CREE DEVELOPMENT CORPORATION

Respect · Collaboration · Strength

LA GRANDE ALLIANCE

## Feasibility study Phase I Report

# Executive Summary

**Client Reference: 2020-01**

**Consultant Reference: LGA-1-GN-F-FEX-RT-0001-01**

2022-04-14

Vision Eeyou Istchee

• Connect • Develop • Protect

Stantec | DESFOR | SYSTRA

*with subconsultant* KPMG

## General Information

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## Approvals

Prepared by :

**Michel SIMARD, M.A.**
VEI Transport Economist

Revised by :

**Catherine LAPLANTE, M.Sc.**
VEI Transport Economist

**Christopher SALHANY, P. Eng.**
VEI Deputy Project Director

Approved by :

**Alessandro CIRELLA, P.Eng.**
VEI Project Director

# Document Identification

## Report

## Executive Summary

*Consultant Reference:*
*LGA-1-GN-F-FEX-RT-0001-01*

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# List *of* Volumes

**TRANSPORTATION INFRASTRUCTURE FEASIBILITY STUDY, PHASE I**

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# 1. INTRODUCTION

## 1.1 La Grande Alliance

La Grande Alliance (LGA) program is a plan to protect, connect and develop the Eeyou-Istchee Baie-James territory. It includes a study of a transport development that encompasses a renewal of existing Cree Community roads, the implementation of a north-south link Matagami to the James-Bay area and finally, a deep-sea port. It materialized in 2018 when the Grand Council of the Cree (GCC) and le Governement du Québec (GQ) signed a memorandum of understanding for the study. The study has involved the Cree First Nations communities from the beginning of the initiative to ensure community engagement, and respect for the traditional way of life and values. The study is overseen by the Cree Development Corporation (CDC) on behalf of the CNG.

## 1.2 Phase 1 Mandate

The Cree Development Corporation (CDC), on behalf of the GCC/CNG and the GQ, has been mandated to oversee the study. In turn, they have assigned Vision Eeyou Istchee (VEI), a consortium formed by STANTEC, DESFOR and SYSTRA, to carry out a Feasibility Study on the technical, socio-environmental and economic components in Phase I of the LGA infrastructure program, covering years 1-5 from the beginning of construction. The CDC appointed WSP to perform a pre-feasibility study of Phases II-III of the program (covering years 6-15 and subsequently years 16-30).

Phase I of LGA includes:

- A north-south railway (NSR) line parallel to the Billy Diamond Highway (BDH) between Matagami and the Rupert River, located at the kilometric point (KP) 257 of the BDH;
- The rehabilitation of the Grevet-Chapais railway (GCR) line;
- The implementation of trans-shipment centres along these two railway lines (especially one near KP 257 of the BDH);
- The upgrading/paving of local road connections to the four Cree communities of Waskaganish, Eastmain, Wemindji and Nemaska
- The renewal of the Route du Nord; and
- The construction of a new secondary access road to Mistissini via the Route-du-Nord.

# 2. SOCIO-ENVIRONMENTAL STUDY

## 2.1 INTRODUCTION

The CDC made it clear from the beginning of the LGA process that they wanted local community involvement, and environmental and social criteria evaluated at the same level as technical and financial criteria in the infrastructure design and planning. To meet these principles, VEI did the following:

- Organised internal bi-weekly meetings and direct exchanges between colleagues to share relevant land use and environmental information with the other study teams as it was collected;
- Used an online database (interactive ArcGIS map) to make land use, environmental and technical data accessible to targeted team members;
- Organized a workshop, bringing together tallymen and engineers, to review the potential BDH railway alignment, and identify main issues;
- Accommodated the tallymen's recommendations as much as possible;
- Encouraged team members to communicate with the Cree Liaison Officers and have ad-hoc discussions with them;
- Prioritised Cree workers and companies in the organization of field campaigns;
- Invited tallymen and land users to meet the field crews and participate in fieldwork;
- Reviewed and included information shared by the following organizations:
  - Cree Nation Government (Land Use Planning Commission, including the Protected Areas Working Group and Environment Department;
  - Aanischaaukamikw Cree Cultural Institute;
  - Cree Outfitting and Tourism Association (COTA);
  - Cree companies, Cree communities, and the CIOs.

## 2.2 PERSPECTIVE AND KNOWLEDGE OF THE IMPLICATED POPULATIONS

In the spirit of LGA's innovative and collaborative approach, VEI has put the Cree community members and land users at the center of its work, considering them not only as a main source of information for the studies but also as advisors in the infrastructure design and planning. VEI's engagement strategy relies on a liaison task force composed of two Cree Liaison Officers, one focused on inland communities and the other on coastal communities, and two Liaison Support Members. Having a permanent presence in Eeyou Istchee has allowed building strong relationships with the CIOs and community members and facilitated communications.

Initially, presenting LGA to each Cree community's Council and General Assembly was considered the gateway to start building relationships with the communities. The Cree Liaison Officers (CIOs) played a crucial role in facilitating liaison work with community leadership despite COVID restrictions. They helped establish communication channels with the communities and ensured that the project team engaged with the appropriate representatives. As a result, the first contacts with the communities were often with the CIOs, who were able to connect the project team with tallymen and land users who would potentially be impacted by the project. This approach allowed VEI to build relationships with the communities and gain a deeper understanding of local priorities and political context.

In collaboration with the CIOs, and prior to the conduct of individual land use interviews, information sessions were organized specifically for the potentially impacted tallymen and land users of each community (8). Prior to each engagement activity, the Liaison Officers explained to the participants that their presence did not mean that they were in favour of LGA, nor that they accepted the infrastructure to be built. For many tallymen and land users, this was an important clarification and a condition to their participation. VEI also reached out to the tallymen of traplines where fieldwork would take place, to inform them of the works, request their authorization, and encourage them to participate in the campaigns.

Tallymen of the potentially impacted traplines by the BDH railway alignment (BHDR) were all invited to participate in a workshop with engineers to review and discuss the potential alignment. It provided an opportunity to identify the main issues with the alignment and to modify it based on Tallymen's comments. Table 2-1 summarizes engagement activities carried out by VEI.

Table 2-1: Summary of Engagement with the Crees

| Activity | Details |
|---|---|
| Presentation at communities' local general assemblies | • Oujé-Bougoumou (1)<br>• Waskaganish (3)<br>• Waskaganish CTA (2)<br>• Wemindji (2)<br>• Mistissini (1)<br>• Washaw Sibi [1](1) |
| Presentation at Regional Assemblies | • Cree Nation Youth Council (1)<br>• Regional CTA (1) |
| Presentation to local Councils | Mistissini: Informal presentation of the 2nd access road alignments |
| Engagement with land users of potentially impacted traplines<br>• A total of **57 traplines** are potentially impacted by Phase 1 infrastructure<br>• 4 traplines are potentially impacted by Phase 2 infrastructure | Tallymen or land users of **at least 52 traplines** were engaged in different activities.<br>Tallymen information sessions:<br>• Washaw Sibi (1)<br>• Waswanipi (1)<br>• Oujé-Bougoumou (2)<br>• Mistissini (1)<br>• Nemaska (1)<br>• Waskaganish (1)<br>• Eastmain (2)<br>• Wemindji (1)<br>50 land use interviews conducted |
| Engagement related to fieldwork | • Fish habitat characterization<br>• Geotechnical surveys<br>• Archaeological fieldwork |
| Workshops and focus groups | • Tallymen potentially impacted by BDH railway<br>• Mistissini's 2nd access road |

Engagement activities and several informal conversations with the Cree answered their questions, and provided understanding of their concerns, their use of the territory, and how the development of the LGA infrastructure could benefit or impact their activities. They also provided VEI team with a wealth of knowledge concerning the territory and a Cree perspective on the infrastructure program. Sensitive areas, potential land use conflicts, and the need to address past issues and previous impacts were highlighted throughout the process.

[1] The Washa Sibi community is recognized by the Crees but is not necessarily legally recognized by the Québec government. In the lens of the study, the community of Washaw Sibi was considered equivalent to all other participating Cree communities. The study team does not allude to make any legal statements regarding their status, but this is rather an initiative to be as inclusive as possible

Appearing in the photo:

- Johnny Saganash (VEI)
- Sydney Coonishish (Oujé-Bougoumou CIO)
- Oujé-Bougoumou tallymen and land users

Tallymen information session in Oujé-Bougoumou.

## 2.3 Cree Land Use

### 2.3.1 Engagement and Interviews

The objectives of the Cree land use study were to:

- Document Cree land use in each study area;
- Gather the land users' comments and concerns;
- Identify preliminary potential impacts;
- Integrate Cree knowledge and perspective into the design and planning of the potential infrastructure.

In collaboration with the CIOs, VEI organized information sessions for Tallymen as described in Section Table 2-1. Prior to starting the individual land use interviews, the participants were asked if they had questions about LGA, and information about LGA and additional information was presented to those who had not attended the information sessions. These were conducted mostly in Cree, by one of VEI's Cree Liaison Officers and VEI's anthropologist. Large paper maps were used to locate land use features and information shared by the participants.

Appearing in the photo:

- Ian Diamond (VEI)
- Raymond Dixon (tallyman of trapline W23B)
- Cheyenne Gull (former Waswanipi CIO), and
- Johnny Saganash (VEI)

A Cree Land Use Interview

The interview questions touched upon the following themes:

- Description of land use activities and features;
- Environmental information concerning the study area;
- Condition of the existing infrastructures;
- Potential effects and recommendations.

Once the interview notes were compiled and the information was included in a GIS database, validation interviews were organized with the participants, so they could review the data collected, verify its accuracy, and add any additional applicable information.

### 2.3.2 Cree Land Use in the BDHR Alignment Study Area

The study area defined for the potential BDH railway alignment consists of a five (5) km buffer zone on either side of the potential BDH railway alignment, which goes from Matagami, (Kp 0 of the BDH) to the Rupert River, (Kp 257 of the BDH). Table 2-2 summarizes the number of traplines intersected by the potential BDH railway alignment.

Table 2-2: Traplines Intersected by the Potential BDH Railway Alignment

| Community | Number of Traplines Intersected |
|---|---|
| Washaw Sibi | 1 |
| Waswanipi | 7 |
| Waskaganish | 1 |
| Nemaska | 4 |
| **Total** | **13** |

The land and resources in the study area are used by the tallymen, their family members and other Cree land users. The BDH provides easy access to the territory, and recreative anglers and hunters, as well as cottage owners and tourists, also frequent the study area; consequently, various non-Cree activities were also reported along the BDH.

Several Cree camps and hunting and fishing areas are in proximity to the BDH (± 100 m). For many land users, the camp located along the highway is a central point for land use in the broader surroundings, such that moving a camp implies shifting an entire suite of activities elsewhere on the trapline where access is likely more restricted. Study participants also identified valued sites within the study area, such as burial sites, drinking water sources and protected areas, that they would like to protect from development. A few tallymen indicated that around Kp 136 and Kp 257 of the BDH would be good locations for passenger stations since they are already known stopping points.

Given the proximity of some of their camps and harvesting areas to the BDH (and to the potential BDH railway alignment), many tallymen and land users were concerned about the noise, vibration, dust, and safety hazards caused by the train. Some of them expressed a desire for electric trains to reduce noise.

The project to open a new railway corridor in the area will have impacts on the use of the affected trapping areas, which is a major concern for the trap masters and users of the territory. Indeed, they have already seen the size of their territory significantly reduced over the years by other development projects such as mining, hydroelectric and forestry operations. Furthermore, the subdivision of trapping areas by former trap masters has also contributed to the loss of area in these areas. This situation is particularly concerning in the southern part of the study area.

In order to minimize the negative impacts on trap masters and users of the territory, solutions have been proposed. For example, it could be considered to relocate affected trap masters to neighbouring areas where they could continue their activity without interruption. Additionally, financial compensation could be offered to compensate for the loss of income resulting from the loss of use of the affected trapping areas.

### 2.3.3 Cree Land Use in the Grevet-Chapais Alignment Study Area

In November 2021, following initial discussions with the Waswanipi Tallymen and land users, the area study was expanded beyond its original one-kilometer buffer zone to encompass a larger five-kilometer buffer zone. This decision was made to account for the cumulative impacts of previous development projects. As a result, the Cree land use study included three more traplines, which comprised two from Waswanipi and one from Oujé-Bougoumou.

Table 2-3: Traplines Intersected by the Grevet-Chapais Study Area

| Community | Number of Traplines Intersected |
|---|---|
| Washaw Sibi | 1 |
| Waswanipi | 10 |
| Oujé-Bougoumou | 2 |
| **Total** | **13** |

The land and resources in the area are used by the Tallymen, their family members, and by other Cree and non-Cree land users. Forestry companies as well as snowmobile and ATV clubs currently share the use of the existing Grevet-Chapais trail (former CN railway). It is an important artery where residents of the region, Cree and non-Cree, circulate by snowmobile, ATV or, on some sections, road vehicle.

During interviews, tallymen and land users explained that when the Grevet-Chapais railway was built, the Cree moved their camps and activities away from it. After the railway was decommissioned, they gradually returned to the area and established camps in proximity to the Grevet-Chapais trail to take advantage of the ease of access. Several non-Cree frequent the area and have built cottages around the waterbodies for the same reason.

Converting the Grevet-Chapais trail into a railway would mean the loss of an important access for tallymen and land users. The railway would also intersect forestry roads and trails that are part of a local transportation network. As with the BDH alignment, many were concerned about nuisances from the train and hoped for electric trains. They anticipate having to displace some camps and harvesting activities.

The predominant question was: "*is there a real need for a railway in the area?*". Since the railway was dismantled some 40 years ago, study participants wondered what could justify putting it back into service today.

### 2.3.4 Cree Land Use in the Access Roads and the Route du Nord Study Areas

The study areas defined for the community access roads and the Route du Nord consist of a one (1) km buffer zone on either side of each road's centerline and they cover the entire length of the roads. Table 2-4 summarizes the number of traplines intersected by each road.

Table 2-4: Traplines Intersected by the Communities' Access Roads and the Route du Nord

| Road | Number of Traplines Intersected | Trapline Locations |
|---|---|---|
| Waskaganish Access Road | 4 | 3 - on Waskaganish territory<br>1 - on Nemaska territory |
| Eastmain Access Road | 3 | All are located on Eastmain territory |
| Wemindji Access Road | 3 | All are located on Wemindji territory |
| Nemaska Access Road | 1 | Entirely located on Nemaska territory |
| Route du Nord | 21 | 2 - on Oujé-Bougoumou territory<br>12 - on Mistissini territory<br>6 - on Nemaska territory<br>1 - on Waskaganish territory |
| Mistissini's Potential Second Road Alignment | 4 | All located on Mistissini territory |

In each community, the land and resources in the study area are used not only by the tallymen, and their family members, but also by several community members. This also applies to the Route du Nord study area, where people from outside of the communities add to the Cree land users.

Tallymen and land users are in favour of upgrading and paving their community's access road and of the Route-du-Nord, as it would greatly improve road safety. Dust created by the circulation of vehicles on gravel roads brings visibility issues that can cause accidents, especially at dusk, in summertime and in fall. Paving would also eliminate the soft road shoulders and lack of aggregates which make the roads' edges unsuitable for vehicles. This leads drivers to operate closer to the middle of the road which presents a major hazard, especially on the Route-du-Nord which is used by several big transport trucks. Many study participants mentioned collisions, some of them fatal, that occurred on the Route du Nord. Some dangerous curves and drainage problems were identified, and their location was shared with the Technical Team.

Various other upgrading ideas and recommendations were expressed by the study participants. The most recurring ones are summarized below:

- The road shoulders in proximity to the communities should allow pedestrians, cyclists, and ATVs to circulate safely.
- Roads shoulders, in general should be widened to park roadside, and existing parking areas should be enlarged because community members park along the roads to hunt, to pick berries, or because of mechanical problems and they block part of the lane.
- Rest areas and/or additional parking areas should be built along the roads, so people transiting on the roads would not use the tallymen's parking areas, camps and toilets.
- Vegetation along the roads should be regularly slashed, especially where other accesses and trails connect to the main roads, because it blocks the view.

The only inconvenience that was mentioned in relation to the paving of the roads is that vehicles' speed would increase since the road condition would be better.

Regarding Mistissini's second road potential alignment, the tallymen and land users recommended that the new road alignment should follow existing trails, to avoid deforesting and opening new areas, and that it should be as straight as possible. They have also identified valued sites that should be avoided. Various trails and forestry roads go through Mistissini's second road study area, so many community members and non-Cree tourists visit it. Therefore, even if the tallymen and their family members use the area, they have not established their camps there.

## 2.4 ARCHAEOLOGY

The Grande Alliance (LGA) archaeology program evaluated the archaeological potential within the buffered alignment of the proposed railway paralleling the Billy Diamond Highway and an alternative option of an access road to the community of Mistissini. A predictive Geographical Information System (GIS) model was developed to operate as a tool for site prediction, design planning, and archaeological assessment.

The 2022 field season was a preliminary archaeological survey that sampled areas predicted by the model to be of archaeological potential and was used to test the accuracy of the predictive model. To do so, the 2022 field program consisted of both pedestrian survey and shovel testing.

During field work, the Cree field crew shared information concerning animals' behaviour, hide processing, how to set up a camp, wood splitting, and how to move through the land during both snow-free and snow-covered conditions. The preliminary archaeological survey resulted in the identification of over 60 areas of archaeological potential. Additional field work is recommended for all these sites. Six newly discovered archaeological sites consisting of surface and subsurface lithic belongings were identified and recommended to the ministère de la Culture et des Communications for protection. Three sites were assigned Borden Numbers. A number of remnant Cree camps, trails (pedestrian, small game, snowmobile, portage), fishing, hunting, and trapping activity areas, and wood harvesting evidence were also recorded.

Based on the results of the 2022 field season, the model was refined and revised to enhance its value as a tool for planning future archaeological surveys of LGA. However, the field work did not thoroughly test the model but kept to areas of safe access. Additional fieldwork will provide more comprehensive testing of the model, allowing for the continued evolution of the model.

## 2.5 SERVITUDES AND TITLES

A 2 km study corridor was considered for each alignment (Billy Diamond, Grevet-Chapais, Mistissini), and the existing servitudes and titles present along the three projected alignments were identified to highlight potential land use conflicts. All public services, mining claims, leases on public land and Cree territorial claims were examined.

The main public service constraints identified in Billy Diamond Highway and Grevet-Chapais corridors are associated with Hydro-Québec infrastructures (ex.: power lines). In the Mistissini corridor, two experimental ex.: power lines). In the Mistissini corridor, two experimental forests (areas dedicated to scientific research) are a constraint.

Several mine claims have been inventoried in the study corridors (315 for Billy Diamond, 585 for Grevet-Chapais, and none for Mistissini), but only a few of them represent a potential conflict. One is located 11m from the Billy Diamond alignment and two of them are located at less than 100 m from the Grevet-Chapais alignment. On public lands, 64 leases were granted by the provincial government in the three corridors. Two leases are located between 40 and 80 m from the Billy Diamond alignment and will need specific attention. Six are located between 24 and 85 m from the Grevet-Chapais alignment.

Consultations held in the Cree communities has highlighted several areas in the vicinity of the alignments that are of importance to Cree land users (for example: camps, hunting and fishing areas, see section 2.3).

Servitudes and titles in conflict with the proposed infrastructures will require discussions and agreements with Cree Communities and leaseholders, while some impacts may possibly lead to relocation or compensation.

A number of snowmobile trails and logging roads have also been identified in the three corridors (MERN, 2022a). In some places, these trails cross the alignments, while in other places the alignments perfectly overlap the current trails. In the first case, special attention should be given to signage and user safety on the trails, while in the second case, certain portions of the snowmobile trails/forestry roads will need to be relocated. Any relocation will require active discussions with the users of these trails to ensure that the new trail responds to their needs. Preliminary consultation was conducted with the main stakeholders (tallymen, forestry companies, snowmobile clubs, etc.) and will pursue during the next steps of planning. Furthermore, the cost of the relocation will need to be integrated as part of the project construction costs.

## 2.6 Protected Areas

Currently, 23% of the Eeyou Istchee territory is designated as protected areas by the provincial government, with an objective to increase this proportion to 50 % by 2030. A 2-km wide study corridor centered on each alignment was considered to determine whether the planned infrastructures are problematic to the protected areas in terms of potential encroachment or indirect perturbations.

Of the 33 types of protected areas registered in the *Registre des aires protégées au Québec*, only 4 are found in the study areas: a biological refuge, projected aquatic reserve, a projected biodiversity reserve and a territorial reserve for protected area purposes. Areas dedicated to the protection of woodland caribou were also included in the analysis, although they do not possess the status of “protected areas” as implied by the current legislation. No protected area is located in any alignments’ right-of-way.

The BDHR study area overlaps one biological refuge. The alignment was modified to avoid this protected area. Three planned protected areas are also located within the corridor: Chisesaakahikan-and-Broadback-River biodiversity reserve, Chisesaakahiikan territorial reserve for protected area purposes and a proposed biological refuge. The Billy Diamond Highway alignment overlaps the territories dedicated to woodland caribou protection over a cumulative distance of 70 km.

Two planned protected areas are present in the Grevet-Chapais study corridor, and the Grevet-Chapais alignment, overlaps the boundaries of the projected Waswanipi Lake Aquatic Reserve for 162 km along its south side.

Only one protected area is included in the Mistissini 2$^{nd}$ access road corridor. The Mistissini road alignment crosses a “connectivity zone” for the woodland caribou over an 11 km section but the woodland caribou’s presence seems to be scarce in this area as the main herd is located further north.

Protected areas were established under the Paix des Braves: sites of special interest (1 % of each trapline) and site of special wildlife interest (25% of productive forest of each trapline). The location of theses areas was not available due to their confidentiality.

Potential impacts include accidental encroachment of the construction work into the peripheries of conservation areas, disturbance of wildlife, including woodland caribou within lands designated for their protection (due to noise, vibration, etc.), the introduction of non-indigenous species (fauna or flora) via materials (sludge, plant fragments, etc.) on machinery coming from the south, isolation of conservation areas due to deforestation on their peripheries and pollution (air or water) in the event of an accident or spill (contamination of the food chain by heavy metals, alteration of water quality, etc.). Mitigation measures should be implemented to reduce the potential impacts.

## 2.7 IMPACTS ON COMMUNITY HEALTH

A first step of a health impact assessment of the Grande Alliance Phase I components was conducted. It was based on desktop research which considered all potentially affected populations, including workers and locals from Cree communities, the expected changes in human exposures and the project's effects on these communities downward to the individual level and any changes in human contact with infectious diseases or their vectors.

This study highlighted all potential impacts based on an extensive literature review of a similar projects, including impacts on the physical health of potentially exposed populations, on socio-cultural well-being and on health care facilities and occupational.

A total of eight social processes were retained related to four types of impacts that could occur given the project's nature and context to produce health outcomes. These processes were related to changes emerging from the construction and operation of railways and roads, and these processes could impact communities and individuals in numerous ways.

Table 2-5: Summary of major social processes and impacts

| Stressor | Social Processes | Impacts |
| --- | --- | --- |
| • Railway and road construction<br>• Railway and road operation | • Presence and nature of new project employment<br>• Local economy and an influx of money<br>• Population and demographic<br>• Social structures<br>• Physical and mental well-being<br>• Community cohesion and sense of belonging<br>• Quality and access to the environment<br>• Institutional, political, and equity | • Health infrastructure and services<br>• Food security<br>• Mental and physical health<br>• Subsistence activities |

The construction mainly increases pressure on health infrastructure and services, possibly increasing hospitalization rates for self-injuries and assaults, longer waiting hours, delays in having an appointment and periods without service. It could also put healthcare providers under higher pressure (feeling overwhelming, more chance of mistakes, mental and physical health issues, burn-out).

When it comes to food security, it's important to consider the potential impacts of any given project. In the case of this particular project, there are both positive and negative outcomes to consider. Some of the negative effects that have been identified include an increased risk of nutrition-related chronic diseases, such as diabetes, obesity, and heart disease. Additionally, individuals may experience reduced self-esteem or feel discouraged if they perceive eating healthy as an unachievable goal. There is also a risk of contamination-related acute or chronic health problems.

However, it's important to note that this project may also have several positive impacts. For instance, it may help maintain traditional food preparation skills and add new ones to the mix. This, in turn, could lead to a decrease in nutrition-related chronic diseases. The project could also help to maintain cultural practices, such as "going out on the land," and improve community cohesion and a sense of belonging. Similarly, the construction and operation phases of the project may generate both positive and adverse impacts on subsistence activities: Ultimately, it's important to consider any food security project's positive and negative impacts before moving forward.

**Positive impacts**

- Positive long-term physical and psychological health effects
- Sustained practice of subsistence activities
- Intergenerational learning and knowledge transfer
- Maintain of cultural practice of "going out on the land"
- Improve and maintain community cohesion and a sense of belonging
- Maintain traditional food preparation skills
- Gratification of having a job
- Desire to pursuit formation

**Negative impacts**

- Negative Long-term physical and psychological health effects
- Relationship problems
- Poor work performance
- increased levels of violence (domestic and other)
- Poor educational attainment
- Social exclusion and tension
- Gender inequality-emancipation of women

Based on the impacts presented above, it should be determined whether or not a complete Health Impact Assessment is relevant. Although the legislation and regulatory processes do not require an HIA, the Cree Board of Health prefers this approach to understand and identify potential impacts. Therefore, the following steps should entail pinpointing the most crucial determinants to be considered and setting up boundaries and level of effort to complete the study.

## 2.8 FLORA & FAUNA AND SPECIES AT RISK

Due to harsh climatic conditions in the Eeyou Istchee territory, the vegetation is not very diverse. A high proportion of conifer stands due to the very uneven terrain, with black spruce as the most common in the landscape. Balsam fir is usually found on hillsides. Paper birch and trembling aspen are almost the only hardwoods in the territory. Poplars are found on less hilly sites and sites recently perturbed by forest fires or clear-cutting without any corresponding replanting, while balsam firs usually accompany the rare paper birches on hillsides. The forest dynamics of Eeyou Istchee are mainly driven by forest fire and forest harvesting. As a result, regenerating forests occupy nearly 50% of vegetation cover along the alignments.

The territory hosts over 40 wildlife species, 250 bird species (most of which are migratory species), and 36 fish species. Fish inventories conducted in the study area in 2021 and 2022 revealed the presence of 15 fish species. Databases consulted indicate the presence of 26 plant species at risk in the study area, but none were reported within the alignment corridors. Of the 23 animal species at risk which could, potentially, be present, 18 are reported within the study corridor. The woodland caribou, black bear and the Canada goose are keystone species embedded in the Cree culture, while lake sturgeon, also highly valued by the Cree, is a sensitive species which is also present.

Habitat suitability for the woodland caribou is considered low along all alignments studied. Wildlife, including large species such as caribou and, to a lesser extent, moose and bears, usually tend to avoid linear infrastructure, which may create barriers to animal movement across the landscape.

Potential impacts of the construction phase on flora and fauna include the following:

- Loss of vegetation and wildlife habitat during initial site preparation (removal of vegetation);
- Risk of introduction of invasive plant species into the environment by machinery and vehicles;
- Destruction or disturbance of bird nesting;
- Relocation of some species due to habitat disruption and modification;
- Disruption caused by transportation and traffic, presence of workers and construction activity in general that may force nearby animals to alter their home ranges temporarily based on neighbouring habitats;
- Increased risk of collisions with wildlife;
- Disturbance of fish habitat due to sediment introduction and emission of turbidity plumes;
- Temporary obstacle to free fish movement on either side of the work site (upstream/downstream);
- Permanent and temporary encroachment into fish habitat;
- Accidental hydrocarbons spill into the environment during machinery use, movement, fuelling and maintenance.

Potential impacts of the operation phase on flora and fauna include the following:

- Accidental spill of hydrocarbons into the environment accidental hydrocarbon releases from road and rail traffic and maintenance of this infrastructure;
- Alteration of vegetation by salt splashes and runoff when road salts are applied in winter;
- Fragmentation of habitat and change to the quality of the connectivity for wildlife movement;
- Loss of functional habitat caused by disturbances (traffic, noise, vibrations, increased human footprint);
- Increase of collision and fatality risks for wildlife, as well as for human safety.

To minimize potential impacts, it is important to implement appropriate mitigation measures. Bridge and culvert designs must ensure unobstructed passage for fish, and construction activities should be carefully planned and executed outside of sensitive wildlife periods. Given the identification of endangered wildlife species within or in close proximity to the study corridors, additional mitigation measures tailored to the specific requirements of each species may be necessary. For instance, the BDHR should be situated as close to the highway in the caribou-sensitive area.

## 2.9 OTHER REGIONAL STAKEHOLDERS

The LGA team, composed of VEI, WSP and Edelman representatives, met with elected officials, citizens, and socio-economic actors of the five main Jamesian towns:

- Matagami
- Lebel-sur-Quévillon
- Chapais
- Chibougamau
- Radisson

Virtual introductory meetings were held with the director general and elected officials of each municipality or locality and were followed by public in-place information sessions, except for Matagami where it was held virtually due to the Covid-19 protocols in force at that time. Socio-economic actors from Lebel-sur-Quévillon, Chapais and Chibougamau participated in workshops with LGA team to discuss local issues, concerns, and potential opportunities more in depth. These meetings allowed the team to meet over 100 Jamesians, answer their questions, understand their use of the territory, their concerns, and how the development of the LGA infrastructure could benefit or impact their activities.

The participants appreciated being informed about LGA and having an opportunity to share their concerns and visions of local development. They welcomed the fact that La Grande Alliance provides a unique opportunity for Cree and Jamesians to collaborate, coordinate interests, and build together a vision of development that will benefit everyone on the territory. They highly valued development predictability and balance between protection and development, which form core parts of LGA.

Jamesians highlighted the importance of connectedness with existing infrastructure and of positioning the potential infrastructure within a global context. For example, the Grevet-Chapais railway could be part of a Canadian east-west northern route, and the deep-sea port in Whapmagoostui, connected to the BDH railway, could play an important role in the development of a northwest maritime link. Intermodality was mentioned as a staple of the infrastructure program and passenger transportation was seen as a must. According to some participants, building new railways in Eeyou Istchee Baie-James could increase the attractiveness of local industrial parks, mining processing plants among others, and favour tourism. It could also improve the supply of food, raw and second materials, while having a positive impact on climate change by reducing the number of trucks on the roads.

The main concerns expressed in relation to the infrastructure under study were:

- The need to relocate the snowmobile and ATV trails currently using the Grevet-Chapais roadbed (snowmobile trail Trans-Québec 93);
- Nuisances from the train for residents of Cavan Lake;
- Loss of access to cottages around Opawica Lake.

The addition of a study analyzing potential costs and alignment for an alternate snowmobile trail was very well received by snowmobilers and Jamesians in general. VEI communicated with representatives of the Fédération des clubs de motoneigistes du Québec (FCMQ) and local snowmobile clubs. A meeting with all of them together answered questions, clarified timelines of the infrastructure program, addressed concerns, and discussed the criteria to be considered in the development of an alternate snowmobile trail.


**Public information session in Chapais.**

Appearing in the photo:

- Paul Wattez (WSP),
- Marie-Hélène Côté (VEI),
- Samuel Lessard (Edelman), and
- Stéphanie Houde (ville de Chapais)

**Workshop with Lebel-sur-Quévillon socio-economic actors.**

Appearing in the photo:

- Marie-Hélène Côté (VEI),
- Joanie Landry Désaulniers (WSP) and
- Samuel Lessard (Edelman)

## 2.10 WILDLIFE MANAGEMENT

The Eeyou Istchee region supports a diverse terrestrial and aquatic fauna, among which some species are prized for hunting and sport fishing. The arrival of workers practicing these activities in their spare time leads to a potential overexploitation of wildlife resources, as well as a risk of land use conflicts with Cree communities, who depend upon these resources on a subsistence and cultural basis. The potential impacts on wildlife resources lie mainly in the construction phase, during which the largest contingents of workers will be present on the territory.

These are important issues, that need to be addressed by structuring and managing hunting and fishing activities. To this end, the Weh-Sees Indohoun hunting and fishing management system sets a very relevant example to follow. Identified sensitive areas or habitats should receive further special management considerations.

## 2.11 WATERSHED, WETLANDS, AND SENSITIVE HABITATS

The available geospatial information related to watersheds, wetlands, and sensitive habitats was inventoried and analysed, to provide support for Engineering, and to highlight significant habitats that could involve compensation costs and mitigation measures during the construction phase.

The three considered alignments (Billy Diamond, Grevet-Chapais and Mistissini) intersect three main. The available geospatial information related to watersheds, wetlands, and sensitive habitats was inventoried and analysed, to provide support for Engineering, and to highlight significant habitats that could involve compensation costs and mitigation measures during the construction phase.

The three considered alignments (Billy Diamond Highway, Grevet-Chapais and Mistissini) intersect three main watersheds, which are amongst the most significant ones in the province of Quebec: Nottaway, Broadback and Rupert. The Billy Diamond railway alignment crosses 264 watercourses and its right of way touches 18 lakes. The Grevet-Chapais alignment crosses 275 watercourses and its right of way touches 60 lakes. The Mistissini alignment crosses 36 watercourses and its right of way touches 2 lakes. The modeling of upstream watersheds for every water crossing, will contribute to the conception of the bridges and culverts in accordance with the current regulations.

Wetlands are vital for hydrological cycles and provide important habitats for many species, especially waterfowl. The wetlands distribution in the alignments' right-of-way (ROW) is as follows.

Table 2-6: Wetlands Distribution for the Three Alignments Studied

| | Billy Diamond | Grevet-Chapais | Chapais |
|---|---|---|---|
| Right-of-Way encroachment in wetlands areas | 3.24 km$^2$ | 3.24 km$^2$ | 0.2 km$^2$ |
| Proportion of wetlands in Right-of-Way | 48% | 59% | 11% |

The sensitive habitats that have been identified within the study corridors are: lake sturgeon habitat, fish habitat in general, and important wildlife areas for Cree users. Presence of fish has been confirmed in the studied watersheds and considering their interconnectivity, all the watersheds are considered as fish habitats. Besides fish habitat, no designated wildlife habitat listed by the Règlement sur les habitats fauniques has been documented within the study corridors.

Watersheds are geographic spaces defined according to their drainage system that converges at a lower point (watercourse). The main impacts of the construction work and operation are potential degradation of surface water and groundwater quality and restriction of flow in the watercourses. These impacts have already been covered in the section on impacts on fish habitat (see section 2.8). Sensitive plant and wildlife habitats are also discussed in section 2.8.

Potential impacts of the construction phase on wetlands include the following:

- Loss of wetlands during initial site preparation and earthwork (removal of vegetation);
- Disturbance of wetlands due to sediment introduction from the work site;
- Risk of introduction of invasive plant species into wetlands;
- Risk of accidental spill of hydrocarbons into the environment during machinery use, movement, fuelling and maintenance, as well as use and storage of hazardous substances, if required.

Potential impacts of the operation phase on wetlands include the following:

- Accidental spill of hydrocarbons into the environment accidental hydrocarbon releases from road and rail traffic and maintenance of this infrastructure;
- Alteration of vegetation by salt splashes and runoff when road salts are applied in winter.

Mitigation measures should be implemented to reduce the potential impacts. Notably, to minimize removal of natural plant cover in or near the wetlands, zones with existing disturbance (forest cuts, borrow pits, etc.) should be chosen for establishment of camps and storage areas in particular. Likewise, the use of existing roads should be prioritized for transportation and vehicle movement.

## 2.12 Climate Change

As part of its evaluation of the components and their operation scenarios, the Grande Alliance included in his scope a high-level assessment of the greenhouse gases (GHG) emissions, i.e. $CO_2$, $CH_4$ and $N_2O$, generated during the construction phase as well as the operation phase.

Targeted emission sources during construction were combustion of fossil fuels in mobile heavy equipment and vehicles as well as in fixed equipment such as generators and deforestation activities (removal of sequestered carbon). Use of mobile and fixed equipment/vehicles account for 55% of the total emissions followed by deforestation accounting for approximately 45%. The total GHG emissions of the construction phase (378 kt $CO_2$eq) represent 0.5% of the total 2020 GHG emissions for the province of 74,000 kt $CO_2$eq.

The GHG assessment of the operation phase of the study included the calculation of the GHG emissions for the following scenarios:

1. Projected use of current roadways by vehicles and trucks for the transportation of raw materials and goods, without the use of rail transport.
2. Projected use of current roadways considering the addition of a diesel-powered train travelling on railroads along the Billy Diamond Highway and Grevet-Chapais segments.
3. Projected use of current roadways considering the addition of an electric-powered train travelling on railroads along the Billy Diamond Highway and Grevet-Chapais segments.
4. Projected use of current roadways considering the addition of a hybrid-powered (diesel and electric) train travelling on railroads along the Billy Diamond Highway and Grevet-Chapais segments.

The comparison of scenario no 1 with each of scenarios n$^{os}$ 2 through N$^{o}$4 will help determine which generates the largest reduction in GHG emissions.

The results show that there is a reduction of GHG emissions with either scenario n$^{os}$ 2, 3 or 4, considered for the study with respect to the status quo (scenario n$^{o}$ 1). Indeed, the study scenarios n$^{o}$ 2 (diesel powered train) and n$^{o}$ 3 (electrically powered train) generate reductions in the GHG emissions of 28 and 31% respectively. The data available for scenario n$^{o}$ 4 (use of a hybrid motorization for the train), was limited to the Billy Diamond segment, therefore the comparison exercise could not be performed. However, it is possible to state that the GHG emissions of scenario n$^{o}$ 4 would fall between scenarios n$^{os}$ 2 and 3, with its GHG emissions being closer to the order of magnitude of the scenario n$^{o}$ 2 emissions. With a hybrid motorization, the train would be using diesel fuel when traveling on railways, which represents the main energy demand and contributor to the GHG emissions, while the electric motor would only be used when the train is moving at low speeds at maintenance yards or when leaving a station.

The design criteria for culvert and bridge flow capacities and freeboards will reflect the potential for higher temperatures and higher run-off volumes due to climate change. The railway track design criteria will also account for a higher potential for track buckling due to the potential increase in the number of degree day over 30$^{o}$C.

### 2.13 Grevet-Chapais Replacement Trail

The reactivation of the Grevet-Chapais rail line could create a conflict of use with the current users of the corridor, 93 km of which is currently used by snowmobile associations as a trail and 84 km by the forest industry as a major logging road. These two groups of users have communicated that they have invested significant amounts of money in recent years to ensure the sustainability of their activities. The relocation of these two groups is an integral part of reactivating the Grevet-Chapais rail corridor, and the necessary costs have been estimated.

It could be a challenge to accommodate the railroad, a logging road and a snowmobile trail in the same corridor, given the different physical constraints and safety issues. After discussions with the snowmobile clubs, the possibility of relocating the snowmobile trail in the Route 113 corridor seems plausible. The trail would follow the axis of Route 113, but far enough away to keep the trail in the forest, thus maintaining the recreational aspect. It would occasionally be returning close to the road to provide access for emergency interventions and user safety.

To estimate the distance that needs to be relocated, we assumed that the existing forest roads in the current corridor could be used to relocate the major logging road. However, this scenario would require the construction or repair of 87km of forest roads.

# 3. FIELD WORK

## 3.1 TOPOGRAPHY– LIDAR SURVEY

During the first stages of the Phase I work a lack of precise topographic data was identified. This data gap would also create problems for the completion of Phases II/III pre-feasibility study. Upon request, the CDC approved the acquisition of LIDAR data and the related imagery[2]. The LIDAR deliverables were completed on October 24 and those concerning the imagery should be completed at the end of November.

Table 3-1: Topographic Data Delivery Dates

| Sections | LIDAR | Orthophotos |
|---|---|---|
| VEI - Billy Diamond Railway (Matagami to km 257) | October 24 2022 | November 29 2022 |
| VEI - Grevet Chapais Railway (160 km) | September 8 2022 | November 11 2022 |
| VEI - Route du Nord (405 km) | October 14 2022 | November 11 2022 |
| VEI - Eastmain | September 26 2022 | November 28 2022 |
| WSP - Radisson to Whapmagoostui (63km +13km) | October 20 2022 | November 18 2022 |
| VEI - Billy Diamond Railway (Matagami to km 257) | October 24 2022 | November 29 2022 |

## 3.2 GEOTECHNICAL

### 3.2.1 Permitting

In order to ensure compliance with relevant laws and regulations and to protect the natural environment, Vision Eeyou Ischee obtained the necessary authorizations and permits for geotechnical work, including land use (MERN), tree cutting (MFFP), and drilling in wetlands and proximity of watercourses (Declaration of compliance - MELCC).

All activities, such as land occupancy, wood cutting, exploration trenches, and drilling, were carried out in compliance with these laws and regulations, and employees familiarized themselves with Safe Work Practices (SWPs) and the health and safety plan before beginning any fieldwork. The employees also completed and signed Stantec's pre-job Health and Safety Checklist, which identifies health and safety risks. Requests were also submitted to Info-Excavation and site owners to identify underground public services in the vicinity of the exploration locations, preventing accidental damage to public infrastructure.

Following the completion of fieldwork, efforts were made at each site (such as clean up and organizing) to minimize the impact of the work on the natural environment, demonstrating a commitment towards responsible environmental stewardship.

### 3.2.2 Geotechnical Investigations

Geotechnical investigations were carried out from mid-February to mid-November to determine the characteristics, nature and some properties of the existing fill, overburden and bedrock, and to determine groundwater conditions when relevant. This information will be used to estimate the baseline conditions at every site and provide input to the design and the construction of the various infrastructures for this mandate.

[2] The acquisition was undertaken in the spring of 2022 but the weather caused difficulties and acquisition work continued until the end of the summer.

Table 3-2 below summarizes all the geotechnical field investigations that were carried out within the scope of this project.

Table 3-2: Summary Geotechnical Site Investigations

| Infrastructure | Location | Type of Investigation |
|---|---|---|
| Access Road | Waskaganish | 15 boreholes with road traffic management |
| Access Road | Eastmain | 15 boreholes with road traffic management |
| Access Road | Wemindji | 15 boreholes with road traffic management |
| Access Road | Nemaska | 4 boreholes with road traffic management |
| Road | Route du Nord | 153 boreholes with road traffic management |
| Railway | Billy-Diamond | 40 boreholes<br>198 manual investigations |
| Railway | Grevet-Chapais | 36 boreholes |

All geotechnical soil samples recovered from the test holes were placed in moisture-proof bags, appropriately labelled, and returned to our laboratory for detailed visual examination, geotechnical classification and geotechnical laboratory analyses. At the time of preparing this deliverable, laboratory testing was still ongoing.

All of this collected information and the resulting recommendations will be presented in multiple geotechnical reports dedicated to each infrastructure.

### 3.2.3 Potential Borrow Sources (bedrock and granular materials)

The field investigation for potential borrows sources confirmed the quality and quantity of suitable materials (bedrock and granular) initially identified by aerial photo and LiDAR data interpretation. The identified borrow sources will provide the various types of materials that will be required for grading, resurfacing, and paving of the access roads, as well as for the production of railroad ballast and sub-ballast. The field investigation was carried out during winter, summer and fall of 2022. Laboratory testing to determine the quality of the encountered materials is still underway. In general, the boreholes were drilled to a depth of 10 m while the tests pits were excavated to a depth ranging from 1.5 to 5 m. A summary of the field investigation work is presented in Table 3-3.

Table 3-3: Summary of Borrow Source Field Investigations

| Infrastructure | Potential Granular Borrow Sources | | | Potential Quarry Sites | | |
|---|---|---|---|---|---|---|
| | Existing | New | Selected for geotechnical field investigation | Existing | New | Selected for geotechnical field investigation |
| Potential BHD Railway | 4 | 1 | 5 | 2 | 4 | **6** |
| Grevet-Chapais Railway | 2 | | 2 | | 3 | **3** |
| Waskaganish Access Road | 1 | 3 | | 2 | | **2** |
| Eastmain Access Road | | 3 | 2 | | 1 | **1** |
| Wemindji Access Road | 1 | 4 | - | 1 | 3 | **2** |
| Nemaska Access Road | 1 | | - | 1 | | **1** |
| Route du Nord | **10** | **1** | **N/A** | **3** | **5** | **N/A** |

* No field investigations were conducted along the Route du Nord or the Mistissini Access Road

The sites identified for the Grevet-Chapais railway are usually adjacent to the existing railway corridor, are located close to Route 113 or are accessible from existing forestry roads. Some of the potential granular borrow sources were existing borrow sites that were already partially excavated while others were new (potential) locations. The quarry sites were specifically identified for the present infrastructure study.

Along the projected Billy-Diamond Highway railway, the investigated sites are located on either side of the existing corridor between Matagami and the Rupert River area. Most of them are accessible using an existing access road; however, some new potential quarry sites would require the construction of approximately 1.5 to 2.5 km of new access roads. Some of the sites were found to be used by SDBJ but others were used by multiple users.

One or two quarry sites were explored for each of the community access roads. The targeted locations are usually adjacent to the access roads except for the Nemaska potential quarry site which would require the construction of approximately 1.5 km of access road.

## 3.3 HYDROLOGIC AND HYDRAULIC STUDIES

The studies of the following 5 bridges are currently underway.

- Wemindji road at KP 4
- Northern road at KP 19, KP 237 and KP278
- Grevet-Chapais road at KP 125.5

The hydrologic studies have been completed for all 5 structures. The watershed have been identified and flood flows calculated using the watershed transfer method. The results are shown in the following Table 3-4.

Table 3-4: Retained Flow Rates for Each Bridge

| Bridge | KM 4 | KM 19 | KM 125 | KM 237 | KM 278 |
|---|---|---|---|---|---|
| **Watershed size / ($km^2$)** | **1,000** | **455** | **9,798** | **27,690** | **1,266** |
| **Frequency (years)** | **Flood Flow Rates ($m^3/s$)** | | | | |
| 2 | 221 | 119 | 654 | 951 | 112 |
| 10 | 312 | 159 | 862 | 1,168 | 161 |
| 20 | 342 | 176 | 953 | 1,240 | 180 |
| 25 | 351 | 186 | 995 | 1,261 | 186 |
| 50 | 379 | 196 | 1,064 | 1,326 | 204 |
| 100 | 406 | 210 | 1,146 | 1,389 | 223 |

A bathymetric survey is a survey that measures the depth of water bodies, such as lakes, rivers, and oceans. In this case, a bathymetric survey was conducted in September to measure the depth of the water near the bridges at Km 4, 125.5, and 238. However, due to the high-water velocity (the speed at which the water was flowing), it was considered unsafe for the field team to conduct surveys underwater at these bridges. Therefore, the field team had to rely on other sources of information, such as existing bridge drawings and their own observations, to develop hypothetical underwater channel forms. These hypothetical forms are based on the team's best estimate of the shape and characteristics of the riverbed and channel near the bridges.

Based on primary results, the existing structures do not have major hydraulic issues. Overall, the actual bridges spans are adequate, but some structures have small freeboards and high flow velocities.

## 3.4 ARCHAEOLOGY AND CULTURE HERITAGE

The 2022 preliminary archaeological survey consisted of four 8- day field shifts, for a total of 32 days of field work. Field work occurred between August 15th and October 5th, 2022. The first three shifts focused on the proposed Billy Diamond railway alignment, and the fourth shift focused on the proposed Mistissini alternative access road. A total of nine Cree field technicians from Waskaganish, Oujé-Bougoumou, and Mistissini participated in the field work over the four shifts. In addition, an archaeologist from Aanischaaukamikw Cree Cultural Institute joined the crew for the third and fourth shifts. A condensed course explaining the basics of what archaeology is, and how it is practiced, and a lithic (stone tool making) workshop were offered to the participants. The field program consisted of both pedestrian survey and shovel testing.

**Shift # 4 Mistissini Alternative Road field crew**

## 3.5 FISH AND FISH HABITAT

Field work has been conducted in 2021 and 2022 characterize fish habitats as well as the species present in the watercourses by crossed by both railroads and Mistissini's second access road. Approximately 20% of the watercourses intersected by the proposed infrastructure were surveyed.

**Field work in 2021**

Two campaigns were carried out in 2021 (September 21–30 and October 13–25) during which 58 watercourses crossed by the Billy Diamond (48) and Grevet-Chapais (10) alignments were surveyed. Whenever possible, fish sampling was conducted to document the diversity of fish species. The surveys also included the identification of sensitive fish habitats, such as spawning or nursery grounds, within 500 m of the alignments.

For this work, one professional specialized in aquatic fauna from VEI was accompanied by two community members from Waswanipi.

**Field work in 2022**

With the same methodology as in 2021, 18 watercourses crossed by the Mistissini second access road alignment options were surveyed between August 23 and September two by two professionals from VEI.

One of the streams visited during fish habitat characterization

Installation of a trap nets during experimental fishing

Cree field personnel

Brook trout (Salvelinus fontinalis)

Northern pike (Esox Lucius)

Mooneye (Hiodon tergisus)

Walleye (Sander vitreus)

Figure 3-1: Fish and habitat

## 3.6 INSPECTIONS

### 3.6.1 Chapais Subdivision Roadbed Inspection

The Grevet-Chapais roadbed was inspected for its entire length in September 2021. Several objectives were accomplished including:

- Survey of the roadbed platform;
- Visual inspection of culverts and bridges;
- Location of potential transshipment areas and stations.
- Identification of locations where the subgrade needs rebuilding due to erosion and encroachment of the forest, as shown in Figure 3-2.

Figure 3-2: Erosion and Forest Encroachment on the old Chapais Subdivision Trail

### 3.6.2 Chapais Subdivision Bridge Inspections

Visual inspections of nine railway bridges on the Chapais-Grevet line were carried out by Vision Eeyou Istchee's inspection teams in 2021 (see Figure 3-3) to establish which structures could be rehabilitated and which needed to be reconstructed to reopen railway traffic.

Figure 3-3: Timber Trestle Bridge at MP 105.6 (Left) and DPG' Steel Bridge at MP 122.3(Right).

Table 3-5: Recommendations for the Nine Railway Bridges on the Chapais-Grevet Line

| Rehabilitate | Reconstruct |
|---|---|
| MP 91.0 Chapais (Steel) | MP 104.1 Chapais (Wood) |
| MP 101.8 Chapais (Steel) | MP 105.6 Chapais (Wood) |
| MP 118.8 Chapais (Steel) | MP 147.1 Chapais (Wood) |
| MP 122.30 Chapais (Steel) | MP 156.0 Chapais (Steel) |
| MP 125.30 Chapais (Steel) | |

To outline the extent of the rehabilitation work required the load carrying capacity was evaluated for the five structures. If only minor works are required at a bridge, it has been recommended to be rehabilitated, however if the rehabilitation works are deemed too costly a bridge has been considered for reconstruction. The bridge at MP 125.30 Chapais of the Chapais Subdivision needed a detailed visual inspection before proceeding with the evaluation to obtain additional measurements, given its relative geometric complexity. This was completed in June 2022 (see Figure 3-4).


Figure 3-4: Detailed Inspection of the Bridge at MP 125.30 Chapais s/d

### 3.6.3 Bridge Rating Assessment

The load carrying capacity of the five railway bridges was evaluated following the recommendations of the Manual for Railway Engineering of the American Railway Engineering and Maintenance-of-Way Association (AREMA). The inspected bridges were considered to be in good condition and so no deterioration of the structural components was considered during the evaluation.

For live loads, four types of trains were simulated: a passenger train (VIA Rail) and three freight trains (268 000 lbs, 286 000 lbs and 315 000 lbs). All trains were evaluated for speeds varying between 10 and 60 mph. The maximum speed allowed for each type of train is presented in Table 3-6. If the existing bridge cannot support a train travelling at 60 mph, the type of structural rehabilitation needed is indicated in below table.

Table 3-6: Maximum Speed Allowed on Bridges for 3 Types of Trains and any Needed Rehabilitation

| Bridge | Train Type | Maximum Allowable Speed for Existing Bridge | Rehabilitation Needed for 60 mph |
|---|---|---|---|
| 91.0 Chapais 3 DPG Spans | VIA Rail | 60 mph | N/A |
| | 268K | 20 mph | Girder reinforcement |
| | 286K | | |
| 101.8 Chapais 2 BM Spans and1 DPG Span | VIA Rail | 60 mph | N/A |
| | 268K | | |
| | 286K | | |
| 118.8 Chapais 2 TPG Spans | VIA Rail | 60 mph | N/A |
| | 268K | | |
| | 286K | | |
| 122.30 Chapais 2 DPG Spans | VIA Rail | 60 mph | N/A |
| | 268K | | |
| | 286K | | |
| 125.30 Chapais 2 DPG Spans and 1 TT Span | VIA Rail | 0 mph | End portal reinforcement and Floor beams |
| | 268K | 0 mph | End portal, posts, floor beams and stringer reinforcement |
| | 286K | 0 mph | DPG girder, end portal, diagonals, posts and floor beam reinforcement |

# 4. DEMAND, TRAFFIC AND REVENUE

This Market Study covers all components in the three phases and has been carried out jointly by VEI and WSP, which is responsible for the Phase II-III Prefeasibility Study. This market study covers Eeyou Istchee Baie-James and, for some economic activities, the neighboring regions of Nunavik to the north as well as Abitibi-Témiscamingue and Saguenay-Lac-Saint-Jean to the south. From reviewing and analysing a wide array of documentation and use of a survey with potential users, shippers and communities, the study provides insight into a profile of communities, economic sectors, projects and outlook. It also provides a projection of population and economic growth as well as an assessment of economic needs relating to the proposed infrastructure, a forecast of freight and passenger traffic and revenue on LGA components.

## 4.1 RATIONALE OF THE PROJECT

The goals of the upgrading of community access roads and regional roads such as the construction of the route 167, the extension of the BDH to Whapmagoostui/Kuujjuarapik, as well as the upgrading of the Route du Nord include:

- Ensuring safe, reliable, and cost-efficient travel for the local communities; and
- Integrating the communities into the regional economy.

The long-term transportation goals for the Billy-Diamond corridor railway and the re-commissioning of the Grevet-Chapais railway are:

- To provide an integrated railway that links the communities and the Eeyou Istchee territory to the existing national railway network
- To provide a link that is safe, efficient and reliable for the movements of goods and people
- To identify roads when possible to avoid negative impacts on the sensitive natural and social environment, and enhance cultural, social, and economic conditions; and
- To maintain sustainable development of the region.

## 4.2 MARKET SURVEY

A survey combining online-based questionnaire and interviews was conducted with different potential users, carriers and communities. A total of 60 organizations responded (or 78% of the targeted sample). Figure 4-1 presents a breakdown of the respondents by sector, for all respondents and Figure 4-2 presents the subset for Cree respondents.

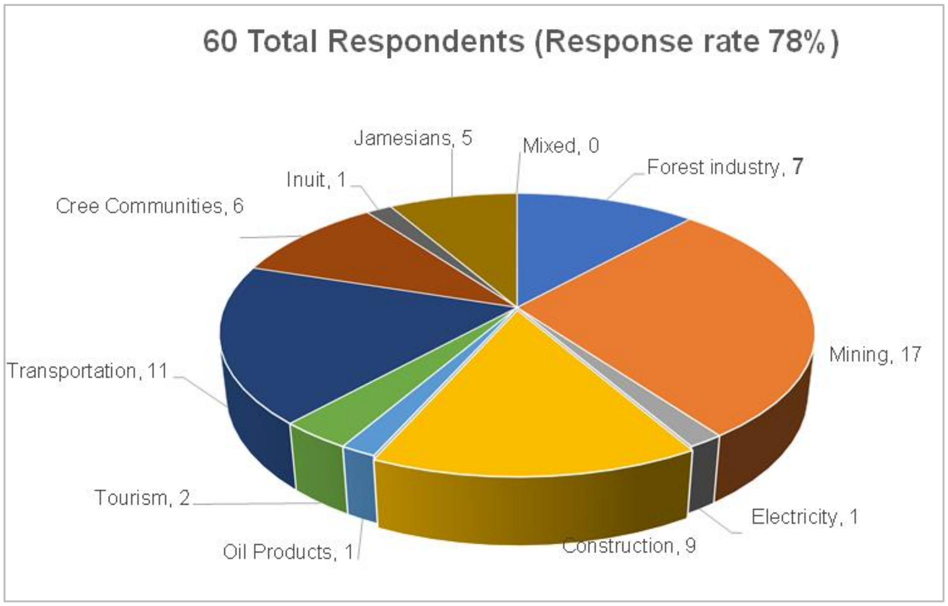



Figure 4-1: Breakdown of total respondents to the Market Survey

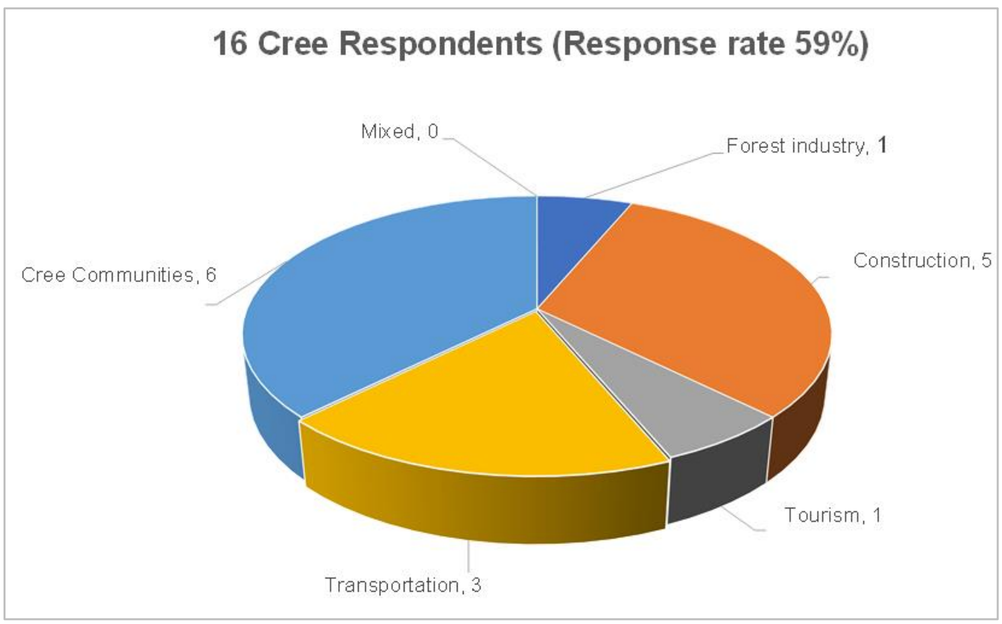



Figure 4-2: Breakdown of Cree respondents to the Market Survey

## 4.3 POPULATION AND DEVELOPMENT

The territory of Eeyou Istchee Baie-James is vast, the climate is harsh, and the distances are significant. The region has approximately 32,000 inhabitants, of which 18,700 (58%) are Cree and 13,400 (42%) are Jamesian. The Cree population is young and rapidly growing, while the Jamesian population has tended to decrease. If the trends continue, the regional population is forecasted to increase to up to increase up to 38,500 inhabitants, with 27,000 Cree people and 11,500 Jamesians by 2051.

The level of education amongst the Cree has improved considerably over the last few decades, with half of the population now holding a high-school diploma. The health and quality of life of the population has increased greatly since the creation of the Cree Board of Health and Social Services of James Bay (CBHSSJB) in 1978. Although hunting and traditional activities remain important, the Cree's participation in the labour market has risen significantly. The implementation of local public services has provided the number of jobs for the Cree. As the economy of Eeyou Istchee Baie-James relies mainly on hydroelectricity, mining and forestry production, aboriginal and regional hiring policies in these sectors have contributed to provide direct jobs to the Cree workers whilst many Cree entrepreneurs have been established mainly in construction and transportation to support these activities. This has allowed Cree workers to develop their skills.

The current strong international demand for base metals, precious metals and strategic minerals, lithium in particular, the development of new activities in the forest industry by both Cree and Jamesian companies, the ambition to develop joint Cree-Jamesian regional tourism, as well as the housing, consumption and service needs of a growing population are factors that should be driving an economic growth and employment in Eeyou Istchee Baie-James for the next 10–20 years. The ongoing development of skills and capabilities, companies and joint-ventures, and the consideration of the Crees in planning economic and human resource development, in concordance with the preservation of the environment and culture, is considered to enhance the employment and welfare in the population.

To maximize these opportunities, it is crucial to continue developing the skills and capacities of local businesses and joint ventures, while involving the Cree in economic and human resources development planning. Preservation of the environment and culture must also be taken into account to ensure the well-being of the population. In summary, by combining a responsible and sustainable approach to economic development with consideration for the needs of local communities, we can stimulate economic growth while improving the quality of life for the population of the Eeyou Istchee Baie-James region.

Long-term stability or growth of employment and local communities could be limited by several factors, such as the cyclical nature of resource-based economic activities, dependence on "fly in fly out" schedules, the low remaining share of Cree in the workforce of resource-based companies active in the region, lack of housing development projects, lack of funding, and high transportation costs and skills to be developed.

## 4.4 TRANSPORT NETWORK

All communities, except Whapmagoostui which is the northernmost Cree village with its neighboring Inuit community Kuujjuarapik, are connected by access roads to the regional road network comprising the Billy-Diamond highway, routes 113 and 167, as well as the Route du Nord. The road network is under the responsibility of various jurisdictions, which complexifies its coherence and exploitation. The BDH, built 51 years ago, has just been rehabilitated. The SDBJ now impose more restrictive load limits, especially in the thaw period, to extend the service life as much as possible. The Route du Nord is graveled on all its 400-km length, with an alignment and structures posing safety and comfort problems that dissuade the users, either leading them to use a much longer route or to avoid making a journey. Although this road is geographically an important link for intraregional and interregional exchanges, its features do not fully satisfy this function. Although the accident rate is less in Eeyou Istchee Baie-James than in Quebec in general, the severity of accidents is higher. This could be explained by the isolated nature typical for most of the region.

Canadian National (CN) provides rail transportation up to Matagami via Barraute-Senneterre and to Chibougamau-Chapais via Saint-Félicien. The railway lines are used mostly by the transport of lumber and pulp and paper, and less importantly for minerals and petroleum products. Due to the low traffic on these lines, the track maintenance has been minimal for some time and the load limit is consequently low. The current traffic on the Matagami subdivision, even lower with the recent closing of the Glencore nickel zinc mine, prevents a strong justification for the continuation of service on this line. The Matagami multimodal transshipment yard plans to develop services for the future lithium mines in the Nemaska area, which would increase the traffic on the CN Matagami subdivision. Chibougamau intends to develop a transshipment yard to serve the inbound and outbound freight movements in the eastern part of Eeyou Istchee Baie-James. VIA operates 3 passenger trains per week between Montreal and Senneterre via La Tuque with a journey duration of 13.5 hours for a fare of $110 in economy class.

Air transportation, mainly provided by Air Creebec and Air Inuit, serves workers' journeys under a fly in fly out regime, business trips, outfitting and, the northernmost and isolated communities, particularly with regard to perishable foodstuffs. Air fares remain high for personal matters. Although seven Cree communities have an airport nearby, lack of air support services coupled with limited length runway make the development of air transportation difficult.

In Eeyou Istchee Baie-James, the maritime infrastructure is limited to small community wharfs in Wemindji and Whapmagoostui.

## 4.5 TRANSPORT DEMAND

The forestry sector is an export-oriented harvesting and industry, with many companies located south of Eeyou Istchee Baie-James. Forest exploitation activities are expected to remain relatively constant due to harsh climate, young forests, the mandated cut allowances and long distances. The implementation of the Nordic Kraft plant at Lebel-sur-Quévillon and the future activity of Mistuk at Waswanipi is intended to create demand for freight by rail. Since Resolute did not respond to the survey, their potential demand for the proposed transport infrastructure (possibly between their sites in Lebel-sur-Quévillon, Abitibi and Lac-Saint-Jean) has not been included within this study.

The region is rich in mineral deposits of base metals (e.g., iron, zinc, copper), strategic minerals (e.g. lithium) and precious metals (e.g. gold, silver). Out of one hundred of exploration sites in Eeyou Istchee Baie-James, many will be exploited in the near future or could be operated on the long term. The copper projects (Quebec Copper, Doré Copper, Yorbeau) in the Chapais-Chibougamau area shall generate traffic on the Grevet-Chapais railway towards Rouyn-Noranda while the traffic generated by iron mining projects (Orion) in the same area will go eastward by the CN Cran subdivision. The major Duncan Lake iron mining project located southeast of Chisasibi, if it is realized, would generate an outstanding annual volume of 12 million tonnes per year (MTPA) on Phase II BDHR.

There are several lithium spodumene projects (Moblan, Whabouchi, Rose, James Bay) planned to be implemented over the next 3 years. These projects sum up to more than 1 MTPA of shipments southward or eastward to maritime ports, Bécancour or Abitibi. This demand would be attracted by LGA proposed railway lines. Other explored sites could be exploited in the future.

There are a multitude of gold sites under exploration that could be extracted from in the long-term future. There are a few gold mining development projects in the region notably Osisko near Lebel-sur-Quévillon and Waswanipi. Gold output shall continue to use trucking while a marginal volume of inputs such as oil products and materials, either during construction or operation, could use rail, but under specific conditions and according to the chain supply possibilities. Materials could be transported partly by rail during construction although the transshipment rail-truck may limit this possibility.

Stornoway should extend the operation of the Renard mine for an extra decade. They are concerned by the dangerousness of the Route 167 during winter due to maintenance practices, which lead to issues in hiring trucking services. As the Renard mine is not served by Hydro-Québec and the energy must then be produced from oil products, the northern extension Route 167 could be interesting if it is combined with the construction of an electricity distribution line.

The construction sector relies on the demand from local housing and building, forestry, mining and electricity sectors. Cree and Jamesian entrepreneurs and workers have a strong and proven record in the construction sector, in particular the CCDC's capacity in numerous fields such as civil engineering, roads, and buildings. The procurement of goods and oil product procurement to communities and companies is provided mainly by native-owned companies including ADC, Kepa Transport, Petronor and the FCNQ.

The future volumes for the maintenance and rehabilitation of hydroelectricity installations should remain rather constant in the short and medium terms. Hydro-Québec could not provide a specific long-term plan for the needs of the rehabilitation and construction of installations in Eeyou Istchee Baie-James. Considering that equipment infrastructure (transformer substations, turbines, etc.) lasts for about 50 years, this indicates that there should be a need for the transport of these pieces over the 2030–2060 period. Furthermore, as the demand for electricity should increase greatly due to economic growth, electric vehicles and the general decarbonization of economies, the upgrading or construction of hydroelectric production plants could be envisioned over the 50-year period considered. These development projects will require the consent of the Crees.

Because of the remoteness, the tourism attendance in Eeyou Istchee Baie-James remains low. The visitors come from the neighboring regions to see their family and friends, or for outfitting. The Robert-Bourassa dam near Radisson is among the most important tourism attractions. The Cree culture is unique, and each community has its own traditional activities. The obsolete transportation infrastructure, especially the BDH which has just been rehabilitated, and the lack of journey services, has limited the development of tourism in the region. The Cree Outfitting and Tourism Association (COTA) and Tourisme Baie-James (TBJ) work closely together to develop several tourism attractions projects to enhance the supply in the region.

Overall, the majority of stakeholders have expressed the view that the existing transportation infrastructure is obsolete and needs to be upgraded (which is partly solved with the rehabilitation of the BDH), and that future socio-economic development in Eeyou Istchee Baie-James relies greatly on the efficiency of the transportation infrastructure. The poor condition, safety risks and the lack of transport services along the road network may result in a lower share of the regional firms in outsourcing from basic economic activity such as mining or hydroelectricity, or in higher transportation and global costs for regional companies. Trucking costs have been increasing because of the increase in prices and taxes on oil products and shortage of manpower. Furthermore, the presence of major transportation infrastructure may contribute to the realization of major economic projects that could have been less attractive for financial decision-makers.

## 4.6 TRAFFIC FORECASTS

### 4.6.1 Freight Traffic and Revenue Forecasts

Traffic forecasts suggest that the freight traffic would amount realistically to approximately 1.6 MTPA globally on projected railway lines in Phase I, as shown in Table 4-1.This would be a volume of around 1 MTPA on the BDHR (Matagami-Rupert) and around 600,000 tonnes per annum (TPA) on the Grevet-Chapais line.

Table 4-1: Freight Traffic Forecast, Railways, Phase I, 2030 (tonnes per year)

| Infrastructure | Pessimistic | Realistic | Optimistic |
|---|---|---|---|
| ***Billy Diamond Highway Railway*** | ***759,000*** | ***1,001,000*** | ***1,443,000*** |
| Southbound | 668,000 | 881,000 | 1,294,000 |
| Northbound | 91,000 | 120,000 | 149,000 |
| ***Grevet-Chapais Railway*** | ***363,000*** | ***576,000*** | ***816,000*** |
| Eastbound | 7,000 | 12,000 | 16,000 |
| Westbound | 356,000 | 565,000 | 799,000 |
| **Total** | **1,123,000** | **1,578,000** | **2,259,000** |

Note: Totals may differ slightly from the sums of elements due to rounding.

The commodities carried on the considered railway lines would include mostly mining ore (lithium and copper) and forest materials (logs, chips) and products. Out of the 1.6 MTPA of estimated base case traffic, 1.2 MPTA are related to the mining industry, and of which 1 MTPA come from strategic metals. The predominance of mining and forest materials in the forecast traffic explains the great directionality, southbound from the lithium deposit area in the case of the BDHR and westbound towards Lebel-sur-Quévillon and Rouyn-Noranda for the GCR. Over time the overall freight traffic would remain relatively constant since for basic sectors, the production shall be stable while good procurement, which should grow along with the increase in population, constitutes a small share of total railway traffic.

The potential traffic levels were evaluated for pessimistic, realistic (base case) and optimistic levels. The base case is a likely achievable traffic level given the current economic activities and economic projects which should materialize, with a feasibility study for example, or interest shown during the survey. The pessimistic case applies a probability of risk of some projects not being achieved or with smaller production, while the optimistic traffic reflects the materialization of potential mining. Table 4-2 displays the traffic forecast by the economic sector and by the demand level assumption case. The range of values in the forecast can be wide given the uncertainty regarding the materialisation of specific projects.

Phase II in isolation does not add more tonnage on railway lines. Phase II however, in conjunction with Phase I would allow for a longer use of the train for some users. Moreover, if major iron ore projects such as Duncan Lake (Century) with an annual production of 12MTPA take place, then the potential traffic would be much bigger on Phase I-II BDHR, or on Phase III BDHR-seaport combination. Furthermore, the presence of major transportation infrastructure increases the feasibility of the project since the construction of a private port near Chisasibi included in Duncan Lake project would then not be required.

Table 4-2: Annual Rail Freight Forecast, by Sector, Line and Demand Level

| TPA | Matagami-Rupert | Matagami-La-Grande | Grevet-Chapais |
|---|---|---|---|
| Forest Sector | 90,000 | 90,000 | 174,000 |
| Mining | 858,000 | 4,458,300 | 393,400 |
| Others | 53,000 | 53,100 | 10,000 |
| **Total - Realistic** | **1,001,000** | **4,601,400** | **577,400** |
| Pessimistic | 759,000 | 759,300 | 364,000 |
| | *-24.2%* | -83.5% | -37.0% |
| Optimistic | 1,243,000 | 13,177,300 | 816,800 |
| | *24.1%* | 186.4% | 41.5% |

Note: Totals/percentages may differ slightly from the sums/divisions of elements due to rounding.

Tariffs for the railway operation have been projected as being significantly below the current trucking tariffs to account for the distances to and from Eeyou Istchee Baie-James, as shown in Table 4-3. Comparison of overall container transport costs between Waskaganish yard and the final destination shows potential savings ranging from 12% to 67%.

Table 4-3: Typical Industry In-Quebec Freight Rates

| ($/t-km) | Rail | Truck |
|---|---|---|
| Forest products | 0.075 | . |
| Mining | 0.089 | . |
| Other | 0.091 | . |
| **Average** | **0.09** | **0.23** |

Table 4-4 presents the annual revenue the transport of freight on the two railway lines under study using the rates in Table 3. The annual revenue is estimated at $31.7 M in total, with $21.3 M for the BHDR and $10.4 M for the GCR ($2023).

Table 4-4: Annual Freight Railway Revenue, Phase I

| | Payload (Million Tonne-km) | Revenue ($M) |
|---|---|---|
| BDH Railway | 245.4 | 21.3 |
| Grevet-Chapais Railway | 122.0 | 10.4 |
| **Total** | **367.38** | **31.7** |

The future traffic forecasts on the proposed infrastructure are subject to large uncertainty and unpredictability on the run, notably because of the cyclical nature of the regional economy which depends on the difficulty to predict future international economic conditions, conditions over which the regional and national actors have little to no control and conditions that determine the financial feasibility of major projects that could justify the implementation of a railway or of a deep-sea port on economic grounds.

Furthermore, the market survey revealed that many stakeholders had difficulty projecting their needs in the distant future. Also, the choices of modes and routes (for example via Matagami or Chibougamau-Chapais) by shippers and suppliers depend upon the overall transportation infrastructure and services offered and the selection with regards to future infrastructure which shall influence their choice. Finally, the presence of the infrastructure could induce new opportunities that companies or entrepreneurs can take advantage of and therefore generate new, different or more economy and transport activities, which cannot be assessed here.

### 4.6.2 Passenger Traffic

Railway passenger traffic has been projected for the years 2036 to 2081 to account for the anticipated population growth in the Eeyou-Istchee Baie-James. Passenger service is expected to be extended to Senneterre and Jonquière, allowing passenger connections to other services in the East-West axis. Figure 4-3 presents the anticipated ridership for the BDHR and GCR lines over time. The total annual anticipated ridership is expected to grow from 6,100 passengers per year (PPY) in the first year of operation to 8,400 PPY in 2080.

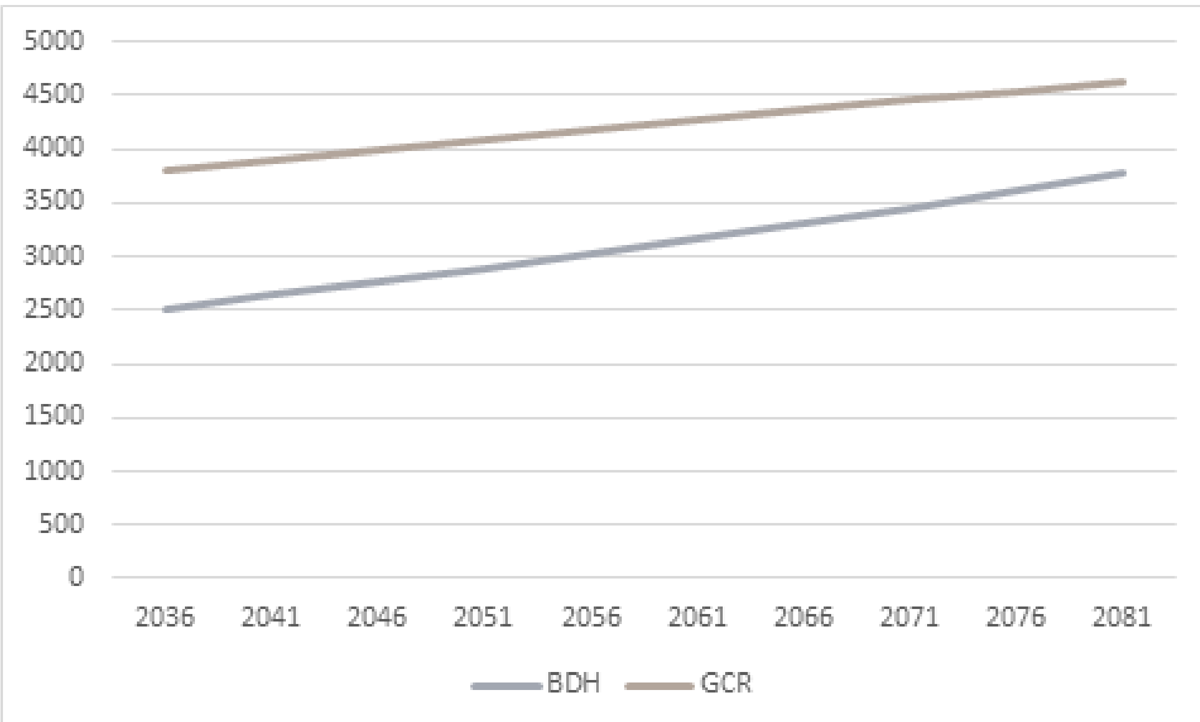



Figure 4-3: Projected Traffic Growth over Project Life

### 4.6.3 Revenue on Railway Segments

Traffic and revenue forecast for railway segments are summarized in Table 4-5. Passenger values are for 2036.

Table 4-5 : Railway Annual Traffic and Revenue Forecast Summary, Realistic Case

| Traffic | Passengers | Freight (T) | |
|---|---|---|---|
| A1 - Matagami-Rupert | 2,106 | 1,001,400 | |
| A2 - Rupert-La-Grande | 5,103 | - | |
| A2 - Rupert-La-Grande (Duncan Lake) | | 3,600,000 | |
| B1 - Grevet-Chapais | 3,762 | 576,400 | |
| **Total** | **10,971** | **5,177,800** | |
| **Revenue ($)** | **Passengers** | **Freight** | **Total** |
| A1 - Matagami-Rupert | 93,000 | 21,282,000 | 21,375,000 |
| A2 - Rupert-La Grande (excl Duncan Lake) | 520,000 | 15,563,000 | 16,083,000 |
| B1 - Grevet-Chapais | 107,000 | 10,421,000 | 10,528,000 |
| **Total** | **720,000** | **47,266,000** | **47,986,000** |

## 4.7 Remarks on Infrastructure Corridors

The economic needs and demand forecast lead to some remarks regarding the selection of infrastructure corridors:

- The Route du Nord and the Billy-Diamond Highway have the potential to play a significant role in the regional development of Cree communities. It is essential to ensure that these roads are designed and built in a way that corresponds to their function.
- Access roads are critical for the success and sustainability of Cree communities and the railway infrastructure. Therefore, any development project should prioritize the development of efficient and safe access roads that facilitate the transportation of goods and people.
- Freight traffic is vital to railway revenue. Since most populated communities to the North are not served by rail in Phase I, it is crucial to ensure the development of efficient access roads that allow for the safe and reliable transportation of goods and services to all communities and enable them to take part in economic development.
- The developing lithium mining sector could create economic opportunities for local communities. Therefore, it is crucial to have access to economic activities that drive job creation. Access roads and transportation infrastructure can play a vital role in facilitating this development.
- An adequate condition and sufficient bearing capacity of the existing railway network accessing Matagami, Chapais and Chibougamau is essential to the development of the railway lines in Eeyou Istchee Baie-James.
- The presence and development of road and railway networks in Eeyou Istchee Baie-James increase the economic opportunities in several sectors, especially for Cree community various activities including lumber and tourism, and also for mining exploration and projects, making them more profitable and likely.
- The rehabilitation of the Grevet-Chapais Railway could contribute to the development of the Cree wood industry, copper mines, and a better integration of the forestry industry. Access roads can improve the efficiency of transportation and logistics, which can boost economic activity in these industries.

- The phasing of the BDHR could be more optimal if Phase I extended to KP 381, north of the junction with the Route du Nord. In Phase II, the railway could be further extended to Radisson if the Duncan Lake mine project moves forward. Access to the developing lithium mining sector and other economic activities is crucial for the success and sustainability of the railway infrastructure.
- The market study did not find any significant evidence of freight traffic through the deep-sea port.

## Social and Economic Benefits

This project is an opportunity to create a beneficial position for the Cree population by creating targeted programs to ensure the growing population has access to the job opportunities to come. The first opportunities could come from the construction of the LGA infrastructure and then after, induced construction projects associated with the augmented attractiveness of the area. The second source of opportunities is associated with the operations and maintenance of the transport infrastructure as well as other induced developed activities. The final benefits are intended to come from secondary induced activities associated with the increased attractiveness of the area such as restaurants, hotels, and stores may be established to serve the needs of the growing population. Both employees and employers can develop highly skilled competencies and hence a cumulative causation effect.

Hence, the LGA program with its several components will not only address the current issues related to transportation such as emissions, road safety, accessibility, and reduction in transportation costs, but also induce many latent opportunities for both the population living in the area and the companies offering their service. Clearly, the proposed LGA program will increase the supply side of transportation to a great extent and consequently lead to wider benefits.

In the current context, the forecasted demand was found to be limited for rail transportation. The upgrade of the Route du Nord to a really interregional link serving the main economic generators in the region may reveal to be a sensible long-term investment, like the recent rehabilitation of the BDH. With a logical sequence of the realization and maintenance of the LGA nine infrastructure components and with a more precise evaluation of the robustness of their future anticipated use, the development could be seen as a strategic investment to position the Cree population in the management of their land and the resources they hold.

In the case a component of the LGA program is retained for development, involving Cree entrepreneurs and workers in the construction and operation of the infrastructure is the key factor to make the project socially, economically, and culturally viable, in conformity with the spirit and legal requirements of the JBNQA.

# 5. RAILWAY OPERATIONS

## 5.1 TRAIN OPERATIONS

It is assumed freight trains will operate on the Billy Diamond Highway Railway 3 times a week, carrying mixed supplies (groceries, construction equipment, etc.) north and minerals and timber south. An overnight stay in Waskaganish Yard provides adequate time for loading and unloading.

On the Grevet-Chapais, freight trains would operate a shuttle service twice per week, leaving cars at the Grevet Exchange Tracks for onward movement over the CN system and picking up cars to return to Chapais

Table 5-1: Freight Train Schedules

| DIRECTION | | KP | Station | | Direction | |
|---|---|---|---|---|---|---|
| **Northbound: Days 1, 3, 5** | | | | **Billy Diamond** | **Southbound: Days 2, 4, 6** | |
| Dep | 09:00 | 0 | Matagami | | Arr. | 15:00 |
| Arr. | 09:30 | 60 | Timber Siding | | Dep. | 13:30 |
| Dep. | 10:30 | 60 | Timber Siding | | Arr. | 12:30 |
| Arr. | 13:30 | 233 | Waskaganish | | Dep. | 09:00 |
| **Eastbound: Days 2, 5, 7** | | | | **Grevet-Chapais** | **Westbound: Days 2, 5, 7** | |
| Dep. | 09:00 | 275 | Chapais | | Arr. | 17:00 |
| Arr. | 11:30 | 123 | Grevet | | Dep. | 14:30 |

We assume that two passenger trains a week would serve Waskaganish and Matagami and continue on the CN Network to connect to VIA Rail Services, one at Senneterre and the other at Jonquière. The Waswanipi Station between Grevet and Chapais is the closest point to the railway, with a good road connection (Highway 113), to the community of Waswanipi.

Table 5-2: Passenger Train Schedules

**Waskaganish/Jonquiere**

| Down Train Southbound Day: Mon. (1) | | KP | Station | Up Train Northbound Day: Tues. (2) | |
|---|---|---|---|---|---|
| | | 0 | Waskaganish | 12:53 | Arr. |
| Dep. | 12:00 | | | 9:58 | Dep. |
| Arr. | 14:55 | 233 | Matagami | 9:48 | Arr. |
| Dep. | 15:05 | | | 7:30 | Dep. |
| Arr. | 17:22 | 332 | Franquet | 7:20 | Arr. |
| Dep. | 17:32 | | (Chapais Jct.) | 6:48 | Dep. |
| Arr. | 18:05 | 342 | Grevet | 6:38 | Arr. |
| Dep. | 18:15 | | | 6:02 | Dep. |
| Arr. | 18:51 | 385 | Waswanipi | 5:52 | Arr. |
| Dep. | 19:01 | | | 4:27 | Dep. |
| Arr. | 20:26 | 507 | Chapais | 3:57 | Arr. |
| Dep. | 20:56 | | | 3:23 | Dep. |
| Arr. | 21:29 | 529 | Faribault Jct. | 3:13 | Arr. |
| Dep. | 21:39 | | (Chibougamau) | 22:27 | Dep. |
| Arr. | 2:26 | 748 | Saint-Felicien | 22:17 | Arr. |
| Dep. | 2:36 | | | 21:09 | Dep. |
| Arr. | 3:44 | 795 | Chambord | 20:59 | Arr. |
| Dep. | 3:54 | | | | |
| Arr. | 4:53 | 863 | Jonquiere | 20:00 | Dep. |

**Waskaganish/Senneterre**

| Down Train Southbound Day: Sat. (6) | | KP | Station | Up Train Northbound Day: Sun. (7) | |
|---|---|---|---|---|---|
| | | 0 | Waskaganish | 17:38 | Arr. |
| Dep. | 8:00 | | | 13:30 | Dep. |
| Arr. | 12:08 | 233 | Matagami | 13:20 | Arr. |
| Dep. | 12:18 | | | 11:03 | Dep. |
| Arr. | 14:35 | 332 | Franquet | 10:53 | Arr. |
| Dep. | 14:45 | | (Chapais Jct.) | 10:10 | Dep. |
| Arr. | 15:27 | 358 | Quevillon | 10:00 | Arr. |
| Dep. | 15:37 | | | 7:54 | Dep. |
| Arr. | 17:43 | 448 | Barraute | 7:44 | Arr. |
| Dep. | 17:53 | | | | |
| Arr. | 18:38 | 476 | Senneterre | 7:00 | Dep. |

## 5.2 Rolling Stock

Various types of rolling stock are needed to provide the transportation requirements.

**Rail Freight Cars**

Bulkhead flat


Wood chip gondola

Covered hopper

20’ Lithium RTEUs

64’ Flat car with 3 TEUs


20’ Tank-tainer

Covered mill gondola

89’ Flat car

**Rail Passenger Cars**

Passenger coach

Generator car

**Motive Power**

Locomotive

**Railway Maintenance Cars**

Ballast car

Side dump car

Box car

Table 5-3 lists the different rolling stock, the commodities they transport, the number of each in a typical train for the two railway lines (Billy Diamond and Grevet – Chapais), and their total quantities.

Table 5-3: Rolling Stock Summary

| | | Number per Typical Train | | Total fleet |
|---|---|---|---|---|
| **Type** | **Commodity** | **Billy Diamond** | **Grevet - Chapais** | |
| Bulkhead flat car | Logs | 18 | | 56 |
| Wood chip gondola | Wood chips & Biomass | | 15 | 47 |
| Covered hopper | Spodumene | 36 | 15 | 159 |
| Covered mill gondola | Copper concentrate | | 15 | 47 |
| 64' flat car | Lithium in 20' RTEUs | 19 | | 59 |
| 64' flat car | Containerized HQ equip. | 10 | 1 | 35 |
| 64' flat car | Fuels in 20' tank-tainers | 2 | | 7 |
| **Motive power** | | | | |
| Locomotives | N/A | 2 | 2 | 6 |
| **Passenger Services** | | | | |
| Passenger Coaches | N/A | 3 | 3 | 4 |
| Generator Cars | N/A | 1 | 1 | 2 |
| **Yard equipment** | | | | |
| Car Movers | N/A | 2 | 2 | 5 |
| Stacker-Reacher | Twenty Foot Equivalent Unit (TEU) | 1 | | 2 |
| **OCS (Railway Maintenance ) Cars** | | | | |
| Ballast car | Ballast | | | 10 |
| Side dump car | Ballast | | | 3 |
| 89' flat car | Misc. | | | 5 |
| Box car | Misc. | | | 2 |

In the scenario contemplated, maintenance would be carried out at the Matagami Maintenance Shop. Locomotive maintenance is a combination of Preventative Maintenance, comprising regular inspections and scheduled 90-day, 180 day and yearly tasks, and Corrective Maintenance which is unscheduled. The shop is not equipped for major overhauls which will be contracted out to specialised companies. Freight car maintenance comprises Preventative Maintenance; Running Repairs based on Train Trip Inspections; Planned Maintenance; and Conditional Maintenance. In the event of a failure or incident Corrective Maintenance is also undertaken.

## 5.3 MAINTENANCE OF INFRASTRUCTURE

Track and Right-of-Way maintenance will be handled by 4 “Track Team” (a group of employees responsible for doing daily maintenance on the track, bridges, and signalling systems), based one each in Waskaganish and Chapais and 2 in Matagami. The second Matagami team will be mobile and support work on both the Billy Diamond and Grevet-Chapais lines. A “Heavy” track team equipped for heavier track operations such as tie replacement, tamping and welding will be based in Matagami. Telecommunications and Signalling maintenance teams will be based in Chapais and Matagami.

Certain maintenance activities such as rail grinding, and electronic geometry inspections, are needed perhaps once a year or less and require specialised equipment and operating crews. These activities will be contracted out to specialised companies who also provide the necessary equipment.

A fleet of road and road/rail (Hi-rail) vehicles compliments the Overhead Catenary System (OCS) fleet and provides the needed mobility to the maintenance teams.

Table 5-4: Maintenance of Infrastructure Road and Road/Rail Vehicles

| Item | Number |
|---|---|
| Passenger car | 5 |
| Railroad truck | 2 |
| Hi-rail truck | 5 |
| Maintenance trolley | 4 |
| Railroad excavator | 2 |
| Ballast regulator | 2 |

## 5.4 STAFFING AND FACILITIES

The oganisation of the railway will be based on functional lines of reponsibility, with infrastructure, rolling stock and operational departments reporting to a director of operations, the entire team is in turn supported by a group providing payroll, purchasingand other general administrative functions.

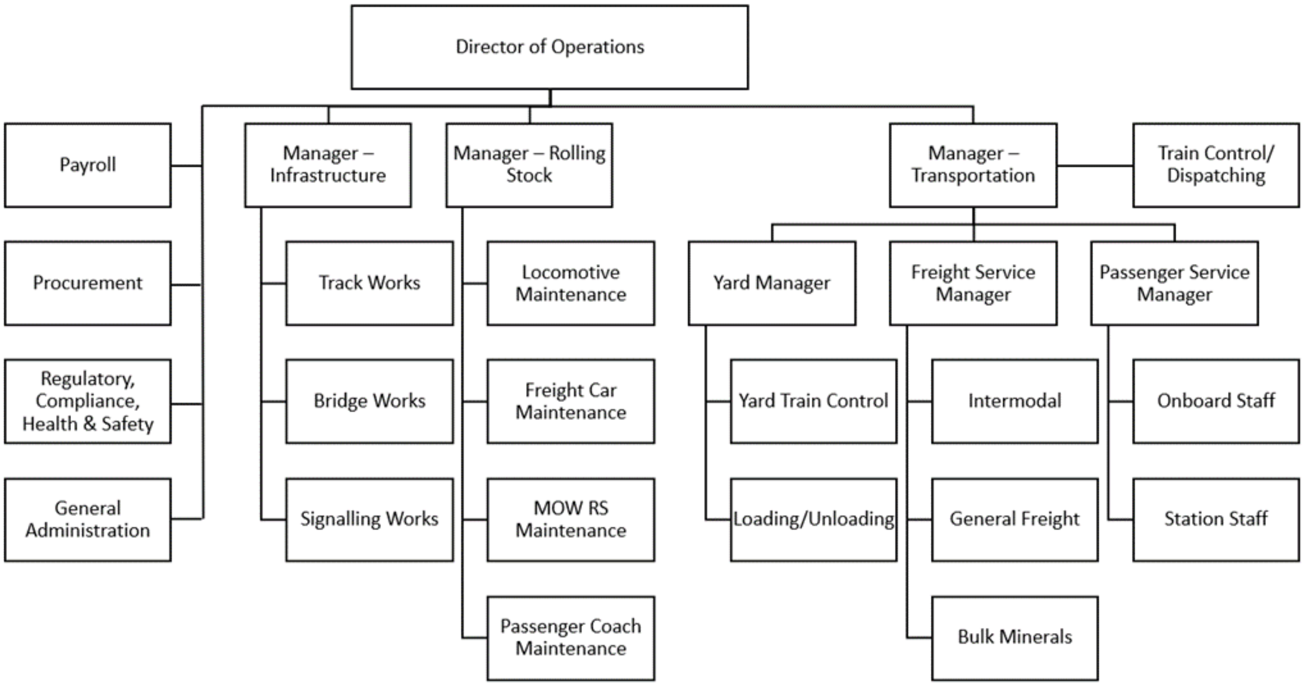



Figure 5-1: Proposed Railway Organisation Chart

The different types of facility required by the railway are distributed amongst the communities serves as shown in Table 5-5.

Table 5-5: Locations of Operating Buildings and Facilities

| | Matagami | Waskaganish | | Chapais | Waswanipi |
|---|---|---|---|---|---|
| System Headquarters | X | | | | |
| Rolling Stock Maintenance Shop | X | | | | |
| Maintenance of Way Buildings | X | X | | X | |
| Passenger Stations | X | X | | X | X |

Railway staff will be based at the various communities served by the railway as shown in  Table 5-6Table 5-5.

Table 5-6: Permanent Railway Staff by Department

| | Billy Diamond | Grevet - Chapais |
|---|---|---|
| Head Quarters | 12 | 2 |
| Operations | 74 | 18 |
| Mechanical | 45 | 2 |
| Track Maintenance | 29 | 11 |
| Passenger Services | 17 | 3 |
| **Total** | **177** | **36** |

The System Headquarters staff can be located in the office area of the Rolling Stock Maintenance Shop, as are the Management team for the Rail Operations. The Rollingstock Maintenance Building is located beside the Matagami freight yard and the service tracks to the shop are accessed from the principal ladder track of the yard. The general arrangement of the Rollingstock Maintenance Building (or Shop) is shown in Figure 5-2:

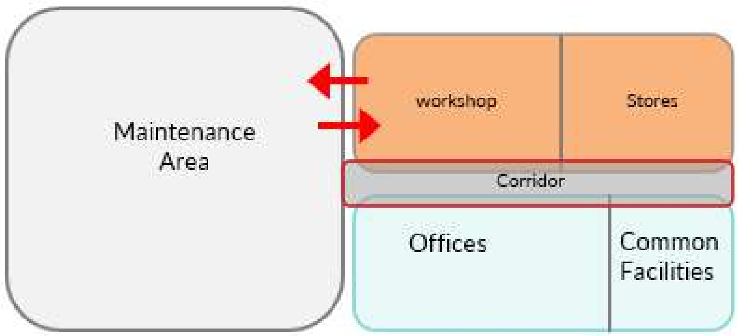
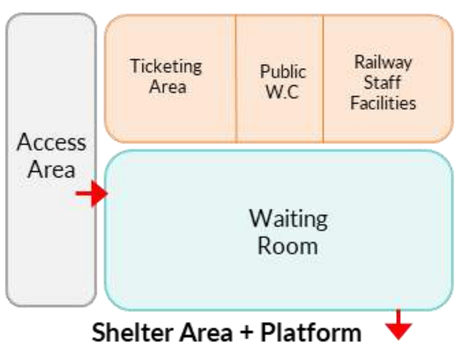



Figure 5-2: General Arrangement of the Rolling Stock Maintenance Shop

Maintenance of Way buildings provide facilities for the maintenance-of-way staff, the garaging of rail bound maintenance of way equipment and areas for carrying-out minor repairs on maintenance-of-way equipment

Passenger stations comprise a parking area, basic passenger facilities and railway staff facilities, as shown in Figure 5-3.



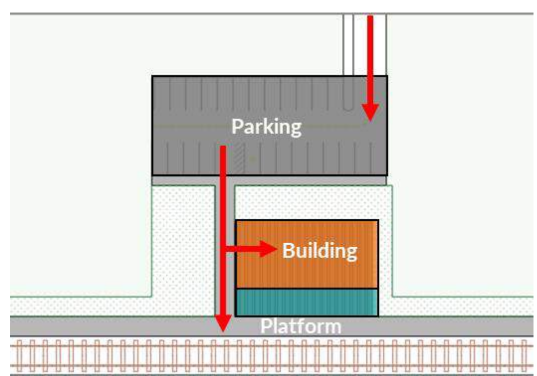
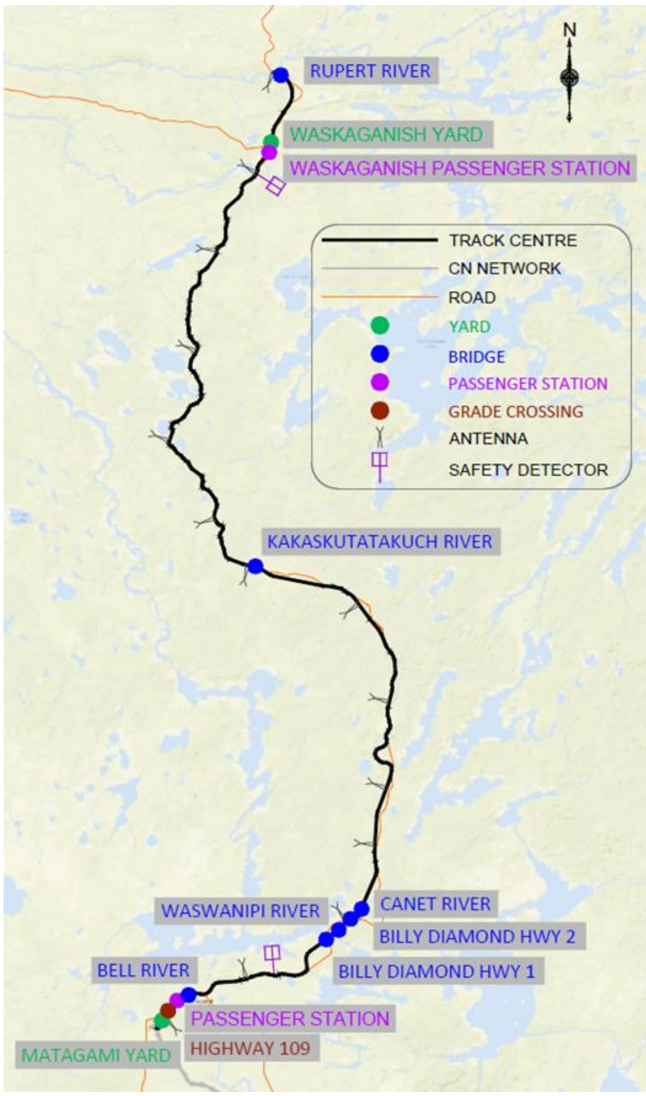




Figure 5-3: General Arrangement of a Passenger Station

# 6. RAILWAY INFRASTRUCTURE

## 6.1 ALIGNMENT GEOMETRY AND CORRIDOR

Two sections of railway have been studied, a new line of about 250 km between Matagami and the Rupert River and the rehabilitation of approximately 160 km abandoned section of the CN Chapais Subdivision between Grevet and Chapais. Both lines have been designed to Transport Canada standards for passenger service speeds of 100 km/h (60 mph) and freight service speeds of 65 km/h (40 mph).




Much of the Billy Diamond Railway shares the same transportation route as the Billy Diamond Highway, using a corridor up to 100 m from the highway (60% of total alignment within 100m of the Billy Diamond Highway).

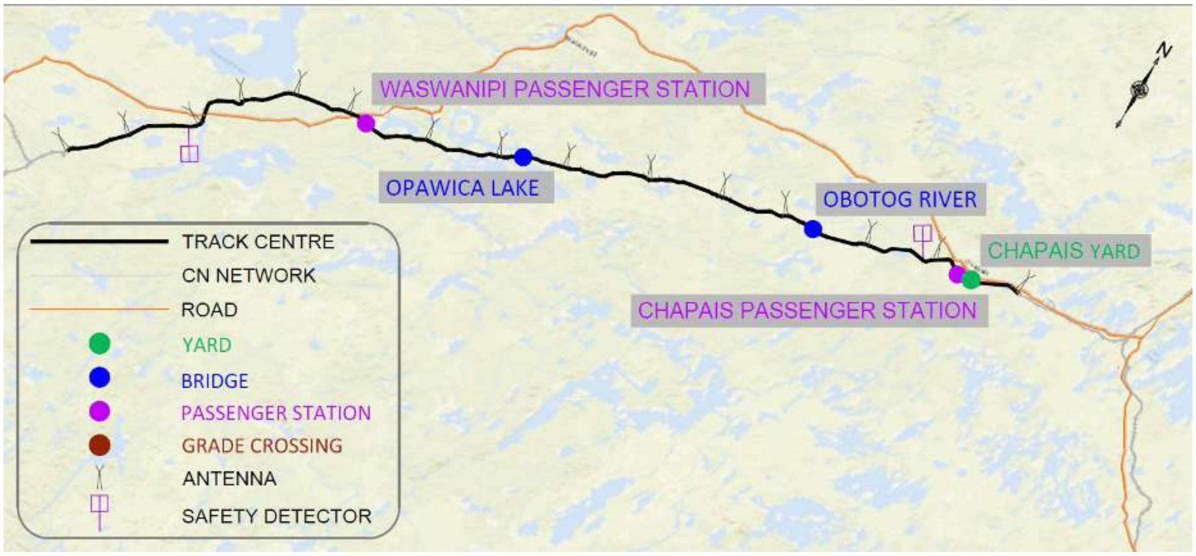
The route crosses Highway 109 at grade near Matagami, crosses over the Billy Diamond Highway twice, to the west of Matagami and remains on the west side of the highway thereafter.

Curvature and gradient limits are different for railway than a road and some diversions out of the 100m corridor are needed to accommodate the more restrictive railway geometry and to avoid incursions into the highway right-of-way. The adopted plan and profile present no speed restrictions and fully complies with the set standards.

The five major river bridges, all over 100m in length, are shown on the adjacent plan with the locations of the passenger stations and railway yards.

Railway signalling devices and the location of train safety equipment is also indicated on the plan.

The railway linking Grevet to Chapais is a re-commissioning of the abandoned portion of CN's old Chapais Subdivision.




The line follows the existing subgrade both in plan and in profile. To avoid construction outside the existing right of way and to use the as many of the existing bridges as possible speed restriction are needed for approximately 11.5 km.

The two longest bridges that need replacing are on the plan above with the locations of the passenger stations and railway yards. Railway signalling devices and the location of train safety equipment is also indicated on the plan.

## 6.2 Civil Works

Both lines are of single-track configuration with passing sidings, both have 2 passing sidings. Billy Diamond also has a timber loading siding about 60km north of Matagami and the Grevet-Chapais line has a set of exchange tracks at Grevet. A standard track structure has been adopted using timber ties with tie plates and 115 lb rail, as shown in Figure 6-1.

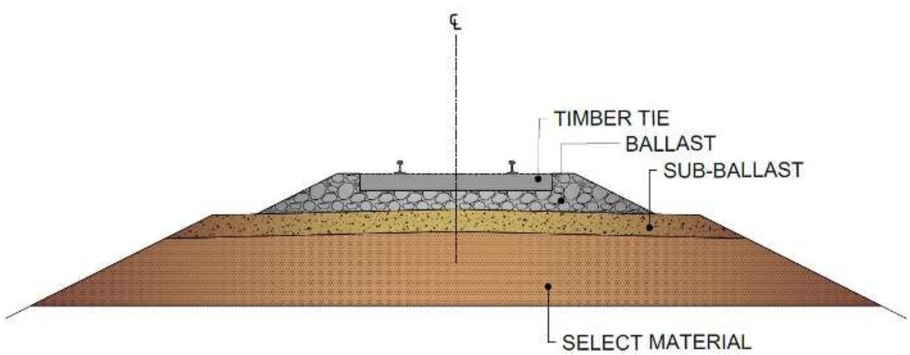



Figure 6-1: Standard Railroad Track Structure

Billy Diamond has a completely new subgrade and uses 17 bridges and 300 culverts. Many of the bridges will parallel the existing road bridges on the Billy Diamond Highway as illustrated in Figure 6-2

Figure 6-2: Conceptual Billy Diamond Road and Railway River Crossing (Approximately KP 253)

Grevet Chapais also needs 9 bridges and 181 culverts replaced. Table 6-1 quantifies the work for key components required for both lines.

Table 6-1: Rounded Key Quantities by Line

| | Billy Diamond | Grevet - Chapais |
|---|---|---|
| Length of Main line (km) | 253 | 165 |
| Length of Secondary Track - Yards and Passing loops (km.) | 17 | 10 |
| Fill (cu .m.) x $10^6$ | 7,000 000 | 1,700,000 |
| Cut (cu .m.) x $10^6$ | 10,000,000 | 1,700,000 |
| Borrow material (cu .m.) x $10^6$ | 0 | 200 000 |
| Rail (tonnes) km | 540 | 350 |
| Timber ties (each) | 506,000 | 327,000 |
| Track ballast (cu.m. or tonnes) | 850,000 | 547,000 |
| Length of Bridges (m) | 1,518 | 495 |
| Number of Culverts (ea.) | 300 | 139 |

## 6.3 SIDINGS AND YARDS

Table 6-2: Sidings and Exchange Tracks Summary

| | Billy Diamond | Grevet - Chapais |
|---|---|---|
| Number of sidings | 3 | 2 |
| Total length of siding tracks (m) | 4,910 | 2,230 |
| Number of backtracks for sidings | 3 | 2 |
| Total length of backtracks (m) | 820 | 550 |
| Exchange tracks | 0 | 1 |
| Total length of exchange tracks (m) | 0 | 2,100 |
| Number of backtracks for exchange tracks | 0 | 1 |
| Total length of backtracks for exchange tracks (m) | 0 | 280 |

Sidings are provided to allow opposing trains to pass, with back tracks to stable track maintenance equipment. Two (2) passing sidings are required on Billy Diamond (Table 6-2 adjacent) with a separate timber loading/ siding at KM60. Two (2) passing sidings are also provided on the Grevet-Chapais line with interchange tracks close to Grevet for exchange of freight cars with CN.

Table 6-3: Yard Tracks Summary

| | Matagami | Waskaganish | Chapais | Grevet |
|---|---|---|---|---|
| Intermodal /General Freight Tracks | | 1 | | |
| Bulk Loading Tracks | | 2 | 2 | |
| Interchange Tracks | 2 | | | 2 |
| Arrival/Departure Tracks | | 1 | 2 | |
| MoW Service Tracks | 2 | 1 | 1 | |
| Equipment Storage Tracks | 3 | 3 | 3 | |
| Locomotive Turning Tracks (Wye) | | 1 | 1 | |

Freight yards provide tracks and laydown areas for loading/unloading freight trains, carrying out safety inspects, garaging idle equipment, turning locomotives and effecting minor running repairs.

## 6.4 SIGNALLING AND TELECOM

A Fixed Block signalling system with axel counters in combination with some PTC components has been selected which uses antennae, up to 20m tall, distributed along the track at intervals varying between 11km and 25km on the Billy Diamond line and 9km and 15km on the Grevet Chapais line

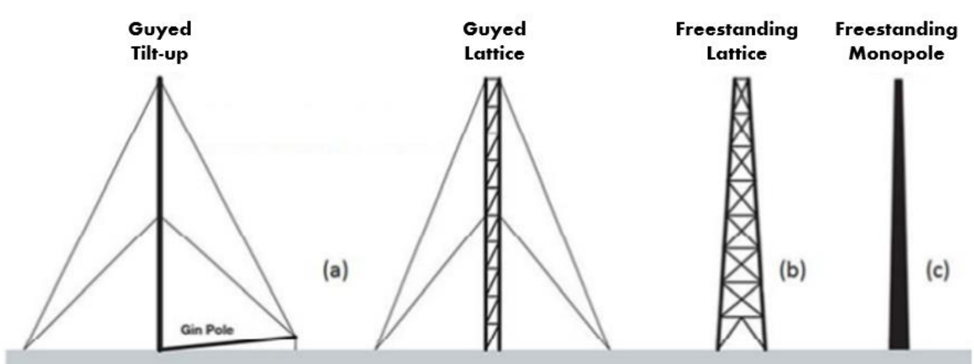



Figure 6-3: Typical Antenna Configurations

The telecommunication systems provide services to other systems. The networking infrastructure (LAN and WAN) open standard Inter protocols for the ground-based network. Cybersecurity appliances are embedded in the networking infrastructure with GPS network time synchronization and Network Management System (NMS).

Mobile voice communications are provided which meet the communication requirements of CROR and cover the entire rail network. A SCADA system is also provided to handle command and control of non signaling system equipment, which also to provides a centralized handling of alarms and events for all of the provided systems. Access Control is also be provided to secure the facilities of the network. A CCTV system complements the access control and provides site and passenger security

Safety detectors would be used be used to verify that the locomotive and rail cars are in good condition while in transit. Train condition detectors will be placed near the  Matagami and Waskaganish stations on the Billy diamond line and near Chapais station and Grevet on the Grevet-Chapais line as shown in the maps in Section 6.1.

Power is required at strategic locations along the railroad to power detectors and other track appliances. A connexion will be established with Hydro Quebec's high voltage network and step-down transformers will provide the appropriate low DC voltages needed.

Connections to the Hydro Quebec network and medium voltage lines installed along the track will provide power to the Billy Diamond and Grevet Chapais lines.

## 6.5 ALTERNATIVE POWER OPTIONS

The Alternative Train Propulsion Technologies study will provide a discussion and validation of the feasibility of using alternative train propulsion modes for Phase 1 of the Billy Diamond Railway, with the aim of reducing the lifespan GHG emissions of the project. The study is considering:

- Battery-powered trains;
- Fully electric trains powered by overhead infrastructure (catenary);
- Hybrid trains, including combinations of battery/diesel and battery/electric(catenary) propulsion.

Electrified passenger and freight railways are fairly common around the world, but not in North America (mainly attributed to lack of battery technology and not enough financial incentive for railways to invest in un-tested technology), while some transit railways are electrified, no electric freight locomotives are manufactured or sold in North America. Importing locomotives is challenging due to locomotive standards and constructing a standard electrified railway requires a significant capital investment for the catenary infrastructure.

The battery technology for powering trains is under development, but no extensive real-world testing has been done in the context of freight operations. Developments in battery technology for the automotive industry are likely to result in continuous improvements to such aspects as the capacity, lifespan, and cost of batteries. Such benefits will, over time, contribute to the technology becoming more viable for train propulsion.

Given the challenges and cost of full railway electrification and the current status of battery technologies, a reasonable approach would be to adopt a hybrid scenario. If battery driven locomotives are used in combination with diesel locomotives, they will provide a significant reduction of the GHG emissions and allow operators to gain experience while testing the viability of battery-powered locomotives. Over time, as the technology matures, the transition to full battery-powered operations should be possible.

# 7. ROADS

## 7.1 INTRODUCTION

The existing road network (728 km) covered by this study consists of three access roads. The first links the James Bay Road to the communities of Waskaganish, Eastmain and Wemindji, the second is the Route du Nord which links Chibougamau to the James Bay road and lastly, the access road which connects the community of Nemaska to the Route du Nord.

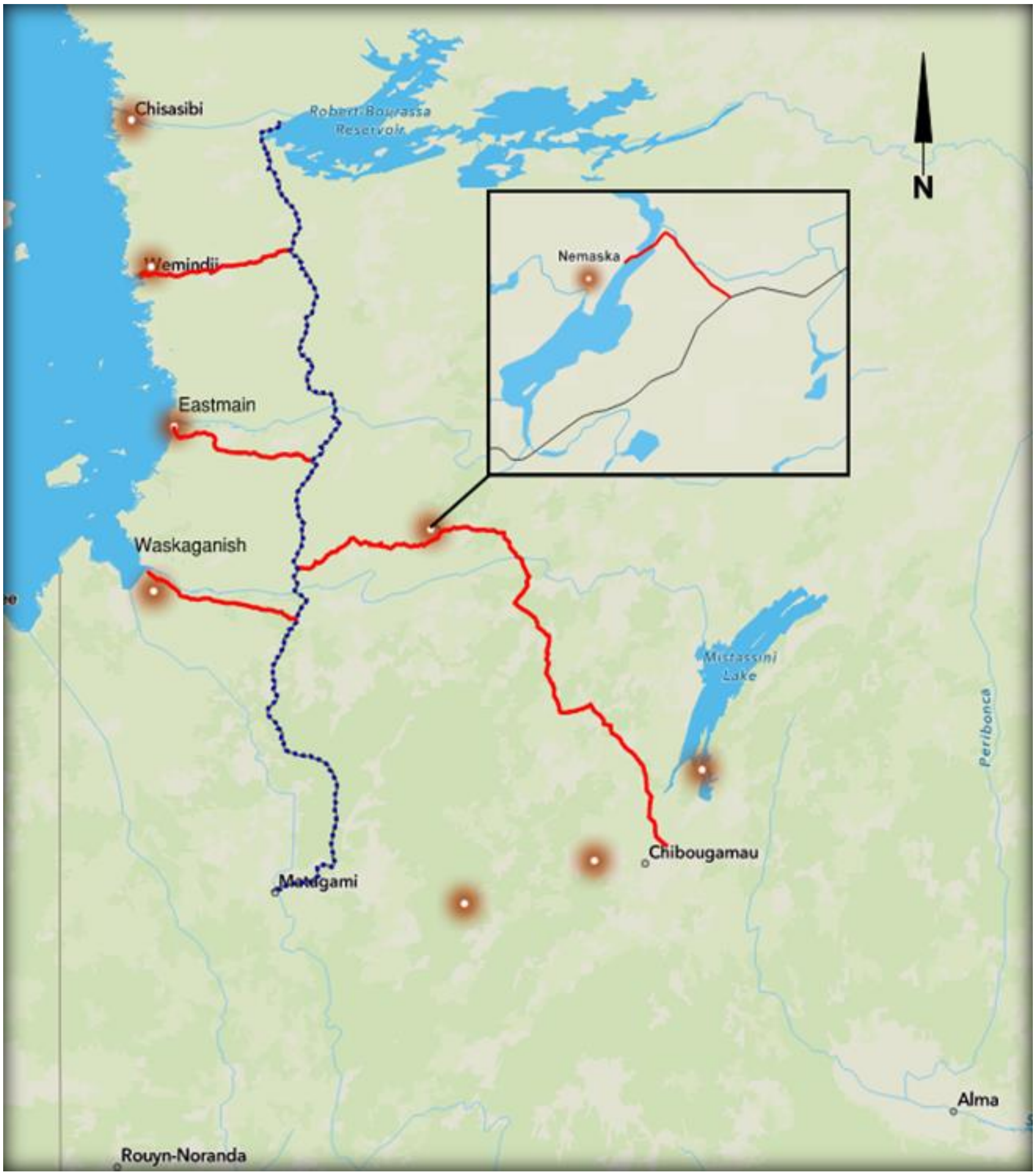



Figure 7-1: Community Access Road Location Plan

**The Waskaganish road** (102 km) connects to kilometer marker 237 of the James Bay Road. Only 22,3 km located at the west end are paved.

**The Eastmain road** (104 km) connects to kilometer marker 350 of the James Bay Road. Only 30 km located at the west end are paved.

**The Wemindji road** (98 km) connects to kilometer marker 518 of James Bay Road and was built in the 1990s. Only 22,6 km located at the west end of the road are paved.

**The Nemaska road** (10 km) connects to kilometer marker 296 of the Route du Nord. Only 4 km located at the north end of the road are paved.

**The Route du Nord** is a 407-kilometre, gravel road connecting Chibougamau to the James-Bay Road. The road has opened up access to the Nemaska community and the forestry industry.

The purpose of this report is to outline the design of the existing access roads to determine possible improvement works according to today's geometric design standards, while improving quality of life for local residents.

### 7.1.1 Scope and Objective

To improve the access roads to the communities and the Route-du-Nord, a technical assessment, from the existing plans, of the different characteristics of the existing roadway was carried out to determine its deficiencies. The problems raised by the stakeholders and the road users of the area were considered in the establishment of corrective measures. Without limitation, the following elements were analyzed:

- Horizontal geometry and superelevation
- Vertical profile
- Cross section
- Culverts
- Issues raised by the community
- Public services
- Safety barrier

#### *7.1.1.1 Analytical Approach for Existing Roads*

The geometry of the segments of the road corridor, located upstream and downstream of the project site have been considered to maintain coherence with the geometry of the overall corridor, since a one-time change to the geometry of the road without considering the rest of the corridor risks compromising safety if no other improvements are planned. Therefore, specific interventions must be consistent with the whole sector to avoid sudden changes in the road environment, modifying the driver's perception and expectations. The cross section, the operating speed and the driver's workload are the main elements considered in this analysis. The following four principles should be considered in assessing the consistency of a layout: the homogeneity of the cross section, the uniformity of driver operating speeds, consistency with the environment crossed and crash history.

### 7.1.2 Community Access Roads and Route du Nord

#### *7.1.2.1 Horizontal Geometry*

An analysis of the horizontal alignment of the access roads was carried out to validate the operating speed at which users can safely navigate existing horizontal curves. The following table presents the result of this analysis.

Table 7-1: Horizontal Curves and Exiting Permissible Speeds

| | Total | More than 80 km/h | 70–79km/h | 60–69km/h | Less than 60 km/h |
|---|---|---|---|---|---|
| Wemindji | 78 | 66 | 9 | 3 | 0 |
| Eastmain | 106 | 94 | 12 | 0 | 0 |
| Waskaganish | 62 | 62 | 0 | 0 | 0 |
| Nemaska | 24 | 12 | 7 | 4 | 1 |
| Route du Nord | 376 | 327 | 35 | 12 | 2 |
| **Total** | **646** | **561** | **63** | **19** | **3** |
| | | ☑ | ☑ | 55 km/h 65 km/h | ☒ |

☑ Compliant ☒ Uncompliant

For low volume roads with less than 400 vehicles per day, the design speed is the same as the posted speed.

Based on this analysis:

1. 624 horizontal curves do not require intervention for operating speeds greater than 70 km/h;

- For horizontal curves corresponding to an operating speed of 60 km/h, the installation of horizontal curve signs (D-110) with a recommended speed sign (D-110-P-2) of 55 km/h is required;
- For horizontal curves representing operating speeds lower than 60 km/h, improving the horizontal curve radius is recommended.

### 7.1.3 Superelevation

When the horizontal alignment is in a straight line, the roadway has a normal crown with cross slopes of 2%. In horizontal curves, a superelevation varying according to the radius of curvature and the design speed is required. An analysis of the existing superelevation in the existing horizontal curves has been carried out and the non-conforming horizontal curves will be corrected by regrading with additional granular material.

### 7.1.4 Vertical Profile

The maximum slope is generally determined by the terrain and the design speed. Steep grades can reduce construction costs but can significantly impact operating conditions (snow, frost). According to the design guidelines, slopes greater than 10% could be problematic, as higher downslopes increase breaking distance, while higher upslopes reduce operating speeds, especially those of heavy vehicles.

Table 7-2: Slopes greater than 10%

| | Slopes greater than 10% |
|---|---|
| Wemindji | - |
| Eastmain | - |
| Waskaganish | - |
| Nemaska | - |
| Route du Nord | 15 |
| Total | 15 |

Considering that it is an existing road with low traffic flow, that the majority of the slopes are close to the 10% limit and that they have a short length, slopes slightly higher than those recommended for other roads are acceptable in this case. In addition, a slight slope correction would have little impact on the heavy vehicle operating speeds.

An analysis of the existing sag and crest vertical curves was also carried out to validate whether they allow for sufficient sight distance and are sufficiently long for the design speed.

Table 7-3: Vertical Curves and Exiting permissible Speeds

| Vertical curves speed | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Roads | Total | | 80 km/h | | 70 km/h | | 60 km/h | | 50 km/h | | 40 km/h | | <40 km/h | |
| | Crest | Sag | Crest | Sag | Crest | Sag | Crest | Sag | Crest | Sag | Crest | Sag | Crest | Sag |
| Wemindji | 193 | 373 | 175 | 331 | 12 | 17 | 5 | 11 | 1 | 10 | | 4 | | |
| Eastmain | 275 | 299 | 259 | 249 | 11 | 27 | 4 | 15 | 1 | 7 | | 0 | | 1 |
| Waskaganish | 183 | 189 | 183 | 185 | | 2 | | 2 | | | | | | |
| Nemaska | 29 | 29 | 27 | 26 | | | 2 | 2 | | | | | | |
| Route du Nord | 899 | 984 | 631 | 537 | 156 | 99 | 101 | 137 | 10 | 132 | 1 | 74 | | 5 |
| Subtotal | 1579 | 1874 | 1275 | 1328 | 179 | 145 | 112 | 167 | 12 | 150 | 1 | 78 | | 6 |
| | | | ☑ | | ☑ | | ⚠ | ☑ | ⚠ | ☑ | ☒ | ☑ | - | - |
| Total | 3453 | | 2603 | | 324 | | 279 | | 162 | | 79 | | 6 | |

☑ Compliant ☒ Uncompliant

Due to the large number of non-compliant vertical curves and the very low traffic flow observed, it is suggested not to correct sag curves that would have only a limited effect on user safety. However, and in order to limit construction costs, it is recommended to install restricted visibility signs in crest curves for speeds of 50 and 60 km/h (124 vertical curves). For speed below 40 km/h, it is desirable to carry out repair work (2 vertical curves).

### 7.1.5 Cross Section

Based on the comments of community stakeholders, the current paved surfaces are too narrow, and road users typically drive in the center of the roadway (risk of frontal collision or leaving the road). Also, the existing shoulders are unstable and do not allow vehicles to park alongside the road to access nearby resources. Using an inventory of the existing roadway widths, an assessment of the space available for the future development of the road lanes, shoulders and eventual lifting of the roadway with additional granular material and pavement was made. This assessment assumed the road would remain on the existing platform to limit additional encroachments in wetlands and minimize impacts on watercourses at the culverts, while salvaging the existing roadway as a sub-base. To increase visibility and improve the drainage of the side ditches, clearing of the roadside and cleaning of the side ditches is suggested using the lower third method.

It is also recommended that the access road be paved, it reduces fine dust particles that can have an impact on the respiratory tract, reduces the frequency of crashes due to loss of visibility and reduced traction on a gravel road, minimizes impacts of dust on the environment (vegetation and water) and reduce damage to vehicles.

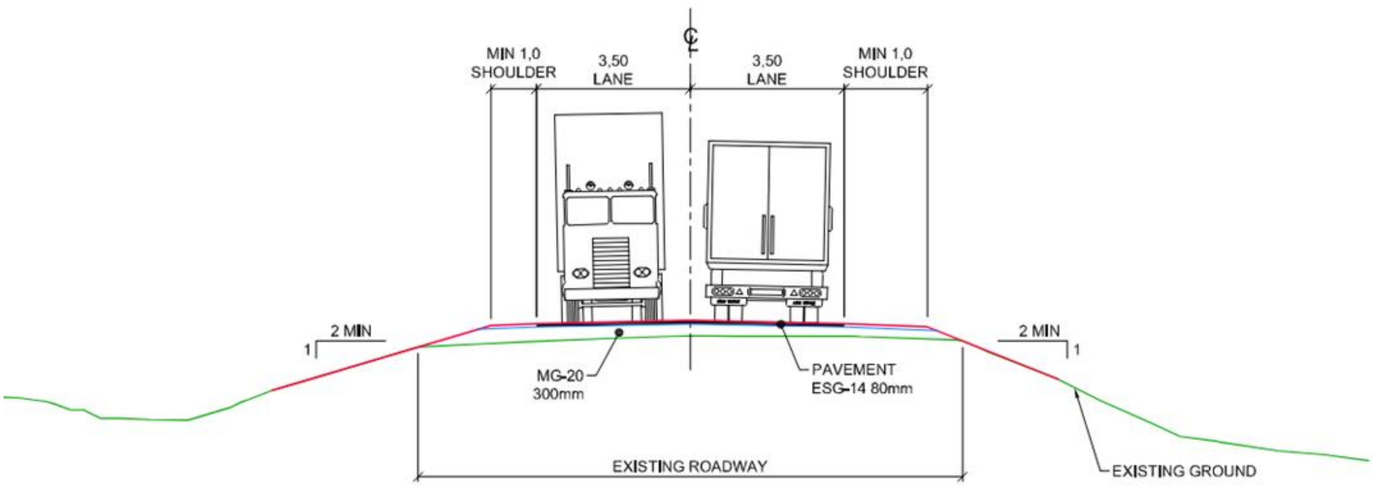



Figure 7-2 - Roadway cross section

Based on this analysis, an E type cross section is proposed with some modifications but maintaining the total width:

- 3,5 m, lanes to facilitate trucking;
2. gravel shoulders of 1 m minimum;
3. maintaining of existing embankment slopes (2H-1V min.).

The proposed roadway structure above the existing road is as follows, backed by geotechnical analysis and recommendations:

4. 300 mm granular recharge with MG 20;
5. 80 mm paved surface with ESG 14 asphalt.

### 7.1.6 Culverts

The assessment of the condition of the existing culverts, consisting mainly of corrugated steel pipe, was based on data provided by Ministère des Transports et de la Mobilité durable (MTMD) and site visits. The following table presents the condition classes according to the condition index of the culvert. It should be noted that the complete inventory of culverts was not available.

The inspection of 54 culverts was carried out in the summer of 2022 and confirmed the results obtained from the MTMD.

Table 7-4: Culvert Condition Classes

| Condition Class | Definition |
|---|---|
| A | Culverts free from defects or having negligible defects requiring no intervention |
| B | Culverts with slight defects requiring no major intervention in the short term. |
| C | Culverts with significant defects requiring no major short-term intervention. Minor interventions may be required to extend the life of the culverts. |
| D | Culverts in poor condition requiring minor or major interventions in the short term. |
| E | Culverts in very poor condition requiring minor or major interventions in the short term. |

For this study, condition class C, D and E culverts are replaced. The following table presents the summary of the condition of the culverts available.

Table 7-5: Distribution and Conditions of Culverts (MTMD)

| | km | Condition Class A or B | Condition Class C or D or E | Total Culverts Inspected |
|---|---|---|---|---|
| Wemindji | 17–98 | 100 | 19 | 119 |
| Eastmain | 9–104 | Not inspected | Not inspected | Not inspected |
| Waskaganish | 24–102 | 135 | 7 | 142 |
| Route du Nord et Nemaska | 0-304 | 415 | 209 | 624 |
| **Total** | | **650** | **235** | **885** |

The existing corrugated steel culverts are already over thirty years old. Assuming that the new roads will be paved, it is recommended that all the culverts be replaced to avoid any excavation of the newly paved surface in the short-term future. The use of a longitudinal transition of 20H-1V during the excavation is desirable to avoid differential settlement of the road under the effect of frost. Hydraulic studies, environmental inventories, including presence of fish species, will be necessary prior to culvert replacement.

### 7.1.7 Crash Barriers on Access Roads

A summary inventory of the existing crash barriers at the culverts was carried out. This assessment found that there is a significant lack of crash barriers. An extra 1.2m shoulder width is required for their installation and proper use. The following table provides a summary of the inventory of these devices.

Table 7-6: Crash Barrier Work Requirements

| | Existing to be Replaced | New Sites | Sites with Devices Not Required | Total Sites Analyzed |
|---|---|---|---|---|
| **Wemindji** | 1 | 143 | 0 | 144 |
| **Eastmain** | 8 | 132 | 0 | 140 |
| **Waskaganish** | 2 | 144 | 7 | 153 |
| **Route du Nord et Nemaska** | 40 | 557 | 40 | 637 |
| **Total** | **51** | **976** | **47** | **1074** |

### 7.1.8 Integration of Cree Perspective and Knowledge

The principal community concerns raised by stakeholders and proposed solutions are tabulated below.

Table 7-7: Issues raised and proposed solutions

| Issues raised | Suggested solutions |
|---|---|
| Roadway too narrow when passing vehicles | Revision of the cross-section of the road |
| Narrow and unstable shoulders | |
| Difficulty parking on the side of the road | Development of access, parking areas and turning areas along the road corridor |
| Road too narrow near communities and used by pedestrians and hunters | Development of multipurpose trails near communities |
| Lack of signage (numbers of traplines, camps, moose, etc.) | Complete overhaul of signage |
| Various overflowing culverts and presence of beavers | Replacement of culverts and installation of beaver barriers |
| Dangerous curves and slopes | Dangerous curves and slopes will be improved, addition of danger signage |
| Rock near the roadway | The rock located inside the lateral clearance of users will be excavated. |
| Loss of visibility due to roadside vegetation | Roadside vegetation trimming |
| Roadway erosion | Stone embankment stabilization |
| Dust | Asphalt pavement surfacing |

### 7.1.9 Public services

The roads are crossed by Hydro-Québec transmission and distribution lines. Due to the proposed improvements, the roadway will be lifted. Consequently, the vertical clearances under the power line conductors need to be validated to ensure that Hydro-Québec standards are met in this regard. Table 7-8 details the number of overhead line crossings for the different roads.

Table 7-8: Power Line Crossings

| Access Road | Number of Crossings of Hydro-Québec Lines |
|---|---|
| Wemindji | 0 |
| Eastmain | 12 |
| Waskaganish | 2 |
| Route du Nord et Nemaska | 39 |
| **Total** | **53** |

Additionally, some sections of these roads have underground fiber optic cables. Cable locations need to be validated for each section of road, to ensure that they are protected during culvert replacement work.

## 7.2 ACCESS ROAD TO MISTISSINI - TECHNICAL ASPECTS

The community of Mistissini has expressed the need for a second access road due to safety concerns, such as infrastructure failure on the current single access road. The Grand Alliance has included the identification and cost estimation for establishing this second access road in the Vision Eeyou Istchee plan.

The most recent aerial photos from 2012 and 2013 were acquired, and with surface deposit layers and LIDAR topography, two route options were established, each with two variations. The proposed routes connect the Mistissini community to PK 32.5 of the Northern Road (Figure 7-3).

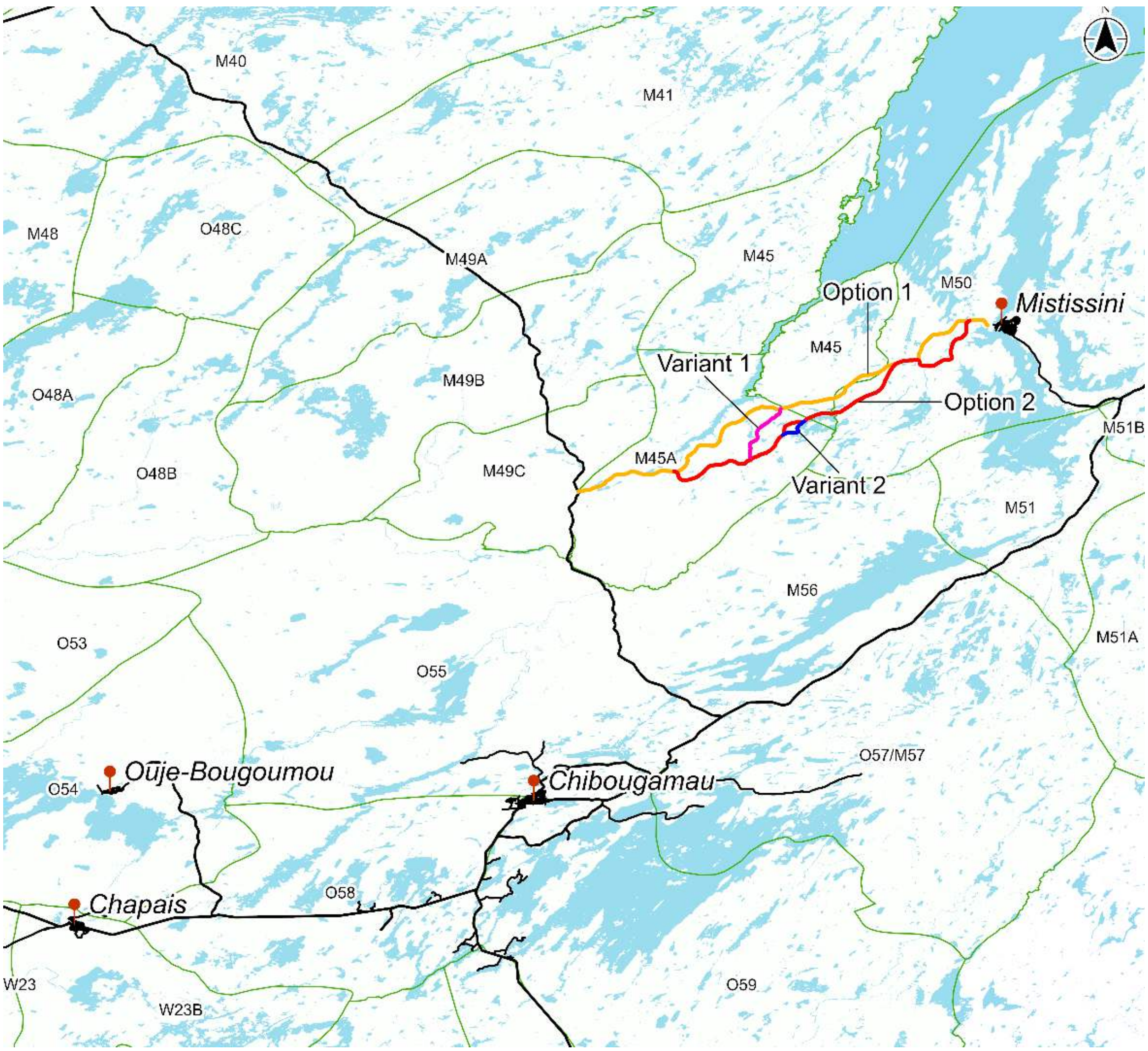



Figure 7-3 : Location of proposed options

Initially, the chosen routes prioritize the use of existing corridors to address concerns raised by the Eeyou Planning Commission regarding potential territorial division caused by new routes. Subsequently, physical factors such as surface deposits, wetlands, and watercourses were taken into consideration in making the final route selection.

The two proposed alignments, without taking into account the variants, totalled 42.3 km for Option 1, and 45.0 km for Option 2. Option 1 uses 14.2 km of more or less recent road corridors, and Option 2 uses 25.8 km. The characteristics of the alignments are presented in Table 7-9 below.

Table 7-9: Proposed route Characteristics

| Criteria | Option 1 | Option 2 |
|---|---|---|
| Total length | 42,3km | 45,0km |
| Length within existing routes | 14,2km | 25,8km |
| Quality of surface deposits | Mieux | Bon |
| Number of stream crossings | Plus | Moins |
| Length passing through potential wetlands | 5,4km | 4,9km |
| Length with potential recreational conflicts | 18,1km | 3,8km |

The design parameters used for the road are similar to those used in other communities. However, given that there are forestry activities in Mistissini's territory, particularly in the area under study, we propose a standard road section that is 2 meters wider than the road proposed in the rest of the Grand Alliance study, but unpaved. This proposal respects the local communities' desire for a wider and therefore safer road. An unpaved road will allow forestry activities without oversize trucks damaging the pavement. Until receiving community feedback on this proposal, the design parameters initially proposed by the Grand Alliance will be used for the road's design.

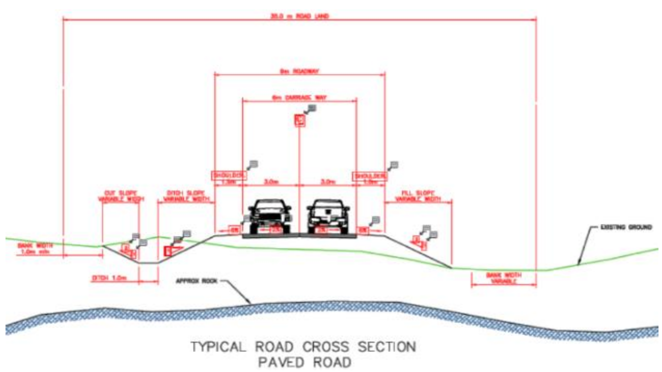



Figure 7-4 : Section de route proposée pour La Grande Alliance

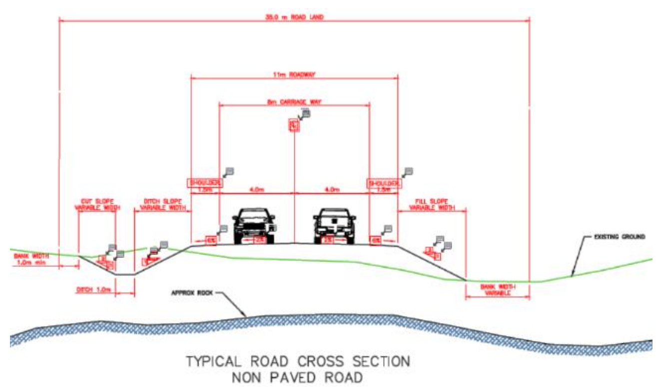



Figure 7-5 : Section de route de Mistissini proposée

The proposed routes were presented to the concerned trapping masters, who voted in favor of Option 2 with Variant 2.

Option 2's route was optimized, and a concept was developed to estimate the costs. The optimized Option 2 route utilizes 29 km of existing corridors, 12 km of new road, and 4.5 km of already constructed road. In total, 31 stream crossings have been identified. New culverts will need to be installed, and some others will need to be replaced.

# 8. COST ESTIMATE AND SCHEDULE

## 8.1 CAPITAL EXPENDITURE

The total amount of railway capital expenditure (CAPEX) is $3.2 billion, such as detailed in Table 8-1.This amount excludes GST and QST. It includes owner's fees of 17% and a contingency of 20% but excludes the risk reserve. The structure of this cost: local works (earthworks, forest road/trail, drainage and culverts, ballast) representing 38.0 % of total cost; bridges and structures with 11.7 % of total cost; railway equipment (rail, ties, level crossings, signalling and telecommunications) with 46.2 % of total cost; and buildings and storage with 4.1 %. T he capital costs amount to $2.1 billion (65%) for the BDHR and $1.1 billion for the GCR (35%)."

Table 8-1: Railway Capital Expenditure

| Million dollars | BDHR | GCR | Total | % |
|---|---|---|---|---|
| Earthworks | 571.2 | 157.8 | 729.0 | 22.6 % |
| Forest road / snowmobile trail | 0.0 | 115.3 | 115.3 | 3.6 % |
| Drainage and Culverts | 84.0 | 24.0 | 108.0 | 3.4 % |
| Bridges and structures | 256.4 | 120.7 | 377.2 | 11.7 % |
| Ballast | 165.0 | 106.1 | 271.1 | 8.4 % |
| Rail and turnouts | 553.3 | 360.5 | 913.8 | 28.4 % |
| Ties | 284.4 | 183.3 | 467.7 | 14.5 % |
| Level crossings | 2.7 | 1.4 | 4.1 | 0.1 % |
| Signaling and telecoms | 13.8 | 14.4 | 28.2 | 0.9 % |
| Stations and buildings | 36.1 | 6.3 | 42.3 | 1.3 % |
| Stocking spaces | 57.6 | 24.9 | 82.6 | 2.6 % |
| Environmental measures | 5.6 | 0.0 | 5.6 | 0.2 % |
| Rolling stock | 52.1 | 22.7 | 74.8 | 2.3 % |
| **Total** | 2,082.1 | 1,137.6 | 3,219.7 | 100 % |
| **%** | 64.7 % | 35.3 % | 100 % | |

Note: Due to rounding, the sum of the elements may not correspond to the total.

The total CAPEX for road construction amount to $1.2 billion, before taxes, including related expenses of 14% and a contingency of 20%, but excluding the risk reserve, as detailed in Table 8-2.

Table 8-2: Road Capital Expenditure

| (M$) | Waska-ganish | Eastmain | Wemindji | Nemaska | Mistissini | RDN | Total | % |
|---|---|---|---|---|---|---|---|---|
| Work preparation | 39.9 | 36.0 | 36.4 | 6.8 | 16.9 | 119.0 | 254.8 | 20.7 % |
| Earthworks | 15.6 | 11.3 | 11.7 | 1.3 | 17.1 | 39.9 | 96.8 | 7.9 % |
| Roadway and pavement | 92.1 | 79.7 | 78.7 | 8.9 | 36.6 | 259.4 | 555.5 | 45.1 % |
| Drainage and structures | 20.0 | 13.9 | 18.7 | 1.5 | 3.1 | 54.2 | 111.5 | 9.1 % |
| Traffic maintenance and signaling | 0.8 | 1.1 | 1.1 | 0.1 | 0.7 | 3.2 | 7.0 | 0.6 % |
| Other works | 7.7 | 5.4 | 5.9 | 0.7 | 1.5 | 19.7 | 41.0 | 3.3 % |
| Landscaping | 0.2 | 0.2 | 0.2 | 0.0 | 0.1 | 0.5 | 1.1 | 0.1 % |
| Environmental measures | 0.4 | 0.5 | 0.4 | 0.1 | 0.0 | 1.3 | 2.6 | 0.2 % |
| Administration and profit | 26.5 | 22.2 | 23.0 | 2.9 | 11.4 | 74.6 | 160.5 | 13.0 % |
| **Total** | **203.1** | **170.4** | **176.0** | **22.3** | **87.4** | **571.7** | **1,230.8** | **100 %** |
| % | 16.5 % | 13.8 % | 14.3 % | 1.8 % | 7.1 % | 46.5 % | 100 % | |

Note: Due to rounding, the sum of the elements may not correspond to the total.

## 8.2 Operating Expenditure

The operating costs (OPEX) of the railway include all current expenses necessary to ensure the operation of trains and serve the expected traffic. Costs for fuel, personnel, materials, and parts necessary for the continuous maintenance of mechanical equipment, rolling stock, and infrastructure are among the major expense categories. Annual operating expenses are estimated at $44.6 million, as detailed in Table 8-3. This estimate is for the realistic traffic forecast or base case. Given that the freight traffic is stable over time and that no passenger trains will be added over the years, the OPEX is relatively constant.

Table 8-3: Railway Annual Operating Expenditure

| (2023 $million/yr) | BDHR | GCR | Total | % |
|---|---|---|---|---|
| Management and administration | 1.3 | 0.9 | 2.2 | 4.9 % |
| Train operation | 4.8 | 2.5 | 7.3 | 16.4 % |
| Yard and Station Operation | 10.0 | 4.2 | 14.2 | 31.8 % |
| Maintenance of Way | 8.1 | 3.6 | 11.7 | 26.2 % |
| Rolling Stock maintenance | 6.5 | 2.7 | 9.2 | 20.7 % |
| **Total** | **30.8** | **13.8** | **44.6** | **100%** |
| Personnel | 22.0 | 9.2 | 31.2 | 70.0 % |
| Expenses | 8.8 | 4.6 | 13.4 | 30.0 % |
| **Total** | **30.8** | **13.8** | **44.6** | **100%** |
| % | 69.1 % | 30.9 % | 100 % | |

Note: Due to rounding, the sum of the elements may not correspond to the total.

## 8.3 CONSTRUCTION SCHEDULE

Construction work should be carried out under separate contracts:

- one for the rehabilitation of the Grevet-Chapais line, led by a rail specialized contractor;
- one for construction of the new Billy Diamond line led by a large civil works contractor, possibly incorporating track, signalling, and telecommunications sub-contractors;
- one for the rehabilitation of the community roads, led by a large civil works contractor.

The contract structure should favour Cree community companies and workers by offering sizable work packages. The overall construction period for both contracts is expected to take 5 years from contract signature to final commissioning.

The figure below provides a graphic representation of the annual cash flow for the project for years 1 through 5 of the construction period. The pre-construction costs represent the funds spent moving the project to construction start-up and include detailed design, land acquisition, the governments' Project Implementation Unit (PIU), and costs for a transaction advisor to arrange financing.

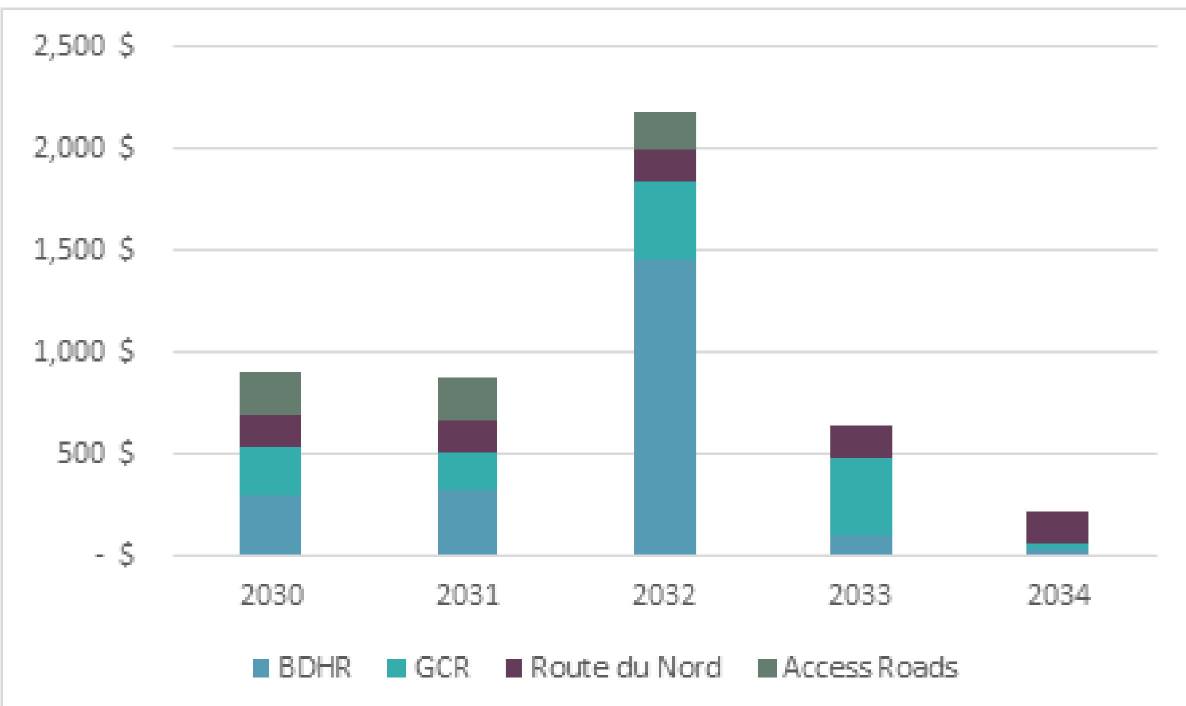



Figure 8-1: Construction period cash flow ($ million)

# 9. ECONOMIC ANALYSIS

The economic analysis is comprised of the benefit cost analysis, the economic impact assessment, and the wider economic benefits, including the employment opportunities.

## 9.1 Benefit Cost Analysis

### 9.1.1 Concepts and Parameters

The costs and benefits of the infrastructure projects are analyzed in the economic analysis from a societal perspective. The situation with the construction and presence of new rail infrastructure and of paved and improved roads is compared to the status quo situation in which they are not built but the existing roads need to be maintained.

From the viewpoint of the society, the costs include capital and operating expenditure of the new infrastructure and service at factor costs, i.e., exempt from any form of tax such as sales taxes, fuel excise taxes, or municipal taxes, as well as other external costs as the pollution or nuisances generated during the works. The new or improved infrastructure will produce benefits for shippers and passengers. The benefits include the value of the new service for users, in the form of reduction in prices, in fuel consumption and vehicle use, in journey time, improvement in comfort, etc. Benefits also include externalities (for all people and not only users) which are composed of reduction in road accidents, air pollution, greenhouse emissions.

From an economic standpoint, opportunity cost refers to the cost of choosing one option over another or the cost of foregoing the next best alternative. When deciding between two or more options, the opportunity cost of the chosen option is the value of the benefits that could have been obtained from the next best alternative, foregone. Opportunity cost is an important concept in economics because it helps decision makers evaluate the trade-offs associated with different choices. By considering the opportunity cost of a decision, more informed choices that maximize benefits and minimize costs can be made. For the LGA infrastructure program, the opportunity cost of building the BDHR and GCR to move freight and people by train rather than by car or truck is evaluated.

Economic costs and benefits are quantified in monetary value, in constant dollars of 2023 (without inflation), over a 5-year construction period followed by a 30 years of operations (2035–20654), which is a period of time long enough to obtain a reliable comparison of benefits and costs for the service life of the infrastructure. The benefits and costs are thus calculated and added up in their present value using an economic discount rate of 2.37% starting 2030. This rate is taken from the latest update of the Guide to Cost-Benefit Analysis of Public Transport Projects of the MTMD (2017).

### 9.1.2 Costs

For the 30-year period, the present value of economic capital costs, including initial construction, sustaining capital, pollution during construction, avoided capital costs by not rehabilitating the existing gravel roads, amounts to $2.2 billion for BDHR, $1.2 billion for GCR, $891 million for the Route du Nord, and $680 million for the access roads. The costs are broken down in Table 9-1.

Table 9-1: Economic Present Value of Capital Costs, 2030–2060

| Present value (2023 $M) | CAPEX | Sustaining Capital | Pollution during Construction | Total |
|---|---|---|---|---|
| BDHR | 2,077 | 55 | 96 | ***2,228*** |
| GCR | 1,132 | 23 | 30 | ***1,185*** |
| Route du Nord (improvement) | 738 | 121 | 32 | ***891*** |
| Access Roads (improvement) | 576 | 86 | 18 | ***680*** |
| Capital expenditure | 4,523 | 284 | 175 | ***4,982*** |
| Route du Nord (gravel) | (32) | (19) | | ***(51)*** |
| Access Roads (gravel) | (103) | (62) | | ***(165)*** |
| Differed Capital | **(135)** | **(81)** | | ***(216)*** |
| **Capital expenditure and Pollution during Construction** | **4,388** | **203** | **175** | **4,591** |

Note : The numbers have been rounded, so the sum of the elements may not correspond to the total.

The discounted operating costs amount to $532 million for BDHR and $181 million for GCR, as detailed in Table 9-2. The differences are primarily driven by the railway's length, annual tonnage, and level of passengers. The total passenger service operating costs are $31 million for BDHR and $10 million for GCR, amounting to a total of $41 million over the 30-year operation period. The extra road maintenance cost is marginal ($0.6 million) and is due to the presence of the new Mistissini access road since the maintenance paved roads are less than those of gravel roads.

Table 9-2: Economic Present Value of Operating Costs, 2030–2060

| Present value (2023M$) | Maintenance of Way Workforce | Rolling Stock Maintenance | Freight Operation | Passenger Operation | Total |
|---|---|---|---|---|---|
| BDHR | 144 | 39 | 319 | 31 | 532 |
| GCR | 51 | 18 | 102 | 10 | 181 |
| Railways | 195 | 56 | 421 | 41 | 714 |
| | Improved Roads | Avoided (Gravel roads) | | | Total |
| Route du Nord | 16 | -17 | | | -1 |
| Access roads | 11 | -9 | | | 2 |
| Roads | 27 | -26 | | | 1 |
| **Total** | | | | | **715** |

Note : The numbers have been rounded, so the sum of the elements may not correspond to the total.

The present value of total costs amounts to $5.3B, divided into $2.760 billion for the BDHR, $1.366 billion for the GCR, $839 million for the Route du Nord, and $517 million for the access roads.

The discounted maintenance costs amount to $11M for the access roads and $16M for the Route du Nord when they are paved (Table 9-3). The annual maintenance cost is lower for paved roads compared to gravel roads, which explains a discounted cost reduction of $1M for the Route du Nord. For the access roads, the discounted cost is higher by $1.7M due to the addition of the new access road to Mistissini. The net discounted cost thus amounts to $0.62M over the 30 years of operation. The benefits to road users are not further detailed. Network effects are presumed to be marginal because traffic volumes are low and speed differentials are negligible. However, paving the access roads and the Route du Nord will certainly improve road safety and travel comfort for users by enhancing visibility and grip during the summer period.

Table 9-3: Road maintenance costs in present value

| (M$ 2023) | Paved roads | Unpaved roads | Difference |
|---|---|---|---|
| Access Roades | 10,99 | 9,32 | 1,67 |
| Route du Nord | 16,05 | 17,09 | -1,04 |
| **Total** | **27,04** | 26,42 | 0,62 |

### 9.1.3 Benefits

From an economic standpoint, opportunity cost refers to the cost of choosing one option over another, or the cost of giving up the next best alternative. When deciding between two or more options, the opportunity cost of the chosen option is the value of the benefits that could have been obtained with the next best alternative that was abandoned.

Opportunity cost is an important concept in economics because it helps decision-makers evaluate the trade-offs associated with different choices. By considering the opportunity cost of a decision, more informed choices can be made that maximize benefits and minimize costs. For the LGA infrastructure program, the opportunity cost of building the BHDR and GCR to transport goods and people by train rather than by car or truck is evaluated.

This project will produce benefits for both freight and passenger demands, and these two segments of travel demand are treated separately.

The socio-economic benefits of phase 1 are calculated in three steps, in the following order:

- The direct benefits to train users;
- The indirect benefits to road users;
- The benefits to the wider community, including pollution reduction.

The benefits to train users are determined by evaluating consumer surplus resulting from the demand curve for shippers and passengers. The consumer surplus takes into account the following benefits:

- Time savings;
- Fuel savings;
- Vehicle operating costs;
- Consumer surplus;
- Safety.

The indirect benefits that road users receive include:

- Time savings for other road users;
- Reduced vehicle operating costs;
- Reduced fuel consumption;

- Reduced number of road accidents;
- Reduction in pollution.

The net present value of benefits is presented for railway lines in Table 9-4Table 9-4. The total benefits amount to a present value of $1.4 billion on both railway lines, $840 million on the BDHR and $554 million on the GCR. Globally, reduction in transportation costs (fuel, vehicle, shipping) explains for the largest share of the benefits ($700 million) while reduction in travel time represents a present value of $222 million, improvement in transport safety $214 million, and reduction in environment burden $89 million.

Table 9-4: Economic Present Value of Railway Benefits

| Present value (2023 $M) | BDHR | GCR | Total |
|---|---|---|---|
| Reduction in travel time | 132 | 90 | ***222*** |
| Fuel costs | 306 | 210 | ***516*** |
| Vehicle operating costs | 101 | 69 | ***170*** |
| Reduction in pollutants | 24 | 16 | ***40*** |
| Reduction in GHG | 29 | 20 | ***49*** |
| Reduction in accidents | 127 | 87 | ***214*** |
| Reduction in shipping costs | 120 | 61 | ***181*** |
| **Total** | **840** | **554** | **1,394** |

### 9.1.4 Results

For railways, the economic benefit cost analysis of Phase 1 returns a negative net present value (the difference between benefits and costs), indicating that for the selected social discount rate of 2.37%, the project's costs outweigh its anticipated benefits. Another financial metric used to evaluate the economic feasibility of a project is the Cost-Benefit Ratio (CBR), which compares the present value of the anticipated benefits, including the residual value, to the costs. A CBR of 0.55 suggests that for every dollar invested in the project, only 55 cents in benefits are expected to be returned.

Table 9-5: Economic Benefit Cost Analysis Results, Railways, 2030–2060

| Present value (2023 M$) | BDHR | GCR | Total |
|---|---|---|---|
| Costs | -2,760 | -1,366 | -4,126 |
| Benefits | 840 | 554 | 1,394 |
| Residual value | 568 | 320 | 888 |
| Net present value | -1,352 | -492 | -1,844 |
| Benefit/cost ratio | 0.51 | 0.64 | 0.55 |

The sensitivity analysis is a technique used to determine how changes in a single assumption impact the analysis outcome. The sensitivity analyses results are presented in Table 9-6. The sensitivity analysis revealed that a change of ± 30 % of the initial capital expenditure make vary the cost-benefit ratio for the BDHR between 0.42 and 0.66, and for the GCR between 0.51 et 0.85. Changes in freight volumes to both pessimistic and optimistic scenarios make vary the B/C ratio between 0.44 and 0.60 for the BDHR, and between 0.49 and 0.82 for the GCR. cost ratio.

The sensitivity analysis on the discount rate showed that the net present value (NPV) was highly impacted. Given that the NPV was negative at 2.37%, the focus of the sensitivity analysis was to explore a reduction in the discount rate. However, the lowest value explored was close to zero, indicating that the expected economic internal rate of return (EIRR) was negative or that the BDHR did not generate sufficient traffic to justify the investment in the railway. With a near zero discount rate, the NPV becomes slightly positive with a B/C ratio of 1.02 for the GCR.

Table 9-6: Economic Benefit Cost Sensitivity Analysis, Railways, 2030-2060

| | BDHR | | GCR | |
|---|---|---|---|---|
| | B/C ratio | NPV ($M) | B/C ratio | NPV ($M) |
| Capex +30 % | 0.42 | (1,975) | 0.51 | (832) |
| Capex -30 % | 0.66 | (729) | 0.85 | (153) |
| Freight volume – Pessimistic | 0.44 | (1,552) | 0.49 | (693) |
| Freight volume – Optimistic | 0.60 | (1,102) | 0.82 | (249) |
| Increase Passenger revenues (0.4$/km) | 0.51 | (1,350) | 0.64 | (490) |
| 0.0001 % Discount rate | 0.80 | (637) | 1.02 | 35 |
| 1 % Discount rate | 0.66 | (1,021) | 0.84 | (243) |
| Base case (2.37 % Discount rate) | 0.51 | (1,352) | 0.64 | (492) |
| 5 % Discount rate | 0.32 | (1,631) | 0.40 | (727) |
| 10 % Discount rate | 0.15 | (1,666) | 0.19 | (818) |

Figure 9-1 presents the net present value for different levels of freight volume demand. The breaking point, when the benefits are equal to costs in present value, is reached when there is a 136 % increase in demand. This is a significant increase, as it is equivalent to doubling the anticipated tonnage. It is noteworthy that this specific sensitivity analysis affects both the operating costs and annual revenues, highlighting the importance of considering demand fluctuations in business planning.

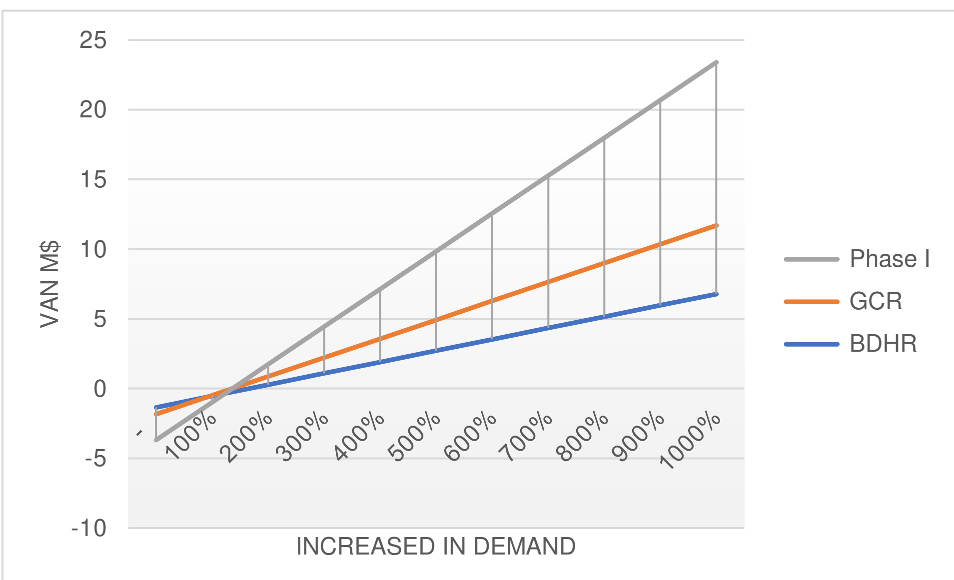



Figure 9-1: Net Present Value as a function of Freight Traffic Increase

## 9.2 ECONOMIC IMPACTS

### 9.2.1 Impact on the Quebec Economy

The economic impacts considered here are those stemming from capital expenditures (during the construction period), and operating and maintenance expenses (during operation) of the railway and roadway infrastructure included in Phase I. The assessment of these economic impacts consists of estimating the standard indicators of the economic activity generated by the project, in terms of employment, value added (at basic prices) or the income generated in wages and company profit, Quebec and federal fiscal revenue including tax on wages, indirect taxes (GST, TVQ, excise), and incidental revenue or paratax (RRQ, FSS, CSST, RQAP, EI, etc.), and imports (purchase outside Quebec), for the entire Quebec. The instrument used to quantify the economic impacts is the Quebec Intersectoral Model (QIM), developed by the Institut de la statistique du Québec (ISQ) for direct and indirect effects, and the Keynesian multiplier approach for the induced effects.

Economic impacts of an expenditure are the sum of direct, indirect, and induced effects. Direct effects correspond to the fact that the company (here the promoter, the constructor, and the owner/operator) incurs expenses directly in the form of salaries and social benefits for its employees, and in the form of the profit for the company. From salaries and profit from which are derived government revenue, including income tax and incidental taxes. Indirect effects are explained the supply chain that includes suppliers of goods and services to the constructor or operator and the succession of purchases of goods and services from different levels of suppliers, notably construction companies, material, and equipment suppliers, etc. Induced effects are generated by the fact that a portion of the salaries paid to employees in sectors related to the different productive sectors affected by railway and road expenditures (both direct and indirect effects) is spent again in the Quebec economy, creating additional demand for goods and services.

Economic impact analysis is an important tool in project or activity assessment in that it measures the value added or income that remains in Quebec or in the region from the expenditure or investment, to workers, companies, and governments, compared to the economic leakage which is a loss to the Quebec economy. From the public point of view, it may be sensible for public authorities to invest or subsidy a project or an activity.

The overall economic impact of the construction of road and rail components of Phase I of LGA, for a CAPEX of $4.5B spent over five years ($3.2B for railways and $1.2B for roads), is shown in Table 9-7. The total employment over the construction period is estimated at 28,300 years-persons, from which 18,200 for railways and 10,100 for roads. The value added at basic prices amounts to $2.9B, divided into railways for $2.0B and roads for $0.9B. This valued added takes the form of wages before taxes ($1.6B) and other income, mainly corporate profits ($1.4B). The imports are important with a value of $2.1B. Government revenue totals to $690M, mainly from tax on wages and incidental revenue from the workforce. Direct effects account for half of the economic impact, indirect effects for a third, and induced effects for 16%.

Table 9-7: Railway and Road Construction, Phase I, Economic Impact

| | Railways | Roads | Total |
|---|---|---|---|
| Workforce (pers-yr) | 18,196 | 10,099 | ***28,295*** |
| **(M$)** | | | |
| ***Value added*** | ***2,008*** | ***940*** | ***2,948*** |
| Wages before taxes | 1,031 | 555 | ***1,586*** |
| Other income (companies) | 978 | 385 | ***1,362*** |
| Imports | 1,675 | 458 | ***2,133*** |
| Gouvernement du Québec revenue | 334 | 185 | ***519*** |
| Canada government revenue | 114 | 57 | ***171*** |
| **% effects** | | | |
| ***Workforce*** | ***100%*** | ***100%*** | ***100%*** |
| Direct effects | 49.2% | 49.6% | 49.4% |
| Indirect effects | 34.5% | 34.7% | 34.6% |
| Induced effects | 16.2% | 15.6% | 16.0% |
| ***Value added*** | ***100%*** | ***100%*** | ***100%*** |
| Direct effects | 54.6% | 54.1% | 54.4% |
| Indirect effects | 30.5% | 37.0% | 32.6% |
| Induced effects | 14.9% | 8.8% | 13.0% |

Note : The numbers have been rounded, so the sum of the elements may not correspond to the total.

The annual operating expenses for the two railway lines of the magnitude of $44.6M generate impacts every year on the Québec economy, as shown in Table 9-8. The total employment created or supported is estimated at 375 person-years every year. The value-added amounts to $38.4M and imports to $17.0M. Wages before taxes are equivalent to $30.4M and the additional revenue for governments to $12.3M every year.

Table 9-8: Railway Annual Operation, Phase I, Economic Impact

| | Direct Effects | Indirect Effects | Induced Effects | Total Effects |
|---|---|---|---|---|
| Workforce (pers-yr) | 214 | 73 | 89 | ***375*** |
| **(M$)** | | | | |
| ***Value added*** | ***23.0*** | ***9.8*** | ***5.5*** | ***38.4*** |
| Wages before taxes | 23.0 | 3.5 | 3.8 | ***30.4*** |
| Other income (companies) | 0.0 | 6.3 | 1.7 | ***8.0*** |
| Imports | 0.0 | 11.5 | 5.5 | ***17.0*** |
| Gouvernement du Québec revenue | 6.2 | 0.9 | 1.9 | ***9.0*** |
| Canada government revenue | 2.1 | 0.3 | 0.8 | ***3.3*** |

Note: The numbers have been rounded, so the sum of the elements may not correspond to the total.

The additional annual road maintenance cost due to the upgrading of access roads and of the Route du Nord, as well as the additional Mistissini access road, is estimated at $1.4M, from which more than half ($0.8M) for the RDN. Given this cost is marginal in view of the total infrastructure maintenance and operating cost, the economic impact is considered marginal and thus has not been estimated.

### 9.2.2 Regional Impact

The regional impact of the construction and operation of railways and roads considered in Phase I should be important in view of the large share of possible local works, except for the railway material and equipment procurement, the intensity of the workforce required during both construction and operation periods, the provisions of the JBNQA and of CCQ regulation, the experience of Cree companies and communities in major construction projects and, the commitment of the CNG and the CDC towards the Grande Alliance infrastructure program as a tool for economic development of the Cree communities.

The size of these railway and road projects shall require a lot of human, physical, and organisational resources during construction, beyond regional capability. The construction schedule would enhance the likelihood of maximizing the Cree participation in terms of employment and procurement.

The management and operation of BDHR and GCR railways, by the Cree, as well as their participation to road maintenance, are objectives to aim at. The Innu-Naskapi operation of Transport ferroviaire Tshituetin (TFT) is an experience that would be useful to the Cree.

## 9.3 Employment Opportunities and Wider Economic Benefits

New railways and roads can bring various economic benefits to a northern community. The potential benefits include:

- Improved, more efficient and safer infrastructure;
- Increased accessibility for inhabitants and companies;
- Reduced transportation costs benefiting local businesses and consumers;
- Increased trade and enlarged markets enhancing the creation and growth of companies;
- Increased economic activity allowed by improved accessibility and better efficiency;
- Job creation during the construction and operation of the railway lines and roads and additional jobs in related industries, and in overall increase economic activity;
- Increase in income resulting from the enhanced regional economy;
- Improved access to workplaces and services;
- Increased contacts between members of different communities and enhanced cultural conditions;
- Reduced trucking movements and improvement in quality of life for residents, making the community a more attractive place;
- Improvement in community infrastructure;
- Increase in community engagement.

### 9.3.1 Regional Workforce

In 2021, there were more than 1,100 Cree workers which profession was trades, transport and equipment operators and related occupations: approximately 460 workers in construction, 110 people in transportation, 300 in the primary sector. There were 1,205 people occupying business, finance and administration occupations (820 with such education), which is not surprising since more than half of the Cree workforce work in public administration, education and health sectors. The construction market in James-Bay region requires 1M person-hours per year, which are fulfilled very partially by construction workers who live in the region. Thus, although most of this workforce is already employed, the human resource pool in Cree and Jamesian communities constitutes a basis to the needs of transportation infrastructure construction and operation.

### 9.3.2 LGA Employment Opportunities and Training Requirements

The construction and the operation of the railways and roads included in Phase I of LGA will provide important employment opportunities for the Cree youth and adults. The construction will require hundreds and thousands of workers while the rail operation shall require more than 200 employees. Table 9-9 summarizes the types of positions during road construction, railway construction and railway operations as well as general training requirements for these positions.

Table 9-9: Indicative Positions and Training Requirements, LGA Phase I Construction and Operation Periods

| Position | Road Construction | Rail Contruction | Rail Operation | Training Requirements |
|---|---|---|---|---|
| Executive | x | x | x | U |
| Project manager and Assistant Project Manager | x | x | | PMP |
| Superintendent, foreman | x | x | | W |
| Land surveying, Surveying data processing | x | x | | C |
| Engineering (design, quality control, supervision) | x | x | | C U OIQ |
| Civil works (clearing, earthworks, drainage, structural) | x | x | x | CCQ |
| Specialized labour (carpenter, electrician, etc.) | x | x | | C CCQ |
| Site mechanic | x | x | | CCQ |
| Shovel operator, Heavy equipment operator, loader operator | x | x | x | CCQ |
| Production of materials (sub-ballast, ballast, gravel) | x | x | x | CCQ |
| Transport of materials | x | x | x | DL-1 |
| Asphalt and concrete | x | | | CCQ |
| Track laying (rail laying and welding, ties and fastenings, surfacing, ballast work, level crossings) | | x | x | R |
| Signalling and telecommunications systems | | x | x | R / SP |
| Erection of construction camps | x | x | | CCQ |
| Lodging and food services | x | x | | - |
| Signal maintainer, road flagman | x | | | - |
| Fuel transportation and supply | x | x | | DL-1 |
| Superintendent – Transportation, train master, train/yard operations coordinator, yard master, intermodal terminal manager, train dispatcher, train crew, timekeeper | | | x | CROR |

| Position | Road Construction | Rail Contruction | Rail Operation | Training Requirements |
|---|---|---|---|---|
| Loader operator | | | x | CCQ |
| Gateman/Agent, Yardmen/Labourer, Yard Jockey, Carload Manager, Carload Supervisor, Senior & general clerk, loading and handling | | | x | OMOT |
| Maintenance manager, Locomotive maintenance, fuelling, servicing, inspection, car and MoW maintenance, maintenance shop helper | | | x | C R/OMOT |
| Station and on-board services | | | x | OMOT |
| Worksite security | x | x | x | SF |
| Health and safety management | x | x | x | C R |
| Regulatory, human resource, accounting, finance, training officer | x | x | x | U |
| Environmental protection | x | x | x | C U |

C Collegial degree / CCQ Certification by the Commission de la construction du Québec/ CROR Canadian Rail Operating Rules Certification / DL-1 Class 1 driver's licence / OIQ Member of the Ordre des ingénieurs du Québec/ OMOT Operation Mobilization Orientation and Training / PMP Project Management Professional / R Rail hands-on or specific training / SF Security guards permit and firearms license / SP Specialized training / U Bachelor's degree / W Work experience.

To accelerate the integration of Cree individuals into railway operations and construction, training should commence as soon as possible. Some of the training will require long-term education and hands-on experience, which should continue even after operations begin. Succession plans, which are typically part of regional organizations, can be incorporated into the project setup. The project can be divided into six phases concerning workforce training and education:

- Partnership formation;
- Preparatory phase;
- Construction phase;
- Operations mobilization orientation and training (OMOT) 6-month period before starting operations;
- Hands-on Training Phase;

Normal operations with training new personnel after rotation. The long-term training would take place in the years leading up to the beginning of the project to ensure that there is enough qualified Cree labour to cover the workforce requirements for both the construction and operating phases. The OMOT will take place in the months leading up to the beginning of railway operations and it will prepare staff for their duties on the railways.

Figure 9-2 describes the partnerships to ensure a proper training and mobilization of human resources among the Cree communities. The experience involving educational institutions in partnership with Cree communities, notably with the Cree School Board, Apatissiiwin Skills Development, the Cégep de Saint-Félicien, UQAT and others, as well as Transport Ferroviaire Tshiuetin's experience in First nations' railway operating over the last 20 years, should serve as a model to plan and provide training and support to Cree workers.

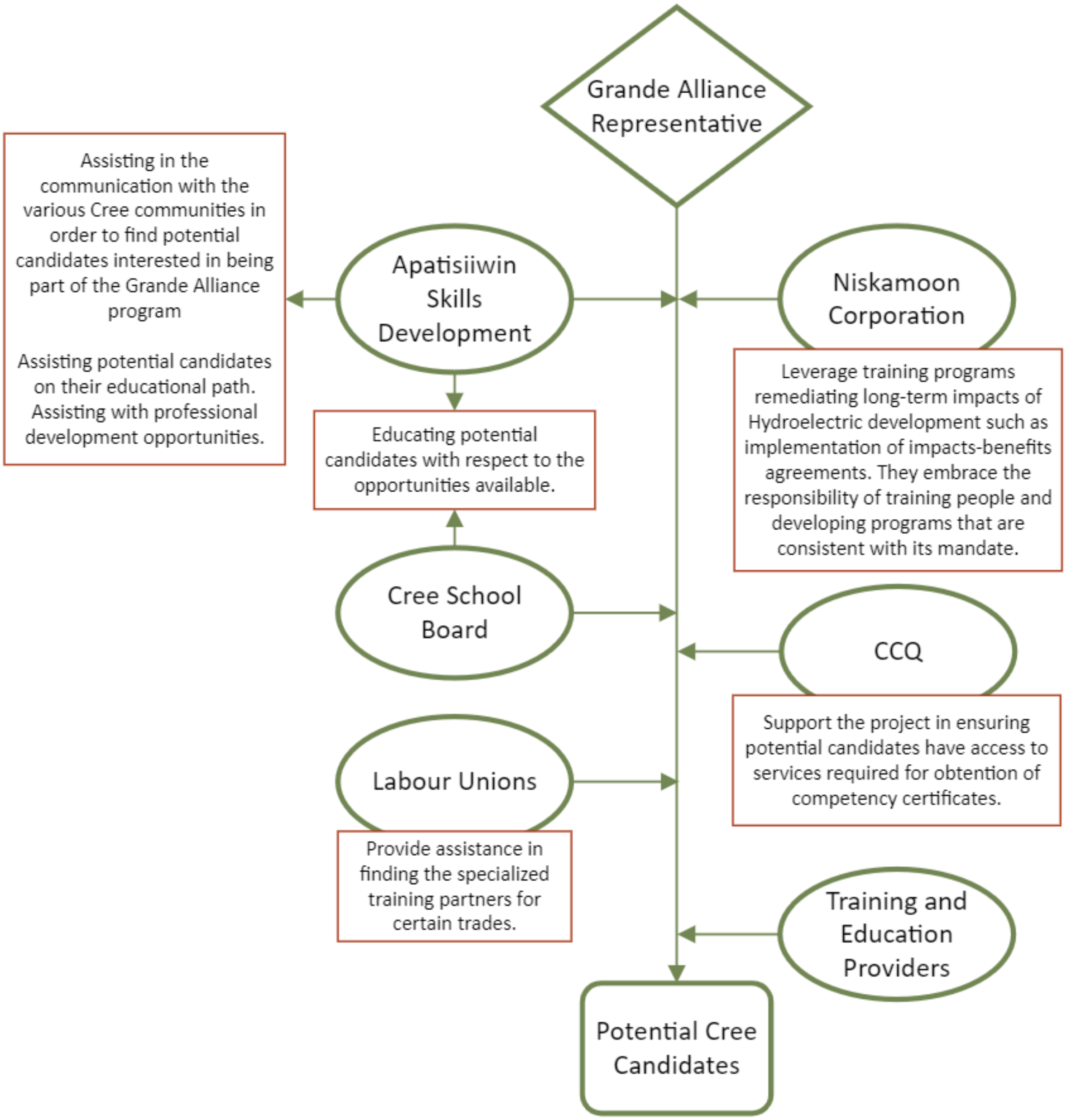



Figure 9-2: Proposed roles for education and training partners

The proposed next steps as relating to the project opportunities and training:

- Meetings and presentations with the GACIOs to obtain their views and recommendations.
- Formation of a committee which will oversee LGA training initiative.
- Establishment of a training plan, outlining the training and educational paths for each job opportunity.
- Establishment of an collaborative relationship with educational institutions and other partners.
- Definition of specific inputs needed by the project's educational partners to ensure the success of the training and educational program.

- Adaptation of the training plan based on recommendations from Cree community representatives and key educational partners.
- Adaptation of the project delivery necessary to maximize Cree involvement.
- Initiate discussions, between LGA program and the Cree communities, on the various agreements which should be put in place.

### 9.3.3 Other Business and Employment Opportunities

Business and employment opportunities may be made possible or more likely with improved access and regional roads or with the train service. These wider benefits could include:

- Creation and integration of new tourism attractions or services, notably along with COTA/TBJ tourism development planning elements, as tourist circuits declining many themes, or tourist/service nodes for example at the Waskaganish Junction that could integrate a train station, a yard, rest area services, tourist information, art craft shop, stop or start of circuits, etc. This needs the development of competencies in entrepreneurship, tourism, and services, for example.
- The development of Cree forestry activity and territorial knowledge more in phase with the preservation of the environment and the transmittal of the Cree culture, more responsive to the local population's needs, and in a comprehensive approach so as to allow herds of caribou to get maintained.
- The consolidation of mining projects and their likelihood to get realized, in a proper way and to maximize the participation of the Cree workforce in these activities. The use of railways rather than roads to carry minerals, fuel and supplies would limit disturbances along the roads. The mining sector offers the most employment opportunities in Eeyou Istchee Baie-James while current Cree workers are only a few in this sector.
- To develop these activities, training and transmittal of knowledge and know-how for wildlife protection officers and assistants, park rangers and guardians, research field assistants, guides, tourism, craft persons, salespeople, machinery operators, drivers, mining, engineering.

### 9.3.4 Social Aspects

The extension of the road up north to Whapmagoostui and of the R167 to the Trans-Taiga Road, as well as the improvement road access and of the Route du Nord, shall facilitate the access to the traplines for those who hunt and fish, especially those who benefit from the Economic Social Program. The beneficiaries of this program are mostly among the group of youths and elderly people. These infrastructure elements shall thus enhance the inclusion of these age groups and less rich people.

In addition to contribute to improving the physical access to employment locations, the improvement of the road network, especially the access road and the RDN would allow for easier exchanges with other Cree communities. More especially, the new hospital centre and a possibly collegial study centre in Chisasibi would be regional service centres more accessible to the members of other Cree communities and consequently contribute to a higher use of these installations and more education opportunities to the Cree.

# 10. FINANCIAL ANALYSIS

The financial analysis completed as part of this study identifies expected financial outcomes from a proposed investment. This allows for a better understanding of the project's financial viability, with and without public funding.

The project is taken with a point of view of a hypothetical institutional entity that will build, manage, and operate the infrastructure. This has been assumed in the modelling as a 'New Railway Entity' which takes the role of the Rail Infrastructure Operator, who would build the New Railway asset and then is assumed to:

- Give access to the New Rail Infrastructure to Railway Operators
- Charges fares to passenger users on the New Railway
- Charges tariffs to freight and bulk shippers using the New Railway services
- Manages maintenance, life-cycle investments, and operations of the New Railway - Rail Infrastructure and the Road, in the Rail & Road scenario.

The financial analysis, over the 30-year appraisal period, involves assessing the financial outcomes for BDHR and GCR separately with cash flow comparisons for these revenues (freight and passenger) against the expenses, including capital, operational and life-cycle costs, to work out the corresponding financial equilibrium and return ratios. The table below summarizes the NPV costs of the railways.

Table 10-1: Total NPV Costs by Railway – $M

| | BDHR | GCR | Combined |
|---|---|---|---|
| Total construction costs | (2,746.1) | (1,488.7) | (4,234.8) |
| Operational costs – Freight | (410.8) | (137.9) | (548.7) |
| Operational costs – Passenger | (28.8) | (11.0) | (39.9) |
| Revenues – Freight | 336.7 | 164.9 | 501.6 |
| Revenues – Passenger | 1.6 | 1.8 | 3.4 |
| **Total project** | **(2,847.4)** | **(1,471.0)** | **(4,318.3)** |

To meet the requirements of funding from the Canadian Infrastructure Bank (CIB), it is important to assess whether the railways would return a positive NPV. This would demonstrate that the project is profitable. Further to the review of the analysis, it became evident that both elements of the railway return a negative NPV and are therefore not profitable without any further funding. This becomes apparent in the analysis of the financial cash flows, as the large upfront spending of construction costs equating to 87% and 91% of total NPV costs for BDHR and GCR respectively, and total revenues only subsidizing for 10–12% of the construction costs. Furthermore, funding scenarios were included in the analysis to assess the assumptions required to make the project both profitable and attractive to potential investors.

Funding scenarios include the assessment of targeting the funding through specifying IRR values and terms of funding and includes an evaluation of their financial outcomes. The scenarios were:

- The base scenario with no funding: no change in capital contribution and evaluates the financial outcomes of the project under this condition;

- An optimal operational grant (tariff) funding with 0% project return: holding the assumption that the annual funding covers the ongoing operational costs of the project, but with no expectation of a return on investment. This ensures that the project is achievable over the operational phase of the railways; and
- The optimal tariff with 0% Project Return plus an optimal upfront public funding: in addition to the above scenario, this includes an assumption of receiving the maximum amount of annual public funding available, with an expected return on investment. This further aims for the project to be more attractive to investors by assuming an upfront public funding to ensure an equity internal rate of return of 12% with a debt gearing ratio of 90% (equity of 10%).

The tables below conclude the findings of these tests for both railways. With a cost of debt of 5.5% and cost of equity of 12%, and a gearing ratio of 90% debt, the value of Weighted Average Capital Costs (WACC) is calculated as 6.15%.

Table 10-2: BDHR: Total NPV Costs, $M

| BDHR Scenario | Base | Base + Tariff | Base + Tariff + Investment Grant (90% debt gearing) |
|---|---|---|---|
| Project IRR | N/A | 0.1% | 0.1% |
| Total Project NPV | (2,847.4) | (1,693.9) | (1,693.9) |
| Equity IRR | N/A | 0.5% | 12.0% |
| Equity NPV | (236.1) | (227.9) | 0.1 |
| Annual Tariff Required for Funding (Operations Grant) with 0% Project IRR (2023 Prices) – $M | N/A | 72.9 | 72.9 |
| Investment Grant required for 12% Equity IRR (2030 Prices) – $M | N/A | N/A | 1,762.3 |

Table 10-3: GCR: Total NPV Costs $M

| GCR Scenario | Base | Base + Tariff | Base + Tariff + Investment Grant (90% debt gearing) |
|---|---|---|---|
| Project IRR | N/A | 0.1% | 0.1% |
| Total Project NPV | (1,471.0) | (921.7) | (921.7) |
| Equity IRR | N/A | 0.4% | 12.0% |
| Equity NPV | (127.5) | (123.2) | 0.8 |
| Annual Tariff Required for Funding (Operations Grant) with 0% Project IRR (2023 Prices) – $M | N/A | 34.7 | 34.7 |
| Investment Grant required for 12% Equity IRR (2030 Prices) – $M | N/A | N/A | 959.0 |

For both projects, the tariff results in a project IRR of just above 0% but do not result in a positive Project NPV. This is due to the IRR being less than the cost of capital (WACC values). In turn, the Project IRR represents the value that the WACC would be required to be to return NPV=0, where in all cases for the funding sensitivities it would have to be 0.1%.

The level of annual operations grants for the projects to return a Project IRR of 0%, are $72.9M and $34.7M for BDHR and GCR respectively (in 2023 prices). When comparing to the total revenues, this is a large, contributed proportion to the revenues to achieve the targeted project IRR in these sensitivities.

The level of upfront funding required for the projects to return a target Equity IRR of 12% with 90% debt to equity ratio, are $1,762.3M and $959.0M for BDHR and GCR respectively (in 2030 prices, given the drawdown date of 2030).

## 10.1 Sensitivity Analysis

Various sensitivity tests were also conducted, which concluded that there were no significant impacts when varying the revenues and operational costs, given the small proportion of the total NPV these represent. Further to this, the results suggested that for both projects, to reach a project NPV of zero, the revenues would be required to be around 10 times their current value (1,000%).

Tests were also conducted on the percentage capital contribution (or decrease in capital costs) which demonstrated proportionally larger impacts to the NPV compared to the other sensitivities. This is primarily due to the large proportion of the CAPEX costs contributed to the overall project costs. With this in mind, it is worth noting that due to the negative earnings of the BDHR, even with no capital costs, the project would still not remain affordable. This slightly differs to the GCR, which has greater revenues than operational costs and therefore results in a positive cashflow during the operations of the project. This would indicate that the project does achieve the financial equilibrium required by the CIB, but this does not mean that the project is making an overall return, when considering the capital costs. This was investigated in the sensitivity testing of the funding explained above. To put these results for GCR into context, with an assumption of no public funding available, the project would be required to be operational with the same level of OPEX and revenues for another ~1,000 years to account for its initial capital outlay.

## 10.2 OWNERSHIP AND FUNDING STRATEGIES

This text discusses the importance of the institutional structure of a railway and how it affects the organization, financing, and regulatory requirements of the railway. The institutional structure includes the entities that own, maintain, and operate the railway infrastructure, as well as the relationships between these entities. The financing options and regulatory requirements of a railway are affected by its institutional structure. There are two options for the institutional structure of a railway: vertical integration and horizontal integration. Vertical integration refers to a railway that owns and controls all aspects of the railway system, while horizontal integration involves the merger or acquisition of other railway companies to create a larger network. The horizontal integration is not applicable to certain railway companies.

The BOOT model involves a private entity designing, building, and operating the railway infrastructure for a set period, after which ownership is transferred to the government or other public entity. The PPP model involves a partnership between the government or public entity and a private entity, with both parties sharing the risks and rewards of the project.

The concession model involves a private entity being granted a concession to operate the railway infrastructure for a set period, and the Joint Venture model involves two or more entities collaborating to design, build, and operate the railway infrastructure.

The **BOOT agreement** is a contract agreement used for infrastructure projects such as tool roads, airports, and railway operations. In a BOOT agreement, a private company is granted a contract to design, build, operate, and maintain a railway project for a specified period of time, after which ownership and control of the project is transferred back to the government or another public entity.

The **Public-Private Partnership (PPP)** model, which involves collaboration between a public sector entity (such as the government) and a private sector company to design, build, operate, and maintain infrastructure projects like railways. The specific terms and conditions of the PPP will be determined through negotiations between the parties involved, and the type of PPP model will depend on various factors.

The **Affermage model** is a type of PPP model used in infrastructure projects where a private operator is contracted to operate and maintain a public utility and collect user fees from customers. The affermage model is often used when the public entity lacks the resources or expertise to operate and maintain the infrastructure effectively. In the context of a railway project, the affermage model could be applied by contracting with a private operator to operate and maintain the railway system and collect user fees from customers, while the public entity retains ownership and overall control of the system.

The affermage model of public-private partnership (PPP) can have both advantages and disadvantages. On the one hand, by contracting with a private operator to operate and maintain the infrastructure, the public entity can benefit from the private sector's expertise and efficiency in managing the system. Additionally, the affermage model can allow the public entity to save money on infrastructure projects by transferring the operational and maintenance costs to the private operator, leading to lower government spending. Private sector involvement can also attract investment and improve the quality and efficiency of the infrastructure, which can result in improved service delivery.

On the other hand, there are also several potential drawbacks to the affermage model. Conflict can arise between the public entity and private operator over issues such as user fees, service levels, and infrastructure maintenance, leading to potential for conflict. Private operators may prioritize short-term profits over long-term sustainability, which can result in deferred maintenance and reduced quality of service. Furthermore, the public entity may have limited control over the private operator's actions and may be held accountable for the operator's actions, which could lead to lack of accountability. Additionally, the public entity may lose control over the day-to-day operation of the infrastructure, which can lead to decreased transparency and accountability. Finally, there is the potential for private operators to use their position to extract rents from customers, leading to higher user fees and reduced affordability.

The **lease model** is a type of public-private partnership where the private partner assumes responsibility for providing the service and meeting quality and service standards, while the public authority retains responsibility for new and replacement investments. The lease contract typically lasts for 10–20 years, during which time the private sector takes over the responsibility of service provision. In the context of the railway project, the Infrastructure Operator would pay a lease payment to InfraCo for the use of the infrastructure, providing InfraCo with a stable income stream and improving the bankability of the project. However, users would have to pay the lease payment based on railway usage, even if the track is unavailable due to maintenance, which creates potential affordability risks.

Overall, the lease model can be effective, but careful consideration should be given to its potential risks and drawbacks. In summary, the lease model for infrastructure development and management has several advantages, including the transfer of operational risk to the private partner, access to private sector expertise, and the provision of a stable income stream for the private partner. Additionally, lease contracts can be structured to include different levels of responsibility and risk sharing between the public and private sectors, providing flexibility in project development. However, this model also has its drawbacks, such as limited control for the public entity, financial burden for the public entity, revenue risk for the private partner, and the potential for conflicts of interest between the private partner's obligation to maximize profits and the public entity's goals for the infrastructure.

The **availability model** is a type of public-private partnership where the private partner assumes responsibility for designing, building, financing, operating, and maintaining an infrastructure asset or system for a fixed period. In return, the public entity pays the private partner a regular payment based on the availability of the asset or system, rather than on actual usage. The private partner bears the risks associated with the asset or system and is incentivized to ensure high availability and performance. The availability model can be attractive for infrastructure projects with uncertain demand or where the public entity lacks the expertise to operate and maintain the asset or system. However, the public entity still bears the ultimate financing risk, and the availability model can be complex to set up and manage. The private partner may also prioritize availability over other important factors, and the availability model may not be appropriate for all types of infrastructure projects.

A **joint venture agreement** for railway construction and operation is a legal contract that outlines the terms and conditions of a partnership between companies. It covers key aspects such as costs, profits, and risks sharing, as well as the roles and responsibilities of each party. The agreement aims to ensure the project's success and protection of each party's interests by establishing rules and regulations, dispute resolution processes, and communication frameworks. Other aspects covered in the agreement include management, duration, confidentiality, and governing law. The agreement is critical to the project's success and should be carefully considered by all parties.

A **public funding model** for a railway infrastructure company involves the government or a public entity providing financial support for the development, maintenance, and expansion of the railway infrastructure. The funds can be provided through grants, loans, bonds, or direct investment and are used to build new tracks, upgrade existing infrastructure, purchase equipment, and hire personnel. The company typically operates as a public-private partnership with the government as a major stakeholder and is required to meet certain performance standards and targets. The model ensures accountability and transparency in the company's management.

## 10.3 PUBLIC FUNDING

The **Canadian Infrastructure Bank (CIB)** could serve as an example for a public funding strategy The CIB is a federal government-owned financial institution that was created in 2017 with the mandate of investing in and attracting private sector investment to infrastructure projects in Canada. The goal of the CIB is to help address Canada's infrastructure deficit by financing and providing expertise to projects that have the potential to generate revenue, provide economic and social benefits, and improve the quality of life for Canadians.

The CIB's role is to provide funding, expertise, and support to infrastructure projects that meet certain criteria. These criteria include:

**Revenue-generating potential :** The CIB provides funding to infrastructure projects that have the potential to generate revenue. This can come from user fees, private investment, or other sources.

**Private sector involvement** : The CIB's funding is designed to attract private sector investment to infrastructure projects. Projects must have a significant private sector investment component in order to be eligible for CIB funding.

**Economic and social benefits** : Infrastructure projects must have a positive economic and social impact, including job creation, environmental benefits, and improved quality of life for Canadians.

**Financial viability** : Infrastructure projects must be financially viable, meaning that they must be able to generate sufficient revenue to cover their operating costs and repay any loans or investments made by the CIB and its private sector partners.

**Public interest** : Infrastructure projects must serve the public interest and be aligned with government priorities, such as promoting economic growth, reducing carbon emissions, and improving public transportation.

In addition to these criteria, the CIB also requires that infrastructure projects undergo a rigorous due diligence process to assess their feasibility, financial viability, and potential impact. This includes conducting market assessments, financial analysis, and risk assessments, as well as engaging with stakeholders and conducting public consultations.

Overall, the CIB's role is to provide funding and support to infrastructure projects that have the potential to generate revenue, provide economic and social benefits, and improve the quality of life for Canadians, while also attracting private sector investment and expertise to these projects.

Given the current demand, it may be difficult to finance the railway project in Eeyou Istchee. Additional mining sites are needed to secure sufficient travel demand to generate enough revenues to make the project financially viable. It may also be necessary to engage the mining sector in providing equity in the railway and involve the Cree Nation in the ownership and operation of the rail to ensure its success.

Under those conditions, the public funding model could be the most suitable for a railway in Eeyou Istchee. This model would allow the government or a public entity to provide financial support for the development, maintenance, and expansion of the railway infrastructure. The Cree Nation could also be involved in the ownership and operation of the rail, as this would align with the public interest criteria of the Canadian Infrastructure Bank. Additionally, the mining sector could provide equity in the railway, which would help to attract private sector investment and potentially increase the viability of the project. However, it is important to conduct a rigorous due diligence process to assess the financial viability, potential impact, and feasibility of the project before moving forward with any funding strategy.

# 11. RISK ANALYSIS

## 11.1 RISK AND MITIGATION

Project Risk Management is viewed as a core function which supports the achievement of Project and business objectives through proactive management, including at the earliest stages. The risks were analyzed in a risk register overall for the entire Phase I, including road and railway infrastructure. Workshops grouping members from each discipline involved in the study allowed to analyze the various categories of risks. Risks were in this way identified, described, qualified in terms of source, consequence, schedule, and mitigation. Then, they were quantified as for probability and cost incurred if the risk materializes. A Monte Carlo simulation was performed to estimate the mean global risk from multiple mix of various values for each specific risk.

Table 11-1: presents the two risk reserves, after the Monte Carlo simulation, in nominal dollars. The capital risk reserve includes the risks associated with the planning, design, and construction (including commissioning) phases of the project. The long-term covers a 50-year operation period.

Table 11-1: Risk Reserve by Type

| Type of risk | Risk Reserve (Nominal $M) |
|---|---|
| Capital risks | 946 |
| Long-term operation and maintenance risks | 5.4 |

- *Risk reserve with a correlation factor of 0.4 and a confidence level of 80 % (in millions of nominal dollars)*

The construction category represents a significant portion (39% as shown in Table 11-2) of the capital risk reserve as it includes among other things the risk for the lack of competition in the procurement process for the construction, resulting in higher bids and increase in the project costs.

Table 11-2: Capital Risk Allocation per Category

| Risk Category | % of the risk reserve |
|---|---|
| Planning | 5 % |
| Social | 4 % |
| Site | 4 % |
| Environment | 7 % |
| Design | 11 % |
| Construction | 39 % |
| Operation and maintenance – commissioning | 7 % |
| Financial | 3 % |
| Legal | 5 % |
| Other (Pre-construction delay risks) | 15 % |
| **Total** | **100 %** |

Table 11-3 provides a summary of the capital costs, contingencies, and project risk reserve for the project. The risk reserve obtained following the analysis represents 19 % of the estimated CAPEX. This proportion is considered consistent with the level of progress of the project (pre-feasibility study stage).

Table 11-3: Capital costs, contingency, and risk reserve

| | (nominal $M) |
|---|---|
| Capital costs | 4,891 |
| Contingency | 978 |
| Capital risk reserve | 946 |
| Total costs | |
| % of contingency / capital costs | 20 % |
| % of risk reserve / capital costs | 19 % |
| % of Contingency and Risk Reserve / Capital Costs | 39 % |

Table 11-4 presents the five most important capital risks. The three major risks (lack of competition, delay before works, changes in specifications) generate a mean value of $571 million, or 11.7% in extra of the reference CAPEX.

Table 11-4: Major Capital Risks

| Risk | ($M) |
|---|---|
| Lack of competition from suppliers / Lack of bidding | 311 |
| Pre-construction delays risks | 153 |
| Significant changes to project specifications by the client and stakeholders | 107 |
| Unavailability of construction raw materials (steel, aggregates, concrete, glass, gasoline, etc.) | 38 |
| Identification of new environmental constraints (including contaminated lands) | 35 |

Table 11-5 provides a summary of the operation and maintenance costs, contingency, and long-term O&M risk reserve. Considering the project stage and the fact that the operation and maintenance risk reserve was calculated over the 50-year operation period, the proportion of the risk reserve appears consistent with the annual operating costs.

Table 11-5: Project operating costs, contingencies, and risk reserve

| | (2023 $M/yr) |
|---|---|
| Operation and maintenance costs (OPEX) | 55.8 |
| Contingency | 11.2 |
| Risk reserve | 5.4 |
| Total | |
| % of contingency / OPEX | 20 % |
| % of project risks reserve / OPEX | 10 % |
| % of Contingency and Project Risks Reserve / OPEX | 30 % |

Table 11-6 presents the two major risks for long-term operations and maintenance. They are related to the demand, either in terms of their specifications for the service, or the attractiveness of the service. It is to be noted that the traffic forecasts may be considered conservative on the long term, which has an impact on the resulting overall operating risk.

Table 11-6: Major Operation and Maintenance Risks

| Description | Quantification (in millions of nominal dollars) |
|---|---|
| Change in users’ requirements during the operating period | 32 % |
| Change in the attractiveness for freight and passenger users compared to the existing needs | 68% |

## 12. OBSERVATIONS AND NEXT STEPS

Some residents of the territory found the idea of such a large infrastructure program disquieting. People require time to become familiar with the proposed concepts and grasp the potential positive and negative effects. The effectiveness of emphasizing community participation and the resulting progress made is reflected in the attitude and the feedback received from people who were met at the beginning of the mandate and towards the end, such as the tallyman who was totally opposed to a new railway that would intersect his trapline, then indicated several months later that he could accept it, “if it’s an electric train”.

Involving the residents of Eeyou Istchee Baie-James from the start of the project has enabled the team to design infrastructure that integrates harmoniously into the environment and is adapted to the people’s needs. It was much appreciated by Crees and Jamesians, as indicated in a quote from a Waswanipi tallyman “I am glad you bring this up before it’s done, not like forestry does.”

The interaction with, and involvement of the residents provided information that was essential to:

- The early identification and prevention of potential land use conflicts.
- The ability to protect the integrity of sensitive areas and significant activity zones.
- The redesign of alignments to avoid sensitive areas.
- The inclusion of the communities’ needs, future projects, and safety concerns; in the assessment and planning of work on existing infrastructure.
- Not falling into the trap of “desktop work” done by outsiders.
- The critical need to add the alternate snowmobile trail study and the electric train study to the mandate.
- Completion of the economic and financial analyses will provide the needed by the implicated communities to decide upon a way forward that is socially, environmentally and economically beneficial as well as financially viable.

# 13. CONCLUSION

The Grande Alliance is an innovative Memorandum of Understanding between the Cree Nation Government and the Quebec government, focused on the economic development of the Nation's territory and its specific cultural and ancestral rights on the land. To ensure a true long-term collaboration, the basis of this alliance is focused on three main points – Connect, Develop, and Protect.

A logical continuation of the Paix des Braves Treaty (2002) established in the context of the James Bay and Northern Quebec Agreement (1975), this alliance mobilizes the participation of all Cree Nation communities ("Connect") to involve Cree actors in contributing to a common vision of socio-economic development of the territory ("Develop"), while protecting the ways of doing things and to heritage assets ("Protect").

The Crees of Eeyou Istchee continue to explore new boundaries and it is in the spirit of the past agreements that La Grande Alliance was proposed by the Cree Nation and created between Quebec and the Cree Nation. The fast economic and social developments in the First Nations have initiated the need for bigger and better community infrastructure in a vast variety of disciplines, such as employment, education, housing, municipal networks, telecommunication, environment, transportation, economic development, etc. This initiative's main objective is to build a promising program for the strategic, predictable and sustainable development of the territory, and will show how First Nations, governments, and other stakeholders can work together on developing society through natural resources. The Cree Nation realizes that in order for this initiative to succeed, it must include and accommodate the people of Eeyou Istchee and point to a solution that the communities and the people will see themselves in.

La Grande Alliance is foremost an engagement to the Crees of Eeyou Istchee to attain a certain stability, further guarantee the long-term protection of protected areas, improve the living standards and improve and extend the transportation network. La Grande Alliance consists of four avenues of future development – transportation infrastructure, communication, electrification, and protection – to devise a roadmap that takes into consideration innovative economic and technical opportunities and/or constraints, as defined by communities, land users and other relevant groups. This report deals specifically with the transportation infrastructure component envisioned through the MOU.

The Cree Development Corporation (CDC), on behalf of the GCC/CNG and the GQ, has been mandated to oversee the study. In turn, they have assigned Vision Eeyou Istchee (VEI), a consortium formed by STANTEC, DESFOR and SYSTRA, to carry out a Feasibility Study on the technical, socio-environmental and economic components in Phase I of the LGA infrastructure program. This study was divided into 4 main components, socio-environmental, technical feasibility, market study and risk mitigation.

## 13.1 Socio-Environmental Study

This socio-environmental study was conducted in a manner whereby social acceptability and community development was placed at the forefront in planning the development of transportation infrastructure projects in the Phase I of the Grande Alliance and ensuring that the requirements of communities and the opinions of its members were incorporated in the Phase I feasibility study. Engagement activities were conducted throughout the study by a liaison task force in conjunction with the CIOs. In general:

1 Tallymen and Cree land users are in favour of upgrading and paving of access roads;
2 Crees and Jamesians appreciated being engaged and informed on the LGA program and this led to changes to the initial concepts and recommended continuing engagement activities;

3 Crees expressed concerns regarding the potential loss of use of part of the affected traplines, as well as the noise, vibration, dust, and safety hazards caused by the train.

4 Crees and Jamesians expressed concerns about access to their camps or cottages and the relocation of the snowmobile and ATV trails on the Grevet-Chapais corridor;

5 The archaeological field study enabled to test the predictive model and identified over 60 areas of archaeological potential and numerous features of interest, six new sites of which three were assigned Borden Numbers;

6 Some servitudes and titles within less than 100 m from the alignments and will require discussions and agreements with Cree Communities and leaseholders or landowners, including the relocation of a snowmobile trail and logging road on the Grevet-Chapais alignment;

7 Four types of protected areas are found within the study areas of the proposed new infrastructure: biological refuge, projected aquatic reserve, projected biodiversity reserve, and territorial reserve for protected area purposes. The route of the BDHR has been modified to avoid two biological refuges.

8 A health impact assessment of the Grande Alliance Phase I components was conducted and in was found that the train itself will not have the most impact rather than the projects developed afterward;

9 Mitigation measures should be implemented to reduce potential impacts on flora (plants and wetlands) and fauna, including species at risks during the construction phase due to the project footprint and influx of workers and machinery and during operation due to nuisance and habitat fragmentation;

10 The addition of the railway will reduce the travel on roads and therefore generate approximately 30% less of GHG emissions compared to a status quo.

## 13.2 Technical Study

The proposed new transportation infrastructure (railways, new access road) in Phase I of the Grande Alliance will likely require a social-environmental impact study under the JBNQA, the EQA and IAA and obtain permits as per several regulations prior to its implementation. The next steps will include updating available data and fieldwork programs to document existing conditions before development and refining the location of routes to reduce impacts on biophysical and social environments. The continuum of engagement activities throughout the project will be essential to achieving social acceptability.

### 13.2.1 Railway

The transportation sector is one of the most important levers in national social and economic development efforts. Among all modes of transportation, including maritime, air, and road, rail transportation is one of the four main modes and plays an important role in multi-sectoral development. The Grand Alliance railway line under study has all the qualities of a structuring project, as it aims not only for growth but can also act as a development multiplier in northern regions. This report reviewed the technical disciplines impacted by the selected route, including rail, earthworks, structures, hydraulic and sanitation works, roadways, environment, various constraints, as well as mitigation measures, transshipment areas, stations, and rolling stock.

The technical feasibility study of the railway infrastructure concludes that:

1 The environment between Matagami and Rupert River is characterized by moderately hilly terrain, clayey soils and peatlands;

2 The proposed corridor is surrounded by protected and sensitive areas;

3 A reconsolidation of the existing soils is required in certain areas with softer soils;
4 The speed is set to 65 km/h (40 mph) for freight, and 100 km/h (60 mph) for passengers;
5 The Grevet-Chapais line does not present significant difficulties for reintegration into operation
6 Operation

### 13.2.2 Roads

The technical study included the analysis and assessment of the work required for the upgrading and paving of the access roads to the Communities of Waskaganish, Eastmain, Wemindji and Nemaska, the upgrading and paving of the Route du Nord and the addition of a secondary access road to Mistissini from the Route du Nord. The communities, tallymen and land users were engaged by the VEI liaison team along with the CIOs and brought great knowledge on the current issues with those access roads. In general ;

1 The horizontal geometry revealed issues with several curves (10%) mainly lacking signage and with three (3) curves that must be rebuilt;
2 Guard rails are required in certain sections;
3 The vertical geometry assessment revealed that 6% require signage and one (1) curve that must be corrected;
4 The geotechnical studies revealed that the surface structure is deficient and lacking in several places and in general 300 mm of surface aggregates would be required;
5 The inspection of the culverts revealed that most are approximately 30 years old and should therefore all be replaced given the rehabilitation works required and ultimately followed by pavement;
6 The land users also mentioned the importance of safety along the access roads and claimed the addition of stopping areas for emergencies or access to the territory, addition of signage and a safe multifunctional path;
7 The visibility should also be improved with the slashing of trees and brush along the roads.

## 13.3 MARKET STUDY

The market study, through a documentary synthesis and the survey of several companies and groups, made it possible to identify the following elements:

1 Road traffic volumes are low on the entire road network of Eeyou Istchee Baie-James, except for roads 113 and 167 in the sector of the towns of Chapais and Chibougamau; count data in the western part of the region are non-existent or patchy; the proportion of heavy vehicles is high; debits largely depend on economic activity; volumes have been generally up or stable over the medium term, notwithstanding the effect of the pandemic.
2 Gravel roads in poor condition result in uncomfortable driving conditions; dust limits visibility and causes damage to vehicles, leading to the use of vans rather than cars; the difficulty of travel may reduce the propensity to travel outside the communities or impose long detours, as in the case of the Route du Nord.
3 Accidents are less frequent, often occur in poor weather or road surface conditions and can be serious.
4 The Canadian National railway lines going to Matagami from Barraute, and to Chibougamau-Chapais from Saint-Félicien are poorly maintained because of low traffic; Following the closure of the Glencore mine in Matagami, the City of Matagami aims to ensure the transshipment of the volumes of lithium spodumene that will be shipped by the three or four mines that should be in operation in the next few years in the Nemaska area, otherwise the rail service from Barraute could be abandoned.
5 The population of the Cree communities will continue to grow strongly for quite a long period; this growth will require increased housing stock and many jobs to fill the workforce; this growth, combined with the increase

in motorization (vehicles per person), should result in increased traffic on access roads and the regional road network.

6 The population of Jamesian communities has experienced a decline due to economic difficulties; this trend has diminished in recent years; future growth will depend on economic development projects and the ability to attract labour.

7 The Cree population works mainly in services to the population, in construction and in certain other fields; people with high education remain few; although there are some large companies in the region that employ a certain proportion of Crees, the local workforce is still poorly integrated into the regional economy.

8 The participation of the Cree and Jamesian workforce is well below the needs of the region's major employers. Increasing this participation remains a priority objective. The extent of this participation will depend on the provisions of the specific agreements regarding local and regional workforce integration and subcontracting obligations, work schedules (regular versus fly in fly out), measures implemented place to attract and retain labour in the region (housing, recreation, etc.).

9 The regional economy is based on the exploitation of natural resources, in particular the forestry industry, mining and hydroelectricity; the forest industry is experiencing a revival with the reopening of the Lebel-sur-Quévillon plant, the interregional integration of establishments and the opening of the sawmill in Waswanipi; the mining industry is expected to experience major growth with the opening of new extraction sites, including iron, copper and lithium – processing in the region; investment in new facilities by Hydro-Québec remains undefined; tourism can develop through the integrated planning of COTA/TBJ and local initiatives.

10 The market survey made it possible to estimate traffic of the order of 1 MTPA on the BDHR and 600,000 TPA on the GCR for annual revenues of $31.7 million in total ($21.3 million and $10.4 million respectively) under the realistic assumption; demand consists mainly of lithium, copper, wood and wood products. The quantified forecast falls within a range of -30%/+42%. This forecast is based on existing activities and probable projects. The intended exploitation takes place over a fairly distant horizon, which limits its certainty. Nevertheless, the traffic forecast approach is relatively conservative and other traffic could be added, especially from potential users who did not respond to the survey.

11 The realization of a major mining project and several other mining projects, for example Duncan Lake or other lithium extraction sites or others, can bring much more traffic than the realistic scenario. This request may require the construction of Phase II infrastructure or part of such infrastructure.

12 Ridership is estimated at 6,000 passengers per year at the start of operation to reach 8,000 per year in the long term. This traffic is comparable to similar cases. Revenue from passengers of $200,000/year represents a marginal share (less than 1%) of the railway revenue.

## 13.4 Economic, Financial and Risks

The economic study dealt, on the one hand, with the evaluation of the effectiveness of the Grand Alliance's transport infrastructure program and, on the other hand, addressed economic development issues, the main findings of which are:

1 The capital costs (CAPEX) of the rail network are estimated at $3.2 billion, including $2.1 billion for the CFRBD and $1.1 billion for the CFGC. These amounts include related costs of 17% and a contingency of 20% but exclude taxes and the risk reserve.

2 The capital costs (CAPEX) of the access roads and the Route du Nord are estimated at $1.3 billion, including $571 million for the Route du Nord. These amounts include related costs of 14% and a contingency of 20% but exclude taxes and the risk reserve.

3 The work schedule is spread over a period of five years. Due to the intensity of the work related to the installation of the railway tracks, nearly half of the disbursement for the work is made during the third year.

4 The annual operating costs (OPEX) of the railways are estimated at $44.6 million for the traffic level of the realistic forecast. These amounts include a 15% contingency but exclude taxes and the risk reserve.

5 Annual maintenance costs for the access roads and the Route du Nord will be slightly lower with paving compared to gravel. The addition of the second access road to Mistissini slightly increases the annual costs for all the roads considered.

6 The benefit-cost analysis has established that the railway projects do not yield a positive net present value, i.e. benefits exceeding the costs, under the conditions of the base scenario. The realistic traffic forecast in the market research study remains insufficient in view of the importance of the initial capital costs. The conditions required to generate a surplus from the company's point of view involve a substantial reduction in project costs, significantly higher traffic and/or a lower discount rate. Given the use of the discount rate recommended by the MTMD, the project to be justified must include both a reduction in costs and greater freight traffic.

7 The financial analysis has established that the traffic revenues cover a small part of the total discounted costs (~10%) nor the entire operating costs. Without optimization of the project and pricing and in the absence of public contribution, the profitability of the project requires traffic ten times greater than the realistic forecast.

8 The subsidies necessary for an attractive rate of return on equity for the private investor are high, because assuming additional annual revenues of $107 million compared to the $32 million projected by the realistic demand scenario, an initial public contribution of $2.7 billion would be required with 90% private debt financing, and $3.9 billion without private investor debt financing.

9 The Canada Infrastructure Bank is a public contribution opportunity. Potential users, in particular mining companies, a certain horizontal integration (CN) and even the Cree Nation could be among the potential investors.

10 The estimate of the risk reserve must be added to the project budget and considered in the financial analysis of the project. Given that the identification of mitigation measures could not be completed, it would be necessary to finalize this task, including determining the associated budgets and the risk owners responsible for these actions.

11 The construction of roads and railway lines constitutes a major volume of employment opportunities over a fairly long period. The operation of the railways would create between 100 and 200 sustainable jobs.

12 Finally, it will be important for the project team to plan for the next risk management activities, including maintenance and updating of the risk register and the next risk analysis workshops at key project stages.

13 Once mitigation measures are identified, risk owners responsible within the project team must implement the associated actions. These actions should be included in the project activities to ensure proper follow-up.

14 In order to maximize the benefits of these direct project activities, it is necessary to define specific needs well in advance and prepare potential workforce accordingly. A training approach has been developed in the study.

15 The benefits for the socio-economic development of the Crees are of several kinds, including improved accessibility to workplaces, services, resources, markets, and other local communities; reduced costs and prices; improved socio-economic conditions, reduced nuisances, and improved quality of life.

16 The presence of these new transport infrastructure or the improvement of existing ones makes other business and employment opportunities more possible, particularly in tourism, forestry, the mining industry, trade, and land management.

17 Major investment costs make it difficult to achieve financial viability and economic justification for carrying out projects. However, the resulting socio-economic benefits can be significant.

In terms of market and economy, the next activities should aim to clarify and reduce uncertainty regarding forecasts and assessments in order to increase the justification of the program and maximize socioeconomic benefits for the Cree and Jamesian. To achieve this:

1 Ensure ongoing traffic counts on the roads in the western part of the region, as has been done in the eastern part.

2 Further documents and analyze the demand for local travel and its determinants.

3 Complete and refine traffic forecasts with businesses and organizations that have not yet responded or in addition to information. Establish conditions to increase traffic and revenue forecasts to more optimal levels in relation to costs.

4 Establish and implement a socio-economic development strategy to maximize regional and local benefits from natural resource development and tourism, combining different sectors of activity and different local communities, with or without the infrastructure program.

5 Clarify with each community the economic development and workforce participation axes, and how the different components of the Grand Alliance program contribute to this development objective.

6 Optimize the design and operating mode of projects to reduce costs, including through a value analysis exercise and taking into account risks.

7 Risk analysis must be refined, including the definition of mitigation measures, determination of associated budgets, and actions of risk owners. The risk register should be updated through new risk workshops at program milestones.

8 Valuate the interest of certain stakeholders in joining a partnership for road and rail projects.

9 Prioritize program components through a multi-criteria evaluation and stakeholder consultation.

10 Adjust the implementation schedule to maximize regional economic benefits.

## 13.5 RECOMMENDATIONS

The presence of these new transport infrastructure or the improvement of existing ones makes other business and employment opportunities more possible, particularly in tourism, forestry, the mining industry, trade and land management. Major investment costs make it difficult to achieve financial viability and economic justification for carrying out projects. However, the resulting socio-economic benefits can be significant.
Recommendations

Cree and Jamesian stakeholders showed an interest in reviewing and discussing the results of the various studies that compose Phase I Feasibility Study. VEI recommends continuing engagement activities through different channels, for example:

1 Visit the Cree communities and Jamesian towns to present and discuss the studies' results;

2 Maintain CIOs role and implication in each Cree communities;

3 Organize focus groups with economical actors;

4 Use different means of communications to disseminate information about LGA, such as local newspaper, radio stations, and web sites;
5 Prepare and distribute summaries of different aspects of the studies in Cree, English and French;
6 Send news and updates to Chief and Council, mayors and directors general;
7 Organize discussions sessions with all Jamesian mayors and director general.
8 Update available data as well as field work programs to document the existing conditions prior to development and allow to refine the location of the alignments to reduce impacts on the biophysical and social environments;
9 Perform additional field studies as the scope of work for the different infrastructures define themselves;

In subsequent stages for the rail and road infrastructures, a more detailed level of design will be sought, and to that end, we recommend the following actions, if necessary:

1 Additional geotechnical investigations, as well as tests to characterize all sites crossed by the route, for a better understanding of the environment;
2 Surveying in specific locations such as culverts, structures, and others. Lidar alone is not sufficient;
3 Comprehensive consultations with residents, Cree communities, and others;
4 Supplementary environmental studies and proposals for mitigation or attenuation measures;
5 Conducting detailed analyses and studies according to the desired level of design.

In terms of the market and the economy, the next activities must aim to clarify and reduce uncertainty regarding forecasts and assessments so as to increase the justification of the program and maximize the socioeconomic benefits for the Cree and Jamesian:

1 Complete and refine traffic forecasts with companies and organizations that have not responded or in addition and monitoring information. Establish the conditions to increase traffic and revenue forecasts to more cost-optimal levels.
2 Establish and implement a socioeconomic development strategy to maximize the regional and local spinoffs from the development of natural resources and tourism, bringing together the various sectors of activity and the various local communities, with or without the infrastructure program.
3 Clarify with each community the areas of economic development and labour force participation, and how the different components of the Grand Alliance program contribute to this development objective.
4 Optimize the design and operation of projects in order to reduce costs, in particular through a value analysis exercise and taking risks into account.
5 The risk analysis must be refined, in particular the definition of the mitigation measures, the determination of the associated budgets as well as the actions of the risk owners. It will be important to plan the next risk management activities, including the maintenance and updating of the risk register and the next risk analysis workshops at key stages of the project.
6 Assess the interest of certain stakeholders in being part of a partnership for road and rail projects.
7 Prioritize program components through multi-criterion assessment and stakeholder consultation.
8 Adapt the construction schedule to maximize regional economic spinoffs.

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