PROJECT NO.: 191-01753-00

JAMES BAY LITHIUM MINE

MELCC'S QUESTIONS AND COMMENTS RECEIVED AS PART OF THE ENVIRONMENTAL IMPACT STUDY REVIEW

JULY 2019

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GALAXY LITHIUM (CANADA) INC.

PROJECT NO.: 191-01753-00
DATE: JULY 2019

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FOREWORD

As part of the review of the Environmental Impact Assessment (EIA) for the James Bay Lithium Mine project the *Ministère de l'Environnement et de la Lutte contre les Changements climatiques* (MELCC) submitted a request for additional information on April 18, 2019 (Appendix A-1).

This document is the second addendum to the EIA of this project, in response to the MELCC's Request for Information, the first addendum being the one submitted to the CEAA as part of the concordance phase. The MELCC's questions and comments are presented in a box and in bold type to easily distinguish them in the text from the answers provided. A code and a number are associated with each of the questions or comments (QC - 1, QC - 2, etc.) and with each of the answers provided (A - 1, A - 2, etc.) in order to facilitate any follow-up. Finally, the appendices supporting the answers to each of the questions or comments are also numbered according to the code and number to which they refer (A-4, A-6, etc.).

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1 PROJECT CONTEXT AND RATIONALE

1.1 PROJECT RATIONALE (SECTION 2.3)

QC - 1.	**Page 2-6 mentions that one advantage of the project from an environmental and socioeconomic standpoint is the onsite primary processing of the concentrate. The concentrate production activities described in the study are mostly associated with ore treatment activities, as specified in section 109 of the Mining Act. Going forward, the Project Proponent shall refer to ore treatment not ore processing activities.**

A - 1: The term "primary processing of the concentrate" will thereafter be replaced by "processing of ore" since the definition specified in section 109 of the Regulation Respecting Mineral Substances Other than Petroleum, Natural Gas and Brine Mining Act includes the activities this study refers to.

QC - 2.	**The impact study presents little information on the possibilities for transformation of the spodumene concentrate on the Eeyou Istchee James Bay territory, which would notably allow the optimization of the project's socioeconomic benefits in the area. The Project Proponent shall reveal how opportunities for spodumene concentrate transformation across the territory and elsewhere in Quebec were assessed.**

A - 2: The processing of ore is a complex area which is still being explored. The economic opportunity study will be conducted when applying for the mining lease. The supply chain up to the battery or vehicle manufacturers must be considered when deciding where the secondary processing of the lithium should occur. Each manufacturer uses different lithium products (hydroxide, carbonate) of various levels of impurity. Industrial secrets are also at stake when it comes to secondary processing.

The following elements, among others, must be considered when deciding on the appropriate location for the feasibility of the secondary processing of lithium: power and chemical supply, skilled labor and safety. The processing of spodumene into lithium requires a great amount of power, hazardous chemicals and skilled workforce. The processing method is a hybrid of pyrometallurgy and hydrometallurgy.

The development of a lithium processing plant on the Eeyou Istchee James Bay territory is subject to significant constraints leading to a substantial increase in construction and operating costs, as well as environmental risks.

The process requires a significant and regular power supply, including a portion from natural gas (more than 1M GJ/year). The transport of natural gas via pipeline is not possible on the Eeyou Istchee James Bay territory. Liquified natural gas (LNG) is available, but for two to three times the cost and requires storage tanks. The processing of spodumene into lithium also demands large quantities of sulphuric acid, sodium hydroxide (caustic soda) and calcium oxide (quicklime) which will need to be transported to and stored on the Eeyou Istchee James Bay territory. In addition to the increase in operating costs, the transport activities would significantly increase traffic, GHG emissions, and environmental and safety risks.

Also, the process requires skilled workforce which cannot be found across the Eeyou Istchee James Bay territory. The workforce shall originate from regions showcasing experience with chemical processes, which will also result in a significant increase in costs.

Considering the facts mentioned above, the construction and operating costs of a chemical processing plant on the Eeyou Istchee James Bay territory shall increase for various aspects and thus significantly reduce the potential for profitability. Also, there would be no benefits for the local communities (accessible jobs and contracts being very limited) and irritants such as traffic, risks of accidents, fly-in fly-out (FIFO) workers, visible chimneys, etc. would be aggravated.

Contrary to mine projects that must be located at the site of the deposit, the secondary processing of metal products is a worldwide competition. The construction of a lithium processing plant on the Eeyou Istchee James Bay territory has no chance of being competitive in the global industry. Moreover, it will increase environmental and safety risks and GHG emissions given the additional transport.

QC - 3. The James Bay project was suspended in 2012, a year after submission of the preliminary information. According to the Project Proponent, the price of lithium had fallen on the market, compromising the viability of the project. A few years later, the significant increase in the demand for lithium and promising forecasts for this market made it possible for Galaxy to relaunch its project. The Project Proponent claims that the demand for lithium is consistently growing, thus ensuring the profitability and optimization of the project. However, some forecasts published over the last few months show a downward trend in prices for lithium. We are aware of the complex character of markets, but ask that the Project Proponent provide updated information on the economic rationale behind the project to better understand the initial justification for the project and support its claims.

A - 3: The current and future projected market for lithium chemicals is vastly different compared to the market of 2012. Despite the retraction in lithium chemical (lithium carbonate and lithium hydroxide) prices seen throughout 2018, the current price of lithium chemicals in China is still close to double the respective prices of 2012. This multiple is even greater in other end user markets for lithium, including Japan, Korea, USA and Europe.

The key driver of the rise in lithium chemicals seen throughout the period of 2015 – 2018 was due to an undersupply of lithium chemicals and a market expectation of a growing undersupply in the future. This is underpinned by a consensus expectation that demand for lithium chemicals is expected to grow at a compound annual growth rate ("CAGR") of 15-20% throughout the period through to 2025. Total demand for lithium chemicals in 2018 was approximately 270,000 tonnes of lithium carbonate equivalent ("LCE"), representing 35% growth in the 2 years since 2016. Market expectations of demand for lithium chemicals in 2025 ranges from approximately 700,000 – 1,000,000 tonnes LCE, highlighting the expected exponential growth curve for lithium consumption.

Expectations of consumption growth are underpinned by expected growth in demand for lithium-ion battery applications, led by the electric vehicle and energy storage sectors, and supported by traditional applications such as lithium-ion batteries for consumer electronics and the glass and ceramics industries. As evidence of this growth in demand, China reported New Energy Vehicle ("NEV") production of 1.27 million vehicles in 2018, representing growth of over 60% year-on-year. Significant growth rates were also experienced in end markets outside of China with the USA and Europe reporting growth in plug in vehicle deliveries of 81% and 26% respectively. China NEV sales are projected to reach 1.8 million and 2.6 million vehicles in 2019 and 2020, respectively, and the country is targeting production of 7 million vehicles per annum by 2025 (20% market share). At these levels it is expected that China would represent approximately 40-50% of the total global production of electric vehicles. Further demand upside is forecast to be derived from the emergence of battery energy storage to support market penetration of renewable energy. Given the fact that lithium-ion is already a commercial technology, lithium-ion batteries are expected to absorb a substantial market share in this sector.

Currently, as we stand in 2019 the market for lithium chemicals is relatively balanced, hence the retraction in prices experienced in 2018 following a period of undersupply. However, the expectation of consumption growth as described above will require a significant increase in the supply of lithium chemicals in order to service demand. In light of this, the current lithium industry is underinvested in order to bring on the additional supply required to keep markets balanced. Combined with a number of additional supply side challenges, including the lack of shovel-ready projects today, lead times associated with project construction and traditional ramp-up challenges it is expected that the market will revert to a supply deficit in the next 12-24 months providing strong tailwinds to an increase in lithium prices.

The James Bay project (subject to final feasibility) is expected to be commissioned within the next 2 – 5 years, right in the midst of the enormous growth in lithium markets. Further, it is expected to have an all in sustaining cost (including operating costs, royalties, depreciation of capital expenditure, etc.) that falls within the bottom half of the cost curve. Combined with the market's expectation of lithium chemical pricing these factors justify the economic case for the project.

2 PROJECT ALTERNATIVES

2.1 WASTE ROCK, TAILINGS AND OVERBURDEN STOCKPILES (SECTION 3.1)

QC - 4.	**On page 3-2, it is mentioned that the quantity considered for the assessment of waste rock disposal methods is 233.4 Mt of waste rocks. However, Table 1 of the geochemical study establishes a total quantity of 11.6 Mt of waste rocks for the four lithologies assessed. The Project Proponent shall explain this difference.**

A - 4: The difference can be explained by the data available used for writing of the reports. The 233.4 Mt of waste rocks refers to the storage capacity used for design of the waste rock stockpile. The mine plan, completed in May 2018, indicates a total of 133.3 Mt of waste rocks (including 5.9 Mt of overburden) that would be placed at the waste rock stockpile.

QC - 5.	**On page 3-2, the Project Proponent states that "since the data concerning the density for these materials [waste rock and tailings] were not available at the time of the study, assumptions were made, namely, 2.4 t/m^3 for waste rock and 1.7 t/m^3 for tailings, giving them volumes of 100 Mm^3 and 20 Mm^3 respectively." A small difference in the actual density of materials when compared to the estimated density can have a significant impact on the waste rock/tailings volume to be stored, and therefore the stockpile volumes. The Project Proponent shall justify the assumptions used and indicate which factor of safety was applied.**

A - 5: Here are the values used for the design of stockpiles:

WASTE ROCKS

- In situ rock density= 2.77 t/m^3
- Particle size= 0-700 mm
- Void ratio= 35%
- Apparent density= 2.05 t/m^3

TAILINGS

- In situ rock density= 2,77 t/m^3
- Particle size= 0-15 mm
- Void ratio= 65%
- Apparent density= 1.68 t/m^3

QC - 6.	**On page 3-2, it is stated that "considering the lack of information available on the economic viability of extracting the resources that will be left in the deposit once the operation phase is completed, the deposit-in-the-pit option was also not assessed." The deposit-in-the-pit option towards the end of the life of mine should not be dismissed from the outset. The Project Proponent shall assess this option and justify its choice.**

A - 6: Indeed, the option to use one or several depleted pits to store tailings should be considered. Once mine work will have started and reached a certain depth, it will be possible to perform drilling as to validate the presence or absence of economic ore in depth. The development of the tailings site will be carried out in stages. The construction is planned to start in the *east* sector. After a few years of operation, if drilling work shows that the pits can be dewatered, the subsequent stages of the stockpile construction will be replaced by the stockpiling in one or several pits. For now, the stockpile to be constructed can receive all waste rocks produced during the projected years of operation. The design drawings are produced for the whole infrastructure, but drawings for construction will only be developed for the first stages.

QC - 7.	**For the comparative analysis of the waste rock and tailings stockpile options, it is mentioned that the optimization of the design of the stockpile at the engineering stage has made up for the shortfall in volume of Option 2. The Project Proponent shall specify the optimization conducted to allow storage of 120 Mm^3 of tailings at this stockpile (its initial capacity was estimated at 77.5 Mm^3).**

A - 7: To increase its capacity, the surface area of the waste rock stockpile was increased. The west section of the basin was removed and the stockpile was extended to the north boundary of the property, which allowed for the equalization of the stockpile elevation to 300 m.

2.2 POWER SUPPLY AT THE MINE SITE (SECTION 3.4)

QC - 8.	**To optimize management of the preliminary design studies and permit applications, the option to connect part of Hydro-Québec's grid to the 69 kV line was prioritized. However, the Project Proponent states that Hydro-Québec will only be able to supply a maximum of 7.6 MW with this option. The project requires 8.3 MW for power supply of all infrastructure. To make up the difference, the Project Proponent opted for another source of energy, propane, which will be used for heating of buildings of the administrative and industrial area. According to data presented in the EIA, propane is the largest source of greenhouse gas (GHG) emissions from stationary combustion. Since connection to the grid may generate significant fuel savings, considerable reductions in GHG emissions, and incidentally reductions in costs associated with carbon, the Project Proponent shall assess the option related to a complete electrification in the medium term instead of using propane or other fossil energies.**

A - 8: After verification and discussions with Hydro-Québec, it was confirmed that they can increase the available power to 7.8 MW instead of 7.6 MW as discussed in 2018. Our engineers are still working on reducing the project's energy demand. To date, no significant change which would allow a decrease in demand was noted. Galaxy will remain on the lookout for any reduction opportunity for the various project phases.

Galaxy would prefer not using propane. If it can be replaced by hydropower, it will be done. For the needs of the feasibility study, Galaxy has to make sure all power requirements are met.

QC - 9.	**In Section 4.15.3, the Project Proponent states that the installation of conveyors for the transport of extracted rock to the concentrator and waste rock stockpile is considered. According to the Project Proponent, this option, whose advantage is a reduction in GHG and dust emissions, is currently limited by the power supply for the project. The Project Proponent shall confirm its intention regarding these conveyors if the optimization of the power supply and use occurs.**

A - 9: Despite the fact that this opportunity was identified in 2018, studies were not completed given the lack of electricity available. Galaxy commits to conducting a feasibility study on the subject should Hydro-Québec be able to provide the additional power.

QC - 10. The Project Proponent mentions that "the possibility of powering a few mobile generators with solar panels with batteries will be evaluated." The Project Proponent shall present this evaluation.

A - 10: At the moment, there is very little solar irradiance across the project area, i.e. barely 4 kWh/m^2 according to Natural Resources Canada's databases. Using a conversion efficiency of 35% of solar power to DC power (for polycrystalline PV panels), and then a conversion of 90% of DC power to AC power, the system's total efficiency would be 31.5% vs 35%, and above, for a generator. Also, the investment cost is much higher for a solar system, i.e. almost CAD 2.5 per W vs CAD 1 per W for generators. This does not include costs associated with energy storage.

Generators are used as reserve installed capacity and not as functioning capacity. The project's power supply comes from a power grid (99% from hydropower). This system is much more stable, barely influenced by precipitation and causes very few fluctuations.

There are currently very few, if any, solar facilities within northern Indigenous communities, precisely because of the economic feasibility of this type of project in northern regions.

However, wind power is well established. We plan on setting up a station to collect the necessary data in order to assess the wind potential for backup energies in the beginning of the operation phase.

QC - 11. The Quebec government is actively working to diversify and improve the power supply across the province. The objective is to provide a better access to natural gas and liquified natural gas (LNG) in unserviced areas of the Côte-Nord and Nord-du-Québec. Since the start of work at the James Bay Lithium Mine project is planned for 2020, with its commissioning in 2022, the natural gas and LNG supply options should not be dismissed from the outset. In the absence of power supply and greener technologies in the context of the project, these fuels, as well as biodiesel or hydrogen, may satisfy part of the site's energy requirements and offer a reduction in GHG emissions when compared to conventional diesel. The Project Proponent shall further study these sources of energy and report on the process.

A - 11: In 2018, Galaxy contacted Energir (natural gas and liquified natural gas [LNG] distributor in Quebec) to discuss the use of LNG to power haulage trucks (Appendix A-11). According to information provided by Energir, to obtain the same energy supply in MBTU, the proportion of diesel must remain at 65% since there is still no existing application of LNG for powering of trucks of that size and also to maintain an efficiency equivalent to that of the diesel. Sure enough, the LNG portion, or LNG-R (biomethane), leads to a reduction in greenhouse gas (GHG) emissions, NO_x and noise. Using 35% of LNG and 35% of LNG-R leads to a reduction in GHG emissions of 10% and 35%, respectively. The cost of fuel for the diesel-LNG-R mix is comparable to the cost of diesel, but 27% below for the diesel-LNG mix. The first issue is that this scenario does not eliminate diesel nor its transportation to the James Bay region and its storage. The second issue is the transportation and storage of LNG and LNG-R on the James Bay territory. Energir introduced two options: Option 1 is the transportation by road only: from the Montréal transfer centre to a station to be constructed in Matagami, meaning an itinerary of 1,460 km round trip, for a delivery once every three days. From Matagami to the Galaxy site, the ore transport trucks would be equipped with natural gas engines with an endurance of about 1,000 km, therefore able to make the Matagami-Galaxy round trip (765 km). The scenario where ore transport and haulage trucks are both powered by LNG would require two deliveries every three days from Montréal to Matagami, the construction of a station in Matagami and the construction of a station at the Galaxy site.

The GHG emissions associated with the transportation of LNG to Matagami are not considered in Énergir's presentation. The deliveries made once every three days represent some 170,000 km to 340,000 km per year, depending on the options. One LNG shipment represents 30,000 m^3 of LNG or LNG-R, while a diesel tanker truck can transport up to 55,000 L, which means fewer journeys.

Thus, considering the full cycle, including the transportation of LNG (and losses during transportation and storage), the anticipated reduction in GHG emissions is minimal. These solutions will drive capital costs of the project up, without having a significant positive impact on the environment. Additional technological and health and safety risks (accidents) must also be considered. Based on this evaluation, LNG-fuelled trucks are not as beneficial a choice as it might seem at first sight.

QC - 12.	**The Project Proponent refers to a preliminary study conducted by a specialized firm (Tugliq) to evaluate the opportunity of developing solar or wind farms. The Project Proponent shall provide the aforementioned study and further justify why solar and wind power sources were not selected for the project.**

A - 12: Minutes of meeting prepared by Tugliq Energy Co. are presented in Appendix QC-12. These minutes provide the key justification that led to the selection of Hydro-Québec's power.

2.3 POWER SUPPLY FOR MOBILE EQUIPMENT (SECTION 3.5)

QC - 13.	**Section 3.5 addresses the electric options for mobile equipment. However, it was concluded that the electrification of mobile equipment was not a feasible measure for the reduction of GHG emissions in the context of the James Bay Lithium Mine project given its inherent characteristics. According to the Project Proponent, the current market offers a limited choice of electric mining equipment for an open-pit mine like Galaxy's. Also, the current high cost of electric equipment would be difficult to absorb over the project life cycle. The Project Proponent shall justify the cost of diesel used for comparison, i.e. 0.940 $/l. Moreover, the use of electric equipment is usually associated with lower maintenance costs than for diesel equipment[1], notably thanks to the great reliability of electric motors and the smaller number of mobile parts. The Project Proponent shall justify why, for instance, the maintenance cost for the PC 3000 electric excavator is significantly higher than its diesel equivalent. These two factors have an impact on the comparison between the two types of excavators. The Project Proponent shall also indicate if other vehicle models or equipment parts that are not currently available on the market but which may become available at the time of the mine commissioning in 2022 were considered in the comparative analysis. There are hybrid technologies applicable to equipment used within the Quebec mining sector allowing a reduction in fuel consumption. The Project Proponent shall assess the use of hybrid technologies from both a technical and economic standpoint and present the impact on the reduction of GHG emissions. For information purposes, the purchase and installation of these auxiliary systems can even be funded via the Programme Écocamionnage[2]. It should be noted that there are many provincial programs meant to contribute to the funding of initiatives for the reduction of GHG emissions or to favour the adaptation of the Quebec society to the impacts of climate change. All programs resulting from the 2013-2020 Climate Change Action Plan managed by the various government departments and bodies are presented, by sector or client, on the MELCC's website: http://www.environnement.gouv.qc.ca/cgfv/programmes.htm.**

A - 13: A comparative analysis was conducted in 2018 by Mining Plus regarding the use of LNG-fuelled haulage trucks. The cost of diesel was set to 0.94 $/L at the time, but would be more around 1,00 $/L these days according to the various tenders provided by local contractors. It should be noted that Galaxy will use dyed diesel on the mine site since it is less expensive (exempt from certain taxes). The difference in the cost of diesel does not drastically change the outcome.

1 https://gmggroup.org/wp-content/uploads/2018/11/20180621_UG_Mining_BEV_GMG-WG-v02-r01.pdf
2 List of eligible technologies available online (French only): https://www.transports.gouv.qc.ca/fr/aide-finan/entreprises-camionnage/aide-ecocamionnage/Documents/liste-technologies-admissibles-francais.pdf

It is true that the maintenance fees for electrical equipment are lower than for diesel equipment. The term "maintenance cost" used in Table 3-8 of the EIA does not refer to the maintenance cost, but rather to the costs associated with the replacement of equipment. Besides, the paragraph above the table mentions that the costs considered only include the initial outlay and energy consumption. This type of equipment has an average useful life of 10 years; it is therefore highly probable that it will need to be replaced considering the mine life cycle (15 years).

Mining Plus's engineering briefs (Appendix A-13) show the researches conducted on LNG equipment and electric equipment. All-electric or hybrid equipment will only be available for trucks of 200 t and more and for shovels of more than 20 m^3. According to the shape and dimensions of the Galaxy deposit, mining will be optimum with 65 t trucks, although trucks up to 100 t could work. Shovels of 10 m^3 are recommended.

Pilot tests were conducted by Tech Resources in Western Canada on equipment of similar dimensions, with a LNG-diesel mix which is necessary to ensure the energy supply (see information provided by Energir in answer QC-11). Test results remained confidential, but it would seem that the reduction in GHG emissions was not significant. Also, the behaviour of equipment in northern conditions is uncertain.

Power and LNG conversion kits exist and cost approximately one million dollars for each piece of equipment. However, equipment manufacturers void the warranty once modifications are made. The cost and loss of equipment warranty greatly reduce the benefits of operating the modified equipment. Some mine projects put forward a modified truck in their feasibility study. The truck is twice as small as the size recommended for Galaxy. We will closely monitor the performance of these trucks in the James Bay climate.

Also, the power provided by Hydro-Québec does not even satisfy the demand of fixed equipment. Loading of electricity-powered trucks is unthinkable without the adequate hydropower supply.

The Écocammionage Program by the Green Fund is set to end in 2020. It will be difficult for Galaxy to be granted a subsidy without operating permits. However, Galaxy will surely search for available aid programmes and for the most diesel-efficient equipment available when the time comes for purchase.

QC - 14. Other mine projects employ special expertise to reduce their GHG emissions, for instance, by adapting fossil-fuel vehicles to electric energy or by redefining the mine operating model in accordance with available vehicles and equipment of lesser GHG emission impact. The Project Proponent shall describe the efforts made in that sense as part of the James Bay Lithium Mine project.

A - 14: Galaxy is always on the lookout for technological advancement in energy with the objective of limiting its dependence on fossil fuels, thus reducing its GHG emissions. As a producer and developer of lithium products used for the development of electric vehicle batteries, Galaxy is at the forefront of the field. It will be in Galaxy's best interest to implement these new technologies when they become available as it is an inherent part of the company's values.

However, for preliminary design studies to be recognized by the financial markets, they must be based on known and verified technologies. Also, the fact that Hydro-Québec's power supply to Galaxy is limited will probably hinder the adoption of new technologies on the short and medium terms.

3 PROJECT DESCRIPTION

3.1 INDUSTRIAL AND ADMINISTRATIVE AREA GENERAL ARRANGEMENT (SECTION 4.3)

QC - 15. According to the BH-36 geotechnical borehole drilled in the sedimentation pond area of the industrial and administrative sector, the bedrock is located about 5 m deep and covered by peat and sand. The pond in the industrial and administrative area shall be waterproofed to prevent infiltration of contaminated water into the ground. The Project Proponent shall describe the waterproofing measures that will be implemented.

A - 15: The bottom of the sedimentation pond of the industrial and administrative sector will be lined with an HDPE geomembrane to prevent infiltration of contact water into the ground. The geomembrane will be covered with a protective layer of sand and crushed stone. A typical geomembrane product would be Texel TM480.

QC - 16. On page 4-12, the Project Proponent indicates that the site will be converted into a storage yard when construction is completed. However, it is said on page 4-5 that the site will be converted into a dry storage area. The Project Proponent shall further specify the storage method for residual materials at this site as well as the storage duration and capacity.

A - 16: The concrete batch plant site that will be converted into a storage yard will mainly be used for equipment parts or dry products. The storage of residual materials at this site is not projected.

3.2 PREPARATORY WORK (SECTION 4.4)

QUARRY AND BORROW PITS (SECTION 4.4.3)

QC - 17. A quarry for the construction phase will be located in part within the pit footprint. Characterization of waste rocks of this quarry showed that said rocks presented potential for generation of acid. The Project Proponent shall indicate if kinetic tests were conducted on materials from this quarry. Otherwise, the Project Proponent shall indicate how he plans on making sure the quarry material is inert, or at least non-potentially acid generating (PAG) on the short and medium terms, before use for construction purposes.

A - 17: Acid generation testing is being conducted on samples composed solely of diabase which is the material targeted in the quarry. Results will be transmitted to the MELCC once available.

QC - 18. The Project Proponent shall provide details on rehabilitation measures for quarries and sandpits, and if applicable, sections of decommissioned roads. These measures shall be developed with the participation of the tallyman.

A - 18: A public presentation was held in the form of an open house in July 2018 to present the main results of the EIA and mitigation measures to the Eastmain Cree community. The trapline tallyman actively participated to all consultation activities. Galaxy is continuously exchanging with the tallyman.

The community requested information on the mitigation and restoration measures, but no negative comments were made. All measures may still be commented by the Eastmain community after consultation of the EIA which was submitted to the Band Council in the fall of 2018. Galaxy remains open to improving its list of measures in order to integrate comments by the Cree community throughout the project life cycle.

Sandpits and quarries are subjected to specific restoration plans for their applications for authorization. For this project, the only quarry envisaged at the moment is part of the mine project and its restoration will be combined to the restoration of the pits. Sandpits are usually under non-exclusive licences and their method of restoration is part of the operating permit. Each sandpit, or portion of sandpit, used will be closed in accordance with requirements of the permits issued. Surface right holders, notably trapline tallymen, are involved in application for sandpit permits.

For roads, the preliminary restoration plan foresees that their future will be subject to consultations with local communities, including the tallyman.

EARTHWORKS (SECTION 4.4.5)

QC - 19. The Project Proponent shall map surfaces across the project site that will need to be deforested.

A - 19: Map QC-19 superimposes the project footprint with the current vegetation. The vegetation located in the project footprint are the areas that must be deforested.

3.3 GEOCHEMICAL CHARACTERIZATION (SECTION 4.7)

QC - 20. The Project Proponent states that kinetic column tests were initiated in May 2018. These tests are conducted on materials similar to waste rocks/tailings that will be stored on the site and are based on the two recommended management methods (codisposition and codeposition). The Project Proponent shall present all kinetic test results.

A - 20: See report in Appendix A-20 which includes results of the kinetic tests conducted in 2018-2019.

QC - 21. It should be mentioned that tailings that do not meet characteristics in Table 1 (Appendix II of Directive 019 for high risk tailings) are not automatically considered as "low risk" materials. A "low risk" tailing is a tailing with metal concentrations that do not exceed the local background concentrations and does not leach. The kinetic tests indicate that the waste rocks are leachable and sometimes acid generating. The Project Proponent shall wait for the kinetic test results before ruling on the waste rock characteristics. Implications on the project design may be significant depending on the results (PAG or non-PAG, leachable or not), notably on the design return flood, stockpile sealing, dike design, possible uses for waste rocks and site restoration. In light of results obtained, the Project Proponent shall describe the required changes to the project design, if applicable.

A - 21: The report in Appendix A-20 includes results of kinetic tests conducted on waste rocks in 2018-2019.

Results of these tests show that waste rocks, tailings and the codisposition mix are non-PAG.

Results also show that materials stop leaching after maximum 14 weeks of testing, except for copper in the case of a waste rock and unsaturated tailings mix, with ad hoc leaching stopping after 28 weeks of testing.

Hence, waste rocks and tailings are deemed non-leaching at the end of the useful life of the tailings/waste rocks, and therefore considered of "low risk".

QC - 22. The EIA states that the tailings are considered as "low risk" materials. As previously specified, this statement is inexact since the static tests showed that the tailings are leachable, even under the CTEU-9 test. Unless proven otherwise by kinetic tests, the tailings stockpile shall comply with Level A sealing measures as required by Directive 019.

A - 22: First, it should be noted that the only static leaching test considered by D019 to determine the leaching character of tailings is the TCLP test (EPA 1311). Thus, only exceedances resulting from this test are considered as a decisive factor for ruling on the leaching or non-leaching character of tailings. Potential exceedances of the RES criteria during the CTEU-9 test cannot be used to determine if tailings are leachable. It is also not relevant to mention that exceedances of the RES criteria were obtained "even" for the CTEU-9 test since exceedances obtained for this test are not a measure of the severity of leaching. CTEU-9 test is simply conducted on very finely crushed material with a rinsing liquid of different pH.

The particle size of the material and pH of the rinsing liquid mean that not necessarily the same metals are leachable for CTEU-9 than for TCLP and SPLP tests.

According to the kinetic column test results presented in Appendix 20, tailings are non-acid generating and stop leaching after maximum 14 weeks of testing, except for copper in the case of a waste rock and unsaturated tailings mix, with ad hoc release stopping after 28 weeks of testing. Hence, waste rocks and tailings are deemed non-leaching at the end of the useful life of the tailings stockpile, and therefore considered of "low risk".

QC - 23. The EIA reports that 96% of ore samples are considered as "low risk" materials. As mentioned before, this statement is inexact since static tests have revealed that they could leach and are partly PAG. Therefore, water from the waste rock stockpile shall be collected and managed in accordance with Directive 019.

A - 23: There has been a mistake; it should have been written that, in light of static leaching test results, the ore is not considered as "high risk" material, but cannot be considered as "low risk" either.

It is important to remember that according to results obtained during the initial characterization (static tests), 83% of ore samples are leachable for manganese, 50% for zinc and 46% for copper, while between 13% and 42% of samples are leachable for arsenic and/or barium and/or cadmium and/or nickel and/or lead.

Also, 79% of ore samples are considered as potentially acid-generating (PAG), while 21% are considered as non-potentially acid-generating (non-PAG) according to requirements of D019. However, by analyzing the difference between the gross neutralization potential (GNP) and the maximum potential acidity (MAP), as well as the GNP/MAP ratio for URSTM and MEND criteria, it can be confirmed that 64% of samples are non-PAG, while 36% of samples are uncertain and none are considered PAG.

In light of these results, the ore will be stored on a watertight surface, with watertight runoff water collection ditches. Drainage water from the ore stockpile will also be managed in accordance with D019.

QC - 24. According to the information provided, the ore displays geochemical characteristics which could lead to the potential generation of acid. However, no kinetic column test on the ore is planned. The Project Proponent shall indicate how, in the absence of kinetic tests, he plans on ruling on the acid mine drainage (AMD) potential, determining the time period before generation of AMD, and identifying the measures required to prevent contamination of surface water and groundwater.

A - 24: As mentioned in the answer to QC-23, the ore is considered leachable and potentially acid-generating in a proportion of up to 21% of samples according to requirements of D019.

Kinetic tests on ore are currently under way. If classified as high risk, the ore will be stored on a watertight surface with watertight runoff water collection ditches. Drainage water from the ore stockpile will be managed in accordance with D019. However, if the ore is classified as low risk, the storage area will not be made watertight.

In any case, drainage water will be forwarded towards process water (Appendix A-24).

QC - 25. Analysis results from leaching tests of the two soil horizons (sand and clay) show that some elements exceed the "A" generic criteria of the *Guide d'intervention – Protection des sols et réhabilitation des terrains contaminées* (hereinafter "Guide d'intervention") (MELCC, 2016). Also, the clay layer leaches when subjected to TCLP and SPLP tests for certain metals. Water leaching tests (CTEU-9) would allow a better understanding of the soil leaching potential under environmental conditions similar to those prevailing at the site. The Project Proponent shall perform water leaching tests (CTEU-9) on soils and attach the results at the end of this document. In light of the current and future analytical findings, the Project Proponent shall indicate how he plans on reducing the expected impacts of soils on surface water and groundwater.

A - 25: Soil samples subjected to TCLP and SPLP leaching tests were collected from in situ natural soils of the project site and were used to calculate background levels in the area. Leaching tests were conducted to address specific federal requirements and were included in the EIA in good faith to supplement project data.

Since these soils are natural in situ soils, and therefore present on site well before the project, it does not seem relevant to conduct additional soil tests. Also, it does not appear pertinent to propose measures for mitigation of a potential impact associated with the presence of these soils since they were naturally present before Galaxy came to show an interest for the area, and thus have no connection with the proposed project. In this instance, the quality of the groundwater in natural soil is a better evaluation of metal concentrations leaching into groundwater. Static leaching tests are not suitable in this case since the impact of soils on groundwater quality can be assessed on site. Therefore, Galaxy does not consider itself responsible for the possible leaching caused by the natural composition of in situ soils which would have happened naturally anyway.

It should also be noted that disturbed soil will remain on site for use during restoration work. During the operation phase, materials will stay in the same form as their initial one. Therefore, they will have no more leaching surface area than if they would have remained in place.

QC - 26. According to the information provided, M1 and M2 lithologies (waste rocks) present geochemical characteristics which could lead to the generation of acid or were confirmed as generating AMD. Considering their characteristics, the opportunities for valorization are limited, both on and off site. If kinetic tests happen to show that the waste rocks can be used as construction material, the Project Proponent shall assess this option which would allow reduction of the needs in borrow material. The Project Proponent shall refer to the *Guide de valorisation des matières résiduelles inorganiques non dangereuses de source industrielle comme matériau de construction* (MENV, 2002) for the characterization and validation of the possible uses according to the established classes.

A - 26: Results of metal analyses, TCLP, SPLP and CTEU-9 leaching tests as well as PAG tests conducted on waste rocks were compared to requirements of the *Guide de valorisation des matières résiduelles inorganiques non dangereuses de source industrielle comme matériau de construction* (MENV, 2002) to assess if waste rocks that will be extracted from the James Bay lithium mine can be valorized.

As mentioned in answer QC-17, the various criteria detailed in the *Guide de valorisation* help classify residual materials (RM) into three categories of materials which are then used for different applications. Materials that meet none of the criteria cannot be valorized according to the *Guide de valorisation*.

The various decision-making steps presented in the *Guide de valorisation* (MENV, 2002) were used to validate the potential for valorization of waste rocks that will be extracted from the James Bay lithium mine. The static test to predict acid generation potential conducted on waste rock samples show that 30% of the samples of unit M1 and 50% of the samples of unit M2 are potentially acid generating (PAG). According to the requirements of the *Guide de valorisation*, in no way can these waste rocks be valorized. Kinetic tests were conducted on a mix of waste rocks composed of M1 (79%), M2 (14%), V3B (4%) and I1G (4%). Kinetic test results showed that the mix of waste rocks was non-potentially acid generating (non-PAG). Since units M1 and M2 make up for 93% of the mix, it is likely that these units are non-PAG. However, it is impossible to rule on the specific behaviour of these two units beyond reasonable doubt when it comes to acid generation.

Moreover, 32% of the samples of unit I1G, 80% of the samples of unit M1, 85% of the samples of unit M2 and 100% of samples of unit V3B exceeded criteria "C" of the Guide for at least one of the metals analyzed.

Thus, waste rocks of all units may only be reused as Class III materials.

3.4 STOCKPILES (SECTION 4.8)

QC - 27. It is stated on page 4-40 that the stockpile design is supported by stability analyses. The Project Proponent shall provide the stability analyses of its structures.

A - 27: The stockpile design is under revision. Details will be available in the feasibility study which will be completed at the end of the fall 2019. One thing is certain: the selected design will be developed as to ensure the stability of dikes. The stability studies will be presented to you as soon as possible.

QC - 28. Codisposition and codeposition waste rock and tailings management methods are generally best suited for a mix of "low risk" waste rocks and tailings. Based on the kinetic test results, the Project Proponent shall provide details on the selected management method together with its associated conceptual components (e.g. anticipated infiltration water flow system, anticipated degree of water saturation, anticipated circulation of oxygen, etc.). The proposed management method shall allow for a significant reduction in the generation of AMD. Since the operating conditions can greatly differ from the conceptual model, the Project Proponent shall propose and implement an environmental monitoring specific to the waste rock/tailings stockpile as to assess the prevailing conditions at the deposition site during operations and to adjust said operations or design if needed.

A - 28: Kinetic tests conducted on the mix of waste rocks and tailings now show that materials are of "low risk". The quality of drainage water from the waste rock/tailings mix will be monitored throughout the operations since it is part of the main effluent. As mentioned in answer to QC-39, the supply of a water treatment plant is planned. If needed, water will be treated before being discharged in the environment.

QC - 29. The Project Proponent shall describe the technology that will be used for dewatering of the tailings before their stockpiling. The Project Proponent shall indicate the targeted humidity percentage of the tailings and describe how he plans on making sure the targeted humidity percentage is reached given that a humidity percentage that is too high can compromise the stockpiling of tailings.

A - 29: The residues come in three size fractions. These are -15/+4 mm (44.5% by mass), -4/+1 mm (27.7%) and <1 mm (27.7%).

The -15/+4 mm and -4/+1 mm size fractions are each dewatered on separate horizontal linear vibrating screens. A membrane filter will be used to dewater the fine residues (<1 mm). The -15/+4 mm and -4/+1 mm size fractions have a target moisture content of <10% w/w. The <1 mm size fraction has a target moisture content of <15%w/w and the combined residue has a target moisture content of <11.4%w/w. Each of the residue streams discharges to a conveyor where an automatic sampler takes a sample that can be analyzed for moisture content.

QC - 30. Part of the footprint of the waste rock stockpile contains a significant layer of clay that will need to be managed to ensure the integrity of the structure. On page 4-46, it is mentioned that a hydrogeological model is currently being developed to assess the environmental impacts of the stockpile development. The model shall allow the estimate of percolation rates below the future stockpile and assessment of the potential impact on groundwater quality. The modelling, together with the geochemical test results, shall allow finalization of the structure design. The Project Proponent shall attach the study at the end of this document.

A - 30: Galaxy believes that a hydrogeological model is no longer required since waste rocks are considered of "low risk".

QC - 31. The Project Proponent shall indicate if the option of leaving clay in place below the stockpile to obtain a sufficient tightness level without jeopardizing the stability of the structure was assessed.

A - 31: The waterproofing layer is no longer necessary as waste rocks and tailings are considered of "low risk". The stockpile structure was revised to avoid the removal of clay without jeopardizing the stability. Clay will be left in place, but drained to obtain a better stability in areas where the clay layer is currently soft with a low bearing capacity.

3.5 WATER MANAGEMENT (SECTION 4.9)

DESIGN PARAMETERS (SECTION 4.9.1)

QC - 32. The design parameters proposed by the Project Proponent for the waste rock/tailings stockpile are consistent with "low risk" tailings whereas some tailings are considered as PAG and leachable. As mentioned in Directive 019, design criteria in such cases are stricter than those proposed by the Project Proponent. Depending on the kinetic test results, the Project Proponent shall review its design criteria in accordance with the nature of the tailings to be managed, including the design return flood and the sealing measures for the stockpile areas. A hydrogeological study shall be carried out as to make sure sealing measures of Directive 019 are complied with. Moreover, the installation of emergency spillways shall be planned for water retention structures with retaining reservoir for the safe evacuation of a probable maximum flood. The factors of safety in Table 2.7 (Directive 019) shall also be complied with.

A - 32: The report on the comprehensive kinetic test results is presented in Appendix A-20. Waste rocks and tailings are not considered PAG and are thought to be leaching for a limited period for specific metals. However, these materials are of "low risk".

The quality of water from the stockpile areas will be modelled again while taking into account the relevant design criteria, the kinetic test results and water balance to make sure the design criteria allow compliance with requirements of D019.

The installation of emergency spillways is planned for water retention structures with retaining reservoir for the safe evacuation of a probable maximum flood. The factors of safety in Table 2.7 (D019) will be complied with.

The quality of drainage water from the waste rock/tailings mix will be monitored throughout the operation phase since it is part of the main effluent. As mentioned in answer to QC-39, the supply of a water treatment plant is planned. If needed, water will be treated before being discharged in the environment.

QC - 33. On page 4-49, it is stated that the freeboard of the main water retention basin dike is 1.5 m to account for possible variations with regards to climate change. The Project Proponent shall present the method used to determine the freeboard and indicate the associated confidence level.

A - 33: No calculation method was used to determine the freeboard. Section 2.9.3.1 of D019 recommends a minimum freeboard of 1.0 m when there are no sensitive receptors downstream. As a precaution, the freeboard was increased to account for possible variations with regards to climate change, among other things. The final freeboard will be decided at the detailed design stage and comply with requirements of the Canadian Dam Association (CDA) and D019. The freeboard may be increased for the operation phase if a greater variation with regards to climate change is observed.

INFRASTRUCTURE – STOCKPILES (SECTION 4.9.2)

QC - 34. The project plans two effluent discharge points: creek CE2 for water from the main water retention basin and creek CE3 for water from the overburden stockpile sedimentation pond. The development of several final effluent discharge points goes against what is usually preferred, i.e. a single final effluent on the mine site. If the Project Proponent still wishes to manage two effluents separately, compliance with requirements of Directive 019 shall be enforced for both points. Monitoring of those two discharge points shall also be conducted.

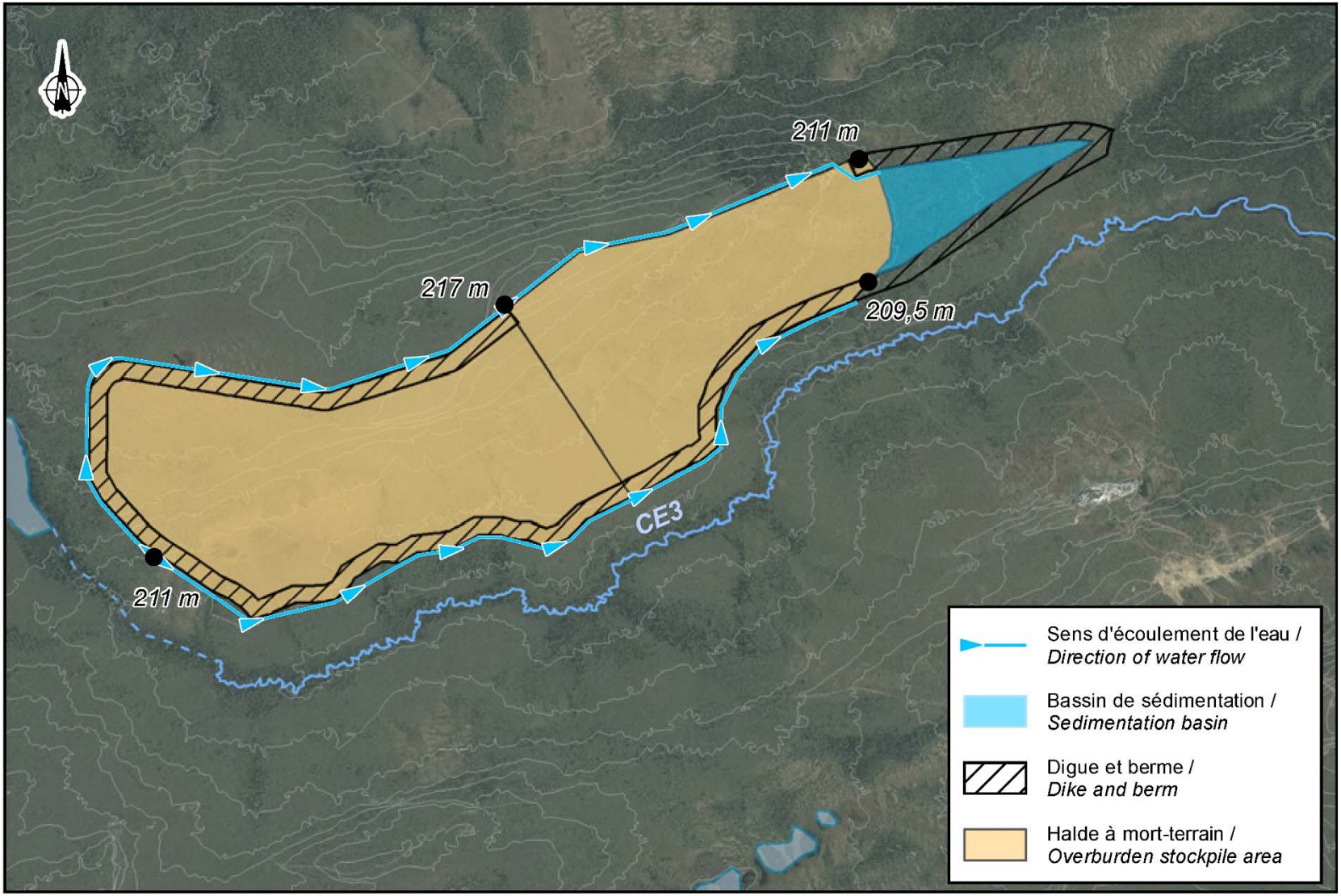
A - 34: The overburden stockpile will also be modified following changes to the waste rock/tailings stockpile area design (see answer QC-35). The overburden area will not be contaminated by the mine water; thus the effluent will not be subject to the mining effluent criteria. The only mining effluent is the one from the waste rocks/tailings stockpile which discharges into CE2.

QC - 35. According to Directive 019, mine wastewater is defined as "mine water, water from tailings stockpile areas, runoff water contaminated by mining activities, wastewater from ore processing and any industrial wastewater produced by mining activities." Since runoff water from overburden stockpiles is "runoff water contaminated by mining activities", it is considered as mine wastewater. Thus, the overburden stockpile water retention basin, as well as the tailings/waste rock stockpile basin, represents a water retaining structure with retaining reservoir as defined in Section 2.9.3 of the Directive 019. The overburden stockpile basin shall therefore comply with requirements of Directive 019 (design flood, freeboard, spillway, pumping of exfiltration, etc.). The Project Proponent shall demonstrate how the basin design and safety measures will allow compliance with requirements of Directive 019.

A - 35: Work conducted for the optimization of the tailings/waste rock stockpile led to a reduction in the volume of overburden to be stored. As a matter of fact, the volume of clay has been significantly reduced. The overburden stockpile will therefore mainly include sand, organic material and clay excavated from the surrounding area for installation of the drain.

Hydrographically, the overburden stockpile will be isolated from the rest of the mine site (Figure 35-1). It will have its own precipitation collection basin. The basin's capacity will be calculated to prevent overflow and by considering that the peat and clay are already saturated and that sand may retain a small quantity of water. Slopes will be stabilized with a retention berm built using the quarry material located within the site (diabase). The basin water will be discharged into creek CE3 after travelling in sorbent booms to prevent the discharge of suspended materials (SS) or biogenous hydrocarbons. Soil contaminated by petroleum hydrocarbons (caused by the human) will not be stored in this stockpile. Soil will be put in barrels and removed from the site by the contractor in charge of managing the residual materials.

Figure 35-1 Ditches course around the overburden stockpile area



Note that the overburden stockpile will not be contaminated by the mining activities. The tailings/waste rock stockpile, located just north of the overburden stockpile, is lower and cannot drain towards the overburden stockpile. As previously mentioned, the berm will be built with material from the quarry and not with waste rocks. Consequently, the basin does not have to be built in accordance with criteria of the D019 for mine drainage water.

QC - 36. Water of the overburden stockpile retention basin may be loaded with suspended solids (SS). On page 4-54 it is stated that the basin dimensions were determined as to allow settling of the SS and compliance with the effluent quality criteria. However, this had to be "validated at a later stage with a particle sedimentation model, when more information regarding the particle properties of the stockpile materials becomes available." The Project Proponent shall demonstrate, based on results of the model, how the basin design will allow compliance with water quality requirements.

A - 36: Galaxy considers that the particle sedimentation model is not required. Sediment barriers, combined with absorbent booms, will be placed at the exit of the basin to prevent discharge of SS. Thus, compliance with water quality obligations will be ensured.

QC - 37. The *Étude spécialisée sur la géochimie* indicates that clay would be leachable for barium, copper, lead, zinc and manganese. It is therefore possible that requirements of Directive 019 regarding metals be exceeded for water of the overburden stockpile basin at the discharge point. On page 4-54, the Project Proponent mentions that "if non-conformities are measured at the outflow of the sedimentation pond, water will be redirected to the main water retention basin." The Project Proponent shall demonstrate that the main water retention basin will be able to collect water coming from the overburden stockpile basin and specify the retention time.

A - 37: It was agreed after issue of the EIA that clays should be left in place. Consequently, the overburden stockpile will be composed of unconsolidated deposits (mainly sand and organic materials). Results of leaching tests performed on samples from the sand unit show that no sample exceeded requirements of D19 (Section 4.7.4 of the EIA). The discharge of water from the overburden stockpile into the main water retention basin is therefore not projected since the overburden stockpile sedimentation basin is mainly used for the control of suspended solids that may be generated from the overburden stockpile runoff water. It should be noted that very little water will have to be managed in the overburden stockpile since a large portion of storm water will percolate through the sand.

QC - 38. Sludge will gather at the bottom of the waste rock stockpile retention basin and the overburden stockpile sedimentation pond. The Project Proponent shall indicate if some of this sludge needs to be removed from the basins during the operation phase. If so, the Project Proponent shall estimate the expected quantities of sludge. Also, sludge from the waste rock and overburden stockpile basins is considered as tailings. It shall be characterized before its disposal or during restoration of the basins. The Project Proponent shall indicate how he plans on managing sludge.

A - 38: The expected quantities of sludge were not estimated. This represents an operational constraint that shall be managed according to the laws and regulations in force. If accumulated sludge needs to be removed from the basins, a trade contractor shall perform work. The sludge shall then be analyzed and managed accordingly.

INFRASTRUCTURE – WATER TREATMENT PLANT (SECTION 4.9.2)

QC - 39. The Project Proponent shall specify the quantities of sludge from the Water Treatment Plant (WTP) that will be generated and how they will be managed.

A - 39: For now, the need for a water treatment plant has yet to be defined. According to the D019, the ore is considered as leachable for various parameters (As, Mn, Cu, Zn, etc.). Water table and surface water protection measures are planned for the on-site storage of the ore. However, the storage will be occasional and only for a short time before being forwarded to the treatment plant. The vast majority of the ore will be dumped directly into the primary crusher. The ore stockpile as well as the industrial water basin (the one located between the workers' camp and the concentrator) will be waterproofed thanks to a HDPE geomembrane. Water draining from the stockpile will be directed towards the industrial water basin and water from this basin will recirculate directly into the concentrator.

As per D019's definition, waste rocks and tailings are considered as "low risk" which means that, according to this directive, a water treatment plant is not necessary. However, some parameters do not meet the Environmental discharge objectives (EDOs).

Obviously, both effluents will be subjected to testing before being discharged in the environment and discharge will be stopped in case of nonconformity with D019 criteria. Also, absorbents will be available in case of suspended solid or hydrocarbon contamination. If the pH, the iron or another metal, exceeds the criteria, batch treatment may be conducted directly in either of the basins.

For the EDOs, considering the low leaching results which are close to the EDO boundary values, it is impossible to determine if it is necessary, and technically possible, to reach the EDO lower boundary values at the moment. We believe that we need to wait for the analysis results following a full year of production before establishing the treatment chain. Space and financial reserve are integrated to the project, but the plant's detailed design will only be developed once we know for which parameter and with what intensity treatment is required.

Regarding the disposal of treatment sludge (when such disposal is necessary), the sludge will be analyzed and either forwarded to a waste rock and tailings stockpile area or considered as contaminated soil or hazardous residual materials after discussion with MELCC's Representatives. The expected quantities of sludge are hard to estimate, but there is no doubt that they will not be comparable with the quantities produced by acid water treatment systems. It is even possible that no sludge will have to be treated.

INFRASTRUCTURE – POTABLE WATER WELLS (SECTION 4.9.2)

QC - 40. According to the information presented on page 4-56, either two or three wells will be needed during the operations to satisfy the potable water requirements of 41 m^3 per day for 150 workers. The Project Proponent shall specify the location and characteristics of wells to be developed.

A - 40: According to the hydrogeological characteristics of the area, the aquifer identified as exploitable would be the bedrock aquifer. Based on the studies conducted, the rock permeability varies depending on its nature and degree of fracturing. A water search will help target areas suitable for potable water exploitation and development of open wells in bedrock. Their diameter is to be determined, but will most likely vary between 6 and 8 in, with a depth of 30 to 100 m. It will be possible to withdraw the water volume required for the workers' camp thanks to a submersible pump installed in the well. The number of wells to be developed will depend on the aquifer capacity at the boreholes. At the moment, two wells are proposed (Map QC-40).

QC - 41. For the drinking water supply wells at the km 381 truck stop, the Project Proponent shall:

- **Provide characteristics of the wells, such as the number of wells, type, depth, exploited aquifer, average and maximum pumping flows, water levels, available water column, and well capacity if available (if not available, an estimate is acceptable);**
- **Sample wells as to establish the initial water quality;**
- **Describe the mitigation measures planned in case wells are affected by the mine activities in a significant manner (water shortage or deterioration of water quality);**
- **Confirm that there is no other groundwater sampling within a 2 km radius from the pit (dewatering zone of influence estimated with the numerical model).**

A - 41: There are two active wells (depth of 35 and 250 ft., respectively) at the km 381 truck stop. The only information provided by the SDBJ indicates that there are four water/sewer service connection points available and that connection of two buildings of 20 rooms per point is possible which offers a potential of 160 additional rooms on the site.

Galaxy commits to conducting water quality analyses in these water supply wells in order to characterize water under initial conditions. If the wells happen to be significantly affected as a consequence of the mine activities, Galaxy commits to developing other drinking water wells as to supply the km 381 truck stop.

Regarding groundwater sampling, the only documented point is the one at km 381.

QC - 42. On page 7-23, the Project Proponent states that no water extraction from the watercourses shall occur for the purposes of the project. The Project Proponent shall specify how the needs for fresh water for the concentrator, protection against fires, dust control, service buildings and garage shall be met. The Project Proponent shall provide an estimate of the water volume to be collected from the groundwater wells as to meet the needs for drinking water, and if applicable, other fresh water needs of the project.

A - 42: No water will be extracted from the watercourses. The needs for water for the concentrator will be met via the main water retention basin and drainage water from the ore stockpile area. Water for protection against fires, dust control and service buildings will be supplied by the main retention basin only. The water volume estimate is presented in the water balance diagram in Appendix A-24.

WATER BALANCE (SECTION 4.9.3)

QC - 43. According to Table 4-18 summarizing the water balance for the main water retention basin, the effluent flow discharged in creek CE2 shall vary between 4,953 m^3/d (Years -1 to 1) and 30,411 m^3/d (Years 6 to 10). From Year 11 to the end of operations, the discharge flow shall be in the range of 22,022 m^3/d. Furthermore, the site water balance is illustrated in Figure 4-11 for Years 11 to 16 during the summer. The Project Proponent shall explain why the effluent flow presented in Figure 4-11 (19,630 m^3/d) does not match the flow in Table 4-18 for the same period (19,197 m^3/d).

A - 43: The water balance was revised in accordance with the optimized site layout. As a result, water volumes from the various mine site areas and volumes flowing towards the main retention basin then to creek CE2 were revised. Calculated average volumes are presented in the water balance diagram (Appendix A-24). Detailed results are presented in Appendix A-43 for each season and for normal, dry and wet conditions.

QC - 44. According to Table 4-19 summarizing the water balance for the overburden stockpile sedimentation pond, the annual outflow is 5.13 m^3/d (Years 11 to rest of LOM). However, according to the water balance presented in Figure 4-11, the effluent flow discharged in creek CE3 is 26,930 m^3/d for Years 11 to 16 during the summer. The Project Proponent shall explain the discrepancy. The Project Proponent shall specify the expected flow rates at the outflow of the overburden stockpile sedimentation pond for the various years of operation and indicate if flow rates include domestic wastewater.

A - 44: The overburden stockpile water balance was revised after issue of the EIA.

QC - 45. It is mentioned on page 4-55 that the water treatment plant capacity will be 500 m^3/hr for the first nine years of operation. However, according to Table 4-18, the required WTP flow rate during spring melt for Years 6 to 10 is 1,267 m^3/hr. Moreover, the table indicates that the WTP will be in operation during the spring melt and that an effluent with a flow rate of 4,953 m^3/d to 30,411 m^3/d will be generated (Year -1 to the end of the LOM). However, page 7-33 states that the "water treatment plant will operate from June to October."
The Project Proponent shall specify during which months the WTP will be in operation and indicate during which period an effluent will be treated and discharged in the receiving environment, both in creeks CE2 and CE3. The Project Proponent shall specify the water treatment plant capacity and prove that said capacity is sufficient to treat the water input from the overburden stockpile basin.

A - 45: It was determined that the WTP was no longer required after issue of the EIA. The water balance was revised accordingly.

QC - 46. According to Table 4-18, the dewatering flow increases up to 0.485M m^3/30 d for years 6 to 10, then drops to 0.321M m^3/30 d from year 11. The Project Proponent shall further explain this diminution.

A - 46: The drop is likely a result of where mining is coming from within the pit during those years. The Years 6-10 period is the period with the largest annual mining rates, while Years 11 to rest of LOM shows decreasing annual mining rate requirements. During the period where the drop is shown, the mine plan was not scheduled to the pit bottom, so the operational requirement was reduced. The lower dewatering requirement for yr 11-LOM is due to completion of the JB1 & JB2 mining areas before JB3, where it was planned that it was no longer required to dewater JB2 after completion.

3.6 EMISSIONS, DISCHARGES AND WASTE MANAGEMENT (SECTION 4.10)

GREENHOUSE GAS (SECTION 4.10.1)

QC - 47. Annual GHG emissions due to the mine operations, mainly exhaust gas (fixed equipment), propane combustion for heating and explosives related to the extraction activities, are estimated at 16,919 tCO_2eq. Since annual GHG emissions should be under 25,000 tCO_2eq, the mine will not necessarily be subject to the cap-and-trade system for GHG allowances (SPEDE). It should be noted that GHG emissions due to exhaust gas from mobile equipment used on the site are excluded from the emissions considered to determine the SPEDE obligation threshold. However, when considering all fuels consumed on site by mobile and fixed equipment, the annual GHG emissions amount to 61,232 tCO_2eq. The cost of carbon associated with the use of fuels should be considered (it currently amounts to about 20$/metric tonne of CO_2eq). Even though this cost is borne by the fuel distributors, it is transferred to the fuel bill paid by the consumer, in this case the Project Proponent. According to the SPEDE rules, the cost of carbon associated to these emissions will increase of 5% each year in addition to the indexation[3]. Also, the Intergovernmental Panel on Climate Change (IPCC, 2018) exposed in its most recent report the impacts of global warming of 1.5 °C above pre-industrial levels and concluded it was critical to reduce emissions of CO_2 by 45% from 2010 levels by 2030, reaching 'net zero' around 2050. The report states that limiting global warming to 1.5 °C would require rapid and far-reaching transitions in energy, land, urban and infrastructure (including transport and buildings) and industrial systems. To compensate the increase in the cost of carbon, and in turn reduce GHG emissions of all operations including fixed and mobile equipment emissions and comply with IPCC's recommendations to reach 'net zero' CO_2 emissions around 2050, the Project Proponent shall submit an energy transition plan in support of the EIA which presents energy efficiency or fuel substitution measures together with the implementation schedule of such measures.

A - 47: Efforts made to reduce GHG emissions, as well as the projected evolution of the power supply are detailed in answers to QC-8 to QC-14. The current mine life cycle is greater than the useful life of a heavy truck (10 years).

For the purpose of the feasibility study, the cost associated with the replacement of diesel equipment was incorporated in the project. However, there is no doubt that replacement will occur if power equipment or equipment powered with fuels of fewer CO2eq emissions becomes available in the next 10 years.

It should be noted that Galaxy would prefer powering its entire mining complex using hydroelectricity, but right now, Hydro-Québec cannot guarantee a full supply.

The energy supply plan depends on the power provided by Hydro-Québec and will evolve concurrently. For the purpose of the feasibility study, Galaxy has to ensure a year-round supply of power for all its activities.

3 For information, the cost of carbon associated with emissions attributable to the use of diesel may amount to 9.9 ¢/l in 2030 (it currently is 6.3 ¢/l). An issuer may demand that an establishment it operates and which is not subject to the SPEDE become subject to it if all qualifying requirements are met. Information on voluntary adhesion is available on the following website (French only): http://www.mddelcc.gouv.qc.ca/changements/carbone/adhesion-volontaire/index.htm

QC - 48. The calculation of GHG emissions attributable to the transport of products shipped does not consider emissions from the transport of concentrate by train from Matagami to the final place of delivery. The concentrate may be transported to a processing plant in southern Quebec, whose exact location is unknown, or shipped out of the country from a port. Based on current assumptions, or by considering a conservative approach, the Project Proponent shall include the calculation of GHG emissions between Matagami and the concentrate's final place of delivery within the boundaries of Quebec.

A - 48: A new calculation was conducted by considering transport by truck on 400 km (mine to Matagami) and on 950 km (Matagami to Port of Trois-Rivières). Transport by rail on 550 km adds approximately 2,629 tonnes of CO_2eq. Note that the reference consulted regarding GHG emissions for transport by rail (Railway Association of Canada, Locomotive Emissions Monitoring) only provides a global CO_2eq potential; CH_4 and N_2O emissions from transport by rail cannot be determined. Transport of the end product was also calculated by considering transport by truck on 1,100 km to Trois-Rivières, which is an unlikely scenario as transport by rail will be prioritized.

In this scenario, the GHG emissions for transport of shipped products are:

Transport Scenario	GHG Emisions (tonne)			
	CO_2	CH_4	N_2O	CO_2eq
400 km by truck – Mine to Matagami only	6,912	0.28	0.39	7,035
950 km by truck – Mine to Port of Trois-Rivières	16,417	0.67	0.92	16,708
400 km by truck and 550 km by rail – Mine to Port of Trois-Rivières	n.d.	n.d.	n.d.	9,664

WASTE WATER MANAGEMENT (SECTION 4.10.2)

QC - 49. It is indicated that the effluent discharge point shall be on the creek CE3, either through the overburden stockpile sedimentation pond or directly into the creek. To avoid mixing wastewater from various origins, the option of discharging treated domestic wastewater into the overburden stockpile sedimentation pond will not be accepted. The Project Proponent shall provide a direct discharge point for treated domestic wastewater in the creek CE3.

A - 49: If the option of discharging treated domestic wastewater into the overburden stockpile sedimentation pond is not accepted by the MELCC, then treated domestic wastewater will be directly discharged into creek CE3. The discharge point will be located besides the sedimentation pond discharge point.

Estimated low flow, presented in the EIA, are considered as representative of local conditions. Since the watershed area at the discharge point is no bigger than 5 km^2, the low flow was considered as void for calculation of the environmental discharge objectives (EDO). Therefore, the expected purification performance of the treatment chain will be designed as to meet requirements for compliance with EDOs shared on May 13, 2019, by the MELCC.

QC - 50. It is impossible to reach a conclusion on the efficiency of the proposed wastewater treatment unit based on information provided by the Project Proponent. The Project Proponent shall demonstrate that the selected domestic wastewater treatment unit is able to treat all domestic wastewater generated during the construction period.

A - 50: The wastewater treatment plant (WWTP) carried in the design and estimate will serve for both construction and operations. The technology selected is a biological reactor and discharge in CE3 due to the nature of the native soil & the close proximity of wetlands. The unit selected can treat the flow during construction (i.e. 56,000 l/d, based on a peak construction force of 280 individuals). The flow during the operation phase reads 30,000 l/d, based on an average work force of 150 individuals). The flow falls below the maximum capacity of the WWTP.

RESIDUAL MATERIALS (SECTION 4.10.3)

QC - 51. Table 4-23 presents the estimated quantities of residual materials (RM) produced during the construction and operation phases. The quantities are expressed in million tonnes (Mt). The Project Proponent shall validate if the quantities are rather expressed in tonnes (t).

A - 51: Quantities in Table 4-23 are expressed in metric tons. The unit of measurement should be (t) rather than (Mt).

QC - 52. The Project Proponent states that all possible efforts will be put forth to minimize the generation of "waste". It important to remember that the Quebec Residual Materials Management Policy derived from the Environment Quality Act (EQA) relies on the principle of action that priority should be given to management methods that will have the least impact on the environment. Known as the 4R-D, this principle prioritizes the following actions (in order of priority):

1° reduction at source;

2° reuse;

2° recycling, including by biological treatment or landspreading;

3° any other forms of reclamation through which residual materials are processed for use as raw material substitutes;

4° energy production; and

5° disposal.

The Project Proponent shall demonstrate that he gives priority to the residual materials management methods according to the above-mentioned order of priority for all materials generated on the site.

A - 52: Galaxy will make sure to comply with the Quebec Residual Materials Management Policy derived from the EQA by giving priority to management methods for all residual materials produced on site that will have the least impact on the environment. Galaxy will see that the selected management methods follow the 4R-D order of priority. As part of the implementation of its management system, Galaxy will establish a program and procedures to ensure compliance with the 4R-D principle.

QC - 53. The remoteness of the project on a territory where residual material (RM) treatment facilities are either missing, remote or of insufficient capacity to treat large volumes of materials is a challenge to their management. Tackled individually, it can be difficult to achieve profitable responsible management of all RM and to prevent the mere disposal of RM over great distances. Efforts are currently being made by various stakeholders across the territory to implement a joint management of residual materials at the regional scale[4]. The Project Proponent is invited to initiate exchanges with the neighbouring community (Eastmain), managers of the km 381 truck stop, and even other businesses and communities, as to cooperate on a potential regional approach to residual materials management. The Project Proponent shall report on the discussions held in this regard.

4 For example, Nemaska Lithium Whabouchi Mine Inc., together with the Community of Nemaska, has engaged in a regional approach to residual materials management.

A - 53: As mentioned in Section 4.10.3 of the EIA report, residual materials will be sorted and collected on the site, then taken over by specialized contractors authorized for this type of work. Galaxy has reached out to Recyclage Ungava, in Chibougamau, which is currently managing residual materials from mine sites in the region (Éléonore [in part], Nemaska and Renard) and takes care of recyclable materials, construction waste, hazardous residual materials, non-hazardous residual materials and compostable materials. Recyclage Ungava searches for sites where it is possible to obtain short, medium or long-term contracts at competitive rates and even provides on-site services for adequate sorting of materials. At the moment, recyclable materials, as well as non-hazardous residual materials, could be managed at Chibougamau, while Amos could receive putrescible materials. Matagami and Hydro-Québec deny residual materials from other sites. Hazardous residual materials would be managed by one of the contractors servicing the region (Véolia, Sanivac, Amnor and Groupe Gilbert). No residual material loads may leave the site without validation of the transport and disposal permits. Upon signing of a contract with Galaxy, Recyclage Ungava would take the required measures to assure Galaxy that the appropriate disposal of recyclable and non-recyclable residual materials is conducted. As soon as the contract is signed, a copy (blank, i.e. without cost) will be sent to the MELCC's Representative assigned to the case.

QC - 54. The current plan is to transport residual materials by truck to an outside facility managed by a third-party contractor. If so, the Project Proponent shall specify the final RM disposal facility and provide proof that the facility is of sufficient capacity and has been approved to receive the project residual materials. The Project Proponent shall also specify the distance between the project site and the disposal facility and the number of trucks per week.

A - 54: See A – 53.

QC - 55. The Project Proponent shall identify Contractors that will receive recyclable residual materials. The Project Proponent shall prioritize the transport of all materials produced to recycling centres, including construction and demolition waste materials.

A - 55: See A – 53.

QC - 56. It is mentioned on page 4-67 that cafeteria waste will be disposed in an authorized sanitary landfill site (or landfills as per terminology used in the Regulation Respecting the Landfilling and Incineration of Residual Materials). Putrescible materials can be subject to biological treatment through composting[5]. The Project Proponent shall assess the option of conducting biological treatment (composting) of putrescible materials on the project site. The Project Proponent shall also assess the option of integrating residual waste fertilizer into the plant cover restoration work.

A - 56: Galaxy is thinking of minimizing the generation of residual materials. A good approach to that end is to compost putrescible materials. The addition of a composter is being examined. This composter could greatly reduce the quantity of residual materials leaving the site. In addition to an input of nitrogen-rich materials (food remains), the composter requires an input of carbon-rich materials which can be easily satisfied by soiled cardboards.

If we look at the current residual material management proposal, the plan is to potentially send the putrescible materials to Amos; having a composter would prevent the trip by truck to this location, as well as the in-situ storage of food remains.

5 For example, the Éléonore Mine composts putrescible materials generated by its cafeteria using a rotating composter.

In 18 days, the proposed industrial composter produces compost which could be stored over the overburden stockpile for use during the restoration phase. The composter generates CO_2 and would produce approximately 2 m^3 of compost a week, which represents 100 m^3 per year. The compost could also help stabilize soft materials in the overburden stockpile (peat and clay).

The CO_2 balance would be revised according to the reduction in transport and in the volume of materials buried, which produces methane (CO_2eq = x23).

HAZARDOUS WASTE (SECTION 4.10.4)

QC - 57. The Project Proponent identified two possible methods for the storage of residual hazardous materials: in proper double floored containers or in a dry area with a containment pad and ventilation. The Project Proponent shall specify which storage method he plans on using and indicate how he intends on ensuring tightness of the storage area flooring and safety of the premises.

A - 57: Residual hazardous materials (RHM) will be stored in a double floored container known under the term "marine container". The container will be subjected to regular inspections and managed as required under provincial regulation.

QC - 58. The Project Proponent shall present a layout plan of the storage areas to illustrate the location of facilities for the various types of residual hazardous materials listed in Table 4-24.

A - 58: RHM waiting to be collected by a specialized contractor authorized for this type of work will be stored in a dedicated double floored container. The container may hold used hazardous products, unwashed containers of hazardous products, waste oil and grease, rags soiled by hazardous materials, and contaminated soil. The container will be regularly emptied and a storage record will be updated after each new addition or removal of materials.

Products will be placed in containers (barrels or semi-bulk bags cubic metre) which do not react with the disposed materials. Content of the containers will be identified with the date when storage began. Sections reserved for each type of content will be identified on the interior walls of the container.

Besides the difference between solid and liquid materials, the residual hazardous materials generated by the mining operations should not be incompatible. For example, liquids will mainly be oils or antifreeze agents; they will not be mixed since their disposal is more expensive if they are. Solvents are almost never found in RHM since they evaporate and mechanics replenish the container, but almost never empty it, unless there is a significant contamination.

Aerosols, as well as fluorescents, will be collected in specific barrels. Paints will be dried before being sent to waste. If large quantities of paint must be disposed of, they will be offered to the community. Procedures (most likely via a Residual Material Management Program) will be established for the appropriate management of hazardous and non-hazardous residual materials. New hazardous materials will be managed in accordance with requirements of the National Fire Code of Canada (NFC) and the National Building Code of Canada (NBC) (a section of the warehouse will be reserved for these materials).

3.7 OTHER INFRASTRUCTURE (SECTION 4.11)

SITE BUILDINGS (SECTION 4.11.1)

QC - 59. The EIA presents little information regarding the design of the site buildings. The Project Proponent shall indicate if eco-friendly construction principles were integrated into the design of the various buildings as to notably minimize the energy demand, GHG emissions and residual materials generated.

A - 59: Design of the site buildings is part of a global project cost reduction approach. Power supply being a limiting factor, the design and choice of building materials were made by giving priority to energy-saving solutions. However, no specific eco-design principle was applied. Energy efficiency and reduction of residual materials are an integral part of Galaxy's environmental policy (http://www.gxy.com/media/corporate-governance/environmental-policy.pdf) applicable to all employees and contracting parties: "develop products and services and operate facilities in such a manner that prevents pollution, improve efficiency, reduce energy use, use renewable resources and minimize waste through recycling wherever possible."

QC - 60. The Project Proponent shall indicate if he plans on promoting the use of materials available in the region or on implementing proximity purchasing policies.

A - 60: Galaxy will prioritize the purchase of local products and services as part of its approach for the optimization of economic benefits for the region and surrounding communities and as to promote the local social acceptance of the project. The terms and conditions will be mainly defined in the Impact Benefit Agreement negotiated with the Eastmain Community.

SITE ACCESS ROAD (SECTION 4.11.2) AND SERVICE ACCESS ROADS (SECTION 4.11.3)

QC - 61. On page 4-11, the Project Proponent states that minor upgrades to increase safety will be made to the James Bay road at km 382. Also, turning lanes will be added in to and out of the site at the point of contact between the James Bay road and the site access road. The Project Proponent shall clarify its role in the context of the road upgrades/turning lane work.

A - 61: SDBJ owns the James Bay Road. Galaxy will have to discuss with SDBJ regarding improvements to be made and have SDBJ approve the plans. Nothing has been decided yet about the roles of each party, including work supervision. However, one thing is certain: Galaxy will pay for the work.

QC - 62. Characteristics of the site access road are presented in Section 4.11.2. MTQ standards specify the prescribed width, sight distance, and criteria regarding the installation of drainage pipes. These standards are attached in Appendix A. The Project Proponent shall indicate how he plans on complying with said standards and describe the installation of the proposed road signage at the entry of the access road and for the turning lanes on James Bay road.

A - 62: MTQ standards (signage, traffic control, drainage, visibility, etc.) will be followed in the right of way of James Bay Road. On the project site, access roads will not necessarily follow MTQ standards (foundation, surface, etc.) since they will be private roads. A traffic plan (considering signage, speed limits, protective berms/guard rails, etc.) will, however, have to be prepared at the detailed design stage. Attention will be given to the intersection with James Bay Road.

QC - 63. The EIA provides little detail on the layout of the site roads. The Project Proponent shall provide further details on the actual overall area disturbed by road development. The estimate shall consider the width at the base of the embankment. The Project Proponent shall also indicate how he plans on complying with provisions of the Regulation Respecting the Sustainable Development of Forests in the Domain of the State, especially section 67 (which prohibits the construction or improvement of a road within 60 m of an open peat bog with a pond, a marsh, a riparian swamp, a lake or a permanent watercourse, as well as within 30 m of an intermittent watercourse) and section 70 (which prohibits the construction or improvement of a road segment longer than 100 m in an open peat bog). The Project Proponent shall also specify the projected measures to ensure connection of wetlands and free flow on either side of the roads (e.g. balance culverts).

A - 63: The project footprint presented in the EIA includes the encroachment area of the site roads. Eight metres (from the road surface limit) on both sides of the road surface were added as to consider the width at the base of the embankment. Mitigation measures associated with the development of site roads are specified in Table 7-5 of the EIA and listed in the following paragraphs (mitigation of road impacts on watercourses and wetlands).

Road layouts were developed as to avoid unnecessary encroachment upon watercourses by minimizing crossings. Culverts will be installed in accordance with standard NOR 05 and outside the periods specified in FAU 01.

To the extent possible, road layouts avoid wetlands. However, since wetlands can be found over a large portion of the study area, it is impossible to fully avoid them. Encroachment areas per type of environment and type of infrastructure can be found in Table 7-10 of the EIA. Site roads will affect 2.93 ha of shrub peatland, 5.37 ha of wooded peatland and 8.32 ha of open peatland. Mitigation measures detailed in Table 7-5 (VEG 01 to VEG 07, SUR 01 to SUR 04, QUA 01 to QUA 05, QUA 10 to QUA 12), as well as standards NOR 02 to NOR 04 and NOR 10, shall be implemented. A compensation program for the loss of wetlands will be developed as to comply with MELCC's requirements (NOR 15). This program will be prepared and presented to the MELCC with the application for work authorization.

ACCOMMODATION (SECTION 4.11.4)

QC - 64. The EIA presents little information on the design of accommodation buildings for workers, but indicates that they will be modular-type buildings and require a total electricity demand of 432 kWh (estimate). The Project Proponent shall specify the projected measures to minimize the electricity demand and environmental footprint of the buildings.

A - 64: At the moment, the electricity demand for the workers' camp is 649 kW. Appendix A-64 presents the projected design. Various scenarios are currently being discussed with the suppliers in order to minimize the electricity demand and environmental footprint of the buildings.

FUEL STORAGE (SECTION 4.11.6)

QC - 65. The fuel storage area shall consist of three aboveground diesel tanks. Based on information presented, these tanks must supply a fuelling station for refuelling of vehicles and machinery. The planned capacity of these tanks (80,000 l) exceeds the authorized limit specified in Section 8.139 of the Building Code. This limit represents 50,000 l per tank for a maximum cumulative limit of 150,000 l for the overall site. Exceeding the capacity limit via another storage measure may be authorized by the Régie du bâtiment if a request to this extent is presented. Such exceeding of the limit shall be justified and it must be proven that the installation provides a sufficient degree of safety. The Project Proponent shall indicate how he plans on making sure the fuel storage and distribution facilities comply with provisions of the Building Code.

A - 65: An application for authorization will be submitted to the *Régie du bâtiment* to use tanks adding up to 80,000 L (which would exceed the authorized limit of 50,000 L). The fuel storage and distribution facilities will comply with provisions under the Building Code and be managed in accordance with the Safety Code.

QC - 66. The Project Proponent shall indicate if it is planned that tanks also supply standby generators with fuel (plant and workers' camp). If so, the Project Proponent shall provide installation details.

A - 66: The main tanks will not supply standby generators with fuel. The standby generators will be refuelled by mobile tankers which comply with regulation (e.g. small tankers for on-site use).

POWER LINE (SECTION 4.11.7)

QC - 67. The main source of power supply for the project will be Hydro-Québec's 69 kV power transmission line. HQ shall be in charge of the line route and commissioning to the high voltage substation. The Project Proponent shall report on negotiations with Hydro-Québec in this regard and specify if special requirements are to be planned for both parties.

A - 67: There are no ongoing negotiations with Hydro-Québec. A pre-project agreement was signed in 2018 and Hydro-Québec is moving the studies forward. Galaxy and Hydro-Québec meet on a regular basis to discuss progress of the studies, but there is no negotiation underway.

So far, discussions that were held with Hydro-Québec have mainly revolved around the technical fastening with respect to connection details to Galaxy's substation and work deadlines for both parties, namely construction of the line in a timely manner for the electrical supply of the mine site substation.

QC - 68. Even though HQ is responsible for the construction of the power line part of its distribution network, the Project Proponent shall present the line route and give an overall picture of the construction and impacts associated to the development of the projected line.

A - 68: Hydro-Québec is fully responsible for the design of the line route, as well as the construction and operation of the future power line. Hydro-Québec will obtain all required authorizations to develop and operate the line in due course. We suggest you communicate directly with Hydro-Québec for more information on this work.

QC - 69. The power demand of the project is 8.3 MW, whereas the power capacity supplied by Hydro-Québec is limited to 7.6 MW. However, it is mentioned in Section 4.15.3 that "Hydro-Québec is progressing with a study that could make additional power available." The Project Proponent is assessing various options to reduce and optimize its energy demand. The Project Proponent shall report on efforts made on both sides.

A - 69: After verification and discussions with Hydro-Québec, it was confirmed that there were no opportunities to increase the available power beyond what was discussed in 2018. Engineering firms are still working on reducing the project's energy demand. To date, no significant change which would allow a decrease in demand was noted. Galaxy remains on the lookout for any reduction opportunity for the various project phases.

OPTICAL FIBRE CABLE (SECTION 4.11.11)

QC - 70.	**The installation of an optical fibre cable is planned between the km 381 truck stop and the project site. If overhead crossing of James Bay road is considered, the clearance height shall be decided based on heavy hauling. If underground crossing of James Bay road is considered, the driving method (or push-pipe) shall be selected instead of road excavation.**

A - 70: The optical fibre cable between the km 381 truck stop and the project site will be buried. Excavation of the road for burying of the cable is not planned. Rather, directional drilling will be employed so as not to affect the surrounding environment and the existing infrastructure.

3.8 CONCENTRATE TRANSPORT TO MATAGAMI (SECTION 4.12)

QC - 71.	**The Project Proponent shall give a description of the transhipment terminal in Matagami the concentrate will be hauled to. The description shall include: location, surface area, capacity, site layout, and required infrastructure and equipment for storage and transhipment of the concentrate. If applicable, the Project Proponent shall describe the projected development work and methods for the storage and transhipment of the concentrate and specify the partners involved in these stages of the project.**

A - 71: The description of the transhipment terminal in Matagami, as well as projected facilities and storage methods, is presented in Appendix A-71.

3.9 MINE REHABILITATION (SECTION 4.13)

QC - 72.	**The description of mine rehabilitation options provided in the EIA is very succinct and makes it impossible to rule on the acceptability of the proposed rehabilitation designs. On page 4-72, the Project Proponent refers to a conceptual mine closure and rehabilitation plan prepared by Sanexen in 2018. This document is not presented in the EIA. Also, a conceptual rehabilitation plan cannot be submitted to the Ministère de l'Énergie et des Ressources naturelles (MERN) for application for a mining lease. The Project Proponent shall submit a complete rehabilitation and restoration plan as required under section 101 of the Mining Act (chapter M-13.1). The plan shall be prepared in accordance with requirements of the Guidelines for Preparing Mine Closure Plans in Quebec (the Guide) (MERN, 2017). This plan must be submitted to the MERN for approval with a copy to the Administrator for information. It is recommended to prepare the rehabilitation plan together with the tallyman of the impacted area and with Representatives of the Eastmain Community. The Project Proponent shall report on exchanges on this regard between the parties.**

A - 72: Sanexen's report (2018), upon which the description of restoration work in the EIA is based, is presented in Appendix A-72. Also, as required under section 101 of the Mining Act, a rehabilitation and restoration plan will be produced at a later stage. The plan will comply with requirements of the Guidelines for Preparing Mine Closure Plans in Quebec (MERN, 2017) and the tallyman will be consulted. It should be noted that the restoration plan must be approved by the MERN and the MELCC before the mining lease is issued.

QC - 73. The proposed waste rock stockpile rehabilitation option provides for a softening down of bench slopes, addition of overburden and topsoil, and then revegetation. A simple revegetation of the stockpile will be inadequate if kinetic tests demonstrate that tailings show potential for acid mine drainage. The Project Proponent shall reconsider the projected rehabilitation methods according to the real nature of tailings.

A - 73: The report on kinetic tests conducted on waste rocks is presented in Appendix A-20.

Kinetic test results show that waste rocks are non-PAG and stop leaching after maximum 14 weeks of stockpiling (except 28 weeks for copper) and therefore are considered "low risk" at the end of this period. Thus, the proposed waste rock rehabilitation option is retained and considered suitable given the behaviour of waste rocks and tailings.

QC - 74. The project will lead to gradual dewatering of the Lake Kapisikama caused by the drawdown of the underground water table and decrease in the surface water inflow. The EIA does not specify measures for remediation of the lake. The Project Proponent shall indicate the projected remediation measures and include monitoring of the effectiveness of the measures in its monitoring program. The Project Proponent shall report on consultation with the concerned tallyman regarding this subject.

A - 74: As specified in A-18, only a conceptual mine rehabilitation and restoration plan was prepared at this stage of the project. As required under section 101 of the Mining Act, a complete rehabilitation and restoration plan will be produced at a later stage. The plan will comply with requirements of the Guidelines for Preparing Mine Closure Plans in Quebec (MERN, 2017) and the tallyman will be consulted. It should be noted that the restoration plan must be approved by the MERN and the MELCC before the mining lease is issued.

QC - 75. The EIA does not include the *Programme de confinement et de contrôle lors d'une fermeture temporaire* (Containment and Control Program in the Context of Temporary Closure) as requested under the *Directive pour le projet de mine de lithium Baie James* (Directive). The Project Proponent shall present this control program.

A - 75: In the event that mining operations are temporarily suspended, Galaxy will notify the government authorities in writing of the date operations ceased and anticipated date of resumption in accordance with the regulation.

In accordance with Section 2 (Measures Applicable in the Event of a Temporary Shutdown) of the MERN's Guidelines for Preparing Mine Closure Plans in Quebec, Galaxy will implement safety measures if mining operations are temporarily suspended for more than six months. These measures are meant to restrict access to the site, the buildings and other structures, maintain quality control of effluents and ensure the physical and chemical stability of the various storage and accumulation areas.

In the event that mining operations are temporarily suspended, the following measures will be applied:

- access to the mine site will be prohibited. A barrier will be installed at the mine site entrance and ensure its safety;
- a protection berm will be installed around the pit to ensure the safety of land users;
- an effluent monitoring program will be conducted. The program will include sampling and analyses according to requirements of the Environment Quality Act;
- measures (visual inspections and water analyses) will be taken to ensure the physical and chemical stability of the accumulation areas.

3.10 OPPORTUNITIES FOR PROJECT OPTIMIZATION (SECTION 4.15)

QC - 76. On page 4-79, the Project Proponent mentions that a study is currently underway to evaluate two air transport solutions, i.e. via the Eastmain airport and the Opinaca airport. The Project Proponent shall specify the factors taken into consideration to make its choice. The Project Proponent shall introduce the selected option and a preview of planned work activities and associated key impacts. The Project Proponent shall also report on consultation held with the tallyman of the land where the Opinaca airport runway is located.

A - 76: Galaxy had the two options assessed by Octant (consulting firm specialized in aviation). Both options, whether it is the use of the Opinaca airport runway or of the Eastmain airport, present benefits and disadvantages.

The Opinaca runway is closer to the site, but is currently closed. The property is classified as a vacant land located on Category III lands and on trapline V35 owned by the Eastmain Community. Thus, occupation and construction permits, as well as land use rights would need to be requested. Also, except for the runway, there is no infrastructure on site; everything would need to be built. It shall be confirmed with COMEX whether or not the construction of the infrastructure is subjected to the impact assessment and review procedure contemplated by Chapter II of the EQA (section 153).

The Eastmain airport is farther away from the site; more hours paid to employees and transport by bus must be considered. Risks of accidents and GHG emissions would be higher.

The existing facilities are lacking:

- airport building is too small;
- fuel is not available;
- ground handling equipment is insufficient;
- de-icing equipment is unsuitable;
- no hangar.

No impact assessment is required for the work that needs to be conducted (hangar construction, airport building expansion, addition of equipment and installation of fuel tank). Plus, the Eastmain Community would like for its airport to be improved.

Despite the longer and more expensive transport of employees via the Eastmain airport, and given the timelines for construction work at Opinaca, temporary facilities should be developed at Eastmain to welcome workers for the first few years.

It was therefore decided to go forward with the Eastmain airport option based on the CAPEX, time and Eastmain Community satisfaction criteria.

QC - 77. It is mentioned that discussions are currently underway with the Société de développement de la Baie-James (SDBJ) regarding the use of the km 381 truck stop for accommodation of workers during the construction (130 rooms) and operation (40 rooms) phases. The Project Proponent shall indicate if such agreement was reached. If so, the Project Proponent shall describe the nature of the agreement and specify the number of workers lodged at the truck stop during the various project phases. It shall be proven that the truck stop possesses the required capacity in terms of drinking water supply, wastewater treatment and residual materials management. The Project Proponent shall also specify the measures to be implemented to prevent issues related to alcohol and drug consumption or prostitution.

A - 77: Galaxy is examining SDBJ's proposals to add 100 additional rooms. Galaxy finds the proposals very interesting. There seems to be a common interest to optimize the accommodation. That being said, Galaxy cannot commit to the SDBJ until the EIA is approved.

The SDBJ estimates that 100 additional rooms can be developed by slightly modifying its facilities. Since the SDBJ is an independent Crown corporation and is not, at the moment, one of Galaxy's supplier, it is not Galaxy's role to make sure the SDBJ has all the tools and facilities to carry out its mission. Galaxy will ask SDBJ for no further details.

Regarding the measures to be implemented to prevent issues related to alcohol and drug consumption or prostitution, SDBJ's procedures will be enforced across its site. To our knowledge, the SDBJ has clear alcohol, drug and prostitution policies. Those will continue to apply.

QC - 78. It is mentioned in Section 4.15.6. that a pre-selection system will be used, i.e. a sensor installed on a conveyor belt. The Project Proponent indicates that the system shall improve the resource utilization and reduce energy consumption, GHG emissions and water losses. The Project Proponent shall specify the expected reductions thanks to the installation of the system and provide further details on the technology.

A - 78: The anticipated pre-selection system will not be integrated into the project. Since writing of the report in October 2018, the system has been tested at our Mount Cattlin concentrator, in Australia, to mixed results.

QC - 79. On page 2-6, the Project Proponent mentions that the deposit "provides a significant potential for expansion". As indicated in the Directive, the Project Proponent shall specify if development or expansion phases are planned, and if so, describe them.

A - 79: The local geological map shows more spodumene-bearing pegmatite outcrops, which explains the interest for a potential expansion. However, Galaxy Lithium Canada has yet to begin additional exploration campaigns in the areas. For now, the priority is set on the deposit identified and no exploration campaign is planned.

3.11 SUSTAINABLE DEVELOPMENT PRINCIPLES APPLIED TO THE PROJECT (SECTION 4.16)

QC - 80. The Project Proponent shall indicate if synergy with other mine projects has been considered. The Project Proponent shall discuss about the potential coordination opportunities with other projects regarding training, residual materials management, transport, ore treatment, or any other coordination effort.

A - 80: Synergy with other mine projects is very difficult for various reasons.

While Galaxy is open to consider coordinated training efforts in the future, in the short term it is challenging as other projects in the area are on different timelines, project schedules and in different development phases. We intend to further assess coordinated efforts in the future. As for residual materials management, it is likely to be undertaken by a James Bay area contractor (see answers to questions 53-54-56). He coordinates different type of waste collection and ensures adequate disposal. With regards to transport, there are no coordination opportunities since there is too much distance separating the mine projects. As for ore treatment, opportunities were not considered given that the other mine projects are competitors to Galaxy.

QC - 81. The project may result in direct and indirect economic benefits for the Eeyou Istchee James Bay region through, among other things, the creation of jobs, training and economic opportunities for local businesses. However, these benefits will be mostly seen in economic sectors where women are generally a minority. The Project Proponent shall specify how he plans on considering this factor in the realization of the project. The Project Proponent shall indicate the anticipated measures to promote the presence of women in training programs, favour hiring of women and facilitate the work-family balance, etc.

A - 81: At a high level Galaxy Resources Inc., has established discrimination standards and policies that must be adhered to internationally- these policies can be found in CDMS and HR Standards. In Australia there is a Flexible Work Arrangement Standard (Appendix A-81), that GLCI will be evaluating to determine how this standard will offer value to all employees- including women who could befit from flexible hours- in Canada.

More directly the presence of women in training programs, the hiring of female workers, and how to facilitate work-family balance recruitment, etc., will be assessed and discussed through the IBA process. There will be ongoing consultation through life of project to evaluate Galaxy's role in the advancement of female education, training and professional development with respect to the Project.

Some of initiatives will include, but are not limited to:

- Ensuring there is a diverse and well-trained recruitment team;
- Establish recruitment targets for women, both shortlisting and interview targets;
- Share targets with recruitment agencies and encourage them to partner to achieve these targets;
- Train recruiters and managers to recognize stereotypes and unconscious bias about the sort of work women can do and what women can do in non-traditional roles;
- Adhere to a process focused on meritocracy from the CV screening phase through selection process and to final offers;
- Broaden capabilities and pool of potential candidates by broadening the skills and experience required for non-traditional roles to increase the number of potential candidates; and expand the pool of potential candidates for non-traditional roles and include local women;
- Offer opportunities for women to network for information sharing and support;
- When possible, offer flexibility in the time and location of training;
- Provide development for women focusing on specific skills such as influencing, networking and offering dedicated 'on-the-job' training and development";
- In addition to the mine, there will be supporting positions in the community of Eastmain, in an effort to keep women closer to their families.

4 PUBLIC HEARINGS

QC - 82. In Table 5-2, it is mentioned that an introductory meeting was held with COMEX on February 20, 2018. However, this meeting was held on December 17, 2018.

A - 82: There was a mistake. The date in Table 5-2 for the introductory meeting with COMEX should have read as December 17, 2018.

QC - 83. In Section 5.7, the Project Component commits to developing sustainable relationships with stakeholders and to sharing information on the project, specifically by holding open houses and information-sharing sessions, committing to having Galaxy's community relations manager spend one week per month in the community, posting updates on its website and maintain direct links with employers. The last information and consultation activities reported in the EIA were conducted in July 2018. The Project Proponent shall describe the information, consultation and engagement activities with stakeholders that have been carried out since then. If applicable, the Project Proponent shall mention any change, improvement, mitigation or improvement measure made to the project following these activities. The Project Proponent shall specify the information and consultation activities he plans on conducting in the short and medium term by providing a program detailing said activities (types of activities, means, stakeholders that should be consulted, schedule, etc.).

A - 83: Since the EIA was submitted, stakeholder consultation activities have been pursued with regular updates, visits to the community and meetings in Montreal. The stakeholder consultation register is maintained. The following table presents the list of activities conducted since July 2018.

DATE	ACTIVITY	STAKEHOLDERS
November 2018	Meeting with the Eastmain Band Council (CNE) to provide a general update about the project and the process initiated following the submittal of the ESIA	Municipal administration – CNE
December 17, 2018	Presentation of the project	COMEX
December 19, 2018	Introductory meeting	Municipal administration - Waskaganish Council Band
February 28, 2019	Meeting with the tallymen of Waswanipi to present the project and discuss how the project will increase traffic	Community members of Waswanipi
March 15, 2019	PDA Signed	Municipal administration - CNE

The visits were somewhat less frequent due to multiple reasons from both sides including goose break, moose break and in the winter, travel conditions. Galaxy's community manager had a medical issue that prevented the anticipated frequency in terms of Eastmain visits last winter, but regular contact was established via calls and email (including in person meetings in Montreal/Ottawa). The necessity and rational behind the frequency was to foster a relationship built on mutual respect and trust, which we believe was achieved. Also, for roughly 2 months prior (and naturally during), the election process in Eastmain, Galaxy minimized the level of community engagement as to not impact the democratic process in the community. Although not presented in detail in the stakeholder consultation register, many meetings were held with the Chief and Council, and Tallyman to discuss the PDA. These meetings included project updates when relevant.

The next consultation event in Eastmain is anticipated for September or October 2019.

QC - 84. In Section 5.7.1, the Project Proponent mentions that discussions have been initiated between Galaxy and Eastmain stakeholders to sign an Impact Benefit Agreement (IBA). If the IBA is not reached, in which case it is requested that the Project Proponent provide the Administrator with a copy of the IBA for information purposes, the Project Proponent shall report on the current status of discussions and give an overview of the terms of the agreement which could have an impact in the context of this assessment.

A - 84: As presented in A-83, the PDA was signed with the Eastmain Band Council on March 15, 2019. IBA discussions are in preliminary stages. Discussions are moving forward but at this point specific terms cannot be shared as they are still being identified and agreed upon between the two parties. The IBA will follow a similar framework to other IBA's in the region/territory. There was an election in April 2019, which halted IBA discussions/forward momentum with Galaxy's IBA discussions before, during and after the election.

QC - 85. During exchanges held in 2011-2012, the RE1 trapline tallyman has stated not being concerned about the Galaxy Project since he does not use the project area. The Project Proponent shall indicate if the RE1 trapline tallyman was consulted again during the consultation activities in 2017-2018 to confirm his position.

A - 85: The RE1 trapline tallyman was interviewed in 2011-2012 since his territory was part of the project's initial study area. The boundaries of the study area having changed since 2012, its territory is now outside the study area. Although we have not consulted the RE1 trapline tallyman individually since 2011-2012, he has participated to meetings organized by Galaxy since 2012.

QC - 86. According to the information provided, the RE3 trapline tallyman was not consulted during the information and consultation activities held in 2011-2012 and 2017-2018. However, according to Map 6-22, part of the RE3 trapline seems to be located within the social environment study area. The Project Proponent shall consult the RE3 trapline tallyman.

A - 86: The RE3 trapline tallyman was not consulted since his territory is outside the study area, more than 10 km from the project. The south-west boundary of the social environment study area is adjacent to the north-east boundary of the RE3 trapline.

QC - 87. As specified in the Directive, the description of the biophysical and social environments must integrate the traditional knowledge of the Cree population. The Project Proponent shall specify how the traditional knowledge was taken into consideration for the description of the various components of the environment, including the wetlands, shoreline, banks and flood-risk areas, animal species of traditional interest, as well as plants used for traditional purposes. The Project Proponent shall clearly identify the traditional knowledge gathered through interviews with elders, trapline tallymen, land users and other stakeholders.

A - 87: Interviews were conducted with trapline tallymen and their families during consultations of 2018 as to document the use of lands and of resources. Since consultations were carried out late in the impact assessment process, the traditional knowledge acquired during the interviews with the land users were not incorporated in the description of the biophysical environment. The knowledge was processed under the social environment topic, mainly under the "Current Use of Land and Resources for Traditional Purposes" valued component (Section 6.4.6.1 of the EIA). The vast majority of information in this section was acquired in these meetings. The traditional knowledge also contributed to the impact assessment and mitigation measures phases. Also, this knowledge will continue to be deepened throughout the follow-up studies.

It should be noted that the field teams were accompanied by two Cree people (land users) during the inventories of the avifauna, chiroptera, herpetofauna and water sampling. Information and directions were exchanged in an informal way. The team was able to benefit from the Cree people's expertise on the site, notably regarding trails that could be used to access the sampling stations.

The following paragraphs present the information on the environment that was shared by the Crees, mainly land users, met during consultations. This information validates the information presented in the description of the biophysical environment and confirms results of the impact assessment. There is no modification to the EIA.

RESOURCES IN GENERAL

According to land users, the 2013 forest fire affected a major part of the trapline, resulting a decrease in the presence of resources and thus their hunting (porcupine, moose, beaver, moose). However, the revegetation and gradual return of resources have been recently observed.

Regarding the general quantity and quality of resources, land users of the VC35 trapline mentioned that the resources had been greatly impacted in the past due to the flooding of a major section of the trapline following the creation of the Opinaca reservoir in the 80s, the Eastmain 1 and Eastmain 1-A hydropower projects, as well as the diversion of the Opinaca and Eastmain rivers.

WETLANDS, SHORELINE, BANKS AND FLOOD-RISK AREAS

No specific question relating to the characterization of current and future wetlands, shoreline, banks and flood-risk areas were asked to users met as part of the public consultations. However, some views were shared at the time of the consultation regarding wetlands. Elders mentioned that an accidental spill had occurred in the engineered landfill (LETI) area before and that they had heard of a spill at the Lacorne lithium mine. They value wetlands for the beaver.

WILDLIFE OF TRADITIONAL INTEREST

Caribou

Land users were questioned on the presence and hunting of caribou during consultations. Land users of the RE2 trapline mentioned that there are fewer and fewer migratory caribou across the territory and that no caribou were observed in 2018. It seems that the migratory caribou is no longer in the area since fires destroyed the forests. It was observed along the Eastmain River in the past. The woodland caribou is sometimes observed south of the RE2 trapline (west of James Bay road). According to one user, this area would be the north boundary of the woodland range. However, the species is not observed every year.

Moose

Moose hunting was addressed during consultations. One user mentioned that moose are just beginning to come back in the study area following work of the Eastmain 1-A project, completed in 2013. According to land users, moose is observed in the study area along the Eastmain River (along the James Bay road).

Beaver

Land users were questioned on the trapping of beavers. According to land users of the RE2 trapline, their entire territory is a suitable habitat for the beaver although, according to older users interviewed, the beaver population has been declining steadily since the construction of the James Bay road. One elder of the RE2 trapline mentioned that the taste of beaver had started to change since the construction of the road due to the associated pollution. There are still many good trapping areas across the trapline, notably beaver lodges along the Eastmain River and the James Bay road.

Geese

According to users of trapline RE3 interviewed, various locations in the study area are visited by geese, mainly east of the James Bay Road, including former borrow pits which have become attractive to the goose, at certain lake outlets and at stream crossings along the James Bay road. Close to a dozen of these sites was noted across the study area of the social environment (grouped per sector on Map 6-22 of the EIA).

Information was provided by land users of traplines RE2, VC35 and VC33:

- Noise and smell caused by the mine will have a repulsive effect on geese nearby the site where hunting activities take place;
- Geese should not be too greatly disrupted by noise. They are used to it as they arrive from heavily populated and industrialized areas in the south;
- Mine operations could, however, have a local impact on the bird migration route by altering the availability and usage of staging and foraging areas in the vicinity of the site.

Sturgeon

One participant of a group meeting with the elders of Eastmain as part of the project consultations mentioned that the sturgeon had been greatly disrupted by the diversion of the Eastmain River in 1980 and had slowly started coming back to the river. The quality of sturgeon, based on its texture (which had changed since the diversion), was also improving.

Users interviewed during consultations consider that sturgeon are more sensitive to disturbance to the social environment than humans and that they could feel vibrations in the water which cannot be felt by humans. They fear that vibrations emitted may have an impact on sturgeon given the presence of a new spawning site on the Eastmain River, which could be disrupted. It should be noted that the spawning site is located 10 km north of the project site and that vibrations resulting from blasting do not travel that far.

Porcupine

Users interviewed during consultations mentioned that porcupines were valued by members of the community. No concern was raised.

5 DESCRIPTION OF THE RECEIVING ENVIRONMENT

5.1 PHYSICAL ENVIRONMENT (SECTION 6.2)

HYDROGRAPHY (SECTION 6.2.7)

QC - 88. Table 6-9 shows the total surface area of the watersheds of the watercourse in the study area (CE1 to CE6). For calculation of the Effluent Discharge Objectives (EDO), it is necessary to know the surface area of the watershed of each creek receiving effluent (CE2 and CE3) at the location of the projected effluent discharge point, and not at the outflow. The Project Proponent shall specify the surface area data. The surface areas of the watersheds of creeks CE2 and CE3 are 9.07 km^2 and 10.33 km^2 respectively. The watershed area at the effluent discharge point could be in the order of 5 km^2 or less. For very small watersheds (surface area < 5 km^2), low flows are considered as void given uncertainties associated with the low flow estimate and their potential dewatering. Considering these conditions, no mixing zone is allocated for dilution of the effluent and the EDOs are consistent with the water quality criteria. Low flows shall be provided if surface areas at the effluent discharge point of creeks CE2 and CE3 are greater than 5 km^2. For the calculation of EDOs, the flow of the creek selected for dilution of the effluent represents the lowest value between either the winter dry conditions or summer dry conditions. As mentioned in *Estimation des débits d'étiage pour le Nord-du-Québec* (MELCC, 2017), annual statistics are no longer taken into consideration given the different nature of processes behind each type of dry condition (low water).

A - 88: The watersheds of creeks CE2 and CE3 were redefined at the projected effluent discharge point (see map QC-88). The new surface areas are 4.1 km^2 for CE2 and 3.6 km^2 for CE3. Since the watershed surface areas are smaller than 5 km^2, low flows are considered as void for the calculation of EDOs. EDO calculated values were received on May 13, 2019.

SURFACE WATER AND GROUNDWATER QUALITY (SECTION 6.2.8)

QC - 89. During the initial characterization of the receiving environment, fluoride should have been assessed in the same way as other major ions. Fluoride concentrations measured during leaching tests on waste rocks are not negligible when compared to surface water quality criteria. This parameter shall be characterized in the CE2 receiving watercourse before implementation of the mine.

A - 89: Fluoride values were measured at all stations during specific sampling campaigns (one or two campaigns out of six). Results were incorporated in the summary table presented in the EIA. The corrected Table 6-13 shows fluoride values measured at the various stations.

Table 6-13 (corrected) Median and Deviation for Each Parameter Analyzed over Six Inventory Campaigns

Parameters	Units	Station																	
		1A		1B		2A		2B		3A		3B		4A		5A		5B	
		Median	Devia-tion	Median	Devia-tion	Median	Devia-tion	Median	Devia-Tion	Median	Devia-tion	Median	Devia-tion	Median	Devia-tion	Median	Devia-tion	Median	Devia-tion
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
Fluoride	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

n/a (not applicable): deviation cannot be calculated with only one piece of data.

QC - 90. The initial characterization of the receiving environment shall be supplemented by a characterization of mercury in fish. Given the proven leaching of ore and tailings, the risk of mercury contamination via the future effluents is not negligible. Knowing the initial mercury concentration in fish (if applicable) will help making sure that the potential presence of mercury in the effluent will not result in contamination of the food chain. The characterization of mercury in fish shall be conducted in accordance with the *Protocole d'échantillonnage pour le suivi des substances toxiques dans la chair des poissons de pêche sportive en eau douce* (MELCC, 2017). Monitoring of fish flesh may be recommended if values observed at the effluent exceed a given threshold. Monitoring of concentration in fish is not recommended for all contaminants, only for those that are persistent, such as mercury, and potentially bioaccumulative. Mercury will be a recommended parameter for monitoring at the effluent (EDO).

A - 90: The ore will be temporarily stored and contact water will be managed and sent back into the concentrator process. This means that there will be no effluent discharge into the natural environment.

According to results of the latest kinetic tests on waste rocks and tailings (Appendix A-20), mercury is deemed leachable to some extent. Mercury exceeds the RES criterion for unsaturated tailings and saturated waste rock mix for the first 14 weeks of testing. For the unsaturated waste rock mix, concentrations stayed below the LOD throughout testing, except for the initial analysis. Results of surface water and sediment characterization for creek CE2 (which will receive the stockpile effluent) conducted in June 2017 show that mercury was detected at a concentration of 0.000003 mg/L in surface water and between 0.02 and 0.03 mg/kg in sediments (September 2017). Two species were caught (brook trout and lake chub) during the fish inventories conducted in 2017.

Given those results, it is agreed upon that mercury analyses in fish flesh found in creek CE2 would be relevant to determine the initial mercury concentration in fish since this contaminant already exists in the environment surrounding the effluent discharge point. However, the number of fish in CE2 appears to be low and it would be surprising that a sufficient number of fish be caught to provide a good statistical representativeness of the population. Despite the low number of fish, results may be able to provide an overview of the initial situation. Galaxy commits to conducting mercury analyses on fish found in creek CE2 in the summer of 2019.

QC - 91. Table 6-17 presents natural background levels for aluminum, arsenic, barium, copper, iron, lithium, manganese and zinc. The Project Proponent shall complete the table and provide the background levels for all metals found in Table 2.1 of Directive 019.

A - 91: It can be observed by comparing values found in Table 6-17 with metals in Table 2.1 of D019 that the natural background levels for nickel and lead were not presented in the EIA table. These values were not calculated since no exceedance of the criteria was observed. Following MELCC's request, the background levels for these parameters were calculated as to establish the background level before the start of work.

Table 6-17 Calculation of Natural Background Levels of Metals in Groundwater

Parameter/Lithology Unit	Natural Background Levels (ug/L)	
	Unconsolidated Deposits (Till)	Rock
Aluminum	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

100 : Calculated NBL Value > RSW Criterion
100 : Calculated NBL Value > Threshold Alert
100 : Calculated NBL Value > Criterion / Drinking Water Recommendation

SOIL AND SEDIMENT QUALITY (SECTION 6.2.9)

QC - 92. According to information provided in Section 6.2.9.1, there will be a number of 13 samples (for coarse sand) and 17 samples (for fine sand) analyzed for each "stratigraphic unit". This number is considerably lower than the minimum of 30 samples per typical layer mentioned in the *Guide de caractérisation physicochimique de l'état initial des sols avant l'implantation d'un projet industriel* (MELCC, 2015). The ensuing statistical analysis is therefore not admissible. The Project Proponent shall indicate how he plans on supplementing this information.

A - 92: The *Guide de caractérisation physicochimique de l'état initial des sols avant l'implantation d'un projet industriel* (MELCC, 2015) states that "scientific literature recognizes that with about 30 data per typical layer and per parameter it is possible to form a representative statistical population to establish a background level (ISO 19258)."

As mentioned in the Soil Background Concentrations Technical Study [1], the statistical software ProUCL is able to perform statistical calculations for distributions composed of minimally three results above the laboratory reported detection limit (RDL). In addition to assessing the data distribution, the software takes into consideration values below the RDL using more suitable statistical methods than mere substitution of the RDL or RDL/2. The result is bound to be closer to actual values and there is a smaller chance of over or underestimating the background levels.

A statistical analysis was conducted for all parameters where three or more results exceeded the RDL. For each parameter, the basic descriptive statistics (minimum, maximum, average, standard deviation and quartile) were calculated and a histogram was developed. Where data below the RDL were observed, the average and deviation were calculated using the Kaplan-Meier (KM) method by assuming a normal distribution.

The normal distribution, or log-normal distribution, of data was verified using the Shapiro-Wilk test (SW).

[1] WSP. 2018. Mine de lithium Baie-Jame – Étude spécialisée sur la teneur de fond naturelle dans les sols. Rapport préparé pour Galaxy Lithium (Canada) inc. N/réf : 171-06062-00. 29 pages et annexes.

Each statistical method is meant to analyze datasets of various and specific characteristics (number, difference between values, data sought at the completion of the statistical analysis, etc.). Thus, every statistical method has a minimum amount of data required to reach representative results. The background technical study states that "…although the software assesses the normality using the Lilliefors and Shapiro-Wilk tests, only the Shapiro-Wilk test was used since the other performs better for distributions of 50 pieces of data or more." Therefore, the minimum number of samples required so the statistical method is representative varies, a factor that was considered in the selection of the method (the amount of data was also considered).

The assessment of natural background levels from the normal distribution, or log-normal, was based on the determination of the confidence interval around a percentile in accordance with EPA's suggested method [2]. Thus, the background level for each parameter was determined by establishing the lower confidence interval at 95% of the 90th percentile of the distribution. In other words, thanks to this method, we can establish the boundary value for which it is certain that 95% of the value is equal or below the 90th percentile.

For a normal distribution, background level is assessed using the following equation:

$$\textit{Background level} = \textit{average} + \textit{standard deviation} * \tau(P;n;\alpha)$$

Where τ is an independent factor of the confidence interval (1 - α = 95%), the desired percentile (P) and number of data (n). In cases where the distribution has been transformed at the beginning of the analysis, the background level obtained must be retransformed in accordance with the reverse transformation.

For comparison, Tukey's range test proposed by the MELCC (2016a) was also implemented using the following equation:

$$\textit{Tukey's range test} = 3^{rd}\ \textit{quartile} + (3^{rd}\ \textit{quartile} - 1^{st}\ \textit{quartile}) * 1.5$$

This method was only selected when data did not follow a normal or log-normal distribution since, according to the EPA (EPA 2019) it is only suitable for identification of outliers or comparing several datasets from different populations against each other. Also, this method assumes an approximately symmetrical data distribution without testing this assumption.

It is considered that the number of samples analyzed per typical layer is sufficient for the statistical analysis conducted in accordance with the statistical methods employed.

ProUCL recommends that the statistical analysis be conducted on at least 10 results above the RDL. The EPA recommends that a proportion of at least 50% of analyzed results be above the RDL.

It should be noted that the following metals do not fully comply with the requirements: calcium (4.0%), lithium (6,46%) and vanadium (5.39%) for the coarse sand unit, and barium (9.47%), hexavalent chromium (6.67%), lithium (4.21%) and vanadium (4.21%).

The fact that the concentrations of many samples were under the RDL does not necessarily mean that the distribution is inadequate. It is possible that natural concentrations in soil for these metals were initially low or that the number of samples above the RDL recommended by the ProUCL and EPA is not reached for a distribution with more samples. This does not undermine the credibility of the distribution analyzed; it merely means that the background levels calculated for metals listed above shall be interpreted with caution.

[2] EPA, 2009. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance*, EPA 530/R 09-2007. United States Environmental Protection Agency.

QC - 93. The natural background level (NBL) of hexavalent chromium in the coarse sand unit lies between the *Guide d'intervention* criteria "C" and "D". Given that the hexavalent chromium is anthropogenic in nature, the interpretation of results shall conclude to contamination greater than criterion "C". The Project Proponent shall consider the presence of hexavalent chromium contaminated soil and address this matter in the project assessment (Section 7.2.1). The Project Proponent shall specify the projected measures for the possible management of contaminated soil.

A - 93: Results that exceeded criteria "A" for the hexavalent chromium (Cr(VI)) were obtained for surveys conducted in areas where there had been no human activity and come from areas distant enough from one another for it to be unlikely that human activities occurred on all areas. The project environment is also exempt from human activities which could have resulted in Cr(VI) contamination (siderurgy, chemical industries, leather tanning, etc.). No exceedance for the Cr(VI) was observed in samples collected in trenches dug during the environmental characterization in the engineered landfill area, i.e. the area most likely to have been affected by a potential human contamination.

Studies solely devoted to the chromium oxidation process show that the oxidation of Cr(III) is influenced by the presence of manganese oxides in rocks or soils (Bartlett, R.J., and B. James, 1979). Manganese (Mn) oxides are formed in very reducing conditions in soils, collect at the surface of clays or iron oxides and generally possess a negative charge (except for a very acid pH). Mn oxides also have a very high absorption capacity, especially for heavy metals such as chromium (Bartlett, R.J., and B. James, 1979).

Thus, Cr(III) would be adsorbed to Mn oxides. As chromium oxides, it tends to generate Mn odixes. Also, it is true that Cr(VI) is hardly ever present in rocks. However, given the low mobility of Cr(III), transport of Cr in the aqueous phase occurs almost exclusively in the hexavalent form, i.e. Cr(VI) (M. Chrysochoou *et al.*, 2016). Thus, the release of Cr(VI) depends primarily on two subsequent reactions: release of Cr(III) into solution due to mineral weathering and oxidation of Cr(III) to Cr(VI). Even minerals with lower Cr concentrations may be substantial sources of Cr(VI) to soil solution given their relative susceptibility to weathering and dissolution (M. Chrysochoou et al., 2016).

Several studies were conducted in various locations around the world on the natural presence of Cr(VI) in aquifers located in mafic or ultramafic geologic settings, and in soils derived from these geologic units.

Mafic minerals, such as amphiboles and pyroxenes, are often Mn and Cr-rich. Garnets contain a lot of chromium; they appear to be one of the largest contributors to chromium in mafic and ultramafic rocks (up to 20% of Cr_2O_3). The weathering of these minerals and Fe-Mn oxides seem to result in the oxidation of Cr(III) to Cr(VI) (M. Chrysochoou *et al.*, 2016). This forms what is called hexavalent chromium of geogenic origin.

Soils present a wider distribution of Cr(VI) concentrations than rocks or groundwater given the diverse and numerous soil environments with mixed geologic backgrounds, in addition to the dilution factor when mixing soils directly from the weathering of mafic/ultramafic rocks with soils from other sources (M. Chrysochoou *et al.*, 2016).

Naturally occurring high Cr(VI) concentrations were reported in Brazil in a sedimentary aquifer consisting of quartzose sandstones. The natural occurrence of Cr(VI) was attributed to weathering of diopside grains which contained up to 1.2% of Cr_2O_3 (M. Chrysochoou *et al.,* 2016). Even though not applicable to the study area, it should be noted that research shows that using ammonium fertilizers for agricultural activities lead to the nitrification and acidification of soils resulting in the production of H^+, which favours the increased dissolution of Cr(III), which is the limiting step for oxidation and production of Cr(VI). Much higher Cr(VI) concentrations have been reported in top soil layers (fertilized) versus underlying layers (non-fertilized) (M. Chrysochoou *et al.,* 2016). This proves that naturally occurring Cr(VI) can be found in various environments.

An amphibolitized basalt unit with amphibolite is located just north of the Project. We can formulate the theory that Cr(VI) found in soils result from the weathering of the basalt/amphibolite. Moreover, a large portion of the bedrock at the project site is composed of paragneiss. Garnets are very common in gneiss; their presence could be another explanation for the Cr(VI) concentrations observed in soils. It is very unlikely that Cr(VI) found on the site is of anthropogenic origin.

QC - 94. Section 6.2.9.2 of the EIA and Section 3.2 of the Aquatic Inventory and Baseline Study (*Étude spécialisée sur l'habitat aquatique*) present the results of the sediment characterization for creeks CE1 to CE5 and for Lake Asiyan Akwakwatipusich. As mentioned in the *Guide de caractérisation physicochimique de l'état initial du milieu aquatique avant l'implantation d'un projet industriel* (MELCC, 2017), the Project Proponent shall identify the bodies of water likely to be impacted by the mining effluent and further define the areas prone to sedimentation (fine sediments). Results presented in Table 17 of the Aquatic Inventory and Baseline Study show that sediments collected at several stations (CE-1A, CE-2B, CE-5A, CE-5B) are of sandy or gravelly nature. However, it is mentioned in Section 6.3.3 of the EIA that the substrate in creeks CE1, CE2, CE3, CE4 and CE5 is mainly fine particles. The Project Proponent shall specify if areas of the receiving environment prone to sedimentation (lakes, ponds, meanders) were characterized and identify, together with the necessary justifications, stations that can be considered as "exposed" or as "control" stations based on guidelines of the *Guide*. If the initial characterization of sediments is incomplete (minimally, three exposed stations, one control station, five samples per station), the Project Proponent shall indicate how he plans on completing it.

A - 94: The bodies of water likely to be impacted by the mining effluent are creeks CE2. It is planned that water from the waste rock and tailings stockpiles will be discharged in CE2 and water from the overburden stockpile basin, as well as domestic water, will be discharged in CE3 (Map 4-1 of the EIA). The areas located downstream of these discharge points that feature sharp curves or stagnant water are the areas most prone to sedimentation.

Although a thin layer of fine sediments generally characterizes creeks CE1 to CE5, the sedimentation areas where there is enough sediment deposition to allow sampling are composed of coarser sediments, as demonstrated by the particle size results. The locations of the sampling stations are shown on Map 2 of the Aquatic Inventory and Baseline Study. The map shows that most stations are located along watercourses, not in lakes or pronounced meanders. It should be emphasized that stations were selected based on areas where there is enough sediment deposition to allow the collection of five samples. The initial characterization of sediments is considered comprehensive since it minimally includes three exposed stations (2B-3B-3A), one control station (1A), and five samples per station.

QC - 95. As specified in Chapter 4 of the *Guide de caractérisation physicochimique de l'état initial du milieu aquatique avant l'implantation d'un projet industriel*, sulphur is part of parameters set out by the physicochemical monitoring of sediments. However, this parameter was not characterized. The Project Proponent shall indicate how he plans on completing the characterization.

A - 95: Sulphur concentration was not analyzed in sediment samples during the environmental characterization campaign. Sampling will be conducted at the seven sediment characterization stations (Map 6-8 of the EIA). Sulphur will be analyzed prior to the application for the certificate of authorization for construction of the concentrator. Results will be presented to the MELCC as soon as they are available.

5.2 BIOLOGICAL ENVIRONMENT (SECTION 6.3)

VEGETATION (SECTION 6.3.1)

QC - 96. The assessment of the preferred habitats of plant species likely to be threatened or vulnerable (PSLTV) and plant surveys are limited to the mining infrastructure area. However, the project provides for the potential use of quarries and borrow pits located outside this zone (Map 4-4). The Project Proponent shall specify if projected sites for the potential quarries and borrow pits are active or if they are new sites. If new sites, the Project Proponent shall assess the presence of the preferred habitats of PSLTV within the sites. Further inventories should be planned and mitigation measures proposed (as required) in the event that potential habitats are present.

A - 96: The assessment of the preferred habitats of PSLTVs focused on areas affected by the project footprint, where exploitable borrow pits and quarries are located. Except for one Carex species, revealed to be a common species (QC-128), the EIA reports no PSLTV within the project footprint and very little potential in terms of habitat for this species. Other areas that could potentially be used as borrow pits or quarries were identified outside the project footprint. Sectors identified in the EIA as potential borrow pits and quarries will not all be selected. This selection has not yet been made.

Based on the very conservative early estimates, the maximum granular material volumes required from the borrow pits to satisfy project needs are 620,000 m^3 of sand and 480,000 m^3 of gravel. According to early estimates, borrow pits located within the project boundaries shall be able to provide up to 648,245 m^3 of material (Section 4.4.3 of the EIA). Existing borrow pits nearby the project could potentially provide 138,290 m^3 of additional material. Given costs associated with the commissioning of a new borrow pit, it is likely that locations already impacted by the project footprint, as well as existing borrow pits, be prioritized. These borrow pits should cover a good portion of needs, i.e. more than 70% based on maximum estimates. The use of borrow pit BE-03 (Map 4-4 of the EIA), which has a capacity of 415,000 m^3, would thus satisfy the totality of maximum granular material needs. The selection of this potential borrow pit is also based on the fact that it presents a reduced footprint, requiring a short access road and located at 1,800 m from the truck stop. It should be noted that the potential borrow pit BE-03 would be commissioned as a last resort and only partially exploited (maximum of 313,465 m^3 would be used, which represents a maximum of 75% of its total capacity).

The borrow pit BE-03 is located within a burnt area (Map QC-96). Generally speaking, burnt areas are not considered suitable habitats for PSLTVs detected in the James Bay region or in the vicinity (Table 6-27, Section 6.3.1.2 of the EIA). PSLTVs have a low potential of being present in the area, and thus, the potential is deemed to be minor in burnt areas.

QC - 97. The Project Proponent reported the presence of 27 plant species of traditional interest used by the Cree population in the study area. It is indicated on page 6-60 that the traditional use of plants was investigated while reviewing the literature. The Project Proponent shall consult with the Cree community (elders, trapline tallymen, land users, etc.) to integrate the traditional knowledge and complete information on the traditional use of plants and their medicinal uses.

A - 97: In addition to the review of literature regarding the knowledge on plant species of traditional interest, the use of plants was assessed during consultation with Cree land users, notably users of traplines RE2, VC35 and VC33. The following paragraphs present findings of the interviews on the subject. Information is also presented in Sub-section 6.4.6.1 of the EIA ("Current Use of Land and Resources for Traditional Purposes").

Plants for Traditional Purposes

According to land users of traplines RE2, VC33 and VC35 interviewed, plant gathering and berry picking is done at various locations across the land. They mentioned that blueberry picking is mainly carried out in areas that have been affected by forest fires (2004 fire among others), including in the James Bay Road area. The gathering of mushrooms, conducted by the community for commercial purposes, is also done in the James Bay Road area.

According to Crees surveyed, to be used, medicinal plants must be "pure", meaning that they must be contamination-free. Users of the traplines RE2, VC35 and VC33 are worried that vegetation may be contaminated (medicinal plants, berries or plants eaten by the wildlife) through degradation of air quality, and soil or water contamination, most notably caused by dust and snow (contaminated by the mine particles) seeping into the ground. For instance, even though berries growing under power lines located across the territory seem plumper, VC35 land users prefer not eating them since, from their perspective, the vegetation is affected by radiation emitted by the power lines.

TERRESTRIAL FAUNA (SECTION 6.3.2)

QC - 98. According to the study on woodland caribou by Rudolph et al. (2012) mentioned on page 6-75, "the results of surveys done in 2003, 2007, 2009 and 2011 estimate the number of caribou in the Nottaway population to be 137, 50, 26 and 17 animals. Considering that the range of this population is estimated at 36,400 km^2, the approximate density in 2011 would be roughly 0.1 woodland caribou/100 km^2." However, the numbers of caribou for surveys done in 2003, 2007, 2009 and 2011 in the Rudolph et al. study do not represent an estimate of the Nottaway population, but rather the number of caribou observed during the surveys. The Project Proponent shall consider this distinction in its assessment and indicate if the anticipated impacts of the project on caribou are modified.

A – 98: The following correction must be made to the EIA: "results of surveys done in 2003, 2007, 2009 and 2011 respectively estimate 137, 50, 26 and 17 animals. Considering that the range of this population is estimated at 36,400 km^2, the approximate density would be roughly 1.69 woodland caribou/100 km^2 (Rupolph et coll., 2012)."

There is no modification to the assessment of impacts on the large fauna stemming from this correction (Section 7.3.2. of the EIA). The inventories and review of existing data conducted during the EIA strongly indicate that the study area is not inhabited by the woodland caribou. Also, since fires destroyed vegetation and that regrowth will take time, it is unlikely that the situation will change in the short or medium term. This impact therefore remains of minor importance for the large fauna throughout all project phases, as described in the impact assessment.

QC - 99. It is mentioned on page 6-93 that "in light of the extent of the forest fires that affected the study area, the [rock vole] is unlikely to still occur there." The species is known for being present in areas without forest cover, such as forest cut less than a year ago. It uses underground trails, meaning that it can survive extreme weather events. Therefore, forest fires may not necessarily have caused the disappearance of the rock vole from the area. Also, the rock vole may have population cycles similar to the southern red-backed vole, although slightly less marked. Since rock vole population density is already generally low, it is possible that the species' presence was not detected by snares if the survey year matched a year of population decline. This does not necessarily mean the complete disappearance of the species from the area. In light of this information, the Project Proponent shall indicate if modifications must be made to the assessment of anticipated project impacts on this component and to proposed mitigation measures.

A - 99: Even though the rock vole occurs in certain open habitats on the edge or surrounded by woodland stands, such as small clearings, transition areas between open habitats and forest habitats or newly cut environments, it is first and foremost a forest species whose preferred habitat is mixed-wood stands or mature softwood stands (Duhamel and Tremblay, 2013). Although mature stands were still present in the study area at the time of our first small mammal survey in 2011 (the rock vole was reported), the habitat had virtually disappeared by our 2017 inventory.

Although the rock vole population density is relatively low, it does appear to be subject to interannual variation, as is the case for most of the Cricetidae family (French and Crowell, 1985; Etnier, 1989). However, Jannett (1990) suggests that the rock vole does not conform to the 3 to 4-year cycle usually followed by this family. It seems that the rock vole population presents fewer specimens, but is more stable over time (Jannett, 1998).

There remains the possibility that a population decline affecting all small mammal species and habitats observed contributed to the capture success of virtually zero observed across the study area in 2017. Some rock vole specimens could also have survived to a fire destroying their habitat, although the species does not strictly live underground, but rather digs shallow burrows and develops trails between rocks (Desrosiers et coll., 2002). Even though this behaviour, associated to the sometimes significant insulating effect of a snow layer, likely contributes to sheltering the rock vole from predators and extreme weather events (Timm et coll., 1977), it is unlikely that effectively protected the rock vole from the repeated fires in the study area.

Since the rock vole preferred habitat has virtually disappeared from the study area, we consider unlikely that viable rock vole populations remained in the study area, even if a few specimens may have survived the repeated fires.

ICHTYOFAUNA (SECTION 6.3.3)

QC - 100. According to results of the aquatic fauna surveys, the yellow perch is allopatric in Lake Kapisikama. However, the yellow perch is known for being in sympatry with other species in bodies of water. There is no literature documenting allopatric populations of yellow perch in Quebec. The observation would be even more unusual for a northern region if it turns out to be true. To validate the observation, the Project Proponent shall provide additional information, such as photographs of specimens or using another method. Since Lake Kapisikama will be gradually dewatered over the course of the project, the Project Proponent shall properly characterize the yellow perch population before it is impacted by the project as to propose a suitable mitigation plan for this habitat.

A - 100: Test fishing in Lake Kapisikama was conducted in accordance with Canadian Wildlife Service's Multi-species Survey Protocol (2011). The fishing effort totalled six nets/night (four large mesh nets and two small mesh nets). The nets were installed as to cover all types of habitats. Details of the methodology are presented in Section 2.3 of the Aquatic Inventory and Baseline Study. Catching of yellow perch at this latitude is not unusual. The lake description (headwater lake surrounded by peatlands) indicates that the effluent (flowing towards CE4) is diffuse. Also, no flow was visible at the time of the field visit. This lake is therefore considered isolated, which eliminates the possibility of fish swimming from creek CE4 to the lake, and vice versa. The lake is shallow and relatively acid, which are unfavourable conditions for various fish species.

Considering the lake characteristics (Table 30 of the baseline study), the number of catches (total of 81 specimens, Table 32 of the baseline study), and the considerable fishing effort conducted as per a reliable protocol, it is unlikely that the yellow perch lives in sympatry in this lake with one or more species.

Moreover, no fish was captured in the creek CE4 upstream of the James Bay Road. Even though it is still possible that the species was isolated in the lake in the past, it is indeed surprising that this species was found in allopatry in James Bay.

However, the severe lack of diversity may be due to the lake specific conditions; it is possible that other smaller species are present, but were not captured. These species are of no interest to the land users though.

Galaxy committed itself to producing a compensation plan for any known losses of fish habitat (see NOR 16, Table 7-5 of the EIA). The plan will be presented to the DFO and MELCC prior to submission of the applications for environmental permits. The applications shall include the projected compensation plan, where appropriate.

AVIFAUNA (SECTION 6.3.5)

QC - 101. Section 6.3.5 presents a few observations whose unusual nature was not mentioned by the Project Proponent, such as:

- **the presence of veery was reported in two types of habitats (open habitats and softwood stands) in a sufficient number for the density of breeding pairs to be assessed. Veery is a species associated with deciduous forest stands that has been observed north of the 50th parallel only twice during the survey for the second *Québec Breeding Bird Atlas* and which has never been observed north of the 51st parallel. As part of survey work for the Atlas, no veery was heard at the listening stations in lot 18UC59 which covers an extensive part of the mine study area. Therefore, the fact that several individuals were observed in two different types of habitats, including very atypical habitats for the species (softwood stands) is surprising;**
- **a small number of Le Conte's sparrow was reported. Until today, all observations of this species have been restricted to the coastal marshes of Rupert, Cabbage Willows and Boatswain Bays. The species had never been observed further north than the Boatswain Bay. The observation of the species in the study area is unusual, although not impossible, even if it was made almost 80 km from the coast;**
- **a northern mockingbird was observed in the vicinity of the km 381 truck stop. This species sometimes wanders. Therefore, it is possible that it was really seen at this location. The species may also have been mistaken with the Northern shrike, a species which is more likely to have been observed at the truck stop;**
- **no ruby-crowned kinglet has been reported in wetlands nor open habitats. Very few were observed in softwood habitats (0.07 IP/ha). And yet, the ruby-crowned kinglet is one of the most abundant species in the boreal forest. The species is highly vocal and therefore easy to detect during surveys at listening stations. Results of the *Québec Breeding Bird Atlas* show that the species is indeed present along the James Bay road and that it was detected at 47% at listening stations in lot 18UC59. Also, the EIA reports spruce grouse breeding pairs data in wetlands and softwood stands. Even though it is normal for the spruce grouse to be present in the study area, the species is not very vocal and its detection at listening stations is usually low. It is surprising that results at the listening stations show a near absence of ruby-crowned kinglet in the study area and a 4-fold increase in spruce grouse abundance in softwood stands.**

The Project Proponent shall comment on the unusual nature of these observations and, if necessary, indicate if modifications must be made to the assessment of anticipated project impacts on avifauna and to proposed mitigation measures.

A - 101: Thanks to your observations, we were able to notice a clerical error which affected the last five rows of Table 8 of the Terrestrial Wildlife and Avifauna Baseline Study, and also touched on the questions regarding the ruby-crowned kinglet and spruce grouse. We revised the table and corrected the values accordingly (see the corrected table below). We also removed the calculations of indicated breeding pair density for species barely observed, such as the fox sparrow or the spruce grouse, which does not really lend itself to the calculation.

We also agree that some bird sightings may appear unusual. However, it should be reminded that the surveyed environments have been strongly disrupted by recent forest fires. Thus, the wealth and density of birds reported cannot be compared to those of similar non-disturbed environments. The effect of fires notably translates into a greater visibility, characterized by very low herbaceous and shrub layers and mostly bare trees. Under the circumstances, we have no doubt about the validity of the bird observations made by our ornithologists, including the veery (two observations), spruce grouse (one observation) and northern mockingbird. The latter, which has a very powerful voice and was observed on a recurring basis on the edge of the truck stop, cannot be mistaken for a northern shrike.

Table 8 (Corrected) Density of Terrestrial Forest Birds at Listening Stations

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 (*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 (*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 (*Poecile hudsonicus)*	-	-	obs
Grey jay (*Perisoreus canadensis)*	0.04	0.14	-
Alder flycatcher (*Empidonax alnorum)*	obs	obs	obs
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
Spruce grouse (*Falcipennis 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: species observed, but too few observations to establish a breeding pair density.

5.3 SOCIAL ENVIRONMENT (SECTION 6.4)

LAND USE (SECTION 6.4.6)

QC - 102. The EIA reports the presence of two navigable waterways in the vicinity of the project site on which few trips have been made in recent years. The Project Proponent shall validate the information with land users and report on consultations conducted. The Project Proponent shall also describe the past, present and future use of lakes and watercourses by the Cree community for recreation or navigation purposes.

A - 102: Based on information collected from RE2 trapline and VC33 and VC35 land users, watercourses of the study area on which Crees navigate as part of traditional activities are (see Map QC-102):

- Eastmain River up to Weir #5 (except Mantuwataw Rapids which can be avoided using a portage path);
- Nistam Siyachistawach Lake (south-west of the study area);
- Amiskw Matawaw Lake (south-west of the study area);
- Miskimatao River (south-west of the study area);
- East section of creek CE5; river can be reached from James Bay road and leads up to Eastmain River (east of the study area).

Navigation on the last two watercourses was seldom conducted over the past few years. It should be noted that no expected change is likely to impact navigable waters of the study area.

QC - 103. The Project Proponent shall specify the nature (groundwater or surface water) and use of the drinking water sources identified on Map 6-22 and describe their potential for future use.

A - 103: During consultations conducted as part of the project, drinking water sources (for consumption or other food-related purposes, as needed) were located by land users. No additional information was provided regarding the nature, quality or potential for future use of these water sources. Water is mainly collected at the km 381 truck stop, but other water sources exist and are sometimes used by land users.

QC - 104. The Project Proponent shall complete the description regarding the land use by including the past use of land, burial sites, and sites and areas of special value to the Cree population. This description shall be based, among other things, on information provided by the trapline tallymen and land users.

A - 104: Many activities were conducted to properly describe the land use, including:

- Interviews with tallymen of traplines and their families as to document the use of land and resources;
- Document review regarding traditional know-how, more specifically medicinal plants;
- Visual simulations which integrate components valued by land users.

Land users were also interviewed on the presence of burial sites, sites of archaeological interest or other sites valued for their natural and cultural heritage. Since no archaeological site or built environment of interest was identified by Cree users in this area, no information on this matter was documented in the baseline conditions of the natural and cultural heritage.

However, the study area affects valued areas that land users wish to protect either because of the abundance of certain resources or because of the strong generational attachment to the territory. The information provided by Crees regarding the valued areas is presented in Section 6.4.6.1 Current Use of Land and Resources for Traditional Purposes.

The past use of land is mainly discussed in the archaeology section of the EIA and in answers to QC-107, QC-108 and QC-109.

HERITAGE AND ARCHAEOLOGY (SECTION 6.4.9)

NATURAL HERITAGE (SECTION 6.4.9.1)

QC - 105.	**The objective of the Quebec government is for 20% of the Plan Nord territory to be composed of protected areas by 2020. With this in mind, several regional planning initiatives for protected areas are underway in James Bay. The Eastmain Community has provided the government with two proposals, including one that partly overlaps the project's social environment study area. However, the EIA does not consider these proposals. The Project Proponent shall consult the community regarding their proposals for protected areas and consider said proposals in the project impact assessment.**

A - 105: The answer to QC-105 was written together with the answer to QC-106 as to consolidate similar information. Thus, see A-106 for the answer to QC-105.

QC - 106.	**The objective of the Quebec government is for 50% of the Plan Nord territory to be used for activities other than industrial by 2035, i.e. for environmental protection and biodiversity safeguarding. The Project Proponent shall consult the Quebec government, Société du Plan Nord, Cree Nation Government and the Regional Government of Eeyou Istchee James Bay regarding their respective projected plans for protected areas and integrated land use planning. The Project Proponent shall also assess the compatibility of its project with the bodies' projected land use planning.**

A - 106: Galaxy specifically consulted the Eastmain Band Council, the Protected Land Use and Planning Committee, as well as Mr. Raymond Shanouch, Commissioner of the Cree Nation of Eastmain, about projects for protected areas. Information collected show that proposed protected area projects are located outside the mine project study area and all stakeholders interviewed agree that no impact of the mine project is anticipated on the proposed protection projects and that no subsequent consultation is required.

In parallel, we contacted the Société du Plan Nord (SPN – Ms. Nichèle Compartino) to obtain more information on the land protection projects across the Société's territory that could conflict with Galaxy's mine project. So far, no information on projected protected areas has been forwarded; only existing protected areas have been referenced (as stated in QC-151, data on the areas can be found at the following link: http://www.environnement.gouv.qc.ca/biodiversite/aires_protegees/carte-interactive.htm). The protected areas available at the previous link were mapped (Map QC-105, QC-106, QC-151) and the *Direction des aires protégées* was contacted. The various areas proposed for protection in the region are currently being assessed and those selected will be only known at the end of 2019. Only then will the selected areas be communicated to Galaxy so they can be considered in later stages.

ARCHAEOLOGY (SECTION 6.4.9.2)

QC - 107.	**The Project Proponent shall specify how Indigenous traditional knowledge and comments and concerns gathered during consultations were taken into consideration to determine the reference status of the natural and archaeological heritage.**

A - 107: The Indigenous traditional knowledge gathered during consultations with Cree land users were used to better understand their means of travel and land resource development strategies. The testimonies provided by the inhabitants teach us and provide information on their landscape and include trails they have taken, camps they used and experiences they lived or have been told. An archaeologist provided with such data is better equipped to assess the archaeological potential of the land. By combining the experiences lived by Cree land users to the experience of archaeologists equipped with related knowledge useful to understand past events, it is clear that the findings are more in line with what the past human occupation at this location could have been.

The reference status of the natural and cultural heritage remains the same as what was proposed in the archaeological potential study conducted by Arkéos (2018). Since the Indigenous traditional knowledge is essential to understanding the past and present social landscape, the archaeologist must take note of this knowledge before establishing the location and potential of the archaeological potential areas, to the same extent as the use he/she makes of the knowledge gained during the geological, geomorphological, hydrological, biological and anthropological studies conducted across the study area. The archaeologist is thus well equipped to identify areas where human occupation could have been possible at various moments in time since the withdrawal of the Laurentide Ice Sheet.

QC - 108. The archaeological data presented in the EIA is taken from the archaeological potential study conducted by Arkéos (2018). However, the study presents no Indigenous traditional knowledge which could prove valuable to evaluate the archaeological potential of the study area. The study should draw on the traditional knowledge gathered from elders, land users or other members of the Cree community. The Project Proponent shall present detailed information on past and current lands used, history of traplines, traditional travel routes (by land and on water) and camp sites used in the past.

A - 108: The Indigenous traditional knowledge was considered and respected. For example, the archaeological areas that were listed in the north-west quadrant of the archaeological potential study area (P-2, P-3 and P-4 areas) cover areas located within a zone known for its fairly good performance when it comes to the trapping of fur-bearing animals (see WSP, 2018; Map 6-22).

In the table (Table 3) where the geomorphology and drainage of area P-5 are described, it is stated that the zone covers “a presumably bumpy area (till mound) in a peatland.” (Arkéos, 2018: 27). We can imagine that the area may have been used, and still be used, for hunting near wetlands, such as peatlands. In this case, the till mound is nicely located and offers a great view over the surrounding environments and sand terraces. The till mound represents a well-drained area at the heart of a now paludified former lacustrine outlet. The description of the geomorphology and drainage in area P-5 also considers the contribution of knowledge the archaeologist gained when studying the stories and descriptions provided by the Cree land users. To demonstrate the contribution of traditional knowledge gathered from Cree land users, a column showing the strategic aspect of the archaeological potential area can be found in Map 3 (Arkéos, 2018; 27; Appendix A-108).

Regarding the last request, i.e. presenting detailed information on past and current lands used, history of traplines, traditional travel routes (by land and on water) and camp sites used in the past, it is possible to access such information in the social environment study conducted as part of this project (see WSP, 2018: 6-119 to 6-156). It shall be pointed out that the objective of an archaeological potential study is to identify areas where human occupation may have occurred in the past and that will likely be affected by the projected mine work. Field validation followed by an archaeological inventory, i.e. work that allows the systematic sampling of an archaeological area, would allow a better definition of areas selected during the potential study and to assess the presence of remains bearing witness to the past occupation of the land. As specified in answer to QC-149, the field validation will be conducted by the end of fall 2019. It will then be possible to provide detailed information on the camp grounds used in the past. Based on information available right now, it is impossible to identify such locations.

QC - 109.	**According to the archaeological potential study, human occupation dates back to about 5000 years; the oldest sites uncovered are dated 4600 and 4100 BP. The study should consider the possibility that human occupation in the region is prior to this date given the ecological conditions favourable to human occupation as early as 6000 BP and the presence of the Sakami Moraine east of the study area. Shorelines could have been uncovered during the retreat of the Tyrrell Sea and then been used by former inhabitants of the Eeyou Istchee area, such as what happened at the Wapekeka site (Hamilton, 2004) in northern Ontario. The study should consider the delimitation of potential shorelines that can be observed on aerial photos and, if necessary, modification to the zones of archaeological potential.**

A - 109: One of the study conducted on peatlands located in the middle section of the Eastmain River watershed present a picture of the plant colonization across the James Bay territory after glacial and sea retreat. Brosseau (2008: 81-82) dates the beginning of the formation of Le Caron Lake peatland to 6640 ± 40 years ^{14}C BP. The peatland is located just under 80 km east (80°) from the study area. Brosseau also specifies that at that moment, water of the Tyrell Sea was located under the altitude of 246 m MSL. It is even likely that the sea water left the peatland area before 7200 years ^{14}C BP. The altitude of the potential areas defined as part of Arkéos' archaeological potential study (2018) for the Galaxy Lithium mine project is between 190 and 205 m MSL. It should be reminded that the hill selected for the mine development is still a noteworthy massive only culminating at ± 235 m MSL, i.e. merely 35 m above the surrounding plain (Arkéos, 2018:9).

The isostatic rebound begins later in the Quebec portion of the Hudson Bay basin than in the Ontario portion. At the time of occupation of the Wapekeka site (Hamilton, 2004), the Quebec portion is still a landscape of desolation composed of stagnant water and wetlands. The eskers, long sand ridges offering well-drained surfaces, were used as routes. As a matter of fact, the Ontario esker system appears to have been used for the exploration of newly emerged territories[1]. This does not mean that the Quebec esker system was used in the same way. Comparisons between these two regions are too biased to really rule on this matter. It is still possible that such ancient occupation took place in the James Bay region, but current data suggests a delay of more than a millennium before the territory became habitable.

In Arkéos' study (2018), the definition of the archaeological potential areas also considers locations with space able to welcome human occupation, i.e. an area which stands out from the ever-present wetlands of the study area. In this kind of environment, areas that are strategically well-positioned for the exploitation of resources or development of camps (from bivouac to base camp) are usually located on well-drained eminences. These two characteristics are essential for the selection of archaeological potential areas for the targeted study area.

[1] Two ancient archaeological sites are close to the 54th parallel, near Big Trout Lake. The first one, Wapekeka Burial Site (FlJj-1), dates back to 7000 years (Hamilton, 2004) while the second, McKay Burial Site, dates back to 5000 years (ibid.)
See: http://kilands.org/wp-content/uploads/2012/08/KI-Bones-research-poster.pdf
Site visited on June 12, 2019.

6 IDENTIFICATION AND ASSESSMENT OF ENVIRONMENTAL IMPACTS

6.1 IMPACT ASSESSMENT METHOD (SECTION 7.1)

IMPACT ASSESSMENT (SECTION 7.1.3)

QC - 110.	**The Project Proponent shall describe how he integrated comments gathered from the trapline tallymen and land users in the impact assessment. More specifically, the Project Proponent shall present how comments collected were considered for the identification of environmental components likely to be impacted by the project, for the assessment of anticipated impacts and their level of importance, as well as for the selection of proposed mitigation measures.**

A - 110: Consultation activities with the First Nations affected by the project were conducted from the project outset in 2011-2012, and then again in 2017-2018. These consultations allowed for further development of knowledge about the environment, discussion on stakeholders' concerns and expectations regarding the project, as well as identification of the project main challenges.

Components valued by Indigenous Nations were determined after consultation with the Crees, from themes addressed during meetings and aspects which are sensitive or present a specific interest for people consulted.

Here are the main components valued by Indigenous Nations:

- Water quality (including Eastmain River and creek CE5);
- Air quality;
- Soil quality;
- Overall wildlife quality (especially beaver, moose, goose, sturgeon, trout, porcupine);
- Quality of vegetation consumed by users and animals (including medicinal plants and berries);
- Land integrity;
- Quality of life at worker camp (health, dust, noise);
- Jobs.

Since a valued component is considered as an element of scientific, social, cultural, economic, historical, archaeological or esthetic value, the components valued by Indigenous Nations were merged in the EIA as to consider the experience of professionals. Therefore, these elements were assessed under the social environment, mainly the "Land Use for Traditional Purposes", "Perception of Physical Environment", "Quality of Life", "Landscape" and "Local and Regional Economy" valued components.

The consultation of the Eastmain Cree community allowed for optimization of the project design by providing for several environmental protection measures.

It should be noted that the assessment of impacts sometimes differed for some Cree members interviewed.

Consultations were an occasion to discuss the various mitigation measures meant for reduction of project impacts on components valued by Indigenous Nations. Mitigation or improvement measures were provided to address concerns of the Eastmain population, including several environment monitoring surveys to study the evolution of components and assess the efficiency of measures, as well as means of communication to keep stakeholders informed of monitoring results. Galaxy remains open to reviewing the mitigation measures implemented and adjusting them throughout the project to properly address concerns of stakeholders.

Section 7.4.3 of the EIA was improved as to highlight the perception of people interviewed regarding project impacts on physical and natural environments. Changes made are underlined in the text below.

7.4.3 PERCEPTION OF THE PHYSICAL AND NATURAL ENVIRONMENTS

CONSTRUCTION PHASE

SOURCES OF IMPACT

- Site preparation and infrastructure construction.
- Water management.
- Transportation and traffic.

MITIGATION MEASURES

Mitigation measures PER 01, UTT 02, CIR 04 and VIE 01 must be applied, as well as the measures intended to decrease atmospheric emissions (AIR 01 to AIR 05), noise (SON 01), water contamination (QUA 01 to QUA 05, QUA 07 to QUA 13), night-time lighting (LUM 01 to LUM 03), vibrations and air overpressure (VIB 01), as well as all relevant standards (NOR 2 to NOR 5, NOR 9, NOR 11, NOR 13 and NOR 14). These are set out in Table 7-5.

IMPACT

Activities associated with the construction phase will result in various disturbances that could potentially affect the perception of quality of the atmospheric environment, lighting and noise, underground and surface water, as well as vibrations felt by Cree who use the areas surrounding the mine, km 381 truck stop workers and visitors, even if the regulatory requirements are met. It should be noted that before construction begins, territory users will be informed of when it will start and of its progress. Furthermore, an area closed to traditional activities near the mining site will be established in collaboration with the Tallyman, thereby limiting the use of this sector.

Since the site is in an isolated area, the current air quality in the area studied is very good. During the construction phase, activities to prepare the site and to build infrastructure will change the air properties since there will be an increased suspension of particulate matter in the air. However, results of the air dispersion modelling study show that the standard will be met at the sensitive receptors. It should be noted that RE2, VC33 and VC35 land users consider that the project impacts on air quality will be felt over a greater area, beyond the radius used for modelling. Also, people interviewed raised concerns regarding the impacts of dust accumulation on the vegetation and its infiltration in the soil, as well as the impacts on the quality of wildlife resources, such as beaver, moose and goose, regarding the ingestion of said vegetation. Others have observed deformities on moose and attributed the situation to radiations emitted by power lines near their feeding area.

Regarding ambient noise, the only current anthropogenic contributors in the local study area are the James Bay road and the km 381 truck stop. During the construction, the standards set out in D019 will be met. The noise modelling survey produced demonstrates that noise levels during operations (under the worst operating conditions) will be compliant (WSP, 2018*d*). The construction activities planned will be smaller in scale than those simulated. Thus, noise levels will increase, but will still be acceptable. Like for air quality, Cree land users believe that the radius used to measure project impacts on the ambient noise is too small. They estimate that noise will be detected over a greater area. They also fear the impacts of noise on goose migration routes.

Because of its remote location, sources of vibrations in the study area are nearly non-existent. Vibrations may occur during construction in conjunction with quarry operations. However, blasting operations will be less significant than during the operations phase. Currently, it is expected that vibration thresholds at the km 381 truck stop will be acceptable, as well as the other sensitive areas surrounding the pit. These elements confirm that activities of a lesser scale will also be acceptable. However, some may still feel vibrations when blasting occurs. Cree land users fear that vibrations emitted may have an impact on sturgeon given the presence of new spawning site on the Eastmain River, which could be disrupted. People interviewed consider that sturgeon is more sensitive to disturbance to the environment than humans and that they could feel vibrations in the water which cannot be felt by humans. However, it should be noted that the site is located 10 km north of the project site and that vibration waves caused by blasting do not travel that far.

In the study area, the only current artificial lighting at night comes from the km 381 truck stop. It emits very little light and the effect it has on the night sky fades quickly as you drive away from it. Some changes are expected since artificial lighting will be added to Galaxy's facilities during construction.

During the consultation activities that took place from 2017-2017, SDBJ's representative expressed a concern that the mining activities, from the start of construction through the end of rehabilitation, may affect the km 381 truck stop's drinking water supply, sourced from artesian wells on its property. It should also be noted that Cree territory users also draw their drinking water from the same location when they stay at their camps. There are two drinking water sources in this location. Construction activities are not likely to affect the drinking water supply at the km 381 truck stop.

As for surface water, current conditions measured in the study area are representative of natural environments, even though they have quite high acidity levels and contain certain metals due to the presence of peatlands, the nature of the rock and unconsolidated deposits. At the sampling stations inventoried, the surface water is generally unaffected by human activity. No change to the surface water quality is anticipated during construction. The risks of accidental spills remain, but Galaxy's emergency response plan allows for those to be dealt with quickly, if such an event were to occur. It should be noted that Cree land users expressed concern regarding risks of accidental spill given the raised topography of the mine in relation to the Eastmain River. They fear its potential contamination, as well as contamination of other smaller creeks (especially creek CE5, which is an area valued by users), peatland and groundwater, which users believe could occur through infiltration. They also fear the impacts of a potential contamination on wildlife and fish resources. They raised questions on the efficiency of the treatment of water discharged via effluents and mention that even treated, discharged water will not be of same quality as initially. Still on the subject of project impacts on surface and groundwater, Cree land users are concerned by the impacts on water flow.

The tranquility of the area, especially the Cree camps located around the mining site itself, could also be affected by mine construction activities. People who are used to performing traditional activities in the projected infrastructure sector could find their safety compromised by the site's new use. During consultations with Cree land users, they raised concerns on the safety, both on the road (accidents, road degradation) and regarding break-ins at the camps because of the presence of workers. However, the Cree territory users and workers at the km 381 truck stop will be able to view the survey and environmental monitoring reports that will monitor the status of the situation in terms of water, air, noise and soil. Furthermore, beginning with the construction phase and throughout the entire project period, mechanisms will be put in place so that worrisome situations can be reported to and handled by Galaxy.

IMPACT ASSESSMENT

The intensity of this impact is deemed to be low due to the activities specific to the construction phase, which will produce less disturbance. Furthermore, the mitigation measures will decrease the potential negative effects. The extent of the expected residual effects is deemed to be very limited, since they will likely only be felt by Cree territory users who access certain specific sectors around the mining site, as well as dozen or so workers and visitors at the km 381 truck stop. The duration is short. Thus, the significance of the impact on the perception of the physical environment during the construction phase is considered to be **minor**.

Despite the fact that modelling results show that impacts are contained within the modelling perimeter, Cree land users consider that adverse effects during the construction period will be felt within a greater perimeter than what has been used for the air quality and noise modelling studies. Moreover, impacts of construction activities on their negative perception of the environment and water quality will continue over time since they consider these changes irreversible. Thus, according to their assessment, despite a low intensity, the extent of residual impacts would be local and of long-term, and therefore of medium significance. Environmental monitoring surveys shall help make sure impacts of the construction activities do not continue over time.

OPERATION PHASE

SOURCES OF IMPACT

- Presence and operation of the pit.
- Other infrastructure in operation.
- Management of economic material, overburden and waste rock.
- Water management.
- Transportation and traffic.

MITIGATION MEASURES

Mitigations measures PER 01, UTT 02, CIR 04 and VIE 01 must be applied, as well as the measures intended to decrease atmospheric emissions (AIR 01 to AIR 05), noise (SON 01), water contamination (QUA 01 to QUA 05, QUA 07 to QUA 13), night-time lighting (LUM 01 to LUM 03), vibrations and air overpressure (VIB 01 to VIB 04), as well as all relevant standards (NOR 2 to NOR 9, and NOR 11 to NOR 14). These are set out in Table 7-5.

IMPACT

During operations, the activities are likely to result in more disturbances than during the construction phase, affecting the perception of the quality of the atmospheric environment, lighting and noise, underground and surface water, as well as vibrations felt by Cree who use the areas surrounding the mine, km 381 truck stop workers and visitors. As stipulated for the construction phase, the number of Cree territory users in the mining sector will be decreased with establishment of an area closed to traditional activities.

The impacts described for the construction phase are similar to those for the operation phase. Thus, air quality will be altered by mining operations since an increase in suspended particulate matter will change the air properties. However, the results of the air dispersion modelling survey show that the standard will be met at the sensitive receptors. As for noise, the modelling survey demonstrates that noise levels during operations (under the worst operating conditions) will be compliant (WSP, 2018*d*). Thus, noise levels will increase, but will still be acceptable. For the construction period, the RE2, VC33 and VC35 land users consider that project impacts on the air quality and noise environment will be felt within a greater perimeter than the one used for modelling. They also have concerns about dust accumulation on the vegetation and its infiltration in the soil, as well as the impacts on the quality of wildlife resources associated with the ingestion of said vegetation. Others have observed deformities on moose and attributed the situation to radiations emitted by power lines near their feeding area. They also fear the impacts of noise on bird migration routes.

Because of its remote location, sources of vibrations in the study area are nearly non-existent. Vibrations will occur when blasting takes place in the pit. The vibration thresholds at the km 381 truck stop and other sensitive areas surrounding the pit will be acceptable. When values calculated were close to the limits, mitigation measures were added to ensure the thresholds were not exceeded. However, some may still feel vibrations when blasting occurs. As previously mentioned, the Cree land users fear that vibrations emitted may have an impact on sturgeon given the presence of a new spawning site on the Eastmain River, which could be disrupted. People interviewed consider that sturgeon is more sensitive to disturbances to the environment than humans and that they could feel vibrations in the water which cannot be felt by humans.

In the study area, the only current artificial lighting at night comes from the km 381 truck stop. However, some changes are anticipated since artificial lighting will be added to Galaxy's permanent facilities, in addition to that needed for operations.

As previously indicated, SDBJ had expressed a concern that mining activities may affect the km 381 truck stop's drinking water supply. The specialized hydrogeology report demonstrated that groundwater lowering associated with the pit will be minimal where the wells are located (WSP, 2018*a*). In that respect, Galaxy has agreed to monitor the groundwater levels and verify the results of the hydrogeological modelling.

According to the INSPQ, the issues of water quality, quantity and access are the Cree's primary concerns (INSPQ, 2014). As mentioned for the construction phase, Cree land users expressed concerns regarding risks of accidental spill given the raised topography of the mine in relation to the Eastmain River. They fear its potential contamination, as well as contamination of other smaller creeks (especially creek CE5, which is an area valued by users), peatland and groundwater, which users believe could occur through infiltration. They also fear the impacts of a potential contamination on wildlife and fish resources. They raised questions on the efficiency of the treatment of water discharged via effluents and mention that even treated, discharged water will not be of same quality as initially. Still on the subject of project impacts on surface and groundwater, Cree land users are concerned by the impacts on water flow.

To that end, the watercourses in the study area were subjected to chemical analyses (water and sediments) within the context of a specialized study on aquatic habitat (WSP, 2018*e*). The watercourses in question run from east to west, toward the Eastmain River. The hydrographic system in the local study area represents a very low percentage of the Eastmain River's watershed (0.1% total). During operations, run-off water from the entire site will be captured and channelled to water retention basins. This water will then undergo WTP treatment, if necessary, before it is discharged into the environment. Under future conditions, water quality will be ensured by means of a monitoring program. Furthermore, D019, MDMER and EDO requirements will also be met.

As is the case during the construction phase, the tranquility of the premises, especially in the Cree camps located around the mining site itself, could also be affected by mine activities. People who are used to performing traditional activities in the projected infrastructure sector could find their safety compromised by the site's new use. The communication measures implemented during the construction phase will continue throughout the operation phase; the survey and environmental monitoring reports will also be available during this period. For safety purposes, the area closed to traditional activities that is established in collaboration with the Tallyman during the construction phase will be maintained.

IMPACT ASSESSMENT

During the operation phase, the intensity of this impact is deemed to be moderate since activities specific to this phase will feature a higher number of sources of disturbance. That being said, the mitigation measures will decrease the potential negative effects. The extent of the expected residual effects is deemed to be very limited, since they will likely only be felt by Cree territory users who access specific sectors around the mining site, as well as the dozen or so workers and visitors at the km 381 truck stop. The duration is short since the impacts will not be continuously felt. Thus, the significance of the impact on the risks of disturbance during the operation phase is considered to be **minor**.

Cree land users consider that adverse effects during the operation period will be felt within a greater perimeter than what has been used for the air quality and noise modelling studies. Moreover, impacts of operation activities on their negative perception of the environment and water quality will continue over time since they consider these changes irreversible. Thus, according to their assessment, despite a medium intensity, the extent of residual impacts would be local and of long-term, and therefore of medium significance.

REHABILITATION PHASE

SOURCES OF IMPACT

- Dismantling of infrastructure.
- Water management.
- Transportation and traffic.
- Economic development and presence of workers.

MITIGATION MEASURES

Mitigation measures PER 01, UTT 02, CIR 04 and VIE 01 must be applied, as well as the measures intended to decrease atmospheric emissions (AIR 01 to AIR 03), noise (SON 01), water contamination (QUA 01 to QUA 05, QUA 07 to QUA 13), night-time lighting (LUM 01 to LUM 03), and all relevant standards (NOR 1 to NOR 9, NOR 11, NOR 12 and NOR 14). These are set out in Table 7-5.

IMPACT

During the rehabilitation phase, the risks of disturbance will be, for all intents and purposes, the same as for the construction phase.

IMPACT ASSESSMENT

Application of the mitigation measures will minimize the impacts on the risks of disturbances during the rehabilitation phase. As a result, the intensity is considered to be low. Its extent is deemed to be punctual, since it pertains to Cree territory users in the sector surrounding the mine, as well as the km 381 truck stop workers and customers. Its duration will be short, since the impact will only be felt during the rehabilitation phase. The significance of the impact will only be felt during the rehabilitation phase. The significance of the impact on the territory use during the rehabilitation phase is considered to be **minor**.

POST-REHABILITATION PHASE

The negative perception associated with the site remains, is one element that was brought out during the consultation activities that took place within the Eastmain community in 2017-2018. The concerns pertain to possible contamination of the lakes and watercourses surrounding the mine, the effect on resources (fish, wildlife, plants or other natural resources) used for traditional purposes, as well as its effect on human health. Some people are also worried about the potential effects on future generations. The potential impacts on the perception of the physical environment during the post-rehabilitation phase are negative. All in all, implementation of the rehabilitation plan complies with MERN requirements, and the monitoring program arising out of those should help to minimize this impact.

6.2 IMPACTS ON THE PHYSICAL ENVIRONMENT (SECTION 7.2)

SOILS (SECTION 7.2.1)

QC - 111.	**The NOR 03 mitigation measure includes the disposal of contaminated excavation waste beyond criterion C (except for those contaminated with hydrocarbons) in the stockpile, and failing that, its transport to another authorized site. However, Directive 019 states that "unless obtaining prior authorization from the Ministère, only tailings are accepted in the tailings areas." The Project Proponent shall make sure contaminated excavation waste is managed in accordance with the Contaminated Soil Management Grid set out in the *Guide d'intervention* unless having obtained the prior authorization required.**

A - 111: Galaxy commits to the disposal of contaminated excavation in accordance with the Contaminated Soil Management Grid set out in the *Guide d'intervention*. If disposal in the stockpile turns out to be an attracting option, Galaxy will submit an application for authorization to the Ministère and only take action after issuance of said authorization.

QC - 112.	**According to the Phase I characterization report, a Phase II soil characterization is recommended. The Project Proponent shall present results of Phase II and consider these results in Section 7.2.1 as to assess impacts of the project on this component.**

A - 112: Characterization work (ESA – Phase II) was conducted in the summer of 2017 on the project site, at the remote engineered landfill (LETI), as recommended by the Environmental Site Assessment Report (ESA) – Phase I. The only place across the site where significant risks of contamination were identified in the ESA report – Phase I is the LETI. Results of the ESA – Phase II show non-compliant levels of contaminants in the soil and in groundwater at the LETI.

However, as specified in Section 7.2.1 of the EIA, the LETI is located outside the area where work is projected and is unlikely to have affected the sites of the future work. For this reason, no modification was made to Section 7.2.1 of the EIA.

The Phase II characterization report can be found in Appendix A-112.

HYDROGEOLOGY (SECTION 7.2.2)

QC - 113.	**According to the information presented, the only groundwater user listed in the sector is located approximately 700 m from the pit boundary (potable water well at the km 381 truck stop), that is, at the edge of the potential water table drawdown area. The Project Proponent shall commit to supplying the truck stop with drinking water or to drilling a new potable water well in case drawdown of the groundwater makes the truck stop drinking water well unserviceable.**

A - 113: Galaxy commits to supplying the truck stop with drinking water or drilling a new drinking water well in case drawdown of the groundwater makes the truck stop drinking water well unserviceable. To this end, monitoring of well water volume and quality will be conducted every year. Also, people in charge of the truck stop will be asked to report any change observed between each assessment that would require a more thorough inspection.

QC - 114.	**It is indicated on page 7-21 that the pit is expected to fill up with water in 120 to 170 years. The Project Proponent shall provide details of this calculation.**

A - 114: The pit filling time was simulated in a simplified manner from the 3D model developed in the Feflow modelling software. This same model was also used for the assessment of the dewatering flow. Many filling levels (50 m, 150 m and 209 m) were specified to determine the pit filling time. Thanks to this method, it was possible to assess the variation of groundwater flow entering the pit. Groundwater flow for each level was calculated, and thus, it was possible to establish the time required to fill up the associated volume with groundwater. Effective rainfall was then added. Depending on the scenario, results show that the pit filling time is estimated between 120 and 170 years.

HYDROLOGICAL REGIME (SECTION 7.2.3)

QC - 115.	**The fourth paragraph of page 7-23 mentions the "influence of the water table drawdown through pumping around the pit." Pumping around the pit is referenced nowhere else in the study. The Project Proponent shall specify if pumping of the water table via peripheral wells is planned in order to reduce the quantity of water to be managed in the pit. If so, the Project Proponent shall indicate the fate of that water and address the impacts associated with the management of the pumping water. If not, the Project Proponent shall confirm that it is mine water pumped into the pit and not around it.**

A - 115: It is indeed only mine water pumped into the pit. No pumping wells will be installed on the periphery of the pit.

QC - 116.	**The EIA mentions that during the rehabilitation phase, creeks CE2 and CE6 will return to their original watersheds in terms of area. The presence of the waste rock stockpile will nonetheless have a permanent impact on the topography of these watersheds resulting in greater reactivity to precipitation. The Project Proponent shall address the hydrological impacts of these watersheds on the wetlands, as well as their ecological functions, particularly on the capacity of wetlands to regulate a greater and/or sudden water intensity.**

A - 116: Once the site rehabilitation completed, the watersheds of creeks CE2 and CE6 will return to a surface area relatively similar to the current conditions. Only the CE2 watershed will decrease of 7% when compared to current conditions since the south portion of the waste rock stockpile will now drain towards creek CE3. The exact surface areas of the watersheds are presented in Table A-116. We can observe that if the north-west portion (i.e. watershed after the confluence of creeks CE1, CE2 and CE6) is considered as a whole, the total surface area in post-rehabilitation conditions is almost equal to the current conditions. In addition to the slight, but permanent, modification to the watershed surface areas, the presence of the waste rock stockpiles (vegetated) will increase the average slope of the CE2 and CE6 watersheds. In post-rehabilitation conditions, the stockpile will represent 20% of the CE6 watershed area and 10.5% of the CE2 watershed area.

Thus, we can expect that these two watersheds will be slightly more reactive to precipitation, meaning that their time of concentration will be somewhat reduced and unit peak flow somewhat increased.

Considering both components (change in surface area and slope of watersheds), we can anticipate that the average and low water flows of creek CE2 will be slightly lower than the current conditions. The expected increase in peak flows caused by the change in the watershed topography should be mitigated by the small loss of surface area. For creek CE6, the average and low water flows shall return to values very similar to the current conditions. Flood flows might be slightly more pronounced.

Table A-116 Change in Watershed Surface Areas

Name	Surface Area (km²)		
	Current Conditions	Operation (end)	Post-rehabilitation
North-west section (CE1+CE2+CE6)	**19.81**	**20.95**	**19.12**
CE1	7.63	7.63	7.63
CE2	9.07	10.84	8.40
Natural	9.07	7.11	8.40
Main effluent		3.73	
CE6	3.11	2.47	3.09

Considering that changes of minor significance are expected, no significant impact is anticipated on wetlands and their ecological functions.

QC - 117. During the post-rehabilitation phase, the pit will gradually fill up with water thus resulting in the creation of a lake with an outflow toward creek CE3. Discharge at the outflow of the pit lake will cause an increase in the water inflow to the CE3 watershed. Even if no discharge is planned for the first 100 years following the end of mining operations, the Project Proponent shall assess the impacts of discharge on creek CE3, surrounding environments, infrastructure of the area (e.g. James Bay road) and land users.

A - 117: During the first part of the post-rehabilitation phase, the pit will gradually fill up via natural precipitation. No discharge is planned for about the first 100 years (according to the hydrogeological study estimates). The watershed of creek CE3 will then have a surface area of approx. 5.98 km^2 at the James Bay road and 10.58 km^2 at Asiyan Lake outlet (at the confluence with creek CE4), a surface area very similar to the current conditions (very slight increase of about 2%).

It should be reminded that during the operation phase, in addition to the loss of watershed for certain watercourses due to the mining infrastructure, pit dewatering will play a part in exacerbating the decrease in base flows of the watercourses under study, especially creek CE3. During the restoration phase, after stoppage of pumping and with the gradual filling of the pit, creek CE3 base flow shall gradually recover. We can estimate that characteristic flows of creek CE3 will progressively return to values very similar to current conditions.

Then, after approximately one hundred years, it was estimated that the pit will be full and may potentially start discharging excess precipitation like a natural lake would do. The overflow, whose exact characteristics are unknown at this stage of the project, shall be directed towards creek CE3. The watershed of creek CE3 will therefore increase to about 6.9 km^2 at the James Bay road and 11.50 km^2 at the Asiyan Lake outlet, representing an increase of 18% and 11%, respectively, when compared to current conditions. We can assume that the approximate increase in characteristic flows of creek CE3 will be proportional to the increase in surface area. However, the presence of the lake created by the pit flooding will cause the reduction of peak flows in period of high hydraulicity. Thus, the increase of flood flows shall be somewhat mitigated and under 10% on average.

The culvert under James Bay road has a diameter of 2.8 m. According to simulations conducted during the EIA, as well as field observations, there is currently no issue with the passage of flood flow, even of high recurrence. The projected increase in flows during the second part of the post-rehabilitation phase should not be a problem in terms of capacity for this culvert.

As mentioned in the EIA, the study area is characterized by very gentle slopes and a significant presence of beaver dams, and other small hydraulic control structures, meaning that an increase in flows translates into a slight increase in water level. The expected water level increase for creek CE3 during the second part of the rehabilitation phase is very small (a few centimetres).

The table below presents the watershed surface areas of creek CE3 at the James Bay road culvert and downstream of Asiyan Lake, at the confluence with CE4, for various phases of the project. These estimated values were determined by only considering the project impacts; they do not consider climate change impacts.

CE3	Surface Area [km²]		Impact vs CC [%]	
	At James Bay road	At Asiyan Lake outlet	At James Bay Road	At Asiyan Lake outlet
Current conditions (CC)	5.85	10.33	/	/
Operation phase*	5.11	9.71	-13%	-6%
Post-rehabilitation 0-100 years	5.98	10.58	2%	2%
Post-rehabilitation 100+ years	6.90	11.50	18%	11%

* A portion travels via ditches on the site before being discharged, by gravity, in creek CE3.

WATER AND SEDIMENTS (SECTION 7.2.4)

QC - 118. Several results of the leaching tests (SPLP, TCLP, CTEU-9) on the four lithologies making up the waste rocks, tailings and ore samples exceed the criteria for resurgence in surface water (*résurgence dans les eaux de surface*) for several metals. The Project Proponent shall assess the impact of these potential sources of contamination on surface and groundwater.

A - 118: As presented in the kinetic test report (Appendix A-20), results show that waste rocks, tailings and the codisposition mix (waste rocks and tailings) are non-PAG.

Results also show that these materials stop leaching after maximum 14 weeks of testing, except copper in the case of the unsaturated waste rocks and tailings mix (occasional leaching stops after 28 weeks of testing).

Waste rocks and tailings are considered non-PAG at the end of the waste rock stockpile useful life, and therefore deemed “low risk”.

Based on these results, no significant impact is anticipated regarding the leaching of waste rocks and tailings.

As mentioned in A-23, the ore will be stored on a watertight surface and drainage water will be collected by watertight collection ditches, then managed in accordance with D019.

QC - 119.	**On page 7-32, the Project Proponent mentions that "when the infrastructure for water management on the site is dismantled, the surface water's physicochemical nature will return to its initial condition." The Project Proponent shall explain this statement considering that during dismantlement of the infrastructure for water management, water will remain in contact with walls of the pit and stockpile, among others.**

A - 119: As previously mentioned, results of kinetic tests conducted on waste rocks and tailings show that materials are of "low risk" by the end of the column kinetic testing period. Thus, no impact is anticipated for the post-closure period regarding the contact of water with materials stored in the stockpile.

Walls of the pit will be composed of the same materials as the waste rocks, which means their geochemical behaviour should be similar to the behaviour of waste rocks. The risk of leaching on the long-term is therefore not significant.

Also, most of the pit will be flooded. Flooding is a recognized method used to drastically limit the metal leaching processes.

QC - 120.	**During the post-rehabilitation phase, the pit will gradually fill up with water and part of that water will be in contact with exposed rock walls. Thus, contaminants may flow into the hydrographic network and affect the surface water quality. The Project Proponent shall indicate how he plans on making sure Directive 019 is complied with at all times after closure of the mine.**

A - 120: As mentioned in A-119, the walls of the pit will be composed of the same materials as the waste rocks, which means their geochemical behaviour should be similar to the behaviour of waste rocks. The risk of leaching on the long-term is therefore not significant.

Also, most of the pit will be flooded. Flooding is a recognized method used to drastically limit the acid generation and metal leaching processes.

Galaxy will conduct an environmental monitoring during the post-rehabilitation phase as mentioned in Section 2.10 of the D019. The monitoring program will be developed to comply with requirements specified in D019.

As stated in Section 2.11 of D019, a post-rehabilitation monitoring will be conducted to assess the groundwater quality once site rehabilitation has been completed. Effluents should no longer exist; all water flowing through the site will be directed towards the pit to accelerate its filling. The monitoring will be used to detect, if applicable, potential nonconformities and to develop remedial actions as required.

During the post-closure phase, the pit will have filled up to its maximum level. Thus, it is not anticipated that metals will be drastically released. Moreover, the post-rehabilitation monitoring will have allowed the implementation of the required actions to ensure a situation in equilibrium with the receiving environment.

ATMOSPHERE (SECTION 7.2.5)

QC - 121.	**Results of the modelling survey for the construction and operation phases show concentrations of total particulate matter (TPM) and fine particles ($PM_{2.5}$) which exceed MELCC's 24-hour air quality standards. These standards are nonetheless complied with at sensitive receptors. During the construction and operation phases, the Project Proponent must be able to demonstrate that standard mitigation measures, including watering of road sections and work areas, are implemented. The Project Proponent shall record relevant information (frequency of watering, number of trucks, etc.) in a log book available for consultation.**

A - 121: Galaxy will keep a watering and dust control agent spraying log book during the site construction and operation. The frequency and intensity of road watering will be combined to meteorological conditions and to the air quality monitoring. This management practice will help Galaxy assess the efficiency of the control measures and target the required adjustments to ensure compliance with air quality standards. This commitment is mentioned in the Preliminary Dust Emission Management Plan presented in Appendix A-123.

QC - 122.	**For the operation phase, concentration results for metals and metalloids modelled, except crystalline silica, comply with standards considered for the operation phase. Results for the crystalline silica show exceedances of MELCC's one-hour and yearly criteria at the limit of application and at sensitive receptors. At the most affected sensitive receptor, the maximum concentrations modelled for one hour and one year are 103.3 µg/m^3 and 0.128 µg/m^3 respectively. These results correspond to 449% of the hourly criterion and 182% of the yearly criterion. Considering this information and given the magnitude of exceedances for crystalline silica, the Project Proponent shall propose additional mitigation measures as to considerably reduce modelled crystalline silica concentrations at sensitive receptors. The Project Proponent shall specify how he plans on developing and enforcing these mitigation measures. The additional measures shall be integrated into the Air Quality Monitoring Program.**

A - 122: New modelling is in progress to reduce the magnitude of exceedances for crystalline silica. Several mitigation measures are currently being studied, including the reduction of the plant emissions by reducing concentrations from the main point sources to under 20 mg/Rm^3, the increase of the haulage truck payload from 64 tonnes (CAT 775) to 89 tonnes (CAT 777), the addition of restrictions regarding weather conditions during blasting work, and the integration of the latest mine planning update. Results of the crystalline silica modelling optimization will be transmitted to the MELCC as soon as they are available.

As mentioned in the answer to QC-158, the monitoring of crystalline silica near the km 381 truck stop was added to the various monitoring programs conducted by Galaxy. The monitoring will be used to see if crystalline silica concentrations anticipated in modelling are actually measured in the ambient air and to adjust the mitigation measures, notably the restrictions contemplated for blasting (see the Preliminary Dust Emission Management Plan).

QC - 123.	**The Project Proponent shall present a preliminary particle management plan. This plan shall include monitoring measures to be included in the Air Quality Monitoring Program.**

A - 123: The Preliminary Dust Emission Management Plan is presented in Appendix A-123.

VIBRATIONS AND OVERPRESSURE (SECTION 7.2.8)

QC - 124.	**The Project Proponent shall implement a self-noise and vibration monitoring system during blasting as provided in Section 2.4.2 of Directive 019.**

A - 124: As provided in Section 2.4.2 of D019, Galaxy commits to implementing a self-noise and vibration monitoring system during blasting.

6.3 IMPACTS ON THE BIOLOGICAL ENVIRONMENT (SECTION 7.3)

QC - 125.	**Many animal and plant species can currently be found within the site where the mine infrastructure is located. The Project Proponent addresses the impacts associated with the loss of habitats for the organisms, as well as disturbances caused by the project activities, but the impacts related to the presence of contaminants in areas of the mine site where wildlife is present were not considered. It should also be noted that concerns regarding the contamination of the vegetation, aquatic and terrestrial fauna were expressed by land users. The Project Proponent should first address the risks associated with the exposure of vegetation and terrestrial/aquatic fauna to contaminants (impact of bioaccumulation). The Project Proponent shall describe to what extent residual concentrations of contaminants are likely to impact the wildlife.**

A - 125: The assessment of toxicological risks to the human health prepared by Sanexen Services Environnementaux Inc. (2018) is presented in Appendix A-125.

Various exposure cases were considered as part of this study, including the "Traditional Activities" exposure scenario consisting in people (adults and children) part of the Cree community who would visit the close exposure area sporadically for part of the year (extended period of 8 weeks per year and 44 weekends for a total duration of 20.5 weeks per year) and would eat food products on site (game, fish, small fruits and other medicinal plants and/or plants for brewing) from the area. It was assumed that these products of local origin were consumed on a daily basis and that the quantities eaten daily corresponded to those documented in Canada for individuals or populations that eat a lot of meat, fish and fruits. As there was insufficient data, it was also assumed that 2 grams of medicinal plants and/or plants for brewing were consumed daily. It was also supposed that all food eaten during the stay was from the close exposure area.

Risks to the health of the population that may be exposed to metal emissions in the air (population that might visit the study area and/or eat products from traditional activities conducted in the study area, including the close exposure area) are negligible (additional risk of cancer is negligible and absence of risk of other impacts on the health).

Thus, the risk associated with residual concentrations of contaminants in the flora and fauna was not specifically studied, but risks to human health (last link of the food chain) were assessed and considered negligible.

VEGETATION AND WETLANDS (SECTION 7.3.1)

QC - 126.	**Wetlands prevail in the study area, covering 74.4% (2,743.96 ha), and primarily represented by open and wooded peatlands. The project will result in the loss of roughly 302 ha of wetlands and additionally 50 ha via indirect impacts. The Project Proponent mentions that a compensation program will be developed to make up for the inevitable loss of wetlands. This program will be presented with the application for work authorization. The Project Proponent shall describe the key components of the projected compensation program and provide an overview of rehabilitation work, projects for the creation of wetlands or other suggested installations to mitigate the residual loss of wetlands. The Project Proponent shall list stakeholders who were consulted for development of the compensation plan, notably communities, tallymen, land users, etc.**

A - 126: The Wetland Compensation Plan proposed by Galaxy will comply with requirements of the MELCC for this type of project, i.e. a mining project in northern Québec. The Project Proponent already committed to preparing a compensation plan to be closely developed with the MELCC that will consider the MELCC's expectations and general and specific requirements.

At this stage, it would be premature to specify the projects, work or measures that might be included in the compensation plan. Similarly, it is too early to identify specific and tangible markers framing the compensation measures, either regarding the location of the measures part of the plan or establishing the equivalence in terms of type of environment or surface area that may be deemed acceptable. However, we can tackle the major points and general strategies that may be adopted when developing the compensation plan.

The compensation plan will include a set of measures, work activities and projects meant to achieve the objective which is to offset the loss of wetlands. The plan shall primarily include regional measures. This implies that communities and major players in the region will be an integral part of the reflection leading to the identification of suitable offset measures. It should be noted that the northern context and remoteness of the project means that there are currently few projects being developed the Project Proponent could contribute to.

A few avenues are being considered at this point in time regarding suitable offset measures. These measures could include participation to the restoration of abandoned mine sites in Northern Quebec or the creation of wetlands whether for site restoration improvement or restoration of degraded sites (several types of wetlands could be developed). This could include riparian shrub swamps or shallow water areas around the future pit (which will be flooded at the end of operations) or the development of treed swamps (black spruce stand with lichen). The restoration of peatlands in collaboration with the Peatland Ecology Research Group (PERG), affiliated with Université Laval, may also be an interesting avenue for inclusion in the compensation plan. Financial contribution to research could be considered, notably for the acquisition of fundamental knowledge applied to the boreal wetlands of Northern Quebec (ecology of wetlands, plant ecology, biodiversity conservation, wetland restoration). To that extent, partnerships with various academic researchers could be established, such as Professor Nicole Fenton (Université du Québec en Abitibi-Témiscamingue), Chairholder of the NSERC-UQAT Industrial Research Chair on northern biodiversity in a mining context, and professor Line Rochefort (ULaval), Chairholder of the Industrial Research Chair in Peatland Management.

It is not excluded that financial compensation be part of the offset measures. The Project Proponent shall continue its efforts to identify opportunities for participation and development of compensation work and projects. All elements may be discussed with the MELCC beforehand and presented in a comprehensive compensation plan that could be submitted one year after being granted governmental authorizations.

QC - 127. Some wetlands may be subject to partial dewatering in the periphery of drainage ditches. The Project Proponent proposes the construction of a small clay berm along stripped areas to reduce the impact. The Project Proponent shall demonstrate how the design of ditches, including building of the berm, will help limit drainage of wetlands.

A - 127: The construction of a clay berm along stripped areas shall reduce the horizontal drainage of surrounding wetlands, thus reducing indirect losses. However, the concrete efficiency of this innovative measure, proposed when developing the EIA, has yet to be demonstrated, which is why the indirect losses were assessed without considering the efficiency of the clay berm measure. It should be noted that the indirect impacts calculated in the study consider a maximum dewatering (without berms). It was mentioned that monitoring of vegetation in the vicinity of the infrastructure shall allow to assess the effectiveness of the measure. Following monitoring of vegetation, and if the measure turns out to be as efficient as anticipated, the indirect losses of wetlands to be integrated to the mitigation measures may be revised.

QC - 128.	**The Project Proponent conducted plant surveys in July 2017 and reported two occurrences of sterile sedge (*Carex sterilis*), a plant species likely to be designated threatened or vulnerable. After review of the specimen scanned documents, it was confirmed that the plant was rather *Carex exilis*, a vascular plant common to the boreal fen of Quebec. Therefore, relocation of the population, as proposed by the Project Proponent, is not required.**

A - 128: The occurrence of *Carex sterilis* was confirmed by two biologists specialized in botany from WSP, Mr. Jean Deshayes and Mr. Jean-Bastien Lambert. The analysis of the specimens under stereoscopic microscope, conducted after the inventory campaign, confirmed the identification of the species. However, the high variability of inflorescence in a single individual was observed for specimens collected. This is a natural variability of the phenotype often seen in *Carex sterilis*. Various criteria were, however, used to distinguish *Carex sterilis* from *Carex exilis*:

- presence of several spikes carried by each floriferous stem (see pictures below);
- flat leaves (not involute) (width of 1.2-2.6 mm);
- Size of perigynous: 2.5-3.0 mm in length and 1.2-2.2 in width.

One thing is for sure, the high variability of *Carex sterilis* makes its identification sometimes difficult. A few sources even consider this taxon as a hybrid rather than a distinct species (e.g. BOIVIN, B., "Les cypéracées de l'est du Canada", Provancheria, #25, 1992). Nonetheless, the overall characteristics of the specimens collected point to the *Carex sterilis* rather than the *Carex exilis*. Galaxy is confident that the specimens collected are *Carex sterilis*. Specimens may be provided upon request if in-depth expertise is required for the identification. If MELCC's experts consider that relocation of the population is not required, such work will be removed from the mitigation measures applicable to the project.

QC - 129.	**No invasive alien plant species was observed across the site during surveys. The Project Proponent states that machinery transportation and traffic on the work site could accidentally introduce or propagate invasive alien species. Two common mitigation measures are proposed to reduce those risks, i.e. cleaning of excavation machinery or vessels before using them on site and verification of the potential introduction or not of invasive alien plant species annually and quickly eradicate, wherever possible, any new occurrences of invasive alien plant species observed. The Project Proponent shall supplement the two measures with a follow-up survey two years after the end of work as to assess if invasive alien plant species have grown.**

A - 129: As mentioned in Section 10.4.4.1 of the EIA, monitoring of the introduction and spreading of invasive alien plant species is proposed and will take place every year during the mine construction, operation and rehabilitation phases. The monitoring will be conducted to detect the presence of invasive alien plan species in work areas. Once rehabilitation is complete, the site will be monitored one more time. It may be monitored a second year if needed and requested by the MELCC.

QC - 130.	**On page 6-67, the Project Proponent identifies 27 plant species of traditional interest used by the Cree people in the study area. The Project Proponent shall describe how the project impacts on these plants were assessed for each phase (construction, operation, rehabilitation and post-rehabilitation). The Project Proponent shall integrate the comments and knowledge gathered from the trapline tallymen and land users.**

A - 130: The 27 plant species of traditional interest listed in Table 6-28 are species known for being used by all Cree communities of the James Bay region according to the literature review. They are thus likely to be used by the Eastmain Cree community. This list must be viewed as exhaustive since it includes a larger number of taxa than the ones whose use was confirmed during interviews with members of the local community. Moreover, all species listed are abundant and common in the vicinity of the mine area and across the James Bay territory.

In order to mitigate the project impacts on plants of traditional interest, information was gathered from the trapline tallymen and their families (RE2, VC33 and VC35) and other land users (James Bay region communities and Eastmain Cree community) as part of the consultation activities described in Chapter 5 and Appendix G of the EIA. The interviews helped demonstrate that the traditional use of the territory by trapline tallymen regarding the local flora mainly consists in blueberry and mushroom picking and that the territory is seldom used. Other plants are of interest for brewing (e.g. Labrador tea), but this activity was not documented during interviews. Tree species are said to be mostly used for their wood and medicinal use.

Users of these resources shared worries regarding the environment and the integrity of the territory. Dust from mining activities that might contaminate the environment appears to be the primary concern.

With that in mind, chemical analyses were conducted to document the concentration of 24 metals found in the leaves/needles, fruits and branches of six species sampled in the study area. The results serve as an indication of the background concentration of chemical elements in the vegetation and are used to assess the risk of contamination for traditional food found across the projected mine territory. Monitoring meant to document the concentration of contaminants in vegetation over time in various areas surrounding the mine will be implemented and begin at the implementation of the project and continue after the site restoration. The detailed monitoring program will be presented to the MELCC when obtaining the environmental authorizations for the beginning of construction.

QC - 131. It is indicated on page 7-48 that the assessment of impacts on the vegetation and wetlands during the rehabilitation phase is not required and that impacts during the post-rehabilitation phase will be nonexistent. The Project Proponent shall further justify this statement.

A - 131: As mentioned in Section 7-48 of the EIA, the sources of impacts identified for the rehabilitation phase, once the mining operation is completed, are limited to transport and traffic, and dismantlement of infrastructure. The introduction and spreading of invasive alien species may arise from the aforementioned activities, namely transport and traffic of machinery. Nevertheless, the implementation of mitigation measures shall reduce the risks to a negligible level.

The rehabilitation phase shall consist in the revegetation of infrastructure in accordance with standards and acts in force (Mining Act) as to initiate the redevelopment of a plant cover and the primary succession across stripped areas affected by the mining activities. The impacts of the rehabilitation phase on the vegetation and wetlands are deemed positive in so far as no invasive alien species is introduced at the end of work required in this phase. For the post-rehabilitation phase, the connectivity of the restored site with the surrounding environment will allow the gradual establishment of local indigenous vegetation over time. The site's ecological processes and functions will come close to resembling the surrounding environments' as it mature. Since no mining activity is planned during the post-rehabilitation phase, the negative impacts on the vegetation and wetlands are inexistent.

QC - 132. The rehabilitation shall promote the restoration of wetlands so they are similar to their initial conditions. The Project Proponent shall specify how the restoration of ecological functions was considered in the development of the proposed rehabilitation measures.

A - 132: The different stages of the methodology for the restoration of wetlands will be provided when submitting the restoration plan. This plan will be provided to the *Ministère de l'Énergie et des Ressources naturelles* (MERN) so it can be made public at least 30 days before the consultation begins, in accordance with provisions of the Mining Act (CQLR, Ch. M-13.1). To ensure the restoration of ecological functions to a state as similar to the initial conditions of wetlands as possible, various types of wetlands could be developed to enhance the site rehabilitation, including riparian shrub swamps, shallow water areas and treed swamps (black spruce stand with lichen). The rehabilitation could also include peatland restoration methods developed by the Peatland Ecology Research Group (PERG) affiliated with Université Laval. These wetland areas could represent added value for the site rehabilitation and also be integrated to the compensation plan to be developed in parallel. The proposals put forward during consultations for the mining lease will be taken into consideration for a subsequent revision of the rehabilitation plan.

LARGE FAUNA (SECTION 7.3.2)

QC - 133. The presence of household waste and food resources may attract animals, especially bears, near the site. To prevent this, the Project Proponent mentions on page 7-49 that "workers will be made aware of the importance of not feeding animals or leaving food lying about." In addition to the implementation of good individual practices, appropriate residual material management measures shall be proposed. For example, the use of bear-resistant trash cans, fencing of residual material storage areas or other measures can be considered to limit access to food sources on the site. The Project Proponent shall present additional mitigation measures.

A - 133: The answer to QC-56 shows a willingness to compost household waste. The composter would be regularly fed meaning that cafeteria waste would not accumulate.

If the installation of the composter is delayed, cafeteria waste will be stored in a container until its disposal at an authorized landfill. Although details of the site where the container will be located are not specifically defined, the presence of bears or other animals feeding from residual materials is clearly not desirable. Appropriate exclusion measures will be implemented: the container will prevent animal access and actual access to the container storage area will be controlled with wire mesh and fences. The management of residual materials that may attract animals will therefore be conducted as to prevent the intrusion of animals in the container area.

ICHTHYOFAUNA (SECTION 7.3.4)

QC - 134.	**One of the mitigation measures presented by the Project Proponent consists in banning recreational fishing for the mine site workers as to limit the impacts of catches from this type of fishing. The Project Proponent shall indicate how he plans on implementing this measure and if an arrangement was made with authorities having jurisdiction regarding restriction on recreational fishing.**

A - 134: The ban on recreational fishing throughout the working visit, as well as during the mobilization and demobilization activities, will be part of the worker's contract. Workers hired by Galaxy shall commit to complying with this directive by signing an agreement. Failure to respecting this commitment and to complying with the established rules may subject workers to disciplinary measures, possibly even going as far as layoff.

QC - 135.	**A sturgeon spawning ground community project is planned at the intersection of James Bay road and Eastmain River. Even though this project is located several kilometres north of the site, land users have expressed some concern. The Project Proponent shall address the potential impacts of the project on this spawning ground and, if necessary, present planned mitigation measures to limit the impacts.**

A - 135: No impact is anticipated on sturgeon spawning ground since the project is located 10 km north of the spawning ground. Even though watercourses of the study area flow either to the east or to the west, towards the Eastmain River, the drainage network of the local study area accounts for a very small percentage of the Eastmain River watershed (0.1% in total). During operation, runoff water from across the site will be caught and forwarded to the water retention basins. If needed, water will be treated before its discharge into the environment. Water quality will be ensured via a monitoring program.

6.4 IMPACT ON THE SOCIAL ENVIRONMENT (SECTION 7.4)

CURRENT USE OF LAND AND RESOURCES FOR TRADITIONAL PURPOSES (SECTION 7.4.1)

QC - 136.	**It will be easy to access the mining infrastructure. To ensure safety of land users, the Project Proponent proposes to establish an exclusion zone for traditional activities near the mine site, in collaboration with the RE2 trapline tallyman. It is also mentioned that "the at-risk developments on the site will be secured." The Project Proponent shall specify the protection measures he plans on implementing to ensure the safety of land users near the mine site.**

A - 136: The project site will be surrounded by a fire prevention barrier used as a boundary and preventing access to the site. Explanations will also be provided to the trapline tallyman and his family to ensure their safety.

A fence will be installed around the industrial and administrative sector, which includes the ore stockpile, concentrator, mechanical workshop, warehouses, administrative buildings and the workers' camp.

Fences will also circle the propane tanks and generators. Another fence will be around the explosive magazine.

QC - 137.	**One of the measures for mitigation of the project impacts on the land use for traditional purposes consists in "establishing and maintaining a communication plan to inform the public, users, and municipal authorities about the start and progress of work." It is also proposed to make monitoring and environment quality monitoring reports available. The Project Proponent shall indicate the exchange mechanisms with the land users and the public that will be put in place.**

A - 137: It is mentioned at the beginning of Section 5.7 (EIA) that:

> "Galaxy has agreed to develop sustainable relationships with stakeholders, to maximize the social and economic benefits of the project while minimizing its environmental impacts. The mining company is also sharing information on the project, specifically by holding open houses, committing to having Galaxy's community relations manager spend one week per month in the community, organizing sessions with stakeholders, posting updates on the website, and maintaining direct links with employees. With these commitments, Galaxy aims to offer timely and relevant responses to all the comments and concerns voiced with regard to the James Bay Lithium Mine project.
>
> The relationship and exchanges between Galaxy and stakeholders will be maintained throughout the life of the project."

It is also mentioned in Section 5.7.2 of the EIA that a monitoring committee will be established prior to the mine's construction and will remain active throughout its life. Therefore, exchanges of information may be conducted via this committee which will be composed of at least one representative from the Eastmain Band Council, one from the business community, one from the city of Eastmain and one from the EIJBRG. Galaxy would also like to include either the RE2 tallyman or one of his family members.

QC - 138.	**The Project Proponent suggested a few information activities (field visits, Mining 101 course) so the community can get a better sense of the mining work and impacts. A few members of the community have mentioned that they feel that the projected impacts of the project are being minimized (page 5-8) and that they do not have complete trust in the mitigation measures proposed. The Project Proponent shall indicate how the environmental and social concerns expressed by the community were addressed and which mitigation measures can be used to alleviate those concerns. The Project Proponent shall also specify which mitigation measures were proposed by Cree people, which ones were selected, and if applicable, justify why certain measures proposed by the Cree people were not selected.**

A - 138: Mitigation measures proposed by the Nations, and how they were addressed by the Project Proponent, are presented in Table 138-1.

Table 138-1 Mitigation Measures Proposed by the First Nations

THEME	MITIGATION MEASURE OR SUGGESTION MADE BY STAKEHOLDERS	CONSIDERED (C), CONSIDERED IN PART (CP), NOT CONSIDERED (NC), NOT ANSWERED (NA)
Impacts on the environment	The Eastmain Cree First Nation Council should list impacts of commissioned lithium mines to assess the extent of impacts for such operations.	NA: Measure intended for the First Nations Council.
	Measures are necessary for dust control.	C: Implement the following mitigation measures (Table 7-5 of the EIA): • AIR 01: Regularly water roads, work areas, and stockpiles by moistening them to prevent resuspension and dust emission. • AIR 02: Avoid unnecessary engine idling to reduce noise and disturbances from exhaust gas, smoke, dust, or any other contaminants likely to come from the machinery. • AIR 03: Limit the vehicle speed on the various sites as well as for mine operations. • AIR 05: Optimize stripping according to the real needs of the operation so as not to overexpose unused stripped surfaces in relation to wind erosion and/or to restrict, as needed, access to these surfaces if they are not used during long periods of time.
	If the project is approved, environmental tests must be conducted every week or every month to monitor water quality and the presence of contaminants in the environment.	C: Through the implementation of an environmental monitoring program during the construction phase (Section 10.3 of the EIA), of environmental monitoring during operations (Section 10.4 of the EIA) and of post-rehabilitation monitorings (Section 10.5 of the EIA), as well as the PER 01 measure. Make sure supervision and environment quality monitoring reports are available
Give hiring priority to Cree workers in Eastmain	• The Eastmain Cree community wants to have the priority for all types of jobs required throughout project (accommodation, construction, transportation, aviation, services, etc.). • Jobs must be available for Indigenous people. Qualifications for the jobs must be posted ahead of time as to plan training of members of the community, including the youth. • Galaxy should provide jobs to local contractors.	C: Implement the following mitigation measures (Table 7-5 of the EIA): • ELR 01: Establish a regional purchasing policy that would prioritize local and regional companies in the competitive bidding process where the skill and price are competitive. • ELR 03: Prioritize hiring local workers. • ELR 04: Develop a memorandum of understanding and partnership agreement for Indigenous participation in the project. • ELR 06: Establish a communication plan to announce to local stakeholders the positions to be filled at the mine. Galaxy also commits to organizing training programs in partnership with the HRDC so that Cree workers can have access to jobs at the mine.
Professional ethics and standards endorsed by Galaxy which could be a barrier for Indigenous workers	• Galaxy must develop a training workshop or program to prepare future Indigenous workers so they comply with professional ethics and standards implemented by the mining company. • A Cree Representative must be identified for liaison between the Cree workers/community and the mining company in case of dispute. The liaison officer or mediator shall mitigate problems.	C: Implement the following mitigation measures (Table 7-5 of the EIA): • ELR 04: Develop a memorandum of understanding and partnership agreement for Indigenous participation in the project (agreement on impacts and benefits). • ELR 05: Implement mechanisms to integrate workers, particularly for members of Indigenous communities (information sessions, human resources representatives, employee assistance program, etc.). • VIE 01: Establish an ongoing dialogue with the public through an internal community relations group and communication program. • VIE 02: Establish and implement a code of ethics for workers.
Training	• Galaxy should work together with the Cree school board and the HRDC to develop training programs. • These training programs should be provided to the community to ensure success of students. • Galaxy shall start training of community members without delay and maintain the training programs established with a long-term perspective. • It would be interesting to conduct a survey of the youth to assess their interest in regard to the mining industry and training programs they would be interested to. • Training opportunities shall be properly advertised within the community.	C: Galaxy works with the Cree school board and the HRDC for the training and professional development of the Eastmain population. Galaxy will encourage training institutions to provide training within the community. Training programs within the community will commence following the issue of provincial and federal environmental authorizations.
Work and culture	Establish cultural diversity workshops and set up a code of ethics to respect.	C: Galaxy has policies on employment equity and sexual harassment on the workplace, which commits the company in regard to gender equity, sexual orientation, family status, domestic responsibilities, race, impairment, political or religious beliefs, and age. This commitment shall translate into the integration of intercultural events in the company's disciplinary process, the preparation of an intercultural training component within the orientation program and the hiring of a Cree liaison officer. Implement the following mitigation measures (Table 7-5 of EIA): • VIE 02: Establish and implement a code of ethics for workers. • ELR 05: Implement mechanisms to integrate workers, particularly for members of Indigenous communities (information sessions, human resources representatives, employee assistance program, etc.). • UTT 01: Ensure workers are aware of traditional practices of Indigenous communities and activities of Indigenous users of the territory.

Table 138-1 Mitigation Measures Proposed by the First Nations (continued)

THEME	MITIGATION MEASURE OR SUGGESTION MADE BY STAKEHOLDERS	CONSIDERED (C), CONSIDERED IN PART (CP), NOT CONSIDERED (NC), NOT ANSWERED (NA)
Labour dispute	• Appoint a representative to mediate between the community and the mine. • Construction of a *sabtuan* (large gathering tent) at the workers camp could be a great initiative. • A cultural village should be developed at the workers camp.	C: Implement the following mitigation measures (Table 7-5 of the EIA): • ELR 05: Implement mechanisms to integrate workers, particularly for members of Indigenous communities (information sessions, human resources representatives, employee assistance program, etc.). • UTT 01: Ensure workers are aware of traditional practices of Indigenous communities and activities of Indigenous users of the territory. • VIE 01: Establish an ongoing dialogue with the public through an internal community relations group and communication program.
Sexual harassment	• Galaxy shall organize a workshop on sexual harassment intended for Indigenous and non-Indigenous people. • A grievance procedure shall be implemented to ensure support to victims of sexual harassment. After a while, a liaison officer or mediator shall contact the victims for follow-up. The agent shall be a woman to facilitate thrust.	C: Implement the following mitigation measures (Table 7-5 of the EIA): • ELR 05: Implement mechanisms to integrate workers, particularly for members of Indigenous communities (information sessions, human resources representatives, employee assistance program, etc.). • UTT 01: Ensure workers are aware of traditional practices of Indigenous communities and activities of Indigenous users of the territory. • VIE 01: Establish an ongoing dialogue with the public through an internal community relations group and communication program.
Enhancement of mining knowledge	• Galaxy could invite a chemical engineer, or someone well acquainted with operations of a lithium mine, to the community to talk about mining operations and answer questions. • A course on mining operations is also requested as to understand each stage of the procedure and to be able to identify impacts.	C: Introductory course on mining operations and lithium was provided to the Eastmain community on July 11, 12 and 13, 2018. Other information sessions on the project development are planned.
Business/partnership (partnership with the Eastmain community for the mine development)	• A mutual relationship or partnership shall be established between Galaxy, the Eastmain First Nation Council and the WEDC.	C: Galaxy wants to establish a partnership link with the community and is working to that end. The following mitigation measure is presented in Table 7-5 of the EIA: • ELR 04: Develop a memorandum of understanding and partnership agreement for Indigenous participation in the project.
Fair trade contributing to the enrichment of the community while complying with its values	• Establish a fair trade with a business model which will contribute to the enrichment of the community while complying with its culture and values.	CP: This element will be developed after permitting. The following mitigation measures are still provided in Table 7-5 of the EIA: • ELR 01: Establish a regional purchasing policy that would prioritize local and regional companies in the competitive bidding process where the skill and price are competitive. • ELR 07: Regularly update forecasts regarding the duration of operations and announce in advance the closure of the mine.
Boom and bust phenomenon and its impacts	• Diversify economic activities and services to face the boom and bust phenomenon resulting from the mining project.	C: Galaxy is working with the community so it benefits from positive economic and social impacts. The project development will be in accordance with reality of the mining industry, i.e. the development is designed with the mine life cycle in mind. Preparation for mine closure will be done throughout the development. The following measures will also be implemented (Table 7-5 of the EIA): • ELR 01: Establish a regional purchasing policy that would prioritize local and regional companies in the competitive bidding process where the skill and price are competitive. • ELR 02: Offer training programs to fill mine positions. • ELR 03: Prioritize hiring local workers. • ELR 06: Establish a communication plan to announce to local stakeholders the positions to be filled at the mine. • ELR 07: Regularly update forecasts regarding the duration of operations and announce in advance the closure of the mine. • ELR 08: Develop an Employee Assistance Program to provide closure transition support (e.g. reclassification assistance committee for workers).
Workers' traditional activities	• Galaxy should grant leave to Cree workers in spring for goose hunting and in fall for moose hunting.	C: Implement the following mitigation measure (Table 7-5 of the EIA): • VIE 05: Establish with the representatives of the Cree community an annual calendar of the main traditional activities and set time slots for production stoppages based on their participation in these activities.
Use of territory by non-Indigenous people	• Galaxy should consider setting up a special hunting and fishing zone, such as the Weh Sees Indohoun special zone established for Hydro-Québec projects. • Galaxy should set up a security patrol to prevent non-Indigenous workers from hunting or fishing, or stealing equipment, on the Eastmain territory.	C: Implement the following mitigation measure (Table 7-5 of the EIA): • UTT 04: Prohibit hunting and recreational fishing for workers at the mine site.
Traffic, transportation and roads	• Use electric cars to reduce pollution from mine operations	C: Information is presented in Section 3.5 of the EIA: For hauling and road transport vehicles as well as heavy equipment (excavators, power shovels, etc.), the international supply of electrical engines was assessed as to reduce GHG emissions. Finds out models required for the project are not available in Canada at the present time. The mobile fleet, including pick-up trucks, will be diesel-powered and a few pieces of equipment will use electric engines (on a trial basis) if they become readily available in Canada before construction works of the project start.

Table 138-1 Mitigation Measures Proposed by the First Nations (continued)

THEME	MITIGATION MEASURE OR SUGGESTION MADE BY STAKEHOLDERS	CONSIDERED (C), CONSIDERED IN PART (CP), NOT CONSIDERED (NC), NOT ANSWERED (NA)
Impact of increased traffic on the James Bay Road on driving conditions	• Local radio advertisement for traffic of heavy equipment or large trucks.	C: Implement the following mitigation measure (Table 7-5 of the EIA): • CIR 01: Establish a traffic management plan, including the addition of signage.
Investment in maintenance of James Bay Road	• Plan road pavement resurfacing once mine is completed.	NC: Galaxy will not directly pay for maintenance of the road. It shall pay taxes to the governmental authorities.
Transportation of chemical products	• Supervision of transportation of chemical products.	C: There will be few hazardous products on the site. Diesel will be the main product being transported on the road. Its transportation will be monitored and done in accordance with the applicable regulation.
Reopening of the Opinaca airport	• Pave the road leading to the Opinaca airport in the event of its reopening as to minimize dust. Install road signs along the road to limit speed. • Close the road leading to the Opinaca airport which goes along the VC35 trapline as to not disturb land users. Workers shall make a detour to avoid the camp.	NC: Galaxy is still considering this opportunity as part of its project optimization procedure.
Economy – Benefits for the community	• Galaxy should contribute to the community by offering sponsorships or scholarships. • Galaxy should also support Cree companies, such as a solar panel company of Waskaganish, Creenewable Energy, by using and advertising their products.	CP: Distribution of benefits will have its own section in the agreement with Eastmain community (Impact and Benefit Agreement).
Galaxy policies regarding alcohol and drug use on the mine site and at the workers camp	• Galaxy shall develop a policy regarding alcohol and drug use on its mine site and at the workers camp. • Education regarding alcohol abuse is required within communities, notably for the youth, to ensure professional success. • Require that people working on the mine, particularly people working with machinery or driving trucks, be tested for drug use. All workers should be tested before start of their work shift.	CP: Implement the following mitigation measures (Table 7-5): • VIE 02: Establish and implement a code of ethics for workers. • VIE 03: Prohibit alcohol consumption in the worker camp at the site.
Demands on the community health services	• Galaxy should have a pharmacy, nursing staff, doctor and emergency transportation service on site. • Galaxy should invest in the community health services and in accommodation for the additional personnel.	C: No demand on the Eastmain health services is anticipated. Galaxy will operate autonomously on its site; a nurse will be on-site at all times and an ambulance will be available.
Revenue management	• Provide courses on the management of personal finances.	C: Galaxy is open to the idea of providing support for the management of workers' finances.
Benefits for Cree workers	• Cree workers should have access to benefits such as insurance, family allowance, etc. They should not pay tax on their salary. • Galaxy could establish good work schedules, such as 14 days of work/14 days of rest or 14 days of work/10 days of rest.	CP: Cree workers' work schedule and benefits will be discussed in negotiations on the Impact and Benefit Agreement with the Eastmain community.
Impact of workers absence on their families	• A schedule consisting in 7 days of work and 7 days at home could be suitable for women with young children. A schedule consisting in 14 days of work and 14 days at home could be favorable for women with older children, but they will need a lot of support from their family. • Galaxy should set up a benefit for Indigenous workers with dependent children. • Galaxy could consider contributing to certain school programs given the impact the project will have on children.	CP: Cree workers' work schedule and benefits will be discussed in negotiations on the Impact and Benefit Agreement with the Eastmain community.
Environmental monitoring and follow-up	• Conduct a study before start of blasting operations as to establish a reference state for appropriate monitoring of potential environmental impacts.	C: The reference state was established as part of the EIA (Chapter 6 of the EIA). A preliminary environmental monitoring program was also developed in the EIA. It shall be improved after receiving environmental authorizations.

QC - 139. Section 7.4.1 mentions that the project could result in the modification and shifting of traditional hunting and trapping activities. The Project Proponent shall provide further details on how the project will impact traditional wildlife hunting activities, including waterfowl and caribou hunting.

A - 139: The mine activities during the construction, operation and rehabilitation phases may affect the traditional activities of land users in various ways. Land users are concerned about the noise, vibrations and pollution emitted by the mine which can be detrimental to the vegetation regenerating across the land after the 2013 forest fire. Traditional activities have temporarily slowed down since the fire, but land users plan on continuing to perform such activities in the area.

They estimate that the noise will disrupt wildlife thus leading to their departure from the surrounding area. Traditional moose and small game hunting and trapping activities that are usually conducted within a certain radius of the mine may have to be moved. However, at this stage of the project, the land users cannot assess the extent of this radius. Users may have to invest a great amount of time to find new small game hunting and trapping sites. According to the land users, the pollution emitted by the mining activities could affect the fauna and flora, and thus, the health of users eating these resources. Users will prefer moving away to an area not affected by the industrial activities to conduct harvesting activities. However, the impacts associated with the shifting of small game hunting and trapping sites may be mitigated by the likely increase in population density around the mine. For most small game species, the shifting of individuals whose home range overlaps or borders on the infrastructure right-of-way may lead to an increase, at least temporarily, in population density around the study area where similar habitats can be found.

Land users also dread accidental spills and water pollution which would interfere with or disrupt their fishing activities, notably on the Eastmain River. They also mentioned that the study area has always been favourable to beaver populations even if a certain amount of time is required for their resettlement following forest fires. Land users are worried that vegetation undergoing regeneration might be contaminated, or that water be polluted by spills, thus greatly disturbing that resource. As a result, a decrease in trapping activities would be observed.

No change to the surface water quality is anticipated during the construction phase. Although the risk of accidental petroleum hydrocarbon spills cannot be excluded, several mitigation measures will be implemented to minimize the risk. This environmental risk is also taken into consideration in the emergency measures plan and procedures will be established to prevent spills and minimize their impacts. In 2018, Sanexen conducted an assessment of the ecotoxicological risks to human health. The assessment considered traditional activities as an exposure scenario and concluded that the risks to the population were negligible for all exposure scenarios.

For the waterfowl, land users who hunt geese near the site mentioned that the noise and smell caused by the mine may have a repulsive effect on geese. Their migratory route may even be affected according to land users. They fear that geese will avoid the areas where they usually hunt. If this is the case, they will have to hunt elsewhere and get used to new activity areas. However, some users think that geese should not be too strongly disrupted by the noise and believe they will not have to change hunting area. Also, land users mention that geese might feed on plants contaminated by particles from the mine which, carried by snow, are absorbed by plants. These users would be reluctant to eat geese that stayed within a certain radius of the mine.

To allow them to adapt their hunting and trapping activities to the new conditions created by the project, land users will be informed before the work begins and of its progress. In addition, for security reasons, prior to the start of work, an exclusion zone for traditional activities will also be established near the mine site, in collaboration with the RE2 trapline tallyman.

Land users mentioned that there are fewer and fewer migratory caribou across the territory and that no caribou have been observed since the 2013 forest fire. No specific impact associated with the mine activities on this subspecies of caribou was therefore mentioned. The woodland caribou should not be particularly affected since its range is south of the study area boundary and that, according to one land user, it does not travel further north.

INFRASTRUCTURE (SECTION 7.4.2)

QC - 140.	**The EIA does not present the impacts associated with the storage and transhipment of the concentrate to the Matagami transhipment facility. The Project Proponent shall specify the impacts of these activities on the environment, including the economic and transportation impacts for the City of Matagami and its residents.**

A - 140: The assessment of impacts associated with the storage and transhipment of the concentrate to the Matagami transhipment facility is presented below.

QUALITY OF LIFE AND LOCAL ECONOMY – MATAGAMI

CONTEXT

The Matagami transhipment yard will be called upon only during the operation phase for storage and transhipment of the spodumene concentrate coming from the mine. The concentrate will be transferred into trains at this location. About 22 trucks will be required daily for the transport of the concentrate.

The transhipment yard is owned by the City of Matagami. The yard has a railway network of 3 km, 250,000 m^2 of storage space and almost as much area ready to be developed[1]. It is located about 4 km south-west of downtown Matagami, just off of Route 109 which is an extension of James Bay road. Route 109 skirts around the city (approximately 400 m from the nearest residential neighbourhoods), crosses the industrial district (boulevard Industriel, Route 109) and runs within close proximity of the cemetery before reaching the transhipment yard.

In addition to the transport of the concentrate, the input required for the operation of the facilities (propane, diesel, etc.) will be delivered by truck (estimate of about five shipments per day). The average annual daily traffic (AADT) of trucks as a result of the mine activities is therefore estimated to about 53 trucks (considering round trips).

According to SDBJ data[2], approx. 57,000 vehicles use the James Bay road on average each year, which translates to a AADT of about 314 vehicles (considering round trips). Of those, about 31% consist of heavy vehicles (of various types).

OPERATION PHASE

SOURCES OF IMPACT

- Transportation and traffic in Matagami, including increase in activity at the transhipment yard.
- Economic development and presence of workers.

MITIGATION MEASURES

Measures NOR 09, AIR 02, NOR 11, SON 01, CIR 01, VIE 01 and VIE 02 must be applied. They are indicated in Table 7-5 of the EIA.

[1] Matagami transhipment yard [Online]: https://ct-matagami.com/accueil/acces/ [consulted on June 3, 2019] [French only].
[2] Traffic data on the James Bay road compiled for 2014 and 2017. Email exchange, Jean Nouvellet, Société de développement de la Baie-James, May 2018.

DESCRIPTION OF IMPACT

During the operation phase, the use of 53 heavy vehicles is planned for daily round trips of spodumene concentrate to the Matagami transhipment yard. The impact of the project on the AADT on the James Bay road represents a global increase of 17%, or an increase of 54% if we only consider heavy vehicles. However, the traffic flow on that road remains low. In comparison, the traffic flow on Route 109 south of Matagami, starting from the airport road, is approximately 600 vehicles according to traffic flow data released by Transport Québec[3].

At the beginning of the operation phase, users of the James Bay road and Route 109 in Matagami may have to adapt to the increase in heavy vehicle traffic all the way to the transhipment site given the increased accident risk, dust and pollution created by these trucks. However, since the nearest residential neighbourhoods are 400 m from the road, and approximately 4 km from the transhipment site, the noise produced by the traffic influx resulting from the project should not particularly inconvenience residents, especially since a forest cover separates the road and the site, thus mitigating the extent of noise. Also, transport should mainly occur during the day.

Where appropriate, standard mitigation measures planned for traffic on the James Bay road will also be implemented on Route 109 to the transhipment site. The site's safety measures and standards will then be applied and thus mitigate disturbances associated with the increase in traffic.

Furthermore, the transport and transhipment of the concentrate to Matagami should be a benefit to the local and regional economy. Drivers will need to be hired to transport the concentrate to the transhipment site. A greater need for labour may also be felt for the development of the transhipment yard (if required), and for the daily acceptance of the concentrate associated with the increase in activities. The local economy could also be boosted given the necessities required for the maintenance of trucks and to satisfy the needs of drivers (food, accommodation). An increase in the activities of services and businesses will be seen as a result.

Measures to prioritize the hiring of local workforce and favouring regional businesses (Cree and non-native communities) are planned. They will contribute to the positive impact of the project on Matagami's economy.

IMPACT ASSESSMENT

During the operation phase, the project impact associated with the local economy of Matagami is considered **positive**.

The intensity of the impact associated with the quality of life in Matagami is considered low. For the first few years of operation, citizens will have to adapt to the nuisance caused by the increased traffic. However, they are familiar with heavy vehicle traffic on the James Bay road and Route 109. Also, the transhipment yard is a fair distance from the city.

Its extent is local since the impacts might be felt by users of the James Bay road and of Route 109 (mainly in Matagami). The duration is medium since the period of adjustment needed by land users will stretch over only a few years. Thus, the significance of the impact on the quality of life in Matagami is considered **minor**.

QC - 141. The Project Proponent shall assess the impacts of transportation caused by the project on the James Bay road for Cree users of trapline areas adjacent to the road.

A - 141: The assessment of impacts of transportation caused by the project on the James Bay road for Cree users of trapline areas adjacent to the road is presented below.

[3] Transport Québec. Traffic flow. Last update on January 31, 2019 [online] https://www.donneesquebec.ca/recherche/fr/dataset/debit-de-circulation [consulted on February 5, 2019] [French only]

TRADITIONAL LAND USE ALONG THE JAMES BAY ROAD

STUDY AREA

The area that might be affected by the transport resulting from the project activities is the area located near James Bay road, between the km 381 and Matagami. For the purposes of the current assessment, the area within a 2-km radius from either side of the road was considered.

CURRENT CONDITIONS

The James Bay road is a secluded road connecting Matagami to Radisson over a distance of 620 km. The road comprised within the selected study area has a length of approximately 360 km. The road crosses no cities nor native communities over its entire length and occupy Category III lands. The road is entirely paved, maintained and plowed during winter. The road was built in the 70s to provide access to Hydro-Québec's projects. According to SDBJ data, approx. 57,000 vehicles use the James Bay road on average each year, which translates to a AADT of about 314 vehicles (considering round trips). Of those, about 31% consist of heavy vehicles (of various types).

Twenty Cree traplines associated to the Eastmain (2 traplines), Waskaganish (7 traplines), Nemaska (4 traplines) and Waswanipi (7 traplines) communities are crossed or located less than 2 km from the road. For the trapline primarily affected by the project (RE2), the study area includes a permanent camp, goose hunting grounds, trapping and fishing areas, snowmobile trails and a source of drinking water.

Other Cree users of the area located further south, along the road, may practice traditional activities (hunting, fishing, trapping, etc.) in the study area, or have camps in that area.

The construction of new access roads is often a good opportunity to establish camps and develop activity areas in the vicinity. It is therefore likely that Cree users have been using activity areas near the road since the 70s. However, there is very little public data which offer a portrait of these land uses in the study area.

CONSTRUCTION PHASE

SOURCES OF IMPACT

- Transportation and traffic.

MITIGATION MEASURES

Measures NOR 11, SON 01, UTT 01, UTT 02, CIR 01 and VIE must be applied. They are indicated in Table 7-5 of the EIA.

DESCRIPTION OF IMPACT

The study area considered as part of this assessment is visited by Cree land users of traplines adjacent to the road (CONSORTIUM GENIVAR-WASKA, 2015). The presence of a road access often makes it possible for Cree users to set up camps in the vicinity and develop traditional activity areas.

During the construction period, the traffic generated by the project will represent a source of nuisance given the noise and dust, increased accident risk and disturbance. Some users may see their traditional activities or their tranquility disrupted. A period of adjustment will be necessary to they can adapt to the changes the project will create. It should be mentioned that the James Bay road is entirely paved, meaning that nuisance such as noise and dust will be limited.

The impact of the project on the AADT on the James Bay road during the construction phase represents a global increase of 17%, or an increase of 54% if we only consider heavy vehicles. However, the traffic flow on that road remains low. In comparison, the traffic flow on Route 109 south of Matagami, starting from the airport road, is approximately 600 vehicles according to traffic flow data released by Transport Québec[3].

Users of the study area are already familiar with the presence of the road. Galaxy has already met with land users to share information on the project, expected impacts and projected management measures, as well as to collect their concerns and expectations. Standard mitigation measures will also be implemented to limit the nuisance associated with noise and contaminant emissions into the air.

Workers hired by Galaxy and its contractors will be educated on the Cree land users traditional practices to minimize disturbance. An efficient system for the management and follow-up of complaints will be operated by Galaxy to find solutions to issues that may be raised by the local population. Appropriate signage will be provided by Galaxy, from the James Bay road, indicating the site of its activities.

IMPACT ASSESSMENT

For all the reasons mentioned above, the intensity of this impact is considered low. Despite the fact that the peacefulness and activities of land users will be disturbed by nuisance of the project, the practice of these activities will not be threatened and following a period of adjustment, the land users may adjust their practices to the changes. The extent of the anticipated residual impacts is regional given that the impacts are likely to be felt by the users of 20 targeted traplines that visit the study area. The duration is short. Thus, the significance of the impact on the land use during the construction phase is considered **minor**.

OPERATION PHASE

SOURCES OF IMPACT

— Transportation and traffic.

MITIGATION MEASURES

Measures NOR 11, SON 01, UTT 01, UTT 02, CIR 01 and VIE must be complied with. They are indicated in Table 7-5 of the EIA.

DESCRIPTION OF IMPACT

Impacts felt during the operation phase will be similar to that felt during the construction, i.e. disruption to traditional activities and peacefulness of the area, followed by a period of adjustment which will have started during the construction period.

A global increase of 17% of the AADT is expected on James Bay road during the operation phase, or an increase of 54% if we only consider heavy vehicles.

[3] Transport Québec. Traffic flow. Last update on January 31, 2019 [online] https://www.donneesquebec.ca/recherche/fr/dataset/debit-de-circulation [consulted on February 5, 2019] [French only]

The implementation of standard mitigation measures established during the construction phase will continue during the operation phase and will help accelerate the period of adjustment.

IMPACT ASSESSMENT

The intensity of the impacts of transportation caused by the project on the traditional uses along the James Bay road is considered minor. Despite the nuisance the project will cause, land users will be able to continue practicing their activities following a period of adjustment, even if it means moving certain activities if deemed preferable by the land users. The extent of the anticipated residual impacts is regional since the impacts might be felt by the land users of 20 targeted traplines that visit the study area. The duration is long. Thus, the significance of the impact on the land use during the construction phase is considered **medium**.

QUALITY OF LIFE (SECTION 7.4.4)

QC - 142.	**Section 7.4.4 describes the potential project impacts on health issues among workers and communities, as well as the additional pressure that the project may place on the Cree Board of Health and Social Services of James Bay (CBHSSJB). The Project Proponent therefore suggested collaborating with the CBHSSJB. The Project Proponent shall describe the nature of its general collaboration with the CBHSSJB and, more specifically, with the Nemaska and Eastmain health clinics which are the closest to the project. The Project Proponent shall shed light on the role of each party in the context of incidents involving a high number of victims, as well as in the context of individual urgent and non-urgent health concerns.**

A - 142: Since Galaxy will build a workers' camp, a nursing service, including a first-aid room and first-aiders, must be provided as stipulated in the First-aid Minimum Standards Regulation (CQLR A-3.001, r.10).

Given the proximity to the km 381 truck stop, talks have been initiated with the managers of the truck stop to find out if they would be interested in sharing certain medical or ambulance services. We reached out to CBHSSJB since the medical services at the truck stop are provided by them (Region 10). Both sides have expressed their willingness to collaborate, but no decision can be taken at this stage. For now, the truck stop is serviced by Radisson. The CBHSSJB's project consisting of providing the truck stop with an ambulance has yet to progress. One thing is for sure, Galaxy will help employees and residents of the truck stop in case of emergencies. However, Galaxy's medical service will not turn into a local medical centre accessible 24/7. Nemaska and Eastmain's medical services are not associated with the CBHSSJB; they are under Region 18. It is natural for the various medical services to collaborate in case of incidents, especially major ones, and Galaxy's medical service will do just that.

QC - 143.	**On page 7-70, it is mentioned that an agreement is currently being developed with the SDBJ to see that an emergency medical service is offered in conjunction with the existing services at the km 381 truck stop. The Project Proponent shall report on exchanges with the SDBJ regarding the provision of emergency medical services. If applicable, the Project Proponent shall describe the nature of the agreement.**

A - 143: See A – 142.

QC - 144.	**One of the mitigation measures proposed by the members of the Eastmain community was to create a cultural village at the workers' camp. The Project Proponent shall indicate if the measure is implemented.**

A - 144: The measure proposed by the members of Eastmain to create a cultural village at the workers' camp is inspired by the area dedicated to Cree cultural activities at the Éléonore Mine, near Wemindji. Galaxy will make sure that its Cree employees are satisfied with their life at the camp. If reasonable accommodation is required, it will be done, but it is unlikely that an area as big as the Éléonore Mine's will be dedicated to cultural activities, mainly because there are fewer employees (1,000 vs 150 for Galaxy) and that the land does not allow for the construction of as many facilities. It should be noted that the Éléonore Mine facilities are located across a sandy land, while the Galaxy Project area is covered at 75% of wetlands.

LOCAL AND REGIONAL ECONOMY (SECTION 7.4.5)

QC - 145.	**For the construction phase, the Project Proponent indicates on page 4-76 that 210 workers on average will be required while it is stated on page 7-74 that 300 workers are needed. For the operation phase, it is indicated on page 7-74 that operation of the mine shall create 360 new jobs while Figure 4-15 indicates 250 to 360 workers. Also, the workers camp is designed to accommodate a maximum of 280 workers during the construction phase and 150 workers during the operation phase. The Project Proponent shall specify the estimated number of direct jobs for the construction, operation and closure phases of the project.**

A - 145: The number of workers was revised as part of the feasibility study. The number of employees required for the construction phase will not be constant and will vary between 16 and 208 employees on a monthly basis (Figure 145-1).

Similar to the construction phase, the number of workers will vary during the operation phase. For the first five years, the number of workers will be between 95 and 270 workers, depending on the years (Figure 145-2).

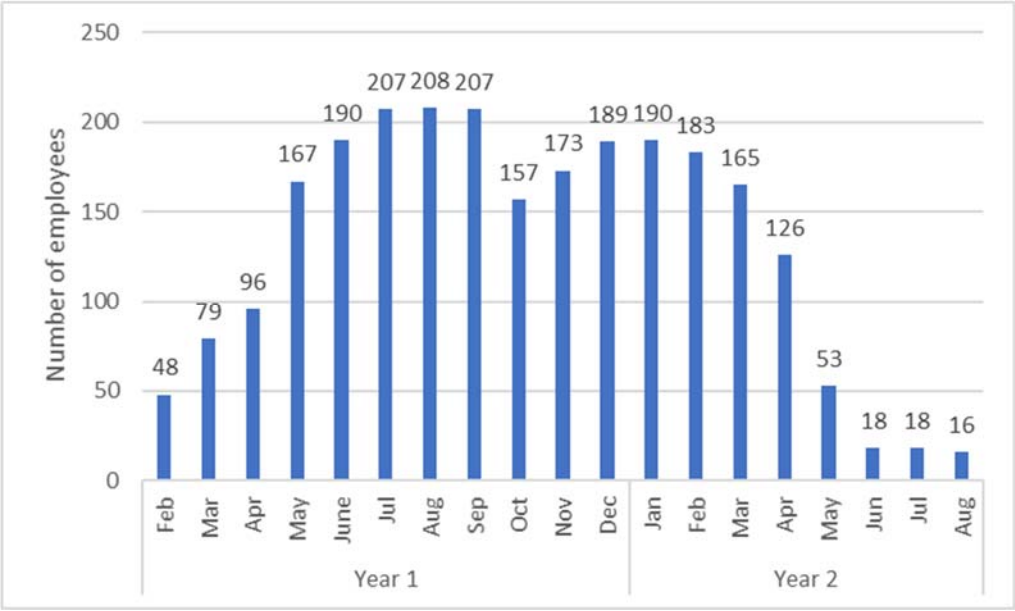


Figure 145-1 Maximum number of employees on the site during the construction phase

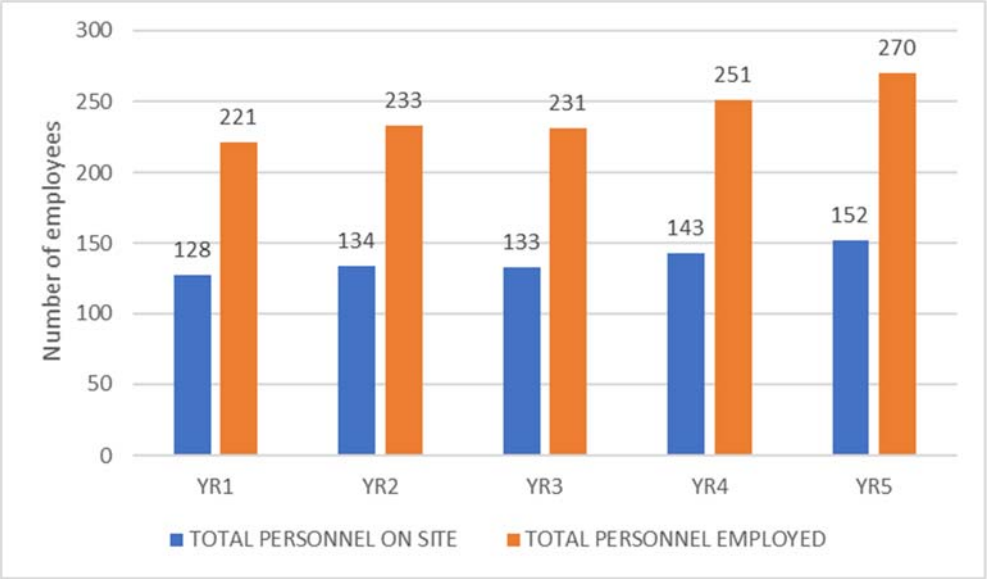


Figure 145-2 Estimated number of workers for the first five years of operation

QC - 146.	**According to the Project Proponent, the project shall result in the creation of good, well-paying jobs. For the most part. these jobs will require technical expertise and a high level of specialization. The Project Proponent wishes to promote the hiring of local workers, especially Cree workers. Thus, considering that Cree people are mostly hired for jobs of the tertiary sector or service sector, combined to their low graduation rate, Cree people are likely to have a hard time having access to jobs of the project (especially specialized jobs). To promote the hiring of Cree workers, the Project Proponent plans on providing tailored training programs. It is indicated on page 2-5 that the Project Proponent plans on participating with the James Bay School Board to develop training programs for the mining industry, in collaboration with other mining companies. It is also indicated on page 4-83 that the Project Proponent is in discussions with the Council of the Cree Nation of Eastmain with a view to developing training programs. The Project Proponent shall specify how he plans on developing and implementing training programs tailored to the specific needs of the project. The Project Proponent shall identify the partners and present the means through which he will promote the training offer. The Project Proponent shall present its targets for hiring of Cree people and indicate how the training and hiring processes will help reach those targets. The Project Proponent shall report on meeting of the targets in its annual report.**

A - 146: Discussions regarding hiring and training of Cree workers are ongoing with the CNE. Galaxy is currently working to complete a Business and Employment Capacity Study to help better understand capacity, and capacity challenges in Eastmain. Other communities are being studied in this process, but at a higher level. If specific targets are identified, they will be included in the IBA. IBA discussions have not advanced to the point where these numbers/percentages have been agreed upon, nor exactly how CNE would like Galaxy to approach the hiring and training process with the community. Galaxy is having regular discussions with the Cree Human Resource Development (CHRD) / (James Bay School Board) JBSB and the CNE to discuss the best approach. The CHRD/JBSB and CNE are collaborating with Galaxy to find solutions to identified challenges – to aid in this process, Galaxy is in the process of hiring an HR Mining Consultant. Specific roles as it relates to the mining lifecycle will be identified in the updated Feasibility Study (intended for completion in Q4 2019), which will also assist in the planning process and IBA discussions with respect to hiring and training. Specialized training programs may be offered in the community at the expense of Galaxy - however, there need to greater Project certainty before undertaking such initiatives. Training through the JBSB is often free, but Galaxy recognizes the challenges around course schedules, locations where the courses are offered, and language barriers (some courses are only offered in French and the CNE are predominantly English). Galaxy intends to start training initiatives in collaboration with JBSB. Galaxy is committed to working with the CNE to ensure the greatest number of Cree hires.

QC - 147.	**The Project Proponent is planning on establishing a communication plan to announce to local stakeholders the positions to be filled at the mine. The Project Proponent shall indicate when the plan will be made available and provide the Administrator with the plan for information.**

A - 147: The jobs associated with the different phases of the mine's lifecycle will be available through the updated feasibility study that is due for completion in Q4 2019. A communication plan will be created in collaboration with the CNE with respect to training and hiring – this plan will follow a signed IBA. This plan will then be sent to the JBNQA administrator.

QC - 148.	**One of the measures proposed to enhance the positive benefits of the project consists in developing a "memorandum of understanding and partnership agreement for Cree participation." The Project Proponent shall present the memorandum, or if not completed the status of discussions, as well as an overview of the components of the agreement that may have an impact on this assessment. The Project Proponent shall also specify the objectives of the agreement, the partners and organizations involved and proposed initiatives in terms of employment and the economy.**

A - 148: The understanding and partnership agreement for Cree participation mentioned in the EIA is in fact the Impact and Benefit Agreement (IBA) to be signed with the Eastmain Cree community. As presented in the answer to QC-83, a predevelopment agreement was signed in March of 2019. The various terms and conditions to be included in the IBA are still being negotiated. Talks to date have yet to come to an agreement regarding figures/percentages, nor how the Eastmain Band Council wants Galaxy to address the hiring and training process with the community. Galaxy is having regular discussions with officials of the Cree Human Resources Development Department (CHRDD), James Bay School Board and Eastmain Band Council.

HERITAGE AND ARCHAEOLOGY (SECTION 7.4.6)

QC - 149.	**In total, 27 zones of archaeological potential have been identified in the study area. These zones correspond to the areas most likely to contain remains of past human activity. Since the zones of archaeological potential were not subjected to on-site verification, the Project Proponent shall commit to conducting, before the start of work which could affect these zones, an archaeological inventory of the potential zones identified. The inventory shall allow the assessment of the on-site archaeological heritage and define, if necessary, additional mitigation measures in case of possible discoveries. The Project Proponent shall ensure participation of the concerned tallyman, or as agreed upon with the monitoring committee(s) established. If certain zones are excluded from the inventory, the Project Proponent shall justify this exclusion.**

A - 149: Galaxy commits to conducting an on-site verification of the boundaries of the archaeological potential zones identified in the study provided by Arkéos (2018) by the end of the fall of 2019. Thus, modifications to the zones of potential may be done if needed. For example, the major 2013 forest fire may have sped up the wind erosion of some slopes, thus exposing archaeological remains. This on-site verification may also lead to the recommendation of certain archaeological zones for exclusion. Other areas may also be identified given their condition or possible disturbances.

7 ASSESSMENT OF CUMULATIVE EFFECTS

7.1 IDENTIFICATION OF VALUED COMPONENTS (SECTION 8.4)

QC - 150.	**The Project Proponent stated that the assessment made it possible to identify the main issues and repercussions of the project on environmental components and understand the primary concerns of the population. Taken together, these two elements enabled the identification of the valued components (VC) associated with the project and, ultimately, the selection of those that would be subject to an assessment of cumulative effects. On this basis, two VCs were selected for the analysis of cumulative effects; the Chiroptera and traditional use of the territory by the Cree people. The Project Proponent shall indicate how Cree communities, land users or other stakeholders were consulted for the selection of VCs for assessment of cumulative effects and how their comments were considered. If this procedure was not conducted, the Project Proponent must perform it.**

A - 150: Cumulative effects were broadly addressed during consultations with RE2, VC33 and VC35 land users. Users described the effects they were experiencing or had experienced because of past projects. Chapter 8 of the EIA regarding the cumulative effects takes into account these elements.

Sections 8.4, 8.4.2.2, 8.5.3, 8.5.4.1, 8.6.2.4, of Chapter 8 were changed as to better represent comments submitted by the Cree people. These changes are underlined in the text below.

8.4 IDENTIFICATION OF VALUED COMPONENTS

As indicated in Schedule 2 of the *Canadian Environmental Assessment Act* (which refers to subparagraph 5(1) a) and subsection 5(3)), the valued components to be considered when assessing a project's cumulative effects could include:

- fish and fish habitat;
- migratory birds;
- species at risk;
- all other relevant components.

According to the MDDELCC guideline for the project, the valued components to consider when assessing cumulative effects should be associated with project issues, namely:

- use of the territory by the Cree population;
- the region's socioeconomic situation;
- the community's use of the sector for cultural purposes;
- recreational and tourism activities, particularly sport hunting and fishing;
- the plant and wildlife species at risk;
- the wildlife and its habitat;
- climate change.

Furthermore, and still as per the MDDELCC guideline, the impact of the workers' presence on wildlife must be taken into consideration, as must the repercussions this presence could have on future hunting and fishing by the Cree population. On another note, the traditional knowledge of the communities concerned must be included when assessing cumulative environmental effects.

As part of this specific project, two VCs were selected for an analysis of cumulative effects; the Chiroptera (bats, a species at risk) and traditional use of the territory by the Cree. It bears noting that fish and birds were not selected, due to few individuals and limited varieties having been identified during the field inventories. The moose inventory also attested to a similar trend. The effects of the project were thus assessed as minor and only slightly likely to influence the VCs on a larger scale. In addition, the interviews with socioeconomic stakeholders of the James Bay region indicated that there were no recreational and tourism activities practised by non-Indigenous people and no cultural activities near the site. It should be noted that RE2 trapline Cree users indicated that moose hunting and fishing activities were sometimes performed by non-Indigenous people on the Eastmain River and nearby the James Bay Road. There are, however, boat launches, the closest of which is 9 km from the mining site.

Even though the overall project impact on bats is judged to be minor, this species was nonetheless selected as a VC for the analysis of cumulative effects, chiefly for the reasons indicated hereafter. Firstly, the presence of bat species with a special status in the project zone was confirmed during the 2017 inventories, as was their low numbers. Secondly, the presence and rapid spread of the WNS in Québec, now heralded as the key factor behind the decline of bat populations in northeastern North America (section 8.5.5), has made bats more vulnerable to cumulative effects than any other wildlife species found in the area being studied. Comparatively, the common nighthawk, in spite of having a special status and its presence in the project zone having been confirmed, was not selected as a VC, given that its overall population is not threatened to the same extent as that of the bats. Furthermore, mitigation measures implemented during the project have allowed for curtailing the negative effects on this species.

The traditional use of the territory by the Cree was also selected as a VC for the analysis of cumulative effects, given that this use is linked to project issues, was identified as a concern during the public consultations, and will be somewhat significantly impacted by the project (impact of medium importance during the construction and operation phases). Also, other specific activities (past and future) have had, are having and will have an effect on this component. Comparatively, traffic, in spite of impacting the quality of life and having been noted as a concern during the public consultations, was not selected as a VC. In fact, the project will require that 25 additional trucks travel over the road network each day during the operation phase; according to the traffic statistics compiled by the SDBJ (section 8.5.3), this represents an increase of 16% in the number of vehicles travelling on these roads.

8.4.2.2 TRADITIONAL USE OF THE TERRITORY BY INDIGENOUS PEOPLE

The traditional use of the territory by the Eastmain Cree VC refers to the overall traditional practices, which mainly include the hunting, fishing and trapping activities of desired species, but also all other activities using the territory and its resources for ritual or social purposes.

Although use of the territory by the Cree has evolved over the years, this fundamental component of their culture is still as important as ever because of its heritage value. As a result, the link the Cree have with the recognized ancestral territory remains essential, above all, to the transmission of their culture to future generations. It is important to note the sturgeon spawning ground project located at the eastern corner of the road and the Eastmain River. The community fears that the project will have an impact on the future spawning ground and wishes to make sure there will be none. Given the distance of the projected spawning site from the project, no impact is anticipated.

From the 1980s onwards, the Cree witnessed important changes to the territory they occupied. These are linked to energy development, involving several diversions of watercourses and the establishment of Hydro-Québec dams, and to mining development. The year 1980 was therefore selected as past temporal scoping and the future scoping was set at 2028. It is very difficult to make projections beyond this scope based on the existing documentation (master plan, development strategies, etc.).

Moreover, the analysis of the cumulative effects on this VC covers the overall territory frequented by the Eastmain Cree. The considered territory extends over almost 240 km from Eastmain village. The width of the considered territory extends from 40 to 95 km (Map 8-2).

8.5.3 USE OF THE TERRITORY BY NON-INDIGENOUS PEOPLE

This theme covers sport fishing and hunting activities and the associated recreation infrastructure. These involve primarily use of the territory by non-Indigenous people.

Since 1980, development of the James Bay Road has resulted in increased recreational activities within the territory (tourism, sport fishing and hunting), especially since the opening of the James Bay Road to non-Indigenous people in 1986. However, these activities have remained concentrated primarily in the southern portion of James Bay and east of the Robert-Bourassa hydroelectric facilities. In 1991, a follow-up done to evaluate the impact of sport fishing and hunting on animal populations recorded nearly 11,000 vehicles at the entrance to the James Bay Road (Hydro-Québec Production, 2001). Traffic statistics compiled by the SDBJ showed 56,139 recorded trips on the James Bay Road in 2014 and 55,632 in 2017 (personal communication with the SDBJ, 2018).

Some activities, such as snaring of hares, trapping, and fishing of sturgeon and whitefish, are reserved exclusively for beneficiaries of the JBNQA throughout the territory. Hunters and fishers who are not JBNQA beneficiaries are subject to the laws and regulation in force in the territory and must hold a sport hunting or fishing licence from the Québec Government, applicable on all Category III land. Before April 1, 2018, and since 2002, different regulations applied to the hunting sectors of Weh-Sees Indohoun (WSI) and Eastmain, in which the project is located. To hunt and fish on Category I and II lands, authorization must have been issued by the Band Councils concerned.

In the past, recreational hunting and fishing activities in the project sector were practised mostly by Hydro-Québec workers involved in building the Eastmain-1-A and Sarcelle hydroelectric projects, and the Rupert River diversion. However, there are far fewer of these workers since construction work associated with the Eastmain-Sarcelle-Rupert complex finished, and the MFFP believes that the vast majority of these workers have left the territory. However, according to Cree users interviewed during consultation activities in 2018, non-Indigenous people hunt (moose) and fish on the territory. These activities are performed along the James Bay Road, notably at the intersection of the Eastmain River, and on certain lakes not far from the road.

According to the Québec Original website (Tourisme Québec), there are three outfitters within a 150-km radius of the project site, but it is possible that some small Cree outfitters were not recorded. Some families have opened outfitter's camps, or plan to do so to offer guided hiking, hunting and fishing trips (Goldcorp, Not dated). However, little information is available on this matter. During the 2017–2018 consultation conducted for this EIA, a very preliminary outfitting project was mentioned by users of trapline VC35. This trapline is located northeast of the project, on the north shore of the Eastmain River.

According to the EIA of the Whabouchi mining project (Nemaska Lithium, 2013), a series of land rights were issued to non-Indigenous people by MERN in the Whabouchi mining project. About 10 km north of the project site, there is a vacation lot lease. Including this lease, 16 vacation lot leases are located within the borders of the study area of the cumulative effects on use of the territory. (Map 8-2) Some 20 km northeast of the study area there is a vacation lot lease for rustic shelters. Including this lease, there are three vacation lot leases for rustic shelters in the study area.

8.5.4.1 WILDLIFE RESERVES, SANCTUARIES AND BIODIVERSITY RESERVES

No wildlife reserve is located within the study areas of cumulative effects.

On the other hand, biodiversity reserves are planned within the JBNQA territory. The primary objective of these planned reserves is to maintain biodiversity in the terrestrial environment. For each biodiversity reserve planned, a conservation plan is developed. Within biodiversity reserves, mining activities and forest management are prohibited. The end date of temporary protection varies from one reserve to the next, and ranges between 2018 and 2025.

The planned Paakumshumwaau-Maatuskaau biodiversity reserve follows a proposal by the Cree community of Wemindji who want to preserve the watersheds of the Vieux-Comptoir and Des Peupliers rivers, a territory that has traditionally been used by the Cree Nation for over 3,500 years (Gouvernement du Québec, 2010). Located roughly 32.5 km north of the Cree village of Eastmain, the planned reserve is located outside the study area of the cumulative effects of land use, but falls within that for bats. The temporary protection of the reserve is slated to end on June 11, 2020.

When conducting public consultations in the summer of 2018, Eastmain community representatives wished to suggest a major part of the RE2 trapline be recognized by the Quebec government as a protected area according to the *Natural Heritage Conservation Act*.

8.6.2.4 CUMULATIVE EFFECTS

According to the impact assessment, the project would have a moderate residual effect on Cree land use. For Cree users, the loss of tranquility in the area surrounding the project could lead to avoidance of some popular areas or disruption of traditional activities. It should be noted that there will be a permanent worker camp at the mine site, which is on the RE2 trapline, and that it will house 150 employees during the operating period. The presence of these mainly non-Indigenous workers may cause Cree users to worry about contamination or disturbance of the natural environment and animal and fish populations. Mine activities may create the same kind of fears. These concerns could eventually lead to avoidance of certain areas near the mine or a decrease in harvesting of certain animals or fish species. It should be noted, however, that Galaxy will not allow mine workers to hunt or fish. During consultations with Cree land users, they raised concerns on the safety, both on the road (accidents, road degradation) and regarding break-ins at the camps because of the presence of workers.

Of the previous projects on the territory, those that most affected land use near the project site are the diversion of the Eastmain River and the creation of the Eastmain 1 reservoir and Eastmain-Sarcelle-Rupert complex. The COMEX report (2013) on the public consultations held following construction of the Eastmain-1-A and Sarcelle powerhouses and the Rupert diversion states that, without denying the project's significant impacts on the territory and its inhabitants, the proponent took the necessary measures to mitigate the residual effects to an acceptable level. It states that one of the most important issues for the Crees in all the James Bay development projects reviewed by COMEX is protection of the Cree traditional way of life as it evolves. In that light, it considers that the real challenge is to ensure the Crees can continue to practise their traditional activities and can adapt to the altered environments. The changes brought about by the new hydroelectric developments (Eastmain-1 and Eastmain-1-A/Sarcelle/Rupert) may lead to a decline in some species and an increase in others as nature seeks to return to equilibrium in the coming years. At the same time, the Cree population is growing (from 2,500 at the beginning of the 20th century to over 17,700 today[1]), and non-Indigenous people are showing an ever-increasing interest in hunting and fishing on the territory. "At this rate, the environment and natural resources may no longer be able to meet the population's needs as they did in the past. New solutions must be found to prevent overharvesting of wildlife" (COMEX, 2013).

[1] Crees residing and not residing in Cree communities.

Among the current or future projects that could affect land use by the Eastmain community are the Rose lithium-tantalum mining project by the Critical Elements Corporation. The anticipated effects of this project on land and resource use are quite similar to those of this project: disruption of hunting, trapping, gathering practices and firewood collection, and changes to access to the territory. Once the various mitigation measures were put in place (hunting and fishing ban), the residual effect on land and resource use was evaluated as low and non-significant.

The completion of the Rose lithium-tantalum project will change current land and resource use, particularly within the RE1 traplines, which are used by many members of the Eastmain community. Located 60 km northwest of the proposed Rose mine, the present project affects RE2 users, including those who had to adapt their use of the land to the Eastmain River diversion in 1980. This group expressed fears about the project's effect on sturgeon, which was greatly impacted by the diversion. Tallymen of traplines nearby (VC33 and VC35) also raised concerns that echoed those of RE1 and RE2 users, particularly with respect to the effects on hunting grounds (section 5.5.1). It should also be noted that one user (VC35) mentioned that, even though resources available had greatly decreased since the advent of hydropower projects on the territory, he was still able to harvest traditional food (mainly fish, beaver, moose and goose), including along the Eastmain River. He also indicated that moose were starting to come back in the area following construction of the Eastmain-Rupert-Sarcelle Complex. These Eastmain users are therefore especially affected by changes on their traplines and fear that the areas available will be disrupted again. Although the territory is still vast and can support the displacement of harvesting activities (hunting, fishing, trapping), the Crees must invest time and resources to search for and adapt to new harvesting sites.

Users worry about the risk of contamination of resources and the water system as well as an increase in cancer rates due to contaminants in the food chain. They emphasize that contaminated animals move around the territory. They also worry about contamination of vegetation (medicinal plants, berries or plants consumed by the wildlife), especially by dust, and snow which percolates into the ground. This worry is even greater among Cree users located between the three mines (or projected mines). They also fear that additional projects will be implemented in the vicinity.

Some fear that the project will exacerbate the impacts of other sources. For example, many expressed concern that the project is detrimental to the regeneration of vegetation in the area, which is only beginning to recover after the 2013 forest fires, saying that beaver no longer tastes the same since the construction of James Bay Road because of the pollution, and are afraid that the situation will gradually worsen. Moreover, the trapline tallymen attributed deformities observed on moose to the use of certain herbicides within the right-of-way of existing power lines and worry that this type of product will continue to be used. Thus, power lines in development across the territory may increase the risk for certain land users and cause a loss of activity area. Some users feel that the power lines have an impact on the wildlife and vegetation due to radiation. They also avoid these areas in fear of electrical shock. Broadly speaking, users interviewed during consultations consider that the projected effects of the mine are minimized and that they will be felt more strongly in the future.

Deforestation related to construction of the mine and its infrastructure will result in the loss of more land for users, although as a result of legislation, it will be revegetated in the long run (about 30 years) and likely be usable again for hunting, gathering and trapping. However, some users interviewed wonder if the resources may still be contaminated many years after the project.

With respect to natural disturbances, forest fires have caused, and are likely to cause, temporary disruptions to traditional Cree activities and even material losses for some members of the community.

Although individually, the project and each of the other projects on the territory may have overall low residual effects on the VC land use for traditional purposes by the Crees, they each result in changes to parts of the traplines (increased traffic, noise and light disturbances, changes in air and water quality, pressure on the resource, avoidance of the area and land loss) which, cumulatively, can disrupt Cree activities in the long run. However, although the projects mentioned will change the way these activities are practised on the territory, they will not prevent their continuation.

The cumulative effect on land use is limited to a small area. It will be especially felt by families who use the trapline where the project is located (RE2). The cumulative effect on this VC could increase with completion of the potential mining projects in the area, despite taking Cree users into consideration in the various compensation plans and mitigation measures planned. Noise, light, dust, increased traffic, loss of wildlife habitat and related traditional activities will affect a growing number of users for each new project on the territory, especially since the number of users is expected to continue growing.

Several major forest fires have occurred in the study area, particularly the fire of 2013, which affected a large part of Eastmain land. Temporary loss of land has an adverse effect on this VC.

With respect to the project in relation to other past sources of impact, particularly the major hydroelectric projects and forest fires, the cumulative effect on the Crees' current use of the land and resources is considered of low intensity, point-like in extent and long-term in duration; therefore, low. The cumulative effect of the project on Cree use of the land for traditional purposes is therefore non-significant.

7.2 PROJECTS, ACTIVITIES OR EVENTS LINKED TO VALUED COMPONENTS (SECTION 8.5)

QC - 151.	**Section 8.5.4.1 mentions the presence of a planned biodiversity reserve within the study area of cumulative effects, i.e. the projected Paakumshumwaau-Maatuskaau biodiversity reserve. The Project Proponent states that the temporary protection of the reserve is slated to end on June 11, 2020. It should be mentioned that the government intends to protect this territory permanently. In the event that all steps for granting of a permanent status are not completed by June 11, 2020, the required procedures shall be undertaken so the temporary protection status is extended, in accordance with provisions under the Natural Heritage Conservation Act (CQLR, chapter C-61.01). In addition to the Paakumshumwaau-Maatuskaau reserve, two other planned biodiversity reserves are found within the study area of cumulative effects on Chiroptera, i.e. the Waskaganish and Chisesaakahikan-et-de-la-Rivière-Broadback biodiversity reserves. All data on protected areas is available on the *Registre des aires protégées* and *Données Québec* websites[6]. The Project Proponent shall consider these areas in its assessment.**

A - 151: The boundaries of the projected Paakumshumwaau-Maatuskaau, Waskaganish and Chisesaakahikan-et-de-la-Rivière-Broadback biodiverstity reserves were added to Map QC-151. The reserves are located 50 km, 80 km and 93 km respectively from the projected mine site. Even though the reserves are not located within the study area for the assessment of the project's direct impacts, part of their territory is included within the boundaries of the study area established for assessing the cumulative effects on Chiroptera ("study area").

First, Section 8.5.4.1 of the EIA was updated. General information on the projected Waskaganish and Chisesaakahikan-et-de-la-Rivière-Broadback biodiversity reserves was added. It should be noted that no detailed data on the types of habitats and the Chiroptera species inventoried in these reserves was available from the data sources mentioned by the Ministère in its question.

6 http://www.environnement.gouv.qc.ca/biodiversite/aires_protegees/registre/index.htm
https://www.donneesquebec.ca/recherche/fr/dataset/aires-protegees-du-quebec

Section 8.6.1.4 of the EIA was then updated by taking into consideration the three projected biodiversity reserves for the assessment of the cumulative effects on the Chiroptera. It appears that the presence of a part of their territory within the study area represents a positive impact for the Chiroptera thanks to an increase in protected areas, including habitats of interest to this faunal group. However, this does not modify the assessment regarding the significance of the cumulative effect of the project on Chiroptera (deemed minor in the EIA). It is therefore possible to conclude that the project will result in no significant cumulative effect on the Chiroptera even when taking into account the three biodiversity reserves.

Changes/improvements made to Sections 8.5.4.1 and 8.6.1.4 of the EIA are underlined in the text below.

8.5.4.1 WILDLIFE RESERVES, SANCTUARIES AND BIODIVERSITY RESERVES

No wildlife reserve is located within the study areas of cumulative effects.

On the other hand, biodiversity reserves are planned within the JBNQA territory. The primary objective of these planned reserves is to maintain biodiversity in the terrestrial environment. For each biodiversity reserve planned, a conservation plan is developed. Within biodiversity reserves, mining activities and forest management are prohibited. The end date of temporary protection varies from one reserve to the next, and ranges between 2018 and 2025.

The planned Paakumshumwaau-Maatuskaau biodiversity reserve follows a proposal by the Cree community of Wemindji who want to preserve the watersheds of the Vieux-Comptoir and Des Peupliers rivers, a territory that has traditionally been used by the Cree Nation for over 3,500 years (Gouvernement du Québec, 2010). Located roughly 32.5 km north of the Cree Village of Eastmain, the temporary protection of the reserve is slated to end on June 11, 2020. <u>However, it should be mentioned that the government intends to protect this territory permanently. In the event that all steps for granting of a permanent status are not completed by June 11, 2020, the required procedures shall be undertaken so the temporary protection status is extended, in accordance with provisions under the Natural Heritage Conservation Act (CQLR, chapter C-61.01).</u>

<u>The projected Waskaganish biodiversity reserve is located approximately 40 km east of the Waskaganish Cree Village. With a surface area of 1,062.7 km^2, the projected reserve encompasses five islands located at the mouth of the Pontax River. These islands are a priori habitats of great ecological interest since located at the transition from salt water to fresh water. The reserve also includes ecotones on the edge of the Rupert Bay, which could potentially harbour special fauna and flora.</u>

<u>The projected Chisesaakahikan-et-de-la-Rivière-Broadback biodiversity reserve is located approximately 150 km northeast of Matagami. With a surface area of 4,977.9 km^2, the reserve was first created to ensure the protection and maintenance of the biological diversity and of associated natural and cultural resources.</u>

<u>The three projected biodiversity reserves are located outside the study area for the cumulative effects on the land use, but are located within the study area for the Chiroptera.</u>

8.6.1.4 CUMULATIVE EFFECTS

The main threats facing bats are habitat loss, wind energy developments and WNS (Tremblay and Jutras, 2010). Given the absence of wind energy projects in the region, the potential negative effects of human development projects essentially involve habitat loss.

The assessment of the James Bay Lithium Mine project's impact in terms of habitat loss and disturbance for bat populations concluded that the residual effect is of minor significance, even considering the fact that bats of the genus *Myotis* and the hoary bat are species with a special status. Also, because of forest fires, most of the natural environments that will be affected by the project are characterized by the absence or virtual absence of a tree stratum. These environments are therefore not the most propitious for the bat species identified in the study area, which is essentially arboreal. In addition, considering the planned remediation activities, habitat loss is not likely to compromise the integrity of local populations. Moreover, if deforestation is not carried out during the breeding season, the fact that there are sufficient replacement habitats of similar quality in the region means that the effect of this habitat loss will not prove significant for bat populations.

Past, present and future actions likely to lead to habitat loss in the area include projects leading to the disappearance of mature forest stands or wetlands and hydrous environments, or potential travel corridors (encased valleys, lakeshores, watercourses, etc.). Essentially, these are represented by the creation of the Eastmain 1 reservoir and the Eastmain-Sarcelle-Rupert complex, the Nemiscau and Opinaca airports, the Whabouchi and Éléonore mining projects and the roads and energy transmission lines associated with them. Their effects are nevertheless limited in terms of surface area in view of the spatial boundaries considered for the assessment of cumulative effects. The presence of a part of the territory of the three projected biodiversity reserves within the study area for the assessment of the cumulative effects represents a positive impact for the Chiroptera thanks to the increase in protected areas, including habitats of interest to the bats.

Forest fires have caused, and will likely continue to cause, substantial habitat loss inside the spatial and temporal boundaries considered, particularly with regard to forest stands. Thus, when compared with losses caused by forest fires, the anticipated habitat loss caused by the present project is very minor.

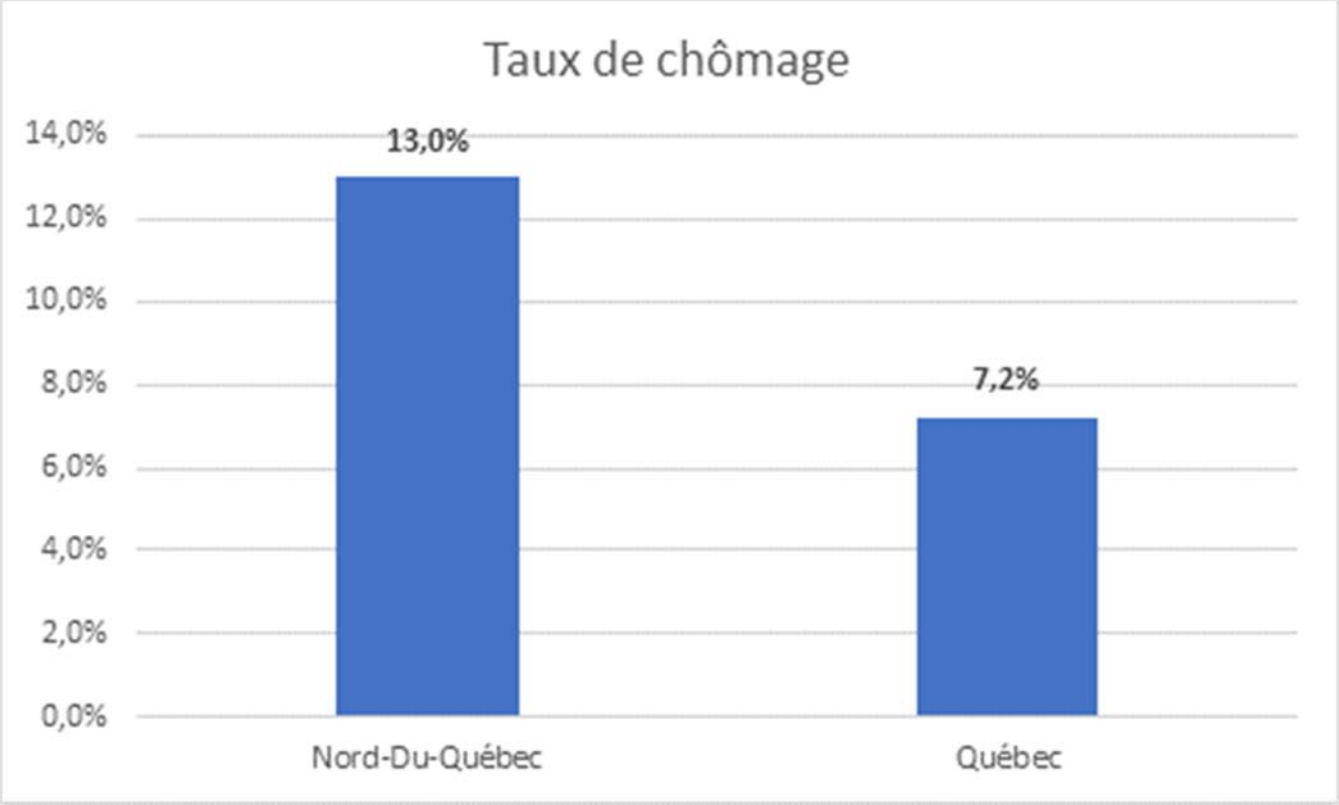
Again, in connection with natural disturbances, the appearance of WNS has already caused and will probably continue to cause substantial mortality in resident bat populations, particularly in species of the genus *Myotis*. Because the fungus attacks bats during the hibernation period, they die of exhaustion before winter's end (Chauve-souris.ca, 2018). Very little data is available regarding the location of hibernation sites in the Nord-du-Québec region. The northernmost known hibernation site lies a little to the north of Level-sur-Quévillon. Nevertheless, since bats can cove hundreds of kilometres to reach their hibernation site, the risk that species of hibernating bats identified in the study area will be affected by WNS during the hibernation period is high, which could cause a marked fall in the number of bats present in the study area. As a guide, in hibernation sites in the United States, the recorded decline in the species that are present in Québec stands at 91% for the little brown myotis (*Myotis lucifugus*), 98% for the northern myotis (*Myotis septentrionalis*), 41% for the big brown bat (*Eptesicus fuscus*), 75% for the tri-coloured bat (*Perimyotis subflavus*) and 12% for the eastern small-footed myotis (*Myotis leibii*) (Chauve-souris.ca, 2018). Consequently, the effects of the white-nose syndrome constitute heavy pressure on bats of the genus *Myotis* within the spatial and temporal boundaries considered.

Finally, the anticipated cumulative effects of the project on bats are judged to be negligible and will consist mainly in an increase in disturbance of bats near the site, as well as occasional loss and modification of the habitat. For this reason, the cumulative effect on bats is deemed to be of low magnitude, local extent and long duration. The importance of this cumulative effect is definitively deemed to be minor. The project will therefore not entail substantial cumulative effects on bats (*chiroptera*).

7.3 ANALYSIS OF CUMULATIVE EFFECTS (SECTION 8.6)

QC - 152.	**The Project Proponent shall indicate how he considered the cumulative interactions of its project with the employment and availability of human resources. In a context where the region is currently experiencing a labour shortage, the Project Proponent shall address the combined effect of its project and other existing and future mining projects which call upon the same workforce within the same territory. The Project Proponent shall also assess the additional pressure put on by the project on the available workforce for local businesses and the provision of services among the communities.**

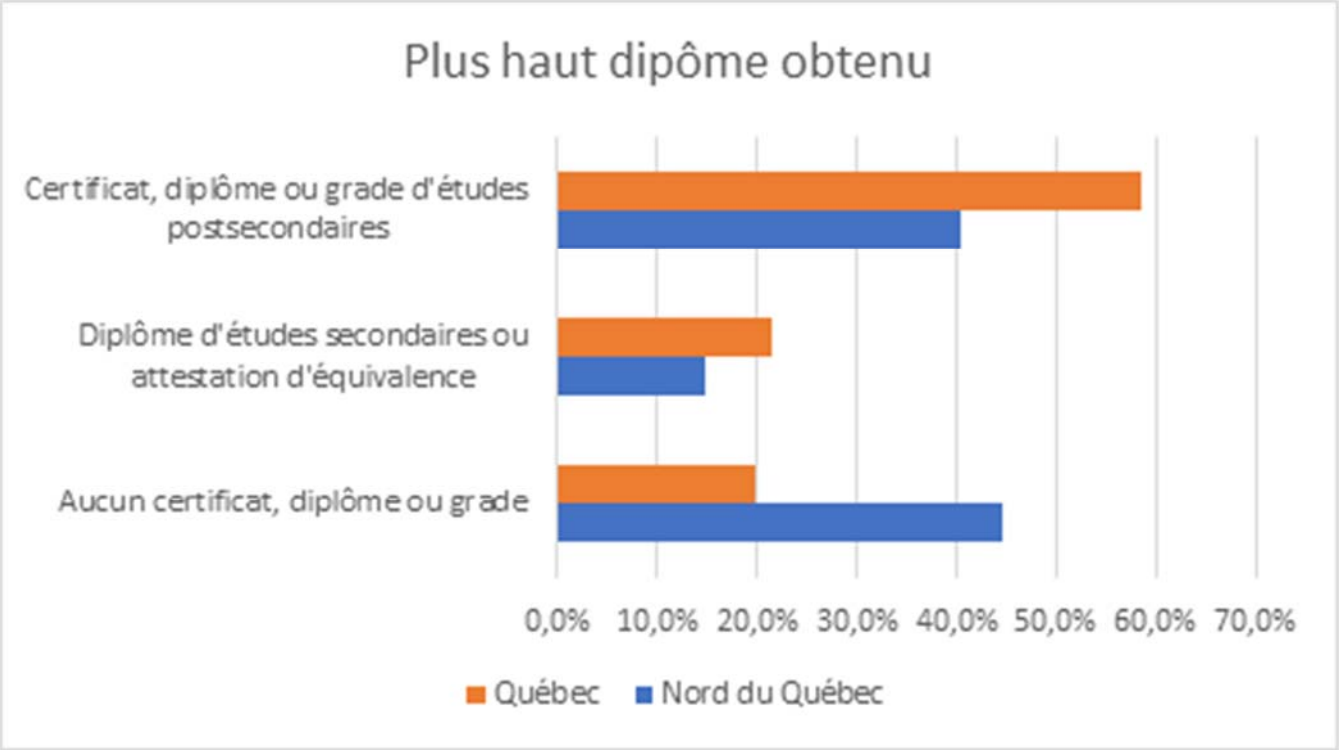
A - 152: According to the Project Proponent, the region is not experiencing a labour shortage. The unemployment rate in the region is almost twice the rate in the Province of Quebec.



Source: Census Profile

We can observe that workforce is available.

Moreover, there is an important pool of unemployed workers without diploma when compared to Quebec as a whole.



Source: Census Profile

There is a significant pool of unskilled positions which are most likely to be filled by local resources. The absence of industries within the Eastmain Community means that a small number of potential workers have experience in the field and could migrate from industry to the mine.

The establishment of a workers' camp by the mining company and an adjustable fly-in fly-out schedule shall help limit the potential pressure on the labour market.

QC - 153. On page 8-5, the Project Proponent mentions that "comparatively, traffic, in spite of impacting the quality of life and having been noted as a concern during the public consultations, was not selected as a VC." The Project Proponent shall address the cumulative effect of the project on transport. The Project Proponent shall present a transport study including, but not limited to, transport associated with supply, ore transport, workers transport for the various project phases, and transport related to other projects, activities or events listed in Section 8.5. Items presented may notably include:

- **Traffic volume and existing type of use for the James Bay road;**
- **Traffic volume and anticipated type of use by the project;**
- **Traffic volume and anticipated type of use by other planned projects on James Bay road;**
- **Assessment of cumulative effects associated with transport on James Bay road.**

A - 153: Transhipment of the concentrate produced by the processing plant will be conducted by truck. Trucks will take the James Bay road from the mine site to Matagami, which represents a distance of approximately 385 km. About 22 trucks will be required daily for the transport of the concentrate. In addition to the transport of the concentrate, the input required for the operation of the facilities (propane, diesel, etc.) will be delivered by truck (estimate of about five shipments per day). The average annual daily traffic (AADT) of trucks as a result of the mine activities is therefore estimated to about 53 trucks (considering round trips). Traffic will occur during the day.

The James Bay road is a secluded road connecting Matagami to Radisson over a distance of 620 km. The road crosses no cities nor native communities and occupy Category III lands over its entire length. The road is entirely paved, maintained and plowed during winter. The road was built in the 70s to provide access to Hydro-Québec's projects. According to SDBJ data[1], approx. 57,000 vehicles use the James Bay road on average each year, which translates to a AADT of about 314 vehicles (considering round trips). Of those, about 31% consist of heavy vehicles (of various types).

The impact of the project on the AADT on the James Bay road, i.e. about 53 trucks per day (which translates to a AADT of approximately 151 trucks) represents a global increase of 17%, or an increase of 54% if we only consider heavy vehicles. However, the traffic flow on that road remains low. In comparison, the traffic flow on Route 109 south of Matagami, starting from the airport road, is approximately 600 vehicles according to traffic flow data released by Transport Québec (2019). A comparison of AADT for the James Bay road before and after the project and for Route 109 is presented in Table 153-1.

Table 153-1: Average Annual Daily Traffic

Road	Average Annual Daily Traffic		
	Heavy Vehicles	Light Vehicles	Total
James Bay road – before project	98	216	314
James Bay road – with project	151	216	367
Route 109	222	378	600

By adding haulage associated with other upcoming projects, the percentage of the global increase or of heavy vehicles associated with Galaxy's activities would be even more reduced. Thus, considering the small contribution to the AADT anticipated for the project, and given that this additional traffic influx does not represent a significant challenge, further analysis of this matter was deemed unnecessary.

[1] Traffic data on the James Bay road compiled for 2014 and 2017. Email exchange, Jean Nouvellet, Société de développement de la Baie-James, May 2018.

8 ACCIDENT RISK MANAGEMENT

QC - 154.	**One of the risks identified in this section is associated with leaks and accidental spills of petroleum products. The Project Proponent shall characterize the leak and spill detection systems of the storage tanks and petroleum product containment facilities.**

A - 154: Petroleum equipment and reservoirs shall all be designed as to prevent and contain any potential spillage as illustrated on drawing found in Appendix A-154. Even though the final model has not been yet selected, it shall be similar, if not identical, to the one presented in the drawing. The equipment is regulated by the Building Act and subject to a RBQ (Régie du bâtiment du Québec) permit.

QC - 155.	**In Section 9.3.9, the Project Proponent presents the projected preventive and control measures to be put in place to reduce the risk of tailings dike collapse. The Project Proponent shall further characterize the monitoring instruments that will be installed, including the leak detection system.**

A - 155: No water will be retained within the waste rock and tailings storage facility (WRTSF). The water retention basin located next to the WRTSF and the overburden and peat storage area settling pond will be designed and operated to meet or exceed the design criteria set out in Directive 019 as well as those set out by the CDA (Canadian Dam Association) guidelines.

As discussed in the response to QC-20, the waste rock and tailings are anticipated to be of Low Risk. Under Directive 019, there is no requirement to implement sealing measures or a leak detection system for Low Risk storage facilities (Section 2.9.4). Perimeter drainage ditches will, however, be constructed around the WRTSF to direct WRTSF contact water runoff to the Water Retention Pond. Further, a groundwater drain will be installed within the foundation beneath the perimeter slopes to capture groundwater in the event that it does not meet effluent groundwater criteria.

9 SURVEILLANCE AND MONITORING PROGRAM

9.1 ENVIRONMENTAL MONITORING DURING OPERATIONS (SECTION 10.4)

WATER QUALITY MONITORING (SECTION 10.4.1)

QC - 156.	**The environmental monitoring proposed by the Project Proponent does not include the physicochemical quality monitoring of sediments. The Project Proponent shall include the physicochemical quality monitoring of sediments to be conducted three years after the start of the operation phase, and then once every 5 years, at the same stations as those established for the initial characterization, as indicated in Chapter 7 of the *Guide de caractérisation physicochimique de l'état initial du milieu aquatique avant l'implantation d'un projet industriel.***

A - 156: Galaxy commits to conducting a physicochemical quality monitoring of sediments. The monitoring will comply with procedures described in the *Guide de caractérisation physicochimique de l'état initial du milieu aquatique avant l'implantation d'un projet industriel*. The monitoring program will tie into the water quality monitoring program: the same stations sampled for the initial characterization will be used. Specifics of the program will be proposed to the MELCC during the application for a depollution attestation and the program will be adjusted as required.

GROUNDWATER MONITORING (SECTION 10.4.2)

QC - 157.	**Groundwater monitoring shall comply with requirements of Directive 019 and of section 4 et seq. of the Land Protection and Rehabilitation Regulation. The Project Proponent shall adjust the proposed monitoring according to these requirements, including the annual sampling frequency.**

A - 157: Galaxy commits to making sure the groundwater monitoring program complies with requirements of D019 and of section 4 et seq. of the *Land Protection and Rehabilitation Regulation*. The groundwater monitoring program presented in Section 10.4.2 of the EIA details the projected monitoring. The detailed program will be proposed to the MELCC during the application for the certificate of authorization of the concentrator and adjusted as required.

AIR QUALITY MONITORING (SECTION 10.4.5)

QC - 158.	**The air quality monitoring program proposed by the Project Proponent must be improved. Given that the air dispersion modelling study showed exceedances for the crystalline silica, the Project Proponent shall include the monitoring of this substance nearby the km 381 struck stop. The monitoring must be implemented from the outset of the project.**

A - 158: Monitoring of the crystalline silica was added to the Air Quality Monitoring Program. The program can be found in the Preliminary Dust Emission Management Plan presented in Appendix A-123.

SOCIAL ENVIRONMENT MONITORING (SECTION 10.4.6)

QC - 159.	**Many social and/or health problems will be monitored, most notably issues associated with alcohol and drug consumption, enrichment management, safety of road users, etc. The Project Proponent shall indicate its plan for working together with the regional health services, including the CBHSSJB and other partners, to conduct monitoring in the communities where these organizations are already working. The Project Proponent shall indicate what means are considered for implementation of the collaboration.**

A - 159: As required under paragraph 101.0.3 of the Mining Act, Galaxy will establish a monitoring committee before the start of construction. Actions have been initiated with the CBHSSJB so a representative of the organization sits on the committee.

The social impact monitoring program will provide specific activities for the monitoring of more targeted issues, such as alcohol and drug consumption, management of the enrichment, safety of road users, or any other issue that might arise in the course of the project. These activities could take the form of biennial interviews with local stakeholders where it would be possible to document issues and collect recommendations. Galaxy will endeavour to implement whenever possible solutions to mitigate the social and/or health issues brought to its attention. If Galaxy cannot resolve an issue, the monitoring committee must be made aware of the reasons preventing Galaxy from addressing said issue.

Details of the social impact monitoring program, such as targeted stakeholders, activities proposed and issues for which monitoring will be conducted, will be specified once the project has been authorized, before the construction period.

QC - 160.	**In Section 10.4.6, the Project Proponent mentions that monitoring of socioeconomic conditions will be conducted for various elements, including the training programs, number of Cree employees at the mine, type and duration of jobs, etc. According to the proposed schedule, the monitoring will be conducted after 10 years of operation. The monitoring shall be conducted every year and data must be included in the annual report.**

A - 160: Galaxy commits to conducting all social monitoring campaigns on a yearly basis. Data will also be included in the annual report. Data collected as part of these campaigns will be analyzed and be the subject of specific reports every 10 years.

OTHERS (SECTION 10.4.6)

QC - 161.	**No infrastructure inspection program is introduced in the EIA. According to requirements of Directive 019, an inspection program must be implemented as to ensure the integrity of infrastructure, including dikes and any other element or component which could result in instabilities, failures or poor management of surface water. The Project Proponent shall commit to presenting an inspection program to ensure the lastingness of infrastructure. For information, such program shall include the following elements:** • **daily site visits involving brief visual inspection of the dike(s) and its main components;** • **brief inspections involving a more detailed visual examination of the dike(s) and its main components and may also include taking measurements, as required (surveying, piezometric level, etc.);** • **Annual detailed inspection involving the detailed visual examination with instruments of the dike(s) and its components. Inspection to be conducted by an independent, external firm.**

A - 161: Galaxy plans on presenting an inspection program to ensure the lastingness of its infrastructure, but also for the sake of continuous prevention. This program will be part of the site management system. For the operation phase, Galaxy plans on implementing a full management system that will not only cover the administrative aspects, but also the environmental and health-safety management aspects of work. When developing these systems, all activities and infrastructure are assessed regarding the risks and impacts that they generate, or may generate, before and after the implementation of the control measures. The inspection programs and operation procedures are control measures implemented to minimize risks. Galaxy is a member of the Québec Mining Association which demands that its members implement the TSM protocols, notably the protocol for the management of mine tailings. Specifics of the Galaxy program have yet to be developed at this stage of the project, but it shall include various types of inspections, including a formal inspection (annual or biennial, to be determined) conducted by an independent third-party. The detailed infrastructure inspection program will be presented when applying for the certificate of authorization.

* TSM: Towards Sustainable Mining, program initiated by the Mining Association of Canada (see www.mining.ca).

QC - 162.	**No monitoring of the hydrological conditions of bodies of water and watercourses affected by the mine activities is presented. Yet, such monitoring would allow documentation of the project impacts on the water regime in the study area, facilitate the interpretation of the environmental monitoring data for the biophysical environment, and to draw a distinction between the direct impacts of the project and the impacts associated with natural variations in the environment and with climate change. The Project Proponent shall propose a hydrological monitoring program. The Project Proponent shall specify the following information, including but not limited to: objectives, methodology and hydrological parameters of the monitoring, frequency and duration of the monitoring.**

A - 162: The impact assessment does not specifically include the monitoring of hydrological conditions. However, Galaxy plans on including the measurement of hydrological conditions to its monitoring program. Data collected shall be used for the inventory of the project impacts on the hydrological regime within the study area. The data will be collected during the monitoring of the fish and its habitat, since these components are closely connected.

A team specialized in hydrometry will be in charge of installing the various measurement devices, including the installation of level probes in the watercourses to monitor variations (over several consecutive years) and take flow measurements at various periods of the year. The data will also be combined to data provided by the rain gauge/barometer. All data collected will be used to interpret changes to the hydrological regime, if applicable.

10 OTHER CONSIDERATIONS

FEASIBILITY STUDY

QC - 163.	**In the Directive from January 2018, the Project Proponent is asked to provide a project description which includes key technical and economic characteristics as they appear in the feasibility study outlined by the Canadian Institute of Mining, Metallurgy and Petroleum. However, the Project Proponent gives the impression that the feasibility study for its project has not been completed. The document referenced to by the Project Proponent (Project Definition, Primero, 2018) was not produced with regard to a feasibility study. Therefore, it cannot prove the economic viability of the project. Also, recommendations of the latest site technical report (2018) states to "continue assessment of the project under various aspects, including engineering and metallurgy, as to assess the viability of the project." Since the economic viability has not been proven, many significant changes could still be made to the project. The Project Proponent shall submit the project feasibility study, which will help make sure no major changes are made to the project during the environmental assessment process and that impacts assessed are indeed those that could potentially happen.**

A - 163: The feasibility study is currently being updated, which includes an update of the market prices and the suppliers' which have significantly changed over the past year. Progress of the feasibility study confirms the economic viability of the project and if changes to the mine design are recommended, such changes will be minor and result in no modification to the project footprint nor to the significance of the environmental impacts previously identified in the EIA. Galaxy will provide COMEX with the feasibility study once completed in the fall of 2019.

CONSIDERATIONS RELATED TO CLIMATE CHANGE AND EXTREME WEATHER CONDITIONS FOR THE PROJECT DEVELOPMENT AND IMPACT ASSESSMENT

QC - 164.	**The EIA presents climate change outlook to 2050, but only partially assess the potential impacts of climate change on the project and its site. The Project Proponent shall assess all risks associated with climate change for the project and its site. The Project Proponent shall demonstrate that the infrastructure design considers the impacts of the future climate, even if it means going beyond applicable laws, regulations and codes. Also, extreme weather conditions will become more frequent and intense and the precipitation regime will be different in the future climate. The Project Proponent must demonstrate that the project infrastructure will be adequate in this context. In that regard, historical climate conditions and climate projections reported by the Ouranos Consortium are a great reference. The MERN also published a report titled "Analyse de risques et de vulnérabilités liés aux changements climatiques pour le secteur minier québécois" (Bussières et al. 2017). This analysis specifically covers the province of Quebec and provides details about northern regions, including James Bay. MERN's Guidelines for Preparing Mine Closure Plans in Quebec address the same topic in the context of mining activities. Even though the guide is about the mine reclamation phase, it can still apply to all phases, including operation. CCEBJ has recently made public the report "État des connaissances relatives aux changements climatiques et à l'adaptation dans le territoire Eeyou Istchee Baie James" produced in collaboration with the Ouranos Consortium (Hennigs et al., 2017). The Project Proponent is invited to consult these documents as to elaborate on the climate change considerations. All structures required for the mine operation phase, in particular the design and selection of restoration methods for structures that will remain in place after closure of the mine, must consider climate change. Generally speaking, the key components of an approach for adaptation to climate change for the mining sector include:** • **definition of impacts of the current climate and assessment of impacts of the future climate by taking into account various climate scenarios;**

- **knowledge of the mining infrastructure vulnerability to climate change and identification of risks;**
- **knowledge of appropriate adaptation solutions and implementation by the designer.**

The Project Proponent shall conduct the following actions, but not limited to, for all equipment and infrastructure required during the mine operation phase:

- **present models used for calculations and predictions. It is suggested to favour Representative Concentration Pathways (RCP) 8.5 and 4.5 emissions scenarios (Moss et al., 2010) while making sure the selected models cover at least the range of model-simulated climate sensitivity (climate change signal amplitude) which goes from low, medium to high climate sensitivity and also covers at least the envelope of uncertainty in climate projections;**
- **identify infrastructure vulnerable to climate change impacts, notably structures associated with water management and stockpile areas;**
- **identify the risks considered and measures intended to limit those risks. For example, the Project Proponent shall:**
  - **demonstrate that the water management infrastructure design and safety measures are adapted to conditions generated by the climate projections;**
  - **demonstrate that the WTP capacity is suitable for conditions generated by the climate scenarios;**
  - **demonstrate that the pit filling time calculation considers future climate scenarios;**
  - **etc.**

The restoration plan shall consider climate change since the main vulnerabilities of the mining sector associated with climate change are observed for mine site restoration. The Project Proponent shall comply with requirements for climate change considerations detailed in MERN's Guidelines for Preparing Mine Closure Plans in Quebec and specify said requirements below (or indicate where the information can be found in its restoration plan). To better assess climate change considerations in its study, the Project Proponent is invited to elaborate on elements mentioned above and to address the subject in a separate section.

A - 164: Appendix A-164 presents the preliminary assessment of the climate resiliency of the project.

The climate change impacts on the James Bay mining project - Galaxy and its environment were assessed following a high-level preliminary risk assessment. The method is consistent with the early stages of ISO 31,000 standard on Risk Management. The study established the scope of the project, the climate trends and the related hazards in terms of probability and consequences. A multi-risk matrix was used to prioritize the levels of risk and suggest appropriate mitigation methods for the design, operations, and dismantling of the project. The results suggested that the most important risks on a medium-term basis (duration of operations) requiring controls and mitigation/adaptation measures were wildfires (infrastructure and health & safety risks), heatwaves (health & safety risk), dam failure (infrastructure) and flooding (health & safety). In the long term (corresponding to the timeline of the dismantling and restoration phase), important risks mainly concern soil drought and heatwaves. Immediate consideration is needed to properly prepare the post-operation phase, which will very likely happen under climate conditions significantly different from the current ones.

COMMITMENTS

QC - 165. The Project Proponent shall provide a summary list of all general and specific mitigation measures, commitments proposed by the Project Proponent and commitments requested in this document.

A - 165: It will be possible to consolidate all general and specific mitigation measures and commitments made in all documents issued once the project has gone through the various provincial and federal review stages. The various measures and commitments will be compiled in a table to be provided to the JBNQA's Administrator and to the MELCC together with the report on the first year of operation.

11 APPENDIX I. PRELIMINARY EMERGENCY MEASURES PLAN

QC - 166. **A preliminary emergency measures plan is presented in Appendix I of the EIA. This plan shall be periodically revised:**

- **revised versions of the emergency measures plan shall include management of contaminated soil;**
- **revised versions of the emergency measures plans shall include the Sécurité civile du Québec in the warning plan as to consider incidents having impacts outside the site. The Project Proponent shall also add the contact information of the Centre des opérations gouvernementales du Québec (+1 866 650-1666) to the external resources directory on page 43 so a 24/7 on call intervenor can be reached;**
- **revised versions of the emergency measure plan shall include cooperation mechanisms with the CBHSSBJ for incidents resulting in a high number of victims and for evacuation of patients, if applicable.**

A - 166: The emergency measures plan presented in Appendix I of the EIA is indeed preliminary. The plan is for this version to be regularly revised together with the risk register. Measures that are critical to the control of residual risks will be integrated to the plan, including measures for the management of contaminated soil and of regional incidents or incidents resulting in a high number of victims. The revised emergency measures plan (EMP) will include a description of the roles and responsibilities of each party, a warning plan and a directory of resources. The EMP will be updated on a regular basis and a copy will be available to all external key stakeholders.

12 TECHNICAL STUDIES

12.1 AIR DISPERSION MODELLING STUDY

QC - 167.	**In Tables 2 and 3 of Section 3.3.1 and Tables 5 and 6 of Section 3.3.2, only activities in bold were modelled. Activities which are not in bold were not included in the modelling. For example, in Table 6 of Section 3.3.2, the "Rock extraction (quarry)" activity, where 453,399 tonnes will be handled, was not modelled. The Project Proponent shall justify why each activity not in bold was not included in the modelling.**

A - 167: Modelling scenarios for activities of the construction phase and for the expansion of the waste rock stockpile represent days of operation where air emissions are at a maximum, despite the fact that a great variation is expected throughout these phases in both the intensity of emissions (tonnage, number of equipment, etc.) and location across the site. WSP's assessment regarding the sequence of activities to be conducted simultaneously show that activities in bold in Tables 2 and 3 of Section 3.3.1 and Tables 5 and 6 of Section 3.3.2 represent the "worst case" scenario.

In Tables 2 and 3, WSP's assessment show that less emissions are produced by the *Mass Excavation* and *Dike Construction* phases than by the *Material Extraction and Production* phase. According to estimates provided by engineering, daily distances covered by 775 trucks are estimated at 1,370 km, 1,475 km and 1,945 km for the *Mass Excavation*, *Dike Construction* and *Material Extraction and Production* phases respectively. The sequence of operations associated with the *Material Extraction and Production* was therefore selected to represent the maximum emissions during the construction phase.

Even though the tonnage handled is higher for the *Mass Excavation*, the daily distance covered for the *Material Extraction and Production* activities is greater. Since haulage is the principal contributor to the various emissions, the transport of material over greater distances produces more emissions than an increase in extraction activities at the quarry. It should also be noted that emissions from *Crushing and Screening (rock)* will be the same for the *Material Extraction and Production* and for the *Dike Construction* phases; thus, this source of emission does not affect the "worst case" scenario assessment.

The same reasoning applies to Tables 5 and 6. However, in this case, fewer emissions are produced by the *Mass Excavation* and the *Material Extraction and Production* phases than by the *Dike Construction*. Daily distances covered by 775 trucks are estimated at 1,300 km, 470 km and 1,450 km for the *Mass Excavation*, *Material Extraction and Production*, and *Dike Construction* phases respectively. The sequence of operations associated with the *Dike Construction* was therefore selected for combination to the operating activities of Year 9.

QC - 168.	**It is mentioned in Section 4.1.4 that air emission factors proposed in AP-42 Section 11.19.2 (Crushed Stone Processing and Pulverized Mineral Processing) were used to assess the particle emissions produced by the crusher. Referring to AP-42 Section 11.24, the Project Proponent concludes that particle emissions produced by feeding of the crusher and transfer of materials from a unit to another are included in these emission factors. The Project Proponent shall provide further explanation regarding its interpretation of AP-42 Section 11.24 since a different interpretation can be given. Also, Table 11.24-1 presents an emission factor rating for material handling and transfer – all minerals except bauxite. The Project Proponent shall justify why this emission factor was not used.**

A - 168: Section 11.24 of the AP-42 clearly states that emissions from the supply of the crusher and transfer of materials from one equipment to another are included in the emission factors:

> "The emission factors in Tables 11.24-1 and 11.24-2 are for the process operations as a whole. At most metallic mineral processing plants, each process operation requires several types of equipment. A single crushing operation likely includes a hopper or ore dump, screen(s), crusher, surge bin, apron feeder, and conveyor belt transfer points. Emissions from these various pieces of equipment are often ducted to a single control device. The emission factors provided in Tables 11.24-1 and 11.24-2 for primary, secondary, and tertiary crushing operations are for process units that are typical arrangements of the above equipment."

Regarding the emission factor rating provided in Table 11.24-1 for "material handling and transfer – all minerals except bauxite", this rating is provided to represent a transfer point between two conveyors without other crushing or screening operations, for example. Thus, this does not apply to the mobile crusher operations described in Section 4.1.4 of WSP's modelling report.

Regarding the use of the emission factors of Section 11.19.2 vs. those of Section 11.24, it was mentioned in the first paragraph of Section 11.19.2 that "Major rock types processed by the crushed stone industry include limestone, granite, dolomite, traprock, sandstone, quartz, and quartzite." However, lithologies that will be crushed by the new mobile crusher during the construction and expansion work are waste rocks: gneiss, ribonned gneiss or diabase. These lithologies are associated with the type of rocks listed in Section 11.19.2, while the factors in Section 11.24 are associated with metallic minerals, i.e. rocks from which metal can be extracted for a profit. Based on this, the emission factors in Section 11.19.2 were therefore preferred.

QC - 169. Section 6.2 presents results for the operation scenario. The Project Proponent shall confirm if results presented include emissions from the two scenarios presented in Section 4, i.e. the operation scenario for production activities and the operation scenario for expansion activities.

A - 169: Results presented in Section 6.2 for the operation scenario include the emission sources mentioned in Sections 4.2 and 4.3. These results also match the scenario described in Section 3.3.2.2.

QC - 170. The Project Proponent shall justify why results of metal and metalloid concentrations in the ambient air for the construction phase are not presented.

A - 170: Results of metal and metalloid concentrations in the ambient air for the construction phase are not presented because information on lithologies handled is uncertain. However, according to the hypothesis that the same lithologies are handled during both phases, WSP estimates that metal and metalloid concentrations in the ambient air during construction are below concentrations during operation. The highest concentration modelled for TMP during construction is 208 $\mu g/m^3$ while it is 216 $\mu g/m^3$ during operation, which also includes construction activities of a similar intensity than those modelled in the construction phase scenario.

QC - 171. Section 7.2.2 refers to the study by Golder Associates (2012) for the determination of attenuation rates for frozen soils. Study results cannot be transposed to other projects since characteristics of tailings used to cover the roads are different from one location to another. It is considered that, even in winter, various materials will be laid out on road sections even if the soil is frozen. This means that particles will be resuspended into the air by traffic of mining vehicles. The attenuation rates of 94% and 96% appear to be high. The Project Proponent shall comment on the use of such attenuation rates for frozen soils.

A - 171: Section 7.2.2 of the modelling report addresses the uncertainties and limitations of the emissions rates used for modelling. The attenuations measured by Golder Associates for winter conditions were not modelled. Nonetheless, results of the study are presented for information purposes as to put into perspective the modelling results. Given that winter conditions are not considered in the emission rates, it is deemed that the modelling method is conservative. All of Section 7 – *Conservatisme et limitation* of the modelling report is provided for information purposes as to put into perspective the modelling results without, however, having modified the modelling method relative to the arguments presented.

QC - 172.	**In Section 7.2.3, it is mentioned that filtration of emissions by the ground cover is not currently supported by the dispersion models. Yet, this physical phenomenon is said to contribute to a significant reduction in actual air particle concentrations, especially in light wind conditions. One study even reports a reduction rate up to 85% (Pace 2005). However, this study precedes the latest AP-42 document (2011). Factors taken from AP-42 may present some uncertainty regarding the discharge of particles. Such factor cannot be accepted without conducting a study specific to the site.**

A - 172: Section 7.2.3 addresses the uncertainties and limitations of the assessment of particulate matter dispersion. The reduction ratios mentioned in this section were not considered for the modelling (see answer to QC-171). However, results of the study by Pace are presented for information purposes as to put into perspective the modelling results and to highlight their conservative nature. This study assesses the reduction of particulate matter transported via phenomena that are not factored in the modelling.

It is not a direct reduction of emissions, but rather a dispersion effect. The AP-42, which presents emission factors, does not consider these dispersion effects. Regarding the date of publication of the AP-42, even though modifications to some sections were made in 2011, the majority of equations used were published in previous versions and references used date back to several years, even several decades. For example, only one significant update has been made to Section 13.2.2 – Unpaved Road since 1995, even though the section is dated 2011. Section 13.2.2.4, just before the list of references, mentions that a major revision of the section was made in 1998 and that only minor changes have been made since then.

QC - 173.	**Emission rates way higher than those presented are obtained in the C.1.3 calculation example for loading/unloading activities. The daily loading/unloading tonnage value used (21,144 ktm/day) does not seem realistic. The Project Proponent shall verify the emission rate calculation and present its findings.**

A - 173: There has been a mistake. The daily loading/unloading tonnage value should have been 21.144 ktm/day. All other values used for the calculation are consistent with this correction.

12.2 SOIL BACKGROUND CONCENTRATION TECHNICAL STUDY

QC - 174.	**Some analyzed samples (e.g. TR-24-PM3, BH-31 SS-2 and BH-40 SS-3 A) associated with the fine sand "stratigraphic unit" rather correspond to the coarse sand "stratigraphic unit". Conversely, other samples (e.g. CE-TR3 PM2, CE-TR9 PM1 and CE-TR10 PM1) associated with the coarse sand "stratigraphic unit" correspond in fact to the fine sand "stratigraphic unit". The Project Proponent shall provide further clarification on the operational definition used to differentiate the two "stratigraphic units".**

A - 174: The various stratigraphic units were named "fine sand" and "coarse sand" as to be concise. However, as mentioned in the Soil Background Concentration Technical Study[1], here is the general description of these units:

- Coarse sand: composed of coarse sand to sand with gravel to some gravel, with pebbles (0% to 15%) and sometimes boulders (0% to 10%), brown to reddish brown silt and clay.
- Fine sand: composed of fine sand to silty sand, with some gravel to coarse in some places, pale grey to pale brown.

Given the heterogeneity of soils in all boreholes, the distinction between units was not only conducted on the basis of particle size, which changed within the same soil layer, but also on the visual appearance of soils (aspect, color, oxidation state, etc.).

Thus, samples listed in this question are indeed associated with the units to which they were assigned.

QC - 175. A few metals analyzed in the soil are present, but their concentrations can be compared to no criteria since none exist. Comparison criteria shall be developed for lithium, titanium and vanadium, among others, by asking the MELCC's relevant sector.

A - 175: Only criteria specified in the *Guide d'intervention* (MELCC, 2019) apply to the site. Background levels were, however, developed for lithium, titanium and vanadium in the Soil Background Concentrations Technical Study. These criteria may be used as benchmark criteria after validation with MELCC's representative.

12.3 HYDROGEOLOGICAL TECHNICAL STUDY

SITE DESCRIPTION / CONCEPTUAL MODEL (SECTION 4)

QC - 176. Permeability tests were only carried out in two locations within the area of the future stockpiles (between creeks CE2 and CE3): BH-10A/BH-10B and WSP-MW8R/WSP-MW8S. The number of permeability tests conducted is not sufficient given the surface area (greater than 200 ha). This number must be proportional to the surface area as to cover the entire area where the future stockpiles will be implemented. The Project Proponent shall perform the additional permeability tests and make sure to have sufficient field data to prove that the construction of the stockpiles will comply with requirements of Directive 019.

A - 176: A total of 23 boreholes were developed in the future stockpile area. Out of these boreholes, five are observation wells. In addition to the permeability tests conducted in BH-10A/BH-10B and WSP-MW8R/WSP-MW8S, 30 particle size analyses were carried out, thanks to which, it was possible to assess the permeability of surface deposits in the area of the future stockpiles (52 across the entire site). Results of the analyses can be found in Table 176-1. For bedrock, four tests in two wells were conducted in the future stockpile area, and 14 tests in 8 wells, as well a one pumping test, allowed for the characterization of all bedrock units found across the site under study. From the data collected, a numerical model was developed, calibrated and used to reproduce the water levels observed in the bedrock aquifer. Given the reproducibility of data, it is assumed that the permeability assigned to the bedrock aquifer is representative of the environment. The assigned value is within the range of value measured on site for this unit. Given the uncertainties associated with the production of a hydrogeological model, a sensitivity analysis was carried out regarding the hydraulic conductivity of the bedrock as to assess the impact of an increase of conductivity on results.

[1] WSP. 2018. Mine de lithium Baie-Jame – Étude spécialisée sur la teneur de fond naturelle dans les sols. Rapport préparé pour Galaxy Lithium (Canada) inc. N/réf : 171-06062-00. 29 pages et annexes.

It appears that the amount of data available in the future stockpile area is sufficient. All the more so as the future stockpile area will rest on the surface deposits whose permeability was clearly determined.

Table 176-1 List of Samples Analyzed – Future Stockpile Area

Unit	Well #	Sample #	Description	Permeability (m/s)		
				Geometric Mean	Minimum	Maximum
Clay deposits	BH-3	BH-3-3	Clayey silt, traces of sand	3.02E-09	4.27E-10	5.31E-08
	BH-3	BH-3-6A	Silt, some clay, traces of sand	3.32E-09	7.91E-10	1.31E-08
	BH-5	BH-5-5	Clay and silt, traces of sand	4.24E-11	1.52E-12	3.77E-10
	BH-5	BH-5-8	Clayey silt, traces of sand	4.19E-09	5.09E-10	1.00E-07
	BH-10	BH-10-5	Clay and silt, traces of sand	5.37E-11	6.48E-12	2.60E-10
	BH-10	BH-10-8	Silt and clay, traces of sand	2.30E-10	1.30E-10	5.17E-10
	BH-13	BH-13-3	Silty clay, traces of sand	5.83E-11	5.13E-12	3.31E-10
	BH-13	BH-13-5	Clay and silt	8.35E-11	9.85E-12	4.09E-10
	BH-13	BH-13-8	Silt, some clay, traces of sand	2.99E-09	1.50E-09	6.01E-09
	BH-15	BH-15-3	Clay and silt	7.90E-11	8.63E-12	4.03E-10
	BH-15	BH-15-4	Silt and clay, traces of sand	7.70E-10	1.76E-10	5.20E-09
	BH-16	BH-16-3	Clay and silt, traces of sand	3.56E-12	8.71E-16	3.84E-10
	BH-16	BH-16-6	Clayey silt, traces of sand	8.73E-10	2.49E-10	3.78E-09
	BH-18	BH-18-2	Clay and silt, traces of sand	1.67E-10	6.94E-11	4.35E-10
Clay deposits (till)	BH-7	BH-7-3	Sandy gravel, some silt	2.67E-04	5.58E-06	1.23E-01
	BH-8	BH-8-4	Gravel and sand, some silt	4.31E-05	3.64E-06	1.34E-02
	BH-11	BH-11-3	Sand and silt, some gravel, traces of clay	1.93E-06	3.27E-07	5.94E-06
	BH-12	BH-12-8	Sandy gravel, some silt, traces of clay	1.05E-05	2.79E-06	3.64E-05
	BH-14	BH-14-3	Sand and silt, some gravel, traces of clay	1.14E-06	1.55E-07	5.05E-06
	BH-14	BH-14-9	Sand and silt, traces of gravel	1.48E-06	7.10E-07	5.76E-06
	BH-17	BH-17-13	Silty sand, some gravel, traces of clay	2.56E-07	7.52E-09	1.30E-05
	BH-17	BH-17-2	Silty and gravelly sand, traces of clay	3.14E-06	1.24E-07	1.31E-04
	BH-17	BH-17-4	Sandy and silty gravel, traces of clay	7.10E-06	6.92E-07	2.86E-03
	BH-17	BH-17-9	Silty sand, some gravel	3.12E-06	1.03E-06	1.13E-05
	BH-21	BH-21-11	Silty and gravelly sand, traces of clay	5.21E-06	7.21E-07	2.26E-05
	BH-21	BH-21-6	Silty sand, some gravel, traces of clay	2.23E-06	2.42E-07	1.78E-05
	BH-23	BH-23-2B	Sand, some silt, traces of gravel and clay	6.87E-06	2.32E-06	2.39E-05
	BH-23	BH-23-5	Silty and gravelly sand	7.53E-06	1.09E-06	7.45E-05
	BH-24	BH-24-4	Sandy gravel, some silt, traces of clay	1.56E-06	1.88E-08	2.41E-02
	BH-26	BH-26-3	Silty gravel, sand	8.23E-06	5.97E-07	1.50E-03

QC - 177. Map 6 shows that clay thickness at the location of the future waste rock stockpile ranges from 0 to 6 m. According to the information presented in the EIA, waste rocks are leachable and acid generating, while tailings are leachable for certain parameters. Based on field work data, the Project Proponent shall delimit areas were sealing work will be conducted to meet groundwater protection objectives as required under Directive 019.

A - 177: Results presented in the technical note prepared by WSP after submittal of the EIA (WSP, 2018; Appendix 177) indicated that sealing work would have to be conducted for the entire area where the clay thickness is less than 1 m. Results of kinetic tests presented in Appendix QC-20 show that waste rocks and tailings are of low risk. Thus, sealing work for the protection of groundwater is no longer necessary.

QC - 178.	**According to Table 11, the average hydraulic conductivity of clay deposits is 9.96 x 10-10 m/s. However, the value presented in Section 4.3.3 for the same parameter is 3.16 x 10-10 m/s. For sand deposits, the average hydraulic conductivity indicated in Table 11 is 9.61 x 10-6 m/s, but 6.07 x 10-5 m/s in Section 4.5.1.1. The Project Proponent shall explain these differences.**

A - 178: There has been a mistake for clay deposits. The average hydraulic conductivity value that should be used is the one in Table 11, i.e. 9.96 x 10-10 m/s. For sand deposits, the difference can be explained by the fact that Table 11 compiles all results (particle size and permeability test), while the results presented in Section 4.5.1.1 only consider results of the particle size analyses.

QC - 179.	**It is indicated on page 15 that the elevation within the modelled area ranges from 240 m to 381 m (total elevation difference of 140 m). However, the topographic curves on Map 2 show different values. The Project Proponent shall explain this difference.**

A - 179: There has been a mistake. As shown on Map 15, the topography of the modelled area presents elevations ranging from 190 to 260 m for a total elevation difference of 70 m.

FLOW MODEL DEVELOPMENT AND CALIBRATION (SECTIONS 6 AND 7)

QC - 180.	**Map 2 does not illustrate the boundary of the modelled area. The Project Proponent shall add said boundary to the map.**

A - 180: The modelled area was added on Map QC-180 (formerly Map 2).

QC - 181.	**Map 3 shows the boundary of the modelled area and boundaries of the five subwatersheds located within this area. The Project Proponent shall justify why the modelled area does not include all watersheds and explain why two small zones of the left limit of watershed 5 and the north section of watershed 1 are excluded.**

A - 181: The southernmost portion of watershed 5 was excluded so that the lake could act as the imposed boundary. The small zone just above was not included because the detailed topography was not available when the model was produced. These two zones are far from the future infrastructure and therefore have no impact on the results. The north section of watershed 1 was excluded to use creek CE1 as boundary. Also, the detailed topography did not cover all of watershed 1.

QC - 182. **For Map 8, the Project Proponent shall explain and/or justify the following elements:**

- **Map 8 shows that the same watercourse can be represented in part by imposed load conditions and in part by drainage conditions (e.g. CE1, CE2, CE3 and CE5). The Project Proponent shall explain in detail why these loads were used;**
- **justify why the area between creeks CE2 and CE3 was represented by drainage conditions;**
- **explain why the condition at the outer boundaries of Lake 1 was represented by no flow conditions instead of imposed load conditions;**
- **explain why the condition at the outer boundaries of the lake located at the south corner of the model was represented by no flow conditions;**
- **justify the attribution of drainage boundary conditions for the area between Lake Kachiskamikach and the outer boundary of the model (represented by imposed load boundary conditions).**

A - 182: The imposed loads were applied only on watercourses that we know to be permanent. For the watercourse from the southern lake to creek CE5, data available were not sufficient to have the entire watercourse in imposed load conditions. The section for which we had no data was therefore left in drainage boundary conditions. For the two areas on creek CE5, there has been a mistake when sending data to cartography (the entire watercourse shall be represented by imposed load conditions in the model). Lake 1 and the lake located at the south corner present imposed loads in the model. Map 8 was reissued to represent the conditions applied to the model.

The area located between creeks CE2 and CE3 is a marsh area; drainage load boundary conditions were therefore applied as to allow water to leave the model.

Indeed, the four nodes between Lake Kachiskamikach and the model boundary could have been imposed. However, results show that water comes out at the elevation where the drainage condition was imposed. Thus, this does not impact calibration and results of predictive simulations.

QC - 183. Map 12 shows that all watercourses within the modelled area correspond to resurgence areas. The Project Proponent shall explain how a watercourse represented by an imposed load condition can be a resurgence area at the same time.

A - 183: The notion of imposed load implies that the load will remain constant throughout the simulation. However, for this to happen, it is required to receive or to transfer flow (water) at the node to maintain the load. It is possible to see if nodes (assigned as imposed loads) act as resurgence areas or recharge areas. For a given imposed load, we can know if water enters or exits to maintain the water level at the imposed elevation which makes it possible to define the recharge/resurgence areas. For this project, all watercourses represent resurgence areas. This means that water must experience a resurgence at this location to maintain the imposed load.

QC - 184. The study presents no detail regarding the number of layers used in the numerical model, their thickness or the boundary conditions applied to these layers. The Project Proponent shall provide the information in written form and in a 3D figure showing the variation in thicknesses of each layer based on field work conducted on the site.

A - 184: The thickness of surface deposits was established based on field observations:

- peat thickness ranges from 0 to 3.2 m across the modelled area;
- clay thickness ranges from 0 to 10 m;
- sandy deposit thickness ranges from 0 to 18.6 m.

The total thickness of surface deposits varies between 0 and 19.4 m. Each layer created is divided into 15 layers to obtain a better “z” refinement and facilitate calculation. The thickness of layers varies between 0.01 m and 4.3 m. The bedrock aquifer was divided into 22 layers to obtain a good “z” refinement for the predictive simulations of the pit. The thickness of layers for this unit varies between 4 m and 50 m.

The following figure presents a 3D view of the variation in thickness for the various units and layers of the model.

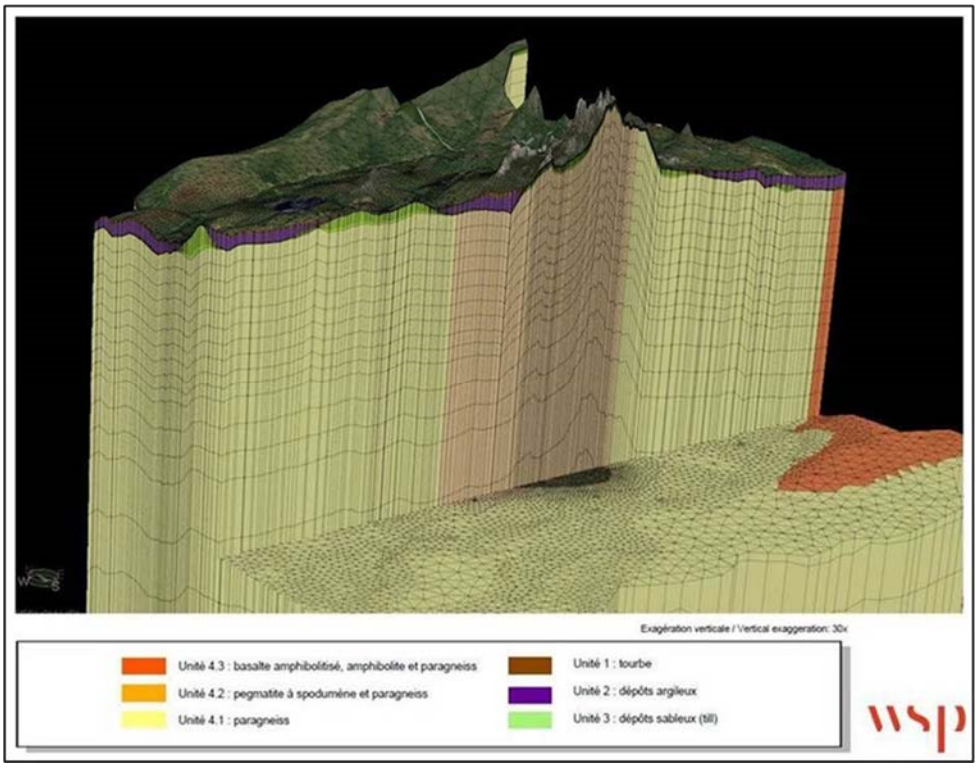


Figure 184 3D View – Hydrogeologic Model

QC - 185.	**The Project Proponent shall provide a recharge distribution map for the modelled area. The map shall come with an explanation on how the recharge was estimated based on total precipitation, evapotranspiration and runoff values.**

A - 185: Map QC-185 shows the recharge applied across the entire modelled area. The recharge varies between 10 and 310 mm/yr across the area. First, the potential recharge was assessed from a water balance. The potential recharge lies within the range presented in Section 4.2.2 of the Hydrogeological Technical Study (WSP, 2018). Values were defined according to the type of soil and the slope. A minimum recharge was applied to watercourses, lakes and areas with clay deposits. The final recharge was set during the calibration phase from ranges previously set for each of the areas (type of soil, slope, piezometry).

NUMERICAL SIMULATION RESULTS (SECTION 8)

QC - 186.	**Based on the pit area (estimated at 69.55 ha) and an average annual precipitation of 697.2 mm, the Project Proponent assessed the daily water volume from direct precipitation into the pit at about 1,400 m^3/d. However, this value does not consider the evaporation and runoff rate. The Project Proponent shall correct the water volume value accordingly.**

A - 186: This volume was meant to be a conservative value as to obtain a maximum average flow from precipitation. All water falling into the pit will run to the bottom and be pumped. The water volume to be managed can be calculated from effective precipitation, i.e. 345.7 mm/year (Section 4.2.2 of the Hydrogeological Technical Study, WSP, 2018). This represents an average daily volume of approximately 700 m^3/d to manage.

QC - 187. According to values presented in Table 8 of the hydrogeological technical study, the average precipitation is 683.9 mm/year. However, on page 6-5 of the EIA, the precipitation value is 697.2 mm/year. The Project Proponent shall select a single precipitation value and make the necessary corrections.

A - 187: The difference between the two values is explained by the fact that the data was not compiled for the same period. For the EIA, data was collected between 1981 and 2010 (true for all climate components, Section 6.2.1). For the hydrogeological study, data was gathered between 1976 and 2017. Data factored in the hydrogeological study covers a greater period of time and also includes more recent data, and is therefore deemed more accurate since it integrates variability over a greater number of days. Values presented in Table 8 of the hydrogeological technical study must be prioritized for the finer analysis, while data presented in the EIA can be used to provide a more global portrait of the "Climate" component where all required data was only available for the 1981-2010 period. No modification to the results of the project impact assessment is required.

12.4 TERRESTRIAL VEGETATION BASELINE STUDY

QC - 188. The *Guide d'identification et délimitation des milieux humides du Québec méridional* (Bazoge et al., 2014) recommends the implementation of 3 inventory plots per ha for homogeneous vegetation units of less than 10 ha. An adapted sampling strategy can be proposed for homogeneous units of more than 10 ha. The terrestrial vegetation baseline study indicates that the number and distribution of plots were adjusted according to field observations. Some of these adjustments resulted in little inventory effort. For example, the open peatland #10 (surface area of 600 ha) includes 19 inventory plots which corresponds to a ratio of one inventory station per 31 ha. Little inventory effort, especially at the location of the future infrastructure, may lead to the exclusion of key facts. For example:

- **no inventory station was placed west of the waste rock stockpile nor at the main water retention basin site. Even if a stereoscopic analysis of aerial photographs was conducted in this area, those environments will be completely destroyed;**
- **there are few sampling stations south of the projected pit in the shrubland #03 polygon which was categorized as a terrestrial environment. This type of environment includes dominant hygrophilous plants and is part of an area that will be destroyed by the project.**

The Project Proponent shall justify the sampling effort, mostly in areas where future infrastructure is planned. The Project Proponent shall supplement the information presented for these areas. The Project Proponent shall present a map which overlaps the wetland boundaries and the projected infrastructure.

A - 188: As specified in the *Guide d'identification et délimination des milieux humides du Québec méridional* (Bazoge *et al.*, 2015), photo interpretation is essential for large-scale projects such as the current project. Considering the large project area, a significant photo interpretation effort was put forth before and after on-site inventories as to get a more accurate characterization and delineation.

It should be noted that a more up-to-date version of the Appendix A (Inventory Sheets) should have been attached to the Specialized Study on Flora at the time of its issue. The up-to-date version, dated June 11, 2018, can therefore be found in Appendix A-188, and replaces the version dated December 4, 2017. The new version differs little from the previous version, except that it corrects typos and regroups wetlands together.

As specified in Section 6.3.3.1 of the EIA and in the Specialized Study on Flora (WSP, 2018f), sampling activities in the study area started with the 2D photo interpretation of a coloured satellite image which includes data from a wetland inventory conducted in 2011.

Inventory plots were positioned within each land or wetland polygon group (homogenous vegetation unit). Each polygon was explored during field inventories and a varying number of complete plots was achieved, according to the size of the vegetation units, as to properly characterize the vegetation found in the environments and to record all key components for the description of the environment.

Field inventories made it possible to note that all types of environments found within the study area are **highly homogenous and similar** in their floristic assemblage (Map QC-188). This observation is in line with what is usually observed in this sector since the study area is located at the junction of the bioclimatic domain of the spruce-moss and spruce-lichen stands. For example, the forest cover is clearly dominated by the black spruce at various locations, creating very large monospecific peaty tree and shrub stands. The shrub layer is also dominated by heaths. Thus, the existing peatlands (shrubby, treed or open) are homogenous, very large and usually of limited diversity.

These findings explain why the sampling effort required for the characterization of the environments does not demand the same resolution as what is usually required for the characterization of environments found in southern Quebec. The number of inventory plots must also be assessed by considering that going through the vegetation units can tell us more about their characteristics. It should also be considered that significant efforts were put forth so that photo interpretation supported first and foremost the field inventories, but could also be used after the inventory campaigns to specify the observations made through photo interpretation.

It should also be noted that the open peatland #10 is somewhat of a special case. This vegetation unit forms the backdrop of the territory, i.e. open peatlands with former treed peatlands over which a fire spread, as well as ombrotrophic and open minerotrophic peatlands spared by the latest forest fires. When considering the section of this vegetation unit that was visited directly during the inventory campaign, it is rather an official plot of 20 ha that was surveyed. The remainder of the homogenous vegetation unit was assessed through photo interpretation. Also, a section of this polygon spreads beyond the direct footprint of the projected infrastructure.

As requested, overlapping of the projected infrastructure and the wetland boundaries was conducted (Appendix A-188). The map shows that for the most part, field inventories allowed for a proper documentation of environments found within the local study area and within the sector where infrastructure will be implemented. Since details on the location of future infrastructure were not defined at the time of inventories, the west sector of the waste rock stockpile was not surveyed during field campaigns. However, it can be noted that this sector includes peaty wetlands of the same kind as the ones documented further east. According to the photo interpretation, this sector is almost entirely dominated by peaty wetlands, i.e. approximately 95% of the territory within the footprint of the future stockpile located west of plots P-45 and P-46. Based on our field observations and on the photo interpretation, it is highly unlikely that this sector is poorly characterized at the moment.

Shrubland #3 has been greatly disrupted by a recent forest fire of likely high intensity. Only the shrub layer is still clearly represented which means that the characterization of its terrestrial or wetland nature is solely based on the presence of two shrubs where the plot was placed (*Chamaedaphne calyculata* and *Rhododendron groenlandicum*). While the vegetation is dominated by hydrophytic plant species (based on data collected), which is often the case at this latitude, the terrestrial nature of the environment is obvious. Organic soil is found over only 10 cm and the underlying soil has a sandy non hydromorphic texture. Herbaceous plants seen elsewhere in this polygon are rather non-indicative species (WSP, 2018f; page 21 of Appendix A). Also, no hydrological indicator was observed. The water table was not observed in the first 30 cm of depth and the plot was placed at the start of a slope which gets steeper towards the south. Based on all these components, this environment must be considered as terrestrial despite the dominance of hydrophytic plant species. It should be noted that no official list has been published by the MELCC identifying which species are hydrophytic (optional or mandatory plants of wetlands) in northern Quebec. At the moment, the list provided by the MELCC only applies to southern Quebec. Data provided at plot P-82, located south of the future pit, clearly shows that this shrubland is rather terrestrial.

QC - 189. In Section 3.1.1 of the terrestrial vegetation baseline study, alder groves are categorized as terrestrial environment. However, these communities include dominant hygrophilous plants. The Project Proponent shall explain why all shrublands are categorized as terrestrial environment instead of wetland.

A - 189: The alders described in Section 3.1.1 refer to the dominance of green alder over the environment (*Alnus alnobetula subsp. crispa*), a species considered non-indicative of wetlands (Bazoge A. *et al.* 2015). Contrary to the grey alder (*Alnus alnobetula subsp. rugosa*), the green alder is a pioneer and opportunistic species with the ability to colonize a wide spectrum of terrestrial and wetland habitats. Bare mineral surfaces, dry soil of spruce stands and grey pine forests (*Pinus banksiana*), as well as well-drained or gravelly riparian habitats are conducive to the presence of green alder (Payette S. et al. 2015). The categorization of shrublands dominated by the green alder as a terrestrial habitat is therefore in accordance with information found in the literature, as it is not dominated by hygrophilous plants. In any case, all characterized shrublands are dominated by plants non-indicative of wetlands, except shrubland 03. For this specific case, the reasons behind the categorization of this shrubland as a terrestrial environment instead of a wetland are detailed in the answer to QC-188. It can also be noted that not all shrublands are categorized as terrestrial environments since shrub peatlands are found across the study area.

QC - 190. The methodology used to identify wetlands and terrestrial environments is mostly adequate and appears similar to the methodology recommended by the MELCC. However, Section 2.3.2 mentions that "given the large area of this [inventory] area, the wetland high water mark was not surveyed on the entire perimeter." The high water mark is usually used to identify the shoreline of a hydrous environment. It is mentioned in Section 3.1.2 that "photointerpretation of minerotrophic peatlands contributed to the delineation of the watercourse shorelines in the study area." The Project Proponent shall explain the methodology used to delineate the wetlands (especially remote areas).

A - 190: As mentioned in Sections 2.2 and 2.3 of the Specialized Study on Flora (WSP, 2018f), the methodology used for the delineation of wetlands is mostly based on the one described in the *Guide d'identification et de delimitation des milieu humides du Québec méridional* (Bazoge et all., 2015). As specified in this guide, photo interpretation is essential for large-scale projects such as the current project. Considering the large project area, a significant photo interpretation effort was put forth before and after on-site inventories as to get a more accurate characterization and delineation. As specified in the Specialized Study on Flora, a first 2D photo interpretation campaign served as the basis for work and provided guidance for the field inventories.

There seems to be some confusion, most likely due to the use of "wetland high water mark" in Section 2.3.2 to refer to the wetland boundaries. To clarify the situation, we can reformulate by specifying that field inventories were able to, among other things, validate the photo interpreted wetland boundaries. Section 2.3.2 specifies that the wetland boundaries were adjusted or surveyed, if necessary, in the case of inaccuracy or error in the photo interpretation. However, this boundary was not surveyed with a GPS along its entire perimeter. It should be specified that photo interpretation was conducted by specialized experts with state-of-the-art tools, thus allowing a highly accurate work. The wetland characterization and delineation were completed after the field campaign via 3D photo analysis on a screen by the same photo interpretation experts by incorporating observations made on site. As required, wetland boundaries and the types of wetlands were therefore validated and defined during the inventory campaign, thus making it possible to optimize the photo interpretation effort. The combination of the photo interpretation and field work provided a highly precise and complete portrait of the vegetation units and wetlands across the territory.

Some adjustments were required during the field work as to adapt the wetland characterization and delineation method to a northern context since the study area is located up north. The ecology of species and ecological processes at this latitude are not the same as those occurring in southern Quebec. For example, the water status of the black spruce (*Picea mariana*) which is found in wetlands of southern Quebec, is a species dominating both the wetlands and terrestrial environments in northern Quebec. The biophysical and hydrological indicators, and in situ soil characteristics, made it possible to rule on the water status of groups in cases where vegetation did not allow the establishment of a clear identification.

The high water mark of watercourses flowing within the vast wetlands of the study area was established following an analysis based on observations made on site and on 3D photo interpretation of minerotrophic peatlands. High resolution images obtained by drone were also used to identify the shoreline boundaries of the hydrous environments. As mentioned in Section 3.1.2 (WSP, 2018f), minerotrophic peatlands are found along watercourses. These riparian habitats are flooded by watercourses in spring which results in them being part of their shoreline. The end of the shoreline is therefore located at the boundary of this type of group along the watercourses. The biophysical criteria observed on site were in line with the identification of the HWM at this location. The wetland complex formed by the transition between minerotrophic and ombrotrophic peatlands (ecotone) sometimes spreads beyond the actual high water mark of watercourses. This situation is common in this region of northern Quebec, where ombrotrophic peatlands are often very large and in direct connectivity with watercourses across the territory. As a consequence, it becomes difficult to accurately establish the HWM of watercourses within a peatland with only one field visit. In our opinion, the assessment of the HWM based on the method used includes, without a doubt and at least in part, the transition ecotone and is therefore conservative compared to the actual level reached by the watercourse in 2-year flood conditions.

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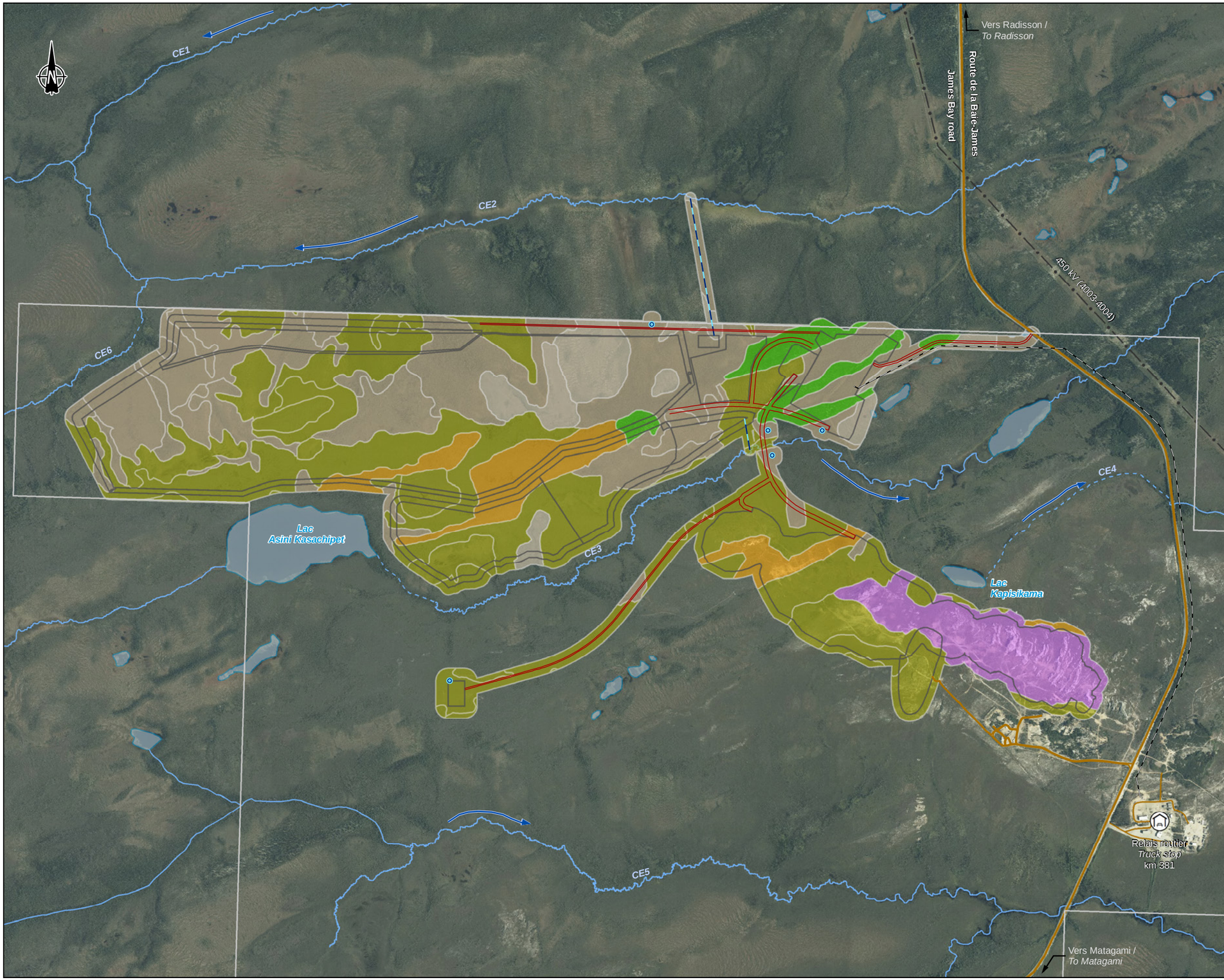
MAPS



Limite de propriété / *Property limit*

Composantes du projet / *Project Component*

- Route / *Road*
- Effluent minier / *Mine effluent*
- Station de pompage / *Pumping station*
- Câble de fibre optique / *Optical fiber cable*
- Infrastructures minières / *Mining Infrastructure*

Peuplements terrestres / *Terrestrial Vegetation*

- Affleurement rocheux / *Rock outcrop*
- Arbustaie / *Scrubland*
- Pessière noire à lichen / *Black spruce lichen forest*
- Anthropique / *Anthropogenic*

Peuplements humides / *Wetland*

- Tourbière arbustive / *Shrubby peatland*
- Tourbière boisée / *Treed peatland*
- Tourbière ouverte / *Open bog*

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

GALAXY

Mine de lithium Baie-James /
James Bay Lithium Mine

Réponses aux question du MELCC / MELCC requests

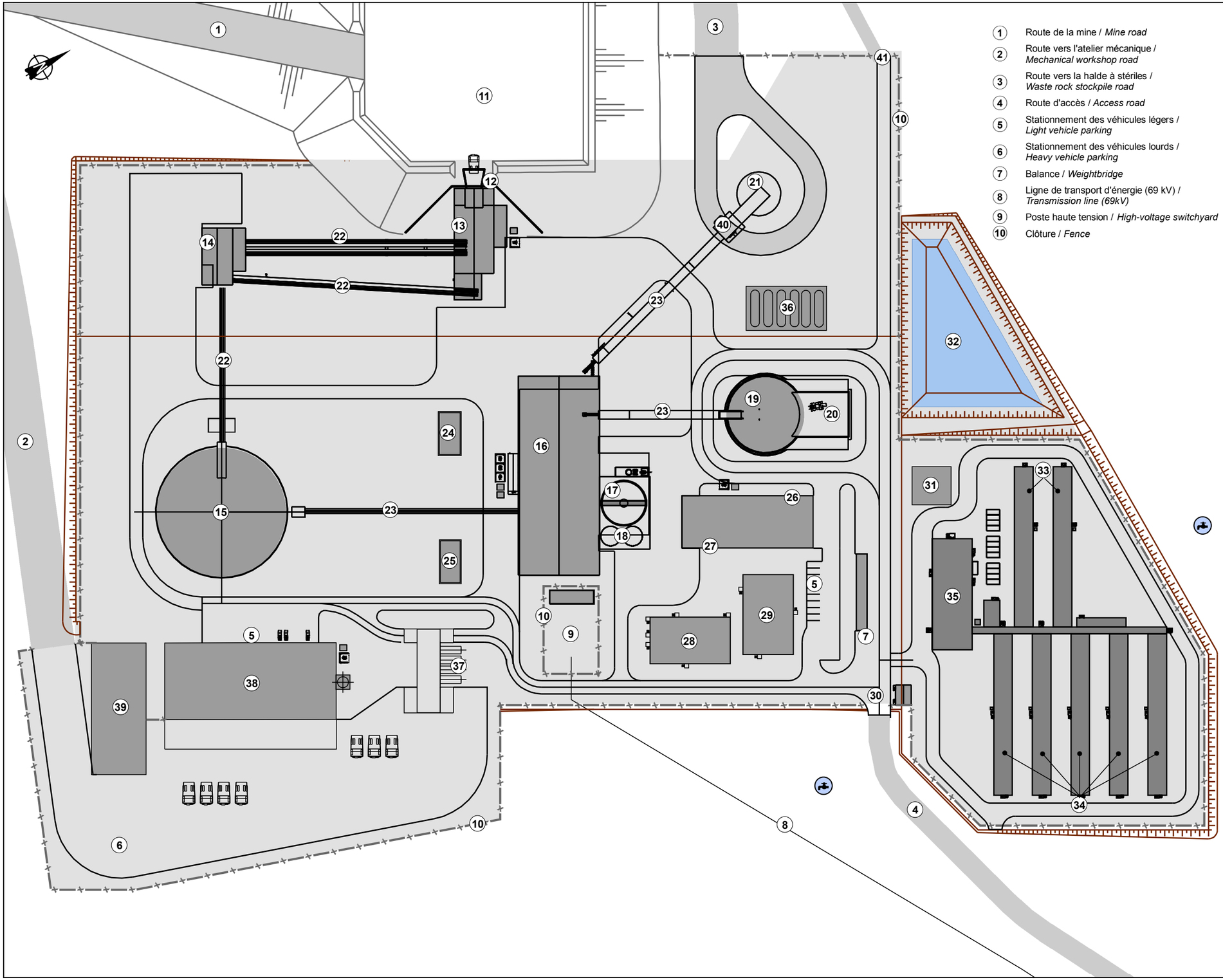
QC-19
Terrassement / *Earthworks*

Sources :
Orthoimage : Galaxy, août / august 2017
Données du projet / Project data : Galaxy, 2018
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

0 180 360 m
UTM, fuseau 18, NAD83

Dessin : A. Masson
Approbation : C. Martineau
171-02562-00_cMELCC-QC-19_wspT222_terrassement_190516.mxd

wsp



1 Route de la mine / *Mine road*
2 Route vers l'atelier mécanique / *Mechanical workshop road*
3 Route vers la halde à stériles / *Waste rock stockpile road*
4 Route d'accès / *Access road*
5 Stationnement des véhicules légers / *Light vehicle parking*
6 Stationnement des véhicules lourds / *Heavy vehicle parking*
7 Balance / *Weightbridge*
8 Ligne de transport d'énergie (69 kV) / *Transmission line (69kV)*
9 Poste haute tension / *High-voltage switchyard*
10 Clôture / *Fence*
11 Halde à minerai / *ROM pad*
12 Déchargement de minerai / *Material unloading*
13 Concasseur primaire / *Primary crusher*
14 Concasseurs secondaire et tertiaire / *Secondary and tertiary crushers*
15 Dôme de minerai concassé / *Crushed material dome*
16 Concentrateur / *Concentrator*
17 Épaississement des résidus / *Tailings thickening*
18 Réservoirs d'eau / *Water tanks*
19 Dôme de concentré / *Concentrate dome*
20 Zone de chargement / *Loading area*
21 Stockage temporaire de résidus miniers / *Temporary storage for tailings*
22 Convoyeur semi-couvert / *Semi-covered conveyor*
23 Convoyeur couvert / *Covered conveyor*
24 Entrepôt à produits pour le SMD et l'UTE / *DMS and WTP products warehouse*
25 Entrepôt à matières résiduelles / *Residual material warehouse*
26 Entrepôt / *Warehouse*
27 Ateliers / *Workshops*
28 Laboratoire / *Laboratory*
29 Administration et services médicaux / *Administration and medical services*
30 Guérite / *Gatehouse*
31 Gestion de l'eau potable et eaux usées / *Drinking water and wastewater management*
32 Bassin de sédimentation / *Settling pond*
33 Dortoirs de la construction (temporaire) / *Construction dormitories (temporary)*
34 Dortoirs / *Dormitories*
35 Cafétéria et aire de repos / *Cafeteria and lounge*
36 Réservoirs de propane / *Propane storage*
37 Réservoirs de diesel / *Fuel storage*
38 Atelier mécanique / *Mechanical workshop*
39 Entrepôt à pièces mécaniques / *Mechanical warehouse*
40 Chargement de résidus miniers / *Tailings loading*
41 Route vers l'usine de traitement de l'eau / *Water treatment plant road*

Puits d'alimentation en eau potable / *Potable water wells*

GALAXY

Mine de lithium Baie-James /James Bay Lithium Mine

Réponses aux questions du MELCC / MELCC Requests

QC-40

Localisation proposée pour les puits d'alimentation en eau potable /
Proposed Location for Potable Water Wells

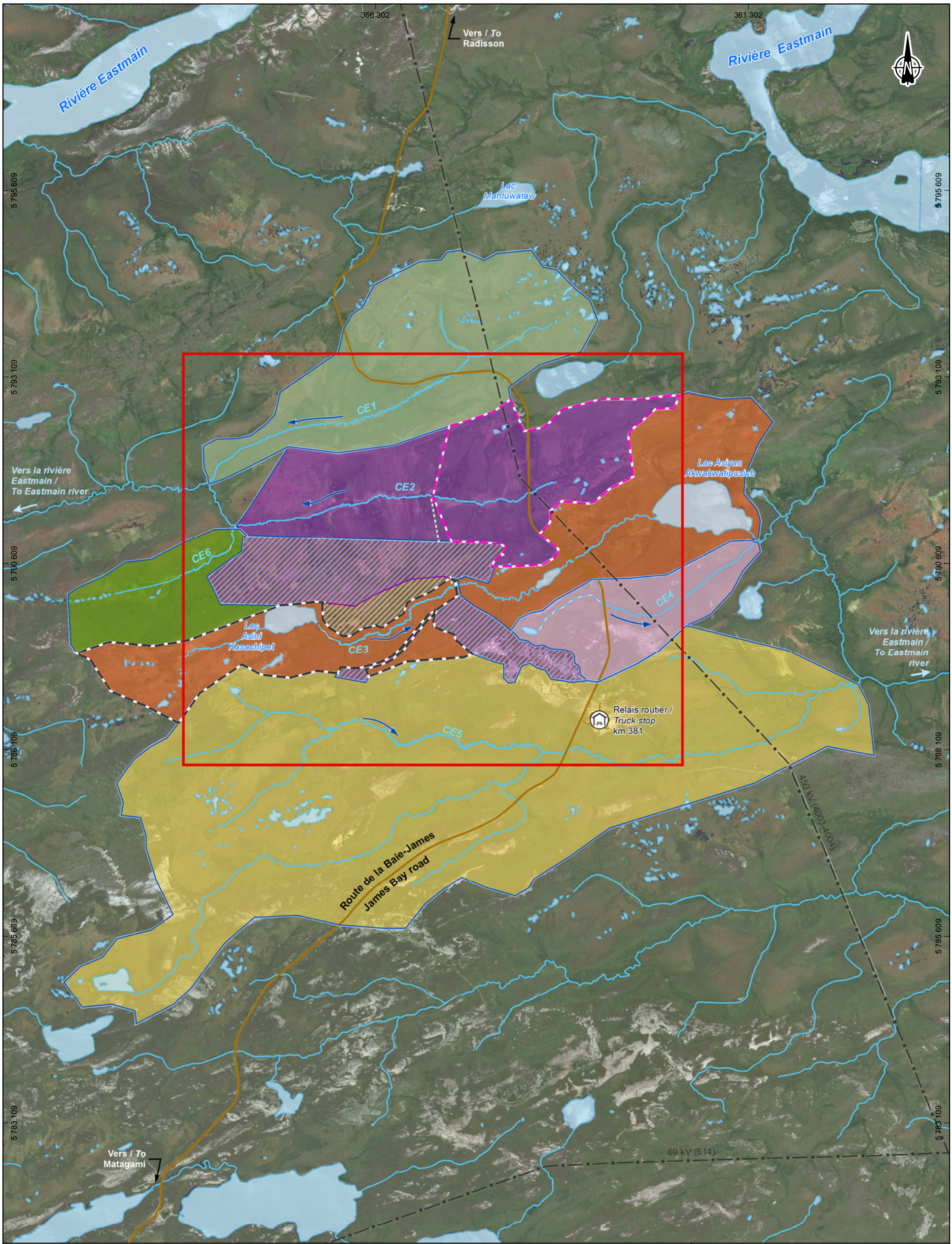
Sources :
Données du projet / Project data : Galaxy 2018

0 17,5 35 m
UTM, fuseau 18, NAD83

Dessin : A. Masson
Approbation : C. Martineau

191-01753-00_cMELCC-QC-40_wspT230_processing_190619.mxd

wsp



Zone d'étude locale / *Local study area*

Hydrographie / *Hydrography*

Limite de bassin versant / *Watershed limit*

Bassin versant 1 / *Watershed 1*

Bassin versant 2 / *Watershed 2*

Ruissellement sur le site vers l'effluent CE2 / *Site runoff to CE2 effluent*

Bassin versant 3 / *Watershed 3*

Ruissellement sur la halde de mort-terrain vers l'effluent CE3 / *Runoff from overburden stockpile to CE3 effluent*

Bassin versant 2 – amont de l'effluent / *Wathershed 2 – upstream effluent*

Bassin versant 3 – amont de l'effluent / *Wathershed 3 – upstream effluent*

Bassin versant 4 / *Watershed 4*

Bassin versant 5 / *Watershed 5*

Bassin versant 6 / *Watershed 6*

Cours d'eau permanent / *Permanent stream*

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

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

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

Effluent minier / *Mine effluent*

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
Réponses aux questions du MELCC / MELCC Requests

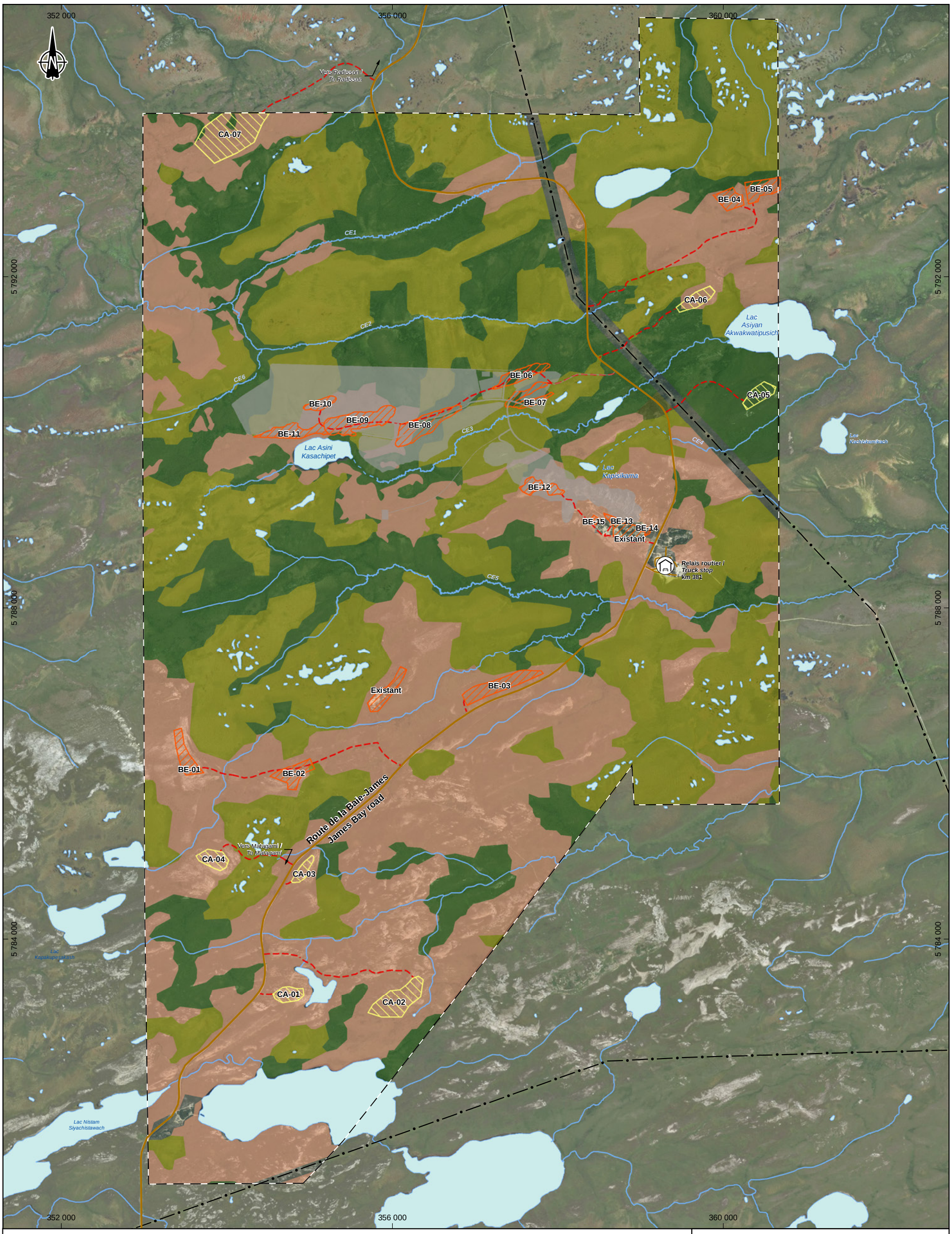
QC-88
Bassins versants aux conditions projetées / *Future Watershed Limits*

Sources :
Orhtoimage, ESRI, DigitalGlobe, juillet 2015
Inventaire / Inventory : WSP 2018

0 450 900 m
UTM, fuseau 18, NAD83

Dessin : A. Masson
Approbation : C. Martineau
171-02562-00_cMELCC-QC-88_wspT229_BasVer_190522.mxd

wsp



Composantes du projet / *Project Components*

- Route d'accès potentielle / *Potential access road*
- Source potentielle de matériaux d'emprunt / *Potential borrow sources*
- Carrière potentielle / *Potential quarry*
- Infrastructures minières / *Mining infrastructure*

Infrastructures / *Infrastructure*

- Route principale / *Principal 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 ou diffused flow stream*
- Plan d'eau / *Waterbody*

Végétation / *Végétation*

- Résineux
- Brulis (depuis 2005)
- Milieu humide

GALAXY

Mine de lithium Baie-James /James Bay Lithium Mine
Réponses aux questions du MELCC / MELCC Requests

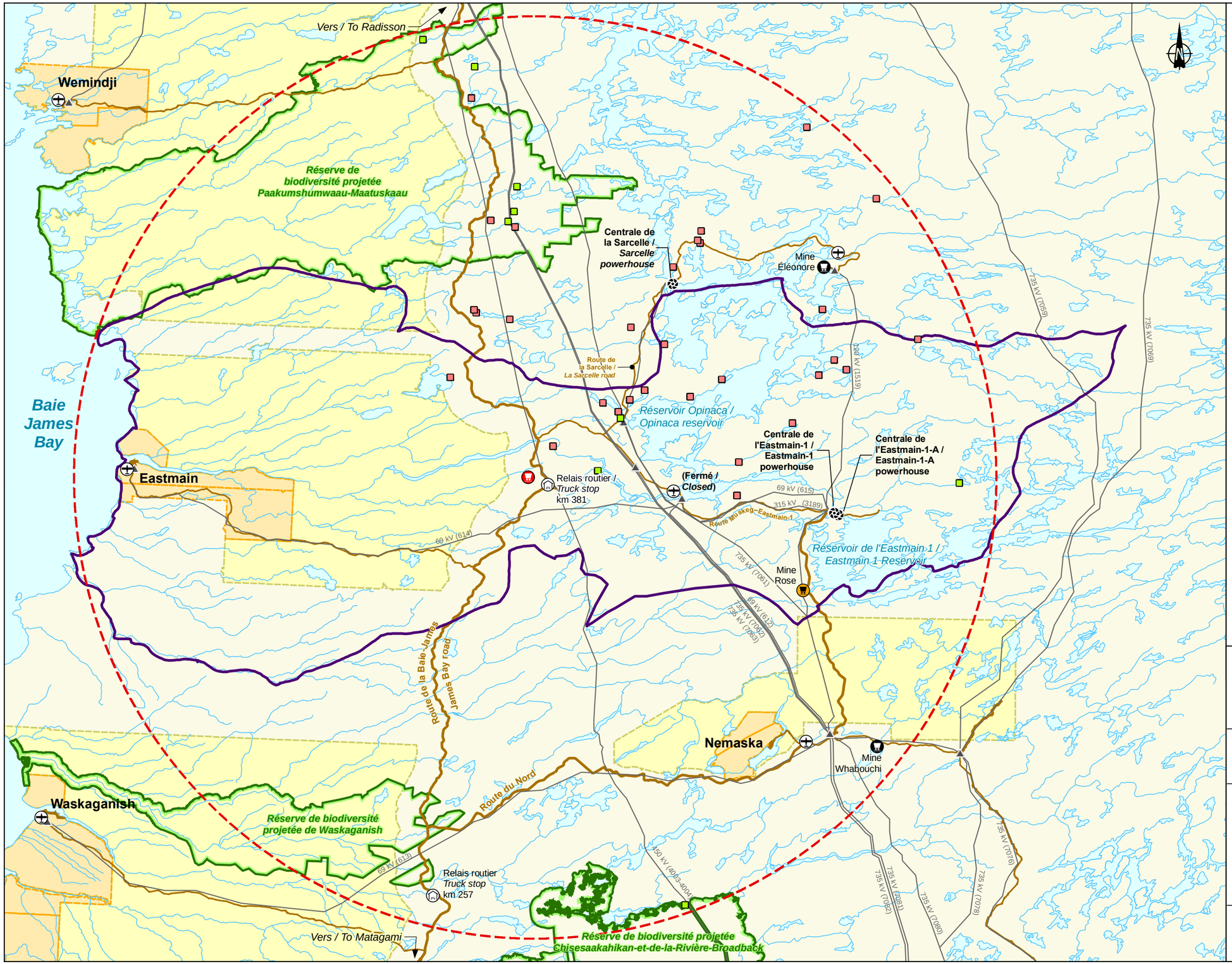
QC-96
Végétation trouvée aux localisation des bancs d'emprunt et carrières potentiels / *Vegetation at Potential Borrow Pits and Construction Quarries Location*

Sources :
World Imagery, DigitalGlobe, juillet 2015
Orthoimage : Galaxy, août / august 2017
Photo interpretation : WSP 2018

0 450 900 m
UTM, fuseau 18, NAD83

Dessin : A. Masson
Approbation : C. Martineau
171-02562-00_cMELCC-QC-96_wspT223_vegetation_190516.mxd

wsp



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

Infrastructures / *Infrastructure*

- Relais routier / *Truck stop*
- Aéroport / *Airport*
- Mine existante / *Existing mine*
- Mine projetée / *Projected mine*
- Centrale hydroélectrique / *Hydroelectric powerhouse*
- Poste et ligne de transport d'énergie / *Substation and transmission line*
- Route principale / *Main road*
- Autre route / *Other road*

Limites / *Boundary*

- Zone d'étude des effets cumulatifs sur l'utilisation du territoire par les Cris d'Eastmain / *Eastmain Crees traditional landuse cumulative effect study area*
- Zone d'étude des effets cumulatifs sur les chiroptères / *Bat cumulative effect study area*
- Réserve de biodiversité projetée / *Projected biodiversity reserve*
- Terres de catégorie I / *Category I land*
- Terres de catégorie II / *Category II land*

Baux de villégiature / *Recreational Lease*

- Fins de villégiature / *Recreational use*
- Fins d'abri sommaire en forêt / *Rough forest shelter*

GALAXY

Mine de lithium Baie-James / James Bay Lithium Mine

Réponses aux question du MELCC / MELCC Request

QC-105, QC-106, QC-151
Aires protégées à l'échelle régionale / *Regional Protected Areas*

Sources :
Canvec, 1 : 50 000, RNCan, 2015
BDGA, 1 : 1 000 000, RNCan, 2011
Terres de catégorie/ Category land : Carto-Média, 2001
Réserve de biodiversité projetée/ Projected biodiversity reserve, MELCC, 2019
Baux de villégiature / Recreational lease, MRNF Québec, juin/June 2018

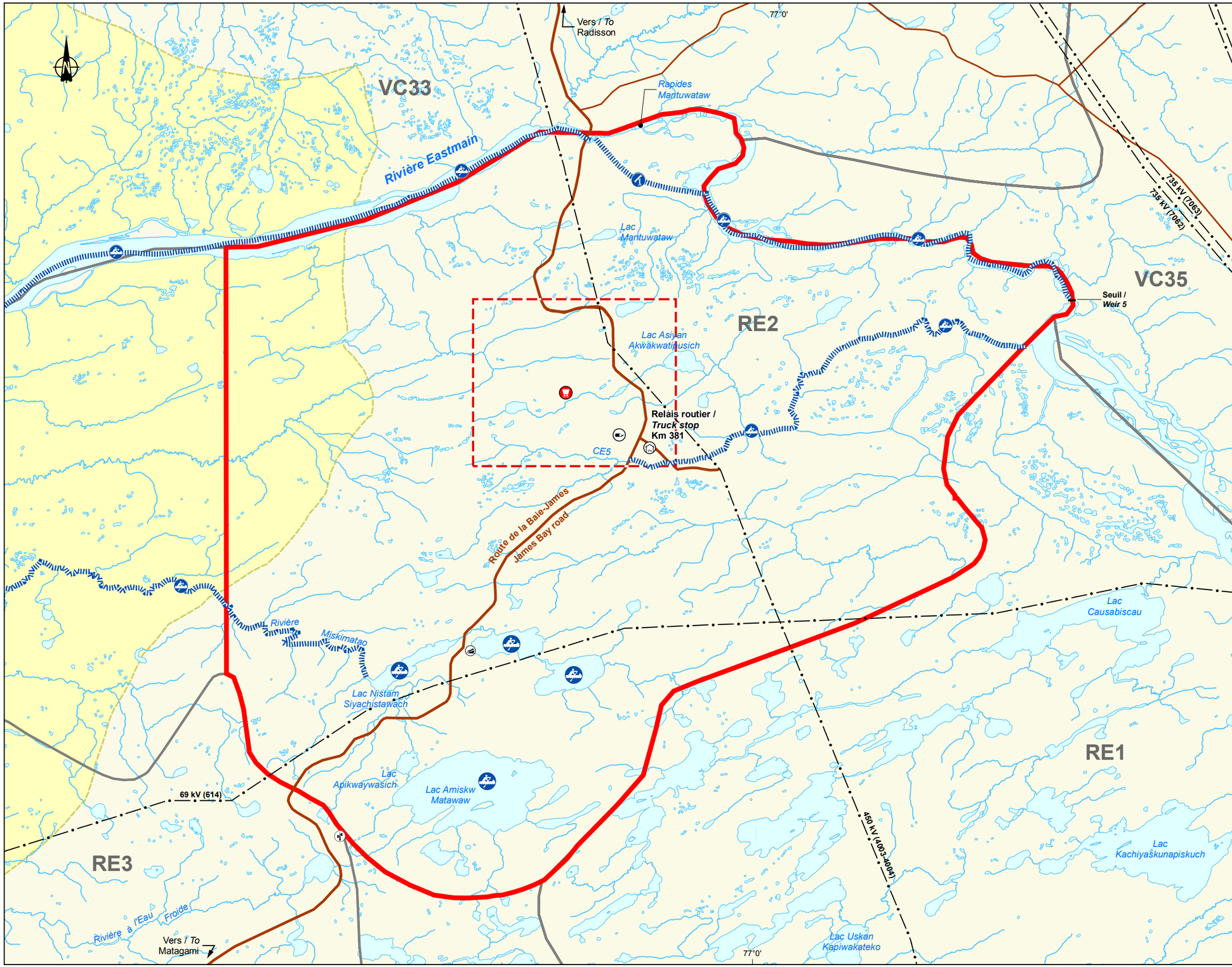
0 9 18 km

UTM, fuseau 18, NAD83

Dessin : A. Masson
Approbation : C. Martineau

171-02562-00_cMELCC-QC-151_wspT221_biodiversit_190516.mxd

wsp



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*
- Tour de télécommunication / *Telecommunication tower*
- Lieu d'enfouissement en territoire isolé (LETI) / *Remote landfill*
- Rampe de mise à l'eau / *Boat ramp*

Eaux navigables / *Navigable water*

- Parcours de navigation / *Navigation route*
- Portage / *Portage*

Limites / *Limits*

- Zone d'étude du milieu humain / *Social environment study area*
- Zone d'étude locale / *Local study area*
- Terre de catégorie II / *Category II land*
- RE2 Terrain de trappage / *Trapline*

GALAXY

Mine de lithium Baie-James /James Bay Lithium Mine

Réponses aux questions du MELCC / MELCC Requests

QC-102

Eaux navigables / *Navigable water*

Sources :

Canvec, 1 : 50 000, RNCan, 2015
BDGA, 1 : 1 000 000, RNCan, 2011
Terres de catégorie / Category land : Carto-Média, 2001
Inventaire / Inventory : WSP, 2018

Cartographié par / mapping by : WSP

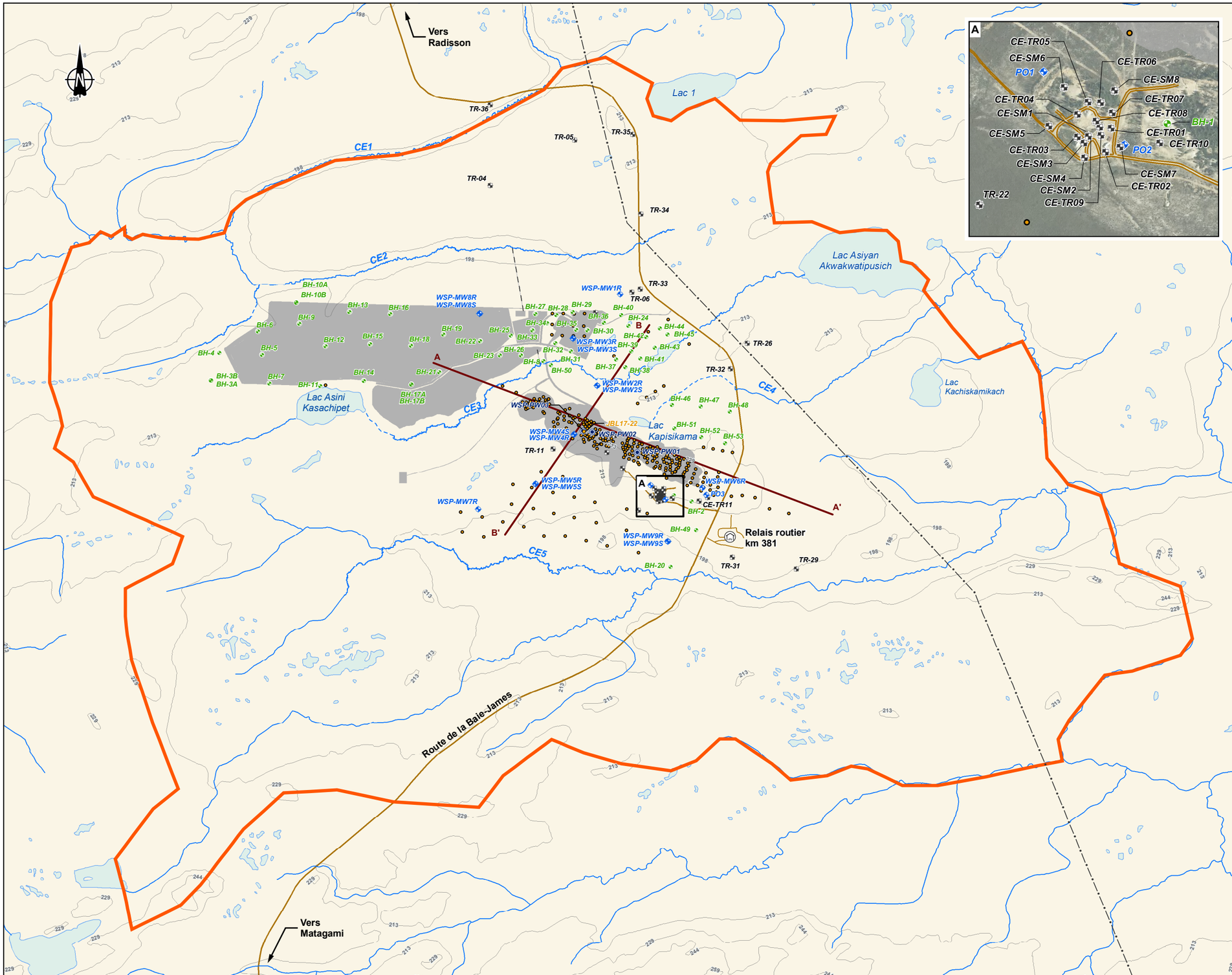
0 1,25 2,5 km

UTM, fuseau 18, NAD83

Dessin : A. Masson
Approbation : C. Martineau

191-01753-00_cMELCC-QC-102_wspT231_navig_190619.mxd

wsp



GALAXY

Mine de lithium Baie-James / James Bay Lithium Mine

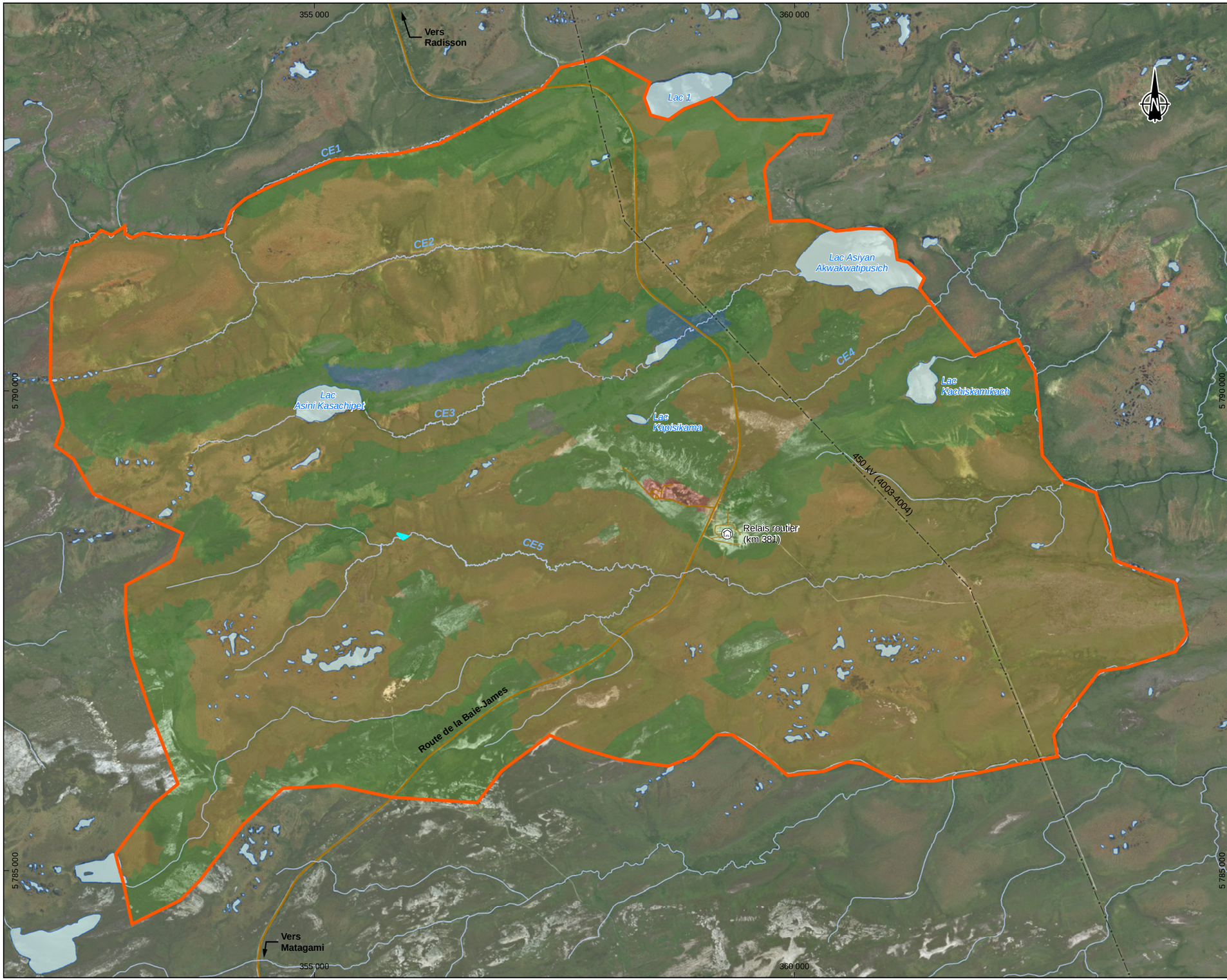
Réponses aux question du MELCC / MELCC requests

QC-180
Localisation des sondages / *Location of the Survey*

Sources :
Données du projet / Project data : Galaxy, 2018
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
Inventaire / Inventory: WSP 2018

Préparé par : S. Bottier
Dessin : A. Masson
Approbation : C. Martineau
191-01753-00_cMELCC-QC-180_wspT225_zone_model_190523.mxd

wsp



Limite de la zone modélisée / *Limit of the modeled area*

Recharge / *Aquifer recharge*

- 10
- 100
- 275
- 310

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*

GALAXY

Mine de lithium Baie-James / James Bay Lithium Mine

Réponses aux question du MELCC / MELCC requests

QC-185

Répartition de la recharge sur la zone modélisée / *Recharge of the Modeled Area*

Sources :
Orthoimage : ESRI, DigitalGlode, juillet / july 2015
Inventaire / Inventory: WSP 2018

0 400 800 m

UTM, fuseau 18, NAD83

Dessin : A. Masson
Approbation : C. Martineau

191-01753-00_cMELCC-QC-185_wspT226_recharge_190523.mxd

wsp

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*

- 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*

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 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*

Composantes du projet / *Project Component*

- Infrastructures minières / *Mining infrastructures*
- Route d'accès / *Access road*

GALAXY

Mine de lithium Baie-James /
James Bay Lithium Mine

Réponses aux question du MELCC / MELCC requests

QC-188
Végétation / *Flora*

Sources :
Orthoimage : Galaxy, août / august 2017
Données du projet / Project data : Galaxy, 2018
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
Inventaire / Inventory: WSP 2017

0 240 480 m
UTM, fuseau 18, NAD83

Dessin : A. Masson
Approbation : C. Martineau
191-01753-00_cMELCC-QC-188_wspT224_flore_190611.mxd

wsp

APPENDIX

A-1

MELCC'S QUESTIONS AND COMMENTS, APRIL 18, 2019

Ministère
de l'Environnement
et de la Lutte contre
les changements
climatiques
Québec

Direction de l'évaluation environnementale des projets miniers et nordiques
et de l'évaluation environnementale stratégique

Le 18 avril 2019

Madame Gail Amyot
Directrice Environnement-Santé-Sécurité
Galaxy Lithium (Canada) inc.
2000, rue Peel, bureau 720
Montréal (Québec) H3A 2W5

Objet : Questions et commentaires - Projet de mine de lithium Baie-James
N/Réf : 3214-14-055

Madame,

Dans le cadre de la procédure d'évaluation et d'examen des impacts sur l'environnement et le milieu social prévue au titre II de la Loi sur la qualité de l'environnement et après consultation du Comité d'examen (COMEX), vous trouverez ci-joint un document comprenant les questions et commentaires sur l'étude d'impact du projet ci-dessus mentionné.

Avant de poursuivre l'analyse de votre projet, nous vous demandons de donner suite aux commentaires et de répondre aux questions dans une version révisée de l'étude d'impact ou dans un document complémentaire. Ce document doit être transmis au sous-ministre de l'Environnement et de la Lutte contre les changements climatiques en dix (10) copies, de même que trois (3) copies de ces documents sur support informatique en format PDF (Portable Document Format). Nous vous recommandons de nous fournir en anglais, cinq (5) copies des documents papiers et trois (3) copies sur support informatique en format PDF. Vous devez également déposer une lettre attestant que les copies sur support informatique sont identiques aux copies papiers.

À la suite de la réception des renseignements complémentaires et à leur validation, le COMEX poursuivra l'analyse du projet. Le COMEX pourra ensuite transmettre sa recommandation sur votre projet.

... 2

Édifice Marie-Guyart, 6e étage, boîte 83
675, boulevard René-Lévesque Est
Québec (Québec) G1R 5V7

Téléphone : 418 521-3933 poste 4067
Télécopieur : 418 644-8222
Internet : www.environnement.gouv.qc.ca
Courriel : Dominique.Lavoie@environnement.gouv.qc.ca

Pour toute information additionnelle, vous pouvez joindre Mme Murielle Vachon, de notre direction, au numéro de téléphone 418 521-3933, poste 7280.

Je vous prie d'agréer, Madame, l'expression de mes sentiments les meilleurs.

La directrice,

Dominique Lavoie
DL/MV/dl

p. j. Document de questions et commentaires
c. c. M. Lucas Del Vecchio, secrétariat, Gouvernement de la Nation crie
Mme Vanessa Chalifour, secrétariat, COMEX

Questions et commentaires

Projet de mine de lithium Baie-James
par Galaxy Lithium (Canada) inc.

Dossier 3214-14-055

Avril 2019

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ANNEXE A 54

COMMENTAIRES GÉNÉRAUX

Le présent document comprend des questions et commentaires adressés à Galaxy Lithium (Canada) inc. dans le cadre de l'analyse de l'étude d'impact sur l'environnement (ÉIE) du projet de mine de lithium Baie-James.

Les questions et commentaires sont émis à la suite de l'examen des impacts sur l'environnement et le milieu social réalisé à partir de l'ensemble des informations fournies à ce jour par le promoteur de même que de leur analyse réalisée par la Direction de l'évaluation environnementale des projets nordiques et miniers en collaboration avec les unités administratives concernées du MELCC, de certains autres ministères et du Gouvernement de la Nation crie.

Les directions, autres ministères et organismes consultés dans le cadre de cet examen sont les suivants :

- Direction de l'évaluation environnementale des projets nordiques et miniers et de l'évaluation environnementale stratégique;
- Direction de l'évaluation environnementale des projets hydriques et industriels;
- Direction régionale de l'Abitibi-Témiscamingue et du Nord-du-Québec;
- Direction du Programme de réduction des rejets industriels et des Lieux contaminés;
- Direction des eaux usées;
- Direction générale du suivi de l'état de l'environnement;
- Direction des Politiques de la qualité de l'atmosphère;
- Direction de l'eau potable et des eaux souterraines;
- Direction de l'expertise en biodiversité;
- Direction des aires protégées;
- Direction de l'expertise hydrique;
- Direction des matières dangereuses et des pesticides;
- Direction des matières résiduelles;
- Direction de l'expertise climatique et économique et des relations extérieures;
- Gouvernement de la nation crie;
- Ministère de la Culture et des Communications;
- Ministère de la Santé et des Services sociaux;
- Ministère de la Sécurité publique;
- Ministère de l'Économie et de l'Innovation;
- Ministère de l'Énergie et des Ressources naturelles;
- Ministère des Affaires municipales et de l'Habitation;
- Ministère des Forêts, de la Faune et des Parcs;
- Ministère des Transports;
- Régie du bâtiment;
- Conseil cri de la santé et des services sociaux de la Baie James.

Cette analyse visait à vérifier si les exigences spécifiées dans la Directive pour le projet de mine de lithium Baie-James émise en janvier 2018 ont été traitées de façon satisfaisante par le promoteur. Il en ressort que plusieurs éléments ne sont pas complets et que des précisions sont à apporter avant de pouvoir conclure sur l'acceptabilité du projet.

Les questions et commentaires sont regroupés selon l'ordre de présentation de l'étude afin de faciliter la compréhension. Pour cette même raison, le promoteur est invité à y répondre en suivant la même séquence. Les sections pour lesquelles aucune question n'est posée ne sont pas représentées.

DESCRIPTION DU PROJET

Galaxy Lithium (Canada) inc. (ci-après Galaxy) projette d'exploiter un gisement de pegmatites à spodumène, un minéral qui contient du lithium. Le site du projet est situé à une dizaine de kilomètres au sud de la rivière Eastmain, à quelques 100 km à l'est de la Baie James, à proximité du relais routier du km 381 de la route dite de la « Baie James ». La propriété se trouve sur des terres de catégorie III selon la Convention de la Baie James et du Nord Québécois.

Les principales infrastructures projetées incluent une fosse à ciel ouvert, un concentrateur de spodumène, des aires d'entreposage et d'accumulation de mort-terrain, de stériles/résidus, de minerai et de concentré, des bassins de rétention d'eau, une unité de traitement de l'eau, un dépôt d'explosifs, un campement pour les travailleurs de même que des bâtiments administratifs et d'opération. Le réseau routier existant permet d'accéder facilement au site.

L'extraction du minerai sera effectuée à partie d'une fosse à ciel ouvert selon les méthodes minières conventionnelles de prélèvement de surface, incluant des travaux de forage et de dynamitage. L'extraction totale prévue est d'environ 40 Mt de minerai. Le procédé de traitement du minerai comprendra le concassage du minerai, suivi d'une séparation en milieu dense. Le concentrateur, d'une capacité de 2 000 000 tonnes/an, permettra d'obtenir un concentré de spodumène dans lequel se retrouvera environ 6 % d'oxyde de lithium. Une halde combinée sera aménagée pour entreposer les stériles et les résidus miniers. Le concentré sera transporté par camions en empruntant la route de la Baie-James jusqu'au centre de transbordement de Matagami. Il sera ensuite expédié par rail jusqu'à une usine de transformation dont l'emplacement est indéterminé ou jusqu'à un port afin d'être expédié à l'étranger.

Le début des travaux de construction au site minier est prévu en 2020, pour une mise en service en 2022. La période d'exploitation prévue est d'environ 15 à 20 ans.

2. MISE EN CONTEXTE ET JUSTIFICATION DU PROJET

JUSTIFICATION DU PROJET (SECTION 2.3)

QC - 1. Il est mentionné à la page 2-6, à titre d'avantages d'un point de vue environnemental et socioéconomique, qu'une première transformation du minerai sera effectuée sur place. Les activités de production du concentré décrites dans l'étude sont davantage associées à des activités de traitement du minerai, telles que définies à l'article 109 de la Loi sur les Mines. Le promoteur devra à l'avenir référer à un traitement du minerai et non à des activités de transformation.

QC - 2. L'étude d'impact présente peu d'information sur les possibilités de transformation du concentré de spodumène sur le territoire Eeyou Istchee Baie-James, qui permettrait notamment d'optimiser les retombées socio-économiques du projet sur le territoire. Le promoteur devra présenter de quelle façon la possibilité de transformer le concentré sur ce territoire a été évaluée, de même que les possibilités de transformation ailleurs au Québec.

QC - 3. En 2012, soit un an après avoir déposé des renseignements préliminaires, le projet Baie-James avait été interrompu car, selon le promoteur, le prix du lithium avait diminué sur le marché ce qui compromettait la viabilité du projet. Quelques années plus tard, l'augmentation importante de la demande en lithium et les projections prometteuses de ce marché ont permis à Galaxy de redémarrer son projet. Le promoteur affirme que la demande pour le lithium est en croissance continue ce qui permettra la rentabilité et l'optimisation du projet. Certaines prévisions publiées au cours des derniers mois indiquent toutefois une tendance à la baisse du prix du lithium. Conscient du caractère complexe des marchés, mais pour mieux comprendre la justification initiale du projet et appuyer ses affirmations, le promoteur devra fournir des détails actualisés sur l'argumentaire économique qui justifie le projet.

3. VARIANTES DE RÉALISATION DU PROJET

HALDES À STÉRILES, RÉSIDUS ET MORT-TERRAIN (SECTION 3.1)

QC - 4. À la page 3-2, il est mentionné que les quantités considérées pour l'évaluation des méthodes de disposition des stériles sont de 233,4 Mt de stériles. Toutefois, le tableau 1 de l'étude géochimique présente une quantité totale de 116,6 Mt tonnes de stériles pour les quatre lithologies évaluées. Le promoteur devra expliquer cet écart.

QC - 5. À la page 3-2, le promoteur indique que « puisque les données concernant la densité de ces matériaux [stériles et résidus] n'étaient pas disponibles au moment de l'étude, des hypothèses ont été émises, à savoir 2,4 t/ pour les stériles et 1,7 t/m^3 pour les résidus leur conférant des volumes de 100 Mm^3 et 20 Mm^3 ». Une petite variation de la densité réelle des matériaux par rapport aux densités estimées peut avoir un impact important sur le volume de stériles / résidus à entreposer et donc sur le volume des haldes. Le promoteur devra justifier les hypothèses utilisées et indiquer quel facteur de sécurité a été appliqué.

QC - 6. À la page 3-2, il est indiqué que « considérant l'absence d'information disponible sur la viabilité économique d'extraire les ressources qui seront laissées dans le gisement une fois la phase d'exploitation terminée, l'option de dépôt dans la fosse n'a pas non plus été évaluée ». L'option de dépôt dans la fosse vers la fin de la vie de la mine ne devrait pas être écartée d'emblée. Le promoteur devra évaluer cette possibilité et justifier son choix.

QC - 7. Concernant l'analyse comparative des options des haldes à stériles et résidus miniers, il est mentionné qu'une optimisation du design à l'étape de l'ingénierie a permis de combler le manque de capacité requise de l'option 2. Le promoteur devra décrire l'optimisation réalisée afin de permettre l'entreposage de 120 Mm^3 de résidus dans cette halde dont la capacité était initialement estimée à 77,5 Mm^3.

SOURCES D'ÉNERGIE DU SITE MINIER (SECTION 3.4)

QC - 8. Afin d'optimiser la gestion des études d'avant-projet et des demandes de permis, l'option d'un branchement sur la ligne à 69 kV du réseau d'Hydro-Québec a été priorisée. Toutefois, le promoteur affirme dans son étude qu'avec cette option, Hydro-Québec ne pourrait fournir qu'une puissance maximale de 7,6 MW alors que le projet requiert quelque 8,3 MW pour alimenter l'ensemble de ses infrastructures. Pour combler cette différence, le promoteur a opté pour une autre source d'énergie, le gaz propane, qui sera utilisé pour le chauffage des bâtiments du secteur administratif et industriel. Selon les données présentées dans l'ÉIE, il s'agit de la plus importante source d'émissions de gaz à effet de serre (GES) de combustion fixe.

Considérant qu'un branchement électrique peut amener des économies significatives de combustibles, des réductions appréciables des émissions de GES et incidemment des coûts associés au carbone, le promoteur devra évaluer l'option d'une électrification complète à moyen terme en lieu et place de l'utilisation du propane ou de toute autre énergie fossile.

QC - 9. À la section 4.15.3, le promoteur indique qu'il envisage l'installation de convoyeurs pour le transport du minerai vers le concentrateur ainsi que pour le transport des stériles vers la halde à stériles. Cette option, qui présente l'avantage de réduire les émissions de GES et les émissions de poussières, serait, selon le promoteur, actuellement limitée par l'approvisionnement en électricité du projet. Advenant une optimisation dans la fourniture d'électricité et de son utilisation, le promoteur devra confirmer son intention à l'égard de ces convoyeurs.

QC - 10. Le promoteur indique que « l'option d'alimenter quelques génératrices mobiles par des panneaux solaires avec accumulateurs sera évaluée ». Le promoteur devra présenter cette évaluation.

QC - 11. Le gouvernement du Québec travaille activement à diversifier et améliorer l'approvisionnement en énergie sur le territoire du Québec et vise notamment à permettre un meilleur accès au gaz naturel ou au gaz naturel liquéfié dans les régions non desservies de la Côte-Nord et du Nord-du-Québec. Puisque le projet de mine de lithium Baie-James prévoit le début des travaux en 2020 et une mise en service en 2022, l'approvisionnement en gaz naturel ou en gaz naturel liquéfié ne devrait pas être écarté d'emblée. À défaut d'approvisionnements et de la disponibilité de technologies plus écologiques dans le contexte du projet, ces combustibles de même que le biodiésel ou l'hydrogène pourraient combler une partie des besoins énergétiques du site et réduire les émissions de GES comparativement au diesel conventionnel. Le promoteur devra approfondir ses recherches en ce qui concerne ces sources d'énergie et rendre compte de ses démarches.

QC - 12. Le promoteur réfère à une étude préliminaire réalisée par la firme spécialisée Tugliq afin d'évaluer l'opportunité d'installer des parcs solaires ou éoliens. Le promoteur devra fournir cette étude et justifier davantage pourquoi les sources solaires et éoliennes d'approvisionnement en énergie n'ont pas été retenues dans le cadre de son projet.

SOURCES D'ÉNERGIE DES ÉQUIPEMENTS MOBILES (SECTION 3.5)

QC - 13. La section 3.5 aborde les possibilités d'options électriques pour les équipements mobiles. Toutefois, en raison des caractéristiques intrinsèques du projet minier Baie-James, il est conclu que l'électrification des équipements mobiles n'est pas applicable à titre de mesure de réduction des émissions de GES. Selon le promoteur, le marché actuel offre un choix limité d'équipements miniers électriques adaptés à une mine à ciel ouvert de la taille du projet. Une autre raison évoquée est le surcoût actuel des équipements électriques qui serait difficile à amortir sur la durée de vie du projet.

Le promoteur devra justifier le coût du diesel qui a été utilisé à des fins de comparaison, soit 0,940 $/litre. De plus, l'utilisation d'équipement électrique est généralement associée à des coûts d'entretien plus faibles que son équivalent diesel[1], en raison notamment de la grande fiabilité des moteurs électriques ainsi qu'au plus faible nombre de pièces mobiles.

[1] https://gmggroup.org/wp-content/uploads/2018/11/20180621_UG_Mining_BEV_GMG-WG-v02-r01.pdf

Le promoteur devra justifier, par exemple, pourquoi le coût d'entretien de l'excavatrice PC 3000 électrique est significativement plus élevé que celui de son équivalent diesel. Ces deux facteurs ont un impact sur la comparaison entre les deux types d'excavatrices.

Le promoteur devra également indiquer si d'autres modèles de véhicules ou de pièces d'équipement, qui ne sont pas actuellement disponibles sur le marché, mais qui pourraient le devenir au moment de la mise en service de la mine en 2022, ont été considérés dans l'évaluation comparative.

Il existe des technologies hybrides applicables aux équipements utilisés dans le secteur minier au Québec qui permettent de réduire la consommation de carburant. Le promoteur devra évaluer le recours aux technologies hybrides tant d'un point de vue technique qu'économique, et présenter l'impact sur la réduction des émissions de GES. À titre d'information, l'acquisition et l'installation de ces systèmes auxiliaires peuvent même être financées via le programme Écocamionnage[2]. Soulignons par ailleurs que plusieurs programmes provinciaux sont également en place pour contribuer au financement d'initiatives qui visent à réduire les émissions de GES ou à favoriser l'adaptation de la société québécoise aux impacts des changements climatiques. L'ensemble des programmes découlant du Plan d'action 2013-2020 sur les changements climatiques administrés par les différents ministères et organismes sont présentés, par secteur d'activité ou par clientèle, sur le site du MELCC à l'adresse suivante : http://www.environnement.gouv.qc.ca/cgfv/programmes.htm.

QC - 14. D'autres projets miniers mobilisent des expertises spécialisées afin de réduire leurs émissions de GES, par exemple en adaptant des véhicules à combustibles fossiles à l'énergie électrique ou en redéfinissant le modèle d'exploitation de la mine en fonction des véhicules et des équipements à moindre impact sur les émissions de GES disponibles. Le promoteur devra décrire les efforts effectués en ce sens dans le cadre du projet mine de lithium Baie-James.

[2] Liste des technologies admissibles disponible en ligne: https://www.transports.gouv.qc.ca/fr/aide-finan/entreprises-camionnage/aide-ecocamionnage/Documents/liste-technologies-admissibles-francais.pdf

4. DESCRIPTION DU PROJET

AMÉNAGEMENT DU SECTEUR INDUSTRIEL ET ADMINISTRATIF (SECTION 4.3)

QC - 15. Selon le sondage géotechnique BH-36 effectué dans le secteur du bassin de sédimentation du secteur industriel et administratif, le socle rocheux serait situé à environ 5 mètres de profondeur, le tout, recouvert de tourbe et de sable. Le bassin du secteur industriel et administratif devra être étanchéisé afin de prévenir l'infiltration d'eau contaminée dans le sol. Le promoteur devra décrire les mesures d'étanchéisation qui seront mises en place.

QC - 16. À la page 4-17, le promoteur indique que le site de l'usine à béton sera converti en une cour d'entreposage lorsque la construction sera terminée. Toutefois, il indique à la page 4-5 que ce site sera reconverti en un espace de stockage à sec. Le promoteur devra préciser davantage le mode d'entreposage des matières résiduelles sur ce site de même que la durée et la capacité d'entreposage.

TRAVAUX PRÉPARATOIRES (SECTION 4.4)

Carrière et bancs d'emprunt (section 4.4.3)

QC - 17. Une carrière pour la construction sera située en partie dans l'empreinte de la fosse, dont la caractérisation des stériles a démontré un potentiel de génération d'acide (PGA). Le promoteur devra indiquer si des tests cinétiques ont été réalisés sur le matériel provenant de cette carrière. Dans la négative, il devra indiquer comment il compte s'assurer que le matériel provenant de cette carrière est inerte, ou du moins non PGA à court et moyen terme, avant de l'utiliser à des fins de construction.

QC - 18. Le promoteur devra fournir des précisions sur les mesures de remise en état des lieux pour les carrières et sablières et, le cas échéant, les portions de routes désaffectées. Ces mesures devront être développées avec la participation du maître de trappage.

Terrassement (section 4.4.5)

QC - 19. Le promoteur devra cartographier les surfaces qui devront être déboisées sur l'ensemble du site du projet.

CARACTÉRISATION GÉOCHIMIQUE (SECTION 4.7)

QC - 20. Le promoteur indique que des essais cinétiques en colonnes ont été amorcés en mai 2018. Ces essais sont réalisés sur des matériaux s'apparentant aux stériles / résidus miniers qui seront entreposés sur le site, et sont basés sur les deux modes de gestion préconisés (co-disposition et co-déposition). Le promoteur devra présenter l'ensemble des résultats des essais cinétiques.

QC - 21. Il importe de préciser qu'un résidu qui ne rencontre pas les caractéristiques du tableau 1 de l'annexe II de la Directive 019 pour un résidu à risque élevé n'est pas automatiquement considéré à faible risque. Un résidu à faible risque est un résidu dont les concentrations en métaux n'excèdent pas les teneurs de fond locales et qui n'est pas lixiviable. Or, les essais statiques indiquent que les stériles sont lixiviables et parfois acidogènes. Le promoteur devra attendre les résultats des essais cinétiques avant de statuer sur les caractéristiques des stériles.

Selon les résultats obtenus (PGA ou non, lixiviables ou non), les implications sur la conception du projet pourraient s'avérer significatives, notamment sur les récurrences de crue de projet, l'étanchéité des haldes, la conception des digues, les utilisations possibles des stériles et la restauration du site. À la lumière des résultats obtenus, le promoteur devra décrire, le cas échéant, les modifications requises à la conception du projet.

QC - 22. L'ÉIE rapporte que les résidus miniers sont considérés comme matériaux « à risque faible ». Tel qu'indiqué précédemment, cette affirmation est inexacte puisque les essais statiques ont montré que les résidus sont lixiviables, même à l'essai CTEU-9. La halde contenant les résidus devra respecter des mesures d'étanchéité de niveau A, tel que prescrit par la Directive 019, à moins que des essais cinétiques ne prouvent le contraire.

QC - 23. L'ÉIE rapporte que 96 % des échantillons de minerai sont considérés comme matériaux « à risque faible ». Tel qu'indiqué précédemment, cette affirmation est inexacte puisque les essais statiques ont révélé qu'ils peuvent être lixiviables, et une partie PGA. En conséquence, les eaux de la halde à minerai devront être captées et gérées conformément à la Directive 019.

QC - 24. Selon les informations présentées, le minerai présente des caractéristiques géochimiques pouvant mener à générer de l'acide. Toutefois, aucun essai cinétique en colonne n'est prévu sur le minerai. Le promoteur devra indiquer de quelle façon, en l'absence d'essais cinétiques, il prévoit pouvoir statuer sur le potentiel de drainage minier acide (DMA), déterminer le délai avant la génération de DMA, et identifier les mesures nécessaires pour prévenir la contamination des eaux de surface et souterraines.

QC - 25. Les résultats analytiques provenant des essais de lixiviation des deux horizons de sol (sable et argile) montrent des dépassements, pour certains éléments, des critères génériques « A » du *Guide d'intervention – Protection des sols et réhabilitation des terrains contaminés* (ci-après Guide d'intervention) (MDDELCC, 2016), alors que la couche d'argile lixivie aux essais TCLP et SPLP pour certains métaux. Des essais de lixiviation à l'eau (CTEU-9) permettraient de mieux connaître le potentiel de lixiviation des sols dans des conditions environnementales se rapprochant de celles prévalant sur le site.

Le promoteur devra réaliser des essais de lixiviation à l'eau (CTEU-9) sur les sols et en présenter les résultats avec les réponses au présent document. À la lumière des résultats analytiques actuels et futurs, le promoteur devra indiquer de quelle façon il compte réduire les impacts appréhendés des sols sur les eaux de surface et souterraines.

QC - 26. Selon les informations présentées, les lithologies M1 et M2 (stériles) présentent des caractéristiques géochimiques pouvant mener à générer de l'acide ou sont confirmées comme étant génératrices de DMA. Considérant les caractéristiques de ces matériaux, les possibilités de valorisation sont limitées, tant sur le site qu'à l'extérieur de celui-ci. Advenant que les essais cinétiques démontrent que les stériles peuvent être utilisés comme matériau de construction, le promoteur devra évaluer cette option qui permettrait de réduire les besoins de matériel d'emprunt. Il devra se référer au *Guide de valorisation des matières résiduelles inorganiques non dangereuses de source industrielle comme matériau de construction* (MENV, 2002) pour la caractérisation et la validation des usages possibles en fonction des classes établies.

HALDES (SECTION 4.8)

QC - 27. À la page 4-42, il est indiqué que la conception des haldes est appuyée par des analyses de stabilité. Le promoteur devra fournir les études de stabilité des ouvrages.

QC - 28. Les méthodes de gestion des stériles et résidus miniers par codéposition ou par co-entreposage sont généralement plus adaptées à un mélange de stériles et de résidus miniers à faibles risques. Sur la base des résultats des essais cinétiques, le promoteur devra fournir le détail du mode de gestion retenu avec les éléments conceptuels s'y rattachant (ex. régime d'écoulement anticipé des eaux d'infiltration, degré anticipé de saturation en eau, circulation anticipée de l'oxygène, etc.). Le mode de gestion proposé devra permettre de réduire significativement la production de DMA.

Comme les conditions d'opération peuvent différer significativement du modèle conceptuel, le promoteur devra proposer et mettre en œuvre un suivi environnemental spécifique à la halde à stériles / résidus miniers afin d'évaluer les conditions prévalant sur le site de disposition au cours des opérations, et d'ajuster les opérations ou la conception au besoin.

QC - 29. Le promoteur devra détailler la technologie qui sera utilisée pour l'assèchement des résidus avant leur déposition dans la halde. Il devra indiquer quel sera le pourcentage d'humidité visé de ces résidus. Puisqu'un pourcentage d'humidité trop élevé peut compromettre la mise en pile des résidus, le promoteur devra décrire de quelle façon il compte s'assurer de l'atteinte du pourcentage d'humidité visé.

QC - 30. Une partie de la surface de la halde à stériles comporte une couche importante d'argile qui devra être contrôlée pour assurer l'intégrité de l'ouvrage. À la page 4-48, il est mentionné qu'une modélisation hydrogéologique est en cours de préparation afin de vérifier les impacts de l'implantation de la halde sur le milieu. Cette modélisation doit permettre d'estimer les débits de percolation sous la future halde et de vérifier l'impact potentiel sur la qualité des eaux souterraines. Cette modélisation, avec les résultats des essais géochimiques, permettra de finaliser la conception des infrastructures. Le promoteur devra fournir cette étude avec les réponses au présent document.

QC - 31. Le promoteur devra indiquer si l'option de laisser les argiles en place sous la halde, afin de fournir un degré d'étanchéité suffisant sans pour autant compromettre la stabilité de l'ouvrage, a été évaluée.

GESTION DES EAUX (SECTION 4.9)

Critères de conception (section 4.9.1)

QC - 32. Les critères de conception proposés par le promoteur pour la halde à stériles/résidus miniers correspondent à des résidus miniers à faibles risques alors que certains résidus miniers sont considérés comme étant acidogènes et lixiviables. Les critères de conception dans de tels cas, tels que mentionnés à la Directive 019, sont plus stricts que ceux proposés par le promoteur.

Selon les résultats des essais cinétiques, le promoteur devra reconsidérer ses critères de conception selon la nature des résidus miniers qu'il aura à gérer, notamment la récurrence de la crue de projet ainsi que les mesures d'étanchéité des aires d'accumulation. À cet effet, une étude hydrogéologique devra être effectuée afin de s'assurer que les mesures d'étanchéité de la Directive 019 sont rencontrées. De plus, l'installation de déversoir d'urgence devra être planifiée pour les ouvrages de rétention avec retenue d'eau afin de pouvoir évacuer de façon sécuritaire une crue maximale probable. Enfin, les facteurs de sécurité du tableau 2.7 de la Directive 019 devront être respectés.

QC - 33. À la page 4-52, il est indiqué que la revanche de la digue du bassin de rétention d'eau principal est de 1,5 mètre afin de tenir compte des variations possibles causées par les changements climatiques. Le promoteur devra présenter la méthode utilisée pour déterminer la hauteur de revanche et devra indiquer le niveau de confiance qui y est associée.

Infrastructures - Haldes (section 4.9.2)

QC - 34. Le projet prévoit deux points de rejet des effluents, soit le cours d'eau CE2 pour les eaux provenant du bassin de rétention principal, et le cours d'eau CE3 pour les eaux provenant du bassin de sédimentation des haldes à mort-terrain. La création de plusieurs effluents finaux va à l'encontre de ce qui est habituellement privilégié, soit un seul effluent final sur le site minier. Si le promoteur souhaite tout de même gérer deux effluents séparément, le respect des exigences de la Directive 019 s'appliquera aux deux effluents et un suivi devra également être effectué aux deux effluents.

QC - 35. Selon la Directive 019, les eaux usées minières sont définies comme suit : « Eau d'exhaure, eau qui provient des aires d'accumulation de résidus miniers, eau de ruissellement contaminée par les activités minières, eau usée provenant d'un procédé de traitement du minerai et toute eau usée industrielle produite par une activité minière ». Puisque les eaux de ruissellement des haldes à mort-terrain sont des « eaux de ruissellement contaminées par une activité minière », elles sont donc considérées comme des eaux usées minières. Ainsi, le bassin de rétention des haldes à mort-terrain, tout comme le bassin des haldes à résidus/stériles, est un ouvrage de rétention avec retenue d'eau au sens de la section 2.9.3 de la Directive 019. Le bassin de la halde à mort-terrain devra donc respecter les exigences de la Directive 019 (crue de projet, revanche, déversoir, pompage des exfiltrations, etc.). Le promoteur devra démontrer de quelle façon la conception et les mesures de sécurité du bassin permettront le respect des exigences de la Directive 019.

QC - 36. En ce qui concerne les eaux du bassin de rétention des haldes à mort-terrain, celles-ci pourraient être chargées en matières en suspension (MES). À la page 4-56, il est indiqué que les dimensions du bassin ont été conçues de façon à permettre la décantation de ces particules et de respecter les critères de qualité en matière d'effluent. Ceci devait toutefois être « validé ultérieurement grâce à un modèle de sédimentation de particules, lorsque davantage de renseignements concernant les propriétés des particules des matériaux des haldes seront disponibles ». Le promoteur devra démontrer, à partir des résultats de ce modèle, de quelle façon la conception du bassin permettra d'assurer le respect des obligations en matière de qualité de l'eau.

QC - 37. L'étude spécialisée en géochimie indique que les argiles seraient lixiviables en baryum, cuivre, plomb, zinc et manganèse. Un dépassement des exigences de la Directive 019 en métaux à l'effluent est donc possible pour les eaux du bassin des haldes à mort-terrain. À la page 4-56, le promoteur mentionne que « si des mesures démontrent une non-conformité à la sortie du bassin de sédimentation, l'eau sera redirigée vers le bassin principal de rétention d'eau ». Le promoteur devra démontrer que le bassin principal de rétention d'eau sera en mesure d'accumuler les eaux en provenance du bassin des haldes à mort-terrain et devra en préciser le temps de rétention.

QC - 38. Des boues s'accumuleront au fond du bassin de rétention des haldes à stériles de même qu'au fond du bassin de sédimentation des haldes à mort-terrain. Le promoteur devra indiquer si une partie de ces boues devra être retirée des bassins au cours de la phase d'exploitation. Dans l'affirmative, il devra estimer les quantités de boues attendues.

Par ailleurs, les boues provenant du bassin des haldes à stériles et du bassin des haldes à mort-terrain sont considérées comme des résidus miniers. Une caractérisation de ces boues devra être réalisée avant leur disposition ou lors de la restauration des bassins. Le promoteur devra indiquer de quelle façon il prévoit gérer ces boues.

Infrastructures – Usine de traitement de l'eau (section 4.9.2)

QC - 39. En ce qui concerne les boues de l'usine de traitement de l'eau (UTE), le promoteur devra préciser les quantités de boues qui seront générées et la gestion qui en sera faite.

Infrastructures – Puits d'eau potable (section 4.9.2)

QC - 40. Selon l'information présentée à la page 4-58, l'approvisionnement en eau potable pendant la phase d'exploitation nécessitera deux à trois puits afin de combler des besoins estimés à 41 m^3 par jour pour 150 travailleurs. Le promoteur devra préciser la localisation et les caractéristiques des puits qui seront installés.

QC - 41. Pour les puits d'alimentation en eau potable du relais routier du km 381, le promoteur devra :

- Fournir les caractéristiques des puits tels que le nombre, type, profondeur, aquifère exploité, débits de pompage moyen et maximal, niveaux d'eau, colonne d'eau disponible et les capacités des puits si disponibles (si non disponibles, une estimation est acceptable);
- Échantillonner les puits afin d'établir la qualité initiale de l'eau des puits;
- Indiquer quelles mesures d'atténuation sont prévues si les puits sont affectés d'une façon significative (manque d'eau ou détérioration de la qualité de l'eau) par les activités de la mine;
- Confirmer qu'il n'y a aucun autre prélèvement d'eau souterraine dans un rayon de deux kilomètres autour la fosse (zone d'influence de dénoyage estimé par le modèle numérique).

QC - 42. À la page 7-27, le promoteur indique qu'aucun prélèvement d'eau dans les cours d'eau ne sera effectué pour les besoins du projet. Le promoteur devra préciser de quelle façon seront comblés les besoins en eau fraîche destinée au concentrateur, à la protection des incendies, au contrôle des poussières, aux bâtiments de services et au garage. Il devra fournir une estimation du volume d'eau qui sera prélevé à partir des puits d'eau souterraine pour combler les besoins en eau potable et, le cas échéant, les autres besoins en eau fraîche du projet.

Bilan d'eau (section 4.9.3)

QC - 43. Selon le tableau 4-18 présentant le bilan d'eau pour le bassin de rétention d'eau principal, le débit de l'effluent acheminé au cours d'eau CE2 variera entre 4 953 m^3/jour (années - 1 à 1) à 30 411 m^3/j (années 6 à 10). À partir de l'année 11 et jusqu'à la fin de l'exploitation, le débit rejeté sera de l'ordre de 22 022 m^3/j. D'autre part, le bilan d'eau à l'échelle du site est illustré à la figure 4-11 pour les années 11 à 16 en période estivale. Le promoteur devra expliquer pourquoi le débit d'effluent présenté sur cette figure (19 630 m^3/j) ne correspond pas à celui du tableau 4-18 pour la même période (19 197 m^3/j).

QC - 44. Selon le tableau 4-19 présentant le bilan d'eau pour le bassin de sédimentation des haldes à mort-terrain, le débit annuel sortant est de 5,13 m^3/j (années 11 à VDM). Toutefois, selon le bilan d'eau présenté à la figure 4-11, le débit d'effluent rejeté au cours d'eau CE3 est de 26 930 m^3/j pour les années 11 à 16 en période estivale. Le promoteur devra expliquer cet écart. Il devra préciser les débits prévus à la sortie du bassin de sédimentation des haldes à mort-terrain pour les différentes années d'exploitation de la mine. Il devra également indiquer si ces débits incluent les eaux usées domestiques.

QC - 45. À la page 4-57, il est mentionné que la capacité de l'usine de traitement de l'eau sera de 500 m^3/h pour les 9 premières années. Or, selon le tableau 4-18, le débit requis à l'UTE lors de la fonte printanière des années 6 à 10 est de 1 267 m^3/h. Toujours selon le tableau 4-18, l'usine de traitement de l'eau serait fonctionnelle en période de fonte printanière et un effluent serait généré avec un débit de 4 953 m^3/j à 30 411 m^3/j (de l'an -1 à la fin de la vie de la mine).

Toutefois, à la page 7-33, il est indiqué que « l'usine de traitement de l'eau sera opérée entre juin et octobre ».

Le promoteur devra préciser pendant quels mois de l'année l'UTE sera en fonction. Il devra indiquer durant quelle période un effluent sera traité et rejeté dans le milieu récepteur, tant dans le cours d'eau CE2 que dans le cours d'eau CE3. Il devra préciser la capacité de traitement de l'UTE et devra démontrer que cette capacité est suffisante pour traiter l'apport provenant des eaux du bassin des haldes à mort-terrain.

QC - 46. Selon le tableau 4-18, le débit de dénoyage augmente jusqu'à 0,485 Mm^3/30 j pour les années 6 à 10, puis diminue à 0,321 Mm^3/30 j à partir de la 11e année. Le promoteur devra expliquer davantage cette diminution.

GESTION DES ÉMISSIONS, DES REJETS ET DES DÉCHETS (SECTION 4.10)

Gaz à effet de serre (section 4.10.1)

QC - 47. Les émissions de GES annuelles attribuables à l'exploitation de la mine, principalement dues à la combustion du diesel des équipements fixes, du propane pour le chauffage et l'utilisation d'explosifs pour les activités d'extraction, sont estimées à 16 919 tonnes en équivalent dioxyde de carbone (CO_2). Puisque les émissions annuelles de GES devraient être sous le seuil de 25 000 tonnes en équivalent CO_2, la mine ne sera pas obligatoirement assujettie au système de plafonnement et d'échange de droits d'émission de GES (SPEDE). Mentionnons que les émissions de GES attribuables à la consommation de diesel des équipements mobiles utilisés sur le site sont exclues des émissions prises en considération pour déterminer le seuil d'assujettissement au SPEDE.

Toutefois, en considérant tous les carburants et combustibles consommés sur le site par les équipements mobiles et fixes, les émissions de GES annuelles s'élèvent à 61 232 tonnes en équivalent CO_2. Un coût carbone associé à l'utilisation des carburants et combustibles est à prévoir : actuellement celui-ci représente environ 20 $/tonne métrique en équivalent CO_2. Ce coût, bien qu'il soit assumé par les distributeurs de carburants et combustibles, est transféré dans la facture de carburant payée par le consommateur, ici le promoteur. Selon les règles de fonctionnement du SPEDE, le coût carbone associé à ces émissions augmentera chaque année de 5 % en plus de l'indexation[3].

[3] À titre informatif, le coût carbone associé aux émissions de carburants diesels, qui s'élève actuellement à 6,3 ¢/litre, pourrait s'élever à 9,9 ¢/litre en 2030. De plus, un émetteur peut demander qu'un établissement qu'il exploite et qui n'est pas assujetti au RSPEDE le devienne si toutes les conditions d'admissibilité sont remplies. Des renseignements sur l'adhésion volontaire sont disponibles sur le site web ministériel à l'adresse suivante : http://www.mddelcc.gouv.qc.ca/changements/carbone/adhesion-volontaire/index.htm

Par ailleurs, dans son plus récent rapport, le Groupe intergouvernemental d'experts sur le climat (GIEC, 2018) expose les conséquences d'un réchauffement des températures au-delà de 1,5 °C par rapport aux niveaux préindustriels et conclut à l'impératif de réduire globalement les émissions de CO_2 de 45 % par rapport à leur niveau de 2010 d'ici 2030, et ensuite atteindre un bilan nul des émissions de CO_2 autour de 2050. Il est indiqué dans le rapport que la limitation du réchauffement planétaire à 1,5 °C nécessiterait des transitions rapides, de grande envergure et sans précédent dans les domaines de l'aménagement du territoire, de l'énergie, de l'industrie, du bâtiment, du transport et de l'urbanisme.

Afin de compenser la hausse du coût carbone, et par le fait même de réduire ses émissions de GES pour l'ensemble de ses opérations en y incluant les émissions fixes et mobiles, et de répondre aux recommandations du GIEC visant un bilan nul des émissions de CO_2 autour de 2050, le promoteur devra soumettre à l'appui de son ÉIE un plan de transition énergétique présentant des mesures d'efficacité énergétique ou de substitution de carburants et de combustibles et un calendrier de mise en œuvre de ces mesures.

QC - 48. En ce qui concerne le calcul des émissions de GES dues au transport des produits expédiés, le calcul ne tient pas compte des émissions reliées au transport du concentré par train de Matagami jusqu'au lieu final de livraison. Le concentré pourrait être acheminé à une usine de transformation au sud du Québec dont l'emplacement précis n'est pas connu, ou à l'étranger à partir d'un port. Le promoteur devra inclure, selon les hypothèses actuelles ou en prenant une approche conservatrice, le calcul des émissions de GES entre Matagami et le lieu final de livraison du concentré dans les limites de la province du Québec.

Rejet des eaux usées (section 4.10.2)

QC - 49. Il est indiqué que le point de rejet de l'effluent sanitaire sera le cours d'eau CE3, soit via le bassin de sédimentation des haldes à mort-terrain ou directement dans le cours d'eau. Afin d'éviter le mélange d'eaux usées de provenances diverses, l'option de rejeter les eaux sanitaires traitées dans le bassin de sédimentation des haldes à mort-terrain n'est pas acceptable. Le promoteur devra prévoir un rejet direct dans le cours d'eau CE3 des eaux sanitaires traitées.

QC - 50. Les informations fournies par le promoteur ne permettent pas de conclure sur l'efficacité du système de traitement des eaux sanitaires proposé. Le promoteur devra démontrer que le système de traitement des eaux usées domestiques retenu sera en mesure de traiter l'ensemble des eaux sanitaires générées pendant la période de construction.

Matières résiduelles (section 4.10.3)

QC - 51. Le tableau 4-23 présente les quantités estimées de matières résiduelles (MR) produites pendant la phase de construction et la phase d'exploitation. Les quantités sont exprimées en millions de tonnes (Mt). Le promoteur devra valider s'il s'agit plutôt de tonnes (t).

QC - 52. Le promoteur précise qu'il mettra de l'avant tous les efforts possibles afin de minimiser la production de « déchets ». Il convient de rappeler que la Politique québécoise de gestion des matières résiduelles découlant de la Loi sur la qualité de l'environnement (LQE) s'appuie sur un principe d'action qui veut qu'une priorité soit donnée aux modes de gestion des matières résiduelles qui auront le moins d'impacts sur l'environnement. Connu sous l'acronyme 3RV - E, ce principe privilégie, en ordre de priorité les actions suivantes, soit :

1° la réduction à la source;
2° le réemploi;
2° le recyclage, y compris par traitement biologique ou épandage sur le sol;
3° toute autre opération de valorisation par laquelle des matières résiduelles sont traitées pour être utilisées comme substitut à des matières premières;
4° la valorisation énergétique;
5° l'élimination.

Le promoteur devra démontrer qu'il priorise les modes de gestion des MR selon cet ordre pour l'ensemble des matières générées sur le site.

QC - 53. L'éloignement du projet sur un territoire où les sites de traitement des matières résiduelles sont soit absents, éloignés ou de capacité insuffisante pour traiter de grands volumes représente un enjeu pour la gestion des MR. Abordé individuellement, il peut-être difficilement rentable économiquement d'entreprendre une gestion responsable de l'ensemble des matières résiduelles et éviter que les MR ne soient simplement évacuées sur de très longues distances. À cet effet, des efforts sont actuellement déployés par divers acteurs du territoire afin de mettre en place une gestion conjointe des matières résiduelles à l'échelle régionale[4]. Le promoteur est invité à initier des pourparlers, notamment avec la communauté limitrophe (Eastmain), les gestionnaires de la halte routière du km 381, voire d'autres entreprises et communautés, en vue de collaborer à une éventuelle approche régionale de gestion des matières résiduelles. Le promoteur devra faire état des discussions menées à cet égard.

QC - 54. Il est actuellement prévu que les matières résiduelles seront transportées par camion vers une installation externe gérée par un tiers entrepreneur. Le cas échéant, le promoteur devra préciser le lieu final d'élimination des matières résiduelles. Il devra fournir la preuve de la capacité et de l'accord de ce lieu à recevoir les matières résiduelles du projet. Le promoteur devra également préciser la distance entre le site du projet et le lieu d'élimination de même que le nombre de camions par semaine.

QC - 55. Le promoteur devra identifier les entrepreneurs qui feront la réception des matières résiduelles recyclables. Le promoteur devra prioriser l'acheminement vers des centres de tri de l'ensemble des matières produites, incluant les résidus de construction et de démolition.

[4] Citons par exemple la minière Nemaska Lithium Whabouchi Mine Inc. qui est engagée, avec la communauté de Nemaska, dans une démarche visant à mettre en place une gestion régionale des matières résiduelles.

QC - 56. Il est mentionné à la page 4-70 que les déchets de la cafétéria seront enfouis dans un site d'enfouissement sanitaire autorisé (ou lieu d'enfouissement selon la terminologie du *Règlement sur l'enfouissement et l'incinération de matières résiduelles*). Les matières putrescibles peuvent faire l'objet d'un traitement biologique par compostage[5]. Le promoteur devra évaluer la possibilité d'effectuer un traitement biologique par compostage des matières putrescibles sur le site. Il devra aussi évaluer la possibilité d'intégrer les matières résiduelles fertilisantes lors des différents travaux de restauration de la couverture végétale.

Déchets dangereux (section 4.10.4)

QC - 57. Le promoteur identifie deux modes possibles d'entreposage des matières résiduelles dangereuses, soit dans des conteneurs à double plancher ou dans un espace sec et ventilé muni d'un bac de confinement. Le promoteur devra préciser quel mode d'entreposage il compte utiliser. Il devra également indiquer de quelle façon il prévoit s'assurer de l'étanchéité du plancher de l'aire d'entreposage et de la sécurité des lieux.

QC - 58. Le promoteur devra présenter un schéma de l'aménagement des aires d'entreposage afin de représenter la disposition des installations pour les différents types de matières dangereuses résiduelles énumérées au tableau 4-24.

AUTRES INFRASTRUCTURES (SECTION 4.11)

Bâtiment du site (section 4.11.1)

QC - 59. L'étude présente peu de détails sur la conception des bâtiments du site. Le promoteur devra indiquer s'il a intégré des principes d'éco-construction à la conception des différents bâtiments en vue notamment, de minimiser la demande en énergie, les émissions de GES de même que les matières résiduelles produites.

QC - 60. Le promoteur devra indiquer s'il compte privilégier le recours à des matériaux disponibles dans la région et s'il prévoit la mise en place de politiques d'achat de proximité.

Route d'accès au site (section 4.11.2) et routes de service (section 4.11.3)

QC - 61. À la page 4-11, le promoteur indique que des améliorations mineures seront apportées à la route de la Baie-James au km 382 afin d'en accroître la sécurité. Des voies de virage seront aussi ajoutées pour entrer ou sortir du site à l'intersection de la route de la Baie-James et de la route d'accès au site. Le promoteur devra clarifier son rôle dans le cadre des travaux d'amélioration de la route et d'ajout des voies de virage.

[5] Par exemple, la mine Éléonore effectue le compostage des matières putrescibles générées par sa cafétéria à l'aide d'un composteur rotatif.

QC - 62. Les caractéristiques de la route d'accès au site sont présentées à la section 4.11.2. Les normes du Ministère des Transports du Québec (MTQ) spécifient la largeur prescrite, les distances de visibilité à rencontrer ainsi que les critères relatifs à l'installation des tuyaux de drainage. Ces normes sont jointes à l'annexe A. Le promoteur devra indiquer de quelle façon il entend respecter ces normes. Il devra également détailler l'installation de signalisation routière proposée pour l'entrée de la route d'accès ainsi que pour les voies de virage sur la route de la Baie-James.

QC - 63. L'ÉIE fournit peu de détails sur l'aménagement des routes du site. Le promoteur devra détailler davantage la superficie totale réelle perturbée par l'aménagement des routes. Cette estimation devra considérer la largeur à la base du remblai.

De plus, le promoteur devra indiquer comment il prévoit respecter les dispositions du *Règlement sur l'aménagement durable des forêts du domaine de l'État* (RADF), notamment de l'article 67 (qui interdit la construction ou l'amélioration d'un chemin dans les 60 mètres d'une tourbière ouverte avec mare, d'un marais, d'un marécage riverain, d'un lac ou d'un cours d'eau permanent ainsi que dans les 30 mètres d'un cours d'eau intermittent) et de l'article 70 (qui interdit la construction ou l'amélioration d'un tronçon de chemin de plus de 100 mètres dans une tourbière ouverte). Il devra également préciser quelles mesures sont prévues afin d'assurer la connexion des milieux humides et assurer le libre écoulement de part et d'autre des routes (ex. ponceaux d'équilibre).

Hébergement (section 4.11.4)

QC - 64. L'étude présente peu de détails sur la conception des bâtiments destinés au campement des travailleurs, mais indique que ceux-ci seront de type modulaire et occasionneront une demande totale en électricité estimée à 432 kWh. Le promoteur devra indiquer quelles mesures ont été prévues pour minimiser la demande en énergie et l'empreinte environnementale de ces bâtiments.

Stockage de carburant (section 4.11.6)

QC - 65. La zone de stockage de carburant sera constituée de trois réservoirs hors sol de carburant diesel. Selon les informations présentées, ces réservoirs doivent alimenter un poste de distribution pour le ravitaillement des véhicules et de la machinerie. Or, la capacité prévue de ces réservoirs (80 000 litres) excède la limite autorisée à l'article 8.139 du Code de construction. Cette limite s'élève à 50 000 L par réservoir, tandis que la limite maximale cumulative s'élève à 150 000 L au total sur le site. Un dépassement des capacités de stockage par mesure différente peut être autorisé par la Régie du bâtiment si une demande à cet effet lui est présentée. Le dépassement doit alors être justifié et il doit être démontré que l'installation procure un niveau de sécurité suffisant. Le promoteur devra indiquer de quelle façon il prévoit s'assurer de la conformité de ses installations de stockage et de distribution de carburant avec les dispositions du Code de construction.

QC - 66. Le promoteur devra indiquer s'il est prévu que les réservoirs alimentent aussi des génératrices de secours (pour l'usine et le campement). Le cas échéant, il devra fournir les détails de l'installation.

Ligne électrique (section 4.11.7)

QC - 67. La principale source d'approvisionnement en énergie du projet sera la ligne électrique de 69 kV du réseau de distribution d'Hydro-Québec. Hydro-Québec sera responsable du tracé et de la mise en service de la ligne électrique jusqu'au poste de haute tension. Le promoteur devra rendre compte des négociations avec Hydro-Québec à cet égard, et précisera si des exigences particulières sont à prévoir pour les deux parties.

QC - 68. Bien qu'Hydro-Québec soit responsable de la construction de la ligne électrique provenant de son réseau de distribution, le promoteur devra présenter le tracé, et donner un portrait général de la construction et des impacts associés à l'aménagement de la ligne projetée.

QC - 69. Les besoins en énergie du projet sont de 8,3 MW alors que la puissance pouvant être fournie par Hydro-Québec s'élève à 7,6 MW. Il est toutefois mentionné à la section 4.15.3 que « Hydro-Québec a débuté une étude qui pourrait permettre d'augmenter l'énergie disponible pour le site ». De son côté, le promoteur évalue différentes options afin de réduire et d'optimiser sa demande énergétique. Le promoteur devra rendre compte des efforts de part et d'autre.

Câble à fibres optiques (section 4.11.11)

QC - 70. Il est prévu installer un câble à fibres optiques entre le relais routier du km 381 et le site du projet. Dans le cas où une traverse aérienne de la route de la Baie-James est envisagée, la hauteur de dégagement appliquée devra être en fonction du transport hors norme. Dans le cas où une traverse souterraine de la route de la Baie-James est envisagée, la méthode par fonçage (ou « push-pipe ») devra être prévue plutôt que par excavation de la route.

TRANSPORT DU CONCENTRÉ JUSQU'À MATAGAMI (SECTION 4.12)

QC - 71. Le promoteur devra présenter une description du centre de transbordement de Matagami où le concentré sera acheminé. Cette description devra inclure la localisation, la superficie, la capacité et l'aménagement du site, de même que les infrastructures et les équipements nécessaires aux activités d'entreposage et de transbordement du concentré. Le cas échéant, il décrira les travaux d'aménagement envisagés. Il devra décrire les modalités d'entreposage et de transbordement du concentré, et devra spécifier les partenaires impliqués dans ces étapes du projet.

RESTAURATION DE LA MINE (SECTION 4.13)

QC - 72. La description des travaux de restauration fournie dans l'étude est très succincte et ne permet pas de se prononcer sur l'acceptabilité des concepts de restauration proposés. À la page 4-76, le promoteur réfère à un plan de fermeture et de restauration conceptuel préparé par Sanexen en 2018. Ce document n'est pas présenté dans l'ÉIE. Par ailleurs, un plan de restauration conceptuel ne pourra pas être déposé au ministère de l'Énergie et des Ressources naturelles (MERN) pour l'obtention d'un bail minier.

Le promoteur devra déposer un plan de réaménagement et de restauration complet, tel qu'exigé à l'article 101 de la Loi sur les mines (chapitre M-13.1). Ce plan devra être rédigé conformément aux exigences du *Guide de préparation du plan de réaménagement et de restauration des sites miniers au Québec* (ci-après Guide de restauration minière) (MERN, 2017). Ce plan devra être déposé au MERN pour approbation et en copie à l'Administrateur pour information. Il est recommandé que ce plan de restauration soit conçu avec la participation du maître de trappage dont l'aire est affectée ainsi qu'en collaboration avec des représentants de la communauté d'Eastmain. Le promoteur devra faire état des échanges intervenus à ce sujet avec ces derniers.

QC - 73. La restauration proposée des haldes à stériles prévoit l'adoucissement des pentes, l'ajout de mort-terrain et de terre végétale, puis la revégétalisation. Une simple remise en végétation de la halde sera insuffisante si les essais cinétiques démontrent que les résidus présentent un potentiel de drainage minier acide. Le promoteur devra reconsidérer les techniques de restauration prévues selon la nature réelle des résidus miniers.

QC - 74. Le projet entraînera un assèchement graduel du lac Kapisikama causé par le rabattement de la nappe d'eau souterraine et la réduction de l'apport d'eau de surface. L'ÉIE ne précise pas ce qui est envisagé pour la remise en état de ce lac. Le promoteur devra indiquer les mesures prévues de remise en état. Il devra inclure le suivi de l'efficacité de ces mesures à son programme de suivi. Il devra faire état des consultations menées à ce sujet auprès du maître de trappage concerné.

QC - 75. L'étude ne présente pas le programme de confinement et de contrôle lors d'une fermeture temporaire tel que demandé dans la *Directive pour le projet de mine de lithium Baie-James* (Directive du projet). Le promoteur devra présenter ce programme.

OPPORTUNITÉS D'OPTIMISATION DU PROJET (SECTION 4.15)

QC - 76. À la page 4-83, le promoteur indique que deux options pour le transport par avion sont en cours d'évaluation, soit via l'aéroport d'Eastmain ou l'aéroport d'Opinaca. Le promoteur devra préciser les éléments considérés pour faire son choix. Il devra présenter l'option retenue de même qu'un aperçu des travaux envisagés et des principaux impacts associés à cette option. Il devra également rendre compte des consultations effectuées à cet égard, notamment auprès du maître de trappage du terrain où se trouve la piste de l'aéroport d'Opinaca.

QC - 77. Il est mentionné que des discussions sont en cours avec la Société de développement de la Baie-James (SDBJ) concernant l'utilisation du relais routier du km 381 pour loger des travailleurs lors de la construction (130 chambres), puis tout au long de la réalisation du projet (40 chambres). Le promoteur devra indiquer si une entente en ce sens a été convenue.

Le cas échéant, il devra décrire la nature de cette entente et préciser le nombre de travailleurs qui seront logés au relais routier lors des différentes phases du projet. Il devra démontrer que le relais routier a les capacités requises en termes d'approvisionnement en eau potable, de traitement des eaux usées et de gestion des matières résiduelles. Le promoteur devra également préciser les mesures qui seront mises en place afin de prévenir les problématiques associées à la consommation d'alcool, de drogues ou de prostitution.

QC - 78. À la section 4.15.6, il est mentionné qu'un système de présélection sera utilisé, soit une sonde capteur installée sur un convoyeur. Le promoteur indique que ce système permettra d'améliorer l'utilisation des ressources et de réduire la consommation d'énergie, les émissions de GES et les pertes en eau. Le promoteur est invité à préciser, pour information, quelles sont les réductions attendues de l'installation de ce système et fournir des détails sur cette technologie.

QC - 79. À la page 2-6, le promoteur mentionne que le gisement permet « d'offrir un potentiel d'expansion significatif ». Tel qu'indiqué dans la Directive du projet, le promoteur devra préciser si des phases de développement ou d'expansion sont envisagées. Le cas échéant, le promoteur devra les présenter.

PRINCIPES DE DÉVELOPPEMENT DURABLE APPLIQUÉS AU PROJET (SECTION 4.16)

QC - 80. Le promoteur devra indiquer si des synergies avec d'autres projets miniers ont été envisagées. Il discutera, entre autres, des possibilités de coordination possible avec d'autres projets concernant la formation professionnelle, la gestion des matières résiduelles, le transport, le traitement du minerai ou tout autre effort de coordination.

QC - 81. Le projet pourrait entraîner des retombées économiques directes et indirectes pour la région Eeyou Istchee Baie-James, grâce entres autres à la création d'emploi, la formation et les opportunités économiques pour les entreprises régionales. Toutefois, ces retombées se feront essentiellement ressentir dans des secteurs économiques où la présence des femmes est généralement minoritaire. Le promoteur devra préciser de quelle façon il entend intégrer cette considération dans l'accomplissement de son projet. Il devra préciser, par exemple, quelles mesures sont prévues pour favoriser la présence des femmes dans les programmes de formation, pour favoriser l'embauche de la main-d'œuvre féminine, pour faciliter la conciliation travail-famille, etc.

5. CONSULTATIONS DU MILIEU

QC - 82. Au tableau 5-2, il est mentionné qu'une rencontre d'introduction a été tenue avec le COMEX le 20 février 2018. Cette rencontre d'introduction a plutôt eu lieu le 17 décembre 2018.

QC - 83. À la section 5.7, le promoteur s'engage à développer des relations durables avec les parties prenantes et à poursuivre l'échange d'informations à propos du projet de diverses façons, notamment en organisant des portes ouvertes et des sessions de partage d'informations, en assurant la présence du responsable des relations communautaires de Galaxy une semaine par mois au sein de la communauté, et à rejoindre celle-ci via leur site internet et par un contact direct. Les dernières activités d'information et de consultation rapportées dans l'ÉIE ont été effectuées en juillet 2018. Le promoteur devra décrire les activités d'information, de consultation et d'engagement des parties prenantes effectuées depuis. Le cas échéant, il indiquera toute modification, amélioration, mesure d'atténuation ou mesure de bonification apportée au projet à la suite de ces activités. Il précisera les activités d'information et de consultation qu'il entend réaliser à court et moyen terme en fournissant un programme à cet effet (types d'activités, moyens, parties prenantes à rencontrer, échéancier, etc.).

QC - 84. À la section 5.7.1, le promoteur souligne que des discussions sont en cours entre Galaxy et la communauté d'Eastmain en vue de conclure une entente sur les répercussions et avantages (ERA). À défaut d'avoir conclu une ERA, auquel cas le promoteur est invité à en fournir une copie pour information à l'Administrateur, le promoteur devra présenter l'état des discussions à cet égard et donner un aperçu des éléments de l'entente pouvant avoir une incidence dans le cadre de la présente analyse.

QC - 85. Lors des consultations menées en 2011-2012, le maître de trappage du terrain RE1 avait indiqué ne pas se sentir concerné par le projet de Galaxy, la zone du projet n'étant pas utilisée par celui-ci. Le promoteur devra indiquer si le maître de trappage du terrain RE1 a été contacté à nouveau lors des consultations en 2017-2018 afin de confirmer sa position.

QC - 86. Selon les informations présentées, le maître de trappage du terrain RE3 n'a pas été rencontré lors des activités d'information et de consultation menées en 2011-2012, ni lors des activités menées en 2017-2018. Or, selon la carte 6-22, une partie du terrain de trappage RE3 semble située à l'intérieur de la zone d'étude du milieu humain. Le promoteur devra consulter le maître de trappage du terrain RE3.

QC - 87. Tel qu'indiqué dans la Directive du projet, la description des milieux biophysique et humain doit intégrer le savoir traditionnel de la population crie. Le promoteur devra préciser de quelle façon le savoir traditionnel a été pris en compte dans la description des différentes composantes du milieu, notamment des milieux humides, du littoral, des rives et des zones inondables, des espèces fauniques d'intérêt traditionnel, ainsi que des plantes utilisées à des fins traditionnelles. Il devra identifier clairement les connaissances traditionnelles recueillies auprès des aîné(e)s, maîtres de trappage, utilisateurs du territoire ou autres parties prenantes consultées.

6. DESCRIPTION DU MILIEU RÉCEPTEUR

MILIEU PHYSIQUE (SECTION 6.2)

Hydrographie (section 6.2.7)

QC - 88. Le tableau 6-9 présente les superficies totales des bassins versants des cours d'eau de la zone d'étude (CE1 à CE6). Pour le calcul des objectifs environnementaux de rejet (OER), il est nécessaire de connaître la superficie du bassin versant de chaque cours d'eau recevant un effluent (CE2 et CE3) à l'emplacement du point de rejet prévu pour l'effluent et non à l'exutoire. Le promoteur devra préciser les données de superficies.

Les superficies drainées par les bassins versants des cours d'eau CE2 et CE3 sont respectivement de 9,07 km^2 et de 10,33 km^2. Au niveau du point de rejet de chacun des effluents, la superficie du bassin pourrait être de l'ordre de 5 km^2 ou moins. Dans de très petits bassins versants (superficie inférieure à 5 km^2), les débits d'étiage sont considérés nuls en raison des incertitudes liées à l'estimation des débits d'étiage et de la possibilité d'assèchement de ceux-ci. Dans ces conditions, aucune zone de mélange n'est allouée pour la dilution de l'effluent et les OER correspondent aux critères de qualité de l'eau.

Si les superficies drainées au point de rejet de l'effluent dans les cours d'eau CE2 et CE3 sont supérieures à 5 km^2, les débits d'étiage devront être fournis. Pour le calcul des OER, le débit du cours d'eau retenu pour la dilution de l'effluent correspond à la valeur la plus basse entre le débit d'étiage hivernal et le débit d'étiage estival. Comme mentionnées dans le document *Estimation des débits d'étiage pour le Nord-du-Québec* (MDDELCC, 2017), les statistiques annuelles ne sont plus considérées en raison de la nature différente des processus à l'origine de chacun des types d'étiage.

Qualité des eaux de surface et souterraines (section 6.2.8)

QC - 89. Lors de la caractérisation initiale du milieu récepteur, les fluorures auraient dû être analysés au même titre que les autres ions majeurs. Les concentrations de fluorures mesurées lors des essais de lixiviation sur les stériles ne sont pas négligeables en comparaison des critères de qualité des eaux de surface. Ce paramètre devra être caractérisé dans le cours d'eau récepteur CE2 avant l'implantation de la mine.

QC - 90. La caractérisation initiale du milieu récepteur devra être complétée par une caractérisation du mercure dans le poisson. Étant donné la lixiviation avérée du minerai et des résidus, le risque de contamination au mercure par les futurs effluents n'est pas négligeable. Connaître la teneur initiale dans le poisson permettra, s'il y a lieu, de s'assurer que la présence éventuelle de mercure à l'effluent n'entraînera pas la contamination de la chaîne alimentaire. La caractérisation du mercure dans le poisson devra être réalisée conformément au protocole présenté dans le document *Protocole d'échantillonnage pour le suivi des substances toxiques dans la chair des poissons de pêche sportive en eau douce* (MDDELCC, 2017).

Un suivi des tissus de poisson pourrait être recommandé si les valeurs obtenues à l'effluent dépassent un certain seuil. Le suivi dans le poisson n'est pas recommandé pour tous les contaminants, mais uniquement pour ceux qui sont persistants comme le mercure et qui ont un potentiel de bioaccumulation. Le mercure sera un paramètre recommandé pour le suivi à l'effluent (OER).

QC - 91. Le tableau 6-17 présente les teneurs de fond naturelles pour l'aluminium, l'arsenic, le baryum, le cuivre, le fer, le lithium, le manganèse et le zinc. Le promoteur devra compléter ce tableau et fournir les teneurs de fond pour tous les métaux du tableau 2.1 de la Directive 019.

Qualité des sols et des sédiments (section 6.2.9)

QC - 92. Selon les informations présentées à la section 6.2.9.1, le nombre d'échantillons analysés dans chaque « unité stratigraphique » de sol est de 13 échantillons pour le sable graveleux et de 17 échantillons pour le sable fin. Ces nombres sont nettement inférieurs au nombre minimum de 30 par couche typique mentionnée dans le *Guide de caractérisation physicochimique de l'état initial des sols avant l'implantation d'un projet industriel* (MDDELCC, 2 015). L'analyse statistique qui s'en suit n'est donc pas recevable. Le promoteur devra indiquer de quelle façon il prévoit compléter ces informations.

QC - 93. La teneur de fond naturelle (TDFN) du chrome hexavalent dans l'unité de sable graveleux se situe entre les critères « C » et « D » du Guide d'intervention. Le chrome hexavalent étant de nature anthropique, l'interprétation des résultats devra conclure à la présence d'une contamination supérieure au critère C. Le promoteur devra tenir compte de la présence de sol contaminé au chrome hexavalent et adresser cet aspect dans l'évaluation du projet (section 7.2.1). Il devra notamment indiquer les mesures prévues pour une éventuelle gestion du sol contaminé.

QC - 94. La section 6.2.9.2 de l'étude d'impact et la section 3.2 de l'étude spécialisée sur l'habitat aquatique présentent les résultats de la caractérisation des sédiments effectuée pour les cours d'eau CE1 à CE5 et pour le lac Asiyan Akwakwatipusich. Tel qu'indiqué dans le *Guide de caractérisation physicochimique de l'état initial du milieu aquatique avant l'implantation d'un projet industriel* (MDDELCC, 2017), le promoteur devra d'abord identifier les plans d'eau susceptibles d'être influencés par l'effluent minier et préciser les zones qui sont propices à la sédimentation (sédiments fins).

Les résultats présentés au tableau 17 de l'étude spécialisée sur l'habitat aquatique montrent que les sédiments prélevés à plusieurs des stations (CE-1A, CE-2B, CE-5A, CE-5B) sont de nature sableuse ou graveleuse. Or, il est indiqué à la section 6.3.3 de l'étude d'impact que le substrat des cours d'eau CE1, CE2, CE3, CE4 et CE5 est dominé par des particules fines.

Le promoteur devra préciser si les secteurs du milieu récepteur propices à la sédimentation (lacs, étangs, méandres) ont été caractérisés et identifier, avec les justifications requises, les stations qui peuvent être considérées comme des stations « exposées » et celles qui peuvent être considérées comme des stations « témoins », selon les indications du guide mentionné plus haut. Si la caractérisation initiale des sédiments est incomplète (minimalement trois stations exposées, une station témoin, 5 échantillons par station), le promoteur devra indiquer de quelle façon il compte la compléter.

QC - 95. Tel qu'indiqué au chapitre 4 du *Guide de caractérisation physicochimique de l'état initial du milieu aquatique avant l'implantation d'un projet industriel*, le soufre fait partie des paramètres visés par le suivi physicochimique des sédiments. Or, ce paramètre n'a pas été caractérisé. Le promoteur devra indiquer de quelle façon il compte compléter la caractérisation.

MILIEU BIOLOGIQUE (SECTION 6.3)

Végétation (section 6.3.1)

QC - 96. L'évaluation des habitats préférentiels des espèces floristiques susceptibles d'être désignées menacées ou vulnérables (EFMVS) et les relevés floristiques se limitent au secteur visé par les infrastructures minières. Toutefois, le projet prévoit l'utilisation potentielle de carrières et de bancs d'emprunt situés à l'extérieur de cette zone (carte 4-4). Le promoteur devra préciser si les secteurs visés pour les carrières et bancs d'emprunt potentiels sont actifs ou s'il s'agit de nouveaux sites. S'il s'agit de nouveaux sites, le promoteur devra évaluer la présence d'habitats potentiels d'EFMVS sur ces sites. Advenant la présence d'habitats potentiels, des inventaires complémentaires sont à prévoir et des mesures d'atténuation devront être proposées au besoin.

QC - 97. Le promoteur rapporte la présence de 27 espèces floristiques d'intérêt traditionnel utilisées par les Cris dans la zone d'étude. À la page 6-53, il indique que l'évaluation de l'utilisation traditionnelle des plantes est basée sur la littérature. Le promoteur devra consulter la communauté crie (ainé(e)s, maîtres de trappage, utilisateurs du territoire, etc.) afin d'intégrer le savoir traditionnel et de compléter les informations portant sur l'utilisation traditionnelle des plantes et les usages médicinaux.

Faune terrestre (section 6.3.2)

QC - 98. À la page 6-78, il est indiqué que selon l'étude Rudolph et coll. (2012) sur le caribou forestier, « les résultats des inventaires qui ont eu lieu en 2003, en 2007, en 2009 et en 2011, ont permis d'estimer que le nombre d'individus de la population Nottaway était respectivement de 137, 50, 26 et 17 individus. En considérant l'aire de répartition de cette population estimée à 36 400 km^2, la densité estimée en 2011 serait d'environ 0,1 caribou forestier/100 km^2». Or, les nombres d'individus publiés dans l'étude de Rudolph et coll. pour les inventaires de 2003, 2007, 2009 et 2011 ne sont pas des estimations de la population Nottaway, mais plutôt le nombre d'individus observés lors des inventaires. Le promoteur devra considérer cette nuance dans son évaluation et indiquer si les effets anticipés du projet sur le caribou s'en trouvent modifiés.

QC - 99. Concernant le campagnol des rochers, il est indiqué à la page 6-97 que « compte tenu de l'ampleur des feux de forêt qui ont touché la zone d'étude, il est peu probable que cette espèce y soit encore présente ». Le campagnol des rochers est connu pour utiliser des endroits sans couvert forestier, tels que des coupes de moins d'un an et son utilisation de sentier sous-terrain lui permettent de survivre à des évènements météorologiques extrêmes. Les feux de forêt n'auraient donc pas forcément entraîné la disparition du campagnol des rochers du secteur. De plus, le campagnol des rochers pourrait avoir des cycles de population similaires à ceux des campagnols à dos roux de Gapper, bien qu'un peu moins prononcés. Puisque les densités des campagnols des rochers sont déjà généralement faibles, si l'année d'inventaire correspondait à une année de baisse de population, il est possible que leur présence n'ait pas été détectée par les pièges. Cela ne représenterait pas une disparition complète de l'espèce du secteur pour autant. Le promoteur devra indiquer si, à la lumière de ces informations, des ajustements doivent être apportés à l'évaluation des effets anticipés du projet sur cette composante et aux mesures d'atténuation proposées.

Ichtyofaune (section 6.3.3)

QC - 100. Selon les résultats des inventaires de faune aquatique, la perchaude serait en allopatrie dans le lac Kapisikama. Or, la perchaude est plutôt connue pour se retrouver dans des plans d'eau en sympatrie avec d'autres espèces. Il n'existe aucune documentation de populations allopatriques de perchaudes au Québec. Si cette observation s'avérait exacte, elle serait d'autant plus inhabituelle pour une région nordique. Afin de valider cette observation, le promoteur devra fournir des renseignements supplémentaires, tels que des photographies des spécimens ou au moyen d'une autre méthodologie. Enfin, puisque le lac Kapisikama sera graduellement asséché au cours du projet, le promoteur devra caractériser cette population de façon adéquate avant qu'elle ne soit affectée par le projet en vue de proposer un plan de compensation adéquat pour cet habitat.

Avifaune (section 6.3.5)

QC - 101. La section 6.3.5 fait état de certaines observations dont le caractère inusité n'est pas souligné par le promoteur, par exemple :

- la présence de grives fauves est rapportée pour deux types d'habitats (milieux ouverts et peuplements résineux), en nombre suffisamment abondant pour qu'une densité de couples nicheurs puisse être évaluée. La grive fauve est une espèce associée aux peuplements feuillus qui n'a été observée qu'à deux reprises au nord du 50e parallèle lors des travaux d'inventaire du deuxième *Atlas des oiseaux nicheurs du Québec* et qui n'a jamais été observée au nord du 51e parallèle[6]. Dans le cadre des travaux de l'Atlas, aucune grive fauve n'a été entendue aux points d'écoute dans la parcelle 18UC59 qui couvre une vaste partie de l'aire d'étude de la mine. L'observation de plusieurs grives fauves, dans deux types d'habitats différents, incluant des habitats très atypiques pour l'espèce (peuplements résineux), apparaît surprenante;

[6] Les mentions de grive fauve au nord du 51e parallèle concernent des individus chanteurs. La nidification n'est pas confirmée.

- l’observation d'un faible nombre de bruants de Le Conte est rapportée. Jusqu'à présent, toutes les observations de cette espèce étaient confinées aux marais côtiers des baies de Rupert, Cabbage Willows et Boatswain. Cette espèce n'avait jamais été observée plus au nord que la baie de Boatswain. L'observation de cette espèce dans la zone d’étude est inusitée, quoique n'est pas impossible, même si elle a été réalisée à près de 80 km de la côte;
- un moqueur polyglotte a été observé à proximité du relais routier du km 381. Cette espèce s'égare parfois et il est possible qu'elle ait bien été observée à cet endroit. Cette espèce peut être confondue avec la pie-grièche boréale, une espèce plus susceptible d'être observée au relais routier;
- aucune observation de roitelet à couronne rubis n’est rapportée dans les milieux humides ni dans les milieux ouverts et très peu dans les peuplements résineux (0,07 ÉC/ha). Le roitelet à couronne rubis est pourtant l'une des espèces les plus abondantes en forêt boréale. C’est une espèce qui vocalise abondamment et donc qui est facile à détecter lors de la réalisation de points d'écoute. Les résultats de *l'Atlas des oiseaux nicheurs du Québec* montrent d'ailleurs que l'espèce est bien présente tout le long de la route de la Baie-James et qu’elle a été détectée à 47 % des points d'écoute réalisés dans la parcelle 18UC59. À l'opposé, l’étude rapporte des données d'équivalent couples pour le tétras du Canada dans les milieux humides et dans les peuplements résineux. Bien qu'il soit normal que le tétras du Canada soit présent dans l'aire d'étude, il ne s'agit pas d'une espèce qui vocalise beaucoup et sa détection à l'aide de points d'écoute est normalement faible. Le fait que les résultats des points d'écoute montrent une quasi-absence de roitelet à couronne rubis dans l'aire d'étude et une abondance quatre fois plus élevée de tétras du Canada dans les peuplements résineux apparaît surprenant.

Le promoteur devra commenter le caractère inusité de ces observations et, le cas échéant, indiquer si des ajustements doivent être apportés à l’évaluation des effets anticipés du projet sur l’avifaune et aux mesures d’atténuation proposées.

MILIEU HUMAIN (SECTION 6.4)

Utilisation du territoire (section 6.4.6)

QC - 102. L’ÉIE rapporte la présence de deux cours d’eau navigables aux environs du site du projet, sur lesquels peu de déplacements auraient été effectués au cours des dernières années. Le promoteur devra valider ces informations auprès des utilisateurs du territoire et rendre compte des consultations effectuées. Il devra également décrire l’usage passé, présent et futur des lacs et des cours d’eau à des fins récréatives ou de navigation par la communauté crie.

QC - 103. Le promoteur devra préciser la nature (eaux souterraines ou de surface) et l’usage des sources d’alimentation en eau potable identifiées sur la carte 6-22 et décrire leur potentiel d’utilisation future.

QC - 104. Le promoteur devra compléter la description de l'utilisation du territoire en incluant l'utilisation passée du territoire, les lieux de sépulture de même que les sites et les secteurs ayant une valeur particulière pour la population crie. Cette description devra s'appuyer, entre autres, sur des informations recueillies auprès du maître de trappage et des utilisateurs du territoire.

Patrimoine et archéologie (section 6.4.9)

Patrimoine naturel (section 6.4.9.1)

QC - 105. Le gouvernement du Québec vise d'ici 2020 à ce que 20 % du territoire du Plan Nord soit constitué d'aires protégées. Dans cette optique, plusieurs démarches de planification régionale des aires protégées sont en cours à la Baie-James. Pour sa part, la communauté d'Eastmain a soumis au gouvernement deux propositions, dont une qui chevauche en partie la zone d'étude du milieu humain du projet. L'ÉIE ne tient pas compte de ces propositions. Le promoteur devra se renseigner auprès de la communauté quant à leurs propositions d'aires protégées et devra tenir compte de ces propositions dans le cadre de l'analyse des impacts du projet.

QC - 106. Le gouvernement du Québec s'est donné pour objectif, d'ici 2035, à ce que 50 % du territoire du Plan Nord soit consacré à des fins autres qu'industrielles, à la protection de l'environnement et à la sauvegarde de la biodiversité. Le promoteur devra s'informer auprès du gouvernement du Québec et de la Société du Plan Nord, du Gouvernement de la Nation crie et du gouvernement régional Eeyou Istchee Baie-James sur leur planification respective envisagée pour les aires protégées et l'aménagement intégré du territoire et évaluer la compatibilité entre son projet et les mesures d'aménagement du territoire prévues par ces instances.

Patrimoine archéologique (section 6.4.9.2)

QC - 107. Le promoteur devra indiquer de quelle façon les connaissances traditionnelles autochtones et les commentaires et préoccupations recueillis lors des consultations ont été pris en compte pour établir l'état de référence du patrimoine naturel et archéologique.

QC - 108. Les informations archéologiques présentées dans l'étude d'impact sont tirées de l'étude de potentiel archéologique réalisée par Arkéos (2018). Or, cette étude ne présente aucune connaissance traditionnelle autochtone qui pourrait pourtant s'avérer précieuse pour déterminer le potentiel archéologique de la zone. L'étude devrait s'appuyer sur des connaissances traditionnelles recueillies auprès des aîné(e)s, des utilisateurs du territoire ou d'autres membres de la communauté crie. Le promoteur devra présenter des informations détaillées sur les zones passées et présentes d'utilisation du territoire, l'historique des terrains de piégeage, les voies de déplacement traditionnelles (terrestres et navigables) et les lieux de campement utilisés dans le passé.

QC - 109. L’étude de potentiel archéologique indique que l’occupation humaine remonterait à environ 5 000 ans, les plus vieux sites mis au jour étant datés de 4 600 et 4 100 ans BP. L’étude devrait considérer la possibilité que l’occupation humaine y soit antérieure compte tenu des conditions écologiques favorables à l’occupation humaine dès 6 000 BP et de la présence de la moraine de Sakami à l’est de la zone d’étude. Lors du retrait de la mer Tyrell, certains rivages auraient pu être mis à jour. Les rivages auraient alors pu être utilisés par les anciens occupants d'Eeyou Istchee, tel que pour le site de Wapekeka (Hamilton, 2004) dans le nord de l'Ontario. L’étude devrait tenir compte d’une délimitation des éventuelles lignes de rivage pouvant être observées sur des photos aériennes et, le cas échéant, un ajustement des zones de potentiel archéologique.

7. IDENTIFICATION ET ÉVALUATION DES IMPACTS SUR L'ENVIRONNEMENT

MÉTHODE D'ÉVALUATION DES IMPACTS (SECTION 7.1)

Évaluation des impacts (section 7.1.3)

QC - 110. Le promoteur devra présenter de quelle façon il a intégré les commentaires recueillis auprès des maîtres de trappage et des utilisateurs du territoire dans l'évaluation des impacts. Plus spécifiquement, il devra présenter de quelle façon les commentaires recueillis ont été pris en compte dans l'identification des composantes environnementales susceptibles d'être affectées par le projet, dans l'évaluation des impacts anticipés et leur niveau d'importance, ainsi que dans la sélection des mesures d'atténuation proposée.

IMPACTS SUR LE MILIEU PHYSIQUE (SECTION 7.2)

Sols (section 7.2.1)

QC - 111. La mesure d'atténuation NOR 03 prévoit la disposition des déblais contaminés au-delà du critère C (à l'exception de ceux contaminés aux hydrocarbures) dans la halde, ou à défaut, dans un autre site autorisé. Or, la Directive 019 indique : « À moins d'obtenir l'autorisation préalable du Ministère, seuls les résidus miniers sont acceptés dans les aires d'accumulation de résidus miniers ». Le promoteur devra s'assurer que les déblais contaminés seront gérés selon la grille de gestion des sols contaminés du Guide d'intervention à moins d'avoir obtenu l'autorisation préalable requise.

QC - 112. Le rapport de la phase I de caractérisation recommande la réalisation d'une phase II de caractérisation. Le promoteur devra présenter les résultats de cette phase II. Il devra tenir compte de ces résultats dans la section 7.2.1 et évaluer les effets du projet pour cette composante.

Hydrogéologie (section 7.2.2)

QC - 113. Selon les informations présentées, le seul utilisateur d'eau souterraine répertorié dans le secteur du projet est le relais routier du km 381 dont le puits est situé à environ 700 mètres de la limite de la fosse, soit à la limite de la zone potentielle de rabattement de la nappe d'eau souterraine. Le promoteur devra s'engager à fournir de l'eau potable au relais routier ou à forer un nouveau puits d'eau potable dans le cas où le rabattement rende inutilisable le puits d'eau potable du relais routier.

QC - 114. À la page 7-23, il est indiqué que le temps de remplissage de la fosse est estimé de 120 à 170 années. Le promoteur devra présenter les détails de ce calcul.

Régime hydrologique (section 7.2.3)

QC - 115. Au premier paragraphe de la page 7-27, l'étude mentionne « l'influence du rabattement de la nappe phréatique par le pompage autour de la fosse ». Le pompage en périphérie de la fosse n'est abordé nulle part ailleurs dans l'étude. Le promoteur devra préciser si un pompage de la nappe par l'entremise de puits périphériques est prévu afin de réduire la quantité d'eau à gérer dans la fosse. Dans l'affirmative, le promoteur devra préciser le destin de ces eaux et traiter des impacts de la gestion de ces eaux de pompage. Sinon, le promoteur devra confirmer qu'il s'agit des eaux d'exhaure pompées dans la fosse et non autour de la fosse.

QC - 116. L'ÉIE indique qu'en phase de restauration, les cours d'eau CE2 et CE6 retrouveront leurs bassins versants originaux du point de vue de leurs superficies. Or, la présence de la halde à stériles laissera un impact permanent sur la topographie de ces bassins versants, lesquels auront une plus grande réactivité aux précipitations. Le promoteur devra aborder les effets hydrologiques sur les milieux humides de ces bassins versants ainsi que sur leurs fonctions écologiques, notamment sur la capacité de ces milieux à réguler une plus grande et/ou soudaine intensité d'eau.

QC - 117. En phase post-restauration, la fosse sera graduellement mise en eau permettant la création d'un lac avec un exutoire se déversant dans le cours d'eau CE3. Le déversement à l'exutoire du lac de la fosse aura pour effet d'augmenter l'apport en eau du bassin versant du CE3. Même si aucun déversement n'est prévu au cours des 100 premières années suivant la fin de l'exploitation, le promoteur devra évaluer les impacts de ce déversement sur le cours d'eau CE3, les milieux environnants de même que sur les infrastructures du secteur (ex. sur la route de la Baie-James) et les utilisateurs du territoire.

Eau et sédiments (section 7.2.4)

QC - 118. Plusieurs résultats analytiques, provenant des essais de lixiviation (SPLP, TCLP, CTEU-9) des quatre lithologies constituant les stériles, les résidus ainsi que les échantillons de minerai, dépassent les critères de résurgence dans l'eau de surface pour plusieurs métaux. Le promoteur devra évaluer l'impact de ces sources potentielles de contamination sur les eaux souterraines et les eaux de surface.

QC - 119. À la page 7-34, le promoteur indique que « lorsque les infrastructures de gestion de l'eau sur le site seront démantelées, la nature physicochimique d'origine des eaux de surface sera rétablie. » Le promoteur devra expliquer cette affirmation considérant que lors du démantèlement des infrastructures de gestion de l'eau, l'eau demeurera en contact avec les parois de fosse et de la halde notamment.

QC - 120. En phase post-restauration, la fosse se remplira graduellement d'eau et une partie de l'eau sera en contact avec les parois rocheuses exposées. Des contaminants pourraient ainsi s'écouler dans le réseau hydrographique et modifier la qualité de l'eau de surface. Le promoteur devra indiquer de quelle façon il prévoit s'assurer du respect de la Directive 019 en tout temps après la fermeture de la mine.

Atmosphère (section 7.2.5)

QC - 121. Les résultats de modélisation pour le scénario de construction et le scénario d'exploitation montrent que les concentrations de particules totales (PST) et de particules fines (PM2.5) obtenues excèdent les normes de qualité de l'atmosphère 24 heures du MELCC. Ces normes sont toutefois respectées aux récepteurs sensibles.

Lors de la construction et de l'exploitation du site, le promoteur devra être en mesure de démontrer que les mesures d'atténuation courantes, notamment l'arrosage des segments routiers et des zones de travail, seront appliquées. Il devra consigner les informations pertinentes (fréquence d'arrosage, nombre de camions, etc.) dans un registre disponible pour consultation.

QC - 122. Dans le scénario d'exploitation, à l'exception de la silice cristalline, les résultats de concentrations de métaux et métalloïdes obtenus à la suite de la modélisation respectent les normes considérées pour le scénario d'exploitation. Toutefois, les résultats de modélisation de la silice cristalline dépassent les critères 1 heure et annuel du MELCC à la limite d'application ainsi qu'aux récepteurs sensibles. Au récepteur sensible le plus impacté, les concentrations maximales modélisées sur 1 heure et sur 1 an sont respectivement de 103,3 $\mu g/m^3$ et de 0,128 $\mu g/m^3$. Ces résultats correspondent à 449 % du critère horaire et à 182 % du critère annuel.

Considérant cela et vu l'ampleur des dépassements de silice cristalline, le promoteur devra proposer des mesures d'atténuation supplémentaires afin de réduire de façon notable les concentrations modélisées de silice cristalline aux récepteurs sensibles. Il indiquera de quelle façon il compte mettre en place et appliquer ces mesures d'atténuation. Les mesures d'atténuation supplémentaires devront être intégrées au programme de suivi de la qualité de l'air.

QC - 123. Le promoteur devra présenter un plan préliminaire de gestion des particules. Ce plan devra prévoir des mesures de suivi qui devront être incluses au programme de suivi la qualité de l'air.

Vibrations et suppressions d'air (section 7.2.8)

QC - 124. Le promoteur devra mettre en place un système d'autosurveillance des vibrations et du bruit lors des opérations de sautage tel que prévu à la section 2.4.2 de la Directive 019.

IMPACTS SUR LE MILIEU BIOLOGIQUE (SECTION 7.3)

QC - 125. Plusieurs espèces fauniques et floristiques sont actuellement présentes sur le site où seront aménagées les infrastructures minières. Le promoteur couvre les impacts associés à la perte d'habitats pour les organismes ainsi qu'aux dérangements occasionnés par les activités du projet. Toutefois, les impacts associés à la présence de contaminants dans les zones du site minier utilisées par la faune et la flore ne sont pas considérés. Mentionnons également que des préoccupations ont été soulevées par les utilisateurs du secteur relativement à la contamination de la végétation, de la faune aquatique et des espèces fauniques terrestres.

Le promoteur devra aborder les risques associés à des expositions aux contaminants pour la végétation, de même que pour la faune terrestre et aquatique (effet de bioaccumulation). Il devra décrire dans quelle mesure les concentrations résiduelles de contaminants sont susceptibles d'affecter la faune et la flore.

Végétation et milieux humides (section 7.3.1)

QC - 126. Les milieux humides couvrent 74,4 % (2 743,96 ha) de la zone d'étude et sont essentiellement représentés par les tourbières ouvertes ou boisées. Le projet entraînera la perte d'environ 302 ha de milieux humides auxquels s'ajoutent 50 ha par effets indirects. Le promoteur indique qu'un programme de compensation des milieux humides sera élaboré afin de compenser les pertes inévitables de milieux humides et que ce programme sera présenté lors de la demande d'autorisation des travaux.

Le promoteur devra détailler les principaux éléments du plan de compensation envisagé. Il devra fournir un aperçu des travaux de restauration, projets de création de milieux humides ou autres aménagements proposés pour compenser les pertes résiduelles de milieux humides. Le promoteur devra indiquer les intervenants consultés dans le cadre de l'élaboration du plan de compensation, notamment les communautés, maîtres de trappage, utilisateurs du territoire, etc.

QC - 127. Certains milieux humides pourraient subir un assèchement partiel en périphérie des fossés de drainage. Le promoteur propose d'aménager une petite berme d'argile le long des aires décapées afin de limiter cet impact. Le promoteur devra démontrer de quelle façon la conception des fossés, incluant l'aménagement d'une berme, permettra de limiter le drainage des milieux humides.

QC - 128. Le promoteur a réalisé des relevés floristiques en juillet 2017 et rapporte la détection de 2 occurrences de carex stérile (*Carex sterilis*), une espèce susceptible d'être désignée menacée ou vulnérable. Une vérification de la numérisation du spécimen d'herbier a permis de confirmer qu'il s'agit plutôt du *Carex exilis*, une plante vasculaire commune au fen boréal québécois. Ainsi, la relocalisation de la population proposée par le promoteur n'est pas requise.

QC - 129. Aucune espèce végétale exotique envahissante (EVEE) n'a été relevée sur le site lors des inventaires. Le promoteur identifie des risques d'introduction et de propagation des EVEE pour les activités associées au transport et à la circulation de la machinerie. Afin de réduire ces risques, il propose deux mesures d'atténuation courantes, soit le nettoyage de la machinerie excavatrice ou des embarcations avant leur utilisation sur le site et une validation annuelle de l'introduction potentielle ou non d'EVEE afin d'éradiquer rapidement, dans la mesure du possible, toute nouvelle occurrence observée. Le promoteur devra compléter ces mesures par un suivi, réalisé sur une période de deux ans suivant la fin des travaux, afin de vérifier si des EVEE se sont établies.

QC - 130. À la page 6-69, le promoteur identifie 27 espèces végétales d'intérêt traditionnel utilisées par les Cris dans la zone d'étude. Le promoteur devra présenter de quelle façon, il a évalué les impacts du projet sur ces plantes d'intérêt pour chacune des phases du projet (construction, exploitation, restauration et post-restauration). Il devra s'assurer d'intégrer les commentaires et connaissances recueillis auprès du maître de trappage et des utilisateurs du territoire.

QC - 131. À la page 7-50, le promoteur indique que l'évaluation de l'impact sur la végétation et les milieux humides en phase de restauration n'est pas requise et que les impacts en phase de post-restauration seront inexistants. Le promoteur devra justifier davantage ces affirmations.

QC - 132. La restauration devra favoriser le rétablissement de milieux humides se rapprochant des milieux initialement présents. Le promoteur devra indiquer de quelle façon le rétablissement des fonctions écologiques a été pris en compte dans l'élaboration des mesures de restauration proposées.

Grande faune (section 7.3.2)

QC - 133. La présence de déchets domestiques et de ressources alimentaires pourrait attirer des animaux, notamment des ours, à proximité du site. Afin de ne pas attirer les animaux, le promoteur indique à la page 7-51 que « les travailleurs seront sensibilisés au fait de ne pas nourrir les animaux et de ne pas laisser traîner de nourriture ». En plus de l'application de bonnes pratiques individuelles, des mesures de gestion des matières résiduelles adaptées devront être prévues. Par exemple, l'utilisation de bennes anti-ours, le clôturage des zones d'entreposage des matières résiduelles ou autres peuvent être envisagées afin de limiter l'accès aux sources de nourriture sur le site. Le promoteur devra présenter des mesures d'atténuation complémentaires.

Ichtyofaune (section 7.3.4)

QC - 134. Parmi les mesures d'atténuation présentées pour l'ichtyofaune, le promoteur propose d'interdire la pêche récréative aux travailleurs du site minier afin de limiter les impacts du prélèvement par la pêche sportive. Le promoteur devra indiquer de quelle façon il entend appliquer cette mesure et s'il a pris entente avec les autorités responsables de restreindre ces activités.

QC - 135. Un projet communautaire de frayère à esturgeon est prévu au croisement de la route de la Baie-James et de la rivière Eastmain. Bien que ce projet soit situé à plusieurs kilomètres au nord du site, certaines préoccupations ont été soulevées par les utilisateurs du territoire. Le promoteur devra aborder les impacts potentiels du projet sur cette frayère et, le cas échéant, les mesures d'atténuation prévues pour en limiter les effets.

IMPACTS SUR LE MILIEU HUMAIN (SECTION 7.4)

Usage courant des terres et des ressources à des fins traditionnelles (section 7.4.1)

QC - 136. Les installations du site minier seront facilement accessibles. Pour assurer la sécurité des utilisateurs du territoire, le promoteur propose d'établir, en collaboration avec le maître de trappage du terrain RE2, une zone d'exclusion des activités traditionnelles. Il indique également « que les aménagements à risques seront sécurisés ». Le promoteur devra préciser les mesures de protection qu'il entend mettre en place pour assurer la sécurité des utilisateurs du territoire à proximité du site de la mine.

QC - 137. L'une des mesures d'atténuation des impacts du projet sur l'utilisation des terres à des fins traditionnelles consiste à « établir et maintenir un plan de communication afin d'informer la population, les utilisateurs et les autorités municipales du début et du déroulement des travaux ». Dans le même esprit, il est aussi proposé de rendre disponibles les rapports de surveillance et de suivis de la qualité du milieu. Le promoteur devra préciser les mécanismes d'échange avec les utilisateurs du territoire et l'ensemble de la population qui seront mis en place.

QC - 138. Le promoteur a proposé certaines activités d'information (visites de site, cours d'introduction sur l'exploitation minière) afin de permettre une meilleure compréhension des activités et des impacts de l'exploitation minière. Certains membres de la communauté indiquent tout de même avoir l'impression que les effets projetés du projet sont minimisés (p.5- 8) et n'ont pas pleinement confiance dans les mesures d'atténuation proposées. Le promoteur devra indiquer de quelle façon les préoccupations environnementales et sociales exprimées par la communauté ont été traitées et quelles mesures d'atténuation permettent de les adresser. Il devra également préciser quelles mesures d'atténuation ont été proposées par les membres cris, lesquelles ont été retenues et, le cas échéant, justifier pourquoi certaines mesures proposées par les membres cris n'ont pas été retenues.

QC - 139. À la section 7.4.1, il est mentionné que le projet pourrait entraîner la modification et le déplacement de la pratique des activités traditionnelles de chasse et de piégeage. Le promoteur devra détailler davantage de quelle façon le projet affectera les activités de prélèvement d'espèces fauniques à des fins traditionnelles, notamment de la sauvagine et du caribou.

Infrastructures (section 7.4.2)

QC - 140. L'ÉIE ne présente pas les impacts liés à l'entreposage et au transbordement du concentré au centre de transbordement de Matagami. Le promoteur devra préciser les impacts de ces activités sur le milieu, notamment les impacts économiques de même que ceux liés au transport pour la ville de Matagami et ses citoyens.

QC - 141. Le promoteur devra évaluer les impacts du transport occasionné par les activités de son projet sur la route de la Baie-James pour les utilisateurs cris des aires de trappage contigües à la route.

Qualité de vie et bien-être (section 7.4.4)

QC - 142. La section 7.4.4 décrit les effets potentiels du projet sur les problématiques de santé chez les travailleurs et les communautés ainsi que la pression supplémentaire que le projet peut exercer sur le fonctionnement du Conseil cri de la santé et des services sociaux de la Baie-James (CCSSSBJ). À cet effet, le promoteur propose de collaborer avec le CCSSSBJ. Le promoteur devra décrire la nature de sa collaboration avec le CCSSSBJ en général et plus particulièrement avec les cliniques de santé de Nemaska et d'Eastmain qui sont les cliniques les plus rapprochées géographiquement du projet. Il devra clarifier les rôles lors d'incidents comportant un nombre élevé de victimes ainsi que dans le cadre de problèmes de santé individuels urgents et non-urgents.

QC - 143. À la page 7-74, il est mentionné qu'une entente avec la SDBJ est en discussion afin d'offrir un service de soins de santé et d'urgences médicales conjointement avec le relais routier du km 381. Le promoteur devra faire état des échanges avec la SDBJ concernant la prestation de services de santé et d'urgences médicales. Le cas échéant, il devra décrire la nature de cette entente.

QC - 144. L'une des mesures d'atténuation proposée par les membres de la communauté d'Eastmain était de créer un village culturel au campement de travailleurs. Le promoteur devra indiquer si cette mesure sera mise en œuvre.

Économie locale et régionale (section 7.4.5)

QC - 145. Le promoteur indique à la page 4-80 que 210 travailleurs seront requis en moyenne pendant la phase de construction alors que ce sont 300 travailleurs qui sont indiqués à la page 7-77 pour la même phase. Pour la phase d'exploitation, il est indiqué à la page 7-78 que l'exploitation de la mine entraînera la création de 360 emplois alors que la figure 4-15 indique un effectif entre 250 et 360 travailleurs. Par ailleurs, la conception du campement des travailleurs prévoit l'hébergement d'au plus 280 travailleurs en phase de construction et 150 travailleurs en phase d'exploitation. Le promoteur devra préciser le nombre d'emplois directs estimé pendant les phases de construction, d'exploitation et de fermeture du projet.

QC - 146. Selon le promoteur, le projet permettra la création d'emplois de qualité et bien rémunérés. Il s'agira d'emplois requérants, pour la plupart, une expertise technique et un niveau de spécialisation élevé. Le promoteur souhaite favoriser l'embauche de travailleurs locaux et plus particulièrement de travailleurs cris. Or, considérant que les membres des communautés cris sont surtout engagés dans des emplois du secteur tertiaire ou dans l'industrie des services, en plus du faible taux de diplomation, les travailleurs cris sont susceptibles d'avoir de la difficulté à accéder aux emplois du projet (et plus particulièrement les emplois spécialisés). Afin de favoriser l'emploi des travailleurs cris, le promoteur compte offrir des programmes de formation adaptés. Il indique à la page 2-6 qu'il prévoit participer au développement de programmes de formation dans le domaine minier de la Commission scolaire de la Baie-James en collaboration avec d'autres entreprises minières. Il indique également à la page 4-87 qu'il est en cours de discussion avec le Conseil de la Nation crie d'Eastmain afin de développer des programmes de formation.

Le promoteur devra préciser de quelle façon il entend développer et mettre sur pied des programmes de formation adaptés aux besoins spécifiques du projet. Il devra identifier les partenaires et présenter les moyens par lesquels il fera connaître l'offre de formations. Il devra présenter ses cibles d'embauche pour les Cris et indiquer comment les processus de formation et de recrutement permettront l'atteinte de ces cibles. Il devra rendre compte de l'atteinte de ces cibles dans son rapport annuel.

QC - 147. Le promoteur prévoit établir un plan de communication pour informer les acteurs locaux des postes à combler. Le promoteur devra indiquer à quel moment ce plan sera rendu disponible et devra le transmettre à l'Administrateur pour information.

QC - 148. L'une des mesures proposées afin de bonifier les retombées positives du projet consiste à élaborer un « protocole d'entente et de partenariat pour la participation crie ». Le promoteur devra présenter ledit protocole, ou s'il n'est pas complété, l'état des discussions à ce sujet ainsi qu'un aperçu des éléments de cette entente pouvant avoir une incidence dans le cadre de la présente analyse. Il devra notamment préciser les objectifs de l'entente, les partenaires et organismes impliqués et les actions envisagées en matière d'emploi et d'économie.

Patrimoine et archéologie (section 7.4.6)

QC - 149. Au total, 27 zones à potentiel archéologique ont été identifiées dans la zone d'étude. Ces zones correspondent aux espaces les plus susceptibles de contenir des vestiges de l'activité humaine passée. Comme ces zones de potentiel archéologique n'ont fait l'objet d'aucune validation terrain, le promoteur devra s'engager à réaliser, préalablement au début des travaux pouvant affecter ces zones, un inventaire archéologique des zones de potentiel identifiées. L'inventaire devra permettre d'évaluer le patrimoine archéologique en place et de définir, le cas échéant, des mesures d'atténuation supplémentaires en cas d'éventuelles découvertes. Le promoteur devra s'assurer de la participation du maître de trappage concerné ou selon ce qui aura été entendu avec le ou les comité(s) de suivi mis en place. Si certaines zones sont exclues de cet inventaire, le promoteur devra le justifier.

8. ÉVALUATION DES EFFETS CUMULATIFS

DÉTERMINATION DES COMPOSANTES VALORISÉES (SECTION 8.4)

QC - 150. Le promoteur indique que l'évaluation a permis de déterminer les principaux enjeux et répercussions du projet sur les composantes du milieu et d'identifier les principales préoccupations du milieu. Ces deux aspects combinés ont permis de sélectionner les composantes valorisées (CV) associées au projet, puis de choisir celles devant faire l'objet d'une évaluation des effets cumulatifs. Sur cette base, deux CV ont été retenues pour l'analyse des effets cumulatifs, soit les chiroptères et l'utilisation traditionnelle du territoire par les Cris.

Le promoteur devra indiquer de quelle façon les communautés cries, les utilisateurs du territoire ou d'autres parties prenantes ont été consultés sur le choix des composantes valorisées retenues dans le cadre de l'évaluation des effets cumulatifs. Il devra expliquer de quelle façon leurs commentaires ont été pris en compte dans le choix des composantes valorisées. Si cette démarche n'a pas été ainsi complétée, il devra la réaliser.

PROJETS, ACTIONS OU ÉVÉNEMENTS LIÉS AUX COMPOSANTES VALORISÉES (SECTION 8.5)

QC - 151. La section 8.5.4.1 mentionne la présence d'une réserve de biodiversité projetée dans la zone d'étude des effets cumulatifs, soit la réserve de biodiversité projetée Paakumshumwaau-Maatuskaau. Le promoteur indique que la fin de la protection provisoire de la réserve de biodiversité projetée Paakumshumwaau-Maatuskaau est prévue pour le 11 juin 2020. Il importe de mentionner que l'intention gouvernementale est de protéger ce territoire de façon permanente. Dans l'éventualité où toutes les étapes devant conduire à l'octroi d'un statut permanent ne seraient pas complétées en date du 11 juin 2020, les démarches nécessaires seront entreprises afin que le statut de protection provisoire soit prolongé, conformément aux dispositions prévues à la Loi sur la conservation du patrimoine naturel (RLRQ, chapitre C-61.01).

En plus de la réserve Paakumshumwaau-Maatuskaau, deux autres réserves de biodiversité projetées sont présentes dans la zone d'étude des effets cumulatifs sur les chiroptères. Il s'agit de la réserve de biodiversité projetée de Waskaganish et de la réserve de biodiversité projetée de Chisesaakahikan-et-de-la-Rivière-Broadback. L'ensemble des données sur les aires protégées est disponible sur le site du Registre des aires protégées et de Données Québec[7]. Le promoteur devra tenir compte de ces aires dans son évaluation.

[7] http://www.environnement.gouv.qc.ca/biodiversite/aires_protegees/registre/index.htm
https://www.donneesquebec.ca/recherche/fr/dataset/aires-protegees-du-quebec

ANALYSE DES IMPACTS CUMULATIFS (SECTION 8.6)

QC - 152. Le promoteur devra indiquer de quelle façon il a considéré les interactions cumulables de son projet sur l'emploi et la disponibilité des ressources humaines. Dans un contexte où la région connaît actuellement une pénurie de main-d'œuvre, le promoteur devra traiter de l'effet conjugué de son projet et des autres projets miniers actuels et futurs, qui sollicitent une même main-d'œuvre sur un même territoire. Le promoteur devra également évaluer la pression supplémentaire exercée par le projet sur la main-d'œuvre disponible pour les entreprises locales et la prestation de services au sein des communautés.

QC - 153. À la page 8-6, le promoteur indique « À titre comparatif, et bien que la circulation ait un effet sur la qualité de vie et qu'elle ait été soulevée comme préoccupation lors des consultations, elle n'a pas été retenue comme composante valorisée ». Le promoteur devra traiter de l'impact cumulatif de son projet sur le transport. À cet effet, il devra présenter une étude de trafic, incluant sans s'y restreindre, le transport associé aux approvisionnements, au transport du minerai ainsi qu'au transport des travailleurs lors des différentes phases du projet, de même que des activités de transport associées aux autres projets, activités ou événements indiqués à la section 8.5. Les éléments présentés pourraient inclure notamment :

- Volume et type d'utilisation actuelle de la route de la Baie-James;
- Volume et type d'utilisation anticipée par le projet;
- Volume et type d'utilisation anticipé par les autres projets prévus sur la route de la Baie-James;
- Évaluation des impacts cumulatifs associés au transport sur la route de la Baie-James.

9. GESTION DES RISQUES D'ACCIDENT

QC - 154. Un des risques d'accident identifié dans cette section concerne les fuites et les déversements accidentels de produits pétroliers. Le promoteur devra décrire les systèmes de détection des fuites et de déversements des réservoirs de stockage et des installations de confinement des produits pétroliers.

QC - 155. À la section 9.3.9, le promoteur présente les mesures de prévention et de contrôle prévues afin de réduire les risques de rupture de digue de rétention. Le promoteur devra décrire davantage l'instrumentation de surveillance qui sera mise en place, notamment le système de détection des fuites.

10. PROGRAMME DE SURVEILLANCE ET SUIVI

SUIVIS ENVIRONNEMENTAUX EN EXPLOITATION (SECTION 10.4)

Suivis de la qualité de l'eau (section 10.4.1)

QC - 156. Le suivi du milieu proposé par le promoteur n'inclut pas le suivi de la qualité physico-chimique des sédiments. Le promoteur devra inclure un suivi de la qualité physico-chimique des sédiments, effectué trois ans après le début de l'exploitation et aux cinq ans par la suite, aux mêmes stations que celles établies pour la caractérisation initiale comme indiqué au chapitre 7 du *Guide de caractérisation physicochimique de l'état initial du milieu aquatique avant l'implantation d'un projet industriel*.

Suivis des eaux souterraines (section 10.4.2)

QC - 157. Le suivi de la qualité de l'eau souterraine devra être conforme aux exigences de la Directive 019 et devra également respecter les exigences des articles 4 et suivants du *Règlement sur la protection et la réhabilitation des terrains*. Le promoteur devra ajuster le suivi proposé en fonction de ces exigences, notamment pour la fréquence annuelle de l'échantillonnage.

Suivis de la qualité de l'air (section 10.4.5)

QC - 158. Le programme de suivi de la qualité de l'air auquel s'est engagé le promoteur devra être bonifié. Considérant que la modélisation de la dispersion atmosphérique a révélé des dépassements pour la silice cristalline, le promoteur devra inclure à son programme le suivi de la silice cristalline à proximité du relais routier du km 381. Ce suivi devra être mis en place dès le début du projet.

Suivis du milieu humain (section 10.4.6)

QC - 159. Plusieurs problématiques sociales et/ou de santé feront l'objet d'un suivi, notamment les problématiques associées à la consommation d'alcool et de drogues, la gestion de l'enrichissement, la sécurité des usagers de la route, etc. Le promoteur devra indiquer de quelle façon il entend travailler conjointement avec les services de santé régionaux, incluant le CCSSSBJ et d'autres partenaires, pour effectuer ces suivis dans les communautés où ces organismes œuvrent déjà. Il devra indiquer quels moyens sont envisagés pour mettre en œuvre cette collaboration.

QC - 160. À la section 10.4.6, le promoteur mentionne qu'un suivi des conditions socioéconomiques sera effectué pour différents aspects, notamment les programmes de formation, le nombre d'emplois occupés par des Cris à la mine, le type et la durée des emplois, etc. Selon le calendrier proposé, ce suivi sera effectué après dix ans d'exploitation. Ce suivi devra être réalisé annuellement et les données devront être incluses au rapport annuel.

Autres suivis (section 10.4.6)

QC - 161. L'ÉIE ne présente pas de programme d'inspection des infrastructures. Selon les exigences de la Directive 019, un programme d'inspection doit être mis en place afin de s'assurer de l'intégrité des infrastructures, notamment des digues ainsi que de tout autre élément ou composante pouvant entraîner des instabilités, des ruptures ou une mauvaise gestion des eaux de surface. Le promoteur devra s'engager à présenter un programme d'inspection afin de s'assurer de la pérennité des infrastructures. À titre indicatif, un tel programme devrait notamment inclure les éléments suivants :

- des visites de reconnaissance journalières consistant à faire une vérification visuelle sommaire de la ou des digues et de leurs principales composantes;
- des inspections sommaires consistant en un examen visuel plus détaillé de la ou des digues et de leurs principales composantes et pouvant comprendre au besoin la prise de mesures (arpentage, niveau piézométrique, etc.);
- des inspections détaillées sur une base annuelle consistant en un examen visuel détaillé et instrumenté des digues ainsi que chacune de leurs composantes. Ces inspections doivent être réalisées par une firme externe et indépendante.

QC - 162. Aucun suivi des conditions hydrologiques des plans d'eau et des cours d'eau affectés par les activités de la mine n'est présenté. Un suivi hydrologique permettrait pourtant de documenter les effets du projet sur le régime hydrologique dans la zone d'étude, de faciliter l'interprétation des données de suivi environnemental du milieu biophysique et de distinguer les effets directs du projet de ceux liés aux variations naturelles du milieu et de celles occasionnées par les changements climatiques. Le promoteur devra proposer un programme de suivi hydrologique. Il devra, entre autres, identifier les éléments d'information suivant : les objectifs, la méthodologie et les paramètres hydrologiques de suivi, la fréquence et la durée du suivi.

AUTRES CONSIDÉRATIONS

Étude de faisabilité

QC - 163. Dans la Directive datée de janvier 2018, il est demandé au promoteur de fournir une description du projet présentant ses principales caractéristiques techniques et économiques, telles qu'elles apparaissent à l'étude de faisabilité définie par l'Institut canadien des mines, de la métallurgie et du pétrole. Or, le promoteur donne l'impression de ne pas avoir complété l'étude de faisabilité pour son projet. Le document auquel le promoteur fait référence, le document de définition de projet (« Project Definition »; Primero, 2018), n'a pas été réalisé à l'égard d'une étude de faisabilité et ne permet pas de démontrer la viabilité économique du projet. Par ailleurs, les recommandations du dernier rapport technique de la propriété (2018) indiquent de « poursuivre l'évaluation du projet sous ses différents aspects, dont ingénierie et métallurgie, afin d'évaluer la viabilité du projet ». La viabilité économique n'ayant pas été démontrée, plusieurs modifications importantes pourraient encore être apportées au projet.

Le promoteur devra déposer l'étude de faisabilité du projet. Celle-ci devra permettre de s'assurer que le projet ne sera pas modifié de façon majeure au cours du processus d'évaluation environnementale et que les impacts analysés sont bien ceux ayant le potentiel de se produire.

Prise en compte des changements climatiques et des conditions climatiques extrêmes dans l'élaboration du projet et l'évaluation des impacts

QC - 164. L'étude d'impact présente des projections climatiques à l'horizon 2050, mais n'évalue que partiellement les effets possibles des changements climatiques sur le projet et sur le milieu d'implantation de ce dernier. Le promoteur devra évaluer l'ensemble des risques liés aux changements climatiques pour son projet et son milieu d'implantation. Il devra faire la démonstration que la conception des infrastructures prend en compte les conséquences occasionnées par le climat futur, même si cela implique d'aller au-delà des lois, règlements et codes applicables. De plus, les conditions météorologiques exceptionnelles seront plus fréquentes et plus intenses et le régime des précipitations sera différent en climat futur. Le promoteur devra démontrer que les infrastructures du projet seront appropriées dans ce contexte.

À titre de références, les conditions climatiques historiques et les projections climatiques publiées par le Consortium Ouranos sont une excellente référence en la matière. Le MERN a également publié un rapport, « *Analyse de risques et de vulnérabilités liés aux changements climatiques pour le secteur minier québécois* » (Bussières et al. 2017). Cette analyse traite spécifiquement du Québec et présente des précisions relatives aux régions nordiques incluant la Baie-James. Il en est de même pour le Guide de restauration minière du MERN qui traite le sujet dans la perspective des activités minières. Bien que ce guide concerne la phase de restauration minière, l'approche peut s'appliquer à toutes les phases de la mine, incluant l'exploitation. Plus récemment, le CCEBJ rendait public le rapport *État des connaissances relatives aux changements climatiques et à l'adaptation dans le territoire Eeyou Istchee Baie James*, réalisé en collaboration avec le consortium Ouranos (Hennigs et al., 2017). Le promoteur est invité à consulter ces documents pour détailler les considérations relatives aux changements climatiques.

L'ensemble des ouvrages nécessaires à la phase d'exploitation de la mine et tout particulièrement la conception et le choix des techniques de restauration des ouvrages qui resteront sur place après la fermeture de la mine doivent tenir compte des changements climatiques. Généralement, les éléments clés d'une démarche d'adaptation aux changements climatiques applicable au secteur minier incluent :

- la définition des impacts du climat actuel et l'évaluation des impacts du climat futur en considérant les différents scénarios climatiques;
- la connaissance de la vulnérabilité des infrastructures minières aux changements climatiques et l'identification des risques;
- la connaissance des solutions d'adaptation appropriées et leur application par le concepteur.

Pour l'ensemble des équipements et infrastructures nécessaires pendant la phase d'exploitation de la mine, le promoteur devra, sans s'y limiter :

- présenter les modèles utilisés dans les calculs et les prédictions. Il est suggéré de privilégier les scénarios d'émissions RCP « Representative Concentration Pathways » 8,5 et 4,5 (Moss et al., 2010) en s'assurant que les modèles choisis couvrent au moins la plage de sensibilité climatique (amplitude du signal de changement climatique) issue des modèles, allant de faible, moyenne et forte sensibilité climatique, couvrant ainsi au minimum l'enveloppe de l'incertitude des projections climatiques;
- identifier les infrastructures vulnérables aux impacts des changements climatiques, notamment celles qui sont reliées à la gestion des eaux et aux aires d'accumulation;
- identifier les risques qui ont été considérés et les mesures prévues pour limiter ces risques. Par exemple, le promoteur devra :
    - démontrer que la conception et les mesures de sécurité des infrastructures de gestion des eaux sont adaptées aux conditions induites par les projections climatiques;
    - démontrer que la capacité de traitement de l'UTE est adaptée aux conditions induites par les scénarios climatiques;
    - démontrer que le calcul du temps de remplissage de la fosse tient compte des scénarios climatiques futurs;
    - etc.

Puisque les principales vulnérabilités du secteur minier relatives aux changements climatiques se retrouvent au niveau de la restauration des sites, le plan de restauration devra tenir compte des changements climatiques. Le promoteur devra notamment se conformer aux exigences relatives à la prise en compte des changements climatiques détaillées dans le Guide de restauration minière du MERN et les préciser dans les réponses au présent document (ou indiquer où se retrouvent ces éléments dans son plan de restauration).

Afin de mieux estimer la prise en compte des changements climatiques dans son étude, le promoteur est invité à détailler les éléments mentionnés ci-haut et à traiter spécifiquement de cet aspect dans une section spécifique.

Engagements

QC - 165. Le promoteur devra fournir une liste récapitulative reprenant l'ensemble des mesures d'atténuation courantes, des mesures de compensation spécifiques, des engagements proposés par le promoteur de même que des engagements demandés dans le présent document.

ANNEXE I. PLAN PRÉLIMINAIRE DES MESURES D'URGENCE

QC - 166. Un plan préliminaire des mesures d'urgence est présenté à l'Annexe I de l'ÉIE. Ce plan devra être révisé périodiquement :

- les versions révisées du plan de mesures d'urgence devront inclure la gestion de sols contaminés;
- les versions révisées du plan de mesures d'urgence devront inclure la Sécurité civile du Québec au schéma d'alerte afin de tenir compte d'un incident ayant des impacts hors site. Le promoteur devra également ajouter au bottin des ressources externes de la page 43, les coordonnées du Centre des opérations gouvernementales du Québec (1 866 650-1666) qui permettent de joindre un intervenant de garde 24/7;
- les versions révisées du plan de mesures d'urgence devront inclure des mécanismes de coopération avec le CCSSSBJ pour les incidents entraînant un nombre élevé de victimes et pour les évacuations de patients, s'il y a lieu.

ÉTUDES SPÉCIALISÉES

ÉTUDE DE MODÉLISATION DE LA DISPERSION ATMOSPHÉRIQUE

QC - 167. Aux tableaux 2 et 3 de la section 3.3.1 et aux tableaux 5 et 6 de la section 3.3.2, seules les activités surlignées en caractère gras ont été modélisées. Les activités qui ne sont pas indiquées en caractère gras n'ont pas été incluses dans la modélisation. À titre d'exemple, au tableau 6 de la section 3.3.2, l'activité « Extraction de roche (carrière) » au cours de laquelle 453 399 tonnes seront manipulées n'a pas été considérée dans la modélisation. Le promoteur devra justifier, pour chaque activité qui n'est pas en caractère gras, pourquoi elle n'a pas été incluse dans la modélisation.

QC - 168. À la section 4.1.4, il est indiqué que les facteurs d'émissions proposés à la section 11.19.2 de l'AP-42 (Crushed Stone Processing and Pulverized Mineral Processing) ont été utilisés pour évaluer les émissions de particules du concasseur. Le promoteur réfère à la section 11.24 de l'AP-42 pour conclure que les émissions de particules produites par l'alimentation du concasseur et par le transfert des matériaux d'une unité à l'autre sont incluses dans ces facteurs d'émission. Le promoteur devra fournir des explications supplémentaires en ce qui concerne son interprétation de la section 11.24 de l'AP-42, car une interprétation différente peut en être faite.

De plus, un facteur d'émission est spécifié à la table 11.24-1 pour le transfert des matériaux (Material handling and transfert - all minerals except bauxite). Le promoteur devra justifier pourquoi ce facteur d'émission n'a pas été utilisé.

QC - 169. La section 6.2 présente les résultats pour le scénario d'exploitation. Le promoteur devra confirmer si les résultats présentés incluent les émissions provenant des deux scénarios présentés à la section 4, soit le scénario d'exploitation pour les activités de production et le scénario d'exploitation pour les activités d'agrandissement.

QC - 170. Le promoteur devra justifier pourquoi les résultats de concentrations de métaux et métalloïdes dans l'air ambiant pour la phase de construction ne sont pas présentés.

QC - 171. La section 7.2.2 cite l'étude de Golder Associates (2012) pour l'établissement de taux d'atténuation pour les sols gelés. Les résultats de cette étude ne peuvent être transposés à d'autres projets puisque les caractéristiques des résidus utilisés pour recouvrir les routes sont différentes d'un emplacement à l'autre. Il est considéré que, même en hiver, différentes matières seront déposées sur les segments routiers même si les sols sont gelés. Des particules seront alors remises en suspension lors du passage des véhicules miniers. Les atténuations obtenues de 94% et 96 % apparaissent élevées. Le promoteur devra commenter l'utilisation de tels taux d'atténuation pour les sols gelés.

QC - 172. À la section 7.2.3, il est mentionné que la filtration des émissions par la couverture du sol n'est actuellement pas supportée par les modèles de dispersion. Or, ces phénomènes physiques contribueraient à réduire de façon considérable les concentrations réelles de particules dans l'air, particulièrement par vent faible. À cet effet, une étude (Pace 2005) est citée où un taux de réduction pouvant atteindre 85 % est rapporté. Or, cette étude est antérieure au dernier document AP-42 (2011). Les facteurs tirés de l'AP-42 peuvent effectivement présenter une certaine incertitude sur les rejets de particules. Toutefois, un tel facteur ne peut être accepté sans étude spécifique au site.

QC - 173. Dans l'exemple de calcul C.1.3 pour les activités de chargement / déchargement, des taux d'émissions beaucoup plus élevés que ceux présentés sont obtenus. La valeur du tonnage journalier chargé / déchargé utilisée (21 144 ktm/jour) n'apparait pas réaliste. Le promoteur devra vérifier le calcul de ces taux d'émission et en faire état.

ÉTUDE SPÉCIALISÉE SUR LA TENEUR DE FOND NATURELLE DANS LES SOLS

QC - 174. Certains échantillons analysés (ex. TR-24-PM3, BH-31 SS-2 et BH-40 SS-3 A) associés à l'« unité stratigraphique » de sable fin correspondent plutôt à l'« unité stratigraphique » de sable graveleux. À l'inverse, certains échantillons analysés (ex. CE-TR3 PM2, CE-TR9 PM1 et CE-TR10 PM1) associés à l'« unité stratigraphique » de sable graveleux correspondent plutôt à l'« unité stratigraphique » de sable fin. Le promoteur devra clarifier la définition opérationnelle utilisée pour distinguer ces deux « unités stratigraphiques ».

QC - 175. Certains métaux analysés dans le sol y sont effectivement présents, mais leurs concentrations ne peuvent être comparées à aucun critère parce que ces critères sont inexistants. Des critères de comparaison devront être élaborés, notamment pour le lithium, le titane et le vanadium, en s'adressant auprès du secteur concerné du MELCC.

ÉTUDE SPÉCIALISÉE SUR L'HYDROGÉOLOGIE

Description du site / Modèle conceptuel (section 4)

QC - 176. Dans le secteur des futures haldes (entre les cours d'eau CE2 et CE3), les tests de perméabilité ont été réalisés en deux endroits seulement : BH-10A / BH-10B et WSP- MW8R / WSP-MW8S. Étant donné que cette superficie est de plus de 200 hectares, le nombre de tests de perméabilité n'est pas suffisant. Le nombre de tests de perméabilité doit être proportionnel à la superficie afin de bien couvrir l'ensemble de la surface où les futures haldes seront mises en place. Le promoteur devra compléter les tests de perméabilité et s'assurer d'avoir suffisamment de données terrain pour démontrer que la construction des haldes pourra respecter les exigences de la Directive 019.

QC - 177. La carte 6 montre que l'épaisseur d'argile à l'endroit de la future halde à stériles varie entre 0 et 6 mètres. Selon les informations présentées dans l'ÉIE, les stériles sont lixiviables et acidogènes et les résidus miniers sont lixiviables pour certains paramètres. Le promoteur devra, en se basant sur les données des travaux de terrain, délimiter les zones où des travaux d'imperméabilisation seront effectués afin de répondre aux objectifs de protection des eaux souterraines tels que demandé dans la Directive 019.

QC - 178. Selon le tableau 11, la conductivité hydraulique moyenne des dépôts argileux est de 9.96 x 10-10 m/s. Toutefois, la valeur indiquée à la section 4.3.3 pour ce même paramètre est de 3.16 x 10-10 m/s. Pour les dépôts sableux, la conductivité hydraulique moyenne indiquée au tableau 11 est de 9.61 x 10-6 m/s alors que la valeur indiquée à la section 4.5.1.1 pour ce même paramètre est de 6.07 x 10-5 m/s. Le promoteur devra expliquer ces différences.

QC - 179. À la page 15, il est indiqué qu'à l'intérieur de la zone modélisée, l'élévation varie entre 240 mètres et 381 mètres pour un dénivelé total de 140 mètres. Toutefois, les courbes topographiques de la carte 2 montrent des valeurs différentes. Le promoteur devra expliquer ces différences.

Construction et calibration du modèle d'écoulement (sections 6 et 7)

QC - 180. La carte 2 ne présente pas la limite de la zone modélisée. Le promoteur devra ajouter cette limite sur la carte.

QC - 181. La carte 3 montre la limite de la zone modélisée et les limites des cinq sous-bassins versants qui se trouvent à l'intérieur de la zone modélisée. Le promoteur devra justifier pourquoi la zone modélisée n'inclut pas l'ensemble des bassins versants. Il devra notamment expliquer pourquoi deux petites zones de la limite gauche du bassin versant 5 sont exclues de même que la partie nord du bassin versant 1.

QC - 182. En ce qui concerne la carte 8, le promoteur devra expliquer et/ou justifier les éléments suivants :

- la carte 8 montre qu'un même cours d'eau peut être représenté en partie par une condition limite de type charge imposée et en partie par une condition limite de type drain (ex. CE1, CE2, CE3 et CE5). Le promoteur devra expliquer en détail pourquoi ces charges ont été utilisées;
- justifier pourquoi la zone qui se trouve entre les cours d'eau CE2 et CE3 a été représentée par une condition limite de type drain;
- expliquer pourquoi la condition aux limites externes à l'endroit du Lac 1 a été représentée par une condition de type flux nul au lieu de charge imposée;
- expliquer pourquoi la condition aux limites externes au lac qui se trouve au coin sud du modèle a été représentée par une condition de type flux nul;
- justifier l'attribution de condition limite de type drain à la zone comprise entre le Lac Kachiskamikach et la limite externe du modèle (qui sont représentés par une condition limite de type charge imposée).

QC - 183. La carte 12 montre que tous les cours d'eau dans la zone modélisée représentent des zones de résurgence. Le promoteur devra expliquer comment un cours d'eau qui a été représenté par une condition de type charge imposée peut en même temps être une zone de résurgence.

QC - 184. L'étude ne présente aucun détail concernant le nombre des couches utilisées dans le modèle numérique, leurs épaisseurs et les conditions aux limites appliquées à ces couches. Le promoteur devra fournir ces informations sous la forme d'un texte et d'une figure en 3D qui démontrent la variation des épaisseurs de chaque couche en se basant sur les travaux de terrain réalisés sur le site.

QC - 185. Le promoteur devra fournir une carte de distribution de recharge pour la zone modélisée. Cette carte devra être accompagnée d'une explication sur la façon dont cette recharge a été estimée en se basant sur les valeurs de précipitation totale, d'évapotranspiration et des ruissellements.

Résultats des simulations numériques (section 8)

QC - 186. À partir de la superficie de la fosse estimée à 69,55 ha et une valeur moyenne de précipitations annuelles de 697,2 mm, le promoteur a évalué le volume d'eau journalier en provenance de la précipitation directe sur la fosse à environ 1 400 m^3/j. Ce volume d'eau ne tient pas compte des taux d'évaporation et de ruissellement. Le promoteur devra corriger la valeur du volume d'eau en conséquence.

QC - 187. Selon les valeurs présentées au tableau 8 de l'étude spécialisée sur l'hydrogéologie, la précipitation moyenne est de 683,9 mm/an. Toutefois, à la page 6-5 de l'étude d'impact, la valeur de précipitation est de 697,2 mm/an. Le promoteur devra adopter une seule valeur de précipitation et faire les corrections nécessaires.

ÉTUDE SPÉCIALISÉE SUR LA FLORE

QC - 188. Le guide *Identification et délimitation des milieux humides du Québec méridional* (Bazoge et al., 2014) préconise la mise en place de 3 parcelles d'inventaire par hectare pour les unités homogènes de végétation de moins de 10 ha. Pour les unités homogènes de plus de 10 ha, une stratégie d'échantillonnage adaptée peut être proposée. Dans l'étude spécialisée sur la flore, il est indiqué que le nombre et la répartition des parcelles ont été ajustés en fonction des observations terrain. Certains de ces ajustements se traduisent par un faible effort d'inventaire. Par exemple, la tourbière ouverte no 10, d'une superficie de 600 ha, compte 19 placettes d'inventaire, ce qui correspond à un ratio de 1 station d'inventaire par 31 ha. Un faible effort d'inventaire, surtout aux endroits où les infrastructures sont projetées, peut entraîner l'exclusion de certains éléments importants. Par exemple :

- aucune placette d'inventaire n'a été installée à l'ouest de la halde à stériles et au site du bassin de rétention d'eau principal. Même si une analyse stéréoscopique des photographies aériennes a été réalisée pour ce secteur, il s'agit de milieux qui seront complètement détruits;

- au sud de la fosse projetée, on retrouve peu de parcelles d'échantillonnage dans le polygone de l'arbustaie 03 qui a été classée comme milieu terrestre. Ce type de milieu compte des plantes dominantes hygrophiles et fait partie d'un secteur qui sera détruit par le projet.

Le promoteur devra justifier son effort d'échantillonnage surtout pour les secteurs où des infrastructures sont projetées. Le promoteur devra compléter les informations présentées pour ces secteurs. Il devra présenter une carte qui superpose la délimitation des milieux humides avec les infrastructures projetées.

QC - 189. À la section 3.1.1 de l'étude spécialisée sur la flore, les aulnaies sont classées comme milieu terrestre alors que ces groupements comptent des plantes dominantes hygrophiles. Le promoteur devra expliquer les raisons pour lesquelles toutes les arbustaies sont classées comme milieu terrestre plutôt que milieu humide.

QC - 190. La méthodologie utilisée pour déterminer les milieux humides et terrestres est généralement appropriée et se rapproche de celle préconisée par le MELCC. Toutefois, la section 2.3.2 indique « qu'en raison de la grande superficie de cette zone [d'inventaire], la ligne des hautes eaux des milieux humides n'a cependant pas été relevée sur l'ensemble de leur périmètre ». La ligne des hautes eaux est généralement utilisée pour identifier la limite du littoral d'un milieu hydrique. Par ailleurs, il est mentionné à la section 3.1.2 que « la photo-interprétation des tourbières minérotrophes ont contribué à délimiter le littoral des cours d'eau de la zone d'étude ». Le promoteur devra expliquer la méthodologie utilisée pour délimiter les milieux humides (surtout les milieux isolés).

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ACCÈS

Transports, Mobilité durable et Électrification des transports
Québec

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10.1 Introduction

La Loi sur la voirie (RLRQ, chapitre V-9) établit les responsabilités du ministre des Transports relativement aux routes dont la gestion lui incombe. Les articles 22 à 25 de cette loi portent plus spécialement sur les accès.

Ainsi, c'est le ministre qui autorise un nouvel accès à la route et qui en détermine la localisation et les exigences de construction afin qu'elle soit fonctionnelle et sécuritaire pour les usagers. L'autorisation doit être obtenue avant la construction de l'accès. Dans le cas contraire, le ministre peut exiger qu'un accès aménagé sans autorisation soit démoli.

Le ministre peut également interdire ou limiter l'accès à une route aux endroits qu'il détermine. Une servitude de non-accès acquise par le ministre ne peut être levée, diminuée ou rendue inopérante qu'avec le consentement du ministre et aux conditions qu'il détermine.

La présente norme s'applique aux entrées résidentielles, commerciales, industrielles et aux entrées d'entreprises agricoles, forestières ou d'élevage. Elle exclut les intersections de routes ou de rues.

10.2 Références

La présente norme renvoie à l'édition la plus récente des documents suivants :

NORMES

MINISTÈRE DES TRANSPORTS,
DE LA MOBILITÉ DURABLE ET DE
L'ÉLECTRIFICATION DES TRANSPORTS

Tome II – Construction routière.

Tome III – Ouvrages d'art.

Tome IV – Abords de route.

Tome VIII – Dispositifs de retenue.

AUTRES DOCUMENTS

Gouvernement du Québec

Loi sur la voirie (RLRQ, chapitre V-9).

MINISTÈRE DES TRANSPORTS,
DE LA MOBILITÉ DURABLE ET DE
L'ÉLECTRIFICATION DES TRANSPORTS

Manuel administratif.

10.3 Gestion des accès

Autoroutes

Les accès sont en tout temps interdits sur les autoroutes.

Nouvelles routes

Lors de la construction d'une nouvelle route, les entrées doivent être construites conformément aux présentes normes. Dans le cas des routes nationales et des nouveaux contournements de village, aucun accès n'est permis.

Cependant, une autorisation de passage (qui ne signifie en rien la levée de la servitude de non-accès) peut être accordée pour accéder à des terres agricoles.

Réfection de routes

Lors de travaux de reconstruction ou de drainage, les entrées existantes doivent être reconstruites selon les présentes normes.

10.4 Profils d'une entrée

Les entrées sont construites suivant les dessins normalisés 001 à 002 selon que la route est en remblai ou en déblai par rapport aux terrains adjacents. Toutes les entrées doivent être construites de façon à demeurer praticables et sécuritaires en toute saison.

L'aménagement de l'entrée en milieu rural ne doit pas permettre à l'eau de ruissellement provenant de celle-ci de s'écouler sur la chaussée, en raison des dangers qui peuvent en découler pour les usagers.

10.5 Catégories d'entrées

10.5.1 Entrée résidentielle

Cette entrée donne accès à la route pour une propriété d'au plus cinq logements.

Les types d'entrées résidentielles permises sont :

– l'entrée simple, qui permet l'accès d'un seul véhicule;
– l'entrée double, qui permet l'accès de deux véhicules côte à côte;
– l'entrée mitoyenne, qui permet l'accès à deux propriétés voisines.

10.5.1.1 Entrée résidentielle en milieu rural

Le tableau 10.5–1 donne la géométrie d'une entrée résidentielle en milieu rural à respecter en fonction de la classification fonctionnelle et du DJMA. Le choix de la géométrie se fait en fonction du critère le plus élevé des deux (DJMA et classification).

À noter qu'aucune entrée double n'est autorisée en milieu rural.

Tableau 10.5–1
Géométrie d'une entrée résidentielle en milieu rural

DJMA	Classification fonctionnelle	Géométrie de l'entrée	
		Largeur (1) (m)	Rayon (m)
> 5 000	Nationale(2)	6,0	6
< 5 000	Nationale(2)	6,0	4
< 3 000	Régionale	6,0	4
< 1 000	Collectrice et locale	6,0	2

1. Dans le cas d'une demande pour une entrée mitoyenne, la largeur totale est de 8 m.
2. Route nationale sans servitude de non-accès seulement.

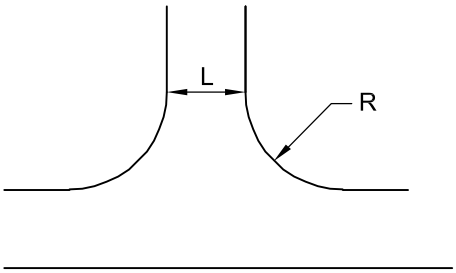
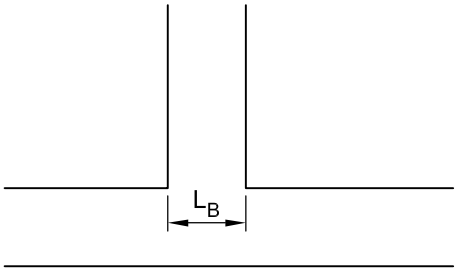


Tableau 10.5–2
Géométrie d'une entrée résidentielle en milieux urbain et périurbain

Vitesse affichée (km/h)	DJMA	Largeur de l'entrée à la bordure L_B	
		Simple (1) (m)	Double (m)
V ≤ 50	—	4,5	5,5
50 < V ≤ 70	< 10 000	5,5	6,5
50 < V ≤ 70	> 10 000	6,5	7,5
V > 70	—	6,5	sans objet

1. Si une demande est faite concernant une entrée mitoyenne, la largeur de celle-ci sera determinée par la largeur de l'entrée simple plus 2 m.



10.5.1.2 Entrée résidentielle en milieux urbain et périurbain

L'accès à la route est donné en abaissant la bordure ou le trottoir comme indiqué au dessin normalisé 002 selon la largeur donnée au tableau 10.5–2.

Le choix de la géométrie se fait en fonction du critère le plus élevé, soit la vitesse affichée ou le DJMA.

10.5.2 Entrée d'une entreprise agricole, forestière ou d'élevage

Cette entrée est utilisée par des véhicules de ferme, des camions lourds de service et d'utilitaires.

Les types d'entrées permises à ces entreprises sont :

– l'entrée simple, qui permet l'accès d'un seul véhicule;
– l'entrée mitoyenne, qui permet l'accès à deux propriétés voisines.

Deux types d'aménagements sont autorisés pour donner accès à la route à ces entreprises : l'entrée principale et l'entrée auxiliaire. Ces deux accès présentent les mêmes critères de conception.

L'entrée principale est un aménagement qui donne accès à la route à partir des terrains où sont localisés les bâtiments principaux d'une exploitation. L'entrée auxiliaire, quant à elle, donne accès à la route, à des lots de culture ou à des lots boisés ainsi qu'à des bâtiments secondaires. Elle est utilisée sur une base occasionnelle.

Telle qu'elle est montrée au dessin normalisé 003, la géométrie de l'entrée d'une entreprise agricole, forestière ou d'élevage permet aux véhicules de ne pas empiéter sur la voie opposée lors d'une manœuvre de virage. Un léger empiétement sur la voie opposée peut être accepté si la distance de visibilité à l'arrêt est conforme aux exigences du chapitre 7 « Distance de visibilité » du présent tome. La largeur de l'entrée est limitée à 8 m et le rayon des entrées doit permettre aux véhicules empruntant l'accès d'effectuer la manœuvre de virage.

La géométrie de l'entrée peut être modifiée pour des raisons de sécurité. Lorsque cela est réalisable, les entrées de chaque côté de la route doivent être localisées face à face.

10.5.3 Entrée commerciale

Cette entrée donne accès à la route à partir d'établissements institutionnels et de commerces.

Les types d'entrées commerciales permises sont :

– l'entrée simple, qui permet en même temps l'accès d'un véhicule et la sortie d'un autre;
– l'entrée mitoyenne, qui permet l'accès à deux propriétés voisines.

Ces commerces ou établissements institutionnels entraînent des mouvements d'entrée et de sortie à une fréquence plus élevée que les entrées résidentielles et requièrent donc un contrôle plus rigoureux de la géométrie de façon à assurer la sécurité des usagers.

Pour des propriétés voisines, il est souhaitable d'avoir une distance minimale de 12 m entre deux entrées simples en milieu urbain et de 20 m en milieu rural.

Les entrées commerciales se divisent en deux catégories : les petites surfaces et les grandes surfaces.

10.5.3.1 Entrée commerciale : commerce à petite surface

Ce type d'aménagement donne accès à la route à tout bâtiment de six logements et plus ou à tout autre bâtiment comportant une vocation commerciale, industrielle, institutionnelle, récréationnelle (petit camping, halte routière, kiosque touristique, etc.) ou de services d'urgence.

Ces aménagements diffèrent selon le milieu où ils sont localisés (urbain ou rural). Les dessins normalisés 005 à 012 montrent différentes possibilités d'aménagement.

Certains points sont à souligner :

– Un rayon de 25 m est autorisé pour l'une des entrées d'un commerce qui donne des services à une clientèle de véhicules lourds. Un seul rayon de 25 m est autorisé, et seulement là où le débit, la vitesse de circulation et la sécurité le justifient.
– Ce rayon de 25 m, comme tout autre rayon faisant partie de la géométrie d'une entrée, doit préférablement être tourné devant la propriété concernée et ne pas empiéter sur la façade de la propriété voisine. Cette limite des propriétés se situe perpendiculairement à la route au point de rencontre de la limite des propriétés et de l'emprise.

10.5.3.2 Entrée commerciale : commerce à grande surface

Ce type d'entrée est emprunté le plus souvent par des véhicules de promenade et dessert les grandes aires de stationnement : ciné-parcs, centres commerciaux, grands complexes domiciliaires, grands établissements institutionnels (hôpitaux, écoles, etc.) et grands terrains de camping.

Les dessins normalisés 013 et 014 montrent deux aménagements possibles en faisant varier le nombre de voies d'entrée ou de sortie.

10.5.4 Entrée industrielle

Cette entrée dessert tous genres d'industries engendrant une circulation de véhicules lourds (carrières, industries lourdes, entreprises de transport, entrepôts, etc.).

Une entrée industrielle doit pouvoir être utilisée par deux véhicules en même temps (entrée et sortie). Le véhicule type utilisé pour simuler les mouvements des virages doit être représentatif du plus gros véhicule susceptible d'emprunter l'entrée.

Les véhicules utilisant cette entrée ne doivent pas empiéter sur la voie en sens inverse sur la route principale.

Le dessin normalisé 015 montre ce type d'aménagement.

10.6 Restriction à la localisation des accès

Il est nécessaire, avant de répondre à une demande d'accès au réseau routier, de tenir compte de certains critères relatifs à la sécurité afin de délimiter les zones d'exclusion pour restreindre la localisation des accès. Les accès doivent être interdits aux endroits présentant des dangers dans une zone où ils affecteraient fortement les conditions existantes de circulation de la route ou dans une zone de conflits de circulation.

Les critères qui sont ici retenus ne sont pas les mêmes pour toutes les catégories d'entrées étant donné les fortes différences d'achalandage des entrées.

Les entrées auxiliaires d'entreprises agricoles, forestières ou d'élevage ne sont pas touchées par les limites fixées par la présente norme si leur utilisation est très occasionnelle et pour ne pas imposer une contrainte supplémentaire à l'exploitation des terres. Il demeure cependant nécessaire de tenir compte des critères de sécurité énumérés ci-après afin de limiter les situations dangereuses.

10.6.1 Localisation du non-accès

Toutes les règles relatives aux servitudes de non-accès doivent être respectées. Aucune entrée (y inclus les entrées auxiliaires d'une entreprise agricole, forestière ou d'élevage) ne sera autorisée dans les zones touchées par ces servitudes et décrites au chapitre 11 « Servitudes de non-accès » du présent tome.

Il est recommandé de suivre ces mêmes règles dans les cas de routes existantes où la servitude de non-accès n'a pas été officiellement acquise.

10.6.2 Entrée résidentielle et entrée principale d'une entreprise agricole, forestière ou d'élevage

10.6.2.1 Distance de visibilité

Aucun accès n'est autorisé si, de part et d'autre d'une entrée résidentielle, d'une entrée principale d'une entreprise agricole, forestière ou d'élevage, la distance de visibilité d'arrêt est inférieure à celle indiquée au tableau 10.6–1.

La distance de visibilité d'arrêt est mesurée le long de la route en utilisant les hauteurs d'objet et d'œil du conducteur données au chapitre 7 « Distance de visibilité » du présent tome.

10.6.2.2 Rayons de courbure

Aucune entrée résidentielle, entrée principale d'une entreprise agricole, forestière ou d'élevage n'est autorisée dans une courbe si le rayon de la courbe est inférieur au rayon minimal (fonction de la vitesse et du dévers), tel qu'il est défini au chapitre 6 « Tracés et profils » du présent tome.

Tableau 10.6–1
Distances de visibilité d'arrêt (entrée résidentielle et entrée principale d'une entreprise agricole, forestière ou d'élevage)

Vitesse de base (km/h)	Distance (m)
40	45
50	65
60	85
70	110
80	140
90	170
100	200

10.6.2.3 Pentes

Aucun accès n'est autorisé dans une pente si, de part et d'autre d'une entrée résidentielle, d'une entrée principale d'une entreprise agricole, forestière ou d'élevage, la distance de visibilité d'arrêt est inférieure à celle montrée au tableau 10.6–2.

10.6.3 Entrée d'un commerce à petite surface

10.6.3.1 Distance de visibilité

Aucun accès n'est autorisé si, de part et d'autre de l'entrée d'un commerce à petite surface, la distance de visibilité d'arrêt est inférieure à celle montrée au tableau 10.6–3.

La distance de visibilité d'arrêt est mesurée le long de la route en utilisant les hauteurs d'objet et d'œil du conducteur données au chapitre 7 « Distance de visibilité » du présent tome.

10.6.3.2 Rayons de courbure

Aucun accès à un commerce à petite surface n'est autorisé dans une courbe si le rayon de la courbe est inférieur à 1,5 fois le rayon minimal (fonction de la vitesse et du dévers), tel qu'il est décrit au chapitre 6 « Tracés et profils » du présent tome.

10.6.3.3 Pentes

Aucun accès n'est autorisé dans une pente si, de part et d'autre d'une entrée d'un commerce à petite surface, la distance de visibilité d'arrêt est inférieure à celle montrée au tableau 10.6–4.

Aucun accès n'est autorisé si la pente de la route est supérieure à 9 %.

Tableau 10.6–2
Distances de visibilité d'arrêt en fonction de la pente (entrée résidentielle et entrée principale d'une entreprise agricole, forestière ou d'élevage)

Vitesse de base (km/h)	Distance de visibilité à l'arrêt en fonction de la pente (m)					
	En montée			En descente		
	Pente < 3 %	3 % ≤ Pente < 6 %	6 % ≤ Pente < 9 %	Pente < 3 %	3 % ≤ Pente < 6 %	6 % ≤ Pente < 9 %
40	45	45	45	45	45	50
50	65	65	60	65	70	75
60	85	80	80	90	95	100
70	105	100	100	120	125	135
80	135	130	125	150	160	175
90	165	155	150	180	200	215
100	190	180	170	215	230	260

Tableau 10.6–3
Distances de visibilité d'arrêt (entrée d'un commerce à petite surface)

Vitesse de base (km/h)	Distance (m)
40	75
50	100
60	120
70	145
80	175
90	200
100	225

10.6.4 Entrée d'un commerce à grande surface ou entrée industrielle

10.6.4.1 Distance de visibilité

Aucun accès n'est autorisé si, de part et d'autre d'une entrée d'un commerce à grande surface ou d'une entrée industrielle, la distance de visibilité est inférieure à la distance de visibilité exigée aux carrefours plans, comme indiqué au chapitre 7 « Distance de visibilité » du présent tome.

La distance de visibilité nécessaire est déterminée en fonction de la vitesse de base de la route, du type de véhicule (P, SU, WB) et des valeurs de créneaux nécessaires pour effectuer les manœuvres permises à l'accès.

La distance de visibilité est mesurée en utilisant les hauteurs d'objet et d'œil du conducteur données au chapitre 7 « Distance de visibilité » du présent tome. Lors de la mesure de la distance de visibilité, la position de l'observateur doit être au minimum à 3,4 m par rapport à la ligne de rive, afin d'assurer un certain dégagement par rapport à celle-ci.

Dans le cas où la distance de visibilité nécessaire n'est pas disponible et que la vitesse affichée est supérieure à 70 km/h, la possibilité d'aménager une voie d'accélération devrait être analysée.

10.6.4.2 Rayons de courbure

Aucun accès à un commerce à grande surface ou accès industriel n'est autorisé dans une courbe si le rayon de la courbe est inférieur à 1,5 fois le rayon minimal (fonction de la vitesse et du dévers), tel qu'il est décrit au chapitre 6 « Tracés et profils » du présent tome.

Tableau 10.6–4
Distances de visibilité d'arrêt en fonction de la pente (entrée d'un commerce à petite surface)

Vitesse de base (km/h)	Distance de visibilité dans une pente (m)			
	En montée et jusqu'à une descente inférieure à 3 %	Descente de 3 % à 6 %	Descente de 6 % à 9 %	Descente supérieure à 9 %
40	75	80	80	Entrée interdite
50	100	105	110	
60	120	130	135	
70	145	160	170	
80	175	195	210	
90	200	230	245	
100	225	255	285	

10.6.4.3 Pentes

Pour les pentes supérieures à 3 %, la distance de visibilité nécessaire à une entrée d'un commerce à grande surface ou à une entrée industrielle doit être corrigée en fonction de la pente. La méthode de correction est présentée à la section portant sur la distance de visibilité aux carrefours plans du chapitre 7 « Distance de visibilité » du présent tome.

Aucun accès n'est autorisé si, de part et d'autre d'une entrée d'un commerce à grande surface ou d'une entrée industrielle, la distance de visibilité est inférieure à celle établie avec la méthode de correction pour la distance de visibilité aux carrefours plans. Aucun accès n'est autorisé si la pente de la route est supérieure à 9 %.

10.7 Notions générales relatives à l'autorisation d'un accès

10.7.1 Localisation d'un accès sur le lot

Avant d'autoriser un accès, il faut :

- *demander, lorsque le lot est contigu à plus d'un chemin public, que l'accès soit localisé sur la route de moindre classification ou de moindre importance;*
- *demander au propriétaire riverain qu'il aménage son accès pour que les véhicules puissent accéder en marche avant à des routes où la vitesse est élevée et à fort débit de circulation.*

Pour une entrée existante, il faut demander les modifications rendues nécessaires par tout changement de vocation.

10.7.2 Nombre d'accès par lot

Il faut réduire au minimum le nombre d'accès. Les besoins en desserte de la propriété riveraine ne doivent pas affecter sérieusement la fonction et les conditions d'utilisation de la route.

Cette limitation des points d'accès est en relation avec la largeur de la façade du lot. La restriction du nombre d'accès réduit le nombre d'aires conflictuelles et améliore les conditions des manœuvres de virage.

Enfin, précisons que deux ou plusieurs propriétaires riverains peuvent, par entente écrite, construire une entrée mitoyenne desservant leur propriété respective.

Cette entrée mitoyenne doit respecter les normes contenues dans le présent chapitre. Un permis d'accès doit être délivré à tous les propriétaires desservis par l'entrée mitoyenne. Ce permis doit souligner qu'il y a eu accord préalable de toutes les parties et que la desserte de leur propriété se fait par cette entrée.

10.7.3 Accès en marche avant

Afin d'assurer l'accès à la route en marche avant sur les routes à vitesse élevée et à fort débit de circulation, le Ministère peut autoriser la construction de différents types d'aménagements tels que l'entrée en U (voir figure 10.7–1) ou suggérer un aménagement en T (voir figure 10.7–2).

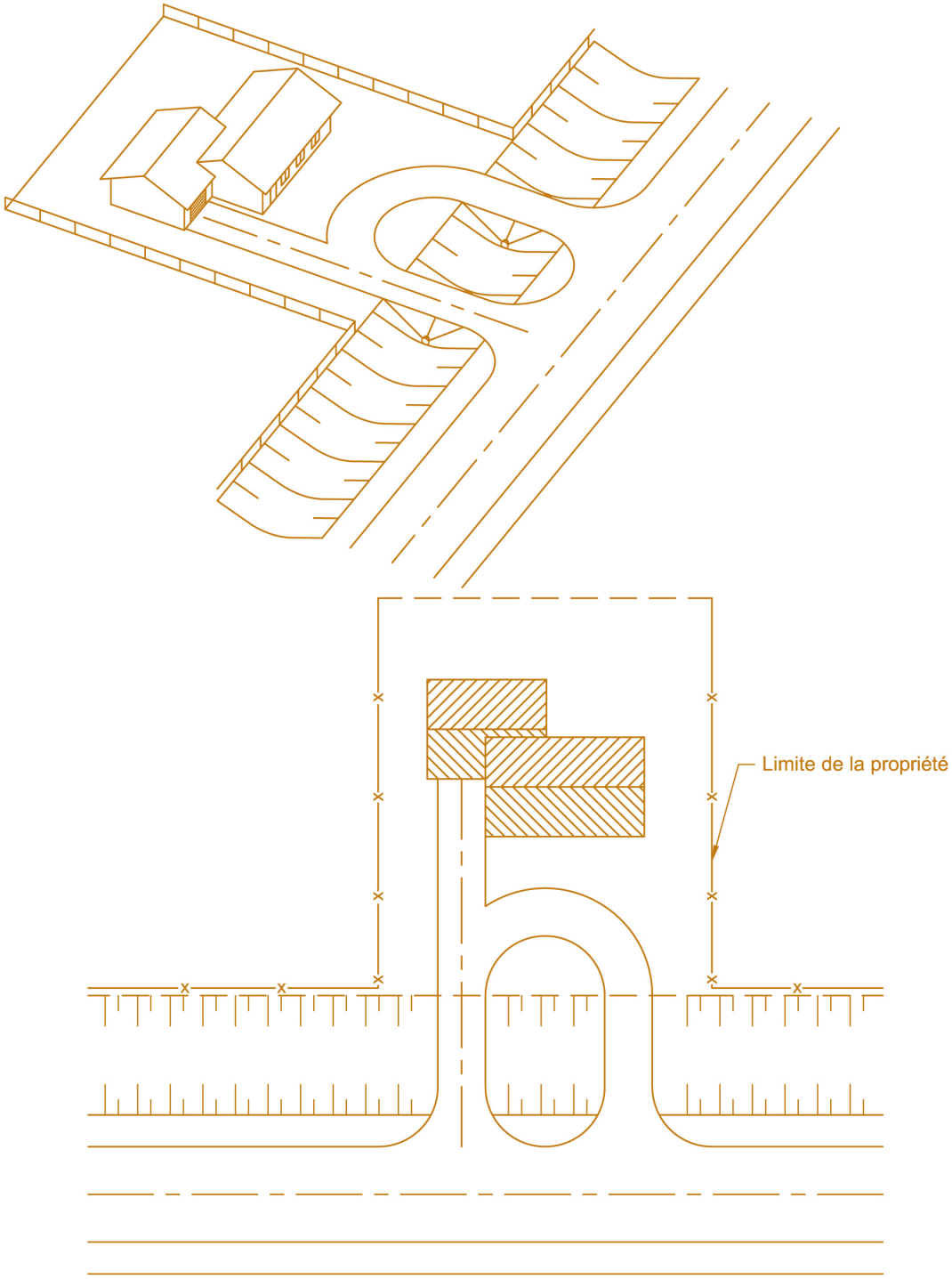


Figure 10.7–1
Entrée en U

ACCÈS

Transports Québec

NORME

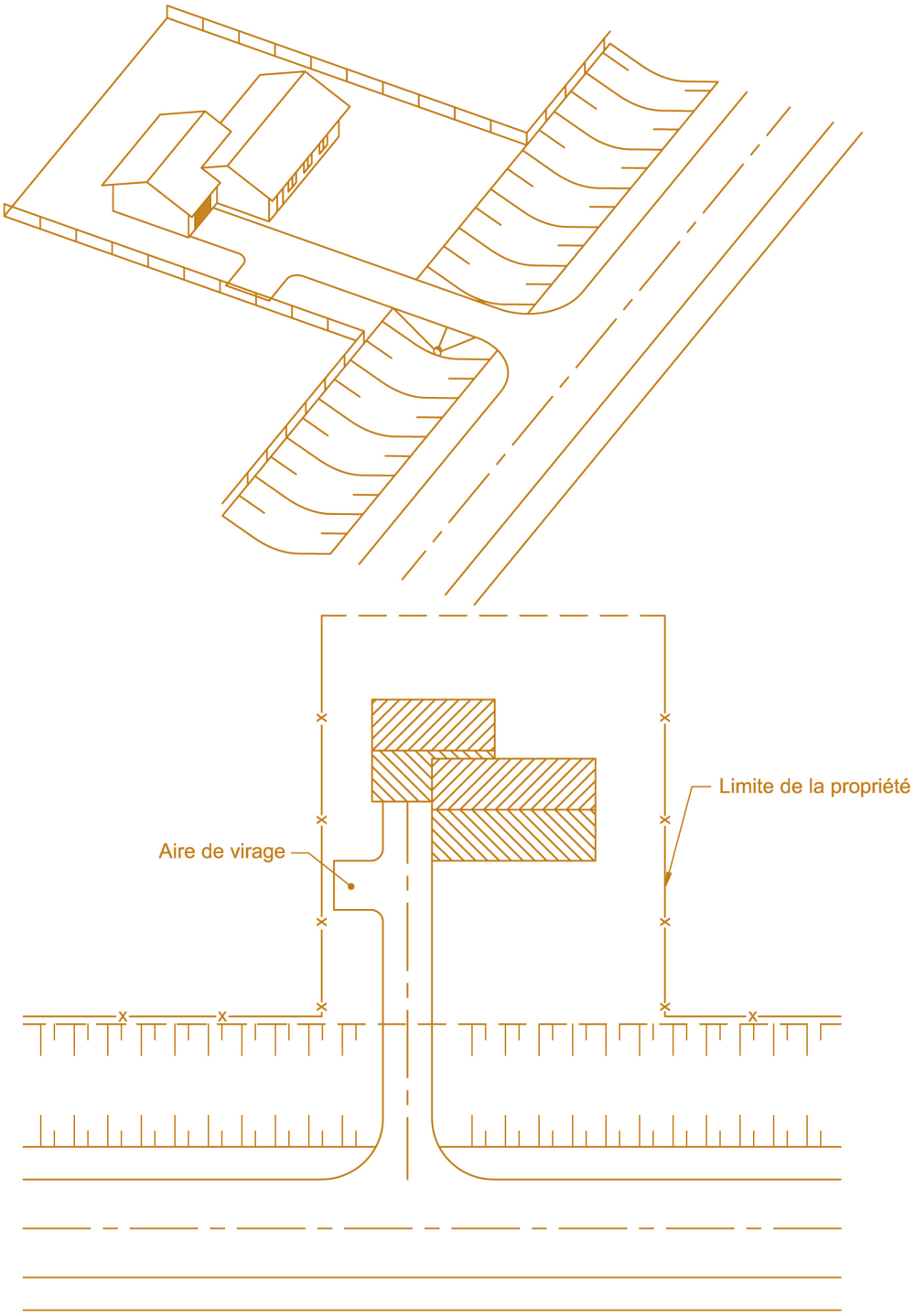


Figure 10.7–2
Entrée en T

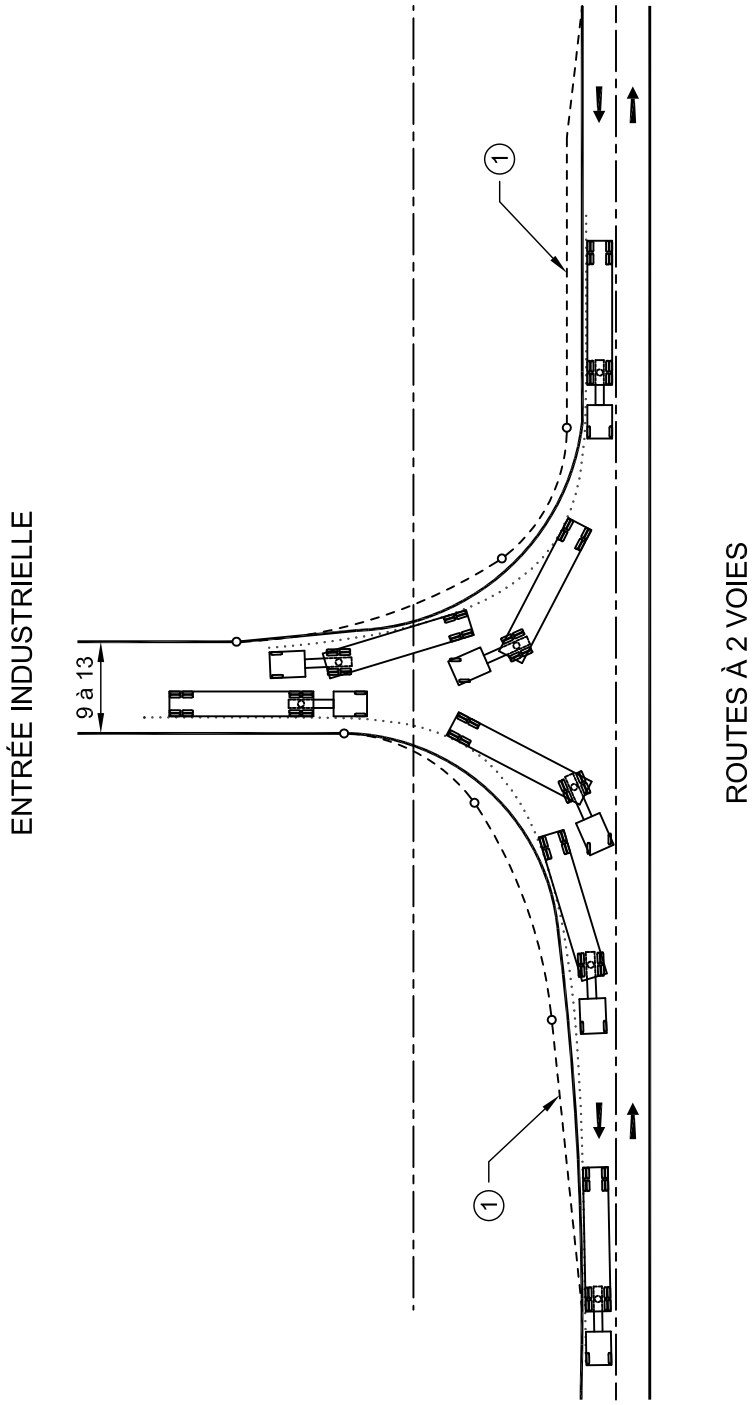
Transports Québec

NORME

DESSIN NORMALISÉ

ENTRÉE INDUSTRIELLE

Tome	Chapitre	Numéro	Date
I	10	015	2014 06 15



(1) Voir la figure 8.9–1 « Longueur de la voie de virage (droite ou gauche) », chapitre 8 « Carrefours plans » (si requis).

Notes :

- la largeur d'une entrée industrielle varie de 9 à 13 m. L'utilisation d'une largeur de 9 m requiert cependant des valeurs de rayon plus élevées;
- en milieu urbain, la conception de l'entrée est étudiée cas par cas;
- les cotes sont en mètres.

Contenu normatif

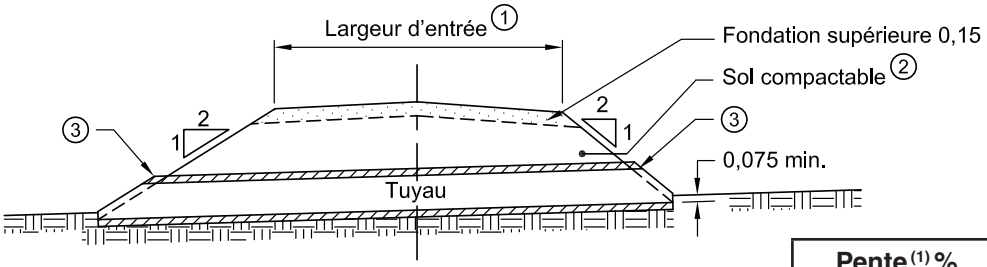
Transports, Mobilité durable et Électrification des transports
Québec

NORME

DESSIN NORMALISÉ

PROFIL D'UNE ENTRÉE EN MILIEU RURAL

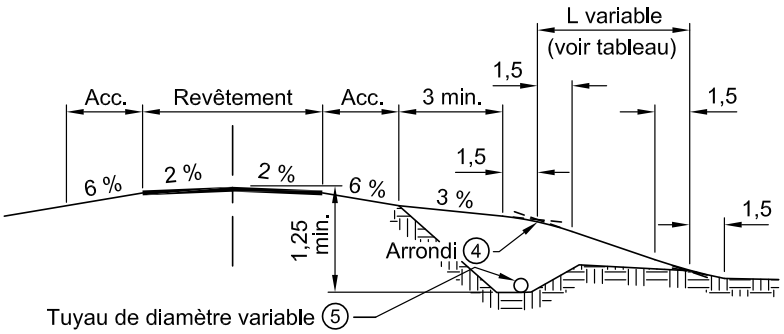
Tome	Chapitre	Numéro	Date
I	10	001	2018 06 15



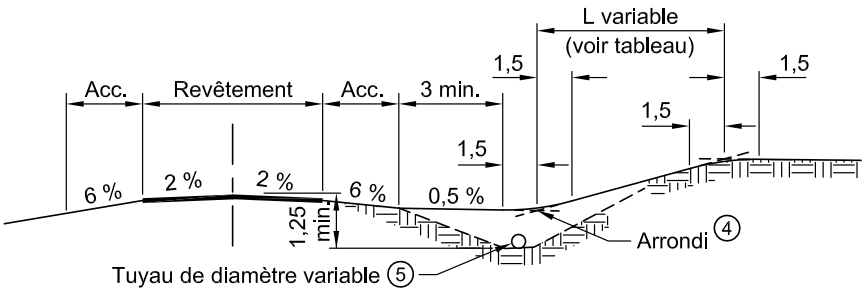
COUPE EN TRAVERS

Pente (1) %	L (m) max.
10	20
12,5	15
15	10
20	5

1. Dans le cas des entrées auxiliaires d'une entreprise agricole, forestière ou d'élevage, ces pentes et ces longueurs peuvent être augmentées pour tenir compte de leur usage occasionnel. Il faut prendre en considération le type de véhicule qui les emprunte (véhicules agricoles, etc.).



PROFIL EN LONG EN REMBLAI



PROFIL EN LONG EN DÉBLAI

① La largeur de l'entrée est fonction de son type (voir les dessins normalisées 003 à 008).

② Si les matériaux d'emprunt sont argileux ou imperméables, il faut assurer le drainage de la sous-fondation de la route jusqu'au fossé.

③ Les tuyaux situés à l'intérieur de la zone de dégagement latéral (*Tome VIII – Dispositifs de retenue*, chapitre 2 « Sécurisation des abords de route » tableau 2.3–2) doivent être biseautés en fonction de la pente du talus. Les tuyaux en béton armé, en tôle ondulée ou en polyéthylène (double paroi) doivent être munis d'extrémités biseautées préfabriquées afin que leur durabilité ne soit pas affectée *(Tome III – Ouvrages d'art, chapitre 4,* « Ponceaux »). Le revêtement de protection applicable selon le diamètre du tuyau d'entrée doit être conforme aux exigences du *Tome IV – Abords de route*, chapitre 8, « Revêtement de protection ».

④
- Pente souhaitable plus petite ou égale à 5 % (sinon voir le tableau).
- Lorsque cela est possible, la pente doit être plus petite ou égale à la pente existante.
- L'arc de cercle reliant le bord de l'accotement à celui de l'entrée doit avoir un rayon tel qu'il est prescrit en correspondant à l'entrée (voir les dessins normalisés 003 à 008).
- La directive concernant la construction des entrées d'une propriété est présentée dans le *Manuel administratif*.

⑤ Le diamètre du tuyau est de 0,45 m au minimum. Le type et la classe doivent respecter les exigences du *Tome III – Ouvrages d'art*, chapitre 4, « Ponceaux ».

Note :
- les cotes sont en mètres.

Contenu normatif

APPENDIX

A-11

ÉNERGIR'S PRESENTATION
"LNG FUEL FOR ROAD AND MINING TRUCKS – GALAXY LITHIUM"

LNG as fuel for road & mining trucks
-
Galaxy Lithium

David Ducasse, ing.
Nicolas Lapointe
Sébastien Lajoie, ing.

December 2018

Component 1: Road Transport – Galaxy Lithium

Assumptions provided by Galaxy:

- Mine located near KM 381 Road Relay
- Road transport of concentrate to Matagami (rail transfer)
- Total distance of 381 km
- Transport of 300,000 tons of concentrate per year between the mine and Matagami
- Number of convoys via trucks of 37.5 tons = 82,500 lbs:
  - → 24 deliveries (24 trucks) per day (337 working days)
- Start of operations in 2022
- **Period of commercial exploitation: 15 to 20 years**

Fuel consomption of trucks:

24 delivery / day @ (381 km @ 54L/100 km + 381 km @ 32L/100 km) x 337 days / year
= **2.7 M liters diesel / year**

Lifetime of truck ≈ 1.5M à 2.0M Km

Replacement cycle: 6 to 8 years

Component 1: Road Transport – Galaxy Lithium

Energir' s assumptions for the use of liquefied natural gas (LNG) as a fuel:

- Tractor truck + 2-axle trailer with 37.5 tons of load ≈ 110,000 pounds of total weight
- Natural gas tractor truck & engine:
  - **Engine: Cummins-Westport ISX12N:**
    - 11.9 Liters / 400 HP / 1450 lb*pi
    - Overdrive transmission & axles ratio
  - **2 x 60 DGE LNG tanks = 450 m3**
    - +1000 km range
  - **≈ 50K$ premium per truck (include grants from Quebec's ministry of transport)**
    - → **Diesel price at 1,10$/L**
      - (include road taxes)
    - → **LNG price at 0,61$/m3** (0,63$/DLE) **@ Matagami**
      - (price without fueling infrastructures)
    - → **Renewable LNG price at 0,81$/m3 @ Matagami**
      - (price without fueling infrastructures)
    - → **NG Engine relative efficiency compare to diesel: 0.78**
      - (efficiency ajusted for a 110K lb weight)

Comparative table of environmental impacts and fuel costs for diesel and natural gas engines

Moteurs:	Cummins ISX15	Cummins-Westport ISX12N	
Max power:	605 HP	400 HP	
Fuels:	100% Diesel	100% LNG	100% R-LNG
Engine relative efficiency vs diesel:	1,00	0,78	
Diesel volume (L):	2 700 000	-	
LNG volume (m3):	-	3 601 781	
Energy (MBTU)	92 156	118 149	
GHG emissions (Tons of CO_2 eq.):	7533	6804	40
GHG reduction vs Diesel:	- -	(729) -10%	(7 493) -99,5%
NOx emissions (g/hp*hr):	0,17	0,01	
NOx reduction vs diesel:	-	-94%	
Engine noise (dB):	107,5	102	
Noise reduction vs diesel:	-	-23%	
Diesel cost:	2 970 000 $	-	-
LNG cost:	-	2 189 163 $	2 909 519 $
Total fuel cost:	2 970 000 $	2 189 163 $	2 909 519 $
Fuel economy vs diesel:	-	(780 837 $) -26%	(60 481 $) -2%

Component 2: Mining trucks – Galaxy Lithium

Assumptions provided by Galaxy and Mining-Plus:

- 15 mining trucks
- 10.5 Millions liters of diesel / year

Assumptions proposed by Énergir:

- **GFS Corps** type LNG conversion system
- Diesel substitution rate between 35% - 50%
- 360 DGE LNG tanks per truck
- System price ≈ 350K USD

Total LNG consomption:

= **3.8 M à 5.4 M m3 / year**

→ **Diesel price at 0,95$/L**

→ **LNG price at 0,70$/m3** (0,73$/DLE) **@ KM 381**
(price without fueling infrastructures)

→ **Renewable LNG price at 0,90$/m3 @ KM 381**
(price without fueling infrastructures)

→ **Relative engine's efficiency compare to diesel: 1.00**

Comparative table of environmental impacts and fuel costs for diesel and natural gas engines

Moteurs:	CAT C15	GFS EVO_MT	
Max power:	515 HP	515 HP	
Fuels:	100% Diesel	35% LNG	35% R-LNG
		65% Diesel	
Engine relative efficiency vs diesel:	1,00	1,00	
Diesel volume (L):	10 500 000	6 825 000	
LNG volume (m3):	-	3 823 891	
Energy (MBTU)	358 386	358 386	
GHG emissions (Tons of CO_2 eq.):	29 295	26 265	19 084
GHG reduction vs Diesel:	-	(3 030)	(10 211)
	-	-10%	-35%
NOx emissions (g/hp*hr):	0,17	ND	
NOx reduction vs diesel:	-	-	
Engine noise (dB):	107,5	ND	
Noise reduction vs diesel:	-	-	
Diesel cost:	9 975 000 $	6 483 750 $	6 483 750 $
LNG cost:	-	2 677 489 $	3 442 267 $
Total fuel cost:	9 975 000 $	9 161 239 $	9 926 017 $
Fuel economy vs diesel:	-	(813 761 $)	(48 983 $)
		-27%	-2%

Refueling option 1: Road transport only

Énergir's LNG plant

LNG transfert

3.6M m3 LNG / y
1 loading
+ 1 delivery /
3 days

Transport over 730 km

Matagami

1 station: 16 000 gallons

CAPEX 1.5M $[1]
OPEX 25K$[1] / y

0,61$/m3 FAB[1]

Baie-James road
2x 381 km round trip

24 trucks with NG engine

CAPEX +1.2M $[1]
OPEX -781K $[1] / y

Galaxy

Note 1: Budgetairy price only. To be validatated with Énergir and/or other suppliers.

Refueling option 2: Road transport + mining trucks

Énergir's LNG plant

LNG transfert

7.4M m3 LNG / y
2 loading
+ 2 delivery /
3 days

Transport over 730 km

0,61$/m3 FAB[1]

Transport over 1100 km

Matagami

1 station: 16 000 gallons

CAPEX 1.5M $[1]
OPEX 25K$[1] / y

Baie-James road
2x 381 km round trip

24 trucks with NG engine

CAPEX +1.2M $[1]
OPEX -781K $[1] / y

0,70$/m3 FAB[1]

Galaxy

1 station: 16 000 gallons

CAPEX 1.5M $[1]
OPEX 25K$[1] / y

15 Dual-fuel trucks
360 gallons

CAPEX 5.25M $US[1]
OPEX -814K $[1] / y

Note 1: Budgetairy price only. To be validatated with Énergir and/or other suppliers.

APPENDIX

A-12

LETTER FROM TUGLIQ ENERGY CO.

TUGLIQ Energy Co.
2060 De la Montagne, Suite 401
Montréal, (Québec)
Canada, H3G 1Z7

April 14th, 2018

Power Supply of the James Bay Mine

To: Gail Amyot
Director of Health, Safety and Environment
Galaxy Resources Limited

TUGLIQ performed a high-level assessment of different sources of energy to supply the Galaxy Resources Limited's James Bay mine. Wind and solar energy were compared to connecting on the Hydro Québec's grid.

The average wind speed in the area ranges from 7 to 7.5 m/s. It is considered a good resource and it is economically viable when compared to building new generating asset from other sources. It cannot be considered a source of firm power.

The solar irradiance ranges between 1100 to 1200 kWh/m^2 in the area. It is considered a poor to average resource and is not economical when compared to building new generating assets from other sources. It cannot be considered a source of firm power.

The nearby grid connection is in the vicinity of the mine. Large hydroelectricity dams nearby are operated by Hydro Quebec. Industrial tariffs are very attractive in the Quebec province and this is considered an economical option when compared to building new generating asset from other sources. It can be considered a source of firm power.

With a Life of Mine expected between 15 and 20 years, preliminary results concluded that connecting the mine to the nearby grid is the preferred solution, delivering the lowest cost of energy to the mine.

We remain at your disposal for any additional enquiries

Best Regards,

Nicolas Seguin
Director of Business Development and Projects

Mobile : +1 514-216-5546
Email : nseguin@tugliq.com

APPENDIX

A-13

ELECTRIC VS DIESEL EQUIPMENT TRADE-OFF STUDY

MINING PLUS

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Memorandum

To: Luc Coussement, James McCann

From: Amanda Fitch, Andy Chan

Date: January 19, 2018

Subject: Electric vs Diesel Equipment Trade-off Study

Introduction

The deposit for James Bay is considered a smaller scale mine, with an estimated 2million tonnes of ROM material moved per annum. The deposit consists of several swarms of pegmatite dykes' with dips ranging between 55 and 65 degrees with an average lens length varying from 100-250m long and a height ranging from 100-400m with the average approximately 200m. Thicknesses of the dykes ranges from 17-40m with the majority of the tonnage contained in lenses greater than 25m thick.

Loader selection was considered for shovels with bucket widths between 2 – 3m to minimize on dilution and ore loss. Buckets capacities between 6 – 11m^3 generally meet production and width requirements.

Trucks were evaluated based on a 3 to 5 pass match with the shovel generally resulting haul trucks with capacities between 60 to 100 tonnes. The movement matching (for required production rates), helps in minimizing the capital cost of the project, and optimizes utilization.

This study will evaluate electric and diesel options for primary equipment with the following capacities:

- 60 - 100t haul truck
- 6 - 11m^3 bucket hydraulic mining shovel
- 50t articulated truck
- 5m^3 bucket excavator
- 152 mm DTH drill

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Trucks

Options for electric haul trucks are not currently available, however, Kuhn, a European Komatsu distributor, has collaborated with Swiss company Lithium Storage Gmbh to test a battery-powered truck. Tests revolve around a 65 tonne haul truck in a quarry located in Switzerland and operated by Ciments Vigier. Based on the existing prototype, it costs $1 million to convert a diesel truck to a 600kWh Lithium-ion battery powered truck.

Haul trucks with electric drives were considered but only offered for larger capacity trucks of 200 tonnes and higher.

Trolley-assisted systems were explored; such systems involve a haul truck equipped with a structure to receive power from an overhead electrical line. The diesel engine idles while the electric drives are powered by the overhead lines. Trolley-assist systems are installed on ramps as fuel burn rates are highest as a truck is loaded and hauling up gradient. Economics of the system are ideally intended for large scale, deep open pit operations and not applicable for the scale of this project. The system will be not be feasible for the cold weather conditions on site; issues such as icing of power lines will result in power line failure.

Shovels

In the spring of 2016 Hitachi announced 6 tethered electric hydraulic shovels. The EX 1900 E-6 was considered as it offers bucket capacities between 4 – 11m^3 for backhoe configuration and 8.8 – 12 m^3 for shovel configuration with a rated power of 610kW. Upon inquiry, MP was informed that the economics of the smaller electrified shovels are not favourable to the diesel counterpart. As a

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result Hitachi has discontinued the EX1900E-6 and EX2600E-6. Currently the smallest tethered electric shovel offered is the EX3600E-6 with a 22m^3 bucket size.

It was thought that Caterpillar and Komatsu offered tethered electric alternatives to their hydraulic shovels. Caterpillar offers the CAT 6018AC with buckets ranging between 6.6 to 10 m^3 in backhoe and front shovel configuration with 650kW rated power. From further investigation, Caterpillar no longer offers the model. The smallest electric shovel available, CAT 6030 (16.5 m^3 bucket size), was outside of the ideal bucket capacity for this study.

The smallest tethered electric hydraulic shovel offered by Komatsu, the PC3000-6, was considered a possibility, as a 10 m^3 bucket is offered over the 15m^3 nominal bucket. P&H (a subsidiary of Komatsu) offers the 1900AL electric rope shovels providing dipper sizes (7.5 – 10.7m^3) required for the study. Speaking with a local Komatsu dealer, the shovel is not offered in North America as it does not meet safety regulations and therefore is restricted from being imported.

P&H also offers the 2650 hybrid rope shovel which provides switch reluctance technology to capture regenerative power during braking. The shovel claims to reduce fuel consumption by 25% with an overall 10-15% reduction in ownership costs (compared to hydraulic excavators). However the smallest bucket size offered (27.1m^3) was considered too large.

Drilling

Electric trailing cable blasthole drills were considered and looked into from various equipment suppliers. However only drills with capabilities of drilling 229 - 444mm sized diameter holes offered this option. Based on an estimated powder factor of 0.38 required to blast pegmatite material along with hole spacing and burden of 5m and 4.2m respectively a 152mm hole diameter was deems appropriate to achieve the required results.

Equipment Availability

As discussed in the previous sections, electric equipment was not available for the required equipment sizes for the scope of this study.

Electricity in Northern Quebec

Hydro Quebec has a 450-kV direct-current line running near the James Bay property along with another 735-kV line running parallel. Two hydro stations rated 245MW or more are located in Eastmain (Eastmain-1, Eastmain-1-A). Two substations exist approximately 100 – 150 km from the Eastmain hydro stations. (Source: 2016 Annual Report).

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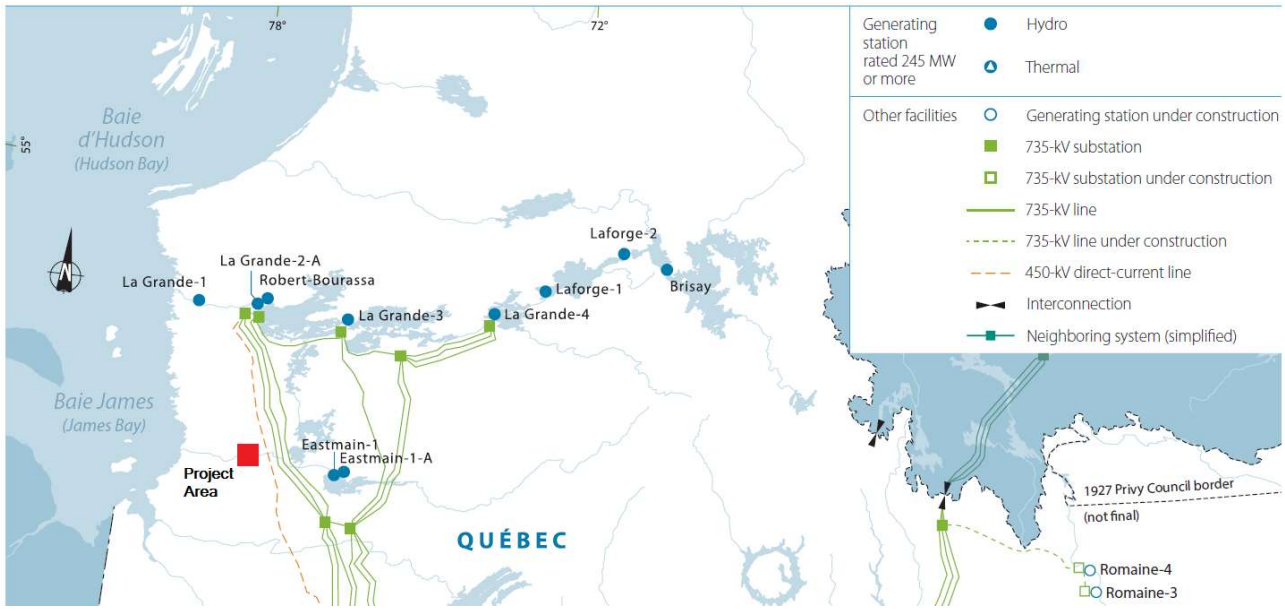
Power line extensions were considered for 69kV, 120kV and 315kV voltages. The current selection is the 69kV line which will extend 7km south of the processing plant with a capacity of 8-10 MVA. Consumption is estimated at 5MVA from the process plant, a total consumption of 8MVA is anticipated after support equipment is accounted for. The timeline for construction of the power line is anticipated to be completed within 2 years and will require a substation upgrade. If required, an upgrade to 315kV line will cost an estimated $45 million, three times the cost of the 69kV line and require a construction duration of 4 years.

Hydro Quebec generates an excess of power than being consumed and is a motivated seller. Discussions can be held Power extensions could be potentially subsidized. Power costs in Quebec are the lowest in America at 4.75 cents/kWh.



Benchmark Studies

The majority of electric mining equipment presently exists only for underground purposes for cost reductions in ventilation and savings from increasing diesel costs.

The Lac a Paul project is an open pit phosphate project located Saguenay-Lac-Saint-Jean region of northern Quebec utilizes electric shovel equipment. The scale of the mining project is considered larger in scale compared to the James Bay project. On average the mine is projected to move approximately 37 million tonnes (waste and ore), with certain years peaking between 60 – 90 million tonnes. The 2013 Feasibility Study the mine has electric hydraulic excavators (Komatsu PC

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5500-6 with 28 m^3 bucket capacity) paired with CAT 793F, 226t diesel trucks. The Study indicates that the option to use electric drills (203.2mm) are still being considered but not chosen for that study.

Cost Comparison

A high level cost assessment was conducted to compare capital and operating costs between utilizing the smallest available electric shovel over the more compatible diesel counterpart.

The Komatsu PC 3000, a 250-260 tonne shovel with a 10m^3 bucket, was selected for the comparison as the electric shovel. The Komatsu PC-1250, a 100 tonne shovel with a 5.75 m^3 bucket, was selected as the better suited diesel counterpart. Costs considered for this comparison will only be differences in initial capital and energy consumption. Maintenance costs were not considered along with additional costs required for an electrified equipment (i.e. in-pit power lines, cable handing costs, etc.).

The comparison is based on a preliminary mine plan which estimates a required 288,000 operating shovel hours for the PC 1250 and 166,000 hours for the PC3000 over a 20 year mine life. It is assumed that the shovels will be purchased over a span of the three years from the start of the mine. The following table summarizes the parameters and results from the assessment.

Results from the assessment generally show unfavourable for electrified equipment. Overall there is minimal undiscounted net gain for electrified equipment with a long payback period. The energy savings will likely be diminished once additional capital and operating costs required to install and maintaining additional power line & cable infrastructure.

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Summary of Cost Benefit Comparison		
Category	**Units**	**Value**
Parameters		
Life of Mine	**Years**	**20**
Operating Hours		
PC 1250 - Diesel	Hours	288,000
PC 3000 - Electric	Hours	166,000
Purchased Shovels		
PC 1250 - Diesel	-	5
PC 3000 - Electric	-	3
Operating Costs		
Energy Costs		
Fuel	$/l	0.95
Electricity	$/kWh	0.0475
Fuel	$	21,500,000
Electric	$	7,000,000
Energy Savings	**$**	**14,500,000**
Capital Costs		
Diesel	$	5,900,000
Electric	$	18,000,000
Increased Capital Cost (Diesel to Electric)	**$**	**12,100,000**

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Pros & Cons

Disadvantages

One of the main disadvantages with tethered electric equipment is limited mobility and longer tramming times with the trailing cable. Considerations of additional capital costs should be accounted for including:

- Power line infrastructure (including cable poles)
- Cable Handlers
- Transformers
- Replacement of damaged cables from rocks, equipment, cable stresses, and normal wear
- Additional support equipment required for powerline moves

Operational disadvantages that arise from tethered electric equipment should be factored including:

- Additional worker hazard that occurs from cable moves
- Cable poles carry a risk of top fires from excessive dusty or may fail due to icing from wet snow from cold weather.
- The frequency of power line relocations and cable handling provides additional level of complexity for operational planning
- Limitations in cable ranges will require additional

Availability of electric equipment and support should also be considered

- Longer lead times are required deliver of tethered electric shovels. Suppliers generally require a 12 – 15 month window for delivery.
- The local labour forces needs to be assessed to ensure that suitable crafts and trades personnel are available

Advantages

Advantages to having an electric shovel include costs savings from the elimination of engine related consumables (i.e. engine oil, filters, coolant/fan belts, air filters, radiators and mufflers).

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Electricity costs within Quebec are considered to be one of the lowest within North America. Hydro Quebec is a motivated seller and may provide subsidies for power line infrastructure extensions.

Natural Resources Canada provides incentives through the Clean Energy Innovation Program to reduce diesel consumption for industrial operators in remote northern communities. Use of electric equipment may help obtain project support from the government and local communities.

Considerations

The equipment being considered are vital towards for mine production. If electrified equipment is considered there will be heavy reliance on the robustness of the power grid. A power study should be conducted modelling power consumption ensuring any restarts with electric equipment or processing plant will not overload and trip out the system. Flywheel/transistor banks can be considered to provide surge power for equipment start-ups or employing soft start technology within electrical equipment.

If electrified equipment is utilized, plan should be to ensure adequate backup generators, and/or secondary diesel equipment are present to reduce or mitigate the effects of a power outage.

Conclusions

In the current market, there is limited choice for electrified equipment in open pit mining of this size and production. Most electrified equipment is offered only for underground equipment as it offers favourable economics (i.e. reduced ventilation costs). Battery powered trucks are not offered for open pit while tethered electric drills and shovels were available only as larger-sized equipment. Smaller sized electric equipment have been discontinued or discouraged by the suppliers due to unfavourable economics when compared to the diesel counterpart. Therefore it is concluded, based on the scale of the James Bay, the use of electrified equipment is not compatible for the project.

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Memorandum

To: Denis Couture, Galaxy Lithium Canada Inc.

Cc:

From: Joanne Robinson, Neda Farmer

Date: December 12, 2018

Subject: LNG Trade-Off Analysis – Final

Reference: CCGALJ22 - 5147: James Bay FS-Variation #6 Mining Trade-off Studies

---

Galaxy Lithium Canada Inc. (Galaxy) is a wholly owned subsidiary of Galaxy Resources Limited (Galaxy Resources), a company listed on the Australian Securities Exchange (ASX). Galaxy has retained the services of Mining Plus (MP) to prepare a high-level trade-off study on the use of Liquefied Natural Gas (LNG) as a fuel source for haul trucks for the James Bay Lithium Mine Project.

Mining Plus completed a feasibility level open pit mine design and life-of-mine (LOM) plan in May 2018. The LOM plan targets an annual concentrator feed rate of 2 Mtpa over an approximate 16 year mine life. Equipment selection for the open pit included a 140 tonne hydraulic excavator (backhoe) with a 7m^3 bucket capacity (example model is CAT6015), loading a 61.5 tonne rigid frame haul truck (example model is CAT775). Caterpillar (CAT) equipment specifications have been used in this study however this does not preclude other equivalent equipment suppliers from being utilized.

The mine plan presented a large haulage requirement, with annual haulage unit costs ranging from an estimated $2.11/t to $4.17/t and averaging $2.48/t over the LOM. The haulage component accounted for approximately 53% of the mine operating costs. Diesel fuel costs were estimated at 22% of the haulage expense and averaged over the LOM, 4 million litres of diesel fuel per annum. As a result, Galaxy is investigating options that may improve the haulage economics.

The marketed benefits for displacing diesel fuel with natural gas is lower fuel costs and reduction in greenhouse gases (GHG) and air pollutants (NOx, SOx, PM, HC and CO). The current challenge is gaining access to reliable and proven technology for LNG use in mine haul trucks, as well as establishing the required related infrastructure to secure and use natural gas at open pit mine sites.

An internet search indicates that existing and emerging technologies for natural gas use in mine haul trucks exists today. Existing opportunities are limited mainly to LNG-diesel dual fuel EVO-MT System conversion provided by GFS Corp., an after-market supplier, for a range of Komatsu and Caterpillar models.

OEMs

Original Equipment Manufacturers (OEMs), like Caterpillar and Komatsu to name two, do not currently have any LNG fuel based haul trucks on the market.

In November 2017, Caterpillar announced that it will be offering its dynamic gas blending retrofit kit for the CAT785C mining truck. Cat Dynamic Gas Blending (DGB) technology allows engines to run on both diesel and LNG. DGB lowers fuel cost while maintaining diesel power and transient performance. The 785C Retrofit Kit is the first DGB system Caterpillar has offered for mining machines, and it was available for purchase in January 2018 from the global Cat dealer network. Caterpillar plans to offer additional DGB systems in the future.

After-market Conversion Kits

GFS Corp, based in Florida USA, produces the EVO-MT[R] System comprised of various components and assemblies that are retrofitted into the haul truck's engine bay, chassis and operator cabin. The installation of the EVO-MT System is performed after-market without significant modification to the vehicle or engine. After the EVO-MT System has been installed, the truck can be operated on either 100% diesel fuel or on a combination of diesel fuel and LNG.

According to the GFS Corp website, GFS Corp currently offers retrofit systems for Caterpillar 777 (B, C, and D), 785 (B, C, and D), 793 (B, C, and D) trucks and 992 (G and K) wheel loaders, as well as Komatsu 830DC, AC, and 930E trucks, and Terex Unit Rig 4400 (now CAT MT4400D AC) truck.

These trucks are all larger capacity than what is sized for the James Bay project.

The after-market conversion kits appear to be not supported by OEM's and may invalidate warranties.

Teck Resources LNG Pilot Project

In 2015, Teck Resources embarked on a pilot project of testing LNG as a fuel for haul trucks. The pilot marked the first use of LNG as a haul truck fuel at a Canadian mine site. The pilot project involved replacing full diesel usage with a diesel/ LNG blend on four Komatsu 830E and two 930E haul trucks at their Fording River coal mine by retrofitting the trucks with the GFS Corp conversion kits which were mounted externally to the engines.

FortisBC was a key partner in their project, transporting and supplying LNG to the mine site and providing financial support towards upgrading the truck maintenance shop, and supporting the implementation of the comprehensive safety program developed by Fording River Operations.

The pilot results remain confidential and proprietary. However, according to public statements and sources, the pilot project was ended in 2016. It was cited that the particular LNG technology used in the pilot did not achieve the targeted emission reductions.

Analysis

Based on information from Ferus Natural Gas Fuels

Contact was made with Ferus Natural Gas Fuels ("Ferus"), who also participated in the study of natural gas for haul trucks for Teck, to provide indicative pricing for this study. Ferus provided the estimated delivered price for LNG in Table 1 below. It cost approximately $0.75/diesel liter equivalent ("DLE") to have LNG on site for the James Bay Project.

Table 1 Estimated Cost of LNG on site

ITEM	COST ($/ DLE)
Liquefaction	0.32
Transportation	0.27
Natural gas commodity price	0.16
Estimated delivered price	**0.75**

Table 1 is based on the following:

- Price of natural gas as of October 2018
- 3rd party supplier of liquefaction, and
- Transport distance of 500 kilometers from natural gas source

Ferus also provided an estimated capital cost for converting the haul truck fleet and providing facilities to receive and dispense LNG on site which is summarized in Table 2. For truck conversions, 15 haul trucks were used over the life of the mine.

Table 2 Estimated Capital Cost for Converting Truck Fleet

ITEM	UNIT PRICE (CA$)	FLEET COST (CA$)
Truck Conversions	200,000	3,000,000
Mobile LNG Truck	500,000	500,000
Fixed LNG fueling Island	1,500,000	1,500,000
Total		**5,000,000**

Based on a delivered diesel price of $0.95/DLE, the annual fuel savings at the mine site would be $400,000. This saving is based on a fleet of 15 trucks with a substitution rate of 50% diesel substitution and a total annual diesel requirement of 4 million liters/year.

It would take approximately 12.5 years to pay off the capital outlay and the project would have an NPV(10%) of -$2.5 million.

Based on information from Energir

We have reached out and made contact with Energir (previously GazMetro). In April 2017, Energir announced that new liquefied natural gas (LNG) production capacity was now available at the Gaz Métro liquefaction plant located in Montréal.

The information supplied by Energir for the mining trucks, is available in Appendix A and summarized below.

Table 3 provides the estimated annual consumption and costs for 15 mining trucks.

Table 3 Annual Diesel Consumption and Cost

ITEM	VALUE
Diesel Consumption	4,000,000 L
Diesel Supply and Transport Costs*	$3,800,000

** using a price of $0.95 per liter for diesel*

Table 4 summarizes the same operating cost for 15 mining trucks after they have been converted to LNG.

Table 4 Annual LNG Consumption and Cost

ITEM	VALUE
Diesel supply and transport costs*	$2,470,000
LNG Supply and transport costs	$1,020,000
LNG Storage and dispensing costs	$25,000
Total	**$3,515,000**

Table 4 is based on the following:

- Efficiency Factor or Substitution amount :35%
- Fuel Consumption: 2,600,000 liters diesel/yr
- LNG Consumption: 1,400,000 m^3
- Diesel Price supply and delivery cost: 0.95 $/L
- LNG fuel supply and delivery cost: 0.61 $/$m^3$

Table 5 below summarizes the operating cost savings when using LNG verses diesel for mining trucks not accounting for capital costs.

Table 5 Summary of Annual Operating Cost Savings when using LNG for Mining Trucks

ITEM	100% DIESEL	35% LNG
Diesel Cost	$3,800,000	$2,470,000
LNG Cost		$1,020,000
Total Fuel Cost	$3,800,000	$3,490,000
Cost Difference LNG vs. Diesel	0	$310,000

Energir provided an estimated capital cost for converting the mining haul truck fleet and providing facilities to receive and dispense LNG on site. It is estimated that approximately $466,667 per truck is

required to convert a mining truck from diesel to LNG. Based on 15 trucks the total capital cost is $7 million for the fleet. A further $1.5 million is required to construct an LNG storage island and provide a mobile truck for transporting LNG around the mine site.

Base on the above information, it will take 24 years to pay off the additional capital expenditure so this option is not worth further investigation unless there is a significate increase in price of diesel in the future.

In Energir's analysis, the 35% LNG option for Mining Trucks estimated a 10% reduction in Greenhouse Gas (GHG) emissions when compared to the 100% diesel option.

Discussion and Conclusions

This trade off analysis only looked at the haul truck fleet for LNG conversion. If LNG were to be used for other purposes on site it would allow the capital cost of the fixed LNG station to be shared between multiple end users. However, if the capital cost component for the fixed fueling island from Table 2 were removed, the haul truck portion's NPV(10%) is still negative.

Both Komatsu and Caterpillar have plans in the future for developing LNG fueled trucks however both companies seem to be at least 5 years away from offering a commercial solution based on the conversations we had with their representatives. Neither company currently has trucks even in the pilot stage with LNG. Both are focusing on perfecting their Tier IV engines to ensure they get good availability and can be rebuilt efficiently. Of course, these equipment manufacturers would speed up development if diesel costs when up to $1.20/L and stayed there, than customers would demand the technology.

The key bottlenecks to deploying LNG technology for more widespread applications mentioned were:

- Substitution rates of 50% or lower, until the technology can achieve 100% it will remain difficult to select LNG.
- Lack of supply of LNG close to projects. Fuel providers have diesel depots located all over the country and usually it is a short trucking distance to bring diesel to a project. LNG only has a few supply points in a given location so the haul distance is long.
- Capital cost of LNG dispensing system at site is significantly more expensive than a diesel equivalent.
- Lack of a commercial solution from OEM companies such as Komatsu, Hitachi, and Caterpillar.

As per the analysis, the use of LNG as a fuel source for the Mining Trucks option is not worth further investigation unless there is a significate increase in the price of diesel in the future.

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APPENDIX A – INFORMATION FROM ENERGIR

Excerpts for Mining Truck component only

energir

LNG as fuel for road & mining trucks
-
Galaxy Lithium

David Ducasse, ing.
Nicolas Lapointe
Sébastien Lajoie, ing.

December 2018

Component 2: Mining trucks – Galaxy Lithium

energir

Assumptions provided by Galaxy and Mining-Plus:

- 15 mining trucks
- Between 4.0 to 10.5 Millions liters of diesel / year

Assumptions proposed by Énergir:

- **GFS Corps** type LNG conversion system
- Diesel substitution rate between 35% - 50%
- 360 DGE LNG tanks per truck
- System price ≈ 350K USD

Total LNG consumption @ 35% substitution rate:
= **1.4 M to 3.6 M m3 / year**

→ **Diesel price at 0,95$/L**

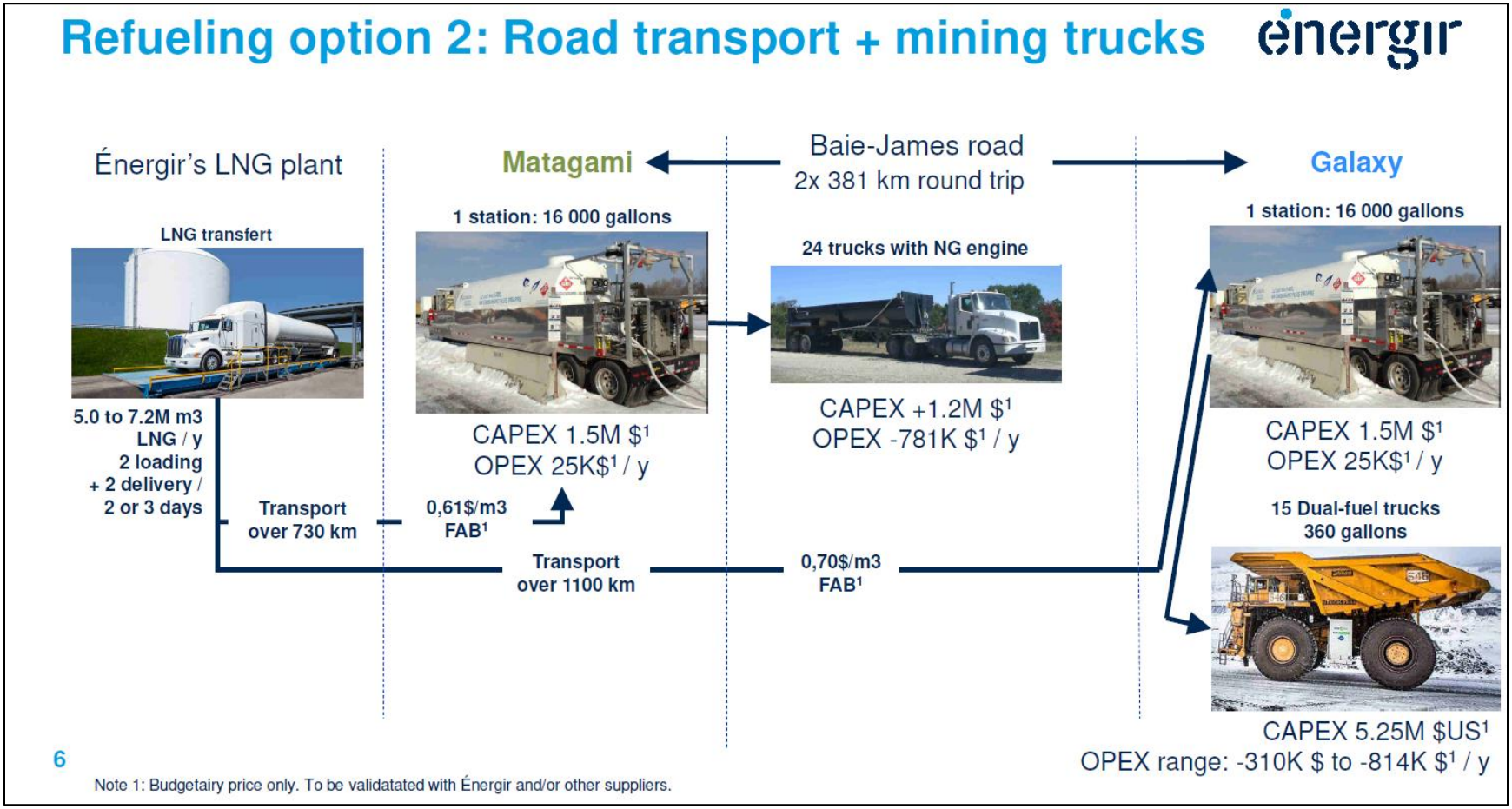
→ **LNG price at 0,70$/m3** (0,73$/DLE) **@ KM 381**
(price without fueling infrastructures)

→ **Renewable LNG price at 0,90$/m3 @ KM 381**
(price without fueling infrastructures)

→ **Relative engine's efficiency compare to diesel: 1.00**

Comparative table of environmental impacts and fuel costs for diesel and natural gas engines

Moteurs:	CAT C15	GFS EVO_MT	
Max power:	515 HP	515 HP	
Fuels:	100% Diesel	35% LNG	35% R-LNG
		65% Diesel	
Engine relative efficiency vs diesel:	1,00	1,00	
Diesel volume (L):	4 000 000	2 600 000	
LNG volume (m3):	-	1 456 720	
Energy (MBTU)	136 528	136 528	
GHG emissions (Tons of CO_2 eq.):	11 160	10 006	7 270
GHG reduction vs Diesel:	-	(1 154)	(3 890)
	-	-10%	-35%
Diesel cost:	3 800 000 $	2 470 000 $	2 470 000 $
LNG cost:	-	1 019 996 $	1 311 340 $
Total fuel cost:	3 800 000 $	3 489 996 $	3 781 340 $
Fuel economy vs diesel:	-	(310 004 $)	(18 660 $)
		-10%	-1%
@ 10.5 M litres of diesel ref.		(813 761 $)	(48 983 $)
		-27%	-2%


Refueling option 2: Road transport + mining trucks
énergir
Énergir's LNG plant
Matagami
Baie-James road
2x 381 km round trip
Galaxy
LNG transfert
1 station: 16 000 gallons
24 trucks with NG engine
1 station: 16 000 gallons
5.0 to 7.2M m3 LNG / y
2 loading
+ 2 delivery /
2 or 3 days
CAPEX 1.5M $1
OPEX 25K$1 / y
CAPEX +1.2M $1
OPEX -781K $1 / y
CAPEX 1.5M $1
OPEX 25K$1 / y
Transport over 730 km
0,61$/m3 FAB1
15 Dual-fuel trucks
360 gallons
Transport over 1100 km
0,70$/m3 FAB1
CAPEX 5.25M $US1
OPEX range: -310K $ to -814K $1 / y
6
Note 1: Budgetairy price only. To be validatated with Énergir and/or other suppliers.

APPENDIX

A-20

RESULTS OF THE KINETIC COLUMN TESTS, JUNE 2019

GALAXY LITHIUM (CANADA) INC.
PROJET N^{O} : 171-02562-00

MINE DE LITHIUM BAIE-JAMES
RÉSULTATS DES ESSAIS CINÉTIQUES EN COLONNES

JUIN 2019

MINE DE LITHIUM BAIE-JAMES

RÉSULTATS DES ESSAIS CINÉTIQUES EN COLONNES

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Le présent rapport a été préparé par WSP Canada Inc. pour le compte de Galaxy Lithium (Canada) inc. conformément à l'entente de services professionnels. La divulgation de tout renseignement faisant partie du présent rapport incombe uniquement au destinataire prévu. Son contenu reflète le meilleur jugement de WSP Canada Inc. à la lumière des informations disponibles au moment de la préparation du rapport. Toute utilisation que pourrait en faire une tierce partie ou toute référence ou toutes décisions en découlant sont l'entière responsabilité de ladite tierce partie. WSP Canada Inc. n'accepte aucune responsabilité quant aux dommages, s'il en était, que pourrait subir une tierce partie à la suite d'une décision ou d'un geste basé sur le présent rapport. Cet énoncé de limitation fait partie du présent rapport.

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1 INTRODUCTION

1.1 MISE EN CONTEXTE

Galaxy Lithium (Canada) inc. (Galaxy) est une filiale de Galaxy Resources Limited, une importante société minière sur le marché du lithium. Actuellement, Galaxy Resources Limited exploite une mine de spodumène en Australie et deux projets sont en développement : un au Québec et l'autre en Argentine.

Galaxy agit à titre d'initiateur du projet mine de lithium Baie-James, situé dans la région administrative du Nord-du-Québec. Le site minier à l'étude se trouve à environ 10 km au sud de la rivière Eastmain et à quelque 100 km à l'est de la baie James, à la même latitude que le village cri d'Eastmain. La propriété minière (claims) de Galaxy se trouve sur des terres de catégorie III selon la Convention de la Baie James et du Nord québécois (CBJNQ). Les terres sous claims miniers sont facilement accessibles par la route de la Baie-James qui traverse la propriété à proximité du relais routier du km 381.

Le projet prévoit l'exploitation d'une fosse de façon conventionnelle, d'où environ 2 Mt par année de pegmatites à spodumène seront extraites pour ensuite être dirigées vers un concentrateur. Outre ces installations, le site accueillera notamment des aires d'accumulation (mort-terrain, terre végétale, stériles/résidus, minerai, concentré), des bassins de rétention, une unité de traitement d'eau, des bâtiments administratifs, un campement pour les travailleurs, des ateliers et entrepôts ainsi qu'un dépôt d'explosifs. La période d'exploitation prévue est de 16 ans.

Le projet mine de lithium Baie-James est assujetti à la procédure provinciale d'évaluation et d'examen des impacts sur l'environnement, comme prévu à l'article 153 du chapitre II de la Loi sur la qualité de l'environnement (LQE). L'annexe A de la LQE liste les projets obligatoirement soumis à la procédure d'évaluation et d'examen, dont « tout projet minier, y compris l'agrandissement, la transformation ou la modification d'une exploitation minière existante ». Conjointement à la LQE, l'annexe 1 du chapitre 22 de la CBJNQ dresse une liste de projets soumis au processus d'évaluation, dont les projets d'exploitation minière. Le projet est également assujetti à une évaluation environnementale fédérale, comme prévu à l'article 13 de la Loi canadienne sur l'évaluation environnementale (2012) (L.C. 2012, ch. 19, art. 52), puisque l'extraction de minerai dépassera 3 000 t/jour (article 16(a)) et que la capacité de l'usine de concentration dépassera 4 000 t/jour (article 16(b) du Règlement désignant les activités concrètes [DORS/2012-147]).

Galaxy a fait appel à WSP Canada Inc. (WSP) afin de réaliser une caractérisation géochimique des stériles miniers, du minerai, des dépôts meubles de surface et des résidus miniers qui seront extraits et produits lors de la mise en production du gisement, qui a été déposée dans le cadre de l'étude d'impact sur l'environnement (ÉIE) en juillet 2018.

À la suite des résultats de cette étude, afin de raffiner les conclusions sur le potentiel de génération d'acide et de lixiviation des stériles et des résidus miniers, Galaxy a mandaté WSP afin de réaliser des essais cinétiques en colonnes. Le présent rapport présente les résultats de ces essais.

1.2 RÉSULTATS DE LA CARACTÉRISATION GÉOCHIMIQUE

Lors de la caractérisation géochimique réalisée en 2018, les échantillons de stériles, de minerai et de résidus miniers ont été soumis à des analyses pour le contenu en métaux disponibles, à des essais de lixiviation (TCLP, SPLP et CTEU-9) ainsi qu'à des essais visant à déterminer le potentiel de génération d'acide de ces matériaux (*Modified Acid Base Accounting* [MABA]) et leur radioactivité.

L’étude a révélé que les stériles provenant de toutes les unités lithologiques seraient lixiviables en métaux en regard de cette même directive à différents degrés. Les stériles de l’unité de gneiss (M1) étaient également réputés potentiellement générateurs d’acidité (PGA) dans une proportion de 30 %, alors que 50 % des échantillons de l’unité de gneiss rubanné (M2) étaient réputés PGA.

Quant aux échantillons de minerai, ils étaient également lixiviables en métaux en regard de la Directive 019 sur l'industrie minière (D019), et réputés PGA dans une proportion de 21 %.

Finalement, les échantillons de résidus analysés étaient également réputés lixiviables en métaux en regard de la D019, et étaient tous réputés non potentiellement générateurs d’acidité (NPGA).

Les conclusions de la caractérisation géochimique précisaient qu’il serait pertinent de procéder à des essais supplémentaires afin de vérifier le PGA des unités de stériles et le potentiel de lixiviation des résidus miniers et des stériles, afin de réaliser les essais sur des matériaux grossiers s’apparentant à la granulométrie et à la composition réelle des résidus qui seront entreposés sur le site minier.

1.3 OBJECTIFS DE L’ÉTUDE

La présente caractérisation géochimique vise à confirmer avec plus de certitude le potentiel de génération d’acide et de lixiviation à long terme des stériles. Le potentiel de lixiviation des résidus miniers sera également évalué lors de la présente étude. Pour ce faire, des essais cinétiques en colonnes ont été entrepris afin de réaliser les essais sur des matériaux grossiers s’apparentant à la granulométrie et à la composition réelle des stériles et des résidus qui seront entreposés sur le site minier.

Le programme d’essais cinétiques a été basé sur la gestion des stériles et des résidus que Galaxy préconise pour le moment, en évaluant le comportement d’un mélange de l’ensemble des unités de stériles (en conditions saturées et non saturées) et le comportement des résidus. Il est à noter que Galaxy envisage de faire la codéposition des stériles et des résidus; les résultats des essais en colonnes sur chacun de ces matériaux permettront d’évaluer leur comportement distinct et de statuer sur les infrastructures requises pour leur entreposage.

2 PROGRAMME D'ÉCHANTILLONNAGE

2.1 CONTEXTE GÉOLOGIQUE LOCAL

Selon les informations tirées de la description de projet (WSP, 2017) et du rapport d'évaluation des ressources minérales du projet (SRK Consulting, 2010), la mine de lithium Baie-James est située dans la province géologique du Supérieur et fait partie de la ceinture de roches vertes archéennes du groupe d'Eastmain. Les roches de cette ceinture volcanique sont majoritairement constituées d'amphibolites et de roches métasédimentaires et métavolcaniques. Sous les roches du groupe d'Eastmain, on retrouve la formation d'Auclair, composée de paragneiss recoupé par des intrusions de pegmatite à spodumène. Les roches non intrusives de la propriété montrent une foliation est-nord-est et un pendage subvertical, alors que les intrusions sont plutôt massives.

Le gisement de la mine de lithium Baie-James est constitué d'essaim de dykes et de lentilles de pegmatite, qui atteignent chacun jusqu'à 150 m de largeur par 100 m de longueur. L'ensemble des essaims est compris dans un corridor discontinu s'étendant sur environ 4 km de longueur par 300 m de largeur. Une bordure de contact de quelques centimètres d'épaisseur est visible au contact des pegmatites et des roches encaissantes.

Les pegmatites composant le gisement de la mine de lithium Baie-James contiennent du spodumène, qui est retrouvé en cristaux d'une taille variant de 5 cm à plus de 1 m.

2.2 TYPES DE LITHOLOGIES DU GISEMENT

D'après la consultation des rapports de forages disponibles et selon les informations recueillies auprès des géologues de projet, quatre lithologies principales ont été ciblées et composeront les stériles de la mine de lithium Baie-James. Ces unités sont décrites plus en détail dans les sous-sections qui suivent.

2.2.1 PEGMATITE STÉRILE

L'unité de pegmatite stérile (I1G), de couleur blanche à grise, est caractérisée par un assemblage de cristaux de quartz, feldspaths et de micas, à habitus grossier. De l'apatite est également présente en traces, par endroits. Des cristaux de spodumène sont présents dans la pegmatite classée stérile, généralement en proportion moindre que dans la pegmatite considérée comme minerai. Cette unité est évaluée en tant que stériles en périphérie du gisement de pegmatite à spodumène et au contact des unités de gneiss.

2.2.2 GNEISS

L'unité de gneiss (M1) présente une couleur variant du gris foncé au brun gris. Elle est composée de roches sédimentaires métamorphisées et la taille des grains varie de fins à grossiers. Les minéraux qui y sont retrouvés varient selon le protholite, mais la biotite, le quartz et le feldspath sont communs. Le gneiss est également altéré en chlorite par endroits. Une faible foliation orientée en moyenne entre 20 et 55 degrés est visible dans cette unité.

2.2.3 GNEISS RUBANNÉ

L'unité de gneiss rubanné (M2) est semblable à l'unité M1, mais présente un rubanement induit par la ségrégation des minéraux lors du métamorphisme, qui la distingue de l'unité M1. Des plis sont parfois visibles dans cette unité.

2.2.4 ROCHE VOLCANIQUE MAFIQUE/BASALTE

L'unité composée de roche volcanique mafique (V3) et de basalte (V3B) est de couleur vert-noirâtre foncé et est finement grenue. L'amphibolitisation et la chloritisation sont des types d'altérations communes dans cette unité. Des traces de minéraux sulfureux sont localement observées dans cette unité.

2.3 RÉSIDUS

Les résidus miniers ont été récupérés à la suite de la réalisation des essais métallurgiques effectués par le laboratoire SGS de Lakefield, en Ontario, sur des échantillons de minerai sélectionnés par Galaxy. Les résidus sont représentatifs des procédés métallurgiques qui seront utilisés en cours d'opération.

2.4 MÉTHODOLOGIE

La sélection des échantillons visait à obtenir une représentativité spatiale adéquate des stériles qui seront extraits et mis en entreposage lors de l'exploitation de la mine de lithium Baie-James, de même que des résidus miniers qui seront produits en cours d'exploitation. Un premier tri a été fait parmi la base de données de forages. De manière générale, le pourcentage moyen de minéraux sulfureux présents dans les stériles et le minerai est également utilisé pour la sélection des échantillons. Toutefois, Galaxy a indiqué à WSP n'avoir aucune donnée disponible concernant la concentration ou le pourcentage en minéraux sulfureux dans sa base de données.

Les échantillons ont été prélevés par le personnel de Galaxy dans des carottes de forage d'exploration et des forages réalisés dans le cadre des investigations géotechniques selon les directives de l'équipe de WSP. Les échantillons de résidus miniers ont été prélevés à la suite de l'essai métallurgique réalisé par Galaxy en 2018.

Lorsque possible, des échantillons attenants à certains échantillons ayant été caractérisés lors de la réalisation des essais statiques ont été sélectionnés (provenant de forage d'exploration), afin que des matériaux semblables soient soumis aux essais en colonnes. Des échantillons provenant d'autres intervalles de forage et/ou d'autres forages ont également été sélectionnés afin d'obtenir une représentation spatiale représentative des stériles du gisement et d'avoir suffisamment de matériel.

Les données de forages ont été importées dans le logiciel Promine, permettant une visualisation en 3D de ces données. Les enveloppes minéralisées du gisement ainsi que les contours de la fosse prévue ont aussi été importés. Les intervalles de forage ont donc pu être sélectionnés en 3D afin d'assurer une bonne dispersion spatiale dans l'ensemble des secteurs prévus pour l'exploitation. Cette façon de faire a également permis de sélectionner avec précision les intervalles associés aux zones minéralisées prévues pour l'exploitation du projet.

La sélection a été basée sur les informations mises à la disposition de WSP, soit des rapports de forages et des études antérieures. Toutefois, après validation auprès des géologues du projet, il a été constaté que des disparités existaient entre les descriptions colligées dans les rapports de forage et la composition réelle des carottes de forage décrites. La description visuelle des carottes de forage comportant une certaine part de subjectivité, les données issues de la description des carottes ont été validées auprès des géologues de projet, qui ont assisté WSP dans la sélection des échantillons en validant la cohérence des descriptions et en proposant des alternatives, lorsque requis.

2.5 ÉCHANTILLONS SÉLECTIONNÉS

Les échantillons provenant de carottes de forages étaient constitués de la carotte entière et chaque échantillon représentait 0,5 m de longueur de carottes. Les carottes de forages étaient de diamètre NQ ou HQ.

Afin de constituer le matériel correspondant aux deux colonnes de stériles, respectivement 21 échantillons de l'unité M1, trois échantillons de l'unité M2 et un échantillon des unités I1G et V3B ont été sélectionnés. Le nombre d'échantillons est représentatif de la proportion de chacune des unités de stériles qui seront entreposés dans le parc à résidus miniers. Les résidus soumis à l'essai en colonne proviennent de l'essai métallurgique réalisé dans le cadre du projet.

Les proportions de chacune des unités de stériles ont été attribuées en fonction de l'estimation de Galaxy pour la période de production de la mine. À titre comparatif, le tableau 1 présente les proportions de chaque unité lithologique qui composeront les stériles miniers lors de l'opération de la mine, de même que les pourcentages relatifs des lithologies composant les échantillons de stériles utilisés pour les essais cinétiques. Les échantillons sélectionnés sont présentés au tableau 2.

Tableau 1 Comparaison des tonnages des unités de stériles

Unité	Tonnage (tm)	Pourcentage relatif du tonnage total (%)	Pourcentage des échantillons de stériles utilisés pour les essais en colonnes (%)
M1	98 989 641	84,9	79
M2	16 274 088	14,0	14
V3B	1 008 878	0,9	4
I1G	367 461	0,3	4
Total	**116 640 067**	**100**	**100**

Tableau 2 Échantillons de stériles sélectionnés pour les colonnes 2 et 3 (mélange de stériles, saturés et non saturés)

Numéro d'échantillon		Forage	Intervalle (m)		Unité lithologique
			De	À	
W171732	CIN-S-I1G-1	JBL17-34	15	15,5	I1G
W171733	CIN-S-M1-2	JBL18-GT01	68	68,5	M1
W171734	CIN-S-M1-3	JBL09-42	76	76,5	M1
W171735	CIN-S-M1-4	JBL09-63	121	121,5	M1
W171736	CIN-S-M1-5	JBL09-66	32	32,5	M1
W171737	CIN-S-M1-6	JBL09-79	10,5	11	M1
W171738	CIN-S-M1-7	JBL17-07	11,5	12	M1
W171739	CIN-S-M1-8	JBL17-126	27	27,5	M1
W171740	CIN-S-M1-9	JBL17-15	16	16,5	M1
W171741	CIN-S-M1-10	JBL17-34	47	47,5	M1
W171742	CIN-S-M1-11	JBL17-118	61	61,5	M1
W171743	CIN-S-M1-12	JBL09-17	30	30,5	M1
W171744	CIN-S-M1-13	JBL18-M08-D9.2	50	50,5	M1
W171745	CIN-S-M1-14	JBL17-78	26	26,5	M1
W171746	CIN-S-M1-15	JBL17-92	5	5,5	M1
W171747	CIN-S-M1-16	JBL09-08	65,5	66	M1
W171748	CIN-S-M1-17	JBL09-24	90	90,5	M1

Tableau 2 (suite) Échantillons de stériles sélectionnés pour les colonnes 2 et 3 (mélange de stériles, saturés et non saturés)

Numéro d'échantillon		Forage	Intervalle (m)		Unité lithologique
			De	À	
W171749	CIN-S-M1-18	JBL18-GT07	34	34,5	M1
W171750	CIN-S-M1-19	JBL18-GT10	18,5	19	M1
W171751	CIN-S-M1-20	JBL18-GT14	35	35,5	M1
W171752	CIN-S-M1-21	JBL17-M04-D17	12	12,5	M1
W171753	CIN-S-M2-22	JBL09-05	8	8,5	M2
W171754	CIN-S-M2-23	JBL17-90	19,5	20	M2
W171755	CIN-S-M2-24	JBL18-M08-D9.2	35	35,5	M2
W171756	CIN-S-V3B-25	JBL18-GT06	66,5	67	V3B

3 DESCRIPTION DES COLONNES D'ESSAI

Des diagrammes présentant le design des colonnes d'essai ainsi que des photographies de ces dernières sont présentés à l'annexe B.

3.1 MÉTHODE DES ESSAIS CINÉTIQUES EN COLONNES

Les essais cinétiques en colonnes visent à déterminer le comportement des matériaux sur une période d'essai prolongée. Ils permettent de donner une appréciation des réactions d'altération et de lixiviation des matériaux et des changements de comportement dans le temps. Ils consistent généralement en des tubes (PVC, ou autres matériaux) dans lesquels sont confinés des matériaux, soumis à des rinçages à une fréquence donnée. Le lixiviat est ensuite récupéré à la suite de chaque rinçage, afin d'être analysé. Les caractéristiques de la colonne (masse totale des matériaux, granulométrie, fréquence de rinçage, etc.) sont déterminées en fonction des objectifs visés par l'essai et du type de matériaux. Les essais en colonnes où les matériaux sont soumis à des cycles de mouillage-séchage donnent également une vision du pire scénario en ce qui a trait au potentiel de génération d'acide et de lixiviation.

3.1.1 COLONNE 1 - RÉSIDUS NON SATURÉS

Une colonne comportant des résidus a été mise en place afin d'évaluer le comportement des résidus. Les résidus ont été prélevés parmi les résidus produits lors de l'essai métallurgique et sont considérés représentatifs des matériaux qui seront entreposés dans le futur parc à résidus miniers. Les résidus ont été laissés à leur granulométrie d'origine, qui était déjà inférieure à 25 mm. Un total de 21,534 kg de résidus a été mis en place dans la colonne.

Cette colonne était gardée en conditions non saturées la plupart du temps. Un rinçage a été effectué toutes les semaines ou aux deux semaines. Ainsi, lors de chaque rinçage, de l'eau distillée était ajoutée à la colonne jusqu'à ce que le niveau d'eau atteigne 2 cm au-dessus de la surface des matériaux et qu'il n'y ait plus de bulles d'air remontant à la surface. La colonne était laissée saturée pendant le reste de la journée, puis le lixiviat était récupéré par l'ouverture du fond de la colonne par où est drainée l'eau pendant au minimum une heure.

3.1.2 COLONNE 2 - STÉRILES SATURÉS

Un total de 26 398 kg de stériles a été mis en place dans la colonne. Les stériles ont été concassés à une granulométrie maximale de 25 mm, pour simuler les conditions d'entreposage prévues.

Cette colonne était gardée en conditions saturées en tout temps, avec une couverture d'eau d'environ 2 cm à la surface des matériaux. Une fois par semaine ou par deux semaines, l'eau contenue dans la colonne était drainée par une valve au bas de la colonne, qui était laissée ouverte au minimum une heure pour récupérer le lixiviat. Par la suite, la colonne était remplie à l'aide d'eau distillée afin de laisser un couvert d'eau de 2 cm au-dessus de la surface des matériaux. Au besoin, si le niveau d'eau au-dessus des stériles descendait sous 1 cm, de l'eau distillée était ajoutée pour atteindre au minimum 2 cm au-dessus des stériles à nouveau. Le volume d'eau supplémentaire ajoutée chaque semaine était comptabilisé.

3.1.3 COLONNE 3 - STÉRILES NON SATURÉS

Un total de 26 709 kg de stériles a été mis en place dans la colonne. Les stériles ont été concassés à une granulométrie maximale de 25 mm, pour simuler les conditions d'entreposage prévues.

Cette colonne était gardée en conditions non saturées la plupart du temps. Un rinçage a été effectué toutes les semaines ou aux deux semaines. Ainsi, lors de chaque rinçage, de l'eau distillée était ajoutée à la colonne jusqu'à ce que le niveau d'eau atteigne 2 cm au-dessus de la surface des matériaux et qu'il n'y ait plus de bulles d'air remontant à la surface. La colonne était laissée en conditions saturées pendant le reste de la journée, puis le lixiviat était récupéré par l'ouverture du fond de la colonne, par où est drainée l'eau pendant au minimum une heure.

4 PROGRAMME ANALYTIQUE

4.1 PROGRAMME ANALYTIQUE

4.1.1 PÉRIODE D'ESSAI ET FRÉQUENCE D'ÉCHANTILLONNAGE

Les essais cinétiques ont été conduits sur une période de 50 semaines, soit environ 11 mois et demi. À chaque rinçage, un échantillon de lixiviat a été analysé. Au cours des quatre premières semaines d'essai, un rinçage a été effectué toutes les semaines (4). Par la suite, les rinçages ont été réalisés toutes les deux semaines. Au total, 28 rinçages ont été effectués.

Au cours des semaines 33 et 34, en raison de la période des Fêtes, les journées de mesure et de rinçage ont été décalées d'une journée.

4.1.2 PROGRAMME D'ANALYSES ET D'ESSAIS

Des analyses ont d'abord été réalisées sur les fractions solides, soit :

- analyse des éléments traces (ICP-OES/MS);
- potentiel de génération d'acide (*Modified Acid-Base Accounting* (MABA));
- *Whole rock analysis.*

En cours d'essai, les analyses suivantes ont été réalisées sur le lixiviat récupéré lors de chaque rinçage :

- pH;
- potentiel d'oxydoréduction;
- conductivité;
- alcalinité;
- acidité;
- sulfates (SO4)
- métaux dissous (35).

Les paramètres d'essai (quantité d'eau de rinçage ajoutée/récupérée, pH et conductivité immédiats) ont également été mesurés toutes les semaines, indépendamment des rinçages.

Les mêmes analyses que celles réalisées initialement sur les fractions solides ont été réalisées sur les fractions solides restantes à la fin de l'essai.

4.2 CRITÈRES APPLICABLES

Les résultats des analyses en métaux disponibles réalisées sur la fraction solide ont été interprétés en fonction des critères génériques du Guide d'intervention – Protection des sols et réhabilitation des terrains contaminés (Guide d'intervention) du ministère de l'Environnement et de la Lutte contre les changements climatiques (MELCC) pour la province géologique du Supérieur. La D019 mentionne que les résidus miniers ne doivent pas excéder les critères A du Guide d'intervention du MELCC (2019) ou présenter des concentrations inférieures aux critères RES du même Guide lorsque soumis à l'essai de lixiviation TCLP EPA-1311, afin de pouvoir être considérés comme étant à faibles risques.

Ainsi, les résultats analytiques sur les lixiviats ont également été comparés aux critères de résurgence dans les eaux de surface (RES) du Guide d'intervention du MELCC. Selon la D019, si les concentrations dans le lixiviat sont supérieures aux critères RES, les résidus sont considérés comme étant lixiviables, et les résidus sont considérés à risque élevé s'ils lixivient à des concentrations supérieures à celles mentionnées au tableau 1 de l'annexe II de la D019.

Finalement, les résultats analytiques sur les lixiviats ont été comparés aux *Exigences au point de rejet de l'effluent final* du tableau 2.1 de la D019. Les résultats ont été comparés aux exigences pour la concentration moyenne mensuelle acceptable et aux exigences pour la concentration maximale acceptable. Cette comparaison permet de valider si les lixiviats pourraient occasionner des rejets qui ne respecteraient pas les exigences au point d'effluent final du site.

4.3 PROGRAMME DE CONTRÔLE DE LA QUALITÉ

Le laboratoire a réalisé son propre programme de contrôle et de la qualité, qui est inclus dans les certificats d'analyses présentés à l'annexe D.

5 RÉSULTATS

Les résultats des essais sont présentés dans les tableaux de l'annexe C, et les certificats d'analyses sont présentés à l'annexe D.

5.1 CARACTÉRISATION INITIALE DES MATÉRIAUX

WHOLE ROCK ANALYSIS

L'analyse initiale a révélé que les stériles utilisés pour confectionner les colonnes d'essai étaient composés principalement de silice (65,3 %) et d'alumine (15,8 %). Ces derniers contenaient aussi, en moindres proportions, des oxydes de fer (5,18 %), de sodium (3,60 %), de magnésium (2,21 %), de calcium (2,30%) et de potassium (2,60 %). Le reste des stériles (1,81 %) était constitué de divers composés présents en traces.

En ce qui concerne les résidus utilisés lors de l'essai, ceux-ci étaient composés principalement de silice (76,4 %) et d'alumine (13,6 %). Ces derniers contenaient aussi, en moindres proportions, des oxydes de sodium (4,45 %) et de potassium (3,24 %). Le reste des résidus (1,81 %) était constitué de divers composés présents en traces.

CONTENU EN MÉTAUX

Les concentrations initiales en métaux dans les stériles utilisés pour confectionner les colonnes d'essai étaient généralement inférieures aux critères A du Guide d'intervention pour la province géologique du Supérieur. Toutefois, les concentrations en étain, en molybdène et en nickel étaient comprises dans la plage « A-B » des critères du même Guide, alors que les concentrations en baryum et en cuivre étaient comprises dans la plage « B-C ». Finalement, la concentration en arsenic dans les stériles était supérieure au critère D.

Les concentrations initiales en métaux dans les résidus utilisés lors de l'essai étaient toutes inférieures aux critères A du Guide d'intervention, à l'exception de celles pour le cuivre et l'étain qui étaient comprises dans la plage « A-B », et de celle pour l'arsenic qui était comprise dans la plage « B-C » des critères du même Guide.

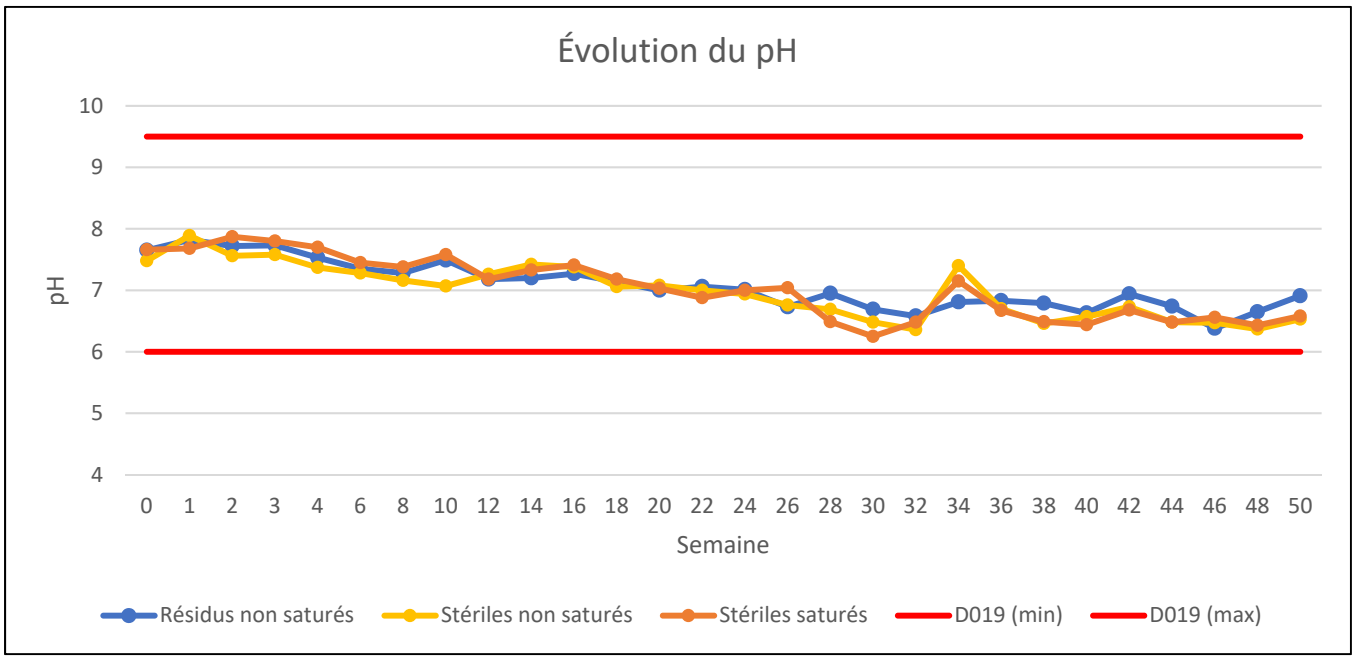
5.2 QUALITÉ DES EAUX DE RINÇAGE

5.2.1 PARAMÈTRES PHYSICOCHIMIQUES ET ACIDO BASIQUES

PH

Au cours des 20 premières semaines d'essai, le pH est demeuré entre 7 et 8 pour les trois colonnes. Le pH a présenté une légère tendance à la baisse, du début de l'essai jusqu'aux semaines 30 et 32, à partir desquelles le pH s'est stabilisé entre 6,25 et 7,01. Le lixiviat des colonnes est donc jugé neutre.

Une hausse marquée a toutefois été obtenue à la semaine 34. Le laboratoire a rapporté qu'en raison d'une maintenance sur la ligne de distribution d'eau, de l'eau du robinet a été utilisée par erreur pour le rinçage lors de la semaine 34; ceci explique donc la hausse de pH obtenue lors de cette semaine.

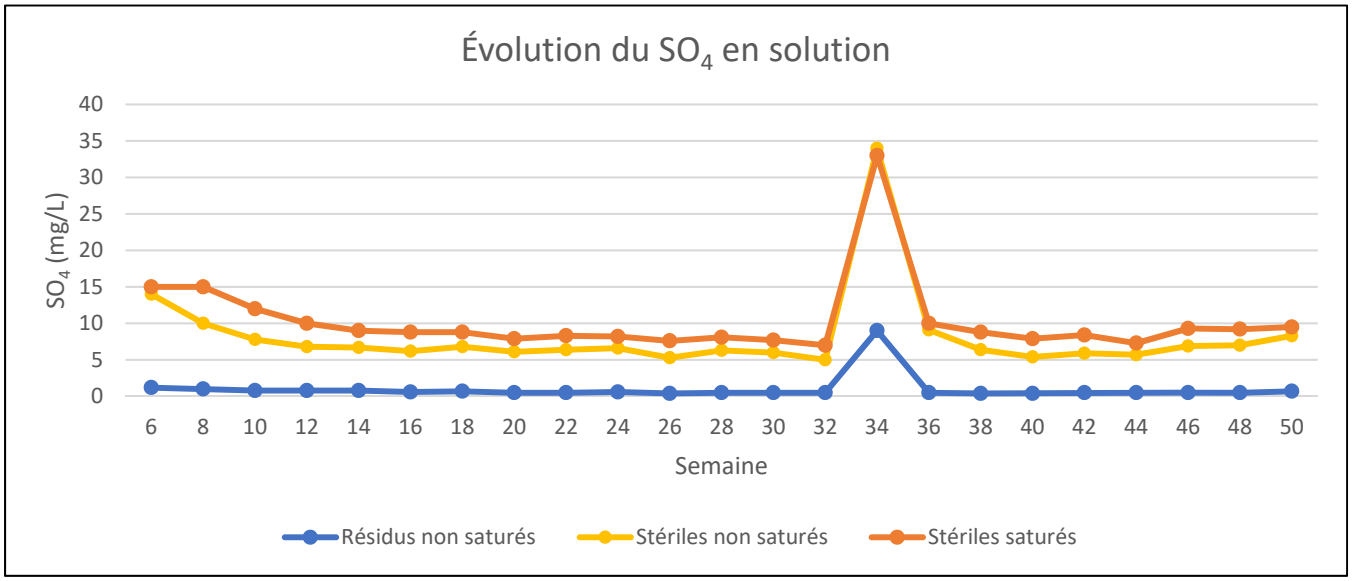


SO_4

Les concentrations de SO_4 en solution ont été mesurées à partir de la 6e semaine d'essai. Celles-ci sont demeurées constantes et entre 0 et 1 mg/l pour la colonne de résidus, et ce, dès la première semaine de mesures.

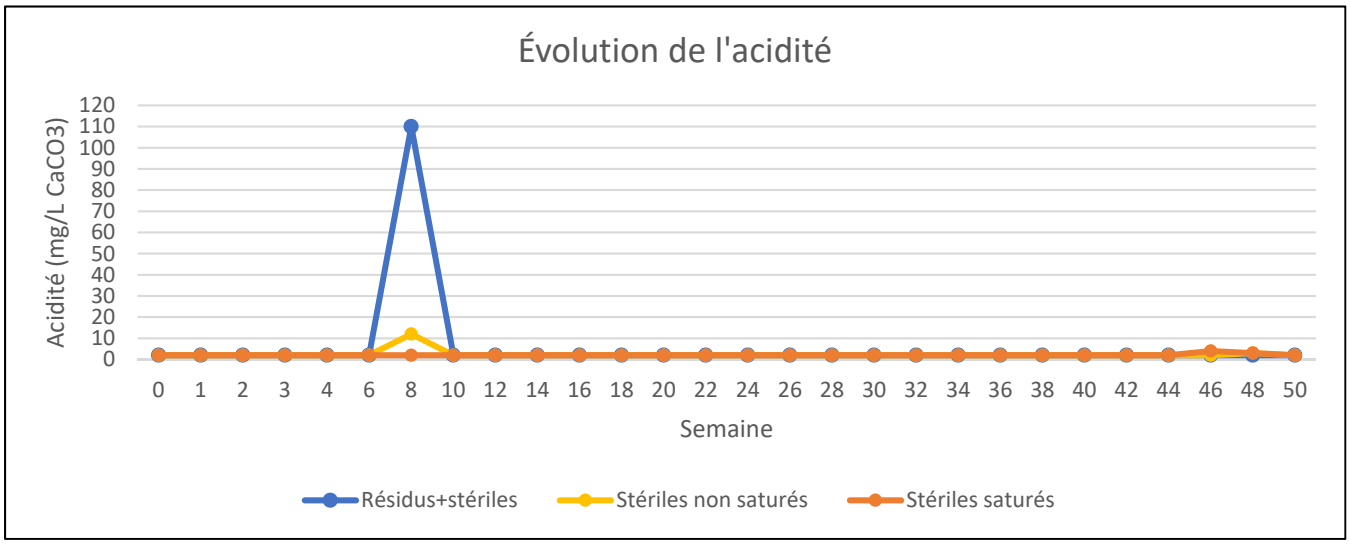
Les concentrations de SO_4 pour les colonnes de stériles non saturés et saturés suivent la même courbe de tendance, soit une diminution progressive des concentrations entre les semaines 6 à 14, puis l'atteinte d'un plateau relativement stable par la suite, à environ 6,5 mg/L pour la colonne de stériles non saturés et à environ 8 mg/L pour la colonne de stériles saturés. Les concentrations en SO_4 sont donc en accord avec les valeurs de pH obtenues.

Toutefois, comme mentionné précédemment, le laboratoire a rapporté qu'en raison d'une maintenance sur la ligne de distribution d'eau, de l'eau du robinet a été utilisée par erreur pour le rinçage lors de la semaine 34; ceci s'est traduit par une hausse marquée de SO_4 en solution à la 34e semaine.



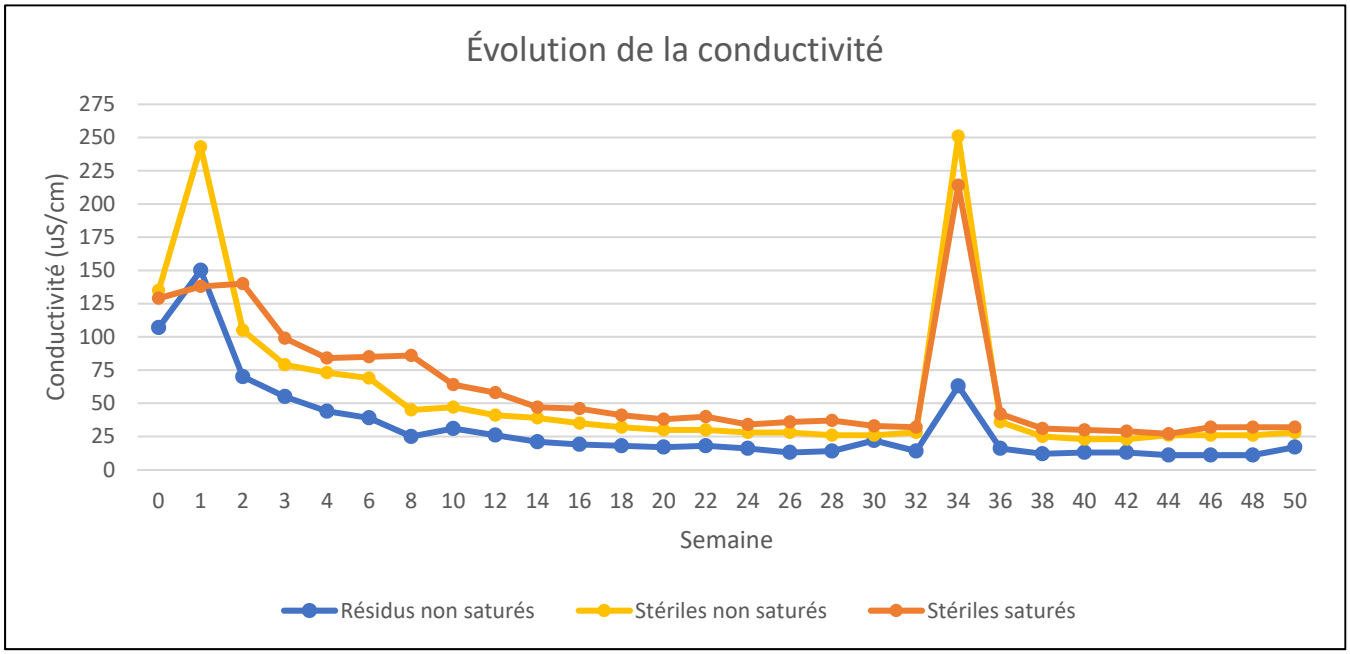
ACIDITÉ

L'acidité est demeurée très près ou sous les limites de détection du laboratoire tout au long de l'essai pour les trois colonnes étudiées, à l'exception de la 8e semaine, où une hausse à 12 mg/L $CaCO_3$ pour les stériles non saturés, et une autre à 110 mg/L $CaCO_3$ pour les résidus, ont été obtenus. Aucune hausse n'a été observée pour les stériles saturés.



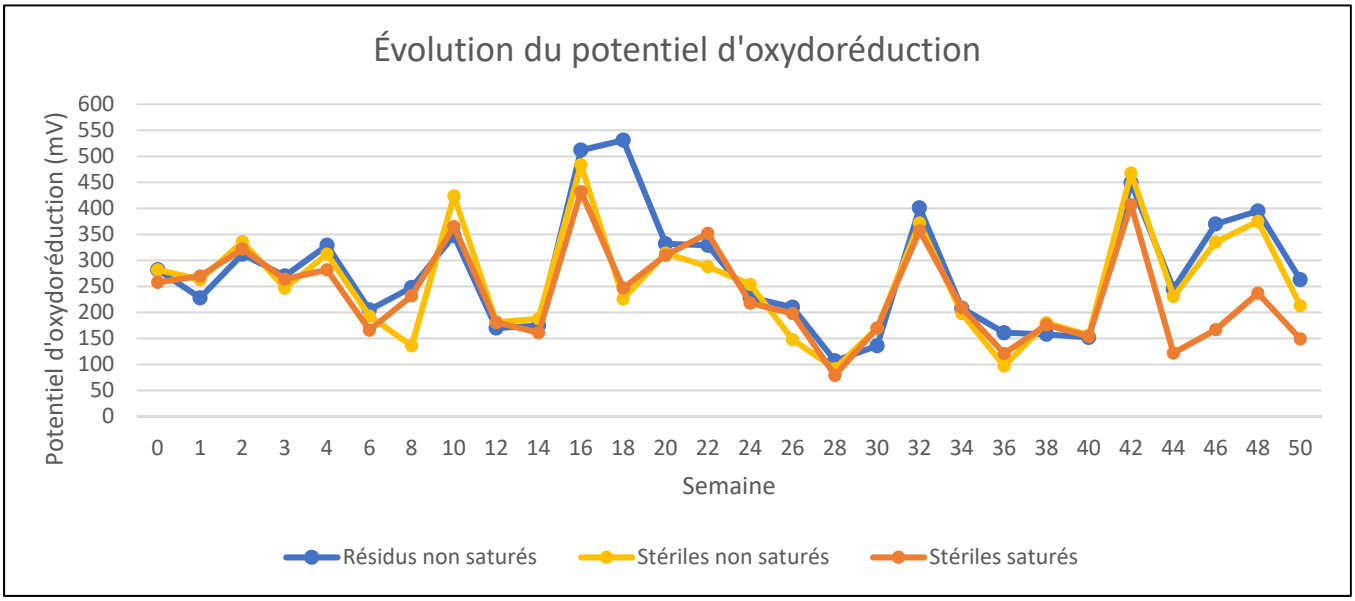
CONDUCTIVITÉ ÉLECTRIQUE

Une hausse de la conductivité électrique a été observée à la 1ere semaine pour les trois colonnes. La conductivité a ensuite diminué de façon progressive au cours des semaines suivantes et tend vers un plateau à partir de la 14e semaine pour les trois colonnes étudiées, soit autour de 15 µS/cm pour la colonne de résidus, de 28 µS/cm pour la colonne de stériles non saturés et de 35 µS/cm pour la colonne de stériles saturés. Ces valeurs sont relativement en accord avec les valeurs de pH mesurées lors des essais.



POTENTIEL D'OXYDORÉDUCTION

Le potentiel d'oxydoréduction a varié constamment tout au long de l'essai. Il s'est toutefois maintenu entre 500 mV et 75 mV. Le lixiviat des colonnes est jugé peu oxydant en raison de ces valeurs.



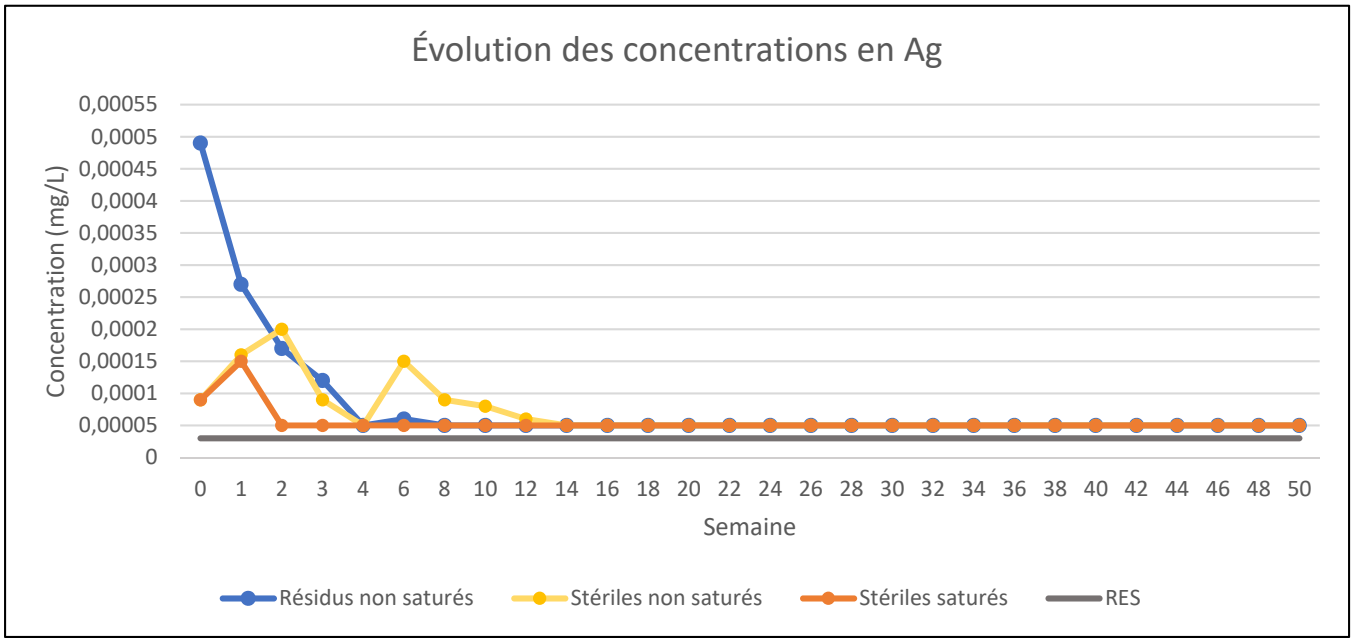
5.2.2 MÉTAUX DISSOUS

Seulement les métaux normés (D019 et RES) ont été analysés, en plus du lithium à titre indicatif. Pour les valeurs inférieures à la limite de détection rapportées par le laboratoire (LDR), une valeur égale à la LDR a été utilisée pour la mise en graphique.

ARGENT

Les quantités d'argent lixivié se sont maintenues au-dessus du critère RES durant les 6 premières semaines de l'essai pour la colonne de résidus, et durant les 12 premières semaines de l'essai pour le mélange de stériles non saturés. Par la suite, les concentrations ont atteint un plateau sous la LDR (0,00005 mg/L), qui se trouve tout juste au-dessus de la valeur du critère RES (0,00003 mg/L).

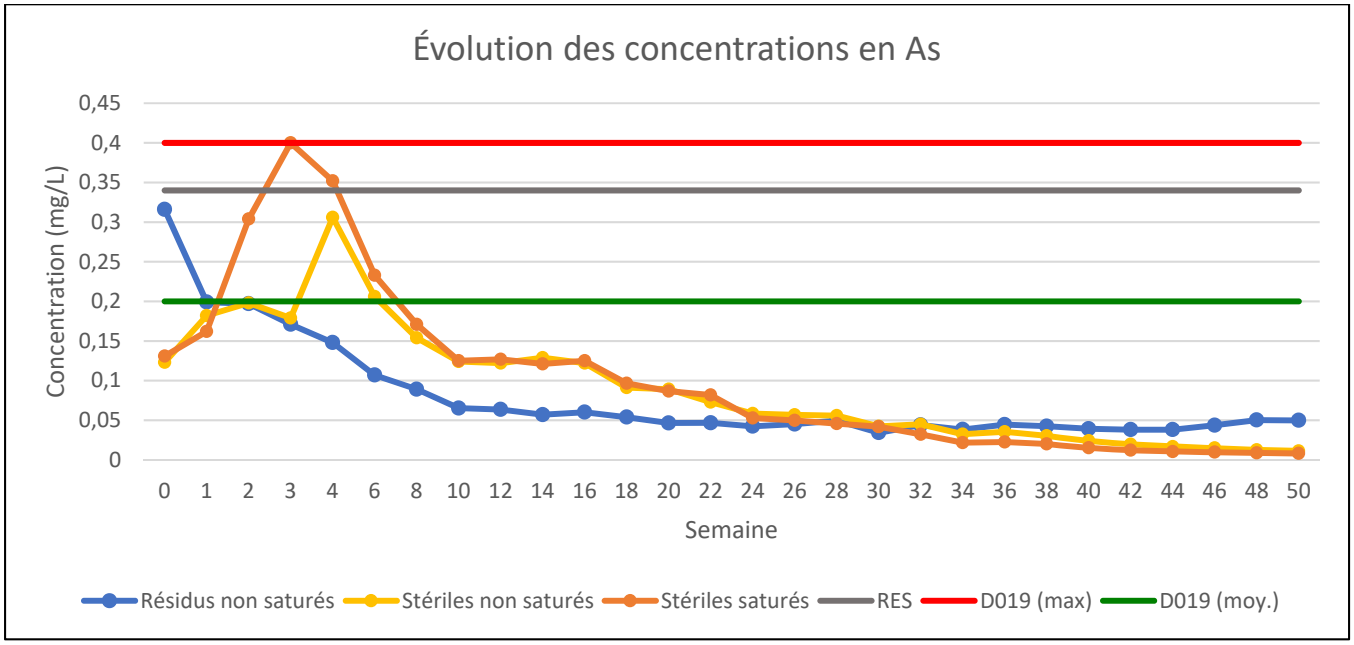
Les concentrations pour les stériles saturés ont dépassé le critère RES seulement lors de l'analyse initiale et celle de la 1ere semaine. Ces valeurs sont probablement dues à la mise en solution des métaux lors de leur contact avec l'eau. Par la suite, les valeurs sont demeurées sous les limites de détection du laboratoire. Une valeur égale à la LDR (0,00005 mg/L), et donc supérieure au critère RES, a aussi été obtenue à la semaine 46 pour la colonne de résidus. Comme cette valeur est ponctuelle et tout juste sur la LDR, elle n'est pas considérée avoir un impact significatif sur la qualité de l'eau. Il pourrait également s'agir d'un faux positif du laboratoire.



ARSENIC

Les valeurs en arsenic sont demeurées sous la concentration maximale acceptable à l'effluent final de la D019, à l'exception de la semaine 3 pour la colonne de stériles saturés. Pour cette même colonne, des valeurs supérieures à la concentration moyenne mensuelle acceptable de la D019 ont toutefois été obtenues aux semaines 2, 4 et 6, et des concentrations supérieures au critère RES ont aussi été obtenues pour les semaines 3 et 4. Des dépassements de la concentration moyenne mensuelle acceptable de la D019 ont également été obtenus pour la colonne de stériles non saturés aux semaines 4 et 6. Toutes les autres valeurs pour les trois colonnes sont demeurées sous le critère RES.

Les distributions des trois colonnes ont présenté une tendance à la baisse tout au long de l'essai, et semblent atteindre un plateau sous 0,05 mg/L vers la 24e semaine.



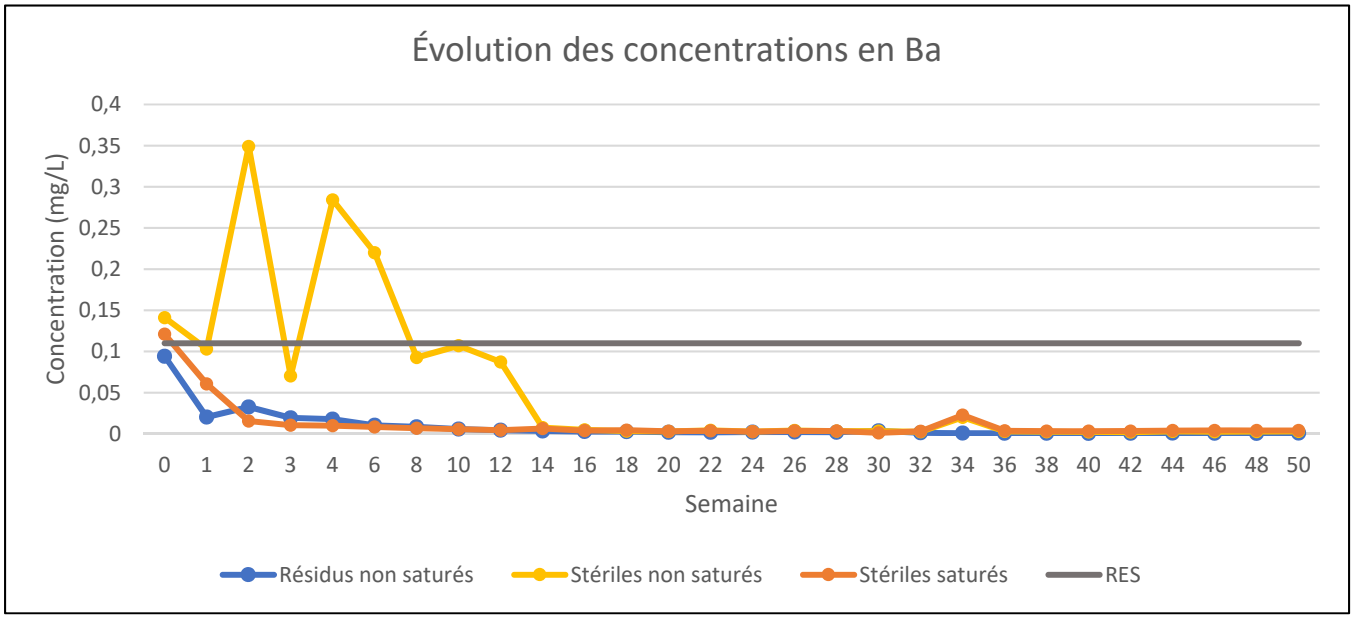
BARYUM

Les concentrations en baryum pour la colonne de résidus sont demeurées près ou sous la LDR tout au long de l'essai, à l'exception de l'analyse initiale. Les concentrations mesurées sont demeurées sous le critère RES tout au long de l'essai.

Pour la colonne de stériles non saturés, les résultats ont dépassé le critère RES à l'analyse initiale et aux semaines 2, 4 et 6. À partir de la 14e semaine, l'ensemble des résultats sont sous la limite de détection rapportée par le laboratoire.

Pour la colonne de stériles saturés, le résultat de l'analyse initiale était supérieur au critère RES. À partir de la 2e semaine, les concentrations sont demeurées près ou sous la LDR.

Comme mentionné précédemment, une légère hausse a été observée à la semaine 34, attribuable à l'erreur du laboratoire lors du rinçage lors de la semaine 34.



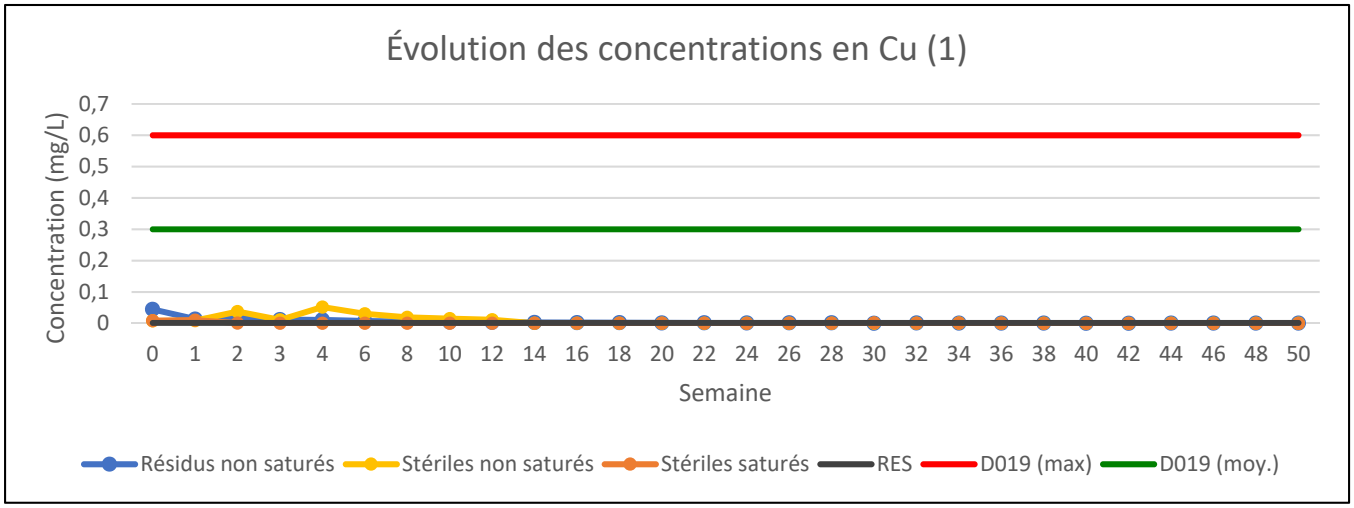
CUIVRE

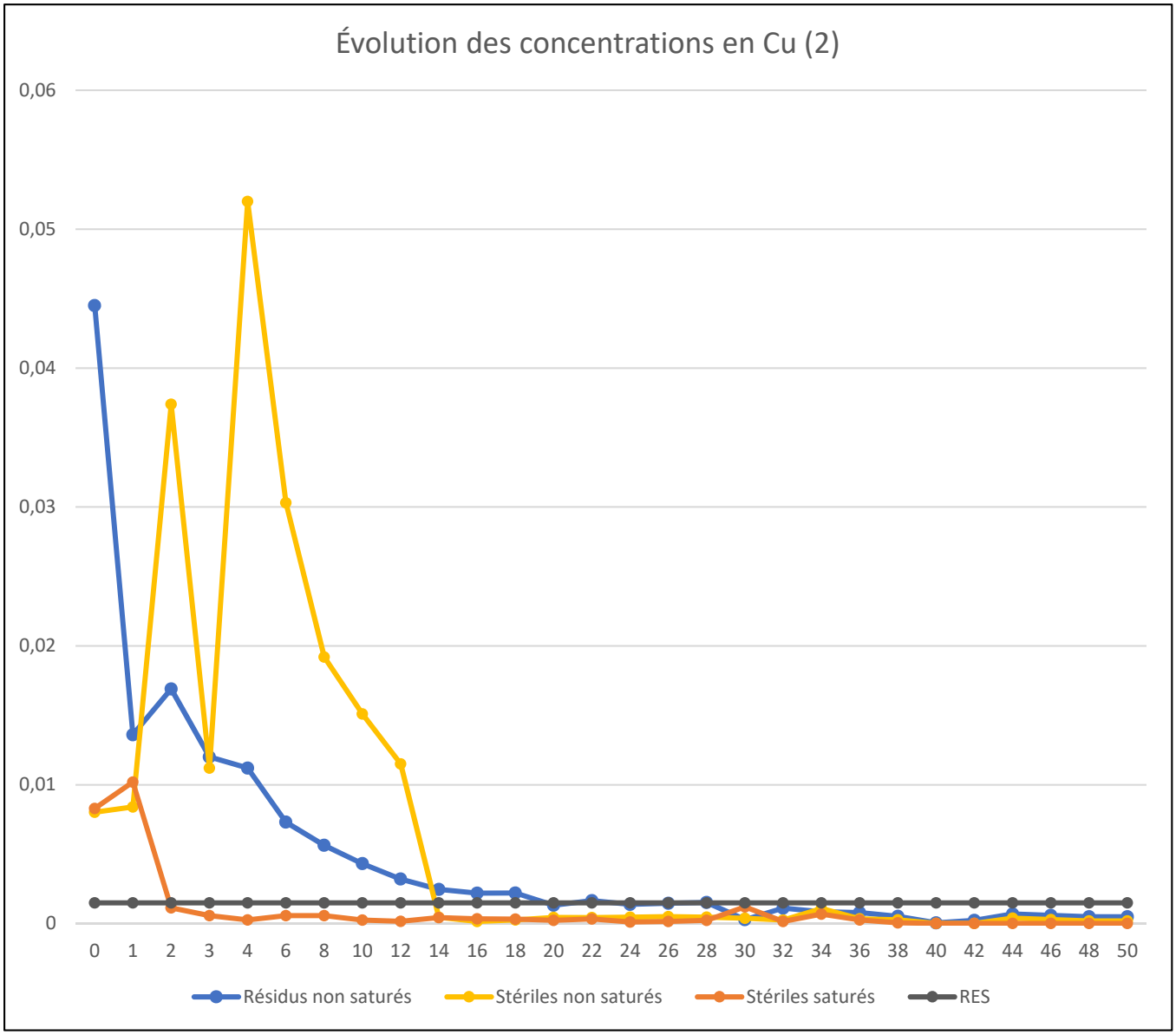
Les concentrations en cuivre sont demeurées sous les exigences de rejet à l'effluent final maximales et moyennes mensuelles de la D019 tout au long de l'essai, et ce, pour les trois colonnes étudiées.

Les concentrations pour la colonne de résidus sont demeurées au-dessus du critère RES jusqu'à la semaine 28, après quoi elles sont demeurées sous le critère RES.

Les concentrations pour la colonne de stériles non saturées sont quant à elles demeurées au-dessus du critère RES jusqu'à la semaine 12, après quoi elles sont demeurées sous le critère RES.

Les concentrations pour la colonne de stériles saturés étaient au-dessus du critère RES lors de l'analyse initiale et à la 1ere semaine, mais sont demeurées sous ce critère par la suite.


Évolution des concentrations en Cu (1)
Concentration (mg/L)
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
0 1 2 3 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50
Semaine
Résidus non saturés
Stériles non saturés
Stériles saturés
RES
D019 (max)
D019 (moy.)


Évolution des concentrations en Cu (2)
0,06
0,05
0,04
0,03
0,02
0,01
0
0 1 2 3 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50
Résidus non saturés
Stériles non saturés
Stériles saturés
RES

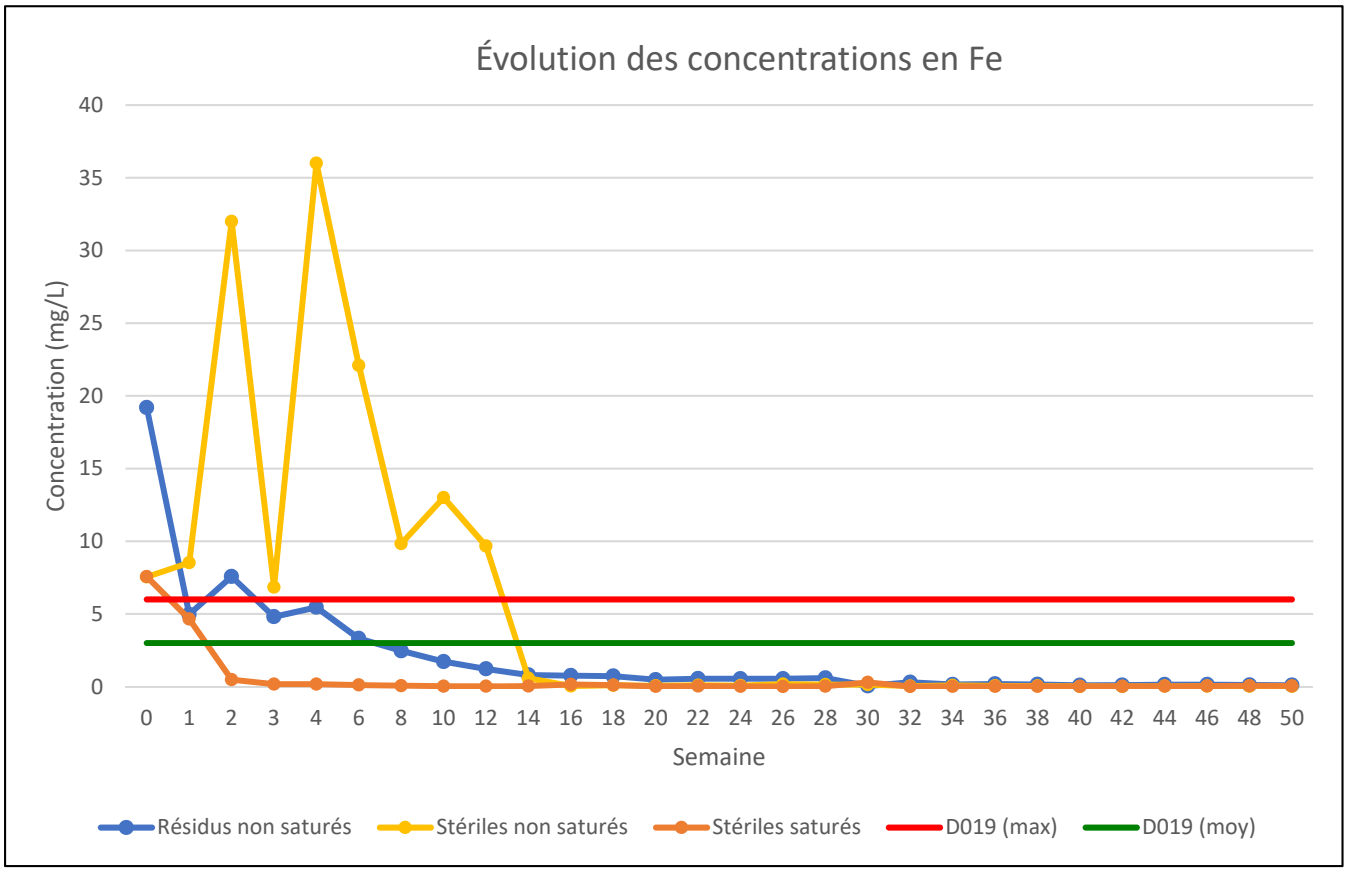
FER

Les valeurs en fer pour la colonne de stériles non saturés sont demeurées au-dessus de la concentration maximale acceptable de rejet à l'effluent final de la D019 jusqu'à la semaine 12. Par la suite, les résultats se stabilisent sous ce critère, près de la LDR.

Celles de la colonne de stériles saturés ont dépassé la concentration maximale acceptable de rejet à l'effluent final de la D019 lors de l'analyse initiale et la concentration moyenne mensuelle acceptable à la semaine 1, mais sont par la suite demeurées sous les exigences de la D019 à l'effluent final, et près de la LDR.

Pour la colonne de résidus, des dépassements ont été obtenus lors de l'analyse initiale et à la 2e semaine, et étaient supérieurs à la concentration moyenne mensuelle acceptable aux semaines 1, 3, 4 et 6. Les résultats atteignent un plateau près de la LDR à partir de la 12e semaine.

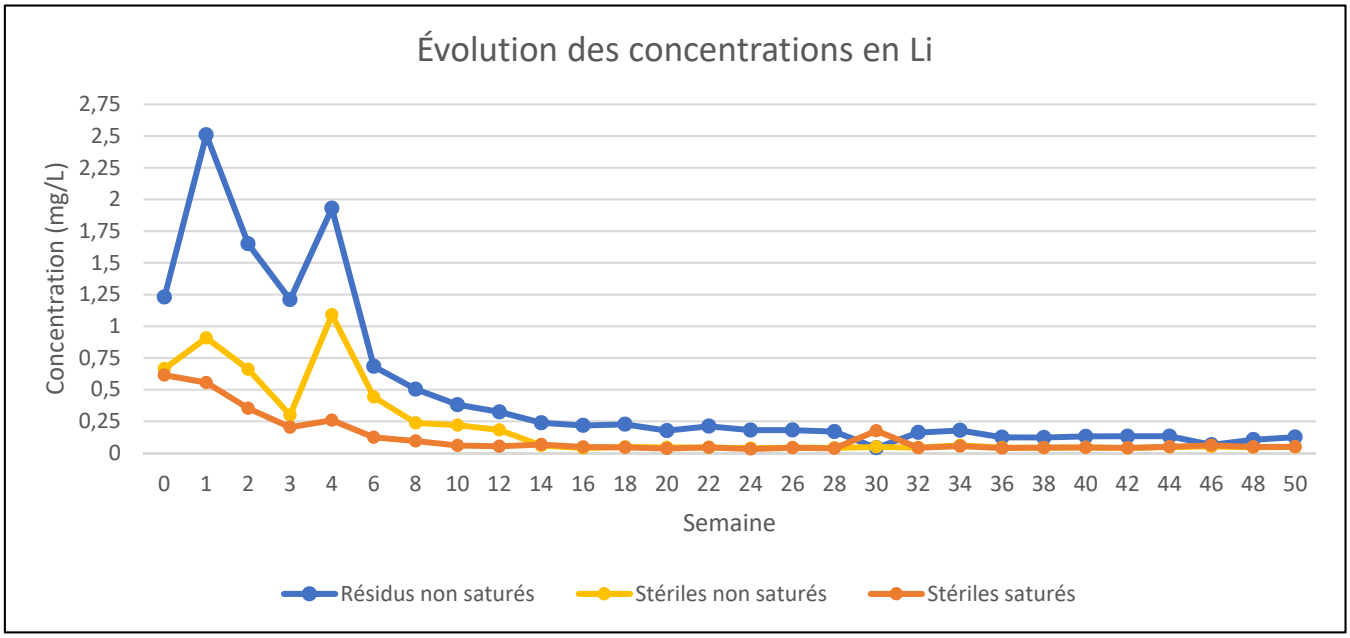
Les résultats en Fe sont en accord avec les pH obtenus lors des essais.



LITHIUM

Les valeurs en lithium tendent vers un plateau à partir de la 6e semaine pour les trois colonnes. La colonne de résidus présente des valeurs de l'ordre de 3,5 fois plus élevées que pour les deux colonnes de stériles en début d'essai.

Des hausses ont été observées dans toutes les colonnes aux semaines 1 et 4.



MANGANÈSE

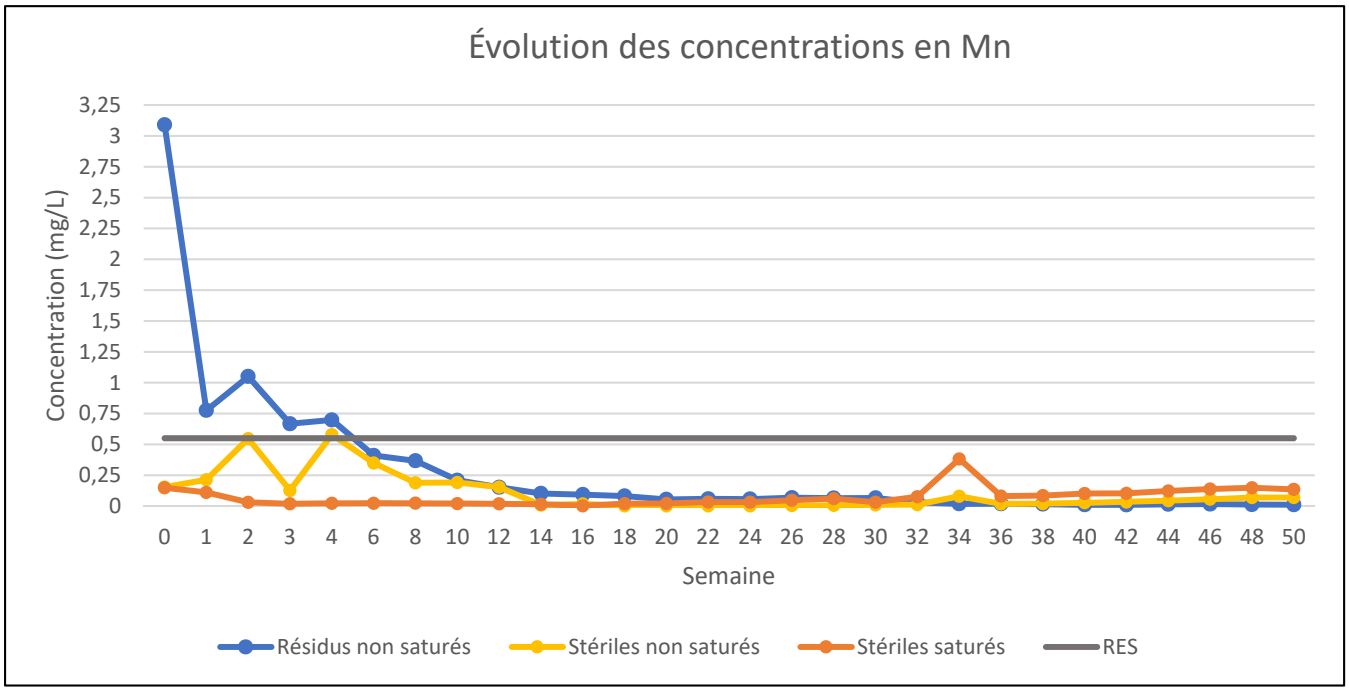
Les valeurs en manganèse pour la colonne de stériles non saturés sont demeurées près ou sous la LDR tout au long de l'essai, et donc sous le critère RES.

Des dépassements du critère RES ont été obtenus jusqu'à la 4e semaine pour la colonne de résidus.

Un seul dépassement à la 4e semaine a été obtenu pour la colonne de stériles non saturée.

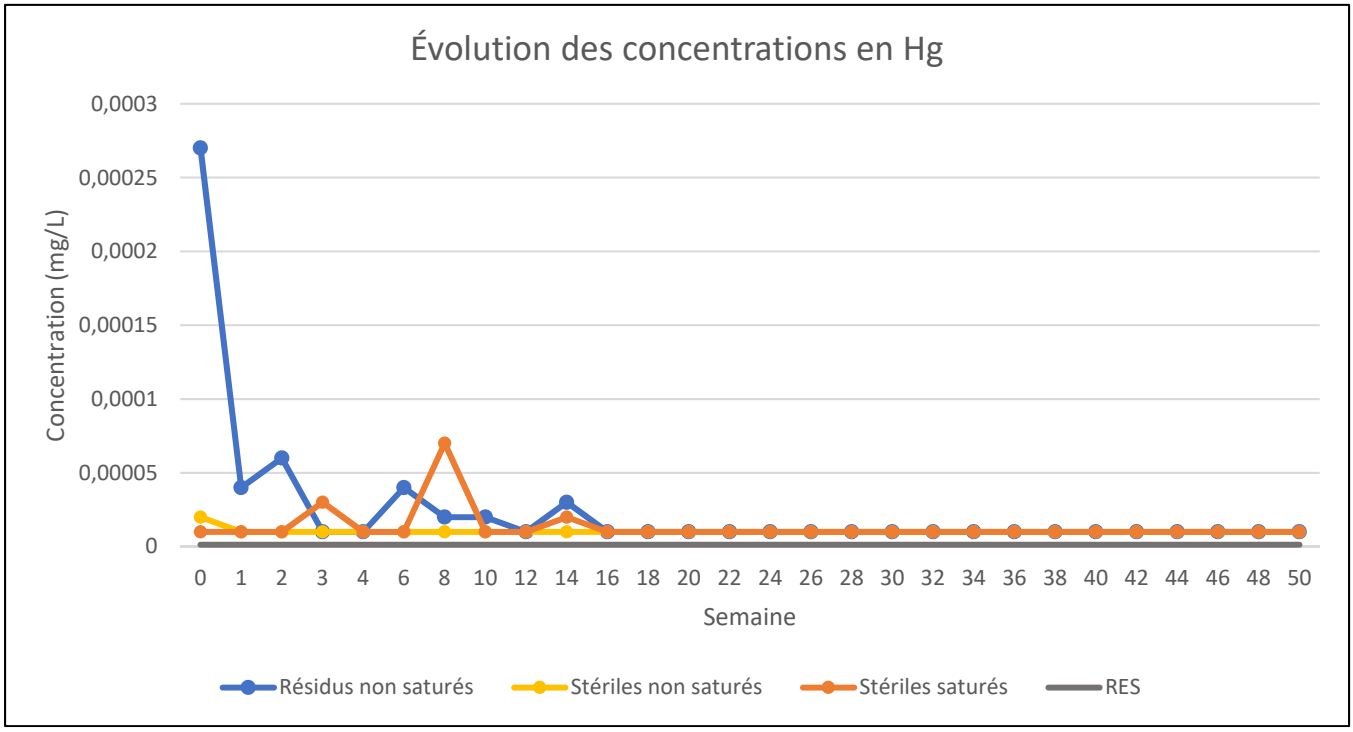
Ces deux colonnes semblent atteindre un plateau près de la LDR à partir de la 14e semaine.

Comme mentionné précédemment, une légère hausse a été observée à la semaine 34, attribuable à l'erreur du laboratoire lors du rinçage lors de la semaine 34.



MERCURE

Étant donné la très faible valeur du critère RES pour le mercure, les valeurs pour les trois colonnes sont demeurées au-dessus de ce dernier ou sous la LDR (plus élevée que le critère) tout au long de l'essai. Toutefois, les concentrations de mercure sont demeurées stables sous la LDR depuis la semaine 16.



NICKEL

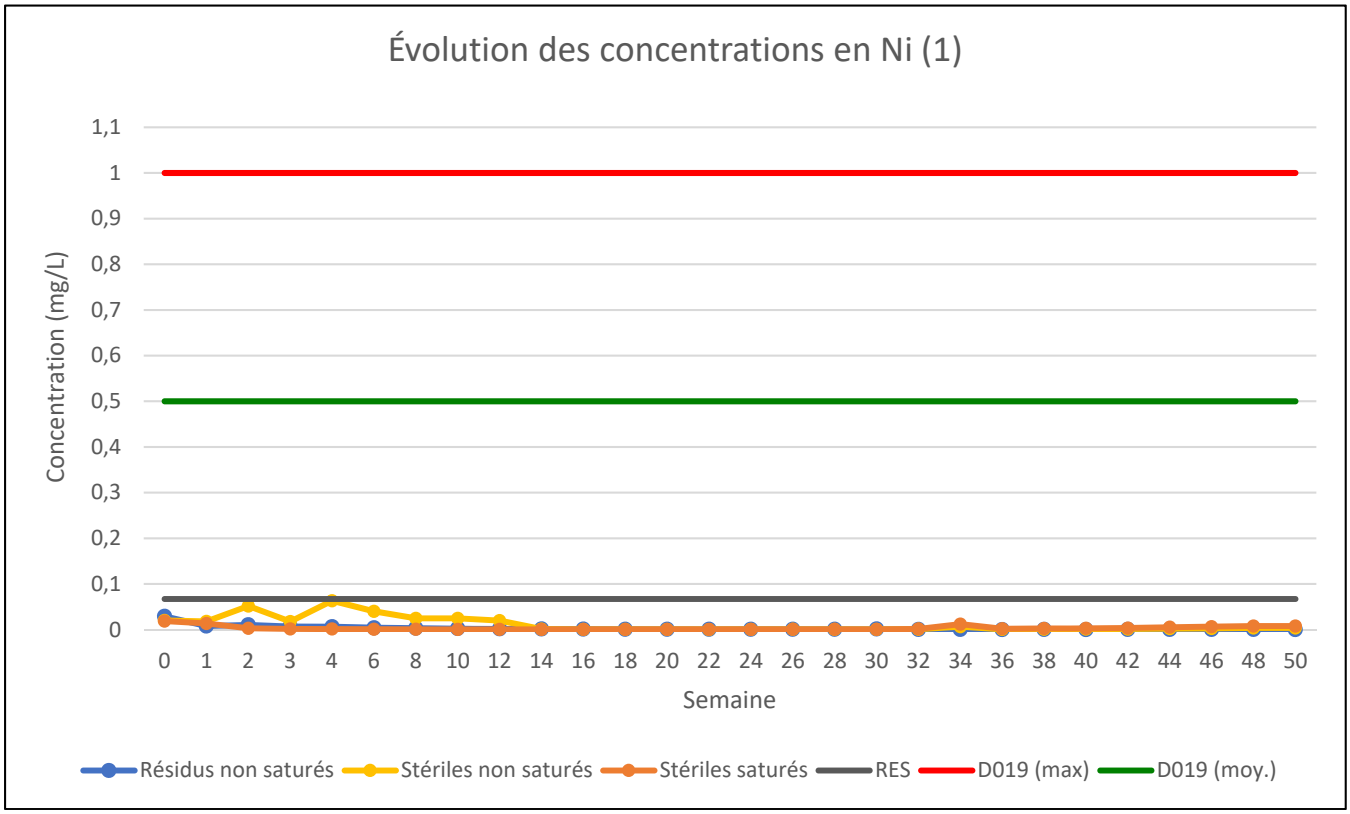
Les concentrations en nickel sont demeurées sous les exigences de rejet à l'effluent final maximales et moyennes mensuelles de la D019 tout au long de l'essai, et ce, pour les trois colonnes. Elles sont également demeurées sous le critère RES.

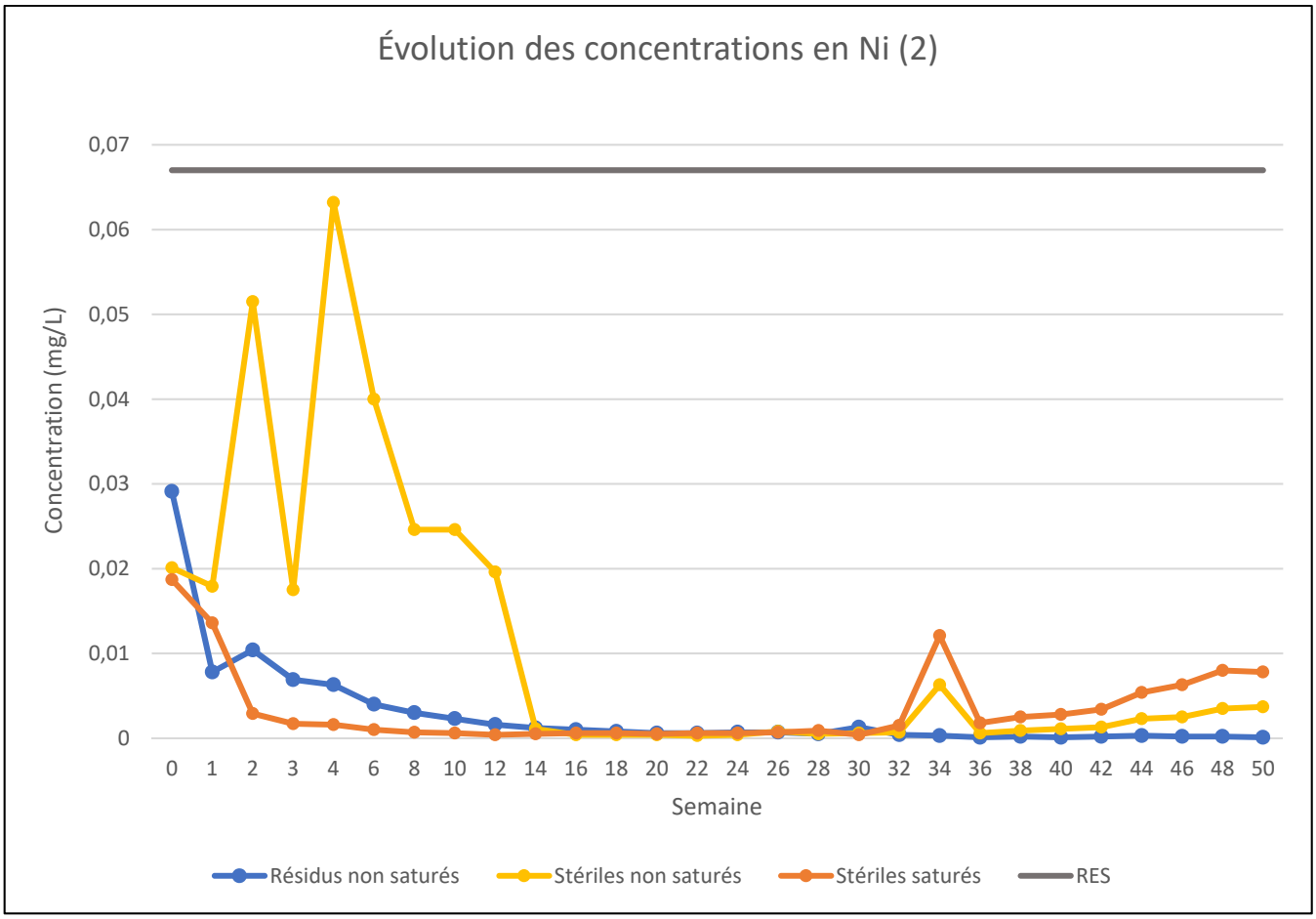
La colonne de résidus et la colonne de stériles saturés présentent des concentrations à la baisse dès la 2e semaine, et atteignent un plateau près de la LDR vers la 12e semaine.

Pour ce qui est de la colonne de stériles non saturés, des hausses sont observées à la 2e et la 4e semaine, et les résultats chutent pour atteindre un plateau à partir de la 14e semaine.

Comme mentionné précédemment, une légère hausse a été observée à la semaine 34, attribuable à l'erreur du laboratoire lors du rinçage lors de la semaine 34.

Une légère tendance à la hausse des concentrations a toutefois été observée à la suite de la 34e semaine. Il est possible que le type d'eau utilisée ait mené à l'activation d'une réaction induisant une certaine libération du nickel.


Évolution des concentrations en Ni (1)
Concentration (mg/L)
1,1
1
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
0 1 2 3 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50
Semaine
Résidus non saturés
Stériles non saturés
Stériles saturés
RES
D019 (max)
D019 (moy.)

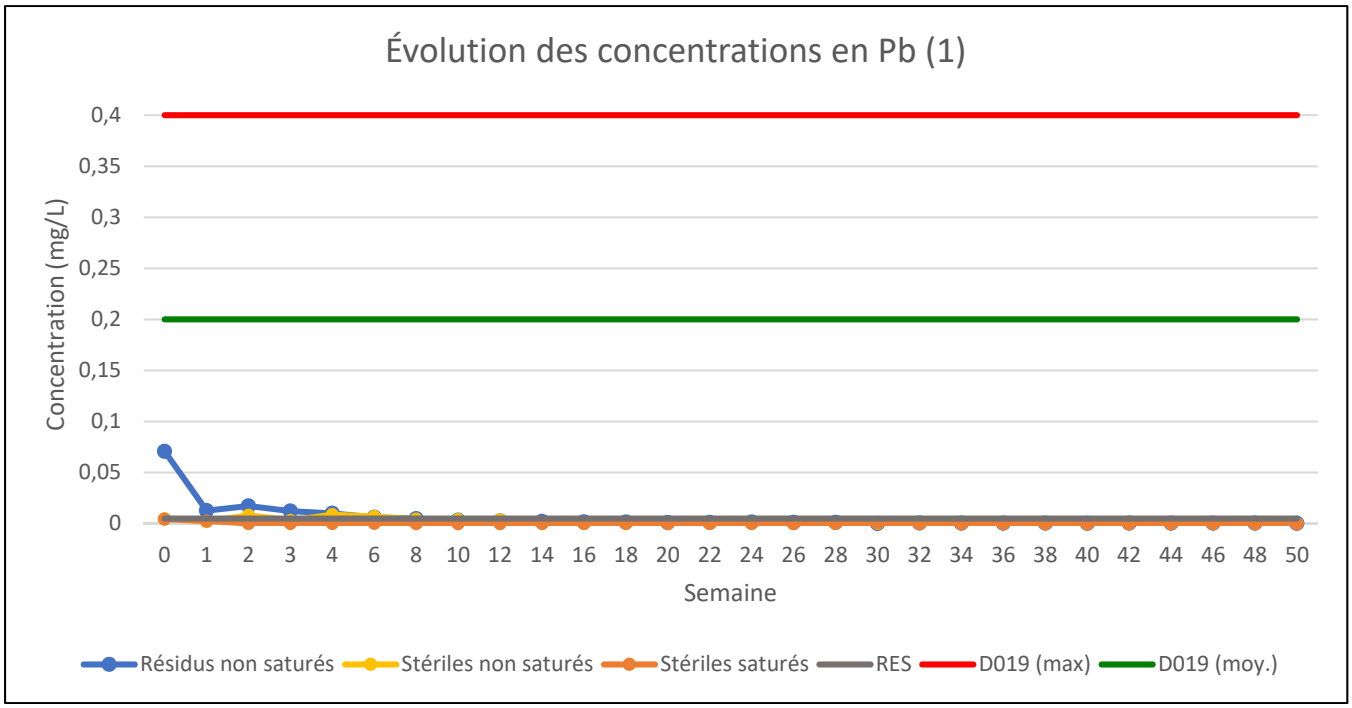

Évolution des concentrations en Ni (2)
Concentration (mg/L)
0,07
0,06
0,05
0,04
0,03
0,02
0,01
0
0 1 2 3 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50
Semaine
Résidus non saturés
Stériles non saturés
Stériles saturés
RES

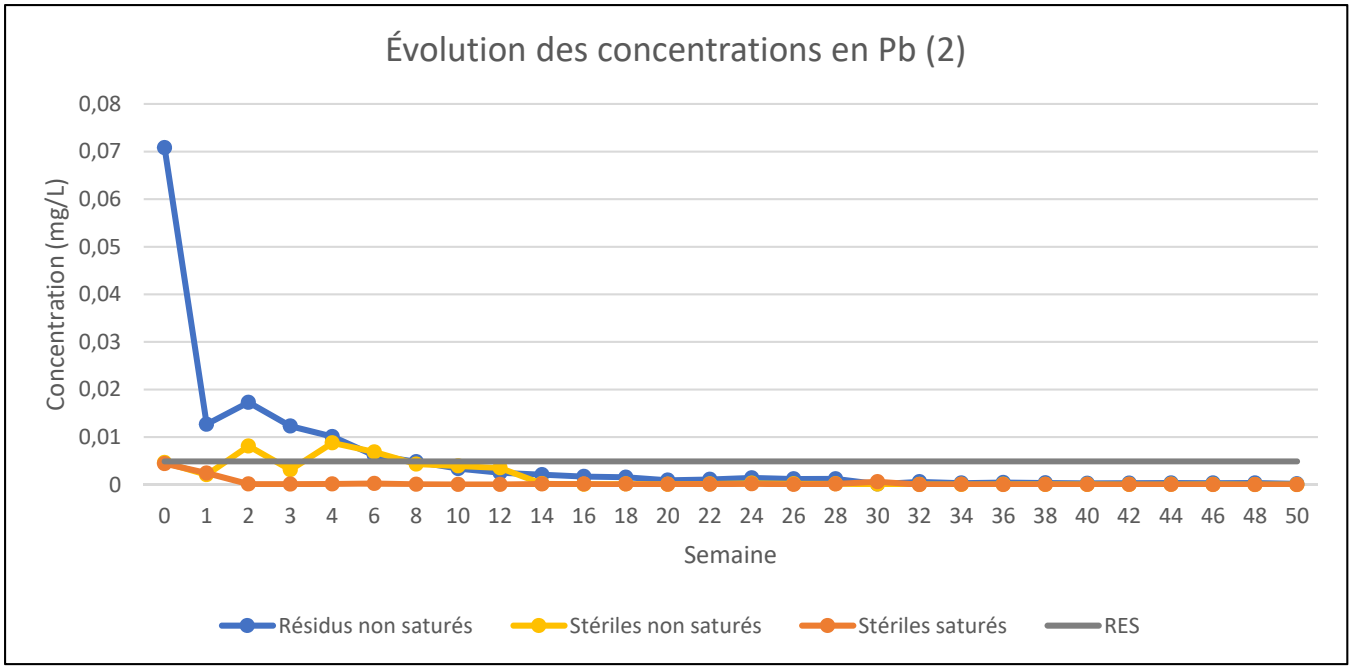
PLOMB

Les concentrations en plomb sont demeurées sous les exigences de rejet à l'effluent final maximales et moyennes mensuelles de la D019, et ce, pour les trois colonnes.

Les concentrations en plomb pour les stériles saturés sont également demeurées sous le critère RES tout au long de l'essai.

Celles pour la colonne de stériles non saturés ont montré des dépassements aux semaines 2, 4 et 6 alors que pour la colonne de résidus, des dépassements ont été obtenus jusqu'à la 6e semaine. Ces deux dernières colonnes atteignent un plateau près de la LDR à partir de la 10e semaine.



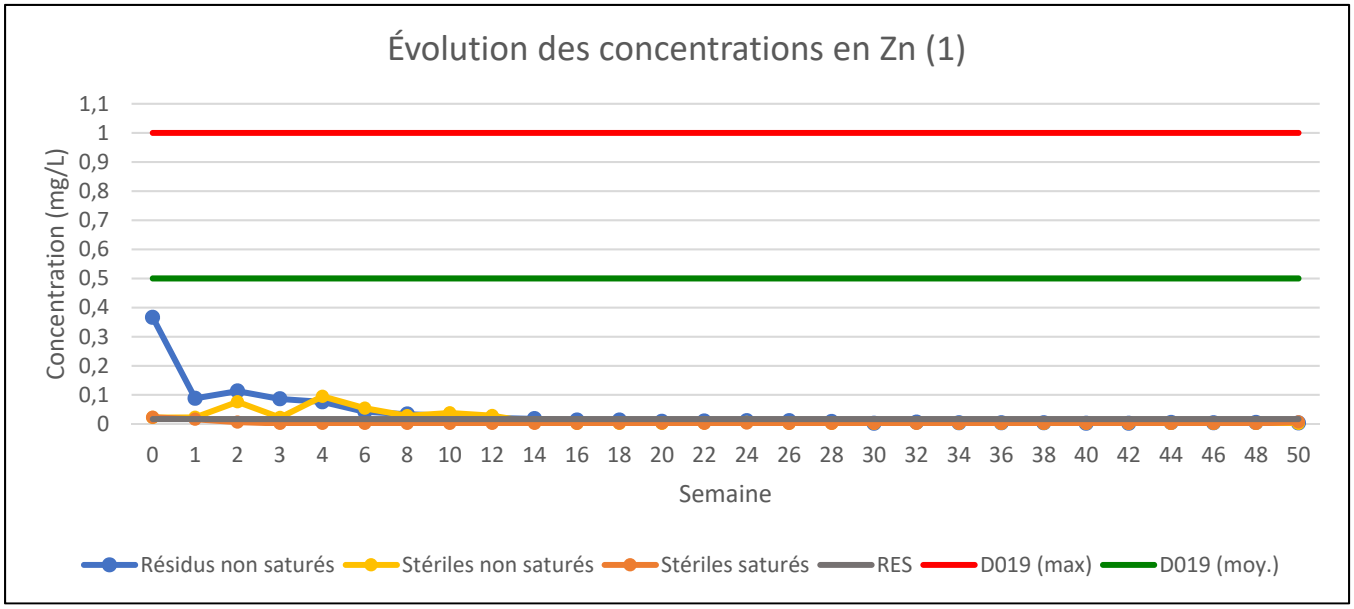


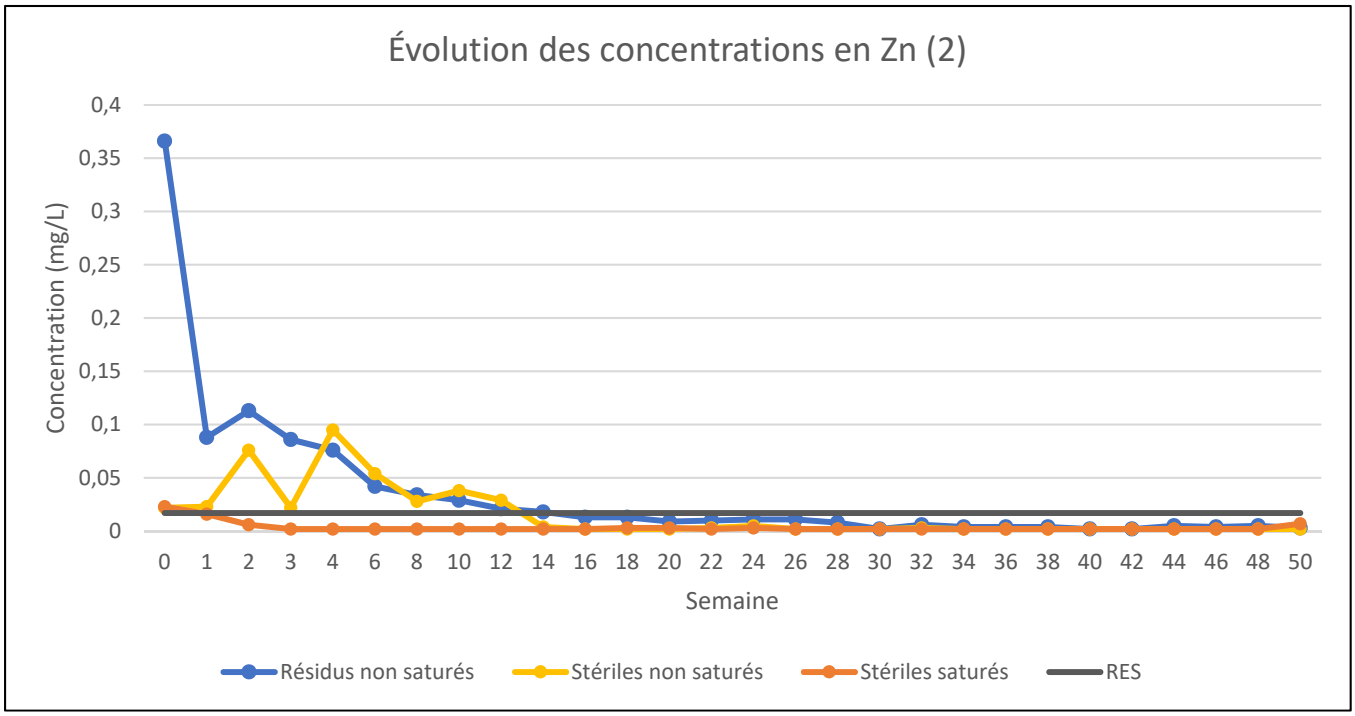
ZINC

Les concentrations en zinc sont demeurées sous les exigences de rejet à l'effluent final maximales et moyennes mensuelles de la D019, et ce, pour les trois colonnes.

Les concentrations en zinc pour la colonne de stériles saturés sont également demeurées sous le critère RES tout au long de l'essai, à l'exception de l'analyse initiale.

Celles pour les colonnes de stériles non saturés et de résidus ont montré des dépassements jusqu'à la 12e et 14e semaine respectivement. Ces deux colonnes atteignent toutefois par la suite un plateau près de la LDR.





6 INTERPRÉTATION DES RÉSULTATS

6.1 POTENTIELS DE GÉNÉRATION D'ACIDE

Trois colonnes d'essai ont fait l'objet de suivi au cours des essais cinétiques, soit une colonne composée de résidus, une colonne composée d'un mélange de stériles non saturés et une colonne composée d'un mélange de stériles maintenus saturés. Les résultats observés lors des essais cinétiques ont permis les observations suivantes :

- Le pH du lixiviat pour les trois colonnes s'est maintenu entre 7 et 8 au cours des 20 premières semaines d'essai, puis s'est stabilisé entre 6,25 et 7,01 jusqu'à la fin de l'essai.
- Les concentrations en SO_4 se sont maintenues entre 5 et 10 mg/L au cours de la majorité de l'essai pour les deux colonnes de stériles, alors qu'elles se sont maintenues en-dessous de 1 mg/L pour la colonne de résidus.
- L'acidité mesurée dans le lixiviat des trois colonnes s'est maintenue près de la limite de détection tout au long de l'essai. Seule une hausse a été mesurée à la 8e semaine pour les stériles non saturés (12 mg/L) et les stériles saturés (110 mg/L).
- La conductivité électrique était maximale en début d'essai, puis a atteint un plateau vers la 14e semaine pour les trois colonnes, soit à environ 15 µS/cm pour la colonne de résidus, 28 µS/cm pour la colonne de stériles non saturés et 35 µS/cm pour la colonne de stériles saturés.
- Le potentiel d'oxydoréduction a varié tout au long de l'essai pour les trois colonnes, se maintenant toutefois entre 500 mV et 75 mV.

Ainsi, à la lumière des résultats obtenus dans le cadre de ces essais cinétiques en colonnes, il apparaît que le potentiel de génération d'acide, tant des stériles en conditions saturées et non saturées que des résidus, est non significatif puisque le pH des trois colonnes s'est maintenu entre 6,25 et 8 tout au long de l'essai, et que le taux d'acidité dans l'eau de lixiviation est demeuré sous la LDR pratiquement tout au long de l'essai, de façon similaire dans les trois colonnes.

La conductivité mesurée est également moins importante pour les résidus que pour les stériles.

Les concentrations de SO_4 en solution sont également demeurées stables au long de l'essai. Il apparaît également que les concentrations de SO_4 dans le lixiviat des résidus sont moindres que dans celui des stériles. Les résidus miniers et les stériles sont donc jugés non générateurs d'acide.

6.2 POTENTIEL DE LIXIVIATION

COLONNE 1 –RÉSIDUS NON SATURÉS

- Les concentrations en argent étaient supérieures au critère RES les 6 premières semaines d'essai. Elles se sont maintenues sous la LDR à partir de la 8e semaine d'essai (à noter que la LDR [0, 00005 mg/L] était supérieure au critère RES [0,00003 mg/L]). Une valeur égale à la LDR, et donc supérieure au critère RES, a aussi été obtenue à la semaine 46. Comme cette valeur est ponctuelle et tout juste sur la LDR, elle n'est pas considérée avoir un impact significatif sur la qualité de l'eau. Il pourrait également s'agir d'un faux positif du laboratoire.
- Un dépassement de la concentration moyenne mensuelle de rejet à l'effluent final de la D019 a été obtenu lors de l'analyse initiale.

- Des dépassements du critère RES en cuivre ont été obtenus aux semaines 0 à 18, 22 et 28. Après la semaine 28, les concentrations se sont maintenues sous le critère RES.
- Des dépassements de la concentration maximale acceptable à l'effluent final de la D019 ont été obtenus pour le fer aux semaines 0 et 2, et des dépassements de la concentration moyenne mensuelle acceptable de rejet à l'effluent final ont été obtenus aux semaines 1, 3, 4 et 6. Les concentrations ont par la suite diminué graduellement, pour atteindre un plateau près de la LDR vers la 14e semaine.
- Des dépassements du critère RES pour le manganèse ont été obtenus entre les semaines 0 à 4 seulement. Les concentrations atteignent un plateau près de la LDR à partir de la 14e semaine.
- Des dépassements du critère RES ont été obtenus pour le mercure principalement entre les semaines 0 et 14. À partir de la semaine 16, les concentrations se maintiennent sous la LDR (à noter que la LDR [0,00001 mg/L] était supérieure au critère RES [0,0000013 mg/L]).
- Des dépassements du critère RES ont été obtenus pour le plomb au cours des 6 premières semaines d'essai. Les concentrations se stabilisent près de la LDR à partir de la 10e semaine.
- Des dépassements du critère RES ont été obtenus pour le zinc au cours des 14 premières semaines d'essai. Les concentrations se stabilisent près de la LDR à partir de la 16e semaine.
- Aucun dépassement des critères RES n'a été obtenu lors de l'essai pour l'arsenic, le baryum, le nickel.
- Aucun dépassement des concentrations acceptables (moyennes et maximales) de rejet à l'effluent final de la D019 n'a été obtenu lors de l'essai pour le cuivre, le nickel, le plomb et le zinc.

COLONNE 2 – MÉLANGE DE STÉRILES SATURÉS

- Seuls les résultats de l'analyse initiale et celle de la 1ere semaine étaient supérieurs à la LDR. Les concentrations se sont par la suite maintenues sous la LDR (à noter que la LDR [0, 00005 mg/L] était supérieure au critère RES (0,00003 mg/L).
- Un dépassement de la concentration maximale acceptable de rejet à l'effluent final de la D019 a été obtenu pour l'arsenic à la 3e semaine, et des dépassements de la concentration moyenne mensuelle acceptable ont été obtenus aux semaines 2, 4 et 6. Des dépassements du critère RES ont aussi été obtenus aux semaines 3 et 4. Les concentrations ont par la suite chuté pour atteindre un plateau vers la 24e semaine.
- Un dépassement du critère RES pour le baryum a été obtenu lors de l'analyse initiale. Les concentrations se stabilisent toutefois près de la LDR à partir de la 2e semaine.
- Des dépassements du critère RES pour le cuivre ont été obtenus lors de l'analyse initiale et celle de la semaine 1. Les concentrations se stabilisent toutefois sous le critère RES à partir de la 2e semaine.
- Un dépassement de la concentration maximale acceptable de rejet à l'effluent final de la D019 a été obtenu pour le fer lors de l'analyse initiale, et un dépassement de la concentration moyenne mensuelle a été obtenu lors de la 1ere semaine; les concentrations se sont stabilisées près de la LDR dès la 2e semaine.
- Des dépassements du critère RES ont été obtenus pour le mercure principalement entre les semaines 0 et 14. À partir de la semaine 16, les concentrations se maintiennent sous la LDR (à noter que la LDR [0,00001 mg/L] était supérieure au critère RES [0,0000013 mg/L]).
- Un dépassement du critère RES pour le zinc a été obtenu lors de l'analyse initiale seulement. Par la suite, les concentrations sont demeurées près ou sous la LDR.

- Aucun dépassement du critère RES n'a été obtenu lors de l'essai pour le manganèse, le nickel et le plomb.
- Aucun dépassement des concentrations acceptables (moyennes et maximales) de rejet à l'effluent final de la D019 n'a été obtenu lors de l'essai pour le cuivre, le nickel, le plomb et le zinc.

COLONNE 3 – MÉLANGE DE STÉRILES NON SATURÉS

- Les concentrations en argent étaient supérieures au critère RES les 12 premières semaines d'essai. Elles se sont maintenues sous la LDR à partir de la 14e semaine d'essai (à noter que la LDR [0, 00005 mg/L] était supérieure au critère RES [0, 00003 mg/L]).
- Des dépassements de la concentration moyenne mensuelle acceptable de rejet à l'effluent final de la D019 pour l'arsenic ont été obtenus aux semaines 4 et 6; les concentrations sont demeurées sous les exigences de la D019 par la suite.
- Des dépassements du critère RES pour le baryum ont été obtenus aux semaines 0, 2, 4, 5 et 10. Les concentrations se stabilisent toutefois près de la LDR à partir de la 14e semaine.
- Des dépassements du critère RES pour le cuivre ont été obtenus entre les semaines 0 et 12. Les concentrations se stabilisent toutefois sous le critère RES à partir de la 14e semaine.
- Des dépassements de la concentration maximale acceptable de rejet à l'effluent final de la D019 ont été obtenus pour le fer entre les semaines 0 et 12. Les concentrations ont chuté pour atteindre un plateau près de la LDR à la 14e semaine.
- Des dépassements du critère RES pour le manganèse ont été obtenus aux semaines 2 et 4 seulement. Les concentrations atteignent un plateau près de la LDR à partir de la 14e semaine.
- Les concentrations se sont maintenues sous la LDR tout au long de l'essai, à l'exception de l'analyse initiale (à noter que la LDR [0,00001 mg/L] était supérieure au critère RES [0,0000013 mg/L]).
- Des dépassements du critère RES ont été obtenus pour le plomb aux semaines 2, 4 et 6. Les concentrations se stabilisent près de la LDR à partir de la 10e semaine.
- Des dépassements du critère RES ont été obtenus pour le zinc au cours des 12 premières semaines d'essai. Les concentrations se stabilisent près de la LDR à partir de la 14e semaine.
- Aucun dépassement des critères RES n'a été obtenu lors de l'essai pour l'arsenic et le nickel.
- Aucun dépassement des concentrations acceptables (moyennes et maximales) de rejet à l'effluent final de la D019 n'a été obtenu lors de l'essai pour le cuivre, le nickel, le plomb et le zinc.

À la lumière de ces résultats, bien que certains métaux aient été relargués en concentrations excédant les critères du RES et/ou les exigences de rejet à l'effluent final de la D019, le relargage s'est limité, dans la majorité des cas, aux premières semaines de l'essai. Une valeur égale à la LDR (0,00005 mg/L), et donc supérieure au critère RES, a aussi été obtenue à la semaine 46 pour la colonne de résidus. Comme cette valeur est ponctuelle et tout juste sur la LDR, elle n'est pas considérée avoir un impact significatif sur la qualité de l'eau. Il pourrait également s'agir d'un faux positif du laboratoire.

Ainsi, dans le cas de la colonne de résidus, aucun dépassement des critères RES et/ou des exigences de rejet à l'effluent final de la D019 n'était obtenu après la 14e semaine sauf pour le cuivre, pour lequel les dépassements ont cessé après la 28e semaine.

En ce qui concerne la colonne du mélange de stériles non saturés, aucun dépassement des critères RES et/ou des exigences de rejet à l'effluent final de la D019 n'était obtenu après la 12e semaine.

Dans le cas de la colonne du mélange de stériles saturés, à l'exception du mercure, les dépassements des critères RES et/ou des exigences de rejet à l'effluent final de la D019 se sont limités aux premières semaines d'essai, soit jusqu'à la semaine 4.

Il apparaît donc qu'au terme de l'essai, les stériles en conditions non saturées et saturées et les résidus miniers semblent présenter des comportements similaires sur l'échelle de temps de l'essai.

Le relargage de métaux est moins important et s'échelonne sur une période plus restreinte pour la colonne de stériles saturés que pour les autres, exception faite de l'arsenic. Ceci peut s'expliquer par le fait que l'arsenic est plus soluble dans l'eau que plusieurs autres métaux.

Ces résultats supposent que les stériles et les résidus sont potentiellement lixiviables à court terme, mais que le relargage de métaux est significativement limité et respecte les critères et exigences applicables (D019 et RES) après en moyenne 12 semaines. Ces matériaux peuvent donc être considérés comme étant à faibles risques selon la D019 au terme de cette période.

Tableau 3 Sommaire des dépassements des critères RES et des exigences à l'effluent final de la D019 au cours des essais en colonnes

Colonne	Paramètre	Dépassement D019[1, 2]	Dépassement RES	Stabilisation	Dépassement D019 à la fin de l'essai	Dépassement RES à la fin de l'essai
Colonne 1 - Résidus non saturés	Argent	-	Semaines 0 à 6, semaine 46 (0,00005 mg/L)	Semaine 8	-	Non (LDR > RES)
	Arsenic	Semaine 0 (moy.)	-	-	Non	-
	Cuivre	-	Semaines 0 à 18, 22 et 28	Semaine 32	-	Non
	Fer	Semaines 0 et 2 (max.) Semaines 1, 3, 4 et 6 (moy.)	-	Semaine14	Non	-
	Manganèse	-	Semaines 0 à 4	Semaine 10	-	Non
	Mercure	-	Semaines 0 à 14	Semaine 16	-	Non (LDR > RES)
	Plomb	-	Semaines 0 à 6	Semaine 10	-	Non
	Zinc	-	Semaines 0 à 14	Semaine 16	-	Non
Colonne 2 – Mélange de stériles saturés	Argent	-	Semaine 1	Semaine 2	-	Non (LDR > RES)
	Arsenic	Semaine 3 (max.) Semaines 2, 4 et 6 (moy.)	Semaines 3 et 4	Semaine 24	Non	Non
	Baryum	-	Semaine 0	Semaine 2	-	Non
	Cuivre	-	Semaine 0 et 1	Semaine 2	-	Non
	Fer	Semaine 0 (max.) Semaine 1 (moy.)	-	Semaine 2	Non	-
	Mercure	-	Semaines 0 à 14	Semaine 16	-	Non (LDR > RES)
	Zinc	-	Semaine 0	Semaine 2	-	Non
Colonne 3 – Mélange de stériles non saturés	Argent	-	Semaines 0 à 12	Semaine 14	-	Non (LDR > RES)
	Arsenic	Semaines 4 et 6 (moy.)	-	-	Non	-
	Baryum	-	Semaines 0, 2, 4, 5 et 10	Semaine 14	-	Non
	Cuivre	-	Semaines 0 à 12	Semaine 14	-	Non
	Fer	Semaines 0 à 12 (max.)	-	Semaine 14	Non	-
	Manganèse	-	Semaines 2 et 4	Semaine 14	-	Non
	Mercure	-	Semaine 0	Semaine 1	-	Non (LDR > RES)
	Plomb	-	Semaines 2, 4 et 6	Semaine 10	-	Non
	Zinc	-	Semaines 0 à 12	Semaine 14	-	Non

[1] : Max. : dépassement pour la concentration maximale acceptable – Tableau 2.1 -Exigences au point de rejet de l'effluent final
[2] : Moy. : dépassement pour la concentration moyenne mensuelle acceptable – Tableau 2.1 -Exigences au point de rejet de l'effluent final

7 CONCLUSIONS

Galaxy a fait appel à WSP afin de réaliser une caractérisation géochimique des stériles miniers, du minerai, des dépôts meubles de surface et des résidus miniers qui seront extraits et produits lors de la mise en production du gisement, qui a été déposée dans le cadre de l'ÉIE en juillet 2018.

À la suite des résultats de cette étude, afin de raffiner les conclusions sur le potentiel de lixiviation des stériles et des résidus miniers, Galaxy a mandaté WSP afin de réaliser des essais cinétiques en colonnes.

Ainsi, à la lumière des résultats obtenus dans le cadre de ces essais cinétiques en colonnes, il apparaît que le potentiel de génération d'acide des stériles en conditions saturées et non saturées et des résidus est non significatif, puisque le pH des trois colonnes s'est maintenu entre 6,25 et 8 tout au long de l'essai, et que le taux d'acidité dans l'eau de lixiviation est demeuré sous la LDR pratiquement tout au long de l'essai. Les résidus miniers et les stériles sont donc jugés non générateurs d'acide.

De plus, il apparaît, au terme de l'essai que les stériles et les résidus présentent des comportements similaires sur l'échelle de temps de l'essai.

Le relargage de métaux est moins important et s'échelonne sur une période plus restreinte pour la colonne de stériles saturés que pour les autres colonnes, exception faite de l'arsenic. Ceci peut s'expliquer par le fait que l'arsenic est plus soluble dans l'eau que plusieurs autres métaux.

Ainsi, ces résultats supposent que les stériles et les résidus sont potentiellement lixiviables à court terme selon la D019, mais que le relargage de métaux est significativement limité et respecte les critères et exigences applicables (D019 et RES) après en moyenne 12 à 14 semaines, à l'exception du cuivre dans la colonne de résidus, qui lui est lixiviable ponctuellement jusqu'à 28 semaines. Étant donné que les matériaux solides (stériles et résidus miniers) ont indiqué des concentrations supérieures aux critères génériques « A » du Guide d'intervention du MELCC pour certains métaux et que les résultats en métaux dans le lixiviat sont inférieurs au critère RES du MELCC, ces matériaux peuvent donc être considérés comme étant à faibles risques selon la D019 au terme de cette période.

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ANNEXE

A

LIMITES ET CONDITIONS GÉNÉRALES DE L'ÉTUDE

Le présent rapport est constitué de la partie descriptive du texte ainsi que de l'ensemble des tableaux, cartes et annexes associés. L'utilisation d'informations extraites de ce rapport, mises hors du contexte général de l'étude, peut conduire à une fausse interprétation de résultats partiels ou fragmentaires.

Le présent document a été préparé pour l'usage exclusif du client. Toute utilisation d'information contenue dans ce rapport ne peut être effectuée sans une approbation écrite des personnes ou entités pour lesquelles il a été préparé.

Les informations présentées dans ce rapport et qui ont été obtenues par l'entremise d'un tiers n'ont pas été indépendamment vérifiées ou autrement examinées par WSP pour en déterminer l'exactitude ou la totalité. WSP a utilisé ces informations de bonne foi et n'acceptera aucune responsabilité pour toute déficience, mauvaise interprétation ou inexactitude présentée dans ce rapport résultant d'omissions, de mauvaises interprétations ou encore, d'actes frauduleux des personnes interviewées ou contactées dans le contexte de cette étude.

L'étude des dossiers raisonnablement vérifiables inclut tous les dossiers fournis par le client ou offerts au public et pouvant être obtenus dans des délais raisonnables et moyennant des frais raisonnables.

L'étude dresse un portrait de la propriété à un moment précis dans le temps. Les observations relevées lors de la visite de la propriété se limitent aux conditions existantes le jour où les représentants de WSP étaient présents sur les lieux.

Les travaux réalisés, tels que décrits dans ce rapport, ont été conduits avec le même niveau de prudence et de diligence qui est normalement exercé dans le domaine de l'ingénierie et des sciences dans des conditions similaires.

Le contenu de ce rapport est basé sur l'information obtenue au cours des travaux, sur notre compréhension actuelle des conditions prévalant sur le site et sur notre jugement professionnel à la lumière de ces informations au moment d'écrire ce rapport. Les observations, les opinions émises et l'interprétation des informations sont relatives à la présence de signes de pollution réelle ou potentielle sur la propriété et ne s'avèrent pas une évaluation de la propriété en ce qui a trait aux aspects structuraux du bâtiment ou aux aspects géotechniques du site. Ce rapport ne procure pas une opinion légale en regard des réglementations et lois applicables.

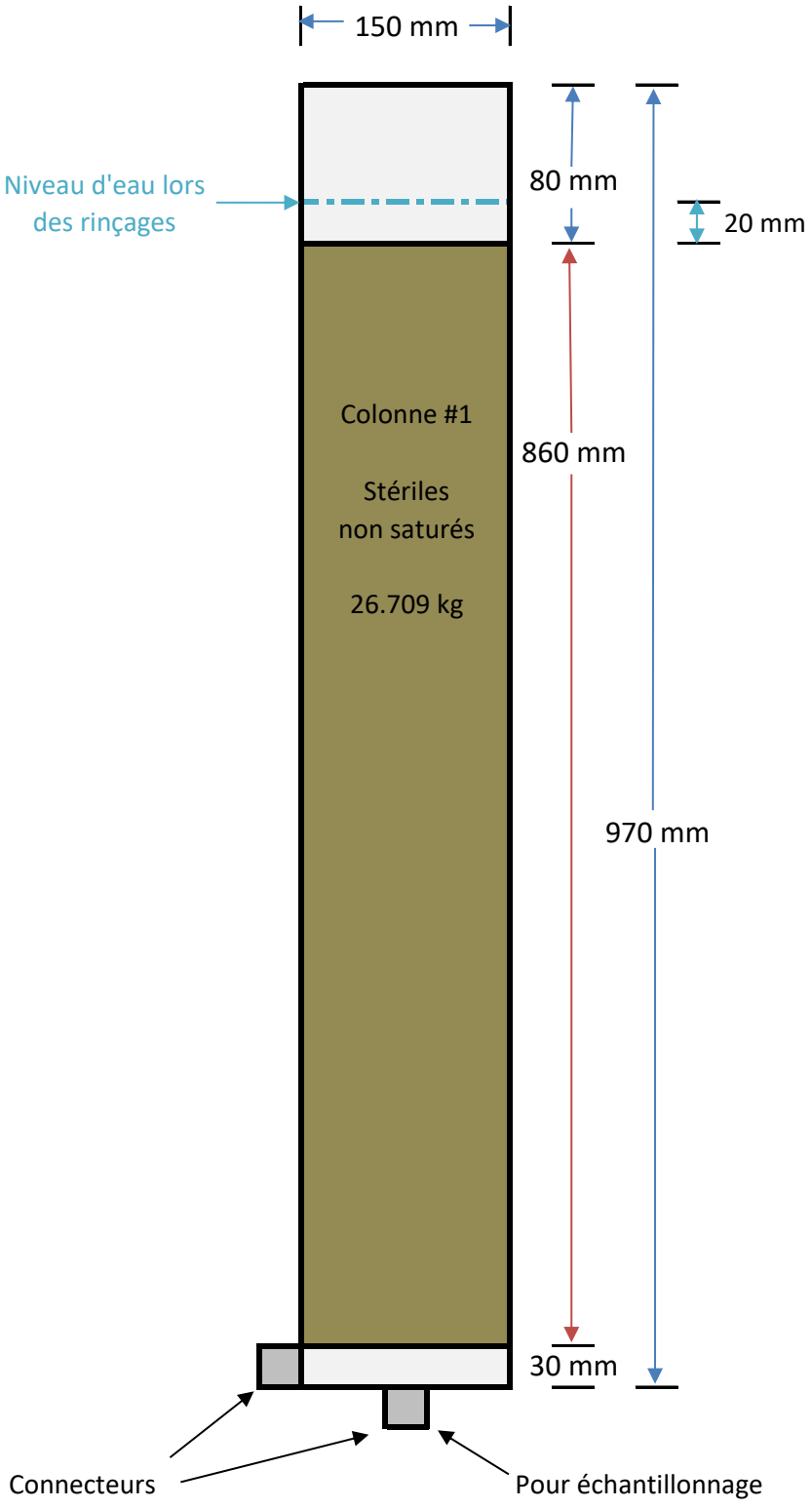
WSP n'a aucun lien avec le client, ni aucun intérêt dans la propriété à l'étude.

ANNEXE

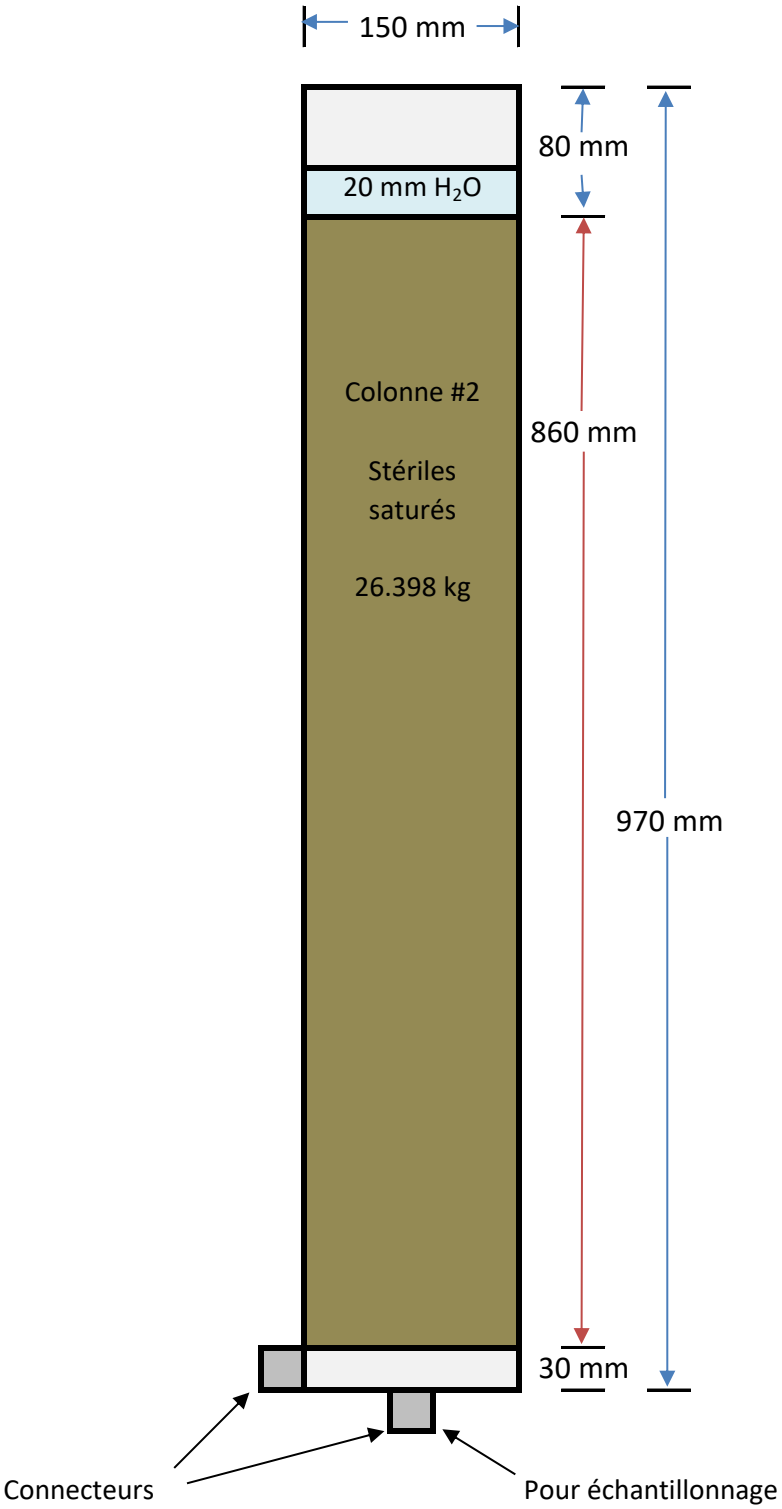
B

SCHÉMAS DES COLONNES

Colonne 1 - Stériles non saturés



Colonne 3 - Stériles saturés



Colonne 2 - Mélange de stériles et résidus

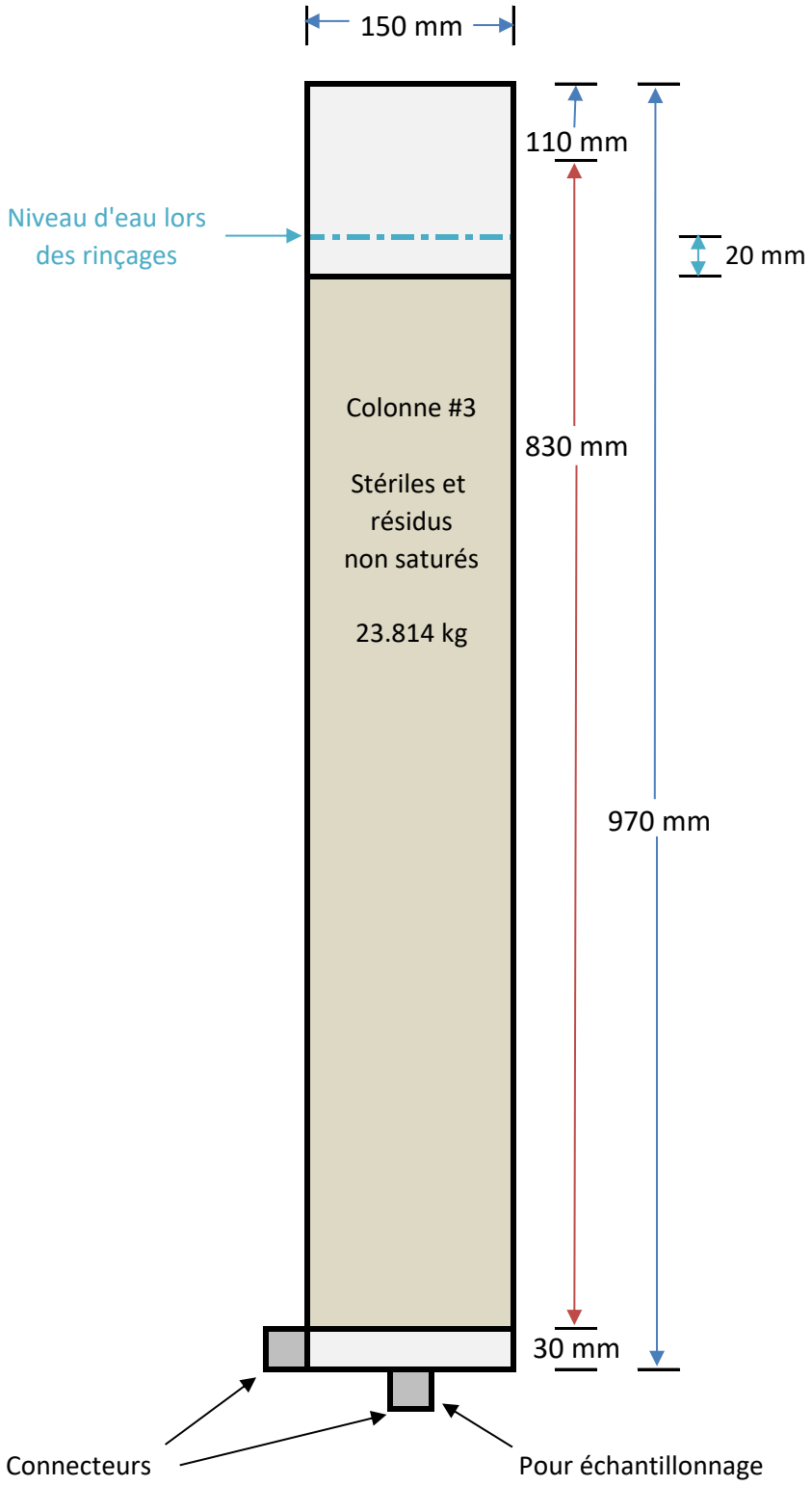


Photo 1 : Colonne nº 1. Résidus non saturés (photo prise lors d'un rinçage)	Photo 2 : Colonne nº 2. Stériles saturés (photo prise lors d'un rinçage)	Photo 3 : Colonne nº 3. Stériles non saturés (photo prise lors d'un rinçage)

ANNEXE

C

TABLEAUX DES RÉSULTATS DES ESSAIS CINÉTIQUES

Tableau C-1
Résultats des essais en colonnes
Analyses initiales sur les stériles et les résidus - Composition initiale
Projet Galaxy
N/Réf : 171-02562-00

Paramètres	Critères (1) ou valeurs limites (2) (mg/kg)				LDR (3) (mg/kg)	Échantillon / Date de prélèvement / Résultats d'analyse (mg/kg)	
	A	B	C	D		Galaxy Waste Rock	Bulk DMS Tails
						Avril 2018	Avril 2018
Whole Rock Analysis (%)							
SiO2	-	-	-	-	0,1	65,3	76,4
Al2O3	-	-	-	-	0,1	15,8	13,6
Fe2O3	-	-	-	-	0,1	5,18	0,37
MgO	-	-	-	-	0,1	2,21	0,06
CaO	-	-	-	-	0,1	2,30	0,39
Na2O	-	-	-	-	0,1	3,60	4,45
K2O	-	-	-	-	0,1	2,60	3,24
TiO2	-	-	-	-	0,1	0,44	0,02
P2O5	-	-	-	-	0,1	0,27	0,33
MnO	-	-	-	-	0,1	0,07	0,04
Cr2O3	-	-	-	-	0,1	0,02	0,01
V2O5	-	-	-	-	0,1	0,02	<0,01
LOI	-	-	-	-	0,1	0,96	0,56
Somme	-	-	-	-	0,1	98,8	99,5
Métaux (mg/kg)							
Aluminium	-	-	-	-		67000	57000
Antimoine	-	-	-	-		<0,8	<0,8
Argent	2	20	40	200	0,5	0,21	0,04
Arsenic	6	30	50	250	1	***300***	**34**
Baryum	340	500	2 000	10 000	20	**510**	71
Béryllium	-	-	-	-		11	63
Bore	-	-	-	-		<1	<1
Bismuth	-	-	-	-		1,2	0,85
Calcium	-	-	-	-		15000	2600
Cadmium	1,5	5	20	100	0,5	0,7	0,4
Chrome	100	250	800	4 000	2	92	31
Cobalt	25	50	300	1 500	2	17	0,87
Cuivre	50	100	500	2 500	1	**120**	**53**
Étain	5	50	300	1 500	5	**28**	**23**
Fer	-	-	-	-		32000	2900
Potassium	-	-	-	-		20000	24000
Lithium	-	-	-	-		770	1100
Magnésium	-	-	-	-		11000	180
Manganèse	1000	1 000	2 200	11 000	10	550	210
Mercure	0,2	2	10	50	0,2	<0,05	<0,05
Molybdène	2	10	40	200	1	**8,7**	**7,8**
Nickel	50	100	500	2 500	2	**53**	2,6
Plomb	50	500	1 000	5 000	5	17	18
Sélénium	1	3	10	50	0,5	<0,7	<0,7
Sodium	-	-	-	-		23000	28000
Strontium	-	-	-	-		320	84
Thorium	-	-	-	-		7,4	11
Titane	-	-	-	-		2300	540
Thallium	-	-	-	-		3,1	5,5
Tungstène	-	-	-	-		9	1,4
Uranium (4)	-	-	-	-		3,8	5,1
Vanadium	-	-	-	-		75	13
Yttrium	-	-	-	-		7,7	6,2
Zinc	140	500	1 500	7 500	5	80	14

NOTES:

(1): Critères génériques du Guide d'intervention - Protection des sols et réhabilitation des terrains contaminés (MDDELCC, 2019).
Pour les métaux et métalloïdes, les critères « A » utilisés représentent la teneur de fond établie pour la province géologique du Supérieur.

(2): Normes de l'Annexe I du Règlement sur l'enfouissement des sols contaminés (RESC), communément appelées critères D.

(3): Limite de détection rapportée par le laboratoire d'analyses.

LÉGENDE:

-	: Non défini ou non analysé
100	: Concentration ≤ A
100	: A < Concentration ≤ B
100	: Concentration >CCME

100
100
100

Tableau C-2
Résultats des essais en colonnes
Analyses initiales sur les stériles et les résidus - MABA
Projet Galaxy
N/Réf : 171-02562-00

Paramètres	**Échantillon / Échantillon par code de lithologie / Date de prélèvement / Intervalle d'échantillonnage (m) / Résultats d'analyse**	
	Galaxy Waste Rock	Bulk DMS Tails
	Avril 2018	Avril 2018
Données initiales		
Paste pH	9,66	9,61
Fizz rate	1	1
Poids de l'échantillon	2,00	2,01
Potentiel (kg $CaCO_3$/T)		
Potentiel neutralisant brut (PN)	6,6	5,1
Potentiel d'acidité maximum (PA)	3,44	0,62
Soufre (% masse sèche)		
Soufre total	0,214	<0,005
Sulfates	0,1	<0,02
Sulfures	0,11	<0,02
Analyse [1]		
PN-PA	3,16	4,48
Ratio PN/PA	1,92	8,23
Résultat D019 [2]	NPGA	NPGA
Résultat MEND [3]	*Zone d'incertitude*	*NPGA*

LÉGENDE:
PAG : Potentiellement générateur d'acide
Incertain : Dans la zone d'incertitude de potentiel de génération d'acide
NPAG : Non potentiellement générateur d'acide

[1] Lorsque le résultat était inférieur à la limite de détection, une valeur égale à la limite de détection a été utilisée pour le calcul du PN-PA et du ration PN/PA.
[2] Résultats interprétés selon la définition du potentiel de génération d'acide des résidus ou stériles miniers exprimée dans la Directive 019 sur l'industrie minière.
[3] Résultats interprétés selon la définition du potentiel de génération d'acide des résidus ou stériles miniers exprimée dans le *Prediction Manual for* Drainage Chemistry from Sulphidic Geologic Materials du *Mine Environement Neutral Drainage Program* (MEND).

Tableau C-3 (1 de 5)
Résultats des essais en colonnes
Colonne #1 : Résidus non saturés
Projet Galaxy
N/Réf : 171-02562-00

Paramètres	Critères (mg/L)		LDR[3] (mg/L)	Semaine / Résultats d'analyse (mg/L)												
	RES [1]	D019 [2]		Initial		Semaine 1		Semaine 2		Semaine 3		Semaine 4		Semaine 5	Semaine 6	
				Totaux	Dissouts	Totaux	Dissouts	Totaux	Dissouts	Totaux	Dissouts	Totaux	Dissouts	Totaux	Totaux	Dissouts
Métaux (mg/L)																
Aluminium	-	-	0,0003	27,5	5,65	5,53	0,184	11,4	0,435	5,59	0,154	6,43	0,403	---	3,44	0,841
Antimoine	1,1	-	0,0002	0,0008	<0,0002	0,0017	0,0016	0,0013	0,0015	0,001	0,0028	0,0011	<0,0002	---	0,0011	<0,0002
Argent [4]	0,00003	-	0,000002	**0,00049**	**0,00018**	**0,00027**	<0,00005	**0,00017**	<0,00005	**0,00012**	<0,00005	<0,00005	<0,00005	---	**0,00006**	<0,00005
Arsenic	0,34	0,4	0,0002	0,316	0,224	0,199	0,124	0,197	0,125	0,171	0,0944	0,148	0,101	---	0,107	0,0743
Baryum [4]	0,11	-	0,00002	0,0942	0,045	0,0204	0,00074	0,0326	0,00156	0,0194	0,0005	0,0179	0,00168	---	0,0104	0,00365
Béryllium	-	-	0,000007	0,018500	0,006620	0,003900	0,000125	0,006140	0,000231	0,003610	0,000069	0,005610	0,000331	---	0,002260	0,000506
Bore	28	-	0,0002	0,065	0,047	0,052	0,046	0,037	0,016	0,015	0,011	0,025	0,010	---	0,014	0,009
Bismuth	-	-	0,000007	0,039600	0,018400	0,006550	0,000130	0,009910	0,000435	0,007110	0,000150	0,005570	0,000598	---	0,003420	0,000945
Calcium	-	-	0,01	11,90	9,82	8,15	6,05	6,27	3,35	5,46	3,26	6,20	3,70	---	4,39	3,26
Cadmium [4]	0,0002	-	0,000003	**0,000669**	**0,000410**	0,000156	0,000017	**0,000219**	0,000013	0,000115	0,000003	0,000116	0,000006	---	0,000082	0,000022
Chrome	-	-	0,00003	0,02430	0,01280	0,00822	0,00060	0,01500	0,00104	0,00964	0,00069	0,01200	0,00160	---	0,00874	0,00247
Cobalt	0,37	-	0,000004	0,008890	0,005780	0,002490	0,000524	0,003030	0,000239	0,002000	0,000092	0,001840	0,000218	---	0,001160	0,000370
Cuivre [4]	0,0015	0,6	0,00002	**0,04450**	**0,02840**	**0,01360**	**0,00310**	**0,01690**	**0,00235**	**0,01200**	0,00125	**0,01120**	0,00144	---	**0,00731**	**0,00226**
Étain	-	-	0,00001	0,06810	0,06600	0,08020	0,07730	0,04850	0,03600	0,02130	0,01920	0,01530	0,01370	---	0,00949	0,00827
Fer	-	6	0,002	**19,200**	**8,870**	4,970	0,093	**7,570**	0,308	4,810	0,074	5,460	0,382	---	3,310	0,857
Potassium	-	-	0,002	11,1	7,24	7,21	6,02	7,65	3,97	4,72	3,01	4,69	2,6	---	2,64	2
Lithium	-	-	0,000006	1,23	0,859	2,51	2,4	1,65	1,62	1,21	1,15	1,93	1,35	---	0,683	0,636
Magnésium	-	-	0,003	2,31	0,891	0,984	0,594	1	0,348	0,694	0,335	0,71	0,375	---	0,485	0,342
Manganèse [4]	0,55	-	0,00001	**3,09**	**1,96**	**0,775**	0,0153	**1,05**	0,0416	**0,667**	0,00635	**0,698**	0,0645	---	0,41	0,101
Mercure	0,0000013	-	0,00001	**0,00027**	**0,00014**	**0,00004**	<0,00001	**0,00006**	**0,00004**	<0,00001	<0,00001	**0,00001**	<0,00001	---	**0,00004**	**0,00002**
Molybdène	29	-	0,00001	0,00469	0,00294	0,00727	0,00703	0,00370	0,00319	0,00255	0,00229	0,00251	0,00202	---	0,00210	0,00200
Nickel [4]	0,067	1	0,0001	0,0291	0,0167	0,0078	0,0012	0,0104	0,0013	0,0069	0,0004	0,0063	0,0008	---	0,0040	0,0010
Plomb [4]	0,0049	0,4	0,00001	**0,07080**	**0,03320**	**0,01270**	0,00022	**0,01730**	0,00064	**0,01230**	0,00021	**0,01010**	0,00104	---	**0,00616**	0,00164
Soufre	-	-	0,1	---	---	---	---	<0,1	<0,1	0,4	0,4	2,3	1,2	---	<0,1	<0,1
Sélénium	0,062	-	0,00004	0,00012	0,00009	0,00021	0,00012	0,00008	0,00004	0,00007	<0,00004	0,00007	<0,00004	---	<0,00004	<0,00004
Sodium	-	-	0,01	14,00	9,65	12,80	11,60	7,23	3,72	3,25	1,82	3,60	1,20	---	1,07	0,13
Strontium	-	-	0,00002	0,141	0,0907	0,0608	0,0257	0,0607	0,0154	0,0434	0,0123	0,0523	0,0165	---	0,032	0,0157
Thorium	-	-	0,0001	0,0042	0,0016	0,0009	0,0002	0,0016	<0,0001	0,0007	0,0001	0,0007	<0,0001	---	0,0005	0,0002
Titane	-	-	0,00005	0,118	0,0648	0,0488	0,00173	0,148	0,00551	0,0498	0,00139	0,0747	0,00417	---	0,0467	0,0114
Thallium	-	-	0,000005	0,00168	0,000308	0,000403	0,000047	0,00107	0,00006	0,000436	0,000026	0,000434	0,000046	---	0,000295	0,000091
Tungstène	-	-	0,00002	0,00217	0,0009	0,00151	0,00105	0,00263	0,00094	0,00111	0,00063	0,00115	0,00052	---	0,00102	0,00063
Uranium [4]	0,32	-	0,000002	0,0891	0,048	0,0275	0,00995	0,0251	0,00169	0,0159	0,00146	0,0125	0,00186	---	0,00725	0,00219
Vanadium	-	-	0,00001	0,0115	0,00681	0,00501	0,00188	0,00778	0,00209	0,00507	0,00154	0,00629	0,00166	---	0,00469	0,00188
Yttrium	-	-	0,000002	0,00114	0,000663	0,000322	0,000008	0,000448	0,000019	0,000306	0,000011	0,000328	0,000025	---	0,000205	0,000048
Zinc [4]	0,017	1	0,002	**0,366**	**0,216**	**0,088**	0,002	**0,113**	0,005	**0,086**	<0,002	**0,076**	0,008	---	**0,042**	0,009
Autres composés inorganiques																
Sulfates (SO4)	-	-	0,2	---	---	---	---	---	---	---	---	---	---	---	1,2	---
Paramètres physico-chimiques																
Alcalinité (mg/L CaCO3)	-	-	1	31		43		35		28		23		---	22	
Acidité (mg/L CaCO3)	-	-	2	<2		<2		<2		<2		<2		---	<2	
Conductivité (uS/cm)	-	-	1	107		150		70		55		44		---	39	
Matières en suspension (mg/L)	-	30	3	**485**		**261**		**188**		**257**		---		---	**139**	
pH	-	6 - 9,5	0,01	7,65		7,82		7,72		7,73		7,53		---	7,35	
Potentiel d'oxydoréduction (mV)	-	-	1	282		228		312		270		329		---	205	
Paramètres d'essai																
Quantité d'eau de rinçage ajoutée (g)	-	-	0,01	6140		3566,4		3832,3		3792,9		3768,58		3881,32	3878,3	
Quantité d'eau de rinçage récupérée (g)	-	-	0,01	---		3823,3		3848,35		3848,3		3775,91		3910,65	3945,79	
pH immédiat	-	-	0,01	7,78		8,1		8,04		8,34		8,08		8,17	7,32	
Conductivité immédiate (uS/cm)	-	-	0,1	198,4		153,3		66,5		22,9		45,2		35,7	26,3	

NOTES:

(1): Critères de Résurgence dans les eaux de surface (RES) du Guide d'intervention - Protection des sols et réhabilitation des terrains contaminés (MELCC, 2019).

(2): Concentration maximale acceptable au point de rejet de l'effluent final selon la Directive 019 sur l'industrie minière (MDDEP, 2012)

(3): Limite de détection rapportée par le laboratoire d'analyses.

(4): Ajustement de la valeur du critère en fonction d'une dureté de l'eau ($CaCO_3$) de 10 mg/L.

LÉGENDE:

-	: Non défini ou non analysé
100	: Concentration < RES et D019
100	: Concentration > RES
100	: Concentration > D019

Tableau C-3 (2 de 5)
Résultats des essais en colonnes
Colonne #1 : Résidus non saturés
Projet Galaxy
N/Réf : 171-02562-00

Paramètres	Critères (mg/L)		LDR[3] (mg/L)	Semaine / Résultats d'analyse (mg/L)											
	RES [1]	D019 [2]		Semaine 7	Semaine 8		Semaine 9	Semaine 10		Semaine 11	Semaine 12	Semaine 13	Semaine 14	Semaine 15	Semaine 16
				Totaux	Totaux	Dissouts	Totaux	Totaux	Dissouts	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux
Métaux (mg/L)															
Aluminium	-	-	0,0003	---	3,03	0,396	---	2,48	0,538	---	1,5	---	1,05	---	0,886
Antimoine	1,1	-	0,0002	---	0,0006	0,0036	---	0,0007	0,0021	---	0,0006	---	0,0003	---	0,0004
Argent [4]	0,00003	-	0,000002	---	<0,00005	<0,00005	---	<0,00005	<0,00005	---	<0,00005	---	<0,00005	---	< 0,00005
Arsenic	0,34	0,4	0,0002	---	0,0891	0,0671	---	0,0653	0,0567	---	0,0636	---	0,057	---	0,0601
Baryum [4]	0,11	-	0,00002	---	0,00854	0,00253	---	0,00584	0,0018	---	0,00434	---	0,00348	---	0,00278
Béryllium	-	-	0,000007	---	0,001570	0,000290	---	0,001530	0,000382	---	0,000889	---	0,000641	---	0,000492
Bore	28	-	0,0002	---	0,009	0,006	---	0,007	0,004	---	0,004	---	0,005	---	0,004
Bismuth	-	-	0,000007	---	0,00263	0,00060	---	0,00181	0,00061	---	0,00135	---	0,00117	---	0,00088
Calcium	-	-	0,01	---	3,91	2,98	---	3,76	3,24	---	3,10	---	2,65	---	2,47
Cadmium [4]	0,0002	-	0,000003	---	0,000053	0,000005	---	0,000046	0,000012	---	0,000027	---	0,000032	---	0,000016
Chrome	-	-	0,00003	---	0,00577	0,00140	---	0,00458	0,00152	---	0,00329	---	0,00326	---	0,00181
Cobalt	0,37	-	0,000004	---	0,000831	0,000194	---	0,000633	0,000227	---	0,000421	---	0,000320	---	0,000275
Cuivre [4]	0,0015	0,6	0,00002	---	**0,00564**	**0,00224**	---	**0,00432**	**0,00165**	---	**0,00321**	---	**0,00247**	---	**0,00220**
Étain	-	-	0,00001	---	0,00696	0,00578	---	0,00597	0,00481	---	0,00383	---	0,00272	---	0,00240
Fer	-	6	0,002	---	2,46	0,457	---	1,72	0,51	---	1,22	---	0,805	---	0,759
Potassium	-	-	0,002	---	2,5	1,56	---	1,99	1,26	---	1,3	---	0,976	---	0,815
Lithium	-	-	0,000006	---	0,503	0,442	---	0,381	0,317	---	0,324	---	0,238	---	0,217
Magnésium	-	-	0,003	---	0,403	0,271	---	0,398	0,307	---	0,321	---	0,263	---	0,243
Manganèse [4]	0,55	-	0,00001	---	0,367	0,0722	---	0,209	0,0656	---	0,152	---	0,102	---	0,0928
Mercure	0,0000013	-	0,00001	---	**0,00002**	**0,00002**	---	**0,00002**	<0,00001	---	<0,00001	---	**0,00003**	---	< 0,00001
Molybdène	29	-	0,00001	---	0,00183	0,00154	---	0,00168	0,00158	---	0,00149	---	0,00127	---	0,00137
Nickel [4]	0,067	1	0,0001	---	0,0030	0,0008	---	0,0023	0,0008	---	0,0016	---	0,0012	---	0,0010
Plomb [4]	0,0049	0,4	0,00001	---	0,00483	0,00108	---	0,00339	0,00112	---	0,00251	---	0,00211	---	0,00171
Soufre	-	-	0,1	---	1,1	1,0	---	<0,1	<0,1	---	<0,1	---	<0,1	---	< 0,1
Sélénium	0,062	-	0,00004	---	<0,00004	<0,00004	---	<0,00004	<0,00004	---	<0,00004	---	<0,00004	---	< 0,00004
Sodium	-	-	0,01	---	1,06	0,32	---	1,04	0,49	---	0,7	---	0,53	---	0,37
Strontium	-	-	0,00002	---	0,0271	0,0139	---	0,0215	0,0139	---	0,0182	---	0,01326	---	0,01369
Thorium	-	-	0,0001	---	0,0003	<0,0001	---	0,0002	<0,0001	---	0,0001	---	0,0001	---	0,0001
Titane	-	-	0,00005	---	0,0305	0,00508	---	0,0295	0,00671	---	0,0174	---	0,01002	---	0,0106
Thallium	-	-	0,000005	---	0,00018	0,000022	---	0,000189	0,000047	---	0,000122	---	0,000086	---	0,000082
Tungstène	-	-	0,00002	---	0,00057	0,00028	---	0,00045	0,00026	---	0,00025	---	0,00022	---	0,00022
Uranium [4]	0,32	-	0,000002	---	0,00517	0,00136	---	0,00378	0,00123	---	0,00301	---	0,002512	---	0,0018
Vanadium	-	-	0,00001	---	0,00354	0,00156	---	0,00269	0,00148	---	0,00207	---	0,00154	---	0,00172
Yttrium	-	-	0,000002	---	0,000152	0,000063	---	0,00011	0,000031	---	0,000079	---	0,000057	---	0,000054
Zinc [4]	0,017	1	0,002	---	**0,034**	0,008	---	**0,029**	0,01	---	**0,021**	---	**0,018**	---	0,013
Autres composés inorganiques															
Sulfates (SO4)	-	-	0,2	---	1,0	-	---	0,8	---	---	0,8	---	0,8	---	0,6
Paramètres physico-chimiques															
Alcalinité (mg/L CaCO3)	-	-	1	---	63		---	15		---	9	---	10	---	8
Acidité (mg/L CaCO3)	-	-	2	---	110		---	<2		---	<2	---	<2	---	< 2
Conductivité (uS/cm)	-	-	1	---	25		---	31		---	26	---	21	---	19
Matières en suspension (mg/L)	-	30	3	---	**95**		---	**71**		---	---	---	---	---	---
pH	-	6 - 9,5	0,01	---	7,28		---	7,49		---	7,18	---	7,2	---	7,27
Potentiel d'oxydoréduction (mV)	-	-	1	---	248		---	348		---	170	---	175	---	512
Paramètres d'essai															
Quantité d'eau de rinçage ajoutée (g)	-	-	0,01	3997,61	4360,81		4098,02	3944,6		4004,82	4185,45	4641,88	4000,25	4319,9	4450,71
Quantité d'eau de rinçage récupérée (g)	-	-	0,01	3938,32	4301,09		4211,71	3909,05		3990,17	4226,49	4454,2	4371,89	4255,45	4417,14
pH immédiat	-	-	0,01	7,3	7,67		7,6	7,45		7,35	7,45	7,09	7,01	7,08	7,3
Conductivité immédiate (uS/cm)	-	-	0,1	33,8	30,9		25,1	29,5		27,6	24,3	19,3	20,1	18,2	18,8

NOTES:

(1): Critères de Résurgence dans les eaux de surface (RES) du Guide d'intervention - Protection des sols et réhabilitation des terrains contaminés (MELCC, 2019).

(2): Concentration maximale acceptable au point de rejet de l'effluent final selon la Directive 019 sur l'industrie minière (MDDEP, 2012)

(3): Limite de détection rapportée par le laboratoire d'analyses.

(4): Ajustement de la valeur du critère en fonction d'une dureté de l'eau ($CaCO_3$) de 10 mg/L.

LÉGENDE:

-	: Non défini ou non analysé
100	: Concentration < RES et D019
100	: Concentration > RES
100	: Concentration > D019

Tableau C-3 (3 de 5)
Résultats des essais en colonnes
Colonne #1 : Résidus non saturés
Projet Galaxy
N/Réf : 171-02562-00

Paramètres	Critères (mg/L)		LDR[3] (mg/L)	Semaine / Résultats d'analyse (mg/L)											
	RES [1]	D019 [2]		Semaine 17	Semaine 18	Semaine 19	Semaine 20	Semaine 21	Semaine 22	Semaine 23	Semaine 24	Semaine 25	Semaine 26	Semaine 27	Semaine 28
				Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux
Métaux (mg/L)															
Aluminium	-	-	0,0003	---	1,23	---	0,764	---	0,745	---	0,749	---	0,837	---	0,683
Antimoine	1,1	-	0,0002	---	0,0005	---	0,0004	---	0,0005	---	0,0005	---	0,0002	---	0,0004
Argent [4]	0,00003	-	0,000002	---	< 0,00005	---	< 0,00005	---	< 0,00005	---	< 0,00005	---	< 0,00005	---	< 0,00005
Arsenic	0,34	0,4	0,0002	---	0,0539	---	0,0465	---	0,0467	---	0,0424	---	0,0451	---	0,0496
Baryum [4]	0,11	-	0,00002	---	0,00272	---	0,00189	---	0,00184	---	0,00209	---	0,00225	---	0,00195
Béryllium	-	-	0,000007	---	0,000702	---	0,000424	---	0,000348	---	0,000559	---	0,000364	---	0,000386
Bore	28	-	0,0002	---	0,010	---	0,014	---	0,005	---	0,004	---	0,002	---	0,003
Bismuth	-	-	0,000007	---	0,00082	---	0,00060	---	0,00074	---	0,00066	---	0,00064	---	0,00050
Calcium	-	-	0,01	---	2,53	---	2,06	---	1,96	---	2,06	---	1,92	---	2,00
Cadmium [4]	0,0002	-	0,000003	---	0,000013	---	0,000014	---	0,000014	---	0,00002	---	0,000011	---	0,000184
Chrome	-	-	0,00003	---	0,00163	---	0,00128	---	0,00140	---	0,00125	---	0,00099	---	0,001
Cobalt	0,37	-	0,000004	---	0,000227	---	0,000154	---	0,000175	---	0,000169	---	0,000194	---	0,000199
Cuivre [4]	0,0015	0,6	0,00002	---	**0,00221**	---	0,00133	---	**0,00166**	---	0,00139	---	0,00147	---	**0,00153**
Étain	-	-	0,00001	---	0,00217	---	0,00196	---	0,00157	---	0,00146	---	0,00129	---	0,00113
Fer	-	6	0,002	---	0,725	---	0,476	---	0,55	---	0,543	---	0,546	---	0,595
Potassium	-	-	0,002	---	0,938	---	0,674	---	0,623	---	0,603	---	0,551	---	0,549
Lithium	-	-	0,000006	---	0,226	---	0,176	---	0,211	---	0,18	---	0,181	---	0,169
Magnésium	-	-	0,003	---	0,259	---	0,197	---	0,187	---	0,199	---	0,173	---	0,186
Manganèse [4]	0,55	-	0,00001	---	0,0813	---	0,0544	---	0,0589	---	0,057	---	0,0677	---	0,0647
Mercure	0,0000013	-	0,00001	---	< 0,00001	---	< 0,00001	---	< 0,00001	---	**0,00001**	---	**0,00001**	---	< 0,00001
Molybdène	29	-	0,00001	---	0,00131	---	0,00099	---	0,00136	---	0,00109	---	0,00083	---	0,00112
Nickel [4]	0,067	1	0,0001	---	0,0008	---	0,0006	---	0,0006	---	0,0007	---	0,0007	---	0,0005
Plomb [4]	0,0049	0,4	0,00001	---	0,00156	---	0,00095	---	0,00112	---	0,00143	---	0,00122	---	0,00123
Soufre	-	-	0,1	---	< 0,1	---	0,8	---	< 0,1	---	< 0,1	---	< 0,1	---	< 0,1
Sélénium	0,062	-	0,00004	---	< 0,00004	---	< 0,00004	---	< 0,00004	---	< 0,00004	---	< 0,00004	---	< 0,00004
Sodium	-	-	0,01	---	0,57	---	0,47	---	0,36	---	0,11	---	0,36	---	0,34
Strontium	-	-	0,00002	---	0,0126	---	0,0096	---	0,0111	---	0,0107	---	0,0101	---	0,0104
Thorium	-	-	0,0001	---	< 0,0001	---	0,0002	---	0,0001	---	< 0,0001	---	< 0,0001	---	< 0,0001
Titane	-	-	0,00005	---	0,0133	---	0,00742	---	0,0074	---	0,00959	---	0,00577	---	0,00781
Thallium	-	-	0,000005	---	0,000097	---	0,000057	---	0,000064	---	0,000059	---	0,000052	---	0,000058
Tungstène	-	-	0,00002	---	0,00023	---	0,00028	---	0,0002	---	0,00039	---	0,00008	---	0,00018
Uranium [4]	0,32	-	0,000002	---	0,00168	---	0,0012	---	0,00136	---	0,00124	---	0,00136	---	0,00135
Vanadium	-	-	0,00001	---	0,00148	---	0,00116	---	0,00147	---	0,00129	---	0,00135	---	0,00148
Yttrium	-	-	0,000002	---	0,000042	---	0,000029	---	0,00003	---	0,000045	---	0,000034	---	0,000036
Zinc [4]	0,017	1	0,002	---	0,013	---	0,009	---	0,01	---	0,011	---	0,011	---	0,008
Autres composés inorganiques															
Sulfates (SO4)	-	-	0,2	---	0,7	---	0,5	---	0,5	---	0,6	---	0,4	-	0,5
Paramètres physico-chimiques															
Alcalinité (mg/L CaCO3)	-	-	1	---	8	---	7	---	6	---	7	---	5	---	6
Acidité (mg/L CaCO3)	-	-	2	---	< 2	---	< 2	---	< 2	---	< 2	---	< 2	---	< 2
Conductivité (uS/cm)	-	-	1	---	18	---	17	---	18	---	16	---	13	---	14
Matières en suspension (mg/L)	-	30	3	---	---	---	---	---	---	---	---	---	---	---	---
pH	-	6 - 9,5	0,01	---	7,14	---	7	---	7,06	---	7,01	---	6,73	---	6,95
Potentiel d'oxydoréduction (mV)	-	-	1	---	531	---	332	---	329	---	229	---	210	---	107
Paramètres d'essai															
Quantité d'eau de rinçage ajoutée (g)	-	-	0,01	4754,28	4282,83	4164,62	4712,05	4264,01	4512,25	4317,95	4164,23	4406,56	4902,17	4838,8	4435,78
Quantité d'eau de rinçage récupérée (g)	-	-	0,01	5033,57	4342,5	4238,15	4662,59	4321,84	4397,83	4349,9	4021,92	4650,11	4776,84	4917,33	4108,91
pH immédiat	-	-	0,01	6,96	6,84	6,88	6,69	6,58	6,66	6,73	6,66	6,74	6,61	6,47	6,48
Conductivité immédiate (uS/cm)	-	-	0,1	15,2	18,5	16,1	14,3	14,4	14,8	14,9	14,6	14,2	11,4	11,4	12,6

NOTES:

(1): Critères de Résurgence dans les eaux de surface (RES) du Guide d'intervention - Protection des sols et réhabilitation des terrains contaminés (MELCC, 2019).

(2): Concentration maximale acceptable au point de rejet de l'effluent final selon la Directive 019 sur l'industrie minière (MDDEP, 2012)

(3): Limite de détection rapportée par le laboratoire d'analyses.

(4): Ajustement de la valeur du critère en fonction d'une dureté de l'eau ($CaCO_3$) de 10 mg/L.

LÉGENDE:

-	: Non défini ou non analysé
100	: Concentration < RES et D019
100	: Concentration > RES
100	: Concentration > D019

Tableau C-3 (4 de 5)
Résultats des essais en colonnes
Colonne #1 : Résidus non saturés
Projet Galaxy
N/Réf : 171-02562-00

Paramètres	Critères (mg/L)		LDR[3] (mg/L)	Semaine / Résultats d'analyse (mg/L)											
	RES [1]	D019 [2]		Semaine 29	Semaine 30	Semaine 31	Semaine 32	Semaine 33	Semaine 34	Semaine 35	Semaine 36	Semaine 37	Semaine 38	Semaine 39	Semaine 40
				Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux
Métaux (mg/L)															
Aluminium	-	-	0,0003	---	0,081	---	0,565	---	0,219	---	0,355	---	0,339	---	0,235
Antimoine	1,1	-	0,0002	---	0,0003	---	< 0,0002	---	0,0003	---	< 0,0002	---	< 0,0002	---	< 0,0002
Argent [4]	0,00003	-	0,000002	---	< 0,00005	---	< 0,00005	---	< 0,00005	---	< 0,00005	---	< 0,00005	---	< 0,00005
Arsenic	0,34	0,4	0,0002	---	0,0343	---	0,044	---	0,0383	---	0,0445	---	0,0425	---	0,0392
Baryum [4]	0,11	-	0,00002	---	0,00365	---	0,00121	---	0,00085	---	0,00076	---	0,00065	---	0,00054
Béryllium	-	-	0,000007	---	0,000008	---	0,000278	---	0,000127	---	0,000182	---	0,000139	---	0,000121
Bore	28	-	0,0002	---	< 0,002	---	0,005	---	0,004	---	< 0,002	---	0,005	---	0,007
Bismuth	-	-	0,000007	---	< 0,000007	---	0,00033	---	0,00016	---	0,00026	---	0,00021	---	0,00016
Calcium	-	-	0,01	---	3,78	---	1,75	---	5,32	---	1,66	---	1,49	---	1,62
Cadmium [4]	0,0002	-	0,000003	---	0,00001	---	0,000007	---	0,000013	---	0,000011	---	0,000015	---	0,000003
Chrome	-	-	0,00003	---	0,00026	---	0,00069	---	0,00041	---	0,00049	---	0,00043	---	0,00026
Cobalt	0,37	-	0,000004	---	0,000465	---	0,000091	---	0,000060	---	0,000063	---	0,000024	---	0,000035
Cuivre [4]	0,0015	0,6	0,00002	---	0,00029	---	0,00112	---	0,00086	---	0,00080	---	0,00053	---	0,00006
Étain	-	-	0,00001	---	0,00122	---	0,00162	---	0,00066	---	0,00061	---	0,00050	---	0,00040
Fer	-	6	0,002	---	0,047	---	0,3	---	0,15	---	0,184	---	0,155	---	0,094
Potassium	-	-	0,002	---	0,876	---	0,429	---	0,63	---	0,358	---	0,324	---	0,276
Lithium	-	-	0,000006	---	0,0405	---	0,162	---	0,178	---	0,124	---	0,122	---	0,131
Magnésium	-	-	0,003	---	0,38	---	0,161	---	0,453	---	0,143	---	0,141	---	0,143
Manganèse [4]	0,55	-	0,00001	---	0,0658	---	0,031	---	0,01797	---	0,0188	---	0,015	---	0,0103
Mercure	0,0000013	-	0,00001	---	< 0,00001	---	< 0,00001	---	< 0,00001	---	< 0,00001	---	< 0,00001	---	< 0,00001
Molybdène	29	-	0,00001	---	0,00009	---	0,00026	---	0,00090	---	0,00112	---	0,00091	---	0,00075
Nickel [4]	0,067	1	0,0001	---	0,0013	---	0,0004	---	0,0003	---	< 0,0001	---	0,0002	---	0,0001
Plomb [4]	0,0049	0,4	0,00001	---	0,00013	---	0,00060	---	0,00034	---	0,00046	---	0,00038	---	0,00029
Soufre	-	-	0,1	---	1,9	---	0,4	---	2,9	---	1,0	---	1,2	---	0,7
Sélénium	0,062	-	0,00004	---	0,00006	---	< 0,00004	---	< 0,00004	---	< 0,00004	---	< 0,00004	---	< 0,00004
Sodium	-	-	0,01	---	0,45	---	0,35	---	3,31	---	0,76	---	0,42	---	0,28
Strontium	-	-	0,00002	---	0,0334	---	0,00829	---	0,0225	---	0,00766	---	0,00696	---	0,00721
Thorium	-	-	0,0001	---	< 0,0001	---	< 0,0001	---	0,0002	---	< 0,0001	---	< 0,0001	---	< 0,0001
Titane	-	-	0,00005	---	0,00305	---	0,00633	---	0,00276	---	0,0041	---	0,0032	---	0,00209
Thallium	-	-	0,000005	---	0,000011	---	0,000052	---	0,000024	---	0,000036	---	0,000024	---	0,000018
Tungstène	-	-	0,00002	---	0,00031	---	0,00007	---	0,00007	---	0,0001	---	0,00012	---	0,00006
Uranium [4]	0,32	-	0,000002	---	0,000129	---	0,000727	---	0,000624	---	0,00052	---	0,000387	---	0,000405
Vanadium	-	-	0,00001	---	0,00039	---	0,00113	---	0,00095	---	0,00106	---	0,00103	---	0,00088
Yttrium	-	-	0,000002	---	0,000027	---	0,000019	---	0,000011	---	0,000012	---	0,000023	---	0,000007
Zinc [4]	0,017	1	0,002	---	0,002	---	0,006	---	0,004	---	0,004	---	0,004	---	0,002
Autres composés inorganiques															
Sulfates (SO4)	-	-	0,2	-	0,5	---	0,5	---	9,0	---	0,5	---	0,4	---	0,4
Paramètres physico-chimiques															
Alcalinité (mg/L CaCO3)	-	-	1	---	5	---	6	---	10	---	6	---	5	---	4
Acidité (mg/L CaCO3)	-	-	2	---	< 2	---	< 2	---	< 2	---	< 2	---	< 2	---	< 2
Conductivité (uS/cm)	-	-	1	---	22	---	14	---	63	---	16	---	12	---	13
Matières en suspension (mg/L)	-	30	3	---	---	---	---	---	---	---	---	---	---	---	---
pH	-	6 - 9,5	0,01	---	6,69	---	6,58	---	6,81	---	6,83	---	6,79	---	6,63
Potentiel d'oxydoréduction (mV)	-	-	1	---	136	---	401	---	208	---	161	---	158	---	152
Paramètres d'essai															
Quantité d'eau de rinçage ajoutée (g)	-	-	0,01	4612,41	4720,6	5265,92	4553,05	4463,64	4267,08	4255,91	4104,68	4566,96	4748,93	4310,3	4431,99
Quantité d'eau de rinçage récupérée (g)	-	-	0,01	4836,44	4341,71	4260,21	4614,85	4479,76	3989,73	4222,11	4175,36	4511,25	4667,04	4375,5	4318,56
pH immédiat	-	-	0,01	6,37	6,62	6,24	6,08	6,28	6,68	6,56	6,26	6,26	6,21	6,12	6,09
Conductivité immédiate (uS/cm)	-	-	0,1	12,2	11,5	11,1	10,6	11,4	52	15,4	13,9	13,8	11	11,9	10,6

NOTES:

(1): Critères de Résurgence dans les eaux de surface (RES) du Guide d'intervention - Protection des sols et réhabilitation des terrains contaminés (MELCC, 2019).

(2): Concentration maximale acceptable au point de rejet de l'effluent final selon la Directive 019 sur l'industrie minière (MDDEP, 2012)

(3): Limite de détection rapportée par le laboratoire d'analyses.

(4): Ajustement de la valeur du critère en fonction d'une dureté de l'eau ($CaCO_3$) de 10 mg/L.

LÉGENDE:

-	: Non défini ou non analysé
100	: Concentration < RES et D019
100	: Concentration > RES
100	: Concentration > D019

Tableau C-3 (5 de 5)
Résultats des essais en colonnes
Colonne #1 : Résidus non saturés
Projet Galaxy
N/Réf : 171-02562-00

Paramètres	Critères (mg/L)		LDR[3] (mg/L)	Semaine / Résultats d'analyse (mg/L)									
	RES [1]	D019 [2]		Semaine 41	Semaine 42	Semaine 43	Semaine 44	Semaine 45	Semaine 46	Semaine 47	Semaine 48	Semaine 49	Semaine 50
				Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux
Métaux (mg/L)													
Aluminium	-	-	0,0003	---	0,214	---	0,213	---	0,275	---	0,205	---	0,192
Antimoine	1,1	-	0,0002	---	< 0,0002	---	< 0.0009	---	< 0.0009	---	< 0.0009	---	< 0.0009
Argent [4]	0,00003	-	0,000002	---	< 0,00005	---	< 0.00005	---	**0,00005**	---	< 0.00005	---	< 0.00005
Arsenic	0,34	0,4	0,0002	---	0,0381	---	0,0381	---	0,0437	---	0,0502	---	0,0498
Baryum [4]	0,11	-	0,00002	---	0,00066	---	0,00087	---	0,00074	---	0,00057	---	0,00089
Béryllium	-	-	0,000007	---	0,000102	---	0,000089	---	0,000146	---	0,000080	---	0,000088
Bore	28	-	0,0002	---	0,029	---	0,005	---	0,004	---	0,004	---	0,003
Bismuth	-	-	0,000007	---	0,00020	---	0,00018	---	0,00019	---	0,00015	---	0,000159
Calcium	-	-	0,01	---	1,68	---	1,45	---	1,40	---	1,26	---	1,24
Cadmium [4]	0,0002	-	0,000003	---	< 0,000003	---	< 0.000003	---	0,000012	---	< 0.000003	---	< 0.000003
Chrome	-	-	0,00003	---	0,00024	---	0,00034	---	0,00042	---	0,00034	---	0,00036
Cobalt	0,37	-	0,000004	---	0,000044	---	0,000046	---	0,000090	---	0,000104	---	0,000022
Cuivre [4]	0,0015	0,6	0,00002	---	0,00024	---	0,00070	---	0,00060	---	0,00050	---	0,0005
Étain	-	-	0,00001	---	0,00036	---	0,00035	---	0,00037	---	0,00033	---	0,00036
Fer	-	6	0,002	---	0,103	---	0,145	---	0,143	---	0,113	---	0,1
Potassium	-	-	0,002	---	0,398	---	0,27	---	0,245	---	0,238	---	0,213
Lithium	-	-	0,000006	---	0,132	---	0,132	---	0,0648	---	0,105	---	0,125
Magnésium	-	-	0,003	---	0,169	---	0,143	---	0,123	---	0,112	---	0,113
Manganèse [4]	0,55	-	0,00001	---	0,00967	---	0,0137	---	0,016	---	0,0118	---	0,0106
Mercure	0,0000013	-	0,00001	---	< 0,00001	---	< 0.00001	---	< 0.00001	---	< 0.00001	---	< 0.00001
Molybdène	29	-	0,00001	---	0,00154	---	0,00093	---	0,00079	---	0,00075	---	0,00079
Nickel [4]	0,067	1	0,0001	---	0,0002	---	0,0003	---	0,0002	---	0,0002	---	0,0001
Plomb [4]	0,0049	0,4	0,00001	---	0,00033	---	0,00035	---	0,00034	---	0,00035	---	0,00018
Soufre	-	-	0,1	---	< 0,3	---	0,6	---	< 0.3	---	< 0.3	---	< 0.3
Sélénium	0,062	-	0,00004	---	< 0,00004	---	< 0.00004	---	< 0.00004	---	< 0.00004	---	< 0.00004
Sodium	-	-	0,01	---	0,34	---	0,24	---	0,28	---	0,19	---	0,2
Strontium	-	-	0,00002	---	0,0069	---	0,00656	---	0,00615	---	0,00582	---	0,00635
Thorium	-	-	0,0001	---	< 0,0001	---	< 0.0001	---	< 0.0001	---	< 0.0001	---	< 0.0001
Titane	-	-	0,00005	---	0,00202	---	0,00166	---	0,00252	---	0,002	---	0,00157
Thallium	-	-	0,000005	---	0,000023	---	0,000007	---	0,000023	---	< 0.000005	---	0,000019
Tungstène	-	-	0,00002	---	0,00004	---	0,00006	---	0,00005	---	0,00004	---	0,00005
Uranium [4]	0,32	-	0,000002	---	0,00029	---	0,000426	---	0,000383	---	0,000349	---	0,000357
Vanadium	-	-	0,00001	---	0,00092	---	0,00111	---	0,00113	---	0,00105	---	0,00106
Yttrium	-	-	0,000002	---	0,000012	---	0,000007	---	0,000012	---	0,000021	---	0,000011
Zinc [4]	0,017	1	0,002	---	0,002	---	0,005	---	0,004	---	0,005	---	0,003
Autres composés inorganiques													
Sulfates (SO4)	-	-	0,2	---	0,5	---	0,5	---	0,5	---	0,5	---	0,7
Paramètres physico-chimiques													
Alcalinité (mg/L CaCO3)	-	-	1	---	5	---	3	---	63	---	4	---	4
Acidité (mg/L CaCO3)	-	-	2	---	< 2	---	< 2	---	< 2	---	< 2	---	< 2
Conductivité (uS/cm)	-	-	1	---	13	---	11	---	11	---	11	---	17
Matières en suspension (mg/L)	-	30	3	---	---	---	---	---	---	---	---	---	---
pH	-	6 - 9,5	0,01	---	6,94	---	6,74	---	6,38	---	6,65	---	6,91
Potentiel d'oxydoréduction (mV)	-	-	1	---	449	---	245	---	370	---	395	---	263
Paramètres d'essai													
Quantité d'eau de rinçage ajoutée (g)	-	-	0,01	4293,29	4268,4	4599,64	4720,12	4471,25	4716,96	4283,7	4855,41	4535,05	4276,9
Quantité d'eau de rinçage récupérée (g)	-	-	0,01	4277,74	4241,8	4598,48	4782,64	4308,43	4383,02	4544,77	4509,74	4524,12	4258,73
pH immédiat	-	-	0,01	5,99	6,21	6,14	6,1	6,22	6,42	6,06	6,42	6,34	6,21
Conductivité immédiate (uS/cm)	-	-	0,1	11	12,9	10,8	11	11	10,6	11	10	10,5	10,9

NOTES:

(1): Critères de Résurgence dans les eaux de surface (RES) du Guide d'intervention - Protection des sols et réhabilitation des terrains contaminés (MELCC, 2019).

(2): Concentration maximale acceptable au point de rejet de l'effluent final selon la Directive 019 sur l'industrie minière (MDDEP, 2012)

(3): Limite de détection rapportée par le laboratoire d'analyses.

(4): Ajustement de la valeur du critère en fonction d'une dureté de l'eau ($CaCO_3$) de 10 mg/L.

LÉGENDE:

-	: Non défini ou non analysé
100	: Concentration < RES et D019
100	: Concentration > RES
100	: Concentration > D019

Tableau C4 (1 de 5)
Résultats des essais en colonnes
Colonne #2 : Mélange de stériles saturés
Projet Galaxy
N/Réf : 171-02562-00

Paramètres	Critères (mg/L)		LDR[3] (mg/L)	Semaine / Résultats d'analyse (mg/L)												
	RES [1]	D019 [2]		Initial		Semaine 1		Semaine 2		Semaine 3		Semaine 4		Semaine 5	Semaine 6	
				Totaux	Dissouts	Totaux	Dissouts	Totaux	Dissouts	Totaux	Dissouts	Totaux	Dissouts	Totaux	Totaux	Dissouts
Métaux (mg/L)																
Aluminium	-	-	0,0003	11,8	3,1	5,18	0,188	0,513	0,111	0,324	0,129	0,391	0,185	---	0,286	0,207
Antimoine	1,1	-	0,0002	0,0009	< 0,0002	0,0016	0,0014	0,002	0,0015	0,0019	0,0034	0,0018	< 0,0002	---	0,0013	< 0,0002
Argent [4]	0,00003	-	0,000002	**0,00009**	< 0,00005	**0,00015**	< 0,00005	< 0,00005	< 0,00005	< 0,00005	< 0,00005	< 0,00005	< 0,00005	---	< 0,00005	< 0,00005
Arsenic	0,34	0,4	0,0002	0,131	0,102	0,162	0,124	0,304	0,296	**0,4**	0,332	**0,352**	0,335	---	0,233	0,22
Baryum [4]	0,11	-	0,00002	**0,121**	0,0505	0,0607	0,0126	0,0155	0,0114	0,0105	0,0082	0,00994	0,00807	---	0,00842	0,00736
Béryllium	-	-	0,000007	0,000952	0,000287	0,000358	0,000007	0,000016	< 0,000007	0,000017	< 0,000007	0,000026	< 0,000007	---	0,000012	< 0,000007
Bore	28	-	0,0002	0,034	0,034	0,034	0,032	0,034	0,032	0,021	0,020	0,022	0,019	---	0,015	0,016
Bismuth	-	-	0,000007	0,00029	0,00011	0,00014	< 0,000007	0,00004	0,00002	0,00002	< 0,000007	0,00003	< 0,000007	---	0,00001	< 0,000007
Calcium	-	-	0,01	7,49	6,12	8,99	8,04	10,20	10,20	8,82	8,64	9,58	8,98	---	9,15	8,68
Cadmium [4]	0,0002	-	0,000003	0,000038	0,000009	0,000027	0,000005	0,000007	< 0,000003	0,000006	0,000005	0,00001	0,000009	---	0,000006	< 0,000003
Chrome	-	-	0,00003	0,0266	0,0102	0,0146	0,0003	0,00159	0,00005	0,00056	0,00004	0,00058	0,00012	---	0,000	0,000
Cobalt	0,37	-	0,000004	0,004980	0,002350	0,003750	0,000532	0,000573	0,000396	0,000352	0,000244	0,000399	0,000304	---	0,000327	0,000251
Cuivre [4]	0,0015	0,6	0,00002	**0,0083**	**0,0024**	**0,0102**	0,00079	0,00114	0,00083	0,00058	0,00051	0,00027	< 0,00002	---	0,00058	0,00149
Étain	-	-	0,00001	0,0515	0,0479	0,0420	0,0382	0,0334	0,0330	0,0192	0,0191	0,0141	0,0133	---	0,01000	0,00938
Fer	-	6	0,002	**7,57**	2,95	4,65	0,087	0,479	< 0,007	0,169	0,008	0,173	0,031	---	0,118	0,036
Potassium	-	-	0,002	16,3	14,8	12,1	11	12,6	12,4	7,77	7,68	6,7	6,12	---	4,82	4,36
Lithium	-	-	0,000006	0,614	0,574	0,555	0,483	0,352	0,346	0,203	0,194	0,259	0,21	---	0,123	0,116
Magnésium	-	-	0,003	3,8	2	3,1	1,54	1,91	1,74	1,28	1,22	1,29	1,18	---	1,04	0,974
Manganèse [4]	0,55	-	0,00001	0,148	0,0725	0,111	0,0349	0,0306	0,0235	0,01936	0,0163	0,0226	0,0191	---	0,0229	0,0204
Mercure	0,0000013	-	0,00001	< 0,00001	< 0,00001	< 0,00001	**0,00002**	< 0,00001	< 0,00001	**0,00003**	< 0,00001	< 0,00001	< 0,00001	---	< 0,00001	< 0,00001
Molybdène	29	-	0,00001	0,00199	0,00195	0,00200	0,00204	0,00223	0,00216	0,00105	0,00113	0,00071	0,00067	---	0,00050	0,00050
Nickel [4]	0,067	1	0,0001	0,0187	0,0093	0,0136	0,0032	0,0029	0,0023	0,0017	0,0016	0,0016	0,0012	---	0,0010	0,0008
Plomb [4]	0,0049	0,4	0,00001	0,00443	0,00146	0,00244	0,00005	0,00014	0,00005	0,00012	0,00004	0,00016	0,00006	---	0,00026	0,00016
Soufre	-	-	0,1	---	---	---	---	6,0	6,5	4,6	4,0	7,1	6,5	---	5,4	5,1
Sélénium	0,062	-	0,00004	0,00057	0,00045	0,00067	0,00044	0,00029	0,00027	0,00023	0,00016	0,0002	0,00019	---	0,00011	0,00013
Sodium	-	-	0,01	10,5	8,98	8,2	7,72	5,86	5,78	2,95	2,88	2	1,84	---	0,61	< 0,01
Strontium	-	-	0,00002	0,101	0,0698	0,118	0,095	0,11	0,113	0,0834	0,0811	0,0908	0,0854	---	0,0784	0,0732
Thorium	-	-	0,0001	0,0061	0,0011	0,0028	< 0,0001	0,0003	< 0,0001	0,0002	< 0,0001	0,0001	< 0,0001	---	0,0002	< 0,0001
Titane	-	-	0,00005	0,578	0,201	0,348	0,00595	0,0331	0,00041	0,0116	0,00027	0,014	0,00244	---	0,00867	0,00111
Thallium	-	-	0,000005	0,000544	0,000239	0,000301	0,000053	0,000066	0,00004	0,00004	0,000028	0,000037	0,000027	---	0,000038	0,00003
Tungstène	-	-	0,00002	0,0109	0,0113	0,00746	0,00631	0,0103	0,0101	0,00659	0,00628	0,00451	0,00438	---	0,00298	0,00279
Uranium [4]	0,32	-	0,000002	0,00403	0,00184	0,00685	0,00497	0,0073	0,00718	0,00836	0,00804	0,0102	0,0101	---	0,00689	0,00675
Vanadium	-	-	0,00001	0,0194	0,00876	0,0108	0,00138	0,00363	0,00261	0,00292	0,00249	0,00279	0,00235	---	0,0021	0,00175
Yttrium	-	-	0,000002	0,00443	0,00173	0,00238	0,000102	0,000171	0,000035	0,000092	0,000026	0,000109	0,000042	---	0,000057	0,000017
Zinc [4]	0,017	1	0,002	**0,023**	0,01	0,016	< 0,002	0,006	< 0,002	< 0,002	< 0,002	< 0,002	< 0,002	---	< 0,002	< 0,002
Autres composés inorganiques																
Sulfates (SO4)	-	-	0,2	---	---	---	---	---	---	---	---	---	---	---	15,0	---
Paramètres physico-chimiques																
Alcalinité (mg/L CaCO3)	-	-	1	35		27		42		31		27		---	21	
Acidité (mg/L CaCO3)	-	-	2	< 2		< 2		< 2		< 2		< 2		---	< 2	
Conductivité (uS/cm)	-	-	1	129		138		140		99		84		---	85	
Matières en suspension (mg/L)	-	30	3	**103**		**1360**		19		8		---		---	6	
pH	-	6 - 9,5	0,01	7,66		7,68		7,87		7,8		7,7		---	7,45	
Potentiel d'oxydoréduction (mV)	-	-	1,0	258,0		270,0		322,0		264,0		282,0		---	166,0	
Paramètres d'essai																
Quantité d'eau de rinçage ajoutée (g)	-	-	0,01	6260		5119,8		5344,1		5102,5		5260,88		5054,38	4849,78	
Quantité d'eau de rinçage récupérée (g)	-	-	0,01	5119,8		5093,4		4932,3		5260,5		4928,38		4824,11	4934,72	
pH immédiat	-	-	0,01	8,04		7,47		8,45		8,55		8,14		8,26	7,43	
Conductivité immédiate (uS/cm)	-	-	0,1	266		265		100,8		68,7		119,3		89,1	105,5	

NOTES:

(1): Critères de Résurgence dans les eaux de surface (RES) du Guide d'intervention - Protection des sols et réhabilitation des terrains contaminés (MELCC, 2019).

(2): Concentration maximale acceptable au point de rejet de l'effluent final selon la Directive 019 sur l'industrie minière (MDDEP, 2012)

(3): Limite de détection rapportée par le laboratoire d'analyses.

(4): Ajustement de la valeur du critère en fonction d'une dureté de l'eau ($CaCO_3$) de 10 mg/L.

LÉGENDE:

-	: Non défini ou non analysé
100	: Concentration < RES et D019
100	: Concentration > RES
100	: Concentration > D019

Tableau C4 (2 de 5)
Résultats des essais en colonnes
Colonne #2 : Mélange de stériles saturés
Projet Galaxy
N/Réf : 171-02562-00

Paramètres	Critères (mg/L)		LDR[3] (mg/L)	Semaine / Résultats d'analyse (mg/L)											
	RES [1]	D019 [2]		Semaine 7	Semaine 8		Semaine 9	Semaine 10		Semaine 11	Semaine 12		Semaine 13	Semaine 14	
				Totaux	Totaux	Dissouts	Totaux	Totaux	Dissouts	Totaux	Totaux	Dissouts	Totaux	Totaux	Dissouts
Métaux (mg/L)															
Aluminium	-	-	0,0003	---	0,25	0,164	---	0,173	0,131	---	0,154	---	---	0,185	---
Antimoine	1,1	-	0,0002	---	0,0007	0,0031	---	0,0008	0,002	---	0,0007	---	---	0,0007	---
Argent [4]	0,00003	-	0,000002	---	< 0,00005	< 0,00005	---	< 0,00005	< 0,00005	---	< 0,00005	---	---	< 0,00005	---
Arsenic	0,34	0,4	0,0002	---	0,171	0,172	---	0,125	0,123	---	0,127	---	---	0,121	---
Baryum [4]	0,11	-	0,00002	---	0,0069	0,00602	---	0,00568	0,00465	---	0,00445	---	---	0,0064	---
Béryllium	-	-	0,000007	---	0,000011	< 0,000007	---	0,000007	< 0,000007	---	0,000007	---	---	0,000007	---
Bore	28	-	0,0002	---	0,010	0,009	---	0,008	0,007	---	0,005	---	---	0,008	---
Bismuth	-	-	0,000007	---	< 0,000007	< 0,000007	---	0,00001	< 0,000007	---	0,00001	---	---	0,00001	---
Calcium	-	-	0,01	---	8,92	9,03	---	9,02	8,18	---	6,65	---	---	5,86	---
Cadmium [4]	0,0002	-	0,000003	---	< 0,000003	< 0,000003	---	0,000006	< 0,000003	---	< 0,000003	---	---	0,000008	---
Chrome	-	-	0,00003	---	0,00034	0,00005	---	0,00016	0,00010	---	0,00021	---	---	0,00025	---
Cobalt	0,37	-	0,000004	---	0,000222	0,000182	---	0,000180	0,000163	---	0,000153	---	---	0,000165	---
Cuivre [4]	0,0015	0,6	0,00002	---	0,00058	0,00094	---	0,00026	0,00025	---	0,00017	---	---	0,00044	---
Étain	-	-	0,00001	---	0,00797	0,00771	---	0,00843	0,00821	---	0,00658	---	---	0,00762	---
Fer	-	6	0,002	---	0,065	0,01	---	0,034	0,011	---	0,033	---	---	0,044	---
Potassium	-	-	0,002	---	4,11	4,03	---	3,21	3,06	---	2,25	---	---	1,81	---
Lithium	-	-	0,000006	---	0,095	0,091	---	0,0587	0,0576	---	0,0528	---	---	0,0672	---
Magnésium	-	-	0,003	---	0,945	0,966	---	1,05	0,818	---	0,657	---	---	0,592	---
Manganèse [4]	0,55	-	0,00001	---	0,0235	0,0229	---	0,0206	0,0197	---	0,0183	---	---	0,01519	---
Mercure	0,0000013	-	0,00001	---	**0,00007**	**0,00007**	---	< 0,00001	< 0,00001	---	< 0,00001	---	---	**0,00002**	---
Molybdène	29	-	0,00001	---	0,00038	0,00040	---	0,00036	0,00033	---	0,00027	---	---	0,00022	---
Nickel [4]	0,067	1	0,0001	---	0,0007	0,0005	---	0,0006	0,0006	---	0,0004	---	---	0,0005	---
Plomb [4]	0,0049	0,4	0,00001	---	0,00008	0,00002	---	0,00006	0,00087	---	0,00006	---	---	0,00015	---
Soufre	-	-	0,1	---	5,9	6,0	---	4,0	3,7	---	2,2	---	---	2,7	---
Sélénium	0,062	-	0,00004	---	0,00008	0,00007	---	0,00011	0,00011	---	0,00009	---	---	0,00009	---
Sodium	-	-	0,01	---	0,51	0,78	---	0,7	0,58	---	0,41	---	---	0,34	---
Strontium	-	-	0,00002	---	0,0725	0,0738	---	0,0635	0,0596	---	0,052	---	---	0,04162	---
Thorium	-	-	0,0001	---	< 0,0001	< 0,0001	---	0,0001	< 0,0001	---	0,0001	---	---	< 0,0001	---
Titane	-	-	0,00005	---	0,00506	0,00066	---	0,0024	0,0007	---	0,00235	---	---	0,0038	---
Thallium	-	-	0,000005	---	< 0,000005	0,000008	---	0,000017	0,000016	---	0,000014	---	---	0,000019	---
Tungstène	-	-	0,00002	---	0,00189	0,00187	---	0,00153	0,00143	---	0,00099	---	---	0,00145	---
Uranium [4]	0,32	-	0,000002	---	0,00399	0,00383	---	0,00292	0,00272	---	0,00223	---	---	0,002575	---
Vanadium	-	-	0,00001	---	0,00174	0,00164	---	0,00152	0,00138	---	0,00122	---	---	0,00117	---
Yttrium	-	-	0,000002	---	0,000046	0,000016	---	0,000025	0,000013	---	0,000023	---	---	0,000041	---
Zinc [4]	0,017	1	0,002	---	< 0,002	< 0,002	---	< 0,002	< 0,002	---	< 0,002	---	---	< 0,002	---
Autres composés inorganiques															
Sulfates (SO4)	-	-	0,2	---	15,0	---	---	12,0	---	---	10,0	---	---	9,0	---
Paramètres physico-chimiques															
Alcalinité (mg/L CaCO3)	-	-	1	---	16		---	15		---	11		---	10	
Acidité (mg/L CaCO3)	-	-	2	---	< 2		---	< 2		---	<2		---	<2	
Conductivité (uS/cm)	-	-	1	---	86		---	64		---	58		---	47	
Matières en suspension (mg/L)	-	30	3	---	< 2		---	< 3		---	---		---	---	
pH	-	6 - 9,5	0,01	---	7,38		---	7,58		---	7,18		---	7,33	
Potentiel d'oxydoréduction (mV)	-	-	1,0	---	232,0		---	365,0		---	181,0		---	161,0	
Paramètres d'essai															
Quantité d'eau de rinçage ajoutée (g)	-	-	0,01	4948,51	5781		4689,77	5128,23		4822,4	5263,4		4967,56	5740,13	
Quantité d'eau de rinçage récupérée (g)	-	-	0,01	5001,34	4566,93		5154,53	4759,65		5245,9	4961,88		5690,78	5773,42	
pH immédiat	-	-	0,01	7,75	7,8		7,83	7,91		7,67	7,52		7,14	7,55	
Conductivité immédiate (uS/cm)	-	-	0,1	118,7	65,1		106,4	71,6		79,5	67,3		32,1	53,6	

NOTES:

(1): Critères de Résurgence dans les eaux de surface (RES) du Guide d'intervention - Protection des sols et réhabilitation des terrains contaminés (MELCC, 2019).

(2): Concentration maximale acceptable au point de rejet de l'effluent final selon la Directive 019 sur l'industrie minière (MDDEP, 2012)

(3): Limite de détection rapportée par le laboratoire d'analyses.

(4): Ajustement de la valeur du critère en fonction d'une dureté de l'eau ($CaCO_3$) de 10 mg/L.

LÉGENDE:

-	: Non défini ou non analysé
100	: Concentration < RES et D019
100	: Concentration > RES
100	: Concentration > D019

Tableau C4 (3 de 5)
Résultats des essais en colonnes
Colonne #2 : Mélange de stériles saturés
Projet Galaxy
N/Réf : 171-02562-00

Paramètres	Critères (mg/L)		LDR[3] (mg/L)	Semaine / Résultats d'analyse (mg/L)											
	RES [1]	D019 [2]		Semaine 15	Semaine 16	Semaine 17	Semaine 18	Semaine 19	Semaine 20	Semaine 21	Semaine 22	Semaine 23	Semaine 24	Semaine 25	Semaine 26
				Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux
Métaux (mg/L)															
Aluminium	-	-	0,0003	---	0,303	---	0,216	---	0,111	---	0,101	---	0,053	---	0,048
Antimoine	1,1	-	0,0002	---	0,0006	---	0,0006	---	0,0005	---	0,0006	---	0,0005	---	0,0003
Argent [4]	0,00003	-	0,000002	---	< 0,00005	---	< 0,00005	---	< 0,00005	---	< 0,00005	---	< 0,00005	---	< 0,00005
Arsenic	0,34	0,4	0,0002	---	0,125	---	0,0966	---	0,0868	---	0,0819	---	0,0528	---	0,0498
Baryum [4]	0,11	-	0,00002	---	0,00397	---	0,00451	---	0,00312	---	0,00375	---	0,00277	---	0,00348
Béryllium	-	-	0,000007	---	0,000013	---	0,000010	---	0,000007	---	< 0,000007	---	< 0,000007	---	< 0,000007
Bore	28	-	0,0002	---	0,005	---	0,005	---	0,008	---	0,004	---	< 0,002	---	< 0,002
Bismuth	-	-	0,000007	---	< 0,000007	---	< 0,000007	---	0,00001	---	0,00001	---	0,00003	---	0,00002
Calcium	-	-	0,01	---	4,35	---	5,44	---	4,79	---	4,85	---	3,78	---	4,59
Cadmium [4]	0,0002	-	0,000003	---	< 0,000003	---	< 0,000003	---	0,000005	---	0,000007	---	0,000004	---	0,000005
Chrome	-	-	0,00003	---	0,00054	---	0,00039	---	0,00011	---	0,00016	---	0,00021	---	0,000
Cobalt	0,37	-	0,000004	---	0,000168	---	0,000222	---	0,000178	---	0,000258	---	0,000230	---	0,000316
Cuivre [4]	0,0015	0,6	0,00002	---	0,00035	---	0,00033	---	0,00024	---	0,00034	---	0,00012	---	0,00016
Étain	-	-	0,00001	---	0,00278	---	0,00311	---	0,00242	---	0,00293	---	0,00206	---	0,00191
Fer	-	6	0,002	---	0,151	---	0,112	---	0,023	---	0,036	---	0,013	---	0,008
Potassium	-	-	0,002	---	1,63	---	1,52	---	1,26	---	1,32	---	0,968	---	1,16
Lithium	-	-	0,000006	---	0,0479	---	0,0435	---	0,0357	---	0,0442	---	0,0312	---	0,041
Magnésium	-	-	0,003	---	0,525	---	0,587	---	0,484	---	0,503	---	0,412	---	0,435
Manganèse [4]	0,55	-	0,00001	---	0,0026	---	0,0207	---	0,02129	---	0,0326	---	0,0322	---	0,0474
Mercure	0,0000013	-	0,00001	---	< 0,00001	---	< 0,00001	---	< 0,00001	---	< 0,00001	---	< 0,00001	---	< 0,00001
Molybdène	29	-	0,00001	---	0,00018	---	0,00018	---	0,00017	---	0,00029	---	0,00011	---	0,00011
Nickel [4]	0,067	1	0,0001	---	0,0006	---	0,0006	---	0,0005	---	0,0006	---	0,0006	---	0,0007
Plomb [4]	0,0049	0,4	0,00001	---	0,00014	---	0,00014	---	0,00007	---	0,00009	---	0,00018	---	0,00005
Soufre	-	-	0,1	---	1,1	---	3,4	---	2,8	---	2,5	---	1,3	---	2,9
Sélénium	0,062	-	0,00004	---	0,00011	---	0,00011	---	0,00008	---	0,00008	---	0,00009	---	0,00006
Sodium	-	-	0,01	---	0,24	---	0,32	---	0,33	---	0,28	---	< 0,01	---	0,23
Strontium	-	-	0,00002	---	0,03228	---	0,0398	---	0,034	---	0,0425	---	0,0333	---	0,0358
Thorium	-	-	0,0001	---	< 0,0001	---	< 0,0001	---	< 0,0001	---	< 0,0001	---	< 0,0001	---	< 0,0001
Titane	-	-	0,00005	---	0,0118	---	0,0072	---	0,00214	---	0,00216	---	0,00092	---	0,0004
Thallium	-	-	0,000005	---	0,000021	---	0,000015	---	0,000013	---	0,000016	---	0,000007	---	0,000008
Tungstène	-	-	0,00002	---	0,00048	---	0,00064	---	0,00066	---	0,00062	---	0,00055	---	0,00031
Uranium [4]	0,32	-	0,000002	---	0,00337	---	0,000735	---	0,000444	---	0,000422	---	0,000235	---	0,000193
Vanadium	-	-	0,00001	---	0,00156	---	0,001	---	0,00073	---	0,00087	---	0,00054	---	0,0005
Yttrium	-	-	0,000002	---	0,00008	---	0,000052	---	0,000022	---	0,000022	---	0,00001	---	0,000005
Zinc [4]	0,017	1	0,002	---	< 0,002	---	0,003	---	0,003	---	< 0,002	---	0,003	---	< 0,002
Autres composés inorganiques															
Sulfates (SO4)	-	-	0,2	---	8,8	---	8,8	---	7,9	---	8,3	---	8,2	---	7,6
Paramètres physico-chimiques															
Alcalinité (mg/L CaCO3)	-	-	1	---	25	---	8	---	8	---	6	---	6	---	7
Acidité (mg/L CaCO3)	-	-	2	---	< 2	---	< 2	---	< 2	---	< 2	---	< 2	---	< 2
Conductivité (uS/cm)	-	-	1	---	46	---	41	---	38	---	40	---	34	---	36
Matières en suspension (mg/L)	-	30	3	---	---	---	---	---	---	---	---	---	---	---	---
pH	-	6 - 9,5	0,01	---	7,41	---	7,18	---	7,03	---	6,88	---	7	---	7,04
Potentiel d'oxydoréduction (mV)	-	-	1,0	---	432,0	---	247,0	---	310,0	---	352,0	---	218,0	---	198,0
Paramètres d'essai															
Quantité d'eau de rinçage ajoutée (g)	-	-	0,01	5597,84	5394,46	5649,25	5676,35	5586,42	5620,35	5569,8	5597,78	5777,02	5746,56	5587,23	5883,8
Quantité d'eau de rinçage récupérée (g)	-	-	0,01	5558,91	5404,42	6041,78	5586,6	5633,88	5619,74	5561,51	5576,36	5491,35	5206,08	5676,78	5820,48
pH immédiat	-	-	0,01	7,51	7,6	7,37	7,3	7,15	7,13	6,98	6,93	7	6,96	6,42	6,82
Conductivité immédiate (uS/cm)	-	-	0,1	46,8	53,9	39,4	47,5	40,4	37,6	33,58	34,4	34,5	40,1	30,9	30

NOTES:

(1): Critères de Résurgence dans les eaux de surface (RES) du Guide d'intervention - Protection des sols et réhabilitation des terrains contaminés (MELCC, 2019).

(2): Concentration maximale acceptable au point de rejet de l'effluent final selon la Directive 019 sur l'industrie minière (MDDEP, 2012)

(3): Limite de détection rapportée par le laboratoire d'analyses.

(4): Ajustement de la valeur du critère en fonction d'une dureté de l'eau ($CaCO_3$) de 10 mg/L.

LÉGENDE:

-	: Non défini ou non analysé
100	: Concentration < RES et D019
100	: Concentration > RES
100	: Concentration > D019

Tableau C4 (4 de 5)
Résultats des essais en colonnes
Colonne #2 : Mélange de stériles saturés
Projet Galaxy
N/Réf : 171-02562-00

Paramètres	Critères (mg/L)		LDR[3] (mg/L)	Semaine / Résultats d'analyse (mg/L)											
	RES [1]	D019 [2]		Semaine 27	Semaine 28	Semaine 29	Semaine 30	Semaine 31	Semaine 32	Semaine 33	Semaine 34	Semaine 35	Semaine 36	Semaine 37	Semaine 38
				Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux
Métaux (mg/L)															
Aluminium	-	-	0,0003	---	0,053	---	0,512	---	0,026	---	0,014	---	0,019	---	0,02
Antimoine	1,1	-	0,0002	---	0,0004	---	0,0003	---	< 0,0002	---	0,0003	---	< 0,0002	---	< 0,0002
Argent [4]	0,00003	-	0,000002	---	< 0,00005	---	< 0,00005	---	< 0,00005	---	< 0,00005	---	< 0,00005	---	< 0,00005
Arsenic	0,34	0,4	0,0002	---	0,0457	---	0,042	---	0,0322	---	0,0218	---	0,0226	---	0,0201
Baryum [4]	0,11	-	0,00002	---	0,00356	---	0,00118	---	0,00324	---	0,0228	---	0,00373	---	0,00341
Béryllium	-	-	0,000007	---	< 0,000007	---	0,000268	---	< 0,000007	---	< 0,000007	---	< 0,000007	---	< 0,000007
Bore	28	-	0,0002	---	0,002	---	< 0,002	---	0,004	---	0,009	---	< 0,002	---	0,003
Bismuth	-	-	0,000007	---	< 0,000007	---	0,00033	---	< 0,000007	---	< 0,000007	---	< 0,000007	---	< 0,000007
Calcium	-	-	0,01	---	4,11	---	1,69	---	3,92	---	25,60	---	4,58	---	3,73
Cadmium [4]	0,0002	-	0,000003	---	0,000008	---	0,000008	---	0,000008	---	0,000051	---	0,000011	---	0,000023
Chrome	-	-	0,00003	---	0,00006	---	0,00064	---	0,00014	---	< 0,00003	---	0,00004	---	< 0,00003
Cobalt	0,37	-	0,000004	---	0,000460	---	0,000086	---	0,000548	---	0,002646	---	0,000689	---	0,000807
Cuivre [4]	0,0015	0,6	0,00002	---	0,00024	---	0,00121	---	0,00016	---	0,00069	---	0,00027	---	0,00006
Étain	-	-	0,00001	---	0,00148	---	0,00108	---	0,00192	---	0,00117	---	0,00086	---	0,00133
Fer	-	6	0,002	---	0,033	---	0,291	---	0,012	---	0,022	---	0,013	---	0,021
Potassium	-	-	0,002	---	1,01	---	0,428	---	0,876	---	2,26	---	0,819	---	0,751
Lithium	-	-	0,000006	---	0,0367	---	0,175	---	0,0416	---	0,0542	---	0,0386	---	0,0427
Magnésium	-	-	0,003	---	0,451	---	0,163	---	0,39	---	2,43	---	0,465	---	0,383
Manganèse [4]	0,55	-	0,00001	---	0,0606	---	0,0324	---	0,0756	---	0,382	---	0,0812	---	0,0852
Mercure	0,0000013	-	0,00001	---	< 0,00001	---	< 0,00001	---	< 0,00001	---	< 0,00001	---	< 0,00001	---	< 0,00001
Molybdène	29	-	0,00001	---	0,00016	---	0,00075	---	< 0,00001	---	0,00022	---	0,00010	---	0,00008
Nickel [4]	0,067	1	0,0001	---	0,0009	---	0,0004	---	0,0015	---	0,0121	---	0,0018	---	0,0025
Plomb [4]	0,0049	0,4	0,00001	---	0,00015	---	0,00063	---	< 0,00001	---	0,00007	---	0,00002	---	0,00004
Soufre	-	-	0,1	---	2,5	---	< 0,1	---	3,0	---	11,3	---	4,7	---	2,6
Sélénium	0,062	-	0,00004	---	0,00008	---	< 0,00004	---	0,00008	---	0,00023	---	0,00008	---	0,00005
Sodium	-	-	0,01	---	0,25	---	0,49	---	0,26	---	9,99	---	1,14	---	0,49
Strontium	-	-	0,00002	---	0,0341	---	0,00854	---	0,0334	---	0,207	---	0,037	---	0,0306
Thorium	-	-	0,0001	---	< 0,0001	---	< 0,0001	---	< 0,0001	---	< 0,0001	---	< 0,0001	---	< 0,0001
Titane	-	-	0,00005	---	0,0033	---	0,0053	---	0,00065	---	0,00051	---	0,00058	---	0,00078
Thallium	-	-	0,000005	---	0,000008	---	0,000036	---	0,000011	---	0,000026	---	0,000011	---	0,000006
Tungstène	-	-	0,00002	---	0,00036	---	0,00009	---	0,00022	---	0,00017	---	0,00018	---	0,00012
Uranium [4]	0,32	-	0,000002	---	0,000183	---	0,00071	---	0,000115	---	0,00103	---	0,000153	---	0,000083
Vanadium	-	-	0,00001	---	0,00047	---	0,00104	---	0,0003	---	0,0002	---	0,00019	---	0,00016
Yttrium	-	-	0,000002	---	0,000019	---	0,000019	---	0,000008	---	0,000049	---	0,000008	---	0,000007
Zinc [4]	0,017	1	0,002	---	< 0,002	---	0,006	---	< 0,002	---	0,002	---	< 0,002	---	< 0,002
Autres composés inorganiques															
Sulfates (SO4)	-	-	0,2	---	8,1	---	7,7	---	7,0	---	33,0	---	10,0	---	8,8
Paramètres physico-chimiques															
Alcalinité (mg/L CaCO3)	-	-	1	---	4	---	4	---	5	---	45	---	5	---	3
Acidité (mg/L CaCO3)	-	-	2	---	< 2	---	< 2	---	< 2	---	< 2	---	< 2	---	< 2
Conductivité (uS/cm)	-	-	1	---	37	---	33	---	32	---	214	---	42	---	31
Matières en suspension (mg/L)	-	30	3	---	---	---	---	---	---	---	---	---	---	---	---
pH	-	6 - 9,5	0,01	---	6,49	---	6,25	---	6,48	---	7,15	---	6,67	---	6,49
Potentiel d'oxydoréduction (mV)	-	-	1,0	---	79,0	---	170,0	---	357,0	---	209,0	---	121,0	---	176,0
Paramètres d'essai															
Quantité d'eau de rinçage ajoutée (g)	-	-	0,01	5764	5704,28	5587,23	5767,9	5563,75	5558,23	5643,37	5728,38	5689,28	5113,04	5559,05	5783,28
Quantité d'eau de rinçage récupérée (g)	-	-	0,01	5696,17	5604,44	5676,78	5372,57	5716,66	5631,36	5652,06	5557,25	5170,61	5626,39	5526,04	5718,51
pH immédiat	-	-	0,01	6,54	6,49	6,42	6,68	6,4	6,18	6,77	6,67	6,34	6,13	6,21	6,08
Conductivité immédiate (uS/cm)	-	-	0,1	29	39,2	30,9	39,6	23,9	25,2	29,9	180,6	80,8	42,6	47,1	30,2

NOTES:

(1): Critères de Résurgence dans les eaux de surface (RES) du Guide d'intervention - Protection des sols et réhabilitation des terrains contaminés (MELCC, 2019).

(2): Concentration maximale acceptable au point de rejet de l'effluent final selon la Directive 019 sur l'industrie minière (MDDEP, 2012)

(3): Limite de détection rapportée par le laboratoire d'analyses.

(4): Ajustement de la valeur du critère en fonction d'une dureté de l'eau ($CaCO_3$) de 10 mg/L.

LÉGENDE:

-	: Non défini ou non analysé
100	: Concentration < RES et D019
100	: Concentration > RES
100	: Concentration > D019

Tableau C4 (5 de 5)
Résultats des essais en colonnes
Colonne #2 : Mélange de stériles saturés
Projet Galaxy
N/Réf : 171-02562-00

Paramètres	Critères (mg/L)		LDR[3] (mg/L)	Semaine / Résultats d'analyse (mg/L)											
	RES [1]	D019 [2]		Semaine 39	Semaine 40	Semaine 41	Semaine 42	Semaine 43	Semaine 44	Semaine 45	Semaine 46	Semaine 47	Semaine 48	Semaine 49	Semaine 50
				Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux
Métaux (mg/L)															
Aluminium	-	-	0,0003	---	0,011	---	0,006	---	0,006	---	0,004	---	0,003	---	< 0.001
Antimoine	1,1	-	0,0002	---	< 0,0002	---	< 0,0002	---	< 0.0009	---	< 0.0009	---	< 0.0009	---	< 0.0009
Argent [4]	0,00003	-	0,000002	---	< 0,00005	---	< 0,00005	---	< 0.00005	---	< 0.00005	---	< 0.00005	---	< 0.00005
Arsenic	0,34	0,4	0,0002	---	0,0153	---	0,0123	---	0,0104	---	0,0099	---	0,0088	---	0,0081
Baryum [4]	0,11	-	0,00002	---	0,00342	---	0,00343	---	0,00404	---	0,00408	---	0,00408	---	0,00413
Béryllium	-	-	0,000007	---	< 0,000007	---	< 0,000007	---	< 0.000007	---	< 0.000007	---	< 0.000007	---	< 0.000007
Bore	28	-	0,0002	---	0,005	---	0,008	---	0,002	---	< 0.002	---	0,002	---	< 0.002
Bismuth	-	-	0,000007	---	< 0,000007	---	< 0,000007	---	< 0.000007	---	< 0.000007	---	< 0.000007	---	< 0.000007
Calcium	-	-	0,01	---	3,54	---	3,49	---	3,60	---	3,63	---	3,45	---	3,33
Cadmium [4]	0,0002	-	0,000003	---	0,000013	---	0,000017	---	0,000022	---	0,000037	---	0,000025	---	0,000035
Chrome	-	-	0,00003	---	0,00005	---	< 0,00003	---	< 0.00008	---	< 0.00008	---	< 0.00008	---	< 0.00008
Cobalt	0,37	-	0,000004	---	0,001029	---	0,001260	---	0,001850	---	0,002290	---	0,002810	---	0,00297
Cuivre [4]	0,0015	0,6	0,00002	---	< 0,00002	---	< 0,00002	---	< 0.0002	---	< 0.0002	---	< 0.0002	---	< 0.0002
Étain	-	-	0,00001	---	0,00069	---	0,00056	---	0,00096	---	0,00052	---	0,00048	---	0,00043
Fer	-	6	0,002	---	0,02	---	0,02	---	0,028	---	0,043	---	0,062	---	0,055
Potassium	-	-	0,002	---	0,66	---	0,753	---	0,701	---	0,664	---	0,659	---	0,576
Lithium	-	-	0,000006	---	0,0444	---	0,0409	---	0,0495	---	0,0605	---	0,0478	---	0,0487
Magnésium	-	-	0,003	---	0,334	---	0,355	---	0,408	---	0,335	---	0,353	---	0,325
Manganèse [4]	0,55	-	0,00001	---	0,102	---	0,103	---	0,123	---	0,138	---	0,148	---	0,136
Mercure	0,0000013	-	0,00001	---	< 0,00001	---	< 0,00001	---	< 0.00001	---	**0,00001**	---	< 0.00001	---	< 0.00001
Molybdène	29	-	0,00001	---	0,00005	---	0,00014	---	0,00006	---	0,00004	---	< 0.00004	---	< 0.00004
Nickel [4]	0,067	1	0,0001	---	0,0028	---	0,0034	---	0,0054	---	0,0063	---	0,0080	---	0,0078
Plomb [4]	0,0049	0,4	0,00001	---	0,00004	---	0,00005	---	0,00003	---	< 0.00001	---	0,00002	---	< 0.00001
Soufre	-	-	0,1	---	3,6	---	3,5	---	3,6	---	3,8	---	4,1	---	3,1
Sélénium	0,062	-	0,00004	---	0,00006	---	0,00006	---	0,00006	---	0,00006	---	0,00004	---	0,00008
Sodium	-	-	0,01	---	0,28	---	0,34	---	0,28	---	0,27	---	0,22	---	0,24
Strontium	-	-	0,00002	---	0,0297	---	0,0262	---	0,029	---	0,0294	---	0,0316	---	0,0304
Thorium	-	-	0,0001	---	< 0,0001	---	< 0,0001	---	< 0.0001	---	< 0.0001	---	< 0.0001	---	< 0.0001
Titane	-	-	0,00005	---	0,00046	---	0,0002	---	0,00012	---	0,00016	---	0,00017	---	0,00006
Thallium	-	-	0,000005	---	0,000012	---	0,00001	---	< 0.000005	---	0,000012	---	< 0.000005	---	0,000014
Tungstène	-	-	0,00002	---	0,00008	---	0,00008	---	0,00006	---	0,00002	---	< 0.00002	---	0,00003
Uranium [4]	0,32	-	0,000002	---	0,000106	---	0,000067	---	0,000075	---	0,000072	---	0,000067	---	0,00006
Vanadium	-	-	0,00001	---	0,00012	---	0,00008	---	0,00008	---	0,00007	---	0,00004	---	0,00004
Yttrium	-	-	0,000002	---	0,000017	---	0,000006	---	0,000005	---	0,000007	---	0,000008	---	0,000007
Zinc [4]	0,017	1	0,002	---	< 0,002	---	< 0,002	---	< 0.002	---	< 0.002	---	< 0.002	---	0,007
Autres composés inorganiques															
Sulfates (SO4)	-	-	0,2	---	7,9	---	8,4	---	7,3	---	9,3	---	9,2	---	9,5
Paramètres physico-chimiques															
Alcalinité (mg/L CaCO3)	-	-	1	---	3	---	4	---	2	---	2	---	3	---	3
Acidité (mg/L CaCO3)	-	-	2	---	< 2	---	< 2	---	< 2	---	4	---	3	---	< 2
Conductivité (uS/cm)	-	-	1	---	30	---	29	---	27	---	32	---	32	---	32
Matières en suspension (mg/L)	-	30	3	---	---	---	---	---	---	---	---	---	---	---	---
pH	-	6 - 9,5	0,01	---	6,44	---	6,68	---	6,48	---	6,56	---	6,43	---	6,58
Potentiel d'oxydoréduction (mV)	-	-	1,0	---	154,0	---	407,0	---	122,0	---	167,0	---	237,0	---	149
Paramètres d'essai															
Quantité d'eau de rinçage ajoutée (g)	-	-	0,01	5574,12	5712,78	5610,13	5613,54	5658,59	5648,72	5650,08	5772,88	5505,8	5797,54	5767,47	5709,33
Quantité d'eau de rinçage récupérée (g)	-	-	0,01	5619,37	5604,9	5618,32	5568,01	5667,53	5617,73	5546,14	5500,56	5723,97	5512,83	5874,11	5678,55
pH immédiat	-	-	0,01	5,88	6,03	6,02	6,06	6,05	5,97	6,19	6,22	6,14	6,14	6,18	6,12
Conductivité immédiate (uS/cm)	-	-	0,1	36,2	28,4	28,5	48,6	28,1	35,5	30,3	35,4	35,1	34,3	34,8	32,9

NOTES:

(1): Critères de Résurgence dans les eaux de surface (RES) du Guide d'intervention - Protection des sols et réhabilitation des terrains contaminés (MELCC, 2019).

(2): Concentration maximale acceptable au point de rejet de l'effluent final selon la Directive 019 sur l'industrie minière (MDDEP, 2012)

(3): Limite de détection rapportée par le laboratoire d'analyses.

(4): Ajustement de la valeur du critère en fonction d'une dureté de l'eau ($CaCO_3$) de 10 mg/L.

LÉGENDE:

-	: Non défini ou non analysé
100	: Concentration < RES et D019
100	: Concentration > RES
100	: Concentration > D019

Tableau C5 (1 de 5)
Résultats des essais en colonnes
Colonne #3 : Mélange de stériles non saturés
Projet Galaxy
N/Réf : 171-02562-00

Paramètres	Critères (mg/L)		LDR[3] (mg/L)	Semaine / Résultats d'analyse (mg/L)												
	RES [1]	D019 [2]		Initial		Semaine 1		Semaine 2		Semaine 3		Semaine 4		Semaine 5	Semaine 6	
				Totaux	Dissouts	Totaux	Dissouts	Totaux	Dissouts	Totaux	Dissouts	Totaux	Dissouts	Totaux	Totaux	Dissouts
Métaux (mg/L)																
Aluminium	-	-	0,0003	11,9	3,88	7,14	0,165	33,6	0,072	6,38	0,085	32,4	0,133	---	19,6	0,169
Antimoine	1,1	-	0,0002	0,0011	< 0,0002	0,0033	0,0031	0,0011	0,0012	0,001	0,003	0,0012	< 0,0002	---	0,0013	< 0,0002
Argent [4]	0,00003	-	0,000002	**0,00009**	< 0,00005	**0,00016**	< 0,00005	**0,0002**	< 0,00005	**0,00009**	< 0,00005	**0,00005**	< 0,00005	---	**0,00015**	< 0,00005
Arsenic	0,34	0,4	0,0002	0,123	0,101	0,182	0,151	0,198	0,139	0,179	0,128	0,306	0,164	---	0,206	0,137
Baryum [4]	0,11	-	0,00002	**0,141**	0,0658	0,103	0,0248	**0,349**	0,0108	0,0704	0,0053	**0,284**	0,0067	---	**0,22**	0,00666
Béryllium	-	-	0,000007	0,001160	0,000325	0,000296	0,000010	0,000871	< 0,000007	0,000413	< 0,000007	0,001580	0,000007	---	0,000717	0,000008
Bore	28	-	0,0002	0,049	0,034	0,061	0,061	0,025	0,023	0,018	0,017	0,028	0,019	---	0,013	0,013
Bismuth	-	-	0,000007	0,000437	0,000243	0,000160	0,000008	0,000544	0,000025	0,000268	0,000012	0,000560	< 0,000007	---	0,00040	0,00001
Calcium	-	-	0,01	8,07	6,39	15,90	15,40	10,10	6,38	6,78	5,23	13,00	5,99	---	8,20	5,54
Cadmium [4]	0,0002	-	0,000003	0,000036	0,000019	0,000035	0,000008	0,000147	< 0,000003	0,00004	0,000008	0,000145	0,000008	---	0,000098	< 0,000003
Chrome	-	-	0,00003	0,0275	0,0148	0,0265	0,0004	0,1130	0,0002	0,0221	< 0,00003	0,1140	0,0002	---	0,077	0,000
Cobalt	0,37	-	0,000004	0,005240	0,003550	0,004390	0,000954	0,016600	0,000207	0,005710	0,000411	0,019700	0,000478	---	0,012800	0,000452
Cuivre [4]	0,0015	0,6	0,00002	**0,0080**	**0,0032**	**0,0084**	0,0005	**0,03740**	0,00042	**0,01120**	0,00029	**0,05200**	< 0,00002	---	**0,03030**	0,00040
Étain	-	-	0,00001	0,0610	0,0520	0,0679	0,0643	0,04270	0,02550	0,01680	0,01420	0,02760	0,01170	---	0,01940	0,00828
Fer	-	6	0,002	**7,55**	4,29	**8,53**	0,151	**32**	0,034	**6,84**	0,012	**36**	0,047	---	**22,1**	0,105
Potassium	-	-	0,002	18,2	15,7	22	20	21,9	8,72	8,41	6	21,1	5,7	---	13,4	3,96
Lithium	-	-	0,000006	0,665	0,631	0,907	0,856	0,66	0,315	0,299	0,214	1,09	0,261	---	0,442	0,135
Magnésium	-	-	0,003	4	2,62	5,47	2,66	13,5	1,24	3,41	0,945	14,4	1,04	---	9,15	0,89
Manganèse [4]	0,55	-	0,00001	0,154	0,0999	0,214	0,0743	0,546	0,00303	0,126	0,01521	**0,579**	0,0118	---	0,35	0,00696
Mercure	0,0000013	-	0,00001	**0,00002**	**0,00001**	< 0,00001	< 0,00001	< 0,00001	< 0,00001	< 0,00001	< 0,00001	< 0,00001	< 0,00001	---	< 0,00001	**0,00002**
Molybdène	29	-	0,00001	0,00198	0,00179	0,00467	0,00485	0,00194	0,00144	0,00091	0,00218	0,00127	0,00068	---	0,00060	0,00046
Nickel [4]	0,067	1	0,0001	0,0201	0,0135	0,0179	0,0070	0,0515	0,0017	0,0175	0,0021	0,0632	0,0023	---	0,0400	0,0019
Plomb [4]	0,0049	0,4	0,00001	0,00464	0,00216	0,00209	0,00005	**0,00813**	0,00007	0,00313	0,00004	**0,00878**	0,00006	---	**0,00688**	0,00009
Soufre	-	-	0,1	8,9	9,1	15,5	15,8	5,1	6,5	5,0	4,8	8,9	6,9	---	3,8	4,5
Sélénium	0,062	-	0,00004	0,00054	0,00047	0,00099	0,00075	0,00036	0,00022	0,00028	0,00019	0,00035	0,0002	---	0,00024	0,00014
Sodium	-	-	0,01	11,2	8,62	14,5	14,7	6,97	4,95	3,98	3	5,93	2,48	---	2,37	0,53
Strontium	-	-	0,00002	0,109	0,0729	0,226	0,224	0,104	0,0721	0,0719	0,0526	0,138	0,0628	---	0,0816	0,0531
Thorium	-	-	0,0001	0,0066	0,0013	0,0024	0,0001	0,013	< 0,0001	0,0024	< 0,0001	0,0094	< 0,0001	---	0,0077	< 0,0001
Titane	-	-	0,00005	0,619	0,279	0,602	0,00837	2,37	0,00206	0,469	0,00054	2,62	0,00318	---	1,58	0,0066
Thallium	-	-	0,000005	0,000615	0,000332	0,000484	0,000055	0,00207	0,000049	0,00041	0,000029	0,00169	0,000036	---	0,00141	0,000046
Tungstène	-	-	0,00002	0,0122	0,0104	0,0198	0,0186	0,01	0,00374	0,00303	0,00182	0,00562	0,00111	---	0,00539	0,00095
Uranium [4]	0,32	-	0,000002	0,00472	0,00273	0,0201	0,0182	0,0103	0,00248	0,0058	0,00338	0,0101	0,00386	---	0,00832	0,00335
Vanadium	-	-	0,00001	0,0201	0,0114	0,0194	0,0021	0,075	0,00139	0,0155	0,00105	0,0767	0,00122	---	0,0517	0,00116
Yttrium	-	-	0,000002	0,00483	0,00248	0,00253	0,000223	0,00808	0,000044	0,00256	0,000024	0,0105	0,0001	---	0,00617	0,000062
Zinc [4]	0,017	1	0,002	**0,022**	0,013	**0,023**	< 0,002	**0,076**	< 0,002	**0,022**	< 0,002	**0,095**	< 0,002	---	**0,054**	< 0,002
Autres composés inorganiques																
Sulfates (SO4)	-	-	0,2	---	---	---	---	---	---	---	---	---	---	---	14,0	---
Paramètres physico-chimiques																
Alcalinité (mg/L CaCO3)	-	-	1	33		57		22		16		17		---	16	
Acidité (mg/L CaCO3)	-	-	2	< 2		< 2		< 2		< 2		< 2		---	< 2	
Conductivité (uS/cm)	-	-	1	135		243		105		79		73		---	69	
Matières en suspension (mg/L)	-	30	3	**82**		**291**		**826**		**562**		---		---	**503**	
pH	-	6 - 9,5	0,01	7,48		7,89		7,56		7,58		7,37		---	7,28	
Potentiel d'oxydoréduction (mV)	-	-	1,0	282,0		263,0		336,0		247,0		312,0		---	193,0	
Paramètres d'essai																
Quantité d'eau de rinçage ajoutée (g)	-	-	0,01	6290		5290,5		5351,7		5449		5405		5359,27	5437,52	
Quantité d'eau de rinçage récupérée (g)	-	-	0,01	5219,4		5291,8		5339,7		5460,2		5392,69		5368,71	5443,46	
pH immédiat	-	-	0,01	7,88		8,36		8,46		8,75		8,28		8,41	7,48	
Conductivité immédiate (uS/cm)	-	-	0,1	328		138,5		112,5		37,6		35,2		36,6	46,3	

NOTES:

(1): Critères de Résurgence dans les eaux de surface (RES) du Guide d'intervention - Protection des sols et réhabilitation des terrains contaminés (MELCC, 2019).

(2): Concentration maximale acceptable au point de rejet de l'effluent final selon la Directive 019 sur l'industrie minière (MDDEP, 2012)

(3): Limite de détection rapportée par le laboratoire d'analyses.

(4): Ajustement de la valeur du critère en fonction d'une dureté de l'eau ($CaCO_3$) de 10 mg/L.

LÉGENDE:

- / ---	: Non défini ou non analysé
100	: Concentration < RES et D019
100	: Concentration > RES
100	: Concentration > D019

Tableau C5 (2 de 5)
Résultats des essais en colonnes
Colonne #3 : Mélange de stériles non saturés
Projet Galaxy
N/Réf : 171-02562-00

Paramètres	Critères (mg/L)		LDR(3) (mg/L)	Semaine / Résultats d'analyse (mg/L)											
	RES (1)	D019 (2)		Semaine 7	Semaine 8		Semaine 9	Semaine 10		Semaine 11	Semaine 12		Semaine 13	Semaine 14	
				Totaux	Totaux	Dissouts	Totaux	Totaux	Dissouts	Totaux	Totaux	Dissouts	Totaux	Totaux	Dissouts
Métaux (mg/L)															
Aluminium	-	-	0,0003	---	10,2	0,457	---	11	0,069	---	8,29	---	---	0,634	---
Antimoine	1,1	-	0,0002	---	0,0006	0,0039	---	0,0007	0,0021	---	0,0006	---	---	0,0005	---
Argent (4)	0,00003	-	0,000002	---	**0,00009**	< 0,00005	---	**0,00008**	< 0,00005	---	**0,00006**	---	---	< 0,00005	---
Arsenic	0,34	0,4	0,0002	---	0,154	0,117	---	0,124	0,101	---	0,122	---	---	0,129	---
Baryum (4)	0,11	-	0,00002	---	0,0928	0,00877	---	0,107	0,00419	---	0,0872	---	---	0,0076	---
Béryllium	-	-	0,000007	---	0,000521	0,000040	---	0,000420	< 0,000007	---	0,000351	---	---	0,000020	---
Bore	28	-	0,0002	---	0,011	0,009	---	0,008	0,006	---	0,005	---	---	0,006	---
Bismuth	-	-	0,000007	---	0,000248	0,000022	---	0,000221	0,000011	---	0,000199	---	---	0,000017	---
Calcium	-	-	0,01	---	7,11	5,04	---	6,55	4,82	---	5,56	---	---	4,56	---
Cadmium (4)	0,0002	-	0,000003	---	0,000045	< 0,000003	---	0,000061	0,000006	---	0,000045	---	---	0,000009	---
Chrome	-	-	0,00003	---	0,032	0,002	---	0,043	0,000	---	0,032	---	---	0,002	---
Cobalt	0,37	-	0,000004	---	0,007810	0,000864	---	0,007780	0,000291	---	0,006140	---	---	0,000312	---
Cuivre (4)	0,0015	0,6	0,00002	---	**0,01920**	**0,00158**	---	**0,01510**	0,00018	---	**0,01150**	---	---	0,00046	---
Étain	-	-	0,00001	---	0,01050	0,00638	---	0,00981	0,00524	---	0,00745	---	---	0,00361	---
Fer	-	6	0,002	---	**9,84**	0,507	---	**13**	0,03	---	**9,67**	---	---	0,584	---
Potassium	-	-	0,002	---	7,26	3,48	---	7,82	2,68	---	5,98	---	---	2,18	---
Lithium	-	-	0,000006	---	0,237	0,0946	---	0,219	0,0541	---	0,182	---	---	0,0595	---
Magnésium	-	-	0,003	---	4,26	0,865	---	5,22	0,641	---	4,09	---	---	0,729	---
Manganèse (4)	0,55	-	0,00001	---	0,189	0,0143	---	0,191	0,00462	---	0,154	---	---	0,00832	---
Mercure	0,0000013	-	0,00001	---	< 0,00001	< 0,00001	---	< 0,00001	< 0,00001	---	< 0,00001	---	---	< 0,00001	---
Molybdène	29	-	0,00001	---	0,00047	0,00032	---	0,00035	0,00026	---	0,00028	---	---	0,00019	---
Nickel (4)	0,067	1	0,0001	---	0,0246	0,0036	---	0,0246	0,0012	---	0,0196	---	---	0,0011	---
Plomb (4)	0,0049	0,4	0,00001	---	0,00432	0,00030	---	0,00393	0,00003	---	0,00353	---	---	0,00021	---
Soufre	-	-	0,1	---	3,8	4,3	---	2,3	2,5	---	1,2	---	---	1,7	---
Sélénium	0,062	-	0,00004	---	0,00013	0,00009	---	0,00017	0,00012	---	0,00014	---	---	0,00011	---
Sodium	-	-	0,01	---	2,02	0,63	---	1,66	0,57	---	1,28	---	---	0,4	---
Strontium	-	-	0,00002	---	0,073	0,0458	---	0,0572	0,038	---	0,0517	---	---	0,03066	---
Thorium	-	-	0,0001	---	0,0032	0,0002	---	0,0027	< 0,0001	---	0,0025	---	---	0,0001	---
Titane	-	-	0,00005	---	0,697	0,0343	---	0,887	0,00227	---	0,65	---	---	0,04017	---
Thallium	-	-	0,000005	---	0,000468	0,000028	---	0,000683	0,00002	---	0,000546	---	---	0,000041	---
Tungstène	-	-	0,00002	---	0,00281	0,00085	---	0,00221	0,00061	---	0,00158	---	---	0,0007	---
Uranium (4)	0,32	-	0,000002	---	0,00542	0,00271	---	0,00465	0,00194	---	0,00484	---	---	0,003869	---
Vanadium	-	-	0,00001	---	0,0222	0,00215	---	0,02888	0,00104	---	0,0214	---	---	0,00252	---
Yttrium	-	-	0,000002	---	0,00356	0,000225	---	0,00321	0,000024	---	0,00277	---	---	0,000157	---
Zinc (4)	0,017	1	0,002	---	**0,028**	0,008	---	**0,038**	< 0,002	---	**0,029**	---	---	0,004	---
Autres composés inorganiques															
Sulfates (SO4)	-	-	0,2	---	10,0	---	---	7,8	---	---	6,8	---	---	6,7	---
Paramètres physico-chimiques															
Alcalinité (mg/L CaCO3)	-	-	1	---	21		---	7		---	8		---	10	
Acidité (mg/L CaCO3)	-	-	2	---	12		---	< 2		---	<2		---	<2	
Conductivité (uS/cm)	-	-	1	---	45		---	47		---	41		---	39	
Matières en suspension (mg/L)	-	30	3	---	**951**		---	**298**		---	---		---	---	
pH	-	6 - 9,5	0,01	---	7,16		---	7,07		---	7,26		---	7,42	
Potentiel d'oxydoréduction (mV)	-	-	1,0	---	136,0		---	424,0		---	181,0		---	188,0	
Paramètres d'essai															
Quantité d'eau de rinçage ajoutée (g)	-	-	0,01	5449,35	5493		5444,76	5587,37		5494,22	5798,02		5507,44	5171,95	
Quantité d'eau de rinçage récupérée (g)	-	-	0,01	5410,57	5534,96		5475,77	5573,21		5518,05	5544,79		5134,29	5542,98	
pH immédiat	-	-	0,01	7,44	7,69		7,97	7,8		7,33	7,38		7,6	7,8	
Conductivité immédiate (uS/cm)	-	-	0,1	83,7	58,5		64,5	46,6		42,2	45,5		67,5	60,6	

NOTES:

(1): Critères de Résurgence dans les eaux de surface (RES) du Guide d'intervention - Protection des sols et réhabilitation des terrains contaminés (MELCC, 2019).

(2): Concentration maximale acceptable au point de rejet de l'effluent final selon la Directive 019 sur l'industrie minière (MDDEP, 2012)

(3): Limite de détection rapportée par le laboratoire d'analyses.

(4): Ajustement de la valeur du critère en fonction d'une dureté de l'eau ($CaCO_3$) de 10 mg/L.

LÉGENDE:

- / ---	: Non défini ou non analysé
100	: Concentration < RES et D019
100	: Concentration > RES
100	: Concentration > D019

Tableau C5 (3 de 5)
Résultats des essais en colonnes
Colonne #3 : Mélange de stériles non saturés
Projet Galaxy
N/Réf : 171-02562-00

Paramètres	Critères (mg/L)		LDR[3] (mg/L)	Semaine / Résultats d'analyse (mg/L)											
	RES [1]	D019 [2]		Semaine 15	Semaine 16	Semaine 17	Semaine 18	Semaine 19	Semaine 20	Semaine 21	Semaine 22	Semaine 23	Semaine 24	Semaine 25	Semaine 26
				Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux
Métaux (mg/L)															
Aluminium	-	-	0,0003	---	0,152	---	0,253	---	0,211	---	0,223	---	0,156	---	0,313
Antimoine	1,1	-	0,0002	---	0,0007	---	0,0005	---	0,0005	---	0,0005	---	0,0005	---	< 0,0002
Argent [4]	0,00003	-	0,000002	---	< 0,00005	---	< 0,00005	---	< 0,00005	---	< 0,00005	---	< 0,00005	---	< 0,00005
Arsenic	0,34	0,4	0,0002	---	0,122	---	0,0912	---	0,0891	---	0,0729	---	0,0584	---	0,0568
Baryum [4]	0,11	-	0,00002	---	0,00489	---	0,00334	---	0,00291	---	0,00428	---	0,00272	---	0,00407
Béryllium	-	-	0,000007	---	0,000007	---	0,000013	---	0,000013	---	0,000010	---	< 0,000007	---	0,000014
Bore	28	-	0,0002	---	0,005	---	0,006	---	0,010	---	0,004	---	< 0,002	---	< 0,002
Bismuth	-	-	0,000007	---	0,000010	---	0,000015	---	0,000011	---	0,000014	---	0,000050	---	0,000022
Calcium	-	-	0,01	---	5,64	---	4,04	---	3,86	---	3,28	---	3,11	---	3,10
Cadmium [4]	0,0002	-	0,000003	---	0,000004	---	< 0,000003	---	< 0,000003	---	0,000005	---	0,000009	---	< 0,000003
Chrome	-	-	0,00003	---	0,00018	---	0,00036	---	0,00033	---	0,00183	---	0,00029	---	0,00062
Cobalt	0,37	-	0,000004	---	0,000169	---	0,000133	---	0,000105	---	0,000133	---	0,000123	---	0,000258
Cuivre [4]	0,0015	0,6	0,00002	---	0,00016	---	0,00027	---	0,00045	---	0,00044	---	0,00047	---	0,00051
Étain	-	-	0,00001	---	0,00372	---	0,00216	---	0,00179	---	0,00178	---	0,00149	---	0,00127
Fer	-	6	0,002	---	0,045	---	0,095	---	0,059	---	0,099	---	0,072	---	0,171
Potassium	-	-	0,002	---	1,46	---	1,56	---	1,36	---	1,14	---	0,973	---	1,03
Lithium	-	-	0,000006	---	0,0396	---	0,0477	---	0,0443	---	0,0444	---	0,0373	---	0,0433
Magnésium	-	-	0,003	---	0,548	---	0,503	---	0,462	---	0,416	---	0,407	---	0,401
Manganèse [4]	0,55	-	0,00001	---	0,0174	---	0,00167	---	0,00143	---	0,00212	---	0,00185	---	0,00397
Mercure	0,0000013	-	0,00001	---	< 0,00001	---	< 0,00001	---	< 0,00001	---	< 0,00001	---	< 0,00001	---	< 0,00001
Molybdène	29	-	0,00001	---	0,00023	---	0,00015	---	0,00014	---	0,00029	---	0,00007	---	0,00009
Nickel [4]	0,067	1	0,0001	---	0,0004	---	0,0004	---	0,0004	---	0,0003	---	0,0004	---	0,0008
Plomb [4]	0,0049	0,4	0,00001	---	0,00009	---	0,00013	---	0,00009	---	0,00015	---	0,00030	---	0,00018
Soufre	-	-	0,1	---	1,9	---	2,8	---	2,3	---	2,0	---	1,0	---	2,0
Sélénium	0,062	-	0,00004	---	0,0001	---	0,00009	---	0,00009	---	0,00008	---	0,00006	---	0,00006
Sodium	-	-	0,01	---	0,19	---	0,31	---	0,33	---	0,23	---	< 0,01	---	0,22
Strontium	-	-	0,00002	---	0,04408	---	0,028	---	0,026	---	0,0277	---	0,0265	---	0,0235
Thorium	-	-	0,0001	---	< 0,0001	---	< 0,0001	---	0,0001	---	0,0001	---	< 0,0001	---	< 0,0001
Titane	-	-	0,00005	---	0,00346	---	0,00681	---	0,00635	---	0,00706	---	0,00537	---	0,0122
Thallium	-	-	0,000005	---	0,000015	---	0,000017	---	0,000014	---	0,000017	---	0,000011	---	0,000015
Tungstène	-	-	0,00002	---	0,00076	---	0,00033	---	0,00033	---	0,00036	---	0,00038	---	0,00016
Uranium [4]	0,32	-	0,000002	---	0,001	---	0,00234	---	0,0016	---	0,00124	---	0,00066	---	0,000546
Vanadium	-	-	0,00001	---	0,00111	---	0,00119	---	0,00108	---	0,00113	---	0,00087	---	0,00105
Yttrium	-	-	0,000002	---	0,000038	---	0,000053	---	0,000034	---	0,000052	---	0,000054	---	0,000086
Zinc [4]	0,017	1	0,002	---	< 0,002	---	0,002	---	< 0,002	---	0,003	---	0,005	---	< 0,002
Autres composés inorganiques															
Sulfates (SO4)	-	-	0,2	---	6,2	---	6,8	---	6,1	---	6,4	---	6,6	---	5,3
Paramètres physico-chimiques															
Alcalinité (mg/L CaCO3)	-	-	1	---	8	---	7	---	7	---	6	---	6	---	5
Acidité (mg/L CaCO3)	-	-	2	---	< 2	---	< 2	---	< 2	---	< 2	---	< 2	---	< 2
Conductivité (uS/cm)	-	-	1	---	35	---	32	---	30	---	30	---	28	---	28
Matières en suspension (mg/L)	-	30	3	---	---	---	---	---	---	---	---	---	---	---	---
pH	-	6 - 9,5	0,01	---	7,38	---	7,06	---	7,08	---	7	---	6,94	---	6,76
Potentiel d'oxydoréduction (mV)	-	-	1,0	---	484,0	---	226,0	---	314,0	---	288,0	---	254,0	---	148,0
Paramètres d'essai															
Quantité d'eau de rinçage ajoutée (g)	-	-	0,01	5472,13	5502,3	5619,6	5627,73	5322,56	5495,22	5561,11	5619,4	5581,35	5669,34	5211,83	5804,81
Quantité d'eau de rinçage récupérée (g)	-	-	0,01	5435,66	5499,81	5582,66	5284,01	5450,97	5504,19	5558,03	5597,15	5699,81	5317,38	5619,4	5588,16
pH immédiat	-	-	0,01	7,72	7,75	7,44	7,27	7,41	7,34	7,14	7,01	7,03	6,96	7,14	6,73
Conductivité immédiate (uS/cm)	-	-	0,1	36,8	47,6	27,7	44,8	41,9	34	35,5	28	28	29,3	65,6	21,5

NOTES:

(1): Critères de Résurgence dans les eaux de surface (RES) du Guide d'intervention - Protection des sols et réhabilitation des terrains contaminés (MELCC, 2019).

(2): Concentration maximale acceptable au point de rejet de l'effluent final selon la Directive 019 sur l'industrie minière (MDDEP, 2012)

(3): Limite de détection rapportée par le laboratoire d'analyses.

(4): Ajustement de la valeur du critère en fonction d'une dureté de l'eau ($CaCO_3$) de 10 mg/L.

LÉGENDE:

- / ---	: Non défini ou non analysé
100	: Concentration < RES et D019
100	: Concentration > RES
100	: Concentration > D019

Tableau C5 (4 de 5)
Résultats des essais en colonnes
Colonne #3 : Mélange de stériles non saturés
Projet Galaxy
N/Réf : 171-02562-00

Paramètres	Critères (mg/L)		LDR[3] (mg/L)	Semaine / Résultats d'analyse (mg/L)											
	RES [1]	D019 [2]		Semaine 27	Semaine 28	Semaine 29	Semaine 30	Semaine 31	Semaine 32	Semaine 33	Semaine 34	Semaine 35	Semaine 36	Semaine 37	Semaine 38
				Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux
Métaux (mg/L)															
Aluminium	-	-	0,0003	---	0,198	---	0,207	---	0,12	---	0,081	---	0,088	---	0,07
Antimoine	1,1	-	0,0002	---	0,0004	---	0,0003	---	< 0,0002	---	0,0003	---	< 0,0002	---	< 0,0002
Argent [4]	0,00003	-	0,000002	---	< 0,00005	---	< 0,00005	---	< 0,00005	---	< 0,00005	---	< 0,00005	---	< 0,00005
Arsenic	0,34	0,4	0,0002	---	0,0558	---	0,0424	---	0,045	---	0,0324	---	0,0354	---	0,0304
Baryum [4]	0,11	-	0,00002	---	0,00326	---	0,00331	---	0,00251	---	0,02	---	0,00294	---	0,00248
Béryllium	-	-	0,000007	---	0,000011	---	0,000014	---	0,000008	---	< 0,000007	---	0,000007	---	< 0,000007
Bore	28	-	0,0002	---	0,003	---	< 0,002	---	0,004	---	0,009	---	< 0,002	---	0,003
Bismuth	-	-	0,000007	---	< 0,000007	---	< 0,000007	---	0,000012	---	< 0,000007	---	0,000014	---	0,000009
Calcium	-	-	0,01	---	3,14	---	2,93	---	2,96	---	28,60	---	3,76	---	2,82
Cadmium [4]	0,0002	-	0,000003	---	< 0,000003	---	0,000004	---	0,000008	---	0,000039	---	0,000013	---	0,00001
Chrome	-	-	0,00003	---	0,00045	---	0,00052	---	0,00020	---	0,00029	---	0,00019	---	0,00014
Cobalt	0,37	-	0,000004	---	0,000217	---	0,000215	---	0,000210	---	0,001540	---	0,000355	---	0,000323
Cuivre [4]	0,0015	0,6	0,00002	---	0,00047	---	0,00039	---	0,00026	---	0,00109	---	0,00035	---	0,00028
Étain	-	-	0,00001	---	0,00105	---	0,00085	---	0,00158	---	0,00076	---	0,00071	---	0,00091
Fer	-	6	0,002	---	0,138	---	0,135	---	0,043	---	0,086	---	0,059	---	0,052
Potassium	-	-	0,002	---	0,992	---	0,886	---	0,872	---	2,49	---	0,82	---	0,734
Lithium	-	-	0,000006	---	0,0405	---	0,0473	---	0,0429	---	0,0611	---	0,0423	---	0,041
Magnésium	-	-	0,003	---	0,443	---	0,398	---	0,376	---	3,27	---	0,483	---	0,358
Manganèse [4]	0,55	-	0,00001	---	0,00528	---	0,01	---	0,0118	---	0,07923	---	0,0182	---	0,0199
Mercure	0,0000013	-	0,00001	---	< 0,00001	---	< 0,00001	---	< 0,00001	---	< 0,00001	---	< 0,00001	---	< 0,00001
Molybdène	29	-	0,00001	---	0,00013	---	0,00008	---	< 0,00001	---	0,00027	---	0,00014	---	0,00011
Nickel [4]	0,067	1	0,0001	---	0,0005	---	0,0006	---	0,0007	---	0,0063	---	0,0006	---	0,0009
Plomb [4]	0,0049	0,4	0,00001	---	0,00018	---	0,00010	---	0,00006	---	0,00003	---	0,00009	---	0,00006
Soufre	-	-	0,1	---	2,1	---	1,2	---	2,3	---	11,5	---	3,9	---	2,0
Sélénium	0,062	-	0,00004	---	0,00007	---	0,00005	---	0,00008	---	0,00019	---	0,00009	---	0,00005
Sodium	-	-	0,01	---	0,35	---	0,41	---	0,24	---	13	---	1,1	---	0,49
Strontium	-	-	0,00002	---	0,0253	---	0,0252	---	0,0246	---	0,199	---	0,0266	---	0,0205
Thorium	-	-	0,0001	---	< 0,0001	---	< 0,0001	---	< 0,0001	---	< 0,0001	---	< 0,0001	---	< 0,0001
Titane	-	-	0,00005	---	0,00994	---	0,01	---	0,00375	---	0,00611	---	0,00399	---	0,00352
Thallium	-	-	0,000005	---	0,000016	---	0,000014	---	0,000012	---	0,00003	---	0,000014	---	0,000008
Tungstène	-	-	0,00002	---	0,00023	---	0,00019	---	0,00014	---	0,00014	---	0,00018	---	0,00016
Uranium [4]	0,32	-	0,000002	---	0,000439	---	0,000275	---	0,000259	---	0,00655	---	0,000395	---	0,000184
Vanadium	-	-	0,00001	---	0,00094	---	0,00077	---	0,00061	---	0,00056	---	0,00042	---	0,00041
Yttrium	-	-	0,000002	---	0,000066	---	0,000057	---	0,000033	---	0,000055	---	0,000036	---	0,000018
Zinc [4]	0,017	1	0,002	---	< 0,002	---	< 0,002	---	0,003	---	< 0,002	---	< 0,002	---	< 0,002
Autres composés inorganiques															
Sulfates (SO4)	-	-	0,2	---	6,3	---	6,0	---	5,0	---	34,0	---	9,1	---	6,4
Paramètres physico-chimiques															
Alcalinité (mg/L CaCO3)	-	-	1	---	4	---	4	---	5	---	63	---	4	---	3
Acidité (mg/L CaCO3)	-	-	2	---	< 2	---	< 2	---	< 2	---	< 2	---	< 2	---	< 2
Conductivité (uS/cm)	-	-	1	---	26	---	26	---	28	---	251	---	36	---	25
Matières en suspension (mg/L)	-	30	3	---	---	---	---	---	---	---	---	---	---	---	---
pH	-	6 - 9,5	0,01	---	6,69	---	6,48	---	6,36	---	7,4	---	6,7	---	6,46
Potentiel d'oxydoréduction (mV)	-	-	1,0	---	92,0	---	170,0	---	372,0	---	198,0	---	97,0	---	180,0
Paramètres d'essai															
Quantité d'eau de rinçage ajoutée (g)	-	-	0,01	5666,28	5623,62	5548,38	5539,02	5389,18	5500,82	5346,88	5475,65	5419,87	5346,28	5587,76	5596,09
Quantité d'eau de rinçage récupérée (g)	-	-	0,01	5657,48	5457,47	5652,66	5254,59	5449,57	5581,95	5449,68	5276,97	5159,21	5599,71	5565,08	5545,7
pH immédiat	-	-	0,01	6,67	6,78	6,43	6,81	6,49	6,35	6,58	6,87	6,82	6,21	6,19	6,1
Conductivité immédiate (uS/cm)	-	-	0,1	23,4	32,1	26,1	40,8	23,9	---	28,9	218	64,3	40,9	45,5	25,6

NOTES:

(1): Critères de Résurgence dans les eaux de surface (RES) du Guide d'intervention - Protection des sols et réhabilitation des terrains contaminés (MELCC, 2019).

(2): Concentration maximale acceptable au point de rejet de l'effluent final selon la Directive 019 sur l'industrie minière (MDDEP, 2012)

(3): Limite de détection rapportée par le laboratoire d'analyses.

(4): Ajustement de la valeur du critère en fonction d'une dureté de l'eau ($CaCO_3$) de 10 mg/L.

LÉGENDE:

- / ---	: Non défini ou non analysé
100	: Concentration < RES et D019
100	: Concentration > RES
100	: Concentration > D019

Tableau C5 (5 de 5)
Résultats des essais en colonnes
Colonne #3 : Mélange de stériles non saturés
Projet Galaxy
N/Réf : 171-02562-00

Paramètres	Critères (mg/L)		LDR[3] (mg/L)	Semaine / Résultats d'analyse (mg/L)											
	RES [1]	D019 [2]		Semaine 39	Semaine 40	Semaine 41	Semaine 42	Semaine 43	Semaine 44	Semaine 45	Semaine 46	Semaine 47	Semaine 48	Semaine 49	Semaine 50
				Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux	Totaux
Métaux (mg/L)															
Aluminium	-	-	0,0003	---	0,03	---	0,023	---	0,04	---	0,037	---	0,019	---	0,005
Antimoine	1,1	-	0,0002	---	< 0,0002	---	< 0,0002	---	< 0.0009	---	< 0.0009	---	< 0.0009	---	< 0.0009
Argent [4]	0,00003	-	0,000002	---	< 0,00005	---	< 0,00005	---	< 0.00005	---	< 0.00005	---	< 0.00005	---	< 0.00005
Arsenic	0,34	0,4	0,0002	---	0,0241	---	0,0198	---	0,0167	---	0,0151	---	0,0127	---	0,0113
Baryum [4]	0,11	-	0,00002	---	0,0023	---	0,0021	---	0,00296	---	0,00264	---	0,00274	---	0,00291
Béryllium	-	-	0,000007	---	< 0,000007	---	< 0,000007	---	< 0.000007	---	< 0.000007	---	< 0.000007	---	< 0.000007
Bore	28	-	0,0002	---	0,006	---	0,011	---	0,002	---	< 0.002	---	0,003	---	< 0.002
Bismuth	-	-	0,000007	---	0,000011	---	0,000009	---	< 0.000007	---	0,000011	---	0,000008	---	0,000007
Calcium	-	-	0,01	---	2,53	---	2,65	---	2,78	---	2,67	---	2,62	---	2,69
Cadmium [4]	0,0002	-	0,000003	---	0,000011	---	0,000006	---	0,000021	---	0,000014	---	0,000026	---	0,000032
Chrome	-	-	0,00003	---	0,00008	---	0,00005	---	0,00014	---	0,00012	---	0,00013	---	< 0.00008
Cobalt	0,37	-	0,000004	---	0,000411	---	0,000517	---	0,000796	---	0,000960	---	0,001420	---	0,00167
Cuivre [4]	0,0015	0,6	0,00002	---	< 0,00002	---	< 0,00002	---	0,00040	---	0,00030	---	< 0.0002	---	< 0.0002
Étain	-	-	0,00001	---	0,00049	---	0,00042	---	0,00045	---	0,00041	---	0,00035	---	0,00036
Fer	-	6	0,002	---	0,012	---	0,009	---	0,038	---	0,039	---	0,03	---	0,02
Potassium	-	-	0,002	---	0,635	---	0,793	---	0,716	---	0,651	---	0,664	---	0,632
Lithium	-	-	0,000006	---	0,0438	---	0,0394	---	0,0477	---	0,0517	---	0,0451	---	0,0475
Magnésium	-	-	0,003	---	0,293	---	0,322	---	0,371	---	0,311	---	0,326	---	0,313
Manganèse [4]	0,55	-	0,00001	---	0,028	---	0,0325	---	0,044	---	0,0563	---	0,0691	---	0,0696
Mercure	0,0000013	-	0,00001	---	< 0,00001	---	< 0,00001	---	< 0.00001	---	< 0.00001	---	< 0.00001	---	< 0.00001
Molybdène	29	-	0,00001	---	0,00007	---	0,00030	---	0,00008	---	0,00009	---	< 0.00004	---	< 0.00004
Nickel [4]	0,067	1	0,0001	---	0,0011	---	0,0013	---	0,0023	---	0,0025	---	0,0035	---	0,0037
Plomb [4]	0,0049	0,4	0,00001	---	0,00003	---	0,00004	---	0,00007	---	0,00005	---	< 0.00001	---	< 0.00001
Soufre	-	-	0,1	---	3,2	---	2,7	---	3,0	---	2,9	---	3,2	---	2,7
Sélénium	0,062	-	0,00004	---	0,00006	---	0,00007	---	0,00006	---	0,00007	---	0,00008	---	0,00006
Sodium	-	-	0,01	---	0,28	---	0,33	---	0,26	---	0,26	---	0,2	---	0,22
Strontium	-	-	0,00002	---	0,0196	---	0,0181	---	0,0208	---	0,0202	---	0,0225	---	0,0241
Thorium	-	-	0,0001	---	< 0,0001	---	< 0,0001	---	< 0.0001	---	< 0.0001	---	< 0.0001	---	< 0.0001
Titane	-	-	0,00005	---	0,0007	---	0,00046	---	0,00197	---	0,00209	---	0,0011	---	0,00016
Thallium	-	-	0,000005	---	0,00001	---	0,000008	---	< 0.000005	---	0,000011	---	< 0.000005	---	0,000009
Tungstène	-	-	0,00002	---	0,0001	---	0,00009	---	0,0001	---	0,00007	---	0,00004	---	0,00006
Uranium [4]	0,32	-	0,000002	---	0,000206	---	0,000111	---	0,000138	---	0,000096	---	0,000089	---	0,000076
Vanadium	-	-	0,00001	---	0,00025	---	0,00021	---	0,00026	---	0,0002	---	0,00012	---	0,00006
Yttrium	-	-	0,000002	---	0,00001	---	0,000005	---	0,000014	---	0,000009	---	0,000007	---	0,000005
Zinc [4]	0,017	1	0,002	---	< 0,002	---	< 0,002	---	0,002	---	< 0.002	---	< 0.002	---	< 0.002
Autres composés inorganiques															
Sulfates (SO4)	-	-	0,2	---	5,4	---	5,9	---	5,7	---	6,9	---	7,0	---	8,3
Paramètres physico-chimiques															
Alcalinité (mg/L CaCO3)	-	-	1	---	3	---	3	---	2	---	2	---	2	---	2
Acidité (mg/L CaCO3)	-	-	2	---	< 2	---	< 2	---	< 2	---	2	---	3	---	< 2
Conductivité (uS/cm)	-	-	1	---	23	---	23	---	23	---	26	---	26	---	28
Matières en suspension (mg/L)	-	30	3	---	---	---	---	---	---	---	---	---	---	---	---
pH	-	6 - 9,5	0,01	---	6,57	---	6,73	---	6,48	---	6,47	---	6,37	---	6,53
Potentiel d'oxydoréduction (mV)	-	-	1,0	---	156,0	---	468,0	---	231,0	---	335,0	---	375,0	---	213,0
Paramètres d'essai															
Quantité d'eau de rinçage ajoutée (g)	-	-	0,01	5568,01	5565,74	5452,16	5485,77	5523,56	5615,71	5526,37	5653,65	5425,44	5687,4	5724	5526,51
Quantité d'eau de rinçage récupérée (g)	-	-	0,01	5615,64	5502,89	5440,23	5447,64	5609,74	5604,01	5620,2	5483,06	5548,53	5510,23	5715,65	5507,07
pH immédiat	-	-	0,01	6,15	6,01	6,14	6,38	5,98	5,91	6,13	6,32	6,26	6,37	6,26	5,97
Conductivité immédiate (uS/cm)	-	-	0,1	43,4	24,3	25,4	48,6	23,2	34,2	23,6	27,4	30	27,1	32,5	28,6

NOTES:

(1): Critères de Résurgence dans les eaux de surface (RES) du Guide d'intervention - Protection des sols et réhabilitation des terrains contaminés (MELCC, 2019).

(2): Concentration maximale acceptable au point de rejet de l'effluent final selon la Directive 019 sur l'industrie minière (MDDEP, 2012)

(3): Limite de détection rapportée par le laboratoire d'analyses.

(4): Ajustement de la valeur du critère en fonction d'une dureté de l'eau ($CaCO_3$) de 10 mg/L.

LÉGENDE:

- / ---	: Non défini ou non analysé
100	: Concentration < RES et D019
100	: Concentration > RES
100	: Concentration > D019

ANNEXE

D

CERTIFICATS D'ANALYSES

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

SGS Lakefield Environmental Met
Attn : Barb Bowman

Project : CALR-13531-002

05-July-2018

Date Rec. : 11 May 2018
LR Report: **CA14350-MAY18**
Reference: 13531-002-004

Copy: #2

CERTIFICATE OF ANALYSIS

Final Report - Revised

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 0	10: Waste Rock Unsturated Column Week 0	11: Waste Rock Saturated Column Week 0	12: DMS Tails Unsaturated Column Week 0 Dissolved	13: Waste Rock Unsturated Column Week 0 Dissolved	14: Waste Rock Saturated Column Week 0 Dissolved
Sample Date & Time							Date:N/A	Date:N/A	Date:N/A	Date:N/A	Date:N/A	Date:N/A
Temperature Upon Receipt [°C]	---	---	---	---	---	---	8.0	8.0	8.0	8.0	8.0	8.0
Total Suspended Solids [mg/L]	18-May-18	09:51	< 2	99%	0%	NA	485	82	103	---	---	---
pH [no unit]	17-May-18	22:21	NA	100%	0%	NA	7.65	7.48	7.66	---	---	---
Alkalinity [mg/L as CaCO3]	17-May-18	22:21	< 2	96%	0%	NA	31	33	35	---	---	---
Conductivity [uS/cm]	17-May-18	22:21	< 2	100%	0%	NA	107	135	129	---	---	---
Acidity [mg/L as CaCO3]	17-May-18	22:21	< 2	110%	ND	NA	< 2	< 2	< 2	---	---	---
Redox Potential [mV]	14-May-18	10:52	NA	106%	1%	---	282	282	258	---	---	---
Mercury (total) [mg/L]	15-May-18	08:50	< 0.00001	101%	ND	107%	0.00027	0.00002	< 0.00001	0.00014	0.00001	< 0.00001
Silver (total) [mg/L]	16-May-18	13:36	< 0.00005	101%	ND	NV	0.00049	0.00009	0.00009	0.00018	< 0.00005	< 0.00005
Aluminum (total) [mg/L]	17-May-18	14:09	< 0.001	95%	4%	82%	27.5	11.9	11.8	5.65	3.88	3.10
Arsenic (total) [mg/L]	16-May-18	13:36	< 0.0002	104%	6%	89%	0.316	0.123	0.131	0.224	0.101	0.102
Barium (total) [mg/L]	16-May-18	13:36	< 0.00002	99%	1%	NV	0.0942	0.141	0.121	0.0450	0.0658	0.0505
Beryllium (total) [mg/L]	16-May-18	13:36	< 0.000007	99%	2%	84%	0.0185	0.00116	0.000952	0.00662	0.000325	0.000287
Boron (total) [mg/L]	16-May-18	13:36	< 0.002	100%	1%	NV	0.065	0.049	0.034	0.047	0.034	0.034
Bismuth (total) [mg/L]	16-May-18	13:36	< 0.000007	98%	20%	87%	0.0396	0.000437	0.000288	0.0184	0.000243	0.000108
Calcium (total) [mg/L]	16-May-18	13:36	< 0.01	95%	2%	NV	11.9	8.07	7.49	9.82	6.39	6.12
Cadmium (total) [mg/L]	16-May-18	13:36	< 0.000003	100%	ND	79%	0.000669	0.000036	0.000038	0.000410	0.000019	0.000009
Cobalt (total) [mg/L]	16-May-18	13:36	< 0.000004	102%	3%	96%	0.00889	0.00524	0.00498	0.00578	0.00355	0.00235
Chromium (total) [mg/L]	16-May-18	13:36	< 0.00003	103%	2%	113%	0.0243	0.0275	0.0266	0.0128	0.0148	0.0102

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Test method information available upon request. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

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SGS Canada Inc.
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Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Project : CALR-13531-002
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Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 0	10: Waste Rock Unsturated Column Week 0	11: Waste Rock Saturated Column Week 0	12: DMS Tails Unsaturated Column Week 0 Dissolved	13: Waste Rock Unsturated Column Week 0 Dissolved	14: Waste Rock Saturated Column Week 0 Dissolved
Copper (total) [mg/L]	16-May-18	13:36	< 0.00002	101%	2%	NV	0.04450	0.00803	0.00830	0.0284	0.00316	0.00244
Iron (total) [mg/L]	16-May-18	13:36	< 0.007	100%	2%	NV	19.2	7.55	7.57	8.87	4.29	2.95
Potassium (total) [mg/L]	16-May-18	13:36	< 0.003	96%	1%	NV	11.1	18.2	16.3	7.24	15.7	14.8
Lithium (total) [mg/L]	16-May-18	13:36	< 0.0001	99%	3%	87%	1.23	0.665	0.614	0.859	0.631	0.574
Magnesium (total) [mg/L]	16-May-18	13:36	< 0.001	100%	2%	NV	2.31	4.00	3.80	0.891	2.62	2.00
Manganese (total) [mg/L]	16-May-18	13:36	< 0.00001	104%	2%	NV	3.09	0.154	0.148	1.96	0.0999	0.0725
Molybdenum (total) [mg/L]	16-May-18	13:36	< 0.00001	99%	1%	86%	0.00469	0.00198	0.00199	0.00294	0.00179	0.00195
Sodium (total) [mg/L]	16-May-18	13:36	< 0.01	95%	1%	NV	14.0	11.2	10.5	9.65	8.62	8.98
Nickel (total) [mg/L]	16-May-18	13:36	< 0.0001	106%	6%	88%	0.0291	0.0201	0.0187	0.0167	0.0135	0.0093
Lead (total) [mg/L]	16-May-18	13:36	< 0.00001	97%	0%	82%	0.0708	0.00464	0.00443	0.0332	0.00216	0.00146
Sulfur (total) [mg/L]	04-Jul-18	08:35					2.9	8.9	7.7	3.5	9.1	8.2
Antimony (total) [mg/L]	16-May-18	13:36	< 0.0002	91%	ND	121%	0.0008	0.0011	0.0009	< 0.0002	< 0.0002	< 0.0002
Selenium (total) [mg/L]	16-May-18	13:36	< 0.00004	101%	ND	73%	0.00012	0.00054	0.00057	0.00009	0.00047	0.00045
Tin (total) [mg/L]	16-May-18	13:36	< 0.00001	100%	ND	NV	0.0681	0.0610	0.0515	0.0660	0.0520	0.0479
Strontium (total) [mg/L]	16-May-18	13:36	< 0.00002	103%	4%	NV	0.141	0.109	0.101	0.0907	0.0729	0.0698
Thorium (total) [mg/L]	16-May-18	13:36	< 0.00001	98%	9%	NV	0.0042	0.0066	0.0061	0.0016	0.0013	0.0011
Titanium (total) [mg/L]	16-May-18	13:36	< 0.00005	96%	6%	NV	0.118	0.619	0.578	0.0648	0.279	0.201
Thallium (total) [mg/L]	16-May-18	13:36	< 0.000005	96%	12%	86%	0.00168	0.000615	0.000544	0.000308	0.000332	0.000239
Uranium (total) [mg/L]	16-May-18	13:36	< 0.000002	100%	0%	87%	0.0891	0.00472	0.00403	0.0480	0.00273	0.00184
Vanadium (total) [mg/L]	16-May-18	13:36	< 0.00001	101%	2%	93%	0.0115	0.0201	0.0194	0.00681	0.0114	0.00876
Tungsten (total) [mg/L]	16-May-18	13:36	< 0.00002	100%	ND	NV	0.00217	0.0122	0.0109	0.00090	0.0104	0.0113
Yttrium (total) [mg/L]	16-May-18	13:36	< 0.000002	103%	0%	NV	0.00114	0.00483	0.00443	0.000663	0.00248	0.00173
Zinc (total) [mg/L]	16-May-18	13:36	< 0.002	106%	0%	NV	0.366	0.022	0.023	0.216	0.013	0.010

Report revised to include results for Total Sulphur as requested by client.

Patti Stark
Project Specialist Environmental Services, Analytical

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Test method information available upon request. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

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SGS Lakefield Environmental Met
Attn : Barb Bowman

Project : CALR-13531-002

05-July-2018

Date Rec. : 15 May 2018
LR Report: **CA14428-MAY18**
Reference: 13531-002-005

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CERTIFICATE OF ANALYSIS

Final Report - Revised

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 1	10: Waste Rock Unsturated Column Week 1	11: Waste Rock Saturated Column Week 1	12: DMS Tails Unsaturated Column Week 1 Dissolved	13: Waste Rock Unsturated Column Week 1 Dissolved	14: Waste Rock Saturated Column Week 1 Dissolved
Sample Date & Time							Date:N/A	Date:N/A	Date:N/A	Date:N/A	Date:N/A	Date:N/A
Temperature Upon Receipt [°C]	---	---	---	---	---	---	8.0	8.0	8.0	8.0	8.0	8.0
Total Suspended Solids [mg/L]	20-May-18	22:31	< 2	97%	0%	NA	261	291	1360	---	---	---
pH [no unit]	18-May-18	15:10	NA	100%	0%	NA	7.82	7.89	7.68	---	---	---
Alkalinity [mg/L as CaCO3]	18-May-18	15:10	< 2	102%	0%	NA	43	57	27	---	---	---
Conductivity [uS/cm]	18-May-18	15:10	< 2	98%	0%	NA	150	243	138	---	---	---
Acidity [mg/L as CaCO3]	18-May-18	15:10	< 2	96%	ND	NA	< 2	< 2	< 2	---	---	---
Redox Potential [mV]	18-May-18	14:38	NA	105%	3%	NA	228	263	270	---	---	---
Mercury (total) [mg/L]	18-May-18	10:11	< 0.00001	92%	ND	109%	0.00004	< 0.00001	< 0.00001	< 0.00001	< 0.00001	0.00002
Silver (total) [mg/L]	22-May-18	11:12	< 0.00005	98%	ND	NV	0.00027	0.00016	0.00015	< 0.00005	< 0.00005	< 0.00005
Aluminum (total) [mg/L]	22-May-18	11:12	< 0.001	100%	4%	NV	5.53	7.14	5.18	0.184	0.165	0.188
Arsenic (total) [mg/L]	22-May-18	11:12	< 0.0002	102%	10%	77%	0.199	0.182	0.162	0.124	0.151	0.124
Barium (total) [mg/L]	22-May-18	11:12	< 0.00002	99%	9%	77%	0.0204	0.103	0.0607	0.00074	0.0248	0.0126
Beryllium (total) [mg/L]	22-May-18	11:12	< 0.000007	95%	ND	NV	0.003900	0.000296	0.000358	0.000125	0.000010	0.000007
Boron (total) [mg/L]	22-May-18	11:12	< 0.002	97%	11%	NV	0.052	0.061	0.034	0.046	0.061	0.032
Bismuth (total) [mg/L]	22-May-18	11:12	< 0.000007	99%	ND	NV	0.00655	0.000160	0.000142	0.000130	0.000008	< 0.000007
Calcium (total) [mg/L]	22-May-18	11:12	< 0.01	101%	5%	NV	8.15	15.9	8.99	6.05	15.4	8.04
Cadmium (total) [mg/L]	22-May-18	11:12	< 0.000003	97%	4%	79%	0.000156	0.000035	0.000027	0.000017	0.000008	0.000005

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SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
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Project : CALR-13531-002
LR Report : **CA14428-MAY18**

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 1	10: Waste Rock Unsturated Column Week 1	11: Waste Rock Saturated Column Week 1	12: DMS Tails Unsaturated Column Week 1 Dissolved	13: Waste Rock Unsturated Column Week 1 Dissolved	14: Waste Rock Saturated Column Week 1 Dissolved
Cobalt (total) [mg/L]	22-May-18	11:12	< 0.000004	99%	1%	90%	0.00249	0.00439	0.00375	0.000524	0.000954	0.000532
Chromium (total) [mg/L]	22-May-18	11:12	< 0.00003	100%	5%	98%	0.00822	0.0265	0.0146	0.00060	0.00044	0.00030
Copper (total) [mg/L]	22-May-18	11:12	< 0.00002	99%	4%	70%	0.0136	0.00841	0.0102	0.00310	0.00051	0.00079
Iron (total) [mg/L]	22-May-18	11:12	< 0.007	100%	3%	NV	4.97	8.53	4.65	0.093	0.151	0.087
Potassium (total) [mg/L]	22-May-18	11:12	< 0.003	98%	3%	79%	7.21	22.0	12.1	6.02	20.0	11.0
Lithium (total) [mg/L]	22-May-18	11:12	< 0.0001	91%	7%	71%	2.51	0.907	0.555	2.40	0.856	0.483
Magnesium (total) [mg/L]	22-May-18	11:12	< 0.001	100%	3%	72%	0.984	5.47	3.10	0.594	2.66	1.54
Manganese (total) [mg/L]	22-May-18	11:12	< 0.00001	100%	4%	89%	0.775	0.214	0.111	0.0153	0.0743	0.0349
Molybdenum (total) [mg/L]	22-May-18	11:12	< 0.00001	103%	6%	99%	0.00727	0.00467	0.00200	0.00703	0.00485	0.00204
Sodium (total) [mg/L]	22-May-18	11:12	< 0.01	99%	3%	76%	12.8	14.5	8.20	11.6	14.7	7.72
Nickel (total) [mg/L]	22-May-18	11:12	< 0.0001	100%	1%	84%	0.0078	0.0179	0.0136	0.0012	0.0070	0.0032
Lead (total) [mg/L]	22-May-18	11:12	< 0.00001	93%	ND	76%	0.0127	0.00209	0.00244	0.00022	0.00005	0.00005
Sulfur (total) [mg/L]	04-Jul-18	08:36					5.1	15.5	10.0	4.8	15.8	9.7
Antimony (total) [mg/L]	22-May-18	11:12	< 0.0002	100%	3%	92%	0.0017	0.0033	0.0016	0.0016	0.0031	0.0014
Selenium (total) [mg/L]	22-May-18	11:12	< 0.00004	108%	1%	NV	0.00021	0.00099	0.00067	0.00012	0.00075	0.00044
Tin (total) [mg/L]	22-May-18	11:12	< 0.00001	94%	ND	NV	0.0802	0.0679	0.0420	0.0773	0.0643	0.0382
Strontium (total) [mg/L]	22-May-18	11:12	< 0.00002	101%	5%	NV	0.0608	0.226	0.118	0.0257	0.224	0.0950
Thorium (total) [mg/L]	22-May-18	11:12	< 0.00001	102%	91%	NV	0.0009	0.0024	0.0028	0.0002	0.0001	< 0.0001
Titanium (total) [mg/L]	22-May-18	11:12	< 0.00005	101%	ND	NV	0.0488	0.602	0.348	0.00173	0.00837	0.00595
Thallium (total) [mg/L]	22-May-18	11:12	< 0.000005	102%	5%	74%	0.000403	0.000484	0.000301	0.000047	0.000055	0.000053
Uranium (total) [mg/L]	22-May-18	11:12	< 0.000002	99%	9%	77%	0.0275	0.0201	0.00685	0.00995	0.0182	0.00497
Vanadium (total) [mg/L]	22-May-18	11:12	< 0.00001	100%	3%	98%	0.00501	0.0194	0.0108	0.00188	0.00210	0.00138
Tungsten (total) [mg/L]	22-May-18	11:12	< 0.00002	96%	15%	NV	0.00151	0.0198	0.00746	0.00105	0.0186	0.00631
Yttrium (total) [mg/L]	22-May-18	11:12	< 0.000002	100%	ND	NV	0.000322	0.00253	0.00238	0.000008	0.000223	0.000102
Zinc (total) [mg/L]	22-May-18	11:12	< 0.002	98%	5%	NV	0.088	0.023	0.016	0.002	< 0.002	< 0.002

NA - Not applicable
ND - Not Detected
NV - No Value

Report revised to include results for Total Sulphur as requested by client.

OnLine LIMS

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Project : CALR-13531-002
LR Report : **CA14428-MAY18**

Patti Stark
Project Specialist Environmental Services, Analytical

OnLine LIMS

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Strong Acid Digest ICP-OES/MS

Parameter	Unit	Galaxy Waste Rock	Bulk DMS Tails
LIMS		11051-APR18	11051-APR18
Hg	µg/g	< 0.05	< 0.05
Ag	µg/g	0.21	0.04
Al	µg/g	67000	57000
As	µg/g	300	34
B	µg/g	< 1	< 1
Ba	µg/g	510	71
Be	µg/g	11	63
Bi	µg/g	1.2	0.85
Ca	µg/g	15000	2600
Cd	µg/g	0.71	0.43
Co	µg/g	17	0.87
Cr	µg/g	92	31
Cu	µg/g	120	53
Fe	µg/g	32000	2900
K	µg/g	20000	24000
Li	µg/g	770	1100
Mg	µg/g	11000	180
Mn	µg/g	550	210
Mo	µg/g	8.7	7.8
Na	µg/g	23000	28000
Ni	µg/g	53	2.6
Pb	µg/g	17	18
Sb	µg/g	< 0.8	< 0.8
Se	µg/g	< 0.7	< 0.7
Sn	µg/g	28	23
Sr	µg/g	320	84
Th	µg/g	7.4	11
Ti	µg/g	2300	540
Tl	µg/g	3.1	5.5
U	µg/g	3.8	5.1
V	µg/g	75	13
W	µg/g	9.0	1.4
Y	µg/g	7.7	6.2
Zn	µg/g	80	14

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SGS Lakefield Environmental Met
Attn : Barb Bowman

Project : CALR-13531-002

05-July-2018

Date Rec. : 23 May 2018
LR Report: **CA14632-MAY18**
Reference: 13531-002-006

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CERTIFICATE OF ANALYSIS

Final Report - Revised

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 2	10: Waste Rock Unsturated Column Week 2	11: Waste Rock Saturated Column Week 2	12: DMS Tails Unsaturated Column Week 2 Dissolved	13: Waste Rock Unsturated Column Week 2 Dissolved	14: Waste Rock Saturated Column Week 2 Dissolved
Sample Date & Time							Date:N/A	Date:N/A	Date:N/A	Date:N/A	Date:N/A	Date:N/A
Temperature Upon Receipt [°C]	---	---	---	---	---	---	18.0	18.0	18.0	18.0	18.0	18.0
Total Suspended Solids [mg/L]	31-May-18	21:02	< 2	93%	4%	NA	188	828	19	---	---	---
pH [no unit]	25-May-18	14:11	NA	100%	0%	NA	7.72	7.56	7.87	---	---	---
Alkalinity [mg/L as CaCO3]	25-May-18	14:11	< 2	97%	1%	NA	35	22	42	---	---	---
Conductivity [uS/cm]	25-May-18	14:11	< 2	98%	1%	NA	70	105	140	---	---	---
Acidity [mg/L as CaCO3]	25-May-18	14:11	2	102%	ND	NA	< 2	< 2	< 2	---	---	---
Redox Potential [mV]	24-May-18	10:05	NA	106%	1%	NA	312	336	322	---	---	---
Mercury (total) [mg/L]	25-May-18	09:09	< 0.00001	94%	ND	90%	0.00006	< 0.00001	< 0.00001	0.00004	< 0.00001	< 0.00001
Silver [mg/L]	31-May-18	13:19	< 0.00005	100%	ND	NV	0.00017	0.00020	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Aluminum [mg/L]	01-Jun-18	11:36	< 0.001	99%	ND	95%	11.4	33.6	0.513	0.435	0.072	0.111
Arsenic [mg/L]	31-May-18	13:19	< 0.0002	99%	ND	102%	0.197	0.198	0.304	0.125	0.139	0.296
Barium [mg/L]	31-May-18	13:19	< 0.00002	98%	0%	NV	0.0326	0.349	0.0155	0.00156	0.0108	0.0114
Beryllium [mg/L]	31-May-18	13:19	< 0.000007	96%	ND	81%	0.00614	0.000871	0.000016	0.000231	< 0.000007	< 0.000007
Boron [mg/L]	31-May-18	13:19	< 0.002	92%	1%	NV	0.037	0.025	0.034	0.016	0.023	0.032
Bismuth [mg/L]	31-May-18	13:19	< 0.000007	92%	ND	NV	0.00991	0.000544	0.000038	0.000435	0.000025	0.000016
Calcium [mg/L]	31-May-18	13:19	< 0.01	99%	1%	NV	6.27	10.1	10.2	3.35	6.38	10.2
Cadmium [mg/L]	31-May-18	13:19	< 0.000003	99%	ND	115%	0.000219	0.000147	0.000007	0.000013	< 0.000003	< 0.000003

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Project : CALR-13531-002
LR Report : **CA14632-MAY18**

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 2	10: Waste Rock Unsturated Column Week 2	11: Waste Rock Saturated Column Week 2	12: DMS Tails Unsaturated Column Week 2 Dissolved	13: Waste Rock Unsturated Column Week 2 Dissolved	14: Waste Rock Saturated Column Week 2 Dissolved
Cobalt [mg/L]	31-May-18	13:19	< 0.000004	100%	0%	107%	0.00303	0.0166	0.000573	0.000239	0.000207	0.000396
Chromium [mg/L]	31-May-18	13:19	< 0.00003	102%	2%	111%	0.0150	0.113	0.00159	0.00104	0.00015	0.00005
Copper [mg/L]	31-May-18	13:19	< 0.00002	101%	0%	113%	0.0169	0.0374	0.00114	0.00235	0.00042	0.00083
Iron [mg/L]	31-May-18	13:19	< 0.007	100%	ND	NV	7.57	32.0	0.479	0.308	0.034	< 0.007
Potassium [mg/L]	31-May-18	13:19	< 0.003	109%	1%	NV	7.65	21.9	12.6	3.97	8.72	12.4
Lithium [mg/L]	31-May-18	13:19	< 0.0001	93%	1%	72%	1.65	0.660	0.352	1.62	0.315	0.346
Magnesium [mg/L]	31-May-18	13:19	< 0.001	99%	1%	NV	1.00	13.5	1.91	0.348	1.24	1.74
Manganese [mg/L]	31-May-18	13:19	< 0.00001	102%	0%	106%	1.05	0.546	0.0306	0.0416	0.00303	0.0235
Molybdenum [mg/L]	31-May-18	13:19	< 0.00001	101%	2%	100%	0.00370	0.00194	0.00223	0.00319	0.00144	0.00216
Sodium [mg/L]	31-May-18	13:19	< 0.01	99%	1%	NV	7.23	6.97	5.86	3.72	4.95	5.78
Nickel [mg/L]	31-May-18	13:19	< 0.0001	102%	10%	106%	0.0104	0.0515	0.0029	0.0013	0.0017	0.0023
Lead [mg/L]	31-May-18	13:19	< 0.00001	94%	0%	92%	0.0173	0.00813	0.00014	0.00064	0.00007	0.00005
Sulfur (total) [mg/L]	04-Jul-18	08:37					< 0.1	5.1	6.0	< 0.1	6.5	6.5
Antimony [mg/L]	31-May-18	13:19	< 0.0002	94%	1%	111%	0.0013	0.0011	0.0020	0.0015	0.0012	0.0015
Selenium [mg/L]	31-May-18	13:19	< 0.00004	103%	9%	81%	0.00008	0.00036	0.00029	0.00004	0.00022	0.00027
Tin [mg/L]	31-May-18	13:19	< 0.00001	103%	2%	NV	0.0485	0.0427	0.0334	0.0360	0.0255	0.0330
Strontium [mg/L]	31-May-18	13:19	< 0.00002	103%	2%	NV	0.0607	0.104	0.110	0.0154	0.0721	0.113
Thorium [mg/L]	31-May-18	13:19	< 0.00001	103%	ND	NV	0.0016	0.0130	0.0003	< 0.0001	< 0.0001	< 0.0001
Titanium [mg/L]	31-May-18	13:19	< 0.00005	95%	20%	NV	0.148	2.37	0.0331	0.00551	0.00206	0.00041
Thallium [mg/L]	31-May-18	13:19	< 0.000005	93%	2%	89%	0.00107	0.00207	0.000066	0.000060	0.000049	0.000040
Uranium [mg/L]	31-May-18	13:19	< 0.000002	100%	2%	80%	0.0251	0.0103	0.00730	0.00169	0.00248	0.00718
Vanadium [mg/L]	31-May-18	13:19	< 0.00001	101%	7%	99%	0.00778	0.0750	0.00363	0.00209	0.00139	0.00261
Tungsten [mg/L]	31-May-18	13:19	< 0.00002	105%	1%	NV	0.00263	0.0100	0.0103	0.00094	0.00374	0.0101
Yttrium [mg/L]	31-May-18	13:19	< 0.000002	102%	7%	NV	0.000448	0.00808	0.000171	0.000019	0.000044	0.000035
Zinc [mg/L]	31-May-18	13:19	< 0.002	101%	ND	95%	0.113	0.076	0.006	0.005	< 0.002	< 0.002

NA - Not applicable
ND - Not Detected
NV - No Value

Report revised to include results for Total Sulphur as requested by client.

OnLine LIMS

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Project : CALR-13531-002
LR Report : **CA14632-MAY18**

Patti Stark
Project Specialist Environmental Services, Analytical

OnLine LIMS

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Modified Acid Base Accounting

Parameter	Unit	Galaxy Waste Rock	Bulk DMS Tails
LIMS		11052-APR18	11052-APR18
Paste pH	units	9.66	9.61
Fizz Rate	---	1	1
Sample weight	g	2	2.01
HCl added	mL	20.00	20.00
HCl	Normality	0.10	0.10
NaOH	Normality	0.10	0.10
NaOH to pH=8.3	mL	17.36	17.95
Final pH		0.99	0.90
NP	t $CaCO_3$/1000 t	6.6	5.1
AP	t $CaCO_3$/1000 t	3.44	0.62
Net NP	t $CaCO_3$/1000 t	3.16	4.48
NP/AP	ratio	1.92	8.23
S	%	0.214	< 0.005
Acid Leachable SO_4-S	%	0.10	< 0.02
Sulphide	%	0.11	< 0.02
C	%	0.029	0.048
CO_3	%	0.080	0.140
CO_3 NP	t $CaCO_3$/1000 t	1.3	2.3

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SGS Lakefield Environmental Met
Attn : Barb Bowman

Project : CALR-13531-002

05-July-2018

Date Rec. : 29 May 2018
LR Report: **CA14907-MAY18**
Reference: 13531-002-07

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 3	10: Waste Rock Unsturated Column Week 3	11: Waste Rock Saturated Column Week 3	12: DMS Tails Unsaturated Column Week 3 Dissolved	13: Waste Rock Unsturated Column Week 3 Dissolved	14: Waste Rock Saturated Column Week 3 Dissolved
Sample Date & Time							Date:N/A	Date:N/A	Date:N/A	Date:N/A	Date:N/A	Date:N/A
Temperature Upon Receipt [°C]	---	---	---	---	---	---	18.0	18.0	18.0	18.0	18.0	18.0
Total Suspended Solids [mg/L]	04-Jun-18	13:45	< 2	98%	2%	NA	257	562	8	---	---	---
pH [no unit]	04-Jun-18	15:38	NA	100%	0%	NA	7.73	7.58	7.80	---	---	---
Alkalinity [mg/L as CaCO3]	04-Jun-18	15:38	< 2	101%	0%	NA	28	16	31	---	---	---
Conductivity [uS/cm]	04-Jun-18	15:38	< 2	99%	1%	NA	55	79	99	---	---	---
Acidity [mg/L as CaCO3]	04-Jun-18	15:38	2	100%	0%	NA	< 2	< 2	< 2	---	---	---
Redox Potential [mV]	04-Jun-18	15:38	NA	108%	0%	NA	270	247	264	---	---	---
Mercury [mg/L]	01-Jun-18	10:09	< 0.00001	103%	ND	95%	< 0.00001	< 0.00001	0.00003	< 0.00001	< 0.00001	< 0.00001
Silver [mg/L]	04-Jun-18	14:26	< 0.00005	101%	ND	NV	0.00012	0.00009	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Aluminum [mg/L]	04-Jun-18	14:26	< 0.001	100%	13%	107%	5.59	6.38	0.324	0.154	0.085	0.129
Arsenic [mg/L]	04-Jun-18	14:26	< 0.0002	102%	1%	108%	0.171	0.179	0.400	0.0944	0.128	0.332
Barium [mg/L]	04-Jun-18	14:26	< 0.00002	101%	0%	NV	0.0194	0.0704	0.0105	0.0005	0.0053	0.0082
Beryllium [mg/L]	04-Jun-18	14:26	< 0.000007	106%	ND	94%	0.00361	0.000413	0.000017	0.000069	< 0.000007	< 0.000007
Boron [mg/L]	04-Jun-18	14:26	< 0.002	104%	1%	NV	0.015	0.018	0.021	0.011	0.017	0.020
Bismuth [mg/L]	04-Jun-18	14:26	< 0.000007	108%	ND	91%	0.00711	0.000268	0.000024	0.000150	0.000012	< 0.000007
Calcium [mg/L]	04-Jun-18	14:26	< 0.01	100%	1%	NV	5.46	6.78	8.82	3.26	5.23	8.64
Cadmium [mg/L]	04-Jun-18	14:26	< 0.000003	100%	ND	89%	0.000115	0.000040	0.000006	0.000003	0.000008	0.000005

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Project : CALR-13531-002
LR Report : **CA14907-MAY18**

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 3	10: Waste Rock Unsturated Column Week 3	11: Waste Rock Saturated Column Week 3	12: DMS Tails Unsaturated Column Week 3 Dissolved	13: Waste Rock Unsturated Column Week 3 Dissolved	14: Waste Rock Saturated Column Week 3 Dissolved
Cobalt [mg/L]	04-Jun-18	14:26	< 0.000004	99%	7%	101%	0.00200	0.00571	0.000352	0.000092	0.000411	0.000244
Chromium [mg/L]	04-Jun-18	14:26	< 0.00003	98%	17%	102%	0.00964	0.0221	0.00056	0.00069	< 0.00003	0.00004
Copper [mg/L]	04-Jun-18	14:26	< 0.00002	99%	0%	NV	0.0120	0.0112	0.00058	0.00125	0.00029	0.00051
Iron [mg/L]	04-Jun-18	14:26	< 0.007	98%	5%	NV	4.81	6.84	0.169	0.074	0.012	0.008
Potassium [mg/L]	04-Jun-18	14:26	< 0.003	100%	2%	NV	4.72	8.41	7.77	3.01	6.00	7.68
Lithium [mg/L]	04-Jun-18	14:26	< 0.0001	101%	3%	81%	1.21	0.299	0.203	1.15	0.214	0.194
Magnesium [mg/L]	04-Jun-18	14:26	< 0.001	101%	2%	114%	0.694	3.41	1.28	0.335	0.945	1.22
Manganese [mg/L]	04-Jun-18	14:26	< 0.00001	100%	2%	103%	0.667	0.126	0.01936	0.00635	0.01521	0.01630
Molybdenum [mg/L]	04-Jun-18	14:26	< 0.00001	101%	1%	104%	0.00255	0.00091	0.00105	0.00229	0.00218	0.00113
Sodium [mg/L]	04-Jun-18	14:26	< 0.01	103%	1%	NV	3.25	3.98	2.95	1.82	3.00	2.88
Nickel [mg/L]	04-Jun-18	14:26	< 0.0001	100%	3%	95%	0.0069	0.0175	0.0017	0.0004	0.0021	0.0016
Lead [mg/L]	04-Jun-18	14:26	< 0.00001	102%	3%	94%	0.0123	0.00313	0.00012	0.00021	0.00004	0.00004
Sulfur (total) [mg/L]	04-Jul-18	08:37					0.4	5.0	4.6	0.4	4.8	4.0
Antimony [mg/L]	04-Jun-18	14:26	< 0.0002	98%	ND	122%	0.0010	0.0010	0.0019	0.0028	0.0030	0.0034
Selenium [mg/L]	04-Jun-18	14:26	< 0.00004	99%	ND	112%	0.00007	0.00028	0.00023	< 0.00004	0.00019	0.00016
Tin [mg/L]	04-Jun-18	14:26	< 0.00001	105%	8%	NV	0.0213	0.0168	0.0192	0.0192	0.0142	0.0191
Strontium [mg/L]	04-Jun-18	14:26	< 0.00002	98%	1%	NV	0.0434	0.0719	0.0834	0.0123	0.0526	0.0811
Thorium [mg/L]	04-Jun-18	14:26	< 0.00001	96%	ND	NV	0.0007	0.0024	0.0002	0.0001	< 0.0001	< 0.0001
Titanium [mg/L]	04-Jun-18	14:26	< 0.00005	102%	8%	NV	0.0498	0.469	0.0116	0.00139	0.00054	0.00027
Thallium [mg/L]	04-Jun-18	14:26	< 0.000005	108%	ND	101%	0.000436	0.000410	0.000040	0.000026	0.000029	0.000028
Uranium [mg/L]	04-Jun-18	14:26	< 0.000002	105%	2%	90%	0.0159	0.00580	0.00836	0.00146	0.00338	0.00804
Vanadium [mg/L]	04-Jun-18	14:26	< 0.00001	99%	ND	104%	0.00507	0.0155	0.00292	0.00154	0.00105	0.00249
Tungsten [mg/L]	04-Jun-18	14:26	< 0.00002	103%	3%	NV	0.00111	0.00303	0.00659	0.00063	0.00182	0.00628
Yttrium [mg/L]	04-Jun-18	14:26	< 0.000002	99%	15%	NV	0.000306	0.00256	0.000092	0.000011	0.000024	0.000026
Zinc [mg/L]	04-Jun-18	14:26	< 0.002	100%	3%	NV	0.086	0.022	< 0.002	< 0.002	< 0.002	< 0.002

NA - Not applicable
ND - Not Detected
NV - No Value

Report revised to include results for Total Sulphur as requested by client.

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Project : CALR-13531-002
LR Report : **CA14907-MAY18**

Patti Stark
Project Specialist Environmental Services, Analytical

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Whole Rock Analysis

Parameter	Unit	Galaxy Waste Rock	Bulk DMS Tails
LIMS		11053-APR18	11053-APR18
SiO_2	%	65.3	76.4
Al_2O_3	%	15.8	13.6
Fe_2O_3	%	5.18	0.37
MgO	%	2.21	0.06
CaO	%	2.30	0.39
Na_2O	%	3.60	4.45
K_2O	%	2.60	3.24
TiO_2	%	0.44	0.02
P_2O_5	%	0.27	0.33
MnO	%	0.07	0.04
Cr_2O_3	%	0.02	0.01
V_2O_5	%	0.02	< 0.01
LOI	%	0.96	0.56
Sum	%	98.8	99.5

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SGS Lakefield Environmental Met
Attn : Barb Bowman

Project : CALR-13531-002

05-July-2018

Date Rec. : 05 June 2018
LR Report: **CA14134-JUN18**
Reference: 13531-002-08

Copy: #2

CERTIFICATE OF ANALYSIS

Final Report - Revised

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 4	10: Waste Rock Unsturated Column Week	11: Waste Rock Saturated Column Week 4	12: DMS Tails Unsaturated Column Week 4 Dissolved	13: Waste Rock Unsturated Column Week 4 Dissolved	14: Waste Rock Saturated Column Week 4 Dissolved
Sample Date & Time							Date:N/A	Date:N/A	Date:N/A	Date:N/A	Date:N/A	Date:N/A
Temperature Upon Receipt [°C]	---	---	---	---	---	---	21.0	21.0	21.0	21.0	21.0	21.0
Total Suspended Solids [mg/L]	13-Jun-18	15:02	< 2	NA	1%	NA	174	709	4	---	---	---
pH [no unit]	12-Jun-18	15:56	NA	100%	1%	NA	7.53	7.37	7.70	---	---	---
Alkalinity [mg/L as CaCO3]	12-Jun-18	15:56	< 2	104%	ND	NA	23	17	27	---	---	---
Conductivity [uS/cm]	12-Jun-18	15:56	< 2	98%	0%	NA	44	73	84	---	---	---
Acidity [mg/L as CaCO3]	12-Jun-18	15:56	2	90%	ND	NA	< 2	< 2	< 2	---	---	---
Redox Potential [mV]	11-Jun-18	22:03	NA	108%	0%	NA	329	312	282	---	---	---
Mercury (total) [mg/L]	08-Jun-18	11:34	< 0.00001	113%	ND	114%	0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Silver (total) [mg/L]	11-Jun-18	12:54	< 0.00005	105%	ND	NV	< 0.00005	0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Aluminum (total) [mg/L]	11-Jun-18	12:54	< 0.001	100%	2%	112%	6.43	32.4	0.391	0.403	0.133	0.185
Arsenic (total) [mg/L]	11-Jun-18	12:54	< 0.0002	109%	0%	101%	0.148	0.306	0.352	0.101	0.164	0.335
Barium (total) [mg/L]	11-Jun-18	12:54	< 0.00002	108%	1%	100%	0.0179	0.284	0.00994	0.00168	0.00670	0.00807
Beryllium (total) [mg/L]	11-Jun-18	12:54	< 0.000007	107%	ND	94%	0.00561	0.00158	0.000026	0.000331	0.000007	< 0.000007
Boron (total) [mg/L]	11-Jun-18	12:54	< 0.002	102%	14%	NV	0.025	0.028	0.022	0.010	0.019	0.019
Bismuth (total) [mg/L]	11-Jun-18	12:54	< 0.000007	105%	6%	94%	0.00557	0.000560	0.000028	0.000598	< 0.000007	< 0.000007
Calcium (total) [mg/L]	11-Jun-18	12:54	< 0.01	104%	3%	99%	6.20	13.0	9.58	3.70	5.99	8.98
Cadmium (total) [mg/L]	11-Jun-18	12:54	< 0.000003	109%	13%	103%	0.000116	0.000145	0.000010	0.000006	0.000008	0.000009

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Project : CALR-13531-002
LR Report : **CA14134-JUN18**

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 4	10: Waste Rock Unsturated Column Week	11: Waste Rock Saturated Column Week 4	12: DMS Tails Unsaturated Column Week 4 Dissolved	13: Waste Rock Unsturated Column Week 4 Dissolved	14: Waste Rock Saturated Column Week 4 Dissolved
Cobalt (total) [mg/L]	11-Jun-18	12:54	< 0.000004	107%	2%	100%	0.00184	0.0197	0.000399	0.000218	0.000478	0.000304
Chromium (total) [mg/L]	11-Jun-18	12:54	< 0.00003	109%	5%	106%	0.0120	0.114	0.00058	0.00160	0.00023	0.00012
Copper (total) [mg/L]	11-Jun-18	12:54	< 0.00002	108%	2%	100%	0.0112	0.0520	0.00027	0.00144	< 0.00002	< 0.00002
Iron (total) [mg/L]	11-Jun-18	12:54	< 0.007	107%	2%	NV	5.46	36.0	0.173	0.382	0.047	0.031
Potassium (total) [mg/L]	11-Jun-18	12:54	< 0.003	108%	5%	115%	4.69	21.1	6.70	2.60	5.70	6.12
Lithium (total) [mg/L]	11-Jun-18	12:54	< 0.0001	104%	19%	90%	1.93	1.09	0.259	1.35	0.261	0.210
Magnesium (total) [mg/L]	11-Jun-18	12:54	< 0.001	107%	1%	100%	0.710	14.4	1.29	0.375	1.04	1.18
Manganese (total) [mg/L]	11-Jun-18	12:54	< 0.00001	109%	1%	105%	0.698	0.579	0.0226	0.0645	0.0118	0.0191
Molybdenum (total) [mg/L]	11-Jun-18	12:54	< 0.00001	109%	0%	103%	0.00251	0.00127	0.00071	0.00202	0.00068	0.00067
Sodium (total) [mg/L]	11-Jun-18	12:54	< 0.01	107%	0%	100%	3.60	5.93	2.00	1.20	2.48	1.84
Nickel (total) [mg/L]	11-Jun-18	12:54	< 0.0001	107%	1%	95%	0.0063	0.0632	0.0016	0.0008	0.0023	0.0012
Lead (total) [mg/L]	11-Jun-18	12:54	< 0.00001	109%	1%	98%	0.0101	0.00878	0.00016	0.00104	0.00006	0.00006
Sulfur (total) [mg/L]	04-Jul-18	08:32					2.3	8.9	7.1	1.2	6.9	6.5
Antimony (total) [mg/L]	11-Jun-18	12:54	< 0.0002	92%	1%	106%	0.0011	0.0012	0.0018	< 0.0002	< 0.0002	< 0.0002
Selenium (total) [mg/L]	11-Jun-18	12:54	< 0.00004	109%	17%	86%	0.00007	0.00035	0.00020	< 0.00004	0.00020	0.00019
Tin (total) [mg/L]	11-Jun-18	12:54	< 0.00001	109%	1%	ND	0.0153	0.0276	0.0141	0.0137	0.0117	0.0133
Strontium (total) [mg/L]	11-Jun-18	12:54	< 0.00002	110%	1%	97%	0.0523	0.138	0.0908	0.0165	0.0628	0.0854
Thorium (total) [mg/L]	12-Jun-18	09:31	< 0.00001	99%	ND	NV	0.0007	0.0094	0.0001	< 0.0001	< 0.0001	< 0.0001
Titanium (total) [mg/L]	11-Jun-18	12:54	< 0.00005	109%	ND	NV	0.0747	2.62	0.0140	0.00417	0.00318	0.00244
Thallium (total) [mg/L]	11-Jun-18	12:54	< 0.000005	110%	0%	98%	0.000434	0.00169	0.000037	0.000046	0.000036	0.000027
Uranium (total) [mg/L]	11-Jun-18	12:54	< 0.000002	109%	3%	97%	0.0125	0.0101	0.0102	0.00186	0.00386	0.0101
Vanadium (total) [mg/L]	11-Jun-18	12:54	< 0.00001	108%	1%	93%	0.00629	0.0767	0.00279	0.00166	0.00122	0.00235
Tungsten (total) [mg/L]	11-Jun-18	12:54	< 0.00002	108%	ND	NV	0.00115	0.00562	0.00451	0.00052	0.00111	0.00438
Yttrium (total) [mg/L]	11-Jun-18	12:54	< 0.000002	110%	3%	ND	0.000328	0.0105	0.000109	0.000025	0.000100	0.000042
Zinc (total) [mg/L]	11-Jun-18	12:54	< 0.002	106%	9%	117%	0.076	0.095	< 0.002	0.008	< 0.002	< 0.002

NA - Not applicable
ND - Not Detected
NV - No Value

Report revised to include results for Total Sulphur as requested by client.

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Project : CALR-13531-002
LR Report : **CA14134-JUN18**

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Project Specialist Environmental Services, Analytical

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SGS Lakefield Environmental Met
Attn : Barb Bowman

Project : CALR-13531-002

05-July-2018

Date Rec. : 19 June 2018
LR Report: **CA14646-JUN18**
Reference: 13531-002-09

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CERTIFICATE OF ANALYSIS

Final Report - Revised

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 6	10: Waste Rock Unsturated Column Week 6	11: Waste Rock Saturated Column Week 6	12: DMS Tails Unsaturated Column Week 6 Dissolved	13: Waste Rock Unsturated Column Week 6 Dissolved	14: Waste Rock Saturated Column Week 6 Dissolved
Sample Date & Time							Date:N/A	Date:N/A	Date:N/A	Date:N/A	Date:N/A	Date:N/A
Temperature Upon Receipt [°C]	---	---	---	---	---	---	18.0	18.0	18.0	18.0	18.0	18.0
Total Suspended Solids [mg/L]	26-Jun-18	15:35	< 2	NV	0%	NA	139	503	6	---	---	---
pH [no unit]	22-Jun-18	15:29	NA	100%	0%	NA	7.35	7.28	7.45	---	---	---
Alkalinity [mg/L as CaCO3]	22-Jun-18	15:29	< 2	98%	0%	NA	22	16	21	---	---	---
Conductivity [uS/cm]	22-Jun-18	15:29	< 2	103%	1%	NA	39	69	85	---	---	---
Acidity [mg/L as CaCO3]	22-Jun-18	15:29	< 2	110%	ND	NA	< 2	< 2	< 2	---	---	---
Redox Potential [mV]	21-Jun-18	10:48	NA	109%	1%	NA	205	193	166	---	---	---
Mercury (total) [mg/L]	25-Jun-18	14:21	< 0.00001	84%	ND	107%	0.00004	< 0.00001	< 0.00001	0.00002	0.00002	< 0.00001
Silver (total) [mg/L]	29-Jun-18	10:06	< 0.00005	104%	ND	NV	0.00006	0.00015	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Aluminum (total) [mg/L]	29-Jun-18	10:06	< 0.001	103%	1%	104%	3.44	19.6	0.286	0.841	0.169	0.207
Arsenic (total) [mg/L]	29-Jun-18	10:06	< 0.0002	107%	7%	116%	0.107	0.206	0.233	0.0743	0.137	0.220
Barium (total) [mg/L]	29-Jun-18	10:06	< 0.00002	107%	5%	113%	0.0104	0.220	0.00842	0.00365	0.00666	0.00736
Beryllium (total) [mg/L]	29-Jun-18	10:06	< 0.000007	105%	2%	109%	0.00226	0.000717	0.000012	0.000506	0.000008	< 0.000007
Boron (total) [mg/L]	29-Jun-18	10:06	< 0.002	94%	7%	NV	0.014	0.013	0.015	0.009	0.013	0.016
Bismuth (total) [mg/L]	29-Jun-18	10:06	< 0.000007	105%	13%	79%	0.00342	0.000401	0.000010	0.000945	0.000007	< 0.000007
Calcium (total) [mg/L]	29-Jun-18	10:06	< 0.01	101%	2%	102%	4.39	8.20	9.15	3.26	5.54	8.68
Cadmium (total) [mg/L]	29-Jun-18	10:06	< 0.000003	104%	3%	110%	0.000082	0.000098	0.000006	0.000022	< 0.000003	< 0.000003

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Project : CALR-13531-002
LR Report : **CA14646-JUN18**

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 6	10: Waste Rock Unsturated Column Week 6	11: Waste Rock Saturated Column Week 6	12: DMS Tails Unsaturated Column Week 6 Dissolved	13: Waste Rock Unsturated Column Week 6 Dissolved	14: Waste Rock Saturated Column Week 6 Dissolved
Cobalt (total) [mg/L]	29-Jun-18	10:07	< 0.000004	104%	2%	98%	0.00116	0.0128	0.000327	0.000370	0.000452	0.000251
Chromium (total) [mg/L]	29-Jun-18	10:07	< 0.00003	105%	0%	82%	0.00874	0.0768	0.00045	0.00247	0.00040	0.00015
Copper (total) [mg/L]	29-Jun-18	10:07	< 0.00002	105%	1%	76%	0.00731	0.0303	0.00058	0.00226	0.00040	0.00149
Iron (total) [mg/L]	29-Jun-18	10:07	< 0.007	98%	2%	NV	3.31	22.1	0.118	0.857	0.105	0.036
Potassium (total) [mg/L]	29-Jun-18	10:07	< 0.003	100%	0%	90%	2.64	13.4	4.82	2.00	3.96	4.36
Lithium (total) [mg/L]	29-Jun-18	10:07	< 0.0001	94%	5%	89%	0.683	0.442	0.123	0.636	0.135	0.116
Magnesium (total) [mg/L]	29-Jun-18	10:07	< 0.001	101%	2%	93%	0.485	9.15	1.04	0.342	0.890	0.974
Manganese (total) [mg/L]	29-Jun-18	10:07	< 0.00001	107%	2%	104%	0.410	0.350	0.0229	0.101	0.00696	0.0204
Molybdenum (total) [mg/L]	29-Jun-18	10:07	< 0.00001	104%	1%	122%	0.00210	0.00060	0.00050	0.00200	0.00046	0.00050
Sodium (total) [mg/L]	29-Jun-18	10:07	< 0.01	98%	2%	106%	1.07	2.37	0.61	0.13	0.53	< 0.01
Nickel (total) [mg/L]	29-Jun-18	10:07	< 0.0001	103%	1%	99%	0.0040	0.0400	0.0010	0.0010	0.0019	0.0008
Lead (total) [mg/L]	29-Jun-18	10:07	< 0.00001	103%	5%	103%	0.00616	0.00688	0.00026	0.00164	0.00009	0.00016
Sulfur (total) [mg/L]	04-Jul-18	08:34					< 0.1	3.8	5.4	< 0.1	4.5	5.1
Antimony (total) [mg/L]	29-Jun-18	10:07	< 0.0002	95%	3%	125%	0.0011	0.0013	0.0013	< 0.0002	< 0.0002	< 0.0002
Selenium (total) [mg/L]	29-Jun-18	10:07	< 0.00004	105%	5%	NV	< 0.00004	0.00024	0.00011	< 0.00004	0.00014	0.00013
Tin (total) [mg/L]	29-Jun-18	10:07	< 0.00001	99%	5%	NV	0.00949	0.0194	0.0100	0.00827	0.00828	0.00938
Strontium (total) [mg/L]	29-Jun-18	10:08	< 0.00002	107%	1%	105%	0.0320	0.0816	0.0784	0.0157	0.0531	0.0732
Thorium (total) [mg/L]	29-Jun-18	10:08	< 0.00001	98%	ND	NV	0.0005	0.0077	0.0002	0.0002	< 0.0001	< 0.0001
Titanium (total) [mg/L]	29-Jun-18	10:08	< 0.00005	104%	ND	NV	0.0467	1.58	0.00867	0.0114	0.00660	0.00111
Thallium (total) [mg/L]	29-Jun-18	10:08	< 0.000005	105%	6%	106%	0.000295	0.00141	0.000038	0.000091	0.000046	0.000030
Uranium (total) [mg/L]	29-Jun-18	10:08	< 0.000002	104%	2%	99%	0.00725	0.00832	0.00689	0.00219	0.00335	0.00675
Vanadium (total) [mg/L]	29-Jun-18	10:09	< 0.00001	104%	5%	100%	0.00469	0.0517	0.00210	0.00188	0.00116	0.00175
Tungsten (total) [mg/L]	29-Jun-18	10:09	< 0.00002	98%	13%	NV	0.00102	0.00539	0.00298	0.00063	0.00095	0.00279
Yttrium (total) [mg/L]	29-Jun-18	10:09	< 0.000002	106%	4%	NV	0.000205	0.00617	0.000057	0.000048	0.000062	0.000017
Zinc (total) [mg/L]	29-Jun-18	10:09	< 0.002	107%	0%	121%	0.042	0.054	< 0.002	0.009	< 0.002	< 0.002

NA - Not applicable
ND - Not Detected
NV - No Value

Report revised to include results for Total Sulphur as requested by client.

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Project : CALR-13531-002
LR Report : **CA14646-JUN18**

Patti Stark
Project Specialist Environmental Services, Analytical

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SGS Lakefield Environmental Met
Attn : Barb Bowman

Project : CALR-13531-002

18-July-2018

Date Rec. : 03 July 2018
LR Report: **CA14035-JUL18**
Reference: 13531-002-10

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 8	10: Waste Rock Unsturated Column Week 8	11: Waste Rock Saturated Column Week 8	12: DMS Tails Unsaturated Column Week 8 Dissolved	13: Waste Rock Unsturated Column Week 8 Dissolved	14: Waste Rock Saturated Column Week 8 Dissolved
Sample Date & Time							Date:N/A	Date:N/A	Date:N/A	Date:N/A	Date:N/A	Date:N/A
Temperature Upon Receipt [°C]	---	---	---	---	---	---	21.0	21.0	21.0	21.0	21.0	21.0
Total Suspended Solids [mg/L]	06-Jul-18	14:27	< 2	NV	2%	NV	95	951	< 2	---	---	---
pH [no unit]	10-Jul-18	13:14	NA	100%	0%	NA	7.28	7.16	7.38	---	---	---
Alkalinity [mg/L as CaCO3]	10-Jul-18	13:14	< 2	106%	ND	NA	63	21	16	---	---	---
Conductivity [uS/cm]	10-Jul-18	13:14	2	105%	1%	NA	25	45	86	---	---	---
Acidity [mg/L as CaCO3]	10-Jul-18	13:14	< 2	130%	3%	NA	110	12	< 2	---	---	---
Redox Potential [mV]	05-Jul-18	12:41	NA	104%	2%	NA	248	136	232	---	---	---
Sulphate [mg/L]	09-Jul-18	14:50	< 0.2	101%	6%	100%	1.0	10	15	---	---	---
Mercury [mg/L]	04-Jul-18	14:39	< 0.00001	93%	ND	89%	0.00002	< 0.00001	0.00007	0.00002	< 0.00001	0.00007
Silver [mg/L]	06-Jul-18	15:36	< 0.00005	103%	ND	NV	< 0.00005	0.00009	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Aluminum [mg/L]	06-Jul-18	15:36	< 0.001	99%	ND	NV	3.03	10.2	0.250	0.396	0.457	0.164
Arsenic [mg/L]	06-Jul-18	15:36	< 0.0002	103%	ND	105%	0.0891	0.154	0.171	0.0671	0.117	0.172
Barium [mg/L]	06-Jul-18	15:36	< 0.00002	102%	1%	NV	0.00854	0.0928	0.00690	0.00253	0.00877	0.00602
Beryllium [mg/L]	06-Jul-18	15:36	< 0.000007	102%	ND	102%	0.00157	0.000521	0.000011	0.000290	0.000040	< 0.000007
Boron [mg/L]	06-Jul-18	15:36	< 0.002	103%	1%	NV	0.009	0.011	0.010	0.006	0.009	0.009
Bismuth [mg/L]	06-Jul-18	15:36	< 0.000007	91%	ND	84%	0.00263	0.000248	< 0.000007	0.000601	0.000022	< 0.000007
Calcium [mg/L]	06-Jul-18	15:36	< 0.01	99%	0%	70%	3.91	7.11	8.92	2.98	5.04	9.03

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Project : CALR-13531-002
LR Report : **CA14035-JUL18**

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 8	10: Waste Rock Unsturated Column Week 8	11: Waste Rock Saturated Column Week 8	12: DMS Tails Unsaturated Column Week 8 Dissolved	13: Waste Rock Unsturated Column Week 8 Dissolved	14: Waste Rock Saturated Column Week 8 Dissolved
Cadmium [mg/L]	06-Jul-18	15:36	< 0.000003	102%	ND	107%	0.000053	0.000045	< 0.000003	0.000005	< 0.000003	< 0.000003
Cobalt [mg/L]	06-Jul-18	15:36	< 0.000004	101%	2%	102%	0.000831	0.00781	0.000222	0.000194	0.000864	0.000182
Chromium [mg/L]	06-Jul-18	15:36	< 0.00003	101%	ND	109%	0.00577	0.0324	0.00034	0.00140	0.00182	0.00005
Copper [mg/L]	06-Jul-18	15:36	< 0.00002	101%	ND	88%	0.00564	0.0192	0.00058	0.00224	0.00158	0.00094
Iron [mg/L]	06-Jul-18	15:36	< 0.007	97%	1%	NV	2.46	9.84	0.065	0.457	0.507	0.010
Potassium [mg/L]	06-Jul-18	15:36	< 0.003	110%	4%	75%	2.50	7.26	4.11	1.56	3.48	4.03
Lithium [mg/L]	06-Jul-18	15:36	< 0.0001	104%	4%	96%	0.503	0.237	0.0950	0.442	0.0946	0.0910
Magnesium [mg/L]	06-Jul-18	15:36	< 0.001	99%	1%	NV	0.403	4.26	0.945	0.271	0.865	0.966
Manganese [mg/L]	06-Jul-18	15:36	< 0.00001	104%	1%	NV	0.367	0.189	0.0235	0.0722	0.0143	0.0229
Molybdenum [mg/L]	06-Jul-18	15:36	< 0.00001	102%	0%	106%	0.00183	0.00047	0.00038	0.00154	0.00032	0.00040
Sodium [mg/L]	06-Jul-18	15:36	< 0.01	101%	3%	NV	1.06	2.02	0.51	0.32	0.63	0.78
Nickel [mg/L]	06-Jul-18	15:36	< 0.0001	102%	4%	98%	0.0030	0.0246	0.0007	0.0008	0.0036	0.0005
Lead [mg/L]	06-Jul-18	15:36	< 0.00001	95%	ND	97%	0.00483	0.00432	0.00008	0.00108	0.00030	0.00002
Sulfur [mg/L]	06-Jul-18	15:36	< 0.1	98%	0%	NV	1.1	3.8	5.9	1.0	4.3	6.0
Antimony [mg/L]	06-Jul-18	15:36	< 0.0002	95%	0%	95%	0.0006	0.0006	0.0007	0.0036	0.0039	0.0031
Selenium [mg/L]	06-Jul-18	15:36	< 0.00004	100%	ND	99%	< 0.00004	0.00013	0.00008	< 0.00004	0.00009	0.00007
Tin [mg/L]	06-Jul-18	15:36	< 0.00001	101%	ND	NV	0.00696	0.0105	0.00797	0.00578	0.00638	0.00771
Strontium [mg/L]	06-Jul-18	15:36	< 0.00002	103%	1%	NV	0.0271	0.0730	0.0725	0.0139	0.0458	0.0738
Thorium [mg/L]	06-Jul-18	15:36	< 0.00001	91%	ND	NV	0.0003	0.0032	< 0.0001	< 0.0001	0.0002	< 0.0001
Titanium [mg/L]	06-Jul-18	15:36	< 0.00005	99%	ND	NV	0.0305	0.697	0.00506	0.00508	0.0343	0.00066
Thallium [mg/L]	06-Jul-18	15:36	< 0.000005	93%	ND	95%	0.000180	0.000468	< 0.000005	0.000022	0.000028	0.000008
Uranium [mg/L]	06-Jul-18	15:36	< 0.000002	100%	1%	90%	0.00517	0.00542	0.00399	0.00136	0.00271	0.00383
Vanadium [mg/L]	06-Jul-18	15:36	< 0.00001	102%	2%	99%	0.00354	0.0222	0.00174	0.00156	0.00215	0.00164
Tungsten [mg/L]	06-Jul-18	15:36	< 0.00002	105%	ND	NV	0.00057	0.00281	0.00189	0.00028	0.00085	0.00187
Yttrium [mg/L]	06-Jul-18	15:36	< 0.000002	101%	ND	NV	0.000152	0.00356	0.000046	0.000063	0.000225	0.000016
Zinc [mg/L]	06-Jul-18	15:36	< 0.002	99%	3%	115%	0.034	0.028	< 0.002	0.008	0.008	< 0.002

NA - Not applicable
ND - Not Detected
NV - No Value

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Project : CALR-13531-002
LR Report : **CA14035-JUL18**

Patti Stark
Project Specialist Environmental Services, Analytical

OnLine LIMS

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SGS Lakefield Environmental Met
Attn : Barb Bowman

Project : CALR-13531-002

01-August-2018

Date Rec. : 17 July 2018
LR Report: **CA14438-JUL18**

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CERTIFICATE OF ANALYSIS
Final Report

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 10	10: Waste Rock Unsaturated Column Week 10	11: Waste Rock Saturated Column Week 10	12: DMS Tails Unsaturated Column Week 10 Dissolved	13: Waste Rock Unsturated Column Week 10 Dissolved	14: Waste Rock Saturated Column Week 10 Dissolved
Sample Date & Time							Date:N/A	Date:N/A	Date:N/A	Date:N/A	Date:N/A	Date:N/A
Temperature Upon Receipt [°C]	---	---	---	---	---	---	18.0	18.0	18.0	18.0	18.0	18.0
Total Suspended Solids [mg/L]	31-Jul-18	10:21	< 2	NV	1%	NA	71	298	< 3	---	---	---
pH [no unit]	19-Jul-18	13:58	NA	100%	0%	NA	7.49	7.07	7.58	---	---	---
Alkalinity [mg/L as CaCO3]	19-Jul-18	13:58	< 2	104%	ND	NA	9	7	15	---	---	---
Conductivity [uS/cm]	19-Jul-18	13:58	< 2	98%	1%	NA	31	47	64	---	---	---
Acidity [mg/L as CaCO3]	19-Jul-18	13:58	< 2	104%	2%	NA	38	< 2	< 2	---	---	---
Redox Potential [mV]	18-Jul-18	07:53	NA	102%	0%	NA	348	424	365	---	---	---
Sulphate [mg/L]	25-Jul-18	15:48	< 0.2	95%	0%	102%	0.8	7.8	12	---	---	---
Mercury [mg/L]	30-Jul-18	10:33	< 0.00001	80%	ND	NV	0.00002	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Silver [mg/L]	27-Jul-18	16:44	< 0.00005	103%	ND	101%	< 0.00005	0.00008	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Aluminum [mg/L]	27-Jul-18	16:44	< 0.001	108%	2%	98%	2.48	11.0	0.173	0.538	0.069	0.131
Arsenic [mg/L]	27-Jul-18	16:44	< 0.0002	97%	6%	94%	0.0653	0.124	0.125	0.0567	0.101	0.123
Barium [mg/L]	27-Jul-18	16:44	< 0.00002	100%	1%	NV	0.00584	0.107	0.00568	0.00180	0.00419	0.00465
Beryllium [mg/L]	27-Jul-18	16:44	< 0.000007	102%	15%	95%	0.00153	0.000420	0.000007	0.000382	< 0.000007	< 0.000007
Boron [mg/L]	27-Jul-18	16:44	< 0.002	103%	3%	NV	0.007	0.008	0.008	0.004	0.006	0.007
Bismuth [mg/L]	27-Jul-18	16:45	< 0.000007	101%	1%	87%	0.00181	0.000221	0.000010	0.000607	0.000011	< 0.000007
Calcium [mg/L]	27-Jul-18	16:45	< 0.01	104%	2%	NV	3.76	6.55	9.02	3.24	4.82	8.18
Cadmium [mg/L]	27-Jul-18	16:45	< 0.000003	104%	8%	108%	0.000046	0.000061	0.000006	0.000012	0.000006	< 0.000003
Cobalt [mg/L]	27-Jul-18	16:45	< 0.000004	104%	2%	107%	0.000633	0.00778	0.000180	0.000227	0.000291	0.000163
Chromium [mg/L]	27-Jul-18	16:45	< 0.00003	105%	9%	107%	0.00458	0.0434	0.00016	0.00152	0.00018	0.00010
Copper [mg/L]	27-Jul-18	16:45	< 0.00002	106%	1%	96%	0.00432	0.0151	0.00026	0.00165	0.00018	0.00025

OnLine LIMS

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LR Report : **CA14438-JUL18**

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 10	10: Waste Rock Unsaturated Column Week 10	11: Waste Rock Saturated Column Week 10	12: DMS Tails Unsaturated Column Week 10 Dissolved	13: Waste Rock Unsturated Column Week 10 Dissolved	14: Waste Rock Saturated Column Week 10 Dissolved
Iron [mg/L]	27-Jul-18	16:45	< 0.007	102%	2%	NV	1.72	13.0	0.034	0.510	0.030	0.011
Potassium [mg/L]	27-Jul-18	16:45	< 0.003	109%	4%	NV	1.99	7.82	3.21	1.26	2.68	3.06
Lithium [mg/L]	27-Jul-18	16:45	< 0.0001	103%	3%	79%	0.381	0.219	0.0587	0.317	0.0541	0.0576
Magnesium [mg/L]	27-Jul-18	16:45	< 0.001	104%	1%	NV	0.398	5.22	1.05	0.307	0.641	0.818
Manganese [mg/L]	27-Jul-18	16:45	< 0.00001	101%	1%	76%	0.209	0.191	0.0206	0.0656	0.00462	0.0197
Molybdenum [mg/L]	27-Jul-18	16:45	< 0.00001	98%	7%	100%	0.00168	0.00035	0.00036	0.00158	0.00026	0.00033
Sodium [mg/L]	27-Jul-18	16:45	< 0.01	104%	0%	NV	1.04	1.66	0.70	0.49	0.57	0.58
Nickel [mg/L]	27-Jul-18	16:45	< 0.0001	105%	3%	103%	0.0023	0.0246	0.0006	0.0008	0.0012	0.0006
Lead [mg/L]	27-Jul-18	16:45	< 0.00001	102%	1%	91%	0.00339	0.00393	0.00006	0.00112	0.00003	0.00087
Sulfur [mg/L]	27-Jul-18	16:45	< 0.1	97%	2%	NV	< 0.1	2.3	4.0	< 0.1	2.5	3.7
Antimony [mg/L]	27-Jul-18	16:45	< 0.0002	102%	2%	104%	0.0007	0.0007	0.0008	0.0021	0.0021	0.0020
Selenium [mg/L]	27-Jul-18	16:45	< 0.00004	104%	12%	106%	< 0.00004	0.00017	0.00011	< 0.00004	0.00012	0.00011
Tin [mg/L]	27-Jul-18	16:45	< 0.00001	101%	2%	NV	0.00597	0.00981	0.00843	0.00481	0.00524	0.00821
Strontium [mg/L]	27-Jul-18	16:46	< 0.00002	104%	0%	NV	0.0215	0.0572	0.0635	0.0139	0.0380	0.0596
Thorium [mg/L]	27-Jul-18	16:46	< 0.00001	105%	ND	NV	0.0002	0.0027	0.0001	< 0.0001	< 0.0001	< 0.0001
Titanium [mg/L]	27-Jul-18	16:46	< 0.00005	102%	1%	NV	0.0295	0.887	0.00240	0.00671	0.00227	0.00070
Thallium [mg/L]	27-Jul-18	16:46	< 0.000005	102%	0%	94%	0.000189	0.000683	0.000017	0.000047	0.000020	0.000016
Uranium [mg/L]	27-Jul-18	16:46	< 0.000002	94%	5%	84%	0.00378	0.00465	0.00292	0.00123	0.00194	0.00272
Vanadium [mg/L]	27-Jul-18	16:46	< 0.00001	102%	1%	106%	0.00269	0.02888	0.00152	0.00148	0.00104	0.00138
Tungsten [mg/L]	27-Jul-18	16:46	< 0.00002	101%	ND	NV	0.00045	0.00221	0.00153	0.00026	0.00061	0.00143
Yttrium [mg/L]	27-Jul-18	16:46	< 0.000002	103%	3%	NV	0.000110	0.00321	0.000025	0.000031	0.000024	0.000013
Zinc [mg/L]	27-Jul-18	16:46	< 0.002	104%	1%	105%	0.029	0.038	< 0.002	0.010	< 0.002	< 0.002

NA - Not applicable
ND - Not Detected
NV - No Value

Patti Stark
Project Specialist Environmental Services, Analytical

OnLine LIMS

0001460726

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SGS Lakefield Environmental Met
Attn : Barb Bowman

Project : CALR-13531-002

15-August-2018

Date Rec. : 01 August 2018
LR Report: **CA14001-AUG18**
Reference: 13531-002-12

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 12	10: Waste Rock Unsaturated Column Week 12	11: Waste Rock Saturated Column Week 12
Sample Date & Time							Date:N/A	Date:N/A	Date:N/A
Temperature Upon Receipt [°C]	---	---	---	---	---	---	7.0	7.0	7.0
pH [no unit]	03-Aug-18	09:03	NA	100%	0%	NA	7.18	7.26	7.18
Alkalinity [mg/L as CaCO3]	03-Aug-18	09:03	< 2	102%	0%	NA	9	8	11
Conductivity [uS/cm]	03-Aug-18	09:03	< 2	98%	0%	NA	26	41	58
Acidity [mg/L as CaCO3]	03-Aug-18	09:03	2	120%	ND	NA	< 2	< 2	< 2
Redox Potential [mV]	07-Aug-18	13:12	NA	107%	1%	NA	170	181	181
Sulphate [mg/L]	10-Aug-18	13:34	< 0.2	95%	ND	96%	0.8	6.8	10.0
Mercury (total) [mg/L]	07-Aug-18	09:03	< 0.00001	75%	ND	84%	< 0.00001	< 0.00001	< 0.00001
Silver (total) [mg/L]	07-Aug-18	11:34	< 0.00005	99%	ND	94%	< 0.00005	0.00006	< 0.00005
Aluminum (total) [mg/L]	07-Aug-18	11:34	< 0.001	99%	8%	103%	1.50	8.29	0.154
Arsenic (total) [mg/L]	07-Aug-18	11:34	< 0.0002	96%	8%	93%	0.0636	0.122	0.127
Barium (total) [mg/L]	07-Aug-18	11:34	< 0.00002	101%	2%	100%	0.00434	0.0872	0.00445
Beryllium (total) [mg/L]	07-Aug-18	11:34	< 0.000007	97%	0%	98%	0.000889	0.000351	0.000007
Boron (total) [mg/L]	07-Aug-18	11:34	< 0.002	102%	1%	NV	0.004	0.005	0.005
Bismuth (total) [mg/L]	07-Aug-18	11:34	< 0.000007	99%	ND	92%	0.00135	0.000199	0.000010
Calcium (total) [mg/L]	07-Aug-18	11:34	< 0.01	99%	7%	99%	3.10	5.56	6.65
Cadmium (total) [mg/L]	07-Aug-18	11:34	< 0.000003	98%	ND	99%	0.000027	0.000045	< 0.000003
Cobalt (total) [mg/L]	07-Aug-18	11:34	< 0.000004	98%	5%	97%	0.000421	0.00614	0.000153
Chromium (total) [mg/L]	07-Aug-18	11:34	< 0.00003	99%	2%	100%	0.00329	0.0315	0.00021
Copper (total) [mg/L]	07-Aug-18	11:34	< 0.00002	99%	1%	96%	0.00321	0.0115	0.00017

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Project : CALR-13531-002
LR Report : **CA14001-AUG18**

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 12	10: Waste Rock Unsaturated Column Week 12	11: Waste Rock Saturated Column Week 12
Iron (total) [mg/L]	07-Aug-18	11:34	< 0.007	98%	4%	NV	1.22	9.67	0.033
Potassium (total) [mg/L]	07-Aug-18	11:34	< 0.003	106%	6%	95%	1.30	5.98	2.25
Lithium (total) [mg/L]	07-Aug-18	11:34	< 0.0001	98%	2%	80%	0.324	0.182	0.0528
Magnesium (total) [mg/L]	07-Aug-18	11:34	< 0.001	99%	3%	98%	0.321	4.09	0.657
Manganese (total) [mg/L]	07-Aug-18	11:34	< 0.00001	102%	5%	102%	0.152	0.154	0.0183
Molybdenum (total) [mg/L]	07-Aug-18	11:34	< 0.00001	100%	7%	98%	0.00149	0.00028	0.00027
Sodium (total) [mg/L]	07-Aug-18	11:34	< 0.01	95%	3%	95%	0.70	1.28	0.41
Nickel (total) [mg/L]	07-Aug-18	11:34	< 0.0001	100%	7%	98%	0.0016	0.0196	0.0004
Lead (total) [mg/L]	07-Aug-18	11:34	< 0.00001	98%	4%	98%	0.00251	0.00353	0.00006
Sulfur (total) [mg/L]	07-Aug-18	11:34	< 0.1	97%	ND	NV	< 0.1	1.2	2.2
Antimony (total) [mg/L]	07-Aug-18	11:34	< 0.0002	92%	ND	108%	0.0006	0.0006	0.0007
Selenium (total) [mg/L]	07-Aug-18	11:34	< 0.00004	98%	6%	94%	< 0.00004	0.00014	0.00009
Tin (total) [mg/L]	07-Aug-18	11:34	< 0.00001	97%	6%	NV	0.00383	0.00745	0.00658
Strontium (total) [mg/L]	07-Aug-18	11:34	< 0.00002	100%	2%	99%	0.0182	0.0517	0.0520
Thorium (total) [mg/L]	07-Aug-18	11:34	< 0.00001	99%	4%	NV	0.0001	0.0025	0.0001
Titanium (total) [mg/L]	07-Aug-18	11:34	< 0.00005	100%	8%	NV	0.0174	0.650	0.00235
Thallium (total) [mg/L]	07-Aug-18	11:34	< 0.000005	98%	ND	95%	0.000122	0.000546	0.000014
Uranium (total) [mg/L]	07-Aug-18	11:34	< 0.000002	100%	4%	99%	0.00301	0.00484	0.00223
Vanadium (total) [mg/L]	07-Aug-18	11:34	< 0.00001	98%	7%	93%	0.00207	0.0214	0.00122
Tungsten (total) [mg/L]	07-Aug-18	11:34	< 0.00002	103%	12%	NV	0.00025	0.00158	0.00099
Yttrium (total) [mg/L]	07-Aug-18	11:34	< 0.000002	100%	6%	NV	0.000079	0.00277	0.000023
Zinc (total) [mg/L]	07-Aug-18	11:34	< 0.002	100%	2%	108%	0.021	0.029	< 0.002

NA - Not applicable
ND - Not Detected
NV - No Value

Patti Stark
Project Specialist Environmental Services, Analytical

OnLine LIMS

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SGS Lakefield Environmental Met
Attn : Barb Bowman

Project : CALR-13531-002

24-August-2018

Date Rec. : 15 August 2018
LR Report: **CA14374-AUG18**
Reference: 13531-002-14

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 14	10: Waste Rock Unsaturated Column Week 14	11: Waste Rock Saturated Column Week 14
Sample Date & Time							Date:N/A	Date:N/A	Date:N/A
Temperature Upon Receipt [°C]	---	---	---	---	---	---	18.0	18.0	18.0
pH [no unit]	24-Aug-18	10:05	NA	101%	0%	NA	7.20	7.42	7.33
Alkalinity [mg/L as CaCO3]	24-Aug-18	10:05	< 2	106%	1%	NA	10	10	10
Conductivity [uS/cm]	24-Aug-18	10:05	< 2	98%	0%	NA	21	39	47
Acidity [mg/L as CaCO3]	24-Aug-18	10:05	< 2	100%	ND	NA	< 2	< 2	< 2
Redox Potential [mV]	16-Aug-18	13:28	NA	108%	4%	NA	175	188	161
Sulphate [mg/L]	22-Aug-18	15:13	< 0.2	97%	2%	91%	0.8	6.7	9.0
Mercury (total) [mg/L]	17-Aug-18	11:26	< 0.00001	106%	ND	89%	0.00003	< 0.00001	0.00002
Silver (total) [mg/L]	17-Aug-18	15:29	< 0.00005	100%	ND	99%	< 0.00005	< 0.00005	< 0.00005
Aluminum (total) [mg/L]	17-Aug-18	15:29	< 0.001	6%	4%	119%	1.05	0.634	0.185
Arsenic (total) [mg/L]	17-Aug-18	15:29	< 0.0002	94%	ND	99%	0.0570	0.129	0.121
Barium (total) [mg/L]	17-Aug-18	15:29	< 0.00002	103%	1%	101%	0.00348	0.00760	0.00640
Beryllium (total) [mg/L]	17-Aug-18	15:29	< 0.000007	94%	ND	98%	0.000641	0.000020	0.000007
Boron (total) [mg/L]	17-Aug-18	15:29	< 0.002	91%	2%	NV	0.005	0.006	0.008
Bismuth (total) [mg/L]	17-Aug-18	15:29	< 0.000007	97%	ND	101%	0.001167	0.000017	0.000008
Calcium (total) [mg/L]	17-Aug-18	15:29	< 0.01	100%	0%	103%	2.65	4.56	5.86
Cadmium (total) [mg/L]	17-Aug-18	15:29	7e-006	99%	ND	98%	0.000032	0.000009	0.000008
Cobalt (total) [mg/L]	17-Aug-18	15:29	< 0.000004	103%	2%	104%	0.000320	0.000312	0.000165
Chromium (total) [mg/L]	17-Aug-18	15:29	< 0.00003	103%	18%	104%	0.00326	0.00199	0.00025
Copper (total) [mg/L]	17-Aug-18	15:29	< 0.00002	104%	1%	99%	0.00247	0.00046	0.00044

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Project : CALR-13531-002
LR Report : **CA14374-AUG18**

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 14	10: Waste Rock Unsaturated Column Week 14	11: Waste Rock Saturated Column Week 14
Iron (total) [mg/L]	17-Aug-18	15:29	< 0.007	97%	0%	NV	0.805	0.584	0.044
Potassium (total) [mg/L]	17-Aug-18	15:29	< 0.003	104%	1%	103%	0.976	2.18	1.81
Lithium (total) [mg/L]	17-Aug-18	15:29	< 0.0001	93%	0%	92%	0.238	0.0595	0.0672
Magnesium (total) [mg/L]	17-Aug-18	15:29	< 0.001	95%	2%	102%	0.263	0.729	0.592
Manganese (total) [mg/L]	17-Aug-18	15:29	< 0.00001	103%	0%	97%	0.102	0.00832	0.01519
Molybdenum (total) [mg/L]	17-Aug-18	15:29	< 0.00001	106%	2%	104%	0.00127	0.00019	0.00022
Sodium (total) [mg/L]	17-Aug-18	15:29	< 0.01	97%	2%	102%	0.53	0.40	0.34
Nickel (total) [mg/L]	17-Aug-18	15:29	< 0.0001	103%	7%	102%	0.0012	0.0011	0.0005
Lead (total) [mg/L]	17-Aug-18	15:29	< 0.00001	97%	1%	101%	0.00211	0.00021	0.00015
Sulfur (total) [mg/L]	17-Aug-18	15:29	< 0.1	109%	4%	NV	< 0.1	1.7	2.7
Antimony (total) [mg/L]	17-Aug-18	15:29	< 0.0002	94%	ND	113%	0.0003	0.0005	0.0007
Selenium (total) [mg/L]	17-Aug-18	15:29	< 0.00004	99%	15%	100%	< 0.00004	0.00011	0.00009
Tin (total) [mg/L]	17-Aug-18	15:29	< 0.00001	99%	16%	NV	0.00272	0.00361	0.00762
Strontium (total) [mg/L]	17-Aug-18	15:29	< 0.00002	96%	1%	94%	0.01326	0.03066	0.04162
Thorium (total) [mg/L]	17-Aug-18	15:29	< 0.0001	101%	ND	NV	0.0001	0.0001	< 0.0001
Titanium (total) [mg/L]	17-Aug-18	15:29	< 0.00005	109%	ND	NV	0.01002	0.04017	0.00380
Thallium (total) [mg/L]	17-Aug-18	15:29	< 0.000005	95%	13%	100%	0.000086	0.000041	0.000019
Uranium (total) [mg/L]	17-Aug-18	15:29	< 0.000002	97%	3%	100%	0.002512	0.003869	0.002575
Vanadium (total) [mg/L]	17-Aug-18	15:29	< 0.00001	102%	ND	102%	0.00154	0.00252	0.00117
Tungsten (total) [mg/L]	17-Aug-18	15:29	< 0.00002	99%	ND	NV	0.00022	0.00070	0.00145
Yttrium (total) [mg/L]	17-Aug-18	15:29	< 0.000002	104%	ND	NV	0.000057	0.000157	0.000041
Zinc (total) [mg/L]	17-Aug-18	15:29	< 0.002	101%	2%	109%	0.018	0.004	< 0.002

NA - Not applicable
ND - Not Detected
NV - No Value

Patti Stark
Project Specialist Environmental Services, Analytical

OnLine LIMS

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SGS Lakefield Environmental Met
Attn : Barb Bowman

Project : CALR-13531-002

10-September-2018

Date Rec. : 28 August 2018
LR Report: **CA14823-AUG18**
Reference: 13531-002-15

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 16	10: Waste Rock Unsaturated Column Week 16	11: Waste Rock Saturated Column Week 16
Sample Date & Time							NA	NA	NA
Temperature Upon Receipt [°C]	---	---	---	---	---	---	20.0	20.0	20.0
pH [no unit]	30-Aug-18	16:08	NA	100%	1%	NA	7.27	7.38	7.41
Alkalinity [mg/L as CaCO3]	30-Aug-18	16:08	< 2	102%	ND	NA	8	8	25
Conductivity [uS/cm]	30-Aug-18	16:08	< 2	99%	0%	NA	19	35	46
Acidity [mg/L as CaCO3]	30-Aug-18	16:08	< 2	120%	0%	NA	< 2	< 2	< 2
Redox Potential [mV]	29-Aug-18	08:13	NA	103%	2%	NA	512	484	432
Sulphate [mg/L]	29-Aug-18	12:35	< 0.2	97%	1%	103%	0.6	6.2	8.8
Mercury (total) [mg/L]	04-Sep-18	11:23	< 0.00001	110%	ND	80%	< 0.00001	< 0.00001	< 0.00001
Silver (total) [mg/L]	30-Aug-18	16:03	< 0.00005	101%	ND	84%	< 0.00005	< 0.00005	< 0.00005
Aluminum (total) [mg/L]	30-Aug-18	16:03	< 0.001	104%	1%	ND	0.886	0.152	0.303
Arsenic (total) [mg/L]	30-Aug-18	16:03	< 0.0002	101%	1%	NV	0.0601	0.122	0.125
Barium (total) [mg/L]	30-Aug-18	16:03	< 0.00002	101%	1%	NV	0.00278	0.00489	0.00397
Beryllium (total) [mg/L]	30-Aug-18	16:03	< 0.000007	97%	1%	97%	0.000492	0.000007	0.000013
Boron (total) [mg/L]	30-Aug-18	16:03	< 0.002	103%	11%	NV	0.004	0.005	0.005
Bismuth (total) [mg/L]	30-Aug-18	16:03	< 0.000007	91%	3%	94%	0.000875	0.000010	< 0.000007

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0001503719

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Project : CALR-13531-002
LR Report : CA14823-AUG18

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 16	10: Waste Rock Unsaturated Column Week 16	11: Waste Rock Saturated Column Week 16
Calcium (total) [mg/L]	30-Aug-18	16:03	< 0.01	101%	2%	NV	2.47	5.64	4.35
Cadmium (total) [mg/L]	30-Aug-18	16:03	< 0.000003	99%	2%	95%	0.000016	0.000004	< 0.000003
Cobalt (total) [mg/L]	30-Aug-18	16:03	< 0.000004	102%	3%	89%	0.000275	0.000169	0.000168
Chromium (total) [mg/L]	30-Aug-18	16:03	< 0.00003	103%	1%	70%	0.00181	0.00018	0.00054
Copper (total) [mg/L]	30-Aug-18	16:03	< 0.00002	101%	0%	NV	0.00220	0.00016	0.00035
Iron (total) [mg/L]	30-Aug-18	16:03	< 0.007	101%	0%	NV	0.759	0.045	0.151
Potassium (total) [mg/L]	30-Aug-18	16:03	< 0.003	103%	1%	NV	0.815	1.46	1.63
Lithium (total) [mg/L]	30-Aug-18	16:03	< 0.0001	97%	3%	70%	0.217	0.0396	0.0479
Magnesium (total) [mg/L]	30-Aug-18	16:03	< 0.001	103%	2%	76%	0.243	0.548	0.525
Manganese (total) [mg/L]	30-Aug-18	16:03	< 0.00001	107%	2%	NV	0.0928	0.0174	0.00260
Molybdenum (total) [mg/L]	30-Aug-18	16:03	< 0.00001	103%	9%	100%	0.00137	0.00023	0.00018
Sodium (total) [mg/L]	30-Aug-18	16:03	< 0.01	98%	ND	NV	0.37	0.19	0.24
Nickel (total) [mg/L]	30-Aug-18	16:03	< 0.0001	100%	0%	81%	0.0010	0.0004	0.0006
Lead (total) [mg/L]	30-Aug-18	16:03	< 0.00001	101%	1%	NV	0.00171	0.00009	0.00014
Sulfur (total) [mg/L]	30-Aug-18	16:03	< 0.1	109%	ND	NV	< 0.1	1.9	1.1
Antimony (total) [mg/L]	30-Aug-18	16:03	< 0.0002	96%	3%	113%	0.0004	0.0007	0.0006
Selenium (total) [mg/L]	30-Aug-18	16:03	< 0.00004	103%	17%	NV	< 0.00004	0.00010	0.00011
Tin (total) [mg/L]	30-Aug-18	16:03	< 0.00001	101%	4%	NV	0.00240	0.00372	0.00278
Strontium (total) [mg/L]	30-Aug-18	16:03	< 0.00002	104%	2%	70%	0.01369	0.04408	0.03228
Thorium (total) [mg/L]	30-Aug-18	16:03	< 0.0001	100%	11%	NV	0.0001	< 0.0001	< 0.0001
Titanium (total) [mg/L]	30-Aug-18	16:03	< 0.00005	106%	0%	NV	0.0106	0.00346	0.0118
Thallium (total) [mg/L]	30-Aug-18	16:03	< 0.000005	93%	2%	87%	0.000082	0.000015	0.000021
Uranium (total) [mg/L]	30-Aug-18	16:03	< 0.000002	94%	2%	85%	0.00180	0.00100	0.00337
Vanadium (total) [mg/L]	30-Aug-18	16:03	< 0.00001	103%	ND	98%	0.00172	0.00111	0.00156
Tungsten (total) [mg/L]	30-Aug-18	16:03	< 0.00002	104%	ND	NV	0.00022	0.00076	0.00048
Yttrium (total) [mg/L]	30-Aug-18	16:03	< 0.000002	104%	2%	NV	0.000054	0.000038	0.000080
Zinc (total) [mg/L]	30-Aug-18	16:03	< 0.002	103%	0%	NV	0.013	< 0.002	< 0.002

NA - Not applicable
ND - Not Detected
NV - No Value

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OnLine LIMS

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Project : CALR-13531-002
LR Report : **CA14823-AUG18**

Patti Stark
Project Specialist Environmental Services, Analytical

OnLine LIMS

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SGS Lakefield Environmental Met
Attn : Barb Bowman

Project : CALR-13531-002

24-September-2018

Date Rec. : 12 September 2018
LR Report: **CA14286-SEP18**
Reference: 13531-002-16

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 18	10: Waste Rock Unsaturated Column Week 18	11: Waste Rock Saturated Column Week 18
Sample Date & Time							Date:N/A	Date:N/A	Date:N/A
Temperature Upon Receipt [°C]	---	---	---	---	---	---	20.0	20.0	20.0
pH [no unit]	18-Sep-18	22:16	NA	100%	0%	NA	7.14	7.06	7.18
Alkalinity [mg/L as CaCO3]	18-Sep-18	22:16	< 2	104%	0%	NA	8	7	8
Conductivity [uS/cm]	18-Sep-18	22:16	< 2	98%	0%	NA	18	32	41
Acidity [mg/L as CaCO3]	18-Sep-18	22:16	NV	110%	ND	NA	< 2	< 2	< 2
Redox Potential [mV]	13-Sep-18	14:26	NA	110%	2%	NA	531	226	247
Sulphate [mg/L]	14-Sep-18	16:36	< 0.2	97%	1%	100%	0.7	6.8	8.8
Mercury (total) [mg/L]	22-Sep-18	14:41	< 0.1	100%	ND	NV	< 0.00001	< 0.00001	< 0.00001
Silver (total) [mg/L]	18-Sep-18	16:07	< 0.00005	98%	1%	NV	< 0.00005	< 0.00005	< 0.00005
Aluminum (total) [mg/L]	18-Sep-18	16:07	< 0.001	98%	4%	NV	1.23	0.253	0.216
Arsenic (total) [mg/L]	18-Sep-18	16:07	< 0.0002	98%	2%	NV	0.0539	0.0912	0.0966
Barium (total) [mg/L]	18-Sep-18	16:07	< 0.00002	100%	3%	NV	0.00272	0.00334	0.00451
Beryllium (total) [mg/L]	18-Sep-18	16:07	< 0.000007	96%	5%	114%	0.000702	0.000013	0.000010
Boron (total) [mg/L]	18-Sep-18	16:07	< 0.002	98%	1%	NV	0.010	0.006	0.005
Bismuth (total) [mg/L]	18-Sep-18	16:07	< 0.000007	101%	3%	77%	0.000815	0.000015	< 0.000007
Calcium (total) [mg/L]	18-Sep-18	16:07	< 0.01	100%	1%	NV	2.53	4.04	5.44
Cadmium (total) [mg/L]	18-Sep-18	16:07	< 0.000003	98%	2%	NV	0.000013	< 0.000003	< 0.000003
Cobalt (total) [mg/L]	18-Sep-18	16:07	< 0.000004	99%	3%	NV	0.000227	0.000133	0.000222
Chromium (total) [mg/L]	18-Sep-18	16:07	< 0.00003	98%	5%	88%	0.00163	0.00036	0.00039
Copper (total) [mg/L]	18-Sep-18	16:07	< 0.00002	98%	0%	NV	0.00221	0.00027	0.00033

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OnLine LIMS

0001519951

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Project : CALR-13531-002
LR Report : **CA14286-SEP18**

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 18	10: Waste Rock Unsaturated Column Week 18	11: Waste Rock Saturated Column Week 18
Iron (total) [mg/L]	18-Sep-18	16:07	< 0.007	101%	1%	NV	0.725	0.095	0.112
Potassium (total) [mg/L]	18-Sep-18	16:07	< 0.003	109%	1%	NV	0.938	1.56	1.52
Lithium (total) [mg/L]	18-Sep-18	16:07	< 0.0001	94%	4%	NV	0.226	0.0477	0.0435
Magnesium (total) [mg/L]	18-Sep-18	16:07	< 0.001	101%	2%	NV	0.259	0.503	0.587
Manganese (total) [mg/L]	18-Sep-18	16:07	< 0.00001	99%	2%	NV	0.0813	0.00167	0.0207
Molybdenum (total) [mg/L]	18-Sep-18	16:07	< 0.00001	98%	2%	NV	0.00131	0.00015	0.00018
Sodium (total) [mg/L]	18-Sep-18	16:07	< 0.01	97%	4%	NV	0.57	0.31	0.32
Nickel (total) [mg/L]	18-Sep-18	16:07	< 0.0001	97%	0%	NV	0.0008	0.0004	0.0006
Lead (total) [mg/L]	18-Sep-18	16:07	< 0.00001	100%	1%	NV	0.00156	0.00013	0.00014
Sulfur (total) [mg/L]	18-Sep-18	16:07	0.233	93%	6%	NV	< 0.1	2.8	3.4
Antimony (total) [mg/L]	18-Sep-18	16:07	< 0.0002	94%	5%	75%	0.0005	0.0005	0.0006
Selenium (total) [mg/L]	18-Sep-18	16:07	< 0.00004	99%	6%	71%	< 0.00004	0.00009	0.00011
Tin (total) [mg/L]	18-Sep-18	16:07	< 0.00001	101%	3%	NV	0.00217	0.00216	0.00311
Strontium (total) [mg/L]	18-Sep-18	16:07	< 0.00002	100%	1%	96%	0.0126	0.0280	0.0398
Thorium (total) [mg/L]	18-Sep-18	16:07	< 0.0001	97%	ND	NV	< 0.0001	< 0.0001	< 0.0001
Titanium (total) [mg/L]	18-Sep-18	16:07	< 0.00005	93%	0%	NV	0.0133	0.00681	0.00720
Thallium (total) [mg/L]	18-Sep-18	16:07	< 0.000005	100%	4%	74%	0.000097	0.000017	0.000015
Uranium (total) [mg/L]	18-Sep-18	16:07	< 0.000002	94%	3%	NV	0.00168	0.00234	0.000735
Vanadium (total) [mg/L]	18-Sep-18	16:07	< 0.00001	99%	2%	NV	0.00148	0.00119	0.00100
Tungsten (total) [mg/L]	18-Sep-18	16:07	0	101%	4%	NV	0.00023	0.00033	0.00064
Yttrium (total) [mg/L]	18-Sep-18	16:07	< 0.000002	100%	3%	NV	0.000042	0.000053	0.000052
Zinc (total) [mg/L]	18-Sep-18	16:07	< 0.002	98%	2%	94%	0.013	0.002	0.003

NA - Not applicable
ND - Not Detected
NV - No Value

Patti Stark
Project Specialist Environmental Services, Analytical

OnLine LIMS

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SGS Lakefield Environmental Met
Attn : Barb Bowman

Project : CALR-13531-002

05-October-2018

Date Rec. : 25 September 2018
LR Report: **CA14638-SEP18**
Reference: 13531-002-18

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CERTIFICATE OF ANALYSIS
Final Report

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 20	10: Waste Rock Unsaturated Column Week 20	11: Waste Rock Saturated Column Week 20
Sample Date & Time							Date:N/A	Date:N/A	Date:N/A
Temperature Upon Receipt [°C]	---	---	---	---	---	---	19.0	19.0	19.0
pH [no unit]	28-Sep-18	11:48	NA	100%	1%	NA	7.00	7.08	7.03
Alkalinity [mg/L as CaCO3]	28-Sep-18	11:48	< 2	104%	ND	NA	7	7	8
Conductivity [uS/cm]	28-Sep-18	11:48	< 2	99%	0%	NA	17	30	38
Acidity [mg/L as CaCO3]	28-Sep-18	11:48	2	110%	ND	NA	< 2	< 2	< 2
Redox Potential [mV]	27-Sep-18	14:41	NA	108%	2%	NV	332	314	310
Sulphate [mg/L]	28-Sep-18	09:55	< 0.2	95%	7%	106%	0.5	6.1	7.9
Mercury (total) [mg/L]	01-Oct-18	10:59	< 0.00001	110%	ND	92%	< 0.00001	< 0.00001	< 0.00001
Silver (total) [mg/L]	02-Oct-18	16:52	< 0.00005	92%	3%	NV	< 0.00005	< 0.00005	< 0.00005
Aluminum (total) [mg/L]	02-Oct-18	16:52	< 0.001	98%	1%	NV	0.764	0.211	0.111
Arsenic (total) [mg/L]	02-Oct-18	16:52	< 0.0002	104%	2%	82%	0.0465	0.0891	0.0868
Barium (total) [mg/L]	02-Oct-18	16:52	< 0.00002	96%	4%	75%	0.00189	0.00291	0.00312
Beryllium (total) [mg/L]	02-Oct-18	16:52	< 0.000007	94%	17%	76%	0.000424	0.000013	0.000007
Boron (total) [mg/L]	02-Oct-18	16:52	< 0.002	91%	1%	NV	0.014	0.010	0.008
Bismuth (total) [mg/L]	02-Oct-18	16:52	< 0.000007	100%	6%	78%	0.000599	0.000011	0.000007
Calcium (total) [mg/L]	02-Oct-18	16:52	< 0.01	96%	4%	94%	2.06	3.86	4.79
Cadmium (total) [mg/L]	02-Oct-18	16:52	< 0.000003	94%	ND	79%	0.000014	< 0.000003	0.000005
Cobalt (total) [mg/L]	02-Oct-18	16:52	< 0.000004	96%	12%	79%	0.000154	0.000105	0.000178
Chromium (total) [mg/L]	02-Oct-18	16:52	< 0.00003	97%	ND	NV	0.00128	0.00033	0.00011
Copper (total) [mg/L]	02-Oct-18	16:52	< 0.00002	97%	5%	88%	0.00133	0.00045	0.00024

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Project : CALR-13531-002
LR Report : **CA14638-SEP18**

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 20	10: Waste Rock Unsaturated Column Week 20	11: Waste Rock Saturated Column Week 20
Iron (total) [mg/L]	02-Oct-18	16:52	< 0.007	97%	0%	NV	0.476	0.059	0.023
Potassium (total) [mg/L]	02-Oct-18	16:52	< 0.003	96%	2%	84%	0.674	1.36	1.26
Lithium (total) [mg/L]	02-Oct-18	16:52	< 0.0001	92%	4%	76%	0.176	0.0443	0.0357
Magnesium (total) [mg/L]	02-Oct-18	16:52	< 0.001	97%	2%	81%	0.197	0.462	0.484
Manganese (total) [mg/L]	02-Oct-18	16:52	< 0.00001	98%	3%	87%	0.0544	0.00143	0.02129
Molybdenum (total) [mg/L]	02-Oct-18	16:52	< 0.00001	100%	1%	83%	0.00099	0.00014	0.00017
Sodium (total) [mg/L]	02-Oct-18	16:52	< 0.01	96%	0%	NV	0.47	0.33	0.33
Nickel (total) [mg/L]	02-Oct-18	16:52	< 0.0001	97%	8%	75%	0.0006	0.0004	0.0005
Lead (total) [mg/L]	02-Oct-18	16:52	< 0.00001	95%	4%	74%	0.00095	0.00009	0.00007
Sulfur (total) [mg/L]	02-Oct-18	16:52	< 0.1	107%	2%	NV	0.8	2.3	2.8
Antimony (total) [mg/L]	02-Oct-18	16:52	< 0.0002	90%	2%	NV	0.0004	0.0005	0.0005
Selenium (total) [mg/L]	02-Oct-18	16:52	< 0.00004	104%	4%	80%	< 0.00004	0.00009	0.00008
Tin (total) [mg/L]	02-Oct-18	16:52	0	97%	4%	NV	0.00196	0.00179	0.00242
Strontium (total) [mg/L]	02-Oct-18	16:52	< 0.00002	98%	5%	91%	0.00960	0.026	0.034
Thorium (total) [mg/L]	04-Oct-18	15:26	< 0.0001	98%	ND	NV	0.0002	0.0001	< 0.0001
Titanium (total) [mg/L]	02-Oct-18	16:52	< 0.00005	98%	1%	NV	0.00742	0.00635	0.00214
Thallium (total) [mg/L]	02-Oct-18	16:52	< 0.000005	101%	10%	76%	0.000057	0.000014	0.000013
Uranium (total) [mg/L]	02-Oct-18	16:52	< 0.000002	100%	1%	NV	0.0012	0.0016	0.000444
Vanadium (total) [mg/L]	02-Oct-18	16:52	< 0.00001	95%	5%	76%	0.00116	0.00108	0.00073
Tungsten (total) [mg/L]	02-Oct-18	16:52	4e-005	101%	2%	NV	0.00028	0.00033	0.00066
Yttrium (total) [mg/L]	02-Oct-18	16:52	< 0.000002	99%	2%	NV	0.000029	0.000034	0.000022
Zinc (total) [mg/L]	02-Oct-18	16:52	< 0.002	94%	ND	105%	0.009	< 0.002	0.003

NA - Not applicable
ND - Not Detected
NV - No Value

Patti Stark
Project Specialist Environmental Services, Analytical

OnLine LIMS

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Project : CALR-13531-002

18-October-2018

SGS Lakefield Environmental Met
Attn : Barb Bowman

Date Rec. : 10 October 2018
LR Report: **CA14185-OCT18**
Reference: 13531-002-18

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CERTIFICATE OF ANALYSIS
Final Report

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 22	10: Waste Rock Unsaturated Column Week 22	11: Waste Rock Saturated Column Week 22
Sample Date & Time							Date:N/A	Date:N/A	Date:N/A
Temperature Upon Receipt [°C]	---	---	---	---	---	---	21.0	21.0	21.0
pH [no unit]	13-Oct-18	21:24	NA	100%	0%	NA	7.06	7.00	6.88
Alkalinity [mg/L as CaCO3]	13-Oct-18	21:24	< 2	102%	ND	NA	6	6	6
Conductivity [uS/cm]	13-Oct-18	21:24	< 2	98%	0%	NA	18	30	40
Acidity [mg/L as CaCO3]	13-Oct-18	21:24	< 2	96%	ND	NA	< 2	< 2	< 2
Redox Potential [mV]	11-Oct-18	10:44	NA	104%	0%	NA	329	288	352
Sulphate [mg/L]	17-Oct-18	14:23	< 0.2	94%	1%	82%	0.5	6.4	8.3
Mercury (total) [mg/L]	12-Oct-18	09:18	< 0.00001	103%	ND	NV	< 0.00001	< 0.00001	< 0.00001
Silver (total) [mg/L]	15-Oct-18	13:37	< 0.00005	105%	ND	NV	< 0.00005	< 0.00005	< 0.00005
Aluminum (total) [mg/L]	15-Oct-18	13:37	< 0.001	107%	3%	NV	0.745	0.223	0.101
Arsenic (total) [mg/L]	15-Oct-18	13:37	< 0.0002	102%	3%	94%	0.0467	0.0729	0.0819
Barium (total) [mg/L]	15-Oct-18	13:37	< 0.00002	108%	6%	115%	0.00184	0.00428	0.00375
Beryllium (total) [mg/L]	15-Oct-18	13:37	< 0.000007	104%	2%	97%	0.000348	0.000010	< 0.000007
Boron (total) [mg/L]	15-Oct-18	13:37	< 0.002	100%	0%	NV	0.005	0.004	0.004
Bismuth (total) [mg/L]	15-Oct-18	13:37	< 0.000007	103%	ND	95%	0.000740	0.000014	0.000011
Calcium (total) [mg/L]	15-Oct-18	13:37	< 0.01	100%	4%	101%	1.96	3.28	4.85
Cadmium (total) [mg/L]	15-Oct-18	13:37	< 0.000003	104%	2%	106%	0.000014	0.000005	0.000007
Cobalt (total) [mg/L]	15-Oct-18	13:37	< 0.000004	105%	3%	103%	0.000175	0.000133	0.000258
Chromium (total) [mg/L]	15-Oct-18	13:37	< 0.00003	106%	ND	109%	0.00140	0.00183	0.00016
Copper (total) [mg/L]	15-Oct-18	13:37	< 0.00002	105%	3%	103%	0.00166	0.00044	0.00034
Iron (total) [mg/L]	15-Oct-18	13:37	< 0.007	100%	3%	NV	0.550	0.099	0.036
Potassium (total) [mg/L]	15-Oct-18	13:37	< 0.003	102%	2%	85%	0.623	1.14	1.32
Lithium (total) [mg/L]	15-Oct-18	13:37	< 0.0001	108%	0%	103%	0.211	0.0444	0.0442
Magnesium (total) [mg/L]	15-Oct-18	13:37	< 0.001	100%	2%	97%	0.187	0.416	0.503
Manganese (total) [mg/L]	15-Oct-18	13:37	< 0.00001	106%	3%	115%	0.0589	0.00212	0.0326
Molybdenum (total) [mg/L]	15-Oct-18	13:37	< 0.00001	110%	5%	104%	0.00136	0.00029	0.00029
Sodium (total) [mg/L]	15-Oct-18	13:37	< 0.01	110%	3%	102%	0.36	0.23	0.28
Nickel (total) [mg/L]	15-Oct-18	13:37	< 0.0001	121%	3%	102%	0.0006	0.0003	0.0006
Lead (total) [mg/L]	15-Oct-18	13:37	< 0.00001	106%	5%	105%	0.00112	0.00015	0.00009
Sulfur (total) [mg/L]	15-Oct-18	13:37	< 0.1	90%	2%	NV	< 0.1	2.0	2.5
Antimony (total) [mg/L]	15-Oct-18	13:37	< 0.0002	100%	ND	113%	0.0005	0.0005	0.0006
Selenium (total) [mg/L]	15-Oct-18	13:37	< 0.00004	103%	3%	106%	< 0.00004	0.00008	0.00008
Tin (total) [mg/L]	15-Oct-18	13:37	< 0.00001	108%	ND	NV	0.00157	0.00178	0.00293
Strontium (total) [mg/L]	15-Oct-18	13:37	< 0.00002	107%	4%	105%	0.0111	0.0277	0.0425

OnLine LIMS

0001546666

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Project : CALR-13531-002

LR Report : **CA14185-OCT18**

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 22	10: Waste Rock Unsaturated Column Week 22	11: Waste Rock Saturated Column Week 22
Thorium (total) [mg/L]	15-Oct-18	13:37	< 0.0001	104%	9%	NV	0.0001	0.0001	< 0.0001
Titanium (total) [mg/L]	15-Oct-18	13:37	< 0.00005	108%	1%	NV	0.00740	0.00706	0.00216
Thallium (total) [mg/L]	15-Oct-18	13:37	< 0.000005	108%	6%	106%	0.000064	0.000017	0.000016
Uranium (total) [mg/L]	15-Oct-18	13:37	< 0.000002	108%	5%	118%	0.00136	0.00124	0.000422
Vanadium (total) [mg/L]	15-Oct-18	13:37	< 0.00001	104%	10%	103%	0.00147	0.00113	0.00087
Tungsten (total) [mg/L]	15-Oct-18	13:37	< 0.00002	108%	ND	NV	0.00020	0.00036	0.00062
Yttrium (total) [mg/L]	15-Oct-18	13:37	< 0.000002	107%	2%	NV	0.000030	0.000052	0.000022
Zinc (total) [mg/L]	15-Oct-18	13:37	< 0.002	107%	2%	111%	0.010	0.003	< 0.002

NA - Not applicable
ND - Not Detected
NV - No Value

Patti Stark
Project Specialist Environmental Services, Analytical

OnLine LIMS

0001546666

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SGS Lakefield Environmental Met
Attn : Barb Bowman

Project : CALR-13531-002

31-October-2018

Date Rec. : 23 October 2018
LR Report: **CA14545-OCT18**
Reference: 13531-002-19

Copy: #1

CERTIFICATE OF ANALYSIS
Final Report

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 24	10: Waste Rock Unsaturated Column Week 24	11: Waste Rock Saturated Column Week 24
Sample Date & Time							Date:N/A	Date:N/A	Date:N/A
Temperature Upon Receipt [°C]	---	---	---	---	---	---	19.0	19.0	19.0
pH [no unit]	25-Oct-18	15:27	NA	100%	0%	NA	7.01	6.94	7.00
Alkalinity [mg/L as CaCO3]	25-Oct-18	15:27	< 2	102%	ND	NA	7	6	6
Conductivity [uS/cm]	25-Oct-18	15:27	< 2	99%	0%	NA	16	28	34
Acidity [mg/L as CaCO3]	25-Oct-18	15:27	< 2	100%	0%	NA	< 2	< 2	< 2
Redox Potential [mV]	25-Oct-18	10:46	NA	104%	3%	NA	229	254	218
Sulphate [mg/L]	30-Oct-18	10:12	< 0.2	96%	ND	95%	0.6	6.6	8.2
Mercury (total) [mg/L]	26-Oct-18	15:53	< 0.00001	97%	ND	105%	0.00001	< 0.00001	< 0.00001
Silver (total) [mg/L]	30-Oct-18	10:30	< 0.00005	98%	4%	83%	< 0.00005	< 0.00005	< 0.00005
Aluminum (total) [mg/L]	30-Oct-18	10:30	< 0.001	99%	ND	NV	0.749	0.156	0.053
Arsenic (total) [mg/L]	30-Oct-18	10:30	< 0.0002	101%	3%	NV	0.0424	0.0584	0.0528
Barium (total) [mg/L]	30-Oct-18	10:30	< 0.00002	101%	2%	NV	0.00209	0.00272	0.00277
Beryllium (total) [mg/L]	30-Oct-18	10:30	< 0.000007	99%	ND	87%	0.000559	< 0.000007	< 0.000007
Boron (total) [mg/L]	30-Oct-18	10:30	< 0.002	98%	5%	NV	0.004	< 0.002	< 0.002
Bismuth (total) [mg/L]	30-Oct-18	10:30	< 0.000007	93%	ND	121%	0.000662	0.000050	0.000033
Calcium (total) [mg/L]	30-Oct-18	10:30	< 0.01	99%	4%	NV	2.06	3.11	3.78

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0001561411

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Project : CALR-13531-002
LR Report : CA14545-OCT18

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 24	10: Waste Rock Unsaturated Column Week 24	11: Waste Rock Saturated Column Week 24
Cadmium (total) [mg/L]	30-Oct-18	10:30	< 0.000003	98%	19%	91%	0.000020	0.000009	0.000004
Cobalt (total) [mg/L]	30-Oct-18	10:30	< 0.000004	99%	2%	NV	0.000169	0.000123	0.000230
Chromium (total) [mg/L]	30-Oct-18	10:30	< 0.00003	101%	ND	100%	0.00125	0.00029	0.00021
Copper (total) [mg/L]	30-Oct-18	10:30	< 0.00002	100%	5%	NV	0.00139	0.00047	0.00012
Iron (total) [mg/L]	30-Oct-18	10:30	< 0.007	95%	1%	NV	0.543	0.072	0.013
Potassium (total) [mg/L]	30-Oct-18	10:30	< 0.003	97%	4%	NV	0.603	0.973	0.968
Lithium (total) [mg/L]	30-Oct-18	10:30	< 0.0001	100%	0%	111%	0.180	0.0373	0.0312
Magnesium (total) [mg/L]	30-Oct-18	10:30	< 0.001	98%	2%	89%	0.199	0.407	0.412
Manganese (total) [mg/L]	30-Oct-18	10:30	< 0.00001	103%	1%	86%	0.0570	0.00185	0.0322
Molybdenum (total) [mg/L]	30-Oct-18	10:30	< 0.00001	98%	0%	NV	0.00109	0.00007	0.00011
Sodium (total) [mg/L]	30-Oct-18	10:30	< 0.01	102%	ND	NV	0.11	< 0.01	< 0.01
Nickel (total) [mg/L]	30-Oct-18	10:30	< 0.0001	91%	1%	84%	0.0007	0.0004	0.0006
Lead (total) [mg/L]	30-Oct-18	10:30	< 0.00001	98%	8%	79%	0.00143	0.00030	0.00018
Sulfur (total) [mg/L]	30-Oct-18	10:30	< 0.1	101%	4%	NV	< 0.1	1.0	1.3
Antimony (total) [mg/L]	30-Oct-18	10:30	< 0.0002	107%	5%	NV	0.0005	0.0005	0.0005
Selenium (total) [mg/L]	30-Oct-18	10:30	< 0.00004	97%	3%	NV	< 0.00004	0.00006	0.00009
Tin (total) [mg/L]	30-Oct-18	10:30	< 0.00001	97%	ND	NV	0.00146	0.00149	0.00206
Strontium (total) [mg/L]	30-Oct-18	10:30	< 0.00002	106%	1%	NV	0.0107	0.0265	0.0333
Thorium (total) [mg/L]	30-Oct-18	10:30	< 0.0001	94%	ND	NV	< 0.0001	< 0.0001	< 0.0001
Titanium (total) [mg/L]	30-Oct-18	10:30	< 0.00005	97%	ND	NV	0.00959	0.00537	0.00092
Thallium (total) [mg/L]	30-Oct-18	10:30	< 0.000005	92%	9%	78%	0.000059	0.000011	0.000007
Uranium (total) [mg/L]	30-Oct-18	10:30	< 0.000002	90%	3%	NV	0.00124	0.000660	0.000235
Vanadium (total) [mg/L]	30-Oct-18	10:30	< 0.00001	101%	7%	99%	0.00129	0.00087	0.00054
Tungsten (total) [mg/L]	30-Oct-18	10:30	< 0.00002	99%	2%	NV	0.00039	0.00038	0.00055
Yttrium (total) [mg/L]	30-Oct-18	10:30	< 0.000002	102%	8%	NV	0.000045	0.000054	0.000010
Zinc (total) [mg/L]	30-Oct-18	10:30	< 0.002	101%	20%	NV	0.011	0.005	0.003

NA - Not applicable
ND - Not Detected
NV - No Value

OnLine LIMS

0001561411

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Project : CALR-13531-002
LR Report : **CA14545-OCT18**

Patti Stark
Project Specialist Environmental Services, Analytical

OnLine LIMS

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SGS Lakefield Environmental Met
Attn : Barb Bowman

Project : CA20M-00000-110-13531-02

19-November-2018

Date Rec. : 07 November 2018
LR Report: **CA15144-NOV18**
Reference: 13531-002-20

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 26	10: Waste Rock Unsaturated Column Week 26	11: Waste Rock Saturated Column Wekk 26
Sample Date & Time							N/A	N/A	N/A
Temperature Upon Receipt [°C]	---	---	---	---	---	---	18.0	18.0	18.0
pH [no unit]	12-Nov-18	11:55	NA	100%	2%	NA	6.73	6.76	7.04
Alkalinity [mg/L as CaCO3]	12-Nov-18	11:55	< 2	102%	ND	NA	5	5	7
Acidity [mg/L as CaCO3]	12-Nov-18	11:55	< 2	110%	0%	NA	< 2	< 2	< 2
Conductivity [uS/cm]	12-Nov-18	11:55	< 2	98%	2%	NA	13	28	36
Sulphate [mg/L]	13-Nov-18	16:15	< 0.2	97%	19%	103%	0.4	5.3	7.6
EMF [mV]	08-Nov-18	10:45	NA	102%	1%	NA	210	148	198
Mercury (total) [mg/L]	15-Nov-18	07:13	< 0.00001	NV	ND	125%	< 0.00001	< 0.00001	< 0.00001
Silver (total) [mg/L]	13-Nov-18	16:48	< 0.00005	103%	ND	80%	< 0.00005	< 0.00005	< 0.00005
Aluminum (total) [mg/L]	13-Nov-18	16:48	< 0.001	103%	0%	NV	0.837	0.313	0.048
Arsenic (total) [mg/L]	13-Nov-18	16:48	< 0.0002	105%	ND	73%	0.0451	0.0568	0.0498
Barium (total) [mg/L]	13-Nov-18	16:48	< 0.00002	107%	3%	NV	0.00225	0.00407	0.00348
Beryllium (total) [mg/L]	13-Nov-18	16:48	< 0.000007	101%	ND	76%	0.000364	0.000014	< 0.000007
Boron (total) [mg/L]	13-Nov-18	16:48	< 0.002	98%	8%	NV	0.002	< 0.002	< 0.002
Bismuth (total) [mg/L]	13-Nov-18	16:48	< 0.000007	106%	ND	NV	0.000640	0.000022	0.000016
Calcium (total) [mg/L]	13-Nov-18	16:48	< 0.01	104%	8%	112%	1.92	3.10	4.59
Cadmium (total) [mg/L]	13-Nov-18	16:48	< 0.000003	103%	ND	78%	0.000011	< 0.000003	0.000005
Cobalt (total) [mg/L]	13-Nov-18	16:48	< 0.000004	104%	2%	NV	0.000194	0.000258	0.000316
Chromium (total) [mg/L]	13-Nov-18	16:48	< 0.00003	105%	6%	114%	0.00099	0.00062	0.00011
Copper (total) [mg/L]	13-Nov-18	16:48	< 0.00002	102%	ND	NV	0.00147	0.00051	0.00016

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OnLine LIMS
0001580836

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Project : CA20M-00000-110-13531-02
LR Report : **CA15144-NOV18**

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 26	10: Waste Rock Unsaturated Column Week 26	11: Waste Rock Saturated Column Wekk 26
Iron (total) [mg/L]	13-Nov-18	16:48	< 0.007	104%	4%	NV	0.546	0.171	0.008
Potassium (total) [mg/L]	13-Nov-18	16:48	< 0.003	102%	2%	85%	0.551	1.03	1.16
Lithium (total) [mg/L]	13-Nov-18	16:48	< 0.0001	101%	14%	80%	0.181	0.0433	0.0410
Magnesium (total) [mg/L]	13-Nov-18	16:48	< 0.001	105%	5%	110%	0.173	0.401	0.435
Manganese (total) [mg/L]	13-Nov-18	16:48	< 0.00001	106%	2%	NV	0.0677	0.00397	0.0474
Molybdenum (total) [mg/L]	13-Nov-18	16:48	< 0.00001	103%	ND	105%	0.00083	0.00009	0.00011
Sodium (total) [mg/L]	13-Nov-18	16:48	< 0.01	99%	ND	NV	0.36	0.22	0.23
Nickel (total) [mg/L]	13-Nov-18	16:48	< 0.0001	103%	6%	84%	0.0007	0.0008	0.0007
Lead (total) [mg/L]	13-Nov-18	16:48	< 0.00001	100%	ND	76%	0.00122	0.00018	0.00005
Antimony (total) [mg/L]	13-Nov-18	16:48	< 0.0002	90%	ND	101%	0.0002	< 0.0002	0.0003
Selenium (total) [mg/L]	13-Nov-18	16:48	< 0.00004	103%	ND	85%	< 0.00004	0.00006	0.00006
Tin (total) [mg/L]	13-Nov-18	16:48	< 0.00001	103%	ND	NV	0.00129	0.00127	0.00191
Strontium (total) [mg/L]	13-Nov-18	16:48	< 0.00002	105%	6%	98%	0.0101	0.0235	0.0358
Sulfur (total) [mg/L]	16-Nov-18	09:12	< 0.1	105%	10%	NV	< 0.1	2.0	2.9
Thorium (total) [mg/L]	13-Nov-18	16:48	< 0.0001	102%	ND	NV	< 0.0001	< 0.0001	< 0.0001
Titanium (total) [mg/L]	13-Nov-18	16:48	< 0.00005	102%	9%	NV	0.00577	0.0122	0.00040
Thallium (total) [mg/L]	13-Nov-18	16:48	< 0.000005	105%	ND	80%	0.000052	0.000015	0.000008
Uranium (total) [mg/L]	13-Nov-18	16:49	< 0.000002	107%	16%	80%	0.00136	0.000546	0.000193
Vanadium (total) [mg/L]	13-Nov-18	16:49	< 0.00001	103%	ND	110%	0.00135	0.00105	0.00050
Tungsten (total) [mg/L]	13-Nov-18	16:49	< 0.00002	102%	ND	NV	0.00008	0.00016	0.00031
Yttrium (total) [mg/L]	13-Nov-18	16:49	< 0.000002	105%	1%	NV	0.000034	0.000086	0.000005
Zinc (total) [mg/L]	13-Nov-18	16:49	< 0.002	101%	ND	NV	0.011	< 0.002	< 0.002

NA - Not applicable
ND - Not Detected
NV - No Value

Patti Stark
Project Specialist Environmental Services, Analytical

OnLine LIMS

0001580836

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SGS Lakefield Environmental Met
Attn : Barb Bowman

Project : CA20M-00000-110-13531-02

27-November-2018

Date Rec. : 20 November 2018
LR Report: **CA14417-NOV18**
Reference: 13531-002-21

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 28	10: Waste Rock Unsaturated Column Week 28	11: Waste Rock Saturated Column Wekk 28
Sample Date & Time							NA	NA	NA
Temperature Upon Receipt [°C]	---	---	---	---	---	---	19.0	19.0	19.0
pH [no unit]	23-Nov-18	17:46	NA	101%	0%	NA	6.69	6.95	6.49
Alkalinity [mg/L as CaCO3]	23-Nov-18	17:46	< 2	102%	ND	NA	4	6	4
Acidity [mg/L as CaCO3]	23-Nov-18	17:46	< 2	120%	ND	NA	< 2	< 2	< 2
Conductivity [uS/cm]	23-Nov-18	17:46	< 2	96%	0%	NA	26	14	37
Sulphate [mg/L]	27-Nov-18	11:26	< 0.2	95%	0%	100%	6.3	0.5	8.1
EMF [mV]	21-Nov-18	10:29	NA	103%	2%	NA	92	107	79
Mercury (total) [mg/L]	23-Nov-18	07:51	< 0.00001	110%	ND	95%	< 0.00001	< 0.00001	< 0.00001
Silver (total) [mg/L]	26-Nov-18	11:48	< 0.00005	99%	1%	NV	< 0.00005	< 0.00005	< 0.00005
Aluminum (total) [mg/L]	26-Nov-18	11:48	< 0.001	97%	0%	NV	0.198	0.683	0.053
Arsenic (total) [mg/L]	26-Nov-18	11:48	< 0.0002	100%	0%	NV	0.0558	0.0496	0.0457
Barium (total) [mg/L]	26-Nov-18	11:48	< 0.00002	102%	2%	NV	0.00326	0.00195	0.00356
Beryllium (total) [mg/L]	26-Nov-18	11:48	< 0.000007	98%	5%	3%	0.000011	0.000386	< 0.000007
Boron (total) [mg/L]	26-Nov-18	11:48	< 0.002	90%	8%	NV	0.003	0.003	0.002
Bismuth (total) [mg/L]	26-Nov-18	11:48	< 0.000007	101%	13%	NV	< 0.000007	0.000498	< 0.000007
Calcium (total) [mg/L]	26-Nov-18	11:48	< 0.01	97%	4%	NV	3.14	2.00	4.11
Cadmium (total) [mg/L]	26-Nov-18	11:48	< 0.000003	100%	5%	NV	< 0.000003	0.000184	0.000008
Cobalt (total) [mg/L]	26-Nov-18	11:48	< 0.000004	98%	0%	117%	0.000217	0.000199	0.000460
Chromium (total) [mg/L]	26-Nov-18	11:48	< 0.00003	97%	1%	NV	0.00045	0.00125	0.00006
Copper (total) [mg/L]	26-Nov-18	11:48	< 0.00002	96%	1%	NV	0.00047	0.00153	0.00024

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OnLine LIMS

0001589577

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
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Project : CA20M-00000-110-13531-02
LR Report : **CA14417-NOV18**

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 28	10: Waste Rock Unsaturated Column Week 28	11: Waste Rock Saturated Column Wekk 28
Iron (total) [mg/L]	26-Nov-18	11:48	< 0.007	100%	1%	NV	0.138	0.595	0.033
Potassium (total) [mg/L]	26-Nov-18	11:48	< 0.003	103%	1%	99%	0.992	0.549	1.01
Lithium (total) [mg/L]	26-Nov-18	11:48	< 0.0001	97%	6%	NV	0.0405	0.169	0.0367
Magnesium (total) [mg/L]	26-Nov-18	11:48	< 0.001	96%	0%	4%	0.443	0.186	0.451
Manganese (total) [mg/L]	26-Nov-18	11:48	0	101%	0%	80%	0.00528	0.0647	0.0606
Molybdenum (total) [mg/L]	26-Nov-18	11:48	< 0.00001	101%	2%	NV	0.00013	0.00112	0.00016
Sodium (total) [mg/L]	26-Nov-18	11:48	< 0.01	94%	0%	NV	0.35	0.34	0.25
Nickel (total) [mg/L]	26-Nov-18	11:48	< 0.0001	95%	1%	NV	0.0005	0.0005	0.0009
Lead (total) [mg/L]	26-Nov-18	11:48	< 0.00001	100%	5%	129%	0.00018	0.00123	0.00015
Antimony (total) [mg/L]	26-Nov-18	11:48	< 0.0002	100%	5%	77%	0.0004	0.0004	0.0004
Selenium (total) [mg/L]	26-Nov-18	11:48	< 0.00004	99%	9%	NV	0.00007	< 0.00004	0.00008
Tin (total) [mg/L]	26-Nov-18	11:48	< 0.00001	98%	7%	NV	0.00105	0.00113	0.00148
Strontium (total) [mg/L]	26-Nov-18	11:48	< 0.00002	101%	1%	NV	0.0253	0.0104	0.0341
Sulfur (total) [mg/L]	26-Nov-18	11:48	< 0.1	102%	2%	NV	2.1	< 0.1	2.5
Thorium (total) [mg/L]	26-Nov-18	11:48	< 0.0001	100%	7%	NV	< 0.0001	< 0.0001	< 0.0001
Titanium (total) [mg/L]	26-Nov-18	11:48	< 0.00005	101%	0%	NV	0.00994	0.00781	0.00330
Thallium (total) [mg/L]	26-Nov-18	11:48	< 0.000005	102%	2%	NV	0.000016	0.000058	0.000008
Uranium (total) [mg/L]	26-Nov-18	11:48	< 0.000002	103%	6%	114%	0.000439	0.00135	0.000183
Vanadium (total) [mg/L]	26-Nov-18	11:48	< 0.00001	97%	3%	NV	0.00094	0.00148	0.00047
Tungsten (total) [mg/L]	26-Nov-18	11:48	< 0.00002	99%	7%	NV	0.00023	0.00018	0.00036
Yttrium (total) [mg/L]	26-Nov-18	11:48	0	101%	0%	NV	0.000066	0.000036	0.000019
Zinc (total) [mg/L]	26-Nov-18	11:48	< 0.002	99%	1%	NV	< 0.002	0.008	< 0.002

NA - Not applicable
ND - Not Detected
NV - No Value

Patti Stark
Project Specialist Environmental Services, Analytical

OnLine LIMS

0001589577

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SGS Canada Inc.
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SGS Lakefield Environmental Met
Attn : Barb Bowman

Project : CA20M-00000-110-13531-02

13-December-2018

Date Rec. : 05 December 2018
LR Report: **CA14093-DEC18**
Reference: 13531-002-22

Copy: #1

CERTIFICATE OF ANALYSIS
Final Report

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 30	10: Waste Rock Unsaturated Column Week 30	11: Waste Rock Saturated Column Week 30
Sample Date & Time							NA	NA	NA
Temperature Upon Receipt [°C]	---	---	---	---	---	---	17.0	17.0	17.0
pH [no unit]	11-Dec-18	11:12	NA	100%	1%	NA	6.69	6.48	6.25
Alkalinity [mg/L as CaCO3]	11-Dec-18	11:12	< 2	104%	0%	NA	5	4	4
Acidity [mg/L as CaCO3]	11-Dec-18	11:12	< 2	98%	ND	NA	< 2	< 2	< 2
Conductivity [uS/cm]	11-Dec-18	11:12	< 2	98%	0%	NA	22	26	33
Sulphate [mg/L]	12-Dec-18	14:23	< 0.2	95%	10%	96%	0.5	6.0	7.7
EMF [mV]	07-Dec-18	18:02	NA	103%	1%	NA	136	203	170
Mercury (total) [mg/L]	07-Dec-18	12:38	< 0.00001	114%	ND	118%	< 0.00001	< 0.00001	< 0.00001
Silver (total) [mg/L]	11-Dec-18	16:55	< 0.00005	104%	ND	84%	< 0.00005	< 0.00005	< 0.00005
Aluminum (total) [mg/L]	11-Dec-18	16:55	< 0.001	103%	0%	113%	0.081	0.207	0.512
Arsenic (total) [mg/L]	11-Dec-18	16:55	< 0.0002	103%	ND	96%	0.0343	0.0424	0.0420
Barium (total) [mg/L]	11-Dec-18	16:55	< 0.00002	100%	1%	92%	0.00365	0.00331	0.00118
Beryllium (total) [mg/L]	11-Dec-18	16:55	< 0.000007	103%	2%	99%	0.000008	0.000014	0.000268
Boron (total) [mg/L]	11-Dec-18	16:55	< 0.002	105%	8%	NV	< 0.002	< 0.002	< 0.002
Bismuth (total) [mg/L]	11-Dec-18	16:55	< 0.000007	97%	ND	79%	< 0.000007	< 0.000007	0.000333
Calcium (total) [mg/L]	11-Dec-18	16:55	< 0.01	101%	1%	95%	3.78	2.93	1.69

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OnLine LIMS
0001604729

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Project : CA20M-00000-110-13531-02
LR Report : CA14093-DEC18

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 30	10: Waste Rock Unsaturated Column Week 30	11: Waste Rock Saturated Column Week 30
Cadmium (total) [mg/L]	11-Dec-18	16:55	< 0.000003	103%	4%	95%	0.000010	0.000004	0.000008
Cobalt (total) [mg/L]	11-Dec-18	16:55	< 0.000004	103%	1%	95%	0.000465	0.000215	0.000086
Chromium (total) [mg/L]	11-Dec-18	16:55	< 0.00003	104%	ND	96%	0.00026	0.00052	0.00064
Copper (total) [mg/L]	11-Dec-18	16:55	< 0.00002	105%	5%	85%	0.00029	0.00039	0.00121
Iron (total) [mg/L]	11-Dec-18	16:55	< 0.007	96%	1%	NV	0.047	0.135	0.291
Potassium (total) [mg/L]	11-Dec-18	16:55	< 0.003	100%	1%	89%	0.876	0.886	0.428
Lithium (total) [mg/L]	11-Dec-18	16:55	< 0.0001	99%	1%	91%	0.0405	0.0473	0.175
Magnesium (total) [mg/L]	11-Dec-18	16:55	< 0.001	97%	0%	91%	0.380	0.398	0.163
Manganese (total) [mg/L]	11-Dec-18	16:55	< 0.00001	107%	3%	99%	0.0658	0.0100	0.0324
Molybdenum (total) [mg/L]	11-Dec-18	16:55	< 0.00001	99%	4%	94%	0.00009	0.00008	0.00075
Sodium (total) [mg/L]	11-Dec-18	16:55	< 0.01	96%	1%	88%	0.45	0.41	0.49
Nickel (total) [mg/L]	11-Dec-18	16:55	< 0.0001	104%	3%	93%	0.0013	0.0006	0.0004
Lead (total) [mg/L]	11-Dec-18	16:55	< 0.00001	101%	2%	95%	0.00013	0.00010	0.00063
Antimony (total) [mg/L]	11-Dec-18	16:55	< 0.0002	100%	ND	112%	0.0003	0.0003	0.0003
Selenium (total) [mg/L]	11-Dec-18	16:55	< 0.00004	103%	0%	95%	0.00006	0.00005	< 0.00004
Tin (total) [mg/L]	11-Dec-18	16:55	< 0.00001	98%	32%	NV	0.00122	0.00085	0.00108
Strontium (total) [mg/L]	11-Dec-18	16:55	< 0.00002	107%	1%	98%	0.0334	0.0252	0.00854
Sulfur (total) [mg/L]	11-Dec-18	16:55	< 0.1	93%	2%	NV	1.9	1.2	< 0.1
Thorium (total) [mg/L]	11-Dec-18	16:55	< 0.0001	96%	ND	NV	< 0.0001	< 0.0001	< 0.0001
Titanium (total) [mg/L]	11-Dec-18	16:55	< 0.00005	96%	ND	NV	0.00305	0.0100	0.00530
Thallium (total) [mg/L]	11-Dec-18	16:55	< 0.000005	101%	11%	92%	0.000011	0.000014	0.000036
Uranium (total) [mg/L]	11-Dec-18	16:55	< 0.000002	101%	2%	94%	0.000129	0.000275	0.000710
Vanadium (total) [mg/L]	11-Dec-18	16:55	< 0.00001	104%	18%	92%	0.00039	0.00077	0.00104
Tungsten (total) [mg/L]	11-Dec-18	16:55	< 0.00002	99%	ND	NV	0.00031	0.00019	0.00009
Yttrium (total) [mg/L]	11-Dec-18	16:55	< 0.000002	105%	4%	NV	0.000027	0.000057	0.000019
Zinc (total) [mg/L]	11-Dec-18	16:55	< 0.002	100%	3%	107%	0.002	< 0.002	0.006

NA - Not applicable
ND - Not Detected
NV - No Value

OnLine LIMS

0001604729

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Project : CA20M-00000-110-13531-02
LR Report : **CA14093-DEC18**

Patti Stark
Project Specialist,
Environment, Health & Safety

OnLine LIMS

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SGS Lakefield Environmental Met
Attn : Barb Bowman

Project : CA20M-00000-110-13531-02

21-December-2018

Date Rec. : 18 December 2018
LR Report: **CA14428-DEC18**

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 32	10: Waste Rock Unsaturated Column Week 32	11: Waste Rock Saturated Column Week 32
Sample Date & Time							NA	NA	NA
Temperature Upon Receipt [°C]	---	---	---	---	---	---	18.0	18.0	18.0
pH [no unit]	20-Dec-18	14:13	NA	100%	2%	NA	6.58	6.36	6.48
Alkalinity [mg/L as CaCO3]	20-Dec-18	14:13	< 2	104%	ND	NA	6	5	5
Acidity [mg/L as CaCO3]	20-Dec-18	14:13	3	120%	ND	NA	< 2	< 2	< 2
Conductivity [uS/cm]	20-Dec-18	14:13	< 2	96%	0%	NA	14	28	32
Sulphate [mg/L]	21-Dec-18	15:06	< 0.2	96%	9%	97%	0.5	5.0	7.0
EMF [mV]	21-Dec-18	11:53	NA	108%	3%	NA	401	372	357
Mercury (total) [mg/L]	20-Dec-18	11:15	< 0.00001	120%	ND	104%	< 0.00001	< 0.00001	< 0.00001
Silver (total) [mg/L]	20-Dec-18	14:17	< 0.00005	105%	ND	108%	< 0.00005	< 0.00005	< 0.00005
Aluminum (total) [mg/L]	20-Dec-18	14:17	< 0.001	103%	10%	NV	0.565	0.120	0.026
Arsenic (total) [mg/L]	20-Dec-18	14:17	< 0.0002	106%	14%	81%	0.0440	0.0450	0.0322
Barium (total) [mg/L]	20-Dec-18	14:17	< 0.00002	104%	13%	NV	0.00121	0.00251	0.00324
Beryllium (total) [mg/L]	20-Dec-18	14:17	< 0.000007	102%	ND	77%	0.000278	0.000008	< 0.000007
Boron (total) [mg/L]	20-Dec-18	14:17	< 0.002	107%	5%	NV	0.005	0.004	0.004
Bismuth (total) [mg/L]	20-Dec-18	14:17	< 0.000007	93%	10%	NV	0.000330	0.000012	< 0.000007
Calcium (total) [mg/L]	20-Dec-18	14:17	< 0.01	107%	13%	NV	1.75	2.96	3.92
Cadmium (total) [mg/L]	20-Dec-18	14:17	< 0.000003	101%	3%	82%	0.000007	0.000008	0.000008
Cobalt (total) [mg/L]	20-Dec-18	14:17	< 0.000004	103%	19%	71%	0.000091	0.000210	0.000548
Chromium (total) [mg/L]	20-Dec-18	14:17	< 0.00003	102%	8%	NV	0.00069	0.00020	0.00014
Copper (total) [mg/L]	20-Dec-18	14:17	< 0.00002	102%	11%	NV	0.00112	0.00026	0.00016
Iron (total) [mg/L]	20-Dec-18	14:17	< 0.007	104%	7%	NV	0.300	0.043	0.012

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OnLine LIMS
0001615416

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Project : CA20M-00000-110-13531-02
LR Report : **CA14428-DEC18**

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 32	10: Waste Rock Unsaturated Column Week 32	11: Waste Rock Saturated Column Week 32
Potassium (total) [mg/L]	20-Dec-18	14:17	< 0.003	106%	13%	NV	0.429	0.872	0.876
Lithium (total) [mg/L]	20-Dec-18	14:17	< 0.0001	102%	10%	NV	0.162	0.0429	0.0416
Magnesium (total) [mg/L]	20-Dec-18	14:17	< 0.001	110%	8%	NV	0.161	0.376	0.390
Manganese (total) [mg/L]	20-Dec-18	14:17	< 0.00001	106%	15%	NV	0.0310	0.0118	0.0756
Molybdenum (total) [mg/L]	20-Dec-18	14:17	< 0.00001	97%	26%	80%	0.00026	< 0.00001	< 0.00001
Sodium (total) [mg/L]	20-Dec-18	14:17	< 0.01	100%	7%	NV	0.35	0.24	0.26
Nickel (total) [mg/L]	20-Dec-18	14:17	< 0.0001	103%	12%	109%	0.0004	0.0007	0.0015
Lead (total) [mg/L]	20-Dec-18	14:17	< 0.00001	102%	ND	NV	0.00060	0.00006	< 0.00001
Antimony (total) [mg/L]	20-Dec-18	14:17	< 0.0002	91%	ND	NV	< 0.0002	< 0.0002	< 0.0002
Selenium (total) [mg/L]	20-Dec-18	14:17	< 0.00004	100%	ND	71%	< 0.00004	0.00008	0.00008
Tin (total) [mg/L]	20-Dec-18	14:17	< 0.00001	104%	ND	NV	0.00162	0.00158	0.00192
Strontium (total) [mg/L]	20-Dec-18	14:17	< 0.00002	105%	12%	NV	0.00829	0.0246	0.0334
Sulfur (total) [mg/L]	20-Dec-18	14:17	< 0.1	103%	19%	NV	0.4	2.3	3.0
Thorium (total) [mg/L]	20-Dec-18	14:17	< 0.0001	92%	ND	NV	< 0.0001	< 0.0001	< 0.0001
Titanium (total) [mg/L]	20-Dec-18	14:17	< 0.00005	99%	16%	NV	0.00633	0.00375	0.00065
Thallium (total) [mg/L]	20-Dec-18	14:17	< 0.000005	102%	106%	74%	0.000052	0.000012	0.000011
Uranium (total) [mg/L]	20-Dec-18	14:17	< 0.000002	102%	ND	NV	0.000727	0.000259	0.000115
Vanadium (total) [mg/L]	20-Dec-18	14:17	< 0.00001	102%	ND	NV	0.00113	0.00061	0.00030
Tungsten (total) [mg/L]	20-Dec-18	14:17	< 0.00002	103%	ND	NV	0.00007	0.00014	0.00022
Yttrium (total) [mg/L]	20-Dec-18	14:17	< 0.000002	105%	11%	NV	0.000019	0.000033	0.000008
Zinc (total) [mg/L]	20-Dec-18	14:17	< 0.002	103%	15%	NV	0.006	0.003	< 0.002

NA - Not applicable
ND - Not Detected
NV - No Value

Patti Stark
Project Specialist,
Environment, Health & Safety

OnLine LIMS

0001615416

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SGS Lakefield Environmental Met
Attn : Barb Bowman

Project : CA20M-00000-110-13531-02

10-January-2019

Date Rec. : 02 January 2019
LR Report: **CA14019-JAN19**
Reference: 13531-002-24

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CERTIFICATE OF ANALYSIS
Final Report

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 34	10: Waste Rock Unsaturated Column Week 34	11: Waste Rock Saturated Column Week 34	12: EnviroMet DI Water
Sample Date & Time							NA	NA	NA	NA
Temperature Upon Receipt [°C]	---	---	---	---	---	---	17.0	17.0	17.0	17.0
pH [no unit]	04-Jan-19	12:31	NA	100%	0%	NA	6.81	7.40	7.15	7.30
Alkalinity [mg/L as CaCO3]	04-Jan-19	12:31	< 2	110%	0%	NA	10	63	45	71
Acidity [mg/L as CaCO3]	04-Jan-19	12:31	2	100%	ND	NA	< 2	< 2	< 2	< 2
Conductivity [uS/cm]	04-Jan-19	12:31	< 2	98%	0%	NA	63	251	214	255
Sulphate [mg/L]	09-Jan-19	09:13	< 0.2	94%	NV	NV	9.0	34	33	28
EMF [mV]	04-Jan-19	07:38	NA	102%	2%	NV	208	198	209	235
Mercury (total) [mg/L]	07-Jan-19	10:48	< 0.00001	98%	ND	122%	< 0.00001	< 0.00001	< 0.00001	0.00002
Silver (total) [mg/L]	04-Jan-19	16:22	< 0.00005	100%	ND	102%	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Aluminum (total) [mg/L]	04-Jan-19	16:22	< 0.001	104%	4%	NV	0.219	0.081	0.014	0.019
Arsenic (total) [mg/L]	04-Jan-19	16:22	< 0.0002	102%	3%	106%	0.0383	0.0324	0.0218	< 0.0002
Barium (total) [mg/L]	04-Jan-19	16:22	< 0.00002	105%	8%	NV	0.00085	0.0200	0.0228	0.0271
Beryllium (total) [mg/L]	04-Jan-19	16:22	< 0.000007	102%	15%	101%	0.000127	< 0.000007	< 0.000007	< 0.000007
Boron (total) [mg/L]	04-Jan-19	16:22	< 0.002	98%	4%	NV	0.004	0.009	0.009	0.008
Bismuth (total) [mg/L]	04-Jan-19	16:22	< 0.000007	109%	ND	NV	0.000161	< 0.000007	< 0.000007	< 0.000007
Calcium (total) [mg/L]	04-Jan-19	16:22	< 0.01	105%	1%	NV	5.32	28.6	25.6	29.5

OnLine LIMS

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Project : CA20M-00000-110-13531-02
LR Report : **CA14019-JAN19**

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 34	10: Waste Rock Unsaturated Column Week 34	11: Waste Rock Saturated Column Week 34	12: EnviroMet DI Water
Cadmium (total) [mg/L]	04-Jan-19	16:22	< 0.000003	100%	3%	100%	0.000013	0.000039	0.000051	0.000008
Cobalt (total) [mg/L]	04-Jan-19	16:22	< 0.000004	100%	4%	102%	0.000060	0.001540	0.002646	0.000109
Chromium (total) [mg/L]	04-Jan-19	16:22	< 0.00003	100%	2%	105%	0.00041	0.00029	< 0.00003	< 0.00003
Copper (total) [mg/L]	04-Jan-19	16:22	< 0.00002	101%	3%	97%	0.00086	0.00109	0.00069	0.01831
Iron (total) [mg/L]	04-Jan-19	16:22	< 0.007	103%	4%	NV	0.150	0.086	0.022	0.169
Potassium (total) [mg/L]	04-Jan-19	16:22	0.003	101%	2%	116%	0.630	2.49	2.26	0.997
Lithium (total) [mg/L]	04-Jan-19	16:22	< 0.0001	101%	9%	103%	0.178	0.0611	0.0542	0.0010
Magnesium (total) [mg/L]	04-Jan-19	16:22	< 0.001	101%	1%	117%	0.453	3.27	2.43	3.35
Manganese (total) [mg/L]	04-Jan-19	16:22	< 0.00001	103%	4%	NV	0.01797	0.07923	0.382	0.00167
Molybdenum (total) [mg/L]	04-Jan-19	16:22	< 0.00001	101%	7%	109%	0.00090	0.00027	0.00022	0.00017
Sodium (total) [mg/L]	04-Jan-19	16:22	< 0.01	96%	3%	82%	3.31	13.0	9.99	14.9
Nickel (total) [mg/L]	04-Jan-19	16:22	< 0.0001	102%	6%	101%	0.0003	0.0063	0.0121	0.0011
Lead (total) [mg/L]	04-Jan-19	16:22	< 0.00001	104%	8%	106%	0.00034	0.00003	0.00007	0.00055
Antimony (total) [mg/L]	04-Jan-19	16:22	< 0.0002	110%	24%	NV	0.0003	0.0003	0.0003	< 0.0002
Selenium (total) [mg/L]	04-Jan-19	16:22	< 0.00004	100%	ND	112%	< 0.00004	0.00019	0.00023	< 0.00004
Tin (total) [mg/L]	04-Jan-19	16:22	< 0.00001	98%	18%	NV	0.00066	0.00076	0.00117	0.00008
Strontium (total) [mg/L]	04-Jan-19	16:22	< 0.00002	103%	4%	NV	0.0225	0.199	0.207	0.106
Sulfur (total) [mg/L]	04-Jan-19	16:22	< 0.1	108%	3%	NV	2.9	11.5	11.3	9.9
Thorium (total) [mg/L]	04-Jan-19	16:22	< 0.0001	110%	ND	NV	0.0002	< 0.0001	< 0.0001	< 0.0001
Titanium (total) [mg/L]	04-Jan-19	16:22	< 0.00005	99%	ND	NV	0.00276	0.00611	0.00051	0.00006
Thallium (total) [mg/L]	04-Jan-19	16:22	< 0.000005	102%	ND	105%	0.000024	0.000030	0.000026	< 0.000005
Uranium (total) [mg/L]	04-Jan-19	16:22	< 0.000002	105%	2%	110%	0.000624	0.00655	0.00103	0.000014
Vanadium (total) [mg/L]	04-Jan-19	16:22	< 0.00001	100%	2%	109%	0.00095	0.00056	0.00020	0.00012
Tungsten (total) [mg/L]	04-Jan-19	16:22	< 0.00002	100%	ND	NV	0.00007	0.00014	0.00017	< 0.00002
Yttrium (total) [mg/L]	04-Jan-19	16:22	< 0.000002	102%	4%	NV	0.000011	0.000055	0.000049	0.000003
Zinc (total) [mg/L]	04-Jan-19	16:22	< 0.002	101%	7%	NV	0.004	< 0.002	0.002	0.072

NA - Not applicable
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NV - No Value

OnLine LIMS

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Project : CA20M-00000-110-13531-02
LR Report : **CA14019-JAN19**

Patti Stark
Project Specialist,
Environment, Health & Safety

OnLine LIMS

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SGS Lakefield Environmental Met
Attn : Barb Bowman

Project : CA20M-00000-110-13531-02

24-January-2019

Date Rec. : 15 January 2019
LR Report: **CA14315-JAN19**
Reference: 13531-002-25

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CERTIFICATE OF ANALYSIS
Final Report

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 36	10: Waste Rock Unsaturated Column Week 36	11: Waste Rock Saturated Column Week 36
Sample Date & Time							Date:N/A	Date:N/A	Date:N/A
Temperature Upon Receipt [°C]	---	---	---	---	---	---	19.0	19.0	19.0
pH [no unit]	18-Jan-19	08:21	NA	100%	0%	NA	6.83	6.70	6.67
Alkalinity [mg/L as CaCO3]	18-Jan-19	08:21	< 2	104%	1%	NA	6	4	5
Conductivity [uS/cm]	18-Jan-19	08:21	< 2	99%	1%	NA	16	36	42
Acidity [mg/L as CaCO3]	18-Jan-19	08:21	< 2	96%	3%	NA	< 2	< 2	< 2
Redox Potential [mV]	16-Jan-19	11:58	NA	108%	10%	NA	161	97	121
Sulphate [mg/L]	22-Jan-19	13:54	< 0.2	93%	2%	101%	0.5	9.1	10
Mercury (total) [mg/L]	17-Jan-19	11:51	< 0.00001	102%	ND	100%	< 0.00001	< 0.00001	< 0.00001
Silver (total) [mg/L]	18-Jan-19	11:40	< 0.00005	99%	ND	NV	< 0.00005	< 0.00005	< 0.00005
Aluminum (total) [mg/L]	18-Jan-19	11:40	< 0.001	100%	1%	NV	0.355	0.088	0.019
Arsenic (total) [mg/L]	18-Jan-19	11:40	< 0.0002	99%	5%	NV	0.0445	0.0354	0.0226
Barium (total) [mg/L]	18-Jan-19	11:40	< 0.00002	101%	2%	NV	0.00076	0.00294	0.00373
Beryllium (total) [mg/L]	18-Jan-19	11:40	< 0.000007	100%	1%	NV	0.000182	0.000007	< 0.000007
Boron (total) [mg/L]	18-Jan-19	11:40	< 0.002	97%	3%	NV	< 0.002	< 0.002	< 0.002
Bismuth (total) [mg/L]	18-Jan-19	11:40	< 0.000007	93%	0%	NV	0.000257	0.000014	< 0.000007
Calcium (total) [mg/L]	18-Jan-19	11:40	< 0.01	99%	ND	NV	1.66	3.76	4.58

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Project : CA20M-00000-110-13531-02
LR Report : CA14315-JAN19

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 36	10: Waste Rock Unsaturated Column Week 36	11: Waste Rock Saturated Column Week 36
Cadmium (total) [mg/L]	18-Jan-19	11:40	< 0.000003	98%	18%	NV	0.000011	0.000013	0.000011
Cobalt (total) [mg/L]	18-Jan-19	11:40	< 0.000004	100%	4%	NV	0.000063	0.000355	0.000689
Chromium (total) [mg/L]	18-Jan-19	11:40	< 0.00003	100%	ND	NV	0.00049	0.00019	0.00004
Copper (total) [mg/L]	18-Jan-19	11:40	< 0.00002	99%	6%	NV	0.00080	0.00035	0.00027
Iron (total) [mg/L]	18-Jan-19	11:40	< 0.007	97%	1%	NV	0.184	0.059	0.013
Potassium (total) [mg/L]	18-Jan-19	11:40	< 0.003	100%	1%	NV	0.358	0.820	0.819
Lithium (total) [mg/L]	23-Jan-19	10:54	< 0.0001	100%	ND	NV	0.124	0.0423	0.0386
Magnesium (total) [mg/L]	18-Jan-19	11:40	< 0.001	97%	1%	NV	0.143	0.483	0.465
Manganese (total) [mg/L]	18-Jan-19	11:40	< 0.00001	100%	1%	NV	0.0188	0.0182	0.0812
Molybdenum (total) [mg/L]	18-Jan-19	11:40	< 0.00001	101%	2%	NV	0.00112	0.00014	0.00010
Sodium (total) [mg/L]	18-Jan-19	11:40	< 0.01	103%	3%	NV	0.76	1.10	1.14
Nickel (total) [mg/L]	18-Jan-19	11:40	< 0.0001	100%	ND	NV	< 0.0001	0.0006	0.0018
Lead (total) [mg/L]	18-Jan-19	11:40	< 0.00001	99%	1%	NV	0.00046	0.00009	0.00002
Sulfur (total) [mg/L]	18-Jan-19	11:40	< 0.1	105%	1%	NV	1.0	3.9	4.7
Antimony (total) [mg/L]	18-Jan-19	11:40	< 0.0002	105%	ND	NV	< 0.0002	< 0.0002	< 0.0002
Selenium (total) [mg/L]	18-Jan-19	11:40	< 0.00004	95%	ND	NV	< 0.00004	0.00009	0.00008
Tin (total) [mg/L]	18-Jan-19	11:40	0	99%	2%	NV	0.00061	0.00071	0.00086
Strontium (total) [mg/L]	18-Jan-19	11:40	< 0.00002	100%	1%	NV	0.00766	0.0266	0.0370
Thorium (total) [mg/L]	18-Jan-19	11:40	< 0.0001	103%	20%	NV	< 0.0001	< 0.0001	< 0.0001
Titanium (total) [mg/L]	18-Jan-19	11:40	< 0.00005	98%	8%	NV	0.00410	0.00399	0.00058
Thallium (total) [mg/L]	18-Jan-19	11:40	< 0.000005	99%	ND	NV	0.000036	0.000014	0.000011
Uranium (total) [mg/L]	18-Jan-19	11:40	< 0.000002	100%	2%	NV	0.000520	0.000395	0.000153
Vanadium (total) [mg/L]	18-Jan-19	11:40	< 0.00001	97%	4%	NV	0.00106	0.00042	0.00019
Tungsten (total) [mg/L]	18-Jan-19	11:40	< 0.00002	99%	15%	NV	0.00010	0.00018	0.00018
Yttrium (total) [mg/L]	18-Jan-19	11:40	< 0.000002	103%	ND	NV	0.000012	0.000036	0.000008
Zinc (total) [mg/L]	18-Jan-19	11:40	< 0.002	100%	1%	NV	0.004	< 0.002	< 0.002

NA - Not applicable
ND - Not Detected
NV - No Value

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Project : CA20M-00000-110-13531-02
LR Report : **CA14315-JAN19**

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Project Specialist,
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OnLine LIMS

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SGS Lakefield Environmental Met
Attn : Barb Bowman

Project : CA20M-00000-110-13531-02

04-February-2019

Date Rec. : 29 January 2019
LR Report: **CA14590-JAN19**
Reference: 13531-02-26

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CERTIFICATE OF ANALYSIS
Final Report

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 38	10: Waste Rock Unsaturated Column Week 38	11: Waste Rock Saturated Column Week 38
Sample Date & Time							NA	NA	NA
Temperature Upon Receipt [°C]	***	***	***	***	***	***	***	***	***
pH [no unit]	31-Jan-19	11:40	NA	101%	1%	NA	6.79	6.46	6.49
Alkalinity [mg/L as CaCO3]	31-Jan-19	11:40	< 2	97%	0%	NA	5	3	3
Acidity [mg/L as CaCO3]	31-Jan-19	11:40	2	98%	0%	NA	< 2	< 2	< 2
Conductivity [uS/cm]	31-Jan-19	11:40	< 2	99%	1%	NA	12	25	31
Sulphate [mg/L]	31-Jan-19	13:40	< 0.2	96%	5%	123%	0.4	6.4	8.8
EMF [mV]	29-Jan-19	21:08	NA	108%	1%		158	180	176
Mercury (total) [mg/L]	31-Jan-19	09:21	< 0.00001	95%	17%	113%	< 0.00001	< 0.00001	< 0.00001
Silver (total) [mg/L]	31-Jan-19	09:21	< 0.00005	101%	ND	93%	< 0.00005	< 0.00005	< 0.00005
Aluminum (total) [mg/L]	31-Jan-19	09:21	< 0.001	97%	8%	NV	0.339	0.070	0.020
Arsenic (total) [mg/L]	31-Jan-19	09:21	< 0.0002	103%	9%	98%	0.0425	0.0304	0.0201
Barium (total) [mg/L]	31-Jan-19	09:21	< 0.00002	101%	4%	NV	0.00065	0.00248	0.00341
Beryllium (total) [mg/L]	31-Jan-19	09:21	< 0.000007	96%	15%	88%	0.000139	< 0.000007	< 0.000007
Boron (total) [mg/L]	31-Jan-19	09:21	< 0.002	103%	4%	NV	0.005	0.003	0.003
Bismuth (total) [mg/L]	31-Jan-19	09:21	< 0.000007	92%	18%	107%	0.000205	0.000009	< 0.000007
Calcium (total) [mg/L]	31-Jan-19	09:21	< 0.01	106%	1%	NV	1.49	2.82	3.73

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Project : CA20M-00000-110-13531-02
LR Report : **CA14590-JAN19**

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 38	10: Waste Rock Unsaturated Column Week 38	11: Waste Rock Saturated Column Week 38
Cadmium (total) [mg/L]	31-Jan-19	09:21	< 0.000003	102%	ND	88%	0.000015	0.000010	0.000023
Cobalt (total) [mg/L]	31-Jan-19	09:21	< 0.000004	100%	6%	94%	0.000024	0.000323	0.000807
Chromium (total) [mg/L]	31-Jan-19	09:21	< 0.00003	98%	11%	108%	0.00043	0.00014	< 0.00003
Copper (total) [mg/L]	31-Jan-19	09:21	< 0.00002	100%	6%	102%	0.00053	0.00028	0.00006
Iron (total) [mg/L]	31-Jan-19	09:21	< 0.007	106%	2%	NV	0.155	0.052	0.021
Potassium (total) [mg/L]	31-Jan-19	09:21	< 0.003	105%	1%	78%	0.324	0.734	0.751
Lithium (total) [mg/L]	31-Jan-19	09:21	< 0.0001	93%	10%	80%	0.122	0.0410	0.0427
Magnesium (total) [mg/L]	31-Jan-19	09:21	< 0.001	108%	2%	NV	0.141	0.358	0.383
Manganese (total) [mg/L]	31-Jan-19	09:21	< 0.00001	101%	1%	NV	0.0150	0.0199	0.0852
Molybdenum (total) [mg/L]	31-Jan-19	09:21	< 0.00001	105%	0%	100%	0.00091	0.00011	0.00008
Sodium (total) [mg/L]	31-Jan-19	09:21	< 0.01	106%	1%	NV	0.42	0.49	0.49
Nickel (total) [mg/L]	31-Jan-19	09:21	< 0.0001	103%	3%	91%	0.0002	0.0009	0.0025
Lead (total) [mg/L]	31-Jan-19	09:21	< 0.00001	98%	12%	94%	0.00038	0.00006	0.00004
Antimony (total) [mg/L]	31-Jan-19	09:21	< 0.0002	90%	ND	110%	< 0.0002	< 0.0002	< 0.0002
Selenium (total) [mg/L]	31-Jan-19	09:21	< 0.00004	96%	20%	100%	< 0.00004	0.00005	0.00005
Tin (total) [mg/L]	31-Jan-19	09:21	< 0.00001	102%	10%	NV	0.00050	0.00091	0.00133
Strontium (total) [mg/L]	31-Jan-19	09:21	< 0.00002	101%	0%	81%	0.00696	0.0205	0.0306
Sulfur (total) [mg/L]	01-Feb-19	11:21	< 0.1	105%	3%	NV	1.2	2.0	2.6
Thorium (total) [mg/L]	31-Jan-19	09:21	< 0.0001	101%	ND	NV	< 0.0001	< 0.0001	< 0.0001
Titanium (total) [mg/L]	31-Jan-19	09:21	< 0.00005	96%	11%	NV	0.00320	0.00352	0.00078
Thallium (total) [mg/L]	31-Jan-19	09:21	< 0.000005	98%	40%	90%	0.000024	0.000008	0.000006
Uranium (total) [mg/L]	31-Jan-19	09:21	< 0.000002	101%	6%	NV	0.000387	0.000184	0.000083
Vanadium (total) [mg/L]	31-Jan-19	09:21	< 0.00001	98%	3%	97%	0.00103	0.00041	0.00016
Tungsten (total) [mg/L]	31-Jan-19	09:21	< 0.00002	100%	ND	NV	0.00012	0.00016	0.00012
Yttrium (total) [mg/L]	31-Jan-19	09:21	< 0.000002	100%	3%	NV	0.000023	0.000018	0.000007
Zinc (total) [mg/L]	31-Jan-19	09:21	< 0.002	98%	1%	NV	0.004	< 0.002	< 0.002

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OnLine LIMS

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Project : CA20M-00000-110-13531-02
LR Report : **CA14590-JAN19**

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OnLine LIMS

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Test method information available upon request. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

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SGS Lakefield Environmental Met
Attn : Barb Bowman

Project : CA20M-00000-110-13531-02

21-February-2019

Date Rec. : 12 February 2019
LR Report: **CA14342-FEB19**
Reference: 13531-002-27

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 40	10: Waste Rock Unsaturated Column Week 40	11: Waste Rock Saturated Column Week 40
Sample Date & Time							Date:N/A	Date:N/A	Date:N/A
Temperature Upon Receipt [°C]	---	---	---	---	---	---	19.0	19.0	19.0
pH [no unit]	15-Feb-19	11:09	NA	101%	0%	NA	6.63	6.57	6.44
Alkalinity [mg/L as CaCO3]	15-Feb-19	11:09	< 2	102%	0%	NA	4	3	3
Conductivity [uS/cm]	15-Feb-19	11:09	< 2	100%	0%	NA	13	23	30
Acidity [mg/L as CaCO3]	15-Feb-19	11:09	2	100%	ND	NA	< 2	< 2	< 2
Redox Potential [mV]	13-Feb-19	11:06	NA	108%	2%		152	156	154
Sulphate [mg/L]	15-Feb-19	11:56	< 0.2	94%	NV	95%	0.4	5.4	7.9
Mercury (total) [mg/L]	15-Feb-19	10:43	< 0.00001	98%	ND	106%	< 0.00001	< 0.00001	< 0.00001
Silver (total) [mg/L]	15-Feb-19	10:43	< 0.00005	104%	ND	NV	< 0.00005	< 0.00005	< 0.00005
Aluminum (total) [mg/L]	15-Feb-19	10:43	< 0.001	102%	2%	NV	0.235	0.030	0.011
Arsenic (total) [mg/L]	15-Feb-19	10:43	< 0.0002	102%	ND	89%	0.0392	0.0241	0.0153
Barium (total) [mg/L]	15-Feb-19	10:43	< 0.00002	104%	8%	NV	0.00054	0.00230	0.00342
Beryllium (total) [mg/L]	15-Feb-19	10:43	< 0.000007	98%	ND	89%	0.000121	< 0.000007	< 0.000007
Boron (total) [mg/L]	15-Feb-19	10:43	< 0.002	102%	5%	NV	0.007	0.006	0.005
Bismuth (total) [mg/L]	15-Feb-19	10:43	< 0.000007	91%	0%	98%	0.000161	0.000011	< 0.000007
Calcium (total) [mg/L]	15-Feb-19	10:43	< 0.01	95%	2%	NV	1.62	2.53	3.54

OnLine LIMS

0001016385

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Project : CA20M-00000-110-13531-02
LR Report : **CA14342-FEB19**

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 40	10: Waste Rock Unsaturated Column Week 40	11: Waste Rock Saturated Column Week 40
Cadmium (total) [mg/L]	15-Feb-19	10:43	< 0.000003	102%	18%	75%	0.000003	0.000011	0.000013
Cobalt (total) [mg/L]	15-Feb-19	10:43	< 0.000004	101%	5%	82%	0.000035	0.000411	0.001029
Chromium (total) [mg/L]	15-Feb-19	10:43	< 0.00003	100%	6%	NV	0.00026	0.00008	0.00005
Copper (total) [mg/L]	15-Feb-19	10:43	< 0.00002	100%	1%	NV	0.00006	< 0.00002	< 0.00002
Iron (total) [mg/L]	15-Feb-19	10:43	< 0.007	91%	1%	NV	0.094	0.012	0.020
Potassium (total) [mg/L]	15-Feb-19	10:43	0.005	94%	7%	NV	0.276	0.635	0.660
Lithium (total) [mg/L]	15-Feb-19	10:43	< 0.0001	80%	ND	NV	0.131	0.0438	0.0444
Magnesium (total) [mg/L]	15-Feb-19	10:43	< 0.001	95%	6%	89%	0.143	0.293	0.334
Manganese (total) [mg/L]	15-Feb-19	10:43	< 0.00001	107%	1%	NV	0.0103	0.0280	0.102
Molybdenum (total) [mg/L]	15-Feb-19	10:43	< 0.00001	98%	ND	NV	0.00075	0.00007	0.00005
Sodium (total) [mg/L]	15-Feb-19	10:43	< 0.01	98%	4%	NV	0.28	0.28	0.28
Nickel (total) [mg/L]	15-Feb-19	10:43	< 0.0001	100%	17%	79%	0.0001	0.0011	0.0028
Lead (total) [mg/L]	15-Feb-19	10:43	< 0.00001	96%	14%	118%	0.00029	0.00003	0.00004
Sulfur (total) [mg/L]	15-Feb-19	10:43	< 0.3	91%	ND	NV	0.7	3.2	3.6
Antimony (total) [mg/L]	15-Feb-19	10:43	< 0.0002	101%	ND	NV	< 0.0002	< 0.0002	< 0.0002
Selenium (total) [mg/L]	15-Feb-19	10:43	< 0.00004	105%	ND	102%	< 0.00004	0.00006	0.00006
Tin (total) [mg/L]	15-Feb-19	10:43	< 0.00001	100%	ND	NV	0.00040	0.00049	0.00069
Strontium (total) [mg/L]	15-Feb-19	10:43	< 0.00002	101%	3%	115%	0.00721	0.0196	0.0297
Thorium (total) [mg/L]	15-Feb-19	10:43	< 0.0001	93%	ND	NV	< 0.0001	< 0.0001	< 0.0001
Titanium (total) [mg/L]	15-Feb-19	10:43	< 0.00005	93%	ND	NV	0.00209	0.00070	0.00046
Thallium (total) [mg/L]	15-Feb-19	10:43	< 0.000005	98%	17%	83%	0.000018	0.000010	0.000012
Uranium (total) [mg/L]	15-Feb-19	10:43	< 0.000002	98%	0%	100%	0.000405	0.000206	0.000106
Vanadium (total) [mg/L]	15-Feb-19	10:43	< 0.00001	98%	13%	120%	0.00088	0.00025	0.00012
Tungsten (total) [mg/L]	15-Feb-19	10:43	< 0.00002	93%	15%	NV	0.00006	0.00010	0.00008
Yttrium (total) [mg/L]	15-Feb-19	10:43	< 0.000002	102%	1%	NV	0.000007	0.000010	0.000017
Zinc (total) [mg/L]	15-Feb-19	10:43	< 0.002	101%	19%	NV	0.002	< 0.002	< 0.002

NA - Not applicable
ND - Not Detected
NV - No Value

OnLine LIMS

0010163850

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Project : CA20M-00000-110-13531-02
LR Report : **CA14342-FEB19**

Patti Stark
Project Specialist,
Environment, Health & Safety

OnLine LIMS

0001693850

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SGS Lakefield Environmental Met
Attn : Barb Bowman

Project : CA20M-00000-110-13531-02

05-March-2019

Date Rec. : 26 February 2019
LR Report: **CA14612-FEB19**
Reference: 13531-002-28

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 42	10: Waste Rock Unsaturated Column Week 42	11: Waste Rock Saturated Column Week 42
Sample Date & Time							Date:N/A	Date:N/A	Date:N/A
Temperature Upon Receipt [°C]	---	---	---	---	---	---	16.0	16.0	16.0
pH [no unit]	01-Mar-19	14:54	NA	101%	0%	NA	6.94	6.73	6.68
Alkalinity [mg/L as CaCO3]	01-Mar-19	14:54	< 2	102%	ND	NA	5	3	4
Conductivity [uS/cm]	01-Mar-19	14:54	< 2	101%	0%	NA	13	23	29
Acidity [mg/L as CaCO3]	01-Mar-19	14:54	2	98%	ND	NA	< 2	< 2	< 2
Redox Potential [mV]	26-Feb-19	22:29	NA	103%	0%	NV	449	468	407
Sulphate [mg/L]	05-Mar-19	08:31	< 0.2	95%	6%	122%	0.5	5.9	8.4
Mercury (total) [mg/L]	28-Feb-19	07:29	< 0.00001	96%	ND	98%	< 0.00001	< 0.00001	< 0.00001
Silver (total) [mg/L]	28-Feb-19	10:22	< 0.00005	104%	ND	105%	< 0.00005	< 0.00005	< 0.00005
Aluminum (total) [mg/L]	28-Feb-19	10:22	< 0.001	94%	ND	NV	0.214	0.023	0.006
Arsenic (total) [mg/L]	28-Feb-19	10:22	< 0.0002	96%	ND	98%	0.0381	0.0198	0.0123
Barium (total) [mg/L]	28-Feb-19	10:22	< 0.00002	102%	9%	NV	0.00066	0.00210	0.00343
Beryllium (total) [mg/L]	28-Feb-19	10:22	< 0.000007	103%	ND	93%	0.000102	< 0.000007	< 0.000007
Boron (total) [mg/L]	28-Feb-19	10:22	< 0.002	98%	2%	NV	0.029	0.011	0.008
Bismuth (total) [mg/L]	28-Feb-19	10:22	< 0.000007	106%	ND	123%	0.000202	0.000009	< 0.000007
Calcium (total) [mg/L]	28-Feb-19	10:22	< 0.01	98%	1%	NV	1.68	2.65	3.49
Cadmium (total) [mg/L]	28-Feb-19	10:22	< 0.000003	99%	ND	101%	< 0.000003	0.000006	0.000017
Cobalt (total) [mg/L]	28-Feb-19	10:22	< 0.000004	94%	ND	98%	0.000044	0.000517	0.00126
Chromium (total) [mg/L]	28-Feb-19	10:22	< 0.00003	97%	ND	NV	0.00024	0.00005	< 0.00003
Copper (total) [mg/L]	28-Feb-19	10:22	< 0.00002	94%	19%	114%	0.00024	< 0.00002	< 0.00002
Iron (total) [mg/L]	28-Feb-19	10:22	< 0.007	97%	ND	NV	0.103	0.009	0.020

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0001675845

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Project : CA20M-00000-110-13531-02
LR Report : **CA14612-FEB19**

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 42	10: Waste Rock Unsaturated Column Week 42	11: Waste Rock Saturated Column Week 42
Potassium (total) [mg/L]	28-Feb-19	10:22	< 0.003	98%	2%	NV	0.398	0.793	0.753
Lithium (total) [mg/L]	28-Feb-19	10:22	< 0.0001	104%	16%	107%	0.132	0.0394	0.0409
Magnesium (total) [mg/L]	28-Feb-19	10:22	< 0.001	101%	4%	71%	0.169	0.322	0.355
Manganese (total) [mg/L]	28-Feb-19	10:22	< 0.00001	99%	5%	NV	0.00967	0.0325	0.103
Molybdenum (total) [mg/L]	28-Feb-19	10:22	< 0.00001	94%	18%	111%	0.00154	0.00030	0.00014
Sodium (total) [mg/L]	28-Feb-19	10:22	< 0.01	101%	0%	NV	0.34	0.33	0.34
Nickel (total) [mg/L]	28-Feb-19	10:22	< 0.0001	94%	ND	98%	0.0002	0.0013	0.0034
Lead (total) [mg/L]	28-Feb-19	10:22	< 0.00001	104%	ND	102%	0.00033	0.00004	0.00005
Sulfur (total) [mg/L]	28-Feb-19	10:22	< 0.3	95%	2%	NV	< 0.3	2.7	3.5
Antimony (total) [mg/L]	28-Feb-19	10:22	< 0.0002	103%	ND	114%	< 0.0002	< 0.0002	< 0.0002
Selenium (total) [mg/L]	28-Feb-19	10:22	< 0.00004	96%	ND	84%	< 0.00004	0.00007	0.00006
Tin (total) [mg/L]	28-Feb-19	10:22	< 0.00001	95%	13%	NV	0.00036	0.00042	0.00056
Strontium (total) [mg/L]	28-Feb-19	10:22	< 0.00002	97%	1%	NV	0.0069	0.0181	0.0262
Thorium (total) [mg/L]	28-Feb-19	10:22	< 0.0001	100%	ND	NV	< 0.0001	< 0.0001	< 0.0001
Titanium (total) [mg/L]	28-Feb-19	10:22	< 0.00005	92%	ND	NV	0.00202	0.00046	0.00020
Thallium (total) [mg/L]	28-Feb-19	10:22	< 0.000005	106%	ND	101%	0.000023	0.000008	0.000010
Uranium (total) [mg/L]	28-Feb-19	10:22	< 0.000002	94%	15%	92%	0.000290	0.000111	0.000067
Vanadium (total) [mg/L]	28-Feb-19	10:22	< 0.00001	96%	ND	NV	0.00092	0.00021	0.00008
Tungsten (total) [mg/L]	28-Feb-19	10:22	< 0.00002	98%	ND	NV	0.00004	0.00009	0.00008
Yttrium (total) [mg/L]	28-Feb-19	10:22	< 0.000002	96%	10%	NV	0.000012	0.000005	0.000006
Zinc (total) [mg/L]	28-Feb-19	10:22					0.002	< 0.002	< 0.002

NA - Not applicable
ND - Not Detected
NV - No Value

Patti Stark
Project Specialist,
Environment, Health & Safety

OnLine LIMS

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SGS Lakefield Environmental Met
Attn : Barb Bowman

Project : CA20M-00000-110-13531-02

19-March-2019

Date Rec. : 12 March 2019
LR Report: **CA14299-MAR19**
Reference: 13531-002-29

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 44	10: Waste Rock Unsaturated Column Week 44	11: Waste Rock Saturated Column Week 44
Sample Date & Time							N/A	N/A	N/A
Temperature Upon Receipt [°C]	---	---	---	---	---	---	17.0	17.0	17.0
pH [no unit]	15-Mar-19	16:37	NA	101%	0%	NA	6.74	6.48	6.48
Alkalinity [mg/L as CaCO3]	15-Mar-19	16:37	< 2	99%	0%	NA	3	2	2
Conductivity [uS/cm]	15-Mar-19	13:11	< 2	100%	0%	NA	11	23	27
Acidity [mg/L as CaCO3]	15-Mar-19	13:11	< 2	92%	ND	NA	< 2	< 2	< 2
Redox Potential [mV]	13-Mar-19	14:20	NA	107%	7%		245	231	122
Sulphate [mg/L]	15-Mar-19	10:58	< 0.2	94%	0%	96%	0.5	5.7	7.3
Mercury (total) [mg/L]	13-Mar-19	22:19	< 0.00001	96%	15%	94%	< 0.00001	< 0.00001	< 0.00001
Silver (total) [mg/L]	19-Mar-19	12:12	< 0.00005	101%	ND	90%	< 0.00005	< 0.00005	< 0.00005
Aluminum (total) [mg/L]	19-Mar-19	12:12	< 0.001	107%	9%	NV	0.213	0.040	0.006
Arsenic (total) [mg/L]	19-Mar-19	12:12	< 0.0002	99%	ND	83%	0.0381	0.0167	0.0104
Barium (total) [mg/L]	19-Mar-19	12:12	< 0.00002	104%	4%	102%	0.00087	0.00296	0.00404
Beryllium (total) [mg/L]	19-Mar-19	12:12	< 0.000007	104%	ND	96%	0.000089	< 0.000007	< 0.000007
Boron (total) [mg/L]	19-Mar-19	12:12	< 0.002	103%	2%	NV	0.005	0.002	0.002
Bismuth (total) [mg/L]	19-Mar-19	12:12	< 0.000007	94%	18%	103%	0.000184	< 0.000007	< 0.000007

OnLine LIMS

6896891000

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Project : CA20M-00000-110-13531-02
LR Report : **CA14299-MAR19**

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 44	10: Waste Rock Unsaturated Column Week 44	11: Waste Rock Saturated Column Week 44
Calcium (total) [mg/L]	19-Mar-19	12:12	< 0.01	92%	2%	NV	1.45	2.78	3.60
Cadmium (total) [mg/L]	19-Mar-19	12:12	6e-006	100%	ND	96%	< 0.000003	0.000021	0.000022
Cobalt (total) [mg/L]	19-Mar-19	12:12	< 0.000004	100%	16%	95%	0.000046	0.000796	0.00185
Chromium (total) [mg/L]	19-Mar-19	12:12	< 0.00008	101%	ND	100%	0.00034	0.00014	< 0.00008
Copper (total) [mg/L]	19-Mar-19	12:12	< 0.0002	100%	16%	88%	0.0007	0.0004	< 0.0002
Iron (total) [mg/L]	19-Mar-19	12:12	< 0.007	97%	ND	NV	0.145	0.038	0.028
Potassium (total) [mg/L]	19-Mar-19	12:12	< 0.009	90%	3%	NV	0.270	0.716	0.701
Lithium (total) [mg/L]	19-Mar-19	12:12	< 0.0001	105%	5%	102%	0.132	0.0477	0.0495
Magnesium (total) [mg/L]	19-Mar-19	12:12	< 0.001	101%	0%	95%	0.143	0.371	0.408
Manganese (total) [mg/L]	19-Mar-19	12:12	< 0.00001	101%	5%	NV	0.0137	0.0440	0.123
Molybdenum (total) [mg/L]	19-Mar-19	12:12	< 0.00004	101%	0%	101%	0.00093	0.00008	0.00006
Sodium (total) [mg/L]	19-Mar-19	12:12	< 0.01	95%	0%	NV	0.24	0.26	0.28
Nickel (total) [mg/L]	19-Mar-19	12:12	< 0.0001	100%	ND	98%	0.0003	0.0023	0.0054
Lead (total) [mg/L]	19-Mar-19	12:12	< 0.00001	104%	ND	98%	0.00035	0.00007	0.00003
Sulfur (total) [mg/L]	19-Mar-19	12:12	< 0.3	97%	4%	NV	0.6	3.0	3.6
Antimony (total) [mg/L]	19-Mar-19	12:12	< 0.0009	104%	5%	112%	< 0.0009	< 0.0009	< 0.0009
Selenium (total) [mg/L]	19-Mar-19	12:12	< 0.00004	99%	0%	97%	< 0.00004	0.00006	0.00006
Tin (total) [mg/L]	19-Mar-19	12:12	< 0.00006	103%	1%	NV	0.00035	0.00045	0.00096
Strontium (total) [mg/L]	19-Mar-19	12:12	< 0.00002	106%	1%	73%	0.00656	0.0208	0.0290
Thorium (total) [mg/L]	19-Mar-19	12:12	< 0.0001	100%	ND	NV	< 0.0001	< 0.0001	< 0.0001
Titanium (total) [mg/L]	19-Mar-19	12:12	< 0.00005	93%	1%	NV	0.00166	0.00197	0.00012
Thallium (total) [mg/L]	19-Mar-19	12:12	< 0.000005	105%	ND	100%	0.000007	< 0.000005	< 0.000005
Uranium (total) [mg/L]	19-Mar-19	12:12	< 0.000002	104%	4%	99%	0.000426	0.000138	0.000075
Vanadium (total) [mg/L]	19-Mar-19	12:12	< 0.00001	99%	3%	NV	0.00111	0.00026	0.00008
Tungsten (total) [mg/L]	19-Mar-19	12:12	< 0.00002	104%	4%	NV	0.00006	0.00010	0.00006
Yttrium (total) [mg/L]	19-Mar-19	12:12	< 0.000002	103%	ND	NV	0.000007	0.000014	0.000005
Zinc (total) [mg/L]	19-Mar-19	12:12	< 0.002	104%	ND	98%	0.005	0.002	< 0.002

NA - Not applicable
ND - Not Detected
NV - No Value

OnLine LIMS

6896891000

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Project : CA20M-00000-110-13531-02
LR Report : **CA14299-MAR19**

Patti Stark
Project Specialist,
Environment, Health & Safety

OnLine LIMS

6896891000

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Project : CA20M-00000-110-13531-02

11-April-2019

SGS Lakefield Environmental Met
Attn : Barb Bowman

Date Rec. : 26 March 2019
LR Report: **CA14701-MAR19**
Reference: 13531-002-30

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 46	10: Waste Rock Unsaturated Column Week 46	11: Waste Rock Saturated Column Week 46
Sample Date & Time							N/A	N/A	N/A
Temperature Upon Receipt [°C]	---	---	---	---	---	---	17.0	17.0	17.0
pH [no unit]	29-Mar-19	15:04	NA	100%	2%	NA	6.38	6.47	6.56
Alkalinity [mg/L as CaCO3]	29-Mar-19	15:04	< 2	97%	ND	NA	63	2	2
Conductivity [uS/cm]	29-Mar-19	15:04	< 2	102%	2%	NA	11	26	32
Acidity [mg/L as CaCO3]	29-Mar-19	15:04	< 2	110%	4%	NA	< 2	2	4
Redox Potential [mV]	29-Mar-19	11:27	NA	101%	0%	NV	370	335	167
Sulphate [mg/L]	01-Apr-19	09:43	< 0.2	97%	0%	99%	0.5	6.9	9.3
Mercury (total) [mg/L]	01-Apr-19	15:08	< 0.00001	86%	ND	30%	< 0.00001	< 0.00001	0.00001
Silver (total) [mg/L]	28-Mar-19	14:34	< 0.00005	99%	ND	NV	0.00005	< 0.00005	< 0.00005
Aluminum (total) [mg/L]	28-Mar-19	14:34	< 0.001	104%	4%	NV	0.275	0.037	0.004
Arsenic (total) [mg/L]	28-Mar-19	14:34	< 0.0002	100%	1%	91%	0.0437	0.0151	0.0099
Barium (total) [mg/L]	28-Mar-19	14:34	< 0.00002	104%	2%	NV	0.00074	0.00264	0.00408
Beryllium (total) [mg/L]	28-Mar-19	14:34	< 0.000007	99%	ND	91%	0.000146	< 0.000007	< 0.000007
Boron (total) [mg/L]	28-Mar-19	14:34	< 0.002	103%	ND	NV	0.004	< 0.002	< 0.002
Bismuth (total) [mg/L]	28-Mar-19	14:34	< 0.000007	97%	ND	111%	0.000193	0.000011	< 0.000007
Calcium (total) [mg/L]	28-Mar-19	14:34	< 0.01	98%	3%	117%	1.40	2.67	3.63
Cadmium (total) [mg/L]	28-Mar-19	14:34	< 0.000003	99%	9%	82%	0.000012	0.000014	0.000037
Cobalt (total) [mg/L]	28-Mar-19	14:34	< 0.000004	100%	3%	78%	0.000090	0.000960	0.00229
Chromium (total) [mg/L]	28-Mar-19	14:34	< 0.00008	101%	1%	86%	0.00042	0.00012	< 0.00008
Copper (total) [mg/L]	28-Mar-19	14:34	< 0.0002	101%	2%	88%	0.0006	0.0003	< 0.0002
Iron (total) [mg/L]	28-Mar-19	14:34	< 0.007	95%	3%	NV	0.143	0.039	0.043
Potassium (total) [mg/L]	28-Mar-19	14:34	< 0.009	105%	3%	NV	0.245	0.651	0.664
Lithium (total) [mg/L]	10-Apr-19	14:09	< 0.0001	ND	ND	NV	0.0648	0.0517	0.0605
Magnesium (total) [mg/L]	28-Mar-19	14:34	< 0.001	96%	5%	108%	0.123	0.311	0.335
Manganese (total) [mg/L]	28-Mar-19	14:34	< 0.00001	103%	3%	NV	0.0160	0.0563	0.138
Molybdenum (total) [mg/L]	28-Mar-19	14:34	< 0.00004	101%	7%	79%	0.00079	0.00009	0.00004
Sodium (total) [mg/L]	28-Mar-19	14:34	< 0.01	95%	ND	NV	0.28	0.26	0.27
Nickel (total) [mg/L]	28-Mar-19	14:34	< 0.0001	100%	3%	75%	0.0002	0.0025	0.0063
Lead (total) [mg/L]	28-Mar-19	14:34	< 0.00001	99%	1%	89%	0.00034	0.00005	< 0.00001
Sulfur (total) [mg/L]	28-Mar-19	14:34	< 0.3	101%	4%	NV	< 0.3	2.9	3.8
Antimony (total) [mg/L]	28-Mar-19	14:34	< 0.0009	98%	9%	NV	< 0.0009	< 0.0009	< 0.0009
Selenium (total) [mg/L]	28-Mar-19	14:34	< 0.00004	100%	12%	NV	< 0.00004	0.00007	0.00006
Tin (total) [mg/L]	28-Mar-19	14:34	< 0.00006	101%	10%	NV	0.00037	0.00041	0.00052
Strontium (total) [mg/L]	28-Mar-19	14:34	< 0.00002	101%	3%	107%	0.00615	0.0202	0.0294

OnLine LIMS

0001711261

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Project : CA20M-00000-110-13531-02
LR Report : **CA14701-MAR19**

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 46	10: Waste Rock Unsaturated Column Week 46	11: Waste Rock Saturated Column Week 46
Thorium (total) [mg/L]	28-Mar-19	14:34	< 0.0001	104%	ND	NV	< 0.0001	< 0.0001	< 0.0001
Titanium (total) [mg/L]	28-Mar-19	14:34	< 0.00005	102%	0%	NV	0.00252	0.00209	0.00016
Thallium (total) [mg/L]	28-Mar-19	14:34	< 0.000005	99%	14%	86%	0.000023	0.000011	0.000012
Uranium (total) [mg/L]	28-Mar-19	14:34	< 0.000002	100%	4%	95%	0.000383	0.000096	0.000072
Vanadium (total) [mg/L]	28-Mar-19	14:34	< 0.00001	101%	2%	93%	0.00113	0.00020	0.00007
Tungsten (total) [mg/L]	28-Mar-19	14:34	< 0.00002	104%	6%	NV	0.00005	0.00007	0.00002
Yttrium (total) [mg/L]	28-Mar-19	14:34	< 0.000002	100%	4%	NV	0.000012	0.000009	0.000007
Zinc (total) [mg/L]	28-Mar-19	14:34	< 0.002	100%	3%	104%	0.004	< 0.002	< 0.002

NA - Not applicable
ND - Not Detected
NV - No Value

Patti Stark
Project Specialist,
Environment, Health & Safety

OnLine LIMS

0001711261

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SGS Lakefield Environmental Met
Attn : Barb Bowman

Project : CA20M-00000-110-13531-02

16-April-2019

Date Rec. : 09 April 2019
LR Report: **CA14302-APR19**
Reference: 13531-002-31

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CERTIFICATE OF ANALYSIS
Final Report

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 48	10: Waste Rock Unsaturated Column Week 48	11: Waste Rock Saturated Column Week 48
Sample Date & Time							Date:N/A	Date:N/A	Date:N/A
Temperature Upon Receipt [°C]	---	---	---	---	---	---	17.0	17.0	17.0
pH [no unit]	15-Apr-19	13:47	NA	100%	0%	NA	6.65	6.37	6.43
Alkalinity [mg/L as CaCO3]	15-Apr-19	13:47	< 2	104%	ND	NA	4	2	3
Conductivity [uS/cm]	15-Apr-19	13:47	< 2	96%	0%	NA	11	26	32
Acidity [mg/L as CaCO3]	15-Apr-19	13:47	< 2	94%	ND	NA	< 2	3	3
Redox Potential [mV]	11-Apr-19	11:33	NA	103%	1%	NA	395	375	237
Sulphate [mg/L]	12-Apr-19	16:08	< 0.2	95%	0%	104%	0.5	7.0	9.2
Mercury (total) [mg/L]	11-Apr-19	16:13	< 0.00001	80%	ND	84%	< 0.00001	< 0.00001	< 0.00001
Silver (total) [mg/L]	12-Apr-19	16:44	< 0.00005	96%	ND	91%	< 0.00005	< 0.00005	< 0.00005
Aluminum (total) [mg/L]	12-Apr-19	16:44	< 0.001	98%	ND	NV	0.205	0.019	0.003
Arsenic (total) [mg/L]	12-Apr-19	16:44	< 0.0002	98%	19%	98%	0.0502	0.0127	0.0088
Barium (total) [mg/L]	12-Apr-19	16:44	< 0.00002	94%	6%	128%	0.00057	0.00274	0.00408
Beryllium (total) [mg/L]	12-Apr-19	16:44	< 0.000007	96%	ND	72%	0.000080	< 0.000007	< 0.000007
Boron (total) [mg/L]	16-Apr-19	11:35	< 0.002	100%	1%	NV	0.004	0.003	0.002
Bismuth (total) [mg/L]	12-Apr-19	16:44	< 0.000007	90%	ND	95%	0.000154	0.000008	< 0.000007
Calcium (total) [mg/L]	12-Apr-19	16:44	< 0.01	96%	2%	NV	1.26	2.62	3.45

OnLine LIMS

0001717162

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Project : CA20M-00000-110-13531-02
LR Report : **CA14302-APR19**

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 48	10: Waste Rock Unsaturated Column Week 48	11: Waste Rock Saturated Column Week 48
Cadmium (total) [mg/L]	12-Apr-19	16:44	< 0.000003	92%	ND	97%	< 0.000003	0.000026	0.000025
Cobalt (total) [mg/L]	12-Apr-19	16:44	< 0.000004	96%	ND	91%	0.000104	0.00142	0.00281
Chromium (total) [mg/L]	12-Apr-19	16:44	< 0.00008	97%	ND	NV	0.00034	0.00013	< 0.00008
Copper (total) [mg/L]	12-Apr-19	16:44	< 0.0002	96%	2%	NV	0.0005	< 0.0002	< 0.0002
Iron (total) [mg/L]	12-Apr-19	16:44	< 0.007	96%	ND	NV	0.113	0.030	0.062
Potassium (total) [mg/L]	12-Apr-19	16:44	< 0.009	97%	12%	NV	0.238	0.664	0.659
Lithium (total) [mg/L]	12-Apr-19	16:44	< 0.0001	96%	ND	NV	0.105	0.0451	0.0478
Magnesium (total) [mg/L]	12-Apr-19	16:44	< 0.001	97%	3%	NV	0.112	0.326	0.353
Manganese (total) [mg/L]	12-Apr-19	16:44	< 0.00001	100%	10%	NV	0.0118	0.0691	0.148
Molybdenum (total) [mg/L]	12-Apr-19	16:44	< 0.00004	99%	11%	102%	0.00075	< 0.00004	< 0.00004
Sodium (total) [mg/L]	12-Apr-19	16:44	< 0.01	99%	1%	NV	0.19	0.20	0.22
Nickel (total) [mg/L]	12-Apr-19	16:44	< 0.0001	94%	ND	81%	0.0002	0.0035	0.0080
Lead (total) [mg/L]	12-Apr-19	16:44	< 0.00001	93%	5%	91%	0.00035	< 0.00001	0.00002
Sulfur (total) [mg/L]	12-Apr-19	16:44	< 0.3	105%	1%	NV	< 0.3	3.2	4.1
Antimony (total) [mg/L]	12-Apr-19	16:44	< 0.0009	109%	ND	104%	< 0.0009	< 0.0009	< 0.0009
Selenium (total) [mg/L]	12-Apr-19	16:44	< 0.00004	95%	ND	90%	< 0.00004	0.00008	0.00004
Tin (total) [mg/L]	12-Apr-19	16:44	< 0.00006	97%	ND	NV	0.00033	0.00035	0.00048
Strontium (total) [mg/L]	12-Apr-19	16:44	< 0.00002	98%	1%	100%	0.00582	0.0225	0.0316
Thorium (total) [mg/L]	12-Apr-19	16:44	< 0.0001	96%	ND	NV	< 0.0001	< 0.0001	< 0.0001
Titanium (total) [mg/L]	12-Apr-19	16:44	< 0.00005	96%	ND	NV	0.00200	0.00110	0.00017
Thallium (total) [mg/L]	12-Apr-19	16:44	< 0.000005	94%	ND	92%	< 0.000005	< 0.000005	< 0.000005
Uranium (total) [mg/L]	12-Apr-19	16:44	< 0.000002	94%	4%	95%	0.000349	0.000089	0.000067
Vanadium (total) [mg/L]	12-Apr-19	16:44	< 0.00001	97%	ND	NV	0.00105	0.00012	0.00004
Tungsten (total) [mg/L]	12-Apr-19	16:44	< 0.00002	100%	ND	NV	0.00004	0.00004	< 0.00002
Yttrium (total) [mg/L]	12-Apr-19	16:44	< 0.000002	97%	4%	NV	0.000021	0.000007	0.000008
Zinc (total) [mg/L]	12-Apr-19	16:44	< 0.002	96%	ND	NV	0.005	< 0.002	< 0.002

NA - Not applicable
ND - Not Detected
NV - No Value

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Project : CA20M-00000-110-13531-02
LR Report : **CA14302-APR19**

Patti Stark
Project Specialist,
Environment, Health & Safety

OnLine LIMS

000171162

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SGS Lakefield Environmental Met
Attn : Barb Bowman

Project : CA20M-00000-110-13531-02

03-May-2019

Date Rec. : 23 April 2019
LR Report: **CA14824-APR19**
Reference: 13531-002-32

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CERTIFICATE OF ANALYSIS
Final Report

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 50	10: Waste Rock Unsaturated Column Week 50	11: Waste Rock Saturated Column Week 50
Temperature Upon Receipt [°C]	---	---	---	---	---	---	18.0	18.0	18.0
pH [no unit]	25-Apr-19	11:05	NA	100%	0%	NA	6.91	6.53	6.58
Alkalinity [mg/L as CaCO3]	25-Apr-19	11:05	< 2	102%	0%	NA	4	2	3
Conductivity [uS/cm]	25-Apr-19	11:05	< 2	99%	0%	NA	17	28	32
Acidity [mg/L as CaCO3]	25-Apr-19	11:05	< 2	90%	ND	NA	< 2	< 2	< 2
Redox Potential [mV]	24-Apr-19	20:25	NA	106%	1%	NV	263	213	149
Sulphate [mg/L]	30-Apr-19	06:45	< 0.2	98%	1%	98%	0.7	8.3	9.5
Mercury (total) [mg/L]	30-Apr-19	08:25	< 0.00001	95%	ND	93%	< 0.00001	< 0.00001	< 0.00001
Silver (total) [mg/L]	28-Apr-19	11:05	< 0.00005	99%	ND	95%	< 0.00005	< 0.00005	< 0.00005
Aluminum (total) [mg/L]	28-Apr-19	11:05	< 0.001	101%	3%	NV	0.192	0.005	< 0.001
Arsenic (total) [mg/L]	28-Apr-19	11:05	< 0.0002	103%	9%	114%	0.0498	0.0113	0.0081
Barium (total) [mg/L]	28-Apr-19	11:05	< 0.00002	100%	1%	99%	0.00089	0.00291	0.00413
Beryllium (total) [mg/L]	28-Apr-19	11:05	< 0.000007	99%	ND	98%	0.000088	< 0.000007	< 0.000007
Boron (total) [mg/L]	28-Apr-19	11:05	< 0.002	96%	3%	NV	0.003	< 0.002	< 0.002
Bismuth (total) [mg/L]	28-Apr-19	11:05	< 0.000007	96%	13%	96%	0.000159	0.000007	< 0.000007
Calcium (total) [mg/L]	28-Apr-19	11:05	< 0.01	100%	2%	81%	1.24	2.69	3.33
Cadmium (total) [mg/L]	28-Apr-19	11:05	< 0.000003	98%	6%	84%	< 0.000003	0.000032	0.000035

OnLine LIMS

0001735506

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Project : CA20M-00000-110-13531-02
LR Report : **CA14824-APR19**

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: QC - Blank	6: QC - STD % Recovery	7: QC - DUP % RPD	8: QC - Spike Rep	9: DMS Tails Unsaturated Column Week 50	10: Waste Rock Unsaturated Column Week 50	11: Waste Rock Saturated Column Week 50
Cobalt (total) [mg/L]	28-Apr-19	11:05	< 0.000004	100%	1%	105%	0.000022	0.00167	0.00297
Chromium (total) [mg/L]	28-Apr-19	11:05	< 0.00008	104%	ND	106%	0.00036	< 0.00008	< 0.00008
Copper (total) [mg/L]	28-Apr-19	11:05	< 0.0002	95%	1%	NV	0.0005	< 0.0002	< 0.0002
Iron (total) [mg/L]	28-Apr-19	11:05	< 0.007	94%	0%	NV	0.100	0.020	0.055
Potassium (total) [mg/L]	28-Apr-19	11:05	< 0.009	102%	0%	100%	0.213	0.632	0.576
Lithium (total) [mg/L]	28-Apr-19	11:05	< 0.0001	98%	1%	78%	0.125	0.0475	0.0487
Magnesium (total) [mg/L]	28-Apr-19	11:05	< 0.001	101%	2%	NV	0.113	0.313	0.325
Manganese (total) [mg/L]	28-Apr-19	11:05	< 0.00001	101%	1%	NV	0.0106	0.0696	0.136
Molybdenum (total) [mg/L]	28-Apr-19	11:05	< 0.00004	98%	1%	119%	0.00079	< 0.00004	< 0.00004
Sodium (total) [mg/L]	28-Apr-19	11:05	< 0.01	102%	1%	71%	0.20	0.22	0.24
Nickel (total) [mg/L]	28-Apr-19	11:05	< 0.0001	92%	0%	90%	0.0001	0.0037	0.0078
Lead (total) [mg/L]	28-Apr-19	11:05	< 0.00001	98%	2%	96%	0.00018	< 0.00001	< 0.00001
Sulfur (total) [mg/L]	28-Apr-19	11:05	< 0.3	102%	5%	NV	< 0.3	2.7	3.1
Antimony (total) [mg/L]	28-Apr-19	11:05	< 0.0009	105%	ND	78%	< 0.0009	< 0.0009	< 0.0009
Selenium (total) [mg/L]	28-Apr-19	11:05	< 0.00004	101%	5%	99%	< 0.00004	0.00006	0.00008
Tin (total) [mg/L]	28-Apr-19	11:05	< 0.00006	100%	ND	NV	0.00036	0.00036	0.00043
Strontium (total) [mg/L]	28-Apr-19	11:05	< 0.00002	101%	1%	78%	0.00635	0.0241	0.0304
Thorium (total) [mg/L]	28-Apr-19	11:05	< 0.0001	99%	ND	NV	< 0.0001	< 0.0001	< 0.0001
Titanium (total) [mg/L]	28-Apr-19	11:05	< 0.00005	99%	18%	NV	0.00157	0.00016	0.00006
Thallium (total) [mg/L]	28-Apr-19	11:05	< 0.000005	101%	6%	99%	0.000019	0.000009	0.000014
Uranium (total) [mg/L]	28-Apr-19	11:05	< 0.000002	100%	11%	99%	0.000357	0.000076	0.000060
Vanadium (total) [mg/L]	28-Apr-19	11:05	< 0.00001	102%	15%	110%	0.00106	0.00006	0.00004
Tungsten (total) [mg/L]	28-Apr-19	11:05	< 0.00002	98%	ND	NV	0.00005	0.00006	0.00003
Yttrium (total) [mg/L]	28-Apr-19	11:05	2e-006	101%	11%	NV	0.000011	0.000005	0.000007
Zinc (total) [mg/L]	28-Apr-19	11:05	< 0.002	101%	0%	NV	0.003	< 0.002	0.007

NA - Not applicable
ND - Not Detected
NV - No Value

OnLine LIMS

0001735506

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Test method information available upon request. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Project : CA20M-00000-110-13531-02
LR Report : **CA14824-APR19**

Chris Sullivan

CHARTERED
Christopher Sullivan
CHEMIST
ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO

Chris Sullivan, B.Sc., C.Chem
Project Specialist,
Environment, Health & Safety

OnLine LIMS

0001735506

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Test method information available upon request. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Project : CALR-13531-002

10-July-2018

SGS Lakefield Environmental Met
Attn : Barb Bowman

Date Rec. : 06 July 2018
LR Report: **CA14139-JUL18**
Reference: 13531-002-09

Copy: #1

CERTIFICATE OF ANALYSIS
Final Report

Sample ID	Sample Date & Time	Temperature Upon Receipt °C	Sulphate mg/L
3: Analysis Approval Date		---	09-Jul-18
4: Analysis Approval Time		---	14:51
5: QC - Blank		---	< 0.2
6: QC - STD % Recovery		---	101%
7: QC - DUP % RPD		---	6%
8: QC - Spike Rep		---	100%
9: DMS Tails Unsaturated Column Week 6	Date:N/A	18.0	1.2
10: Waste Rock Unsturated Column Week 6	Date:N/A	18.0	14
11: Waste Rock Saturated Column Week 6	Date:N/A	18.0	15

Additional analysis for SGS report CA14646-JUN18

Patti Stark
Project Specialist Environmental Services, Analytical

OnLine LIMS

0001435059

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Test method information available upon request. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

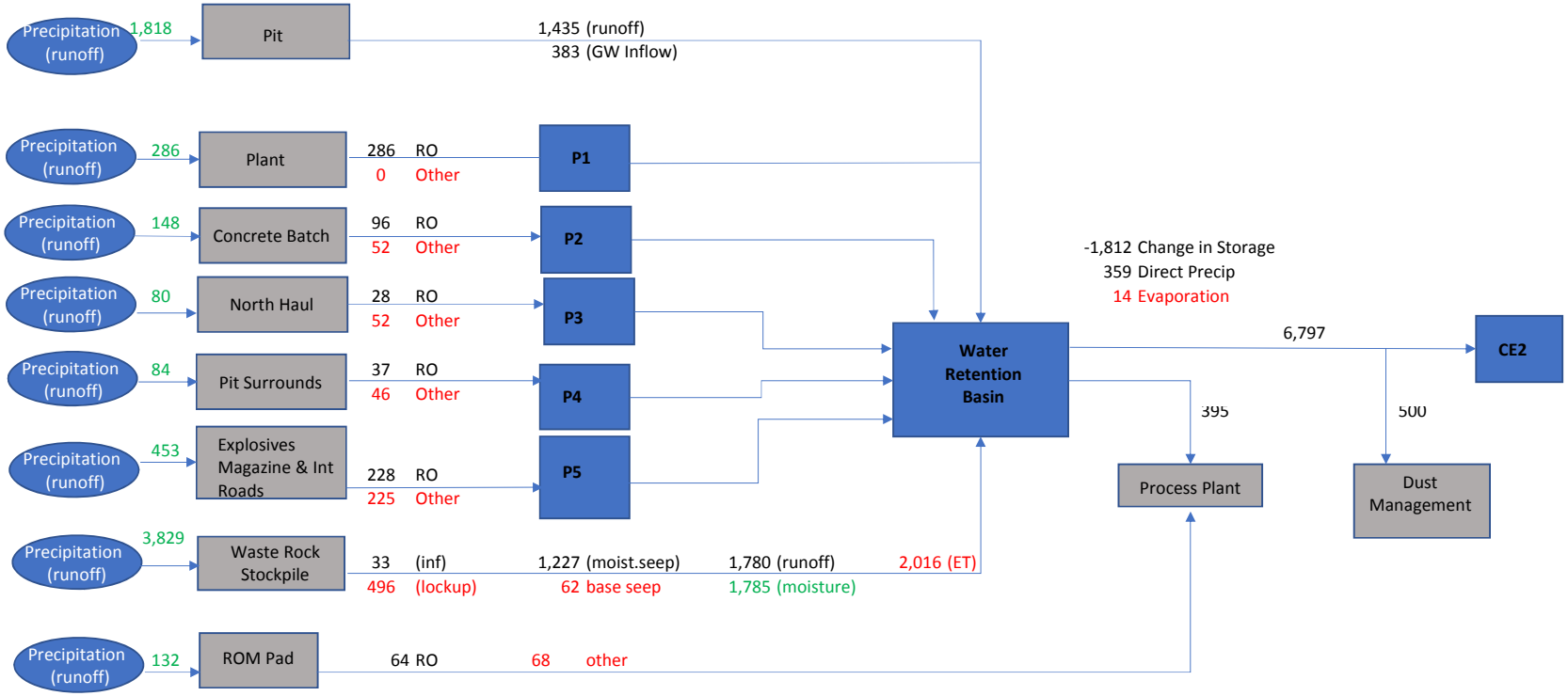
APPENDIX

A-24

WATER BALANCE DIAGRAM, JULY 2019

Water Balance at Ultimate Pit Development - Average Climactic Conditions

Flows in m^3/day



Legend	123 Inflows	RO	Runoff
	123 Outflows to a receiver	Other	Seepage and evapotranspiration
	123 Outflows that are removed from the water balance		

APPENDIX

A-43

WATER BALANCE – DETAILED RESULTS

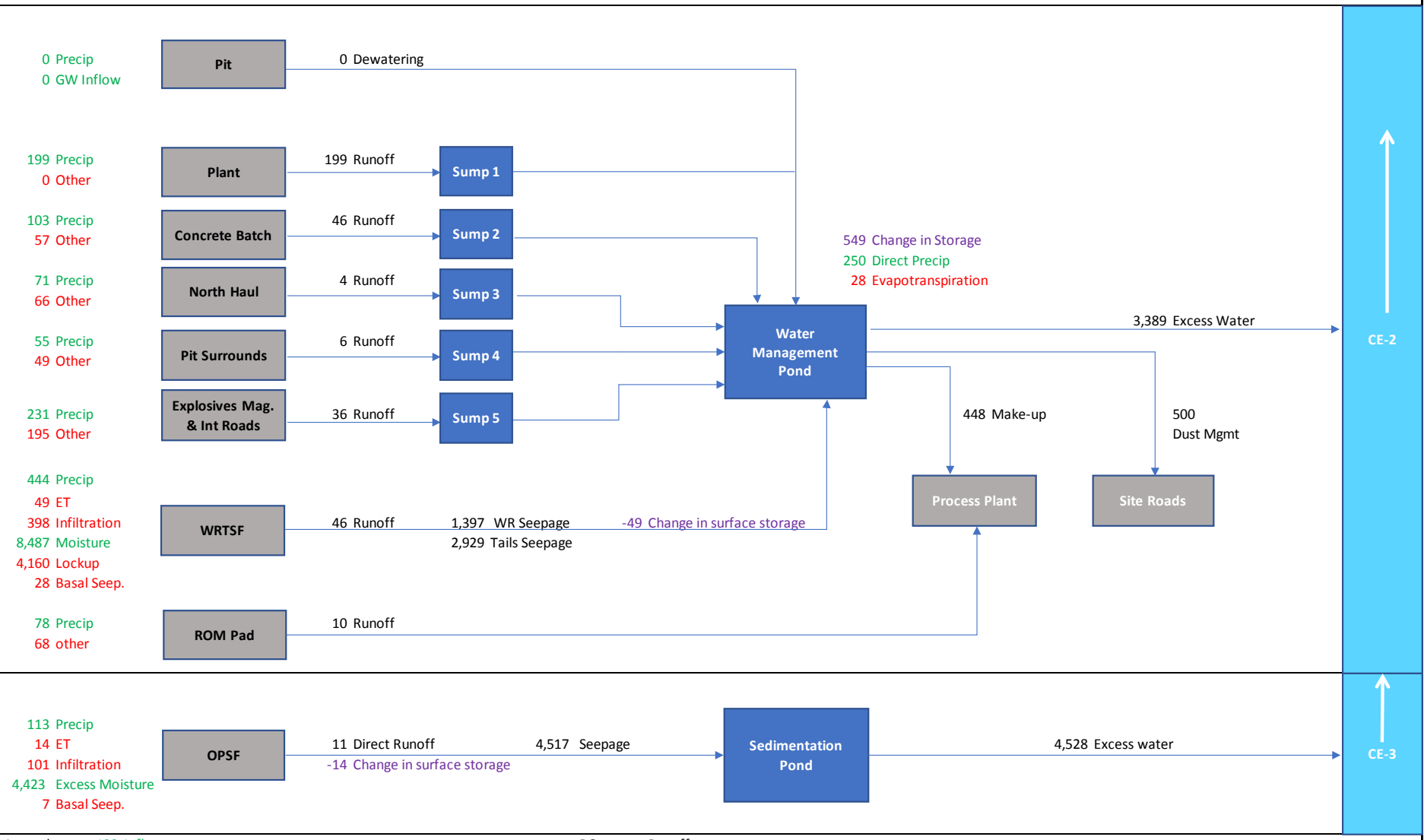
Galaxy Lithium — Site Wide Water Balance

James Bay Project - Feasibility Study

18/Jul/2019

Average Flows in m^3/day

Year	**1**
Functional Season	**Winter (Nov-April)**
Climate conditions	**Normal**



Legend			
	123 Inflows	RO	Runoff
	123 Outflows to a receiver	Other	Seepage and evapotranspiration
	123 Losses and Transfers	123	Changes in storage

Stantec

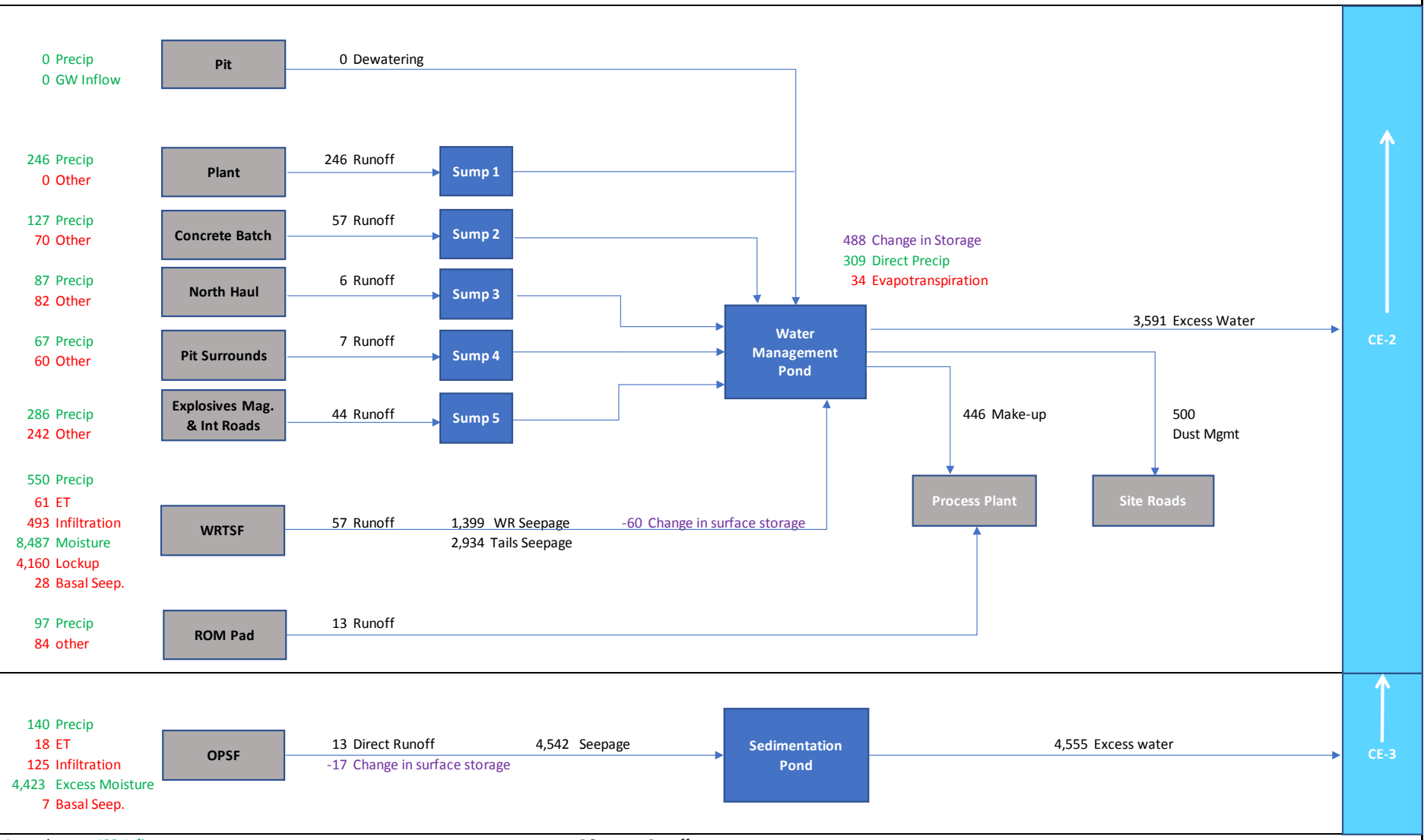
Galaxy Lithium — Site Wide Water Balance

James Bay Project - Feasibility Study

18/Jul/2019

Average Flows in m^3/day

Year	1
Functional Season	**Winter (Nov-April)**
Climate conditions	**25 year wet**



Legend			
	123 Inflows	RO	Runoff
	123 Outflows to a receiver	Other	Seepage and evapotranspiration
	123 Losses and Transfers	123	Changes in storage

Stantec

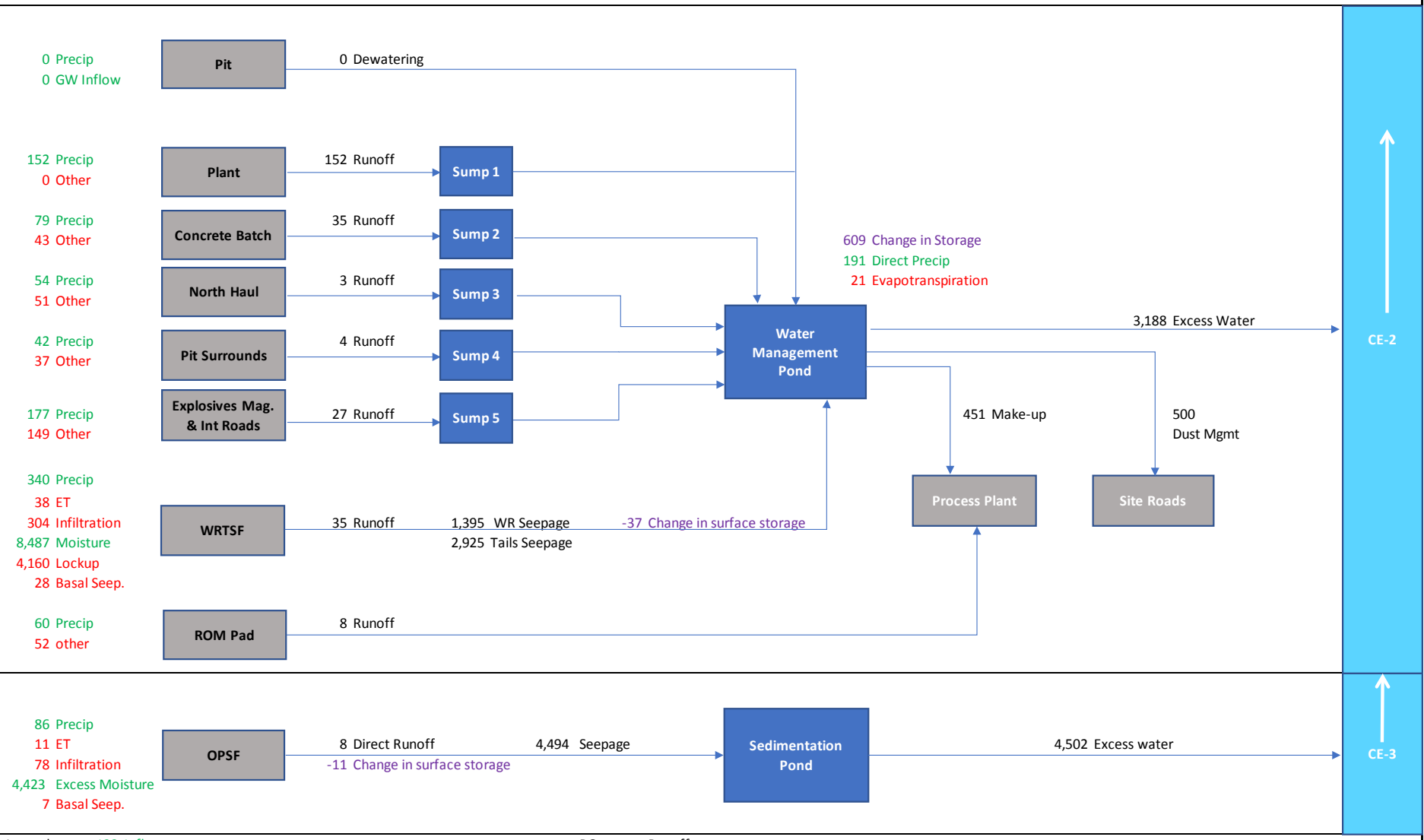
Galaxy Lithium — Site Wide Water Balance

James Bay Project - Feasibility Study

18/Jul/2019

Average Flows in m^3/day

Year	**1**
Functional Season	**Winter (Nov-April)**
Climate conditions	**25 year dry**



Legend			
	123 Inflows	RO	Runoff
	123 Outflows to a receiver	Other	Seepage and evapotranspiration
	123 Losses and Transfers	123	Changes in storage

Stantec

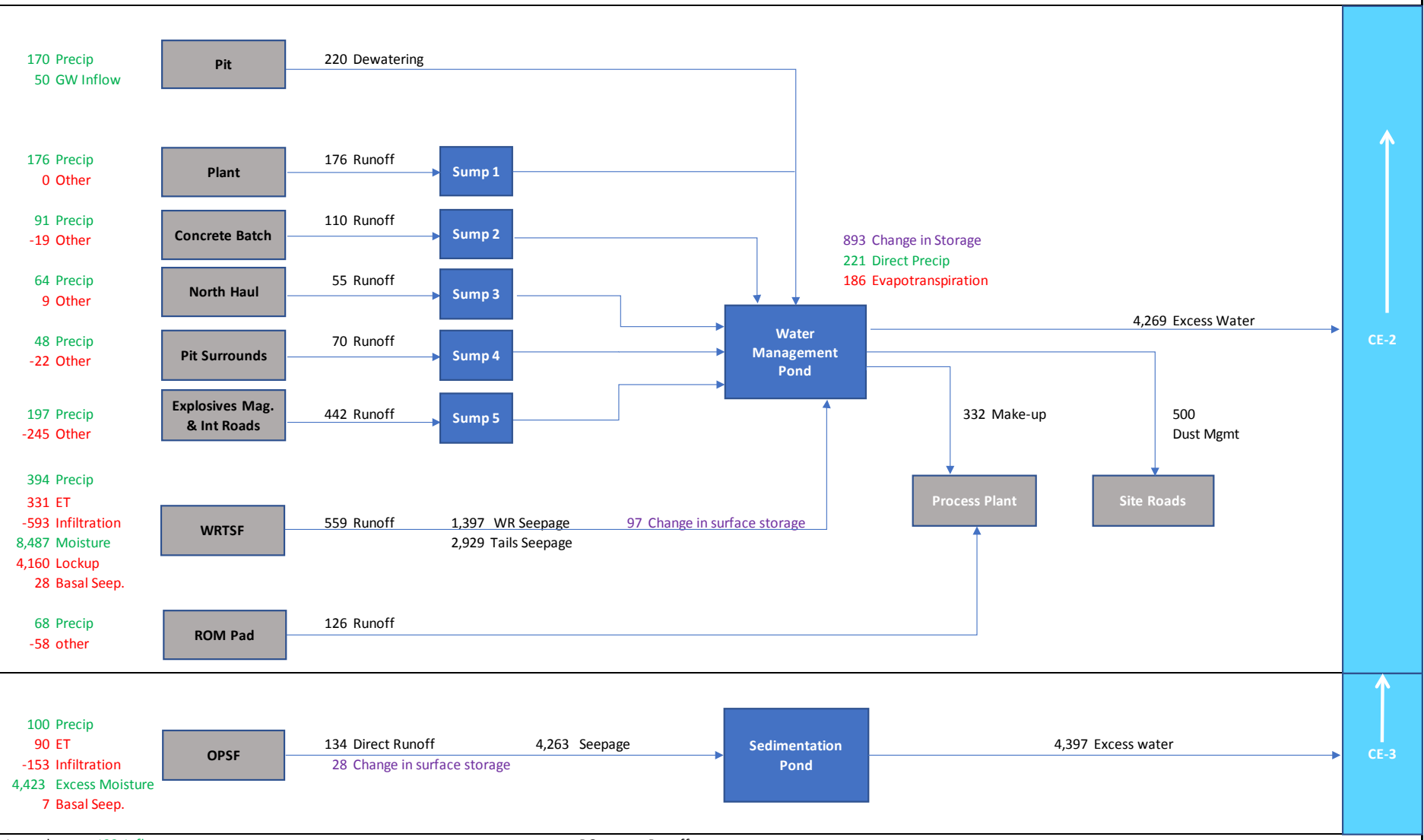
Galaxy Lithium — Site Wide Water Balance

James Bay Project - Feasibility Study

18/Jul/2019

Average Flows in m^3/day

Year	1
Functional Season	Spring
Climate conditions	Normal



Legend			
	123 Inflows	RO	Runoff
	123 Outflows to a receiver	Other	Seepage and evapotranspiration
	123 Losses and Transfers	123	Changes in storage

Stantec

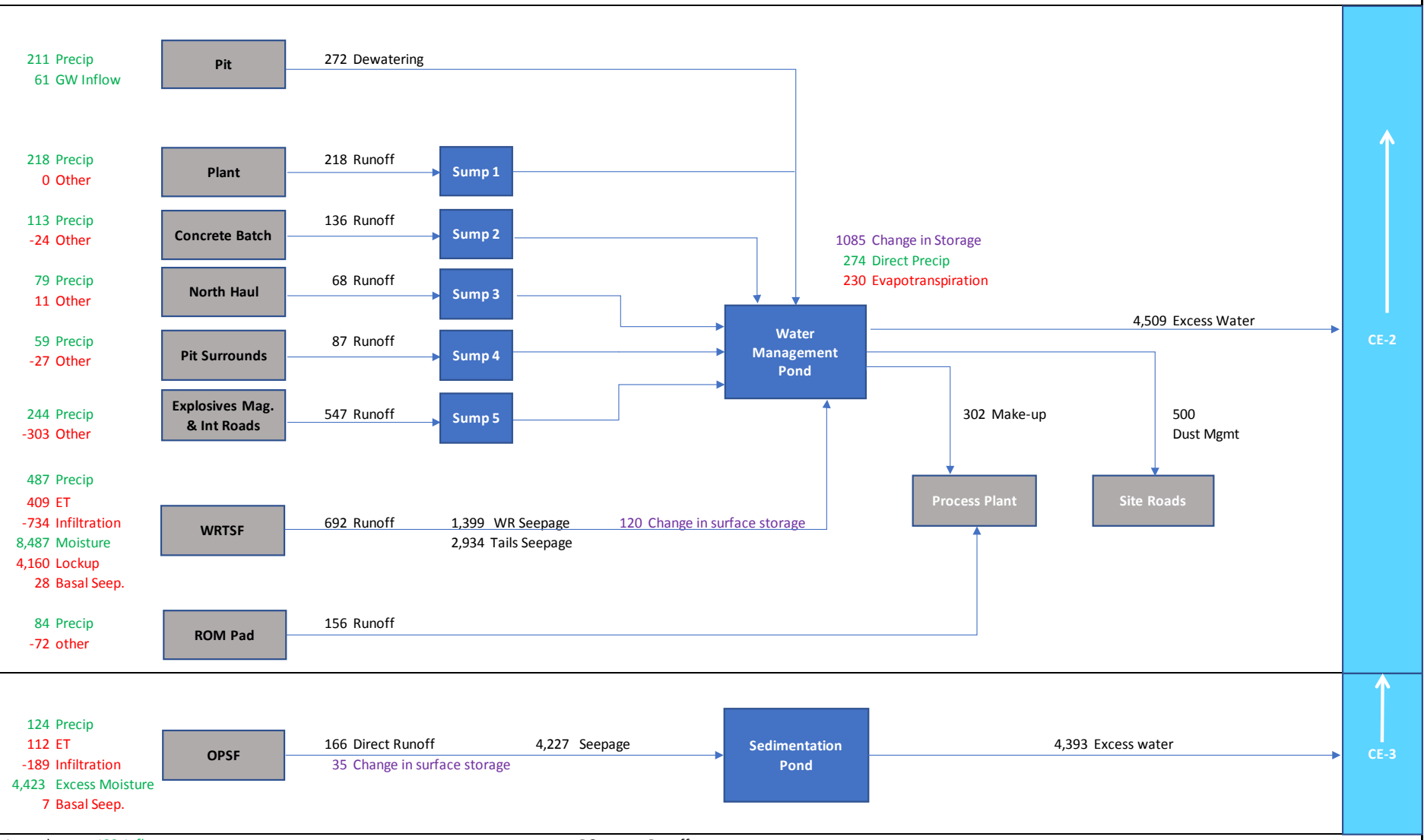
Galaxy Lithium — Site Wide Water Balance

James Bay Project - Feasibility Study

18/Jul/2019

Average Flows in m^3/day

Year	**1**
Functional Season	**Spring**
Climate conditions	**25 year wet**



Legend			
	123 Inflows	RO	Runoff
	123 Outflows to a receiver	Other	Seepage and evapotranspiration
	123 Losses and Transfers	123	Changes in storage

Stantec

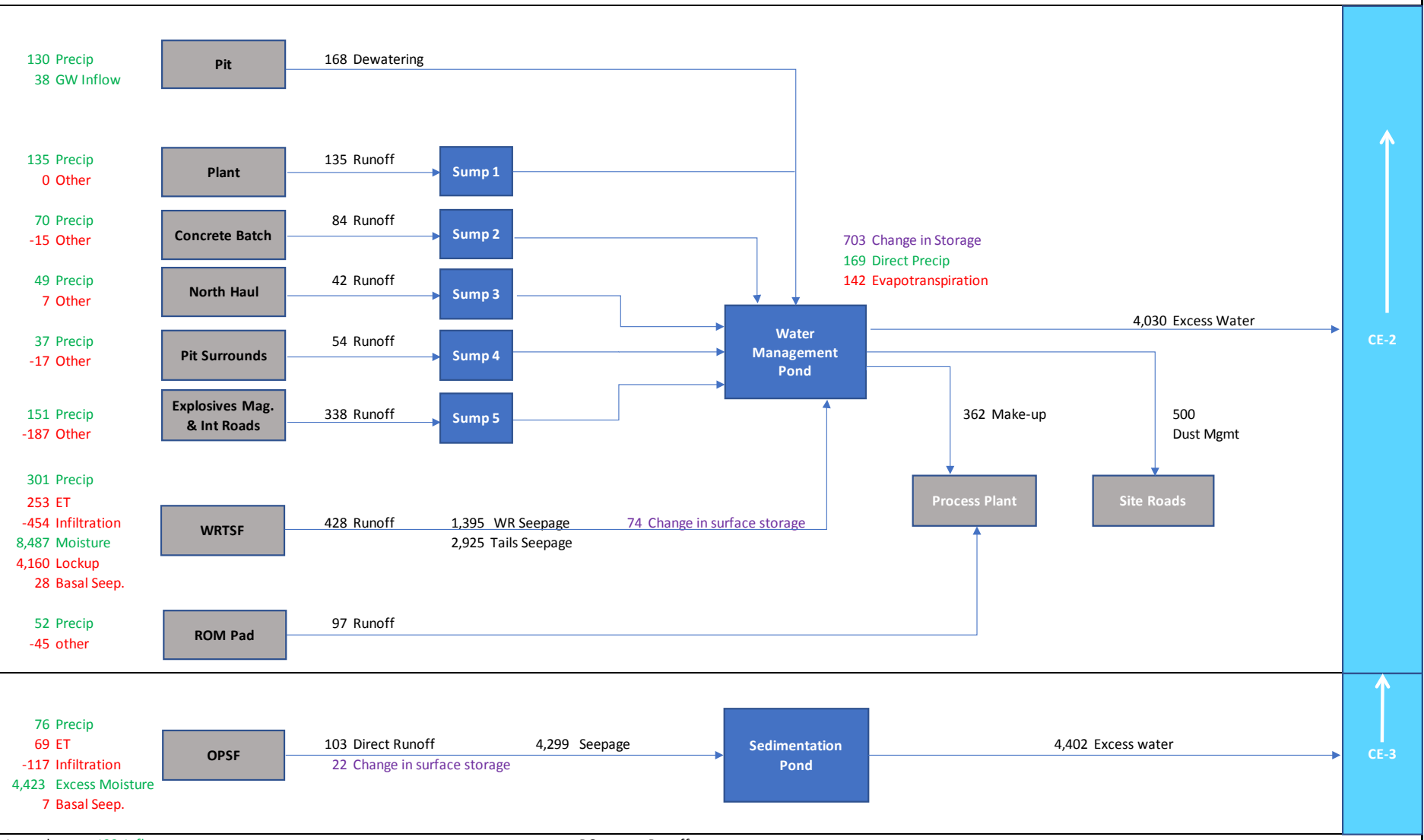
Galaxy Lithium — Site Wide Water Balance

James Bay Project - Feasibility Study

18/Jul/2019

Average Flows in m^3/day

Year	**1**
Functional Season	**Spring**
Climate conditions	**25 year dry**



Legend			
	123 Inflows	RO	Runoff
	123 Outflows to a receiver	Other	Seepage and evapotranspiration
	123 Losses and Transfers	123	Changes in storage

Stantec

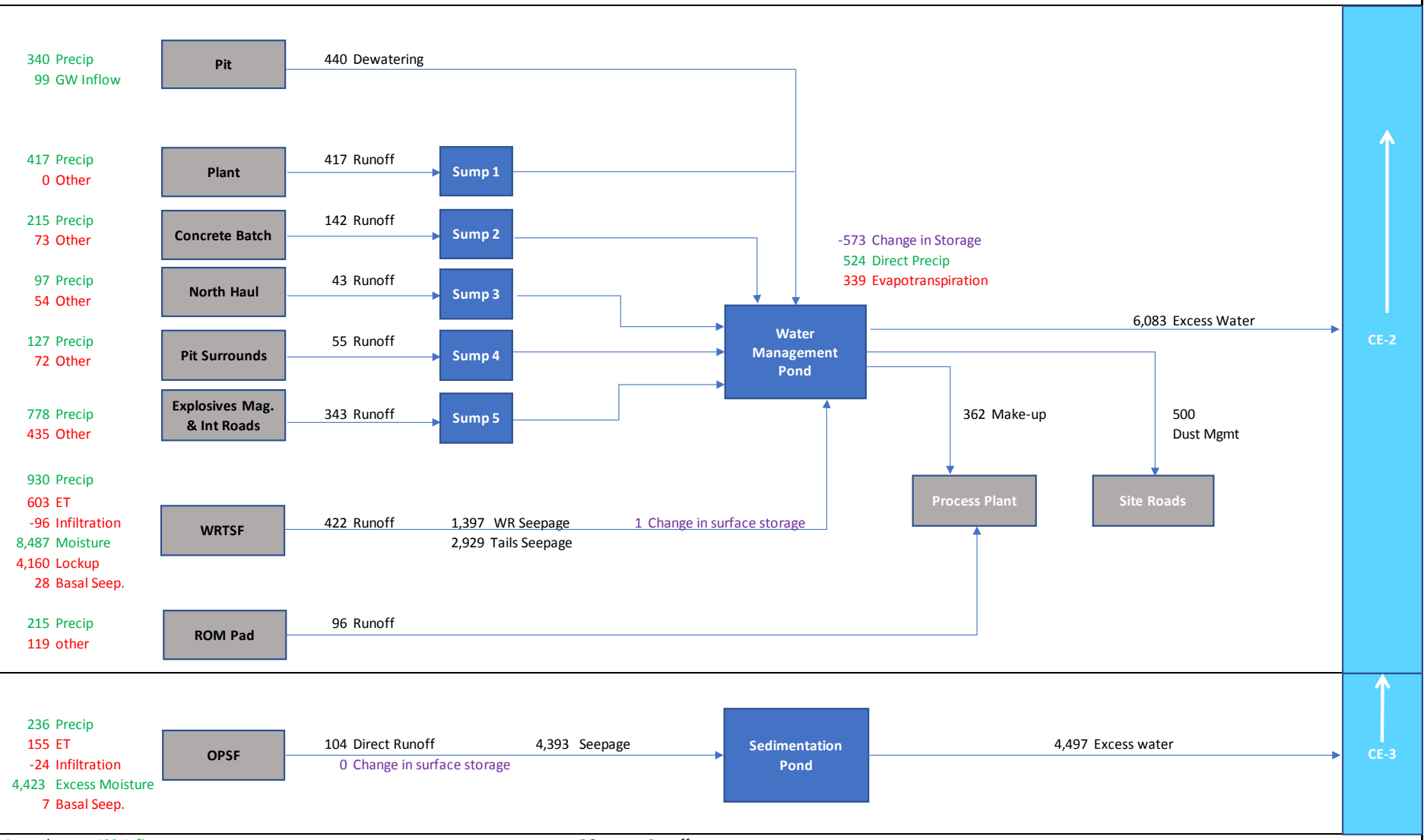
Galaxy Lithium — Site Wide Water Balance

James Bay Project - Feasibility Study

18/Jul/2019

Average Flows in m^3/day

Year	1
Functional Season	Summer/Fall
Climate conditions	Normal



Legend			
	123 Inflows	RO	Runoff
	123 Outflows to a receiver	Other	Seepage and evapotranspiration
	123 Losses and Transfers	123	Changes in storage

Stantec

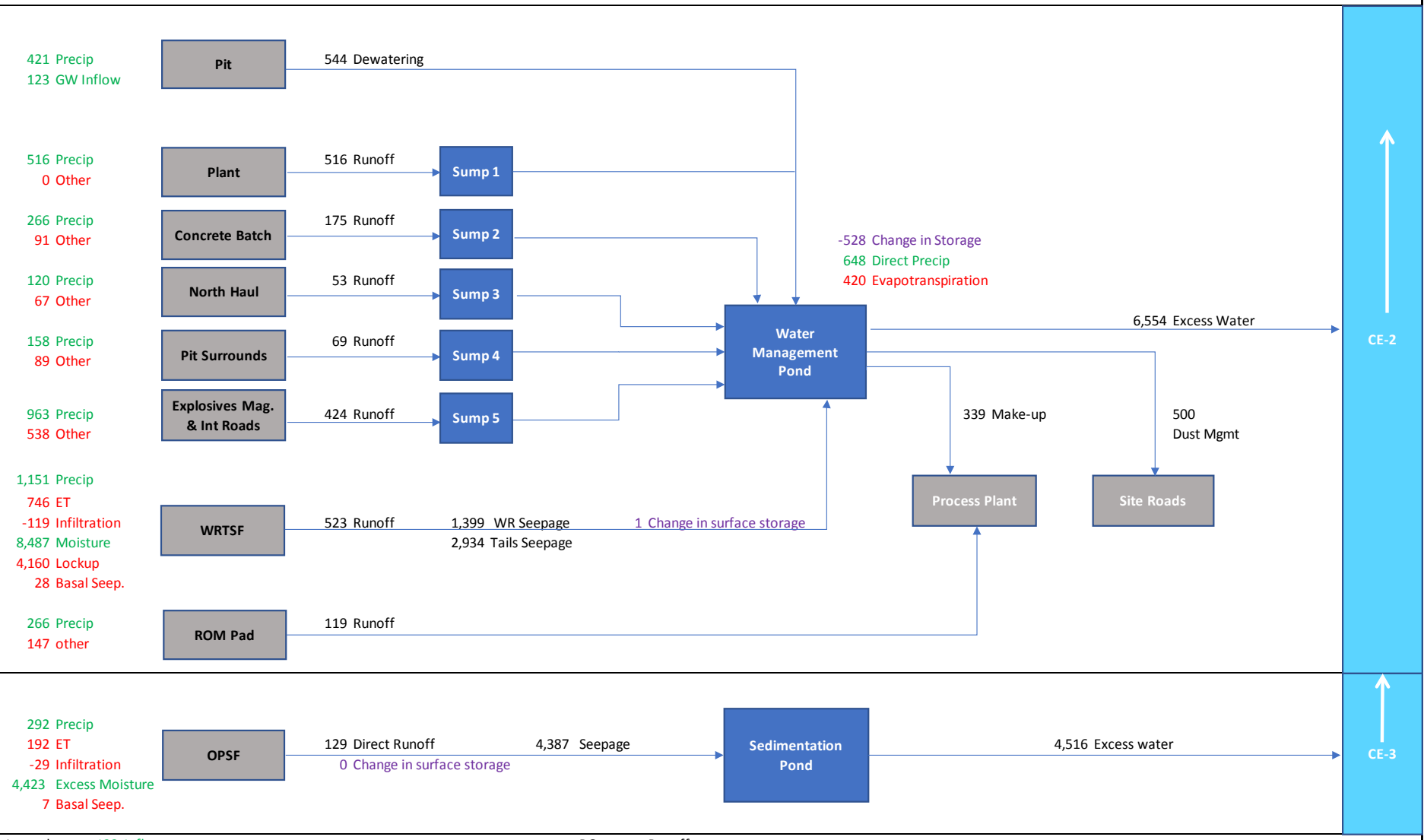
Galaxy Lithium — Site Wide Water Balance

James Bay Project - Feasibility Study

18/Jul/2019

Average Flows in m^3/day

Year	**1**
Functional Season	**Summer/Fall**
Climate conditions	**25 year wet**



Legend			
	123 Inflows	RO	Runoff
	123 Outflows to a receiver	Other	Seepage and evapotranspiration
	123 Losses and Transfers	123	Changes in storage

Stantec

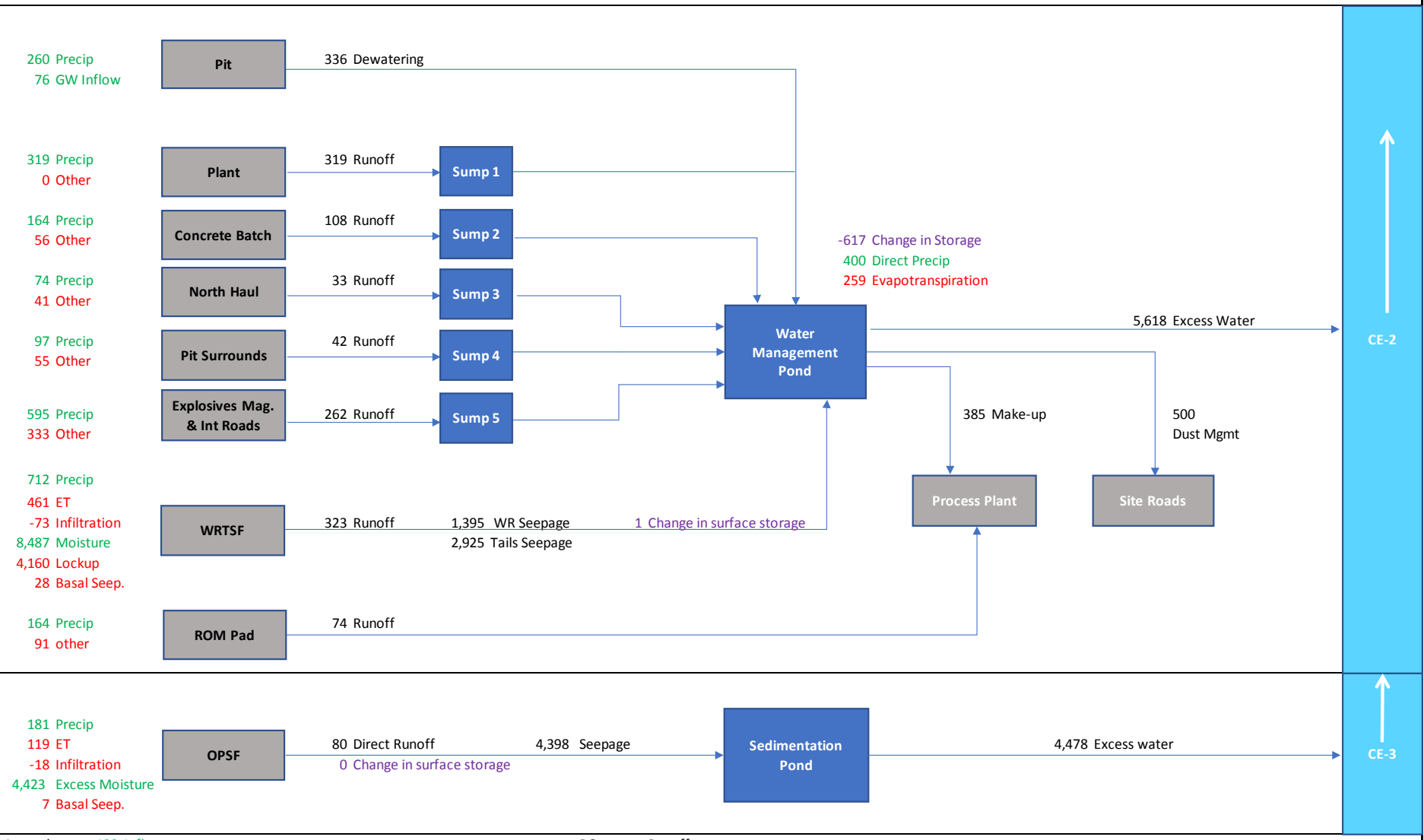
Galaxy Lithium — Site Wide Water Balance

James Bay Project - Feasibility Study

18/Jul/2019

Average Flows in m^3/day

Year	**1**
Functional Season	**Summer/Fall**
Climate conditions	**25 year dry**



Legend			
	123 Inflows	RO	Runoff
	123 Outflows to a receiver	Other	Seepage and evapotranspiration
	123 Losses and Transfers	123	Changes in storage

Stantec

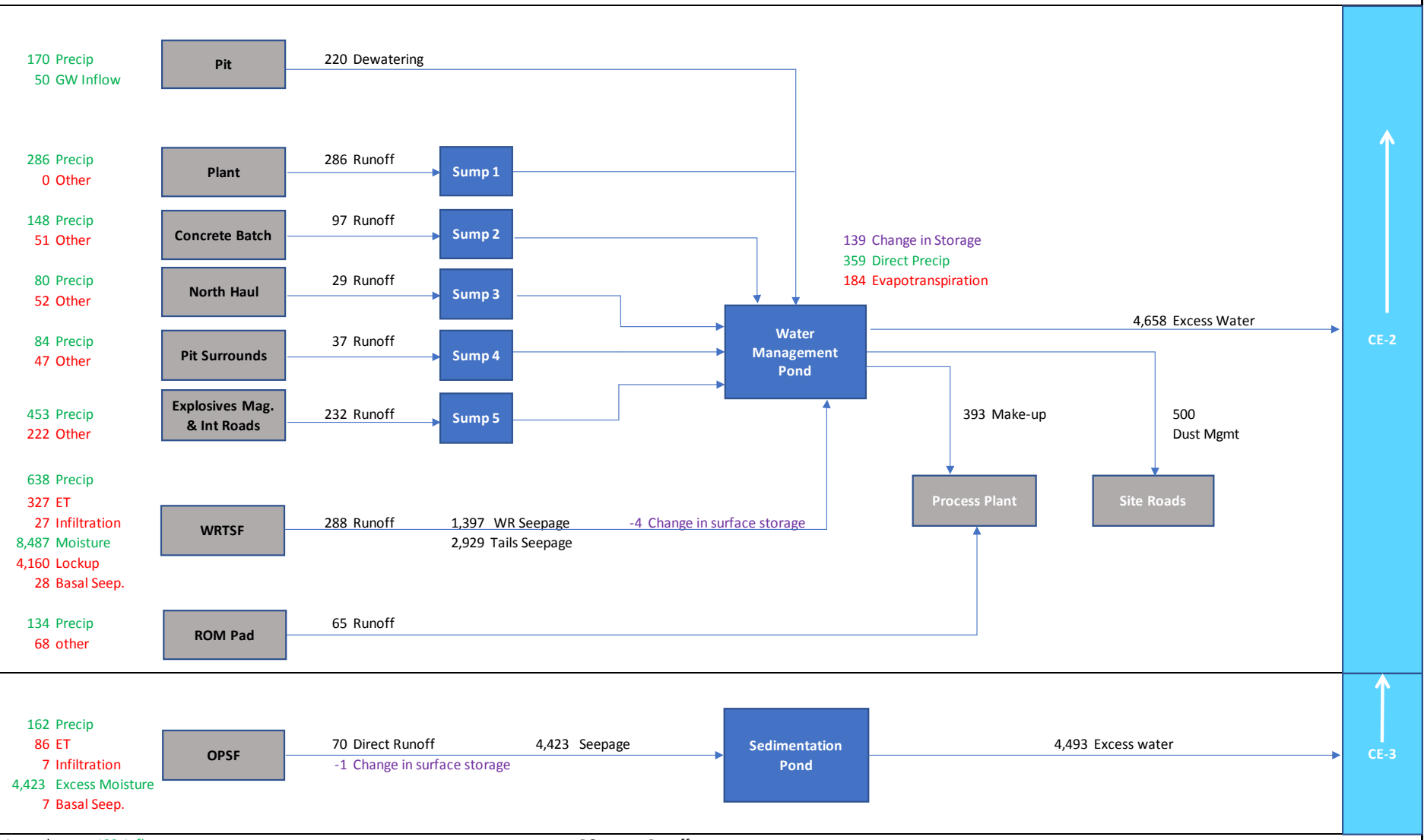
Galaxy Lithium — Site Wide Water Balance

James Bay Project - Feasibility Study

18/Jul/2019

Average Flows in m^3/day

Year	1
Functional Season	*
Climate conditions	**Normal**



Legend			
	123 Inflows	RO	Runoff
	123 Outflows to a receiver	Other	Seepage and evapotranspiration
	123 Losses and Transfers	123	Changes in storage

Stantec

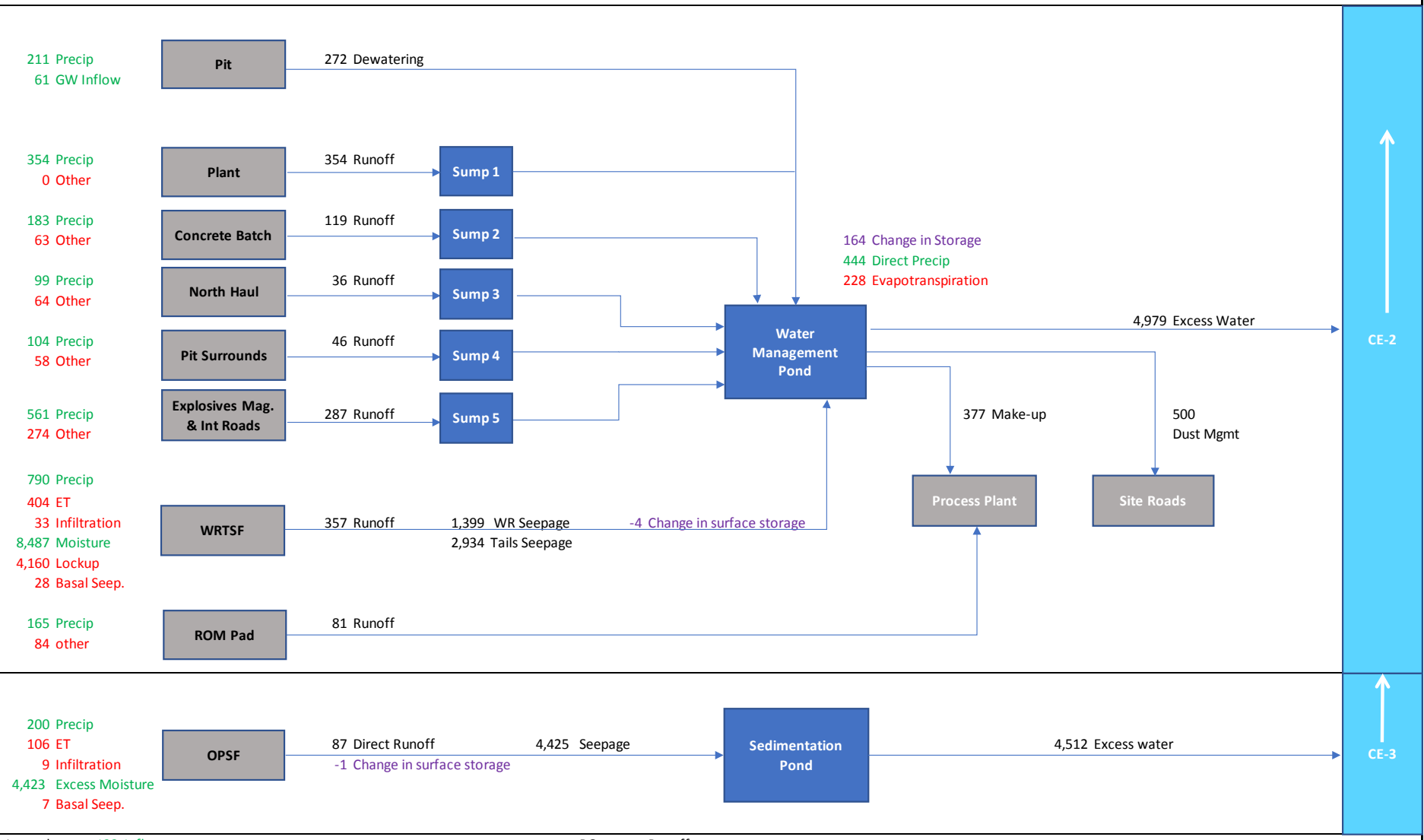
Galaxy Lithium — Site Wide Water Balance

James Bay Project - Feasibility Study

18/Jul/2019

Average Flows in m^3/day

Year	1
Functional Season	*
Climate conditions	**25 year wet**



Legend			
	123 Inflows	RO	Runoff
	123 Outflows to a receiver	Other	Seepage and evapotranspiration
	123 Losses and Transfers	123	Changes in storage

Stantec

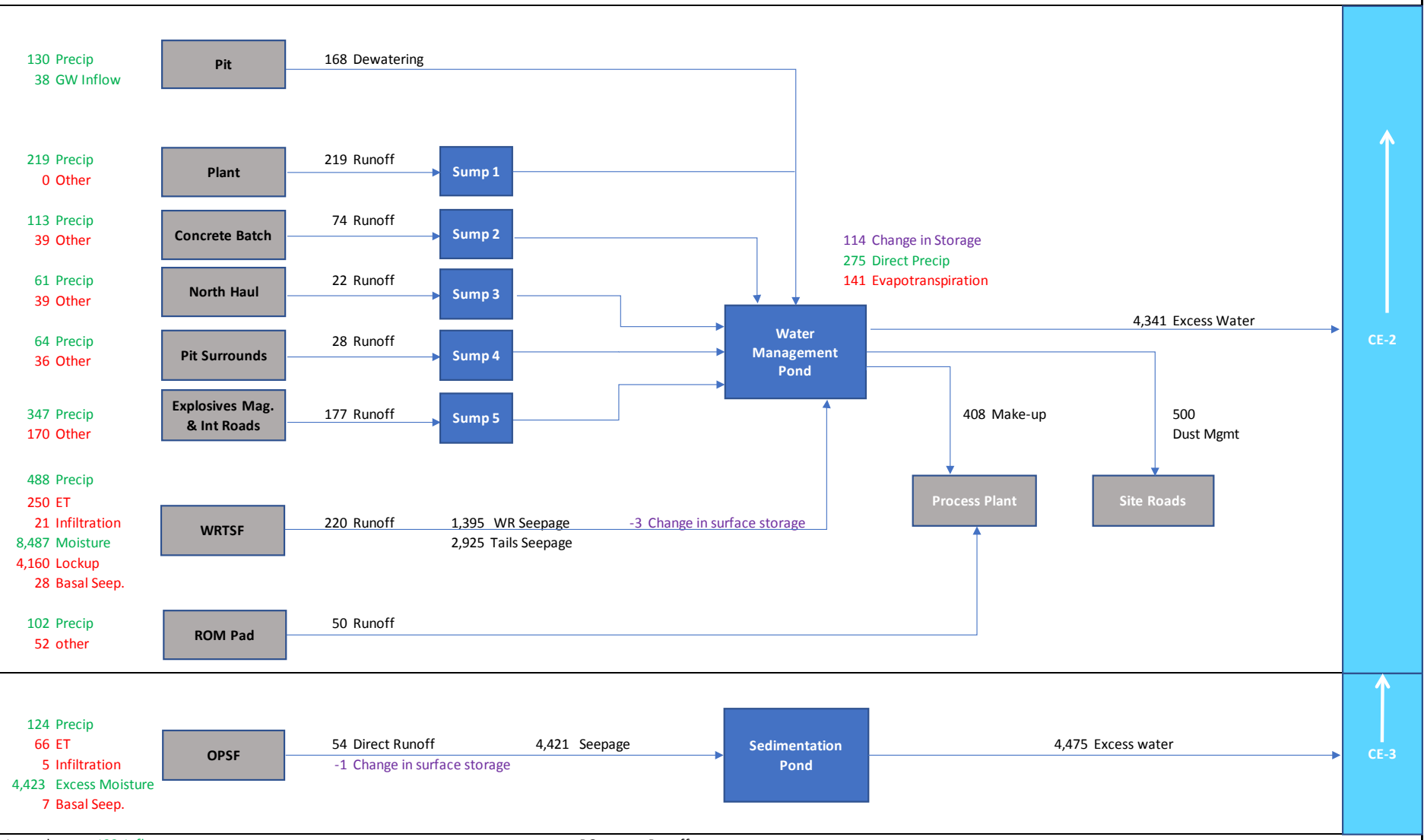
Galaxy Lithium — Site Wide Water Balance

James Bay Project - Feasibility Study

18/Jul/2019

Average Flows in m^3/day

Year	1
Functional Season	*
Climate conditions	**25 year dry**



Legend			
	123 Inflows	RO	Runoff
	123 Outflows to a receiver	Other	Seepage and evapotranspiration
	123 Losses and Transfers	123	Changes in storage

Stantec

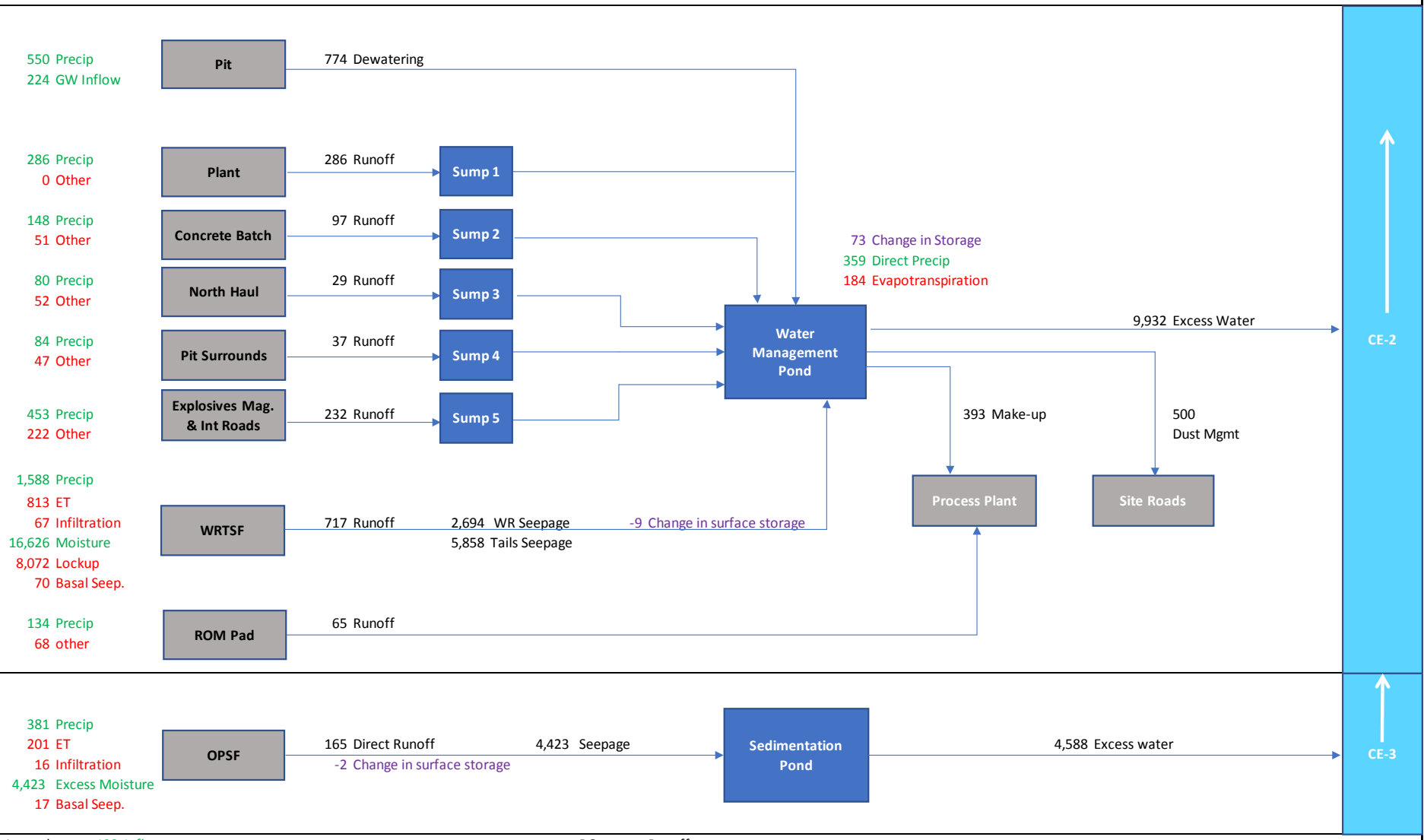
Galaxy Lithium — Site Wide Water Balance

James Bay Project - Feasibility Study

18/Jul/2019

Average Flows in m^3/day

Year	3
Functional Season	*
Climate conditions	**Normal**



Legend			
	123 Inflows	RO	Runoff
	123 Outflows to a receiver	Other	Seepage and evapotranspiration
	123 Losses and Transfers	123	Changes in storage

Stantec

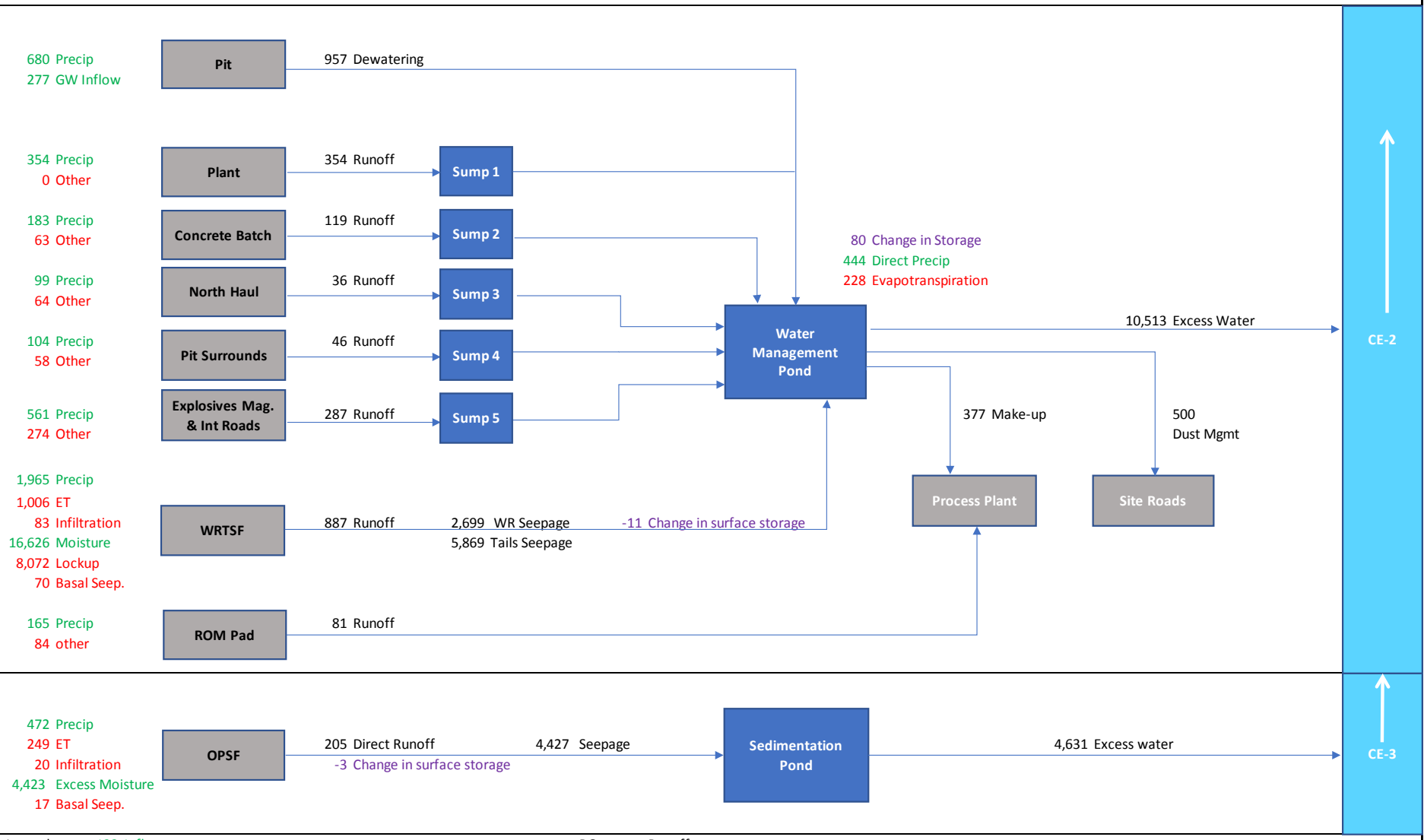
Galaxy Lithium — Site Wide Water Balance

James Bay Project - Feasibility Study

18/Jul/2019

Average Flows in m^3/day

Year	3
Functional Season	*
Climate conditions	25 year wet



Legend			
	123 Inflows	RO	Runoff
	123 Outflows to a receiver	Other	Seepage and evapotranspiration
	123 Losses and Transfers	123	Changes in storage

Stantec

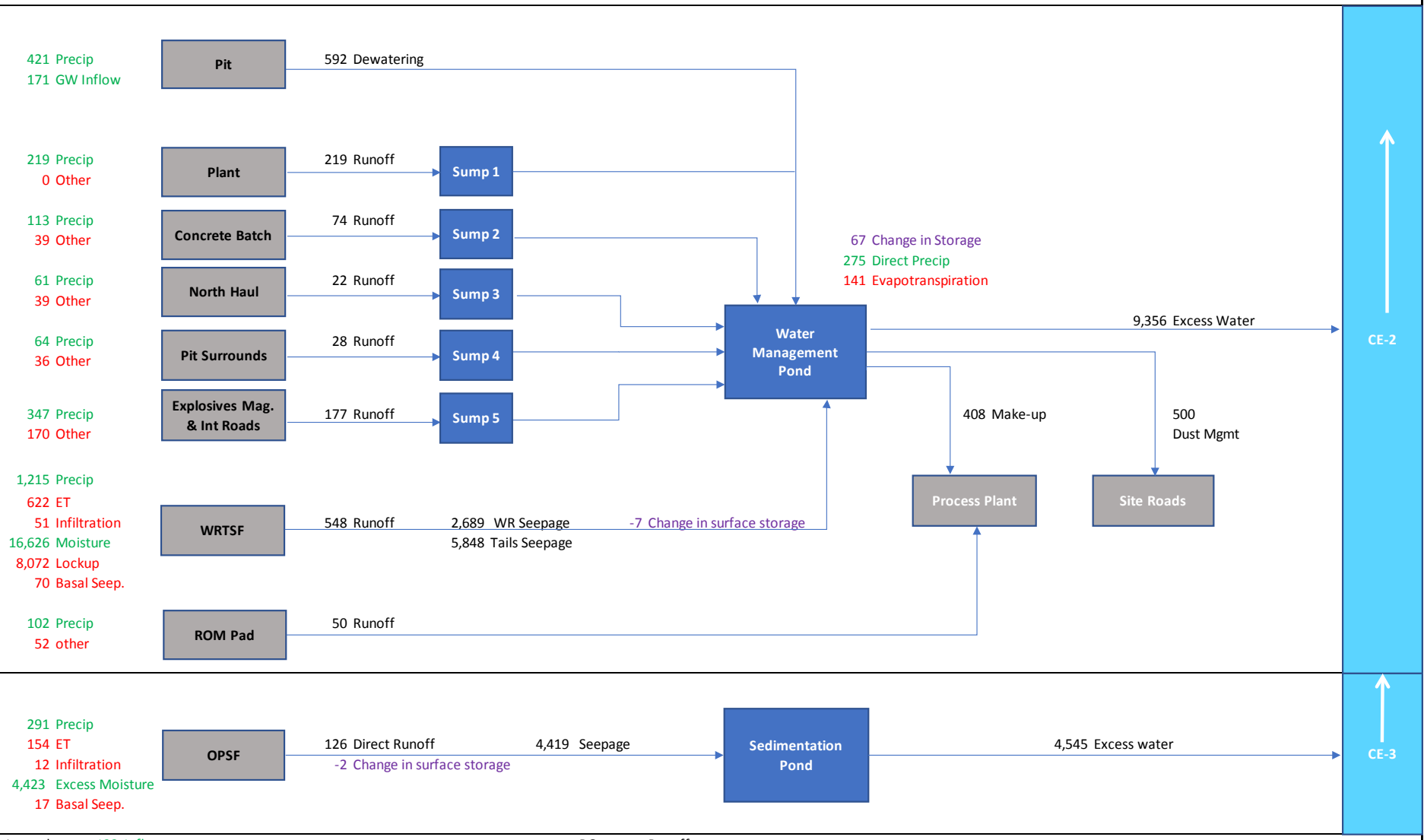
Galaxy Lithium — Site Wide Water Balance

James Bay Project - Feasibility Study

18/Jul/2019

Average Flows in m^3/day

Year	3
Functional Season	*
Climate conditions	25 year dry



Legend			
	123 Inflows	RO	Runoff
	123 Outflows to a receiver	Other	Seepage and evapotranspiration
	123 Losses and Transfers	123	Changes in storage

Stantec

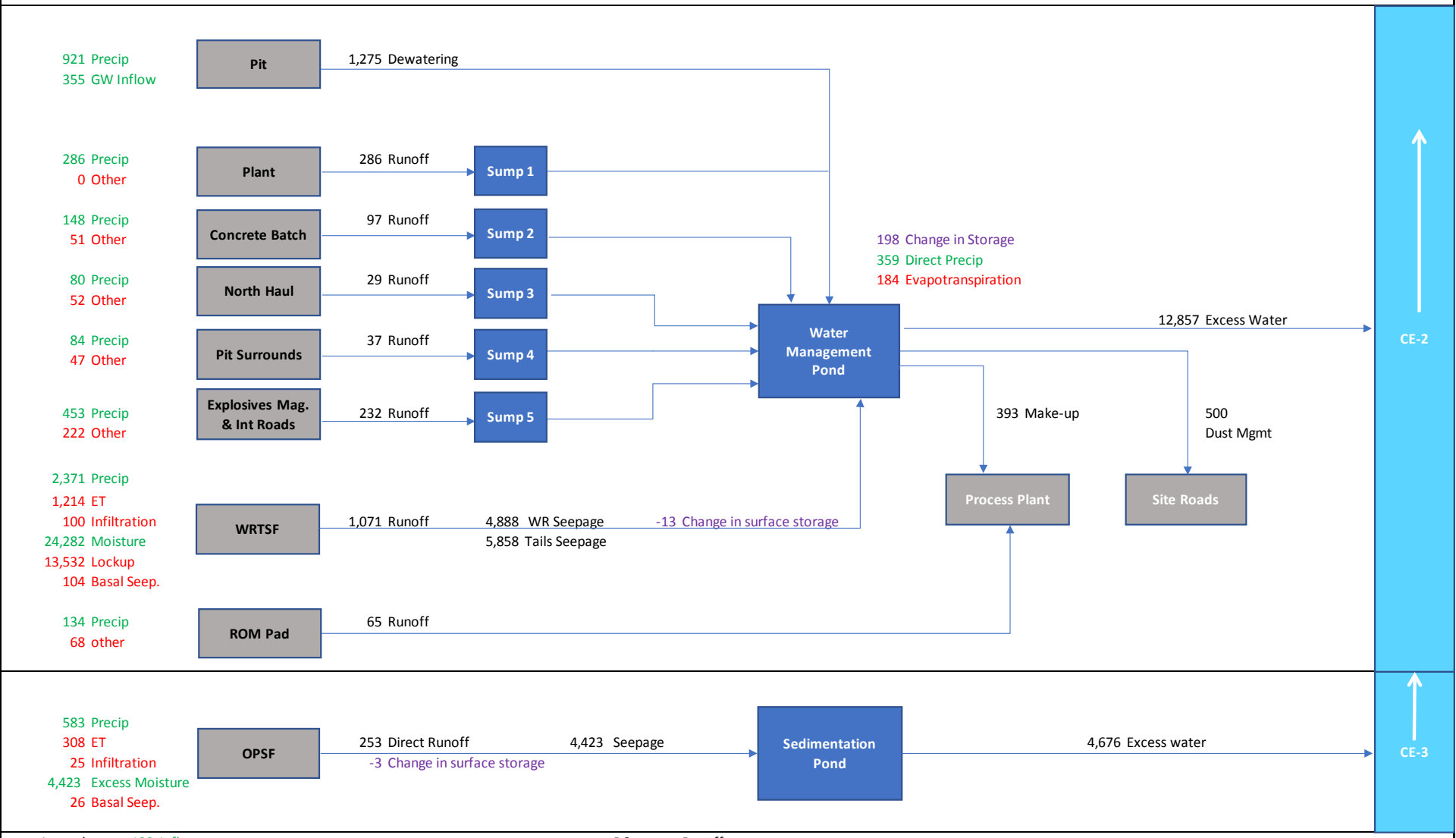
Galaxy Lithium — Site Wide Water Balance

James Bay Project - Feasibility Study

18/Jul/2019

Average Flows in m^3/day

Year	5
Functional Season	*
Climate conditions	**Normal**



Legend			
	123 Inflows	RO	Runoff
	123 Outflows to a receiver	Other	Seepage and evapotranspiration
	123 Losses and Transfers	123	Changes in storage

Stantec

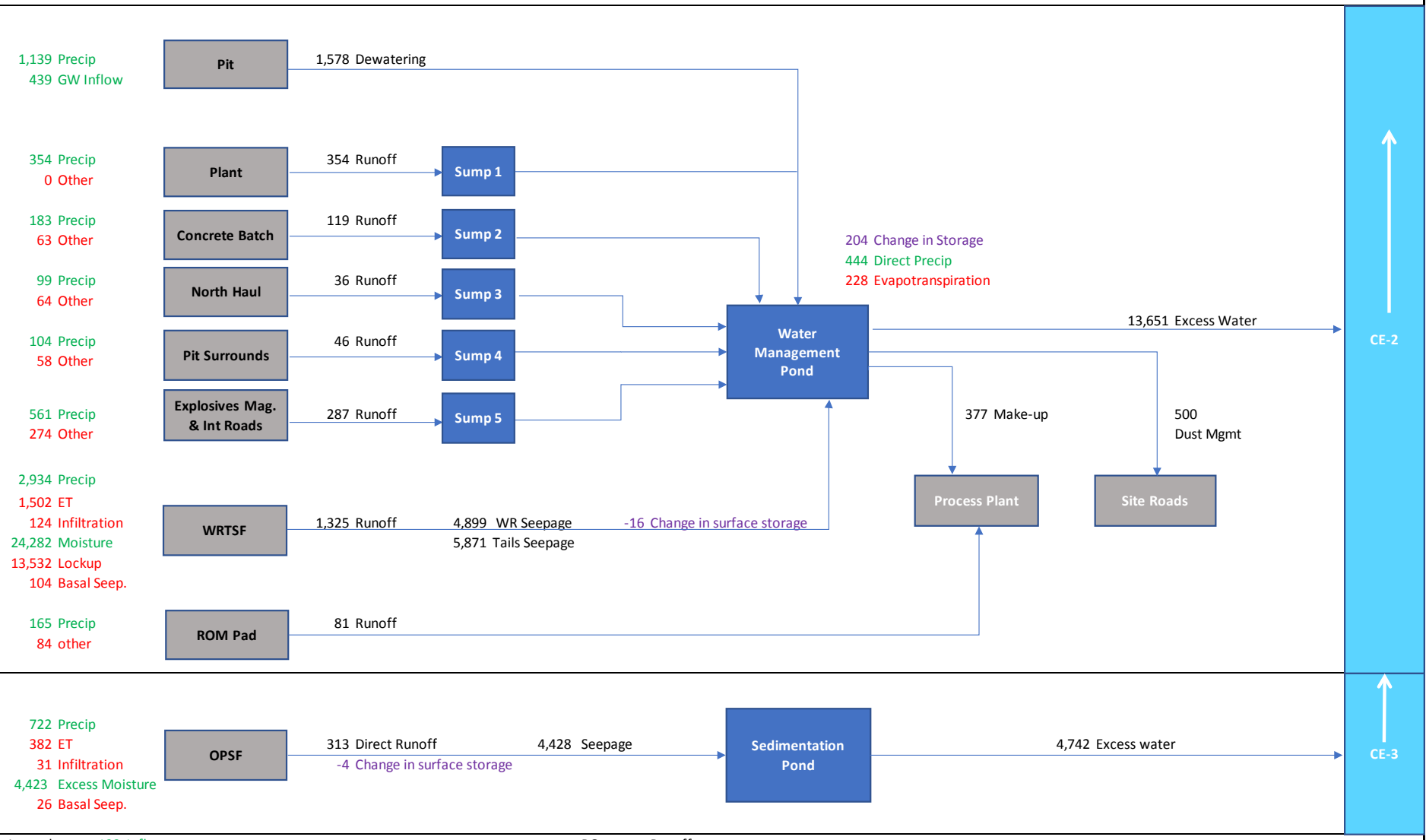
Galaxy Lithium — Site Wide Water Balance

James Bay Project - Feasibility Study

18/Jul/2019

Average Flows in m^3/day

Year	5
Functional Season	*
Climate conditions	25 year wet



Legend			
	123 Inflows	RO	Runoff
	123 Outflows to a receiver	Other	Seepage and evapotranspiration
	123 Losses and Transfers	123	Changes in storage

Stantec

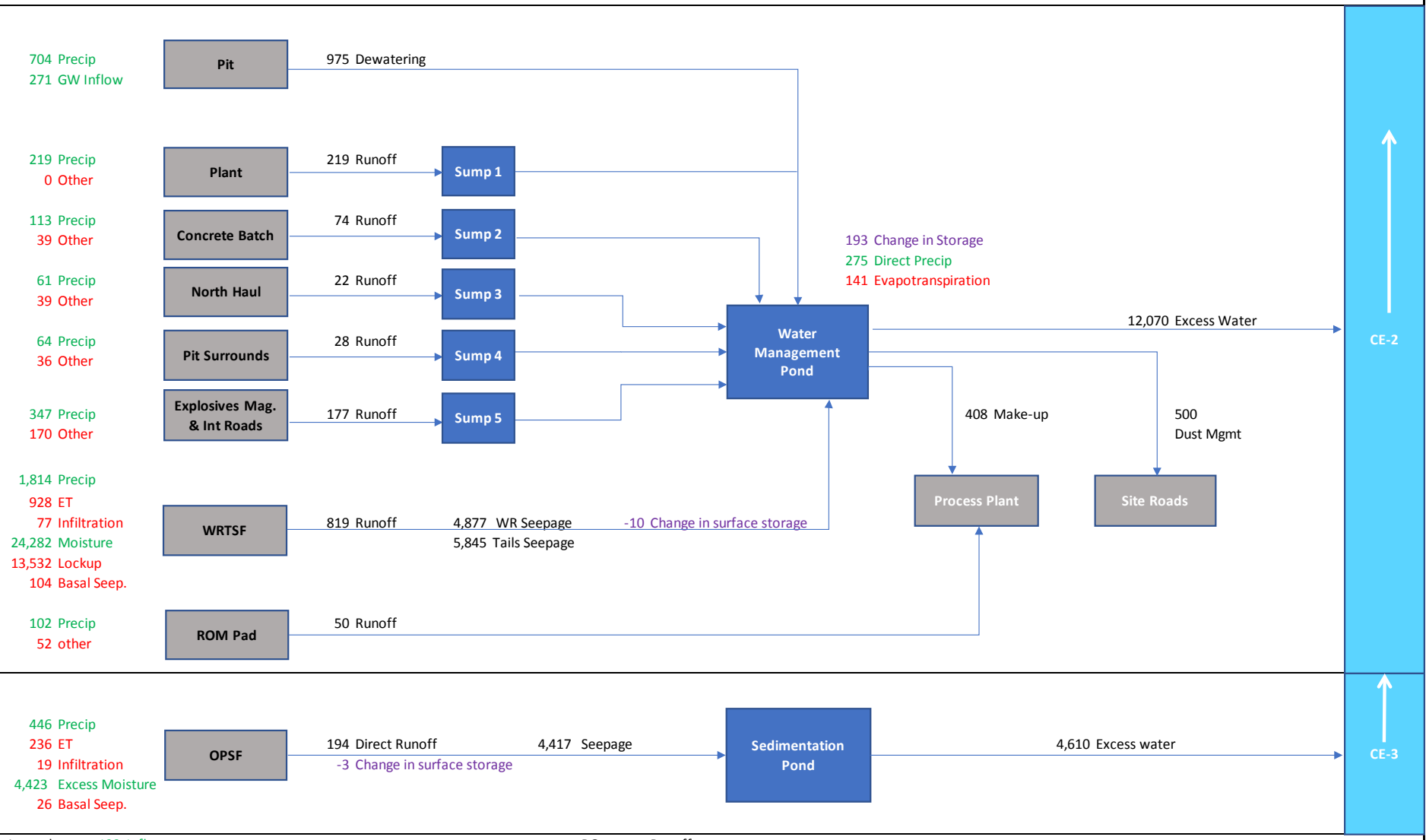
Galaxy Lithium — Site Wide Water Balance

James Bay Project - Feasibility Study

18/Jul/2019

Average Flows in m^3/day

Year	5
Functional Season	*
Climate conditions	**25 year dry**



Legend			
	123 Inflows	RO	Runoff
	123 Outflows to a receiver	Other	Seepage and evapotranspiration
	123 Losses and Transfers	123	Changes in storage

Stantec

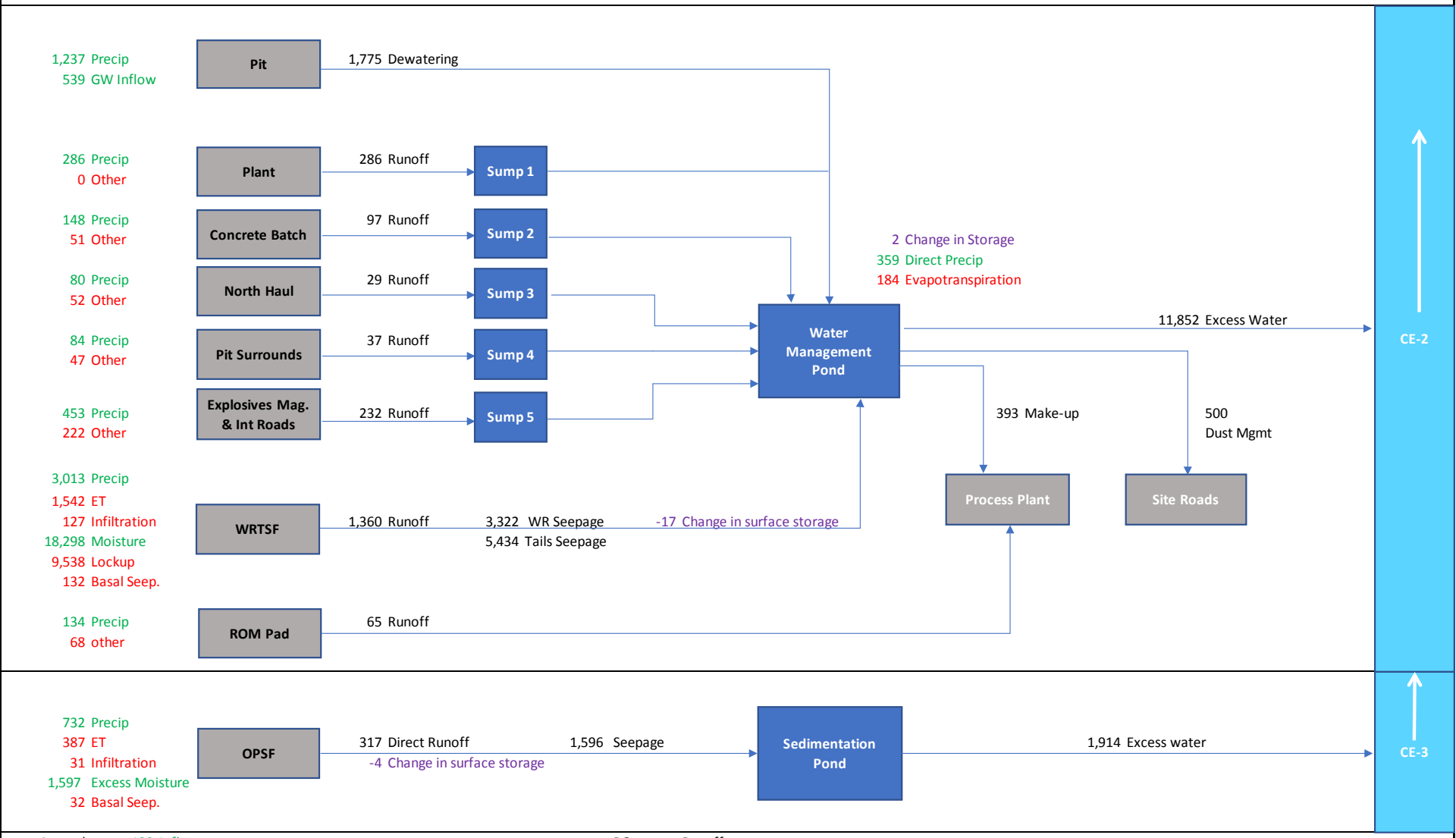
Galaxy Lithium — Site Wide Water Balance

James Bay Project - Feasibility Study

18/Jul/2019

Average Flows in m^3/day

Year	>0
Functional Season	*
Climate conditions	**Normal**



Legend			
	123 Inflows	RO	Runoff
	123 Outflows to a receiver	Other	Seepage and evapotranspiration
	123 Losses and Transfers	123	Changes in storage

Stantec

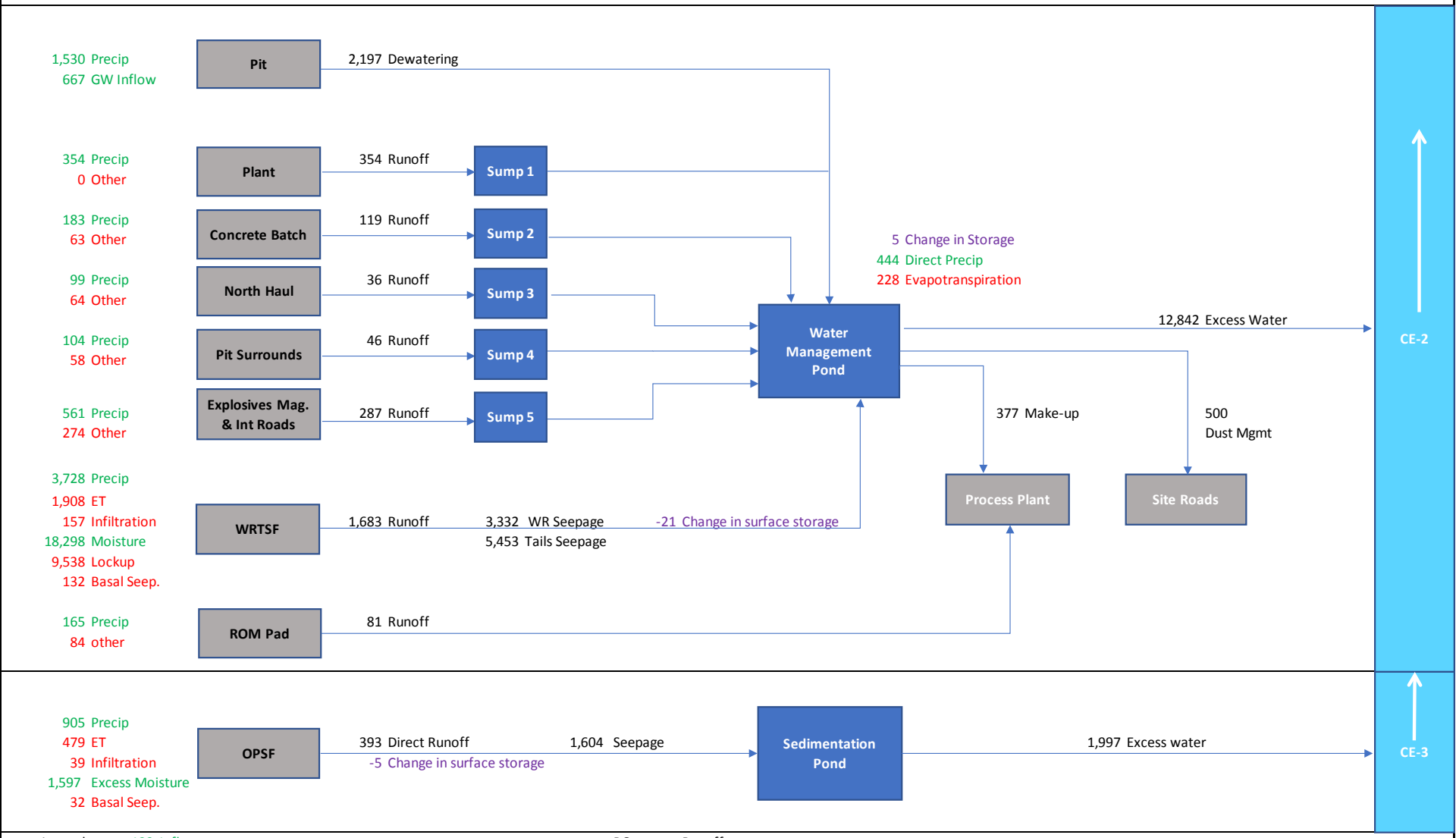
Galaxy Lithium — Site Wide Water Balance

James Bay Project - Feasibility Study

18/Jul/2019

Average Flows in m^3/day

Year	>0
Functional Season	*
Climate conditions	**25 year wet**



Legend			
	123 Inflows	RO	Runoff
	123 Outflows to a receiver	Other	Seepage and evapotranspiration
	123 Losses and Transfers	123	Changes in storage

Stantec

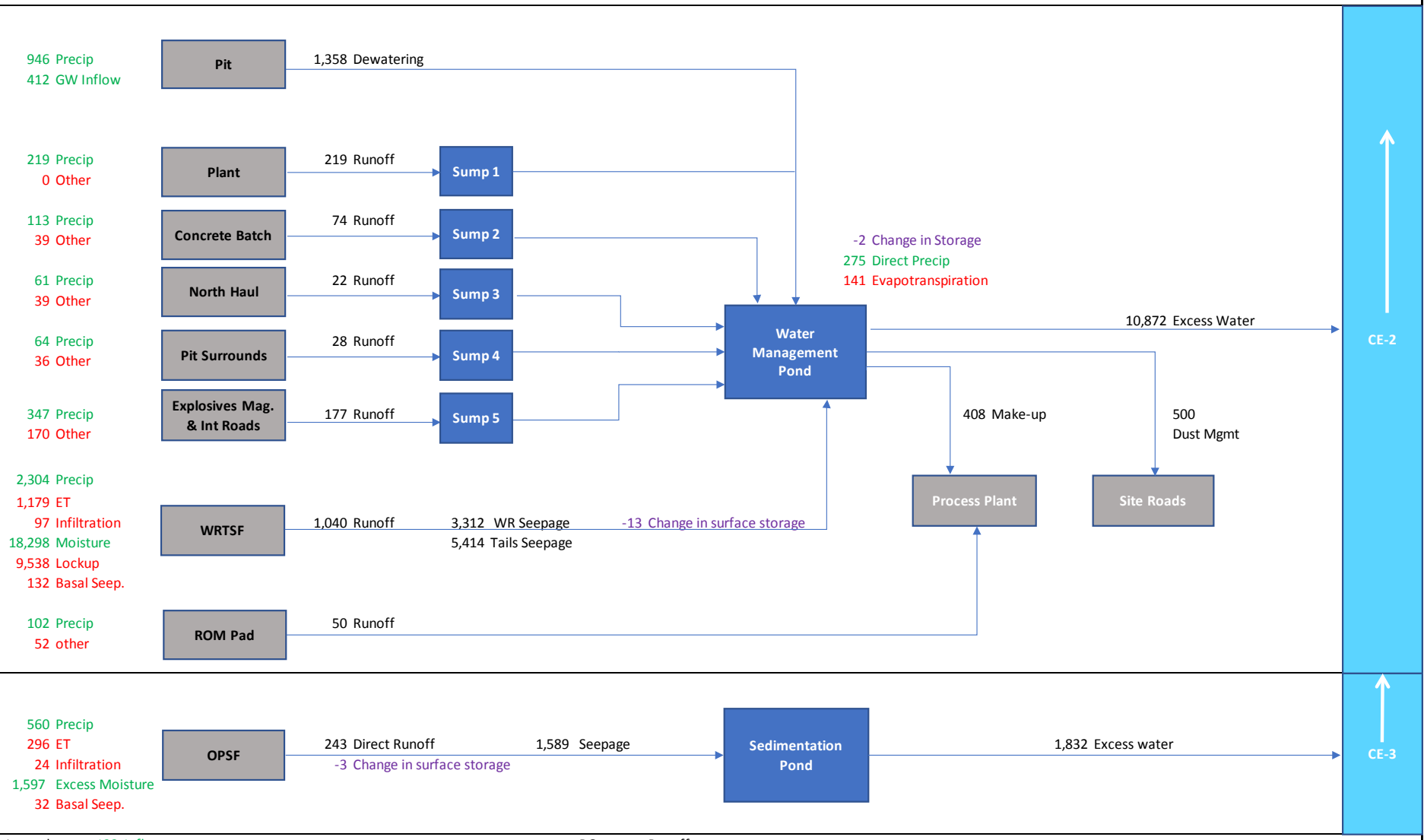
Galaxy Lithium — Site Wide Water Balance

James Bay Project - Feasibility Study

18/Jul/2019

Average Flows in m^3/day

Year	>0
Functional Season	*
Climate conditions	**25 year dry**



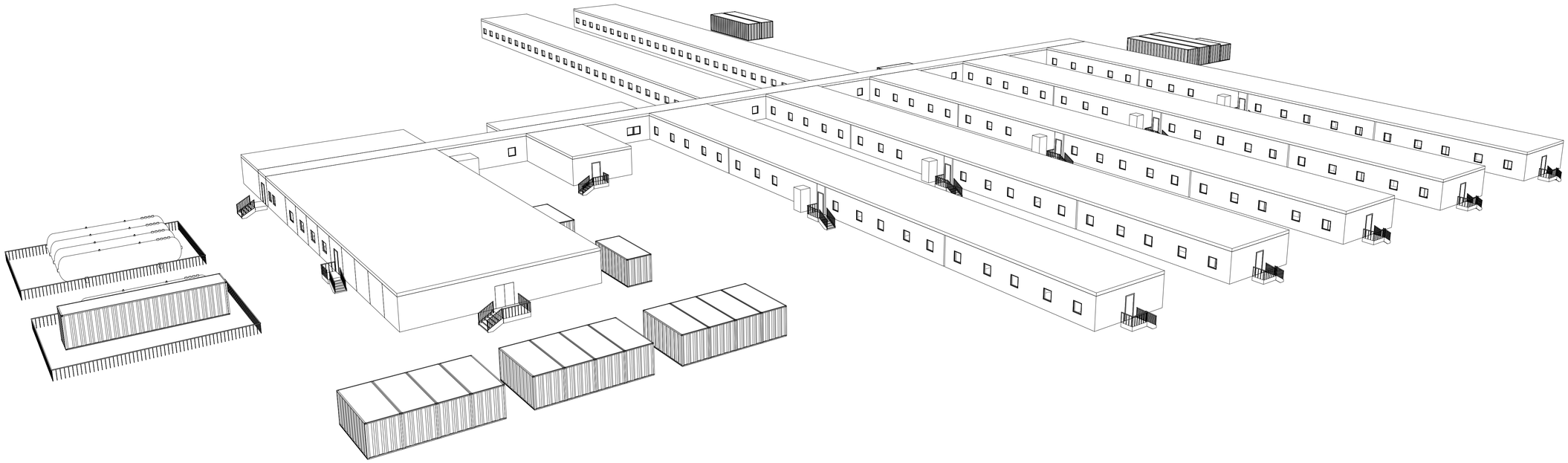
Legend			
	123 Inflows	RO	Runoff
	123 Outflows to a receiver	Other	Seepage and evapotranspiration
	123 Losses and Transfers	123	Changes in storage

Stantec

APPENDIX

A-64

WORK CAMP DESIGN



1 3D View Camp

Outland
une division de Carillion
Approche locale, expertise globale.

www.outlandcamps.ca

Outland camps
200, 6e rue Ouest
Amos, QC
J9T 2T5
Tél. : (819) 727-5556
Téléc. : (819) 727-4656

No.	Description	Date

CAMPEMENT 278 PERSONNES

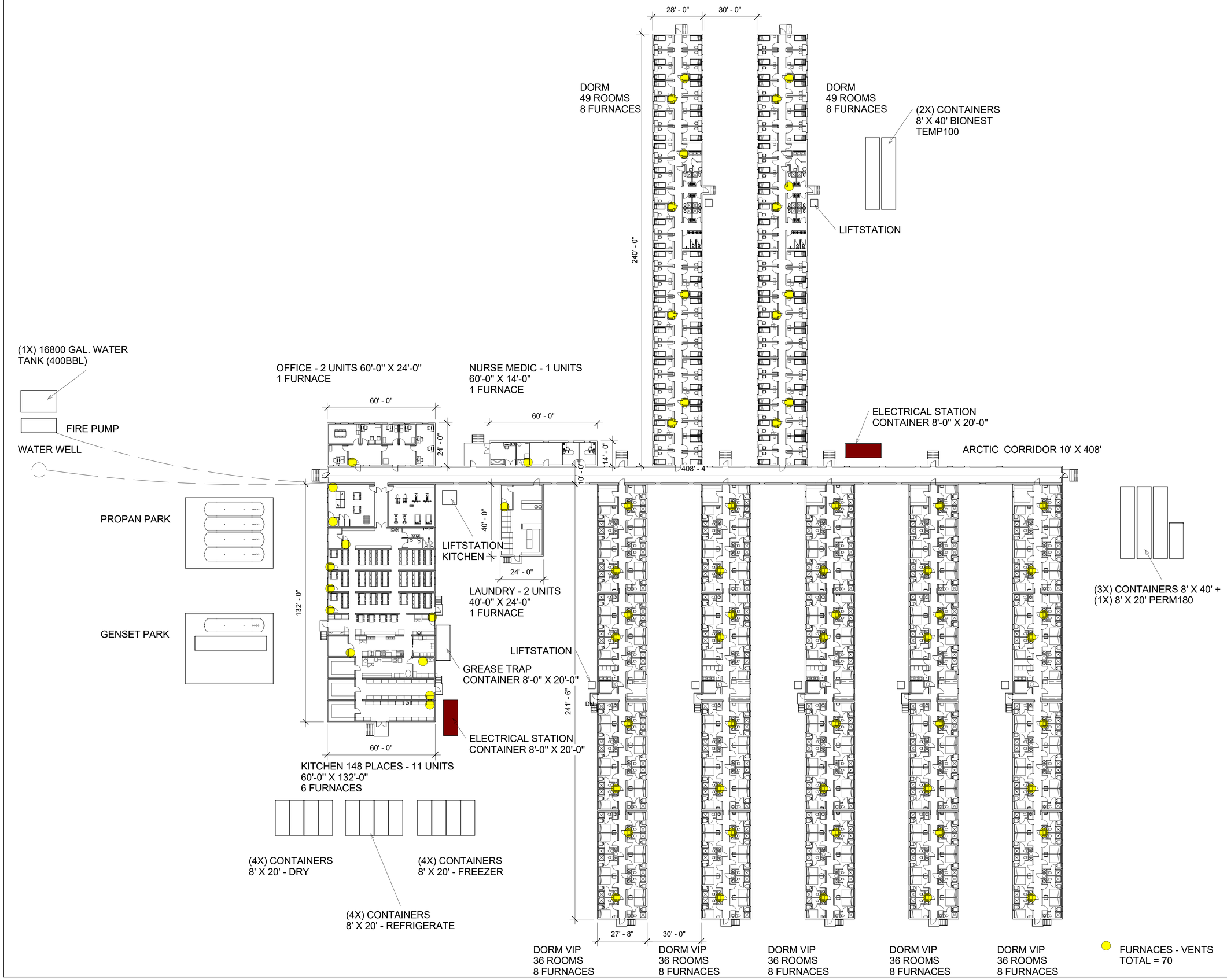
VIEW

Project number	0001
Date	08-03-2018
Drawn by	S.R.
Checked by	S.R.

A100

Scale

08/03/2018 16:18:59



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www.outlandcamps.ca

Outland camps
200, 6e rue Ouest
Amos, QC
J9T 2T5
Tél. : (819) 727-5556
Téléc. : (819) 727-4656

No.	Description	Date

CAMPEMENT 278 PERSONNES

PLAN

Project number	0001
Date	08-03-2018
Drawn by	S.R.
Checked by	S.R.

A101

Scale	1 : 300

08/03/2018 16:20:06

APPENDIX

A-71

DESCRIPTION OF THE MATAGAMI TRANS-SHIPMENT CENTRE

VILLE DE MATAGAMI

cour de transbordement Matagami

DESCRIPTION DU CENTRE DE TRANSBORDEMENT DE MATAGAMI

La cour de transbordement de Matagami appartient à la Ville de Matagami. La Ville a pour mandat de mettre en valeur ce site en lui redonnant ses fonctions d'antan. Lieu principal de logistique pour la construction du complexe hydroélectrique La Grande, la cour de transbordement possède un réseau de voies ferrées de 4 kilomètres, 250 000 mètres carrés d'espace d'entreposage et presque tout autant de terrain prêt à être aménagé. On y retrouve un entrepôt de 1 500 mètres carrés et une capacité d'entreposage de 3 400 tonnes en silos. La cour de transbordement est le point le plus nordique de l'Ouest du Québec pour rejoindre le réseau ferroviaire national et son intermodalité avec la route de la Baie-James en fait un endroit incontournable pour toutes les questions de logistique et d'optimisation du transport de marchandises.

Depuis qu'elle est propriétaire de la cour de transbordement, la Ville de Matagami a remis pleinement opérationnelle son infrastructure.

En 2016, nous avons refait les accès à la cour en installant une nouvelle clôture dotée d'un système de contrôle par carte magnétique. Nous avons effectué un grand nettoyage en dégageant tous les espaces d'entreposage extérieur, en dégageant la végétation qui empiétait sur les voies ferrées et en nettoyant également toutes les aires de manutention.

Nous avons sécurisé notre entrepôt afin de le rendre prêt pour utilisation immédiate. Il s'agit d'une infrastructure d'entreposage intérieure. L'entrepôt donne directement sur la voie ferrée et possède une aire de manutention asphaltée. En 2018 nous avons investi des sommes importantes pour rendre l'entrepôt pleinement fonctionnel et corriger certaines déficiences au niveau de l'enveloppe et de l'isolation du bâtiment.

Toujours en 2016, nous avons procédé à la mise à niveau de 1 200 mètres de voie ferrées en remplaçant les traverses et en procédant au nivellement des voies, ce qui nous donne un réseau pleinement opérationnel dans l'immédiat. Une portion d'environ 700 mètres demeure à être mise à niveau, ce qui est prévu pour l'automne 2019 ou le printemps 2020.

Nous avons procédé à l'installation d'un nouveau poste de pesée pouvant recevoir jusqu'à 100 tonnes nettes et d'une longueur de 27,4 mètres muni d'un système électronique d'accès permettant une facturation simple par usager.

Nous avons également investi massivement dans la réfection de nos silos afin de les remettre en opération pour alimenter les entreprises minières de la région. Cet investissement permet à tous de réduire leurs coûts d'opération.

La cour de transbordement de Matagami est sise au 2200, boulevard Industriel, soit le long de la route 109 au sud de Matagami, directement en continuité avec la route de la Baie-James. La

localisation exacte est 49°44'05.5"N 77°41'02.4"O. Pour plus de détails et d'images à jour, le site www.ct-matagami.com peut être consulté.

Il est à noter que la cour de transbordement de Matagami est déjà en opération et travaille avec de nombreux clients dont la Société de développement de la Baie-James, Newmont-Goldcorp, Lafarge-Holcim, le Canadien National, Hydro-Québec et le Réseau de communication Eeyou.

La cour de transbordement se positionne comme un lieu incontournable pour la logistique nordique et s'intègre dans une stratégie globale de développement qui aura des effets structurants sur toute la région. De nombreux projets sont en développement afin de faciliter le transbordement de produits en vrac et en vue d'innover pour les moyens de transport de demain.

Le site, utilisé pour la logistique de la construction du complexe hydroélectrique La Grande, possède une énorme capacité de transbordement. Plus de 250 000 mètres carrés de terrain sont disponibles immédiatement pour des opérations de transbordement. Dans le cadre du projet James Bay Lithium (JBL) de Galaxy, bien que nous n'en soyons qu'à l'étape des esquisses pour les aménagements requis, nous estimons que les besoins sont de l'ordre de 30 000 mètres carrés tout au plus, donc bien loin de la capacité disponible actuelle du site.

Les aménagements requis pour le transbordement des produits de JBL sont sommaires. Un dôme extérieur sera aménagé afin que les camions puissent y décharger leur cargaison. Le tout sera sur dalle de béton. Le dôme sera à proximité de la voie ferrée C-56 sur laquelle seront chargés des wagons de type gondole avec un chargeur frontal sur roues (front end loader). Il s'agit d'une opération conventionnelle, simple et efficace. Les seuls travaux requis pour procéder au transbordement sont ceux de l'aménagement du dôme dont les dimensions officielles ne sont pas encore arrêtées, les variables du scénario final d'opération n'étant pas encore entièrement déterminées. La fréquence des jours de service du CN, le type de camion utilisé, la dimension des gondoles, le type de couvercles et la destination finale peuvent avoir des incidences sur les choix techniques à venir.

Quelques partenaires seront impliqués dans les opérations de transbordement, dont les transporteurs et des sous-traitants pour la manutention à proprement dite, car ce ne sont pas les employés de la Ville de Matagami qui réaliseront les opérations sur le terrain. La Ville demeure essentiellement le propriétaire et un gestionnaire de l'infrastructure. Il est intéressant de rappeler que la cour de transbordement de Matagami est un outil collectif qui génère de l'activité économique locale et contribue à diversifier les sources de revenus de la municipalité.

Daniel Cliche
Directeur du développement

cour de transbordement

GT Matagami

chaîne logistique COMPLÈTE SOLUTION robuste

Document de présentation à l'intention de
GALAXY pour le projet JAMES BAY LITHIUM

Propositions

01. Transport

Scénarios pour le transport routier

02. Manutention

Transbordement et consolidation de matériel

03. Expédition

Une chaîne d'approvisionnement robuste, de la mine au port

04. Environnement

Minimiser les impacts environnementaux des activités de transport

cour de transbordement
Matagami

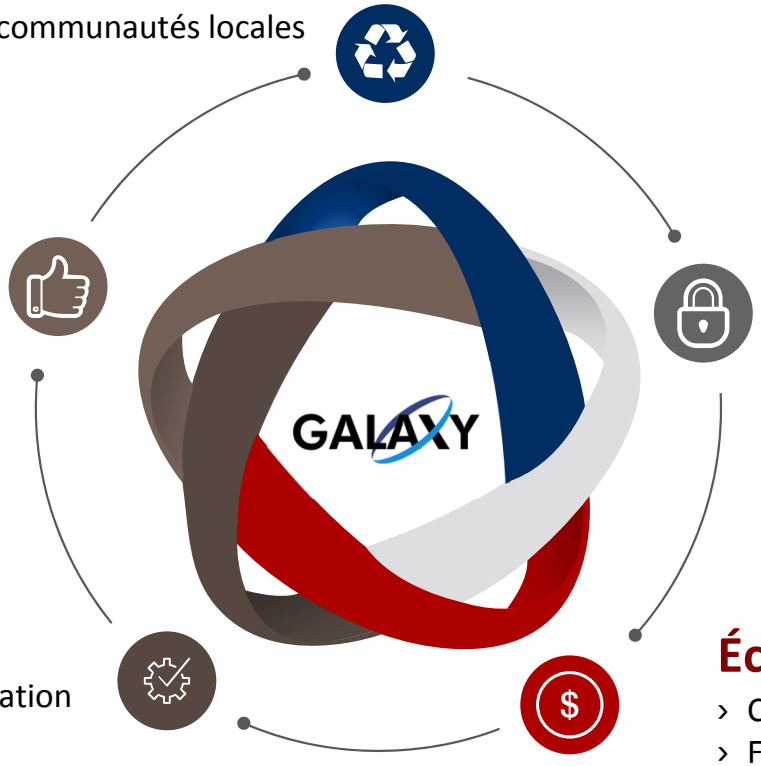
Des solutions qui tiennent compte de tous les aspects

Environnement

- Protection de la nature
- Collaboration des communautés locales

Acceptabilité

- Matagami
- Partenaires Cris
- Partenaires gouvernementaux
- Partenaires d'affaires.



Sécurité

- Transport routier
- Manutention
- Entreposage
- Expédition
- Approvisionnement

Efficience

- Transport routier
- Manutention et consolidation
- Respect des échéanciers
- Souplesse et flexibilité.

Économie

- Capital initial
- Frais d'opération
- Gestion du risque.

cour de transbordement
Matagami

cour de transbordement
Matagami

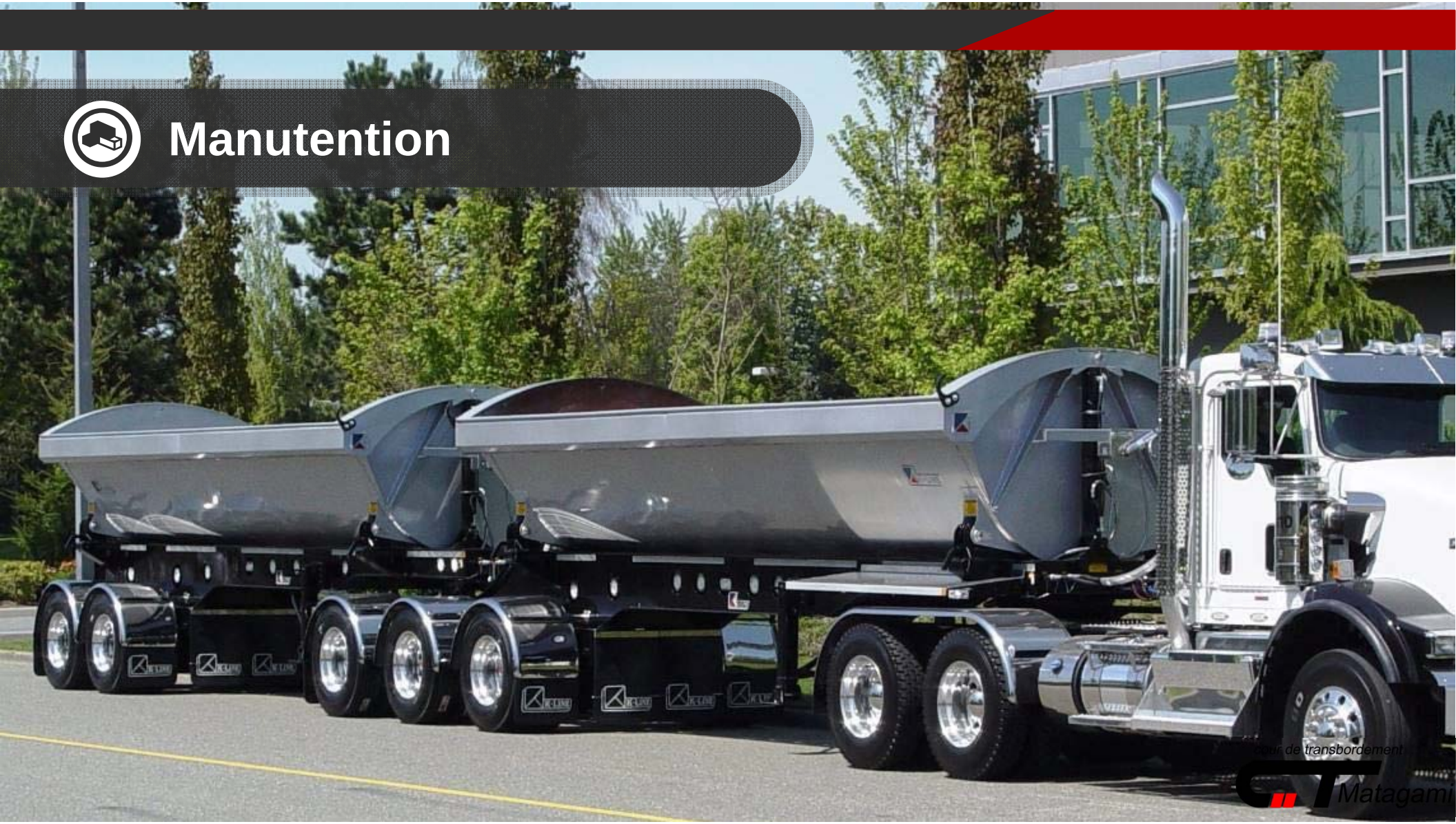
cour de transbordement
Matagami

Manutention

- Méthode de déchargement proposée
- Entreposage du matériel selon vos besoins
- Méthode de chargement des wagons

cour de transbordement
CT Matagami

Manutention



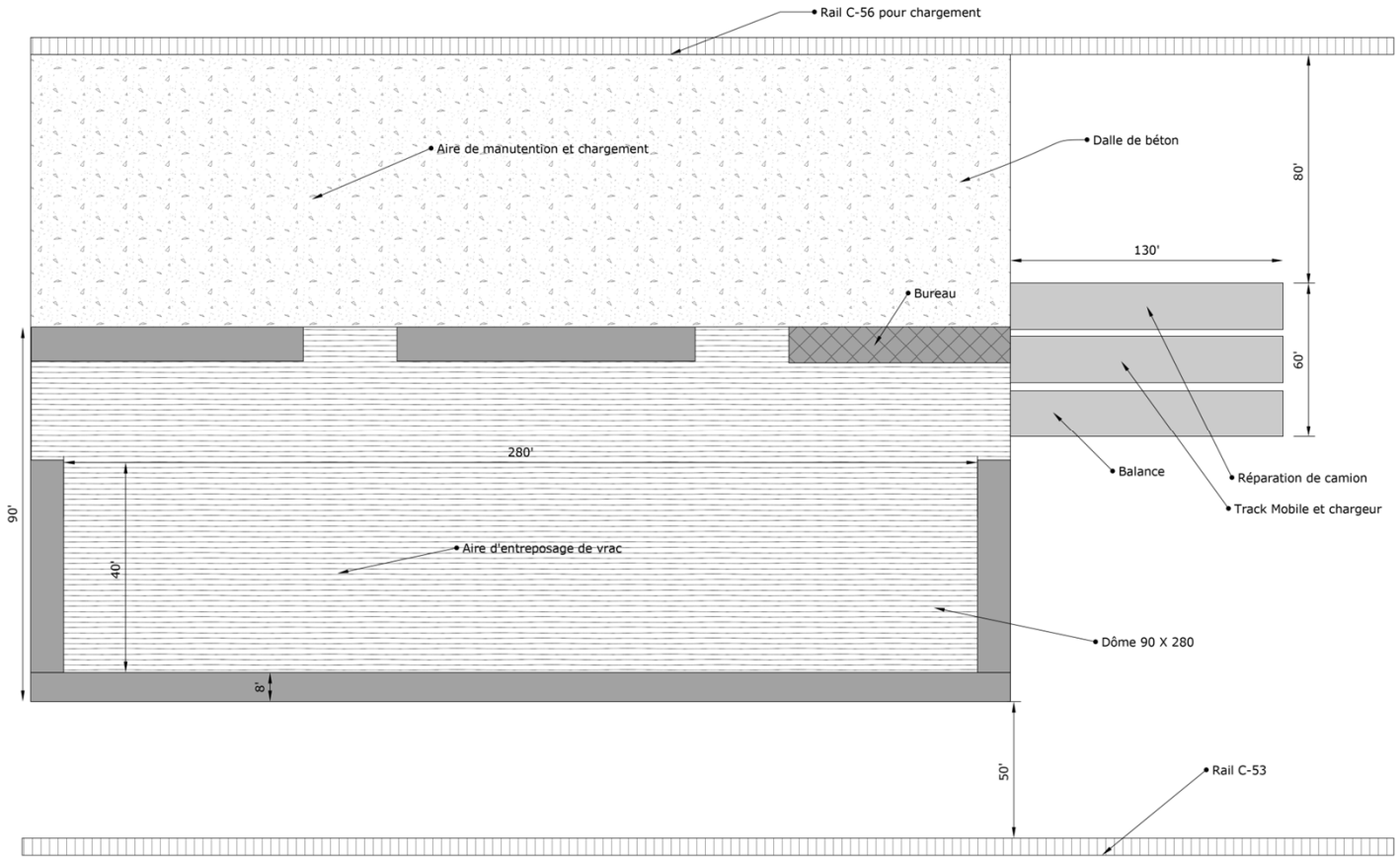
cour de transbordement
Matagami

Manutention

- Méthode de chargement des wagons
  - Chargeur frontal:
    - Disponibilité d’équipement
    - Versatilité d’équipement
    - Facilité d’entretien
    - Robustesse et fiabilité
    - Capitalisation minimale

cour de transbordement
CT Matagami

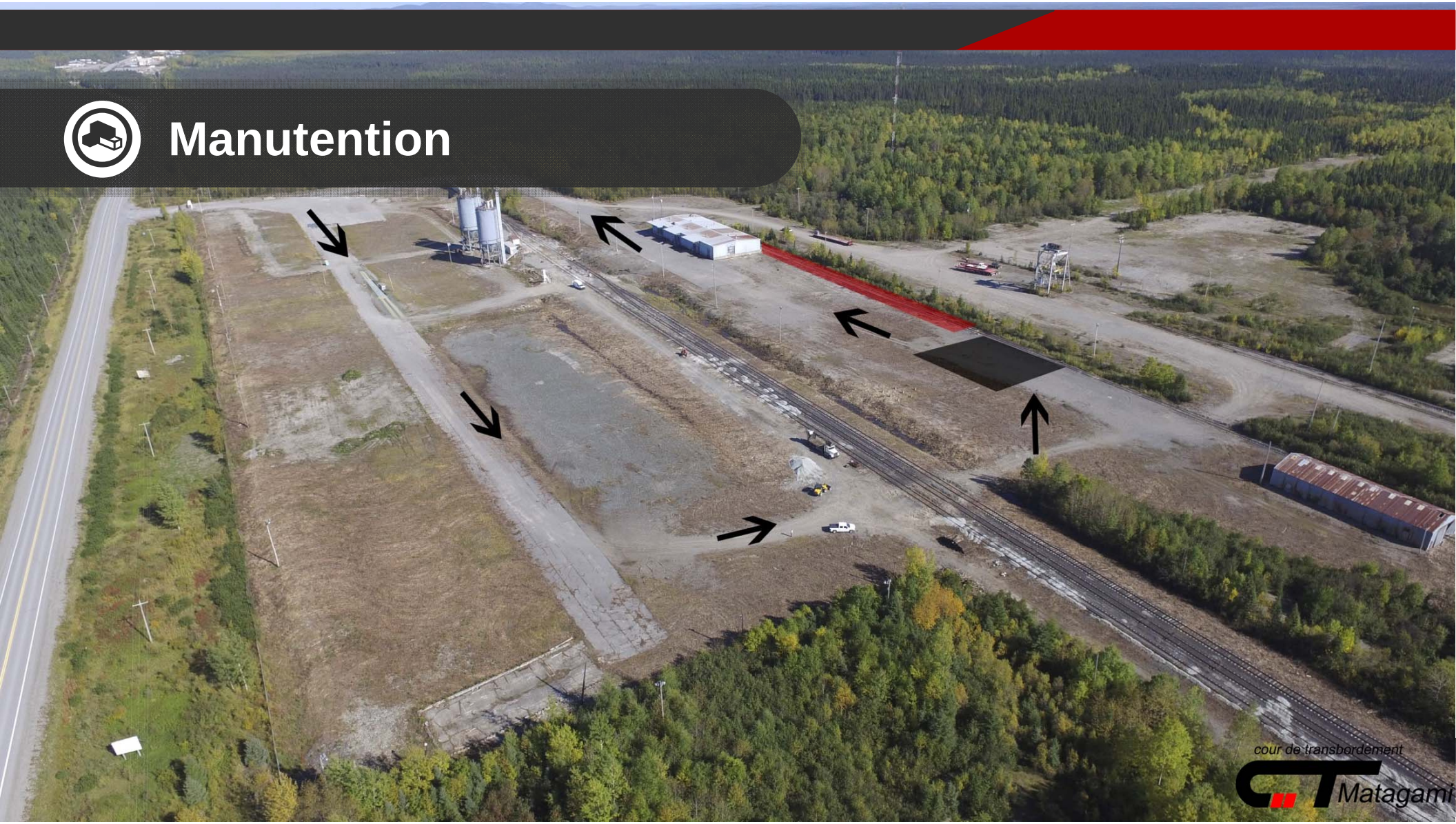
Manutention



cour de transbordement

Matagami

Manutention



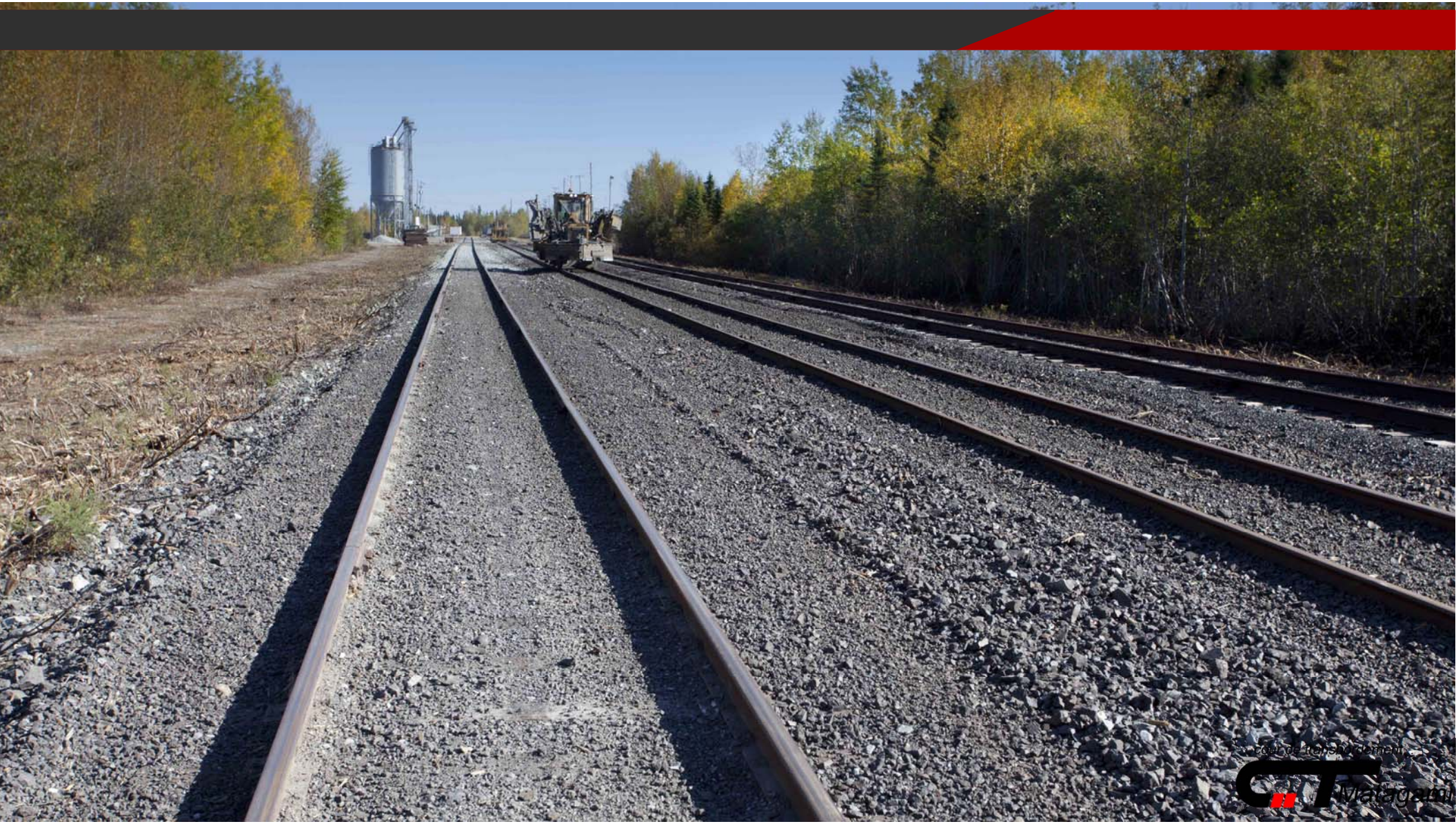
cour de transbordement

Matagami

Expédition

- Quel est le plan de contingence:
  - Pour le chemin de fer:
    - Entreposage à Matagami pour une semaine de production
    - Utilisation de la route jusqu'à Val d'Or
    - Utilisation de la route jusqu'au port ou l'usine
    - Capacité d'entreposage de wagons à Matagami (Demeurage)
    - Capacité d'entreposage de wagons à Senneterre (Demeurage)

cour de transbordement
CT Matagami


Top of the Shelf Marketing
Matagami

Environnement

- Les mesures prises pour la protection de l'environnement:
  - Durant le transport
  - Pour la manutention
  - Pour l'entreposage
  - Pour l'expédition

cour de transbordement
CT Matagami

Environnement

- Quelles sont les mesures prises pour la protection de l'environnement:
  - Durant le transport:
    - Le train émet moins de GES que le camion
    - Possibilités de consolidation du transport à vide
      - Métal
      - Bois
      - Matières résiduelles
      - Échantillons de laboratoire
      - Conteneurs spécialisés

cour de transbordement
CT Matagami

Environnement

- Quelles sont les mesures prises pour la protection de l'environnement:
  - Pour la manutention:
    - Site industriel reconnu, en bordure d'une route principale, éloignée du milieu habité:
      - Bruit
      - Circulation
      - Vibration
      - Poussière

cour de transbordement
CT Matagami

Environnement

- Quelles sont les mesures prises pour la protection de l'environnement:
  - Pour l'entreposage:
    - Site existant sans empreinte supplémentaire au sol
    - Possibilité de réduire l'empreinte au sol à la mine avec de l'entreposage à Matagami
    - Consolidation du transport pour approvisionnement

cour de transbordement
CT Matagami

Environnement

- Quelles sont les mesures prises pour la protection de l'environnement:
  - Pour l'expédition
    - Pas de communautés locales à traverser
    - Peu d'impacts sur les routes provinciales

cour de transbordement
CT Matagami

cour de transbordement
Matagami

Économie locale

- Maximiser les retombées économiques locales
  - Offrir le transport aérien depuis Matagami
  - Consolider de l'approvisionnement à Matagami
  - Faire la promotion des emplois à venir
  - Installer un bureau de supervision et d'entretien
  - Agent de liaison
  - Prévoir un mécanisme d'achat décentralisé avec soumission de comparaison
  - Location de maison à long terme

cour de transbordement
CT Matagami

cour de transbordement
Matagami

Construction

- Transport hors-normes depuis Matagami
- Potentiel de travaux hors décret
- Potentiel de pré-assemblage et entreposage
- Livraison « juste à temps »
- Réduction des délais d'obtention des permis
  - Transport
  - Usage du territoire
- Réutilisation des infrastructures d'entreposage pour la construction

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CT Matagami

580 Super L
CAT
cour de transbordement
Matagami

APPENDIX

A-72

CLOSURE AND RESTAURATION COSTS

SANEXEN
ENVIRONMENTAL SERVICES INC.

May 17, 2018

Mr. Jacques Parent
General Manager Americas
Primero Americas
2000 Peel Street, Suite 905
Montreal, Quebec H3A 2W5

O/Ref.: RE18-408

Subject: Cost Estimate – Galaxy Lithium Mine Closure

Dear Mr. Parent:

Sanexen Environmental Services Inc. (Sanexen) is pleased to present the enclosed appraisal for the closure and post-restoration monitoring of the above-mentioned site.

1. CONTEXT AND OBJECTIVE

The Australian Company Galaxy Resources recently updated its resources at the James Bay lithium mine, located near the Km 381 rest stop on the James Bay Road. The company intends to mine an estimated 40 million tonnes of lithium-bearing ore over a period of approximately 20 years.

To complete the feasibility study, Primero Americas. retained Sanexen to perform an appraisal of the closure and restoration costs related to this project.

2. SITE CLOSURE

2.1 Characterization

Following a definitive cessation of activities, the mining company is required to perform a **characterization study** of the property, as this type of activity falls into one of the categories listed in Schedule III of the LPRR[1]. As part of the study, particular attention will be paid to areas likely to have been contaminated mainly by PHCs[2] and metals. All areas where petroleum product storage tanks and transfer sites may have been present prior to and during mining operations, as well as the ROM pad and all petroleum product transfer sites will be sampled and analyzed to confirm the degree of contamination.

1 Land Protection and Rehabilitation Regulation (CQLR, Q-2, r.37), 2003, updated February 1, 2013
2 Petroleum hydrocarbons

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T 819 762 9181 F 819 764 6749 info@sanexen.com
www.sanexen.com / www.mineregeneration.com

2.2 Dismantling and Demolition

In addition, the site redevelopment and restoration include the dismantling and demolition of all buildings and surface infrastructures, as well as the electrical and support infrastructures.

The foundations must be levelled, and the concrete slabs washed, perforated or crushed, to ensure proper drainage of water, and covered with reserved materials to promote the growth and maintenance of self-sustaining vegetation. The process water retention ponds must also be drained, sludge removed and sent to an authorized disposal facility. Eventually, the process water retention ponds will be reinstated as a wetland.

It should be noted that the management of the dismantling materials must be carried out in compliance with current regulations, namely the RRLIRM[1], as well as the *Guide de bonnes pratiques pour la gestion des matériaux de démantèlement*[2].

2.3 Management and Disposal of Petroleum Products, Chemical Products and Hazardous Waste

Upon closure of the mining site, all equipment and heavy machinery will be sold or drained of any fluids, broken down into parts and sent to an authorized recycling facility. All petroleum tanks and related pipelines will be drained, cleaned and sold or disposed of in accordance with applicable regulations. No residual hazardous material will be present on the site after the cessation of the mining activities.

2.4 Revegetation

The processing plant and mine tailings and concentrates accumulation areas as well as the roads (surfaces and shoulders) must be revegetated to control erosion and restore to a natural condition in balance with the surrounding environment and original conditions. Prior to revegetation, the surfaces will be scarified, seeded with indigenous herbaceous plants, and amendments necessary to promote plant growth will be added.

The revegetation must allow the area to reach a satisfactory condition, which means that once in place, the plants must be hardy, provide long-term viability, and not require amendments or other care to ensure their sustainability.

2.5 Monitoring Program

The restoration plan must also include a monitoring program. This program serves to monitor the performance of the reinstatement and corrective measures implemented after the site closure. Furthermore, geotechnical, environmental and agronomic monitoring should also be performed. Unless otherwise notified, monitoring should be performed over a period of 5 years.

2.5.1 Geotechnical Monitoring

Following the permanent closure of the site, geotechnical monitoring must be performed to verify the stability of the earthworks. For the first 3 years, annual visual inspections of the Site must be performed by a professional engineer, then periodically over a period of 10 years. The purpose of these inspections is to

1 Regulation respecting the landfilling and incineration of residual materials (CQLR, c. Q-2, r.19)

2 *Guide de bonnes pratiques pour la gestion des matériaux de démantèlement, Ministère du Développement durable, de l'Environnement et des Parcs,* © Quebec Government, 2002

ensure that all earthworks, as well as stockpiles of waste rock and tailings subject to erosion, settlement, sloughing, cracking, and lateral movement remain stable over time.

2.5.2 Environmental Monitoring

Water quality monitoring during the post-restoration period must include the same parameters as the regular monitoring of final effluents during the exploitation period. Indeed, in the event mining effluents are to be discharged into the environment, the discharge norms outlined in Section 2.1.1.1 of Directive 019[1] must be upheld. With respect to groundwater, semi-annual monitoring campaigns, i.e. spring and fall to represent both the high- and low water periods, must be carried out, and the chemical analyses must comply with the criteria established in Directive 019.

It should be noted that additional parameters could be added, depending on the mining site. These parameters are generally mentioned in the Certificates of Approval (CA) or Depollution Attestations (AS).

2.5.3 Agronomic Monitoring

To assess the vegetative establishment, agronomic monitoring must be performed by an experienced professional agronomist. In the event of a partial failure during the first 2 years of vegetative development, additional seeding and/or amendments must be applied.

3. COSTS

Sanexen's cost appraisal to carry out the closure of the Galaxy Site, as described in Table 1, is **$18,630,000** (exclusive of applicable taxes). The cost appraisal was drawn up based on the dollar value on the date of the proposal.

TABLE 1
Summary Cost Breakdown for Galaxy Site Closure

Activity	Cost (CAN$)
Phase I and II Environmental Site Assessments	565,000
Dismantling of surface buildings and infrastructures	13,640,000
Hazardous waste and petroleum tanks	350,000
Revegetation	3,625,000
Physical stability monitoring	200,000
Environmental monitoring	230,000
Agronomic monitoring and maintenance	20,000
Total	**18,630,000**

The prices presented in Table 1 are subject to the conditions and limitations presented in Appendix A.

1 *Directive 019 sur l'industrie minière, Ministère du Développement durable, de l'Environnement et des Parcs*, March 2012

Should you require additional information, please do not hesitate to contact us.

Regards,

Karine Dufresne, Biol., M.Sc.A.
Assistant Director – Revegetation/Environment

Karl Côté, P.Eng., M.Eng.
Project Director
Northern and Indigenous Affairs/Environment
(*OIQ*[1] Member No. 111880)

KD/KC/kaf

Encl.

1 *Ordre des ingénieurs du Québec* (Quebec Order of Licensed Professional Engineers)

APPENDIX A

Conditions and Limitations

LIMITATIONS AND SPECIFICATIONS OF THE PROPOSAL

The cost assessment for the closure of the James Bay Lithium Mine Site was calculated based on the documents received:

- 15119-100-DRG-GE-001-WIP.PDF;
- 15119-100-DRG-GE-001—B1-WIP.PDF;
- 15119-200-DRG-GE-050- to 15119-200-DRG-GE-063-A.PDF;
- 15119-200-DRG-GE-066-A to 15119-200-DRG-GE-067-A.PDF;
- 15119-200-DRG-GE-066-A to 15119-200-DRG-GE-067-A.PDF;
- 15119-203-DRG-GE-001-A.PDF;
- Outland-camp-007-2.pdf;
- 15119-LST-ME-GE-001-Facility List;
- 5- Closure (2);
- 171-02562-00-wspT-032-EEI-C1-1_loc_pr.

Dismantling

The costs for the building dismantling were calculated by taking into consideration the labour and equipment necessary to carry out the work in a heavy industrial environment. The time and effort required for the dismantling work were cross-checked with completed projects similar in scope.

The calculations are a rough estimate, since no information was available as to the types or quantities of building materials. The details of the engineering plans (structural, building systems, electrical, architectural) and other construction information were also limited. An update to the dismantling costs may be performed, once more information is available.

The amounts calculated for the dismantling work include:

- The mobilization and demobilization of equipment and personnel necessary for the work;
- The cleaning of each building prior to dismantling;
- The removal of foundations and slabs as well as the crushing of concrete directly on-site;
- Use of the crushed concrete for backfilling and levelling of the processing plant area, as well as the management and supervision of the work.

We have considered that camp installations would be available to house workers until completion of the dismantling work.

The transport and disposal of materials requiring off-site disposal is not included; however, the present value of ferrous and non-ferrous metals would cover the transport costs to existing recycling facilities.

Revegetation

- The cost of revegetation is $14,500/ha. The area of the sectors to be revegetated was evaluated at 250 ha. To this, add $20,000 for agronomic monitoring for a period of 3 years.
- The maximum slope for piles remaining on the property must be between 4H:1V and 3H:1V.
- Mine tailings presenting a minimum of 50% fine particles (revegetated sector not requiring cover).
- The transport, purchase and spreading to cover the surfaces (coarse mine tailings, bedrock) are not included.

Rehabilitation

- *MDDELCC*[1] approval of the remediation plan must be obtained prior to the start of the work;
- The cost for the Phase I Environmental Site Assessment (ESA) is 32 160$;
- The cost of the characterization study is based on the excavation of 320 test pits and drilling of 30 boreholes. The number of test pits could be less, depending on Site conditions following mine closure;
- The characterization work will be carried out over a period of 20 days, employing 3 technicians and 2 heavy equipment operators: two technician will be affected to the test pits, and the other one to the boreholes;
- The cost for the characterization study includes the laboratory analyses and drafting of the final report;
- It is impossible at this time to estimate the volumes of contaminated soils to be excavated and shipped off-site;
- Sanexen's proposal is based on the hypothesis that all PHC[2]-impacted soils will be managed gradually to avoid accumulated volumes to be managed at the time of the site closure;
- The contaminated soils must be transported and disposed of at an *MDDELCC*-approved facility.

Residual Hazardous Materials Management

The disposal of RHMs[3] must be carried out on a regular basis.

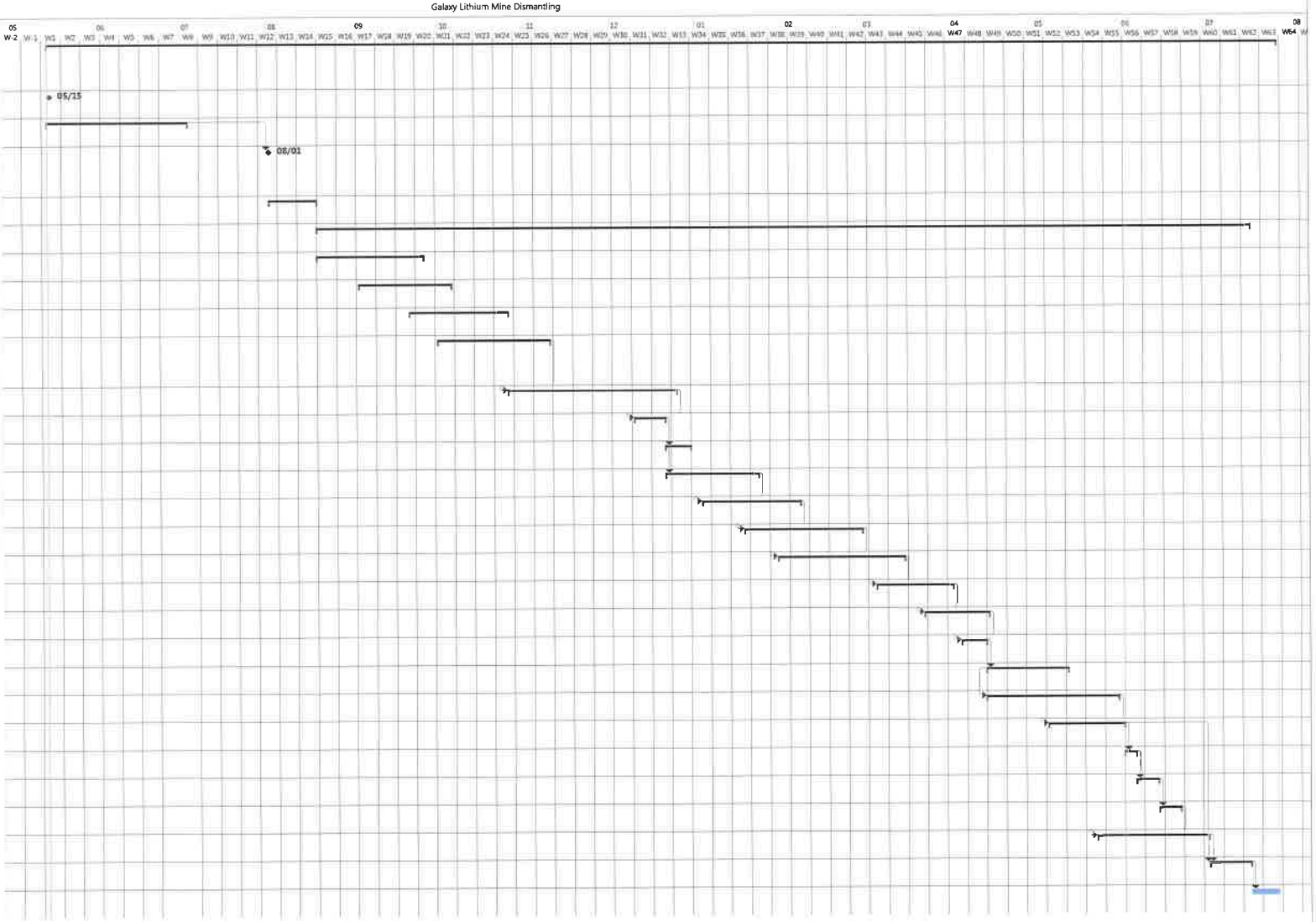
1 *Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques*
2 Petroleum hydrocarbons
3 Residual hazardous materials

APPENDIX B

Quantities and Back-up for Pricing

Galaxy Lithium Mine Dismantling

ID	Task Mode	Task Name	Duration
1		**Dismantling and cleanup of Galaxy Mine Buildings**	414 days
2		Contract Award	1 day
3		**Submitals and Preparation**	36 days
8		Approvals from Environment	1 day
9		**Mobilization and site setup**	15 days
12		**Site Work**	332 days
13		**Crushing**	38 days
18		**Crusher Product Screening**	33 days
23		**Primary Ore Stockpile**	35 days
28		**Mine Service Admin blg, Workshop &WashBay**	40 days
33		**DMS Blg**	60 days
38		**Reagent Storage**	11 days
43		**Diesel Storage**	9 days
48		**Workshop & Warehouse**	33 days
53		**Tails thickener**	35 days
58		**Final Product Stockpilling**	42 days
63		**final Product Stockpilling**	45 days
68		**Lab**	27 days
73		**Administration and Medical**	23 days
78		**LPG Storage**	9 days
83		**Tails Stacking**	29 days
88		**Accomodation Camp**	47 days
93		**Water Treatment**	27 days
98		**Waste Management**	4 days
103		**Weighbridge building**	8 days
108		**Waste Management incineration**	8 days
113		**Megadome (5X)**	40 days
118		**Sediment Pond**	15 days
121		Demobilisation	10 days



Project: Echéancier
Date: Tue 05/15/18

Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Progress | Manual Progress

Sanexen Services Environnementaux Inc.

Sommaire des prix de vente

TPL Estimation

No. Client : PRIMERO Nom : Mine Galaxy Date de fermeture : 05/18/18

No. Interne : RE18-408 Description : Galaxy Closure Demolition

Numéro	Description	Quantité bordereau	Unité bordereau	Prix final	Montant final
0	Mobilisation	1.00	GL	217 500.00 $	217 500.00 $
1	1_Crushing	1.00	GL	978 600.00 $	978 600.00 $
2	2_Crusher_Product_Screening	1.00	GL	662 100.00 $	662 100.00 $
3	3_Primary_Ore_Stockpile	1.00	GL	799 200.00 $	799 200.00 $
4	4_Mine_Service_Admin_Blg_Workshop & WashBay	1.00	GL	841 400.00 $	841 400.00 $
5	5_DMS_Blg	1.00	GL	1 592 900.00 $	1 592 900.00 $
6	6_Reagent_Storage	1.00	GL	187 200.00 $	187 200.00 $
7	7_Diesel_Storage	1.00	GL	160 800.00 $	160 800.00 $
8	8_Workshop & Warehouse	1.00	GL	716 900.00 $	716 900.00 $
9	9_Tails_Thickener	1.00	GL	782 700.00 $	782 700.00 $
10	10_Final_Product_Stockpilling	1.00	GL	830 500.00 $	830 500.00 $
11	11_HV_Switchyard	1.00	GL	935 400.00 $	935 400.00 $
12	12_Lab	1.00	GL	594 000.00 $	594 000.00 $
13	13_Administration & Medical	1.00	GL	527 500.00 $	527 500.00 $
14	14_LPG_Storage	1.00	GL	160 800.00 $	160 800.00 $
15	15_Tails_Stacking	1.00	GL	585 700.00 $	585 700.00 $
16	16_Accomodation_Camp	1.00	GL	910 500.00 $	910 500.00 $
17	17_Water_Treatment	1.00	GL	583 400.00 $	583 400.00 $
18	18_Waste_Management	1.00	GL	73 800.00 $	73 800.00 $
19	19_Weighbridge_Building	1.00	GL	159 800.00 $	159 800.00 $
20	20_Waste_Management_Incineration	1.00	GL	159 800.00 $	159 800.00 $
21	21_Megadome	1.00	GL	769 600.00 $	769 600.00 $
22	Sediment Pond	1.00	GL	219 000.00 $	219 000.00 $
23	Demobilisation (sans transport et disposition métaux et matières)	1.00	GL	190 900.00 $	190 900.00 $

Sous total :	**13 640 000.00 $**
Taxe 1 :	**0.00 $**
Sous total avec taxe 1 :	**13 640 000.00 $**
Taxe 2 :	**0.00 $**
Grand total :	**13 640 000.00 $**

Sommaire des prix de vente

No. Client :	PRIMERO	Nom :	Mine Galaxy	Date de fermeture :	05/18/18
No. Interne :	RE18-408	Description :	Galaxy Closure Demolition		

Note :

APPENDIX

A-81

CORPORATE WORKPLACE POLICY (STANDARD) FLEXIBLE WORK ARRANGEMENT

Corporate Workplace Policy (Standard) Flexible Work Arrangement - Australia

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1.0 PURPOSE

The purpose of this policy is to provide supporting information for employees and managers/supervisors in Australia;

- the right of certain employees to request access to flexible working arrangements, and
- the responsibilities of the Company to consider their request in accordance with the provisions of the Fair Work Act, 2009 (as amended).

2.0 SCOPE

This applies to all Galaxy full time and part-time employees in Australia.

3.0 DEFINITIONS

Flexible Work Arrangement	An arrangement agreed by the employer and employee that allows an employee to access altered working arrangements specifically to meet their personal needs, balanced with needs of the organisation.
Home-Based Work	Employee performs most work responsibilities from home

4.0 RESPONSIBILITIES

4.1 Managers & Supervisors

- Considering each employee application in conjunction with this policy and relevant legislation e.g. Fair Work Act 2009 in deciding if a request can be accommodated and the terms of any arrangement
- Ensuring Flexible Working Arrangements are in line with this policy
- Providing the necessary resources and equipment to facilitate flexible working arrangements within the context of this policy
- Evaluating the outcomes of Flexible Working Arrangements and looking for improvements.

4.2 Employees

- Identifying personal needs and possible solutions and being realistic about what is possible.
- Ensuring the physical security of Company information and assets at all times when outside of Company premises.
- Taking responsibility for delivering their own workload as agreed with their manager/supervisor.
- Reporting any workplace incidents, injuries or illnesses that occur whilst undertaking flexible working arrangements.
- Reporting any potential hazards that may exist in a Home-Based Work arrangement environment as it changes from time to time.
- Reviewing and modifying arrangements as their personal circumstances or operational requirements change from time to time.

4.3 HR

- All managers, supervisors and employees are aware of their obligations and responsibilities in relation to requests for and managing flexible work arrangements.

5.0 FLEXIBLE WORK ARRANGEMENTS

The Company recognises that flexible working arrangements may assist staff members to balance their work, personal and family needs, including meeting competing commitments. Further, certain employees have the right to request flexible working arrangements and the Company is obliged to consider each request on its merit and respond formally within 21 days. Whilst flexible working arrangements are intended to accommodate employees' needs, employees are also expected to organise their time on a 'give-and-take' basis to ensure the proper and efficient operations of the Company.

The Company may – subject to this policy and applicable Australian legislation – agree to allow an employee to change their conditions of employment to accommodate the employee's personal circumstances in particular situations.

An eligible employee (see below) may request that the Company agree to flexible work arrangements because they are in one or more of the following circumstances:

- they are a parent;
- they are responsible for the care of a child who is of school age or younger;
- they have a disability;
- they are 55 years or older;
- they are experiencing family violence;
- they are a carer;
- they are providing care or support to a member of their immediate family or household because they are experiencing violence from a family member.

The changes in working arrangements must relate to changes that would assist an employee to care for that person.

Flexible work arrangements include arrangements in relation to:

- patterns of work hours, e.g. working part-time;
- number of work hours, e.g. flexible start and finish times;
- staggered return to work after parental leave, e.g. returning part-time and building up to full-time;
- unpaid leave arrangements;
- scheduling of staff meetings;
- limitations on work travel;
- working from home; and
- job-sharing.

Changing work arrangements may be for a fixed or indefinite period of time.

5.1 ELIGIBILITY

To be an 'eligible employee', i.e. able to make a request for flexible work arrangements, an employee must:

- have been employed for at least 12 months;
- make a request in writing to the Company in which the employee:
  - sets out the proposed change; and
  - sets out the reasons for the proposed change.

Requests for flexible work arrangements should be made to the employee's manager or supervisor and the manager or supervisor will liaise with the HR Manager to manage the request and response for flexible work arrangements.

5.2 PROCESS

Once an Eligible Employee has made a request in writing for flexible work arrangements, the Company will:

- arrange a meeting between the employee and their manager to discuss the request and
- provide the employee with a written response within 21 days stating whether the Company will grant or refuse the employee's request. This should include a period for a trial period as described below.

The Company will only refuse an eligible employee's request on reasonable business grounds.

In making its decision, the Company will take into account the following circumstances:

- the nature of the employee's work circumstances;
- the nature and cost of implementing the proposed arrangements;
- the financial circumstances of the Company at the time of the request;

- the nature and size of the Company's business and its operational requirements;
- the effect of the proposed arrangements on the Company (not limited to the financial impacts);
- the effect of the proposed arrangement on other employees;
- the limitations imposed under applicable industrial laws, workplace health and safety laws and workers' compensation laws;
- the proposed commencement date of the arrangement and how long it is proposed to operate; and
- whether there is sufficient information provided by the employee for the employer to make a decision.

Employees should take independent advice on the effect that the granting of the request may have on their accrued entitlements and the resulting financial impacts on them.

5.3 TRIAL PERIOD OF FLEXIBLE WORK ARRANGEMENTS

Any flexible work arrangement approved under this policy should undergo a trial period of up to three (3) months to ensure the arrangements meet the Company's business requirements and the flexibility required by the employee.

If the trial is successful and flexible working arrangements are adopted, managers/supervisors must review these work arrangements with the employee on a regular basis (e.g. monthly or quarterly) to ensure:

- All deliverables are being met.
- The quality, quantity and timeliness of the work performed is to the standard required.
- The impact on other members of the work team is not detrimental to the overall performance of the team and Company.
- The operational requirements of the employee's area are being met.
- The employee is complying with the terms of the agreement.
- The flexible working arrangements is continuing to meet the needs of the employee.
- Work Health and Safety requirements continue to be met.
- Company standards and procedures are being adhered to.

APPENDIX

A-108

ARCHEOLOGICAL POTENTIAL STUDY

Galaxy Lithium (Canada) inc.
Mine de lithium Baie-James
Étude d'impact sur l'environnement
Étude de potentiel archéologique

Arkéos inc.
Société d'expertise en recherches anthropologiques

Juin 2019

Galaxy Lithium (Canada) inc.
Mine de lithium Baie-James
Étude d’impact sur l’environnement
Étude de potentiel archéologique

Arkéos inc.
Société d'expertise en recherches anthropologiques
51, rue Jean-Talon Est, Montréal (Québec) H2R 1S6

850-882

RÉSUMÉ

Dans le cadre de l'étude d'impact sur l'environnement du projet de Mine de lithium Baie-James de Galaxy Lithium (Canada) inc. , qui vise l'exploitation des métaux de lithium sur le territoire de la municipalité de la Baie-James (*Eeyou Istchee*), WSP a mandaté Arkéos inc. afin de déterminer le potentiel archéologique pouvant être touché par ce projet.

Du point de vue de la paléogéographie, la zone d'étude aurait pu accueillir des groupes humains dès 6 000 ans BP et même avant. La bordure de la baie (mer de Tyrrell en régression) se situait alors à environ 120 km à l'est de la zone d'étude. Il est permis de postuler que les conditions étaient alors favorables à l'existence d'une faune présentant des similitudes avec l'actuelle puisque les conditions écologiques étaient comparables.

Selon les connaissances acquises dans le cadre des recherches archéologiques effectuées lors des travaux d'aménagement du complexe de l'Eastmain-1, l'occupation humaine de la région serait plus tardive, les plus vieux sites mis au jour étant datés entre 4 600 et 4 100 ans BP. Un site archéologique préhistorique est actuellement connu au campement du km 381.

La détermination du potentiel archéologique a d'abord été faite par une localisation du territoire à l'étude dans l'espace régional, à l'aide des cartes topographiques au 1 : 250 000 et au 1 : 50 000. Par la suite, une interprétation de la couverture de photos aériennes au 1 : 15 000 a permis d'identifier les caractéristiques particulières de la topographie et de déterminer les conditions de circulation et d'habitabilité. Vingt-sept zones de potentiel archéologique ont ainsi été distinguées. Il est recommandé de réaliser un inventaire archéologique au terrain pour les zones affectées par l'une des composantes du projet.

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LISTE DES PARTICIPANTS

WSP

Andréanne Boisvert	Géographe, Directrice de projet | Environnement
Josée Marcoux	Géographe, Conseillère technique | Environnement

ARKÉOS INC.

Pierre Bibeau	Archéologue et coordonnateur
Gilles Rousseau	Géographe et archéologue
Daniel Poulin	Archéologue
David Tessier	Archéologue
Yves Simon	Géomaticien
Mor Coumba Ndiaye	Technicien en géomatique
Louise Beaudoin	Adjointe administrative
Maryvonne Trudeau	Secrétaire et chargée d'édition

1 INTRODUCTION

1.1 Contexte de l'étude et mandat

Dans le cadre de l'étude d'impact sur l'environnement du projet de Mine de lithium Baie-James de Galaxy Resources Limited, qui vise l'exploitation des métaux de lithium sur le territoire de la municipalité de la Baie-James (*Eeyou Istchee*), WSP a mandaté Arkéos inc. afin de déterminer le potentiel archéologique pouvant être touché par ce projet (figure 1).

Sur place, le complexe minier comprend un secteur d'exploitation à ciel ouvert, une usine de concentration pour le minerai, des aires d'entreposage, une usine de traitement des eaux usées, des bassins de rétention et divers bâtiments permettant de loger les travailleurs et assurer la bonne marche administrative et logistique des lieux. Il faudra également pourvoir le complexe en approvisionnement d'énergie et en voie de circulation.

Cette étude a été réalisée à l'automne 2011, puis revisée à l'automne 2017 afin d'intégrer une nouvelle zone d'étude plus réduite.

1.2 Situation de projet

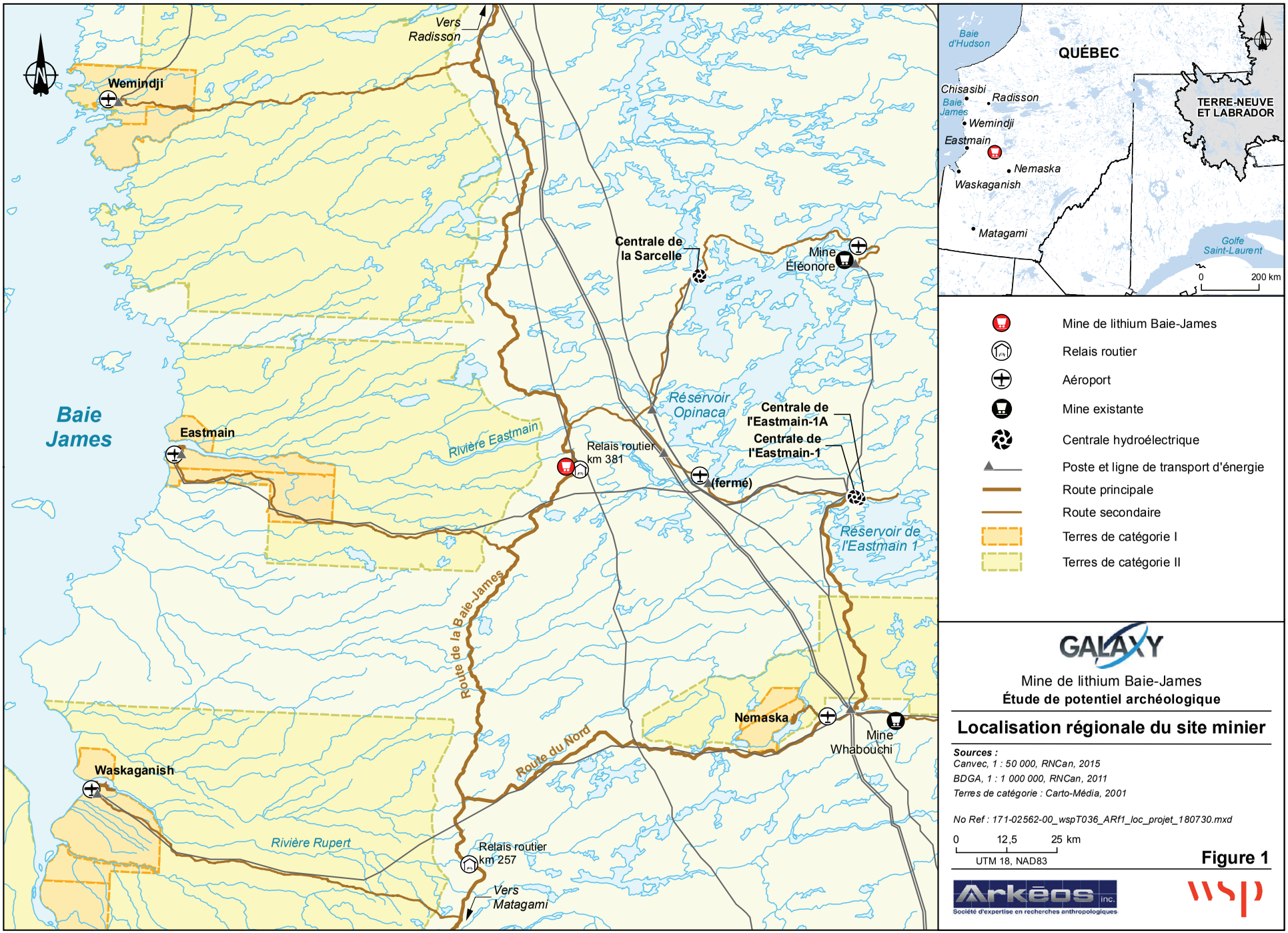
Le projet de Mine de lithium Baie-James est situé à l'intérieur du territoire de la communauté crie d'Eastmain (terres de catégorie III), à proximité du relais routier du kilomètre 381 de la route de la Baie James.

La zone d'étude se localise par ailleurs au sud de la rivière Eastmain, vis-à-vis un tronçon qui fait un important crochet vers le nord et dont le cours intègre les rapides Mantuwataw. Dans cette section nommée gorge Conglomerate, le niveau de la rivière s'abaisse rapidement d'environ 37 m, passant de ± 177 m à ± 140 m. Le site prévu pour l'exploitation minière se localise à 9,4 km au sud de la gorge Conglomerate. Malgré sa relative proximité de l'Eastmain, la zone analysée chevauche deux bassins hydrographiques secondaires qui s'écoulent plus ou moins parallèlement à celle-ci : le premier (sans nom) s'écoule en direction de l'est et va rejoindre le cours de l'Eastmain à ± 22 km de la gorge Conglomerate, en suivant son cours sinueux ; le second, la rivière Miskimatao, va rejoindre le cours de l'Eastmain vers l'ouest-sud-ouest à une distance de près de 50 km de la gorge Conglomerate. Les cours d'eau qui constituent la tête des deux bassins hydrographiques se voisinent dans un environnement dominé par les tourbières. La zone d'étude occupe donc des terres humides dans une zone de transition à la tête de deux bassins hydrographiques secondaires bordés au nord par le bassin de l'Eastmain dont les affluents latéraux drainent une bande étroite variant entre 1,0 et 4,0 km.

La zone d'étude considérée pour l'étude de potentiel archéologique correspond à un rectangle de 9,43 km est-ouest x 6,00 km nord-sud, soit une superficie 56,6 km^2.

1.3 Contenu du rapport

Le prochain chapitre fait état de la méthodologie employée. Le milieu physique et son évolution sont décrits au chapitre 3. Le chapitre 4 dresse un portrait général de la présence humaine en préhistoire et après l'arrivée des Européens. Le chapitre 5 concerne l'identification des interventions archéologiques antérieures et des sites connus pour la zone d'étude. Le potentiel archéologique est énoncé au chapitre 6. Le dernier chapitre contient finalement les recommandations.


Vers Radisson
Wemindji
Baie James
Eastmain
Rivière Eastmain
Relais routier km 381
Centrale de la Sarcelle
Mine Éléonore
Réservoir Opinaca
Centrale de l'Eastmain-1A
Centrale de l'Eastmain-1
(fermé)
Réservoir de l'Eastmain 1
Route de la Baie-James
Route du Nord
Nemaska
Mine Whabouchi
Waskaganish
Rivière Rupert
Relais routier km 257
Vers Matagami
Baie d'Hudson
QUÉBEC
TERRE-NEUVE ET LABRADOR
Chisasibi
Radisson
Baie James
Wemindji
Eastmain
Nemaska
Waskaganish
Matagami
Golfe Saint-Laurent
0
200 km
Mine de lithium Baie-James
Relais routier
Aéroport
Mine existante
Centrale hydroélectrique
Poste et ligne de transport d'énergie
Route principale
Route secondaire
Terres de catégorie I
Terres de catégorie II
GALAXY
Mine de lithium Baie-James
Étude de potentiel archéologique
Localisation régionale du site minier
Sources :
Canvec, 1 : 50 000, RNCan, 2015
BDGA, 1 : 1 000 000, RNCan, 2011
Terres de catégorie : Carto-Média, 2001
No Ref : 171-02562-00_wspT036_ARf1_loc_projet_180730.mxd
0
12,5
25 km
UTM 18, NAD83
Figure 1
Arkéos inc.
Société d'expertise en recherches anthropologiques
wsp

2 MÉTHODOLOGIE

L'étude de potentiel a pour objectif la détermination de zones d'intérêt pour retrouver des vestiges associés à la présence humaine ancienne. La démarche consiste tout d'abord en l'identification des études archéologiques antérieures et des sites archéologiques déjà connus. C'est également à cette occasion qu'un bref survol des modalités de l'occupation humaine régionale passée et récente est dressé afin d'esquisser les traces matérielles pouvant être trouvées. La seconde étape permet la sélection des espaces possédant les plus grandes probabilités de contenir des sites archéologiques. Les quelques milliers de sites archéologiques actuellement connus sur le territoire québécois ne représentent en effet qu'une faible fraction des sites présents. Leur découverte et leur protection ne deviennent possibles que grâce à de nouvelles recherches.

2.1 Données connues

Pour l'occupation amérindienne, la démarche s'appuie tout d'abord sur l'état de la connaissance en regard de l'archéologie et de l'ethnohistoire pour la zone d'étude et ses environs. On y fait particulièrement état des populations concernées, des modes d'établissement et de subsistance, ainsi que des axes de déplacement. Les connaissances qu'ont les individus qui habitent le territoire à l'étude permettent de mieux comprendre l'utilisation qui a pu en être faite et les expériences qui ont pu y être vécues. Outre la revue de la littérature scientifique, certains répertoires, à partir de la banque de données de l'ISAQ (Inventaire des sites archéologiques du Québec) et du Géo-portail disponible au ministère de la Culture et des Communications (MCC), facilitent ces acquisitions. Les données ainsi recueillies permettent d'identifier les paléocultures en présence et l'examen des contextes environnementaux des sites connus oriente la sélection des zones de potentiel ultérieurement définies.

2.2 Analyse du potentiel

L'objectif poursuivi lors de l'exercice de détermination du potentiel archéologique consiste en une catégorisation des espaces géographiques contenus dans une zone d'étude afin de discriminer des espaces où il existe une probabilité de retrouver des indices d'occupation humaine. L'exercice présume que la présence d'un site archéologique à un endroit donné n'est pas aléatoire et résulte d'une suite de choix et de décisions des individus et des groupes culturels, liés par leur perception du milieu environnemental de même que par diverses contraintes sociales, culturelles et économiques. Il sous-entend également notre capacité à circonscrire des zones où la recherche de ces indices devient une entreprise rationnelle et faisable. Le reste du territoire peut avoir porté des occupations ou des activités humaines diverses, mais la probabilité de les découvrir est perçue comme faible et relevant plutôt du hasard.

L'analyse doit tout d'abord tenir compte de la transformation du paysage et des écosystèmes depuis la dernière glaciation. Le milieu physique, les conditions climatologiques, la faune et la flore se sont modifiés depuis la fonte des glaciers et les populations humaines ont nécessairement adapté leurs modes de subsistance aux possibilités offertes. La localisation et la nature des sites archéologiques susceptibles d'être retrouvés sont fortement influencées par ces conditions.

L'étude de potentiel doit également prendre en compte que, pour la plus grande partie de la préhistoire, les groupes humains potentiellement présents dans le territoire étaient des nomades dont l'économie de subsistance s'appuyait sur une exploitation opportuniste des ressources de l'environnement. L'analyse du potentiel est donc effectuée en s'appuyant sur ces connaissances et en prenant en compte deux grandes catégories d'attributs (tableau 1). La première comprend des *critères d'ordre topologique* qui réfèrent à la position des lieux et à l'organisation (la structure) de l'espace géographique. Il est postulé que la circulation à travers le territoire et l'occupation des lieux se faisaient d'une façon logique, selon des stratégies qui tenaient compte des avantages et des inconvénients de l'espace géographique. C'est principalement l'analyse de la carte topographique qui permet d'appréhender l'organisation (la structure) du paysage. Cette étape de l'analyse permet alors de repérer les éléments suivants : les corridors de circulation potentielle, les points de rencontre, les caractéristiques générales des paléorivages, etc. De façon générale, les cours d'eau étaient des voies de circulation à travers le territoire. Leurs rives peuvent donc avoir été choisies pour des établissements, dans le cycle du nomadisme, ou comme simple lieu de bivouac, au cours des déplacements. De plus, cette étape permet d'appréhender des relations dans un espace géographique étendu.

Tableau 1 - Principaux critères considérés pour l'étude de potentiel archéologique, période préhistorique

Organisation de l'espace	Critères discriminants pour le potentiel archéologique
Topologie régionale	Association à un ou des systèmes de vallées qui ont pu canaliser la circulation sur le territoire et son occupation.
Topographie locale	Association à des formes de terrain qui favorisent l'établissement, telles que surfaces planes, plus ou moins surélevées : particulièrement des rebords de terrasses marines, lacustres ou fluviales. Association à des bombements morainiques (Iroquoïens).
Sédimentologie	Association à des matériaux meubles relativement bien drainés : sables limoneux, sables, graviers et moraines.
Hydrographie	Association à des cours d'eau primaires (navigables) ou secondaires (ruisseaux, marais, tourbières).

La seconde catégorie comprend des *critères d'ordre topographique* qui réfèrent aux caractéristiques morphologiques et topographiques des lieux. À cette étape, l'interprétation des photos aériennes permet de reconnaître le détail des formes de terrain dans le but de délimiter des surfaces présentant de bonnes qualités pour l'établissement : surfaces planes ou faiblement inclinées, drainage adéquat, etc. Tout au long de la préhistoire, l'émersion des terres a entraîné une modification du profil des rivières. Ce profil s'est encaissé en faisant émerger des seuils (portages) et en produisant des terrasses étagées correspondant aux différentes étapes de l'évolution des cours d'eau. L'interprétation des photos aériennes, combinée à l'analyse des cartes topographiques, permet alors de circonscrire ces rivages et d'en reconnaître les qualités pour l'établissement humain.

Ces aspects physiques du paysage naturel participent à la formation du paysage humain. Ce dernier est formé par la compréhension qu'on se fait d'un paysage naturel. Cette compréhension, quant à elle, s'est fabriquée et se fabrique par les expériences qui y ont été vécues et racontées. L'occupation humaine d'un endroit ne peut se résumer qu'aux gestes qui y ont été posés et qui ont laissé des traces. En effet, un endroit occupé est souvent peuplé de souvenirs qui interpellent davantage l'utilisateur qui en connait le récit et la valeur. Les connaissances partagées par les Cris du terrain de trappage RE2 permettent justement d'ajouter l'expérience humaine du territoire à une lecture souvent trop fonctionnelle du paysage naturel.

En bref, la démarche permettant de produire l'étude de potentiel a été réalisée en suivant les étapes suivantes :

- Consultation des données sur l'occupation ancienne du territoire ;
- Analyse du relief au moyen des cartes topographiques au 1 : 50 000 et 1 : 250 000, dans le but de reconnaître l'organisation physique du paysage et d'identifier les réseaux de circulation que les formes et particulièrement les bassins hydrographiques peuvent favoriser ;
- Analyse de l'évolution du territoire depuis la fin de la dernière glaciation ;
- Examen d'une couverture de photos aériennes de la zone d'étude, afin de circonscrire, le cas échéant, les zones à potentiel archéologique et d'identifier les aménagements récents visibles qui ont pu altérer les possibilités réelles de retrouver des vestiges. Des photos aériennes (1 : 15 000) ont été examinées ;
- Consultation des résumés d'entrevues faites auprès des Cris qui y vivent depuis plusieurs générations. Les données illustrées sur les cartes traitant des composantes du milieu humain dans l'étude d'impact sur l'environnement (WSP, 2018) ont été examinées et mises à contribution.

3 GÉOGRAPHIE DE LA ZONE D'ÉTUDE

3.1 Caractérisation du paysage

PHYSIOGRAPHIE ET TOPOGRAPHIE

Les données présentées dans ce chapitre proviennent principalement d'un article contenu dans un ouvrage publié suite aux travaux archéologiques du projet Eastmain 1 d'Hydro-Québec/SEBJ (Rousseau, 2015). Toute la péninsule du Québec-Labrador, dans laquelle se situe la zone d'étude, fait partie du Bouclier canadien. La zone d'étude se localise plus précisément dans les *basses-terres d'Eastmain*, une division du Bouclier (Bostock, 1972 et Atlas du Canada[1]) qui occupe la frange littorale de la baie James (figure 2). À environ 45 km de la zone d'étude, en direction de l'est, cette division fait place aux *bas-plateaux* qui présentent un paysage plus accidenté, où le substrat rocheux se manifeste sous la forme de collines et de bombements dont le sommet se relève progressivement. Les *basses-terres* correspondent plutôt à un paysage marqué par de grandes surfaces planes à légèrement ondulées, qui s'est développé sur une importante couverture de dépôts meubles.

Dans la zone d'étude, le niveau de base est constitué de grandes surfaces gisantes occupées par des tourbières et parcourues par un réseau de petits cours d'eau qui rejoignent les deux cours d'eau principaux. L'altitude générale de ces grandes surfaces se situe légèrement sous la cote de 200 m. La monotonie de ce paysage de plaine est tout de même brisée par quelques collines et des bombements allongés approximativement sur l'axe est-ouest. Ces collines s'élèvent au-dessus de la plaine jusqu'à une élévation qui atteint rarement l'altitude de 240 m ; ainsi, la colline retenue pour le développement minier représente un massif tout de même remarquable qui ne culmine qu'à ± 235 m, soit à peine 35 m au-dessus de la plaine environnante

HYDROGRAPHIE

En raison de sa position de part et d'autre d'une ligne de partage des eaux, le réseau hydrographique ne draine pas de grandes surfaces et le volume des cours d'eau est plutôt restreint. Il s'agit donc de cours d'eau très probablement non navigables, sauf le tronçon principal de chacun des deux bassins, celui sans nom qui s'écoule vers l'est et la rivière Miskimatao qui coule vers l'ouest. La zone d'étude analysée comprend quelques petits lacs répartis entre les deux bassins et qui sont affublés de toponymes en langage probablement cri, ce qui constitue une marque d'appropriation qui pourrait témoigner d'un usage de ces secteurs.

1 Les informations cartographiques sur la physiographie sont tirées de l'Atlas national du Canada 4e édition, feuillet nº 5-6, régions physiographiques, 1/15M, 1974. Cette carte est disponible sur le site Web d'Environnement Canada.

Figure 2 - Localisation de la zone d'étude par rapport aux principaux cours d'eau et de la position de la moraine de Sakami

STRUCTURE DU PAYSAGE ET MOBILITÉ

Sur la base des éléments structuraux qui organisent le paysage de la zone d'étude, nous allons maintenant formuler des hypothèses quant au style de mobilité que ce paysage peut soutenir et favoriser. Cette perception du cadre topologique, étant comprise comme l'expression d'un réseau relationnel théorique, a servi de canevas lors de la démarche d'élaboration du potentiel archéologique ; cette donnée s'ajoute aux autres informations qui permettent de délimiter concrètement des zones à potentiel archéologique : accessibilité, caractéristiques des surfaces d'accueil, disponibilité et abondance des ressources, position par rapport aux voies de circulation, etc.

La zone d'étude se situe en marge du cours de la rivière Eastmain (figure 2), qui constitue une voie de circulation majeure, mais qui est obstruée par des rapides importants qui commandent des portages. Les rapides les plus importants se situent à l'emplacement de la gorge Conglomerate, mais d'autres sont aussi présents à l'amont, dans le segment compris entre la gorge et l'embouchure de la rivière sans nom. Des portages auraient bien sûr permis de contourner chacune de ces zones de rapides. D'autres trajectoires empruntant des successions de cours d'eau secondaires et des voies terrestres auraient aussi pu permettre d'éviter cette succession de rapides et de court-circuiter l'important crochet vers le nord que décrit le cours de l'Eastmain, au nord de la zone d'étude. La rivière sans nom s'écoulant vers l'est et son prolongement vers l'ouest, la rivière Miskimatao, auraient pu être une de ces trajectoires. Il en existe une autre, légèrement plus au sud, qui aurait pu emprunter la rivière Causabiscau[2] pour rejoindre une chaîne de lacs importants au sud de la zone d'étude, avant de passer dans le bassin de la rivière Miskimatao. Enfin, d'autres trajectoires auraient pu emprunter des segments de ces différents bassins pour contourner les obstacles de l'Eastmain ou simplement pour accéder aux ressources présentes dans l'environnement de la zone d'étude.

3.2 Paléoenvironnement

L'objet principal de cette section est de présenter l'information permettant d'établir le cadre dans lequel les occupations humaines les plus anciennes auraient ou ont pu se réaliser. Il fournira les principales données sur l'évolution environnementale qui a précédé les occupations humaines, alors que le paysage prenait les caractéristiques d'avant la création du réservoir.

2 La Causabiscau rejoint l'Eastmain vers l'amont à environ 8,0 km au sud-est de la rivière sans nom qui draine le secteur qui borde la zone d'étude vers l'est.

DÉGLACIATION

La fonte de l'inlandsis laurentidien, qui a recouvert totalement le territoire, constitue la condition initiale pour que toute occupation humaine puisse être envisagée. Lorsque la déglaciation de la zone d'étude a débuté, la vallée du Saint-Laurent et la région des Grands Lacs étaient déjà libres de glace depuis 2,8 millénaires et des établissements humains s'étaient déjà produits. Les données que nous allons utiliser proviennent de plusieurs études (Hardy, 1977 et 1982 ; Vincent et Hardy, 1977 ; Hillaire-Marcel *et al.*, 1981 ; Veillette, 1997) qui traitent du processus de déglaciation du versant sud-est de la baie James.

Vers 7 900 ans BP, les masses glaciaires d'Hudson et du Nouveau-Québec s'étaient déjà séparées et le lac proglaciaire Ojibway s'était vidangé pour laisser place aux eaux saumâtres de la mer de Tyrrell. Le front du glacier du Nouveau-Québec avait alors reculé vers le nord-est pour se stabiliser à la position Sakami (figure 2). Cette position correspond à une phase de stabilisation du front glaciaire qui dessinait alors un large arc de cercle avec la concavité vers l'est. Cette moraine suit un parcours sud-nord qui débute au lac Mistassini, passe par Nemiscau, longe la limite ouest du réservoir Opinaca et remonte vers LG2 et l'embouchure de la rivière Grande-Baleine. Le centre de la zone d'étude se localisait alors à une vingtaine de kilomètres à l'ouest de cette position frontale du glacier et les *basses-terres d'Eastmain*, y inclus la zone d'étude, gisaient sous les eaux de la mer de Tyrrell qui ont atteint le niveau 280-290 m au maximum de l'invasion. Sur la base de l'importance des formes et de la quantité de sédiments mis en place dans le complexe morainique de Sakami, Hardy (1982 : 61, 1977 : 272) estime que le front du glacier serait resté stable durant une période d'environ 200 ans. Une carte des isochrones de l'âge des terres déglacées produite par Richard (1995 : 125) montre que vers 7 000 ans BP, le front glaciaire avait déjà considérablement retraité vers le nord-est et que la péninsule Québec-Labrador était déglacée jusqu'à la latitude de la rivière La Grande. Une masse glaciaire couvrait alors le centre de la péninsule, ainsi que la péninsule du Nunavit. La même carte montre que les dernières masses glaciaires résiduelles disparaîtront autour de 6 000 ans BP, à l'exception de quelques petites masses qui perdureront jusque vers 5 600 ans BP (Richard *et al.* 1982 : 85) sur les hauts plateaux du sud-ouest et de l'ouest de la baie d'Ungava.

ÉMERSION PROGRESSIVE DES BASSES TERRES DE LA BAIE JAMES ET LE RAJUSTEMENT ISOSTATIQUE

Vers 7 900 ans BP, la déglaciation de la baie d'Hudson a entraîné la vidange du lac proglaciaire Ojibway et le recouvrement des basses terres de la baie James par les eaux saumâtres de la mer de Tyrrell, un processus qui aurait été très rapide (Veillette, 1997 : 142). Durant les premiers millénaires de la déglaciation, le relèvement isostatique a aussi été très rapide ; Hardy (1977 : 270)

estimait le taux d'émersion à 9 m/100 ans au début et à 90 cm/100 ans pour les quatre derniers millénaires. Dans son étude sur le couvert végétal du Québec-Labrador, il y a 6 000 ans BP, Richard (1995 : 124) indique que la limite marine atteignait alors 140 m à environ 75 km au sud du réservoir LG-2, ce qui implique un taux d'émersion plus rapide que celui estimé par Hardy. Compte tenu de ces données, on peut évaluer que la zone d'étude, dont le niveau de base se situe autour de 200 m, aurait commencé à émerger environ un siècle après l'invasion marine maximale, soit vers 6 900-6 800 ans BP. En tout cas, le secteur était complètement émergé vers 6 000 ans BP puisque, d'après Richard (1995) le niveau marin se situait alors autour de 140 m.

Dans l'hypothèse d'une occupation humaine très ancienne de la baie James et de la zone d'étude, il faudrait tenir compte du contexte présenté précédemment. L'occupation initiale étant plus récente, il est probable que le système hydrographique avait déjà en gros acquis ses caractéristiques actuelles, du moins en amont des rapides Misinichikamikw et de la gorge Clouston, dont le niveau amont se situe à ± 140 m. Les reconstitutions du couvert végétal (Richard, 1995) nous apprennent de plus que le paysage de la Jamésie commençait déjà à ressembler au paysage actuel, il y a 6 000 ans BP. Du point de vue de la paléogéographie, on peut donc conclure que la zone d'étude aurait pu accueillir des groupes humains dès 6000 ans BP et même avant. La bordure de la baie (mer de Tyrrell en régression) se situait alors à environ 35 km à l'ouest du centre de la zone d'étude.

ÉVOLUTION DU COUVERT VÉGÉTAL ET DU CLIMAT

Dans un essai de reconstitution du couvert végétal du Québec-Labrador il y a 6 000 ans BP, Richard (1995) arrive à la conclusion, qu'à l'exception des zones encore sous l'influence directe de masses glaciaires, la carte du couvert végétal était semblable à la carte de la distribution actuelle des formations végétales. Cette carte (figure 3) nous montre que la zone d'étude se situait dans la zone des pessières fermées, en marge de la taïga arbustive, alors qu'aujourd'hui elle se situe plutôt dans la zone de taïga (pessière à cladines) ou zone des forêts ouvertes.

Ces paysages présentaient quand même certaines caractéristiques qui les différentient des paysages actuels. Dans l'ensemble, les pessières fermées différaient peu des pessières actuelles, mais l'entourbement des basses terres et des terres humides était moins développé qu'actuellement. La taïga était cependant plus dense et son couvert végétal était plus diversifié qu'actuellement ; Richard (1995 : 128) la décrit comme une « *forêt ouverte dominée par l'épinette noire, à parterre essentiellement arbustif, très différente de la pessière à cladines qui domine aujourd'hui la Taïga* ». Le parterre forestier aujourd'hui occupé par les cladines était alors plutôt couvert par les buissons.

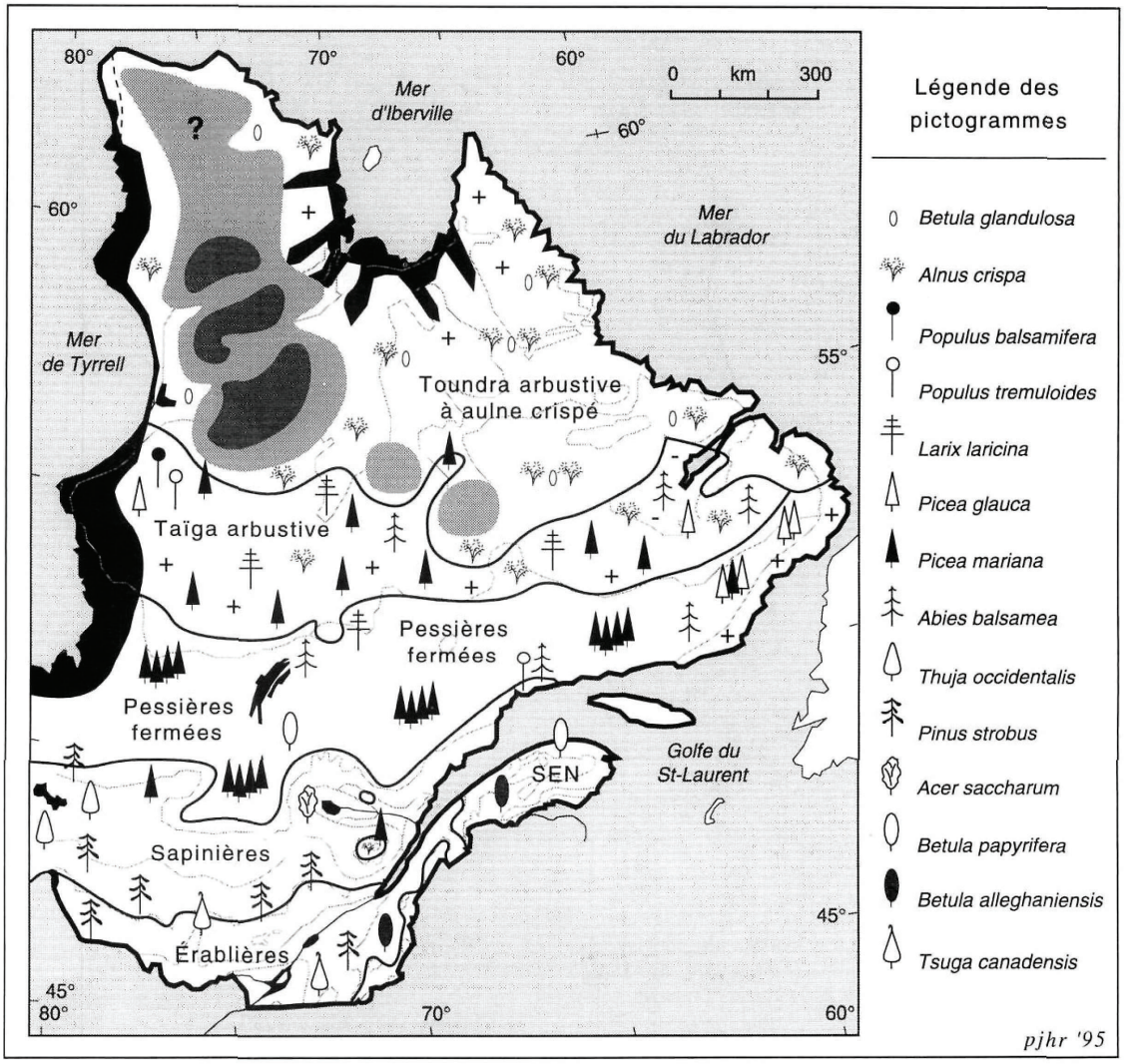


Figure 3 - Couvert végétal du Québec-Labrador il y a 6 000 ans BP ; la bande noire le long des mers représente les surfaces encore alors inondées (tirée de Richard, 1995 : 126)

Dans la zone d'étude, la présence de milieux humides a favorisé le développement des tourbières au détriment de la forêt. L'examen des photos aériennes montre en effet que le couvert forestier couvre de faibles surfaces sur le versant des collines et sur les bombements mieux drainés, de même que le long des rives de certains cours d'eau.

Certains indices font dire à Richard (1995 : 132) que les conditions climatiques estivales d'il y a 6 000 ans BP étaient légèrement plus chaudes et plus humides qu'actuellement ; le plus haut niveau d'humidité aurait alors favorisé une moins grande incidence des feux de forêt et un moindre développement des parterres de lichens. Ces conditions semblent avoir prévalu jusque vers 4 000-3 500 ans BP.

Même si nous ne disposons pas de données sur la faune à cette période, il est permis de postuler que les conditions étaient favorables à l'existence d'une faune présentant des similitudes avec la faune actuelle puisque les conditions écologiques étaient comparables. Ces données viennent conforter l'idée qu'une occupation humaine était possible à 6 000 ans BP et probablement un peu auparavant. La balle retourne donc dans le camp du contexte culturel : est-ce que des groupes humains avaient le besoin ou le désir de se rendre si loin au nord, à cette date ?

4 SURVOL DE L'OCCUPATION AMÉRINDIENNE

4.1 Préhistoire

Les vestiges archéologiques de la région sont le produit des activités de groupes organisés qui ont vécu en bandes très mobiles, explorant puis s'appropriant ce territoire. Dans le cadre de leurs déplacements et de leurs diverses activités, ces groupes ont occupé une multitude de lieux, qu'ils ont utilisés, exploités et modifiés selon leurs besoins. Après leur abandon, ces lieux, devenus sites archéologiques, se sont lentement dégradés et se sont intégrés progressivement au sol. Dans le subarctique québécois, les vestiges sont rarement enfouis à plus de 30 cm sous la surface du sol, mais le caractère fugace des traces laissées s'explique par l'utilisation, dans plusieurs aspects de leurs activités quotidiennes, de matériaux organiques (bois, cuir, os frais) qui se dégradent rapidement à cause de l'acidité du sol podzolique. La présence amérindienne préhistorique est donc le plus souvent révélée par des vestiges moins périssables constitués de témoins immobiliers (éléments structuraux, telles des habitations et des aires de combustion) et mobiliers (tels des outils et des déchets de la taille de la pierre, de la céramique et des restes osseux carbonisés).

Comme discuté au chapitre précédent, les reconstitutions du paléoenvironnement suggèrent que le paysage de la Jamésie pouvait supporter une occupation humaine dès 6 000 ans BP. Cependant, selon les connaissances acquises dans le cadre des recherches archéologiques effectuées lors des travaux d'aménagement du complexe de l'Eastmain-1, l'occupation humaine de la région serait plus tardive, les plus vieux sites mis au jour étant datés entre 4 600 et 4 100 ans BP. Ces sites ont été identifiés suite à la découverte de petites quantités de produits de débitage lithique, principalement du quartz, autour de structures de combustion (foyers) circulaires peu élaborées et contenant des restes osseux carbonisés de caribous. Le caractère temporaire des installations évoque une grande mobilité des groupes fort probablement stimulée par la migration des caribous. Ces sites sont localisés à une trentaine de kilomètres à l'est de la zone d'étude, le long de la rive droite de la rivière Eastmain.

Une seconde période d'occupation comprise autour de 3 500 ans BP a été reconnue. Les sites sont maintenant organisés autour d'une structure de combustion de forme allongée avec plus d'une concentration de débitage lithique en périphérie. Cette situation suggère la présence d'une occupation plus élaborée que lors de la période précédente, laissant supposer qu'après une période exploratoire où les utilisateurs découvraient le territoire, ils s'approprient maintenant celui-ci. Par ailleurs, le quartzite de Mistassini (provenant de la région du lac Mistassini) occupe maintenant une place importante dans la panoplie des matières lithiques utilisées. Cette occupation se poursuivra

de façon relativement régulière jusqu'à la période comprise autour de 2 400 ans BP qui marquera alors une interruption encore inexpliquée de l'occupation de ce vaste territoire, interruption qui se poursuivra jusque vers 2 000 ans BP.

À partir de ce moment, la région accueille de nouveau les groupes de chasseurs nomades et cette occupation se poursuivra de façon continue et intensive jusqu'à nos jours. Cette présence est toujours centrée autour de l'exploitation du caribou qui assurait une certaine stabilité, mais requérait à la fois une grande mobilité et le maintien d'un vaste réseau de parenté. L'habitation de forme allongée, qui apparaît à cette période (Denton, 1989), pouvait donc accueillir plusieurs unités familiales ou des contingents de chasseurs partageant des savoirs différents. Cette période sera également marquée par une présence nouvelle, mais récurrente de sites dans les environs du Grand Détour de la rivière Eastmain. C'est aussi la période qui voit apparaître le chert des basses terres de la baie James sur les sites de la rivière Eastmain. L'occupation humaine demeurera intense jusqu'à la période du contact avec les Européens.

4.2 Période historique

Alors que leurs voisins du sud font déjà du commerce avec les postes de traite, les groupes amérindiens de la Jamésie ne participent au système de traite des fourrures qu'à partir de la fin du XVIIe siècle alors que des postes de traite sont finalement établis sur leur territoire (fondation de Fort Charles-Rupert House-Waskaganish en 1669 et du poste de East Main en 1684). On perçoit une continuité culturelle entre les groupes de la fin de la période préhistorique et ceux de la période historique. À partir de son ouverture jusque vers 1820, le poste de Eastmain à l'embouchure de la rivière du même nom dans la baie James est le plus important comptoir d'échanges. C'est également à partir de ce poste que sont organisées toutes les explorations vers l'intérieur et vers le nord le long de la côte. Avec l'installation du comptoir de la Compagnie de la Baie d'Hudson dans l'embouchure de la rivière, des familles amérindiennes s'établissent dans les environs et finalement, le village d'Eastmain est fondé au début du XVIIIe siècle sur la rive droite de ladite rivière, mais sera relocalisé sur la rive gauche en 1762, pour des raisons de commodités.

4.3 Occupation contemporaine

Aujourd'hui, la zone d'étude est englobée dans les limites du territoire régi par la *Convention de la Baie James et du Nord Québécois* (CBJNQ) instaurée en 1975, dont la juridiction s'étend entre les 49e et 55e parallèles. Elle fait également partie de la municipalité de la Baie-James qui est reliée à la partie méridionale du Québec par la route de la Baie James et la route du Nord.

L'activité économique de la région est principalement tributaire des industries minière, forestière et touristique. L'activité forestière et minière est concentrée dans la partie sud du territoire. Les principaux intérêts touristiques sont la chasse et la pêche sportive, l'écotourisme et la visite d'installations hydroélectriques.

Les communautés cries ont une économie mixte, qui combine le travail salarié, principalement dans les secteurs des services et de l'administration locale, à l'économie dite traditionnelle, basée sur la récolte des ressources fauniques. Cette économie traditionnelle est maintenant assujettie au régime territorial introduit par la CBJNQ qui prévoit la division du territoire de la baie James en terres de catégories I, II et III. Dans le cas présent, la zone d'étude recoupe des terres de catégorie III[1].

Antérieurement, c'est-à-dire au cours des années 1930, le gouvernement québécois avait divisé toute la région de la Baie-James en réserves à castors dans le but de faciliter les activités de piégeage des Autochtones. Chacune des réserves à castors a été subdivisée en lots de piégeage et pour chacun d'eux, la gestion des ressources et des activités de récolte est la responsabilité du maître de trappage (*tallyman*). L'utilisation du territoire par les Cris est constituée d'un ensemble de pratiques, de savoirs et de règles. La forme contemporaine de cette utilisation est à la fois le produit de l'histoire récente et le prolongement d'un mode d'exploitation qui s'est développé bien avant l'arrivée des Européens.

Les campements utilisés par les Cris sur le territoire peuvent être regroupés selon trois catégories :

1) les campements permanents, établis près de lieux recherchés pour la pêche ou la chasse à l'oie, par le fait même, des pôles de concentration de différentes familles. Les campements permanents situés à l'intérieur des terres et loin du réseau routier sont surtout fréquentés à la fin de l'automne et en hiver pour le trappage et la chasse au gros gibier. Ceux qui sont établis aux abords des routes sont utilisés plus fréquemment en raison de leur meilleure accessibilité.

2) les campements temporaires établis le long des circuits usuels d'exploitation des utilisateurs ou comme points d'arrêt durant leurs expéditions dans les secteurs isolés du territoire. Ils sont ainsi aménagés bien souvent pour des activités saisonnières telles que la chasse à l'oie, la pêche et la chasse au gros gibier.

1 Les terres de catégorie III représentent toutes les terres du territoire conventionné non incluses dans les terres de catégories I et II. Sur ces terres, les Cris jouissent de l'exclusivité du droit de trappage des animaux à fourrure et de certains avantages dans le domaine de la pourvoirie sans droits exclusifs. Ils peuvent y établir tout campement nécessaire pour la chasse, la pêche et le trappage et dans ce cas, un titre du gouvernement du Québec n'est pas requis. De plus, les Cris n'ont pas besoin d'un permis pour la pratique de ces activités et aucune limite ne leur est imposée quant au nombre de prises. En outre, certaines espèces fauniques leur sont réservées pour leurs activités de chasse et de pêche. Ils détiennent le droit d'exploiter les espèces piscicoles ainsi réservées à des fins de pêcheries commerciales. Sur ces territoires, la chasse et la pêche sont permises autant pour les autochtones que les allochtones.

3) les campements culturels qui sont des lieux de rassemblement d'intérêt communautaire où s'exerce principalement la transmission de la culture crie aux jeunes générations. Les campements culturels sont établis à des endroits choisis pour leurs attributs propices à l'enseignement des pratiques traditionnelles ou en raison de leur proximité des villages.

La chasse, la pêche et le piégeage des animaux à fourrure sont les principales activités pratiquées sur les lots de piégeage. La chasse au gros gibier occupe aujourd'hui une place importante dans le mode d'exploitation du territoire. L'orignal est important, en particulier dans les communautés situées au centre et au sud du territoire de la Baie-James. La chasse au caribou est quant à elle plus intense dans la portion nord du territoire. L'orignal et le caribou sont chassés principalement en automne et en hiver. Au printemps, la migration des outardes vers le Nord signale le début d'une période d'intense activité sur le territoire. La chasse à l'outarde monopolise alors la majorité des membres des différentes communautés durant au moins deux semaines. La chasse à l'oie est aussi pratiquée lors de la migration automnale, quoique de façon moins intensive.

La pêche est pratiquée dans la plupart des plans d'eau et cours d'eau du territoire. Les principales espèces recherchées sont le brochet, le cisco de lac, le doré, l'esturgeon, le grand corégone, l'omble de fontaine et le touladi. Les activités de pêche sont plus intenses en été et en automne, notamment dans les lieux localisés à proximité des villages, aux abords de plans d'eau importants ainsi que dans la baie de Rupert et la baie James. La pêche se poursuit néanmoins en hiver et au printemps pour certaines espèces telles que le cisco de lac, l'esturgeon ou le grand corégone.

Les activités de piégeage ont lieu de la fin de l'automne jusqu'à la période de dégel. Chaque lot de piégeage est habituellement divisé en deux ou plusieurs secteurs qui sont exploités selon un système de rotation et d'alternance. Outre le castor, les espèces trappées sont le lièvre d'Amérique, la loutre, le lynx, la martre d'Amérique, le rat musqué, le renard et le vison.

À l'automne, les trappeurs quittent le village et se dirigent vers leur terrain pour entreprendre leurs activités de piégeage. Depuis une trentaine d'années, le mode d'accès au territoire et de déplacement à l'intérieur des terres a été sensiblement modifié par le développement du réseau routier et l'adoption de véhicules motorisés comme mode de transport privilégié. Avant les années 1960, la majorité des déplacements depuis les villages vers les lieux de campement et les aires d'exploitation se faisaient en canot et les terrains de trappage étaient parcourus à pied, en raquettes ou, sur la côte, en traîneau à chien. Au début des années 1970, le recours à l'hydravion comme moyen de transport est devenu une pratique courante pour accéder aux terrains. Aujourd'hui, les utilisateurs se déplacent le plus souvent en véhicule motorisé (camionnette), en

motoneige et en bateau à moteur, mais l'avion à flotteurs ou à skis est toujours utilisé pour amener les familles jusqu'aux secteurs difficiles d'accès. À partir de leurs campements permanents, les utilisateurs sillonnent leur terrain en motoneige, ce qui leur permet de couvrir d'importantes distances en une journée. Ce moyen de transport a modifié le mode d'exploitation des terrains, entre autres, en réduisant la durée des expéditions de chasse ou de trappage dans les secteurs éloignés des campements. Les utilisateurs se déplacent sur le territoire en suivant les cours et plans d'eau favorables à l'habitat du castor ou d'autres espèces. Durant les mois d'été, les activités de prélèvement sur le territoire sont à toutes fins pratiques interrompues, à l'exception de la pêche et de la cueillette des petits fruits.

L'utilisation du territoire évoque plus qu'un mode traditionnel de subsistance pour les Cris. Elle leur confère une identité et traduit un profond sentiment d'appartenance au territoire. Celui-ci est le lieu où s'inscrivent les mémoires collectives et individuelles, les évènements importants, les naissances et les décès, les légendes et les croyances. La zone d'étude et ses abords englobent des parties plus ou moins importantes des lots de piégeage RE1, RE2, VC33 et VC35. Les informations colligées pour les lots de piégeage RE1 et VC35 (Nove Environnement, 2004) et celles provenant des consultations faites auprès des utilisateurs cris du terrain de trappage RE2 (WSP, 2018) ont servi aux réflexions menant à la définition des zones de potentiel archéologique.

4.4 Eurocanadiens

La route de la Baie-James, dont la construction a débuté en 1971, traverse la zone d'étude dans un axe plus ou moins orienté nord-sud. Elle a été conçue dans le but premier de permettre à la machinerie et aux travailleurs d'accéder par voie terrestre aux grands chantiers des projets hydroélectriques entrepris au cours des années 1970. Toutefois, avant d'entreprendre la construction de la route, les travailleurs ont d'abord dû aménager des campements de fortune avant de se mettre au travail et des vestiges de ces camps peuvent fort probablement encore être mis au jour en bordure de la route. La route a été complétée en octobre 1974 et s'étire sur plus de 600 kilomètres entre Matagami et Radisson ; le seul endroit où il est possible de faire le plein d'essence[2], le relais routier du kilomètre 381, est l'un des plus isolés en Amérique du Nord.

Outre les projets hydroélectriques, des projets miniers d'envergure sont également accessibles grâce à la route de la baie James, dont le projet Wabamisk-Anatacau qui est localisé le long de la rive droite (nord) de la rivière Eastmain dans le coin nord-est de la zone d'étude. Ce projet d'exploration minière est l'œuvre des Mines Virginia, également responsable de la découverte et mise en marche du projet Éléonore.

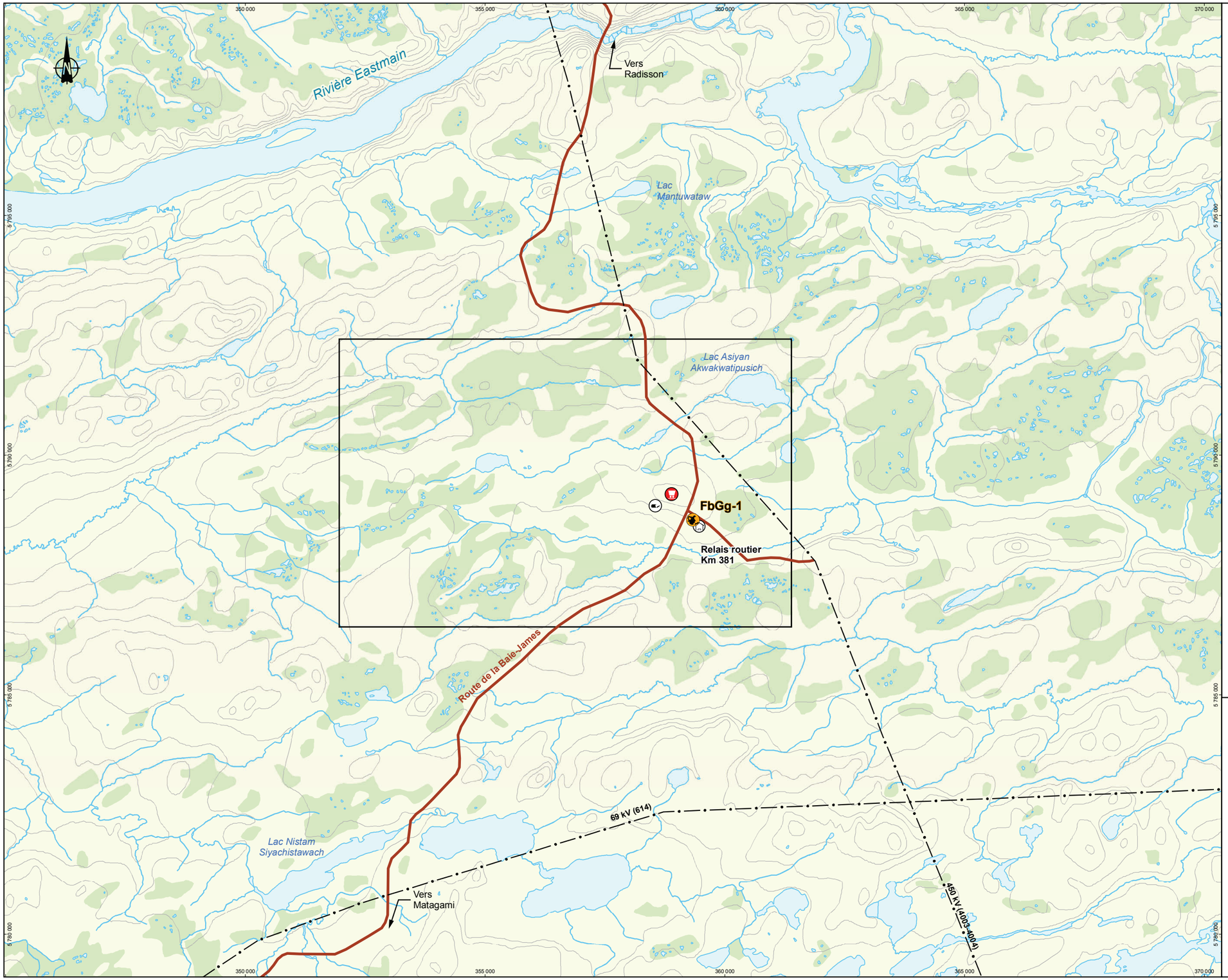
2 Le relais routier du kilomètre 381 contient également des services d'urgence et de dépannage mécanique.

4.5 Études archéologiques antérieures

Un inventaire archéologique a été réalisé pour le tracé de la ligne de transport d'électricité à 450 kV qui traverse la zone d'étude. Deux zones à proximité ont été visitées, soit à la traversée de la rivière Eastmain et à la traversée de la rivière Pontax. Cet inventaire n'a pas permis de mettre au jour de site archéologique, mais une découverte fortuite a été effectuée sur le site du relais routier du km 381 (où l'équipe d'archéologue a été hébergée), soit une pointe de projectile en chert qui reposait en surface du sol bouleversé par l'aménagement du relais (figure 3).

Tableau 2 - Site archéologique dans la zone d'étude

Code Borden	Localisation	Bassin hydrographique	Coordonnées		État	Travaux réalisés	Identité culturelle	Période	Fonction
FbGg-1	Relais routier km 381	Rivière Eastmain	52 13 49	77 03 35	Bouleversé à 100 %	Inspection visuelle	Amérindien	Préhistorique indéterminée	Indéterminée



Mine de lithium Baie-James

Archéologie

FbGg-1 Site archéologique connu

Limites

Zone d'étude du potentiel archéologique

Infrastructures

Route principale

Route d'accès

Ligne de transport d'énergie

Relais routier

Tour de télécommunication

Lieu d'enfouissement en territoire isolé (LETI)

GALAXY

Mine de lithium Baie-James

Étude de potentiel archéologique

Localisation du site archéologique connu

Sources :

Canvec, 1 : 50 000, RNCan, 2015

BDGA, 1 : 1 000 000, RNCan, 2011

Archéologie, Arkéos, 2017

Cartographié par : WSP

No Ref : 171-02562-00_wspT153_ARf4_archeo_180730.mxd

0 0,8 1,6 km

UTM 18, NAD83

Figure 4

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5 DÉTERMINATION DU POTENTIEL ARCHÉOLOGIQUE

L'habitabilité d'un territoire constitue la condition initiale pour que des humains puissent y circuler et se l'approprier. La fonte du glacier, le retrait des eaux marines et lacustres et l'amélioration des conditions de l'environnement sont des conditions initiales à toute occupation humaine. Les données présentées plus haut nous montrent que le territoire à l'étude a d'abord été libéré des glaces un peu avant 7 900 ans BP, mais qu'il a alors été recouvert par les eaux de la mer de Tyrrell. Le taux de relèvement isostatique étant relativement rapide durant le premier millénaire, la zone d'étude aurait commencé à émerger vers 6 900-6 800 ans BP et vers 6 000 ans BP, le niveau se situait autour de 140 m. Les reconstitutions du couvert végétal montrent, par ailleurs, que le paysage de la région ressemblait déjà au paysage actuel il y a environ 6 000 ans. Bien que l'occupation du territoire aurait donc été possible à une date aussi ancienne, les sites les plus anciens découverts lors des recherches le long de la rivière Eastmain datent entre 4 600 et 4 100 ans BP.

Pour réaliser cette étude de potentiel, nous avons d'abord procédé à une localisation du territoire à l'étude dans l'espace régional, à l'aide des cartes topographiques au 1 : 250 000 et au 1 : 50 000 ; cette démarche avait pour but de caractériser le système hydrographique dans lequel s'insérait la zone d'étude, d'examiner le réseau de circulation qu'il pouvait soutenir et de caractériser la topographie de la zone d'étude et des territoires voisins. Par la suite, une interprétation de la couverture de photos aériennes au 1 : 15 000 a permis d'identifier les caractéristiques particulières de la topographie et de déterminer les conditions de circulation et d'habitabilité. Les résultats de l'étude sont présentés sur la figure 5 et au tableau 3 qui présente les caractéristiques des 27 zones à potentiel retenues.

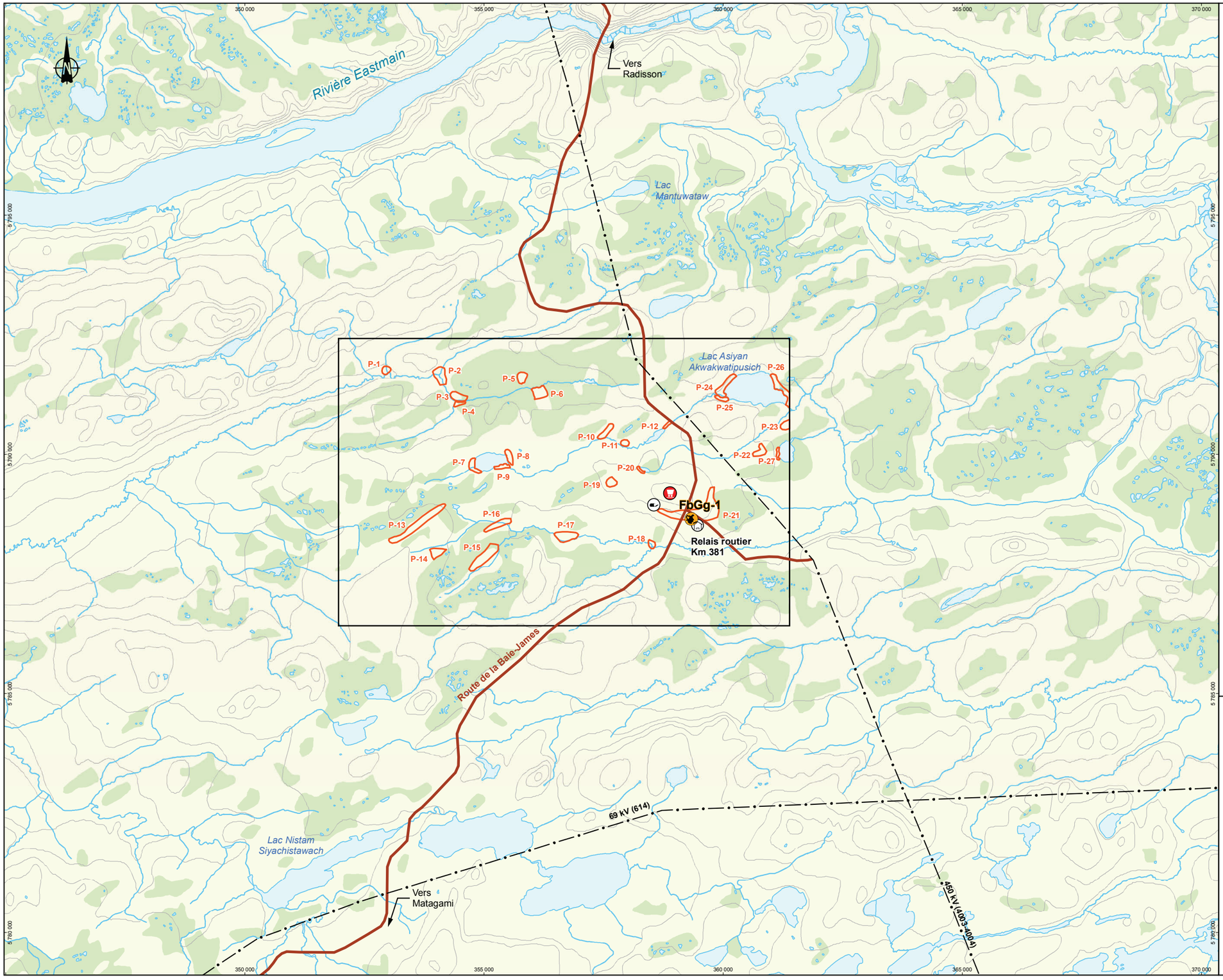
La zone d'étude se caractérise par le fait qu'elle se situe dans un paysage de tourbières et qu'elle chevauche deux bassins hydrographiques secondaires s'écoulant plus ou moins parallèlement à l'Eastmain, et dans des directions opposées. Vis-à-vis la zone d'étude, au nord, le cours de l'Eastmain est marqué par la présence de rapides importants qui commandent des portages. Il est possible que les occupants du territoire aient emprunté la trajectoire tracée par le cours principal de ces deux bassins pour contourner cette section de l'Eastmain. L'occupation de la zone d'étude aurait d'autre part pu se réaliser dans le cadre d'une exploitation des ressources du milieu, particulièrement la faune des milieux humides qui devaient profiter du réseau de petits cours d'eau qui se diffusent à travers les tourbières.

La présence humaine ancienne dans la zone d'étude est attestée par la toponymie et par au moins un site archéologique (FbGg-1) localisé sur la bordure est de la colline retenu pour le développement minier. Ce site n'est pas associé directement à la bordure d'un cours d'eau ; il se situe en retrait, dans une zone de transition entre la colline elle-même et les tourbières qui l'entourent. L'étude de potentiel a principalement retenu des zones apparemment mieux drainées, associées le plus souvent (pas toujours) à des petites bandes ou des parcelles forestières, et se situant le long des cours d'eau et des lacs. Le long des cours d'eau, une valeur particulière a été accordée aux points de convergence d'affluents avec le cours principal puisqu'ils permettent d'accéder à des aires de trappage plus étendues et qu'ils peuvent être le site de petits campements ou de bivouacs installés lors des rondes. Enfin, des zones offrant de meilleures conditions d'habitabilité et se situant sur des bombements morainiques entourés de tourbières ont été retenues, même si elles se distançaient de la rive des cours d'eau.

Tableau 3 - Zones de potentiel archéologique préhistorique

Zone	Photos aériennes	Bassin hydrographique	Situation	Altitude	Géomorphologie et drainage	Critères de sélection	Aspects stratégiques	Recommandations / remarques
P-1	AS10107-134	Rivière Miskimatao / rivière Eastmain	Rive nord d'un affluent de la Miskimatao, à la rencontre d'un petit affluent en provenance du nord	Surfaces à environ 190 m	Surface presque gisante, drainage moyen à faible	Accès à un grand secteur de zones humides (tourbières)	Zone de confluence / en périphérie de grandes tourbières	Examen visuel et sondages archéologiques si requis dans les sections plus propices
P-2	AS10107-134	Rivière Miskimatao / rivière Eastmain	Les rives d'un affluent de la Miskimatao, à la convergence de trois cours d'eau	Surfaces à environ 190 m	Surface presque gisante, drainage moyen à faible	Accès à un grand secteur de zones humides (tourbières)	Zone de confluence / Secteur favorisé pour le trappage (castor et autres animaux à fourrure (WSP, 2018 : carte 6-22).	Examen visuel et sondages archéologiques si requis dans les sections plus propices
P-3	AS10107-134	Rivière Miskimatao / rivière Eastmain	Rive droite d'un affluent de la Miskimatao, à la rencontre d'un petit affluent en provenance du sud	Surfaces à environ 190 m	Surface presque gisante, drainage moyen à faible	Accès à un grand secteur de zones humides (tourbières), point de convergence	Zone de confluence des ruisseaux CE2 et CE6 (WSP, 2018 : carte 6-1)/ Secteur favorisé pour le trappage (castor et autres animaux à fourrure (WSP, 2018 : carte 6-22).	Examen visuel et sondages archéologiques si requis dans les sections plus propices
P-4	AS10107-134	Rivière Miskimatao / rivière Eastmain	Rive gauche d'un affluent de la Miskimatao, à la rencontre d'un petit affluent en provenance du sud	Surfaces à environ 190 m	Surface presque gisante, drainage moyen à faible	Accès à un grand secteur de zones humides (tourbières) ; point de convergence	Zone de confluence des ruisseaux CE2 et CE6 (WSP, 2018 : carte 6-1)/ Secteur favorisé pour le trappage (castor et autres animaux à fourrure (WSP, 2018 : carte 6-22).	Examen visuel et sondages archéologiques si requis dans les sections plus propices
P-5	AS10107-132	Rivière Miskimatao / rivière Eastmain	Rive droite (nord) d'un affluent de la Miskimatao, dans un secteur de tourbière	Surfaces à environ 190 m	Surface probablement bosselée (butte de till) dans un milieu de tourbière	Zone habitable à proximité de la rivière, dans un milieu humide	Secteur favorisé pour le trappage (castor et autres animaux à fourrure (WSP, 2018 : carte 6-22).	Examen visuel et sondages archéologiques si requis dans les sections plus propices
P-6	AS10107-132	Rivière Miskimatao / rivière Eastmain	Rive gauche (sud) d'un affluent de la Miskimatao, dans un secteur de tourbière	Surfaces à environ 190 m	Surface probablement bosselée (butte de till) dans un milieu de tourbière	Zone habitable à proximité de la rivière, dans un milieu humide	Secteur favorisé pour le trappage (castor et autres animaux à fourrure (WSP, 2018 : carte 6-22).	Examen visuel et sondages archéologiques si requis dans les sections plus propices
P-7	AS10107-132	Bras nord-ouest d'une rivière sans nom (rejoint l'Eastmain vers l'est) / rivière Eastmain	Rive ouest du lac Asini Kasachipet	Surfaces à environ 205 m	Surface presque gisante, drainage moyen à faible	Rives à la tête du lac	Lac très peu productif et son utilisation par le poisson semble limitée (WSP, 2018 : carte 6-100). Plan d'eau pouvant servir de point de repère dans un environnement de tourbières.	Examen visuel et sondages archéologiques si requis dans les sections plus propices
P-8	AS10107-132	Bras nord-ouest d'une rivière sans nom (rejoint l'Eastmain vers l'est) / rivière Eastmain	Rive est du lac Asini Kasachipet	Surfaces à environ 205 m	Surface presque gisante, drainage moyen à faible	Rives à l'embouchure du lac	Lac très peu productif et son utilisation par le poisson semble limitée (WSP, 2018 : carte 6-100). Plan d'eau pouvant servir de point de repère dans un environnement de tourbières.	Examen visuel et sondages archéologiques si requis dans les sections plus propices
P-9	AS10107-132	Bras nord-ouest d'une rivière sans nom (rejoint l'Eastmain vers l'est) / rivière Eastmain	Rive sud-est du lac Asini Kasachipet	Surfaces à environ 205 m	Surface presque gisante, drainage moyen à faible	Rives à l'embouchure du lac	Lac très peu productif et son utilisation par le poisson semble limitée (WSP, 2018 : carte 6-100). Plan d'eau pouvant servir de point de repère dans un environnement de tourbières.	Examen visuel et sondages archéologiques si requis dans les sections plus propices
P-10	AS10107-130	Bras nord-ouest d'une rivière sans nom (rejoint l'Eastmain vers l'est) / rivière Eastmain	Rive nord, dans la tourbière	Surfaces à environ 195 m	Butte morainique allongée (remaniée par phase marine), bon drainage	Butte habitable à proximité de la rivière, dans un environnement humide (tourbière)	Rive nord du ruisseau CE3 (WSP, 2018 : carte 6-22)	Examen visuel et sondages archéologiques si requis dans les sections plus propices
P-11	AS10107-130	Bras nord-ouest d'une rivière sans nom (rejoint l'Eastmain vers l'est) / rivière Eastmain	Rive nord, dans la tourbière	Surfaces à environ 195 m	Butte morainique (remaniée par phase marine), bon drainage	Butte habitable à proximité de la rivière, dans un environnement humide (tourbière)	Rive nord du ruisseau CE3 (WSP, 2018 : carte 6-22)	Examen visuel et sondages archéologiques si requis dans les sections plus propices
P-12	AS10107-130	Bras nord-ouest d'une rivière sans nom (rejoint l'Eastmain vers l'est) / rivière Eastmain	Rive nord d'un lac sans nom	Surfaces à environ 190 m	Faible butte morainique (remaniée par phase marine), bon drainage	Butte habitable à proximité de la rivière, dans un environnement humide (tourbière)	Dans la portion nord d'une aire de chasse, de trappage ou de pêche (WSP, 2018 : carte 6-22).	Examen visuel et sondages archéologiques si requis dans les sections plus propices
P-13	AS10107-111	Bras central d'une rivière sans nom (rejoint l'Eastmain vers l'est) / rivière Eastmain	Dans la zone de partage des eaux entre la rivière sans nom et la rivière Miskimatao ; dans une zone humide (tourbière)	Surfaces à environ 198 m	Longue butte morainique (remaniée par phase marine), bon drainage	Dans la zone de partage des eaux entre la rivière sans nom et la tête de la rivière Miskimatao ; surface habitable dans une grande zone humide	À proximité d'un axe de circulation - ruisseau CE5 (WSP, 2018 : carte 6-1).	Examen visuel et sondages archéologiques si requis dans les sections plus propices
P-14	AS10107-111	Bras central d'une rivière sans nom (rejoint l'Eastmain vers l'est) / rivière Eastmain	Dans la zone de partage des eaux entre la rivière sans nom et la rivière Miskimatao ; dans une zone humide (tourbière)	Surfaces à environ 198 m	Extrémité nord-est d'une butte morainique entourée de tourbière	Dans la zone de partage des eaux entre la rivière sans nom et la tête de la rivière Miskimatao ; surface habitable dans une grande zone humide	Extrémité amont du ruisseau CE5 (WSP, 2018 : carte 6-1). Ce ruisseau est valorisé par les utilisateurs principalement pour l'accès direct qu'il offre à la rivière Eastmain - parcours de navigation (WSP, 2018 : carte 6-22).	Examen visuel et sondages archéologiques si requis dans les sections plus propices
P-15	AS10107-113	Bras sud-ouest d'une rivière sans nom (rejoint l'Eastmain vers l'est) / rivière Eastmain	Dans la zone de partage des eaux entre la rivière sans nom et la rivière Miskimatao ; dans une zone humide (tourbière)	Surfaces à environ 198 m	Longue butte morainique (remaniée par phase marine), bon drainage	Dans la zone de partage des eaux entre la rivière sans nom et la tête de la rivière Miskimatao ; surface habitable dans une grande zone humide au nord du cours d'eau	Affluent au cours principal du ruisseau CE5 (WSP, 2018 : carte 6-1).	Examen visuel et sondages archéologiques si requis dans les sections plus propices

Zone	Photos aériennes	Bassin hydrographique	Situation	Altitude	Géomorphologie et drainage	Critères de sélection	Aspects stratégiques	Recommandations / remarques
P-16	AS10107-113	Bras central d'une rivière sans nom (rejoint l'Eastmain vers l'est) / rivière Eastmain	Dans la zone de partage des eaux entre la rivière sans nom et la rivière Miskimatao ; dans une zone humide (tourbière)	Surfaces à environ 198 m	Longue butte morainique (remaniée par phase marine), bon drainage	Dans la zone de partage des eaux entre la rivière sans nom et la tête de la rivière Miskimatao ; surface habitable traversée par le cours d'eau, dans une grande zone humide au nord du cours d'eau	Cours principal du ruisseau CE5 – aire valorisée par les utilisateurs du terrain de trappage RE2 (WSP, 2018 : cartes 6-1 et 6-22).	Examen visuel et sondages archéologiques si requis dans les sections plus propices
P-17	AS10107-113	Rivière sans nom (rejoint l'Eastmain vers l'est) / rivière Eastmain	Rive nord de la rivière sans nom, en marge d'une zone humide	Surfaces à environ 198 m	Surface probablement bosselée (butte de till) dans un milieu de tourbière	Surface habitable sur la rive nord de la rivière dans un milieu humide	Cours principal du ruisseau CE5 – aire valorisée par les utilisateurs du terrain de trappage RE2 (WSP, 2018 : cartes 6-1 et 6-22).	Examen visuel et sondages archéologiques si requis dans les sections plus propices
P-18	AS10107-116	Rivière sans nom (rejoint l'Eastmain vers l'est) / rivière Eastmain	Rives de la rivière dans la confluence d'un cours d'eau en provenance du sud-ouest	Surfaces à environ 198 m	Surface presque gisante, drainage moyen à faible	Zone de convergence de 2 cours d'eau	Cours principal du ruisseau CE5 – confluence avec un ruisseau sans hydronyme –aire de chasse, de trappage et de pêche – aire valorisée par les utilisateurs du terrain de trappage RE2 (WSP, 2018 : cartes 6-1 et 6-22).	Examen visuel et sondages archéologiques si requis dans les sections plus propices
P-19	AS10107-114	Bras nord d'une rivière sans nom (rejoint l'Eastmain vers l'est) / rivière Eastmain	Extrémité ouest d'une importante colline	Surfaces à environ 213 m	Large bombement morainique, dans la plongée ouest de la colline, bon drainage	Extrémité ouest d'une butte entourée d'un milieu humide	Importante éminence dans le paysage de tourbières.	Examen visuel et sondages archéologiques si requis dans les sections plus propices
P-20	AS10107-116	Bras nord d'une rivière sans nom (rejoint l'Eastmain vers l'est) / rivière Eastmain	Rives sud et ouest du lac Kapisikama	Surfaces à environ 200 m	Surface presque gisante, drainage moyen à faible	Rives d'un petit lac portant un toponyme	Présence de perchaude (limite nord de son aire de distribution). Extrémité nord-ouest d'une aire de chasse, de trappage et de pêche qui offre un potentiel reconnu pour la cueillette de baies (WSP, 2018 : carte 6-22)	Examen visuel et sondages archéologiques si requis dans les sections plus propices
P-21	AS10107-116	Rivière sans nom (rejoint l'Eastmain vers l'est) / rivière Eastmain	Pourtour sud et est d'une importante colline	Surfaces à environ 210 m	Surfaces gisantes à faiblement inclinées, bon drainage	Présence d'un site connu (FbGg-1) sur la forme ; extrémité d'une colline entourée d'un milieu humide, au nord d'une rivière	Aire de chasse, de trappage ou de pêche traversée par la route de la Baie-James - Secteur propice pour le trappage du castor (WSP, 2018 : cartes 6-139 et 6-22). L'espace dégagé du tracé de la route de la Baie-James est valorisé pour son potentiel pour la chasse à l'orignal (WSP, 2018 : 6-139).	Examen visuel et sondages archéologiques si requis dans les sections plus propices
P-22	AS10107-127	Bras nord d'une rivière sans nom (rejoint l'Eastmain vers l'est) / rivière Eastmain	Butte morainique dans une tourbière, à l'ouest du lac Kachiskakamikach	Surfaces à environ 195 m	Butte morainique (remaniée par phase marine), bon drainage	Butte habitable à proximité d'un cours d'eau et d'un lac, dans un environnement humide (tourbière)	Proximité du ruisseau CE4 (WSP, 2018 : carte 6-1).	Examen visuel et sondages archéologiques si requis dans les sections plus propices
P-23	AS10107-127	Bras nord d'une rivière sans nom (rejoint l'Eastmain vers l'est) / rivière Eastmain	Butte morainique dans une tourbière, entre les lacs Asiyan Akwakwatipusich et Kachiskakamikach	Surfaces à environ 195 m	Butte morainique (remaniée par phase marine), bon drainage	Butte habitable à proximité d'un cours d'eau et d'un lac, dans un environnement humide (tourbière)	Proximité du ruisseau CE4 (WSP, 2018 : carte 6-1).	Examen visuel et sondages archéologiques si requis dans les sections plus propices
P-24	AS10107-128	Bras nord d'une rivière sans nom (rejoint l'Eastmain vers l'est) / rivière Eastmain	Rive ouest, à la tête du lac Asiyan Akwakwatipusich, rive nord d'un affluent en provenance du sud-ouest	Surfaces à environ 195 m	Surface probablement gisante, drainage bon à mauvais	Rives d'un grand lac portant un toponyme	Présence du grand brochet (WSP, 2018 : carte 6-99).	Examen visuel et sondages archéologiques si requis dans les sections plus propices
P-25	AS10107-128	Bras nord d'une rivière sans nom (rejoint l'Eastmain vers l'est) / rivière Eastmain	Rive ouest, à la tête du lac Asiyan Akwakwatipusich, rive sud d'un affluent en provenance du sud-ouest	Surfaces à environ 195 m	Surface probablement gisante, drainage bon à mauvais	Rives d'un grand lac portant un toponyme	Présence du grand brochet (WSP, 2018 : carte 6-99).	Examen visuel et sondages archéologiques si requis dans les sections plus propices
P-26	AS10107-128	Bras nord d'une rivière sans nom (rejoint l'Eastmain vers l'est) / rivière Eastmain	Rive est du lac Asiyan Akwakwatipusich, au nord de son embouchure	Surfaces à environ 195 m	Surfaces gisantes à faiblement inclinées, drainage bon à mauvais	Rives d'un grand lac portant un toponyme	Présence du grand brochet (WSP, 2018 : carte 6-99).	Examen visuel et sondages archéologiques si requis dans les sections plus propices
P-27	AS10107-127	Bras nord d'une rivière sans nom (rejoint l'Eastmain vers l'est) / rivière Eastmain	Rive ouest du lac Kachiskakamikach, de part et d'autre d'un petit affluent venant des tourbières	Surfaces à environ 195 m	Surfaces probablement gisantes, drainage bon à mauvais	Rives d'un lac avec toponyme	Petit plan d'eau - repère	Examen visuel et sondages archéologiques si requis dans les sections plus propices



Mine de lithium Baie-James

Archéologie

FbGg-1 Site archéologique connu

Zone de potentiel archéologique

Limites

Zone d'étude du potentiel archéologique

Infrastructures

Route principale

Route d'accès

Ligne de transport d'énergie

Relais routier

Tour de télécommunication

Lieu d'enfouissement en territoire isolé (LETI)

GALAXY

Mine de lithium Baie-James

Étude de potentiel archéologique

Localisation du site archéologique connu et des zones de potentiel archéologique

Sources :
Canvec, 1 : 50 000, RNCan, 2015
BDGA, 1 : 1 000 000, RNCan, 2011
Archéologie, Arkéos, 2017

Cartographié par : WSP

No Ref : 171-02562-00_wspT154_ARf5_archeo_180731.mxd

0 0,8 1,6 km

UTM 18, NAD83

Figure 5

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6 RECOMMANDATIONS

L'étude de potentiel a été réalisée pour une zone d'étude de 56,6 km^2. À l'intérieur de cet espace, un site archéologique préhistorique est actuellement connu suite à une découverte fortuite au camp du km 381. Outre la présence de ce site, la présence amérindienne dans la zone d'étude est attestée par l'abondance de toponymes en langue crie, ce qui indique une appropriation et un usage du secteur par les Amérindiens. Aujourd'hui, les Cris qui habitent le terrain de trappage RE2 perpétuent cette présence tout en tentant de préserver un mode de vie traditionnel.

Au total, 27 zones de potentiel archéologique ont été sélectionnées (figure 5 et tableau 3). Ces endroits correspondent aux espaces les plus susceptibles de contenir des vestiges qui sont témoins de présence humaine, de la préhistoire jusqu'au XXe siècle. Plusieurs constructions seront nécessaires pour réaliser la mise en œuvre du complexe minier du projet minier - James Bay Lithium de Galaxy Resources Limited ; elles sont sommairement évoquées en introduction. La nature et la localisation exactes de celles-ci sont en voie d'élaboration. Afin de s'assurer que les travaux de construction prévus n'entraînent pas la destruction de vestiges archéologiques ou ethnologiques, il est recommandé qu'une équipe d'archéologues procède à un inventaire archéologique préalable aux travaux à l'intérieur des zones de potentiel susceptibles d'être touchées par le projet. L'inventaire permettra en une seule étape de valider l'examen effectué sur les cartes et photos aériennes et de procéder aux relevés d'usage si requis.

L'inventaire devra comprendre une inspection visuelle de la surface et des sondages archéologiques systématiques, généralement à chaque 10 m ou aux endroits jugés propices par les archéologues. Il est important que l'inventaire prenne place avant la phase de construction, lorsque le couvert nival sera absent, généralement à partir du début juin dans cette région. Suite à cet inventaire, d'autres recommandations peuvent être émises en fonction d'éventuelles découvertes. Ces recommandations additionnelles pourraient comprendre notamment des fouilles archéologiques.

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APPENDIX

A-112

PHASE II ENVIRONEMENTAL SITE CHARACTERISATION OF THE REMOTE LANDFILL

MINE DE LITHIUM BAIE-JAMES

CARACTÉRISATION ENVIRONNEMENTALE DE SITE – PHASE II DU LIEU D'ENFOUISSEMENT EN TERRITOIRE ISOLÉ

JUIN 2018

MINE DE LITHIUM BAIE-JAMES

CARACTÉRISATION ENVIRONNEMENTALE DE SITE – PHASE II DU LIEU D'ENFOUISSEMENT EN TERRITOIRE ISOLÉ

GALAXY LITHIUM (CANADA) INC.

VERSION FINALE

PROJET N^{O} : 171-02562-00
DATE : JUIN 2018

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Directrice du projet — Date

Le présent rapport a été préparé par WSP Canada inc. pour le compte de Galaxy Lithium (Canada) inc. conformément à l'entente de services professionnels. La divulgation de tout renseignement faisant partie du présent rapport incombe uniquement au destinataire prévu. Son contenu reflète le meilleur jugement de WSP Canada inc. à la lumière des informations disponibles au moment de la préparation du rapport. Toute utilisation que pourrait en faire une tierce partie ou toute référence ou toutes décisions en découlant sont l'entière responsabilité de ladite tierce partie. WSP Canada inc. n'accepte aucune responsabilité quant aux dommages, s'il en était, que pourrait subir une tierce partie à la suite d'une décision ou d'un geste basé sur le présent rapport. Cet énoncé de limitation fait partie du présent rapport.

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A LIMITES ET CONDITIONS GÉNÉRALES DE L'ÉTUDE

B REPORTAGE PHOTOGRAPHIQUE

C RAPPORTS DE SONDAGE

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1 INTRODUCTION

1.1 MISE EN CONTEXTE DU PROJET

Galaxy Lithium (Canada) inc. (Galaxy) est une filiale de Galaxy Resources Limited, une importante société minière sur le marché du lithium. Actuellement, Galaxy Resources Limited exploite une mine de spodumène en Australie et deux projets sont en développement, un au Québec et l'autre en Argentine.

Galaxy agit à titre d'initiateur du projet Mine de lithium Baie-James situé dans la région administrative du Nord-du-Québec. Le site minier à l'étude se trouve à environ 10 km au sud de la rivière Eastmain et à quelque 100 km à l'est de la baie James, à la même latitude que le village cri d'Eastmain (carte 1). La propriété minière (claims) de Galaxy se trouve sur des terres de catégorie III selon la Convention de la Baie James et du Nord québécois (CBJNQ). Les terres sous claims miniers sont facilement accessibles par la route de la Baie-James qui traverse la propriété à proximité du relais routier du km 381.

Le projet prévoit l'exploitation d'une fosse de façon conventionnelle d'où environ 2 Mt par année de pegmatites à spodumène seront extraites pour ensuite être dirigées vers un concentrateur. Outre ces installations, le site accueillera notamment des aires d'accumulation (mort-terrain, terre végétale, stériles/résidus, minerai, concentré), des bassins de rétention, une unité de traitement d'eau, des bâtiments administratifs, un campement pour les travailleurs, des ateliers et entrepôts, ainsi qu'un dépôt d'explosifs. La période d'exploitation prévue est de 16 ans.

Le projet Mine de lithium Baie-James est assujetti à la procédure provinciale d'évaluation et d'examen des impacts sur l'environnement, tel que prévu à l'article 153 du chapitre II de la *Loi sur la qualité de l'environnement* (LQE). L'annexe A de la LQE liste les projets obligatoirement soumis à la procédure d'évaluation et d'examen, dont « tout projet minier, y compris l'agrandissement, la transformation ou la modification d'une exploitation minière existante ». Conjointement à la LQE, l'annexe 1 du chapitre 22 de la CBJNQ dresse une liste de projets soumis au processus d'évaluation, dont les projets d'exploitation minière. Le projet est également assujetti à une évaluation environnementale fédérale, tel que prévu à l'article 13 de la *Loi canadienne sur l'évaluation environnementale* (2012) (L.C. 2012, ch. 19, art. 52), puisque l'extraction de minerai dépassera 3 000 t/jour (article 16(a)) et que la capacité de l'usine de concentration dépassera 4 000 t/jour (article 16(b) du *Règlement désignant les activités concrètes* (DORS/2012-147)).

1.2 MISE EN CONTEXTE DE L'ÉTUDE

Une évaluation environnementale de site (ÉES) – phase I a été réalisée à l'été 2017 afin de déterminer si des risques de nature environnementale étaient présents pour la propriété visée par le projet Mine de lithium Baie-James (WSP, 2018). Les informations portées à l'attention de WSP au cours de l'ÉES – phase I ont permis d'identifier plusieurs risques de contamination significatifs pour le site à l'étude, soit :

1. La présence de matières résiduelles enfouies dans le sol au lieu d'enfouissement en territoire isolé (LETI);
2. La présence d'amoncellements de poteaux de bois traité en surface du LETI;
3. La possible incinération de matières résiduelles dans le LETI;
4. La présence temporaire d'un poste de distribution mobile de carburant à l'intérieur des limites du LETI.

Une caractérisation environnementale de site (ÉES – phase II) a donc été recommandée afin de vérifier l'impact de ces risques sur les sols et l'eau souterraine du secteur du LETI.

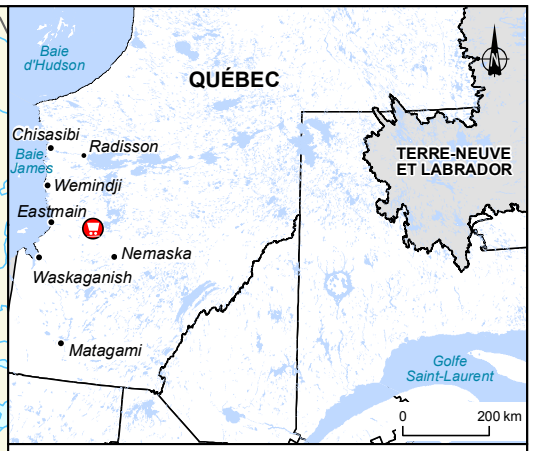
1.3 OBJECTIFS DE L'ÉTUDE

Le principal objectif de cette étude est de préciser la qualité environnementale des sols et de l'eau souterraine du site à l'étude. Par la suite, si des sols contaminés sont identifiés, l'étude permet de localiser les secteurs affectés et d'estimer les superficies et les volumes de sols par plages et type de contamination.

1.4 LIMITES ET CONDITIONS GÉNÉRALES

Le présent rapport a été préparé à la demande de Galaxy, dans le contexte déterminé par les termes spécifiques du mandat accordé à WSP. Aucune copie en tout ou en partie de ce rapport ne peut être réalisée par un tiers sans le consentement explicite de Galaxy.

Les informations contenues dans ce rapport sont soumises aux limites et conditions générales décrites à l'annexe A.



- Mine de lithium Baie-James
- Relais routier
- Aéroport
- Mine existante
- Centrale hydroélectrique
- Poste et ligne de transport d'énergie
- Route principale
- Route secondaire
- Terres de catégorie I
- Terres de catégorie II

GALAXY

Mine de lithium Baie-James

Caractérisation environnementale de site – phase II du lieu d'enfouissement en territoire isolé

Localisation régionale du site minier

Sources :
Canvec, 1 : 50 000, RNCan, 2015
BDGA, 1 : 1 000 000, RNCan, 2011
Terres de catégorie : Carto-Média, 2001

No Ref : 171-02562-00_wspT051_pIIc1_localis_180719.mxd

0 12,5 25 km
UTM 18, NAD83

Carte 1

wsp

2 DESCRIPTION DU SITE

2.1 LOCALISATION ET DONNÉES GÉNÉRALES

Les données générales concernant le site à l'étude sont présentées au tableau 1.

Tableau 1 : Données générales concernant le site à l'étude

Adresse :	Route de la Baie-James, Eeyou Istchee Baie-James (Québec)
Lots et cadastre :	Partie non divisée du territoire du Bassin-de-la-Rivière-Eastmain
Coordonnées Géographiques (nad 83) :	Latitude : 52° 13' 57'' N Longitude : 77° 04' 18'' O
Superficie du terrain :	Non déterminée
Occupation actuelle du site :	Un lieu d'enfouissement en territoire isolé (LETI)
Propriétaire du terrain :	Terres publiques faisant partie du domaine de l'État
Zonage du site :	52-03-C
Usages autorisés :	**Commerce et service** • Cd : Commerce et service liés à l'automobile • Ce : Commerce et service d'hébergement et de restauration **Industrie** • Ib : Commerce, services et industries à incidences moyennes • Ie : Équipement d'utilité publique **Loisir et récréation** • La : Parc et espace vert • Lb : Usages extensifs **Public et institutionnel** • Pa : Publique et institutionnelle **Ressource** • Ra : Exploitation des ressources
Zonage des terrains voisins :	Comme pour le site à l'étude
Zones de contraintes connues :	Terres de catégorie III au sens de la Convention de la Baie-James et du Nord québécois (CBJNQ)
Titres miniers actifs :	**Détenus à 80 % par Galaxy Lithium (Ontario) inc. et à 20 % par Lithium Galaxy (Canada) inc. :** • CDC-2126859, CDC-2126860, CDC-2126872, CDC-2126873, CDC-2126988, CDC-2126989, CDC-2126990, CDC-2183503, CDC-2183504, CDC-2183505, CDC-2183506, CDC-2183507, CDC-2183508, CDC-2192842, CDC-2238478, CDC-2238480, CDC-2329090, CDC-2329092, CDC-2329093, CDC-2329094, CDC-2329095, CDC-2329096, CDC-2329097, CDC-2329098, CDC-2329099, CDC-2329100, CDC-2329101, CDC-2329102 **Détenus à 100 % par Lithium Galaxy (Canada) inc. :** • CDC-2437963, CDC-2437964 **Détenu à 100 % par Osisko Baie-James SENC :** • CDC-2126896 **Détenus à 100 % par des particuliers :** • CDC-2455586, CDC-2455587, CDC-2455588, CDC-2455589

2.2 TOPOGRAPHIE

Le site à l'étude est à une altitude moyenne d'environ 215 m au-dessus du niveau moyen des mers (RNC, 2013). Dans ce secteur, le terrain présente une pente descendante en direction sud, mais est relativement plat à l'emplacement du LETI.

2.3 GÉOLOGIE

Le socle rocheux de la zone où s'inscrit le site fait partie de la province géologique du Supérieur et est composé majoritairement de paragneiss à minéraux métamorphiques, de basalte, d'amphibolite et de pegmatite à spodumène (MERN, 2017). Aucune information n'a été obtenue concernant les dépôts meubles naturels. Plusieurs affleurements rocheux sont toutefois répertoriés sur le site à l'étude (MERN, 2017).

2.4 HYDROLOGIE, HYDROGÉOLOGIE ET RESSOURCES EN EAU

2.4.1 HYDROLOGIE

Le site à l'étude se draine vers un cours d'eau situé à 800 m au sud du LETI (RNC, 2013). Ce cours d'eau s'écoule vers l'est pour rejoindre la rivière Eastmain. Plusieurs zones du site sont également cartographiées comme étant des milieux humides.

2.4.2 HYDROGÉOLOGIE

En l'absence d'informations hydrogéologiques spécifiques au site à l'étude, il est présumé que les eaux souterraines s'écoulent dans la même direction que les eaux de surface, soit vers le sud.

2.4.3 OUVRAGES DE CAPTAGE D'EAU SOUTERRAINE

Selon l'ÉES - phase I (WSP, 2018), aucun puits n'est répertorié dans un rayon de 1 km du site à l'étude, mais le relais routier du km 381 situé à l'est de cette route et du site à l'étude est approvisionné par trois puits dont l'emplacement est inconnu.

2.5 ÉGOUTS ET SYSTÈMES D'APPROVISIONNEMENT EN EAU

Le site à l'étude n'est présentement pas desservi par des réseaux d'alimentation en eau potable et d'égouts.

3 DESCRIPTION DES TRAVAUX DE TERRAIN

3.1 PROGRAMME DE CARACTÉRISATION

Le programme de caractérisation a été élaboré en s'inspirant des principes énoncés dans le Guide de caractérisation des terrains du MDDELCC (MENV, 2003). Dans l'ensemble, le programme a compris les activités suivantes :

- la mobilisation de l'équipe de WSP, de l'équipe de forage, de l'équipe d'excavation et du matériel requis pour la réalisation des travaux;
- la réalisation de 3 forages aménagés en puits d'observation jusqu'à un minimum de 1,5 m sous le niveau présumé de la nappe d'eau souterraine, de façon à déterminer le sens d'écoulement de l'eau souterraine et d'évaluer l'impact de l'enfouissement de matières résiduelles sur la qualité environnementale de l'eau souterraine;
- la réalisation de 11 tranchées d'exploration jusqu'à la profondeur maximale pouvant être atteinte par la pelle hydraulique, afin d'évaluer l'impact de l'enfouissement de matières résiduelles (CE-TR1 à CE-TR11), du poste de distribution de carburant mobile (CE-TR1) et d'un éventuel déversement de produit pétrolier autour des conteneurs (CE-TR2) sur la qualité environnementale des sols, et de vérifier la présence de matières résiduelles dans une ancienne gravière (CE-TR10 et CE-TR11);
- la réalisation de 8 sondages manuels d'une profondeur de 30 cm, afin d'évaluer l'impact de l'entreposage de poteaux de bois traité (CE-SM1 et CE-SM2) et de la possible incinération de matières résiduelles dans le LETI (CE-SM3 à CE-SM8) sur la qualité environnementale des sols de surface;
- l'échantillonnage en continu des sols dans les tranchées d'exploration et dans les sondages manuels, et la description des matériaux rencontrés en fonction de la stratigraphie;
- le prélèvement d'échantillons de sols en duplicata pour le programme d'assurance et de contrôle de la qualité (AC/CQ);
- la délimitation de la zone d'enfouissement de matières résiduelles;
- le relevé du niveau d'eau, le développement, la purge et l'échantillonnage de l'eau souterraine dans les puits d'observation;
- la démobilisation de l'équipe de WSP, de l'équipe de forage, de l'équipe d'excavation et du matériel requis pour la réalisation des travaux;
- la transmission des échantillons au laboratoire responsable des analyses chimiques;
- la réalisation du programme analytique décrit à la section 3.5.

Une sélection de photographies prises lors de la réalisation des travaux est présentée à l'annexe 2.

3.2 MÉTHODOLOGIE D'ÉCHANTILLONNAGE

3.2.1 RÉFÉRENCES

À moins d'indication contraire, le prélèvement, les manipulations et la conservation des échantillons ont été effectués conformément aux procédures décrites dans les guides habituellement utilisés dans le domaine, soit :

- Guide d'échantillonnage à des fins d'analyses environnementales : généralités (cahier 1) (Centre d'expertise en analyse environnementale du Québec [CEAEQ], 2008);

- Guide d'échantillonnage à des fins d'analyses environnementales : échantillonnage des eaux souterraines (cahier 3) (CEAEQ, 2012);
- Guide d'échantillonnage à des fins d'analyses environnementales : échantillonnage des sols (cahier 5) (CEAEQ, 2010);
- Guide de caractérisation des terrains (MENV, 2003).

3.2.2 DESCRIPTION DES ÉCHANTILLONS DE SOLS

La nature et certaines propriétés des sols rencontrées dans les sondages ont été décrites à partir d'un examen visuel des échantillons, selon les méthodes d'identification et de classification reconnues et utilisées dans le domaine de la géotechnique et des sols, soit le système de classification unifiée des sols.

3.2.3 PRÉLÈVEMENT ET NOMENCLATURE DES ÉCHANTILLONS DE SOLS

Tous les échantillons de sols ont été prélevés manuellement (PM) avec des gants de nitrile neufs (à usage unique).

La nomenclature utilisée pour les échantillons de sols a été établie à partir du nom du sondage suivi d'un numéro séquentiel d'échantillon (p. ex. CE-TR1/PM1).

3.2.4 NETTOYAGE DES ÉQUIPEMENTS

Aucun nettoyage n'a été requis pour des équipements non dédiés hormis la sonde à niveau d'eau, qui a été rincée à l'eau distillée entre les mesures.

3.2.5 CONSERVATION ET TRANSPORT DES ÉCHANTILLONS

Les échantillons ont été placés dans les pots fournis par le laboratoire sélectionné, puis ils ont été déposés et conservés dans des glacières dont la température interne était maintenue autour de 4 °C à l'aide de cellules réfrigérantes, jusqu'à leur arrivée chez AGAT Laboratoires de Montréal.

3.3 CARACTÉRISATION DES SOLS

3.3.1 LOCALISATION DES SONDAGES

Des plans de localisation des sondages ont été préparés préalablement aux travaux par monsieur Steve St-Cyr et madame Isabelle Liard, ingénieurs de WSP. La localisation des sondages a été reportée sur le terrain par monsieur Rivest à l'aide d'un appareil GPS d'une précision d'environ 5 m. Les sondages ont tous été réalisés aux emplacements prévus, dont la localisation est illustrée à la carte 2.

3.3.2 FORAGES ENVIRONNEMENTAUX

Trois forages nommés PO1 à PO3 ont été réalisés les 25 et 26 août 2017 par l'entreprise Les Forages Nelson Gagné de East Broughton, à l'aide d'une foreuse à percussion-rotation à l'air comprimé. Ces travaux ont été effectués sous la supervision de monsieur Jean-François Rivest, technicien de WSP. Les forages ont atteint une profondeur variant entre 7,3 et 8,5 m.

Dans les forages, aucun échantillon de sol n'a été prélevé étant donné le type de forage (destructif). La description des sols a tout de même pu être effectuée à partir des déblais de forage.

3.3.3 TRANCHÉES D'EXPLORATION

Onze tranchées d'exploration nommées CE-TR1 à CE-TR11 ont été réalisées le 30 août 2017 par Les entreprises Roy et frères de St-Mathieu inc. de Saint-Mathieu-d'Harricana[1], à l'aide d'une pelle hydraulique Doosan 235LCR. Ces travaux ont été effectués sous la supervision de monsieur Rivest et de madame Valérie Houde, ingénieure junior de WSP. La profondeur atteinte a été de seulement 3,4 à 4,0 m, puisque les parois d'excavation ne cessaient de s'affaisser en raison de la lâcheté des matériaux granulaires.

Dans les tranchées d'exploration, des échantillons de sols ont été prélevés dans certaines des unités stratigraphiques rencontrées. Ils ont été recueillis dans les déblais d'excavation. Les échantillons étaient généralement des échantillons composés préparés à partir de cinq sous-échantillons homogénéisés. Aucun équipement spécialisé pour le prélèvement d'échantillons destinés à l'analyse des composés organiques volatils (COV) n'ayant été prévu pour cette campagne, les pots ont été remplis en réduisant les espaces d'air au maximum.

3.3.4 SONDAGES MANUELS

Huit sondages manuels nommés CE-SM1 à CE-SM8 ont été réalisés par madame Houde le 30 août 2017, à l'aide d'une pelle ronde. Ces sondages ont atteint une profondeur de 30 cm comme prévu.

Dans les sondages manuels, les échantillons ont été prélevés de façon composée sur les parois des sondages, dans les intervalles de profondeur 0-5 cm, 5-10 cm et 10-30 cm.

3.3.5 DÉLIMITATION DE LA ZONE D'ENFOUISSEMENT DE MATIÈRES RÉSIDUELLES

Lorsque des matières résiduelles étaient présentes dans une tranchée d'exploration, une nouvelle tranchée d'exploration sans échantillonnage était réalisée à quelques mètres de la première jusqu'à l'atteinte d'un sondage sans matières résiduelles, afin d'estimer les limites latérales de la zone d'enfouissement dans toutes les directions.

3.4 CARACTÉRISATION DE L'EAU SOUTERRAINE

3.4.1 AMÉNAGEMENT DES PUITS D'OBSERVATION

Tous les forages ont été aménagés en puits d'observation. Les puits sont composés d'un tube de polychlorure de vinyle (PVC) de 51 mm de diamètre intérieur à raccords vissés et d'une crépine faite du même matériel. La partie crépinée des puits a été enrobée d'un matériau filtrant constitué de sable de silice qui se poursuit jusqu'à 30 cm au-dessus du sommet de la crépine. Un bouchon de bentonite a été mis en place au-dessus de la lanterne de silice afin d'éviter toute infiltration d'eau à partir de la surface et de l'horizon sus-jacent. L'espace entre les bouchons a été comblé à l'aide de déblais de forage, faits de sable. Finalement, un tube protecteur de PVC muni d'un couvercle a été mis en place en surface.

Les schémas d'aménagement des puits sont présentés sur les rapports de forages à l'annexe 3.

3.4.2 RELEVÉ DES NIVEAUX D'EAU

Les niveaux d'eau ont été mesurés à l'aide d'une sonde à niveau d'eau lors du développement, le 27 août 2017.

[1] Sous-traitant de Béton Fortin inc. dans le présent mandat.

3.4.3 DÉVELOPPEMENT DES PUITS D'OBSERVATION

Après un délai minimal de 24 h suivant la fin de son aménagement, chacun des puits d'observation a été développé afin de retirer les particules fines libérées lors des opérations de forage et redonner à la formation aquifère sa conductivité hydraulique naturelle. Le développement a été effectué manuellement (PO1) ou à l'aide d'un Hydrolift II (PO2). Cette opération a été réalisée par madame Houde de WSP le 27 août 2017. Une tubulure de polyéthylène haute densité (PEHD) Waterra dédiée à chaque puits et munie d'une vanne à bille et d'un anneau de développement a été mise en place pour ce faire. Le développement a été effectué jusqu'à l'obtention d'une eau claire.

Bien qu'ayant présenté des signes d'humidité lors du forage, le puits d'observation PO3 est demeuré sec. Il n'a donc pu être développé.

3.4.4 PURGE ET ÉCHANTILLONNAGE

L'eau souterraine des puits d'observation a été purgée et échantillonnée à l'aide d'écopes à bille le 31 août 2017 par madame Houde de WSP. L'écope était descendue au milieu de la colonne d'eau puis remontée. Le pH, la concentration en oxygène dissous, la température ainsi que le potentiel d'oxydoréduction ont ensuite été mesurés directement dans les puits à l'aide d'une sonde multiparamètres YSI 650 préalablement au prélèvement des échantillons.

Les échantillons prélevés pour l'analyse des métaux ont été filtrés sur le terrain à l'aide de filtres 45 µm dédiés.

Bien qu'ayant présenté des signes d'humidité lors du forage, le puits d'observation PO3 est demeuré sec.

3.5 PROGRAMME ANALYTIQUE

Les détails du programme analytique réalisé sont présentés au tableau 2. Les paramètres d'analyse ont été sélectionnés en fonction des risques identifiés lors de l'ÉES – phase I.

Le laboratoire sélectionné, AGAT Laboratoires de Montréal, est agréé par le CEAEQ pour les paramètres demandés (accréditation nº 480).

Sondages

- Tranchée d'exploration
- Puits d'observation
- Sondage manuel

Risques de contamination

- Conteneur d'incinération de déchets
- Poste de distribution de carburant mobile
- Aire d'enfouissement de déchets domestiques (GENIVAR, 2011)
- Amoncellement de bois traité

Résultats de caractérisation

P01-CF8 — Nom de l'échantillon
Métaux — Paramètre analysé

- Concentration ≤ critères A du MDDELCC
- Concentration dans la plage A-B des critères du MDDELCC
- Concentration dans la plage B-C des critères du MDDELCC
- Concentration dans la plage C-D des critères du MDDELCC
- Concentration > Critère D
- Aucune analyse effectuée
- Limite observée de la zone d'enfouissement de déchets domestiques
- Zone de sols affectés > A

GALAXY

Mine de lithium Baie-James

Caractérisation environnementale de site – phase II du lieu d'enfouissement en territoire isolé

Localisation des sondages et résultats analytiques pour les sols

Sources :
Imagery, ESRI, 2017
Inventaire, WSP 2017

No Ref : 171-02562-00_wspT049_pllc2_caract_180621.mxd

0 25 50 m
UTM 18, NAD83

Carte 2

wsp

La précision des limites et les mesures montrées sur ce document ne doivent pas servir à des fins d'ingénierie ou de délimitation foncière. Aucune analyse foncière n'a été effectuée par un arpenteur-géomètre.

Tableau 2 : Programme analytique réalisé

Matrice	Paramètres	Nombre d'analyses réalisées		Duplicatas (%)
		Échantillons originaux	Duplicatas	
Sols	Hydrocarbures pétroliers C_{10}-C_{50} (HP C_{10}-C_{50})	17	1	6
	Hydrocarbures aromatiques polycycliques (HAP)	13	1	8
	Composés organiques volatils (COV), incluant les hydrocarbures aromatiques monocycliques (HAM) et les hydrocarbures aliphatiques chlorés (HAC) et l'acrylonitrile	3	0	0
	Benzène, toluène, éthylbenzène et xylènes (BTEX)	2	0	0
	Soufre total	6	2	33
	Composés phénoliques	3	0	0
	Métaux	11	2	18
	Phtalates	2	1	50
	Dioxines et furannes chlorés	5	0	0
Eau souterraine	HP C_{10}-C_{50}	2	0	0
	Métaux et métalloïdes	2	0	0
	Carbone organique total	2	0	0
	Ions	2	0	0
	Sulfures totaux	2	0	0
	Conductivité électrique	2	0	0
	Solides dissous totaux	2	0	0

3.6 PROGRAMME DE CONTRÔLE DE LA QUALITÉ

Afin de confirmer la validité des méthodes d'échantillonnage, un programme de contrôle de la qualité a été préparé en s'inspirant des recommandations du Guide de caractérisation des terrains (MENV, 2003). Ce programme a compris le prélèvement et l'analyse d'échantillons en duplicata dans une proportion moyenne d'au moins 10 % des échantillons de sols prélevés et analysés. Le tableau 2 présente la proportion d'analyses réalisées en duplicata. Des contrôles internes ont également été effectués par le laboratoire dans le contexte de son propre programme de contrôle de la qualité. Aucun duplicata n'a été prélevé pour l'eau souterraine étant donné la faible quantité d'échantillons analysés.

4 GÉOLOGIE ET HYDROGÉOLOGIE

4.1 GÉOLOGIE LOCALE

Les dépôts meubles de secteur du LETI sont constitués de sable fin à moyen de couleur variable avec des traces de gravier et de cailloux. Un horizon de sable graveleux a été rencontré à partir de 4,9 m dans le sondage PO3. Un mince horizon de remblai de sable avec un peu de gravier a été observé en surface au droit du sondage CE-TR3.

Des matières résiduelles (papier, plastique, métal, bois, tissu) ont été rencontrées en traces (<10 %) dans les sondages CE-TR2 (0 à 0,6 m), CE-TR5 (0 à 3,0 m) et en proportions estimées à 60 % dans le sondage CE-TR8 (1,0 à 3,5 m). La carcasse d'un réservoir a été aperçue dans le sondage CE-TR5.

Le roc probable a été rencontré à 7,2 m dans les forages PO1 et PO3.

4.2 HYDROGÉOLOGIE

4.2.1 UNITÉS HYDROSTRATIGRAPHIQUES

Une seule unité hydrostratigraphique a été identifiée avec certitude lors de la réalisation des sondages, soit les dépôts meubles, décrits à la section 4.1.

4.2.2 PROPRIÉTÉS HYDRAULIQUES DES MATÉRIAUX

Des essais de perméabilité ont été effectués le 29 août 2017 dans les puits d'observation PO1 et PO2. Les détails de ces essais et les résultats seront présentés dans un rapport distinct couvrant tous les travaux d'hydrogéologie réalisés sur le site à l'étude.

4.2.3 PIÉZOMÉTRIE ET ÉCOULEMENT DES EAUX SOUTERRAINES

Les niveaux d'eau mesurés le 27 août 2017 sont présentés au tableau 3.

Tableau 3 : Niveaux d'eau dans les puits d'observation

Puits d'observation	Hauteur PVC p/r au sol (m)	Profondeur de la nappe p/r au pvc (m)	Profondeur de la nappe p/r au sol (m)
PO1	0,57	4,36	3,79
PO2	0,60	5,03	4,43
PO3	0,60	*À sec*	*À sec*

Étant donné le nombre insuffisant de données et l'absence de levé géodésique des puits d'observation, aucune carte piézométrique n'a pu être tracée spécifiquement pour le secteur du LETI.

5 CONSTAT ENVIRONNEMENTAL

5.1 CRITÈRES DE COMPARAISON

5.1.1 EAU SOUTERRAINE

Considérant le sens d'écoulement présumé et la faible possibilité qu'un puits d'alimentation en eau potable soit aménagé dans les dépôts meubles en aval du LETI, le principal impact appréhendé est lié à la résurgence des eaux souterraines du site à l'étude dans les eaux de surface, c'est pourquoi les résultats ont été comparés aux critères de Résurgence dans les eaux de surface (RES) du Guide d'intervention. En général, les critères de RES sont déterminés à partir des critères pour l'eau de surface décrits dans « Critères de qualité de l'eau de surface » (MDDELCC, 2015). La valeur retenue pour chaque paramètre correspond alors à la plus basse des quatre valeurs suivantes :

- 100 X CPCO (Critère de prévention de la contamination des organismes aquatiques);
- 1 X CVAA (Critère de protection de la vie aquatique, effet aigu);
- 100 X CVAC (Critère de protection de la vie aquatique, effet chronique);
- 100 X CFTP (Critère de protection de la faune terrestre piscivore).

Pour les eaux souterraines, des seuils d'alerte, correspondant à une concentration à partir de laquelle il y a lieu d'appréhender une perte de la ressource, ont été établis. Un seuil d'alerte égal à 50 % de la valeur des critères de qualité applicable est généralement appliqué.

Pour le pH, la Politique et le Guide d'intervention du MDDELCC ne mentionnent aucun critère. Les eaux souterraines du site étant susceptibles de faire résurgence dans les eaux de surface, le critère pour ces dernières a été utilisé, à titre indicatif.

Les critères de RES pour certains composés doivent par ailleurs être ajustés en fonction de certains paramètres du milieu récepteur. Les valeurs mesurées pour l'échantillon du mois d'août de la station d'eau de surface 5B ont été utilisées pour le calcul des critères, cette station étant jugée comme représentative du milieu récepteur (elle se trouve à environ 800 m en aval du secteur du LETI). Les valeurs utilisées sont précisées au tableau 4.

5.1.2 SOLS

Les résultats des analyses effectuées sur les échantillons de sols ont été interprétés en fonction des critères génériques du Guide d'intervention – Protection des sols et réhabilitation des terrains contaminés (Guide d'intervention) du Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques (MDDELCC, 2016) et des valeurs limites de l'annexe I du Règlement sur l'enfouissement des sols contaminés (RESC) (Gouvernement du Québec, 2017). Pour un site à vocation industrielle, les critères applicables sont généralement les critères génériques « C ».

5.2 RÉSULTATS D'ANALYSES POUR L'EAU SOUTERRAINE

Les échantillons prélevés dans les puits d'observation PO1 et PO2 ont présenté des concentrations inférieures au seuil d'alertes sauf pour :

- l'argent et le cuivre (concentrations supérieures au seuil d'alertes, mais inférieures aux critères de RES dans l'un et/ou l'autre des puits);
- les sulfures d'hydrogène (concentrations supérieures aux critères de RES dans les deux puits);
- le pH (valeurs à l'extérieur de la plage recommandée dans les deux puits).

L'origine de cette contamination ne peut être identifiée uniquement à partir des données disponibles.

Les résultats des analyses effectuées sur les échantillons de sols sont présentés au tableau 5 et à la carte 3, et le certificat analytique est inséré à l'annexe 4.

5.3 RÉSULTATS D'ANALYSES POUR LES SOLS

Tous les échantillons analysés ont présenté des concentrations inférieures aux critères génériques « A » pour tous les paramètres à l'exception de deux échantillons. L'échantillon CE-TR8/PM2 a été prélevé dans un horizon contenant environ 60 % de matières résiduelles (papier, plastique, métal, bois, tissu). Cet échantillon et/ou son duplicata a affiché des concentrations en HP C_{10}-C_{50}, en arsenic, en zinc et en soufre total se situant dans la plage « A-B » des critères génériques, une concentration en étain se situant dans la plage « B-C » des critères génériques et une concentration en plomb supérieure à la valeur limite de l'annexe I du RESC. L'échantillon CE-SM1/PM1, prélevé à la base d'un amoncellement de bois traité, a quant à lui présenté une concentration en chrome hexavalent se situant dans la plage « B-C » des critères génériques.

Étant donné l'absence de résultats supérieurs aux critères génériques « A » dans les autres sondages, la contamination décelée dans les sols du secteur du LETI semble associée à la présence de matières résiduelles enfouies.

Les résultats des analyses effectuées sur les échantillons de sols sont présentés au tableau 5 et à la carte 2, et le certificat analytique est inséré à l'annexe 4.

5.4 RÉSULTATS DU PROGRAMME DE CONTRÔLE ET D'ASSURANCE-QUALITÉ

Deux duplicatas de sols ont été analysés pour vérifier leur correspondance avec les échantillons originaux. Les écarts relatifs obtenus sont inférieurs à 30 % dans 90 % des cas. Les paramètres présentant les plus grands écarts sont le phtalate de di(2-éthylehexyle) et les métaux pour le couple CE-TR8/PM2 – 20170830-DUP3. Ces écarts peuvent être dus à la nature hétérogène de l'horizon (sols en contact avec des matières résiduelles).

Les résultats obtenus dans le contexte du programme de contrôle de la qualité sur les échantillons de sols sont présentés au tableau 6.

Puits d'observation de l'eau souterraine

Risques de contamination

- Conteneur d'incinération de déchets
- Poste de distribution de carburant mobile
- Aire d'enfouissement de déchets domestiques (GENIVAR, 2011)
- Amoncellement de bois traité

Résltats de caractérisation

P01	Nom de l'échantillon
Métaux	Paramètre analysé / Niveau de contamination

- Concentration ≤ Seuil d'alerte
- Seuil d'alerte < Concentration ≤ RES
- Concentration > RES
- Aucune analyse effectuée

GALAXY

Mine de lithium Baie-James

Caractérisation environnementale de site – phase II du lieu d'enfouissement en territoire isolé

Résultats analytiques pour l'eau souterraine

Sources :
Imagery, ESRI, 2017
Inventaire, WSP 2017

No Ref : 171-02562-00_wspT050_pIIc3_eau_sout_180621.mxd

0 25 50 m
UTM 18, NAD83

Carte 3

wsp

La précision des limites et les mesures montrées sur ce document ne doivent pas servir à des fins d'ingénierie ou de délimitation foncière. Aucune analyse foncière n'a été effectuée par un arpenteur-géomètre.

Tableau 4 : Résultats des analyses chimiques sur les échantillons d'eau souterraine

Paramètres	Critères (µg/L) SA[1]	Critères (µg/L) RES[1]	LDR[2] (µg/L)	Échantillon/Date de prélèvement/Résultats d'analyse (µg/L) PO1-20170831 2017-08-31	PO2-20170831 2017-08-31
Hydrocarbures pétroliers					
Hydrocarbures pétroliers C_{10}-C_{50}	1 400	2 800	100	<100	318
Autres substances organiques					
Carbone organique total	-	-	200	1 600	1 330
Métaux et métalloïdes dissous					
Aluminium	-	-	1	49	55
Antimoine	550	1 100	1	<1,0	<1,0
Argent[3]	0,02	0,03	0,04	**0,24**	<0,04
Arsenic	170	340	0,2	0,6	<0,2
Baryum[3]	54	108	1	13	18
Béryllium	-	-	0,01	0,04	0,06
Bore	14 000	28 000	20	<20	<20
Cadmium[3]	0,11	0,21	0,02	<0,02	<0,02
Calcium	-	-	20	1 310	1 520
Chrome	-	-	0,5	<0,5	<0,5
Cobalt	185	370	0,5	1,4	0,7
Cuivre[3]	0,8	1,5	0,5	**1,0**	**0,9**
Étain	-	-	1	<1	<1
Fer	-	-	60	69	<60
Lithium	-	-	1	3	3
Magnésium	-	-	100	354	390
Manganèse[3]	276	551	0,4	11,7	5,8
Molybdène	14 500	29 000	0,5	<0,5	<0,5
Nickel[3]	34	67	1	3	2
Plomb[3]	2,5	4,9	0,1	<0,1	<0,1
Potassium	-	-	100	341	423
Sélénium	31	62	1	<1	<1
Silicium	-	-	20	4 010	3 690
Sodium	-	-	2	1 320	1 250
Strontium	-	-	2	25	27
Titane	-	-	3	<3	<3
Uranium[3]	160	320	0,5	<0,5	<0,5
Vanadium	-	-	1	<1	<1
Zinc[3]	9	17	3	<3	<3

Tableau 4 : Résultats des analyses chimiques sur les échantillons d'eau souterraine (suite)

Paramètres	Critères (µg/L) SA[1]	Critères (µg/L) RES[1]	LDR[2] (µg/L)	Échantillon/Date de prélèvement/Résultats d'analyse (µg/L) PO1-20170831 2017-08-31	PO2-20170831 2017-08-31
Autres composés inorganiques					
Bicarbonate	-	-	1 000	4 000	4 000
Bromures	-	-	100	<100	<100
Carbonates	-	-	1 500	<1 500	<1 500
Chlorures	430 000	860 000	50	835	760
Cyanures totaux	11	22	3	<3	<3
Fluorures	2 000	4 000	10	16	24
Nitrates	145 000	290 000	10	282	331
Nitrites[4]	30	60	10	<10	<10
Phosphore total	-	-	20	1 020	820
Sulfates	-	-	80	2 900	2 910
Sulfures totaux	-	-	2	14	5
Sulfures d'hydrogène (calculés)[5]	-	3,2	-	**11**	**4**
Paramètres physico-chimiques					
Conductivité électrique (à 25 °C, µS/cm)	-	-	2	16	16
pH (in situ, sans unités)	-	6,5 à 9,0	-	**6,3**	**5,7**
Solides dissous totaux	-	-	9 000	14 000	20 000

NOTES :

(1) : Critères de Résurgence dans les eaux de surface (RES) du Guide d'intervention - Protection des sols et réhabilitation des terrains contaminés (MDDELCC, 2016) et seuils d'alerte (SA) correspondant à 50 % du critère de RES.

(2) : Limite de détection rapportée par le laboratoire d'analyses.

(3) : Ajustement de la valeur du critère en fonction d'une dureté de l'eau du milieu récepteur ($CaCO_3$) de 10 mg/L (échantillon 5B, août 2017).

(4) : Ajustement de la valeur du critère en fonction d'une concentration en chlorures de l'eau du milieu récepteur ($CaCO_3$) inférieure à 2 mg/L (échantillon 5B, août 2017).

(5) : Pour un pH du milieu récepteur de 6,5, selon le ratio présenté dans le Guide d'intervention.

LÉGENDE :

-	: Non défini ou non analysé
100	: Concentration ≤ Seuil d'alerte
100	: Seuil d'alerte < Concentration ≤ RES
100	: Concentration > RES

Tableau 5 : Résultats des analyses chimiques sur les échantillons de sols

Paramètres	Critères [1] ou valeurs limites [2] (mg/kg)				LDR [3] (mg/kg)	Échantillon/Date de prélèvement/Résultats d'analyse (mg/kg)						
						CE-SM1/PM1	CE-SM2/PM1	CE-SM3/PM1	CE-SM4/PM1	CE-SM6/PM1	CE-SM7/PM1	CE-SM8/PM2
	A	B	C	D		2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30
Hydrocarbures pétroliers												
Hydrocarbures pétroliers C_{10}-C_{50}	300	700	3 500	10 000	100	<100	<100	<100	<100	-	<100	<100
Composés phénoliques non chlorés												
2,4-diméthylphénol	0,1	1	10	140	0,1	<0,1	<0,1	-	-	-	-	-
2-Nitrophénol	0,5	1	10	130	0,1	<0,1	<0,1	-	-	-	-	-
4-Nitrophénol	0,5	1	10	290	0,1	<0,1	<0,1	-	-	-	-	-
m-Crésol	0,1	1	10	56	0,1	<0,1	<0,1	-	-	-	-	-
o-Crésol	0,1	1	10	56	0,1	<0,1	<0,1	-	-	-	-	-
p-Crésol	0,1	1	10	56	0,1	<0,1	<0,1	-	-	-	-	-
Phénol	0,2	1	10	62	0,1	<0,1	<0,1	-	-	-	-	-
Composés phénoliques chlorés												
4-Chlorophénol	0,1	0,5	5	57	0,1	<0,1	<0,1	-	-	-	-	-
Chlorophénol-2	0,1	0,5	5	57	0,1	<0,1	<0,1	-	-	-	-	-
Chlorophénol-3	0,1	0,5	5	57	0,1	<0,1	<0,1	-	-	-	-	-
Dichlorophénol-2,3	0,1	0,5	5	140	0,1	<0,1	<0,1	-	-	-	-	-
Dichlorophénol-2,4 et 2,5 (totaux)	0,2	1	10	-	0,1	<0,1	<0,1	-	-	-	-	-
Dichlorophénol-2,6	0,1	0,5	5	140	0,1	<0,1	<0,1	-	-	-	-	-
Dichlorophénol-3,4	0,1	0,5	5	140	0,1	<0,1	<0,1	-	-	-	-	-
Dichlorophénol-3,5	0,1	0,5	5	140	0,1	<0,1	<0,1	-	-	-	-	-
Pentachlorophénol	0,1	0,5	5	74	0,1	<0,1	<0,1	-	-	-	-	-
Tétrachloro-2, 3, 4, 5 phénol	0,1	0,5	5	74	0,1	<0,1	<0,1	-	-	-	-	-
Tétrachloro-2, 3, 4, 6 phénol	0,1	0,5	5	74	0,1	<0,1	<0,1	-	-	-	-	-
Tétrachloro-2, 3, 5, 6 phénol	0,1	0,5	5	74	0,1	<0,1	<0,1	-	-	-	-	-
Trichloro-2, 3, 4 phénol	0,1	0,5	5	74	0,1	<0,1	<0,1	-	-	-	-	-
Trichloro-2, 3, 5 phénol	0,1	0,5	5	74	0,1	<0,1	<0,1	-	-	-	-	-
Trichloro-2, 3, 6 phénol	0,1	0,5	5	74	0,1	<0,1	<0,1	-	-	-	-	-
Trichloro-2, 4, 5 phénol	0,1	0,5	5	74	0,1	<0,1	<0,1	-	-	-	-	-
Trichloro-2, 4, 6 phénol	0,1	0,5	5	74	0,1	<0,1	<0,1	-	-	-	-	-
Trichloro-3, 4, 5 phénol	0,1	0,5	5	74	0,1	<0,1	<0,1	-	-	-	-	-

NOTES :

(1) : Critères génériques du Guide d'intervention - Protection des sols et réhabilitation des terrains contaminés (MDDELCC, 2016). Pour les métaux et métalloïdes, les critères « A » utilisés représentent la teneur de fond établie pour la province géologique du Supérieur et de Rae.

(2) : Normes de l'Annexe I du Règlement sur l'enfouissement des sols contaminés (RESC), communément appelées critères D.

(3) : Limite de détection rapportée par le laboratoire d'analyses.

(4) : La sommation est calculée avec les facteurs d'équivalence toxique de l'OTAN (1988). Pour les valeurs inférieures à la LDR, la concentration utilisée est nulle.

LÉGENDE :

-	: Non défini ou non analysé
100	: Concentration ≤ A
100	: A < Concentration ≤ B
100	: B < Concentration ≤ C
100	: C < Concentration < D
100	: Concentration ≥ D

Tableau 5 : Résultats des analyses chimiques sur les échantillons de sols (suite)

Paramètres	Critères [1] ou valeurs limites [2] (mg/kg)				LDR [3] (mg/kg)	Échantillon/Date de prélèvement/Résultats d'analyse (mg/kg)						
						CE-SM1/PM1	CE-SM2/PM1	CE-SM3/PM1	CE-SM4/PM1	CE-SM6/PM1	CE-SM7/PM1	CE-SM8/PM2
	A	B	C	D		2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30
Hydrocarbures aromatiques polycycliques (HAP)												
Acénaphtène	0,1	10	100	100	0,1	<0,1	<0,1	-	-	-	-	-
Acénaphtylène	0,1	10	100	100	0,1	<0,1	<0,1	-	-	-	-	-
Anthracène	0,1	10	100	100	0,1	<0,1	<0,1	-	-	-	-	-
Benzo (a) anthracène	0,1	1	10	34	0,1	<0,1	<0,1	-	-	-	-	-
Benzo (a) pyrène	0,1	1	10	34	0,1	<0,1	<0,1	-	-	-	-	-
Benzo (b) fluoranthène	0,1	1	10	-	0,1	<0,1	<0,1	-	-	-	-	-
Benzo (c) phénanthrène	0,1	1	10	56	0,1	<0,1	<0,1	-	-	-	-	-
Benzo (g, h, i) pérylène	0,1	1	10	18	0,1	<0,1	<0,1	-	-	-	-	-
Benzo (j) fluoranthène	0,1	1	10	-	0,1	<0,1	<0,1	-	-	-	-	-
Benzo (k) fluoranthène	0,1	1	10	-	0,1	<0,1	<0,1	-	-	-	-	-
Chrysène	0,1	1	10	34	0,1	<0,1	<0,1	-	-	-	-	-
Dibenzo(a,h)anthracène	0,1	1	10	82	0,1	<0,1	<0,1	-	-	-	-	-
Dibenzo(a,h)pyrène	0,1	1	10	34	0,1	<0,1	<0,1	-	-	-	-	-
Dibenzo(a,i)pyrène	0,1	1	10	34	0,1	<0,1	<0,1	-	-	-	-	-
Dibenzo(a,l)pyrène	0,1	1	10	34	0,1	<0,1	<0,1	-	-	-	-	-
Diméthyl-1,3naphtalène	0,1	1	10	56	0,1	<0,1	<0,1	-	-	-	-	-
Diméthyl-7,12benzo(a)anthracène	0,1	1	10	34	0,1	<0,1	<0,1	-	-	-	-	-
Fluoranthène	0,1	10	100	100	0,1	<0,1	<0,1	-	-	-	-	-
Fluorène	0,1	10	100	100	0,1	<0,1	<0,1	-	-	-	-	-
Indéno (1, 2, 3-c, d) pyrène	0,1	1	10	34	0,1	<0,1	<0,1	-	-	-	-	-
Méthyl-1 naphtalène	0,1	1	10	56	0,1	<0,1	<0,1	-	-	-	-	-
Méthyl-2 naphtalène	0,1	1	10	56	0,1	<0,1	<0,1	-	-	-	-	-
Méthyl-3 cholanthrène	0,1	1	10	150	0,1	<0,1	<0,1	-	-	-	-	-
Naphtalène	0,1	5	50	56	0,1	<0,1	<0,1	-	-	-	-	-
Phénanthrène	0,1	5	50	56	0,1	<0,1	<0,1	-	-	-	-	-
Pyrène	0,1	10	100	100	0,1	<0,1	<0,1	-	-	-	-	-
Triméthyl-2, 3, 5 naphtalène	0,1	1	10	56	0,1	<0,1	<0,1	-	-	-	-	-
Dioxines et furannes												
Sommation PCDDs et PCDFs[4](ng/kg)	2	15	750	5 000	0,5	1,18	0,023 8	-	0,047 4	0,005 05	-	-

NOTES :

(1) : Critères génériques du Guide d'intervention - Protection des sols et réhabilitation des terrains contaminés (MDDELCC, 2016). Pour les métaux et métalloïdes, les critères « A » utilisés représentent la teneur de fond établie pour la province géologique du Supérieur et de Rae.

(2) : Normes de l'Annexe I du Règlement sur l'enfouissement des sols contaminés (RESC), communément appelées critères D.

(3) : Limite de détection rapportée par le laboratoire d'analyses.

(4) : La sommation est calculée avec les facteurs d'équivalence toxique de l'OTAN (1988). Pour les valeurs inférieures à la LDR, la concentration utilisée est nulle.

LÉGENDE :

-	: Non défini ou non analysé
100	: Concentration ≤ A
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Tableau 5 : Résultats des analyses chimiques sur les échantillons de sols (suite)

Paramètres	Critères (1) ou valeurs limites (2) (mg/kg)				LDR (3) (mg/kg)	Échantillon/Date de prélèvement/Résultats d'analyse (mg/kg)						
						CE-SM1/PM1	CE-SM2/PM1	CE-SM3/PM1	CE-SM4/PM1	CE-SM6/PM1	CE-SM7/PM1	CE-SM8/PM2
	A	B	C	D		2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30
Métaux												
Argent	0,5	20	40	200	0,5	<0,5	<0,5	-	-	-	-	-
Arsenic	5	30	50	250	5	<5	<5	-	-	-	-	-
Baryum	240	500	2 000	10 000	20	<20	<20	-	-	-	-	-
Cadmium	0,9	5	20	100	0,9	<0,9	<0,9	-	-	-	-	-
Chrome total	100	250	800	4 000	45	<45	<45	-	-	-	-	-
Chrome hexavalent	-	0,6	10	4 000	2,0	**7,4**	3,5					
Cobalt	30	50	300	1 500	15	<15	<15	-	-	-	-	-
Cuivre	65	100	500	2 500	40	<40	<40	-	-	-	-	-
Étain	5	50	300	1 500	5	<5	<5	-	-	-	-	-
Manganèse	1 000	1 000	2 200	11 000	10	61	46	-	-	-	-	-
Molybdène	8	10	40	200	2	<2	<2	-	-	-	-	-
Nickel	50	100	500	2 500	30	<30	<30	-	-	-	-	-
Plomb	40	500	1 000	5 000	30	<30	<30	-	-	-	-	-
Zinc	150	500	1 500	7 500	100	<100	<100	-	-	-	-	-

NOTES :

(1) : Critères génériques du Guide d'intervention - Protection des sols et réhabilitation des terrains contaminés (MDDELCC, 2016). Pour les métaux et métalloïdes, les critères « A » utilisés représentent la teneur de fond établie pour la province géologique du Supérieur et de Rae.

(2) : Normes de l'Annexe I du Règlement sur l'enfouissement des sols contaminés (RESC), communément appelées critères D.

(3) : Limite de détection rapportée par le laboratoire d'analyses.

(4) : La sommation est calculée avec les facteurs d'équivalence toxique de l'OTAN (1988). Pour les valeurs inférieures à la LDR, la concentration utilisée est nulle.

LÉGENDE :

-	: Non défini ou non analysé
100	: Concentration ≤ A
100	: A < Concentration ≤ B
100	: B < Concentration ≤ C
100	: C < Concentration < D
100	: Concentration ≥ D

Tableau 5 : Résultats des analyses chimiques sur les échantillons de sols (suite)

Paramètres	Critères (1) ou valeurs limites (2) (mg/kg)				LDR (3) (mg/kg)	Échantillon/Date de prélèvement/Résultats d'analyse (mg/kg)										
						CE-TR1/PM1	CE-TR2/PM1	CE-TR3/PM2	CE-TR4/PM3	CE-TR5/PM3	CE-TR6/PM2	CE-TR7/PM2	CE-TR8/PM2	CE-TR9/PM1	CE-TR10/PM1	CE-TR11/PM2
	A	B	C	D		2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30
Hydrocarbures pétroliers																
Hydrocarbures pétroliers C_{10}-C_{50}	300	700	3 500	10 000	100	<100	<100	<100	<100	<100	<100	<100	**384**	<100	<100	<100
Hydrocarbures aromatiques monocycliques (HAM)																
Benzène	0,2	0,5	5	5	0,1	<0,1	<0,1	<0,1	-	<0,1	-	-	<0,1	-	-	-
Chlorobenzène	0,2	1	10	10	0,2	-	-	<0,2	-	<0,2	-	-	<0,2	-	-	-
Dichloro-1,2 benzène	0,2	1	10	10	0,2	-	-	<0,2	-	<0,2	-	-	<0,2	-	-	-
Dichloro-1,3 benzène	0,2	1	10	10	0,2	-	-	<0,2	-	<0,2	-	-	<0,2	-	-	-
Dichloro-1,4 benzène	0,2	1	10	10	0,2	-	-	<0,2	-	<0,2	-	-	<0,2	-	-	-
Éthylbenzène	0,2	5	50	50	0,2	<0,2	<0,2	<0,2	-	<0,2	-	-	<0,2	-	-	-
Styrène	0,2	5	50	50	0,2	-	-	<0,2	-	<0,2	-	-	<0,2	-	-	-
Toluène	0,2	3	30	30	0,2	<0,2	<0,2	<0,2	-	<0,2	-	-	<0,2	-	-	-
Xylènes (o, m, p)	0,4	5	50	50	0,2	<0,2	<0,2	<0,2	-	<0,2	-	-	<0,2	-	-	-
Hydrocarbures aliphatiques chlorés (HAC)																
Chloroforme	0,2	5	50	50	0,2	-	-	<0,2	-	<0,2	-	-	<0,2	-	-	-
Chlorure de vinyle	0,4	0,02	0,03	60	0,4	-	-	<0,4	-	<0,4	-	-	<0,4	-	-	-
Dichloro-1,1 éthane	0,2	5	50	50	0,2	-	-	<0,2	-	<0,2	-	-	<0,2	-	-	-
Dichloro-1,1 éthène	0,2	5	50	50	0,2	-	-	<0,2	-	<0,2	-	-	<0,2	-	-	-
Dichloro-1,2 éthane	0,2	5	50	50	0,2	-	-	<0,2	-	<0,2	-	-	<0,2	-	-	-
Dichloro-1,2 éthène (cis et trans)	0,2	5	50	50	0,2	-	-	<0,2	-	<0,2	-	-	<0,2	-	-	-
Dichloro-1,2 éthène (cis)	0,2	5	50	-	0,2	-	-	<0,2	-	<0,2	-	-	<0,2	-	-	-
Dichloro-1,2 éthène (trans)	0,2	5	50	-	0,2	-	-	<0,2	-	<0,2	-	-	<0,2	-	-	-
Dichloro-1,2 propane	0,2	5	50	50	0,2	-	-	<0,2	-	<0,2	-	-	<0,2	-	-	-
Dichloro-1,3 propène (cis et trans)	0,2	5	50	50	0,2	-	-	<0,2	-	<0,2	-	-	<0,2	-	-	-
Dichloro-1,3 propène (cis)	0,2	5	50	-	0,2	-	-	<0,2	-	<0,2	-	-	<0,2	-	-	-
Dichloro-1,3 propène (trans)	0,2	5	50	-	0,2	-	-	<0,2	-	<0,2	-	-	<0,2	-	-	-
Dichlorométhane	-	5	50	50	0,2	-	-	<0,2	-	<0,2	-	-	<0,2	-	-	-
Tétrachloro-1, 1, 2, 2 éthane	0,2	5	50	50	0,2	-	-	<0,2	-	<0,2	-	-	<0,2	-	-	-
Tétrachloroéthène	0,3	5	50	50	0,2	-	-	<0,2	-	<0,2	-	-	<0,2	-	-	-
Tétrachlorure de carbone	0,1	5	50	50	0,1	-	-	<0,1	-	<0,1	-	-	<0,1	-	-	-
Trichloro-1, 1, 1 éthane	0,2	5	50	50	0,2	-	-	<0,2	-	<0,2	-	-	<0,2	-	-	-
Trichloro-1, 1, 2 éthane	0,2	5	50	50	0,2	-	-	<0,2	-	<0,2	-	-	<0,2	-	-	-
Trichloroéthène	0,2	5	50	50	0,2	-	-	<0,2	-	<0,2	-	-	<0,2	-	-	-
Autres substances organiques																
Acrylonitrile	0,2	1	5	-	0,2	-	-	<0,2	-	<0,2	-	-	<0,2	-	-	-

NOTES :

(1) : Critères génériques du Guide d'intervention - Protection des sols et réhabilitation des terrains contaminés (MDDELCC, 2016). Pour les métaux et métalloïdes, les critères « A » utilisés représentent la teneur de fond établie pour la province géologique du Supérieur et de Rae.

(2) : Normes de l'Annexe I du Règlement sur l'enfouissement des sols contaminés (RESC), communément appelées critères D.

(3) : Limite de détection rapportée par le laboratoire d'analyses.

(4) : La sommation est calculée avec les facteurs d'équivalence toxique de l'OTAN (1988). Pour les valeurs inférieures à la LDR, la concentration utilisée est nulle.

LÉGENDE :

-	: Non défini ou non analysé
100	: Concentration ≤ A
100	: A < Concentration ≤ B
100	: B < Concentration ≤ C
100	: C < Concentration < D
100	: Concentration ≥ D

Tableau 5 : Résultats des analyses chimiques sur les échantillons de sols (suite)

Paramètres	Critères (1) ou valeurs limites (2) (mg/kg)				LDR (3) (mg/kg)	Échantillon/Date de prélèvement/Résultats d'analyse (mg/kg)										
						CE-TR1/PM1	CE-TR2/PM1	CE-TR3/PM2	CE-TR4/PM3	CE-TR5/PM3	CE-TR6/PM2	CE-TR7/PM2	CE-TR8/PM2	CE-TR9/PM1	CE-TR10/PM1	CE-TR11/PM2
	A	B	C	D		2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30
Composés phénoliques non chlorés																
2,4-diméthylphénol	0,1	1	10	140	0,1	-	-	-	-	-	-	-	<0,1	-	-	-
2-Nitrophénol	0,5	1	10	130	0,1	-	-	-	-	-	-	-	<0,1	-	-	-
4-Nitrophénol	0,5	1	10	290	0,1	-	-	-	-	-	-	-	<0,1	-	-	-
m-Crésol	0,1	1	10	56	0,1	-	-	-	-	-	-	-	<0,1	-	-	-
o-Crésol	0,1	1	10	56	0,1	-	-	-	-	-	-	-	<0,1	-	-	-
p-Crésol	0,1	1	10	56	0,1	-	-	-	-	-	-	-	<0,1	-	-	-
Phénol	0,2	1	10	62	0,1	-	-	-	-	-	-	-	<0,1	-	-	-
Composés phénoliques chlorés																
4-Chlorophénol	0,1	0,5	5	57	0,1	-	-	-	-	-	-	-	<0,1	-	-	-
Chlorophénol-2	0,1	0,5	5	57	0,1	-	-	-	-	-	-	-	<0,1	-	-	-
Chlorophénol-3	0,1	0,5	5	57	0,1	-	-	-	-	-	-	-	<0,1	-	-	-
Dichlorophénol-2,3	0,1	0,5	5	140	0,1	-	-	-	-	-	-	-	<0,1	-	-	-
Dichlorophénol-2,4 et 2,5 (totaux)	0,2	1	10	-	0,1	-	-	-	-	-	-	-	<0,1	-	-	-
Dichlorophénol-2,6	0,1	0,5	5	140	0,1	-	-	-	-	-	-	-	<0,1	-	-	-
Dichlorophénol-3,4	0,1	0,5	5	140	0,1	-	-	-	-	-	-	-	<0,1	-	-	-
Dichlorophénol-3,5	0,1	0,5	5	140	0,1	-	-	-	-	-	-	-	<0,1	-	-	-
Pentachlorophénol	0,1	0,5	5	74	0,1	-	-	-	-	-	-	-	<0,1	-	-	-
Tétrachloro-2, 3, 4, 5 phénol	0,1	0,5	5	74	0,1	-	-	-	-	-	-	-	<0,1	-	-	-
Tétrachloro-2, 3, 4, 6 phénol	0,1	0,5	5	74	0,1	-	-	-	-	-	-	-	<0,1	-	-	-
Tétrachloro-2, 3, 5, 6 phénol	0,1	0,5	5	74	0,1	-	-	-	-	-	-	-	<0,1	-	-	-
Trichloro-2, 3, 4 phénol	0,1	0,5	5	74	0,1	-	-	-	-	-	-	-	<0,1	-	-	-
Trichloro-2, 3, 5 phénol	0,1	0,5	5	74	0,1	-	-	-	-	-	-	-	<0,1	-	-	-
Trichloro-2, 3, 6 phénol	0,1	0,5	5	74	0,1	-	-	-	-	-	-	-	<0,1	-	-	-
Trichloro-2, 4, 5 phénol	0,1	0,5	5	74	0,1	-	-	-	-	-	-	-	<0,1	-	-	-
Trichloro-2, 4, 6 phénol	0,1	0,5	5	74	0,1	-	-	-	-	-	-	-	<0,1	-	-	-
Trichloro-3, 4, 5 phénol	0,1	0,5	5	74	0,1	-	-	-	-	-	-	-	<0,1	-	-	-
Phtalates																
Diéthylphtalate	-	-	60	280	0,1	-	-	-	-	<0,1	-	-	<0,1	-	-	-
Diméthylphtalate	-	-	60	280	0,1	-	-	-	-	<0,1	-	-	<0,1	-	-	-
Phtalate de benzyle butyle	-	-	60	60	0,1	-	-	-	-	<0,1	-	-	<0,1	-	-	-
Phtalate de di(2-éthylehexyle)	-	-	60	60	0,2	-	-	-	-	<0,2	-	-	<0,2	-	-	-
Phtalate de dibutyle	0,2	6	70 000	-	0,1	-	-	-	-	<0,1	-	-	<0,1	-	-	-
Phtalate de di-N-octyle	-	-	60	280	0,1	-	-	-	-	<0,1	-	-	<0,1	-	-	-

NOTES :

(1) : Critères génériques du Guide d'intervention - Protection des sols et réhabilitation des terrains contaminés (MDDELCC, 2016). Pour les métaux et métalloïdes, les critères « A » utilisés représentent la teneur de fond établie pour la province géologique du Supérieur et de Rae.

(2) : Normes de l'Annexe I du Règlement sur l'enfouissement des sols contaminés (RESC), communément appelées critères D.

(3) : Limite de détection rapportée par le laboratoire d'analyses.

(4) : La sommation est calculée avec les facteurs d'équivalence toxique de l'OTAN (1988). Pour les valeurs inférieures à la LDR, la concentration utilisée est nulle.

LÉGENDE :

-	: Non défini ou non analysé
100	: Concentration ≤ A
100	: A < Concentration ≤ B
100	: B < Concentration ≤ C
100	: C < Concentration < D
100	: Concentration ≥ D

Tableau 5 : Résultats des analyses chimiques sur les échantillons de sols (suite)

Paramètres	Critères [1] ou valeurs limites [2] (mg/kg)				LDR [3] (mg/kg)	Échantillon/Date de prélèvement/Résultats d'analyse (mg/kg)										
						CE-TR1/PM1	CE-TR2/PM1	CE-TR3/PM2	CE-TR4/PM3	CE-TR5/PM3	CE-TR6/PM2	CE-TR7/PM2	CE-TR8/PM2	CE-TR9/PM1	CE-TR10/PM1	CE-TR11/PM2
	A	B	C	D		2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30
Hydrocarbures aromatiques polycycliques (HAP)																
Acénaphtène	0,1	10	100	100	0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Acénaphtylène	0,1	10	100	100	0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Anthracène	0,1	10	100	100	0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Benzo (a) anthracène	0,1	1	10	34	0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Benzo (a) pyrène	0,1	1	10	34	0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Benzo (b) fluoranthène	0,1	1	10	-	0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Benzo (c) phénanthrène	0,1	1	10	56	0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Benzo (g, h, i) pérylène	0,1	1	10	18	0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Benzo (j) fluoranthène	0,1	1	10	-	0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Benzo (k) fluoranthène	0,1	1	10	-	0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Chrysène	0,1	1	10	34	0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Dibenzo(a,h)anthracène	0,1	1	10	82	0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Dibenzo(a,h)pyrène	0,1	1	10	34	0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Dibenzo(a,i)pyrène	0,1	1	10	34	0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Dibenzo(a,l)pyrène	0,1	1	10	34	0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Diméthyl-1,3naphtalène	0,1	1	10	56	0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Diméthyl-7,12benzo(a)anthracène	0,1	1	10	34	0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Fluoranthène	0,1	10	100	100	0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Fluorène	0,1	10	100	100	0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Indéno (1, 2, 3-c, d) pyrène	0,1	1	10	34	0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Méthyl-1 naphtalène	0,1	1	10	56	0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Méthyl-2 naphtalène	0,1	1	10	56	0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Méthyl-3 cholanthrène	0,1	1	10	150	0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Naphtalène	0,1	5	50	56	0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Phénanthrène	0,1	5	50	56	0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Pyrène	0,1	10	100	100	0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Triméthyl-2, 3, 5 naphtalène	0,1	1	10	56	0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Dioxines et furannes																
Sommation PCDDs et PCDFs[4](ng/kg)	2	15	750	5 000	0,5	-	-	-	-	-	-	-	-	-	0	-

NOTES :

(1) : Critères génériques du Guide d'intervention - Protection des sols et réhabilitation des terrains contaminés (MDDELCC, 2016). Pour les métaux et métalloïdes, les critères « A » utilisés représentent la teneur de fond établie pour la province géologique du Supérieur et de Rae.

(2) : Normes de l'Annexe I du Règlement sur l'enfouissement des sols contaminés (RESC), communément appelées critères D.

(3) : Limite de détection rapportée par le laboratoire d'analyses.

(4) : La sommation est calculée avec les facteurs d'équivalence toxique de l'OTAN (1988). Pour les valeurs inférieures à la LDR, la concentration utilisée est nulle.

LÉGENDE :

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Tableau 5 : Résultats des analyses chimiques sur les échantillons de sols (suite)

Paramètres	Critères [1] ou valeurs limites [2] (mg/kg)				LDR [3] (mg/kg)	Échantillon/Date de prélèvement/Résultats d'analyse (mg/kg)										
						CE-TR1/PM1	CE-TR2/PM1	CE-TR3/PM2	CE-TR4/PM3	CE-TR5/PM3	CE-TR6/PM2	CE-TR7/PM2	CE-TR8/PM2	CE-TR9/PM1	CE-TR10/PM1	CE-TR11/PM2
	A	B	C	D		2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30	2017-08-30
Métaux																
Argent	0,5	20	40	200	0,5	-	-	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5
Arsenic	5	30	50	250	5	-	-	<5	<5	<5	<5	<5	**7,9**	<5	<5	<5
Baryum	240	500	2 000	10 000	20	-	-	<20	<20	<20	<20	<20	21	23	<20	<20
Cadmium	0,9	5	20	100	0,9	-	-	<0,9	<0,9	<0,9	<0,9	<0,9	<0,9	<0,9	<0,9	<0,9
Chrome total	100	250	800	4 000	45	-	-	<45	<45	<45	<45	<45	<45	<45	<45	<45
Chrome hexavalent	-	0,6	10	4 000	0,4	-	-	0,6	0,9	0,6	0,9	0,5	1,8	1,5	1,0	1,4
Cobalt	30	50	300	1 500	15	-	-	<15	<15	<15	<15	<15	<15	<15	<15	<15
Cuivre	65	100	500	2 500	40	-	-	<40	<40	<40	<40	<40	61	<40	<40	<40
Étain	5	50	300	1 500	5	-	-	<5	<5	<5	<5	<5	**154**	<5	<5	<5
Manganèse	1 000	1 000	2 200	11 000	10	-	-	36	35	35	75	26	209	99	58	43
Molybdène	8	10	40	200	2	-	-	<2	<2	<2	<2	<2	<2	<2	<2	<2
Nickel	50	100	500	2 500	30	-	-	<30	<30	<30	<30	<30	<30	<30	<30	<30
Plomb	40	500	1 000	5 000	30	-	-	<30	<30	<30	<30	<30	**1 830**	<30	<30	<30
Zinc	150	500	1 500	7 500	100	-	-	<100	<100	<100	<100	<100	**311**	<100	<100	<100
Autres composés inorganiques																
Soufre total	400	2 000	2 000	-	200	-	-	<200	<200	<200	<200	<200	**1 310**	-	-	-

NOTES :

(1) : Critères génériques du Guide d'intervention - Protection des sols et réhabilitation des terrains contaminés (MDDELCC, 2016). Pour les métaux et métalloïdes, les critères « A » utilisés représentent la teneur de fond établie pour la province géologique du Supérieur et de Rae.

(2) : Normes de l'Annexe I du Règlement sur l'enfouissement des sols contaminés (RESC), communément appelées critères D.

(3) : Limite de détection rapportée par le laboratoire d'analyses.

(4) : La sommation est calculée avec les facteurs d'équivalence toxique de l'OTAN (1988). Pour les valeurs inférieures à la LDR, la concentration utilisée est nulle.

LÉGENDE :

-	: Non défini ou non analysé
100	: Concentration ≤ A
100	: A < Concentration ≤ B
100	: B < Concentration ≤ C
100	: C < Concentration < D
100	: Concentration ≥ D

Tableau 6 : Résultats du programme de contrôle de la qualité sur les échantillons de sols

Paramètres	Critères (1) ou valeurs limites (2) (mg/kg)				LDR (3) (mg/kg)	Échantillon/Date de prélèvement/Résultats d'analyse (mg/kg)					
						20 170 830-DUP6	CE-TR6/PM2		20 170 830-DUP3	CE-TR8/PM2	
	A	B	C	D		2017-08-30	2017-08-30	Écart relatif(4)	2017-08-30	2017-08-30	Écart relatif(4)
Hydrocarbures pétroliers											
Hydrocarbures pétroliers C_{10}-C_{50}	300	700	3500	10 000	100	<100	<100	0 %	-	**384**	-
Hydrocarbures aromatiques monocycliques (HAM)											
Benzène	0,2	0,5	5	5	0,1	-	-	-	-	<0,1	-
Chlorobenzène	0,2	1	10	10	0,2	-	-	-	-	<0,2	-
Dichloro-1,2 benzène	0,2	1	10	10	0,2	-	-	-	-	<0,2	-
Dichloro-1,3 benzène	0,2	1	10	10	0,2	-	-	-	-	<0,2	-
Dichloro-1,4 benzène	0,2	1	10	10	0,2	-	-	-	-	<0,2	-
Éthylbenzène	0,2	5	50	50	0,2	-	-	-	-	<0,2	-
Styrène	0,2	5	50	50	0,2	-	-	-	-	<0,2	-
Toluène	0,2	3	30	30	0,2	-	-	-	-	<0,2	-
Xylènes (o, m, p)	0,4	5	50	50	0,2	-	-	-	-	<0,2	-
Hydrocarbures aliphatiques chlorés (HAC)											
Chloroforme	0,2	5	50	50	0,2	-	-	-	-	<0,2	-
Chlorure de vinyle	0,4	0,02	0,03	60	0,4	-	-	-	-	<0,4	-
Dichloro-1,1 éthane	0,2	5	50	50	0,2	-	-	-	-	<0,2	-
Dichloro-1,1 éthène	0,2	5	50	50	0,2	-	-	-	-	<0,2	-
Dichloro-1,2 éthane	0,2	5	50	50	0,2	-	-	-	-	<0,2	-
Dichloro-1,2 éthène (cis et trans)	0,2	5	50	50	0,2	-	-	-	-	<0,2	-
Dichloro-1,2 éthène (cis)	0,2	5	50	-	0,2	-	-	-	-	<0,2	-
Dichloro-1,2 éthène (trans)	0,2	5	50	-	0,2	-	-	-	-	<0,2	-
Dichloro-1,2 propane	0,2	5	50	50	0,2	-	-	-	-	<0,2	-
Dichloro-1,3 propène (cis et trans)	0,2	5	50	50	0,2	-	-	-	-	<0,2	-
Dichloro-1,3 propène (cis)	0,2	5	50	-	0,2	-	-	-	-	<0,2	-
Dichloro-1,3 propène (trans)	0,2	5	50	-	0,2	-	-	-	-	<0,2	-
Dichlorométhane	-	5	50	50	0,2	-	-	-	-	<0,2	-
Tétrachloro-1, 1, 2, 2 éthane	0,2	5	50	50	0,2	-	-	-	-	<0,2	-
Tétrachloroéthène	0,3	5	50	50	0,2	-	-	-	-	<0,2	-
Tétrachlorure de carbone	0,1	5	50	50	0,1	-	-	-	-	<0,1	-
Trichloro-1, 1, 1 éthane	0,2	5	50	50	0,2	-	-	-	-	<0,2	-
Trichloro-1, 1, 2 éthane	0,2	5	50	50	0,2	-	-	-	-	<0,2	-
Trichloroéthène	0,2	5	50	50	0,2	-	-	-	-	<0,2	-
Autres substances organiques											
Acrylonitrile	0,2	1	5	-	0,2	-	-	-	-	<0,2	-

NOTES :

(1) : Critères génériques du Guide d'intervention - Protection des sols et réhabilitation des terrains contaminés (MDDELCC, 2016). Pour les métaux et métalloïdes, les critères « A » utilisés représentent la teneur de fond établie pour la province géologique du Supérieur et de Rae.

(2) : Normes de l'Annexe I du Règlement sur l'enfouissement des sols contaminés (RESC), communément appelées critères D.

(3) : Limite de détection rapportée par le laboratoire d'analyses.

(4) : Écart relatif calculé selon l'équation suivante : (|Conc. éch#1 - Conc. éch# 2| /Conc. moyenne)* 100. Pour une valeur inférieure à la LDR, *la concentration utilisée correspond à |LDR|*.

LÉGENDE :

-	: Non défini ou non analysé
100	: Concentration ≤ A
100	: A < Concentration ≤ B
100	: B < Concentration ≤ C
100	: C < Concentration < D
100	: Concentration ≥ D

Tableau 6 : Résultats du programme de contrôle de la qualité sur les échantillons de sols (suite)

Paramètres	Critères (1) ou valeurs limites (2) (mg/kg)				LDR (3) (mg/kg)	Échantillon/Date de prélèvement/Résultats d'analyse (mg/kg)					
						20 170 830-DUP6	CE-TR6/PM2		20 170 830-DUP3	CE-TR8/PM2	
	A	B	C	D		2017-08-30	2017-08-30	Écart relatif(4)	2017-08-30	2017-08-30	Écart relatif(4)
Composés phénoliques non chlorés											
2,4-diméthylphénol	0,1	1	10	140	0,1	-	-	-	-	<0,1	-
2-Nitrophénol	0,5	1	10	130	0,1	-	-	-	-	<0,1	-
4-Nitrophénol	0,5	1	10	290	0,1	-	-	-	-	<0,1	-
m-Crésol	0,1	1	10	56	0,1	-	-	-	-	<0,1	-
o-Crésol	0,1	1	10	56	0,1	-	-	-	-	<0,1	-
p-Crésol	0,1	1	10	56	0,1	-	-	-	-	<0,1	-
Phénol	0,2	1	10	62	0,1	-	-	-	-	<0,1	-
Composés phénoliques chlorés											
4-Chlorophénol	0,1	0,5	5	57	0,1	-	-	-	-	<0,1	-
Chlorophénol-2	0,1	0,5	5	57	0,1	-	-	-	-	<0,1	-
Chlorophénol-3	0,1	0,5	5	57	0,1	-	-	-	-	<0,1	-
Dichlorophénol-2,3	0,1	0,5	5	140	0,1	-	-	-	-	<0,1	-
Dichlorophénol-2,4 et 2,5 (totaux)	0,2	1	10	-	0,1	-	-	-	-	<0,1	-
Dichlorophénol-2,6	0,1	0,5	5	140	0,1	-	-	-	-	<0,1	-
Dichlorophénol-3,4	0,1	0,5	5	140	0,1	-	-	-	-	<0,1	-
Dichlorophénol-3,5	0,1	0,5	5	140	0,1	-	-	-	-	<0,1	-
Pentachlorophénol	0,1	0,5	5	74	0,1	-	-	-	-	<0,1	-
Tétrachloro-2, 3, 4, 5 phénol	0,1	0,5	5	74	0,1	-	-	-	-	<0,1	-
Tétrachloro-2, 3, 4, 6 phénol	0,1	0,5	5	74	0,1	-	-	-	-	<0,1	-
Tétrachloro-2, 3, 5, 6 phénol	0,1	0,5	5	74	0,1	-	-	-	-	<0,1	-
Trichloro-2, 3, 4 phénol	0,1	0,5	5	74	0,1	-	-	-	-	<0,1	-
Trichloro-2, 3, 5 phénol	0,1	0,5	5	74	0,1	-	-	-	-	<0,1	-
Trichloro-2, 3, 6 phénol	0,1	0,5	5	74	0,1	-	-	-	-	<0,1	-
Trichloro-2, 4, 5 phénol	0,1	0,5	5	74	0,1	-	-	-	-	<0,1	-
Trichloro-2, 4, 6 phénol	0,1	0,5	5	74	0,1	-	-	-	-	<0,1	-
Trichloro-3, 4, 5 phénol	0,1	0,5	5	74	0,1	-	-	-	-	<0,1	-

NOTES :

(1) : Critères génériques du Guide d'intervention - Protection des sols et réhabilitation des terrains contaminés (MDDELCC, 2016). Pour les métaux et métalloïdes, les critères « A » utilisés représentent la teneur de fond établie pour la province géologique du Supérieur et de Rae.

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(4) : Écart relatif calculé selon l'équation suivante : (|Conc. éch#1 - Conc. éch# 2| /Conc. moyenne)* 100. Pour une valeur inférieure à la LDR, *la concentration utilisée correspond à |LDR|*.

LÉGENDE :

-	: Non défini ou non analysé
100	: Concentration ≤ A
100	: A < Concentration ≤ B
100	: B < Concentration ≤ C
100	: C < Concentration < D
100	: Concentration ≥ D

Tableau 6 : Résultats du programme de contrôle de la qualité sur les échantillons de sols (suite)

Paramètres	Critères [1] ou valeurs limites [2] (mg/kg)				LDR [3] (mg/kg)	Échantillon/Date de prélèvement/Résultats d'analyse (mg/kg)					
						20 170 830-DUP6	CE-TR6/PM2		20 170 830-DUP3	CE-TR8/PM2	
	A	B	C	D		2017-08-30	2017-08-30	Écart relatif[4]	2017-08-30	2017-08-30	Écart relatif[4]
Hydrocarbures aromatiques polycycliques (HAP)											
Acénaphtène	0,1	10	100	100	0,1	<0,1	<0,1	0 %	-	<0,1	-
Acénaphtylène	0,1	10	100	100	0,1	<0,1	<0,1	0 %	-	<0,1	-
Anthracène	0,1	10	100	100	0,1	<0,1	<0,1	0 %	-	<0,1	-
Benzo (a) anthracène	0,1	1	10	34	0,1	<0,1	<0,1	0 %	-	<0,1	-
Benzo (a) pyrène	0,1	1	10	34	0,1	<0,1	<0,1	0 %	-	<0,1	-
Benzo (b) fluoranthène	0,1	1	10	-	0,1	<0,1	<0,1	0 %	-	<0,1	-
Benzo (c) phénanthrène	0,1	1	10	56	0,1	<0,1	<0,1	0 %	-	<0,1	-
Benzo (g, h, i) pérylène	0,1	1	10	18	0,1	<0,1	<0,1	0 %	-	<0,1	-
Benzo (j) fluoranthène	0,1	1	10	-	0,1	<0,1	<0,1	0 %	-	<0,1	-
Benzo (k) fluoranthène	0,1	1	10	-	0,1	<0,1	<0,1	0 %	-	<0,1	-
Chrysène	0,1	1	10	34	0,1	<0,1	<0,1	0 %	-	<0,1	-
Dibenzo(a,h)anthracène	0,1	1	10	82	0,1	<0,1	<0,1	0 %	-	<0,1	-
Dibenzo(a,h)pyrène	0,1	1	10	34	0,1	<0,1	<0,1	0 %	-	<0,1	-
Dibenzo(a,i)pyrène	0,1	1	10	34	0,1	<0,1	<0,1	0 %	-	<0,1	-
Dibenzo(a,l)pyrène	0,1	1	10	34	0,1	<0,1	<0,1	0 %	-	<0,1	-
Diméthyl-1,3naphtalène	0,1	1	10	56	0,1	<0,1	<0,1	0 %	-	<0,1	-
Diméthyl-7,12benzo(a)anthracène	0,1	1	10	34	0,1	<0,1	<0,1	0 %	-	<0,1	-
Fluoranthène	0,1	10	100	100	0,1	<0,1	<0,1	0 %	-	<0,1	-
Fluorène	0,1	10	100	100	0,1	<0,1	<0,1	0 %	-	<0,1	-
Indéno (1, 2, 3-c, d) pyrène	0,1	1	10	34	0,1	<0,1	<0,1	0 %	-	<0,1	-
Méthyl-1 naphtalène	0,1	1	10	56	0,1	<0,1	<0,1	0 %	-	<0,1	-
Méthyl-2 naphtalène	0,1	1	10	56	0,1	<0,1	<0,1	0 %	-	<0,1	-
Méthyl-3 cholanthrène	0,1	1	10	150	0,1	<0,1	<0,1	0 %	-	<0,1	-
Naphtalène	0,1	5	50	56	0,1	<0,1	<0,1	0 %	-	<0,1	-
Phénanthrène	0,1	5	50	56	0,1	<0,1	<0,1	0 %	-	<0,1	-
Pyrène	0,1	10	100	100	0,1	<0,1	<0,1	0 %	-	<0,1	-
Triméthyl-2, 3, 5 naphtalène	0,1	1	10	56	0,1	<0,1	<0,1	0 %	-	<0,1	-

NOTES :

(1) : Critères génériques du Guide d'intervention - Protection des sols et réhabilitation des terrains contaminés (MDDELCC, 2016). Pour les métaux et métalloïdes, les critères « A » utilisés représentent la teneur de fond établie pour la province géologique du Supérieur et de Rae.

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Tableau 6 : Résultats du programme de contrôle de la qualité sur les échantillons de sols (suite)

Paramètres	Critères (1) ou valeurs limites (2) (mg/kg)				LDR (3) (mg/kg)	Échantillon/Date de prélèvement/Résultats d'analyse (mg/kg)					
						20 170 830-DUP6	CE-TR6/PM2		20 170 830-DUP3	CE-TR8/PM2	
	A	B	C	D		2017-08-30	2017-08-30	Écart relatif(4)	2017-08-30	2017-08-30	Écart relatif(4)
Phtalates											
Diéthylphtalate	-	-	60	280	0,1	-	-	-	<0,1	<0,1	0 %
Diméthylphtalate	-	-	60	280	0,1	-	-	-	<0,1	<0,1	0%
Phtalate de benzyle butyle	-	-	60	60	0,1	-	-	-	<0,1	<0,1	0 %
Phtalate de di(2-éthylehexyle)	-	-	60	60	0,2	-	-	-	1,1	<0,2	138 %
Phtalate de dibutyle	0,2	6	70 000	-	0,1	-	-	-	<0,1	<0,1	0 %
Phtalate de di-N-octyle	-	-	60	280	0,1	-	-	-	<0,1	<0,1	0 %
Métaux											
Argent	0,5	20	40	200	0,5	<0,5	<0,5	0 %	<0,5	<0,5	0 %
Arsenic	5	30	50	250	5	<5	<5	0 %	**6,2**	**7,9**	24 %
Baryum	240	500	2000	10 000	20	<20	<20	0 %	24	21	13 %
Cadmium	0,9	5	20	100	0,9	<0,9	<0,9	0 %	<0,9	<0,9	0 %
Chrome	100	250	800	4000	45	<45	<45	0 %	<45	<45	0 %
Cobalt	30	50	300	1500	15	<15	<15	0 %	<15	<15	0 %
Cuivre	65	100	500	2500	40	<40	<40	0 %	<40	61	42 %
Étain	5	50	300	1500	5	<5	<5	0 %	**6**	**154**	185 %
Manganèse	1 000	1 000	2200	11 000	10	90	75	18 %	60	209	111 %
Molybdène	8	10	40	200	2	<2	<2	0 %	<2	<2	0 %
Nickel	50	100	500	2500	30	<30	<30	0 %	<30	<30	0 %
Plomb	40	500	1 000	5000	30	<30	<30	0 %	***7830***	**1830**	124 %
Zinc	150	500	1500	7500	100	<100	<100	0 %	133	**311**	80 %
Autres composés inorganiques											
Soufre total	400	2000	2000	-	200	<200	<200	0 %	**1110**	**1310**	17 %

NOTES :

(1) : Critères génériques du Guide d'intervention - Protection des sols et réhabilitation des terrains contaminés (MDDELCC, 2016). Pour les métaux et métalloïdes, les critères « A » utilisés représentent la teneur de fond établie pour la province géologique du Supérieur et de Rae.

(2) : Normes de l'Annexe I du Règlement sur l'enfouissement des sols contaminés (RESC), communément appelées critères D.

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6 ÉTENDUE DE LA CONTAMINATION

6.1 SOLS CONTAMINÉS SUR LE SITE À L'ÉTUDE

Les résultats de la présente étude constituant un état de référence pour les futures activités de Galaxy, une estimation préliminaire du volume de sols contaminés au-delà des critères génériques « A » a été préparée. Les volumes ont été obtenus par multiplication de l'épaisseur de sols contaminés dans le sondage par la superficie du polygone associé à ce sondage, soit :

- Sondage CE-TR8 : 2,5 m x 1 203 m^2 = 3 008 m^3 de sols contaminés en plomb au-delà des critères génériques « C ». Ils contiennent aussi des HP C_{10}-C_{50}, des métaux et du soufre total en concentrations se situant dans la plage « A-B » et des métaux en concentrations se situant dans la plage « B-C » des critères génériques. Ces sols sont en contact avec les matières résiduelles du LETI et sont considérés comme non conformes pour un site à vocation industrielle en raison de leur concentration en plomb;
- Sondage CE-SM1 : 0,05 m x 108 m^2 = 5 m^3 de sols contaminés en chrome VI dans la plage « B-C » des critères génériques par l'entreposage de poteaux de bois traité.

De façon générale, les polygones ont été tracés par la méthode des mi-distances entre les sondages du même type. Certaines limites du polygone associé à CE-SM1 ont été ajustées pour correspondre aux limites de l'amoncellement de bois traité, de façon à tenir compte des caractéristiques de migration de ce type de contamination. Les polygones obtenus sont illustrés à la carte 2.

6.2 MATIÈRES RÉSIDUELLES

Le volume de matières résiduelles enfouies dans le LETI a été estimé de façon préliminaire. Le volume correspond à la superficie de la zone d'enfouissement (1 391 m^2), déterminée à l'aide des sondages effectués lors de la présente étude, multipliée par la moyenne arithmétique du produit de l'épaisseur des horizons contenant des matières résiduelles dans les sondages et par la proportion de matières résiduelles dans ces horizons (0,54 m)[2], interprétée à partir des observations au terrain. Le volume obtenu est de 756 m^3. La limite de la zone est montrée à la carte 2.

6.3 IMPACTS APPRÉHENDÉS ET RISQUES DE MIGRATION

En fonction des concentrations rencontrées et des directions d'écoulement mesurées, l'eau souterraine contaminée en métaux et en sulfures d'hydrogène se retrouvant dans le secteur du LETI pourrait migrer vers le milieu récepteur, représenté par le cours d'eau présent à la limite sud de la propriété visée par le projet Mine de lithium Baie-James. Ces dépassements pourront être mieux mis en contexte dans de futures études couvrant une plus grande partie de la propriété visée par le projet Mine de lithium Baie-James.

[2] CE-TR2 : 0,6 m à 5 % CE-TR5 : 2,0 m à 5 % CE-TR8 : 2,5 m à 60 %

7 CONCLUSIONS ET RECOMMANDATIONS

WSP a été mandatée par Galaxy pour réaliser une caractérisation environnementale des sols et de l'eau souterraine du secteur du LETI de son projet Mine de lithium Baie-James, en lien avec les risques de contamination significatifs identifiés lors de l'ÉES – phase I (WSP, 2018).

L'objectif principal de l'étude était de vérifier la qualité environnementale des sols et de l'eau souterraine, puis d'estimer les volumes de sols contaminés, le cas échéant.

Les travaux de terrain se sont déroulés du 25 au 31 août 2017 et ont compris la réalisation de trois forages aménagés en puits d'observation, de onze tranchées d'exploration et de huit sondages manuels, le prélèvement d'échantillons de sols dans les tranchées d'exploration et les huit sondages et le prélèvement d'échantillons d'eau souterraine dans les puits d'observation.

Des matières résiduelles (papier, plastique, métal, bois, tissu) ont été observées en proportions allant de 5 % à 60 % dans le remblai de trois sondages. Le volume de matières résiduelles enfouies dans le LETI a été estimé à 756 m^3 à partir des observations au terrain. Dans l'éventualité où le secteur ferait l'objet de travaux d'excavation, ces matières devraient être ségréguées des sols autant que possible afin d'être gérées de façon distincte.

Des sols dont les concentrations en HP C_{10}-C_{50} et en soufre total excèdent les critères génériques « A » du Guide d'intervention du MDDELCC et dont les concentrations en métaux excèdent les valeurs limites de l'annexe I du RESC ont été mis au jour lors des travaux. Ces sols sont en contact avec les matières résiduelles du LETI et sont considérés comme non conformes pour un site à vocation industrielle en raison de leur concentration en plomb. Le volume de sols contaminés au droit du sondage CE-TR8 a été évalué à 3 008 m^3 de façon préliminaire. Des sols dont la concentration en chrome VI se situe dans la plage « B-C » des critères génériques ont aussi été mis au jour en surface dans le sondage CE-SM1, réalisé à la base d'un amoncellement de poteaux de bois traité. Le volume associé à ce type de contamination a été évalué à 5 m^3. S'ils venaient à être excavés, tous ces sols seraient soumis à la Grille de gestion des sols excavés du Guide d'intervention.

L'eau souterraine du secteur est, quant à elle, contaminée en métaux et en sulfures d'hydrogène au-delà des seuils d'alerte applicables, et elle présente un pH à l'extérieur de la plage recommandée. L'origine de cette contamination ne peut être identifiée uniquement à partir des données disponibles. Ces dépassements pourront être mieux mis en contexte dans de futures études couvrant une plus grande partie de la propriété visée par le projet Mine de lithium Baie-James.

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ANNEXE

A

LIMITES ET CONDITIONS GÉNÉRALES DE L'ÉTUDE

Le présent rapport est constitué de la partie descriptive du texte ainsi que de l'ensemble des tableaux, cartes et annexes associés. L'utilisation d'informations extraites de ce rapport, mises hors du contexte général de l'étude, peut conduire à une fausse interprétation de résultats partiels ou fragmentaires. Le présent document a été préparé pour l'usage exclusif de Galaxy. Toute utilisation d'information contenue dans ce rapport ne peut être effectuée sans une approbation écrite de Galaxy et de WSP Canada Inc.

Les informations présentées dans ce rapport et qui ont été obtenues par WSP Canada Inc., par l'entremise d'un tiers, n'ont pas été indépendamment vérifiées ou autrement examinées par WSP Canada Inc. pour en déterminer l'exactitude ou la totalité. WSP Canada Inc. a utilisé ces informations de bonne foi et n'acceptera aucune responsabilité pour toute déficience, mauvaise interprétation ou inexactitude présentée dans ce rapport résultant d'omissions, de mauvaises interprétations ou encore, d'actes frauduleux des personnes interviewées ou contactées dans le contexte de cette étude.

Les conditions environnementales du site étudié ont été déterminées à partir des résultats analytiques obtenus pour les échantillons de sols prélevés aux emplacements des forages. Les conditions environnementales du lot peuvent être différentes des lieux de prélèvements d'échantillons. Il n'est jamais possible, même avec un échantillonnage exhaustif, d'éliminer la possibilité qu'une partie du lot soit contaminée sans avoir été détectée.

Les travaux réalisés, tels que décrits dans ce rapport, ont été conduits avec le même niveau de prudence et de diligence qui est normalement exercé dans le domaine de l'ingénierie et des sciences professionnelles dans des conditions similaires.

Le contenu de ce rapport est basé sur l'information obtenue au cours des travaux, sur notre compréhension actuelle des conditions des lots à l'étude et sur notre jugement professionnel à la lumière de ces informations au moment d'écrire ce rapport. Ce rapport ne procure pas une opinion légale en regard des réglementations et lois applicables.

Les conclusions de ce rapport sont valides seulement à la date de ce rapport. Si de nouvelles informations étaient mises à jour lors de travaux futurs, incluant des excavations, des forages ou d'autres études, WSP Canada Inc. demande à pouvoir réévaluer les conclusions de ce rapport et à produire un amendement, le cas échéant.

ANNEXE

B

REPORTAGE PHOTOGRAPHIQUE

Photo B-1 : Stratigraphie typique sur le site du LETI

Photo B-2 : Réservoir vide dans la tranchée d'exploration CE-TR5

Photo B-3 : Horizon de matières résiduelles dans la tranchée d'exploration CE-TR8

ANNEXE

C

RAPPORTS DE SONDAGE

Le contenu de cette annexe est présenté sur cédérom

ANNEXE

D

CERTIFICATS D'ANALYSES CHIMIQUES

Le contenu de cette annexe est présenté sur cédérom

APPENDIX

A-123

DUST EMISSION MANAGEMENT PLAN

MINE DE LITHIUM BAIE-JAMES

Plan de gestion des émissions de poussières

CONCEPTUEL

Version préliminaire - Juin 2019

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CONCEPTUEL

1 INTRODUCTION

1.1 Contexte et objectifs

Galaxy Lithium (Canada) inc. (Galaxy) est une filiale de Galaxy Resources Limited, l'une des plus importantes sociétés minières sur le marché du lithium. Galaxy exploite présentement un gisement et plusieurs autres projets de classe mondiale sont actuellement en développement, dont celui de la Baie-James.

Galaxy agit à titre d'initiateur du présent projet mine de lithium Baie-James, situé dans la région administrative du Nord-du-Québec. Le site minier à l'étude se trouve à environ 10 km au sud de la rivière Eastmain, à quelque 100 km à l'est de la Baie James, à la même latitude que le village d'Eastmain.

Le gisement prévoit l'exploitation d'une fosse de façon conventionnelle dont environ 2 millions de tonnes par année de pegmatites à spodumène seront extraites pour ensuite être dirigées vers un concentrateur. Outre ces installations, le site accueillera notamment des aires d'accumulation (mort-terrain, terre végétale, stériles/résidus, minerai, concentré), des bassins de rétention, des bâtiments administratifs et d'opérations, un campement pour les travailleurs, des garages et un site d'entreposage des explosifs. La période d'exploitation prévue est de 16 ans.

Galaxy s'engage à mettre en place un « **Plan de gestion des émissions de poussières** » comprenant un contrôle des émissions et un programme détaillé de suivi de la qualité de l'air.

Ce plan de gestion est présenté dans les sections suivantes. Celui-ci sera maintenu et mis à jour au cours de toutes les phases du projet, soit la construction, l'exploitation et la fermeture.

1.2 Responsabilité et mise en application

Un membre du personnel de Galaxy sera responsable du « Plan de gestion des émissions de poussières ». Bien que l'application des mesures de ce plan soit sous la responsabilité des responsables de chaque département, le responsable du plan aura pour mandat de leur communiquer les mesures prévues dans ce plan. De plus, il devra veiller à la mise à jour du plan selon l'évolution du projet et des constatations faites en cours d'opération. Le programme sera intégré au système de gestion du site.

Le personnel de Galaxy et ses sous-traitants seront informés et sensibilisés aux contenus de ce plan de gestion de manière à mettre en application les bonnes pratiques permettant de réduire les émissions atmosphériques sur le site de la mine de lithium Baie-James. Des formations sur les différentes procédures utilisées seront données au personnel et aux sous-traitants concernés.

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1.3 Législations et exigences externes

Les principales exigences provinciales en matière de qualité de l'atmosphère sont définies par la *Loi de la qualité de l'environnement* (L.R.Q., chapitre Q-2) et, en particulier, via le *Règlement sur l'assainissement de l'atmosphère* (RAA) (R.R.Q., chapitre Q-2., r. 4.1). Plus précisément, le RAA définit des normes de qualité de l'atmosphère (R.R.Q., chapitre Q-2., r. 4.1 a. 196). Ces normes sont des seuils de références à respecter à la limite d'application des normes et critères.

De plus, le ministère de l'Environnement et de la Lutte contre les changements climatiques (MELCC) a publié un document intitulé *Normes et critères québécois de qualité de l'atmosphère.* En plus des normes de qualité de l'atmosphère du RAA, ce document présente un ensemble de critères établi afin d'évaluer les résultats de mesures de la qualité de l'air et également lors de l'étude de projets générant des émissions atmosphériques. Ces critères représentent des seuils de références à interpréter à la limite d'application des normes et critères. Il est important de noter que ces critères ne se retrouvent, pour l'instant, dans aucune loi et aucun règlement.

Les principales exigences provinciales en matière de qualité de l'atmosphère sont donc définies dans les documents suivants :

- *Loi de la qualité de l'environnement* (L.R.Q., chapitre Q-2);
- *Règlement sur l'assainissement de l'atmosphère* (R.R.Q., chapitre Q-2., r. 4.1);
- *Normes et critères québécois de qualité de l'atmosphère,* version 6. MELCC, 2018. Québec, Direction du suivi de l'état de l'environnement, ISBN 978-2-550-82698-9.

2 SOURCES D'ÉMISSIONS ATMOSPHÉRIQUES

La première phase du projet de la mine de lithium Baie-James sera la phase de construction comprenant la construction des infrastructures, la préparation du terrain et l'extraction de mort-terrain. Durant cette phase, les principales sources d'émissions découleront des activités suivantes :

- Décapage (sol arable et mort-terrain);
- Opération de forage;
- Dynamitage;
- Chargement et déchargement des matériaux;
- Boutage sur les haldes;
- Concassage de roche stérile pour l'aménagement du site (unité mobile);
- Transport des différents matériaux sur le site minier (routage).

Par la suite, durant la phase d'exploitation de la mine, l'extraction du minerai et des stériles et le traitement du minerai s'ajouteront aux activités de la phase de construction. Les activités d'agrandissement de la halde à stériles s'ajouteront

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également aux activités d'exploitation. Les principales sources d'émissions atmosphériques qui s'ajouteront relativement à la phase de construction sont :

- Dynamitage dans la fosse;
- Sources ponctuelles de l'usine de concentration;
- Expédition du concentré de spodumène;
- Concassage de roche stérile pour les activités d'agrandissement (unité mobile);
- Érosion éolienne des aires d'entreposage.

3 MESURES D'ATTÉNUATION COURANTES

La stratégie de gestion de Galaxy est d'appliquer continuellement des mesures d'atténuation courantes à l'ensemble de ses activités minières génératrices d'émissions atmosphériques, et ce, afin de répondre aux exigences suivantes :

- Limiter les effets individuels et cumulatifs d'émissions atmosphériques sur la qualité de l'air en périphérie du site;
- Contrôler et contenir les émissions sur le site;
- Minimiser les effets négatifs sur les écosystèmes du secteur;
- Respecter les normes de qualité de l'air.

3.1 Phase de construction

3.1.1 *Décapage (sol arable et morts-terrains)*

Le décapage sera limité au minimum afin d'éviter l'érosion éolienne sur les surfaces décapées. En effet, les opérations de décapage seront planifiées en fonction des besoins du plan d'exploitation.

Lorsqu'il sera possible de le faire, la couche arable sera enlevée pendant qu'elle est humide ou peu de temps avant qu'elle soit recouverte. L'arrosage des zones de travail pourra être effectué au besoin.

3.1.2 *Opérations de forage*

Les foreuses seront équipées de dispositif de dépoussiérage humide ou à sec. La poussière recueillie par ces appareils sera éliminée de manière à minimiser sa volatilité.

L'entretien mécanique des équipements sera effectué régulièrement afin de réduire les vibrations qui peuvent augmenter les émissions. Le système de dépoussiéreurs sera aussi vérifié régulièrement.

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3.1.3 *Dynamitage*

Les charges et la superficie sautée vont être adaptées pour réduire les inconvénients. Des matériaux adéquats seront utilisés pour le bourrage des explosifs. La hauteur du bourrage final devra alors être adéquate, en toute circonstance, pour éviter le phénomène de débourrage.

Les opérations de dynamitage seront effectuées selon les règles de l'art par des spécialistes en dynamitage.

3.1.4 *Chargement et déchargement des matériaux*

La hauteur à laquelle le matériel est relâché ainsi que la distance sur laquelle il sera en chute libre seront gardées au minimum. De plus, puisque les matières particulaires s'accumulent généralement à proximité de la machinerie, le nettoyage et l'arrosage régulier, au besoin, des zones de travail seront effectués afin d'empêcher la resuspension de ces matières particulaires.

Autant que possible le basculage du mort-terrain et des stériles par les camions sur les haldes sera limité à une hauteur de 10 mètres pour minimiser les émissions de matières particulaires.

3.1.5 *Boutage sur les haldes*

Les opérations de boutage des matières déchargées seront gérées afin d'éviter la propagation des poussières.

3.1.6 *Concassage de roche stérile pour l'aménagement du site*

Le concasseur mobile sera positionné afin qu'il ne soit pas exposé aux grands vents. Les émissions seront limitées par l'utilisation de jets d'eau au concasseur.

3.1.7 *Transport des différents matériaux sur le site minier (routage)*

Le transport des matériaux sur les routes non pavées représente la plus grande source d'émission de matières particulaires du projet.

L'utilisation de matériaux non friables et présentant une bonne résistance à l'abrasion routière sera priorisée pour la construction et l'entretien des routes. L'entretien régulier des routes sera priorisé afin de maintenir une bonne surface de roulement et un faible taux de silt. Aucun matériel argileux ne sera utilisé pour la construction des routes et les matériaux ayant une faible teneur en silice seront favorisés.

Les émissions de poussières liées à la circulation dépendent de la vitesse des véhicules. Afin de limiter les émissions, Galaxy prévoit limiter la vitesse de circulation des équipements miniers de transport sur le site à 40 km/h.

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Enfin, les émissions seront contrôlées par l'arrosage régulier des surfaces routières. Dans le cas où des épisodes de poussières seraient malgré tout observés, l'utilisation d'abat-poussière chimique sera considérée. Les produits chimiques hygroscopiques utilisés seront certifiés conformes par le Bureau de Normalisation du Québec à la norme BNQ 2410-300. Enfin, un programme de gestion de l'arrosage des routes sera mis en place. Celui-ci est présenté à la section 4.

3.2 Phase d'exploitation

La stratégie de gestion des émissions atmosphériques de la phase d'exploitation reprend intégralement les mesures d'atténuation identifiées pour les activités de la phase de construction qui seront poursuivies lors de l'exploitation. Il s'agit notamment des opérations de forage, du chargement et déchargement des matériaux, du boutage sur les haldes et du transport des différents matériaux sur le site minier (routage). Seulement les mesures d'atténuation spécifiques à l'exploitation de la mine sont donc décrites aux sections suivantes.

3.2.1 *Dynamitage dans la fosse*

Les charges et la superficie sautée vont être adaptées pour réduire les inconvénients. Des matériaux adéquats seront utilisés pour le bourrage des explosifs. La hauteur du bourrage final devra alors être adéquate, en toute circonstance, pour éviter le phénomène de débourrage.

Pour éviter la dispersion des poussières de silice hors du site minier, si nécessaire, le sautage sera restreint durant les périodes de grands vents ou lorsque les vents dominants peuvent transporter la poussière vers les zones sensibles (relais routier du km 381). Les zones sautées seront humidifiées pour que la dispersion des matériaux secs et fins déposés en surface par les activités de forage soit évitée.

3.2.2 *Sources ponctuelles de l'usine de concentration*

Le minerai sera transporté de la mine à ciel ouvert vers le circuit de concassage à trois étages comprenant un concasseur primaire, un concasseur à cône secondaire et un concasseur à cône tertiaire fermé avec un crible-classeur pour produire la taille de produit ciblée.

Le minerai concassé sera entreposé dans un dôme avant d'être acheminé au circuit de la séparation en milieu dense (SMD) de l'usine de concentration. Des systèmes de dépoussiérage seront installés au circuit de concassage.

Les dépoussiéreurs seront contrôlés quotidiennement (inspection visuelle) et nettoyés régulièrement. La poussière recueillie par ces appareils sera éliminée de manière à prévenir sa dispersion.

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3.2.3 *Expédition du concentré de spodumène*

Afin de limiter les émissions liées à l'expédition du concentré de spodumène, les routes non pavées du site qui sont empruntées par les camions seront arrosées régulièrement. Dans le cas où des épisodes de poussières seraient malgré tout observés, l'utilisation d'abat-poussière chimique sera considérée. Les produits chimiques hygroscopiques utilisés seront certifiés conformes par le Bureau de Normalisation du Québec à la norme BNQ 2410-300.

3.2.4 *Concassage de roche stérile pour les activités d'agrandissement*

Des opérations de concassage et de criblage seront effectuées à la cour d'entreposage pour l'obtention des granulats nécessaires aux activités d'agrandissement. Le concasseur sera positionné afin qu'il ne soit pas exposé aux grands vents. Les émissions seront limitées par l'utilisation de jets d'eau.

3.2.5 *Érosion éolienne des aires d'entreposage*

Il est prévu que les haldes de roches stériles, de matière organique et de dépôts meubles seront revégétées. Tout au long des différentes phases du projet, la restauration progressive, particulièrement des pentes extérieures de ces haldes, sera favorisée lorsque possible afin de minimiser les émissions de matières particulaires générées par l'érosion éolienne.

Il est par contre important de rappeler que les précipitations et l'humidité contribuent au lavage des surfaces et à la cimentation des particules fines, en particulier lorsque les haldes sont principalement constituées de matériaux grossiers; ce qui est notamment le cas pour certaines haldes du projet de la mine de lithium Baie-James.

La circulation routière et les perturbations physiques des aires d'entreposages seront contrôlées et minimisées.

4 PROGRAMME DE GESTION DE L'ARROSAGE DES ROUTES

Étant donné que le routage sur le site minier a été identifié par la modélisation de la dispersion atmosphérique comme le plus important contributeur des émissions de matières particulaires, Galaxy prévoit le contrôle de ces émissions par l'arrosage régulier des routes non pavées.

Un programme de gestion de l'arrosage des routes sera donc mis en place afin d'effectuer un suivi de l'efficacité des mesures de contrôles prévues. La fréquence et l'intensité d'arrosage des routes seront conjuguées aux conditions météorologiques.

L'atténuation des émissions due à l'arrosage dépend de plusieurs facteurs; la quantité d'eau appliquée sur la route par unité de surface, le temps entre les arrosages, l'intensité du trafic et les conditions météorologiques pendant cette période. Or, l'efficacité de l'arrosage comme méthode d'atténuation des émissions

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peut être estimée selon la règle empirique décrite dans le document Control of Open Fugitive Dust Sources (Cowherd et coll., 1988) et en utilisant le taux d'évaporation moyen spécifique au site de la mine de lithium Baie-James (ATLAS-1978 et EPA-2007).

Selon les opérations prévues, ce modèle théorique prévoit que les besoins quotidiens en eau pourront atteindre un volume de 300 m^3 en condition estivale, lors de journées sèches, afin d'atteindre l'efficacité de contrôle cible de 75 %. Cette quantité d'eau est estimée dans les conditions d'opération maximale, soit le scénario d'exploitation de l'année 9 à 42,3 kilotonnes par jour. Pour les segments les plus achalandés, l'intensité d'arrosage maximale requise représente 0,24 $l/m^2/h$.

Pour l'arrosage des routes du site minier, l'eau traitée provenant du bassin principal sera utilisée. Tel que présenté dans le bilan d'eau, le débit provenant de la fosse fournira en tout temps suffisamment d'eau pour les besoins d'arrosage.

Références :

- Cowherd, C, G. E. Muleski and J. Kinsey. *Control of Open Fugitive Dust Sources*, Kansas City, EPA-450/3-88-008. 1988.
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5 PROGRAMME PRÉLIMINAIRE DE SUIVI DE LA QUALITÉ DE L'AIR

L'objectif du programme de suivi sera de mesurer l'impact des activités minières sur la qualité de l'air locale et régionale, et ensuite de déterminer la conformité et l'acceptabilité des activités minières par rapport aux normes et critères applicables présentés dans le document Normes et critères québécois de qualité de l'atmosphère, version 6 du MELCC (2018). Ce programme comprendra deux volets, soit l'acquisition de données météorologiques et l'échantillonnage de la qualité de l'air ambiant.

5.1 Station météorologique

Une station météorologique sera installée à court terme à un emplacement représentatif afin d'acquérir suffisamment de données pour déterminer le positionnement des stations d'air ambiant lors du démarrage du projet. Cette station permettra aussi de juger convenablement des conditions locales pour appuyer l'interprétation des mesures de qualité de l'air obtenues aux nouvelles stations qui seront installées dans le cadre du suivi de la qualité de l'air.

Les équipements utilisés, leurs modalités d'installation, la compilation des données météorologiques incluant la fréquence de mesure, le calcul des valeurs horaires ainsi que les étiquettes de données seront conformes aux normes édictées dans le

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document Normes de gestion et d'exploitation des réseaux du Réseau météorologique coopératif du Québec.

Avant l'installation, la localisation de la station météo et les équipements prévus seront présentés au MELCC pour approbation dans un devis détaillé.

Les données météorologiques seront par ailleurs transmises au Ministère régulièrement via un site FTP ou selon un autre format défini par le Réseau météorologique coopératif du Québec.

5.2 Échantillonnage de la qualité de l'air ambiant

Le programme de suivi de la qualité de l'air repose principalement sur un échantillonnage de la qualité de l'air ambiant. Galaxy propose de faire un suivi séquentiel des matières particulaires totales (PMT), des métaux et de la silice cristalline, et ce, dès le début des travaux de construction. Il est prévu de moduler ce suivi selon les résultats recueillis.

5.2.1 *Localisation des stations d'échantillonnage*

La position des stations d'échantillonnage sera déterminée de façon à dresser un portrait adéquat de la qualité de l'air en direction du relais routier du km 381. Le positionnement exact sera défini à partir des directions des vents dominants spécifiques au site, lesquelles seront obtenues à partir des données météorologiques de la station qui sera installée au site. Au préalable, la localisation prévue sera soumise au MELCC pour approbation.

Une vérification sera effectuée pour s'assurer de respecter les critères de localisation d'Environnement Canada et du MELCC, soit :

- situé minimalement à 100 m d'un cours d'eau ou d'une étendue d'eau;
- situé minimalement à deux fois la hauteur des obstacles brise-vent;
- situé de manière à ce que les points de cueillette ou les buses d'échantillonnages soient localisés à au moins 2 m du sol;
- situé de manière à ce que l'on puisse considérer les mesures réalisées comme représentatives de la zone à l'étude.

5.2.2 *Méthodes et fréquences d'analyses*

Pour l'analyse des matières particulaires, un appareil recommandé par l'US-EPA (« List of Designated Reference and Equivalent Method ») sera nécessaire, à savoir :

- Un échantillonneur à haut débit (Hi-Vol) (référence US-EPA : 40 CFR Part 50, Appendix B); modèle TE-5170 MFC de la compagnie Tisch-environmental ou équivalent;

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- Un échantillonneur de type PQ-100PM10 ou l'équivalent, doté d'une tête sélective/cyclone SCCA ou l'équivalent

Pour les PMT, les échantillonnages à l'aide du Hi-Vol seront d'une durée de 24 heures de minuit à minuit le lendemain et réalisés une fois par six jours. Le suivi de l'exposition à certains métaux est également prévu à partir de l'analyse de ces échantillons. Les métaux dont les normes sont sur des distributions de particules de tailles inférieures, telles que le nickel, seront d'abord mesurés sur les particules totales. Dans le cas où des dépassements seraient observés, la mesure de ces tailles de particules sera envisagée.

Le suivi de la silice cristalline sera effectué sur les particules prélevées sur filtres par échantillonnages des PM4 à l'aide d'un échantillonneur de type PQ100PM10. La fraction des PM4 sera collectée en utilisant un débit de prélèvement et une tête sélective doté d'un cyclone approprié (SCCA ; 11,1 LPM). De manière à obtenir une limite de détection adéquate, les échantillonnages seront effectués sur une durée de 5 jours (7 200 minutes). Les analyses de silice en laboratoire seront effectuées en suivant le protocole NIOSH 7500.

Toutes les analyses seront réalisées dans un laboratoire agréé par le MELCC. Les méthodes utilisées seront en accord avec celles de référence développées par le CEAEQ, si disponibles. Plusieurs mesures d'assurance qualité et de contrôle qualité (AQ/CQ) seront mises en place dans le cadre de la campagne d'échantillonnage pour assurer la représentativité et la précision des résultats.

Les fréquences d'échantillonnage sont présentées au tableau 1 alors que les méthodes d'échantillonnage et d'analyse sont résumées au tableau 2. Les fréquences seront modulées selon les résultats recueillis dès la première année d'exploitation. Les résultats des mesures seront transmis au ministère et la fréquence des suivis sera ajustée selon les résultats obtenus et soumise au MELCC pour approbation.

Tableau 1 : Fréquences d'échantillonnage

Paramètre	Fréquence
Matières particulaires totales PMT (Hi-Vol)	1 fois / 6 jours (modulable selon les résultats)
Métaux[1] dans PMT (Hi-Vol)	
Silice cristalline	1 fois / 15 jours (modulable selon les résultats)

[1] Métaux : selon les Normes et critères québécois de qualité de l'atmosphère du MELCC (2018).

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Tableau 2 : Méthodes d'échantillonnage et d'analyse

Paramètre	Méthode	Analyse
Particules totales (PMT)	US-EPA – Division AMTIC – Compendium of Methods for the Determination of Inorganic Compounds in Ambient Air – Compendium Method IO-2.1 –SAMPLING OF AMBIENT AIR FOR TOTAL SUSPENDED PARTICULATE MATTER (SPM) CENTRE D'EXPERTISE EN ANALYSE ENVIRONNEMENTALE DU QUÉBEC. Détermination des particules : méthode gravimétrique, MA. 100 – Part. 1.0, Rév. 3, Ministère du Développement durable, de l'Environnement et des Parcs du Québec, 2010, 9 p.	Gravimétrie – différence de poids des filtres avant et après les prélèvements
Métaux dans PMT ***Selon le document Normes et critères québécois de qualité de l'atmosphère du MELCC (2018).***	US-EPA – Division AMTIC - Compendium of Methods for the Determination of Inorganic Compounds in Ambient Air - Compendium Method IO-3.5 - DETERMINATION OF METALS IN AMBIENT PARTICULATE MATTER USING INDUCTIVELY COUPLED PLASMA/ MASS SPECTROMETRY (ICP/MS)	Extraction des métaux avec une solution d'acide nitrique et acide chlorhydrique et analyse par ICP-MS
Silice cristalline	Protocole établi avec le MELCC avec tête d'échantillonnage de PM4 et débit de 11,1 LPM, Durée de 120 h analyse avec méthode NIOSH 7500.	Filtration, tête sélective de taille de particule, analyse par rayons X.

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6 SUIVI DES ÉMISSIONS À LA SOURCE

En complément au programme de suivi de la qualité de l'air, les équipements représentant des sources d'émissions fixes seront échantillonnés. Les équipements faisant l'objet d'un suivi des émissions à la source seront ceux identifiés dans l'attestation d'assainissement.

Ce programme de suivi des émissions à la source respectera les exigences du MELCC précisées dans son Guide de caractérisation et de suivi de l'air ambiant (Couture 2005). L'échantillonnage sera effectué selon les modalités et les méthodes de référence prescrites dans le Guide d'échantillonnage aux fins d'analyses environnementales – Cahier 4 – Échantillonnage des émissions atmosphériques en provenance de sources fixes (MDDELCC, 2016).

Un rapport d'échantillonnage sera systématiquement produit et transmis au MELCC. Si l'analyse révèle un dépassement d'une valeur limite ou d'une norme d'émission, l'événement sera mentionné ainsi que les mesures correctrices appliquées.

7 MAINTENANCE ET ENTRETIEN

Les équipements miniers seront inspectés régulièrement et les défectuosités seront réparées dans les plus brefs délais pour maximiser leur efficacité.

Les matières particulaires récupérées par les dépoussiéreurs seront disposées de façon à minimiser leur dispersion.

Les pièces de rechange pour les principaux équipements d'atténuation seront conservées sur le site (pompes à eau, sacs filtrants, etc.).

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CONCEPTUEL

APPENDIX

A-125

ASSESSMENT OF THE TOXICOLOGICAL RISKS FOR HUMAN HEALTH

ÉVALUATION DES RISQUES TOXICOLOGIQUES À LA SANTÉ HUMAINE

PROJET MINE DE LITHIUM BAIE-JAMES

Document présenté à

LITHIUM (CANADA) INC.

Galaxy Lithium (Canada) inc.
720-2000, rue Peel
Montréal (Québec) H3A 2W5

Rapport final

29 novembre 2018

N/Réf. : RA17-370-1

SANEXEN
SERVICES ENVIRONNEMENTAUX INC.

ÉVALUATION DES RISQUES TOXICOLOGIQUES À LA SANTÉ HUMAINE

PROJET MINE DE LITHIUM BAIE-JAMES

Document présenté à

GALAXY LITHIUM (CANADA) INC.

Préparé et vérifié par :

Marie-Odile Fouchécourt, Ph.D.
Directrice adjointe – Analyse de risques

Approuvé par :

Agnès Renoux, Ph.D.
Directrice – Analyse de risques

Rapport final

29 novembre 2018

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SANEXEN
SERVICES ENVIRONNEMENTAUX INC.

ÉQUIPE DE TRAVAIL

Marie-Odile Fouchécourt, Ph. D.	Direction du projet Analyse de l'information Estimation des risques (inhalation) Évaluation des risques Rédaction
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Agnès Renoux, Ph. D.	Contrôle qualité

SANEXEN
SERVICES ENVIRONNEMENTAUX INC.

RÉSUMÉ

Galaxy Lithium (Canada) inc. (Galaxy) souhaite exploiter à ciel ouvert un gisement de spodumène pour l'extraction du lithium. Le gisement est situé au sud du 55e parallèle, dans la région administrative du Nord-du-Québec, à environ 100 km à l'est du village d'Eastmain, près du relais routier du km 381 de la route de la Baie-James (le « Relais routier »). Ce projet minier (le « Projet ») se situe dans le territoire couvert par la Convention de la Baie-James et du Nord québécois, dans le terrain de trappage RE2 utilisé par la communauté crie d'Eastmain (« la Communauté crie »). Les installations minières du Projet incluent, en plus d'une fosse à ciel ouvert, un concentrateur de minerai, des aires d'accumulation de matériaux (dépôts meubles, terre végétale, stériles/résidus, minerai, concentré), des bassins de rétention, une unité de traitement d'eau ainsi que des infrastructures connexes. Le Projet prévoit que l'exploitation débute en 2022 et se termine entre 2037 et 2042, soit une durée d'exploitation de 15 à 20 ans. Afin d'obtenir les autorisations nécessaires à sa mise en œuvre, Galaxy a fait réaliser (par la firme WSP) une étude d'impact environnemental (ÉIE).

En complément de l'ÉIE, Galaxy souhaitait que soient évalués les risques à la santé pour la population qui fréquente le secteur de la mine, soit la « zone d'étude » correspondant à celle définie dans l'ÉIE pour les composantes sociales. Ainsi, Sanexen Services Environnementaux inc. (Sanexen) a été retenue par Galaxy pour évaluer les risques toxicologiques pour la population qui pourrait, directement ou indirectement, être affectée par les émissions engendrées par le Projet. En principe, les émissions atmosphériques et les rejets aqueux devaient être évalués. Cependant, s'il est établi que la qualité des effluents liquides respectera les critères en vigueur (Directive 019 et normes du Règlement sur les Mines de Métaux et les Mines de Diamant), les données sur la qualité de ces effluents ne peuvent être disponibles à cette étape du Projet. Dans ces conditions, les risques pour la santé humaine posés par les rejets aqueux dans le milieu aquatique n'ont pas pu être estimés. La présente évaluation porte donc sur les émissions atmosphériques du Projet uniquement. Toutefois l'omission de considérer les rejets aqueux et ses conséquences sur l'exposition de la population ont été discutées à la section traitant des incertitudes et prises en compte qualitativement dans la présente évaluation.

L'évaluation quantitative porte à la fois sur les émanations gazeuses de monoxyde de carbone (CO), de dioxyde d'azote (NO_2) et de dioxyde de soufre (SO_2), et sur les émissions dans l'air de particules et de leurs constituants (particules fines ($PM_{2.5}$), 24 métaux[1] et silice cristalline). Tous les effets toxiques ont été étudiés pour chaque substance, ce qui inclut ceux pouvant découler d'une exposition de courte durée et à plus long terme (cancer et autres effets chroniques sur la santé).

L'évaluation des risques a été réalisée en se conformant aux *Lignes directrices pour la réalisation des évaluations du risque toxicologique d'origine environnementale au Québec* publiées en 2012 par l'Institut national de santé publique du Québec (INSPQ). Les niveaux d'exposition découlant des activités projetées ont été estimés à partir de concentrations modélisées dans l'air, fournies par WSP. Les risques ont ensuite été calculés puis évalués selon les critères d'acceptabilité de l'INSPQ. Selon ces critères, le risque est jugé négligeable lorsque le risque additionnel de cancer est inférieur ou égal à un cas sur un million et lorsque, pour les autres effets sur la santé, les niveaux d'exposition sont inférieurs à ceux jugés sécuritaires par des institutions de santé reconnues.

1 Bien que tous les éléments minéraux considérés dans la présente étude ne soient pas des métaux, le terme « métaux » a été utilisé de façon générique pour représenter les éléments suivants dans le rapport : aluminium (Al), antimoine (Sb), argent (Ag), arsenic (As), baryum (Ba), béryllium (Be), bore (B) cadmium (Cd), chrome (Cr), cobalt (Co), cuivre (Cu), étain (Sn), lithium (Li), manganèse (Mn), mercure (Hg), molybdène (Mo), nickel (Ni), plomb (Pb), sélénium (Se), strontium (Sr), titane (Ti), uranium (U), vanadium (V) et zinc (Zn).

Les activités humaines ayant lieu dans la zone d'étude ont été prises en compte pour élaborer des scénarios d'exposition et localiser les lieux fréquentés par des individus (désignés comme des « récepteurs »). Une « zone d'exposition rapprochée », plus restreinte, a été définie afin de cibler les milieux susceptibles d'être les plus affectés par les émissions du Projet. Elle correspond à une zone circulaire d'environ 5 km de rayon, centrée sur les installations minières tout en les excluant. D'une superficie de 83 km^2, cette zone inclut notamment le Relais routier (à l'est), un camp permanent utilisé par la Communauté crie (au nord), les cours d'eau CE1 à CE6 ainsi que plusieurs zones de chasse et de trappage fréquentées par la Communauté crie. La zone d'exposition rapprochée a été utilisée pour évaluer de façon prudente les risques posés par le Projet advenant la pratique, dans la zone d'étude, d'activités dites « traditionnelles », c'est-à-dire pratiquées par la Communauté crie.

Les scénarios d'exposition ont été définis en se basant sur l'information disponible concernant les habitudes de vie de la population autochtone et allochtone dans et à proximité de la zone d'étude. Ces scénarios visaient à représenter la fréquentation de la zone d'étude par des individus fictifs (récepteurs). Pour chaque scénario, des hypothèses prudentes ont été retenues pour représenter l'exposition potentielle des récepteurs. Les différents récepteurs et leurs scénarios d'exposition respectifs sont définis comme suit :

- Scénario d'exposition au « Relais routier », représentant des individus (adultes) qui fréquenteraient le Relais routier comme employés sur une base régulière (24 heures sur 24, à raison de 25 semaines par année). Ces récepteurs peuvent être exposés aux émissions engendrées par le Projet par inhalation d'air, par ingestion de poussières déposées à l'intérieur du bâtiment ainsi que par contact cutané avec l'air et ces poussières. Il a été considéré que l'alimentation de ces récepteurs était comparable à celle documentée pour la population canadienne en général.
- Scénario d'exposition « Activités traditionnelles », représentant des individus (adultes et enfants) de la Communauté crie qui fréquenteraient la zone d'exposition rapprochée de façon discontinue pour une partie de l'année (période prolongée de 8 semaines par année et 44 fins de semaine, soit une durée totale de 20,5 semaines par année), et qui consommeraient sur place des denrées alimentaires (gibier, poisson, petits fruits et autres plantes médicinales et/ou à infuser) provenant de cette même zone. Il a été supposé que ces aliments d'origine locale étaient consommés chaque jour, et que les quantités consommées quotidiennement correspondaient à celles documentées au Canada pour des individus ou des populations qui consomment beaucoup de viande, de poisson et de fruits. Faute d'information, il a été supposé que 2 grammes de plantes médicinales et/ou à infuser étaient aussi consommées quotidiennement. Par ailleurs, il a été considéré que la totalité des aliments consommés durant ce séjour provenait de la zone d'exposition rapprochée.
- Scénario d'exposition « Domestique », représentant des individus (adultes et enfants) de la Communauté crie qui, à la maison, consommeraient régulièrement du gibier, du poisson et des végétaux (petits fruits et plantes médicinales et/ou à infuser) provenant de la zone d'exposition rapprochée. Il a été supposé que la moitié (50%) de la viande, du poisson et des fruits ainsi que 2 grammes d'autres plantes (médicinales et/ou à infuser) consommés chaque jour à la maison pourraient provenir des activités traditionnelles pratiquées dans la zone d'exposition rapprochée. Pour compléter, la moitié de l'apport alimentaire documenté pour la population canadienne en général a aussi été considéré.
- Scénario « Combiné » : comme il est vraisemblable que le scénario d'exposition domestique s'applique à des individus de la Communauté crie qui pratiquent des activités traditionnelles dans la zone d'étude, les deux précédents scénarios ont été combinés pour représenter à la fois l'exposition directe lors des séjours d'activités traditionnelles (20,5 semaines par année) et l'exposition indirecte qui découle de la consommation des denrées rapportées à la maison le reste de l'année.

L'exposition des récepteurs a été calculée selon ces scénarios à partir de concentrations mesurées dans l'environnement, lorsque disponibles, ou à partir de concentrations estimées par modélisation :

- L'exposition bruit de fond (non engendrée par les activités du Projet) a été estimée à partir de données obtenues localement (concentrations mesurées dans des sols, de l'eau et des végétaux prélevés dans la zone d'étude) ou, par défaut, à partir de valeurs aussi représentatives que possible d'un environnement comparable à celui du Projet avant son implantation (ex. : concentrations dans l'air mesurées au Canada dans des régions isolées). Les concentrations de métaux dans les aliments issus d'activités traditionnelles ont été estimées par modélisation. Les apports en métaux dans l'alimentation des Canadiens ont aussi été documentés (pour les scénarios Relais routier et Domestique).
- L'exposition dite « additionnelle » qui pourrait être engendrée par le Projet est basée sur les résultats de modélisation de la dispersion atmosphérique des émissions du Projet fournis par WSP (modélisation conforme à la méthodologie du MELCC, qui vise à surestimer les concentrations dans l'air). Plus précisément, les données retenues correspondent aux concentrations additionnelles estimées dans l'air (valeurs les plus élevées parmi toutes celles modélisées pour les récepteurs d'intérêt) et aux taux de dépôt atmosphérique. À partir de ces données, les concentrations additionnelles dans les milieux environnementaux (air intérieur, poussières intérieures, eau de surface, végétaux, chair de gibier et de poisson) de la zone d'exposition rapprochée ont pu être estimées par modélisation par Sanexen.

Les niveaux de risque ont été calculés en comparant les niveaux d'exposition estimés pour les récepteurs avec les niveaux d'exposition jugés sécuritaires pour la santé humaine (valeurs établies par des institutions de santé reconnues par l'INSPQ telles que Santé Canada, l'OMS[1], U.S. EPA[2], ATSDR[3] ou Cal/EPA[4]). Pour la plupart des substances (gaz, $PM_{2.5}$ et silice cristalline), l'inhalation d'air est la seule voie d'exposition associée à des effets néfastes sur la santé. Les risques d'effets sur la santé à court terme (exposition aiguë) et à moyen terme (exposition sous-chronique) ont ainsi été estimés pour les scénarios Relais routier et Activités traditionnelles. Les scénarios Relais routier et Combiné ont quant à eux été utilisés pour estimer les risques d'effets sur la santé à long terme (exposition chronique). Il a été considéré que les récepteurs pourraient être exposés durant toute la période d'exploitation de la mine, soit une durée probable de 16 années.

L'objectif de l'étude étant de détecter tout risque potentiel, des hypothèses prudentes ont été retenues à chaque étape, ce qui a entrainé une surestimation de l'exposition et du risque pour les récepteurs. Une telle approche permet d'affirmer que, sur la base de l'information toxicologique disponible, un projet ne présente pas de risque pour la santé humaine lorsque les niveaux de risque obtenus ne dépassent pas les critères d'acceptabilité établis par l'INSPQ. Lorsque ces critères sont dépassés, une analyse plus approfondie des résultats doit être effectuée afin de pouvoir qualifier le risque. Cette analyse vise à évaluer la marge de sécurité (aussi appelée incertitude) qu'entrainent les hypothèses retenues tout au long de l'étude.

Les résultats de l'évaluation des risques posés par les activités du Projet indiquent que :

- Les risques pour la santé de la population qui pourrait être exposée par inhalation au dioxyde de soufre, au monoxyde de carbone et à la silice cristalline (population fréquentant la zone d'étude) sont négligeables;
- Les risques pour la santé de la population qui pourrait être exposée par inhalation aux particules fines ($PM_{2.5}$) et au dioxyde d'azote (population fréquentant la zone d'étude) sont vraisemblablement négligeables En effet, les

1 Organisation mondiale pour la santé.
2 Agence de protection de l'environnement des États-Unis.
3 *Agency for Toxic Substances and Disease Registry* (États-Unis).
4 Agence de protection de l'environnement de la Californie.

risques ayant été estimés à partir de données et d'hypothèses prudentes, il est peu plausible que les concentrations maximales estimées dans l'air ambiant soient atteintes dans la réalité;

- Les risques pour la santé de la population qui pourrait être exposée aux métaux émis dans l'air (population qui fréquenterait la zone d'étude et/ou qui consommerait des produits issus d'activités traditionnelles venant de la zone d'étude, incluant la zone d'exposition rapprochée) sont négligeables (risque additionnel de cancer négligeable et absence de risque d'autres effets sur la santé).

Les risques posés par les rejets aqueux dans les cours d'eau de la zone d'exposition rapprochée (CE2 et CE3) n'ont pu être évalués faute de données. Comme ces cours d'eau ne sont pas utilisés pour la pêche de subsistance, cette omission semble mineure et sans conséquences significatives sur les conditions d'exposition des récepteurs et les risques pour la santé humaine. Cela devrait toutefois être validé lorsque des données de suivi de qualité de l'eau seront disponibles.

Sur la base de ces résultats, et considérant que les risques ont été estimés en se basant sur la combinaison de multiples hypothèses prudentes, nous sommes d'avis que les activités projetées à la mine de lithium Baie-James ne devraient présenter aucun risque significatif pour la santé de la population qui fréquenterait la zone d'étude et/ou qui consommerait, tout au long de l'année et durant toute la période d'exploitation, des produits issus d'activités traditionnelles pratiquées dans la zone d'étude.

SUMMARY

Galaxy Lithium (Canada) Inc. (Galaxy) wishes to open-pit mine a spodumene deposit for lithium extraction. The deposit is located south of the 55th Parallel, in the *Nord-du-Québec* administrative region, approximately 100 km east of the Village of Eastmain, near Road stop km 381 on the James-Bay Highway (the "Road Stop"). This mining project (the "Project") is located in the territory covered by the *James Bay and Northern Quebec Agreement*, on the RE2 trapline used by the Eastmain Cree Community ("the Cree Community"). The Project mining installations include, in addition to an open-pit mine, an ore concentrator, material accumulation areas (surficial deposits, topsoil, waste rocks/residues, ore, concentrate), retention ponds, a water treatment unit, as well as related infrastructures. The Project intends for exploitation to begin in 2022 and end between 2037 and 2042, for an operating period of 15 to 20 years. To obtain the approvals necessary for the implementation, Galaxy contracted an environmental impact study (EIS) through the firm WSP.

Complementary to the EIS, Galaxy wishes that the health risks to the population who frequent the sector of the mine, namely the "Study Area" corresponding to that defined in the EIS for the social components, were assessed. As such, Sanexen Environmental Services Inc. (Sanexen) was retained by Galaxy to assess the toxicological risks to the population who could, directly or indirectly, be affected by the emissions created by the Project. In principle, the atmospheric emissions and aqueous discharges should have been assessed. However, if it is established that the quality of the liquid effluents will meet the applicable criteria (Directive 019 and standards from the Metal and Diamond Mining Effluent Regulations (SOR/2002-222)), the data regarding the quality of these effluents cannot be available at this phase of the Project. Under these conditions, the risks to human health posed by the aqueous discharges into the aquatic environment could not be estimated. As such, the present assessment addresses the Project's atmospheric emissions only. However, omitting to consider the aqueous discharge and its consequences on the exposure of the population were discussed in the section addressing uncertainties and qualitatively taken into consideration in the present assessment.

The quantitative assessment addresses the gaseous emissions of carbon monoxide (CO), nitrogen dioxide (NO_2) and sulphur dioxide (SO_2), as well as the emissions in the air of particles and their constituents (fine $PM_{2.5}$ particles, 24 metals[1] and crystalline silica). All toxic effects were studied for each substance, including those that could result from short duration exposure and from longer term exposure (cancer and other chronic health effects).

The risk assessment was performed pursuant to the Quebec guidance for conducting human health risk assessment (*Lignes directrices pour la réalisation des évaluations du risque toxicologique d'origine environnementale au Québec*) published in 2012 by the public health expertise and reference centre (*INSPQ*[2]). The exposure levels resulting from projected activities were estimated from modelled concentrations in the air, provided by WSP. The risks were calculated and evaluated according to the *INSPQ* acceptability criteria. According to these criteria, a risk is deemed negligible when the additional risk of cancer is less than or equal to one case in one million and when, for the other health effects, the exposure levels are below those deemed safe by recognized public health agencies.

1 Although all mineral elements considered in the present study are not metals, the term "metals" was used in a generic manner in the report to represent the following elements: aluminium (Al), antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), boron (B) cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), lead (Pb), lithium (Li), manganese (Mn), mercury (Hg), molybdenum (Mo), nickel (Ni), selenium (Se), silver (Ag), strontium (Sr), titanium (Ti), uranium (U), tin (Sn), vanadium (V) and zinc (Zn).

2 *Institut national de santé publique du Québec.*

The human activities practised in the Study Area were taken into account when elaborating the exposure scenarios and locating the areas frequented by individuals (designated as "receptors"). A more restricted "proximate exposure area" was defined to target the environments likely to be affected by the Project emissions. This area corresponds to an approximate radius of 5 km centred around, but excluding, the mining installations. Measuring 83 km², this area includes the Road stop (to the east), a permanent camp used by the Cree Community (to the north), watercourses CE1 through CE6, as well as several hunting and trapping areas frequented by the Cree Community. The proximate exposure area was used to conservatively assess the risks posed by the Project in the event of so-called "traditional" activities practiced in the Study Area by the Cree Community.

The exposure scenarios were defined based on available information regarding the lifestyle habits of the Indigenous and non-Indigenous population in and proximate to the Study Area. These scenarios aim to represent the frequentation of the Study Area by fictional individuals (receptors). For each scenario, conservative assumptions were retained to represent the potential exposure of the receptors. The various receptors and their exposure scenarios are defined as follows:

- The "Road stop" exposure scenario, representing individuals (adults) who frequent the Road stop on a regular basis (24 hours per day over 25 weeks per year) as employees. These receptors could be exposed to emissions generated by the Project through air inhalation, the ingestion of dust deposited inside the building, as well as through cutaneous contact with the air and dust. It was considered that the diet of these receptors was comparable to that documented for the Canadian population in general;
- The "Traditional Activities" exposure scenario, representing individuals (adults and children) from the Cree Community who would frequent the proximate exposure area on a discontinuous basis for a portion of the year (prolonged stay of 8 weeks per year and 44 weekends for a total duration of 20.5 weeks per year), and who would consume on-site foodstuffs (game, fish, berries and other medicinal and/or infusion plants) from this same area. It was proposed that these locally-sourced foods would be consumed daily, and that the quantities consumed daily correspond to those documented in Canada for individuals or populations who consume large quantities of meat, fish and fruits. Due to lack of information, it was proposed that 2 g of medicinal and/or infusion plants were also consumed daily. Moreover, it was considered that all the food consumed during the stay was sourced from the proximate exposure area;
- The "Domestic" exposure scenario, representing individuals (adults and children) from the Cree Community who, at home, would regularly consume game, fish and plants (berries and medicinal and/or infusion plants) from the proximate exposure area. It was proposed that half (50%) of the meat, fish and fruits, as well as 2 g of other plants (medicinal and/or infusion plants) consumed at home each day would come from traditional activities practised in the proximate exposure area. To complete the diet, half of the food intake documented for the general population in Canada was also considered;
- The "Combined" scenario; as it is likely that the Domestic exposure scenario applies to individuals from the Cree Community who practise traditional activities in the Study Area, the 2 preceding scenarios were combined to represent both direct exposure during traditional activities (20.5 weeks per year) and indirect exposure resulting from, for the balance of the year, the consumption of foodstuffs brought home.

Receptor exposure was calculated according to these scenarios based on concentrations measured in the environment, when available, or based on concentrations estimated through modelling:

- Background exposure (not resulting from the Project activities) was estimated from locally-obtained data (concentrations measured in the soils, water and vegetation collected in the Study Area) or, by default, from values representing an environment comparable to that of the Project before its implementation (e.g., concentrations in the air measured in Canada in remote regions). Metals concentrations in the foodstuffs

resulting from traditional activities were estimated by modelling. The Canadian intake of metals in food was also documented (for the Road stop and Domestic scenarios);

- Said "additional" exposure that could result from the Project is based on the results of atmospheric dispersion modelling of Project emissions provided by WSP (modelling in compliance with the *MELCC* methodology, which aims to overestimate concentrations in the air). More specifically, the data retained corresponds to additional estimated concentrations in the air (highest values among those modelled for the receptors of interest) and the rates of atmospheric deposition. From this data, Sanexen was able to estimate by modelling the additional concentrations in the environments (indoor air and dust, surface water, vegetation, game meat and fish) within the proximate exposure area.

The risk levels were calculated by comparing the exposure levels estimated for the receptors to the exposure levels deemed safe for human health (values established by public health agencies recognized by the *INSPQ*, such as Health Canada, the WHO[1], U.S. EPA[2], ATSDR[3] or Cal/EPA[4]). For the majority of the substances (gas, $PM_{2.5}$ and crystalline silica), inhalation of the air is the only exposure pathway associated with adverse health effects. As such, the risks of adverse effects after short-term (acute) exposure and intermediate-term (subchronic) exposure were estimated for the Road stop and Traditional Activities scenarios. The Road stop and Combined scenarios were used to estimate the risks after long-term (chronic) exposure. It was considered that receptors could be exposed during the entire period of the mine exploitation, which is a probable duration of 16 years.

As the study objective was to detect potential risks, conservative assumptions were retained at each step, thus incurring an overestimation of the exposure and risk levels for the receptors. Such an approach allows to conclude that, based on the available toxicological information, a project does not present a risk to human health when the obtained risk levels do not exceed the acceptability criteria established by the *INSPQ*. When these criteria are exceeded, a more in-depth analysis of the results must be performed to qualify the risk. This analysis aims to evaluate the margin of safety (also called uncertainty) brought forth by the assumptions retained throughout the study.

The results of the evaluation of the risks posed by the Project activities indicate that:

- The risks to the health of the population who could be exposed to sulphur dioxide, carbon monoxide and crystalline silica through inhalation (population frequenting the Study Area) are negligible;
- The risks to the health of the population who could be exposed to fine particles ($PM_{2.5}$) and nitrogen dioxide through inhalation (population frequenting the Study Area) are likely negligible. Indeed, the risks having been estimated from conservative data and assumptions, it is hardly plausible that the maximum estimated concentrations in the ambient air would actually be reached;
- The risks posed to the health of the population who could be exposed to the metals emitted in the air (population frequenting the Study Area and/or who would consume foodstuffs resulting from traditional activities in the Study Area, including the proximate exposure area) are negligible (negligible additional risk of cancer and no risk of other health impacts).

1 World Health Organization
2 United States Environmental Protection Agency
3 Agency for Toxic Substances and Disease Registry (United States)
4 California Environmental Protection Agency

The risks posed by the aqueous discharge into watercourses in the proximate exposure area (CE2 and CE3) could not be assessed due to a lack of data. As these watercourses are not used for subsistence fishing, this omission appears minor and without significant consequence to the receptors' exposure conditions and the risks to human health. However, it should be validated once water quality monitoring data is available.

Based on these results, and considering that the risks were estimated based on a combination of multiple conservative assumptions, it is our opinion that the future activities of the James Bay Lithium Mine should pose no significant risk to the health of the population who would frequent the Study Area and/or would consume, year-round during the entire exploitation period, products resulting from traditional activities practised in the Study Area.

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LISTE DES ABRÉVIATIONS ET ACRONYMES

µg	Microgramme (1 µg = 0,000001 g)
Alb.	Alberta
Add.	(Concentration ou dose) additionnelle
Ag	Argent
Al	Aluminium
As	Arsenic
ATSDR	*Agency for Toxic Substances and Disease Registry* (États-Unis)
B	Bore
Ba	Baryum
Be	Béryllium
BF	Bruit de fond
BMD	Dose Benchmark
BMDL	Limite inférieure de l'intervalle confiance à 95% de la BMD
c. VTR	VTR chronique
Cal/EPA	*California Environmental Protection Agency*
C.-B.	Colombie Britannique
CBJNQ	Convention de la Baie-James et du Nord québécois
CCME	Conseil canadien des Ministres de l'environnement
Cd	Cadmium
CIRC	Centre international de recherche sur le cancer (IARC en anglais)
Co	Cobalt
CO	Monoxyde de carbone
Cr	Chrome
Cu	Cuivre
FBC	Facteur de bioconcentration
FBT	Facteur de biotransfert
Li	Lithium
Hg	Mercure
HSDB	*Hazardous Substances Data Bank* (États-Unis)
IARC	*International Agency for Research on Cancer* (CIRC en français)
INERIS	Institut national de l'environnement industriel et des risques (France)
INSPQ	Institut national de Santé publique du Québec
IPCS	*International Programme on Chemical Safety* (OMS)
Î.-P.-É	Iles du Prince Edouard
IR	Indice de risque
IR_{Add}	Indice de risque correspondant à l'exposition additionnelle (engendrée par le projet)
IR_{BF}	Indice de risque correspondant à l'exposition bruit de fond
IRIS	*Integrated Risk Information System* (base de données de l'U.S. EPA)
IR_{Tot}	Indice de risque correspondant à l'exposition totale (bruit de fond + additionnelle)
Kd-sed	Coefficient de partage entre l'eau et les sédiments
Li	Lithium
LOAEL	Plus faible dose (ou concentration) ayant conduit à l'observation d'effets néfastes (*Lowest Observed Adverse Effect Level*)
LSC95	Limite supérieure de confiance à 95% sur la moyenne
MELCC	Ministère de l'Environnement et de la Lutte contre les changements climatiques

MDDELCC	Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques (ancienne appellation du MELCC)
MDDEP	Ministère du Développement durable, de l'Environnement et des Parcs (ancienne appellation du MELCC)
MEF	Ministère de l'Environnement et de la Faune (ancienne appellation du MELCC)
MERN	Ministère de l'Énergie et des Ressources naturelles
mg	Milligramme (1 mg = 0,001 g)
mg/kg-pc	Dose exprimée en milligramme par kilogramme de poids corporel
Mn	Manganèse
Mo	Molybdène
Ni	Nickel
N.-B.	Nouveau-Brunswick
N.-É.	Nouvelle-Écosse
NO_2	Dioxyde d'azote
NOAEL	Dose (ou concentration) la plus élevée sans effet néfaste observé (*No Observed Adverse Effect Level*)
OMS	Organisation mondiale de la santé (WHO en anglais)
Ont.	Ontario
OTR	*Ontario Typical Range*
PATP	Plan d'affectation du territoire public
Pb	Plomb
PM_{10}	Particules inhalables (diamètre aérodynamique < 10 µm)
$PM_{2.5}$	Particules fines (diamètre aérodynamique < 2,5 µm)
PST	Particules en suspension totales
Qc	Québec
RAA	Règlement sur l'assainissement de l'atmosphère
RIVM	*National Institute of Public Health and the Environment* des Pays-Bas
Sb	Antimoine
s.c. VTR	VTR sous-chronique
Se	Sélénium
Sn	Étain
SO_2	Dioxyde de soufre
Sr	Strontium
Ti	Titane
TLV-TWA	*Threshold Limit Value - Time Weighted Average* (norme en milieu de travail)
T.N.-O.	Territoires du Nord-Ouest
U	Uranium
U.S. EPA	*United States Environmental Protection Agency*
USGS	*United States Geological Survey*
V	Vanadium
VTR	Valeur toxicologique de référence
WHO	*World Health Organization* (OMS en français)
WSP	WSP Canada inc
Zn	Zinc

1. INTRODUCTION

1.1 Mise en contexte

Galaxy Lithium (Canada) inc. (Galaxy) souhaite exploiter à ciel ouvert un gisement de spodumène pour l'extraction du lithium. Le gisement est situé au sud du 55e parallèle, dans la région administrative du Nord-du-Québec, à environ 100 km à l'est du village d'Eastmain, près du relais routier du km 381 de la route de la Baie-James (figure 1). Ce projet minier (le « Projet ») se situe dans le territoire couvert par la Convention de la Baie-James et du Nord québécois. Les installations minières du Projet incluent, en plus d'une fosse à ciel ouvert, un concentrateur de minerai, des aires d'accumulation de matériaux (dépôts meubles, terre végétale, stériles/résidus, minerai, concentré), des bassins de rétention, une unité de traitement d'eau ainsi que des infrastructures connexes. Le minerai concentré sera transporté vers un centre de transbordement à Matagami d'où il sera acheminé vers un ou des centres de conversion du lithium afin d'être transformé en produits chimiques de lithium. Le Projet prévoit que l'exploitation débute en 2022 et se termine entre 2037 et 2042, soit une durée d'exploitation de 15 à 20 ans.

Le plan général de l'aménagement du site minier[1] est présenté à l'annexe A.

La mise en œuvre du Projet requiert diverses autorisations de ministères provinciaux et fédéraux. Afin de fournir l'information aux autorités concernées, Galaxy a confié la réalisation de l'étude d'impact environnemental (ÉIE) à la firme WSP Canada inc. (WSP). Cette étude indique que les émissions atmosphériques associées aux activités d'exploitation (extraction, entreposage et circulation des véhicules) sont la principale source appréhendée d'impact sur l'environnement par le Projet (WSP, 2018a). En complément, Galaxy souhaitait que soient évalués les risques pour la santé humaine de la population qui fréquente la zone d'étude.

Sanexen Services Environnementaux inc. (Sanexen) a été retenue par Galaxy pour réaliser l'évaluation des risques toxicologiques pour la santé de la population qui pourrait, directement ou indirectement, être affectée par les émissions qui pourraient être engendrées par le Projet. En principe, les émissions atmosphériques et les rejets aqueux devaient être évalués. Cependant, s'il est établi que la qualité des effluents liquides respectera les critères en vigueur (Directive 019 et normes du Règlement sur les Mines de Métaux et les Mines de Diamant), les données sur la qualité de ces effluents ne peuvent être disponibles à cette étape du Projet. Dans ces conditions, les risques pour la santé humaine posés par les rejets aqueux dans le milieu aquatique n'ont pas pu être estimés. La présente évaluation porte donc sur les émissions atmosphériques du Projet uniquement. Toutefois l'omission de considérer les rejets aqueux et ses conséquences sur l'exposition de la population ont été discutées à la section traitant des incertitudes et prises en compte dans la présente évaluation.

1.2 Objectifs de l'étude

L'objectif général de la présente étude est d'estimer les risques toxicologiques pour la santé humaine que pourraient poser les émissions atmosphériques, et d'évaluer ces risques selon les critères d'acceptabilité de l'Institut national de Santé publique du Québec (INSPQ).

Les substances considérées dans l'air sont celles susceptibles d'être émises dans l'environnement par les activités minières et pour lesquelles des concentrations modélisées dans l'air étaient disponibles, c'est-à-

1 Carte 4-1 intitulée « Aménagement du site miniers », tirée de l'ÉIE.

dire les particules, les oxydes gazeux[1], 24 éléments minéraux et la silice cristalline (valeurs fournies par la firme WSP). Bien que tous les éléments minéraux considérés dans la présente étude ne soient pas des métaux, le terme « métaux » a été utilisé de façon générique pour représenter tous ces éléments dans le reste du rapport.

La zone d'étude pour les fins de l'évaluation des risques toxicologiques correspond à la zone d'étude pour les composantes sociales définie dans l'ÉIE (après exclusion de la zone délimitant les infrastructures projetées de la mine). Les limites de la zone d'étude sont indiquées à l'annexe A[2].

1.3 Démarche générale de l'évaluation des risques

Au Québec, toute évaluation des risques toxicologiques doit être réalisée conformément aux « Lignes directrices pour la réalisation des évaluations du risque toxicologique d'origine environnementale au Québec » de l'INSPQ (2012). Cette méthodologie a donc été suivie dans le cadre de la présente étude.

La démarche générale d'une évaluation des risques par modélisation consiste essentiellement à mettre en relation les données toxicologiques sur les substances en cause avec les niveaux d'exposition potentiels estimés pour un récepteur (ex. : individu fréquentant la zone d'étude), selon les conditions d'exposition propres à la zone d'étude. Cette approche peut être décrite en quatre principales étapes (figure 2) :

A *l'identification du danger* consiste à identifier les substances potentiellement présentes et pouvant poser un risque pour la santé (sélection des substances d'intérêt);

B *la caractérisation toxicologique* de chaque substance consiste à identifier les effets possibles sur la santé et les niveaux jugés sécuritaires, c'est-à-dire assurant l'absence d'effets pour la santé humaine (valeurs toxicologiques de référence (VTR) relatives au cancer et aux autres effets sur la santé);

C *la caractérisation de l'exposition* consiste à estimer, à partir de mesures ou par modélisation, les niveaux d'exposition de l'organisme récepteur (humain) à partir des concentrations estimées dans les milieux environnementaux d'intérêt et des conditions d'exposition à ces différents milieux (scénario d'exposition);

D l'estimation et l'évaluation des risques consistent à comparer les niveaux d'exposition obtenus avec les VTR (calcul des indices de risque et des risques de cancer) selon les recommandations émises par les autorités de santé publique (critères d'acceptabilité). Tel qu'expliqué ci-après, l'évaluateur doit réaliser une analyse approfondie des incertitudes reliées aux différents intrants de la modélisation pour qualifier le risque.

Dans la présente étude, le risque correspond à une probabilité qu'un évènement (survenue d'un effet néfaste à la santé) se produise. Par conséquent, le risque nul (une probabilité égale à zéro) n'existe pas et il est nécessaire de se référer à des balises pour évaluer le risque. L'INSPQ juge que le risque d'effets sur la santé est « négligeable »[3] lorsque le risque additionnel[4] de cancer à vie est inférieur ou égal à un cas par million de personnes exposées (≤ 1E-06, soit une augmentation du risque de 0,0001%) et lorsque, pour les autres effets sur la santé, les niveaux d'exposition sont inférieurs aux VTR (indices de risque inférieurs à l'unité).

1 Monoxyde de carbone (CO), dioxyde d'azote (NO_2) et dioxyde de soufre (SO_2).
2 Carte 6-22 intitulée « Composantes du milieu humain », tirée de l'ÉIE.
3 C'est-à-dire absence de risque à toute fin pratique, mais le risque étant une probabilité, il n'est pas possible de conclure à l'absence de risque (risque nul).
4 Par « additionnel », on entend additionnel au bruit de fond, c.-à-d. correspondant à la source qui est étudiée (le Projet dans le cas présent).

Il est aussi possible que la probabilité que l'évènement se produise soit extrêmement faible advenant le dépassement de ces critères d'acceptabilité. En effet, l'objectif d'une évaluation déterministe de risque est de détecter tout risque potentiel, et non d'estimer précisément un niveau de risque. Par conséquent, le risque est estimé en utilisant des hypothèses prudentes, c.-à-d. qui vont surestimer l'exposition (et donc le risque), tout en restant réalistes. La combinaison de multiples hypothèses prudentes conduit nécessairement à une surestimation du risque par rapport au risque réel appréhendé. Cette surestimation volontaire doit être considérée lors de l'interprétation des résultats pour déterminer si le risque est significatif ou non. Il convient alors de procéder à une analyse approfondie des résultats en tenant compte du niveau de confiance (incertitude) attribué à chacune des étapes de l'étude. Lorsque, à la suite de cet exercice, la probabilité que l'événement se produise est jugée non significative, le risque est qualifié de « vraisemblablement négligeable », pour le distinguer du risque défini précédemment comme « négligeable ».

1.4 Approche méthodologique

L'évaluation des risques toxicologiques pour la santé a été réalisée en se conformant aux lignes directrices de l'INSPQ (2012). Les risques toxicologiques pour la santé de la population potentiellement affectée ont été estimés par modélisation à partir des concentrations dans l'environnement mesurées ou modélisées, puis évalués selon les critères d'acceptabilité de l'INSPQ en tenant compte de l'incertitude découlant des hypothèses utilisées pour estimer le risque.

Des scénarios d'exposition ont été élaborés à partir des renseignements fournis par WSP sur la fréquentation de la zone d'étude ainsi que sur les comportements de pêche, chasse, cueillette et autres activités pouvant mener à l'exposition d'individus ou de leur famille, ces individus pouvant être d'origine autochtone ou allochtone. Pour chaque scénario, toutes les voies d'exposition affectées par la qualité de l'air ont été combinées pour estimer les doses par inhalation, ingestion et contact cutané. L'exposition pouvant varier grandement suivant la localisation des récepteurs et de leurs proies, les doses pour différents scénarios ont été estimées.

L'évaluation concerne les substances (gaz, particules, métaux, silice cristalline) dont les émissions qui pourraient être engendrées par le Projet ont été modélisées. L'exposition des récepteurs humains a été estimée à partir des teneurs de fond (exposition bruit de fond) et des concentrations additionnelles (exposition qui pourrait être engendrée par le Projet), ce qui a permis d'estimer l'exposition totale (bruit de fond + additionnelle).

Dans la mesure du possible, les concentrations mesurées dans l'environnement aux alentours du Projet (teneurs de fond) ont été utilisées pour représenter l'exposition bruit de fond. Pour représenter la situation projetée (c.-à-d. à la suite de l'implantation du Projet), les concentrations dans l'air qui pourraient être engendrées par Projet ont été estimées par modélisation (par WSP). Ces concentrations dans l'air dites « additionnelles » ont été utilisées pour estimer (par modélisation) les concentrations additionnelles dans les autres milieux environnementaux. Pour les métaux, les concentrations dans les végétaux et les cours d'eau ont été estimées (par Sanexen) à partir des retombées atmosphériques modélisées (par WSP) et prises en compte pour estimer l'exposition des récepteurs humains via la consommation de plantes, l'utilisation d'eau de surface, et la consommation de chair animale (mammifères, oiseaux, poissons). Les transferts de métaux dans les milieux environnementaux d'intérêt et leur bioaccumulation dans les organismes représentant les différents niveaux de la chaîne alimentaire ont été estimés par modélisation en se basant sur un modèle conceptuel de l'écosystème élaboré de manière à représenter la complexité du transfert des métaux et la diversité des organismes récepteurs. Ces tâches ont principalement été effectuées à l'aide du logiciel TerraSys^{MC} version 1.09 (Sanexen, 2002).

1.5 Limites d'interprétation de l'étude

Les conditions générales et limitations de l'étude sont fournies à l'annexe B.

La présente étude est une évaluation des risques toxicologiques pour la santé humaine posés par la présence potentielle dans l'environnement de métaux, de particules et de gaz émis dans l'air par les activités projetées de la mine; elle concerne les risques pour la santé estimés et évalués pour la population qui fréquenterait la zone d'étude et/ou qui consommerait des denrées alimentaires (gibier, végétaux, poisson) provenant de cette zone.

Comme dans toute évaluation des risques, il n'est pas toujours possible de déterminer avec précision les concentrations dans l'environnement auxquelles une population potentiellement affectée par une activité industrielle pourrait être réellement exposée. La présente étude est basée sur la meilleure information disponible, ce qui inclut les concentrations actuelles de métaux mesurées dans les milieux terrestre et aquatique (sol, végétaux, sédiments, eau de surface) de la zone d'étude ainsi que des concentrations dans l'air modélisées (par WSP) en s'appuyant sur la méthodologie du MELCC[1]. Les incertitudes qui demeurent pour estimer les risques sont présentées et discutées à la section 5.2.3.

Les concentrations additionnelles de métaux dans le sol qui pourraient découler des activités projetées (retombées atmosphériques des particules) peuvent difficilement être estimées. En effet, les concentrations de métaux accumulées dans le sol ne sauraient être prédites de façon satisfaisante à partir des taux de retombées car, une fois que les métaux (associés aux particules) sont déposés au sol, leur devenir est difficilement prévisible (dépend de nombreux processus tels que remise en suspension dans l'air par l'érosion éolienne, ruissellement vers les plans d'eau environnants, infiltration vers le sol plus en profondeur et/ou vers l'eau souterraine). Considérant ce qui précède, la potentielle accumulation à long terme des métaux dans les sols n'a pu être ni estimée ni considérée dans la présente étude et les concentrations additionnelles dans les sols ont été considérées nulles. La présente étude ne couvre donc pas les risques toxicologiques associés aux retombées atmosphériques à long terme sur les sols.

1 Depuis le 18 octobre 2018, l'appellation du MDDELCC a été modifiée pour le MELCC.

La présente étude a été réalisée selon les règles de l'art de l'analyse de risques, en suivant les lignes directrices de l'INSPQ. Les risques ont été estimés en utilisant les hypothèses prudentes recommandées par l'INSPQ pour estimer l'exposition des individus. Il s'agit d'une analyse déterministe et les conclusions sont valides dans la mesure où les hypothèses retenues sont représentatives de la réalité ou conduisent à une surestimation des concentrations de gaz, particules, métaux et silice cristalline dans l'environnement. L'ensemble des limitations décrites ci-haut ont été considérées à l'étape finale d'interprétation et d'évaluation du risque.

2. IDENTIFICATION DU DANGER

2.1 Description de la zone d'étude

Le Projet est situé[1] sur le territoire régional d'Eeyou Istchee Baie-James, dans la région administrative du Nord-du-Québec. Il se trouve à environ 10 km au sud de la rivière Eastmain, et à environ 100 km à l'est de la Baie James, à la hauteur du village d'Eastmain (figure 1). Le site du Projet est facilement accessible par la route de la Baie-James (« la Route »), qui relie Matagami et Radisson. La propriété se trouve sur des terres de catégorie III selon la Convention de la Baie-James et du Nord québécois, dans le terrain de trappage RE2 utilisé par la communauté crie d'Eastmain (« la Communauté crie »).

La zone d'étude (figure 2) a une superficie de 450 km^2. Elle correspond à la zone d'étude pour les composantes sociales définie dans l'ÉIE (après exclusion de la zone délimitant les infrastructures projetées de la mine). Essentiellement constituée de milieux naturels (tourbières, plans d'eau), cette zone est traversée par la route de la Baie James au bord de laquelle se trouve le relais routier du km 381 (le « Relais routier »), situé à proximité du Projet. Dans la partie sud-ouest de la zone d'étude, des sentiers de motoneige relient les rives du lac Nistam Siyachistawach à des secteurs situés plus à l'ouest dans le terrain de trappage RE2 (annexe A)[2].

La zone d'étude se situe dans le bassin versant de la rivière Eastmain (superficie d'environ 46 000 km^2). Elle inclut six cours d'eau, nommés CE1 à CE6 pour les besoins de l'ÉIE. Les cours d'eau CE1, CE2 et CE6 s'écoulent vers l'ouest en direction de la rivière Miskimatao, puis rejoignent la rivière Eastmain. Les cours d'eau CE3, CE4 et CE5 s'écoulent quant à eux vers l'est, pour rejoindre la rivière Eastmain également. Le réseau hydrographique de la zone d'étude, dans lequel se trouvent les bassins versants des cours d'eau CE1 à CE6, correspond à une proportion minime (environ 0,1%) du bassin versant de la rivière Eastmain (WSP, 2018b).

Pour les fins de l'évaluation des risques toxicologiques, la zone d'étude ainsi qu'une zone plus restreinte (« zone d'exposition rapprochée ») ont été définies :

- Les activités ayant lieu dans la zone d'étude ont été considérées pour élaborer les scénarios d'exposition et localiser les lieux fréquentés par des individus (désignés comme des « récepteurs »).
- La zone d'exposition rapprochée a été définie afin de cibler les milieux les plus proches de la mine, c.-à-d. ceux susceptibles d'être les plus affectés par les émissions du Projet. Elle correspond à une zone circulaire d'environ 5 km de rayon, centrée sur les installations minières, tout en les excluant, ce qui correspond à une superficie de 83 km^2. Ses limites sont indiquées à la figure 3. Cette zone inclut notamment le Relais routier, un camp permanent utilisé par la Communauté crie (Camp 8), les cours d'eau CE1 à CE6 ainsi que plusieurs zones de chasse et de trappage fréquentées par la Communauté crie (voir section 2.2.1). La zone d'exposition rapprochée a été utilisée pour évaluer de façon prudente les risques posés par le Projet advenant la pratique d'activités dites « traditionnelles », c'est-à-dire pratiquées par la Communauté crie, à proximité des installations.

1 Coordonnées géographiques en UTM (fuseau 18, NAD83) du site : X = 358 891, Y = 5 789 180.
2 Carte 6-22 intitulée « Composantes du milieu humain », tirée de l'ÉIE.

2.2 Usage et fréquentation de la zone d'étude

À l'exception du Relais routier, géré par la Société de développement de la Baie-James, aucune agglomération, résidence permanente ou institution ne se trouve à proximité du Projet. Toutefois, la zone d'étude (située dans un terrain de trappage) est fréquentée par des membres de la Communauté crie qui y pratiquent des activités traditionnelles (ex. : chasse, trappage, pêche, cueillette).

2.2.1 Activités traditionnelles

La fréquentation et les usages du terrain de trappage RE2 ont été documentés dans le cadre du Projet en 2012 puis en 2018 lors de rencontres avec les maitres de trappage[1] et leur famille (GENIVAR, 2012; WSP, 2018c). L'information recueillie lors de ces rencontres est en partie illustrée à l'annexe A[2]. Il est à noter qu'en raison des incendies de forêt, la faune et la flore ainsi que les activités anthropiques (localisation/utilisation des camps) évoluent au fil du temps. L'information pertinente pour les fins de la présente étude peut être résumée comme suit :

- Des sites de campements actifs (avec ou sans infrastructures) ainsi que des camps temporaires se trouvent dans la zone d'étude ou à proximité. Les 2 camps actifs identifiés dans la zone d'étude sont le Camp 1, au sud (à proximité du lac Nistam Siyachistawach) et le Camp 8, au nord (à proximité de la Route, dans la zone d'exposition rapprochée). Ces deux camps sont utilisés à l'année. Les camps temporaires sont situés à proximité de la rivière Eastmain.
- La fréquence et la durée des séjours dans le terrain de trappage RE2 varient selon la saison et les utilisateurs. Au printemps, les membres de la Communauté crie peuvent rester un mois sur place pour la chasse aux outardes. Le reste de l'année, ils viennent plutôt la fin de semaine et pour les vacances.
- La chasse est pratiquée par les membres de la Communauté crie à plusieurs endroits dans le terrain de trappage RE2 :
  - Dans la zone d'étude,
    - Les outardes/canards sont le principal gibier chassé. Des étangs créés à environ 2 km à l'est du Relais routier (dans la zone d'exposition rapprochée) et les lacs Nistam Siyachistawach et Amiskw Matawaw (dans le secteur du Camp 1) font partie des meilleures zones de chasse.
    - Le trappage du castor y est également pratiqué au niveau de deux petits lacs situés à l'est de la Route, à quelques km au nord-est du Projet, et au niveau des ruisseaux CE2 et CE3 (respectivement situés au nord et au sud du Projet), ainsi qu'aux alentours du Camp 1 (à 5 km et plus du Projet, au sud). La plupart de ces sites de trappage se situent dans la zone d'exposition rapprochée.
    - Les autres gibiers chassés/trappés incluent le porc-épic, le lapin et l'ours (à proximité du Relais routier).
  - Des orignaux sont présents dans le terrain de trappage RE2 mais ils sont plutôt rares et il n'y a pas de lieu précis pour les chasser. Quelques caribous forestiers ont déjà été observés au sud-ouest de la Route, hors de la zone d'étude. Depuis l'incendie de 2013, il semble ne plus y avoir de caribou migrateur.

1 Feu M. Clarence Mayappo (rencontré en 2012) et M. Brian Weapenicappo (rencontré en avril et juin 2018).
2 Carte 6-22 intitulée « Composantes du milieu humain », tirée de l'ÉIE.

- La pêche est pratiquée par les membres de la Communauté crie à divers endroits dans le terrain de trappage RE2, en été et en automne.
  - Dans la zone d'étude, les principaux sites de pêche sont situés à proximité du Camp 1 (lac Nistam Siyachistawach, de part et d'autre de la Route, lac Amiskw Matawaw et autres petits lacs de ce secteur) ainsi que sur la rivière Eastmain, en aval du pont de la Route (c.-à-d. à la limite nord de la zone d'étude). Les espèces pêchées sont le grand brochet, le doré jaune, le grand corégone et l'esturgeon jaune. Tous ces sites de pêche sont en dehors de la zone d'exposition rapprochée.
  - Les ruisseaux CE1 à CE6, situés dans la zone d'exposition rapprochée, ne sont pas utilisés pour la pêche.
- La cueillette de petits fruits (ex. : bleuets) est pratiquée par les membres de la Communauté crie dans les endroits qui s'y prêtent (notamment les secteurs ravagés par un incendie, et aux alentours de la Route). Aucune information relative à la cueillette d'autres plantes n'a été rapportée lors des rencontres, (excepté la cueillette commerciale de champignons, voir section 2.2.2). Toutefois, l'étude spécialisée sur la flore réalisée par WSP (2018d) indique que 27 plantes observées sur le terrain[1] sont susceptibles d'être utilisées par les Cris. Il s'agit d'espèces arborescentes[2] (utilisation de cônes, écorce et/ou racines), arbustives[3] (utilisation de feuilles, fruits, tiges, rameaux, écorce et/ou racines), herbacées[4] (utilisation de feuilles, fruits ou toute la plante) et d'une espèce invasculaire muscinale (sphaigne brune, utilisée dans sa totalité). L'étude précise que ces espèces sont communes à la zone d'étude et au territoire jamésien en général.
- L'eau potable consommée dans la zone d'étude provient de plusieurs points d'eau. Le Relais routier, approvisionné par deux puits (eau souterraine), est le principal point d'eau utilisé. Trois autres points d'eau potable sont situés dans le secteur nord (au sud de la rivière Eastmain, et au pont de la Route sur la rivière Eastmain) et dans le secteur sud (sur la Route, quasiment à la sortie de la zone d'étude); la nature de l'eau fournie (eau souterraine ou eau de surface) n'est pas connue.
- La nourriture dite « traditionnelle », c'est-à-dire non obtenue commercialement mais grâce aux activités traditionnelles de la Communauté crie, représente une part importante de l'alimentation des membres de la communauté qui fréquentent le terrain de trappage RE2, même si cette part a diminué à la suite de l'incendie de forêt de 2013.
  - La consommation de nourriture traditionnelle a lieu sur place et à domicile. De la nourriture traditionnelle est rapportée au moins une fois par semaine. Lors d'occasions spéciales, la nourriture traditionnelle est partagée avec la communauté. Les personnes rencontrées n'ont pas pu fournir d'estimation de la quantité ou de la proportion de nourriture traditionnelle dans leur alimentation. La nature des produits consommés varie avec la saison (ex. : plus d'outarde au printemps, plus d'orignal en automne).
  - La nourriture provient du terrain de trappage RE2 mais également d'autres secteurs.
- La section du ruisseau CE5 située à l'est de la Route (entre la Route et la rivière Eastmain) est empruntée pour le canotage. Quelques activités de pêche (à la croisée de la Route) et de chasse ont parfois lieu le long de ce cours d'eau.

1 La zone d'étude définie dans l'étude floristique couvre une superficie de 3 688,47 km², dont 16,4% correspondent à des milieux terrestres, 76,3% à des milieux humides, 6,1% à des milieux hydriques (lacs, cours d'eau) et 1,2% à des milieux anthropiques.
2 Mélèze laricin, épinette noire, pin gris, peuplier faux tremble, cerisier de Pennsylvanie.
3 Aulne crispé, aulne rugueux, andromède glauque, camarine noire, petit thé, genévrier commun déprimé, genévrier commun, genévrier horizontal, kalmia à feuille étroites, thé du Labrador, framboisier sauvage, saule de Bebb, saule à feuilles planes, saules, bleuet, pimbina.
4 Prêle des bois, comandre livide, maïanthème du Canada, grand nénuphar jaune, sarracénie pourpre.

2.2.2 Autres activités

Les activités dites « non traditionnelles » recensées dans la zone d'étude incluent des activités de chasse et pêche par des individus ne faisant pas partie de la Communauté crie (activités sportives), ainsi que les activités commerciales du Relais routier.

La chasse et la pêche sont pratiquées dans le terrain de trappage RE2 par des personnes qui proviennent d'Eastmain ou de Waskaganish ou qui transitent sur la Route. Selon les renseignements fournis lors de la rencontre des maitres de trappage, les allochtones chassent le gros gibier (orignal, caribou) aux abords de la rivière Eastmain (à l'ouest de la Route) et pêchent (principalement le doré jaune) aux endroits autorisés indiqués sur la Route, notamment aux extrémités nord et sud (lac Amiskw Matawaw) de la zone d'étude (WSP, 2018c).

Des activités de cueillette de champignons pour exportation au Japon ont lieu sur le territoire Eastmain, dans le cadre d'un partenariat entre la Nation Crie d'Eastmain et un organisme nippon. Ces activités pourraient avoir lieu dans la zone d'étude.

Le Relais routier, situé dans la zone d'exposition rapprochée, offre hébergement, restauration et douches. Il comporte également un dépanneur, un poste d'essence et un garage mécanique. Le personnel qui y travaille est présent 24 heures sur 24 durant 14 jours, puis est absent durant 14 jours.

2.3 Identification et caractérisation des sources d'émissions atmosphériques

L'identification et la description des sources d'émissions atmosphériques du Projet ont été présentées dans l'étude sur la qualité de l'air (WSP, 2018e). Brièvement, l'exploitation de la mine est susceptible d'entraîner l'émission dans l'atmosphère de particules et de composés gazeux, attribuables aux opérations et aux infrastructures. Les principales sources d'émissions identifiées incluent les activités d'extraction et de transport, les installations de la mine et les aires d'accumulation de matériaux.

2.3.1 Sources de particules

Les sources volumiques de particules incluent les activités d'extraction et le transport des différentes matières sur le site de la mine. Elles comprennent les opérations minières et le transport routier de camion lourd. Les activités d'extraction incluent les forages et sautages dans la fosse, le chargement du minerai et son déchargement au concasseur, le déchargement et le boutage de minerai et de stériles sur leurs aires d'accumulation respectives. Les émissions attribuables au transport sur routes non pavées découlent du soulèvement de poussières causé par le camionnage de la fosse vers le concasseur et vers les différentes aires d'accumulation.

Les sources ponctuelles d'émission de particules identifiées par WSP incluent le dépoussiéreur du concasseur ainsi que les équipements émetteurs de gaz d'échappement, soit les véhicules de transport et de support minier et équipements localisés (excavatrices, chargeuses, bouteurs et foreuses) et le chauffage des bâtiments.

Les sources surfaciques de particules[1] incluent les aires d'accumulation de matériaux (minerai, stériles et résidus miniers). Afin de tenir compte de la cimentation des surfaces au fil du temps lorsque la surface est

1 Les particules sont remises en suspension dans l'air après érosion éolienne de la surface des matériaux.

non perturbée par des activités mécaniques, les zones rafraichies au cours d'un jour d'activité (minerai) ou d'un mois d'activité (stériles et résidus miniers) ont été définies comme des surfaces actives d'émission.

Toutes ces sources ont été considérées par WSP lors de la modélisation de la dispersion atmosphérique des particules et de leurs constituants (métaux et silice cristalline).

2.3.2 Sources d'émanations gazeuses

Dans le cadre de l'exploitation de la mine, les sources d'émissions d'oxydes gazeux identifiées et considérées comprennent :

- Les opérations de sautage à l'aide d'explosifs;
- Les gaz d'échappement des véhicules (affectés au routage, au support minier et au transport sur les routes d'accès) et de la machinerie en opération sur le site (forage, chargement et déchargement, boutage);
- Le chauffage (au gaz propane) des bâtiments.

2.4 Sélection des substances d'intérêt

Toutes les substances ayant fait l'objet de modélisation de la dispersion atmosphérique ont été considérées pour l'évaluation des risques, ce qui inclut :

- Les oxydes gazeux, représentés par le dioxyde d'azote (NO_2), le dioxyde de soufre (SO_2) et le monoxyde de carbone (CO);
- Les particules fines ($PM_{2,5}$);
- Les métaux associés à des particules de roche qui pourraient être émis dans l'air et pour lesquels de l'information toxicologique appropriée est disponible pour estimer les risques à la santé humaine[1], soit 23 métaux. Comme le Projet consiste en une mine de lithium, cet élément pour lequel l'information toxicologique est limitée a été ajouté à la liste des substances d'intérêt, ce qui porte à 24 le nombre de métaux évalués. Les éléments peu toxiques et auxquels la population est très largement exposée *via* l'alimentation (calcium, magnésium, sodium, potassium, phosphore et soufre) n'ont pas été retenus;
- La silice cristalline associée à des particules de roche qui pourrait être émise dans l'air.

Le tableau[2] 1 résume les substances d'intérêt pour l'évaluation des risques.

1 Parmi les éléments détectés dans les roches mais exclus de l'étude figurent 8 éléments pour lesquels il n'existe aucune valeur toxicologique de référence reconnue par l'INSPQ (indium, lutécium, praséodyme, samarium, thallium, tungstène, yttrium et zirconium) et 3 éléments pour lesquels aucune information toxicologique pertinente n'est disponible (lanthane, scandium et thulium).

2 Les tableaux sont fournis à la fin du rapport.

3. CARACTÉRISATION TOXICOLOGIQUE

La toxicité d'une substance est déterminée par plusieurs facteurs, incluant sa toxicité intrinsèque (son « pouvoir » toxique), le niveau, la durée et la fréquence de l'exposition, la ou les voie(s) d'exposition et la sensibilité de chaque individu envers chaque substance.

La caractérisation toxicologique comporte deux objectifs distincts :

- Identifier les effets possibles de l'exposition à une substance toxique sur la santé;
- Déterminer les VTR qui permettront d'estimer quantitativement le risque pour une exposition donnée.

Ces aspects sont traités dans les sous-sections suivantes.

3.1 Effets potentiels sur la santé

Deux grands types d'effets sur la santé sont considérés dans une évaluation des risques toxicologiques :

- *Le développement de cancer*. Pour ce type d'effet généralement dit « sans seuil », on considère qu'il n'existe pas de seuil d'effet, c'est-à-dire qu'à toute dose non nulle est associé un niveau de risque (probabilité) qui est d'autant plus élevé que la dose cumulée à long terme est importante. On considère ici tout développement de cancer chez des individus exposés par inhalation, ingestion et/ou contact cutané.
- *Les autres effets, dits « avec seuil »*, pour lesquels l'existence d'un seuil de toxicité est généralement admise. Ce seuil correspond à la dose à laquelle une personne peut être exposée, pendant une durée et à une fréquence déterminées, sans subir d'effets toxiques. On considère ici tout effet autre que le cancer pouvant avoir une incidence significative sur la santé des personnes exposées par inhalation, ingestion ou absorption cutanée, que ce soit à court, moyen ou long terme.

Les informations toxicologiques rapportées dans la littérature scientifique pour les substances à l'étude ont été résumées au tableau 2. Les effets possibles sur la santé indiqués dans ce tableau correspondent à des effets observés chez des animaux de laboratoire et/ou des humains exposés à court, moyen et/ou long terme. En général, ces effets ont été observés à des niveaux d'exposition beaucoup plus élevés que les niveaux correspondant aux VTR. Par ailleurs, plusieurs des métaux étudiés sont des éléments essentiels (ex. : Co, Cr, Cu, Li, Se, Zn), ce qui signifie que leur apport quotidien (ex. : *via* l'alimentation) est nécessaire pour être en bonne santé; toutefois, un apport trop important pourrait avoir un effet néfaste.

3.2 Définition et application des valeurs toxicologiques de référence

En règle générale, les effets toxiques d'une substance sont d'autant plus marqués que l'exposition est longue. En d'autres termes, pour un niveau d'exposition donné, une substance pourrait présenter des effets à long terme sans présenter d'effet à court terme. Inversement, un individu peut être exposé, sans risque d'effets, à des concentrations relativement élevées si l'exposition est sporadique.

Les VTR sont des indicateurs permettant d'estimer s'il est probable ou non qu'un niveau d'exposition donné conduise à un risque significatif pour la santé. Ces indicateurs définissent la toxicité des substances à l'étude et sont établis à partir des résultats d'études expérimentales (études toxicologiques chez l'animal ou l'humain) ou épidémiologiques (études au sein d'une population humaine).

Différentes institutions gouvernementales ou paragouvernementales proposent des VTR. Bien que les méthodes utilisées par ces diverses institutions pour l'établissement des valeurs de référence puissent varier, elles sont toutes basées sur des approches similaires. Pour élaborer les VTR, une distinction est faite entre les effets dits « sans seuil » (cancer) et les autres effets, dits « avec seuil ».

Dans le cadre de la présente étude, il convenait d'évaluer les risques correspondant à des expositions de différentes durées du fait des variations temporelles des concentrations estimées dans l'air ambiant (ex. : concentration maximale sur une heure > concentration maximale sur 24 heures > concentration moyenne annuelle) et de la fréquentation non continue de la zone d'étude. Des VTR correspondant à différentes durées d'exposition ont donc été identifiées. La définition des VTR en fonction du type d'effet et les approches utilisées pour l'élaboration de ces valeurs sont présentées dans les sous-sections suivantes.

3.2.1 Effets autres que le cancer

Une VTR pour effets autres que le cancer correspond à une dose (ou une concentration) seuil en-deçà de laquelle il n'est pas attendu de voir apparaître des effets néfastes. Par conséquent, plus la substance est toxique, plus la VTR est faible. Ce type de VTR est exprimé en termes de dose journalière (milligramme de substance par kilogramme de poids corporel par jour : mg/kg-pc par jour) ou de concentration dans l'air (microgramme[1] de substance par mètre cube d'air : µg/m^3).

Ces VTR sont généralement spécifiques à une voie d'exposition (ingestion, inhalation) et à une durée d'exposition (aiguë[2], sous-chronique[3] ou chronique[4]) données. Dans la présente étude, les acronymes a. VTR, s.c. VTR et c. VTR, respectivement, ont été utilisées pour représenter les VTR correspondant à ces trois durées d'exposition, et les acronymes VTR_{inh} et VTR_{ing}, respectivement, ont été utilisées pour représenter les VTR établie pour une exposition par inhalation et par ingestion.

Il n'existe pas de VTR pour l'exposition par voie cutanée (le risque posé par l'exposition cutanée est généralement estimé en combinant l'exposition par cette voie avec l'exposition par ingestion).

En ce qui concerne l'inhalation, deux situations peuvent être rencontrées :

- Lorsqu'une substance présente une toxicité différente par inhalation (ex. : substance ayant des effets sur le système respiratoire) et par ingestion (ex. : effet systémique, c'est-à-dire après distribution de la substance dans l'organisme), il existe généralement une VTR propre à chacune de ces voies. Dans ce cas, les risques correspondant à chaque voie sont estimés à partir d'une VTR distincte[5] et sont évalués séparément. Pour les particules ($PM_{2.5}$) et les oxydes gazeux, dont les effets appréhendés découlent uniquement de l'inhalation, seules des VTR par inhalation sont pertinentes;
- Lorsque rien n'indique que la substance a une toxicité différente par inhalation et par ingestion, ou lorsqu'aucune VTR par inhalation n'a été dérivée par une institution reconnue, il est présumé que la substance a une toxicité semblable par l'une et l'autre voie. Dans ce cas, les doses par inhalation,

1 1 microgramme correspond à 0,001 milligramme.
2 À court terme (un jour ou moins).
3 À moyen terme (quelques jours à plusieurs mois).
4 À long terme (une année et plus).
5 Le risque par inhalation est estimé en divisant la concentration d'exposition (µg/m^3) par la VTR correspondante (VTR_{inh}). Le risque par ingestion et contact cutané est estimé en divisant la dose (mg/kg-pc par jour) combinant l'exposition par ingestion et contact cutané par la VTR correspondante (VTR_{ing}).

ingestion et contact cutané sont combinées[1] pour estimer le risque posé par l'exposition via toutes ces voies.

Pour évaluer le risque d'effets autres que le cancer, la VTR doit être comparée avec la dose « totale » d'exposition, c'est-à-dire la dose qui inclut à la fois l'exposition « bruit de fond » (exposition générale de la population, sans lien avec le projet à l'étude) et l'exposition « additionnelle » (attribuable au projet à l'étude). À titre d'exemple, plusieurs institutions recommandent une VTR par ingestion de 0,002 mg/kg-pc par jour pour une exposition chronique au béryllium. Selon cette valeur, une personne qui serait exposée (toute sa vie durant) par voie orale à une dose journalière de béryllium n'excédant pas 0,002 mg/kg-pc par jour ne devrait pas subir d'effets toxiques liés à cette substance.

Les VTR pour les effets autres que le cancer sont établies à partir du niveau d'exposition associé à l'effet le plus sensible (effet critique) identifié lors d'une analyse exhaustive de la documentation scientifique disponible. Ce niveau d'exposition (dose ou concentration) est généralement appelé le « point de départ ». La valeur point de départ est ensuite divisée par des facteurs de sécurité afin de tenir compte de la variabilité et de l'incertitude associée à cette valeur. La VTR est donc estimée comme suit :

$$\text{VTR (dose ou concentration)} = \frac{\text{Point de départ (dose ou concentration)}}{\text{Facteur d'incertitude global}}$$

La valeur point de départ peut correspondre à i) un niveau sans effet observé (*NOAEL : no-observed adverse effect level :* dose (ou concentration) la plus élevée sans effet néfaste observé, déterminée expérimentalement), ii) un niveau minimal avec effet observé (*LOAEL : lowest observed adverse effect level*) ou iii) un niveau dit *Benchmark*. Les NOAEL et LOAEL correspondent à une dose (ou concentration) testée expérimentalement, alors que les valeurs *Benchmark* sont estimées par modélisation de la courbe dose-réponse. Les doses ou concentrations *Benchmark* (BMD ou BMC, respectivement) représentent une estimation de l'exposition correspondant à un niveau donné d'effet, considéré comme significatif sur le plan toxicologique (ex. : BMD_{10} correspondant à 10 % de réduction des lymphocytes dans le sang). Généralement, les valeurs *Benchmark* utilisées comme point de départ correspondent à une valeur plus faible (c.-à-d. plus prudentes) que la BMD, soit la limite inférieure de l'intervalle confiance à 95% de la BMD pour le niveau de réponse souhaité (ex. : $BMDL_{10}$).

Le facteur d'incertitude global est quant à lui obtenu en multipliant entre eux tous les facteurs de sécurité applicables. La nature et la valeur des facteurs appliqués dépendent de la qualité de l'information toxicologique disponible. Le plus souvent, les valeurs attribuées par les institutions aux différents facteurs correspondent à des valeurs par défaut. Toutefois, lorsque l'information disponible le permet, les valeurs par défaut peuvent être remplacées par une valeur dûment documentée. Les facteurs appliqués visent à tenir compte de :

- La variabilité inter-espèces, qui reflète les différences entre l'animal et l'humain au niveau de la toxicité intrinsèque de la substance. Par défaut, on considère qu'à dose égale, l'humain pourrait être 10 fois plus sensible que l'espèce animale testée. Ce facteur ne s'applique pas lorsque la VTR est basée sur une valeur point de départ obtenue chez l'humain;

1 Lorsque les données disponibles permettent de supposer que l'absorption d'une substance par inhalation diffère significativement de l'absorption par ingestion, les doses par inhalation sont converties en dose équivalente par ingestion (cas du Cu).

- La variabilité interindividuelle, qui reflète les différences au sein de la population humaine. Ce facteur vise à protéger les groupes plus sensibles, par exemple les enfants. Une valeur de 10 est généralement attribuée à ce facteur;
- La durée d'exposition, qui reflète l'adéquation entre la durée de l'étude utilisée pour établir la valeur point de départ et la durée de l'exposition à laquelle s'applique la VTR. Par exemple, une VTR pour une exposition chronique devrait être basée sur une valeur point de départ issue d'une étude chronique, c'est-à-dire dans laquelle les individus testés ont été exposés durant une période représentative de leur durée de vie (ex. : 2 ans chez le rat, 7 ans chez l'humain). Toutefois, en l'absence d'une telle étude, une VTR pour une exposition chronique peut être dérivée d'une étude plus courte (sous-chronique) en appliquant un facteur d'incertitude dédié. Ce facteur repose sur la prémisse qu'une exposition plus longue peut conduire à des effets néfastes à dose plus faible. Généralement, une valeur de 1, 3 ou 10 est attribuée à ce facteur (selon l'information toxicologique disponible);
- La qualité de la base de données toxicologiques. Ce facteur est appliqué (par certaines institutions) lorsque certains types d'effets n'ont pas été suffisamment documentés. Le cas échéant, la valeur par défaut est généralement de 3 ou 10 (selon les lacunes identifiées).

3.2.2 Cancer

Des VTR permettant d'estimer le risque de cancer sont disponibles pour différentes substances classées comme cancérogènes ou probablement cancérogènes pour l'humain (voir l'annexe C pour plus d'information sur les classifications). Ces VTR sont généralement exprimées sous forme de *coefficient de cancérogénicité* ou de *risque unitaire*, et correspondent au « potentiel cancérogène » de la substance, c'est-à-dire à la probabilité qu'une dose (ou concentration) donnée entraine un cas de cancer. Plus la substance en cause est fortement cancérogène, plus la VTR est élevée. Ces VTR sont exprimées en risque par unité de dose d'exposition (coefficient de cancérogénicité : risque pour une exposition à vie à 1 mg/kg-pc par jour, exprimé en (mg/kg-pc par jour)$^{-1}$) ou en risque par unité de concentration d'exposition (par exemple, dans l'air, risque unitaire pour une exposition à vie à 1 µg/m³, exprimé en (µg/m³)$^{-1}$).

Les VTR pour le cancer sont le plus souvent dérivées d'études toxicologiques conduites sur des animaux en laboratoire, après un ajustement animal-humain approprié des doses (ou concentrations). Toutefois, lorsque disponibles, des études épidémiologiques adéquates peuvent aussi être utilisées. Les VTR pour le cancer sont généralement estimées à partir de la pente reliant l'incidence de cancer à la dose (plus exactement, en utilisant la limite supérieure d'un niveau de confiance à 95 % de cette pente). Lorsque plusieurs études fournissent des valeurs de pente différentes, la moyenne géométrique des pentes estimées est souvent retenue par les institutions comme valeur finale de VTR.

Pour évaluer le risque de cancer posé par une situation ou un projet, on estime le « risque additionnel » de cancer plutôt que le risque total. Le risque additionnel correspond au risque supplémentaire encouru à la suite de l'exposition spécifiquement liée au projet à l'étude. Ce risque s'ajoute au « risque bruit de fond » découlant de tous les autres facteurs pouvant conduire au développement d'un cancer (incluant l'exposition des personnes à l'ensemble des agents cancérogènes présents dans leur milieu de vie)[1]. Le risque additionnel de cancer est estimé en multipliant le niveau d'exposition additionnel (dose ou concentration) par la VTR correspondante (coefficient de cancérogénicité ou risque unitaire).

1 Le risque total est la somme du risque bruit de fond et du risque additionnel.

Par exemple, pour une dose par ingestion moyenne à vie d'arsenic estimée à 0,001 mg/kg-pc par jour, et en utilisant un coefficient de cancérogénicité de 1,5 (mg/kg-pc par jour)$^{-1}$ (valeur proposée par IRIS et Cal/EPA), le risque additionnel de cancer serait estimé à :

$$\begin{aligned} Risque &= 0{,}001\ mg/kg - pc\ \ par\ jour \times \frac{1{,}5}{mg/kg - pc\ \ par\ jour} \\ &= 0{,}0015\ (\text{ou } 1{,}5\ \mathrm{E} - 03) \\ &= 1\ cas\ additionnel\ sur\ 667\ personnes\ exposées\ (1/0{,}0015) \end{aligned}$$

3.2.3 Sources de VTR

3.2.3.1 Valeurs élaborées par des institutions reconnues

La sélection des VTR utilisées dans la présente étude a été effectuée parmi les valeurs proposées par des institutions reconnues par l'INSPQ (2012). La sélection a été effectuée en tenant compte des critères identifiés par l'INSPQ, notamment la qualité et la pertinence des études de base, la rigueur scientifique lors des étapes de calcul d'extrapolation ou de modélisation, et la date de mise à jour de la valeur. Les valeurs retenues correspondent généralement aux valeurs les plus sévères parmi celles disponibles. Les institutions reconnues par l'INSPQ sont les suivantes :

- Santé Canada (SC);
- L'Organisation mondiale de la santé (OMS);
- L'*United States Environmental Protection Agency* (U.S. EPA), via sa base de données *Integrated Risk Information System* (IRIS);
- L'*Agency for Toxic Substances and Disease Registry* (ATSDR);
- La *California Environmental Protection Agency* (Cal/EPA);
- Le *National Institute of Public Health and the Environment* des Pays-Bas (RIVM).

Ces institutions fournissent des VTR pour l'exposition par ingestion et/ou par inhalation qui correspondent à différentes durées d'exposition (ex. : 1 heure, 8 heures, 1 à 14 jours, 15-364 jours, une année et plus).

Des VTR correspondant à au moins une voie d'exposition[1] et une durée d'exposition[2] ont été recensées pour la plupart des substances à l'étude. Toutefois, pour certaines des substances d'intérêt, aucune VTR n'est proposée pour certaines voies et/ou durées d'exposition. Par exemple, peu de valeurs sont disponibles pour estimer les risques posés par une exposition aiguë aux métaux (ce qui s'explique par le fait que la plupart des métaux ne présentent pas de toxicité particulière à court terme). Plusieurs valeurs de référence provisoires ont donc été retenues. Ces VTR provisoires sont détaillées à la section suivante.

1 Ingestion, inhalation ou contact cutané.
2 Aiguë, sous-chronique ou chronique.

3.2.3.2 Valeurs provisoires

En l'absence de VTR recommandée par une institution reconnue par l'INSPQ, des valeurs provisoires ont aussi été utilisées afin d'identifier tout risque potentiel, dans la mesure des données toxicologiques disponibles. En effet, il apparaissait important d'évaluer, au moins de façon préliminaire, les risques qui pourraient être posés par chacune des substances d'intérêt à court terme, à la suite d'une exposition aiguë par inhalation (reflétant des pics de concentrations), et à moyen ou long terme, à la suite d'une exposition répétée via différentes voies (inhalation, ingestion et contact cutané).

Les valeurs provisoires considérées incluent :

- Les VTR proposées par des institutions non listées par l'INSPQ (cas de la c. VTR_{ing} pour le Ti fournie par NSF International et de la c. VTR_{inh} pour la silice cristalline fournis par la *Texas Commission on Environmental Quality* (TCEQ)[1]) ou publiées dans une revue scientifique avec révision par des pairs (cas du Co pour s.c. VTR_{ing} et c. VTR_{ing});
- Les valeurs provisoires (*Provisional Peer Review Toxicity Values*) proposées par U.S. EPA[2] qui sont cohérentes avec les autres VTR disponibles pour la substance d'intérêt (cas de Sb pour s.c. VTR_{ing} et de Li pour s.c. VTR_{ing} et c. VTR_{ing}).
- Des VTR provisoires dérivées pour les fins de la présente étude (VTR provisoires *ad hoc*), selon une approche volontairement prudente qui peut être résumée comme suit (davantage d'information est fournie à l'annexe C) :
  - Exposition aiguë (8 heures) par inhalation – en l'absence de VTR fournie par les institutions susmentionnées pour évaluer le risque par inhalation à court terme (ex. : 1 heure, 8 heures, 24 heures), des valeurs provisoires pour une exposition de 8 heures ont été dérivées en divisant la concentration moyenne permise en milieu de travail (TLV-TWA[3]) par un facteur de sécurité :
    - Un facteur de sécurité arbitraire de 100 a généralement été retenu afin de tenir compte du fait que le niveau de protection recherché en santé environnementale (absence de tout effet néfaste pour la population, incluant les individus les plus sensibles) est plus élevé qu'en milieu de travail (ex. : tolérance d'effets réversibles chez des adultes en bonne santé). Ce facteur de sécurité a été appliqué à 10 métaux (Al, Sb, Ba, Cr, Co, Sn, Mo, Pb, Ti, U);
    - Pour l'argent, la TLV-TWA vise à protéger d'un effet cumulatif. Un facteur de sécurité réduit (10) a donc été appliqué pour estimer le risque associé à des pics de concentrations sur 8 heures, ce qui reste très prudent;
    - Pour 2 métaux (Be et Se), la TLV-TWA divisée par 100 était plus faible que la VTR pour une exposition chronique et n'a donc pas été retenue.

1 Il s'agit de la seule VTR disponible actuellement qui soit applicable sans restriction de durée de d'exposition.
2 http://hhpprtv.ornl.gov/.
3 *Threshold Limit Value – Time-Weighted Average* : concentration moyenne sur une journée de travail (8 ou 10 heures) permise en milieu de travail, ou valeur équivalente (voir annexe C).

- Exposition aiguë (8 heures) par inhalation – cas du manganèse. Cal/EPA propose une VTR de 0,17 µg/m^3 pour des expositions répétées de 8 h au Mn sous forme de particules respirables. Cette valeur est basée sur un niveau d'effet critique (51 µg/m^3)[1] identifié chez des travailleurs exposés durant plusieurs années (5,3 ans en moyenne). Elle intègre un facteur de sécurité de 100 qui vise à protéger les enfants (plus sensibles que les adultes) et un facteur additionnel de 3 qui tient compte du fait que les travailleurs ont été exposés durant une période plus courte que la durée de vie. L'application de ce dernier facteur n'est pas pertinente pour une VTR qui est appliquée à une exposition aiguë (définie comme une exposition sporadique à des pics de concentration). Par conséquent, une VTR provisoire de 0,51 µg/m^3 a été retenue pour estimer le risque posé par la concentration maximale de Mn sur 8 heures;
- Exposition aiguë (1 heure) par inhalation – en l'absence de VTR fournie par les institutions susmentionnées ou de toute autre valeur (ex. : TLV-TWA) permettant de dériver une VTR provisoire pour évaluer le risque par inhalation à court terme, une VTR provisoire *ad hoc* a été dérivée en divisant la concentration limite d'exposition en situation d'urgence de niveau 1 (ex. : TEEL-1)[2] par un facteur de sécurité arbitraire de 100 (cas de Li, Sr et Zn);
- Exposition aiguë (24 heures) par inhalation – application de la c. VTR_{inh} lorsque celle-ci est basée sur un effet sensibilisant (cas du Be) et/ou lorsque la TLV-TWA divisée par 100 était plus faible que la VTR pour une exposition chronique (cas de Be et Se);
- Exposition sous-chronique – application de la VTR chronique (c. VTR) : lorsque la c. VTR est basée sur des données de toxicité chronique, cette valeur a été retenue par défaut, sans ajustement pour la durée d'exposition (cas de Ag, Be, Cr, Cu, Mo, Mn, Ni, Pb, S, Ti, U et Zn par ingestion, et de NO_2, SO_2, $PM_{2.5}$, Ag, As, Ba, Be, Cd, Co, Mn, Mo, Hg, Pb, Se et V par inhalation), ce qui constitue une approche prudente;
- Exposition sous-chronique et/ou chronique - extrapolation de la voie d'exposition : pour les substances ayant une VTR par ingestion seulement, et lorsqu'il était biologiquement plausible que l'exposition par inhalation conduise aux mêmes effets, le risque posé par l'inhalation a été estimé conjointement avec le risque posé par l'ingestion[3]. Cette extrapolation, effectuée selon l'approche recommandée par l'INSPQ, a été appliquée à 8 métaux (Al, Sb, Cu, Sn, Li, Sr, Ti et Zn).
- Exposition chronique – cas de l'argent. La valeur retenue pour l'exposition sous-chronique et chronique par inhalation correspond à la TLV-TWA (qui vise à protéger d'un effet cumulatif) divisée par un facteur de sécurité de 10 afin de protéger les groupes les plus sensibles de la population;
- Exposition chronique – extrapolation de la durée d'exposition : lorsque la VTR sous-chronique était basée sur des données de toxicité sous-chronique, cette s.c. VTR a été divisée par un facteur de sécurité supplémentaire d'une valeur de 10 (cas du V par ingestion et du Cr par inhalation).

3.3 Valeurs toxicologiques de référence retenues

Les VTR retenues pour les fins de la présente étude sont indiquées aux tableaux 3 (exposition aiguë), 4 (exposition sous-chronique) et 5 (exposition chronique) pour les effets autres que le cancer ainsi qu'au tableau 6 pour le cancer.

1 Concentration ajustée pour une exposition continue.
2 *Temporary Emergency Exposure Limit* de niveau 1 recommandé par le *Department of Emergency* des États-Unis. Correspond à la concentration dans l'air (sur 15 minutes) en deçà de laquelle il est attendu que la plupart des individus ne devraient pas subir d'effets autres que légers et transitoires ou pourraient percevoir une odeur désagréable clairement définie.
3 À titre indicatif, une VTR provisoire par inhalation dérivée de la VTR par ingestion est indiquée entre parenthèses aux tableaux 4 et 5 pour ces substances.

Pour les métaux dont la toxicité dépend de la forme chimique, les VTR sélectionnées correspondent, dans la mesure du possible, à la forme qu'il est le plus plausible de retrouver dans les particules émises par le Projet (formes minérales) ou, par défaut, à la forme la plus toxique. Par exemple :

- Chrome : il est vraisemblable que le chrome présent dans le gisement soit principalement sous forme de chrome trivalent. Considérant que l'exposition par inhalation concerne des particules fraichement émises, le risque par inhalation a donc été évalué pour le chrome trivalent en utilisant, par prudence, les VTR correspondant aux formes les plus toxiques (sels solubles du chrome trivalent). Pour évaluer le risque par voie orale, c'est-à-dire posé par l'ingestion de gibier, plantes, sol, eau ou poisson, provenant de la zone d'étude, il convenait de tenir compte du fait que des processus environnementaux peuvent conduire à un changement de la valence du chrome. Les VTR disponibles pour le chrome hexavalent (plus toxique que la forme trivalente) ont donc été retenues pour la voie orale, ce qui constitue une approche prudente.
- Mercure : il est vraisemblable que le mercure présent dans le gisement soit principalement sous forme non organique. Advenant l'absence de VTR pour le mercure inorganique (Hg^{2+}) par inhalation, les VTR correspondant au mercure élémentaire (Hg^{0}) ont été retenues, ce qui constitue une approche prudente.
- Nickel : les VTR les plus appropriées sont celles fournies par Santé Canada pour les formes de « nickel oxygéné, sulfure, soluble », ce qui inclut les oxydes (de nickel, de nickel-cuivre, de silicate de nickel et les oxydes complexes), le nickel sulfuré (incluant le subsulfure de nickel) et les formes de nickel solubles dans l'eau (principalement le sulfate de nickel et le chlorure de nickel) ainsi que les formes stables (ex. : minéraux sulfiques porteurs de nickel et oxyde de nickel) qui peuvent se dissoudre sous certaines conditions de pH (ex. : résidus miniers acides) ou potentiel d'oxydo-réduction (ex. : sédiments enfouis à potentiel réducteur) dans l'environnement (Santé Canada, 2010).
- Titane : les VTR basées sur des données toxicologiques pour le dioxyde de titane ont été utilisées. Les VTR établies pour le tétrachlorure de titane ont été écartées car ce composé n'existe pas naturellement (il est produit uniquement lors de la transformation industrielle du titane par chloration) (ATSDR, 1997).
- Uranium : l'uranium présent le gisement correspond à de l'uranium dit naturel.

4. ESTIMATION DE L'EXPOSITION

L'estimation de l'exposition des individus (récepteurs) est une étape déterminante de l'évaluation des risques. En effet, ce sont les contacts possibles de ces récepteurs avec les substances à l'étude qui peuvent donner naissance à des effets sur la santé. Il est donc important d'identifier les voies d'exposition potentielles par lesquelles les individus pourraient être exposés (ingestion, inhalation et/ou contact cutané) ainsi que les patrons d'exposition (fréquence et durée de l'exposition). Un autre élément essentiel à l'estimation de l'exposition est la détermination des concentrations de contaminants dans les divers compartiments environnementaux d'intérêt (ex. : air ambiant, aliments).

L'exposition potentielle aux substances retenues a été estimée conformément aux lignes directrices de l'INSPQ (2012). Trois catégories d'exposition ont donc été estimées :

- Les niveaux d'exposition dits « bruit de fond », qui sont associés à la présence des substances à l'étude dans l'environnement général (air, eau, sol, poussières, alimentation) et qui ne sont pas attribuables aux activités du Projet;
- Les niveaux dits « additionnels », qui représentent l'exposition des individus attribuable au Projet et qui ne tiennent pas compte de l'exposition bruit de fond;
- Les niveaux « totaux », qui sont la somme des niveaux bruit de fond et additionnels.

Les détails relatifs à l'estimation de l'exposition bruit de fond, additionnelle et totale sont présentés dans les sous-sections suivantes.

4.1 Définition des scénarios d'exposition

4.1.1 Fréquentation

Sur la base de l'information disponible concernant les usages et la fréquentation de la zone d'étude par la population autochtone et allochtone, les individus potentiellement les plus exposés aux émissions générées par les activités du Projet ont été identifiés comme suit :

- Les individus qui fréquentent le Relais routier : les employés, présents sur place 24 heures sur 24 à raison de 2 semaines sur 4, sont vraisemblablement les individus qui sont le plus souvent présents au Relais routier. Aucune personne (adulte, enfant) n'y réside à l'année longue;
- Les individus qui fréquentent la zone d'étude pour y pratiquer des activités traditionnelles ou sportives : l'information recueillie dans les études portant sur les habitudes des autochtones et des allochtones de la région indique que les séjours effectués dans la zone d'étude varient d'une journée (ex. : visiteurs occasionnels) à plusieurs semaines consécutives (membres de la Communauté crie). Des adultes, mais aussi des enfants et des adolescents, peuvent pratiquer ces activités tout au long de l'année. En plus d'être exposés lors de séjours dans la zone d'étude, ces individus et leurs familles peuvent être exposés de façon indirecte en consommant les produits chassés/récoltés ramenés à la maison (exposition domestique). Les autochtones pratiquent des activités traditionnelles et fréquentent le territoire de façon beaucoup plus assidue que les allochtones (activités sportives). A priori, les activités traditionnelles entrainent donc une fréquentation et une consommation accrues. Elles ont donc été utilisées pour établir des scénarios d'exposition prudents.

À partir de ces informations, des hypothèses prudentes de fréquentation de la zone d'étude et de consommation des produits traditionnels ont été formulées. Ainsi, les scénarios d'exposition considérés, qui se veulent prudents tout en demeurant réalistes, visent à représenter :

- Des individus adultes (employés) qui fréquenteraient le Relais routier sur une base régulière (24 heures sur 24, 7 jours par semaine, 2 semaines sur 4) pour un total de 25 semaines par année[1]). Les risques d'effets sur la santé à court terme (exposition aiguë) et à long terme (exposition chronique) ont été estimés pour ce type de récepteur (scénario d'exposition au « Relais routier »).
- Des individus adultes et enfants qui fréquenteraient la zone d'exposition rapprochée de façon discontinue pour une durée totale de 20,5 semaines[2] par année, et qui consommeraient sur place des denrées alimentaires (viande, végétaux, poissons) provenant de la zone d'exposition rapprochée (scénario d'exposition « Activités traditionnelles »). Il est à noter que l'inclusion de la consommation de poisson dans le scénario d'exposition correspond à une hypothèse très prudente car les plans d'eau actuellement utilisés pour la pêche ne devraient pas être affectés par les activités du Projet (voir sections 2.2.2 et 2.4). Les risques d'effets sur la santé à court terme (exposition aiguë) et à moyen terme (exposition sous-chronique) ont été estimés pour ce type de récepteur.
- Des individus qui consommeraient régulièrement de la viande, du poisson et des végétaux (petits fruits et plantes médicinales et/ou à infuser) provenant de la zone d'exposition rapprochée (scénario d'exposition domestique). Comme il est vraisemblable que ce scénario d'exposition domestique s'applique à des individus qui pratiquent des activités traditionnelles dans la zone d'étude, les deux scénarios ont été combinés pour représenter à la fois l'exposition directe (20,5 semaines par année) lors des séjours d'activités traditionnelles et l'exposition indirecte (31,5 semaines par année) qui découle de la consommation des produits rapportés à la maison. Ce scénario « combiné » (activités traditionnelles et exposition domestique) a été utilisé pour estimer l'exposition et les risques d'effets sur la santé à long terme (exposition chronique).

Pour tous les scénarios, il a été considéré que l'exposition additionnelle avait lieu durant 16 années (durée probable de l'exploitation de la mine).

4.1.2 Voies d'exposition

Différentes voies d'exposition doivent être considérées afin d'estimer l'exposition (bruit de fond et additionnelle) des récepteurs décrits précédemment. Les scénarios d'exposition retenus sont inspirés des scénarios génériques indiqués par l'INSPQ (des ajustements étaient parfois nécessaires pour tenir compte de certaines particularités des récepteurs ou des situations évaluées). Lorsqu'aucun ajustement n'était requis, les taux d'exposition recommandés par l'INSPQ ont également été utilisés.

Ainsi, sauf indication contraire, l'exposition des récepteurs a été estimée à l'aide des paramètres représentatifs de conditions d'exposition moyennes pour une estimation déterministe (ex. : taux d'inhalation, taux d'ingestion de sol et d'eau, poids corporel, surface corporelle) et des équations recommandées par l'INSPQ (2012). Les voies retenues pour chaque scénario d'exposition sont résumées au tableau 7, et les paramètres et équations utilisés sont détaillés à l'annexe D.

Les différents scénarios d'exposition et leurs particularités sont présentés aux sous-sections suivantes.

1 En comptant 2 semaines de vacances annuelles.
2 En supposant la fréquentation suivante : 8 semaines par année en continu (soit 56 jours), et 44 fins de semaine (soit 88 jours).

4.1.3 Scénarios d'exposition additionnelle

4.1.3.1 Scénario d'exposition au Relais routier

Les doses d'exposition additionnelles ont été estimées en tenant compte de toutes les voies d'exposition identifiées par l'INSPQ (2012) dans un contexte commercial. Toutefois, le scénario retenu tient compte du fait que les employés du Relais routier sont présents sur place jours et nuits (24 heures sur 24, 7 jours sur 7) à raison de 2 semaines par mois (et non 10 heures par jour, 5 jours par semaine, comme indiqué dans le scénario commercial de l'INPSQ). Par ailleurs, afin d'identifier tout risque potentiel découlant de la fréquentation du Relais routier par des mères qui allaitent, les doses d'exposition des tout-petits (0-6 mois) *via* l'ingestion de lait maternel ont également été estimées même si, dans la pratique, cette situation est peu probable.

Les doses d'exposition additionnelles ont donc été estimées pour des récepteurs mixtes adultes (hommes et femmes de 20 ans et plus)[1] et pour des bébés (advenant le cas hypothétique où une mère travaillant au Relais continuerait d'allaiter son enfant) en considérant toutes les voies d'exposition pertinentes (tableau 7), soit l'inhalation (air intérieur et extérieur), le contact cutané avec l'air et avec les poussières intérieures, l'ingestion de poussières intérieures et la consommation de lait maternel.

4.1.3.2 Scénario d'exposition lors des séjours d'activités traditionnelles

Ce scénario vise à représenter l'exposition d'individus qui séjourneraient régulièrement dans la zone d'exposition rapprochée pour y pratiquer des activités traditionnelles (voir section 2.2.1). Plus précisément, il a été supposé les récepteurs pourraient demeurer dans cette zone à raison de 20,5 semaines par année. Les doses d'exposition ont été estimées en tenant compte de toutes les voies d'exposition identifiées par l'INSPQ (2012) dans un contexte résidentiel en milieu rural.

Les doses d'exposition additionnelles ont été estimées pour des récepteurs mixtes (hommes et femmes) et pour tous les groupes d'âge (0-6 mois, 0,5-4 ans, 5-11 ans, 12-19 ans, 20 ans et plus), en considérant toutes les voies d'exposition pertinentes (tableau 7). Davantage de détails relatifs au scénario d'exposition sont fournis ci-après.

- Il a été supposé que lors des séjours d'activités traditionnelles, les récepteurs passaient en moyenne 12 heures par jour à l'extérieur et que le reste du temps (12 heures) est passé à l'intérieur d'un bâtiment.
- Il a été supposé que l'eau potable consommée par les récepteurs durant les séjours d'activités traditionnelles provenait du Relais routier (le Relais étant un point de ravitaillement reconnu), et que l'eau utilisée à des fins d'hygiène correspondait plutôt à de l'eau de surface provenant de la zone d'exposition rapprochée.
- Il a été supposé que, lors des séjours dans la zone d'étude, les produits issus des activités traditionnelles (viande, poisson, petits fruits et tisanes/plantes médicinales) représentaient une partie importante de l'alimentation des récepteurs. Une hypothèse très prudente a donc été retenue en considérant que la totalité (100%) de la viande, du poisson et des végétaux (fruits et infusions de matières végétales) consommés durant ce séjour provenait de la zone d'exposition rapprochée.

1 Afin de faciliter la lecture et la compréhension, les tranches d'âge ainsi nommées ont été utilisées dans le reste du rapport à la place des appellations indiquées dans le document de l'INSPQ (c.-à-d. 0 – 6 mois, 6 mois - < 5 ans, 5 - < 12 ans, 12 - < 20 ans, 20 ans et plus).

En l'absence de données spécifiques à la population visée dans la présente étude, les taux de consommation retenus sont issus de recommandations basées sur des données Canadiennes :

- Pour la viande de gibier, les taux de consommation retenus sont, pour les tranches d'âge 0-6 mois, 0,5-4 ans, 5-11 ans, 12-19 ans, 20 ans et plus, respectivement, de 0,0, 0,084, 0,126, 0,177 et 0,269 kg/jour (Richardson, 1997). Ces valeurs représentent les quantités moyennes consommées par des autochtones Canadiens (Amérindiens et Inuits combinés) ayant consommé de tels produits[1] lors d'une enquête réalisée en 1971 et 1972. Ces valeurs sont cohérentes avec les taux de consommation de viande de gibier (115 kg/personne par an en 1978-1979, 106 kg/personne par an en 1990) rapportées pour des communautés cries de la Baie James (Berkes, George *et coll.*, 1994). Ces valeurs sont significativement plus élevées que celles recommandées par l'INSPQ pour la population générale. Les doses additionnelles découlant de la consommation de viande de gibier ont été estimées à partir de la plus élevée des concentrations estimées dans la chair de diverses espèces de mammifères et d'oiseaux (voir section 4.2.7.2), ce qui constitue un niveau supplémentaire de prudence.
- Pour le poisson, les taux d'ingestion proposés par Richardson (1997) pour les populations habitant certaines régions reconnues pour leur forte consommation ont été retenus, comme suggéré par l'INSPQ (2012). Pour les tranches d'âge 0-6 mois, 0,5-4 ans, 5-11 ans, 12-19 ans et 20 ans et plus, respectivement, ces taux sont de 0,00, 0,056, 0,090, 0,104 et 0,111 kg/jour.
- Pour les petits fruits cueillis, le taux de consommation correspond à celui indiqué l'INSPQ (2012) pour la consommation de fruits et jus de fruits pour la population générale (soit 0,042, 0,426, 0,504, 0,568 et 0,382 kg/jour pour les tranches d'âge 0-6 mois, 0,5-4 ans, 5-11 ans, 12-19 ans, 20 ans et plus, respectivement). Ces valeurs sont plus élevées que les taux moyens de consommation documentés pour la population canadienne.
- Enfin, il a été considéré que les récepteurs de tous âges pourraient consommer des infusions ou des herbes médicinales. Pour représenter ces situations, le terme « infusion » a été retenu et il a été supposé qu'une infusion pourrait être consommée par jour (2 grammes de matière végétale, ce qui correspond à la masse des sachets à infuser du commerce). Les doses d'exposition ont été estimées en supposant que la totalité (100%) des métaux se trouvant dans ces végétaux était extraite lors de l'infusion de celles-ci.

4.1.3.3 Scénario d'exposition combinée (séjours d'activités traditionnelles et exposition domestique)

Ce scénario d'exposition a été construit en combinant l'exposition des récepteurs lors des séjours d'activités traditionnelles (20,5 semaines par année) avec l'exposition à la maison (consommation de denrées issues des activités traditionnelles, 31,5 semaines par an). Les doses d'exposition ont été estimées pour des récepteurs mixtes (hommes et femmes) et pour tous les groupes d'âge (0-6 mois, 0,5-4 ans, 5-11 ans, 12-19 ans, 20 ans et plus).

Les doses d'exposition découlant des séjours d'activités traditionnelles sont celles estimées selon le scénario décrit à la section 4.1.3.2.

Lorsque les récepteurs se trouvent à la maison, la seule voie d'exposition associée aux activités de la mine correspond à la consommation de produits issus des activités traditionnelles (viande, poisson, petits fruits et infusions) provenant de la zone d'exposition rapprochée. Les doses d'exposition additionnelles ont été estimées en se basant sur les hypothèses suivantes :

1 Consommateurs de viande seulement.

- Il a été supposé que la moitié (50%) de la viande, du poisson et des fruits consommés chaque jour pourrait provenir des activités traditionnelles pratiquées dans la zone d'exposition rapprochée (cette proportion correspond à celle recommandée par l'INSPQ pour estimer le risque dans un contexte résidentiel en milieu rural). Les taux de consommation indiqués à la section 4.1.3.2 ont été utilisés.
- Il a été supposé que 100% des plantes utilisées pour préparer les infusions provenaient de la zone d'exposition rapprochée.
- Les taux de consommation utilisés sont identiques à ceux indiqués à la section 4.1.3.2

4.1.4 Scénarios d'exposition bruit de fond

L'exposition bruit de fond a été estimée par modélisation à partir des taux d'exposition indiqués par l'INSPQ (à moins d'indication contraire) et des teneurs de fond dans les milieux environnementaux (voir section 4.2) et en tenant compte de l'apport alimentaire en métaux (voir sections 4.2.6 et 4.2.7). Les voies d'exposition sont résumées au tableau 7. Les particularités de chaque situation sont soulignées ci-après :

- Pour le scénario d'exposition bruit de fond au Relais routier, toutes les voies d'exposition indiquées par l'INSPQ dans un contexte résidentiel en milieu urbain ont été retenues, à l'exception de la consommation d'aliments d'origine locale car les apports alimentaires de métaux documentés pour la population générale ont été utilisés pour représenter l'exposition bruit de fond découlant de l'alimentation.
- Pour le scénario d'exposition bruit de fond lors des séjours d'activités traditionnelles, toutes les voies d'exposition indiquées par l'INSPQ dans un contexte résidentiel en milieu rural ont été retenues. L'apport alimentaire a été estimé à partir des teneurs de fond mesurées ou estimées dans la viande, le poisson et les végétaux et des taux de consommation précédemment indiqués pour ce scénario (voir section 4.1.3.2).
- Pour le scénario combiné (séjours d'activités traditionnelles et exposition domestique),
  - l'exposition bruit de fond correspondant au temps passé dans la zone d'exposition rapprochée (20,5 semaines par année) est identique à celle décrite ci-haut.
  - l'exposition bruit de fond correspondant au temps passé à la maison (32,5 semaines par année) a été estimée pour toutes les voies d'exposition indiquées par l'INSPQ dans un contexte résidentiel en milieu rural. Comme il a été supposé que 50% de la viande, du poisson et des fruits consommées à la maison ainsi que la totalité (100%) des autres plantes (infusion) provenaient des activités traditionnelles, une partie équivalente (50%) de l'apport alimentaire documenté pour la population générale a été ajoutée afin de représenter une alimentation plus réaliste.

4.2 Concentrations dans les médias environnementaux

Puisque l'objectif de l'évaluation des risques est d'identifier tout risque potentiel pouvant découler du Projet, les concentrations retenues pour l'évaluation des risques sont volontairement prudentes.

Pour l'exposition bruit de fond, les concentrations utilisées (« teneurs de fond ») sont idéalement celles mesurées dans la zone d'étude avant le Projet (concentrations initiales). Advenant l'absence de données locales, des données régionales, provinciales, nationales ou nord-américaines ont été recherchées (en suivant cet ordre de préférence).

Pour la situation projetée, les concentrations additionnelles qui pourraient découler des activités de la mine ont été estimées à partir des concentrations modélisées dans l'air ainsi que des taux de dépôt atmosphérique fournis par WSP.

La méthodologie utilisée et les concentrations retenues sont présentées dans les sections qui suivent. Les données locales utilisées pour estimer les concentrations dans les médias (sols, sédiments, eau potable, eau de surface) sont fournies à l'annexe C.

4.2.1 Air ambiant

La qualité de l'air ambiant l'air dépend de nombreux paramètres relatifs aux sources d'émissions[1] (qui peuvent être naturelles, comme l'érosion éolienne des sols, ou découler d'activités humaines) et aux conditions de dispersion dans l'atmosphère (ex. : température, stabilité atmosphérique, vitesse et direction des vents). Les concentrations de gaz, particules, métaux et silice cristalline dans l'air peuvent donc être très variables (ex. : pics de concentration sur des périodes très courtes). Dans un contexte d'évaluation du risque, il est donc primordial que la concentration d'exposition évaluée soit en adéquation avec la période d'exposition de la VTR. Par exemple, si la VTR est définie pour une durée de 1 heure, le risque doit être estimé à partir d'une concentration d'exposition mesurée ou estimée sur 1 heure.

Par ailleurs, d'un point de vue toxicologique, les particules présentant un intérêt pour estimer le risque posé par l'inhalation de métaux sont les particules inhalables (PM_{10})[2] car les VTR par inhalation pour les métaux sont basées sur des données toxicologiques obtenues avec des particules généralement plus petites (les particules plus grossières ne pénètrent pas profondément dans le système respiratoire). Pour les fins de la présente étude, le risque par inhalation a donc été estimé à partir des concentrations de métaux dans les PM_{10}, lorsque disponibles, ce qui constitue une approche prudente. Pour la silice cristalline, les particules d'intérêt sont les particules dites respirables (PM_4).

En ce qui concerne l'exposition aux métaux par ingestion (ex. : *via* le dépôt atmosphérique des particules sur les feuilles des végétaux) et par contact cutané, la taille des particules ne représente pas une limite. Dès lors, l'exposition par ces voies a été estimée à partir des concentrations annuelles moyennes de métaux dans les particules en suspension totales (PST).

4.2.1.1 Teneurs de fond

Les teneurs de fond dans l'air ambiant retenues pour la présente étude sont présentées au tableau 8. Pour la majorité des substances, ces valeurs ont été déterminées à partir des données les plus récentes du Réseau national de surveillance de la pollution atmosphérique (RNSPA)[3] ou de la base de données nationales sur la chimie atmosphérique (NAtChem)[4] d'Environnement et Changement climatique Canada. Les valeurs retenues correspondent (lorsque disponibles) à des concentrations mesurées à des stations localisées à des endroits jugés représentatifs de la zone d'étude (région éloignée, zone non urbanisée).

1 Du fait de la dispersion atmosphérique et du transport sur de longues distances des polluants dans l'atmosphère, la qualité de l'air à un endroit donné est affectée par des sources qui peuvent être locales, régionales, continentales et à l'échelle de la planète.
2 Particules dont le diamètre aérodynamique est inférieur à 10 µm. Les PM_{10} incluent les $PM_{2.5}$.
3 Données disponibles en ligne à : http://maps-cartes.ec.gc.ca/rnspa-naps/data.aspx?lang=en
4 Données disponibles en ligne à : https://www.canada.ca/en/environment-climate-change/services/air-pollution/monitoring-networks-data/national-atmospheric-chemistry-database.html.

- **Particules fines ($PM_{2.5}$) et gaz (CO, NO_2, SO_2)**

Pour les $PM_{2.5}$ et les gaz, les teneurs de fond dans l'air ont été déterminées à partir des fichiers sommaires du RNSPA (année 2016) qui présentent, pour chaque station, des valeurs statistiques (ex. : divers centiles représentatifs des distributions de concentrations, moyenne mensuelle, moyenne annuelle) calculées à partir de mesures horaires.

Les stations jugées représentatives de la zone d'étude ont été sélectionnées en deux étapes, et d'une façon indépendante pour chaque substance. Une première sélection a été réalisée à partir du classement du RNSPA, en retenant les stations représentatives du bruit de fond régional et situées en milieux peu ou pas urbanisés et peu peuplés[1]. La sélection a ensuite été affinée à partir de photos aériennes, en éliminant les stations pour lesquelles des sources d'émission (industries, champs agricoles, aéroports, zones d'exploitation forestière, etc.) susceptibles d'affecter les concentrations mesurées étaient visibles à proximité.

- Pour les $PM_{2.5}$, les teneurs de fond ont été déterminées à partir des mesures de 10 stations[2];
- Pour le CO, les teneurs de fond ont été déterminées à partir des mesures de 4 stations[3];
- Pour le NO_2, les teneurs de fond ont été déterminées à partir des mesures de 3 stations[4];
- Pour le SO_2, les teneurs de fond ont été déterminées à partir des mesures de 4 stations[5].

Pour chaque durée d'exposition et chaque substance, la teneur de fond retenue (tableau 8) correspond à la une estimation prudente de la moyenne (LSC95[6]) des valeurs statistiques rapportées aux stations préalablement sélectionnées[7] :

- Pour les teneurs de fond sur 1 heure, 8 heures ou 24 heures, ces valeurs statistiques correspondent aux 98e centiles des concentrations rapportées pour chaque période de temps[8];
- Pour les teneurs de fond sur une base mensuelle, ces valeurs statistiques correspondent aux concentrations mensuelles moyennes rapportées dans les fichiers sommaires du RNSPA. La teneur de fond retenue correspond au maximum des LSC95 calculées pour chaque mois de l'année;
- Pour les teneurs de fond sur une base annuelle, ces valeurs statistiques correspondent à la médiane (50e centile) des concentrations horaires. La teneur de fond retenue correspond à la LSC95 de ces valeurs.

1 Selon le classement du RNSPA, ces stations sont classées RB (bruit de fond régional), NU (milieu non urbanisé, population < 1000), SU (milieu peu urbanisé : population 1000 à 29 999), et P1 (population < 500) ou P2 (population 500 à 9999).
2 Fichier « 2016_AnnualPM25_v1.xls », station 52301, 52801, 53201, 53601, 53701, 53901, 54901, 55001 et 55101 (Qc), et 63301 (Ont.).
3 Fichier « 2016_AnnualCO_v1.xls », stations 54401 et 55201 (QC), 101401 (C.B.) et 10901 (T.-N.-L). Les concentrations du tableau 8, exprimées en µg/m^3, ont été converties à partir des valeurs fournies par le RNSPA qui sont exprimées en ppm (1 ppm = 1146 µg/m^3).
4 Fichier « 2016_AnnualNO2_v1.xls », stations 62501 (Ont.), 91801 et 94401 (Alb.). Les concentrations du tableau 8, exprimées en µg/m^3, ont été converties à partir des valeurs fournies par le RNSPA qui sont exprimées en ppb (1 ppb = 1,88 µg/m^3).
5 Fichier « 2016_AnnualSO2_v1.xls », stations 91101, 91801 et 94001 (Alb.), et 104303 (C.B.). Les concentrations du tableau 8, exprimées en µg/m^3, ont été converties à partir des valeurs fournies par le RNSPA qui sont exprimées en ppb (1 ppb = 2,62 µg/m^3).
6 Limite supérieure de l'intervalle de confiance à 95% sur la moyenne déterminée à l'aide de la loi de Student.
7 Lorsque la LSC95 était supérieure à la valeur maximale rapportée, la valeur maximale a été retenue comme teneur de fond.
8 Sur 1 heure, les 98e centiles sont calculés directement à partir de la distribution des concentrations horaires mesurées durant l'année. Sur 8 heures et 24 heures, les concentrations sur chaque période successive de 8 heures ou 24 heures sont d'abord calculées. Les 98e centiles des concentrations moyennes sur ensuite déterminés.

- **Métaux**

Des données du NAtChem étaient disponibles pour la plupart des métaux. Ces données correspondent à des concentrations de métaux associés à des particules inhalables (PM_{10}) et ont de ce fait été jugées plus pertinentes que celles disponibles auprès du RNSPA (concentrations associées aux $PM_{2.5}$), même si ces dernières sont généralement plus récentes. Les données disponibles auprès du NAtChem ont été jugées appropriées pour représenter les teneurs de fond dans l'air ambiant de la zone d'étude pour 22 métaux :

- Pour 21 métaux[1], les données (année 2010) proviennent de deux stations (Point Petre et Burnt Island) situées dans des zones rurales et peu peuplées en Ontario. Les concentrations ont été mesurées approximativement à tous les 12 jours (~30 mesures dans l'année) et l'échantillonnage portait sur des périodes de 24 heures. Ces données ont permis de déterminer des teneurs de fond sur 24 heures (98e centile des concentrations mesurées) et sur une base annuelle (LSC95[2] des concentrations sur 24 heures). Les données disponibles ne permettaient pas d'estimer des teneurs de fond pour des périodes plus courtes que 24 heures.
- Pour le mercure (Hg), les données disponibles (année 2017) proviennent d'une station située à l'extrémité nord du Nunavut[3], représentative de régions isolées. Plus de 2 700 valeurs (concentrations mesurées sur des périodes non successives de 2 heures) sont disponibles[4] et ont permis de calculer des concentrations quotidiennes moyennes[5]. Des teneurs de fond sur 2 heures et 24 heures (98e centiles des données sur 2 heures et 24 heures) ainsi que sur une base annuelle (LSC95[6] des concentrations sur 2 heures) ont ainsi pu être estimées. Pour les fins de l'estimation des risques, les valeurs sur 2 heures ont été retenues, par défaut, pour estimer les risques sur 1 heure.

Pour l'uranium, des mesures associées aux $PM_{2.5}$ (57 mesures réalisées sur des périodes de 24 h) étaient disponibles pour l'année 2016 à une station du RNSPA jugée suffisamment représentative de la zone d'étude, soit celle de St-Anicet (Québec). Toutes les concentrations étaient inférieures à la limite de détection rapportée. Cette dernière a donc été retenue comme teneur de fond (sur 24 heures et sur une base annuelle).

Pour le lithium, aucune donnée assimilable à une teneur de fond dans l'air n'a pu être documentée. Les teneurs de fond ont donc été estimées par modélisation, en supposant que les concentrations en lithium dans l'air étaient attribuables à la remise en suspension de particules (PM_{10}) de sol (c.-à-d. en multipliant la teneur de fond en lithium dans le sol par les teneurs de fond en PM_{10} dans l'air déterminées[7] à partir des données mesurées à 2 stations[8] du RNSPA). Des teneurs de fond en lithium ont ainsi pu être estimées sur 1 heure et sur une base annuelle.

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1 Al, Sb, Ag, As, Ba, Be, B, Cd, Cr, Co, Cu, Sn, Mn, Mo, Ni, Pb, Se, Sr, Ti, V et Zn, fichier « AtmosphericParticles-ParticulateMetals-GLB-AllSites-2010.csv » accessible à : http://donnees.ec.gc.ca/data/air/monitor/monitoring-of-atmospheric-particles/particulate-metals/ParticulateMetals/?lang=en.

2 Limites supérieures de confiance à 95% déterminées à l'aide du logiciel ProUCL.

3 Fichier « AtmosphericGases_Particles-SpeciatedMercury-SMM-NU_Alert-2017.CSV », accessible au http://donnees.ec.gc.ca/data/air/monitor/monitoring-of-combined-atmospheric-gases-and-particles/speciated-mercury/?lang=en.

4 Des mesures de Hg élémentaire, particulaire et associé aux gaz réactifs sont disponibles. Pour chaque période d'échantillonnage, la somme de ces trois formes de mercure a été calculée. Les teneurs de fond correspondent donc à du Hg total.

5 Moyenne des concentrations sur 2 heures disponibles pour chacune des journées de l'année.

6 Limites supérieures de confiance à 95% déterminées à l'aide du logiciel ProUCL.

7 À partir du fichier sommaire du RNSPA 2016_AnnualPM10_TEOM_v1.xls, selon la méthodologie décrite précédemment pour estimer les teneurs de fond en $PM_{2.5}$ (section 4.2.1.1).

8 101401 et 105301 (C.B.).

- **Silice cristalline**

  La silice cristalline respirable dans l'air ambiant n'est pas un paramètre réglementé et aucune donnée de suivi de la qualité de l'air n'est disponible au Canada. Par défaut, la concentration indiquée par le MDDELCC (2016a) pour représenter la teneur de fond sur une base annuelle (concentration dite initiale) a été retenue.

4.2.1.2 Concentrations additionnelles

Les concentrations additionnelles dans l'air ont été fournies par WSP[1]. Elles ont été estimées par modélisation de la dispersion atmosphérique en s'appuyant sur la méthodologie proposée par le MELCC[2] et en se basant sur des hypothèses qui visent à maximiser les concentrations dans l'air (WSP, 2018e). Les concentrations dans l'air qui pourraient être engendrées par les activités du Projet ont été estimées selon un scénario qui vise à représenter une journée d'opération de la phase d'exploitation en maximisant les émissions atmosphériques. Ce scénario représente la situation d'exploitation maximale (année 9 d'exploitation) ainsi que des activités de production (concentration du minerai) et d'agrandissement des infrastructures minières (construction de la digue).

Brièvement, les modélisations ont été réalisées en considérant toutes les sources d'émission pertinentes, à partir de données météorologiques horaires couvrant 5 années complètes et représentatives de la zone d'étude. Les concentrations additionnelles ont été fournies à Sanexen pour plus d'une cinquantaine d'emplacements dans la zone d'étude susceptibles d'être fréquentés par la population (récepteurs). La localisation de ces récepteurs est indiquée à la figure 3. Ces récepteurs représentent notamment la position du Relais routier (REL1) et de différents lieux fréquentés par la Communauté crie pour des activités traditionnelles tels que camps permanents ou temporaires (CRI), sites[3] de chasse (CHS), de trappage (TRP) ou de pêche (PCH), points d'eau (EAU), sentiers de motoneige (MOT), etc. L'ensemble des concentrations additionnelles fournies par WSP est présentée à l'annexe E.

Aux fins de l'évaluation des risques posés par le Projet, l'exposition additionnelle des récepteurs a été estimée à partir des concentrations dans l'air indiquées aux tableaux 9 et 10 (exposition par inhalation) et au tableau 11 (exposition des récepteurs par voies multiples). Ces concentrations additionnelles dans l'air ambiant correspondent, pour chaque substance et chaque durée d'exposition, à la valeur la plus élevée parmi celles estimées par modélisation pour chacune des 5 années météorologiques :

- Sur 1 heure, 8 heures et/ou 24 heures (exposition aiguë par inhalation) : concentration maximale identifiée dans la zone d'étude (récepteur le plus exposé). Ces concentrations maximales correspondent à des récepteurs situés à quelques centaines de mètres à l'est du Projet[4].
- Sur 2 semaines (exposition sous-chronique par inhalation au Relais routier) : concentration maximale identifiée durant 14 jours consécutifs pour le récepteur REL1;
- Sur un mois (exposition sous-chronique lors de séjours d'activités traditionnelles) :

1 Fichiers fournis par WSP en aout-septembre 2018.
2 *Guide de modélisation de la dispersion atmosphérique* (Leduc, 2005; http://www.mddelcc.gouv.qc.ca/air/atmosphere/guide-mod-dispersion.pdf), et *Guide d'instruction – Préparation et réalisation d'une modélisation de la dispersion des émissions atmosphériques - Projets miniers* (MDDELCC, 2017; http://www.mddelcc.gouv.qc.ca/air/criteres/secteur_minier.pdf).
3 Par exemple, lieux de chasse, trappage et/ou cueillette : CHS1 à CHS6, CCT1, TRP1 à TRP6, lieux de pêche : PCH1 à PCH5, sources d'eau potable : EAU1 à EAU6.
4 Récepteurs EAU2 ou MOT1, localisés à la figure 3.

- Pour l'exposition par inhalation, concentration maximale identifiée durant 4 semaines consécutives dans la zone d'exposition rapprochée (pour les métaux, concentration sous forme de PM_{10});
- Pour l'exposition par voies multiples (intrant pour modéliser les concentrations moyennes de métaux dans les milieux environnementaux[1] et les produits issus des activités traditionnelles dans la zone d'exposition rapprochée) : concentration moyenne sur une base annuelle pour la zone d'exposition rapprochée dans son ensemble (pour les métaux, concentration sous forme de PST).

➤ Sur une base annuelle (exposition chronique au Relais routier) :

- Pour l'exposition par inhalation, concentration moyenne sur une base annuelle au récepteur REL1 (pour les métaux, concentration sous forme de PM_{10});
- Pour l'exposition par voies multiples (intrant pour modéliser les concentrations moyennes de métaux dans les milieux environnementaux) : concentration moyenne sur une base annuelle au récepteur REL1 (pour les métaux, concentration sous forme de PST).

4.2.2 Sols et sédiments

4.2.2.1 Teneurs de fond

Pour la plupart des métaux, des données locales étaient disponibles pour déterminer des teneurs de fond dans les sols et les sédiments. Pour les sols, les concentrations de 20 métaux[2] d'intérêt ont été documentées pour différents horizons[3] (WSP, 2018f). En raison du nombre limité d'échantillons (N = 34) et de la proportion fréquemment élevée de valeurs non détectées pour plusieurs paramètres, les résultats analytiques de l'ensemble des horizons de sols ont été combinés pour l'analyse statistique. Des sédiments ont également été échantillonnés dans des cours d'eau de la zone d'étude (incluant CE1 à CE5) puis analysés pour tous les métaux d'intérêt (WSP, 2018g); tous les échantillons (N = 38) ont été combinés pour l'analyse statistique.

Pour chaque métal analysé, la concentration moyenne dans les sols et dans les sédiments a été calculée à l'aide du logiciel ProUCL (U.S. EPA, 2015a). Lorsque les séries de données contenaient des valeurs non détectées, la moyenne a été déterminée à l'aide de l'estimateur de Kaplan-Meier (U.S. EPA, 2015b). Lorsque calculables, les teneurs de fond dans les sols et dans les sédiments correspondent aux concentrations moyennes déterminées pour le type de substrat correspondant[4].

Pour 11 métaux (B, Cd, Co, Cu, Hg, Ni, Pb, Se, Sr, U et Zn), aucune concentration moyenne dans les sols n'a pu être calculée soit parce qu'aucune mesure n'a été réalisée, soit en raison de la valeur relativement élevée des limites de détection atteintes. Pour ces substances, la concentration moyenne déterminée pour les sédiments a été retenue comme teneur de fond dans les sols.

Pour 4 métaux (Sb, Ag, Be et Sn), les mesures locales (sols et/ou sédiments) se sont toutes avérées inférieures aux limites de détection et des données provenant d'autres sources ont été utilisées :

1 Excepté pour la modélisation des concentrations dans l'eau de surface (voir annexe F).
2 Al, Sb, Ag, As, Ba, Cd, Co, Cr, Cu, Sn, Li, Mn, Hg, Mo, Ni, Pb, Se, Ti, V et Zn.
3 WSP a décrit 2 horizons de sols distincts, qui ont été définis sur la base de la composition du sol (sable, limon, argile) plutôt que de la profondeur.
4 Pour les sols, cas de : Al, As, Ba, Cr, Li, Mn, Mo, Ti et V.
Pour les sédiments : Al, As, Ba, B, Cd, Cr, Co, Cu, Li, Mn, Hg, Mo, Ni, Pb, Se, Sr, Ti, U, V et Zn.

- Pour l'antimoine et l'argent, les données présentées par le Ministère des Ressources Naturelles (Choinière et Beaumier, 1997) pour le secteur du lac Lichteneger de la province géologique Supérieur et Rae (secteur S3, situé à environ 125 km à l'est de la zone d'étude) ont été utilisées. Les teneurs de fond retenues correspondent aux moyennes calculées à partir de l'ensemble des échantillons analysés (N > 1700);
- Pour l'étain, non documenté dans le rapport de Choinière et Beaumier, la teneur de fond (5 mg/kg) indiquée dans le *Guide d'intervention* du MDDELCC (2016b) et applicable à toutes les provinces géologiques du Québec a été retenue. Cette valeur est identique à la limite de détection atteinte lors de l'analyse des échantillons de sédiments;
- En l'absence de données spécifiques à la province du Québec, la teneur de fond retenue pour le béryllium (sols et sédiments) correspond à la concentration moyenne indiquée pour les parcs ruraux en Ontario (OMOE, 2011).

Les teneurs de fond retenues dans les sols et les sédiments sont présentées au tableau 12.

4.2.2.2 Concentrations additionnelles

Comme indiqué à la section 1.5, faute de pouvoir estimer ce processus de façon satisfaisante, l'accumulation à long terme de métaux dans les sols n'est pas considérée par la présente étude. Les concentrations additionnelles dans les sols ont été considérées nulles.

Pour la même raison, et puisque les concentrations additionnelles dans l'eau de surface ont été estimées en supposant que les particules se déposant à la surface des cours d'eau de la zone d'exposition rapprochée demeuraient dans l'eau (plutôt que de sédimenter, voir section 1.4.2 de l'annexe F), les concentrations additionnelles dans les sédiments ont également été considérées nulles.

4.2.3 Eau potable

4.2.3.1 Teneurs de fond

Un échantillon d'eau potable a été prélevé au Relais routier le 29 juin 2018 puis analysé en laboratoire pour l'ensemble des métaux d'intérêt excepté le mercure. Pour les métaux ayant été détectés dans cet échantillon, les valeurs retenues pour la présente étude correspondent aux concentrations mesurées. Pour les métaux non détectés dans cet échantillon, la valeur retenue correspond à la limite de détection ou à la teneur de fond déterminée dans l'eau de surface de la zone d'étude (section 4.2.4) (la plus faible de ces valeurs a été retenue). Pour le mercure (non mesuré), la concentration moyenne dans l'eau souterraine du secteur Supérieur et Rae (dans lequel se trouve la zone d'étude) rapportée par Choinière et Beaumier (1997) a été retenue.

Les teneurs de fond retenues dans l'eau potable sont présentées au tableau 12.

4.2.3.2 Concentrations additionnelles

Le Projet ne devrait avoir aucun impact sur la qualité de l'eau souterraine dans le secteur du Relais routier puisque l'eau s'écoule en direction de la mine (WSP, 2018h). Conséquemment, les concentrations additionnelles dans l'eau potable ont été considérées nulles.

4.2.4 Eau de surface

4.2.4.1 Teneurs de fond

La qualité de l'eau de surface dans la zone d'exposition rapprochée a été documentée dans une étude spécialisée sur l'habitat aquatique (WSP, 2018g). Cinq cours d'eau (CE1 à CE5) ont été échantillonnés à 6 reprises entre juin et novembre 2017. Au total, 50 échantillons d'eau ont été analysés pour les métaux inclus à la liste des substances d'intérêt, excepté l'étain et le titane. Aucune tendance temporelle significative n'a été notée dans les concentrations en métaux mesurées dans les différents cours d'eau. Par ailleurs, la qualité de l'eau variait peu d'un cours d'eau à l'autre, à l'exception de CE4 (ruisseau très peu profond et à très faible vitesse d'écoulement) qui présente pour plusieurs paramètres des concentrations légèrement plus élevées que celles mesurées dans les 4 autres cours d'eau. Afin de déterminer les teneurs de fond dans l'eau de surface, toutes les données disponibles ont été combinées[1]. La compilation de ces données est fournie à l'annexe E. Les teneurs de fond retenues dans l'eau de surface correspondent aux moyennes[2] calculées à l'aide de ProUCL (U.S. EPA, 2015a). Ces valeurs sont indiquées au tableau 12.

Pour l'étain, des concentrations mesurées dans l'eau de surface de 15 cours d'eau situés au Canada et aux États-Unis sont résumées dans un document d'évaluation de l'Organisation mondiale de la santé (Howe et Watts, 2005). Sur les 59 échantillons analysés, 3 présentaient des concentrations détectables (1,3 à 2,1 µg/L). Sur cette base, une teneur de fond de 1 µg/L a été retenue pour la présente étude.

Pour le titane, très peu de données sont disponibles. Un document présentant les critères canadiens de qualité de l'eau (CCME, 1987) indique des concentrations en titane mesurés dans l'eau de surface au Canada et aux États-Unis variant entre 2 et 107 µg/L. Sur cette base, une teneur de fond de 50 µg/L a été retenue pour la présente étude.

4.2.4.2 Concentrations additionnelles

Pour la présente étude, l'eau de surface a été définie à la fois comme l'eau utilisée à des fins d'hygiène par les récepteurs humains lors des séjours d'activités traditionnelles et comme l'eau qui est en contact avec les récepteurs écologiques (mammifères et oiseaux) consommés par les récepteurs humains.

L'information disponible suggère que les cours d'eau les plus fréquentés par les récepteurs humains sont en dehors de la zone d'exposition rapprochée (rivière Eastmain, située à plus de 6,5 km au nord des installations minières projetées, ainsi que deux lacs situés à l'est et à l'ouest du Camp 1, situés à plus de 7,5 km au sud des installations minières projetées). Les récepteurs écologiques sont quant à eux susceptibles de fréquenter l'ensemble des cours d'eau de la zone d'étude.

La majorité des lacs et rivières de la zone d'étude ne recevront aucune eau en provenance des installations minières. Les cours d'eau qui pourraient recevoir, directement ou indirectement, un apport d'eau potentiellement affectée par le Projet sont :

- CE2, situé au nord des installations minières, qui recevra l'effluent minier final. L'effluent sera traité avant d'être déversé. Cependant le débit et la qualité de l'eau traitée ne sont pas connus pour l'instant.

1 Pour l'antimoine, une valeur mesurée a été jugée aberrante (maximum mesuré de 9,05 µg/L, soit environ 50 fois supérieur au second maximum de 0,193 µg/L) et n'a pas été considérée dans l'analyse statistique des données.

2 Pour chaque métal pour lequel des valeurs non détectées se trouvaient dans la série de données, la concentration moyenne a été déterminée par ProUCL à l'aide de l'estimateur de Kaplan Meier (U.S. EPA, 2015b).

Les concentrations additionnelles dans l'eau de CE2 associées à l'effluent minier ne peuvent donc pas être estimées à cette étape du Projet, ce qui représente une source d'incertitude. Il faut noter que le promoteur s'est engagé à tendre vers les objectifs environnementaux de rejet qui seront fournis par le MELCC. Les objectifs environnementaux de rejet sont déterminés en fonction des conditions hydrodynamiques et des usages du milieu. Ces valeurs sont définies comme les concentrations et les charges de contaminants pouvant être rejetées dans un milieu aquatique sans compromettre les usages de l'eau;

- CE3, qui pourrait recevoir de l'eau d'infiltration en provenance des aires d'accumulation de dépôts meubles et de terre végétale. A priori, les concentrations en métaux dans ces matériaux et dans les sols de la région devraient être semblables. L'apport de cette eau d'infiltration ne devrait donc pas affecter la qualité de l'eau de CE3. Cette hypothèse est valide dans la mesure où l'eau de ruissellement qui atteint CE3 n'est pas chargée en particules (érosion des aires d'accumulation de dépôts meubles et de terre végétale);
- La rivière Eastmain, qui est le récepteur final de l'ensemble des sous-bassins versants de la zone d'étude. Puisque le réseau hydrographique de la zone d'étude ne représente que 0,1% du bassin versant de la rivière Eastmain (WSP, 2018b), l'apport en métaux découlant des activités du Projet devrait être négligeable.

Le dépôt des particules émises dans l'air par le Projet représente une autre source potentielle d'apport en métaux dans l'eau de surface de la zone d'exposition rapprochée. Pour les fins de la présente étude, les concentrations additionnelles de métaux dans l'eau de surface de la zone d'exposition rapprochée ont été estimées à partir de l'information disponible dans l'ÉIE concernant le débit des cours d'eau (information limitée aux cours d'eau CE1 à CE5) et les émissions atmosphériques. L'approche utilisée est détaillée à l'annexe F. Brièvement, les concentrations additionnelles de métaux dans l'eau de chaque ruisseau (CE1 à CE5) ont été estimées à partir des taux de dépôt atmosphérique[1] disponibles pour des récepteurs (identifiés dans la modélisation des émissions atmosphériques) situés à proximité de chaque ruisseau et des débits mensuels moyens. La moyenne des concentrations dans l'eau obtenues (CE1 à CE5) a ensuite été estimée. Cette concentration moyenne a été retenue pour représenter la concentration de métaux dans l'eau de surface de la zone d'exposition rapprochée. Les cours d'eau CE1 à CE5 étant les plus proches de la mine (donc les plus affectés par les émissions atmosphériques), la concentration retenue est vraisemblablement prudente pour représenter la concentration additionnelle découlant des dépôts atmosphériques dans l'ensemble des cours d'eau de la zone rapprochée, d'autant plus que les cours d'eau les plus fréquentés par les récepteurs humains sont plus éloignés des activités minières que les cours d'eau CE1 à CE5.

Les concentrations additionnelles dans l'eau de surface de la zone d'exposition rapprochée retenues pour la présente étude sont présentées au tableau 13.

4.2.5 Air intérieur, poussières intérieures et eau domestique

Les concentrations dans l'air intérieur, les poussières intérieures et l'eau domestique sont requises pour estimer l'exposition à l'intérieur d'un bâtiment, ce qui concerne ici tous les scénarios.

Les concentrations (teneurs de fond et concentrations additionnelles) dans l'air intérieur et les poussières intérieures ont été estimées à partir des concentrations dans l'air ambiant (voir section 4.2.1) et dans les

1 Les taux de dépôt correspondent à la masse de particules totales (en g) qui se dépose annuellement par unité de surface du territoire (m^2).

sols (voir section 4.2.2), selon les équations présentées à l'annexe F. Les valeurs obtenues sont présentées aux tableaux 12 (teneurs de fond) et 13 (additionnelles).

Il a été considéré que l'eau potable du Relais routier (voir section 4.2.3) était utilisée pour les activités domestiques au Relais routier ainsi que dans les résidences considérées pour l'exposition domestique (aucune information spécifique sur les sources et la qualité de l'eau potable à ces résidences n'étant disponible). Lors des séjours dans la zone d'exposition rapprochée (activités traditionnelles), il a été supposé que l'eau de surface (voir section 4.2.4) était utilisée à des fins d'hygiène.

4.2.6 Aliments d'origine commerciale

Du fait de la présence de métaux dans la plupart des aliments, les apports en métaux découlant de la consommation alimentaire en général doivent être pris en compte pour estimer l'exposition bruit de fond. Pour la plupart des métaux d'intérêt, les apports alimentaires (doses) ont été documentés pour la population canadienne par Santé Canada. Ces données sont considérées comme une information fiable et représentative de l'exposition de la population en général via l'alimentation et ont été utilisées lorsque disponibles. Par défaut, les apports alimentaires de quelques métaux ont dû être déterminés à partir d'autres données disponibles dans la littérature. Les apports alimentaires utilisés sont présentés à l'annexe G.

4.2.7 Aliments issus des activités traditionnelles

Lorsque disponibles, des données locales ont été utilisées (cas des teneurs de fond de métaux dans les végétaux). Par défaut, les concentrations dans les végétaux (concentration additionnelle), la chair de gibier et la chair de poisson ont été estimées par modélisation à partir des concentrations mesurées ou estimées dans les milieux environnementaux.

Davantage de détails sont fournis ci-après. Les modèles et les paramètres utilisés sont présentés à l'annexe F. Les concentrations retenues pour estimer l'exposition des récepteurs humains sont présentées au tableau 13 (teneurs de fond) et au tableau 14 (concentrations additionnelles).

4.2.7.1 Concentrations dans les végétaux

Les valeurs retenues pour représenter les teneurs de fond dans les végétaux correspondent à la moyenne des concentrations mesurées dans les 32 échantillons[1] prélevés dans la zone d'étude dans le cadre de l'étude spécialisée sur la flore (WSP, 2018d) (voir annexe E).

Les concentrations additionnelles de métaux dans les plantes (feuilles, fruits et racines de végétaux terrestres) ont été estimées à partir des concentrations additionnelles modélisées dans l'air ambiant.

Les concentrations dans les végétaux retenues pour estimer l'exposition des récepteurs humains à chacun des métaux peuvent être décrites comme suit :

- Teneur de fond : moyenne des concentrations mesurées dans les végétaux (mélange de fruits, tiges, feuilles provenant d'herbacées, d'arbustes et d'arbres).

1 Les échantillons prélevés sont des composites de différents tissus (feuilles, fruits, branches), en proportion variable et non rapportée. Les espèces échantillonnées sont le bleuet (*Vacccinium spp.*), le thé du Labrador (*Rhododendron groenlandicum*), le kalmia à feuilles étroites (*Kalmia angustifolia*), l'aulne (*Alnus spp.*), l'épinette noire (*Picea mariana*) et le mélèze laricin (*Larix laricina*).

- Concentration additionnelle : pour les fruits, concentrations estimées dans les parties reproductrices des plantes arbustives, et pour l'infusion, moyenne des concentrations estimées dans les feuilles d'herbacées, d'arbustes et arbres.

4.2.7.2 Concentrations dans la chair de gibier

En l'absence de données mesurées, les concentrations (bruit de fond et additionnelles) dans la chair de gibier ont dû être estimées par modélisation. Pour ce faire, les espèces de mammifères et d'oiseaux potentiellement consommées par les récepteurs ont été identifiées et intégrées dans un modèle conceptuel de l'écosystème de la zone d'étude. Puisque certains carnivores s'alimentent de petits mammifères, ce modèle intègre également la musaraigne cendrée et la souris sylvestre.

Les espèces potentiellement consommées ont été identifiées à partir de l'information recueillie lors des entrevues réalisées auprès de la Communauté crie dans le cadre du Projet (WSP, 2018g), de la liste des espèces observées dans la zone d'étude (WSP, 2018b) ainsi que d'une présentation portant sur l'alimentation des Cris de l'Eeyou Istchee (Godin, 2004).

- Les espèces de mammifères chassées ou trappées par les Cris (et donc potentiellement consommées) retenues pour la présente étude sont : le caribou forestier, le castor du Canada, le lièvre arctique, le lynx du Canada, la martre d'Amérique, l'orignal, l'ours noir et le porc-épic d'Amérique.
- En ce qui concerne les oiseaux, en l'absence d'information spécifique sur les espèces réellement consommées[1], les espèces ont été sélectionnées de façon à représenter la diversité des modes de vie (alimentation, milieu de vie principal) des oiseaux potentiellement chassés dans la région. Les espèces retenues pour la présente étude sont : la bernache du Canada, le canard noir, le lagopède des saules, la petite oie des neiges, la sarcelle d'hiver et le tétras du Canada.

Les régimes alimentaires de l'ensemble des espèces incluses au modèle conceptuel ont été documentés, et les concentrations dans la chair des différents mammifères et oiseaux ont été estimées sur une base saisonnière, en considérant l'ensemble des voies d'exposition pertinentes (ex. : inhalation, ingestion de sols et/ou de sédiments, ingestion d'eau, alimentation).

Les concentrations dans la chair de gibier retenues pour estimer l'exposition des récepteurs humains à chacun des métaux peuvent être décrites comme suit :

- Sélection des concentrations saisonnières les plus élevées (teneur de fond et concentration additionnelle);
- Teneur de fond : en l'absence d'information sur la proportion de chaque espèce de mammifère et d'oiseau dans la diète des récepteurs, moyenne des teneurs de fond modélisées dans la chair des différentes espèces potentiellement consommées;
- Concentration additionnelle : valeur la plus élevée parmi les concentrations modélisées pour les diverses espèces potentiellement consommées, ce qui constitue une approche prudente.

1 Extrait des entrevues réalisées dans le cadre du Projet : *All kinds of geese and ducks are hunted. "Whatever we have. Geese is geese to us, [we] don't group them out. Like the [ducks]."*

4.2.7.3 Concentrations dans la chair de poisson

En l'absence de données mesurées, les concentrations de métaux (bruit de fond et additionnelles) dans la chair de poisson ont aussi dû être estimées par modélisation. Le modèle utilisé ne fait pas de distinction entre les espèces de poissons. Les concentrations estimées dans la chair de poisson ne sont donc pas spécifiques à certaines espèces de poissons.

Les concentrations dans la chair de poisson retenues pour estimer l'exposition des récepteurs humains à chacun des métaux peuvent être décrites comme suit :

- Teneur de fond : concentration modélisée dans la chair de poisson à partir de la teneur de fond dans l'eau de surface;
- Concentration additionnelle : concentration modélisée dans la chair de poisson à partir de la concentration additionnelle dans l'eau de surface.

4.3 Niveaux d'exposition des récepteurs

Les niveaux d'exposition des récepteurs découlant des activités du Projet (exposition additionnelle) ou non (exposition bruit de fond) ont été estimées de façon indépendante à partir des concentrations présentées dans les tableaux 8 à 14 et selon les scénarios d'exposition décrits à la section 4.1 (scénarios du Relais routier, d'activités traditionnelles ou combiné). Les niveaux d'exposition par inhalation sont exprimés sous forme de concentrations dans l'air. Les niveaux d'exposition par plusieurs voies (ingestion + contact cutané ± inhalation[1]) sont quant à eux exprimés sous forme de doses (en mg/kg-pc par jour).

Les niveaux d'exposition estimés à court, moyen et long terme sont présentés ci-après respectivement pour les expositions aiguë, sous-chronique et chronique.

4.3.1 Exposition aiguë

L'exposition aiguë par inhalation du récepteur le plus exposé dans la zone d'étude a pu être estimée pour les situations suivantes :

- Exposition bruit de fond, correspondant aux teneurs de fond estimées sur 1 heures, 8 heures et/ou 24 heures pour les gaz (CO, NO_2, SO_2), les $PM_{2.5}$ et quelques métaux sous forme de PM_{10} (tableau 8);
- Exposition additionnelle engendrée par les activités d'exploitation de la mine, correspondant aux concentrations maximales modélisées sur 1 heure, 8 heures et/ou 24 heures pour les gaz (CO, NO_2, SO_2), les $PM_{2.5}$ et les 24 métaux sous forme de PM_{10} (tableau 9).

4.3.2 Exposition sous-chronique

L'estimation de l'exposition sous-chronique par inhalation et par voies multiples est pertinente pour des récepteurs qui ne fréquentent pas la zone d'étude de façon continue. Dans le cas présent, les situations qui correspondent à ce critère sont l'exposition des travailleurs du Relais routier (séjours répétés de 2 semaines) et celle des récepteurs fréquentant la zone d'exposition rapprochée selon le scénario d'exposition lors des séjours pour activités traditionnelles (séjours d'une durée de quelques jours à 1 mois).

1 L'exposition par inhalation est ajoutée à celle par ingestion et contact cutané lorsque les effets par inhalation s'apparentent aux effets par ingestion et contact cutané, ou lorsqu'aucune VTR par inhalation n'est disponible.

L'exposition sous-chronique de ces récepteurs a été estimée à partir des concentrations mesurées ou modélisées dans l'air, dans le sol (teneur de fond), dans l'eau potable (eau du Relais routier), dans l'eau de surface et des apports alimentaires (issus d'aliments du commerce ou des activités traditionnelles).

4.3.2.1 Inhalation

L'exposition sous-chronique par inhalation du récepteur le plus exposé dans la zone d'étude a pu être estimée pour les situations suivantes :

- Exposition bruit de fond, correspondant aux teneurs de fond documentées sur une base mensuelle, lorsque disponible (gaz et $PM_{2.5}$) (tableau 8);
- Exposition additionnelle engendrée par les activités d'exploitation de la mine, correspondant à la plus élevée des concentrations modélisées sur 2 semaines ou sur une base mensuelle pour les gaz (CO, NO_2, SO_2), les $PM_{2.5}$ et les 24 métaux sous forme de PM_{10} (tableau 10).

4.3.2.2 Voies multiples

L'exposition sous-chronique aux métaux par voies multiples (ingestion, contact cutané, inhalation[1]) a pu être estimée pour les situations suivantes :

- Exposition bruit de fond: doses d'exposition estimées à partir des teneurs de fond en métaux dans les milieux environnementaux (tableau 12) ainsi que des apports alimentaires documentés pour la population générale (annexe G), pour le scénario du Relais routier, ou estimés à partir des teneurs de fond retenues dans les aliments issus des activités traditionnelles (tableau 13), pour le scénario des activités traditionnelles.
- Exposition additionnelle engendrée par les activités d'exploitation de la mine : doses d'exposition estimées à partir des concentrations annuelles de métaux sous forme de PST modélisées dans l'air (tableau 11) et des concentrations additionnelles estimées dans les autres milieux et les aliments issus des activités traditionnelles (tableau 14 et annexe F). L'utilisation des concentrations de métaux sous forme de PST pour estimer les doses d'exposition par inhalation conduit à une surestimation de l'exposition par cette voie.

Les doses d'exposition sous-chroniques retenues sont présentées au tableau 15 (bruit de fond et additionnelles) pour le scénario « Relais routier » et aux tableaux 16 (bruit de fond) et 17 (additionnelles) pour le scénario « Activités traditionnelles ». Elles correspondent à la valeur maximale entre l'exposition estimée en été et celle estimée en hiver. Le détail des doses par voie d'exposition est fourni à l'annexe H. Les résultats peuvent être résumés comme suit :

- La contribution (à l'exposition totale) des doses additionnelles est négligeable (<1%) pour la majorité des métaux. Des contributions faibles (1-10%) ou significatives (>10%) ont été obtenues pour 7 métaux (Al ≤ 4,3%, Be ≤ 5,7%, Cr ≤ 7,6%, Co ≤ 2,4%, Li ≤ 4,0%, Ti ≤ 11,5% et V ≤ 19,1%);
- Pour l'exposition bruit de fond de l'ensemble des récepteurs, l'ingestion est la voie d'exposition prépondérante (> 80%) pour la plupart des métaux. La contribution de l'exposition par contact cutané est significative pour 2 métaux (Be : 4-57%, Cr : 7-41%).

1 L'exposition par inhalation est ajoutée à celle par ingestion et contact cutané lorsque les effets par inhalation s'apparentent aux effets par ingestion et contact cutané, ou lorsqu'aucune VTR par inhalation n'est disponible.

- Pour l'exposition additionnelle, les voies contribuant le plus à l'exposition dépendent du scénario :
  - Scénario d'exposition au Relais routier : pour les principaux récepteurs (adultes), qui a priori consomment des aliments d'origine commerciale, l'exposition est essentiellement (pour près de 90%) due à l'ingestion et au contact cutané (dans des proportions variables pour les différents métaux); l'inhalation représente moins de 10% de l'exposition. Pour le mercure, l'inhalation est toutefois la seule voie d'exposition significative (99,9%). Pour les bébés (0-6 mois), l'ingestion (de lait maternel) est l'unique voie d'exposition;
  - Scénario d'exposition lors des séjours d'activités traditionnelles : l'ingestion est généralement la voie d'exposition prépondérante (> 80%). La contribution de l'exposition par contact cutané est toutefois significative pour 9 métaux (Al : 2-10%, Ag : 5-18%, Ba : 3-14%, Be : 35-69%, Cr : 7-39%, Mn : 3-17%, Ni : 13-39%, Ti : 2-18%, V : 6-25%).

4.3.3 Exposition chronique

L'estimation de l'exposition chronique par inhalation et par voies multiples est pertinente pour des récepteurs exposés de façon régulière et à long terme. Pour l'exposition par inhalation, seul le scénario d'exposition au Relais routier répond à ce critère. Pour l'exposition par voies multiples, les trois scénarios (exposition au Relais routier, lors des activités traditionnelles et domestique) répondent à ce critère.

4.3.3.1 Inhalation

L'exposition chronique par inhalation du récepteur représentant le Relais routier (REL1) a pu être estimée pour les situations suivantes :

- Exposition bruit de fond, correspondant aux teneurs de fond documentées sur une base annuelle pour les métaux (tableau 8).
- Exposition additionnelle engendrée par les activités d'exploitation de la mine, correspondant aux concentrations moyennes annuelles modélisées pour les gaz (CO, NO_2, SO_2), les $PM_{2.5}$, les 24 métaux sous forme de PM_{10} et la silice cristalline respirable (tableau 10).

4.3.3.2 Voies multiples

L'estimation de l'exposition chronique aux métaux via plusieurs voies (ingestion, contact cutané, inhalation[1]) a été estimée pour chacun des trois scénarios décrits à la section 4.1 à partir des concentrations environnementales et apports alimentaires fournis à la section 4.2. Tel qu'expliqué à la section 4.1.3.3, les résultats correspondant au scénario « Activités traditionnelles » ont été ajoutés à ceux de l'exposition domestique (scénario « combiné » présenté ci-dessous).

L'exposition chronique par voies multiples a pu être estimée pour les situations suivantes :

- Exposition bruit de fond : doses d'exposition estimées à partir des teneurs de fond en métaux dans les milieux environnementaux (tableau 12) ainsi que des apports alimentaires documentés pour la population générale (annexe G), pour le scénario du Relais routier et pour l'exposition domestique, ou estimés à partir des teneurs de fond retenues dans les aliments issus des activités traditionnelles

1 L'exposition par inhalation est ajoutée à celle par ingestion et contact cutané lorsque les effets par inhalation s'apparentent aux effets par ingestion et contact cutané, ou lorsqu'aucune VTR par inhalation n'est disponible.

(tableau 13), pour le scénario des activités traditionnelles. Les doses bruit de fond correspondent à la moyenne de l'exposition estimée en été et en hiver.

- Exposition additionnelle engendrée par les activités d'exploitation de la mine : doses estimées à partir des concentrations annuelles de métaux sous forme de PST modélisées dans l'air (tableau 11) et des concentrations additionnelles estimées dans les autres milieux et les aliments issus des activités traditionnelles[1] (tableau 14 et annexe F). L'utilisation des concentrations de métaux sous forme de PST pour estimer les doses d'exposition par inhalation conduit à une surestimation de l'exposition par cette voie. Pour le scénario au Relais routier, les doses additionnelles ont été calculées en considérant un temps de présence dans la zone d'étude de 25 semaines par année. Pour le scénario combiné, les doses ont été calculées en considérant 20,5 semaines par an de présence dans la zone d'exposition rapprochée et 31,5 semaines par an de présence au domicile.

Les doses d'exposition chronique ainsi estimées sont présentées au tableau 18 pour le scénario d'exposition au Relais routier et aux tableaux 19 (bruit de fond) et 20 (additionnelles) pour le scénario combiné. L'annexe J fournit le détail des doses bruit de fond et additionnelles par voie d'exposition. Les résultats peuvent être résumés comme suit :

- La contribution (à l'exposition totale) des doses additionnelles est négligeable (<1%) pour la majorité des métaux. Des contributions faibles (1-10%) ont été obtenues pour 6 métaux (Al ≤ 1,9%, Be ≤ 4%, Cr ≤ 4%, Li ≤ 1,1%, Ti ≤ 3,6% et V ≤ 5,1%);
- Pour l'exposition bruit de fond de l'ensemble des récepteurs, l'ingestion est la voie d'exposition prépondérante (> 80%) pour la plupart des métaux. L'exposition par contact cutané est significative pour 2 métaux (Be : 3-42%, Cr : 5-30%).
- Pour l'exposition additionnelle, les voies contribuant le plus à l'exposition dépendent du scénario :
  - Scénario d'exposition au Relais routier : pour les principaux récepteurs (adultes), qui a priori consomment des aliments d'origine commerciale, l'exposition est essentiellement (pour près de 90%) due à l'ingestion et au contact cutané (dans des proportions variables pour les différents métaux); l'inhalation représente moins de 12% de l'exposition. Pour le mercure, l'inhalation est toutefois la seule voie d'exposition significative (99,9%). Pour les bébés (0-6 mois), l'ingestion (de lait maternel) est l'unique voie d'exposition;
  - Scénario combiné (activités traditionnelles + exposition domestique): l'ingestion est généralement la voie d'exposition prépondérante (plus de 80%). L'exposition par contact cutané est toutefois significative pour 9 métaux (Al : 1-13%, Ag : 6-21%, Ba : 3-19%, Be : 39-73%, Cr : 8-43%, Mn : 5-18%, Ni : 15-40%, Ti : 2-19%, V : 7-29%).

Ces doses ont été utilisées pour estimer les risques d'effets autres que le cancer à long terme.

1 Pour le scénario d'exposition domestique, seules les concentrations additionnelles dans les aliments provenant de la zone d'exposition rapprochée sont considérées.

4.3.4 Niveaux d'exposition moyens à vie

Dans le cadre de l'estimation du risque additionnel de cancer, il est généralement considéré que le risque est proportionnel à la dose cumulée durant la vie. Pour évaluer le risque additionnel de cancer, il convient donc d'utiliser le niveau d'exposition moyen à vie, qui dans le cas présent correspond à la dose additionnelle cumulée durant 16 années (durée d'exploitation probable de la mine prévue) divisée par 70 ans (INSPQ, 2012).

Comme pour l'exposition chronique, l'estimation de l'exposition moyenne à vie est présentée pour deux scénarios (exposition au Relais routier et exposition combinée). Les niveaux d'exposition moyens à vie ont été estimés comme suit :

- Pour l'inhalation, les concentrations moyennes cumulées à vie ont été estimées pour le Relais routier (récepteur REL1) et pour le récepteur le plus exposé situé dans la zone d'exposition rapprochée (récepteur EAU2 ou TRC1 selon la substance), à partir des concentrations additionnelles annuelles présentées au tableau 10;
- Pour l'exposition par voies multiples, les doses d'exposition moyennes à vie ont été estimées à partir des doses additionnelles estimées pour une exposition chronique (tableaux 18 et 20).
- Afin de maximiser[1] l'exposition estimée pour le scénario combiné (qui inclut tous les groupes d'âge), il a été supposé que l'individu récepteur naîtra au début de l'exploitation (2022). Pour le scénario Relais routier, l'exposition cumulée a été estimée pour un récepteur adulte.

Les niveaux d'exposition moyens à vie par ingestion et par inhalation ont été calculés selon l'équation suivante en pondérant le niveau d'exposition de chaque groupe d'âge par la durée correspondante (T_i).

$$Exposition\ moyenne\ \text{à}\ vie = \frac{\sum_{i=1}^{5}[Dose_i\ ou\ Concentration_i] \times T_i}{\sum_{i=1}^{5} T_i}$$

Où

Exposition moyenne à vie :	Dose (mg/kg-pc par jour) ou concentration (µg/m^3) moyenne entre 0 et 70 ans;
$Dose_i$:	Dose ou concentration d'exposition additionnelle (moyenne sur une base annuelle) du groupe d'âge i;
T_i :	Nombre d'années correspondant au groupe d'âge i.

L'exposition moyenne à vie, présentée au tableau 21, n'a été calculée que pour les substances classées cancérogènes ou probablement cancérogènes pour l'humain, et pour lesquelles un risque unitaire (applicable à une concentration dans l'air) ou un coefficient de cancérogénicité (applicable à une dose) est disponible, c.-à-d. pour 5 métaux.

1 À concentration d'exposition égale, la dose d'exposition des enfants est plus élevée que celle des adultes car leurs taux d'exposition relatifs à leur poids corporel est plus élevé (par exemple, le taux global d'ingestion de nourriture d'un enfant de 0,5-4 ans est de 0,07 kg/kg-pc par jour tandis que celui d'un adulte est environ 5 fois plus faible (0,014 kg/kg-pc par jour). L'exposition cumulée sur 16 ans estimée pour un enfant (qui évolue de 0 à 16 ans) est donc plus élevée que celle estimé pour un adulte.

5. ESTIMATION ET ÉVALUATION DES RISQUES

5.1 Estimation des risques

5.1.1 Effets autres que le cancer

5.1.1.1 Calcul des indices de risque

Les niveaux de risques d'effets autres que le cancer sont représentés par des indices de risque (IR) qui sont calculés en divisant, pour chaque substance et chaque durée d'exposition[1], le niveau d'exposition estimé (concentrations dans l'air ou doses d'exposition) par la VTR correspondante (tableaux 3, 4 et 5). Les VTR étant définies comme des concentrations ou des doses n'entraînant pas d'effet néfaste sur la santé advenant une exposition de la durée indiquée, un IR inférieur ou égal à l'unité (IR ≤ 1) assure l'absence d'effets sur la santé. Toutefois, un IR supérieur à l'unité (IR > 1) ne signifie pas nécessairement qu'il y a un risque réel pour la santé des individus exposés, car les VTR sont assorties d'une certaine marge de sécurité (pouvant atteindre plusieurs ordres de grandeur).

L'approche utilisée pour estimer les risques varie en fonction de la toxicité des substances et/ou des VTR disponibles selon la voie d'exposition. En l'absence de VTR par voie cutanée, la VTR par ingestion s'applique à la dose d'exposition conjointe par ingestion et par contact cutané. En ce qui concerne l'inhalation, deux situations peuvent être rencontrées :

- Lorsqu'une substance présente une toxicité différente par inhalation (ex. : substance ayant des effets sur le système respiratoire) et par ingestion (ex. : effet systémique, c'est-à-dire après distribution de la substance dans l'organisme), il existe généralement une VTR propre à chacune de ces voies. Dans ce cas, deux IR distincts sont calculés et les risques correspondant à chaque voie sont estimés et évalués séparément. L'IR par inhalation correspond alors à la concentration d'exposition divisée par la VTR exprimée en concentration (µg/m^3). L'IR par ingestion et contact cutané est quant à lui calculé en divisant la dose combinant ingestion et contact cutané par la VTR par voie orale exprimée en dose (mg/kg-pc par jour). Pour les gaz (CO, SO_2 et NO_2), les particules ($PM_{2.5}$) et la silice cristalline respirable, dont les effets appréhendés découlent uniquement de l'inhalation, seules des VTR par inhalation sont disponibles;
- Lorsque rien n'indique que la substance a une toxicité différente par inhalation et par ingestion, ou lorsqu'aucune VTR par inhalation n'a été dérivée par une institution reconnue, il est présumé que la substance a une toxicité semblable par l'une et l'autre voie. Dans ce cas, les doses par inhalation, ingestion et contact cutané sont combinées pour estimer le risque posé par l'exposition via toutes ces voies.

Les IR combinant plusieurs voies d'exposition (ingestion, contact cutané et, dans certains cas, inhalation) sont appelés « IR par plusieurs voies ». Lorsque les données disponibles permettent de supposer que l'absorption d'une substance par inhalation ou par contact cutané diffère significativement de l'absorption par ingestion, les doses par inhalation ou contact cutané sont converties en dose par ingestion équivalente[2].

1 Aiguë, sous-chronique ou chronique.
2 Cas du cuivre, pour lequel l'absorption par inhalation a été fixée à 100% tandis que l'absorption par ingestion a été fixée à 12%. La dose par inhalation est dans ce cas divisée par 12% avant de l'ajouter à la dose par ingestion.

Pour chaque substance et durée d'exposition, trois IR ont été estimés (dans la mesure où l'information requise était disponible) :

- L'IR bruit de fond (IR_{BF}), calculé à partir de la concentration bruit de fond dans l'air ou de la dose bruit de fond. Ces IR sont indépendants des activités de la mine;
- L'IR additionnel (IR_{Add}), calculé à partir de la concentration additionnelle dans l'air ou de la dose additionnelle. Ces IR découlent des activités de la mine;
- L'IR total (IR_{Tot}), qui correspond à la somme de l'IR additionnel et de l'IR bruit de fond.

Les résultats sont présentés aux sous-sections suivantes pour les effets engendrés par une exposition aiguë (1 heure, 8 heures et 24 heures), sous-chronique (2 semaines et 1 mois) et chronique (≥ 1 ans). Dans les tableaux, les IR basés sur une VTR provisoire sont indiqués entre parenthèses et les IR supérieurs à l'unité sont indiqués en caractères gras.

Ces résultats sont discutés plus en détails à la section 5.3 (Évaluation des risques).

5.1.1.2 Niveaux de risque estimés – Exposition aiguë par inhalation

Les risques qui pourraient être engendrés par les activités du Projet (IR_{Add}) ont été estimés à partir des concentrations additionnelles maximales modélisées (sur 1 heure, 8 heures et/ou 24 heures) dans la zone d'étude (tableau 9). Les IR_{Add} maximaux obtenus sont présentés au tableau 22, en parallèle avec les IR_{BF} et les IR_{Tot} maximaux. Faute de teneur de fond sur 1 et 8 heures, certains IR_{BF} n'ont pas pu être estimés. Aussi, aucune VTR n'ayant été développée pour la silice pour une exposition aiguë à la silice (absence d'effets reconnus à court-terme), aucun IR n'a été estimé (les effets d'une exposition à long terme ont toutefois été estimés à section 5.1.1.4). Les résultats indiquent que :

- Sur 1 heure, tous les IR sont inférieurs à l'unité, excepté pour le NO_2 (IR_{Add} et IR_{Tot});
- Sur 8 heures, tous les IR sont inférieurs à l'unité;
- Sur 24 heures, tous les IR sont inférieurs à l'unité, excepté pour les $PM_{2.5}$ (IR_{Tot}).

5.1.1.3 Niveaux de risque estimés – Exposition sous-chronique

Les risques posés par une exposition sous-chronique (inhalation et voies multiples) ont été estimés en supposant qu'un individu (de tout âge) pourrait passer jusqu'à 4 semaines consécutives la zone d'exposition rapprochée.

- **Indices de risque par inhalation**

  Les IR par inhalation sont présentés au tableau 23. Ils ont été calculés à partir des teneurs de fond dans l'air (sur une base mensuelle, lorsque disponibles; tableau 8) et à partir des concentrations additionnelles maximales estimées sur 2 semaines (scénario Relais routier) ou sur 1 mois (scénario activités traditionnelles). Les résultats (tableau 10) peuvent être résumés comme suit :

  - Tous les IR_{Add} (découlant uniquement des activités du Projet) sont inférieurs à l'unité;
  - Tous les IR_{Tot} (découlant du bruit de fond et des activités du Projet) sont également inférieurs à l'unité.

- **Indices de risque par voies multiples (métaux)**

Les indices de risque totaux (IR_{Tot}) découlant de l'exposition par plusieurs voies (séjours de 2 semaines au Relais routier ou de 1 mois dans la zone d'exposition rapprochée) sont présentés aux tableaux 24 et 25 en parallèle avec la contribution du Projet au risque total (contribution exprimée en pourcentage). Les autres indices (IR_{BF} et IR_{Add}) sont présentés à l'annexe I. Ces indices de risque ont été calculés à partir des doses d'exposition indiquées aux tableaux 15 à 17. Ces résultats peuvent être résumés comme suit :

- Tous les IR_{Add} (découlant uniquement des activités du Projet) sont inférieurs à l'unité ($IR_{Add} \leq 0,5$ pour l'arsenic, et $IR_{Add} \leq 0,03$ pour les autres substances);
- Parmi les métaux dont les IR sont basés sur des VTR reconnues par l'INSPQ, le mercure présente des IR_{BF}, et par conséquent des IR_{Tot}, qui dépassent l'unité ($IR_{Tot} \leq 1,6$). La contribution des activités du Projet est négligeable (0,07%);
- Parmi les métaux dont les IR sont basés sur des VTR provisoires, certains présentent des IR_{BF}, et par conséquent des IR_{Tot}, qui dépassent l'unité. Il s'agit de l'arsenic ($IR_{Tot} \leq 695$), du cuivre ($IR_{Tot} \leq 1,8$), du lithium ($IR_{Tot} \leq 3$), du manganèse ($IR_{Tot} \leq 16$), du nickel ($IR_{Tot} \leq 1,3$), du sélénium ($IR_{Tot} \leq 1,1$) et du zinc ($IR_{Tot} \leq 1,5$). Dans tous les cas, la contribution du Projet est négligeable (≤ 0,55% pour l'arsenic, et ≤ 0,1% pour les autres métaux).

5.1.1.4 Niveaux de risque estimés – Exposition chronique

Tel que mentionné précédemment (section 4.3.3), les risques posés par une exposition chronique sont présentés pour le scénario d'exposition au Relais routier (inhalation et voies multiples) et pour le scénario combiné (activités traditionnelle et exposition domestique; voies multiples uniquement).

- **Indices de risque par inhalation**

Les IR chroniques par inhalation sont présentés au tableau 26. Ils ont été calculés à partir des teneurs de fond dans l'air (sur une base annuelle; tableau 8) et des concentrations additionnelles maximales modélisées sur une base annuelle (tableau 10). Les résultats peuvent être résumés comme suit :

- Tous les IR_{Add} (découlant uniquement des activités du Projet) sont inférieurs à l'unité;
- Tous les IR_{Tot} (découlant du bruit de fond et des activités du Projet) sont également inférieurs à l'unité.

- **Indices de risque par voies multiples (métaux)**

Les indices de risque totaux (IR_{Tot}) par plusieurs voies sont présentés aux tableaux 27 et 28 en parallèle avec la contribution du Projet au risque total (contribution exprimée en pourcentage). Les autres indices (IR_{BF} et IR_{Add}) sont présentés à l'annexe I (tableau I-3). Ces indices de risque ont été calculés à partir des doses d'exposition indiquées aux tableaux 18 à 20. Ces résultats peuvent être résumés comme suit :

- Tous les IR_{Add} (découlant uniquement des activités du Projet) sont inférieurs à l'unité ($IR_{Add} \leq 0,25$ pour l'arsenic, et $IR_{Add} \leq 0,044$ pour les autres substances);
- Parmi les métaux dont les IR sont basés sur des VTR reconnues par l'INSPQ, certains présentent des IR_{BF}, et par conséquent des IR_{Tot}, qui dépassent l'unité. Il s'agit de l'arsenic ($IR_{Tot} \leq 695$), du cadmium ($IR_{Tot} \leq 2,6$), du cuivre ($IR_{Tot} \leq 1,8$), du nickel ($IR_{Tot} \leq 1,3$), du sélénium ($IR_{Tot} \leq 1,1$) et du zinc ($IR_{Tot} \leq 1,5$). Dans tous les cas, la contribution du Projet est négligeable (≤ 0,06%);

- Parmi les métaux dont les IR sont basés sur des VTR provisoires, certains présentent des IR_{BF}, et par conséquent des IR_{Tot}, qui dépassent l'unité. Il s'agit de l'étain ($IR_{Tot} \leq 3,9$), du lithium ($IR_{Tot} \leq 3$), et du vanadium ($IR_{Tot} \leq 1,5$). Dans tous les cas, la contribution du Projet est négligeable (≤ 1% pour le lithium, ≤ 0,01% pour l'étain et le vanadium).

5.1.2 Risque additionnel de cancer estimé sur la durée de vie

La plupart des substances cancérogènes sont considérées comme des substances toxiques pour lesquelles à toute dose non nulle correspond un risque plus ou moins important (effet « sans seuil »). C'est pourquoi le risque est exprimé en termes de probabilité. Il devient donc nécessaire de définir un niveau de risque additionnel de cancer jugé négligeable. Le niveau de risque additionnel de cancer jugé négligeable par l'INSPQ (2012) est de 1,0E-06, soit un cas additionnel par million d'individus qui seraient exposés toute leur vie durant dans les conditions d'exposition décrites.

Le risque additionnel de cancer a été estimé pour toutes les substances considérées cancérogènes et pour lesquelles des VTR pour le cancer étaient disponibles, à partir des niveaux d'exposition additionnels moyens à vie présentés au tableau 21. Les résultats, présentés au tableau 29, peuvent être résumés comme suit :

- Le niveau global de risque additionnel de cancer maximal estimé (3,1E-07, pour le scénario combiné) est extrêmement faible et correspond à un cas sur 3,2 millions;
- Ce risque additionnel de cancer maximal estimé est plus faible que le niveau de risque jugé négligeable par l'INSPQ. Le niveau de risque additionnel de cancer attribuable aux activités du Projet est donc négligeable.

5.2 Analyse de l'incertitude

Les niveaux de risques calculés dans la présente étude sont basés sur des niveaux d'exposition estimés par modélisation, ce qui implique plusieurs sources d'incertitude. Les principales sources d'incertitude identifiées à chacune des trois premières étapes de la démarche d'évaluation du risque sont discutées dans les sous-sections suivantes.

5.2.1 Identification du danger

Toutes les substances gazeuses (CO, NO_2 et SO_2) ou particulaires (particules; métaux et silice cristalline associés aux particules) pour lesquelles des concentrations modélisées dans l'air et des VTR reconnues par l'INSPQ étaient disponibles ont été considérées dans la présente étude. Par manque d'information toxicologique appropriée, les éléments rares[1] détectés dans les roches ont été exclus de l'étude, à l'exception du lithium.

Les macroéléments qui sont peu toxiques et auxquels la population est très largement exposée *via* l'alimentation[2] n'ont pas été considérés dans la présente étude. Rien ne laisse supposer que des substances supplémentaires auraient dû être incluses à la liste des substances d'intérêt.

1 Indium, lanthane, lithium, lutécium, praséodyme, samarium, scandium thallium, thulium tungstène, yttrium et zirconium.
2. Calcium, magnésium, sodium, potassium, phosphore et soufre.

5.2.2 Caractérisation toxicologique

Une caractérisation toxicologique exhaustive a été effectuée afin d'identifier les effets possibles de ces substances sur la santé ainsi que les VTR disponibles pour chacune d'elles, chaque durée d'exposition (aiguë, sous-chronique et chronique) et chaque voie d'exposition (inhalation, ingestion et contact cutané).

Comme indiqué précédemment (section 3.2), les VTR correspondent à des niveaux d'exposition jugés sécuritaires. Elles sont basées sur un niveau d'exposition associé à un effet critique divisé par un facteur global de sécurité. Le niveau d'exposition associé à l'effet critique est caractérisé à partir de données toxicologiques obtenues chez l'animal (en laboratoire) ou chez l'humain (volontaires exposés expérimentalement) ou de données épidémiologiques (travailleurs exposés en milieu de travail ou population exposée *via* la contamination de son environnement). Le niveau d'exposition critique est souvent beaucoup plus élevé que le niveau d'exposition environnemental qui doit être évalué. Le facteur global de sécurité est composé de facteurs multiplicatifs qui sont sélectionnés en fonction des données toxicologiques disponibles (ex. : espèce(s) testée(s), durée de l'exposition, voie d'exposition, information disponible concernant la relation dose-réponse (NOAEL, LOAEL, BMDL), nature des effets étudiés) et de la durée d'exposition désirée pour la VTR (ex. : dérivation d'une VTR chronique à partir d'une étude de durée sous-chronique). Les facteurs sont utilisés pour pallier le manque d'information (ex. : information insuffisante pour une catégorie d'effets donnée, information insuffisante pour une exposition à long terme, différences entre espèces) et pour tenir compte de la présence d'individus sensibles au sein de la population générale.

Les VTR étant définies comme des niveaux d'exposition jugés sécuritaires, c'est-à-dire auxquels un individu peut être exposé de façon répétée durant la période indiquée (ex. : pour une VTR chronique, exposition quotidienne durant toute la vie), le respect d'une VTR peut être interprété comme une absence de risque. Toutefois, l'interprétation d'un dépassement de VTR (IR > 1) nécessite une analyse plus approfondie qui tient compte à la fois de l'incertitude associée à la VTR et de l'incertitude associée au niveau d'exposition estimé.

Des VTR recommandées par des institutions de santé reconnues par l'INSPQ ont été identifiées pour la plupart des substances, notamment pour l'estimation du risque posé par une exposition chronique (cancer et autres effets néfastes sur la santé). Des VTR correspondant à des durées d'exposition plus courtes (ex. : 1 heure, 8 heures, 24 heures) ont également été identifiées pour quelques substances. Pour l'exposition sous-chronique, la préférence a été donnée aux VTR proposées pour une durée d'exposition dite intermédiaire (ATSDR : 15-365 jours) ou sous-chronique (U.S. EPA : <365 jours). Par défaut, les VTR définies pour une exposition chronique ont été appliquées. Considérant que les VTR diminuent lorsque la durée d'exposition augmente, cette approche est prudente et permet de détecter des problématiques éventuelles, ce qui peut conduire à une analyse approfondie des résultats. Pour le cadmium et la silice cristalline, dont la toxicité dépend de la quantité accumulée dans l'organisme au cours du temps, il est toutefois inapproprié d'estimer le risque à court terme[1]; le risque a donc été estimé pour une exposition chronique seulement.

1 Le cadmium exerce ses effets toxiques lorsque sa concentration dans le cortex rénal dépasse un certain niveau (concentration critique). Les institutions de santé ont donc établi la VTR chronique de façon à s'assurer que le cumul de cadmium tout au long de la vie ne conduise pas au dépassement de cette concentration critique dans le rein. Dans ces conditions, il est probable qu'une exposition de courte durée conduisant à une dose supérieure à la VTR chronique n'ait pas d'impact significatif sur la dose totale cumulée à long terme, donc sur le niveau de risques d'effets néphrotoxiques.

Des VTR permettant d'estimer le risque de cancer étaient disponibles pour toutes les substances classées comme cancérogènes ou probablement cancérogènes chez l'humain (arsenic, béryllium, cadmium, nickel et plomb) excepté les particules et la silice cristalline respirable. Aucune VTR n'était disponible pour les substances classées comme possiblement cancérogènes chez l'humain (cobalt, mercure inorganique, (dioxyde de) titane, (pentoxyde de) vanadium). Toutefois, ces substances ont tout de même été évaluées pour les risques d'effets chroniques autres que le cancer.

Les risques de cancer posés par les particules fines ($PM_{2.5}$) ont été évalués indirectement *via* les métaux cancérogènes ou probablement cancérogènes pour l'humain présents dans les particules inhalables (PM_{10}).

Pour la silice cristalline, la VTR retenue (2,0 µg/m^3), proposée par le Texas (TCEQ, 2009), est la seule qui soit applicable sans restriction de durée de d'exposition[1]. Elle découle d'une étude épidémiologique reconnue par plusieurs institutions comme étant la plus appropriée pour établir une relation dose-réponse basée sur l'exposition cumulée à la silice cristalline respirable. Le point de départ issu de la modélisation de la relation dose-réponse ainsi que l'approche utilisée pour dériver la VTR font consensus puisqu'ils ont été utilisés par plusieurs institutions pour établir une VTR (Cal/EPA, 2005; TCEQ, 2009) ou un critère de qualité de l'air[2]. Cette VTR permet d'évaluer le risque de silicose. Les données disponibles actuellement ne permettent pas de réaliser une évaluation quantitative des risques pour d'autres effets sur la santé. Il est à noter toutefois que le TCEQ (2009) a élaboré une valeur de dépistage[3] qui permet d'estimer le risque d'excès de cancer dans la population du Texas. Cette valeur est basée sur les résultats d'une méta-analyse de dix études épidémiologiques portant, sans distinction, sur des travailleurs atteints ou non de silicose (Steenland, Mannetje *et coll.*, 2001). Ces données ne permettant pas de différencier les travailleurs silicotiques et non-silicotiques, leur utilisation pour estimer le risque de cancer dans la population générale conduit à une surestimation du risque. Par ailleurs, le risque unitaire déterminé spécifiquement pour la population du Texas (ajustements basés sur le taux de mortalité totale et due au cancer du poumon au Texas et aux États-Unis) n'est pas directement applicable à une autre population (car les taux de mortalité seraient *a priori* différents).

Afin de pallier l'absence de VTR pour certaines combinaisons de substances et durées d'exposition, des VTR provisoires ont été dérivées de façon prudente, en appliquant des facteurs de sécurité. Sur cette base, il est attendu que le respect de ces VTR provisoires assure de l'absence de risque. En cas de dépassement, il est souhaitable d'évaluer les risques en comparant les niveaux d'exposition avec le niveau d'effet critique (ex. : NOAEL, LOAEL, BMDL) utilisé pour dériver la VTR provisoire (ce qui correspond à une estimation de la marge d'exposition).

Toutes les substances ont été évaluées pour une exposition à court, moyen et/ou long terme.

1 La seule autre VTR est celle proposée par Cal/EPA (3,0 µg/m^3), applicable pour une exposition de 24 années ou moins.
2 Les critères de qualité de l'air correspondent, à New-York, à la VTR du TECQ (2,0 µg/m^3), et, au Michigan et au Minnesota, à la VTR de Cal/EPA (3,0 µg/m^3).
3 Risque unitaire de 3,6E-05 par µg/m^3.

5.2.3 Caractérisation de l'exposition

5.2.3.1 Concentrations dans l'air ambiant

- **Teneurs de fond**

L'absence de données sur la qualité de l'air local représente une source d'incertitude pour l'estimation du risque par inhalation. Néanmoins, comme le Projet est situé dans une région éloignée, la qualité de l'air initiale est vraisemblablement bonne car elle ne devrait pas être influencée par des sources industrielles locales.

Pour les particules et les gaz, les teneurs de fond utilisées correspondent à des endroits pas ou peu influencés par d'autres sources anthropiques locales ou régionales, ce qui est comparable à la situation du Projet.

À défaut de telles mesures pour les métaux, les concentrations de métaux mesurées à des stations situées en Ontario à Burnt Island (berges du lac Huron) et à Point Petre (berges du lac Ontario), ont été utilisées pour 21 des 24 métaux (concentrations associées à des PM_{10}). Ces données ont permis de documenter des teneurs de fond sur des périodes de 24 heures et sur une base annuelle pour presque tous les métaux. Bien que situées dans des secteurs moins isolés que la zone d'étude, ces stations sont tout de même localisées en zones rurales et aucune source d'émission ponctuelle n'est visible à proximité de celles-ci. Les concentrations mesurées à ces stations sont susceptibles de surestimer légèrement l'exposition bruit de fond en métaux dans la zone d'étude. L'incertitude sur ces valeurs est jugée faible.

Pour le mercure, les données disponibles sont celles d'une station d'échantillonnage située à Alert (Nunavut). Les valeurs disponibles ont permis d'estimer des teneurs de fond sur 2 heures, 24 heures et sur une base annuelle. Les valeurs utilisées sont compatibles avec les cartes présentées par le Programme des Nations-Unis pour l'environnement (UNEP, 2018), qui suggèrent que les concentrations mesurées au nord-est de l'Amérique du Nord (c.-à-d. l'ensemble du Québec, l'est de l'Ontario et du Nunavut ainsi qu'une large portion du Groenland) sont peu variables. L'incertitude sur les teneurs de fond en mercure est donc jugée faible.

Pour l'uranium, des mesures associées aux $PM_{2.5}$ étaient disponibles pour la station de St-Anicet (QC), qui est située en zone rurale. Ces données ont permis d'estimer des teneurs de fond sur 24 heures et annuelle. Cette station est située dans un secteur moins isolé que la zone d'étude. Toutefois, considérant que les $PM_{2.5}$ représentent une fraction des PM_{10}, il est attendu que les concentrations de métaux retenues (associées aux $PM_{2.5}$) soient plus faibles que celles qui seraient associées à des PM_{10}. L'utilisation de ces données pour estimer le risque reste néanmoins pertinente car les VTR par inhalation pour les métaux sont basées sur des données toxicologiques obtenues avec des particules plus petites que les PM_{10}. Compte tenu de ce qui précède, l'incertitude associée à ces valeurs est jugée relativement faible.

Pour le lithium, aucune donnée assimilable à une teneur de fond dans l'air n'a pu être documentée. Les teneurs de fond ont donc été estimées à partir de la teneur de fond dans les sols de la zone d'étude et des teneurs de fond en PM_{10} dans l'air de régions rurales. L'incertitude associée à ces valeurs est plus élevée que pour les autres métaux.

- **Concentrations additionnelles**

Les concentrations additionnelles dans l'air ambiant ont été fournies par WSP. Elles ont été estimées par modélisation de la dispersion atmosphérique des émissions de la mine selon l'approche requise par le MELCC pour évaluer le respect du règlement sur l'assainissement de l'atmosphère (RAA). L'objectif de cette modélisation était d'estimer les concentrations potentielles maximales pouvant survenir pendant les activités projetées de la mine, tout en tenant compte du fait que les particules en suspension (notamment les plus grossières) finissent par retomber du fait de la gravité. Il est donc attendu que les concentrations retenues dans l'air conduisent à une surestimation de l'exposition additionnelle par inhalation appréhendée pour des récepteurs fréquentant la zone d'étude.

Les principales sources d'incertitude associées aux concentrations additionnelles dans l'air ambiant sont identifiées dans l'étude de modélisation de la dispersion atmosphérique (WSP, 2018e).

5.2.3.2 Concentrations de métaux dans les sols et les sédiments

- **Teneurs de fond**

Pour la plupart des métaux (20 sur 24), les teneurs de fond dans le sol et les sédiments retenues pour estimer l'exposition bruit de fond ont été estimées à partir de données locales, ce qui correspond à la meilleure source d'information possible. Pour 11 de ces métaux, les teneurs de fond dans les sols ont été estimées à partir des concentrations mesurées dans les sédiments. Pour les métaux détectés à la fois dans les sols et les sédiments, la différence entre les concentrations mesurées dans ces deux médias était inférieure à un facteur 2. L'incertitude sur ces données est donc jugée très faible.

Pour les autres métaux, les teneurs de fond ont été estimées à partir de données québécoises ou ontariennes. Puisque les concentrations en métaux dans les sols sont susceptibles de varier, parfois considérablement, d'une région à l'autre, l'absence de données locales constitue une incertitude qui peut sous-estimer ou surestimer l'exposition des récepteurs. L'incertitude sur ces données demeure faible.

- **Concentrations additionnelles**

Dans le cadre de la présente étude, aucune concentration additionnelle dans les sols ou dans les sédiments n'a pas pu être considérée puisque l'accumulation à long terme de métaux dans ces médias à partir de retombées atmosphériques ne saurait être prédite de façon satisfaisante. Par ailleurs, une revue de la littérature a montré que les concentrations de métaux dans les sols étaient rarement documentées à proximité de sites miniers sans fonderie à proximité. Ainsi, la seule étude identifiée (Merrington et Alloway, 1994) suggère que l'accumulation de métaux dans les sols situés à proximité d'une mine serait limitée lorsqu'aucune fonderie ne se trouve à proximité. Ces auteurs ont étudié le flux de certains métaux dans des sols affectés par plus de 100 ans de dépôts de particules provenant d'aires d'accumulation de stériles d'anciennes mines. Les sols étudiés étaient situés à 250-300 mètres du centre des aires d'accumulation de stériles (de dimensions non rapportées), et les échantillons de sol prélevés afin de déterminer les teneurs de fond régionales étaient situés entre 1 et 5 km des aires d'accumulation. Les auteurs ont remarqué qu'il n'était pas possible d'identifier de zones d'accumulation en métaux le long du profil vertical (0-25 cm) des sols étudiés, et que les concentrations de certains métaux (Cd et Zn en particulier) étaient très faibles comparativement aux taux de dépôt mesurés. Ces résultats suggèrent une faible rétention de ces éléments dans les sols de surface. Considérant ce qui précède, l'incertitude (sous-estimation) associée au fait d'avoir négligé

l'accumulation des métaux dans les sols de surface et dans les sédiments est donc vraisemblablement faible.

5.2.3.3 Concentrations de métaux dans l'eau potable

- **Teneurs de fond**

Pour 5 métaux sur 24, les teneurs de fond dans l'eau de surface correspondent à des valeurs mesurées dans l'échantillon prélevé au Relais routier. Pour 7 autres métaux, les valeurs retenues correspondent aux limites de détection atteintes lors de l'analyse de cet échantillon. Bien qu'un seul échantillon ait été prélevé au Relais routier, les teneurs de fond ainsi déterminées sont jugées représentatives de la réalité (valeurs mesurées) ou prudentes (limites de détection).

Pour 11 métaux, les teneurs de fond retenues dans l'eau potable correspondent aux valeurs mesurées dans l'eau de surface de la zone d'étude[1]. Pour 8 de ces métaux, les concentrations mesurées dans l'eau de surface sont plus faibles (mais du même ordre de grandeur) que les limites de détection atteintes lors de l'analyse de l'échantillon d'eau potable. L'utilisation de ces valeurs demeure donc prudente. Pour les 3 autres métaux (Ag, Be, U), les concentrations mesurées dans l'eau de surface sont plus faibles que les limites de détection atteintes dans l'eau potable par des facteurs variant entre 18 et 53. L'incertitude découlant de l'utilisation de ces valeurs est donc plus élevée mais n'a pas d'impact significatif sur les résultats (en utilisant les limites de détection dans l'eau potable comme teneur de fond, le risque resterait négligeable).

Pour le mercure (non analysé dans l'échantillon d'eau potable), la concentration moyenne dans l'eau souterraine rapportée par Choinière et Beaumier (1997) a été retenue. Ce document mentionne que les limites de détection atteintes lors de l'analyse des 5 482 échantillons recensés avaient de 1×10^{-5} mg/L (~50% des échantillons) et 5×10^{-5} mg/L (~50% des échantillons). Aucune information n'est fournie quant à la façon selon laquelle les valeurs non détectées ont été traitées lorsque l'analyse statistique a été réalisée. La teneur de fond retenue ($3{,}7 \times 10^{-5}$ mg/L) est située entre les deux limites de détection atteintes. Cette valeur pourrait donc être essentiellement représentative de ces limites de détection. À titre comparatif, la teneur de fond retenue dans l'eau de surface est près de 20 fois plus faible que la teneur de fond retenue dans l'eau potable. Cette dernière est donc jugée prudente.

- **Concentrations additionnelles**

Les concentrations additionnelles dans l'eau potable consommée au Relais routier ou au domicile des récepteurs ont été considérées nulles. Compte tenu de la distance entre la mine projetée et les résidences les plus proches (c.-à-d. en dehors de la zone d'étude), il est en effet possible d'affirmer que la mine n'aura aucun impact sur la qualité de l'eau potable aux résidences. Quant au cas du Relais routier, aucun impact du Projet n'est anticipé compte tenu du sens d'écoulement de l'eau souterraine (WSP, 2018h).

Pour ce qui concerne l'eau potable consommée lors des séjours d'activités traditionnelles, il a été considéré qu'il s'agissait de l'eau du Relais routier. Cependant, il ne peut être exclu que de l'eau provenant d'autres endroits soit consommée. Le cas échéant, il conviendrait de vérifier que les

1 Les teneurs de fond dans l'eau de surface ont été retenues lorsqu'elles étaient plus faibles que les limites de détection atteintes pour l'échantillon d'eau potable analysé.

activités du Projet n'ont pas d'impact significatif sur la qualité de cette eau, ou que des mesures soient prises pour éviter que celle-ci ne soit consommée.

5.2.3.4 Concentrations de métaux dans l'eau de surface

- **Teneurs de fond**

Pour 22 des 24 métaux d'intérêt, les teneurs de fond dans l'eau de surface ont été mesurées dans des échantillons prélevés localement. L'incertitude sur ces valeurs est très faible.

Pour l'étain et le titane, la représentativité des valeurs est plus incertaine puisqu'il s'agit de concentrations mesurées ailleurs au Canada ou aux États-Unis. Pour l'étain, la teneur de fond correspond à une limite de détection (1 µg/L) et 56 des 59 échantillons analysés présentaient des concentrations sous cette valeur. Cette valeur retenue (limite de détection) semble donc prudente. Pour le titane, la teneur de fond retenue (50 µg/L) est située au centre d'une plage de concentrations mesurées dans l'eau de surface au Canada et aux États-Unis (2-107 µg/L). Cette valeur est 5 fois plus élevée que la limite de détection atteinte lors de l'analyse de l'échantillon d'eau potable du Relais routier (le titane n'a pas été détecté dans cet échantillon). La teneur de fond retenue est donc jugée prudente.

- **Concentrations additionnelles**

Il est vraisemblable que le rejet de l'effluent final de la mine (dans le cours d'eau CE2) sera la principale source de métaux dans l'eau de surface de la zone d'étude. Par ailleurs, de l'eau ayant ruisselé ou s'étant infiltré dans les aires d'accumulation de dépôts meubles et de terre végétale pourrait aussi apporter des métaux dans le cours d'eau CE3. En l'absence d'information par rapport aux débits et à la qualité de l'effluent et des eaux de ruissellement/infiltration, les concentrations additionnelles dans l'eau de surface des cours d'eau de la zone d'étude attribuables aux rejets aqueux de la mine n'ont pas pu été considérées.

Dans ces conditions, les concentrations additionnelles dans l'eau de surface de la zone d'exposition rapprochée ont été estimées à partir des taux de dépôt atmosphériques estimés pour les récepteurs situés à proximité des cours d'eau CE1 à CE5, et des débits mensuels de ces cours d'eau, en considérant que les métaux associés à des particules en suspension dans l'eau ne sédimentent pas (ce qui pourrait surestimer la concentration dans l'eau).

Sur la base de ce qui précède, il semble acquis que les concentrations additionnelles de métaux dans l'eau de CE2 et, dans une mesure moindre, de CE3, soient sous-estimées. Bien qu'incertaines, les concentrations additionnelles estimées pour CE1, CE4 et CE5 sont réputées fournir un ordre de grandeur des valeurs attendues.

L'incertitude associée aux concentrations estimées est donc importante, notamment pour CE2 et CE3. Toutefois, les concentrations additionnelles dans l'eau de surface retenues pour la présente étude surestime vraisemblablement les concentrations dans les cours d'eau qui sont réellement fréquentés par les récepteurs puisque les cours d'eau les plus fréquentés par les récepteurs semblent être la rivière Eastmain et des lacs situés à proximité du Camp 1, c.-à-d. des plans d'eau qui sont situés à l'extérieur de la zone d'exposition rapprochée. Néanmoins, un suivi de la qualité de l'eau de surface devrait être réalisé pour CE3 et CE2 car certains récepteurs écologiques chassés ou trappés sont susceptibles d'y être exposés.

5.2.3.5 Concentrations de métaux dans les aliments issus des activités traditionnelles

- **Teneurs de fond**

Les teneurs de fond dans les végétaux ont été déterminées à partir de mesures réalisées dans plus de 30 échantillons provenant de 6 espèces de plantes différentes. Bien que les analyses aient été réalisées sur des échantillons composites (feuilles, fruits, tiges) et que les concentrations puissent varier d'une partie à l'autre de la plante, l'incertitude sur ces valeurs est faible.

Les teneurs de fond dans la chair de gibier et de poisson ont été modélisées et sont donc associées à une certaine incertitude. En effet, tous les modèles correspondent à une simplification de processus complexes et les résultats produits par ceux-ci correspondent à une approximation de la réalité. Le recours à la modélisation peut aussi bien sous-estimer que surestimer l'exposition des récepteurs.

Afin d'évaluer la fiabilité des estimations, les teneurs de fond modélisées dans la chair de gibier et de poisson ont été comparées aux concentrations rapportées dans la viande, la volaille et le poisson du commerce par différents auteurs (Ysart, Miller *et coll.*, 1999; Leblanc, Guérin *et coll.*, 2005; Health Canada, 2016). Pour la très grande majorité des métaux, les concentrations estimées dans la chair du caribou, de la petite oie des neiges[1] et des poissons étaient du même ordre de grandeur que celles mesurées dans la viande (bœuf, porc, agneau), la volaille (poulet, dinde) et les poissons du commerce[2], respectivement. Pour 7 métaux (Al, Ba, Be, Sn, Mn, Pb et U), la concentration modélisée dans l'un de ces 3 types de produits excède par un facteur entre 10 et 100 les mesures rapportées. Pour le vanadium, les concentrations modélisées dans ces trois types de chair excèdent les valeurs mesurées par des facteurs variant entre 12 et 23.

En définitive, les écarts observés entre les teneurs de fond modélisées et les concentrations mesurées dans la viande et le poisson du commerce sont jugés faibles. Ces derniers écarts sont de la même ampleur que la variabilité observée dans les concentrations mesurées dans différents échantillons de viande, volaille ou poisson du commerce. Sur la base de ces comparaisons, il semble raisonnable de considérer que l'incertitude sur les concentrations estimées dans la chair de gibier est d'environ un ordre de grandeur. Dans tous les cas où les teneurs de fond modélisées différaient par plus d'un ordre de grandeur des concentrations mesurées, les concentrations dans la chair de gibier étaient supérieures aux concentrations mesurées (possible surestimation des concentrations).

- **Concentrations additionnelles**

Les concentrations additionnelles de métaux dans les végétaux ont été estimées à l'aide d'un modèle proposé par le MELCC (MEF, 1996). Les principaux processus susceptibles d'influencer l'accumulation des métaux présents dans les particules dans l'air qui se déposent (c.-à-d. interception des particules par les végétaux, la production simultanée de nouvelles feuilles et la perte de surface principalement due au lessivage causé par la pluie) sont intégrés au modèle. Ces processus sont pris en compte à l'aide de paramètres empiriques moyens déterminés pour trois grandes classes de végétaux (herbacées, arbustes, arbres). Ce modèle est réputé fournir un ordre de grandeur des concentrations additionnelles dans les végétaux.

1 La comparaison a été réalisée à partir du caribou et de la petite oie des neiges en raison des similitudes (régime alimentaire, taille) avec les espèces commerciales.

2 Les concentrations rapportées dans les aliments du commerce étaient, pour certaines substances, très variables (différence de plus de 2 ordres de grandeur entre les valeurs minimales et maximales rapportées). Dans ce cas, les concentrations modélisées ont été comparées à la plage de valeurs mesurées.

L'incertitude associée aux concentrations additionnelles dans la chair de gibier et de poisson est plus élevée que celle considérée pour les teneurs de fond. Cette incertitude supplémentaire est principalement attribuable au fait que les concentrations additionnelles dans les milieux environnementaux (eau de surface, végétaux) ont été modélisées (à partir des concentrations dans l'air) plutôt que mesurées. Puisque les concentrations additionnelles dans l'air ont été modélisées à partir d'une approche réaliste mais prudente (WSP, 2018e), les concentrations additionnelles estimées à partir de celles-ci sont vraisemblablement prudentes. Ceci n'est toutefois valide que dans la mesure où i) les concentrations additionnelles estimées dans l'eau de CE2 et de CE3 sont représentatives de la réalité (c.-à-d. qu'elles n'augmentent pas de façon significative, ce qui devra être vérifié) et que ii) l'accumulation à long terme des métaux dans les sols de surface est faible et n'a pas d'impact significatif sur les concentrations de métaux dans les sols et les végétaux. Par ailleurs, tel que discuté précédemment, le recours à la modélisation pour estimer les concentrations additionnelles de métaux dans la chair de gibier et de poisson est également associé à une incertitude pouvant atteindre un facteur 10 (voir discussion ci-haut sur les teneurs de fond dans la chair de gibier).

5.2.3.6 Concentrations dans l'air intérieur et les poussières intérieures

Les concentrations dans l'air intérieur et dans les poussières intérieures ont été estimées par modélisation à partir des concentrations dans l'air ambiant, le sol et l'eau domestique (pour le mercure). L'incertitude sur les concentrations ainsi estimées est donc surtout reliée à l'incertitude sur les concentrations dans ces milieux. L'incertitude sur ces concentrations sont discutées dans les sections 5.2.3.1 à 5.2.3.4.

5.2.3.7 Exposition des récepteurs

➤ **Inhalation**

L'incertitude associée à l'exposition bruit de fond par inhalation est surtout attribuable à la représentativité des teneurs de fond retenues dans l'air ambiant (voir section 5.2.3.1). L'incertitude associée à l'exposition additionnelle[1] par inhalation peut être résumée comme suit :

- Les concentrations additionnelles utilisées ont été estimées par modélisation de la dispersion atmosphérique de façon volontairement prudente (voir section 5.2.3.1);
- L'exposition additionnelle dépend fortement de la localisation des récepteurs tout au long de leurs séjours. Afin de détecter tout risque potentiel, l'exposition a été estimée à partir des concentrations additionnelles modélisées les plus élevées, représentatives du récepteur le plus exposé se trouvant à l'intérieur de la zone d'exposition rapprochée. Cette approche est particulièrement prudente pour estimer les risques posés par une exposition sous-chronique ou chronique;
- L'exposition additionnelle aux métaux a été estimée à partir des concentrations de métaux dans les PM_{10}. Les PM_{10} incluent des particules fines qui peuvent rejoindre les poumons et des particules plus grossières qui sont piégées dans les voies respiratoires supérieures (et possiblement ingérées). La proportion de PM_{10} suffisamment petites pour pénétrer dans les voies respiratoires profondes est donc inférieure à 100%. Le fait de considérer que la quantité totale de métal présente dans les PM_{10} peut atteindre la partie profonde du système respiratoire constitue

1 Pour le scénario domestique, l'exposition additionnelle par inhalation est réputée nulle en raison de la distance entre les activités du Projet et les résidences des récepteurs.

une hypothèse prudente et peut conduire à une surestimation du risque par inhalation lorsque la VTR a été établie à partir de particules plus fines (ce qui est généralement le cas).

- **Apports alimentaires de la population en général**

Les apports alimentaires en métaux documentés pour la population générale correspondent *a priori* à une diète normale et complète, et ont été estimés à partir de concentrations mesurées dans des aliments achetés dans le commerce. Ces apports, qui ont été utilisés afin d'estimer l'exposition bruit de fond des récepteurs, sont jugés représentatifs de l'exposition de la population canadienne.

- **Exposition découlant des activités traditionnelles**

Les enquêtes disponibles sur les activités traditionnelles des récepteurs ont permis de brosser un portrait général de la fréquentation de la zone d'étude. Il appert que cette zone est fréquentée de façon régulière par plusieurs individus. L'exposition des récepteurs découlant de la consommation d'aliments issus des activités traditionnelles a toutefois été estimée en supposant que l'ensemble de ces activités étaient réalisées à l'intérieur de la zone d'exposition rapprochée, ce qui constitue une approche assez prudente. En effet, s'il est acquis que la zone d'exposition rapprochée est fréquentée par certains récepteurs, l'information disponible suggère que les récepteurs passent une bonne proportion de leur temps à l'extérieur de cette zone (Camp 1) ou en périphérie (Camp 8) de cette zone. Aussi, il semble que les cours d'eau situés dans la zone d'exposition rapprochée ne soient pas utilisés pour la pêche de subsistance. Finalement, les mammifères et oiseaux chassés ou trappés par les récepteurs ne proviennent pas exclusivement de la zone d'exposition rapprochée.

L'exposition des récepteurs découlant de la consommation d'aliments issus des activités traditionnelles a été estimée en se basant sur des hypothèses prudentes qui pourraient surestimer la quantité d'aliments consommées provenant de la zone d'exposition rapprochée. Les taux d'ingestion utilisés impliquent que pour une famille de 5 personnes (2 adultes, et 3 enfants ayant respectivement 0,5-4 ans, 5-11 ans et 12-19 ans), la quantité de nourriture (excluant les parties non consommées comme les os par exemple) provenant cette zone de 83 km^2 inclurait près de 570 kg de bleuets (ou autres petits fruits), 150 kg de viande, 75 kg de poisson et 3,7 kg d'herbes à infuser. Par ailleurs, il a été supposé que la totalité des métaux contenus dans les matières végétales étaient extraits, ce qui n'est pas le cas dans la réalité.

En définitive, le scénario à partir duquel l'exposition des récepteurs découlant de la consommation d'aliments issus des activités traditionnelles est jugé réaliste mais prudent. Les récepteurs fréquentant la zone d'étude ne passent pas la totalité de leur temps dans la zone d'exposition rapprochée. Par ailleurs, pour atteindre les taux d'ingestion d'aliments issus des activités traditionnelles considérés par la présente étude, les récepteurs doivent consommer de façon quotidienne ces aliments. L'information tirée des entrevues réalisées dans le cadre du Projet (WSP, 2018c) suggère que les aliments issus des activités traditionnelles sont consommés sur une base hebdomadaire plutôt que quotidienne. Il ne peut être exclu que certains récepteurs consomment plus d'herbes à infuser que ce qui a été supposé. Cependant, même si les doses additionnelles avaient été estimées en multipliant par 10 ce taux de consommation, les doses totales des récepteurs n'auraient pas augmenté de façon significative. Cette source d'incertitude n'est donc pas susceptible d'influencer les conclusions de la présente étude.

- **Autres voies d'exposition**

  Toutes les autres voies d'exposition pertinentes ont été considérées pour estimer l'exposition aux métaux, ce qui inclut l'ingestion et le contact cutané avec le sol (bruit de fond), les poussières intérieures (bruit de fond) et l'eau (bruit de fond et additionnel). La contribution de ces voies aux doses bruit de fond étant faible, l'incertitude associée à l'estimation de ces doses n'a aucune influence sur les conclusions de la présente étude. En ce qui concerne l'exposition additionnelle, celle par contact cutané peut être significative. C'est en particulier le cas du scénario « Relais routier » puisque ces récepteurs ne consomment aucun aliment provenant de la zone d'étude. Considérant la très faible contribution des doses additionnelles aux doses totales, l'incertitude associée à l'estimation de ces doses n'a aucune influence sur les conclusions de la présente étude

- **Combinaison des hypothèses retenues**

  En résumé, les hypothèses retenues pour estimer l'exposition bruit de fond et additionnelle des récepteurs sont prudentes tout en restant réalistes. La combinaison de ces hypothèses prudentes mène vraisemblablement à une surestimation des doses d'exposition estimées.

5.3 Évaluation des risques

5.3.1 Risques toxicologiques posés par les particules fines ($PM_{2.5}$)

Les risques posés par l'inhalation de $PM_{2.5}$ ont pu être estimés pour une exposition aiguë (24 heures; tableau 22), sous-chronique (tableau 23) et chronique (tableau 26).

5.3.1.1 Exposition aiguë

La VTR la plus sévère (15 µg/m^3) a été retenue pour évaluer les risques posés par l'inhalation de $PM_{2.5}$ sur une période de 24 heures. Cette valeur est définie par Santé Canada comme « *un niveau au-dessus duquel on sait qu'il existe (importance statistique) une relation dose-réponse et on a la capacité de fournir une certaine quantification des effets nocifs* » (Santé Canada et Environnement Canada, 1998).

L'indice de risque additionnel maximal sur 24 heures basé sur cette VTR et qui découle des activités du Projet est inférieur à l'unité (IR_{Add} = 0,58). L'ajout de la concentration bruit de fond (11,4 µg/m^3, IR_{BF} = 0,76) mène à un indice de risque total maximal légèrement supérieur à l'unité (IR_{Tot} de 1,34).

L'interprétation des résultats doit tenir compte de l'incertitude associée aux concentrations dans l'air qui ont été utilisées pour évaluer le risque :

- La teneur de fond retenue[1] (11,4 µg/m^3) est une valeur prudente car elle découle du 98e centile des concentrations sur 24 heures mesurées au Canada à des endroits comparables à la zone d'étude. Il est donc vraisemblable que les concentrations dans l'air ambiant de la zone d'étude (avant implantation du Projet) soient plus faibles que 11,4 µg/m^3 à raison de 98% du temps. Par exemple, les données de bruit de fond suggèrent que 95% du temps, la concentration dans l'air ambiant serait inférieure à 9,7 µg/m^3 ($IR_{BF} \leq 0,65$);

1 Pour mémoire, la teneur de fond en $PM_{2.5}$ sur 24 heures correspond à une estimation prudente de la moyenne (LSC95) des 98e centile des concentrations mesurées sur 24 heures à 10 stations du RNSPA (section 4.2.1). Par définition, les concentrations dans l'air ambiant sont plus faibles que le 98e centile à raison de 98% du temps.

- Les concentrations additionnelles correspondent à des valeurs maximales (combinaison des émissions et des conditions météorologiques les plus défavorables sur 5 années);
- La distribution statistique des concentrations sur 24 heures dans le secteur le plus exposé (à très faible distance au sud et à l'est du Site) indique que 95% du temps (347 jours par année), la concentration additionnelle dans l'air au récepteur le plus exposé (≤ 3,1 µg/m^3) serait au moins deux fois plus faible que la concentration maximale et représenterait moins de 21% de la VTR (IR_{Add} ≤ 0,21);
- Par ailleurs, il importe de mettre en perspectives la VTR retenue en comparant cette dernière avec celles recommandées par d'autres institutions[1]. La plus sévère de ces autres valeurs correspond à la recommandation de l'Organisation mondiale de la santé (OMS), laquelle vise à ce que le 99e centile de la distribution des concentrations sur 24 heures ne dépasse pas 25 µg/m^3 (assimilable à une VTR). En appliquant strictement la méthodologie proposée par l'OMS, l'interprétation des résultats indique que les concentrations totales estimées[2] restent toujours en deçà de 25 µg/m^3.

Le fait de combiner la concentration maximale dans l'air attribuable aux activités du Projet avec une teneur de fond correspondant au 98e centile conduit à une surestimation du risque puisque l'IR_{Tot} maximal obtenu est indicateur d'une situation peu vraisemblable, qui correspond à la combinaison des pires situations anticipées en ce qui a trait au bruit de fond et aux émissions de la mine. Sur la base de tout ce qui précède, il est vraisemblable que la concentration totale de $PM_{2.5}$ serait inférieure à 15 µg/m^3 (IR_{Tot} ≤ 0,86) plus de 95% du temps pour le récepteur le plus exposé.

5.3.1.2 Exposition sous-chronique et chronique

En l'absence de VTR pour une exposition sous-chronique, le risque associé aux concentrations maximales sur 2 semaines et sur un mois a été évalué de façon provisoire à partir de la VTR chronique (10 µg/m^3), ce qui constitue une approche prudente.

Les concentrations totales représentatives de l'exposition sous-chronique et chronique sont toujours en deçà de cette VTR et conduisent donc à des indices de risque inférieurs à l'unité.

5.3.1.3 Conclusion pour les particules fines

Selon l'analyse approfondie de l'ensemble de l'information disponible, les résultats permettent de conclure que les concentrations maximales de $PM_{2.5}$ attribuables au Projet ne devraient présenter aucun risque significatif pour la santé de la population qui fréquenterait la zone d'étude selon les scénarios évalués.

5.3.2 Risques toxicologiques posés par les émanations gazeuses

Les risques posés par l'inhalation de gaz ont pu être estimés pour une exposition aiguë (1 heure, 8 heures et/ou 24 heures; tableau 22), sous-chronique (tableau 23) et chronique (tableau 26).

1 OMS : 25 µg/m^3 applicable au 99e centile, CCME : 30 µg/m^3 applicable à la moyenne triennale du 98e centile annuel, U.S. EPA : 35 µg/m^3 applicable à la moyenne triennale du 98e centile annuel (voir annexe B).

2 Pour le récepteur le plus exposé, concentration estimée à 17 µg/m^3 (99e centile des concentrations additionnelles sur 24 heures pour le récepteur le plus exposé (3,8 µg/m^3) + LSC95 des 99e centile aux stations retenues pour la teneur de fond (12,3 µg/m^3).

5.3.2.1 Monoxyde de carbone

Les risques posés par l'inhalation de CO ont pu être estimés pour une exposition aiguë. Aucun des indices de risques estimés pour le CO (1 et 8 heures) ne dépasse l'unité.

Ces résultats permettent de conclure que le risque posé par les concentrations maximales de CO attribuables au Projet est négligeable pour la santé de la population qui fréquenterait la zone d'étude selon les scénarios évalués.

5.3.2.2 Dioxyde d'azote

Les risques posés par l'inhalation de NO_2 ont pu être estimés pour une exposition aiguë (concentration maximale de NO_2 sur 1 heure), sous-chronique (concentration maximale de NO_2 sur 2 semaines et 1 mois) et chronique.

- **Exposition sur 1 heure**

La VTR (200 µg/m^3) retenue pour estimer le risque posé par une exposition de 1 heure au NO_2 est celle recommandée par l'OMS. Cette valeur est basée sur un niveau d'effet critique de 400 µg/m^3 (légers effets respiratoires réversibles) divisée par un facteur de sécurité de 2 afin de protéger les sujets dont les fonctions pulmonaires sont déjà compromises (par exemple, personnes asthmatiques ou atteintes de maladies pulmonaires obstructives chroniques).

L'indice de risque additionnel maximal sur 1 heure basé sur cette VTR et qui découle des activités du Projet est proche de l'unité (IR_{Add} = 1,2). L'ajout de la teneur de fond (15 µg/m^3, IR_{BF} = 0,08) mène à un indice de risque total maximal de 1,28 (IR_{Tot}).

L'examen approfondi des résultats pour le récepteur le plus exposé de la zone d'étude indique que 99,9% du temps[1], la concentration additionnelle est inférieure à 135 µg/m^3, ce qui conduit à un IR_{Add} inférieur à l'unité ($IR_{Add} \leq 0,55$).

Par ailleurs, il convient de rappeler qu'il est peu vraisemblable que la teneur de fond (98e centile des concentrations sur 1 heure, c.-à-d. atteinte moins de 2% du temps) coïncide avec les très rares épisodes de concentrations additionnelles qui conduiraient à un IR_{Tot} supérieur à l'unité.

Sur la base de ce qui précède, il est très peu probable que la concentration totale de NO_2 sur 1 heure dépasse la VTR (200 µg/m^3). Advenant un dépassement, celui-ci serait très localisé, de faible amplitude ($IR_{Tot} \leq 1,28$) et les concentrations totales (de l'ordre de 256 µg/m^3) resteraient en deçà du niveau auquel des effets ont été observés chez l'humain (400 µg/m^3).

- **Exposition sous-chronique et chronique**

En l'absence de VTR pour une exposition sous-chronique, le risque associé aux concentrations maximales sur 2 semaines et sur un mois a été évalué de façon provisoire à partir de la VTR chronique (40 µg/m^3), ce qui constitue une approche prudente.

1 Si le scénario d'exploitation appliqué pour la modélisation atmosphérique (représentant les émissions maximales) et si l'année météorologique conduisant à la concentration maximale étaient permanents. Dans les faits, les concentrations obtenues avec les 4 autres années météorologiques conduisaient à des concentrations plus faibles, ce qui réduit la probabilité que des concentrations supérieures à 135 µg/m^3 soient atteintes.

Les concentrations totales de NO_2 représentatives de l'exposition sous-chronique et chronique sont toujours en deçà de cette VTR et conduisent donc à des indices de risque inférieurs à l'unité.

- **Conclusion pour le dioxyde d'azote**

  Ces résultats permettent de conclure que les concentrations maximales de NO_2 attribuables au Projet ne devraient présenter aucun risque significatif pour la santé de la population qui fréquenterait la zone d'étude selon les scénarios évalués.

5.3.2.3 Dioxyde de soufre

Les risques posés par l'inhalation de NO_2 ont été estimés pour une exposition aiguë (concentrations maximales sur 1 heure et sur 24 heures), sous-chronique (concentration maximale sur 2 semaines et 1 mois) et chronique. Aucun des indices de risque estimés pour le SO_2 ne dépasse l'unité.

Ces résultats permettent de conclure que le risque posé par les concentrations maximales de SO_2 attribuables au Projet est négligeable pour la santé de la population qui fréquenterait la zone d'étude selon les scénarios évalués.

5.3.2.4 Conclusion pour les émanations gazeuses

Ces résultats permettent de conclure que les concentrations maximales de NO_2 attribuables au Projet ne devraient présenter aucun risque significatif pour la santé de la population qui fréquenterait la zone d'étude selon les scénarios évalués. Le risque posé par les concentrations maximales de CO et de SO_2 est négligeable.

5.3.3 Risques toxicologiques posés par les métaux

5.3.3.1 Exposition par inhalation

Tous les indices de risque par inhalation qui ont pu être estimés pour une exposition aiguë (1 heure, 8 heures ou 24 heures; tableau 22), sous-chronique (2 semaines ou 1 mois; tableau 23) et chronique (tableau 26) sont inférieurs à l'unité.

5.3.3.2 Exposition via plusieurs voies

Les risques posés par la combinaison de plusieurs voies d'exposition (ingestion, contact cutané et, pour certains métaux, inhalation) ont pu être estimés pour tous les métaux, pour des expositions sous-chroniques dans la zone d'exposition rapprochée (au Relais routier et lors de séjours d'activités traditionnelles) et chroniques (au Relais routier et en combinant Activités traditionnelles et exposition domestique). Les résultats (tableaux 24, 25, 27 et 28) sont interprétés par métal ou par groupe de métaux dans les paragraphes suivants. Le tableau 30 résume l'information pertinente à l'évaluation des métaux pour lesquels certains indices de risques supérieurs à l'unité ont été obtenus.

- **Aluminium, antimoine, argent, baryum, béryllium, bore, chrome, cobalt, molybdène, plomb, strontium, titane et uranium**

  Pour ces 13 métaux, tous les indices de risque (sous-chronique et chronique) correspondant à l'exposition bruit de fond, additionnelle et totale sont inférieurs à l'unité. Ces résultats permettent de conclure que, selon les scénarios évalués, les risques à la santé posés par ces métaux sont négligeables pour les récepteurs qui fréquenteraient la zone d'étude selon les scénarios évalués.

- **Arsenic, cadmium, cuivre, étain, lithium, manganèse, mercure, nickel, sélénium, vanadium et zinc**

  Pour ces 11 métaux, l'exposition bruit de fond à elle seule conduit à des indices de risque (sous-chronique et/ou chronique) supérieurs à l'unité. Toutefois, dans tous les cas où des IR_{Tot} supérieurs à l'unité ont été estimés (c.-à-d. pour tous les groupes d'âge, durées d'exposition et scénarios évalués), la contribution du Projet à l'exposition totale est négligeable (≤ 0,99%).

5.3.3.3 Exposition durant toute la vie

Conformément aux lignes directrices de l'INSPQ, les niveaux de risque additionnel de cancer ont été estimés pour chacun des métaux reconnus comme cancérogènes ou probablement cancérogènes pour l'humain (arsenic, béryllium, cadmium, nickel et plomb). Le risque additionnel de cancer global obtenu (3,1E-7) est inférieur au niveau jugé négligeable (1E-06).

5.3.3.4 Conclusion pour les métaux

L'examen approfondi de l'ensemble de l'information disponible permet de conclure que, selon tous les scénarios évalués, les risques posés par les émissions atmosphériques de métaux attribuables au Projet et découlant d'une exposition directe (inhalation) ou indirecte (consommation de gibier, de poisson et de plantes) sont négligeables.

5.3.4 Risques toxicologiques posés par la silice cristalline

Les risques posés par l'inhalation de silice cristalline respirable ont pu être estimés pour une exposition chronique. Aucun des indices de risque estimés ne dépasse l'unité.

Ces résultats permettent de conclure que les concentrations moyennes annuelles de silice cristalline respirables attribuables au Projet ne devraient présenter aucun risque significatif pour la santé de la population qui fréquenterait la zone d'étude selon les scénarios évalués.

6. CONCLUSION

Les risques toxicologiques à la santé humaine posés par les activités projetées à la mine de lithium Baie-James ont été estimés et évalués selon les lignes directrices de l'INSPQ, en utilisant des hypothèses généralement prudentes. Les résultats de l'évaluation indiquent que :

- Les risques pour la santé de la population qui pourrait être exposée par inhalation au dioxyde de soufre, au monoxyde de carbone et à la silice cristalline (population fréquentant la zone d'étude) sont négligeables;
- Les risques pour la santé de la population qui pourrait être exposée par inhalation aux particules fines ($PM_{2.5}$) et au dioxyde d'azote (population fréquentant la zone d'étude) sont vraisemblablement négligeables En effet, les risques ayant été estimés à partir de données et d'hypothèses prudentes, il est peu plausible que les concentrations maximales estimées dans l'air ambiant soient atteintes dans la réalité;
- Les risques pour la santé de la population qui pourrait être exposée aux métaux émis dans l'air (population qui fréquenterait la zone d'étude et/ou qui consommerait des produits issus d'activités traditionnelles venant de la zone d'étude, incluant la zone d'exposition rapprochée) sont négligeables (risque additionnel de cancer négligeable et absence de risque d'autres effets sur la santé).

Les risques posés par les rejets aqueux dans les cours d'eau de la zone d'exposition rapprochée (CE2 et CE3) n'ont pu être évalués faute de données. Comme ces cours d'eau ne sont pas utilisés pour la pêche de subsistance, cette omission semble mineure et sans conséquences significatives sur les conditions d'exposition des récepteurs et les risques pour la santé humaine. Cela devrait toutefois être validé lorsque des données de suivi de qualité de l'eau seront disponibles.

Sur la base de ces résultats, et considérant que les risques ont été estimés en se basant sur la combinaison de multiples hypothèses prudentes, nous sommes d'avis que les activités projetées à la mine de lithium Baie-James ne devraient présenter aucun risque significatif pour la santé de la population qui fréquenterait la zone d'étude et/ou qui consommerait, tout au long de l'année et durant toute la période d'exploitation, des produits issus d'activités traditionnelles pratiquées dans la zone d'étude.

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TABLEAU 1
Liste des substances retenues pour l'évaluation des risques

Oxydes gazeux	Monoxyde de carbone (CO)		
	Dioxyde d'azote (NO_2)		
	Dioxyde de soufre (SO_2)		
Particules	Particules fines ($PM_{2,5}$)		
Métaux	Aluminium (Al)	Chrome (Cr)	Nickel (Ni)
	Antimoine (Sb)	Cobalt (Co)	Plomb (Pb)
	Argent (Ag)	Cuivre (Cu)	Sélénium (Se)
	Arsenic (As)	Étain (Sn)	Strontium (Sr)
	Baryum (Ba)	Lithium (Li)	Titane (Ti)
	Béryllium (Be)	Manganèse (Mn)	Uranium (U)
	Bore (B)	Mercure (Hg)	Vanadium (V)
	Cadmium (Cd)	Molybdène (Mo)	Zinc (Zn)
Silice	Silice cristalline		

TABLEAU 2

Effets potentiels sur la santé associés à l'exposition aux substances d'intérêt

Substances	Bases toxicologiques et effets possibles sur la santé
Monoxyde de carbone (CO)	Formation de carboxyhémoglobine (COHb) qui a pour effet de réduire la concentration en hémoglobine dans le sang disponible pour acheminer l'oxygène aux divers tissus et organes dans le corps. Les organes les plus rapidement affectés sont donc ceux ayant les besoins en oxygène les plus importants, soit le cœur, le système cardiovasculaire, le cerveau ainsi que le système nerveux en formation. Peut entrainer la mort par asphyxie. Potentiel cancérogène chez l'humain non évalué (U.S. EPA, CIRC).
Dioxyde d'azote (NO_2)	Irritation des muqueuses (yeux, poumons). Effets sur le système respiratoire (altération des fonctions respiratoires et de la résistance pulmonaire, œdème pulmonaire, inflammation des voies respiratoires (pneumonite, bronchite, bronchiolite) chez les gens en santé, aggravation des symptômes chez les patients asthmatiques. Potentiel cancérogène chez l'humain non évalué par le CIRC et U.S. EPA.
Dioxyde de soufre (SO_2)	Inflammation de l'appareil respiratoire (toux, production de mucus), bronchoconstriction, augmentation des symptômes d'asthme et de la résistance pulmonaire chez les asthmatiques, bronchites chroniques, sensibilisation aux infections, aggravation de maladies respiratoires (emphysème, bronchite) ou cardiovasculaires. Non classable pour son potentiel cancérogène chez l'humain (CIRC).
Particules (≤ 10 µm)	Irritation des voies respiratoires, toux et difficultés à respirer. Effets sur le système respiratoire, sur le système cardiovasculaire, aggravation de l'asthme, décès. Les particules aéroportées (nature et taille non précisées) ont récemment été classées comme cancérogènes pour l'humain par le CIRC. Potentiel cancérogène chez l'humain non évalué par U.S. EPA.
Aluminium	Irritation possible de la peau. Effets possibles sur le système respiratoire, le système nerveux, les reins et le développement. Note : utilisé dans des produits antisudorifiques
Antimoine	Irritation de la peau, des yeux et des voies respiratoires. Selon la forme chimique, effets possibles sur les systèmes cardiovasculaire, respiratoire et gastro-intestinal, le foie, la chimie du sang (glycémie, cholestérol), les reins et la reproduction. Tumeurs dans les poumons de rats exposés par inhalation. Note : utilisation thérapeutique (pour soigner les infections par certains parasites).
Argent	Effets possibles sur la coloration de la peau et d'autres tissus (argyrose), et sur le système respiratoire. Réactions allergiques possibles. Non classable pour son potentiel cancérogène chez l'humain (U.S. EPA). Potentiel cancérogène chez l'humain non évalué par le CIRC.
Arsenic (inorganique)	Irritation des voies respiratoires et de la peau. Effets possibles sur le tractus gastro-intestinal, le sang, le système cardio-vasculaire, le système nerveux et le développement. Cancer des poumons et de multiples organes internes (foie, rein et vessie) ainsi que cancer de la peau observés chez l'humain. Classé comme cancérogène pour l'humain (U.S. EPA, CIRC et Santé Canada).
Baryum	Effets possibles sur le tractus gastro-intestinal, les muscles, le système cardiovasculaire et les reins. Non classable pour son potentiel cancérogène chez l'humain (U.S. EPA et Santé Canada). Potentiel cancérogène chez l'humain non évalué par le CIRC.
Béryllium	Effets possibles sur le système respiratoire (bérylliose) et le système gastro-intestinal. Classé comme cancérogène pour l'humain par le CIRC et comme probablement cancérogène pour l'humain par U.S. EPA.
Bore	Irritation du nez, de la gorge et des yeux. Effets possibles sur le système gastro-intestinal, le foie, les reins, le cerveau, le système reproducteur masculin et le développement. Potentiel cancérogène chez l'humain non évalué par le CIRC et US EPA.
Cadmium	Effets possibles sur les systèmes respiratoire, cardiovasculaire et gastro-intestinal, les reins, le sang, le squelette et le développement. Tumeurs dans les testicules (rat et souris), les glandes mammaires (rat mâle), les poumons et dans d'autres organes non spécifiés (rat). Classé comme cancérogène pour l'humain par le CIRC et comme probablement cancérogène pour l'humain par U.S. EPA et Santé Canada.
Chrome	Forme trivalente: élément essentiel. Effets possibles sur les reins. Non classable pour son potentiel cancérogène chez l'humain (U.S. EPA, CIRC). Forme hexavalente: irritation nasale, ulcères cutanés (avec certains composés du chrome). Effets possibles sur le tractus gastro-intestinal, les reins, le foie et la reproduction. Réactions allergiques possibles (peau). Tumeurs dans les voies respiratoires (poumon, nez, sinus). Advenant le dépassement d'un seuil d'exposition par voie orale, tumeurs dans le système gastro-intestinal (documentées chez l'animal). Par inhalation, classé comme cancérogène pour l'humain (U.S. EPA, Santé Canada et CIRC). Par ingestion : non classable pour son potentiel cancérogène chez l'humain (U.S. EPA).

Substances	Bases toxicologiques et effets possibles sur la santé
Cobalt	Élément essentiel (vitamine B12). Effets possibles sur le système respiratoire, le cœur, la peau, le foie, les reins et la reproduction. Sensibilisant. Classé comme possiblement cancérogène pour l'humain par le CIRC. Potentiel cancérogène chez l'humain non évalué par U.S. EPA.
Cuivre	Élément essentiel. Irritation du nez et de la gorge. Effets possibles sur le tractus gastro-intestinal, le foie, les reins et le développement. Non classable pour son potentiel cancérogène chez l'humain (U.S. EPA). Potentiel cancérogène chez l'humain non évalué par le CIRC.
Étain (inorganique)	Irritation de la peau et des yeux. Effets possibles sur l'estomac, le sang (anémie), le foie et les reins. Potentiel cancérogène chez l'humain non évalué par le CIRC et U.S. EPA.
Lithium	Élément essentiel. Les données sur la toxicité du lithium sont principalement issues de son utilisation médicamenteuse par voie orale avec des effets surtout gastro-intestinaux, neurologiques, rénaux, cardiaques lors d'un surdosage aigu et des effets neurologiques, rénaux, cardio-vasculaires, endocriniens lors de prises répétées. Des effets embryo et foeto-toxiques ainsi que des effets tératogènes ont été décrits chez des patientes traitées pendant leur grossesse. Une toxicité a été rapportée chez des enfants allaités par des femmes traitées par du lithium. Les données de la littérature ne permettent pas de conclure à une génotoxicité et ne montrent pas de potentiel cancérogène chez l'homme pour le lithium ou ses composés (données jugées inadéquates par U.S. EPA). En milieu professionnel, les effets décrits sont une irritation plus ou moins sévère (cutanée, respiratoire, oculaire) en particulier lors d'accidents d'exposition avec l'hydrure de lithium. Potentiel cancérogène chez l'humain non évalué par le CIRC et U.S. EPA (IRIS).
Manganèse	Élément essentiel. Effets possibles sur le système nerveux, le système respiratoire et la reproduction. Tumeurs du pancréas et de la thyroïde observées chez des rongeurs. Non classable pour son potentiel cancérogène chez l'humain (U.S. EPA). Potentiel cancérogène chez l'humain non évalué par le CIRC.
Mercure	Irritation du système respiratoire et de la peau (sensibilisation). Effets possibles sur le système respiratoire, gastro-intestinal, nerveux, cardiovasculaire, hépatique, musculo-squelettique, hématologique et immunitaire, et sur les reins, la reproduction et le développement. Mercure élémentaire et inorganique non classable pour son potentiel cancérogène chez l'humain (CIRC et U.S EPA). Méthylmercure possiblement cancérogène chez l'humain (CIRC, U.S EPA).
Molybdène	Élément essentiel. Effets possibles sur la reproduction. Potentiel cancérogène chez l'humain non évalué par le CIRC et U.S. EPA.
Nickel	Allergie de contact (peau). Effets possibles sur le système respiratoire, l'estomac, le sang, les reins, la reproduction et le développement. Tumeurs dans les poumons, la cavité nasale et les sinus para-nasaux (selon les formes chimiques). Classification du potentiel cancérogène chez l'humain variable selon les formes chimiques (cancérogène, probablement cancérogène ou non classable) (U.S. EPA, CIRC et Santé Canada).
Plomb	Effets possibles sur le système nerveux, le système cardio-vasculaire, le cerveau, les reins, le sang, le tractus gastro-intestinal, les muscles, la reproduction et le développement. Tumeurs dans le rein (rat et souris). Classé comme cancérogène probable (U.S. EPA et CIRC) ou possible (Santé Canada) chez l'humain.
Sélénium	Élément essentiel. Irritation du tractus respiratoire. Effets possibles sur le tractus gastro-intestinal, les phanères, le système nerveux, le système respiratoire et la reproduction. Non classable pour son potentiel cancérogène chez l'humain (U.S. EPA et CIRC).
Strontium	Effets possibles sur le squelette. Potentiel cancérogène chez l'humain non évalué par U.S. EPA et le CIRC.
Titane	Tétrachlorure de titane : irritation, effets sur le système respiratoire. Dioxyde de titane : tumeurs dans les poumons. Possiblement cancérogène pour l'humain (CIRC); non évalué par US.EPA.
Uranium (naturel)	Pilo-érection, perte de poids et hémorragies. Effets possibles sur le rein (principalement), le foie et la glande thyroïde, effets sur la reproduction et le développement. Données inadéquates pour la classification en regard du potentiel cancérogène (Santé Canada). Potentiel cancérogène chez l'humain non évalué par U.S. EPA et par le CIRC.
Vanadium	Effets possibles sur les voies respiratoires (inhalation*), les yeux, le foie et les reins. Tumeurs dans les poumons chez l'animal (V_2O_3). Le V_2O_3 est classé possiblement cancérogène pour l'humain par le CIRC. Aucune forme de vanadium n'a été évaluée par U.S. EPA pour son potentiel cancérogène. * Toutes les études par inhalation ont été effectuées avec du pentoxyde de vanadium (V_2O_3).
Zinc	Élément essentiel. Effets possibles sur le tractus gastro-intestinal, le sang et la reproduction. Non classable pour son potentiel cancérogène chez l'humain (U.S. EPA). Potentiel cancérogène chez l'humain non évalué par le CIRC.

Substances	Bases toxicologiques et effets possibles sur la santé
Silice cristalline (respirable)	Irritation des yeux et des voies respiratoires supérieures (nez, gorge). À plus long terme, bronchite chronique, limitations chroniques des voies respiratoires, hypersécrétion de mucus et emphysème pathologique peuvent se développer. Advenant une exposition prolongée ou à des niveaux élevés, développement possible de la silicose (fibrose pulmonaire progressive), complications possibles de la silicose (tuberculose, insuffisance respiratoire, bronchite chronique obstructive, décès) et autres effets sur le foie et la rate (silicose hépatosplénique), la peau (granulomes cutanés de silice ou nodules), le cœur (élargissement du ventricule droit pour compenser les anomalies pulmonaires), détérioration de la santé dentaire (abrasion), maladies auto-immunes. Classée comme cancérogène pour l'humain (groupe 1) par le CIRC. Potentiel cancérogène chez l'humain non évalué par U.S. EPA.

Sources : ATSDR[1], American Thoracic Society (1997), BIA (2003), Cal/EPA[2], CCME[3], CIRC[4], HSDB[5], INERIS (2011), INSPQ (2012a), Institute of Medicine (2001), IPCS[6], OMS (WHO Europe (2006); WHO (2013)), Santé Canada[7], U.S. EPA[8].

1 *Toxic Substances Portal* (http://www.atsdr.cdc.gov/toxfaqs/index.asp).
2 *Office of Environmental Health Assessment (OEHHA).* Air https://oehha.ca.gov/air).
3 Recommandations canadiennes pour la qualité de l'environnement (http://www.ccme.ca/publications/ceqg_rcqe.fr.html)
4 Monographies du CIRC sur l'évaluation des risques de cancérogénicité pour l'homme - Liste des évaluations du CIRC (http://monographs.iarc.fr/FR/Classification/index.php).
5 *Hazardous Substances Data Bank* (http://toxnet.nlm.nih.gov/index.html)
6 *Chemical Safety Information from Intergovernmental Organizations* (http://www.inchem.org/),
7 Objectifs nationaux de qualité de l'air ambiant quant aux matières particulaires - Sommaire. Partie 1: Rapport d'évaluation scientifique. Groupe de travail fédéral-provincial de la LCPE sur les objectifs de la qualité de l'air (Santé Canada et Environnement Canada, 1998, http://www.hc-sc.gc.ca/ewh-semt/pubs/air/naaqo-onqaa/particulate_matter_matieres_particulaires/summary-sommaire/index-fra.php);
Recommandations pour la qualité de l'eau potable au Canada - documents techniques (http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/index-fra.php#doc_tech);
Évaluation des risques pour la santé humaine du dioxyde de soufre (N° CAS: 7446-09-5) - Analyse de l'exposition au dioxyde de soufre dans l'air ambiant et ses effets sur la santé de la population canadienne (Santé Canada, janvier 2016);
Évaluation des risques pour la santé humaine des particules grossières (Santé Canada, janvier 2016);
Évaluation des risques pour la santé humaine du dioxyde d'azote ambiant (Santé Canada, mai 2016).
Évaluation préalable pour le Défi concernant le quartz (Numéro de registre du Chemical Abstracts Service 14808-60-7) et la cristobalite (Numéro de registre du Chemical Abstracts Service 14464-46-1). (Environnement Canada et Santé Canada, 2013).
8 *National Ambient Air Quality Standards (NAAQS) (*https://www.epa.gov/criteria-air-pollutants/naaqtable*);*
Nitrogen dioxide, (https://www.epa.gov/no2-pollution/basic-information-about-no2#Effects);
Sulfur dioxide (https://www.epa.gov/so2-pollution/sulfur-dioxide-basics#effects).
Integrated Science Assessment for Oxides of Nitrogen – Health Criteria (https://www.epa.gov/isa/integrated-science-assessment-isa-nitrogen-dioxide-health-criteria);
Integrated Science Assessment for Sulfur Dioxide – Health Criteria (https://www.epa.gov/isa/integrated-science-assessment-isa-sulfur-dioxide-health-criteria);
Particulate Matter (PM) (http://www3.epa.gov/airquality/particlepollution/health.html);
Integrated Risk Information System (IRIS) (http://www.epa.gov/iris/).
PPRTV Derivation Support Document - Lithium. https://hhpprtv.ornl.gov/quickview/pprtv.php
Ambient levels and noncancer effects of inhaled crystalline and amorphous silica. Health issue assessment. Rapport no. EPA/600/R-95/115.

TABLEAU 3

Valeurs toxicologiques de référence retenues pour une exposition aiguë par inhalation

Substance	Inhalation (VTR_{inh}, µg/m³)					
	1 heure		8 heures		24 heures	
	VTR	Origine[a]	VTR	Origine[a]	VTR	Origine[a]
CO	23 000	Cal/EPA	10 000	OMS		
NO_2	200	OMS				
SO_2	500	OMS			20	OMS
$PM_{2.5}$					15	Santé Canada
Aluminium			(10)[b]	TLV-TWA/100		
Antimoine			(5)	TLV-TWA/100		
Argent			(1)	TLV-TWA/10		
Arsenic	0,2[c]	Cal/EPA				
Baryum			(5)	TLV-TWA/100		
Béryllium					(0,02)[d]	c. VTR
Bore					300	ASTDR
Cadmium					0,03	ATSDR
Chrome			(5)[e]	TLV-TWA/100		
Cobalt			(0,2)	TLV-TWA/100		
Cuivre	100	Cal/EPA				
Étain			(20)	TLV-TWA/100		
Lithium	(33)	TEEL-1/100				
Manganèse			(0,51)[f]	Dérivé de Cal/EPA		
Mercure	0,6[g]	Cal/EPA	0,06[g]	Cal/EPA		
Molybdène			(100)[h]	TLV-TWA/100		
Nickel	0,2	Cal/EPA	0,06	Cal/EPA		
Plomb			(0,5)	TLV-TWA/100		
Sélénium					(20)[d]	c. VTR
Strontium	(300)	TEEL-1/100				
Titane			(60)	TLV-TWA/100		
Uranium			(2)[i]	TLV-TWA/100		
Vanadium	17	Cal/EPA			0,8	ATSDR
Zinc	(60)	TEEL-1/100				
Silice cristalline						

a **ATSDR** : *Maximum Risk Level* (MRL) pour une exposition dite aiguë (1 à 14 jours consécutifs) par inhalation recommandée par ATSDR (http://www.atsdr.cdc.gov/toxprofiles/index.asp); **Cal/EPA** : *Reference Exposure Level* (REL) pour une exposition aiguë par inhalation (http://www.oehha.ca.gov/air/allrels.html); **OMS** : Recommandation dans l'air ambiant (http://www.euro.who.int/document/e71922.pdf) ; **Santé Canada**: groupe de travail fédéral-provincial de la LCPE sur les objectifs nationaux de la qualité de l'air (http://www.hc-sc.gc.ca/ewh-semt/pubs/air/naaqo-onqaa/particulate_matter_matieres_particulaires/summary-sommaire/index-fra.php); **TLV-TWA/x** : Norme en milieu de travail (*Threshold Limit Value-Time Weighted Average;* http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB) divisée par un facteur de sécurité de x; **c. VTR**: VTR chronique (voir tableau 5).

b Dérivé de la TLV-TWA la plus sévère, soit celle établie pour l'aluminium sous forme de particules respirables (PM_5) et composés insolubles de l'aluminium.

c VTR établie pour une durée de 4 heures.

d La TLV-TWA divisée par un facteur de sécurité de 100 étant plus faible que la c. VTR, cette dernière a été retenue et appliquée pour une exposition de 24 heures.

e VTR correspondant à la forme trivalente (c.-à-d. forme vraisemblablement émise dans l'air par les activités projetées de la mine).

f Pour dériver la VTR provisoire (applicable à des pics de concentration dont la fréquence est sporadique), le facteur de sécurité (3) appliqué par Cal/EPA pour tenir compte de la durée non chronique de l'exposition a été supprimé (voir section 3.2.3).

g Dérivée de la TLV-TWA établie pour le mercure élémentaire (aucune valeur disponible pour le mercure inorganique).

h TLV-TWA établie pour le molybdène et ses composés insolubles dans les particules inhalables (PM_{10}).

i TLV-TWA établie pour les composés solubles et insolubles de l'uranium naturel.

( ) Les valeurs entre parenthèses indiquent les valeurs provisoires (voir section 3.2.3).

TABLEAU 4

Valeurs toxicologiques de référence retenues pour une exposition sous-chronique (s.c. VTR) – effets autres que le cancer

Substance	Ingestion (s.c. VTR_{ing})		Inhalation (s.c. VTR_{inh})		
	Dose (mg/kg-pc par jour)	Origine[a]	Dose (mg/kg-pc par jour)	Concentration (µg/m³)	Origine[a]
CO	NA				
NO_2	NA			(40)	c. VTR
SO_2	NA			(20)	c. VTR
$PM_{2.5}$	NA			(10)	c. VTR
Aluminium	1,0	ATSDR	(1,0)		Dérivé de ingestion
Antimoine	(0,0004)	PPRTV	(0,0004)		Dérivé de ingestion
Argent	(0,005)	c. VTR		(0,45)	c. VTR
Arsenic	(3,5E-06)	c. VTR	(3,5E-06)		c. VTR
Baryum	0,2	ASTDR		(1,0)	c. VTR
Béryllium	(0,002)	c. VTR		(0,02)	c. VTR
Bore	0,2	ATSDR		(300)	ATSDR [b]
Cadmium	NA			0,01	c. VTR
Chrome	(0,0022) [c]	c. VTR		0,1 [d]	ATSDR
Cobalt	(0,02)	Publication		(0,1)	c. VTR
Cuivre	(0,091-0,141) [e]	c. VTR	(0,01-0,017)		Dérivé de ingestion
Étain	0,3	ATSDR	(0,3)		Dérivé de ingestion
Lithium	(0,002)	PPRTV	(0,002)		Dérivé de ingestion
Manganèse	(0,122-0,156) [e]	c. VTR		0,05 [f]	c. VTR
Mercure	0,002	ATSDR		0,03 [g]	c. VTR
Molybdène	(0,023-0,028) [e]	c. VTR		(0,4)	c. VTR
Nickel	(0,011)	c. VTR		0,2	ATSDR
Plomb	(0,0036)	c. VTR		(0,5)	c. VTR
Sélénium	(0,005)	c. VTR	(0,005)	(20)	c. VTR
Strontium	(2,0)	ATSDR	(2,0)		Dérivé de ingestion
Titane	(3,0)	c. VTR	(3,0)		Dérivé de ingestion
Uranium	(0,006) [h]	c. VTR		0,1 h	ATSDR
Vanadium	0,01	ATSDR		(0,1)	c. VTR
Zinc	(0,48-0,57)[e]	c. VTR	(0,48-0,57)		Dérivé de ingestion
Silice cristalline					

a **ATSDR** : *Maximum Risk Level* (MRL) pour une exposition dite intermédiaire (15-364 jours consécutifs) recommandée par ATSDR (http://www.atsdr.cdc.gov/toxprofiles/index.asp); **PPRTV** : valeur provisoire (*Provisional Peer Review Toxicity Value)* dérivée par U.S. EPA (http://hhpprtv.ornl.gov/); **Publication** : Finley et coll. (2012) doi: 10.1016/j.yrtph.2012.08.022; **c. VTR**: VTR chronique (voir tableau 5).

b ATSDR suggère que VTR aiguë pour le bore (300 µg/m³) est protectrice pour des expositions de plus longue durée (sous-chronique et chronique).

c VTR correspondant à la forme hexavalente du chrome (plus toxique que la forme trivalente)

d VTR correspondant aux composés solubles de la forme trivalente (plus toxiques que les composés insolubles).

e Valeurs spécifiques à chaque groupe d'âge.

f VTR correspondant au manganèse sous forme de particules respirables (PM_5).

g VTR correspondant au mercure élémentaire (aucune valeur disponible pour mercure inorganique).

h VTR correspondant aux composés solubles de l'uranium (plus toxiques que les composés insolubles).

( ) Les valeurs entre parenthèses indiquent les valeurs provisoires (voir section 3.2.3).

NA Non applicable : la substance ne présente pas de toxicité via cette voie d'exposition (gaz, PM) ou aucune VTR n'est appropriée pour cette durée d'exposition (Cd par ingestion).

TABLEAU 5
Valeurs toxicologiques de référence retenues pour une exposition chronique (c. VTR) – Effets autres que le cancer

Substance	Ingestion (c. VTR_{ing})		Inhalation (c. VTR_{inh})		
	Dose (mg/kg-pc par jour)	Origine[a]	Dose (mg/kg-pc par jour)	Concentration (µg/m³)	Origine[b]
CO	NA				
NO_2	NA			40	OMS
SO_2	NA			20	OMS
$PM_{2.5}$	NA			10	OMS
Aluminium	1,0	ATSDR, OMS	(1,0)		Dérivé de ingestion
Antimoine	0,0002	Santé Canada	(0,0002)		Dérivé de ingestion
Argent	0,005	IRIS		(0,45)	Dérivé de TLV-TWA[c]
Arsenic	3,5E-06	Cal/EPA	3,5E-06	0,015	Cal/EPA
Baryum	0,2	IRIS, ASTDR, Santé Canada		1,0	RIVM
Béryllium	0,002	IRIS, ATSDR, Cal/EPA, OMS		0,02	OMS, IRIS
Bore	0,2	IRIS		(300)	ATSDR [d]
Cadmium	0,0001	ATSDR		0,01	ATSDR
Chrome	0,0022 [e]	Santé Canada		(0,01) [f]	Dérivé de s.c. VTR
Cobalt	(0,02)	Publication		0,1	ATSDR, OMS
Cuivre	0,091-0,141 [g]	Santé Canada	(0,01-0,017)		Dérivé de ingestion
Étain	(0,03)	Dérivé de s.c. VTR	(0,03)		Dérivé de ingestion
Lithium	(0,002)	PPRTV	(0,002)		Dérivé de ingestion
Manganèse	0,122-0,156 [g]	Santé Canada		0,05	IRIS
Mercure	0,0003	Santé Canada, IRIS		0,03 [h]	Cal/EPA
Molybdène	0,023-0,028 [g]	Santé Canada		0,4	ATSDR
Nickel	0,011	Cal/EPA		0,02	Santé Canada
Plomb	0,0036	Santé Canada, RIVM, OMS		0,5	OMS
Sélénium	0,005	IRIS, ATSDR, Cal/EPA	0,005	20	Cal/EPA
Strontium	1,417	Santé Canada	(1,417)		Dérivé de ingestion
Titane	3,0	NSF	(3,0)		Dérivé de ingestion
Uranium	(0,0006) [i]	Santé Canada, OMS		0,04 [i]	ATSDR
Vanadium	(0,001) [j]	Dérivé de s.c. VTR		0,1	ATSDR
Zinc	0,48-0,57 [g]	Santé Canada	(0,48-0,57)		Dérivé de ingestion
Silice cristalline	NA			2,0	TCEQ

a **ATSDR** : *Maximum Risk Level* (MRL) pour une exposition chronique par ingestion recommandée par ATSDR (http://www.atsdr.cdc.gov/toxprofiles/index.asp); **Cal/EPA** : *Reference Exposure Level* (REL) pour une exposition chronique par ingestion (http://www.oehha.ca.gov/air/allrels.html); **IRIS** : *Reference Dose (RfD)* pour une exposition chronique par ingestion recommandée par le *Integrated Risk Information System* de l'U.S. EPA (http://www.epa.gov/iris/index.html); **NSF** : *Reference Dose (RfD)* dérivée par *NSF International* pour une exposition chronique (accès via http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?iter); **OMS** : dose journalière recommandée ou dose dérivée d'une valeur hebdomadaire recommandée (http://www.inchem.org/) ; **PPRTV :** valeur provisoire (*Provisional Peer Review Toxicity Value)* dérivée par U.S. EPA (http://hhpprtv.ornl.gov/); **Publication** : Finley et coll. (2012) doi: 10.1016/j.yrtph.2012.08.022; **Santé Canada** : Dose Journalière Tolérable (DJT), apport quotidien tolérable (AQT) ou AMT recommandé pour une exposition chronique par Santé Canada (Santé Canada (2010), et http://www.hc-sc.gc.ca/fn-an/nutrition/reference/index-fra.php); **s.c. VTR** : VTR sous-chronique (voir tableau 4), **TCEQ** : *Texas Commission on Environmental Quality.* https://www.tceq.texas.gov/assets/public/implementation/tox/dsd/final/october09/silica_crystalline_forms.pdf**.**

b **ATSDR** : *Maximum Risk Level* (MRL) pour une exposition chronique par inhalation recommandée par ATSDR (http://www.atsdr.cdc.gov/toxprofiles/index.asp); **Cal/EPA** : *Reference Exposure Level* (REL) pour une exposition chronique par inhalation (http://www.oehha.ca.gov/air/allrels.html); **IRIS** : *Reference Concentration* (RfC) pour une exposition chronique par inhalation recommandée par le *Integrated Risk Information System* de l'U.S. EPA (http://www.epa.gov/iris/index.html); **OMS** : Recommandation dans l'air ambiant (http://www.euro.who.int/document/e71922.pdf) ; **RIVM** : Concentration tolérable dans l'air recommandée pour une exposition chronique par inhalation par le *National Institute of Public Health and the Environment* des Pays-Bas (http://www.rivm.nl/bibliotheek/rapporten/711701025.pdf); **Santé Canada** : Concentration tolérable (CT) dans l'air (Santé Canada, 2010); **s.c. VTR**: VTR sous-chronique (voir tableau 4); **TLV-TWA** : Norme en milieu de travail (*Threshold Limit Value-Time Weighted Average;* http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB).

c La TLV/TWA (10 µg/m^3) protège des effets cumulatifs d'expositions répétées aux sels solubles de l'argent (argyrose). La c. VTR provisoire a été dérivée après conversion pour une exposition continue et application d'un facteur de sécurité de 10.

d ATSDR suggère que VTR aiguë est protectrice pour des expositions de plus longue durée (sous-chronique et chronique).

e VTR correspondant à la forme hexavalente (plus toxique que le chrome trivalent).

f VTR correspondant aux composés solubles de la forme trivalente (plus toxiques que les composés insolubles).

g Valeurs spécifiques à chaque groupe d'âge.

h Valeur correspondant au mercure élémentaire (aucune valeur disponible pour mercure inorganique).

i VTR correspondant aux composés solubles de l'uranium (plus toxiques que les composés insolubles).

j Valeur provisoire correspondant à la VTR sous-chronique du vanadium divisée par un facteur de sécurité de 10.

( ) Les valeurs entre parenthèses indiquent les valeurs provisoires (voir section 3.2.3).

NA Non applicable : la substance ne présente pas de toxicité via cette voie d'exposition (gaz, $PM_{2.5}$, silice).

TABLEAU 6

Valeurs toxicologiques de référence retenues pour évaluer le risque de cancer

Substance	Potentiel cancérogène pour l'humain[a]	Ingestion		Inhalation	
		Coefficient de cancérogénicité $(mg/kg.j)^{-1}$	Origine[b]	Risque unitaire $(\mu g/m^3)^{-1}$	Origine[b]
NO_2	NC	NA		NA	
SO_2	NC	NA		NA	
$PM_{2.5}$	1	NA		ND	
Aluminium	NC	NA		NA	
Antimoine	NC	NA		NA	
Argent	NC	NA		NA	
Arsenic	A, 1, I	1,5	IRIS, Cal/EPA	4,3E-03	IRIS
Baryum	NC	NA		NA	
Béryllium	B1, 1	NA[c]		2,4E-03	IRIS, Cal/EPA, OMS
Bore	NC	NC		NC	
Cadmium	B1, 1, II	NA[c]		4,2E-03	Cal/EPA
Chrome	NC [d], A[e], 1[e], I[e]	NA[f]		NA[g]	
Cobalt	2B	ND		ND	
Cuivre	NC	NA		NA	
Étain	NC	NA		NA	
Lithium	NC	NA		NA	
Manganèse	NC	NA		NA	
Mercure	NC, C[h]	NA		NA	
Molybdène	NC	NA		NA	
Nickel	1; 2B, B2	ND		1,3E-03	Santé Canada
Plomb	B2, 2A, IIIB	0,0085	Cal/EPA	1,2E-05	Cal/EPA
Sélénium	NC	NA		NA	
Strontium	NC	NA		NA	
Titane	2B[i]	ND		ND	
Uranium	NC	NA		NA	
Vanadium	2B[j]	ND		ND	
Zinc	NC	NA		NA	

a Classification selon U.S. EPA (IRIS) : groupe A : cancérogène pour l'humain, groupes B1 et B2 : probablement cancérogène pour l'humain, groupe C : possiblement cancérogène pour l'humain (http://www.epa.gov/iris/index.html).
Classification selon CIRC: groupe 1 : cancérogène pour l'humain, groupe 2A : probablement cancérogène pour l'homme, groupe 2B : peut-être cancérogène pour l'homme (http://monographs.iarc.fr/FR/Classification/index.php).
Classification selon Santé Canada : groupe I : cancérogène pour l'humain, groupe II : probablement cancérogène pour l'humain, groupe III : susceptible d'être cancérogène pour l'humain (http://www.hc-sc.gc.ca/ewh-semt/pubs/contaminants/approach/index-eng.php).

b **Cal/EPA** : *Cancer Potency Factors* (http://www.oehha.ca.gov/air/hot_spots/tsd052909.html); **IRIS** : *Oral Slope Factors* et *Inhalation Unit Risks* recommandés dans la base de données IRIS (*Integrated Risk Information System)* par U.S. EPA (http://www.epa.gov/iris/index.html); **Santé Canada** : VTR de substances cancérogènes (Santé Canada, 2010).

c Non applicable à l'ingestion.

d Classification du chrome trivalent

e Classification du chrome hexavalent.

f La VTR par ingestion retenue pour une exposition chronique (tableau 5) protège des effets cancérigènes du chrome hexavalent (voir annexe B).

g Le coefficient de cancérogénicité par inhalation pour le chrome hexavalent n'est pas indiqué car le chrome émis dans l'air par la mine sera vraisemblablement sous forme trivalente.

h Classification du mercure inorganique.

i Classification attribuée au dioxyde de titane.

j Classification attribuée au pentoxyde de vanadium.

NC Substance non classée comme cancérogène, cancérogène probable ou cancérogène possible pour l'humain (ou substance non évaluée) par U.S.EPA, CIRC ou Santé Canada.

NA Non applicable.

ND Non disponible.

TABLEAU 7
Voies d'exposition considérées

Scénario d'exposition	Relais routier		Activités traditionnelles		Domestique	
Voie d'exposition	**Bruit de fond**	**Additionnelle**	**Bruit de fond**	**Additionnelle**	**Bruit de fond**	**Additionnelle**
Inhalation d'air extérieur	√	√	√	√	√	
Inhalation d'air intérieur	√	√	√	√	√	
Ingestion d'eau potable	√		√		√	
Ingestion de sol	√		√		√	
Ingestion de poussières intérieures	√	√	√	√	√	
Ingestion d'aliments d'origine commerciale[a]	√				√	
Ingestion de produits issus des activités traditionnelles			√	√	√	√
Ingestion de lait maternel (0-6 mois)[b]	√	√	√	√	√	√
Contact cutané avec le sol	√		√		√	
Contact cutané avec les poussières intérieures	√	√	√	√	√	
Contact cutané avec l'air	√	√	√	√	√	
Contact cutané avec l'eau	√		√		√	

a Apports alimentaires documentés pour la population générale.

b L'exposition des nourrissons *via* le lait maternel a été estimée selon une des méthodologies reconnues par l'INSPQ (2012b), soit celle décrite par le ministère de l'Environnement et de la Faune (MEF, 1996).

TABLEAU 8
Teneurs de fond (µg/m^3) dans l'air ambiant

Substance	1 heure	8 heures	24 heures	Mensuelle	Annuelle
CO	460	460	--		--
NO_2	15	--	--	7,5	3,8
SO_2	7,9	--	5,2	2,1	1,6
$PM_{2.5}$	--	--	11,4	6,0	4,9
Aluminium			1,94E-04		6,80E-05
Antimoine			1,10E-06		2,82E-07
Argent			5,34E-08		2,32E-08
Arsenic			1,38E-06		5,11E-07
Baryum			5,89E-06		1,61E-06
Béryllium			1,18E-08		8,42E-09
Bore			6,52E-06		6,52E-06
Cadmium			2,15E-07		8,04E-08
Chrome			1,03E-06		5,77E-07
Cobalt			2,28E-07		8,29E-08
Cuivre			1,95E-05		7,64E-06
Étain			7,80E-07		3,44E-07
Lithium	7,33E-08				2,55E-08
Manganèse			8,29E-06		3,20E-06
Mercure	1,90E-06		1,85E-06		1,23E-06
Molybdène			5,00E-07		2,08E-07
Nickel			1,39E-06		5,96E-07
Plomb			5,86E-06		2,17E-06
Sélénium			2,43E-06		6,74E-07
Strontium			3,23E-06		7,69E-07
Thallium			3,20E-08		2,78E-08
Titane			5,72E-06		2,27E-06
Uranium			9,26E-09		9,26E-09
Vanadium			2,00E-06		7,19E-07
Zinc			2,08E-05		7,63E-06
Silice cristalline respirable	--	--	--	--	0,04

Gaz et $PM_{2.5}$: valeurs issues du RNSPA (Environnement et Changement climatique Canada) pour l'année 2016, après conversion des concentrations de gaz en µg/m^3 (les valeurs fournies par le RNSPA sont exprimées en ppm (CO) ou en ppb (NO_2 et SO_2)). Valeurs retenues : 1 heure, 8 heures ou 24 heures = LSC95 des 98e centiles des concentrations rapportées pour chaque période de temps; Mensuelle = maximum des LSC95 calculées pour chaque mois de l'année (à partir des concentrations mensuelles moyennes rapportées dans les fichiers sommaires du RNSPA); Annuelle = LSC95 des 50e centiles des concentrations horaires.

Métaux : valeurs issues du NAtChem (Environnement et Changement climatique Canada) pour l'année 2010, correspondant aux teneurs sous forme de PM_{10}. Valeurs retenues : 24 heures = 98^e centile des concentrations mesurées 24 heures, Annuelle = LSC95 des concentrations mesurées sur 24 heures. Par défaut, pour le lithium, valeurs estimées en multipliant la teneur de fond en lithium dans le sol par les teneurs de fond en PM_{10} dans l'air (voir section 4.2.1.1) et pour la silice, concentration dite initiale indiquée par le MELCC (http://www.mddelcc.gouv.qc.ca/air/criteres/index.htm)

-- Valeur non disponible (teneur de fond), non requise (absence de valeur toxicologique de référence pour cette durée d'exposition).

TABLEAU 9

Concentrations additionnelles (µg/m^3) modélisées
dans l'air ambiant pour estimer l'exposition aiguë par inhalation

Substance	Maximum sur 1 heure	Maximum sur 8 heures	Maximum sur 24 heures
CO	10 456	1496,53	--
NO_2	241	--	--
SO_2	19	2,7	0,81
$PM_{2.5}$	--	--	8,8
Aluminium	3,1E+01	8,2E+00	3,7E+00
Antimoine	3,4E-04	5,5E-05	2,4E-05
Argent	5,0E-04	8,0E-05	3,0E-05
Arsenic	3,5E-02	5,2E-03	1,6E-03
Baryum	2,7E-01	8,1E-02	3,6E-02
Béryllium	3,6E-02	5,1E-03	1,6E-03
Bore	3,1E-01	4,5E-02	1,4E-02
Cadmium	3,4E-04	5,5E-05	2,2E-05
Chrome	1,1E-01	1,8E-02	5,5E-03
Cobalt	1,8E-02	6,2E-03	2,7E-03
Cuivre	2,0E-02	4,2E-03	1,9E-03
Étain	1,5E-02	2,3E-03	6,9E-04
Lithium	1,3E+00	1,9E-01	5,9E-02
Manganèse	5,8E-01	2,0E-01	8,7E-02
Mercure	8,2E-06	2,8E-06	1,2E-06
Molybdène	5,0E-03	7,5E-04	2,3E-04
Nickel	3,2E-02	5,9E-03	2,7E-03
Plomb	6,0E-03	1,3E-03	5,7E-04
Sélénium	4,9E-03	7,0E-04	2,2E-04
Strontium	1,3E-01	4,5E-02	2,0E-02
Titane	5,4E+00	1,9E+00	8,1E-01
Uranium	2,1E-03	3,1E-04	9,5E-05
Vanadium	1,3E-01	4,3E-02	1,9E-02
Zinc	6,6E-02	2,1E-02	9,4E-03
Silice cristalline respirable	--	--	--

Valeurs fournies par WSP (M. Julien Poirier, communications personnelles, septembre 2018). Concentrations correspondant au récepteur le plus exposé sur la durée totale de l'exploitation prévue (EAU1, EAU2 ou TRC1 sur 1 heure, EAU2 ou MOT1 sur 8 heures et 24 heures, selon la substance).

Pour les métaux, les concentrations sont celles associées aux PM_{10}.

-- Valeur non requise (absence de valeur toxicologique de référence pour cette durée d'exposition).

TABLEAU 10

Concentrations additionnelles (µg/m^3) modélisées dans l'air ambiant pour estimer l'exposition sous-chronique et chronique par inhalation

Type d'exposition	Sous-chronique		Chronique
Scénario	Relais routier	Activités traditionnelles	Relais routier
Période	2 semaines[a]	1 mois[b]	Annuelle[c]
CO	--	--	--
NO_2	15,5	10,2	2,6
SO_2	0,09	0,06	0,008
$PM_{2,5}$	1,74	1,86	0,61
Aluminium	7,2E-01	7,3E-01	2,5E-01
Antimoine	4,7E-06	4,7E-06	1,6E-06
Argent	6,1E-06	6,1E-06	2,0E-06
Arsenic	2,1E-04	1,4E-04	4,8E-05
Baryum	7,0E-03	7,1E-03	2,4E-03
Béryllium	4,8E-05	4,9E-05	1,4E-05
Bore	1,4E-03	8,9E-04	1,8E-04
Cadmium	4,5E-06	4,4E-06	1,5E-06
Chrome	9,4E-04	9,2E-04	3,1E-04
Cobalt	5,2E-04	5,3E-04	1,8E-04
Cuivre	3,7E-04	3,7E-04	1,3E-04
Étain	5,4E-05	5,2E-05	1,7E-05
Lithium	3,3E-03	2,9E-03	9,1E-04
Manganèse	1,7E-02	1,7E-02	5,9E-03
Mercure	2,4E-07	2,4E-07	8,3E-08
Molybdène	2,3E-05	2,3E-05	7,5E-06
Nickel	5,2E-04	5,2E-04	1,8E-04
Plomb	1,1E-04	1,1E-04	3,8E-05
Sélénium	8,7E-06	8,9E-06	2,8E-06
Strontium	3,8E-03	3,9E-03	1,3E-03
Titane	1,6E-01	1,6E-01	5,5E-02
Uranium	8,6E-06	6,7E-06	2,2E-06
Vanadium	3,6E-03	3,7E-03	1,3E-03
Zinc	1,8E-03	1,8E-03	6,2E-04
Silice cristalline respirable		--	6,2E-02

Valeurs fournies par WSP (communication personnelle de M. Julien Poirier, septembre 2018).
Pour les métaux, concentration sous forme de PM_{10} (particules inhalables).

a Valeur correspondant à la plus élevée des concentrations moyennes sur une période de 2 semaines au Relais routier (récepteur REL1) (parmi les 5 années météorologiques modélisées).

b Concentration correspondant au récepteur le plus exposé (selon les substances : EAU2 ou TRC1) sur une période de 4 semaines (valeur la plus élevée parmi les 5 années météorologiques modélisées).

c Valeur correspondant à la plus élevée des concentrations moyennes sur une période d'une année au récepteur REL1 (parmi les 5 années météorologiques modélisées).

-- Valeurs non requises (absence de VTR pour la durée d'exposition correspondante et/ou voie d'exposition non pertinente).

TABLEAU 11

Concentrations additionnelles (µg/m^3) modélisées dans l'air ambiant retenues pour estimer l'exposition par voies multiples

Scénario d'exposition	Relais routier[a]	Activités traditionnelles[b]
CO	--	--
NO_2	--	--
SO_2	--	--
$PM_{2,5}$	--	--
Aluminium	4,8E-04	1,8E-04
Antimoine	3,1E-09	1,2E-09
Argent	3,9E-09	1,5E-09
Arsenic	9,4E-08	3,6E-08
Baryum	4,7E-06	1,8E-06
Béryllium	2,1E-08	8,0E-09
Bore	3,8E-07	1,4E-07
Cadmium	2,9E-09	1,1E-09
Chrome	6,0E-07	2,3E-07
Cobalt	3,5E-07	1,3E-07
Cuivre	2,5E-07	9,2E-08
Étain	3,0E-08	1,2E-08
Lithium	1,6E-06	6,0E-07
Manganèse	1,1E-05	4,3E-06
Mercure	1,6E-10	6,0E-11
Molybdène	1,4E-08	5,3E-09
Nickel	3,5E-07	1,3E-07
Plomb	7,5E-08	2,8E-08
Sélénium	4,5E-09	1,7E-09
Strontium	2,6E-06	9,7E-07
Titane	1,1E-04	4,0E-05
Uranium	3,9E-09	1,5E-09
Vanadium	2,4E-06	9,2E-07
Zinc	1,2E-06	4,5E-07
Silice cristalline respirable	--	--

Valeurs fournies par WSP (communication personnelle de M. Julien Poirier, septembre 2018).

a Concentration moyenne sur une base annuelle estimée au récepteur REL1 (valeur correspondant à la plus élevée des concentrations annuelles parmi les 5 années météorologiques modélisées). Concentrations de métaux sous forme de PST (particules totales).

b Concentration moyenne sur une base annuelle représentative de la zone d'exposition rapprochée (valeur correspondant à la plus élevée des concentrations annuelles parmi les 5 années météorologiques modélisées). Concentrations de métaux sous forme de PST (particules totales).

-- Valeurs non requises (absence de VTR pour la durée d'exposition correspondante et/ou voie d'exposition non pertinente).

TABLEAU 12

Teneurs de fond en métaux dans les sols, l'eau, l'air intérieur et les poussières intérieures

Substance	Sol (mg/kg)	Sédiments (mg/kg)	Eau potable (mg/L)	Eau de surface (mg/L)	Air intérieur (µg/m³)	Poussières intérieures (mg/kg)	
						Été	Hiver
Aluminium	4 194	3 851	6,0E-03	2,0E-01	4,8E-02	602	680
Antimoine	0,14	0,14	1,0E-04	2,0E-04	2,0E-04	2,0	2,8
Argent	0,4	0,4	5,6E-06	5,6E-06	1,6E-05	0,17	0,23
Arsenic	5,5	13,2	5,0E-04	1,2E-03	3,6E-04	3,7	5,1
Baryum	24,6	31,8	1,1E-02	4,4E-03	1,1E-03	12,0	16,1
Béryllium	0,58	0,58	1,2E-05	1,2E-05	5,9E-06	0,08	0,08
Bore	42,6	42,6	1,4E-03	1,4E-03	4,6E-03	46,9	65,2
Cadmium	0,38	0,38	1,9E-05	1,9E-05	5,6E-05	0,57	0,80
Chrome	45,7	20,8	6,0E-04	9,2E-04	4,0E-04	5,4	5,8
Cobalt	3,3	3,3	2,6E-04	2,6E-04	5,8E-05	0,68	0,83
Cuivre	9,7	9,7	1,0E+00	3,3E-04	5,3E-03	53,8	76,4
Étain	5	5	1,0E-03	1,0E-03	2,4E-04	2,6	3,4
Lithium	3,2	6,5	2,4E-03	2,4E-03	1,8E-05	0,27	0,26
Manganèse	56,1	103	3,8E-03	3,0E-02	2,2E-03	24,1	32,0
Mercure	0,036	0,036	3,7E-05	2,1E-06	2,2E-03	3,7E-03	3,4E-03
Molybdène	2,2	2,8	6,2E-05	6,2E-05	1,5E-04	1,5	2,1
Nickel	7,2	7,2	4,9E-04	4,9E-04	4,2E-04	4,4	6,0
Plomb	9,1	9,1	3,0E-04	4,1E-04	1,5E-03	15,5	21,7
Sélénium	1,1	1,1	1,8E-04	1,8E-04	4,7E-04	4,8	6,7
Strontium	36,7	36,7	8,5E-02	1,7E-02	5,4E-04	6,5	7,7
Titane	370	330	1,0E-02	5,0E-02	1,6E-03	27,0	22,7
Uranium	24	24	1,9E-05	1,9E-05	6,5E-06	0,78	0,09
Vanadium	16,3	25	6,4E-05	6,4E-05	5,0E-04	5,5	7,2
Zinc	18,8	18,8	6,1E-02	4,3E-03	5,3E-03	54	76,3

TABLEAU 13

Teneurs de fond (en mg/kg-frais) en métaux mesurées ou modélisées dans les aliments issus d'activités traditionnelles

Substance	Végétaux[a]		Chair de gibier[d]	Chair de poisson
	Fruits[b]	Infusions[c]		
Aluminium	1,1E+01	1,1E+01	5,6E+00	4,3E+01
Antimoine	4,8E-03	4,8E-03	2,2E-04	3,2E-03
Argent	1,6E-03	1,6E-03	1,3E-02	5,2E-04
Arsenic	9,1E-03	9,1E-03	1,0E-02	2,2E-01
Baryum	6,5E+00	6,5E+00	6,6E-02	3,1E+00
Béryllium	6,2E-04	6,2E-04	8,8E-05	7,9E-04
Bore	9,3E-01	1,2E+00	2,6E-01	3,2E-01
Cadmium	3,8E-03	3,8E-03	9,3E-04	4,1E-03
Chrome	1,3E-02	1,3E-02	1,3E-01	2,0E-02
Cobalt	9,9E-03	6,4E-02	8,3E-03	9,0E-03
Cuivre	6,0E-01	6,0E-01	2,7E-01	1,4E-01
Étain	3,8E-03	1,9E-02	5,8E-01	3,0E+00
Lithium	6,6E-03	1,6E-02	1,5E-01	3,3E-02
Manganèse	7,6E+01	7,6E+01	7,8E-01	3,3E-01
Mercure	6,4E-04	8,3E-04	3,9E-02	7,7E-01
Molybdène	1,3E-02	1,6E-02	2,2E-02	2,0E-02
Nickel	2,0E-01	2,0E-01	1,3E-02	2,8E-02
Plomb	3,4E-02	3,4E-02	2,4E-03	3,3E-03
Sélénium	1,0E-02	1,0E-02	2,2E-01	6,5E-01
Strontium	3,4E+00	3,4E+00	1,3E+00	3,9E+00
Titane	1,8E-01	1,8E-01	1,5E+01	3,5E+01
Uranium	4,1E-04	3,9E-04	1,3E-02	8,8E-04
Vanadium	1,1E-02	1,1E-02	2,2E-02	2,0E-02
Zinc	3,6E+00	4,1E+00	3,0E+01	9,4E+00

a Concentrations mesurées dans des échantillons composites de fruits, feuilles et tiges, ou concentrations modélisées (voir annexe F).

b Concentrations retenues dans les parties reproductrices des végétaux arbustifs (représentatif des bleuets).

c Moyenne des concentrations retenues dans les parties végétatives des végétaux herbacés, arbustifs et arborescents.

d Moyenne des teneurs de fond modélisées dans les différentes espèces d'oiseaux et de mammifères potentiellement chassés ou trappés dans la zone d'étude.

TABLEAU 14

Concentrations additionnelles de métaux modélisées dans les milieux d'exposition et les aliments issus d'activités traditionnelles dans la zone d'exposition rapprochée

Scénario d'exposition	Relais routier			Activités traditionnelles							
Substance	Poussières intérieures (mg/kg)		Air intérieur (µg/m³)	Poussières intérieures (mg/kg)		Air intérieur (µg/m³)	Eau de surface (mg/L)	Végétaux (mg/kg-frais)		Chair animale (mg/kg-frais)	
	Été	Hiver		Été	Hiver			Fruits[a]	Infusions[b]	Gibier[c]	Poisson
Aluminium	3,3E+03	4,8E+03	3,3E-01	1,3E+03	1,8E+03	1,3E-01	3,7E-03	7,0E-02	3,7E-01	3,8E-02	7,4E-01
Antimoine	2,1E-02	3,1E-02	2,1E-06	8,1E-03	1,2E-02	8,1E-07	2,4E-08	4,1E-07	2,4E-06	1,6E-07	2,4E-06
Argent	2,8E-02	3,9E-02	2,8E-06	1,0E-02	1,5E-02	1,0E-06	3,1E-08	8,9E-07	3,1E-06	4,2E-06	2,7E-06
Arsenic	6,6E-01	9,4E-01	6,6E-05	2,5E-01	3,6E-01	2,5E-05	6,9E-07	1,3E-05	7,5E-05	1,0E-05	1,0E-04
Baryum	3,3E+01	4,7E+01	3,3E-03	1,2E+01	1,8E+01	1,2E-03	3,5E-05	4,2E-04	3,6E-03	8,8E-05	2,2E-02
Béryllium	1,5E-01	2,1E-01	1,5E-05	5,6E-02	8,0E-02	5,6E-06	3,3E-07	2,9E-06	1,6E-05	3,4E-07	2,1E-05
Bore	2,6E+00	3,8E+00	2,6E-04	9,9E-01	1,4E+00	9,9E-05	2,2E-06	1,7E-04	2,9E-04	1,6E-05	4,4E-04
Cadmium	2,0E-02	2,9E-02	2,0E-06	7,6E-03	1,1E-02	7,6E-07	2,3E-08	7,1E-07	2,2E-06	5,6E-07	4,5E-06
Chrome	4,2E+00	6,0E+00	4,2E-04	1,6E+00	2,3E+00	1,6E-04	4,7E-06	3,2E-04	4,7E-04	5,6E-04	9,4E-05
Cobalt	2,5E+00	3,5E+00	2,5E-04	9,3E-01	1,3E+00	9,3E-05	2,7E-06	1,1E-04	2,7E-04	3,8E-05	8,0E-05
Cuivre	1,7E+00	2,5E+00	1,7E-04	6,5E-01	9,2E-01	6,5E-05	1,8E-06	1,4E-04	1,9E-04	4,9E-04	6,4E-04
Étain	2,1E-01	3,1E-01	2,1E-05	8,1E-02	1,2E-01	8,1E-06	3,0E-07	5,5E-06	2,4E-05	2,4E-04	8,9E-04
Lithium	1,1E+01	1,6E+01	1,1E-03	4,2E+00	6,0E+00	4,2E-04	1,8E-05	2,3E-04	1,2E-03	5,1E-03	1,4E-04
Manganèse	8,0E+01	1,1E+02	8,0E-03	3,0E+01	4,3E+01	3,0E-03	8,6E-05	2,0E-03	8,8E-03	8,7E-04	8,6E-04
Mercure	1,9E-07	2,5E-07	1,6E-07	7,1E-08	9,3E-08	6,0E-08	1,2E-09	5,3E-08	2,2E-07	9,4E-05	4,2E-04
Molybdène	9,9E-02	1,4E-01	9,9E-06	3,7E-02	5,3E-02	3,7E-06	1,2E-07	3,1E-06	1,1E-05	2,1E-05	2,5E-05
Nickel	2,4E+00	3,5E+00	2,4E-04	9,2E-01	1,3E+00	9,2E-05	2,6E-06	3,1E-04	2,7E-04	1,9E-05	1,3E-04
Plomb	5,2E-01	7,5E-01	5,2E-05	2,0E-01	2,8E-01	2,0E-05	5,6E-07	1,3E-05	5,8E-05	5,0E-06	4,2E-06
Sélénium	3,2E-02	4,5E-02	3,2E-06	1,2E-02	1,7E-02	1,2E-06	5,8E-08	4,1E-06	3,5E-06	7,2E-05	1,7E-04
Strontium	1,8E+01	2,6E+01	1,8E-03	6,8E+00	9,7E+00	6,8E-04	1,9E-05	2,3E-04	2,0E-03	1,1E-03	3,9E-03
Titane	7,4E+02	1,1E+03	7,4E-02	2,8E+02	4,0E+02	2,8E-02	8,0E-04	5,2E-02	8,2E-02	7,0E-01	5,6E-01
Uranium	2,7E-02	3,9E-02	2,7E-06	1,1E-02	1,5E-02	1,1E-06	3,8E-08	1,7E-06	3,1E-06	1,3E-07	1,4E-06
Vanadium	1,7E+01	2,5E+01	1,7E-03	6,4E+00	9,2E+00	6,4E-04	1,8E-05	1,2E-03	1,9E-03	1,3E-03	3,7E-03
Zinc	8,4E+00	1,2E+01	8,4E-04	3,2E+00	4,5E+00	3,2E-04	9,3E-06	6,5E-04	9,3E-04	3,5E-02	1,9E-02

Concentrations estimées par modélisations (voir annexe F) à partir des concentrations additionnelles dans l'air indiquées au tableau 11.

a Concentrations modélisées dans les parties reproductrices de la végétation arbustive.

b Moyenne des concentrations modélisées dans les parties végétatives des végétaux herbacés, arbustifs et arborescents.

c Concentrations maximales modélisées dans la chair de gibier (espèces de mammifères et d'oiseaux potentiellement chassées ou trappées dans la zone d'étude).

TABLEAU 15

Doses bruit de fond et additionnelles (mg/kg-pc par jour) de métaux estimées
pour une exposition sous-chronique - Scénario « Relais routier »

Type d'exposition	Doses bruit de fond						Doses additionnelles					
Voie d'exposition	Ingestion		Cutané		Inhalation		Ingestion		Cutané		Inhalation	
Substances	0-6 mois	20 ans et +	0-6 mois	20 ans et +	0-6 mois	20 ans et +	0-6 mois	20 ans et +	0-6 mois	20 ans et +	0-6 mois	20 ans et +
Aluminium	6,9E-02	1,6E-01	3,2E-04	2,0E-03	2,5E-05	1,1E-05	2,1E-06	6,4E-04	0,0E+00	4,7E-04	0,0E+00	7,5E-05
Antimoine	2,0E-04	4,8E-05	3,3E-07	1,6E-07	1,0E-07	4,6E-08	4,8E-12	4,1E-09	0,0E+00	1,5E-09	0,0E+00	4,8E-10
Argent	2,9E-03	6,7E-04	2,3E-07	5,5E-07	-	-	4,2E-09	5,3E-09	0,0E+00	9,8E-09	-	-
Arsenic	2,4E-03	5,8E-04	8,1E-07	1,4E-06	1,9E-07	9,2E-08	1,4E-10	1,3E-07	0,0E+00	3,7E-08	0,0E+00	1,5E-08
Baryum	2,0E-02	6,6E-03	2,3E-05	2,6E-05	-	-	6,6E-08	6,3E-06	0,0E+00	6,7E-06	-	-
Béryllium	1,7E-05	3,5E-06	8,2E-07	4,6E-06	-	-	9,8E-12	2,8E-08	0,0E+00	3,5E-07	-	-
Bore	1,1E-01	1,5E-02	2,8E-06	3,4E-06	-	-	7,3E-09	5,0E-07	0,0E+00	4,2E-08	-	-
Cadmium	2,6E-04	2,0E-04	1,8E-07	1,5E-07	-	-	4,4E-11	3,9E-09	0,0E+00	1,1E-09	-	-
Chrome	1,7E-04	2,4E-04	2,5E-05	1,7E-04	2,1E-07	1,0E-07	1,3E-07	8,0E-07	0,0E+00	4,6E-06	0,0E+00	9,4E-08
Cobalt	6,3E-04	1,5E-04	5,8E-08	1,7E-07	-	-	9,1E-09	4,7E-07	0,0E+00	3,5E-08	-	-
Cuivre	1,6E-01	4,8E-02	8,7E-05	4,2E-05	2,7E-06	1,9E-05	6,3E-09	3,3E-07	0,0E+00	2,4E-08	0,0E+00	3,9E-08
Étain	1,2E-01	2,3E-02	2,2E-07	3,2E-07	1,3E-07	7,4E-08	3,9E-10	4,1E-08	0,0E+00	3,0E-09	0,0E+00	4,8E-09
Lithium	6,1E-03	2,8E-03	2,7E-07	3,1E-07	9,5E-09	4,7E-08	4,1E-07	2,1E-06	0,0E+00	1,9E-07	0,0E+00	2,5E-07
Manganèse	7,5E-02	5,5E-02	1,6E-05	3,2E-05	-	-	7,6E-08	1,5E-05	0,0E+00	1,1E-05	-	-
Mercure	1,4E-04	6,2E-05	3,4E-09	3,3E-09	-	-	1,3E-13	3,3E-14	0,0E+00	6,0E-15	-	-
Molybdène	1,1E-02	2,5E-03	8,4E-08	1,4E-07	-	-	3,1E-10	1,9E-08	0,0E+00	1,4E-09	-	-
Nickel	1,4E-02	3,1E-03	2,3E-05	4,2E-05	-	-	9,9E-07	4,6E-07	0,0E+00	3,4E-06	-	-
Plomb	4,3E-04	1,4E-04	8,0E-07	7,8E-07	-	-	2,9E-10	1,0E-07	0,0E+00	7,4E-09	-	-
Sélénium	5,7E-03	2,3E-03	3,1E-06	1,5E-06	2,4E-07	1,1E-07	1,6E-09	6,0E-09	0,0E+00	9,0E-09	0,0E+00	7,1E-10
Strontium	9,2E-02	2,1E-02	3,8E-05	2,6E-05	2,9E-07	1,6E-06	8,2E-08	3,5E-06	0,0E+00	1,3E-06	0,0E+00	4,1E-07
Titane	4,4E-02	1,0E-02	7,5E-05	5,7E-04	8,4E-07	5,5E-07	5,7E-05	1,4E-04	0,0E+00	3,5E-04	0,0E+00	1,7E-05
Uranium	2,9E-04	1,0E-04	2,1E-07	5,3E-06	-	-	3,7E-11	5,2E-09	0,0E+00	1,9E-09	-	-
Vanadium	1,5E-03	3,4E-04	1,1E-05	3,3E-05	-	-	3,0E-09	3,3E-06	0,0E+00	9,4E-06	-	-
Zinc	7,3E-01	1,7E-01	4,7E-06	2,3E-06	2,7E-06	2,3E-06	1,5E-07	1,6E-06	0,0E+00	1,2E-07	0,0E+00	1,9E-07

- Valeur non requise (une s.c. VTR_{inh} étant disponible, les doses par inhalation n'ont pas été combinées aux autres voies pour estimer les risques posés par l'inhalation).

TABLEAU 16

Doses bruit de fond (mg/kg-pc par jour) de métaux estimées
pour une exposition sous-chronique - Scénario « Activités traditionnelles »

Voie d'exposition	Ingestion					Cutané					Inhalation				
Substances	**0-6 mois**	**0,5-4 ans**	**5-11 ans**	**12-19 ans**	**20 ans et +**	**0-6 mois**	**0,5-4 ans**	**5-11 ans**	**12-19 ans**	**20 ans et +**	**0-6 mois**	**0,5-4 ans**	**5-11 ans**	**12-19 ans**	**20 ans et +**
Aluminium	8,2E-02	5,3E-01	3,4E-01	2,0E-01	1,4E-01	4,8E-04	4,4E-03	3,6E-03	1,2E-03	1,1E-03	2,9E-05	2,7E-05	2,2E-05	1,7E-05	1,3E-05
Antimoine	4,6E-05	1,7E-04	9,6E-05	5,4E-05	3,3E-05	3,8E-07	2,8E-07	2,4E-07	1,9E-07	1,8E-07	1,2E-07	1,1E-07	9,2E-08	7,1E-08	5,3E-08
Argent	2,3E-05	1,2E-04	8,1E-05	5,3E-05	5,5E-05	2,3E-07	1,1E-06	9,2E-07	3,2E-07	3,0E-07	-	-	-	-	-
Arsenic	1,2E-04	1,2E-03	8,7E-04	5,0E-04	4,2E-04	8,8E-07	2,7E-06	2,2E-06	8,7E-07	8,2E-07	2,2E-07	2,0E-07	1,7E-07	1,3E-07	9,7E-08
Baryum	4,4E-02	2,0E-01	1,2E-01	6,7E-02	3,9E-02	1,4E-05	4,3E-05	3,6E-05	1,4E-05	1,4E-05	-	-	-	-	-
Béryllium	6,2E-06	2,3E-05	1,4E-05	7,8E-06	5,0E-06	8,2E-07	9,8E-06	8,2E-06	2,6E-06	2,4E-06	-	-	-	-	-
Bore	6,5E-03	3,0E-02	1,8E-02	1,0E-02	6,3E-03	2,8E-06	6,3E-06	5,2E-06	2,2E-06	2,1E-06	-	-	-	-	-
Cadmium	2,9E-05	1,3E-04	8,1E-05	4,6E-05	3,0E-05	1,8E-07	2,7E-07	2,2E-07	1,2E-07	1,1E-07	-	-	-	-	-
Chrome	2,4E-04	1,3E-03	8,6E-04	5,6E-04	5,9E-04	2,8E-05	3,6E-04	3,0E-04	9,3E-05	8,7E-05	2,5E-07	2,3E-07	1,9E-07	1,5E-07	1,1E-07
Cobalt	1,1E-04	3,9E-04	2,4E-04	1,4E-04	1,0E-04	5,8E-08	3,5E-07	3,0E-07	1,0E-07	9,5E-08	-	-	-	-	-
Cuivre	1,0E-01	8,0E-02	5,1E-02	3,2E-02	3,0E-02	1,6E-06	1,2E-06	1,0E-06	8,2E-07	7,7E-07	3,3E-06	3,0E-06	2,5E-06	1,9E-06	1,4E-06
Étain	1,9E-04	1,5E-02	1,1E-02	6,9E-03	6,6E-03	2,2E-07	6,2E-07	5,2E-07	2,1E-07	2,0E-07	1,5E-07	1,4E-07	1,1E-07	8,7E-08	6,5E-08
Lithium	3,9E-04	1,3E-03	9,1E-04	6,0E-04	6,7E-04	2,7E-07	5,9E-07	4,9E-07	2,3E-07	2,2E-07	1,1E-08	1,0E-08	8,3E-09	6,4E-09	4,8E-09
Manganèse	5,0E-01	2,2E+00	1,3E+00	7,1E-01	3,9E-01	3,8E-05	8,1E-05	6,8E-05	3,1E-05	2,9E-05	-	-	-	-	-
Mercure	1,3E-05	3,1E-03	2,5E-03	1,4E-03	1,3E-03	4,6E-10	3,8E-09	3,3E-09	1,3E-09	1,3E-09	-	-	-	-	-
Molybdène	9,9E-05	5,8E-04	3,7E-04	2,2E-04	1,8E-04	8,4E-08	2,7E-07	2,2E-07	8,6E-08	8,0E-08	-	-	-	-	-
Nickel	1,6E-03	6,0E-03	3,5E-03	2,0E-03	1,1E-03	2,3E-05	8,3E-05	7,0E-05	2,6E-05	2,4E-05	-	-	-	-	-
Plomb	2,9E-04	1,1E-03	6,2E-04	3,5E-04	2,0E-04	8,0E-07	1,4E-06	1,1E-06	5,3E-07	5,0E-07	-	-	-	-	-
Sélénium	2,4E-04	4,0E-03	3,0E-03	1,8E-03	1,8E-03	3,1E-06	2,3E-06	1,9E-06	1,6E-06	1,5E-06	2,9E-07	2,6E-07	2,2E-07	1,7E-07	1,3E-07
Strontium	3,1E-02	1,2E-01	7,7E-02	4,5E-02	3,0E-02	9,1E-06	2,4E-05	2,0E-05	8,7E-06	8,2E-06	3,3E-07	3,0E-07	2,5E-07	1,9E-07	1,5E-07
Titane	1,2E-02	2,2E-01	1,7E-01	1,1E-01	1,1E-01	1,9E-04	1,3E-03	1,1E-03	3,8E-04	3,5E-04	9,8E-07	8,9E-07	7,4E-07	5,7E-07	4,3E-07
Uranium	4,2E-05	1,3E-04	7,2E-05	4,7E-05	5,3E-05	2,1E-07	1,2E-05	9,8E-06	2,8E-06	2,7E-06	-	-	-	-	-
Vanadium	1,1E-04	5,7E-04	3,5E-04	2,1E-04	1,7E-04	1,1E-05	6,7E-05	5,6E-05	1,9E-05	1,8E-05	-	-	-	-	-
Zinc	4,2E-02	3,1E-01	2,2E-01	1,4E-01	1,4E-01	1,8E-06	1,3E-06	1,1E-06	9,2E-07	8,6E-07	3,3E-06	3,0E-06	2,5E-06	1,9E-06	1,4E-06

- Valeur non requise (une s.c. VTR_{inh} étant disponible, les doses par inhalation n'ont pas été combinées aux autres voies pour estimer les risques posés par l'inhalation).

TABLEAU 17

Doses additionnelles (mg/kg-pc par jour) de métaux estimées
pour une exposition sous-chronique - Scénario « Activités traditionnelles »

Voie d'exposition	Ingestion					Cutané					Inhalation				
Substances	**0-6 mois**	**0,5-4 ans**	**5-11 ans**	**12-19 ans**	**20 ans et +**	**0-6 mois**	**0,5-4 ans**	**5-11 ans**	**12-19 ans**	**20 ans et +**	**0-6 mois**	**0,5-4 ans**	**5-11 ans**	**12-19 ans**	**20 ans et +**
Aluminium	3,2E-03	1,0E-02	4,6E-03	2,3E-03	1,8E-03	3,7E-04	2,8E-04	2,4E-04	1,9E-04	1,8E-04	7,8E-05	7,1E-05	5,9E-05	4,5E-05	3,4E-05
Antimoine	2,0E-08	5,5E-08	2,1E-08	1,0E-08	7,8E-09	1,2E-09	9,0E-10	7,5E-10	6,1E-10	5,8E-10	5,0E-10	4,5E-10	3,7E-10	2,9E-10	2,2E-10
Argent	3,5E-08	1,0E-07	4,9E-08	2,8E-08	2,6E-08	7,7E-09	5,8E-09	4,9E-09	4,0E-09	3,7E-09	-	-	-	-	-
Arsenic	6,5E-07	1,9E-06	7,8E-07	3,9E-07	3,1E-07	3,0E-08	2,3E-08	1,9E-08	1,5E-08	1,4E-08	1,6E-08	1,4E-08	1,2E-08	9,2E-09	6,9E-09
Baryum	3,0E-05	1,5E-04	8,3E-05	4,5E-05	3,8E-05	5,2E-06	3,9E-06	3,3E-06	2,7E-06	2,5E-06	-	-	-	-	-
Béryllium	1,4E-07	3,9E-07	1,6E-07	7,7E-08	5,8E-08	2,8E-07	2,1E-07	1,8E-07	1,4E-07	1,3E-07	-	-	-	-	-
Bore	3,3E-06	1,1E-05	5,0E-06	2,6E-06	1,8E-06	3,3E-08	2,5E-08	2,1E-08	1,7E-08	1,6E-08	-	-	-	-	-
Cadmium	2,1E-08	7,2E-08	3,4E-08	1,8E-08	1,4E-08	9,8E-10	7,3E-10	6,1E-10	5,0E-10	4,7E-10	-	-	-	-	-
Chrome	5,6E-06	1,9E-05	9,3E-06	5,2E-06	4,1E-06	3,6E-06	2,7E-06	2,3E-06	1,9E-06	1,7E-06	9,8E-08	8,9E-08	7,4E-08	5,7E-08	4,3E-08
Cobalt	2,8E-06	7,5E-06	3,0E-06	1,5E-06	1,0E-06	2,8E-08	2,1E-08	1,7E-08	1,4E-08	1,3E-08	-	-	-	-	-
Cuivre	2,4E-06	1,2E-05	6,7E-06	4,0E-06	3,5E-06	1,9E-08	1,4E-08	1,2E-08	9,9E-09	9,2E-09	4,0E-08	3,6E-08	3,0E-08	2,3E-08	1,7E-08
Étain	2,3E-07	5,2E-06	3,8E-06	2,3E-06	2,2E-06	2,4E-09	1,8E-09	1,5E-09	1,2E-09	1,2E-09	5,0E-09	4,6E-09	3,8E-09	2,9E-09	2,2E-09
Lithium	1,4E-05	5,3E-05	2,9E-05	1,8E-05	2,0E-05	1,6E-07	1,2E-07	9,8E-08	8,0E-08	7,5E-08	2,6E-07	2,3E-07	1,9E-07	1,5E-07	1,1E-07
Manganèse	7,9E-05	1,9E-04	6,5E-05	3,0E-05	2,1E-05	8,9E-06	6,7E-06	5,6E-06	4,6E-06	4,3E-06	-	-	-	-	-
Mercure	4,3E-09	2,1E-06	1,6E-06	1,0E-06	9,7E-07	1,1E-13	8,6E-14	7,7E-14	7,1E-14	7,0E-14	-	-	-	-	-
Molybdène	1,0E-07	4,5E-07	2,4E-07	1,4E-07	1,4E-07	1,1E-09	8,4E-10	7,0E-10	5,7E-10	5,4E-10	-	-	-	-	-
Nickel	4,5E-06	1,3E-05	6,4E-06	3,4E-06	2,0E-06	2,7E-06	2,0E-06	1,7E-06	1,4E-06	1,3E-06	-	-	-	-	-
Plomb	5,2E-07	1,2E-06	4,2E-07	2,0E-07	1,3E-07	5,8E-09	4,4E-09	3,6E-09	3,0E-09	2,8E-09	-	-	-	-	-
Sélénium	9,6E-08	1,2E-06	8,9E-07	5,5E-07	5,4E-07	7,1E-09	5,4E-09	4,5E-09	3,7E-09	3,4E-09	7,4E-10	6,7E-10	5,6E-10	4,3E-10	3,2E-10
Strontium	1,7E-05	5,5E-05	2,6E-05	1,4E-05	1,2E-05	1,0E-06	7,6E-07	6,3E-07	5,2E-07	4,9E-07	4,2E-07	3,8E-07	3,2E-07	2,5E-07	1,8E-07
Titane	1,2E-03	8,7E-03	5,6E-03	3,5E-03	3,7E-03	2,8E-04	2,1E-04	1,7E-04	1,4E-04	1,3E-04	1,7E-05	1,6E-05	1,3E-05	1,0E-05	7,6E-06
Uranium	3,4E-08	9,7E-08	4,2E-08	2,1E-08	1,3E-08	1,6E-09	1,2E-09	9,8E-10	8,0E-10	7,5E-10	-	-	-	-	-
Vanadium	2,2E-05	8,2E-05	4,2E-05	2,3E-05	1,8E-05	7,4E-06	5,5E-06	4,6E-06	3,8E-06	3,5E-06	-	-	-	-	-
Zinc	2,4E-05	3,0E-04	2,1E-04	1,4E-04	1,6E-04	9,3E-08	7,0E-08	5,9E-08	4,8E-08	4,5E-08	2,0E-07	1,8E-07	1,5E-07	1,1E-07	8,5E-08

- Valeur non requise (une s.c. VTR_{inh} étant disponible, les doses par inhalation n'ont pas été combinées aux autres voies pour estimer les risques posés par l'inhalation).

TABLEAU 18

Doses bruit de fond et additionnelles (mg/kg-pc par jour) de métaux estimées
pour une exposition chronique - Scénario « Relais routier »

Substances	Doses bruit de fond						Doses additionnelles					
	Ingestion		Cutané		Inhalation		Ingestion		Cutané		Inhalation	
	0-6 mois	20 ans et +	0-6 mois	20 ans et +	0-6 mois	20 ans et +	0-6 mois	20 ans et +	0-6 mois	20 ans et +	0-6 mois	20 ans et +
Aluminium	6,6E-02	1,6E-01	2,3E-04	1,0E-03	2,5E-05	1,1E-05	9,6E-07	2,6E-04	0,0E+00	3,1E-04	0,0E+00	3,7E-05
Antimoine	2,0E-04	4,8E-05	4,4E-07	2,3E-07	1,0E-07	4,7E-08	2,3E-12	1,7E-09	0,0E+00	1,0E-09	0,0E+00	2,4E-10
Argent	2,9E-03	6,7E-04	1,8E-07	3,0E-07	-	-	1,7E-09	2,2E-09	0,0E+00	6,5E-09	-	-
Arsenic	2,4E-03	5,8E-04	6,4E-07	7,9E-07	1,9E-07	9,1E-08	6,6E-11	5,2E-08	0,0E+00	2,5E-08	0,0E+00	7,3E-09
Baryum	2,0E-02	6,6E-03	2,1E-05	1,8E-05	-	-	2,9E-08	2,6E-06	0,0E+00	4,4E-06	-	-
Béryllium	1,6E-05	3,4E-06	6,4E-07	2,4E-06	-	-	3,8E-12	1,1E-08	0,0E+00	2,3E-07	-	-
Bore	1,1E-01	1,5E-02	2,2E-06	2,1E-06	-	-	3,2E-09	2,1E-07	0,0E+00	2,8E-08	-	-
Cadmium	2,6E-04	2,0E-04	1,6E-07	1,1E-07	-	-	2,0E-11	1,6E-09	0,0E+00	7,6E-10	-	-
Chrome	1,6E-01	4,8E-02	8,8E-05	4,3E-05	2,8E-06	1,9E-05	2,7E-09	1,3E-07	0,0E+00	1,6E-08	0,0E+00	1,9E-08
Cobalt	1,2E-01	2,3E-02	1,9E-07	2,0E-07	1,3E-07	7,3E-08	1,7E-10	1,7E-08	0,0E+00	2,0E-09	0,0E+00	2,4E-09
Cuivre	6,1E-03	2,8E-03	2,7E-07	2,2E-07	9,3E-09	4,7E-08	1,8E-07	8,5E-07	0,0E+00	1,3E-07	0,0E+00	1,2E-07
Étain	7,5E-02	5,5E-02	1,3E-05	1,8E-05	-	-	3,5E-08	6,2E-06	0,0E+00	7,5E-06	-	-
Lithium	1,4E-04	6,2E-05	3,4E-09	2,4E-09	-	-	6,3E-14	1,4E-14	0,0E+00	5,1E-15	-	-
Manganèse	1,1E-02	2,5E-03	6,6E-08	8,0E-08	-	-	1,3E-10	7,7E-09	0,0E+00	9,3E-10	-	-
Mercure	1,4E-02	3,1E-03	1,8E-05	2,4E-05	-	-	3,9E-07	1,9E-07	0,0E+00	2,3E-06	-	-
Molybdène	4,3E-04	1,4E-04	6,2E-07	5,0E-07	-	-	1,2E-10	4,1E-08	0,0E+00	4,9E-09	-	-
Nickel	5,7E-03	2,3E-03	4,1E-06	2,5E-06	2,5E-07	1,1E-07	6,8E-10	2,5E-09	0,0E+00	5,9E-09	0,0E+00	3,5E-10
Plomb	9,2E-02	2,1E-02	3,8E-05	2,2E-05	2,8E-07	1,6E-06	3,9E-08	1,4E-06	0,0E+00	8,5E-07	0,0E+00	2,0E-07
Sélénium	4,4E-02	1,0E-02	6,0E-05	3,0E-04	8,3E-07	5,4E-07	2,3E-05	5,8E-05	0,0E+00	2,3E-04	0,0E+00	8,2E-06
Strontium	2,8E-04	1,0E-04	1,1E-07	2,7E-06	-	-	1,8E-11	2,1E-09	0,0E+00	1,3E-09	-	-
Titane	1,5E-03	3,4E-04	8,5E-06	1,8E-05	-	-	1,2E-09	1,3E-06	0,0E+00	6,2E-06	-	-
Uranium	7,3E-01	1,7E-01	5,3E-06	3,0E-06	2,8E-06	2,3E-06	6,6E-08	6,6E-07	0,0E+00	7,9E-08	0,0E+00	9,2E-08
Vanadium	6,6E-02	1,6E-01	2,3E-04	1,0E-03	2,5E-05	1,1E-05	9,6E-07	2,6E-04	0,0E+00	3,1E-04	0,0E+00	3,7E-05
Zinc	2,0E-04	4,8E-05	4,4E-07	2,3E-07	1,0E-07	4,7E-08	2,3E-12	1,7E-09	0,0E+00	1,0E-09	0,0E+00	2,4E-10

- Valeur non requise (une c. VTR_{inh} étant disponible, les doses par inhalation n'ont pas été combinées aux autres voies pour estimer les risques par inhalation).

TABLEAU 19

Doses bruit de fond (mg/kg-pc par jour) de métaux estimées
pour une exposition chronique – Scénario « combiné »

Voie d'exposition	Ingestion					Cutané					Inhalation				
Substances	**0-6 mois**	**0,5-4 ans**	**5-11 ans**	**12-19 ans**	**20 ans et +**	**0-6 mois**	**0,5-4 ans**	**5-11 ans**	**12-19 ans**	**20 ans et +**	**0-6 mois**	**0,5-4 ans**	**5-11 ans**	**12-19 ans**	**20 ans et +**
Aluminium	7,6E-02	4,6E-01	3,5E-01	2,3E-01	1,5E-01	3,0E-04	4,3E-03	3,6E-03	1,1E-03	1,1E-03	2,7E-05	2,4E-05	2,0E-05	1,6E-05	1,2E-05
Antimoine	9,3E-05	1,6E-04	9,5E-05	5,4E-05	3,7E-05	4,7E-07	4,2E-07	3,5E-07	2,5E-07	2,4E-07	1,1E-07	1,0E-07	8,5E-08	6,6E-08	5,0E-08
Argent	9,1E-04	7,3E-04	4,6E-04	2,7E-04	2,4E-04	1,8E-07	1,1E-06	9,2E-07	3,2E-07	3,0E-07	-	-	-	-	-
Arsenic	8,2E-04	1,4E-03	9,5E-04	5,5E-04	4,7E-04	6,8E-07	2,7E-06	2,2E-06	8,5E-07	8,0E-07	2,0E-07	1,8E-07	1,6E-07	1,2E-07	9,3E-08
Baryum	3,7E-02	1,5E-01	8,8E-02	4,9E-02	2,9E-02	2,2E-05	5,0E-05	3,9E-05	1,7E-05	1,6E-05	-	-	-	-	-
Béryllium	9,1E-06	2,0E-05	1,2E-05	6,6E-06	4,6E-06	6,9E-07	9,9E-06	8,2E-06	2,6E-06	2,4E-06	-	-	-	-	-
Bore	3,9E-02	3,8E-02	2,1E-02	1,2E-02	9,1E-03	2,3E-06	6,3E-06	5,2E-06	2,2E-06	2,1E-06	-	-	-	-	-
Cadmium	9,8E-05	2,5E-04	2,0E-04	1,2E-04	8,0E-05	1,8E-07	2,8E-07	2,2E-07	1,2E-07	1,1E-07	-	-	-	-	-
Chrome	1,8E-04	1,2E-03	7,6E-04	4,9E-04	4,8E-04	2,1E-05	3,6E-04	3,0E-04	9,2E-05	8,6E-05	2,3E-07	2,1E-07	1,8E-07	1,4E-07	1,1E-07
Cobalt	2,7E-04	4,4E-04	2,8E-04	1,7E-04	1,2E-04	5,5E-08	3,6E-07	3,0E-07	1,0E-07	9,5E-08	-	-	-	-	-
Cuivre	1,2E-01	8,9E-02	5,9E-02	3,7E-02	3,5E-02	8,0E-05	6,1E-05	3,5E-05	2,8E-05	2,6E-05	3,0E-06	2,7E-06	2,1E-05	1,6E-05	1,2E-05
Étain	3,6E-02	3,7E-02	2,3E-02	1,9E-02	1,2E-02	2,1E-07	6,4E-07	5,2E-07	2,1E-07	2,0E-07	1,3E-07	1,2E-07	1,2E-07	9,4E-08	7,0E-08
Lithium	2,1E-03	3,0E-03	2,0E-03	1,3E-03	1,3E-03	3,5E-07	6,5E-07	4,9E-07	2,3E-07	2,2E-07	1,0E-08	9,1E-09	5,2E-08	4,0E-08	3,0E-08
Manganèse	3,8E-01	1,6E+00	9,1E-01	5,1E-01	2,9E-01	2,3E-05	7,1E-05	5,9E-05	2,4E-05	2,3E-05	-	-	-	-	-
Mercure	5,1E-05	2,2E-03	1,7E-03	1,0E-03	9,2E-04	3,3E-09	6,0E-09	4,4E-09	2,2E-09	2,1E-09	-	-	-	-	-
Molybdène	3,4E-03	2,9E-03	2,1E-03	1,2E-03	8,7E-04	6,8E-08	2,7E-07	2,2E-07	8,6E-08	8,0E-08	-	-	-	-	-
Nickel	5,3E-03	7,0E-03	4,4E-03	2,5E-03	1,7E-03	1,8E-05	8,3E-05	7,0E-05	2,6E-05	2,4E-05	-	-	-	-	-
Plomb	3,4E-04	8,8E-04	5,0E-04	2,9E-04	1,8E-04	6,2E-07	1,4E-06	1,1E-06	5,3E-07	5,0E-07	-	-	-	-	-
Sélénium	1,9E-03	4,8E-03	3,7E-03	2,2E-03	2,0E-03	4,2E-06	5,3E-06	4,4E-06	2,6E-06	2,5E-06	2,6E-07	2,4E-07	2,0E-07	1,6E-07	1,2E-07
Strontium	5,0E-02	1,1E-01	6,8E-02	3,9E-02	2,7E-02	3,7E-05	4,6E-05	3,1E-05	1,8E-05	1,7E-05	3,0E-07	2,8E-07	1,8E-06	1,4E-06	1,1E-06
Titane	2,1E-02	1,7E-01	1,3E-01	7,8E-02	7,9E-02	1,1E-04	1,3E-03	1,1E-03	3,4E-04	3,2E-04	8,9E-07	8,1E-07	8,6E-07	6,7E-07	5,0E-07
Uranium	1,0E-04	1,4E-04	8,0E-05	5,3E-05	6,8E-05	1,2E-07	1,2E-05	9,8E-06	2,8E-06	2,7E-06	-	-	-	-	-
Vanadium	5,1E-04	7,4E-04	4,5E-04	2,6E-04	2,2E-04	8,6E-06	6,7E-05	5,6E-05	1,9E-05	1,8E-05	-	-	-	-	-
Zinc	2,5E-01	3,8E-01	2,6E-01	1,7E-01	1,5E-01	5,1E-06	5,7E-06	4,1E-06	2,6E-06	2,4E-06	3,0E-06	2,7E-06	3,4E-06	2,6E-06	2,0E-06

- Valeur non requise (une c. VTR_{inh} étant disponible, les doses par inhalation n'ont pas été combinées aux autres voies pour estimer les risques).

TABLEAU 20

Doses additionnelles (mg/kg-pc par jour) de métaux estimées
pour une exposition chronique - Scénario « combiné »

Voie d'exposition	Ingestion					Cutané					Inhalation				
Substances	**0-6 mois**	**0,5-4 ans**	**5-11 ans**	**12-19 ans**	**20 ans et +**	**0-6 mois**	**0,5-4 ans**	**5-11 ans**	**12-19 ans**	**20 ans et +**	**0-6 mois**	**0,5-4 ans**	**5-11 ans**	**12-19 ans**	**20 ans et +**
Aluminium	1,3E-03	4,8E-03	2,5E-03	1,3E-03	1,1E-03	2,0E-04	1,5E-04	1,3E-04	1,0E-04	9,8E-05	3,1E-05	2,8E-05	2,3E-05	1,8E-05	1,3E-05
Antimoine	8,0E-09	2,4E-08	1,1E-08	5,5E-09	4,6E-09	6,5E-10	4,9E-10	4,1E-10	3,3E-10	3,1E-10	2,0E-10	1,8E-10	1,5E-10	1,1E-10	8,6E-11
Argent	1,5E-08	5,1E-08	2,8E-08	1,6E-08	1,7E-08	4,2E-09	3,1E-09	2,6E-09	2,1E-09	2,0E-09	-	-	-	-	-
Arsenic	2,5E-07	8,5E-07	4,2E-07	2,2E-07	1,9E-07	1,6E-08	1,2E-08	1,0E-08	8,3E-09	7,8E-09	6,2E-09	5,6E-09	4,7E-09	3,6E-09	2,7E-09
Baryum	1,2E-05	8,2E-05	5,3E-05	2,9E-05	2,5E-05	2,8E-06	2,1E-06	1,8E-06	1,5E-06	1,4E-06	-	-	-	-	-
Béryllium	5,6E-08	1,7E-07	8,2E-08	4,2E-08	3,4E-08	1,5E-07	1,1E-07	9,5E-08	7,7E-08	7,3E-08	-	-	-	-	-
Bore	1,4E-06	5,0E-06	2,5E-06	1,3E-06	1,0E-06	1,8E-08	1,3E-08	1,1E-08	9,1E-09	8,5E-09	-	-	-	-	-
Cadmium	8,8E-09	3,5E-08	1,9E-08	1,0E-08	8,5E-09	5,2E-10	3,9E-10	3,3E-10	2,7E-10	2,5E-10	-	-	-	-	-
Chrome	2,5E-06	9,2E-06	4,8E-06	2,7E-06	2,5E-06	2,0E-06	1,5E-06	1,2E-06	1,0E-06	9,4E-07	3,9E-08	3,5E-08	2,9E-08	2,2E-08	1,7E-08
Cobalt	1,2E-06	3,2E-06	1,4E-06	6,9E-07	5,4E-07	1,5E-08	1,1E-08	9,4E-09	7,7E-09	7,2E-09	-	-	-	-	-
Cuivre	1,1E-06	6,4E-06	4,0E-06	2,3E-06	2,3E-06	1,0E-08	7,8E-09	6,5E-09	5,3E-09	5,0E-09	1,6E-08	1,4E-08	1,2E-08	9,2E-09	6,9E-09
Étain	9,8E-08	3,5E-06	2,6E-06	1,6E-06	1,5E-06	1,3E-09	9,8E-10	8,2E-10	6,7E-10	6,3E-10	2,0E-09	1,8E-09	1,5E-09	1,2E-09	8,7E-10
Lithium	6,5E-06	2,9E-05	1,8E-05	1,2E-05	1,4E-05	8,4E-08	6,3E-08	5,3E-08	4,3E-08	4,0E-08	1,0E-07	9,2E-08	7,6E-08	5,9E-08	4,5E-08
Manganèse	3,2E-05	7,6E-05	2,9E-05	1,3E-05	1,1E-05	4,8E-06	3,6E-06	3,0E-06	2,5E-06	2,3E-06	-	-	-	-	-
Mercure	3,0E-09	1,5E-06	1,1E-06	7,0E-07	6,7E-07	4,4E-14	3,4E-14	3,1E-14	2,8E-14	2,8E-14	-	-	-	-	-
Molybdène	4,3E-08	2,4E-07	1,5E-07	8,7E-08	8,9E-08	6,0E-10	4,5E-10	3,8E-10	3,1E-10	2,9E-10	-	-	-	-	-
Nickel	2,2E-06	6,1E-06	3,0E-06	1,5E-06	1,1E-06	1,5E-06	1,1E-06	9,2E-07	7,5E-07	7,1E-07	-	-	-	-	-
Plomb	2,1E-07	5,0E-07	1,8E-07	8,5E-08	6,6E-08	3,1E-09	2,4E-09	2,0E-09	1,6E-09	1,5E-09	-	-	-	-	-
Sélénium	5,5E-08	8,1E-07	6,0E-07	3,7E-07	3,7E-07	3,9E-09	2,9E-09	2,4E-09	2,0E-09	1,9E-09	2,9E-10	2,6E-10	2,2E-10	1,7E-10	1,3E-10
Strontium	6,5E-06	2,7E-05	1,5E-05	8,4E-06	7,9E-06	5,5E-07	4,1E-07	3,4E-07	2,8E-07	2,6E-07	1,7E-07	1,5E-07	1,2E-07	9,7E-08	7,3E-08
Titane	6,3E-04	5,3E-03	3,7E-03	2,3E-03	2,5E-03	1,5E-04	1,1E-04	9,4E-05	7,7E-05	7,2E-05	6,8E-06	6,2E-06	5,1E-06	4,0E-06	3,0E-06
Uranium	1,5E-08	4,3E-08	1,9E-08	9,5E-09	7,0E-09	8,4E-10	6,3E-10	5,3E-10	4,3E-10	4,1E-10	-	-	-	-	-
Vanadium	9,7E-06	4,1E-05	2,3E-05	1,2E-05	1,1E-05	4,0E-06	3,0E-06	2,5E-06	2,0E-06	1,9E-06	-	-	-	-	-
Zinc	1,4E-05	2,0E-04	1,4E-04	9,6E-05	1,1E-04	5,1E-08	3,8E-08	3,2E-08	2,6E-08	2,4E-08	7,7E-08	7,0E-08	5,8E-08	4,5E-08	3,4E-08

- Valeur non requise (une c. VTR_{inh} étant disponible, les doses par inhalation n'ont pas été combinées aux autres voies pour estimer les risques).

TABLEAU 21

Niveaux moyens d'exposition additionnelle à vie pour les métaux cancérogènes ou probablement cancérogènes chez l'humain

Scénario d'exposition	**Relais routier[a]**		**Combiné[b]**	
Substance	**Inhalation** (concentration, µg/m³)	**Ingestion et contact cutané** (dose, mg/kg-pc par jour)	**Inhalation** (concentration, µg/m³)	**Ingestion et contact cutané** (dose, mg/kg-pc par jour)
Arsenic	5,2E-06	1,7E-08	1,1E-05	1,3E-07
Béryllium	1,5E-06	--	3,7E-06	--
Cadmium	1,6E-07	--	3,4E-07	--
Nickel	1,9E-05	--	4,0E-05	--
Plomb	4,1E-06	1,0E-08	8,6E-06	7,4E-08

a Pour un adulte qui fréquenterait le Relais routier 25 semaines par année durant les 16 années d'exploitation de la mine.

b Pour un individu qui fréquenterait la zone d'exposition rapprochée (scénario « Activités traditionnelles ») à raison de 20,5 semaines/an) et qui consommerait des aliments provenant de ces activités à la maison (scénario « domestique ») à raison de 31,5 semaines/an), durant les 16 années d'exploitation de la mine.

-- Substances pour lesquelles aucun coefficient de cancérogénicité par voie orale n'est disponible.

TABLEAU 22

Indices de risque pour l'exposition aiguë par inhalation

Substance	1 heure			8 heures			24 heures		
	IR_{BF}	IR_{Add}	IR_{Tot}	IR_{BF}	IR_{Add}	IR_{Tot}	IR_{BF}	IR_{Add}	IR_{Tot}
CO	0,02	0,45	0,47	0,05	0,15	0,20			
NO_2	0,08	**1,20**	**1,28**						
SO_2	0,02	0,04	0,05				0,10	0,04	0,14
$PM_{2.5}$							0,76	0,58	**1,34**
Aluminium					(0,82)	(0,82)			
Antimoine					(<0,01)	(<0,01)			
Argent					(<0,01)	(<0,01)			
Arsenic		0,18[a]	0,18[a]						
Baryum					(0,02)	(0,02)			
Béryllium							(<0,01)	(0,08)	(0,08)
Bore							<0,01	<0,01	<0,01
Cadmium							<0,01	<0,01	0,01
Chrome					(<0,01)	(<0,01)			
Cobalt					(0,03)	(0,03)			
Cuivre		<0,01	<0,01						
Étain					(<0,01)	(<0,01)			
Lithium	(<0,01)	(0,04)	(0,04)		(<0,01)	(<0,01)			
Manganèse					0,39	0,39			
Mercure	<0,01	<0,01	<0,01		<0,01	<0,01			
Molybdène					(<0,01)	(<0,01)			
Nickel		(0,16)	(0,16)		0,10	0,10			
Plomb					(<0,01)	(<0,01)			
Sélénium							(<0,01)	(<0,01)	(<0,01)
Strontium		(<0,01)	(<0,01)						
Titane					(0,03)	(0,03)			
Uranium					(<0,01)	(<0,01)			
Vanadium		(<0,01)	(<0,01)				<0,01	0,02	0,02
Zinc		(<0,01)	(<0,01)						
Silice[b]									

IR_{BF} Indice de risque bruit de fond = teneur de fond correspondant à la durée d'exposition (1 heure, 8 heures ou 24 heures; tableau 8) / VTR_{inh} correspondant à la même durée d'exposition (tableau 3).

IR_{Add} Indice de risque additionnel = concentration additionnelle (valeur maximale estimée sur la durée d'exposition; tableau 9) / VTR_{inh} correspondant à la même durée d'exposition (tableau 3). Ces indices de risque correspondent au récepteur le plus exposé dans la zone d'exposition rapprochée.

IR_{Tot} Indice de risque total = IR_{Add} + IR_{BF}.

a Concentration sur 1 heure divisée par une VTR établie pour 4 heures (cette approche est prudente car la concentration maximale estimée sur une heure est plus élevée que la concentration maximale sur 4 heures).

b Aucune VTR n'est appropriée pour une exposition aiguë.

( ) Les parenthèses indiquent les indices de risque basés sur une VTR provisoire.

Les caractères **gras** indiquent les substances pour lesquelles des indices de risque sont supérieurs à l'unité.

TABLEAU 23

Indices de risque pour l'exposition sous-chronique par inhalation

Scénario d'exposition	Bruit de fond	Relais routier		Activités traditionnelles	
Substances	**IR_{BF}**	**IR_{Add}**	**IR_{Tot}**	**IR_{Add}**	**IR_{Tot}**
CO[a]					
NO_2	(0,19)	(0,39	(0,58)	(0,25)	(0,44)
SO_2	(0,11)	(<0,01)	(0,11)	(<0,01)	(0,11)
$PM_{2.5}$	(0,60)	(0,17)	(0,77)	(0,19)	(0,79)
Aluminium		-	-	-	-
Antimoine		-	-	-	-
Argent		(<0,01)	(<0,01)	(<0,01)	(<0,01)
Arsenic		(0,014)	(0,014)	(<0,01)	(<0,01)
Baryum		(<0,01)	(<0,01)	(<0,01)	(<0,01)
Béryllium		(<0,01)	(<0,01)	(<0,01)	(<0,01)
Bore		<0,01	<0,01	<0,01	<0,01
Cadmium		(<0,01)	(<0,01)	(<0,01)	(<0,01)
Chrome		<0,01	<0,01	<0,01	<0,01
Cobalt		(<0,01)	(<0,01)	(<0,01)	(<0,01)
Cuivre		-	-	-	-
Étain		-	-	-	-
Lithium		-	-	-	-
Manganèse		0,34	0,34	0,34	0,34
Mercure		(<0,01)	(<0,01)	(<0,01)	(<0,01)
Molybdène		(<0,01)	(<0,01)	(<0,01)	(<0,01)
Nickel		<0,01	<0,01	<0,01	<0,01
Plomb		<0,01	<0,01	<0,01	<0,01
Sélénium		(<0,01)	(<0,01)	(<0,01)	(<0,01)
Strontium		-	-	-	-
Titane		-	-	-	-
Uranium		<0,01	<0,01	<0,01	<0,01
Vanadium		(0,04)	(0,04)	(0,04)	(0,04)
Zinc		-	-	-	-
Silice[b]					

IR_{BF} Indice de risque bruit de fond = teneur de fond (Mensuelle, tableau 8) / s.c. VTR_{inh} (tableau 4).

IR_{Add} Indice de risque additionnel = concentration additionnelle maximale sur 2 semaines (Relais routier) ou sur 1 mois (Activités traditionnelles, pour le récepteur le plus exposé dans la zone d'exposition rapprochée) (tableau 10) /s.c. VTR_{inh} (tableau 4).

IR_{Tot} Indice de risque total = IR_{Add} + IR_{BF}.

( ) Les parenthèses indiquent les indices de risque basés sur une VTR provisoire.

\- Substance pour laquelle les risques posés par une exposition sous-chronique ont été estimés en combinant toutes les voies d'exposition (résultats fournis aux tableau 24 et 25).

a Aucune VTR n'est appropriée pour cette durée d'exposition.

Les caractères **gras** indiquent les substances pour lesquelles des indices de risque sont supérieurs à l'unité.

TABLEAU 24

Indices de risque pour l'exposition sous-chronique aux métaux par plusieurs voies - Scénario « Relais routier »

Substances	Voies d'exposition[a]	0-6 mois		20 ans et +	
		IR_{Tot}	Contr.	IR_{Tot}	Contr.
Aluminium	Ingestion + contact cutané + inhalation	0,07	<0,01%	0,16	0,74%
Antimoine	Ingestion + contact cutané + inhalation	(0,51)	<0,01%	(0,12)	0,01%
Argent	Ingestion + contact cutané	(0,59)	<0,01%	(0,13)	<0,01%
Arsenic	Ingestion + contact cutané + inhalation	**(695)**	<0,01%	**(165)**	0,03%
Baryum	Ingestion + contact cutané	0,10	<0,01%	0,03	0,19%
Béryllium	Ingestion + contact cutané	(0,01)	<0,01%	(<0,01)	4,5%
Bore	Ingestion + contact cutané	0,56	<0,01%	0,08	<0,01%
Cadmium	-[b]	-	-	-	-
Chrome	Ingestion + contact cutané + inhalation	(0,09)	0,07%	(0,19)	1,3%
Cobalt	Ingestion + contact cutané	(0,03)	<0,01%	(0,01)	0,33%
Cuivre	Ingestion + contact cutané + inhalation	**(1,8)**	<0,01%	(0,34)	<0,01%
Étain	Ingestion + contact cutané + inhalation	0,39	<0,01%	0,08	<0,01%
Lithium	Ingestion + contact cutané + inhalation	**(3,0)**	0,01%	**(1,4)**	0,09%
Manganèse	Ingestion + contact cutané	(0,55)	<0,01%	(0,36)	0,05%
Mercure	Ingestion + contact cutané	0,07	<0,01%	0,03	<0,01%
Molybdène	Ingestion + contact cutané	(0,48)	<0,01%	(0,09)	<0,01%
Nickel	Ingestion + contact cutané	**(1,3)**	0,01%	(0,28)	0,12%
Plomb	Ingestion + contact cutané	(0,12)	<0,01%	(0,04)	0,07%
Sélénium	Ingestion + contact cutané + inhalation	**(1,1)**	<0,01%	(0,47)	<0,01%
Strontium	Ingestion + contact cutané + inhalation	(0,05)	<0,01%	(0,01)	0,02%
Titane	Ingestion + contact cutané + inhalation	(0,01)	0,13%	(<0,01)	4,5%
Uranium	Ingestion + contact cutané	(0,05)	<0,01%	(0,02)	0,01%
Vanadium	Ingestion + contact cutané	0,15	<0,01%	0,04	3,2%
Zinc	Ingestion + contact cutané + inhalation	**(1,5)**	<0,01%	(0,31)	<0,01%

Contr. Contribution du Projet à la dose totale (en pourcentage) = (dose additionnelle x 100) / (dose additionnelle + dose bruit de fond).
IR_{Tot} Indice de risque total = [dose d'exposition bruit de fond (tableau 15) + dose additionnelle (tableau 15)] / s.c. VTR_{ing} (tableau 4).
a Voies d'exposition qui ont été combinées pour estimer les IR.
b Aucune VTR_{ing} n'est appropriée pour cette durée d'exposition.
( ) Les parenthèses indiquent les indices de risque basés sur une VTR provisoire.
Les caractères **gras** indiquent les substances pour lesquelles des indices de risque sont supérieurs à l'unité.

TABLEAU 25

Indices de risque pour l'exposition sous-chronique aux métaux par plusieurs voies - Scénario « Activités traditionnelles »

Substances	Voies d'exposition[a]	0-6 mois		0,5-4 ans		5-11 ans		12-19 ans		20 ans et +	
		IR_{Tot}	Contr.	IR_{Tot}	Contr.	IR_{Tot}	Contr.	IR_{Tot}	Contr.	IR_{Tot}	Contr.
Aluminium	Ingestion + contact cutané + inhalation	0,09	4,3%	0,54	1,9%	0,35	1,4%	0,20	1,3%	0,15	1,4%
Antimoine	Ingestion + contact cutané + inhalation	(0,12)	0,05%	(0,41)	0,03%	(0,24)	0,02%	(0,14)	0,02%	(0,08)	0,03%
Argent	Ingestion + contact cutané	(<0,01)	0,18%	(0,02)	0,09%	(0,02)	0,07%	(0,01)	0,06%	(0,01)	0,05%
Arsenic	Ingestion + contact cutané + inhalation	**(35,5)**	0,56%	**(342)**	0,16%	**(248)**	0,09%	**(144)**	0,08%	**(121)**	0,08%
Baryum	Ingestion + contact cutané	0,22	0,08%	1,0	0,08%	0,59	0,07%	0,34	0,07%	0,19	0,10%
Béryllium	Ingestion + contact cutané	(<0,01)	5,7%	(0,02)	1,8%	(0,01)	1,5%	(0,01)	2,1%	(<0,01)	2,5%
Bore	Ingestion + contact cutané	0,03	0,05%	0,15	0,04%	0,09	0,03%	0,05	0,03%	0,03	0,03%
Cadmium	-[b]	-	-	-	-	-	-	-	-	-	-
Chrome	Ingestion + contact cutané + inhalation	(0,12)	3,4%	(0,77)	1,3%	(0,53)	0,99%	(0,30)	1,1%	(0,31)	0,87%
Cobalt	Ingestion + contact cutané	(0,01)	2,4%	(0,02)	1,9%	(0,01)	1,2%	(0,01)	1,1%	(0,01)	0,98%
Cuivre	Ingestion + contact cutané + inhalation	**(1,1)**	<0,01%	(0,88)	0,01%	(0,46)	0,01%	(0,25)	0,01%	(0,21)	0,01%
Étain	Ingestion + contact cutané + inhalation	<0,01	0,12%	0,05	0,04%	0,04	0,03%	0,02	0,03%	0,02	0,03%
Lithium	Ingestion + contact cutané + inhalation	(0,20)	3,5%	(0,67)	4,0%	(0,47)	3,1%	(0,31)	3,0%	(0,34)	3,0%
Manganèse	Ingestion + contact cutané	**(3,7)**	0,02%	**(16)**	0,01%	**(10,4)**	0,01%	**(5,0)**	<0,01%	**(2,5)**	0,01%
Mercure	Ingestion + contact cutané	0,01	0,03%	**1,6**	0,07%	**1,2**	0,07%	0,72	0,07%	0,64	0,08%
Molybdène	Ingestion + contact cutané	(<0,01)	0,11%	(0,03)	0,08%	(0,02)	0,07%	(0,01)	0,06%	(0,01)	0,08%
Nickel	Ingestion + contact cutané	(0,15)	0,45%	(0,56)	0,25%	(0,33)	0,23%	(0,18)	0,24%	(0,11)	0,29%
Plomb	Ingestion + contact cutané	(0,08)	0,18%	(0,31)	0,11%	(0,17)	0,07%	(0,10)	0,06%	(0,06)	0,07%
Sélénium	Ingestion + contact cutané + Inhalation	(0,05)	0,04%	(0,80)	0,03%	(0,60)	0,03%	(0,37)	0,03%	(0,36)	0,03%
Strontium	Ingestion + contact cutané + inhalation	(0,02)	0,06%	(0,06)	0,05%	(0,04)	0,03%	(0,02)	0,03%	(0,02)	0,04%
Titane	Ingestion + contact cutané + inhalation	(<0,01)	11,5%	(0,08)	3,8%	(0,06)	3,3%	(0,04)	3,3%	(0,04)	3,4%
Uranium	Ingestion + contact cutané	(0,01)	0,08%	(0,02)	0,07%	(0,01)	0,05%	(0,01)	0,04%	(0,01)	0,03%
Vanadium	Ingestion + contact cutané	0,02	19,1%	0,07	12,1%	0,05	10,3%	0,03	10,5%	0,02	10,1%
Zinc	Ingestion + contact cutané + inhalation	(0,08)	0,06%	(0,65)	0,09%	(0,42)	0,10%	(0,26)	0,10%	(0,25)	0,11%

Contr. Contribution du Projet à la dose totale (en pourcentage) = (dose additionnelle x 100) / (dose additionnelle + dose bruit de fond).
IR_{Tot} Indice de risque total = [dose d'exposition bruit de fond (tableau 16) + dose additionnelle (tableau 17)] / s.c. VTR_{ing} (tableau 4).
a Voies d'exposition qui ont été combinées pour estimer les IR.
b Aucune VTR_{ing} n'est appropriée pour cette durée d'exposition.
( ) Les parenthèses indiquent les indices de risque basés sur une VTR provisoire.
Les caractères **gras** indiquent les substances pour lesquelles des indices de risque sont supérieurs à l'unité.

TABLEAU 26

Indices de risque pour l'exposition chronique par inhalation – Scénario « Relais routier »

Substances	IR_{BF}	IR_{Add}	IR_{Tot}
CO			
NO_2	0,10	0,06	0,16
SO_2	0,08	<0,01	0,08
$PM_{2.5}$	0,49	0,06	0,55
Aluminium	-	-	-
Antimoine	-	-	-
Argent	<0,01	<0,01	<0,01
Arsenic	<0,01	<0,01	<0,01
Baryum	<0,01	<0,01	<0,01
Béryllium	<0,01	<0,01	<0,01
Bore	<0,01	<0,01	<0,01
Cadmium	<0,01	<0,01	<0,01
Chrome	(<0,01)	(0,03)	(0,03)
Cobalt	<0,01	<0,01	<0,01
Cuivre	-	-	-
Étain	-	-	-
Lithium	-	-	-
Manganèse	<0,01	0,12	0,12
Mercure	<0,01	<0,01	<0,01
Molybdène	<0,01	<0,01	<0,01
Nickel	<0,01	<0,01	<0,01
Plomb	<0,01	<0,01	<0,01
Sélénium	<0,01	<0,01	<0,01
Strontium	-	-	-
Titane	-	-	-
Uranium	<0,01	<0,01	<0,01
Vanadium	<0,01	0,013	0,013
Zinc	-	-	-
Silice	0,02	0,03	0,05

IR_{BF} Indice de risque bruit de fond = teneur de fond (Annuelle, tableau 8) / c. VTR_{inh} (tableau 5).
IR_{Add} Indice de risque additionnel = concentration additionnelle maximale sur une année (Annuelle, tableau 10) / c. VTR_{inh} (tableau 5)
IR_{Tot} Indice de risque total = IR_{Add} + IR_{BF}.
( ) Les parenthèses indiquent les indices de risque basés sur une VTR provisoire.
\- Substance pour laquelle les risques posés par une exposition chronique ont été estimés en combinant toutes les voies d'exposition (voir résultats fournis aux tableaux 27 et 28 pour les scénarios « Relais routier » et « combiné », respectivement).

TABLEAU 27

Indices de risque pour l'exposition chronique aux métaux
par plusieurs voies - Scénario « Relais routier »

Substances	Voies d'exposition[a]	0-6 mois		20 ans et +	
		IR_{Tot}	Contr.	IR_{Tot}	Contr.
Aluminium	Ingestion + contact cutané + inhalation	0,07	<0,01%	0,16	0,38%
Antimoine	Ingestion + contact cutané + inhalation	1,0	<0,01%	0,24	0,01%
Argent	Ingestion + contact cutané	0,59	<0,01%	0,13	<0,01%
Arsenic	Ingestion + contact cutané + inhalation	**695**	<0,01%	**165**	0,01%
Baryum	Ingestion + contact cutané	0,10	<0,01%	0,03	0,10%
Béryllium	Ingestion + contact cutané	0,01	<0,01%	<0,01	4,0%
Bore	Ingestion + contact cutané	0,56	<0,01%	0,08	<0,01%
Cadmium	Ingestion + contact cutané	**2,6**	<0,01%	**2,0**	<0,01%
Chrome	Ingestion + contact cutané + inhalation	0,07	0,03%	0,15	1,0%
Cobalt	Ingestion + contact cutané	(0,03)	<0,01%	(0,01)	0,14%
Cuivre	Ingestion + contact cutané + inhalation	**1,8**	<0,01%	0,34	<0,01%
Étain	Ingestion + contact cutané + inhalation	**(3,9)**	<0,01%	(0,77)	<0,01%
Lithium	Ingestion + contact cutané + inhalation	**(3,0)**	<0,01%	**(1,4)**	0,04%
Manganèse	Ingestion + contact cutané	0,55	<0,01%	0,36	0,02%
Mercure	Ingestion + contact cutané	0,45	<0,01%	0,21	<0,01%
Molybdène	Ingestion + contact cutané	0,48	<0,01%	0,09	<0,01%
Nickel	Ingestion + contact cutané	**1,3**	<0,01%	0,28	0,08%
Plomb	Ingestion + contact cutané	0,12	<0,01%	0,04	0,03%
Sélénium	Ingestion + contact cutané + inhalation	**1,1**	<0,01%	0,47	<0,01%
Strontium	Ingestion + contact cutané + inhalation	0,06	<0,01%	0,01	0,01%
Titane	Ingestion + contact cutané + inhalation	0,01	0,05%	<0,01	2,8%
Uranium	Ingestion + contact cutané	(0,46)	<0,01%	(0,17)	<0,01%
Vanadium	Ingestion + contact cutané	**(1,5)**	<0,01%	(0,37)	2,0%
Zinc	Ingestion + contact cutané + inhalation	**1,5**	<0,01%	0,31	<0,01%

Contr. Contribution du Projet à la dose totale (en pourcentage) = (dose additionnelle x 100) / (dose additionnelle + dose bruit de fond).
IR_{Tot} Indice de risque total = [dose d'exposition bruit de fond (tableau 18) + dose additionnelle (tableau 18)] / c. VTR_{ing} (tableau 5).
a Voies d'exposition qui ont été combinées pour estimer les IR.
( ) Les parenthèses indiquent les indices de risque basés sur une VTR provisoire.
Les caractères **gras** indiquent les substances pour lesquelles des indices de risque sont supérieurs à l'unité.

TABLEAU 28

Indices de risque pour l'exposition chronique aux métaux par plusieurs voies - Scénario « combiné »

Substances	Voies d'exposition[a]	0-6 mois		0,5-4 ans		5-11 ans		12-19 ans		20 ans et +	
		IR_{Tot}	Contr.	IR_{Tot}	Contr.	IR_{Tot}	Contr.	IR_{Tot}	Contr.	IR_{Tot}	Contr.
Aluminium	Ingestion + contact cutané + inhalation	0,08	2,1%	0,47	1,2%	0,36	0,83%	0,23	0,70%	0,15	0,87%
Antimoine	Ingestion + contact cutané + inhalation	0,47	0,01%	0,81	0,02%	0,48	0,01%	0,27	0,01%	0,19	0,01%
Argent	Ingestion + contact cutané	0,18	<0,01%	0,15	0,01%	0,09	0,01%	0,05	0,01%	0,05	0,01%
Arsenic	Ingestion + contact cutané + inhalation	**235**	0,04%	**399**	0,07%	**273**	0,05%	**158**	0,05%	**134**	0,04%
Baryum	Ingestion + contact cutané	0,19	0,04%	0,73	0,06%	0,44	0,06%	0,25	0,06%	0,15	0,09%
Béryllium	Ingestion + contact cutané	<0,01	1,7%	0,01	0,96%	0,01	0,83%	<0,01	1,1%	<0,01	1,3%
Bore	Ingestion + contact cutané	0,19	<0,01%	0,19	0,02%	0,10	0,02%	0,06	0,02%	0,05	0,01%
Cadmium	Ingestion + contact cutané	0,98	0,01%	**2,5**	0,02%	**2,0**	0,01%	**1,2**	0,01%	0,80	0,01%
Chrome	Ingestion + contact cutané + inhalation	0,10	2,0%	0,70	0,82%	0,49	0,66%	0,27	0,73%	0,26	0,61%
Cobalt	Ingestion + contact cutané	(0,01)	0,50%	(0,02)	0,92%	(0,01)	0,66%	(0,01)	0,59%	(0,01)	0,55%
Cuivre	Ingestion + contact cutané + inhalation	**1,3**	<0,01%	0,98	0,01%	0,54	0,01%	0,3	0,01%	0,25	0,01%
Étain	Ingestion + contact cutané + inhalation	**(1,2)**	<0,01%	**(1,2)**	0,01%	(0,75)	0,01%	(0,65)	0,01%	(0,39)	0,01%
Lithium	Ingestion + contact cutané + inhalation	**(1,1)**	0,34%	**(1,5)**	1,1%	(0,99)	0,96%	(0,64)	0,98%	(0,66)	1,1%
Manganèse	Ingestion + contact cutané	**2,8**	0,01%	**11,4**	0,01%	**7,4**	<0,01%	**3,6**	<0,01%	**1,9**	<0,01%
Mercure	Ingestion + contact cutané	0,17	0,01%	**7,4**	0,07%	**5,8**	0,07%	**3,4**	0,07%	**3,1**	0,07%
Molybdène	Ingestion + contact cutané	0,15	<0,01%	0,13	0,01%	0,09	0,01%	0,04	0,01%	0,03	0,01%
Nickel	Ingestion + contact cutané	0,48	0,07%	0,65	0,13%	0,40	0,11%	0,23	0,11%	0,16	0,11%
Plomb	Ingestion + contact cutané	0,09	0,07%	0,25	0,07%	0,14	0,05%	0,08	0,04%	0,05	0,04%
Sélénium	Ingestion + contact cutané + inhalation	0,38	<0,01%	0,95	0,02%	0,73	0,02%	0,44	0,02%	0,39	0,02%
Strontium	Ingestion + contact cutané + inhalation	0,04	0,02%	0,08	0,03%	0,05	0,02%	0,03	0,02%	0,02	0,03%
Titane	Ingestion + contact cutané + inhalation	0,01	3,6%	0,06	3,3%	0,04	3,0%	0,03	3,1%	0,03	3,2%
Uranium	Ingestion + contact cutané	(0,17)	0,02%	(0,25)	0,04%	(0,15)	0,03%	(0,09)	0,03%	(0,12)	0,01%
Vanadium	Ingestion + contact cutané	(0,54)	2,6%	(0,86)	6,0%	(0,54)	5,4%	(0,30)	5,7%	(0,25)	5,3%
Zinc	Ingestion + contact cutané + inhalation	0,51	0,01%	0,79	0,05%	0,51	0,06%	0,31	0,06%	0,27	0,07%

Contr. Contribution du Projet à la dose totale (en pourcentage) = (dose additionnelle x 100) / (dose additionnelle + dose bruit de fond).

IR_{Tot} Indice de risque total = [dose d'exposition bruit de fond (tableau 19) + dose additionnelle (tableau 20)] / c. VTR_{ing} (tableau 5).

a Voies d'exposition qui ont été combinées pour estimer les IR.

( ) Les parenthèses indiquent les indices de risque basés sur une VTR provisoire.

Les caractères **gras** indiquent les substances pour lesquelles des indices de risque sont supérieurs à l'unité.

TABLEAU 29

Risque additionnel de cancer estimé pour une exposition durant toute la durée du Projet

Scénario d'exposition	Relais routier		Combiné	
Substance	**Inhalation[a]**	**Ingestion[b]**	**Inhalation[a]**	**Ingestion[b]**
Arsenic	2,2E-08	2,6E-08	4,7E-08	2,0E-07
Béryllium	3,6E-09	--	9,0E-09	--
Cadmium	6,8E-10	--	1,4E-09	--
Nickel	2,5E-08	--	5,2E-08	--
Plomb	5,0E-11	8,9E-11	1,0E-10	6,3E-10
Sous-totaux	5,2E-08	2,6E-08	1,1E-07	2,0E-07
Total	7,8E-08		3,1E-07	

a Risque = concentration additionnelle moyenne à vie (tableau 21) x risque unitaire (tableau 6).
b Risque = dose additionnelle moyenne à vie (ingestion + contact cutané, tableau 21) x coefficient de cancérogénicité (tableau 6).
-- Substances pour lesquelles aucun coefficient de cancérogénicité par voie orale n'est disponible.

TABLEAU 30

Sommaire des indices de risque supérieurs à l'unité pour les métaux

Substance	Voies d'exposition	Durée d'exposition	Indices de risque[a]	Commentaire[b]
Arsenic	Ingestion + contact cutané + inhalation	Sous-chronique	IR_{BF} = (35,3-695) IR_{Tot} = (35,5-695)	Basé sur une VTR provisoire Contribution du Projet : négligeable (≤0,56%)
		Chronique	IR_{BF} = 134-695 IR_{Tot} = 134-695	Contribution du Projet : négligeable (≤0,06%)
Cadmium	Ingestion + contact cutané	Chronique	IR_{BF} = 0,8-2,6 IR_{Tot} = 0,8-2,6	Contribution du Projet : négligeable (≤0,01%)
Cuivre	Ingestion + contact cutané + inhalation	Sous-chronique	IR_{BF} = (0,21-1,8) IR_{Tot} = (0,21-1,8)	Basé sur une VTR provisoire Contribution du Projet : négligeable (≤0,01%)
		Chronique	IR_{BF} = 0,25-1,8 IR_{Tot} = 0,25-1,8	Contribution du Projet : négligeable (0,01%)
Étain	Ingestion + contact cutané + inhalation	Chronique	IR_{BF} = (0,4-3,9) IR_{Tot} = (0,4-3,9)	Basé sur une VTR provisoire Contribution du Projet : négligeable (≤0,01%)
Lithium	Ingestion + contact cutané + inhalation	Sous-chronique	IR_{BF} = (0,2-3,1) IR_{Tot} = (0,2-3,1)	Basé sur une VTR provisoire Contribution du Projet : négligeable à faible (<0,01% à 4,0%)[c]
		Chronique	IR_{BF} = (0,63-3,0) IR_{Tot} = (0,64-3,0)	Basé sur une VTR provisoire Contribution du projet : négligeable à faible (<0,01% à 1,1%)
Manganèse	Ingestion + contact cutané	Sous-chronique	IR_{BF} = (0,4-16) IR_{Tot} = (0,4-16)	Basé sur une VTR provisoire Contribution du projet : négligeable (≤0,05%)
		Chronique	IR_{BF} = 0,4-11,4 IR_{Tot} = 0,4-11,4	Contribution du Projet : négligeable (≤0,02%)
Mercure	Ingestion + contact cutané	Sous-chronique	IR_{BF} = 0,01-1,6 IR_{Tot} = 0,01-1,6	Contribution du Projet : négligeable (≤0,08%)
		Chronique	IR_{BF} = 0,2-7,4 IR_{Tot} = 0,2-7,4	Contribution du Projet : négligeable (≤0,07%)
Nickel	Ingestion + contact cutané	Sous-chronique	IR_{BF} = (0,11-1,3) IR_{Tot} = (0,11-1,3)	Basé sur une VTR provisoire Contribution du Projet : négligeable (≤0,45%)
		Chronique	IR_{BF} = 0,2-1,3 IR_{Tot} = 0,2-1,3	Contribution du Projet : négligeable (≤0,1%)
Sélénium	Ingestion + contact cutané + inhalation	Sous-chronique	IR_{BF} = (0,05 – 1,1) IR_{Tot} = (0,05 – 1,1)	Basé sur une VTR provisoire Contribution du Projet : négligeable (≤0,04%)
		Chronique	IR_{BF} = 0,4 – 1,3 IR_{Tot} = 0,4 – 1,3	Contribution du projet : négligeable (<0,02%)
Vanadium	Ingestion + contact cutané	Chronique	IR_{BF} = (0,24 – 1,5) IR_{Tot} = (0,25 – 1,5)	Basé sur une VTR provisoire Contribution du Projet : négligeable à faible (<0,01 à 5,1%)[c]
Zinc	Ingestion + contact cutané + inhalation	Sous-chronique	IR_{BF} = (0,08 – 1,5) IR_{Tot} = (0,08 – 1,5)	Basé sur une VTR provisoire Contribution du Projet : négligeable (≤0,11%)
		Chronique	IR_{BF} = 0,3 – 1,5 IR_{Tot} = 0,3 – 1,5	Contribution du Projet : négligeable (≤0,07%)

a Intervalle des valeurs fournies aux tableaux 24 et 25 pour l'expositions sous-chronique (scénarios « Relais routier » et « Activités traditionnelles ») et aux tableaux 27 et 28 pour l'exposition chronique (scénarios « Relais routier » et « combiné »).

b Contribution du Projet au risque total = Indice de risque additionnel (IR_{Add}) / Indice de risque total (IR_{Tot}) x 100 (détails disponibles à l'annexe I).

c Pour les scénarios et groupes d'âges pour lesquels les IR_{Tot} sont supérieurs à 1, la contribution du Projet est négligeable (<0,1%).

( ) Les parenthèses indiquent les indices de risque basés sur une VTR provisoire.

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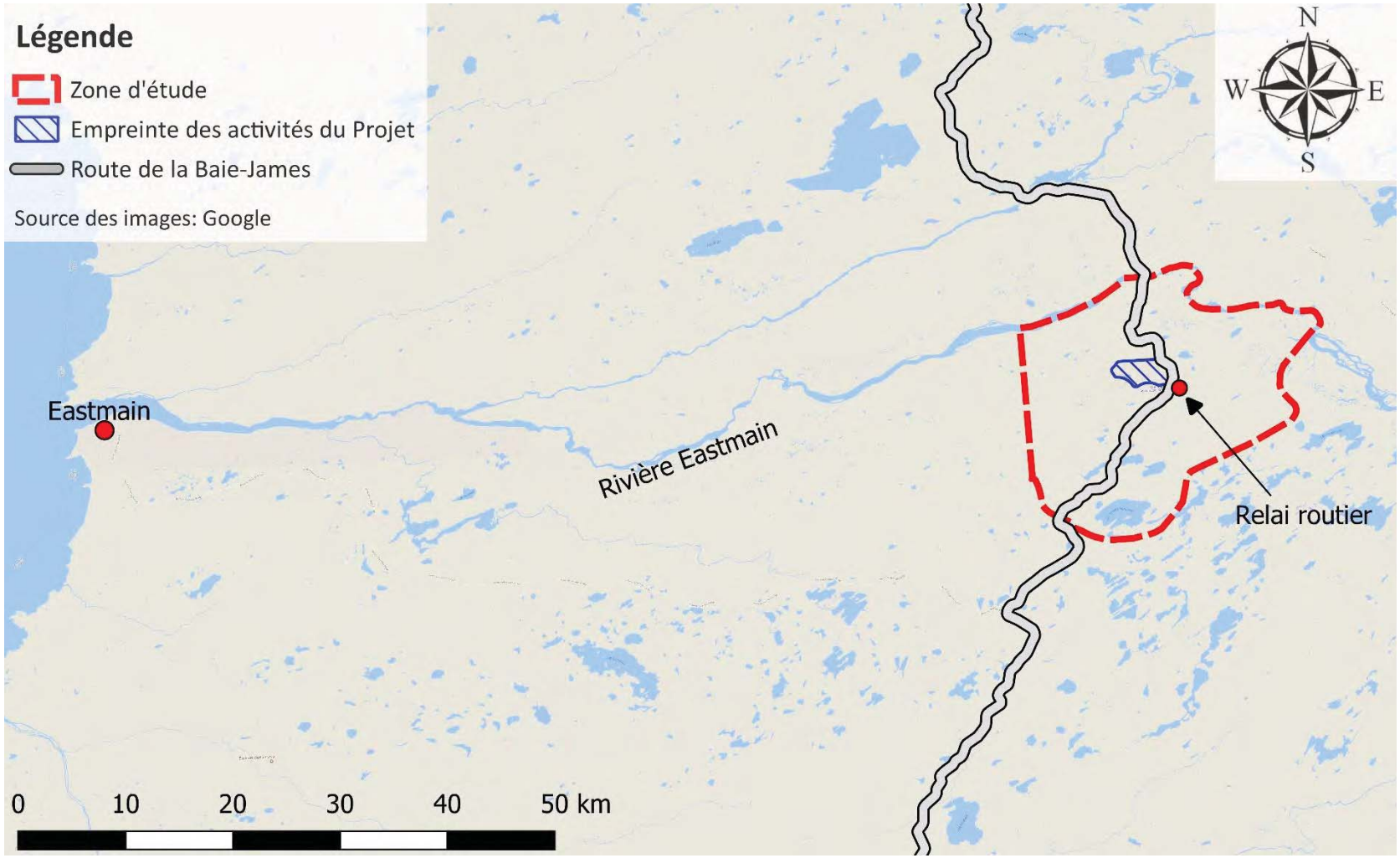


FIGURE 1 Localisation régionale du Projet

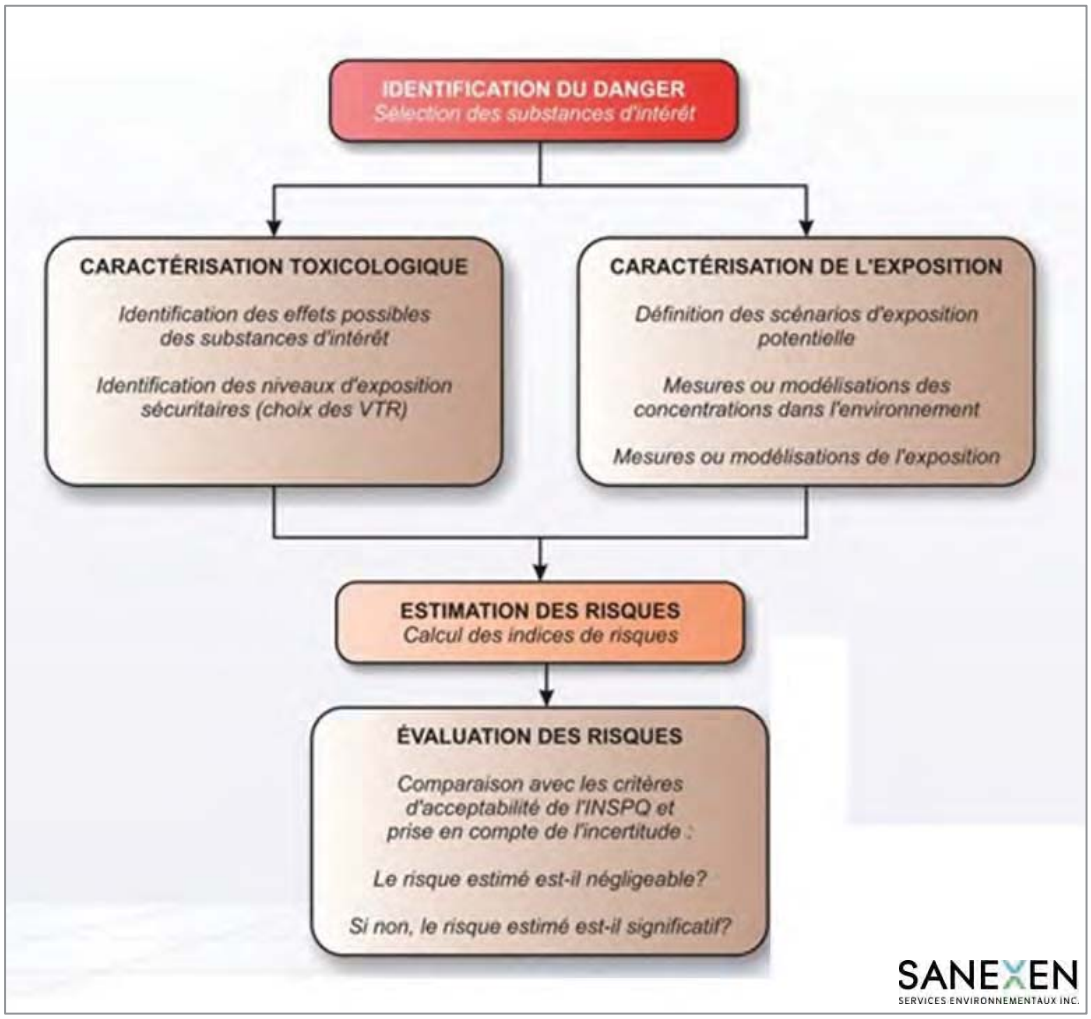


FIGURE 2 Démarche générale de l'évaluation des risques par modélisation

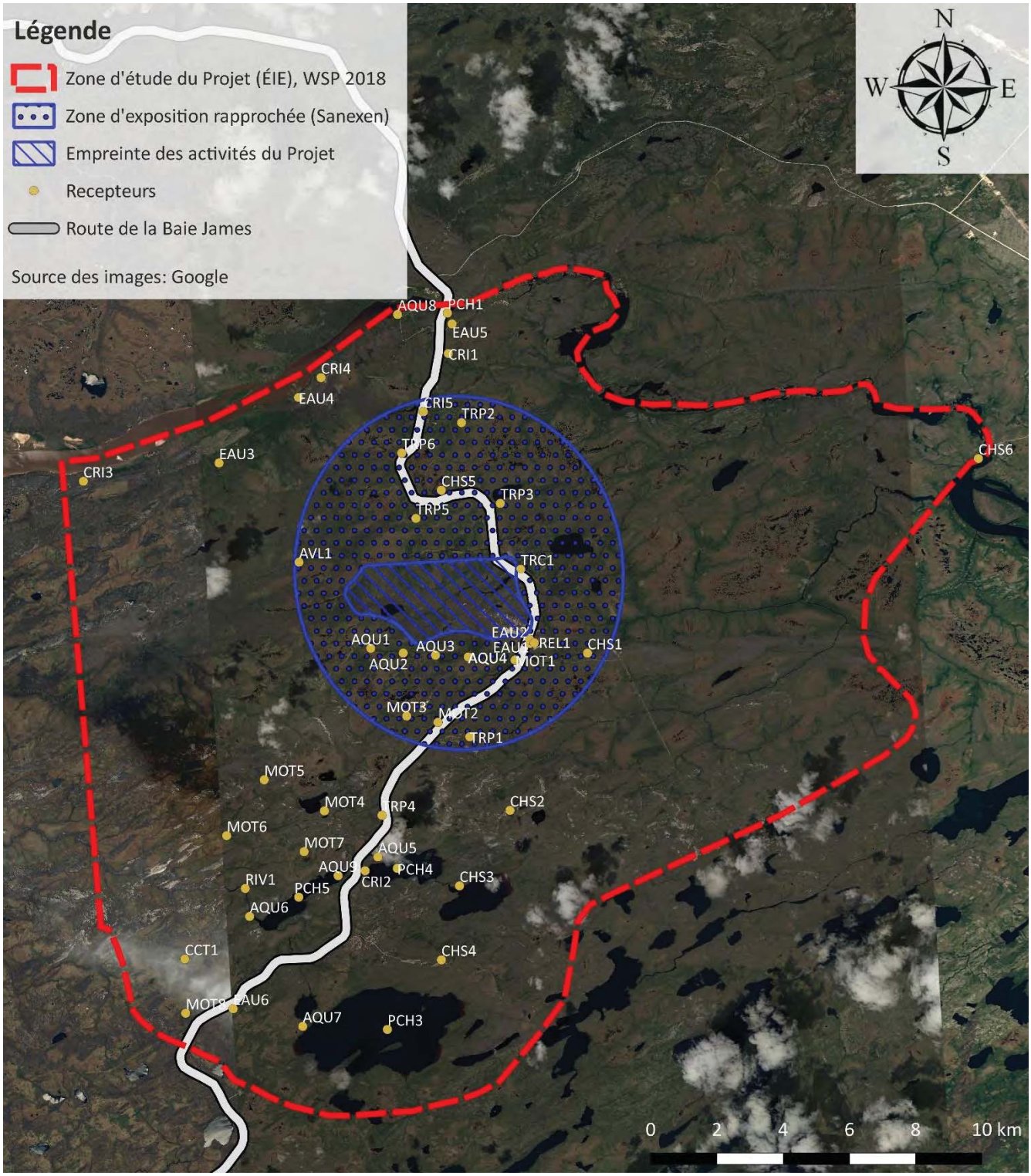
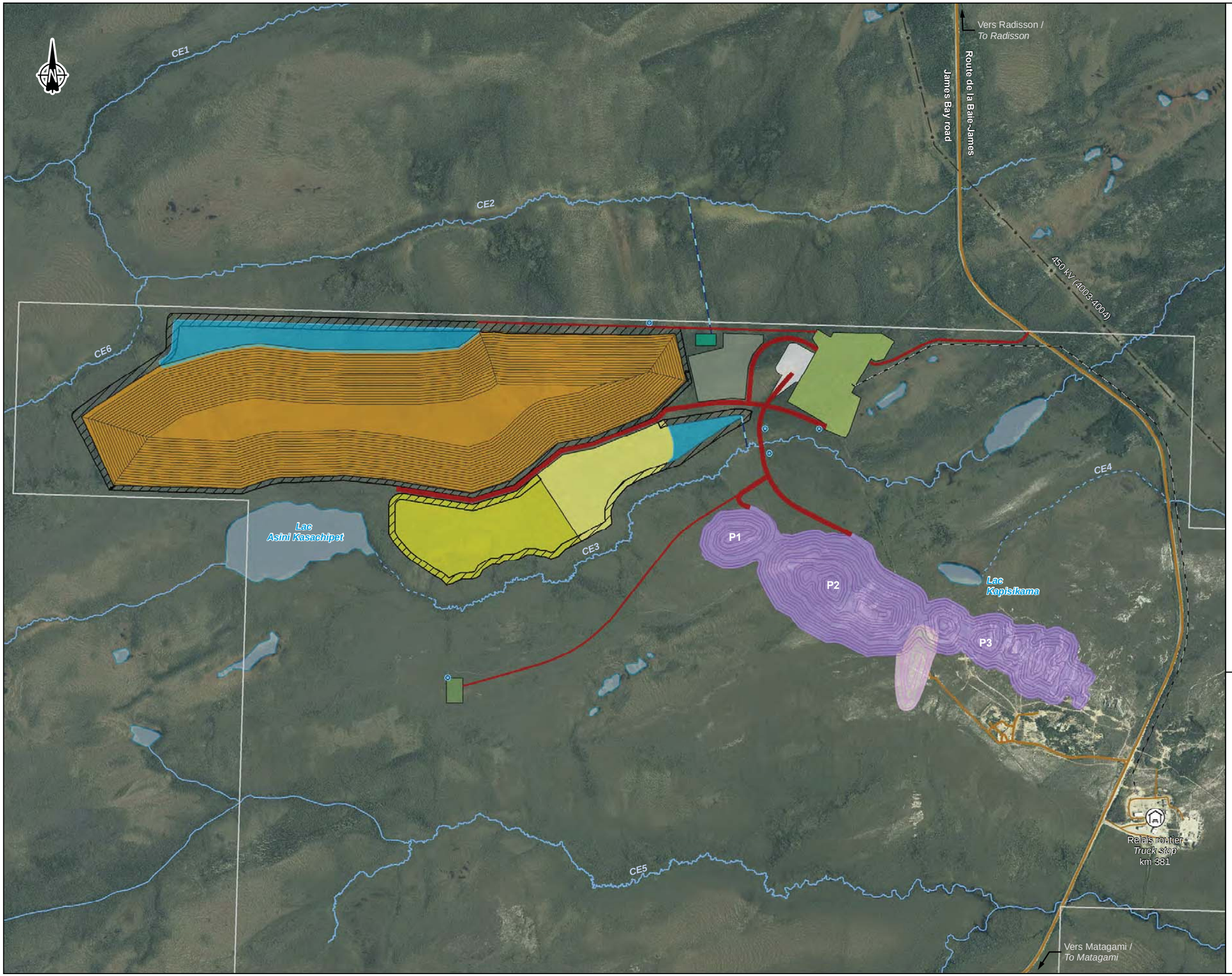


FIGURE 3 Limites de la zone d'exposition rapprochée et localisation des récepteurs évalués

ANNEXE A

Cartes tirées de l’ÉIE



Limite de propriété / *Property limit*

Composantes du projet / *Project Component*

- Route / *Road*
- Effluent minier / *Mine effluent*
- Station de pompage / *Pumping station*
- Usine de traitement de l'eau / *Water treatment plant*
- Secteur administratif et industriel / *Administrative and industrial sector*
- Fosse / *Pit*
- Halde à minerai / *ROM pad*
- Halde à stériles / *Waste rock stockpile*
- Halde à matière organique / *Organic matter stockpile*
- Halde à dépôts meubles / *Unconsolidated deposit stockpile*
- Entrepôt à explosifs / *Explosives magazine*
- Cour d'entreposage / *Dry storage area*
- Carrière / *Quarry*
- Digue et berme / *Dike and berm*
- Bassin de rétention d'eau / *Water retention basin*
- Câble de fibre optique / *Optical fiber cable*

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

Étude d'impact sur l'environnement /
Environmental Impact Assessment

Aménagement du site minier / *Mine Site General Arrangement*

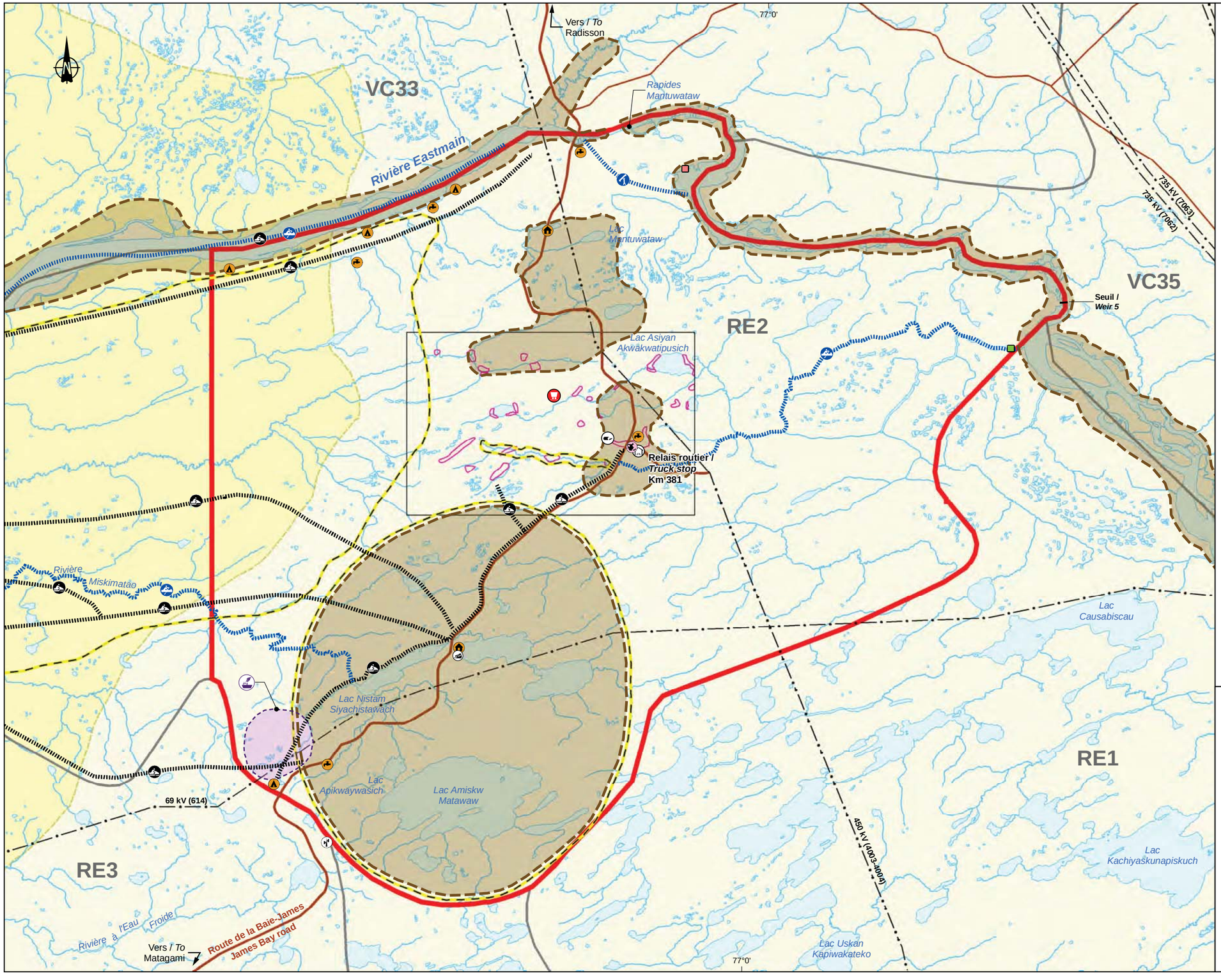
Sources :
Orthoimage : Galaxy, août / august 2017
Données du projet / Project data : Galaxy, 2018
Fosse, carrière et entreposage des explosifs /
Pit, quarry and explosives magasine : Mining Plus, 2018
Secteur administratif et industriel et aire de minerai /
Administrative and industrial sector and ROM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

No Ref : 171-02562-00_wspT098_EIE_c4-1_mine_GA_180831.mxd

0 185 370 m
UTM 18, NAD83

Carte / *Map* 4-1

wsp



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*
- Tour de télécommunication / *Telecommunication tower*
- Lieu d'enfouissement en territoire isolé (LETI) / *Remote landfill*
- Rampe de mise à l'eau / *Boat ramp*

Utilisation du territoire par les Cris / *Cree Land Use*

- Campement permanent cri / *Cree permanent camp*
- Campement temporaire cri / *Cree temporary camp*
- Source d'eau potable / *Drinking water source*
- 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*

Baux de villégiature / *Recreational Lease*

- Fins de villégiature / *Recreational use*
- Fins d'abri sommaire en forêt / *Rough forest shelter*

Archéologie / *Archaeology*

- Site archéologique / *Archaeological site*
- Zone de potentiel archéologique / *Archaeological potential area*

Limites / *Limits*

- Zone d'étude du milieu humain / *Social environment study area*
- Zone d'étude du potentiel archéologique / *Archaeological potential study area*
- Terre de catégorie II / *Category II land*
- RE2 — Terrain de trappage / *Trapline*

GALAXY

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

Étude d'impact sur l'environnement /

Environmental Impact Assessment

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
Archéologie / Archaeology, Arkéos, 2017
Inventaire / Inventory : WSP, 2018

Cartographié par / mapping by : WSP

No Ref : 171-02562-00_wspT040_EIEmh_c6-22_composante_181011.mxd

0 1,25 2,5 km
UTM 18, NAD83

Carte / *Map 6-22*

wsp

ANNEXE B

Conditions générales et limitations de l’étude

CONDITIONS GÉNÉRALES ET LIMITATIONS
ÉVALUATION DES RISQUES

Le présent rapport a été préparé pour l'usage exclusif du client à qui il est adressé (le « **Client** ») et il est strictement confidentiel. L'utilisation de ce rapport ou sa reproduction par une tierce personne ne devra se faire que suite à la réception de l'autorisation écrite du Client, dont une copie sera acheminée à Sanexen Services Environnementaux inc. (« **Sanexen** »), ainsi que de l'autorisation écrite de Sanexen. Cette utilisation et/ou reproduction du rapport est sujette aux présentes conditions générales et limitations. Sanexen décline toute responsabilité ou obligation associée à l'utilisation non autorisée de ce rapport par une tierce personne; toute conséquence découlant de la décision d'une tierce personne d'utiliser ce rapport lui est strictement imputable.

Les données factuelles, les interprétations, les conclusions et recommandations contenues dans ce rapport se rapportent uniquement au site décrit dans ce rapport (le « **Site** ») et ne s'appliquent à aucun autre site ou lieu. Ce rapport doit être lu dans son ensemble, puisque des sections pourraient être mal interprétées lorsque prises individuellement. Par ailleurs, le Client et toute personne autorisée conformément à ce qui précède, ne doivent se fier qu'au texte du rapport portant la mention *« rapport final »*; Sanexen se dégage de toute responsabilité découlant de l'utilisation de tout autre texte, opinion, ébauche ou rapport préliminaire émis par Sanexen ou de la traduction complète ou partielle de la version finale du rapport.

L'évaluation des risques toxicologiques et écotoxicologiques ainsi que des impacts sur l'eau souterraine (l'« **Évaluation des risques** ») effectuée par Sanexen et décrite dans ce rapport a été effectuée aux seules fins spécifiques du contrat octroyé et décrit dans le présent rapport, et ne doit en aucun cas servir à d'autres fins. La méthodologie suivie est celle décrite dans le présent rapport et l'Évaluation des risques est conforme, au meilleur de notre connaissance, aux règles et pratiques professionnelles acceptées au moment de sa réalisation et dans les champs de compétence concernés.

Le présent rapport contient des renseignements obtenus du Client et de tierces parties dont l'exactitude n'a pas été vérifiée. Sanexen présume que les renseignements qui lui ont été fournis par le Client ou par une tierce personne sont exacts et bien fondés. Cependant, Sanexen n'assume aucune responsabilité quant à leur justesse ou à leur fiabilité ni quant à la réticence ou non-divulgation d'une information pertinente ou à la dissimulation d'information par le Client ou par de tierces personnes. Sanexen ne peut notamment pas garantir l'exactitude des données disponibles dans les études antérieures, attestées ou non, servant de base à l'Évaluation des risques. Le fait qu'une substance n'ait pas été évaluée au cours de la présente étude n'exclut pas le fait que cette substance puisse se retrouver à des concentrations supérieures aux limites de détection ou aux critères indiqués dans les politiques, lois et règlements en vigueur, ou puisse représenter un risque pour l'environnement ou la santé humaine. Par ailleurs, la précision des estimations obtenues et leur interprétation sont sujettes aux incertitudes inhérentes aux données toxicologiques existantes, aux modèles mathématiques et au choix des scénarios d'exposition.

Les résultats dont fait état le présent rapport ont été obtenus à partir des données et renseignements disponibles au moment où l'étude a été réalisée et telles que décrites dans le présent document. Sanexen ne pourra être tenue responsable de dommages résultant de conditions cachées ou imprévisibles ou de changements survenus après la date où l'information a été recueillie par Sanexen. De plus, Sanexen n'assume aucune responsabilité quant à l'utilisation de ce rapport à des fins autres que celles pour lesquelles il a été rédigé, à la valeur réelle ou perçue du Site ni à l'échec d'une transaction en raison du contenu de ce rapport. Sanexen n'a aucun intérêt dans le Site faisant l'objet du présent rapport.

À moins d'avis contraire, les résultats, l'interprétation des données, les commentaires, les recommandations et les conclusions contenus dans ce rapport sont basés, au mieux de notre connaissance, sur les politiques, lois et règlements en vigueur au moment de la rédaction du rapport et applicables spécifiquement au Site, ainsi que sur des opinions professionnelles exprimées spécifiquement dans le contexte du contrat octroyé par le Client. Si ces politiques, lois ou règlements sont modifiés ou différents de ceux présumés, Sanexen devra en être informée par le Client afin de réviser, s'il y a lieu, le contenu interprétatif du rapport. Lorsqu'aucune politique, aucune loi ni aucun règlement n'est disponible pour permettre l'interprétation des données, les commentaires, recommandations et conclusions exprimés au présent rapport sont fondés, au meilleur de notre connaissance, sur les règles et pratiques professionnelles acceptées dans les champs de compétence concernés.

Toute opinion exprimée et toute référence aux politiques, lois et règlements qui seraient exprimées dans le texte de ce rapport sont purement techniques et sont fournies à titre indicatif. Ces opinions et références ne doivent aucunement être considérées comme un conseil juridique ou un avis juridique.

ANNEXE C

Information relative aux données toxicologiques

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1. VTR POUR EXPOSITION AIGUË

1.1 *Risk Exposure Level* (*acute REL* et *8-hour REL*) proposés par Cal/EPA

Les REL sont des VTR proposées par *l'Office of Environmental Health Hazard Assessment* (OEHHA) de l'Agence de protection de l'environnement de Californie (Cal/EPA)[1] pour une exposition aiguë définie comme une exposition par inhalation d'une durée d'une heure (*acute REL*) ou de 8 heures (*8-hour REL*). Ces valeurs de référence correspondent à une concentration à laquelle un individu peut être exposé pendant 1 heure (ou 8 heures) sans que ne surviennent d'effets néfastes sur sa santé. Les *acute REL* sont déterminés de façon à être sécuritaires pour la population en général, incluant les sous-groupes les plus sensibles, selon l'approche généralement utilisée pour dériver des VTR protégeant d'effets autres que le cancer (ex. : application d'un facteur de sécurité à la concentration sans effet néfaste observé (NOAEL) ajustée au besoin[2]). La répétition d'expositions de courte durée (≤ 1 h) reste sécuritaire dans la mesure où les épisodes d'exposition sont intermittents. Le *8-hour REL* réfère à la concentration moyenne sur 8 heures, et l'exposition peut être répétée.

1.2 *Minimal Risk Level* (*acute MRL*) proposés par ATSDR

Les *acute MRL*[3] sont proposés par l'*Agency for Toxic Substances and Disease Registry* (ATSDR) pour une exposition aiguë, définie comme une exposition continue durant 1 à 14 jours consécutifs. Les *acute MRL* sont déterminés de façon à être sécuritaires pour la population en général, incluant les sous-groupes les plus sensibles, selon l'approche généralement utilisée pour dériver des VTR protégeant d'effets autres que le cancer (ex. : application d'un facteur de sécurité à la concentration sans effet néfaste observé (NOAEL) ajustée au besoin[4]). Lorsque pertinent, la concentration d'exposition expérimentale est ajustée pour une exposition continue chez l'humain. Ces *acute MRL* réfèrent à une exposition plus longue que les *acute REL* et les *8-hour REL* définis par Cal/EPA.

1.3 Autres sources de données

1.3.1 Concentrations limites d'exposition en situation d'urgence

Les concentrations limites d'exposition en situation d'urgence ne sont pas des VTR à proprement parler. Ce sont plutôt des valeurs qui visent à protéger la population en cas d'urgence environnementale, donc à s'assurer qu'il n'y a pas d'effets sérieux et irréversibles sur la santé de la population. Les valeurs proposées par différents organismes sont présentées ci-dessous.

- Les *Acute Emergency Guideline Level* (AEGL) sont des valeurs développées par le *National Research Council, National Academy of Sciences (NRC/NAS)* puis recommandées par U.S EPA[5]. Les AEGL représentent des seuils limites d'exposition visant à protéger la population générale en situation d'urgence (exposition rare ou « une fois dans une vie »). Jusqu'à trois niveaux de seuils peuvent être déterminés pour cinq durées d'exposition (10 et 30 minutes, 1, 4 et 8 heures), chaque seuil correspondant à des niveaux différents de sévérité d'effets toxiques. L'U.S. EPA présume que les AEGL sont applicables à l'ensemble de la population, incluant les bébés, les enfants et les autres individus

1 http://oehha.ca.gov/air/allrels.html
2 Par exemple, pour tenir compte de la durée d'exposition ou de différences toxicocinétiques entre l'animal et l'humain.
3 http://www.atsdr.cdc.gov/mrls/index.asp
4 Par exemple, pour tenir compte de la durée d'exposition ou de différences toxicocinétiques entre l'animal et l'humain.
5 Les AEGL sont accessibles à : http://www.epa.gov/oppt/aegl/

qui pourraient être sensibles. Le premier niveau de protection (AEGL-1) est défini comme la concentration dans l'air au-delà de laquelle la population générale, incluant les personnes sensibles, pourraient subir un inconfort notoire (odeur, goût), de l'irritation des organes sensoriels ou certains effets asymptomatiques, non liés aux sens. Cependant, les effets ne sont pas handicapants et ils sont transitoires et réversibles après cessation de l'exposition.

- Les *Emergency Response Planning Guideline* (ERPG) sont développés par l'*American Industrial Hygiene Association* (AIHA)[1]. Comme les AEGL, les ERPG ont pour objectif de fournir une estimation des plages de concentration au-dessus desquelles des effets néfastes sur la santé pourraient raisonnablement être anticipés/observés. L'ERPG-1 correspond à la concentration maximale dans l'air (moyenne sur 1 heure) en deça de laquelle presque tous les individus peuvent être exposés sans qu'il y ait d'effets sur leur santé autres que des effets mineurs et transitoires ou sans que ces individus perçoivent une odeur désagréable clairement définie.
- En l'absence d'AEGL et d'ERPG, l'*U.S. Department of Emergency* (U.S. DOE) peut avoir développé des *Temporary Emergency Exposure Limit (TEEL),* qui sont des valeurs provisoires. Le TEEL-1 est défini comme la concentration dans l'air (moyenne sur une heure) au-delà de laquelle la population générale, incluant les individus les plus susceptibles, pourrait ressentir un inconfort notable, de l'irritation ou certains effets asymptomatiques non liés aux sens; cependant, ces effets ne sont pas incapacitants et ils sont transitoires et réversibles après cessation de l'exposition (U.S. DOE 2016)[2].

1.3.2 Normes en milieu de travail

En milieu de travail, la valeur d'exposition moyenne permise (VEMP) ou, en anglais, la *Threshold Limit Value-Time Weighted Average* (TLV-TWA) sont des concentrations moyennes sur 8 ou 10 heures destinées à protéger la santé des travailleurs.

Ces normes en milieu de travail sont déterminées par divers organismes comme *l'American Conference of Governmental Industrial Hygienists (ACGIH*), le *National Institute for Occupationnal Safety and Health (NIOSH*) et *l'Occupationnal Safety and Health Administration (OSHA*). Au Québec, les VEMP sont inscrites dans le Règlement sur la santé et la sécurité du travail (RSST)[3]. Par défaut, des valeurs provisoires *(Workplace Environmental Exposure Levels, WEELs)*[4] peuvent être proposées par l'AIHA ou l'*Occupational Alliance for Risk Science (OARS)*. La VEMP est définie dans le RSST comme « la concentration moyenne, pondérée pour une période de 8 heures par jour, en fonction d'une semaine de 40 heures, d'une substance chimique (sous forme de gaz, poussières, fumées, vapeurs ou brouillards) présente dans l'air au niveau de la zone respiratoire du travailleur ».

1 Les ERPG sont accessibles à : https://www.aiha.org/get-involved/AIHAGuidelineFoundation/EmergencyResponsePlanningGuidelines/Pages/default.aspx
2 https://www.standards.doe.gov/standards-documents/1000/1046-Bhdbk-2016/@@images/file. Les TEEL sont accessibles à : http://www.atlintl.com/DOE/teels/teel.html.
3 Règlement sur la santé et la sécurité du travail. http://www.csst.qc.ca/prevention/reptox/simdut-1988/guide-utilisation-fiche-signaletique/pages/13-reglementation.aspx
4 Les WEEL sont accessibles à : https://www.aiha.org/get-involved/AIHAGuidelineFoundation/WEELs/Pages/default.aspx ou à : http://www.tera.org/OARS/

La notion d'effet néfaste pour les travailleurs n'est pas clairement définie par les organismes qui établissent ces normes et la documentation disponible ne permet pas toujours de connaître la façon dont les concentrations proposées ont été déterminées (dose critique et facteurs de sécurité non détaillés). Lorsque l'information est disponible, il appert que les TLV-TWA ou VEMP correspondent souvent à la NOAEL ou à la plus faible concentration avec effet (ou avec néfaste) observé (LOEL et LOAEL, respectivement) chez l'humain (ou chez l'animal) à la suite d'une exposition de plus ou moins longue durée. Pour les substances ne présentant pas de toxicité aiguë particulière, les TLV-TWA ou VEMP sont basées sur la protection des travailleurs pour une exposition à long terme (effets survenant à des niveaux d'exposition plus faibles que lors d'une exposition à court terme). Les TLV-TWA sont déterminées pour des adultes en bonne santé (moins sensibles que la population générale).

1.4 VTR provisoires

Lorsqu'aucune VTR pour une exposition aiguë (*acute REL, 8-hour REL, acute MRL*) n'était disponible, un effort a été effectué afin de développer des valeurs provisoires permettant une évaluation préliminaire du risque. Cette approche préliminaire vise à identifier des situations où les concentrations mesurées ou estimées dans l'air sur une courte période (ex. : 1 heure, 8 heures, 24 heures) se rapprocheraient des concentrations identifiées comme ayant des effets possibles sur la santé. À cette fin, les concentrations ayant des effets possibles sur la santé à la suite d'une exposition par inhalation de courte durée sont identifiées parmi les valeurs visant à protéger la population en cas d'urgence environnementale (AEGL-1, ERPG-1, TEEL-1) et/ou parmi celles visant à protéger la santé des travailleurs (TLV-TWA, VEMP).

Généralement, les valeurs provisoires ont été dérivées en divisant la plus faible valeur identifiée parmi les TLV-TWA, AEGL-1, ERPG-1 et TEEL-1 disponibles par un facteur de sécurité arbitraire (de 100)[1] qui vise à s'assurer que toute concentration dans l'air se rapprochant d'un niveau d'effet soit identifiée (« système d'alerte »). La VTR provisoire correspond donc à un AEGL-1 (ou ERPG-1 ou TEEL-1 ou TLV-TWA) divisé par 100, à moins que cette valeur soit inférieure à la VTR par inhalation pour une exposition sous-chronique (s.c. VTR_{inh}) ou chronique (c. VTR_{inh}). Dans un tel cas, la VTR sous-chronique ou chronique serait appliquée. Advenant que la concentration estimée ou mesurée soit supérieure à la VTR provisoire (ex. : concentration estimée > TLV-TWA/100), une analyse plus approfondie des résultats est réalisée (ex. : recherche et analyse des données toxicologiques brutes disponibles, évaluation de l'incertitude associées à la toxicité et à l'exposition).

1 Bien que cette valeur de 100 soit issue d'un choix arbitraire, cette valeur peut être vue comme englobant le facteur d'incertitude par défaut (10) généralement appliqué pour tenir compte de la variabilité interindividuelle (protection de la population la plus sensible) multiplié par un facteur additionnel de 10 qui pourrait couvrir d'autres sources d'incertitude comme le niveau d'effet du point de départ (LOAEL), des lacunes de la base de données, etc.

2. VTR POUR EXPOSITION SOUS-CHRONIQUE OU CHRONIQUE

Les valeurs toxicologiques de référence retenues pour estimer le risque d'effets autres que le cancer pour une exposition sous-chronique ou chronique (s.c. VTR et c. VTR, respectivement) ou pour estimer le risque de cancer (risque unitaire, coefficient de cancérogénicité) proviennent généralement des sources suivantes :

- Santé Canada : plusieurs dénominations de VTR (dose journalière acceptable (DJA), dose journalière tolérable (DJT), apport quotidien tolérable (AQT), concentration tolérable (CT), coefficient de cancérogénicité, risque unitaire) sont disponibles dans le document d'orientation pour les sites contaminés[1] et dans d'autres documents disponibles en ligne[2,3];
- Agence pour la protection de l'environnement des États-Unis (U.S. EPA) : base de données IRIS (*Integrated Risk Information System*), qui fournit *Reference Dose* (RfD), *Reference Concentration* (RfC), C*ancer Slope Factor (*coefficient de cancérogénicité) et/ou *Unit Risk* (risques unitaires pour l'air et/ou l'eau potable);
- *Agency for Toxic Substances and Disease Registry* (ATSDR) : *Minimal Risk Levels* (MRLs) pour une exposition aiguë, sous-chronique (*intermediate*) ou chronique présentés dans les *Toxicological Profiles*;
- Organisation mondiale de la santé (OMS) : diverses VTR, comme des doses journalières admissibles (DJA) peuvent être disponibles dans des publications (ex. : *Concise International Chemical Assessment Document* (CICADs), *Environmental Health Criteria* (EHC) *monographs*, *Joint Expert Committee on Food Additives* (JECFA) – *Monographs and Evaluations, Joint Meeting on Pesticide Residues* (JMPR)). Les recommandations européennes[4] pour la qualité de l'air sont aussi une source de VTR, notamment pour les oxydes gazeux et les particules;
- Ministère hollandais de la santé publique et de l'environnement (RIVM);
- Agence pour la protection de l'environnement de Californie (Cal/EPA) : l'*Office of Environmental Health Hazard* (OEHHA) fournit des VTR (REL, *cancer slope factor, unit risk*) dans une base de données[5];
- *Institute of Medicine (IOM)* de la *National Academy of Sciences (NAS)*, qui fournit notamment de l'information pour les éléments inorganiques (ex. : métaux, oligoéléments).

À l'occasion, des VTR provenant d'autres sources peuvent aussi être présentées. Parmi celles-ci figurent notamment les *Provisional Peer-Reviewed Toxicity Values* (PPTRVs) dérivées par l'U.S. EPA pour le *Superfund Program* (http://hhpprtv.ornl.gov/). Les PPTRV (ex. : p-RfD, p-RfC, p-Unit Risk) sont qualifiées de « provisoires » car elles n'ont pas fait l'objet d'un consensus auprès de tous les programmes de l'U.S. EPA, contrairement aux VTR présentées dans IRIS. L'U.S. EPA dérive des PPTRV lorsqu'il n'y a pas de valeur disponible dans IRIS. Ces valeurs sont établies selon la même procédure que les VTR de IRIS (même sources, même directives) et font également l'objet d'une révision par des pairs à l'interne (par deux scientifiques de l'U.S. EPA) et à l'externe (par trois experts scientifiques indépendants). Les PPTRV sont mises à jour régulièrement.

1 L'évaluation du risque pour les sites contaminés fédéraux au Canada - Partie II : Les valeurs toxicologiques de référence (VTR) de Santé Canada, version 2.0
2 Recommandations pour la qualité de l'eau potable au Canada - Documents techniques. http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/index-fra.php#techniques
3 Lignes directrices sur la qualité de l'air intérieur résidentiel. http://www.hc-sc.gc.ca/ewh-semt/air/in/res-in/index-fra.php
4 http://www.who.int/phe/health_topics/outdoorair/outdoorair_aqg/en/
5 https://oehha.ca.gov/chemicals

3. CLASSIFICATIONS DU POTENTIEL CANCÉROGÈNE POUR L'HUMAIN

3.1 Classification selon U.S. EPA - IRIS[1]

Classification la plus récente[2], disponible uniquement pour les substances évaluées à partir de 2005 :

- *Carcinogenic to Humans* (cancérogène pour l'humain)[3];
- *Likely to be Carcinogenic to Humans* (probablement cancérogène pour l'humain)[1];
- *Suggestive Evidence of Carcinogenic Potential* (preuves suggérant un potentiel cancérogène)[1];
- *Inadequate Information to Assess Carcinogenic Potential* (information inadéquate pour évaluer le potentiel cancérogène)[1];
- *Not Likely to be Carcinogenic to Humans* (probablement non cancérogène pour l'humain)[1].

Classification antérieure[4] (1986-2005) :

- Groupe A *: Carcinogenic to Humans* (cancérogène pour l'humain)[1];
- Groupes B1 et B2 : *Probably Carcinogenic to Humans* (probablement cancérogène pour l'humain)[1];
- Groupe C : *Possibly Carcinogenic to Humans* (possiblement cancérogène pour l'humain)[1];
- Groupe D : *Not Classifiable as to Human Carcinogenicity* (non classable pour son potentiel cancérogène chez l'humain)[1].

Les fondements de cette classification sont résumés dans le tableau ci-dessous :

Preuve chez l'humain	Preuve chez l'animal				
	Suffisante	**Limitée**	**Inadéquate**	**Absence de données**	**Absence de preuves**
Suffisante	A	A	A	A	A
Limitée	B1	B1	B1	B1	B1
Inadéquate	B2	C	D	D	D
Absence de données	B2	C	D	D	E
Absence de preuves	B2	C	D	D	E

1 http://www.epa.gov/iris/index.html:
2 *Guidelines for Carcinogen Risk Assessment*, 2005, disponible à : http://www.epa.gov/cancerguidelines/
3 Traduction libre
4 *Guidelines for Carcinogen Risk Assessment*, 1986, disponible à : http://www.epa.gov/cancerguidelines/guidelines-carcinogen-risk-assessment-1986.htm

3.2 Classification selon le Centre international de recherche sur le cancer (CIRC)[1]

- Groupe 1 : cancérogène pour l'humain;
- Groupe 2A : probablement cancérogène pour l'homme;
- Groupe 2B : peut-être cancérogène pour l'homme;
- Groupe 3 : inclassable quant à sa cancérogénicité pour l'homme;
- Groupe 4 : probablement pas cancérogène pour l'homme.

3.3 Classification selon Santé Canada[2]

- Groupe I : cancérogène pour l'humain;
- Groupe II : probablement cancérogène pour l'humain;
- Groupe III : susceptible d'être cancérogène pour l'humain;
- Groupe IV : peu susceptible d'être cancérogène pour l'humain;
- Groupe V : probablement non cancérogène pour l'humain;
- Groupe VI : inclassable en ce qui concerne la cancérogénicité chez l'humain.

1 http://monographs.iarc.fr/FR/Classification/index.php
2 http://www.hc-sc.gc.ca/ewh-semt/pubs/contaminants/approach/index-eng.php

4. INFORMATION SUR LES CONVERSIONS (DOSE-CONCENTRATION)

Pour plusieurs substances, il arrive qu'il existe une VTR par ingestion seulement ou par inhalation seulement. Dans de tels cas et lorsqu'il a été jugé plausible que les effets observés par l'une ou l'autre voie puissent se produire quelle que soit la voie d'exposition (ex. : effets systémiques), une valeur provisoire peut avoir été dérivée selon une approche prudente et en tenant compte :

- Du taux d'absorption relatif de chacune des voies (valeurs documentées ou, par défaut, 100 % par voie orale et 100 % par inhalation);
- Des caractéristiques d'un adulte (soit un volume d'air inhalé par jour arrondi à 0,23 m^3/kg de poids corporel (p.c.) par jour). Cette dernière valeur correspond aux caractéristiques d'exposition recommandées dans les lignes directrices pour l'analyse de risque québécoises[1] (0,223 m^3/kg-p.c. par jour, poids corporel : 74,6 kg, d'où un taux d'inhalation de 16,6 m^3/jour) et fédérales[2] (poids corporel d'un adulte : 70,4 kg, taux d'inhalation : 16,6 m^3/jour, d'où un volume d'air inhalé de 0,235 m^3/jour).

Ainsi :

Concentration de référence provisoire = (Dose de référence / Volume d'air inhalé par jour) x (F_{oral}/F_{inhal}) x 1 000

Et inversement :

Dose de référence provisoire = Concentration de référence x Volume d'air inhalé par jour x (F_{inhal}/F_{oral}) x 0,001

Où :

Concentration de référence provisoire :	Concentration exprimée en µg/m^3
Dose de référence :	Dose exprimée en mg/kg-p.c. par jour
Volume d'air inhalé par jour :	Volume moyen pour un adulte (0,23 m^3/kg-p.c. par jour; voir ci-dessus)
F_{oral} :	Taux d'absorption par voie orale
F_{inhal} :	Taux d'absorption par inhalation
1 000 :	Facteur de conversion de mg à µg
0,001 :	Facteur de conversion de µg à mg

1 INSPQ (2012). Lignes directrices pour la réalisation des évaluations du risque toxicologique d'origine environnementale au Québec. https://www.inspq.qc.ca/publications/1440

2 Santé Canada (2010). L'évaluation du risque pour les sites contaminés fédéraux au Canada - Partie I : L'évaluation quantitative préliminaire des risques (ÉQPR) pour la santé humaine, version 2.0.

ANNEXE D

Paramètres et équations utilisés afin d'estimer les niveaux d'exposition des récepteurs aux métaux

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1. PARAMÈTRES D'EXPOSITION

La section suivante présente les paramètres utilisés afin d'estimer l'exposition des récepteurs. Les paramètres sont présentés séparément pour les trois situations considérées dans la présente étude, soit l'exposition au Relais routier, l'exposition lors des séjours d'activités traditionnelles et l'exposition domestique.

1.1 Exposition au Relais routier

Les paramètres utilisés pour estimer l'exposition des récepteurs selon le scénario du Relais routier sont présentés au tableau D1. Ces paramètres sont ceux recommandés par l'INSPQ (2012) pour les évaluations déterministes, pour des récepteurs mixtes (hommes et femmes combinés) adultes, selon un scénario commercial. Des ajustements ont toutefois été apportés pour tenir compte du fait que le récepteur réside au Relais routier 25 semaines par année (présence 24 heures par jour).

1.2 Exposition lors des séjours d'activités traditionnelles

Les paramètres considérés afin d'estimer l'exposition des récepteurs lors de séjours d'activités traditionnelles dans la zone d'exposition rapprochée sont présentés au tableau D2.

La plupart des paramètres utilisés sont ceux recommandés par l'INSPQ (2012) pour les évaluations déterministes, pour des récepteurs mixtes (hommes et femmes combinés), selon un scénario résidentiel en milieu rural. Toutefois, il est considéré que 100% de l'alimentation provient de la zone d'exposition rapprochée. Les taux de consommation retenus pour les produits de la chasse (viande de gibier) sont ceux rapportés par Richardson (1997). Ils représentent les quantités moyennes consommées par des autochtones canadiens ayant consommé de tels produits[1] lors d'une enquête réalisée en 1971 et 1972. Les taux de consommation de poisson correspondent à ceux recommandés par l'INSPQ (2012) pour les populations consommant beaucoup de poisson/fruits de mer (valeurs moyennes documentées par Richardson (1997)). Le masse de végétaux consommés sous forme d'infusion (2 grammes) correspond à celle habituellement présente dans les sachets achetés dans le commerce.

1.3 Exposition domestique

Les paramètres considérés afin d'estimer l'exposition des récepteurs à la maison (en dehors de la zone d'étude) sont présentés au tableau D3. La plupart de ces paramètres sont ceux recommandés par l'INSPQ (2012) pour les évaluations déterministes, pour des récepteurs mixtes (hommes et femmes combinés) de tous âges, selon un scénario résidentiel en milieu rural. Toutefois, les taux de consommation de viande et de poisson sont plus élevés (identiques à ceux retenues pour le scénario des activités traditionnelles; voir section précédente).

1 Consommateurs de viande seulement.

TABLEAU D1

Paramètres d'exposition des récepteurs - Scénario « Relais routier »

Paramètre	0-6 mois[a]	20 ans et +
Durée totale de l'exposition (ans):	0,5	45
Poids corporel (kg):	6,7	74,75
Surface corporelle (m²):	0,346	1,856
Taux d'inhalation (m³/kg/jour):	0,509	0,223
Taux d'ingestion de sol (mg/jour):	10	10
Taux d'ingestion de poussières intérieures (mg/jour):	10	10
Taux d'ingestion d'eau potable (L/jour):	0,655	1,907
Taux d'ingestion de viandes (kg/jour):	0[b]	0[b]
Taux d'ingestion de poissons et fruits de mer (kg/jour):	0[b]	0[b]
Taux d'ingestion de fruits et légumes (kg/jour) :	0[b]	0[b]
Taux d'ingestion de lait maternel (L/jour)	0,742[c]	0
Aliments d'origine commerciale (%)	100[b]	100[b]
Surface corporelle exposée au sol en été (%):	25	25
Surface corporelle exposée aux poussières en été (%):	25	25
Surface corporelle exposée aux sols en hiver (%)	0	0
Surface corporelle exposée aux poussières en hiver (%)	10	10
Taux d'adhérence du sol sur la peau (mg/cm²):	0	0,07
Taux d'adhérence des poussières sur la peau (mg/cm²):	0,04	0,04
Fréquence des contacts sol-peau (/jour):	1	1
Fréquence des contacts poussières-peau (/jour):	1	1
Fréquence des bains/douches (/semaine):	7	7
Durée moyenne des bains/douches (minutes):	10	10
Temps moyen à l'extérieur en été (heures/jour):	2,47	2,47
Temps moyen à l'extérieur en hiver (heures/jour):	0,55	0,55
Temps passé au Relais routier - heures/jour:	0	24
Temps passé au Relais routier - jours/semaine:	0	7
Temps passé au Relais routier - semaines/an:	0	25

a À l'exception du taux d'ingestion de lait maternel, ces paramètres ne sont utilisés que pour estimer l'exposition bruit de fond des récepteurs de 0-6 mois.

b Les apports alimentaires ont été considérés comme égaux à ceux documentés pour la population générale (voir section 4.2.6 du Rapport)

c Soit environ 0,73 kg/jour.

TABLEAU D2

Paramètres d'exposition des récepteurs – Scénario « Activités traditionnelles »

Paramètre	Tranche d'âge				
	0-6 mois	**0,5-4 ans**	**5-11 ans**	**12-19 ans**	**20 ans et +**
Durée des périodes d'exposition (ans):	0,5	4,5	7	8	50
Poids corporel (kg):	6,7	14,9	30,4	60,75	74,75
Surface corporelle (m²):	0,345	0,577	0,985	1,608	1,856
Taux d'inhalation (m³/kg/jour):	0,509	0,462	0,383	0,297	0,223
Taux d'ingestion de sol (mg/jour):	10	42,5	17,5	10	10
Taux d'ingestion de poussières intérieures (mg/jour):	10	42,5	17,5	10	10
Taux d'ingestion d'eau potable (L/jour):	0,655	0,91	1,198	1,523	1,907
Taux d'ingestion de viandes (kg/jour):	0,00	0,084	0,126	0,177	0,269
Taux d'ingestion de poissons (kg/jour):	0,00	0,056	0,090	0,104	0,111
Taux d'ingestion de fruits (kg/jour)	0,042	0,426	0,504	0,568	0,382
Taux de consommation de feuilles (infusion) (g/jour)	2,0	2,0	2,0	2,0	2,0
Taux d'ingestion de lait maternel (kg/jour):	0,742[a]	0	0	0	0
Aliments d'origine commerciale (%)	0	0	0	0	0
Temps moyen à l'extérieur en été (heures/jour):	12	12	12	12	12
Temps moyen à l'extérieur en hiver (heures/jour):	12	12	12	12	12
Surface corporelle exposée au sol en été (%):	25	25	25	25	25
Surface corporelle exposée aux poussières en été (%):	25	25	25	25	25
Surface corporelle exposée au sol en hiver (%):	0	0	0	0	0
Surface corporelle exposée aux poussières en été (%):	10	10	10	10	10
Taux d'adhérence du sol sur la peau (mg/cm²):	0	0,2	0,2	0,07	0,07
Taux d'adhérence des poussières sur la peau (mg/cm²):	0,04	0,04	0,04	0,04	0,04
Fréquence des contacts sol-peau (/jour):	1	1	1	1	1
Fréquence des contacts poussières-peau (/jour):	1	1	1	1	1
Fréquences des bains/douches (/semaine):	7	7	7	7	7
Durée moyenne des bains/douches (minutes):	10	10	10	10	10
Temps passé dans la zone d'exposition rapprochée - heures/jour:	24	24	24	24	24
Temps passé dans la zone d'exposition rapprochée - jours/semaine:	7	7	7	7	7
Temps passé dans la zone d'exposition rapprochée - semaines/an:	20,5	20,5	20,5	20,5	20,5

a Soit environ 0,73 kg/jour.

TABLEAU D3

Paramètres d'exposition des récepteurs – Scénario « domestique »

Paramètre	Tranche d'âge				
	0-6 mois	**0,5-4 ans**	**5-11 ans**	**12-19 ans**	**20 ans et +**
Durée des périodes d'exposition (ans):	0,5	4,5	7	8	50
Poids corporel (kg):	6,7	14,9	30,4	60,75	74,75
Surface corporelle (m²):	0,345	0,577	0,985	1,608	1,856
Taux d'inhalation (m³/kg/jour):	0,509	0,462	0,383	0,297	0,223
Taux d'ingestion de sol (mg/jour):	10	42,5	17,5	10	10
Taux d'ingestion de poussières intérieures (mg/jour):	10	42,5	17,5	10	10
Taux d'ingestion d'eau potable (L/jour):	0,655	0,91	1,198	1,523	1,907
Taux d'ingestion de viandes (kg/jour):	0,00	0,084	0,126	0,177	0,269
Taux d'ingestion de poissons (kg/jour):	0,00	0,056	0,090	0,104	0,111
Taux d'ingestion de fruits (kg/jour)	0,042	0,426	0,504	0,568	0,382
Taux de consommation de feuilles de végétaux (infusions) (g/jour) :	2,0	2,0	2,0	2,0	2,0
Taux d'ingestion de lait maternel (kg/jour):	0,742[b]	0	0	0	0
Aliments d'origine commerciale (%)	50	50	50	50	50
Temps moyen à l'extérieur en été (heures/jour):	2,47	3,23	3,23	3,88	2,47
Temps moyen à l'extérieur en hiver (heures/jour):	0,55	0,72	0,72	0,58	0,55
Surface corporelle exposée au sol en été (%):	25	25	25	25	25
Surface corporelle exposée aux poussières en été (%):	25	25	25	25	25
Surface corporelle exposée au sol en hiver (%):	0	0	0	0	0
Surface corporelle exposée aux poussières en hiver (%):	10	10	10	10	10
Taux d'adhérence du sol sur la peau (mg/cm²):	0	0,2	0,2	0,07	0,07
Taux d'adhérence des poussières sur la peau (mg/cm²):	0,04	0,04	0,04	0,04	0,04
Fréquence des contacts sol-peau (/jour):	1	1	1	1	1
Fréquence des contacts poussières-peau (/jour):	1	1	1	1	1
Fréquence des bains/douches (/semaine):	7	7	7	7	7
Durée moyenne des bains/douches (minutes):	10	10	10	10	10
Temps passé en dehors de la zone d'étude[a] - heures/jour:	24	24	24	24	24
Temps passé en dehors de la zone d'étude[a] - jours/semaine:	7	7	7	7	7
Temps passé en dehors de la zone d'étude[a] - semaines/an:	32,5	32,5	32,5	32,5	32,5

a Comme aucune résidence n'est située dans la zone d'étude, l'exposition estimée selon ce scénario réfère à une zone non affectée par les émissions du Projet.

b Soit environ 0,73 kg/jour.

2. PROPRIÉTÉS DES MÉTAUX

Les valeurs attribuées aux paramètres requis pour estimer l'exposition des récepteurs sont présentées au tableau D4.

TABLEAU D4
Valeur des paramètres requis pour estimer exposition des récepteurs

Substances	KPE (cm/h)	KPA (cm/h)	$f_{abs\text{-}cut}$ -	f_{abs_GI} -	FAR_{inh} -	FBT_{lait_mater} (j/kg)
Aluminium	1,0E-03	1,4E-03	1,0E-02	1,0E-01	1	2,0E-04
Antimoine	1,0E-03	1,4E-03	1,0E-02	2,0E-01	1	1,0E-04
Argent	6,0E-04	6,3E-04	1,0E-02	4,0E-02	1	2,5E-02
Arsenic	1,0E-03	1,4E-03	4,0E-02	1,0E+00	1	1,0E-04
Baryum	1,0E-03	1,4E-03	1,0E-02	7,0E-02	1	5,0E-04
Béryllium	1,0E-03	1,4E-03	1,0E-02	6,0E-03	1	2,0E-06
Bore	1,0E-03	1,4E-03	1,0E-02	9,0E-01	1	1,5E-03
Cadmium	1,0E-03	1,4E-03	1,0E-03	2,5E-02	1	1,0E-03
Chrome	1,0E-03	1,4E-03	1,0E-02	1,3E-02	1	2,0E-03
Cobalt	1,0E-03	1,4E-03	1,0E-02	1,0E+00	1	2,0E-03
Cuivre	1,0E-03	1,4E-03	1,0E-02	1,0E+00	8,33	2,0E-03
Étain	1,0E-03	1,4E-03	1,0E-02	1,0E+00	1	1,0E-03
Lithium	1,0E-03	1,4E-03	1,0E-02	8,0E-01	1	2,0E-02
Manganèse	1,0E-03	1,4E-03	1,0E-02	1,0E-01	1	3,0E-04
Mercure	1,0E-03	1,4E-03	1,0E-02	1,0E+00	1	5,0E-04
Molybdène	1,0E-03	1,4E-03	1,0E-02	1,0E+00	1	1,7E-03
Nickel	1,0E-04	3,5E-05	4,0E-02	4,0E-02	1	2,0E-02
Plomb	4,0E-06	2,0E-07	1,0E-02	1,0E+00	1	3,0E-04
Sélénium	1,0E-03	1,4E-03	1,0E-02	5,0E-02	1	1,0E-02
Strontium	1,0E-03	1,4E-03	1,0E-02	2,0E-01	1	2,0E-03
Titane	1,0E-03	1,4E-03	1,0E-02	3,0E-02	1	1,0E-02
Uranium	1,0E-03	1,4E-03	1,0E-02	2,0E-01	1	6,0E-04
Vanadium	1,0E-03	1,4E-03	1,0E-02	2,6E-02	1	2,0E-05
Zinc	6,0E-04	6,3E-04	1,0E-02	1,0E+00	1	1,0E-02

KPE : Constante de perméabilité cutanée à partir de l'eau. Valeurs tirées de U.S. EPA (1992). Par défaut, une valeur prudente de 0,001 a été utilisée.

KPA : Constante de perméabilité cutanée à partir de l'air. Valeurs estimées selon logKPA = 1,979279 + 1,60838 logKPE (MEF, 1996)

$f_{abs\text{-}cut}$: Fraction d'absorption cutanée à partir du sol. Valeurs tirées d'INSPQ (2012).

f_{abs_GI} : Valeurs tirées du *Risk Assessment Information System* (https://rais.ornl.gov/cgi-bin/tools/TOX_search?select=chem_spef).

FAR_{inh} : Par défaut, 1. Pour le cuivre, valeur basée sur l'information contenue dans la fiche toxicologique présentée à l'annexe B.

FBT_{lait_mater} : Facteur de biotransfert pour le lait maternel. Valeurs tirées de Yu, Zielen *et coll.* (2001).

3. JEU D'ÉQUATIONS

Les sous-sections suivantes présentent les équations utilisées afin d'estimer l'exposition des récepteurs. Les paramètres d'exposition sont ceux présentés aux tableaux D1 (Relais routier), D2 (Activités traditionnelles) et D3 (exposition domestique). Les paramètres spécifiques aux métaux sont ceux présentés au tableau D4. Il est à noter que les unités de certains paramètres présentés aux tableaux D1 à D4 ont pu être transformées afin de réaliser certains calculs.

3.1 Estimation de la dose par inhalation d'air extérieur

$$Dinh_{ext} = (Ca_{ext.g} + Ca_{ext.part}) \times Inh \times T_{ext} \times FE$$

Où :

$Dinh_{ext}$	Dose par inhalation d'air extérieur, mg/kg-pc par jour
$C_{aext.g}$	Concentration dans l'air extérieur sous forme gazeuse, mg/m^3
$C_{aext.part}$	Concentration dans l'air extérieur sous forme particulaire, mg/m^3
Inh	Taux d'inhalation, m^3/kg-pc par jour
T_{ext}	Proportion du temps passé à l'extérieur (temps passé à l'extérieur (heures par jour)/24 heures)
FE	Fréquence d'exposition pour la période d'exposition considérée (temps passé dans la zone d'étude (jours par période)/durée de la période en jours)

3.2 Estimation de la dose par inhalation d'air intérieur

$$Dinh_{int} = (Ca_{int.g} + Ca_{int.part}) \times Inh \times T_{int} \times FE$$

Où :

$Dinh_{int}$	Dose par inhalation d'air intérieur, mg/kg-pc par jour
$Ca_{ext.g}$	Concentration dans l'air extérieur sous forme gazeuse, mg/m^3
$Ca_{ext.part}$	Concentration dans l'air extérieur sous forme particulaire, mg/m^3
Inh	Taux d'inhalation, m^3/kg-pc par jour
T_{int}	Proportion du temps passé à l'intérieur (temps passé à l'intérieur (heures par jour)/24 heures)
FE	Fréquence d'exposition pour la période d'exposition considérée (temps passé dans la zone d'étude (jours par période)/durée de la période en jours)

3.3 Estimation de la dose par ingestion de sol

$$D_s = \frac{C_s \times QI_s \times FE}{P}$$

Où :

D_s	Dose par ingestion de sol, mg/kg-pc par jour
C_s	Concentration dans le sol de surface, mg/kg
QI_s	Quantité de sol ingéré par jour, kg/jour
FE	Fréquence d'exposition pour la période d'exposition considérée (temps passé dans la zone d'étude (jours par période)/durée de la période en jours)

P Poids corporel, kg

3.4 Estimation de la dose par ingestion de poussières intérieures

$$D_p = \frac{C_p \times QI_p \times FE}{P}$$

Où :

D_p Dose par ingestion de poussières intérieures, mg/kg-pc par jour

C_p Concentration dans le sol de surface, mg/kg

QI_p Quantité de sol ingéré par jour, kg/jour

FE Fréquence d'exposition pour la période d'exposition considérée
(temps passé dans la zone d'étude (jours par période)/durée de la période en jours)

P Poids corporel, kg

3.5 Estimation de la dose par contact cutané avec le sol

$$Dcut_{sol} = \frac{EV \times (C_{sol} \times T_{adh} \times A) \times Abs \times FE \times FCV}{P}$$

Où :

$Dcut_{sol}$ Dose par contact cutané avec le sol, mg/kg-pc par jour

EV Fréquence de l'événement (Nombre de contacts sol-peau par jour)

C_{sol} Concentration dans le sol, mg/kg

T_{adh} Taux d'adhérence des particules sur la peau, mg/cm²-événement

A Surface corporelle exposée aux particules, cm^2

Abs Fraction du contaminant absorbée par la peau ($f_{abs\text{-}cut}$, tableau D4)

FE Fréquence d'exposition pour la période d'exposition considérée
(temps passé dans la zone d'étude (jours par période)/durée de la période en jours)

FCV Facteur de conversion d'unités (1,0E-06 kg/mg)

P Poids corporel, kg

3.6 Estimation de la dose par contact cutané avec les poussières intérieures

$$Dcut_{pou} = \frac{EV \times (C_{pou} \times T_{adh} \times A) \times Abs \times FE \times FCV}{P}$$

Où :

$Dcut_{pou}$ Dose par contact cutané avec les poussières intérieures sol, mg/kg-pc par jour

EV Fréquence de l'événement (Nombre de contacts sol-peau par jour)

C_{pou} Concentration dans les poussières intérieures, mg/kg

T_{adh} Taux d'adhérence des particules sur la peau, mg/cm²-événement

A Surface corporelle exposée aux particules, cm^2

Abs	Fraction du contaminant absorbé par la peau ($f_{abs\text{-}cut}$, tableau D4)
FE	Fréquence d'exposition pour la période d'exposition considérée (temps passé dans la zone d'étude (jours par période)/durée de la période en jours)
FCV	Facteur de conversion d'unités (1,0E-06 kg/mg)
P	Poids corporel, kg

3.7 Estimation de la dose par ingestion d'eau potable

$$D_e = \frac{C_e \times QI_e \times FE \times F_{eau}}{P}$$

Où :

D_e	Dose par ingestion d'eau potable, mg/kg-pc par jour
C_e	Concentration dans l'eau potable, mg/L
QI_e	Taux d'ingestion d'eau potable, L/jour
FE	Fréquence d'exposition pour la période d'exposition considérée (temps passé dans la zone d'étude (jours par période)/durée de la période en jours)
F_{eau}	Fraction de l'eau potable d'origine locale (fixée à 1,0)
P	Poids corporel, kg

3.8 Estimation de la dose par ingestion de fruits/feuilles

$$D_{fruits} = \frac{C_{fruits} \times QI_{fruits} \times FE \times F_{fruits}}{P}$$

Où :

D_{fruits}	Dose par ingestion de fruits ou feuilles, mg/kg-pc par jour
C_{fruits}	Concentration dans les fruits ou feuilles, mg/kg
QI_{fruits}	Taux d'ingestion de fruits ou feuilles, kg/jour
FE	Fréquence d'exposition pour la période d'exposition considérée (temps passé dans la zone d'étude (jours par période)/durée de la période en jours)
F_{fruits}	Fraction des fruits/feuilles d'origine locale (dépend du scénario, voir rapport)
P	Poids corporel, kg

3.9 Estimation de la dose par ingestion de viande

$$D_{viande} = \frac{C_{viande} \times QI_{viande} \times FE \times F_{viande}}{P}$$

Où :

D_{viande}	Dose par ingestion de viande, mg/kg-pc par jour
C_{viande}	Concentration dans la viande, mg/kg
QI_{viande}	Taux d'ingestion de viande, kg/jour

FE	Fréquence d'exposition pour la période d'exposition considérée (temps passé dans la zone d'étude (jours par période)/durée de la période en jours)
F_{viande}	Fraction de la viande d'origine locale (dépend du scénario, voir le rapport)
P	Poids corporel, kg

3.10 Estimation de la dose par ingestion de poisson

$$D_{poisson} = \frac{C_{poisson} \times QI_{poisson} \times FE \times F_{poisson}}{P}$$

Où :

$D_{poisson}$	Dose par ingestion de poisson, mg/kg-pc par jour
$C_{poisson}$	Concentration dans le poisson, mg/kg
$QI_{poisson}$	Taux d'ingestion de poisson, kg/jour
FE	Fréquence d'exposition pour la période d'exposition considérée (temps passé dans la zone d'étude - jours/période / Durée – période)
$F_{poisson}$	Fraction du poisson d'origine locale (dépend du scénario, voir rapport)
P	Poids corporel, kg

3.11 Estimation de la dose par contact cutané avec l'air ambiant en été

$$Dcut_{air} = \frac{[(Cair_{ext} \times Kp_{air} \times A \times t_{ext}) + (Cair_{int} \times Kp_{air} \times A \times t_{int})] \times FE}{P}$$

Où :

$Dcut_{air}$	Dose par contact cutané avec l'air ambiant, mg/kg-pc par jour
$Cair_{ext}$	Concentration dans l'air extérieur sous forme gazeuse, mg/cm³
Kp_{air}	Constante de perméabilité dans l'air sous forme gazeuse, cm/heure (KPA, tableau D4)
A	Surface de la peau exposée aux vapeurs, cm²
t_{ext}	Temps d'exposition à l'extérieur, nombre d'heures par jour
$Cair_{int}$	Concentration dans l'air intérieur sous forme gazeuse, mg/cm³
t_{int}	Temps d'exposition à l'intérieur, nombre d'heures par jour
FE	Fréquence d'exposition pour la période d'exposition considérée (temps passé dans la zone d'étude - jours/période / Durée – période)
P	Poids corporel, kg

3.12 Estimation de la dose par voie cutanée à partir de l'eau (bains)

$$Dcut_{eau} = \frac{DA \times A \times EV \times FE}{P}$$

$$DA = K_{p_eau} \times C_e \times t$$

Où :

$Dcut_{eau}$	Dose par voie cutanée à partir de l'eau, mg/kg-pc par jour
DA	Dose absorbée par événement d'exposition, mg/cm²/événement
A	Surface corporelle exposée, cm²
EV	Nombre d'événements d'exposition par jour
FE	Fréquence d'exposition pour la période d'exposition considérée (temps passé dans la zone d'étude - jours/période / Durée – période)
P	Poids corporel, kg
Kp_{eau}	Coefficient de perméabilité cutanée à partir de l'eau, cm/heure (KPE, tableau D4)
Ce	Concentration dans l'eau, mg/cm³
t	Durée du contact avec l'eau, nombre d'heures par jour

3.13 Estimation de la dose par ingestion de lait maternel (0 à 6 mois)

$$Dose_{lait_mat} = \frac{C_{lait_mat} \times \left(\frac{TI_{lait_mat}}{\delta_{lait_mat}}\right)}{PC}$$

$$C_{lait_mat} = Dose_{éq_orale} \times FBT_{lait_mat} \times \delta_{lait_mat}$$

$$Dose_{éq_orale} = \left[Dose_{tot_ing} + Dose_{tot_inh}\ x\ FAR_{inh} + \frac{Dose_{tot_cut}}{f_{abs_GI}}\right] x\ PC_{mère}$$

$$Dose_{tot_inh} = \left(\frac{Dose_1 + Dose_{20}}{2}\right) + \left(\frac{Dose_2 + Dose_{21}}{2}\right) + Dose_4 + Dose_{27}$$

$$Dose_{tot_cut} = \left(\frac{Dose_5 + Dose_{22}}{2}\right) + \left(\frac{Dose_8 + Dose_{23}}{2}\right) + \left(\frac{Dose_9 + Dose_{24}}{2}\right) + Dose_6 + Dose_7$$

$$Dose_{tot_ing} = \left(\frac{Dose_{11} + Dose_{25}}{2}\right) + \left(\frac{Dose_{12} + Dose_{26}}{2}\right) + Dose_{10} + \sum_{i=13}^{i=18} (Dose_i)$$

Où :

$Dose_{lait_mat}$	Dose par ingestion de lait maternel (0 à 6 mois), mg/kg-pc par jour
C_{lait_mat}	Concentration dans le lait maternel, mg/L
TI_{lait_mat}	Taux d'ingestion de lait maternel, 0,73 kg/jour
d_{lait_mat}	Densité du lait maternel, 1,03 kg/L
PC	Poids corporel, 6,70 kg
$Dose_{éq_orale}$	Dose totale en équivalent oral (ingestion) de la mère, mg/jour
FBT_{lait_mat}	Facteur de biotransfert pour le lait maternel, jour/kg (tableau D4)
$Dose_{tot_ing}$	Dose totale par ingestion de la mère, mg/kg-pc par jour
$Dose_{tot_inh}$	Dose totale par inhalation de la mère, mg/kg-pc par jour
FAR_{Inh}	Facteur d'absorption relative par inhalation, tableau D4)
$Dose_{tot_cut}$	Dose totale par voie cutanée de la mère, mg/kg-pc par jour
$PC_{mère}$	Poids corporel de la mère, 69,1 kg

$Dose_1$ Dose de la mère par inhalation d'air extérieur en été, mg/kg-pc par jour
$Dose_2$ Dose de la mère par inhalation d'air intérieur en été, mg/kg-pc par jour
$Dose_4$ Dose de la mère par tabagisme actif, mg/kg-pc par jour
$Dose_5$ Dose de la mère par voie cutanée avec l'air ambiant en été, mg/kg-pc par jour
$Dose_6$ Dose de la mère par voie cutanée avec l'eau d'usage domestique, mg/kg-pc par jour
$Dose_7$ Dose de la mère par voie cutanée avec l'eau de baignade extérieure, mg/kg-pc par jour
$Dose_8$ Dose de la mère par voie cutanée avec le sol en été, mg/kg-pc par jour
$Dose_9$ Dose de la mère par voie cutanée avec les poussières en été, mg/kg-pc par jour
$Dose_{10}$ Dose de la mère par ingestion d'eau potable, mg/kg-pc par jour
$Dose_{11}$ Dose de la mère par ingestion de sol en été, mg/kg-pc par jour
$Dose_{12}$ Dose de la mère par ingestion de poussières en été, mg/kg-pc par jour
$Dose_{13}$ Dose de la mère par ingestion de fruits, mg/kg-pc par jour
$Dose_{14}$ Dose de la mère par ingestion de légumes, mg/kg-pc par jour
$Dose_{15}$ Dose de la mère par ingestion de viandes, mg/kg-pc par jour
$Dose_{16}$ Dose de la mère par ingestion d'œufs, mg/kg-pc par jour
$Dose_{17}$ Dose de la mère par ingestion de lait et produits laitiers, mg/kg-pc par jour
$Dose_{18}$ Dose de la mère par ingestion de poisson, mg/kg-pc par jour
$Dose_{20}$ Dose de la mère par inhalation d'air extérieur en hiver, mg/kg-pc par jour
$Dose_{21}$ Dose de la mère par inhalation d'air intérieur en hiver, mg/kg-pc par jour
$Dose_{22}$ Dose de la mère par voie cutanée avec l'air ambiant en hiver, mg/kg-pc par jour
$Dose_{23}$ Dose de la mère par voie cutanée avec le sol en hiver, mg/kg-pc par jour
$Dose_{24}$ Dose de la mère par voie cutanée avec les poussières en hiver, mg/kg-pc par jour
$Dose_{25}$ Dose de la mère par ingestion de sol en hiver, mg/kg-pc par jour
$Dose_{26}$ Dose de la mère par ingestion de poussières en hiver, mg/kg-pc par jour
$Dose_{27}$ Dose de la mère par inhalation des aérosols de la douche, mg/kg-pc par jour

3.14 Combinaison des doses d'exposition par ingestion et contact cutané

Aucune VTR n'étant disponible pour évaluer les risques posés par une exposition aux métaux par contact cutané, les doses par contact cutané ont été combinées aux doses par ingestion. Comme les doses par contact cutané calculées à partir des équations présentées dans les sections précédentes correspondent à des doses absorbées, elles doivent être divisées par la fraction absorbée dans le tractus gastro-intestinal afin d'être exprimées en doses équivalentes par voie orale. L'exposition combinée a donc été estimée ainsi :

$$Dose_{cut_éq.oral} = \frac{Dose_{cut}}{f_{abs_GI}}$$

Où :

$Dose_{cut_éq.oral_i}$ Dose par contact cutané exprimée en équivalent oral (mg/kg-pc par jour) pour la voie d'exposition i (ex. : contact cutané avec l'eau);
$Dose_{cut_i}$ Dose absorbée par contact cutané (mg/kg-pc par jour) pour la voie d'exposition i;
f_{abs_cut} Fraction d'absorption cutanée (sans unité) propre à la substance (tableau D3).

De la même façon, lorsque l'exposition par inhalation est combinée à l'exposition par ingestion et par contact cutané, celles-ci doivent être converties afin d'être exprimées en doses équivalentes par voie orale. Cette conversion est réalisée à l'aide de l'équation suivante :

$$Dose_{inh_éq.oral} = Dose_{inh}\ x\ FAR_{inh}$$

Où :

$Dose_{inh_éq.oral_i}$	Dose par inhalation exprimée en équivalent oral (mg/kg-pc par jour) pour la voie d'exposition i (ex. : inhalation d'air extérieur);
$Dose_{cut_i}$	Dose inhalée (mg/kg-pc par jour) pour la voie d'exposition i;
FAR_{inh}	Fraction d'absorption relative par voie orale (sans unité) propre à la substance1 (tableau D4).

Il est à noter que l'ensemble des doses par contact cutané présentées dans le rapport ou dans les annexes sont exprimées en équivalent oral, et peuvent donc être combinées directement avec les doses par ingestion.

1 Conversion réalisée lorsque les données disponibles permettent de supposer que l'absorption d'une substance par inhalation diffère significativement de l'absorption par ingestion. Parmi les substances étudiées, cas du cuivre uniquement (l'absorption du Cu par inhalation a été fixée à 100% tandis que l'absorption par ingestion a été fixée à 12%).

4. RÉFÉRENCES

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ANNEXE E

Concentrations additionnelles et taux de dépôt atmosphérique modélisés dans l'air, et concentrations de métaux mesurées dans la zone d'étude (eau de surface, sédiments et végétaux) (WSP)

TABLEAU E-1 Concentrations additionnelles dans l'air ambiant de la zone d'étude estimées par modélisation de la dispersion atmosphérique (WSP, 2018)

Substances	Taille des particules	Période	Concentration additionnelle estimée dans l'air ambiant (µg/m3)																									
			Récepteur le plus exposé	TRP1	CHS1	CHS2	CHS3	CHS4	CCT1	CHS5	PCH1	PCH2	PCH3	PCH4	PCH5	AVL1	CRI1	CRI2	CRI3	CRI4	CRI5	CHS6	AQU1	AQU2	AQU3	AQU4	AQU5
CO	-	1 heure	1,0E+04	1,9E+02	2,2E+03	4,6E+02	1,8E+02	1,5E+02	5,6E+01	5,6E+02	3,4E+02	1,9E+02	8,9E+01	3,2E+02	5,0E+02	2,5E+02	1,0E+03	1,8E+03	1,7E+02	3,7E+02	6,2E+02	2,0E+02	8,8E+02	7,3E+02	1,8E+03	1,8E+03	1,8E+03
NO2	-	1 heure	2,4E+02	4,5E+01	1,5E+02	1,1E+02	4,3E+01	3,7E+01	3,3E+01	1,3E+02	8,5E+01	4,8E+01	2,4E+01	7,6E+01	1,3E+02	7,1E+01	1,3E+02	1,4E+02	4,2E+01	9,2E+01	1,3E+02	5,3E+01	1,3E+02	1,3E+02	1,4E+02	1,4E+02	1,4E+02
SO2	-	1 heure	1,9E+01	4,0E-01	3,9E+00	8,2E-01	3,2E-01	2,7E-01	9,9E-02	1,0E+00	6,2E-01	3,5E-01	1,6E-01	5,6E-01	8,9E-01	4,5E-01	1,9E+00	3,3E+00	3,0E-01	6,7E-01	1,1E+00	3,6E-01	1,6E+00	1,3E+00	3,3E+00	3,1E+00	3,2E+00
Aluminium	PM10	1 heure	3,1E+01	5,1E+00	1,0E+01	6,3E+00	2,2E+00	2,1E+00	3,7E+00	9,5E+00	3,6E+00	3,6E+00	1,9E+00	2,2E+00	3,4E+00	9,1E+00	4,3E+00	4,8E+00	3,6E+00	3,2E+00	6,6E+00	4,2E+00	1,3E+01	8,7E+00	7,2E+00	7,8E+00	4,6E+00
Antimoine	PM10	1 heure	3,4E-04	3,3E-05	7,9E-05	4,0E-05	1,5E-05	1,4E-05	2,2E-05	6,4E-05	2,3E-05	2,3E-05	1,2E-05	1,3E-05	2,3E-05	5,6E-05	3,3E-05	5,3E-05	2,3E-05	1,9E-05	4,4E-05	2,7E-05	8,6E-05	5,5E-05	6,1E-05	5,4E-05	5,0E-05
Argent	PM10	1 heure	5,0E-04	4,4E-05	1,1E-04	5,2E-05	1,9E-05	1,8E-05	2,9E-05	8,4E-05	2,9E-05	3,0E-05	1,5E-05	1,7E-05	3,1E-05	7,2E-05	4,8E-05	7,8E-05	2,9E-05	2,5E-05	5,7E-05	3,5E-05	1,1E-04	7,1E-05	9,0E-05	7,9E-05	7,5E-05
Arsenic	PM10	1 heure	3,5E-02	1,2E-03	7,3E-03	1,5E-03	5,7E-04	4,8E-04	6,6E-04	2,4E-03	9,4E-04	7,4E-04	3,5E-04	9,3E-04	1,6E-03	1,6E-03	3,2E-03	5,5E-03	7,3E-04	1,1E-03	2,0E-03	8,7E-04	3,8E-03	2,6E-03	6,1E-03	5,5E-03	5,3E-03
Baryum	PM10	1 heure	2,7E-01	5,0E-02	1,0E-01	6,3E-02	2,2E-02	2,1E-02	3,7E-02	9,1E-02	3,5E-02	3,5E-02	1,9E-02	2,2E-02	3,3E-02	9,1E-02	4,2E-02	4,2E-02	3,5E-02	3,1E-02	6,4E-02	4,1E-02	1,2E-01	8,7E-02	7,2E-02	7,9E-02	3,9E-02
Béryllium	PM10	1 heure	3,6E-02	8,8E-04	7,2E-03	1,5E-03	5,7E-04	4,8E-04	2,1E-04	1,9E-03	9,4E-04	6,4E-04	3,0E-04	9,4E-04	1,5E-03	7,4E-04	3,1E-03	5,5E-03	4,7E-04	1,1E-03	2,1E-03	6,4E-04	2,8E-03	2,6E-03	6,0E-03	5,5E-03	5,4E-03
Bore	PM10	1 heure	3,1E-01	7,5E-03	6,3E-02	1,3E-02	5,0E-03	4,2E-03	2,6E-03	1,6E-02	8,2E-03	5,5E-03	2,6E-03	8,3E-03	1,3E-02	6,7E-03	2,7E-02	4,8E-02	4,1E-03	1,0E-02	1,8E-02	5,6E-03	2,5E-02	2,3E-02	5,3E-02	4,8E-02	4,7E-02
Cadmium	PM10	1 heure	3,4E-04	3,2E-05	7,8E-05	3,8E-05	1,4E-05	1,3E-05	2,1E-05	6,1E-05	2,2E-05	2,2E-05	1,1E-05	1,2E-05	2,2E-05	5,3E-05	3,3E-05	5,2E-05	2,1E-05	1,8E-05	4,1E-05	2,5E-05	8,1E-05	5,2E-05	6,1E-05	5,3E-05	5,0E-05
Chrome	PM10	1 heure	1,1E-01	6,9E-03	2,5E-02	8,5E-03	3,1E-03	2,8E-03	4,4E-03	1,4E-02	4,8E-03	4,8E-03	2,3E-03	3,0E-03	6,0E-03	1,1E-02	1,1E-02	1,8E-02	4,7E-03	4,0E-03	9,3E-03	5,5E-03	1,9E-02	1,2E-02	2,0E-02	1,8E-02	1,7E-02
Cobalt	PM10	1 heure	1,8E-02	3,9E-03	7,7E-03	4,7E-03	1,6E-03	1,6E-03	2,8E-03	6,8E-03	2,7E-03	2,6E-03	1,4E-03	1,7E-03	2,4E-03	6,9E-03	3,2E-03	1,9E-03	2,7E-03	2,4E-03	4,8E-03	3,1E-03	9,0E-03	6,5E-03	5,4E-03	6,1E-03	1,7E-03
Cuivre	PM10	1 heure	2,0E-02	2,6E-03	5,2E-03	3,3E-03	1,2E-03	1,1E-03	1,9E-03	4,9E-03	1,9E-03	1,8E-03	9,7E-04	1,1E-03	1,8E-03	4,7E-03	2,2E-03	3,1E-03	1,9E-03	1,6E-03	3,4E-03	2,2E-03	6,8E-03	4,6E-03	3,8E-03	4,0E-03	2,9E-03
Étain	PM10	1 heure	1,5E-02	5,4E-04	3,2E-03	6,4E-04	2,5E-04	2,1E-04	2,3E-04	8,7E-04	4,1E-04	2,9E-04	1,4E-04	4,0E-04	7,1E-04	6,3E-04	1,4E-03	2,4E-03	2,5E-04	5,0E-04	8,9E-04	3,0E-04	1,2E-03	1,1E-03	2,6E-03	2,4E-03	2,3E-03
Lithium	PM10	1 heure	1,3E+00	3,8E-02	2,7E-01	5,6E-02	2,2E-02	1,8E-02	1,2E-02	7,4E-02	3,6E-02	2,4E-02	1,2E-02	3,5E-02	5,9E-02	3,6E-02	1,2E-01	2,1E-01	1,8E-02	4,3E-02	7,7E-02	2,4E-02	1,1E-01	9,8E-02	2,3E-01	2,1E-01	2,0E-01
Manganèse	PM10	1 heure	5,8E-01	1,3E-01	2,5E-01	1,5E-01	5,2E-02	5,1E-02	9,1E-02	2,2E-01	8,5E-02	8,5E-02	4,6E-02	5,4E-02	7,6E-02	2,2E-01	1,0E-01	6,0E-02	8,6E-02	7,7E-02	1,5E-01	1,0E-01	2,9E-01	2,1E-01	1,7E-01	1,9E-01	5,4E-02
Mercure	PM10	1 heure	8,2E-06	1,8E-06	3,5E-06	2,1E-06	7,3E-07	7,2E-07	1,3E-06	3,0E-06	1,2E-06	1,2E-06	6,5E-07	7,6E-07	1,1E-06	3,1E-06	1,4E-06	8,4E-07	1,2E-06	1,1E-06	2,1E-06	1,4E-06	4,0E-06	2,9E-06	2,4E-06	2,8E-06	7,6E-07
Molybdène	PM10	1 heure	5,0E-03	2,1E-04	1,0E-03	2,4E-04	9,3E-05	8,0E-05	1,2E-04	4,3E-04	1,4E-04	1,4E-04	6,2E-05	1,3E-04	2,4E-04	2,9E-04	4,5E-04	7,7E-04	1,3E-04	1,6E-04	2,9E-04	1,5E-04	6,0E-04	3,6E-04	8,6E-04	7,7E-04	7,5E-04
Nickel	PM10	1 heure	3,2E-02	3,6E-03	7,8E-03	4,7E-03	1,6E-03	1,6E-03	2,7E-03	7,0E-03	2,6E-03	2,6E-03	1,4E-03	1,6E-03	2,5E-03	6,6E-03	3,2E-03	5,0E-03	2,6E-03	2,3E-03	4,8E-03	3,1E-03	9,8E-03	6,5E-03	6,0E-03	5,6E-03	4,8E-03
Plomb	PM10	1 heure	6,0E-03	7,8E-04	1,6E-03	1,0E-03	3,5E-04	3,4E-04	5,8E-04	1,5E-03	5,6E-04	5,6E-04	2,9E-04	3,4E-04	5,4E-04	1,4E-03	6,8E-04	9,3E-04	5,6E-04	4,9E-04	1,0E-03	6,6E-04	2,1E-03	1,4E-03	1,1E-03	1,2E-03	8,8E-04
Sélénium	PM10	1 heure	4,9E-03	1,3E-04	9,9E-04	2,0E-04	7,8E-05	6,6E-05	4,0E-05	2,7E-04	1,3E-04	8,8E-05	4,2E-05	1,3E-04	2,2E-04	1,2E-04	4,3E-04	7,6E-04	6,4E-05	1,6E-04	2,8E-04	8,8E-05	3,9E-04	3,6E-04	8,3E-04	7,5E-04	7,4E-04
Strontium	PM10	1 heure	1,3E-01	2,8E-02	5,6E-02	3,5E-02	1,2E-02	1,2E-02	2,1E-02	5,0E-02	1,9E-02	1,9E-02	1,0E-02	1,2E-02	1,8E-02	5,0E-02	2,3E-02	2,0E-02	2,0E-02	1,7E-02	3,5E-02	2,3E-02	6,8E-02	4,8E-02	3,9E-02	4,4E-02	1,9E-02
Thallium	PM10	1 heure	1,5E-03	6,2E-05	3,1E-04	6,2E-05	2,4E-05	2,0E-05	3,0E-05	1,0E-04	4,0E-05	3,6E-05	1,5E-05	3,9E-05	7,1E-05	8,0E-05	1,4E-04	2,3E-04	3,2E-05	4,8E-05	8,7E-05	3,8E-05	1,2E-04	1,1E-04	2,6E-04	2,3E-04	2,2E-04
Titane	PM10	1 heure	5,4E+00	1,2E+00	2,3E+00	1,4E+00	4,9E-01	4,8E-01	8,6E-01	2,0E+00	8,0E-01	7,9E-01	4,3E-01	5,0E-01	7,0E-01	2,1E+00	9,5E-01	5,6E-01	8,0E-01	7,2E-01	1,4E+00	9,4E-01	2,7E+00	2,0E+00	1,6E+00	1,8E+00	5,0E-01
Uranium	PM10	1 heure	2,1E-03	6,8E-05	4,3E-04	8,8E-05	3,4E-05	2,9E-05	2,6E-05	1,2E-04	5,6E-05	3,9E-05	1,9E-05	5,6E-05	9,5E-05	7,4E-05	1,9E-04	3,3E-04	3,1E-05	6,8E-05	1,2E-04	3,9E-05	1,7E-04	1,5E-04	3,6E-04	3,3E-04	3,2E-04
Vanadium	PM10	1 heure	1,3E-01	2,7E-02	5,3E-02	3,2E-02	1,1E-02	1,1E-02	2,0E-02	4,6E-02	1,8E-02	1,8E-02	9,9E-03	1,2E-02	1,6E-02	4,8E-02	2,2E-02	1,3E-02	1,8E-02	1,7E-02	3,3E-02	2,2E-02	6,2E-02	4,5E-02	3,7E-02	4,2E-02	1,2E-02
Zinc	PM10	1 heure	6,6E-02	1,3E-02	2,6E-02	1,6E-02	5,6E-03	5,4E-03	9,6E-03	2,4E-02	9,0E-03	9,1E-03	4,8E-03	5,6E-03	8,6E-03	2,3E-02	1,1E-02	1,0E-02	9,1E-03	8,1E-03	1,7E-02	1,1E-02	3,0E-02	2,2E-02	1,8E-02	2,0E-02	9,6E-03
CO	-	8 heures	1,5E+03	3,3E+01	2,8E+02	5,9E+01	2,2E+01	1,9E+01	7,0E+00	7,1E+01	4,5E+01	2,4E+01	1,1E+01	4,6E+01	8,4E+01	3,2E+01	1,3E+02	2,6E+02	2,1E+01	4,6E+01	7,8E+01	2,5E+01	1,1E+02	9,3E+01	2,3E+02	2,2E+02	2,6E+02
SO2	-	8 heures	2,7E+00	6,4E-02	5,1E-01	1,1E-01	4,0E-02	3,4E-02	2,3E-02	1,3E-01	9,1E-02	6,1E-02	2,1E-02	8,3E-02	1,6E-01	6,1E-02	2,5E-01	4,7E-01	3,9E-02	8,3E-02	1,4E-01	4,6E-02	2,0E-01	2,0E-01	4,1E-01	4,0E-01	4,5E-01
Aluminium	PM10	8 heures	8,2E+00	1,9E+00	4,4E+00	1,3E+00	8,1E-01	6,3E-01	1,4E+00	3,1E+00	8,8E-01	1,1E+00	4,4E-01	5,8E-01	7,6E-01	2,3E+00	1,3E+00	7,9E-01	6,7E-01	7,5E-01	2,1E+00	7,7E-01	3,8E+00	3,5E+00	3,7E+00	4,6E+00	7,6E-01
Antimoine	PM10	8 heures	5,5E-05	1,1E-05	2,8E-05	8,2E-06	5,0E-06	3,9E-06	9,0E-06	2,0E-05	5,7E-06	7,5E-06	2,8E-06	3,7E-06	5,7E-06	1,5E-05	9,9E-06	8,1E-06	4,3E-06	4,7E-06	1,3E-05	4,9E-06	2,4E-05	2,2E-05	2,3E-05	2,7E-05	7,8E-06
Argent	PM10	8 heures	8,0E-05	1,4E-05	3,6E-05	1,1E-05	6,4E-06	5,0E-06	1,2E-05	2,6E-05	7,6E-06	9,7E-06	3,5E-06	4,7E-06	7,7E-06	1,9E-05	1,4E-05	1,2E-05	5,5E-06	6,0E-06	1,7E-05	6,3E-06	3,1E-05	2,8E-05	2,9E-05	3,5E-05	1,1E-05
Arsenic	PM10	8 heures	5,2E-03	4,0E-04	1,3E-03	3,1E-04	1,6E-04	2,2E-04	2,8E-04	6,4E-04	2,7E-04	2,6E-04	7,2E-05	1,5E-04	3,3E-04	5,3E-04	5,9E-04	8,0E-04	1,4E-04	1,5E-04	3,8E-04	1,6E-04	8,5E-04	1,3E-03	7,9E-04	8,6E-04	7,8E-04
Baryum	PM10	8 heures	8,1E-02	1,9E-02	4,4E-02	1,3E-02	8,1E-03	6,3E-03	1,4E-02	3,0E-02	8,6E-03	1,1E-02	4,3E-03	5,7E-03	7,2E-03	2,3E-02	1,2E-02	7,0E-03	6,6E-03	7,5E-03	2,0E-02	7,5E-03	3,7E-02	3,5E-02	3,7E-02	4,6E-02	6,7E-03
Béryllium	PM10	8 heures	5,1E-03	1,6E-04	1,0E-03	2,1E-04	7,2E-05	6,0E-05	6,6E-05	2,7E-04	1,6E-04	1,5E-04	4,6E-05	1,4E-04	2,9E-04	1,4E-04	4,5E-04	8,0E-04	6,1E-05	1,4E-04	2,6E-04	8,0E-05	3,9E-04	4,5E-04	7,7E-04	7,0E-04	7,7E-04
Bore	PM10	8 heures	4,5E-02	2,7E-03	9,1E-03	2,2E-03	1,4E-03	2,0E-03	1,1E-03	2,5E-03	1,7E-03	1,2E-03	3,2E-04	1,2E-03	2,4E-03	4,6E-03	4,3E-03	7,0E-03	5,9E-04	1,3E-03	2,3E-03	7,1E-04	6,0E-03	1,1E-02	6,7E-03	7,6E-03	6,8E-03
Cadmium	PM10	8 heures	5,5E-05	1,1E-05	2,6E-05	7,8E-06	4,7E-06	3,7E-06	8,5E-06	1,9E-05	5,4E-06	7,0E-06	2,6E-06	3,4E-06	5,4E-06	1,4E-05	9,5E-06	8,1E-06	4,0E-06	4,4E-06	1,2E-05	4,6E-06	2,3E-05	2,1E-05	2,1E-05	2,6E-05	7,8E-06
Chrome	PM10	8 heures	1,8E-02	2,2E-03	5,6E-03	1,8E-03	9,9E-04	7,8E-04	1,8E-03	4,1E-03	1,3E-03	1,6E-03	5,4E-04	7,4E-04	1,4E-03	2,9E-03	2,5E-03	2,7E-03	8,8E-04	9,4E-04	2,6E-03	1,0E-03	5,1E-03	4,7E-03	4,6E-03	5,3E-03	2,6E-03
Cobalt	PM10	8 heures	6,2E-03	1,4E-03	3,3E-03	9,9E-04	6,2E-04	4,8E-04	1,1E-03	2,3E-03	6,5E-04	8,4E-04	3,3E-04	4,3E-04	4,9E-04	1,7E-03	8,4E-04	4,0E-04	4,9E-04	5,7E-04	1,5E-03	5,7E-04	2,8E-03	2,6E-03	2,8E-03	3,6E-03	4,5E-04
Cuivre	PM10	8 heures	4,2E-03	9,6E-04	2,3E-03	6,7E-04	4,2E-04	3,3E-04	7,3E-04	1,6E-03	4,5E-04	5,9E-04	2,2E-04	3,0E-04	4,1E-04	1,2E-03	7,2E-04	5,0E-04	3,4E-04	3,9E-04	1,0E-03	4,0E-04	2,0E-03	1,8E-03	1,9E-03	2,3E-03	4,8E-04
Étain	PM10	8 heures	2,3E-03	1,1E-04	5,1E-04	1,1E-04	4,7E-05	4,2E-05	9,1E-05	2,4E-04	9,9E-05	1,1E-04	3,5E-05	6,4E-05	1,4E-04	1,6E-04	2,4E-04	3,5E-04	4,6E-05	6,3E-05	1,5E-04	5,4E-05	2,3E-04	2,2E-04	3,4E-04	3,2E-04	3,4E-04
Lithium	PM10	8 heures	1,9E-01	7,3E-03	4,0E-02	8,5E-03	2,8E-03	2,7E-03	4,7E-03	1,5E-02	7,0E-03	7,0E-03	2,2E-03	5,4E-03	1,1E-02	8,6E-03	1,8E-02	3,0E-02	2,5E-03	5,5E-03	1,0E-02	3,1E-03	1,6E-02	1,8E-02	2,9E-02	2,7E-02	2,9E-02
Manganèse	PM10	8 heures	2,0E-01	4,6E-02	1,1E-01	3,2E-02	2,0E-02	1,5E-02	3,4E-02	7,3E-02	2,1E-02	2,7E-02	1,1E-02	1,4E-02	1,5E-02	5,6E-02	2,7E-02	1,3E-02	1,6E-02	1,8E-02	4,9E-02	1,8E-02	9,0E-02	8,5E-02	9,2E-02	1,2E-01	1,4E-02
Mercure	PM10	8 heures	2,8E-06	6,5E-07	1,5E-06	4,5E-07	2,8E-07	2,2E-07	4,8E-07	1,0E-06	3,0E-07	3,8E-07	1,5E-07	2,0E-07	2,1E-07	7,9E-07	3,7E-07	1,8E-07	2,2E-07	2,6E-07	7,0E-07	2,6E-07	1,3E-06	1,2E-06	1,3E-06	1,6E-06	2,0E-07
Molybdène	PM10	8 heures	7,5E-04	6,8E-05	1,9E-04	5,1E-05	2,6E-05	3,1E-05	5,1E-05	1,2E-04	4,3E-05	4,6E-05	1,4E-05	2,3E-05	5,1E-05	7,9E-05	9,1E-05	1,1E-04	2,5E-05	2,7E-05	7,2E-05	2,8E-05	1,4E-04	1,8E-04	1,2E-04	1,4E-04	1,1E-04
Nickel	PM10	8 heures	5,9E-03	1,3E-03	3,2E-03	9,5E-04	5,9E-04	4,6E-04	1,0E-03	2,2E-03	6,3E-04	8,4E-04	3,1E-04	4,2E-04	6,1E-04	1,7E-03	1,1E-03	7,9E-04	4,9E-04	5,5E-04	1,5E-03	5,6E-04	2,8E-03	2,6E-03	2,7E-03	3,3E-03	7,6E-04
Plomb	PM10	8 heures	1,3E-03	2,9E-04	6,9E-04	2,0E-04	1,3E-04	9,9E-05	2,2E-04	4,8E-04	1,4E-04	1,8E-04	6,8E-05	9,1E-05	1,3E-04	3,6E-04	2,2E-04	1,5E-04	1,0E-04	1,2E-04	3,2E-04	1,2E-04	6,0E-04	5,5E-04	5,7E-04	7,1E-04	1,4E-04
Sélénium	PM10	8 heures	7,0E-04	2,5E-05	1,4E-04	3,0E-05	9,8E-06	8,7E-06	1,4E-05	4,7E-05	2,4E-05	2,4E-05	7,6E-06	2,0E-05	4,1E-05	2,7E-05	6,5E-05	1,1E-04	8,5E-06	2,0E-05	3,6E-05	1,1E-05	5,6E-05	6,2E-05	1,1E-04	9,7E-05	1,1E-04
Strontium	PM10	8 heures	4,5E-02	1,0E-02	2,4E-02	7,1E-03	4,5E-03	3,5E-03	7,7E-03	1,7E-02	4,8E-03	6,2E-03	2,4E-03	3,2E-03	3,9E-03	1,3E-02	6,7E-03	3,5E-03	3,6E-03	4,2E-03	1,1E-02	4,2E-03	2,1E-02	1,9E-02	2,0E-02	2,6E-02	3,3E-03
Titane	PM10	8 heures	1,9E+00	4,3E-01	9,9E-01	3,0E-01	1,9E-01	1,4E-01	3,2E-01	6,8E-01	2,0E-01	2,5E-01	1,0E-01	1,3E-01	1,4E-01	5,2E-01	2,5E-01	1,2E-01	1,5E-01	1,7E-01	4,6E-01	1,7E-01	8,4E-01	8,0E-01	8,6E-01	1,1E+00	1,4E-01
Uranium	PM10	8 heures	3,1E-04	1,6E-05	6,8E-05	1,5E-05	5,9E-06	7,5E-06	1,2E-05	3,1E-05	1,3E-05	1,3E-05	4,2E-06	8,8E-06	1,9E-05	1,9E-05	3,2E-05	4,8E-05	5,9E-06	8,7E-06	1,9E-05	6,9E-06	3,0E-05	3,9E-05	4,7E-05	4,3E-05	4,6E-05
Vanadium	PM10	8 heures	4,3E-02	9,8E-03	2,3E-02	6,9E-03	4,3E-03	3,3E-03	7,3E-03	1,6E-02	4,5E-03	5,8E-03	2,3E-03	3,0E-03	3,3E-03	1,2E-02	5,7E-03	2,8E-03	3,4E-03	3,9E-03	1,1E-02	3,9E-03	1,9E-02	1,8E-02	2,0E-02	2,5E-02	3,1E-03
Zinc	PM10	8 heures	2,1E-02	4,8E-03	1,1E-02	3,4E-03	2,1E-03	1,6E-03	3,6E-03	7,9E-03	2,2E-03	2,9E-03	1,1E-03	1,5E-03	1,9E-03	5,9E-03	3,2E-03	1,7E-03	1,7E-03	1,9E-03	5,2E-03	1,9E-03	9,4E-03	8,9E-03	9,5E-03	1,2E-02	1,6E-03

TABLEAU E-1 Concentrations additionnelles dans l'air ambiant de la zone d'étude estimées par modélisation de la dispersion atmosphérique (WSP, 2018)

Substances	Taille des particules	Période	Concentration additionnelle estimée dans l'air ambiant (µg/m3)																									
			AQU6	AQU7	EAU1	EAU2	REL1	RIV1	TRP2	TRP3	TRP4	TRP5	TRP6	TRC1	MOT1	MOT2	MOT3	MOT4	MOT5	MOT6	MOT7	MOT8	AQU8	AQU9	EAU3	EAU4	EAU5	EAU6
CO	-	1 heure	8,2E+01	4,9E+02	4,9E+03	1,0E+04	9,8E+03	9,9E+01	1,3E+03	1,3E+03	1,6E+03	1,1E+03	5,3E+02	1,8E+03	4,7E+03	1,7E+03	5,6E+02	1,7E+02	8,2E+01	1,2E+02	9,5E+01	9,8E+01	2,8E+02	1,0E+03	3,3E+02	2,7E+02	1,1E+03	6,3E+02
NO2	-	1 heure	4,7E+01	1,2E+02	1,8E+02	2,4E+02	2,3E+02	4,5E+01	1,4E+02	1,4E+02	1,4E+02	1,3E+02	1,3E+02	1,4E+02	1,7E+02	1,4E+02	1,3E+02	4,4E+01	3,4E+01	2,9E+01	4,2E+01	4,4E+01	6,8E+01	1,3E+02	8,5E+01	6,7E+01	1,3E+02	1,3E+02
SO2	-	1 heure	1,5E-01	8,7E-01	8,8E+00	1,9E+01	1,7E+01	1,8E-01	2,3E+00	2,3E+00	2,8E+00	2,0E+00	9,4E-01	3,2E+00	8,4E+00	3,1E+00	9,9E-01	3,0E-01	2,1E-01	2,1E-01	1,7E-01	2,0E-01	5,0E-01	1,9E+00	6,1E-01	4,8E-01	1,9E+00	1,1E+00
Aluminium	PM10	1 heure	5,3E+00	2,4E+00	2,3E+01	3,1E+01	2,9E+01	5,2E+00	5,2E+00	9,3E+00	5,0E+00	6,1E+00	5,8E+00	2,4E+01	1,6E+01	5,1E+00	4,2E+00	5,3E+00	3,7E+00	3,6E+00	4,7E+00	4,6E+00	4,5E+00	3,9E+00	3,7E+00	2,5E+00	4,1E+00	3,2E+00
Antimoine	PM10	1 heure	3,5E-05	1,5E-05	1,9E-04	3,4E-04	3,2E-04	3,2E-05	4,3E-05	5,5E-05	5,0E-05	4,4E-05	3,5E-05	1,5E-04	1,4E-04	5,5E-05	2,8E-05	3,5E-05	2,3E-05	2,2E-05	3,1E-05	3,0E-05	3,0E-05	3,6E-05	2,3E-05	1,5E-05	3,3E-05	2,3E-05
Argent	PM10	1 heure	4,5E-05	2,0E-05	2,8E-04	5,0E-04	4,7E-04	4,0E-05	6,2E-05	7,0E-05	7,2E-05	6,3E-05	4,4E-05	1,9E-04	2,2E-04	8,1E-05	3,6E-05	4,6E-05	2,9E-05	2,9E-05	4,1E-05	3,8E-05	3,9E-05	5,2E-05	2,9E-05	1,9E-05	4,8E-05	3,2E-05
Arsenic	PM10	1 heure	1,2E-03	1,3E-03	1,7E-02	3,5E-02	3,3E-02	8,8E-04	4,0E-03	4,2E-03	4,8E-03	3,8E-03	1,7E-03	5,6E-03	1,6E-02	5,6E-03	1,7E-03	1,3E-03	7,2E-04	6,6E-04	1,1E-03	1,0E-03	1,0E-03	3,3E-03	1,3E-03	8,2E-04	3,3E-03	1,9E-03
Baryum	PM10	1 heure	5,2E-02	2,3E-02	2,3E-01	2,7E-01	2,5E-01	5,2E-02	5,1E-02	9,4E-02	4,4E-02	6,2E-02	5,9E-02	2,4E-01	1,6E-01	4,5E-02	4,1E-02	5,1E-02	3,7E-02	3,6E-02	4,5E-02	4,5E-02	4,4E-02	3,6E-02	3,8E-02	2,5E-02	4,0E-02	3,0E-02
Béryllium	PM10	1 heure	3,5E-04	1,3E-03	1,7E-02	3,6E-02	3,3E-02	2,6E-04	3,9E-03	4,1E-03	4,7E-03	3,6E-03	1,7E-03	5,7E-03	1,6E-02	5,7E-03	1,6E-03	4,7E-04	4,3E-04	3,1E-04	4,0E-04	4,5E-04	9,0E-04	3,3E-03	1,1E-03	8,2E-04	3,3E-03	1,9E-03
Bore	PM10	1 heure	5,6E-03	1,2E-02	1,5E-01	3,1E-01	2,9E-01	3,7E-03	3,4E-02	3,6E-02	4,1E-02	3,1E-02	1,5E-02	5,0E-02	1,4E-01	5,0E-02	1,4E-02	6,3E-03	3,8E-03	2,7E-03	4,9E-03	4,3E-03	7,9E-03	2,9E-02	9,7E-03	7,1E-03	2,9E-02	1,6E-02
Cadmium	PM10	1 heure	3,3E-05	1,4E-05	1,9E-04	3,4E-04	3,2E-04	3,0E-05	4,2E-05	5,2E-05	4,9E-05	4,3E-05	3,3E-05	1,4E-04	1,4E-04	5,4E-05	2,6E-05	3,3E-05	2,1E-05	2,1E-05	2,9E-05	2,8E-05	2,8E-05	3,6E-05	2,2E-05	1,4E-05	3,3E-05	2,2E-05
Chrome	PM10	1 heure	7,3E-03	4,2E-03	6,0E-02	1,1E-01	1,1E-01	6,2E-03	1,4E-02	1,4E-02	1,6E-02	1,3E-02	6,9E-03	2,9E-02	5,0E-02	1,8E-02	5,8E-03	7,6E-03	4,5E-03	4,5E-03	6,6E-03	6,1E-03	6,3E-03	1,1E-02	5,4E-03	2,8E-03	1,1E-02	6,8E-03
Cobalt	PM10	1 heure	3,9E-03	1,7E-03	1,8E-02	1,8E-02	1,5E-02	4,0E-03	3,7E-03	7,3E-03	2,2E-03	4,8E-03	4,5E-03	1,8E-02	1,2E-02	3,3E-03	3,0E-03	3,8E-03	2,8E-03	2,7E-03	3,4E-03	3,4E-03	3,3E-03	2,3E-03	2,9E-03	1,9E-03	3,0E-03	2,1E-03
Cuivre	PM10	1 heure	2,8E-03	1,2E-03	1,2E-02	2,0E-02	1,9E-02	2,7E-03	2,7E-03	4,8E-03	3,1E-03	3,1E-03	3,0E-03	1,2E-02	8,4E-03	3,2E-03	2,2E-03	2,7E-03	1,9E-03	1,9E-03	2,4E-03	2,4E-03	2,3E-03	2,4E-03	1,9E-03	1,3E-03	2,1E-03	1,7E-03
Étain	PM10	1 heure	3,7E-04	5,7E-04	7,5E-03	1,5E-02	1,4E-02	2,8E-04	1,7E-03	1,8E-03	2,1E-03	1,6E-03	7,3E-04	2,4E-03	6,8E-03	2,5E-03	7,2E-04	4,2E-04	2,5E-04	2,1E-04	3,8E-04	3,0E-04	3,9E-04	1,4E-03	5,5E-04	3,6E-04	1,4E-03	8,4E-04
Lithium	PM10	1 heure	1,9E-02	5,0E-02	6,4E-01	1,3E+00	1,3E+00	1,3E-02	1,5E-01	1,6E-01	1,8E-01	1,4E-01	6,3E-02	2,1E-01	5,9E-01	2,1E-01	6,2E-02	2,4E-02	1,6E-02	1,2E-02	2,3E-02	2,0E-02	3,4E-02	1,2E-01	4,4E-02	3,1E-02	1,2E-01	7,2E-02
Manganèse	PM10	1 heure	1,3E-01	5,6E-02	5,8E-01	5,7E-01	5,0E-01	1,3E-01	1,2E-01	2,3E-01	6,7E-02	1,5E-01	1,5E-01	5,8E-01	3,9E-01	1,0E-01	9,8E-02	1,2E-01	9,2E-02	8,7E-02	1,1E-01	1,1E-01	1,1E-01	7,3E-02	9,2E-02	6,2E-02	9,7E-02	6,7E-02
Mercure	PM10	1 heure	1,8E-06	7,8E-07	8,2E-06	8,1E-06	7,1E-06	1,8E-06	1,7E-06	3,3E-06	9,4E-07	2,2E-06	2,1E-06	8,2E-06	5,5E-06	1,5E-06	1,4E-06	1,7E-06	1,3E-06	1,2E-06	1,5E-06	1,5E-06	1,5E-06	1,0E-06	1,3E-06	8,8E-07	1,4E-06	9,0E-07
Molybdène	PM10	1 heure	2,1E-04	1,8E-04	2,5E-03	5,0E-03	4,7E-03	1,6E-04	5,7E-04	5,9E-04	6,8E-04	5,4E-04	2,4E-04	8,0E-04	2,2E-03	7,9E-04	2,3E-04	2,3E-04	1,3E-04	1,2E-04	2,0E-04	1,7E-04	1,9E-04	4,6E-04	1,9E-04	1,2E-04	4,7E-04	2,8E-04
Nickel	PM10	1 heure	3,9E-03	1,7E-03	1,9E-02	3,2E-02	3,0E-02	3,8E-03	4,2E-03	6,7E-03	4,9E-03	4,4E-03	4,2E-03	1,7E-02	1,4E-02	5,2E-03	3,1E-03	3,8E-03	2,7E-03	2,6E-03	3,4E-03	3,4E-03	3,3E-03	3,7E-03	2,7E-03	1,8E-03	3,2E-03	2,5E-03
Plomb	PM10	1 heure	8,4E-04	3,7E-04	3,6E-03	6,0E-03	5,6E-03	8,1E-04	8,2E-04	1,4E-03	9,2E-04	9,5E-04	9,1E-04	3,7E-03	2,5E-03	9,7E-04	6,6E-04	8,2E-04	5,8E-04	5,6E-04	7,3E-04	7,2E-04	7,1E-04	7,1E-04	5,9E-04	3,9E-04	6,4E-04	5,2E-04
Sélénium	PM10	1 heure	5,7E-05	1,8E-04	2,3E-03	4,9E-03	4,6E-03	3,9E-05	5,4E-04	5,6E-04	6,5E-04	5,0E-04	2,3E-04	7,8E-04	2,2E-03	7,8E-04	2,3E-04	7,3E-05	5,9E-05	4,3E-05	7,1E-05	7,0E-05	1,2E-04	4,5E-04	1,6E-04	1,1E-04	4,5E-04	2,6E-04
Strontium	PM10	1 heure	2,9E-02	1,3E-02	1,3E-01	1,3E-01	1,2E-01	2,9E-02	2,8E-02	5,2E-02	2,2E-02	3,4E-02	3,3E-02	1,3E-01	8,8E-02	2,5E-02	2,3E-02	2,8E-02	2,1E-02	2,0E-02	2,5E-02	2,5E-02	2,4E-02	1,9E-02	2,1E-02	1,4E-02	2,2E-02	1,6E-02
Thallium	PM10	1 heure	4,8E-05	5,6E-05	7,4E-04	1,5E-03	1,4E-03	3,9E-05	1,7E-04	1,8E-04	2,0E-04	1,6E-04	7,2E-05	2,4E-04	6,6E-04	2,4E-04	7,0E-05	5,3E-05	3,2E-05	2,9E-05	4,8E-05	4,0E-05	4,5E-05	1,4E-04	5,7E-05	3,5E-05	1,4E-04	8,4E-05
Titane	PM10	1 heure	1,2E+00	5,2E-01	5,4E+00	5,3E+00	4,7E+00	1,2E+00	1,1E+00	2,2E+00	6,2E-01	1,5E+00	1,4E+00	5,4E+00	3,6E+00	9,7E-01	9,1E-01	1,1E+00	8,6E-01	8,2E-01	1,0E+00	1,0E+00	9,8E-01	6,8E-01	8,6E-01	5,8E-01	9,0E-01	6,1E-01
Uranium	PM10	1 heure	4,9E-05	7,9E-05	1,0E-03	2,1E-03	2,0E-03	3,4E-05	2,4E-04	2,5E-04	2,8E-04	2,2E-04	1,0E-04	3,4E-04	9,3E-04	3,4E-04	9,8E-05	5,7E-05	3,3E-05	2,6E-05	5,1E-05	4,0E-05	5,3E-05	1,9E-04	7,3E-05	4,9E-05	2,0E-04	1,1E-04
Vanadium	PM10	1 heure	2,7E-02	1,2E-02	1,2E-01	1,2E-01	1,1E-01	2,7E-02	2,6E-02	5,0E-02	1,4E-02	3,3E-02	3,1E-02	1,3E-01	8,3E-02	2,3E-02	2,1E-02	2,6E-02	2,0E-02	1,9E-02	2,3E-02	2,4E-02	2,3E-02	1,6E-02	2,0E-02	1,3E-02	2,1E-02	1,4E-02
Zinc	PM10	1 heure	1,3E-02	5,9E-03	6,0E-02	6,6E-02	6,1E-02	1,3E-02	1,3E-02	2,4E-02	1,1E-02	1,6E-02	1,5E-02	6,1E-02	4,1E-02	1,1E-02	1,0E-02	1,3E-02	9,6E-03	9,1E-03	1,2E-02	1,2E-02	1,1E-02	9,0E-03	9,7E-03	6,4E-03	1,0E-02	7,8E-03
CO	-	8 heures	1,1E+01	7,0E+01	7,1E+02	1,5E+03	1,4E+03	1,3E+01	1,6E+02	1,6E+02	2,2E+02	1,4E+02	6,6E+01	2,3E+02	6,0E+02	2,9E+02	7,0E+01	2,1E+01	1,0E+01	1,4E+01	1,3E+01	1,8E+01	3,6E+01	1,7E+02	4,2E+01	3,3E+01	1,4E+02	1,1E+02
SO2	-	8 heures	3,3E-02	1,2E-01	1,3E+00	2,7E+00	2,5E+00	2,6E-02	3,1E-01	3,1E-01	4,0E-01	2,5E-01	1,2E-01	4,1E-01	1,1E+00	5,2E-01	1,3E-01	3,8E-02	3,0E-02	2,6E-02	3,4E-02	4,5E-02	6,4E-02	3,1E-01	7,8E-02	6,0E-02	2,6E-01	1,9E-01
Aluminium	PM10	8 heures	1,1E+00	4,5E-01	6,5E+00	6,5E+00	5,7E+00	1,5E+00	1,7E+00	2,0E+00	8,4E-01	2,4E+00	2,0E+00	5,1E+00	8,2E+00	1,8E+00	1,4E+00	1,1E+00	1,2E+00	1,2E+00	9,5E-01	9,6E-01	1,3E+00	7,0E-01	9,9E-01	7,5E-01	1,2E+00	6,1E-01
Antimoine	PM10	8 heures	7,1E-06	2,9E-06	4,0E-05	5,5E-05	5,2E-05	9,7E-06	1,3E-05	1,3E-05	7,9E-06	1,5E-05	1,2E-05	3,2E-05	5,1E-05	1,3E-05	9,1E-06	7,0E-06	7,4E-06	7,4E-06	6,1E-06	6,3E-06	8,7E-06	6,6E-06	6,6E-06	4,7E-06	9,2E-06	5,1E-06
Argent	PM10	8 heures	9,2E-06	3,8E-06	5,5E-05	8,0E-05	7,5E-05	1,3E-05	1,8E-05	1,7E-05	1,1E-05	1,8E-05	1,6E-05	4,1E-05	6,6E-05	1,9E-05	1,2E-05	9,0E-06	9,4E-06	9,5E-06	7,9E-06	8,2E-06	1,1E-05	9,5E-06	8,6E-06	6,0E-06	1,3E-05	7,1E-06
Arsenic	PM10	8 heures	2,4E-04	2,0E-04	2,7E-03	5,2E-03	4,9E-03	3,2E-04	7,9E-04	6,7E-04	7,2E-04	4,9E-04	3,4E-04	9,8E-04	2,1E-03	1,1E-03	6,6E-04	2,1E-04	2,2E-04	2,2E-04	1,9E-04	2,3E-04	3,0E-04	5,8E-04	2,7E-04	1,4E-04	5,9E-04	3,7E-04
Baryum	PM10	8 heures	1,1E-02	4,5E-03	6,5E-02	6,5E-02	5,7E-02	1,5E-02	1,6E-02	1,9E-02	7,6E-03	2,5E-02	2,0E-02	5,0E-02	8,1E-02	1,8E-02	1,4E-02	1,1E-02	1,2E-02	1,2E-02	9,3E-03	9,3E-03	1,3E-02	6,4E-03	9,8E-03	7,5E-03	1,1E-02	5,7E-03
Béryllium	PM10	8 heures	1,1E-04	1,9E-04	2,4E-03	5,1E-03	4,8E-03	8,5E-05	5,9E-04	5,6E-04	7,1E-04	4,6E-04	2,2E-04	7,4E-04	2,1E-03	1,0E-03	2,1E-04	1,2E-04	9,3E-05	8,1E-05	1,1E-04	1,2E-04	1,5E-04	5,7E-04	1,7E-04	1,0E-04	4,6E-04	3,4E-04
Bore	PM10	8 heures	9,9E-04	1,7E-03	2,2E-02	4,5E-02	4,2E-02	1,4E-03	5,7E-03	4,8E-03	6,2E-03	4,2E-03	1,9E-03	6,5E-03	1,8E-02	8,8E-03	5,8E-03	1,0E-03	7,8E-04	7,3E-04	7,6E-04	1,1E-03	1,3E-03	5,0E-03	1,5E-03	9,1E-04	4,4E-03	2,9E-03
Cadmium	PM10	8 heures	6,7E-06	2,8E-06	3,9E-05	5,5E-05	5,1E-05	9,2E-06	1,3E-05	1,2E-05	7,8E-06	1,4E-05	1,2E-05	3,0E-05	4,8E-05	1,3E-05	8,6E-06	6,6E-06	6,9E-06	7,0E-06	5,8E-06	6,0E-06	8,2E-06	6,5E-06	6,2E-06	4,4E-06	8,8E-06	4,9E-06
Chrome	PM10	8 heures	1,5E-03	6,5E-04	1,0E-02	1,8E-02	1,7E-02	2,0E-03	3,4E-03	2,9E-03	2,5E-03	2,8E-03	2,4E-03	6,4E-03	1,0E-02	3,9E-03	2,1E-03	1,4E-03	1,5E-03	1,5E-03	1,2E-03	1,3E-03	1,8E-03	2,0E-03	1,5E-03	9,3E-04	2,4E-03	1,4E-03
Cobalt	PM10	8 heures	8,0E-04	3,3E-04	5,1E-03	5,0E-03	4,4E-03	1,1E-03	1,1E-03	1,4E-03	5,2E-04	1,9E-03	1,5E-03	3,8E-03	6,2E-03	1,4E-03	1,1E-03	8,0E-04	9,1E-04	9,2E-04	7,0E-04	7,0E-04	9,8E-04	4,1E-04	7,2E-04	5,7E-04	7,3E-04	3,5E-04
Cuivre	PM10	8 heures	5,6E-04	2,3E-04	3,3E-03	3,4E-03	3,2E-03	7,8E-04	9,3E-04	1,0E-03	5,1E-04	1,3E-03	1,0E-03	2,6E-03	4,2E-03	9,1E-04	7,5E-04	5,5E-04	6,2E-04	6,2E-04	4,8E-04	4,9E-04	6,9E-04	4,2E-04	5,3E-04	3,9E-04	6,5E-04	3,5E-04
Étain	PM10	8 heures	9,1E-05	8,5E-05	1,1E-03	2,3E-03	2,1E-03	1,0E-04	3,1E-04	2,8E-04	3,1E-04	2,1E-04	1,2E-04	4,2E-04	9,3E-04	4,6E-04	1,3E-04	9,1E-05	8,4E-05	8,0E-05	8,3E-05	8,8E-05	1,2E-04	2,5E-04	1,1E-04	4,7E-05	2,3E-04	1,6E-04
Lithium	PM10	8 heures	5,6E-03	7,3E-03	9,4E-02	1,9E-01	1,8E-01	5,7E-03	2,4E-02	2,2E-02	2,7E-02	1,8E-02	8,4E-03	2,8E-02	8,0E-02	3,8E-02	9,2E-03	5,7E-03	4,9E-03	4,5E-03	5,4E-03	5,7E-03	7,4E-03	2,2E-02	7,6E-03	3,9E-03	1,9E-02	1,3E-02
Manganèse	PM10	8 heures	2,6E-02	1,1E-02	1,6E-01	1,6E-01	1,4E-01	3,6E-02	3,4E-02	4,6E-02	1,7E-02	6,2E-02	5,0E-02	1,2E-01	2,0E-01	4,4E-02	3,5E-02	2,6E-02	2,9E-02	2,9E-02	2,3E-02	2,2E-02	3,1E-02	1,3E-02	2,3E-02	1,8E-02	2,3E-02	1,1E-02
Mercure	PM10	8 heures	3,6E-07	1,5E-07	2,3E-06	2,3E-06	2,0E-06	5,0E-07	4,5E-07	6,5E-07	2,4E-07	8,8E-07	7,0E-07	1,7E-06	2,8E-06	6,2E-07	4,9E-07	3,6E-07	4,1E-07	4,2E-07	3,2E-07	3,1E-07	4,4E-07	1,8E-07	3,2E-07	2,6E-07	3,2E-07	1,4E-07
Molybdène	PM10	8 heures	4,3E-05	2,8E-05	3,9E-04	7,5E-04	7,0E-04	5,8E-05	1,2E-04	1,0E-04	1,0E-04	7,8E-05	6,1E-05	1,9E-04	3,1E-04	1,5E-04	9,2E-05	4,0E-05	3,8E-05	3,8E-05	3,6E-05	4,0E-05	5,3E-05	8,4E-05	4,4E-05	2,4E-05	8,9E-05	5,4E-05
Nickel	PM10	8 heures	7,9E-04	3,3E-04	4,6E-03	5,4E-03	5,0E-03	1,1E-03	1,4E-03	1,4E-03	7,9E-04	1,8E-03	1,5E-03	3,6E-03	5,9E-03	1,4E-03	1,1E-03	7,7E-04	8,8E-04	8,8E-04	6,8E-04	7,0E-04	9,8E-04	6,6E-04	7,5E-04	5,5E-04	9,7E-04	5,3E-04
Plomb	PM10	8 heures	1,7E-04	7,1E-05	1,0E-03	1,0E-03	9,5E-04	2,4E-04	2,8E-04	3,1E-04	1,5E-04	3,8E-04	3,2E-04	7,9E-04	1,3E-03	2,8E-04	2,3E-04	1,7E-04	1,9E-04	1,9E-04	1,5E-04	1,5E-04	2,1E-04	1,3E-04	1,6E-04	1,2E-04	2,0E-04	1,0E-04
Sélénium	PM10	8 heures	1,9E-05	2,7E-05	3,4E-04	7,0E-04	6,6E-04	1,7E-05	8,6E-05	8,0E-05	9,8E-05	6,4E-05	3,0E-05	1,0E-04	2,9E-04	1,4E-04	3,0E-05	1,9E-05	1,6E-05	1,5E-05	1,8E-05	1,9E-05	2,5E-05	7,9E-05	2,6E-05	1,4E-05	6,5E-05	4,8E-05
Strontium	PM10	8 heures	5,9E-03	2,5E-03	3,6E-02	3,6E-02	3,2E-02	8,2E-03	8,6E-03	1,1E-02	3,9E-03	1,4E-02	1,1E-02	2,8E-02	4,5E-02	9,8E-03	7,9E-03	5,8E-03	6,6E-03	6,7E-03	5,1E-03	5,2E-03	7,2E-03	3,3E-03	5,4E-03	4,2E-03	5,9E-03	3,0E-03
Titane	PM10	8 heures	2,4E-01	1,0E-01	1,5E+00	1,5E+00	1,3E+00	3,3E-01	3,1E-01	4,3E-01	1,6E-01	5,8E-01	4,7E-01	1,1E+00	1,9E+00	4,1E-01	3,2E-01	2,4E-01	2,7E-01	2,8E-01	2,1E-01	2,1E-01	2,9E-01	1,2E-01	2,1E-01	1,7E-01	2,1E-01	9,7E-02
Uranium	PM10	8 heures	1,2E-05	1,2E-05	1,5E-04	3,1E-04	2,9E-04	1,4E-05	4,2E-05	3,7E-05	4,3E-05	2,9E-05	1,4E-05	5,7E-05	1,3E-04	6,2E-05	2,3E-05	1,1E-05	9,8E-06	9,4E-06	1,0E-05	1,1E-05	1,5E-05	3,4E-05	1,4E-05	6,3E-06	3,2E-05	2,1E-05
Vanadium	PM10	8 heures	5,5E-03	2,3E-03	3,5E-02	3,5E-02	3,0E-02	7,7E-03	7,3E-03	9,9E-03	3,6E-03	1,3E-02	1,1E-02	2,6E-02	4,3E-02	9,4E-03	7,5E-03	5,5E-03	6,3E-03	6,3E-03	4,8E-03	4,8E-03	6,8E-03	2,8E-03	4,9E-03	4,0E-03	4,9E-03	2,3E-03
Zinc	PM10	8 heures	2,8E-03	1,1E-03	1,7E-02	1,7E-02	1,5E-02	3,8E-03	4,1E-03	4,9E-03	1,9E-03	6,4E-03	5,2E-03	1,3E-02	2,1E-02	4,6E-03	3,6E-03	2,8E-03	3,1E-03	3,1E-03	2,4E-03	2,4E-03	3,4E-03	1,6E-03	2,5E-03	1,9E-03	2,8E-03	1,4E-03

TABLEAU E-1 Concentrations additionnelles dans l'air ambiant de la zone d'étude estimées par modélisation de la dispersion atmosphérique (WSP, 2018)

Substances	Taille des particules	Période	Concentration additionnelle estimée dans l'air ambiant (µg/m3)																									
			Récepteur le plus exposé	TRP1	CHS1	CHS2	CHS3	CHS4	CCT1	CHS5	PCH1	PCH2	PCH3	PCH4	PCH5	AVL1	CRI1	CRI2	CRI3	CRI4	CRI5	CHS6	AQU1	AQU2	AQU3	AQU4	AQU5
SO2	-	24hr	8,1E-01	2,5E-02	1,8E-01	3,8E-02	1,3E-02	1,1E-02	6,4E-03	4,5E-02	3,1E-02	2,1E-02	6,9E-03	2,5E-02	4,3E-02	2,2E-02	8,5E-02	1,4E-01	1,3E-02	2,9E-02	4,7E-02	1,6E-02	7,6E-02	5,7E-02	1,4E-01	1,4E-01	1,4E-01
PM2.5	-	24hr	8,8E+00	3,1E+00	5,2E+00	1,8E+00	1,3E+00	1,0E+00	9,6E-01	2,8E+00	7,4E-01	1,0E+00	3,9E-01	5,2E-01	4,8E-01	2,1E+00	1,1E+00	6,4E-01	6,0E-01	6,9E-01	1,8E+00	7,8E-01	3,1E+00	3,2E+00	4,0E+00	4,9E+00	6,5E-01
Aluminium	PM10	24hr	3,7E+00	1,3E+00	2,2E+00	7,6E-01	5,6E-01	4,3E-01	3,9E-01	1,1E+00	3,0E-01	4,1E-01	1,5E-01	2,2E-01	2,2E-01	9,2E-01	4,7E-01	2,5E-01	2,3E-01	2,8E-01	7,3E-01	2,5E-01	1,3E+00	1,4E+00	1,8E+00	2,3E+00	2,5E-01
Antimoine	PM10	24hr	2,4E-05	8,1E-06	1,4E-05	4,8E-06	3,5E-06	2,7E-06	2,5E-06	7,4E-06	2,1E-06	2,7E-06	9,2E-07	1,4E-06	1,6E-06	5,8E-06	3,5E-06	2,5E-06	1,5E-06	1,8E-06	4,7E-06	1,6E-06	8,1E-06	8,7E-06	1,1E-05	1,4E-05	2,5E-06
Argent	PM10	24hr	3,0E-05	1,0E-05	1,7E-05	6,2E-06	4,4E-06	3,5E-06	3,2E-06	9,6E-06	2,8E-06	3,5E-06	1,2E-06	1,8E-06	2,2E-06	7,4E-06	4,8E-06	3,7E-06	1,9E-06	2,3E-06	6,1E-06	2,0E-06	1,0E-05	1,1E-05	1,4E-05	1,8E-05	3,6E-06
Arsenic	PM10	24hr	1,6E-03	2,5E-04	4,6E-04	1,5E-04	9,7E-05	1,0E-04	7,8E-05	2,4E-04	9,9E-05	1,0E-04	2,6E-05	7,1E-05	9,2E-05	2,8E-04	2,1E-04	2,5E-04	4,9E-05	6,0E-05	1,4E-04	5,1E-05	3,5E-04	7,4E-04	4,2E-04	4,0E-04	2,4E-04
Baryum	PM10	24hr	3,6E-02	1,2E-02	2,1E-02	7,5E-03	5,5E-03	4,3E-03	3,9E-03	1,1E-02	2,9E-03	4,0E-03	1,4E-03	2,2E-03	2,1E-03	9,1E-03	4,5E-03	2,4E-03	2,3E-03	2,7E-03	7,1E-03	2,4E-03	1,3E-02	1,4E-02	1,8E-02	2,3E-02	2,5E-03
Béryllium	PM10	24hr	1,6E-03	8,2E-05	3,6E-04	8,2E-05	3,5E-05	3,4E-05	1,8E-05	1,0E-04	5,7E-05	5,4E-05	1,5E-05	4,3E-05	7,9E-05	5,8E-05	1,5E-04	2,4E-04	2,1E-05	5,1E-05	8,9E-05	2,9E-05	1,6E-04	2,5E-04	2,7E-04	2,7E-04	2,4E-04
Bore	PM10	24hr	1,4E-02	1,0E-03	3,1E-03	7,8E-04	6,2E-04	8,6E-04	3,1E-04	2,0E-03	6,2E-04	5,0E-04	1,1E-04	6,0E-04	6,5E-04	2,5E-03	1,5E-03	2,1E-03	2,7E-04	4,4E-04	7,7E-04	2,5E-04	3,0E-03	6,5E-03	3,5E-03	3,0E-03	2,1E-03
Cadmium	PM10	24hr	2,2E-05	7,6E-06	1,3E-05	4,6E-06	3,3E-06	2,6E-06	2,3E-06	7,0E-06	2,0E-06	2,5E-06	8,6E-07	1,3E-06	1,6E-06	5,4E-06	3,4E-06	2,5E-06	1,4E-06	1,7E-06	4,4E-06	1,5E-06	7,7E-06	8,2E-06	1,0E-05	1,3E-05	2,4E-06
Chrome	PM10	24hr	5,5E-03	1,6E-03	2,7E-03	9,9E-04	6,8E-04	5,4E-04	5,1E-04	1,5E-03	4,9E-04	5,8E-04	1,8E-04	2,8E-04	4,1E-04	1,2E-03	9,0E-04	8,2E-04	3,1E-04	3,7E-04	9,5E-04	3,2E-04	1,7E-03	2,4E-03	2,2E-03	2,7E-03	8,0E-04
Cobalt	PM10	24hr	2,7E-03	9,4E-04	1,6E-03	5,6E-04	4,2E-04	3,2E-04	2,9E-04	8,3E-04	2,1E-04	3,0E-04	1,1E-04	1,7E-04	1,5E-04	6,9E-04	3,0E-04	1,8E-04	1,7E-04	2,1E-04	5,4E-04	1,8E-04	9,5E-04	1,0E-03	1,4E-03	1,7E-03	1,9E-04
Cuivre	PM10	24hr	1,9E-03	6,5E-04	1,1E-03	3,9E-04	2,9E-04	2,2E-04	2,0E-04	5,8E-04	1,6E-04	2,1E-04	7,4E-05	1,2E-04	1,2E-04	4,7E-04	2,6E-04	1,6E-04	1,2E-04	1,4E-04	3,7E-04	1,3E-04	6,7E-04	7,3E-04	9,4E-04	1,2E-03	1,5E-04
Étain	PM10	24hr	6,9E-04	8,8E-05	1,9E-04	6,0E-05	3,7E-05	3,1E-05	2,5E-05	9,1E-05	3,6E-05	3,9E-05	1,2E-05	2,0E-05	4,0E-05	6,2E-05	8,2E-05	1,1E-04	1,6E-05	2,4E-05	5,6E-05	1,7E-05	9,1E-05	1,4E-04	1,4E-04	1,4E-04	1,0E-04
Lithium	PM10	24hr	5,9E-02	4,9E-03	1,5E-02	3,8E-03	2,0E-03	1,8E-03	1,3E-03	5,5E-03	2,6E-03	2,6E-03	7,2E-04	1,7E-03	3,1E-03	3,5E-03	6,4E-03	9,2E-03	9,3E-04	2,0E-03	3,5E-03	1,1E-03	6,7E-03	1,1E-02	1,1E-02	1,1E-02	8,9E-03
Manganèse	PM10	24hr	8,7E-02	3,0E-02	5,2E-02	1,8E-02	1,4E-02	1,0E-02	9,4E-03	2,7E-02	6,7E-03	9,5E-03	3,6E-03	5,5E-03	4,8E-03	2,2E-02	9,6E-03	5,8E-03	5,5E-03	6,6E-03	1,7E-02	5,9E-03	3,0E-02	3,4E-02	4,5E-02	5,6E-02	6,0E-03
Mercure	PM10	24hr	1,2E-06	4,3E-07	7,3E-07	2,6E-07	1,9E-07	1,5E-07	1,3E-07	3,8E-07	9,4E-08	1,3E-07	5,0E-08	7,7E-08	6,7E-08	3,1E-07	1,3E-07	8,2E-08	7,8E-08	9,3E-08	2,5E-07	8,3E-08	4,3E-07	4,7E-07	6,5E-07	8,0E-07	8,4E-08
Molybdène	PM10	24hr	2,3E-04	4,5E-05	7,5E-05	2,8E-05	1,8E-05	1,5E-05	1,4E-05	4,4E-05	1,6E-05	1,7E-05	4,8E-06	1,0E-05	1,4E-05	4,0E-05	3,2E-05	3,5E-05	8,6E-06	1,1E-05	2,7E-05	9,1E-06	5,0E-05	1,0E-04	6,0E-05	7,1E-05	3,4E-05
Nickel	PM10	24hr	2,7E-03	9,2E-04	1,6E-03	5,5E-04	4,0E-04	3,1E-04	2,9E-04	8,2E-04	2,3E-04	3,0E-04	1,0E-04	1,6E-04	1,7E-04	6,7E-04	3,8E-04	2,5E-04	1,7E-04	2,0E-04	5,3E-04	1,8E-04	9,5E-04	1,0E-03	1,3E-03	1,6E-03	2,4E-04
Plomb	PM10	24hr	5,7E-04	2,0E-04	3,4E-04	1,2E-04	8,7E-05	6,7E-05	6,1E-05	1,8E-04	4,8E-05	6,4E-05	2,2E-05	3,5E-05	3,6E-05	1,4E-04	7,8E-05	4,7E-05	3,6E-05	4,4E-05	1,1E-04	3,9E-05	2,0E-04	2,2E-04	2,9E-04	3,5E-04	4,5E-05
Sélénium	PM10	24hr	2,2E-04	1,5E-05	5,2E-05	1,3E-05	6,4E-06	6,0E-06	3,9E-06	1,8E-05	8,7E-06	8,7E-06	2,5E-06	6,1E-06	1,1E-05	1,1E-05	2,2E-05	3,3E-05	3,2E-06	7,2E-06	1,3E-05	4,0E-06	2,4E-05	3,6E-05	3,8E-05	3,8E-05	3,3E-05
Strontium	PM10	24hr	2,0E-02	6,9E-03	1,2E-02	4,1E-03	3,1E-03	2,4E-03	2,1E-03	6,1E-03	1,6E-03	2,2E-03	8,0E-04	1,2E-03	1,1E-03	5,0E-03	2,4E-03	1,3E-03	1,3E-03	1,5E-03	4,0E-03	1,4E-03	7,0E-03	7,7E-03	1,0E-02	1,3E-02	1,4E-03
Titane	PM10	24hr	8,1E-01	2,8E-01	4,9E-01	1,7E-01	1,3E-01	9,8E-02	8,8E-02	2,5E-01	6,2E-02	8,8E-02	3,3E-02	5,1E-02	4,4E-02	2,1E-01	8,7E-02	5,4E-02	5,2E-02	6,2E-02	1,6E-01	5,5E-02	2,8E-01	3,1E-01	4,3E-01	5,3E-01	5,6E-02
Uranium	PM10	24hr	9,5E-05	1,1E-05	2,5E-05	7,2E-06	4,4E-06	3,8E-06	3,2E-06	1,2E-05	4,8E-06	5,0E-06	1,4E-06	2,8E-06	5,2E-06	9,6E-06	1,1E-05	1,5E-05	2,1E-06	3,2E-06	7,0E-06	2,2E-06	1,2E-05	2,5E-05	2,0E-05	1,9E-05	1,4E-05
Vanadium	PM10	24hr	1,9E-02	6,5E-03	1,1E-02	3,9E-03	2,9E-03	2,2E-03	2,0E-03	5,7E-03	1,4E-03	2,0E-03	7,6E-04	1,2E-03	1,0E-03	4,8E-03	2,0E-03	1,2E-03	1,2E-03	1,4E-03	3,7E-03	1,3E-03	6,5E-03	7,3E-03	9,8E-03	1,2E-02	1,3E-03
Zinc	PM10	24hr	9,4E-03	3,2E-03	5,5E-03	1,9E-03	1,4E-03	1,1E-03	9,9E-04	2,9E-03	7,4E-04	1,0E-03	3,8E-04	5,8E-04	5,4E-04	2,3E-03	1,1E-03	6,2E-04	5,9E-04	7,1E-04	1,9E-03	6,3E-04	3,2E-03	3,5E-03	4,7E-03	5,9E-03	6,4E-04
NO2	-	2 semaines	1,8E+01	1,3E+00	3,9E+00	9,5E-01	5,1E-01	3,5E-01	2,7E-01	2,0E+00	6,7E-01	6,1E-01	2,0E-01	4,5E-01	5,7E-01	1,6E+00	1,3E+00	1,5E+00	4,4E-01	5,8E-01	9,4E-01	5,2E-01	2,2E+00	2,6E+00	3,4E+00	4,2E+00	1,5E+00
SO2	-	2 semaines	1,1E-01	3,7E-03	1,8E-02	2,9E-03	1,3E-03	1,1E-03	5,7E-04	6,9E-03	2,8E-03	2,0E-03	9,5E-04	2,0E-03	3,2E-03	5,8E-03	6,8E-03	1,0E-02	2,3E-03	3,1E-03	4,6E-03	2,7E-03	7,7E-03	6,9E-03	1,4E-02	1,2E-02	1,0E-02
PM2.5	-	2 semaines	2,0E+00	3,5E-01	7,9E-01	2,4E-01	1,4E-01	9,6E-02	7,7E-02	5,4E-01	1,6E-01	1,4E-01	4,8E-02	9,6E-02	6,4E-02	3,9E-01	2,1E-01	8,4E-02	1,0E-01	1,2E-01	2,6E-01	8,2E-02	5,7E-01	6,6E-01	8,5E-01	1,0E+00	9,3E-02
Aluminium	PM10	2 semaines	8,5E-01	1,5E-01	3,2E-01	9,7E-02	5,7E-02	3,9E-02	3,1E-02	2,2E-01	6,4E-02	5,3E-02	1,7E-02	3,6E-02	2,5E-02	1,5E-01	8,5E-02	3,0E-02	3,8E-02	4,6E-02	1,0E-01	2,9E-02	2,3E-01	2,8E-01	3,6E-01	4,5E-01	3,4E-02
Antimoine	PM10	2 semaines	5,6E-06	9,2E-07	2,0E-06	6,1E-07	3,5E-07	2,5E-07	2,0E-07	1,4E-06	4,1E-07	3,4E-07	1,1E-07	2,5E-07	1,6E-07	9,8E-07	5,4E-07	2,5E-07	2,4E-07	3,0E-07	6,4E-07	2,0E-07	1,5E-06	1,7E-06	2,5E-06	2,9E-06	2,5E-07
Argent	PM10	2 semaines	7,3E-06	1,2E-06	2,6E-06	7,7E-07	4,5E-07	3,2E-07	2,5E-07	1,8E-06	5,2E-07	4,3E-07	1,5E-07	3,3E-07	2,2E-07	1,3E-06	6,9E-07	3,5E-07	3,1E-07	3,8E-07	8,3E-07	2,6E-07	1,9E-06	2,3E-06	3,3E-06	3,8E-06	3,5E-07
Arsenic	PM10	2 semaines	2,4E-04	2,9E-05	6,0E-05	1,8E-05	1,2E-05	8,5E-06	5,9E-06	6,3E-05	1,2E-05	1,2E-05	3,9E-06	1,0E-05	6,9E-06	5,1E-05	2,1E-05	1,7E-05	8,1E-06	1,0E-05	2,2E-05	7,5E-06	6,0E-05	9,8E-05	1,0E-04	9,7E-05	1,6E-05
Baryum	PM10	2 semaines	8,3E-03	1,5E-03	3,2E-03	9,6E-04	5,6E-04	3,9E-04	3,0E-04	2,1E-03	6,3E-04	5,3E-04	1,7E-04	3,4E-04	2,4E-04	1,5E-03	8,4E-04	2,9E-04	3,8E-04	4,4E-04	1,0E-03	2,8E-04	2,3E-03	2,8E-03	3,6E-03	4,4E-03	3,3E-04
Béryllium	PM10	2 semaines	5,4E-05	7,0E-06	1,5E-05	6,1E-06	2,4E-06	1,7E-06	1,3E-06	1,2E-05	2,8E-06	2,8E-06	9,5E-07	1,7E-06	1,5E-06	5,8E-06	4,2E-06	3,2E-06	1,7E-06	2,2E-06	5,7E-06	1,6E-06	7,0E-06	9,5E-06	1,4E-05	1,6E-05	3,2E-06
Bore	PM10	2 semaines	1,6E-03	1,6E-04	2,9E-04	8,3E-05	6,9E-05	5,9E-05	2,1E-05	4,1E-04	6,9E-05	6,2E-05	1,8E-05	5,9E-05	4,0E-05	3,6E-04	1,3E-04	1,2E-04	5,6E-05	6,0E-05	1,0E-04	4,4E-05	4,0E-04	7,1E-04	6,0E-04	4,9E-04	1,2E-04
Cadmium	PM10	2 semaines	5,3E-06	8,7E-07	1,9E-06	5,7E-07	3,3E-07	2,3E-07	1,8E-07	1,3E-06	3,8E-07	3,2E-07	1,1E-07	2,3E-07	1,6E-07	9,2E-07	5,0E-07	2,4E-07	2,3E-07	2,8E-07	6,1E-07	1,9E-07	1,4E-06	1,7E-06	2,4E-06	2,7E-06	2,4E-07
Chrome	PM10	2 semaines	1,1E-03	1,8E-04	4,0E-04	1,2E-04	6,7E-05	4,7E-05	3,8E-05	2,8E-04	7,8E-05	6,7E-05	2,3E-05	5,2E-05	3,4E-05	2,1E-04	1,0E-04	6,0E-05	4,8E-05	5,9E-05	1,3E-04	4,0E-05	2,8E-04	3,9E-04	5,2E-04	5,8E-04	6,0E-05
Cobalt	PM10	2 semaines	6,2E-04	1,1E-04	2,4E-04	7,4E-05	4,3E-05	2,9E-05	2,3E-05	1,6E-04	4,8E-05	4,0E-05	1,3E-05	2,5E-05	1,8E-05	1,1E-04	6,4E-05	2,2E-05	2,8E-05	3,3E-05	7,7E-05	2,0E-05	1,8E-04	2,1E-04	2,7E-04	3,3E-04	2,4E-05
Cuivre	PM10	2 semaines	4,3E-04	7,5E-05	1,7E-04	5,0E-05	2,9E-05	2,0E-05	1,6E-05	1,1E-04	3,3E-05	2,7E-05	8,9E-06	1,9E-05	1,3E-05	7,9E-05	4,3E-05	1,6E-05	2,0E-05	2,3E-05	5,2E-05	1,5E-05	1,2E-04	1,4E-04	1,9E-04	2,3E-04	1,8E-05
Étain	PM10	2 semaines	6,2E-05	9,2E-06	2,0E-05	6,3E-06	3,4E-06	2,4E-06	1,9E-06	1,5E-05	4,0E-06	3,7E-06	1,1E-06	2,7E-06	1,9E-06	1,1E-05	5,4E-06	3,7E-06	2,4E-06	3,1E-06	7,0E-06	2,1E-06	1,3E-05	1,9E-05	2,6E-05	2,8E-05	3,7E-06
Lithium	PM10	2 semaines	3,7E-03	4,8E-04	1,0E-03	3,5E-04	1,7E-04	1,2E-04	9,7E-05	8,2E-04	2,0E-04	2,0E-04	5,8E-05	1,4E-04	1,1E-04	5,8E-04	3,1E-04	2,3E-04	1,2E-04	1,6E-04	3,9E-04	1,1E-04	6,6E-04	1,0E-03	1,3E-03	1,4E-03	2,3E-04
Manganèse	PM10	2 semaines	2,0E-02	3,6E-03	7,8E-03	2,4E-03	1,4E-03	9,5E-04	7,4E-04	5,2E-03	1,6E-03	1,3E-03	4,1E-04	7,9E-04	5,8E-04	3,7E-03	2,1E-03	6,9E-04	9,1E-04	1,1E-03	2,5E-03	6,6E-04	5,6E-03	6,9E-03	8,8E-03	1,1E-02	7,7E-04
Mercure	PM10	2 semaines	2,8E-07	5,0E-08	1,1E-07	3,4E-08	1,9E-08	1,3E-08	1,0E-08	7,3E-08	2,2E-08	1,8E-08	5,8E-09	1,1E-08	8,2E-09	5,2E-08	2,9E-08	9,6E-09	1,3E-08	1,5E-08	3,5E-08	9,1E-09	7,9E-08	9,7E-08	1,2E-07	1,5E-07	1,1E-08
Molybdène	PM10	2 semaines	2,7E-05	4,2E-06	9,3E-06	2,7E-06	1,6E-06	1,1E-06	8,9E-07	6,8E-06	1,8E-06	1,6E-06	5,3E-07	1,2E-06	8,4E-07	4,9E-06	2,4E-06	1,6E-06	1,1E-06	1,4E-06	3,1E-06	9,6E-07	6,4E-06	9,1E-06	1,2E-05	1,3E-05	1,6E-06
Nickel	PM10	2 semaines	6,2E-04	1,1E-04	2,3E-04	7,0E-05	4,1E-05	2,8E-05	2,2E-05	1,6E-04	4,6E-05	3,9E-05	1,3E-05	2,7E-05	1,8E-05	1,1E-04	6,1E-05	2,4E-05	2,8E-05	3,3E-05	7,4E-05	2,2E-05	1,7E-04	2,0E-04	2,7E-04	3,3E-04	2,5E-05
Plomb	PM10	2 semaines	1,3E-04	2,3E-05	5,1E-05	1,5E-05	8,8E-06	6,1E-06	4,8E-06	3,4E-05	1,0E-05	8,3E-06	2,7E-06	5,7E-06	3,9E-06	2,4E-05	1,3E-05	4,8E-06	6,0E-06	7,1E-06	1,6E-05	4,6E-06	3,7E-05	4,4E-05	5,8E-05	7,1E-05	5,4E-06
Sélénium	PM10	2 semaines	1,0E-05	1,4E-06	3,1E-06	1,1E-06	5,1E-07	3,7E-07	2,8E-07	2,4E-06	6,0E-07	5,6E-07	1,8E-07	3,7E-07	2,9E-07	1,3E-06	8,2E-07	5,8E-07	3,6E-07	4,7E-07	1,1E-06	3,0E-07	1,7E-06	2,2E-06	3,4E-06	3,8E-06	5,7E-07
Strontium	PM10	2 semaines	4,5E-03	8,0E-04	1,8E-03	5,3E-04	3,1E-04	2,1E-04	1,7E-04	1,2E-03	3,5E-04	2,9E-04	9,3E-05	1,9E-04	1,3E-04	8,3E-04	4,6E-04	1,6E-04	2,1E-04	2,4E-04	5,6E-04	1,5E-04	1,3E-03	1,5E-03	2,0E-03	2,4E-03	1,8E-04
Titane	PM10	2 semaines	1,8E-01	3,3E-02	7,3E-02	2,2E-02	1,3E-02	8,8E-03	6,9E-03	4,9E-02	1,5E-02	1,2E-02	3,8E-03	7,3E-03	5,4E-03	3,4E-02	1,9E-02	6,4E-03	8,5E-03	9,9E-03	2,3E-02	6,1E-03	5,3E-02	6,4E-02	8,3E-02	9,9E-02	7,1E-03
Uranium	PM10	2 semaines	9,8E-06	1,1E-06	2,5E-06	7,8E-07	4,7E-07	3,1E-07	2,4E-07	2,4E-06	5,0E-07	5,1E-07	1,5E-07	4,0E-07	2,8E-07	1,8E-06	8,3E-07	6,5E-07	3,1E-07	4,1E-07	9,6E-07	3,0E-07	2,1E-06	3,3E-06	3,9E-06	3,7E-06	6,4E-07
Vanadium	PM10	2 semaines	4,3E-03	7,7E-04	1,7E-03	5,1E-04	3,0E-04	2,0E-04	1,6E-04	1,1E-03	3,3E-04	2,8E-04	8,8E-05	1,7E-04	1,3E-04	7,9E-04	4,4E-04	1,5E-04	2,0E-04	2,3E-04	5,3E-04	1,4E-04	1,2E-03	1,5E-03	1,9E-03	2,3E-03	1,7E-04
Zinc	PM10	2 semaines	2,1E-03	3,8E-04	8,2E-04	2,5E-04	1,4E-04	9,9E-05	7,8E-05	5,5E-04	1,6E-04	1,3E-04	4,3E-05	8,5E-05	6,2E-05	3,9E-04	2,2E-04	7,4E-05	9,6E-05	1,1E-04	2,6E-04	7,0E-05	5,9E-04	7,2E-04	9,3E-04	1,1E-03	8,2E-05

TABLEAU E-1 Concentrations additionnelles dans l'air ambiant de la zone d'étude estimées par modélisation de la dispersion atmosphérique (WSP, 2018)

Substances	Taille des particules	Période	Concentration additionnelle estimée dans l'air ambiant (µg/m3)																									
			AQU6	AQU7	EAU1	EAU2	REL1	RIV1	TRP2	TRP3	TRP4	TRP5	TRP6	TRC1	MOT1	MOT2	MOT3	MOT4	MOT5	MOT6	MOT7	MOT8	AQU8	AQU9	EAU3	EAU4	EAU5	EAU6
SO2	-	24hr	9,3E-03	3,8E-02	3,9E-01	8,1E-01	7,6E-01	7,6E-03	1,1E-01	1,1E-01	1,2E-01	9,4E-02	4,4E-02	1,4E-01	3,7E-01	1,4E-01	4,3E-02	1,3E-02	1,1E-02	8,8E-03	9,5E-03	1,2E-02	2,2E-02	8,5E-02	2,7E-02	2,2E-02	8,7E-02	5,3E-02
PM2.5	-	24hr	7,7E-01	4,8E-01	7,1E+00	7,6E+00	6,7E+00	1,1E+00	1,5E+00	2,2E+00	8,2E-01	2,3E+00	1,6E+00	5,9E+00	8,8E+00	2,2E+00	1,5E+00	7,6E-01	7,3E-01	7,6E-01	6,4E-01	6,7E-01	1,2E+00	5,7E-01	7,6E-01	6,9E-01	9,4E-01	3,7E-01
Aluminium	PM10	24hr	3,1E-01	1,8E-01	3,1E+00	3,3E+00	2,9E+00	4,2E-01	6,2E-01	8,4E-01	3,2E-01	9,7E-01	7,4E-01	2,2E+00	3,7E+00	8,8E-01	6,3E-01	3,1E-01	3,4E-01	3,4E-01	2,7E-01	2,7E-01	4,7E-01	2,2E-01	3,7E-01	3,0E-01	4,2E-01	1,7E-01
Antimoine	PM10	24hr	2,0E-06	1,2E-06	1,9E-05	2,1E-05	1,9E-05	2,7E-06	4,7E-06	5,4E-06	2,5E-06	6,1E-06	4,6E-06	1,4E-05	2,4E-05	5,6E-06	3,9E-06	2,0E-06	2,1E-06	2,1E-06	1,7E-06	1,7E-06	3,1E-06	1,9E-06	2,4E-06	1,9E-06	3,2E-06	1,4E-06
Argent	PM10	24hr	2,6E-06	1,5E-06	2,5E-05	2,7E-05	2,4E-05	3,5E-06	6,4E-06	7,0E-06	3,6E-06	8,0E-06	5,9E-06	1,9E-05	3,0E-05	7,2E-06	5,1E-06	2,5E-06	2,7E-06	2,7E-06	2,2E-06	2,3E-06	4,1E-06	2,7E-06	3,2E-06	2,4E-06	4,5E-06	2,0E-06
Arsenic	PM10	24hr	6,6E-05	6,0E-05	9,5E-04	1,6E-03	1,5E-03	9,1E-05	2,8E-04	2,5E-04	2,2E-04	3,4E-04	1,5E-04	4,1E-04	9,0E-04	3,1E-04	3,1E-04	6,8E-05	6,2E-05	6,1E-05	5,4E-05	6,2E-05	1,1E-04	1,6E-04	9,8E-05	5,5E-05	2,1E-04	1,0E-04
Baryum	PM10	24hr	3,0E-03	1,8E-03	3,1E-02	3,2E-02	2,8E-02	4,1E-03	5,9E-03	8,1E-03	3,1E-03	9,7E-03	7,4E-03	2,1E-02	3,6E-02	8,8E-03	6,2E-03	3,0E-03	3,4E-03	3,4E-03	2,6E-03	2,6E-03	4,6E-03	2,2E-03	3,6E-03	3,0E-03	4,0E-03	1,6E-03
Béryllium	PM10	24hr	3,1E-05	5,9E-05	7,5E-04	1,6E-03	1,5E-03	2,4E-05	2,1E-04	2,0E-04	2,1E-04	1,7E-04	8,1E-05	3,0E-04	8,1E-04	2,8E-04	9,9E-05	3,3E-05	2,6E-05	2,3E-05	3,1E-05	3,2E-05	5,4E-05	1,6E-04	6,1E-05	3,8E-05	1,6E-04	9,3E-05
Bore	PM10	24hr	2,7E-04	5,2E-04	6,6E-03	1,4E-02	1,3E-02	3,8E-04	2,0E-03	1,7E-03	1,8E-03	3,1E-03	1,1E-03	3,0E-03	7,0E-03	2,5E-03	2,6E-03	3,2E-04	2,3E-04	2,1E-04	2,4E-04	2,9E-04	5,4E-04	1,4E-03	5,3E-04	4,7E-04	1,5E-03	8,0E-04
Cadmium	PM10	24hr	1,9E-06	1,1E-06	1,8E-05	2,0E-05	1,7E-05	2,6E-06	4,5E-06	5,1E-06	2,4E-06	5,8E-06	4,4E-06	1,4E-05	2,2E-05	5,3E-06	3,7E-06	1,9E-06	2,0E-06	2,0E-06	1,6E-06	1,6E-06	2,9E-06	1,8E-06	2,3E-06	1,8E-06	3,1E-06	1,4E-06
Chrome	PM10	24hr	4,1E-04	2,4E-04	4,4E-03	5,5E-03	5,2E-03	5,6E-04	1,2E-03	1,1E-03	7,6E-04	1,3E-03	9,4E-04	2,9E-03	4,8E-03	1,2E-03	1,1E-03	4,0E-04	4,1E-04	4,2E-04	3,5E-04	3,7E-04	6,6E-04	5,7E-04	5,3E-04	3,7E-04	8,5E-04	3,9E-04
Cobalt	PM10	24hr	2,3E-04	1,4E-04	2,4E-03	2,4E-03	2,1E-03	3,1E-04	4,0E-04	6,1E-04	2,3E-04	7,4E-04	5,6E-04	1,6E-03	2,7E-03	6,6E-04	4,7E-04	2,3E-04	2,6E-04	2,6E-04	2,0E-04	1,9E-04	3,4E-04	1,7E-04	2,7E-04	2,3E-04	2,6E-04	1,1E-04
Cuivre	PM10	24hr	1,6E-04	9,4E-05	1,6E-03	1,7E-03	1,5E-03	2,2E-04	3,4E-04	4,2E-04	1,6E-04	5,0E-04	3,9E-04	1,1E-03	1,9E-03	4,7E-04	3,2E-04	1,5E-04	1,8E-04	1,8E-04	1,4E-04	1,4E-04	2,4E-04	1,2E-04	1,9E-04	1,6E-04	2,3E-04	9,7E-05
Étain	PM10	24hr	2,5E-05	2,6E-05	3,9E-04	6,9E-04	6,5E-04	2,9E-05	1,1E-04	1,0E-04	9,3E-05	8,7E-05	4,7E-05	2,1E-04	3,8E-04	1,3E-04	7,2E-05	2,6E-05	2,4E-05	2,3E-05	2,3E-05	2,4E-05	4,2E-05	7,0E-05	3,9E-05	1,9E-05	8,1E-05	4,4E-05
Lithium	PM10	24hr	1,6E-03	2,2E-03	3,0E-02	5,9E-02	5,6E-02	1,6E-03	8,5E-03	8,1E-03	7,9E-03	6,9E-03	3,2E-03	1,4E-02	3,1E-02	1,1E-02	5,2E-03	1,6E-03	1,4E-03	1,3E-03	1,5E-03	1,6E-03	2,7E-03	5,9E-03	2,7E-03	1,5E-03	6,4E-03	3,6E-03
Manganèse	PM10	24hr	7,3E-03	4,4E-03	7,6E-02	7,9E-02	6,8E-02	1,0E-02	1,3E-02	2,0E-02	7,5E-03	2,4E-02	1,8E-02	5,1E-02	8,7E-02	2,1E-02	1,5E-02	7,3E-03	8,3E-03	8,4E-03	6,4E-03	6,2E-03	1,1E-02	5,3E-03	8,5E-03	7,4E-03	8,2E-03	3,7E-03
Mercure	PM10	24hr	1,0E-07	6,1E-08	1,1E-06	1,1E-06	9,5E-07	1,4E-07	1,7E-07	2,8E-07	1,1E-07	3,4E-07	2,5E-07	7,2E-07	1,2E-06	3,0E-07	2,1E-07	1,0E-07	1,2E-07	1,2E-07	9,0E-08	8,7E-08	1,5E-07	7,5E-08	1,2E-07	1,0E-07	1,1E-07	5,2E-08
Molybdène	PM10	24hr	1,2E-05	8,6E-06	1,5E-04	2,3E-04	2,2E-04	1,6E-05	4,3E-05	3,9E-05	3,1E-05	4,9E-05	2,5E-05	8,7E-05	1,4E-04	4,6E-05	4,4E-05	1,2E-05	1,1E-05	1,1E-05	1,0E-05	1,1E-05	2,0E-05	2,3E-05	1,6E-05	9,8E-06	3,1E-05	1,5E-05
Nickel	PM10	24hr	2,2E-04	1,3E-04	2,3E-03	2,4E-03	2,1E-03	3,1E-04	5,0E-04	6,0E-04	2,5E-04	7,0E-04	5,5E-04	1,5E-03	2,7E-03	6,6E-04	4,6E-04	2,2E-04	2,5E-04	2,5E-04	1,9E-04	1,9E-04	3,5E-04	1,9E-04	2,8E-04	2,2E-04	3,4E-04	1,5E-04
Plomb	PM10	24hr	4,8E-05	2,9E-05	4,9E-04	5,1E-04	4,5E-04	6,6E-05	1,0E-04	1,3E-04	4,9E-05	1,5E-04	1,2E-04	3,3E-04	5,7E-04	1,4E-04	9,8E-05	4,7E-05	5,3E-05	5,4E-05	4,2E-05	4,2E-05	7,4E-05	3,7E-05	5,9E-05	4,7E-05	7,0E-05	2,9E-05
Sélénium	PM10	24hr	5,2E-06	8,2E-06	1,1E-04	2,2E-04	2,0E-04	4,8E-06	3,0E-05	2,9E-05	2,9E-05	2,5E-05	1,2E-05	4,7E-05	1,1E-04	4,0E-05	1,5E-05	5,4E-06	4,6E-06	4,2E-06	5,1E-06	5,2E-06	8,9E-06	2,2E-05	9,5E-06	5,3E-06	2,3E-05	1,3E-05
Strontium	PM10	24hr	1,7E-03	9,9E-04	1,7E-02	1,8E-02	1,6E-02	2,3E-03	3,2E-03	4,5E-03	1,7E-03	5,4E-03	4,1E-03	1,2E-02	2,0E-02	4,9E-03	3,4E-03	1,7E-03	1,9E-03	1,9E-03	1,5E-03	1,4E-03	2,5E-03	1,2E-03	2,0E-03	1,7E-03	2,1E-03	8,4E-04
Titane	PM10	24hr	6,8E-02	4,1E-02	7,2E-01	7,3E-01	6,3E-01	9,3E-02	1,1E-01	1,8E-01	7,0E-02	2,2E-01	1,7E-01	4,8E-01	8,1E-01	2,0E-01	1,4E-01	6,8E-02	7,7E-02	7,8E-02	5,9E-02	5,8E-02	1,0E-01	5,0E-02	7,9E-02	6,9E-02	7,4E-02	3,4E-02
Uranium	PM10	24hr	3,2E-06	3,6E-06	5,2E-05	9,5E-05	8,9E-05	3,8E-06	1,5E-05	1,4E-05	1,3E-05	1,3E-05	5,8E-06	2,6E-05	5,1E-05	1,8E-05	1,2E-05	3,2E-06	2,8E-06	2,7E-06	2,9E-06	3,1E-06	5,5E-06	9,5E-06	4,9E-06	2,4E-06	1,1E-05	5,9E-06
Vanadium	PM10	24hr	1,6E-03	9,4E-04	1,6E-02	1,7E-02	1,5E-02	2,2E-03	2,7E-03	4,2E-03	1,6E-03	5,2E-03	3,9E-03	1,1E-02	1,9E-02	4,6E-03	3,2E-03	1,6E-03	1,8E-03	1,8E-03	1,4E-03	1,3E-03	2,4E-03	1,1E-03	1,8E-03	1,6E-03	1,8E-03	7,9E-04
Zinc	PM10	24hr	7,8E-04	4,6E-04	8,1E-03	8,4E-03	7,3E-03	1,1E-03	1,5E-03	2,1E-03	8,0E-04	2,5E-03	1,9E-03	5,6E-03	9,4E-03	2,2E-03	1,6E-03	7,8E-04	8,7E-04	8,8E-04	6,9E-04	6,7E-04	1,2E-03	5,6E-04	9,3E-04	7,7E-04	1,0E-03	4,1E-04
NO2	-	2 semaines	2,9E-01	4,3E-01	1,2E+01	1,8E+01	1,6E+01	3,3E-01	1,8E+00	2,9E+00	1,4E+00	2,6E+00	1,2E+00	7,0E+00	6,6E+00	1,9E+00	1,0E+00	3,5E-01	3,1E-01	2,9E-01	2,9E-01	2,7E-01	6,2E-01	9,5E-01	8,0E-01	4,9E-01	1,2E+00	5,9E-01
SO2	-	2 semaines	7,8E-04	2,8E-03	6,9E-02	1,1E-01	9,3E-02	7,5E-04	8,8E-03	1,2E-02	8,9E-03	9,9E-03	5,1E-03	2,8E-02	2,9E-02	1,1E-02	3,7E-03	1,1E-03	1,1E-03	7,9E-04	8,7E-04	9,3E-04	2,1E-03	6,2E-03	3,6E-03	2,1E-03	6,8E-03	3,8E-03
PM2.5	-	2 semaines	7,7E-02	4,9E-02	1,9E+00	2,0E+00	1,7E+00	9,8E-02	3,3E-01	5,9E-01	1,2E-01	7,0E-01	3,1E-01	1,5E+00	1,5E+00	3,2E-01	2,8E-01	9,7E-02	8,0E-02	8,1E-02	7,7E-02	5,5E-02	1,5E-01	7,7E-02	1,5E-01	1,3E-01	1,9E-01	4,4E-02
Aluminium	PM10	2 semaines	2,9E-02	1,8E-02	8,0E-01	8,5E-01	7,2E-01	3,8E-02	1,3E-01	2,3E-01	4,4E-02	2,7E-01	1,2E-01	5,4E-01	6,3E-01	1,2E-01	1,1E-01	3,6E-02	3,1E-02	3,3E-02	2,8E-02	2,2E-02	5,4E-02	2,8E-02	5,5E-02	5,2E-02	7,4E-02	1,6E-02
Antimoine	PM10	2 semaines	1,8E-07	1,1E-07	5,2E-06	5,6E-06	4,7E-06	2,4E-07	8,3E-07	1,5E-06	2,9E-07	2,0E-06	7,8E-07	3,6E-06	4,0E-06	8,2E-07	7,7E-07	2,3E-07	1,9E-07	2,1E-07	1,8E-07	1,4E-07	3,6E-07	2,1E-07	3,6E-07	3,3E-07	4,7E-07	1,2E-07
Argent	PM10	2 semaines	2,4E-07	1,5E-07	6,8E-06	7,3E-06	6,1E-06	3,2E-07	1,1E-06	1,9E-06	3,9E-07	2,7E-06	1,0E-06	4,7E-06	5,1E-06	1,1E-06	1,0E-06	3,1E-07	2,5E-07	2,6E-07	2,4E-07	1,8E-07	4,8E-07	2,8E-07	4,8E-07	4,3E-07	6,0E-07	1,6E-07
Arsenic	PM10	2 semaines	5,6E-06	4,5E-06	1,8E-04	2,4E-04	2,1E-04	7,6E-06	2,9E-05	5,9E-05	1,6E-05	1,0E-04	2,9E-05	1,2E-04	1,1E-04	4,1E-05	3,5E-05	8,0E-06	5,6E-06	5,7E-06	6,3E-06	4,6E-06	1,3E-05	1,1E-05	1,7E-05	1,0E-05	1,9E-05	6,6E-06
Baryum	PM10	2 semaines	2,8E-04	1,7E-04	7,8E-03	8,3E-03	7,0E-03	3,7E-04	1,3E-03	2,2E-03	4,2E-04	2,7E-03	1,2E-03	5,2E-03	6,2E-03	1,2E-03	1,0E-03	3,5E-04	3,1E-04	3,3E-04	2,8E-04	2,1E-04	5,2E-04	2,7E-04	5,3E-04	5,1E-04	7,3E-04	1,6E-04
Béryllium	PM10	2 semaines	1,6E-06	9,2E-07	4,7E-05	5,4E-05	4,8E-05	1,9E-06	6,8E-06	1,5E-05	3,0E-06	1,3E-05	5,4E-06	4,9E-05	3,1E-05	5,7E-06	5,0E-06	1,9E-06	1,3E-06	1,2E-06	1,6E-06	1,3E-06	3,2E-06	2,2E-06	3,0E-06	2,5E-06	3,9E-06	1,4E-06
Bore	PM10	2 semaines	2,1E-05	3,2E-05	1,2E-03	1,6E-03	1,4E-03	2,9E-05	1,8E-04	3,9E-04	1,1E-04	7,0E-04	1,6E-04	5,9E-04	4,5E-04	2,8E-04	2,2E-04	4,1E-05	2,7E-05	2,0E-05	3,3E-05	1,9E-05	6,6E-05	8,0E-05	1,0E-04	5,8E-05	1,2E-04	4,6E-05
Cadmium	PM10	2 semaines	1,7E-07	1,1E-07	4,9E-06	5,3E-06	4,5E-06	2,3E-07	7,8E-07	1,4E-06	2,8E-07	1,9E-06	7,3E-07	3,4E-06	3,7E-06	7,8E-07	7,3E-07	2,2E-07	1,8E-07	1,9E-07	1,7E-07	1,3E-07	3,5E-07	2,0E-07	3,4E-07	3,1E-07	4,4E-07	1,1E-07
Chrome	PM10	2 semaines	3,6E-05	2,2E-05	1,0E-03	1,1E-03	9,4E-04	4,8E-05	1,6E-04	2,8E-04	6,2E-05	4,4E-04	1,6E-04	7,2E-04	7,6E-04	1,7E-04	1,6E-04	4,7E-05	3,7E-05	4,0E-05	3,6E-05	2,8E-05	7,4E-05	4,6E-05	7,7E-05	6,4E-05	9,0E-05	2,7E-05
Cobalt	PM10	2 semaines	2,1E-05	1,3E-05	5,8E-04	6,2E-04	5,2E-04	2,8E-05	9,7E-05	1,7E-04	3,1E-05	2,0E-04	9,2E-05	3,9E-04	4,7E-04	8,9E-05	7,3E-05	2,6E-05	2,4E-05	2,5E-05	2,1E-05	1,6E-05	3,9E-05	2,0E-05	4,0E-05	3,9E-05	5,6E-05	1,2E-05
Cuivre	PM10	2 semaines	1,5E-05	9,1E-06	4,1E-04	4,3E-04	3,7E-04	1,9E-05	6,7E-05	1,1E-04	2,3E-05	1,4E-04	6,3E-05	2,7E-04	3,2E-04	6,4E-05	5,7E-05	1,9E-05	1,6E-05	1,7E-05	1,5E-05	1,1E-05	2,8E-05	1,5E-05	2,8E-05	2,7E-05	3,8E-05	8,3E-06
Étain	PM10	2 semaines	1,9E-06	1,2E-06	5,7E-05	6,2E-05	5,4E-05	2,5E-06	8,4E-06	1,7E-05	3,7E-06	2,3E-05	8,0E-06	4,5E-05	4,0E-05	8,6E-06	8,5E-06	2,4E-06	1,8E-06	1,9E-06	1,9E-06	1,5E-06	4,1E-06	2,7E-06	4,1E-06	3,3E-06	4,9E-06	1,6E-06
Lithium	PM10	2 semaines	1,0E-04	6,5E-05	3,1E-03	3,7E-03	3,3E-03	1,3E-04	4,7E-04	9,8E-04	2,2E-04	1,3E-03	4,1E-04	2,7E-03	2,1E-03	4,6E-04	4,5E-04	1,3E-04	9,3E-05	9,0E-05	1,0E-04	8,5E-05	2,2E-04	1,6E-04	2,3E-04	1,7E-04	2,8E-04	9,7E-05
Manganèse	PM10	2 semaines	6,8E-04	4,3E-04	1,9E-02	2,0E-02	1,7E-02	9,0E-04	3,1E-03	5,3E-03	9,9E-04	6,6E-03	3,0E-03	1,2E-02	1,5E-02	2,9E-03	2,3E-03	8,4E-04	7,6E-04	8,1E-04	6,7E-04	5,0E-04	1,3E-03	6,4E-04	1,3E-03	1,2E-03	1,8E-03	3,8E-04
Mercure	PM10	2 semaines	9,6E-09	6,0E-09	2,6E-07	2,8E-07	2,4E-07	1,3E-08	4,4E-08	7,5E-08	1,4E-08	9,3E-08	4,2E-08	1,7E-07	2,2E-07	4,0E-08	3,2E-08	1,2E-08	1,1E-08	1,2E-08	9,5E-09	7,0E-09	1,8E-08	8,9E-09	1,8E-08	1,8E-08	2,5E-08	5,4E-09
Molybdène	PM10	2 semaines	8,6E-07	5,3E-07	2,5E-05	2,7E-05	2,3E-05	1,1E-06	3,8E-06	7,2E-06	1,6E-06	1,0E-05	3,7E-06	1,9E-05	1,8E-05	4,0E-06	3,9E-06	1,1E-06	8,5E-07	9,0E-07	8,5E-07	6,8E-07	1,8E-06	1,2E-06	1,9E-06	1,5E-06	2,1E-06	6,8E-07
Nickel	PM10	2 semaines	2,1E-05	1,3E-05	5,8E-04	6,2E-04	5,2E-04	2,8E-05	9,4E-05	1,6E-04	3,3E-05	2,1E-04	8,9E-05	3,9E-04	4,5E-04	9,1E-05	8,3E-05	2,6E-05	2,3E-05	2,4E-05	2,1E-05	1,6E-05	4,0E-05	2,1E-05	4,0E-05	3,8E-05	5,4E-05	1,2E-05
Plomb	PM10	2 semaines	4,5E-06	2,8E-06	1,2E-04	1,3E-04	1,1E-04	5,9E-06	2,0E-05	3,5E-05	6,9E-06	4,3E-05	1,9E-05	8,3E-05	9,8E-05	1,9E-05	1,7E-05	5,7E-06	4,9E-06	5,2E-06	4,4E-06	3,3E-06	8,5E-06	4,4E-06	8,6E-06	8,1E-06	1,2E-05	2,5E-06
Sélénium	PM10	2 semaines	3,2E-07	1,9E-07	9,2E-06	1,0E-05	8,7E-06	3,9E-07	1,3E-06	2,8E-06	5,6E-07	2,9E-06	1,2E-06	8,4E-06	6,4E-06	1,2E-06	1,1E-06	3,7E-07	2,7E-07	2,6E-07	3,0E-07	2,5E-07	6,3E-07	4,1E-07	6,0E-07	5,1E-07	7,4E-07	2,5E-07
Strontium	PM10	2 semaines	1,5E-04	9,6E-05	4,3E-03	4,5E-03	3,8E-03	2,0E-04	7,1E-04	1,2E-03	2,3E-04	1,5E-03	6,7E-04	2,8E-03	3,4E-03	6,5E-04	5,5E-04	1,9E-04	1,7E-04	1,8E-04	1,5E-04	1,1E-04	2,9E-04	1,5E-04	2,9E-04	2,8E-04	4,0E-04	8,7E-05
Titane	PM10	2 semaines	6,4E-03	4,0E-03	1,7E-01	1,8E-01	1,6E-01	8,4E-03	2,9E-02	5,0E-02	9,2E-03	6,2E-02	2,8E-02	1,2E-01	1,4E-01	2,7E-02	2,1E-02	7,8E-03	7,1E-03	7,6E-03	6,3E-03	4,7E-03	1,2E-02	5,9E-03	1,2E-02	1,2E-02	1,7E-02	3,6E-03
Uranium	PM10	2 semaines	2,5E-07	1,8E-07	7,6E-06	9,8E-06	8,6E-06	3,2E-07	1,2E-06	2,4E-06	6,1E-07	3,8E-06	1,1E-06	6,0E-06	4,9E-06	1,4E-06	1,3E-06	3,4E-07	2,3E-07	2,3E-07	2,6E-07	2,0E-07	5,7E-07	4,3E-07	6,4E-07	4,2E-07	7,6E-07	2,6E-07
Vanadium	PM10	2 semaines	1,5E-04	9,1E-05	4,0E-03	4,3E-03	3,6E-03	1,9E-04	6,7E-04	1,1E-03	2,1E-04	1,4E-03	6,4E-04	2,7E-03	3,3E-03	6,2E-04	5,0E-04	1,8E-04	1,6E-04	1,8E-04	1,4E-04	1,1E-04	2,7E-04	1,4E-04	2,8E-04	2,7E-04	3,8E-04	8,2E-05
Zinc	PM10	2 semaines	7,2E-05	4,5E-05	2,0E-03	2,1E-03	1,8E-03	9,5E-05	3,3E-04	5,7E-04	1,1E-04	6,9E-04	3,1E-04	1,3E-03	1,6E-03	3,0E-04	2,5E-04	8,9E-05	8,0E-05	8,5E-05	7,1E-05	5,3E-05	1,3E-04	6,8E-05	1,4E-04	1,3E-04	1,9E-04	4,0E-05

TABLEAU E-1 Concentrations additionnelles dans l'air ambiant de la zone d'étude estimées par modélisation de la dispersion atmosphérique (WSP, 2018)

Substances	Taille des particules	Période	Concentration additionnelle estimée dans l'air ambiant (µg/m3)																								
			Récepteur le plus exposé	TRP1	CHS1	CHS2	CHS3	CHS4	CCT1	CHS5	PCH1	PCH2	PCH3	PCH4	PCH5	AVL1	CRI1	CRI2	CRI3	CRI4	CRI5	CHS6	AQU1	AQU2	AQU3	AQU4	AQU5
NO2	-	1 mois	1,0E+01	1,1E+00	3,0E+00	6,6E-01	3,8E-01	2,7E-01	1,6E-01	1,7E+00	5,2E-01	4,6E-01	1,8E-01	3,1E-01	2,9E-01	1,4E+00	8,2E-01	7,9E-01	3,4E-01	4,4E-01	7,8E-01	3,7E-01	2,0E+00	2,5E+00	3,0E+00	3,5E+00	7,8E-01
SO2	-	1 mois	5,7E-02	2,8E-03	1,1E-02	2,0E-03	1,0E-03	7,3E-04	3,9E-04	4,4E-03	1,8E-03	1,4E-03	5,4E-04	1,2E-03	1,5E-03	3,4E-03	3,6E-03	4,9E-03	1,3E-03	1,7E-03	2,6E-03	1,7E-03	5,2E-03	5,7E-03	8,4E-03	9,3E-03	4,8E-03
PM2.5	-	1 mois	1,5E+00	2,7E-01	5,3E-01	1,6E-01	9,2E-02	6,4E-02	4,2E-02	4,7E-01	1,2E-01	1,0E-01	4,0E-02	7,1E-02	5,8E-02	3,6E-01	1,5E-01	6,3E-02	8,2E-02	1,1E-01	2,0E-01	5,6E-02	4,9E-01	6,5E-01	8,6E-01	9,1E-01	7,0E-02
Aluminium	PM10	1 mois	5,4E-01	1,1E-01	2,1E-01	6,8E-02	3,5E-02	2,3E-02	1,6E-02	1,8E-01	4,6E-02	3,9E-02	1,6E-02	2,6E-02	2,2E-02	1,4E-01	6,0E-02	2,3E-02	3,0E-02	3,9E-02	7,7E-02	2,0E-02	2,0E-01	2,8E-01	3,6E-01	4,0E-01	2,6E-02
Antimoine	PM10	1 mois	3,5E-06	6,9E-07	1,4E-06	4,3E-07	2,2E-07	1,5E-07	9,8E-08	1,2E-06	2,9E-07	2,6E-07	9,9E-08	1,7E-07	1,4E-07	9,1E-07	3,8E-07	1,8E-07	2,0E-07	2,5E-07	4,9E-07	1,3E-07	1,3E-06	1,7E-06	2,3E-06	2,4E-06	1,8E-07
Argent	PM10	1 mois	4,5E-06	8,8E-07	1,8E-06	5,5E-07	2,9E-07	2,0E-07	1,3E-07	1,6E-06	3,7E-07	3,3E-07	1,3E-07	2,2E-07	1,8E-07	1,2E-06	4,9E-07	2,4E-07	2,5E-07	3,3E-07	6,4E-07	1,7E-07	1,7E-06	2,2E-06	2,9E-06	3,1E-06	2,5E-07
Arsenic	PM10	1 mois	1,4E-04	1,9E-05	4,7E-05	1,2E-05	7,4E-06	4,9E-06	2,9E-06	4,2E-05	9,7E-06	8,9E-06	2,8E-06	6,4E-06	4,2E-06	3,3E-05	1,4E-05	9,3E-06	6,1E-06	9,2E-06	1,6E-05	5,9E-06	3,9E-05	7,7E-05	6,8E-05	6,6E-05	9,3E-06
Baryum	PM10	1 mois	5,2E-03	1,1E-03	2,1E-03	6,8E-04	3,4E-04	2,3E-04	1,5E-04	1,7E-03	4,5E-04	3,8E-04	1,5E-04	2,6E-04	2,2E-04	1,4E-03	5,9E-04	2,3E-04	3,0E-04	3,8E-04	7,6E-04	2,0E-04	2,0E-03	2,8E-03	3,6E-03	4,0E-03	2,5E-04
Béryllium	PM10	1 mois	4,9E-05	4,7E-06	1,2E-05	4,1E-06	1,6E-06	1,2E-06	6,4E-07	1,0E-05	2,2E-06	2,0E-06	8,1E-07	1,4E-06	1,1E-06	5,5E-06	3,1E-06	1,9E-06	1,4E-06	1,9E-06	4,2E-06	1,3E-06	6,8E-06	8,8E-06	1,3E-05	1,4E-05	1,9E-06
Bore	PM10	1 mois	8,9E-04	8,6E-05	2,0E-04	4,8E-05	3,7E-05	2,9E-05	1,0E-05	2,6E-04	4,8E-05	4,1E-05	1,1E-05	3,3E-05	1,9E-05	2,1E-04	7,6E-05	6,2E-05	3,1E-05	5,2E-05	8,1E-05	3,7E-05	2,1E-04	5,5E-04	4,2E-04	3,6E-04	6,1E-05
Cadmium	PM10	1 mois	3,3E-06	6,4E-07	1,3E-06	4,0E-07	2,1E-07	1,4E-07	9,2E-08	1,1E-06	2,7E-07	2,4E-07	9,3E-08	1,6E-07	1,3E-07	8,6E-07	3,6E-07	1,7E-07	1,8E-07	2,4E-07	4,6E-07	1,2E-07	1,2E-06	1,6E-06	2,1E-06	2,3E-06	1,8E-07
Chrome	PM10	1 mois	7,0E-04	1,3E-04	2,8E-04	8,2E-05	4,3E-05	3,0E-05	1,9E-05	2,4E-04	5,6E-05	5,1E-05	1,9E-05	3,4E-05	2,8E-05	1,8E-04	7,4E-05	4,0E-05	3,8E-05	5,1E-05	9,8E-05	2,7E-05	2,5E-04	3,3E-04	4,3E-04	4,6E-04	4,1E-05
Cobalt	PM10	1 mois	3,9E-04	8,3E-05	1,5E-04	5,2E-05	2,6E-05	1,7E-05	1,2E-05	1,3E-04	3,4E-05	2,9E-05	1,2E-05	2,0E-05	1,7E-05	1,1E-04	4,5E-05	1,7E-05	2,3E-05	2,8E-05	5,7E-05	1,5E-05	1,5E-04	2,1E-04	2,7E-04	3,0E-04	1,9E-05
Cuivre	PM10	1 mois	2,7E-04	5,6E-05	1,1E-04	3,5E-05	1,8E-05	1,2E-05	8,0E-06	9,3E-05	2,3E-05	2,0E-05	8,0E-06	1,3E-05	1,1E-05	7,3E-05	3,1E-05	1,2E-05	1,6E-05	2,0E-05	3,9E-05	1,0E-05	1,0E-04	1,4E-04	1,9E-04	2,0E-04	1,3E-05
Étain	PM10	1 mois	4,3E-05	6,6E-06	1,5E-05	4,5E-06	2,2E-06	1,6E-06	9,5E-07	1,3E-05	2,9E-06	2,7E-06	1,0E-06	1,8E-06	1,5E-06	8,9E-06	4,1E-06	2,3E-06	2,0E-06	2,6E-06	5,3E-06	1,5E-06	1,2E-05	1,6E-05	2,1E-05	2,2E-05	2,4E-06
Lithium	PM10	1 mois	2,6E-03	3,4E-04	8,2E-04	2,5E-04	1,2E-04	8,4E-05	4,8E-05	6,8E-04	1,6E-04	1,5E-04	5,3E-05	9,5E-05	7,7E-05	4,4E-04	2,2E-04	1,4E-04	1,0E-04	1,4E-04	2,9E-04	8,7E-05	5,8E-04	7,9E-04	1,0E-03	1,1E-03	1,4E-04
Manganèse	PM10	1 mois	1,3E-02	2,7E-03	5,0E-03	1,7E-03	8,4E-04	5,5E-04	3,8E-04	4,2E-03	1,1E-03	9,3E-04	3,8E-04	6,3E-04	5,4E-04	3,4E-03	1,4E-03	5,5E-04	7,2E-04	9,1E-04	1,8E-03	4,8E-04	4,9E-03	6,8E-03	8,8E-03	9,8E-03	6,1E-04
Mercure	PM10	1 mois	1,8E-07	3,8E-08	7,0E-08	2,3E-08	1,2E-08	7,8E-09	5,3E-09	5,8E-08	1,5E-08	1,3E-08	5,4E-09	8,9E-09	7,6E-09	4,8E-08	2,0E-08	7,8E-09	1,0E-08	1,3E-08	2,6E-08	6,8E-09	6,9E-08	9,6E-08	1,2E-07	1,4E-07	8,6E-09
Molybdène	PM10	1 mois	1,8E-05	3,1E-06	6,8E-06	2,0E-06	1,0E-06	7,2E-07	4,4E-07	5,8E-06	1,3E-06	1,2E-06	4,5E-07	8,2E-07	6,6E-07	4,2E-06	1,8E-06	1,0E-06	9,1E-07	1,2E-06	2,4E-06	6,6E-07	5,7E-06	7,4E-06	1,0E-05	1,1E-05	1,0E-06
Nickel	PM10	1 mois	3,9E-04	7,9E-05	1,6E-04	4,9E-05	2,5E-05	1,7E-05	1,1E-05	1,3E-04	3,3E-05	2,8E-05	1,1E-05	1,9E-05	1,6E-05	1,0E-04	4,3E-05	1,8E-05	2,2E-05	2,9E-05	5,5E-05	1,5E-05	1,5E-04	2,0E-04	2,6E-04	2,9E-04	1,9E-05
Plomb	PM10	1 mois	8,3E-05	1,7E-05	3,3E-05	1,1E-05	5,4E-06	3,6E-06	2,4E-06	2,8E-05	7,1E-06	6,1E-06	2,4E-06	4,0E-06	3,5E-06	2,2E-05	9,3E-06	3,8E-06	4,8E-06	6,1E-06	1,2E-05	3,1E-06	3,2E-05	4,3E-05	5,7E-05	6,2E-05	4,0E-06
Sélénium	PM10	1 mois	8,4E-06	1,0E-06	2,4E-06	7,7E-07	3,4E-07	2,5E-07	1,4E-07	1,9E-06	4,6E-07	4,1E-07	1,6E-07	2,7E-07	2,3E-07	1,2E-06	6,2E-07	3,6E-07	3,0E-07	3,8E-07	8,3E-07	2,4E-07	1,6E-06	2,1E-06	3,0E-06	3,2E-06	3,6E-07
Strontium	PM10	1 mois	2,9E-03	6,0E-04	1,1E-03	3,7E-04	1,9E-04	1,3E-04	8,5E-05	9,6E-04	2,5E-04	2,1E-04	8,6E-05	1,4E-04	1,2E-04	7,7E-04	3,2E-04	1,2E-04	1,6E-04	2,1E-04	4,2E-04	1,1E-04	1,1E-03	1,5E-03	2,0E-03	2,2E-03	1,4E-04
Titane	PM10	1 mois	1,2E-01	2,5E-02	4,6E-02	1,6E-02	7,9E-03	5,1E-03	3,5E-03	3,9E-02	1,0E-02	8,7E-03	3,6E-03	5,9E-03	5,0E-03	3,2E-02	1,3E-02	5,2E-03	6,8E-03	8,5E-03	1,7E-02	4,5E-03	4,6E-02	6,3E-02	8,3E-02	9,2E-02	5,7E-03
Uranium	PM10	1 mois	5,8E-06	8,1E-07	2,0E-06	5,5E-07	2,9E-07	2,1E-07	1,2E-07	1,7E-06	4,0E-07	3,7E-07	1,2E-07	2,5E-07	1,8E-07	1,2E-06	5,8E-07	3,7E-07	2,6E-07	3,7E-07	7,0E-07	2,3E-07	1,5E-06	2,6E-06	2,6E-06	2,6E-06	3,8E-07
Vanadium	PM10	1 mois	2,7E-03	5,8E-04	1,1E-03	3,6E-04	1,8E-04	1,2E-04	8,1E-05	8,9E-04	2,4E-04	2,0E-04	8,2E-05	1,4E-04	1,2E-04	7,3E-04	3,1E-04	1,2E-04	1,6E-04	2,0E-04	4,0E-04	1,0E-04	1,1E-03	1,5E-03	1,9E-03	2,1E-03	1,3E-04
Zinc	PM10	1 mois	1,3E-03	2,8E-04	5,3E-04	1,7E-04	8,8E-05	5,9E-05	4,0E-05	4,4E-04	1,2E-04	9,8E-05	4,0E-05	6,6E-05	5,7E-05	3,6E-04	1,5E-04	5,8E-05	7,6E-05	9,6E-05	1,9E-04	5,1E-05	5,1E-04	7,1E-04	9,2E-04	1,0E-03	6,4E-05
NO2	-	1 an	3,1E+00	5,0E-01	9,9E-01	3,2E-01	1,6E-01	1,1E-01	6,4E-02	8,5E-01	2,0E-01	1,8E-01	6,8E-02	1,3E-01	1,0E-01	4,6E-01	2,6E-01	1,3E-01	1,1E-01	2,0E-01	3,6E-01	1,1E-01	7,9E-01	1,1E+00	1,5E+00	1,8E+00	1,4E-01
SO2	-	1 an	9,8E-03	1,0E-03	2,7E-03	6,6E-04	3,4E-04	2,3E-04	1,4E-04	2,0E-03	4,8E-04	4,3E-04	1,6E-04	2,9E-04	2,3E-04	9,5E-04	6,6E-04	3,8E-04	2,7E-04	4,5E-04	8,4E-04	3,0E-04	1,5E-03	2,2E-03	2,9E-03	3,6E-03	4,0E-04
PM2.5	-	1 an	8,0E-01	1,4E-01	2,5E-01	8,9E-02	4,4E-02	2,9E-02	1,7E-02	2,4E-01	5,1E-02	4,8E-02	1,8E-02	3,5E-02	2,7E-02	1,3E-01	6,8E-02	3,2E-02	3,0E-02	5,6E-02	9,9E-02	2,7E-02	2,2E-01	3,2E-01	4,4E-01	5,2E-01	3,5E-02
Aluminium	PM10	1 an	2,9E-01	5,8E-02	9,5E-02	3,7E-02	1,7E-02	1,1E-02	6,3E-03	9,0E-02	1,9E-02	1,8E-02	6,6E-03	1,3E-02	1,0E-02	5,1E-02	2,5E-02	1,2E-02	1,1E-02	2,1E-02	3,7E-02	9,5E-03	8,9E-02	1,3E-01	1,8E-01	2,2E-01	1,3E-02
Antimoine	PM10	1 an	1,9E-06	3,6E-07	6,0E-07	2,3E-07	1,1E-07	6,8E-08	4,0E-08	5,9E-07	1,2E-07	1,1E-07	4,1E-08	8,3E-08	6,4E-08	3,3E-07	1,6E-07	7,5E-08	7,1E-08	1,3E-07	2,4E-07	6,1E-08	5,7E-07	8,4E-07	1,2E-06	1,4E-06	8,2E-08
Argent	PM10	1 an	2,4E-06	4,7E-07	7,8E-07	3,0E-07	1,4E-07	8,8E-08	5,1E-08	7,7E-07	1,6E-07	1,5E-07	5,3E-08	1,1E-07	8,2E-08	4,2E-07	2,1E-07	9,7E-08	9,2E-08	1,7E-07	3,1E-07	7,9E-08	7,4E-07	1,1E-06	1,5E-06	1,7E-06	1,1E-07
Arsenic	PM10	1 an	5,6E-05	1,1E-05	1,9E-05	6,6E-06	3,1E-06	2,0E-06	1,1E-06	1,9E-05	3,8E-06	3,7E-06	1,2E-06	2,5E-06	1,8E-06	1,1E-05	5,1E-06	2,2E-06	2,1E-06	4,2E-06	7,5E-06	1,9E-06	1,8E-05	2,7E-05	3,4E-05	3,7E-05	2,5E-06
Baryum	PM10	1 an	2,8E-03	5,7E-04	9,3E-04	3,6E-04	1,6E-04	1,1E-04	6,2E-05	8,7E-04	1,8E-04	1,7E-04	6,4E-05	1,3E-04	1,0E-04	5,0E-04	2,4E-04	1,2E-04	1,1E-04	2,0E-04	3,5E-04	9,2E-05	8,8E-04	1,3E-03	1,8E-03	2,2E-03	1,3E-04
Béryllium	PM10	1 an	2,7E-05	2,4E-06	5,3E-06	1,8E-06	7,7E-07	5,3E-07	3,0E-07	5,7E-06	1,1E-06	1,0E-06	3,2E-07	6,3E-07	4,7E-07	2,3E-06	1,4E-06	5,8E-07	5,6E-07	1,1E-06	2,2E-06	5,6E-07	3,3E-06	5,1E-06	7,3E-06	8,9E-06	6,5E-07
Bore	PM10	1 an	2,2E-04	3,6E-05	7,3E-05	2,0E-05	1,1E-05	8,1E-06	3,5E-06	7,6E-05	1,5E-05	1,5E-05	3,7E-06	9,4E-06	5,3E-06	5,1E-05	2,0E-05	8,2E-06	7,8E-06	1,7E-05	3,0E-05	7,6E-06	7,3E-05	1,1E-04	1,2E-04	1,2E-04	9,1E-06
Cadmium	PM10	1 an	1,8E-06	3,4E-07	5,7E-07	2,2E-07	1,0E-07	6,4E-08	3,7E-08	5,6E-07	1,1E-07	1,1E-07	3,9E-08	7,8E-08	6,0E-08	3,1E-07	1,5E-07	7,1E-08	6,7E-08	1,3E-07	2,2E-07	5,8E-08	5,4E-07	7,9E-07	1,1E-06	1,3E-06	7,7E-08
Chrome	PM10	1 an	3,7E-04	7,0E-05	1,2E-04	4,5E-05	2,1E-05	1,3E-05	7,6E-06	1,2E-04	2,4E-05	2,3E-05	8,0E-06	1,6E-05	1,2E-05	6,5E-05	3,2E-05	1,4E-05	1,4E-05	2,6E-05	4,7E-05	1,2E-05	1,1E-04	1,7E-04	2,3E-04	2,6E-04	1,6E-05
Cobalt	PM10	1 an	2,1E-04	4,3E-05	7,0E-05	2,7E-05	1,2E-05	8,0E-06	4,7E-06	6,6E-05	1,4E-05	1,3E-05	4,9E-06	9,9E-06	7,6E-06	3,7E-05	1,8E-05	9,0E-06	8,3E-06	1,5E-05	2,7E-05	6,9E-06	6,6E-05	9,6E-05	1,4E-04	1,7E-04	9,8E-06
Cuivre	PM10	1 an	1,5E-04	3,0E-05	4,8E-05	1,9E-05	8,5E-06	5,5E-06	3,2E-06	4,6E-05	9,5E-06	8,9E-06	3,3E-06	6,7E-06	5,2E-06	2,6E-05	1,3E-05	6,1E-06	5,7E-06	1,0E-05	1,9E-05	4,8E-06	4,6E-05	6,7E-05	9,4E-05	1,1E-04	6,7E-06
Étain	PM10	1 an	2,4E-05	3,5E-06	6,4E-06	2,4E-06	1,1E-06	6,9E-07	4,0E-07	6,5E-06	1,3E-06	1,2E-06	4,2E-07	8,4E-07	6,3E-07	3,3E-06	1,7E-06	7,6E-07	7,3E-07	1,4E-06	2,6E-06	6,6E-07	5,5E-06	8,2E-06	1,1E-05	1,3E-05	8,4E-07
Lithium	PM10	1 an	1,4E-03	1,7E-04	3,5E-04	1,2E-04	5,5E-05	3,6E-05	2,1E-05	3,6E-04	7,1E-05	6,7E-05	2,2E-05	4,4E-05	3,2E-05	1,7E-04	9,4E-05	4,0E-05	3,8E-05	7,5E-05	1,4E-04	3,6E-05	2,7E-04	4,1E-04	5,6E-04	6,5E-04	4,5E-05
Manganèse	PM10	1 an	6,8E-03	1,4E-03	2,3E-03	8,8E-04	4,0E-04	2,6E-04	1,5E-04	2,1E-03	4,4E-04	4,1E-04	1,6E-04	3,2E-04	2,5E-04	1,2E-03	5,8E-04	2,9E-04	2,7E-04	4,8E-04	8,6E-04	2,2E-04	2,1E-03	3,1E-03	4,4E-03	5,3E-03	3,2E-04
Mercure	PM10	1 an	9,5E-08	2,0E-08	3,2E-08	1,2E-08	5,7E-09	3,6E-09	2,1E-09	3,0E-08	6,2E-09	5,8E-09	2,2E-09	4,5E-09	3,5E-09	1,7E-08	8,2E-09	4,1E-09	3,8E-09	6,8E-09	1,2E-08	3,1E-09	3,0E-08	4,3E-08	6,3E-08	7,5E-08	4,5E-09
Molybdène	PM10	1 an	9,7E-06	1,6E-06	2,9E-06	1,1E-06	4,9E-07	3,2E-07	1,8E-07	2,9E-06	5,8E-07	5,5E-07	1,9E-07	3,9E-07	2,9E-07	1,5E-06	7,7E-07	3,4E-07	3,3E-07	6,3E-07	1,1E-06	2,9E-07	2,6E-06	3,8E-06	5,2E-06	6,1E-06	3,8E-07
Nickel	PM10	1 an	2,1E-04	4,2E-05	6,8E-05	2,6E-05	1,2E-05	7,7E-06	4,5E-06	6,5E-05	1,4E-05	1,3E-05	4,7E-06	9,5E-06	7,3E-06	3,7E-05	1,8E-05	8,6E-06	8,1E-06	1,5E-05	2,6E-05	6,8E-06	6,5E-05	9,5E-05	1,3E-04	1,6E-04	9,4E-06
Plomb	PM10	1 an	4,4E-05	9,0E-06	1,5E-05	5,7E-06	2,6E-06	1,7E-06	9,8E-07	1,4E-05	2,9E-06	2,7E-06	1,0E-06	2,1E-06	1,6E-06	7,9E-06	3,8E-06	1,9E-06	1,7E-06	3,2E-06	5,7E-06	1,5E-06	1,4E-05	2,0E-05	2,9E-05	3,4E-05	2,0E-06
Sélénium	PM10	1 an	4,7E-06	5,1E-07	1,1E-06	3,8E-07	1,6E-07	1,1E-07	6,3E-08	1,1E-06	2,1E-07	2,0E-07	6,6E-08	1,3E-07	9,8E-08	4,9E-07	2,8E-07	1,2E-07	1,1E-07	2,2E-07	4,2E-07	1,1E-07	7,6E-07	1,2E-06	1,6E-06	1,9E-06	1,3E-07
Strontium	PM10	1 an	1,5E-03	3,1E-04	5,1E-04	2,0E-04	9,1E-05	5,8E-05	3,4E-05	4,8E-04	1,0E-04	9,4E-05	3,6E-05	7,2E-05	5,5E-05	2,7E-04	1,3E-04	6,5E-05	6,1E-05	1,1E-04	2,0E-04	5,1E-05	4,8E-04	7,0E-04	1,0E-03	1,2E-03	7,1E-05
Titane	PM10	1 an	6,3E-02	1,3E-02	2,1E-02	8,2E-03	3,7E-03	2,4E-03	1,4E-03	2,0E-02	4,1E-03	3,8E-03	1,5E-03	3,0E-03	2,3E-03	1,1E-02	5,4E-03	2,7E-03	2,5E-03	4,5E-03	8,0E-03	2,1E-03	2,0E-02	2,9E-02	4,1E-02	5,0E-02	3,0E-03
Uranium	PM10	1 an	3,0E-06	4,4E-07	8,4E-07	2,9E-07	1,3E-07	8,8E-08	4,9E-08	8,6E-07	1,7E-07	1,6E-07	5,2E-08	1,1E-07	7,7E-08	4,5E-07	2,3E-07	9,7E-08	9,2E-08	1,8E-07	3,4E-07	8,5E-08	7,2E-07	1,1E-06	1,4E-06	1,6E-06	1,1E-07
Vanadium	PM10	1 an	1,5E-03	3,0E-04	4,9E-04	1,9E-04	8,6E-05	5,5E-05	3,3E-05	4,5E-04	9,5E-05	8,8E-05	3,4E-05	6,9E-05	5,3E-05	2,6E-04	1,2E-04	6,2E-05	5,8E-05	1,0E-04	1,8E-04	4,8E-05	4,6E-04	6,6E-04	9,5E-04	1,1E-03	6,8E-05
Zinc	PM10	1 an	7,2E-04	1,5E-04	2,4E-04	9,3E-05	4,2E-05	2,7E-05	1,6E-05	2,3E-04	4,7E-05	4,4E-05	1,7E-05	3,4E-05	2,6E-05	1,3E-04	6,2E-05	3,0E-05	2,8E-05	5,1E-05	9,1E-05	2,4E-05	2,2E-04	3,2E-04	4,7E-04	5,6E-04	3,3E-05
Silice cristalline	PM4	1 an	8,8E-02	1,3E-02	2,6E-02	8,7E-03	4,2E-03	2,8E-03	1,6E-03	2,7E-02	5,4E-03	5,2E-03	1,6E-03	3,4E-03	2,4E-03	1,5E-02	7,2E-03	3,0E-03	3,0E-03	5,9E-03	1,1E-02	2,8E-03	2,3E-02	3,5E-02	4,3E-02	4,6E-02	3,3E-03

TABLEAU E-1 Concentrations additionnelles dans l'air ambiant de la zone d'étude estimées par modélisation de la dispersion atmosphérique (WSP, 2018)

Substances	Taille des particules	Période	Concentration additionnelle estimée dans l'air ambiant (µg/m3)																									
			AQU6	AQU7	EAU1	EAU2	REL1	RIV1	TRP2	TRP3	TRP4	TRP5	TRP6	TRC1	MOT1	MOT2	MOT3	MOT4	MOT5	MOT6	MOT7	MOT8	AQU8	AQU9	EAU3	EAU4	EAU5	EAU6
NO2	-	1 mois	2,2E-01	2,4E-01	7,6E+00	1,0E+01	8,8E+00	2,3E-01	1,2E+00	2,4E+00	7,8E-01	2,1E+00	9,9E-01	5,8E+00	4,3E+00	1,4E+00	8,9E-01	3,0E-01	2,4E-01	2,2E-01	2,5E-01	1,6E-01	4,6E-01	5,5E-01	5,5E-01	4,1E-01	7,7E-01	2,8E-01
SO2	-	1 mois	5,4E-04	1,4E-03	3,9E-02	5,7E-02	4,9E-02	5,2E-04	4,9E-03	9,8E-03	4,4E-03	7,0E-03	2,6E-03	2,1E-02	1,7E-02	5,3E-03	2,2E-03	8,1E-04	6,3E-04	5,3E-04	6,8E-04	4,5E-04	1,3E-03	3,0E-03	2,2E-03	1,5E-03	3,5E-03	1,8E-03
PM2.5	-	1 mois	5,9E-02	3,2E-02	1,2E+00	1,2E+00	1,1E+00	6,1E-02	2,4E-01	5,2E-01	8,6E-02	6,0E-01	2,7E-01	1,5E+00	1,1E+00	2,5E-01	2,4E-01	8,3E-02	6,4E-02	6,0E-02	6,8E-02	4,3E-02	1,1E-01	5,8E-02	1,1E-01	1,0E-01	1,3E-01	3,4E-02
Aluminium	PM10	1 mois	2,2E-02	1,2E-02	5,1E-01	5,4E-01	4,6E-01	2,3E-02	9,5E-02	1,9E-01	3,2E-02	2,3E-01	1,0E-01	5,2E-01	4,6E-01	1,1E-01	9,6E-02	3,1E-02	2,6E-02	2,3E-02	2,6E-02	1,5E-02	4,1E-02	2,4E-02	4,1E-02	3,7E-02	5,2E-02	1,3E-02
Antimoine	PM10	1 mois	1,4E-07	7,4E-08	3,3E-06	3,5E-06	3,0E-06	1,5E-07	6,2E-07	1,3E-06	2,2E-07	1,5E-06	6,7E-07	3,4E-06	2,8E-06	7,0E-07	5,9E-07	2,0E-07	1,6E-07	1,4E-07	1,6E-07	9,8E-08	2,7E-07	1,7E-07	2,7E-07	2,4E-07	3,3E-07	8,7E-08
Argent	PM10	1 mois	1,8E-07	9,5E-08	4,2E-06	4,5E-06	3,9E-06	1,9E-07	8,0E-07	1,7E-06	3,0E-07	2,0E-06	8,7E-07	4,5E-06	3,6E-06	9,1E-07	7,6E-07	2,6E-07	2,0E-07	1,8E-07	2,1E-07	1,3E-07	3,5E-07	2,2E-07	3,6E-07	3,2E-07	4,3E-07	1,1E-07
Arsenic	PM10	1 mois	4,2E-06	2,9E-06	1,1E-04	1,4E-04	1,2E-04	4,1E-06	2,2E-05	4,7E-05	9,9E-06	6,6E-05	2,3E-05	1,1E-04	7,3E-05	2,8E-05	2,1E-05	6,0E-06	4,5E-06	4,0E-06	4,8E-06	3,0E-06	9,5E-06	7,0E-06	1,2E-05	9,4E-06	1,3E-05	3,1E-06
Baryum	PM10	1 mois	2,1E-04	1,1E-04	4,9E-03	5,2E-03	4,5E-03	2,3E-04	9,3E-04	1,8E-03	3,1E-04	2,2E-03	9,9E-04	4,9E-03	4,5E-03	1,1E-03	9,5E-04	3,1E-04	2,5E-04	2,3E-04	2,5E-04	1,5E-04	4,0E-04	2,3E-04	4,0E-04	3,6E-04	5,1E-04	1,3E-04
Béryllium	PM10	1 mois	1,0E-06	6,3E-07	2,7E-05	3,2E-05	2,8E-05	9,9E-07	5,3E-06	1,4E-05	2,1E-06	1,1E-05	4,8E-06	4,9E-05	2,4E-05	4,6E-06	3,6E-06	1,8E-06	9,7E-07	9,8E-07	1,4E-06	7,3E-07	2,2E-06	1,5E-06	2,1E-06	1,7E-06	2,8E-06	7,9E-07
Bore	PM10	1 mois	1,5E-05	1,7E-05	6,3E-04	8,9E-04	7,8E-04	1,5E-05	1,1E-04	2,5E-04	5,9E-05	4,4E-04	1,2E-04	5,7E-04	3,0E-04	2,1E-04	1,4E-04	2,4E-05	2,2E-05	1,6E-05	1,8E-05	1,1E-05	4,3E-05	3,9E-05	6,8E-05	5,3E-05	7,1E-05	2,1E-05
Cadmium	PM10	1 mois	1,3E-07	6,9E-08	3,1E-06	3,3E-06	2,8E-06	1,4E-07	5,8E-07	1,2E-06	2,1E-07	1,4E-06	6,3E-07	3,2E-06	2,7E-06	6,6E-07	5,6E-07	1,9E-07	1,5E-07	1,4E-07	1,5E-07	9,3E-08	2,6E-07	1,6E-07	2,6E-07	2,3E-07	3,1E-07	8,2E-08
Chrome	PM10	1 mois	2,7E-05	1,5E-05	6,5E-04	7,0E-04	5,9E-04	2,8E-05	1,2E-04	2,6E-04	4,7E-05	3,1E-04	1,3E-04	6,8E-04	5,4E-04	1,4E-04	1,1E-04	3,9E-05	3,0E-05	2,8E-05	3,2E-05	1,9E-05	5,5E-05	3,5E-05	5,7E-05	4,9E-05	6,6E-05	1,7E-05
Cobalt	PM10	1 mois	1,6E-05	8,5E-06	3,7E-04	3,9E-04	3,4E-04	1,8E-05	7,0E-05	1,3E-04	2,4E-05	1,7E-04	7,4E-05	3,7E-04	3,4E-04	8,1E-05	7,2E-05	2,3E-05	1,9E-05	1,7E-05	1,9E-05	1,1E-05	3,0E-05	1,7E-05	3,0E-05	2,7E-05	3,9E-05	9,3E-06
Cuivre	PM10	1 mois	1,1E-05	5,9E-06	2,6E-04	2,7E-04	2,3E-04	1,2E-05	4,9E-05	9,7E-05	1,6E-05	1,2E-04	5,2E-05	2,6E-04	2,3E-04	5,6E-05	4,9E-05	1,6E-05	1,3E-05	1,2E-05	1,3E-05	7,9E-06	2,1E-05	1,3E-05	2,1E-05	1,9E-05	2,7E-05	6,7E-06
Étain	PM10	1 mois	1,4E-06	7,9E-07	3,4E-05	3,8E-05	3,3E-05	1,4E-06	6,5E-06	1,5E-05	2,6E-06	1,6E-05	6,9E-06	4,3E-05	2,9E-05	7,0E-06	5,7E-06	2,1E-06	1,5E-06	1,4E-06	1,7E-06	1,0E-06	2,9E-06	1,9E-06	3,0E-06	2,5E-06	3,6E-06	9,7E-07
Lithium	PM10	1 mois	7,2E-05	4,5E-05	1,8E-03	2,2E-03	2,0E-03	7,0E-05	3,6E-04	8,8E-04	1,5E-04	9,1E-04	3,6E-04	2,6E-03	1,5E-03	3,6E-04	3,0E-04	1,1E-04	7,4E-05	7,1E-05	9,2E-05	5,2E-05	1,6E-04	1,1E-04	1,6E-04	1,4E-04	2,0E-04	5,3E-05
Manganèse	PM10	1 mois	5,2E-04	2,7E-04	1,2E-02	1,3E-02	1,1E-02	5,7E-04	2,2E-03	4,3E-03	7,7E-04	5,3E-03	2,4E-03	1,2E-02	1,1E-02	2,6E-03	2,3E-03	7,5E-04	6,3E-04	5,6E-04	6,1E-04	3,7E-04	9,5E-04	5,4E-04	9,7E-04	8,6E-04	1,2E-03	3,0E-04
Mercure	PM10	1 mois	7,4E-09	3,9E-09	1,7E-07	1,8E-07	1,5E-07	8,1E-09	3,1E-08	6,0E-08	1,1E-08	7,5E-08	3,3E-08	1,7E-07	1,6E-07	3,6E-08	3,3E-08	1,1E-08	8,9E-09	7,9E-09	8,6E-09	5,2E-09	1,3E-08	7,4E-09	1,4E-08	1,2E-08	1,8E-08	4,2E-09
Molybdène	PM10	1 mois	6,4E-07	3,5E-07	1,6E-05	1,7E-05	1,4E-05	6,5E-07	2,9E-06	6,6E-06	1,2E-06	7,4E-06	3,2E-06	1,8E-05	1,3E-05	3,3E-06	2,6E-06	9,5E-07	7,0E-07	6,5E-07	7,7E-07	4,6E-07	1,3E-06	8,6E-07	1,4E-06	1,2E-06	1,6E-06	4,3E-07
Nickel	PM10	1 mois	1,6E-05	8,4E-06	3,7E-04	3,9E-04	3,3E-04	1,7E-05	6,9E-05	1,4E-04	2,3E-05	1,7E-04	7,5E-05	3,7E-04	3,2E-04	8,0E-05	6,9E-05	2,3E-05	1,9E-05	1,7E-05	1,8E-05	1,1E-05	3,0E-05	1,8E-05	3,0E-05	2,7E-05	3,8E-05	9,5E-06
Plomb	PM10	1 mois	3,4E-06	1,8E-06	7,9E-05	8,3E-05	7,2E-05	3,6E-06	1,5E-05	3,0E-05	5,0E-06	3,6E-05	1,6E-05	7,9E-05	7,0E-05	1,7E-05	1,5E-05	4,9E-06	4,0E-06	3,6E-06	4,0E-06	2,4E-06	6,4E-06	3,8E-06	6,4E-06	5,8E-06	8,1E-06	2,0E-06
Sélénium	PM10	1 mois	2,1E-07	1,2E-07	5,4E-06	6,0E-06	5,3E-06	2,1E-07	1,0E-06	2,6E-06	4,0E-07	2,4E-06	1,0E-06	8,4E-06	4,7E-06	1,0E-06	8,1E-07	3,5E-07	2,2E-07	2,1E-07	2,8E-07	1,5E-07	4,5E-07	3,0E-07	4,3E-07	3,7E-07	5,6E-07	1,5E-07
Strontium	PM10	1 mois	1,2E-04	6,2E-05	2,7E-03	2,9E-03	2,5E-03	1,3E-04	5,1E-04	9,9E-04	1,7E-04	1,2E-03	5,4E-04	2,7E-03	2,5E-03	5,9E-04	5,2E-04	1,7E-04	1,4E-04	1,3E-04	1,4E-04	8,4E-05	2,2E-04	1,3E-04	2,2E-04	2,0E-04	2,8E-04	6,9E-05
Titane	PM10	1 mois	4,9E-03	2,6E-03	1,1E-01	1,2E-01	1,0E-01	5,3E-03	2,1E-02	4,0E-02	7,2E-03	5,0E-02	2,2E-02	1,1E-01	1,0E-01	2,4E-02	2,2E-02	7,0E-03	5,9E-03	5,2E-03	5,7E-03	3,4E-03	8,8E-03	4,9E-03	9,0E-03	8,0E-03	1,2E-02	2,8E-03
Uranium	PM10	1 mois	1,8E-07	1,2E-07	4,5E-06	5,8E-06	5,1E-06	1,7E-07	9,2E-07	2,1E-06	4,0E-07	2,5E-06	9,4E-07	5,6E-06	3,4E-06	9,6E-07	8,3E-07	2,7E-07	1,8E-07	1,7E-07	2,2E-07	1,3E-07	4,0E-07	2,9E-07	4,5E-07	3,7E-07	5,3E-07	1,3E-07
Vanadium	PM10	1 mois	1,1E-04	5,9E-05	2,6E-03	2,7E-03	2,3E-03	1,2E-04	4,8E-04	9,2E-04	1,7E-04	1,1E-03	5,1E-04	2,6E-03	2,4E-03	5,6E-04	5,0E-04	1,6E-04	1,3E-04	1,2E-04	1,3E-04	7,9E-05	2,0E-04	1,1E-04	2,1E-04	1,8E-04	2,7E-04	6,4E-05
Zinc	PM10	1 mois	5,5E-05	2,9E-05	1,3E-03	1,3E-03	1,1E-03	6,0E-05	2,4E-04	4,7E-04	8,1E-05	5,7E-04	2,5E-04	1,3E-03	1,2E-03	2,7E-04	2,4E-04	7,9E-05	6,6E-05	5,9E-05	6,4E-05	3,9E-05	1,0E-04	5,8E-05	1,0E-04	9,1E-05	1,3E-04	3,2E-05
NO2	-	1 an	8,7E-02	6,1E-02	2,7E+00	3,0E+00	2,6E+00	9,7E-02	4,3E-01	1,1E+00	1,7E-01	1,2E+00	4,7E-01	3,1E+00	2,2E+00	5,2E-01	4,4E-01	1,4E-01	1,2E-01	1,0E-01	1,1E-01	5,8E-02	1,9E-01	1,2E-01	2,0E-01	2,0E-01	2,2E-01	6,0E-02
SO2	-	1 an	1,9E-04	1,6E-04	8,1E-03	9,7E-03	8,0E-03	2,1E-04	1,1E-03	3,0E-03	4,4E-04	2,6E-03	1,0E-03	9,8E-03	5,3E-03	1,1E-03	8,8E-04	3,0E-04	2,7E-04	2,2E-04	2,4E-04	1,3E-04	4,4E-04	3,0E-04	4,8E-04	4,7E-04	5,8E-04	1,6E-04
PM2.5	-	1 an	2,3E-02	1,6E-02	6,5E-01	6,9E-01	6,1E-01	2,6E-02	1,1E-01	2,8E-01	4,4E-02	3,4E-01	1,3E-01	8,0E-01	5,7E-01	1,4E-01	1,2E-01	3,8E-02	3,3E-02	2,9E-02	3,0E-02	1,5E-02	5,0E-02	3,1E-02	5,2E-02	5,5E-02	5,7E-02	1,6E-02
Aluminium	PM10	1 an	8,7E-03	6,0E-03	2,7E-01	2,9E-01	2,5E-01	9,8E-03	4,2E-02	1,0E-01	1,7E-02	1,3E-01	5,0E-02	2,9E-01	2,4E-01	5,6E-02	4,8E-02	1,4E-02	1,3E-02	1,1E-02	1,1E-02	5,6E-03	1,8E-02	1,2E-02	1,9E-02	2,0E-02	2,1E-02	5,8E-03
Antimoine	PM10	1 an	5,5E-08	3,8E-08	1,7E-06	1,8E-06	1,6E-06	6,1E-08	2,7E-07	6,5E-07	1,1E-07	8,5E-07	3,3E-07	1,9E-06	1,5E-06	3,6E-07	3,1E-07	9,0E-08	8,0E-08	6,7E-08	7,1E-08	3,5E-08	1,2E-07	7,3E-08	1,2E-07	1,3E-07	1,3E-07	3,7E-08
Argent	PM10	1 an	7,0E-08	4,8E-08	2,2E-06	2,4E-06	2,0E-06	7,9E-08	3,5E-07	8,5E-07	1,4E-07	1,1E-06	4,3E-07	2,4E-06	1,9E-06	4,6E-07	4,0E-07	1,2E-07	1,0E-07	8,7E-08	9,2E-08	4,5E-08	1,5E-07	9,4E-08	1,6E-07	1,7E-07	1,7E-07	4,7E-08
Arsenic	PM10	1 an	1,5E-06	1,1E-06	5,1E-05	5,6E-05	4,8E-05	1,7E-06	8,7E-06	2,0E-05	3,2E-06	2,9E-05	1,1E-05	5,5E-05	4,1E-05	1,1E-05	9,9E-06	2,6E-06	2,3E-06	1,9E-06	2,0E-06	9,9E-07	3,8E-06	2,0E-06	3,8E-06	4,1E-06	4,3E-06	1,0E-06
Baryum	PM10	1 an	8,5E-05	5,8E-05	2,6E-03	2,8E-03	2,4E-03	9,6E-05	4,1E-04	9,6E-04	1,6E-04	1,3E-03	4,9E-04	2,7E-03	2,4E-03	5,5E-04	4,8E-04	1,4E-04	1,3E-04	1,1E-04	1,1E-04	5,5E-05	1,8E-04	1,1E-04	1,9E-04	2,0E-04	2,0E-04	5,7E-05
Béryllium	PM10	1 an	4,1E-07	2,9E-07	1,5E-05	1,6E-05	1,4E-05	4,8E-07	2,5E-06	7,3E-06	8,0E-07	7,2E-06	2,8E-06	2,7E-05	1,2E-05	2,4E-06	2,1E-06	6,8E-07	5,5E-07	5,1E-07	5,4E-07	2,7E-07	1,0E-06	5,3E-07	1,0E-06	1,1E-06	1,2E-06	2,8E-07
Bore	PM10	1 an	4,5E-06	3,5E-06	1,9E-04	2,2E-04	1,8E-04	4,9E-06	3,5E-05	7,7E-05	1,2E-05	1,3E-04	4,5E-05	1,7E-04	1,2E-04	4,2E-05	4,0E-05	8,5E-06	7,9E-06	5,8E-06	6,3E-06	3,1E-06	1,5E-05	7,0E-06	1,4E-05	1,6E-05	1,7E-05	3,4E-06
Cadmium	PM10	1 an	5,1E-08	3,5E-08	1,6E-06	1,7E-06	1,5E-06	5,8E-08	2,6E-07	6,2E-07	1,0E-07	8,0E-07	3,1E-07	1,8E-06	1,4E-06	3,4E-07	2,9E-07	8,5E-08	7,5E-08	6,3E-08	6,7E-08	3,3E-08	1,1E-07	6,9E-08	1,2E-07	1,2E-07	1,3E-07	3,4E-08
Chrome	PM10	1 an	1,0E-05	7,3E-06	3,4E-04	3,6E-04	3,1E-04	1,2E-05	5,4E-05	1,3E-04	2,1E-05	1,7E-04	6,5E-05	3,7E-04	2,9E-04	7,0E-05	6,1E-05	1,7E-05	1,5E-05	1,3E-05	1,4E-05	6,8E-06	2,3E-05	1,4E-05	2,4E-05	2,6E-05	2,7E-05	7,1E-06
Cobalt	PM10	1 an	6,5E-06	4,4E-06	2,0E-04	2,1E-04	1,8E-04	7,3E-06	3,1E-05	7,2E-05	1,3E-05	9,3E-05	3,7E-05	2,1E-04	1,8E-04	4,1E-05	3,6E-05	1,1E-05	9,6E-06	8,1E-06	8,5E-06	4,2E-06	1,3E-05	8,8E-06	1,4E-05	1,5E-05	1,5E-05	4,4E-06
Cuivre	PM10	1 an	4,4E-06	3,0E-06	1,4E-04	1,5E-04	1,3E-04	5,0E-06	2,1E-05	5,0E-05	8,5E-06	6,6E-05	2,6E-05	1,4E-04	1,2E-04	2,9E-05	2,5E-05	7,3E-06	6,5E-06	5,5E-06	5,8E-06	2,9E-06	9,3E-06	5,9E-06	9,8E-06	1,0E-05	1,1E-05	3,0E-06
Étain	PM10	1 an	5,4E-07	3,8E-07	1,8E-05	1,9E-05	1,7E-05	6,2E-07	3,0E-06	7,5E-06	1,1E-06	9,2E-06	3,5E-06	2,4E-05	1,5E-05	3,5E-06	3,1E-06	9,1E-07	7,8E-07	6,7E-07	7,2E-07	3,5E-07	1,3E-06	7,2E-07	1,3E-06	1,4E-06	1,4E-06	3,7E-07
Lithium	PM10	1 an	2,8E-05	1,9E-05	9,7E-04	1,0E-03	9,1E-04	3,2E-05	1,6E-04	4,3E-04	5,7E-05	5,0E-04	1,9E-04	1,4E-03	8,0E-04	1,8E-04	1,6E-04	4,7E-05	4,0E-05	3,5E-05	3,7E-05	1,8E-05	7,0E-05	3,7E-05	6,8E-05	7,4E-05	7,9E-05	1,9E-05
Manganèse	PM10	1 an	2,1E-04	1,4E-04	6,4E-03	6,8E-03	5,9E-03	2,4E-04	9,9E-04	2,3E-03	4,0E-04	3,0E-03	1,2E-03	6,7E-03	5,9E-03	1,3E-03	1,1E-03	3,5E-04	3,1E-04	2,6E-04	2,7E-04	1,4E-04	4,3E-04	2,8E-04	4,5E-04	4,8E-04	4,9E-04	1,4E-04
Mercure	PM10	1 an	3,0E-09	2,0E-09	9,1E-08	9,5E-08	8,3E-08	3,3E-09	1,4E-08	3,3E-08	5,7E-09	4,2E-08	1,7E-08	9,4E-08	8,3E-08	1,9E-08	1,6E-08	4,9E-09	4,4E-09	3,7E-09	3,9E-09	1,9E-09	6,0E-09	4,0E-09	6,4E-09	6,7E-09	6,9E-09	2,0E-09
Molybdène	PM10	1 an	2,5E-07	1,7E-07	8,1E-06	8,7E-06	7,5E-06	2,8E-07	1,3E-06	3,2E-06	4,9E-07	4,1E-06	1,6E-06	9,7E-06	6,9E-06	1,6E-06	1,4E-06	4,1E-07	3,6E-07	3,1E-07	3,3E-07	1,6E-07	5,7E-07	3,3E-07	5,8E-07	6,2E-07	6,5E-07	1,7E-07
Nickel	PM10	1 an	6,2E-06	4,3E-06	1,9E-04	2,1E-04	1,8E-04	7,0E-06	3,0E-05	7,1E-05	1,2E-05	9,4E-05	3,7E-05	2,0E-04	1,7E-04	4,1E-05	3,5E-05	1,0E-05	9,2E-06	7,7E-06	8,2E-06	4,0E-06	1,3E-05	8,4E-06	1,4E-05	1,5E-05	1,5E-05	4,2E-06
Plomb	PM10	1 an	1,3E-06	9,2E-07	4,2E-05	4,4E-05	3,8E-05	1,5E-06	6,5E-06	1,5E-05	2,6E-06	2,0E-05	7,8E-06	4,3E-05	3,7E-05	8,7E-06	7,6E-06	2,2E-06	2,0E-06	1,7E-06	1,8E-06	8,7E-07	2,8E-06	1,8E-06	3,0E-06	3,2E-06	3,2E-06	9,1E-07
Sélénium	PM10	1 an	8,5E-08	5,9E-08	2,9E-06	3,1E-06	2,8E-06	9,8E-08	4,9E-07	1,3E-06	1,7E-07	1,4E-06	5,6E-07	4,7E-06	2,5E-06	5,2E-07	4,5E-07	1,4E-07	1,2E-07	1,1E-07	1,1E-07	5,5E-08	2,1E-07	1,1E-07	2,0E-07	2,2E-07	2,3E-07	5,8E-08
Strontium	PM10	1 an	4,7E-05	3,2E-05	1,5E-03	1,5E-03	1,3E-03	5,3E-05	2,2E-04	5,3E-04	9,1E-05	6,9E-04	2,7E-04	1,5E-03	1,3E-03	3,0E-04	2,6E-04	7,8E-05	6,9E-05	5,8E-05	6,2E-05	3,0E-05	9,7E-05	6,4E-05	1,0E-04	1,1E-04	1,1E-04	3,2E-05
Titane	PM10	1 an	2,0E-03	1,3E-03	6,0E-02	6,3E-02	5,5E-02	2,2E-03	9,2E-03	2,2E-02	3,8E-03	2,8E-02	1,1E-02	6,2E-02	5,5E-02	1,2E-02	1,1E-02	3,2E-03	2,9E-03	2,4E-03	2,6E-03	1,3E-03	4,0E-03	2,6E-03	4,2E-03	4,5E-03	4,5E-03	1,3E-03
Uranium	PM10	1 an	6,7E-08	4,7E-08	2,3E-06	2,5E-06	2,2E-06	7,6E-08	3,9E-07	9,9E-07	1,4E-07	1,2E-06	4,7E-07	3,0E-06	1,9E-06	4,6E-07	4,1E-07	1,1E-07	9,8E-08	8,3E-08	8,9E-08	4,4E-08	1,7E-07	8,9E-08	1,7E-07	1,8E-07	1,9E-07	4,5E-08
Vanadium	PM10	1 an	4,5E-05	3,1E-05	1,4E-03	1,5E-03	1,3E-03	5,1E-05	2,1E-04	5,0E-04	8,7E-05	6,4E-04	2,5E-04	1,4E-03	1,3E-03	2,9E-04	2,5E-04	7,4E-05	6,6E-05	5,6E-05	5,9E-05	2,9E-05	9,2E-05	6,1E-05	9,7E-05	1,0E-04	1,0E-04	3,0E-05
Zinc	PM10	1 an	2,2E-05	1,5E-05	6,8E-04	7,2E-04	6,2E-04	2,5E-05	1,1E-04	2,5E-04	4,3E-05	3,2E-04	1,3E-04	7,2E-04	6,2E-04	1,4E-04	1,2E-04	3,6E-05	3,2E-05	2,7E-05	2,9E-05	1,4E-05	4,5E-05	3,0E-05	4,8E-05	5,1E-05	5,2E-05	1,5E-05
Silice cristalline	PM4	1 an	2,1E-03	1,5E-03	6,6E-02	7,1E-02	6,2E-02	2,4E-03	1,2E-02	3,0E-02	4,3E-03	3,9E-02	1,5E-02	8,8E-02	5,2E-02	1,4E-02	1,3E-02	3,6E-03	3,1E-03	2,6E-03	2,8E-03	1,4E-03	5,4E-03	2,8E-03	5,3E-03	5,8E-03	6,0E-03	1,4E-03

TABLEAU E-2 Taux de dépôt atmosphérique (g/m^2/an) utilisés pour estimer les concentrations additionnelles dans l'eau de surface de la zone d'exposition rapprochée

Récepteur sensible:	TRP5	CPT1	CPT1	PLT1	AQU1	AQU2	AQU3	AQU4	MOT1	CHS1
Cours d'eau représenté:	CE1	CE2	CE3	CE4	CE5	CE5	CE5	CE5	CE5	CE5
Aluminium	6,9E-01	5,6E+00	5,6E+00	2,5E+00	4,4E-01	6,0E-01	7,7E-01	8,5E-01	8,1E-01	4,3E-01
Antimoine	4,9E-06	3,6E-05	3,6E-05	1,6E-05	2,8E-06	3,9E-06	4,9E-06	5,4E-06	5,1E-06	2,8E-06
Argent	6,5E-06	4,7E-05	4,7E-05	2,0E-05	3,6E-06	5,1E-06	6,3E-06	6,9E-06	6,6E-06	3,6E-06
Arsenic	2,2E-04	1,0E-03	1,0E-03	5,1E-04	1,0E-04	1,4E-04	1,5E-04	1,7E-04	1,7E-04	9,9E-05
Baryum	6,7E-03	5,3E-02	5,3E-02	2,4E-02	4,3E-03	5,9E-03	7,6E-03	8,4E-03	8,0E-03	4,2E-03
Béryllium	2,6E-05	5,2E-04	5,2E-04	8,3E-05	1,2E-05	1,8E-05	2,1E-05	2,3E-05	2,4E-05	1,5E-05
Bore	1,3E-03	3,2E-03	3,2E-03	2,1E-03	5,0E-04	6,6E-04	6,4E-04	7,1E-04	7,1E-04	4,7E-04
Cadmium	4,6E-06	3,4E-05	3,4E-05	1,5E-05	2,6E-06	3,7E-06	4,6E-06	5,1E-06	4,8E-06	2,6E-06
Chrome	1,0E-03	7,0E-03	7,0E-03	3,1E-03	5,6E-04	7,9E-04	9,6E-04	1,1E-03	1,0E-03	5,6E-04
Cobalt	4,8E-04	4,0E-03	4,0E-03	1,8E-03	3,2E-04	4,4E-04	5,8E-04	6,3E-04	6,1E-04	3,1E-04
Cuivre	3,7E-04	2,7E-03	2,7E-03	1,3E-03	2,3E-04	3,1E-04	4,0E-04	4,4E-04	4,2E-04	2,2E-04
Étain	5,1E-05	4,5E-04	4,5E-04	1,5E-04	2,6E-05	3,7E-05	4,4E-05	4,9E-05	4,8E-05	2,7E-05
Lithium	2,6E-03	2,8E-02	2,8E-02	7,3E-03	1,3E-03	1,8E-03	2,1E-03	2,3E-03	2,3E-03	1,3E-03
Manganèse	1,5E-02	1,3E-01	1,3E-01	5,9E-02	1,0E-02	1,4E-02	1,9E-02	2,0E-02	1,9E-02	1,0E-02
Mercure	2,1E-07	1,8E-06	1,8E-06	8,2E-07	1,5E-07	2,0E-07	2,6E-07	2,9E-07	2,7E-07	1,4E-07
Molybdène	2,4E-05	1,9E-04	1,9E-04	7,2E-05	1,3E-05	1,8E-05	2,2E-05	2,4E-05	2,3E-05	1,3E-05
Nickel	5,3E-04	3,9E-03	3,9E-03	1,8E-03	3,2E-04	4,5E-04	5,7E-04	6,2E-04	5,9E-04	3,2E-04
Plomb	1,1E-04	8,4E-04	8,4E-04	3,9E-04	6,9E-05	9,6E-05	1,2E-04	1,3E-04	1,3E-04	6,8E-05
Sélénium	6,3E-06	8,9E-05	8,9E-05	2,0E-05	3,2E-06	4,6E-06	5,6E-06	6,1E-06	6,1E-06	3,6E-06
Strontium	3,6E-03	2,9E-02	2,9E-02	1,3E-02	2,4E-03	3,2E-03	4,2E-03	4,6E-03	4,4E-03	2,3E-03
Titane	1,4E-01	1,2E+00	1,2E+00	5,5E-01	9,7E-02	1,3E-01	1,7E-01	1,9E-01	1,8E-01	9,3E-02
Uranium	7,9E-06	5,8E-05	5,8E-05	2,0E-05	3,6E-06	5,1E-06	5,7E-06	6,4E-06	6,3E-06	3,7E-06
Vanadium	3,3E-03	2,8E-02	2,8E-02	1,3E-02	2,2E-03	3,1E-03	4,0E-03	4,4E-03	4,2E-03	2,2E-03
Zinc	1,6E-03	1,4E-02	1,4E-02	6,2E-03	1,1E-03	1,5E-03	1,9E-03	2,1E-03	2,0E-03	1,1E-03

TABLEAU E-3 Concentrations (mg/kg) de métaux mesurées dans les sols de la zone d'étude (teneurs de fond)

Identification de l'échantillon	Date	Profondeur minimale (m)	Profondeur maximale (m)	Argent	Aluminium	Arsenic	Baryum	Cadmium	Cobalt	Chrome	Cuivre	Mercure	Lithium	Manganèse	Molybdène	Nickel	Plomb	Antimoine	Sélénium	Étain	Titane	Vanadium	Zinc
TR-04-PM1	08-30-2017	0,80	1,30	<0,5	5610	<5,0	<20	<0,9	<15	<45	<40	<0,2	<2	38	<2	<30	<30	<20	<1,0	<5	373	<15	<100
TR-05-PM1	08-30-2017	0,90	1,40	<0,5	4270	<5,0	<20	<0,9	<15	<45	<40	<0,2	<2	32	<2	<30	<30	<20	<1,0	<5	344	<15	<100
TR-10-PM2	08-30-2017	1,00	2,00	<0,5	12500	12,7	49	<0,9	<15	47	<40	<0,2	15	134	<2	<30	<30	<20	<1,0	<5	773	26,00	<100
TR-11-PM1	08-30-2017	0,80	1,30	<0,5	3540	<5,0	28	<0,9	<15	<45	<40	<0,2	4	46	<2	<30	<30	<20	<1,0	<5	395	<15	<100
TR-12-PM2	08-30-2017	0,20	0,70	<0,5	2990	<5,0	<20	<0,9	<15	<45	<40	<0,2	<2	40	<2	<30	<30	<20	<1,0	<5	321	<15	<100
TR-24-PM2	08-30-2017	0,20	0,50	<0,5	7390	<5,0	<20	<0,9	<15	<45	<40	<0,2	<2	68	<2	<30	<30	<20	<1,0	<5	360	<15	<100
TR-26-PM2	08-30-2017	0,70	1,20	<0,5	5040	<5,0	<20	<0,9	<15	<45	<40	<0,2	<2	64	<2	<30	<30	<20	<1,0	<5	446	<15	<100
TR-30-PM2	08-30-2017	0,20	0,70	<0,5	1650	<5,0	<20	<0,9	<15	<45	<40	<0,2	<2	23	<2	<30	<30	<20	<1,0	<5	261	<15	<100
TR-36-PM2	08-30-2017	0,30	0,70	<0,5	13800	<5,0	<20	<0,9	<15	<45	<40	<0,2	<2	34	<2	<30	<30	<20	<1,0	<5	434	19,00	<100
CE-TR3/PM2	08-30-2017	0,20	0,50	<0,5	6500	<5,0	<20	<0,9	<15	<45	<40	<0,2	4	36	<2	<30	<30	<7	<1	<5	412	16,00	<100
CE-TR6/PM2	08-30-2017	0,50	1,20	<0,5	6750	<5,0	<20	<0,9	<15	<45	<40	<0,2	8	75	<2	<30	<30	<7	<1	<5	505	19,00	<100
CE-TR9/PM1	08-30-2017	0,20	0,50	<0,5	7690	<5,0	23	<0,9	<15	<45	<40	<0,2	6	99	<2	<30	<30	<7	<1	<5	480	19,00	<100
CE-TR10/PM1	08-30-2017	0,00	0,40	<0,5	2590	<5,0	<20	<0,9	<15	<45	<40	<0,2	5	58	<2	<30	<30	<7	<1	<5	330	<15	<100
TR-24-PM3	08-30-2017	0,50	1,40	<0,5	5290	<5,0	27	<0,9	<15	<45	<40	<0,2	3	112	<2	<30	<30	<20	<1,0	<5	367	<15	<100
TR-30-PM4	08-30-2017	1,50	2,80	<0,5	1210	<5,0	<20	<0,9	<15	<45	<40	<0,2	<2	26	<2	<30	<30	<20	<1,0	<5	216	<15	<100
TR-31-PM1	08-30-2017	0,50	1,50	<0,5	2370	<5,0	<20	<0,9	<15	<45	<40	<0,2	<2	29	<2	<30	<30	<20	<1,0	<5	283	<15	<100
TR-33-PM1	08-30-2017	0,90	2,00	<0,5	3600	<5,0	<20	<0,9	<15	<45	<40	<0,2	<2	38	<2	<30	<30	<20	<1,0	<5	346	<15	<100
CE-TR4/PM3	08-30-2017	1,30	2,50	<0,5	2080	<5,0	<20	<0,9	<15	<45	<40	<0,2	3	35	<2	<30	<30	<7	<1	<5	232	<15	<100
CE-TR7/PM2	08-30-2017	1,00	2,00	<0,5	1270	<5,0	<20	<0,9	<15	<45	<40	<0,2	<2	26	<2	<30	<30	<7	<1	<5	180	<15	<100
CE-TR11/PM2	08-30-2017	1,00	2,00	<0,5	2060	<5,0	<20	<0,9	<15	<45	<40	<0,2	4	43	<2	<30	<30	<7	<1	<5	206	<15	<100
BH-14-SS-3	02-18-2018	1,60	2,25	<0,5	4190	12,5	48	<0,9	<15	<45	<40	<0,2	<2	75	<2	<30	<30	<7	<1,0	-	468	18,00	<100
BH-21-SS-4	02-18-2018	2,29	2,98	<0,5	3640	<5,0	43	<0,9	<15	<45	<40	<0,2	<2	92	<2	<30	<30	<7	<1,0	-	489	17,00	<100
BH-22-SS-2A	02-18-2018	0,76	0,97	<0,5	3490	<5,0	23	<0,9	<15	<45	<40	<0,2	<2	52	<2	<30	<30	<7	<1,0	-	403	<15	<100
BH-31-SS-2	02-18-2018	0,76	1,52	<0,5	2840	<5,0	23	<0,9	<15	<45	<40	<0,2	<2	70	<2	<30	<30	<7	<1,0	-	331	<15	<100
BH-33-SS-3	02-18-2018	1,52	2,29	<0,5	2620	<5,0	25	<0,9	<15	<45	<40	<0,2	<2	54	<2	<30	<30	<7	<1,0	-	376	<15	<100
BH-40-SS-3A	02-18-2018	1,52	1,78	<0,5	4780	<5,0	54	<0,9	<15	<45	<40	<0,2	<2	101	<2	<30	<30	<7	<1,0	-	468	21,00	<100
BH-45-SS-2	02-18-2018	0,76	1,29	<0,5	4050	<5,0	24	<0,9	<15	69	<40	<0,2	<2	139	10	<30	<30	<7	<1,0	-	575	20,00	<100
BH-46-SS-2	02-18-2018	0,76	1,45	<0,5	1860	<5,0	<20	<0,9	<15	<45	<40	<0,2	<2	21	<2	<30	<30	<7	<1,0	-	339	<15	<100
BH-48-SS-3	02-18-2018	1,45	2,21	<0,5	1840	<5,0	<20	<0,9	<15	<45	<40	<0,2	<2	30	<2	<30	<30	<7	<1,0	-	322	<15	<100
BH-53-SS-3	02-18-2018	1,45	2,21	<0,5	1730	<5,0	<20	<0,9	<15	<45	<40	<0,2	<2	29	<2	<30	<30	<7	<1,0	-	306	<15	<100
TR-12-PM3	08-30-2017	0,7	2,3	<0,5	1480	<5,0	<20	<0,9	<15	<45	<40	<0,2	<2	27,00	<2	<30	<30	<20	<1,0	<5	146,00	<15	<100
TR-13-PM2	08-30-2017	1,5	2	<0,5	3490	7,9	30	<0,9	<15	<45	<40	<0,2	6,00	53,00	<2	<30	<30	<20	<1,0	<5	361,00	<15	<100
CE-SM1/PM1	08-30-2017	0	-	<0,5	-	<5,0	<20	<0,9	<15	<45	<40	-	-	61	<2	<30	<30	-	-	<5	-	-	<100
CE-SM2/PM1	08-30-2017	0	-	<0,5	-	<5,0	<20	<0,9	<15	<45	<40	-	-	46	<2	<30	<30	-	-	<5	-	-	<100

TABLEAU E-4 Concentrations (mg/kg) de métaux mesurées dans les sédiments de la zone d'étude (teneurs de fond)

Identification de l'échantillon	Date d'échantillonnage	Aluminium	Antimoine	Argent	Arsenic	Baryum	Bore	Béryllium	Cadmium	Chrome	Cobalt	Cuivre	Étain	Lithium	Manganèse	Mercure	Molybdène	Nickel	Plomb	Sélénium	Strontium	Titane	Uranium	Vanadium	Zinc
CE-1A	2017-09-13	3500	<7	<0,5	5,1	27	<10	<1	<0,3	14	< 3	9	< 5	6	53	0,04	< 2	6	< 5	< 1	< 10	359	< 20	12	17
CE-2A-1	2017-09-13	8340	<7	<0,5	13,8	79	11	<1	<0,3	41	5	23	< 5	16	159	0,02	< 2	16	14	< 1	33	780	< 20	32	47
CE-2A-2	2017-09-13	4780	<7	<0,5	12,7	47	<10	<1	<0,3	24	3	15	< 5	9	108	0,03	< 2	10	9	< 1	33	481	< 20	24	56
CE-2A-3	2017-09-13	4980	<7	<0,5	10,8	49	<10	<1	<0,3	24	< 3	12	< 5	11	100	< 0,02	< 2	10	8	< 1	26	475	< 20	23	37
CE-2A-4	2017-09-13	6400	<7	<0,5	9,1	58	<10	<1	<0,3	30	4	17	< 5	12	119	< 0,02	< 2	12	10	< 1	27	606	< 20	26	25
CE-2A-5	2017-09-13	2180	<7	<0,5	4,5	24	<10	<1	<0,3	12	< 3	6	< 5	4	50	< 0,02	< 2	5	< 5	< 1	< 10	290	< 20	11	46
CE-2B-1	2017-09-13	7290	<7	<0,5	<1,5	43	<10	<1	<0,3	37	4	7	< 5	15	117	< 0,02	< 2	13	< 5	< 1	18	800	< 20	46	16
CE-2B-2	2017-09-13	5270	<7	<0,5	<1,5	32	<10	<1	<0,3	26	< 3	< 5	< 5	12	84	< 0,02	< 2	9	< 5	< 1	16	569	< 20	24	< 10
CE-2B-3	2017-09-13	3330	<7	<0,5	<1,5	22	<10	<1	<0,3	19	< 3	< 5	< 5	6	63	< 0,02	< 2	6	< 5	< 1	12	402	< 20	19	< 10
CE-2B-4	2017-09-13	3180	<7	<0,5	<1,5	29	<10	<1	<0,3	14	< 3	< 5	< 5	7	70	< 0,02	< 2	6	< 5	< 1	< 10	306	< 20	16	< 10
CE-2B-5	2017-09-13	4100	<7	<0,5	<1,5	27	<10	<1	<0,3	21	4	< 5	< 5	8	84	< 0,02	< 2	8	< 5	< 1	10	452	< 20	18	21
CE-3A-1	2017-09-13	1840	<7	<0,5	6,9	34	12	<1	<0,3	8	< 3	13	< 5	< 2	102	0,04	< 2	4	< 5	< 1	32	87	< 20	< 10	< 10
CE-3A-2	2017-09-13	503	<7	<0,5	2,2	<20	<10	<1	<0,3	< 2	< 3	< 5	< 5	< 2	47	0,03	< 2	< 2	< 5	< 1	19	20	< 20	< 10	< 10
CE-3A-3	2017-09-13	2790	<7	<0,5	11	33	15	<1	0,4	20	< 3	15	< 5	< 2	142	0,04	< 2	7	< 5	1,4	34	157	< 20	15	12
CE-3A-4	2017-09-13	1390	<7	<0,5	9,7	<20	11	<1	<0,3	9	< 3	17	< 5	< 2	111	0,07	< 2	4	7	< 1	25	98	< 20	< 10	24
CE-3A-5	2017-09-13	3650	<7	<0,5	9,9	32	12	<1	0,5	22	4	7	< 5	< 2	96	0,05	< 2	10	< 5	< 1	24	214	< 20	13	18
CE-3B-1	2017-09-13	1390	<7	<0,5	<1,5	<20	<10	<1	<0,3	7	< 3	16	< 5	< 2	30	0,07	< 2	2	< 5	< 1	19	112	< 20	< 10	< 10
CE-3B-2	2017-09-13	2190	<7	<0,5	3,6	25	<10	<1	<0,3	12	< 3	6	< 5	< 2	46	0,12	< 2	4	8	< 1	38	177	< 20	< 10	< 10
CE-3B-3	2017-09-13	550	<7	<0,5	<1,5	<20	<10	<1	<0,3	2	< 3	< 5	< 5	< 2	18	0,12	< 2	< 2	< 5	< 1	14	42	< 20	< 10	< 10
CE-3B-4	2017-09-13	4270	<7	<0,5	5	25	<10	<1	<0,3	23	< 3	33	< 5	< 2	79	0,04	6	12	< 5	< 1	56	326	< 20	19	17
CE-3B-5	2017-09-13	6020	<7	<0,5	2,1	41	10	<1	<0,3	31	4	16	< 5	6	109	0,04	< 2	13	< 5	< 1	30	635	< 20	20	18
CE-4	2017-09-13	2580	<7	<0,5	115	23	14	<1	1	9	< 3	7	< 5	< 2	27	0,09	27	7	5	< 1	659	190	< 20	30	12
CE-5A-1	2017-09-13	3650	<7	<0,5	29,5	<20	163	<1	0,4	29	< 3	< 5	< 5	< 2	167	< 0,02	< 2	5	20	< 1	10	220	26	68	24
CE-5A-2	2017-09-13	3640	<7	<0,5	54	<20	350	<1	0,9	18	< 3	< 5	< 5	< 2	210	< 0,02	< 2	< 2	39	< 1	13	113	75	89	< 10
CE-5A-3	2017-09-13	3800	<7	<0,5	21,4	<20	74	<1	0,3	38	< 3	< 5	< 5	< 2	101	< 0,02	< 2	7	8	< 1	< 10	270	< 20	54	28
CE-5A-4	2017-09-13	3550	<7	<0,5	67,1	21	288	<1	0,9	22	< 3	< 5	< 5	< 2	188	< 0,02	< 2	< 2	31	< 1	< 10	147	47	81	< 10
CE-5A-5	2017-09-13	3650	<7	<0,5	53,7	33	397	<1	0,8	16	< 3	< 5	< 5	< 2	659	0,02	< 2	< 2	46	3,3	14	100	84	88	< 10
CE-5B-1	2017-09-13	7250	<7	<0,5	7,6	51	<10	<1	<0,3	36	5	12	< 5	18	126	< 0,02	< 2	14	7	< 1	15	664	< 20	25	23
CE-5B-2	2017-09-13	5030	<7	<0,5	4,2	32	<10	<1	<0,3	23	3	8	< 5	15	105	< 0,02	< 2	10	< 5	< 1	11	470	< 20	15	16
CE-5B-3	2017-09-13	4060	<7	<0,5	4,3	27	<10	<1	<0,3	19	< 3	5	< 5	13	77	< 0,02	< 2	7	< 5	2,2	< 10	415	< 20	14	12
CE-5B-4	2017-09-13	3150	<7	<0,5	3,9	28	<10	<1	<0,3	19	< 3	< 5	< 5	9	77	0,02	< 2	7	< 5	< 1	14	302	< 20	< 10	12
CE-5B-5	2017-09-13	2690	<7	<0,5	3,4	<20	<10	<1	<0,3	16	< 3	< 5	< 5	10	57	< 0,02	< 2	7	< 5	< 1	< 10	290	< 20	< 10	< 10
S1	2012	1970	<20	<0,5	<5	<20	<20	<10	<0,9	< 45	< 15	< 40	< 5	-	32	< 0,2	< 2	< 30	< 30	< 1	< 10	167	< 20	< 15	< 100
S2	2012	1730	<20	<0,5	<5	<20	<20	<10	<0,9	< 45	< 15	< 40	< 5	-	29	< 0,2	< 2	< 30	< 30	< 1	< 10	146	< 20	< 15	< 100
S3	2012	4940	<20	<0,5	<5	32	<20	<10	<0,9	< 45	< 15	< 40	< 5	-	79	< 0,2	< 2	< 30	< 30	< 1	20	419	< 20	15	< 100
S5	2012	9290	<20	<0,5	<5	57	<20	<10	<0,9	48	< 15	< 40	< 5	-	131	< 0,2	< 2	< 30	< 30	< 1	27	932	< 20	24	< 100
S6	2012	5440	<20	<0,5	8,4	58	<20	<10	<0,9	< 45	< 15	< 40	< 5	-	24	< 0,2	< 2	< 30	< 30	1	39	142	< 20	15	< 100
S7	2012	1980	<20	<0,5	<5	<20	<20	<10	<0,9	< 45	< 15	< 40	< 5	-	30	< 0,2	< 2	< 30	< 30	< 1	15	162	< 20	< 15	< 100

TABLEAU E-5 Concentrations (µg/L) de métaux mesurées dans l'eau de surface de la zone d'exposition rapprochée et dans l'eau potable du Relais routier (teneurs de fond)

Station	Date d'échantillonnage	Type d'eau	Argent	Aluminium	Arsenic	Bore	Baryum	Béryllium	Cadmium	Cobalt	Chrome	Cuivre	Mercure	Lithium	Manganèse	Moybdène	Nickel	Plomb	Antimoine	Sélénium	Strontium	Uranium	Vanadium	Zinc
1B	2017-06-07	Surface	< 0,003	294	0,84	2,2	3,91	0,027	0,012	0,354	0,92	0,27	0,003	1	45,2	0,06	0,59	0,32	< 0,005	< 0,05	15,8	0,018	< 0,02	4,4
2B	2017-06-07	Surface	0,004	261	0,85	2,2	3,63	0,015	0,015	0,414	1,26	0,3	0,003	1	49,7	0,08	0,54	0,31	< 0,005	< 0,05	14,8	0,016	< 0,02	4,9
5A	2017-06-07	Surface	< 0,003	108	0,69	1	2,5	0,008	0,013	0,078	1,78	0,36	0,002	< 1	11,2	0,14	0,11	0,32	< 0,005	< 0,05	13,1	0,02	< 0,02	1,4
1A	2017-06-08	Surface	< 0,003	96,8	0,65	2,5	2,33	0,007	0,014	0,114	0,93	0,26	< 0,002	1	25,3	0,05	0,15	0,44	< 0,005	< 0,05	10,5	0,008	< 0,02	3,4
2A	2017-06-08	Surface	< 0,003	282	0,59	2,1	6,76	0,016	0,025	0,49	1,65	0,56	< 0,002	< 1	53,2	0,04	0,63	0,49	< 0,005	< 0,05	21,7	0,024	< 0,02	5,8
3A	2017-06-08	Surface	< 0,003	66,7	1,75	< 0,3	2,29	0,006	0,013	0,06	0,87	0,2	0,004	< 1	21,4	0,02	0,1	0,44	< 0,005	< 0,05	9,5	< 0,005	< 0,02	3,7
3B	2017-06-08	Surface	< 0,003	161	2,15	1	3,31	0,014	0,023	0,168	1,07	0,38	0,004	4	24,6	0,06	0,32	0,47	< 0,005	< 0,05	9,79	0,015	< 0,02	2,6
4A	2017-06-08	Surface	< 0,003	140	2,84	1,3	7,39	0,01	0,02	0,333	1,44	0,43	< 0,002	5	20,8	0,3	0,77	0,62	< 0,005	< 0,05	45,3	0,079	< 0,02	1,8
5B	2017-06-08	Surface	< 0,003	197	1,22	1	4,14	0,017	0,019	0,209	1,29	0,34	< 0,002	1	23,4	0,1	0,39	0,37	< 0,005	< 0,05	16,4	0,028	< 0,02	2,3
1A	2017-07-05	Surface	0,044	95,2	0,38	0,8	2,01	0,006	0,015	0,115	0,36	1,02	< 0,0019	< 1	14,2	0,03	0,2	0,31	< 0,005	0,19	7,46	< 0,005	< 0,02	3,3
5B	2017-07-05	Surface	0,038	200	1,06	1,7	4,45	0,012	0,017	0,217	0,74	0,26	< 0,0019	< 1	20,7	0,03	0,42	0,27	9,05	0,23	16,3	0,018	< 0,02	3,1
1B	2017-07-08	Surface	< 0,003	286	0,64	< 0,3	3,66	0,01	0,007	0,4	0,75	< 0,05	< 0,0019	-	47,5	0,04	0,57	0,2	< 0,005	< 0,05	16,5	0,012	< 0,02	4,6
2A	2017-07-08	Surface	0,003	267	0,46	< 0,3	4,63	0,008	0,02	0,3	0,73	< 0,05	< 0,0019	-	27	0,03	0,47	0,32	< 0,005	0,46	16,9	0,013	< 0,02	8,4
2B	2017-07-08	Surface	< 0,003	239	0,45	< 0,3	3,33	0,01	0,006	0,354	0,56	< 0,05	< 0,0019	-	42,7	0,05	0,5	0,18	< 0,005	0,54	15,2	0,01	< 0,02	5,5
3A	2017-07-08	Surface	0,014	74,2	1,32	< 0,3	2,43	< 0,006	< 0,006	0,053	0,22	< 0,05	< 0,0019	-	17,9	0,03	0,18	0,32	< 0,005	0,15	8,6	< 0,005	< 0,02	6,2
3B	2017-07-08	Surface	< 0,003	182	1,94	< 0,3	3,76	0,006	0,023	0,182	0,54	< 0,05	< 0,0019	-	23	0,06	0,37	0,38	< 0,005	0,46	11,4	0,012	< 0,02	5,3
4	2017-07-08	Surface	< 0,003	306	3,16	< 0,3	6,22	0,018	0,04	0,501	0,94	< 0,05	< 0,0019	-	19,3	0,1	1,32	0,35	< 0,005	0,53	20,7	0,048	< 0,02	4,8
5A	2017-07-08	Surface	< 0,003	181	0,87	< 0,3	3,52	0,008	0,023	0,125	0,72	< 0,05	< 0,0019	-	13,8	0,04	0,23	0,34	< 0,005	0,08	14,6	0,015	< 0,02	3,7
1A	2017-07-31	Surface	< 0,003	109	0,98	2,3	2,3	< 0,006	0,013	0,126	0,5	0,67	< 0,0019	2	35,9	0,03	0,22	0,45	0,006	0,16	16,5	0,008	< 0,02	5
2A	2017-07-31	Surface	< 0,003	390	1,03	1,3	7,25	0,011	0,02	0,612	1,36	1,14	< 0,0019	1	60,8	0,03	0,79	0,79	0,006	0,2	29	0,026	< 0,02	7,7
3A	2017-07-31	Surface	< 0,003	86,4	2,64	< 0,3	3	< 0,006	0,012	0,061	0,57	0,17	< 0,0019	< 1	26,1	0,04	0,15	0,62	0,01	0,18	13,3	0,005	< 0,02	2,9
3B	2017-07-31	Surface	< 0,003	207	2,65	0,3	3,88	0,008	0,021	0,196	0,77	0,28	< 0,0019	5	23,2	0,11	0,39	0,59	0,018	< 0,05	11,6	0,018	< 0,02	3
4A	2017-07-31	Surface	< 0,003	130	3,16	0,5	9,01	0,008	0,029	0,33	0,87	0,37	< 0,0019	4	23,7	0,29	0,77	0,54	< 0,005	< 0,05	58,2	0,081	< 0,02	3,2
5B	2017-07-31	Surface	< 0,003	270	2,6	< 0,3	6,05	0,009	0,021	0,411	1,16	0,19	< 0,0019	1	44,1	0,07	0,67	0,52	0,005	0,22	25,8	0,027	< 0,02	3,8
1A	2017-09-14	Surface	0,011	135	0,42	2,6	3,36	0,007	0,019	0,146	0,55	0,36	< 0,025	2	32,1	0,15	0,27	0,58	0,193	0,52	13,8	0,019	0,39	5,7
1B	2017-09-14	Surface	0,004	319	0,87	2,3	4,94	0,012	0,023	0,485	1,18	0,33	< 0,025	2	58,2	0,11	0,72	0,4	0,087	0,42	18,3	0,019	< 0,02	4,3
2A	2017-09-14	Surface	0,019	277	0,49	1,5	5,89	0,008	0,02	0,331	0,98	0,4	< 0,025	< 1	36,3	0,07	0,51	0,5	0,04	0,26	19	0,017	0,07	4,4
2B	2017-09-14	Surface	0,005	257	0,69	2,1	4,58	0,009	0,014	0,413	0,88	0,41	< 0,025	2	57,2	0,03	0,6	0,32	0,012	0,38	17,5	0,012	< 0,02	5,3
3A	2017-09-14	Surface	0,003	84,9	2,02	1	3,95	0,046	0,025	0,123	0,56	0,26	< 0,025	1	31,3	0,06	0,26	0,58	0,064	0,18	13,9	0,03	< 0,02	4,9
3B	2017-09-14	Surface	0,007	211	2,38	1,6	4,94	0,023	0,031	0,235	0,95	0,38	< 0,025	9	27,5	0,07	0,54	0,55	< 0,005	0,35	13,2	0,023	0,66	3,4
4	2017-09-14	Surface	0,005	185	2,29	2,4	7,82	0,018	0,026	0,429	1,12	0,44	< 0,025	11	25,2	0,16	1,06	0,24	< 0,005	0,36	39,2	0,067	< 0,02	2,7
5A	2017-09-14	Surface	< 0,003	156	1,28	1	4,33	0,01	0,023	0,158	1,22	0,31	< 0,025	1	23,2	0,09	0,28	0,46	< 0,005	0,22	18,6	0,021	0,25	2
5B	2017-09-14	Surface	0,005	189	1,15	1,6	5,18	0,012	0,016	0,229	1	0,34	< 0,025	1	28,8	0,05	0,43	0,38	< 0,005	0,39	19,7	0,02	0,28	3,7
1A	2017-10-04	Surface	< 0,003	133	0,47	2,6	3,21	0,006	0,012	0,16	0,6	0,28	< 0,0019	1	23,5	< 0,01	0,35	0,51	< 0,005	< 0,05	12,1	< 0,005	0,04	5,7
1B	2017-10-04	Surface	< 0,003	266	1,06	3,3	4,85	0,011	0,019	0,396	0,81	0,28	< 0,0019	2	45,6	< 0,01	0,74	0,39	< 0,005	< 0,05	17,7	0,007	< 0,02	4,9
2A	2017-10-04	Surface	0,01	241	0,5	3,1	6,98	0,015	0,039	0,373	1,12	0,57	< 0,0019	< 1	36,8	0,03	0,68	0,57	< 0,005	0,27	27,2	0,017	0,17	7,6
2B	2017-10-04	Surface	< 0,003	221	0,67	3,4	4,17	0,009	0,016	0,345	0,79	0,3	< 0,0019	2	43,1	< 0,01	0,56	0,34	< 0,005	< 0,05	17,7	0,006	< 0,02	4,3
3B	2017-10-04	Surface	< 0,003	201	1,84	2,4	5,29	0,011	0,028	0,261	1,18	0,47	< 0,0019	7	26,6	0,06	0,54	0,61	< 0,005	0,09	14,7	0,011	< 0,02	4,5
4	2017-10-04	Surface	< 0,003	289	2,7	2,1	9,98	0,023	0,03	0,675	0,99	0,68	< 0,0019	10	19,8	0,06	1,56	0,5	< 0,005	0,4	28,3	0,032	< 0,02	6,5
5B	2017-10-04	Surface	0,004	201	1,1	2,6	5,76	0,013	0,021	0,246	0,97	0,54	< 0,0019	2	27,2	0,03	0,5	0,48	< 0,005	< 0,05	21,4	0,017	0,12	4,8
5A	2017-10-08	Surface	< 0,003	207	0,97	1,8	5,6	0,012	0,023	0,222	1	0,34	< 0,0019	1	21,8	< 0,01	0,49	0,43	< 0,005	0,18	19,3	0,011	< 0,02	4,2
1A	2017-11-02	Surface	< 0,003	65,4	0,26	1	1,6	< 0,006	0,012	0,065	0,55	0,1	< 0,0019	< 1	25,6	0,06	0,11	0,26	0,066	0,12	6,44	< 0,005	< 1	4,3
1B	2017-11-02	Surface	< 0,003	200	0,52	1,6	2,92	0,008	0,014	0,247	1,04	0,18	< 0,0019	< 1	37,5	0,04	0,4	0,23	0,056	0,13	11,7	0,008	< 1	3
2A	2017-11-02	Surface	< 0,003	187	0,3	1,1	3,72	0,007	0,016	0,226	1,2	0,26	< 0,0019	< 1	23,1	0,03	0,36	0,35	0,052	0,05	11,2	0,009	< 1	3,7
2B	2017-11-02	Surface	< 0,003	181	0,51	1,3	2,66	< 0,006	0,015	0,24	0,93	0,21	< 0,0019	< 1	36,8	0,02	0,37	0,23	0,048	0,07	11,4	0,007	< 1	2,9
3A	2017-11-02	Surface	< 0,003	54,1	1,11	< 0,3	1,61	< 0,006	0,009	0,046	0,58	0,09	< 0,0019	< 1	15,8	0,02	0,1	0,28	0,042	< 0,05	5,63	< 0,005	< 1	2,7
3B	2017-11-02	Surface	< 0,003	119	1,22	0,9	3,06	0,006	0,022	0,147	0,85	0,22	< 0,0019	3	25	0,03	0,27	0,38	0,046	< 0,05	8,64	0,006	< 1	3
4	2017-11-02	Surface	< 0,003	486	1,21	1,5	7,51	0,026	0,02	0,502	1,52	0,86	< 0,0019	5	18,8	0,02	1,28	0,25	0,037	0,12	15,1	0,044	< 1	10
5A	2017-11-02	Surface	< 0,003	115	0,58	0,7	3,06	0,006	0,019	0,105	0,7	0,17	< 0,0019	< 1	13,4	0,02	0,2	0,27	0,034	< 0,05	10,9	0,007	< 1	2,3
5B	2017-11-02	Surface	< 0,003	150	0,8	1,2	3,42	0,007	0,011	0,142	0,9	0,24	< 0,0019	< 1	23,5	0,02	0,32	0,2	0,032	< 0,05	13,5	0,011	< 1	3,2
Relai routier	2018-06-29	Potable	< 0,1	< 6	< 0,5	< 10	11,3	< 0,5	< 0,02	< 0,5	< 0,6	996,8	-	< 5	3,8	< 0,5	< 0,5	< 0,3	< 0,1	< 1	85	< 1	< 0,5	61

Source des données: WSP (2018). Mine de lithium Baie James. Étude spécialisée sur l'habitat aquatique.

TABLEAU E-6 Concentrations (mg/kg-sec) de métaux mesurées dans des végétaux de la zone d'étude (teneurs de fond)

Identification de l'échantillon	Date d'échantillonnage	Aluminium	Antimoine	Argent	Arsenic	Baryum	Béryllium	Bore	Cadmium	Chrome	Cobalt	Cuivre	Lithium	Manganèse	Mercure	Molybdène	Nickel	Plomb	Sélénium	Strontium	Titane	Uranium	Vanadium	Zinc
BLEUET-PF-01	2017-09-25	1900-05-19	< 0,04	0,0047	0,063	70	< 0,003	14	0,12	0,087	0,32	8,2	0,067	1500	0,0045	0,23	1,3	0,27	0,022	13	1,9	0,0026	0,12	62
BLEUET-PF-04	2017-09-25	1900-04-06	< 0,04	0,092	0,11	41	< 0,003	5,4	0,1	< 0,05	0,19	4,4	< 0,02	1500	0,0059	0,095	0,97	1	0,026	8,2	0,52	< 0,001	0,064	39
BLEUET-PF-05	2017-09-25	1900-03-26	< 0,04	0,024	0,12	33	< 0,003	4,7	0,096	0,069	0,046	4,8	0,023	760	0,0055	0,11	1,4	0,17	0,066	20	3,1	0,0014	0,1	45
BLEUET-PF-06	2017-09-25	1900-03-06	< 0,04	0,019	0,062	50	< 0,003	3,8	0,099	< 0,05	0,078	3,4	< 0,02	930	0,0033	0,15	1,1	1	0,021	24	0,44	< 0,001	0,064	43
BLEUET-PF-10	2017-09-25	1901-09-01	< 0,04	0,015	0,33	24	0,014	4,4	0,077	1,1	0,45	5,5	0,51	210	0,0035	0,067	3,1	0,92	0,04	15	9,8	0,033	0,94	30
THE-PF-02	2017-09-25	1900-02-08	< 0,04	0,0031	0,056	70	< 0,003	7,3	0,0065	< 0,05	0,025	4	< 0,02	1100	0,0054	0,014	0,34	0,45	0,019	5,3	0,67	0,002	0,051	22
THE-PF-03	2017-09-25	1900-01-26	< 0,04	0,0034	0,073	30	< 0,003	5,8	0,0025	< 0,05	0,019	2,8	< 0,02	270	0,0056	0,04	0,55	0,08	0,024	23	0,89	0,0012	0,036	27
THE-PF-04	2017-09-25	1900-01-20	< 0,04	0,0046	< 0,005	57	< 0,003	8	0,0072	< 0,05	0,035	5,2	< 0,02	750	0,0038	0,049	0,54	0,1	0,023	15	0,36	< 0,001	0,024	22
THE-PF-06	2017-09-25	1900-02-07	< 0,04	0,0051	< 0,005	79	< 0,003	14	0,0035	0,06	0,019	4,7	< 0,02	570	0,0054	0,056	0,55	0,085	0,025	36	2,2	0,0027	0,051	23
THE-PF-08	2017-09-25	1900-01-26	< 0,04	0,0028	0,028	75	< 0,003	11	0,0066	0,059	0,017	5,9	< 0,02	610	0,0062	0,019	0,37	0,16	0,047	11	0,8	0,0011	0,037	30
KALMIA-PF-01	2017-09-25	1900-02-20	< 0,04	0,007	0,084	67	< 0,003	6,2	0,005	0,092	0,042	6,9	0,033	37	0,0054	0,11	1,1	0,29	0,024	63	1,3	0,0021	0,076	33
KALMIA-PF-03	2017-09-25	1900-02-24	< 0,04	0,0082	0,05	33	< 0,003	6,9	0,0052	0,052	0,026	6,7	< 0,02	190	0,0065	0,13	2,4	0,43	0,045	46	0,42	< 0,001	0,043	25
KALMIA-PF-05	2017-09-25	1900-02-11	< 0,04	0,013	0,056	41	< 0,003	8,5	0,014	0,073	0,023	5,1	< 0,02	310	0,005	0,15	0,52	0,34	0,077	16	1,6	0,0013	0,066	24
KALMIA-PF-06	2017-09-25	1900-03-11	< 0,04	0,0027	0,039	39	< 0,003	8,8	0,0015	0,078	0,0088	5,7	< 0,02	310	0,0067	0,2	1,7	0,068	0,041	18	0,32	< 0,001	0,016	17
KALMIA-PF-07	2017-09-25	1900-02-06	< 0,04	0,006	0,075	67	< 0,003	7,2	0,006	< 0,05	0,0094	5,4	< 0,02	430	0,0059	0,13	0,37	0,1	0,054	20	0,51	< 0,001	0,023	31
KALMIA-PF-07:DUP	2017-09-25	1900-02-13	< 0,04	0,013	0,076	110	< 0,003	8,3	0,0052	< 0,05	0,0098	4,8	< 0,02	730	0,0066	0,14	0,38	0,17	0,06	21	0,41	< 0,001	0,023	30
AULNE-PF-01	2017-09-25	1900-01-16	< 0,04	0,012	0,071	83	0,0057	24	0,032	< 0,05	0,33	14	0,47	740	0,0074	0,36	5,2	0,15	< 0,009	120	0,45	0,0014	0,028	54
AULNE-PF-02	2017-09-25	1900-07-08	< 0,04	0,019	0,056	130	0,028	3,9	0,022	< 0,05	7,3	6,5	0,11	810	0,0072	0,099	6,1	0,31	0,015	40	0,34	0,0012	0,026	51
AULNE-PF-09	2017-09-25	1900-02-13	< 0,04	0,0027	0,075	22	0,01	8,9	0,027	< 0,05	0,76	5,8	0,07	160	0,0031	1,1	4,5	0,23	< 0,009	42	0,56	< 0,001	0,067	39
AULNE-PF-10	2017-09-25	1900-09-16	< 0,04	0,016	0,17	85	0,022	12	0,023	0,71	0,87	11	0,46	280	0,0076	0,32	5,3	0,9	0,018	58	6,4	0,013	0,55	79
AULNE-PF-11	2017-09-25	1900-01-31	< 0,04	0,0024	0,08	58	0,0077	6	0,0058	0,063	13	8,5	3,1	590	0,0019	1,1	6,6	0,065	0,016	25	0,74	0,0012	0,046	16
EPINETTE-PF-02	2017-09-25	1900-01-19	< 0,04	0,012	0,033	12	< 0,003	8,9	0,0077	< 0,05	0,12	3	0,061	760	0,0081	0,012	1	0,057	< 0,009	9,8	0,99	0,0011	0,022	45
EPINETTE-PF-03	2017-09-25	1901-10-21	< 0,04	0,018	0,057	100	< 0,003	5,3	0,013	< 0,05	0,24	2	0,16	330	0,017	0,014	2	0,13	0,05	44	1,2	0,0025	0,046	53
EPINETTE-PF-04	2017-09-25	1900-01-26	< 0,04	0,013	0,052	11	< 0,003	6,5	0,017	0,051	0,066	2,5	0,023	910	0,016	0,0094	0,41	0,098	0,038	8,5	1,5	0,0039	0,048	44
EPINETTE-PF-06	2017-09-25	1900-01-19	< 0,04	0,014	0,031	16	< 0,003	15	0,0086	< 0,05	0,02	4,8	< 0,02	850	0,0051	0,017	1	0,043	< 0,009	6,7	1,2	< 0,001	0,017	58
EPINETTE-PF-08	2017-09-25	1900-02-21	< 0,04	0,038	0,16	30	< 0,003	8,9	0,035	0,12	0,058	3,8	0,11	780	0,02	0,018	0,52	0,57	0,066	9,5	2,8	0,0059	0,15	77
MELEZE-PF-02	2017-09-25	1900-01-24	< 0,04	0,0066	0,05	44	< 0,003	19	0,016	< 0,05	0,032	1,8	< 0,02	260	0,012	0,013	0,53	0,19	0,31	24	1,5	0,0022	0,049	29
MELEZE-PF-03	2017-09-25	1900-04-04	< 0,04	0,0039	0,041	35	< 0,003	6,4	0,0077	< 0,05	0,033	2,5	< 0,02	210	0,01	0,0098	1,6	0,089	0,47	17	1,4	0,0016	0,028	23
MELEZE-PF-04	2017-09-25	1900-02-10	< 0,04	0,0041	0,089	71	< 0,003	24	0,054	< 0,05	0,092	1,6	< 0,02	940	0,012	0,018	0,72	0,1	0,22	44	1,2	0,0015	0,029	18
MELEZE-PF-06	2017-09-25	1900-01-27	< 0,04	0,015	0,075	83	< 0,003	13	0,056	0,06	0,032	3	0,036	890	0,013	0,011	0,48	0,19	0,34	34	1,1	0,0029	0,052	36
MELEZE-PF-08	2017-09-25	1900-01-25	< 0,04	0,013	0,097	38	< 0,003	33	0,053	0,061	0,029	2,9	0,034	790	0,013	0,01	0,35	0,17	0,33	21	1,2	0,0028	0,056	43
MELEZE-PF-08:DUP	2017-09-25	1900-01-31	< 0,04	0,013	0,047	35	< 0,003	18	0,086	0,059	0,04	3	< 0,02	680	0,0097	0,011	0,69	0,25	0,2	49	0,88	0,0023	0,046	36

ANNEXE F

Paramètres et équations utilisés afin de modéliser les concentrations de métaux dans les médias environnementaux d'intérêt

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1. MODÉLISATIONS DES CONCENTRATIONS MULTIMÉDIAS

Les sous-sections suivantes présentent la méthodologie utilisée afin de déterminer les concentrations en métaux dans les différents médias (biotiques et abiotiques) pertinents à l'évaluation des risques. Les données de caractérisation à partir desquelles certaines de ces concentrations ont été déterminées sont fournies à l'annexe E.

1.1 Air ambiant, sols et sédiments

La méthodologie à partir de laquelle les concentrations dans l'air ambiant, dans les sols et dans les sédiments ont été déterminées est présentée aux sections 4.2.1 (air ambiant) et 4.2.2 (sols et sédiments) du rapport.

1.2 Végétaux terrestres

La concentration totale d'un métal dans une plante terrestre correspond à la somme de la contribution de plusieurs voies d'exposition. Dans le cas de la présente étude, les voies d'accumulation significatives sont l'absorption radiculaire (concentrations bruit de fond) et le dépôt atmosphérique (concentrations bruit de fond et additionnelles).

Les concentrations dans les végétaux sont estimées pour les différentes parties des végétaux (racines, parties végétatives et parties reproductrices). Il est à noter que dans le contexte du présent projet, les concentrations dans l'air correspondent, à l'exception du mercure, à des concentrations sous forme particulaire et non gazeuse.

1.2.1 Teneurs de fond

Dans le cadre de son étude spécialisée sur la flore, WSP (2018b) a prélevé 32 échantillons de végétaux et les a fait analyser en laboratoire pour 23 métaux[1] inclus à la liste des substances d'intérêt. Au total, 6 espèces végétales ont été échantillonnées; le bleuet (*Vacccinium spp.*), le thé du Labrador (*Rhododendron groenlandicum*), le kalmia à feuilles étroites (*Kalmia angustifolia*), l'aulne (*Alnus spp.*), l'épinette noire (*Picea mariana*) et le mélèze laricin (*Larix laricina*). Chacune de ces espèces est susceptible d'être consommée par les membres de la Communauté crie à des fins médicinales ou alimentaires. Pour chaque espèce, 5 échantillons (en plus d'un duplicata pour le kalmia et le mélèze) constitués d'un mélange de feuilles, de fruits et de branches ont été analysés. Il est à noter que la proportion de feuilles, de fruits et de tiges dans les différents échantillons n'est pas connue et que celle-ci a pu varier d'un échantillon à l'autre.

Pour l'ensemble des métaux analysés, les teneurs de fond retenues correspondent au 50e centile des concentrations mesurées (médiane). Afin de déterminer ces valeurs, des séries de données distinctes ont d'abord été créées pour les végétaux herbacés et arbustifs (bleuet, thé et kalmia) et pour les végétaux arborescents (aulne, épinette et mélèze). Ces séries de données ont été importées dans le logiciel ProUCL (U.S. EPA, 2015b). et, pour chaque métal, un test d'égalité des médianes (test de Gehan, voir U.S. EPA (2015a) pour plus de détails) a été réalisé afin de comparer les concentrations mesurées dans les végétaux herbacés/arbustif et dans les végétaux arborescents. Pour 7 métaux (B, Co, Li, Hg, Mo, U et Zn), les concentrations médianes mesurées dans les tissus des deux catégories de végétaux étaient significativement différentes. Pour ces substances, des valeurs distinctes correspondant au 50e centile

1 Al, Sb, Ag, As, B, Ba, Be, Cd, Cr, Co, Cu, Li, Mn, Hg, Mo, Ni, Pb, Se, Sr, Ti, U, V, Zn.

des concentrations mesurées dans les échantillons de végétaux herbacés/arbustifs (N = 16) et arborescents (N = 16) ont donc été retenues. Pour les autres métaux analysés, les 50e centiles déterminés à partir de l'ensemble des données disponibles (N = 32) ont été retenues pour toutes les catégories de végétaux. Pour l'antimoine, la teneur de fond retenue correspond à la valeur de la limite de détection car toutes les concentrations mesurées étaient inférieures à celle-ci.

Il est à noter que les résultats analytiques des tissus végétaux ont été fournis par le laboratoire sur une base sèche. Aucun taux d'humidité n'ayant été fourni, les concentrations ont été converties en base humide en supposant que le contenu moyen en eau des végétaux est de 88%, soit la valeur utilisée dans le logiciel TerraSys^{MC} (Sanexen, 2002b). Les concentrations obtenues ont été utilisées pour représenter les teneurs de fond dans toutes les parties de la plante qui risquent d'être consommées (racines, feuilles, fruits, etc.).

L'étain n'ayant pas été analysé dans les échantillons de tissus végétaux, les teneurs de fond ont été estimées par modélisation à partir des teneurs de fond dans les sols et dans l'air ambiant (modèles présentés à la section 1.1.2).

1.2.2 Concentrations additionnelles

1.2.2.1 Parties végétatives

Les concentrations de métaux dans les parties végétatives ont été calculées selon l'équation suivante :

$$C_{vgt} = 0{,}12 * [C_{vgt.rad} + C_{dépôt} + C_{ff}]$$

Où :

C_{vgt} : Concentration totale en contaminant dans les végétaux, mg/kg_{frais}

0,12 : Ratio poids sec/poids frais, kg_{sec}/kg_{frais}

$C_{vgt.rad}$: Concentration provenant de l'absorption radiculaire, mg/kg_{sec}

$C_{dépôt}$: Concentration due au dépôt atmosphérique, mg/kg_{sec}

C_{ff} : Concentration due au transfert air-plante (fixation foliaire), mg/kg_{sec}

Les concentrations dues à l'absorption radiculaire se calculent directement à partir des concentrations dans le sol, à l'aide des facteurs de bioconcentration (FBC) rapportés par Baes III, Sharp *et coll.* (1984). Le FBC est un coefficient empirique qui correspond au ratio de la concentration en une substance mesurée dans la plante et de celle mesurée dans le sol. Les concentrations par absorption radiculaire sont calculées à l'aide de l'équation suivante :

$$C_{vgt.rac} = C_{sol}\ x\ FBC_{sol-vgt}$$

Où :

C_{sol} Concentration en contaminant dans le sol, mg/kg

$FBC_{sol-vgt}$ Facteur de bioconcentration sol-plante, kg/kg_{sec}

Les concentrations dans les végétaux dues au dépôt atmosphérique ont été calculées à partir de l'équation suivante :

$$C_{dépôt} = \frac{\left[T_{dépôt-sec} + T_{dépôt-humide}\ x\ F_w\right]\ x\ R_p\ x\ \left[1 - e^{-(k_p t)}\right]}{Y_p\ x\ k_p}$$

Où :

$T_{dépôt-sec}$: Taux de dépôt atmosphérique sec, mg/m²/s

$T_{dépôt-sec}$: Taux de dépôt atmosphérique humide, mg/m²/s

F_w : Fraction du contaminant dans le dépôt humide qui adhère au végétal

Rp : Fraction d'interception des parties comestibles de la plante (sans unité)

k_p : Coefficient de perte de surface ; la valeur par défaut utilisée par est $5{,}73 \times 10^{-7}\ s^{-1}$

t : Temps moyen d'accumulation des dépôts atmosphériques sur la plante, s

Yp : Productivité de la plante, kg-sec/m²

Les taux de dépôt sec et humide ont été calculés selon :

$$T_{dépôt-sec} = C_{air.p}\ x\ V_{dp} + C_{air.g}\ x\ V_{dg}$$

$$T_{dépôt-humide} = \left[C_{air.p}\ x\ p\ x\ \Lambda_p\right] + \left[C_{air.g}\ x\ p\ x\ \Lambda_g\right]$$

Où :

$C_{air.p}$: Concentration dans l'air sous forme particulaire, mg/m³

V_{dp} : Vitesse de dépôt des particules, m/s

$C_{air.g}$: Concentration dans l'air sous forme gazeuse, mg/m³

V_{dg} : Vitesse de dépôt des gaz, m/s

p : Taux de précipitations, m/s

Λ_p : Ratio de lessivage des particules

Λ_g : Ratio de lessivage du contaminant gazeux

Aux fins d'application des trois équations précédentes, la vitesse de dépôt totale (dépôt sec + humide) des particules a été fixée à 0,01 m/s (Sanexen, 2002a). Le terme de pertes de surface (k_p) a été fixé à une valeur correspondant à une demi-vie de 14 jours. La fraction du contaminant dans le dépôt humide qui adhère au végétal a été fixé à 0,6. Ces valeurs sont celles recommandées par l'U.S. EPA (1999a).

Le temps moyen d'accumulation des dépôts atmosphériques sur la plante est réputé correspondre à la moitié de la période de croissance des végétaux, soit la période où la température moyenne mensuelle de l'air est supérieure à 0°C. Pour le site à l'étude, le temps moyen d'accumulation estimé est donc d'environ trois mois.

Enfin, les termes de productivité végétale et de fraction d'interception sont estimés de manière générale pour l'ensemble des végétaux susceptibles de présenter un intérêt écologique. Comme présenté au tableau F1, la productivité et la fraction d'interception dépendent du type de végétation et de la densité de la végétation. La densité de la végétation a été définie sur la base des rapports descriptifs produits par WSP (2018b). Ces rapports décrivent le couvert végétal de 57 parcelles de la zone d'étude. Chaque parcelle a été fractionnée en sous-secteurs dans lesquels le couvert végétal était relativement homogène, et la densité de la végétation de chaque sous-secteur a été rapporté sous la forme de recouvrements relatifs. Dans les zones de végétation arborescente, les recouvrements relatifs rapportés sont fréquemment de 100%. Sur cette base, la densité de la végétation arborescente a été fixée à « très

forte ». Pour la végétation arbustive, les recouvrements relatifs étaient fréquemment de l'ordre de 10-20%. La densité de la végétation arbustive a donc été fixée à « faible ». Pour ce qui est de la végétation herbacée, les recouvrements relatifs étaient très variables en fonction des sous-secteurs des différentes parcelles investiguées. La densité « modérée » a été jugée représentative de l'étendue des recouvrements relatifs rapportés.

Le ratio de lessivage des particules (Λ_p) a été fixé à 200 000. En ce qui concerne le ratio de lessivage du contaminant gazeux (Λ_g), il a été fixé à 0 pour l'ensemble des métaux sauf le mercure. Le ratio de lessivage du mercure correspond à H'^{-1} (H' = constante de Henry sans dimension) (Sanexen, 2002a).

TABLEAU F1
Productivité de la plante et fraction d'interception en fonction de la densité, pour la végétation herbacée, arbustive et arborescente

Densité de végétation	Productivité de la plante (Y_P) (kg/m²)	Fraction d'interception (Rp)
	Végétation herbacée :	
Densité très faible :	0,05	0,1
Densité faible :	0,25	0,3
Densité modérée :	**0,5**	**0,5**
Densité forte :	1,0	0,75
Densité très forte :	1,5	1,0
	Végétation arbustive :	
Densité très faible :	0,35	0,2
Densité faible :	**0,5**	**0,4**
Densité modérée :	0,85	0,6
Densité forte :	1,25	0,8
Densité très forte :	1,85	1,0
	Végétation arborescente :	
Densité très faible :	1,0	0,25
Densité faible :	1,6	0,45
Densité modérée :	2,4	0,65
Densité forte :	3,1	0,85
Densité très forte :	**3,6**	**1,0**

Les caractères **gras** indiquent les valeurs retenues.

La fixation foliaire est le processus par lequel une substance sous forme gazeuse est transférée de l'atmosphère vers les végétaux. Puisque le mercure est le seul métal pouvant être retrouvé sous forme gazeuse aux températures ambiantes, ce processus de transfert ne concerne que cette substance. La concentration attribuable à la fixation foliaire se calcule à partir de l'équation suivante :

$$C_{ff} = \left[\frac{C_{air}\ x\ (1 - f_{ptc})}{1{,}2}\right] x\ FBT_{air-vgt}\ x\ \left[1 - \theta_{w-vgt}\right]$$

Où :

C_{ff} : Concentration due à la fixation foliaire, mg/kg_{sec}

C_{air} : Concentration de contaminant dans l'air, mg/m^3

f_{ptc} : Fraction adsorbée moyenne du contaminant dans l'air pendant la période de croissance des végétaux (sans unité, calculée selon les équations présentées à la section 1.9)

$FBT_{air\text{-}vgt}$: Facteur de biotransfert air-végétaux (soit 2,3 x 10^4 pour le mercure)

$\theta_{w\text{-}veg}$: Contenu en eau moyen des végétaux (0,88)

1.2.2.2 Parties reproductrices

Les concentrations dans les parties reproductrices sont estimées à partir des concentrations dans les parties végétatives, à l'aide de ratios r/v (tableau F5) tirés de Baes III, Sharp *et coll.* (1984).

$$C_{rep} = C_{veg}\ x\ Ratio_{r/v}$$

Où :

C_{rep} : Concentration de contaminant dans les parties reproductrices de la plante, mg/kg

C_{veg} : Concentration de contaminant dans les parties végétatives de la plante, mg/kg

$Ratio_{r/v}$: Ratio des concentrations dans les parties reproductrices et végétatives (sans unité)

1.2.2.3 Racines

La répartition des métaux dans les différentes parties des végétaux découle d'une série de processus complexes qui dépendent de plusieurs facteurs (métal, conditions environnementales, type/espèce de plante, voie d'entrée). Selon Baes III, Sharp *et coll.* (1984), lorsque non uniformément distribuées, les concentrations dans les différentes parties des végétaux varient généralement selon l'ordre suivant : racines > feuilles ≥ tiges > tubercules ≥ fruits ≥ graines. Cette information est corroborée par Tremel-Schaub et Feix (2005), qui précisent que seule une fraction des métaux absorbés par les feuilles (dépôt atmosphérique) ou par les racines (absorption radiculaire) est transportée dans les autres parties de la plante. Dans le cadre du présent projet, puisque les concentrations additionnelles étaient attribuables au dépôt atmosphérique, les concentrations dans les racines ont été considérées équivalentes aux concentrations dans les parties végétatives. Cette approche est prudente.

1.3 Invertébrés terrestres

La catégorie des invertébrés terrestres regroupe une panoplie d'organismes ayant un mode de vie, et donc une exposition aux substances d'intérêt, très variable. Ainsi, si les invertébrés du sol (ex. : les vers de terre) sont en contact intime avec le sol, plusieurs autres invertébrés sont principalement associés avec la végétation. Par ailleurs, pour plusieurs de ces invertébrés, la durée du stade larvaire peut excéder la durée de la forme adulte. Le milieu avec lequel ces organismes sont en contact durant leur stade larvaire et leur stade adulte peut différer (Sanexen, 2002a).

Sur cette base, les concentrations bruit de fond et additionnelles ont été estimées par des approches distinctes. Celle-ci sont décrites dans les sous-sections suivantes.

1.3.1 Teneurs de fond

Les modèles les mieux validés pour estimer les concentrations de métaux dans les invertébrés terrestres sont ceux développés pour les invertébrés du sol. Dès lors, les teneurs de fond ont été estimées pour cette classe d'invertébrés. Selon l'information disponible dans la littérature, ces concentrations ont été estimées à partir de deux équations distinctes. L'équation de type I permet de représenter la non

linéarité de la relation entre les concentrations dans les sols et celles dans les invertébrés[1]. Des droites de régression suivant cette forme ont été développées par Sample, Beauchamp *et coll.* (1998) pour 7 métaux (As, Cu, Mn, Hg, Pb, Se et Zn, voir section 2.2). Pour les métaux pour lesquels aucune droite de régression n'est disponible, l'équation de type II a été utilisée. Celle-ci considère implicitement que la relation entre les concentrations dans les sols et les invertébrés est linéaire ($FBC_{sol\text{-}inv_sol}$ invariable).

Type I :

$$C_{inv_terr} = 0{,}2\ x\ e^{[B0+B1\ln(C_{sol})]}$$

Type 2 :

$$C_{inv_terr} = 0{,}2\ x\ C_{sol}\ x\ FBC_{sol-inv_sol}$$

Où :

C_{inv_terr} : Concentration de contaminant dans les invertébrés terrestres, mg/kg_{frais}

0,2 : Facteur de conversion masse sèche vers masse fraîche, kg_{sec}/kg_{frais}

B0 : Ordonnée à l'origine de la droite de régression(Sample, Beauchamp *et coll.*, 1998)

B1 : Pente de la droite de régression (Sample, Beauchamp *et coll.*, 1998)

C_{sol} : Concentration de contaminant dans le sol, mg/kg

$FBC_{sol\text{-}inv_sol}$: Facteur de bioconcentration sol-invertébrés du sol (base sèche, kg_{sol}/kg_{sec})

1.3.2 Concentrations additionnelles

Dans le cadre du présent projet, aucune concentration additionnelle dans les sols n'a été considérée (voir section 4.2.2.2 du rapport). Les concentrations additionnelles estimées dans les invertébrés du sol à l'aide des équations présentées à la section 1.3.1 seraient donc nulles. Or, des concentrations additionnelles non nulles pourraient être retrouvées dans les invertébrés terrestres associés à la végétation ou dans certaines espèces dont le stade larvaire est associé au milieu aquatique. De façon prudente, les concentrations additionnelles dans les invertébrés terrestres ont été estimées en supposant que ceux-ci sont associés aux parties végétatives de la végétation terrestre (50%) et à l'eau de surface (50%). Les concentrations additionnelles ont été estimées à l'aide de l'équation suivante :

$$C_{inv_terr} = 0{,}5\ x\ \left[(C_{vgt}\ x\ FBC_{vgt-inv_terr}) + C_{inv_aq}\right]$$

Où :

C_{inv_terr} : Concentration de contaminant dans les invertébrés terrestres, mg/kg_{frais}

0,5 : Facteur de pondération

C_{vgt} : Concentration de contaminant dans les parties végétatives de la végétation terrestre[2], en mg/kg_{frais}

$FBC_{vgt\text{-}inv_terr}$: Facteur de bioconcentration entre les végétaux et les invertébrés terrestres associés aux végétaux (soit, par défaut, 1 kg_{frais}/kg_{frais})

C_{inv_aq} : Concentration de contaminant dans les invertébrés aquatiques, en mg/kg_{frais}

1 Cette relation est attendue notamment pour les métaux essentiels régulés par les organismes vivants; à faible concentration dans le sol, les organismes auront tendance à accumuler davantage les métaux qu'à forte concentration. Ainsi, malgré une augmentation de la concentration dans les invertébrés, le $FBC_{sol\text{-}inv_sol}$ (C_{inv_sol}/C_{sol}) diminuera à mesure que la concentration dans le sol augmentera.

2 La moyenne des concentrations estimées dans les parties végétatives de la végétation herbacée, arbustive et arborescente a été utilisée.

1.4 Eau de surface

1.4.1 Teneurs de fond

Pour la plupart des substances d'intérêt, les teneurs de fond dans l'eau de surface ont été déterminées à partir de concentrations mesurées dans des échantillons d'eau de surface de la zone d'étude. En l'absence de valeurs mesurées, les teneurs de fond ont été documentées à partir de la littérature. Les données disponibles et la méthodologie à partir de laquelle les teneurs de fond dans l'eau de surface ont été déterminées sont détaillées à la section 4.2.4.1 du rapport.

1.4.2 Concentrations additionnelles

Les concentrations additionnelles dans l'eau de surface ont été déterminées de façon à pouvoir évaluer si l'exposition des récepteurs découlant du dépôt atmosphérique des particules pourrait être significatif. Les valeurs calculées fournissent un ordre de grandeur des concentrations additionnelles attendues dans l'eau de surface de la zone d'exposition rapprochée lorsque la mine sera en opération. Celles-ci ont été estimées à partir de l'information disponible, soit :

1. Les débits mensuels moyens des cours d'eau CE1 à CE5[1] présentés dans l'étude spécialisée en hydrologie réalisée par WSP (2018a);
2. Les taux de dépôt atmosphérique[2] estimés pour chaque récepteur sensible (situé à proximité de ces cours d'eau) considéré par l'étude de modélisation de dispersion atmosphérique de WSP (2018c);
3. La longueur de parcours et la largeur du chenal des cours d'eau CE1 à CE5 dans la zone d'exposition rapprochée fournies dans l'étude spécialisée sur l'habitat aquatique de WSP (2018d), ou estimées à partir de photographies aériennes.

Les concentrations additionnelles dans l'eau de surface qui pourraient découler des émissions atmosphériques de la mine ont été estimées à partir des équations suivantes :

$$C_{add_es-i} = \frac{1000\ x\ T_{dep_moy-i}\ x\ Long_totale_i\ x\ Larg_i}{2\ x\ Q_{moy-i}\ x\ FC}$$

$$C_{add_es} = \sum \left[\frac{Long_zone_i}{Long_zone_{tot}}\ x\ C_{add_es-i} \right]$$

$$Long_{tot} = \sum \mathrm{Long}_i$$

Où :

$C_{add\text{-}es}$: Concentration additionnelle dans l'eau de surface de la zone d'exposition rapprochée, en mg/L

$C_{add_es\text{-}i}$: Concentration additionnelle dans l'eau de surface du cours d'eau *i*, en mg/L

1 Aucune information par rapport au cours d'eau CE6 n'est fournie dans l'étude spécialisée sur l'habitat aquatique (WSP, 2018d). Conséquemment, CE6 n'a pas été considéré dans l'estimation des concentrations additionnelles dans l'eau de surface de la zone d'exposition rapprochée. La carte de dépôts de PST présentée dans l'étude de modélisation de la dispersion atmosphérique (WSP, 2018c) permet de constater que les taux de dépôts anticipés à la surface de CE6 sont du même ordre de grandeur (CE1 et CE5) ou plus faibles (CE2, CE3 et CE4) que ceux estimés à la surface des autres cours d'eau. Les concentrations additionnelles attendues dans l'eau de CE6 sont donc du même ordre de grandeur ou inférieures à celles estimées dans CE1 à CE5.

2 Les taux de dépôt correspondent à la masse de particules totales (en g) qui se déposent annuellement par unité de surface du territoire (m^2).

1000 : Facteur de conversion, mg/g

$T_{dep_moy\text{-}i}$: Taux de dépôt moyen à la surface du cours d'eau *i*, en g/m²/an (valeur spécifique à chaque métal, voir tableau E2)

$Long_totale_i$: Longueur de parcours totale du cours d'eau *i* à l'intérieur de zone d'exposition rapprochée[1], en m (tableau F2)

$Long_zone_i$: Longueur de parcours du cours d'eau *i* dans la zone d'exposition rapprochée[2], en m (tableau F2)

$Larg_i$: Largeur moyenne du chenal du cours d'eau *i* dans la zone d'exposition rapprochée, en m (tableau F2)

2 : Facteur d'ajustement (voir explication ci-bas)

$Q_{moy\text{-}i}$: Débit annuel moyen du cours d'eau *i*, en L/s (tableau F2)

FC : Facteur de conversion, soit 365 x 24 x 60 x 60 s/an

$Long_zone_{tot}$: Longueur de parcours total des cours d'eau CE1 à CE5 dans la zone d'exposition rapprochée

Les concentrations additionnelles dans l'eau de surface des différents cours d'eau ($C_{add_es\text{-}i}$) ont été calculées en divisant, pour chaque cours d'eau, la masse totale de métal se déposant à la surface de l'eau (g/an) par le volume d'eau traversant annuellement la zone d'exposition rapprochée (L/an). En réalité, le dépôt de particules se faisant en continu, les concentrations additionnelles dans les cours d'eau CE1 à CE5 augmenteront graduellement à mesure que les masses d'eau traverseront la zone d'exposition rapprochée. Le facteur d'ajustement de 2 vise à estimer les concentrations additionnelles moyennes en métaux dans l'eau de surface, soit les concentrations additionnelles retrouvées à mi-parcours entre l'entrée et la sortie de la zone d'exposition rapprochée de chaque cours d'eau.

Les concentrations additionnelles dans l'eau de surface ont été estimées en supposant que les particules se déposant à la surface de l'eau se répartissaient uniformément dans la totalité des volumes d'eau traversant la zone d'exposition rapprochée et qu'aucune sédimentation ne se produisait. Il a par ailleurs été supposé que le dépôt se produisant à l'extérieur de la zone d'exposition rapprochée serait négligeable.

TABLEAU F2
Caractéristiques des cours d'eau de la zone d'exposition rapprochée

Caractéristique	CE1	CE2	CE3	CE4	CE5
Largeur moyenne (m)	2,2	2,4	20	2,4	4,8
Longueur de parcours totale (m)	5270	6180	9000	2100	7000
Longueur de parcours dans la zone (m)	5270	6180	2300	1100	7000
Débit annuel moyen (L/s)	148	174	115	24	369

1.5 Végétaux aquatiques

1.5.1 Parties végétatives et reproductrices

1 Incluant l'empreinte des activités du Projet.
2 Excluant l'empreinte des activités du Projet.

Dans le cadre du présent projet, afin de maximiser l'exposition des récepteurs humains, il a été supposé que les végétaux aquatiques consommés par les récepteurs écologiques (ultérieurement chassés ou piégés par les récepteurs humains) possédaient des racines en contact avec les sédiments ainsi que des parties végétatives émergées de l'eau (ex. : nénuphars, typha). Considérant ceci, les concentrations dans les parties végétatives de ces plantes ont été estimées à partir des équations (présentées à la section 1.2.2.1) qui ont été utilisées afin d'estimer les concentrations dans les parties végétatives des plantes terrestres herbacées[1].

En l'absence de facteurs de bioconcentration sédiments-végétaux aquatiques ($FBC_{sed\text{-}vgt}$), les concentrations dans les végétaux aquatiques ont été estimées à l'aide des $FBC_{sol\text{-}vgt}$ présentés à la section 2.1. Cette approche est celle retenue par l'U.S. EPA (1999). De la même façon, comme pour les végétaux terrestres, les concentrations dans les parties reproductrices des végétaux aquatiques ont été estimées à l'aide du $ratio_{r/v}$ présenté à la section 1.2.2.2.

1.5.2 Racines

Les teneurs de fond dans les racines des végétaux aquatiques ont été estimées à partir des concentrations mesurées dans les sédiments de la zone d'étude, à l'aide de l'équation suivante :

$$C_{rac_veg_aq} = 0{,}12 \; x \; C_{sed} \; x \; FBC_{sed-rac_vgt_aq}$$

Où

$C_{rac_veg_aq}$:	Concentration dans les racines des végétaux aquatiques, mg/kg_{frais}
C_{sed} :	Concentration dans les sédiments, mg/kg
0,12 :	Facteur de conversion masse sèche/masse fraîche, kg_{sec}/kg_{frais}
$FBC_{sed\text{-}rac_vgt_aq}$:	Facteur de bioconcentration sédiments-racines des végétaux, kg/kg_{sec}

Comme pour les végétaux terrestres, il a été considéré que les concentrations additionnelles dans les végétaux aquatiques seraient majoritairement attribuables au dépôt de particules sur les parties émergées des végétaux et non au transfert à partir des sédiments (voir section 1.2.2.3). Dès lors, les concentrations additionnelles dans les racines ont été considérées équivalentes aux concentrations dans les parties végétatives, ce qui constitue une approche prudente.

1.6 Invertébrés aquatiques

Les concentrations de métaux dans les invertébrés aquatiques ont été estimées selon deux approches, en fonction du milieu principal avec lequel ces organismes sont en contact. Pour les invertébrés benthiques (vivant dans les sédiments), deux types d'équations ont été utilisés. La forme de ces équations est similaire à celle des modèles retenus pour estimer les teneurs de fond dans les invertébrés terrestres (voir section 1.3.1).

Invertébrés aquatiques vivant dans la colonne d'eau :

$$C_{inv_aq} = C_{eau} \; x \; FBC_{eau-inv_aq}$$

1 Il est à noter que les concentrations dues à l'absorption radiculaire ont été estimées à partir des concentrations dans les sédiments plutôt que celles dans les sols.

Invertébrés aquatiques benthiques (vivant dans les sédiments)

Type I :

$$C_{inv_aq} = 0{,}2\ x\ 10^{[B0+B1\ x\ \log_{10}(C_{sed})]}$$

Type II :

$$C_{inv_aq} = C_{sed}\ x\ FBC_{sed-inv_aq}$$

Où

C_{inv_aq} :	Concentration dans les invertébrés aquatiques, mg/kg_{frais}
C_{sed} :	Concentration dans les sédiments, mg/kg
C_{eau} :	Concentration dans l'eau, mg/L
0,2 :	Facteur de conversion masse sèche vers masse fraîche, kg_{sec}/kg_{frais}
B0 :	Ordonnée à l'origine de la droite de régression (ORNL, 1998)
B1 :	Pente de la droite de régression (ORNL, 1998)
$FBC_{eau-inv_aq}$:	Facteur de bioconcentration eau-invertébrés aquatiques, L/kg_{frais}
$FBC_{sed-inv_aq}$:	Facteur de bioconcentration eau-invertébrés aquatiques, kg/kg_{frais}

1.7 Chair des poissons

En l'absence de données mesurées, les concentrations dans les poissons ont été estimées à l'aide des facteurs de bioaccumulation ($FBA_{poisson}$) documentés à partir de la littérature. Le calcul a été réalisé à l'aide de l'équation suivante :

$$C_{poisson} = C_{eau}\ x\ FBA_{poisson}$$

Où

$C_{poisson}$:	Concentration dans les poissons, mg/kg_{frais}
C_{eau} :	Concentration dans l'eau, mg/L
$FBA_{poisson}$:	Facteur de bioaccumulation chez le poisson, L/kg_{frais}

1.8 Chair des mammifères et des oiseaux

1.8.1 Considérations générales

Les concentrations en métaux dans la chair de différentes espèces de mammifères et d'oiseaux ont été estimées à partir des doses d'exposition multivoies. Pour ce faire, les propriétés des récepteurs, les régimes alimentaires ainsi que certaines habitudes de vie pouvant influencer l'exposition aux substances d'intérêt (ex. : taux d'ingestion de sol) ont été documentées. Plusieurs propriétés des espèces sont celles documentées dans les bases de données de TerraSys^{MC} (Sanexen, 2002b). Le reste des informations provient de la littérature. Les propriétés des récepteurs écologiques d'intérêt sont présentées aux tableaux F7 et F8.

1.8.2 Ajustement des facteurs de biotransfert (FBT)

Le FBT est défini, pour un récepteur et une substance donnés, comme le ratio de la concentration dans la chair (muscle, ou autre organe, en mg/kg) et de la dose d'exposition sous-jacente (en mg/jour). Les données de la littérature suggèrent que les FBT associés aux organismes de grande taille sont plus faibles que ceux associés aux organismes de petite taille (OEHHA, 2012). Pour toutes les substances d'intérêt, des FBT expérimentaux sont disponibles pour le bœuf. Pour quelques-unes d'entre-elles, des FBT expérimentaux sont également disponibles pour le poulet. Or, les espèces de mammifères et d'oiseaux pertinents à la présente étude peuvent être significativement plus petits ou plus grands que ces espèces. Dans son guide technique, l'OEHHA (2012) recommande, en l'absence de FBT documentés pour certaines espèces, d'extrapoler les FBT d'une espèce à l'autre à partir d'une équation allométrique basée sur le taux métabolique de chaque espèce. Cette approche a été retenue pour la présente étude. Ainsi, des FBT mesurés pour le bœuf et, lorsque disponible, pour le poulet ont été documentés pour l'ensemble des substances d'intérêt. Les FBT spécifiques aux différentes espèces de mammifères et d'oiseaux pertinents à la présente étude ont ensuite été estimés à partir de ces FBT de référence (tableau F5). Les masses corporelles des espèces de référence, à partir desquelles la conversion a été réalisée, sont de 500 kg pour le bœuf et 1,75 kg pour le poulet.

1.8.3 Définition des taux d'ingestion de sol et de sédiments

Sur la base d'analyses du contenu stomacal, le taux d'ingestion de sol et de sédiments de plusieurs espèces de mammifères et d'oiseaux ont été estimés. Les valeurs sont généralement rapportées comme une proportion du taux de consommation de nourriture (sur une base sèche). Plusieurs de ces taux ont été rapportés par l'U.S. EPA (1993).

Lorsque disponibles, les taux d'ingestion de sol documentés pour les espèces pertinentes à la présente étude ont été utilisés. Cependant, pour plusieurs espèces, aucun taux n'était disponible. Sur la base des valeurs publiées, quatre catégories de taux d'ingestion de sols et de sédiments ont été créés : 2%, 5%, 10% et 15%. La valeur de 15% a été utilisée uniquement pour les espèces d'oiseaux qui sont susceptibles d'ingérer une grande quantité de sol ou de sédiments en s'alimentant. C'est le cas, par exemple, de la sarcelle d'hiver qui filtre à l'aide de son bec la vase dans laquelle se trouvent les proies dont elle s'alimente[1]. Pour les mammifères et les oiseaux s'alimentant principalement au sol (invertébrés du sol, graines picorées à même le sol, invertébrés benthiques, racines et/ou herbe), un taux d'ingestion de 10% a été retenu. Pour les organismes ne s'alimentant que partiellement à partir du sol (qui consomment de la viande, des fruits, des feuilles de végétaux arbustifs, arborescents et/ou aquatiques, etc.), un taux d'ingestion de 5% a été retenu. Finalement, pour les organismes qui ne se nourrissent pas au sol, un taux d'ingestion 2% a été appliqué.

Tous les taux d'ingestion de sol documentés ou retenus par défaut sont fournis sur une base sèche ($kg_{sol}/kg_{aliments\ secs}$). Or, les taux d'ingestion de nourriture documentés sont fournis sur une base humide. Afin de convertir les taux d'ingestion de nourriture de la base humide à la base sèche, le pourcentage d'humidité des aliments consommés par les omnivores, herbivores, insectivores et carnivores ont été fixés à 75%, 80%, 75% et 75%, respectivement (Sanexen, 2002a). Il est à noter que l'ingestion de sol n'a été considérée que pour les mois durant lesquels le sol n'est pas recouvert de neige[2].

1.8.4 Définition des régimes alimentaires

1 https://inpn.mnhn.fr/docs/cahab/fiches/Sarcelle-dhiver.pdf
2 Mois durant lesquels la température moyenne est supérieure au point de congélation, soit 6 mois par année.

Les régimes alimentaires des espèces de mammifères et d'oiseaux ont été définis sur la base de la meilleure information disponible. Lorsque nécessaire et possible, les régimes alimentaires ont été définis sur une base saisonnière (printemps, été, automne et hiver). Ainsi, pour la bernache du Canada, la fiche préparée par le CEAEQ (2005), qui rapporte le pourcentage de plusieurs types d'aliments dans l'œsophage de certains spécimens, permet une définition détaillée du régime alimentaire. Cependant, pour la majorité des espèces, aucune information quantitative n'était disponible. Pour ces récepteurs, la proportion de chaque type d'aliment dans le régime alimentaire est donc approximative.

1.8.5 Équations utilisées

Les concentrations dans les tissus des mammifères et des oiseaux ont été calculées en faisant la sommation des concentrations découlant de l'alimentation, de l'ingestion de sol de surface et de l'inhalation. Dans le présent projet, la contribution du contact cutané avec le sol de surface a été négligée. En raison de leur plumage ou de leur fourrure, le contact cutané est généralement une voie d'exposition négligeable pour ces récepteurs (Suter II, Efroymson *et coll.*, 2000). Par ailleurs, puisque les concentrations additionnelles dans les sols de surface sont réputées nulles (voir section 4.2.2.2 du rapport), cette voie n'aurait pas contribué à l'exposition additionnelle des récepteurs.

Les concentrations dans la chair des mammifères et des oiseaux ont été estimées à partir des équations suivantes, inspirées de celles intégrées au logiciel TerraSys^{MC} (Sanexen, 2002b) :

$$C_{chair} = \left[\sum_i f_{alim\ i}\ x\ T_{ing-alim}\ x\ C_{alim\ i}) + T_{ing-eau}\ x\ C_{eau} + T_{ing-sol/sed}\ x\ C_{sol/sed} + T_{inh}\ x\ C_{Air}\right] x\ FBT$$

$$FBT = \mathrm{FBT}_{reference} * \frac{M_{reference}^{0,75}}{M_{espèce}^{0,75}}$$

Où

C_{chair} : Concentration dans la chair d'une espèce (en mg/kg$_{frais}$);

i : Indice de chaque élément de l'alimentation;

$f_{alim\ i}$: Fraction de l'élément i dans l'alimentation (en kg$_{frais}$/kg$_{frais}$, tableau F8)

$T_{ing-alim}$: Taux d'ingestion de nourriture de l'espèce considérée (en kg$_{frais}$/j, tableau F7);

$C_{alim\ i}$: Concentration dans l'élément i du régime alimentaire (en mg/kg$_{frais}$);

$T_{ing-eau}$: Taux d'ingestion d'eau de surface (en L/j, tableau F7);

C_{eau} : Concentration dans l'eau de surface (en mg/L);

$T_{ing-sol}$: Taux d'ingestion de sol ou de sédiments (en kg$_{sol\ sec}$/j, tableaux F7);

C_{sol} : Concentration dans le sol ou dans les sédiments (en mg/kg$_{sol\ sec}$);

T_{inh} Taux d'inhalation (en m^3/j, tableau F7);

C_{Air} : Concentration dans l'air ambiant (en mg/m^3);

FBT : Facteur de biotransfert spécifique à l'espèce (en j/kg$_{frais}$);

$FBT_{reference}$: Facteur de biotransfert de l'espèce de référence (en j/kg$_{frais}$, tableau F5);

$M_{espèce}$ Masse de l'espèce considérée (en kg$_{frais}$, tableaux F7);

$M_{référence}$ Masse de l'espèce de référence (soit 1,75 kg$_{frais}$ pour les oiseaux et 60 kg pour les mammifères, voir section 1.8.2).

1.9 Air intérieur

Les concentrations dans l'air intérieur des bâtiments fréquentés par les récepteurs humains ont été estimées à partir des équations suivantes :

$$C_{ai} = (C_{air} \times f_{gaz}) + (C_{air} \times f_{ptc} \times TP_m)$$

$$f_{ptc} = \frac{c \times S_T}{p_L^s + (c \times S_T)}$$

$$p_L^s = PV \qquad (Pt_{fusion} > T_K)$$

$$p_L^s = \frac{PV}{e^{-6,79\,\psi}} \qquad (Pt_{fusion} <= T_K)$$

$$\psi = \left(\frac{Pt_{fusion}}{T_{(K)}}\right) - 1$$

$$S_T = 4,2 \times 10^{-7} \qquad (\text{région isolée})$$

$$f_{gaz} = 1,0 - f_{ptc}$$

Où :

C_{ai} : Concentration dans l'air intérieur, mg/m³

C_{air} : Concentration dans l'air extérieur, mg/m³

f_{gaz} : Fraction gazeuse du contaminant dans l'air extérieur, sans unité (valeur nulle pour tous les métaux, sauf pour le mercure (~1,0))

f_{ptc} : Fraction adsorbée du contaminant dans l'air extérieur, sans unité (valeur de 1,0 pour tous les métaux, sauf pour le mercure (1,12E-04 en été et 5,17E-05 en hiver))

TP_m : Taux de pénétration des particules dans la résidence, sans unité (fixé à 0,7)

c : Constante de Junge, 1,7E-04 atm.cm

S_T : Surface moyenne des particules, cm²/cm³

p^s_L : Pression de vapeur du contaminant en phase libre, atm

PV : Pression de vapeur du contaminant, atm

Pt_{fusion} : Température de fusion du contaminant, K

T_K : Température de l'air ambiant, K (fixé à 256,6 K en hiver et 292,7 K et été)

Puisque les teneurs de fond dans l'air ont été considérées constantes durant toute l'année, et compte tenu de la nature des substances à l'étude (métaux), les concentrations estimées en été et en hiver sont équivalentes.

Pour le mercure, seule substance métallique à pouvoir se volatiliser aux températures ambiantes, la concentration intérieure attribuable à l'utilisation de l'eau domestique ainsi qu'à l'intrusion de vapeurs ont également été considérées.

La concentration attribuable à l'utilisation de l'eau domestique a été estimée à partir des équations suivantes et des paramètres présentés au tableau F3 :

$$C_{us_eau} = \frac{Q_{us_eau}}{[\,Lng_{hab} \times Lrg_{hab} \times (Htr_{hab} + Prf_{ss})\,] \times [\,TR_{air} \times 24\,]}$$

$$Q_{us_eau} = Q_{douches} + Q_{bains} + Q_{vaisselle} + Q_{lessive} + Q_{nettoyage} + Q_{cuisine} + Q_{toilettes}$$

$$Q_{douches} = Us_{douches} \times Eff_{douches} \times C_{eau}$$

$$Q_{bains} = Us_{bains} \times Eff_{bains} \times C_{eau}$$

$$Q_{vaisselle} = Us_{vaisselle} \times Eff_{vaisselle} \times C_{eau}$$

$$Q_{lessive} = Us_{lessive} \times Eff_{lessive} \times C_{eau}$$

$$Q_{nettoyage} = Us_{nettoyage} \times Eff_{nettoyage} \times C_{eau}$$

$$Q_{cuisine} = Us_{cuisine} \times Eff_{cuisine} \times C_{eau}$$

$$Q_{toilettes} = Us_{toilettes} \times Eff_{toilettes} \times C_{eau}$$

$$Eff_{douches} = Eff_{Rdn,\ douches} \times \frac{\varphi_{Rn}}{\varphi}$$

$$Eff_{bains} = Eff_{Rdn,\ bains} \times \frac{\varphi_{Rn}}{\varphi}$$

$$Eff_{vaisselle} = Eff_{Rdn,\ vaisselle} \times \frac{\varphi_{Rn}}{\varphi}$$

$$Eff_{lessive} = Eff_{Rdn,\ lessive} \times \frac{\varphi_{Rn}}{\varphi}$$

$$Eff_{nettoyage} = Eff_{Rdn,\ nettoyage} \times \frac{\varphi_{Rn}}{\varphi}$$

$$Eff_{cuisine} = Eff_{Rdn,\ cuisine} \times \frac{\varphi_{Rn}}{\varphi}$$

$$Eff_{toilettes} = Eff_{Rdn,\ toilettes} \times \frac{\varphi_{Rn}}{\varphi}$$

$$\varphi_{Rn} = \frac{2,5}{De_{Rn}^{0,667}} + \frac{R \times T}{Da_{Rn}^{0,667} \times H_{Rn}}$$

$$\varphi = \frac{2,5}{De^{0,667}} + \frac{R \times T}{Da^{0,667} \times H}$$

TABLEAU F3
Paramètres et propriétés utilisés pour modéliser la concentration de mercure dans l'air intérieur attribuable à l'utilisation de l'eau domestique

Paramètre	Description	Valeur	Unités
Lng_{hab}	Longueur de la résidence	20	m
Lrg_{hab}	Largeur de la résidence	15	m
Htr_{hab}	Hauteur de la résidence	3	m
Prf_{ss}	Profondeur du sous-sol de la résidence	0,5	m
TR_{air}	Taux de renouvellement de l'air dans la résidence	0,9	/heure
$Us_{douches}$	Quantité d'eau utilisée pour les douches	180,00	L/jour
Us_{bains}	Quantité d'eau utilisée pour les bains	150,00	L/jour
$Us_{vaisselle}$	Quantité d'eau utilisée pour la vaisselle	40,00	L/jour
$Us_{lessive}$	Quantité d'eau utilisée pour la lessive	40,00	L/jour
$Us_{nettoyage}$	Quantité d'eau utilisée pour le nettoyage	12,00	L/jour
$Us_{cuisine}$	Quantité d'eau utilisée pour la cuisine	8,00	L/jour
$Us_{toilettes}$	Quantité d'eau utilisée pour les toilettes	320,00	L/jour
$Eff_{douches}$	Efficacité de transfert de l'eau à l'air pour les douches	1,05	-
Eff_{bains}	Efficacité de transfert de l'eau à l'air pour les bains	0,49	-
$Eff_{vaisselle}$	Efficacité de transfert de l'eau à l'air pour la vaisselle	1,59	-
$Eff_{lessive}$	Efficacité de transfert de l'eau à l'air pour la lessive	1,46	-
$Eff_{nettoyage}$	Efficacité de transfert de l'eau à l'air pour le nettoyage	1,46	-
$Eff_{cuisine}$	Efficacité de transfert de l'eau à l'air pour la cuisine	0,49	-
$Eff_{toilettes}$	Efficacité de transfert de l'eau à l'air pour les toilettes	0,49	-
$Eff_{Rdn,douches}$	Efficacité de transfert du radon pour les douches	0,65	-
$Eff_{Rdn,bains}$	Efficacité de transfert du radon pour les bains	0,30	-
$Eff_{Rdn,vaisselle}$	Efficacité de transfert du radon pour la vaisselle	0,98	-
$Eff_{Rdn,lessive}$	Efficacité de transfert du radon pour la lessive	0,90	-
$Eff_{Rdn,nettoyage}$	Efficacité de transfert du radon pour le nettoyage	0,90	-
$Eff_{Rdn,cuisine}$	Efficacité de transfert du radon pour la cuisine	0,30	-
$Eff_{Rdn,toilettes}$	Efficacité de transfert du radon pour les toilettes	0,30	-
De_{Rn}	Diffusivité du radon dans l'eau	1,40E-09	m^2/seconde
Da_{Rn}	Diffusivité du radon dans l'air	2,00E-05	m^2/seconde
De	Diffusivité du mercure dans l'eau	3,01E-09	m^2/seconde
Da	Diffusivité du mercure dans l'air	1,09E-06	m^2/seconde
R	Constante des gaz	0,062	torr.m^3/mole.K
T	Température	293,00	K
H	Constante de Henry du mercure	5,40	torr.m^3/mole
H_{Rn}	Constante de Henry du radon	7,00E+04	torr.m^3/mole
24	Nombre d'heures dans une journée	24	heures/jour

La concentration attribuable à l'intrusion de vapeur a, quant à elle, été estimée à partir des équations suivantes et des paramètres présentés au tableau F4 :

$$C_{intrusion} = \alpha \times C_{source}$$

$$C_{source} = \frac{H'_{TS} \times C_R \times \rho_b}{\theta_w + K_d \rho_b + H'_{TS} \theta_a}$$

$$K_d = K_{oc} \times f_{oc}$$

$$H'_{TS} = \frac{\exp\left[-\frac{\Delta H_{v,TS}}{R_c}\left(\frac{1}{T_S} - \frac{1}{T_R}\right)\right] H_R}{R \times T_S}$$

$$\Delta H_{v,TS} = \Delta H_{v,b} \left[\frac{1 - \frac{T_S}{T_C}}{1 - \frac{T_B}{T_C}}\right]^{\gamma}$$

$$\gamma = 0{,}3 \qquad (T_B / T_C < 0{,}57)$$

$$\alpha = \frac{\left(\frac{D_T^{eff} A_B}{Q_{résid} L_T}\right) \times \exp\left(\frac{Q_{soil} L_{crack}}{D_{crack} A_{crack}}\right)}{\left\{\exp\left(\frac{Q_{soil} L_{crack}}{D_{crack} A_{crack}}\right) + \left(\frac{D_T^{eff} A_B}{Q_{résid} L_T}\right) + \left(\frac{D_T^{eff} A_B}{Q_{soil} L_T}\right)\left[\exp\left(\frac{Q_{soil} L_{crack}}{D_{crack} A_{crack}}\right) - 1\right]\right\}}$$

$$D_T^{eff} = \frac{L_T}{\sum_{i=0}^{i=2}\left(\frac{L_i}{D_i^{eff}}\right)}$$

$$D_{cz}^{eff} = D_a\left(\frac{\theta_{a,cz}^{3,33}}{n_{cz}^2}\right) + \left(\frac{D_w}{H'_{TS}}\right)\left(\frac{\theta_{w,cz}^{3,33}}{n_{cz}^2}\right)$$

$$L_{cz} = \frac{0{,}15}{R_{pores}}$$

$$R_{pores} = 0{,}2 \times \varnothing_{ptc}$$

$$D_{uz}^{eff} = D_a\left(\frac{\theta_{a,uz}^{3,33}}{n_{uz}^2}\right) + \left(\frac{D_w}{H'_{TS}}\right)\left(\frac{\theta_{w,uz}^{3,33}}{n_{uz}^2}\right)$$

$$Q_{résid} = \frac{L_B \; W_B \; H_B \; ER}{3600}$$

$$Q_{soil} = \frac{2\pi \ \Delta P \ k_v \ X_{crack}}{\mu \ \ln\left(\frac{2 \ Z_{crack}}{r_{crack}}\right)}$$

$$\Delta P = \left(\frac{\Delta T}{12}\right)^2$$

$$\Delta T = 20 - T_{ext} \qquad (\Delta T \geq 0)$$

$$r_{crack} = \eta \left(\frac{A_B}{X_{crack}}\right) \qquad (0 \leq \eta \leq 1)$$

$$\eta = \left(\frac{A_{crack}}{A_B}\right)$$

$$\alpha \leq \frac{\left(\frac{D_T^{eff} \ A_B}{Q_{résid} \ L_T}\right)}{\left(\frac{D_T^{eff} \ A_B}{Q_{soil} \ L_T}\right) + 1}$$

$$k_v = k_i \times k_{rg}$$

$$k_i = \frac{K_s \ \mu_w}{\rho_w \ g}$$

$$k_{rg} = (1 - S_{te})^{0.5} \left(1 - S_{te}^{1/M}\right)^{2M}$$

$$S_{te} = \frac{(\theta_w - \theta_r)}{(n - \theta_r)}$$

$$\theta_w = \theta_r + \frac{\theta_s - \theta_r}{2^M}$$

$$L_{uz} = L_T - L_{cz} \qquad \{ L_{uz} > 0 \}$$

TABLEAU F4

Paramètres et propriétés utilisés pour modéliser la concentration de mercure dans l'air intérieur attribuable à l'intrusion de vapeurs

Paramètre	Description	Valeur été	Valeur hiver	Unités
α	Facteur d'atténuation air interstitiel-air intérieur	6,10E-07	2,73E-06	-
C_R	Concentration initiale dans le sol	3,60E-08	3,60E-08	g/g
H'_{TS}	Constante de Henry à la température du sol	0,12	0,12	-
P_b	Densité brute du sol	1,57	1,57	g/cm³

Paramètre	Description	Valeur été	Valeur hiver	Unités
θw	Contenu en eau du sol	0,13	0,13	-
θa	Contenu en air du sol	0,26	0,26	-
$\Delta H_{v,TS}$	Enthalpie de vaporisation à la température du sol	1,51E+04	1,51E+04	cal/mole
R_c	Constante des gaz	1,99	1,99	cal/mole.K
T_S	Température du système (sol-eau souterraine)	288	288	K
T_R	Température de référence pour la constante de Henry	298	298	K
H_R	Constante de Henry à la température de référence	0,0071	0,0071	atm.m³/mole
R	Constante des gaz	8,21E-05	8,21E-05	atm.m³/mole.K
$\Delta H_{v,b}$	Enthalpie de vaporisation au point normal d'ébullition	1,41E+04	1,41E+04	cal/mole
T_C	Température critique	2008	2008	K
T_B	Point d'ébullition du contaminant	629,6	629,6	K
D^{eff}_T	Coefficient de diffusion effective totale	5,53E-04	5,53E-04	cm²/sec.
A_B	Surface de l'espace clos en contact avec le sol	3,35E+06	3,35E+06	cm²
$Q_{résid}$	Taux de ventilation de la résidence	2,25E+05	2,25E+05	cm³/sec.
L_T	Distance entre la contamination et la fondation de la résidence	11,25	11,25	cm
Q_{soil}	Flux volumétrique du gaz dans l'espace clos de la résidence	5,10E-05	0,61	cm³/sec.
L_{crack}	Épaisseur de la fondation de la résidence	11,25	11,25	cm
A_{crack}	Surface totale des fissures dans la fondation de la résidence	1846	1846	cm²
D_{crack}	Coefficient de diffusion effective à travers les fissures	8,37E-04	8,37E-04	cm²/sec.
D^{eff}_{cz}	Coefficient de diffusion effective dans la zone capillaire	8,37E-04	8,37E-04	cm²/sec.
L_{cz}	Épaisseur de la zone capillaire	17,05	17,05	cm
D^{eff}_{uz}	Coefficient de diffusion effective dans la zone insaturée	8,37E-04	8,37E-04	cm²/sec.
L_{uz}	Épaisseur de la zone insaturée	0	0	cm
D_a	Diffusivité dans l'air du contaminant	0,011	0,011	cm²/sec.
$\theta a,cz$	Contenu en air du sol dans la zone capillaire	0,26	0,26	cm³/cm³
$\theta w,cz$	Contenu en eau du sol dans la zone capillaire	0,13	0,13	cm³/cm³
n_{cz}	Porosité dans la zone capillaire	0,39	0,39	cm³/cm³
D_w	Diffusivité dans l'eau du contaminant	3,01E-05	3,01E-05	cm²/sec.
R_{pores}	Rayon moyen des pores entre les particules de sol	0,0088	0,0088	cm
θcz	Contenu en air du sol dans la zone insaturée	0,26	0,26	cm³/cm³
$\theta w,uz$	Contenu en eau du sol dans la zone insaturée	0,13	0,13	cm³/cm³
$n uz$	Porosité dans la zone insaturée	0,39	0,39	cm³/cm³
L_B	Longueur de la résidence	2000	2000	cm
W_B	Largeur de la résidence	1500	1500	cm
H_B	Hauteur de la résidence	300	300	cm
ER	Taux de renouvellement d'air de la résidence	0,9	0,9	/heure
Δ_P	Différence de pression entre le sol de surface et l'espace clos	7,72E-04	9,2	g/cm.sec.²
Δ_T	Différence de température entre l'air extérieur et intérieur	0,33	36,4	°C
T_{ext}	Température de l'air extérieur	19,67	-16,4	°C
k_v	Perméabilité du sol à la vapeur	1,99E-09	1,99E-09	cm²
X_{crack}	Périmètre du joint entre les murs et le plancher de la fondation	7000	7000	cm
μ	Viscosité de l'air	1,81E-04	1,81E-04	g/cm.sec.
Z_{crack}	Profondeur des fissures dans la fondation sous le niveau du sol	200	200	cm
r_{crack}	Rayon équivalent à l'aire des fissures	0,26	0,26	cm
k_i	Perméabilité intrinsèque du sol	1,62E-08	1,62E-08	cm²
k_{rg}	Perméabilité relative de l'air	0,12	0,12	-
K_S	Conductivité hydraulique saturée du sol	0,0012	0,0012	cm/sec.
μw	Viscosité dynamique de l'eau	0,013	0,013	g/cm.sec.
ρw	Densité de l'eau	1	1	g/cm³
g	Constante d'accélération due à la gravité	980,66	980,66	cm/sec.²

Paramètre	Description	Valeur été	Valeur hiver	Unités
S_{te}	Saturation fluide effective totale	0,23	0,23	-
M	Paramètre de forme de Van Genuchthen	1,75	1,75	-
n	Porosité totale du sol	0,39	0,39	-
θr	Contenu résiduel en eau du sol	0,049	0,049	-
θs	Contenu en eau du sol saturé	0,39	0,39	-
γ	Exposant de l'équation du calcul de l'enthalpie de vaporisation	0,3	0,3	-
∅ptc	Diamètre moyen des particules de sol	0,044	0,044	cm

1.10 Poussières intérieures

L'estimation des concentrations dans les poussières intérieures des bâtiments a été réalisée à partir des concentrations dans le sol et dans l'air ambiant à l'aide des équations suivantes.

$$C_{pou} = (C_{sol}\ x\ f_{sol}) + (C_{ptc}\ x\ f_{MES})$$

$$C_{ptc} = \frac{C_{ai} \times f_{ptc}}{C_{MES} \times FCV}$$

$$f_{MES} = 0,10$$

$$C_{MES} = 10 \qquad (\text{région isolée})$$

$$f_{ptc} = \frac{c \times S_T}{p_L^s + (c \times S_T)}$$

$$p_L^s = PV \qquad (Pt_{fusion} > T_K)$$

$$p_L^s = \frac{PV}{e^{-6,79\ \psi}} \qquad (Pt_{fusion} <= T_K)$$

$$\psi = \left(\frac{Pt_{fusion}}{T_{(K)}}\right) - 1$$

$$S_T = 4,2 \times 10^{-7} \qquad (\text{région isolée})$$

Où :

C_{pou} : Concentration dans les poussières intérieures, mg/kg
C_{sol} : Concentration dans le sol de surface, mg/kg
f_{sol} : Fraction des poussières provenant du sol de surface, sans unité (fixé à 0,30 pour l'été et 0 pour l'hiver (sol gelé))
C_{ptc} : Concentration dans les particules de l'air intérieur, mg/kg
f_{MES} : Fraction des poussières provenant des matières en suspension, sans unité (fixé à 0,1)
C_{ai} : Concentration dans l'air intérieur, mg/m³
f_{ptc} : Fraction du contaminant adsorbé aux particules dans l'air intérieur, sans unités (fixé à 1,0, sauf pour le mercure (1,19E-04 en été et 1,08E-04 en hiver))
C_{MES} : Concentration de matières en suspension dans l'air intérieur, fixé à 10 µg/m³

FCV :	Facteur de conversion d'unités, 1,0E-09 kg/µg
c :	Constante de Junge, 1,7E-04 atm.cm
S_T :	Surface moyenne des particules, cm^2/cm^3
$p°_L$:	Pression de vapeur du contaminant en phase libre, atm
PV :	Pression de vapeur du contaminant, atm
Pt_{fusion} :	Température de fusion du contaminant, K
T_K :	Température de l'air intérieur, K (fixé à 298 K)

2. PROPRIÉTÉS DES SUBSTANCES D'INTÉRÊT

Les propriétés des métaux requises par les modèles présentés à la section 1 sont fournies au tableau F5. À moins d'indication contraire dans les sous-sections qui suivent, les propriétés des substances d'intérêt sont celles incluses dans la base de données du logiciel TerraSys^{MC} (Sanexen, 2002b). Celles-ci ont été documentées à partir de la littérature scientifique.

TABLEAU F5
Propriétés des métaux utilisées pour modéliser des concentrations multimédias

Substance	$FBC_{sol-vgt}$	$Ratio_{r/v}$	Invertébrés terrestres		$FBC_{sol-inv_sol}$	$FBC_{vgt_inv_terr}$	$FBC_{sed-rac_vgt_aq}$	$FBC_{eau-inv_aq}$
	kg/kg_{sec}	-	B0	B1	kg/kg_{sec}	Kg_{frais}/kg_{frais}	Kg/kg_{sec}	L/kg_{frais}
Aluminium	4,0E-03	0,16	-	-	4,3E-02	1	1,1	31
Antimoine	2,0E-01	0,15	-	-	1,1	1	0,04	7
Argent	4,0E-01	0,25	-	-	2,05	1	0,26	298
Arsenic	4,0E-02	0,15	-1,42	0,71	-	1	0,48	73
Baryum	1,5E-01	0,10	-	-	0,091	1	0,17	200
Béryllium	1,0E-02	0,15	-	-	4,5E-02	1	0,20	45
Bore	4,0E+00	0,50	-	-	1,1	1	22,3	100
Cadmium	5,5E-01	0,27	-	-	-	1	5,1	3461
Chrome[a]	7,5E-03	0,60	-	-	0,31	1	1,3	3000
Cobalt	2,0E-02	0,35	-	-	0,12	1	0,53	300
Cuivre	4,0E-01	0,63	1,68	0,26	-	1	1,3	3718
Étain	3,0E-02	0,20	-	-	0,52	1	0,65	1000
Lithium	2,5E-02	0,16	-	-	1,1	1	0,11	4066
Manganèse	2,5E-01	0,20	-0,809	0,682	-	1	3,5	4066
Mercure	9,0E-01	0,22	-0,684	0,118	-	1	5,0	20184
Molybdène	2,5E-01	0,24	-	-	0,95	1	0,87	4066
Nickel	6,0E-02	1,00	3,68	-0,26	2,5	1	1,2	28
Plomb	4,5E-02	0,20	-0,22	0,81	-	1	2,2	5059
Sélénium	2,5E-02	1,00	-0,075	0,73	-	1	2,7	1262
Strontium	2,5E+00	0,10	-	-	0,09	1	0,28	200
Titane	5,5E-03	0,55	-	-	1,1	1	0,016	4066
Uranium	8,5E-03	0,47	-	-	0,5	1	0,13	500
Vanadium	5,5E-03	0,55	-	-	0,04	1	0,17	4066
Zinc	1,5E+00	0,60	4,45	0,33	-	1	3,8	4578

$FBC_{sol-vgt}$: Facteur de bioconcentration sol-végétaux (parties végétatives).
$Ratio_{r/v}$: Ratio des concentrations dans les parties reproductrices et végétatives.
B0, B1 : Coefficients de la droite de régression concentrations dans le sol-concentrations dans les invertébrés du sol.
$FBC_{sol-inv_sol}$: Facteur de bioconcentration sol-invertébrés du sol.
$FBC_{vgt-inv_terr}$: Facteur de bioconcentration végétaux-invertébrés terrestres (par défaut, 1).
$FBC_{sed-rac_vgt_aq}$: Facteur de bioconcentration sédiments-racines des végétaux aquatiques.
$FBC_{eau-inv_aq}$: Facteur de bioconcentration eau-invertébrés aquatiques.
- Propriété non disponible ou non requise.
a À l'exception du $FBA_{poisson}$, il n'a pas été possible d'identifier des propriétés distinctes pour le chrome trivalent, hexavalent et total. Le $FBA_{poisson}$ retenu (20, applicable au chrome total) est plus élevé que celui disponible pour le chrome hexavalent (3, selon U.S. EPA (2005)). Dans ces conditions, il n'était pas requis de détailler l'estimation des concentrations de chrome trivalent et hexavalent pour détecter le risque posé par le chrome.

TABLEAU F5
Propriétés des métaux utilisées pour modéliser des concentrations multimédias (suite)

Substance	Invertébrés benthiques		$FBC_{sed\text{-}inv_aq}$	$FBA_{poisson}$	FBT_{boeuf}	FBT_{poulet}
	B0	B1	kg/kg_{frais}	L/kg_{frais}	j/kg_{frais}	j/kg_{frais}
Aluminium	-	-	0,8	200	1,5E-03	9,8E-02
Antimoine	-	-	0,0113	100	1,0E-03	6,5E-02
Argent	-	-	0,9	88	2,0E-02	1,3E+00
Arsenic	-0,292	0,754	-	150	2,0E-03	1,3E-01
Baryum	-	-	0,137	633	3,5E-04	2,3E-02
Béryllium	-	-	0,132	62	3,0E-04	2,0E-02
Bore	-	-	0,229	198	8,0E-04	5,2E-02
Cadmium	0,0395	0,692	-	200	1,0E-03	6,5E-02
Chrome	0,2092	0,365	-	20	5,5E-03	3,6E-01
Cobalt	-	-	0,0024	30	2,0E-03	1,3E-01
Cuivre	1,089	0,278	-	350	1,0E-02	6,5E-01
Étain	-	-	0,9	3000	8,0E-02	5,2E+00
Lithium	-	-	0,9	8	1,0E-02	6,5E-01
Manganèse	-	-	2	10	3,5E-04	2,3E-02
Mercure	-0,67	0,327	-	350000	1,0E-01	6,5E+00
Molybdène	-		0,9	200	6,0E-03	3,9E-01
Nickel	-		0,2	50	1,0E-03	6,5E-02
Plomb	-0,776	0,801	-	8	2,5E-04	1,6E-02
Sélénium	-	-	0,626	3000	1,0E-01	6,5E+00
Strontium	-	-	0,9	200	8,0E-03	5,2E-01
Titane	-	-	0,9	700	3,0E-02	2,0E+00
Uranium	-	-	0,9	38	6,0E-04	3,9E-02
Vanadium	-	-	0,0148	200	2,5E-03	1,6E-01
Zinc	1,8	0,208	-	2000	1,0E-01	6,5E+00

B0, B1 : Coefficients de la droite de régression concentrations dans les sédiments – concentrations dans les invertébrés benthiques.

$FBC_{sed\text{-}inv_aq}$: Facteur de bioconcentration sédiments-invertébrés aquatiques (benthiques).

$FBA_{poisson}$: Facteur de bioaccumulation par le poisson.

FBT_{boeuf} : Facteur de biotransfert pour le bœuf.

FBT_{poulet} : Facteur de biotransfert pour le poulet.

- Propriété non disponible ou non requise.

2.1 Facteurs de bioconcentration sol-végétaux, sédiments-végétaux et $ratio_{r/v}$

Le rapport de Baes III, Sharp *et coll.* (1984) présente, pour chaque substance d'intérêt, des facteurs de bioconcentration sol-végétaux applicables aux parties végétatives (B_v) ainsi qu'aux parties reproductrices (B_r). Ces valeurs ont été déterminées sur la base des données compilées à partir de la littérature scientifique. Les $FBC_{sol\text{-}vgt}$ et les $FBC_{sed\text{-}vgt}$ utilisés correspondent aux facteurs B_v rapportée par Baes III, Sharp *et coll.* (1984). Les $ratios_{r/v}$ ont été calculés comme le ratio des facteurs B_r et B_v.

Il est à noter que les facteurs B_r et B_v rapportés par Baes III, Sharp *et coll.* (1984) permettent d'estimer les concentrations dans les végétaux sur une base sèche (mg/kg_{sec}).

En l'absence de FBC spécifiques aux sédiments, les $FBC_{sol\text{-}vgt}$ et les $ratios_{r/v}$ ont été utilisés pour estimer les concentrations dans la végétation aquatique (teneurs de fond uniquement, puisque les concentrations additionnelles dans les sédiments sont réputées nulles).

2.2 Facteur de bioconcentration sol-invertébrés du sol

La source principale à partir de laquelle les $FBC_{sol\text{-}inv_sol}$ ont été sélectionnés est le rapport de Sample, Beauchamp *et coll.* (1998), qui présente, pour 7 métaux (As, Cu, Mn, Hg, Pb, Se et Zn), des droites de régression permettant d'estimer les concentrations dans les invertébrés du sol en fonction de la concentration dans le sol. Cette estimation est réalisée à partir de paramètres (B0 et B1) spécifiques à chaque métal, à l'aide de l'équation de type I présentée à la section 1.3.1. Il est à noter que bien que des paramètres aient été présentés pour le cadmium et le nickel, aucune corrélation entre les concentrations dans les invertébrés et le sol n'a été observée pour ces métaux et les droites de régression n'ont donc pas été utilisées.

Pour les autres métaux, l'équation de type II présentée à la section 1.3.1 a été utilisée.

Pour le cadmium et le nickel, les $FBC_{sol\text{-}inv_sol}$ ont été déterminés à partir des données expérimentales présentées par Sample, Beauchamp *et coll.* (1998). Pour le cadmium, la teneur de fond documentée dans les sols de la zone d'étude est de 0,33 mg/kg. À cette concentration dans le sol, les données expérimentales suggèrent une concentration dans les invertébrés d'environ 1 mg/kg_{sec}. Sur cette base, un $FBC_{sol\text{-}inv_sol}$ de 3 a été retenu. Pour le nickel, à la teneur de fond documentée dans les sols de la zone d'étude (21,1 mg/kg), les concentrations rapportées dans les invertébrés varient entre environ 10 et 100 mg/kg_{sec}. Sur cette base, un $FBC_{sol\text{-}inv_sol}$ moyen de 2,5 a été retenu[1].

Pour 8 métaux (Al, Ag, Cr, Co, Sn, Mo, Sr et V), les $FBC_{sol\text{-}inv_sol}$ retenus sont ceux utilisés dans le cadre de 2 études d'impact sur l'environnement (Stantec, 2009; Stantec, 2010). Ces $FBC_{sol\text{-}inv_sol}$ ont été déterminés à partir des données présentées à l'annexe A du rapport de Sample, Beauchamp *et coll.* (1998). Puisque cette annexe n'est pas présentée sur les versions du rapport disponibles en ligne, ces $FBC_{sol\text{-}inv_sol}$ n'ont pas pu être vérifiés.

Pour l'uranium, le $FBC_{sol\text{-}inv_sol}$ a été calculé à partir des concentrations dans les sols et dans les invertébrés mesurées par Giovanetti, Fesenko *et coll.* (2010).

Pour l'antimoine, le bore, le lithium et le titane, aucune donnée expérimentale à partir de laquelle un $FBC_{sol\text{-}inv_sol}$ aurait pu être calculé n'a été identifiée. Dans cette situation, conformément à l'approche retenue par l'U.S. EPA (1999), un $FBC_{sol\text{-}inv_sol}$ par défaut de 1,1 a été utilisé[2].

Tous les $FBC_{sol\text{-}inv_sol}$ retenus sont exprimés sur une base sèche.

2.3 Facteur de bioconcentration sédiments-racines (végétaux aquatiques)

Pour tous les métaux excepté l'argent, le lithium et le titane, des $FBC_{sed\text{-}rac_vgt_aq}$ ont pu être calculés à partir de concentrations mesurées dans les sédiments et les racines de végétaux aquatiques et

1 Les données présentées par Sample, Beauchamp *et coll.* (1998) suggèrent que la concentration en nickel dans les invertébrés ne varie virtuellement pas en fonction de la concentration dans les sols. Une telle relation est attendue pour les éléments hautement régulés par les organismes.

2 La valeur retenue par l'U.S. EPA, soit 0,22, est fournie sur une base sèche. Celle-ci a été convertie en base humide, en considérant un taux d'humidité moyen de 80% dans les invertébrés du sol.

documentées dans un rapport émanant d'instances gouvernementales américaines (Tadayon, King *et coll.*, 1997) ou des articles publiés (Punshon, Gaines *et coll.*, 2003; Shuping, Snyman *et coll.*, 2011; Bonanno, 2011; Klink, Macioł *et coll.*, 2013; Di Leo, Annicchiarico *et coll.*, 2013; Singh, Kaur *et coll.*, 2017). Pour chaque étude citée précédemment, le $FBC_{sed\text{-}rac_vgt_aq}$ moyen[1] a été calculé (pour chaque substance d'intérêt mesurée) en divisant les concentrations mesurées dans les racines par celles mesurées dans les sédiments. Ces valeurs ont été compilées dans une base de données. Pour chaque substance d'intérêt, la moyenne des $FBC_{sed\text{-}rac_vgt_aq}$ obtenus dans les différentes études a été retenu pour la présente étude.

Pour l'argent, le lithium et le titane, aucune mesure réalisée en milieu aquatique n'a permis l'estimation d'un $FBC_{sed\text{-}rac_vgt_aq}$. Cependant, des mesures réalisées en milieu terrestre ont permis le calcul de $FBC_{sol\text{-}racines}$. Pour chaque substance, la valeur moyenne parmi les $FBC_{sol\text{-}racines}$ ayant pu être calculés a été retenue comme $FBC_{sed\text{-}rac_vgt_aq}$. Pour l'argent, les données publiées par Desjardins, Pitre *et coll.* (2016) (accumulation de l'argent dans les racines de 4 espèces végétales à partir de 2 types de sols) ont été utilisées. Pour le lithium, les données utilisées sont celles de Alagić, Medic *et coll.* (2016) (accumulation du lithium dans des vignes poussant dans 8 secteurs d'une même région). Finalement, pour le titane, les concentrations mesurées par Šijakova-Ivanova, Boev *et coll.* (2017) dans des sols et dans les racines de 3 espèces de végétaux terrestres ont servi au calcul du $FBC_{sed\text{-}rac_vgt_aq}$.

Les concentrations rapportées dans les racines des végétaux étant fournies en base sèche (mg/kg_{sec}), les $FBC_{sed\text{-}rac_vgt_aq}$ calculés sont également présentés en base sèche (kg/kg_{sec}).

2.4 Facteur de bioconcentration eau-invertébrés aquatiques

Pour la majorité des substances d'intérêt (Al, Sb, Ag, As, Ba, Be, Cd, Cr, Cu, Hg, Ni, Pb, Se et Zn), des $FBC_{eau\text{-}inv_aq}$ basés sur des données expérimentales ont été proposées par l'U.S. EPA (1999). Ces valeurs ont été retenues pour la présente étude.

Pour l'aluminium, le profil toxicologique préparé par l'ATSDR (2008) rapporte des concentrations dans l'eau et dans des nymphes d'éphémères (*Heptagenia sulphurea*). À partir des concentrations rapportées, un FBC de 6,2 peut être calculé. Ce FBC, exprimé sur une base sèche, a été converti en considérant un taux d'humidité dans les invertébrés aquatiques de 80% (Sanexen, 2002b). Le $FBC_{eau\text{-}inv_aq}$ retenu pour la présente étude, exprimé sur une base humide, vaut 31.

Pour l'antimoine et le béryllium, un FBC de 100 L/kg_{frais} a été retenu. Cette valeur, rapportée par Wang, Biwer *et coll.* (1993), est tirée de documents non publiés provenant de l'Agence internationale de l'énergie atomique et du *National Council on Radiation Protection and Measurements* (NCRP).

Pour le bore, le CCME (2009) rapporte que cette substance ne s'accumule pas de façon importante dans la chaine alimentaire aquatique et que les $FBC_{eau\text{-}inv_aq}$ recensés n'excédaient pas 100. La valeur de 100 a donc été retenue pour la présente étude.

Pour le cobalt, le dossier d'enregistrement contenu dans la base de données de l'ECHA (2018) mentionne que les $FBC_{eau\text{-}inv_aq}$ recensés dans la littérature pour cette substance sont inférieurs à 300. La valeur de 300 a donc été retenue.

1 Moyenne de l'ensemble des sédiments et espèces de végétaux étudiés.

Pour l'étain, le rapport de Howe et Watts (2005) rapporte que bien que les données expérimentales soient limitées, les $FBC_{eau\text{-}inv_aq}$ disponibles sont de l'ordre de 1000. Cette valeur a été retenue pour la présente étude.

Pour le strontium, le dossier d'enregistrement contenu dans la base de données de l'ECHA (2018) rapporte des $FBC_{eau\text{-}inv_aq}$ variant entre 0,7 et 200. De façon prudente, la valeur de 200 a été retenue pour la présente étude.

L'accumulation de l'uranium dans l'invertébré aquatique *Chironomus Tentans* a été étudié dans le cadre d'un projet de maîtrise (Muscatello, 2004). Des $FBC_{eau\text{-}inv_aq}$ d'environ 100 ont été mesurés expérimentalement. Ce FBC, exprimé en masse sèche, a été converti en base humide en supposant une teneur en eau de 80% dans les invertébrés aquatiques (Sanexen, 2002b). Le $FBC_{eau\text{-}inv_aq}$ retenu pour la présente étude est donc de 500.

Pour le lithium, le manganèse, le molybdène, le titane et le vanadium, aucun $FBC_{eau\text{-}inv_aq}$ expérimental n'a pu être identifié. Comme proposé par l'U.S. EPA (1999), une valeur par défaut de 4 066 a été retenue. Cette valeur correspond à la moyenne arithmétique des $FBC_{eau\text{-}inv_aq}$ disponibles pour les autres substances inorganiques.

Tous les $FBC_{eau\text{-}inv_aq}$ retenus sont exprimés sur une base humide.

2.5 Facteur de bioconcentration sédiments-invertébrés aquatiques

Comme présenté à la section 1.6, deux types d'équations ont été utilisées afin d'estimer les concentrations en métaux dans les invertébrés benthiques. Pour 7 métaux (As, Cd, Cr, Cu, Hg, Pb et Zn), des droites de régression entre les concentrations dans les sédiments et celles dans les invertébrés benthiques (en base sèche) ont été proposées dans un rapport de l'ORNL (1998). Celles-ci ont été retenues pour la présente étude, et ont été utilisées avec l'équation de type I présentée à la section 1.6.

Pour les autres métaux, l'équation de type II, basée sur le $FBC_{sed\text{-}inv_aq}$, a été utilisée.

Pour le nickel, les données présentées par l'ORNL (1998) ont été utilisées pour estimer le $FBC_{sed\text{-}inv_aq}$. Pour des concentrations dans les sédiments similaires à la teneur de fond retenue pour la zone d'étude (~7 mg/kg), les concentrations dans les sédiments et dans les invertébrés sont similaires. Le $FBC_{sed\text{-}inv_aq}$ retenu, exprimé sur une base sèche, est donc de 1. En supposant un taux d'humidité d'environ 80% dans les invertébrés benthiques, un $FBC_{sed\text{-}inv_aq}$ de 0,2 (base humide) a été retenu.

Pour 7 métaux (Sb, Ba, Be, B, Co, Se et V), les $FBC_{sed\text{-}inv_aq}$ présentés par Stantec (2009) (annexe K) ont été retenus pour la présente étude. Ces derniers, exprimés sur une base humide, ont été déterminés à partir de données tirées de la littérature scientifique.

Pour l'aluminium et le manganèse, les $FBC_{sed\text{-}inv_aq}$ maximums parmi ceux observés par Chiba, Passerini *et coll.* (2011), soit 4 et 10 (respectivement), ont été retenus. Puisque l'article mentionne que ces $FBC_{sed\text{-}inv_aq}$ ont été déterminés à partir d'un échantillon d'invertébrés pesant 2 grammes (poids sec), ces valeurs sont réputées être exprimées sur une base sèche. En supposant un taux d'humidité de 80%, les $FBC_{sed\text{-}inv_aq}$ exprimés sur une base humide sont de 0,8 et 2, pour l'aluminium et le manganèse.

Pour 6 métaux (Ag, Sn, Li, Sr, Ti et U), aucune donnée expérimentale n'a permis d'estimer un $FBC_{sed\text{-}inv_aq}$. Conséquemment, conformément à l'approche retenue par l'U.S. EPA (1999), une valeur par défaut de 0,9 (base humide) a été utilisée.

2.6 Facteur de bioaccumulation par le poisson

La source de données primaire à partir de laquelle les $FBA_{poisson}$ ont été déterminés correspond à une base de données compilée par Sanexen dans le cadre de projets antérieurs. Afin de préserver, à la demande de ses clients, la confidentialité de ces données, aucune information géographique spécifique n'est fournie. Il importe de préciser que les concentrations dans l'eau (lacs) et dans la chair de poissons incluses dans la base de données sont spécifiques à des écosystèmes d'eau douce au Québec. La base de données contient des mesures pour 12 métaux (As, Cd, Cr, Co, Cu, Mn, Hg, Mo, Ni, Pb, Se, Zn). À partir de ces données (présentées au tableau F6), des graphiques de la concentration mesurée dans l'eau et du $FBA_{poisson}$ correspondant ont été tracés. Ces graphiques montrent que les $FBA_{poisson}$ de l'ensemble des métaux (sauf le mercure) décroissent lorsque la concentration dans l'eau augmente. Pour le mercure, les $FBA_{poisson}$ sont plutôt corrélés à la taille des poissons. Pour chaque métal inclus dans la base de données, le $FBA_{poisson}$ retenu pour la présente étude a été sélectionné à partir des valeurs estimées pour les lacs présentant une concentration aqueuse similaire à la teneur de fond[1] dans l'eau de surface présentée au tableau 12 du rapport. Pour le nickel, la teneur de fond dans l'eau de surface retenue pour la présente étude était significativement plus faible que les concentrations mesurées dans les lacs pour lesquels des données étaient disponibles. Dès lors, le $FBA_{poisson}$ a été estimé à l'aide de l'équation de la courbe de régression produite à partir des données expérimentales[2]. Pour le mercure, le $FBA_{poisson}$ maximal présenté au tableau F6 a été retenu.

Pour l'argent et le baryum, le $FBA_{poisson}$ retenu pour la présente étude est celui proposé par l'U.S. EPA (2005). Pour l'antimoine et le béryllium, les valeurs proposées par l'U.S. EPA (1999) ont été retenues.

Pour l'aluminium, le $FBA_{poisson}$ retenu correspond au haut de la plage des valeurs rapportées par ATSDR (2008). Cette valeur a été sélectionnée parmi les $FBA_{poisson}$ rapportés pour le saumon de l'Atlantique et l'omble de fontaine.

Pour le bore, peu de données sont disponibles. Le $FBA_{poisson}$ retenu correspond à la valeur maximale rapportée par ATSDR (2010), qui mentionne par ailleurs que le bore n'est pas réputé se bioaccumuler significativement dans les organismes aquatiques.

Peu de données sur la bioaccumulation de l'étain sont disponibles. Pour les formes inorganiques de l'étain (c.-à-d. les plus susceptibles de se retrouver dans la zone d'étude)[3], un $FBA_{poisson}$ de 3 000 L/kg_{frais} a été rapporté (Wang, Biwer *et coll.*, 1993; WHO, 2005). Cette valeur a été retenue pour la présente étude.

Pour le lithium, le $FBA_{poisson}$ retenu correspond à la valeur maximale de la plage (1-8 L/kg_{frais}) rapportée dans la base de données de l'ECHA (2018) pour des poissons d'eau douce.

Le FBA_{poisso} du strontium a été déterminé à partir des données présentées par Vanderploeg, Parzyck *et coll.* (1975). Les données présentées dans ce rapport permettent de constater que l'accumulation du strontium dans la chair des poissons d'eau douce est inversement proportionnelle à la concentration en

1 Puisque les concentrations additionnelles en métaux dans l'eau de surface sont faibles comparativement aux teneurs de fond, il n'a pas été jugé nécessaire de définir des $FBC_{eau\text{-}poissons}$ distincts pour estimer les concentrations bruit de fond et additionnelles dans la chair de poisson.

2 $FBA_{poisson} = 0{,}041 \times [C_{eau}]^{-0{,}923}$ avec $FBA_{poisson}$ en L/kg_{frais} et C_{eau} en mg/L ($R^2 = 0{,}93$).

3 Les formes organiques (molécule d'étain à laquelle est substitué un hydrocarbure) sont utilisées, entre autres, comme des agents stabilisants par l'industrie du plastique et dans des peintures; elles n'ont pas lieu d'être présentes dans l'environnement de la zone d'étude.

calcium dans l'eau de surface. Ainsi, pour des concentrations en calcium similaires à celles mesurées dans l'eau de surface de la zone d'étude (généralement inférieure à 2 mg/L), les $FBA_{poisson}$ rapportés pour la chair de poisson sont d'environ 200 L/kg_{frais}. Cette valeur a été retenue pour la présente étude.

Pour le titane, le $FBA_{poisson}$ retenu (700 L/kg_{frais}) correspond à la valeur maximale rapportée par Jovanović, Whitley *et coll.* (2015) pour le dioxide de titane (TiO_2). Aucune information par rapport aux $FBA_{poisson}$ applicables à d'autres formes de titane n'a pu être identifiée.

Pour l'uranium, le profil toxicologique réalisé par l'ATSDR (2013) mentionne que l'accumulation de cette substance dans les poissons d'eau douce est faible. Le $FBA_{poisson}$ retenu correspond à la valeur maximale rapportée dans ce profil toxicologique.

Pour le vanadium, la valeur proposée par le NCRP (1996) (200 L/kg_{frais}), telle que rapportée par Karlsson, Meili *et coll.* (2002), a été retenue pour la présente étude. Cette valeur est supérieure par près d'un ordre de grandeur aux $FBA_{poisson}$ rapportés par Smit (2012).

TABLEAU F6
Concentrations aqueuses et facteurs de bioaccumulation par le poisson
observés dans des écosystèmes d'eau douce situés au Québec

	Identification du plan d'eau	Lac A	Lac B	Lac C	Lac D	Lac E	Lac F	Lac G
	Longueur médiane des poissons (cm)	18,9	23,1	26,9	29,3	31,1	25,0	19,7
Arsenic	Concentration-eau (mg/L)	9,4E-05	1,2E-04	6,8E-05	6,7E-05	-	-	-
	FBA (L/kg frais)	208	127	258	336	-	-	-
Cadmium	Concentration-eau (mg/L)	2,5E-05	3,5E-05	9,3E-06	1,2E-05	3,0E-05	1,3E-04	4,0E-05
	FBA (L/kg frais)	187	26,2	135	152	311	60,5	70,3
Chrome	Concentration-eau (mg/L)	2,0E-04	3,3E-04	1,3E-04	1,3E-04	-	-	-
	FBA (L/kg frais)	26,8	17,6	31,0	58,9	-	-	-
Cobalt	Concentration-eau (mg/L)	1,4E-02	1,9E-02	8,1E-04	3,0E-03	1,4E-03	6,3E-02	2,2E-02
	FBA (L/kg frais)	9,3	6,1	38,6	26,6	26,6	1,1	2,8
Cuivre	Concentration-eau (mg/L)	7,7E-03	1,3E-02	6,9E-04	2,4E-03	-	5,6E-03	2,8E-03
	FBA (L/kg frais)	34,0	26,7	356	143	-	41,1	96,1
Manganèse	Concentration-eau (mg/L)	6,5E-02	2,6E-02	1,1E-02	2,1E-02	5,7E-03	1,8E-01	7,5E-03
	FBA (L/kg frais)	1,3	3,2	6,8	2,7	14,0	0,3	8,3
Mercure	Concentration-eau (mg/L)	3,7E-06	-	5,1E-06	2,7E-06	-	-	2,1E-06
	FBA (L/kg frais)	28 767	-	145 866	350 735	-	-	49 048
Molybdène	Concentration-eau (mg/L)	9,9E-05	2,3E-04	1,3E-05	2,6E-05	-	-	-
	FBA (L/kg frais)	70,9	17,5	357	200	-	-	-
Nickel	Concentration-eau (mg/L)	5,0E-02	8,4E-02	1,7E-03	1,2E-02	8,5E-03	3,3E-01	1,2E-01
	FBA (L/kg frais)	1,0	0,8	13,4	2,9	2,1	0,1	0,2
Plomb	Concentration-eau (mg/L)	8,3E-05	7,4E-05	1,4E-04	9,0E-05	-	-	-
	FBA (L/kg frais)	20,0	22,2	7,4	32,7	-	-	-
Sélénium	Concentration-eau (mg/L)	1,2E-04	1,3E-04	1,0E-04	1,3E-04	-	1,1E-03	-
	FBA (L/kg frais)	2915	2543	2900	2984	-	365	-
Zinc	Concentration-eau (mg/L)	7,2E-03	1,0E-02	1,3E-03	2,7E-03	3,3E-03	2,1E-02	1,1E-02
	FBA (L/kg frais)	944	429	4076	1949	1319	178	374

2.7 Facteur de biotransfert de référence pour les mammifères et les oiseaux

Trois sources principales ont permis d'identifier des FBT expérimentaux pour le bœuf (Baes III, Sharp *et coll.*, 1984; Yu, Zielen *et coll.*, 2001; OEHHA, 2012). Pour le poulet, des FBT expérimentaux n'étaient disponibles que pour quelques métaux (OEHHA, 2012). En l'absence de valeurs expérimentales, les FBT pour le poulet ont été extrapolés à partir des valeurs retenues pour le bœuf. Pour ce faire, l'équation suivante a été utilisée :

$$FBT_{poulet} = \mathrm{FBT}_{boeuf} * \frac{5{,}943\ x\ M_{boeuf}^{0{,}727}}{4{,}797\ x\ M_{poulet}^{0{,}749}}$$

Où :

FBT_{poulet} : Facteur de biotransfert pour le poulet, j/kg_{frais}

FBT_{boeuf} : Facteur de biotransfert pour le bœuf, j/kg_{frais}

M_{boeuf} : Masse corporelle du bœuf, soit 500 000 g

M_{poulet} : Masse corporelle du poulet, soit 1 750 g

D'une façon similaire à l'équation d'extrapolation des FBT présentée à la section 1.8, l'équation précédente est basée sur la prémisse que le taux de transfert des métaux dans les tissus des organismes de plus grande taille était plus faible que celui observé dans les organismes de plus petite taille. En effet, proportionnellement à leurs poids respectifs, le taux métabolique des organismes de petite taille est supérieur à celui des organismes de grande taille (OEHHA, 2012). L'extrapolation des FBT du bœuf vers le poulet a été réalisée sur la base du taux métabolique respectif de chaque espèce. Au numérateur de l'équation précédente se trouve une équation allométrique permettant d'estimer, à partir du poids (en g), le taux métabolique sur le terrain[1] des mammifères herbivores. Au dénominateur se trouve l'équation allométrique équivalente développée pour les oiseaux non-passériformes. Ces équations ont été développées par l'U.S. EPA (1993).

Afin de sélectionner les FBT les plus appropriés pour la présente étude, les concentrations[2] dans la viande de bœuf et dans la volaille ont été documentées (Ysart, Miller *et coll.*, 1999; Schrauzer, 2002; Leblanc, Guérin *et coll.*, 2005; Turhan, 2006; Golasik, Herman *et coll.*, 2014; Health Canada, 2016; ATSDR, 2018). En parallèle, les teneurs de fond dans la chair des différentes espèces de mammifères pertinentes à la présente étude ont été estimées à l'aide des FBT pour le bœuf proposés par Baes III, Sharp *et coll.* (1984). Les concentrations documentées et estimées ont ensuite été comparées[3].

Pour l'ensemble des métaux sauf 6 (Ag, Be, Hg, Se, Sr et Zn), les concentrations estimées et documentées étaient du même ordre de grandeur (à l'intérieur d'un facteur 10). Pour ces substances, les FBT proposés par Baes III, Sharp *et coll.* (1984) ont donc été conservés.

Pour l'argent, aucune concentration dans la viande de bœuf du commerce n'a été identifiée. Le FBT proposé par Baes III, Sharp *et coll.* (1984) a donc été retenu pour la présente étude, ce dernier menant à des concentrations dans la chair des mammifères légèrement supérieures que les FBT proposés par les autres sources.

1 Traduction libre de « *field metabolic rate* ».
2 Pour plusieurs substances d'intérêt, les concentrations rapportées dans la littérature étaient très variables. Celles-ci ont donc été documentées sous la forme de plages.
3 Comparaisons effectuées pour le caribou, qui est l'espèce la plus similaire au bœuf en termes de taille et de régime alimentaire.

Pour le béryllium, le seul FBT permettant d'estimer correctement les concentrations rapportées dans la viande du commerce est celui proposé par l'OEHHA (2012). Cette valeur a été retenue pour la présente étude.

Pour le mercure, le sélénium, le strontium et le zinc, les FBT proposés par Yu, Zielen *et coll.* (2001) étaient significativement différents de ceux rapportés par Baes III, Sharp *et coll.* (1984), et menaient à des concentrations estimées et documentées du même ordre de grandeur (à l'intérieur d'un facteur 10). Ces FBT ont donc été retenus pour la présente étude.

En ce qui concerne les oiseaux, des concentrations documentées dans la volaille du commerce ont été comparées aux teneurs de fond estimées dans la chair de la petite oie des neiges[1]. Pour l'ensemble des substances d'intérêt sauf le béryllium, les FBT pour le poulet extrapolés à partir des FBT retenus pour le bœuf ont mené à des concentrations estimées dans la chair d'oie du même ordre de grandeur que les concentrations documentées dans la volaille (à l'intérieur d'un facteur 10). Pour le béryllium, le FBT pour le poulet extrapolé à partir du FBT retenu pour le bœuf a mené à une différence d'un facteur de 25 entre les concentrations estimées et documentées[2]. En utilisant le FBT expérimental pour le poulet rapporté par l'OEHHA (2012), les concentrations estimées et documentées différaient par un facteur de plus de 260. En définitive, pour l'ensemble des substances d'intérêt, les FBT retenus pour le poulet dans la présente étude sont ceux extrapolés à partir des FBT pour le bœuf.

1 Espèce la plus similaire au poulet d'élevage en termes de taille et de régime alimentaire.
2 Les teneurs de fond estimées sont 25 fois plus grandes que les concentrations rapportées dans la volaille du commerce.

3. PROPRIÉTÉS DES DIFFÉRENTES ESPÈCES DE MAMMIFÈRES ET D'OISEAUX INCLUSES AU MODÈLE CONCEPTUEL

Les propriétés des espèces de mammifères et d'oiseaux incluses au modèle conceptuel sont présentées au tableau F7. Les régimes alimentaires documentés pour ces espèces, pour l'été et l'hiver, sont présentés au tableau F8.

TABLEAU F7
Propriété des espèces de mammifères et d'oiseaux incluses au modèle conceptuel

Espèce	Poids corporel (kg)	Taux d'ingestion				Taux d'inhalation (m^3/j)
		Aliments (kg_{frais}/j)	Eau (L/j)	Sol (kg/j)	Sédiments (kg/j)	
Campagnol des champs	0,033	0,021	0,0046	1,0E-04	0,0E+00	0,036
Caribou forestier	170	23,41	10,07	2,3E-01	0,0E+00	33,22
Castor du Canada	20	4,03	1,47	3,2E-02	8,1E-03	6,0
Lièvre arctique	4,0	1,07	0,34	4,3E-03	0,0E+00	1,65
Lynx du Canada	9,76	1,76	0,77	8,9E-03	0,0E+00	3,38
Martre d'Amérique	1,25	0,33	0,0017	0,0E+00	0,0E+00	0,65
Musaraigne cendrée	0,0037	0,0028	6,4E-04	6,9E-05	0,0E+00	0,0062
Orignal	400	47,3	21,75	1,9E-01	2,8E-01	59,06
Ours noir	136	15,59	8,24	1,1E-01	0,0E+00	27,79
Porc-épic d'Amérique	10,25	2,33	0,8	1,9E-02	4,7E-03	3,51
Souris sylvestre	0,024	0,0036	0,0035	6,4E-05	0,0E+00	0,028
Bernache du Canada	3,56	0,7	0,14	7,5E-03	7,5E-03	1,09
Canard noir	1,25	0,32	0,069	1,5E-03	5,0E-03	0,49
Lagopède des saules	0,55	0,17	0,04	1,7E-03	0,0E+00	0,26
Petite oie des neiges	2,63	0,56	0,11	5,6E-03	0,0E+00	0,86
Sarcelle d'hiver	0,33	0,12	0,028	1,2E-03	2,3E-03	0,17
Tétras du Canada	0,47	0,15	0,036	1,5E-03	0,0E+00	0,23

TABLEAU F8

Régimes alimentaires des espèces de mammifères et d'oiseaux incluses au modèle conceptuel

Espèce	Végétation								Invertébrés						Poissons		Mammifères		Oiseaux	
	Herbacée		Arbustive		Arborescente		Aquatique		Terrestres		Aquatiques		Benthiques							
	Été	Hiver	Été	Hiver	Été	Hiver	Été	Hiver	Été	Hiver	Été	Hiver	Été	Hiver	Été	Hiver	Été	Hiver	Été	Hiver
Campagnol des champs	-	50% vgt. 35% rac. 15% rep.	85% vgt. 1% rac. 14% rep.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Caribou forestier	55% vgt.	20% vgt.	30% vgt.	20% vgt.	10% vgt.	60% vgt.	5% vgt.	-	-	-	-	-	-	-	-	-	-	-	-	-
Castor du Canada	70% vgt.	-	10% rep.	20% vgt.	10% vgt.	50% vgt.	10% vgt.	25% vgt. 5% rac.	-	-	-	-	-	-	-	-	-	-	-	-
Lièvre arctique	5-0% vgt. 10% rac. 10% rep.	-	30% vgt.	-	-	80% vgt. 20% rac.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lynx du Canada	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	70% lie. 10% sou. 10% cam.		10% tétr.	
Martre d'Amérique	-	-	10% rep.	-	-	-	-	-	-	-	-	-	-	-	-	-	20% mus. 20% sou. 20% cam.		15% lag. 15% tétr.	20% lag. 20% tétr.
Musaraigne cendrée	-	50% rep.	-	50% rep.	-	-	-	-	100%	-	-	-	-	-	-	-	-	-	-	-
Orignal	20% vgt.	-	20% vgt.	5% vgt. 45% rep.	20% vgt.	5% vgt. 45% rep.	35% vgt. 5% rac.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ours noir[a]	10% vgt. 1% rac.	-	10% vgt. 2% rac. 25% rep.	-	10% vgt. 2% rac. 20% rep.	-	-	-	-	-	-	-	-	-	5%	-	3% mus. 3% sou. 4% cam.	-	-	-
Porc-épic d'Amérique	10% vgt.	-	-	-	60% vgt. 10% rep.	100% vgt.	20% vgt.	-	-	-	-	-	-	-	-	-	-	-	-	-
Souris sylvestre	5% rac. 50% rep.		5% vgt. 10% rep.		5% vgt. 20% rep.		-	-	5%		-	-	-	-	-	-	-	-	-	-
Bernache du Canada	38,5% vgt. 17,5% rac. 14% rep.	-	-	-	-	20,6% vgt. 6,9% rac.	-	-	-	-	2,5%	-	-	-	-	-	-	-	-	-
Canard noir[a]	-	-	-	-	-	-	60% rac. 20% rep.	-	5%	-	7,5%	-	7,5%	-	-	-	-	-	-	-

Espèce	Végétation								Invertébrés						Poissons		Mammifères		Oiseaux	
	Herbacée		Arbustive		Arborescente		Aquatique		Terrestres		Aquatiques		Benthiques							
	Été	Hiver	Été	Hiver	Été	Hiver	Été	Hiver	Été	Hiver	Été	Hiver	Été	Hiver	Été	Hiver	Été	Hiver	Été	Hiver
Lagopède des saules	60% vgt.	-	10% vgt. 10% rep.	-	10% vgt.	85% vgt. 15% rep.	-	-	10%	-	-	-	-	-	-	-	-	-	-	-
Petite oie des neiges[a]	100% vgt.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sarcelle d'hiver[a]	25% rep.	-	-	-	-	-	20% vgt. 40% rep.	-	5%	-	5%	-	5%	-	-	-	-	-	-	-
Tétras du Canada	25% vgt.	-	15% rep.	-	50% vgt.	100% vgt.	-	-	10%	-	-	-	-	-	-	-	-	-	-	-

Légende : Cam. : Campagnol des champs; Lag. : Lagopède des saules; Lie. : Lièvre arctique; Rac. : Racines; Rep. : Parties reproductrices (fruits et graines); Sou. : Souris sylvestre; Tétr. : Tétras du Canada; Vgt. : Parties végétatives (feuilles, tiges, écorces).

Références : Campagnol des champs : CEAEQ (2006b); Caribou forestier : Miller, Rothfels *et coll.* (2005), (Stantec, 2010), Lauzon (2016); Castor du Canada : Trottier et Hood (2017); Lièvre arctique : Musée canadien de la nature (2004); Lynx du Canada : Keith (2001); Martre d'Amérique : Northcott (1987); Musaraigne cendrée : (CEAEQ, 2006a); Orignal : FCSAP (2012); Ours noir : U.S. EPA (2003); Porc-épic d'Amérique : (Espace pour la vie Montréal, Date inconnue); Souris sylvestre : Desrosiers, Morin *et coll.* (2002); Bernache du Canada : CEAEQ (2005); Canard noir : Miller, Rothfels *et coll.* (2005); Lagopède des saules : Aniskowicz (1994); Petite oie des neiges : McKelvey (1989); Sarcelle d'hiver : Collin et Le-Dantec (2002); Tétras du Canada : MFFP (2016).

a : Récepteur qui hiberne ou qui est absent de la zone d'étude durant l'hiver.

4. CONCENTRATIONS ESTIMÉES OU MODÉLISÉES DANS LES MÉDIAS ENVIRONNEMENTAUX

Les teneurs de fond estimées ou modélisées dans les médias environnementaux pertinents pour l'évaluation des risques sont présentées au tableau F9. Les concentrations additionnelles sont, quant à elles, présentées au tableau F10.

TABLEAU F9

Teneurs de fond (mg/kg-pc frais) en métaux modélisées dans les végétaux, les invertébrés, le gibier et le poisson

Substance	Végétation terrestre[a]		Végétaux aquatiques			Invertébrés			Bernache du Canada	Canard noir	Lagopède des saules	Petite oie des neiges	Sarcelle d'hiver	Tétras du Canada
	Herbacée et arbustive	Arborescente	Feuilles	Racines	Fruits et graines	Terrestres	Aquatiques	Benthiques						
Aluminium	1,1E+01	1,1E+01	2,1E+00	5,2E+02	3,3E-01	3,6E+01	6,7E+00	3,1E+03	5,3E+00	3,1E+01	2,2E+00	2,2E+00	1,1E+01	2,2E+00
Antimoine	4,8E-03	4,8E-03	4,2E-03	7,4E-04	6,3E-04	3,1E-02	2,2E-04	1,6E-03	2,0E-04	1,9E-04	2,3E-04	1,7E-04	2,2E-04	2,3E-04
Argent	1,6E-03	1,6E-03	1,9E-02	1,2E-02	4,8E-03	1,6E-01	1,7E-03	3,6E-01	7,8E-03	5,5E-02	1,2E-02	3,0E-03	2,4E-02	1,1E-02
Arsenic	9,1E-03	9,1E-03	6,5E-02	7,6E-01	9,7E-03	1,6E-01	1,1E-01	7,2E-01	1,5E-02	4,1E-02	4,2E-03	3,5E-03	2,1E-02	4,2E-03
Baryum	6,5E+00	6,5E+00	5,8E-01	6,6E-01	5,8E-02	4,5E-01	9,8E-01	4,4E+00	5,0E-02	1,8E-02	6,1E-02	6,4E-02	2,8E-02	6,0E-02
Béryllium	6,2E-04	6,2E-04	7,2E-04	1,4E-02	1,1E-04	5,2E-03	5,8E-04	7,7E-02	1,1E-04	2,4E-04	5,5E-05	5,2E-05	1,8E-04	5,4E-05
Bore	9,3E-01	1,6E+00	2,0E+01	1,1E+02	1,0E+01	9,4E+00	1,6E-01	9,8E+00	2,9E-01	1,6E+00	4,8E-02	2,9E-02	2,3E-01	5,3E-02
Cadmium	3,8E-03	3,8E-03	2,5E-02	2,3E-01	6,9E-03	2,3E-01	7,2E-02	1,1E-01	9,1E-04	4,7E-03	7,9E-04	2,1E-04	1,1E-03	7,9E-04
Chrome	1,3E-02	1,3E-02	2,0E-02	3,3E+00	1,2E-02	2,8E+00	3,0E+00	9,8E-01	1,5E-01	4,4E-01	1,1E-01	7,0E-02	1,8E-01	1,1E-01
Cobalt	9,9E-03	1,7E-01	8,1E-03	2,1E-01	2,8E-03	8,0E-02	9,0E-02	7,9E-03	5,1E-03	1,1E-02	9,2E-03	2,3E-03	6,0E-03	9,1E-03
Cuivre	6,0E-01	6,0E-01	4,9E-01	1,5E+00	3,0E-01	1,9E+00	1,5E+00	4,6E+00	2,3E-01	5,3E-01	2,2E-01	1,9E-01	2,9E-01	2,2E-01
Étain	1,9E-02	1,8E-02	1,9E-02	3,9E-01	3,8E-03	5,2E-01	1,0E+00	4,5E+00	3,8E-01	2,8E+00	2,5E-01	1,5E-01	9,9E-01	2,4E-01
Lithium	6,6E-03	3,6E-02	1,9E-02	8,5E-02	3,1E-03	7,0E-01	1,7E+01	5,8E+00	1,4E-01	1,3E+00	3,0E-02	1,1E-02	3,6E-01	3,2E-02
Manganèse	7,6E+01	7,6E+01	3,1E+00	4,3E+01	6,2E-01	1,4E+00	1,4E+02	2,1E+02	5,8E-01	7,3E-01	7,0E-01	7,2E-01	3,8E-01	7,0E-01
Mercure	6,4E-04	1,2E-03	9,3E-03	2,2E-02	2,1E-03	6,8E-02	4,4E-02	1,4E-02	1,6E-02	6,5E-02	2,1E-02	2,7E-03	2,8E-02	2,1E-02
Molybdène	1,3E-02	2,3E-02	8,4E-02	2,9E-01	2,0E-02	4,3E-01	4,0E-01	2,5E+00	1,8E-02	1,2E-01	1,2E-02	5,7E-03	4,4E-02	1,3E-02
Nickel	2,0E-01	2,0E-01	5,4E-02	1,0E+00	5,4E-02	3,6E+00	1,6E-02	1,4E+00	1,0E-02	2,9E-02	1,6E-02	7,4E-03	1,5E-02	1,6E-02
Plomb	3,4E-02	3,4E-02	5,6E-02	2,4E+00	1,1E-02	9,6E-01	2,2E+00	2,0E-01	3,0E-03	1,2E-02	1,4E-03	8,5E-04	3,1E-03	1,4E-03
Sélénium	1,0E-02	1,0E-02	5,3E-03	3,6E-01	5,3E-03	2,0E-01	2,7E-01	6,9E-01	1,7E-01	8,6E-01	1,1E-01	5,7E-02	2,6E-01	1,1E-01
Strontium	3,4E+00	3,4E+00	1,1E+01	1,2E+00	1,1E+00	6,4E-01	3,9E+00	3,3E+01	1,2E+00	2,1E+00	7,4E-01	8,1E-01	1,4E+00	7,4E-01
Titane	1,8E-01	1,8E-01	2,2E-01	6,3E-01	1,2E-01	8,1E+01	2,0E+02	3,0E+02	1,0E+01	9,3E+01	9,6E+00	3,2E+00	3,2E+01	9,5E+00
Uranium	4,1E-04	3,4E-04	2,5E-02	3,8E-01	1,2E-02	2,4E+00	1,2E-02	2,2E+01	8,8E-03	8,3E-02	7,6E-03	3,9E-03	3,1E-02	7,6E-03
Vanadium	1,1E-02	1,1E-02	1,9E-02	5,2E-01	1,0E-02	1,4E-01	4,0E-01	3,7E-01	3,4E-02	5,7E-02	1,2E-02	1,2E-02	4,8E-02	1,2E-02
Zinc	3,6E+00	5,2E+00	3,4E+00	8,5E+00	2,0E+00	4,5E+01	2,2E+01	2,3E+01	1,3E+01	4,3E+01	2,1E+01	1,0E+01	2,0E+01	2,3E+01

a Concentrations mesurées dans des échantillons composites de fruits, feuilles et tiges. Les concentrations calculées pour la végétation herbacée/arbustive et arborescente ont été assignées à toutes les parties des végétaux (feuilles, fruits, graines et racines).

TABLEAU F9

Teneurs de fond (mg/kg-pc frais) en métaux modélisées dans les végétaux, les invertébrés, le gibier et le poisson (suite)

Substance	Campagnol des champs	Caribou forestier	Castor de Canada	Lièvre d'Amérique	Lynx du Canada	Martre d'Amérique	Musaraigne cendrée	Orignal	Ours noir	Porc-épic d'Amérique	Souris sylvestre	Poisson
Aluminium	1,3E+00	4,2E+00	3,5E+00	6,1E+00	1,7E+00	1,2E+00	1,1E+00	4,1E+00	2,7E+00	3,3E+00	8,2E-01	4,3E+01
Antimoine	1,6E-04	3,3E-04	2,8E-04	3,5E-04	2,1E-04	3,0E-05	4,3E-05	6,8E-04	2,7E-04	2,6E-04	5,4E-05	3,2E-03
Argent	2,0E-03	6,8E-03	6,6E-03	1,4E-02	2,6E-03	3,5E-03	1,2E-02	6,9E-02	1,2E-02	7,9E-03	2,1E-03	5,2E-04
Arsenic	2,0E-03	7,1E-03	7,9E-03	1,9E-02	2,5E-03	2,1E-03	2,0E-03	1,2E-02	5,5E-03	8,0E-03	1,5E-03	2,2E-01
Baryum	6,7E-02	1,2E-01	9,8E-02	1,3E-01	9,3E-02	2,4E-03	8,4E-03	4,5E-02	8,1E-02	9,9E-02	1,5E-02	3,1E+00
Béryllium	2,9E-05	1,0E-04	8,7E-05	1,2E-04	3,5E-05	3,0E-05	2,7E-05	1,2E-04	6,1E-05	8,4E-05	2,1E-05	7,9E-04
Bore	2,6E-02	1,0E-01	4,3E-01	6,3E-01	5,1E-02	6,7E-03	8,7E-03	1,6E-01	5,8E-02	2,0E-01	1,1E-02	3,2E-01
Cadmium	1,6E-04	4,6E-04	9,6E-04	1,5E-03	2,1E-04	7,3E-05	1,1E-04	4,7E-03	7,2E-04	5,1E-04	1,4E-04	4,1E-03
Chrome	3,6E-02	1,4E-01	1,0E-01	1,5E-01	4,3E-02	5,1E-02	6,0E-02	4,3E-01	1,1E-01	1,0E-01	3,3E-02	2,0E-02
Cobalt	1,5E-03	1,1E-02	9,7E-03	1,4E-02	1,4E-02	1,3E-03	1,3E-03	6,4E-03	7,3E-03	1,5E-02	1,4E-03	9,0E-03
Cuivre	1,9E-01	3,7E-01	3,1E-01	3,9E-01	2,6E-01	8,7E-02	9,1E-02	4,3E-01	2,8E-01	2,9E-01	5,2E-02	1,4E-01
Étain	9,3E-02	2,9E-01	2,4E-01	3,9E-01	1,2E-01	3,9E-01	7,9E-01	1,0E+00	8,5E-01	2,3E-01	6,1E-02	3,0E+00
Lithium	6,5E-03	2,4E-02	2,3E-02	4,1E-02	1,5E-02	9,4E-03	1,8E-02	1,5E-01	3,4E-02	3,0E-02	6,8E-03	3,3E-02
Manganèse	7,6E-01	1,4E+00	1,1E+00	1,5E+00	1,1E+00	1,3E-02	8,5E-02	5,2E-01	8,9E-01	1,1E+00	1,6E-01	3,3E-01
Mercure	2,3E-03	7,9E-03	1,9E-02	2,9E-02	4,9E-03	1,6E-02	1,0E-01	1,4E-01	2,0E-01	1,4E-02	3,0E-03	7,7E-01
Molybdène	4,0E-03	1,3E-02	1,5E-02	2,6E-02	5,6E-03	3,4E-03	5,2E-03	5,7E-02	1,3E-02	1,5E-02	2,8E-03	2,0E-02
Nickel	6,8E-03	1,4E-02	1,2E-02	1,5E-02	9,2E-03	1,5E-03	2,3E-03	7,5E-02	1,6E-02	1,1E-02	3,1E-03	2,8E-02
Plomb	5,6E-04	1,7E-03	2,0E-03	3,5E-03	7,1E-04	4,0E-04	3,9E-04	5,9E-03	1,5E-03	1,4E-03	3,8E-04	3,3E-03
Sélénium	4,4E-02	1,1E-01	1,3E-01	2,1E-01	5,9E-02	2,1E-01	4,2E-01	4,5E-01	3,1E-01	8,8E-02	2,5E-02	6,5E-01
Strontium	8,2E-01	1,7E+00	1,9E+00	2,8E+00	1,1E+00	3,0E-01	2,4E-01	5,4E-01	1,1E+00	1,8E+00	2,0E-01	3,9E+00
Titane	1,7E+00	6,2E+00	5,1E+00	6,2E+00	2,0E+00	4,6E+00	1,4E+01	5,4E+01	1,3E+01	5,0E+00	2,0E+00	3,5E+01
Uranium	2,0E-03	7,6E-03	6,5E-03	8,9E-03	2,3E-03	2,5E-03	2,4E-03	3,5E-02	7,2E-03	6,4E-03	2,0E-03	8,8E-04
Vanadium	6,3E-03	2,3E-02	2,2E-02	3,5E-02	7,7E-03	7,5E-03	7,1E-03	2,6E-02	1,4E-02	2,1E-02	4,8E-03	2,0E-02
Zinc	1,1E+01	2,4E+01	2,1E+01	2,6E+01	2,1E+01	5,6E+01	8,3E+01	9,0E+01	3,9E+01	2,3E+01	4,0E+00	9,4E+00

TABLEAU F10

Concentrations additionnelles de métaux modélisées dans les poussières intérieures (mg/kg), l'air intérieur (mg/m^3), l'eau de surface (mg/L), les végétaux, les invertébrés, le gibier et le poisson (mg/kg-pc frais)

Substance	Relais routier			Activités traditionnelles			Eau de surface	Végétation[a]		Invertébrés			Bernache du Canada	Canard noir	Lagopède des saules
	Poussières intérieures		Air intérieur	Poussières intérieures		Air intérieur		Feuilles et racines	Fruits et graines	Terrestres	Aquatiques	Benthiques			
	Été	Hiver		Été	Hiver										
Aluminium	3,3E+03	4,8E+03	3,35E-04	1,3E+03	1,8E+03	1,3E-04	3,7E-03	5,4E-01	8,7E-02	2,4E-01	1,1E-01	0,0E+00	1,9E-02	1,5E-02	1,6E-02
Antimoine	2,1E-02	3,1E-02	2,14E-09	8,1E-03	1,2E-02	8,1E-10	2,4E-08	3,4E-06	5,1E-07	1,3E-06	1,7E-07	0,0E+00	7,9E-08	6,1E-08	6,9E-08
Argent	2,8E-02	3,9E-02	2,76E-09	1,0E-02	1,5E-02	1,0E-09	3,1E-08	4,4E-06	1,1E-06	6,2E-06	9,3E-06	0,0E+00	2,2E-06	2,1E-06	2,0E-06
Arsenic	6,6E-01	9,4E-01	6,60E-08	2,5E-01	3,6E-01	2,5E-08	6,9E-07	1,1E-04	1,6E-05	6,3E-05	5,1E-05	0,0E+00	5,1E-06	4,1E-06	4,5E-06
Baryum	3,3E+01	4,7E+01	3,28E-06	1,2E+01	1,8E+01	1,2E-06	3,5E-05	5,3E-03	5,3E-04	5,3E-03	7,0E-03	0,0E+00	4,4E-05	3,8E-05	4,0E-05
Béryllium	1,5E-01	2,1E-01	1,47E-08	5,6E-02	8,0E-02	5,6E-09	3,3E-07	2,4E-05	3,6E-06	1,6E-05	1,5E-05	0,0E+00	1,7E-07	1,4E-07	1,5E-07
Bore	2,6E+00	3,8E+00	2,64E-07	9,9E-01	1,4E+00	9,9E-08	2,2E-06	4,2E-04	2,1E-04	2,6E-04	2,2E-04	0,0E+00	8,4E-06	7,0E-06	7,3E-06
Cadmium	2,0E-02	2,9E-02	2,02E-09	7,6E-03	1,1E-02	7,6E-10	2,3E-08	3,2E-06	8,8E-07	4,0E-05	7,8E-05	0,0E+00	1,3E-07	5,6E-07	1,7E-07
Chrome	4,2E+00	6,0E+00	4,19E-07	1,6E+00	2,3E+00	1,6E-07	4,7E-06	6,7E-04	4,0E-04	7,3E-03	1,4E-02	0,0E+00	1,4E-04	5,6E-04	1,8E-04
Cobalt	2,5E+00	3,5E+00	2,48E-07	9,3E-01	1,3E+00	9,3E-08	2,7E-06	4,0E-04	1,4E-04	5,4E-04	8,0E-04	0,0E+00	2,0E-05	1,9E-05	1,8E-05
Cuivre	1,7E+00	2,5E+00	1,72E-07	6,5E-01	9,2E-01	6,5E-08	1,8E-06	2,8E-04	1,7E-04	3,5E-03	6,7E-03	0,0E+00	1,1E-04	4,9E-04	1,5E-04
Étain	2,1E-01	3,1E-01	2,14E-08	8,1E-02	1,2E-01	8,1E-09	3,0E-07	3,4E-05	6,9E-06	1,6E-04	3,0E-04	0,0E+00	8,0E-05	1,8E-04	8,7E-05
Lithium	1,1E+01	1,6E+01	1,09E-06	4,2E+00	6,0E+00	4,2E-07	1,8E-05	1,8E-03	2,8E-04	3,7E-02	7,3E-02	0,0E+00	9,0E-04	5,1E-03	1,3E-03
Manganèse	8,0E+01	1,1E+02	7,98E-06	3,0E+01	4,3E+01	3,0E-06	8,6E-05	1,3E-02	2,6E-03	1,8E-01	3,5E-01	0,0E+00	1,9E-04	8,7E-04	2,5E-04
Mercure	1,9E-07	2,5E-07	1,60E-10	7,1E-08	9,3E-08	6,0E-11	1,2E-09	2,6E-07	5,8E-08	1,2E-05	2,4E-05	0,0E+00	2,3E-06	1,7E-05	3,8E-06
Molybdène	9,9E-02	1,4E-01	9,87E-09	3,7E-02	5,3E-02	3,7E-09	1,2E-07	1,6E-05	3,8E-06	2,6E-04	5,0E-04	0,0E+00	4,2E-06	2,1E-05	5,9E-06
Nickel	2,4E+00	3,5E+00	2,43E-07	9,2E-01	1,3E+00	9,2E-08	2,6E-06	3,9E-04	3,9E-04	1,7E-04	7,2E-05	0,0E+00	1,0E-05	8,8E-06	8,6E-06
Plomb	5,2E-01	7,5E-01	5,22E-08	2,0E-01	2,8E-01	2,0E-08	5,6E-07	8,4E-05	1,7E-05	1,4E-03	2,8E-03	0,0E+00	9,6E-07	5,0E-06	1,4E-06
Sélénium	3,2E-02	4,5E-02	3,16E-09	1,2E-02	1,7E-02	1,2E-09	5,8E-08	5,1E-06	5,1E-06	3,8E-05	7,3E-05	0,0E+00	1,8E-05	5,6E-05	2,1E-05
Strontium	1,8E+01	2,6E+01	1,81E-06	6,8E+00	9,7E+00	6,8E-07	1,9E-05	2,9E-03	2,9E-04	2,9E-03	3,9E-03	0,0E+00	5,5E-04	4,8E-04	5,0E-04
Titane	7,4E+02	1,1E+03	7,42E-05	2,8E+02	4,0E+02	2,8E-05	8,0E-04	1,2E-01	6,5E-02	1,7E+00	3,3E+00	0,0E+00	1,5E-01	7,0E-01	2,0E-01
Uranium	2,7E-02	3,9E-02	2,74E-09	1,1E-02	1,5E-02	1,1E-09	3,8E-08	4,5E-06	2,1E-06	1,1E-05	1,9E-05	0,0E+00	7,3E-08	1,1E-07	7,1E-08
Vanadium	1,7E+01	2,5E+01	1,72E-06	6,4E+00	9,2E+00	6,4E-07	1,8E-05	2,7E-03	1,5E-03	3,8E-02	7,5E-02	0,0E+00	2,9E-04	1,3E-03	3,9E-04
Zinc	8,4E+00	1,2E+01	8,40E-07	3,2E+00	4,5E+00	3,2E-07	9,3E-06	1,3E-03	8,1E-04	2,2E-02	4,2E-02	0,0E+00	6,2E-03	3,0E-02	8,4E-03

a Valeurs modélisées pour la végétation herbacée et aquatique. Les concentrations modélisées dans la végétation arbustive et arborescente sont respectivement 1,3 et 3,6 fois plus faibles que les valeurs présentées

TABLEAU F10

Concentrations additionnelles de métaux modélisées dans les poussières intérieures (mg/kg), l'air intérieur (mg/m^3), les végétaux, les invertébrés, le gibier et le poisson (mg/kg-pc frais) (suite)

Substance	Petite oie des neiges	Sarcelle d'hiver	Tétras du Canada	Campagnol des champs	Caribou forestier	Castor de Canada	Lièvre d'Amérique	Lynx du Canada	Martre d'Amérique	Musaraigne cendrée	Orignal	Ours noir	Porc-épic d'Amérique	Souris sylvestre	Poisson
Aluminium	2,2E-02	7,5E-03	9,7E-03	2,0E-02	3,8E-02	3,1E-02	3,7E-02	2,8E-02	1,1E-03	7,8E-04	7,2E-03	1,3E-02	1,6E-02	1,2E-03	7,4E-01
Antimoine	9,3E-08	3,0E-08	4,0E-08	8,6E-08	1,6E-07	1,3E-07	1,6E-07	1,2E-07	3,4E-09	2,6E-09	2,5E-08	4,8E-08	7,0E-08	4,9E-09	2,4E-06
Argent	2,4E-06	1,3E-06	1,3E-06	2,3E-06	4,2E-06	3,4E-06	4,1E-06	3,1E-06	1,6E-06	8,8E-07	2,4E-06	1,6E-06	1,8E-06	1,9E-07	2,7E-06
Arsenic	5,8E-06	2,1E-06	2,7E-06	5,4E-06	1,0E-05	8,2E-06	9,9E-06	7,4E-06	4,0E-07	2,4E-07	2,5E-06	3,2E-06	4,4E-06	3,2E-07	1,0E-04
Baryum	5,0E-05	1,9E-05	2,4E-05	4,6E-05	8,8E-05	7,0E-05	8,4E-05	6,3E-05	7,8E-07	8,6E-07	3,7E-05	4,0E-05	3,7E-05	2,6E-06	2,2E-02
Béryllium	1,9E-07	7,2E-08	9,0E-08	1,8E-07	3,4E-07	2,7E-07	3,3E-07	2,5E-07	3,5E-09	4,5E-09	9,4E-08	1,1E-07	1,5E-07	1,1E-08	2,1E-05
Bore	9,1E-06	5,4E-06	4,5E-06	9,0E-06	1,6E-05	1,3E-05	1,5E-05	1,2E-05	2,8E-07	5,2E-07	4,1E-06	6,3E-06	7,0E-06	9,7E-07	4,4E-04
Cadmium	8,8E-08	2,0E-07	1,4E-07	8,3E-08	1,5E-07	1,2E-07	1,5E-07	1,1E-07	3,7E-09	9,0E-09	7,9E-07	1,4E-07	6,6E-08	1,8E-08	4,5E-06
Chrome total	1,0E-04	2,2E-04	1,5E-04	1,0E-04	1,8E-04	1,5E-04	1,7E-04	1,3E-04	2,1E-05	4,3E-05	7,9E-04	1,5E-04	7,8E-05	2,4E-05	9,4E-05
Cobalt	2,1E-05	1,3E-05	1,2E-05	2,1E-05	3,8E-05	3,1E-05	3,6E-05	2,8E-05	1,5E-06	1,5E-06	2,1E-05	1,4E-05	1,6E-05	2,0E-06	8,0E-05
Cuivre	7,4E-05	1,9E-04	1,2E-04	7,5E-05	1,3E-04	1,1E-04	1,3E-04	1,0E-04	2,9E-05	6,1E-05	6,8E-04	1,4E-04	5,8E-05	2,0E-05	6,4E-04
Étain	7,5E-05	7,5E-05	6,4E-05	7,0E-05	1,3E-04	1,1E-04	1,3E-04	9,5E-05	2,0E-04	2,0E-04	2,5E-04	2,4E-04	5,6E-05	8,2E-06	8,9E-04
Lithium	4,8E-04	1,7E-03	1,2E-03	4,5E-04	8,5E-04	6,8E-04	8,2E-04	6,1E-04	1,9E-04	5,8E-04	7,3E-03	1,1E-03	3,6E-04	1,4E-04	1,4E-04
Manganèse	1,2E-04	3,0E-04	2,1E-04	1,1E-04	2,1E-04	1,7E-04	2,0E-04	1,5E-04	2,1E-06	6,0E-06	1,2E-03	1,9E-04	9,1E-05	2,6E-05	8,6E-04
Mercure	7,1E-07	5,3E-06	3,7E-06	6,7E-07	1,3E-06	1,1E-06	1,3E-06	9,4E-07	3,7E-06	1,8E-05	2,4E-05	9,4E-05	8,0E-07	4,3E-07	4,2E-04
Molybdène	2,6E-06	7,1E-06	5,1E-06	2,4E-06	4,6E-06	3,7E-06	4,4E-06	3,3E-06	6,1E-07	1,5E-06	3,0E-05	4,9E-06	2,0E-06	6,4E-07	2,5E-05
Nickel	1,1E-05	9,5E-06	5,7E-06	1,1E-05	1,9E-05	1,6E-05	1,8E-05	1,5E-05	4,3E-07	1,1E-06	6,9E-06	8,7E-06	8,3E-06	1,9E-06	1,3E-04
Plomb	5,7E-07	1,7E-06	1,2E-06	5,3E-07	1,0E-06	8,0E-07	9,6E-07	7,2E-07	8,0E-09	2,6E-08	7,1E-06	1,0E-06	4,3E-07	1,4E-07	4,2E-06
Sélénium	1,4E-05	2,7E-05	1,7E-05	1,5E-05	2,4E-05	2,1E-05	2,3E-05	1,9E-05	5,3E-05	7,2E-05	7,5E-05	6,6E-05	1,1E-05	3,6E-06	1,7E-04
Strontium	6,3E-04	2,4E-04	3,1E-04	5,8E-04	1,1E-03	8,8E-04	1,1E-03	7,9E-04	1,6E-04	8,2E-05	4,7E-04	3,8E-04	4,7E-04	3,3E-05	3,9E-03
Titane	9,7E-02	2,6E-01	1,7E-01	9,6E-02	1,7E-01	1,4E-01	1,6E-01	1,3E-01	1,1E-01	2,5E-01	9,9E-01	2,4E-01	7,4E-02	2,6E-02	5,6E-01
Uranium	7,3E-08	6,2E-08	4,9E-08	7,1E-08	1,3E-07	1,1E-07	1,2E-07	9,6E-08	1,9E-09	4,3E-09	1,3E-07	5,6E-08	5,6E-08	9,0E-09	1,4E-06
Vanadium	1,9E-04	4,9E-04	3,3E-04	1,8E-04	3,3E-04	2,7E-04	3,1E-04	2,5E-04	1,9E-05	4,8E-05	1,9E-03	3,3E-04	1,4E-04	5,0E-05	3,7E-03
Zinc	3,6E-03	1,1E-02	7,3E-03	3,6E-03	6,4E-03	5,3E-03	6,2E-03	4,9E-03	1,5E-02	3,5E-02	4,3E-02	1,6E-02	2,8E-03	1,1E-03	1,9E-02

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ANNEXE G

Apports alimentaires en métaux pour la population générale

TABLEAU G1

Doses alimentaires (mg/kg-pc par jour) documentées pour la population en général

Substance	Apport alimentaire (mg/kg-pc par jour)					Méthode de détermination	Source
	0 – 6 mois	>0,5 – 4 ans	>4 – 11 ans	>11 – 19 ans	20 ans+		
Aluminium	6,08E-02	2,95E-01	3,80E-01	3,05E-01	1,57E-01	Étude sur l'alimentation totale des Canadiens menée en 2003 (Montréal)[a]	Santé Canada (2011)
Antimoine	1,88E-04	1,43E-04	8,97E-05	5,13E-05	4,47E-05	Doses estimées à partir de la concentration moyenne rapportée dans les aliments[b]	Santé Canada (1997)
Argent	2,82E-03	2,14E-03	1,34E-03	7,68E-04	6,70E-04	Adultes : dose estimée à partir de l'apport quotidien moyen rapporté dans plusieurs études[c]; Autres tranches d'âge : doses calculées par Sanexen à partir de celle obtenue pour les adultes[b]	Santé Canada (1986)
Arsenic	2,37E-03	1,80E-03	1,13E-03	6,45E-04	5,63E-04	Adultes : dose d'exposition estimée à partir de l'apport quotidien moyen rapporté pour les Canadiens par Santé Canada[c]; Autres tranches d'âge : doses calculées à partir de celle obtenue pour les adultes[b]	Santé Canada (2006)
Baryum	1,85E-02	2,11E-02	1,56E-02	8,45E-03	6,32E-03	Étude sur l'alimentation totale des Canadiens menée en 2003 (Montréal)[a]	Santé Canada (2011)
Béryllium	1,48E-05	1,05E-05	6,00E-06	3,50E-06	3,10E-06	Étude sur l'alimentation totale des Canadiens menée en 2003 (Montréal)[a]	Santé Canada (2011)
Bore	1,12E-01	5,78E-02	2,72E-02	1,48E-02	1,54E-02	Doses estimées à partir des apports moyens de la population des États-Unis (*Continuing Survey of Food Intakes by Individuals,* 1994-1996)[d]	Institute of Medicine (2001)
Cadmium	2,52E-04	5,18E-04	4,70E-04	2,75E-04	1,95E-04	Étude sur l'alimentation totale des Canadiens menée en 2003 (Montréal)[a]	Santé Canada (2011)
Chrome	2,81E-05	7,51E-04	4,94E-04	3,25E-04	2,20E-04	Apports moyens estimés pour les Canadiens	Sanexen (2009)
Cobalt	5,95E-04	5,14E-04	3,70E-04	2,20E-04	1,46E-04	Étude sur l'alimentation totale des Canadiens menée en 2003 (Montréal)[a]	Santé Canada (2011)
Cuivre	6,15E-02	4,89E-02	4,00E-02	2,45E-02	2,25E-02	Étude sur l'alimentation totale des Canadiens menée en 2003 (Montréal)[a]	Santé Canada (2011)

Substance	Apport alimentaire (mg/kg-pc par jour)					Méthode de détermination	Source
	0 – 6 mois	>0,5 – 4 ans	>4 – 11 ans	>11 – 19 ans	20 ans+		
Étain	1,17E-01	8,90E-02	4,80E-02	4,80E-02	2,30E-02	Étude de l'alimentation totale -Grande-Bretagne (2006)	Committee on Toxicity of Chemicals in Food (2008)
Lithium	5,41E-03	6,63E-03	4,31E-03	2,71E-03	2,72E-03	Doses estimées à partir de la concentration moyenne rapportée dans les aliments[b]	Leblanc, Guérin *et coll.* (2005)
Manganèse	7,45E-02	1,01E-01	8,20E-02	4,85E-02	5,53E-02	Étude sur l'alimentation totale des Canadiens menée en 2003 (Montréal)[a]	Santé Canada (2011)
Mercure	1,32E-04	1,37E-04	1,04E-04	6,56E-05	6,15E-05	Apports alimentaires estimés pour les Québécois	INSPQ (2005)
Molybdène	1,11E-02	8,26E-03	5,99E-03	3,37E-03	2,47E-03	Étude de l'alimentation totale - Canada (1993-1999)	Santé Canada (2003)
Nickel	1,32E-02	9,35E-03	6,30E-03	3,70E-03	3,07E-03	Étude sur l'alimentation totale des Canadiens menée en 2003 (Montréal)[a]	Santé Canada (2011)
Plomb	3,65E-04	2,88E-04	2,10E-04	1,35E-04	1,32E-04	Étude sur l'alimentation totale des Canadiens menée en 2003 (Montréal)[a]	Santé Canada (2011)
Sélénium	5,50E-03	6,51E-03	5,17E-03	3,07E-03	2,32E-03	Étude de l'alimentation totale - Moyenne des valeurs rapportées pour Toronto (2005), Halifax (2006) et Vancouver (2007)	Santé Canada (2011)
Strontium	8,33E-02	6,69E-02	4,40E-02	2,45E-02	1,84E-02	Étude sur l'alimentation totale des Canadiens menée en 2003 (Montréal)[a]	Santé Canada (2011)
Titane	4,17E-02	3,17E-02	1,99E-02	1,14E-02	9,90E-03	Adultes : dose d'exposition estimée à partir de l'apport moyen rapporté dans plusieurs études[g]; Autres tranches d'âge : doses calculées à partir de celle obtenue pour les adultes[b]	WHO (1982)
Uranium	2,55E-04	1,24E-04	9,00E-05	6,50E-05	9,90E-05	Étude sur l'alimentation totale des Canadiens menée en 2003 (Montréal)[a]	Santé Canada (2011)
Vanadium	1,43E-03	1,09E-03	6,82E-04	3,90E-04	3,40E-04	Adultes : dose moyenne rapportée pour la population de certains États américains, 1999 (étude NHEXAS)[h]; Autres tranches d'âge : doses calculées à partir de celle des adultes[b]	ATSDR (2012)
Zinc	7,14E-01	5,29E-01	3,65E-01	2,32E-01	1,73E-01	Étude sur l'alimentation totale des Canadiens menée en 2003 (Montréal)[a]	Santé Canada (2011)

a Les doses alimentaires fournies par Santé Canada pour différentes classes d'âge (0-1 mois, 2-3 mois, 4-6 mois, 7-9 mois, 10-12 mois, 1-4 ans, 5-11 ans, 12-19 ans, 20-39 ans, 40-64 ans et 65 ans et plus) ont été pondérées afin de correspondre à la durée des classes d'âge recommandées par (INSPQ, 2012) et retenues dans la présente étude (6 mois, 4,5 ans, 7 ans, 8 ans et 50 ans).

b À partir des taux de consommation d'aliments recommandés par le MSSS (2002) et des poids corporels indiqués par l'INSPQ (2012).

c À partir des poids corporels indiqués par l'INSPQ (2012).

d Les apports alimentaires fournis par l'*Institute of Medicine* pour différentes classes d'âge (0-6 mois, 7-12 mois, 1-3 ans, 4-8 ans, 9-13 ans, 14-18 ans, 19-30 ans, 31-50 ans, 51-70 ans et 71 ans et plus) ont été pondérés afin de correspondre à la durée des classes d'âge recommandées par l'INSPQ (2012) et retenues dans la présente étude (6 mois, 4,5 ans, 7 ans, 8 ans et 50 ans)

e Les apports alimentaires fournis par l'*Institute of Medicine* pour différentes classes d'âge (19-30 ans, 31-50 ans, 51-70 ans et 71-74 ans) ont été pondérées afin de correspondre à la durée des classes d'âge recommandées par l'INSPQ (2012) et retenues dans la présente étude (50 ans pour les adultes). Les doses ont été obtenues à partir des poids corporels retenus par l'INSPQ (2012).

f Les apports alimentaires fournis par l'*Institute of Medicine* pour différentes classes d'âge (0-6 mois, 7-12 mois, 1-3 ans, 4-8 ans, 9-13 ans, 14-18 ans, 19-30 ans) ont été pondérés afin de correspondre à la durée des classes d'âge recommandées par l'INSPQ (2012) et retenues dans la présente étude (6 mois, 4,5 ans, 7 ans et 8 ans). Les doses ont été obtenues à partir des poids corporels retenus par l'INSPQ (2012).

g Apport moyen calculé d'après 7 valeurs rapportées par l'OMS (WHO).

h Dose alimentaire rapportée par ATSDR pour la population de certains États américains (Indiana, Illinois, Michigan, Minnesota, Ohio et Wisconsin).

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ANNEXE H

Détail des doses de métaux estimées pour chacune des voies d’exposition

TABLEAU H-1 Doses d'exposition bruit de fond détaillées (mg/kg-pc par jour) - Scénario "Relais routier"

Voie d'exposition:	Inhalation		Cutané[a]				Ingestion							Inhalation		Cutané[a]			Ingestion				
Saison:	Été		Été	Été + hiver	Été		Été + hiver	Été		Été + hiver				Hiver		Hiver			Hiver		Été + hiver	Été	Hiver
Dose:	Air extérieur	Air intérieur	Air (int + ext)	Eau	Sol	Poussières intérieures	Eau	Sol	Poussières intérieures	Fruits	Légumes	Viande	Poisson	Air extérieur	Air intérieur	Air (int + ext)	Sol	Poussières intérieures	Sol	Poussières intérieures	Aérosols de douche	Lait maternel	Lait maternel
Groupe d'âge du récepteur: 0-6 mois																							
Aluminium	3,6E-06	2,2E-05	0,0E+00	5,1E-07	0,0E+00	3,1E-05	5,9E-04	6,3E-03	9,0E-04	0,0E+00	0,0E+00	0,0E+00	0,0E+00	7,9E-07	2,4E-05	0,0E+00	0,0E+00	1,4E-05	0,0E+00	1,0E-03	0,0E+00	2,4E-04	2,4E-04
Antimoine	1,5E-08	9,0E-08	0,0E+00	8,6E-09	0,0E+00	1,0E-07	9,8E-06	2,1E-07	3,0E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	3,3E-09	9,8E-08	0,0E+00	0,0E+00	5,8E-08	0,0E+00	4,2E-06	0,0E+00	3,6E-08	3,6E-08
Argent	1,2E-09	7,4E-09	0,0E+00	2,9E-10	0,0E+00	9,0E-09	5,5E-07	6,0E-07	2,6E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,7E-10	8,1E-09	0,0E+00	0,0E+00	4,8E-09	0,0E+00	3,5E-07	0,0E+00	1,3E-04	1,3E-04
Arsenic	2,7E-08	1,6E-07	0,0E+00	4,3E-08	0,0E+00	7,7E-07	4,9E-05	8,3E-06	5,6E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	6,0E-09	1,8E-07	0,0E+00	0,0E+00	4,2E-07	0,0E+00	7,6E-06	0,0E+00	4,4E-07	4,4E-07
Baryum	8,4E-08	5,1E-07	0,0E+00	9,7E-07	0,0E+00	6,2E-07	1,1E-03	3,7E-05	1,8E-05	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,9E-08	5,6E-07	0,0E+00	0,0E+00	3,3E-07	0,0E+00	2,4E-05	0,0E+00	2,5E-05	2,5E-05
Béryllium	4,4E-10	2,7E-09	0,0E+00	9,9E-10	0,0E+00	3,9E-09	1,1E-06	8,7E-07	1,1E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	9,8E-11	2,9E-09	0,0E+00	0,0E+00	1,7E-09	0,0E+00	1,3E-07	0,0E+00	1,2E-10	5,5E-11
Bore	3,4E-07	2,1E-06	0,0E+00	1,2E-07	0,0E+00	2,4E-06	1,4E-04	6,4E-05	7,0E-05	0,0E+00	0,0E+00	0,0E+00	0,0E+00	7,6E-08	2,3E-06	0,0E+00	0,0E+00	1,3E-06	0,0E+00	9,7E-05	0,0E+00	1,7E-04	1,7E-04
Cadmium	4,2E-09	2,6E-08	0,0E+00	1,6E-09	0,0E+00	3,0E-09	1,9E-06	5,7E-07	8,6E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	9,4E-10	2,8E-08	0,0E+00	0,0E+00	1,7E-09	0,0E+00	1,2E-06	0,0E+00	1,5E-06	1,5E-06
Chrome	3,0E-08	1,8E-07	0,0E+00	5,1E-08	0,0E+00	2,8E-07	5,9E-05	6,8E-05	8,1E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	6,7E-09	2,0E-07	0,0E+00	0,0E+00	1,2E-07	0,0E+00	8,6E-06	0,0E+00	6,2E-06	3,7E-06
Cobalt	4,3E-09	2,6E-08	0,0E+00	2,3E-08	0,0E+00	3,5E-08	2,6E-05	4,9E-06	1,0E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	9,7E-10	2,9E-08	0,0E+00	0,0E+00	1,7E-08	0,0E+00	1,2E-06	0,0E+00	2,3E-06	2,3E-06
Cuivre	4,0E-07	2,4E-06	0,0E+00	8,6E-05	0,0E+00	2,8E-06	9,7E-02	1,4E-05	8,0E-05	0,0E+00	0,0E+00	0,0E+00	0,0E+00	8,9E-08	2,7E-06	0,0E+00	0,0E+00	1,6E-06	0,0E+00	1,1E-04	0,0E+00	7,5E-04	7,5E-04
Étain	1,8E-08	1,1E-07	0,0E+00	8,6E-08	0,0E+00	1,3E-07	9,8E-05	7,5E-06	3,8E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	4,0E-09	1,2E-07	0,0E+00	0,0E+00	7,1E-08	0,0E+00	5,1E-06	0,0E+00	1,7E-04	1,7E-04
Lithium	1,3E-09	8,2E-09	0,0E+00	2,1E-07	0,0E+00	1,4E-08	2,3E-04	4,8E-06	4,1E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	3,0E-10	8,9E-09	0,0E+00	0,0E+00	5,3E-09	0,0E+00	3,8E-07	0,0E+00	4,2E-04	4,2E-04
Manganèse	1,7E-07	1,0E-06	0,0E+00	3,3E-07	0,0E+00	1,2E-06	3,7E-04	8,4E-05	3,6E-05	0,0E+00	0,0E+00	0,0E+00	0,0E+00	3,7E-08	1,1E-06	0,0E+00	0,0E+00	6,6E-07	0,0E+00	4,8E-05	0,0E+00	1,3E-04	1,3E-04
Mercure	6,4E-08	1,0E-06	4,9E-11	3,2E-09	0,0E+00	1,9E-10	3,6E-06	5,4E-08	5,5E-09	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,4E-08	1,1E-06	4,0E-11	0,0E+00	7,0E-11	0,0E+00	5,1E-09	0,0E+00	2,4E-07	2,4E-07
Molybdène	1,1E-08	6,6E-08	0,0E+00	5,3E-09	0,0E+00	7,8E-08	6,1E-06	3,3E-06	2,3E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,4E-09	7,2E-08	0,0E+00	0,0E+00	4,3E-08	0,0E+00	3,1E-06	0,0E+00	3,2E-05	3,2E-05
Nickel	3,1E-08	1,9E-07	0,0E+00	4,2E-09	0,0E+00	9,0E-07	4,8E-05	1,1E-05	6,6E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	7,0E-09	2,1E-07	0,0E+00	0,0E+00	4,9E-07	0,0E+00	8,9E-06	0,0E+00	4,7E-04	4,7E-04
Plomb	1,1E-07	6,9E-07	0,0E+00	1,0E-10	0,0E+00	8,0E-07	2,9E-05	1,4E-05	2,3E-05	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,5E-08	7,6E-07	0,0E+00	0,0E+00	4,5E-07	0,0E+00	3,2E-05	0,0E+00	3,3E-07	3,3E-07
Sélénium	3,5E-08	2,2E-07	0,0E+00	1,5E-08	0,0E+00	2,4E-07	1,7E-05	1,6E-06	7,1E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	7,9E-09	2,3E-07	0,0E+00	0,0E+00	1,4E-07	0,0E+00	1,0E-05	0,0E+00	1,8E-04	1,8E-04
Strontium	4,0E-08	2,5E-07	0,0E+00	7,3E-06	0,0E+00	3,3E-07	8,3E-03	5,5E-05	9,7E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	9,0E-09	2,7E-07	0,0E+00	0,0E+00	1,6E-07	0,0E+00	1,1E-05	0,0E+00	3,1E-04	3,1E-04
Titane	1,2E-07	7,3E-07	0,0E+00	8,6E-07	0,0E+00	1,4E-06	9,8E-04	5,5E-04	4,0E-05	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,6E-08	7,9E-07	0,0E+00	0,0E+00	4,7E-07	0,0E+00	3,4E-05	0,0E+00	8,1E-04	7,7E-04
Uranium	4,9E-10	3,0E-09	0,0E+00	1,6E-09	0,0E+00	4,0E-08	1,9E-06	3,6E-05	1,2E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,1E-10	3,2E-09	0,0E+00	0,0E+00	1,9E-09	0,0E+00	1,4E-07	0,0E+00	4,9E-07	4,5E-07
Vanadium	3,8E-08	2,3E-07	0,0E+00	5,5E-09	0,0E+00	2,8E-07	6,3E-06	2,4E-05	8,2E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	8,4E-09	2,5E-07	0,0E+00	0,0E+00	1,5E-07	0,0E+00	1,1E-05	0,0E+00	5,7E-08	5,2E-08
Zinc	4,0E-07	2,4E-06	0,0E+00	3,1E-06	0,0E+00	2,8E-06	6,0E-03	2,8E-05	8,1E-05	0,0E+00	0,0E+00	0,0E+00	0,0E+00	8,9E-08	2,7E-06	0,0E+00	0,0E+00	1,6E-06	0,0E+00	1,1E-04	0,0E+00	1,3E-02	1,3E-02
Groupe d'âge du récepteur: 20 ans et plus																							
Aluminium	1,6E-06	9,5E-06	0,0E+00	2,5E-07	1,8E-04	1,5E-05	1,5E-04	5,6E-04	8,1E-05	0,0E+00	0,0E+00	0,0E+00	0,0E+00	3,5E-07	1,0E-05	0,0E+00	0,0E+00	6,8E-06	0,0E+00	9,1E-05	1,1E-07	-	-
Antimoine	6,5E-09	3,9E-08	0,0E+00	4,1E-09	6,1E-09	4,9E-08	2,6E-06	1,9E-08	2,6E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,4E-09	4,3E-08	0,0E+00	0,0E+00	2,8E-08	0,0E+00	3,8E-07	1,8E-09	-	-
Argent	5,3E-10	3,2E-09	0,0E+00	1,4E-10	1,7E-08	4,3E-09	1,4E-07	5,4E-08	2,3E-08	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,2E-10	3,5E-09	0,0E+00	0,0E+00	2,3E-09	0,0E+00	3,1E-08	1,0E-10	-	-
Arsenic	1,2E-08	7,2E-08	0,0E+00	2,1E-08	9,6E-07	3,7E-07	1,3E-05	7,4E-07	5,0E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,6E-09	7,8E-08	0,0E+00	0,0E+00	2,0E-07	0,0E+00	6,8E-07	8,9E-09	-	-
Baryum	3,7E-08	2,3E-07	0,0E+00	4,7E-07	1,1E-06	3,0E-07	2,9E-04	3,3E-06	1,6E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	8,2E-09	2,5E-07	0,0E+00	0,0E+00	1,6E-07	0,0E+00	2,2E-06	2,0E-07	-	-
Béryllium	1,9E-10	1,2E-09	0,0E+00	4,8E-10	2,5E-08	1,9E-09	2,9E-07	7,8E-08	1,0E-08	0,0E+00	0,0E+00	0,0E+00	0,0E+00	4,3E-11	1,3E-09	0,0E+00	0,0E+00	8,4E-10	0,0E+00	1,1E-08	2,1E-10	-	-
Bore	1,5E-07	9,1E-07	0,0E+00	5,8E-08	1,9E-06	1,2E-06	3,6E-05	5,7E-06	6,3E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	3,3E-08	9,9E-07	0,0E+00	0,0E+00	6,5E-07	0,0E+00	8,7E-06	2,5E-08	-	-
Cadmium	1,8E-09	1,1E-08	0,0E+00	7,9E-10	1,7E-09	1,4E-09	4,8E-07	5,1E-08	7,7E-08	0,0E+00	0,0E+00	0,0E+00	0,0E+00	4,1E-10	1,2E-08	0,0E+00	0,0E+00	8,0E-10	0,0E+00	1,1E-07	3,4E-10	-	-
Chrome	1,3E-08	8,1E-08	0,0E+00	2,5E-08	2,0E-06	1,3E-07	1,5E-05	6,1E-06	7,2E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,9E-09	8,8E-08	0,0E+00	0,0E+00	5,7E-08	0,0E+00	7,7E-07	1,1E-08	-	-
Cobalt	1,9E-09	1,2E-08	0,0E+00	1,1E-08	1,4E-07	1,7E-08	6,7E-06	4,4E-07	9,1E-08	0,0E+00	0,0E+00	0,0E+00	0,0E+00	4,2E-10	1,3E-08	0,0E+00	0,0E+00	8,2E-09	0,0E+00	1,1E-07	4,7E-09	-	-
Cuivre	1,8E-07	1,1E-06	0,0E+00	4,1E-05	4,2E-07	1,3E-06	2,5E-02	1,3E-06	7,2E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	3,9E-08	1,2E-06	0,0E+00	0,0E+00	7,6E-07	0,0E+00	1,0E-05	1,8E-05	-	-
Étain	7,9E-09	4,8E-08	0,0E+00	4,1E-08	2,2E-07	6,4E-08	2,6E-05	6,7E-07	3,4E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,8E-09	5,2E-08	0,0E+00	0,0E+00	3,4E-08	0,0E+00	4,6E-07	1,8E-08	-	-
Lithium	5,9E-10	3,6E-09	0,0E+00	9,9E-08	1,4E-07	6,8E-09	6,1E-05	4,3E-07	3,7E-08	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,3E-10	3,9E-09	0,0E+00	0,0E+00	2,5E-09	0,0E+00	3,4E-08	4,3E-08	-	-
Manganèse	7,3E-08	4,5E-07	0,0E+00	1,6E-07	2,4E-06	6,0E-07	9,7E-05	7,5E-06	3,2E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,6E-08	4,9E-07	0,0E+00	0,0E+00	3,2E-07	0,0E+00	4,3E-06	6,8E-08	-	-
Mercure	2,8E-08	4,4E-07	9,5E-11	1,5E-09	1,6E-09	9,2E-11	9,4E-07	4,8E-09	4,9E-10	0,0E+00	0,0E+00	0,0E+00	0,0E+00	6,3E-09	4,8E-07	3,6E-11	0,0E+00	3,4E-11	0,0E+00	4,5E-10	6,6E-10	-	-
Molybdène	4,8E-09	2,9E-08	0,0E+00	2,6E-09	9,7E-08	3,8E-08	1,6E-06	3,0E-07	2,0E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,1E-09	3,2E-08	0,0E+00	0,0E+00	2,1E-08	0,0E+00	2,8E-07	1,1E-09	-	-
Nickel	1,4E-08	8,3E-08	0,0E+00	2,0E-09	1,3E-06	4,4E-07	1,2E-05	9,7E-07	5,9E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	3,0E-09	9,1E-08	0,0E+00	0,0E+00	2,4E-07	0,0E+00	8,0E-07	8,7E-09	-	-
Plomb	5,0E-08	3,0E-07	0,0E+00	5,0E-11	4,0E-07	3,8E-07	7,7E-06	1,2E-06	2,1E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,1E-08	3,3E-07	0,0E+00	0,0E+00	2,2E-07	0,0E+00	2,9E-06	5,4E-09	-	-
Sélénium	1,5E-08	9,4E-08	0,0E+00	7,4E-09	4,8E-08	1,2E-07	4,5E-06	1,5E-07	6,4E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	3,4E-09	1,0E-07	0,0E+00	0,0E+00	6,7E-08	0,0E+00	9,0E-07	3,2E-09	-	-
Strontium	1,8E-08	1,1E-07	0,0E+00	3,5E-06	1,6E-06	1,6E-07	2,2E-03	4,9E-06	8,7E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	3,9E-09	1,2E-07	0,0E+00	0,0E+00	7,6E-08	0,0E+00	1,0E-06	1,5E-06	-	-
Titane	5,2E-08	3,2E-07	0,0E+00	4,1E-07	1,6E-05	6,7E-07	2,6E-04	5,0E-05	3,6E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,2E-08	3,5E-07	0,0E+00	0,0E+00	2,3E-07	0,0E+00	3,0E-06	1,8E-07	-	-
Uranium	2,1E-10	1,3E-09	0,0E+00	7,9E-10	1,0E-06	1,9E-08	4,8E-07	3,2E-06	1,0E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	4,7E-11	1,4E-09	0,0E+00	0,0E+00	9,2E-10	0,0E+00	1,2E-08	3,4E-10	-	-
Vanadium	1,7E-08	1,0E-07	0,0E+00	2,7E-09	7,1E-07	1,4E-07	1,6E-06	2,2E-06	7,4E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	3,7E-09	1,1E-07	0,0E+00	0,0E+00	7,1E-08	0,0E+00	9,6E-07	1,1E-09	-	-
Zinc	1,8E-07	1,1E-06	0,0E+00	1,5E-06	8,2E-07	1,3E-06	1,6E-03	2,5E-06	7,2E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	3,9E-08	1,2E-06	0,0E+00	0,0E+00	7,6E-07	0,0E+00	1,0E-05	1,1E-06	-	-

a: Les valeurs fournies correspondent aux doses absorbées par voie cutanée.

TABLEAU H-2 Doses d'exposition additionnelles détaillées (mg/kg-pc par jour) - Scénario "Relais routier"

Voie d'exposition:	Inhalation		Cutané[a]				Ingestion							Inhalation		Cutané[a]			Ingestion		Inhalation	Ingestion	
Saison:	Été		Été	Été + hiver	Été		Été + hiver	Été		Été + hiver				Hiver		Hiver			Hiver		Été + hiver	Été	Hiver
Dose:	Air extérieur	Air intérieur	Air (int + ext)	Eau	Sol	Poussières intérieures	Eau	Sol	Poussières intérieures	Fruits	Légumes	Viande	Poisson	Air extérieur	Air intérieur	Air (int + ext)	Sol	Poussières intérieures	Sol	Poussières intérieures	Aérosols de douche	Lait maternel	Lait maternel
Groupe d'âge du récepteur: 0-6 mois																							
Aluminium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,1E-06	1,9E-06
Antimoine	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	4,7E-12	4,8E-12
Argent	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	4,2E-09	3,1E-09
Arsenic	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,3E-10	1,4E-10
Baryum	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	6,6E-08	5,4E-08
Béryllium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	9,8E-12	5,9E-12
Bore	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	5,8E-09	7,3E-09
Cadmium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	4,1E-11	4,4E-11
Chrome	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,3E-07	8,5E-08
Cobalt	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	7,2E-09	9,1E-09
Cuivre	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	5,0E-09	6,3E-09
Étain	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	3,1E-10	3,9E-10
Lithium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	3,3E-07	4,1E-07
Manganèse	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	7,6E-08	6,7E-08
Mercure	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,3E-13	1,3E-13
Molybdène	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,4E-10	3,1E-10
Nickel	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	9,9E-07	6,2E-07
Plomb	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,3E-10	2,9E-10
Sélénium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,6E-09	1,2E-09
Strontium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	8,0E-08	8,2E-08
Titane	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	5,7E-05	4,0E-05
Uranium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	3,7E-11	3,7E-11
Vanadium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	3,0E-09	2,0E-09
Zinc	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,2E-07	1,5E-07
Groupe d'âge du récepteur: 20 ans +																							
Aluminium	1,1E-05	6,7E-05	0,0E+00	0,0E+00	0,0E+00	8,3E-05	0,0E+00	0,0E+00	4,5E-04	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,4E-06	7,3E-05	0,0E+00	0,0E+00	4,7E-05	0,0E+00	6,4E-04	0,0E+00	-	-
Antimoine	7,0E-11	4,3E-10	0,0E+00	0,0E+00	0,0E+00	5,3E-10	0,0E+00	0,0E+00	2,9E-09	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,6E-11	4,7E-10	0,0E+00	0,0E+00	3,0E-10	0,0E+00	4,1E-09	0,0E+00	-	-
Argent	9,0E-11	5,5E-10	0,0E+00	0,0E+00	0,0E+00	6,8E-10	0,0E+00	0,0E+00	3,7E-09	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,0E-11	6,0E-10	0,0E+00	0,0E+00	3,9E-10	0,0E+00	5,3E-09	0,0E+00	-	-
Arsenic	2,2E-09	1,3E-08	0,0E+00	0,0E+00	0,0E+00	6,6E-08	0,0E+00	0,0E+00	8,8E-08	0,0E+00	0,0E+00	0,0E+00	0,0E+00	4,8E-10	1,4E-08	0,0E+00	0,0E+00	3,7E-08	0,0E+00	1,3E-07	0,0E+00	-	-
Baryum	1,1E-07	6,6E-07	0,0E+00	0,0E+00	0,0E+00	8,2E-07	0,0E+00	0,0E+00	4,4E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,4E-08	7,2E-07	0,0E+00	0,0E+00	4,7E-07	0,0E+00	6,3E-06	0,0E+00	-	-
Béryllium	4,8E-10	2,9E-09	0,0E+00	0,0E+00	0,0E+00	3,6E-09	0,0E+00	0,0E+00	2,0E-08	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,1E-10	3,2E-09	0,0E+00	0,0E+00	2,1E-09	0,0E+00	2,8E-08	0,0E+00	-	-
Bore	8,7E-09	5,3E-08	0,0E+00	0,0E+00	0,0E+00	6,6E-08	0,0E+00	0,0E+00	3,5E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,9E-09	5,8E-08	0,0E+00	0,0E+00	3,7E-08	0,0E+00	5,0E-07	0,0E+00	-	-
Cadmium	6,6E-11	4,0E-10	0,0E+00	0,0E+00	0,0E+00	5,0E-11	0,0E+00	0,0E+00	2,7E-09	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,5E-11	4,4E-10	0,0E+00	0,0E+00	2,9E-11	0,0E+00	3,9E-09	0,0E+00	-	-
Chrome	1,4E-08	8,4E-08	0,0E+00	0,0E+00	0,0E+00	1,0E-07	0,0E+00	0,0E+00	5,6E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	3,1E-09	9,1E-08	0,0E+00	0,0E+00	5,9E-08	0,0E+00	8,0E-07	0,0E+00	-	-
Cobalt	8,1E-09	5,0E-08	0,0E+00	0,0E+00	0,0E+00	6,2E-08	0,0E+00	0,0E+00	3,3E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,8E-09	5,4E-08	0,0E+00	0,0E+00	3,5E-08	0,0E+00	4,7E-07	0,0E+00	-	-
Cuivre	5,6E-09	3,4E-08	0,0E+00	0,0E+00	0,0E+00	4,3E-08	0,0E+00	0,0E+00	2,3E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,3E-09	3,7E-08	0,0E+00	0,0E+00	2,4E-08	0,0E+00	3,3E-07	0,0E+00	-	-
Étain	7,0E-10	4,3E-09	0,0E+00	0,0E+00	0,0E+00	5,3E-09	0,0E+00	0,0E+00	2,9E-08	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,6E-10	4,7E-09	0,0E+00	0,0E+00	3,0E-09	0,0E+00	4,1E-08	0,0E+00	-	-
Lithium	3,6E-08	2,2E-07	0,0E+00	0,0E+00	0,0E+00	2,7E-07	0,0E+00	0,0E+00	1,5E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	8,0E-09	2,4E-07	0,0E+00	0,0E+00	1,5E-07	0,0E+00	2,1E-06	0,0E+00	-	-
Manganèse	2,6E-07	1,6E-06	0,0E+00	0,0E+00	0,0E+00	2,0E-06	0,0E+00	0,0E+00	1,1E-05	0,0E+00	0,0E+00	0,0E+00	0,0E+00	5,8E-08	1,7E-06	0,0E+00	0,0E+00	1,1E-06	0,0E+00	1,5E-05	0,0E+00	-	-
Mercure	3,7E-12	3,2E-11	1,0E-14	0,0E+00	0,0E+00	4,7E-15	0,0E+00	0,0E+00	2,5E-14	0,0E+00	0,0E+00	0,0E+00	0,0E+00	8,2E-13	3,5E-11	3,6E-15	0,0E+00	2,5E-15	0,0E+00	3,3E-14	0,0E+00	-	-
Molybdène	3,2E-10	2,0E-09	0,0E+00	0,0E+00	0,0E+00	2,5E-09	0,0E+00	0,0E+00	1,3E-08	0,0E+00	0,0E+00	0,0E+00	0,0E+00	7,2E-11	2,2E-09	0,0E+00	0,0E+00	1,4E-09	0,0E+00	1,9E-08	0,0E+00	-	-
Nickel	8,0E-09	4,9E-08	0,0E+00	0,0E+00	0,0E+00	2,4E-07	0,0E+00	0,0E+00	3,2E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,8E-09	5,3E-08	0,0E+00	0,0E+00	1,4E-07	0,0E+00	4,6E-07	0,0E+00	-	-
Plomb	1,7E-09	1,0E-08	0,0E+00	0,0E+00	0,0E+00	1,3E-08	0,0E+00	0,0E+00	7,0E-08	0,0E+00	0,0E+00	0,0E+00	0,0E+00	3,8E-10	1,1E-08	0,0E+00	0,0E+00	7,4E-09	0,0E+00	1,0E-07	0,0E+00	-	-
Sélénium	1,0E-10	6,3E-10	0,0E+00	0,0E+00	0,0E+00	7,8E-10	0,0E+00	0,0E+00	4,2E-09	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,3E-11	6,9E-10	0,0E+00	0,0E+00	4,5E-10	0,0E+00	6,0E-09	0,0E+00	-	-
Strontium	5,9E-08	3,6E-07	0,0E+00	0,0E+00	0,0E+00	4,5E-07	0,0E+00	0,0E+00	2,4E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,3E-08	3,9E-07	0,0E+00	0,0E+00	2,6E-07	0,0E+00	3,5E-06	0,0E+00	-	-
Titane	2,4E-06	1,5E-05	0,0E+00	0,0E+00	0,0E+00	1,8E-05	0,0E+00	0,0E+00	9,9E-05	0,0E+00	0,0E+00	0,0E+00	0,0E+00	5,4E-07	1,6E-05	0,0E+00	0,0E+00	1,1E-05	0,0E+00	1,4E-04	0,0E+00	-	-
Uranium	9,0E-11	5,5E-10	0,0E+00	0,0E+00	0,0E+00	6,8E-10	0,0E+00	0,0E+00	3,7E-09	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,0E-11	6,0E-10	0,0E+00	0,0E+00	3,9E-10	0,0E+00	5,2E-09	0,0E+00	-	-
Vanadium	5,6E-08	3,4E-07	0,0E+00	0,0E+00	0,0E+00	4,3E-07	0,0E+00	0,0E+00	2,3E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,3E-08	3,7E-07	0,0E+00	0,0E+00	2,4E-07	0,0E+00	3,3E-06	0,0E+00	-	-
Zinc	2,8E-08	1,7E-07	0,0E+00	0,0E+00	0,0E+00	2,1E-07	0,0E+00	0,0E+00	1,1E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	6,1E-09	1,8E-07	0,0E+00	0,0E+00	1,2E-07	0,0E+00	1,6E-06	0,0E+00	-	-

a: Les valeurs fournies correspondent aux doses absorbées par voie cutanée.

TABLEAU H-3 Doses d'exposition bruit de fond détaillées (mg/kg-pc par jour) - Scénario "Activités traditionnelles"

Voie d'exposition:	Inhalation		Cutané[a]				Ingestion							Inhalation		Cutané[a]			Ingestion		Inhalation	Ingestion	
Saison:	Été		Été	Été + hiver	Été		Été + hiver	Été		Été + hiver				Hiver		Hiver			Hiver		Été + hiver	Été	Hiver
Dose:	Air extérieur	Air intérieur	Air (int + ext)	Eau	Sol	Poussières intérieures	Eau	Sol	Poussières intérieures	Fruits	Légumes	Viande	Poisson	Air extérieur	Air intérieur	Air (int + ext)	Sol	Poussières intérieures	Sol	Poussières intérieures	Aérosols de douche	Lait maternel	Lait maternel
Groupe d'âge du récepteur: 0-6 mois																							
Aluminium	1,7E-05	1,2E-05	0,0E+00	1,7E-05	0,0E+00	3,1E-05	5,9E-04	6,3E-03	9,0E-04	7,1E-02	3,4E-03	0,0E+00	0,0E+00	1,7E-05	1,2E-05	0,0E+00	0,0E+00	1,4E-05	0,0E+00	1,0E-03	0,0E+00	2,4E-04	2,3E-04
Antimoine	7,2E-08	5,0E-08	0,0E+00	1,7E-08	0,0E+00	1,0E-07	9,8E-06	2,1E-07	3,0E-06	3,0E-05	1,4E-06	0,0E+00	0,0E+00	7,2E-08	5,0E-08	0,0E+00	0,0E+00	5,8E-08	0,0E+00	4,2E-06	0,0E+00	2,7E-08	2,7E-08
Argent	5,9E-09	4,1E-09	0,0E+00	2,9E-10	0,0E+00	9,0E-09	5,5E-07	6,0E-07	2,6E-07	1,0E-05	4,8E-07	0,0E+00	0,0E+00	5,9E-09	4,1E-09	0,0E+00	0,0E+00	4,8E-09	0,0E+00	3,5E-07	0,0E+00	1,1E-05	1,1E-05
Arsenic	1,3E-07	9,1E-08	0,0E+00	1,1E-07	0,0E+00	7,7E-07	4,9E-05	8,3E-06	5,6E-06	5,7E-05	2,7E-06	0,0E+00	0,0E+00	1,3E-07	9,1E-08	0,0E+00	0,0E+00	4,2E-07	0,0E+00	7,6E-06	0,0E+00	3,5E-07	3,4E-07
Baryum	4,1E-07	2,9E-07	0,0E+00	3,8E-07	0,0E+00	6,2E-07	1,1E-03	3,7E-05	1,8E-05	4,1E-02	1,9E-03	0,0E+00	0,0E+00	4,1E-07	2,9E-07	0,0E+00	0,0E+00	3,3E-07	0,0E+00	2,4E-05	0,0E+00	1,6E-04	1,6E-04
Béryllium	2,1E-09	1,5E-09	0,0E+00	9,9E-10	0,0E+00	3,9E-09	1,1E-06	8,7E-07	1,1E-07	3,9E-06	1,9E-07	0,0E+00	0,0E+00	2,1E-09	1,5E-09	0,0E+00	0,0E+00	1,7E-09	0,0E+00	1,3E-07	0,0E+00	1,5E-10	8,5E-11
Bore	1,7E-06	1,2E-06	0,0E+00	1,2E-07	0,0E+00	2,4E-06	1,4E-04	6,4E-05	7,0E-05	5,8E-03	3,4E-04	0,0E+00	0,0E+00	1,7E-06	1,2E-06	0,0E+00	0,0E+00	1,3E-06	0,0E+00	9,7E-05	0,0E+00	7,7E-05	7,7E-05
Cadmium	2,0E-08	1,4E-08	0,0E+00	1,6E-09	0,0E+00	3,0E-09	1,9E-06	5,7E-07	8,6E-07	2,4E-05	1,1E-06	0,0E+00	0,0E+00	2,0E-08	1,4E-08	0,0E+00	0,0E+00	1,7E-09	0,0E+00	1,2E-06	0,0E+00	2,4E-07	2,4E-07
Chrome	1,5E-07	1,0E-07	0,0E+00	7,9E-08	0,0E+00	2,8E-07	5,9E-05	6,8E-05	8,1E-06	8,4E-05	4,0E-06	0,0E+00	0,0E+00	1,5E-07	1,0E-07	0,0E+00	0,0E+00	1,2E-07	0,0E+00	8,6E-06	0,0E+00	1,2E-05	9,6E-06
Cobalt	2,1E-08	1,5E-08	0,0E+00	2,3E-08	0,0E+00	3,5E-08	2,6E-05	4,9E-06	1,0E-06	6,2E-05	1,9E-05	0,0E+00	0,0E+00	2,1E-08	1,5E-08	0,0E+00	0,0E+00	1,7E-08	0,0E+00	1,2E-06	0,0E+00	1,7E-06	1,7E-06
Cuivre	1,9E-06	1,4E-06	0,0E+00	2,8E-08	0,0E+00	2,8E-06	9,7E-02	1,4E-05	8,0E-05	3,8E-03	1,8E-04	0,0E+00	0,0E+00	1,9E-06	1,4E-06	0,0E+00	0,0E+00	1,6E-06	0,0E+00	1,1E-04	0,0E+00	4,8E-04	4,8E-04
Étain	8,8E-08	6,1E-08	0,0E+00	8,6E-08	0,0E+00	1,3E-07	9,8E-05	7,5E-06	3,8E-06	2,4E-05	5,6E-06	0,0E+00	0,0E+00	8,8E-08	6,1E-08	0,0E+00	0,0E+00	7,1E-08	0,0E+00	5,1E-06	0,0E+00	5,4E-05	5,4E-05
Lithium	6,5E-09	4,5E-09	0,0E+00	2,1E-07	0,0E+00	1,4E-08	2,3E-04	4,8E-06	4,1E-07	4,1E-05	4,8E-06	0,0E+00	0,0E+00	6,5E-09	4,5E-09	0,0E+00	0,0E+00	5,3E-09	0,0E+00	3,8E-07	0,0E+00	1,1E-04	1,1E-04
Manganèse	8,1E-07	5,7E-07	0,0E+00	2,6E-06	0,0E+00	1,2E-06	3,7E-04	8,4E-05	3,6E-05	4,7E-01	2,3E-02	0,0E+00	0,0E+00	8,1E-07	5,7E-07	0,0E+00	0,0E+00	6,6E-07	0,0E+00	4,8E-05	0,0E+00	9,6E-04	9,6E-04
Mercure	3,1E-07	5,6E-07	9,0E-11	1,8E-10	0,0E+00	1,9E-10	3,8E-06	5,4E-08	5,5E-09	4,0E-06	2,5E-07	0,0E+00	0,0E+00	3,1E-07	5,6E-07	9,0E-11	0,0E+00	7,0E-11	0,0E+00	5,1E-09	0,0E+00	5,2E-06	5,2E-06
Molybdène	5,3E-08	3,7E-08	0,0E+00	5,3E-09	0,0E+00	7,8E-08	6,1E-06	3,3E-06	2,3E-06	8,0E-05	4,9E-06	0,0E+00	0,0E+00	5,3E-08	3,7E-08	0,0E+00	0,0E+00	4,3E-08	0,0E+00	3,1E-06	0,0E+00	2,4E-06	2,4E-06
Nickel	1,5E-07	1,1E-07	0,0E+00	4,2E-09	0,0E+00	9,0E-07	4,8E-05	1,1E-05	6,6E-06	1,3E-03	6,0E-05	0,0E+00	0,0E+00	1,5E-07	1,1E-07	0,0E+00	0,0E+00	4,9E-07	0,0E+00	8,9E-06	0,0E+00	1,9E-04	1,9E-04
Plomb	5,5E-07	3,9E-07	0,0E+00	1,4E-10	0,0E+00	8,0E-07	2,9E-05	1,4E-05	2,3E-05	2,2E-04	1,0E-05	0,0E+00	0,0E+00	5,5E-07	3,9E-07	0,0E+00	0,0E+00	4,5E-07	0,0E+00	3,2E-05	0,0E+00	4,9E-07	4,9E-07
Sélénium	1,7E-07	1,2E-07	0,0E+00	1,5E-08	0,0E+00	2,4E-07	1,7E-05	1,6E-06	7,1E-06	6,4E-05	3,0E-06	0,0E+00	0,0E+00	1,7E-07	1,2E-07	0,0E+00	0,0E+00	1,4E-07	0,0E+00	1,0E-05	0,0E+00	1,5E-04	1,5E-04
Strontium	2,0E-07	1,4E-07	0,0E+00	1,5E-06	0,0E+00	3,3E-07	8,3E-03	5,5E-05	9,7E-06	2,1E-02	1,0E-03	0,0E+00	0,0E+00	2,0E-07	1,4E-07	0,0E+00	0,0E+00	1,6E-07	0,0E+00	1,1E-05	0,0E+00	4,9E-04	4,9E-04
Titane	5,8E-07	4,0E-07	0,0E+00	4,3E-06	0,0E+00	1,4E-06	9,8E-04	5,5E-04	4,0E-05	1,1E-03	5,5E-05	0,0E+00	0,0E+00	5,8E-07	4,0E-07	0,0E+00	0,0E+00	4,7E-07	0,0E+00	3,4E-05	0,0E+00	8,9E-03	8,8E-03
Uranium	2,4E-09	1,6E-09	0,0E+00	1,6E-09	0,0E+00	4,0E-08	1,9E-06	3,6E-05	1,2E-06	2,6E-06	1,2E-07	0,0E+00	0,0E+00	2,4E-09	1,6E-09	0,0E+00	0,0E+00	1,9E-09	0,0E+00	1,4E-07	0,0E+00	2,9E-07	2,5E-07
Vanadium	1,8E-07	1,3E-07	0,0E+00	5,5E-09	0,0E+00	2,8E-07	6,3E-06	2,4E-05	8,2E-06	7,0E-05	3,4E-06	0,0E+00	0,0E+00	1,8E-07	1,3E-07	0,0E+00	0,0E+00	1,5E-07	0,0E+00	1,1E-05	0,0E+00	3,3E-08	2,8E-08
Zinc	1,9E-06	1,4E-06	0,0E+00	2,2E-07	0,0E+00	2,8E-06	6,0E-03	2,8E-05	8,1E-05	2,3E-02	1,2E-03	0,0E+00	0,0E+00	1,9E-06	1,4E-06	0,0E+00	0,0E+00	1,6E-06	0,0E+00	1,1E-04	0,0E+00	1,2E-02	1,2E-02
Groupe d'âge du récepteur: 0,5 - 4ans																							
Aluminium	1,6E-05	1,1E-05	0,0E+00	1,3E-05	8,1E-04	2,3E-05	3,7E-04	1,2E-02	1,7E-03	3,2E-01	1,5E-03	3,2E-02	1,6E-01	1,6E-05	1,1E-05	0,0E+00	0,0E+00	1,1E-05	0,0E+00	1,9E-03	0,0E+00	-	-
Antimoine	6,5E-08	4,6E-08	0,0E+00	1,3E-08	2,7E-08	7,7E-08	6,1E-06	4,0E-07	5,6E-06	1,4E-04	6,4E-07	1,2E-06	1,2E-05	6,5E-08	4,6E-08	0,0E+00	0,0E+00	4,4E-08	0,0E+00	8,0E-06	0,0E+00	-	-
Argent	5,4E-09	3,8E-09	0,0E+00	2,2E-10	7,7E-08	6,8E-09	3,4E-07	1,1E-06	5,0E-07	4,6E-05	2,1E-07	7,2E-05	1,9E-06	5,4E-09	3,8E-09	0,0E+00	0,0E+00	3,6E-09	0,0E+00	6,6E-07	0,0E+00	-	-
Arsenic	1,2E-07	8,3E-08	0,0E+00	8,0E-08	4,3E-06	5,8E-07	3,1E-05	1,6E-05	1,1E-05	2,6E-04	1,2E-06	5,7E-05	8,2E-04	1,2E-07	8,3E-08	0,0E+00	0,0E+00	3,2E-07	0,0E+00	1,5E-05	0,0E+00	-	-
Baryum	3,7E-07	2,6E-07	0,0E+00	2,9E-07	4,8E-06	4,7E-07	6,9E-04	7,0E-05	3,4E-05	1,9E-01	8,8E-04	3,7E-04	1,2E-02	3,7E-07	2,6E-07	0,0E+00	0,0E+00	2,5E-07	0,0E+00	4,6E-05	0,0E+00	-	-
Béryllium	1,9E-09	1,4E-09	0,0E+00	7,4E-10	1,1E-07	3,0E-09	7,0E-07	1,7E-06	2,2E-07	1,8E-05	8,3E-08	5,0E-07	3,0E-06	1,9E-09	1,4E-09	0,0E+00	0,0E+00	1,3E-09	0,0E+00	2,4E-07	0,0E+00	-	-
Bore	1,5E-06	1,1E-06	0,0E+00	9,1E-08	8,3E-06	1,8E-06	8,6E-05	1,2E-04	1,3E-04	2,7E-02	1,5E-04	1,5E-03	1,2E-03	1,5E-06	1,1E-06	0,0E+00	0,0E+00	1,0E-06	0,0E+00	1,9E-04	0,0E+00	-	-
Cadmium	1,9E-08	1,3E-08	0,0E+00	1,2E-09	7,4E-09	2,2E-09	1,2E-06	1,1E-06	1,6E-06	1,1E-04	5,1E-07	5,2E-06	1,6E-05	1,9E-08	1,3E-08	0,0E+00	0,0E+00	1,2E-09	0,0E+00	2,3E-06	0,0E+00	-	-
Chrome	1,3E-07	9,3E-08	0,0E+00	6,0E-08	8,9E-06	2,1E-07	3,7E-05	1,3E-04	1,5E-05	3,8E-04	1,8E-06	7,3E-04	7,5E-05	1,3E-07	9,3E-08	0,0E+00	0,0E+00	8,9E-08	0,0E+00	1,6E-05	0,0E+00	-	-
Cobalt	1,9E-08	1,3E-08	0,0E+00	1,7E-08	6,4E-07	2,6E-08	1,6E-05	9,4E-06	1,9E-06	2,8E-04	8,6E-06	4,7E-05	3,4E-05	1,9E-08	1,3E-08	0,0E+00	0,0E+00	1,3E-08	0,0E+00	2,4E-06	0,0E+00	-	-
Cuivre	1,8E-06	1,2E-06	0,0E+00	2,1E-08	1,9E-06	2,1E-06	6,1E-02	2,8E-05	1,5E-04	1,7E-02	8,1E-05	1,5E-03	5,3E-04	1,8E-06	1,2E-06	0,0E+00	0,0E+00	1,2E-06	0,0E+00	2,2E-04	0,0E+00	-	-
Étain	7,9E-08	5,6E-08	0,0E+00	6,5E-08	9,7E-07	9,9E-08	6,1E-05	1,4E-05	7,3E-06	1,1E-04	2,5E-06	3,3E-03	1,1E-02	7,9E-08	5,6E-08	0,0E+00	0,0E+00	5,3E-08	0,0E+00	9,8E-06	0,0E+00	-	-
Lithium	5,9E-09	4,1E-09	0,0E+00	1,5E-07	6,2E-07	1,1E-08	1,5E-04	9,1E-06	7,8E-07	1,9E-04	2,2E-06	8,2E-04	1,2E-04	5,9E-09	4,1E-09	0,0E+00	0,0E+00	4,0E-09	0,0E+00	7,3E-07	0,0E+00	-	-
Manganèse	7,4E-07	5,2E-07	0,0E+00	1,9E-06	1,1E-05	9,3E-07	2,3E-04	1,6E-04	6,9E-05	2,2E+00	1,0E-02	4,4E-03	1,3E-03	7,4E-07	5,2E-07	0,0E+00	0,0E+00	5,0E-07	0,0E+00	9,1E-05	0,0E+00	-	-
Mercure	2,8E-07	5,1E-07	1,3E-10	1,3E-10	7,0E-09	1,4E-10	2,4E-06	1,0E-07	1,1E-08	1,8E-05	1,1E-07	2,2E-04	2,9E-03	2,8E-07	5,1E-07	1,3E-10	0,0E+00	5,3E-11	0,0E+00	9,7E-09	0,0E+00	-	-
Molybdène	4,8E-08	3,4E-08	0,0E+00	4,0E-09	4,3E-07	5,9E-08	3,8E-06	6,4E-06	4,3E-06	3,6E-04	2,2E-06	1,2E-04	7,4E-05	4,8E-08	3,4E-08	0,0E+00	0,0E+00	3,2E-08	0,0E+00	5,9E-06	0,0E+00	-	-
Nickel	1,4E-07	9,6E-08	0,0E+00	3,1E-09	5,6E-06	6,8E-07	3,0E-05	2,1E-05	1,3E-05	5,8E-03	2,7E-05	7,0E-05	1,1E-04	1,4E-07	9,6E-08	0,0E+00	0,0E+00	3,7E-07	0,0E+00	1,7E-05	0,0E+00	-	-
Plomb	5,0E-07	3,5E-07	0,0E+00	1,0E-10	1,8E-06	6,0E-07	1,8E-05	2,6E-05	4,4E-05	9,8E-04	4,6E-06	1,4E-05	1,2E-05	5,0E-07	3,5E-07	0,0E+00	0,0E+00	3,4E-07	0,0E+00	6,2E-05	0,0E+00	-	-
Sélénium	1,6E-07	1,1E-07	0,0E+00	1,1E-08	2,1E-07	1,8E-07	1,1E-05	3,1E-06	1,4E-05	2,9E-04	1,4E-06	1,2E-03	2,4E-03	1,6E-07	1,1E-07	0,0E+00	0,0E+00	1,0E-07	0,0E+00	1,9E-05	0,0E+00	-	-
Strontium	1,8E-07	1,2E-07	0,0E+00	1,1E-06	7,1E-06	2,5E-07	5,2E-03	1,0E-04	1,8E-05	9,7E-02	4,6E-04	7,3E-03	1,5E-02	1,8E-07	1,2E-07	0,0E+00	0,0E+00	1,2E-07	0,0E+00	2,2E-05	0,0E+00	-	-
Titane	5,2E-07	3,7E-07	0,0E+00	3,2E-06	7,2E-05	1,0E-06	6,1E-04	1,1E-03	7,7E-05	5,2E-03	2,5E-05	8,6E-02	1,3E-01	5,2E-07	3,7E-07	0,0E+00	0,0E+00	3,5E-07	0,0E+00	6,5E-05	0,0E+00	-	-
Uranium	2,1E-09	1,5E-09	0,0E+00	1,2E-09	4,6E-06	3,0E-08	1,2E-06	6,8E-05	2,2E-06	1,2E-05	5,2E-08	7,5E-05	3,3E-06	2,1E-09	1,5E-09	0,0E+00	0,0E+00	1,4E-09	0,0E+00	2,6E-07	0,0E+00	-	-
Vanadium	1,7E-07	1,2E-07	0,0E+00	4,2E-09	3,1E-06	2,1E-07	3,9E-06	4,6E-05	1,6E-05	3,2E-04	1,5E-06	1,3E-04	7,4E-05	1,7E-07	1,2E-07	0,0E+00	0,0E+00	1,1E-07	0,0E+00	2,1E-05	0,0E+00	-	-
Zinc	1,8E-06	1,2E-06	0,0E+00	1,7E-07	3,6E-06	2,1E-06	3,7E-03	5,4E-05	1,5E-04	1,0E-01	5,6E-04	1,7E-01	3,5E-02	1,8E-06	1,2E-06	0,0E+00	0,0E+00	1,2E-06	0,0E+00	2,2E-04	0,0E+00	-	-

TABLEAU H-3 Doses d'exposition bruit de fond détaillées (mg/kg-pc par jour) - Scénario "Activités traditionnelles"

Voie d'exposition:	Inhalation		Cutané[a]				Ingestion							Inhalation		Cutané[a]			Ingestion		Inhalation	Ingestion	
Saison:	Été		Été	Été + hiver	Été		Été + hiver	Été		Été + hiver				Hiver		Hiver			Hiver		Été + hiver	Été	Hiver
Dose:	Air extérieur	Air intérieur	Air (int + ext)	Eau	Sol	Poussières intérieures	Eau	Sol	Poussières intérieures	Fruits	Légumes	Viande	Poisson	Air extérieur	Air intérieur	Air (int + ext)	Sol	Poussières intérieures	Sol	Poussières intérieures	Aérosols de douche	Lait maternel	Lait maternel
Groupe d'âge du récepteur: 5 - 11 ans																							
Aluminium	1,3E-05	9,1E-06	0,0E+00	1,1E-05	6,8E-04	1,9E-05	2,4E-04	2,4E-03	3,5E-04	1,9E-01	7,4E-04	2,3E-02	1,3E-01	1,3E-05	9,1E-06	0,0E+00	0,0E+00	8,8E-06	0,0E+00	3,9E-04	0,0E+00	-	-
Antimoine	5,4E-08	3,8E-08	0,0E+00	1,1E-08	2,3E-08	6,4E-08	3,9E-06	8,1E-08	1,1E-06	8,0E-05	3,2E-07	8,9E-07	9,4E-06	5,4E-08	3,8E-08	0,0E+00	0,0E+00	3,7E-08	0,0E+00	1,6E-06	0,0E+00	-	-
Argent	4,4E-09	3,1E-09	0,0E+00	1,8E-10	6,5E-08	5,7E-09	2,2E-07	2,3E-07	1,0E-07	2,6E-05	1,1E-07	5,3E-05	1,5E-06	4,4E-09	3,1E-09	0,0E+00	0,0E+00	3,0E-09	0,0E+00	1,3E-07	0,0E+00	-	-
Arsenic	9,8E-08	6,8E-08	0,0E+00	6,7E-08	3,6E-06	4,9E-07	2,0E-05	3,2E-06	2,2E-06	1,5E-04	6,0E-07	4,2E-05	6,5E-04	9,8E-08	6,8E-08	0,0E+00	0,0E+00	2,6E-07	0,0E+00	2,9E-06	0,0E+00	-	-
Baryum	3,1E-07	2,2E-07	0,0E+00	2,4E-07	4,0E-06	3,9E-07	4,5E-04	1,4E-05	6,9E-06	1,1E-01	4,3E-04	2,7E-04	9,2E-03	3,1E-07	2,2E-07	0,0E+00	0,0E+00	2,1E-07	0,0E+00	9,3E-06	0,0E+00	-	-
Béryllium	1,6E-09	1,1E-09	0,0E+00	6,2E-10	9,4E-08	2,5E-09	4,5E-07	3,3E-07	4,4E-08	1,0E-05	4,1E-08	3,7E-07	2,3E-06	1,6E-09	1,1E-09	0,0E+00	0,0E+00	1,1E-09	0,0E+00	4,8E-08	0,0E+00	-	-
Bore	1,2E-06	8,7E-07	0,0E+00	7,6E-08	6,9E-06	1,5E-06	5,5E-05	2,5E-05	2,7E-05	1,5E-02	7,6E-05	1,1E-03	9,5E-04	1,2E-06	8,7E-07	0,0E+00	0,0E+00	8,5E-07	0,0E+00	3,8E-05	0,0E+00	-	-
Cadmium	1,5E-08	1,1E-08	0,0E+00	1,0E-09	6,2E-09	1,9E-09	7,5E-07	2,2E-07	3,3E-07	6,3E-05	2,5E-07	3,8E-06	1,2E-05	1,5E-08	1,1E-08	0,0E+00	0,0E+00	1,0E-09	0,0E+00	4,6E-07	0,0E+00	-	-
Chrome	1,1E-07	7,7E-08	0,0E+00	5,0E-08	7,4E-06	1,8E-07	2,4E-05	2,6E-05	3,1E-06	2,2E-04	8,8E-07	5,4E-04	5,9E-05	1,1E-07	7,7E-08	0,0E+00	0,0E+00	7,5E-08	0,0E+00	3,3E-06	0,0E+00	-	-
Cobalt	1,6E-08	1,1E-08	0,0E+00	1,4E-08	5,3E-07	2,2E-08	1,0E-05	1,9E-06	3,9E-07	1,6E-04	4,2E-06	3,5E-05	2,7E-05	1,6E-08	1,1E-08	0,0E+00	0,0E+00	1,1E-08	0,0E+00	4,8E-07	0,0E+00	-	-
Cuivre	1,5E-06	1,0E-06	0,0E+00	1,8E-08	1,6E-06	1,7E-06	3,9E-02	5,6E-06	3,1E-05	1,0E-02	4,0E-05	1,1E-03	4,2E-04	1,5E-06	1,0E-06	0,0E+00	0,0E+00	9,9E-07	0,0E+00	4,4E-05	0,0E+00	-	-
Étain	6,6E-08	4,6E-08	0,0E+00	5,4E-08	8,1E-07	8,3E-08	3,9E-05	2,9E-06	1,5E-06	6,3E-05	1,2E-06	2,4E-03	8,9E-03	6,6E-08	4,6E-08	0,0E+00	0,0E+00	4,5E-08	0,0E+00	2,0E-06	0,0E+00	-	-
Lithium	4,9E-09	3,4E-09	0,0E+00	1,3E-07	5,2E-07	8,9E-09	9,4E-05	1,8E-06	1,6E-07	1,1E-04	1,1E-06	6,0E-04	9,7E-05	4,9E-09	3,4E-09	0,0E+00	0,0E+00	3,3E-09	0,0E+00	1,5E-07	0,0E+00	-	-
Manganèse	6,1E-07	4,3E-07	0,0E+00	1,6E-06	9,1E-06	7,8E-07	1,5E-04	3,2E-05	1,4E-05	1,3E+00	5,0E-03	3,3E-03	9,9E-04	6,1E-07	4,3E-07	0,0E+00	0,0E+00	4,1E-07	0,0E+00	1,8E-05	0,0E+00	-	-
Mercure	2,4E-07	4,2E-07	2,2E-10	1,1E-10	5,8E-09	1,2E-10	1,5E-06	2,1E-08	2,1E-09	1,1E-05	5,5E-08	1,6E-04	2,3E-03	2,4E-07	4,2E-07	2,2E-10	0,0E+00	4,4E-11	0,0E+00	2,0E-09	0,0E+00	-	-
Molybdène	4,0E-08	2,8E-08	0,0E+00	3,3E-09	3,6E-07	4,9E-08	2,4E-06	1,3E-06	8,8E-07	2,1E-04	1,1E-06	9,1E-05	5,9E-05	4,0E-08	2,8E-08	0,0E+00	0,0E+00	2,7E-08	0,0E+00	1,2E-06	0,0E+00	-	-
Nickel	1,1E-07	8,0E-08	0,0E+00	2,6E-09	4,7E-06	5,7E-07	1,9E-05	4,2E-06	2,5E-06	3,3E-03	1,3E-05	5,2E-05	8,3E-05	1,1E-07	8,0E-08	0,0E+00	0,0E+00	3,1E-07	0,0E+00	3,4E-06	0,0E+00	-	-
Plomb	4,2E-07	2,9E-07	0,0E+00	8,7E-11	1,5E-06	5,0E-07	1,2E-05	5,3E-06	8,9E-06	5,7E-04	2,3E-06	1,0E-05	9,7E-06	4,2E-07	2,9E-07	0,0E+00	0,0E+00	2,8E-07	0,0E+00	1,2E-05	0,0E+00	-	-
Sélénium	1,3E-07	9,0E-08	0,0E+00	9,6E-09	1,8E-07	1,5E-07	7,0E-06	6,3E-07	2,7E-06	1,7E-04	6,7E-07	9,2E-04	1,9E-03	1,3E-07	9,0E-08	0,0E+00	0,0E+00	8,7E-08	0,0E+00	3,9E-06	0,0E+00	-	-
Strontium	1,5E-07	1,0E-07	0,0E+00	9,3E-07	5,9E-06	2,1E-07	3,3E-03	2,1E-05	3,7E-06	5,6E-02	2,2E-04	5,4E-03	1,2E-02	1,5E-07	1,0E-07	0,0E+00	0,0E+00	1,0E-07	0,0E+00	4,4E-06	0,0E+00	-	-
Titane	4,3E-07	3,0E-07	0,0E+00	2,7E-06	6,0E-05	8,7E-07	3,9E-04	2,1E-04	1,6E-05	3,0E-03	1,2E-05	6,3E-02	1,0E-01	4,3E-07	3,0E-07	0,0E+00	0,0E+00	2,9E-07	0,0E+00	1,3E-05	0,0E+00	-	-
Uranium	1,8E-09	1,2E-09	0,0E+00	1,0E-09	3,9E-06	2,5E-08	7,5E-07	1,4E-05	4,5E-07	6,8E-06	2,5E-08	5,5E-05	2,6E-06	1,8E-09	1,2E-09	0,0E+00	0,0E+00	1,2E-09	0,0E+00	5,3E-08	0,0E+00	-	-
Vanadium	1,4E-07	9,6E-08	0,0E+00	3,5E-09	2,6E-06	1,8E-07	2,5E-06	9,4E-06	3,2E-06	1,9E-04	7,4E-07	9,2E-05	5,9E-05	1,4E-07	9,6E-08	0,0E+00	0,0E+00	9,3E-08	0,0E+00	4,1E-06	0,0E+00	-	-
Zinc	1,5E-06	1,0E-06	0,0E+00	1,4E-07	3,0E-06	1,7E-06	2,4E-03	1,1E-05	3,1E-05	6,0E-02	2,7E-04	1,3E-01	2,8E-02	1,5E-06	1,0E-06	0,0E+00	0,0E+00	9,9E-07	0,0E+00	4,4E-05	0,0E+00	-	-
Groupe d'âge du récepteur: 12 - 19 ans																							
Aluminium	1,0E-05	7,1E-06	0,0E+00	8,6E-06	1,9E-04	1,6E-05	1,5E-04	6,9E-04	9,9E-05	1,1E-01	3,7E-04	1,6E-02	7,4E-02	1,0E-05	7,1E-06	0,0E+00	0,0E+00	7,2E-06	0,0E+00	1,1E-04	0,0E+00	-	-
Antimoine	4,2E-08	2,9E-08	0,0E+00	8,9E-09	6,5E-09	5,2E-08	2,5E-06	2,3E-08	3,3E-07	4,5E-05	1,6E-07	6,3E-07	5,4E-06	4,2E-08	2,9E-08	0,0E+00	0,0E+00	3,0E-08	0,0E+00	4,6E-07	0,0E+00	-	-
Argent	3,4E-09	2,4E-09	0,0E+00	1,5E-10	1,9E-08	4,6E-09	1,4E-07	6,6E-08	2,9E-08	1,5E-05	5,3E-08	3,7E-05	8,8E-07	3,4E-09	2,4E-09	0,0E+00	0,0E+00	2,5E-09	0,0E+00	3,8E-08	0,0E+00	-	-
Arsenic	7,6E-08	5,3E-08	0,0E+00	5,5E-08	1,0E-06	4,0E-07	1,3E-05	9,1E-07	6,2E-07	8,5E-05	3,0E-07	3,0E-05	3,7E-04	7,6E-08	5,3E-08	0,0E+00	0,0E+00	2,2E-07	0,0E+00	8,4E-07	0,0E+00	-	-
Baryum	2,4E-07	1,7E-07	0,0E+00	2,0E-07	1,1E-06	3,2E-07	2,8E-04	4,1E-06	2,0E-06	6,1E-02	2,1E-04	1,9E-04	5,3E-03	2,4E-07	1,7E-07	0,0E+00	0,0E+00	1,7E-07	0,0E+00	2,7E-06	0,0E+00	-	-
Béryllium	1,3E-09	8,8E-10	0,0E+00	5,1E-10	2,7E-08	2,0E-09	2,9E-07	9,5E-08	1,3E-08	5,8E-06	2,0E-08	2,6E-07	1,4E-06	1,3E-09	8,8E-10	0,0E+00	0,0E+00	8,9E-10	0,0E+00	1,4E-08	0,0E+00	-	-
Bore	9,7E-07	6,8E-07	0,0E+00	6,2E-08	2,0E-06	1,2E-06	3,5E-05	7,0E-06	7,7E-06	8,7E-03	3,8E-05	7,7E-04	5,5E-04	9,7E-07	6,8E-07	0,0E+00	0,0E+00	6,9E-07	0,0E+00	1,1E-05	0,0E+00	-	-
Cadmium	1,2E-08	8,4E-09	0,0E+00	8,4E-10	1,8E-09	1,5E-09	4,8E-07	6,3E-08	9,5E-08	3,6E-05	1,3E-07	2,7E-06	7,1E-06	1,2E-08	8,4E-09	0,0E+00	0,0E+00	8,5E-10	0,0E+00	1,3E-07	0,0E+00	-	-
Chrome	8,6E-08	6,0E-08	0,0E+00	4,1E-08	2,1E-06	1,4E-07	1,5E-05	7,5E-06	8,9E-07	1,3E-04	4,4E-07	3,8E-04	3,4E-05	8,6E-08	6,0E-08	0,0E+00	0,0E+00	6,1E-08	0,0E+00	9,5E-07	0,0E+00	-	-
Cobalt	1,2E-08	8,6E-09	0,0E+00	1,2E-08	1,5E-07	1,8E-08	6,6E-06	5,4E-07	1,1E-07	9,2E-05	2,1E-06	2,4E-05	1,5E-05	1,2E-08	8,6E-09	0,0E+00	0,0E+00	8,8E-09	0,0E+00	1,4E-07	0,0E+00	-	-
Cuivre	1,1E-06	7,9E-07	0,0E+00	1,5E-08	4,5E-07	1,4E-06	2,5E-02	1,6E-06	8,9E-06	5,6E-03	2,0E-05	7,8E-04	2,4E-04	1,1E-06	7,9E-07	0,0E+00	0,0E+00	8,1E-07	0,0E+00	1,3E-05	0,0E+00	-	-
Étain	5,1E-08	3,6E-08	0,0E+00	4,4E-08	2,3E-07	6,8E-08	2,5E-05	8,2E-07	4,2E-07	3,6E-05	6,2E-07	1,7E-03	5,1E-03	5,1E-08	3,6E-08	0,0E+00	0,0E+00	3,6E-08	0,0E+00	5,7E-07	0,0E+00	-	-
Lithium	3,8E-09	2,7E-09	0,0E+00	1,1E-07	1,5E-07	7,3E-09	6,0E-05	5,3E-07	4,5E-08	6,1E-05	5,3E-07	4,3E-04	5,6E-05	3,8E-09	2,7E-09	0,0E+00	0,0E+00	2,7E-09	0,0E+00	4,2E-08	0,0E+00	-	-
Manganèse	4,8E-07	3,3E-07	0,0E+00	1,3E-06	2,6E-06	6,4E-07	9,5E-05	9,2E-06	4,0E-06	7,1E-01	2,5E-03	2,3E-03	5,7E-04	4,8E-07	3,3E-07	0,0E+00	0,0E+00	3,4E-07	0,0E+00	5,3E-06	0,0E+00	-	-
Mercure	1,8E-07	3,3E-07	3,4E-10	9,1E-11	1,7E-09	9,8E-11	9,8E-07	5,9E-09	6,1E-10	6,0E-06	2,7E-08	1,1E-04	1,3E-03	1,8E-07	3,3E-07	3,4E-10	0,0E+00	3,6E-11	0,0E+00	5,6E-10	0,0E+00	-	-
Molybdène	3,1E-08	2,2E-08	0,0E+00	2,7E-09	1,0E-07	4,0E-08	1,6E-06	3,7E-07	2,5E-07	1,2E-04	5,4E-07	6,4E-05	3,4E-05	3,1E-08	2,2E-08	0,0E+00	0,0E+00	2,2E-08	0,0E+00	3,4E-07	0,0E+00	-	-
Nickel	8,9E-08	6,2E-08	0,0E+00	2,1E-09	1,3E-06	4,6E-07	1,2E-05	1,2E-06	7,2E-07	1,9E-03	6,6E-06	3,6E-05	4,8E-05	8,9E-08	6,2E-08	0,0E+00	0,0E+00	2,5E-07	0,0E+00	9,8E-07	0,0E+00	-	-
Plomb	3,2E-07	2,3E-07	0,0E+00	7,1E-11	4,2E-07	4,1E-07	7,5E-06	1,5E-06	2,5E-06	3,2E-04	1,1E-06	7,1E-06	5,6E-06	3,2E-07	2,3E-07	0,0E+00	0,0E+00	2,3E-07	0,0E+00	3,6E-06	0,0E+00	-	-
Sélénium	1,0E-07	7,0E-08	0,0E+00	7,9E-09	5,1E-08	1,3E-07	4,5E-06	1,8E-07	7,8E-07	9,5E-05	3,4E-07	6,4E-04	1,1E-03	1,0E-07	7,0E-08	0,0E+00	0,0E+00	7,1E-08	0,0E+00	1,1E-06	0,0E+00	-	-
Strontium	1,1E-07	8,0E-08	0,0E+00	7,6E-07	1,7E-06	1,7E-07	2,1E-03	6,0E-06	1,1E-06	3,2E-02	1,1E-04	3,8E-03	6,7E-03	1,1E-07	8,0E-08	0,0E+00	0,0E+00	8,1E-08	0,0E+00	1,3E-06	0,0E+00	-	-
Titane	3,4E-07	2,4E-07	0,0E+00	2,2E-06	1,7E-05	7,1E-07	2,5E-04	6,1E-05	4,4E-06	1,7E-03	6,0E-06	4,5E-02	6,0E-02	3,4E-07	2,4E-07	0,0E+00	0,0E+00	2,4E-07	0,0E+00	3,7E-06	0,0E+00	-	-
Uranium	1,4E-09	9,6E-10	0,0E+00	8,4E-10	1,1E-06	2,1E-08	4,8E-07	4,0E-06	1,3E-07	3,8E-06	1,3E-08	3,9E-05	1,5E-06	1,4E-09	9,6E-10	0,0E+00	0,0E+00	9,8E-10	0,0E+00	1,5E-08	0,0E+00	-	-
Vanadium	1,1E-07	7,5E-08	0,0E+00	2,8E-09	7,5E-07	1,5E-07	1,6E-06	2,7E-06	9,1E-07	1,1E-04	3,7E-07	6,5E-05	3,4E-05	1,1E-07	7,5E-08	0,0E+00	0,0E+00	7,6E-08	0,0E+00	1,2E-06	0,0E+00	-	-
Zinc	1,1E-06	7,9E-07	0,0E+00	1,1E-07	8,7E-07	1,4E-06	1,5E-03	3,1E-06	8,9E-06	3,4E-02	1,4E-04	8,8E-02	1,6E-02	1,1E-06	7,9E-07	0,0E+00	0,0E+00	8,1E-07	0,0E+00	1,3E-05	0,0E+00	-	-

TABLEAU H-3 Doses d'exposition bruit de fond détaillées (mg/kg-pc par jour) - Scénario "Activités traditionnelles"

Voie d'exposition:	Inhalation		Cutané[a]				Ingestion							Inhalation		Cutané[a]			Ingestion		Inhalation	Ingestion	
Saison:	Été		Été	Été + hiver	Été		Été + hiver	Été		Été + hiver				Hiver		Hiver			Hiver		Été + hiver	Été	Hiver
Dose:	Air extérieur	Air intérieur	Air (int + ext)	Eau	Sol	Poussières intérieures	Eau	Sol	Poussières intérieures	Fruits	Légumes	Viande	Poisson	Air extérieur	Air intérieur	Air (int + ext)	Sol	Poussières intérieures	Sol	Poussières intérieures	Aérosols de douche	Lait maternel	Lait maternel
Groupe d'âge du récepteur: 20 ans +																							
Aluminium	7,6E-06	5,3E-06	0,0E+00	8,1E-06	1,8E-04	1,5E-05	1,5E-04	5,6E-04	8,1E-05	5,8E-02	3,0E-04	2,0E-02	6,4E-02	7,6E-06	5,3E-06	0,0E+00	0,0E+00	6,8E-06	0,0E+00	9,1E-05	0,0E+00	-	-
Antimoine	3,1E-08	2,2E-08	0,0E+00	8,3E-09	6,1E-09	4,9E-08	2,6E-06	1,9E-08	2,6E-07	2,5E-05	1,3E-07	7,7E-07	4,7E-06	3,1E-08	2,2E-08	0,0E+00	0,0E+00	2,8E-08	0,0E+00	3,8E-07	0,0E+00	-	-
Argent	2,6E-09	1,8E-09	0,0E+00	1,4E-10	1,7E-08	4,3E-09	1,4E-07	5,4E-08	2,3E-08	8,2E-06	4,3E-08	4,6E-05	7,7E-07	2,6E-09	1,8E-09	0,0E+00	0,0E+00	2,3E-09	0,0E+00	3,1E-08	0,0E+00	-	-
Arsenic	5,7E-08	4,0E-08	0,0E+00	5,2E-08	9,6E-07	3,7E-07	1,3E-05	7,4E-07	5,0E-07	4,6E-05	2,4E-07	3,7E-05	3,3E-04	5,7E-08	4,0E-08	0,0E+00	0,0E+00	2,0E-07	0,0E+00	6,8E-07	0,0E+00	-	-
Baryum	1,8E-07	1,3E-07	0,0E+00	1,8E-07	1,1E-06	3,0E-07	2,9E-04	3,3E-06	1,6E-06	3,3E-02	1,7E-04	2,4E-04	4,6E-03	1,8E-07	1,3E-07	0,0E+00	0,0E+00	1,6E-07	0,0E+00	2,2E-06	0,0E+00	-	-
Béryllium	9,4E-10	6,6E-10	0,0E+00	4,8E-10	2,5E-08	1,9E-09	2,9E-07	7,8E-08	1,0E-08	3,2E-06	1,7E-08	3,2E-07	1,2E-06	9,4E-10	6,6E-10	0,0E+00	0,0E+00	8,4E-10	0,0E+00	1,1E-08	0,0E+00	-	-
Bore	7,3E-07	5,1E-07	0,0E+00	5,8E-08	1,9E-06	1,2E-06	3,6E-05	5,7E-06	6,3E-06	4,8E-03	3,1E-05	9,5E-04	4,8E-04	7,3E-07	5,1E-07	0,0E+00	0,0E+00	6,5E-07	0,0E+00	8,7E-06	0,0E+00	-	-
Cadmium	9,0E-09	6,3E-09	0,0E+00	7,9E-10	1,7E-09	1,4E-09	4,8E-07	5,1E-08	7,7E-08	2,0E-05	1,0E-07	3,3E-06	6,1E-06	9,0E-09	6,3E-09	0,0E+00	0,0E+00	8,0E-10	0,0E+00	1,1E-07	0,0E+00	-	-
Chrome	6,4E-08	4,5E-08	0,0E+00	3,8E-08	2,0E-06	1,3E-07	1,5E-05	6,1E-06	7,2E-07	6,9E-05	3,6E-07	4,7E-04	3,0E-05	6,4E-08	4,5E-08	0,0E+00	0,0E+00	5,7E-08	0,0E+00	7,7E-07	0,0E+00	-	-
Cobalt	9,2E-09	6,5E-09	0,0E+00	1,1E-08	1,4E-07	1,7E-08	6,7E-06	4,4E-07	9,1E-08	5,1E-05	1,7E-06	3,0E-05	1,3E-05	9,2E-09	6,5E-09	0,0E+00	0,0E+00	8,2E-09	0,0E+00	1,1E-07	0,0E+00	-	-
Cuivre	8,5E-07	6,0E-07	0,0E+00	1,4E-08	4,2E-07	1,3E-06	2,5E-02	1,3E-06	7,2E-06	3,1E-03	1,6E-05	9,6E-04	2,1E-04	8,5E-07	6,0E-07	0,0E+00	0,0E+00	7,6E-07	0,0E+00	1,0E-05	0,0E+00	-	-
Étain	3,8E-08	2,7E-08	0,0E+00	4,1E-08	2,2E-07	6,4E-08	2,6E-05	6,7E-07	3,4E-07	1,9E-05	5,0E-07	2,1E-03	4,5E-03	3,8E-08	2,7E-08	0,0E+00	0,0E+00	3,4E-08	0,0E+00	4,6E-07	0,0E+00	-	-
Lithium	2,8E-09	2,0E-09	0,0E+00	9,9E-08	1,4E-07	6,8E-09	6,1E-05	4,3E-07	3,7E-08	3,3E-05	4,3E-07	5,3E-04	4,9E-05	2,8E-09	2,0E-09	0,0E+00	0,0E+00	2,5E-09	0,0E+00	3,4E-08	0,0E+00	-	-
Manganèse	3,6E-07	2,5E-07	0,0E+00	1,2E-06	2,4E-06	6,0E-07	9,7E-05	7,5E-06	3,2E-06	3,9E-01	2,0E-03	2,8E-03	5,0E-04	3,6E-07	2,5E-07	0,0E+00	0,0E+00	3,2E-07	0,0E+00	4,3E-06	0,0E+00	-	-
Mercure	1,4E-07	2,4E-07	3,9E-10	8,5E-11	1,6E-09	9,2E-11	9,9E-07	4,8E-09	4,9E-10	3,3E-06	2,2E-08	1,4E-04	1,1E-03	1,4E-07	2,4E-07	3,9E-10	0,0E+00	3,4E-11	0,0E+00	4,5E-10	0,0E+00	-	-
Molybdène	2,3E-08	1,6E-08	0,0E+00	2,6E-09	9,7E-08	3,8E-08	1,6E-06	3,0E-07	2,0E-07	6,5E-05	4,4E-07	7,9E-05	2,9E-05	2,3E-08	1,6E-08	0,0E+00	0,0E+00	2,1E-08	0,0E+00	2,8E-07	0,0E+00	-	-
Nickel	6,6E-08	4,7E-08	0,0E+00	2,0E-09	1,3E-06	4,4E-07	1,2E-05	9,7E-07	5,9E-07	1,0E-03	5,4E-06	4,5E-05	4,2E-05	6,6E-08	4,7E-08	0,0E+00	0,0E+00	2,4E-07	0,0E+00	8,0E-07	0,0E+00	-	-
Plomb	2,4E-07	1,7E-07	0,0E+00	6,7E-11	4,0E-07	3,8E-07	7,7E-06	1,2E-06	2,1E-06	1,8E-04	9,2E-07	8,7E-06	4,9E-06	2,4E-07	1,7E-07	0,0E+00	0,0E+00	2,2E-07	0,0E+00	2,9E-06	0,0E+00	-	-
Sélénium	7,5E-08	5,3E-08	0,0E+00	7,4E-09	4,8E-08	1,2E-07	4,5E-06	1,5E-07	6,4E-07	5,2E-05	2,7E-07	8,0E-04	9,6E-04	7,5E-08	5,3E-08	0,0E+00	0,0E+00	6,7E-08	0,0E+00	9,0E-07	0,0E+00	-	-
Strontium	8,6E-08	6,0E-08	0,0E+00	7,2E-07	1,6E-06	1,6E-07	2,2E-03	4,9E-06	8,7E-07	1,7E-02	9,1E-05	4,6E-03	5,8E-03	8,6E-08	6,0E-08	0,0E+00	0,0E+00	7,6E-08	0,0E+00	1,0E-06	0,0E+00	-	-
Titane	2,5E-07	1,8E-07	0,0E+00	2,1E-06	1,6E-05	6,7E-07	2,6E-04	5,0E-05	3,6E-06	9,3E-04	4,9E-06	5,5E-02	5,2E-02	2,5E-07	1,8E-07	0,0E+00	0,0E+00	2,3E-07	0,0E+00	3,0E-06	0,0E+00	-	-
Uranium	1,0E-09	7,2E-10	0,0E+00	7,9E-10	1,0E-06	1,9E-08	4,8E-07	3,2E-06	1,0E-07	2,1E-06	1,0E-08	4,8E-05	1,3E-06	1,0E-09	7,2E-10	0,0E+00	0,0E+00	9,2E-10	0,0E+00	1,2E-08	0,0E+00	-	-
Vanadium	8,0E-08	5,6E-08	0,0E+00	2,7E-09	7,1E-07	1,4E-07	1,6E-06	2,2E-06	7,4E-07	5,7E-05	3,0E-07	8,0E-05	2,9E-05	8,0E-08	5,6E-08	0,0E+00	0,0E+00	7,1E-08	0,0E+00	9,6E-07	0,0E+00	-	-
Zinc	8,5E-07	6,0E-07	0,0E+00	1,1E-07	8,2E-07	1,3E-06	1,6E-03	2,5E-06	7,2E-06	1,8E-02	1,1E-04	1,1E-01	1,4E-02	8,5E-07	6,0E-07	0,0E+00	0,0E+00	7,6E-07	0,0E+00	1,0E-05	0,0E+00	-	-

a: Les valeurs fournies correspondent aux doses absorbées par voie cutanée.

TABLEAU H-4 Doses d'exposition additionnelles détaillées (mg/kg-pc par jour) - Scénario "Activités traditionnelles"

Voie d'exposition:	Inhalation		Cutané[a]				Ingestion							Inhalation		Cutané[a]			Ingestion		Inhalation	Ingestion	
Saison:	Été		Été	Été + hiver	Été		Été + hiver	Été		Été + hiver				Hiver		Hiver			Hiver		Été + hiver	Été	Hiver
Dose:	Air extérieur	Air intérieur	Air (int + ext)	Eau	Sol	Poussières intérieures	Eau	Sol	Poussières intérieures	Fruits	Légumes	Viande	Poisson	Air extérieur	Air intérieur	Air (int + ext)	Sol	Poussières intérieures	Sol	Poussières intérieures	Aérosols de douche	Lait maternel	Lait maternel
Récepteurs:	0-6 mois																						
Aluminium	4,6E-05	3,2E-05	0,0E+00	3,2E-07	0,0E+00	6,5E-05	0,0E+00	0,0E+00	1,9E-03	4,4E-04	1,1E-04	0,0E+00	0,0E+00	4,6E-05	3,2E-05	0,0E+00	0,0E+00	3,7E-05	0,0E+00	2,7E-03	0,0E+00	3,3E-06	3,2E-06
Antimoine	2,9E-10	2,0E-10	0,0E+00	2,1E-12	0,0E+00	4,1E-10	0,0E+00	0,0E+00	1,2E-08	2,6E-09	7,1E-10	0,0E+00	0,0E+00	2,9E-10	2,0E-10	0,0E+00	0,0E+00	2,4E-10	0,0E+00	1,7E-08	0,0E+00	6,5E-12	6,6E-12
Argent	3,8E-10	2,7E-10	0,0E+00	1,6E-12	0,0E+00	5,4E-10	0,0E+00	0,0E+00	1,6E-08	5,6E-09	9,2E-10	0,0E+00	0,0E+00	3,8E-10	2,7E-10	0,0E+00	0,0E+00	3,1E-10	0,0E+00	2,2E-08	0,0E+00	6,2E-09	5,8E-09
Arsenic	9,2E-09	6,5E-09	0,0E+00	5,9E-11	0,0E+00	5,2E-08	0,0E+00	0,0E+00	3,8E-07	8,1E-08	2,2E-08	0,0E+00	0,0E+00	9,2E-09	6,5E-09	0,0E+00	0,0E+00	3,0E-08	0,0E+00	5,4E-07	0,0E+00	2,5E-10	2,5E-10
Baryum	4,5E-07	3,1E-07	0,0E+00	3,0E-09	0,0E+00	6,3E-07	0,0E+00	0,0E+00	1,8E-05	2,6E-06	1,1E-06	0,0E+00	0,0E+00	4,5E-07	3,1E-07	0,0E+00	0,0E+00	3,6E-07	0,0E+00	2,6E-05	0,0E+00	1,7E-07	1,6E-07
Béryllium	2,0E-09	1,4E-09	0,0E+00	2,9E-11	0,0E+00	2,9E-09	0,0E+00	0,0E+00	8,3E-08	1,8E-08	4,9E-09	0,0E+00	0,0E+00	2,0E-09	1,4E-09	0,0E+00	0,0E+00	1,6E-09	0,0E+00	1,2E-07	0,0E+00	4,5E-12	3,0E-12
Bore	3,6E-08	2,5E-08	0,0E+00	1,9E-10	0,0E+00	5,1E-08	0,0E+00	0,0E+00	1,5E-06	1,1E-06	8,7E-08	0,0E+00	0,0E+00	3,6E-08	2,5E-08	0,0E+00	0,0E+00	2,9E-08	0,0E+00	2,1E-06	0,0E+00	1,9E-08	1,9E-08
Cadmium	2,8E-10	1,9E-10	0,0E+00	1,9E-12	0,0E+00	3,9E-11	0,0E+00	0,0E+00	1,1E-08	4,4E-09	6,7E-10	0,0E+00	0,0E+00	2,8E-10	1,9E-10	0,0E+00	0,0E+00	2,2E-11	0,0E+00	1,6E-08	0,0E+00	1,1E-10	1,1E-10
Chrome	5,8E-08	4,0E-08	0,0E+00	4,0E-10	0,0E+00	8,1E-08	0,0E+00	0,0E+00	2,4E-06	2,0E-06	1,4E-07	0,0E+00	0,0E+00	5,8E-08	4,0E-08	0,0E+00	0,0E+00	4,7E-08	0,0E+00	3,4E-06	0,0E+00	1,1E-07	8,8E-08
Cobalt	3,4E-08	2,4E-08	0,0E+00	2,3E-10	0,0E+00	4,8E-08	0,0E+00	0,0E+00	1,4E-06	7,0E-07	8,2E-08	0,0E+00	0,0E+00	3,4E-08	2,4E-08	0,0E+00	0,0E+00	2,7E-08	0,0E+00	2,0E-06	0,0E+00	1,4E-08	1,5E-08
Cuivre	2,3E-08	1,6E-08	0,0E+00	1,6E-10	0,0E+00	3,3E-08	0,0E+00	0,0E+00	9,6E-07	8,6E-07	5,7E-08	0,0E+00	0,0E+00	2,3E-08	1,6E-08	0,0E+00	0,0E+00	1,9E-08	0,0E+00	1,4E-06	0,0E+00	5,4E-08	5,5E-08
Étain	3,0E-09	2,1E-09	0,0E+00	2,5E-11	0,0E+00	4,2E-09	0,0E+00	0,0E+00	1,2E-07	3,5E-08	7,1E-09	0,0E+00	0,0E+00	3,0E-09	2,1E-09	0,0E+00	0,0E+00	2,4E-09	0,0E+00	1,7E-07	0,0E+00	1,8E-08	1,8E-08
Lithium	1,5E-07	1,1E-07	0,0E+00	1,5E-09	0,0E+00	2,1E-07	0,0E+00	0,0E+00	6,2E-06	1,4E-06	3,7E-07	0,0E+00	0,0E+00	1,5E-07	1,1E-07	0,0E+00	0,0E+00	1,2E-07	0,0E+00	8,9E-06	0,0E+00	3,3E-06	3,3E-06
Manganèse	1,1E-06	7,6E-07	0,0E+00	7,4E-09	0,0E+00	1,5E-06	0,0E+00	0,0E+00	4,5E-05	1,3E-05	2,6E-06	0,0E+00	0,0E+00	1,1E-06	7,6E-07	0,0E+00	0,0E+00	8,8E-07	0,0E+00	6,4E-05	0,0E+00	5,9E-08	5,6E-08
Mercure	1,5E-11	1,5E-11	4,0E-15	1,0E-13	0,0E+00	3,7E-15	0,0E+00	0,0E+00	1,1E-13	3,3E-10	6,7E-11	0,0E+00	0,0E+00	1,5E-11	1,5E-11	4,0E-15	0,0E+00	1,9E-15	0,0E+00	1,4E-13	0,0E+00	3,9E-09	3,9E-09
Molybdène	1,4E-09	9,5E-10	0,0E+00	1,1E-11	0,0E+00	1,9E-09	0,0E+00	0,0E+00	5,6E-08	1,9E-08	3,3E-09	0,0E+00	0,0E+00	1,4E-09	9,5E-10	0,0E+00	0,0E+00	1,1E-09	0,0E+00	8,0E-08	0,0E+00	1,8E-09	1,8E-09
Nickel	3,3E-08	2,3E-08	0,0E+00	2,2E-11	0,0E+00	1,9E-07	0,0E+00	0,0E+00	1,4E-06	2,0E-06	8,1E-08	0,0E+00	0,0E+00	3,3E-08	2,3E-08	0,0E+00	0,0E+00	1,1E-07	0,0E+00	2,0E-06	0,0E+00	6,1E-07	4,7E-07
Plomb	7,2E-09	5,0E-09	0,0E+00	1,9E-13	0,0E+00	1,0E-08	0,0E+00	0,0E+00	2,9E-07	8,4E-08	1,7E-08	0,0E+00	0,0E+00	7,2E-09	5,0E-09	0,0E+00	0,0E+00	5,8E-09	0,0E+00	4,2E-07	0,0E+00	2,7E-10	3,0E-10
Sélénium	4,4E-10	3,0E-10	0,0E+00	5,0E-12	0,0E+00	6,2E-10	0,0E+00	0,0E+00	1,8E-08	2,6E-08	1,1E-09	0,0E+00	0,0E+00	4,4E-10	3,0E-10	0,0E+00	0,0E+00	3,5E-10	0,0E+00	2,6E-08	0,0E+00	4,4E-08	4,4E-08
Strontium	2,5E-07	1,7E-07	0,0E+00	1,7E-09	0,0E+00	3,5E-07	0,0E+00	0,0E+00	1,0E-05	1,5E-06	6,0E-07	0,0E+00	0,0E+00	2,5E-07	1,7E-07	0,0E+00	0,0E+00	2,0E-07	0,0E+00	1,4E-05	0,0E+00	2,0E-07	2,1E-07
Titane	1,0E-05	7,1E-06	0,0E+00	6,9E-08	0,0E+00	1,4E-05	0,0E+00	0,0E+00	4,2E-04	3,3E-04	2,5E-05	0,0E+00	0,0E+00	1,0E-05	7,1E-06	0,0E+00	0,0E+00	8,2E-06	0,0E+00	6,0E-04	0,0E+00	3,1E-04	3,0E-04
Uranium	3,8E-10	2,7E-10	0,0E+00	3,3E-12	0,0E+00	5,4E-10	0,0E+00	0,0E+00	1,6E-08	1,1E-08	9,2E-10	0,0E+00	0,0E+00	3,8E-10	2,7E-10	0,0E+00	0,0E+00	3,1E-10	0,0E+00	2,2E-08	0,0E+00	5,9E-11	5,9E-11
Vanadium	2,3E-07	1,6E-07	0,0E+00	1,6E-09	0,0E+00	3,3E-07	0,0E+00	0,0E+00	9,6E-06	7,5E-06	5,7E-07	0,0E+00	0,0E+00	2,3E-07	1,6E-07	0,0E+00	0,0E+00	1,9E-07	0,0E+00	1,4E-05	0,0E+00	3,5E-09	3,2E-09
Zinc	1,1E-07	8,0E-08	0,0E+00	4,8E-10	0,0E+00	1,6E-07	0,0E+00	0,0E+00	4,7E-06	4,0E-06	2,8E-07	0,0E+00	0,0E+00	1,1E-07	8,0E-08	0,0E+00	0,0E+00	9,3E-08	0,0E+00	6,7E-06	0,0E+00	1,3E-05	1,3E-05
Recepteurs:	0,5 à 4 ans																						
Aluminium	4,2E-05	2,9E-05	0,0E+00	2,4E-07	0,0E+00	4,9E-05	0,0E+00	0,0E+00	3,6E-03	2,0E-03	5,0E-05	2,2E-04	2,8E-03	4,2E-05	2,9E-05	0,0E+00	0,0E+00	2,8E-05	0,0E+00	5,1E-03	0,0E+00	-	-
Antimoine	2,7E-10	1,9E-10	0,0E+00	1,5E-12	0,0E+00	3,1E-10	0,0E+00	0,0E+00	2,3E-08	1,2E-08	3,2E-10	9,2E-10	9,0E-09	2,7E-10	1,9E-10	0,0E+00	0,0E+00	1,8E-10	0,0E+00	3,3E-08	0,0E+00	-	-
Argent	3,4E-10	2,4E-10	0,0E+00	1,2E-12	0,0E+00	4,0E-10	0,0E+00	0,0E+00	3,0E-08	2,5E-08	4,1E-10	2,4E-08	1,0E-08	3,4E-10	2,4E-10	0,0E+00	0,0E+00	2,3E-10	0,0E+00	4,3E-08	0,0E+00	-	-
Arsenic	8,4E-09	5,9E-09	0,0E+00	4,5E-11	0,0E+00	3,9E-08	0,0E+00	0,0E+00	7,2E-07	3,7E-07	1,0E-08	5,8E-08	3,9E-07	8,4E-09	5,9E-09	0,0E+00	0,0E+00	2,2E-08	0,0E+00	1,0E-06	0,0E+00	-	-
Baryum	4,1E-07	2,8E-07	0,0E+00	2,3E-09	0,0E+00	4,8E-07	0,0E+00	0,0E+00	3,5E-05	1,2E-05	4,9E-07	5,0E-07	8,3E-05	4,1E-07	2,8E-07	0,0E+00	0,0E+00	2,7E-07	0,0E+00	5,0E-05	0,0E+00	-	-
Béryllium	1,8E-09	1,3E-09	0,0E+00	2,2E-11	0,0E+00	2,2E-09	0,0E+00	0,0E+00	1,6E-07	8,2E-08	2,2E-09	1,9E-09	7,8E-08	1,8E-09	1,3E-09	0,0E+00	0,0E+00	1,2E-09	0,0E+00	2,3E-07	0,0E+00	-	-
Bore	3,3E-08	2,3E-08	0,0E+00	1,4E-10	0,0E+00	3,8E-08	0,0E+00	0,0E+00	2,8E-06	4,8E-06	3,9E-08	9,1E-08	1,6E-06	3,3E-08	2,3E-08	0,0E+00	0,0E+00	2,2E-08	0,0E+00	4,1E-06	0,0E+00	-	-
Cadmium	2,5E-10	1,8E-10	0,0E+00	1,5E-12	0,0E+00	3,0E-11	0,0E+00	0,0E+00	2,2E-08	2,0E-08	3,0E-10	3,1E-09	1,7E-08	2,5E-10	1,8E-10	0,0E+00	0,0E+00	1,7E-11	0,0E+00	3,1E-08	0,0E+00	-	-
Chrome	5,2E-08	3,7E-08	0,0E+00	3,0E-10	0,0E+00	6,1E-08	0,0E+00	0,0E+00	4,5E-06	9,3E-06	6,3E-08	3,2E-06	3,5E-07	5,2E-08	3,7E-08	0,0E+00	0,0E+00	3,5E-08	0,0E+00	6,4E-06	0,0E+00	-	-
Cobalt	3,1E-08	2,2E-08	0,0E+00	1,7E-10	0,0E+00	3,6E-08	0,0E+00	0,0E+00	2,7E-06	3,2E-06	3,7E-08	2,1E-07	3,0E-07	3,1E-08	2,2E-08	0,0E+00	0,0E+00	2,1E-08	0,0E+00	3,8E-06	0,0E+00	-	-
Cuivre	2,1E-08	1,5E-08	0,0E+00	1,2E-10	0,0E+00	2,5E-08	0,0E+00	0,0E+00	1,8E-06	3,9E-06	2,6E-08	2,7E-06	2,4E-06	2,1E-08	1,5E-08	0,0E+00	0,0E+00	1,4E-08	0,0E+00	2,6E-06	0,0E+00	-	-
Étain	2,7E-09	1,9E-09	0,0E+00	1,9E-11	0,0E+00	3,1E-09	0,0E+00	0,0E+00	2,3E-07	1,6E-07	3,2E-09	1,4E-06	3,3E-06	2,7E-09	1,9E-09	0,0E+00	0,0E+00	1,8E-09	0,0E+00	3,3E-07	0,0E+00	-	-
Lithium	1,4E-07	9,6E-08	0,0E+00	1,2E-09	0,0E+00	1,6E-07	0,0E+00	0,0E+00	1,2E-05	6,5E-06	1,7E-07	2,9E-05	5,4E-07	1,4E-07	9,6E-08	0,0E+00	0,0E+00	9,2E-08	0,0E+00	1,7E-05	0,0E+00	-	-
Manganèse	9,9E-07	6,9E-07	0,0E+00	5,6E-09	0,0E+00	1,2E-06	0,0E+00	0,0E+00	8,5E-05	5,8E-05	1,2E-06	4,9E-06	3,2E-06	9,9E-07	6,9E-07	0,0E+00	0,0E+00	6,6E-07	0,0E+00	1,2E-04	0,0E+00	-	-
Mercure	1,4E-11	1,4E-11	6,2E-15	7,8E-14	0,0E+00	2,8E-15	0,0E+00	0,0E+00	2,0E-13	1,5E-09	3,0E-11	5,3E-07	1,6E-06	1,4E-11	1,4E-11	6,2E-15	0,0E+00	1,4E-15	0,0E+00	2,7E-13	0,0E+00	-	-
Molybdène	1,2E-09	8,6E-10	0,0E+00	7,9E-12	0,0E+00	1,4E-09	0,0E+00	0,0E+00	1,1E-07	8,7E-08	1,5E-09	1,2E-07	9,2E-08	1,2E-09	8,6E-10	0,0E+00	0,0E+00	8,3E-10	0,0E+00	1,5E-07	0,0E+00	-	-
Nickel	3,0E-08	2,1E-08	0,0E+00	1,7E-11	0,0E+00	1,4E-07	0,0E+00	0,0E+00	2,6E-06	8,9E-06	3,6E-08	1,0E-07	4,8E-07	3,0E-08	2,1E-08	0,0E+00	0,0E+00	8,1E-08	0,0E+00	3,7E-06	0,0E+00	-	-
Plomb	6,5E-09	4,5E-09	0,0E+00	1,4E-13	0,0E+00	7,6E-09	0,0E+00	0,0E+00	5,6E-07	3,8E-07	7,8E-09	2,8E-08	1,6E-08	6,5E-09	4,5E-09	0,0E+00	0,0E+00	4,4E-09	0,0E+00	8,0E-07	0,0E+00	-	-
Sélénium	4,0E-10	2,8E-10	0,0E+00	3,7E-12	0,0E+00	4,6E-10	0,0E+00	0,0E+00	3,4E-08	1,2E-07	4,8E-10	4,0E-07	6,5E-07	4,0E-10	2,8E-10	0,0E+00	0,0E+00	2,6E-10	0,0E+00	4,9E-08	0,0E+00	-	-
Strontium	2,2E-07	1,6E-07	0,0E+00	1,3E-09	0,0E+00	2,6E-07	0,0E+00	0,0E+00	1,9E-05	6,6E-06	2,7E-07	6,2E-06	1,5E-05	2,2E-07	1,6E-07	0,0E+00	0,0E+00	1,5E-07	0,0E+00	2,8E-05	0,0E+00	-	-
Titane	9,2E-06	6,5E-06	0,0E+00	5,2E-08	0,0E+00	1,1E-05	0,0E+00	0,0E+00	8,0E-04	1,5E-03	1,1E-05	3,9E-03	2,1E-03	9,2E-06	6,5E-06	0,0E+00	0,0E+00	6,2E-06	0,0E+00	1,1E-03	0,0E+00	-	-
Uranium	3,5E-10	2,4E-10	0,0E+00	2,4E-12	0,0E+00	4,1E-10	0,0E+00	0,0E+00	3,0E-08	4,8E-08	4,2E-10	7,2E-10	5,4E-09	3,5E-10	2,4E-10	0,0E+00	0,0E+00	2,3E-10	0,0E+00	4,3E-08	0,0E+00	-	-
Vanadium	2,1E-07	1,5E-07	0,0E+00	1,2E-09	0,0E+00	2,5E-07	0,0E+00	0,0E+00	1,8E-05	3,4E-05	2,5E-07	7,5E-06	1,4E-05	2,1E-07	1,5E-07	0,0E+00	0,0E+00	1,4E-07	0,0E+00	2,6E-05	0,0E+00	-	-
Zinc	1,0E-07	7,3E-08	0,0E+00	3,6E-10	0,0E+00	1,2E-07	0,0E+00	0,0E+00	9,0E-06	1,8E-05	1,3E-07	2,0E-04	7,0E-05	1,0E-07	7,3E-08	0,0E+00	0,0E+00	7,0E-08	0,0E+00	1,3E-05	0,0E+00	-	-

TABLEAU H-4 Doses d'exposition additionnelles détaillées (mg/kg-pc par jour) - Scénario "Activités traditionnelles"

Voie d'exposition:	Inhalation		Cutané[a]				Ingestion							Inhalation		Cutané[a]			Ingestion		Inhalation	Ingestion	
Saison:	Été		Été	Été + hiver	Été		Été + hiver	Été		Été + hiver				Hiver		Hiver			Hiver		Été + hiver	Été	Hiver
Dose:	Air extérieur	Air intérieur	Air (int + ext)	Eau	Sol	Poussières intérieures	Eau	Sol	Poussières intérieures	Fruits	Légumes	Viande	Poisson	Air extérieur	Air intérieur	Air (int + ext)	Sol	Poussières intérieures	Sol	Poussières intérieures	Aérosols de douche	Lait maternel	Lait maternel
Recepteurs:	5 à 11 ans																						
Aluminium	3,4E-05	2,4E-05	0,0E+00	2,0E-07	0,0E+00	4,1E-05	0,0E+00	0,0E+00	7,3E-04	1,2E-03	2,4E-05	1,6E-04	2,2E-03	3,4E-05	2,4E-05	0,0E+00	0,0E+00	2,3E-05	0,0E+00	1,0E-03	0,0E+00	-	-
Antimoine	2,2E-10	1,5E-10	0,0E+00	1,3E-12	0,0E+00	2,6E-10	0,0E+00	0,0E+00	4,6E-09	6,8E-09	1,6E-10	6,8E-10	7,1E-09	2,2E-10	1,5E-10	0,0E+00	0,0E+00	1,5E-10	0,0E+00	6,6E-09	0,0E+00	-	-
Argent	2,9E-10	2,0E-10	0,0E+00	1,0E-12	0,0E+00	3,4E-10	0,0E+00	0,0E+00	6,0E-09	1,5E-08	2,0E-10	1,8E-08	8,1E-09	2,9E-10	2,0E-10	0,0E+00	0,0E+00	1,9E-10	0,0E+00	8,6E-09	0,0E+00	-	-
Arsenic	7,0E-09	4,9E-09	0,0E+00	3,7E-11	0,0E+00	3,3E-08	0,0E+00	0,0E+00	1,5E-07	2,1E-07	4,9E-09	4,3E-08	3,1E-07	7,0E-09	4,9E-09	0,0E+00	0,0E+00	1,9E-08	0,0E+00	2,1E-07	0,0E+00	-	-
Baryum	3,4E-07	2,4E-07	0,0E+00	1,9E-09	0,0E+00	4,0E-07	0,0E+00	0,0E+00	7,1E-06	7,0E-06	2,4E-07	3,6E-07	6,6E-05	3,4E-07	2,4E-07	0,0E+00	0,0E+00	2,3E-07	0,0E+00	1,0E-05	0,0E+00	-	-
Béryllium	1,5E-09	1,1E-09	0,0E+00	1,8E-11	0,0E+00	1,8E-09	0,0E+00	0,0E+00	3,2E-08	4,7E-08	1,1E-09	1,4E-09	6,1E-08	1,5E-09	1,1E-09	0,0E+00	0,0E+00	1,0E-09	0,0E+00	4,6E-08	0,0E+00	-	-
Bore	2,7E-08	1,9E-08	0,0E+00	1,2E-10	0,0E+00	3,2E-08	0,0E+00	0,0E+00	5,7E-07	2,8E-06	1,9E-08	6,7E-08	1,3E-06	2,7E-08	1,9E-08	0,0E+00	0,0E+00	1,8E-08	0,0E+00	8,2E-07	0,0E+00	-	-
Cadmium	2,1E-10	1,5E-10	0,0E+00	1,2E-12	0,0E+00	2,5E-11	0,0E+00	0,0E+00	4,4E-09	1,2E-08	1,5E-10	2,3E-09	1,3E-08	2,1E-10	1,5E-10	0,0E+00	0,0E+00	1,4E-11	0,0E+00	6,3E-09	0,0E+00	-	-
Chrome	4,3E-08	3,0E-08	0,0E+00	2,5E-10	0,0E+00	5,1E-08	0,0E+00	0,0E+00	9,1E-07	5,4E-06	3,1E-08	2,3E-06	2,8E-07	4,3E-08	3,0E-08	0,0E+00	0,0E+00	2,9E-08	0,0E+00	1,3E-06	0,0E+00	-	-
Cobalt	2,5E-08	1,8E-08	0,0E+00	1,4E-10	0,0E+00	3,0E-08	0,0E+00	0,0E+00	5,4E-07	1,8E-06	1,8E-08	1,6E-07	2,4E-07	2,5E-08	1,8E-08	0,0E+00	0,0E+00	1,7E-08	0,0E+00	7,7E-07	0,0E+00	-	-
Cuivre	1,8E-08	1,2E-08	0,0E+00	9,8E-11	0,0E+00	2,1E-08	0,0E+00	0,0E+00	3,7E-07	2,3E-06	1,3E-08	2,0E-06	1,9E-06	1,8E-08	1,2E-08	0,0E+00	0,0E+00	1,2E-08	0,0E+00	5,3E-07	0,0E+00	-	-
Étain	2,2E-09	1,6E-09	0,0E+00	1,6E-11	0,0E+00	2,6E-09	0,0E+00	0,0E+00	4,7E-08	9,1E-08	1,6E-09	1,0E-06	2,6E-06	2,2E-09	1,6E-09	0,0E+00	0,0E+00	1,5E-09	0,0E+00	6,7E-08	0,0E+00	-	-
Lithium	1,1E-07	8,0E-08	0,0E+00	9,7E-10	0,0E+00	1,4E-07	0,0E+00	0,0E+00	2,4E-06	3,8E-06	8,1E-08	2,1E-05	4,2E-07	1,1E-07	8,0E-08	0,0E+00	0,0E+00	7,7E-08	0,0E+00	3,4E-06	0,0E+00	-	-
Manganèse	8,2E-07	5,7E-07	0,0E+00	4,6E-09	0,0E+00	9,7E-07	0,0E+00	0,0E+00	1,7E-05	3,4E-05	5,8E-07	3,6E-06	2,5E-06	8,2E-07	5,7E-07	0,0E+00	0,0E+00	5,5E-07	0,0E+00	2,5E-05	0,0E+00	-	-
Mercure	1,2E-11	1,2E-11	1,0E-14	6,5E-14	0,0E+00	2,3E-15	0,0E+00	0,0E+00	4,1E-14	8,8E-10	1,5E-11	3,9E-07	1,3E-06	1,2E-11	1,2E-11	1,0E-14	0,0E+00	1,2E-15	0,0E+00	5,4E-14	0,0E+00	-	-
Molybdène	1,0E-09	7,2E-10	0,0E+00	6,6E-12	0,0E+00	1,2E-09	0,0E+00	0,0E+00	2,2E-08	5,1E-08	7,2E-10	8,7E-08	7,3E-08	1,0E-09	7,2E-10	0,0E+00	0,0E+00	6,9E-10	0,0E+00	3,1E-08	0,0E+00	-	-
Nickel	2,5E-08	1,8E-08	0,0E+00	1,4E-11	0,0E+00	1,2E-07	0,0E+00	0,0E+00	5,3E-07	5,2E-06	1,8E-08	7,7E-08	3,8E-07	2,5E-08	1,8E-08	0,0E+00	0,0E+00	6,8E-08	0,0E+00	7,5E-07	0,0E+00	-	-
Plomb	5,4E-09	3,8E-09	0,0E+00	1,2E-13	0,0E+00	6,4E-09	0,0E+00	0,0E+00	1,1E-07	2,2E-07	3,8E-09	2,1E-08	1,2E-08	5,4E-09	3,8E-09	0,0E+00	0,0E+00	3,6E-09	0,0E+00	1,6E-07	0,0E+00	-	-
Sélénium	3,3E-10	2,3E-10	0,0E+00	3,1E-12	0,0E+00	3,9E-10	0,0E+00	0,0E+00	6,9E-09	6,8E-08	2,3E-10	3,0E-07	5,1E-07	3,3E-10	2,3E-10	0,0E+00	0,0E+00	2,2E-10	0,0E+00	9,8E-09	0,0E+00	-	-
Strontium	1,9E-07	1,3E-07	0,0E+00	1,0E-09	0,0E+00	2,2E-07	0,0E+00	0,0E+00	3,9E-06	3,8E-06	1,3E-07	4,6E-06	1,1E-05	1,9E-07	1,3E-07	0,0E+00	0,0E+00	1,3E-07	0,0E+00	5,6E-06	0,0E+00	-	-
Titane	7,6E-06	5,3E-06	0,0E+00	4,3E-08	0,0E+00	9,0E-06	0,0E+00	0,0E+00	1,6E-04	8,6E-04	5,4E-06	2,9E-03	1,7E-03	7,6E-06	5,3E-06	0,0E+00	0,0E+00	5,2E-06	0,0E+00	2,3E-04	0,0E+00	-	-
Uranium	2,9E-10	2,0E-10	0,0E+00	2,0E-12	0,0E+00	3,4E-10	0,0E+00	0,0E+00	6,0E-09	2,8E-08	2,0E-10	5,3E-10	4,3E-09	2,9E-10	2,0E-10	0,0E+00	0,0E+00	1,9E-10	0,0E+00	8,6E-09	0,0E+00	-	-
Vanadium	1,8E-07	1,2E-07	0,0E+00	9,9E-10	0,0E+00	2,1E-07	0,0E+00	0,0E+00	3,7E-06	2,0E-05	1,2E-07	5,5E-06	1,1E-05	1,8E-07	1,2E-07	0,0E+00	0,0E+00	1,2E-07	0,0E+00	5,3E-06	0,0E+00	-	-
Zinc	8,6E-08	6,0E-08	0,0E+00	3,0E-10	0,0E+00	1,0E-07	0,0E+00	0,0E+00	1,8E-06	1,1E-05	6,1E-08	1,4E-04	5,5E-05	8,6E-08	6,0E-08	0,0E+00	0,0E+00	5,8E-08	0,0E+00	2,6E-06	0,0E+00	-	-
Recepteurs:	12 à 19 ans																						
Aluminium	2,7E-05	1,9E-05	0,0E+00	1,6E-07	0,0E+00	3,3E-05	0,0E+00	0,0E+00	2,1E-04	6,5E-04	1,2E-05	1,1E-04	1,3E-03	2,7E-05	1,9E-05	0,0E+00	0,0E+00	1,9E-05	0,0E+00	3,0E-04	0,0E+00	-	-
Antimoine	1,7E-10	1,2E-10	0,0E+00	1,1E-12	0,0E+00	2,1E-10	0,0E+00	0,0E+00	1,3E-09	3,9E-09	7,8E-11	4,8E-10	4,1E-09	1,7E-10	1,2E-10	0,0E+00	0,0E+00	1,2E-10	0,0E+00	1,9E-09	0,0E+00	-	-
Argent	2,2E-10	1,5E-10	0,0E+00	8,2E-13	0,0E+00	2,8E-10	0,0E+00	0,0E+00	1,7E-09	8,3E-09	1,0E-10	1,2E-08	4,7E-09	2,2E-10	1,5E-10	0,0E+00	0,0E+00	1,6E-10	0,0E+00	2,5E-09	0,0E+00	-	-
Arsenic	5,4E-09	3,8E-09	0,0E+00	3,1E-11	0,0E+00	2,7E-08	0,0E+00	0,0E+00	4,2E-08	1,2E-07	2,5E-09	3,0E-08	1,8E-07	5,4E-09	3,8E-09	0,0E+00	0,0E+00	1,5E-08	0,0E+00	6,0E-08	0,0E+00	-	-
Baryum	2,6E-07	1,8E-07	0,0E+00	1,5E-09	0,0E+00	3,3E-07	0,0E+00	0,0E+00	2,0E-06	3,9E-06	1,2E-07	2,6E-07	3,8E-05	2,6E-07	1,8E-07	0,0E+00	0,0E+00	1,9E-07	0,0E+00	2,9E-06	0,0E+00	-	-
Béryllium	1,2E-09	8,3E-10	0,0E+00	1,5E-11	0,0E+00	1,5E-09	0,0E+00	0,0E+00	9,2E-09	2,7E-08	5,4E-10	1,0E-09	3,6E-08	1,2E-09	8,3E-10	0,0E+00	0,0E+00	8,5E-10	0,0E+00	1,3E-08	0,0E+00	-	-
Bore	2,1E-08	1,5E-08	0,0E+00	9,7E-11	0,0E+00	2,6E-08	0,0E+00	0,0E+00	1,6E-07	1,6E-06	9,6E-09	4,7E-08	7,5E-07	2,1E-08	1,5E-08	0,0E+00	0,0E+00	1,5E-08	0,0E+00	2,3E-07	0,0E+00	-	-
Cadmium	1,6E-10	1,1E-10	0,0E+00	1,0E-12	0,0E+00	2,0E-11	0,0E+00	0,0E+00	1,3E-09	6,6E-09	7,4E-11	1,6E-09	7,7E-09	1,6E-10	1,1E-10	0,0E+00	0,0E+00	1,2E-11	0,0E+00	1,8E-09	0,0E+00	-	-
Chrome	3,4E-08	2,3E-08	0,0E+00	2,1E-10	0,0E+00	4,2E-08	0,0E+00	0,0E+00	2,6E-07	3,0E-06	1,5E-08	1,6E-06	1,6E-07	3,4E-08	2,3E-08	0,0E+00	0,0E+00	2,4E-08	0,0E+00	3,7E-07	0,0E+00	-	-
Cobalt	2,0E-08	1,4E-08	0,0E+00	1,2E-10	0,0E+00	2,5E-08	0,0E+00	0,0E+00	1,5E-07	1,0E-06	9,0E-09	1,1E-07	1,4E-07	2,0E-08	1,4E-08	0,0E+00	0,0E+00	1,4E-08	0,0E+00	2,2E-07	0,0E+00	-	-
Cuivre	1,4E-08	9,6E-09	0,0E+00	8,0E-11	0,0E+00	1,7E-08	0,0E+00	0,0E+00	1,1E-07	1,3E-06	6,3E-09	1,4E-06	1,1E-06	1,4E-08	9,6E-09	0,0E+00	0,0E+00	9,8E-09	0,0E+00	1,5E-07	0,0E+00	-	-
Étain	1,7E-09	1,2E-09	0,0E+00	1,3E-11	0,0E+00	2,1E-09	0,0E+00	0,0E+00	1,3E-08	5,2E-08	7,9E-10	7,0E-07	1,5E-06	1,7E-09	1,2E-09	0,0E+00	0,0E+00	1,2E-09	0,0E+00	1,9E-08	0,0E+00	-	-
Lithium	8,9E-08	6,2E-08	0,0E+00	7,9E-10	0,0E+00	1,1E-07	0,0E+00	0,0E+00	6,9E-07	2,1E-06	4,0E-08	1,5E-05	2,5E-07	8,9E-08	6,2E-08	0,0E+00	0,0E+00	6,3E-08	0,0E+00	9,8E-07	0,0E+00	-	-
Manganèse	6,4E-07	4,4E-07	0,0E+00	3,8E-09	0,0E+00	7,9E-07	0,0E+00	0,0E+00	4,9E-06	1,9E-05	2,9E-07	2,5E-06	1,5E-06	6,4E-07	4,4E-07	0,0E+00	0,0E+00	4,5E-07	0,0E+00	7,0E-06	0,0E+00	-	-
Mercure	8,9E-12	8,9E-12	1,7E-14	5,3E-14	0,0E+00	1,9E-15	0,0E+00	0,0E+00	1,2E-14	4,9E-10	7,4E-12	2,7E-07	7,3E-07	8,9E-12	8,9E-12	1,7E-14	0,0E+00	9,9E-16	0,0E+00	1,5E-14	0,0E+00	-	-
Molybdène	7,9E-10	5,6E-10	0,0E+00	5,4E-12	0,0E+00	9,9E-10	0,0E+00	0,0E+00	6,2E-09	2,9E-08	3,6E-10	6,1E-08	4,2E-08	7,9E-10	5,6E-10	0,0E+00	0,0E+00	5,7E-10	0,0E+00	8,8E-09	0,0E+00	-	-
Nickel	1,9E-08	1,4E-08	0,0E+00	1,1E-11	0,0E+00	9,7E-08	0,0E+00	0,0E+00	1,5E-07	2,9E-06	8,9E-09	5,4E-08	2,2E-07	1,9E-08	1,4E-08	0,0E+00	0,0E+00	5,5E-08	0,0E+00	2,2E-07	0,0E+00	-	-
Plomb	4,2E-09	2,9E-09	0,0E+00	9,9E-14	0,0E+00	5,2E-09	0,0E+00	0,0E+00	3,2E-08	1,3E-07	1,9E-09	1,4E-08	7,2E-09	4,2E-09	2,9E-09	0,0E+00	0,0E+00	3,0E-09	0,0E+00	4,6E-08	0,0E+00	-	-
Sélénium	2,5E-10	1,8E-10	0,0E+00	2,5E-12	0,0E+00	3,2E-10	0,0E+00	0,0E+00	2,0E-09	3,8E-08	1,2E-10	2,1E-07	3,0E-07	2,5E-10	1,8E-10	0,0E+00	0,0E+00	1,8E-10	0,0E+00	2,8E-09	0,0E+00	-	-
Strontium	1,4E-07	1,0E-07	0,0E+00	8,5E-10	0,0E+00	1,8E-07	0,0E+00	0,0E+00	1,1E-06	2,2E-06	6,6E-08	3,2E-06	6,6E-06	1,4E-07	1,0E-07	0,0E+00	0,0E+00	1,0E-07	0,0E+00	1,6E-06	0,0E+00	-	-
Titane	5,9E-06	4,1E-06	0,0E+00	3,5E-08	0,0E+00	7,4E-06	0,0E+00	0,0E+00	4,6E-05	4,9E-04	2,7E-06	2,0E-03	9,6E-04	5,9E-06	4,1E-06	0,0E+00	0,0E+00	4,2E-06	0,0E+00	6,6E-05	0,0E+00	-	-
Uranium	2,2E-10	1,6E-10	0,0E+00	1,7E-12	0,0E+00	2,8E-10	0,0E+00	0,0E+00	1,7E-09	1,6E-08	1,0E-10	3,7E-10	2,5E-09	2,2E-10	1,6E-10	0,0E+00	0,0E+00	1,6E-10	0,0E+00	2,5E-09	0,0E+00	-	-
Vanadium	1,4E-07	9,6E-08	0,0E+00	8,1E-10	0,0E+00	1,7E-07	0,0E+00	0,0E+00	1,1E-06	1,1E-05	6,2E-08	3,9E-06	6,3E-06	1,4E-07	9,6E-08	0,0E+00	0,0E+00	9,7E-08	0,0E+00	1,5E-06	0,0E+00	-	-
Zinc	6,7E-08	4,7E-08	0,0E+00	2,5E-10	0,0E+00	8,4E-08	0,0E+00	0,0E+00	5,2E-07	6,0E-06	3,1E-08	1,0E-04	3,2E-05	6,7E-08	4,7E-08	0,0E+00	0,0E+00	4,8E-08	0,0E+00	7,4E-07	0,0E+00	-	-

TABLEAU H-4 Doses d'exposition additionnelles détaillées (mg/kg-pc par jour) - Scénario "Activités traditionnelles"

Voie d'exposition:	Inhalation		Cutané[a]				Ingestion							Inhalation		Cutané[a]			Ingestion		Inhalation	Ingestion	
Saison:	Été		Été	Été + hiver	Été		Été + hiver	Été		Été + hiver				Hiver		Hiver			Hiver		Été + hiver	Été	Hiver
Dose:	Air extérieur	Air intérieur	Air (int + ext)	Eau	Sol	Poussières intérieures	Eau	Sol	Poussières intérieures	Fruits	Légumes	Viande	Poisson	Air extérieur	Air intérieur	Air (int + ext)	Sol	Poussières intérieures	Sol	Poussières intérieures	Aérosols de douche	Lait maternel	Lait maternel
Recepteurs:	20 ans et plus																						
Aluminium	2,0E-05	1,4E-05	0,0E+00	1,5E-07	0,0E+00	3,1E-05	0,0E+00	0,0E+00	1,7E-04	3,6E-04	9,9E-06	1,4E-04	1,1E-03	2,0E-05	1,4E-05	0,0E+00	0,0E+00	1,8E-05	0,0E+00	2,4E-04	0,0E+00	-	-
Antimoine	1,3E-10	9,0E-11	0,0E+00	9,9E-13	0,0E+00	2,0E-10	0,0E+00	0,0E+00	1,1E-09	2,1E-09	6,4E-11	5,9E-10	3,5E-09	1,3E-10	9,0E-11	0,0E+00	0,0E+00	1,1E-10	0,0E+00	1,5E-09	0,0E+00	-	-
Argent	1,7E-10	1,2E-10	0,0E+00	7,7E-13	0,0E+00	2,6E-10	0,0E+00	0,0E+00	1,4E-09	4,5E-09	8,2E-11	1,5E-08	4,1E-09	1,7E-10	1,2E-10	0,0E+00	0,0E+00	1,5E-10	0,0E+00	2,0E-09	0,0E+00	-	-
Arsenic	4,0E-09	2,8E-09	0,0E+00	2,9E-11	0,0E+00	2,5E-08	0,0E+00	0,0E+00	3,4E-08	6,6E-08	2,0E-09	3,7E-08	1,5E-07	4,0E-09	2,8E-09	0,0E+00	0,0E+00	1,4E-08	0,0E+00	4,9E-08	0,0E+00	-	-
Baryum	2,0E-07	1,4E-07	0,0E+00	1,4E-09	0,0E+00	3,1E-07	0,0E+00	0,0E+00	1,6E-06	2,2E-06	9,7E-08	3,2E-07	3,3E-05	2,0E-07	1,4E-07	0,0E+00	0,0E+00	1,7E-07	0,0E+00	2,4E-06	0,0E+00	-	-
Béryllium	8,9E-10	6,2E-10	0,0E+00	1,4E-11	0,0E+00	1,4E-09	0,0E+00	0,0E+00	7,5E-09	1,5E-08	4,4E-10	1,2E-09	3,1E-08	8,9E-10	6,2E-10	0,0E+00	0,0E+00	7,9E-10	0,0E+00	1,1E-08	0,0E+00	-	-
Bore	1,6E-08	1,1E-08	0,0E+00	9,1E-11	0,0E+00	2,5E-08	0,0E+00	0,0E+00	1,3E-07	8,6E-07	7,8E-09	5,8E-08	6,5E-07	1,6E-08	1,1E-08	0,0E+00	0,0E+00	1,4E-08	0,0E+00	1,9E-07	0,0E+00	-	-
Cadmium	1,2E-10	8,5E-11	0,0E+00	9,3E-13	0,0E+00	1,9E-11	0,0E+00	0,0E+00	1,0E-09	3,6E-09	6,0E-11	2,0E-09	6,7E-09	1,2E-10	8,5E-11	0,0E+00	0,0E+00	1,1E-11	0,0E+00	1,5E-09	0,0E+00	-	-
Chrome	2,5E-08	1,8E-08	0,0E+00	1,9E-10	0,0E+00	3,9E-08	0,0E+00	0,0E+00	2,1E-07	1,7E-06	1,3E-08	2,0E-06	1,4E-07	2,5E-08	1,8E-08	0,0E+00	0,0E+00	2,2E-08	0,0E+00	3,0E-07	0,0E+00	-	-
Cobalt	1,5E-08	1,0E-08	0,0E+00	1,1E-10	0,0E+00	2,3E-08	0,0E+00	0,0E+00	1,2E-07	5,7E-07	7,4E-09	1,4E-07	1,2E-07	1,5E-08	1,0E-08	0,0E+00	0,0E+00	1,3E-08	0,0E+00	1,8E-07	0,0E+00	-	-
Cuivre	1,0E-08	7,2E-09	0,0E+00	7,5E-11	0,0E+00	1,6E-08	0,0E+00	0,0E+00	8,6E-08	7,0E-07	5,1E-09	1,8E-06	9,4E-07	1,0E-08	7,2E-09	0,0E+00	0,0E+00	9,2E-09	0,0E+00	1,2E-07	0,0E+00	-	-
Étain	1,3E-09	9,1E-10	0,0E+00	1,2E-11	0,0E+00	2,0E-09	0,0E+00	0,0E+00	1,1E-08	2,8E-08	6,4E-10	8,7E-07	1,3E-06	1,3E-09	9,1E-10	0,0E+00	0,0E+00	1,2E-09	0,0E+00	1,6E-08	0,0E+00	-	-
Lithium	6,6E-08	4,7E-08	0,0E+00	7,4E-10	0,0E+00	1,0E-07	0,0E+00	0,0E+00	5,6E-07	1,2E-06	3,3E-08	1,8E-05	2,1E-07	6,6E-08	4,7E-08	0,0E+00	0,0E+00	5,9E-08	0,0E+00	8,0E-07	0,0E+00	-	-
Manganèse	4,8E-07	3,3E-07	0,0E+00	3,6E-09	0,0E+00	7,4E-07	0,0E+00	0,0E+00	4,0E-06	1,0E-05	2,4E-07	3,1E-06	1,3E-06	4,8E-07	3,3E-07	0,0E+00	0,0E+00	4,3E-07	0,0E+00	5,7E-06	0,0E+00	-	-
Mercure	6,7E-12	6,7E-12	1,9E-14	5,0E-14	0,0E+00	1,8E-15	0,0E+00	0,0E+00	9,6E-15	2,7E-10	6,0E-12	3,4E-07	6,3E-07	6,7E-12	6,7E-12	1,9E-14	0,0E+00	9,3E-16	0,0E+00	1,2E-14	0,0E+00	-	-
Molybdène	6,0E-10	4,2E-10	0,0E+00	5,1E-12	0,0E+00	9,3E-10	0,0E+00	0,0E+00	5,0E-09	1,6E-08	2,9E-10	7,6E-08	3,6E-08	6,0E-10	4,2E-10	0,0E+00	0,0E+00	5,3E-10	0,0E+00	7,1E-09	0,0E+00	-	-
Nickel	1,5E-08	1,0E-08	0,0E+00	1,1E-11	0,0E+00	9,1E-08	0,0E+00	0,0E+00	1,2E-07	1,6E-06	7,2E-09	6,7E-08	1,9E-07	1,5E-08	1,0E-08	0,0E+00	0,0E+00	5,2E-08	0,0E+00	1,8E-07	0,0E+00	-	-
Plomb	3,1E-09	2,2E-09	0,0E+00	9,2E-14	0,0E+00	4,9E-09	0,0E+00	0,0E+00	2,6E-08	6,9E-08	1,6E-09	1,8E-08	6,2E-09	3,1E-09	2,2E-09	0,0E+00	0,0E+00	2,8E-09	0,0E+00	3,8E-08	0,0E+00	-	-
Sélénium	1,9E-10	1,3E-10	0,0E+00	2,4E-12	0,0E+00	3,0E-10	0,0E+00	0,0E+00	1,6E-09	2,1E-08	9,5E-11	2,6E-07	2,6E-07	1,9E-10	1,3E-10	0,0E+00	0,0E+00	1,7E-10	0,0E+00	2,3E-09	0,0E+00	-	-
Strontium	1,1E-07	7,6E-08	0,0E+00	8,0E-10	0,0E+00	1,7E-07	0,0E+00	0,0E+00	9,1E-07	1,2E-06	5,4E-08	4,0E-06	5,8E-06	1,1E-07	7,6E-08	0,0E+00	0,0E+00	9,6E-08	0,0E+00	1,3E-06	0,0E+00	-	-
Titane	4,4E-06	3,1E-06	0,0E+00	3,3E-08	0,0E+00	6,9E-06	0,0E+00	0,0E+00	3,7E-05	2,7E-04	2,2E-06	2,5E-03	8,3E-04	4,4E-06	3,1E-06	0,0E+00	0,0E+00	4,0E-06	0,0E+00	5,3E-05	0,0E+00	-	-
Uranium	1,7E-10	1,2E-10	0,0E+00	1,6E-12	0,0E+00	2,6E-10	0,0E+00	0,0E+00	1,4E-09	8,6E-09	8,3E-11	4,6E-10	2,1E-09	1,7E-10	1,2E-10	0,0E+00	0,0E+00	1,5E-10	0,0E+00	2,0E-09	0,0E+00	-	-
Vanadium	1,0E-07	7,2E-08	0,0E+00	7,6E-10	0,0E+00	1,6E-07	0,0E+00	0,0E+00	8,6E-07	6,1E-06	5,1E-08	4,8E-06	5,5E-06	1,0E-07	7,2E-08	0,0E+00	0,0E+00	9,1E-08	0,0E+00	1,2E-06	0,0E+00	-	-
Zinc	5,0E-08	3,5E-08	0,0E+00	2,3E-10	0,0E+00	7,8E-08	0,0E+00	0,0E+00	4,2E-07	3,3E-06	2,5E-08	1,3E-04	2,8E-05	5,0E-08	3,5E-08	0,0E+00	0,0E+00	4,5E-08	0,0E+00	6,0E-07	0,0E+00	-	-

a: Les valeurs fournies correspondent aux doses absorbées par voie cutanée.

TABLEAU H-5 Doses d'exposition bruit de fond détaillées (mg/kg-pc par jour) - Scénario domestique

Voie d'exposition:	Inhalation		Cutané[a]				Ingestion							Inhalation		Cutané[a]			Ingestion		Inhalation	Ingestion	
Saison:	Été		Été	Été + hiver	Été		Été + hiver	Été		Été + hiver				Hiver		Hiver			Hiver		Été + hiver	Été	Hiver
Dose:	Air extérieur	Air intérieur	Air (int + ext)	Eau	Sol	Poussières intérieures	Eau	Sol	Poussières intérieures	Fruits	Légumes	Viande	Poisson	Air extérieur	Air intérieur	Air (int + ext)	Sol	Poussières intérieures	Sol	Poussières intérieures	Aérosols de douche	Lait maternel	Lait maternel
Récepteurs:	0-6 mois																						
Aluminium	3,6E-06	2,2E-05	0,0E+00	5,1E-07	0,0E+00	3,1E-05	5,9E-04	6,3E-03	9,0E-04	3,5E-02	3,4E-03	0,0E+00	0,0E+00	7,9E-07	2,4E-05	0,0E+00	0,0E+00	1,4E-05	0,0E+00	1,0E-03	0,0E+00	2,4E-04	2,3E-04
Antimoine	1,5E-08	9,0E-08	0,0E+00	8,6E-09	0,0E+00	1,0E-07	9,8E-06	2,1E-07	3,0E-06	1,5E-05	1,4E-06	0,0E+00	0,0E+00	3,3E-09	9,8E-08	0,0E+00	0,0E+00	5,8E-08	0,0E+00	4,2E-06	0,0E+00	3,2E-08	3,2E-08
Argent	1,2E-09	7,4E-09	0,0E+00	2,9E-10	0,0E+00	9,0E-09	5,5E-07	6,0E-07	2,6E-07	5,0E-06	4,8E-07	0,0E+00	0,0E+00	2,7E-10	8,1E-09	0,0E+00	0,0E+00	4,8E-09	0,0E+00	3,5E-07	0,0E+00	6,9E-05	6,9E-05
Arsenic	2,7E-08	1,6E-07	0,0E+00	4,3E-08	0,0E+00	7,7E-07	4,9E-05	8,3E-06	5,6E-06	2,8E-05	2,7E-06	0,0E+00	0,0E+00	6,0E-09	1,8E-07	0,0E+00	0,0E+00	4,2E-07	0,0E+00	7,6E-06	0,0E+00	3,9E-07	3,9E-07
Baryum	8,4E-08	5,1E-07	0,0E+00	9,7E-07	0,0E+00	6,2E-07	1,1E-03	3,7E-05	1,8E-05	2,0E-02	1,9E-03	0,0E+00	0,0E+00	1,9E-08	5,6E-07	0,0E+00	0,0E+00	3,3E-07	0,0E+00	2,4E-05	0,0E+00	9,2E-05	9,2E-05
Béryllium	4,4E-10	2,7E-09	0,0E+00	9,9E-10	0,0E+00	3,9E-09	1,1E-06	8,7E-07	1,1E-07	1,9E-06	1,9E-07	0,0E+00	0,0E+00	9,8E-11	2,9E-09	0,0E+00	0,0E+00	1,7E-09	0,0E+00	1,3E-07	0,0E+00	1,4E-10	7,0E-11
Bore	3,4E-07	2,1E-06	0,0E+00	1,2E-07	0,0E+00	2,4E-06	1,4E-04	6,4E-05	7,0E-05	2,9E-03	3,4E-04	0,0E+00	0,0E+00	7,6E-08	2,3E-06	0,0E+00	0,0E+00	1,3E-06	0,0E+00	9,7E-05	0,0E+00	1,3E-04	1,3E-04
Cadmium	4,2E-09	2,6E-08	0,0E+00	1,6E-09	0,0E+00	3,0E-09	1,9E-06	5,7E-07	8,6E-07	1,2E-05	1,1E-06	0,0E+00	0,0E+00	9,4E-10	2,8E-08	0,0E+00	0,0E+00	1,7E-09	0,0E+00	1,2E-06	0,0E+00	8,6E-07	8,6E-07
Chrome	3,0E-08	1,8E-07	0,0E+00	5,1E-08	0,0E+00	2,8E-07	5,9E-05	6,8E-05	8,1E-06	4,2E-05	4,0E-06	0,0E+00	0,0E+00	6,7E-09	2,0E-07	0,0E+00	0,0E+00	1,2E-07	0,0E+00	8,6E-06	0,0E+00	9,2E-06	6,6E-06
Cobalt	4,3E-09	2,6E-08	0,0E+00	2,3E-08	0,0E+00	3,5E-08	2,6E-05	4,9E-06	1,0E-06	3,1E-05	1,9E-05	0,0E+00	0,0E+00	9,7E-10	2,9E-08	0,0E+00	0,0E+00	1,7E-08	0,0E+00	1,2E-06	0,0E+00	2,0E-06	2,0E-06
Cuivre	4,0E-07	2,4E-06	0,0E+00	8,6E-05	0,0E+00	2,8E-06	9,7E-02	1,4E-05	8,0E-05	1,9E-03	1,8E-04	0,0E+00	0,0E+00	8,9E-08	2,7E-06	0,0E+00	0,0E+00	1,6E-06	0,0E+00	1,1E-04	0,0E+00	6,2E-04	6,2E-04
Étain	1,8E-08	1,1E-07	0,0E+00	8,6E-08	0,0E+00	1,3E-07	9,8E-05	7,5E-06	3,8E-06	1,2E-05	5,6E-06	0,0E+00	0,0E+00	4,0E-09	1,2E-07	0,0E+00	0,0E+00	7,1E-08	0,0E+00	5,1E-06	0,0E+00	1,1E-04	1,1E-04
Lithium	1,3E-09	8,2E-09	0,0E+00	2,1E-07	0,0E+00	1,4E-08	2,3E-04	4,8E-06	4,1E-07	2,1E-05	4,8E-06	0,0E+00	0,0E+00	3,0E-10	8,9E-09	0,0E+00	0,0E+00	5,3E-09	0,0E+00	3,8E-07	0,0E+00	2,6E-04	2,6E-04
Manganèse	1,7E-07	1,0E-06	0,0E+00	3,3E-07	0,0E+00	1,2E-06	3,7E-04	8,4E-05	3,6E-05	2,4E-01	2,3E-02	0,0E+00	0,0E+00	3,7E-08	1,1E-06	0,0E+00	0,0E+00	6,6E-07	0,0E+00	4,8E-05	0,0E+00	5,4E-04	5,4E-04
Mercure	6,4E-08	1,0E-06	4,9E-11	3,3E-09	0,0E+00	1,9E-10	3,8E-06	5,4E-08	5,5E-09	2,0E-06	2,5E-07	0,0E+00	0,0E+00	1,4E-08	1,1E-06	4,0E-11	0,0E+00	7,0E-11	0,0E+00	5,1E-09	0,0E+00	2,7E-06	2,7E-06
Molybdène	1,1E-08	6,6E-08	0,0E+00	5,3E-09	0,0E+00	7,8E-08	6,1E-06	3,3E-06	2,3E-06	4,0E-05	4,9E-06	0,0E+00	0,0E+00	2,4E-09	7,2E-08	0,0E+00	0,0E+00	4,3E-08	0,0E+00	3,1E-06	0,0E+00	1,7E-05	1,7E-05
Nickel	3,1E-08	1,9E-07	0,0E+00	4,2E-09	0,0E+00	9,0E-07	4,8E-05	1,1E-05	6,6E-06	6,3E-04	6,0E-05	0,0E+00	0,0E+00	7,0E-09	2,1E-07	0,0E+00	0,0E+00	4,9E-07	0,0E+00	8,9E-06	0,0E+00	3,3E-04	3,3E-04
Plomb	1,1E-07	6,9E-07	0,0E+00	1,0E-10	0,0E+00	8,0E-07	2,9E-05	1,4E-05	2,3E-05	1,1E-04	1,0E-05	0,0E+00	0,0E+00	2,5E-08	7,6E-07	0,0E+00	0,0E+00	4,5E-07	0,0E+00	3,2E-05	0,0E+00	4,1E-07	4,1E-07
Sélénium	3,5E-08	2,2E-07	0,0E+00	1,5E-08	0,0E+00	2,4E-07	1,7E-05	1,6E-06	7,1E-06	3,2E-05	3,0E-06	0,0E+00	0,0E+00	7,9E-09	2,3E-07	0,0E+00	0,0E+00	1,4E-07	0,0E+00	1,0E-05	0,0E+00	1,6E-04	1,6E-04
Strontium	4,0E-08	2,5E-07	0,0E+00	7,3E-06	0,0E+00	3,3E-07	8,3E-03	5,5E-05	9,7E-06	1,1E-02	1,0E-03	0,0E+00	0,0E+00	9,0E-09	2,7E-07	0,0E+00	0,0E+00	1,6E-07	0,0E+00	1,1E-05	0,0E+00	4,0E-04	4,0E-04
Titane	1,2E-07	7,3E-07	0,0E+00	8,6E-07	0,0E+00	1,4E-06	9,8E-04	5,5E-04	4,0E-05	5,7E-04	5,5E-05	0,0E+00	0,0E+00	2,6E-08	7,9E-07	0,0E+00	0,0E+00	4,7E-07	0,0E+00	3,4E-05	0,0E+00	4,8E-03	4,8E-03
Uranium	4,9E-10	3,0E-09	0,0E+00	1,6E-09	0,0E+00	4,0E-08	1,9E-06	3,6E-05	1,2E-06	1,3E-06	1,2E-07	0,0E+00	0,0E+00	1,1E-10	3,2E-09	0,0E+00	0,0E+00	1,9E-09	0,0E+00	1,4E-07	0,0E+00	3,9E-07	3,5E-07
Vanadium	3,8E-08	2,3E-07	0,0E+00	5,5E-09	0,0E+00	2,8E-07	6,3E-06	2,4E-05	8,2E-06	3,5E-05	3,4E-06	0,0E+00	0,0E+00	8,4E-09	2,5E-07	0,0E+00	0,0E+00	1,5E-07	0,0E+00	1,1E-05	0,0E+00	4,5E-08	4,0E-08
Zinc	4,0E-07	2,4E-06	0,0E+00	3,1E-06	0,0E+00	2,8E-06	6,0E-03	2,8E-05	8,1E-05	1,1E-02	1,2E-03	0,0E+00	0,0E+00	8,9E-08	2,7E-06	0,0E+00	0,0E+00	1,6E-06	0,0E+00	1,1E-04	0,0E+00	1,2E-02	1,2E-02
Recepteurs:	0,5 à 4 ans																						
Aluminium	4,2E-06	1,9E-05	0,0E+00	3,9E-07	8,1E-04	2,3E-05	3,7E-04	1,2E-02	1,7E-03	1,6E-01	1,5E-03	1,6E-02	8,1E-02	9,4E-07	2,1E-05	0,0E+00	0,0E+00	1,1E-05	0,0E+00	1,9E-03	0,0E+00	-	-
Antimoine	1,8E-08	7,9E-08	0,0E+00	6,5E-09	2,7E-08	7,7E-08	6,1E-06	4,0E-07	5,6E-06	6,9E-05	6,4E-07	6,1E-07	6,0E-06	3,9E-09	8,8E-08	0,0E+00	0,0E+00	4,4E-08	0,0E+00	8,0E-06	0,0E+00	-	-
Argent	1,4E-09	6,5E-09	0,0E+00	2,2E-10	7,7E-08	6,8E-09	3,4E-07	1,1E-06	5,0E-07	2,3E-05	2,1E-07	3,6E-05	9,7E-07	3,2E-10	7,3E-09	0,0E+00	0,0E+00	3,6E-09	0,0E+00	6,6E-07	0,0E+00	-	-
Arsenic	3,2E-08	1,4E-07	0,0E+00	3,2E-08	4,3E-06	5,8E-07	3,1E-05	1,6E-05	1,1E-05	1,3E-04	1,2E-06	2,9E-05	4,1E-04	7,1E-09	1,6E-07	0,0E+00	0,0E+00	3,2E-07	0,0E+00	1,5E-05	0,0E+00	-	-
Baryum	1,0E-07	4,5E-07	0,0E+00	7,3E-07	4,8E-06	4,7E-07	6,9E-04	7,0E-05	3,4E-05	9,3E-02	8,8E-04	1,9E-04	5,8E-03	2,2E-08	5,1E-07	0,0E+00	0,0E+00	2,5E-07	0,0E+00	4,6E-05	0,0E+00	-	-
Béryllium	5,2E-10	2,4E-09	0,0E+00	7,4E-10	1,1E-07	3,0E-09	7,0E-07	1,7E-06	2,2E-07	8,9E-06	8,3E-08	2,5E-07	1,5E-06	1,2E-10	2,6E-09	0,0E+00	0,0E+00	1,3E-09	0,0E+00	2,4E-07	0,0E+00	-	-
Bore	4,1E-07	1,8E-06	0,0E+00	9,1E-08	8,3E-06	1,8E-06	8,6E-05	1,2E-04	1,3E-04	1,3E-02	1,5E-04	7,5E-04	6,0E-04	9,0E-08	2,0E-06	0,0E+00	0,0E+00	1,0E-06	0,0E+00	1,9E-04	0,0E+00	-	-
Cadmium	5,0E-09	2,3E-08	0,0E+00	1,2E-09	7,4E-09	2,2E-09	1,2E-06	1,1E-06	1,6E-06	5,5E-05	5,1E-07	2,6E-06	7,8E-06	1,1E-09	2,5E-08	0,0E+00	0,0E+00	1,2E-09	0,0E+00	2,3E-06	0,0E+00	-	-
Chrome	3,6E-08	1,6E-07	0,0E+00	3,9E-08	8,9E-06	2,1E-07	3,7E-05	1,3E-04	1,5E-05	1,9E-04	1,8E-06	3,7E-04	3,8E-05	8,0E-09	1,8E-07	0,0E+00	0,0E+00	8,9E-08	0,0E+00	1,6E-05	0,0E+00	-	-
Cobalt	5,2E-09	2,3E-08	0,0E+00	1,7E-08	6,4E-07	2,6E-08	1,6E-05	9,4E-06	1,9E-06	1,4E-04	8,6E-06	2,3E-05	1,7E-05	1,1E-09	2,6E-08	0,0E+00	0,0E+00	1,3E-08	0,0E+00	2,4E-06	0,0E+00	-	-
Cuivre	4,8E-07	2,1E-06	0,0E+00	6,4E-05	1,9E-06	2,1E-06	6,1E-02	2,8E-05	1,5E-04	8,6E-03	8,1E-05	7,6E-04	2,7E-04	1,1E-07	2,4E-06	0,0E+00	0,0E+00	1,2E-06	0,0E+00	2,2E-04	0,0E+00	-	-
Étain	2,1E-08	9,6E-08	0,0E+00	6,5E-08	9,7E-07	9,9E-08	6,1E-05	1,4E-05	7,3E-06	5,4E-05	2,5E-06	1,6E-03	5,6E-03	4,8E-09	1,1E-07	0,0E+00	0,0E+00	5,3E-08	0,0E+00	9,8E-06	0,0E+00	-	-
Lithium	1,6E-09	7,1E-09	0,0E+00	1,5E-07	6,2E-07	1,1E-08	1,5E-04	9,1E-06	7,8E-07	9,4E-05	2,2E-06	4,1E-04	6,2E-05	3,5E-10	8,0E-09	0,0E+00	0,0E+00	4,0E-09	0,0E+00	7,3E-07	0,0E+00	-	-
Manganèse	2,0E-07	9,0E-07	0,0E+00	2,5E-07	1,1E-05	9,3E-07	2,3E-04	1,6E-04	6,9E-05	1,1E+00	1,0E-02	2,2E-03	6,3E-04	4,4E-08	1,0E-06	0,0E+00	0,0E+00	5,0E-07	0,0E+00	9,1E-05	0,0E+00	-	-
Mercure	7,6E-08	8,8E-07	5,7E-11	2,5E-09	7,0E-09	1,4E-10	2,4E-06	1,0E-07	1,1E-08	9,1E-06	1,1E-07	1,1E-04	1,4E-03	1,7E-08	9,8E-07	3,5E-11	0,0E+00	5,3E-11	0,0E+00	9,7E-09	0,0E+00	-	-
Molybdène	1,3E-08	5,8E-08	0,0E+00	4,0E-09	4,3E-07	5,9E-08	3,8E-06	6,4E-06	4,3E-06	1,8E-04	2,2E-06	6,2E-05	3,7E-05	2,9E-09	6,5E-08	0,0E+00	0,0E+00	3,2E-08	0,0E+00	5,9E-06	0,0E+00	-	-
Nickel	3,7E-08	1,7E-07	0,0E+00	3,1E-09	5,6E-06	6,8E-07	3,0E-05	2,1E-05	1,3E-05	2,9E-03	2,7E-05	3,5E-05	5,3E-05	8,3E-09	1,9E-07	0,0E+00	0,0E+00	3,7E-07	0,0E+00	1,7E-05	0,0E+00	-	-
Plomb	1,3E-07	6,1E-07	0,0E+00	7,7E-11	1,8E-06	6,0E-07	1,8E-05	2,6E-05	4,4E-05	4,9E-04	4,6E-06	6,8E-06	6,2E-06	3,0E-08	6,8E-07	0,0E+00	0,0E+00	3,4E-07	0,0E+00	6,2E-05	0,0E+00	-	-
Sélénium	4,2E-08	1,9E-07	0,0E+00	1,1E-08	2,1E-07	1,8E-07	1,1E-05	3,1E-06	1,4E-05	1,5E-04	1,4E-06	6,2E-04	1,2E-03	9,3E-09	2,1E-07	0,0E+00	0,0E+00	1,0E-07	0,0E+00	1,9E-05	0,0E+00	-	-
Strontium	4,8E-08	2,2E-07	0,0E+00	5,5E-06	7,1E-06	2,5E-07	5,2E-03	1,0E-04	1,8E-05	4,9E-02	4,6E-04	3,6E-03	7,4E-03	1,1E-08	2,4E-07	0,0E+00	0,0E+00	1,2E-07	0,0E+00	2,2E-05	0,0E+00	-	-
Titane	1,4E-07	6,4E-07	0,0E+00	6,5E-07	7,2E-05	1,0E-06	6,1E-04	1,1E-03	7,7E-05	2,6E-03	2,5E-05	4,3E-02	6,6E-02	3,1E-08	7,1E-07	0,0E+00	0,0E+00	3,5E-07	0,0E+00	6,5E-05	0,0E+00	-	-
Uranium	5,8E-10	2,6E-09	0,0E+00	1,2E-09	4,6E-06	3,0E-08	1,2E-06	6,8E-05	2,2E-06	5,8E-06	5,2E-08	3,7E-05	1,7E-06	1,3E-10	2,9E-09	0,0E+00	0,0E+00	1,4E-09	0,0E+00	2,6E-07	0,0E+00	-	-
Vanadium	4,5E-08	2,0E-07	0,0E+00	4,2E-09	3,1E-06	2,1E-07	3,9E-06	4,6E-05	1,6E-05	1,6E-04	1,5E-06	6,3E-05	3,7E-05	1,0E-08	2,3E-07	0,0E+00	0,0E+00	1,1E-07	0,0E+00	2,1E-05	0,0E+00	-	-
Zinc	4,7E-07	2,1E-06	0,0E+00	2,4E-06	3,6E-06	2,1E-06	3,7E-03	5,4E-05	1,5E-04	5,1E-02	5,6E-04	8,5E-02	1,8E-02	1,1E-07	2,4E-06	0,0E+00	0,0E+00	1,2E-06	0,0E+00	2,2E-04	0,0E+00	-	-

TABLEAU H-5 Doses d'exposition bruit de fond détaillées (mg/kg-pc par jour) - Scénario domestique

Voie d'exposition:	Inhalation		Cutané[a]				Ingestion							Inhalation		Cutané[a]			Ingestion		Inhalation	Ingestion	
Saison:	Été		Été	Été + hiver	Été		Été + hiver	Été		Été + hiver				Hiver		Hiver			Hiver		Été + hiver	Été	Hiver
Dose:	Air extérieur	Air intérieur	Air (int + ext)	Eau	Sol	Poussières intérieures	Eau	Sol	Poussières intérieures	Fruits	Légumes	Viande	Poisson	Air extérieur	Air intérieur	Air (int + ext)	Sol	Poussières intérieures	Sol	Poussières intérieures	Aérosols de douche	Lait maternel	Lait maternel
Recepteurs:	5 à 11 ans																						
Aluminium	3,5E-06	1,6E-05	0,0E+00	3,2E-07	6,8E-04	1,9E-05	2,4E-04	2,4E-03	3,5E-04	9,4E-02	7,4E-04	1,2E-02	6,4E-02	7,8E-07	1,8E-05	0,0E+00	0,0E+00	8,8E-06	0,0E+00	3,9E-04	1,8E-07	-	-
Antimoine	1,5E-08	6,5E-08	0,0E+00	5,4E-09	2,3E-08	6,4E-08	3,9E-06	8,1E-08	1,1E-06	4,0E-05	3,2E-07	4,5E-07	4,7E-06	3,2E-09	7,3E-08	0,0E+00	0,0E+00	3,7E-08	0,0E+00	1,6E-06	3,1E-09	-	-
Argent	1,2E-09	5,4E-09	0,0E+00	1,8E-10	6,5E-08	5,7E-09	2,2E-07	2,3E-07	1,0E-07	1,3E-05	1,1E-07	2,6E-05	7,6E-07	2,7E-10	6,0E-09	0,0E+00	0,0E+00	3,0E-09	0,0E+00	1,3E-07	1,7E-10	-	-
Arsenic	2,6E-08	1,2E-07	0,0E+00	2,7E-08	3,6E-06	4,9E-07	2,0E-05	3,2E-06	2,2E-06	7,5E-05	6,0E-07	2,1E-05	3,2E-04	5,9E-09	1,3E-07	0,0E+00	0,0E+00	2,6E-07	0,0E+00	2,9E-06	1,5E-08	-	-
Baryum	8,3E-08	3,7E-07	0,0E+00	6,1E-07	4,0E-06	3,9E-07	4,5E-04	1,4E-05	6,9E-06	5,4E-02	4,3E-04	1,4E-04	4,6E-03	1,8E-08	4,2E-07	0,0E+00	0,0E+00	2,1E-07	0,0E+00	9,3E-06	3,5E-07	-	-
Béryllium	4,3E-10	2,0E-09	0,0E+00	6,2E-10	9,4E-08	2,5E-09	4,5E-07	3,3E-07	4,4E-08	5,1E-06	4,1E-08	1,8E-07	1,2E-06	9,7E-11	2,2E-09	0,0E+00	0,0E+00	1,1E-09	0,0E+00	4,8E-08	3,5E-10	-	-
Bore	3,4E-07	1,5E-06	0,0E+00	7,6E-08	6,9E-06	1,5E-06	5,5E-05	2,5E-05	2,7E-05	7,7E-03	7,6E-05	5,5E-04	4,7E-04	7,5E-08	1,7E-06	0,0E+00	0,0E+00	8,5E-07	0,0E+00	3,8E-05	4,3E-08	-	-
Cadmium	4,1E-09	1,9E-08	0,0E+00	1,0E-09	6,2E-09	1,9E-09	7,5E-07	2,2E-07	3,3E-07	3,2E-05	2,5E-07	1,9E-06	6,1E-06	9,2E-10	2,1E-08	0,0E+00	0,0E+00	1,0E-09	0,0E+00	4,6E-07	5,8E-10	-	-
Chrome	3,0E-08	1,3E-07	0,0E+00	3,2E-08	7,4E-06	1,8E-07	2,4E-05	2,6E-05	3,1E-06	1,1E-04	8,8E-07	2,7E-04	3,0E-05	6,6E-09	1,5E-07	0,0E+00	0,0E+00	7,5E-08	0,0E+00	3,3E-06	1,8E-08	-	-
Cobalt	4,3E-09	1,9E-08	0,0E+00	1,4E-08	5,3E-07	2,2E-08	1,0E-05	1,9E-06	3,9E-07	8,2E-05	4,2E-06	1,7E-05	1,3E-05	9,5E-10	2,2E-08	0,0E+00	0,0E+00	1,1E-08	0,0E+00	4,8E-07	8,1E-09	-	-
Cuivre	3,9E-07	1,8E-06	0,0E+00	5,4E-05	1,6E-06	1,7E-06	3,9E-02	5,6E-06	3,1E-05	5,0E-03	4,0E-05	5,6E-04	2,1E-04	8,8E-08	2,0E-06	0,0E+00	0,0E+00	9,9E-07	0,0E+00	4,4E-05	3,1E-05	-	-
Étain	1,8E-08	8,0E-08	0,0E+00	5,4E-08	8,1E-07	8,3E-08	3,9E-05	2,9E-06	1,5E-06	3,1E-05	1,2E-06	1,2E-03	4,4E-03	4,0E-09	8,9E-08	0,0E+00	0,0E+00	4,5E-08	0,0E+00	2,0E-06	3,1E-08	-	-
Lithium	1,3E-09	5,9E-09	0,0E+00	1,3E-07	5,2E-07	8,9E-09	9,4E-05	1,8E-06	1,6E-07	5,4E-05	1,1E-06	3,0E-04	4,9E-05	2,9E-10	6,6E-09	0,0E+00	0,0E+00	3,3E-09	0,0E+00	1,5E-07	7,3E-08	-	-
Manganèse	1,6E-07	7,4E-07	0,0E+00	2,1E-07	9,1E-06	7,8E-07	1,5E-04	3,2E-05	1,4E-05	6,3E-01	5,0E-03	1,6E-03	4,9E-04	3,7E-08	8,3E-07	0,0E+00	0,0E+00	4,1E-07	0,0E+00	1,8E-05	1,2E-07	-	-
Mercure	6,3E-08	7,3E-07	7,6E-11	2,1E-09	5,8E-09	1,2E-10	1,5E-06	2,1E-08	2,1E-09	5,3E-06	5,5E-08	8,0E-05	1,1E-03	1,4E-08	8,2E-07	3,5E-11	0,0E+00	4,4E-11	0,0E+00	2,0E-09	1,2E-09	-	-
Molybdène	1,1E-08	4,8E-08	0,0E+00	3,3E-09	3,6E-07	4,9E-08	2,4E-06	1,3E-06	8,8E-07	1,1E-04	1,1E-06	4,6E-05	2,9E-05	2,4E-09	5,4E-08	0,0E+00	0,0E+00	2,7E-08	0,0E+00	1,2E-06	1,9E-09	-	-
Nickel	3,1E-08	1,4E-07	0,0E+00	2,6E-09	4,7E-06	5,7E-07	1,9E-05	4,2E-06	2,5E-06	1,7E-03	1,3E-05	2,6E-05	4,2E-05	6,8E-09	1,5E-07	0,0E+00	0,0E+00	3,1E-07	0,0E+00	3,4E-06	1,5E-08	-	-
Plomb	1,1E-07	5,0E-07	0,0E+00	6,5E-11	1,5E-06	5,0E-07	1,2E-05	5,3E-06	8,9E-06	2,9E-04	2,3E-06	5,0E-06	4,9E-06	2,5E-08	5,6E-07	0,0E+00	0,0E+00	2,8E-07	0,0E+00	1,2E-05	9,2E-09	-	-
Sélénium	3,5E-08	1,6E-07	0,0E+00	9,6E-09	1,8E-07	1,5E-07	7,0E-06	6,3E-07	2,7E-06	8,5E-05	6,7E-07	4,6E-04	9,5E-04	7,7E-09	1,8E-07	0,0E+00	0,0E+00	8,7E-08	0,0E+00	3,9E-06	5,5E-09	-	-
Strontium	4,0E-08	1,8E-07	0,0E+00	4,6E-06	5,9E-06	2,1E-07	3,3E-03	2,1E-05	3,7E-06	2,8E-02	2,2E-04	2,7E-03	5,8E-03	8,8E-09	2,0E-07	0,0E+00	0,0E+00	1,0E-07	0,0E+00	4,4E-06	2,6E-06	-	-
Titane	1,2E-07	5,3E-07	0,0E+00	5,4E-07	6,0E-05	8,7E-07	3,9E-04	2,1E-04	1,6E-05	1,5E-03	1,2E-05	3,2E-02	5,2E-02	2,6E-08	5,9E-07	0,0E+00	0,0E+00	2,9E-07	0,0E+00	1,3E-05	3,1E-07	-	-
Uranium	4,8E-10	2,1E-09	0,0E+00	1,0E-09	3,9E-06	2,5E-08	7,5E-07	1,4E-05	4,5E-07	3,4E-06	2,5E-08	2,8E-05	1,3E-06	1,1E-10	2,4E-09	0,0E+00	0,0E+00	1,2E-09	0,0E+00	5,3E-08	5,8E-10	-	-
Vanadium	3,7E-08	1,7E-07	0,0E+00	3,5E-09	2,6E-06	1,8E-07	2,5E-06	9,4E-06	3,2E-06	9,3E-05	7,4E-07	4,6E-05	2,9E-05	8,3E-09	1,9E-07	0,0E+00	0,0E+00	9,3E-08	0,0E+00	4,1E-06	2,0E-09	-	-
Zinc	3,9E-07	1,8E-06	0,0E+00	2,0E-06	3,0E-06	1,7E-06	2,4E-03	1,1E-05	3,1E-05	3,0E-02	2,7E-04	6,3E-02	1,4E-02	8,8E-08	2,0E-06	0,0E+00	0,0E+00	9,9E-07	0,0E+00	4,4E-05	1,9E-06	-	-
Recepteurs:	12 à 19 ans																						
Aluminium	3,3E-06	1,2E-05	0,0E+00	2,6E-07	1,9E-04	1,6E-05	1,5E-04	6,9E-04	9,9E-05	5,3E-02	3,7E-04	8,2E-03	3,7E-02	4,9E-07	1,4E-05	0,0E+00	0,0E+00	7,2E-06	0,0E+00	1,1E-04	1,4E-07	-	-
Antimoine	1,4E-08	4,9E-08	0,0E+00	4,4E-09	6,5E-09	5,2E-08	2,5E-06	2,3E-08	3,3E-07	2,2E-05	1,6E-07	3,1E-07	2,7E-06	2,0E-09	5,7E-08	0,0E+00	0,0E+00	3,0E-08	0,0E+00	4,6E-07	2,4E-09	-	-
Argent	1,1E-09	4,0E-09	0,0E+00	1,5E-10	1,9E-08	4,6E-09	1,4E-07	6,6E-08	2,9E-08	7,5E-06	5,3E-08	1,9E-05	4,4E-07	1,7E-10	4,7E-09	0,0E+00	0,0E+00	2,5E-09	0,0E+00	3,8E-08	1,3E-10	-	-
Arsenic	2,5E-08	8,9E-08	0,0E+00	2,2E-08	1,0E-06	4,0E-07	1,3E-05	9,1E-07	6,2E-07	4,2E-05	3,0E-07	1,5E-05	1,9E-04	3,7E-09	1,0E-07	0,0E+00	0,0E+00	2,2E-07	0,0E+00	8,4E-07	1,2E-08	-	-
Baryum	7,7E-08	2,8E-07	0,0E+00	5,0E-07	1,1E-06	3,2E-07	2,8E-04	4,1E-06	2,0E-06	3,0E-02	2,1E-04	9,6E-05	2,7E-03	1,2E-08	3,3E-07	0,0E+00	0,0E+00	1,7E-07	0,0E+00	2,7E-06	2,7E-07	-	-
Béryllium	4,0E-10	1,5E-09	0,0E+00	5,1E-10	2,7E-08	2,0E-09	2,9E-07	9,5E-08	1,3E-08	2,9E-06	2,0E-08	1,3E-07	6,8E-07	6,0E-11	1,7E-09	0,0E+00	0,0E+00	8,9E-10	0,0E+00	1,4E-08	2,7E-10	-	-
Bore	3,1E-07	1,1E-06	0,0E+00	6,2E-08	2,0E-06	1,2E-06	3,5E-05	7,0E-06	7,7E-06	4,4E-03	3,8E-05	3,9E-04	2,7E-04	4,7E-08	1,3E-06	0,0E+00	0,0E+00	6,9E-07	0,0E+00	1,1E-05	3,3E-08	-	-
Cadmium	3,9E-09	1,4E-08	0,0E+00	8,4E-10	1,8E-09	1,5E-09	4,8E-07	6,3E-08	9,5E-08	1,8E-05	1,3E-07	1,4E-06	3,5E-06	5,8E-10	1,6E-08	0,0E+00	0,0E+00	8,5E-10	0,0E+00	1,3E-07	4,5E-10	-	-
Chrome	2,8E-08	1,0E-07	0,0E+00	2,6E-08	2,1E-06	1,4E-07	1,5E-05	7,5E-06	8,9E-07	6,3E-05	4,4E-07	1,9E-04	1,7E-05	4,1E-09	1,2E-07	0,0E+00	0,0E+00	6,1E-08	0,0E+00	9,5E-07	1,4E-08	-	-
Cobalt	4,0E-09	1,4E-08	0,0E+00	1,2E-08	1,5E-07	1,8E-08	6,6E-06	5,4E-07	1,1E-07	4,6E-05	2,1E-06	1,2E-05	7,7E-06	6,0E-10	1,7E-08	0,0E+00	0,0E+00	8,8E-09	0,0E+00	1,4E-07	6,2E-09	-	-
Cuivre	3,7E-07	1,3E-06	0,0E+00	4,4E-05	4,5E-07	1,4E-06	2,5E-02	1,6E-06	8,9E-06	2,8E-03	2,0E-05	3,9E-04	1,2E-04	5,5E-08	1,5E-06	0,0E+00	0,0E+00	8,1E-07	0,0E+00	1,3E-05	2,4E-05	-	-
Étain	1,7E-08	6,0E-08	0,0E+00	4,4E-08	2,3E-07	6,8E-08	2,5E-05	8,2E-07	4,2E-07	1,8E-05	6,2E-07	8,5E-04	2,6E-03	2,5E-09	7,0E-08	0,0E+00	0,0E+00	3,6E-08	0,0E+00	5,7E-07	2,4E-08	-	-
Lithium	1,2E-09	4,4E-09	0,0E+00	1,1E-07	1,5E-07	7,3E-09	6,0E-05	5,3E-07	4,5E-08	3,1E-05	5,3E-07	2,1E-04	2,8E-05	1,8E-10	5,2E-09	0,0E+00	0,0E+00	2,7E-09	0,0E+00	4,2E-08	5,7E-08	-	-
Manganèse	1,5E-07	5,6E-07	0,0E+00	1,7E-07	2,6E-06	6,4E-07	9,5E-05	9,2E-06	4,0E-06	3,5E-01	2,5E-03	1,1E-03	2,9E-04	2,3E-08	6,5E-07	0,0E+00	0,0E+00	3,4E-07	0,0E+00	5,3E-06	9,0E-08	-	-
Mercure	5,9E-08	5,5E-07	1,2E-10	1,7E-09	1,7E-09	9,8E-11	9,8E-07	5,9E-09	6,1E-10	3,0E-06	2,7E-08	5,6E-05	6,6E-04	8,8E-09	6,4E-07	3,5E-11	0,0E+00	3,6E-11	0,0E+00	5,6E-10	9,3E-10	-	-
Molybdène	1,0E-08	3,6E-08	0,0E+00	2,7E-09	1,0E-07	4,0E-08	1,6E-06	3,7E-07	2,5E-07	5,9E-05	5,4E-07	3,2E-05	1,7E-05	1,5E-09	4,2E-08	0,0E+00	0,0E+00	2,2E-08	0,0E+00	3,4E-07	1,5E-09	-	-
Nickel	2,9E-08	1,0E-07	0,0E+00	2,1E-09	1,3E-06	4,6E-07	1,2E-05	1,2E-06	7,2E-07	9,4E-04	6,6E-06	1,8E-05	2,4E-05	4,3E-09	1,2E-07	0,0E+00	0,0E+00	2,5E-07	0,0E+00	9,8E-07	1,2E-08	-	-
Plomb	1,0E-07	3,8E-07	0,0E+00	5,3E-11	4,2E-07	4,1E-07	7,5E-06	1,5E-06	2,5E-06	1,6E-04	1,1E-06	3,5E-06	2,8E-06	1,6E-08	4,4E-07	0,0E+00	0,0E+00	2,3E-07	0,0E+00	3,6E-06	7,1E-09	-	-
Sélénium	3,2E-08	1,2E-07	0,0E+00	7,9E-09	5,1E-08	1,3E-07	4,5E-06	1,8E-07	7,8E-07	4,8E-05	3,4E-07	3,2E-04	5,5E-04	4,8E-09	1,4E-07	0,0E+00	0,0E+00	7,1E-08	0,0E+00	1,1E-06	4,2E-09	-	-
Strontium	3,7E-08	1,3E-07	0,0E+00	3,7E-06	1,7E-06	1,7E-07	2,1E-03	6,0E-06	1,1E-06	1,6E-02	1,1E-04	1,9E-03	3,4E-03	5,5E-09	1,6E-07	0,0E+00	0,0E+00	8,1E-08	0,0E+00	1,3E-06	2,0E-06	-	-
Titane	1,1E-07	4,0E-07	0,0E+00	4,4E-07	1,7E-05	7,1E-07	2,5E-04	6,1E-05	4,4E-06	8,5E-04	6,0E-06	2,2E-02	3,0E-02	1,6E-08	4,6E-07	0,0E+00	0,0E+00	2,4E-07	0,0E+00	3,7E-06	2,4E-07	-	-
Uranium	4,4E-10	1,6E-09	0,0E+00	8,4E-10	1,1E-06	2,1E-08	4,8E-07	4,0E-06	1,3E-07	1,9E-06	1,3E-08	1,9E-05	7,5E-07	6,6E-11	1,9E-09	0,0E+00	0,0E+00	9,8E-10	0,0E+00	1,5E-08	4,5E-10	-	-
Vanadium	3,5E-08	1,3E-07	0,0E+00	2,8E-09	7,5E-07	1,5E-07	1,6E-06	2,7E-06	9,1E-07	5,3E-05	3,7E-07	3,2E-05	1,7E-05	5,2E-09	1,5E-07	0,0E+00	0,0E+00	7,6E-08	0,0E+00	1,2E-06	1,5E-09	-	-
Zinc	3,7E-07	1,3E-06	0,0E+00	1,6E-06	8,7E-07	1,4E-06	1,5E-03	3,1E-06	8,9E-06	1,7E-02	1,4E-04	4,4E-02	8,1E-03	5,5E-08	1,5E-06	0,0E+00	0,0E+00	8,1E-07	0,0E+00	1,3E-05	1,4E-06	-	-

TABLEAU H-5 Doses d'exposition bruit de fond détaillées (mg/kg-pc par jour) - Scénario domestique

Voie d'exposition:	Inhalation		Cutané[a]				Ingestion							Inhalation		Cutané[a]			Ingestion		Inhalation	Ingestion	
Saison:	Été		Été	Été + hiver	Été		Été + hiver	Été		Été + hiver				Hiver		Hiver			Hiver		Été + hiver	Été	Hiver
Dose:	Air extérieur	Air intérieur	Air (int + ext)	Eau	Sol	Poussières intérieures	Eau	Sol	Poussières intérieures	Fruits	Légumes	Viande	Poisson	Air extérieur	Air intérieur	Air (int + ext)	Sol	Poussières intérieures	Sol	Poussières intérieures	Aérosols de douche	Lait maternel	Lait maternel
Recepteurs:	20 ans et plus																						
Aluminium	1,6E-06	9,5E-06	0,0E+00	2,5E-07	1,8E-04	1,5E-05	1,5E-04	5,6E-04	8,1E-05	2,9E-02	3,0E-04	1,0E-02	3,2E-02	3,5E-07	1,0E-05	0,0E+00	0,0E+00	6,8E-06	0,0E+00	9,1E-05	1,1E-07	-	-
Antimoine	6,5E-09	3,9E-08	0,0E+00	4,1E-09	6,1E-09	4,9E-08	2,6E-06	1,9E-08	2,6E-07	1,2E-05	1,3E-07	3,9E-07	2,4E-06	1,4E-09	4,3E-08	0,0E+00	0,0E+00	2,8E-08	0,0E+00	3,8E-07	1,8E-09	-	-
Argent	5,3E-10	3,2E-09	0,0E+00	1,4E-10	1,7E-08	4,3E-09	1,4E-07	5,4E-08	2,3E-08	4,1E-06	4,3E-08	2,3E-05	3,8E-07	1,2E-10	3,5E-09	0,0E+00	0,0E+00	2,3E-09	0,0E+00	3,1E-08	1,0E-10	-	-
Arsenic	1,2E-08	7,2E-08	0,0E+00	2,1E-08	9,6E-07	3,7E-07	1,3E-05	7,4E-07	5,0E-07	2,3E-05	2,4E-07	1,8E-05	1,6E-04	2,6E-09	7,8E-08	0,0E+00	0,0E+00	2,0E-07	0,0E+00	6,8E-07	8,9E-09	-	-
Baryum	3,7E-08	2,3E-07	0,0E+00	4,7E-07	1,1E-06	3,0E-07	2,9E-04	3,3E-06	1,6E-06	1,7E-02	1,7E-04	1,2E-04	2,3E-03	8,2E-09	2,5E-07	0,0E+00	0,0E+00	1,6E-07	0,0E+00	2,2E-06	2,0E-07	-	-
Béryllium	1,9E-10	1,2E-09	0,0E+00	4,8E-10	2,5E-08	1,9E-09	2,9E-07	7,8E-08	1,0E-08	1,6E-06	1,7E-08	1,6E-07	5,9E-07	4,3E-11	1,3E-09	0,0E+00	0,0E+00	8,4E-10	0,0E+00	1,1E-08	2,1E-10	-	-
Bore	1,5E-07	9,1E-07	0,0E+00	5,8E-08	1,9E-06	1,2E-06	3,6E-05	5,7E-06	6,3E-06	2,4E-03	3,1E-05	4,8E-04	2,4E-04	3,3E-08	9,9E-07	0,0E+00	0,0E+00	6,5E-07	0,0E+00	8,7E-06	2,5E-08	-	-
Cadmium	1,8E-09	1,1E-08	0,0E+00	7,9E-10	1,7E-09	1,4E-09	4,8E-07	5,1E-08	7,7E-08	9,8E-06	1,0E-07	1,7E-06	3,1E-06	4,1E-10	1,2E-08	0,0E+00	0,0E+00	8,0E-10	0,0E+00	1,1E-07	3,4E-10	-	-
Chrome	1,3E-08	8,1E-08	0,0E+00	2,5E-08	2,0E-06	1,3E-07	1,5E-05	6,1E-06	7,2E-07	3,4E-05	3,6E-07	2,3E-04	1,5E-05	2,9E-09	8,8E-08	0,0E+00	0,0E+00	5,7E-08	0,0E+00	7,7E-07	1,1E-08	-	-
Cobalt	1,9E-09	1,2E-08	0,0E+00	1,1E-08	1,4E-07	1,7E-08	6,7E-06	4,4E-07	9,1E-08	2,5E-05	1,7E-06	1,5E-05	6,7E-06	4,2E-10	1,3E-08	0,0E+00	0,0E+00	8,2E-09	0,0E+00	1,1E-07	4,7E-09	-	-
Cuivre	1,8E-07	1,1E-06	0,0E+00	4,1E-05	4,2E-07	1,3E-06	2,5E-02	1,3E-06	7,2E-06	1,5E-03	1,6E-05	4,8E-04	1,1E-04	3,9E-08	1,2E-06	0,0E+00	0,0E+00	7,6E-07	0,0E+00	1,0E-05	1,8E-05	-	-
Étain	7,9E-09	4,8E-08	0,0E+00	4,1E-08	2,2E-07	6,4E-08	2,6E-05	6,7E-07	3,4E-07	9,6E-06	5,0E-07	1,0E-03	2,2E-03	1,8E-09	5,2E-08	0,0E+00	0,0E+00	3,4E-08	0,0E+00	4,6E-07	1,8E-08	-	-
Lithium	5,9E-10	3,6E-09	0,0E+00	9,9E-08	1,4E-07	6,8E-09	6,1E-05	4,3E-07	3,7E-08	1,7E-05	4,3E-07	2,6E-04	2,4E-05	1,3E-10	3,9E-09	0,0E+00	0,0E+00	2,5E-09	0,0E+00	3,4E-08	4,3E-08	-	-
Manganèse	7,3E-08	4,5E-07	0,0E+00	1,6E-07	2,4E-06	6,0E-07	9,7E-05	7,5E-06	3,2E-06	1,9E-01	2,0E-03	1,4E-03	2,5E-04	1,6E-08	4,9E-07	0,0E+00	0,0E+00	3,2E-07	0,0E+00	4,3E-06	6,8E-08	-	-
Mercure	2,8E-08	4,4E-07	9,5E-11	1,6E-09	1,6E-09	9,2E-11	9,9E-07	4,8E-09	4,9E-10	1,6E-06	2,2E-08	7,0E-05	5,7E-04	6,3E-09	4,8E-07	3,6E-11	0,0E+00	3,4E-11	0,0E+00	4,5E-10	7,0E-10	-	-
Molybdène	4,8E-09	2,9E-08	0,0E+00	2,6E-09	9,7E-08	3,8E-08	1,6E-06	3,0E-07	2,0E-07	3,3E-05	4,4E-07	4,0E-05	1,5E-05	1,1E-09	3,2E-08	0,0E+00	0,0E+00	2,1E-08	0,0E+00	2,8E-07	1,1E-09	-	-
Nickel	1,4E-08	8,3E-08	0,0E+00	2,0E-09	1,3E-06	4,4E-07	1,2E-05	9,7E-07	5,9E-07	5,1E-04	5,4E-06	2,2E-05	2,1E-05	3,0E-09	9,1E-08	0,0E+00	0,0E+00	2,4E-07	0,0E+00	8,0E-07	8,7E-09	-	-
Plomb	5,0E-08	3,0E-07	0,0E+00	5,0E-11	4,0E-07	3,8E-07	7,7E-06	1,2E-06	2,1E-06	8,8E-05	9,2E-07	4,4E-06	2,4E-06	1,1E-08	3,3E-07	0,0E+00	0,0E+00	2,2E-07	0,0E+00	2,9E-06	5,4E-09	-	-
Sélénium	1,5E-08	9,4E-08	0,0E+00	7,4E-09	4,8E-08	1,2E-07	4,5E-06	1,5E-07	6,4E-07	2,6E-05	2,7E-07	4,0E-04	4,8E-04	3,4E-09	1,0E-07	0,0E+00	0,0E+00	6,7E-08	0,0E+00	9,0E-07	3,2E-09	-	-
Strontium	1,8E-08	1,1E-07	0,0E+00	3,5E-06	1,6E-06	1,6E-07	2,2E-03	4,9E-06	8,7E-07	8,7E-03	9,1E-05	2,3E-03	2,9E-03	3,9E-09	1,2E-07	0,0E+00	0,0E+00	7,6E-08	0,0E+00	1,0E-06	1,5E-06	-	-
Titane	5,2E-08	3,2E-07	0,0E+00	4,1E-07	1,6E-05	6,7E-07	2,6E-04	5,0E-05	3,6E-06	4,7E-04	4,9E-06	2,8E-02	2,6E-02	1,2E-08	3,5E-07	0,0E+00	0,0E+00	2,3E-07	0,0E+00	3,0E-06	1,8E-07	-	-
Uranium	2,1E-10	1,3E-09	0,0E+00	7,9E-10	1,0E-06	1,9E-08	4,8E-07	3,2E-06	1,0E-07	1,0E-06	1,0E-08	2,4E-05	6,5E-07	4,7E-11	1,4E-09	0,0E+00	0,0E+00	9,2E-10	0,0E+00	1,2E-08	3,4E-10	-	-
Vanadium	1,7E-08	1,0E-07	0,0E+00	2,7E-09	7,1E-07	1,4E-07	1,6E-06	2,2E-06	7,4E-07	2,9E-05	3,0E-07	4,0E-05	1,5E-05	3,7E-09	1,1E-07	0,0E+00	0,0E+00	7,1E-08	0,0E+00	9,6E-07	1,1E-09	-	-
Zinc	1,8E-07	1,1E-06	0,0E+00	1,5E-06	8,2E-07	1,3E-06	1,6E-03	2,5E-06	7,2E-06	9,2E-03	1,1E-04	5,4E-02	7,0E-03	3,9E-08	1,2E-06	0,0E+00	0,0E+00	7,6E-07	0,0E+00	1,0E-05	1,1E-06	-	-

a: Les valeurs fournies correspondent aux doses absorbées par voie cutanée.

TABLEAU H-6 Doses d'exposition additionnelles détaillées (mg/kg-pc par jour) - Scénario domestique

Voie d'exposition:	Inhalation		Cutané[a]				Ingestion							Inhalation		Cutané[a]			Ingestion		Inhalation	Ingestion	
Saison:	Été		Été	Été + hiver	Été		Été + hiver	Été		Été + hiver				Hiver		Hiver			Hiver		Été + hiver	Été	Hiver
Dose:	Air extérieur	Air intérieur	Air (int + ext)	Eau	Sol	Poussières intérieures	Eau	Sol	Poussières intérieures	Fruits	Légumes	Viande	Poisson	Air extérieur	Air intérieur	Air (int + ext)	Sol	Poussières intérieures	Sol	Poussières intérieures	Aérosols de douche	Lait maternel	Lait maternel
Récepteurs:	0-6 mois																						
Aluminium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,2E-04	1,1E-04	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,2E-06	1,2E-06
Antimoine	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,3E-09	7,1E-10	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,4E-12	2,4E-12
Argent	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,8E-09	9,2E-10	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,3E-09	2,3E-09
Arsenic	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	4,1E-08	2,2E-08	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,0E-10	1,0E-10
Baryum	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,3E-06	1,1E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	7,1E-08	7,1E-08
Béryllium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	9,0E-09	4,9E-09	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	3,6E-13	3,6E-13
Bore	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	5,3E-07	8,7E-08	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	8,3E-09	8,3E-09
Cadmium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,2E-09	6,7E-10	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	4,7E-11	4,7E-11
Chrome	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,0E-06	1,4E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,8E-08	2,8E-08
Cobalt	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	3,5E-07	8,2E-08	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	5,6E-09	5,6E-09
Cuivre	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	4,3E-07	5,7E-08	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,6E-08	2,6E-08
Étain	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,7E-08	7,1E-09	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	9,0E-09	9,0E-09
Lithium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	7,1E-07	3,7E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,6E-06	1,6E-06
Manganèse	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	6,4E-06	2,6E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,5E-08	1,5E-08
Mercure	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,7E-10	6,7E-11	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,0E-09	2,0E-09
Molybdène	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	9,6E-09	3,3E-09	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	8,6E-10	8,6E-10
Nickel	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	9,8E-07	8,1E-08	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,2E-07	1,2E-07
Plomb	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	4,2E-08	1,7E-08	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	9,5E-11	9,5E-11
Sélénium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,3E-08	1,1E-09	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,2E-08	2,2E-08
Strontium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	7,3E-07	6,0E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	8,7E-08	8,7E-08
Titane	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,6E-04	2,5E-05	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,4E-04	1,4E-04
Uranium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	5,3E-09	9,2E-10	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,2E-11	2,2E-11
Vanadium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	3,7E-06	5,7E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,2E-09	1,2E-09
Zinc	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,0E-06	2,8E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	6,3E-06	6,3E-06
Recepteurs:	0,5 à 4 ans																						
Aluminium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,0E-03	5,0E-05	1,1E-04	1,4E-03	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Antimoine	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	5,9E-09	3,2E-10	4,6E-10	4,5E-09	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Argent	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,3E-08	4,1E-10	1,2E-08	5,1E-09	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Arsenic	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,9E-07	1,0E-08	2,9E-08	2,0E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Baryum	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	6,0E-06	4,9E-07	2,5E-07	4,2E-05	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Béryllium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	4,1E-08	2,2E-09	9,6E-10	3,9E-08	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Bore	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,4E-06	3,9E-08	4,5E-08	8,2E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Cadmium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,0E-08	3,0E-10	1,6E-09	8,5E-09	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Chrome	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	4,6E-06	6,3E-08	1,6E-06	1,8E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Cobalt	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,6E-06	3,7E-08	1,1E-07	1,5E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Cuivre	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,0E-06	2,6E-08	1,4E-06	1,2E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Étain	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	7,9E-08	3,2E-09	6,8E-07	1,7E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Lithium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	3,3E-06	1,7E-07	1,4E-05	2,7E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Manganèse	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,9E-05	1,2E-06	2,4E-06	1,6E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Mercure	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	7,6E-10	3,0E-11	2,6E-07	8,0E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Molybdène	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	4,4E-08	1,5E-09	5,9E-08	4,6E-08	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Nickel	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	4,5E-06	3,6E-08	5,2E-08	2,4E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Plomb	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,9E-07	7,8E-09	1,4E-08	7,9E-09	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Sélénium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	5,8E-08	4,8E-10	2,0E-07	3,3E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Strontium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	3,3E-06	2,7E-07	3,1E-06	7,3E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Titane	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	7,4E-04	1,1E-05	2,0E-03	1,1E-03	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Uranium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,4E-08	4,2E-10	3,6E-10	2,7E-09	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Vanadium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,7E-05	2,5E-07	3,8E-06	6,9E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Zinc	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	9,2E-06	1,3E-07	9,8E-05	3,5E-05	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-

TABLEAU H-6 Doses d'exposition additionnelles détaillées (mg/kg-pc par jour) - Scénario domestique

Voie d'exposition:	Inhalation		Cutané[a]				Ingestion							Inhalation		Cutané[a]			Ingestion		Inhalation	Ingestion	
Saison:	Été		Été	Été + hiver	Été		Été + hiver	Été		Été + hiver				Hiver		Hiver			Hiver		Été + hiver	Été	Hiver
Dose:	Air extérieur	Air intérieur	Air (int + ext)	Eau	Sol	Poussières intérieures	Eau	Sol	Poussières intérieures	Fruits	Légumes	Viande	Poisson	Air extérieur	Air intérieur	Air (int + ext)	Sol	Poussières intérieures	Sol	Poussières intérieures	Aérosols de douche	Lait maternel	Lait maternel
Recepteurs:	5 à 11 ans																						
Aluminium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	5,8E-04	2,4E-05	8,0E-05	1,1E-03	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Antimoine	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	3,4E-09	1,6E-10	3,4E-10	3,5E-09	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Argent	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	7,4E-09	2,0E-10	8,8E-09	4,0E-09	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Arsenic	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,1E-07	4,9E-09	2,1E-08	1,5E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Baryum	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	3,5E-06	2,4E-07	1,8E-07	3,3E-05	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Béryllium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,4E-08	1,1E-09	7,1E-10	3,1E-08	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Bore	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,4E-06	1,9E-08	3,3E-08	6,4E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Cadmium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	5,9E-09	1,5E-10	1,2E-09	6,7E-09	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Chrome	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,7E-06	3,1E-08	1,2E-06	1,4E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Cobalt	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	9,2E-07	1,8E-08	7,8E-08	1,2E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Cuivre	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,1E-06	1,3E-08	1,0E-06	9,4E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Étain	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	4,6E-08	1,6E-09	5,0E-07	1,3E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Lithium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,9E-06	8,1E-08	1,1E-05	2,1E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Manganèse	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,7E-05	5,8E-07	1,8E-06	1,3E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Mercure	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	4,4E-10	1,5E-11	1,9E-07	6,3E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Molybdène	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,5E-08	7,2E-10	4,4E-08	3,6E-08	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Nickel	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,6E-06	1,8E-08	3,9E-08	1,9E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Plomb	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,1E-07	3,8E-09	1,0E-08	6,2E-09	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Sélénium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	3,4E-08	2,3E-10	1,5E-07	2,6E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Strontium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,9E-06	1,3E-07	2,3E-06	5,7E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Titane	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	4,3E-04	5,4E-06	1,4E-03	8,3E-04	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Uranium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,4E-08	2,0E-10	2,7E-10	2,1E-09	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Vanadium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	9,9E-06	1,2E-07	2,8E-06	5,4E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Zinc	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	5,4E-06	6,1E-08	7,2E-05	2,7E-05	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Recepteurs:	12 à 19 ans																						
Aluminium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	3,3E-04	1,2E-05	5,6E-05	6,3E-04	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Antimoine	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,9E-09	7,8E-11	2,4E-10	2,0E-09	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Argent	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	4,2E-09	1,0E-10	6,2E-09	2,3E-09	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Arsenic	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	6,1E-08	2,5E-09	1,5E-08	8,9E-08	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Baryum	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,0E-06	1,2E-07	1,3E-07	1,9E-05	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Béryllium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,3E-08	5,4E-10	5,0E-10	1,8E-08	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Bore	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	7,9E-07	9,6E-09	2,3E-08	3,7E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Cadmium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	3,3E-09	7,4E-11	8,1E-10	3,9E-09	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Chrome	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,5E-06	1,5E-08	8,2E-07	8,0E-08	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Cobalt	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	5,2E-07	9,0E-09	5,5E-08	6,8E-08	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Cuivre	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	6,4E-07	6,3E-09	7,1E-07	5,4E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Étain	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,6E-08	7,9E-10	3,5E-07	7,6E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Lithium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,1E-06	4,0E-08	7,4E-06	1,2E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Manganèse	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	9,5E-06	2,9E-07	1,3E-06	7,4E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Mercure	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,5E-10	7,4E-12	1,4E-07	3,6E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Molybdène	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,4E-08	3,6E-10	3,1E-08	2,1E-08	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Nickel	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,5E-06	8,9E-09	2,7E-08	1,1E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Plomb	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	6,3E-08	1,9E-09	7,2E-09	3,6E-09	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Sélénium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,9E-08	1,2E-10	1,0E-07	1,5E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Strontium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,1E-06	6,6E-08	1,6E-06	3,3E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Titane	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,4E-04	2,7E-06	1,0E-03	4,8E-04	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Uranium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	7,9E-09	1,0E-10	1,9E-10	1,2E-09	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Vanadium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	5,6E-06	6,2E-08	1,9E-06	3,1E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Zinc	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	3,0E-06	3,1E-08	5,1E-05	1,6E-05	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-

TABLEAU H-6 Doses d'exposition additionnelles détaillées (mg/kg-pc par jour) - Scénario domestique

Voie d'exposition:	Inhalation		Cutané[a]				Ingestion							Inhalation		Cutané[a]			Ingestion		Inhalation	Ingestion	
Saison:	Été		Été	Été + hiver	Été		Été + hiver	Été		Été + hiver				Hiver		Hiver			Hiver		Été + hiver	Été	Hiver
Dose:	Air extérieur	Air intérieur	Air (int + ext)	Eau	Sol	Poussières intérieures	Eau	Sol	Poussières intérieures	Fruits	Légumes	Viande	Poisson	Air extérieur	Air intérieur	Air (int + ext)	Sol	Poussières intérieures	Sol	Poussières intérieures	Aérosols de douche	Lait maternel	Lait maternel
Recepteurs:	20 ans et plus																						
Aluminium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,8E-04	9,9E-06	6,9E-05	5,5E-04	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Antimoine	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,1E-09	6,4E-11	2,9E-10	1,8E-09	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Argent	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,3E-09	8,2E-11	7,6E-09	2,0E-09	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Arsenic	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	3,3E-08	2,0E-09	1,9E-08	7,7E-08	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Baryum	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,1E-06	9,7E-08	1,6E-07	1,6E-05	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Béryllium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	7,3E-09	4,4E-10	6,2E-10	1,5E-08	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Bore	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	4,3E-07	7,8E-09	2,9E-08	3,2E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Cadmium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,8E-09	6,0E-11	1,0E-09	3,4E-09	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Chrome	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	8,3E-07	1,3E-08	1,0E-06	6,9E-08	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Cobalt	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	2,8E-07	7,4E-09	6,8E-08	5,9E-08	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Cuivre	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	3,5E-07	5,1E-09	8,8E-07	4,7E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Étain	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,4E-08	6,4E-10	4,3E-07	6,6E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Lithium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	5,8E-07	3,3E-08	9,1E-06	1,1E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Manganèse	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	5,2E-06	2,4E-07	1,6E-06	6,4E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Mercure	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,4E-10	6,0E-12	1,7E-07	3,1E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Molybdène	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	7,8E-09	2,9E-10	3,8E-08	1,8E-08	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Nickel	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	8,0E-07	7,2E-09	3,3E-08	9,5E-08	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Plomb	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	3,4E-08	1,6E-09	8,9E-09	3,1E-09	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Sélénium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,0E-08	9,5E-11	1,3E-07	1,3E-07	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Strontium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	5,9E-07	5,4E-08	2,0E-06	2,9E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Titane	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,3E-04	2,2E-06	1,3E-03	4,2E-04	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Uranium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	4,3E-09	8,3E-11	2,3E-10	1,1E-09	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Vanadium	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	3,1E-06	5,1E-08	2,4E-06	2,7E-06	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-
Zinc	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	1,6E-06	2,5E-08	6,3E-05	1,4E-05	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	0,0E+00	-	-

a: Les valeurs fournies correspondent aux doses absorbées par voie cutanée.

ANNEXE I

Détail des indices de risque estimés pour l’exposition aux métaux par voies multiples

TABLEAU I-1 Détail des indices de risque sous-chroniques et chroniques - Scénario "Relais routier"

Période d'exposition:	Sous-chronique						Chronique					
Groupe d'âge:	0-6 mois			20 ans et +			0-6 mois			20 ans et +		
Substance	IR_{BF}	IR_{Add}	IR_{Tot}	IR_{BF}	IR_{Add}	IR_{Tot}	IR_{BF}	IR_{Add}	IR_{Tot}	IR_{BF}	IR_{Add}	IR_{Tot}
Aluminium	6,9E-02	2,1E-06	6,9E-02	1,6E-01	1,2E-03	1,6E-01	6,6E-02	9,6E-07	6,6E-02	1,6E-01	6,1E-04	1,6E-01
Antimoine	5,1E-01	1,2E-08	5,1E-01	1,2E-01	1,5E-05	1,2E-01	1,0E+00	1,2E-08	1,0E+00	2,4E-01	1,5E-05	2,4E-01
Argent	5,9E-01	8,3E-07	5,9E-01	1,3E-01	3,0E-06	1,3E-01	5,9E-01	3,5E-07	5,9E-01	1,3E-01	1,7E-06	1,3E-01
Arsenic	**695**	4,1E-05	**695**	**165**	5,1E-02	**165**	**695**	1,9E-05	**695**	**165**	2,4E-02	**165**
Baryum	9,9E-02	3,3E-07	9,9E-02	3,3E-02	6,5E-05	3,3E-02	9,8E-02	1,4E-07	9,8E-02	3,3E-02	3,5E-05	3,3E-02
Béryllium	8,9E-03	4,9E-09	8,9E-03	4,0E-03	1,9E-04	4,2E-03	8,6E-03	1,9E-09	8,6E-03	2,9E-03	1,2E-04	3,0E-03
Bore	5,6E-01	3,7E-08	5,6E-01	7,7E-02	2,7E-06	7,7E-02	5,6E-01	1,6E-08	5,6E-01	7,7E-02	1,2E-06	7,7E-02
Cadmium	-	-	-	-	-	-	**2,6**	2,0E-07	**2,6**	**2,0**	2,3E-05	**2,0**
Chrome	8,9E-02	6,1E-05	8,9E-02	1,9E-01	2,5E-03	1,9E-01	7,0E-02	2,4E-05	7,0E-02	1,5E-01	1,5E-03	1,5E-01
Cobalt	3,1E-02	4,5E-07	3,1E-02	7,7E-03	2,5E-05	7,7E-03	3,1E-02	2,0E-07	3,1E-02	7,7E-03	1,1E-05	7,7E-03
Cuivre	**1,8**	6,9E-08	**1,8**	3,4E-01	4,8E-06	3,4E-01	**1,8**	3,0E-08	**1,8**	3,4E-01	2,2E-06	3,4E-01
Étain	3,9E-01	1,3E-09	3,9E-01	7,7E-02	1,6E-07	7,7E-02	**3,9**	5,6E-09	**3,9**	7,7E-01	7,0E-07	7,7E-01
Lithium	**3,0**	2,0E-04	**3,0**	**1,4**	1,3E-03	**1,4**	**3,0**	8,8E-05	**3,0**	**1,4**	5,5E-04	**1,4**
Manganèse	5,5E-01	5,6E-07	5,5E-01	3,6E-01	1,7E-04	3,6E-01	5,5E-01	2,5E-07	5,5E-01	3,6E-01	8,8E-05	3,6E-01
Mercure	6,8E-02	6,6E-11	6,8E-02	3,1E-02	2,0E-11	3,1E-02	4,5E-01	2,1E-10	4,5E-01	2,1E-01	6,4E-11	2,1E-01
Molybdène	4,8E-01	1,3E-08	4,8E-01	8,8E-02	7,2E-07	8,8E-02	4,8E-01	5,8E-09	4,8E-01	8,8E-02	3,1E-07	8,8E-02
Nickel	**1,3**	9,0E-05	**1,3**	2,8E-01	3,6E-04	2,8E-01	**1,2**	3,5E-05	**1,2**	2,8E-01	2,2E-04	2,8E-01
Plomb	1,2E-01	8,0E-08	1,2E-01	4,0E-02	3,0E-05	4,0E-02	1,2E-01	3,4E-08	1,2E-01	4,0E-02	1,3E-05	4,0E-02
Sélénium	**1,1**	3,2E-07	**1,1**	4,7E-01	3,0E-06	4,7E-01	**1,1**	1,4E-07	**1,1**	4,7E-01	1,7E-06	4,7E-01
Strontium	4,6E-02	4,1E-08	4,6E-02	1,0E-02	2,6E-06	1,0E-02	6,5E-02	2,8E-08	6,5E-02	1,5E-02	1,7E-06	1,5E-02
Titane	1,5E-02	1,9E-05	1,5E-02	3,6E-03	1,7E-04	3,8E-03	1,5E-02	7,7E-06	1,5E-02	3,5E-03	9,9E-05	3,6E-03
Uranium	4,9E-02	6,2E-09	4,9E-02	1,8E-02	1,2E-06	1,8E-02	4,6E-01	3,0E-08	4,6E-01	1,7E-01	5,7E-06	1,7E-01
Vanadium	1,5E-01	3,0E-07	1,5E-01	3,8E-02	1,3E-03	3,9E-02	**1,5**	1,2E-06	**1,5**	3,6E-01	7,5E-03	3,7E-01
Zinc	**1,5**	3,1E-07	**1,5**	3,1E-01	3,4E-06	3,1E-01	**1,5**	1,4E-07	**1,5**	3,1E-01	1,5E-06	3,1E-01

- : VTR non disponible pour la période d'exposition concernée

TABLEAU I-2 Détail des indices de risque sous-chroniques - Scénario "Activités traditionnelles"

Groupe d'âge:	0-6 mois			0,5 à 4 ans			5 à 11 ans			12 à 19 ans			20 ans et +		
Substance	IR_{BF}	IR_{Add}	IR_{Tot}	IR_{BF}	IR_{Add}	IR_{Tot}	IR_{BF}	IR_{Add}	IR_{Tot}	IR_{BF}	IR_{Add}	IR_{Tot}	IR_{BF}	IR_{Add}	IR_{Tot}
Aluminium	8,3E-02	3,7E-03	8,6E-02	5,3E-01	1,1E-02	5,4E-01	3,4E-01	4,9E-03	3,5E-01	2,0E-01	2,6E-03	2,0E-01	1,4E-01	2,1E-03	1,5E-01
Antimoine	1,2E-01	5,5E-05	1,2E-01	4,1E-01	1,4E-04	4,1E-01	2,4E-01	5,6E-05	2,4E-01	1,4E-01	2,8E-05	1,4E-01	8,3E-02	2,2E-05	8,3E-02
Argent	4,7E-03	8,5E-06	4,7E-03	2,4E-02	2,2E-05	2,4E-02	1,6E-02	1,1E-05	1,6E-02	1,1E-02	6,4E-06	1,1E-02	1,1E-02	5,9E-06	1,1E-02
Arsenic	**35,3**	2,0E-01	**35,5**	**341**	5,4E-01	**342**	**248**	2,3E-01	**248**	**144**	1,2E-01	**144**	**121**	9,4E-02	**121**
Baryum	2,2E-01	1,8E-04	2,2E-01	1,0E+00	7,5E-04	1,0E+00	5,9E-01	4,3E-04	5,9E-01	3,3E-01	2,4E-04	3,4E-01	1,9E-01	2,0E-04	1,9E-01
Béryllium	3,5E-03	2,1E-04	3,7E-03	1,6E-02	3,0E-04	1,7E-02	1,1E-02	1,7E-04	1,1E-02	5,2E-03	1,1E-04	5,3E-03	3,7E-03	9,6E-05	3,8E-03
Bore	3,3E-02	1,7E-05	3,3E-02	1,5E-01	5,3E-05	1,5E-01	8,8E-02	2,5E-05	8,8E-02	5,1E-02	1,3E-05	5,1E-02	3,1E-02	8,9E-06	3,1E-02
Cadmium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chrome	1,2E-01	4,2E-03	1,2E-01	7,6E-01	1,0E-02	7,7E-01	5,3E-01	5,3E-03	5,3E-01	3,0E-01	3,2E-03	3,0E-01	3,1E-01	2,7E-03	3,1E-01
Cobalt	5,7E-03	1,4E-04	5,9E-03	2,0E-02	3,8E-04	2,0E-02	1,2E-02	1,5E-04	1,2E-02	7,1E-03	7,6E-05	7,1E-03	5,1E-03	5,1E-05	5,2E-03
Cuivre	**1,1**	3,0E-05	**1,1**	8,8E-01	1,3E-04	8,8E-01	4,6E-01	6,4E-05	4,6E-01	2,5E-01	3,3E-05	2,5E-01	2,1E-01	2,6E-05	2,1E-01
Étain	6,4E-04	8,0E-07	6,4E-04	4,9E-02	1,7E-05	4,9E-02	3,8E-02	1,3E-05	3,8E-02	2,3E-02	7,7E-06	2,3E-02	2,2E-02	7,4E-06	2,2E-02
Lithium	2,0E-01	7,2E-03	2,0E-01	6,4E-01	2,7E-02	6,7E-01	4,5E-01	1,5E-02	4,7E-01	3,0E-01	9,2E-03	3,1E-01	3,3E-01	1,0E-02	3,4E-01
Manganèse	**3,7**	6,5E-04	**3,7**	**16,0**	1,4E-03	**16,0**	**10,4**	5,8E-04	**10,4**	**5,0**	2,5E-04	**5,0**	**2,5**	1,6E-04	**2,5**
Mercure	6,7E-03	2,2E-06	6,7E-03	**1,6**	1,1E-03	**1,6**	**1,2**	8,2E-04	**1,2**	7,2E-01	5,0E-04	7,2E-01	6,4E-01	4,8E-04	6,4E-01
Molybdène	4,3E-03	4,6E-06	4,3E-03	2,5E-02	2,0E-05	2,5E-02	1,6E-02	1,1E-05	1,6E-02	8,1E-03	5,2E-06	8,1E-03	6,3E-03	4,9E-06	6,3E-03
Nickel	1,5E-01	6,5E-04	1,5E-01	5,5E-01	1,4E-03	5,6E-01	3,3E-01	7,4E-04	3,3E-01	1,8E-01	4,4E-04	1,8E-01	1,1E-01	3,0E-04	1,1E-01
Plomb	8,2E-02	1,5E-04	8,2E-02	3,1E-01	3,4E-04	3,1E-01	1,7E-01	1,2E-04	1,7E-01	9,7E-02	5,5E-05	9,7E-02	5,6E-02	3,7E-05	5,6E-02
Sélénium	4,9E-02	2,1E-05	4,9E-02	8,0E-01	2,5E-04	8,0E-01	6,0E-01	1,8E-04	6,0E-01	3,7E-01	1,1E-04	3,7E-01	3,6E-01	1,1E-04	3,6E-01
Strontium	1,6E-02	9,1E-06	1,6E-02	6,3E-02	2,8E-05	6,3E-02	3,8E-02	1,3E-05	3,8E-02	2,2E-02	7,2E-06	2,2E-02	1,5E-02	6,5E-06	1,5E-02
Titane	3,9E-03	5,1E-04	4,5E-03	7,5E-02	3,0E-03	7,8E-02	5,7E-02	1,9E-03	5,9E-02	3,6E-02	1,2E-03	3,7E-02	3,6E-02	1,3E-03	3,7E-02
Uranium	7,0E-03	5,9E-06	7,0E-03	2,3E-02	1,6E-05	2,3E-02	1,4E-02	7,1E-06	1,4E-02	8,2E-03	3,7E-06	8,2E-03	9,3E-03	2,3E-06	9,3E-03
Vanadium	1,2E-02	2,9E-03	1,5E-02	6,3E-02	8,8E-03	7,2E-02	4,0E-02	4,6E-03	4,5E-02	2,3E-02	2,7E-03	2,5E-02	1,9E-02	2,1E-03	2,1E-02
Zinc	8,5E-02	4,9E-05	8,5E-02	6,5E-01	6,2E-04	6,5E-01	4,2E-01	4,2E-04	4,2E-01	2,6E-01	2,6E-04	2,6E-01	2,5E-01	2,8E-04	2,5E-01

- : VTR non disponible pour la période d'exposition concernée

TABLEAU I-3 Détail des indices de risque chroniques - Scénario combiné

Groupe d'âge:	0-6 mois			0,5 à 4 ans			5 à 11 ans			12 à 19 ans			20 ans et +		
Substance	IR_{BF}	IR_{Add}	IR_{Tot}	IR_{BF}	IR_{Add}	IR_{Tot}	IR_{BF}	IR_{Add}	IR_{Tot}	IR_{BF}	IR_{Add}	IR_{Tot}	IR_{BF}	IR_{Add}	IR_{Tot}
Aluminium	7,6E-02	1,5E-03	7,8E-02	4,6E-01	5,0E-03	4,7E-01	3,6E-01	2,7E-03	3,6E-01	2,3E-01	1,5E-03	2,3E-01	1,5E-01	1,2E-03	1,5E-01
Antimoine	4,7E-01	4,4E-05	4,7E-01	8,1E-01	1,2E-04	8,1E-01	4,8E-01	5,8E-05	4,8E-01	2,7E-01	3,0E-05	2,7E-01	1,9E-01	2,5E-05	1,9E-01
Argent	1,8E-01	3,9E-06	1,8E-01	1,5E-01	1,1E-05	1,5E-01	9,3E-02	6,1E-06	9,3E-02	5,4E-02	3,7E-06	5,4E-02	4,8E-02	3,7E-06	4,8E-02
Arsenic	**235**	7,9E-02	**235**	**398**	2,5E-01	**399**	**273**	1,2E-01	**273**	**158**	6,6E-02	**158**	**134**	5,6E-02	**134**
Baryum	1,9E-01	7,2E-05	1,9E-01	7,3E-01	4,2E-04	7,3E-01	4,4E-01	2,7E-04	4,4E-01	2,5E-01	1,5E-04	2,5E-01	1,4E-01	1,3E-04	1,5E-01
Béryllium	4,9E-03	1,0E-04	5,0E-03	1,5E-02	1,4E-04	1,5E-02	9,9E-03	8,9E-05	1,0E-02	4,6E-03	6,0E-05	4,6E-03	3,5E-03	5,3E-05	3,5E-03
Bore	1,9E-01	7,3E-06	1,9E-01	1,9E-01	2,5E-05	1,9E-01	1,0E-01	1,3E-05	1,0E-01	5,8E-02	6,6E-06	5,8E-02	4,5E-02	5,1E-06	4,5E-02
Cadmium	9,8E-01	9,4E-05	9,8E-01	2,5	3,5E-04	2,5	2,0	1,9E-04	2,0	1,2	1,0E-04	1,2	8,0E-01	8,7E-05	8,0E-01
Chrome	9,2E-02	2,1E-03	9,4E-02	7,0E-01	4,9E-03	7,0E-01	4,8E-01	2,8E-03	4,9E-01	2,7E-01	1,7E-03	2,7E-01	2,6E-01	1,6E-03	2,6E-01
Cobalt	1,4E-02	5,9E-05	1,4E-02	2,2E-02	1,6E-04	2,2E-02	1,4E-02	7,1E-05	1,4E-02	8,4E-03	3,5E-05	8,4E-03	5,9E-03	2,7E-05	6,0E-03
Cuivre	**1,3**	1,3E-05	**1,3**	9,8E-01	7,2E-05	9,8E-01	5,4E-01	3,7E-05	5,4E-01	3,0E-01	1,9E-05	3,0E-01	2,5E-01	1,7E-05	2,5E-01
Étain	**1,2**	3,4E-06	**1,2**	**1,2**	1,2E-04	**1,2**	7,5E-01	8,7E-05	7,5E-01	6,5E-01	5,3E-05	6,5E-01	3,9E-01	5,2E-05	3,9E-01
Lithium	**1,1**	3,3E-03	**1,1**	**1,5**	1,5E-02	**1,5**	9,8E-01	9,0E-03	9,9E-01	6,3E-01	5,9E-03	6,4E-01	6,5E-01	6,9E-03	6,6E-01
Manganèse	**2,8**	2,7E-04	**2,8**	**11,4**	5,9E-04	**11,4**	**7,4**	2,6E-04	**7,4**	**3,6**	1,1E-04	**3,6**	**1,9**	8,3E-05	**1,9**
Mercure	1,7E-01	1,0E-05	1,7E-01	**7,4**	4,9E-03	**7,4**	**5,8**	3,8E-03	**5,8**	**3,4**	2,3E-03	**3,4**	**3,1**	2,2E-03	**3,1**
Molybdène	1,5E-01	1,9E-06	1,5E-01	1,3E-01	1,1E-05	1,3E-01	9,0E-02	6,4E-06	9,0E-02	4,4E-02	3,2E-06	4,4E-02	3,1E-02	3,2E-06	3,1E-02
Nickel	4,8E-01	3,3E-04	4,8E-01	6,5E-01	6,5E-04	6,5E-01	4,0E-01	3,6E-04	4,0E-01	2,3E-01	2,0E-04	2,3E-01	1,6E-01	1,6E-04	1,6E-01
Plomb	9,3E-02	5,9E-05	9,3E-02	2,5E-01	1,4E-04	2,5E-01	1,4E-01	5,2E-05	1,4E-01	8,0E-02	2,4E-05	8,0E-02	5,1E-02	1,9E-05	5,1E-02
Sélénium	3,8E-01	1,2E-05	3,8E-01	9,5E-01	1,6E-04	9,5E-01	7,3E-01	1,2E-04	7,3E-01	4,4E-01	7,4E-05	4,4E-01	3,9E-01	7,5E-05	3,9E-01
Strontium	3,5E-02	5,1E-06	3,5E-02	7,7E-02	2,0E-05	7,7E-02	4,8E-02	1,1E-05	4,8E-02	2,8E-02	6,2E-06	2,8E-02	1,9E-02	5,8E-06	1,9E-02
Titane	7,1E-03	2,6E-04	7,4E-03	5,6E-02	1,8E-03	5,8E-02	4,2E-02	1,3E-03	4,3E-02	2,6E-02	8,0E-04	2,7E-02	2,6E-02	8,5E-04	2,7E-02
Uranium	1,7E-01	2,6E-05	1,7E-01	2,5E-01	7,2E-05	2,5E-01	1,5E-01	3,3E-05	1,5E-01	9,3E-02	1,7E-05	9,3E-02	1,2E-01	1,2E-05	1,2E-01
Vanadium	5,2E-01	1,4E-02	5,4E-01	8,1E-01	4,4E-02	8,5E-01	5,1E-01	2,5E-02	5,3E-01	2,8E-01	1,4E-02	3,0E-01	2,4E-01	1,3E-02	2,5E-01
Zinc	5,1E-01	2,8E-05	5,1E-01	7,9E-01	4,1E-04	7,9E-01	5,1E-01	2,8E-04	5,1E-01	3,1E-01	1,8E-04	3,1E-01	2,7E-01	1,9E-04	2,7E-01

- : VTR non disponible pour la période d'exposition concernée

9935, rue de Châteauneuf
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APPENDIX

A-154

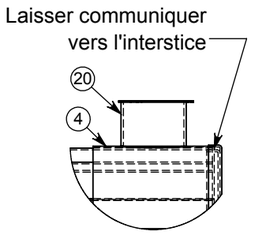
ABOVEGROUND STORAGE TANK

R8114GC-84586

1x S601CHDP84586L 118po

Date de livraison

RÉSERVOIR DE STOCKAGE HORS-SOL CYLINDRIQUE HORIZONTAL À CONFINEMENT SECONDAIRE INTÉGRAL POUR PRODUITS PÉTROLIERS SELON SPEC. CAN/ULC-S601-14



DÉTAIL B
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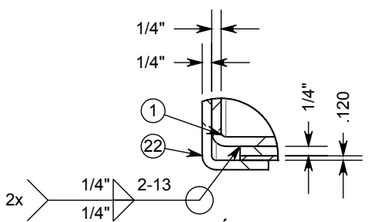
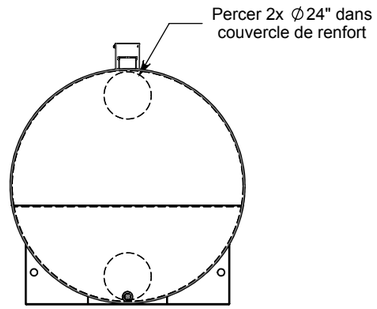
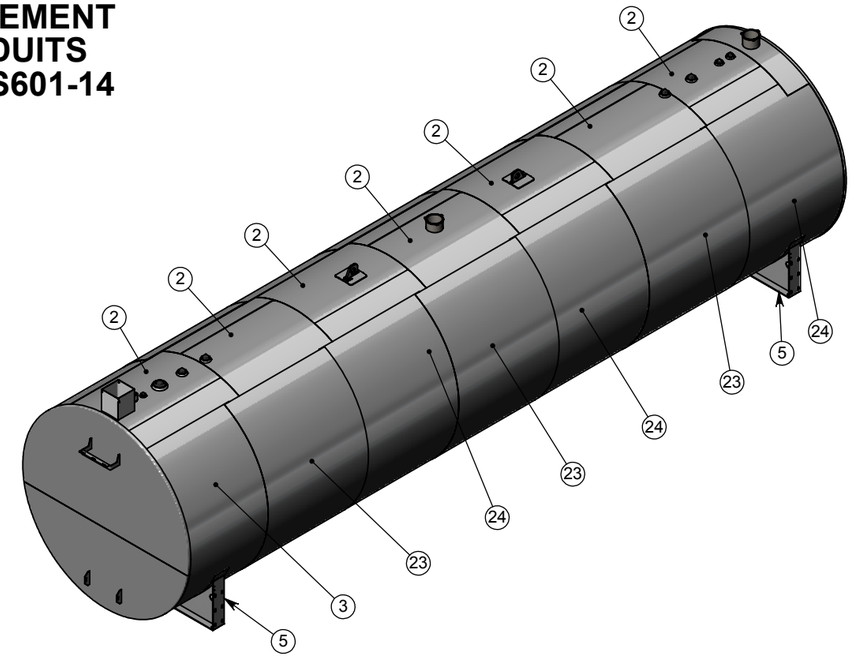


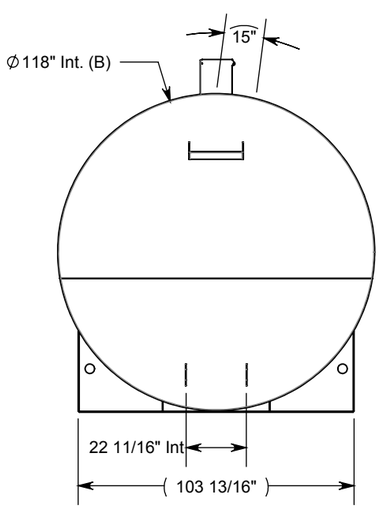
DÉTAIL A
ECHELLE 1 : 4

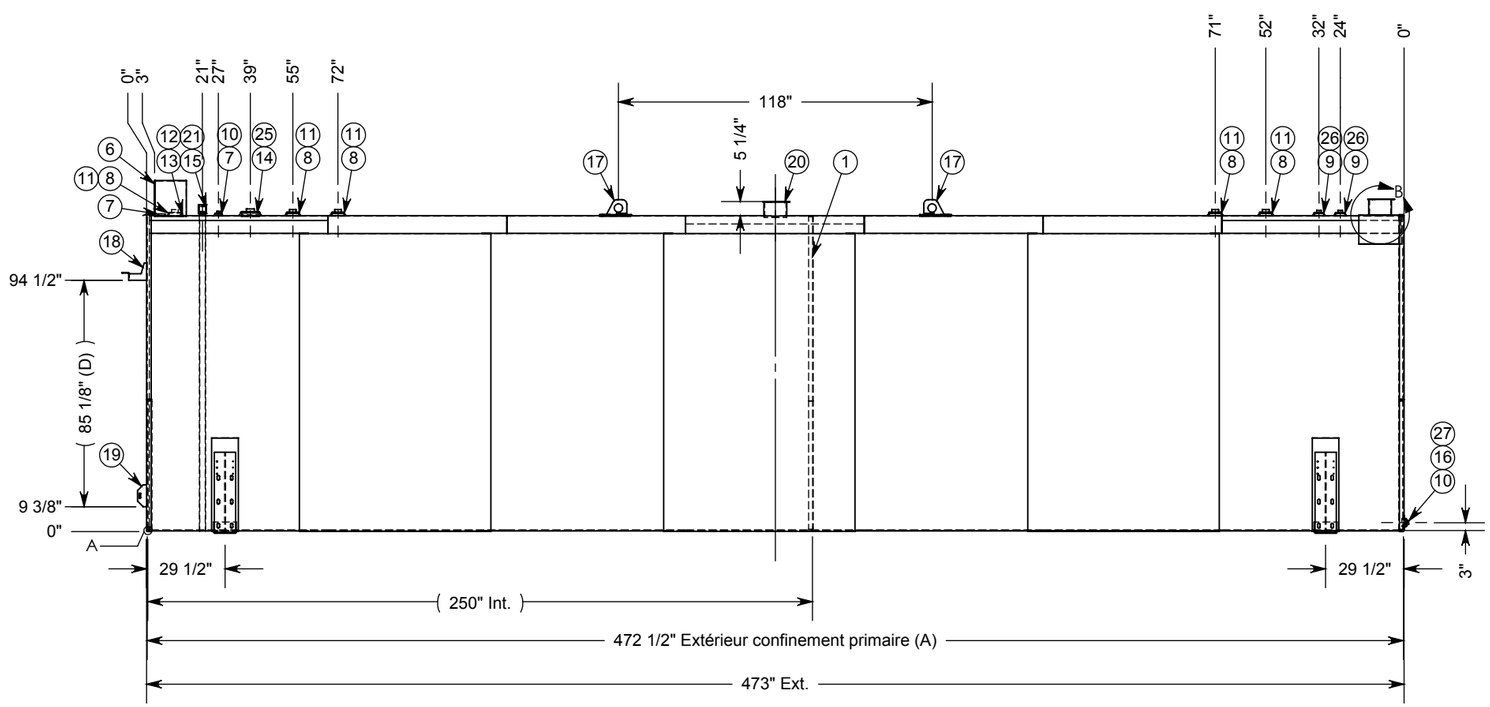


Vue Arrière



Nomenclature pour R8114GC-84586-AA-00						
No.	Qté.	Fab	Mat	Description	No. Pièce	Inv
1	3	S	Acier	Couvercle en 2 parties 0.25" [6] x Ø118" [2997]	R8114GC-84586-AAA-00	
2	7	D	Acier 44W	Corps à recouvrement 118"	R8114GC-84586-AA01-00	
3	1	At	Acier A1011 CS	Doublure à 300° 0.120" [3] x 315" [8001] x 60" [1524]	R8114GC-84586-AA02-00	
4	1	D	Acier	Doublure d'intégral 100% 73" [1854] x 16" [406]	R8114GC-84586-AA13-00	
5	2	S	Acier	Patte Ø118" [2997]	R8114GC-84586-AAB-00	
6	1	D	Acier	Col antidéversement 12" [305] x 12" [305] pour réservoir de Ø118"	R7301-A01-12-12-118	I
7	2	C	Acier	Bride à souder NPT 2" [51]	R6019-2_000	I
8	5	C	Acier	Bride à souder NPT 4" [102]	R6019-4_000	I
9	2	C	Acier	Bride à souder NPT 3" [76]	R6019-3_000	I
10	2	C	Fonte	Bouchon M NPT 2" [51]	R6007-2_000	I
11	5	C	Fonte	Bouchon M NPT 4" [102]	R6007-4_000	I
12	2	C	Fonte	Bouchon M NPT 3/8" [10]	R6007-0_375	I
13	2	C	Acier Astm 865	Demi-bague cl. 150 NPT 3/8" [10]	R6003-0_375	I
14	1	C	Acier	Bride à souder dessous courbé NPT 6" [152]	R6046-6_000	I
15	1	C	Acier	Bague Cl. 3000 NPT 2" [51]	R6034-2_000	I
16	1	C	Acier	Demi-bague cl. 3000 NPT 2" [51]	R6026-2_000	I
17	2	S	Acier 44w	Crochet de levage S601 Type 2 16 501 - 22 000 gal.	R7511-A-16501-22000	
18	1	D	Acier	Support palier	R7553-00	I
19	2	D	Acier	Fixation support passerelle	R7206-A03-00	I
20	2	S	Acier 44w	Base de l'évent d'urgence 8"	R7404-AA-8_000	I
21	1	At	Acier A53	Tuyau Ced 40 fileté à un bout NPT 2" [51] x 120" [3048]	R8114GC-84586-AA05-2_000	
22	2	S	Acier	Couvercle en 2 parties 0.25" [6] x Ø119.239" [3029]	R8114GC-84586-AAC-00	
23	3	At	Acier A1011 CS	Doublure à 300° 0.120" [3] x 315" [8001] x 72" [1829]	R8114GC-84586-AA10-00	
24	3	At	Acier A1011 CS	Doublure à 300° 0.120" [3] x 315" [8001] x 72" [1829]	R8114GC-84586-AA09-00	
25	1	C	Fonte	Bouchon M NPT 6" [152]	R6007-6_000	I
26	2	C	Fonte	Bouchon M NPT 3" [76]	R6007-3_000	I
27	1	D	Acier	Renfort pour bague Cl. 3000 2" [51] 11g	R7413-A01-CL3000-2_000-0_120	I





Modèle :	Requis :
84 586 Litres Ø118"	1x
Capacité réelle : 84 586 Litres [18 606 gal. imp.]	Poids à vide: 22937 lbs [10404 kg]

Déplacement à vide seulement

Matériau du réservoir :
Acier A1011 CS

	Épaisseur	Minimum requis
Têtes :	0.250" [6.4]	0.221" [5.6]
Corps :	0.250" [6.4]	0.221" [5.6]
Doublure des têtes :	0.250" [6.4]	0.221" [5.6]
Doublure du corps :	0.120" [3.0]	0.110" [2.8]

Finition extérieure : Décapage au jet de sable SP-SSPC6
Apprêt époxy gris 3 - 4 mils sec
Finition uréthane blanc 2 - 3 mils sec

Finition intérieure : Nettoyage seulement

Projet :
R8114GC-84586

INDUSTRIES Desjardins

Les Industries Desjardins Ltée
79 rue Principale
St-André (Québec) G0L 2H0

Propriété de : Les Industries Desjardins Ltée.
Toute reproduction partielle ou totale. ainsi que la divulgation des renseignements qu'il contient sont interdites sans l'autorisation écrite de son propriétaire.

Unités : Pouces [mm]

Tolérances non spécifiées:
Longueur du réservoir : +/-2"
Diamètre du réservoir : +/-1/2"
Position des accessoires : +/-1/4"

Créé le : 2018-11-26
Par : DriveWorks
Approuvé par :
Client :

Échelle :	Feuille :	No dessin :	Rev.:
1:57	1 de 1	R8114GC-84586-AA	-

Révisions

Rev.	Description	Date	Par

APPENDIX

A-164

PRELIMINARY ASSESSMENT OF THE PROJECT CLIMATIC RESILIENCE

GALAXY

MINE DE LITHIUM BAIE-JAMES

ÉVALUATION PRÉLIMINAIRE DE LA RÉSILIENCE CLIMATIQUE DU PROJET

BAIE-JAMES, QC

RÉF. WSP : 191-01753-00

DATE : 16 JUILLET 2019

CONFIDENTIEL

GALAXY

MINE DE LITHIUM BAIE-JAMES

ÉVALUATION PRÉLIMINAIRE DE LA RÉSILIENCE CLIMATIQUE DU PROJET

BAIE-JAMES, QC

CONFIDENTIEL

RÉF. WSP : 191-01753-00

DATE : 16 JUILLET 2019

RAPPORT (VERSION FINALE)

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GESTION DE LA QUALITE

VERSION	DATE	DESCRIPTION
00	2019-06-06	Version préliminaire
01	2019-06-26	Version préliminaire incluant le tableau 9 amendé par le client
02	2019-06-27	Version préliminaire incluant la première série de commentaires du client
03	2019-07-16	Version finale incluant la deuxième série de commentaires du client

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WSP. 2019. *Mine de lithium Baie-James, Évaluation préliminaire de la résilience climatique du projet, Baie-James, Qc*. Rapport produit pour Galaxy. 31 pages et annexe.

WSP Canada Inc. (« WSP ») a préparé ce rapport uniquement pour son destinataire Galaxy, conformément à la convention de consultant convenue entre les parties. Advenant qu'une convention de consultant n'ait pas été exécutée, les parties conviennent que les Modalités Générales à titre de consultant de WSP régiront leurs relations d'affaires, lesquelles vous ont été fournies avant la préparation de ce rapport.

Ce rapport est destiné à être utilisé dans son intégralité. Aucun extrait ne peut être considéré comme représentatif des résultats de l'évaluation.

Les conclusions présentées dans ce rapport sont basées sur le travail effectué par du personnel technique, entraîné et professionnel, conformément à leur interprétation raisonnable des pratiques d'ingénierie et techniques courantes et acceptées au moment où le travail a été effectué.

Le contenu et les opinions exprimées dans le présent rapport sont basés sur les observations et/ou les informations à la disposition de WSP au moment de sa préparation, en appliquant des techniques d'investigation et des méthodes d'analyse d'ingénierie conformes à celles habituellement utilisées par WSP et d'autres ingénieurs/techniciens travaillant dans des conditions similaires, et assujettis aux mêmes contraintes de temps, et aux mêmes contraintes financières et physiques applicables à ce type de projet.

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Ces limitations sont considérées comme faisant partie intégrante du présent rapport.

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GALAXY

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RÉSUMÉ & SUMMARY

Les impacts des changements climatiques sur le projet minier d'extraction de lithium Baie-James – Galaxy et son environnement ont été analysés grâce à une évaluation préliminaire des risques. Les méthodes sont cohérentes avec les premières étapes de la norme ISO 31000 sur la gestion des risques. L'étude a établi la portée du projet, les tendances climatiques et les risques connexes en termes de probabilité et de conséquences. Une matrice multirisque a été utilisée pour prioriser les risques en fonction de leur niveau et proposer des mesures d'atténuation appropriées pour la conception, l'exploitation et le démantèlement du projet. Les résultats suggèrent que les risques les plus importants à moyen terme (cohérent avec la durée d'exploitation du site) nécessitant des contrôles et mesures d'atténuation et d'adaptation sont les feux de forêt (infrastructure et risques pour la santé et la sécurité), les canicules (risques pour la santé et la sécurité), les barrages défaillants (infrastructure), et les inondations (santé et sécurité). À long terme (cohérent avec l'horizon du démantèlement et de la restauration du site), les risques concernent essentiellement la sécheresse des sols et les canicules. Des réflexions immédiates sont donc requises pour préparer la phase post-exploitation qui se fera dans des conditions climatiques significativement différentes de celles auxquelles le site est exposé actuellement.

Mots-clés : évaluation de la résilience climatique, projet minier, lithium, Baie-James, Galaxy.

The climate change impacts on the James Bay mining project - Galaxy and its environment were assessed following a high-level preliminary risk assessment. The method is consistent with the early stages of ISO 31,000 standard on Risk Management. The study established the scope of the project, the climate trends and the related hazards in terms of probability and consequences. A multi-risk matrix was used to prioritize the levels of risk and suggest appropriate mitigation methods for the design, operations, and dismantling of the project. The results suggested that the most important risks on a medium-term basis (duration of operations) requiring controls and mitigation/adaptation measures were wildfires (infrastructure and health & safety risks), heatwaves (health & safety risk), dam failure (infrastructure) and flooding (health & safety). In the long term (corresponding to the timeline of the dismantling and restoration phase), important risks mainly concern soil drought and heatwaves. Immediate consideration is needed to properly prepare the post-operation phase, which will very likely happen under climate conditions significantly different from the current ones.

Keywords: climate resilience assessment, mining project, lithium, James Bay, Galaxy.

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ANNEXE

A DONNÉES CLIMATIQUES DÉTAILLÉES

1 MÉTHODE D'ANALYSE

Les nouvelles lignes directrices générales d'Infrastructures Canada concernant l'évaluation de la résilience climatique des projets sont inspirées de la norme ISO 31000 Gestion des risques (figure 1). Elles font partie intégrante de l'Optique des changements climatiques[1] (2018). Nous avons réalisé ici une analyse de résilience multirisque simplifiée en se basant sur ces lignes directrices.

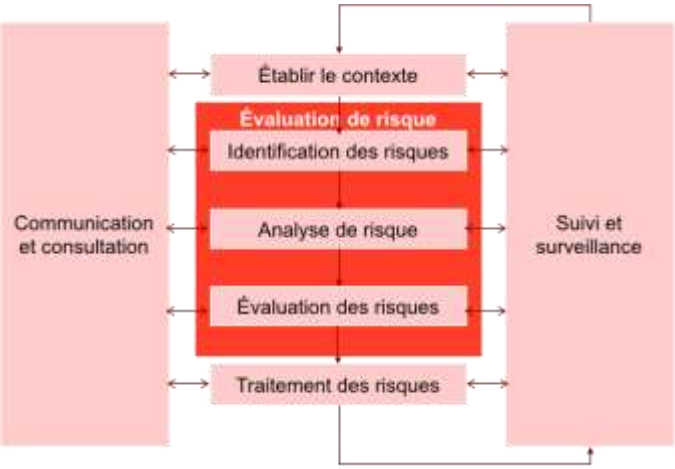

Figure 1 Gestion des risques selon la norme ISO 31000

1.1 CONTEXTE ET ÉTABLISSEMENT DES RISQUES

Nous avons pris connaissance du projet, de ses composantes, de ses phases, ainsi que des caractéristiques du milieu naturel et humain qui accueilleront le projet, afin d'identifier les composantes vulnérables aux risques climatiques du projet et sélectionner certains aléas selon leur pertinence.

1.2 ANALYSE DES TENDANCES CLIMATIQUES

Les données climatiques pour la cellule la plus proche du site du projet proviennent de quatre sources distinctes :

- Le nouvel Atlas climatique du Canada[2] (2018, consulté en mai 2019);
- L'Atlas climatique d'Ouranos[3] (2018, consulté en mai 2019);
- L'outil de courbes intensité-durée-fréquence (IDF) sous l'influence des changements climatiques IDF-CC Tool3.5[4] (2018, consulté en mai 2019);

[1] https://www.infrastructure.gc.ca/pub/other-autre/cl-occ-fra.html
[2] https://atlasclimatique.ca
[3] https://www.ouranos.ca/portraitsclimatiques
[4] https://www.idf-cc-uwo.ca/

- L'Atlas nord-américain des sécheresses[5,6] (2010, consulté en mai 2019).

Le premier est mis à disposition par le Prairie Climate Center (PCC), ayant travaillé en collaboration avec l'université du Manitoba. Le PCC est un consortium travaillant sur les impacts et l'adaptation aux changements climatiques et a réalisé des scénarios climatiques d'ensemble pour le Canada au complet en se basant sur 12 modèles globaux de climat issus de l'exercice CMIP5[7] (Climate Model Intercomparison Project). Ces simulations ont subi une mise à l'échelle statistique (*downscaling*, en anglais), puis ont été agglomérées sur une grille de 130 par 130 km environ. Ces données mises à l'échelle provenant de Ressources Naturelles Canada et du Pacific Climate Impacts Consortium sont fiables et reconnues dans la littérature. L'usager de cette plateforme peut s'informer sur l'évolution d'une trentaine d'indicateurs climatiques, avoir accès à des données graphiques et agrégées et consulter des histogrammes de fréquence anticipée.

Le deuxième provient d'Ouranos qui a réalisé des scénarios climatiques d'ensemble pour le Québec en se basant sur 11 modèles de CMIP5. Ces simulations ont également subi une mise à l'échelle statistique et ont été agglomérées sur une grille d'environ 10 km. Cet Atlas est fiable et reconnu dans divers projets d'évaluation d'impacts et de plans d'adaptation au Québec. L'usager de l'Atlas a accès à l'évolution d'une quinzaine d'indicateurs à l'échelle locale et régionale. Les projections sont présentées à l'aide de trois centiles de la distribution produite par l'éventail de réponses données par les différents modèles : 10ème centile, médiane et 90ème centile. Cela permet d'avoir une estimation du niveau d'incertitudes des projections.

Ces deux premiers Atlas présentent les projections climatiques en se basant sur une référence passée récente, un horizon à moyen terme et un horizon à long terme. Le nouvel Atlas du Canada définit ces périodes comme 1976-2005, 2021-2050 et 2051-2080. L'Atlas climatique d'Ouranos utilise 1981-2010, 2041-2070 et 2071-2100. L'horizon à moyen terme a été sélectionné en tenant compte de la durée du projet, mais les projections à long terme sont aussi considérées dans notre analyse de probabilités en prévision d'une prolongation d'exploitation du site. Les résultats étant très similaires d'un atlas à l'autre, les données du nouvel Atlas climatique du Canada sont utilisées ici, puisque les variables climatiques disponibles représentent davantage les risques naturels auxquels sera exposé un projet minier en milieu nordique. Les fenêtres temporelles d'étude (à moyen et long termes) correspondent d'ailleurs davantage à la période d'exploitation du projet.

L'outil IDF-CC est le résultat d'une utilisation de données de précipitations des stations d'Environnement Canada, d'interpolations spatiales et de statistiques futures se basant sur 24 modèles globaux de climat et 9 modèles régionaux. En fonction des statistiques historiques et des différents scénarios d'émissions de gaz à effet de serre, des courbes IDF et leurs incertitudes sont générées pour différents futurs envisagés. Cet outil fournit entre autres l'évolution du cumul journalier maximum de précipitations avec différents temps de retour allant de 2 à 100 ans. L'évolution est montrée ici pour l'horizon 2021-2070, car une période de minimum 50 ans est requise pour obtenir des statistiques robustes.

Pour finir, l'Atlas nord-américain des sécheresses reconstruit l'historique de l'indice de sécheresse de Palmer. Cet indice rend compte de l'état de la couche supérieure du sol et est construit en se basant sur des indices de température et de précipitations. Les projections futures de cet indice sont données par Cook *et al.*[8] (2015) par le biais de 17 modèles globaux de climat. Le 0 est considéré comme la moyenne, et l'état de sécheresse est représenté par des valeurs négatives ; par exemple, -2 signifie sécheresse modérée, -3 signifie sécheresse sévère, et -4 signifie sécheresse extrême.

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[5] http://drought.memphis.edu/NADA/

[6] Cook, E.R., R. Seager, R.R. Heim Jr, R.S. Vose, C. Herweijer, and C. Woodhouse, 2010: Megadroughts in North America: placing IPCC projections of hydroclimatic change in a long-term palaeoclimate context. *Journal of Quaternary Science*, 25, 48-61.

[7] Taylor, K.E. (2012): An overview of CMIP5 and the Experiment Design, *BAMS*, 4, 485-498.

[8] Cook, B. I., Ault, T. R., and Smerdon, J. E. (2015): Unprecedented 21st century drought risk in the American Southwest and Central Plains, *Science Advances*, 1(1), e1400082.

Les projections sont présentées selon deux scénarios d'émissions de gaz à effet de serre : RCP4.5 et RCP8.5[9] (*Representative Concentration Pathways*). Le RCP8.5 correspond à un scénario *'business-as-usual'* ne comprenant aucune mesure d'atténuation de nos émissions. Le RCP4.5 est un scénario d'atténuation modérée visant à minimiser les coûts pour atteindre une réduction significative des émissions (figure 2). Les mesures prises consistent principalement à appliquer de nouvelles technologies de production d'énergie et à développer la capture et le stockage géologique du carbone.

En se basant sur la classification des probabilités d'occurrence de l'Optique des changements climatiques pour notre analyse de risque, nous avons ajouté un niveau de confiance envers ces probabilités, afin de qualifier l'homogénéité des modèles climatiques compris dans l'ensemble, en relation avec la distribution passée récente. Ce niveau de confiance permet d'évaluer l'incertitude reliée à la variabilité des modèles climatiques. La légende générale des niveaux de probabilité, confiance, conséquence et risque est présentée au tableau 1.

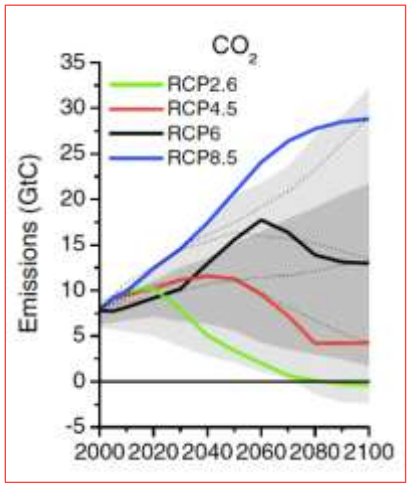


Figure 2 Évolution des émissions anthropiques globales de CO_2 selon différents scénarios RCP (tiré de Van Vuuren *et al*, 2011).

1.3 ANALYSE DES ALÉAS CLIMATIQUES

Les tendances représentent des indicateurs de certains aléas climatiques retenus comme pertinents pour le projet. La relation entre les tendances et les principaux aléas est illustrée à la figure 3. Le pointage moyen des catégories de probabilité a été retenu comme indicateur de probabilité. Ce pointage est pondéré par la confiance, dont l'origine est expliquée plus haut :

- Bonne confiance (probabilité inchangée);
- Confiance moyenne (probabilité -1);
- Confiance faible (probabilité -2).

Cette pondération permet de prendre en compte les faux « positifs » et les faux « négatifs » des tendances climatiques futures avérées.

[9] Van Vuuren, D. et al. (2011): The representative concentration pathways, an overview, *Climatic Change*, 109:5-31.

1.4 ÉVALUATION DES CONSÉQUENCES ET DES RISQUES

Les catégories et niveaux de conséquences et de risques proviennent également des lignes directrices de l'Optique des changements climatiques (4e colonne du tableau 1)

Nous avons également décidé d'inclure une notion d'opportunité. Cette notion permet de considérer toute conséquence positive causée par les changements climatiques et est complétée par la notion de « risque positif » qu'elle entraîne. L'identification des conséquences s'inspire de l'Analyse de risques et de vulnérabilités aux changements climatiques pour le secteur minier québécois10. Selon le pointage de probabilité et de conséquence, chaque risque a été placé dans une matrice d'évaluation permettant d'évaluer le niveau général du risque (5e colonne du tableau 1).

1.5 TRAITEMENT DU RISQUE OU MESURES D'ATTÉNUATION

Les risques ont été priorisés par un code couleur :

- Vert : risque négligeable;
- Jaune : risque faible;
- Orange clair : risque modéré. Cela ne remet pas la faisabilité ou la vitalité d'un projet minier en question, mais des coûts supplémentaires et des actions pourraient devoir être nécessaires pour remédier à la situation;
- Orange foncé : risque élevé. Des actions de plus grande ampleur pourraient devoir être entreprises pour remédier à la situation. Cela pourrait, dans certains cas, affecter la rentabilité ou encore la faisabilité d'un projet minier; des impacts significatifs sur le milieu naturel sont à prévoir;
- Rouge : risque extrême. La faisabilité ou la vitalité d'un projet minier peut être remise en question. Cela s'applique également aux évènements où le risque pour la protection de l'environnement est grand (contaminations, déversements, pollution des cours d'eau, etc.) et pourrait avoir des impacts à long terme sur le milieu naturel;
- Bleu : « positif ». Les changements climatiques peuvent également avoir un effet bénéfique. Une saison estivale plus longue pourrait par exemple avoir des avantages pour le site minier, comme une durée d'exploitation saisonnière plus longue.

Dans la dernière partie de ce rapport, des mesures d'atténuation et leur degré de mise en œuvre sont détaillés pour ce projet en particulier, afin de proposer des solutions pour exploiter le site minier de manière optimale tout en réduisant les dangers potentiels.

[10] Bussière, B. *et al*. (2017) : Analyse de risques et de vulnérabilités aux changements climatiques pour le secteur minier québécois**.** URSTM – Université du Québec en Abitibi-Témiscamingue**.**

Tableau 1 Terminologie complète de l'analyse de risque

Niveau	Probabilité[1]	Confiance	Conséquence[1]	Risque[1]
1 Très bas	1 - Très basse *Ne se produira par durant la période *Ne deviendra pas critique/bénéfique durant la période	Faible L'intervalle des modèles d'ensemble présente une variabilité contraire à la tendance par rapport à la moyenne actuelle	1 – Mineure *Pourrait légèrement affecter ou non la qualité de vie des personnes *Pourrait mener ou non des impacts limités en intensité et spatialement, ou ne pas avoir d'impact	1 - Risque négligeable : Événement ne requérant pas de considération supplémentaire
2 Bas	2 – Basse *Surviendra probablement une fois entre 30-50 ans *Deviendra probablement critique d'ici 30-50 ans		2 – Significative *Pourrait affecter la qualité de vie des personnes de manière temporaire *Pourrait mener à des impacts économiques ou environnementaux localisés et réversibles	2 - Risque faible : Mesures de contrôle probablement non requises
3 Modéré	3 – Modérée *Surviendra probablement entre 10-30 ans *Deviendra probablement critique d'ici 10-30 ans	Moyenne L'intervalle des modèles d'ensemble présente seulement qu'une borne qui est contraire à la tendance par rapport à la moyenne actuelle	3 – Sévère *Pourrait affecter la qualité de vie des personnes de manière prolongée *Pourrait mener à des impacts économiques ou environnementaux importants, mais réversibles	3- Risque modéré : Certaines mesures de contrôle sont requises pour réduire le niveau de risque
4 Haut	4 – Haute *Surviendra probablement une fois d'ici 10 ans *Deviendra probablement critique d'ici 10 ans	Bonne L'intervalle des modèles d'ensemble présente une bonne cohérence avec la tendance, par rapport à la moyenne actuelle	4 – Critique *Pourrait affecter significativement et irrémédiablement la qualité de vie des personnes *Pourrait mener à des impacts économiques ou environnementaux majeurs ou irréversibles sur la durée de vie du projet	4 - Risque élevé : Mesures de contrôle requises en priorité
5 Très haut	5 - Très haute *Surviendra probablement une fois annuellement ou plus *Deviendra un facteur critique/bénéfique d'ici moins de 10 ans		5 – Catastrophe *Pourrait mener à des décès (directs ou non) *Pourrait mener à des impacts économiques ou environnementaux majeurs et irréversibles pour la société	5 - Risque extrême Mesures de contrôle immédiates requises
Opportunité	Selon les catégories ci-dessus	Selon les catégories ci-dessus	5 – Positive *Gain en qualité de vie *Occasion économique ou environnementale	5 - Risque positif : Mesures pour saisir l'occasion recommandée

[1] *Source : Infrastructure Canada (2018) : Optique des changements climatiques.*

2 RÉSULTATS

2.1 LE CONTEXTE DU PROJET

Le projet de mine de lithium Baie-James[11] est situé dans la région administrative du Nord-du-Québec, sur le territoire du Gouvernement régional d'Eeyou Istchee Baie-James. Il se trouve à environ 10 km au sud de la rivière Eastmain et à une centaine de kilomètres à l'est de la Baie-James, à la hauteur du village d'Eastmain. Les coordonnées géographiques du site sont (52.2349N, -77.0664E). Ce projet consiste à mettre en place une opération minière d'extraction de lithium à partir d'une fosse selon les méthodes conventionnelles de prélèvements de surfaces. Un procédé de concentration du spodumène permettra le traitement du minerai. Puis, le minerai sera concassé et séparé en milieu dense pour obtenir le lithium pur. Le début de la construction du site est prévu pour 2020 avec un début d'exploitation espéré en 2022. Selon les plus récentes prévisions, la mine pourra être en exploitation pendant 16 ans (2038) et la restauration du site se fera par la suite.

Les infrastructures de surface prévues sont des infrastructures conventionnelles pour un projet d'extraction à ciel ouvert :

- Une fosse;
- Un concentrateur de spodumène d'une capacité de 2 Mt/an;
- Des aires d'entreposage et d'accumulation de mort-terrain, de terre végétale, de stériles/résidus, de minerai et de concentré;
- Des bassins de rétention d'eau de procédé et brute;
- Des bâtiments administratifs et d'opérations;
- Un campement pour les travailleurs;
- Une usine de traitement d'eau (UTE);
- Des garages permettant l'entretien du matériel mécanique ainsi que des espaces d'entreposage pour les pièces de rechange, des laboratoires, et des installations pour services d'urgence;
- Un site d'entreposage des explosifs;
- Un parc à carburant pour l'approvisionnement de la machinerie, les besoins en chauffage et l'alimentation des génératrices d'urgence;
- Une ligne électrique à 69 kV raccordant le site minier au réseau de distribution électrique d'Hydro-Québec, nécessitant peut-être jusqu'à 11 km de nouvelles lignes;
- Une connexion au réseau de fibre optique.

À la fin de l'exploitation de la mine, des mesures de restauration sont prévues pour remettre le milieu dans un état compatible avec le milieu environnant et son état d'origine. Ces mesures auront une influence sur la gestion du secteur d'exploitation, des stériles, des résidus de traitement et des eaux des bassins de traitement, ainsi que le démantèlement des infrastructures et des installations administratives et de transformation du minerai. Une approche de restauration progressive sera déployée. Un plan de restauration sera déposé au ministère de l'Énergie et des Ressources Naturelles (MERN) avant le début de l'exploitation du projet.

[11] Wang, Y. et Mazur, O. (2018) : Project definition document, James Bay Lithium Mine, Galaxy.

D'autres hypothèses de travail ont été faites dans cette analyse de risque :

- La source d'eau pour la production est indépendante de celle des communautés avoisinantes et sans impact majeur sur la dynamique de la population. Les personnes vulnérables sont donc uniquement les travailleurs;
- La capacité de la halde à stériles aura la possibilité d'être augmentée graduellement en fonction des besoins.

Selon cette description du projet, le tableau 2 liste les composantes du projet vulnérables aux risques climatiques. La liste des aléas climatiques figure au tableau 3. Certains sont retenus et d'autres rejetés en fonction de leur pertinence en vue de la bonne réalisation du projet.

Cette analyse vient, entre autres, s'ajouter à l'étude de la gestion des risques d'accidents (chapitre 9 du rapport) et apporte des compléments d'informations sur les risques décrits aux sections 9.2.1.2 à 9.2.1.5 en ajoutant la modification du niveau des risques tenant compte de la tendance des changements climatiques.

Tableau 2 Composantes vulnérables au climat du projet minier de lithium Baie-James

Phase **Personnes**	**Conception / construction** **travailleurs**	**Opérations** **travailleurs**	**Démantèlement / restauration** **travailleurs**
Économie	— Bâtiments et leur emprise — Réseau électrique — Accès terrestres (routes) et ponceaux — Système de traitement des eaux — Bassins et structures de confinement et leurs déversoirs — Haldes — Fosse — Traitement de l'eau — Traitement du minerai — Dimension des évacuateurs de crue	— Continuité de l'approvisionnement — Arrêt des opérations et isolation du site — Intégrité de la machinerie — Intégrité des bâtiments — Intégrité et entretien des accès terrestres — Intégrité du procédé de traitement de l'eau — Intégrité du système électrique — Matériel de dynamitage — Stabilité du procédé de traitement de l'eau — Stabilité du traitement du minerai — Intégrité des bassins, des haldes et de la fosse — Gestion de l'eau — Gestion des poussières	— Capacité du déversoir de la fosse ou des évacuateurs de crue — Intégrité du milieu après le démantèlement — Intégrité des ouvrages de retenue des sites restaurés — Performance des barrières à l'infiltration à l'eau ou à l'oxygène — Accès au site restauré
Environnement	— Nature environnante — Milieu utilisé pour la construction	— Nature environnante — Milieu utilisé pour l'exploitation	— Nature environnante — Milieu occupé par le site — Milieu utilisé pour la restauration

Tableau 3 Aléas climatiques retenus et rejetés

Retenus		
Inondations	Allongement de la saison estivale	Hausse des niveaux d'eau moyens et de l'érosion graduelle
Feux de forêt	Réchauffement hivernal	Augmentation de la variabilité des précipitations
Canicules	Étiage	Tempêtes
	Sécheresse des sols	
Rejetés	**Justification**	
Variabilité des glaces de rives	Pas de composante directe affectée, Baie-James à 100 km environ	
Dégel du pergélisol	Zone de pergélisol sporadique uniquement[12]	

2.2 LES TENDANCES CLIMATIQUES

Tableau 4 présente les tendances climatiques selon les deux scénarios RCP4.5 et 8.5 pour un horizon à moyen terme (2021-2050 ou 2021-2070 selon l'outil utilisé, cohérent avec le temps d'exploitation de la mine), ainsi que la classe de probabilité, la confiance envers les tendances, les aléas reliés et le pointage de probabilité de chacune des variables. Une colonne informe également sur l'évolution des probabilités et des niveaux de confiance en passant du moyen terme au long terme (2051-2080), la période de restauration pouvant s'étendre au-delà de 2050. Généralement, plus l'horizon est lointain, plus la probabilité est haute et plus la confiance est bonne, puisque les changements sont plus marqués.

La majorité des indicateurs présente une évolution donnant des probabilités de changement élevées (hautes à très hautes). En ce qui concernent les indicateurs de température, **un réchauffement annuel moyen est projeté entre +2 et +2,5°C sur le moyen terme**, tous scénarios confondus. Les températures estivales maximales et les températures hivernales minimales suivent la même tendance, avec une augmentation nettement plus marquée pour les dernières : il est prévu qu'elles augmentent de presque 4°C à moyen terme. S'en **suit une augmentation des jours très chauds et d'une diminution des jours très froids**. Au vu de la localisation du site, les nuits tropicales ne sont et ne seront pas assez nombreuses pour prévoir une tendance significative à moyen terme. L'augmentation générale des températures entrainera également **un allongement de la saison estivale d'environ 15 à 20 jours**.

À moyen terme encore, **les précipitations annuelles augmenteront de 40 à 50 mm (environ 7 à 8 %)**. La confiance dans les tendances liées aux précipitations est plus ou moins similaire que celle des tendances de température. Mais à long terme, la confiance augmente pour la température, contrairement à celle des précipitations qui reste moyenne. Ce phénomène est dû à la plus grande variabilité dans les résultats des modèles climatiques pour les précipitations. Par contre, **la variabilité des régimes de précipitations semble augmenter**, puisque les moyennes annuelles augmentent de concert avec les indicateurs de précipitations extrêmes et l'indice de sécheresse utilisé diminue signifiant une augmentation de la sécheresse estivale. Autrement dit, comme observé lors des printemps 2017 et 2019, il est probable qu'il y ait de plus gros systèmes météorologiques qui amènent énormément de précipitations, alternées avec des périodes sèches plus longues, pouvant mener à des sécheresses saisonnières, comme on a pu l'observer durant l'été 2018. Par exemple, **le cumul journalier de précipitations arrivant une seule fois pendant la durée de vie du projet (i.e. 25 ans) sera 40% plus intense** à moyen terme que dans le passé récent.

[12] https://www.thecanadianencyclopedia.ca/fr/article/pergelisol

La baisse du nombre de cycles de gel-dégel est très légère et fait partie des tendances les moins prononcées dans les projections climatiques faites pour le site de construction. **Aucune information reliée aux instabilités atmosphériques (pointes de vents, éclairs, etc.) n'est mise à disposition** par l'Atlas climatique ni les profils climatiques d'Ouranos. Certaines études faites pour le Québec montrent une réduction des vents en été pour la fin du 21e siècle par rapport au 20e siècle et une faible augmentation des vents en hiver. Des analyses plus poussées sont tout de même nécessaires pour confirmer ces tendances. Ainsi, il existe une très grande incertitude sur les tendances et leur probabilité reliées à ces aléas. Ils peuvent être critiques pour la conception et il est fortement recommandé de les documenter davantage, en initiant par exemple un historique des événements météorologiques marquants sur le site de la mine, dans la mesure où de telles données sont disponibles.

Tableau 4 Tendances climatiques à moyen terme (2021-2050 ou 2021-2070 selon l'outil utilisé) pour la cellule correspondant au site minier et conséquences sur le projet et son environnement

Indicateur climatique	Historique (passé récent)	Scénario faible (RCP4.5)	Scénario fort (RCP8.5)	Probabilité et *confiance*	Modification des évaluations à long terme (2051-2080)	Aléas et *pointage à court (long) terme*
Température annuelle moyenne (°C)	-1.9 [-3,3 – -0,4]	0,1 [-2,0 – 2,1]	0.5 [-1.6 – 2,8]	Haute : dans les deux scénarios, la tendance moyenne et les intervalles sont à la hausse, pour toutes les saisons. Ces changements seront évidents d'ici 10 ans.	Augmentation : très haute	Allongement de la saison estivale Canicule Feux de forêt Réchauffement hivernal
				Bonne confiance	*Pas de changement : bonne*	*4 (5)*
Température annuelle maximale en été (°C)	18,7 [16,6 – 20,8]	20,3 [17,7 – 22,8]	20,5 [17,8 – 23,3]	Haute : dans les deux scénarios, la tendance moyenne et les intervalles sont à la hausse. Ces changements seront évidents d'ici 10 ans.	Augmentation : très haute	Canicules Feux de forêt Sécheresse des sols
				Moyenne confiance	*Augmentation : bonne*	*3 (5)*
Température annuelle minimale en hiver (°C)	-24.3 [-28,0 - -20,7]	-20.8 [-25,8- -16,4]	-20,1 [-24,8 - -15,5]	Très haute : dans les deux scénarios, la tendance moyenne et les intervalles sont à la hausse. Ces changements seront déjà critiques avant les 10 prochaines années.	Pas de changement : très haute	Réchauffement hivernal
				Moyenne confiance	*Augmentation : bonne*	*4 (5)*

Indicateur climatique	Historique (passé récent)	Scénario faible (RCP4.5)	Scénario fort (RCP8.5)	Probabilité et *confiance*	Modification des évaluations à long terme (2051-2080)	Aléas et *pointage à court (long) terme*
Nuits tropicales (nb annuel)	0,0 [0,0 – 0,5]	0,1 [0,0 – 1,4]	0,2 [0,0 – 2,4]	Basse : dans les deux scénarios, la tendance moyenne et les limites supérieures sont très légèrement à la hausse. Ces changements ne seront que très peu ressentis d'ici 2050.	Augmentation : haute (RCP8.5)	Canicules Feux de forêt
				Moyenne confiance	*Augmentation : bonne (RCP8.5)*	*1 (4)*
Jours très chauds (nb annuel, >30°C)	0,8 [0,2 – 3,4]	1,9 [0,3 – 9,0]	2,2 [0,5 – 10,3]	Haute : dans les deux scénarios, la tendance moyenne et les intervalles sont à la hausse sauf le minimum à 8.5. Ces changements pourraient impacter les travailleurs d'ici 10 ans.	Augmentation : très haute	Canicules Feux de forêt
				Moyenne confiance	*Augmentation : bonne*	*3 (5)*
Jours très froids (nb annuel, -30°C ou moins)	26,9 [14,3 – 44,7]	12,2 [3,8 – 32,1]	10,6 [2,6 – 30,1]	Très haute : dans les deux scénarios, la tendance moyenne et les intervalles sont à la baisse. Ces changements deviendront un facteur bénéfique d'ici 10 ans.	Pas de changement : très haute	Réchauffement hivernal
				Moyenne confiance	*Augmentation : bonne*	*4 (5)*

Indicateur climatique	**Historique (passé récent)**	**Scénario faible (RCP4.5)**	**Scénario fort (RCP8.5)**	**Probabilité et *confiance***	**Modification des évaluations à long terme (2051-2080)**	**Aléas et *pointage à court (long) terme***
Cycles gel-dégel (nb jours)	60,7 [47,5 – 73,5]	57,7 [44,7 – 74,1]	55,8 [44,4 – 71,5]	Basse : dans les deux scénarios, la tendance moyenne est à la baisse, mais les intervalles sont légèrement à la baisse (voire à la hausse pour le RCP4.5) et il y a une probabilité qu'aucun changement ne soit observé. Ces changements pourraient devenir un facteur bénéfique d'ici 30 à 50 ans.	Augmentation : modérée	Réchauffement hivernal
				Faible confiance	*Augmentation : moyenne*	*0 (2)*
Date du dernier gel printanier	12 juin [30 mai – 2 juillet]	6 juin [21 mai – 27 juin]	7 juin [17 mai – 23 juin]	Modérée : dans les deux scénarios, la tendance moyenne et les intervalles sont à un printemps légèrement hâtif. Ces changements débuteront entre 10-30 ans.	Augmentation : haute (RCP8.5)	Allongement de la saison estivale
				Moyenne confiance	*Augmentation : bonne (RCP8.5)*	*2 (4)*
Date du premier gel automnal	19 sept. [30 aout – 3 oct.]	29 sept. [8 sept. – 16 oct.]	5 oct. [11 sept. – 19 oct.]	Haute : dans les deux scénarios, la tendance moyenne et les intervalles sont à un automne plus tardif. Ces changements seront critiques d'ici 10 ans.	Augmentation : très haute	Allongement de la saison estivale
				Moyenne confiance	*Augmentation : bonne (RCP8.5)*	*3 (5)*

Indicateur climatique	**Historique (passé récent)**	**Scénario faible (RCP4.5)**	**Scénario fort (RCP8.5)**	**Probabilité et *confiance***	**Modification des évaluations à long terme (2051-2080)**	**Aléas et *pointage à court (long) terme***
Durée de la saison sans gel (nb jours)	99,1 [64,7 – 123,7]	115,2 [79,6 – 142,0]	120,2 [85,8 – 151,0]	Haute : dans les deux scénarios, la tendance moyenne et les intervalles sont à la hausse. Ces changements seront déjà critiques d'ici 10 ans.	Augmentation : très haute	Allongement de la saison estivale
				Moyenne confiance	*Augmentation : bonne (RCP8.5)*	*3 (5)*
Précipitations annuelles moyennes (mm)	690 [582 – 796]	731 [609 – 856]	742 [621 – 881]	Haute : dans les deux scénarios, la tendance moyenne et les intervalles sont à la hausse pour toutes les saisons, de quelques dizaines de mm, sauf l'été ou la variation est nulle (0-1%). Il reste toutefois une incertitude, car les modèles les plus conservateurs indiquent des valeurs inférieures à la moyenne actuelle. Ces changements seront déjà critiques d'ici 10 ans.	Augmentation : très haute	Hausse des niveaux moyens et de l'érosion graduelle Inondations Augmentation de la variabilité des précipitations Étiage Sécheresse des sols
				Moyenne confiance	*Pas de changement : moyenne*	*3 (4)*

Indicateur climatique	**Historique (passé récent)**	**Scénario faible (RCP4.5)**	**Scénario fort (RCP8.5)**	**Probabilité et *confiance***	**Modification des évaluations à long terme (2051-2080)**	**Aléas et *pointage à court (long) terme***
Précipitations printanières (mm)	107 [69 – 147]	117 [75 – 166]	119 [82 – 167]	Haute : dans les deux scénarios, la tendance moyenne est à la hausse, mais les intervalles se chevauchent suffisamment pour douter de la tendance nette : les modèles les plus conservateurs indiquent des valeurs inférieures à la moyenne actuelle. L'augmentation est de +9-12%. Ces changements seront significatifs d'ici 10 ans.	Augmentation : très haute	Inondations Augmentation de la variabilité des précipitations
				Moyenne confiance	*Pas de changement : moyenne*	*3 (4)*
Nombre de jours annuels avec 20 mm de précipitations minimums	1,5 [0,3 – 3,1]	1,8 [0,4 – 3,9]	1,8 [0,4 – 3,9]	Basse : dans les deux scénarios, la tendance moyenne et les intervalles sont légèrement à la hausse. Les deux intervalles conservateurs sont inférieurs au nombre actuel. Ces changements ne deviendront probablement pas significatifs d'ici la fin du siècle.	Augmentation : modérée (RCP8.5)	Inondations Augmentation de la variabilité des précipitations
				Moyenne confiance	*Pas de changement : moyenne*	*1 (2)*

Indicateur climatique	**Historique (passé récent)**	**Scénario faible (RCP4.5)**	**Scénario fort (RCP8.5)**	**Probabilité et *confiance***	**Modification des évaluations à long terme (2051-2080)**	**Aléas et *pointage à court (long) terme***
Maximum du cumul journalier de précipitations, temps de retour de 2 ans (mm)	42 [39 – 48]	49 [45 – 56]	50 [43 – 58]	Très haute : dans les deux scénarios, la tendance moyenne et les intervalles sont à la hausse. Ces changements seront déjà critiques avant les 10 prochaines années.	Mêmes statistiques qu'à moyen terme	Inondations Augmentation de la variabilité des précipitations
				Bonne confiance	*Mêmes statistiques qu'à moyen terme*	*5 (5)*
Maximum du cumul journalier de précipitations, temps de retour de 25 ans (mm)	65 [51 – 76]	93 [75 – 105]	89 [78 – 113]	Très haute : dans les deux scénarios, la tendance moyenne et les intervalles sont à la hausse. Ces changements seront déjà critiques avant les 10 prochaines années.	Mêmes statistiques qu'à moyen terme	Inondations Augmentation de la variabilité des précipitations
				Bonne confiance	*Mêmes statistiques qu'à moyen terme*	*5 (5)*
Indice de sécheresse de Palmer en été (sans unité)	-0,5 [-0,7 – -0,3]	n/a	-0,9 [-1,0 – -0,7]	Haute : selon le scénario RCP8.5, la tendance moyenne et les intervalles sont à la baisse. Ces changements seront significatifs d'ici 10 ans.	Augmentation : très haute (RCP8.5)	Augmentation de la variabilité des précipitations Sécheresse des sols
				Bonne confiance	*Pas de changement : bonne*	*4 (5)*
Régime des vents et orageux (éclairs)	n/a	n/a	n/a	Aucune information publique de probabilité disponible à ce jour		Tempêtes
				Aucune		

2.3 LES ALÉAS CLIMATIQUES

Il s'agit ici de relier les aléas climatiques retenus comme étant pertinents pour le projet de la mine Galaxy (tableau 3) avec les tendances des indicateurs climatiques présentées dans la section précédente (Tableau 4). La figure 3 présente ces différents liens en regroupant les aléas par variable climatique. Le tableau 5 présente le pointage de probabilité pour chacun de ces aléas climatiques dans l'ordre de leur importance pour un moyen et un long terme en se basant sur une moyenne des pointages des aléas concernés.

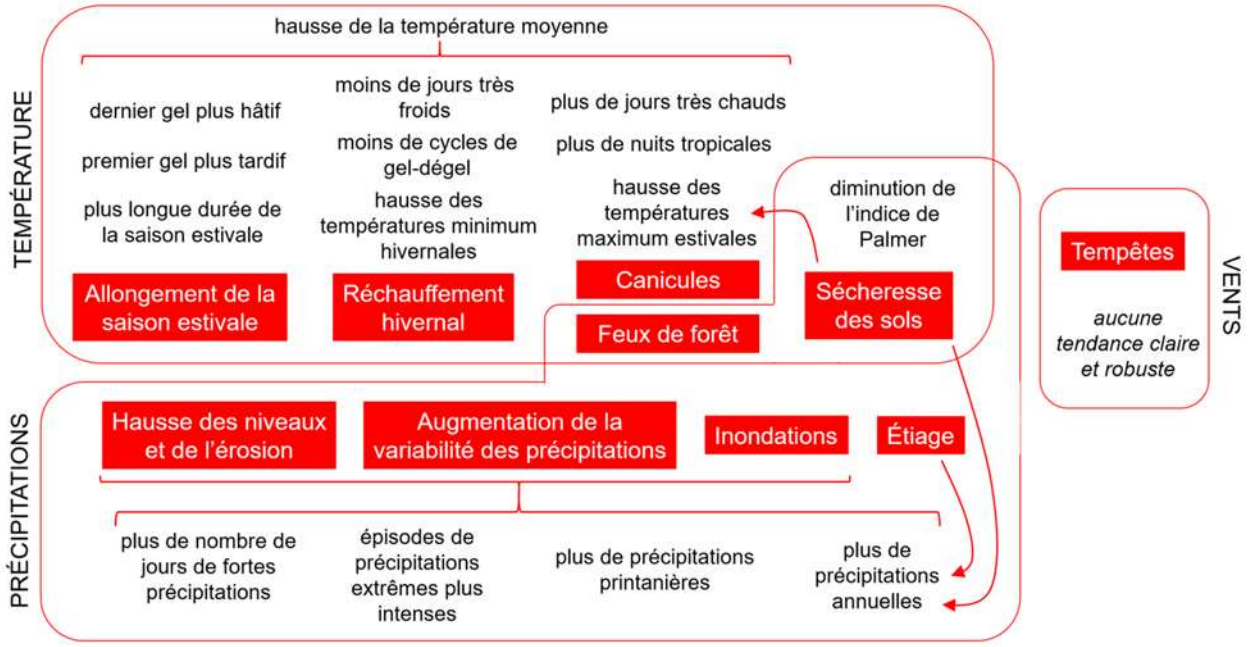


Figure 3 **Liens entre les aléas et les tendances des indicateurs climatiques**

Tableau 5 Lien entre les aléas climatiques, les tendances des indicateurs climatiques et les pointages de probabilité à moyen et long termes

Aléa et symbole	Variables climatiques+	Pointage de probabilité moyen (sur 5)	
		Moyen terme	Long terme
FF – Feux de forêt	*Hausse de la température moyenne *Jours très chauds *Nuits tropicales *Températures maximales en été *Indices de sécheresse de Palmer en été	3	4,8
SE – Allongement de la saison estivale	*Hausse de la température moyenne *Date du dernier dégel *Date du premier gel *Durée de la saison sans gel	3	4,75
C – Canicules	*Hausse de la température moyenne *Jours très chauds *Nuits tropicales *Températures maximales en été	2,75	4,75
SD – Sécheresse des sols	*Températures maximales en été *Précipitations annuelles moyennes *Indices de sécheresse de Palmer en été	3,67	4,33
RH – Réchauffement hivernal	*Hausse de la température moyenne *Jours très froids *Cycles gel-dégel *Températures minimales en hiver	3	4,25
HN – Hausse des niveaux d'eau moyens et de l'érosion graduelle	*Précipitations annuelles moyennes *Jours de précipitations extrêmes *Précipitations printanières *Maximum du cumul journalier à 2 ans *Maximum du cumul journalier à 25 ans	3,4	4

Aléa et symbole	Variables climatiques[+]	Pointage de probabilité moyen (sur 5)	
		Moyen terme	Long terme
I – Inondations	*Précipitations annuelles moyennes *Jours de précipitations extrêmes *Précipitations printanières *Maximum du cumul journalier à 2 ans *Maximum du cumul journalier à 25 ans	3,4	4
E – Étiage	*Précipitations annuelles moyennes	3	4
VP – Augmentation de la variabilité des précipitations	*Précipitations annuelles moyennes *Jours de précipitations extrêmes *Précipitations printanières *Maximum du cumul journalier à 2 ans *Maximum du cumul journalier à 25 ans	3,4	4

[+] *Se référer à la Figure 3 pour identifier les variables climatiques associées à chaque aléa.*

2.4 LES CONSÉQUENCES DES ALÉAS CLIMATIQUES

Le Tableau 6 et le Tableau 7 présentent les conséquences des aléas sur les différents aspects du projet (les personnes, l'économie y compris les infrastructures, et l'environnement), respectivement pour les aléas reliés à la température et ceux reliés aux précipitations.

Tableau 6 Conséquences des aléas climatiques liés à la hausse des températures

Degré	Personnes			Économie			Environnement			
	Santé et sécurité	Déplacement	Perte de qualité de vie	Impacts sur les infrastructures , opérations et démantèlement	Impact financier pour le promoteur	Impact financier pour les parties prenantes	Air	Eau	Terre	Écosystèmes
Mineure							*Migration nordique des écorégions, des espèces perturbatrices et des espèces menacées (SE) *Évapotranspiration accélérée augmentant la probabilité d'érosion des résidus miniers à toxicité quasi-nulle (SD, C)			
Significative	*Vulnérabilité des travailleurs face aux extrêmes de température (C, FF) *Mauvaise acceptabilité des risques par les groupes socioéconomiques vulnérables moins bien informés sur les changements climatiques (tous) *Augmentation des maladies vectorielles (ex. Lyme) par insectes piqueurs (SE)			*Augmentation hivernale des eaux d'exhaure (RH) *Plus d'imprévisibilité des saisons d'activités (SE) *Bris de la machinerie en condition de verglas (RH) *Dilatation thermique des matériaux (C)			*Hausse de la végétation à contrôler sur les chemins d'accès (SE)			
Sévère	*Santé et isolement des travailleurs durant les canicules et feux de forêt et lors du rétablissement des opérations (C, FF)			*Évaporation accélérée dans les bassins (voir précipitations) pouvant influencer la variabilité de la ressource en eau (C, SE)						
Critique	*Augmentation des évacuations pendant les feux de forêt (FF)									
Catastrophique				*Dommages aux infrastructures durant les feux de forêt (FF)						
Opportunité				*Saison d'opérations estivales plus longue (SE) *Économie d'énergie liée au réchauffement hivernal (RH)			*Accélération de la végétalisation naturelle lors du démantèlement (SE)			
Incertitude										

Tableau 7 Conséquences des aléas climatiques liés à la modification des régimes de précipitations

Degré	Personnes			Économie			Environnement			
	Santé et sécurité	Déplacement	Perte de qualité de vie	Impacts sur les infrastructures, opérations et démantèlement	Impact financier pour le promoteur	Impact financier pour les parties prenantes	Air	Eau	Terre	Écosystèmes
Mineure							*Rareté de la ressource en eaux en cas d'étiage prolongé (É)			
Significative				*Besoin d'entretien supplémentaire des voies d'accès en raison d'inondations pluviales (I) *Plus grande variabilité des émissions de poussières (VP)			*Baisse possible de la performance des méthodes de restauration du site en cas de sécheresse (SD) *Changement possible de la dynamique hydro-géomorphologique de la région (SD, VP)			
Sévère	*Santé des travailleurs durant les inondations et lors du rétablissement des opérations (I)			*Besoin de rénovations plus fréquentes (HN, I)						
Critique				*Dommages aux bâtiments liés aux inondations (I) *Insuffisance des ponceaux (colmatage et érosion) (HN, I) *Insuffisance des volumes des bassins de décantation (VP) *Instabilité des pentes de la fosse (VP) *Instabilité des haldes et des bassins (VP) *Groupes électriques exposés aux inondations (I) *Conflits de gestion de l'eau durant les sécheresses et baisse de rendement (SD, VP) *Problème d'approvisionnement en électricité en cas d'étiage prolongé (É)			*Concentration accrue des contaminants dans les cours d'eau en raison de leur moindre dilution (É) *Hausse de la variabilité de la ressource en eau (VP) *Contamination liée aux inondations (I)			
Catastrophique				*Débordement du déversoir d'urgence en cas de précipitations extrêmes (VP)						
Opportunité										
Incertitude				*Fréquence des coupures d'électricité en cas d'augmentation du temps instable ou de bris d'équipements aériens, ou de jours de travail extérieur réduits						

2.5 LES RISQUES CLIMATIQUES

Le tableau 8 présente le croisement entre les probabilités et les conséquences des aléas climatiques, afin de déterminer les niveaux de risque associés. En prenant en compte de la durée d'exploitation du site minier, la probabilité des aléas correspond à l'horizon à moyen terme, à l'exception de ceux qui ont un impact direct sur le démantèlement et la restauration du site. En effet, ces dernières étapes risquent très probablement de s'étaler au-delà de 2050. Les risques concernant les travailleurs sont également évalués à moyen terme, en faisant l'hypothèse que les processus de démantèlement/restauration ne nécessitent pas la présence permanente de travailleurs.

La figure 4 montre la répartition des risques par niveau. Les risques les plus élevés concernent les aléas à long terme, le démantèlement et la restauration du site, tandis que les risques moins élevés concernent les travailleurs, la construction et l'exploitation du site. En moyenne, le niveau de risque est de 3,1/5 à moyen terme et de 3,5/5 à long terme. Certaines mesures sont donc requises à court terme pour réduire les risques à moyen terme. Malgré l'horizon lointain de la restauration du site, des réflexions immédiates sont requises pour préparer la phase post-exploitation qui se fera dans des conditions climatiques significativement différentes de celles que nous avons actuellement.

Des risques positifs sont tout de même à noter comme une saison d'opérations estivales plus longue, une économie d'énergie liée au réchauffement hivernal et l'accélération de la végétalisation naturelle lors du démantèlement du site.

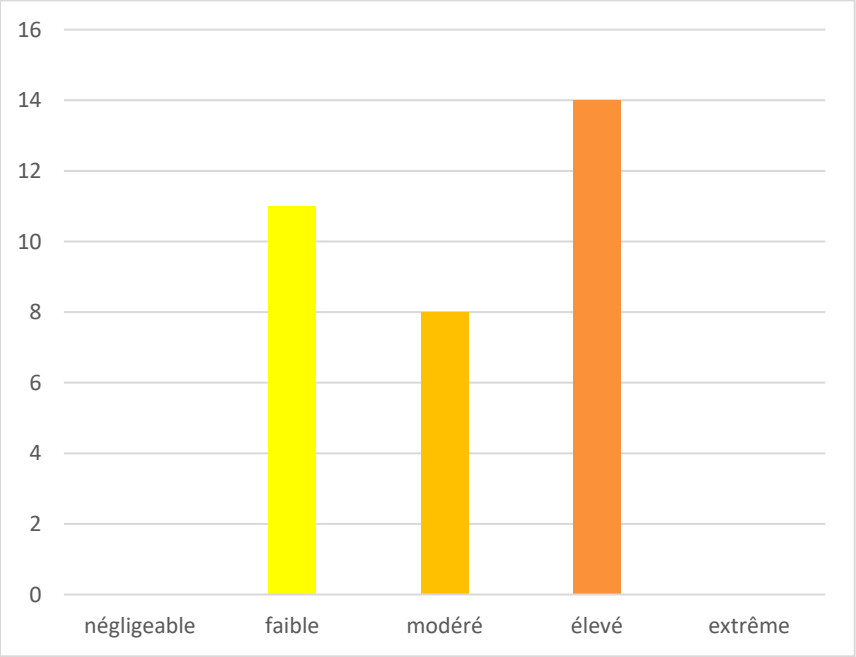


Figure 4 **Répartition des niveaux de risque donnant le nombre de risques (axe des ordonnées) par niveau (axe des abscisses)**

Tableau 8 Matrice multirisque prenant en compte le niveau de probabilité et les conséquences des aléas climatiques

<table>
<tr><th colspan="2" rowspan="2"></th><th colspan="5">Probabilité</th></tr>
<tr><th>Très faible</th><th>Faible</th><th>Moyenne</th><th>Forte</th><th>Très forte</th></tr>
<tr><td rowspan="2">Conséquences</td><td>Catastrophique</td><td>N/A</td><td>N/A</td><td>*Dommages aux infrastructures durant les feux de forêt
*Débordement du déversoir d’urgence en cas de précipitations extrêmes</td><td>N/A</td><td>N/A</td></tr>
<tr><td>Critique</td><td>*Changement possible de la dynamique hydro-géomorphologique de la région
*Rareté de la ressource en eaux en cas d’étiage prolongé</td><td>N/A</td><td>*Augmentation des évacuations pendant les feux de forêt
*Dommages aux bâtiments liés aux inondations
*Insuffisance des ponceaux (colmatage et érosion)
*Insuffisance des volumes des bassins de décantation
*Instabilité des pentes de la fosse
*Instabilité des haldes et des bassins
*Groupes électriques exposés aux inondations
*Problème d’approvisionnement en électricité en cas d’étiage prolongé
*Hausse de la variabilité de la ressource en eau
*Contamination liée aux inondations</td><td>*Conflits de gestion de l’eau durant les sécheresses et baisse de rendement
*Concentration accrue des contaminants dans les cours d’eau en raison de leur moindre dilution</td><td>N/A</td></tr>
</table>

		Probabilité				
		Très faible	**Faible**	**Moyenne**	**Forte**	**Très forte**
Conséquences	**Sévère**	N/A	N/A	*Évaporation accélérée dans les bassins pouvant influencer la variabilité de la ressource en eau * Besoin de rénovations plus fréquentes *Santé et isolement des travailleurs durant les canicules et feux de forêt et lors du rétablissement des opérations *Santé des travailleurs durant les inondations et lors du rétablissement des opérations	N/A	N/A
	Significative	N/A	N/A	*Dilatation thermique des matériaux * Vulnérabilité des travailleurs face aux extrêmes de température *Mauvaise acceptabilité des risques par les groupes socioéconomiques vulnérables moins bien informés sur les changements climatiques *Augmentation des maladies vectorielles (ex. Lyme) par insectes piqueurs *Augmentation hivernale des eaux d'exhaure *Plus d'imprévisibilité des saisons d'activités *Bris de la machinerie en condition de verglas *Hausse de la végétation à contrôler sur les chemins d'accès *Besoin d'entretien supplémentaire des voies d'accès en raison d'inondations pluviales *Plus grande variabilité des émissions de poussières	*Baisse possible de la performance des méthodes de restauration du site en cas de sécheresse	N/A
	Mineure	N/A	N/A	*Migration nordique des écorégions, des espèces perturbatrices et des espèces menacées	N/A	*Évapotranspiration accélérée augmentant la probabilité d'érosion des résidus miniers à toxicité quasi-nulle

	Probabilité				
	Très faible	**Faible**	**Moyenne**	**Forte**	**Très forte**
Opportunité	N/A	N/A	*Saison d'opérations estivales plus longue *Économie d'énergie liée au réchauffement hivernal	N/A	*Accélération de la végétalisation naturelle lors du démantèlement
Manque de connaissance	*Fréquence des coupures d'électricité en cas d'augmentation du temps instable ou de bris d'équipements aériens, ou de jours de travail extérieur réduits				
Risque positif	*Risque négligeable*	*Risque faible*	*Risque modéré*	*Risque élevé*	*Risque extrême*

2.6 LES MESURES D'ADAPTATION ET D'ATTÉNUATION DES RISQUES

Le tableau 9 classifie les risques identifiés par ordre d'importance et les mesures d'adaptation et d'atténuation adoptées et/ou proposées. Leur degré de mise en œuvre dans le projet de site minier Galaxy est également évalué. Conformément à la loi sur la qualité de l'environnement du Québec (LQE), toutes ces mesures sont basées sur le scénario d'émissions RCP8.5 (aucune mesure d'atténuation à l'échelle globale). L'impact de l'incertitude concernant les conditions de vents pourra être abordé par un processus d'acquisition de connaissances alors que les mesures de contingence de gestion des urgences reliées aux systèmes critiques pourraient suffire à prévenir une grande part des dommages anticipés.

Tableau 9 Priorisation des risques, mesures d'adaptation et d'atténuation, degré de mise en œuvre de ces mesures

Niveau	Risque	Mesures d'adaptation et d'atténuation	Degré de mise en œuvre[1]	
5 - Risque extrême	n/a	n/a	n/a	n/a

Niveau	Risque	Mesures d'adaptation et d'atténuation	Degré de mise en œuvre[1]	
4 - Risque élevé	Augmentation des évacuations pendant les feux de forêt	— 1. Procédure d'intervention au plan d'urgence — 2. Sensibilisation des travailleurs	— 1. Acceptée — 2. Acceptée	— 1. Procédure qui sera comprise dans le plan des mesures d'urgence — 2. De la documentation SST sera distribuée et une formation sera donnée aux employés pour prévention.
	Dommages aux infrastructures durant les feux de forêt	— 1. Conception d'espace de confinement (tranchées) — 2. Procédure d'intervention au plan d'urgence — 3. Système d'alerte interne — 4. Souscription d'assurance aux feux de forêt	— 1. Acceptée — 2. À intégrer — 3. Acceptée — 4. À considérer	— 1. Bande de matière organique sera enlevée autour du site du projet pour prévenir les feux de forêt. Cette bande exempte de matière organique devra faire l'objet de travaux de maintenance. — 2. Procédure qui sera comprise dans le plan des mesures d'urgence — 3. Prévu dans l'étude de faisabilité — 4. ---
	Dommages aux bâtiments liés aux inondations	— 1. Localisation des infrastructures hors des zones inondables basée sur une crue centennale — 2. Procédure d'intervention au plan d'urgence — 3. Souscription d'assurances aux inondations	— 1. Acceptée — 2. À intégrer — 3. À considérer	— 1. L'usine, localisée sur un cap rocheux, sera construite sur une base de béton mais les autres bâtiments seront construits sur des tréteaux — 2. Procédure qui sera comprise dans le plan des mesures d'urgence — 3. ---
	Débordement du déversoir d'urgence en cas de précipitations extrêmes	— 1. Conception du déversoir d'urgence incluant un facteur de sécurité supplémentaire basé sur une crue millénale — 2. Plan de surveillance et d'entretien — 3. Système d'alerte interne	— 1. Acceptée — 2. À intégrer — 3. Acceptée	— 1. Facteur de sécurité déjà inclus dans la conception du déversoir d'urgence — 2. Ce plan sera développé à une étape ultérieure — 3. Prévu dans l'étude de faisabilité
	Insuffisance des ponceaux (colmatage et érosion)	Conception des ponceaux avec une cote de crue écologique centennale	Acceptée	Cote de crue déjà comprise dans la conception des ponceaux

Niveau	Risque	Mesures d'adaptation et d'atténuation	Degré de mise en œuvre[1]	
	Insuffisance des volumes des bassins de décantation	– 1. Conception des bassins avec une cote de crue écologique centennale – 2. Augmentation de la capacité des déversoirs et des évacuateurs de crue	– 1. Acceptée – 2. Acceptée	– 1. Code de crue déjà comprise dans la conception des bassins – 2. Dans l'éventualité où la capacité des déversoirs et des évacuateurs de crue était insuffisante, celle-ci sera augmentée
	Instabilité des pentes de la fosse	Conception basée sur des pentes conservatrices, selon les normes en vigueur	Acceptée	Suivi de la stabilité des pentes de la fosse et provision prévue dans le plan des mesures d'urgence
	Instabilité des haldes et des bassins	Conception réalisée selon les normes en vigueur	Acceptée	Suivi de la stabilité des haldes, digues et bermes ainsi que provision prévue dans le plan des mesures d'urgence
	Groupes électriques exposés aux inondations	– 1. Surélévation suffisante des groupes électriques – 2. Disponibilité de génératrices	– 1. Acceptée – 2. Acceptée	– 1. Mesure qui sera intégrée au plan d'ingénierie de détail – 2. Des génératrices seront disponibles si nécessaire
	Problème d'approvisionnement en électricité en cas d'étiage prolongé	Fermeture temporaire	Acceptée	---
	Hausse de la variabilité de la ressource en eau	Plan de continuité en cas de rationnement en eau	À intégrer	Mesure qui sera intégrée dans le plan des mesures d'urgence
	Contamination liée aux inondations	Contrôle continu de l'étendue des milieux humides)	À considérer	---
	Conflits de gestion de l'eau durant les sécheresses et baisses de rendement	Plan de continuité en cas de rationnement en eau	À intégrer	Mesure qui sera intégrée dans le plan des mesures d'urgence
	Concentration accrue des contaminants dans les cours d'eau en raison de leur moindre dilution	Surveillance accrue de la qualité de l'eau du bassin versant	À intégrer	Mesure qui sera intégrée dans les études de suivi des effets sur l'environnement

Niveau	Risque	Mesures d'adaptation et d'atténuation	Degré de mise en œuvre[1]	
3 - Risque modéré	Évapotranspiration accélérée augmentant la probabilité d'érosion des résidus miniers de toxicité quasi-nulle	Contrôle régulier de l'humidité de la surface du parc à résidus	Rejetée	Il n'y a pas de risque d'érosion compte tenu de la taille des résidus miniers (8 mm) et de leur non-toxicité
	Baisse de la performance des méthodes de restauration du site en cas de sécheresse	Contrôle régulier de l'humidité du sol sous et aux environs du parc à résidus	Rejetée	Il n'y a pas de couvert humide sous les résidus
	Besoin de rénovations plus fréquentes	— 1. Programme de surveillance plus accrue des infrastructures — 2. Contingence supplémentaire dans la planification de l'entretien	— 1. À considérer — 2. À considérer	— 1. Si les infrastructures se dégradent plus vite que prévu — 2. Si les infrastructures se dégradent plus vite que prévu
	Santé des travailleurs durant les feux de forêt et lors du rétablissement des opérations	— 1. Procédure d'intervention au plan d'urgence — 2. Système élaboré d'assurance santé — 3. Système d'alerte interne — 4. Centre médical sur place	— 1. À intégrer — 2. À intégrer — 3. Acceptée — 4. Acceptée	— 1. Procédure qui sera comprise dans le plan des mesures d'urgence — 2. Mesure qui est à prévoir dans le plan d'embauche du personnel — 3. Alarmes des bâtiments prévues dans l'étude de faisabilité — 4. Prévu dans la construction
	Santé des travailleurs durant les canicules	— 1. Procédure Santé-Sécurité au travail — 2. Sensibilisation des travailleurs — 3. Système d'alerte interne — 4. Centre médical sur place	— 1. À intégrer — 2. À intégrer — 3. Acceptée — 4. Acceptée	— 1. Procédure qui sera développée dans le plan de santé et sécurité des travailleurs. Les postes de travail à risque seront ciblés. Pauses plus fréquentes lors de journées chaudes. — 2. De la documentation SST sera distribuée et une formation sera donnée aux employés pour prévention. — 3. Prévu dans l'étude de faisabilité — 4. Prévu dans la construction

Niveau	Risque	Mesures d'adaptation et d'atténuation	Degré de mise en œuvre[1]	
	Santé des travailleurs durant des inondations et lors du rétablissement des opérations	– 1. Procédure Santé-Sécurité au travail – 2. Procédure d'intervention au plan d'urgence – 3. Fond de contingence supplémentaire pour les extrêmes climatiques – 4. Système élaboré d'assurance santé – 5. Système d'alerte interne	– 1. À intégrer – 2. À intégrer – 3. À considérer – 4. À intégrer – 5. Acceptée	– 1. Procédure qui sera développée dans le plan de santé et sécurité des travailleurs – 2. Procédure qui sera comprise dans le plan des mesures d'urgence – 3. --- – 4. Mesure qui est à prévoir dans le plan d'embauche du personnel – 5. Prévu dans l'étude de faisabilité
2 - Risque faible	Vulnérabilité des travailleurs face aux extrêmes de température	Mesure particulière de Santé-Sécurité au travail	À intégrer	Mesures à intégrer au plan de santé et sécurité des travailleurs
	Changement possible de la dynamique hydro-géomorphologique de la région	Disposition à collaborer avec le Gouvernement et les institutions académiques pour la surveillance hydro-géomorphologique	Rejetée	Durée de vie de mine trop courte
	Dilatation thermique des matériaux	Conception réalisée en sélectionnant des matériaux/procédés adéquats aux conditions futures (exemple : joints de dilatation)	Rejetée	Durée de vie de mine trop courte
	Mauvaise acceptabilité des risques par les groupes socioéconomiques vulnérables moins bien informés sur les changements climatiques	Activité de sensibilisation aux impacts des changements climatiques en lien avec les activités minières	À intégrer	Mesures à intégrer au plan de santé et sécurité des travailleurs
	Augmentation des maladies vectorielles (ex. Lyme) par insectes piqueurs	Mesure particulière de Santé-Sécurité au travail	À intégrer	Procédures à intégrer au plan de santé et sécurité des travailleurs, dont les procédures reliées aux épidémies
	Augmentation hivernale des eaux d'exhaure	Capacité d'accumulation supérieure	Acceptée	Revanche conçue avec facteur de sécurité
	Plus d'imprévisibilité des saisons d'activités	Contingence comprenant les événements extrêmes ou imprévisibilités saisonnières	Rejetée	L'opération est la même lors de toutes les saisons, mais il pourrait y avoir des arrêts occasionnels imprévus, Aucune structure ne dépend du gel.

Niveau	Risque	Mesures d'adaptation et d'atténuation	Degré de mise en œuvre[1]	
	Bris de la machinerie en condition de verglas	Contingence sur l'entretien de la machinerie	Acceptée	Atelier mécanique et disponibilité d'équipement de remplacement
	Hausse de la végétation à contrôler sur les chemins d'accès	Contingence dans l'entretien des surfaces	Acceptée	Suivi régulier de l'état des chemins d'accès et entretien au besoin
	Besoin d'entretien supplémentaire des voies d'accès en raison d'inondations pluviales	– 1. Contingence pour l'enlèvement des débris et entretien – 2. Plan de continuité des services (ex. examen des voies de contournement/réseau redondant)	– 1. Acceptée – 2. À considérer	– 1. Nettoyage et entretien si nécessaire – 2. ---
	Plus grande variabilité des émissions de poussières	Contingence supplémentaire dans les opérations pour réduire les poussières	À considérer	Plusieurs mesures de réduction des poussières sont déjà incluses dans l'étude des impacts environnementaux. D'autres mesures pourront être considérées le cas échéant.
	Migration nordique des écorégions, des espèces perturbatrices et des espèces menacées	Disposition à collaborer avec le Gouvernement et les institutions académiques pour la surveillance faunique	Acceptée	Mesure à intégrer au plan d'action de la biodiversité
	Rareté de la ressource en eaux en cas d'étiage prolongé	Plan de continuité des opérations en cas d'étiage	À intégrer	Voir plan de rationnement en eau (PMU)
1 - Risque négligeable	n/a	n/a	n/a	n/a
Risque positif	Saison d'opérations estivales plus longue	Ajout d'un scénario optimiste dans la planification des opérations	Rejetée	Les opérations sont prévues 24h/7
	Économie d'énergie liée au réchauffement hivernal	Ajout d'un scénario optimiste dans la planification des opérations	Acceptée	
	Accélération de la végétalisation naturelle lors de la restauration	Ajout d'un scénario optimiste dans la planification du démantèlement	Acceptée	Modification possible des espèces à utiliser pour la restauration, scénario à considérer dans la section « Restauration » du plan d'action de la biodiversité

[1] Degrés de mise en œuvre : Acceptée = mesure comprise dans l'étude d'impacts environnementaux; à intégrer = mesure qui sera intégrée à l'étape de l'ingénierie détaillée ou lors de l'élaboration des systèmes de gestion; à considérer = mesure à considérer et qui pourrait éventuellement être intégrée au projet; rejetée = mesure qui n'a pas été retenue.

2.7 CONCLUSION : CONCEVOIR POUR L'AVENIR

L'objectif central de ce projet a été d'analyser de manière préliminaire les impacts des changements climatiques sur le projet de site minier d'extraction de lithium de la Baie-James. Les résultats sont présentés selon deux horizons : à moyen terme (2021-2050) et à long terme (2051-2080). Le premier horizon correspond aux échéances de l'exploitation du site. Le deuxième horizon permet de prendre en compte l'éventuel temps supplémentaire que le démantèlement et la restauration du site nécessiteront. Les risques sur les personnes, l'économie et l'environnement sont évalués à moyen terme, à l'exception des risques environnementaux liés à la restauration du site qui sont évalués à long terme.

Les résultats à moyen terme suggèrent que les risques les plus importants nécessitant des contrôles et mesures d'atténuation et d'adaptation sont les feux de forêt (infrastructures et risques pour la santé et la sécurité), les canicules (risques pour la santé et la sécurité), les barrages défaillants (infrastructures), et les inondations (santé et sécurité). À long terme, les risques concernent essentiellement la sécheresse des sols et les canicules. Des réflexions immédiates sont donc requises pour préparer la phase post-exploitation qui se fera dans des conditions climatiques significativement différentes de celles que le site a actuellement.

L'approche de WSP « Conçu pour l'avenir » a permis de prendre les dispositions nécessaires pour que les composantes du projet soient prêtes à être adaptées, à faire face et être plus résilientes aux risques engendrés par les changements climatiques. On peut noter en particulier qu'il est possible de :

- *concevoir* pour des températures moyennes à la hausse, mais aussi une plus grande capacité à absorber un nombre croissant de jours extrêmes de chaleur, ainsi qu'une baisse des extrêmes de froid et une saison froide réduite;
- *concevoir* pour des extrêmes de précipitations plus importants, tant du côté de l'abondance que de la rareté de la ressource en eau, mais aussi des changements possibles à l'échelle du bassin versant.

ANNEXE

A DONNÉES CLIMATIQUES DÉTAILLÉES

ANNEXE

Rapport de l'atlas climatique
Région : RESERVOIR OPINACA

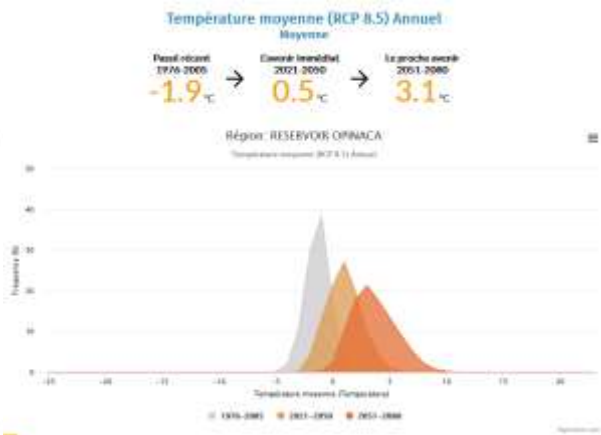
RCP8,5 : scénario de statu quo
Les émissions continuent d'augmenter au rythme actuel

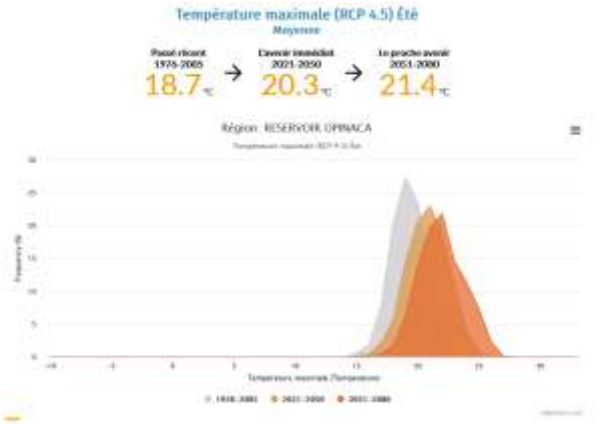
Variable	Période	1976-2005	2021-2050			2051-2080		
		Moyenne	faible	moyenne	haute	faible	moyenne	haute
Précipitations	Annuel	690	622	743	881	668	790	915
Précipitations	Printemps	107	83	119	167	86	128	178
Précipitations	Été	228	161	229	316	154	230	317
Précipitations	L'automne	237	185	257	328	198	269	350
Précipitations	Hiver	116	96	138	187	102	164	253
Température moyenne (°C)	Annuel	-1.9	-1.6	0.5	2.8	0.7	3.1	6.1
Température moyenne (°C)	Printemps	-3.8	-5.4	-2.1	1.6	-3.8	0.4	4.3
Température moyenne (°C)	Été	13	12.6	14.8	17.1	14.3	17.1	20.1
Température moyenne (°C)	L'automne	2.1	1.8	4.2	6.4	3.7	6.2	8.9
Température moyenne (°C)	Hiver	-19	-19.2	-15.2	-11.2	-15.7	-11.3	-6.6
Nuits tropicales	Annuel	0	0	0	2	0	2	9
Les jours très chauds (+30°C)	Annuel	1	1	2	10	2	7	26
Jours très froids (-30°C)	Annuel	27	3	11	30	0	3	16
Date du dernier gel printanier	Annuel	juin 11	mai 16	juin 6	juin 22	mai 6	mai 22	juin 9
Date du premier gel automnal	Annuel	sept. 18	sept. 11	oct. 4	oct. 19	sept. 25	oct. 16	nov. 1
Saison sans gel (days)	Annuel	99	86	120	151	111	147	174

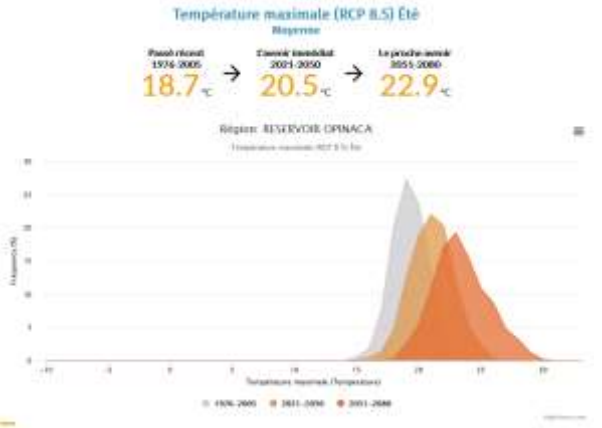
RCP4,5 : une faible teneur en carbone
Les émissions diminues significativement

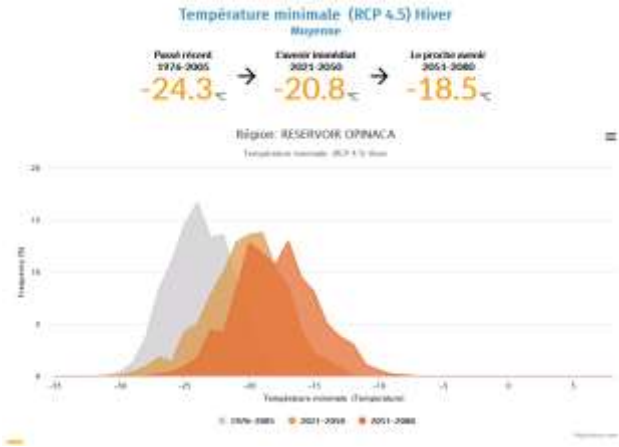
Variable	Période	1976-2005	2021-2050			2051-2080		
		Moyenne	faible	moyenne	haute	faible	moyenne	haute
Précipitations	Annuel	690	610	732	856	635	760	900
Précipitations	Printemps	107	76	117	166	78	121	170
Précipitations	Été	228	167	229	306	161	231	317
Précipitations	L'automne	237	180	254	318	192	261	337
Précipitations	Hiver	116	87	133	186	99	147	212
Température moyenne (°C)	Annuel	-1.9	-2	0.1	2.1	-0.9	1.4	3.9
Température moyenne (°C)	Printemps	-3.8	-5.7	-2.1	1.5	-4.9	-1.2	2.7
Température moyenne (°C)	Été	13	12.4	14.5	16.7	13.2	15.6	18.2
Température moyenne (°C)	L'automne	2.1	1.5	3.7	5.9	2.7	4.8	7.1
Température moyenne (°C)	Hiver	-19	-20.2	-15.8	-12	-18.1	-13.7	-9.2
Nuits tropicales	Annuel	0	0	0	1	0	0	3
Les jours très chauds (+30°C)	Annuel	1	0	2	9	1	3	15
Jours très froids (-30°C)	Annuel	27	4	12	32	1	6	24
Date du dernier gel printanier	Annuel	juin 11	mai 21	juin 6	juin 27	mai 13	mai 28	juin 17
Date du premier gel automnal	Annuel	sept. 18	sept. 7	sept. 29	oct. 16	sept. 16	oct. 6	oct. 22
Saison sans gel (days)	Annuel	99	80	115	142	95	130	156

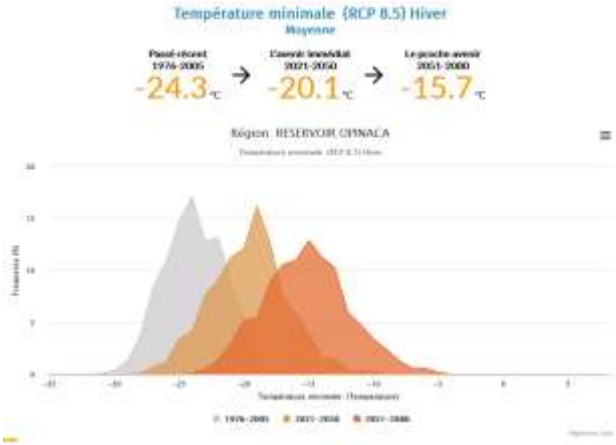
Moyennes et fréquences actuelles et anticipées selon le scénario climatique par variable climatique dans la cellule du Réservoir Opinaca (source : https://atlasclimatique.ca)



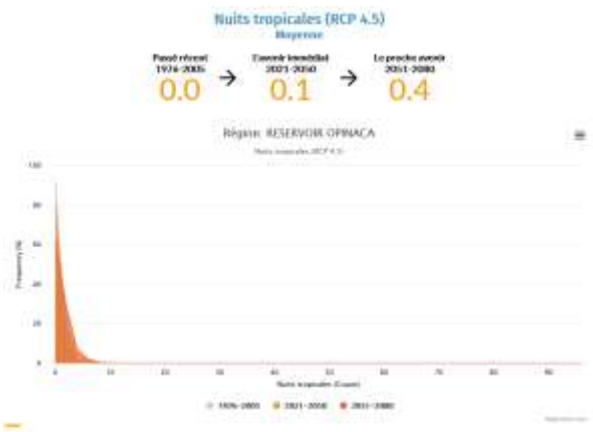




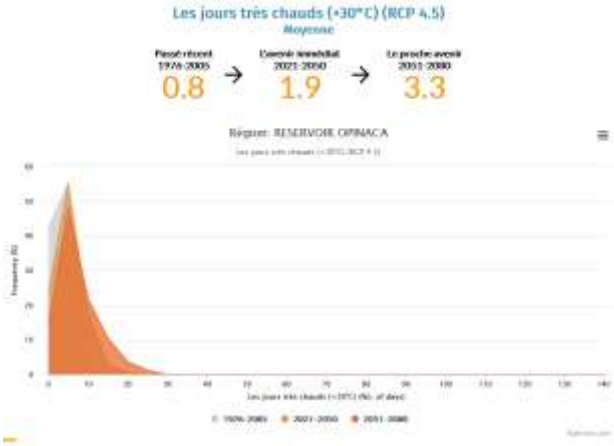


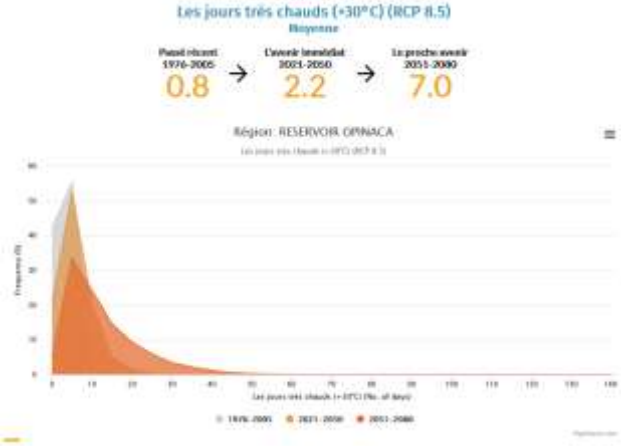


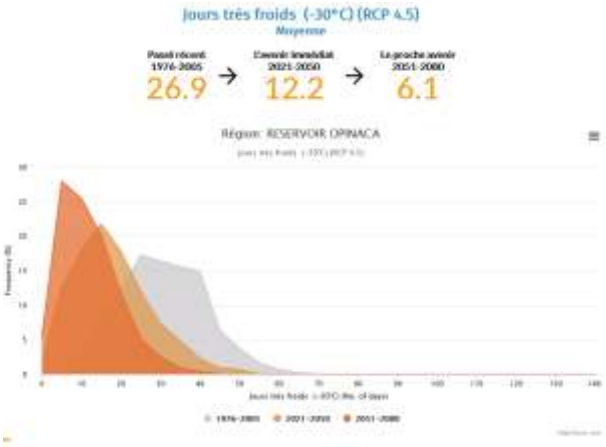
ANNEXE

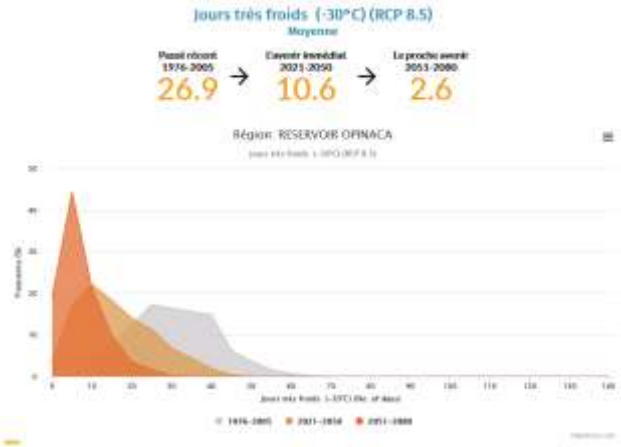

Nuits tropicales (RCP 4.5)
Moyenne
Passé récent 1976-2005
0.0
L'avenir immédiat 2021-2050
0.1
Le proche avenir 2051-2080
0.4
Région: RESERVOIR OPINACA

Nuits tropicales (RCP 8.5)
Moyenne
Passé récent 1976-2005
0.0
L'avenir immédiat 2021-2050
0.2
Le proche avenir 2051-2080
1.5
Région: RESERVOIR OPINACA


Les jours très chauds (+30°C) (RCP 4.5)
Moyenne
Passé récent 1976-2005
0.8
L'avenir immédiat 2021-2050
1.9
Le proche avenir 2051-2080
3.3
Région: RESERVOIR OPINACA


Les jours très chauds (+30°C) (RCP 8.5)
Moyenne
Passé récent 1976-2005
0.8
L'avenir immédiat 2021-2050
2.2
Le proche avenir 2051-2080
7.0
Région: RESERVOIR OPINACA

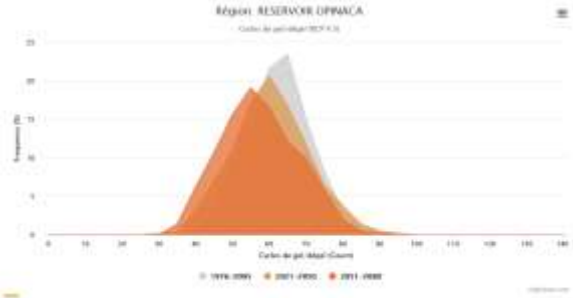

Jours très froids (-30°C) (RCP 4.5)
Moyenne
Passé récent 1976-2005
26.9
L'avenir immédiat 2021-2050
12.2
Le proche avenir 2051-2080
6.1
Région: RESERVOIR OPINACA


Jours très froids (-30°C) (RCP 8.5)
Moyenne
Passé récent 1976-2005
26.9
L'avenir immédiat 2021-2050
10.6
Le proche avenir 2051-2080
2.6
Région: RESERVOIR OPINACA

Cycles de gel/dégel (RCP 4.5)

Moyenne

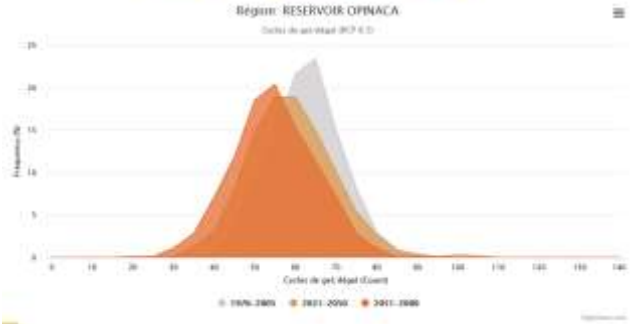
Passé récent 1976-2005		L'avenir immédiat 2021-2050		Le proche avenir 2051-2080
60.7	→	57.7	→	55.4



Cycles de gel/dégel (RCP 8.5)

Moyenne

Passé récent 1976-2005		L'avenir immédiat 2021-2050		Le proche avenir 2051-2080
60.7	→	55.8	→	52.1



Date du dernier gel printanier (RCP 4.5)

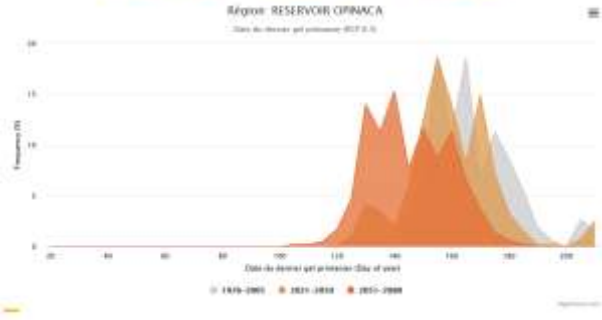
Moyenne

Passé récent 1976-2005		L'avenir immédiat 2021-2050		Le proche avenir 2051-2080
June 12	→	June 6	→	May 29

Date du dernier gel printanier (RCP 8.5)

Moyenne

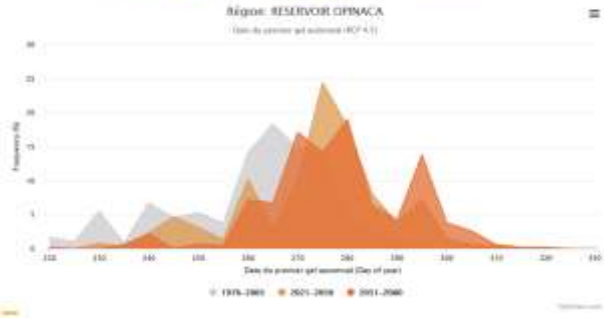
Passé récent 1976-2005		L'avenir immédiat 2021-2050		Le proche avenir 2051-2080
June 12	→	June 7	→	May 22



Date du premier gel automnal (RCP 4.5)

Moyenne

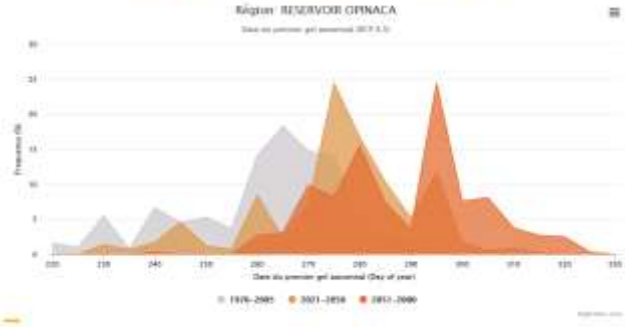
Passé récent 1976-2005		L'avenir immédiat 2021-2050		Le proche avenir 2051-2080
Sep. 19	→	Sep. 29	→	Oct. 6



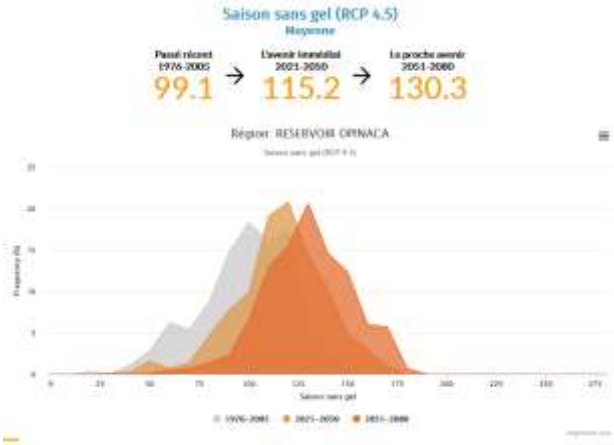
Date du premier gel automnal (RCP 8.5)

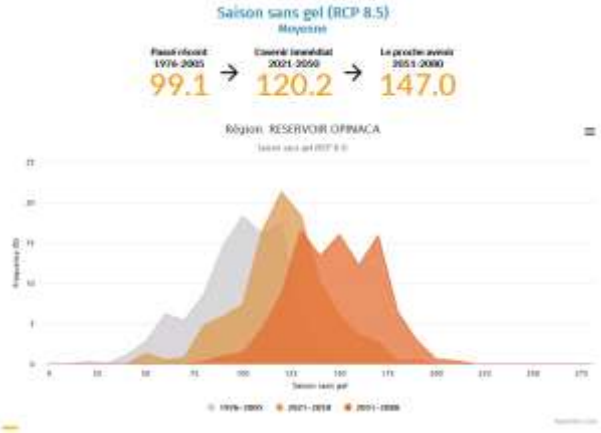
Moyenne

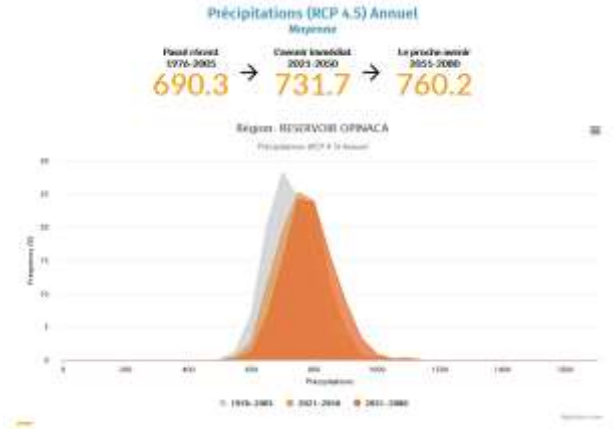
Passé récent 1976-2005		L'avenir immédiat 2021-2050		Le proche avenir 2051-2080
Sep. 19	→	Oct. 5	→	Oct. 16

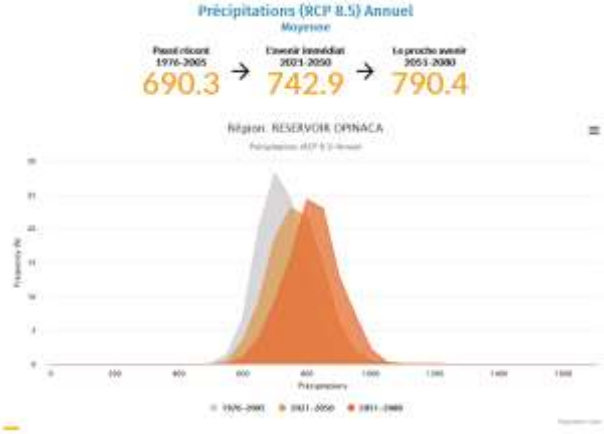


ANNEXE


Saison sans gel (RCP 4.5)
Moyenne
Passé récent 1976-2005
99.1
L'avenir immédiat 2021-2050
115.2
Le proche avenir 2051-2080
130.3
Région: RESERVOIR OPINACA


Saison sans gel (RCP 8.5)
Moyenne
Passé récent 1976-2005
99.1
L'avenir immédiat 2021-2050
120.2
Le proche avenir 2051-2080
147.0
Région: RESERVOIR OPINACA


Précipitations (RCP 4.5) Annuel
Moyenne
Passé récent 1976-2005
690.3
L'avenir immédiat 2021-2050
731.7
Le proche avenir 2051-2080
760.2
Région: RESERVOIR OPINACA


Précipitations (RCP 8.5) Annuel
Moyenne
Passé récent 1976-2005
690.3
L'avenir immédiat 2021-2050
742.9
Le proche avenir 2051-2080
790.4
Région: RESERVOIR OPINACA

Précipitations (RCP 4.5) Printemps
Moyenne
Passé récent 1976-2005
106.9
L'avenir immédiat 2021-2050
116.7
Le proche avenir 2051-2080
121.0
Région: RESERVOIR OPINACA

Précipitations (RCP 8.5) Printemps
Moyenne
Passé récent 1976-2005
106.9
L'avenir immédiat 2021-2050
119.4
Le proche avenir 2051-2080
128.0
Région: RESERVOIR OPINACA

Jours de précipitations fortes (20 mm) (RCP 4.5)

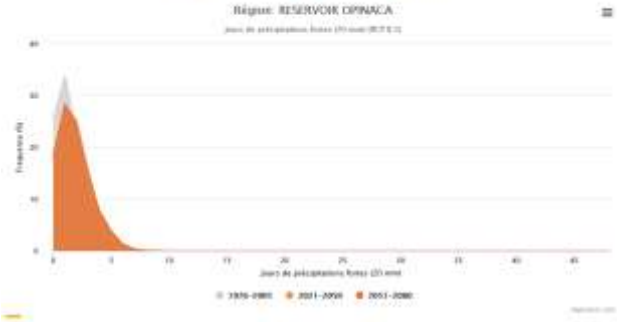
Moyenne

Passé récent 1976-2005		L'avenir immédiat 2021-2050		Le proche avenir 2051-2080
1.5	→	1.8	→	1.6

Jours de précipitations fortes (20 mm) (RCP 8.5)

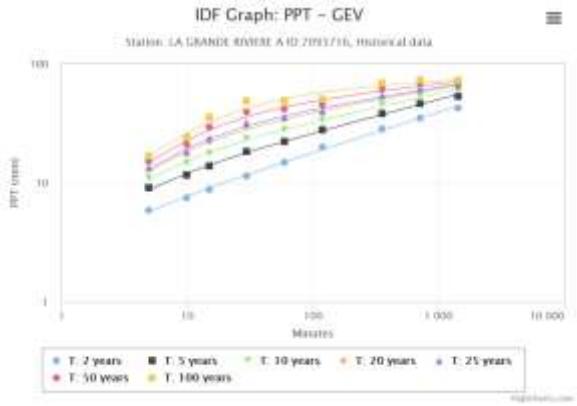
Moyenne

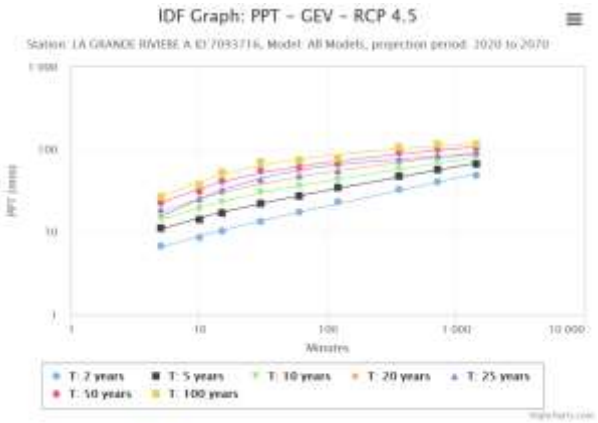
Passé récent 1976-2005		L'avenir immédiat 2021-2050		Le proche avenir 2051-2080
1.5	→	1.8	→	1.9

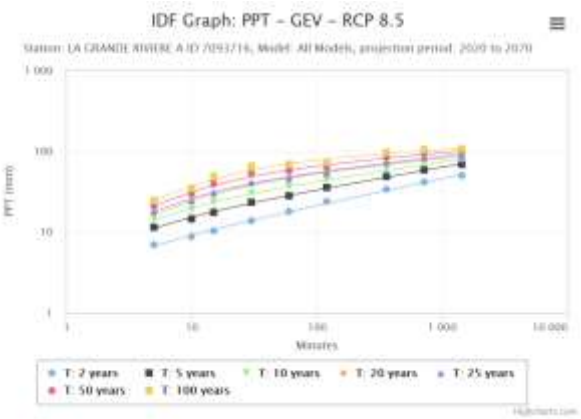


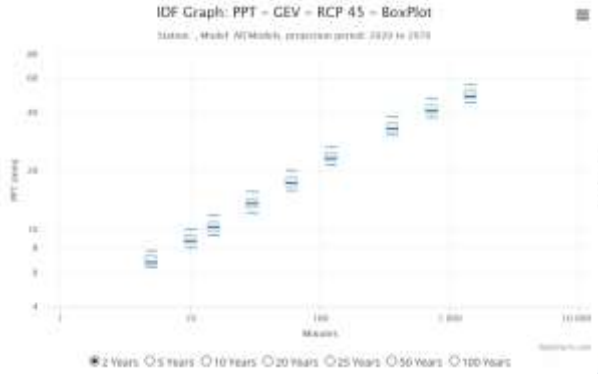
ANNEXE

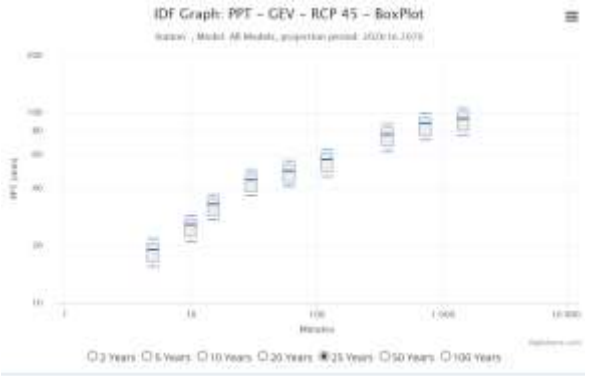
Courbes intensité-durée-fréquence et box-plots d'incertitudes pour les précipitations extrêmes pour la Grande Rivière (source : https://www.idf-cc-uwo.ca/)

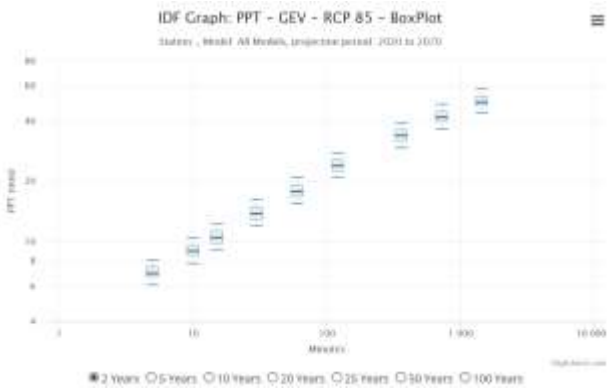


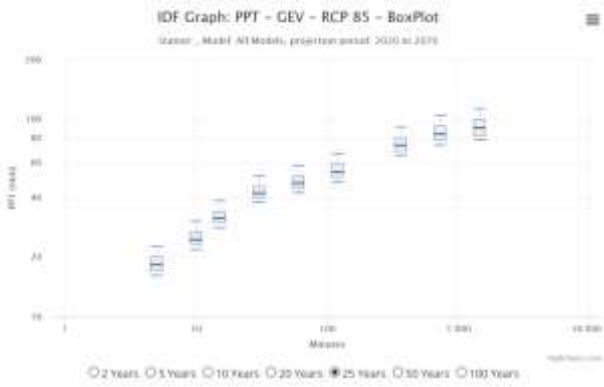




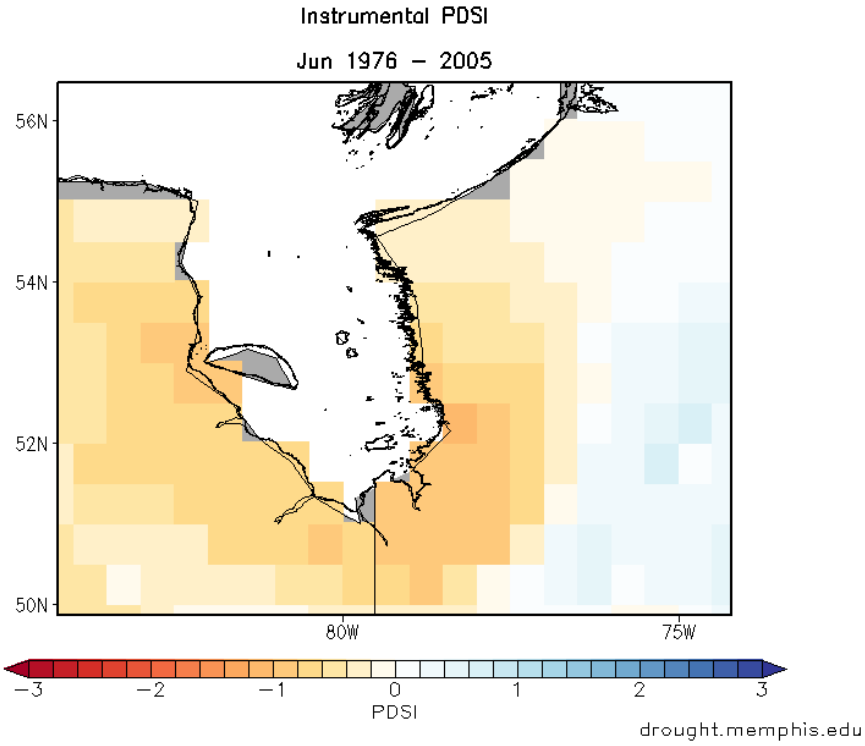








Carte de l'historique de l'indice de sécheresse de Palmer durant les mois d'été (1976-2005) (source : http://drought.memphis.edu)



APPENDIX

A-188

INVENTORY SHEETS, JUNE 11, 2018

InSitu - Rapport descriptif

Projet : Galaxy

171-02562-00

11 juin 2018

Calcul de valeur écologique (VE): Non

TABLEAU SOMMAIRE

Nb polygones (projet) :	**56**	**Sup. totale des polygones en ha**	**1687.2956**
Nb parcelles (projet) :	**99**		
Nb groupements :	**9**		

| MILIEUX HUMIDES

Tourbière arbustive

01-Tourbière arbustive | Sup. (ha) : 4.4479

Parcelle : P-19 ..... *p. 8*

02-Tourbière arbustive | Sup. (ha) : 28.5230

Parcelle : P-20 ..... *p. 11*

03-Tourbière arbustive | Sup. (ha) : 1.0117

Parcelle : P-41 ..... *p. 14*

04-Tourbière arbustive | Sup. (ha) : 3.3154

Parcelle : P-69 ..... *p. 17*

05-Tourbière arbustive | Sup. (ha) : 2.6634

Parcelle : P-53 ..... *p. 20*

Parcelle Validation: P-53-V1 ..... *p.21*

06-Tourbière arbustive | Sup. (ha) : 9.8367

Parcelle : P-72 ..... *p. 23*

07-Tourbière arbustive | Sup. (ha) : 163.4289

Parcelle : P-06 ..... *p. 26*

Parcelle : P-08 ..... *p. 28*

08-Tourbière arbustive | Sup. (ha) : 6.8927

Parcelle : P-11 ..... *p. 31*

Parcelle : P-13 ..... *p. 33*

09-Tourbière arbustive | Sup. (ha) : 20.1391

Parcelle : P-25 ..... *p. 36*

10-Tourbière arbustive | Sup. (ha) : 1.2430

Parcelle : P-22 ..... *p. 39*

11-Tourbière arbustive | Sup. (ha) : 1.3007

Parcelle : P-57 ..... *p. 42*

12-Tourbière arbustive | Sup. (ha) : 2.8115

Parcelle : P-47 ..... *p. 45*

Tourbière boisée

01-Tourbière boisée | Sup. (ha) : 140.5220

Parcelle : P-12 ..... *p. 48*

Parcelle : P-17 ..... *p. 50*

Parcelle Validation: P-17-V1 ..... *p.51*

Parcelle Validation: P-17-V2 ..... *p.51*

Parcelle Validation: P-17-V3 ..... *p.51*

Parcelle : P-21 ..... *p. 52*

Parcelle : P-48 ..... *p. 54*

02-Tourbière boisée | Sup. (ha) : 5.8284

Parcelle : P-24 ..... *p. 57*

03-Tourbière boisée | Sup. (ha) : 1.5574

Parcelle : P-52 ..... *p. 60*

04-Tourbière boisée | Sup. (ha) : 4.1666

Parcelle : P-77 ..... *p. 63*

05-Tourbière boisée | Sup. (ha) : 17.7918

Parcelle : P-07 ..... *p. 66*

06-Tourbière boisée | Sup. (ha) : 3.1646

Parcelle : P-30 ..... *p. 69*

07-Tourbière boisée | Sup. (ha) : 0.8557

Parcelle : P-35 ..... *p. 72*

08-Tourbière boisée | Sup. (ha) : 10.2545

Parcelle : P-38 ..... *p. 75*

09-Tourbière boisée | Sup. (ha) : 20.6407

Parcelle : P-27 ..... *p. 78*

Parcelle Validation: P-27-V1 ..... *p.79*

Tourbière ouverte

InSitu - Rapport descriptif

01-Tourbière ouverte | Sup. (ha) : 1.1908

Parcelle : P-18 ..... *p. 81*

02-Tourbière ouverte | Sup. (ha) : 49.1387

Parcelle : P-78 ..... *p. 84*

Parcelle : P-79 ..... *p. 86*

03-Tourbière ouverte | Sup. (ha) : 250.5288

Parcelle : P-09 ..... *p. 89*

Parcelle Validation: P-09-V1 ..... *p.90*

Parcelle : P-10 ..... *p. 91*

Parcelle : P-46 ..... *p. 93*

04-Tourbière ouverte | Sup. (ha) : 27.5034

Parcelle : P-60 ..... *p. 96*

05-Tourbière ouverte | Sup. (ha) : 1.8365

Parcelle : P-16 ..... *p. 99*

Parcelle Validation: P-16-V1 ..... *p.100*

06-Tourbière ouverte | Sup. (ha) : 13.4696

Parcelle : P-01 ..... *p. 102*

07-Tourbière ouverte | Sup. (ha) : 6.4794

Parcelle : P-02 ..... *p. 105*

09-Tourbière ouverte | Sup. (ha) : 33.8135

Parcelle : P-36 ..... *p. 108*

Parcelle Validation: P-36-V1 ..... *p.109*

Parcelle : P-54 ..... *p. 110*

Parcelle Validation: P-54-V1 ..... *p.111*

Parcelle Validation: P-54-V2 ..... *p.111*

Parcelle Validation: P-54-V3 ..... *p.111*

10-Tourbière ouverte | Sup. (ha) : 511.9583

Parcelle : P-29 ..... *p. 113*

Parcelle : P-31 ..... *p. 115*

Parcelle : P-39 ..... *p. 117*

Parcelle : P-40 ..... *p. 119*

Parcelle Validation: P-40-V1 ..... *p.120*

Parcelle : P-43 ..... *p. 121*

Parcelle : P-49 ..... *p. 123*

Parcelle : P-51 ..... *p. 125*

Parcelle Validation: P-51-V1 ..... p.126

Parcelle : P-64 ..... p. 127

Parcelle : P-66 ..... p. 129

Parcelle : P-68 ..... p. 131

Parcelle : P-70 ..... p. 133

Parcelle : P-71 ..... p. 135

Parcelle : P-73 ..... p. 137

Parcelle Validation: P-73-V1 ..... p.138

Parcelle : P-75 ..... p. 139

Parcelle : P-76 ..... p. 141

Parcelle : P-80 ..... p. 143

Parcelle : P-81 ..... p. 145

12-Tourbière ouverte | Sup. (ha) : 4.4966

Parcelle : P-04 ..... p. 148

13-Tourbière ouverte | Sup. (ha) : 0.7265

Parcelle : P-26 ..... p. 151

14-Tourbière ouverte | Sup. (ha) : 13.0094

Parcelle : P-34 ..... p. 154

15-Tourbière ouverte | Sup. (ha) : 9.9623

Parcelle : P-58 ..... p. 157

| MILIEUX TERRESTRES

Affleurement rocheux

01-Affleurement rocheux | Sup. (ha) : 41.2476

Parcelle : P-67 ..... p. 160

02-Affleurement rocheux | Sup. (ha) : 12.3069

Parcelle : P-65 ..... p. 163

Arbustaie

01-Arbustaie | Sup. (ha) : 26.6969

Parcelle : P-59 ..... p. 166

02-Arbustaie | Sup. (ha) : 9.7364

Parcelle : P-50 ..... p. 169

Parcelle Validation: P-50-V1 ..... p.170

03-Arbustaie | Sup. (ha) : 20.3827

Parcelle : P-56 ..... *p. 172*

04-Arbustaie | Sup. (ha) : 37.2046

Parcelle : P-61 ..... *p. 175*

Parcelle : P-63 ..... *p. 177*

05-Arbustaie | Sup. (ha) : 6.3040

Parcelle : P-45 ..... *p. 180*

06-Arbustaie | Sup. (ha) : 7.2537

Parcelle : P-74 ..... *p. 183*

07-Arbustaie | Sup. (ha) : 17.8312

Parcelle : P-44 ..... *p. 186*

08-Arbustaie | Sup. (ha) : 55.8460

Parcelle : P-82 ..... *p. 189*

Aulnaie crispé

01-Aulnaie crispé | Sup. (ha) : 1.6271

Parcelle : P-62 ..... *p. 192*

02-Aulnaie crispé | Sup. (ha) : 2.9488

Parcelle : P-33 ..... *p. 195*

Dénudé sec

01-Dénudé sec | Sup. (ha) : 17.9271

Parcelle : P-55 ..... *p. 198*

Pessière noire à lichen

01-Pessière noire à lichen | Sup. (ha) : 1.8248

Parcelle : P-14 ..... *p. 201*

02-Pessière noire à lichen | Sup. (ha) : 0.3706

Parcelle : P-15 ..... *p. 204*

03-Pessière noire à lichen | Sup. (ha) : 14.9033

Parcelle : P-37 ..... *p. 207*

04-Pessière noire à lichen | Sup. (ha) : 7.9659

Parcelle : P-23 ..... *p. 210*

Parcelle Validation: P-23-V1 ..... *p.211*

05-Pessière noire à lichen | Sup. (ha) : 11.4255

Parcelle : P-03 ..... *p. 213*

Parcelle Validation: P-03-V1 ..... *p.214*

06-Pessière noire à lichen | Sup. (ha) : 10.7945

Parcelle : P-05 ..... *p. 216*

07-Pessière noire à lichen | Sup. (ha) : 2.0438

Parcelle : P-42 ..... *p. 219*

08-Pessière noire à lichen | Sup. (ha) : 4.4279

Parcelle : P-28 ..... *p. 222*

Pinède grise

01-Pinède grise | Sup. (ha) : 1.7165

Parcelle : P-32 ..... *p. 225*

Tourbière arbustive

01-Tourbière arbustive

Fait par Jean-Bastien Lambert le 2017-8-7

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	44 479
Superficie du complexe de milieux humides (m²) :	22 806 099
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Indirect
Type du lien :	Cours d'eau permanent
Position dans le réseau hydrique	En bordure d'au moins un milieu humide
Présence de dépression humide:	0%

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

REMARQUES

> Remarques générales : Pas d'indices de passage d'un feu dans ce polygone. Certains secteurs de faible superficie sont des tourbières boisée

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

PARCELLES

P-19 - Groupement Tourbière arbustive

Faite par Jean-Bastien Lambert le 2017-8-7

Latitude: **Longitude:** **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	6
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	100	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Herbacée	10%
Eau	0%
Sol nu / Litière	0%
Arbustive (< 4 m)	75%
Muscinale	100%
Arborescente (> 4 m)	10%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	**Picea mariana**	**FACH**		**10**	**100 %**
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**40**	**36.36 %**
Arbustive (< 4 m)	Kalmia polifolia	OBL		1	0.91 %
Arbustive (< 4 m)	Larix laricina	FACH		3	2.73 %

Arbustive (< 4 m)	**Picea mariana**	**FACH**	**55**	**50 %**
Arbustive (< 4 m)	Rhododendron groenlandicum	OBL	10	9.09 %
Arbustive (< 4 m)	Rubus chamaemorus	FACH	1	0.91 %
Herbacée	**Carex oligosperma**	**OBL**	**3**	**25 %**
Herbacée	Eriophorum vaginatum subsp. spissum	OBL	1	8.33 %
Herbacée	**Maianthemum trifolium**	**OBL**	**8**	**66.67 %**
Muscinale	Lichens		3	3.06 %
Muscinale	**Sphagnum sp.**	**FACH**	**95**	**96.94 %**

[1] *Statut hydrique : * = Statut émis par WSP*

02-Tourbière arbustive

Fait par Jean-Bastien Lambert le 2017-7-27

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	285 230
Superficie du complexe de milieux humides (m²) :	22 806 099
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Indirect
Type du lien :	Cours d'eau permanent
Position dans le réseau hydrique	En bordure d'au moins un milieu humide
Présence de dépression humide:	0-25 %

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

REMARQUES

> Remarques générales : Belle tourbière non perturbée. Présence de dépressions avec végétation différente. Pas touchée par un feu.

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-20 - Groupement Tourbière arbustive

Faite par Jean-Bastien Lambert le 2017-7-27

Latitude: **Longitude:**

Type de parcelle: Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	4
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	100	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Arborescente (> 4 m)	0%
Herbacée	25%
Eau	2%
Muscinale	100%
Arbustive (< 4 m)	55%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	Andromeda polifolia var. latifolia	OBL		1	1.52 %
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**20**	**30.3 %**
Arbustive (< 4 m)	Kalmia angustifolia	NI		2	3.03 %
Arbustive (< 4 m)	Kalmia polifolia	OBL		2	3.03 %
Arbustive (< 4 m)	Larix laricina	FACH		8	12.12 %

Arbustive (< 4 m)	**Picea mariana**	**FACH**	**30**	**45.45 %**
Arbustive (< 4 m)	Rhododendron groenlandicum	OBL	2	3.03 %
Arbustive (< 4 m)	Rubus chamaemorus	FACH	1	1.52 %
Herbacée	**Carex oligosperma**	**OBL**	**15**	**65.22 %**
Herbacée	Drosera rotundifolia	OBL	2	8.7 %
Herbacée	Rhynchospora alba	OBL	2	8.7 %
Herbacée	Sarracenia purpurea	OBL	2	8.7 %
Herbacée	Trichophorum alpinum	OBL	2	8.7 %
Muscinale	Lichens		5	5 %
Muscinale	**Sphagnum sp.**	**FACH**	**95**	**95 %**

[1] *Statut hydrique : * = Statut émis par WSP*

03-Tourbière arbustive

Fait par Jean-Bastien Lambert le 2017-7-25

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	10 117
Superficie du complexe de milieux humides (m²) :	22 806 099
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Direct
Type du lien :	Cours d'eau permanent
Position dans le réseau hydrique	Traversé par un cours d'eau ou fossé
Présence de dépression humide:	0-25 %

PERTURBATIONS

Végétation perturbée?	Oui
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Oui

Perturbation Naturelle

Feu	Menaçant peu

REMARQUES

> Troncs et souches

> Potentiel espèces rares flore moyen ou élevé

> Drainage imparfait

> Remarques générales : Ancienne tourbière boisée
Brûlis récent
Partiellement brûlé
Limite du brûlis au sud

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

PARCELLES

P-41 - Groupement Tourbière arbustive

Faite par Jean-Bastien Lambert le 2017-7-25

Latitude: 52.24315 **Longitude:** -77.09285 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	4
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	< 5 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	< 5 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	35	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):	5	Loam limoneux
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

> Troncs et souches

> Présence de chicots

> Potentiel espèces rares flore moyen ou élevé

> Drainage imparfait

INDICATEURS HYDROLOGIQUES

Inondé	X	Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau	X	Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	X
Litière noirâtre	X	Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Eau	20%
Muscinale	25%
Arbustive (< 4 m)	75%
Arborescente (> 4 m)	2%
Herbacée	45%
Sol nu / Litière	5%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	Larix laricina	FACH		2	100 %
Arbustive (< 4 m)	Alnus incana subsp. rugosa	FACH		8	11.27 %
Arbustive (< 4 m)	Betula glandulosa	FACH		1	1.41 %
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**25**	**35.21 %**
Arbustive (< 4 m)	**Myrica gale**	**OBL**		**35**	**49.3 %**
Arbustive (< 4 m)	Salix pyrifolia	FACH		1	1.41 %
Arbustive (< 4 m)	Spiraea alba var. alba	FACH		1	1.41 %
Herbacée	**Calamagrostis canadensis**	**FACH**		**15**	**38.46 %**
Herbacée	Callitriche heterophylla var. heterophylla	OBL		1	2.56 %
Herbacée	**Carex canescens**	**OBL**		**8**	**20.51 %**
Herbacée	Carex lacustris	OBL		5	12.82 %
Herbacée	Comarum palustre	OBL		3	7.69 %
Herbacée	Juncus filiformis	FACH		5	12.82 %
Herbacée	Sparganium natans	OBL		2	5.13 %

[1] *Statut hydrique : * = Statut émis par WSP*

04-Tourbière arbustive

Fait par Claudie Landry et Jean-Bastien Lambert le 2017-7-29

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Occasionnel

DESCRIPTION POLYGONE

Superficie (m²) :	33 154
Superficie du complexe de milieux humides (m²) :	22 806 099
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100* %

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Indirect
Type du lien :	Cours d'eau permanent
Position dans le réseau hydrique	En bordure d'au moins un milieu humide
Présence de dépression humide:	76-100 %

PERTURBATIONS

Végétation perturbée?	Oui
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Oui

Perturbation Naturelle

Feu	Menaçant peu

REMARQUES

> Troncs et souches

> Présence de chicots

> Remarques générales : Brûlis récent partiel.

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

PARCELLES

P-69 - Groupement Tourbière arbustive

Faite par Claudie Landry et Jean-Bastien Lambert le 2017-7-29

Latitude: 52.23690 **Longitude:** -77.10317 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	5
Nb d'espèces dominantes NI (B) :	1
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	>30 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	100	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):	100	

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Eau	0%
Sol nu / Litière	10%
Herbacée	50%
Arbustive (< 4 m)	75%
Muscinale	90%
Arborescente (> 4 m)	1%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	Picea mariana	FACH		1	100 %
Arbustive (< 4 m)	Chamaedaphne calyculata	OBL		8	13.79 %
Arbustive (< 4 m)	Dasiphora fruticosa	FACH		10	17.24 %
Arbustive (< 4 m)	Empetrum nigrum subsp. nigrum	NI		2	3.45 %

Arbustive (< 4 m)	Larix laricina	FACH	1	1.72 %
Arbustive (< 4 m)	Lonicera villosa	NI	3	5.17 %
Arbustive (< 4 m)	**Picea mariana**	**FACH**	**15**	**25.86 %**
Arbustive (< 4 m)	Pinus banksiana	NI	1	1.72 %
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**	**15**	**25.86 %**
Arbustive (< 4 m)	Vaccinium myrtilloides	NI	2	3.45 %
Arbustive (< 4 m)	Vaccinium oxycoccos	OBL	1	1.72 %
Herbacée	Calamagrostis stricta subsp. inexpansa	FACH	1	5.88 %
Herbacée	**Carex aquatilis var. aquatilis**	**OBL**	**8**	**47.06 %**
Herbacée	Cornus canadensis	NI	1	5.88 %
Herbacée	**Linnaea borealis**	**NI**	**2**	**11.76 %**
Herbacée	Lycopodium annotinum	NI	1	5.88 %
Herbacée	Maianthemum trifolium	OBL	1	5.88 %
Herbacée	Symphyotrichum sp.		1	5.88 %
Herbacée	**Trichophorum alpinum**	**OBL**	**2**	**11.76 %**
Muscinale	Mousses		5	5.56 %
Muscinale	**Sphagnum sp.**	**FACH**	**85**	**94.44 %**

[1] *Statut hydrique : * = Statut émis par WSP*

05-Tourbière arbustive

Fait par Claudie Landry le 2017-7-25

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	26 634
Superficie du complexe de milieux humides (m²) :	22 806 099
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Indirect
Type du lien :	Cours d'eau permanent
Position dans le réseau hydrique	En bordure d'au moins un milieu humide
Présence de dépression humide:	76-100 %

PERTURBATIONS

Végétation perturbée?	Oui
Sols perturbés ?	Oui
Milieu affecté par un barrage de castor ?	Non

Perturbation Anthropique

Sentier de véhicules motorisés	Menaçant pas

Perturbation Naturelle

Feu	Menaçant beaucoup

REMARQUES

> Troncs et souches

> Présence de chicots

> Remarques générales : Brûlis très ancien. (avant 2011)
Ancienne tourbière ouverte.

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-53 - Groupement Tourbière arbustive

Faite par Claudie Landry le 2017-7-25

Latitude: 52.24020 **Longitude:** -77.07884 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	3
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	>30 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	40	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):	5	Loam argileux
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Sol nu / Litière	10%
Eau	0%
Arbustive (< 4 m)	80%
Arborescente (> 4 m)	5%
Muscinale	90%
Herbacée	5%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	Picea mariana	FACH		5	100 %
Arbustive (< 4 m)	Chamaedaphne calyculata	OBL		20	12.9 %
Arbustive (< 4 m)	Empetrum nigrum subsp. nigrum	NI		20	12.9 %
Arbustive (< 4 m)	**Picea mariana**	**FACH**		**40**	**25.81 %**

Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**	**60**	**38.71 %**
Arbustive (< 4 m)	Rubus chamaemorus	FACH	5	3.23 %
Arbustive (< 4 m)	Vaccinium myrtilloides	NI	10	6.45 %
Herbacée	Carex trisperma	OBL	5	100 %
Muscinale	**Sphagnum sp.**	**FACH**	**90**	**100 %**
Autre espèce observée	Carex pauciflora	OBL		
Autre espèce observée	Equisetum sylvaticum	FACH		
Autre espèce observée	Eriophorum vaginatum subsp. spissum	OBL		
Autre espèce observée	Kalmia angustifolia	NI		
Autre espèce observée	Larix laricina	FACH		
Autre espèce observée	Lichens			
Autre espèce observée	Maianthemum trifolium	OBL		
Autre espèce observée	Pinus banksiana	NI		

[1] *Statut hydrique : * = Statut émis par WSP*

Parcelles de validation

P-53-V1 (PE3.0007)

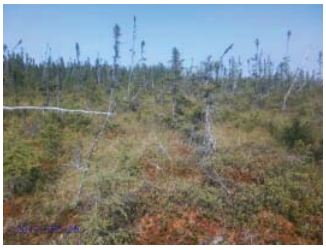
Faite par Claudie Landry le 2017-7-2

Latitude: 52.24003

Longitude: -77.07687

Type de parcelle: Parcelle de validation

Parcelle associée: P-53



06-Tourbière arbustive

Fait par Mathieu St-Germain le 2017-7-24

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	98 367
Superficie du complexe de milieux humides (m²) :	22 806 099
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Indirect
Type du lien :	Cours d'eau permanent
Position dans le réseau hydrique	En bordure d'au moins un milieu humide
Présence de dépression humide:	76-100 %

PERTURBATIONS

Végétation perturbée?	Oui
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

Perturbation Naturelle

Feu	Menaçant beaucoup

REMARQUES

> Remarques générales : Brûlis récent
Tourbière arbustive ayant partiellement brûlé

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-72 - Groupement Tourbière arbustive

Faite par Mathieu St-Germain le 2017-7-24

Latitude: 52.22873 **Longitude:** -77.09561 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	4
Nb d'espèces dominantes NI (B) :	1
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	< 5 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	100	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	X
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	X
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Herbacée	40%
Arbustive (< 4 m)	80%
Arborescente (> 4 m)	0%
Muscinale	90%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [7]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**30**	**29.13 %**
Arbustive (< 4 m)	Kalmia polifolia	OBL		15	14.56 %
Arbustive (< 4 m)	Larix laricina	FACH		3	2.91 %
Arbustive (< 4 m)	Picea mariana	FACH		15	14.56 %
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**		**25**	**24.27 %**
Arbustive (< 4 m)	Rubus chamaemorus	FACH		5	4.85 %
Arbustive (< 4 m)	Vaccinium myrtilloides	NI		5	4.85 %

Arbustive (< 4 m)	Vaccinium oxycoccos	OBL	5	4.85 %
Herbacée	**Carex trisperma**	**OBL**	**20**	**66.67 %**
Herbacée	**Clintonia borealis**	**NI**	**10**	**33.33 %**
Muscinale	**Sphagnum sp.**	**FACH**	**90**	**100 %**

[1] *Statut hydrique : * = Statut émis par WSP*

07-Tourbière arbustive

Fait par Claudie Landry et Mathieu St-Germain le 2017-7-26

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	1 634 289
Superficie du complexe de milieux humides (m²) :	22 806 099
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Indirect
Type du lien :	Cours d'eau permanent
Position dans le réseau hydrique	En bordure d'au moins un milieu humide
Présence de dépression humide:	76-100 %

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Oui
Milieu affecté par un barrage de castor ?	Non

Perturbation Anthropique

Sentier de véhicules motorisés	Menaçant pas

REMARQUES

> Remarques générales : Tourbière avec plusieurs mares.

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

PARCELLES

P-06 - Groupement Tourbière arbustive

Faite par Claudie Landry et Jean-Bastien Lambert le 2017-7-26

Latitude: **Longitude:** **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	6
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	100	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Sol nu / Litière	0%
Herbacée	10%
Arbustive (< 4 m)	75%
Arborescente (> 4 m)	10%
Muscinale	100%
Eau	0%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	**Picea mariana**	**FACH**		**10**	**100 %**
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**40**	**36.36 %**
Arbustive (< 4 m)	Kalmia polifolia	OBL		1	0.91 %
Arbustive (< 4 m)	Larix laricina	FACH		3	2.73 %

Arbustive (< 4 m)	**Picea mariana**	**FACH**	**55**	**50 %**
Arbustive (< 4 m)	Rhododendron groenlandicum	OBL	10	9.09 %
Arbustive (< 4 m)	Rubus chamaemorus	FACH	1	0.91 %
Herbacée	**Carex oligosperma**	**OBL**	**3**	**25 %**
Herbacée	Eriophorum vaginatum subsp. spissum	OBL	1	8.33 %
Herbacée	**Maianthemum trifolium**	**OBL**	**8**	**66.67 %**
Muscinale	Lichens		3	3.06 %
Muscinale	**Sphagnum sp.**	**FACH**	**95**	**96.94 %**

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

P-08 - Groupement Tourbière arbustive

Faite par Claudie Landry et Jean-Bastien Lambert le 2017-7-26

Latitude: **Longitude:** **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	6
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	11-30 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	100	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Eau	0%
Arbustive (< 4 m)	50%
Arborescente (> 4 m)	0%
Muscinale	100%
Sol nu / Litière	0%
Herbacée	30%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**35**	**47.3 %**
Arbustive (< 4 m)	Kalmia polifolia	OBL		2	2.7 %
Arbustive (< 4 m)	Larix laricina	FACH		2	2.7 %
Arbustive (< 4 m)	**Picea mariana**	**FACH**		**35**	**47.3 %**
Herbacée	Carex oligosperma	OBL		2	9.09 %

Herbacée	Eriophorum vaginatum subsp. spissum	OBL	2	9.09 %
Herbacée	**Rhynchospora alba**	**OBL**	**8**	**36.36 %**
Herbacée	**Scheuchzeria palustris**	**OBL**	**5**	**22.73 %**
Herbacée	**Trichophorum alpinum**	**OBL**	**5**	**22.73 %**
Muscinale	Lichens		20	20 %
Muscinale	**Sphagnum sp.**	**FACH**	**80**	**80 %**
Autre espèce observée	Andromeda polifolia var. latifolia	OBL		
Autre espèce observée	Drosera rotundifolia	OBL		
Autre espèce observée	Kalmia angustifolia	NI		
Autre espèce observée	Rhododendron groenlandicum	OBL		
Autre espèce observée	Rubus chamaemorus	FACH		
Autre espèce observée	Sarracenia purpurea	OBL		
Autre espèce observée	Vaccinium myrtilloides	NI		
Autre espèce observée	Vaccinium oxycoccos	OBL		

[1] *Statut hydrique : * = Statut émis par WSP*

08-Tourbière arbustive

Fait par Jean-Bastien Lambert le 2017-7-31

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Occasionnel

DESCRIPTION POLYGONE

Superficie (m²) :	68 927
Superficie du complexe de milieux humides (m²) :	22 806 099
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Direct
Type du lien :	Cours d'eau permanent
Position dans le réseau hydrique	Traversé par un cours d'eau ou fossé
Présence de dépression humide:	76-100 %

PERTURBATIONS

Végétation perturbée?	Oui
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Oui

Perturbation Naturelle

Dommage causé par la faune	Menaçant peu

REMARQUES

> Troncs et souches

> Présence de chicots

> Mares temporaires pour la reproduction des anoures

> Potentiel espèces rares flore moyen ou élevé

> Drainage imparfait

> Remarques générales : Ancienne tourbière boisée de mélèze. Drainage affecté par un barrage de castor. Mélèzes morts à cause de la modification du drainage.

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-11 - Groupement Tourbière arbustive

Faite par Jean-Bastien Lambert le 2017-8-7

Latitude: **Longitude:** **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	4
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	11-20 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	< 5 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	100	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

> Présence de chicots

> Mares temporaires pour la reproduction des anoures

> Drainage imparfait

INDICATEURS HYDROLOGIQUES

Inondé	X	Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Eau	45%
Sol nu / Litière	0%
Arborescente (> 4 m)	10%
Herbacée	70%
Arbustive (< 4 m)	80%
Muscinale	50%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	**Larix laricina**	**FACH**		**8**	**80 %**

Arborescente (> 4 m)	**Picea mariana**	**FACH**	**2**	**20 %**
Arbustive (< 4 m)	**Alnus incana subsp. rugosa**	**FACH**	**65**	**56.03 %**
Arbustive (< 4 m)	Betula glandulosa	FACH	7	6.03 %
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**	**40**	**34.48 %**
Arbustive (< 4 m)	Rhododendron groenlandicum	OBL	2	1.72 %
Arbustive (< 4 m)	Salix sp.	-	2	1.72 %

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

P-13 - Groupement Tourbière arbustive

Faite par Jean-Bastien Lambert le 2017-7-31

Latitude: 52.25523 **Longitude:** -77.07689 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	6
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	6-10 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	< 5 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	90	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

> Troncs et souches

> Présence de chicots

> Mares temporaires pour la reproduction des anoures

> Potentiel espèces rares flore moyen ou élevé

> Drainage imparfait

INDICATEURS HYDROLOGIQUES

Inondé	X	Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	X
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Sol nu / Litière	10%
Arbustive (< 4 m)	65%
Eau	25%
Arborescente (> 4 m)	0%
Muscinale	75%
Herbacée	50%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	Alnus incana subsp. rugosa	FACU		30	35.97 %

		FACH		25.97 %
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**	**25**	**32.47 %**
Arbustive (< 4 m)	Larix laricina	FACH	15	19.48 %
Arbustive (< 4 m)	Myrica gale	OBL	7	9.09 %
Arbustive (< 4 m)	Rhododendron groenlandicum	OBL	7	9.09 %
Arbustive (< 4 m)	Salix pyrifolia	FACH	1	1.3 %
Arbustive (< 4 m)	Spiraea alba var. alba	FACH	2	2.6 %
Eau	**Glyceria borealis**	**OBL**	**1**	**100 %**
Herbacée	Calamagrostis canadensis var. canadensis	FACH	5	13.89 %
Herbacée	Callitriche palustris	OBL	1	2.78 %
Herbacée	**Carex aquatilis var. aquatilis**	**OBL**	**15**	**41.67 %**
Herbacée	Carex canescens	OBL	2	5.56 %
Herbacée	**Comarum palustre**	**OBL**	**10**	**27.78 %**
Herbacée	Equisetum fluviatile	OBL	3	8.33 %
Muscinale	Mousses		15	20 %
Muscinale	**Sphagnum sp.**	**FACH**	**60**	**80 %**
Autre espèce observée	Hippuris vulgaris	OBL		
Autre espèce observée	Potamogeton sp.	OBL		
Autre espèce observée	Sparganium sp.	OBL		

[1] *Statut hydrique : * = Statut émis par WSP*

09-Tourbière arbustive

Fait par Jean-Bastien Lambert et Claudie Landry le 2017-7-30

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	201 391
Superficie du complexe de milieux humides (m²) :	22 806 099
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Indirect
Type du lien :	Cours d'eau permanent
Position dans le réseau hydrique	En amont d'un cours d'eau ou fossé
Présence de dépression humide:	0-25 %

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

REMARQUES

> Mares temporaires pour la reproduction des anoures

> Drainage imparfait

> Remarques générales : Présence de grands étangs à l'ouest.

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

PARCELLES

P-25 - Groupement Tourbière arbustive

Faite par Jean-Bastien Lambert et Claudie Landry le 2017-7-30

Latitude: **Longitude:** **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	3
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	>30 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	120	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

> Drainage imparfait

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	X
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Muscinale	100%
Sol nu / Litière	0%
Eau	2%
Arborescente (> 4 m)	1%
Arbustive (< 4 m)	65%
Herbacée	20%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	Picea mariana	FACH		1	100 %
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**45**	**43.69 %**
Arbustive (< 4 m)	Kalmia polifolia	OBL		3	2.91 %

Arbustive (< 4 m)	**Picea mariana**	**FACH**	**40**	**38.83 %**
Arbustive (< 4 m)	Rhododendron groenlandicum	OBL	2	1.94 %
Arbustive (< 4 m)	Rubus chamaemorus	FACH	10	9.71 %
Arbustive (< 4 m)	Vaccinium oxycoccos	OBL	1	0.97 %
Arbustive (< 4 m)	Vaccinium uliginosum	NI	2	1.94 %
Herbacée	**Carex oligosperma**	**OBL**	**10**	**58.82 %**
Herbacée	Carex pauciflora	OBL	1	5.88 %
Herbacée	Drosera intermedia	OBL	0	0 %
Herbacée	Drosera rotundifolia	OBL	1	5.88 %
Herbacée	Eriophorum vaginatum subsp. spissum	OBL	2	11.76 %
Herbacée	Geocaulon lividum	NI	1	5.88 %
Herbacée	Trichophorum alpinum	OBL	2	11.76 %
Autre espèce observée	Carex limosa	OBL		
Autre espèce observée	Drosera anglica	OBL		
Autre espèce observée	Nuphar variegata	OBL		
Autre espèce observée	Rhynchospora alba	OBL		
Autre espèce observée	Sarracenia purpurea	OBL		
Autre espèce observée	Scheuchzeria palustris	OBL		
Autre espèce observée	Utricularia cornuta	OBL		

[1] *Statut hydrique : * = Statut émis par WSP*

10-Tourbière arbustive

Fait par Jean-Bastien Lambert le 2017-7-27

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	12 430
Superficie du complexe de milieux humides (m²) :	22 806 099
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Indirect
Type du lien :	Cours d'eau permanent
Position dans le réseau hydrique	En bordure d'au moins un milieu humide
Présence de dépression humide:	0-25 %

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

REMARQUES

> Drainage imparfait

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Nom Latin	Désignation	Aire de l'unité	Répartition	Abondance
Carex sterilis	susceptible	> 1001 m²	Uniforme	> 500

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-22 - Groupement Tourbière arbustive

Faite par Jean-Bastien Lambert le 2017-7-27

Latitude: **Longitude:**

Type de parcelle: Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	3
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	< 5 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	< 5 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	60	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé	X	Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre	X	Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Muscinale	70%
Eau	15%
Sol nu / Litière	5%
Arborescente (> 4 m)	0%
Herbacée	50%
Arbustive (< 4 m)	35%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	Juniperus communis var. megistocarpa	NI		2	5 %
Arbustive (< 4 m)	Kalmia polifolia	OBL		2	5 %
Arbustive (< 4 m)	Larix laricina	FACH		3	7.5 %

Arbustive (< 4 m)	Lonicera hirsuta	NI		3	7.5 %
Arbustive (< 4 m)	**Picea mariana**	**FACH**		**25**	**62.5 %**
Arbustive (< 4 m)	Rhododendron groenlandicum	OBL		1	2.5 %
Arbustive (< 4 m)	Rubus chamaemorus	FACH		2	5 %
Arbustive (< 4 m)	Vaccinium oxycoccos	OBL		2	5 %
Herbacée	**Carex sterilis**	**OBL**	**susceptible**	**30**	**65.22 %**
Herbacée	Coptis trifolia	NI		1	2.17 %
Herbacée	Deschampsia flexuosa			2	4.35 %
Herbacée	Drosera rotundifolia	OBL		2	4.35 %
Herbacée	Lichens			8	17.39 %
Herbacée	Trichophorum alpinum	OBL		3	6.52 %
Muscinale	**Sphagnum sp.**	**FACH**		**60**	**100 %**

[1] *Statut hydrique : * = Statut émis par WSP*

11-Tourbière arbustive

Fait par Claudie Landry le 2017-7-28

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	13 007
Superficie du complexe de milieux humides (m²) :	22 806 099
Proportion de milieu naturel dans une bande-tampon de 100 m:	*80-90 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Non
Nature du lien :	
Type du lien :	
Position dans le réseau hydrique	Isolé
Présence de dépression humide:	76-100 %

PERTURBATIONS

Végétation perturbée?	Oui
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

Perturbation Naturelle

Feu	Menaçant peu

REMARQUES

> Troncs et souches

> Remarques générales : Partiellement brûler. Brûlis récent.

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

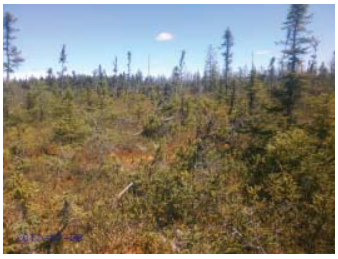
InSitu - Rapport descriptif

PARCELLES

P-57 - Groupement Tourbière arbustive

Faite par Claudie Landry le 2017-7-28

Latitude: 52.24165 **Longitude:** -77.06139 **Type de parcelle:** Parcelle complète



SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	4
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	6-10 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	70	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Arbustive (< 4 m)	85%
Muscinale	100%
Eau	0%
Herbacée	7%
Sol nu / Litière	0%
Arborescente (> 4 m)	10%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	**Picea mariana**	**FACH**		**10**	**100 %**
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**35**	**36.08 %**
Arbustive (< 4 m)	Larix laricina	FACH		7	7.22 %
Arbustive (< 4 m)	**Picea mariana**	**FACH**		**40**	**41.24 %**

Arbustive (< 4 m)	Rhododendron groenlandicum	OBL	10	10.31 %
Arbustive (< 4 m)	Rubus chamaemorus	FACH	5	5.15 %
Herbacée	Maianthemum trifolium	OBL	5	71.43 %
Herbacée	Trichophorum alpinum	OBL	2	28.57 %
Muscinale	Lichens		15	15 %
Muscinale	**Sphagnum sp.**	**FACH**	**85**	**85 %**
Autre espèce observée	Geocaulon lividum	NI		
Autre espèce observée	Kalmia polifolia	OBL		
Autre espèce observée	Vaccinium myrtilloides	NI		
Autre espèce observée	Vaccinium oxycoccos	OBL		

[1] *Statut hydrique : * = Statut émis par WSP*

12-Tourbière arbustive

Fait par Mathieu St-Germain le 2017-7-27

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	28 115
Superficie du complexe de milieux humides (m²) :	22 806 099
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Direct
Type du lien :	Cours d'eau permanent
Position dans le réseau hydrique	En amont d'un cours d'eau ou fossé
Présence de dépression humide:	76-100 %

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

Perturbation Naturelle

Feu	Menaçant beaucoup

REMARQUES

> Remarques générales : Brûlis récent autour. N'a pas brûlé car présence d'eau, à la tête du cours d'eau.

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-47 - Groupement Tourbière arbustive

Faite par Mathieu St-Germain le 2017-7-27

Latitude: **Longitude:**

Type de parcelle: Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	8
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	11-30 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	70	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):	70	

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	X
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Muscinale	100%
Arborescente (> 4 m)	5%
Arbustive (< 4 m)	50%
Herbacée	30%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [7]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	Larix laricina	FACH		1	20 %
Arborescente (> 4 m)	Picea mariana	FACH		4	80 %
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**20**	**21.05 %**
Arbustive (< 4 m)	Empetrum nigrum subsp. nigrum	NI		5	5.26 %
Arbustive (< 4 m)	**Larix laricina**	**FACH**		**15**	**15.79 %**
Arbustive (< 4 m)	**Picea mariana**	**FACH**		**25**	**26.32 %**
Arbustive (< 4 m)	Rhododendron groenlandicum	OBL		10	10.53 %

Arbustive (< 4 m)	Rubus chamaemorus	FACH	5	5.26 %
Arbustive (< 4 m)	Vaccinium oxycoccos	OBL	5	5.26 %
Arbustive (< 4 m)	Vaccinium uliginosum	NI	10	10.53 %
Herbacée	**Carex oligosperma**	**OBL**	**10**	**22.22 %**
Herbacée	**Carex stricta**	**OBL**	**10**	**22.22 %**
Herbacée	Lycopodium annotinum	NI	5	11.11 %
Herbacée	**Maianthemum trifolium**	**OBL**	**10**	**22.22 %**
Herbacée	**Trichophorum alpinum**	**OBL**	**10**	**22.22 %**
Muscinale	Lichens		10	10 %
Muscinale	**Sphagnum sp.**	**FACH**	**90**	**90 %**

[1] *Statut hydrique : * = Statut émis par WSP*

Tourbière boisée

01-Tourbière boisée

Fait par Claudie Landry le 2017-7-27

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	1 405 220
Superficie du complexe de milieux humides (m²) :	22 806 099
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Direct
Type du lien :	Cours d'eau permanent
Position dans le réseau hydrique	Traversé par un cours d'eau ou fossé
Présence de dépression humide:	76-100 %

PERTURBATIONS

Végétation perturbée?	Oui
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

Perturbation Naturelle

Feu	Menaçant beaucoup

REMARQUES

> Remarques générales : Présence accrue de grande faune (ours)

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-12 - Groupement Tourbière boisée

Faite par Jean-Bastien Lambert le 2017-7-27

Latitude: **Longitude:**

Type de parcelle: Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	6
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	11-30 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	100	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Herbacée	30%
Arbustive (< 4 m)	60%
Arborescente (> 4 m)	35%
Sol nu / Litière	0%
Eau	0%
Muscinale	100%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	**Picea mariana**	**FACH**		**35**	**100 %**
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**15**	**27.27 %**
Arbustive (< 4 m)	Kalmia polifolia	OBL		2	3.64 %
Arbustive (< 4 m)	**Picea mariana**	**FACH**		**25**	**45.45 %**
Arbustive (< 4 m)	Rhododendron groenlandicum	OBL		10	18.18 %

Arbustive (< 4 m)	Rubus chamaemorus	FACH	2	3.64 %
Arbustive (< 4 m)	Vaccinium oxycoccos	OBL	1	1.82 %
Herbacée	**Carex aquatilis var. aquatilis**	**OBL**	**20**	**66.67 %**
Herbacée	**Maianthemum trifolium**	**OBL**	**10**	**33.33 %**
Muscinale	**Sphagnum sp.**	**FACH**	**100**	**100 %**

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

P-17 - Groupement Tourbière boisée

Faite par Claudie Landry le 2017-7-27

Latitude: **Longitude:**

Type de parcelle: Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	5
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	>30 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	70	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Herbacée	15%
Eau	0%
Sol nu / Litière	0%
Arborescente (> 4 m)	30%
Muscinale	100%
Arbustive (< 4 m)	70%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	**Picea mariana**	**FACH**		**30**	**100 %**
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**20**	**22.99 %**
Arbustive (< 4 m)	Larix laricina	FACH		7	8.05 %
Arbustive (< 4 m)	**Picea mariana**	**FACH**		**40**	**45.98 %**
Arbustive (< 4 m)	Rhododendron groenlandicum	OBL		10	11.49 %
Arbustive (< 4 m)	Rubus chamaemorus	FACH		5	5.75 %
Arbustive (< 4 m)	Vaccinium myrtilloides	NI		5	5.75 %

Herbacée	Carex pauciflora	OBL	2	16.67 %
Herbacée	**Maianthemum trifolium**	**OBL**	**10**	**83.33 %**
Muscinale	Lichens		15	15 %
Muscinale	**Sphagnum sp.**	**FACH**	**85**	**85 %**
Autre espèce observée	Drosera rotundifolia	OBL		
Autre espèce observée	Empetrum nigrum subsp. nigrum	NI		
Autre espèce observée	Equisetum sylvaticum	FACH		
Autre espèce observée	Eriophorum vaginatum subsp. spissum	OBL		
Autre espèce observée	Geocaulon lividum	NI		
Autre espèce observée	Kalmia polifolia	OBL		
Autre espèce observée	Lycopodium annotinum	NI		
Autre espèce observée	Vaccinium oxycoccos	OBL		

[1] *Statut hydrique : * = Statut émis par WSP*

Parcelles de validation

P-17-V1 (PE1.0025)

Faite par Claudie Landry le 2017-7-

Latitude:

Longitude:

Type de parcelle: Parcelle de validation

Parcelle associée: P-17

P-17-V2 (PE1.0014)

Faite par Mathieu St-Germain le 2017-7-

Latitude:

Longitude:

Type de parcelle: Parcelle de validation

Parcelle associée: P-17

P-17-V3 (PE1.0013)

Faite par Mathieu St-Germain le 2017-7-

Latitude:

Longitude:

Type de parcelle: Parcelle de validation

Parcelle associée: P-17

InSitu - Rapport descriptif

P-21 - Groupement Tourbière boisée

Faite par Jean-Bastien Lambert le 2017-7-27

Latitude: **Longitude:**

Type de parcelle: Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	6
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	100	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Arbustive (< 4 m)	90%
Sol nu / Litière	0%
Eau	0%
Herbacée	10%
Muscinale	100%
Arborescente (> 4 m)	35%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	Larix laricina	FACH		2	5.41 %
Arborescente (> 4 m)	**Picea mariana**	**FACH**		**35**	**94.59 %**
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**55**	**39.57 %**
Arbustive (< 4 m)	Kalmia polifolia	OBL		1	0.72 %
Arbustive (< 4 m)	**Picea mariana**	**FACH**		**35**	**25.18 %**
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**		**35**	**25.18 %**
Arbustive (< 4 m)	Rubus chamaemorus	FACH		5	3.6 %

Arbustive (< 4 m)	Vaccinium myrtilloides	NI	8	5.76 %
Herbacée	Carex pauciflora	OBL	1	14.29 %
Herbacée	Carex trisperma	OBL	1	14.29 %
Herbacée	**Maianthemum trifolium**	**OBL**	**5**	**71.43 %**
Muscinale	Lichens		5	5 %
Muscinale	**Sphagnum sp.**	**FACH**	**95**	**95 %**

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

P-48 - Groupement Tourbière boisée

Faite par Mathieu St-Germain le 2017-7-25

Latitude: 52.23841 **Longitude:** -77.09858 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	6
Nb d'espèces dominantes NI (B) :	1
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	100	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	X
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Muscinale	80%
Arbustive (< 4 m)	90%
Arborescente (> 4 m)	25%
Herbacée	15%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	**Larix laricina**	**FACH**		**10**	**40 %**
Arborescente (> 4 m)	**Picea mariana**	**FACH**		**15**	**60 %**
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**40**	**27.59 %**
Arbustive (< 4 m)	Kalmia polifolia	OBL		10	6.9 %
Arbustive (< 4 m)	Larix laricina	FACH		15	10.34 %
Arbustive (< 4 m)	Picea mariana	FACH		20	13.79 %
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**		**50**	**34.48 %**
Arbustive (< 4 m)	Rubus chamaemorus	FACH		10	6.9 %

Herbacée	**Lycopodium annotinum**	**NI**	**5**	**33.33 %**
Herbacée	**Maianthemum trifolium**	**OBL**	**10**	**66.67 %**
Muscinale	**Sphagnum sp.**	**FACH**	**80**	**100 %**

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

02-Tourbière boisée

Fait par Jean-Bastien Lambert le 2017-7-25

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	58 284
Superficie du complexe de milieux humides (m²) :	22 806 099
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Indirect
Type du lien :	Cours d'eau permanent
Position dans le réseau hydrique	En bordure d'au moins un milieu humide
Présence de dépression humide:	0%

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

REMARQUES

Aucune remarque

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

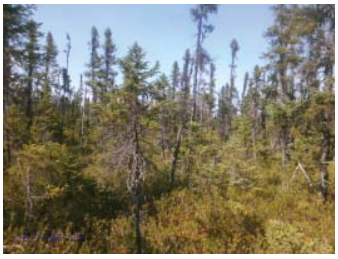
InSitu - Rapport descriptif

PARCELLES

P-24 - Groupement Tourbière boisée

Faite par Jean-Bastien Lambert le 2017-7-25

Latitude: 52.24728 **Longitude:** -77.08343 **Type de parcelle:** Parcelle complète



SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	4
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	100	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Herbacée	5%
Muscinale	100%
Arbustive (< 4 m)	100%
Eau	0%
Sol nu / Litière	0%
Arborescente (> 4 m)	25%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	**Picea mariana**	**FACH**		**25**	**100 %**
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**50**	**35.97 %**
Arbustive (< 4 m)	Kalmia polifolia	OBL		5	3.6 %
Arbustive (< 4 m)	**Picea mariana**	**FACH**		**35**	**25.18 %**

Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**	**40**	**28.78 %**
Arbustive (< 4 m)	Rubus chamaemorus	FACH	8	5.76 %
Arbustive (< 4 m)	Vaccinium oxycoccos	OBL	1	0.72 %
Herbacée	Drosera rotundifolia	OBL	2	50 %
Herbacée	Maianthemum trifolium	OBL	2	50 %

[1] *Statut hydrique : * = Statut émis par WSP*

03-Tourbière boisée

Fait par Claudie Landry le 2017-7-25

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	15 574
Superficie du complexe de milieux humides (m²) :	22 806 099
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Indirect
Type du lien :	Cours d'eau permanent
Position dans le réseau hydrique	En bordure d'au moins un milieu humide
Présence de dépression humide:	76-100 %

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Oui
Milieu affecté par un barrage de castor ?	Non

Perturbation Anthropique

Sentier de véhicules motorisés	Menaçant peu
Coupe partielle	Menaçant beaucoup

REMARQUES

> Troncs et souches

> Présence de chicots

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-52 - Groupement Tourbière boisée

Faite par Claudie Landry le 2017-7-25

Latitude: 52.24050 **Longitude:** -77.08177 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	4
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	>30 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	50	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):	5	Loam
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

> Troncs et souches

> Présence de chicots

INDICATEURS HYDROLOGIQUES

Inondé	X	Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Arborescente (> 4 m)	35%
Eau	0%
Arbustive (< 4 m)	80%
Sol nu / Litière	0%
Muscinale	100%
Herbacée	15%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	**Picea mariana**	**FACH**		**35**	**100 %**
Arbustive (< 4 m)	Chamaedaphne calyculata	OBL		20	16.67 %

Arbustive (< 4 m)	Picea mariana	FACH	20	16.67 %
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**	**60**	**50 %**
Arbustive (< 4 m)	Rubus chamaemorus	FACH	5	4.17 %
Arbustive (< 4 m)	Salix planifolia		10	8.33 %
Arbustive (< 4 m)	Vaccinium oxycoccos	OBL	5	4.17 %
Herbacée	**Equisetum sylvaticum**	**FACH**	**10**	**66.67 %**
Herbacée	Lycopodium annotinum	NI	2	13.33 %
Herbacée	Polytrichium sp.		3	20 %
Muscinale	**Sphagnum sp.**	**FACH**	**100**	**100 %**
Sol nu / Litière	Maianthemum trifolium	OBL	0	0 %

[1] *Statut hydrique : * = Statut émis par WSP*

04-Tourbière boisée

Fait par Jean-Bastien Lambert et Claudie Landry le 2017-7-28

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	41 666
Superficie du complexe de milieux humides (m²) :	22 806 099
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100* %

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Direct
Type du lien :	Cours d'eau permanent
Position dans le réseau hydrique	Traversé par un cours d'eau ou fossé
Présence de dépression humide:	0%

PERTURBATIONS

Végétation perturbée?	Oui
Sols perturbés ?	Oui
Milieu affecté par un barrage de castor ?	Non

Perturbation Naturelle

Feu	Menaçant peu

REMARQUES

> Remarques générales : Le groupement a brûler dans la marge nord du polygone. Brûlis récent.

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

PARCELLES

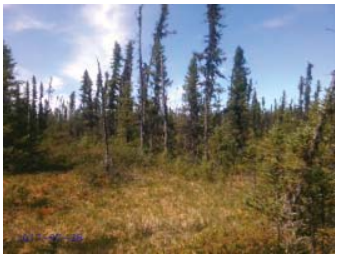
P-77 - Groupement Tourbière boisée

Faite par Jean-Bastien Lambert et Claudie Landry le 2017-7-28

Latitude: 52.22723 **Longitude:** -77.07041 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	6
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui



DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	11-30 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	100	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

> Troncs et souches

> Présence de chicots

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	X
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Muscinale	100%
Arborescente (> 4 m)	25%
Eau	0%
Sol nu / Litière	0%
Arbustive (< 4 m)	60%
Herbacée	20%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	**Picea mariana**	**FACH**		**25**	**100 %**
Arbustive (< 4 m)	Andromeda polifolia var. latifolia	OBL		5	5.95 %

Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**	**25**	**29.76 %**
Arbustive (< 4 m)	Kalmia polifolia	OBL	2	2.38 %
Arbustive (< 4 m)	**Picea mariana**	**FACH**	**30**	**35.71 %**
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**	**20**	**23.81 %**
Arbustive (< 4 m)	Rubus chamaemorus	FACH	1	1.19 %
Arbustive (< 4 m)	Vaccinium oxycoccos	OBL	1	1.19 %
Herbacée	Carex oligosperma	OBL	3	12 %
Herbacée	Eriophorum vaginatum subsp. spissum	OBL	2	8 %
Herbacée	**Maianthemum trifolium**	**OBL**	**20**	**80 %**
Muscinale	**Sphagnum sp.**	**FACH**	**100**	**100 %**

[1] *Statut hydrique : * = Statut émis par WSP*

05-Tourbière boisée

Fait par Jean-Bastien Lambert le 2017-7-26

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	177 918
Superficie du complexe de milieux humides (m²) :	22 806 099
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Indirect
Type du lien :	Cours d'eau permanent
Position dans le réseau hydrique	En bordure d'au moins un milieu humide
Présence de dépression humide:	0-25 %

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

REMARQUES

> Drainage imparfait

> Remarques générales : Non affecée par feu

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-07 - Groupement Tourbière boisée

Faite par Jean-Bastien Lambert le 2017-7-26

Latitude: 52.25550 **Longitude:** -77.13451 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	4
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		X
Profondeur de la nappe (si observée):	11-30 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	50	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):	5	Argile limoneuse
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

> Drainage imparfait

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Sol nu / Litière	2%
Arbustive (< 4 m)	95%
Arborescente (> 4 m)	55%
Muscinale	95%
Herbacée	40%
Eau	3%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	**Picea mariana**	**FACH**		**55**	**100 %**
Arbustive (< 4 m)	Chamaedaphne calyculata	OBL		20	14.29 %
Arbustive (< 4 m)	Kalmia polifolia	OBL		2	1.43 %

Arbustive (< 4 m)	**Picea mariana**	**FACH**	**60**	**42.86 %**
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**	**45**	**32.14 %**
Arbustive (< 4 m)	Rubus chamaemorus	FACH	10	7.14 %
Arbustive (< 4 m)	Vaccinium myrtilloides	NI	3	2.14 %
Herbacée	Carex trisperma	OBL	3	16.67 %
Herbacée	**Maianthemum trifolium**	**OBL**	**15**	**83.33 %**

[1] *Statut hydrique : * = Statut émis par WSP*

06-Tourbière boisée

Fait par Mathieu St-Germain le 2017-7-30

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	31 646
Superficie du complexe de milieux humides (m²) :	22 806 099
Proportion de milieu naturel dans une bande-tampon de 100 m:	*80-90 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Indirect
Type du lien :	Cours d'eau permanent
Position dans le réseau hydrique	En bordure d'au moins un milieu humide
Présence de dépression humide:	76-100 %

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

Perturbation Naturelle

Feu	Menaçant peu

REMARQUES

> Remarques générales : Tourbière ouverte au sud correspond à la partie brûlée du groupement

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-30 - Groupement Tourbière boisée

Faite par Mathieu St-Germain le 2017-7-30

Latitude: 52.24695 **Longitude:** -77.06567 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	5
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	>30 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	70	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):	20	Sable
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	X
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Arbustive (< 4 m)	80%
Arborescente (> 4 m)	30%
Muscinale	100%
Herbacée	7%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [7]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	**Picea mariana**	**FACH**		**30**	**100 %**
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**25**	**21.37 %**
Arbustive (< 4 m)	Linnaea borealis	NI		1	0.85 %
Arbustive (< 4 m)	**Picea mariana**	**FACH**		**25**	**21.37 %**
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**		**50**	**42.74 %**
Arbustive (< 4 m)	Rubus chamaemorus	FACH		5	4.27 %
Arbustive (< 4 m)	Vaccinium myrtilloides	NI		10	8.55 %

Arbustive (< 4 m)	Vaccinium oxycoccos	OBL	1	0.85 %
Herbacée	Maianthemum trifolium	OBL	7	100 %
Muscinale	Lichens		10	10 %
Muscinale	Mousses		5	5 %
Muscinale	**Sphagnum sp.**	**FACH**	**85**	**85 %**

[1] *Statut hydrique : * = Statut émis par WSP*

07-Tourbière boisée

Fait par Jean-Bastien Lambert le 2017-7-28

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	8 557
Superficie du complexe de milieux humides (m²) :	5 061 595
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100* %

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Direct
Type du lien :	Cours d'eau permanent
Position dans le réseau hydrique	Traversé par un cours d'eau ou fossé
Présence de dépression humide:	0-25 %

PERTURBATIONS

Végétation perturbée?	Oui
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Oui

Perturbation Naturelle

Feu	Menaçant peu
Dommage causé par la faune	Menaçant peu

REMARQUES

> Présence de chicots

> Remarques générales : Petites sections brulées.

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-35 - Groupement Tourbière boisée

Faite par Jean-Bastien Lambert le 2017-7-28

Latitude: 52.24275 **Longitude:** -77.05893 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	6
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	11-30 cm			
Pente:	4-8% (faible)	Horizon supérieur (cm)	70	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

> Présence de chicots

> Mares temporaires pour la reproduction des anoures

> Potentiel espèces rares faune élevé

INDICATEURS HYDROLOGIQUES

Inondé	X	Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	X
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Muscinale	40%
Eau	15%
Arborescente (> 4 m)	45%
Sol nu / Litière	5%
Herbacée	55%
Arbustive (< 4 m)	85%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	**Larix laricina**	**FACH**		**10**	**23.26 %**

Arborescente (> 4 m)	**Picea mariana**	**FACH**	**30**	**69.77 %**
Arborescente (> 4 m)	Populus tremuloides	NI	3	6.98 %
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**	**35**	**28.69 %**
Arbustive (< 4 m)	Gaultheria hispidula	NI	2	1.64 %
Arbustive (< 4 m)	Larix laricina	FACH	8	6.56 %
Arbustive (< 4 m)	Myrica gale	OBL	3	2.46 %
Arbustive (< 4 m)	**Picea mariana**	**FACH**	**35**	**28.69 %**
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**	**25**	**20.49 %**
Arbustive (< 4 m)	Rubus chamaemorus	FACH	2	1.64 %
Arbustive (< 4 m)	Salix bebbiana	FACH	5	5.74 %
Arbustive (< 4 m)	Salix bebbiana	FACH	2	5.74 %
Arbustive (< 4 m)	Vaccinium myrtilloides	NI	5	4.1 %
Herbacée	Calamagrostis canadensis	FACH	5	18.52 %
Herbacée	Equisetum scirpoides		5	18.52 %
Herbacée	Espèce non identifiée	-	10	55.56 %
Herbacée	Scirpus atrocinctus	OBL	2	7.41 %
Muscinale	Mousses		20	50 %
Muscinale	**Sphagnum sp.**	**FACH**	**20**	**50 %**

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

08-Tourbière boisée

Fait par Jean-Bastien Lambert le 2017-7-25

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	102 545
Superficie du complexe de milieux humides (m²) :	22 806 099
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Indirect
Type du lien :	Cours d'eau permanent
Position dans le réseau hydrique	En bordure d'au moins un milieu humide
Présence de dépression humide:	0%

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

REMARQUES

Aucune remarque

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-38 - Groupement Tourbière boisée

Faite par Jean-Bastien Lambert le 2017-7-25

Latitude: 52.24433 **Longitude:** -77.08811 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	6
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	100	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non évaluée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Muscinale	90%
Arborescente (> 4 m)	55%
Sol nu / Litière	10%
Herbacée	15%
Arbustive (< 4 m)	60%
Eau	0%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	**Picea mariana**	**FACH**		**50**	**100 %**
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**50**	**30.67 %**
Arbustive (< 4 m)	Kalmia angustifolia	NI		2	1.23 %
Arbustive (< 4 m)	**Picea mariana**	**FACH**		**60**	**36.81 %**

Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**	**40**	**24.54 %**
Arbustive (< 4 m)	Rubus chamaemorus	FACH	5	3.07 %
Arbustive (< 4 m)	Vaccinium myrtilloides	NI	3	1.84 %
Arbustive (< 4 m)	Vaccinium uliginosum	NI	3	1.84 %
Herbacée	Eriophorum vaginatum subsp. spissum	OBL	2	16.67 %
Herbacée	**Maianthemum trifolium**	**OBL**	**10**	**83.33 %**
Muscinale	Mousses		10	11.11 %
Muscinale	**Sphagnum fuscum**	**FACH**	**80**	**88.89 %**

[1] *Statut hydrique : * = Statut émis par WSP*

09-Tourbière boisée

Fait par Mathieu St-Germain et Claudie Landry le 2017-7-30

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	206 407
Superficie du complexe de milieux humides (m²) :	22 806 099
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Indirect
Type du lien :	Cours d'eau permanent
Position dans le réseau hydrique	En bordure d'au moins un milieu humide
Présence de dépression humide:	76-100 %

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

REMARQUES

Aucune remarque

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

PARCELLES

P-27 - Groupement Tourbière boisée

Faite par Mathieu St-Germain et Claudie Landry le 2017-7-30

Latitude: 52.24952 **Longitude:** -77.07065 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	5
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	>30 cm			
Pente:	4-8% (faible)	Horizon supérieur (cm)	35	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):	20	Loam limono-argileux
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	X
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Muscinale	100%
Arborescente (> 4 m)	35%
Arbustive (< 4 m)	90%
Herbacée	10%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	**Picea mariana**	**FACH**		**35**	**100 %**
Arbustive (< 4 m)	Chamaedaphne calyculata	OBL		20	18.18 %
Arbustive (< 4 m)	Empetrum nigrum subsp. nigrum	NI		3	2.73 %
Arbustive (< 4 m)	Linnaea borealis	NI		2	1.82 %
Arbustive (< 4 m)	**Picea mariana**	**FACH**		**35**	**31.82 %**
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**		**40**	**36.36 %**

Arbustive (< 4 m)	Rubus chamaemorus	FACH	5	4.55 %
Arbustive (< 4 m)	Vaccinium myrtilloides	NI	5	4.55 %
Herbacée	Carex sp.	-	3	30 %
Herbacée	**Maianthemum trifolium**	**OBL**	**7**	**70 %**
Muscinale	Lichens		15	15 %
Muscinale	Mousses		5	5 %
Muscinale	**Sphagnum sp.**	**FACH**	**80**	**80 %**

[1] *Statut hydrique : * = Statut émis par WSP*

Parcelles de validation

P-27-V1 (PE1.0026)

Faite par Claudie Landry le 2017-9-3

Latitude:

Longitude:

Type de parcelle: Parcelle de validation

Parcelle associée: P-27

Tourbière ouverte

01-Tourbière ouverte

Fait par Claudie Landry le 2017-7-27

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	11 908
Superficie du complexe de milieux humides (m²) :	22 806 099
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Indirect
Type du lien :	Cours d'eau permanent
Position dans le réseau hydrique	En bordure d'au moins un milieu humide
Présence de dépression humide:	76-100 %

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

REMARQUES

> Remarques générales : Certains secteurs sont plus arbustifs et d'autres plus ouverts. Présence accrue de grande faune (ours)

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-18 - Groupement Tourbière ouverte

Faite par Claudie Landry le 2017-7-27

Latitude: **Longitude:** **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	5
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	< 5 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	100	Matière organique décomposée
Situation topographique:	Dépression	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Arbustive (< 4 m)	40%
Herbacée	30%
Muscinale	100%
Arborescente (> 4 m)	7%
Sol nu / Litière	0%
Eau	0%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	Picea mariana	FACH		7	100 %
Arbustive (< 4 m)	Carex aquatilis var. aquatilis	OBL		5	9.26 %
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**10**	**18.52 %**
Arbustive (< 4 m)	Kalmia polifolia	OBL		2	3.7 %

Arbustive (< 4 m)	Larix laricina	FACH	5	9.26 %
Arbustive (< 4 m)	**Picea mariana**	**FACH**	**20**	**37.04 %**
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**	**10**	**18.52 %**
Arbustive (< 4 m)	Rubus chamaemorus	FACH	2	3.7 %
Herbacée	**Trichophorum alpinum**	**OBL**	**30**	**100 %**
Muscinale	Lichens		35	35 %
Muscinale	**Sphagnum sp.**	**FACH**	**65**	**65 %**
Autre espèce observée	Andromeda polifolia var. latifolia	OBL		
Autre espèce observée	Drosera rotundifolia	OBL		
Autre espèce observée	Eriophorum vaginatum subsp. spissum	OBL		
Autre espèce observée	Vaccinium uliginosum	NI		

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

02-Tourbière ouverte

Fait par Mathieu St-Germain le 2017-7-28

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	491 387
Superficie du complexe de milieux humides (m²) :	1 442 580
Proportion de milieu naturel dans une bande-tampon de 100 m:	*80-90 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Indirect
Type du lien :	Cours d'eau permanent
Position dans le réseau hydrique	En bordure d'au moins un milieu humide
Présence de dépression humide:	76-100 %

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

Perturbation Naturelle

Feu	Impact irréversible

REMARQUES

> Remarques générales : Brûlis récent
Ancienne tourbière boisée

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

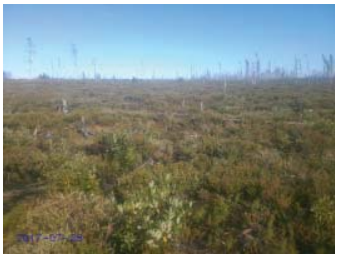
InSitu - Rapport descriptif

PARCELLES

P-78 - Groupement Tourbière ouverte

Faite par Mathieu St-Germain le 2017-7-28

Latitude: 52.22734 **Longitude:** -77.06410 **Type de parcelle:** Parcelle complète



SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	4
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	70	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):	10	Sable
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Sol nu / Litière	70%
Herbacée	30%
Arborescente (> 4 m)	0%
Arbustive (< 4 m)	70%
Muscinale	30%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**20**	**25.32 %**
Arbustive (< 4 m)	Populus tremuloides	NI		3	3.8 %
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**		**35**	**44.3 %**
Arbustive (< 4 m)	Rubus chamaemorus	FACH		1	1.27 %
Arbustive (< 4 m)	Salix sp.	-		10	12.66 %

Arbustive (< 4 m)	Vaccinium myrtilloides	NI	10	12.66 %
Herbacée	**Carex trisperma**	**OBL**	**10**	**28.57 %**
Herbacée	Equisetum sp.	-	15	42.86 %
Herbacée	**Maianthemum trifolium**	**OBL**	**10**	**28.57 %**
Muscinale	Mousses		70	100 %
Autre espèce observée	Kalmia polifolia	OBL		

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

P-79 - Groupement Tourbière ouverte

Faite par Jean-Bastien Lambert le 2017-7-28

Latitude: 52.22587 **Longitude:** -77.06581 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	2
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	> 20 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	< 5 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	80	Matière organique décomposée
Situation topographique:	Dépression	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

> Troncs et souches

> Présence de chicots

> Mares temporaires pour la reproduction des anoures

> Drainage imparfait

INDICATEURS HYDROLOGIQUES

Inondé	X	Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	X
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Eau	75%
Herbacée	85%
Sol nu / Litière	0%
Muscinale	25%
Arborescente (> 4 m)	0%
Arbustive (< 4 m)	30%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**30**	**85.71 %**

Arbustive (< 4 m)	Myrica gale	OBL	3	8.57 %
Arbustive (< 4 m)	Salix sp.	-	2	5.71 %
Herbacée	Calamagrostis canadensis	FACH	8	8.6 %
Herbacée	Carex canescens	OBL	2	2.15 %
Herbacée	**Carex rostrata**	**OBL**	**80**	**36.02 %**
Herbacée	Maianthemum trifolium	OBL	3	3.23 %
Muscinale	Mousses		15	60 %
Muscinale	**Sphagnum sp.**	**FACH**	**10**	**40 %**
Autre espèce observée	Comarum palustre	OBL		
Autre espèce observée	Iris versicolor	OBL		

[1] *Statut hydrique : * = Statut émis par WSP*

03-Tourbière ouverte

Fait par Claudie Landry et Jean-Bastien Lambert le 2017-7-29

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Occasionnel

DESCRIPTION POLYGONE

Superficie (m²) :	2 505 288
Superficie du complexe de milieux humides (m²) :	22 806 099
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Direct
Type du lien :	Cours d'eau permanent
Position dans le réseau hydrique	Traversé par un cours d'eau ou fossé
Présence de dépression humide:	76-100 %

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

REMARQUES

> Potentiel espèces rares flore moyen ou élevé

> Drainage imparfait

> Remarques générales : Dominance des carex selon les secteurs

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-09 - Groupement Tourbière ouverte

Faite par Jean-Bastien Lambert le 2017-7-26

Latitude: 52.25129 **Longitude:** -77.13245 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	4
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	< 5 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	40	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):	10	Loam limono-argileux
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

> Drainage imparfait

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Muscinale	15%
Arborescente (> 4 m)	0%
Herbacée	60%
Arbustive (< 4 m)	40%
Eau	20%
Sol nu / Litière	3%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [7]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Alnus incana subsp. rugosa**	**FACH**		**5**	**20.83 %**
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**15**	**62.5 %**

Arbustive (< 4 m)	Myrica gale	OBL	3	12.5 %
Arbustive (< 4 m)	Spiraea alba		1	4.17 %
Herbacée	Calamagrostis canadensis	FACH	1	1.56 %
Herbacée	Callitriche palustris	OBL	1	1.56 %
Herbacée	Carex canescens	OBL	8	12.5 %
Herbacée	**Carex rostrata**	**OBL**	**20**	**31.25 %**
Herbacée	Carex tenuiflora	OBL	1	1.56 %
Herbacée	Comarum palustre	OBL	3	4.69 %
Herbacée	Eriophorum angustifolium subsp. angustifolium	OBL	3	4.69 %
Herbacée	**Eriophorum virginicum**	**OBL**	**20**	**31.25 %**
Herbacée	Glyceria canadensis var. canadensis	OBL	5	7.81 %
Herbacée	Maianthemum trifolium	OBL	2	3.12 %
Autre espèce observée	Iris versicolor	OBL		

[1] *Statut hydrique : * = Statut émis par WSP*

Parcelles de validation

P-09-V1 (PE1.0030)

Faite par Claudie Landry le 2017-9-

Latitude:

Longitude:

Type de parcelle: Parcelle de validation

Parcelle associée: P-09

InSitu - Rapport descriptif

P-10 - Groupement Tourbière ouverte

Faite par Claudie Landry et Jean-Bastien Lambert le 2017-7-29

Latitude: 52.25354 **Longitude:** -77.11582 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	5
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	< 5 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Eau au-dessus du sol			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	100	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé	X	Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Arborescente (> 4 m)	0%
Eau	5%
Muscinale	100%
Arbustive (< 4 m)	35%
Sol nu / Litière	0%
Herbacée	75%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	Andromeda polifolia var. latifolia	OBL		8	17.78 %
Arbustive (< 4 m)	**Betula glandulosa**	**FACH**		**20**	**44.44 %**
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**10**	**22.22 %**
Arbustive (< 4 m)	Kalmia polifolia	OBL		2	4.44 %
Arbustive (< 4 m)	Myrica gale	OBL		1	2.22 %

Arbustive (< 4 m)	Picea mariana	FACH	2	4.44 %
Arbustive (< 4 m)	Salix sp.	-	1	2.22 %
Arbustive (< 4 m)	Vaccinium oxycoccos	OBL	1	2.22 %
Herbacée	Carex chordorrhiza	OBL	2	4.08 %
Herbacée	Carex magellanica subsp. irrigua	OBL	1	2.04 %
Herbacée	**Carex oligosperma**	**OBL**	**10**	**20.41 %**
Herbacée	**Carex rostrata**	**OBL**	**25**	**51.02 %**
Herbacée	Eriophorum angustifolium subsp. angustifolium	OBL	1	2.04 %
Herbacée	Iris versicolor	OBL	5	10.2 %
Herbacée	Maianthemum trifolium	OBL	5	10.2 %
Muscinale	**Sphagnum sp.**	**FACH**	**100**	**100 %**
Autre espèce observée	Eriophorum tenellum	OBL		
Autre espèce observée	Menyanthes trifoliata	OBL		

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

P-46 - Groupement Tourbière ouverte

Faite par Mathieu St-Germain le 2017-7-27

Latitude: **Longitude:** **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	4
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	< 5 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	< 5 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	100	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé	X	Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Herbacée	20%
Arborescente (> 4 m)	0%
Arbustive (< 4 m)	60%
Sol nu / Litière	10%
Muscinale	80%
Eau	10%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**25**	**44.64 %**
Arbustive (< 4 m)	Kalmia angustifolia	NI		5	8.93 %
Arbustive (< 4 m)	Picea mariana	FACH		5	8.93 %
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**		**15**	**26.79 %**
Arbustive (< 4 m)	Rubus chamaemorus	FACH		5	8.93 %
Arbustive (< 4 m)	Vaccinium oxycoccos	OBL		1	1.79 %

Herbacée	Carex sp.	-	5	18.52 %
Herbacée	Drosera rotundifolia	OBL	1	3.7 %
Herbacée	Eriophorum vaginatum subsp. spissum	OBL	1	3.7 %
Herbacée	Sarracenia purpurea	OBL	5	18.52 %
Herbacée	**Trichophorum alpinum**	**OBL**	**15**	**55.56 %**
Muscinale	Lichens		5	6.25 %
Muscinale	**Sphagnum sp.**	**FACH**	**75**	**93.75 %**

[1] *Statut hydrique : * = Statut émis par WSP*

04-Tourbière ouverte

Fait par Jean-Bastien Lambert le 2017-7-28

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	275 034
Superficie du complexe de milieux humides (m²) :	1 442 580
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100* %

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Direct
Type du lien :	Cours d'eau permanent
Position dans le réseau hydrique	En amont d'un cours d'eau ou fossé
Présence de dépression humide:	0%

PERTURBATIONS

Végétation perturbée?	Oui
Sols perturbés ?	Oui
Milieu affecté par un barrage de castor ?	Non

Perturbation Naturelle

Feu	Impact irréversible

REMARQUES

> Troncs et souches

> Présence de chicots

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

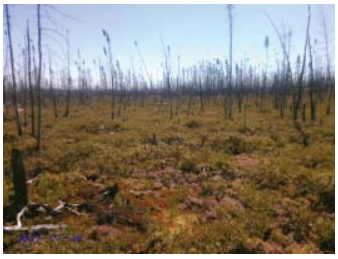
InSitu - Rapport descriptif

PARCELLES

P-60 - Groupement Tourbière ouverte

Faite par Jean-Bastien Lambert le 2017-7-28

Latitude: 52.23786 **Longitude:** -77.05760 **Type de parcelle:** Parcelle complète



SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	4
Nb d'espèces dominantes NI (B) :	1
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	>30 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	65	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):	5	Sable
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

> Troncs et souches

> Présence de chicots

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Herbacée	10%
Arborescente (> 4 m)	0%
Arbustive (< 4 m)	70%
Muscinale	25%
Sol nu / Litière	30%
Eau	1%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**40**	**38.1 %**
Arbustive (< 4 m)	Kalmia polifolia	OBL		2	1.9 %

Arbustive (< 4 m)	Pinus banksiana	NI	2	1.9 %
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**	**30**	**28.57 %**
Arbustive (< 4 m)	Rubus chamaemorus	FACH	1	0.95 %
Arbustive (< 4 m)	**Vaccinium myrtilloides**	**NI**	**30**	**28.57 %**
Herbacée	**Carex trisperma**	**OBL**	**2**	**22.22 %**
Herbacée	Chamerion latifolium		1	11.11 %
Herbacée	Eriophorum vaginatum subsp. spissum	OBL	1	11.11 %
Herbacée	**Maianthemum trifolium**	**OBL**	**5**	**55.56 %**
Muscinale	Mousses		25	100 %
Autre espèce observée	Carex aquatilis var. aquatilis	OBL		
Autre espèce observée	Petasites frigidus var. palmatus	FACH		

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

05-Tourbière ouverte

Fait par Claudie Landry le 2017-7-27

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	18 365
Superficie du complexe de milieux humides (m²) :	22 806 099
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Indirect
Type du lien :	Cours d'eau permanent
Position dans le réseau hydrique	En bordure d'au moins un milieu humide
Présence de dépression humide:	76-100 %

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

REMARQUES

> Remarques générales : Certains secteurs sont plus arbustifs et d'autres plus ouverts. Présence accrue de grande faune (ours)

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-16 - Groupement Tourbière ouverte

Faite par Claudie Landry le 2017-7-27

Latitude: **Longitude:**

Type de parcelle: Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	3
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	< 5 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	40	Matière organique décomposée
Situation topographique:	Dépression	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Herbacée	50%
Eau	0%
Arbustive (< 4 m)	30%
Sol nu / Litière	0%
Arborescente (> 4 m)	5%
Muscinale	100%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	Picea mariana	FACH		5	100 %
Arbustive (< 4 m)	Chamaedaphne calyculata	OBL		5	15.62 %
Arbustive (< 4 m)	Larix laricina	FACH		2	6.25 %
Arbustive (< 4 m)	**Picea mariana**	**FACH**		**20**	**62.5 %**

Arbustive (< 4 m)	Rhododendron groenlandicum	OBL	5	15.62 %
Herbacée	Espèce inconnue		20	70 %
Herbacée	Espèce inconnue		15	70 %
Herbacée	**Trichophorum alpinum**	**OBL**	**15**	**30 %**
Muscinale	**Sphagnum sp.**	**FACH**	**100**	**100 %**
Autre espèce observée	Drosera rotundifolia	OBL		
Autre espèce observée	Maianthemum trifolium	OBL		
Autre espèce observée	Rubus chamaemorus	FACH		
Autre espèce observée	Vaccinium oxycoccos	OBL		

[1] *Statut hydrique : * = Statut émis par WSP*

Parcelles de validation

P-16-V1 (PE1.0024)

Faite par Claudie Landry le 2017-7-

Latitude:

Longitude:

Type de parcelle: Parcelle de validation

Parcelle associée: P-16

InSitu - Rapport descriptif

06-Tourbière ouverte

Fait par Jean-Bastien Lambert le 2017-7-31

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Commun

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Direct
Type du lien :	Cours d'eau permanent
Position dans le réseau hydrique	Traversé par un cours d'eau ou fossé
Présence de dépression humide:	0-25 %

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

REMARQUES

Aucune remarque

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

DESCRIPTION POLYGONE

Superficie (m²) :	134 696
Superficie du complexe de milieux humides (m²) :	22 806 099
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

InSitu - Rapport descriptif

PARCELLES

P-01 - Groupement Tourbière ouverte

Faite par Jean-Bastien Lambert le 2017-7-31

Latitude: 52.26939 **Longitude:** -77.09292 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	4
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	80	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non évaluée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Muscinale	70%
Arborescente (> 4 m)	0%
Herbacée	25%
Arbustive (< 4 m)	80%
Sol nu / Litière	20%
Eau	5%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**60**	**74.07 %**
Arbustive (< 4 m)	Larix laricina	FACH		1	1.23 %
Arbustive (< 4 m)	**Myrica gale**	**OBL**		**20**	**24.69 %**
Herbacée	Callitriche palustris	OBL		1	5 %

Herbacée	**Carex aquatilis var. aquatilis**	**OBL**	**15**	**75 %**
Herbacée	Comarum palustre	OBL	2	10 %
Herbacée	Sparganium fluctuans	OBL	2	10 %
Muscinale	**Sphagnum sp.**	**FACH**	**70**	**100 %**

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

07-Tourbière ouverte

Fait par Jean-Bastien Lambert le 2017-7-29

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	64 794
Superficie du complexe de milieux humides (m²) :	22 806 099
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Direct
Type du lien :	Lac
Position dans le réseau hydrique	En bordure d'un cours d'eau ou d'un plan d'eau ou fossé
Présence de dépression humide:	0-25 %

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

Perturbation Anthropique

Autre - Anthropique	Menaçant peu

REMARQUES

> Potentiel espèces rares flore moyen ou élevé

> Drainage imparfait

> Remarques générales : Quelques espèces calcicoles.
Près de ligne haute tension

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-02 - Groupement Tourbière ouverte

Faite par Jean-Bastien Lambert le 2017-7-29

Latitude: 52.26447 **Longitude:** -77.07943 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	3
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	< 5 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	< 5 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	100	Matière organique décomposée
Situation topographique:	Dépression	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

> Potentiel espèces rares flore moyen ou élevé

> Drainage imparfait

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	X
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Sol nu / Litière	0%
Arbustive (< 4 m)	20%
Arborescente (> 4 m)	0%
Muscinale	100%
Eau	2%
Herbacée	40%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	Andromeda polifolia var. latifolia	OBL		2	8.7 %
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**20**	**86.96 %**

Arbustive (< 4 m)	Picea mariana	FACH	1	4.35 %
Herbacée	Carex exilis	OBL	2	6.06 %
Herbacée	Carex oligosperma	OBL	2	6.06 %
Herbacée	Carex pauciflora	OBL	1	3.03 %
Herbacée	Drosera intermedia	OBL	1	3.03 %
Herbacée	Drosera rotundifolia	OBL	2	6.06 %
Herbacée	Eriophorum vaginatum subsp. spissum	OBL	1	3.03 %
Herbacée	**Rhynchospora alba**	**OBL**	**8**	**24.24 %**
Herbacée	Sarracenia purpurea	OBL	1	3.03 %
Herbacée	**Trichophorum alpinum**	**OBL**	**15**	**45.45 %**
Autre espèce observée	Betula michauxii			
Autre espèce observée	Juncus stygius var. americanus	OBL		
Autre espèce observée	Menyanthes trifoliata	OBL		
Autre espèce observée	Nuphar microphylla	OBL		
Autre espèce observée	Oclemena nemoralis	OBL		
Autre espèce observée	Scheuchzeria palustris	OBL		
Autre espèce observée	Utricularia cornuta	OBL		

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

09-Tourbière ouverte

Fait par Claudie Landry le 2017-7-25

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Occasionnel

DESCRIPTION POLYGONE

Superficie (m²) :	338 135
Superficie du complexe de milieux humides (m²) :	22 806 099
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Direct
Type du lien :	Lac
Position dans le réseau hydrique	En bordure d'un cours d'eau ou d'un plan d'eau ou fossé
Présence de dépression humide:	76-100 %

PERTURBATIONS

Végétation perturbée?	Oui
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

Perturbation Naturelle

Feu	Menaçant beaucoup

REMARQUES

> Troncs et souches

> Présence de chicots

> Remarques générales : Brûlis récent.
Ancienne tourbière ouverte avec 10% d'arbres

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Nom Latin	Désignation	Aire de l'unité	Répartition	Abondance
Carex sterilis	susceptible	101-500 m²	Dispersé	100-500

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-36 - Groupement Tourbière ouverte

Faite par Claudie Landry le 2017-7-28

Latitude: 52.24292 **Longitude:** -77.06146 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	4
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	11-30 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	70	Matière organique décomposée
Situation topographique:	Dépression	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Arbustive (< 4 m)	30%
Herbacée	80%
Arborescente (> 4 m)	0%
Muscinale	90%
Eau	0%
Sol nu / Litière	10%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	Chamaedaphne calyculata	OBL		3	15 %
Arbustive (< 4 m)	**Larix laricina**	**FACH**		**5**	**25 %**
Arbustive (< 4 m)	**Picea mariana**	**FACH**		**10**	**50 %**
Arbustive (< 4 m)	Rhododendron groenlandicum	OBL		2	10 %

Herbacée	Carex sp.	-		5	9.62 %
Herbacée	Carex sterilis	OBL	susceptible	5	9.62 %
Herbacée	Cornus canadensis	NI		5	9.62 %
Herbacée	Muhlenbergia glomerata	FACH		5	9.62 %
Herbacée	Symphyotrichum sp.			2	3.85 %
Herbacée	**Trichophorum alpinum**	**OBL**		**30**	**57.69 %**
Muscinale	**Sphagnum sp.**	**FACH**		**90**	**100 %**
Autre espèce observée	Andromeda polifolia var. latifolia	OBL			
Autre espèce observée	Coptis trifolia	NI			
Autre espèce observée	Dasiphora fruticosa	FACH			
Autre espèce observée	Drosera rotundifolia	OBL			
Autre espèce observée	Eriophorum angustifolium subsp. angustifolium	OBL			
Autre espèce observée	Juniperus communis var. depressa	NI			
Autre espèce observée	Juniperus horizontalis	NI			
Autre espèce observée	Kalmia polifolia	OBL			
Autre espèce observée	Linnaea borealis	NI			
Autre espèce observée	Menyanthes trifoliata	OBL			
Autre espèce observée	Rubus pubescens	FACH			
Autre espèce observée	Vaccinium myrtilloides	NI			
Autre espèce observée	Vaccinium oxycoccos	OBL			

[1] *Statut hydrique : * = Statut émis par WSP*

Parcelles de validation

P-36-V1 (PE1.0018)

Faite par Mathieu St-Germain le 2017-7-2

Latitude: 52.24453

Longitude: -77.06140

Type de parcelle: Parcelle de validation

Parcelle associée: P-36

InSitu - Rapport descriptif

P-54 - Groupement Tourbière ouverte

Faite par Claudie Landry le 2017-7-25

Latitude: 52.24049 **Longitude:** -77.07422 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	3
Nb d'espèces dominantes NI (B) :	1
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	< 5 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	70	Matière organique décomposée
Situation topographique:	Dépression	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Arborescente (> 4 m)	0%
Herbacée	70%
Sol nu / Litière	0%
Arbustive (< 4 m)	35%
Eau	5%
Muscinale	100%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**20**	**54.05 %**
Arbustive (< 4 m)	**Kalmia angustifolia**	**NI**		**10**	**27.03 %**
Arbustive (< 4 m)	Rhododendron groenlandicum	OBL		7	18.92 %
Herbacée	**Carex oligosperma**	**OBL**		**65**	**100 %**
Muscinale	**Sphagnum sp.**	**FACH**		**100**	**100 %**
Autre espèce observée	Carex canescens	OBL			

Autre espèce observée	Carex magellanica subsp. irrigua	OBL
Autre espèce observée	Drosera rotundifolia	OBL
Autre espèce observée	Sarracenia purpurea	OBL
Autre espèce observée	Vaccinium oxycoccos	OBL

[1] *Statut hydrique : * = Statut émis par WSP*

Parcelles de validation

P-54-V1 (PE1.0027)

Faite par Claudie Landry le 2017-7-

Latitude:

Longitude:

Type de parcelle: Parcelle de validation

Parcelle associée: P-54

P-54-V2 (PE1.0028)

Faite par Claudie Landry le 2017-7-

Latitude:

Longitude:

Type de parcelle: Parcelle de validation

Parcelle associée: P-54

P-54-V3 (PE1.0029)

Faite par Claudie Landry le 2017-7-

Latitude:

Longitude:

Type de parcelle: Parcelle de validation

Parcelle associée: P-54

InSitu - Rapport descriptif

10-Tourbière ouverte

Fait par Claudie Landry et Jean-Bastien Lambert le 2017-7-24

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	5 119 583
Superficie du complexe de milieux humides (m²) :	22 806 099
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100* %

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Direct
Type du lien :	Cours d'eau permanent
Position dans le réseau hydrique	Traversé par un cours d'eau ou fossé
Présence de dépression humide:	76-100 %

PERTURBATIONS

Végétation perturbée?	Oui
Sols perturbés ?	Oui
Milieu affecté par un barrage de castor ?	Non

Perturbation Anthropique

Coupe partielle	Menaçant peu
Sentier de véhicules motorisés	Menaçant peu

Perturbation Naturelle

Feu	Impact irréversible

REMARQUES

> Troncs et souches

> Présence de chicots

> Potentiel espèces rares flore moyen ou élevé

> Drainage imparfait

> Remarques générales : Le milieu est plus riche en bordure des cours d'eau. Le milieu semble plus basique vers l'ouest, près de la parcelle P-71.

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-29 - Groupement Tourbière ouverte

Faite par Jean-Bastien Lambert le 2017-7-31

Latitude: 52.24732 **Longitude:** -77.06775 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	3
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	< 5 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	6-10 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	110	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

> Présence de chicots

> Potentiel espèces rares flore moyen ou élevé

> Drainage imparfait

INDICATEURS HYDROLOGIQUES

Inondé	X	Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Arbustive (< 4 m)	35%
Muscinale	75%
Arborescente (> 4 m)	0%
Muscinale	90%
Herbacée	50%
Eau	10%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**30**	**93.75 %**

Arbustive (< 4 m)	Myrica gale	OBL	2	6.25 %
Herbacée	**Carex aquatilis var. aquatilis**	**OBL**	**25**	**64.1 %**
Herbacée	Carex canescens	OBL	1	2.56 %
Herbacée	Carex oligosperma	OBL	5	12.82 %
Herbacée	Comarum palustre	OBL	3	7.69 %
Herbacée	Glyceria borealis	OBL	1	2.56 %
Herbacée	Iris versicolor	OBL	1	2.56 %
Herbacée	Maianthemum trifolium	OBL	2	5.13 %
Herbacée	Scirpus microcarpus	OBL	1	2.56 %
Muscinale	**Sphagnum sp.**	**FACH**	**80**	**100 %**
Autre espèce observée	Carex lasiocarpa subsp. americana	OBL		

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

P-31 - Groupement Tourbière ouverte

Faite par Jean-Bastien Lambert le 2017-7-30

Latitude: 52.24636 **Longitude:** -77.06614 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	2
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	>30 cm			
Pente:	4-8% (faible)	Horizon supérieur (cm)	80	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):	5	Loam limoneux
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

> Troncs et souches

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Sol nu / Litière	20%
Arbustive (< 4 m)	80%
Herbacée	5%
Muscinale	80%
Arborescente (> 4 m)	0%
Eau	0%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [7]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**50**	**57.47 %**
Arbustive (< 4 m)	Picea mariana	FACH		3	3.45 %
Arbustive (< 4 m)	Pinus banksiana	NI		3	3.45 %
Arbustive (< 4 m)	Rhododendron groenlandicum	OBL		15	17.24 %
Arbustive (< 4 m)	Rubus chamaemorus	FACH		10	11.49 %

Arbustive (< 4 m)	Vaccinium myrtilloides	NI	5	5.75 %
Arbustive (< 4 m)	Vaccinium oxycoccos	OBL	1	1.15 %
Herbacée	Carex pauciflora	OBL	1	50 %
Herbacée	Lycopodium annotinum	NI	1	50 %
Muscinale	Lichens		20	28.57 %
Muscinale	Mousses		10	14.29 %
Muscinale	**Sphagnum sp.**	**FACH**	**40**	**57.14 %**

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

P-39 - Groupement Tourbière ouverte

Faite par Jean-Bastien Lambert le 2017-7-25

Latitude: 52.24359 **Longitude:** -77.08964 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	5
Nb d'espèces dominantes NI (B) :	1
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	11-30 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	70	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):	5	Loam limoneux
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Sol nu / Litière	20%
Arborescente (> 4 m)	0%
Herbacée	30%
Eau	0%
Arbustive (< 4 m)	95%
Muscinale	75%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**30**	**25.21 %**
Arbustive (< 4 m)	Kalmia polifolia	OBL		5	4.2 %
Arbustive (< 4 m)	Picea mariana	FACH		2	1.68 %
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**		**50**	**42.02 %**
Arbustive (< 4 m)	Rubus chamaemorus	FACH		5	4.2 %
Arbustive (< 4 m)	**Vaccinium myrtilloides**	**NI**		**25**	**21.01 %**

Arbustive (< 4 m)	Vaccinium oxycoccos	OBL	2	1.68 %
Herbacée	Carex trisperma	OBL	2	15.38 %
Herbacée	**Eriophorum vaginatum subsp. spissum**	**OBL**	**3**	**23.08 %**
Herbacée	**Maianthemum trifolium**	**OBL**	**8**	**61.54 %**
Muscinale	Mousses		40	47.06 %
Muscinale	**Sphagnum sp.**	**FACH**	**45**	**52.94 %**

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

P-40 - Groupement Tourbière ouverte

Faite par Jean-Bastien Lambert et Mathieu St-Germain le 2017-7-25

Latitude: 52.24532 **Longitude:** -77.09124 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	5
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	100	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	X
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Sol nu / Litière	20%
Herbacée	10%
Arbustive (< 4 m)	80%
Muscinale	80%
Arborescente (> 4 m)	0%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**50**	**43.86 %**
Arbustive (< 4 m)	Kalmia polifolia	OBL		15	13.16 %
Arbustive (< 4 m)	Picea mariana	FACH		2	1.75 %
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**		**35**	**30.7 %**
Arbustive (< 4 m)	Rubus chamaemorus	FACH		5	4.39 %
Arbustive (< 4 m)	Vaccinium myrtilloides	NI		3	2.63 %
Arbustive (< 4 m)	Vaccinium oxycoccos	OBL		1	0.88 %

Arbustive (< 4 m)	Vaccinium uliginosum	NI	3	2.63 %
Herbacée	**Carex oligosperma**	**OBL**	**3**	**42.86 %**
Herbacée	Carex pauciflora	OBL	1	14.29 %
Herbacée	**Trichophorum cespitosum**	**OBL**	**3**	**42.86 %**
Muscinale	Mousses		10	12.5 %
Muscinale	**Sphagnum sp.**	**FACH**	**70**	**87.5 %**

[1] *Statut hydrique : * = Statut émis par WSP*

Parcelles de validation

P-40-V1 (PE1.0012)

Faite par Mathieu St-Germain le 2017-7-

Latitude:

Longitude:

Type de parcelle: Parcelle de validation

Parcelle associée: P-40

InSitu - Rapport descriptif

P-43 - Groupement Tourbière ouverte

Faite par Mathieu St-Germain le 2017-7-27

Latitude: **Longitude:** **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	6
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	100	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	X
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Arbustive (< 4 m)	85%
Muscinale	80%
Sol nu / Litière	20%
Arborescente (> 4 m)	1%
Herbacée	20%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	Picea mariana	FACH		1	100 %
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**40**	**37.74 %**
Arbustive (< 4 m)	Kalmia polifolia	OBL		5	4.72 %
Arbustive (< 4 m)	Larix laricina	FACH		1	0.94 %
Arbustive (< 4 m)	Picea mariana	FACH		5	4.72 %
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**		**40**	**37.74 %**
Arbustive (< 4 m)	Rubus chamaemorus	FACH		5	4.72 %

Arbustive (< 4 m)	Vaccinium myrtilloides	NI	10	9.43 %
Herbacée	**Carex oligosperma**	**OBL**	**5**	**25 %**
Herbacée	**Maianthemum trifolium**	**OBL**	**10**	**50 %**
Herbacée	**Trichophorum alpinum**	**OBL**	**5**	**25 %**
Muscinale	Mousses		10	12.5 %
Muscinale	**Sphagnum sp.**	**FACH**	**70**	**87.5 %**
Autre espèce observée	Betula glandulosa	FACH		
Autre espèce observée	Cornus canadensis	NI		

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

P-49 - Groupement Tourbière ouverte

Faite par Mathieu St-Germain le 2017-7-25

Latitude: 52.24013 **Longitude:** -77.09448 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	3
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	100	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	X
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	X
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Sol nu / Litière	30%
Herbacée	1%
Arborescente (> 4 m)	0%
Arbustive (< 4 m)	85%
Muscinale	20%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**30**	**26.09 %**
Arbustive (< 4 m)	Kalmia polifolia	OBL		5	4.35 %
Arbustive (< 4 m)	Picea mariana	FACH		5	4.35 %
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**		**50**	**43.48 %**
Arbustive (< 4 m)	Rubus chamaemorus	FACH		10	8.7 %
Arbustive (< 4 m)	Vaccinium myrtilloides	NI		10	8.7 %
Arbustive (< 4 m)	Vaccinium oxycoccos	OBL		5	4.35 %

Herbacée	Eriophorum vaginatum subsp. spissum	OBL	1	100 %
Muscinale	**Sphagnum sp.**	**FACH**	**20**	**100 %**

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

P-51 - Groupement Tourbière ouverte

Faite par Claudie Landry le 2017-7-25

Latitude: **Longitude:** **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	2
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	40	Matière organique décomposée
Situation topographique:	Dépression	Horizon inférieur (cm):	5	Loam argileux
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Arborescente (> 4 m)	0%
Muscinale	70%
Sol nu / Litière	40%
Herbacée	5%
Arbustive (< 4 m)	80%
Eau	0%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**40**	**38.1 %**
Arbustive (< 4 m)	Pinus banksiana	NI		5	4.76 %
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**		**40**	**38.1 %**
Arbustive (< 4 m)	Rubus chamaemorus	FACH		5	4.76 %
Arbustive (< 4 m)	Vaccinium myrtilloides	NI		15	14.29 %
Herbacée	Maianthemum trifolium	OBL		5	100 %

Muscinale	Lichens		30	42.86 %
Muscinale	Mousses		30	42.86 %
Muscinale	Sphagnum sp.	FACH	10	14.29 %
Autre espèce observée	Kalmia angustifolia	NI		

[1] *Statut hydrique : * = Statut émis par WSP*

Parcelles de validation

P-51-V1 (PE1.0032)

Faite par Mathieu St-Germain le 2017-7-2

Latitude:

Longitude:

Type de parcelle: Parcelle de validation

Parcelle associée: P-51

InSitu - Rapport descriptif

P-64 - Groupement Tourbière ouverte

Faite par Claudie Landry le 2017-7-28

Latitude: 52.23536 **Longitude:** -77.06146 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	1
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	4-8% (faible)	Horizon supérieur (cm)	55	Matière organique décomposée
Situation topographique:	Plateau sur versant	Horizon inférieur (cm):	5	Sable
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Arborescente (> 4 m)	0%
Herbacée	5%
Muscinale	15%
Sol nu / Litière	80%
Arbustive (< 4 m)	70%
Eau	0%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	Chamaedaphne calyculata	OBL		10	12.5 %
Arbustive (< 4 m)	Kalmia angustifolia	NI		15	18.75 %
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**		**40**	**50 %**
Arbustive (< 4 m)	Rubus chamaemorus	FACH		5	6.25 %
Arbustive (< 4 m)	Vaccinium myrtilloides	NI		10	12.5 %
Herbacée	Equisetum sylvaticum	FACH		3	15 %

Herbacée	Maianthemum trifolium	OBL	2	10 %
Herbacée	Sphagnum sp.	FACH	15	75 %

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

P-66 - Groupement Tourbière ouverte

Faite par Mathieu St-Germain et Jean-Bastien Lambert le 2017-7-24

Latitude: 52.23544 **Longitude:** -77.07913 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	2
Nb d'espèces dominantes NI (B) :	1
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	4-8% (faible)	Horizon supérieur (cm)	50	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):	10	Sableuse
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre	X	Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Arbustive (< 4 m)	70%
Herbacée	2%
Sol nu / Litière	25%
Muscinale	15%
Arborescente (> 4 m)	0%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**30**	**32.61 %**
Arbustive (< 4 m)	**Kalmia angustifolia**	**NI**		**25**	**27.17 %**
Arbustive (< 4 m)	Kalmia polifolia	OBL		2	2.17 %
Arbustive (< 4 m)	Rhododendron groenlandicum	OBL		15	16.3 %
Arbustive (< 4 m)	Rubus chamaemorus	FACH		15	16.3 %
Arbustive (< 4 m)	Vaccinium myrtilloides	NI		5	5.43 %

Herbacée	Eriophorum vaginatum subsp. spissum	OBL	1	50 %
Herbacée	Maianthemum trifolium	OBL	1	50 %
Muscinale	**Sphagnum sp.**	**FACH**	**15**	**100 %**
Autre espèce observée	Carex trisperma	OBL		
Autre espèce observée	Drosera rotundifolia	OBL		

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

P-68 - Groupement Tourbière ouverte

Faite par Claudie Landry et Jean-Bastien Lambert le 2017-7-29

Latitude: 52.23728 **Longitude:** -77.09035 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	5
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	11-30 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	60	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Muscinale	100%
Arbustive (< 4 m)	65%
Herbacée	25%
Eau	0%
Arborescente (> 4 m)	0%
Sol nu / Litière	0%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**55**	**47.01 %**
Arbustive (< 4 m)	Empetrum nigrum subsp. nigrum	NI		2	1.71 %
Arbustive (< 4 m)	Kalmia angustifolia	NI		2	1.71 %
Arbustive (< 4 m)	Kalmia polifolia	OBL		1	0.85 %
Arbustive (< 4 m)	Larix laricina	FACH		1	0.85 %
Arbustive (< 4 m)	**Picea mariana**	**FACH**		**45**	**38.46 %**

Arbustive (< 4 m)	Rhododendron groenlandicum	OBL	1	0.85 %
Arbustive (< 4 m)	Rubus chamaemorus	FACH	10	8.55 %
Herbacée	**Carex oligosperma**	**OBL**	**5**	**41.67 %**
Herbacée	Carex pauciflora	OBL	1	8.33 %
Herbacée	Drosera rotundifolia	OBL	1	8.33 %
Herbacée	Eriophorum vaginatum subsp. spissum	OBL	1	8.33 %
Herbacée	Sarracenia purpurea	OBL	1	8.33 %
Herbacée	**Scheuchzeria palustris**	**OBL**	**3**	**25 %**
Muscinale	Lichens		5	5 %
Muscinale	**Sphagnum sp.**	**FACH**	**95**	**95 %**

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

P-70 - Groupement Tourbière ouverte

Faite par Claudie Landry le 2017-7-29

Latitude: 52.23550 **Longitude:** -77.10304 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	4
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	4-8% (faible)	Horizon supérieur (cm)	30	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):	20	Loam sableux
Drainage:	Hydrique	Roc (si observé):	50	

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Sol nu / Litière	95%
Arbustive (< 4 m)	65%
Herbacée	10%
Arborescente (> 4 m)	0%
Eau	0%
Muscinale	5%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**30**	**30.93 %**
Arbustive (< 4 m)	Picea mariana	FACH		2	2.06 %
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**		**50**	**51.55 %**
Arbustive (< 4 m)	Vaccinium myrtilloides	NI		15	15.46 %
Herbacée	**Equisetum sylvaticum**	**FACH**		**8**	**80 %**
Herbacée	**Muhlenbergia uniflora**	**OBL**		**2**	**20 %**

Muscinale	Mousses		2	40 %
Muscinale	Sphagnum sp.	FACH	3	60 %

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

P-71 - Groupement Tourbière ouverte

Faite par Jean-Bastien Lambert le 2017-7-26

Latitude: **Longitude:** **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	2
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	>30 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	100	Matière organique décomposée
Situation topographique:	Dépression	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

> Présence de chicots

> Potentiel espèces rares flore moyen ou élevé

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Arborescente (> 4 m)	0%
Sol nu / Litière	5%
Herbacée	50%
Arbustive (< 4 m)	60%
Muscinale	80%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	Andromeda polifolia var. latifolia	OBL		1	1.52 %
Arbustive (< 4 m)	**Betula glandulosa**	**FACH**		**25**	**37.88 %**
Arbustive (< 4 m)	Chamaedaphne calyculata	OBL		5	7.58 %
Arbustive (< 4 m)	**Dasiphora fruticosa**	**FACH**		**15**	**22.73 %**
Arbustive (< 4 m)	Juniperus horizontalis	NI		3	4.55 %

Arbustive (< 4 m)	Kalmia polifolia	OBL	1	1.52 %
Arbustive (< 4 m)	Larix laricina	FACH	2	3.03 %
Arbustive (< 4 m)	Lonicera villosa	NI	1	1.52 %
Arbustive (< 4 m)	Myrica gale	OBL	3	4.55 %
Arbustive (< 4 m)	Rhamnus alnifolia	OBL	2	3.03 %
Arbustive (< 4 m)	Rhododendron groenlandicum	OBL	2	3.03 %
Arbustive (< 4 m)	Salix pedicellaris	OBL	3	4.55 %
Arbustive (< 4 m)	Spiraea alba		1	1.52 %
Arbustive (< 4 m)	Vaccinium oxycoccos	OBL	2	3.03 %
Herbacée	Carex vesicaria	OBL	5	11.9 %
Herbacée	Cornus canadensis	NI	2	4.76 %
Herbacée	Eriophorum angustifolium subsp. angustifolium	OBL	3	7.14 %
Herbacée	Linnaea borealis	NI	2	4.76 %
Herbacée	Piptatherum canadense		2	4.76 %
Herbacée	Solidago sp.	-	20	47.62 %
Herbacée	Solidago uliginosa	OBL	5	11.9 %
Herbacée	Trichophorum cespitosum	OBL	2	4.76 %
Herbacée	Viola labradorica		1	2.38 %
Autre espèce observée	Cirsium muticum	OBL		
Autre espèce observée	Gentiana linearis	OBL		
Autre espèce observée	Juniperus communis var. megistocarpa	NI		
Autre espèce observée	Rubus X paracaulis			
Autre espèce observée	Viburnum edule	FACH		

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

P-73 - Groupement Tourbière ouverte

Faite par Jean-Bastien Lambert et Claudie Landry le 2017-7-24

Latitude: 52.23182 **Longitude:** -77.08766 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	5
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	>30 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	75	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

> Troncs et souches

> Présence de chicots

> Drainage imparfait

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Muscinale	60%
Arbustive (< 4 m)	80%
Herbacée	25%
Arborescente (> 4 m)	0%
Eau	0%
Sol nu / Litière	20%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**30**	**33.33 %**
Arbustive (< 4 m)	Kalmia angustifolia	NI		10	11.11 %

Arbustive (< 4 m)	Kalmia polifolia	OBL	5	5.56 %
Arbustive (< 4 m)	Picea mariana	FACH	3	3.33 %
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**	**30**	**33.33 %**
Arbustive (< 4 m)	Rubus chamaemorus	FACH	3	3.33 %
Arbustive (< 4 m)	Vaccinium myrtilloides	NI	5	5.56 %
Arbustive (< 4 m)	Vaccinium oxycoccos	OBL	2	2.22 %
Arbustive (< 4 m)	Vaccinium uliginosum	NI	2	2.22 %
Herbacée	Carex pauciflora	OBL	3	13.04 %
Herbacée	**Eriophorum vaginatum subsp. spissum**	**OBL**	**5**	**21.74 %**
Herbacée	**Maianthemum trifolium**	**OBL**	**15**	**65.22 %**
Muscinale	Mousses		50	71.43 %
Muscinale	**Sphagnum sp.**	**FACH**	**20**	**28.57 %**
Autre espèce observée	Carex arcta	OBL		
Autre espèce observée	Coptis trifolia	NI		
Autre espèce observée	Dasiphora fruticosa	FACH		
Autre espèce observée	Juniperus communis var. megistocarpa	NI		
Autre espèce observée	Lonicera villosa	NI		
Autre espèce observée	Platanthera dilatata var. dilatata	FACH		
Autre espèce observée	Rhamnus alnifolia	OBL		
Autre espèce observée	Rosa palustris	OBL		
Autre espèce observée	Solidago uliginosa	OBL		
Autre espèce observée	Trichophorum cespitosum	OBL		

[1] *Statut hydrique : * = Statut émis par WSP*

Parcelles de validation

P-73-V1 (PE1.0003)

Faite par Mathieu St-Germain le 2017-7-2

Latitude: 52.22782

Longitude: -77.09501

Type de parcelle: Parcelle de validation

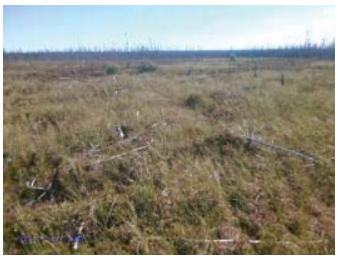
Parcelle associée: P-73

InSitu - Rapport descriptif

P-75 - Groupement Tourbière ouverte

Faite par Jean-Bastien Lambert le 2017-7-28

Latitude: 52.22918 **Longitude:** -77.07234 **Type de parcelle:** Parcelle complète



SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	3
Nb d'espèces dominantes NI (B) :	1
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	60	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

> Troncs et souches

> Présence de chicots

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Arbustive (< 4 m)	50%
Muscinale	55%
Herbacée	50%
Eau	0%
Sol nu / Litière	15%
Arborescente (> 4 m)	0%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**15**	**27.27 %**
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**		**20**	**36.36 %**
Arbustive (< 4 m)	**Vaccinium myrtilloides**	**NI**		**20**	**36.36 %**

Herbacée	Carex sp.	-	35	79.55 %
Herbacée	Equisetum pratense	FACH	2	4.55 %
Herbacée	Eriophorum angustifolium subsp. angustifolium	OBL	5	11.36 %
Herbacée	Maianthemum trifolium	OBL	2	4.55 %
Muscinale	Mousses		40	66.67 %
Muscinale	**Sphagnum sp.**	**FACH**	**20**	**33.33 %**

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

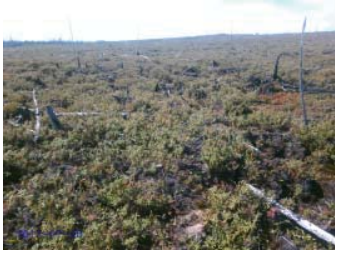
P-76 - Groupement Tourbière ouverte

Faite par Claudie Landry et Jean-Bastien Lambert le 2017-7-28

Latitude: 52.22958 **Longitude:** -77.07160 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	3
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Non



DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	>30 cm			
Pente:	4-8% (faible)	Horizon supérieur (cm)	100	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Sol nu / Litière	50%
Arbustive (< 4 m)	65%
Arborescente (> 4 m)	0%
Muscinale	50%
Eau	0%
Herbacée	8%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**15**	**20.83 %**
Arbustive (< 4 m)	Kalmia angustifolia	NI		10	13.89 %
Arbustive (< 4 m)	Kalmia polifolia	OBL		2	2.78 %
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**		**35**	**48.61 %**
Arbustive (< 4 m)	Rubus chamaemorus	FACH		5	6.94 %
Arbustive (< 4 m)	Vaccinium myrtilloides	NI		5	6.94 %

Herbacée	Maianthemum trifolium	OBL	8	100 %
Muscinale	Mousses		30	60 %
Muscinale	**Sphagnum sp.**	**FACH**	**20**	**40 %**
Autre espèce observée	Carex aquatilis var. aquatilis	OBL		

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

P-80 - Groupement Tourbière ouverte

Faite par Jean-Bastien Lambert le 2017-7-28

Latitude: 52.22464 **Longitude:** -77.06791 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	3
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	> 20 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	< 5 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	80	Matière organique décomposée
Situation topographique:	Dépression	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

> Troncs et souches

> Présence de chicots

> Mares temporaires pour la reproduction des anoures

> Drainage imparfait

INDICATEURS HYDROLOGIQUES

Inondé	X	Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	X
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Herbacée	85%
Eau	75%
Arborescente (> 4 m)	0%
Muscinale	25%
Arbustive (< 4 m)	30%
Sol nu / Litière	0%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**30**	**85.71 %**

Arbustive (< 4 m)	Myrica gale	OBL	3	8.57 %
Arbustive (< 4 m)	Salix sp.	-	2	5.71 %
Herbacée	Calamagrostis canadensis	FACH	8	8.6 %
Herbacée	Carex canescens	OBL	2	2.15 %
Herbacée	**Carex lenticularis var. lenticularis**	**OBL**	**80**	**36.02 %**
Herbacée	Maianthemum trifolium	OBL	3	3.23 %
Muscinale	Mousses		15	60 %
Muscinale	**Sphagnum sp.**	**FACH**	**10**	**40 %**
Autre espèce observée	Comarum palustre	OBL		
Autre espèce observée	Iris versicolor	OBL		

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

P-81 - Groupement Tourbière ouverte

Faite par Claudie Landry le 2017-7-28

Latitude: 52.22424 **Longitude:** -77.06868 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	5
Nb d'espèces dominantes NI (B) :	1
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	< 5 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	60	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé	X	Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Herbacée	50%
Arborescente (> 4 m)	0%
Arbustive (< 4 m)	30%
Muscinale	80%
Eau	0%
Sol nu / Litière	0%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**10**	**26.32 %**
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**		**15**	**39.47 %**
Arbustive (< 4 m)	Rubus chamaemorus	FACH		5	13.16 %
Arbustive (< 4 m)	**Vaccinium myrtilloides**	**NI**		**8**	**21.05 %**
Herbacée	**Carex lenticularis var. lenticularis**	**OBL**		**40**	**80 %**
Herbacée	**Maianthemum trifolium**	**OBL**		**10**	**20 %**

Muscinale	**Sphagnum sp.**	**FACH**	**80**	**100 %**

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

12-Tourbière ouverte

Fait par Claudie Landry et Jean-Bastien Lambert le 2017-7-29

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	44 966
Superficie du complexe de milieux humides (m²) :	22 806 099
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Direct
Type du lien :	Cours d'eau permanent
Position dans le réseau hydrique	Traversé par un cours d'eau ou fossé
Présence de dépression humide:	76-100 %

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

Perturbation Anthropique

Coupe partielle	Menaçant pas

REMARQUES

> Remarques générales : Traversé par l'emprise d'hydro.
Potentiellement minérotrophe, présence de mélèze et de carex plus importante que dans les autres tourbières ouvertes.

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

PARCELLES

P-04 - Groupement Tourbière ouverte

Faite par Claudie Landry et Jean-Bastien Lambert le 2017-7-29

Latitude: 52.25997 **Longitude:** -77.07871 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	4
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	11-30 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	100	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Muscinale	85%
Arborescente (> 4 m)	0%
Sol nu / Litière	15%
Herbacée	50%
Eau	0%
Arbustive (< 4 m)	40%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	Andromeda polifolia var. latifolia	OBL		2	4.76 %
Arbustive (< 4 m)	Chamaedaphne calyculata	OBL		5	11.9 %
Arbustive (< 4 m)	Juniperus communis var. depressa	NI		5	11.9 %
Arbustive (< 4 m)	**Larix laricina**	**FACH**		**15**	**35.71 %**

Arbustive (< 4 m)	Lonicera villosa	NI	1	2.38 %
Arbustive (< 4 m)	**Picea mariana**	**FACH**	**10**	**23.81 %**
Arbustive (< 4 m)	Rhododendron groenlandicum	OBL	1	2.38 %
Arbustive (< 4 m)	Rubus chamaemorus	FACH	2	4.76 %
Arbustive (< 4 m)	Vaccinium oxycoccos	OBL	1	2.38 %
Herbacée	Carex oligosperma	OBL	2	7.69 %
Herbacée	Coptis trifolia	NI	1	3.85 %
Herbacée	Muhlenbergia uniflora	OBL	2	7.69 %
Herbacée	Symphyotrichum sp.		1	3.85 %
Herbacée	**Trichophorum alpinum**	**OBL**	**20**	**76.92 %**
Muscinale	Lichens		15	17.65 %
Muscinale	**Sphagnum sp.**	**FACH**	**70**	**82.35 %**

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

13-Tourbière ouverte

Fait par Jean-Bastien Lambert et Mathieu St-Germain le 2017-7-30

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	7 265
Superficie du complexe de milieux humides (m²) :	22 806 099
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Direct
Type du lien :	Fossé
Position dans le réseau hydrique	En amont d'un cours d'eau ou fossé
Présence de dépression humide:	26-50 %

PERTURBATIONS

Végétation perturbée?	Oui
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

Perturbation Anthropique

Autre - Anthropique	Impact irréversible

REMARQUES

> Drainage imparfait

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

PARCELLES

P-26 - Groupement Tourbière ouverte

Faite par Jean-Bastien Lambert et Mathieu St-Germain le 2017-7-30

Latitude: 52.24992 **Longitude:** -77.07139 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	3
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	6-10 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	< 5 cm			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	120	Matière organique décomposée
Situation topographique:	Dépression	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

> Drainage imparfait

INDICATEURS HYDROLOGIQUES

Inondé	X	Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	X
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Herbacée	50%
Sol nu / Litière	0%
Arbustive (< 4 m)	60%
Muscinale	80%
Eau	20%
Arborescente (> 4 m)	0%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**55**	**85.94 %**
Arbustive (< 4 m)	Larix laricina	FACH		2	3.12 %
Arbustive (< 4 m)	Picea mariana	FACH		5	7.81 %

Arbustive (< 4 m)	Vaccinium oxycoccos	OBL	2	3.12 %
Herbacée	Carex magellanica subsp. irrigua	OBL	1	1.96 %
Herbacée	**Maianthemum trifolium**	**OBL**	**50**	**98.04 %**
Muscinale	Mousses		10	12.5 %
Muscinale	**Sphagnum sp.**	**FACH**	**70**	**87.5 %**
Autre espèce observée	Carex sp.	-		

[1] *Statut hydrique : * = Statut émis par WSP*

14-Tourbière ouverte

Fait par Jean-Bastien Lambert le 2017-7-28

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	130 094
Superficie du complexe de milieux humides (m²) :	5 061 595
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100* %

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Indirect
Type du lien :	Cours d'eau permanent
Position dans le réseau hydrique	En bordure d'au moins un milieu humide
Présence de dépression humide:	0-25 %

PERTURBATIONS

Végétation perturbée?	Oui
Sols perturbés ?	Oui
Milieu affecté par un barrage de castor ?	Non

Perturbation Naturelle

Feu	Impact irréversible

REMARQUES

> Troncs et souches

> Présence de chicots

> Remarques générales : Matière organique brulée à plusieurs endroits.

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-34 - Groupement Tourbière ouverte

Faite par Jean-Bastien Lambert le 2017-7-28

Latitude: 52.24356 **Longitude:** -77.05907 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	5
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	40	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):	5	Loam limono-argileux
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

> Troncs et souches

> Présence de chicots

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Muscinale	60%
Eau	0%
Arborescente (> 4 m)	0%
Herbacée	20%
Arbustive (< 4 m)	90%
Sol nu / Litière	30%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**45**	**38.79 %**

Arbustive (< 4 m)	Picea mariana	FACH	7	6.03 %
Arbustive (< 4 m)	Pinus banksiana	NI	2	1.72 %
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**	**45**	**38.79 %**
Arbustive (< 4 m)	Rubus chamaemorus	FACH	2	1.72 %
Arbustive (< 4 m)	Vaccinium myrtilloides	NI	15	12.93 %
Herbacée	**Carex trisperma**	**OBL**	**10**	**52.63 %**
Herbacée	Eriophorum vaginatum subsp. spissum	OBL	3	15.79 %
Herbacée	Kalmia polifolia	OBL	1	5.26 %
Herbacée	**Maianthemum trifolium**	**OBL**	**5**	**26.32 %**
Muscinale	Lichens		8	13.79 %
Muscinale	Mousses		20	34.48 %
Muscinale	**Sphagnum sp.**	**FACH**	**30**	**51.72 %**

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

15-Tourbière ouverte

Fait par Mathieu St-Germain le 2017-7-28

IDENTIFICATION

Type de milieu :	Tourbière
Type de groupement :	Humide
Maturité :	Tourbière
Stade successionnel :	Tourbière
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	99 623
Superficie du complexe de milieux humides (m²) :	5 061 595
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	N/A
Lien hydrologique ? :	Oui
Nature du lien :	Indirect
Type du lien :	Cours d'eau permanent
Position dans le réseau hydrique	En bordure d'au moins un milieu humide
Présence de dépression humide:	76-100 %

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

Perturbation Naturelle

Feu	Impact irréversible

REMARQUES

> Remarques générales : Brûlis récent

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

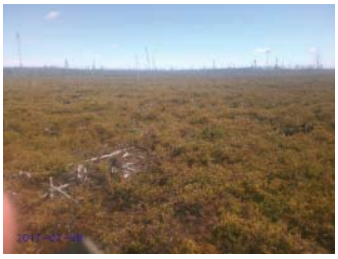
P-58 - Groupement Tourbière ouverte

Faite par Mathieu St-Germain le 2017-7-28

Latitude: 52.24146 **Longitude:** -77.05859 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	4
Nb d'espèces dominantes NI (B) :	1
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Oui
Test d'indicateur hydrologique positif:	Oui



DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	100	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Hydrique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm	X	Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre	X	Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Arbustive (< 4 m)	75%
Arborescente (> 4 m)	0%
Muscinale	20%
Sol nu / Litière	80%
Herbacée	10%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**35**	**35.71 %**
Arbustive (< 4 m)	Pinus banksiana	NI		3	3.06 %
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**		**25**	**25.51 %**
Arbustive (< 4 m)	Rubus chamaemorus	FACH		10	10.2 %
Arbustive (< 4 m)	**Vaccinium myrtilloides**	**NI**		**20**	**20.41 %**

Arbustive (< 4 m)	Vaccinium uliginosum	NI		5	5.1 %
Herbacée	**Carex trisperma**	**OBL**		**5**	**45.45 %**
Herbacée	**Eriophorum angustifolium subsp. angustifolium**	**OBL**		**5**	**45.45 %**
Herbacée	Trichophorum pumilum		susceptible	1	9.09 %
Muscinale	Mousses			20	100 %
Autre espèce observée	Picea mariana	FACH			

[1] *Statut hydrique : * = Statut émis par WSP*

Affleurement rocheux

01-Affleurement rocheux

Fait par Claudie Landry et Mathieu St-Germain le 2017-7-24

IDENTIFICATION

Type de milieu :	Affleurement rocheux
Type de groupement :	Terrestre
Maturité :	Colonisation récente
Stade successionnel :	Herbaçaie/arbustaie/marécage arbustif > De stabilité
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	412 476
Superficie du complexe de milieux humides (m²) :	0
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	Non traversé ou bordé par un cours d'eau
Lien hydrologique ? :	N/A
Nature du lien :	N/A
Type du lien :	N/A
Position dans le réseau hydrique	N/A
Présence de dépression humide:	0-25 %

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Oui
Milieu affecté par un barrage de castor ?	Non

Perturbation Anthropique

Sentier de véhicules motorisés	Menaçant peu
Déchets	Menaçant peu

Perturbation Naturelle

Feu	Impact irréversible

REMARQUES

> Pierres et blocs

> Remarques générales : Présence de tourbe entre les affleurement rocheux.
Perturbation anthropique: forrage

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-67 - Groupement Affleurement rocheux

Faite par Claudie Landry et Mathieu St-Germain le 2017-7-24

Latitude: 52.23837 **Longitude:** -77.08155 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	2
Nb d'espèces dominantes NI (B) :	2
Végétation dominée par des hydrophytes (A>B):	Non
Végétation typique des milieux humides:	Non
Présence de sols hydromorphes:	Non
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non évaluée			
Pente:	31-40% (forte)	Horizon supérieur (cm)		Non observée
Situation topographique:	Sommet	Horizon inférieur (cm):		Non observée
Drainage:	Xérique	Roc (si observé):	1	

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Arbustive (< 4 m)	45%
Arborescente (> 4 m)	0%
Sol nu / Litière	55%
Herbacée	20%
Muscinale	40%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	Chamaedaphne calyculata	OBL		5	7.81 %
Arbustive (< 4 m)	**Kalmia angustifolia**	**NI**		**15**	**23.44 %**
Arbustive (< 4 m)	Populus tremuloides	NI		2	3.12 %
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**		**30**	**46.88 %**
Arbustive (< 4 m)	Rubus chamaemorus	FACH		7	10.94 %
Arbustive (< 4 m)	Vaccinium myrtilloides	NI		5	7.81 %

Herbacée	Aralia hispida	NI	2	8.33 %
Herbacée	**Chamaenerion angustifolium subsp. angustifolium**	**NI**	**7**	**29.17 %**
Herbacée	**Equisetum sylvaticum**	**FACH**	**15**	**62.5 %**
Autre espèce observée	Carex canescens	OBL		
Autre espèce observée	Pinus banksiana	NI		
Autre espèce observée	Vaccinium caespitosum	NI		

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

02-Affleurement rocheux

Fait par Claudie Landry le 2017-7-28

IDENTIFICATION

Type de milieu :	Affleurement rocheux
Type de groupement :	Terrestre
Maturité :	Colonisation récente
Stade successionnel :	Herbaçaie/arbustaie/marécage arbustif > De transition
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	123 069
Superficie du complexe de milieux humides (m²) :	0
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	Non traversé ou bordé par un cours d'eau
Lien hydrologique ? :	N/A
Nature du lien :	N/A
Type du lien :	N/A
Position dans le réseau hydrique	N/A
Présence de dépression humide:	0%

PERTURBATIONS

Végétation perturbée?	Oui
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

Perturbation Naturelle

Feu	Impact irréversible

REMARQUES

> Troncs et souches

> Présence de chicots

> Remarques générales : Brûlis récent.

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-65 - Groupement Affleurement rocheux

Faite par Claudie Landry le 2017-7-28

Latitude: 52.23786 **Longitude:** -77.06291 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	0
Nb d'espèces dominantes NI (B) :	3
Végétation dominée par des hydrophytes (A>B):	Non
Végétation typique des milieux humides:	Non
Présence de sols hydromorphes:	Non
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	16-30% (modéré)	Horizon supérieur (cm)		Non observée
Situation topographique:	Buton	Horizon inférieur (cm):		Non observée
Drainage:	Xérique	Roc (si observé):	0	

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Herbacée	1%
Eau	0%
Muscinale	30%
Arborescente (> 4 m)	0%
Sol nu / Litière	50%
Arbustive (< 4 m)	35%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Kalmia angustifolia**	**NI**		**10**	**23.81 %**
Arbustive (< 4 m)	**Pinus banksiana**	**NI**		**10**	**23.81 %**
Arbustive (< 4 m)	Populus tremuloides	NI		5	11.9 %
Arbustive (< 4 m)	Salix sp.	-		7	16.67 %
Arbustive (< 4 m)	**Vaccinium uliginosum**	**NI**		**10**	**23.81 %**

Herbacée	Chamaenerion angustifolium subsp. angustifolium	NI	1	100 %

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

Arbustaie

01-Arbustaie

Fait par Mathieu St-Germain le 2017-7-28

IDENTIFICATION

Type de milieu :	Arbustaie
Type de groupement :	Terrestre
Maturité :	Colonisation récente
Stade successionnel :	Herbaçaie/arbustaie/marécage arbustif > De transition
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	266 969
Superficie du complexe de milieux humides (m²) :	0
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	Non traversé ou bordé par un cours d'eau
Lien hydrologique ? :	N/A
Nature du lien :	N/A
Type du lien :	N/A
Position dans le réseau hydrique	N/A
Présence de dépression humide:	0%

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

Perturbation Naturelle

Feu	Impact irréversible

REMARQUES

> Remarques générales : Brûlis récent. Brûlé deux fois

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-59 - Groupement Arbustaie

Faite par Mathieu St-Germain le 2017-7-28

Latitude: 52.23945 **Longitude:** -77.05803 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	1
Nb d'espèces dominantes NI (B) :	3
Végétation dominée par des hydrophytes (A>B):	Non
Végétation typique des milieux humides:	Non
Présence de sols hydromorphes:	Non
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	40	Sable
Situation topographique:	Terrain plat	Horizon inférieur (cm):		Non observée
Drainage:	Mésique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Arbustive (< 4 m)	40%
Muscinale	20%
Arborescente (> 4 m)	0%
Herbacée	20%
Sol nu / Litière	60%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Kalmia angustifolia**	**NI**		**15**	**26.79 %**
Arbustive (< 4 m)	Pinus banksiana	NI		10	17.86 %
Arbustive (< 4 m)	Populus tremuloides	NI		1	1.79 %
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**		**15**	**26.79 %**
Arbustive (< 4 m)	**Vaccinium myrtilloides**	**NI**		**15**	**26.79 %**
Herbacée	Anaphalis margaritacea	NI		1	3.12 %
Herbacée	Carex deflexa var. deflexa			10	31.25 %

Herbacée	Carex foenea		10	31.25 %
Herbacée	**Chamaenerion angustifolium subsp. angustifolium**	**NI**	**10**	**31.25 %**
Herbacée	Cornus canadensis	NI	1	3.12 %
Muscinale	Mousses		20	100 %
Autre espèce observée	Rubus idaeus	NI		

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

02-Arbustaie

Fait par Claudie Landry le 2017-7-25

IDENTIFICATION

Type de milieu :	Arbustaie
Type de groupement :	Terrestre
Maturité :	Jeune
Stade successionnel :	Herbaçaie/arbustaie/marécage arbustif > De transition
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	97 364
Superficie du complexe de milieux humides (m²) :	0
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	Non traversé ou bordé par un cours d'eau
Lien hydrologique ? :	N/A
Nature du lien :	N/A
Type du lien :	N/A
Position dans le réseau hydrique	N/A
Présence de dépression humide:	26-50 %

PERTURBATIONS

Végétation perturbée?	Oui
Sols perturbés ?	Oui
Milieu affecté par un barrage de castor ?	Non

Perturbation Anthropique

Coupe partielle	Menaçant beaucoup
Sentier de véhicules motorisés	Menaçant peu

Perturbation Naturelle

Feu	Impact irréversible

REMARQUES

> Troncs et souches

> Pierres et blocs

> Présence de chicots

> Remarques générales : Ancien brûlis.

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-50 - Groupement Arbustaie

Faite par Claudie Landry le 2017-7-25

Latitude: 52.23938 **Longitude:** -77.08935 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	2
Nb d'espèces dominantes NI (B) :	3
Végétation dominée par des hydrophytes (A>B):	Non
Végétation typique des milieux humides:	Non
Présence de sols hydromorphes:	Non
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	4-8% (faible)	Horizon supérieur (cm)	10	Matière organique décomposée
Situation topographique:	Buton	Horizon inférieur (cm):	10	Sable
Drainage:	Mésique	Roc (si observé):	20	

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Muscinale	25%
Herbacée	15%
Sol nu / Litière	35%
Arborescente (> 4 m)	0%
Arbustive (< 4 m)	80%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [7]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Kalmia angustifolia**	**NI**		**30**	**33.33 %**
Arbustive (< 4 m)	Pinus banksiana	NI		15	16.67 %
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**		**30**	**33.33 %**
Arbustive (< 4 m)	Vaccinium myrtilloides	NI		15	16.67 %
Herbacée	**Chamaenerion angustifolium subsp. angustifolium**	**NI**		**5**	**33.33 %**
Herbacée	**Lycopodium annotinum**	**NI**		**10**	**66.67 %**

Muscinale	Lichens		10	40 %
Muscinale	**Sphagnum sp.**	**FACH**	**15**	**60 %**

[1] *Statut hydrique : * = Statut émis par WSP*

Parcelles de validation

P-50-V1 (PE3.0004)

Faite par Claudie Landry le 2017-7-2

Latitude: 52.24117

Longitude: -77.08225

Type de parcelle: Parcelle de validation

Parcelle associée: P-50

InSitu - Rapport descriptif

03-Arbustaie

Fait par Claudie Landry le 2017-7-28

IDENTIFICATION

Type de milieu :	Arbustaie
Type de groupement :	Terrestre
Maturité :	Colonisation récente
Stade successionnel :	Herbaçaie/arbustaie/marécage arbustif > De transition
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	203 827
Superficie du complexe de milieux humides (m²) :	0
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	Traversé ou bordé par un cours d'eau
Lien hydrologique ? :	N/A
Nature du lien :	N/A
Type du lien :	N/A
Position dans le réseau hydrique	N/A
Présence de dépression humide:	0%

PERTURBATIONS

Végétation perturbée?	Oui
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

Perturbation Naturelle

Feu	Impact irréversible

REMARQUES

> Troncs et souches

> Pierres et blocs

> Présence de chicots

> Remarques générales : Brûlis récent.
Ancien brûlis qui a brûler une deuxième fois.

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-56 - Groupement Arbustaie

Faite par Claudie Landry le 2017-7-28

Latitude: 52.24073 **Longitude:** -77.06462 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	2
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Non
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	4-8% (faible)	Horizon supérieur (cm)	10	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):	20	Sable
Drainage:	Mésique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Herbacée	0%
Muscinale	15%
Eau	0%
Sol nu / Litière	30%
Arbustive (< 4 m)	75%
Arborescente (> 4 m)	0%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**40**	**47.06 %**
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**		**30**	**35.29 %**
Arbustive (< 4 m)	Vaccinium uliginosum	NI		15	17.65 %
Muscinale	Lichens			5	33.33 %
Muscinale	Mousses			10	66.67 %

Autre espèce observée	Betula glandulosa	FACH
Autre espèce observée	Chamaenerion angustifolium subsp. angustifolium	NI
Autre espèce observée	Pinus banksiana	NI
Autre espèce observée	Populus tremuloides	NI
Autre espèce observée	Salix sp.	-
Autre espèce observée	Sibbaldia tridentata	

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

04-Arbustaie

Fait par Jean-Bastien Lambert et Mathieu St-Germain le 2017-7-28

IDENTIFICATION

Type de milieu :	Arbustaie
Type de groupement :	Terrestre
Maturité :	Colonisation récente
Stade successionnel :	Herbaçaie/arbustaie/marécage arbustif > De transition
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	372 046
Superficie du complexe de milieux humides (m²) :	0
Proportion de milieu naturel dans une bande-tampon de 100 m:	*60-80* %

HYDROLOGIE

Bande riveraine d'un plan d'eau :	Non traversé ou bordé par un cours d'eau
Lien hydrologique ? :	N/A
Nature du lien :	N/A
Type du lien :	N/A
Position dans le réseau hydrique	N/A
Présence de dépression humide:	0%

PERTURBATIONS

Végétation perturbée?	Oui
Sols perturbés ?	Oui
Milieu affecté par un barrage de castor ?	Non

Perturbation Anthropique

Déchets	Menaçant pas
Sentier de véhicules motorisés	Menaçant pas

Perturbation Naturelle

Feu	Impact irréversible

REMARQUES

> Troncs et souches

> Pierres et blocs

> Présence de chicots

> Remarques générales : Ancienne pinède grise complètement brulée. Affleurement rocheux vers l'est.

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-61 - Groupement Arbustaie

Faite par Jean-Bastien Lambert le 2017-7-28

Latitude: 52.23433 **Longitude:** -77.05842 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	0
Nb d'espèces dominantes NI (B) :	2
Végétation dominée par des hydrophytes (A>B):	Non
Végétation typique des milieux humides:	Non
Présence de sols hydromorphes:	Non
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	9-15% (douce)	Horizon supérieur (cm)	20	Sable
Situation topographique:	Haut de pente	Horizon inférieur (cm):		Non évaluée
Drainage:	Xérique	Roc (si observé):	21	

REMARQUES

> Troncs et souches

> Pierres et blocs

> Présence de chicots

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Eau	0%
Muscinale	20%
Arborescente (> 4 m)	0%
Arbustive (< 4 m)	40%
Sol nu / Litière	50%
Herbacée	15%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [7]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	Kalmia angustifolia	NI		5	10.2 %
Arbustive (< 4 m)	Pinus banksiana	NI		3	6.12 %

Arbustive (< 4 m)	Prunus pensylvanica	NI	1	2.04 %
Arbustive (< 4 m)	Salix humilis var. humilis		25	51.02 %
Arbustive (< 4 m)	**Vaccinium myrtilloides**	**NI**	**15**	**30.61 %**
Herbacée	Anaphalis margaritacea	NI	1	16.67 %
Herbacée	Chamerion latifolium		2	33.33 %
Herbacée	**Cornus canadensis**	**NI**	**2**	**33.33 %**
Herbacée	Maianthemum canadense subsp. canadense	NI	1	16.67 %
Autre espèce observée	Piptatherum pungens			

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

P-63 - Groupement Arbustaie

Faite par Mathieu St-Germain le 2017-7-28

Latitude: 52.23049 **Longitude:** -77.05900 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	0
Nb d'espèces dominantes NI (B) :	3
Végétation dominée par des hydrophytes (A>B):	Non
Végétation typique des milieux humides:	Non
Présence de sols hydromorphes:	Non
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	0-3% (nulle)	Horizon supérieur (cm)	1	Matière organique décomposée
Situation topographique:	Terrain plat	Horizon inférieur (cm):	30	Sable
Drainage:	Mésique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Arbustive (< 4 m)	20%
Muscinale	25%
Sol nu / Litière	75%
Herbacée	2%
Arborescente (> 4 m)	0%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Kalmia angustifolia**	**NI**		**10**	**33.33 %**
Arbustive (< 4 m)	**Pinus banksiana**	**NI**		**8**	**26.67 %**
Arbustive (< 4 m)	Populus tremuloides	NI		2	6.67 %
Arbustive (< 4 m)	**Vaccinium myrtilloides**	**NI**		**10**	**33.33 %**
Herbacée	Chamaenerion angustifolium subsp. angustifolium	NI		2	100 %
Muscinale	Mousses			25	100 %

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

05-Arbustaie

Fait par Mathieu St-Germain le 2017-7-27

IDENTIFICATION

Type de milieu :	Arbustaie
Type de groupement :	Terrestre
Maturité :	Colonisation récente
Stade successionnel :	Herbaçaie/arbustaie/marécage arbustif > De transition
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	63 040
Superficie du complexe de milieux humides (m²) :	0
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	Non traversé ou bordé par un cours d'eau
Lien hydrologique ? :	N/A
Nature du lien :	N/A
Type du lien :	N/A
Position dans le réseau hydrique	N/A
Présence de dépression humide:	0%

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

Perturbation Naturelle

Feu	Impact irréversible

REMARQUES

> Remarques générales : Ancien brûlis a brûlé une 2e fois car aucun arbre brûlé debout.

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-45 - Groupement Arbustaie

Faite par Mathieu St-Germain le 2017-7-27

Latitude: **Longitude:**

Type de parcelle: Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	0
Nb d'espèces dominantes NI (B) :	2
Végétation dominée par des hydrophytes (A>B):	Non
Végétation typique des milieux humides:	Non
Présence de sols hydromorphes:	Non
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	4-8% (faible)	Horizon supérieur (cm)	5	Sable
Situation topographique:	Buton	Horizon inférieur (cm):		Non observée
Drainage:	Xérique	Roc (si observé):	5	

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Sol nu / Litière	50%
Herbacée	0%
Muscinale	30%
Arborescente (> 4 m)	0%
Arbustive (< 4 m)	50%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	Betula glandulosa	FACH		1	1.1 %
Arbustive (< 4 m)	**Kalmia angustifolia**	**NI**		**30**	**32.97 %**
Arbustive (< 4 m)	Picea mariana	FACH		10	10.99 %
Arbustive (< 4 m)	Pinus banksiana	NI		8	8.79 %
Arbustive (< 4 m)	Populus tremuloides	NI		2	2.2 %
Arbustive (< 4 m)	Rhododendron groenlandicum	OBL		10	10.99 %
Arbustive (< 4 m)	Salix sp.	-		5	5.49 %

Arbustive (< 4 m)	**Vaccinium myrtilloides**	**NI**	**20**	**21.98 %**
Arbustive (< 4 m)	Vaccinium uliginosum	NI	5	5.49 %
Muscinale	Mousses		30	100 %

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

06-Arbustaie

Fait par Mathieu St-Germain le 2017-7-28

IDENTIFICATION

Type de milieu :	Arbustaie
Type de groupement :	Terrestre
Maturité :	Colonisation récente
Stade successionnel :	Herbaçaie/arbustaie/marécage arbustif > De transition
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	72 537
Superficie du complexe de milieux humides (m²) :	0
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	Non traversé ou bordé par un cours d'eau
Lien hydrologique ? :	N/A
Nature du lien :	N/A
Type du lien :	N/A
Position dans le réseau hydrique	N/A
Présence de dépression humide:	0%

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

Perturbation Naturelle

Feu	Impact irréversible

REMARQUES

> Remarques générales : Brûlis récent
Cap rocheux dans polygone

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-74 - Groupement Arbustaie

Faite par Mathieu St-Germain le 2017-7-28

Latitude: 52.22838 **Longitude:** -77.07769 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	0
Nb d'espèces dominantes NI (B) :	1
Végétation dominée par des hydrophytes (A>B):	Non
Végétation typique des milieux humides:	Non
Présence de sols hydromorphes:	Non
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	9-15% (douce)	Horizon supérieur (cm)	3	Sable
Situation topographique:	mi-pente	Horizon inférieur (cm):		Non observée
Drainage:	Xérique	Roc (si observé):	3	

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Muscinale	70%
Arborescente (> 4 m)	0%
Sol nu / Litière	30%
Herbacée	7%
Arbustive (< 4 m)	50%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	Pinus banksiana	NI		5	7.14 %
Arbustive (< 4 m)	Populus tremuloides	NI		10	14.29 %
Arbustive (< 4 m)	Rhododendron groenlandicum	OBL		5	7.14 %
Arbustive (< 4 m)	Salix sp.	-		10	14.29 %
Arbustive (< 4 m)	**Vaccinium myrtilloides**	**NI**		**40**	**57.14 %**
Herbacée	Chamaenerion angustifolium subsp. angustifolium	NI		7	100 %

Muscinale	Mousses	70	100 %

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

07-Arbustaie

Fait par Mathieu St-Germain le 2017-7-27

IDENTIFICATION

Type de milieu :	Arbustaie
Type de groupement :	Terrestre
Maturité :	Colonisation récente
Stade successionnel :	Herbaçaie/arbustaie/marécage arbustif > De transition
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	178 312
Superficie du complexe de milieux humides (m²) :	0
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	Non traversé ou bordé par un cours d'eau
Lien hydrologique ? :	N/A
Nature du lien :	N/A
Type du lien :	N/A
Position dans le réseau hydrique	N/A
Présence de dépression humide:	0%

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

Perturbation Naturelle

Feu	Impact irréversible

REMARQUES

> Remarques générales : Brûlis récent.

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-44 - Groupement Arbustaie

Faite par Mathieu St-Germain le 2017-7-27

Latitude: **Longitude:**

Type de parcelle: Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	0
Nb d'espèces dominantes NI (B) :	2
Végétation dominée par des hydrophytes (A>B):	Non
Végétation typique des milieux humides:	Non
Présence de sols hydromorphes:	Non
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	4-8% (faible)	Horizon supérieur (cm)	5	Matière organique décomposée
Situation topographique:	Buton	Horizon inférieur (cm):	25	Sable
Drainage:	Mésique	Roc (si observé):	30	

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Arbustive (< 4 m)	70%
Muscinale	5%
Herbacée	0%
Sol nu / Litière	80%
Arborescente (> 4 m)	0%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [7]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Kalmia angustifolia**	**NI**		**50**	**54.95 %**
Arbustive (< 4 m)	Rhododendron groenlandicum	OBL		10	10.99 %
Arbustive (< 4 m)	Salix sp.	-		1	1.1 %
Arbustive (< 4 m)	**Vaccinium myrtilloides**	**NI**		**30**	**32.97 %**
Muscinale	Lichens			5	100 %

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

08-Arbustaie

Fait par Claudie Landry le 2017-7-26

IDENTIFICATION

Type de milieu :	Arbustaie
Type de groupement :	Terrestre
Maturité :	Colonisation récente
Stade successionnel :	Herbaçaie/arbustaie/marécage arbustif > De transition
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	558 460
Superficie du complexe de milieux humides (m²) :	0
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	Non traversé ou bordé par un cours d'eau
Lien hydrologique ? :	N/A
Nature du lien :	N/A
Type du lien :	N/A
Position dans le réseau hydrique	N/A
Présence de dépression humide:	0-25 %

PERTURBATIONS

Végétation perturbée?	Oui
Sols perturbés ?	Oui
Milieu affecté par un barrage de castor ?	Non

Perturbation Anthropique

Déchets	Menaçant peu
Sentier de véhicules motorisés	Menaçant peu

Perturbation Naturelle

Feu	Impact irréversible

REMARQUES

> Troncs et souches

> Pierres et blocs

> Présence de chicots

> Remarques générales : Brûlis récent.

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-82 - Groupement Arbustaie

Faite par Claudie Landry le 2018-6-11

Latitude: **Longitude:** **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	0
Nb d'espèces dominantes NI (B) :	4
Végétation dominée par des hydrophytes (A>B):	Non
Végétation typique des milieux humides:	Non
Présence de sols hydromorphes:	Non
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	4-8% (faible)	Horizon supérieur (cm)	1	Matière organique décomposée
Situation topographique:	mi-pente	Horizon inférieur (cm):	29	Sable
Drainage:	Mésique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Arborescente (> 4 m)	0%
Arbustive (< 4 m)	45%
Eau	0%
Herbacée	10%
Muscinale	25%
Sol nu / Litière	60%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arbustive (< 4 m)	**Alnus alnobetula subsp. crispa**	**NI**		**10**	**22.22 %**
Arbustive (< 4 m)	**Kalmia angustifolia**	**NI**		**10**	**22.22 %**
Arbustive (< 4 m)	Pinus banksiana	NI		7	15.56 %
Arbustive (< 4 m)	Populus tremuloides	NI		3	6.67 %
Arbustive (< 4 m)	Rhododendron groenlandicum	OBL		5	11.11 %

Arbustive (< 4 m)	**Vaccinium myrtilloides**	**NI**	**10**	**22.22 %**
Herbacée	Anaphalis margaritacea	NI	2	18.18 %
Herbacée	**Chamaenerion angustifolium subsp. angustifolium**	**NI**	**7**	**63.64 %**
Herbacée	Cornus canadensis	NI	2	18.18 %
Muscinale	Mousses		25	100 %
Autre espèce observée	Betula glandulosa	FACH		
Autre espèce observée	Maianthemum canadense subsp. canadense	NI		
Autre espèce observée	Salix sp.	-		

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

Aulnaie crispé

01-Aulnaie crispé

Fait par Jean-Bastien Lambert le 2017-7-28

IDENTIFICATION

Type de milieu :	Arbustaie
Type de groupement :	Terrestre
Maturité :	Jeune
Stade successionnel :	Herbaçaie/arbustaie/marécage arbustif > De transition
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	16 271
Superficie du complexe de milieux humides (m²) :	0
Proportion de milieu naturel dans une bande-tampon de 100 m:	*60-80* %

HYDROLOGIE

Bande riveraine d'un plan d'eau :	Non traversé ou bordé par un cours d'eau
Lien hydrologique ? :	N/A
Nature du lien :	N/A
Type du lien :	N/A
Position dans le réseau hydrique	N/A
Présence de dépression humide:	0%

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Oui
Milieu affecté par un barrage de castor ?	Non

Perturbation Anthropique

Autre - Anthropique	Menaçant peu
Sentier de véhicules motorisés	Menaçant peu

REMARQUES

> Remarques générales : Sol creusé à divers endroits pour raison inconnue.

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-62 - Groupement Aulnaie crispé

Faite par Jean-Bastien Lambert le 2017-7-28

Latitude: 52.23249 **Longitude:** -77.05907 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	0
Nb d'espèces dominantes NI (B) :	1
Végétation dominée par des hydrophytes (A>B):	Non
Végétation typique des milieux humides:	Non
Présence de sols hydromorphes:	Non
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	9-15% (douce)	Horizon supérieur (cm)	25	Sable
Situation topographique:	mi-pente	Horizon inférieur (cm):	5	Sable
Drainage:	Xérique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Arborescente (> 4 m)	5%
Arbustive (< 4 m)	100%
Herbacée	0%
Sol nu / Litière	90%
Eau	0%
Muscinale	5%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	Picea mariana	FACH		5	100 %
Arbustive (< 4 m)	**Alnus alnobetula subsp. crispa**	**NI**		**100**	**91.74 %**
Arbustive (< 4 m)	Picea mariana	FACH		5	4.59 %
Arbustive (< 4 m)	Rhododendron groenlandicum	OBL		1	0.92 %
Arbustive (< 4 m)	Vaccinium myrtilloides	NI		3	2.75 %
Muscinale	Mousses			5	100 %

Autre espèce observée	Empetrum nigrum subsp. nigrum	NI
Autre espèce observée	Larix laricina	FACH
Autre espèce observée	Pinus banksiana	NI
Autre espèce observée	Populus tremuloides	NI

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

02-Aulnaie crispé

Fait par Jean-Bastien Lambert le 2017-7-28

IDENTIFICATION

Type de milieu :	Arbustaie
Type de groupement :	Terrestre
Maturité :	Jeune
Stade successionnel :	Herbaçaie/arbustaie/marécage arbustif > De transition
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	29 488
Superficie du complexe de milieux humides (m²) :	0
Proportion de milieu naturel dans une bande-tampon de 100 m:	*80-90 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	Non traversé ou bordé par un cours d'eau
Lien hydrologique ? :	N/A
Nature du lien :	N/A
Type du lien :	N/A
Position dans le réseau hydrique	N/A
Présence de dépression humide:	0-25 %

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

Perturbation Anthropique

Sentier de véhicules motorisés	Menaçant pas

REMARQUES

Aucune remarque

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-33 - Groupement Aulnaie crispé

Faite par Jean-Bastien Lambert le 2017-7-28

Latitude: 52.24563 **Longitude:** -77.06159

Type de parcelle: Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	0
Nb d'espèces dominantes NI (B) :	1
Végétation dominée par des hydrophytes (A>B):	Non
Végétation typique des milieux humides:	Non
Présence de sols hydromorphes:	Non
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	9-15% (douce)	Horizon supérieur (cm)	25	Sable
Situation topographique:	mi-pente	Horizon inférieur (cm):	5	Sable
Drainage:	Xérique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Arbustive (< 4 m)	100%
Herbacée	0%
Muscinale	5%
Eau	0%
Arborescente (> 4 m)	5%
Sol nu / Litière	90%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	Picea mariana	FACH		5	100 %
Arbustive (< 4 m)	**Alnus alnobetula subsp. crispa**	**NI**		**100**	**91.74 %**
Arbustive (< 4 m)	Picea mariana	FACH		5	4.59 %
Arbustive (< 4 m)	Rhododendron groenlandicum	OBL		1	0.92 %
Arbustive (< 4 m)	Vaccinium myrtilloides	NI		3	2.75 %
Muscinale	Mousses			5	100 %

Autre espèce observée	Empetrum nigrum subsp. nigrum	NI
Autre espèce observée	Larix laricina	FACH
Autre espèce observée	Pinus banksiana	NI
Autre espèce observée	Populus tremuloides	NI

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

Dénudé sec

01-Dénudé sec

Fait par Claudie Landry le 2017-7-25

IDENTIFICATION

Type de milieu :	Affleurement rocheux
Type de groupement :	Terrestre
Maturité :	Colonisation récente
Stade successionnel :	Herbaçaie/arbustaie/marécage arbustif > De transition
Rareté au niveau régional	Occasionnel

DESCRIPTION POLYGONE

Superficie (m²) :	179 271
Superficie du complexe de milieux humides (m²) :	0
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	Non traversé ou bordé par un cours d'eau
Lien hydrologique ? :	N/A
Nature du lien :	N/A
Type du lien :	N/A
Position dans le réseau hydrique	N/A
Présence de dépression humide:	0%

PERTURBATIONS

Végétation perturbée?	Oui
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

Perturbation Naturelle

Feu	Impact irréversible

REMARQUES

> Retouche carto nécessaire

> Remarques générales : Brûlis récent.
Ancienne Pinède grise.
Le sol est maintenant dénudé et beaucoup d'affleurements rocheux sont présents.

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-55 - Groupement Dénudé sec

Faite par Claudie Landry le 2017-7-25

Latitude: | **Longitude:** | **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	0
Nb d'espèces dominantes NI (B) :	1
Végétation dominée par des hydrophytes (A>B):	Non
Végétation typique des milieux humides:	Non
Présence de sols hydromorphes:	Non
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	9-15% (douce)	Horizon supérieur (cm)	5	Sable
Situation topographique:	Buton	Horizon inférieur (cm):		Non observée
Drainage:	Xérique	Roc (si observé):	10	

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Arborescente (> 4 m)	5%
Herbacée	0%
Muscinale	0%
Eau	0%
Sol nu / Litière	90%
Arbustive (< 4 m)	30%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	Larix laricina	FACH		5	100 %
Arbustive (< 4 m)	Kalmia angustifolia	NI		5	16.67 %
Arbustive (< 4 m)	**Pinus banksiana**	**NI**		**10**	**33.33 %**
Arbustive (< 4 m)	Salix sp.	-		15	50 %
Autre espèce observée	Vaccinium myrtilloides	NI			

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

Pessière noire à lichen

01-Pessière noire à lichen

Fait par Claudie Landry le 2017-7-27

IDENTIFICATION

Type de milieu :	Boisé
Type de groupement :	Terrestre
Maturité :	Intermédiaire
Stade successionnel :	Boisé/Marécage arborescent > Fin de succession
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	18 248
Superficie du complexe de milieux humides (m²) :	0
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	Non traversé ou bordé par un cours d'eau
Lien hydrologique ? :	N/A
Nature du lien :	N/A
Type du lien :	N/A
Position dans le réseau hydrique	N/A
Présence de dépression humide:	0-25 %

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

REMARQUES

> Pierres et blocs

> Remarques générales : Présence d'ours dans le secteur. Observation de tannière potentiel et de carcasse.

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-14 - Groupement Pessière noire à lichen

Faite par Claudie Landry le 2017-7-27

Latitude: **Longitude:** **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	3
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Non
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	4-8% (faible)	Horizon supérieur (cm)	5	Matière organique décomposée
Situation topographique:	Buton	Horizon inférieur (cm):	5	Sable
Drainage:	Mésique	Roc (si observé):	10	

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Eau	0%
Herbacée	0%
Arbustive (< 4 m)	60%
Arborescente (> 4 m)	35%
Sol nu / Litière	10%
Muscinale	80%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	**Picea mariana**	**FACH**		**35**	**100 %**
Arbustive (< 4 m)	Chamaedaphne calyculata	OBL		10	13.89 %
Arbustive (< 4 m)	**Picea mariana**	**FACH**		**30**	**41.67 %**
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**		**30**	**41.67 %**

Arbustive (< 4 m)	Vaccinium myrtilloides	NI	2	2.78 %
Muscinale	Lichens		75	83.33 %
Muscinale	Sphagnum sp.	FACH	15	16.67 %
Autre espèce observée	Rubus chamaemorus	FACH		

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

02-Pessière noire à lichen

Fait par Claudie Landry le 2017-7-27

IDENTIFICATION

Type de milieu :	Boisé
Type de groupement :	Terrestre
Maturité :	Intermédiaire
Stade successionnel :	Boisé/Marécage arborescent > Fin de succession
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	3 706
Superficie du complexe de milieux humides (m²) :	0
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	Non traversé ou bordé par un cours d'eau
Lien hydrologique ? :	N/A
Nature du lien :	N/A
Type du lien :	N/A
Position dans le réseau hydrique	N/A
Présence de dépression humide:	0%

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

REMARQUES

> Remarques générales : Présence accrue de grande faune (ours)

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-15 - Groupement Pessière noire à lichen

Faite par Claudie Landry le 2017-7-27

Latitude: **Longitude:**

Type de parcelle: Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	4
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Non
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	4-8% (faible)	Horizon supérieur (cm)	10	Matière organique décomposée
Situation topographique:	Buton	Horizon inférieur (cm):	3	Sable
Drainage:	Mésique	Roc (si observé):	13	

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Arbustive (< 4 m)	80%
Arborescente (> 4 m)	35%
Muscinale	90%
Eau	0%
Sol nu / Litière	0%
Herbacée	0%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	**Picea mariana**	**FACH**		**35**	**100 %**
Arbustive (< 4 m)	**Chamaedaphne calyculata**	**OBL**		**30**	**26.79 %**
Arbustive (< 4 m)	**Picea mariana**	**FACH**		**40**	**35.71 %**
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**		**40**	**35.71 %**

Arbustive (< 4 m)	Vaccinium myrtilloides	NI	2	1.79 %
Muscinale	Lichens		75	83.33 %
Muscinale	Sphagnum sp.	FACH	15	16.67 %
Autre espèce observée	Rubus chamaemorus	FACH		

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

03-Pessière noire à lichen

Fait par Jean-Bastien Lambert le 2017-7-25

IDENTIFICATION

Type de milieu :	Boisé
Type de groupement :	Terrestre
Maturité :	Mature
Stade successionnel :	Boisé/Marécage arborescent > Milieu de succession
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	149 033
Superficie du complexe de milieux humides (m²) :	0
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100* %

HYDROLOGIE

Bande riveraine d'un plan d'eau :	Non traversé ou bordé par un cours d'eau
Lien hydrologique ? :	N/A
Nature du lien :	N/A
Type du lien :	N/A
Position dans le réseau hydrique	N/A
Présence de dépression humide:	0%

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

REMARQUES

> Pierres et blocs

> Présence de chicots

> Remarques générales : Non affecté par feu

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-37 - Groupement Pessière noire à lichen

Faite par Jean-Bastien Lambert le 2017-7-25

Latitude: 52.24614 **Longitude:** -77.08593 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	2
Nb d'espèces dominantes NI (B) :	1
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Non
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	4-8% (faible)	Horizon supérieur (cm)	10	Matière organique décomposée
Situation topographique:	mi-pente	Horizon inférieur (cm):	10	Loam sableux
Drainage:	Mésique	Roc (si observé):		

REMARQUES

> Pierres et blocs

> Présence de chicots

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Eau	0%
Muscinale	80%
Herbacée	0%
Arborescente (> 4 m)	55%
Arbustive (< 4 m)	60%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	**Picea mariana**	**FACH**		**60**	**100 %**
Arbustive (< 4 m)	Empetrum nigrum subsp. nigrum	NI		1	1.39 %
Arbustive (< 4 m)	Gaultheria hispidula	NI		1	1.39 %

Arbustive (< 4 m)	Kalmia latifolia		15	20.83 %
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**	**35**	**48.61 %**
Arbustive (< 4 m)	**Vaccinium myrtilloides**	**NI**	**20**	**27.78 %**

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

04-Pessière noire à lichen

Fait par Claudie Landry le 2017-7-17

IDENTIFICATION

Type de milieu :	Boisé
Type de groupement :	Terrestre
Maturité :	Intermédiaire
Stade successionnel :	Boisé/Marécage arborescent > Fin de succession
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	79 659
Superficie du complexe de milieux humides (m²) :	0
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	Non traversé ou bordé par un cours d'eau
Lien hydrologique ? :	N/A
Nature du lien :	N/A
Type du lien :	N/A
Position dans le réseau hydrique	N/A
Présence de dépression humide:	0%

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

REMARQUES

> Remarques générales : Présence accrue de grande faune (ours)

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-23 - Groupement Pessière noire à lichen

Faite par Claudie Landry le 2017-7-27

Latitude: **Longitude:**

Type de parcelle: Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	3
Nb d'espèces dominantes NI (B) :	1
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Non
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	9-15% (douce)	Horizon supérieur (cm)	6	Matière organique décomposée
Situation topographique:	Buton	Horizon inférieur (cm):	8	Sable
Drainage:	Xérique	Roc (si observé):	14	

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Arborescente (> 4 m)	45%
Arbustive (< 4 m)	75%
Muscinale	100%
Herbacée	0%
Sol nu / Litière	0%
Eau	0%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	**Picea mariana**	**FACH**		**45**	**100 %**
Arbustive (< 4 m)	Kalmia angustifolia	NI		10	10 %
Arbustive (< 4 m)	**Picea mariana**	**FACH**		**30**	**30 %**
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**		**40**	**40 %**

Arbustive (< 4 m)	**Vaccinium myrtilloides**	**NI**	**20**	**20 %**
Muscinale	Lichens		90	90 %
Muscinale	Mousses		10	10 %
Autre espèce observée	Empetrum nigrum subsp. nigrum	NI		

[1] *Statut hydrique : * = Statut émis par WSP*

Parcelles de validation

P-23-V1 (PE1.0023)

Faite par Claudie Landry le 2017-7-

Latitude:

Longitude:

Type de parcelle: Parcelle de validation

Parcelle associée: P-23

InSitu - Rapport descriptif

05-Pessière noire à lichen

Fait par Claudie Landry le 2017-7-29

IDENTIFICATION

Type de milieu :	Boisé
Type de groupement :	Terrestre
Maturité :	Intermédiaire
Stade successionnel :	Boisé/Marécage arborescent > Fin de succession
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	114 255
Superficie du complexe de milieux humides (m²) :	0
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	Traversé ou bordé par un cours d'eau
Lien hydrologique ? :	N/A
Nature du lien :	N/A
Type du lien :	N/A
Position dans le réseau hydrique	N/A
Présence de dépression humide:	0%

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Oui
Milieu affecté par un barrage de castor ?	Non

Perturbation Anthropique

Coupe partielle	Menaçant peu

REMARQUES

> Troncs et souches

> Présence de chicots

> Remarques générales : Le groupement est taversé par une coupe pour l'emprise d'hydro.

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

PARCELLES

P-03 - Groupement Pessière noire à lichen

Faite par Claudie Landry et Mathieu St-Germain le 2017-7-29

Latitude: 52.26333 **Longitude:** -77.07860 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	3
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Non
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	9-15% (douce)	Horizon supérieur (cm)	5	Matière organique décomposée
Situation topographique:	Buton	Horizon inférieur (cm):	20	Sable
Drainage:	Mésique	Roc (si observé):	25	

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Eau	0%
Herbacée	0%
Arbustive (< 4 m)	85%
Muscinale	90%
Arborescente (> 4 m)	55%
Sol nu / Litière	0%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	**Picea mariana**	**FACH**		**55**	**100 %**
Arbustive (< 4 m)	Kalmia angustifolia	NI		5	4.76 %
Arbustive (< 4 m)	**Picea mariana**	**FACH**		**25**	**23.81 %**
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**		**60**	**57.14 %**

Arbustive (< 4 m)	Vaccinium myrtilloides	NI	15	14.29 %
Muscinale	Lichens		70	77.78 %
Muscinale	Mousses		20	22.22 %

[1] *Statut hydrique : * = Statut émis par WSP*

Parcelles de validation

P-03-V1 (PE1.0031)

Faite par Mathieu St-Germain le 2017-7-2

Latitude:

Longitude:

Type de parcelle: Parcelle de validation

Parcelle associée: P-03

InSitu - Rapport descriptif

06-Pessière noire à lichen

Fait par Claudie Landry le 2017-7-26

IDENTIFICATION

Type de milieu :	Boisé
Type de groupement :	Terrestre
Maturité :	Intermédiaire
Stade successionnel :	Boisé/Marécage arborescent > Fin de succession
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	107 945
Superficie du complexe de milieux humides (m²) :	0
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100* %

HYDROLOGIE

Bande riveraine d'un plan d'eau :	Non traversé ou bordé par un cours d'eau
Lien hydrologique ? :	N/A
Nature du lien :	N/A
Type du lien :	N/A
Position dans le réseau hydrique	N/A
Présence de dépression humide:	0%

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

REMARQUES

> Retouche carto nécessaire

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-05 - Groupement Pessière noire à lichen

Faite par Claudie Landry le 2017-7-26

Latitude: | **Longitude:** | **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	3
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Non
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	4-8% (faible)	Horizon supérieur (cm)	10	Matière organique décomposée
Situation topographique:	Buton	Horizon inférieur (cm):	20	Sable
Drainage:	Mésique	Roc (si observé):	30	

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Muscinale	90%
Arborescente (> 4 m)	50%
Eau	0%
Sol nu / Litière	2%
Arbustive (< 4 m)	60%
Herbacée	0%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	**Picea mariana**	**FACH**		**50**	**100 %**
Arbustive (< 4 m)	Betula glandulosa	FACH		15	11.54 %
Arbustive (< 4 m)	**Picea mariana**	**FACH**		**50**	**38.46 %**
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**		**40**	**30.77 %**

Arbustive (< 4 m)	Vaccinium myrtilloides	NI	25	19.23 %
Muscinale	Lichens		90	100 %

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

07-Pessière noire à lichen

Fait par Jean-Bastien Lambert le 2017-7-27

IDENTIFICATION

Type de milieu :	Boisé
Type de groupement :	Terrestre
Maturité :	Mature
Stade successionnel :	Boisé/Marécage arborescent > Fin de succession
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	20 438
Superficie du complexe de milieux humides (m²) :	0
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	Non traversé ou bordé par un cours d'eau
Lien hydrologique ? :	N/A
Nature du lien :	N/A
Type du lien :	N/A
Position dans le réseau hydrique	N/A
Présence de dépression humide:	0%

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

Perturbation Naturelle

Feu	Menaçant peu

REMARQUES

> Remarques générales : Brûlis dans le secteur ouest du polygone

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-42 - Groupement Pessière noire à lichen

Faite par Jean-Bastien Lambert le 2017-7-27

Latitude: **Longitude:** **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	3
Nb d'espèces dominantes NI (B) :	0
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Non
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	4-8% (faible)	Horizon supérieur (cm)	5	Matière organique décomposée
Situation topographique:	Buton	Horizon inférieur (cm):	25	Sable
Drainage:	Mésique	Roc (si observé):		

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Arbustive (< 4 m)	75%
Muscinale	100%
Herbacée	0%
Arborescente (> 4 m)	55%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [7]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	**Picea mariana**	**FACH**		**55**	**100 %**
Arbustive (< 4 m)	Empetrum nigrum subsp. nigrum	NI		2	1.46 %
Arbustive (< 4 m)	Kalmia angustifolia	NI		10	7.3 %
Arbustive (< 4 m)	**Picea mariana**	**FACH**		**60**	**43.8 %**
Arbustive (< 4 m)	**Rhododendron groenlandicum**	**OBL**		**45**	**32.85 %**
Arbustive (< 4 m)	Vaccinium myrtilloides	NI		20	14.6 %
Muscinale	Lichens			75	75 %

Muscinale	Mousses		25	25 %
Autre espèce observée	Diphasiastrum sitchense			
Autre espèce observée	Epigaea repens	NI		
Autre espèce observée	Lycopodium annotinum	NI		

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

08-Pessière noire à lichen

Fait par Jean-Bastien Lambert le 2017-7-30

IDENTIFICATION

Type de milieu :	Boisé
Type de groupement :	Terrestre
Maturité :	Mature
Stade successionnel :	Boisé/Marécage arborescent > Fin de succession
Rareté au niveau régional	Commun

DESCRIPTION POLYGONE

Superficie (m²) :	44 279
Superficie du complexe de milieux humides (m²) :	0
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100 %*

HYDROLOGIE

Bande riveraine d'un plan d'eau :	Non traversé ou bordé par un cours d'eau
Lien hydrologique ? :	N/A
Nature du lien :	N/A
Type du lien :	N/A
Position dans le réseau hydrique	N/A
Présence de dépression humide:	0%

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

Perturbation Naturelle

Chablis	Menaçant pas

REMARQUES

> Pierres et blocs

> Remarques générales : Affleurement rocheux à plusieurs endroits. Xérique mais sans pin gris.

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-28 - Groupement Pessière noire à lichen

Faite par Jean-Bastien Lambert le 2017-7-30

Latitude: 52.24792 **Longitude:** -77.07136 **Type de parcelle:** Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	2
Nb d'espèces dominantes NI (B) :	1
Végétation dominée par des hydrophytes (A>B):	Oui
Végétation typique des milieux humides:	Oui
Présence de sols hydromorphes:	Non
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	9-15% (douce)	Horizon supérieur (cm)	5	Matière organique décomposée
Situation topographique:	Haut de pente	Horizon inférieur (cm):	15	Sable
Drainage:	Xérique	Roc (si observé):		

REMARQUES

> Pierres et blocs

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Sol nu / Litière	15%
Muscinale	85%
Eau	0%
Herbacée	2%
Arbustive (< 4 m)	50%
Arborescente (> 4 m)	40%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	**Picea mariana**	**FACH**		**40**	**100 %**
Arbustive (< 4 m)	Empetrum nigrum subsp. nigrum	NI		1	1.08 %
Arbustive (< 4 m)	Epigaea repens	NI		1	1.08 %

Arbustive (< 4 m)	**Kalmia angustifolia**	**NI**	**30**	**32.26 %**
Arbustive (< 4 m)	Larix laricina	FACH	1	1.08 %
Arbustive (< 4 m)	**Picea mariana**	**FACH**	**35**	**37.63 %**
Arbustive (< 4 m)	Rhododendron groenlandicum	OBL	10	10.75 %
Arbustive (< 4 m)	Vaccinium myrtilloides	NI	15	16.13 %
Herbacée	Diphasiastrum sitchense		1	33.33 %
Herbacée	Vaccinium uliginosum	NI	2	66.67 %
Muscinale	Geocaulon lividum	NI	1	1.14 %
Muscinale	Lichens		80	90.91 %
Muscinale	Mousses		2	2.27 %
Muscinale	Sphagnum sp.	FACH	5	5.68 %
Autre espèce observée	Capnoides sempervirens			

[1] *Statut hydrique : * = Statut émis par WSP*

InSitu - Rapport descriptif

Pinède grise

01-Pinède grise

Fait par Claudie Landry le 2017-7-30

IDENTIFICATION

Type de milieu :	Boisé
Type de groupement :	Terrestre
Maturité :	Mature
Stade successionnel :	Boisé/Marécage arborescent > Fin de succession
Rareté au niveau régional	Occasionnel

DESCRIPTION POLYGONE

Superficie (m²) :	17 165
Superficie du complexe de milieux humides (m²) :	0
Proportion de milieu naturel dans une bande-tampon de 100 m:	*90-100* %

HYDROLOGIE

Bande riveraine d'un plan d'eau :	Non traversé ou bordé par un cours d'eau
Lien hydrologique ? :	N/A
Nature du lien :	N/A
Type du lien :	N/A
Position dans le réseau hydrique	N/A
Présence de dépression humide:	0%

PERTURBATIONS

Végétation perturbée?	Non
Sols perturbés ?	Non
Milieu affecté par un barrage de castor ?	Non

REMARQUES

> Troncs et souches

> Remarques générales : Section de la Pinède grise qui n'a pas brûlé.

ESVM ET EEE

Espèces floristiques à statut particulier observées dans le polygone

Aucune donnée

Espèces fauniques à statut particulier observées dans le polygone

Aucune donnée

Espèces exotiques envahissantes observées dans le polygone

Aucune donnée

InSitu - Rapport descriptif

PARCELLES

P-32 - Groupement Pinède grise

Faite par Claudie Landry le 2017-7-30

Latitude: 52.24597 **Longitude:** -77.06472

Type de parcelle: Parcelle complète

SYNTHÈSE DE LA PARCELLE

Nb d'espèces dominantes FACH ou OBL (A):	0
Nb d'espèces dominantes NI (B) :	3
Végétation dominée par des hydrophytes (A>B):	Non
Végétation typique des milieux humides:	Non
Présence de sols hydromorphes:	Non
Test d'indicateur hydrologique positif:	Non

DONNÉES BIOPHYSIQUES

Hauteur d'eau au-dessus du sol:	0 cm	Mouchetures marquées dans les 30 premiers cm:		Non
Profondeur de la nappe (si observée):	Non atteinte			
Pente:	9-15% (douce)	Horizon supérieur (cm)	5	Sable
Situation topographique:	Buton et cuvette (mosaïque)	Horizon inférieur (cm):		Non observée
Drainage:	Xérique	Roc (si observé):	5	

REMARQUES

Aucune remarque

INDICATEURS HYDROLOGIQUES

Inondé		Écorce érodée	
Sol saturé d'eau dans les 30 premiers cm		Racines d'arbres et d'arbustes hors du sol	
Lignes de démarcation d'eau (roche, arbres, etc)		Lignes de mousses sur le tronc	
Débris ou sédiments apportés par l'eau		Souches hypertrophiées	
Odeur du soufre (œuf pourri)		Système racinaire peu profond	
Litière noirâtre		Racines adventives	
Effet rhizosphère (oxydation autour des racines)		Lenticelles hypertrophiées	

RECOUVREMENTS TOTAUX

Strate	Recouvrement
Arborescente (> 4 m)	70%
Muscinale	20%
Arbustive (< 4 m)	90%
Sol nu / Litière	85%
Eau	0%
Herbacée	0%

RECOUVREMENT PAR STRATE ET ESPÈCES PRINCIPALES

Strate	Nom Latin	Statut hydrique [1]	Désignation	Recouvrement Absolu	Recouvrement Relatif
Arborescente (> 4 m)	**Pinus banksiana**	**NI**		**70**	**100 %**
Arbustive (< 4 m)	**Kalmia angustifolia**	**NI**		**70**	**71.43 %**
Arbustive (< 4 m)	Salix sp.	-		8	8.16 %
Arbustive (< 4 m)	**Vaccinium myrtilloides**	**NI**		**20**	**20.41 %**
Muscinale	Lichens			5	33.33 %

Muscinale	Mousses		10	66.67 %
Autre espèce observée	Cornus canadensis	NI		
Autre espèce observée	Epigaea repens	NI		
Autre espèce observée	Gaultheria hispidula	NI		
Autre espèce observée	Rubus chamaemorus	FACH		

[1] *Statut hydrique : * = Statut émis par WSP*