CREE DEVELOPMENT CORPORATION

LA GRANDE ALLIANCE

LA GRANDE ALLIANCE

PRE-FEASIBILITY STUDY – PHASES II & III – TRANSPORTATION INFRASTRUCTURE

TECHNICAL NOTE 16
CONSTRUCTION COST ESTIMATE

VERSION FINAL

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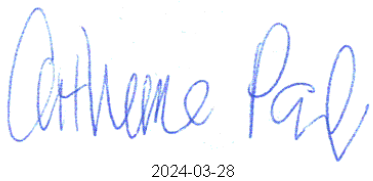

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EXECUTIVE SUMMARY

This Technical Note 16 is intended to provide an order of magnitude of the initial investment costs for the construction of the proposed infrastructures. These estimates will be used in the economic and financial analyses that will follow (refer to report 4). The objective is therefore not the precision of the estimates as such, which would be premature at this stage of a pre-feasibility study, but rather to evaluate the main items of expenditure, and above all to identify the elements subject to strong variations, and to explain the reasons for their variations and the consequences for the subsequent phases. Indeed, due to the large number of unknowns at this current stage of the study, the costs may be provided as a range with indications as to the factors that will have the biggest impact on the costs.

However, the cost estimate of the proposed road to Whapmagoostui/Kuujjuarapik is further detailed than the other infrastructures since this project component is developed up to a feasibility study, which means that its cost estimate is based on field collected data.

Cost estimates have been developed considering that each one of the project components, as listed below, would be a separate project as they could be implemented separately or in sequence in time.

PHASE I (1-5 YEARS)[1] (THE PHASE I IS STUDIED BY OTHERS)

- **Roadway: Upgrading and paving of the community access roads** for Waskaganish, Eastmain, Wemindji and Nemaska.
- **Railway: Matagami to Rupert**

  A proposed railway line following, as much as possible, the Billy-Diamond Highway (BDH) starting from the town of Matagami to the km 257 of the BDH (Rupert River Bridge).
- **Railway: Grevet to Chapais**

  A return to service for the decommissioned railway line between Grevet (Lebel-sur-Quévillon) and Chapais (approximate distance of 147 km).

PHASE II (6-15 YEARS)

- **Railway: Rupert to La Grande**

  A proposed railway alignment following, as much as possible, that of the Billy-Diamond Highway (BDH) starting at km 257 (after the Rupert River Bridge, which is the junction point with the railway alignment developed by the Phase I consultant) all the way to La Grande River. The Phase II railway alignment extends over an approximate distance of 340 km.
- **Route 167: upgrading & extension to the Trans-Taiga Road**

  Upgrading and paving of the section from the Mistissini community access road to the Stornoway Renard Mine access road over an approximate distance of 204 km;

  Extension towards north to connect with the Trans-Taiga Road near km 408, over an approximate distance of 172 km.
- **Road: La Grande to Whapmagoostui/Kuujjuarapik**

  A proposed road corridor connecting Chisasibi community access road and Whapmagoostui/Kuujjuarapik, over an approximate distance of 207 km.

[1] All dates indicated herein are hypothetical and would begin as of the start of the construction period. This therefore does not include all pre-project phases, most notably the Environmental and Social Impact Assessment that would be required if the infrastructures are pursued.

PHASE III (16-30 YEARS)

- **Railway: La Grande to Whapmagoostui/Kuujjuarapik**

  A railway which follows, as much as possible, the projected road leading to Whapmagoostui/Kuujjuarapik (from the junction with the Phase II railway alignment). The Phase III railway alignment extends over an approximate distance of 219 km.

- **Harbour at Whapmagoostui/Kuujjuarapik:**

  A proposed seasonal Harbour for shallow draft vessels/boats (~6 m water depth) along the Whapmagoostui/Kuujjuarapik coastline between the mouth of Great Whale River and the entrance of the Manitounuk Strait.

Construction cost estimates are based on unit costs or linear costs from recent projects completed by WSP teams in Canada and the U.S., with adjustments made to best suit the local northern context.

Construction cost estimates are based on the description and linear meter of the infrastructure described in Technical Notes 10 to 15 (geotechnical, roads, railroads, harbour, civil structures and construction overview). The determination of unit costs was the responsibility of each discipline leader. It was coordinated and validated by the cost estimator and the study management leaders.

Costs are quoted in CAD $2022. Construction costs are based on pre-tax values in August 2022 economic conditions. An escalation of the 2022 costs has been added to reflect the projected work as per anticipated construction schedule (refer to main assumptions section below) assuming a price indexation of 2.1% per annum based on the QIS Q1 2019 report and amounts to 2.1%. Capital costs do not include right-of-way acquisition, applicable taxes, and financing costs.

Table La Grande Alliance's Phase II and III Capital Cost Estimates

PHASE II & III INFRASTRUCTURE		DISTANCE	COST ESTIMATE		COST RANGE
R-167	Upgrading MTQ section from Mistissini to km 411	106 km	$271M	$1,053M	$1.5M to $2.5M per km
	Maintaining MTQ unpaved section from km 411 to km 553	141 km	-		
	Upgrading Mine road from km 553 to Stornoway Renard mine	89 km	$100M		
	Extension Stornoway Renard mine to Trans-Taiga Road	172 km	$685M		
Roadway: La Grande to Whapmagoostui/Kuujjuarapik		207 km	$1,428M		$6M to $8M per km
Railway: Rupert to La Grande		340 km	$3,958M		$10M to $14M per km
Railway: La Grande to Whapmagoostui/Kuujjuarapik		219 km	$4,899M		$20M to $25M per km
Harbour at Whapmagoostui/Kuujjuarapik		-	$57M		-

Note 1: To simplify the presentation, each item amount has been rounded to tenths, according to the detailed data in the source cost estimate file.
Note 2: Class D Estimate -20% to +100% margin of error.

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1 INTRODUCTION

This Technical Note 16 is intended to provide an order of magnitude of the initial investment costs for the construction of La Grande Alliance Phases II and III proposed transportation infrastructures. These estimates will be used in the economic and financial analyses that will follow (refer to Report 4). The objective is therefore not the precision of the estimates as such, which would be premature at the stage of a pre-feasibility and feasibility study, but rather to evaluate the main items of expenditure, and above all to identify the elements subject to strong variations, and to explain the source of their variations and the consequences for the subsequent phases. Indeed, due to the large number of unknowns at this current stage of the study, the costs may be provided as a range with indications as to the factors that will have the biggest impact on the costs.

However, the cost estimate of the proposed road to Whapmagoostui/Kuujjuarapik is further detailed than the other infrastructures since this project component is developed up to a feasibility study, which means that its cost estimate is based on field collected data.

Cost estimates have been developed considering that each of the project components that are part of WSP's mandate, as listed below, would be a separate project as they could be implemented separately or in sequence in time.

PHASE I (1-5 YEARS)[1] (THE PHASE I IS STUDIED BY OTHERS)

- **Roadway: Upgrading and paving of the community access roads** for Waskaganish, Eastmain, Wemindji and Nemaska.
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  A proposed railway alignment following, as much as possible, that of the Billy-Diamond Highway (BDH) starting at km 257 (after the Rupert River Bridge, which is the junction point with the railway alignment developed by the Phase I consultant) all the way to La Grande River. The Phase II railway alignment extends over an approximate distance of 340 km.
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PHASE III (16-30 YEARS)

- **Railway: La Grande to Whapmagoostui/Kuujjuarapik**

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2 METHODOLOGY

The initial capital cost estimate is based on a framework for classification by cost item and summarizes the cost components for each item. The cost estimate considers a percentage of uncertainty on both quantities and unit costs. At the pre-feasibility and feasibility study stage, it falls within a range of accuracy from -20% to +100% (Class D), as defined by the AFG (Association of Engineering Companies). Indeed, a Class C estimate would require a preliminary design of all systems.

Construction cost estimates are based on unit costs or linear costs from recent projects completed by WSP teams in Canada and the U.S., with adjustments made to best suit the local northern context. Data from comparable infrastructure projects, described in Technical Note 1, were also used as a benchmark to develop the initial capital cost estimates.

Construction cost estimates are based on the description and linear meter of the infrastructure described in Technical Notes 10 to 14 (geotechnical, roads, railroads, harbour, civil structures and construction overview). The determination of unit costs was the responsibility of each discipline leader. It was coordinated / controlled by the cluster managers. The final aggregation of the costs was validated by the cost estimator and the study management leaders.

Costs are quoted in CAD $2022. Construction costs are based on pre-tax values in August 2022 economic conditions. An escalation of the 2022 costs has been added to reflect the projected work as per anticipated construction schedule (refer to main assumptions section below) assuming a price indexation of 2.1% per annum based on the QIS Q1 2019 report and amounts to 2.1%. Capital costs do not include right-of-way acquisition, applicable taxes, and financing costs. This cost estimation did not consider the exceptional 6% to 8% inflation for the sole year 2022.

The cost breakdown methodology used is the ASTM Uniformat II Classification for Building Elements (E1557-97).

2.1 MAIN ASSUMPTIONS

The main assumptions used in the costing of the project are as follows:

- Since the project is such at an early stage, procurement analysis decisions are not available yet. We therefore considered a conservative approach based on a traditional delivery mode for this preliminary estimate. The preferred method of implementation will certainly be discussed and analyzed during the future stages of the project as it progresses. An alternative mode of execution (for example: Design - Construction) would modify certain parameters by including the costs of the final designs and plans and specifications in the construction costs. However, the realization mode should not have a significant impact on the global cost for this pre-feasibility study;
- The project cost estimate assumes that the work will be carried out in separate phases. The construction phases are anticipated as follows:
  - **Phase I**
    - 2023-2029: Field investigation, consultation, permits, detailed engineering, and procurement
    - 2030-2035: Railway Construction and beginning of operation
  - **Phase II**
    - 2030-2035: Field investigation, consultation, permits, detailed engineering, and procurement
    - 2035-2040: Railway Construction and beginning of operation
  - **Phase III**
    - 2035-2040: Field investigation, consultation, permits, detailed engineering, and procurement
    - 2040-2045: Railway Construction and beginning of operation

  - For each component, a generic master project schedule was developed considering the various steps that will be required and includes planning, obtaining approvals, environmental assessment, construction, and commissioning of the system. As established by Phase I consulting team, the year "0" has been established as 2028 for those infrastructures to be ready for use in 2035. Refer to Technical Note 15 for more details on Construction Overview.
- Project Schedule: It is difficult to predict today the construction costs, availability of labor, materials and contractors as construction is scheduled between 2035 and 2045. All of these elements can have a significant impact on the project costs estimated today in 2022;
- Although an investigation of archaeological sites has been carried out in close collaboration with local communities, if unknown archaeological sites are discovered during construction, this could significantly impact the execution of the construction works;
- No allowance is included for handling or disposal of hazardous materials and weather delays during construction works;
- Contractor's overhead and markup included at 20% of total direct and indirect cost and they are included in the estimated unit costs for the different items;
- Construction organization includes a main base camp per site with satellite camps at every 60 km;
- This estimate includes the cost of the material, but not the cost of delivery of the material. This cost is covered by the contingencies;
- Provisions for Covid-19 sanitary measures were accounted for. Restrictions in place at the end of 2022 were considered;
- Land acquisition is not included in this cost estimate;
- Rolling stock is included in Phase I cost estimate and it is therefore not included in this estimate.

2.2 CONTINGENCIES

Contingencies are added to account for uncertainties and unknows on both quantities and unit costs. To consider the level of detail of this pre-feasibility/feasibility study, and the constraints that are not known yet, a provisional 30% of the construction costs was established in a joint effort with Phase I team. Contingencies also account for material transport, which is not included in the unit prices.

2.3 RISK

A qualitative risk analysis was carried out and detailed in Technical Note 18. The monitoring of risks associated with the pre-feasibility of any major infrastructure project represents an essential activity that ensures the control of various events that could jeopardize the achievement of the objectives defined in the project plan, specifically with regards to the respect of cost parameters, completion deadlines, and project acceptability. Those events could include unforeseen events, changes in the equipment, materials, or requirements.

In terms of infrastructure design, the projected infrastructures will have to avoid or reduce the risks associated with, among others, protected areas, the environment, the protection of the landscape as well as any other element deemed important by the Cree communities. The design optimization will be possible once more detailed information are available, to be provided by the future preparatory studies (surveys, geotechnical, archaeological, environmental, etc.). That information is an element that will greatly reduce the risks associated with the development of the proposed infrastructures.

Moreover, in terms of construction works, establishing a monetary risk reserve through the quantitative risk analysis is strongly recommended now in this pre-feasibility study and in future stages.

Therefore, for estimation purposes, the risks for infrastructure design and construction works were estimated at a provisional 20% of the construction costs. This additional 20 % for risks was determined in a joint effort with Phase I team. Since Phase I's study is already at a feasibility stage and more detailed information is available, the working hypothesis was to use a proportional reserve for risk.

2.4 PROFESSIONAL FEES

At this pre-feasibility/feasibility stage of the study, professional fees include the future preparatory studies such as surveys, geotechnical campaign, archaeological investigations, environmental characterizations, hydraulic studies, etc. Those fees also include the future design phases by teams of engineers, as well as site and construction supervision and material quality control. This item does not include assistance by professional teams during public or Cree consultation processes. The professional fees are estimated up to 15% of the construction work costs. This additional 15% for professional fees was determined in a joint effort with Phase I team. However, this percentage will need to be revised in the next phases as the proposed infrastructures preliminary alignments get optimized, and the construction works better defined.

2.5 OWNER'S FEES AND PROJECT OFFICE COSTS

The owner's fees and project office costs are estimated up to 5% of the construction work costs. This item covers all costs incurred in connection with the project management, such as technical, engineering, environmental and legal assistance, insurance, communication, consultation, public inquiries, compensation for inconvenience during the work, permits and approval procedures. In the La Grande Alliance context, this item corresponds to the client's internal costs related to a project office and bidding process. No compensation was included for bidders.

This item also includes costs incurred directly by the project owner (professional mandates) to assist for land and topographical surveys, technical detailed field studies (geotechnical, environmental, archaeological, hydraulic), and specific surveys or studies that the project owner deems essential to the completion of the project.

Owner's fees and project office costs were defined in a joint effort with Phase I team.

3 ESTIMATE BREAKDOWN STRUCTURE

The estimates are based on the breakdown structure presented in Table 3-1. This breakdown was defined in coordination with the Phase I consultant. The items included in each infrastructure component are further described in sections 3.1 and 3.2.

Table 3-1 Railway and Roadway Construction Works – Estimate Breakdown Structure

ITEM	RAILWAY CONSTRUCTION	ROADWAY CONSTRUCTION
1. Civil and Earthworks	√	√
2. Civil Structures	√	√
3. Drainage	√	√
4. Track/Roadway Works	√	√
5. Level Crossing	√	X
6. Signaling and Telecommunications	√	X
7. Buildings and Passenger Stations	X	X
8. Depot and Storage Areas	X	X
9. Environmental Protection	√	√
10. Land Acquisition Costs or Land User Compensation	X	X
11. Rolling Stock	X	X

3.1 RAILWAY CONSTRUCTION ITEMS

The proposed railways of La Grande Alliance study present several challenges. They cross a northern territory with some presence of permafrost as well as several lakes and rivers. The estimates are based on the Pre-Feasibility stage proposed alignments that are somewhat limited by the accuracy of information available at the time, as the collection of field data and detailed engineering shall be carried out at future stage. Refer to Technical Note 12 for more detailed information.

The cost items and the unit costs presented below reflect the specificity of railway works. Note that access roads to the different construction sites are not a challenge as the railways' proposed alignments follow the existing Billy-Diamond Highway or the proposed road from La Grande to Whapmagoostui/Kuujjuarapik.

3.1.1 CIVIL AND EARTHWORKS

Cut and fill quantities are based on CAD Civil 3D conceptual profiles. Certain provisions were included to account for future alignment and profile optimization mainly at major bridge's locations. Volumes are without expansion ratios.

For the fill quantities, a certain portion of the excavation volumes was assumed to be reusable. This quantity of reusable excavation was determined based on the soil conditions described in Technical Note 10, i.e., distribution of each identified soil type along the 2km-wide corridor centered on each proposed railway alignments.

Table 3-2 indicates the hypothesis that was defined by the geotechnical experts to estimate the excavation volumes that were recoverable

Table 3-2 Recovery % based on the Types of Soil – Phase II & III Railways

TYPES OF SOIL	% of Phase II Railway on this type of soil	% of Phase III Railway on this type of soil	Recovery % per soil type
Organic soils	26%	5%	0%
Silt and clay	15%	17%	0%
Sand and gravel	28%	10%	50%
Till	16%	44%	10%
Rock	15%	24%	100%

For Phase II and Phase III alignments respectively, this translated to an overall recovery of 31 % and 33 % of the total excavation volumes. The remaining excavation volumes are to be treated and disposed with respect to the regulations in effect.

Table 3-3 presents the source of fill volumes for Phase II and Phase III proposed railways alignment.

Table 3-3 Source of Fill – Phase II & III Railways

	PHASE II	PHASE III
Fill Recovered from Excavation	3,937,000 m³ (31 % of 12,700,000 m³)	4,191,000 m³ (33 % of 12,700,000 m³)
Fill from Borrow Pits	8,563,000 m³	9,809,000 m³
Total Fill	12,500,000 m³	14,000,000 m³

Since Phase III's proposed railway alignment mainly follows the roadway alignment, field investigations for borrow pits identification carried out for the feasibility roadway study were consulted. According to the conclusions, borrow pits located along the railway and roadway alignments between La Grande and Whapmagoostui/Kuujjuarapik are sufficient to supply fill for both the railway and roadway.

Based on the important volumes of materials available in the borrow pits identified along Phase III's alignment, it was considered that the needs for fill from borrow pits for Phase II's alignment would be met by yet unidentified borrow pits along Phase II alignment.

Refer to Technical Note 12 for more detailed information.

The Civil and Earthworks unit prices used for La Grande Alliance proposed railway estimates are as follow:

- Excavation: $30/m³;
- Fill: $30/m³.

This item includes procurement, on site installation, access roads to sites, materials, machinery, erosion protection, environmental protection specific to this work, excavation from borrow pits, rock crushing, and all related costs.

3.1.2 CIVIL STRUCTURES

For estimate purposes, civil structures are divided in the following two categories:

- Bridges: All water, wetlands, valley crossings over 10 m in length;
- Culverts: All other structures less than 10 m in length.

The bridge and culvert differentiation were established to allow for different unit costs depending on the structure's length and its impact on the construction work. Those categories have no connection with the design method of those structures. The design of railway civil structures is based on the AREMA regulations (American Railway Engineering and Maintenance-of-Way Association) and the *Regulation respecting the sustainable development of forests in the domain of the state* (RADF).

Bridges are proposed when they are hydraulically justified. Water crossing distance is measured between water banks and does not include the approaches which are considered in the civil earthworks item. All water crossings over 10 m in length are considered as bridges regardless of the clearance under the bridge or the potential fill embankment. Moreover, bridges are proposed when the railway profile is more than 12 meters over the ground, for example in a valley crossing. The structure's length above a valley was established based on the length required to cover the section of the valley with more than 12 meters in height difference.

At this stage, the railway civil structures are based on steel spans or concrete prefabricated elements to minimize the need for cast-in-place concrete which may be an issue in the north. Corrugated galvanised steel plate or prefabricated concrete culverts may be used for culverts to ensure easier construction. Prefabricated bridge or bridge components and Accelerated Bridge Construction (ABC) techniques should be used to minimize the time required to install. However, a life cycle analysis shall be performed at a later stage of the study to confirm this approach.

Refer to Technical Note 14 for more detailed information.

The Civil Structures unit prices used for La Grande Alliance proposed railway infrastructures estimates are as follow:

- Bridges (over 10 m in length): $100,000/linear meter;
- Culverts (less than 10 m in length): $250,000/unit.

This item includes procurement, on site installation, access roads to sites, materials, machinery, erosion protection, environmental protection specific to this work, and all related costs.

3.1.3 DRAINAGE – RUN-OFF WATER MANAGEMENT

Open drainage is planned with a ditch along both sides of the entire proposed alignments and culverts to ensure transversal drainage across the railway infrastructure. Indeed, in addition to the civil structures mentioned in the previous section, we have considered one 900 mm diameter culvert every 500 m of track for drainage purposes regardless of the topography. These drainage culverts' length varies from 10 m to 15 m, depending on the railway cross section conditions (flat or rugged ground morphology).

The run-off water management unit prices used for La Grande Alliance proposed railway infrastructures estimates are as follow:

- Earthwork for the drainage ditch is accounted for within the civil earthworks cut & fill quantities;
- Drainage culverts (diam. 900 mm): $50,000/unit.

This item includes procurement, installation, materials, erosion protection, environmental protection specific to this work, and all related costs. The earthworks (cut & fill) are not included in this cost.

3.1.4 TRACK WORKS

3.1.4.1 MAIN LINE

At this stage of pre-feasibility study, no typical section was specifically developed. The track infrastructure cross section and material used for this study are from the standard plan TS 2204 and TS 2205 of the Canadian National. In subsequent phases of the project, the proponent will need to verify the applicability of this cross section and its detailed components.

The cost estimation for the procurement and construction of the heavy railway track is based on a unit cost per km. Refer to Technical Note 12 for the typical cross section. The railway track item includes machinery and materials such as rails, rail fastenings, ballast, sub-ballast, wood ties, and all related costs. In recent projects in southern Quebec, the average construction cost for track is approximatively $1M/km. However, to account for the unique aspect of the proposed railways of La Grande Alliance Phases II & III (northern conditions, limited construction season, isolated areas, etc.), the suggested linear cost is $2M/km as described below in Table 3-4.

Table 3-4 Track Works Unit Cost Breakdown

RAILWAY COMPONENT	UNIT COST	QUANTITY	COST
Rail 136 lb/vg	$2,850/ton	150 ton/km	$427,500/km
Wood Ties (including rail fasteners)	$200/unit	1,932 units/km (spacing of 20 3/8 in or 517 mm)	$386,400/km
Ballast and Sub-Ballast	$50/ton	2,000 ton/km (2 ton/m³)	$100,000/km
Labour, Installation and Equipment	-	-	$600,000/km
		Sub-total:	$1,513,900/km
		Total: (Includes premium for northern conditions, limited construction season, isolated areas, etc.),	$2.0M/km

3.1.4.2 SIDINGS

At this stage of pre-feasibility study and based on the foreseen train traffic and the frequency of the proposed one-track railway, two track sidings are foreseen to be required: one located close to La Grande (included in Phase II proposed railway) and one located at Whapmagoostui/Kuujjuarapik (included in Phase III proposed railway). Since track sidings should be longer than the longest train considered, a length of approximately 2 km is suggested herein.

The unit price for sidings based on the projected length is as follow:

- Siding (±2 km): $3,500,000/unit.

This item includes procurement, installation, materials, switches, environmental protection specific to this work, and all related costs. The earthworks (cut & fill) are not included in this cost.

3.1.5 LEVEL CROSSING

This item includes procurement and installation of the at grade railroad crossings, and all related costs. At this stage of pre-feasibility study and as mentioned in Technical Note 12, every railroad crossing is equipped only with signaling lights and bells. This reduces the maintenance cost as crossings equipped with barriers require expertise and maintenance. Note that the future optimization of the alignment should aim to reduce the number of railway roadway crossings because those are critical points for security reasons and to reduce construction, operation and maintenance costs.

The proposed unit price, based on the projected type of level crossings, is $500,000/unit.

This item includes paving the crossing surface, procurement, installation, materials, environmental protection specific to this work, and all related costs.

3.1.6 SIGNALING AND TELECOMMUNICATIONS

Given the low traffic expected for the proposed railways, the centralized traffic control (CTC) mode of operation was not considered due to its very high cost. The running order mode was retained since the area is considered a dead spot, i.e., the area has currently no radio coverage by any major telecom company.

Therefore, the estimated cost for the telecommunications equipment includes the procurement and installation of power and communication cables (fiber optics) and radio antennas. The proposed signaling and telecommunications unit price is as follow and includes all the items listed in Table 3-5:

- Signaling and Telecommunications: $250,000/km.

Table 3-5 Signaling and Telecommunication Linear Cost Breakdown

RAILWAY COMPONENT	DESCRIPTION
Antenna Towers with radio equipment	Self-Supporting Lattice towers spaced approximately 25km apart. Typical range depends on tower height. These are assumed to be 150 ft. Overlapping coverage for redundancy provided.
Fibre Network Design	Backbone network design for overall telecommunications system.
Power Distribution Design	Design for 12.47kV / 7200kV power distribution network with stepdown 120/240V transformers at each drop site. Assuming there are at least a few access points that can be obtained from Hydro Quebec along entire line.
Fibre and Power Cable Installation	Estimate of $80/meter to plow cables into ground via direct burial method. Open trench can bury both power and fibre cables at the same time.
Power Distribution Equipment	Transformers, voltage regulators, fuse disconnects, etc.
Backup Diesel Gensets	Backup diesel generators to support antenna tower infrastructure in case of power loss.
Power Cable	Direct burial power cables to be laid along railway track
Fibre Cable	Direct burial fibre cables to be laid along railway track
Local Telecom and Radio Equipment in Transhipment Yard	One at each end of railway phase, local equipment to support yard marshalling and train dispatch
Derailment Detectors and Landslide Detectors	These detectors could be located near long or expensive structures (bridges) and at potential geotechnical risk areas.
Hot Box and Dragging Detectors	One (1) detector every 50 kilometres of track. This is to prevent railway rolling equipment misfunction.
Rail Lubrication System	Rail lubrication systems are proposed where many and important curves are present.

3.1.7 BUILDINGS AND PASSENGER STATIONS

In coordination with Phase I traffic study, three passenger stations are considered in Phase II's proposed railway (Eastmain, Wemindji & La Grande) and one passenger station is considered in Phase III's proposed railway (Whapmagoostui/Kuujjuarapik).

Their characteristics are not defined yet but since passengers per trip is estimated to be low, the proposed stations are currently considered to be minimalist, i.e., mainly composed of a platform adjacent to main railway track for passenger boarding, a small building, and a parking lot. The boarding platform, such as the one in Schefferville or in Senneterre, could be a simple paved surface along the track, with a prefabricated office building.

Since those passengers' stations were not studied at the same level of detail as the rest of the proposed infrastructures, they were not included in this current estimate. For information in the next phases of the study, a provision of $750,000/station could potentially be considered.

3.1.8 DEPOT AND STORAGE AREAS

A minimum of one railway yard must be considered, located at the terminal station of the railway. A railway yard or transshipment area is also required wherever freight trains need to load or unload goods. Yard and maintenance center must relate to the proposed road network to facilitate transshipment between transportation mode. A connection with the proposed harbour shall be a plus value.

In most previous similar projects, the construction costs for transhipment facilities and railway junction is looked after by the operator such as a private mining company. Size of transshipment areas can significantly vary depending on the specific needs of the operation. The construction cost could not be estimated. A more detailed analysis for possible users should be done in the next phases of the study.

For information, it would be conceivable to consider two transhipment areas. Locations close to Eastmain and La Grande are likely to represent a good potential if mining projects emerge.

3.1.9 ENVIRONMENTAL PROTECTION

Due to the specific environmental conditions of the region, as well as the high importance given to social and environmental concerns by Cree communities, a particular attention was given to environmental measures and monitoring during the construction phase by including this aspect of the work within the unit cost for each item. Those unit costs should be reviewed at subsequent stages to ensure that they fully capture all environment requirements that may follow the *Environmental and Social Impact Assessment Procedure*.

However, this environmental protection item was added to capture other environmental protection or mitigation costs, such as compensation costs that could be imposed by the different authorities if environmental impacts are deemed too severe. Those costs were preliminarily estimated as approximately 20% of the construction costs. This item should be revised in the next phases of the study.

3.2 ROADWAY CONSTRUCTION

The proposed roads of La Grande Alliance study present several challenges. They cross a northern territory with some presence of permafrost as well as several lakes and rivers. The Route 167 estimates are based on the pre-feasibility stage proposed alignments that are somewhat limited by the accuracy of information available at the time, as the collection of field data and detailed engineering shall be carried out at future stage. Moreover, the estimate for proposed road alignment between La Grande and Whapmagoostui/Kuujjuarapik is based on the feasibility study information, as preliminary field collected data was available. Refer to Technical Note 11 for more detailed information.

The cost items and the unit costs presented below reflect the specificity of roadway works. Note that different unit costs are suggested for the different sections for the roadway from La Grande to Whapmagoostui/Kuujjuarapik and for of Route 167. Those proposed roads presenting different challenges, the unit costs were adjusted accordingly.

3.2.1 CIVIL AND EARTHWORKS

Cut and fill quantities are based on CAD Civil 3D conceptual profiles. The topographic profile of the natural ground was extracted from either contour lines (Route 167) or Lidar survey (La Grande to Whapmagoostui/Kuujjuarapik). Volumes are without expansion ratios.

For the fill quantities, a certain portion of the excavation volumes was assumed to be reusable. This quantity of reusable excavation was determined based on the soil conditions described in Technical Note 10, i.e., distribution of each identified soil type along the 2km-wide corridor centered on each proposed roadway alignments.

Table 3-6 indicates the hypothesis that was defined by the geotechnical experts to estimate the excavation volumes that were recoverable

Table 3-6 Recovery % based on the Types of Soil – Phase II Roadways

TYPES OF SOIL	% of Route 167 extension on this type of soil	% of Whapmagoostui Road on this type of soil	Recovery % per soil type
Organic soils	< 1%	5%	0 %
Silt and clay	-	9%	0 %
Sand and gravel	3%	10%	100 %
Till	96%	29%	50 %
Rock	< 1%	47%	100 %

For the roadway from La Grande to Whapmagoostui/Kuujjuarapik and for of Route 167 alignments respectively, this translated to an overall recovery of 51 % and 76 % of the total excavation volumes. The remaining excavation volumes are to be treated and disposed with respect to the regulations in effect.

Table 3-7 presents the source of fill volumes for Phase II proposed roadways alignment.

Table 3-7 Source of Fill – Phase II Roadways

	Route 167 extension	Whapmagoostui Road
Fill Recovered from Excavation	1,269,246 m³ (51 % of 2 461 000 m³)	2 454 454 m³ (76 % of 3 209 000 m³)
Fill from Borrow Pits	1 048 000m³	6 517 554m³
Total Fill	2 316 352 m³	8 972 008m³

Borrow pits located along the roadway alignments between La Grande and Whapmagoostui/Kuujjuarapik are sufficient to supply fill for both the railway and roadway. However, it should be noted that there are no active borrow pit leases and/or quarry leases along the length of the proposed Route 167extension. The Renard Mine has approximately 5,000,000 m^3 of non-acid generating tailings that could be used as a source for granular materials. New quarries and/or gravel pits will need to be identified and developed to build the road.

The Civil and Earthworks unit prices used for La Grande Alliance proposed roadway infrastructures estimates are as follow:

- Route 167: Upgrading and Paving MTQ Section from Mistissini to km 411
  - Excavation: $20/m³;
  - Fill: $39/m³.
- Route 167: Existing Mine Road Upgrade
  - Excavation: $17/m³;
  - Fill: $36/m³.
- Route 167: New Road Extension to Trans-Taiga
  - Excavation: $16/m³;
  - Fill: $33 $/m³.
- Roadway: La Grande to Whapmagoostui/Kuujjuarapik
  - Excavation: $29/m³;
  - Fill: $28/m³.

This item includes procurement, on site installation, access roads to sites, materials, machinery, erosion protection, environmental protection specific to this work, and all related costs.

3.2.2 CIVIL STRUCTURES

For estimate purposes, civil structures are divided in the following two categories:

- Bridges: All water, wetlands, valleys crossings over 4.5 m in length
- Culverts: All other structures less than 4.5 m in length

The bridge and culvert differentiation was established to allow for different unit costs depending on the structure length and its impact on the construction work. The design of the roadway civil structures is based on the MTQ road and bridge design standards *Tome III – Ouvrages d'art* from MTQ's *Normes sur la conception des ouvrages d'art (MTQ, 2021a),* and CSA-S6:19 regulations and criteria.

Bridges are proposed when they are hydraulically justified. Water crossing distance is measured between water bank and does not include the approaches which are considered in the civil earthworks item. All water crossings over 4.5 m in length are considered as bridges regardless the clearance under the bridge or the potential fill embankment.

At this stage, the roadway civil structures are based steel-wood bridges are preferred, when possible, for their ease of construction and prefabrication for this northern construction. However, a life cycle analysis shall be performed at a later stage of the study to conform this approach. Corrugated galvanised steel plate or prefabricated concrete culverts may also be used in some cases to ensure easier construction where environmental regulations can be met. As for the railway structure, prefabricated bridge or bridge components and the Accelerated Bridge Construction (ABC) techniques are recommended, when possible, to minimize the time required to install the structures because the construction period is limited.

Refer to Technical Note 14 for more detailed information.

The Civil Structures unit prices used for La Grande Alliance proposed roadway infrastructures estimates are as follow:

- Upgrade/replacement of existing structures:
  - Bridges or culverts (over 4.5m in length): N/A;
  - Culverts (less than 4.5m in length):
    - Replacement when deemed in bad conditions: $332,000/unit;
    - Provisional: $135,000/unit.
- Proposed new structures:
  - Bridges or culverts (over 4.5m in length): $80,000/linear meter
  - Culverts (less than 4.5m in length):
    - Route 167 Extension to Trans-Taiga: $257,000/unit;
    - Roadway La Grande to Whapmagoostui/Kuujjuarapik: $245,000/unit.

This item includes procurement, on site installation, access roads to sites, materials, machinery, erosion protection, environmental protection specific to this work, and all related costs.

3.2.3 DRAINAGE – RUN-OFF WATER MANAGEMENT

Open drainage is planned with a ditch along both sides of the entire proposed alignments completed with culverts to ensure transversal drainage across the roadway infrastructure. Indeed, in addition to the civil structures mentioned in the previous section, we have considered 900 mm diameter culvert at each low point of the proposed road profile or as required by the natural topography. These drainage culverts length is around 30 m based on the road typical cross section.

The run-off water management unit prices used for La Grande Alliance proposed railway infrastructures estimates are as follow:

- Upgrade/replacement of existing drainage culverts:
  - Provisional: $112,000/unit.
- Proposed new drainage culverts:
  - Route 167 Extension to Trans-Taiga: $213,000/unit;
  - Roadway La Grande to Whapmagoostui/Kuujjuarapik: $202,000/unit.

This item includes procurement, installation, materials, erosion protection, environmental protection specific to this work, and all related costs. The earthworks (cut & fill) are not included in this cost.

3.2.4 ROADWAY WORKS

The cost estimation for roadway procurement and construction is based on a unit cost per km. The road design is based on the MTQ road design standard cross section and details as per a regional collector road described in *Tome 1 - Conception routière ministère des Transports duQuébec, Edition June 2021 (Volume 1 - Road design Quebec Ministry of Transport, June 2021 Edition).* More specifically, the proposed cross-section is a modified type E. Refer to Technical Note 11 for more detailed information.

The unit costs are based mainly on similar and recent projects. The suggested unit costs are the following:

- Route 167:
  - Upgrading and Paving MTQ Section from Mistissini to km 411: $885,000/km;
  - Existing Mine Road Upgrade: $301,000/km;
  - Extension to Trans-Taiga: $887,000/km;
- Proposed roadway - La Grande to Whapmagoostui/Kuujjuarapik: $771,000/km.

Those unit costs include procurement, on site installation, machinery, materials, paving, signaling, guardrails and crash barrier, security devices, junctions, permafrost mitigation measures, environmental protection specific to this work, and all related costs. Note that for road upgrade or replacement, a road traffic management component is also in included in the unit cost.

3.2.5 ENVIRONMENTAL PROTECTION

Due to the specific environmental conditions of the region, as well as the high importance given to social and environmental concerns by Cree communities, a particular attention was given to environmental measures and monitoring during the construction phase by including this aspect of the work within the unit cost for each item. Those unit costs should be reviewed at subsequent stages to ensure that they fully capture all environment requirements that may follow the *Environmental and Social Impact Assessment Procedure*.

However, this environmental protection item was added to capture other environmental protection or mitigation costs, such as compensation costs that could be imposed by the different authorities if environmental impacts are deemed too severe. Those costs were preliminarily estimated as approximately 20% of the construction costs. This item should be revised in the next phases of the study.

4 PROPOSED INFRASTRUCTURES ESTIMATES

4.1 RAILWAY: RUPERT TO LA GRANDE

The Phase II pre-feasibility proposed railway alignment begins just west of the Rupert River crossing, as an extension of the Phase I railway alignment and ends at approximately 3 km south of La Grande River. The proposed railway alignment generally follows the Billy-Diamond Highway. The railway's overall proposed length is 340 km, and its sinuous nature is a consequence of avoiding many lakes as well as the varied topography in the Study Area.

The proposed railway includes 36 civil engineering structures out of which eight (8) are major ones, the longest ones being above Eastmain River, Opinaca River and Vieux Comptoir River for which arch bridges must be considered. For other structures, multi-span bridges are being considered, avoiding foundations in wetlands as much as possible.

Table 4-1 below presents the costs for each item and the total capital cost estimate.

Table 4-1 Railway: Phase II Rupert to La Grande - Detailed Capital Cost Estimate

Railway: Phase II Item		NOTE	UNIT COST	QUANTITY	SUB-TOTAL
1	Civil and Earthworks	Cut	$30/m³	12.7M m³	$381M
		Fill	$30/m³	12.5M m³	$375M
2	Civil Structures	Bridges over 10m	$100k/l.m	2,600 l.m	$260M
		Culverts under 10m	$250k/unit	10 units	$2.5M
3	Drainage	Culvert 900 mm diam.	$50k/unit	680 units	$34M
4	Track Works	Mainline	$2M/l.km	340 l.km	$680M
		Siding (La Grande)	$3.5M/unit	1 unit	$3.5M
5	Level Crossing		$500k/unit	23 units	$11.5M
6	Signaling &Telecommunications		$250k/l.km	340 l.km	$85M
7	Buildings & Passengers Stations	Not included	-	-	-
8	Depot and Storage Areas	Not included	-	-	-
9	Environmental Protection	20 %	-	-	$366.5M
Construction Costs Sub-Total (without contingencies and risk)					**$2,199M**
Contingencies (30 %)					$659.7M
Risk (20 %)					$439.8M
Construction Costs Sub-Total					**$3,298.5M**
Professional Fees (study, design, site supervision, etc.) (15 %)					$494.8M
Owner's Fees and Project Office Costs (5 %)					$164.9M
Total Capital Cost Estimate					**$3,958.2M**

Note 1: To simplify the presentation, each item amount has been rounded to hundredth thousand, according to the detailed data in the source cost estimate file.
Note 2: Class D Estimate -20% to +100% margin of error.

4.2 RAILWAY: LA GRANDE TO WHAPMAGOOSTUI/KUUJJUARAPIK

The Phase III proposed railway alignment begins approximately 3 km south of La Grande River, as an extension of the Phase II proposed railway and progresses northwards to the Whapmagoostui/Kuujjuarapik coastline between the mouth of Great Whale River and the location for the proposed harbour infrastructure. Its overall proposed length is 219 km, and its sinuous nature is a consequence of avoiding many lakes as well as the varied topography in the Study Area. The proposed railway alignment generally follows the feasibility proposed road alignment from Phase II.

The proposed rail section includes 66 civil structures out of which 27 are major ones (length over 50m). The longest ones being above La Grande River and near Great Whale River. For La Grande River crossing, the railway cannot use the Robert-Bourassa spillway due to the heavy axle load and vibrations. The new railway bridge may be designed to accommodate both rail and road traffic. For Great Whale River crossing, a cable-stayed bridge must be considered. For other structures, multi-span bridges are being considered, avoiding foundations in wetlands as much as possible. Table 4-2 below presents the costs for each item and the total capital cost estimate.

Table 4-2 Railway: Phase III La Grande to Whapmagoostui/Kuujjuarapik - Detailed Capital Cost Estimate

Railway: Phase III Item		NOTE	UNIT COST	QUANTITY	SUB-TOTAL
1	Civil and Earthworks	Cut	$30/m³	12,700,000 m³	$381M
		Fill	$30/m³	14,000,000 m³	$420M
2	Civil Structures	Bridges over 10m	$100k/l.m	9,400 l.m	$940M
		Culverts under 10m	$250k/unit	12 units	$3M
3	Drainage	Culvert 900 mm diam.	$50k/unit	438 units	$21.9M
4	Track Works	Mainline	$2M/l.km	219 l.km	$438M
		Siding (Whapmagoostui)	$3.5M/unit	1 unit	$3.5M
5	Level Crossing		$500k/unit	12 units	$6M
6	Signaling &Telecommunications		$250k/l.km	219 l.km	$54.8M
7	Buildings & Passengers Stations	Not included	-	-	-
8	Depot and Storage Areas	Not included	-	-	-
9	Environmental Protection	20 %	-	-	$453.6M
Construction Costs Sub-Total (without contingencies and risk)					**$2,721.8M**
Contingencies (30 %)					$816.5M
Risk (20 %)					$544.4M
Construction Costs Sub-Total					**$4,082.7M**
Professional Fees (study, design, site supervision, etc.) (15 %)					$612.4M
Owner's Fees and Project Office Costs (5 %)					$204.1M
Total Capital Cost Estimate					**$4,899.2M**

Note 1: To simplify the presentation, sub-total of each item amount has been rounded to hundredth thousand, according to the detailed data in the source cost estimate file.

Note 2: Class D Estimate -20% to +100% margin of error.

4.3 ROUTE 167: UPGRADE & EXTENSION TO TRANS-TAIGA ROAD

The roadway alignment connecting the existing Route 167 to the Trans-Taiga Road is 517,6 km long and for this Phase II pre-feasibility study, the cost estimates are based on the foreseen work planned for its 4 different sections.

Table 4-3 below presents the cost estimates for all the proposed works included in this Route 167 study.

Refer to further sections for details on each segment.

Table 4-3 Route 167 – Planned Work

Route 167: Phase II Item	STATION (START)	STATION (END)	LENGTH	COST ESTIMATE
Existing Road				
Existing Gravel Road Upgrade and Paving	305+000	411+700	106.6 km	$271M
Existing Unpaved MTQ Road (no work)	411+700	553+370	141.7 km	$0
Existing Mine Road Upgrade	553+370	642+640	89.3 km	$100M
Proposed Extension to Trans-Taiga				
New Road Extension	642+640	814+710	172 km	$658M
			Total Capital Cost Estimate	**$1,053M**

Note 1: To simplify the presentation, sub-total of each item amount has been rounded to M$, according to the detailed data in the source cost estimate file.
Note 2: Class D Estimate -20% to +100% margin of error.

4.3.1 ROUTE 167: EXISTING GRAVEL ROAD UPGRADE & PAVING

This Phase II pre-feasibility proposed work segment includes the upgrade and paving of the existing roadway from the Mistissini community access road to the Albanel Lake access road over an approximate distance of 204 km.

This proposed segment includes the replacement of an old forestry bridge (P-0125A) at station 351+922, but since this is planned in MTQ five-year program, it is not included in this present cost estimate. Same applies to the replacement of the rated D and E drainage culverts (less than 4.5 m). However, we have included 49 culverts (more than 4.5 m) within the upgrade proposed construction work.

Since this work is related to an existing road, traffic management was included in Roadway Works item. Maintaining an existing roadway in operational during construction leads to significantly higher cost than brand new road in an undeveloped area where traffic management is only for the workers on site.

Table 4-4 below presents the costs for each item and the total capital cost estimate.

Table 4-4 Route 167: Existing Gravel Road Upgrade & Paving - Detailed Capital Cost Estimate

ITEM		NOTE	UNIT COST	QUANTITY	SUB-TOTAL
Proposed Existing Gravel Road Upgrade & Paving: 305+000 to 411+700					
1	Civil and Earthworks	Cut	$20/m³	106,600 m³	$2.1M
		Fill	$39/m³	319,800 m³	$12.5M
2	Civil Structures	Bridges over 4.5m	-	-	$0
		Culverts under 4.5m	$332k/unit	49 units	$16.3M
3	Drainage	Drainage Culvert	-	-	$0
4	Roadway Works		$885k/l.km	107 l.km	$94.7M
9	Environmental Protection	20 %	-	-	$25.1M
Construction Costs Sub-Total (without contingencies and risk)					**$150.7M**
Contingencies (30 %)					$45.2M
Risk (20 %)					$30.1M
Construction Costs Sub-Total					**$226.0M**
Professional Fees (study, design, site supervision, etc.) (15 %)					$33.9M
Owner's Fees and Project Office Costs (5 %)					$11.3M
Total Capital Cost Estimate					**$271.2M**

Note 1: To simplify the presentation, sub-total of each item amount has been rounded to tenths thousand, according to the detailed data in the source cost estimate file.
Note 2: Class D Estimate -20% to +100% margin of error.

4.3.2 ROUTE 167: EXISTING MINING ROAD UPGRADE

Note that for the section between chainages 553+370 and 642+640, both an option of updating the existing road and construction of a new road were studied in Technical Note 11. Nevertheless, the option for existing mine road upgrade was recommended in the Technical Note 11. Only this option was considered in this estimate. Moreover, for this road section, in the absence of data, conservative hypotheses and assumptions were made.

A lump sum of 100,058,000$ was estimated for this road upgrade. It represents approximately 50% of the estimates for the construction of the new road excluding the costs for construction of new bridges, as the existing mining road bridges were constructed recently and are deemed in good conditions. This cost estimate includes contingencies, risk, professional fees and owner's fees.

4.3.3 ROUTE 167: ROAD EXTENSION TO TRANS-TAIGA ROAD

This Phase II pre-feasibility proposed work segment includes an extension connecting the existing road northwards to the Trans-Taiga Road over an approximate distance of 172 km.

The proposed roadway includes 23 civil engineering structures and 63 culverts over 4.5 m in length. As for the number of drainage culverts (163), it was defined based on the projected road profile (at each low point of the profile or natural terrain) and the diameter of the drainage culverts was set generically to 900 mm.

For estimation purposes, the following criteria were retained:

- Deforestation is required on the entire length of the corridor and the width of the right-of-way is 35 m. The deforestation is estimated at 668 hectares.
- Based on a recent Billy-Diamond Highway study, a ratio of 134 m of guardrail/km and a ratio of 1.6 lateral deviation devices/km was used. Also, bridges have automatically 4 bridge connectors.

Table 4-5 below presents the costs for each item and the total capital cost estimate.

Table 4-5 Route 167: Road Extension to Trans-Taiga Road - Detailed Capital Cost Estimate

ITEM		NOTE	UNIT COST	QUANTITY	SUB-TOTAL
Proposed Road Extension to Trans-Taiga: 642+640 to 814+710					
1	Civil and Earthworks	Cut	$16/m³	2,461,000 m³	$39.4M
		Fill	$33/m³	1,048,000 m³	$34.6M
2	Civil Structures	Bridges over 4.5m	$80k/l.m.	468 l.m.	$37.4M
		Culverts under 4.5m	$257k/unit	63 units	$16.2M
3	Drainage	Drainage Culvert	$213k/unit	163 units	$34.7M
4	Roadway Works		$887k/l.km	173 l.km	$153.5M
9	Environmental Protection	20 %	-	-	$63.2M
Construction Costs Sub-Total (without contingencies and risk)					**$378.9M**
Contingencies (30 %)					$113.7M
Risk (20 %)					$75.8M
Construction Costs Sub-Total					**$568.4M**
Professional Fees (study, design, site supervision, etc.) (15 %)					$85.3M
Owner's Fees and Project Office Costs (5 %)					$28.4M
Total Capital Cost Estimate					**$682.0M**

Note 1: To simplify the presentation, sub-total of each item amount has been rounded to tenths thousand, according to the detailed data in the source cost estimate file.
Note 2: Class D Estimate -20% to +100% margin of error.

4.4 ROADWAY: LA GRANDE TO WHAPMAGOOSTUI/KUUJJUARAPIK

The proposed road to Whapmagoostui/Kuujjuarapik is 207.0 km starting at LG-2's spillway to cross La Grande River. The proposed road connects to the Kanajuk Avenue approximately 450 m south of the intersection between the 33N05-6 gravel pit access road and the Kanajuk Avenue.

The proposed roadway includes 61 civil engineering structures out of which 11 are major ones. The Great Whale River crossing is the most significant structure required considering the width of the river at the planned crossing. A cable-stayed bridge must be considered for this site. We have also included for 81 culverts over 4.5 m in length. As for the number of drainage culverts (374), it was defined based on the projected road profile (at each low point of the profile and/or natural terrain) and the diameter of the drainage culverts was set generically to 900 mm.

For estimation purposes, the following criteria were retained:

- Deforestation is required on the entire length of the corridor and the width of the right-of-way is 35 m. The deforestation is estimated at 711 hectares.
- Based on a recent Billy-Diamond Highway study, a ratio of 134 m of guardrail/km and a ratio of 1.6 lateral deviation devices/km was used. Also, bridges have automatically 4 bridge connectors.
- Traffic management is included in Roadway Works item. Since this proposed work is in undeveloped area, the item is minimalist considerably reduced and limited to construction needs.

Table 4-6 Roadway: La Grande to Whapmagoostui/Kuujjuarapik - Detailed Capital Cost Estimate

	ITEM	NOTE	UNIT COST	QUANTITY	SUB-TOTAL
Proposed Road Extension: 650+000 to 822+564					
1	Civil and Earthworks	Cut	$29/m³	3,209,000 m³	$93.1M
		Fill	$28/m³	5,894,000 m³	$165.0M
2	Civil Structures	Bridges over 4.5m	$80k/l.m	1,850 l.m	$148.0M
		Culverts under 4.5m	$245k/unit	81 units	$19.8M
3	Drainage	Drainage Culvert	$202k/unit	374 units	$75.5M
4	Roadway Works		$771k/l.km	207 l.km	$159.6M
9	Environmental Protection	20 %	-	-	$132.2M
Construction Costs Sub-Total (without contingencies and risk)					**$793.3M**
Contingencies (30 %)					$238.0M
Risk (20 %)					$158.7M
Construction Costs Sub-Total					**$1,190.0M**
Professional Fees (study, design, site supervision, etc.) (15 %)					$178.5M
Owner's Fees and Project Office Costs (5 %)					$59.5M
Total Capital Cost Estimate					**$1,427.9M**

Note 1: To simplify the presentation, sub-total of each item amount has been rounded to tenths thousand, according to the detailed data in the source cost estimate file.
Note 2: Class D Estimate -20% to +100% margin of error.

4.5 HARBOUR AT WHAPMAGOOSTUI/ KUUJJUARAPIK

This section provides a high-level estimate of the construction cost for the proposed seasonal Harbour for shallow draft vessels/boats (~6 m water depth) along the Whapmagoostui/Kuujjuarapik coastline between the mouth of Great Whale River and the entrance of the Manitounuk Strait. This estimate is based on limited design input and using budget pricing from previous similar projects.

The cost estimate is based on the following assumptions made:

- Assume a marine crew with 2x barges and 1x tugboat;
- Assume a land-based crew with Ranger (800) drill, 1x CAT 980 sized loader, 3x 40 T rock trucks, 1x CAT D6 dozer and 1x 85 T RT crane;
- Assume 11-hour shifts, 7 days per week;
- Assume all work will be performed by a competent contractor with understanding of logistics to site;
- Assume all excavation and earthworks will be completed in the dry;
- Assume all materials must be transported on site;
- Assume suitable geology for generating riprap and gravel materials at the chosen site;
- Assume mobilization, setup, and construction will take place in one season, and dismantling, and demobilization will take place during the second open water season. All equipment will be captive for the remaining time.

Table 4-7 Harbour at Whapmagoostui/ Kuujjuarapik - Detailed Capital Cost Estimate

	COST CATEGORY	COST ESTIMATE (TOTAL M$)
1	Preparatory work and site operation	$2.3M
2	Harbour construction work	$29.2M
	Construction Costs Sub-Total (without contingencies and risk)	**$31.4M**
	Contingencies (30 %)	$9.5M
	Risk (20 %)	$6.3M
	Construction Costs Sub-Total	**$47.2M**
	Professional Fees (study, design, site supervision, etc.) (15 %)	$7.1M
	Owner's Fees and Project Office Costs (5 %)	$2.4M
	Total Capital Cost Estimate	**$56.6M**

Note 1: To simplify the presentation, each item amount has been rounded to tenths, according to the detailed data in the source cost estimate file.
Note 2: Class D Estimate -20% to +100% margin of error

5 CONCLUSIONS

The purpose of this Technical Note 16 was to provide an order of magnitude of the initial investment costs for the construction of the proposed infrastructures included in Phase II and III of La Grande Alliance study. These infrastructures are:

PHASE II (5-10 YEARS)

- **Railway: Rupert to La Grande;**
- **Route 167: Upgrade & extension to Trans-Taiga Road;**
- **Roadway: La Grande to Whapmagoostui/Kuujjuarapik.**

PHASE III (10-15 YEARS)

- **Railway: La Grande to Whapmagoostui/Kuujjuarapik;**
- **Harbour at Whapmagoostui/Kuujjuarapik.**

The objective was therefore not the precision of the estimates as such, which would be premature at the stage of a pre-feasibility and feasibility study, but rather to evaluate the main items of expenditure, and above all to identify the elements subject to strong variations, and to explain the reasons for their variation and the consequences for the subsequent phases. Consequently, several factors can still influence the costs of the project. These include:

- Project financing method;
- Project implementation methods;
- Political factors and legal requirements;
- Social acceptability and adjustment required to achieve it;
- Communications;
- Law and regulations;
- Protection of the environment;
- Climatic and ecological factors;
- Sensitive site conditions;
- Soil conditions and permafrost;
- Economic factors such as inflation, the condition of supply chains, the availability of resources (human and material) and contractors at the time the work is performed;
- Market conditions;
- Limited local labour resource;
- Planification and design;
- Duration of construction (variation);
- Risk analysis.

Construction cost estimates are based on unit costs or linear costs from recent projects completed by WSP teams in Canada and the U.S., with adjustments made to best suit the local northern context and the particular conditions of this study.

TECHNICAL NOTE 16 – CONSTRUCTION COST ESTIMATE

Construction cost estimates are based on the description and linear meter of the infrastructure described in Technical Notes 10 to 15 (geotechnical, roads, railroads, harbour, civil structures and construction overview). The determination of unit costs was the responsibility of each discipline leader. It was coordinated and validated by the cost estimator and the study management leaders.

Costs are quoted in CAD $2022. Construction costs are based on pre-tax values in August 2022 economic conditions. An escalation of the 2022 costs has been added to reflect the projected work as per anticipated construction schedule (refer to main assumptions section below) assuming a price indexation of 2.1% per annum based on the QIS Q1 2019 report and amounts to 2.1%. Capital costs do not include right-of-way acquisition, applicable taxes, and financing costs.

Table 5-1 La Grande Alliance's Phase II and III Capital Cost Estimates

PHASE II & III INFRASTRUCTURE		DISTANCE	COST ESTIMATE		COST RANGE
R-167	Upgrading MTQ section from Mistissini to km 411	106 km	$271M	$1,053M	$1.5M to $2.5M per km
	Maintaining MTQ unpaved section from km 411 to km 553	141 km	-		
	Upgrading Mine road from km 553 to Stornoway Renard mine	89 km	$100M		
	Extension Stornoway Renard mine to Trans-Taiga Road	172 km	$685M		
Roadway: La Grande to Whapmagoostui/Kuujjuarapik		207 km	$1,428M		$6M to $8M per km
Railway: Rupert to La Grande		340 km	$3,958M		$10M to $14M per km
Railway: La Grande to Whapmagoostui/Kuujjuarapik		219 km	$4,899M		$20M to $25M per km
Harbour at Whapmagoostui/Kuujjuarapik		-	$57M		-

Note 1: To simplify the presentation, each item amount has been rounded to tenths, according to the detailed data in the source cost estimate file.
Note 2: Class D Estimate -20% to +100% margin of error.