates | mg N $L^{-1}$ | 0.005 | 0.005 | 0.005 | 0.100 | 0.005 | 0 | 0.005 | 0.032 | 0.005 | 0.009 | 0.005 | 0.011 | 0.01 | 0.039 | 0.005 | 0.014 | 0.005 | 0.065 |
| Nitrites | mg N $L^{-1}$ | 0.005 | 0 | 0.005 | 0.004 | 0.005 | 0 | 0.005 | 0.006 | 0.005 | 0.009 | 0.005 | 0.007 | 0.005 | 0.010 | 0.005 | 0.007 | 0.005 | 0.006 |
| Trace phosphorus | mg P $L^{-1}$ | 0.0059 | 0.0020 | 0.0122 | 0.0048 | 0.0124 | 0.0031 | 0.0086 | 0.0031 | 0.0065 | 0.0035 | 0.0160 | 0.0037 | 0.0181 | 0.0051 | 0.0084 | 0.0036 | 0.0189 | 0.0058 |
| **Major ions** | | | | | | | | | | | | | | | | | | | |
| Bicarbonates | mg $L^{-1}$ | 0.5 | 1.6 | 4 | 1.7 | 0.5 | 1.1 | 1.3 | 2.2 | 0.5 | 2.0 | 0.8 | 4.2 | 2 | 10.8 | 0.5 | 2.8 | 3.5 | 4.8 |
| Bromides | mg $L^{-1}$ | 0.05 | 0 | 0.05 | 0 | 0.05 | 0 | 0.05 | 0 | 0.05 | 0 | 0.05 | 0 | 0.05 | 0 | 0.05 | 0 | 0.05 | 0 |
| Calcium | mg $L^{-1}$ | 0.79 | 0.41 | 1.43 | 0.30 | 1.85 | 0.43 | 1.32 | 0.24 | 1.18 | 0.48 | 1.19 | 0.20 | 1.70 | 1.08 | 1.37 | 0.39 | 1.73 | 0.38 |
| Carbonates | mg $L^{-1}$ | 0.75 | 0 | 0.75 | 0 | 0.75 | 0 | 0.75 | 0 | 0.75 | 0 | 0.75 | 0 | 0.75 | 0 | 0.75 | 0 | 0.75 | 0 |
| Chlorides | mg $L^{-1}$ | 1.64 | 0.54 | 1.29 | 0.50 | 6.17 | 3.81 | 1.44 | 0.50 | 0.62 | 3.57 | 0.49 | 0.45 | 2.72 | 2.72 | 0.55 | 0.41 | 1.71 | 0.67 |
| Fluorides | µg $L^{-1}$ | 0 | 0 | 0 | n/a | 0 | 0 | 16 | n/a | 0 | 0 | 0 | 0 | 29.0 | 18.4 | 28.0 | 11.3 | 17 | n/a |
| Magnesium | mg $L^{-1}$ | 0.4185 | 0.1825 | 0.6265 | 0.0978 | 0.4713 | 0.1034 | 0.5795 | 0.0792 | 0.1840 | 0.0559 | 0.2680 | 0.0412 | 0.4890 | 0.1966 | 0.3300 | 0.0838 | 0.4810 | 0.0962 |
| Potassium | mg $L^{-1}$ | 0.2805 | 0.2001 | 0.4185 | 0.1524 | 0.3475 | 0.1506 | 0.3395 | 0.1655 | 0.1840 | 0.1214 | 0.1920 | 0.0841 | 0.3870 | 0.2140 | 0.3340 | 0.1313 | 0.3845 | 0.1234 |
| Sodium | mg $L^{-1}$ | 1.585 | 0.616 | 1.545 | 0.253 | 4.460 | 1.768 | 1.535 | 0.234 | 0.494 | 0.151 | 0.766 | 0.284 | 2.280 | 1.611 | 0.966 | 0.413 | 1.690 | 0.426 |
| Sulfates | mg $SO_4$ $L^{-1}$ | 0.2015 | 0.0820 | 0.2090 | 0.0835 | 0.4250 | 0.2319 | 0.2020 | 0.1814 | 0.3470 | 0.7040 | 0.2270 | 0.1386 | 1.1800 | 0.5809 | 0.2370 | 0.5209 | 0.4350 | 0.2210 |
| **Trace metals** | | | | | | | | | | | | | | | | | | | |
| Aluminium | mg $L^{-1}$ | 0.096 | 0.029 | 0.290 | 0.050 | 0.280 | 0.067 | 0.248 | 0.042 | 0.074 | 0.013 | 0.192 | 0.035 | 0.287 | 0.115 | 0.168 | 0.048 | 0.199 | 0.039 |
| Antimony | mg $L^{-1}$ | 0.0000185 | 0.0000649 | 0.0000278 | 0.0000364 | 0.0000025 | 0.0000224 | 0.0000073 | 0.0000195 | 0.0000100 | 0.0000276 | 0.0000025 | 0.0000176 | 0.0000025 | 0.0000122 | 0.0000025 | 0.0000119 | 0.0000038 | 0.0036910 |
| Silver | mg $L^{-1}$ | 0.0000015 | 0.0000149 | 0.0000015 | 0.0000010 | 0.0000015 | 0.0000071 | 0.0000015 | 0.0000016 | 0.0000015 | 0.0000055 | 0.0000015 | 0.0000022 | 0.0000015 | 0.0000012 | 0.0000015 | 0 | 0.0000028 | 0.0000145 |
| Arsenic | mg $L^{-1}$ | 0.0004 | 0.0002 | 0.0009 | 0.0004 | 0.0005 | 0.0002 | 0.0007 | 0.0003 | 0.0018 | 0.0006 | 0.0020 | 0.0005 | 0.0028 | 0.0006 | 0.0008 | 0.0002 | 0.0011 | 0.0006 |
| Barium | mg $L^{-1}$ | 0.002155 | 0.000726 | 0.004380 | 0.000875 | 0.006845 | 0.001443 | 0.003900 | 0.000804 | 0.002430 | 0.000876 | 0.003820 | 0.000891 | 0.009010 | 0.001476 | 0.003600 | 0.000980 | 0.004815 | 0.001008 |
| Beryllium | mg $L^{-1}$ | 0.0000045 | 0.0000019 | 0.0000115 | 0.0000068 | 0.0000115 | 0.0000034 | 0.0000095 | 0.0000039 | 0.0000030 | 0.0000189 | 0.0000095 | 0.0000065 | 0.0000220 | 0.0000064 | 0.0000083 | 0.0000018 | 0.0000120 | 0.0000034 |
| Boron | mg $L^{-1}$ | 0.00165 | 0.00086 | 0.00225 | 0.00103 | 0.00195 | 0.00082 | 0.00215 | 0.00156 | 0.00015 | 0.00094 | 0.00130 | 0.00137 | 0.00215 | 0.00086 | 0.00140 | 0.00071 | 0.00140 | 0.00082 |
| Cadmium | mg $L^{-1}$ | 0.0000125 | 0.0000028 | 0.0000160 | 0.0000057 | 0.0000215 | 0.0000082 | 0.0000150 | 0.0000044 | 0.0000120 | 0.0000080 | 0.0000230 | 0.0000039 | 0.0000300 | 0.0000065 | 0.0000183 | 0.0000048 | 0.0000180 | 0.0000038 |
| Chromium | mg $L^{-1}$ | 0.0005675 | 0.0001607 | 0.0009800 | 0.0002058 | 0.0012800 | 0.0003330 | 0.0008900 | 0.0002270 | 0.0005700 | 0.0002303 | 0.0009000 | 0.0002274 | 0.0010300 | 0.0002344 | 0.0008600 | 0.0003877 | 0.0009850 | 0.0001937 |
| Cobalt | mg $L^{-1}$ | 0.0001145 | 0.0000375 | 0.0003980 | 0.0001795 | 0.0004315 | 0.0001405 | 0.0003835 | 0.0002020 | 0.0000600 | 0.0000310 | 0.0001890 | 0.0000427 | 0.0005020 | 0.0001506 | 0.0001258 | 0.0000466 | 0.0002230 | 0.0000900 |
| Copper | mg $L^{-1}$ | 0.00027 | 0.00033 | 0.00029 | 0.00028 | 0.00057 | 0.00031 | 0.00032 | 0.00008 | 0.00019 | 0.00006 | 0.00038 | 0.00010 | 0.00064 | 0.00016 | 0.00035 | 0.00013 | 0.00030 | 0.00012 |
| Iron | mg $L^{-1}$ | 0.63 | 0.28 | 1.37 | 0.52 | 1.81 | 0.89 | 1.16 | 0.54 | 1.52 | 0.67 | 1.62 | 0.39 | 2.34 | 0.63 | 2.17 | 0.60 | 1.94 | 0.75 |
| Lithium | mg $L^{-1}$ | 0.0005 | 0.0005 | 0.0015 | 0.0008 | 0.0005 | 0.0002 | 0.0010 | 0.0007 | 0.0005 | 0.0002 | 0.0045 | 0.0023 | 0.0100 | 0.0029 | 0.0005 | 0.0002 | 0.0008 | 0.0006 |
| Manganese | mg $L^{-1}$ | 0.02495 | 0.00641 | 0.04655 | 0.01714 | 0.04465 | 0.01466 | 0.04640 | 0.01828 | 0.02140 | 0.00628 | 0.02480 | 0.00180 | 0.01985 | 0.00229 | 0.01485 | 0.00419 | 0.02535 | 0.00843 |
| Mercury | mg $L^{-1}$ | 0.000001 | 0 | 0.000001 | 8.165E-07 | 0.000001 | 0 | 0.000001 | 8.165E-07 | 0.000001 | 1.3416E-06 | 0.000001 | 1.2247E-06 | 0.000001 | 0 | 0.000001 | 3.5355E-07 | 0.000001 | 0 |
| Molybdenum | mg $L^{-1}$ | 0.000035 | 0.000045 | 0.000050 | 0.000036 | 0.000035 | 0.000016 | 0.000040 | 0.000028 | 0.000020 | 0.000021 | 0.000060 | 0.000026 | 0.000080 | 0.000106 | 0.000038 | 0.000068 | 0.000040 | 0.000030 |
| Nickel | mg $L^{-1}$ | 0.000175 | 0.000092 | 0.000655 | 0.000169 | 0.000630 | 0.000156 | 0.000550 | 0.000118 | 0.000150 | 0.000066 | 0.000380 | 0.000113 | 0.001320 | 0.000336 | 0.000230 | 0.000115 | 0.000425 | 0.000120 |
| Lead | mg $L^{-1}$ | 0.000375 | 0.000132 | 0.000355 | 0.000131 | 0.000503 | 0.000170 | 0.000315 | 0.000124 | 0.000440 | 0.000151 | 0.000510 | 0.000102 | 0.000460 | 0.000137 | 0.000343 | 0.000064 | 0.000375 | 0.000121 |
| Selenium | mg $L^{-1}$ | 0.00004875 | 0.000169 | 0.0000775 | 0.0001828 | 0.000125 | 0.00016033 | 0.000225 | 0.00022796 | 0.00015 | 0.00008036 | 0.0000575 | 0.00019268 | 0.000275 | 0.00018521 | 0.00013 | 0.00012192 | 0.0001225 | 0.00015214 |
| Strontium | mg $L^{-1}$ | 0.00898 | 0.00389372 | 0.0171 | 0.00343492 | 0.02185 | 0.00663639 | 0.01635 | 0.00292552 | 0.0095 | 0.00343635 | 0.0115 | 0.00220162 | 0.02785 | 0.01402023 | 0.014475 | 0.00316808 | 0.01805 | 0.0043967 |
| Uranium | mg $L^{-1}$ | 0.0000025 | 0.0000058 | 0.0000145 | 0.0000063 | 0.0000205 | 0.0000064 | 0.000011 | 0.0000039 | 0.0000025 | 0.0000121 | 0.000013 | 0.000006 | 0.000044 | 0.0000212 | 0.0000138 | 0.0000047 | 0.000019 | 0.0000064 |
| Vanadium | mg $L^{-1}$ | 0.00001 | 0.00013 | 0.00001 | 0 | 0.00001 | 0.00007 | 0.00001 | 0 | 0.00001 | 0 | 0.00001 | 0.00027 | 0.00001 | 0 | 0.00001 | 0.00008 | 0.00001 | 0.00011 |
| Zinc | mg $L^{-1}$ | 0.0046 | 0.0009 | 0.0045 | 0.0007 | 0.0060 | 0.0019 | 0.0051 | 0.0013 | 0.0037 | 0.0015 | 0.0032 | 0.0010 | 0.0051 | 0.0026 | 0.0030 | 0.0011 | 0.0035 | 0.0008 |

### SURFACE WATER QUALITY CRITERIA

To put the natural concentrations observed in 2017 into context, they have been compared to the most stringent surface water quality criteria (CCME, 2017; MDDELCC, 2017*b*). These criteria are the following:

- MDDELCC:
  - Criterion to prevent the contamination of aquatic organisms (CPC[EO]);
  - Chronic aquatic life criterion (CVAC).
- Canadian Council of Ministers of the Environment (CCME):
  - Water quality recommendations (fresh water), protection of aquatic life – long-term effects.

### CONCENTRATIONS OBSERVED

In the study area, we found only two potential human sources of surface water contamination: a remote landfill and a truck stop with a gas station. Otherwise, the study area is natural and is not affected by any forms of pollution that originate directly from human activity. Considering the location and isolated nature of these potential sources of contamination, the concentrations of the different parameters measured in the surface water of the watercourses in the study area correspond to levels of natural origin.

#### *In situ* measurements

The physiochemical measurements were taken *in situ* using a multiparameter probe. The measured pH values varied between 3.37 and 6.27. The pH values were therefore lower than the two MDDELCC criteria and the CCME recommendation (between 6.5 and 9) at all the stations. These results show that the surface water is more acidic than the water quality recommendations/criteria. The nature of the soil in the study area is likely to explain these deviations. Flooding of vegetation and forest soil consumes dissolved oxygen and releases minerals and nutritious elements, including carbon dioxide ($CO_2$), which contributes to the acidification of water. This acidification also slows down the decomposition of organic material.

During campaigns 1, 2 and 4, the dissolved oxygen concentration varied between 0.94 and 9.30 mg/L. These concentrations are lower than the CCME recommendation for each sampled station. Values lower than the CCME recommendation and the MDDELCC'S CVAC criteria were also recorded at certain stations during other sampling campaigns. Similar to the pH measurements, the amount of dissolved oxygen is also outside of the bounds recommended by the CCME or the MDDELCC and can also be explained by the nature of the soil found in the area, which acidifies the surface water and decreases oxygen concentration.

#### Basic descriptors, major nutrients and ions

*Overview*

Based on the surface water analysis, the following observations can be made:

- Alkalinity is low, the median value is 0.75 mg/L. Therefore, this water can be qualified as fresh water. This fact explains the low ion concentrations that were observed.
- The number of suspended solids is low, with a median value of 3 mg/L, whereas the normal range is between 2 and 53 mg/L (MDDELCC, 2016).
- The amount of dissolved organic carbon is high, with a median value of 25.7 mg/L, whereas the normal range is between 2.3 and 11.2 mg/L (MDDELCC, 2016). These values can be explained by the ubiquitous presence of peatlands, which are an important source of organic carbon, within empty drainage basins.
- Water in these watercourses is clear, with a median value of 0.9 NTU, whereas the normal range is between 0.6 and 26 NTU (MDDELCC, 2016).
- The amount of all nutrients is low and all within the lower limits of the respective normal ranges for these parameters (MDDELCC, 2016).

#### *Comparison to applicable criteria*

During campaign 4 at station 4A, only one sample did not respect the CVAC criterion for nitrites. As this was a single sample and the concentrations of this element had been weak at other points in time and geographic locations, contamination cannot be excluded as an explanation of this excess. Sampling of nitrogenous elements is sensitive to external contamination.

Finally, except for nitrites at station 4A during campaign 4, the concentrations of basic descriptors were below the reference criteria for all stations and all sampling campaigns.

### Metals

#### *Overview*

The levels of dissolved metals were generally low. Of the 25 metals analyzed, aluminum, iron, manganese and strontium were found to have the highest levels.

The greatest concentration of aluminum (0.486 mg/L) was measured at Station 4A during the 6th campaign. The expected metal concentration range in surface water is between 0.012 and 2.25 mg/L (Jones and Bennett, 1986). Significantly, the same station had the highest concentration of arsenic observed (0.00316 mg/L) on two separate occasions, during the 2nd and 3rd campaigns.

Usually, in Canadian surface water, iron levels are less than 10 mg/L, but they can vary between 0.001 and 90 mg/L (NAQUADAT, 1985). The most significant level of iron (3.90 mg/L) was observed at Station 2A during the 3rd campaign.

Manganese levels in Canadian surface water vary between 0.01 and 0.4 mg/L (NAQUADAT, 1985). The highest median concentrations for this metal were observed at Stations 1B (0.04655 mg/L), 2A (0.04465 mg/L) and 2B (0.04640 mg/L).

Based on an American study (Skougstad and Horr, 1963), levels of strontium vary normally between 0.007 and 13.7 mg/L. The highest median concentration for this metal were observed at Stations 1B (0.171 mg/L), 2A (0.02185 mg/L), 2B (0.01635 mg/L), 3B (0.0115 mg/L) and 4A (0.02785 mg/L).

According to the different sources available, the concentration of dissolved minerals is within a natural range for Canadian surface water.

#### *Comparison to applicable criteria*

Concentrations of dissolved metals exceeding CCME and MDDELCC criteria were observed at nine sampling stations. Levels of aluminum, arsenic and iron exceeded the MDDELCC's CPC(EO) criterion at many stations. The is the most restrictive criteria. In addition, levels of aluminum and iron do not respect CCME recommendations in most samples. Table 6-14 indicates the number of cases of exceeded criteria and recommendations.

The natural content of beryllium and lead in the surface water of the study area seems generally higher than the MDDELCC's CVAC criterion since the concentration of these metals exceeded this criterion's threshold in many samples.

The highest concentration of beryllium (0.000027 mg/L) was measured at Station 1B during the first campaign. Station 2A had the highest concentration of lead (0.00079 mg/L) during the 3rd campaign.

In total, five metals exceeded one and/or both MDDELCC and/or CCME recommended criteria in the majority of samples collected at different stations. In fact, in addition to beryllium and lead, most of the collected samples indicated that the natural concentration of aluminum, arsenic and iron in surface water is greater than at least one criterion of water quality. There does not appear to be any variation between seasons, although mercury concentration exceeded the MDDELCC's CPC(EO) criterion only during the first sampling campaign in June 2017.

In addition, seven samples exceeded the CPC(EO) criterion for manganese over the six campaigns at different stations, and five more samples for mercury, but only in June.

**Table 6-14 Number of surface water samples exceeding criteria**

| Parameter | Number of samples exceeding criteria CPC(EO) | CVAC | CCME |
|---|---|---|---|
| **Physicochemical parameters (*in situ*)** | | | |
| Oxygen | - | 14 | 24 |
| pH | 32 | 32 | 32 |
| **Nutrients** | | | |
| Nitrites | 0 | 1 | 0 |
| **Trace metals** | | | |
| Aluminium | 45 (5 duplicates) | 0 | 56 (5 duplicates) |
| Arsenic | 55 (4 duplicates) | 0 | 0 |
| Beryllium | 0 | 41 (3 duplicates) | 0 |
| Iron | 58 (5 duplicates) | 6 (1 duplicate) | 58 (5 duplicates) |
| Manganese | 7 | 0 | 0 |
| Mercury | 5 | 0 | 0 |
| Lead | 0 | 58 (5 duplicates) | 0 |

Notes: CPC(EO) – *Critère de prévention de la contamination de l'eau ou des organismes aquatiques* (Criterion to prevent the contamination of aquatic organisms).
CVAC - *Critère de vie aquatique chronique* (Chronic aquatic life criterion).
CCME – Canadian Council of the Ministers of the Environment.

#### RADIONUCLIDES

A radionuclide analysis of surface water was carried out in May 2018 on two separate samples taken in creeks CE2 and CE3. Only uranium 234 and 238 and thorium 228 were detected. The results show that radionuclide levels are below the standards prescribed by Canadian guidelines for managing naturally occurring radioactive materials.

#### SEASONAL VARIATIONS

For basic descriptors, turbidity and suspended solids (SS) show similar trends. Some increase in concentrations for these parameters can be observed in late July and September.

In terms of nutrients, total nitrogen showed the same overall trend over the six campaigns. Nitrite levels generally increased in September and then declined in October and November. Phosphorus levels remained relatively constant throughout the period.

No particular trend can be detected for major ions. However, carbonate, calcium, magnesium and sodium showed stable levels over the entire sampling period.

Finally, for trace metals, elements that vary in their levels over time are antimony, beryllium, boron, cobalt, copper, molybdenum and selenium. However, no real trend is noticeable.

### *6.2.8.2 GROUNDWATER QUALITY*

This section presents the main characteristics of groundwater quality in the study area. The comparison between the results obtained and recognized groundwater quality criteria establishes a baseline for the quality of groundwater in the study area. The Hydrogeological Technical Study (*L'étude spécialisé sur l'hydrogéologie*) (WSP, 2018*a*) details the methodology, work and the results.

### METHODOLOGY

A total of 36 groundwater samples were collected from 20 observation wells or piezometer installations to determine the current status (baseline condition before work) of the site's hydrogeological environment. Sampling work was done in three separate campaigns. Sample wells and test dates are listed in Table 6-15 and shown on Map 6-5.

**Table 6-15 List of sampled wells**

| Survey | Test date | Survey | Test date |
|---|---|---|---|
| PO1 | 2017-08-31 | WSP-MW4S | 2017-08-31 |
| | 2018-05-04 | | 2018-05-05 |
| PO2 | 2017-08-31 | WSP-MW5R | 2018-05-05 |
| | 2018-05-04 | | 2018-02-04 |
| WSP-PW03 | 2017-08-31 (1) | WSP-MW5S | 2018-05-05 |
| | 2017-08-31 (2) | | 2018-02-04 |
| | 2017-08-31 (3) | WSP-MW6R | 2017-08-31 |
| | 2018-02-04 | | 2018-05-04 |
| | 2018-05-05 | WSP-MW7R | 2018-05-03 |
| WSP-MW1R | 2018-05-03 | | 2018-02-04 |
| WSP-MW2R | 2018-05-05 | WSP-MW8R | 2018-05-03 |
| WSP-MW2S | 2018-05-05 | | 2018-02-05 |
| | 2018-02-04 | WSP-MW8S | 2018-05-03 |
| WSP-MW3R | 2018-05-03 | WSP-MW9R | 2018-05-04 |
| | 2018-02-04 | WSP-MW9S | 2018-05-04 |
| WSP-MW3S | 2018-05-03 | BH-10R | 2018-05-02 |
| | 2018-02-04 | BH-10S | 2018-05-02 |
| WSP-MW4R | 2017-08-31 | | |
| | 2018-05-05 | | |

### Analytical program

The choice of parameters was based on the risks associated with the use of the site and on the requirements of D019 (MDDEP, 2012). Groundwater samples were analyzed for one or more of the following:

— inorganic compounds (total cyanides, fluorides, nitrates, nitrites, total sulphides);
— C10-C50 petroleum hydrocarbons (PH);
— major ions (bicarbonates, calcium, carbonates, chlorides, magnesium, potassium, sodium and sulphates);
— dissolved metals (scanned);
— acid-soluble metals (pumping test);
— physiochemical parameters (alkalinity, conductivity, hardness, suspended solids, pH, total dissolved solids);
— radionuclides (U-238, U-234, Ra-226, Pb-210, Th-232, Ra-228 and Th-228) – 2 samples.

#### Water quality criteria

Considering the groundwater at the study site could end up in surface water, the results of chemical analysis were compared to the criteria for resurgence in surface water, or RSW (*résurgence dans les eaux de surface,* or RES) in the *Guide d'intervention: Protection des sols et réhabilitation des terrains contaminés* from the MDDELCC (Beaulieu, 2016). Potential recipients are streams and lakes. RSW quality criteria are calculated from the *Critères de qualité de l'eau de surface au Québec* (Surface water quality criteria in Quebec) (MDDEFP, 2013). The value selected for each parameter corresponds to the lowest of the following four values:

- 1 X CVAA - *Critère de vie aquatique aiguë* (Acute aquatic life criterion)
- 100 X CVAC - *Critère de vie aquatique chronique* (Chronic aquatic life criterion)
- 100 X CPCO - *Critère de prévention de la contamination des organismes aquatiques* (Criterion to prevent the contamination of aquatic organisms)
- 100 X CFTP - *Critère de faune terrestre piscivore* (Fish-eating wildlife criterion)

The MDDELCC has established groundwater threshold alerts at concentrations that predict resource loss and risk to health, consumption and the environment. For a site located upstream of a body of water, the MDDELCC imposes a threshold equal to 50% of the value of RSW criteria. Since the study site is less than 1 km from several streams and lakes, a threshold alert of 50% was applied.

### RESULTS

#### Physicochemical parameters

Conductivity, pH, dissolved oxygen and temperature measurements were taken *in situ* using a YSI probe during well sampling. The pH values measured in groundwater samples ranged from 4.38 to 8.98. The lowest pH of 4.38 was recorded in the WSP-MW8S well during the May 2018 campaign; and the highest pH of 8.98 was recorded in the MW05R well in February 2018. Electrical conductivity levels are generally low and range from 4 µS/cm to 543 µS/cm, indicating that the water in the study area is low in minerals. Conductivity tends to be lower in groundwater coming from unconsolidated deposits and higher in water from rock wells. Temperatures measured during the various sampling campaigns varied between 0°C and 10°C.

#### Major ions

Analyzing major ions makes it possible to describe different types of groundwater and compare water quality. The Piper diagram illustrates the similarities and differences between water samples and provides correlations. Figure 6-3 shows the proportion of major ions for all sampled wells. Generally, wells located in recharge areas have higher proportions of carbonates and calcium. When the waters have been in contact for awhile with the geological formations, chlorides, sulphates, sodium and/or potassium enrichment occurs downstream. Most samples from rock wells and wells in unconsolidated deposits have a similar geochemical signature, i.e., $Ca^{2} + Mg^{2+}/HCO_3$ (calcium and magnesium bicarbonate) water types. Five samples (PW03 [3], MW5R and MW2R) have a sodium and potassium bicarbonate geochemical signature and a sample (MW5R) consists of sodium and potassium sulfate.

#### Metals

Of the samples analyzed during the sampling campaigns, 15 exceeded the RSW criteria for one or another of the following metals: silver, copper, manganese and zinc. In addition, 15 additional samples exceeded the alert threshold for one or another of the following metals: silver, barium, copper, manganese and zinc.

If we compare the results with drinking water criteria, some metals would exceed the criteria or recommendations. These are mainly arsenic (all samples exceed criteria except for three samples taken from unconsolidated deposits), aluminum and manganese.

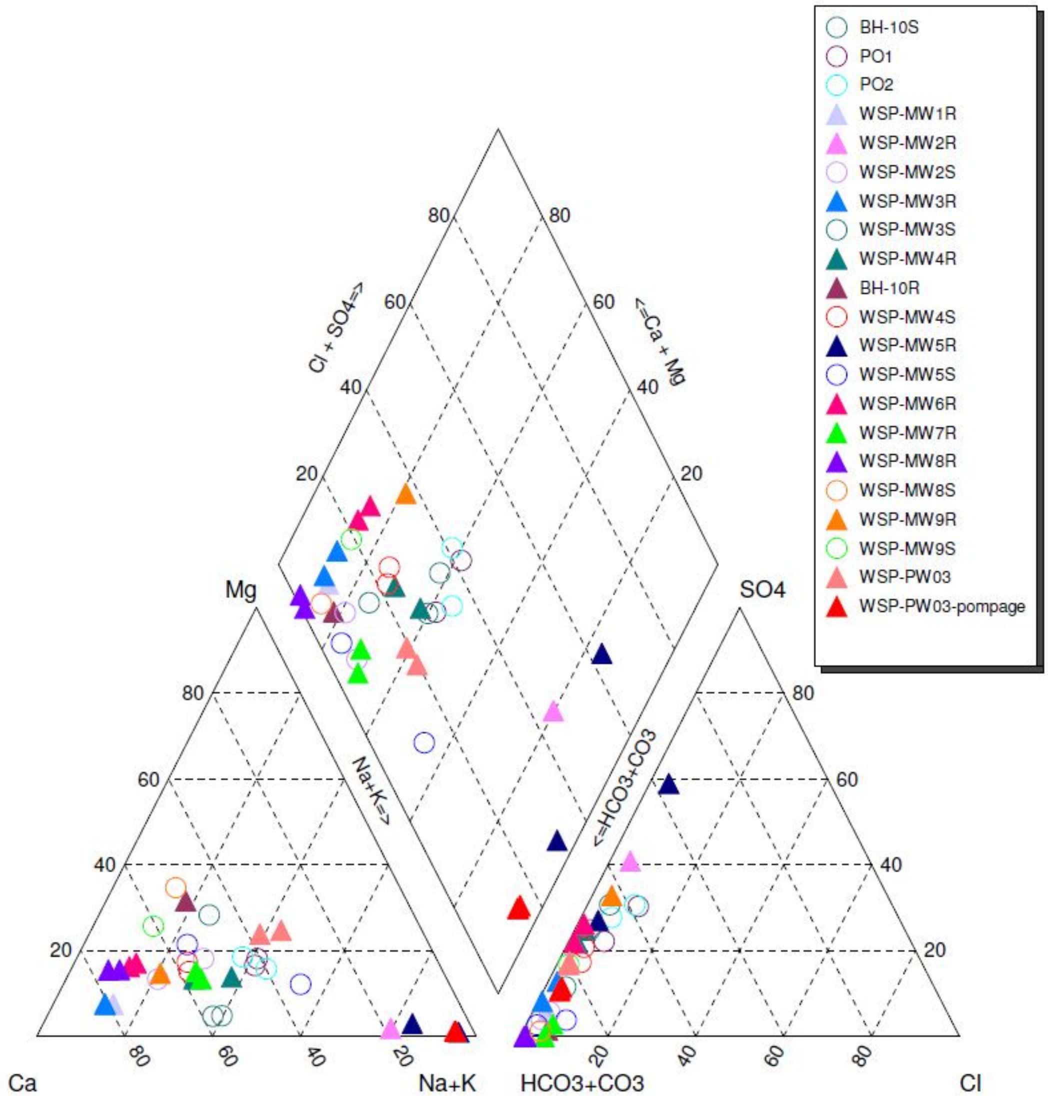



**Figure 6-3 Ternary diagram showing the amounts of major ions in each of the groundwater samples**

Table 6-16 shows the number of threshold alerts exceeded and the RSW and drinking water sample criteria.

### Table 6-16 Number of analyzed groundwater samples exceeding criteria

| Parameter (TA/RSW/DW µg/l criteria) | 2017–2018 campaign | | |
|---|---|---|---|
| | Threshold Alerts (TA) | Resurgence in surface water (RSW) | Drinking water (DW) |
| Aluminium (- / - /100) | - | - | 12/36 |
| Silver (0.015/0.03/100) | 4/36 | 1/36 | 0 |
| Arsenic (170/340/0.3) | 0 | 0 | Only three samples were below drinking water criterion. |
| Barium (54/108/1000) | 3/36 | 0 | 0 |
| Copper (0.75/1.5/1000) | 28/36 | 9/36 | 0 |
| Manganese (275.5/551/50) | 8/36 | 5/36 | 12/36 |
| Zinc (8.5/17/5000) | 8/36 | 2/36 | 0 |

#### Other parameters

Ammonia nitrogen, cyanides, fluorides, nitrates, nitrites and total sulphides were analyzed in all samples. All samples had a concentration below RSW criteria or the laboratory's detection limit.

#### Radionuclides

The various natural radionuclides, and their levels in the water, depend on the geological nature of the watershed and subsoil. Natural levels found in groundwater are due to the levels of radionuclides found in geological formations. Radionuclide analysis was conducted in February and May 2018 on two groundwater samples from wells intercepting different geological units, WSP-PW03 and WSP-MW7R. The levels of radium-228, thorium-230, radium-226, lead-210 and potassium-40 were all below detection limits. For thorium-232, levels were below the detection limit in WSP-PW03 and 0.01 Bq /L in WSP-MW7R. For uranium-234 and uranium-238, levels ranged from 0.001 to 0.02 Bq /L. For thorium-228, the levels varied between 0.5 and 0.6 Bq /L.

### NATURAL BACKGROUND LEVELS

From the statistical analysis results, metal natural background levels (NBLs) were evaluated. The calculated values offer an initial concentration that represents the natural environment before development.

Parameters for which natural background levels were assessed are aluminum, arsenic, barium, copper, iron, lithium, manganese, **nickel, lead** and zinc. Copper, barium, manganese and zinc exceeded the RSW or threshold alert and more than 50% of the samples were above the laboratory's limit of detection (LOD). **Arsenic, nickel and lead did not exceed RSW or threshold alert criteria, but the background level gave a representative picture of the study site. Aluminium, iron and lithium did not** have any RSW or threshold alert criteria, but the results provided an estimate of the natural levels.

Using the Shapiro-Wilk test, an evaluation of the normality determined that all the above parameters followed a normal or log normal distribution. **The summary of the background levels measured is presented in Table 6-17.**

**Table 6-17 Calculation of natural background levels of metals in groundwater**

| Parameter/Lithology unit | Natural background levels (µg/L) | |
|---|---|---|
| | Unconsolidated deposits (till) | Rock |
| Aluminium | **284.2** | **182.0** |
| Arsenic | **7.8** | **94.1** |
| Barium | 30.9 | 32.4 |
| Copper | **1.4** | **2.6** |
| Iron | 3,399 | 1,993 |
| Lithium | 8.8 | 266.1 |
| Manganese | **295.5** | **327.2** |
| Nickel | 3.3 | 3.2 |
| Lead | 0.2 | 0.1 |
| Zinc | **10.3** | **8.7** |

*LEGEND:*

**100** : Calculated NBL Value > RSW Criterion

**100** : Calculated NBL Value > Threshold Alert

**100** : Calculated NBL Value > Criterion / Drinking Water Recommendation

#### Anticipated exceedances

Depending on the analysis performed, barium, copper, manganese and zinc may on occasion exceed the RSW criterion or the threshold alert in some wells. For silver, the concentrations show that natural levels could exceed the criteria. However, the number of analyses with concentrations below detection limits was too great to perform a statistical analysis for this parameter.

## 6.2.9 SOIL AND SEDIMENT QUALITY

### 6.2.9.1 SOIL

#### NATURAL BACKGROUND LEVELS

Evaluation of soil quality in the study area was based mainly on *Lignes directrices sur l'évaluation des teneurs de fond naturelles dans les sols* (Ouellette, 2012) and on *Guide de caractérisation physicochimique de l'état initial des sols avant l'implantation d'un projet industriel* (MDDELCC, 2015). Natural background levels (NBLs) were determined based on soil samples taken at **114** soil sampling sites (**66** exploration trenches and 10 drilling sites) spread out over the study area (Map 6-4).

The surveys were conducted in areas unaffected by anthropogenic activities, based on available information. In addition, samples were taken from natural, undisturbed stratigraphic units. The **updated** Soil Background Concentration Technical Study *(L'Étude spécialisée sur la teneur de fond naturelle dans les sols)* (WSP, **2021a**) details the methodology used, the work carried out and the results obtained.

Four stratigraphic units are frequently found in the natural soils of the study area. First, a horizon of topsoil or peat is present at the surface. Beneath this unit, the natural soils are made up of an alternation of three main stratigraphic units. The first is composed of coarse sand to sand and gravel, containing pebbles and sometimes blocks. The second unit is composed of fine sand to silty sand, containing a little gravel in places. Last, a third unit of silt to clayey silt is sometimes found, mainly at depths. Thus, the calculations leading to the determination of NBLs were conducted using analysis results obtained on stratigraphic units described as being coarse sand (**74** samples) and fine sand (**50** samples), these being more widespread and thus most representative of the soils in the study area.

A separate statistical analysis was performed on the two stratigraphic units considered—the coarse sand unit and the fine sand unit—to establish the background levels. This analysis was carried out based on the analysis results of total metal contained in the soil samples. The NBLs were assessed based on the statistical analysis. The calculated values provided an initial level representative of the natural environment. Because of the substantial proportion of samples below the laboratory limit of detection (LOD), the following parameters were excluded from the analysis: **antimony, silver, arsenic, cadmium, chromium, cobalt, copper, tin, mercury, molybdenum, nickel, lead and selenium**.

**The statistical analysis was thus performed for aluminum, barium, calcium, iron, lithium, magnesium, manganese, potassium, titanium and vanadium. Silicon, sodium, strontium and zinc were also analyzed, but only for the coarse sand unit.**

**Normal background levels were calculated for these parameters using the upper whisker method.** The NBL was **also** assessed for each parameter analyzed by setting the upper confidence limit at 95% of the **95th** percentile of the distribution of levels. For the parameters for which an adjusted NBL was not calculated, the generic criterion "A" of the *Guide d'intervention* was set as the natural background level. The results obtained are presented in Table 6-18.

**The results of the chemical analyses obtained on the coarse sand unit samples showed levels higher than the background levels established for the Superior Geological Province (generic "A" criteria) for two parameters: arsenic (two samples) and hexavalent chromium (six samples). For hexavalent chromium (Cr VI), two samples showed levels that fell between two criteria—"B" and "C"—and four samples showed levels above the "C" criterion. For the fine sand unit, the chemical analysis results also showed concentrations above generic "A" criteria for arsenic (two samples) and above the "B" criterion for Cr VI (one sample).** For all the other parameters analyzed, no generic criterion is defined in the MDDELCC Guide.

### CONCENTRATION IN HEXAVALENT CHROMIUM

**During the 2018 characterization, three analyzed samples showed Cr VI levels that fell between the "B" and "C" criteria and four showed Cr VI levels above the "C" criterion. After these were detected, the MELCC requested a special analysis for Cr VI in order to define the extent of its presence in the soil (WSP, 2021b).**

In 2020, **concentric samples were taken around three trenches that showed levels of hexavalent chromium that exceeded the Guide d'intervention's generic "B" criterion in 2018. All samples collected from a 50 m radius around the three trenches showed hexavalent chromium levels below the Guide d'intervention's generic "A" criterion, when analyzed using ion-exchange chromatography. It is possible that levels detected in samples during characterization in 2018 can be attributed, in full or in part, to interference from the method of analysis used (colorimetry).**

**It therefore seems reasonable to conclude that the higher Cr VI concentrations obtained in 2018 can be attributed to false positives from the method, or at least, that the results of this additional characterization demonstrate that this higher hexavalent chromium level, if it existed, was an isolated event limited to three sectors investigated. Consequently, there is no reason to believe that there is a hexavalent chromium problem on the site.**

### REMOTE LANDFILL

A Phase II Environmental Site Assessment (ESA) was done in summer 2017 at the remote landfill close to the project site (Map 6-4) (WSP, 2018d). According to the results of the assessment, the estimated volume of buried residual materials (paper, plastic, metal, wood, fabric) is 756 $m^3$.

Soils with levels of $C_{10}$-$C_{50}$ petroleum hydrocarbons and total sulphur exceeding the generic "A" criteria of the MDDELCC *Guide d'intervention* and with levels of metals exceeding the limits set out in Schedule I of the *Regulation respecting the landfilling and incineration of residual materials* (RLIRM) were updated during the work. These soils, the preliminary volume estimate of which is approximately 3,000 $m^3$, are in contact with the residual materials of the remote landfill and are considered non-compliant for an industrial site because of their level of lead.

Also, soils whose surface level of chromium VI lay in the "B-C" range of the generic criteria were also updated in the survey performed at the base of a heap of treated-wood poles. The volume associated with this type of contamination was assessed at 5 $m^3$.

## Table 6-12 Calculation of background levels of metals in soils

| Parameter/Lithological unit | Natural background level (mg/kg) | |
|---|---|---|
| | Coarse sand unit | Fine sand unit |
| Aluminum | **12,535.0** | **6,060.5** |
| Antimony | - | - |
| Silver | 0.5 | 0.5 |
| Arsenic | 5 | 5 |
| Barium | **50** | **27.5** |
| Cadmium | 0.9 | 0.9 |
| Calcium | **2,410.0** | **3,238.3** |
| Chromium | 100 | 100 |
| Cobalt | 30 | 30 |
| Copper | 65 | 65 |
| Tin | 5 | 5 |
| Iron | **14,118.0** | **11,725.0** |
| Lithium | **10.5** | **8.9** |
| Magnesium | **4,455.0** | **3,106.5** |
| Manganese | **146.6** | **108.0** |
| Mercury | 0.3 | 0.3 |
| Molybdenum | 8 | 8 |
| Nickel | 50 | 50 |
| Lead | 40 | 40 |
| Potassium | **1,528.8** | **1,189.1** |
| **Silicon** | **1,356.3** | - |
| Selenium | 3 | 3 |
| Sodium | **127.5** | - |
| **Strontium** | **12.5** | - |
| Titanium | **823.8** | **690.5** |
| Vanadium | **27.5** | **15** |
| Zinc | **12.5** | 150 |

*LEGEND:*

100 : NBL value = *Guide d'intervention* criterion "A"

100 : NBL value calculated using **the upper whisker method**

### 6.2.9.2 SEDIMENTS

This section presents the main characteristics of sediments quality in watercourses in the study area, to determine their current contamination level based on various criteria of sediment quality recognized by the provincial and federal governments. In each watercourse, a sampling station made up of five substations was established. The location of stations is shown on Map 6-8. The Aquatic Inventory and Baseline Study (*Étude spécialisée sur l'habitat aquatique*) (WSP, 2018*c*) provides details of the methodology used, the work carried out and the results obtained.

**Two complementary sediment sampling campaigns were done after the 2018 Aquatic Inventory and Baseline Study. Additional sediment samples were collected in September 2019 to analyze sulphur levels, since this parameter had been omitted in the 2018 study. Samples were also collected from two additional stations in July 2020— CE2-C and CE2-D—in order to have three stations exposed downstream of the effluent, as recommended by the MELCC.**

#### GRANULOMETRY

In all the granulometric analyses performed, samples were generally dominated by the fraction associated with sand, except for **four** samples taken from creek CE2 (station 2A, sample CE-2A-3: 47.9%; station 2B, sample CE-2B-2: 26.4%; **station 2C: 23.3%; and station 2D: 24.4%**) and one taken from creek CE5 (station 5B, sample CE-5B-5: 43.0%). The proportions of sand varied from 41.0% (station 2B, sample CE-2B-3) to 89.1% (station 2B, sample CE-2B-5). On average, the samples were composed of approximately **58%** sand, **26%** silt and clay and **16%** gravel.

The granulometry of some samples from creeks CE2 to CE5 could not be determined because they were composed exclusively of organic material (peat). These were samples CE-3A-1 to CE-3A-5, CE-3B-1 to CE-3B-5, CE-2A-4, CE-2B-1, CE-5B-3 and CE-5B-4, as well as the sample from creek CE4.

#### CHEMICAL CHARACTERISTICS

Tables 6-19 and 6-20 present statistics describing the levels measured in sediments as well as the sediment quality criterion.

The analysis results were compared with the sediment quality criteria of ECCC and the MDDELCC (Environment Canada and MDDEP, 2007) and Canadian sediment quality guidelines from the CCME. The criteria and recommendations are:

- ECCC and MDDELCC:
  - rare effect level (REL);
  - threshold effect level (TEL);
  - occasional effect level (OEL);
  - probable effect level (PEL);
  - frequent effect level (FEL).
- CCME:
  - interim sediment quality guidelines (ISQGs);
  - threshold effect level (TEL).

##### Integrative parameters

The analysis results for total oils and greases ranged from below the detection level at station 5B (sample CE-5B-5) to 11,830 mg/kg at station 3A (CE-3A-2). The average value of samples analyzed was **1,949.3** mg/kg, but the standard deviation was relatively large (**2,626.65** mg/kg). With regard to petroleum hydrocarbons, the results were below the detection limit at several stations and the maximum value was 940 mg/kg at station 5B (sample CE-5B-1). The average value was **151.44** mg/kg and the standard deviation was **200.37** mg/kg.

At Asiyan Akwakwatipusich Lake, the total oil and grease level was 937 mg/kg and below the detection limit for petroleum hydrocarbons. No sign of past contamination was visible. However, it is plausible that this contamination might come from the road lying upstream of this lake.

No criterion or guideline is provided for total oils and grease or for petroleum hydrocarbons ($C_{10}$-$C_{50}$).

**The presence of $C_{10}$-$C_{50}$ petroleum hydrocarbons can generally be explained by a spill occurring further upstream contaminating sediment, but may also be a false positive when the soil analyzed is rich in organic matter. When soil with high organic matter content is analyzed for $C_{10}$-$C_{50}$ PH, the measured concentration may be overestimated. Soil that is rich in natural organic compounds can contain, among other things, hydrocarbons that are not from petroleum (biogenic hydrocarbons), but that interfere in the $C_{10}$-$C_{50}$ chromatographic region, despite purification steps required in the analytical method. This possibility means that certain results may turn out to be false positives (MDDELCC, 2016).**

#### Inorganic parameters

Total organic carbon (TOC) values measured ranged from 0.38% at station 5B (sample CE-5B-5) to 90.70% at station 3A (sample CE-3A-2). The average value was 16.67%. The average humidity of the samples analyzed was 55.66%. The total sulphur values measured ranged from below the detection limit at station 2A (sample CE-2A-1) to 16,700 mg/kg at station 3B (sample CE-3B-2). The average value was 1,481 mg/kg. At Asiyan Akwakwatipusich Lake, the TOC level was 2.9%.

There is no criterion or guideline for TOC and humidity.

#### Trace elements and heavy elements

Analysis results for thallium showed levels below the detection limit. Analysis results for titanium showed the greatest variability, with values ranging from **20** mg/kg at station 3**A** (sample CE-3**A-2**) to **4,060** mg/kg at station **2D** (sample CE-**2D-D**), with an average of **611** mg/kg and a standard deviation of **774** mg/kg.

At Asiyan Akwakwatipusich Lake, the highest level was for titanium (932 mg/kg) and the lowest for thallium (7.5 mg/kg).

As with the integrative parameters and inorganic parameters, no criterion or guideline is defined for trace elements and heavy elements.

#### Metals and metalloids

Arsenic levels ranged from 0.75 mg/kg (half the detection limit) to 115 mg/kg for the sample from creek CE4. The average was **13.09** mg/kg, while the standard deviation was **22.04** mg/kg. Thus, up to **29** samples containing natural levels above the rare effects level (REL) criterion were observed. This is the most restrictive criterion, set at 4.1 mg/kg. Arsenic is the substance showing the greatest number of natural levels above the corresponding criterion.

Total chromium levels measured ranged from 1 mg/kg (half the detection limit) to **89** mg/kg (station 2**D**, sample CE-**2D-D**). The average was 2**8.20** mg/kg, while the standard deviation was **22.73** mg/kg. Comparing the samples against the REL criterion, total chromium presented **14** values above the criterion, which is set at 25 mg/kg for this substance.

Cadmium values ranged from 0.15 mg/kg (half the detection limit) to **1.0** mg/kg **for the sample from creek CE4**. Thus, **ten** samples presented natural levels above the REL criterion.

**Mercury levels ranged from 0.01 mg/kg (half the detection limit) to 0.20 mg/kg (station 5B, sample CE-5B-4). Four of these samples presented levels above the REL criteria.**

Lead levels ranged from 2.5 mg/kg (half the detection limit) to 46 mg/kg (station 5A, sample CE-5A-5). Three samples presented levels above the REL criteria. Copper levels ranged from 2.5 mg/kg (half the detection limit) to 33 mg/kg (station 3B, sample CE-3B-4). **Three** of these samples presented levels above the REL criterion.

**Zinc levels ranged from 5 mg/kg (half the detection limit) to 82 mg/kg (station 2D, sample CE-2D-D). Just one of these samples presented levels above the REL criterion.**

For Asiyan Akwakwatipusich Lake, the cadmium level was 0.45 mg/kg, above the REL criterion. Total chromium level was 48 mg/kg, above the TEL criterion. Finally, the mercury level was 0.1 mg/kg, thus above the REL criterion.

#### Radionuclides

An analysis of radionuclides was performed on sediments taken at stations 3B and 5B. This was performed on a homogenate of five samples taken from each station. This led to the finding that radionuclide levels were below the standards set out in the Canadian guidelines for the management of naturally occurring radioactive materials. For Asiyan Akwakwatipusich Lake, only radium 226 in sediments was analyzed in 2012. The level of this substance was below the Canadian guidelines for the management of naturally occurring radioactive materials (WSP, 2018*c*).

## Table 6-19 Average and standard deviation of levels measured in sediments

| | | CE-2A | | CE-2B | | **CE-2C** | | **CE-2D** | | CE-3A | | CE-3B | | | CE-5A | | CE-5B | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Substances | CE-1A | Average | Standard deviation | Average | Standard deviation | **Average** | **Standard deviation** | **Average** | **Standard deviation** | Average | Standard deviation | Average | Standard deviation | CE-4 | Average | Standard deviation | Average | Standard deviation |
| **Metals and metalloids** | | | | | | | | | | | | | | | | | | |
| Aluminum (mg/kg) | 3,500 | 5,336 | 2,162 | 4,634 | 1,825 | **6,249** | **693** | **21,160** | **7,969** | 2,035 | 1,185 | 2,884 | 2,113 | 2,580 | 3,658 | 447 | 4,436 | 2,297 |
| Antimony (mg/kg) | 3.5 | 4 | 0 | 4 | 1 | **3.5** | **0** | **3.5** | **0** | 4 | 0 | 4 | 1 | 3.5 | 4 | 0 | 4 | 1 |
| Silver (mg/kg) | 0.25 | 0.25 | 0 | 0.25 | 0 | **0.25** | **0** | **0.25** | **0** | 0.25 | 0 | 0.25 | 0 | 0.25 | 0.25 | 0 | 0.25 | 0 |
| Arsenic (mg/kg) | 5.1 | 10.2 | 3.9 | 0.8 | 1.3 | **8.6** | **3** | **5.4** | **0.4** | 7.9 | 3.6 | 2.4 | 1.7 | 115.0 | 45.1 | 33.2 | 4.7 | 11.7 |
| Barium (mg/kg) | 27 | 51 | 20 | 31 | 8 | **40** | **5** | **114** | **5** | 24 | 11 | 22 | 12 | 23 | 17 | 9 | 30 | 15 |
| Beryllium (mg/kg) | 0.5 | 0.5 | 0 | 0.5 | 0 | **0.5** | **0** | **0.5** | **0** | 0.5 | 0 | 0.5 | 0 | 0.5 | 0.5 | 0 | 0.5 | 0 |
| Bismuth (mg/kg) | 2.5 | 2.5 | 0 | 2.5 | 1 | **7.5** | **0** | **7.5** | **0** | 2.5 | 0 | 2.5 | 1 | 2.5 | 7.0 | 5 | 2.5 | 1 |
| Boron (mg/kg) | 5 | 6 | 2 | 5 | 1 | **5** | **0** | **5** | **0** | 11 | 4 | 6 | 2 | 14 | 254 | 155 | 5 | 61 |
| Cadmium (mg/kg) | 0.15 | 0.15 | 0 | 0.15 | 0 | **0.15** | **0** | **0.75** | **0.05** | 0.15 | 0 | 0.15 | 0 | 1 | 0.66 | 0 | 0.15 | 0 |
| Calcium (mg/kg) | 948 | 2,722 | 1,209 | 1,788 | 521 | **5,714** | **1,771** | **3,806** | **82** | 7,678 | 2,556 | 3,980 | 1,768 | 12,400 | 1,289 | 4,540 | 2,373 | 1,276 |
| Total chromium (mg/kg) | 14 | 26 | 11 | 23 | 9 | **24.5** | **3** | **83** | **3** | 12 | 8 | 15 | 11 | 9 | 25 | 10 | 23 | 9 |
| Cobalt (mg/kg) | 2 | 3 | 2 | 3 | 1 | **2.75** | **1** | **11** | **0** | 2 | 1 | 2 | 1 | 1.5 | 2 | 0 | 3 | 2 |
| Copper (mg/kg) | 9 | 15 | 6 | 3 | 2 | **4.25** | **1** | **21** | **2** | 11 | 6 | 15 | 11 | 7.0 | 3 | 2 | 6 | 4 |
| Tin (mg/kg) | 2.5 | 2.5 | 0 | 2.5 | 1 | **2.5** | **0** | **2.5** | **0** | 2.5 | 0 | 2.5 | 1 | 2.5 | 2.5 | 0 | 2.5 | 1 |
| Iron (mg/kg) | 5,240 | 8,658 | 3,114 | 7,382 | 2,495 | **16,538** | **1,702** | **35,020** | **16,366** | 11,984 | 3,505 | 6,418 | 3,527 | 12,700 | 275,000 | 155,372 | 7,448 | 60,434 |
| Magnesium (mg/kg) | 1,610 | 2,658 | 910 | 2,568 | 952 | **2,146** | **426** | **13,180** | **4,655** | 779 | 549 | 924 | 948 | 576 | 208 | 258 | 2,374 | 1,101 |
| Manganese (mg/kg) | 53 | 107 | 41 | 84 | 25 | **142** | **35** | **445** | **103** | 100 | 32 | 56 | 35 | 27 | 265 | 223 | 88 | 60 |
| Mercury (mg/kg) | 0.04 | 0.02 | 0.01 | 0.01 | 0.00 | **0.09** | **0** | **0.01** | **0** | 0.05 | 0.06 | 0.08 | 0.04 | 0.09 | 0.01 | 0.03 | 0.05 | 0.08 |
| Molybdenum (mg/kg) | 1 | 1.0 | 0 | 1.0 | 0 | **1.0** | **0** | **1.0** | **0** | 1.0 | 0 | 2.0 | 2 | 27 | 1.0 | 11 | 1.0 | 4 |
| Nickel (mg/kg) | 6 | 11 | 4 | 8 | 3 | **8** | **1** | **34** | **2** | 5 | 3 | 6 | 5 | 7 | 3 | 3 | 9 | 4 |
| Lead (mg/kg) | 2.5 | 8.7 | 4.5 | 2.5 | 0.8 | **8** | **2** | **8** | **0** | 3.4 | 1.8 | 3.6 | 2.3 | 5.0 | 28.8 | 16.7 | 3.4 | 5.7 |
| Potassium (mg/kg) | 815 | 1,557 | 635 | 1,048 | 317 | **980** | **190** | **7,530** | **2,727** | 121 | 317 | 440 | 530 | 131 | 41 | 47 | 1,114 | 537 |
| Silicon (mg/kg) | 357 | 406 | 99 | 367 | 120 | **590** | **29** | **628** | **218** | 469 | 267 | 547 | 188 | 396 | 833 | 386 | 358 | 69 |
| Selenium (mg/kg) | 0.5 | 0.5 | 0 | 0.5 | 0 | **0.25** | **0** | **0.25** | **0** | 0.7 | 0 | 0.5 | 0 | 0.5 | 1.1 | 1 | 0.8 | 1 |
| Sodium (mg/kg) | 60 | 136 | 55 | 113 | 47 | **362** | **151** | **1,308** | **288** | 55 | 10 | 106 | 61 | 104 | 27 | 35 | 60 | 22 |
| Zinc (mg/kg) | 17 | 42 | 15 | 10 | 7 | **38** | **10** | **75** | **5** | 13 | 7 | 10 | 6 | 12 | 13 | 10 | 14 | 6 |
| **Integrative parameters** | | | | | | | | | | | | | | | | | | |
| Total oils and greases (mg/kg) | 501 | 857 | 311 | 384 | 122 | **1,481** | **879** | **150** | **0** | 5,676 | 3,904 | 5,488 | 1,908 | 4,420 | 367 | 1,660 | 557 | 544 |
| Petroleum hydrocarbons (C10 to C50) (mg/kg) | 50 | 365 | 246 | 50 | 80 | **50** | **0** | **50** | **0** | 266 | 210 | 141 | 103 | 151 | 50 | 41 | 240 | 360 |
| **Inorganic parameters** | | | | | | | | | | | | | | | | | | |
| Total organic carbon (%) | 3.49 | 4 | 2 | 2 | 1 | **21** | **3** | **0.64** | **0.16** | 50 | 27 | 53 | 20 | 4.5 | 5 | 1 | 5 | 3 |
| Humidity (%) | 30.6 | 46 | 17 | 26 | 9 | **83.7** | **2.6** | **35.9** | **2.4** | 88 | 15 | 85 | 29 | 79.5 | 48 | 14 | 44 | 18 |
| **Total sulphur (mg/kg)** | **1,250** | **400** | **173** | **-** | **-** | **780** | **425** | **1,452** | **1,165** | **-** | **-** | **4,960** | **6,796** | **1,300** | **180** | **130** | **920** | **676** |
| **Trace elements and heavy elements** | | | | | | | | | | | | | | | | | | |
| Lithium (mg/kg) | 6 | 10 | 4 | 10 | 4 | **10** | **0** | **29** | **2** | 1 | 3 | 2 | 2 | 1 | 1 | 0 | 13 | 6 |
| Thallium (mg/kg) | 7.5 | 7.5 | 0 | 7.5 | 3 | **0.5** | **0** | **0.5** | **0** | 7.5 | 0 | 7.5 | 3 | 7.5 | 7.5 | 0 | 7.5 | 3 |
| Strontium (mg/kg) | 5 | 25 | 13 | 12 | 5 | **44** | **8** | **38** | **1** | 27 | 8 | 31 | 18 | 659 | 9 | 265 | 10 | 104 |
| Titanium (mg/kg) | 359 | 526 | 176 | 506 | 217 | **571** | **51** | **2,440** | **906** | 115 | 101 | 258 | 220 | 190 | 170 | 66 | 428 | 201 |
| Uranium (mg/kg) | 10 | 10 | 0 | 10 | 4 | **10** | **0** | **10** | **0** | 10 | 0 | 10 | 4 | 10 | 48 | 32 | 10 | 9 |
| Vanadium (mg/kg) | 12 | 23 | 8 | 25 | 13 | **15** | **0** | **53** | **2** | 9 | 5 | 11 | 8 | 30 | 76 | 23 | 13 | 9 |

Note: Sediments were sampled only once at stations 1A and 4.

**Table 6-20 Number of criteria exceeded in sediment samples analyzed**

| Substances | CCME[a] | | | | Environment Canada and MDDEP[b] | | | |
|---|---|---|---|---|---|---|---|---|
| | ISQG | TEL | PEL | REL | TEL | OEL | PEL | FEL |
| Arsenic (mg/kg) | **20** | 0 | 6 | **29** | **20** | **14** | 6 | 5 |
| Cadmium (mg/kg) | **9** | 0 | 0 | **10** | **9** | 0 | 0 | 0 |
| Total chromium (mg/kg) | **7** | 0 | 0 | **14** | **7** | **5** | 0 | 0 |
| Copper (mg/kg) | 0 | 0 | 0 | **3** | 0 | 0 | 0 | 0 |
| Mercury (mg/kg) | 1 | 0 | 0 | **4** | 1 | 0 | 0 | 0 |
| Lead (mg/kg) | 2 | 0 | 0 | **3** | 2 | 0 | 0 | 0 |
| **Zinc (mg/kg)** | **0** | **0** | **0** | **1** | **0** | **0** | **0** | **0** |

a: Summary table of Canadian sediment quality guidelines.
b: Criteria for the assessment of freshwater sediment quality.

## *6.2.10 AIR QUALITY*

According to the National Pollutant Release Inventory (NPRI), the closest industrial activities are over 100 km away from the project site. Due to the project's location, air quality in the sector is then considered very good.

No air quality measurement data is available to characterize the study area ambient environment.

However, in its mining instruction guide, the **MELCC** proposes a set of specific initial levels for mining projects that are in northern areas (north of the 51st parallel) and remote from other sources of atmospheric contaminant emissions. These initial levels are presented in Table 6-21**a**.

**Table 6-21a Initial levels for northern projects**

| Compound | Period | Ambient level (μg/m³) |
|---|---|---|
| Total particulate matter (TPM) | 24 hours | 40 |
| Fine particulate matter ($PM_{2.5}$) | 24 hours | 15 |
| | 1 year | 4.5[a] |
| Breathable particulate matter ($PM_{10}$) | 24 hours | 21.8[b] |
| | 1 year | 5.5[b] |
| Carbon monoxide | 1 hour | 600 |
| | 8 hours | 400 |
| Nitrogen dioxide ($NO_2$) | 1 hour | 50 |
| | 24 hours | 30 |
| | 1 year | 10 |
| Sulphur dioxide ($SO_2$) | 4 minutes | 40 |
| | 1 hour | 21[c] |
| | 24 hours | 10 |
| | 1 year | 2 |

a: Level calculated based on data from Pémonca station.
b: Value calculated by interpolation with TPM and $PM_{2.5}$.
c: Based on the initial 4-minute concentration, converted for a one-hour period using the inverted formula of the *Clean Air Regulation.*

**To compare these levels with data from an existing network of air quality measurement stations for a similar environment, data was analyzed from the northernmost stations of the *Réseau de surveillance de la qualité de l'air du Québec* (Quebec Air Quality Monitoring Network, RSQAQ). The Radisson Station was selected from this group as the most representative of the study area. Station positions are illustrated in Map 6-9. Resulting initial concentrations are presented in Table 6-21b below.**

**Table 6-21b Initial particulate matter concentrations at the northernmost RSQAQ stations**

| Station name | Admin. region | Station no. | Substance | Initial concentration[1] (µg/m³) | | Mean annual concentration | | | 24 hour concentration – 98th percentile | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Annual | 24 h | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 |
| Lac-Édouard | **4** | **4750** | **TPM** | **8.7** | **31.8** | **11.6** | **9.1** | **5.3** | **50.1** | **26.2** | **19.0** |
| Radisson | **10** | **10200** | **TPM** | **6.4** | **26.6** | **-** | **7.9** | **4.9** | **-** | **36.4** | **16.9** |
| Lac-Édouard | **4** | **4750** | **PM2.5** | **5.0** | **11.7** | **4.9** | **4.4** | **5.7** | **11.5** | **11.7** | **11.9** |
| Radisson | **10** | **10200** | **PM2.5** | **2.8** | **7.0** | **2.4 [2]** | **2.3** | **3.3** | **7.7 [2]** | **5.9** | **8.1** |
| Pémonca | **2** | **2610** | **PM2.5** | **4.0** | **9.7** | **4.1** | **3.7** | **4.0** | **9.9** | **9.8** | **9.2** |
| Senneterre | **8** | **8450** | **PM2.5** | **4.3** | **11.9** | **4.0** | **4.7** | **4.2** | **10.8** | **13.3** | **11.7** |

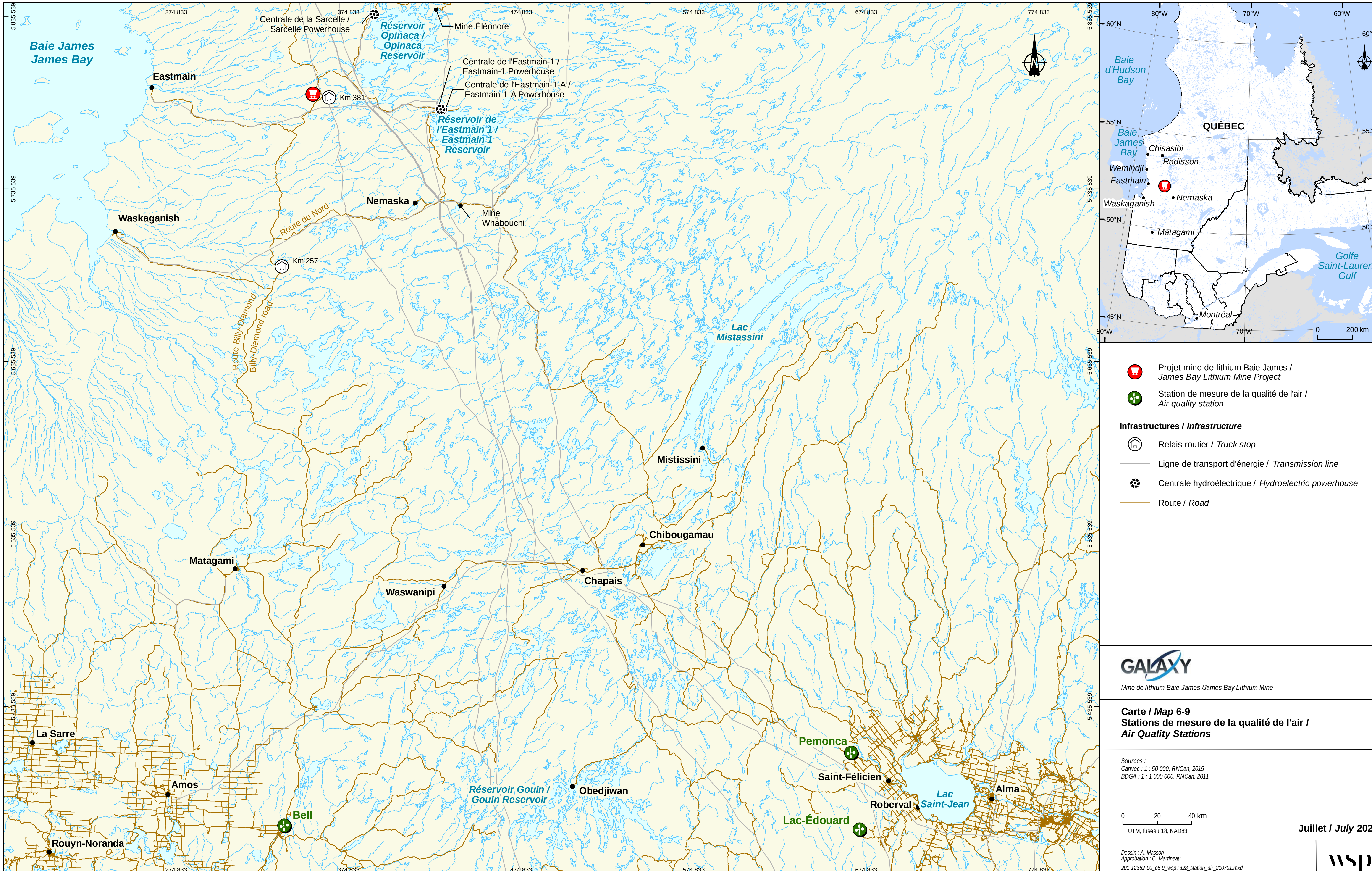
[1] Calculated from a three-year mean based on the MELCC method in accordance with section 202 of the Clearn Air Regulation.

[2] 774 hourly measurements are available at this station for 2017. Statistics are for guidance only.

The compilation results show that the initial concentrations of 40 µg/m³ and 15 µg/m³ for total particulate matter (TMP) and $PM_{2.5}$, respectively, appear to be adequate, and even conservative, to characterize the study site.

For annual concentrations of $PM_{2.5}$, no initial concentration is specified in **the mining instruction guide. An initial concentration of 4.5 µg/m³ is therefore suggested, based on measurements in past years at the Pémonca station. For breathable particulate matter concentrations under 10 µm ($PM_{10}$), no initial concentration is specified in the mining instruction guide. Initial concentrations based on interpolation between concentrations of TPM and $PM_{2.5}$ are therefore suggested. For the purposes of this calculation, an annual TPM concentration of 8 µg/m³, assessed at Lac- Édouard Station[3] was used. Initial concentrations of 21.8 µg/m³ for the 24-hour period and 5.5 µg/m³ for the annual period were obtained this way. The comparison with the Radisson Station data shows that these concentrations are adequate, and even conservative, to characterize the study site.**

**3 Based on the average of 2012-2015 annual data at Lac-Édouard Station**




**Carte / *Map* 6-9**
**Stations de mesure de la qualité de l'air /**
***Air Quality Stations***

Sources :
Canvec : 1 : 50 000, RNCan, 2015
BDGA : 1 : 1 000 000, RNCan, 2011

**Juillet / *July* 2021**

Dessin : A. Masson
Approbation : C. Martineau
201-12362-00_c6-9_wspT328_station_air_210701.mxd

wsp

**Forest fire impact on air quality**

**Forest fires have a major impact on air quality, both locally and regionally. Smoke from the fires and a complex mixture of carbon dioxide ($CO_2$), suspended particles, water vapour, carbon monoxide (CO), organic compounds (such as acrolein and formaldehyde), oxides of nitrogen (NOx) and various minerals.[4] Table 6-21c lays out the generic emission factors estimated by the US EPA[5] that may be associated with emissions from a forest fire. They are provided in kg of emissions of one substance per tonne of combustible material.**

**Table 6-21c Generic emission factors that may be associated with forest fires**

| Substance | Emissions factor (kg/tonne) |
|---|---|
| **$CO_2$** | 1,521 |
| **CO** | 144 |
| **$PM_{2.5}$** | 12 |
| **$PM_{10}$** | 14 |
| **$NO_X$** | 3.1 |
| **VOC** | 6.8 |

While fires produce significant amounts of carbon monoxide and carbon dioxide, particulate matter is the main issue as fine particles can be transported for hundreds of kilometres.

In order to evaluate the impact of forest fires on air quality, forest fire mapping provided by the Québec Ministère des Forêts, de la Faune et des Parcs (MFFP) was analyzed. The data in this mapping relate to all forest fires that took place in Québec for the period from 1972 to 2017.

Table 6-21d presents statistics compiled for fires raging within 200 km of the study site. The data represents the sum of the surface areas burned in $km^2$, more specifically the total area per year and per month. For example, in 1972, a total area of 768 $km^2$ was burned within a 200 km radius of the site, including 11, 20 and 737 $km^2$ for the months of April, May and June, respectively. The compilation of this data shows that the intensity of the fires is very variable from one year to the next. Figure 6-4 also illustrates this large variation. The areas burned during 1983 and 2013 were particularly large.

4 https://www.inspq.qc.ca/pdf/publications/1679_ImpactsSanitParticulesIncendiesForet.pdf
5 https://www3.epa.gov/ttn/chief/ap42/ch13/related/firerept.pdf

## Table 6-21d Area burned by month and year within 200 km of the study site

| Year | Area burned (km² per month) | | | | | | | Total for the year |
|---|---|---|---|---|---|---|---|---|
| | MARCH | APRIL | MAY | JUNE | JULY | AUGUST | SEPTEMBER | |
| **1972** | | 11 | 20 | 737 | | | | 768 |
| **1973** | | | 55 | | 756 | | | 811 |
| **1974** | | | 6 | 7 | | | | 13 |
| **1975** | | 1 | 8 | 27 | | | | 36 |
| **1976** | | | 130 | 249 | | 23 | | 401 |
| **1977** | | | 4 | 164 | | 1 | 2 | 171 |
| **1978** | | | 4 | 11 | | | | 15 |
| **1979** | | | 10 | 3 | 6 | | | 19 |
| **1980** | 49 | 79 | | | 17 | | | 145 |
| **1981** | | | | 384 | 1,047 | | | 1,431 |
| **1982** | | | 71 | | | | | 71 |
| **1983** | | | 1,731 | 3,966 | | | | 5,697 |
| **1986** | | | 258 | | | | | 258 |
| **1987** | | | | | | | | 0 |
| **1988** | | 64 | | | | | | 64 |
| **1990** | | | | | 24 | | | 24 |
| **1991** | | | | | | | | 0 |
| **1992** | | | | | | | | 0 |
| **1993** | | | | | | | | 0 |
| **1994** | | | 1 | | | | | 1 |
| **1995** | | | 2 | | | | | 2 |
| **1996** | | | 508 | | | | | 508 |
| **1997** | | | 343 | | | | | 343 |
| **1998** | | | | 20 | | | | 20 |
| **2000** | | 1 | | | | | | 1 |
| **2001** | | | 40 | 8 | 178 | | | 227 |
| **2002** | | | | 76 | | | | 76 |
| **2003** | | | 255 | 4 | 98 | | | 357 |
| **2004** | | | 4 | 9 | 10 | | | 23 |
| **2005** | | | 2,070 | 603 | | | | 2,674 |
| **2006** | | 270 | 536 | 1 | | | | 807 |
| **2007** | | 85 | 78 | 88 | | | | 251 |
| **2008** | | | | 7 | | | | 8 |
| **2009** | | | 1 | 531 | 1 | | | 533 |
| **2010** | | 1 | 439 | 577 | | | | 1,017 |
| **2011** | | 7 | 7 | 4 | 34 | | | 53 |
| **2012** | | 30 | 144 | 12 | | | | 187 |
| **2013** | | | 498 | 9,357 | | | | 9,855 |
| **2014** | | 27 | 168 | 11 | | | | 206 |
| **2015** | | | 11 | 1 | | | | 12 |
| **2016** | | | 1 | 48 | 1 | | | 50 |
| **2017** | | | 54 | | 1 | | | 55 |
| **Total** | 49 | 576 | 7,459 | 16,907 | 2,174 | 23 | 2 | 27,191 |
| **Max** | 49 | 270 | 2,070 | 9,357 | 1,047 | 23 | 2 | - |

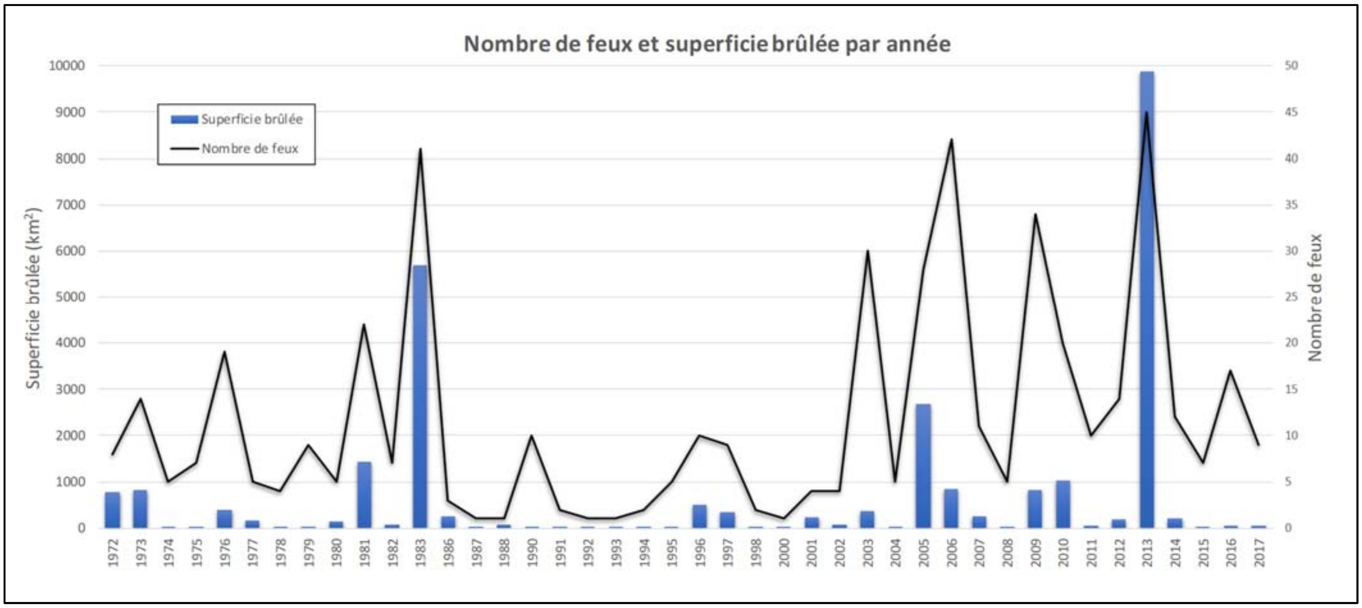



**Figure 6-4 Number of fires and area burned per year within 200 km of the study site**

**Table 6-21e presents a classification by magnitude of each fire. This compilation shows that the majority (96% of cases) of fires caused burns of less than 75 km². Only a few major fires of more than 750 km² have occurred since 1972. A more detailed analysis shows that of the six fires of more than 750 km², three occurred on the same date in 2013. These fires are therefore probably connected.**

**Table 6-21e Classification by magnitude of fire within 200 km of the study site**

| Classification (km²) | Number of fires (1972-2017) |
|---|---|
| **x < 75** | 402 |
| **275 > x > 75** | 45 |
| **750 > x > 275** | 13 |
| **1,500 > x > 750** | 3 |
| **x > 1,500** | 2 |

**With respect to quantifying the impact of forest fires on air quality using results from a complete atmospheric dispersion study, we are of the opinion that the high variability of the fires in terms of both intensity and frequency would not permit the establishment of valid baseline concentrations comparable to the concentrations obtained under section 202 of the Clean Air Regulation.**

## *6.2.11 AMBIENT NOISE*

The project site is close to two main sources of noise: the Billy-Diamond highway and the km 381 truck stop. The surrounding environment is otherwise made up of predominantly softwood terrestrial vegetation and peatland.

Measurements of the soundscape were taken in 2011 at the project site, close to the road and at the km 381 truck stop. These measurements are still considered representative for **2021, since the measurement conditions are similar. There have been no changes to the physical or geographic environment, and no new industry has been set up near the measurement points. Furthermore, according to SDBJ traffic reports, there have not been any significant increases in traffic on the Billy-Diamond highway. In 2014, the total number of vehicles was 56,139, while it was 55,632 in 2017. No more recent data is available (this was checked in December 2020).** The sound readings were taken at seven stations (P1 to P7) between October 7 and 9, 2011 (Map 6-10).

**Ambient noise levels were not measured at Cree community camp sites. These camps are located at distances ranging from 5.4 km to 11.4 km, as the crow flies, from the central point of the project. At these distances, the noise impact of GLCI Lithium operations would be practically non-existent (in other words, the 45 dB$_A$ contour line is reached well before reaching the Cree camps). Consequently, these receptors were not considered in simulations.**

Table 6-22 shows the equivalent sound levels recorded at the measuring stations for both periods of the day. The equivalent continuous sound level ($L_{Aeq}$) represents the average noise level during the measurement period. Minimum and maximum sound levels are also presented.

#### Table 6-22 Sound measurement results

| | Noise level (dB$_A$) | | | | | |
|---|---|---|---|---|---|---|
| | Day (07:00 to 19:00) | | | Night (19:00 to 07:00) | | |
| Measuring point | $L_{Aeq}$ | Maximum | Minimum | $L_{Aeq}$ | Maximum | Minimum |
| Point 1 | 48 | 56 | 29 | 32 | 36 | 26 |
| Point 2 | 38 | 48 | 31 | - | - | - |
| Point 3 | 56 | 83 | 35 | - | - | - |
| Point 4 | 45 | 59 | 35 | - | - | - |
| Point 5 | 44 | 59 | 24 | 48 | 70 | 20 |
| Point 6 | 61 | 86 | 32 | - | - | - |
| Point 7 | 48 | 67 | 39 | 47 | 66 | 38 |

Residual noise at the project site varied between 38 and 48 dB$_A$ during the day and between 32 and 48 dB$_A$ at night. Recorded levels at the km 381 truck stop were: 48 dB$_A$ during the day and 47 dB$_A$ at night. The Billy-Diamond highway is the most important source of noise in the study area, with average sound levels of 56 and 61 dB$_A$ during the day at points 3 and 6 respectively, with maximum values reaching 83 dB$_A$ and 86 dB$_A$. **The peaks observed at points 3 and 6 (see charts in Appendix 6-2-11 and Map 6-10) are associated with passing vehicles. Between vehicle passings, the noise level drops to around 35 dB$_A$. The influence of road traffic noise then decreases based on distance from the road.** No nighttime sound reading was taken at these two stations.

#### Geographic range of noise sources

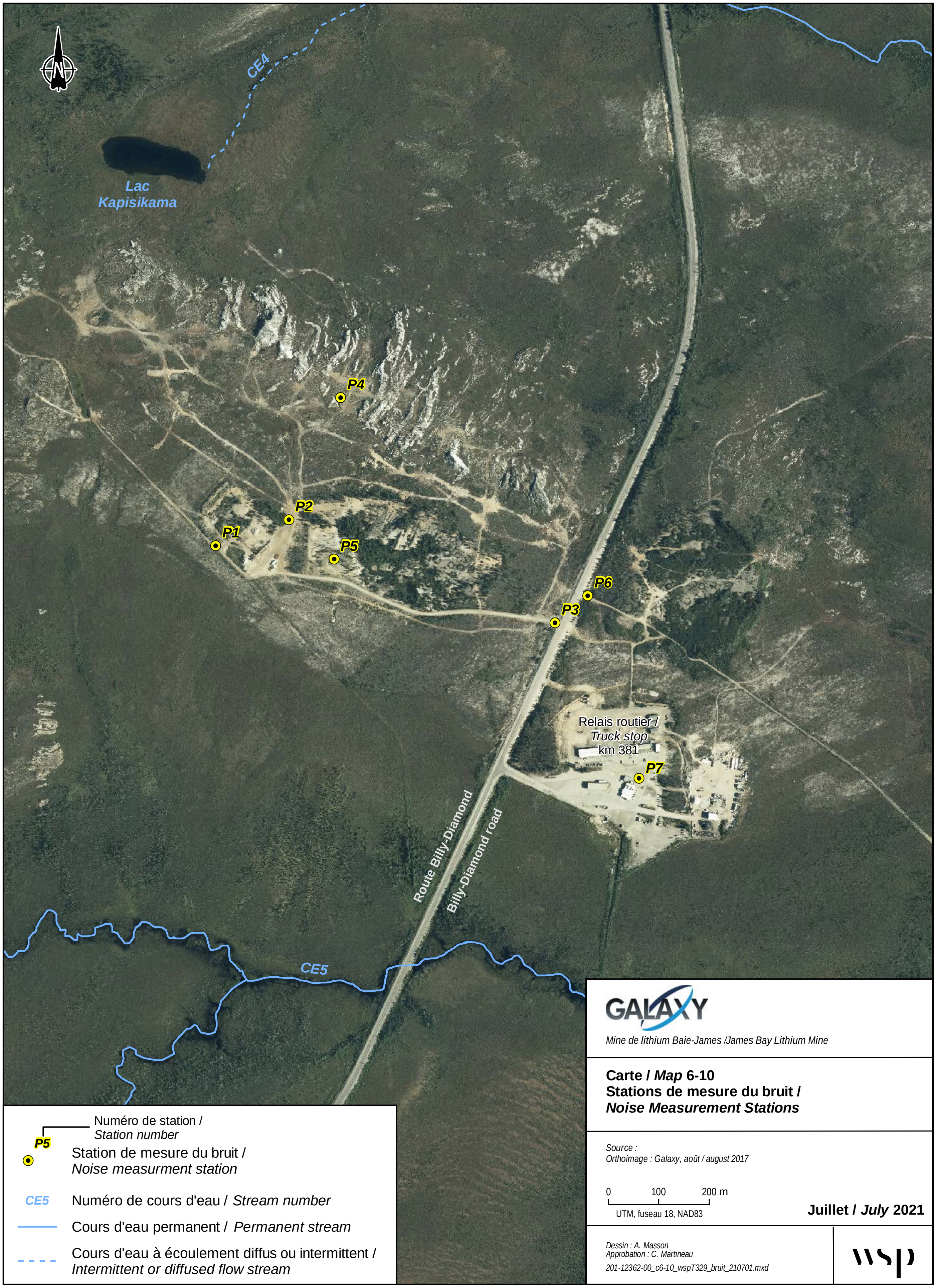
**The geographic range of road traffic noise is based on two main variables. The first variable is the intensity of the noise source, i.e. the speed of passing vehicles and traffic volume. The higher the intensity of the noise source, the greater the geographic range. The second variable is the intensity of existing ambient noise other than noise from the road. The higher this is, the lower the geographic range due to the masking effect of other noise sources (e.g. birds singing, leaves rustling with wind, etc.). In summary, if we take a day during the cold season with no wind, when there are no birds or insects, the geographic range will be much greater than during a windy day or when birds or insects are making noise. Based on the results of the noise measurements, we can expect the geographic range of road traffic noise to be less than 1 km most of the time, because the sound coming from the Billy-Diamond highway is relatively low at measurement points P1, P2 and P4, which are about 600 m away from the road.**

### Variations over time

**Unless there is a significant increase in road traffic, the level of traffic noise coming from the Billy-Diamond highway will remain similar over time. Reference noise variations come mainly from seasonal periods and weather conditions. As explained in the previous period, the soundscape will vary based on weather conditions, especially wind with the rustling of leaves or rain and wildlife noises (animals, birds and insects). The increase in road traffic is expected to be around 15%. This will create a 0.6 $dB_A$ increase in road noise, which is inaudible. A 100% increase, or traffic doubling, would mean a 3 $dB_A$ increase, which would start to be audible.**

### Criteria

For the study area, the noise criteria that apply are those of Zone IV of the document *Traitement des plaintes sur le bruit et exigences aux entreprises qui le génèrent* (MDDEP, 2006), namely 70 $dB_A$, except at campsites and the km 381 truck stop. At these two sites, the criteria to be respected are 55 $dB_A$ during the day, 50 $dB_A$ at night, or the residual noise level, if higher.




Numéro de station /
*Station number*

Station de mesure du bruit /
*Noise measurment station*

CE5 Numéro de cours d'eau / *Stream number*

Cours d'eau permanent / *Permanent stream*

Cours d'eau à écoulement diffus ou intermittent /
*Intermittent or diffused flow stream*

GALAXY

*Mine de lithium Baie-James /James Bay Lithium Mine*

**Carte / *Map* 6-10**
**Stations de mesure du bruit /**
***Noise Measurement Stations***

*Source :*
*Orthoimage : Galaxy, août / august 2017*

0 100 200 m

UTM, fuseau 18, NAD83

**Juillet / *July* 2021**

*Dessin : A. Masson*
*Approbation : C. Martineau*
*201-12362-00_c6-10_wspT329_bruit_210701.mxd*

wsp

## 6.2.12 ARTIFICIAL LIGHT AT NIGHT

The artificial light at night study area is shown on Map 6-11. The Billy-Diamond highway crosses this area from south to north. It includes the Billy-Diamond highway km 381 truck stop, the sole emitter of nocturnal artificial light in the study area. This zone also includes the main sensitive receptors that could be affected by the light emitted by project infrastructure. These sensitive receptors are the permanent and temporary Cree camps.

Sky clarity and intrusive light are measurable parameters that can be affected by an increase in nocturnal artificial light. To classify sky clarity and intrusive light conditions of the study area, a classification system developed by the International Commission on Illumination (CIE, 2003), with measurable limits defined by Narisada and Schreuder (2004), was used. This system provides four classification zones:

— very-low-luminosity sector (national parks or protected sites);
— low-luminosity sector (industrial, residential or rural areas);
— medium-luminosity sector (industrial or residential neighbourhood);
— high-luminosity sector (downtown and shopping areas).

Sky clarity limits are measured in mag/arcsec$^2$; the higher the value, the better the sky clarity. Limits for intrusive lights are measured in lux; the higher the value, the stronger the intrusive light.

Data from the *New World Atlas of Artificial Night Sky Brightness* by Falchi and coll. (2016) were used to present current sky brightness conditions in the study area. These data were imaged using a colour chart indicating sky brightness level, dark grey being the brightest sky and red the least bright for the sector under study. The values in this colour chart are in mag/arcsec$^2$ and the results obtained can be compared against measurements taken in the field. Data for the sector of the study are presented in Map 6-11.

The km 381 truck stop on the Billy-Diamond highway is the sole emitter of nocturnal artificial light in the study area and it can be seen clearly. Little light is emitted by the km 381 truck stop and its effect on sky clarity fades rapidly with increasing distance. The project site is located within this area of influence, given its proximity to the truck stop.

In comparison with southern Quebec, where sky clarity is of poor quality because of the presence of many large cities, sky clarity in northern Quebec is excellent. Except for a few scattered small sectors, either villages or electrical facilities, practically the whole of northern Quebec has optimal sky clarity, that is, a sky entirely unaffected by artificial light.

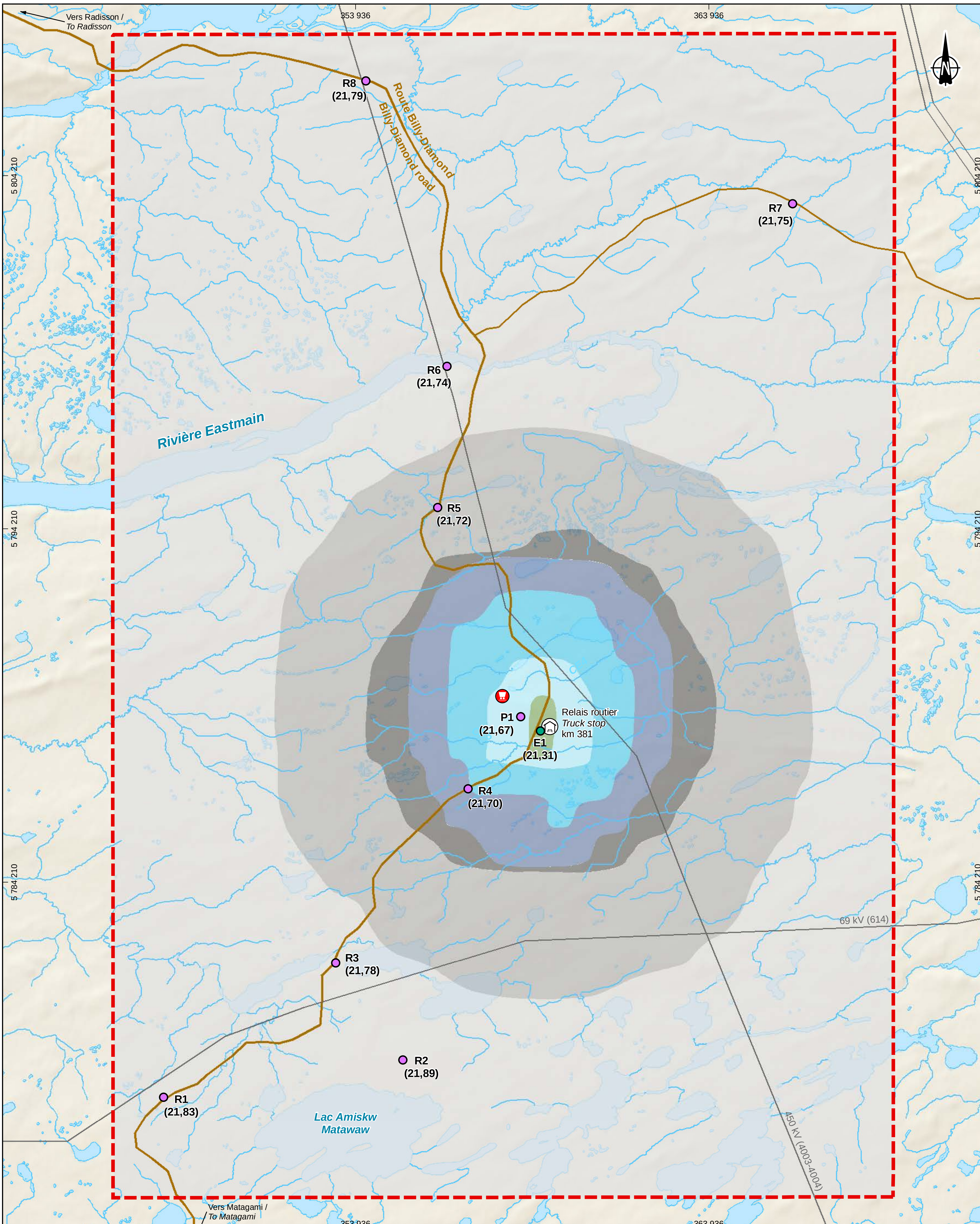
### 6.2.12.1 FIELD READINGS

Readings were taken in the field to obtain spot measurements of sky clarity, the presence of intrusive light and photographs of surrounding nocturnal landscapes. Measurements of sky clarity can also be used to validate the data provided in the 2016 *New Atlas*. Sampling stations were selected to be representative of the area, with particular attention to sectors likely to be affected by the project and light-emitting sources already present. Stations numbered with R represent sensitive receptors, those with E important sources of artificial light emissions and those with P project sectors. Measurements of intrusive light on the ground were obtained using a light meter (model TES 1336A) which provided results in lux for every station.

### 6.2.12.2 RESULTS

#### SKY CLARITY

The results of sky clarity measurements taken at each station are presented in Table 6-23 and Map 6-11. Based on the results obtained, each station was assigned to a CIE classification zone for sky clarity.




**Clarté du ciel / Sky Brightness**

Mag/arcsec²

- > 21,97
- 21,96-21,97
- 21,94-21,96
- 21,90-21,94
- 21,82-21,90
- 21,68-21,82
- 21,45-21,68
- 21,09-21,45
- 20,60-21,09
- 20,02-20,60
- 19,35-20,02
- 18,65-19,35
- 17,93-18,65
- < 17,93

**Résultats de l'inventaire sur le terrain / *Result of the Field Inventory***

Zone d'étude de l'ambiance lumineuse / *Sky brightness study area*

Station d'échantillonnage / *Sampling station*

E1 (21,72)

E = Émetteur /*Transmitter*
R = Récepteur / *Receptor*
P = Projet / *Project*

Résultats des mesures de clarté du ciel (mag/arcsec²) / *Sky brightness measurement (mag/arcsec²)*

Zone de la Commission internationale de l'éclairage (CIE) pour chaque station / *International Commission on Illumination zone (ICI) for each station*

- Zone C1
- Zone C2

Projet mine de lithium Baie-James / *James Bay Lithium Mine Project*

**Infrastructures / *Infrastructure***

- Route principale / *Main road*
- Route d'accès / *Access road*
- Ligne de transport d'énergie / *Transmission line*
- Relais routier / *Truck stop*

**Hydrographie / *Hydrography***

- CE3 Numéro de cours d'eau / *Stream number*
- Cours d'eau / *Stream*
- Plan d'eau / *Waterbody*

GALAXY

*Mine de lithium Baie-James /James Bay Lithium Mine*

**Carte / *Map* 6-11**
**Ambiance lumineuse /**
***Artificial Light at Night***

*Sources :*
*World Shaded Relief, ESRI, 2014*
*Base carto / Cartographic base; CanVec 2017*
*Réseau routier / Road network; BDGA 2014*

0 1 2 km
UTM, fuseau 18, NAD83

**Juillet / *July* 2021**

*Dessin : A. Masson*
*Approbation : C. Martineau*
*201-12362-00_c6-11_wspT330_amb_lum_210701.mxd*

wsp

**Table 6-23 Results of sky clarity measurements**

| Station[1] | Description | Measurement at zenith (mag/arcsec[2]) | CIE zone |
|---|---|---|---|
| R1 | Cree camp that seems no longer used | 21.83 | C1 |
| R2 | Forest trail close to Amiskw Matawaw Lake | 21.89 | C1 |
| R3 | Permanent Cree camp used year-round | 21.78 | C1 |
| R4 | Billy-Diamond highway south of the truck stop | 21.70 | C1 |
| R5 | Cree camp that burned down in 2002 | 21.72 | C1 |
| R6 | Temporary Cree camp on the shores of the Eastmain River | 21.74 | C1 |
| R7 | Track to the east of Billy-Diamond highway | 21.75 | C1 |
| R8 | Billy-Diamond highway north of the Eastmain River | 21.79 | C1 |
| E1 | Km 381 truck stop on the Billy-Diamond highway | 21.31 | C2 |
| P1 | Project site | 21.67 | C1 |

1 R: receptor; E: emitter; P: project.
2 Narisada and Schreuder 2004.

The results show that there are two CIE environmental zones within the study area. Except for station E1 at the km 381 truck stop, all stations presented sky clarity measurements of above 21.4 mag/arcsec$^2$ and thus fall into CIE zone C1, representing sectors that are very little affected by nocturnal artificial light.

A reading of 21.31 mag/arcsec$^2$ was obtained at station E1, indicating that the area immediately around the truck stop lies within the CIE zone C2, that is, a sector of low luminosity. This was the lowest sky clarity reading taken during the surveys. It should be kept in mind that the truck stop is the only light emitter inside the study area. The effect of the light emitted by the truck stop fades very quickly, as shown by the measurement taken at station P1 (project site) at only 1.1 km from the truck stop, with a value of 21.67 mag/arcsec$^2$ (CIE zone C1). The highest sky clarity measurement was obtained at station R2, with a value of 21.89 mag/arcsec$^2$.

In summary, except for the area immediately around the truck stop, the entire study area is part of CIE zone C1. This is an area which is largely unaffected by nocturnal artificial light and in which sky clarity is excellent. As mentioned earlier, this type of sky is not found in or close to urbanized areas. It is totally absent from southern Quebec. However, this sky clarity is very common in northern Quebec.

### INTRUSIVE LIGHT

The results of intrusive light measurements on the ground, taken at each station, are set out in Table 6-24. Based on the results obtained, each station was assigned to a CIE classification zone for intrusive light. These results show that, except for the km 381 truck stop, no intrusive light was measured at the various stations.

A value of 0.12 lux was measured at E1 (truck stop), which puts it in CIE environmental zone E2, that is, a low-luminosity sector. No intrusive light was measured at the other stations in the study area, putting them in CIE zone E1. As with sky clarity, except for the area immediately around the truck stop, the entire study area is part of the CIE zone E1.

## Table 6-24 Intrusive light measurement results

| Station[1] | Description | Intrusive light (lux) | CIE zone |
|---|---|---|---|
| R1 | Cree camp that seems no longer used | 0 | E1 |
| R2 | Forest trail close to Amiskw Matawaw Lake | 0 | E1 |
| R3 | Permanent Cree camp used year-round | 0 | E1 |
| R4 | Billy-Diamond highway south of the truck stop | 0 | E1 |
| R5 | Cree camp that burned down in 2002 | 0 | E1 |
| R6 | Temporary Cree camp on the shores of the Eastmain River | 0 | E1 |
| R7 | Track to the east of Billy-Diamond highway | 0 | E1 |
| R8 | Billy-Diamond highway north of the Eastmain River | 0 | E1 |
| E1 | Km 381 truck stop on the Billy-Diamond highway | 0.12 | E2 |
| P1 | Project site | 0 | E1 |
| 1 R: receptor; E: emitter; P: project. | | | |

### NOCTURNAL LANDSCAPES

As mentioned earlier, there is only one emitter of nocturnal artificial light affecting the nocturnal landscapes within the study area, namely the km 381 truck stop on the Billy-Diamond highway. Photographs of this emitter were taken from several viewpoints.

Photo 6-1 was taken close to station P1 (project site) towards the truck stop. The small luminous halo generated by the km 381 truck stop facilities can be clearly seen. An aurora borealis was visible in the sky at the time the photo was taken. Photo 6-2 shows a view of this aurora borealis from station R4. The truck stop and the small luminous halo it creates are also visible on this photograph. In addition, Photo 6-2 clearly shows the starry sky that was present during the night when surveys were made, demonstrating the quality of the nocturnal landscapes in the study area.

**Photo 6-1 Luminous halo created by nocturnal artificial light emitted by the truck stop seen from station P1**

**Photo 6-2 View of the km 381 truck stop and an aurora borealis seen from station R4**

# 6.3 BIOLOGICAL ENVIRONMENT

## 6.3.1 VEGETATION

Vegetation surveys were carried out between July 24 and 31, 2017, **and July 30 and 21, 2020**. The objective of these surveys was to characterize and delineate land and wetland plant groups, check for the presence of threatened or vulnerable plant species (or species likely to be designated as threatened or vulnerable) and seek out any plant species of traditional interest for Indigenous people. A baseline characterization for metals in certain plants with a traditional use was also performed. **The** method used along with **the** findings are described in greater detail in the Terrestrial Vegetation Baseline Study *(Étude spécialisée sur la flore)* (WSP, 2018e) **and the supplemental technical note (WSP, 2021c)**.

### 6.3.1.1 METHODOLOGY

#### PLANT GROUP CHARACTERIZATION AND DELINEATION

Prior to the field surveys, a photo interpretation of the plant groups in the study area, which included 2011 data taken by WSP, was conducted. Following the photo interpretation, the two environments (land and wetland) were spatially illustrated using polygons.

**During the planning phase,** survey plots were placed within each land or wetland group polygon. For the larger groups, several plots were provided for to ensure a better assessment.

**The survey carried** out between July 24 and 31, 2017, validated the limits, the naming and the characterization of the groups identified at the time of the photo interpretation or during prior characterization work. Data entry records from the *in situ* database developed by WSP were completed in the field, which made it possible to note characteristics of the site habitats (WSP, 2018e). Data for each plot were gathered over a radius of around 10 m, representative of the general environment. Particular care was taken during **the survey** to ascertain the presence of invasive exotic plant species.

**The survey was** primarily **completed** in the areas where the project infrastructure would be located. A total of 98 plots (comprised of 81 complete plots and 17 validation plots, all of them dispersed within 57 polygons) were surveyed (Map 6-12).

**The July 2020 survey was done to complete coverage of the environments that may be affected after the project footprint was changed and to validate the 2017 survey results. The addition of survey plots was also in response to a request from the MELCC in order to clarify information on certain sectors. Eight plots in seven polygons were surveyed using the same method as was used in 2017.**

#### WETLANDS

Wetlands have particular botanical, biophysical and hydrological characteristics (Bazoge and coll., 2015). Table 6-25 provides a non-exhaustive list of the criteria or **elements** to consider when identifying wetlands.

The wetlands observed in the study area were validated in the field following their delineation through photo interpretation. Because of this area's vast size, the **boundary** of the wetlands was not surveyed over their entire perimeter. Where photo interpretation results were inaccurate, changes to wetland boundaries were made by applying the botanical method, which considers all the previously cited elements to establish **this boundary**.

The study area's location in a Northern environment must, however, be considered when establishing the group's water balance. The list of mandatory and optional plants in the 2015 guide *Identification et délimitation des milieux humides du Québec méridional* (Bazoge and coll., 2015) was originally drawn up for southern Quebec and may hence be inaccurate in Northern environments. This is in part due to the fact that the water status of certain plant species varies according to their latitude. Such is the case for the black spruce (*Picea mariana*), which can be mostly found in the wetlands of the south yet is a dominant species in both land and wetland environments in northern Quebec. In those instances where the vegetation does not allow for determining a group's water balance, biophysical and hydrological factors, along with soil characteristics, are key.

**Table 6-25 Wetland characterization criteria**

| Type | Criteria |
|---|---|
| Botanical | • Dominance of mandatory and optional plants in wetlands |
| Biophysical | • Water line (wharf, rocks, trees, etc.)<br>• Waterborne debris – Deposit of sediments<br>• Sulfurous odour (rotten eggs) in the ground<br>• Depressions covered by a blackish litter generated by the faulty decomposition of organic matter<br>• Rhizosphere effect (oxidation around the roots) – marked spots for the first 30 cm underneath the surface<br>• Erosion of tree bark<br>• Exposed shrub and tree roots<br>• Moss lines on trunks<br>• Hypertrophied stumps<br>• Hypertrophied lenticels<br>• Relatively shallow root systems<br>• Adventitious roots |
| Hydrological | • Flooded ground surface<br>• Waterlogged soil for the first 30 cm |

The swamps and peatlands were mainly identified on the basis of the thickness of the sod layer. Peatlands are characterized by an organic surface layer (sod) in excess of 30 cm; below that, groups are considered swamps or marshes, depending on the type of vegetation present.

#### SPECIAL-STATUS PLANT SPECIES

A list of the species likely to be found in the study area was drawn up prior to proceeding with the field surveys. In conjunction with the available database on study area habitats (2011 surveys, 2017 photo interpretation), the following works helped to establish the list of potential species:

— a guide created by the Centre de données sur le patrimoine naturel du Québec (CDPNQ) and the MDDELCC: *Les plantes vasculaires en situation précaire au Québec* (Tardif and coll., 2016);
— *Flore laurentienne* (Frère Marie-Victorin and coll., 2002);
— *Guide de reconnaissance des habitats forestiers des plantes menacées ou vulnérables - Abitibi-Témiscamingue et Nord-du-Québec (secteur sud-ouest)* (Labrecque and coll., 2014);
— the guide entitled *Plantes rares du Québec méridional* (Sabourin, 2009);
— the book *Sedges of Maine – A Field Guide to Cyperaceae* (Arsenault and coll., 2013).

The information gathered made it possible to identify 15 species that could possibly be present in the study area habitats. While surveying, the search for special-status plant species mainly focused on the plant habitats and groups likely to host these taxa, i.e.:

— the banks of watercourses;
— open or wooded fens;
— wet meadows;
— rocky outcrop areas;
— open sandy areas.

A request was also submitted to the CDPNQ to obtain a list of the special-status species located in a radius of about 20 km from the centre of the study area.

#### PLANT SPECIES OF TRADITIONAL INTEREST FOR INDIGENOUS PEOPLE

The traditional use of plants by Cree communities in James Bay was investigated by reviewing the literature. This included looking over the various articles and databases listing the plants used by these communities, to prepare the most comprehensive list possible (Uprety and coll., 2012). **When consulting with Cree land users, who used traplines RE2, VC35 and VC33, the issue of plant use was also brought up**. The species' scientific and common names (in French, English and Cree) were also noted. Information was obtained on the growth habits of these plants (trees, shrubs, herbaceous plants and mosses) as well as the plant parts used by Cree communities.

#### CHEMICAL CHARACTERIZATION

A baseline characterization of the metals in some of the plants with traditional uses was also conducted to identify the initial concentration of certain metals in the various plants present at the project site. The sector sampled is adjacent to the planned project infrastructure. The initial characterization generated a profile of the metal content of the structural tissues (leaves, fruit, branches) of the six plants species found at the study site, namely:

— blueberry (*Vacccinium spp.*);
— Labrador tea (*Rhododendron groenlandicum*);
— sheep laurel (*Kalmia angustifolia*);
— alder (*Alnus spp.*);
— black spruce (*Picea mariana*);
— tamarack (*Larix laricina*).

The field sampling activities in the study area were done on September 25, 2017. A total of 30 composite samples of structural tissues (leaves, fruit, branches), five for each plant species, were gathered in the study area and sent to the laboratory to analyze for 24 different metals. The samples were obtained at 11 stations located in various habitats at the project site. The location of the sampling stations are shown on Map 6-12.

#### *6.3.1.2 RESULTS*

**PLANT GROUPS**

On a regional scope, the study area is situated at the northeastern boundary of the Abitibi and James Bay Lowlands natural province, a zone characterized by large even plateaus dotted with hills and featuring vast fens and bogs often beginning at the shores of James Bay and extending 100 km inland (DUC, 2016). The surveys done confirm that the habitats in the study area are in line with this description.

The main factor in the forest dynamics of the region is the fire cycle (MFFP, 2017*a*). Forest fires therefore have a major impact on plant group structure and composition.

The mapping of recent fires (1970 to now) in the study area by MFFP (**2020**) shows forest fires caused by lightning in 2005, 2009 and 2013 (Map 6-13). The 2009 burn covered a smaller portion of the study area, having mostly impacted the western section. The 2005 and 2013 fires, however, wreaked havoc on large sections of the study area, among them the zone near the km 381 truck stop and the project sector. Evidence of the recent fires is still visible, notably through the sparse nature of the newly growing black spruce and jack pine.

In spite of the ecosystem's adjustment to the dynamics of the forest fires, successive fires over the past 15 years have impacted the study area to the point where the short- and long-term development of existing stands could be disrupted. In fact, a greater number of repeated disturbances could significantly curtail their regeneration.

Map 6-12 shows the plant groups present in the study area and Table 6-26 illustrates the size of the plant groups within this area.

**Land environments**

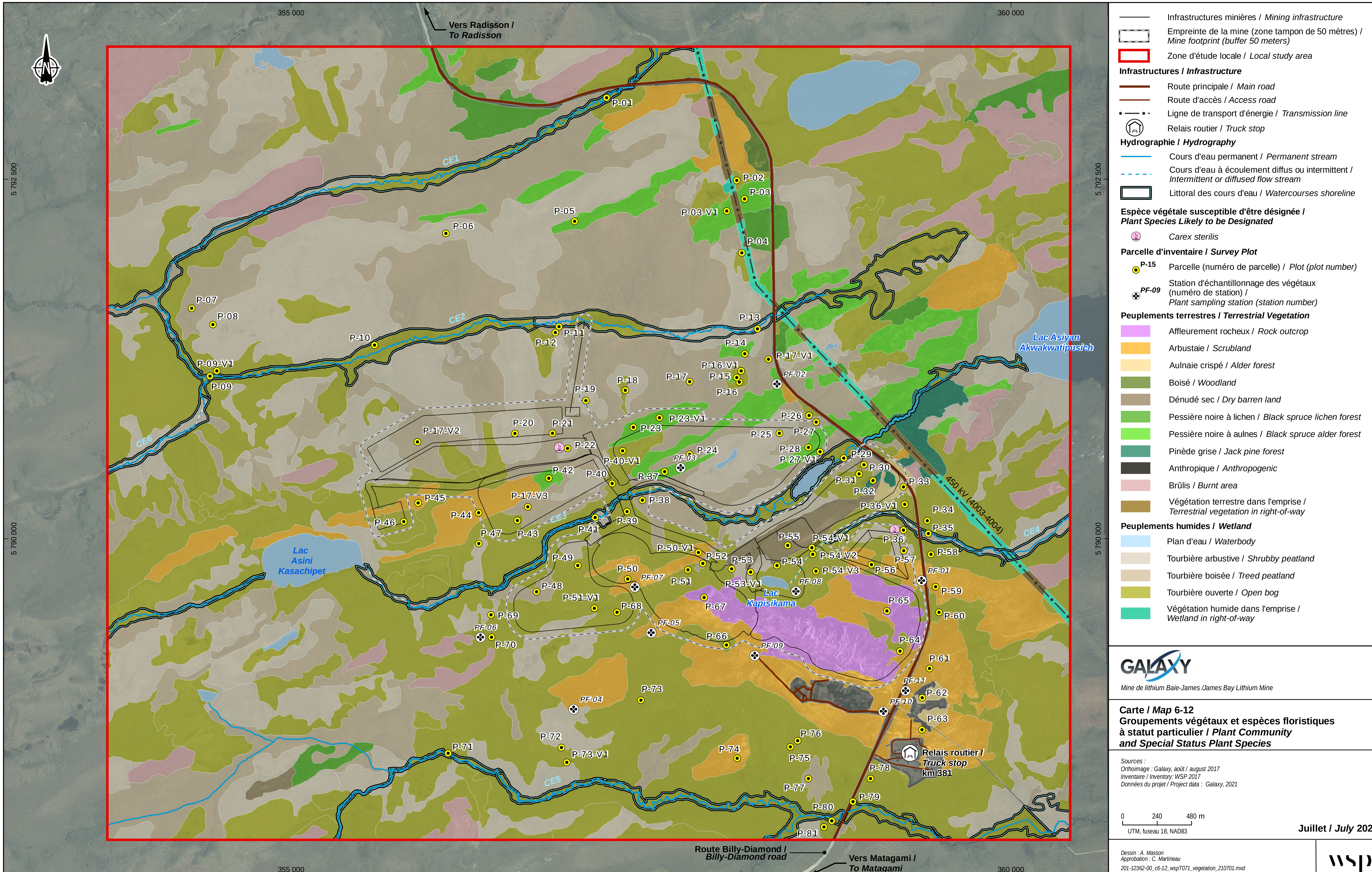
Land environments account for **668.11** ha—or a mere **18.2**%—of the study area. Field surveys allowed for specifying the data obtained from photo interpretation and reclassifying the land environments into 10 distinct groups.

In general, the land groups are mostly found along and east of the Billy-Diamond highway (Map 6-12). Land groups are primarily found on sloped terrain on thin soil containing less than 15 cm of organic matter or directly on sand, and even on rocky outcrops. The rock at these sites is usually observed less than 30 cm from the surface.

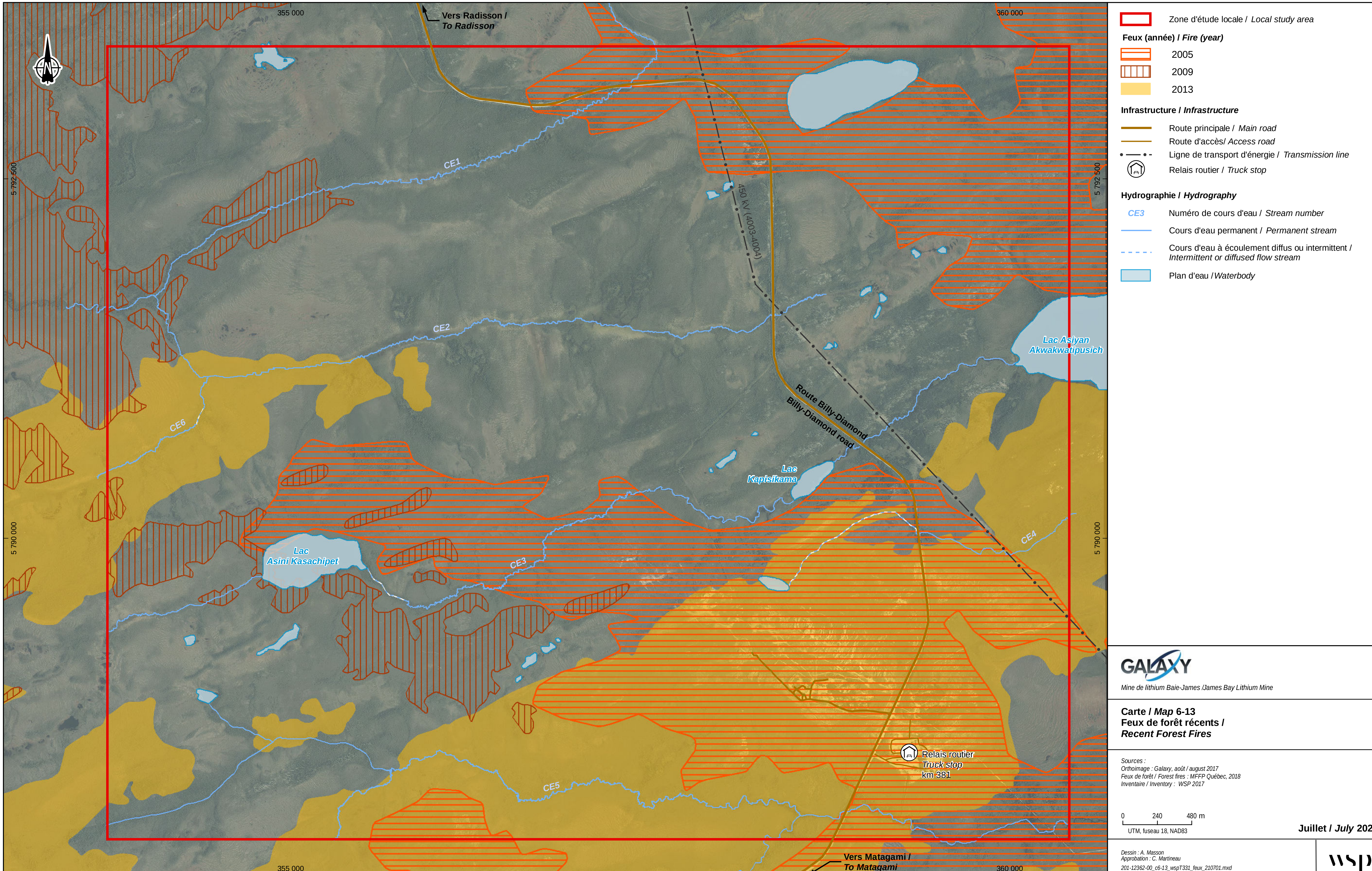
The presence of rocky outcrops and the many recent forest fires have resulted in the lack of a tree stratum in several land groups. The rocky outcrops, scrubland, green alder, burns and dry stripped zones are thus dominated by their shrub layer.

As for the scrubland and burns, their shrub layer is mainly comprised of the jack pine and black spruce regenerated after the forest fires. In these groups, the trembling aspen (*Populus tremuloides*) and white willow (*Salix sp.*) are usually found alongside the two dominant softwood species. Underneath, there is often velvetleaf huckleberry (*Vaccinium myrtilloides*) and sheep laurel (*Kalmia angustifolia*), which further attest to the more xeric water balance of these groups.

Land alder, i.e., groups dominated by green alder (*Alnus alnobetula subsp. crispa),* are most often observed on steep roadside slopes or on sites that were stripped or filled in during the construction of the roads. The alder is thick and nearly monospecific.



Vers Radisson / To Radisson
Route Billy-Diamond / Billy-Diamond road
Vers Matagami / To Matagami
355 000
360 000
5 792 500
5 790 000
Lac Asini Kasachipet
Lac Kapisikama
Lac Asiyan Akwakwatipusich
Relais routier / Truck stop km 381
450 kV (4003-4004)
CE1
CE2
CE3
CE4
CE5
CE6
Infrastructures minières / Mining infrastructure
Empreinte de la mine (zone tampon de 50 mètres) / Mine footprint (buffer 50 meters)
Zone d'étude locale / Local study area
Infrastructures / Infrastructure
Route principale / Main road
Route d'accès / Access road
Ligne de transport d'énergie / Transmission line
Relais routier / Truck stop
Hydrographie / Hydrography
Cours d'eau permanent / Permanent stream
Cours d'eau à écoulement diffus ou intermittent / Intermittent or diffused flow stream
Littoral des cours d'eau / Watercourses shoreline
Espèce végétale susceptible d'être désignée / Plant Species Likely to be Designated
Carex sterilis
Parcelle d'inventaire / Survey Plot
P-15 Parcelle (numéro de parcelle) / Plot (plot number)
PF-09 Station d'échantillonnage des végétaux (numéro de station) / Plant sampling station (station number)
Peuplements terrestres / Terrestrial Vegetation
Affleurement rocheux / Rock outcrop
Arbustaie / Scrubland
Aulnaie crispé / Alder forest
Boisé / Woodland
Dénudé sec / Dry barren land
Pessière noire à lichen / Black spruce lichen forest
Pessière noire à aulnes / Black spruce alder forest
Pinède grise / Jack pine forest
Anthropique / Anthropogenic
Brûlis / Burnt area
Végétation terrestre dans l'emprise / Terrestrial vegetation in right-of-way
Peuplements humides / Wetland
Plan d'eau / Waterbody
Tourbière arbustive / Shrubby peatland
Tourbière boisée / Treed peatland
Tourbière ouverte / Open bog
Végétation humide dans l'emprise / Wetland in right-of-way
GALAXY
Mine de lithium Baie-James /James Bay Lithium Mine
Carte / Map 6-12
Groupements végétaux et espèces floristiques à statut particulier / Plant Community and Special Status Plant Species
Sources :
Orthoimage : Galaxy, août / august 2017
Inventaire / Inventory: WSP 2017
Données du projet / Project data : Galaxy, 2021
0 240 480 m
UTM, fuseau 18, NAD83
Juillet / July 2021
Dessin : A. Masson
Approbation : C. Martineau
201-12362-00_c6-12_wspT071_vegetation_210701.mxd
wsp



Vers Radisson /
To Radisson
355 000
360 000
5 792 500
5 790 000
CE1
CE2
CE3
CE4
CE5
CE6
450 kV (4003-4004)
Route Billy-Diamond
Billy-Diamond road
Lac Asiyan Akwakwatipusich
Lac Kapisikama
Lac Asini Kasachipet
Relais routier
Truck stop
km 381
Vers Matagami /
To Matagami
Zone d'étude locale / Local study area
Feux (année) / Fire (year)
2005
2009
2013
Infrastructure / Infrastructure
Route principale / Main road
Route d'accès/ Access road
Ligne de transport d'énergie / Transmission line
Relais routier / Truck stop
Hydrographie / Hydrography
CE3
Numéro de cours d'eau / Stream number
Cours d'eau permanent / Permanent stream
Cours d'eau à écoulement diffus ou intermittent / Intermittent or diffused flow stream
Plan d'eau / Waterbody
GALAXY
Mine de lithium Baie-James /James Bay Lithium Mine
Carte / Map 6-13
Feux de forêt récents /
Recent Forest Fires
Sources :
Orthoimage : Galaxy, août / august 2017
Feux de forêt / Forest fires : MFFP Québec, 2018
Inventaire / Inventory : WSP 2017
0 240 480 m
UTM, fuseau 18, NAD83
Juillet / July 2021
Dessin : A. Masson
Approbation : C. Martineau
201-12362-00_c6-13_wspT331_feux_210701.mxd

#### Table 6-26 Plant groups identified in the study area

| Plant groups | Surface area (ha) in the study area | Representativeness (%) |
|---|---|---|
| **Terrestrial environment** | | |
| Rocky outcrop | **41.25** | **1.1** |
| Scrubland | **241.64** | 6.6 |
| Green alder | 7.66 | 0.2 |
| Wooded area | 4.58 | 0.1 |
| Burns | 161.65 | 4.4 |
| Dry barren | 21.40 | 0.6 |
| Land footprint | 10.13 | 0.3 |
| Black spruce-lichen stand | 114.61 | 3.1 |
| Black spruce-moss stand | 49.69 | **1.4** |
| Jack pine stand | 15.51 | 0.4 |
| **Terrestrial environment subtotal** | **682.99** | **18.2** |
| **Wetlands** | | |
| Wetland footprint | **15.94** | 0.4 |
| Shrub peatland | **747.95** | **20.3** |
| Wooded peatland | **800.54** | **21.8** |
| Open peatland | **1,326.52** | **36.1** |
| **Wetland subtotal** | **2,743.96** | **78.6** |
| **Hydrous environment** | | |
| Wetland footprint | **0.48** | 0.0 |
| Lake | **67.03** | 1.8 |
| **Pond** | **6.06** | **0.2** |
| **Hydrous environment subtotal** | **73.57** | **2.0** |
| **Human environments** | | |
| **Human environment subtotal** | **43.52** | **1.2** |
| **Total** | **3,676.15** | **100.0** |

The black spruce-lichen stand and the jack pine stand are the two main land groups observed in land wooded areas. In both cases, the velvetleaf huckleberry, sheep laurel and regenerating black spruce are generally the dominant species in the shrub layer; spruce stands, in turn, are often home to Labrador tea (*Rhododendron groenlandicum*). Lichen dominate the muscinal stratum and moss is usually found in slight depressions.

The other undefined wooded areas correspond to land plant groups identified during the photo interpretation of the study area but not physically visited during the field surveys. They are notably located outside of the priority zones targeted for the project infrastructure implementation. Given the limited diversity of the habitats identified during the field surveys, it would be reasonable to assume that these undefined groups mostly consist of blackspruce-lichen stands and jack pine stands.

The study area also includes human environments (over 43.52 ha or 1.2% of the surface area), among them the km 381 truck stop facilities, the Billy-Diamond highway, the off-road trails and the access roads for drilling activities, as well as a remote landfill.

### Wetlands

Wetlands prevail in the study area, covering **2,890.95** ha (**78.6**%) of the total surface area being studied. Following the field surveys, the wetland plant groups of the study area were classified into four types: open peatlands, shrub peatlands, wooded peatlands and the wetland zones in the right-of-way for Hydro-Québec transmission lines. Some larger ponds were also found inside the peatlands.

The wooded and shrub peatlands of the study area are mainly marked by the presence or absence of a tree cover. Black spruce and heath account for the vast majority of the vegetation found in both groups. Heath is mostly comprised of Labrador tea and leatherleaf (*Chamaedapne calyculata*) and the herb layer includes three-leaved Solomon's seal (*Maianthemum trifolium*) and some sedge grasses, among them water sedge (*Carex aquatilis var. aquatilis*), few-seeded sedge (*Carex oligosperma*) and three-seeded sedge (*Carex trisperma*). Onsite observations appear to indicate that the shrub peatlands are actually young wooded peatlands.

On the territory being studied, shrub peatlands distinguish themselves from open peatlands, first because of much thicker regenerating black spruce, sometimes in conjunction with tamarack (*Larix laricina*). In the open peatlands, the shrub layer is generally dominated by heath. In the overall study area, the continuity among the various types of peatlands results in the creation of large wetlands where open, shrub and wooded peatlands converge. Also, some of the bigger shrub peatlands include smaller areas comprised of open peatlands with ponds.

The propagation of forest fires over the past two decades has impacted the distribution of wooded and shrub peatlands in the study area. Today, they are increasingly found in the northern part of the study area, which happens to be the section least affected by the recent burns. Notably, some of the open peatlands identified at the site are in fact former wooded peatlands that have burned in the recent past.

While most of the open peatlands are not very diversified (comprised mostly of heath), some of the ones located along watercourses consist of a greater variety of grass species and shrubs. The same could be said about the richness of the plant association in the shrub peatlands located along watercourses, where tamarack usually prevails over black spruce as far as the regeneration of shrub species is concerned. These more diversified bordering peatlands correspond to fens, which differ from bogs depending on their water supply. Bogs are wetlands essentially supplied by rainwater (rain and snow), while the water supply of fens also includes **runoff** water enriched by minerals culled from the soil of neighbouring habitats (Leboeuf and coll., 2012). Because of this variance in water supply, bogs are more acidic and host fewer nutrients than fens; this has an impact on the composition and diversity of the area's vegetation.

Fens are hence able to rely on a vaster wealth of species. In addition to heath and tamarack, speckled alder (*Alnus incana subsp. rugosa*), scrub birch (*Betula glandulosa*), sweet gale (*Myrica gale*) and willows (*Salix sp.*) are all found in the shrub layer of these fens. The herb layer is dominated by sedge, which includes several species of sedge grass (*Carex aquatilis var. aquatilis, Carex canescens, Carex lenticularis var. lenticularis, Carex oligosperma, Carex pauciflora, Carex rostrata, Carex trisperma*) and cottongrass (*Eriophorum angustifolium subsp. angustifolium, Eriophorum vaginatum var. spissum, Eriophorum virginicum*). The fens located next to calcium-rich soil will contain a particularly wide variety of plant species (Grondin and coll., 2005).

The bogs in the study area are nevertheless the largest and most frequently encountered groups. The surveys carried out made it possible to confirm that these environments have characteristics typical of the wetlands and peatlands encountered throughout the James Bay territory (Payette and Rochefort, 2001).

Hydrous environments, which include lakes and watercourses (drainage bed and adjacent wetlands comprising the littoral), cover 73.57 ha or 2.0% of the study area.

### Functions of wetlands

**The wetlands identified in the study area fulfill functions of biodiversity conservation, with peatlands offering food, shelter and reproduction potential for living species, including some species of wildlife with protected status (Section 6.3.7) such as the common nighthawk and the rusty blackbird, which could use these environments and be found in the bogs during their nesting seasons according to Robert et al. (2019). The habitat function is also supported by the biogeochemical processes of the bogs, which help provide characteristics sought by these species. Wetlands identified in the study area also fulfill biogeochemical functions, including the export of nutrients and organic matter. Bogs help to sequester carbon and mitigate the effects of climate change. Carbon is notably stored in decaying matter, which accumulates over time (Hanson et al., 2008). Peatlands can also play a role in regulating water levels with their water retention capacity, which prevents water from flowing quickly to a receiving watercourse, promoting retention and evaporation.**

## SPECIAL-STATUS PLANT SPECIES

The CDPNQ registers include no mention of threatened or vulnerable plant species within a 20-km radius of the centre of the study area.

The surveys determined that most of the groups (wetland and land) had a very limited potential for comprising threatened or vulnerable plant species, mainly due to the environment's weak biodiversity and numerous disturbances such as severe forest fires, which significantly modified the plant communities in the study area over the last few years. Based on the data regarding habitats in the study area and the preferred habitats of special-status species gathered during the 2017 surveys, Table 6-27 depicts the potential presence of the 15 species targeted prior to the surveys being conducted. **No new special-status plant species, however (April 2021) were identified during the 2017 and 2020 surveys.**

## INVASIVE EXOTIC PLANT SPECIES

Invasive exotic plant species are comprised of plants introduced into zones outside of their natural distribution areas and which could threaten the new environment and its biodiversity. Given their dispersion capabilities and rapid growth, these species have competitive advantages over native species, allowing them to prevail within the plant community of a given environment and possibly even locally eliminate certain native species.

No invasive exotic plant species was observed in the study area during the surveys. While the issue of invasive exotic plant species is not as widespread in northern Quebec as in other areas, care should be taken to ensure that they do not propagate further.

**Table 6-27 Plant species with a special status identified in or near the James Bay region or located near or potentially present in the study area**

| Common name | Latin name | Provincial / federal status | Priority status/ranking[1] | Habitat | Potential presence |
|---|---|---|---|---|---|
| Great northern aster | *Canadanthus modestus* | Likely/none | S2 | • Mostly wetlands (sandy shores, wet meadows, swamps)<br>• Occasionally on land (urban terrain)<br>• On limestone soil<br>• Conducive to sun-loving plants | Low |
| Calypso | *Calypso bulbosa* var. *americana* | Likely/none | S3 | • Palustrine (swamps, wooded fens) and land (coniferous/softwood forests, mixed-wood forests) environments<br>• Conducive to plants that thrive in the shade | Low |
| Ojibway waterwort | *Elatine ojibwayensis* | Likely/none | S1 | • Banks of rivers and streams, marshes. Usually in shallow water<br>• Conducive to sun-loving plants | Low |
| Northern twayblade | *Neottia borealis* | Likely/none | S2 | • Land environment<br>• Coniferous forests, rocky outcrops<br>• On alkaline soil<br>• Conducive to plants that thrive in the shade | Low |
| Purple meadow-rue | *Thalictrum dasycarpum* | Likely/none | S2 | • Boggy banks, glades and wet meadows | Low |
| Northern gooseberry | *Ribes oxyacanthoides* subsp. *oxyacanthoides* | Likely/none | SH | • Rocky or gravel shores<br>• Sometimes on exposed sand<br>• Conducive to sun-loving plants | Low |
| McCall willow | *Salix maccalliana* | Likely/none | S2 | • Rocky and gravel lake shores, swamps, wooded peatlands (bogs/fens)<br>• Conducive to sun-loving plants | Medium |
| False mountain willow | *Salix pseudomonticola* | Likely/none | S1 | • Rocky and gravel shores, swamps, wooded bogs<br>• Conducive to sun-loving plants | Low |

1 S ranking (sub-national): score assigned to an element at the provincial or federal level which designates priority in regard to conservation (scores range from S1 to S5, in order of decreasing priority). Elements ranked S1, S2 and S3 are considered precarious. A score of SH denotes what is deemed an historical occurrence, meaning that no such occurrence has been observed or noted over the past 40 years.

### PLANT SPECIES OF TRADITIONAL INTEREST FOR INDIGENOUS PEOPLE

The plant survey was conducted while paying particular interest to the presence of plants traditionally used by the Cree people. The documents referred to (Uprety and coll., 2012)**, along with the information gathered through consultations with communities, produced a list of** 546 species or groups of species that are potentially used for medicinal purposes by Indigenous people throughout Canada.

Overall, 27 of the plants present in the field are used by the Cree. Five of them are tree species, 16 of them shrub species, five more of them herbaceous species and the remaining one, a nonvascular muscinal species (Table 6-28). **This list also includes mushrooms that grow after a fire (see Section 6.4.6.1).**

The species with medicinal uses observed in the field are common to both the study area and this part of the Quebec territory.

### Table 6-28 Vascular and nonvascular plants traditionally used by the Cree found in the study area

| Scientific name | French name | English name | Cree name | Parts used |
|---|---|---|---|---|
| **Trees** | | | | |
| *Larix laricina* | Mélèze laricin | Tamarack | Waachinaakan | Inner bark |
| *Picea mariana* | Épinette noire | Black spruce | Inaatuk | Cones |
| *Pinus banksiana* | Pin gris | Jack pine | Ushichishk | Cones and inner bark |
| *Populus tremuloides* | Peuplier faux-tremble | Trembling aspen | Mitos, mitosinipiah | Inner bark |
| *Prunus pensylvanica* | Cerisier de Pennsylvanie | Pine cherry | Pasuwiymayatik, pasisawimin, pusawemina | Bark and roots |
| ***Shrubs*** | | | | |
| *Alnus alnobetula* subsp. *crispa* | Aulne crispé | Green alder | Mathato | Leaves |
| *Alnus incana* subsp. *rugosa* | Aulne rugueux | Mountain alder | Utuspii | Bark |
| *Andromeda polifolia* var. *latifolia* | Andromède glauque | Glaucous-leaved bog rosemary | Kakouboushk | Small branches |
| *Empetrum nigrum* subsp. *nigrum* | Camarine noire | Crowberry | Askiminasiht, ebshjimend | Fruit |
| *Gaultheria hispidula* | Petit thé | Creeping snowberry | Unknown | Leaves and fruit |
| *Juniperus communis* var. *depressa* | Génévrier commun déprimé | Juniper | Kaahkaachiiminaahtikw | Roots |
| *Juniperus communis* var. *megistocarpa* | Génévrier commun | Juniper | Kaahkaachiiminaahtikw | Roots |
| *Juniperus horizontalis* | Génévrier horizontal | Creeping juniper | Ahaseminanatik, masekesh, masikeskatik | Small branches and fruit |
| *Kalmia angustifolia* | Kalmia à feuilles étroites | Sheep laurel | Uschipikwh | Leaves |
| *Rhododendron groenlandicum* | Thé du Labrador | Labrador tea | Kachebuk | Leaves |
| *Rubus idaeus* | Framboisier sauvage | Raspberry | Athoskan, athoskunatikwah, ayosikan, uyooskan, ayuwskun, ayooskunak, anosh'kanek | Stems, roots and fruit |
| *Salix bebbiana* | Saule de Bebb | Willow | Nipisigibi, nipisiah, nipisi, nipisis, atikwupamuk, wekope, nepiseatik, nepise, nipistakwah | Small branches, stems and inner bark |
| *Salix planifolia* | Saule à feuilles planes | Tea-leaved willow | Waskayabaduk | Bark |
| *Salix sp.* | Saules | Willow | Utusphi | Inner bark |

## Table 6-28 Vascular and nonvascular plants traditionally used by the Cree found in the study area (cont.)

| Scientific name | French name | English name | Cree name | Parts used |
|---|---|---|---|---|
| *Vaccinium myrtilloides* | Bleuet | Blueberry | Sipikomin, ithinimina, iynimin, iyinimin, inimena | Stems, roots and fruit |
| *Viburnum edule* | Pimbina | Low bush-cranberry | Moosomina, mosomina, moosominahtik | Small branches, buds, stems and leaves |
| ***Herbaceous*** | | | | |
| *Equisetum sylvaticum* | Prêle des bois | Horsetail | Mistatimosoy, okotawask, enskowusk, kiychiwiykusk | Whole plant |
| *Geocaulon lividum* | Comandre livide | Northern comandra | Unknown | Fruit |
| *Maianthemum canadense* subsp. *Canadense* | Maïanthème du Canada | Wild lily-of-the-valley | Sosowipukosak, soskopukwagoh | Leaves |
| *Nuphar variegata* | Grand nénuphar jaune | Yellow pond lily | Waskitipak, oskitipak, waskutamo, waskatamo, waskatamow, oskotamo, pwakumosikum | Whole plant |
| *Sarracenia purpurea* | Sarracénie pourpre | Pitcher plant | Ayigadash | Whole plant |
| ***Mosses*** | | | | |
| *Sphagnum fuscum* | Sphaigne brune | Peat moss | Uske, muskak, askiyah, mikaskwahkawow, asaskumkwa, eskiya, awasistche | Whole plant |

### CHEMICAL CHARACTERIZATION

**Six traditionally used species were selected to undergo chemical analysis.** It should be noted that there are no threshold criteria for the parameters analyzed for these plants. At this time, no standard has been set by the Canadian Council of Ministers of the Environment (CCME) or the **MELCC** for the presence of metals in vegetation. In the case at hand, the analysis therefore serves only to document the baseline concentrations of metals present in the leaves/needles, fruits and branches of the six species sampled in the study area.

Table 6-29 compares the means among all samples for the different parameters measured. This table also provides the mean total for each parameter for the 30 samples as well as the standard deviation for each parameter among the species averages.

Overall, the chemical characterization of the 30 samples of six plant species showed that the concentrations measured in the leaf, branch and fruit tissues were relatively low and indicated a growth environment that was affected little by local or regional industrial activities. Table 6-29 nonetheless reveals that, of the 24 metals analyzed, seven showed elevated average concentrations: aluminum (98 mg/kg), barium (53 mg/kg), boron (10.1 mg/kg), iron (60 mg/kg), manganese (626 mg/kg), strontium (28 mg/kg) and zinc (38 mg/kg). These seven metals showed higher concentrations across all plant species analyzed. The plant species found on the site are nonetheless adapted to these metal-bearing soils and are therefore capable of tolerating high metal concentrations. Plants can regulate the input of metals in soil and thereby reduce its toxicity.

## Table 6-29 Comparison of means for parameters measured in the tissues of six plant species

| Parameter | Blueberry (mg/kg) | Labrador tea (mg/kg) | Sheep laurel (mg/kg) | Alder (mg/kg) | Black spruce (mg/kg) | Tamarack (mg/kg) | All samples (mg/kg) | Standard deviation (mg/kg) |
|---|---|---|---|---|---|---|---|---|
| Aluminum (Al) | 200 | 30 | 51 | 108 | 155 | 42 | 98 | 69 |
| Antimony (Sb) | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | - |
| Silver (Ag) | 0.031 | 0.004 | 0.007 | 0.010 | 0.019 | 0.009 | 0.013 | 0.010 |
| Arsenic (As) | 0.137 | 0.032 | 0.061 | 0.090 | 0.067 | 0.070 | 0.076 | 0.035 |
| Barium (Ba) | 44 | 62 | 49 | 76 | 34 | 54 | 53 | 15 |
| Beryllium (Be) | 0.004 | 0.002 | 0.002 | 0.015 | 0.002 | 0.002 | 0.004 | 0.005 |
| Boron (B) | 6.5 | 9.2 | 7.5 | 11.0 | 7.4 | 19.1 | 10.1 | 4.7 |
| Cadmium (Cd) | 0.098 | 0.005 | 0.006 | 0.022 | 0.016 | 0.037 | 0.031 | 0.035 |
| Chromium (Cr) | 0.261 | 0.039 | 0.064 | 0.170 | 0.049 | 0.039 | 0.104 | 0.092 |
| Cobalt (Co) | 0.217 | 0.023 | 0.022 | 4.452 | 0.101 | 0.044 | 0.810 | 1.786 |
| Copper (Cu) | 5.2 | 4.5 | 6.0 | 9.1 | 3.2 | 2.4 | 5.1 | 2.4 |
| Iron (Fe) | 115 | 34 | 30 | 107 | 36 | 36 | 60 | 40 |
| Lithium (Li) | 0.124 | 0.010 | 0.015 | 0.842 | 0.089 | 0.020 | 0.183 | 0.326 |
| Manganese (Mn) | 980 | 660 | 255 | 516 | 726 | 618 | 626 | 239 |
| Mercury (Hg) | 0.005 | 0.005 | 0.006 | 0.005 | 0.013 | 0.012 | 0.008 | 0.004 |
| Molybdenum (Mo) | 0.130 | 0.036 | 0.144 | 0.596 | 0.014 | 0.012 | 0.155 | 0.223 |
| Nickel (Ni) | 1.57 | 0.47 | 1.22 | 5.54 | 0.99 | 0.74 | 1.75 | 1.90 |
| Lead (Pb) | 0.672 | 0.175 | 0.246 | 0.331 | 0.180 | 0.148 | 0.292 | 0.198 |
| Selenium (Se) | 0.04 | 0.03 | 0.05 | 0.01 | 0.03 | 0.33 | 0.08 | 0.12 |
| Strontium (Sr) | 16 | 18 | 33 | 57 | 16 | 28 | 28 | 16 |
| Titanium (Ti) | 3.2 | 1.0 | 0.8 | 1.7 | 1.5 | 1.3 | 1.6 | 0.8 |
| Uranium (U) | 0.008 | 0.002 | 0.001 | 0.003 | 0.003 | 0.002 | 0.003 | 0.002 |
| Vanadium (V) | 0.258 | 0.040 | 0.045 | 0.143 | 0.057 | 0.043 | 0.098 | 0.088 |
| Zinc (Zn) | 44 | 25 | 26 | 48 | 55 | 30 | 38 | 13 |

Table 6-29 also compares the means for the different parameters measured among all samples for the species collected. We note that, compared with other species analyzed, blueberries showed particularly high concentrations of aluminum (200 mg/kg), iron (115 mg/kg) and manganese (980 mg/kg). The alder tissue samples, on the other hand, showed an elevated average concentration of aluminum (108 mg/kg), barium (76 mg/kg), iron (107 mg/kg) and strontium (57 mg/kg) compared with the other plant species. In black spruce, average concentrations of aluminum (155 mg/kg) and zinc (55 mg/kg) were significantly higher than the total average results compiled for all species. Among Labrador tea, sheep laurel and tamarack, none of the three stood out significantly for the parameters analyzed versus the total mean.

## 6.3.2 TERRESTRIAL FAUNA

### 6.3.2.1 LARGE FAUNA

#### SPATIAL BOUNDARIES AND METHODOLOGY

Three species of large mammals are likely to frequent the study area: caribou (*Rangifer tarandus caribou*), moose (*Alces alces americana*) and black bears (*Ursus americanus*). **The grey wolf, sometimes considered to be a fur-bearing animal, is also likely to use the study area.**

Caribou, and woodland caribou especially, are a sensitive component of the natural environment. This species benefits from dual protection, at both the federal and provincial levels. For these reasons, a study area for large fauna was defined primarily with caribou in mind. The study area corresponded to a 50-km radius from the centre of the proposed mine, which amounts to an area of roughly 7,850 km² (Map 6-14). This limit was established in accordance with the guidelines for managing woodland caribou habitat (Équipe de rétablissement du caribou forestier du Québec, 2013*a*),[6] which specify in point 6 that the minimum area of units of analysis for the habitat disturbance rate for woodland caribou is 5,000 km².

Activity of large fauna in the study area was determined based on different information sources, i.e., data from various government organizations, scientific articles and reports published on mammals in the area or on species biology, and on an aerial survey.

The Direction de l'aménagement de la faune du Nord-du-Québec of the MFFP confirmed that the moose and caribou survey was very limited in the study area. The only aerial survey data available from regional authorities were from a survey of moose per plot in hunting zone 22, conducted in 1991. The region, including the study area, was not formally covered by a survey devoted to woodland caribou. Casual observations of caribou were done during the 1991 survey, but they did not allow definite differentiation between migratory and woodland caribou. Telemetry positions reveal low activity of woodland and migratory caribou in the study area in recent decades. However, it should be noted that locations of collared caribou do not give a full picture of all **individual caribou** frequenting the territory. **Consequently**, the absence of caribou in a given sector does not mean the species is absent from the area.

Based on this information, and to better document use of the area of the proposed mine by caribou and moose, an aerial survey of large fauna was done in the winter of 2018 in a portion of the study area. The survey area selected for caribou covered an area of 1,600 km² and the survey area for moose covered 100 km².

6 The ECCC Recovery Strategy for the Woodland Caribou recommends evaluating the effects of a project taking spatial scope into account, which includes range, as defined in Appendix J of the species recovery program. The project is located in the QC6 conservation unit, which is 621,562 km² in area. Since unit QC6 covers the majority of the range of woodland caribou in Québec, it would be unrealistic to analyze the effects of the project for the whole unit.

The method used was an exhaustive survey of the area. The survey techniques were defined based on the two target species. The survey plan for caribou involved doing equidistant overflights in a north-south direction, spaced 1.75 minutes of longitude (approximately 2 km) apart, consistent with the method used by the MFFP (Courtois and coll., 2001). This overflight was done at an altitude of roughly 200 m and at a maximum speed of 140 km/h. Identification of caribou trails and their characterization, including the counting and classification of animals (sex and age group), was done during a single helicopter overflight phase. Moose were surveyed by means of equidistant 500-m transects, applying the method used by the MFFP (Courtois, 1991).

The navigator/observer was responsible for guiding helicopter movements as well as for entering each observation using a sequential number. This was done using a Touchbook portable computer, in a record specially designed for this purpose. Records and photos were automatically geo-referenced in the database and figured in the flight plan on the screen, thereby preventing duplication of observations collected. Despite the fact that the field campaign targeted primarily caribou and moose, signs of presence or observations of other species of interest identified during overflights, such as grey wolves, were also noted.

The survey was done March 4 to 6, 2018, inclusive. Despite a sometimes partly cloudy sky, visibility allowed clear identification of the trail networks, even for small fauna (hares, ptarmigan). The very open forest environment, due largely to past fires, facilitated the detection of trail networks and animals in general.

### CARIBOU

The report of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) established a national consensus regarding the different designatable units of caribou in Canada. Québec is home to a significant portion of designatable unit no. 6 “boreal caribou” (COSEWIC, 2011), whose distribution in the boreal forest extends from Labrador across Québec, toward Ontario and the prairie provinces to the Rockies and Northwest Territories. At the provincial level, boreal caribou are also known as “woodland caribou.”[7] The status of woodland caribou is distinct from that of eastern “migratory caribou” (unit no. 4), which includes the George River and Leaf River populations (herds). The study area is located in the overlapping area of the ranges of the woodland and migratory caribou of the Leaf River population (Couturier and coll., 2004). Therefore, animals of these two designatable units are likely to frequent the project study area.

#### Federal context for woodland caribou

In response to COSEWIC recommendations (2002), woodland caribou were listed as a threatened species in Canada under the *Species at Risk Act* in June 2003. In developing its recovery strategy, ECCC adopted a probabilistic assessment approach to the level of self-sustainability of populations, based on the capacity of the range to sustain a population of woodland caribou. This approach focuses on assessing three key indicators: the demographic trend of the population, its size and the level of disturbance of the range. Therefore, a population judged to be self-sustaining will have a stable or growing demographic trend, a size exceeding the critical level and a low to moderate level of disturbance within the range occupied.

According to the strategy adopted, ECCC determined a disturbance rate of 35% to be moderate and corresponding to a likelihood of self-sustainability of 0.60. However, it must be considered that the 0.60 threshold is a minimum, since the likelihood that the population will not be self-sustaining remains significant at 0.40. The probabilistic approach applied by ECCC in 2008 was updated in 2011 to consider new data and analytical methods (Environment Canada, 2008 and 2011). Notably, this update revealed, with even greater clarity, that 70% of the variation recorded in recruitment of woodland caribou populations is explained by a single variable, the habitat disturbance rate, which includes human and naturally induced (forest fires) disturbances.

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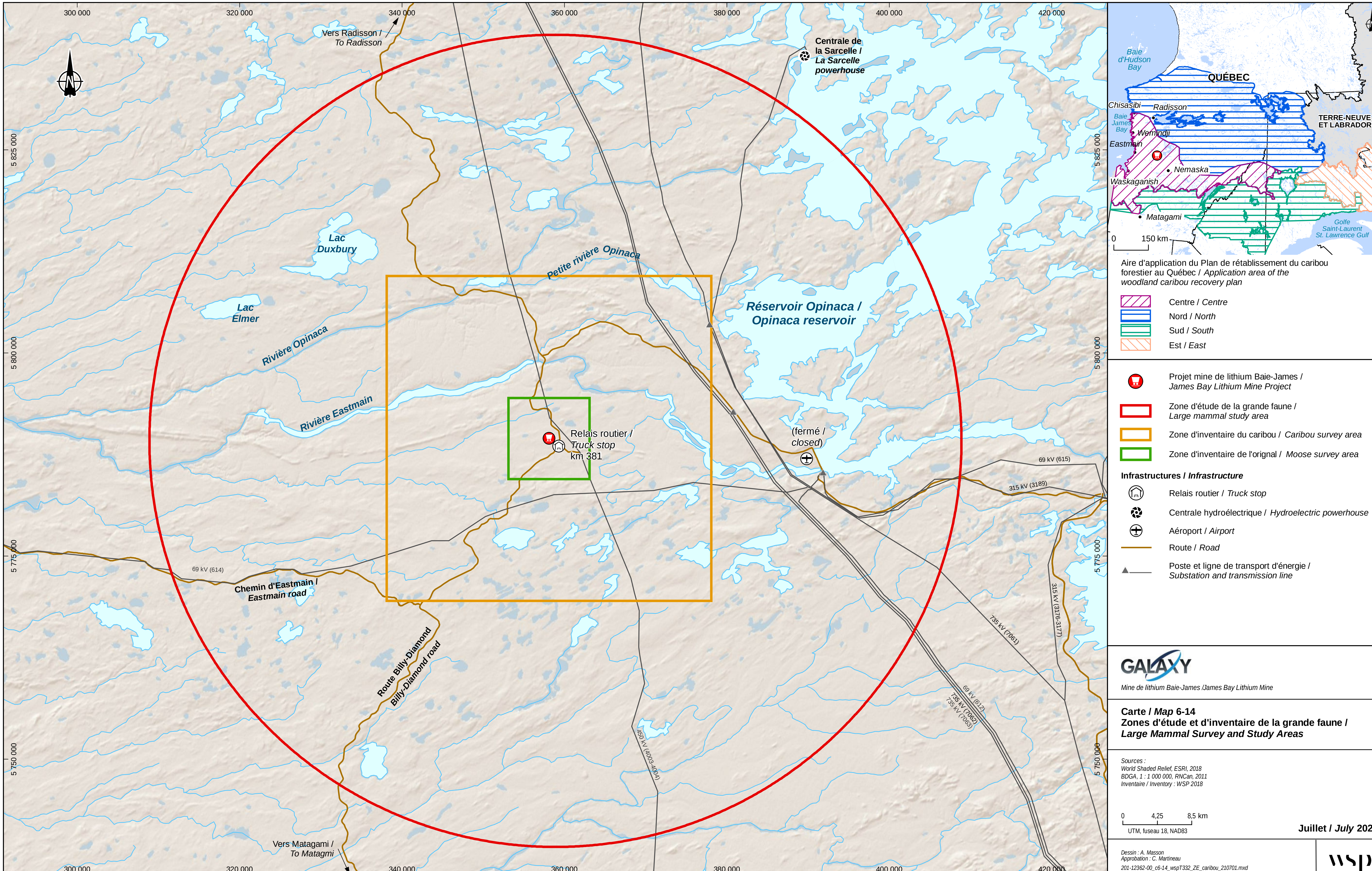
[7] This designation will be used from this point onward in the environmental impact assessment.




**Carte / Map 6-14**
**Zones d'étude et d'inventaire de la grande faune /**
***Large Mammal Survey and Study Areas***

Sources :
World Shaded Relief, ESRI, 2018
BDGA, 1 : 1 000 000, RNCan, 2011
Inventaire / Inventory : WSP 2018

0 4,25 8,5 km
UTM, fuseau 18, NAD83

Juillet / July 2021

Dessin : A. Masson
Approbation : C. Martineau
201-12362-00_c6-14_wspT332_ZE_caribou_210701.mxd

wsp

For each local population, the recovery strategy for the woodland caribou in Canada (EC, 2012) designates the essential caribou habitat (conservation unit) based on three local factors: the habitat location, area and type. Of the six conservation units selected by Québec in the analysis of the federal recovery strategy, three were assessed as non-self-sustaining, two as self-sustaining and one as being of uncertain status.

The project study area is included in conservation unit QC6, an area of 621,562 km² that represents most of the range of woodland caribou in Québec (Table 6-30). The disturbance rate in this unit was evaluated at 30% and the analysis concluded that it is likely that the population occupying it is self-sustaining.

**Table 6-30 Level of disturbance and likelihood of self-sustainability for six conservation units used in the woodland caribou federal recovery strategy for Québec**

| Conservation unit or local population (Québec and Labrador) | Area (km²) | Level of disturbance (%) | | Undisturbed habitat (%) | Likelihood of self-sustainability Risk assessment |
|---|---|---|---|---|---|
| | | Forest fire | Human activity | | |
| QC1- Val-d'Or | 3,469 | 0.1 | 60 | 40 | Unlikely: NSS |
| QC2- Charlevoix | 3,128 | 4 | 77 | 20 | Very unlikely: NSS |
| QC3- Pipmuacan | 13,769 | 11 | 51 | 41 | Unlikely: NSS |
| QC4- Manouane | 27,164 | 18 | 23 | 61 | As likely as not: NSS/SS |
| QC5- Manicouagan | 11,341 | 3 | 30 | 67 | Likely: SS |
| **QC6- Remainder of occupied area** | **621,562** | **20** | **10** | **70** | **Likely: SS** |

Notes: NSS: not self-sustaining; NSS/SS: not self-sustaining or self-sustaining; SS: self-sustaining
Text in bold indicates the conservation unit affected by the project.
Disturbances where fire and human activities overlap were counted only once. Buffer zones of 0.5 km were applied to disturbances caused by human activities.
The status of these units remained unchanged between the 2011 and 2012 Environment Canada surveys.

*Sources: Environment Canada (2011 and 2012).*

### Provincial context for woodland caribou

Woodland caribou were designated as vulnerable in Québec in February 2005 under the *Act respecting threatened or vulnerable species* (Order in Council 75, 2005). As a result, Québec proceeded, within its areas of jurisdiction and obligation, to develop and implement a provincial woodland caribou recovery strategy prepared by the Équipe de rétablissement du caribou forestier du Québec, a team which consists of various specialists and organizations involved in protecting this species. An initial Québec woodland caribou recovery strategy was developed for the period 2005–2012 and a second was submitted to Québec authorities in May 2013 (Équipe de rétablissement du caribou forestier du Québec, 2008 and 2013*b*). The recovery team also prepared guidelines for managing woodland caribou, a first version of which was tabled in 2010, followed by a revised version in 2013 (Équipe de rétablissement du caribou forestier du Québec, 2010 and 2013*a*). The project study area is in the central portion of the area of application of the Québec woodland caribou recovery strategy (Map 6-14).

### Density, demography and land use

Woodland caribou live in very low densities, ranging from one to two animals/100 km², according to surveys conducted in the 1990s (Courtois, 2003). Between 2000 and 2010, the MFFP intensified its woodland caribou survey efforts to harmonize, among other things, forest activities with maintenance of this species. The surveys conducted during this period in the range counted nearly 3,000 caribou over 190,234 km², for an average of 1.5 caribou/100 km² (Équipe de rétablissement du caribou forestier du Québec, 2013*b*).

Woodland caribou populations present in the Nord-du-Québec region are defined according to the patterns of land use by individual animals. Although most animals remain within the territory used by their population, there is nonetheless some movement of individuals between these populations (especially during rut or in spring). Despite these movements between populations, most of these individuals return to winter with their parent population. Membership of an individual to a given population is therefore determined by their location in the month of February each year. Even though most individuals return to winter with their parent population, it occasionally happens that some caribou "migrate" from one population to another.

The woodland caribou of the local population (herd) dubbed Nottaway, which occupies the territory north of Matagami, are the most likely to frequent the study area of the project. Note, however, that there may be exchange of individuals between this population and that of Témiscamie and Assinica populations. A report of a woodland caribou recovery study done by a work group from the Comité scientifique du Nord-du-Québec provides relevant scientific data, particularly regarding the Nottaway population (Rudolph and coll., 2012). It concludes that this population, like those of Témiscamie and Assinica further east, is considered not self-sustaining. An exhaustive survey was done covering the range of the Nottaway woodland caribou herd in 2016 (Szor and Brodeur, 2017). Based on the results of this survey, the population of the Nottaway herd was estimated to be 308 individuals, applying a detection rate of 85% (Courtois and coll., 2001).

The drop in the recruitment rate and the survival rate of adult females along with a disturbance rate higher than the threshold required to ensure persistence of the populations are the key elements supporting this conclusion. Legal and illegal hunting can also play an important role in woodland caribou mortality in the area where the mining project is planned. The study area is part of hunting zone 22, where the simultaneous presence of migratory and woodland caribou is likely in winter. However, before February 1, 2018, hunting of migratory caribou was permitted in sector B of hunting zone 22, north of the study area.[8] Even though this hunt targeted primarily migratory caribou, taking of woodland caribou was probable, especially in winters when migratory caribou frequented more southerly areas (Jean and Lamontagne, 2005).

**Telemetric data was obtained from the MFFP, specifically its woodland caribou monitoring program. The purpose of this monitoring is to increase knowledge about the distribution, abundance, trend and dynamics of woodland (boreal) caribou populations to inform and support the decisions regarding the management and conservation of this species. The acquisition of telemetric data represents only one of the numerous components of the program. The telemetric data is used, among other things, to establish the range of the various populations, describe the patterns of land use, estimate the survival rates of the various segments of the population and locate individuals in order to obtain bioindicators for the assessment of the population trend.**

**Considering that the "female" segment of the population is the one having the biggest impact on the demography of woodland caribou populations, the current monitoring is essentially geared towards females. Thus, the data presented is not necessarily representative of the "male" segment of the population. Also, a very small proportion (<5%) of each woodland caribou population is equipped with telemetric collars. These collars are, as much as possible, evenly distributed across the range of the population. It is important to bear in mind that the absence of telemetric data in the area does not necessarily mean the absence of caribou. Since the behaviour of the woodland caribou is gregarious, especially during winter, it is important to consider that a telemetric localization at a specific location can in fact reflect the presence of several caribou.**

[8] The migratory caribou hunt has been banned indefinitely in Québec since February 1, 2018.

Consequently, according to information provided by MFFP representatives, a single woodland caribou with a telemetric collar frequented the study area from December 2008 to the end of March 2009 (Map 6-15). In the opinion of one MFFP representative,[9] analysis of movement patterns appeared to show that it was an individual from the Assinica population which, for whatever reason, made a rather atypical move and found itself in the area east of Eastmain, historically used by the Nottaway population. Given that migratory caribou were present in this same area in December 2008, it is possible that this individual followed a group of caribou moving north and was found in this area as a result.

**The MFFP's survey and telemetric monitoring methods are standardized across Québec and represent the best available information sources at the provincial level. This information, provided by provincial and territorial authorities, formed the foundation of the estimate of the average size of the local population in the scientific assessment to designate critical habitat for the boreal population of woodland caribou (*Rangifer tarandus caribou)* in Canada (2011 update), presented in Appendix F of the Recovery Strategy for the Woodland Caribou, Boreal Population. Even though the data may display certain biases, it makes it possible to establish the range of the various populations and to describe the patterns of land use by assessing the density of occurrence points. Hence, the data reflects the best representation of the use of the study area by the woodland caribou, which reveals a very low level of use by the boreal caribou.**

Casual observations of signs of caribou presence in the study area were also compiled by the MFFP in September and November 2013. Two caribou were also observed in mid-July 2014 and three at the end of June 2015. The dates of these observations lead to the belief that they were woodland caribou, since migratory caribou are generally not found in this area at those times of year. However, this finding should be qualified, because sometimes migratory caribou in a weakened state or that have suffered injuries do not migrate toward their calving area and remain in their wintering area.[10] It is therefore not certain that signs of presence and casual observations of caribou in the study area were of woodland caribou. Current knowledge therefore indicates that woodland caribou have used the study area very little over the past decade.

Migratory caribou, on the other hand, are likely to frequent the study area in winter, from mid-November to mid-March, in search of food. Telemetric monitoring data provided by the MFFP indicate that, over the past decade, individuals from the Leaf River population frequented the study area during two periods: December 16, 2013, to March 6, 2014, and December 20, 2015, to February 8, 2016 (Map 6-15). This activity occurred within a 20 km and wider radius from the centre of the proposed mine. They were primarily concentrated in the northeast portion of the study area, on the periphery of the Opinaca Reservoir.

The aerial survey done in March 2018 by WSP over a 1,600-km$^2$ portion of the study area did not detect the presence of caribou. It should be noted that during this survey, two Cree participants mentioned that the study area generally had not been frequented by caribou for several years, except a few observations in the Opinaca Reservoir area during periods when migratory caribou usually occupy the area (November to March). Furthermore, the tallyman and his family indicated in April 2018 that caribou are uncommon along the traplines and that, when present, they are generally found in the southern sector of the study area, more than 20 km from the proposed mine.

#### Habitat conditions of woodland caribou

**No ecoforestry database published by the MFFP is available for this area of Québec. The information databases available to characterize the environment are: vegetation (softwood stands) and wetlands from the *Programme d'inventaire forestier du Québec nordique* (PIEN) as well as forest fires (since 1980) and work carried out as part of the EIA of the GLCI James Bay Lithium Mine project (photo interpretation and vegetation surveys conducted in July 2017 by WSP). Information obtained through photo interpretation and the WSP survey provides greater accuracy than information from the PIEN. They were, therefore, used to analyze and describe the biophysical characteristics of different types of habitat frequented by woodland caribou to accomplish their life processes in the study area.**

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9 E-mail from Guillaume Szor, Biologist, Direction de la gestion de la faune du Nord-du-Québec, MFFP, April 20, 2018.
10 Personal conversation with Serge Couturier, Biologist, Ph.D.

*Federal habitat criteria*

The project site is located within the southeastern borders of the Hudson Plains Ecozone (Figure 6-5). The caribou populations likely to use the projected mining site area are located mainly in the Central and Eastern Boreal Shield Ecozones, while the project is located in the Hudson Plains Ecozone. We should therefore consider the biophysical characteristics of critical caribou habitat in these three ecozones.

**Descriptive terms for caribou habitat (Appendix H of the Recovery Strategy for the Woodland Caribou, Environment Canada, 2020) indicate criteria that are difficult to transpose on the sector plant databases available. The wintering period is a critical one for woodland caribou looking for nutritional resources. Biophysical characteristics of broad-scale and winter critical boreal caribou habitat, in the three ecozones that may be used by Nottaway and Assinica caribou populations, are presented below (Tables 6-31 and 6-32).**

**Table 6-31 Biophysical characteristics of critical boreal caribou habitat in the Boreal Shield (East), Boreal Shield (Centre) and Hudson Plains Ecoregions**

| Broad-scale habitat description |
|---|
| **Boreal Shield (East):**<br>• Coniferous and feather moss forests in poorly drained environments and highlands made up of mature coniferous trees with an abundance of terrestrial lichens. Black spruce, jack pine and balsam fir stands with an abundance of lichens.<br>• Bodies of water and wetlands (swamps, swampy areas with tamaracks).<br>• Mountains or undulating terrain.<br>• 300 m elevation.<br>• Intermediate normalized difference vegetation index values.<br>• Selection of old burned areas (more than 40 years old). |
| **Boreal Shield (Centre):**<br>• Lowlands dominated by black spruce in the final successional stage and highlands dominated by jack pine. Bodies of water and wetlands (swamps, swampy areas with tamaracks).<br>• Black spruce lowlands with open canopy.<br>• Low density jack pine or final successional stage black spruce forests and peatlands dominated by black spruce or tamarack with an abundance of terrestrial lichens and a moderate amount of arboreal lichens.<br>• Caribou also use areas with sandy to loamy soil, ranging from dry to wet, and with shallow soil covering bedrock.<br>• 300 m elevation.<br>• Intermediate normalized difference vegetation index values.<br>• Selection of old burned areas (more than 40 years old). |
| **Hudson Plains:**<br>• Environment generally selected to reduce predation risk.<br>• Muskegs, largely shrubbed, and forests of mature coniferous trees with an abundance of lichens.<br>• Shorelines of deep lakes and rivers (birch trees).<br>• Poorly drained areas dominated by sedges, mosses and lichens, as well as open black spruce and tamarack forests.<br>• 150 m elevation.<br>• Intermediate irregularity levels and intermediate values on the normalized difference vegetation index. |

*Source: Environment Canada, 2020*

**Table 6-32 Biophysical characteristics of critical caribou habitat in the wintering period in the 3 ecozones considered**

| Ecozone | Description of winter habitat |
|---|---|
| Hudson Plains | • Dense forests of mature coniferous trees with lichens and wetlands.<br>• Peatlands, mainly open bogs, with terrestrial lichens.<br>• Large patches of intermediate and mature black spruces, muskegs, largely shrubbed, and mixed coniferous stands, all used towards the end of winter. |
| Boreal Shield (Centre) | • Broad ranges of contiguous forest dominated by black spruce.<br>• Open forests of coniferous trees or forests with lower tree density, an abundance of terrestrial and arboreal lichens and low quantities of snow (e.g. shoreline) are also selected. |
| Boreal Shield (East) | • Wooded wetlands. Caribou use the highland tundra to rest.<br>• Dry, bare mountainous terrain, wetlands, forests of mature coniferous trees with lichens, balsam fir stands, dense spruce stands and mixed spruce and fir forests that are over 40 years old selected in the southern regions. Caribou can be observed near frozen bodies of water.<br>• The use of mature forests protected from harvesting increases the possibility of encountering wolves, who choose the same habitat in winter.<br>• Areas with shallow snowfall selected at the end of winter. |

*Source: Environment Canada, 2020*

Based on the general habitat description presented above, the plant communities represented by black spruce forests (with lichen or moss), jack pine forests or wooded peatlands are those that best meet the large-scale habitat conditions for woodland (boreal) caribou. Shrubbed peatland and open bogs were, however, assessed because they may be used during calving, post-calving and rutting periods.

With regard to the biophysical characteristics reported above that come from recovery strategy, the strategy itself states:

> *Biophysical characteristics vary between and within ranges. Since the biophysical characteristics presented in the recovery strategy were developed on a national level based on each ecozone and ecoregion, and not each local population, each provincial or territorial authority could develop or will develop over time a more detailed description of the biophysical characteristics necessary in each range.*

Consequently, the knowledge acquired by the *Gouvernement du Québec* since the recovery strategy was implemented should be considered first when analyzing biophysical characteristics of critical caribou habitat for populations likely to use the projected mining site.

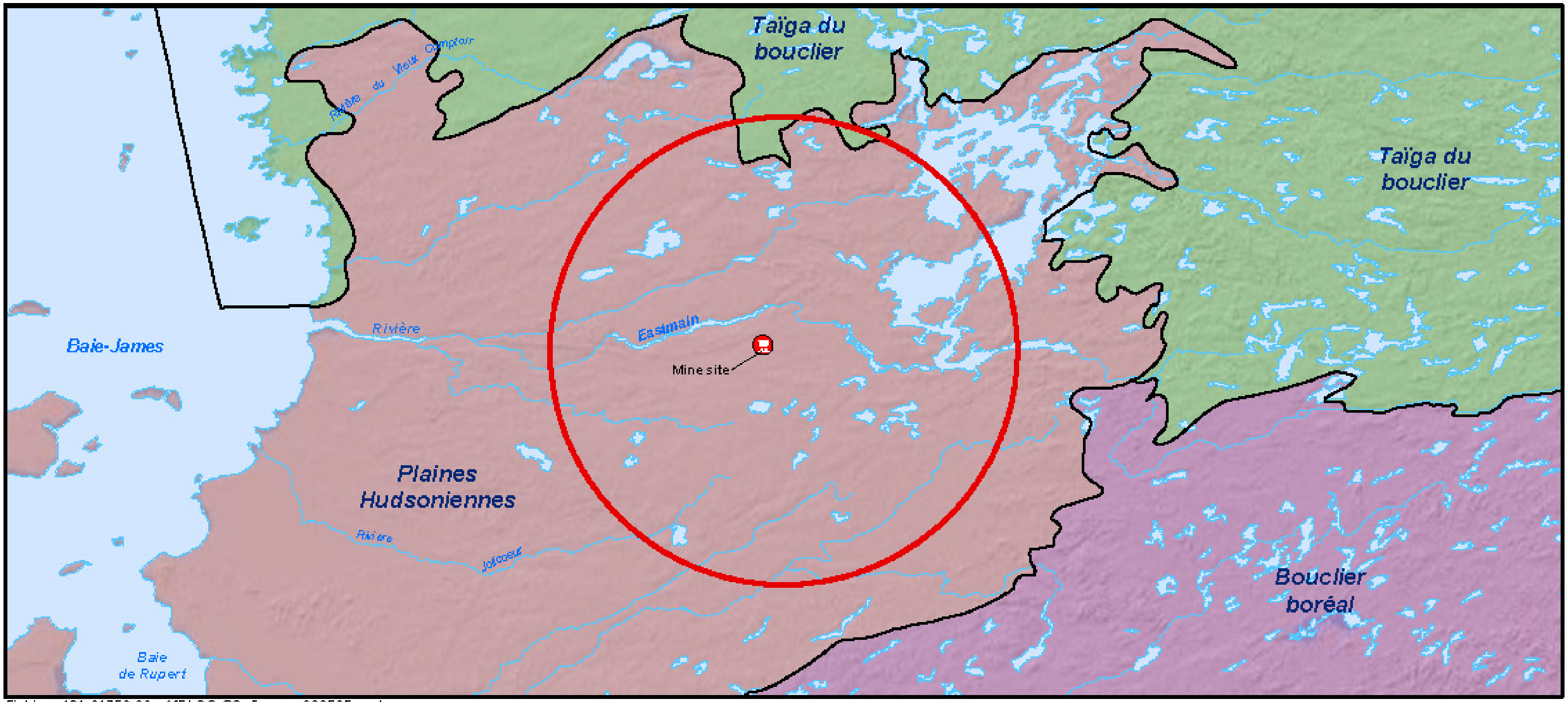

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**Figure 6-5 Project location by ecozone**

### *Provincial habitat criteria*

On a provincial level, the woodland caribou has been designated as a priority species for acquiring knowledge over the last three decades by the Gouvernement du Québec. Since 1990, many scientific studies have been done in Québec, including about 30 master's or doctoral degrees focused on the following four themes:

- effects of forest management and human disturbance;
- habitat selection and use;
- population dynamics;
- effects of predation.

Based on this new knowledge, the Québec woodland caribou recovery strategy was revised in 2013 (Équipe de rétablissement du caribou forestier du Québec, 2008 and 2013a) and guidelines were developed for woodland caribou habitat management (Équipe de rétablissement du caribou forestier du Québec, 2013b). Telemetric data acquired between 1998 and 2019 added additional details, particularly regarding the selection and use of habitats, which are considered in these studies. It also bears mentioning that in 2018, the MFFP started implementing a major program for the surveying and telemetric monitoring of woodland caribou populations across the entire range of the populations of this species. The goals of this program were to expand knowledge on population numbers, range, abundance and trends. These criteria are the main indicators to assess population self-sustainability as prescribed in the species recovery strategy (Environment Canada, 2012) and in the caribou recovery strategy. Ultimately, monitoring will be continued over the long term for each population. The analysis of the effects of the James Bay Mine project in the EIA (WSP, 2018f) was mainly based on this new knowledge, which is the most recent knowledge currently available.

In order to prioritize critical sectors that need to be protected for woodland caribou, as part of the strategy for logging and protected area creation, Québec's leading specialists brought their contemporary scientific knowledge together to do a major study on woodland caribou habitat selection in Québec's boreal forests. This study highlighted the characteristics of habitats selected for the species' main functions, thereby providing greater understanding of the needs of caribou. Habitat selection analysis helped to map out the sectors that offer the most advantageous habitat for caribou by determining the probability of occurrence relative to the species based on models that best describe habitat selection. Within this study, the sector identified as the James Bay region covers around 105,000 $km^2$ and includes the ranges of the Nottaway, Témiscamie and Assinica local caribou populations (herds) in areas subject to forestry activities. Caribou tracked in this sector were primarily in the area located east of James Bay and west of Mistassini Lake. This sector is the most representative habitat that can be selected by caribou likely to use the area of the projected mine. This study demonstrated that, to meet these annual needs, woodland caribou need a very large annual home range (often > 1,000 $km^2$). Habitat selection analysis in the aforementioned study demonstrated the importance of different environments for establishing annual and seasonal woodland caribou home ranges. The study mentions that the results obtained generally matched what had been previously documented in Québec (Courtois et al. 2008; Courbin et al. 2009; Hins et al. 2009).

The main observations on habitat selection were as follows:

- Dry, bare environments have the greatest and most consistent influence on sector use by caribou, both annually and for each of the seasons.
- During the wintering period, caribou seem to primarily select dry bare lands as well as softwood stands that are 40 or more years old with no significant distinction for spruce stands, open or closed fir forests, or other softwoods.
- In winter, wetlands are heavily selected in sectors where they are abundant; these environments seem to be particularly sought out in winter by caribou in the James Bay area.

- **Stands of mature softwoods that are 40-80 years old and 80 or more years are also sought out by caribou, both annually and seasonally.**
- **Open softwood forests (25-40% coverage) made up of spruces and firs are generally selected more often than closed forests, particularly on an annual basis and during rutting.**
- **Bare wetlands were selected most often during calving season and rutting, but their use by caribou seems limited, because they are selected less when they are more available.**
- **Young stands that are 5-40 years old, sectors that have been subject to recent logging or fires, and mixed-wood or hardwood stands are very rarely selected at any point in the year.**

**Multiple authors recognize that during habitat selection, woodland caribou prefer peatlands, mature softwood stands containing lichens and other lichen-rich sites (Équipe de rétablissement du caribou forestier du Québec, 2013a). It is also a recognized fact that caribou avoid recently disturbed environments (Moreau *et al.*., 2012). In summer, woodland caribou mainly live in softwood forests that are over 50 years old (Courbin *et al.*, 2009; Hins *et al.*, 2009; Lantin, 2003), peatlands and dry, bare lands (lichen tundra).**

**Maps were produced for each of the seasons and for the full year, identifying the sectors with characteristics sought out by caribou. According to the authors, the synthesis map produced by combining the habitat selection information from different seasons is the most representative of the potential of a sector's woodland caribou occurrence, because it factors in all of the sites that are the best for meeting the needs of woodland caribou in terms of habitats on an annual basis. Based on the results of this study, a map was produced to show the relative probability of occurrence for woodland caribou, using the habitat selection model developed by Leblond *et al.* (2015). This map identifies sectors where the caribou habitat is of adequate quality. This map (6-17) shows that the project area has a moderate to low relative probability of occurrence for woodland caribou.**

**Spatial distribution and heterogeneity of habitats play important roles in adequately meeting the needs of boreal caribou over the annual cycle. The importance of large forested tracts in meeting the needs of caribou, especially in winter, is well established. The "large areas of contiguous forests" criterion is, however, part of the biophysical characteristics of critical boreal caribou habitat in the Boreal Shield (Centre) Ecoregion. The characteristics of the Boreal Shield (East) Ecoregion also includes "large patches of intermediate and mature black spruce."**

**It should be noted that in Québec, the management strategy for protecting woodland caribou is based on conserving large tracts of coniferous trees (Courtois *et al*. 2004, 2008). The results of the most recent studies demonstrate the importance of maintaining a certain degree of heterogeneity in habitats within these forests. Protecting large forest tracts is mainly designed to protect winter habitats, which are also often selected during calving and rutting. It was demonstrated that woodland caribou occurrence probability varied from 40-48% in 100 $km^2$ forests and from 53-62% for 250 $km^2$ forests (Lesmerises, 2011). A minimum surface area of 500 $km^2$ is necessary to reach a 75% probability of occurrence, while maximum probability of occurrence is reached with a surface area of over 1,000 $km^2$. It was also noted that mature coniferous tree forests outside of large forest tracts are also heavily selected, especially during rutting and while raising young. Lastly, the study concluded that the large surface area of space used annually by caribou indicated that the current size of protected forest tract recommended by Courtois et al. (2004), at 250 $km^2$, is insufficient for long-term woodland caribou conservation.**

### Current disturbances in the study area sector

**Map 6-16 presents potential caribou habitats as well as recent fire disturbances around the local study area.**

**Current permanent human disturbances were simulated by projecting a 500 m zone of influence around the human components in the territory. The components causing permanent human disturbance selected were the Billy-Diamond highway, the 450 kW power transmission line and the km 381 truck stop. The land inside the zone of influence around these components is not considered potential caribou habitat. Consequently, the 1% of surface area covered by planned mine infrastructure and the 14% covered by the 500 m zones of influence around it were excluded from potential woodland caribou habitat.**

**Calculation was carried out to determine the critical habitat (type-wise) for woodland caribou in the mine footprint (Map 6-16). Table 6-33 summarizes the results of the boreal caribou habitat analysis.**

**In the zone of influence around the proposed mine and outside of permanent human disturbances, the natural (undisturbed) environment is composed of biophysical elements, a very large proportion of which do not meet broad-scale habitat criteria for boreal caribou. This situation is common for the landscape surrounding the mine project. Overall, the area has very little mountainous relief or undulating terrain that is useful for, among other things, the winter habitat of boreal caribou.**

**Table 6-33 Analysis of potential boreal caribou winter habitat and calving habitat in the portion of the zone of influence of the planned mine outside of permanent human disturbances**

| | Zone influence (1 122,8 ha) | | | | | |
|---|---|---|---|---|---|---|
| | Total | | perturbé feu | | non perturbé | |
| **Habitat potentiel en période hivernale** | ha | % | ha | % | ha | % |
| Pessière noire à lichen | 17,6 | 1,6% | 0,6 | 0,1% | 17,0 | 1,5% |
| Pessière noire à mousse | - | | | | - | |
| Pinède grise | - | | | | - | |
| Tourbière boisée | 203,0 | 18,1% | 36,4 | 3,2% | 166,7 | 14,8% |
| Dénudé sec | 14,7 | 1,3% | | | 14,7 | 1,3% |
| ***Sous-total*** | ***235,3*** | ***21,0%*** | ***37,0*** | ***3,3%*** | ***198,3*** | ***17,7%*** |
| **Habitat potentiel de mise bas, de poste mise-bas et de rut** | | | | | | |
| Tourbière arbustive | 216,0 | 19,2% | 66,7 | 5,9% | 149,3 | 13,3% |
| Tourbière ouverte | 506,6 | 45,1% | 390,1 | 34,7% | 116,4 | 10,4% |
| ***Sous-total*** | ***722,5*** | ***64,4%*** | ***456,8*** | ***40,7%*** | ***265,7*** | ***23,7%*** |
| **Total habitat potentiel annuel** | **957,9** | **85%** | **493,8** | **44%** | **464,0** | **41%** |
| **Autres groupement non retenus comme habitat potentiel** | | | | | | |
| Lac ou mare | 21,3 | 1,9% | | | 21,3 | 1,9% |
| Affleurement rocheux | 30,8 | 2,7% | | | 30,8 | 2,7% |
| Anthropique | 3,2 | 0,3% | | | 3,2 | 0,3% |
| Arbustaie | 95,0 | 8,5% | | | 95,0 | 8,5% |
| Brûlis | 14,6 | 1,3% | | | 14,6 | 1,3% |
| ***Sous-total*** | ***165,0*** | ***14,7%*** | | | ***179,6*** | ***14,7%*** |
| | **1122,8** | **100,0%** | **493,8** | **44,0%** | **643,7** | **56,0%** |

**Broad-scale habitats are highly fragmented and generally represent small islets of black spruce lichen forest and treed peatland. Their spatial distribution, among other things, does not satisfy the criterion of large areas of contiguous forests as winter habitat for boreal caribou. Moreover, the topography of the area is generally uniform. We can therefore assume that there is no potential winter habitat for boreal caribou in the mine footprint nor in its 500-m zone of influence.**

**Again looking at the portion of the planned mine's zone of influence outside of permanent human disturbances, broad-scale habitat covers 235.3 ha, or 21.0% of the study area. Of this area, 37 ha, or 3.3% of the study area, was affected by recent fires. Broad-scale habitat that was undisturbed by recent fires covers 198.3 ha or 17.7% of the zone of influence undisturbed by permanent human disturbances.**

**With regard to shrubbed peatlands and open peatlands that could serve as habitat for calving periods, post-calving periods and rutting periods, they cover 216 and 506.6 ha, respectively, or 19.2% and 45.1% of the zone of influence of the planned mine that is undisturbed by permanent human components. Of this peatland, a proportion of 40.7% of the study area was affected by recent fires. Consequently, the total area of peatland unaffected by the fires was 265.7 ha, or 23.7% of the zone of influence of the mine that is undisturbed by human components.**

**Available calving habitat within the project's zone of influence currently offers a very low probability of being selected by females during this period, especially since this type of environment (shrubbed or open peatland) is very common both near the project footprint and over the entire James Bay region.**

The probabilistic approach applied by ECCC and updated in 2011 (Environment Canada, 2011) clearly showed that 70% of the variation recorded in recruitment of woodland caribou populations is explained by a single variable that encompasses the human and natural (forest fire) disturbance rates. Therefore, analysis of the habitat disturbance rate appears to be a relevant indicator to characterize current conditions of the habitat in the study area.

The current habitat disturbance rate was also assessed across the study area, within a 50-km radius from the centre of the proposed mine, representing an area in the range of 7,850 km² (Map 6-16). For this simulation, the total disturbance footprint was determined based on the combined effects of fires that occurred over the past 40 years and various human disturbances in the buffer zone (500 m). This assessment method is based on ECCC's demonstration, in which the use of a 500-m buffer zone to map man-made features provided a better representation of the combined effects of heightened predation and avoidance on boreal caribou population trends across the country (Environment Canada, 2011). The habitat disturbance rate within a radius of 5-50 km from the centre of the proposed mine was assessed to identify the variation at different scales (Table 6-34).

First, there are no forestry activities for industrial purposes in the study area, which preserves it from major human disturbances caused by the harvesting of wood substance and the presence of logging road networks. Human disturbances of the habitat are primarily associated with industrial areas (mines), hydroelectric production, linear structures (roads, power transmission lines) and with some land uses.

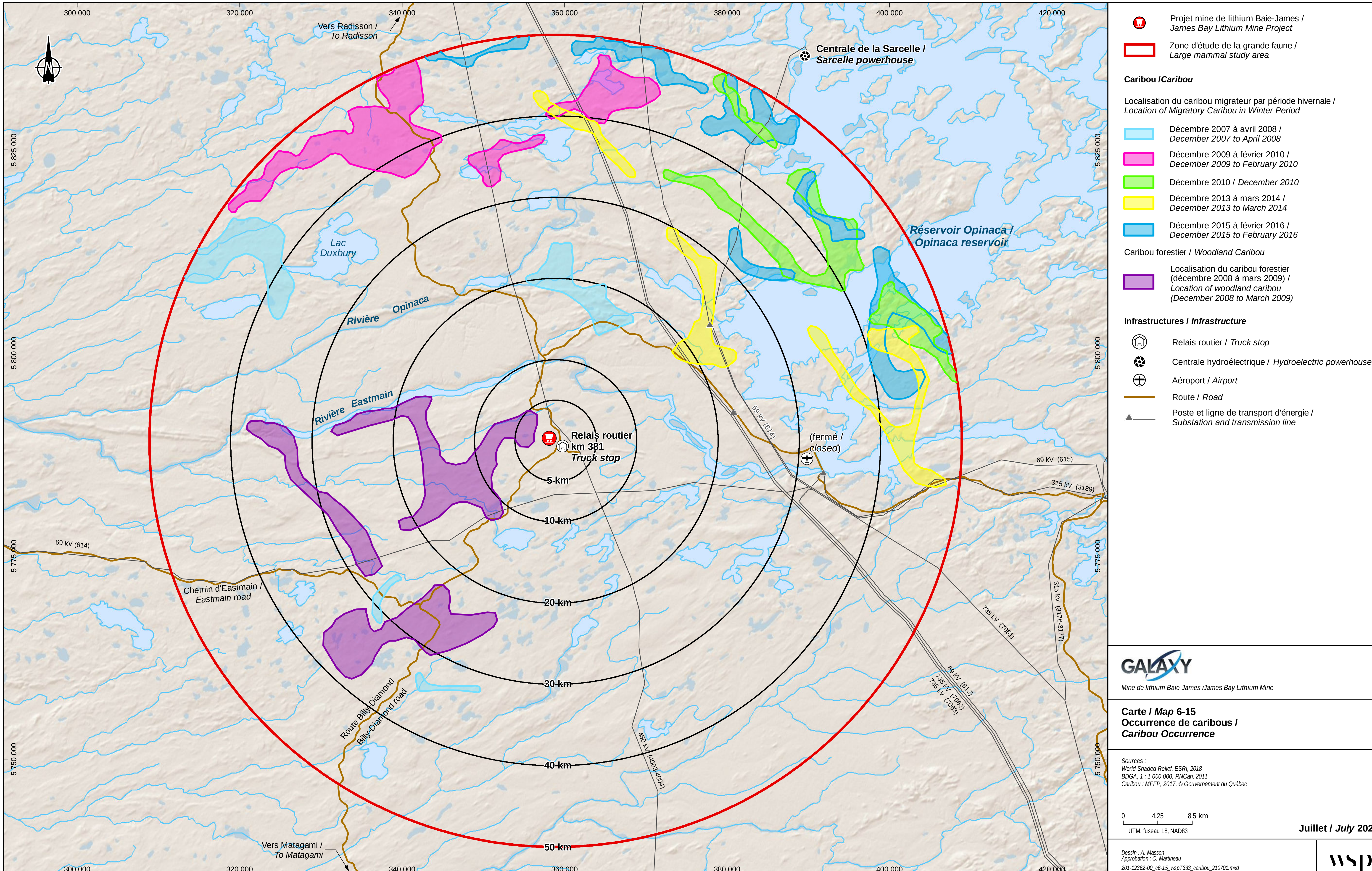
Overall, man-made features disturb 7% of the study area. The km 381 truck stop of the Billy-Diamond highway, near the proposed mine, concentrates human activity and constitutes a significant source of woodland caribou habitat disturbance in this area.

However, the main source of caribou habitat disturbance in the study area is of natural origin. It is associated with large forest fires that have affected the study area over the past 40 years. Fires alone have disturbed caribou habitat in the study area at a rate of 66%. These fire-burn areas overlap with the majority of areas disturbed by man-made features, such that the total percentage of disturbance (natural and human) in the study area is assessed at approximately 68%.

**Table 6-34 Analysis of disturbance rates of woodland caribou habitat within a 5-50 km radius from the centre of the proposed mine**

| Distance from centre of the mine (km) | Type of disturbance | Area (ha) | Disturbance (%) |
|---|---|---|---|
| 5 | **Size of area** | **7,854** | **100%** |
| | Human | 2,013 | 26% |
| | Natural | 7,052 | 90% |
| | Natural and human | 7,231 | 92% |
| 10 | **Size of area** | **31,416** | **100%** |
| | Human | 5,235 | 17% |
| | Natural | 26,545 | 85% |
| | Natural and human | 27,089 | 86% |
| 20 | **Size of area** | **125,664** | **100%** |
| | Human | 14,403 | 12% |
| | Natural | 110,831 | 88% |
| | Natural and human | 112,049 | 89% |
| 30 | **Size of area** | **282,743** | **100%** |
| | Human | 30,320 | 11% |
| | Natural | 229,500 | 81% |
| | Natural and human | 232,594 | 82% |
| 40 | **Size of area** | **502,655** | **100%** |
| | Human | 44,386 | 9% |
| | Natural | 370,337 | 74% |
| | Natural and human | 376,379 | 75% |
| 50 | **Size of area** | **785,396** | **100%** |
| | Human | 57,874 | 7% |
| | Natural | 520,181 | 66% |
| | Natural and human | 531,550 | 68% |

A certain proportion of the burned areas likely have the potential for self-regeneration and can provide conditions suitable for the woodland caribou in the future. However, during the March 2018 aerial survey, the regeneration observed in these areas was characterized as “very poor” (Photos 6-3 and 6-4). This situation can be explained by the fact that a large portion of the territory was subject to successive fires. Young stands and unproductive land are sensitive to natural regeneration occurrences due to limited seed production and become especially vulnerable under short fire cycles (short interval between two disturbances) (Mansuy, 2013).



Projet mine de lithium Baie-James / James Bay Lithium Mine Project
Zone d'étude de la grande faune / Large mammal study area
Caribou / Caribou
Localisation du caribou migrateur par période hivernale / Location of Migratory Caribou in Winter Period
Décembre 2007 à avril 2008 / December 2007 to April 2008
Décembre 2009 à février 2010 / December 2009 to February 2010
Décembre 2010 / December 2010
Décembre 2013 à mars 2014 / December 2013 to March 2014
Décembre 2015 à février 2016 / December 2015 to February 2016
Caribou forestier / Woodland Caribou
Localisation du caribou forestier (décembre 2008 à mars 2009) / Location of woodland caribou (December 2008 to March 2009)
Infrastructures / Infrastructure
Relais routier / Truck stop
Centrale hydroélectrique / Hydroelectric powerhouse
Aéroport / Airport
Route / Road
Poste et ligne de transport d'énergie / Substation and transmission line
GALAXY
Mine de lithium Baie-James / James Bay Lithium Mine
Carte / Map 6-15
Occurrence de caribous / Caribou Occurrence
Sources :
World Shaded Relief, ESRI, 2018
BDGA, 1 : 1 000 000, RNCan, 2011
Caribou : MFFP, 2017, © Gouvernement du Québec
0 4,25 8,5 km
UTM, fuseau 18, NAD83
Juillet / July 2021
Dessin : A. Masson
Approbation : C. Martineau
201-12362-00_c6-15_wspT333_caribou_210701.mxd
wsp
Vers Radisson / To Radisson
Centrale de la Sarcelle / Sarcelle powerhouse
Réservoir Opinaca / Opinaca reservoir
Lac Duxbury
Rivière Opinaca
Rivière Eastmain
Relais routier km 381 Truck stop
(fermé / closed)
5 km
10 km
20 km
30 km
40 km
50 km
69 kV (614)
69 kV (615)
315 kV (3189)
735 kV (7061)
315 kV (3176-3177)
69 kV (612)
735 kV (7062)
735 kV (7063)
450 kV (4003-4004)
Chemin d'Eastmain / Eastmain road
Route Billy-Diamond / Billy-Diamond road
Vers Matagami / To Matagami
300 000
320 000
340 000
360 000
380 000
400 000
420 000
5 825 000
5 800 000
5 775 000
5 750 000


Infrastructures minières / *Mining infrastructure*

Empreinte de la mine (zone tampon de 50 mètres) / *Mine footprint (buffer 50 meters)*

Zone d'étude locale / *Local study area*

Zone de perturbation naturelle (feux de forêt) / *Natural Disturbance (forest fire)*

**Infrastructures / *Infrastructure***

Route principale / *Main road*

Route d'accès / *Access road*

Ligne de transport d'énergie / *Transmission line*

Relais routier / *Truck stop*

**Hydrographie / *Hydrography***

CE3 Numéro de cours d'eau / *Stream number*

Cours d'eau permanent / *Permanent stream*

Cours d'eau à écoulement diffus ou intermittent / *Intermittent or diffused flow stream*

Littoral des cours d'eau / *Watercourses shoreline*

**Habitat à grande échelle / *Large-scale habitat***

Pessière noire à lichen / *Black spruce lichen forest*

Tourbière boisée / *Treed peatland*

Dénudé sec / *Dry barren land*

**Habitat potentiel en période de mise bas, de post mise-bas et de rut / *Potential calving, post-calving and rutting habitat***

Tourbière arbustive / *Shrubby peatland*

Tourbière ouverte / *Open bog*

GALAXY

*Mine de lithium Baie-James / James Bay Lithium Mine*

*Mise à jour de l'étude d'impact sur l'environnement*

**Carte / *Map* 6-16**
**Perturbation de l'habitat potentiel du caribou boréal / *Woodland caribou habitat disturbance***

*Sources :*
*Orthoimage: Galaxy, août 2017*
*Inventaire / Inventory: WSP 2017*
*Données du projet / Project data : Galaxy, 2021*

0 240 480 m

UTM, fuseau 18, NAD83

**Juillet / *July* 2021**

*Dessin : A. Masson*
*Approbation : C. Martineau*
*201-12362-00_c6-16_wspT299_hab_caribou_210701.mxd*

wsp

The location of the projected mine represents one of the sectors in the study area that is most disturbed by human and natural elements. For example, within a 5-km range from the centre of the mine, approximately 92% of the area is disturbed. Fires have disturbed approximately 90% of this sector while human factors generate 26% of the disturbances. Within a 10 km range from the centre of the mine, 86% of the area is disturbed. Fires cover approximately 85% of the latter while human disturbances are responsible for approximately 17%.

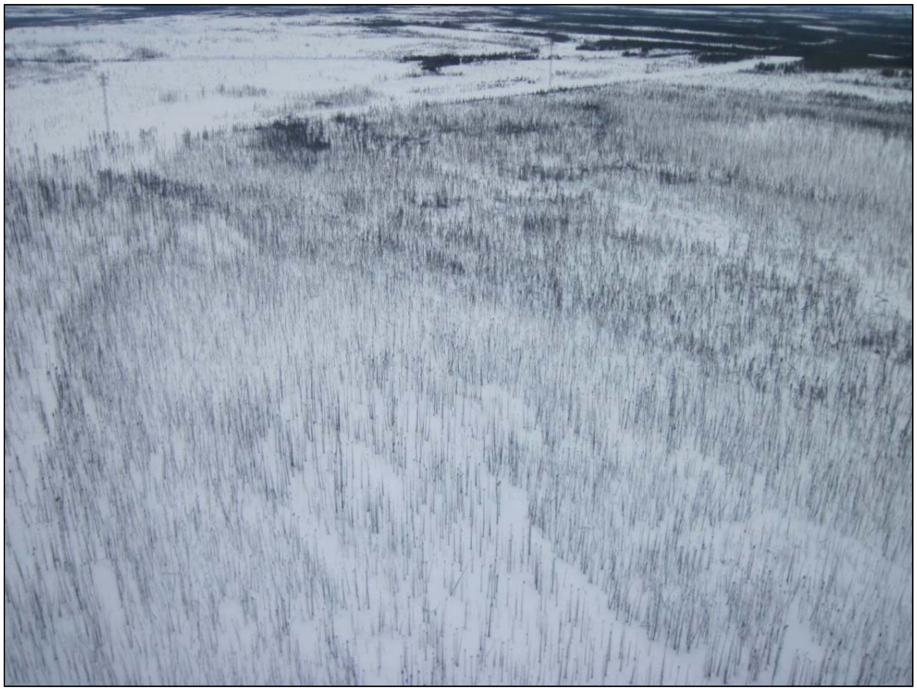


**Photo 6-3 Recent fire area – 2011-2016**

**Photo 6-4 Poor-regeneration fire area – 2001-2010**

The relative probability of occurrence of woodland caribou, based on the habitat selection model by Leblond and coll. (2015), provides another indicator to assess the environmental conditions in terms of habitat for the woodland caribou. This indicator was incorporated in the identification of priority areas to create vast protected areas for the woodland caribou. It is noted, however, that although this mathematical model of habitat selection by a group of individuals incorporates many environmental characteristics, it does not necessarily indicate the real distribution of the species in the area. The model also does not consider the real regeneration conditions of burned forest areas over the last decades. The projected mine area generally presents a medium to low relative probability of woodland caribou occurrence (Map 6-17).

Areas providing the highest probabilities of occurrence are generally residual forest islands formed after forest fires. The habitat available within a 10-km radius of the centre of the projected mine is very fragmented. On this matter, ECCC specifies that to ensure self-sustainability for the local populations, they must have access to continuous tracts of undisturbed habitat with the biophysical characteristics needed to meet their needs during their life cycle (Environment Canada, 2012). Therefore, due to its high disturbance rate, the study area offers poor habitat conditions for woodland caribou.

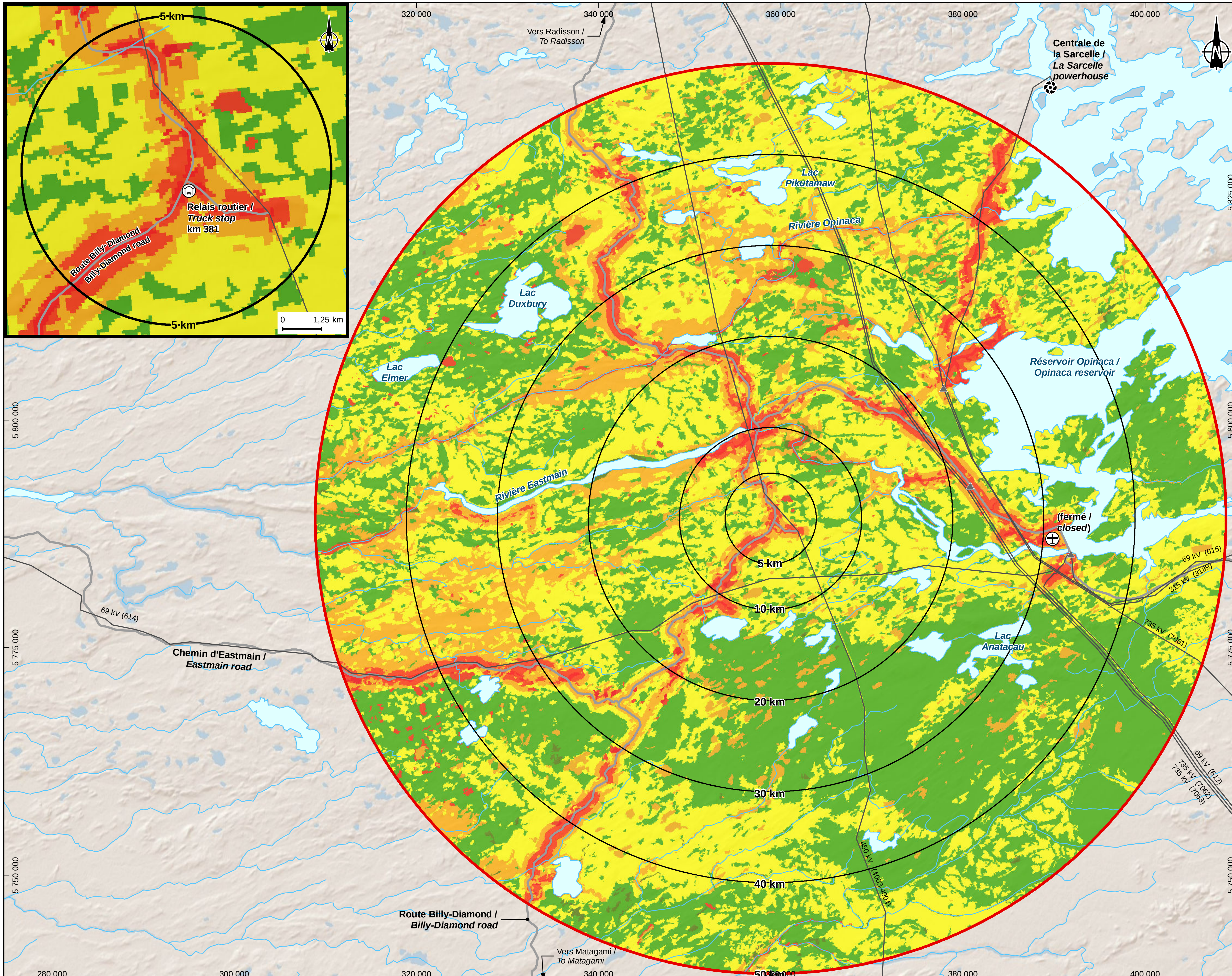
#### MOOSE

The low moose density in Québec's boreal forest is mainly due to an unproductive habitat. It is during winter that low food availability and quality are the most critical. The moose's typical winter habitat is almost always made up of mixed stands, where the arrangement of the coniferous and deciduous trees provides it with cover in proximity to feeding areas.

Fire, which is a disturbance factor in the region's plant dynamics (CRRNTBJ, 2010), can increase the quantity of browse available. Several years after a fire, regeneration in burn areas containing a large proportion of tree or shrub species, constitute rich feeding habitats (Courtois and coll., 1996; Samsom and coll., 2002). The scarcity of birch, poplar and mixed stands could explain the moose's increased use of old burn areas and river scrubland in the Nord-du-Québec region (Maltais and coll., 1993). However, we should note that large expanses of burn areas have little cover to provide shelter.

The forest species that moose seek out as food sources are white birch and willow in the summer and balsam fir in the winter (Dussault and coll., 2002, 2004; Samsom and coll., 2002). Deciduous mixed forests and regenerating forests serving as food sources, interspersed with mature stands offering cover, provide suitable habitats for moose. Mixed forest stands, deciduous forest stands and shrub swamps are scarce in the study area. Scrubland and burns, with or without regeneration, are low-quality environments that are dominant in the landscape of the study area. With regard to the calving period, the preferred habitats are lake and watercourse banks, coniferous forest stands and hilltops.

The March 2018 moose survey, initially planned on a 100-$km^2$ area, was performed instead over a larger area of 1,600 $km^2$. The environment is largely bare due to forest fires and contains small islands of residual forests primarily concentrated along watercourses. These islands, especially when they contain stems from deciduous or shrub species, are the only areas that provide suitable conditions to meet the moose's cover and nutritional requirements during winter. Several watercourses and lakes are present within the study area. However, the limited availability of mature coniferous forest stands constitutes a deficiency in terms of moose habitat suitability, namely, as cover during winter.




Zone d'étude de la grande faune/ *Large mammal study area*

**Caribou forestier / *Woodland caribou***

Probabilité relative d'occurrence / *Relative probability of occurrence*

Faible / *Low*

Élevée / *High*

**Infrastructures / *Infrastructure***

Relais routier / *Truck stop*

Centrale hydroélectrique / *Hydroelectric powerhouse*

Aéroport / *Airport*

Route / *Road*

Poste et ligne de transport d'énergie / *Substation and transmission line*

GALAXY

*Mine de lithium Baie-James /James Bay Lithium Mine*

**Carte / *Map* 6-17**
**Probabilité relative d'occurrence du caribou forestier /**
***Woodland Caribou Relative Probability of Occurrence***

Sources :
BDGA, 1; 1 000 000, 2014
MDDELCC, avril 2015

0 4,25 8,5 km
UTM, fuseau 18, NAD83

**Juillet / *July* 2021**

Dessin : A. Masson
Approbation : C. Martineau
201-12362-00_c6-17_wspT334_occu_car_210701.mxd

wsp

In light of this situation, the survey method used in the 1,600 km² area was adjusted to better detect moose in woodlands appearing to provide more suitable conditions for wintering, by reducing flight speed and altitude and by carrying out a full coverage above the latter. We can therefore infer that moose wintering areas were detected in the 1,600-km² area with an accuracy rate comparable to the 100-km² area where moose-specific survey standards were applied. A reasonable effort was made to count and classify the number of animals for all moose tracks observed. When estimating density per 10 km², an 80% observation rate was used to estimate the number of individuals.

Table 6-35 provides a summary of the data gathered on moose during the March 2018 field campaign. A total of four individuals (three females and one calf) were sighted in a single wintering area inside the moose-specific survey area (Map 6-18), which corresponds to an estimated density of 0.5 moose/10 km². Twenty wintering areas were detected and 34 moose were counted across the 1,600-km² caribou survey area. Applying an 80% observation rate to individuals, 43 moose inhabited this area for a density of about 0.27 moose/10 km². This density is comparable to that reported in the scientific literature.

**Table 6-35 March 2018 moose survey data compilation and density estimate**

| Moose winter range | Female | Male | Fawn | Undetermined | Number observed | Estimated number based on an 80% visibility rate | Density estimate per 10 km² |
|---|---|---|---|---|---|---|---|
| **In the 100-km² survey area** | | | | | | | |
| M-1 | 3 | 0 | 1 | | 4 | 5 | |
| **Subtotal** | **3** | **0** | **1** | **0** | **4** | **5** | 0.50 |
| **Outside the 100-km² survey area** | | | | | | | |
| M-2 | - | 1 | - | | 1 | 1 | |
| M-3 | 1 | - | 1 | | 2 | 3 | |
| M-4 | 1 | - | 1 | | 2 | 3 | |
| M-5 | 1 | - | - | | 1 | 1 | |
| M-6 | 1 | - | - | | 1 | 1 | |
| M-7 | - | 1 | - | | 1 | 1 | |
| M-8 | 3 | - | 1 | | 4 | 5 | |
| M-9 | 1 | - | 1 | | 1 | 1 | |
| M-10 | 1 | - | - | | 1 | 1 | |
| M-11 | 2 | - | - | | 2 | 3 | |
| M-12 | 1 | - | 1 | | 2 | 3 | |
| M-13 | - | 1 | - | | 1 | 1 | |
| M-14 | - | 1 | - | | 1 | 1 | |
| M-16 | - | - | - | 2 | 2 | 3 | |
| M-17 | - | - | - | 1 | 1 | 1 | |
| M-18 | - | 1 | - | | 1 | 1 | |
| M-19 | 1 | - | 1 | | 2 | 3 | |
| M-20 | 2 | 1 | - | | 3 | 4 | |
| M-21 | 1 | - | - | | 1 | 1 | |
| **Subtotal** | **16** | **6** | **6** | **3** | **30** | **38** | **0.25** |
| **Total in the 1,600-km² area** | **19** | **6** | **7** | **3** | **34** | **43** | **0.27** |

The moose density in hunting zone 22, which the study area is a part of, is among the lowest in Québec. It was estimated at 0.26 moose/10 $km^2$ in 1991 and at 0.31 moose/10 $km^2$ in 1997. Applying a 3% growth rate from 1991 to 2012, the moose population is estimated at 0.5 moose/10 $km^2$, or 9,872 individuals (Morin, 2015). In hunting zone 22, an average of **120** moose per year were hunted from **2016 to 2020** (MFFP, **2021**). Among these, based on slaughtering data provided by the MFFP, an average of 15 moose per year were sampled in the large fauna study area.

#### BLACK BEAR

No specific survey of the black bear has been performed in the study area. However, signs of the presence of individual bears were observed during some surveys targeted at other wildlife groups. The black bear is hunted for its meat and fur. In the territory located north of the 50th parallel, however, this practice is for the exclusive use of Indigenous people. They primarily use trapping to capture the animal (Lamontagne and coll., 2006).

In hunting zone 22, the black bear population density was estimated at 0.2 bears/10 $km^2$ in 2003. This density represents a population of approximately 5,600 bears (Lamontagne and coll., 2006). The study area for large fauna is found in fur-bearing animal management unit (FAMU) 92. In the last five seasons for which data is available (**2015-2016 to 2019–2020**), a total of **three** fur pelts were sold (MFFP, **2021**).

In fall, the black bear primarily uses bare lands, areas where heath plants are dominant, recent burns and lichen-free peatlands. In spring, it can also be found in hardwood and mixed forests and shrubland, swamps, marshes, watercourses and lakes (CRRNTBJ, 2010; Tecsult Inc., 2005).

In the study area, the availability of food used by black bears is likely determined by the occurrence of wetlands and disturbed habitats. These are key to produce small fruits on which the bear relies to build up its fat reserves (Samson, 1996). Disturbed habitats are primarily represented by habitats undergoing regeneration following two fires. Moreover, Cree users reported that bears visit the remote landfill in search of food, making this a good hunting area for this species. In short, the overall study area represents a potential suitable habitat for black bears.

#### GREY WOLF

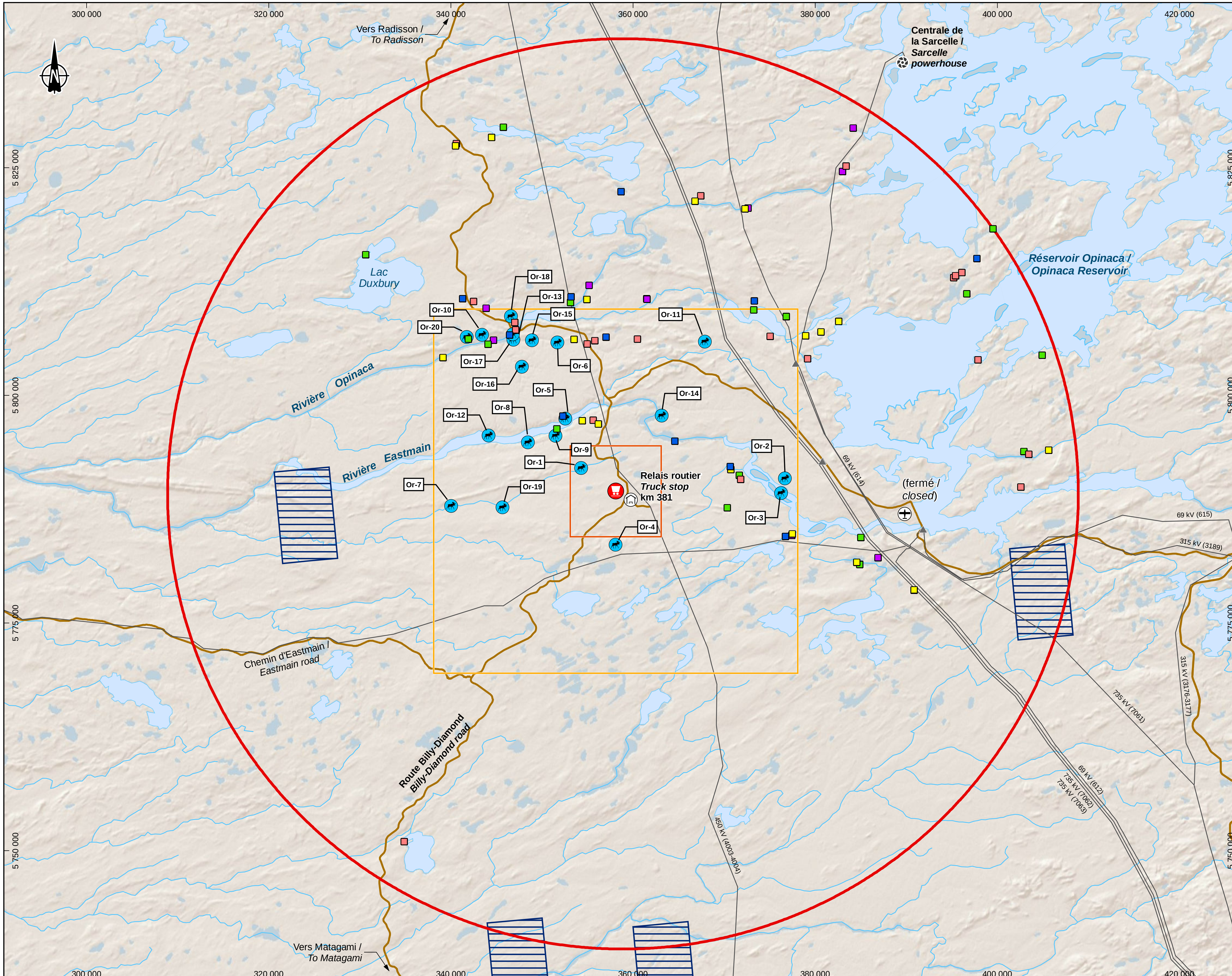
Although the grey wolf (*Canis lupus*) is more often linked to fur-bearing animals than to large mammals, it nevertheless represents one of the main predators of moose and caribou. During the field inventories performed, namely, the March 2018 aerial moose and caribou survey, no signs of wolf activity were observed in the study area. However, the tallyman mentioned a wolf pack sighting in August 2018 near the km 381 truck stop.

### *6.3.2.2 SMALL WILDLIFE*

Based on available data and distribution ranges presented in the documents consulted (Banfield, 1977; CRRNTBJ, 2010; FAPAQ, 2003; MFFP, 2016; Prescott and Richard, 2004), 20 species of small terrestrial wildlife potentially occur in the study area. Table 6-36 lists these species.

Among these species, two have a special status:

- the least weasel (*Mustela nivalis*), which is on the list of species likely to be designated as threatened or vulnerable in Quebec (MFFP, 2006*a*);
- the wolverine (*Gulo gulo*), designated as threatened in Quebec (MFFP, 2006*b*) and endangered in Canada (Government of Canada, 2017).




Projet mine de lithium Baie-James / *James Bay Lithium Mine Project*

Zone d'étude de la grande faune / *Large mammal study area*

Zone d'inventaire du caribou (1 600 km²) / *Caribou inventory area (1 600 km²)*

Zone d'inventaire de l'orignal (100 km²) / *Moose inventory area (100 km²)*

**Orignal / *Moose***

Site d'inventaire / *Survey site*

Or-2 Numéro du site / *Site number*

Sites d'abattage de l'orignal (MFFP, 2017) / *Moose kill sites (MFFP, 2017)*

- 2013
- 2014
- 2015
- 2016
- 2017

Parcelle d'inventaire de l'orignal (MFFP, 1991) / *Moose survey plot (MFFP, 1991)*

**Infrastructures / *Infrastructure***

Relais routier / *Truck stop*

Centrale hydroélectrique / *Hydroelectric powerhouse*

Aéroport / *Airport*

Route / *Road*

Poste et ligne de transport d'énergie / *Subtation and transmission line*

GALAXY

*Mine de lithium Baie-James /James Bay Lithium Mine*

**Carte / *Map* 6-18**
**Points d'occurrence et sites d'abattage de l'orignal /**
***Moose Occurrence Points and Kill Sites***

*Sources :*
*World Shaded Relief, ESRI, 2018*
*Base cartographique / Cartographic base, BDGA, 2011*
*Orignal / Moose : MERN, 2017, © Gouvernement du Québec*

0 4,25 8,5 km

UTM, fuseau 18, NAD83

**Juillet / *July* 2021**

*Dessin : A. Masson*
*Approbation : C. Martineau*
*201-12362-00_c6-18_wspT335_orignal_210701.mxd*

wsp

**Table 6-36 List of small terrestrial wildlife species potentially present in the study area**

| Species* | Scientific name |
|---|---|
| Long-tailed weasel | *Mustela frenata* |
| **Least weasel** | ***Mustela nivalis*** |
| **Wolverine** | ***Gulo gulo*** |
| Canadian beaver | *Castor canadensis* |
| Red squirrel | *Tamiasciurus hudsonicus* |
| Northern flying squirrel | *Glaucomys sabrinus* |
| Ermine | *Mustela erminea* |
| Snowshoe hare | *Lepus americanus* |
| Grey wolf | *Canis lupus* |
| River otter | *Lontra canadensis* |
| Canadian lynx | *Lynx canadensis* |
| Woodchuck | *Marmota monax* |
| American marten | *Martes americana* |
| Striped skunk | *Mephitis* |
| Fisher | *Martes pennanti* |
| American porcupine | *Erethizon dorsatum* |
| Muskrat | *Ondatra zibethicus* |
| Red fox | *Vulpes vulpes* |
| Eastern chipmunk | *Tamias striatus* |
| American mink | *Mustela vison* |
| * Species in bold have a special status. | |

*Sources: Banfield, 1977; CRRNTBJ, 2010; FAPAQ, 2003; MFFP, 2016; Prescott and Richard, 2004.*

### LEAST WEASEL

The least weasel is North America's smallest carnivore. It belongs to the mustelidae family and is related to the ermine (*Neovison erminea*) and to the American mink (*Mustela vison*). In North America, the least weasel lives almost everywhere in Canada and adapts to very diverse habitats. It occupies the tundra or the coniferous forest to the north but prefers, in the more southern areas, open environments such as prairies, wet meadows, swamplands, watercourse banks and brush (MFFP, 2001*a*). In Québec, though the distribution area is vast, sightings of this species are rare (MFFP, 2001*a*) and abundance poorly known. It is found in the Nord-du-Québec region, but likely in very localized areas. Its presence was namely reported in the Eastmain area (FAPAQ, 2003). A study to identify weasel carcasses trapped by the Cree was conducted by the MRNF's Direction régionale du Nord-du-Québec from 2009 to 2011. During this period, a total of 1,021 weasels were sent to the Aménagement de la faune office in Chibougamau. Of this number, 671 were analyzed and a single specimen, captured near Eastmain, proved to be a least weasel (CRRNTBJ, 2010). This rarity can, however, be explained by its secretive habits and small size (FAPAQ, 2003). No weasel is reported in the 2015–2016 trapping data for UGAF92, which Eastmain and the study area are part of (MFFP, 2016).

**WOLVERINE**

The wolverine is the largest terrestrial member of the mustelidae family (Environment Canada, 2016). Though the species is often considered extinct, several sightings in the area have been reported **within the last 20 years** (FAPAQ, 2002). Its distribution range is mainly confined to the north of the province and it is a very secretive species. The wolverine is a solitary animal and primarily a scavenger, whose survival relies on the availability of abundant food resources **(COSEWIC, 2014; Environment Canada, 2016), and that thrives in ecologically intact areas with abundant and diverse prey and other carnivores (COSEWIC, 2014). This means that food is an integral component of this species' habitat (Cardinal, 2004), which must offer adequate food sources throughout the year, mainly in the form of small prey such as rodents and the snowshoe hare, as well as carcasses of large ungulates like moose, caribou and muskoxen (COSEWIC, 2014). Reductions in ungulate populations, which are significant prey in winter, has likely contributed to the wolverine's shrinking range (COSEWIC, 2014). Consequently, in the project region, the only two ungulate species likely to contribute to the wolverine's presence are caribou and moose. As mentioned in the previous pages about potential moose and caribou presence, however (Section 6.3.2.1), the study area offers poor habitat conditions for these species, given the level of disturbance of the natural environment. Wildlife surveys done in 2017 also showed that other wolverine prey species (breeding birds, small rodents; Environment Canada, 2016) are also largely absent from the study area (Sections 6.3.2.3 and 6.3.5.2). Consequently, in the absence of sufficiently abundant and diverse prey, the real potential for wolverines to be present in the study area is not considered to be significant. The** habitat requirements of non-reproductive individuals seem relatively independent of the environment's biophysical attributes, the determining factor being prey availability (Environment Canada, 2016). In 2006, a systematic survey over 100,000 km$^2$ in the Abitibi and James Bay Lowlands natural province identified two potential wolverine track networks some dozen kilometres from La Sarre and Matagami (Environment Canada, 2016; Fortin, 2006).

### *6.3.2.3 SMALL MAMMALS*

**METHODOLOGY**

Small mammal surveys were conducted for this project in 2011 and 2017. The methodology used, described in detail in the Terrestrial Wildlife and Avifauna Baseline Study (*Étude spécialisée sur les faunes terrestre et avienne)* (WSP, 2018*g*), is based on the *Protocole pour les inventaires de micromammifères* (Jutras, 2005) developed at the time by the MRNF. This methodology relies on the use of grill traps set up in typical habitats of the study area. During habitat selection, special attention was paid to the potential presence of the rock vole (*Microtus chrotorrhinus*) and of the southern bog lemming (*Synaptomys cooperi*), two species likely to be designated as threatened or vulnerable in Quebec (MFFP, 2006*a*).

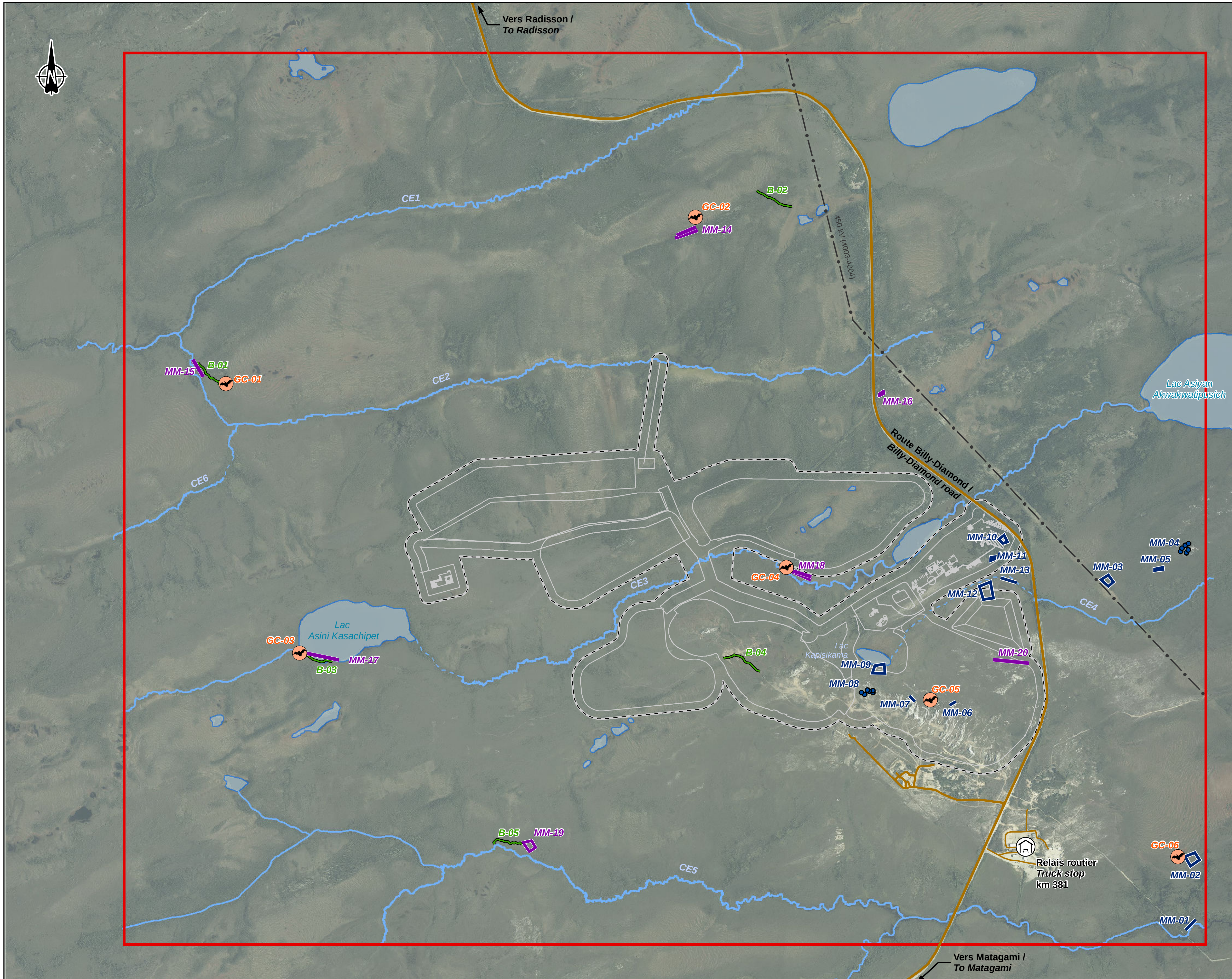
In 2011, 13 trapping sectors were surveyed in the study area's southeast quarter. The traps were set up and monitored during six to nine consecutive days, from September 21–29, 2011. In 2017, seven additional trapping sectors were inventoried to complete the initial coverage of the study area. The traps were set up and monitored during five consecutive days, from September 19–25, 2017. Given the nature, layout and area of habitats targeted in the study area, use of standard trapping grids was sometimes unsuitable, namely, in presence of linear landscape elements (downslopes, watercourses, etc.). Consequently, depending on the shape and area of environments surveyed, a combination of standard grids, half-grids, transects and aggregates was used in this study. The location of the trapping areas is presented on Map 6-19.

**RESULTS**

**2011 survey**

The trapping effort, calculated in number of trap-nights, represents the trapping pressure exerted on an environment or area. A trapping effort of 5,781 trap-nights was carried out for the overall study area in 2011.

During the survey, 117 specimens, belonging to eight different species, were sampled. Three of these species were insectivores: the cinereous *(Sorex cinereus),* smoky *(Sorex fumeus)* and pygmy *(Sorex hoyi)* shrews. The five other species belonged to the family of rodents: the Gapper's red-backed *(Clethrionomys gapperi),* meadow *(Microtus pennsylvanicus)* and rock voles *(Microtus chrotorrhinus)*, the eastern heather vole *(Phenacomys ungava)* and the deer mouse *(Peromyscus maniculatus).* Among these species, only the rock vole is on the list of species likely to be designated as threatened or vulnerable in Québec (MFFP, 2006*a*).




Zone d'étude locale / *Local study area*

Infrastructures minières / *Mining infrastructure*

Empreinte de la mine (zone tampon de 50 mètres) / *Mine footprint (buffer 50 meters)*

**Inventaires / *Inventory***

(GC-XX) Station d'inventaire acoustique des chiroptères / *Bat listening station*

(B-XX) Bardeau à couleuvres / *Grass-snake shingle*

(MM-XX) Secteur de piégeage des micromammifères (2017) / *Small mammal trapping sector (2017)*

(MM-XX) Secteur de piégeage des micromammifères (2011) / *Small mammal trapping sector (2011)*

**Infrastructures / *Infrastructure***

Route principale / *Main road*

Route d'accès / *Access road*

Ligne de transport d'énergie / *Transmission line*

Relais routier / *Truck stop*

**Hydrographie / *Hydrography***

CE3 Numéro de cours d'eau / *Stream number*

Cours d'eau permanent / *Permanent stream*

Cours d'eau à écoulement diffus ou intermittent / *Intermittent or diffused flow stream*

Plan d'eau / *Waterbody*

GALAXY

*Mine de lithium Baie-James /James Bay Lithium Mine*

**Carte / *Map* 6-19**
**Sites d'inventaire de la faune terrestre /**
***Terrestrial Fauna Survey Sites***

*Sources :*
*Orthoimage : Galaxy août / august 2017*
*Inventaire / Inventory : WSP 2017*

0 240 480 m
UTM, fuseau 18, NAD83

**Juillet / *July* 2021**

*Dessin : A. Masson*
*Approbation : C. Martineau*
*201-12362-00_c6-19_wspT336_fau_ter_210701.mxd*

wsp

### 2017 Inventory

In 2017, trapping efforts included 2,141 trap-nights for additional surveys performed in the study area.

Only nine specimens belonging to two species were sampled during this survey: the cinereous shrew, an insectivore, and the deer mouse, belonging to the rodent family.

### Species and habitats

During the 2011 survey, burns were already present in the study area; fewer and not as widespread as in 2017, they formed a mosaic of habitats with the unaffected environments. In these conditions, unaffected habitats represented refuges from which small mammals could recolonize the fire-affected environments (Trottier and coll., 1989). In 2011, a good species diversity was still present in the favourable habitats, but the densities of small mammals observed were already low. Several other fires occurred in the sector over the following years, some of which affected vast areas. Hence, in 2017, most of the study area was characterized by relatively recent burns. The forest fires do not only have short-term impacts like the death and escape of individuals, but also mid- and long-term ones, in cases of intense or recurrent fires, causing the disappearance and/or modification of current habitats (Morris and coll., 2011; Trottier and coll., 1989). Mature forest environments, notably, which are a core element of the habitat of several micromammal species, have virtually disappeared from the study area. Between 2011 and 2017, the number of species surveyed has dropped from eight to two, with a nearly five time lower capture rate.

### Rock Vole

The 2011 survey led to the identification of the rock vole, a species likely to be designated threatened or vulnerable in Québec (MFFP, 2006a). Although its distribution range is widespread across the province, the rock vole remains one of the most rarely seen mammal species in eastern Canada (Prescott and Richard, 2004). As its name indicates, it is closely associated with the presence of rocky outcrops, boulders or rock piles, often in mixed or coniferous forests near water sources. **The rock vole's habitat can also include certain open environments without forest cover, such as cutover areas that are less than a year old, small clearings and transition zones between open environments and mature forests (Duhamel and Tremblay, 2013). The rock vole is, however, primarily a woodland species that prefers to live in mixed-wood stands or mature softwood stands. It seems to prefer to live in areas where forest cover is sparse and the shrub stratum is somewhat dense (Duhamel and Tremblay, 2013). All of these environments—cutover, clearings and transition zones—are directly related to the presence of forest stands, which tends to confirm the presence of the species for forest and forest-adjacent habitats.**

The MM-07 sector, a forest stand downslope of a rock mound, totally matched the species' habitat requirements. **This was also the only habitat in the study area where the species had been observed in 2011 (WSP, 2019a).** However, the entire rocky outcrop sector was struck by several forest fires since 2011 and the remaining habitat no longer has the characteristics that made it suitable for this species (total loss of forest cover). **The mature forest stands that were still present in the study area during the first small mammal survey in 2011, during which the rock vole was observed, disappeared and no suitable habitat for this species was present during the 2017 survey. With regard to the plants that make up the main part of its diet, we find species that are likely to grow after a fire, such as blueberries (*Vaccinium angustifolium*) and other members of the *Vaccinium* genus, as well as some members of the *Rubus* genus, but also and especially species more associated with woodlands, such as the Canadian bunchberry (*Cornus canadensis*), the bluebead lily (*Clintonia borealis*) and the wild lily-of-the-valley (*Maianthemum canadense*) (Duhamel and Tremblay, 2013). The plants identified in the study done in Québec by Goodwin (1929), cited by Duhabel and Tremblay (2013), specifically the heartleaf foamflower (*Tiarella cordifolia*), the sweet white violet (*Viola incognita*), the Canadian bunchberry and the wild lily-of-the-valley are all primarily woodland species. These results also tend to confirm the importance of woodland features in the rock vole's preferred habitat.**

**Since mature forest environments virtually disappeared from the study area (WSP, 2019a) after repeated fires, the accumulation of wood debris on the soil and the presence of certain plant species that grow after fires will not meet the habitat needs of this species over the short- or medium-term.**

Due to its specific habitat preferences, the rock vole lives in small, isolated colonies throughout its distribution area (Banfield, 1977; Christian and Daniel, 1985; Daniel, 1980; Desrosiers *et al.*, 2002; Duhamel and Tremblay, 2013; Kirkland and Jannett, 1982; Prescott and Richard, 2004). Moreover, it seems that this species is generally characterized by a low population density (Banfield, 1977; Daniel, 1980; Desrosiers *et al.*, 2002). These attributes make the rock vole especially vulnerable to habitat disturbance. **Rock vole population densities are still subject to interannual variability, as is the case for most members of the cricetidae family (French and Crowell, 1985; Etnier, 1989). Janette (1990) suggests, however, that this species does not follow the 3-4 year cycles usually seen in this family. It would seem that rock vole populations count fewer individuals, but that they remain more stable over time (Jannett, 1998).**

**It therefore remains possible that a dip in population affecting all small mammal species and all habitats present contributed to the fact that virtually no animals were captured over the entire study zone in 2017. It is also possible that some rock voles survived fires that destroyed their habitat, even though this species does not live entirely underground, but rather digs shallow burrows and creates paths between rocks (Desrosiers and coll., 2002). Yet, while this behaviour, combined with the insulating effect of sometimes thick snow cover, likely helps shelter individuals from predators and extreme weather (Timm et al., 1977), it is unlikely that it provides effective protection from the repeated fires that affected the study area.**

Consequently, and in light of the extent of the forest fires that affected the study area, the species is unlikely to still occur there. **Furthermore, during the aerial caribou surveys done in March 2018, it was observed that the burned areas were characterized by very poor regeneration (WSP, 2018g). This situation can be explained by the fact that a large portion of the area was affected by successive fires and forest stands are particularly vulnerable to short fire cycles (short intervals between two disturbances) (Mansuy, 2013). It is therefore unlikely that the forest component will be restored before the end of the project and, in light of the above, it does not seem necessary to include small mammal surveys in the monitoring program.**

#### Southern bog lemming

The southern bog lemming is a rodent from the cricetidae family. A significant portion of its distribution range is found in Canada, from Manitoba up to Nova Scotia (Fortin and coll., 2004). In Québec, its range covers the southern part of the province (Desrosiers and coll., 2002), where it is generally found in low density, although peaks of abundance are occasionally observed (Fortin and Doucet, 2003). It can also be found in peatlands where sphagnum and heath shrubs are most dominant, in grassy marshes and the moist mixed forests surrounding these habitats (Desrosiers and coll., 2002). It also occurs in fields, prairies, and clearings due to forest clearcut, and among rocks where moss is abundant (Desrosiers and coll., 2002).

Although the species was not caught during the 2011 and 2017 surveys, it is potentially found in the area. However, in light of habitat disturbance by forest fires in the study area—notably, the disappearance of most mature forest environments, including around wetlands—this species is unlikely to occur there.

## 6.3.3 AQUATIC COMMUNITY

### 6.3.3.1 ICHTYOFAUNA

Preliminary sampling campaigns of ichthyofauna were conducted in 2012 and more complete samples were taken in 2017. The Aquatic Habitat Baseline Study *(Étude spécialisée sur l'habitat aquatique*) (WSP, 2018*c*) provides details on the methodology, work and results. This section summarizes the content of the sector study. **In addition, a supplemental survey was done in 2019 for the purpose of verifying mercury levels in fish tissues.** The ichthyofauna sampling sites (fish and benthos) are illustrated on Map 6-8.

#### FISH COMMUNITY

#### 2012 SURVEY

In all, 166 fish from six species were caught during the survey conducted in 2012 as part of the project. The white sucker was the most abundant species and was found in three lakes and watercourses surveyed in the study area. The yellow perch was caught only in Lake Kapisikama; no other species was caught in this lake. The yellow perch were small, a sign of the poor quality of the habitat. Brook trout were caught in creeks CE4 and CE5. Table 6-37 presents a summary of the 2012 catches.

#### 2017 SURVEY

The survey strategy used in 2017 was designed to cover the fish habitat of the study area (not covered in 2012) and to obtain a representation of the various types of habitats available. The survey campaign of fish communities and their habitats was conducted from September 7 to September 14, 2017. The results are presented below by lake and watercourse in the study area.

##### Asiyan Akwakwatipusich Lake

Although a survey was not conducted in 2017 in Asiyan Akwakwatipusich Lake, some characterization work was carried out. Initially, a drone was used to take video images of the lake and a bathymetry was conducted. The banks of the lake are generally steep and a small section of about 50 metres shows signs of erosion on the north shore. In this location, the bank shows signs of slumping. Flood zones covered with herbaceous plants and shrubs are present in this lake on either side of the mouth of watercourseCE3 as well as on its eastern side. These zones may be suitable for northern pike spawning. Northern pike was one of the three species caught in this lake in 2012, along with white sucker and lake chub (Table 6-37). **Table 6-38 presents the main morphometric and physicochemical characteristics of the lake.**

## Table 6-37 Data summary for fish caught in 2012

| Species | Lake Asiyan Akwakwatipusich | | | Lake Kapisikama | Expansion of creek CE3 | CE3 | | CE4 | | CE5 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CACO | COPL | ESLU | PEFL | CACO | COPL | CUIN | CUIN | SAFO | CACO | COPL | CUIN | ESLU | SAFO |
| Number | 57 | 5 | 6 | 38 | 4 | 3 | 20 | 5 | 2 | 18 | 2 | 1 | 2 | 3 |
| Average size (TL, cm) | 32.9 | 11.4 | 44.7 | 12.1 | 15.1 | 10.5 | 4.1 | 5.9 | 9.5 | 20.7 | 12.5 | 4 | 25.5 | 20 |
| Standard deviation (cm) | 5.4 | 2.5 | 11.9 | 1.7 | 3.4 | 1.8 | 1.1 | 0.7 | 0 | 4.3 | 0.7 | - | 14.8 | 8.7 |
| Maximum size (cm) | 46 | 15 | 58 | 15.5 | 18 | 12 | 5.5 | 7 | 9.5 | 35 | 13 | - | 36 | 26 |
| Minimum size (cm) | 17 | 9 | 23 | 9 | 11.5 | 8.5 | 1 | 5 | 9.5 | 16 | 12 | - | 15 | 10 |

TL: Total length.
Species: CACO: white sucker; COPL: lake chub; ESLU; northern pike; PEFL: yellow perch; SAFO: brook trout; CUIN: brook stickleback.

## Table 6-38 Morphometric and physicochemical properties of Asiyan Akwakwatipusich Lake

| | |
|---|---|
| Area (ha) | 62.6 |
| Perimeter (km) | 3.6 |
| Average depth (m) | 1.0 |
| Maximum depth (m) | 1.0 |
| Date of physicochemical surveys | June 30, 2012 |
| Water temperature (°C) | 15.3 |
| Dissolved oxygen (%) | 55 |
| Conductivity (µS/cm) | 8 |
| pH | 6.4 |
| Water transparency (m) | Not available |

### Asini Kasachipet Lake

The aquatic habitat of Asini Kasachipet Lake is very homogeneous. The substrate of this body of water is dominated by silt. Scattered boulders, often protruding from the surface of the water, are observed. On the bank, sand and pebbles dominate the substrate. The aquatic vegetation consists mainly of large yellow-pond lilies (*Nuphar variegata*). The vegetation on the banks of the lake consists mostly of black spruce (*Epicea mariana*), tamarack (*Larix laricina*), heath as well as herbaceous plants and peat moss.

A fishing effort involving four net-nights and two seine searches was deployed in this lake in 2017. The brook stickleback was the only species caught.

The survey results show that Asini Kasachipet Lake is not very productive and fish usage is limited since only the brook stickleback seems to frequent this body of water. The outlet of the lake, creek CE3, does not have any apparent outflow, which could limit upstream migration. The shallowness of the lake and its high acidity could explain its limited use by aquatic fauna.

Table 6-39 presents the main morphometric and physicochemical properties of Asini Kasachipet Lake.

**Table 6-39 Morphometric and physicochemical properties of Asini Kasachipet Lake**

| | |
|---|---|
| Area (ha) | 18.6 |
| Perimeter (km) | 1.9 |
| Average depth (m) | 0.75 |
| Maximum depth (m) | 1.0 |
| Date of physicochemical surveys | September 9, 2017 |
| Water temperature (°C) | 10.6 |
| Dissolved oxygen (%) | 84 |
| Conductivity (µS/cm) | 7 |
| pH | 3.7 |
| Water transparency (m) | 0.3 |

## Kapisikama Lake

The aquatic habitat of Kapisikama Lake is homogeneous. This lake, which is ringed by a floating bog mat, has a substrate made up exclusively of decomposing organic matter. The aquatic vegetation consists primarily of yellow pond-lilies. On the bank, the vegetation consists of heath, herbaceous plants and peat moss. The lake does not have a direct outlet. Instead, it drains through its surrounding bog and ultimately into creek CE4. Table 6-40 summarizes the morphometric and physicochemical properties of Kapisikama Lake.

**Table 6-40 Morphometric and physicochemical properties of Kapisikama Lake**

| | |
|---|---|
| Area (ha) | 1.2 |
| Perimeter (km) | 0.55 |
| Average depth (m) | 2 |
| Maximum depth (m) | 3 |
| Date of physicochemical surveys | September 8, 2017 |
| Water temperature (°C) | 12.5 |
| Dissolved oxygen (%) | 92 (surface) and 77 |
| Conductivity (µS/cm) | 9 |
| pH | 4.6 |
| Water transparency (m) | 0.5 |

**Experimental fishing in this lake was done based on the Canadian Wildlife Service's multi-species survey protocol (2011). The fishing effort totaled six net-nights (four large-mesh and two small-mesh) and was set up to cover all types of habitat. Method details are presented in Section 2.3 of the Aquatic Inventory and Baseline Study. The description of this body of water, a headwater lake surrounded by peatland, indicates that the effluent (flowing into CE4) is diffuse and that no runoff was visible during the field visit. This lake is therefore considered isolated, which rules out the possibility that fish could migrate from the CE4 creek to the lake and vice versa. No fish were caught in the CE4 creek upstream of the Billy-Diamond highway (formerly the James Bay road).**

Yellow perch was the only fish species caught in Kapisikama Lake. This species is found at the northern edge of its distribution area (Scott and Crossman, 1973), although catching yellow perch at this latitude is not exceptional. The population is isolated, and individuals are small and low weight, attesting to the poor habitat. The results of the 2017 and 2012 catches are comparable. The average size of individuals was slightly larger, 12.1 cm versus 11.27 cm (Table 6-41).

**This species' allopatric presence in this region is surprising, but it remains possible that this species was isolated in the lake in the past.** The lake is shallow and relatively acidic, which indicates conditions that are not very favourable for a number of fish species. **It is, however, somewhat likely that the low diversity of fish in this lake is due to special conditions of the lake and that other, smaller species may be present without being caught.**

The survey results show that Kapisikama Lake is not very productive and fish usage is limited. Its isolation, shallowness and high acidity could explain its limited use by aquatic fauna.

**Table 6-41 Data summary for fish caught in Kapisikama Lake**

| Parameter | Yellow perch |
|---|---|
| Number of catches (n) | 81 |
| Average length (TL; cm) | 11.27 |
| Standard deviation (cm) | 1.49 |
| Minimum (cm) | 8 |
| Maximum (cm) | 14 |
| TL: Total length | |

### Unnamed Pond 1

The fish habitat of Unnamed Pond 1 is comparable to that of Kapisikama Lake. When the survey was conducted in September 2017, a fishing effort involving experimental gill netting representing one net-night was used in this lake, but no fish were caught.

Table 6-42 summarizes the main information concerning this body of water.

**Table 6-42 Morphometric and physicochemical properties of Unnamed Pond 1**

| | |
|---|---|
| Area (ha) | 0.6 |
| Perimeter (km) | 0.46 |
| Average depth (m) | 2 |
| Maximum depth (m) | 3 |
| Date of physicochemical surveys | September 12, 2017 |
| Water temperature (°C) | 13 to 14 |
| Dissolved oxygen (%) | 83 (surface) and 67 |
| Conductivity (µS/cm) | 8 |
| pH | 4.2 |
| Water transparency (m) | 2.5 |

### Creek CE1

Creek CE1 is a permanent stream that flows from the vast bog complex east of Billy-Diamond highway. This watercourse drains from east to west. Within the study area, this watercourse is very homogeneous. It is a meandering stream with a low flow rate of less than 0.2 m/s. The average width of the flow channel is 2.2 m and that of the littoral (measured at the natural high-water mark – NHWM) is 51 m. Its average depth is one metre. The substrate is dominated by fine particles. The water is highly coloured.

**The first upstream portion of the watercourse, located at the end of the study area, is 3,670 m in length and flows through a fen. The banks of the watercourse are consequently loose and mainly composed of peat moss, heaths and herbaceous plants. Two beaver dams were observed. The average channel width is 2.5 m, ranging from less than 1 m to over 6 m. The littoral width is, on average, 60 m, ranging from 18 m to 97 m. The facies are made up of meandering channels.**

**The second section of the watercourse is located immediately downstream of the first section and ends at the confluence with CE2. This section is 1,600 m long and characterized by very dense forest cover that almost entirely closes over the stream. The channel and littoral are narrower, averaging 1.75 m (ranging from 1.4 to 2.4 m) and 40 m (ranging from 27 to 56 m), respectively.**

No fish survey was taken in this watercourse **in 2017. Through a sampling campaign in 2019, a station on creek CE1 (Map 6-8) caught five species of brook trout, averaging 1.61 cm in length, with a minimum length of 1.43 cm and a maximum length of 1.84 cm. Individual brook stickleback have also been seen in CE1 (WSP 2019b).**

### Creek CE2

Creek CE2 is a permanent stream, which like creek CE1, flows from a bog located east of Billy-Diamond highway. This watercourse drains from east to west. Within the study area, this watercourse is very homogeneous. It is a meandering stream with a low flow rate ranging from 0.04 m/s (August) to 0.19 m/s (October). The average width of the flow channel is 2.4 m and that of the littoral (measured at the NHWM) is 63 m. The average depth is more than one metre. The substrate is dominated by fine particles, although larger particles are found (gravel, stone and pebble) in some very specific areas. During the surveys done in September 2017, the pH was acidic (between 3.5 and 3.8), conductivity varied between 16 and 17 µS/cm and concentrations of dissolved oxygen were low (between 36% and 42%). The water is highly coloured. **This watercourse can be divided into two sections based on the nature of the banks.**

**The first portion of the watercourse is the upstream portion, over 5,600 m in length, flowing through a fen across the study area. Thus, the banks of the watercourse are very loose and mainly composed of peat moss, heaths and herbaceous plants. A total of five beaver dams were observed. The average channel width is 2 m, ranging from just 60 cm to 3 m. The littoral width is, on average, 66 m, ranging from 22 m to 127 m. The waterway channel is u-shaped. The depth can reach up to 1.75 m. The substrate is composed of silt and decomposing organic matter. The facies are made up of meandering channels.**

**The second section of the watercourse is located immediately downstream of the first section and is 580 m long. It is characterized by denser forest cover and a narrower littoral. The watercourse channel is wider at nearly 4 m on average and features more gradual slopes than those seen in section 1. Although the substrate is mainly made up of fine particles, in some spots, we can see the presence of larger substrate components (gravel, stone and pebble). The littoral width ranges from 40 to 49 m, with an average width of 45 m. Two beaver dams were observed.**

The surveys yielded **three** fish species: the brook trout *(Salvinus fontinalis)*, the lake chub *(Couesius plumbeus)* **and the brook stickleback (*Culaea inconstans*)**. The brook trout was found in creek CE2 even though the habitat is not suitable for salmonids (prevalence of fine particles, low current, low concentration of dissolved oxygen and low pH). No adequate spawning area for brook trout was observed in this watercourse. **Brook stickleback were observed in creek CE2 but were not counted.** Table 6-43a presents the catch details **from 2017 while Table 6-43b shows the catch details from 2019**.

**Table 6-43a Data summary for fish caught in creek CE2 - 2017**

| Parameter | Brook trout | Lake chub |
|---|---|---|
| Number of catches (n) | 6 | 2 |
| Average length (TL; cm) | 17.6 | 11.5 |
| Standard deviation (cm) | 3.9 | 2.1 |
| Minimum (cm) | 14 | 10 |
| Maximum (cm) | 23 | 14 |
| TL: Total length. | | |

**Table 6-43b Data summary for fish caught in creek CE2 - 2019**

| **Parameter** | **Brook trout** |
|---|---|
| **Number of catches (n)** | **15** |
| **Average length (TL; cm)** | **20.5** |
| **Standard deviation (cm)** | **2.3** |
| **Minimum (cm)** | **17.8** |
| **Maximum (cm)** | **23.8** |
| **TL: Total length.** | |

### Creek CE3

Creek CE3 is a permanent stream that flows from Asini Kasachipet Lake. This watercourse drains from west to east. Within the study area, it is very homogeneous and runs 6,800 m. For the portion west of Billy-Diamond road, it is a meandering stream winding its way through a fen. Flow rates are low, ranging from 0.30 m/s in June, to 0.10 m/s in August to 0.27 m/s in October. East of the road, the topography becomes more accentuated, forcing the watercourse into a sequence of small rapids and pools before flowing into Asiyan Akwakwatipusich Lake. The average width of the flow channel is more than 20 m. The littoral width (measured at the NHWM) is 54 m. The average depth is more than one metre. The substrate is dominated by fine particles. During the September 2017 inventories, the pH was acidic (between 4.09 and 4.7), conductivity was between 12 and 13 µS/cm and concentrations of dissolved oxygen ranged from 57% to 82%. The water is highly coloured. Two beaver dams were noted along this body of water. **This watercourse can be divided into seven distinct sections based on the nature of the banks and the channel. Sections located to the east of the Billy-Diamond highway were characterized through photo interpretation and the LIDAR survey.**

**The first section is the portion starting immediately downstream of Asini Kasachipet Lake. This section, which is 379 m long, is characterized by the lack of distinct flow channel at the time of the surveys in late summer 2017. The watercourse seems to flow through dense vegetation made up of peat moss, heaths and black spruce. A flow channel does, however, become visible during high-flow periods. The average littoral width is 37 m (ranging from 27 to 47 m).**

**Starting with the second section, which is over 2,700 m long, a distinct channel bed can be observed. The u-shaped flow channel is relatively straight and is just over a metre wide on average. The average littoral width is 35 m (ranging from 21 to 61 m). In this section, the watercourse crosses treed peatland.**

**The third section of the watercourse, which is 1,870 m long, is characterized by the disappearance of forest cover and the widening of the channel and littoral. The watercourse channel is still u-shaped, with an average width of 3.5 m (ranging from 2.4 to 5.5 m). The littoral is made up of open peatland on both banks. The littoral width ranges from 32 m to over 100 m, averaging 54 m.**

**The fourth section of creek CE3 features a widening. The body of water covers a surface area of 3.3 ha with 1,100 m of shoreline. This body of water is also surrounded by a floating bog mat. The depth never exceeds 2 m. The substrate is made up exclusively of decomposing organic matter. We observed the presence of yellow pond lilies. The bank slope was steeper, thus limiting the littoral width which is less developed on the south shore of the body of water.**

**The fifth section, located immediately between the lake and the Billy-Diamond highway, has characteristics similar to section 3. A beaver dam is located immediately upstream of the road. A culvert is located on the watercourse and can be navigated by fish. The flow inside this culvert has no characteristics that would obstruct the free passage of fish.**

**The sixth section, which starts to the east of the Billy-Diamond highway, offers some contrast due to its more pronounced topography. Small rapids are present along the length of this 900-m section. The flow channel is narrow, at about 1 m wide. The vegetation along the banks is made up of conifers (black spruce and tamaracks) and health shrubs. It was impossible to establish the littoral width of this section because of the presence of a shore fen (see Section 2.1.3: Fish habitat). It was decided instead to apply a uniform strip 10 metres wide based on field observations in 2012, LIDAR data and satellite images.**

**The last section starts where the watercourse crosses a sector of fen immediately downstream of Asiyan Akwakwatipusich Lake. At this location, the channel and the littoral widen and the watercourse resumes a meandering flow before emptying into the lake. The width of the channel ranges from 9 to 13 m (average** of 10.7 m) and the littoral width ranges from 31 m to over 100 m with an average width of 54 m.

The fishing efforts in 2017 yielded four species in creek CE3: the brook trout, white sucker, brook stickleback and lake chub (Table 6-44). Furthermore, while the brook stickleback does not appear in the results of the catches made in the expanded CE3, it is likely that the species is present. Fish of this size could not be caught because of the nets used.

**Table 6-44 Data summary for fish caught in creek CE3**

| Parameter | Brook trout | White sucker | Brook stickleback | Lake chub |
|---|---|---|---|---|
| Number of catches (n) | 2 | 3 | 80 | 4 |
| Average length (TL; cm) | 23.5 | 22.3 | 4.2 | 11.9 |
| Standard deviation (cm) | 3.5 | 5.25 | 0.8 | 1.0 |
| Minimum (cm) | 21 | 17 | 3 | 10.3 |
| Maximum (cm) | 26 | 27.5 | 6.5 | 13 |
| TL: Total length | | | | |

### Creek CE4

Creek CE4 is fed by runoff from the peatlands surrounding Kapisikama Lake. This watercourse starts where a visible flow channel appears, just over 700 m upstream of Billy-Diamond highway (Map 6-8). The flow runs through vegetation; the flow channel appears and then disappears between tree roots. Within the study area, the watercourse runs 2,600 m. It flows from west to east. The substrate consists of fine particles only and the depth does not exceed 0.3 m. Flow rates are low, about 0.01 m/s. During the September 2017 surveys, the pH was acidic (4.58), conductivity was 21 µS/cm and the concentration of dissolved oxygen was 68%. The water is highly coloured. No beaver dam was noted along this watercourse. After crossing the road, the flow channel becomes permanent. Creek CE4 reaches the outlet of Asiyan Akwakwatipusich Lake outside the study area. **Creek CE4 can be divided into three distinct sections.**

**The first section is the 700 first upstream metres of the watercourse. As mentioned, in this location there is an intermittent flow channel less than one metre wide. The littoral is an average of 29 m wide, ranging from 15 to 43 m. Trees and shrubs colonise the littoral and cover the flow channel almost completely. The culvert crossing the Billy-Diamond highway seems blocked and could prevent fish from crossing this culvert.**

**The second section, starting at the Billy-Diamond highway, is 1,400 m long. At this point, the flow channel becomes visible and is an average of 2.4 m wide, ranging from 0.9 m to 3.9 m. The littoral is dominated by trees and shrubs along with herbaceous plants colonizing the immediate shore. The littoral width ranges from 55 m to 93 m for an average of 77 m.**

**Lastly, based on the spring 2018 field surveys (hydraulic surveys), a third section was added between Kapisikama Lake and the upstream portion of section 1. However, due to the fact that the watercourse is intermittent and that it sometimes flows underground and through a bog, it is impossible to get a littoral measurement for this section.**

In 2017, an electrofishing effort was conducted in the watercourse section west of Billy-Diamond highway. The fishing effort was conducted in a 100-metre section of sites with no barriers (Map 6-8). No fish were caught.

#### Creek CE5

Creek CE5 is a stream that flows from a peatland complex west of the study area (Map 6-8). This watercourse drains from west to east. Within the study area, it is homogeneous and runs over 7,000 m. It ultimately flows into the Eastmain River, more than 10 km downstream of the study area. Like the other watercourses described earlier, it is a meandering river that crosses fens. Flow rates are fairly low, ranging from 0.2 m/s in June to 0.05 m/s in August to 0.2 m/s in October. Progressing downstream, the channel and littoral gradually widen. The average width of the flow channel is 4.8 m. The average width of the littoral (measured at the NHWM) is 77 m. The substrate is dominated by fine particles. During the September 2017 inventories, the pH was acidic (5.16), conductivity was 16 µS/cm and the concentration of dissolved oxygen was 63%. The water is highly coloured. Six beaver dams were noted along this watercourse. **This watercourse can be divided into two distinct sections based on the nature of the channel and the banks.**

**The first section, located upstream, is a meandering section 2,800 m long through treed fens. The channel is relatively narrow with an average width of 1.3 m (ranging from 1.2 to 1.4 m) and is u-shaped. In this section, visually, flow rates are higher. The substrate is exclusively composed of fine particles and is no more than 0.5 m deep. The average littoral width is 7 m (ranging from 1.4 m to 13.4 m). The vegetation is dominated by trees and shrubs.**

**The second section starts where the watercourse's littoral becomes characterized by the presence of open fens. This section is 4,300 m long. The river becomes very meandering in this section and its flow rate slows. The flow channel broadens to an average width of 7 m (ranging from 1.4 m to 13.4 m). The average depth is over 1.5 m. The substrate is made up of fine particles. The littoral is wide, ranging from 9 m to 116 m (average of 57 m). Vegetation is mainly dominated by peat moss and herbaceous plants.**

During the survey campaign, a hoop net was set up in this watercourse, resulting in 74 catches. Five fish species were caught: trout perch, white sucker, brook stickleback, lake chub and northern pike (Table 6-45). The lake chub accounted for more than 60% of the catch. The large flood plains dominated by herbaceous vegetation along this watercourse on either side of Billy-Diamond road could be used during the spring floods for northern pike spawning.

**Table 6-45 Data summary for fish caught in creek CE5**

| Parameter | Trout perch | White sucker | Brook stickleback | Northern pike | Lake chub |
|---|---|---|---|---|---|
| Number of catches (n) | 2 | 23 | 3 | 1 | 45 |
| Average length (TL; cm) | 8.5 | 17.1 | 6 | 34.5 | 11.9 |
| Standard deviation (cm) | 0.7 | 2.6 | 0.5 | - | 1.0 |
| Minimum (cm) | 8 | 11.5 | 5.5 | - | 10.3 |
| Maximum (cm) | 9 | 21.5 | 6.5 | - | 13 |
| TL: Total length | | | | | |

### MERCURY LEVELS

**The July 2019 field sampling campaign (WSP, 2019b), resulted in an analysis of initial mercury concentrations in the tissue of fish near the discharge point of creek CE2 and one of its tributaries CE1 (Map 6-8). The results of this sampling campaign are presented in Table 6-46.**

### Table 6-46 Mercury concentrations measured in the fish analyzed

| Station no. | Fish ID | Unit | Detection threshold | Concentration | Station average | Station CV |
|---|---|---|---|---|---|---|
| CE1-1A | 16 | mg/kg | 0.01 | 0.097 | 0.080 | 16% |
| | 17 | mg/kg | 0.01 | 0.075 | | |
| | 18 | mg/kg | 0.01 | 0.084 | | |
| | 19 | mg/kg | 0.01 | 0.063 | | |
| | 20 | mg/kg | 0.01 | 0.082 | | |
| CE2 (near the road) | 01 | mg/kg | 0.01 | 0.18 | 0.120 | 34% |
| | 02 | mg/kg | 0.01 | 0.13 | | |
| | 03 | mg/kg | 0.01 | 0.12 | | |
| | 04 | mg/kg | 0.01 | 0.1 | | |
| | 05 | mg/kg | 0.01 | 0.095 | | |
| | 06 | mg/kg | 0.01 | 0.11 | | |
| | 07 | mg/kg | 0.01 | 0.069 | | |
| | 08 | mg/kg | 0.01 | 0.1 | | |
| | 09 | mg/kg | 0.01 | 0.06 | | |
| | 10 | mg/kg | 0.01 | 0.21 | | |
| | 11 | mg/kg | 0.01 | 0.145 | | |
| | 12 | mg/kg | 0.01 | 0.13 | | |
| | 13 | mg/kg | 0.01 | 0.15 | | |
| | 14 | mg/kg | 0.01 | 0.082 | | |
| | 15 | mg/kg | 0.01 | 0.093 | | |

**The concentration presented for CE2-11 is an average of 2 duplicates of 0.13 and 0.16 mg/kg**

**When we compare the results obtained with the fish consumption recommendation criterion adopted by the MELCC (no consumption restrictions when ≤ 0.29mg/kg, MELCC 2019), we see that, even though all fish have some level of mercury, no sample exceeded the comparison criterion.**

#### *6.3.3.2 BENTHIC COMMUNITY*

Three sampling campaigns of benthic organisms were conducted in 2017: one in July (July 24-31), a second in September (September 5-14) and a final one in October (October 8-12). The locations of the sampling stations are shown on Map 6-8. Benthos samples were collected at depths not exceeding 0.5 m. For stations 1A, 2A and 5B, the substrate was dominated by sand with, in the case of stations 1A and 2A, a large proportion of silt and clay. The substrate of station 3B was made up exclusively of organic matter.

In total, 48 species or taxa were identified in the four stations sampled. In July, three to four taxa or species were identified in stations 1A, 2A and 3B, while 14 were identified for station 5B. In September, between two and five taxa or species were identified in stations 1A, 2A and 3B, while 10 were identified for station 5B. In October, only five species were counted in station 1A while 16 to 19 were counted for the three other stations.

Table 6-47 shows the variation in the abundance per taxon according to the sampling period for the four stations sampled. Insects made up a significant proportion of the benthic community during the three campaigns. The prevalence of bivalves, oligochaeta and acari remained relatively similar. In September, ostracods accounted for almost a third of the organisms, whereas they were less prevalent in July and October.

### Table 6-47 Main taxa collected by sampling campaign

| Taxon | July (%) | September (%) | October (%) |
|---|---|---|---|
| Bivalves | 7 | 16 | 11 |
| Oligochaeta | 6 | 10 | 12 |
| Acari | 6 | 1 | 1 |
| Ostracods | 3 | 28 | 12 |
| Insects | 78 | 45 | 64 |

Table 6-48 shows the abundance, diversity (Shannon index), richness and tolerance to pollution of the organisms identified by station and sampling campaign. In July and September, station 5B had the most abundant, rich and diversified benthic community. Station 1A had the least abundant benthic community for the three campaigns.

Of the four stations sampled, the benthic community was least abundant, rich and diverse in September and richest in October. Lastly, the tolerance of the identified organisms to pollution was generally high and remained fairly constant during the three campaigns.

### Table 6-48 Descriptors of benthic invertebrate communities

| | July | | | | September | | | | October | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | Abundance | Diversity | Richness | Tolerance | Abundance | Diversity | Richness | Tolerance | Abundance | Diversity | Richness | Tolerance |
| 1A | 22 | 0.76 | 3 | 7.6 | 2 | 0.69 | 2 | 7.0 | 5 | 1.61 | 5 | 7.4 |
| 2A | 20 | 1.39 | 4 | 6.0 | 31 | 1.22 | 5 | 9.1 | 195 | 2.00 | 19 | 8.2 |
| 3B | 8 | 1.39 | 4 | 7.0 | 8 | 1.04 | 3 | 8.5 | 51 | 2.43 | 16 | 7.6 |
| 5B | 85 | 2.59 | 14 | 6.0 | 46 | 1.94 | 10 | 7.6 | 131 | 2.07 | 16 | 6.8 |
| Average | 34 | 1.5 | 6 | 7 | 22 | 1.2 | 5 | 8 | 96 | 2.0 | 14 | 8 |

## 6.3.4 HERPETOFAUNA

### 6.3.4.1 METHODOLOGY

The northern edge of the distribution area of most herpetofauna species in Québec is more southern than the study area, for both amphibians and reptiles. As such, only a few species were relatively common to the latitude of this project, including the American toad *(Anaxyrus americanus),* spring peeper *(Pseudacris crucifer)* and mink frog (*Lithobates septentrionalis*) among anurans, and the common garter snake *(Thamnophis sirtalis)* among reptiles.

Since no at-risk herpetofauna species were anticipated in the study area, the survey efforts in their regard consisted of opportunistic searches in potentially suitable habitats. The methodology used for the herpetofauna survey is described in detail in the Terrestrial Wildlife and Avifauna Baseline Study (*Étude spécialisée sur les faunes terrestre et avienne)* (WSP, 2018*g*).

A survey of garter snakes was conducted in suitable habitats throughout the study area, more specifically, buffer strips exposed to the sun, where these animals are likely to seek warmth. This survey was conducted using the asphalt shingle method and active searching, as recommended by the MFFP (Larochelle and coll., 2015). As such, 126 shingles were installed on July 8 and 9, 2017, and surveyed on five occasions until their removal on September 24 and 25, 2017. These surveys were conducted on sunny days when garter snakes would be most attracted to the shingles. Opportunistic surveys of available shelters (rocks, debris, etc.) were also conducted concurrently with the shingle surveys and other inventory activities. The locations of the shingle transects are illustrated on Map 6-19.

#### 6.3.4.2 RESULTS

Only two anuran specimens, representing two species, were observed or heard during the field trips in 2017. The two species were the American toad *(Anaxyrus americanus)* and the wood frog *(Lithobates sylvaticus)*. These two species had also been observed during the surveys in 2012, **along with the mink frog (*Lithobates. septentrionalis*)**. These species are common and widespread in Québec.

The survey conducted by the asphalt shingle method and by active searching in suitable habitats did not reveal any **reptile** specimens in 2017; however, the exuvia of a garter snake was found on the Route du Nord, in a culvert. Based on its known distribution area, only this **reptile** species was likely to be found in the study area. An opportunistic observation of a specimen was collected during the surveys conducted in 2012. It was a common species widespread in Québec. No turtles or signs of turtle eggs were detected during field trips in the study area.

Despite our searches in suitable habitats and during periods favourable for detecting urodeles (salamanders and newts), no specimens of this group were observed.

### 6.3.5 AVIFAUNA

Bird surveys were conducted in 2017 for this project, including aerial surveys of waterfowl, a survey of terrestrial breeding birds and a targeted search of species at risk. These surveys were conducted from June 7 to July 10, 2017. The methodologies used for these surveys are described in detail in the Terrestrial Wildlife and Avifauna Baseline Study (*Étude spécialisée sur les faunes terrestre et avienne)* (WSP, 2018*g*).

A survey of terrestrial breeding birds was also conducted in 2012 in a portion of the study area. However, since the habitats surveyed have changed dramatically due to fire, only the species surveyed was considered and presented in the section titled *Previous Surveys*.

**Map 6-20A illustrates the location of avifauna survey stations, surveyed plant groups and mine site infrastructure. Map 6-20B illustrates this same information, this time with mine site infrastructure.**

#### 6.3.5.1 WATERFOWL AND AQUATIC BIRDS

**METHODOLOGY**

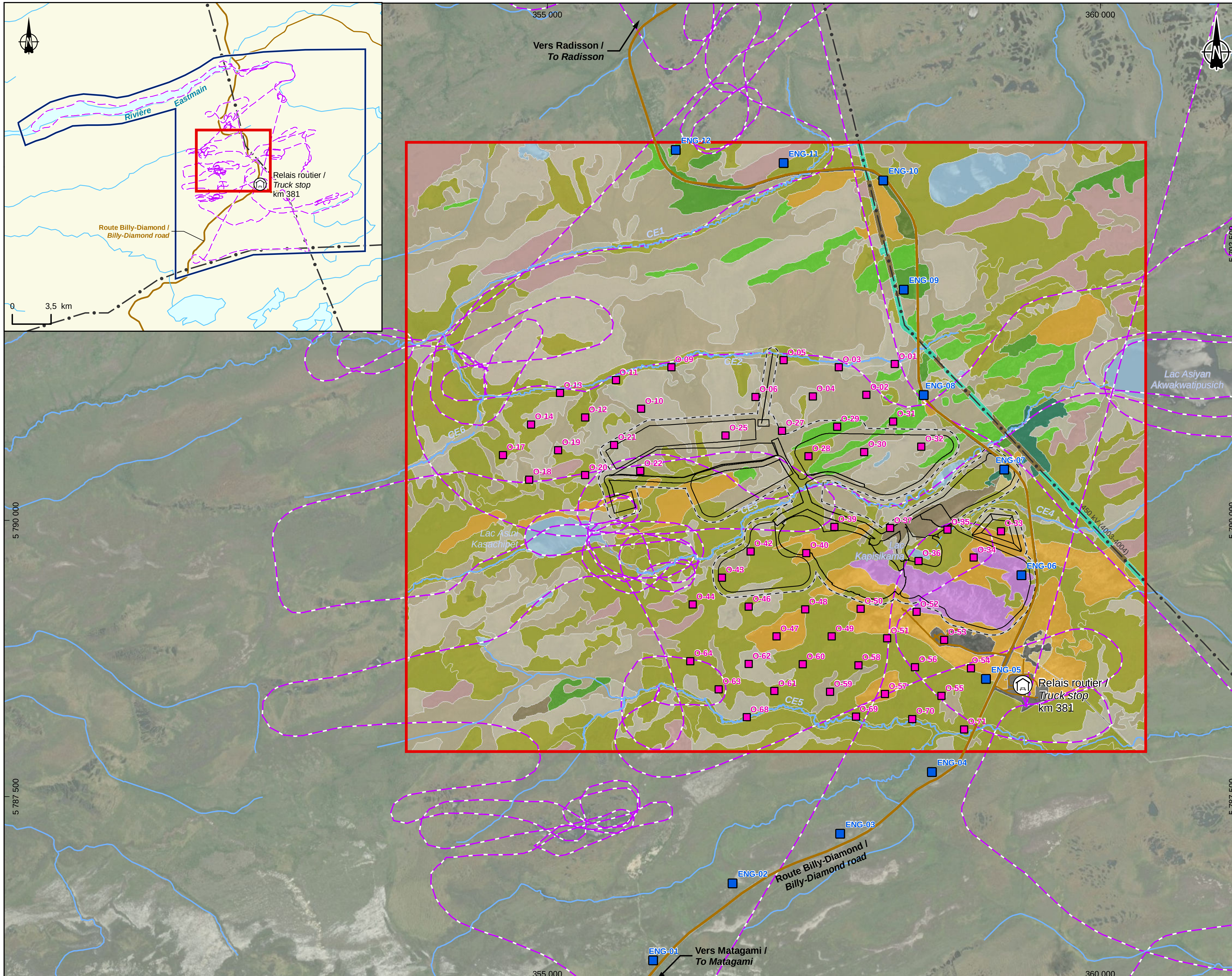
The waterfowl and aquatic bird surveys were essentially conducted by a helicopter flyover. The expanded study area for the helicopter survey is illustrated on Map 6-20A. The specimens observed on the ground during other field activities were also noted.

The aerial survey was conducted on June 7, 2017, with a view to covering all the bodies of water in the expanded study area (Map 6-20A). The surveys were flown at low altitude and at reduced speed, as proposed by the method used by ECCC in the *Black Duck Joint Venture* (Bordage and coll., 2003). During this survey, special attention was paid to the presence of birds of prey. Lastly, a request was submitted to the Canadian Wildlife Service (CWS) to check whether data relevant to the project were available in the *Eastern Waterfowl Monitoring Program* database.

**RESULTS**

The aerial survey revealed just 47 specimens of eight species of waterfowl and aquatic birds (Table 6-49). In addition, an osprey *(Pandion haliaetus)* flying over the Eastmain River was observed.

No notable area of concentration was observed since the few specimens noted were relatively dispersed in the study area. All the specimens observed were adults except for one immature sandhill crane *(Grus canadensis)*. The most abundant species was the Canada goose *(Branta canadensis)* with 19 individuals counted.




Zone d'étude locale / *Local study area*

Zone d'étude pour la sauvagine et les oiseaux aquatiques / *Study area for wildfowl and waterfowl*

Infrastructures minières / *Mining infrastructure*

Empreinte de la mine (zone tampon de 50 mètres) / *Mine footprint (buffer 50 meters)*

**Inventaires / *Inventory***

ENG-08 Station d'inventaire nocturne des engoulevents / *Nighthawk listening station*

O-33 Station d'écoute des oiseaux chanteurs / *Songbird listening station*

Inventaire de la sauvagine / *Wildfowl survey*

**Hydrographie / Hydrography**

CE4 Numéro de cours d'eau / *Stream number*

Cours d'eau permanent / *Permanent stream*

Cours d'eau à écoulement diffus ou intermittent / *Intermittent or diffused flow stream*

**Infrastructures / *Infrastructure***

Route principale / *Main road*

Route d'accès / *Access road*

Ligne de transport d'énergie / *Transmission line*

Relais routier / *Truck stop*

**Peuplements terrestres / *Terrestrial Vegetation***

Affleurement rocheux / *Rock outcrop*

Arbustaie / *Scrubland*

Aulnaie crispé / *Alder forest*

Boisé / *Woodland*

Dénudé sec / *Dry barren land*

Pessière noire à lichen / *Black spruce lichen forest*

Pessière noire à aulnes / *Black spruce alder forest*

Pinède grise / *Jack pine forest*

Anthropique / *Anthropogenic*

Brûlis / *Burnt area*

Végétation terrestre dans l'emprise / *Terrestrial vegetation in right-of-way*

**Peuplements humides / *Wetland***

Plan d'eau / *Waterbody*

Tourbière arbustive / *Shrubby peatland*

Tourbière boisée / *Treed peatland*

Tourbière ouverte / *Open bog*

Végétation humide dans l'emprise / *Wetland in right-of-way*

GALAXY

*Mine de lithium Baie-James /James Bay Lithium Mine*

**Carte / *Map* 6-20A**
**Sites d'inventaire de la faune avienne /**
***Avifauna Survey Sites***

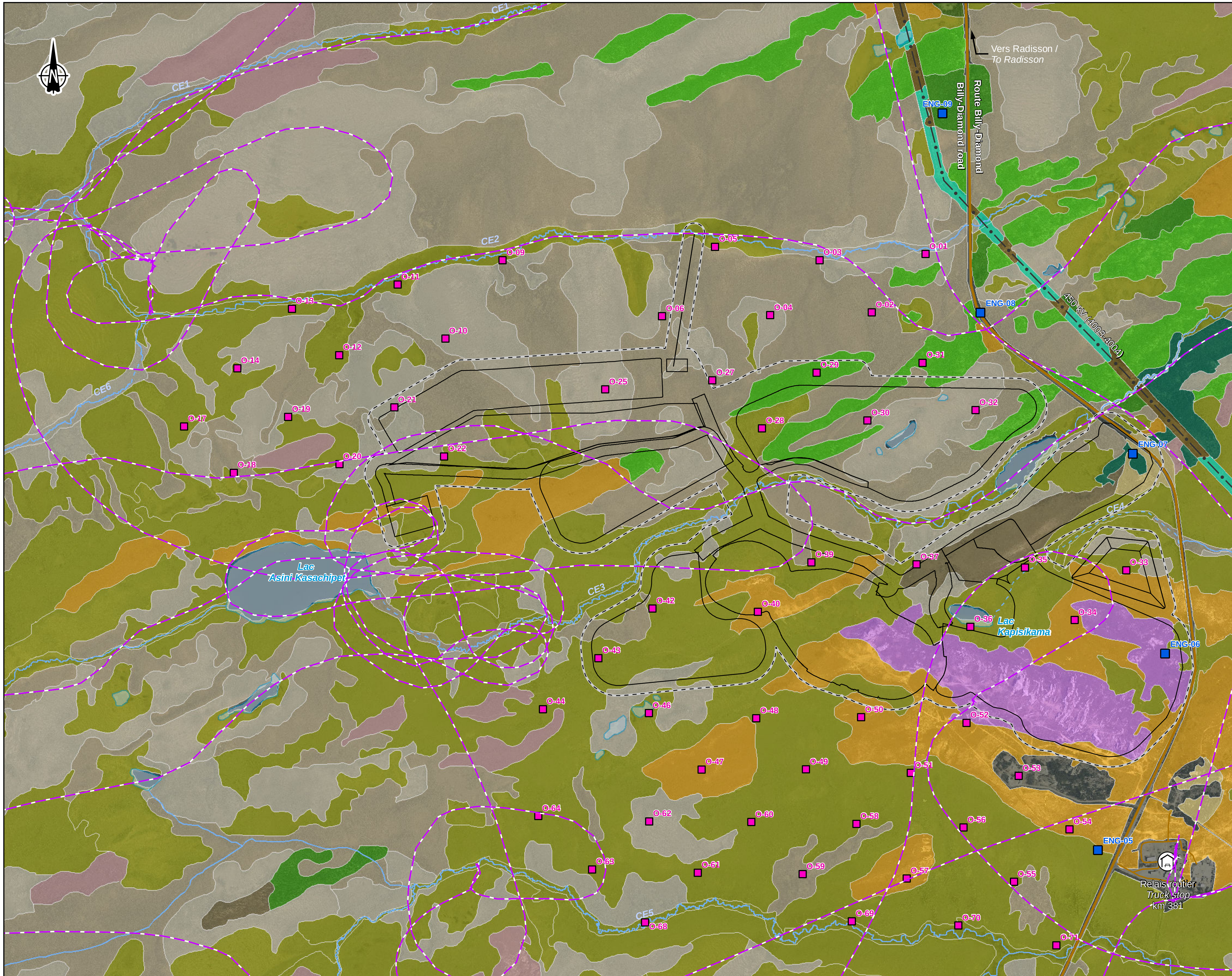
*Sources :*
*Orthoimage: Galaxy, août 2017*
*Inventaire / Inventory: WSP 2017*
*Données du projet / Project data : Galaxy, 2021*

0 350 700 m
UTM, fuseau 18, NAD83

**Juillet / *July* 2021**

*Dessin : A. Masson*
*Approbation : C. Martineau*
*201-12362-00_c6-20A_wspT296_f_avienne_210701.mxd*

wsp




Infrastructures minières / *Mining infrastructure*

Empreinte de la mine (zone tampon de 50 mètres) / *Mine footprint (buffer 50 meters)*

**Inventaires / *Inventory***

ENG-08 Station d'inventaire nocturne des engoulevents / *Nighthawk listening station*

O-33 Station d'écoute des oiseaux chanteurs / *Songbird listening station*

Inventaire de la sauvagine / *Wildfowl survey*

**Infrastructures / *Infrastructure***

Route d'accès / *Access road*

Ligne de transport d'énergie / *Transmission line*

Relais routier / *Truck stop*

**Hydrographie / *Hydrography***

CE3 Numéro de cours d'eau / *Stream number*

Cours d'eau permanent / *Permanent stream*

Cours d'eau à écoulement diffus ou intermittent / *Intermittent or diffused flow stream*

Plan d'eau / *Waterbody*

**Peuplements terrestres / *Terrestrial Vegetation***

Affleurement rocheux / *Rock outcrop*

Arbustaie / *Scrubland*

Aulnaie crispé / *Alder forest*

Boisé / *Woodland*

Dénudé sec / *Dry barren land*

Pessière noire à lichen / *Black spruce lichen forest*

Pessière noire à aulnes / *Black spruce alder forest*

Pinède grise / *Jack pine forest*

Anthropique / *Anthropogenic*

Brûlis / *Burnt area*

Végétation terrestre dans l'emprise / *Terrestrial vegetation in right-of-way*

**Peuplements humides / *Wetland***

Plan d'eau / *Waterbody*

Tourbière arbustive / *Shrubby peatland*

Tourbière boisée / *Treed peatland*

Tourbière ouverte / *Open bog*

Végétation humide dans l'emprise / *Wetland in right-of-way*

GALAXY

*Mine de lithium Baie-James /James Bay Lithium Mine*

***6-20B***
***Sites d'inventaire de la faune avienne /***
***Avifauna Survey Sites***

*Sources :*
*Orthoimage: Galaxy, août 2017*
*Inventaire / Inventory: WSP 2017*
*Données du projet / Project data : Galaxy, 2021*
*Fosse, carrière et entreposage des explosifs /*
*Pit, quarry and explosives magazine : Mining Plus, 2018*
*Secteur administratif et industriel et aire de minerai /*
*Administrative and industrial sector and ROM pad : Primero, 2018*

0 185 370 m

UTM, fuseau 18, NAD83

Juillet / *July* 2021

*Dessin : A. Masson*
*Approbation : C. Martineau*
*201-12362-00_c6-20B_wspT297_f_avienne_mine_210701.mxd*

wsp

**Table 6-49 Results of aerial surveys of waterfowl and aquatic birds – June 2017**

| Species (n = 8) | Number of specimens | Species (n = 8) | Number of specimens |
|---|---|---|---|
| Canada goose *(Branta canadensis)* | 19 | Common merganser *(Mergus merganser)* | 5 |
| Black duck *(Anas rubripes)* | 5 | Sandhill crane *(Grus canadensis)* | 8 |
| Ring-necked duck *(Aythya collaris)* | 1 | Surf scoter *(Melanitta perspicillata)* | 4 |
| Common goldeneye *(Bucephala clangula)* | 1 | Green-winged teal *(Anas crecca)* | 4 |

In addition to the waterfowl and aquatic bird specimens counted in the aerial survey, 33 individuals representing six species were noted during the ground survey activities in 2017 (Table 6-50). The most abundant waterfowl and aquatic bird species observed on the ground were Wilson's snipe *(Gallinago delicata),* the common loon *(Gavia immer)* and the solitary sandpiper *(Tringa solitaria).*

**Table 6-50 Results of ground surveys of waterfowl and aquatic birds – June 2017**

| Species (n = 6) | Number of specimens | Species (n = 6) | Number of specimens |
|---|---|---|---|
| Wilson's snipe *(Gallinago delicata)* | 11 | Sandhill crane *(Grus canadensis)* | 2 |
| Solitary sandpiper *(Tringa solitaria)* | 6 | Common loon *(Gavia immer)* | 7 |
| Greater yellowlegs *(Tringa melanoleuca)* | 5 | Green-winged teal *(Anas crecca)* | 2 |

### *6.3.5.2 TERRESTRIAL BREEDING BIRDS*

#### METHODOLOGY

**Terrestrial** breeding birds, **including the rusty blackbird, the olive-sided flycatcher and the bank swallow, the common nighthawk and the short-eared owl** were surveyed through listening stations (Blondel and coll., 1970; Environment Canada, 1997 and 2007). About 60 stations were set up in the habitats in the local study area for this purpose (Map 6-20A) and each was visited once between July 5 and 10, 2017, inclusively. **Maps 6-20A and 6-20B show the different survey stations based on the type of stand and environment identified. An effort was made to ensure that survey stations were present in all environments identified through photo interpretation of publicly available satellite images. This survey effort was done despite the fact that the project is located outside of harvested forest area and the fact that the ecoforest data available was incomplete and dated from before the forest fires.**

Given the relative homogeneity of the environments, the stations were divided into three habitat categories: wetlands (31 stations), open habitats (18 stations) and softwood stands (9 stations). **The relatively low densities and species richness of the birds surveyed at each station also highlight the importance of grouping environments together into categories with a maximum number of stations.** A survey using listening stations was also conducted at a preliminary stage of the project, from June 30 to July 4, 2012.

**Listening stations were visited early in the morning, between 05:15 and 10:30, in conditions with no rain and little to no wind. At each visit, a five-minute listening period was observed. During this period, each bird or group of birds observed was identified and assigned a radius distance from the observer: 0-50 m or over 50 m. Observations of flying birds or observations at distances of beyond 50 m were used to build out the list of species, but not to estimate abundance or density.**

**Since field ornithologists were fully aware of the list of at-risk species likely to use the study area, they were on the lookout for them and prepared to identify their presence, even while travelling from station to station.**

**Maps 6-20C to 6-20G show the positions of survey stations on maps of potential habitat for each of the five at-risk migratory species present or potentially present that are targeted in this study. They demonstrate the effort to distribute the stations in the way that is best suited to detecting these species in the study area, allowing for sufficient coverage of these habitats and optimizing the likelihood of detection.**

For nighthawks, a nocturnal survey outing, on a clear day, was conducted on July 6, 2017, to take advantage of the species' increased activity periods during the full moon. This survey used ten listening stations along Billy-Diamond road (Map 6-20E), which were surveyed according to the protocol developed by the Regroupement QuébecOiseaux (2015). **The survey started at least 30 minutes before sunset, as soon as the moon was visible, to end no later than moonset. Each listening point consisted of two consecutive three-minute periods. If short-eared owls were present along the route, this species could also have been detected that evening. Both of these species could also be encountered opportunistically during surveys for passerine nesting birds or other survey work done for this project.**

Aside from the field surveys conducted in 2012 and 2017, the Regroupement QuébecOiseaux was asked to provide data from the Étude des populations d'oiseaux du Québec (ÉPOQ; Larivée, 2017) and SOS-POP (SOS-POP, 2018) data banks.

**Table 6-51 outlines the documentary sources and methodology used for the acquisition of avifauna survey data. Since these surveys are based on standard and recognized methods, the results obtained are considered reliable and in accordance with the reality of the study area.**

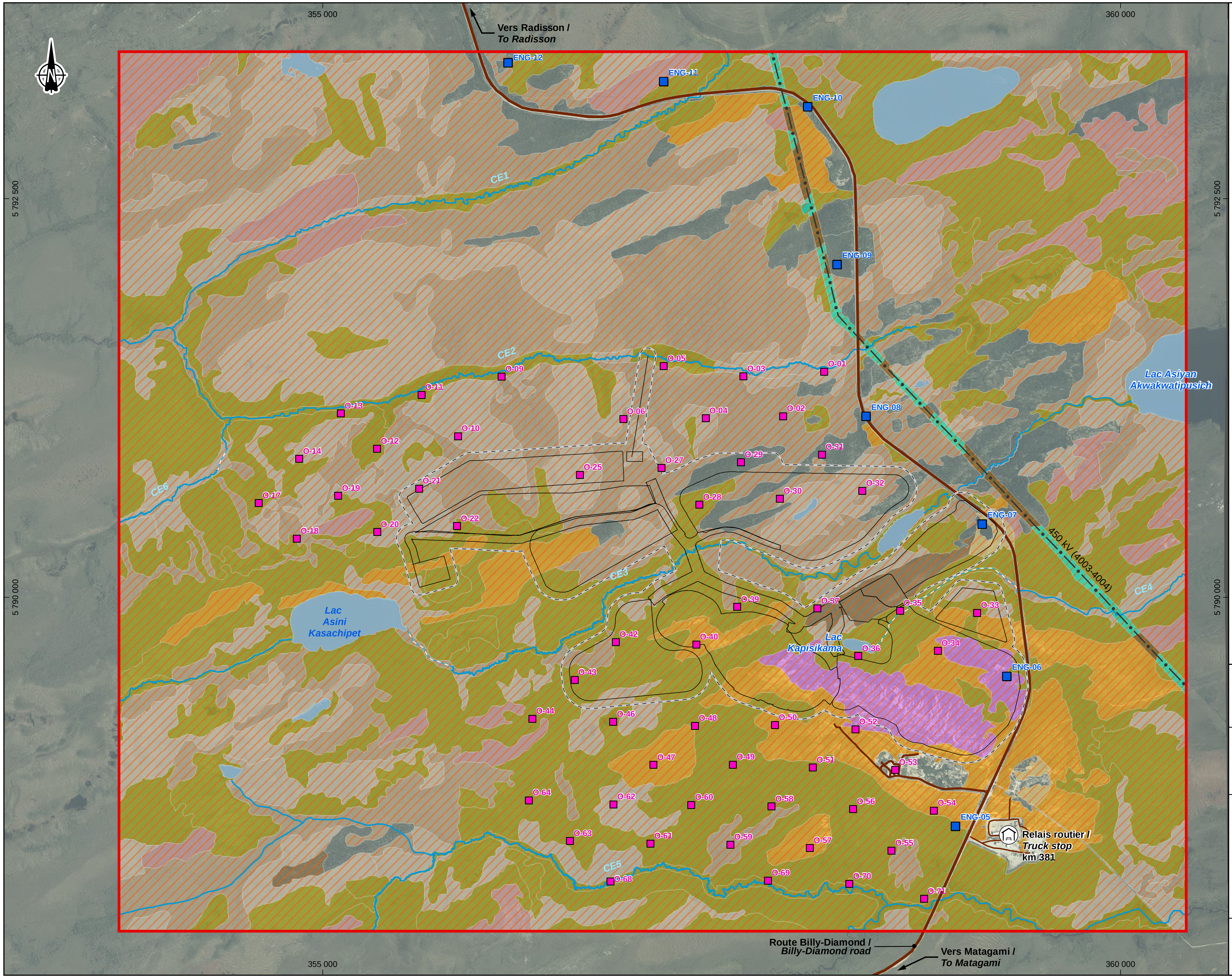
**Table 6-51 Methodologies of avian surveys carried out as part of the project and sources of additional data used**

| SURVEY | METHODOLOGY | DATA SOURCE | HIGHLIGHTS |
|---|---|---|---|
| **James Bay Lithium Mine project** | | | |
| Spring migration of waterfowl (2017) | Survey carried out by helicopter on June 7, 2017, using the Black Duck Joint Venture method (Bordage and coll. 2003).<br>Length of the overflight, 132 km. | WSP, 2018g. | Only 47 specimens of eight waterfowl and aquatic bird species were observed, plus one osprey. No significant concentration areas. |
| Waterfowl nesting (2017) | Additional observations by ground stations in July 2017. | WSP, 2018g. | 33 additional individuals representing six species. |
| Terrestrial breeding birds (2017) | Listening station method (Blondel and coll., 1970; Environment Canada, 1997 and 2007), conducted over 58 stations from June 30 to July 4, 2017. | WSP, 2018g. | 472 individuals representing 32 species. |
| Nighthawks (2017) | Nocturnal listening station method (Regroupement QuébecOiseaux, 2015). Ten stations surveyed on July 6, 2017, along Billy-Diamond highway. | WSP, 2018g. | 3 individuals detected, two of which were above the truck stop. |
| Terrestrial breeding birds (2012) | Listening station method conducted over 32 stations in 2012. | WSP 2018g. Data included in the impact assessment but not analyzed due to subsequent changes in the environment due to fires. | 42 species |
| **Rose Lithium-Tantalum Mine project** | | | |
| Spring migration of waterfowl (2017) | Survey carried out by helicopter in May 2012, using the Black Duck Joint Venture method (Bordage and coll. 2003). | WSP, 2017. | 20 species of aquatic birds, of which 13 are anatidae<br>6 species of birds of prey |
| Terrestrial breeding birds | Listening station method (Blondel and coll., 1970; Environment Canada, 1997 and 2007), conducted over 108 stations between 2012 and 2016. | WSP, 2017. | 31 species. |

**Table 6-51 Methodologies of avian surveys carried out as part of the project and sources of additional data used (cont.)**

| SURVEY | METHODOLOGY | DATA SOURCE | HIGHLIGHTS |
|---|---|---|---|
| **ÉPOQ data bank** | | | |
| | Daily observation sheet from 1981 to 2015 for the study area. Number of sheets: 15. Number of mentions: 186 | List produced by Marie-France Julien of Regroupement QuébecOiseaux on 01/31/2018. | 64 species |

*WSP. 2017. Rose Lithium-Tantalum | Environmental Impact Assessment. Document produced for the Critical Elements Corporation. Project no.: 111-17853-01. 858 p.*




Infrastructures minières / *Mining infrastructure*

Empreinte de la mine (zone tampon de 50 mètres) / *Mine footprint (buffer 50 meters)*

Zone d'étude locale / *Local study area*

Habitat potentiel du hibou des marais / *Potential habitat of short-eared owl*

**Inventaire / *Inventory***

ENG-08 Station d'inventaire nocturne des engoulevents / *Nighthawk listening station*

O-33 Station d'écoute des oiseaux chanteurs / *Songbird listening station*

**Infrastructures / *Infrastructure***

Route principale / *Main road*

Route d'accès / *Access road*

Ligne de transport d'énergie / *Transmission line*

Relais routier / *Truck stop*

**Hydrographie / *Hydrography***

CE3 Numéro de cours d'eau / *Stream number*

Cours d'eau permanent / *Permanent stream*

Cours d'eau à écoulement diffus ou intermittent / *Intermittent or diffused flow stream*

**Peuplements terrestres / *Terrestrial Vegetation***

Affleurement rocheux / *Rock outcrop*

Arbustaie / *Scrubland*

Aulnaie crispé / *Alder forest*

Dénudé sec / *Dry barren land*

Brûlis / *Burnt area*

Végétation terrestre dans l'emprise / *Terrestrial vegetation in right-of-way*

**Peuplements humides / *Wetland***

Plan d'eau / *Waterbody*

Tourbière arbustive / *Shrubby peatland*

Tourbière boisée / *Treed peatland*

Tourbière ouverte / *Open bog*

Végétation humide dans l'emprise / *Wetland in right-of-way*

GALAXY

*Mine de lithium Baie-James /James Bay Lithium Mine*

**Carte / *Map* 6-20C**
**Habitat potentiel du hibou des marais et sites d'inventaire / *Potential Habitat of Short-Eared Owl and Survey Sites***

Sources :
*Orthoimage: Galaxy, août 2017*
*Inventaire / Inventory: WSP 2017*

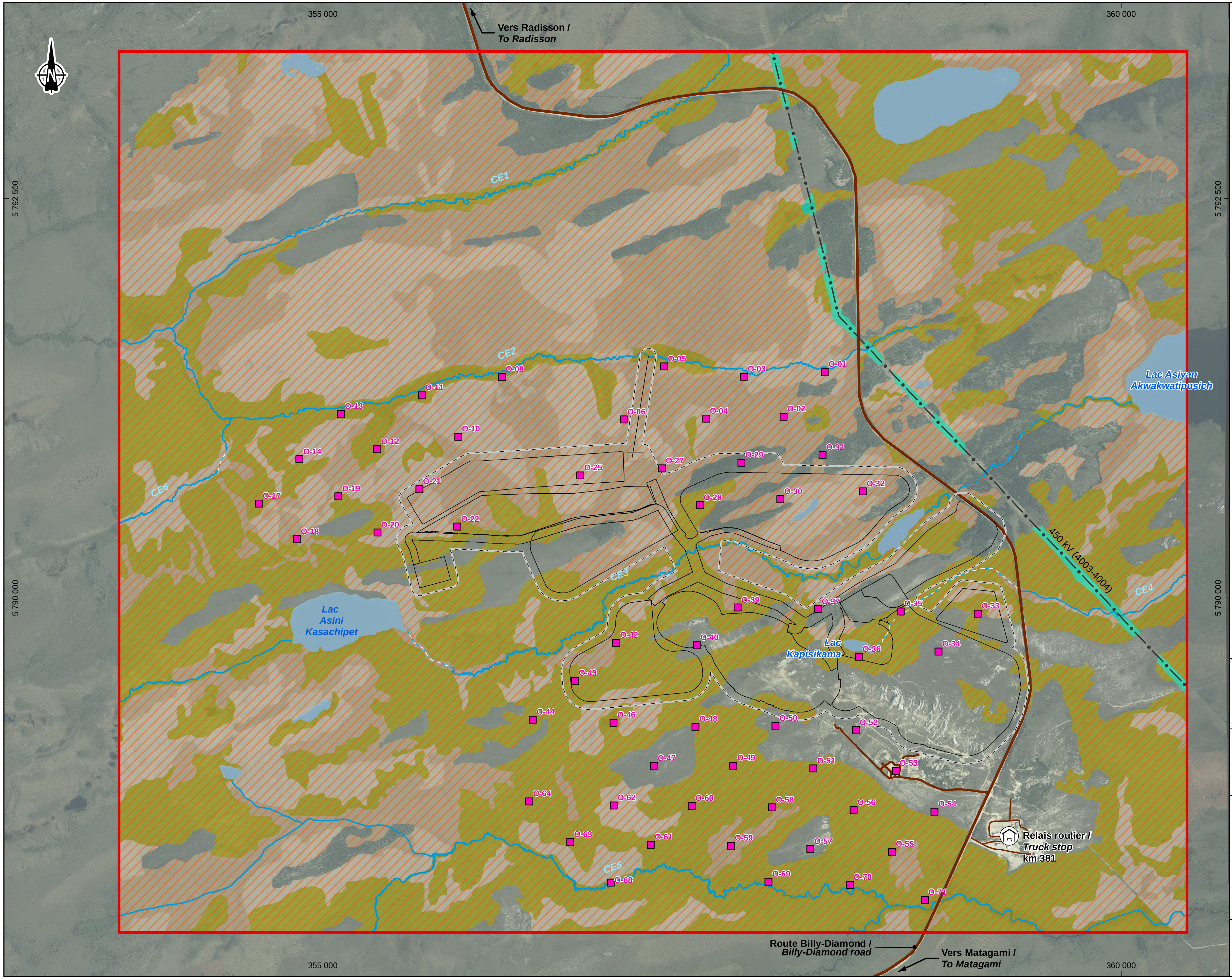
0 240 480 m

UTM, fuseau 18, NAD83

**Juillet / *July* 2021**

*Dessin : A. Masson*
*Approbation : R. Duhamel*
*201-12362-00_c6-20C_wspT291_hibou_210701.mxd*

wsp




Infrastructures minières / *Mining infrastructure*

Empreinte de la mine (zone tampon de 50 mètres) / *Mine footprint (buffer 50 meters)*

Zone d'étude locale / *Local study area*

Habitat potentiel pour le quiscale rouilleux / *Potential habitat of rusty balckbird*

**Inventaire / *Inventory***

O-33 Station d'écoute des oiseaux chanteurs / *Songbird listening station*

**Infrastructures / *Infrastructure***

Route principale / *Main road*

Route d'accès / *Access road*

Ligne de transport d'énergie / *Transmission line*

Relais routier / *Truck stop*

**Hydrographie / *Hydrography***

CE3 Numéro de cours d'eau / *Stream number*

Cours d'eau permanent / *Permanent stream*

Cours d'eau à écoulement diffus ou intermittent / *Intermittent or diffused flow stream*

Plan d'eau / *Waterbody*

**Peuplements humides / *Wetland***

Tourbière arbustive / *Shrubby peatland*

Tourbière boisée / *Treed peatland*

Tourbière ouverte / *Open bog*

Végétation humide dans l'emprise / *Wetland in right-of-way*

GALAXY

Mine de lithium Baie-James /James Bay Lithium Mine

**Carte / *Map* 6-20D**

**Habitat potentiel du quiscale rouilleux et sites d'inventaire / *Potential Habitat of Rusty Blackbird and Survey Sites***

Sources :
Orthoimage: Galaxy, août 2017
Inventaire / Inventory: WSP 2017

0 240 480 m

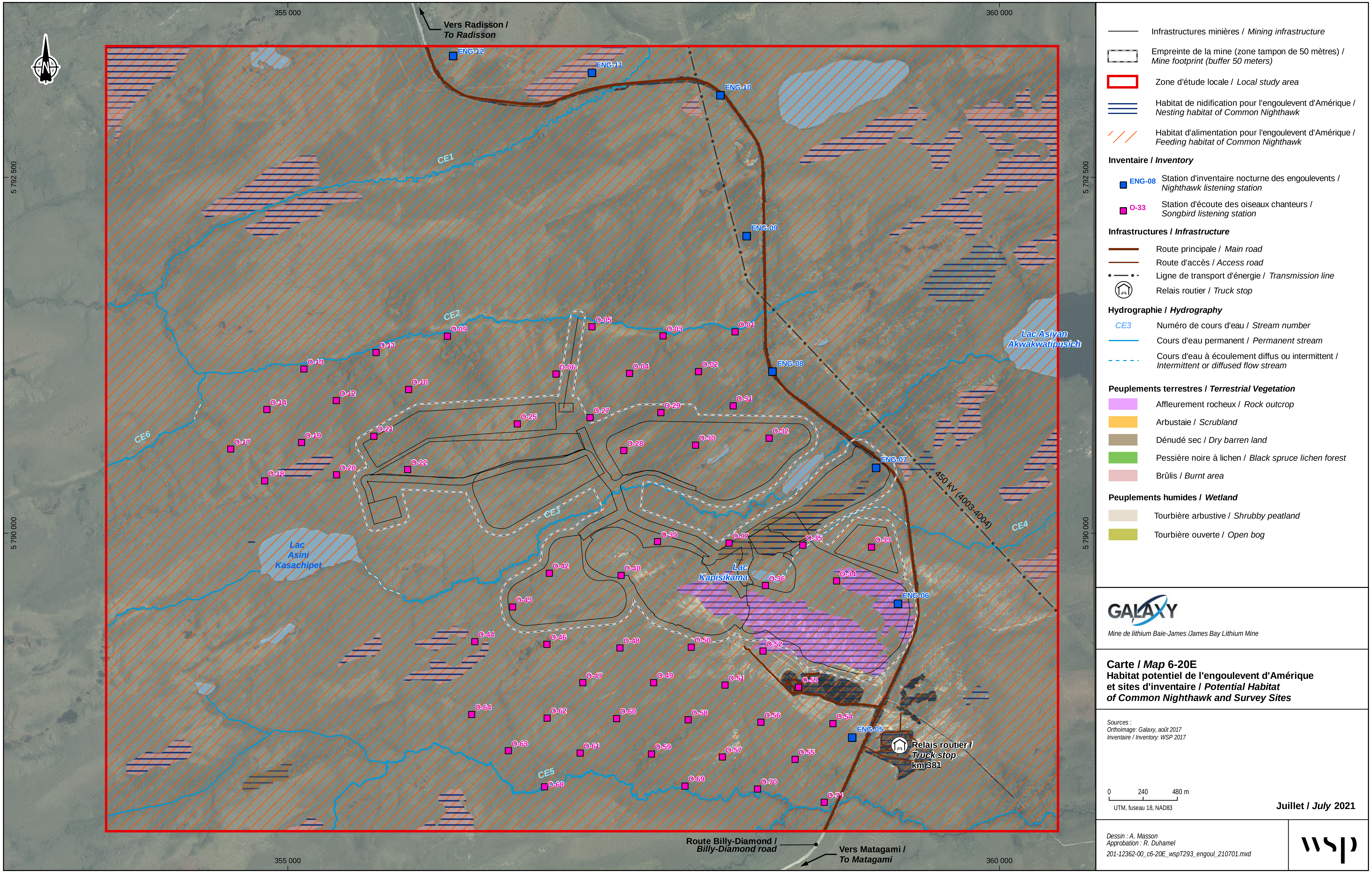
UTM, fuseau 18, NAD83

**Juillet / *July* 2021**

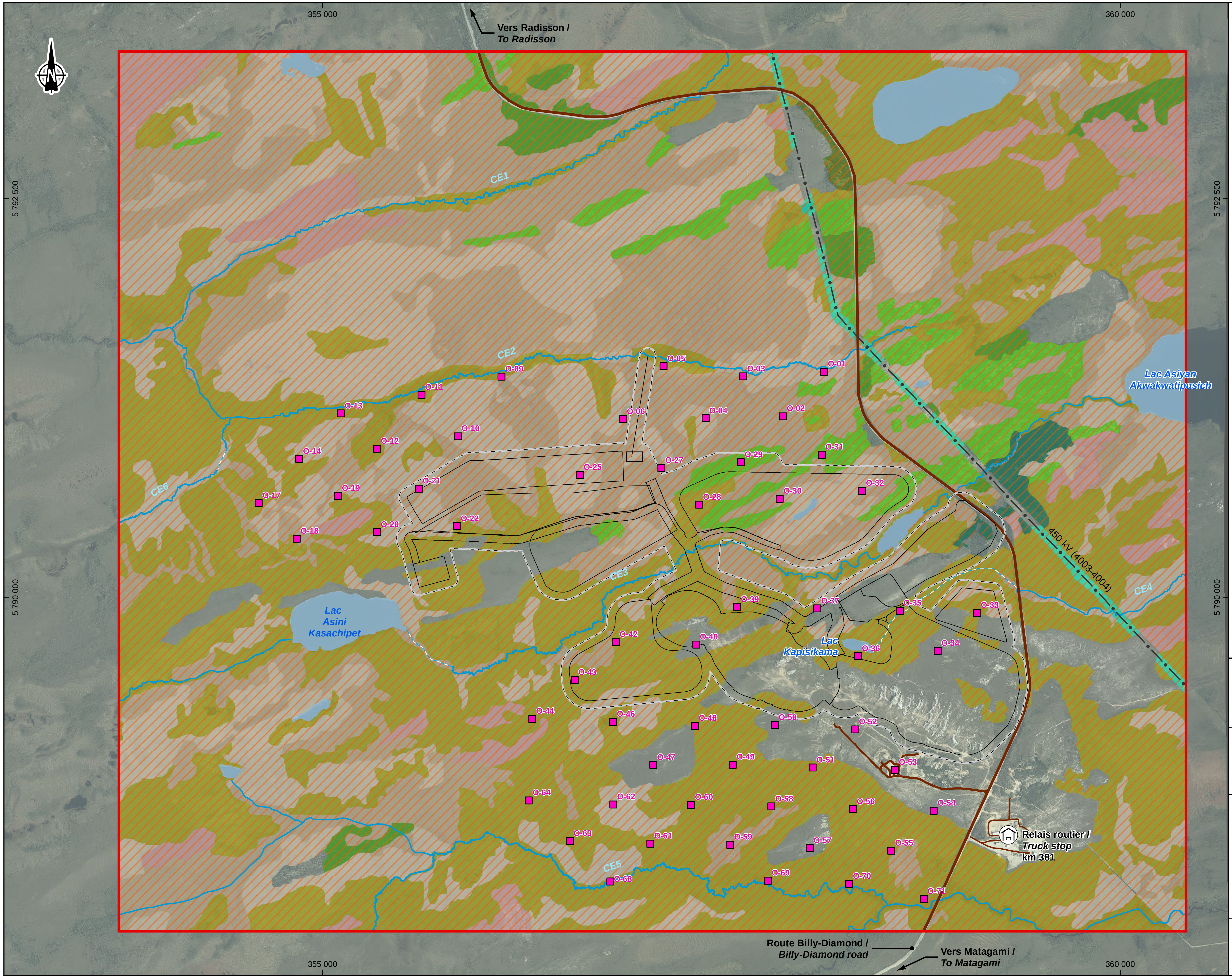
Dessin : A. Masson
Approbation : R. Duhamel

201-12362-00_c6-20D_wspT292_quiscale_210701.mxd

wsp




**Carte / Map 6-20E**
**Habitat potentiel de l'engoulevent d'Amérique et sites d'inventaire / Potential Habitat of Common Nighthawk and Survey Sites**




Infrastructures minières / *Mining infrastructure*

Empreinte de la mine (zone tampon de 50 mètres) / *Mine footprint (buffer 50 meters)*

Zone d'étude locale / *Local study area*

Habitat potentiel du Moucherolle à côtés olive / *Potential Habitat of Olive-sided flycatcher*

**Inventaire / *Inventory***

O-33 Station d'écoute des oiseaux chanteurs / *Songbird listening station*

**Infrastructures / *Infrastructure***

Route principale / *Main road*

Route d'accès / *Access road*

Ligne de transport d'énergie / *Transmission line*

Relais routier / *Truck stop*

**Hydrographie / *Hydrography***

CE3 Numéro de cours d'eau / *Stream number*

Cours d'eau permanent / *Permanent stream*

Cours d'eau à écoulement diffus ou intermittent / *Intermittent or diffused flow stream*

**Peuplements terrestres / *Terrestrial Vegetation***

Boisé / *Woodland*

Pessière noire à lichen / *Black spruce lichen forest*

Pessière noire à aulnes / *Black spruce alder forest*

Pinède grise / *Jack pine forest*

Brûlis / *Burnt area*

**Peuplements humides / *Wetland***

Plan d'eau / *Waterbody*

Tourbière arbustive / *Shrubby peatland*

Tourbière boisée / *Treed peatland*

Tourbière ouverte / *Open bog*

Végétation humide dans l'emprise / *Wetland in right-of-way*

GALAXY

*Mine de lithium Baie-James /James Bay Lithium Mine*

**Carte / *Map* 6-20F**

**Habitat potentiel du moucherolle à côtés olive et sites d'inventaire/ *Potential Habitat of Olive-Sided Flycatcher and Survey Sites***

*Sources :*
*Orthoimage: Galaxy, août 2017*
*Inventaire / Inventory: WSP 2017*

0 240 480 m

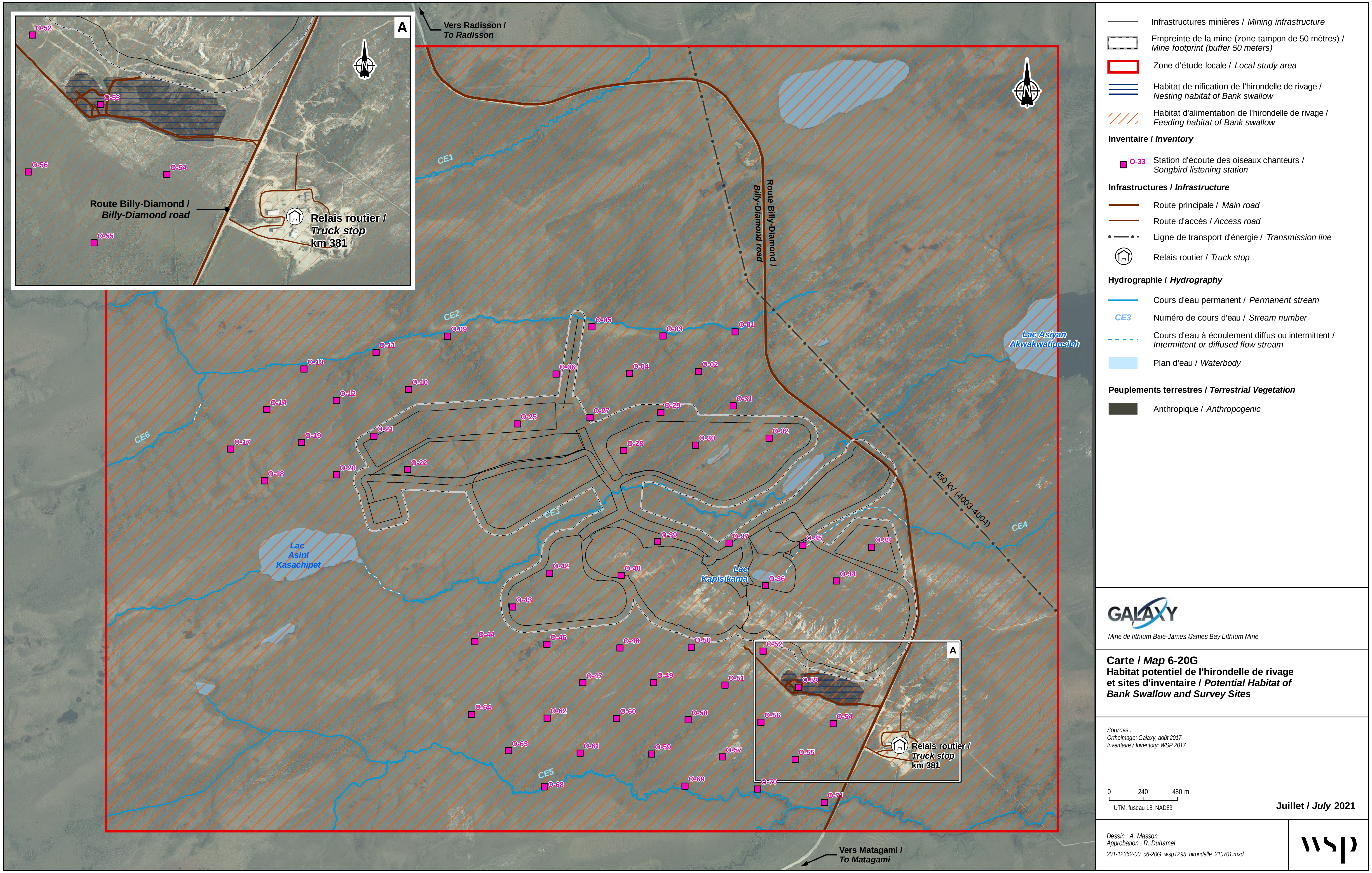
UTM, fuseau 18, NAD83

**Juillet / *July* 2021**

*Dessin : A. Masson*
*Approbation : R. Duhamel*

*201-12362-00_c6-20F_wspT294_mouche_210701.mxd*

wsp


Vers Radisson / To Radisson
Vers Matagami / To Matagami
Route Billy-Diamond / Billy-Diamond road
450 kV (4003-4004)
Lac Asiyan Akwakwatipusich
Lac Asini Kasachipet
Lac Kapisikama
CE1
CE2
CE3
CE4
CE5
CE6
Relais routier / Truck stop km 381
A
Infrastructures minières / Mining infrastructure
Empreinte de la mine (zone tampon de 50 mètres) / Mine footprint (buffer 50 meters)
Zone d'étude locale / Local study area
Habitat de nification de l'hirondelle de rivage / Nesting habitat of Bank swallow
Habitat d'alimentation de l'hirondelle de rivage / Feeding habitat of Bank swallow
Inventaire / Inventory
O-33 Station d'écoute des oiseaux chanteurs / Songbird listening station
Infrastructures / Infrastructure
Route principale / Main road
Route d'accès / Access road
Ligne de transport d'énergie / Transmission line
Relais routier / Truck stop
Hydrographie / Hydrography
Cours d'eau permanent / Permanent stream
CE3 Numéro de cours d'eau / Stream number
Cours d'eau à écoulement diffus ou intermittent / Intermittent or diffused flow stream
Plan d'eau / Waterbody
Peuplements terrestres / Terrestrial Vegetation
Anthropique / Anthropogenic
GALAXY
Mine de lithium Baie-James /James Bay Lithium Mine
Carte / Map 6-20G
Habitat potentiel de l'hirondelle de rivage et sites d'inventaire / Potential Habitat of Bank Swallow and Survey Sites
Sources :
Orthoimage: Galaxy, août 2017
Inventaire / Inventory: WSP 2017
0 240 480 m
UTM, fuseau 18, NAD83
Juillet / July 2021
Dessin : A. Masson
Approbation : R. Duhamel
201-12362-00_c6-20G_wspT295_hirondelle_210701.mxd
wsp

## RESULTS

### Listening station survey in 2017

Four hundred seventy-two (472) individuals were detected during the listening station survey, representing 32 species of terrestrial breeding birds (Table 6-52). Since the objective of the listening station survey was also to estimate the density of indicated breeding pairs per hectare (IP/ha) in the habitats potentially affected by the project, we established densities for the three categories of habitats studied: wetlands, open habitats and softwood stands. The category with the largest number of species was the wetland habitat with 23 species detected, followed by the open and softwood stand habitats with 16 and 11 species, respectively. The densest category in breeding pairs was found in open habitats, at 6.97 IP/ ha, followed by softwood stands and wetlands, with 5.93 and 3.96 IP/ha, respectively, all species combined (Table 6-52).

Of breeding birds, the dark-eyed junco (*Junco hyemalis*) was most abundant in softwood stand and open habitat stations, with 2.19 and 1.49 IP/ha, respectively. The density of the white-throated sparrow *(Zonotrichia albicollis)* was the same as that of the dark-eyed junco (1.49 IP/ha) in open habitats, while it ranked second, with 1.27 IP/ha, in softwood stands. The white-throated sparrow was also the most abundant species in wetland habitats, with 0.84 IP/ha, followed by the dark-eyed junco with 0.82 IP/ha. In short, these two species are dominant in the three habitat categories studied. They are also the species that showed the greatest consistency from one station to another, followed by the hermit thrush *(Catharus guttatus)* and Lincoln's sparrow *(Melospiza lincolnii)*. These are all abundant species common to these latitudes.

### Table 6-52 Density of terrestrial breeding birds in habitats surveyed in 2017

| Species (n =32) | Density (IP/ha) Wetlands (31 stations) | Open habitats (18 stations) | Softwood stands (9 stations) |
|---|---|---|---|
| Two-barred crossbill *(Loxia leucoptera)* | 0.12 | - | - |
| White-crowned sparrow *(Zonotrichia leucophrys)* | - | 0.35 | - |
| White-throated sparrow (*Zonotrichia albicollis*) | 0.84 | 1.49 | 1.27 |
| Song sparrow *(Melospiza melodia)* | **obs** | - | - |
| Le Conte's sparrow[1] *(Ammodramus leconteii)* | **obs** | - | - |
| Lincoln's sparrow *(Melospiza lincolnii)* | 0.35 | 0.78 | 0.28 |
| Swamp sparrow *(Melospiza georgiana)* | 0.14 | - | - |
| Savannah sparrow *(Passerculus sandwichensis)* | 0.31 | - | - |
| Fox sparrow *(Passerella iliaca)* | **obs** | - | - |
| American crow *(Corvus brachyrhynchos)* | - | **obs** | - |
| Common raven[1] *(Corvus corax)* | **obs** | **obs** | **obs** |
| Swainson's thrush *(Catharus ustulatus)* | - | 0.07 | 0.14 |
| Veery *(Catharus fuscescens)* | - | **obs** | **obs** |
| Hermit thrush *(Catharus guttatus)* | 0.10 | 0.85 | 0.85 |
| Tree swallow *(Tachycineta bicolor)* | 0.31 | - | - |
| Cedar waxwing *(Bombycilla cedrorum)* | 0.06 | 0.21 | - |
| Dark-eyed junco *(Junco hyemalis)* | 0.82 | 1.49 | 2.19 |
| American robin *(Turdus migratorius)* | 0.18 | 0.42 | 0.07 |
| Boreal chickadee[1] *(Poecile hudsonicus)* | - | - | **obs** |
| Grey jay *(Perisoreus canadensis)* | 0.04 | 0.14 | - |
| Alder flycatcher *(Empidonax alnorum)* | **obs** | **obs** | **obs** |

**Table 6-52 Density of terrestrial breeding birds in habitats surveyed in 2017 (cont.)**

| Species (n =32) | Density (IP/ha) Wetlands (31 stations) | Open habitats (18 stations) | Softwood stands (9 stations) |
|---|---|---|---|
| Wilson's warbler *(Cardellina pusilla)* | 0.10 | - | - |
| Palm warbler *(Setophaga palmarum)* | 0.06 | 0.18 | 0.71 |
| Yellow-rumped warbler *(Setophaga coronata)* | **obs** | - | - |
| Common yellowthroat *(Geothlypis trichas)* | 0.23 | 0.50 | - |
| Tennessee warbler *(Oreothlypis peregrina)* | - | 0.28 | - |
| Black-backed woodpecker *(Picoides arcticus)* | **obs** | - | - |
| Northern flicker *(Colaptes auratus)* | **obs** | **obs** | **obs** |
| Rusty blackbird *(Euphagus carolinus)* | **0.14** | - | - |
| Ruby-crowned kinglet *(Regulus calendula)* | **0.08** | **0.21** | **0.14** |
| Grey jay *(Perisoreus canadensis)* | - | - | **obs** |
| Winter wren *(Troglodytes hiemalis)* | **0.08** | - | **0.28** |
| **Number of species** | **25** | **18** | **14** |
| **Total density (IP/ha)** | **3.96** | **6.97** | **5.93** |

Obs: Too few observations to establish a breeding pair density.

**Table 6-53 shows the distribution of the listening stations by habitat type. As in Table 6-52, this distribution over three categories—wetlands, open areas and softwood stands—largely reflects the relative availability of these environments in the local study area and on the property affected by the project (Table 6-53), in that over 50% of the stations are located in the most common habitat (wetlands), while open areas and softwood stands, which are less abundant in the local study area and on the property affected by the project, represent 31% and 15.5% of stations, respectively. Although station distribution overestimates the availability of these two types of habitats in the local study area, it is a necessary compromise to obtain a sufficient number of stations in the least represented habitat, i.e. softwood stands unaffected by fire.**

**Table 6-53 Distribution of the types of habitats for songbird surveys and distribution of the listening stations**

| Type of habitat | Surface area of the study area | | Surface area of the property affected by the project | | Surface area of the project footprint | | Distribution of the survey stations | |
|---|---|---|---|---|---|---|---|---|
| | ha | % | ha | % | ha | % | N | % |
| Wetlands | 2,872 | 79.8 | 1,234 | 76.3 | 280 | 76.4 | 31 | 53.5 |
| Open areas | 542 | 15.1 | 342 | 21.1 | 76 | 20.7 | 18 | 31.0 |
| Softwood stands | 184 | 5.1 | 42 | 2.6 | 11 | 2.9 | 9 | 15.5 |

#### Nighthawk survey

There are two types of nighthawk in Québec: the common nighthawk *(Chordeiles minor)* and the eastern whip-poor-will *(Antrostomus vociferus).* On the evening of the survey, only the common nighthawk was detected, at station Eng-06. Two more were also observed a few times between July 5 and 10, 2017, above the km 381 truck stop. The nighthawk appears on the list of species likely to be designated as threatened or vulnerable in Québec (MFFP, 2006*a*). It is also considered threatened at the federal level and appears in Schedule 1 to Canada's *Species at Risk Act* (SARA) (Government of Canada, 2017).

#### Other opportunistic observations

Six more bird species were sighted during field trips in 2017: Bonaparte's gull *(Chroicocephalus philadelphia),* the hen harrier *(Circus cyaneus),* the sharp-tailed grouse *(Tympanuchus phasianellus),* the Nashville warbler *(Oreothlypis ruficapilla),* the eastern bluebird *(Sialia sialis)* and the northern mockingbird *(Mimus polyglottos).* The last two species were sighted on the edge of the km 381 truck stop. If we include the species detected during the surveys of waterfowl, aquatic birds and terrestrial breeding birds, 53 bird species were detected in the study area in 2017.

#### Listening station survey in 2012

The listening station survey conducted in 2012 revealed the presence of 41 species (Table 6-54). The few differences between the species detected in 2012 and in 2017 may be due to the effect of forest fires in the study area between these two periods.

### 6.3.5.3 DATA FROM AVAILABLE DATA BANKS

Although the SOS-POP data bank has no data on the study area, some useful information was found in the ÉPOQ data bank. Data from the *Programme de suivi de la sauvagine de l'Est* does not extend north of 51° 15' N and as such does not cover the study area.

A comprehensive list of bird sightings recorded in the study area was extracted from the ÉPOQ data bank (Larivée, 2017). This data covers a period of more than 30 years, from 1981 to 2015 (Table 6-55). Despite the time span covered, only 186 mentions covering 64 species were recorded in the study area. These are divided into five observations in spring, 147 in summer and 34 in the fall. There are no winter observations.

**In addition to the information from the ÉPOQ data bank, the results reported in the environmental assessment of the Rose Lithium-Tantalum Mine project (WSP, 2017) were also consulted. This project is located approximately 60 km southeast of the James Bay Lithium Mine project. These surveys also included a helicopter survey of waterfowl and other aquatic birds, including birds of prey, as well as a survey of terrestrial forest birds, in spring. The methodology used was comparable to the methodology adopted for this project.**

**The richness of terrestrial birds in the James Bay Lithium Mine project is similar to that observed for the Rose Lithium-Tantalum Mine project (WSP, 2017), located slightly to the northeast of the current project, which reports high aquatic bird richness and density. However, since forest environments are more widespread and the categories of habitats considered for the density estimate are not the same, data harmonization between the two projects remains difficult and inevitably biased.**

**Table 6-52 combines data from both surveys (WSP, 2017 and WSP, 2018g) as well as data saved in the ÉPOQ data bank from 1981 to 2015.**

**Nevertheless, although the inclusion of the species detected during the Rose Lithium-Tantalum Mine project (WSP, 2017) and surveys carried out in 2012 for the James Bay Lithium Mine project provide a more detailed picture of the seasonal richness of the avifauna in the study area before the fires, it does not provide a better assessment of the short-term effects of the James Bay Lithium Mine project, since the current environment inside the study area is disrupted and it is in this environment that the short-term effects of the project will be felt. Furthermore, it cannot be assumed that the area will recover naturally at a rapid pace, nor that new fires will not occur in the near future.**

### 6.3.5.4 SPECIAL STATUS BIRD SPECIES

Among the bird species surveyed in the study area, there are three species at risk in Quebec or in Canada: the common nighthawk, the rusty blackbird *(Euphagus carolinus)* and the bald eagle. The first one nests in burned over areas, bare habitats and flat roofs (Poulin and coll., 1996), all widely available in the study area. The second frequents swamps, beaver ponds and peatlands (Environment Canada, 2014), all of which are still well represented habitats in the study area and the surrounding areas. Both these species were detected in 2012 and 2017. As for the bald eagle, one 2007 sighting of which is recorded in the ÉPOQ data bank (Larivée, 2017), the species was not detected during the 2012 and 2017 surveys.

**Table 6-54 Species detected during the 2012 breeding bird survey**

| Species (n = 41) | Sighted in 2017 | Species (n = 41) | Sighted in 2017 |
|---|---|---|---|
| Two-barred crossbill *(Loxia leucoptera)* | Yes | Dark-eyed junco *(Junco hyemalis)* | Yes |
| Wilson's snipe *(Gallinago delicata)* | Yes | American robin *(Turdus migratorius)* | Yes |
| White-throated sparrow *(Zonotrichia albicollis)* | Yes | Boreal chickadee[1] *(Poecile hudsonicus)* | Yes |
| Lincoln's sparrow *(Melospiza lincolnii)* | Yes | Grey jay *(Perisoreus canadensis)* | Yes |
| Swamp sparrow *(Melospiza georgiana)* | Yes | Alder flycatcher *(Empidonax alnorum)* | Yes |
| Savannah sparrow *(Passerculus sandwichensis)* | Yes | Yellow-bellied flycatcher *(Empidonax flaviventris)* | No |
| Fox sparrow *(Passerella iliaca)* | Yes | Wilson's warbler *(Cardellina pusilla)* | Yes |
| American tree sparrow *(Spizella arborea)* | No | Palm warbler *(Setophaga palmarum)* | Yes |
| Red-tailed hawk *(Buteo jamaicensis)* | No | Yellow-rumped warbler *(Setophaga coronata)* | Yes |
| American crow *(Corvus brachyrhynchos)* | Yes | Nashville warbler *(Oreothlypis ruficapilla)* | Yes |
| Common nighthawk *(Chordeiles minor)* | Yes | Northern waterthrush *(Parkesia noveboracensis)* | No |
| Common starling *(Sturnus vulgaris)* | No | Yellow warbler *(Setophaga petechia)* | No |
| Merlin *(Falco columbarius)* | No | Common yellowthroat *(Geothlypis trichas)* | Yes |
| Herring gull *(Larus argentatus)* | No | Black-backed woodpecker *(Picoides arcticus)* | Yes |
| Common raven[1] *(Corvus corax)* | Yes | American three-toed woodpecker *(Picoides dorsalis)* | No |
| Brown creeper *(Certhia americana)* | No | Northern flicker *(Colaptes auratus)* | Yes |
| Hermit thrush *(Catharus guttatus)* | Yes | Common loon *(Gavia immer)* | Yes |
| Greater yellowlegs *(Tringa melanoleuca)* | Yes | Rusty blackbird *(Euphagus carolinus)* | Yes |
| Sandhill crane *(Grus canadensis)* | Yes | Ruby-crowned kinglet *(Regulus calendula)* | Yes |
| Tree swallow *(Tachycineta bicolor)* | Yes | Winter wren *(Troglodytes hiemalis)* | Yes |
| Cedar waxwing *(Bombycilla cedrorum)* | Yes | | |

**Table 6-55 Seasonal distribution[1] of bird species according to various surveys (WSP, 2017[2]; WSP, 2018g) within the study area and sightings recorded in the ÉPOQ data bank[3] from 1981 to 2015**

| Species* | Spring | Summer | Fall |
|---|---|---|---|
| Northern goshawk *(Accipiter gentilis)* | | x | |
| Osprey *(Pandion haliaetus)* | x | x | |
| Wilson's snipe *(Gallinago delicata)* | | x | |
| Two-barred crossbill *(Loxia leucoptera)* | | x | |
| Red crossbill *(Loxia curvirostra)* | | x | |
| **Canada goose *(Branta canadensis)*** | x | | x |
| White-crowned sparrow *(Zonotrichia leucophrys)* | | x | x |
| White-throated sparrow *(Zonotrichia albicollis)* | | x | x |
| Song sparrow *(Melospiza melodia)* | | x | |
| Lincoln’s sparrow *(Melospiza lincolnii)* | | x | |
| Swamp sparrow *(Melospiza georgiana)* | | x | |
| Fox sparrow *(Passerella iliaca)* | x | x | |
| **American tree sparrow *(Spizella arborea)*** | | x | |
| Hen harrier *(Circus cyaneus)* | | x | |
| **Red-tailed hawk *(Buteo jamaicensis)*** | x | x | x |
| **Rough-legged hawk *(Buteo lagopus)*** | x | | |
| Mallard *(Anas platyrhynchos)* | | x | |
| **American wigeon *(Anas americana)*** | x | | |
| **American black duck *(Anas rubripes)*** | x | | |
| **Northern shoveler *(Anas clypeata)*** | x | | |
| Spotted sandpiper *(Actitis macularius)* | | x | |
| **Solitary sandpiper *(Tringa solitaria)*** | | x | |
| American kestrel *(Falco sparverius)* | | x | |
| Common nighthawk *(Chordeiles minor)* | | x | |
| **Common starling *(Sturnus vulgaris)*** | | x | |
| **Merlin *(Falco columbarius)*** | | x | |
| **Ring-necked duck *(Aythya collaris)*** | x | | |
| **Common goldeneye *(Bucephala clangula)*** | x | | |
| Ruffed grouse *(Bonasa umbellus)* | x | x | |
| **Ring-billed gull *(Larus delawarensis)*** | x | | |
| Herring gull *(Larus argentatus)* | x | x | x |

**[1] None of the documentary sources available covers the winter season.**
**[2] Including data from the 2012 breeding birds survey for the James Bay Lithium Mine project.**
**[3] List produced by Marie-France Julien of Regroupement QuébecOiseaux, on 01/31/2018.**

### Table 6-55 Seasonal distribution[1] of bird species according to various surveys (WSP, 2017[2]; WSP, 2018g) within the study area and sightings recorded in the ÉPOQ data bank[3] from 1981 to 2015 (cont.)

| Species* | Spring | Summer | Fall |
|---|---|---|---|
| Greater yellowlegs *(Tringa melanoleuca)* | | x | |
| Common raven *(Corvus corax)* | x | x | *x* |
| **Common merganser *(Mergus merganser)*** | x | x | x |
| **Great blue heron *(Ardea herodias)*** | x | | x |
| **Great horned owl *(Anas americana)*** | x | | |
| **Brown creeper *(Certhia americana)*** | | x | |
| Swainson's thrush *(Catharus ustulatus)* | | x | x |
| Hermit thrush *(Catharus guttatus)* | | x | x |
| **Sandhill crane *(Grus canadensis)*** | x | x | |
| **Hooded merganser *(Lophodytes cucullatus)*** | x | x | x |
| **Short-eared owl *(Asio flammeus)*** | x | | |
| Tree swallow *(Tachycineta bicolor)* | | x | |
| Cedar waxwing *(Bombycilla cedrorum)* | | x | |
| Dark-eyed junco *(Junco hyemalis)* | | x | x |
| Willow ptarmigan *(Lagopus lagopus)* | | x | |
| **Common scoter *(Melanitta nigra)*** | x | | |
| **Surf scoter *(Melanitta perspicillata)*** | x | | |
| **Velvet scoter *(Melanitta fusca)*** | x | | |
| American robin *(Turdus migratorius)* | | x | x |
| Boreal chickadee *(Poecile hudsonicus)* | | x | x |
| Grey jay *(Perisoreus canadensis)* | | x | x |
| **Yellow-bellied flycatcher (*Empidonax flaviventris*)** | | x | |
| Alder flycatcher *(Empidonax alnorum)* | | x | |
| **Bonaparte's gull (*Chroicocephalus philadelphia*)** | x | x | |
| Wilson's warbler *(Cardellina pusilla)* | | x | |
| Palm warbler *(Setophaga palmarum)* | | x | |
| Yellow-rumped warbler *(Setophaga coronata)* | | x | x |
| Nashville warbler *(Oreothlypis ruficapilla)* | | x | |
| Magnolia warbler *(Setophaga magnolia)* | | x | |
| Northern waterthrush *(Parkesia noveboracensis)* | | x | |
| American redstart *(Setophaga ruticilla)* | | x | |

**[1] None of the documentary sources available covers the winter season.**
**[2] Including data from the 2012 breeding birds survey for the James Bay Lithium Mine project.**
**[3] List produced by Marie-France Julien of Regroupement QuébecOiseaux, on 01/31/2018.**

**Table 6-55 Seasonal distribution[1] of bird species according to various surveys (WSP, 2017[2]; WSP, 2018g) within the study area and sightings recorded in the ÉPOQ data bank[3] from 1981 to 2015 (cont.)**

| Species* | Spring | Summer | Fall |
|---|---|---|---|
| Yellow warbler *(Setophaga petechia)* | | x | |
| Common yellowthroat *(Geothlypis trichas)* | | x | |
| Black-and-white warbler *(Mniotilta varia)* | | x | |
| Tennessee warbler *(Oreothlypis peregrina)* | | x | |
| Mourning warbler *(Geothlypis philadelphia)* | | x | |
| Orange-crowned warbler *(Oreothlypis celata)* | | x | x |
| **Bufflehead *(Bucephala albeola)*** | x | | |
| **Black-backed woodpecker *(Picoides arcticus)*** | | x | |
| **American three-toed woodpecker *(Picoides dorsalis)*** | | x | |
| Hairy woodpecker *(Picoides villosus)* | x | | |
| Northern flicker *(Colaptes auratus)* | | x | x |
| Yellow-bellied sapsucker *(Sphyrapicus varius)* | | x | |
| Buff-bellied pipit *(Anthus rubescens)* | | | x |
| Common loon *(Gavia immer)* | | x | |
| **Bald eagle *(Haliaeetus leucocephalus)*** | x | x | |
| **Golden-crowned kinglet *(Regulus satrapa)*** | | x | |
| Ruby-crowned kinglet *(Regulus calendula)* | | x | x |
| Common teal *(Anas crecca)* | | x | x |
| Red-breasted nuthatch *(Sitta canadensis)* | | x | |
| Common tern *(Sterna hirundo)* | | x | |
| Pine siskin *(Spinus pinus)* | | x | |
| Mourning dove *(Zenaida macroura)* | | x | |
| Winter wren *(Troglodytes hiemalis)* | | x | |
| Philadelphia vireo *(Vireo philadelphicus)* | | x | |

**** Data in bold comes from the Rose Lithium-Tantalum project impact assessment (WSP, 2017).***

## 6.3.6 BATS

Québec is home to eight bat species, **five of which** are resident because they remain in **the** latitudes **of the province** during the winter and three of which are described as migratory since they overwinter farther south. However, in Québec, even resident species migrate during the fall season, although for shorter distances than in the case of so-called migratory species.

**[1] None of the documentary sources available covers the winter season.**
**[2] Including data from the 2012 breeding birds survey for the James Bay Lithium Mine project.**
**[3] List produced by Marie-France Julien of Regroupement QuébecOiseaux, on 01/31/2018.**

### 6.3.6.1 EXISTING DOCUMENTATION

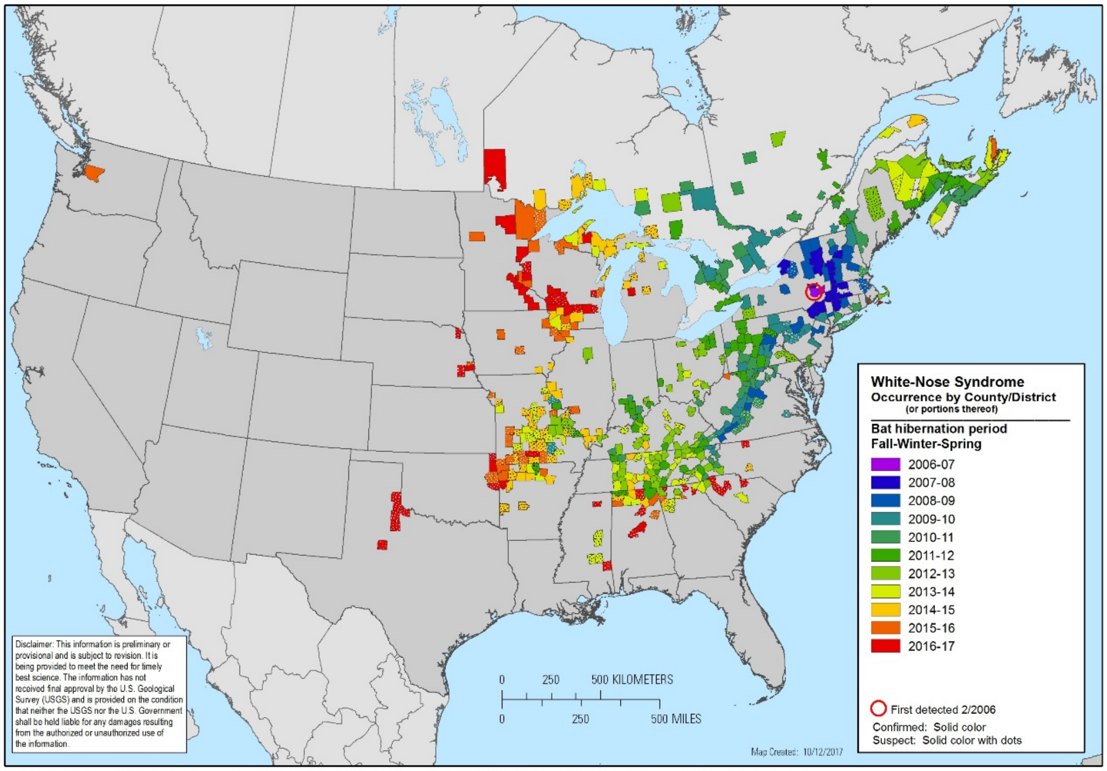
According to the geographic distribution of bat species in Québec (Jutras and coll., 2012), established based on data from the CDPNQ, the study area is potentially frequented by five of the eight bat species present in Québec: the northern myotis, the little brown myotis, the big brown bat, the hoary bat and the eastern red bat *(Lasiurus borealis)*. According to this data, there are no silver-haired bats in the study area: their geographic range stops about 200 kilometres farther south.

Surveys conducted between 2003 and 2009 by the *Réseau québécois d'inventaires acoustiques de chauves-souris* (Jutras and Vasseur, 2011) at Bourbeau Lake, approximately 300 kilometres southeast of the study area, confirmed the presence of four of these five species. Only the eastern red bat was not listed. The dominant species in the Réseau's surveys are the hoary bat (54.7% of records collected between 2003 and 2009) and bats of the genus *Myotis* (39.6% of records). In addition, a survey conducted as part of the impact study for the Whabouchi project, about 100 kilometres southeast of the study area, identified bats of the genus *Myotis* as well as "the hoary bat [...] and/or the eastern red bat [...]." Moreover, a little brown myotis maternity colony of approximately 300 individuals was recorded in this area, and the *Ministère des Ressources naturelles* has confirmed that hoary bats have been observed near Lac du Spodumene (Nemaska Lithium, 2013).

In general, little data is available on bats in the northern environment. The northern limit of their distribution is difficult to define (Environment Canada, 2015). It is possible that the distribution limit for some species may extend farther north than estimates show. In fact, the data collected by our team on the Côte-Nord and in Labrador indicate that the eastern red bat, the northern myotis and the little brown myotis are found up to the 54th parallel, well beyond their known distribution (Brunet, personal communication). It is not known, however, whether these were resident breeding individuals or merely extralimital observations.

A dramatic increase in bat mortality has been observed since 2006–2007 in abandoned mines and natural caves in the northeastern United States. Most of the affected bats showed unique external signs, as some parts of the body, mainly the snout, were covered with a whitish fungal infection, hence the name white-nose syndrome (WNS) (MFFP, 2017b). WNS is spreading rapidly and now affects more than 15 states in the northeastern United States. In Canada, the provinces of Ontario, New Brunswick and Québec have also been also affected. WNS is therefore a major international issue for bat conservation. It is estimated that more than a million bats have succumbed to this syndrome since its discovery, attesting to the magnitude of this disease (MFFP, 2017b). Most North American bat species may be affected by WNS. However, the little brown myotis, the northern myotis, the big brown bat, the tri-coloured bat (*Perimyotis subflavus*) and the Indiana bat (*Myotis sodalis*, absent in Québec) have been especially affected in the northeastern United States and Ontario (MFFP, 2017b). The presence of WNS has been confirmed in Nord-du-Québec (Map 6-21A). Most of the species affected by WNS are insectivorous and cave dwelling.

In 2014, due to the spread of this disease, the tri-coloured bat, the little brown myotis and the northern myotis were classified as "endangered" in Canada and listed in Schedule 1 of SARA (Government of Canada, 2014).



Citation: White-nose syndrome occurrence map - by year (2017). Data Last Updated: 10/12/2017. Available at: https://www.whitenosesyndrome.org/resources/map.

**Map 6-1A Spread of WNS in North America**

### *6.3.6.2 ACOUSTIC MONITORING*

#### METHODOLOGY

In 2017, a bat survey was conducted in the study area using fixed acoustic monitoring, a technique based on the protocol developed for bat surveys in the context of wind projects (MRNF, 2008). This methodology is used to collect point-by-point information on bat activity using automated monitoring stations.

Six monitoring stations were set up to document the habitats most favourable to the activities of potentially present bat species, more specifically, sites suitable for breeding, foraging or roosting, as well as potential movement or migration corridors. These monitoring stations are shown on Map 6-21B. The desired key habitats were associations characterized by the presence of or proximity to two or more of the following:

— open areas;
— mature forests;
— watercourses and bodies of water;
— wetlands.

The stations were set up between July 6 and July 9, 2017, and removed on September 24 and 25, 2017. They were therefore active during the bat breeding season (early June to late July) and the beginning of the migration period (mid-August to mid-October).

The methodology used for this survey is described in detail in the Terrestrial Wildlife and Avifauna Baseline Study (*Étude spécialisée sur les faunes terrestre et avienne*) (WSP, 2018*g*). **Map 6-21B indicates the location of monitoring stations as well as potential habitats.**

#### RESULTS

The acoustic monitoring conducted during the breeding and migration periods in 2017 confirmed the presence of *Myotis* bats as well as two other species, for a total of just 68 passes recorded:

- *Myotis* bats (4.41% of records);
- big brown bat (*Eptesicus fuscus*) (1.47% of records);
- hoary bat (*Lasiurus cinereus*) (86.76% of records).

Of the total, 7.35 % of records were undetermined because the calls were too short to enable identification of the species.

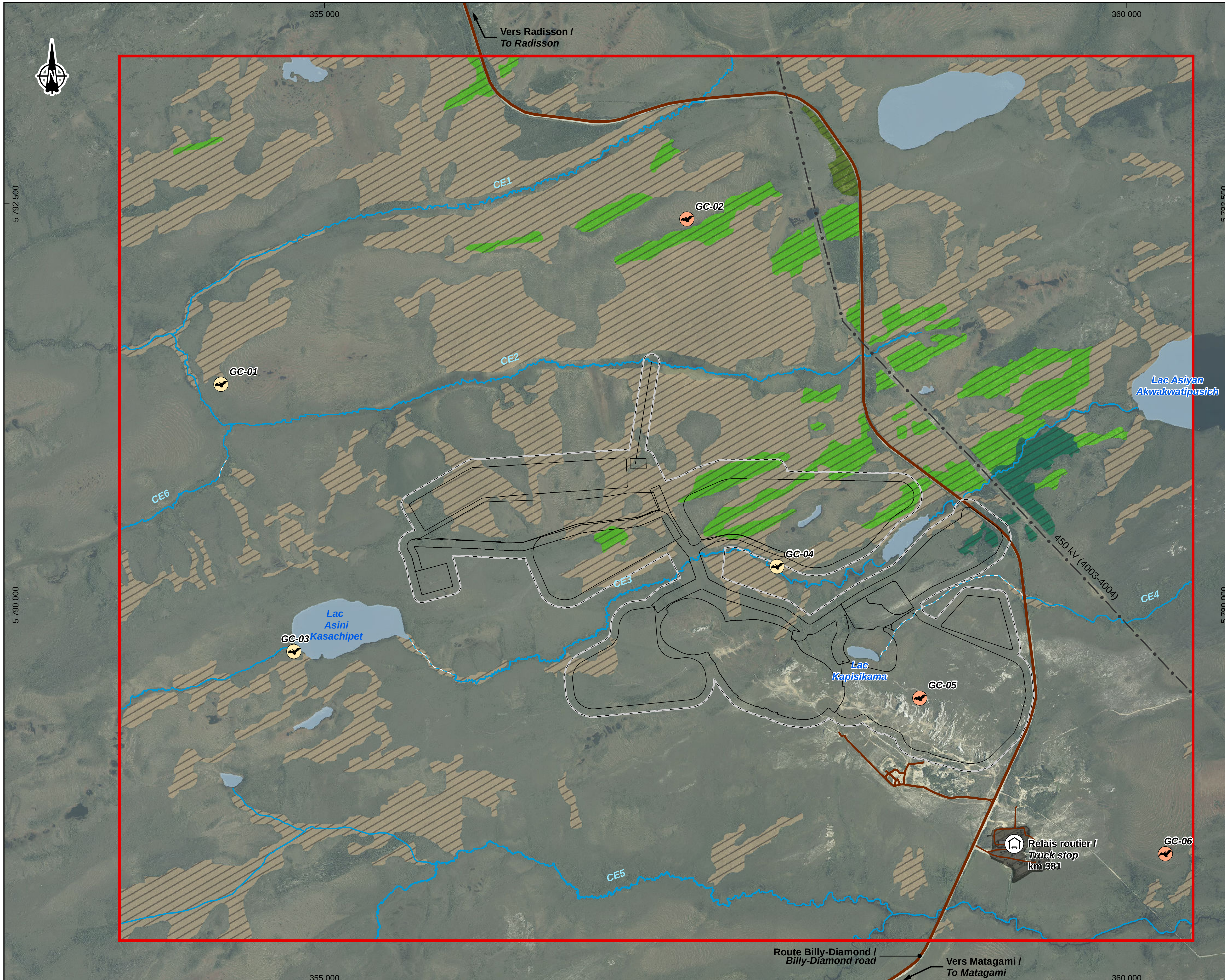
**Except for station GC-03, which was only active during the migration period after a technical problem, the five other stations were active for 20-40 nights during the breeding period and for 10-38 nights during the migration period. The entire survey consisted of 261 station-nights. All of the data collected was analyzed, which went far beyond what was required by the province (MRNF, 2008). Despite this survey effort, only three Myotis bat calls were recorded, accounting for one pass at 3 stations, which can be explained by the general poor environment and the northern nature of the study site. Such a small number of calls cannot lead to the conclusion that the environment is heavily used; the bat detected could have been on the move. The results of the bat survey did not raise any issues that would call for additional surveys.**

These results are consistent with those obtained by the Réseau québécois d'inventaire acoustique de chauves-souris in Abitibi (Jutras and Vasseur, 2011) and the survey conducted for the Wabouchi project (Nemaska Lithium, 2013) concerning the presence of *Myotis* and two other species, as well as for the dominance of the hoary bat.

However, considering the survey effort (261 station-nights), few passes were recorded for the various bat species.

Most of the species surveyed during this inventory were arboreal (Tremblay and Jutras, 2010): the hoary bat, which is a migratory species, essentially roosts in trees, while *Myotis* bats use trees, buildings and rocky structures (Tremblay and Jutras, 2010). For its part, the big brown bat roosts instead in buildings or rocky structures (Tremblay and Jutras, 2010) but also in mature trees with cavities (woodpecker holes, crevices, etc.) (Willis and coll., 2006). Arboreal bats typically look for large, wide-diameter trees (Tremblay and Jutras, 2010).

Consequently, mature forests are particularly suitable for daytime roosts and breeding sites for the at-risk species surveyed in the study area. We know that bats choose swamps, bogs, beaver ponds, lakes and watercourses as hydration and foraging habitats (Taylor, 2006). Consequently, the association of watercourses, bodies of water and other wetlands with mature forests are generally a key habitat for bats. While the presence of watercourses and/or wetlands characterized each monitoring station, mature forests have almost completely disappeared from the study area due to forest fires in the last decade. This probably explains the low bat presence.




Infrastructures minières / *Mining infrastructure*

Empreinte de la mine (zone tampon de 50 mètres) / *Mine footprint (buffer 50 meters)*

Zone d'étude locale / *Local study area*

**Chauve-souris / *Bat***

Station d'inventaire acoustique des chiroptères / *Bat acoustic monitoring station*

Présence confirmée de chauve-souris du genre *Myotis* / *Myotis bat presence confirmed*

Habitat potentiel de repos et de reproduction de la petite chauve-souris brune et de la chauve-souris nordique / *Habitat (roost sites) of Little Brown Myotis and Northern Myotis*

**Infrastructures / *Infrastructure***

Route principale / *Main road*

Route d'accès / *Access road*

Ligne de transport d'énergie / *Transmission line*

Relais routier / *Truck stop*

**Hydrographie / *Hydrography***

CE3 Numéro de cours d'eau / *Stream number*

Cours d'eau permanent / *Permanent stream*

Cours d'eau à écoulement diffus ou intermittent / *Intermittent or diffused flow stream*

Plan d'eau / *Waterbody*

**Peuplements humides / *Wetland***

Tourbière boisée / *Wooded bog*

**Peuplements terrestres / *Terrestrial Vegetation***

Boisé / *Woodland*

Pessière noire à lichen / *Black spruce lichen forest*

Pinède grise / *Jack pine forest*

Anthropique / *Anthropogenic*

GALAXY

*Mine de lithium Baie-James /James Bay Lithium Mine*

*Mise à jour de l'étude d'impact sur l'environnement*

**Carte / *Map* 6-21B**

**Habitat potentiel de repos et de reproduction de la petite chauve-souris brune et de la chauve-souris nordique et sites d'inventaire / *Habitat (roost sites) of Little Brown Myotis and Northern Myotis and survey sites***

*Sources :*
*Orthoimage: Galaxy, août 2017*
*Données du projet / Project data, Galaxy 2021*
*Inventaire / Inventory: WSP 2017*

0 240 480 m

UTM, fuseau 18, NAD83

**Juillet / *July* 2021**

*Dessin : A. Masson*
*Approbation : P. Marcoux-Viel*
*201-12362-00_c6-21B_wspT298_myotis_210701.mxd*

wsp

### *6.3.6.3 SEARCH FOR HIBERNACULA*

Documentary research was conducted to evaluate the potential presence of bat wintering habitats in the study area and in a one-kilometre surrounding buffer zone. We looked for natural cavities or mine openings potentially suitable for this type of habitat. Various sources were consulted, more specifically, the geomining information system (MERN, 2017), internal databases, photos and videos taken during wildlife surveys, as well as the regional offices of the MERN and MFFP.

An analysis of the documents showed that there are no natural cavities or mine openings in the area (Bellemare and Germain, 1987; Gauthier and coll., 1995; McCann, 2014). According to Christine Lambert of the *Direction de la protection de la faune du Nord-du-Québec*, the most northern hibernacula in Québec is found at the Bruneau mine, about 250 km south of the study area.

Hibernation sites must have an appropriate ambient temperature, one that is cold enough to sufficiently decrease the bat's metabolic rate but warm enough that it doesn't freeze to death. The interior ambient temperature of a mine or cave depends in large part on the average annual temperature of the region. Therefore, the 0°C isotherm, the line connecting all points where the average annual temperature is 0°C, would be the theoretical limit above which it would not be likely to find a hibernaculum since the temperature of cavities or mine openings would be too low for bat needs. The presence of hibernacula above this theoretical limit should not, however, be ruled out since microclimate conditions could explain special cases (Gauthier and coll., 1995). Still, this theoretical limit makes it possible to assess the potential of the study site, which is located about 250 km north of the 0°C isotherm (MDDELCC, 2018*a*).

Consequently, since no natural cavity or mine opening was found in the sector and since it is located beyond the theoretical limit described above, we believe that there is no likelihood of bat hibernacula in or around the study area.

### *6.3.6.4 SPECIAL STATUS BAT SPECIES*

#### MYOTIS BAT

Until WNS arrived, the genus *Myotis* was most abundant in eastern Canada (Broders and coll., 2003; Delorme and Jutras, 2006; Jutras and coll., 2012). In Québec, this genus includes the little brown myotis, the northern myotis and the eastern small-footed myotis, the latter never having been surveyed in Abitibi.

The little brown myotis and the northern myotis are two of the five resident species in Québec. They remain in their foraging and breeding habitats until fall (Brunet and coll., 1998; Prescott and Richard, 2004), at which point they move to their wintering habitat, usually in caves or old mine openings (Banfield, 1977; Mc Duff and coll., 2001). In the eastern part of their distribution area, *Myotis* bat populations have been decimated by WNS. This disease was first detected in Canada in 2010 and to date has caused a 94% overall decline in numbers of known hibernating *Myotis* bats in Nova Scotia, New Brunswick, Ontario and Quebec hibernacula (MFFP, 2017b).

The northern myotis is usually found in boreal forests (Broders and coll., 2003; Owen and coll., 2003), while the little brown myotis is found in a greater variety of habitats such as riparian, forest or anthropogenic sites (Prescott and Richard, 2004). In summer, the two species may use both tree structures (natural cavities or those excavated by woodpeckers, cracks under the bark, etc.) and buildings or rock structures as roosts for resting or rearing their young (maternity colonies) (Tremblay and Jutras, 2010).

**In the study site, the little brown myotis and the northern myotis could use trees as roosts such as the mature trees present in treed peatlands, wooded areas, black spruce stands with lichen and jack pine stands. They could also use the buildings present in anthropogenic areas (381 truck stop), but this sector will not be affected by the work.**

**Bats are also someone opportunistic, and can use wetlands and bodies of water to meet their feeding needs as easily as they can mature forests. Wetlands will be affected by the projects. Peatlands, however, which form the entirely of the environments affected, are not generally feeding sites of choice for bats, because open water is not always available there and the acidity of the environment is not favourable to producing large quantities of insects.**

#### HOARY BAT

The hoary bat is also a migratory species found in Québec (MFFP, 2001*b*) and the largest bat species in Canada. It occupies one of the largest distribution areas, from the Atlantic to the Pacific coast, a part of Canada and extending south to the northern part of South America, including Bermuda and the Greater Antilles (MFFP, 2001*b*). Although the hoary bat is even found in spruce domains, it is rare in Québec. Acoustic monitoring carried out at the end of the 1990s revealed its presence in a few locations in Estrie, Montérégie, Outaouais, Abitibi-Témiscamingue, Mauricie, Nord-du-Québec, Saguenay–Lac-Saint-Jean, Bas-Saint-Laurent, Gaspésie (Charbonneau and coll., 2011; MFFP, 2001*b*) and the Capitale-Nationale region (Charbonneau and Tremblay, 2010). It usually lives in wooded and semi-wooded areas and mainly hunts moths over glades and bodies of water. In summer, it roosts in trees. In fall, it migrates south to the U.S. and the Caribbean to overwinter (MFFP, 2001*b*).

A forest-dwelling species, it goes out late in the night to hunt, rarely comes in contact with humans and is difficult to see. The threats faced by this species are not well documented. Loss of habitat due to a reduction in snag numbers could have a negative impact, as could human disturbance of its wintering habitat in caves and mines. Just as for the silver-haired bat, it may suffer the effects of the fight against forest insect pests (MFFP, 2001*b*). Loss of habitat, WNS and the development of wind energy are also threats that could affect hoary bat populations (Tremblay and Jutras, 2010).

#### EASTERN RED BAT

Like the previous species, the eastern red bat is a migratory species (MFFP, 2001c). It is found across North America, including southern Canada and as far as the southern part of Central America and Bermuda. In Québec, the eastern red bat is even found in spruce domains. In summer, it usually roosts during the day by hanging from a tree or bush branch. At night, it hunts insects such as fog-basking beetles, grasshoppers, moths and flies. In early September, eastern red bats migrate as a group to the southeastern United States and northeastern Mexico. It then hibernates in tree foliage, hollow trees containing old woodpecker holes or under loose bark. It returns to our latitude around the end of May, where the female gives birth to two or three pups between early June and July (Tremblay and Jutras, 2010).

Since it is a species that is rarely seen or identified, its population trend in Québec is not known (MFFP, 2001*c*). Data compiled since the mid-1990s has confirmed its presence in small numbers in all the administrative regions of Québec (Tremblay and Jutras, 2010). The fight against insect pests could have a negative impact on this bat, as can loss of habitat and the development of wind energy (MFFP, 2001*c*; Tremblay and Jutras, 2010).

### 6.3.7 REVIEW OF SPECIAL STATUS SPECIES

**Based on the review of the territory, the search for species by geographic distribution and the survey data considered, there could be special status species in or around the local study area. This section looks at species with protected status whose presence has been confirmed or that have significant potential to use the territory. Special status species have been identified in the following faunal groups: land mammals, avifauna and bats.**

**A review of lists of special status species, from COSEWIC and from Schedule 1 of the Species at Risk Act, helped produce a list of species that are at risk or of special concern and that are present or potentially present in the study area. A review of this list resulted in the removal of the Canada warbler, because the study area is beyond its known range (AONQ, 2019). Likewise, the study area is outside of the known range of the tri-coloured bat, so it was also removed. In fact, according to the tri-coloured bat recovery strategy (Environment Canada, 2015), the project study area is located over 500 km to the north of the tri-coloured bat's known range. Other sources also set the northern boundary of the tri-coloured bat's range even further south (Tremblay and Jutras, 2010; Jutras and coll., 2012). Furthermore, the species was not recorded during the 2017 survey (see Section 6.3.6).**

**Table 6-56 presents the species selected and the likelihood of their presence in or around the reference study area.**

**Table 6-56 Status and current likelihood of presence of species that are at risk or of special concern in the study area**

| Species | SARA status | COSEWIC status | Potential presence based on range and habitat availability | Current likelihood of presence |
|---|---|---|---|---|
| Short-eared owl | Special Concern | Special Concern | Yes, but no individuals identified during survey campaigns | Low, given the current availability of their prey |
| Rusty blackbird | Special Concern | Special Concern | Yes | Confirmed |
| Canada warbler* | Threatened | Threatened | No | Nonexistent – beyond known range |
| Common nighthawk | Threatened | Special Concern | Yes | Confirmed |
| Olive-sided flycatcher | Threatened | Special Concern | Uncertain, but no individuals identified during survey campaigns | Low – at the boundary of known range |
| Sand martin | Threatened | Threatened | Yes, but no individuals identified during survey campaigns | High |
| Boreal caribou* | Threatened | Threatened | Possible | Low, given the current condition of their available habitat |
| Migratory caribou* | None | Endangered | Possible | Low, given the current condition of their available habitat |
| Wolverine* | Special Concern | Special Concern | Possible | Low, given the current availability of their prey |
| Tri-coloured bat* | Endangered | Endangered | No | Nonexistent – beyond known range |
| Little brown myotis | Endangered | Endangered | Yes | Confirmed presence of the *Myotis* genus |
| Northern myotis | Endangered | Endangered | Yes | Confirmed presence of the *Myotis* genus |

* Species that are at risk or of special concern that were not selected as potentially present, given their known range or the current condition of their available habitat in the study area.

**Surveys conducted for this project covered all species on the list, as well as potential habitats for the species considered. Survey and habitat characterization efforts, particularly in the area directly affected by the project, seem adequate to assess the potential presence of these species.**

**These areas are presented in Table 6-57, as are the characteristics of the habitat of each species at risk or of special concern in the study areas. Maps 6-20C to 6-20G as well as 6-21 show the location of potential habitats as well as the listening stations for breeding birds and bats.**

**Table 6-57 Potential habitats of species at risk or of special concern and present or potentially present in the study area and surface areas located within the project footprint**

| Species | Habitat characteristics | Surface area within the study area (ha) |
|---|---|---|
| Short-eared owl | The short-earned own uses a wide variety of open habitats, including arctic tundra, prairies, peatlands, marshes and former pastures. It also sometimes reproduces on farmland. Its preferred breeding sites are dense prairies, as well as tundra made up of areas of small willows. It is thought, however, that the main factor in its choice of local habitat, in both summer and winter, is the abundance of food. | 3,387.46 |
| Rusty blackbird[1] | The rusty blackbird nests in boreal forests where the species prefers the edges of wetlands, such as streams with low flow rates, peatlands, marches, swamps and beaver ponds and the borders of pastureland. In wooded regions, the rusty blackbird is rarely found in the interior of the forest. In winter, the rusty blackbird mainly occupies wet woodlands and, to a lesser extent, farmed fields. | 2,891.43 |
| Common nighthawk[1] | The common nighthawk nests in a wide variety of open habitats on land without vegetation, such as dunes, beaches, recently logged forests, burned areas, deforested areas, rocky outcrops, bare rocky terrain, prairies, pastures, peatlands, marshes, lakeshores and riverbanks. The species is also present in coniferous forests with or without deciduous trees. Since European colonization of eastern Canada and the eastern U.S., the common nighthawk has likely benefitted from newly cleared habitats following large-scale deforestation. The appearance of gravel-covered roofs contributed to the expansion of the common nighthawk's territory in North America. | 2,667.34 |
| Olive-sided flycatcher | The olive-sided flycatcher is most often associated with open areas containing living trees or large standing dead trees that can be used as perches, with the species needs to look for food. This bird generally lies in wait for its prey, insects, on a high dominant perch from which it takes off to swallow them mid-flight, then come back to perch again. Open areas may consist of clearings in the middle of the forest, forest edges located near natural openings (such as rivers or swamps), or areas cleared by humans (such as a forest that was cut down), burned forest or openings inside old forest stands, as these forests are characterized by mature trees and large numbers of dead trees. It has been demonstrated that birds nesting in logged habitats have less reproductive success than those that nest in natural open areas. As a general rule, the habitat is either a coniferous forest or a mixed forest. In a boreal forest, the most favourable habitat is most likely to be located in or around wetlands. Although the area covered by old stands has clearly diminished over the 20th century, it would seem at first glance that the surface area covered by the olive-sided flycatcher's habitat has remained more or less constant, since logging continues to create open areas that attract the birds. Recent studies indicate that these spaces are less favourable to reproduction. | 3,310.56 |

**Table 6-57 Potential habitats of species at risk or of special concern and present or potentially present in the study area and surface areas located within the project footprint (cont.)**

| Species | Habitat characteristics | Surface area within the study area (ha) |
|---|---|---|
| Sand martin | The sand martin reproduces in a wide variety of natural and man-made sites with vertical slopes, including the watercourse banks, cliffs along lacs and oceans, aggregate quarries, road cuts and soil embankments. It looks for substrate made up of a mix of sand and silt to dig its nesting burrows. Nesting sites tend to be short-lived as slopes change constantly due to erosion. They are often located near open land environments used for food in flight (e.g. prairies, fields, pastures and farmland). Vast wetlands serve as nighttime community roosting sites after reproduction and during migration and in winter. | 9.27 |
| Little brown myotis | The little brown myotis utilizes a diverse range of habitats depending on its diverse needs and the seasonal cycle. Hibernacula are essential habitats for the little brown myotis. These are generally subterranean openings (abandoned mines, caves, wells, tunnels, etc.) with adequate conditions (temperature between 2 and 10°C, over 80% humidity). For summer habitats, it uses rocky crevices, mature trees (mainly large trees just starting to decompose) and buildings to roost or form maternity colonies. When favourable sites are available, females tend to gather together and form maternity colonies.<br>With regard to food, bats are highly mobile and can travel large distances every night to get to their feeding sites. These sites are in environments where there are high insect concentrations, such as ponds, swamps, bodies of water, mature forests. Bats are opportunistic, and change feeding sites as insects emerge. They can even feed by traveling among several different sites. They also have a diverse range of feeding habitats, based on the availability of prey. | 943.59 |
| Northern myotis | Like the little brown myotis, the northern myotis can use subterranean openings as hibernacula. For daytime roosts, maternity colonies and feeding sites, it seeks roughly the same environments as the little brown myotis, although it has a greater preference for forest environments as feeding sites. | 943.59 |
| **1 Presence confirmed during surveys.** | | |

*Sources: Recovery strategies (MFFP), Status reports and recovery strategies for each species (ECCC)*

**Lastly, general knowledge about the residences, seasonal movement, travel corridors, habitat needs, critical habitats and life cycles, abundance and regional distribution of species at risk or of special concern that are likely to be found in the study area or affected by the project is largely described in the status reports and recovery strategies of the species in question. Table 6-58 summarizes the major points of what is known on each subject within the study area.**

**Table 6-58 Known information for species at risk and of special concern and present or potentially present in the study area with regard to their residence, life cycle, seasonal movement and travel corridors**

| Species | Residence | Seasonal movement | Travel corridors | Life cycle |
|---|---|---|---|---|
| Short-eared owl | Summer | Spring and fall migrations | Unknown locally | Likely local breeding |
| Rusty blackbird | Summer | Spring and fall migrations | Unknown locally | Presence confirmed and likely local breeding |
| Common nighthawk | Summer | Spring and fall migrations | Unknown locally | Presence confirmed and likely local breeding |
| Olive-sided flycatcher | Summer | Spring and fall migrations | Unknown locally | Possible local breeding |
| Sand martin | Summer | Spring and fall migrations | Unknown locally | Possible local breeding |
| Little brown myotis | Summer [1] | Spring and fall migrations | Unknown locally and not detected during surveys | Presence of Myotis genus confirmed locally |
| Northern myotis | Summer | Spring and fall migrations | Unknown locally and not detected during surveys | Presence of Myotis genus confirmed locally |

*Sources: Recovery strategies (MFFP), Status reports and recovery strategies for each species (ECCC)[11]*

# 6.4 HUMAN ENVIRONMENT

## 6.4.1 STUDY AREA

The human environment study area aims to generate a relevant record of the current and future activities of the Cree First Nations members affected by the project and of other territory users. The study area for this specific project comprises the easternmost part of the RE2 trapline (Map 6-22) and is demarcated to the north and east by the boundaries of the RE2 trapline (Map 6-22). To the south, it includes a zone around Amiskw Matawaw Lake that is used by the tallyman's family. And lastly, its western boundary is a little more than 13 kilometres from the project site. **The southwest boundary of the human environment study area is adjacent to the northeast boundary of the RE3 trapline. The human environment study area includes the local study area used to assess the project's impact on most of the components of the physical and biological environment.**

This study area, given the type of activities planned during the mine development phase, will make it possible to adequately evaluate the project's potential impact on the territory users' present or planned activities.

The Cree territory users who participated in the 2017–2018 consultation sessions were questioned with regard to the boundaries of the human environment study area. The RE2 trapline tallyman's family explained that they could not respond to such a query, for they were unaware of the project's impacts at the time of the consultations **in 2017-2018**.

[11] https://mffp.gouv.qc.ca/la-faune/especes/especes-menacees-vulnerables/retablissement/
https://www.canada.ca/fr/environnement-changement-climatique/services/registre-public-especes-peril.html#summary-details3
https://wildlife-species.canada.ca/registre-especes-peril/sar/assessment/status_f.cfm

Some users of the territory comprising the two adjacent traplines (VC33 and VC35) mentioned that they would have preferred a larger study area including the northern bank of the Eastmain River, which is where their families practise traditional activities. **Although the Eastmain River is not an environmental component likely to be affected by the project activities, the portion of the northern bank of the Eastman River was considered because of the concerns raised by the tallymen adjacent to the study area (VC33 and VC35) since their families practise traditional activities in this location.**

**Furthermore, although the RE1 trapline tallyman participated in the meetings GLCI set up since 2012, this land has not been part of the current study zone since the initial study zone was modified in 2012. The project activities will not have any impact on the RE1 trapline.**

Regarding the landscape, the human environment study area takes into account a radius of 7 to 15 kilometres around the project site. Studying the landscape over this particular area allows for understanding the structure of the landscape and defining its units.

A specific study area was used to assess the archaeological potential. The boundaries of this area, which covers a total of 56.6 $km^2$, are shown on Map 6-22.

### 6.4.2 OVERALL CONTEXT

The study area is in the Nord-du-Québec administrative region, a region that includes cities, Northern villages, Cree villages and Indigenous land. The region's territories are subject to distinct administrative management procedures depending on whether they are located north of the 55th parallel (the Kativik Regional Government territory) or south of it (EIJBRG) (Gouvernement du Québec, **2021a**). The study area is in the EIJBRG territory and more specifically on the Eastmain Cree community's territory (Map 1-1).

Established in 2014, the EIJBRG is Québec's only regional government. In addition to the nine Nord-du-Québec Cree communities, it also includes the four James Bay communities of Chibougamau, Chapais, Lebel-sur-Quévillon and Matagami, along with the three James Bay localities of Valcanton, Radisson and Villebois (GREIBJ, **2021**). Of all these geographical entities, which were part of the Municipality of Baie-James prior to the establishment of the EIJBRG, the two villages closest to the study area are Matagami (278 km) and Chapais (313 km) (insert of Map 1- 1).

The two closest Cree villages to the study area are Eastmain and Nemaska, which are respectively 100 kilometres and 82.5 kilometres away (Map 1-1). Each community is administered by a band council and the communities as a whole are governed by the Grand Council of the Crees (GCC). Each community has its own representatives from various regional or governmental bodies, among them the Cree Nation Government (CNG), the Cree Trappers' Association, the Cree Nation Youth Council and the Cree Hunters and Trappers Income Security Board.

In 2016, the village of Eastmain comprised 200 occupied private lodgings (Statistics Canada, 2017). The village also includes the council's administrative building, a courthouse (Photo 6-5), a fire station, a police station, a medical clinic run by the Cree Board of Health and Social Services of James Bay (CBHSSJB) (Photo 6-6), a wellness centre, a first responder station (Photo 6-7), the Cree Trappers' Association's regional office (Photo 6-8), a school belonging to the Cree School Board (*Wabannutao*), a daycare centre, a community centre (the *Multi-Services Day Center*), a sports centre with a skating rink, a gas station with a mechanic's shop, a hotel and restaurant (Photo 6-9), a bank, a post office, a community radio station, an airport and a general and grocery store (*Northern*). The village also has water and septic services.

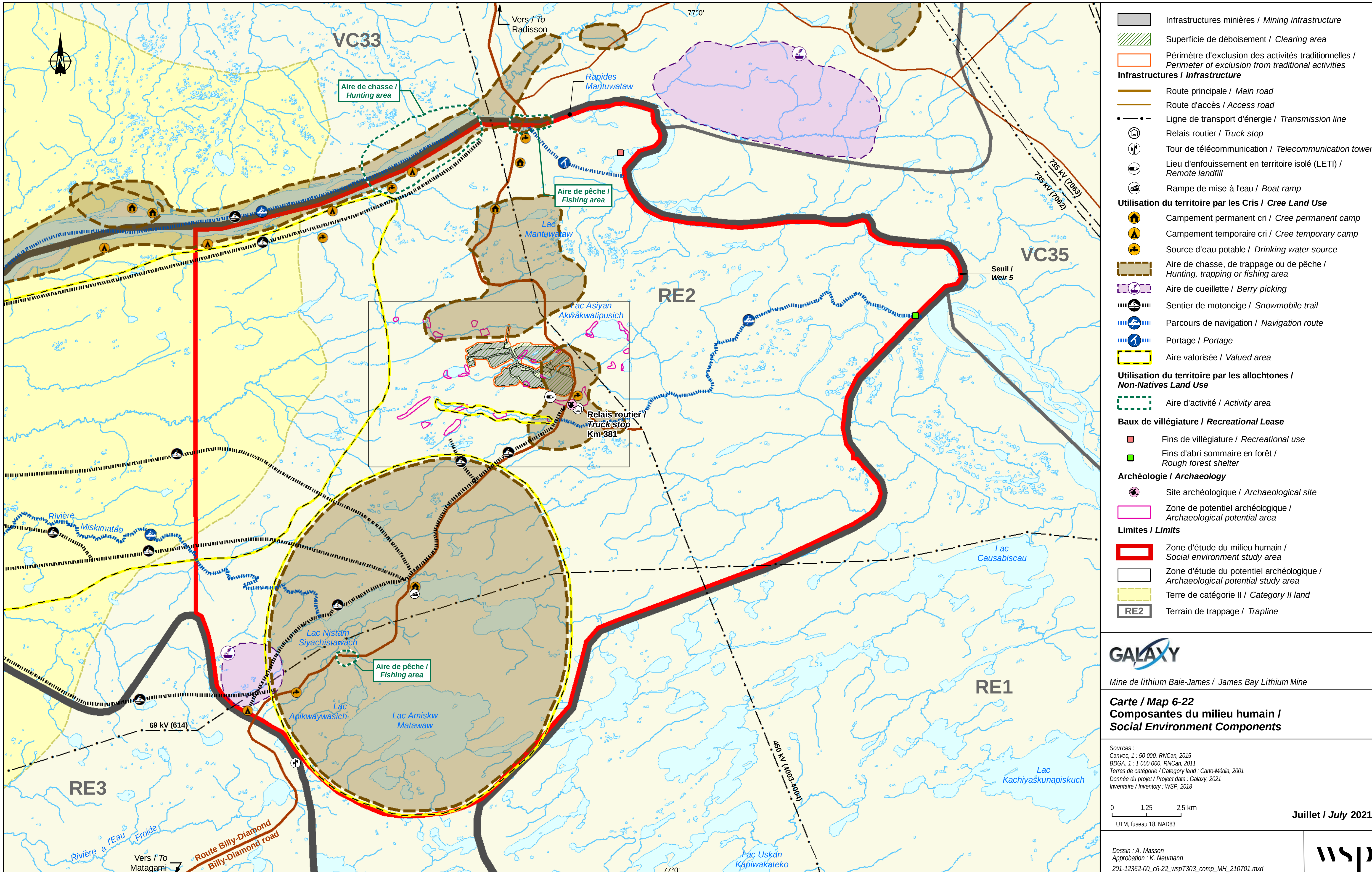
Photo 6-5 Eastmain courthouse

Photo 6-6 Cree Board of Health and Social Services of James Bay

**Photo 6-7 First responder station**

**Photo 6-8 Cree Trappers' Association regional office**

**Photo 6-9 Eneyaauhkaat Lodge**




GALAXY

*Mine de lithium Baie-James / James Bay Lithium Mine*

**Carte / Map 6-22**
**Composantes du milieu humain / *Social Environment Components***

Sources :
Canvec, 1 : 50 000, RNCan, 2015
BDGA, 1 : 1 000 000, RNCan, 2011
Terres de catégorie / Category land : Carto-Média, 2001
Donnée du projet / Project data : Galaxy, 2021
Inventaire / Inventory : WSP, 2018

**Juillet / July 2021**

Dessin : A. Masson
Approbation : K. Neumann
201-12362-00_c6-22_wspT303_comp_MH_210701.mxd

WSP

### 6.4.3 TERRITORY PLANNING AND DEVELOPMENT

Nearly all of the human environment study area considered for the purposes of this project is found on Category III lands, and a northwest portion of this area cuts into Category II lands (Map 6-22). Management and development of the resources on the territory's Category II and Category III lands is jointly ensured by three primary authorities: the CNG, the EIJBRG and the MERN.

**The EIJBRG is also able to declare its authority as a Regional County Municipality (RCM).**

Various development agencies are also involved in regional planning, among them the Cree Regional Authority (James Bay) and the SDBJ.

#### 6.4.3.1 CREE NATION GOVERNMENT AND GRAND COUNCIL OF THE CREES (EEYOU ISTCHEE)

In January 2014, by virtue of *An Act respecting the Cree National Government* (R.S.Q., c. G-1.031, previously the *Act Respecting the Cree Regional Authority*, c. A-6.1), the **Cree Regional Authority** became known as the Cree Nation Government. This authority can exert municipal competence (local or regional county) over some or all Category II lands. The Eeyou Planning Commission (EPC) has been mandated with preparing a regional plan for the use of Category II lands and resources (Secrétariat aux affaires autochtones, 2016). The CNG represents the Crees as required under the JBNQA in areas such as the environment, the hunting, fishing and trapping regime, and economic and community development (GCC, **2021a** and Hydro-Québec, 2004). The CNG's headquarters are in Nemaska.

The mandate of the **Grand Council of the Crees (GCC)** is two-fold, consisting of defending the interests of the Québec Cree Nation at the provincial, national and international levels, and of overseeing the implementation of the JBNQA (of which it is a signatory). The GCC's Board of Directors is made up of a chairman and vice-chairman, elected by popular vote, as well as the chiefs of each of the nine Cree communities, and one other representative from each community. Washaw Sibi, the members of which had yet to form a Cree community, was named as the 10th Cree nation by the General Assembly of the Grand Council of the Crees; although their chief and an elected representative have a voice at the Grand Council, the community's status is not officially recognized by the government (GCC, **2021a**).

The CNG and GCC are two separate legal entities, but they have a similar composition and are managed as a single organization by the Cree Nation (GCC, **2021a**).

#### 6.4.3.2 EEYOU ISTCHEE JAMES BAY REGIONAL GOVERNMENT

The EIJBRG adopted the urban planning regulations that had come into force under the prior Municipality of Baie-James. These regulations notably earmarked the various uses of the different parts of the Category III lands. The territory being studied straddles zones 52-02-R and 52-03-C of zoning regulation no. **213**[12] (EIJBRG, **2020**). More specifically, the planned mining infrastructure is in zone 52-03-C, where the main businesses are vehicle sales and services, accommodations and food services. Other types of uses are also authorized in this sector: resource development, industrial activities (trade, services and industries with a moderate impact, public utility equipment), leisure/recreation (parks and green spaces; intensive and extensive use) and public/institutional uses. Mining activities are thus permitted.

Regarding zone 52-02-R, the primary activity is resource development. Other authorized uses include vacation spots (scattered), industrial activities (public utility equipment), leisure/recreation (parks and green spaces; intensive and extensive use; hunting and fishing camps), public and institutional uses and conservation activities.

**12 The adoption of zoning regulation no. 213 on December 14, 2020 replaced zoning regulation no. 79.**

### 6.4.3.3 MINISTÈRE DE L'ÉNERGIE ET DES RESSOURCES NATURELLES

The MERN has the goal of managing and ensuring the sustainable development of Québec's energy and mineral resources as well as its overall territory (**Gouvernement du Québec, 2021b**). It is involved in the territory's development and resource management for this very purpose. Public land use plans (PLUPs) and the Regional Plan for Public Land are the MERN's two primary tools for the management and development of public land.

Determining the best use of the public land involves establishing the government's main orientations in terms of public land protection and development. The Regional Plan for Public Land, in turn, seeks to identify, in conjunction with regional stakeholders, principles and conditions for ensuring a harmonious use of public land.

According to the MERN, there are currently no PLUPs or Regional Plans for Public Land in force for the Nord-du-Québec region.

### 6.4.3.4 ADMINISTRATION RÉGIONALE BAIE JAMES

The CRE (Conférence régionale des élus de la Baie-James) was the Gouvernement du Québec's main contact for regional development matters. At present, in the Nord-du-Québec administrative region, the tasks of a CRE (regional council of elected representatives) are split between the Administration Régionale Baie James (ARBJ), the CNG, the EIJBRG and the Kativik Regional Government. The ARBJ notably has the mandate of promoting cooperation among the regional partners. The following people sit on its Board of Directors: the mayors of Chapais, Chibougamau, Lebel-sur-Quévillon and Matagami, four members from the municipal councils of each of these cities (chosen by their respective councils), and the heads of the local councils of the villages of Radisson, Valcanton and Villebois (ARBJ, **2021**).

The five-year James Bay development plan (*Plan quinquennal jamésien de développement 2015-2020*) (ARBJ, 2015) recommends nine orientations, 20 action items and 20 development. The objectives notably include financial support for innovative and feasible projects that involve rare earths. Other objectives involve (to varying degrees) the James Bay Lithium Mine project:

- reducing the percentage of workers in the natural resources sector who are obliged to commute;
- increasing the number of companies with a policy promoting the hiring of James Bay workers;
- increasing the number of new training programs adapted to the employment sector;
- increasing the number of women following study programs in non-traditional occupations;
- implementing measures to facilitate the transportation of merchandise within the Nord-du-Québec region;
- increasing the number of active entrepreneurs in the James Bay territory.

The ARBJ has entered into framework agreements and special agreements with the Gouvernement du Québec regarding the key principles of the regional development strategy. One such special agreement concerns the Table jamésienne de concertation manière (TJCM).. This body's mission revolves around supporting and upholding the mining industry's sustainable development in the James Bay territory while also promoting significant socioeconomic spin-offs for territory residents (**TCJM, 2021**).

### 6.4.3.5 SOCIÉTÉ DE DÉVELOPPEMENT DE LA BAIE-JAMES

Created by the *Gouvernement du Québec* in 1971, the SDBJ has the mission of promoting the sustainable economic development, natural resource development and long-term development of natural resources other than the hydroelectric resources managed by Hydro-Québec on the James Bay territory (SDBJ, 2017).

The SDBJ is active in two major sectors, namely economic development and services. Its economic development role mainly consists of identifying, attracting and supporting business projects through a special investment fund. Its activities in the services sector focus on managing transportation infrastructure on behalf of Hydro-Québec and the *Ministère des Transports du Québec* (**MTQ**). Over time, the SDBJ's expertise and regional presence have resulted in its being awarded mandates for the management of over 50% of the regional road network, an airport and two airfields (SDBJ, 2017). The SDBJ is notably responsible for maintenance of the Billy-Diamond highway, which crosses the study area, and administration of the km 381 truck stop, located east of the mining project.

## 6.4.4 REGIONAL AND LOCAL ECONOMY AND POPULATION

This section addresses the socioeconomic situation of the EIJB territory compared to the Nord-du-Québec region and the province as a whole. For each theme, data is first provided for the Cree communities, then for the EIJB communities.

### 6.4.4.1 POPULATION

#### CREE COMMUNITIES

In 2016, the nine Cree communities comprising the Eeyou Istchee James Bay (EIJB) territory represented were home to 17,141 residents, compared to 12,629 in 2001 (Table 6-59). In 2016, in fact, the Cree represented over one third (38.5%) of the population of the Nord-du-Québec region. Eastmain, the Cree community affected by this project, consisted of 866 people in 2016, which placed it in seventh position (from a demographic standpoint) among the Cree communities on the EIJB territory. The percentage change in the community's population between 2001 and 2016 was 41.3%, which is higher than that of other Cree communities on the EIJB territory.

**Table 6-59 Population of Cree communities, Nord-du-Québec and Québec – 2001, 2006, 2011 and 2016**

| Territory | Population (individuals) | | | | Variation |
|---|---|---|---|---|---|
| | 2001 | 2006 | 2011 | 2016 | 2001–2016 (%) |
| Chisasibi | 3,467 | 3,972 | 4,484 | 4,872 | 40.5 |
| Eastmain | 613 | 650 | 767 | 866 | 41.3 |
| Mistissini | 2,597 | 2,897 | 3,427 | 3,523 | 35.7 |
| Nemaska | 566 | 642 | 712 | 760 | 34.3 |
| Oujé-Bougoumou | 553 | 606 | 725 | 737 | 33.3 |
| Waskaganish | 1,699 | 1,864 | 2,206 | 2,196 | 29.3 |
| Waswanipi | 1,261 | 1,473 | 1,777 | 1,759 | 39.5 |
| Wemindji | 1,095 | 1,215 | 1,378 | 1,444 | 31.9 |
| Whapmagoostui | 778 | 812 | 874 | 984 | 26.5 |
| **Cree communities*** | **12,629** | **14,131** | **16,350** | **17,141** | **35.7** |
| **Nord-du-Québec** | **38,757** | **39,817** | **42,579** | **44,561** | **15.0** |
| **Québec** | **7,237,479** | **7,546,131** | **7,903,001** | **8,164,361** | **12.8** |
| * Population living in Cree communities (Indigenous and non-Indigenous). | | | | | |

*Sources: Statistics Canada (2007, 2012 and 2017).*

It should be noted that the population residing in EIJB Cree communities is also very young (Table 6-60). In 2016, close to one third (31.4%) of the Cree population was aged 14 and under (Figure 6-6). This proportion was close to twice that recorded in Québec (16.3%), and stood at 27.5% for Nord-du-Québec, also a high figure. In the Eastmain Cree community, this age group (0–14) had a proportion of 34.1%, higher than the average of the population aged under 15 in the EIJB territory. Conversely, in the same period, the 65-and-over age group was less well represented in the EIJB (5.5%) and Nord-du-Québec (7.7%) communities than in the whole of Québec (18.3%).

For the **2019-2020** year, inter-regional net migration in EIJB was almost nil, standing at -0.**31**%, representing the loss of **54** persons. During this period, these persons moved mainly to the **Laval, Montérégie** and Centre-du-Québec regions (ISQ, **2021a**).

According to the Institut de la statistique du Québec (ISQ), the population of Cree communities should continue its demographic growth over the coming years. Between **2016 and 2041**, it should increase by **30.5**% to reach a total of **22,600** persons. In comparison, the population of Nord-du-Québec and Québec should increase respectively by **16.6**% and **13.7**% over the same period (ISQ, **2019a**). In regard to households, between **2016 and 2041**, their number should increase by close to **60**% in Cree communities, compared with **26**% for Nord-du-Québec and **15.6**% for Québec (ISQ, **2019b**).

**Table 6-60 Age-group distribution of the population in Cree communities, Nord-du-Québec and Québec – 2016**

| | Population by age group | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0–14 | | 15–54 | | 55–64 | | 65 and over | | Total | |
| Territory | Number | % | Number | % | Number | % | Number | % | Number | % |
| Cree communities | 5,385 | 31.4 | 9,670 | 56.4 | 1,175 | 6.9 | 940 | 5.5 | 17,170 | 100 |
| Nord-du-Québec | 12,270 | 27.5 | 24,520 | 55.0 | 4,325 | 9.7 | 3,445 | 7.7 | 44,560 | 100 |
| Québec | 1,333,260 | 16.3 | 4,136,760 | 50.7 | 1,199,145 | 14.7 | 1,495,195 | 18.3 | 8,164,360 | 100 |
| Note: All data in this table has been subjected to random rounding to a multiple of 5 by Statistics Canada. Since totals were rounded separately, they do not necessarily match the sum of the rounded figures. | | | | | | | | | | |

*Source: Statistics Canada, 2017.*

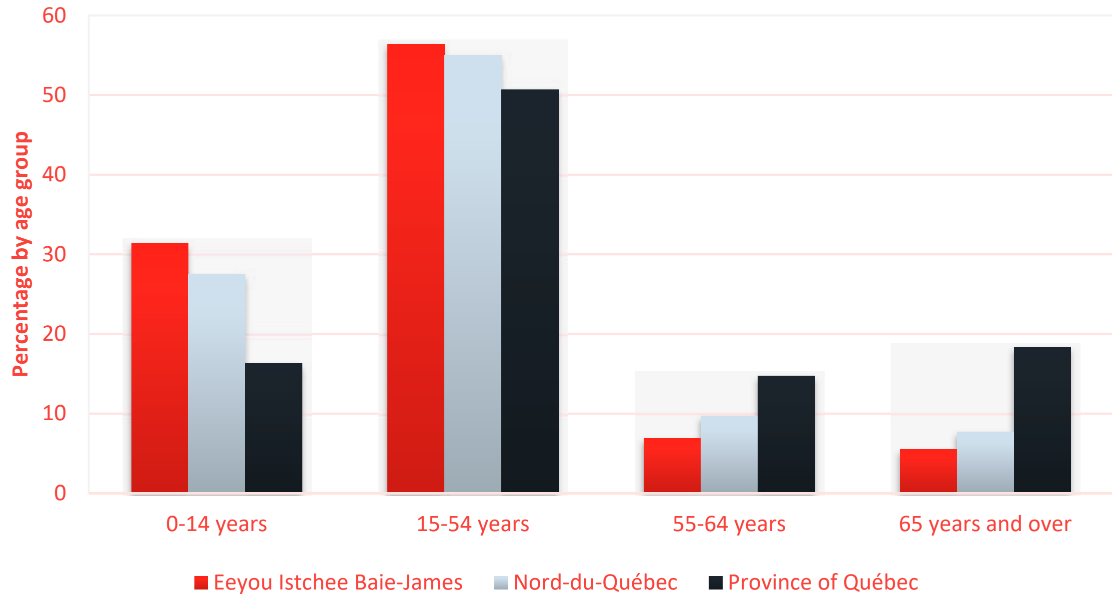



**Figure 6-6** **Population distribution by major age groups in Cree communities, Nord–du-Québec and Québec – 2016**

*Source: Statistics Canada, 2017.*

### JAMES BAY COMMUNITIES

In 2016, the population of James Bay communities was 14,232 persons. Chibougamau was the largest population centre with 7,504 persons, and Lebel-sur-Quévillon, with a population of 2,187, was in second place (Table 6-61). Unlike that of Cree communities, the population of James Bay communities is shrinking. Between 2001 and 2016, James Bay communities lost 12.8% of their population.

**Table 6-61 Population of James Bay communities, Nord-du-Québec and Québec – 2001, 2006, 2011 and 2016**

| Territory | Population (individuals) 2001 | 2006 | 2011 | 2016 | Variation (%) 2001–2016 |
|---|---|---|---|---|---|
| Chapais | 1,795 | 1,630 | 1,610 | 1,499 | -16.5 |
| Chibougamau | 7,922 | 7,563 | 7,541 | 7,504 | -5.3 |
| Lebel-sur-Quévillon | 3,236 | 2,729 | 2,159 | 2,187 | -32.4 |
| Matagami | 1,939 | 1,555 | 1,526 | 1,453 | -25.1 |
| Villages | 1,422 | 1,394 | 1,303 | 1,589 | 11.7 |
| **James Bay communities** | **16,314** | **14,871** | **14,139** | **14,232** | **-12.8** |
| **Nord-du-Québec** | **38,757** | **39,817** | **42,579** | **44,561** | **15.0** |
| **Québec** | **7,237,479** | **7,546,131** | **7,903,001** | **8,164,361** | **12.8** |

*Sources: Statistics Canada 2007, 2012 and 2017.*

A reading of the population data from the 2016 census shows that the James Bay population has an age-group distribution similar to that of Québec, although it has a smaller proportion of persons aged 65 and over, and slightly higher proportions of the three other age groups (Table 6-62). The James Bay population differs, however, from that of Nord-du-Québec, since the latter is influenced by the high level of young people among the Cree population. Also, the average age of the James Bay population in **2019** was **41.1** years, compared with **32.8** for the Nord-du-Québec region and **42.4** for Québec (ISQ, **2021b** and **2021c**).

**Table 6-62 Age-group distribution of the population of James Bay communities, Nord-du-Québec and Québec – 2016**

| Territory | Population by age group: 0–14 Number | 0–14 % | 15–54 Number | 15–54 % | 55–64 Number | 55–64 % | 65 and over Number | 65 and over % | Total Number | Total % |
|---|---|---|---|---|---|---|---|---|---|---|
| James Bay communities | 2,470 | 17.4 | 7,460 | 52.4 | 2,280 | 16.0 | 2,020 | 14.2 | 14,230 | 100 |
| Nord-du-Québec | 12,270 | 27.5 | 24,520 | 55.0 | 4,325 | 9.7 | 3,445 | 7.7 | 44,560 | 100 |
| Québec | 1,333,260 | 16.3 | 4,136,760 | 50.7 | 1,199,145 | 14.7 | 1,495,195 | 18.3 | 8,164,360 | 100 |

Note: All data in this table have been subjected to random rounding to a multiple of 5 by Statistics Canada. Since totals were rounded separately, they do not necessarily match the sum of the rounded figures. In addition, because of rounding, totals do not always equal 100%.

*Sources: Statistics Canada (2017)*

Regarding migration, inter-regional net migration involving the James Bay population shows a loss of **224** persons for the years **2019–2020**. Most of these people went to the **Montréal or Côte-Nord regions, or elsewhere in the Nord-du-Québec region (but not in the James Bay area)** (ISQ, **2021a**).

According to the ISQ, the demographic decline of the James Bay population should continue between **2016 and 2041**. By **2041**, the James Bay population should have declined by **9.0**% since **2016**, to number **12,800** people. In contrast, the population of Nord-du-Québec and Québec should increase by **16.6**% and **13.6**% respectively between **2016 and 2041** (ISQ, **2019a**). The number of James Bay households should diminish by **6.6**% between **2016 and 2041** (ISQ, **2019b**).

### 6.4.4.2 EDUCATION LEVELS

#### CREE COMMUNITIES

In 2011, there were 4,810 Cree aged 15 and over who held at least one secondary-education diploma, amounting to 44.2% of the population of Cree communities, as against 77.8% in Québec (Table 6-63). In 2016, the number had risen to 5,715 Cree, or 48.7% of the population, compared with 80.1% for Québec. Thus, although the graduation rate increased by 4.5 percentage points between 2011 and 2016, the education level of the Cree population remains distinctly lower than the level for Québec.

Moreover, Cree student participation in postsecondary studies is low. Among other things, this translates into a 2016 university degree rate (all cycles taken together) that is lower in Cree communities (8.8%) than in the population of Québec (24.1%). However, the number of university graduates rose from 880 in 2011 to 1,030 in 2016. The greatest increase since 2011 has been seen in college studies, where the variation rate is 26.3%, followed by vocational training with a rate of 19.5%.

According to the JBCSB, in **2017-2018**, there were **511** students enrolled in postsecondary education. **Of this number**, **379** were studying at a general and vocational college (CEGEP), **119** at a university and **13** at another training centre. (JBCSB, **2020**).

**Table 6-63 Highest level of education attained by the population aged 15 and over in Cree communities and in Québec – 2011 and 2016**

| | 2011 | | | 2016 | | | Variation 2011–2016 | |
|---|---|---|---|---|---|---|---|---|
| | Cree communities | | Québec | Cree communities | | Québec | Cree communities | Québec |
| Level of education | Number | % | % | Number | % | % | % | % |
| No high-school diploma | 6,080 | 55.8 | 22.2 | 6,015 | 51.3 | 19.9 | -1.1 | -7.9 |
| High-school diploma or some postsecondary studies | 1,200 | 11.0 | 21.7 | 1,340 | 11.4 | 21.5 | 11.7 | 1.6 |
| Diploma or certificate from a trade school (vocational training) | 1,515 | 13.9 | 16.2 | 1,810 | 15.4 | 16.9 | 19.5 | 6.8 |
| Collegiate diploma or certificate or some university studies | 1,215 | 11.2 | 16.6 | 1,535 | 13.1 | 17.6 | 26.3 | 8.3 |
| University diploma, certificate or degree | 880 | 8.1 | 23.3 | 1,030 | 8.8 | 24.1 | 17.0 | 5.9 |
| **Total** | **10,890** | **100** | **100** | **11,730** | **100** | **100** | **-** | **-** |

Note: All data in this table has been subjected to random rounding to a multiple of 5 by Statistics Canada. Since totals were rounded separately, they do not necessarily match the sum of the rounded figures. In addition, because of rounding, totals do not always equal 100%.

*Sources: Statistics Canada (2012 and 2017).*

#### JAMES BAY COMMUNITIES

In 2016, the level of education was lower in James Bay communities than in the rest of Québec. In total, 73% of residents aged 15 and over had at least one secondary-level diploma, compared with 80.1% for Québec. The discrepancy is greater at the university level. Only 1,360 James Bay residents (12.1%) had a university education (all cycles taken together), that is, about half the proportion in the Québec population (24.1%). However, it should be noted that graduation rates have been increasing since 2011 (Table 6-64). Among James Bay graduates, most hold a vocational diploma, both in 2011 (23.5%) and in 2016 (26.9%).

**Table 6-64 Highest level of education attained by the population aged 15 and over in James Bay communities and in Québec – 2011 and 2016**

| Level of education | 2011 | | | 2016 | | | Variation 2011–2016 | |
|---|---|---|---|---|---|---|---|---|
| | James Bay communities | | Québec | James Bay communities | | Québec | James Bay communities | Québec |
| | Number | % | % | Number | % | % | % | % |
| Without high-school diploma | 3,220 | 31.6 | 22.2 | 3,025 | 27.0 | 19.9 | -6.1 | -7.9 |
| High-school diploma or some postsecondary studies | 1,775 | 17.4 | 21.7 | 1,995 | 17.8 | 21.5 | 12.4 | 1.6 |
| Diploma or certificate from a trade school (vocational training) | 2,395 | 23.5 | 16.2 | 3,015 | 26.9 | 16.9 | 25.9 | 6.8 |
| Collegiate diploma or certificate or some university studies | 1,530 | 15.0 | 16.6 | 1,805 | 16.1 | 17.6 | 18.0 | 8.3 |
| University diploma, certificate or degree | 1,255 | 12.3 | 23.3 | 1,360 | 12.1 | 24.1 | 8.4 | 5.9 |
| **Total** | **10,175** | **100** | **100** | **11,195** | **100** | **100** | **-** | **-** |

Notes: 2011 data does not include the population of Matagami aged 15 and over. Data from the National Household Survey was removed for reasons of data quality or confidentiality.
All data in this table has been subjected to random rounding to a multiple of 5 by Statistics Canada. Since totals were rounded separately, they do not necessarily match the sum of the rounded figures. In addition, because of rounding, totals do not always equal 100%.

*Sources: Statistics Canada (2012 and 2017).*

Regarding high-school graduation among James Bay residents, available data **for the Commission scolaire de Baie-James** shows that in **2018** the rate stood at **63.9**% after five years of schooling. **The rate after seven years was not available for 2018 (MEES, 2019).**

The *Centre de formation professionnelle de la Baie-James* (CFPBJ), in Chibougamau, has two other points of service, one at Lebel-sur-Quévillon and the other at Matagami. It offers a set of study programs in a number of sectors, particularly in the mining sector. Programs offered are determined in collaboration with the *Commission de la Construction du Québec*, the *Agence de santé régionale or Emploi-Québec* in order to ensure that they meet the region's needs for labour. CFPBJ programs of interest to the mining industry are the following: Diamond Drilling, Drilling and Blasting, Mining, and Mining Machinery Operations programs (CFPBJ, 2021). The CFPBJ also works in concert with mining companies to adapt its training programs to their situation and needs. Thanks to this collaboration, field training periods are organized on partner mining sites, enabling students to learn in their future working environment (Sonia Caron, CFBJ, telephone interview, February 2018).

### *6.4.4.3 INCOME*

#### CREE COMMUNITIES

##### Disposable Income Per Capita

In **2017**, disposable income per capita in Cree communities was **$27,582**, which is **$5,208** more than the figure in **2013** (Table 6-65). Although the income levels are lower than what is seen regionally and provincially, the increase between **2013 and 2017** was greater for the Cree than for the Nord-du-Québec region (**$3,913**) and for Québec as a whole (**$3,052**) (ISQ, **2020a**). Per capita disposable income consists of employment income and government transfers, such as Employment Insurance, Old Age Security, Social Assistance and Québec Pension Plan benefits, minus taxes and other contributions.

The proportion of per capita income from government transfers for the Cree in **2017** was higher than that of Nord-du-Québec and Québec as a whole (ISQ, **2020a**).

### Income of Employees Aged 25 to 64

In **2017**, median employment income for workers from 25 to 64 years old in Cree communities was **$41,184** (Table 6-65). Since **2013**, income for this group of workers has increased to **$37,710** for a **9.2%** rise. By comparison, income for employees between 25 and 64 years old in Québec was **$41,058** in **2017** (ISQ, **2021d**).

### Median Family Income

Median after-tax income of couple-families in Cree communities increased from **$81,979** in **2013** to **$88,620** in **2017**, an increase of **8.1%** in four years (Table 6-56). The increase is **roughly the same** as that observed in Nord-du-Québec (**8.3%**) and higher than Québec as a whole (**7.4%**). In **2017**, the median income of Cree families was higher than the level in Nord-du-Québec (**$87,380**) (ISQ, **2020b**).

**Table 6-65 Disposable income per capita, income of workers from 25 to 64 (and couple-family median income in Cree communities, Nord-du-Québec and Québec – 2013-2017**

| | Income ($) | | | | | |
|---|---|---|---|---|---|---|
| | Disposable per capita | | Employees from 25 to 64 years old | | Median for couple-families | |
| Territory | **2013** | **2017** | **2013** | **2017** | **2013** | **2017** |
| Cree communities | **22,374** | **27,582** | **37,710** | **41,184** | **81,979** | **88,620** |
| Nord-du-Québec | **23,452** | **27,365** | **37,533** | **41,469** | **80,655** | **87,380** |
| Québec | **25,968** | **29,020** | **37,793** | **41,058** | **70,009** | **75,210** |

*Sources: ISQ (**2021d, 2020a, 2020b, 2019**)*

### The Income Security Program for Cree Hunters and Trappers

In 1976, the JBNQA established the Cree Hunters and Trappers Income Security Program (ISP) to encourage the Cree, by providing income support, to continue their traditional hunting, fishing and trapping activities. For the **2017–2018** period, the participation rate across the entire EIJB territory was 13.**4**%, **compared to 13.9% in 2016-2017 and 15.2% in 2015-2016**. The rate is also lower than the 2009–2010 rate of 14.9%. In Eastmain, the percentage of ISP participants was **8%, representing a second year in a row of decreasing rates**. There were **68** people (**52** adults and **16** children, equal to **39** family units) from Eastmain enrolled in ISP in **2017-2018**. Note that ISP provided average incomes of nearly $17,000 per claimant (i.e., family unit) in 2016–17 (OSRCPC, 2010 and **2019**).

## JAMES BAY COMMUNITIES

### Disposable Income Per Capita

Per capita disposable income in James Bay communities was **$31,921** in **2017**, up **$3,385** from **2013** (Table 6-66) (ISQ, **2020a**). This income is higher than Québec as a whole (**$29,020**) and the Nord-du-Québec region (**$27,365**) (ISQ, **2020a**).

### Income of Employees Aged 25 to 64

In **2017**, the median employment income of James Bay workers from 25 to 64 years old was **$51,657**. The income for this group of workers is increasing, with a growth rate of **11.6%** for the period **2013–2017**. **For the same period**, the Québec population's median employment income increased by **8.6%**, from **$37,793 to $41,058** (ISQ, **2021d**).

### Median Family Income

A James Bay couple-family's median after-tax income increased from **$80,686** in **2013** to **$86,540** in **2017**, an increase of **7.3%** in four years. This increase is lower than that in Nord-du-Québec (**8.3%**), but **equivalent** to the provincial rate (**7.4%**). A James Bay couple-family median after-tax income is **roughly the same** (**$80,686** in **2013**) as the region's for the same period (**$80,655**) **but was lower in 2017 given the regional income of $87,380** (ISQ, **2020b**).

**Table 6-66 Disposable income per capita, income of workers from 25 to 64 and couple-family median income in the James Bay communities, Nord-du-Québec and Québec (2013–2017)**

| Territory | Income ($) | | | | | |
|---|---|---|---|---|---|---|
| | Disposable per capita | | Employees from 25 to 64 years old | | Median for couple-families | |
| | 2013 | 2017 | 2013 | 2017 | 2013 | 2017 |
| James Bay communities | 28,536 | 31,921 | 46,302 | 51,657 | 80,686 | 86,540 |
| **Nord-du-Québec** | 23,452 | 27,365 | 37,533 | 41,469 | 80,655 | 87,380 |
| **Québec** | 25,968 | 29,020 | 37,793 | 41,058 | 70,009 | 75,210 |

Sources: ISQ (**2021d, 2020a, 2020b, 2019**)

## 6.4.4.4 LABOUR MARKET

From 2012 to **2020**, the participation rate[13] for the Côte-Nord–Nord-du-Québec region increased from **60.8%** to **63.0%** while the employment rate[14] gained **almost** two percentage points, ranging from 56.4% to 58.**1**%. The unemployment rate[15] dropped from 2015 to 2016, from 9.8% to 8.7%, after an increase in 2014–2015. **For the 2017-2019 period, the unemployment rate dropped from 5.8% to 4.8%, but rose back up to 7.6% in 2020. The 2020 rate is comparable to the rate of 7.7% observed in 2012 (ISQ, 2021e).**

### CREE COMMUNITIES

The Cree labour force, 15 years old and over, reached 7,665 people for all Cree communities in 2016. The participation rate for all Cree communities was 67.7% with almost identical rates for men (68.5%) and women (67.0%). The participation rate was 73.0% for Eastmain (420 working people). Participation rates of men and women for Eastmain in 2016 differed by 1.1 percentage points (72.2% for men and 73.3% for women).

Of the working population, the employed represented 6,445 people for all communities (employment rate 57.8%), including 385 in Eastmain. According to Statistics Canada, the number of employed women was generally higher than men.

In 2016, there were 1,225 unemployed people in all Cree communities, with an unemployment rate of 15.0%. More men than women were unemployed (785 versus 425). In Eastmain, the number of unemployed was 40, with an unemployment rate of 9.5% (Statistics Canada, 2017).

13 The participation rate is the working population as a percentage of the total population 15 years old and over.

14 The employment rate (also called the employment-population ratio) reflects the number of people working relative to the population 15 years old and over.

15 The unemployment rate represents the number of unemployed in relation to the working population.

### JAMES BAY COMMUNITIES

In 2016, the unemployment rate for the entire James Bay communities population was 9.0%, higher than Québec (7.2%) (Statistics Canada, 2017). The rate is higher for men (10.1%) than for women (6.9%). The situation is partly due to problems in the forestry industry, a sector employing mainly men. However, participation and employment rates, 66.7% and 61.0% respectively, were higher than those in the rest of Québec (60.5% and 56.7%). According to ISQ data, in **2018**, the James Bay population included **6,150** workers from 25 to 64 years old (ISQ, **2021f**).

In the **last** half of **2017**, among the **51** occupations in demand in the Nord-du-Québec region, six were associated with the mining sector: underground production and development miners, mining and quarrying supervisors, work site and industrial mechanics, **mine** technicians, mining engineers and geologists (Emploi-Québec, 2017).

## *6.4.4.5 STRUCTURE OF THE ECONOMY*

### CREE COMMUNITIES

The structure of the Cree economy is mainly based on the tertiary sector, particularly band councils and school and health institutions. However, traditional hunting, fishing and trapping remain important to Cree communities.

In 2016, almost two thirds (62.8%) of the Cree labour force with experience[16] worked in the following categories: business, finance and administration, sales and services, education, law and social services, community and government services. The trade, transportation and machinery categories accounted for 13.7% of the experienced labour force, 2.6 percentage points lower than in 2011. Occupations in the primary sector accounted for 4.6% of the EIJB workforce in 2016, compared with 1.6% in Québec. The processing, manufacturing and utilities sectors accounted for only 0.9% of the experienced labour force in 2016, compared to 4.9% for Québec (Statistique Canada, 2017).

The Council of the Cree Nation of Eastmain **employed** about 75 people in **2021**. It is divided into eight departments: Administration and Human Resources, Public Works, Public Safety (Public Safety and Fire Protection), Public Health which includes First Responders and "Healing" Departments, Special Projects, Department of Culture, Youth, Sports and Recreation, Housing and the Police (Première Nation d'Eastmain, **2021**).

Economic activities in Eastmain are primarily related to service sectors, restaurants, transportation (including airport management), construction (three companies), trapping and to a lesser extent, trade as well as outfitter sectors (**GCC, 2021b**). The Wabannutao Eeyou Economic Development Corporation's (WEDC) mandate is to foster the development of businesses in the community. It also manages a variety of businesses including a hotel, restaurant, cell phone service store, amusement centre, construction company, gas station and mechanical workshop (Craig William, WEDC, ind. interview, June 2018).

### JAMES BAY COMMUNITIES

When it comes to the economy, James Bay communities are largely dependent on the energy, mining and forestry sectors. The economic structure of the James Bay communities remained relatively identical from 2006 to 2011. Jobs in management, business, finance and administration, science and sales and services accounted for 56.7% of the experienced labour force (15 years old and over) in 2006 and for 59.7% in 2011. However, in 2016, the same sectors experienced a significant drop to 44.9%. Trades, transportation and machinery jobs accounted for about 21% of the experienced labour force in 2006 and 2011. A decrease to 18.5% is evident in 2016. Elsewhere, jobs in the primary sector experienced significant growth in 2016 (7.1%) compared to 2006 (5.9%) and 2011 (3.2%). The experienced labour force in the primary sector remains larger in proportion than in the rest of Québec (1.6%).

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[16] Individuals 15 years old and over who were employed or unemployed during the week prior to Census Day, and last worked for a salary or by contract in 2005 or 2006.

Machinery rental makes up a large part of business for construction companies in James Bay communities. Construction and transportation contracts derive mainly from mining and forestry companies, but really took off during Eastmain-1 and Eastmain-1-A–Sarcelle–Rupert hydroelectric projects. In contrast, residential construction is slowing down due to population declines (CREBJ, not dated).

#### *6.4.4.6 DEVELOPMENT PROJECTS*

**Mine projects**

The EIJB territory is currently under the scrutiny of several mining companies for exploration or extraction. **The MERN (2021 a, b and c) lists multiple mine projects including Rose (Critical Elements Lithium Corporation) and Whabouchi (Nemaska Lithium), as well as the Eau Claire project (Eastmain Resources/Fury Gold Mines).**

The Rose lithium-tantalum mining project by Critical Elements Corporation is located 60 kilometres southeast of this project and is currently undergoing an environmental assessment. **This project is currently undergoing review by the Environmental and Social Impact Review Committee, or COMEX (2021a). In April 2021, the joint committee reviewed the comments received during public consultation on the provisional version of the environmental assessment report and potential conditions in order to prepare the final version of its report. The Rose project** will also require the relocation of a 315-kV electrical transmission line and the construction of a substation. **This project is also undergoing review by COMEX (2021b).**

The Whabouchi mining project by Nemaska Lithium completed its environmental assessment and is currently at the pre-construction phase **(MERN, 2021a)**; it is located more than 100 kilometres southeast of the James Bay Lithium Mine project and will mine a spodumene deposit.

**The Eau Claire gold deposit exploration project is located about 80 km east of the James Bay Lithium Mine project. This project is currently in the exploration phase (Fury Gold Mines, 2021).**

**Billy-Diamond highway**

**The** Billy-Diamond highway repair program, set up by the SDBJ, has been underway since 2015. **The Plan d'action nordique 2020-2023 includes continuing phase 1 repair work on the Billy-Diamond highway, aiming to bring 50% of the asphalt pavement to satisfactory condition (Gouvernement du Québec, 2020). In June 2020, the cost of the repair program was $333.9 million (Secrétariat du Conseil du Trésor, 2021).**

**Access to housing**

**Since 2011, the GCC and Cree communities have developed the Cree Nation Housing Strategy to meet community members' urgent need for affordable, adequate housing. The Strategy is in keeping with an amendment made to the 2017 Cree Nation Governing Agreement eliminating Cree land grant terms for private property. This way, community members become true property owners while participating in the real estate market.**

**The program, with the help of the Government of Canada, focuses on private homeownership. With this program, Cree homeowners build wealth while Cree business owners grow their business. In addition, the initiative opens up community housing to low-income people, seniors and young people. The GCC has also invested $100 million to create the Homeownership Initiative Fund to subsidize construction of new private homes by and for community members. The GCC has also invested large amounts in infrastructure for drinking water, wastewater treatment facilities and civil engineering projects (GCC, 2020).**

**Cree business activities**

During the 2017–2018 consultations, some Cree users of the territory also mentioned that they had recently started the commercial harvest of wild mushrooms in the human environment study area. **In addition, a very preliminary outfitters project was mentioned. In recent consultations with users of the territory, they also mentioned their wish for controlled ecotourism development.**

## 6.4.5 QUALITY OF LIFE AND WELL-BEING

According to the World Health Organization, health is defined as: "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity." This vision of health is characterized by a search for balance between individuals and their environment, such as will optimize their well-being. In this context, health results from a constant interaction between individuals and their environment, with a range of dimensions determining their state of health. These dimensions are called determinants of health, which are the factors, within the population and/or at the individual level, that will change or improve health, depending on their state (INSPQ, 2014).

For the Cree, this "complete state of well-being" is known as *miyupimaatisiiun*, and is not only the result of determinants of health, but also the product of a balance among several social, economic and environmental factors (nature, diet and social balance). This vision of health as a multidimensional and interdependent totality is a holistic vision of health (INSPQ, 2014).

According to the GCC, the Cree population groups that could potentially be concerned by the development of projects on EIJB territory are as follows:

- workers employed on the projects;
- workers employed by businesses offering services and supplies to the projects;
- the spouse(s), children and families of workers;
- users of the territory near the projects;
- the communities whose territory is affected by the projects;
- local health and social services;
- the Cree Nation;
- other populations (GCC, 2011).

A brief overview of the primary determinants of health among the Cree that could be affected by the project is presented in the sections that follow.

### 6.4.5.1 LIFESTYLE

**Every year, in its annual report, the Cree Board of Health and Social Services of James Bay (CBHSSJB) presents the state of health of the population. In its 2019-2020 annual report, the CBHSSJB (2020a) named several factors related to the health of the Cree population.**

**On one hand, large socioeconomic inequities between the Cree population and the population of Québec continue to impact health results. Life expectancy increased by about five years over two decades but continues to be lower than that of the rest of Québec. It is 74 years for Cree men and 80 years for Cree women compared to the Québec averages, which are, respectively, 80 and 84 years.**

**The high level of psychological distress is 38% in this population compared to 28% for the rest of Québec. This has an impact on propensity for smoking. Despite a drop from 53% in 1991 to 43% in 2015, smoking rates are about twice as high as they are in Québec. Alcohol abuse is three times higher than in the rest of the province (57% versus 19%). Rates of cocaine and marijuana use are also higher than those in the rest of the province.**

**Cancer diagnosis and deaths remain lower than or roughly the same as the Québec averages. Kidney cancer, which is relatively rare elsewhere, is the most frequently diagnosed cancer in the region, followed by lung cancer and colorectal cancer. Cancer diagnoses among the Cree population occur at a younger age than in the rest of Québec (60 years versus 68 years).**

**Diabetes and its consequences are the most common chronic diseases, as well as those that are growing fastest in the region. Diabetes rates rose from 2% in 1983 to 27% by late 2017, affecting nearly 3,000 people. Over the last 15 years, new cases of diabetes have remained stable, reflecting lifestyle changes made to stay in good health. At the same time, nearly one in five diabetics is under 40 years of age.**

### *6.4.5.2* SOCIAL ENVIRONMENT

#### SOCIAL ISSUES

Social issues that come up repeatedly in the literature and in consultation meetings held for the James Bay Lithium Mine project revolve primarily around alcohol abuse, theft and vandalism associated with young people, the use of illegal drugs, child neglect and domestic violence.

The causes of excessive alcohol consumption are many. Some point to socioeconomic problems such as idleness, the rapid transition from one way of life to another, lack of income, and frustrated aspirations as underlying causes of the high demand for alcohol, and likely for drugs (INRS, 1998). It appears that abusive alcohol consumption and the associated social issues are tied to the same types of variables in Indigenous communities as among non-Indigenous people. These variables include the person's age, their degree of social integration in the community, social policies, the legal context, and so on; it is the particular combination of these factors that creates the specific problems and their increased prevalence among Indigenous people (May, 1996).

Furthermore, based on several studies done of First Nations, gambling is a veritable "scourge" among Indigenous people. The effects of gambling are much more evident in the context of poverty in which many Indigenous people find themselves, and compound other serious social problems. The problem is particularly acute in urban settings (INSPQ, 2010).

#### SENSE OF BELONGING AND SOCIAL COHESION

There are different definitions of a sense of social connectedness. A majority of researchers agree that it involves a dimension of acceptance (feeling of being understood and respected) and of intimacy, attachment and proximity with other people (Richer and Vallerand, 1998). Furthermore, social cohesion can generally be defined as the result of processes (socialization, participation, interaction, etc.) by which individuals share values and standards of conduct, which provide a sense of belonging to the group. This cohesion leads individuals to trust others and to share resources. It therefore involves living as a group, a sense of sharing, of common good and participation in civil society (Helly, 1999). It is often associated with the level of mutual aid, traditions and language spoken.

The Cree in the EIJB territory show a strong sense of belonging to their community. In 2003, 82% of Cree experienced a sense of belonging (qualified as "somewhat strong" or "very strong"). This proportion is significantly higher than that found among French-speaking Quebecers (56%) (CBHSSJB and INSPQ, 2008). This sense of belonging is equally developed among young and older people. The near absence of immigration seen in the EIJB territory may contribute to the strong general sense of belonging: population growth in the territory is the result of a combination of high fertility and rising life expectancy (INSPQ, 2006).

Social cohesion in Cree communities is higher than that seen in Québec overall. In 2001, a third (32.3%) of Cree aged 15 years or older cared for the elderly without compensation, compared with 17.7% of Québecers. This proportion is similar for both men and women. Despite the changes experienced in the Cree Nation in recent years, it remains very attached to traditional activities and to use of the Cree language, which may contribute to the social cohesion of the Cree nation. Indeed, in 2003, a very high proportion (89%) of Cree spoke mainly Cree at home. Furthermore, most Cree can carry on a conversation in English and some also speak French (CBHSSJB and INSPQ, 2008).

## TRADITIONAL LIFESTYLE

With the development of numerous major projects in the EIJB territory since the 1970s, the culture and identity of the James Bay Cree have been under significant pressure, characterized by several changes related to contemporary life. As development of projects in the EIJB territory is pursued, the GCC expects that Indigenous communities will be increasingly exposed to non-Indigenous people. Development of the territory must therefore go forward with respect for the traditions and culture of First Nations, meaning efforts to heighten awareness must be put in place so that non-Indigenous people are more enlightened and familiar (GCC, 2011).

Furthermore, the GCC has identified passing on Cree culture to young people as a priority in order to preserve the language, knowledge, traditions and abilities of elders. The Cree nation has several organizations that aim to preserve and promote Cree culture and identity: the Department of Traditional Pursuits, Cree Regional Authority (CRA), Aanischauuukamikw Cultural Institute, Cree Native Arts and Crafts Association, and the local cultural coordinator present in each community (GCC, 2011).

### SOCIAL INEQUITY

**Women, young people, and elders in the Eastmain and Waskaganish Cree communities face special challenges. This section presents a selection of socioeconomic data (Statistics Canada, 2017).**

**The situation faced by young people, with regard to education, training and jobs, is at the center of multiple issues in Cree communities:**

- **As in many Indigenous communities in Québec, the Eastmain and Waskaganish Cree communities feature a high proportion of the population under age 30: 60.1% and 56.9%, respectively, in 2016, compared to 33.8% in Québec overall.**
- **The dropout rate observed by the Cree School Board is 67.7% (74.0% for boys and 62.2% for girls). Although this is one of the highest dropout rates in Québec, we can see progress when comparing with 2008-2009 data (MEES, 2018).**
- **Over 60% of 15-24-year-olds experience a high degree of psychological distress, versus 36% in Québec (CBHSSJB, 2020).**
- **The proportion of individuals age 15 and older that are unmarried and not living in common-law marriage is higher in the communities in question (57.4% in Eastmain and 52.5% in Waskaganish) than in the province overall (43.7%) (Statistics Canada, 2017).**

**The situation of single-parent families is another issue that should be considered:**

- **There is a higher proportion of single-parent families in Eastmain and Waskaganish than among Québec families overall, at 41.5% and 34.3%, respectively, versus 16.8% in Québec.**
- **The proportion of single-parent families with three or more children is nearly four times higher in Waskaganish (35.1%) and nearly two times higher in Eastmain (17.5%) than in Québec overall (9.2%).**
- **In both Cree communities concerned, the median income of single-parent families is lower than that of couple-families with children ($56,064 lower in Eastmain and $40,277 lower in Waskaganish) (Statistics Canada, 2017).**

**Statistics on Indigenous women in both communities demonstrate the following:**

- **Employment rates for women (70.0% in Eastmain and 53.5% in Waskaganish) are proportionally higher than those for men (63.0% in Eastmain and 44.1% in Waskaganish), while these gaps are smaller in Québec overall (62.5% for men versus 60.2% for women) (Statistics Canada, 2017).**
- **Birth rates are twice as high in Cree communities as on average in Québec (INSPQ, 2014).**
- **About one in five births involves a mother age 20 or younger (CBHSSJB, 2020).**

**According to 2011 satistics from the Ministère de la Santé et des Services sociaux du Québec (MSSS), the James Bay Cree region had rates of genital chlamydial and gonococcal infection that were 7 and 11 times higher, respectively, than the average rates across Québec, indicating high transmission rates among the Cree population (INSPQ, 2014).**

#### 6.4.5.3 HEALTH AND SOCIAL SERVICES

The CBHSSJB, in partnership with the Ministère de la Santé et des Services sociaux du Québec (MSSS), manages and organizes health and social services in the nine communities of the Cree Territory of James Bay (MSSS Administrative Region 18) (CBHSSJB, **2020b**).

The CBHSSJB manages all establishments providing health and social services in the region. Establishments under its responsibility are the regional hospital in Chisasibi and the **Community Miyupimaatissium (health) Centres (CMCs)**, located in each of the nine Cree communities. The CMCs provide general medical services, home care, dental care and social services. The Chisasibi Hospital has 29 beds, 17 of which are used for active care. A hemodialysis unit has nine beds (CBHSSJB, **2020b**).

During the meeting with CBHSSJB Eastman representatives, the latter presented several problems the organization is currently facing in responding to the needs of the population. Difficulties with nurse recruitment, and the availability of only one ambulance, were mentioned.

### 6.4.6 LAND USE

**The traditional knowledge of the Cree population was considered in the consultations done at the start of the project in 2011-2012 and in 2017-2018 in order to document the use of the land and resources and establish a natural and cultural heritage baseline.**

**This process involved conducting interviews with tallymen and their families, users of the territory and elders. A review of literature on traditional knowledge, particularly for medicinal plants, and visual simulations integrating valued viewpoints were additional activities that helped form a comprehensive description of how the land is used.**

**The Eastmain, Waskaganish and Waswanipi communities were also consulted. Consultations and additional work led to deeper knowledge of the environment, discussions about stakeholder concerns and expectations for the project, and identification of major project challenges and sensitive elements. Considering that the resources are an important food source for Indigenous people and that hunting, fishing and gathering have greater traditional meaning (lifestyle), traditional knowledge has also enhanced the description of components of the biophysical environment.**

**Consultations with land users also touched on the presence of burial sites, sites of archeological interest or other sites that are important for natural or cultural heritage, as well as any components that are of value for their scientific, social, historical or aesthetic importance. For burial sites, in particular, none were listed in the project area, but several sites were identified further downstream, along the Eastmain River. Based on the information provided by the communities, there are no sacred or ceremonial sites, objects or things within the study area.**

**Components related to land use include water quality (especially the Eastmain River and creek CE5), air quality, soil quality, quality of wildlife in general (beavers, moose, geese, sturgeon, trout, porcupines in particular), quality of plants consumed by users and animals (including medicinal plants and berries), as well as land integrity.**

**In addition, two Cree joined the field teams as land users during surveys, so that the teams could benefit from their knowledge of things like accessible trails to reach sampling stations. This also encouraged sharing of information and instructions.**

**The land users pointed out information and observations about certain species of wildlife that are of traditional interest in the sector, specifically: migrating and woodland caribou, moose, beavers, geese, sturgeon and porcupines. The information gleaned shows that sites of memory continue to be actively transmitted, which helped identify cultural landscapes. These were approached through valued areas (see Section 6.4.6.1) and are make up of three main sectors: the Eastmain River, creek CE5 and the area consisting of multiple lakes near Amiskw Matawaw Lake.**

**Some sectors carry greater cultural importance, due to the strong connection to the territory and their generational attachment or because of the abundance of certain resources. Land users wish to protect these valued areas for their cultural, historical or subsistence aspects, and where knowledge is transmitted. These sites are presented and described in section 6.4.6.1. With regard to past land use, it is mainly addressed in section 6.4.9 on archeology.**

#### *6.4.6.1 CURRENT USE OF LAND AND RESOURCES FOR TRADITIONAL PURPOSES*

The EIJB territory has nine Cree communities. The only community found in the project study area is the Eastmain community.

Since the creation of beaver reserves in the 1930s, the Cree territory has been divided in traplines. Each trapline is under the responsibility of a tallyman who, each year, supervises the dividing of the resources to use and areas to preserve to ensure renewal of the species sampled.

The territory of the Eastmain community includes 15 traplines. The planned mining infrastructure is located on the RE2 trapline occupying 5.8% of the Eastmain community's total trapping territory of 15,668 $km^2$.

The principal activities carried out on the traplines are hunting, fishing and trapping of fur-bearing animals. They take place year-round, according to specific practices and timetables. Visiting the trapline is also considered a revitalizing and curative activity for users. Trapping activities usually are usually done in fall and winter. Winter is also a good time for hunting or snaring small wild game (such as ptarmigan or hare) and for hunting moose. Users of these camps are also ISP recipients, which means they spend at least four months per year on the land.

**In fact, the food collected on the territory, mainly in the study area for RE2 trapline users, is starting to come back since the lull imposed by the forest fire. According to some users, a large part of their food comes from what they gather on the trapline, and when they stay there, this is their main food source. Traditional food is also brought back into the community and shared during celebrations such as birthdays or feasts. Generally, some users mentioned they consumed less traditional food since the forest fire and some said they had to turn to other traplines to supply themselves. Therefore, traditional food consumption was estimated at about once a week. The quantity of these foods depends on hunting success and activities per season. For example, goose is consumed more often in spring, moose in fall, and fish in summer and fall.**

**The territory considered for the project and the area around it is currently used by family members of the RE2 trapline tallyman, mainly to hunt moose and geese, to fish and trap, and to gather berries and other plants. Brian Weapenicappo has been the RE2 trapline licensee since he replaced his uncle Clarence Mayappo as tallyman in 2014. Several members of his extended family are occasional or regular trapline users.**

**The RE2 trapline is located 25 kilometres east of the village of Eastmain and spans 90 kilometres. It is bordered to the north by the Eastmain River. The study area, located in the trapline's eastern section, covers nearly half of its area. This is the most frequented section since it is crossed, from north to south, by the Billy-Diamond highway. The km 381 truck stop and two transmission lines are in this part of the trapline.**

**Two permanent encampments are found in the study area, along the Billy-Diamond highway. One of these, built in 2016 and located 7 kilometres northwest of the project site, includes a single camp. The second encampment, less than 10 kilometres south of the project site, includes four camps and a tipi.**

**Some temporary encampment sites are also present along the Eastmain River. Tents can be set up there, when needed, mainly during moose hunting or for fishing.**

**RE2 trapline users report that the entire trapline is good habitat for beavers, although older users that were consulted report that the beaver population has been dropping since the Billy-Diamond highway was built. Generally speaking, the wetlands are valued because of the presence of beavers.**

**RE2 trapline users particularly value the Eastmain River, creek CE5 and the area made up of multiple lakes near Amiskw Matawaw Lake due to the abundant resources that continue to meet their needs and their attachment to these sites going back generations.**

**MOOSE HUNTING**

Moose hunting is carried out in the study area, but there are few sites specific to this activity since the moose population is scattered across the territory. However, the sector of the Eastmain River (in the study area) and Billy-Diamond highway remain especially used for this activity.

**CARIBOU HUNTING**

**Caribou hunting was probably more important in the past than it is now, due to the low caribou population that exists today. Consultations with RE2, VC33 and VC35 trapline users indicated that there had not been any recent woodland or migratory caribou hunts in the study area by the users consulted, because there have not been any caribou there. Historically, caribou have been hunted along the entire Eastmain river.**

**Users of the RE2 trapline land mentioned that there are fewer and fewer migratory caribou on the land since the 2013 forest fires, and that none were observed in 2018-2019.**

**Woodland caribou are sometimes sighted south of the RE2 trapline (west of the Billy-Diamond highway), but none were seen this year.**

**GOOSE HUNTING**

Various locations in the study area are frequented for goose hunting, primarily east of the Billy-Diamond highway. This activity is practised near watercourses, namely, on former borrow pits that have become attractive to the geese, at certain lake outlets and at stream crossings along the Billy-Diamond highway. Nearly ten of these sites were identified in the study area's human environment (grouped per sector on Map 6-22). In spring, users often spend close to one-month goose hunting on the trapline with family members. In fall, hunting is carried out more sporadically, generating less interest or family gatherings. The tallyman has plans for a goose hunting pond project on the Eastmain River (close to the sturgeon spawning ground community project). The increasing number of hunters on the trapline calls for developing new hunting areas.

**TRAPPING**

Users mentioned that the study area, and more specifically the sector around the km 381 truck stop, has always been a great place for beaver trapping. However, few beavers were trapped recently since the resource needs to regenerate following the 2013 forest fire. The same is true of the other trapping sectors on the trapline. The trapline's western part, which includes the study area's western part, is considered a beaver conservation zone, where the population can regenerate before it moves elsewhere on the trapline. Users rarely frequent this sector.

Another sector appreciated for its wealth of resources is in the southern part of the study area, within a radius of 5 kilometres around the main camp and its lakes. This sector is regularly used year-round.

**Fur-bearing animal captures by Cree trappers are documented yearly by the Cree Trappers' Association. In 2015-2016, the main species collected and documented for the Eastmain community are, in rank of importance and including number of specimens: marten (55), beaver (47), moose (20), black bear (14), muskrat (12), lynx (12), fox (various species) (7), and otter (6) (CTA, 2016).**

**The 2013 forest fire affected a large part of the trapline, leading to a decrease in its use and in the wildlife resources collected on the land, including porcupines, caribou, beavers and moose. However, with renewed plant growth and the return of resources, users are gradually getting back to their normal activities, which they expect to continue in the future.**

**FISHING**

**Fishing is mainly practised on two lakes in the study area's southern portion. The intersection of the Billy Diamond highway and Eastmain River (in the study area's northern part) is also well frequented for fishing activities. Fishing is also practised on the CE5, along the road, requiring no navigation. Sturgeon, pike, walleye and whitefish are fished there. The community has plans for a sturgeon spawning ground enhancement project in the vicinity. This will limit fishing on this site for the time needed to ensure its sustainability. This resource seems to have been affected by the diversion of the Eastmain River in 1980, and seems to be starting to come back to this river.**

**GATHERING**

**The use of plants and berries for food and medicinal purposes was also mentioned by users of the RE2, VC33 and VC35 traplines who were consulted.**

The gathering of blueberries and plants **is carried out in various locations on the territory. Blueberries are primarily gathered in sectors that were affected by forest fires, namely in the Billy-Diamond highway sector where access is easy.**

**The community also gathers mushrooms in the same Billy-Diamond highway sector for a commercial project.**

**WATER SUPPLY**

**When staying at their main camp, users primarily get their water supply from the km 381 truck stop. During consultations, land users identified other water sources used for drinking water or for food purposes when travelling on the territory. No additional information was provided about the nature, quality or use of these water sources. Four other sources were identified in the study area: three close to the Eastmain River and one in the southern part of the trapline.**

**TRAVEL**

In addition to using the Billy-Diamond highway and several short access roads linked to it (and mainly travelled by quad), travelling in the study area is mainly done by snowmobile. Thinning of the trapline by the 2013 forest fire facilitated travelling everywhere on the territory, without the need for snowmobile trails.

**NAVIGABLE WATERWAYS**

**The Director of the Eastmain Environmental Department and RE2, VC33 and VC35 trapline users were interviewed to learn what waterways are used to practise traditional activities, as well as to learn more about their past and present use. For this purpose, maps showing the waterways within the study area, as well as the project area on a larger scale, were used. Users said that creeks CE2, CE3 and CE4, as well as Kapisikama and Asini Kasachipet Lakes, were not used.**

**Based on information gathered from trapline users, the navigable waterways used for long trapping trips are (Map 6-22):**

- **the Eastmain River up to Weir 5 (except for the Mantuwataw Rapids, which can be bypassed with a portage);**
- **Nistam Siyachistawach Lake (southwest of the study area);**
- **Amiskw Matawaw Lake (southwest of the study area);**
- **the Miskimatao River (southwest of the study area).**

**Only the downstream part of stream CE5, a river accessible from the Billy-Diamond highway, is sometimes navigated by canoe for trapping and hunting, and often has been in the past for trapping and to get to the Eastmain River (east of the study area.**

**There has been little travel on Miskimatao River and the eastern part of creek CE5 in recent years. Travel is possible from the Billy-Diamond highway to the Eastmain River; westward on the Miskimatao River or eastward on the CE5 stream.**

**The uses mentioned for the other small creeks (CE2, CE3, CE4, CE5 [upstream of the road]) and Kapisikama Lake are snowmobile trapping in winter or goose hunting in spring where they intersect with the road (either by snowmobile or by vehicle.**

**EASTMAIN RIVER**

**The VC33 trapline tallyman mentioned during interviews that he used the Eastmain River and continued to use certain nearby sectors for various activities, like other trapline VC33 users. In winter, when there is ice cover, they are able to reach the trapline from the community. When the river is free of ice, it is navigable in some locations, but since it was diverted by Hydro-Québec, it is no longer possible to reach trapline VC33 by boat from the community. The river remains generally harder to navigate because of the low water level.**

**Eastmain River remains important to VC33 trapline users and their families because it is the site of many activities, including transmitting traditional knowledge to young generations. Users gather and feed themselves with pike, trout and beaver from the river. It was mentioned, however, that the river is much less used now because of the low water level, making the river muddier and the fishing worse since the Hydro-Québec facilities were set up.**

**Various sectors of the Eastmain River are good for hunting geese and moose and fishing. Trapping may take place for other fur-bearing animals when these resources are present.**

**Near the Rupert River, Rapin Stream, which empties into the river near the Eastmain River bridge, is used for various activities. Four family camps were built between this stream and the road to the east of the Billy-Diamond highway (road to the former Opinaca airfield). This camp is located 5 km northeast of the Eastmain River. In 2018, trapline users were planning to build a new camp there. A community camp was also located along the Eastmain River.**

**Although the Eastmain River was diverted in 1980, it is an important cultural landscape for the Cree. Its heavy use historically and its importance as a main navigation route (a historical site and a source of subsistence for past generation) create a strong attachment to this river, which is still used for its resources.**

**MINING ACTIVITY**

GLCI owns **54 claims covering an area of 2,163.75 ha and corresponding** in part to the site of the projected mining infrastructure (Map 2-1). Besides the claims belonging to other owners, no other mining title is present in the study area.

### 6.4.6.2 VACATIONS AND RECREATIONAL ACTIVITIES

There are two MERN vacation lot leases in the study area along the Eastmain River. One of these leases, issued for a cottage, is approximately 4 kilometres east of the Billy-Diamond highway. The second lease, issued for a rustic shelter, is located 13.5 kilometres east of the Billy-Diamond highway (Map 6-22).

The section of the study area located in Category III lands is included in hunting and fishing zone 22, which spans a vast territory from Mistissini in the south to Whapmagoostui in the north, and from James Bay in the west to the Caniapiscau Reservoir in the east, excluding Category I and II lands. In this area, hunters must abide by the hunting rules that apply in the area. According to MFFP data **(2021), an average of 120 moose per year were hunted in this zone from 2016 to 2020 (**MFFP, **2021**). Concerning fishing, some restrictions apply for Category II lands and on fishing methods used, and certain fish species are for exclusive use by Indigenous peoples (MFFP, 2017c).

Furthermore, Québec is divided into 96 fur-bearing animal management units (FAMU). FAMU 92 is affected by the study area. It has the same boundaries are the territory belonging to the Eastmain Cree community. It corresponds to an area where trapping is for the exclusive practice of Indigenous peoples as per the *Regulation respecting beaver reserves* (R.R.Q., 1981, c. C-61, r. 31) and the *Act Respecting Hunting and Fishing Rights in the James Bay and New Québec Territories* (CQLR, chapter D-13.1) (MFFP, 2016). **Available data indicates that a total of 234 beaver pelts, 6 otter pelts, 13 Canadian lynx pelts, 110 marten pelts, 3 black bear pelts, 1 muskrat pelt, 26 red fox pelts and 1 mink pelt were sold over the last five seasons (2015-2016 to 2019-2020) (MFFP, 2021).**

During consultations, Indigenous users of the territory mentioned that hunting and fishing are practised by some non-Indigenous in the study area, mostly at the junction of the Billy-Diamond highway and Eastmain River. **There are, however, fewer non-Indigenous users who practise recreational hunting and fishing in the study area. Since 1980, the development of the James Bay highway network has led to an increase in recreational activity in the territory (tourism, sport hunting and fishing), especially since the Billy-Diamond highway was opened to non-Indigenous populations in 1986. Yet these activities are still mainly concentrated in the southern portion of James Bay and to the east of the Robert-Bourassa power station. In 1991, monitoring was done to assess the impact of sport hunting and fishing on animal populations, and this monitoring counted nearly 11,000 vehicles at the entry of the Billy-Diamond highway (Hydro-Québec Production, 2001).**

According to the Fédération des pourvoiries du Québec, there is no outfitting business in the study area (FPQ, not dated).

The Fédération québécoise du canot et du kayak does not list any canoeable route in the study area (FQCK, 2005). Note that a boat launch ramp is installed near the Billy-Diamond highway, at Nistam Siyachistawach Lake.

### 6.4.6.3 QUARRIES, SANDPITS AND CONTAMINATED SOILS

None of the sites in the study area are listed in the MDDELCC's *Répertoire des dépôts de sols et résidus industriels* or the *Répertoire des terrains contaminés* (2018*b* and *c*).

According to Phase I of the ESA carried out in the project's sector **(WSP, 2018h)**, two quarries were operated at an unknown date prior to October 1982, one on the site of the current remote landfill and/or close to it, and another north of the km 381 truck stop.

## 6.4.7 INFRASTRUCTURE

### 6.4.7.1 ROADS

The main roadway is the Billy-Diamond highway, which crosses the study area from south to north for 30.8 kilometres. This road, originally built to provide access to the hydropower project sites in the 1970s, spans 620 kilometres, crosses the EIJB territory and is an extension of Route 109 (Tourisme Baie-James, 2012). The road begins at Matagami and ends at Radisson. **The road is entirely paved, maintained and cleared of snow in winter. According to SDBJ data,[17] about 57,000 vehicles use Billy-Diamond highway, on average, every year, for an average annual daily traffic of 314 vehicles, factoring in round trips. About 31% of these vehicles are heavy-duty vehicles of various types.**

The road does not cross any Indigenous town or community and is on Category III lands. There are 20 Cree traplines associated with the communities of Eastmain (2 traplines), Waskaganish (7 traplines), Nemaska (4 traplines) and Waswanipi (7 traplines) that are crossed by the road or located within 2 km of it.

The Billy-Diamond highway has not been a provincial highway since 2002 and is now administered by the SDBJ. Many Indigenous communities, including Eastmain, Waskaganish, Wemindji and Chisasibi, can be reached by **this road**, which is also used by their members to travel. Two forks in the road, one at kilometre 275 (North toad) and another at kilometre 544 (Trans-Taiga toad), lead, respectively, to the municipality of Chibougamau and to the Caniapiscau Reservoir.

The Sûreté du Québec ensures road safety on Billy-Diamond highway except for areas under the jurisdiction of Cree communities, which are under the responsibility of the Cree police force.

### 6.4.7.2 AIRPORTS

There is no airport in the project area. The airfields closest to the project site are the airports located at the Eastmain River (97 km), Nemiscau (88 km) and the Éléonore mine (85 km), which is near the Opinaca Reservoir (Map 1-1).

### 6.4.7.3 POWER LINES

There are two power lines near the human environment study area. From north to south, the 4003-4004 circuit (450 kV) crosses the study area where it cuts through the Billy-Diamond highway in three places. The 614 (69 kV) circuit crosses the study area from east to west at its southern part. Neither of these two power lines crosses the planned mining infrastructure (Map 6-22).

### 6.4.7.4 TELECOMMUNICATIONS

Most of the EIJB territory is served by Hydro-Québec's telecommunications network via a microwave link and a regional fibre-optic network owned by Eeyou Communications Network, a not-for-profit telecommunications corporation that provides broadband carrier services for the Cree communities and municipalities of the James Bay region (Eeyou Communications Network, 2017). There is no telecommunications infrastructure in the study area. The closest infrastructure is south of the study area, between the Billy-Diamond highway and Amiskw Matawaw Lake (Map 6-22).

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**17 Data on traffic using Billy-Diamond road compiled for 2014-2017. E-mail communication, Jean Nouvellet, Société de développement de la Baie-James, May 2018.**

#### 6.4.7.5 KM 381 TRUCK STOP AND REMOTE LANDFILL

There is a truck stop in the study area at km 381 of the Billy-Diamond highway. It offers lodging, food services, meeting room rental and mechanical troubleshooting (SDBJ, 2017). A convenience store, a laundry room, a cafeteria, a motel, two garages and a gas station are also part of this complex located on Block 27 of the Eastmain River watershed, a 100-hectare site owned by the SDBJ since 1994.

The truck stop gets its drinking water supply from two **active** artesian wells located in the western part of the site. **Groundwater extraction at the km 381 truck stop is the only point listed within a two-kilometre radius of the pit and is the main source of drinking water supply for land users.** Buildings and other truck stop infrastructure are listed on Map 6-23.

There is a remote landfill near the proposed pit, linked to the activities of the km 381 truck stop. This remote landfill was authorized on July 18, 2006, by the **Ministère de l'Environnement et de la Lutte contre les changements climatiques (MELCC)**. However, the site has been used for waste management since December 5, 1983. Before that, it served as a quarry. Until 2011, the waste brought to this site was buried in trenches and later incinerated in containers. A lease was issued to the SDBJ by the MRNF in 2012 (Raymond Thibault, SDBJ, ind. interview, February 2018, and Alain Coulombe, SDBJ, ind. interview, May 2018). The phase I environmental site assessment **(WSP, 2018h) and the phase II environmental site characterization (WSP, 2018d)**, provide greater detail on this remote landfill.

### 6.4.8 LANDSCAPE

#### 6.4.8.1 COMPONENT TYPES

The landscape survey and analysis method used in this project is based on Hydro-Québec's landscape study method for transmission and distribution lines and station projects (Hydro-Québec, 1992) and the MTQ's visual assessment method for transport infrastructure integration (MTQ, 1986).

The description of the landscape is based on data from surveys of the biophysical and social environments conducted in 2011, 2017 and 2018, as well as on information gathered from various documents such as aerial photos and maps. Field visits were made to inventory the landscape (topography, plants, land use, visual fields).

**REGIONAL LANDSCAPE**

At the regional level, the project site is in the northern part of the natural province of the James Bay Lowlands. This province consists of an immense peat plain which, to the east of Waskaganish, becomes more fragmented due to an increased presence of scattered bodies of water and rocky mounds. The lower reaches of several large rivers (including the Eastmain, Nottaway, Broadback and Rupert) form the largest part of the hydric network while a dense but poor drainage system crosses the plain. Many ponds but few lakes are found around the bogs.


**Infrastructures du relais routier /** ***Truck Stop Infrastructure***

- Puits d'eau potable / *Potable water well*
- ① Caféteria et centre administratif / *Cafeteria and administrative office*
- ② Garage d'entretien / *Maintenance garage*
- ③ Poste à essence / *Fuel station*
- ④ Buanderie / *Laundry*
- ⑤ Logement des employés / *Employee residence*
- ⑥ Motel / *Motel*
- ⑦ Maison SDBJ / *SDBJ house*
- ⑧ Maison Hydro-Québec / *Hydro-Quebec house*
- ⑨ Dôme pour sable et sel de voirie / *Road sand and salt dome*
- ⑩ Entrepôts / *Warehouse*
- ⑪ Génératrices / *Generators*
- ⑫ Carothèque de Galaxy / *Galaxy's core racks*

GALAXY

*Mine de lithium Baie-James /James Bay Lithium Mine*

**Carte /** ***Map*** **6-23**
**Relais routier du km 381 /**
***Km 381 Truck Stop***

*Source :*
*Image Galaxy, 2017*

0 20 40 m

UTM, fuseau 18, NAD83

**Juillet /** ***July*** **2021**

*Dessin : A. Masson*
*Approbation : C. Martineau*
*201-12362-00_c6-23_wspT337_relais_routier_210701.mxd*

Two Cree villages, Waskaganish and Eastmain, are home to most of this province's population. These villages are located near James Bay on the banks of the Rupert River and Eastmain River, respectively.

#### LANDSCAPE IN THE STUDY AREA

The Billy-Diamond highway forms the backbone of the study area from north to south over an approximate distance of 31 kilometres. Most of the traditional activity sites (camps and hunting, fishing and trapping areas) as well as a **truck stop** and secondary roads are connected to it. There are several snowmobile trails that converge on the larger lakes in the southern portion of the study area (Map 6-24).

A natural mosaic characterizes most of the landscape in the study area following a complex pattern generally oriented east-west. This mosaic is composed of various types of plant communities, burns from past years, rocky outcrops and bare soil. The plant communities are very diverse and include terrestrial vegetation (scrubland, woodland, spruce stands, pine stands) and wet growth (shrubby, wooded or open peatland). The woody vegetation is about 10 m high in this region.

The topography of the study area is divided into three distinct parts. The incised valley of the Eastmain River borders the northern limit of the area with an elevation of 175 m to 200 m, while a plateau dominates the landscape to the south with an elevation of 225 m to 250 m. There is a large plain between the valley and the plateau, at an elevation ranging from 175 m to 225 m. It occupies the largest part of the study area. The plain and the plateau are dotted with hills characterized by rocky outcrops. These hills can reach an elevation of about 240 m on the plain and about 280 m on the plateau.

A network of lakes and rivers of different sizes forms the natural fabric of the landscape. The largest lakes are clustered south of the study area in the plateau area, while smaller lakes are scattered to the northeast, on the plain.

The landscape in the study area alternates between open views (bodies of water, open peatland, rocky outcrops, bare soil), no views (blocked by the landscape or by dense groups of coniferous trees) and partial views (burned areas with burned trees still standing, deciduous trees in winter). The hills are natural visual landmarks in the study area, while power transmission towers and the Billy-Diamond highway are anthropogenic visual landmarks.

The landscape in the study area is used for traditional activities or for transit (more specifically, via the Billy-Diamond highway). Cree camp users, as well as hunters, fishers, trappers and visitors to the truck stop are considered temporary fixed observers. Users of the territory travelling on the Billy-Diamond highway, snowmobile trails and navigable bodies of water and watercourses are the main moving observers.

The landscape in the study area is not legally protected.

### *6.4.8.2 LANDSCAPE UNITS*

The identification and analysis of landscape units make it possible to grasp the challenges of the study area both on a visual and human scale. A landscape unit is a separate and homogeneous section of territory characterized by a cluster of similar visual elements. The study area was thus divided into five types of landscape units taking into account the homogeneity of the permanent elements and dominant visual characteristics. These units were defined mainly by the topography and land use, the components least sensitive to the effects of forest fires. The five types of landscape units in the study area are:

- valley;
- plain;
- plateau;
- power line;
- road.

Tables 6-67 to 6-71 describe these landscape units based on the following components:

— limits and specific land use;
— routes;
— land use elements or elements of recognized aesthetic interest;
— topography;
— hydrography;
— vegetation;
— spatial organization;
— observers (within the unit);
— visual field;
— view quality and visual points of view.

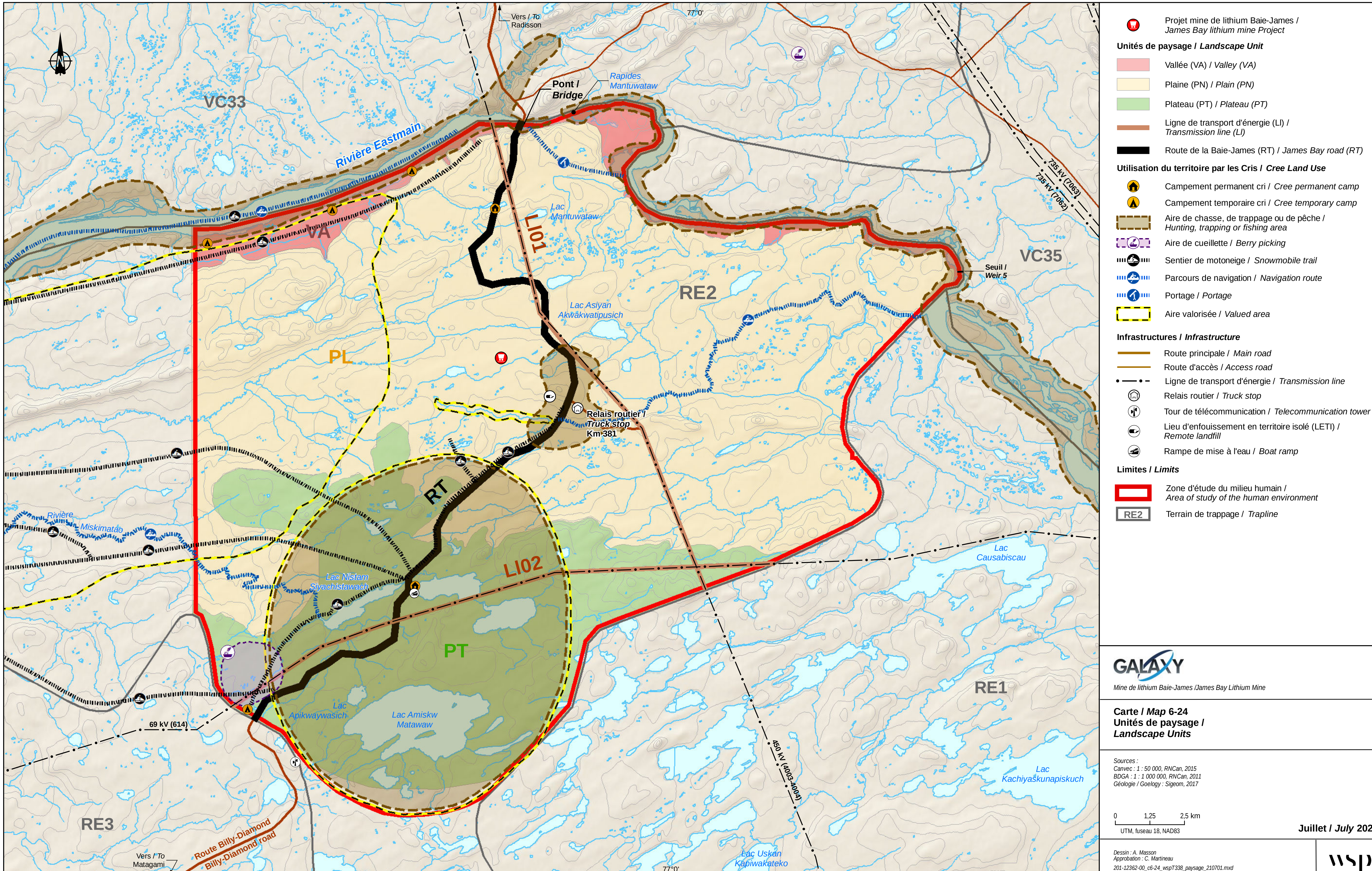
#### VIEW QUALITY AND VISUAL POINTS OF VIEW. VALLEY LANDSCAPE UNIT

The valley landscape unit includes the Eastmain River. It is visually isolated from the study area by its incised position (Map 6-24 and Photo 6-10).

The unit is used for hunting, fishing and its sources of drinking water.

**Table 6-67 Valley landscape unit**

| Component | Description |
|---|---|
| Limits and specific land use | • The valley landscape is located north of the study area and is mainly formed by the lower Eastmain River, its banks, the Mantuwataw Rapids and Weir 5 farther upstream. |
| Roads or transport routes | • The river is a shipping route with a portage path in the vicinity of the Mantuwataw Rapids.<br>• The Billy-Diamond highway crosses the unit for approximately 50 m. From this road, a service road runs west along the river valley. The Billy-Diamond highway bridge straddles the river below the Mantuwataw Rapids.<br>• A power line straddles the river downstream of the bridge.<br>• A snowmobile trail runs along part of the river valley. |
| Land use elements | • Three temporary Cree camps on the south shore of the Eastmain River, downstream of the Mantuwataw Rapids.<br>• Two wildlife areas used for hunting, fishing or trapping as well as one spawning area and one valued area. |
| Topography | • Somewhat incised compared to the adjacent territories, the valley is at an elevation of 150 m to 175 m. |
| Hydrography | • Several small bodies of water flow into the Eastmain River, which flows into James Bay about 90 km to the west. |
| Vegetation | • The unit is characterized by woody vegetation and burns. |
| Spatial organization | • The Eastmain River is the backbone of the valley and is a geographical landmark in the study area. The towers of a power line and the Billy-Diamond highway bridge are the unit's notable landmarks. |
| Unit observers (within the unit) | • Users of temporary Cree camps, hunters and fishers (temporary fixed observers).<br>• Transiting users on the Eastmain River, the Billy-Diamond highway and snowmobile trails (mobile observers). |
| Visual field | • The typical visual field is limited where the river valley is concerned. It is deep in the direction of the river and open views are limited by the topography or woody vegetation. |
| View quality and visual points of view | • The view quality of the unit is based on its natural appearance.<br>• Except for the Billy-Diamond highway bridge, the unit is visually isolated from the study area. |



VC33
VC35
RE1
RE2
RE3
VA
PL
PT
RT
LI01
LI02
Rivière Eastmain
Rivière Miskimatao
Pont / Bridge
Rapides Mantuwataw
Lac Mantuwataw
Lac Asiyan Akwâkwatipusich
Lac Nistam Siyachistawach
Lac Apikwaywasich
Lac Amiskw Matawaw
Lac Causabiscau
Lac Kachiyaškunapiskuch
Lac Uskan Kapiwakateko
Relais routier / Truck stop Km 381
Seuil / Weir 5
Vers / To Radisson
Vers / To Matagami
Route Billy-Diamond
Billy-Diamond road
69 kV (614)
735 kV (7063)
735 kV (7062)
450 kV (4003-4004)
77°0'
Projet mine de lithium Baie-James / James Bay lithium mine Project
Unités de paysage / Landscape Unit
Vallée (VA) / Valley (VA)
Plaine (PN) / Plain (PN)
Plateau (PT) / Plateau (PT)
Ligne de transport d'énergie (LI) / Transmission line (LI)
Route de la Baie-James (RT) / James Bay road (RT)
Utilisation du territoire par les Cris / Cree Land Use
Campement permanent cri / Cree permanent camp
Campement temporaire cri / Cree temporary camp
Aire de chasse, de trappage ou de pêche / Hunting, trapping or fishing area
Aire de cueillette / Berry picking
Sentier de motoneige / Snowmobile trail
Parcours de navigation / Navigation route
Portage / Portage
Aire valorisée / Valued area
Infrastructures / Infrastructure
Route principale / Main road
Route d'accès / Access road
Ligne de transport d'énergie / Transmission line
Relais routier / Truck stop
Tour de télécommunication / Telecommunication tower
Lieu d'enfouissement en territoire isolé (LETI) / Remote landfill
Rampe de mise à l'eau / Boat ramp
Limites / Limits
Zone d'étude du milieu humain / Area of study of the human environment
RE2 Terrain de trappage / Trapline
GALAXY
Mine de lithium Baie-James /James Bay Lithium Mine
Carte / Map 6-24
Unités de paysage / Landscape Units
Sources :
Canvec : 1 : 50 000, RNCan, 2015
BDGA : 1 : 1 000 000, RNCan, 2011
Géologie / Goelogy : Sigeom, 2017
0 1,25 2,5 km
UTM, fuseau 18, NAD83
Juillet / July 2021
Dessin : A. Masson
Approbation : C. Martineau
201-12362-00_c6-24_wspT338_paysage_210701.mxd
wsp

**Photo 6-10 Valley landscape unit, view from an elevated rocky outcrop**

## PLAIN LANDSCAPE UNIT

This landscape unit forms a vast plain that encompasses the project site. The plain is dotted with some elevated rocky outcrops, small hills and power transmission equipment that is visible from afar (Map 6-24 and Photo 6-11). The unit is used for traditional activities and for transit.

**Photo 6-11 Plain landscape unit, view from an elevated rocky outcrop on the plain**

## Table 6-68 Plain landscape unit

| Component | Description |
|---|---|
| Limits and specific land use | • The plain landscape unit runs between the Eastmain River to the north and an elevated plateau to the south. Most of the unit is characterized by a natural mosaic and includes the project site. |
| Roads or transport routes | • The Billy-Diamond highway crosses the unit for about 16 km. Some service roads run west and east from the Billy-Diamond highway.<br>• Two snowmobile trails.<br>• Two long navigable watercourses between Eastmain River, upstream of Weir #5 and the vicinity of the project site, as well as the Miskimatao River, which meets up with the Eastmain River.<br>• A power line crosses the unit for approximately 17 km. |
| Land use elements | • One permanent Cree camp near the Billy-Diamond highway.<br>• Three wildlife areas used for hunting, fishing or trapping and three valued areas. |
| Topography | • The unit is at an elevation ranging from 175 m to 225 m.<br>• Several hills stand out from the plain forming an elongated pattern. Some reach an elevation of 240 m. |
| Hydrography | • Meandering streams drain the plain, which contains several small scattered bodies of water. |
| Vegetation | • The plain vegetation (woodland, scrubland, spruce stands, pine stands, burns and peatland) creates alternating visually open, filtered or closed spaces. Vegetation at the project site and nearby areas has been altered mainly due to successive forest fires. North of the site, however, there is peatland (open, shrubby or forested) and some patches of coniferous trees near the James Bay highway that were not affected by the fires. |
| Spatial organization | • Aside from the Billy-Diamond highway, the spatial organization is dependent on a large, barely perceptible grid. Hills, elevated rocky outcrops, power transmission equipment and the Billy-Diamond highway form visual landmarks. |
| Unit observers (within the unit) | • Users of the permanent Cree camp, hunters, fishermen and trappers (temporary fixed observers).<br>• Transiting users use the Billy-Diamond highway, snowmobile trails and watercourses (moving observers). |
| Visual field | • The unit has highly variable visual fields. Where there are trees, the visual field is limited in depth and opening, and the views are closed. Where there are rocky outcrops, bare soil, open peatland or bodies of water, the visual field is open, as are the views. Where there are burns, the visual field is reduced and the views are filtered. |
| View quality and visual points of view | • The visual quality of the unit is based on its natural appearance.<br>• The depth of the views depends on the height and density of the vegetation, which is highly variable.<br>• The elevated rock outcrops are visible from afar and offer panoramic views. The Billy-Diamond highway offers views towards the unit. |

## PLATEAU LANDSCAPE UNIT

The plateau landscape unit dominates the study area in height and its topography is a little more pronounced than that of the plain. The plateau contains the largest lakes and some hills (Map 6-24 and Photo 6-12). The unit is used for traditional activities and for transit.

### Table 6-69 Plateau landscape unit

| Component | Description |
|---|---|
| Limits and specific land use | • The plateau landscape unit forms the southern part of the study area. Most of the unit is characterized by a natural mosaic. |
| Roads or transport routes | • The Billy-Diamond highway crosses the unit for about 13 km. Some service roads run eastward from the Billy-Diamond highway.<br>• Several snowmobile trails converging on Nistam Siyachistawach Lake.<br>• The Miskimatao River between Eastmain River and Nistam Siyachistawach Lake.<br>• A power line crosses the unit for approximately 20 km. |
| Land use elements | • One permanent Cree camp near Nistam Siyachistawach Lake.<br>• One wildlife area used for hunting, fishing or trapping and one large valued area. |
| Topography | • The unit is at an elevation ranging from 225 m to 250 m.<br>• Several hills stand out from the plateau forming an elongated pattern. Some reach an elevation of 280 m. |
| Hydrography | • The watercourses are rather straight and there are several large lakes. |
| Vegetation | • The vegetation (woodland, scrubland, spruce stands, pine stands, burns and peatland) creates alternating visually open, filtered or closed spaces. |
| Spatial organization | • Aside from the Billy-Diamond highway, the spatial organization is dependent on a large, barely perceptible grid. Hills, elevated rocky outcrops, power transmission equipment and the Billy-Diamond highway form visual landmarks. |
| Unit observers (within the unit) | • Users of the permanent Cree camp, hunters, fishermen and trappers (temporary fixed observers).<br>• Transiting users use the Billy-Diamond highway, snowmobile trails and bodies of water and watercourses (moving observers). |
| Visual field | • The unit has highly variable visual fields. Where there are trees, the visual field is limited in depth and opening, and the views are closed. Where there are rocky outcrops, bare soil, open peatland or bodies of water, the visual field is open, as are the views. Where there are burns, the visual field is reduced and the views are filtered. |
| View quality and visual points of view | • The visual quality of the unit is based on its natural appearance.<br>• The depth of the views depends on the height and density of the vegetation, which is highly variable.<br>• The elevated rock outcrops are visible from afar and offer panoramic views. The Billy-Diamond highway offers views towards the unit. |

**Photo 6-12 Plateau landscape unit, view from an elevated rocky outcrop on the plain towards the plateau**

### POWER LINE LANDSCAPE UNITS

The power line landscape units (LI01 and LI02) are long corridors that cross the landscape in the study area. (Map 6-24 and Photo 6-13). The controlled vegetation and power transmission equipment in these corridors contrast with the surrounding natural landscape. The towers are important visual landmarks of the landscape in the study area.

**Table 6-70 Power line landscape units**

| Component | Description |
|---|---|
| Limits and specific land use | • Landscape units LI01 and LI02 include power transmission equipment and cut across the Billy-Diamond highway in some places. The towers rise well above the treetops. Controlled vegetation under the equipment forms a corridor about 55 m wide.<br>• The LI01 power line landscape unit crosses the study area along a north/south axis for about 20 km. It is usually east of the Billy-Diamond highway. Unit LI02 crosses the study area along an east-west axis for approximately 20 km and runs perpendicular to that of the Billy-Diamond highway. |
| Roads or transport routes | • Each unit is accessible by a secondary road via the Billy-Diamond highway and controlled vegetation allows access to the equipment. |
| Land use elements | • Unit LI02 cuts across one wildlife area and a large valued area.<br>• Unit LI01 cuts across three wildlife areas. |
| Topography | • The units follow the terrain while avoiding the highest hill peaks. |
| Hydrography | • The units straddle many watercourses. |
| Vegetation | • Vegetation is cut regularly and is generally lower than adjacent natural vegetation. |

Table 6-70  Power line landscape units (cont.)

| Component | Description |
|---|---|
| Spatial organization | • The spatial organization of the units is governed by the routes of the power lines.<br>• The part of the power transmission structures that extends beyond the treetops creates landmarks in the landscape. |
| Unit observers (within the unit) | • The main observers are mobile. |
| Visual field | • The visual field is generally deep but limited in opening due to the presence of trees on both sides of the lines. |
| View quality and visual points of view | • The visual quality of the units is based on the plant diversity created by the maintenance of the rights-of-way and the deep views. |

Photo 6-13 Power line landscape unit, view from the Eastmain River valley towards the power transmission equipment

### ROAD LANDSCAPE UNIT

This unit consists of a stretch of the Billy-Diamond highway and its surroundings, including diverse vegetation and a rest area (Map 6-24 and Photo 6-14, 6-15). The Billy-Diamond highway is the backbone from which the James Bay landscape has generally been viewed and experienced since 1970, at least by non-Indigenous people. Its path follows the natural terrain and offers views of the region from certain stretches.

## Table 6-71 Road landscape unit

| Component | Description |
|---|---|
| Limits and specific land use | • The road landscape unit includes a stretch of approximately 31 km of the Billy-Diamond highway and its surroundings (30 m wide on both sides of the road). It crosses the study area from north to southwest following a sometimes winding path. It includes a truck stop at km 381 of the 620 km Billy-Diamond highway. The truck stop is an important geographical landmark for travellers and its buildings are the largest in the study area. There are also abandoned borrow pits whose tracks fade with natural revegetation. |
| Roads or transport routes | • Some service roads are attached to the Billy-Diamond highway and lead to different activity areas. |
| Land use elements | • The road is near the permanent Cree camps in the study area. It cuts across most of the wildlife areas and crosses a large valued area. |
| Topography | • The road follows the topography of its receiving environment while being elevated by at least 1 m because of its sizeable infrastructure. |
| Hydrography | • The road drains into ditches. |
| Vegetation | • The roadside is typically vegetated. Vegetation cover has colonized the road shoulders, which consist of a fine granular material. Vegetation in the surrounding area and on the shoulders is highly varied, like that of the entire study area. However, it often has more trees than the surrounding natural environment. |
| Spatial organization | • The spatial organization of the unit is governed by the fairly winding path of the road.<br>• Where present, woody vegetation forms a visual screen.<br>• The visual landmarks of the road are located in adjacent landscape units (elevated rock outcrops, hills, towers). |
| Unit observers (within the unit) | • The main observers of the unit are mobile and are the users of the Billy-Diamond highway. |
| Visual field | • The visual field is more or less deep in the centre of the road, depending on how winding it is, and its opening is limited or filtered by vegetation. |
| View quality and visual points of view | • The visual quality of the road is based on its natural appearance and deep views. The deepest views are from the high points of the road and where there is no woody vegetation.<br>• The diversity of the visual framing of the Billy-Diamond highway helps heighten perception of the landscape. |

**Photo 6-14 Road landscape unit**

**Photo 6-15 Road landscape unit**

## 6.4.9 HERITAGE AND ARCHAEOLOGY

### 6.4.9.1 NATURAL HERITAGE

With the adoption of Bill 46 and its sanction in March 2021, the *National Heritage Conservation Act* (NHCA) was amended to address three goals (MELCC, 2021a):

- accelerate the process of creating protected areas;
- broaden the range of natural environment protection tools;
- more broadly involve the citizens and Indigenous in the creation and management of protected areas.

The planned areas will receive permanent protected status, abolishing the provisional protected status step. The amendment of the NHCA also introduces a new mechanism for areas north of the 49$^{th}$ parallel by assigning them a new designation as northern conservation areas, along with a public participation process and public register specifically for northern areas.

With regard to potential protected area projects, the following stakeholders were consulted: the Eastmain Band Council, the Protected Land Use and Planning Committee and the Commissioner of the Nation of Eastmain (Raymond Shanouch), the Director of the Eastmain Environmental Department and the Société du Plan Nord (SPN). The MELCC protected areas map (2021b) was also consulted. It was concluded that there are no protected areas in the study area.

### 6.4.9.2 ARCHAEOLOGY

Indigenous traditional knowledge has been collected for consideration through consultations with Cree land users and elders since 2012. The information was collected to better understand their means of travel and land resource development strategies. The accounts provided by the inhabitants teach us and provide information on trails they have taken, camps they have used and experiences they have lived or have been told. Traditional Indigenous knowledge is critical to understanding the past and present human landscape. By combining the experiences of Cree inhabitants with the experience of archaeologists equipped with related knowledge useful to understand past events, it is clear that the findings will be more in line with what the past human occupation at this location could have been.

Moreover, in meetings with land users, their family members, and elders, interview matrices were used to direct these discussions, including questions about the location of places of birth, burial sides, artifacts or former camps that could have been seen in the past, which led to discussions about past use of the land around km 381.

The data collected helped to assess the territory's archaeological potential. Spaces and sectors known for their fur-bearing animal trapping, wetlands with peatlands suitable for hunting, and geomorphological and drainage characteristics were all considered in order to identify archaeological areas. Traditional Indigenous knowledge was also considered and respected. The knowledge acquired by studying the descriptions and accounts of Cree users was also considered.

In the Arkéos study (2018), the process of determining areas with archaeological potential also involved considering locations with spaces that could accommodate human occupation, i.e. a spaces that stood out from the ubiquitous wetlands in the study area. In such an environment, strategically well-placed locations for utilizing resources or establishing camps (bivouac to base camp) are generally located on well-drained elevated areas. These two characteristics remain key in selecting potential archaeological areas for the study area in question.

**The natural and archaeological heritage baseline is detailed in the archaeological potential study by Arkéos (2018), as it identifies the locations where human occupation would have been possible at different times since the retreat of the Laurentide Ice Sheet.**

**In short,** the **study conducted** for the James Bay Lithium Mine project, **helped to** evaluate the archaeological potential in the distinct study area, shown on Map 6-22 (Arkéos, 2018). The following text outlines this study.

The findings of the study were as follows:

- Hydrographic and topographic features may have made Indigenous groups interested in using the study area. The study area straddles two secondary watersheds that flow more or less parallel to the Eastmain River in opposite directions. These watersheds would have been good alternatives to bypass a section of the Eastmain River that has rapids. Otherwise, populations may have been likely to occupy the area in order to use resources found there, particularly the wetland wildlife.
- An archaeological survey was conducted for the 450-kV power line that runs through the study area. Two nearby areas were visited, the crossings of the Eastmain River and the Pontax River. This survey did not uncover any archaeological sites.
- However, ancient human presence in the study area is evidenced by both the toponymy and the existence of at least one archaeological site (FbGg-1) east of the hill where the pit will be built (about 400 m). **This site is near the km 381 truck stop.**

  In total, 27 areas with prehistoric archaeological potential have been targeted within the study area. These sites are those that are most likely to contain remains attesting to a human presence from prehistoric time up to the twentieth century. These areas of archaeological potential are shown on Map 6-22. **They also include potential in connection with camp sites and remains.**

**After a public presentation in Eastmain in July 2018, participants were informed that a characterization study would be done on areas of archaeological potential that were likely to be affected by the project, but the participants did not respond with any specific comments.**

**Field validation and demarcation of areas of archaeological potential found within the projected project footprint are planned for summer 2021. This work will confirm the archaeological potential of the target sites, and, if needed, recommend additional mitigation measures.**

**The RE2 trapline tallyman, or his representative, will accompany the team of archaeologists during the field validation.**

**Lastly, the archaeological strategy implemented will consider how to manage discoveries and collections.**

**MANAGEMENT OF DISCOVERIES**

**The importance of the discoveries will be assessed by archaeological consultants based on the value of the movable and immovable remains from a local, regional and national perspective. The protection of heritage discovered will always be a priority. In that respect, the project shall be modified, to the extent possible, to avoid disruption to the archaeological sites discovered. If the project cannot be modified and a discovery is threatened, the plan is to conduct an archaeological excavation and implement necessary measures for subsequent analysis of the data collected and dissemination of the findings. If the cultural material found is of interest, the collection may be presented to the Cree nation through an exhibit. The discoveries will therefore be showcased through scientific publications ("archaeological" review) and a travelling museum exhibit for the Cree nation.**

**COLLECTION**

**The archaeological collection shall be cleaned and inventoried by the consultant, if need be. If objects require a specific conservation treatment, a request for assistance to the *Centre de conservation du Québec* will be made. The collection may later be given to the Aanischaaukamikw Cree Cultural Institute, in Oujé-Bougoumou, after agreement with the Ministère de la Culture et des Communications.**

**Before the archaeological survey takes place in summer 2021, archaeology experts from the Cree Nation Government and the RE2 trapline tallyman will validate the selected areas of archaeological potential. If needed, areas of archaeological potential may be adjusted based on their feedback.**