



**LA GRANDE ALLIANCE FEASIBILITY
STUDY – PHASE I**

**POTENTIAL BORROW SOURCES
AND QUARRY SITES ASSESSMENT -
EASTMAIN ACCESS ROAD**

April 12, 2023

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1.0 Introduction

1.1 General

La Grande Alliance refers to the Memorandum of Understanding (MOU) on the Cree-Québec Sustainable Infrastructure Program in Eeyou Istchee Baie-James, signed between the Cree Nation Government (CNG) and the Government of Québec on February 17, 2020. The purpose of the MOU is to provide a framework for Cree local and regional entities to work closely with relevant Québec government ministries to connect, develop and protect the territory of the Eeyou Istchee Baie-James region of northern Québec in an inclusive and participatory manner. The main objective of La Grande Alliance is to build a promising program for the strategic, predictable, and sustainable development of the territory over a 30-year time horizon.

Infrastructure development is a major component of *La Grande Alliance*. The program aims at improving and building major transportation infrastructure on the territory, including the implementation of a railway alongside the Billy-Diamond Highway to Whapmagoostui, where the construction of a deep-water port is being considered. The current study is divided into three phases. Phase I being carried out by the Vision Eeyou Istchee Consortium, focusing on the feasibility design of the following infrastructures:

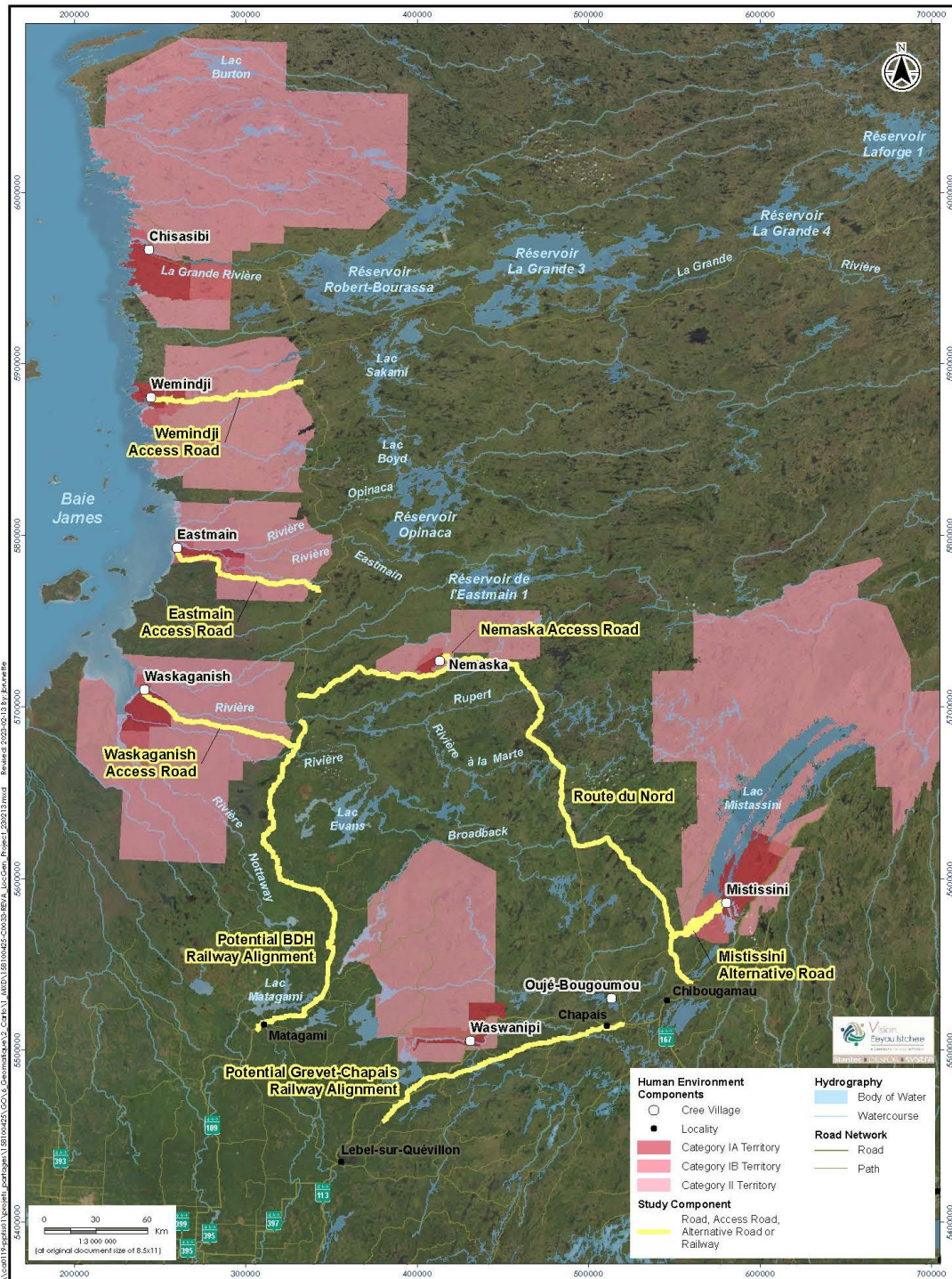
- Upgrade of the existing access roads between the Billy-Diamond Highway (BDH) and the Cree communities of Waskaganish, Eastmain and Wemindji;
- Upgrade of the existing access road between the Route du Nord and the community of Nemaska;
- New railway along the Billy-Diamond Highway (BDH) between the town of Matagami and KP 257 of the same highway (Rupert River Bridge);
- Recommissioning of the railway line from Grevet (Lebel-sur-Quévillon) to Chapais (approximately 225 km);
- Construction of transfer areas along the Billy-Diamond Highway and Grevet-Chapais line corridors, specifically the area at KP 257;
- Upgrade of the Route du Nord, and;
- Construction of a secondary access road to the Cree Nation of Mistissini.

The location of the infrastructures listed above is shown on Figure 1.

Limitations associated with this report and its contents are provided in the Statement of General Conditions included in Appendix A.



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Figure 1 La Grande Alliance – Phase I Feasibility Study Area Overview



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1.2 Scope of Work

One of the objectives of the Vision Eeyou Istchee's feasibility study of Phase I was to evaluate the availability of borrow materials (i.e., granular borrow sources and bedrock quarries) to supply study needs for the construction and/or upgrade of the different infrastructures.

Subsequently, Cree Development Corporation (CDC) mandated Stantec to conduct a geotechnical investigation which includes the exploration of potential borrows sources and quarry sites previously identified within the feasibility study. This report presents the results of the desktop borrow sources and quarry sites assessment and the results of the geotechnical investigations of the targeted site along the Eastmain Access Road.

The main tasks performed regarding the identification and exploration of potential borrow sources and quarry sites consisted of the:

- Selection and acquisition of aerial photos covering the study area;
- Compilation and review of data, related to the geology and the surficial deposits;
- Photo interpretation and delineation of sectors showing potential for material extraction (granular material and bedrock);
- Proposal of a field investigation program and identification of field targets for the conduction of boreholes
- Acquisition of the necessary environmental permits and authorization to carry out the geotechnical investigation
- Execution of the geotechnical field program which includes the:
 - Coordination with subcontractors and tallymen;
 - Forest clearing; and
 - Realization of boreholes.
- Laboratory testing to characterize the materials (bedrock) and to determine the suitability for the study needs
- Preparation of a summary report presenting the main characteristics of the potential borrow sources and quarry sites, including an estimate of the potentially exploitable volumes.

1.3 Material Requirements

Preliminary estimates of borrow materials required for the pavement of the Eastmain Access Road are presented in Table 1. Note that these estimates consist of compacted volumes and exclude quantities generated from the excavation of road cuts.



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Table 1 Summary of the Material Requirements for the Eastmain Access Road

Type of Material	Volume (compacted) (m³)
MG-112	83 750
MG-20	274 130
Pavement (ESG-10 and ESG-14)	74 170

According to the BNQ-2560-114 standards (BNQ, 2014) used by the ministère des Transports et de la Mobilité durable for aggregates used in civil engineering works, several requirements must be met in order for aggregates to be used as a granular material for foundations.

Regarding the intrinsic characteristics, the aggregate must be at most a category 5 meaning that the Micro-Deval test result must be lower than 35%, the Los Angeles test result must be lower than 50%, and the sum of the two results must be lower than 80%. In the case of manufacturing characteristics, they must be classified not more than as a category e, i.e. with a percentage of fragmentation greater than or equal to 50%.



2.0 Study Area and Background Review

The Eastmain Access Road extends for 103.7 km from the Cree community of the same name on the James Bay Shore to the Billy Diamond Highway. The study area has a maximum width of 10 km and consists of an offset of 5 km on each side of the Eastmain access road. Once all problematic areas (environmental and access constraints) are removed, the final study surface is considerably reduced. Potential sites that would require the construction of new access roads crossing major watercourses, waterbodies, and/or wetlands were also avoided when possible.

Regional bedrock geology mapping (SIGEOM, 2023) shows that the study area is underlain by Archean bedrock belonging to the Superior Province. The bedrock encountered along the eastern part of Eastmain Road is mainly composed of garnet paragneiss, sillimanite and cordierite, generally migmatitized, of the Complexe de Jolicoeur. On the westernmost part of the road, the bedrock consists of intrusive igneous rock associated with the Rivière au Mouton intrusion and Akakanipanuch's Batholite. They consist of tonalite, diorite, granodiorite, and a minor proportion of tonalitic gneiss.

During the Late Wisconsinan Glaciation (24 000 to 8 000 years before present (BP), the James Bay region was covered by the Laurentide Ice Sheet. During this glaciation, large amounts of materials were transported and subsequently deposited as till (morainal deposits) across the area. Following the ice melt, the marine transgression of the Tyrrell Sea occurred around 7,900 BP (Hardy 1977). Glaciomarine silt and clay accumulated in the low-lying areas and coarser deposits accumulated along the former Tyrrell Sea shorelines. Peat bogs and fens have accumulated over the glacial and non-glacial deposits, especially over poorly drained glaciomarine and morainal (till) deposits.

Locally, the Eastmain community is located within the altitudinal limit of the Tyrrell Sea. Therefore, the area near the James Bay is mostly covered with glaciomarine clay in the lower sectors and overlain by wetlands alternating with bedrock outcrops. As the altitude rises toward the BDH, the frequency of marine related deposits diminishes while being gradually replaced by till deposits and bedrock outcrops alternating with occasional peatlands in low-lying areas and near water bodies.



3.0 Methodology

3.1 Photo Interpretation and Identification of Potential Borrow Sources and Quarry Sites

Photo interpretation allows the geomorphologists to assess the study area in three dimensions in order to identify landforms that are likely to contain granular materials. Spatial delineation of potential borrow sources is based on the geomorphologist knowledge of Quaternary deposits and on their ability to identify landforms that could potentially provide suitable granular borrow materials. Within the study area, landforms expected to be favorable for borrow material extraction include littoral deposits from the postglacial Tyrrell Sea.

In addition to granular deposits, potential quarry sites were selected by identifying favorable bedrock hills – generally about ten (10) meters above the surrounding terrain – and by delineating areas that could provide significant volumes.

The photo interpretation exercise was completed using a mirror stereoscope for the visualization of black and white 1:15 000 to 1:60 000 scale aerial photos. The aerial photos used for the achievement of this mandate were acquired from Natural Resources Canada (2023) - National Air Photo Library (NAPL) and are listed in Table 2.

The potential sites were selected based on their distance from the Eastmain Access Road or other existing access in order to limit the costs associated with the construction and/or maintenance of access roads. Special attention was also given to avoid environmental constraints such as the proximity of the potential sites to watercourses or waterbodies, and wetlands.

The potential borrow sources and quarry sites were identified and drawn directly onto the aerial photographs. These were subsequently scanned and georeferenced, and the delineated landforms were digitized using ArcMap© software. The sites are identified by the prefixes GD (Granular Deposit) or Q (Quarry) followed by the kilometre point of their location (i.e. GD-60.1 or Q-55).

Table 2 Aerial Photos Used for the Identification of Potential Borrow Sources and Quarry Sites

Year	Roll number	No. of aerial photo	Scale
1956	A15255	1 to 7	1: 60 000
1956	A15256	1 to 7; 41 to 44	1: 60 000
1986	A31453	1 to 49; 52 to 57	1: 15 000
2001	A31815	3 to 26	1: 15 000



3.2 Environmental Permitting

Before proceeding with the geotechnical investigations, Vision Eeyou Istchee obtained the necessary authorizations and permits for the execution of the work:

- Land use (obtained from the ministère des Ressources naturelles et des Forêts du Québec);
- Tree cutting (obtained from the ministère des Forêts, de la Faune et des Parcs du Québec); and
- Declaration of compliance (submitted to the ministère de l'Environnement, de la Lutte contre les changements climatiques du Québec).

All activities conducted on the territory (land occupancy, land clearing, exploration trenches and drilling) were carried out in compliance with the current laws and regulations.

3.3 Geotechnical Field Investigation

A total of two (2) potential borrow source and three (3) potentially favorable quarry sites were identified and delineated during the desktop assessment. At the current stage of the feasibility study, the geotechnical investigation was limited to the exploration of potential quarry site Q-55.

The fieldwork for the potential quarry site assessment was carried out on July 19, 2022 and consisted in drilling two (2) boreholes (Q-55-BH22-01, Q-55-BH22-02) within the delineated potential quarry site Q-55. The boreholes were drilled using a track-mounted CME-55 drill rig to depths of 10.39 m and 10.01 m, respectively. The subsurface stratigraphy encountered was recorded by Stantec field personnel. When encountered, overburden samples were recovered at regular intervals using a B or N sized split-spoon sampler. Rock coring was carried out in both boreholes using a NQ-size core barrel (with an inner diameter of 47.6 mm) to confirm the type and characteristics of the bedrock. Bedrock samples collected during the fieldwork investigation were sent to Stantec's laboratory for detailed classification and additional testing.

3.4 Laboratory Testing

All rock samples were brought back to Stantec's laboratory were subjected to detailed visual examination and additional classification by a geologist. Laboratory testing conducted on rock cores consisted of four (4) Micro-Deval tests (LC 21-070) and Los Angeles tests (LC 21-400).

3.5 Volume Calculation

The volume estimates were calculated by multiplying the potential borrow sources or quarry sites area by the estimated average thickness of suitable materials or exploitable bedrock. Photo interpretation and Canadian Digital Surface Models derived from radar data (NRCan, 2000) were used to determine the potential exploitable thickness of granular material or bedrock. However, a conservative approach was used while estimating the potential volumes to avoid overestimating the material availability.



3.6 Site Potential Classification

The site potential classification consists of a qualitative assessment of the site based on the accessibility, material quality (Granulometry, Los Angeles and Micro-Deval results), potential volumes available, and the efforts required to develop the site.

The classification uses four different categories which are defined as:

High – Clean, well-graded sand with variable proportions of gravel, or bedrock suitable to use as high-quality aggregates with minimum processing. Presence of significant volumes and easy to access with minimum efforts required for site development.

Good – Good quality material generally consisting of well-graded sand with variable proportions of gravel and limited quantities of silt, or good quality bedrock which could provide good quality aggregates with minimal processing efforts. Presence of significant volumes and relatively easy to access with limited efforts required for site development.

Fair - Fair quality material consisting generally of poorly graded sand and variable proportions of gravel with or without substantial silt content or fair quality bedrock. Available material volumes are less significant and/or are relatively difficult to access (absence, existing access or requiring significant rehabilitation efforts). Materials may require treatment to meet the standards (granulometric specification).

Poor (not suitable) - Poor quality material generally consisting of silty, poorly graded, fine-grained sand with minor gravel, poor-quality bedrock or presence of major extraction constraints (shallow water table, thick overburden, etc.).

The site potential classification is provided only for the site for which a geotechnical field investigation was conducted as part of this mandate (in this case one quarry site – Q-55) since no site-specific data are available for the other sites.



4.0 Results

Using aerial photo interpretation, two (2) potential borrow sources and three (3) potential quarry sites were identified as being more likely to contain suitable material along the Eastmain Access Road. The potential borrow sources consist of littoral landforms, which are a common source of sand and gravel materials in the James Bay region. The potential quarry sites consist of small bedrock hills with a potential depth of ± 10 m. A specific attention was paid to avoid as much as possible the sites where environmental constraints (proximity of watercourses, waterbodies, or wetlands) are present. The main characteristics of the identified borrow sources and quarry sites are listed in Table 3, while the specific descriptions are presented below.

The location of the identified potential quarry sites and drilled boreholes are shown on the maps in Appendix B. Detailed borehole descriptions are provided within the borehole records in Appendix C. Laboratory test results are shown in Appendix D while a photographic album of the bedrock cores is provided in Appendix E.



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Table 3 Potential Borrow Sources and Quarry Sites Identified Along the Eastmain Access Road

Site ID	Cell	Status	Centroid Coordinates (NAD 83 CSRS MTM 9)		No. SMS (lease expiration date) ¹	Claim (expiration date) ¹	Material Type	Area (ha)
			Easting (m)	Northing (m)				
GD-60.1	-	New	209 440	5 773 590	-	No	Sand and gravel	4.0
GD-72.4	A	Existing	219 770	5 770 930	33C04-02 (expired)	Partially (expired)	Sand and gravel	2.8
	B	Existing	220 294	5 770 860			Sand and gravel	0.9
Q-55	-	New	410 375	5 774 240	-	No	Bedrock (Granite)	2.3
Q-58.6	-	New	208 220	5 774 200	-	No	Bedrock (Paragneiss) ²	4.0
Q-88.5	-	Unknown	234 690	5 773 295	33C04-25 (expired)	No	Bedrock (Paragneiss) ²	3.9

¹ Source: Gestim Plus, 2023

² Bedrock lithology source: SIGÉOM, 2023



4.1 Potential Granular Borrow Sources

The following sections (4.1.1 and 4.1.2) present the potential borrow sources identified along the Eastmain Access Road. Figure B1 (Appendix B) shows an overview map of the potential borrow source locations of the along the Eastmain Access Road while Figure B2 and B3 (Appendix B) show site-specific maps of each site. Along this access road, the opened pits were generally completely exploited and many sites that were not exploited were previously explored. The delineated sites are those appearing the most favorable for granular materials extraction.

4.1.1 Potential Borrow Source GD-60.1

Landform type: Littoral deposit (beaches)

Material: Sand and gravel

Estimated average material thickness: 2 m

Estimated volume: 30 000 m³

Site description:

The potential borrow source GD-60.1 is located 100 m south of the KP 60.1 of the Eastmain Access Road. These littoral deposit shows a southwest/ northeast orientation. The landform has never been exploited and is densely forested. The site has a maximum length of 350 m, a maximum width of 150 m, and an area of 4 ha. A peatland is located approximately 20 m to the northeast of the site. Consequently, a specific attention should be paid to respect the regulatory distance (30 m) between the site and the wetland.

Site access:

A new access road of about 110 m long should be built from the Eastmain Access Road to the site to allow its exploitation.

4.1.2 Potential Borrow Source GD-72.4

Landform type: Littoral deposit

Material: sand and gravel

Potentially exploitable thickness: 4 m

Estimated volume: Cell A: 40 000 m³
Cell B: 15 000 m³

Site description:

The potential borrow source GD-72.4 is located between 50 and 120 m south of the surroundings of KP 72.4 of the Eastmain Access Road. The site consists of a west/east orientated littoral deposit arranged in a west/east orientation that was divided into two cells since the middle section was previously exploited. The cell A has a length of about 400 m, a width of about 70 m, and an area of 2.8 ha. The cell B has a length of 120 m, a width of 85 m, and an area of 0.9 ha. The cell A is mostly surrounded by



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wetlands; therefore, a particular attention must be paid to respect the regulatory distance (30 m) between a wetland and a pit. A camp composed of two (2) cabins is also located approximately 120 m southeast of the eastern extremity of the cell B, on the shore of the Kauschiskakamach Great Lake.

Site access:

The site can easily be reached using the 70 m long existing access road.

4.2 Potential Quarry Site

The following section (4.2.1 and 4.2.2) present the potential quarry sites identified along the Eastmain Access Road. Figure B1 (Appendix B) shows an overview map of the potential borrow source locations of the along the Eastmain Access Road while Figure B4 and B5 (Appendix B) show site-specific maps of each site.

4.2.1 Potential quarry site Q-55

Landform type: Rounded rocky hill

Material: Bedrock (grey and black granite)

Estimated average material thickness: 8-10 m

Estimated volume: 100 000 m³ (115 000m³ including a swell ratio of 1.15 once compacted)

Site description:

The potential quarry site identified as Q-55 is located approximately 250 m north of KP 55 of the Eastmain Access Road. The landform consists of a rounded rocky hill between 5 and 12 m above the surrounding terrain. It has an approximate length of 190 m and a width of 120 m for a total area of 3.6 ha. The site is only partially vegetated and has never been exploited. A power line right-of-way borders the site on its southern flank with which a safe distance should be maintained. No other environmental constraints that could affect the potential exploitable volume were observed in the vicinity of the site. Figure 2 shows a picture of the site.

Site access:

Reaching a favorable extraction bedrock face would require the construction of an approximately 350 m long access road.

Field investigation program and laboratory testing:

Two boreholes (Q-55-BH22-01, Q-55-BH22-02) were drilled on site on July 19, 2022, reaching depths of 10.39 m and 10.01 m, respectively. Due to the access conditions, the borehole Q-55-BH22-02 was drilled within the ROW. Following the description of the bedrock cores by a geologist, representative samples of rock were selected to perform two (2) Micro-Deval tests (LC 21-070), and two (2) Los Angeles tests (LC 21-400) for each borehole.



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Figure 2 Picture of the Rocky Hill at the Site Q-55

Subsurface conditions:

The bedrock observed in borehole Q-55-BH22-01 and Q-55-BH22-02 consists of grey and black granite from the surface to the bottom of the holes.

The laboratory test results for the selected samples showed that the Micro-Deval values ranged from 14 to 18 %, while the Los Angeles results ranged from 29 to 45 % which indicates that the bedrock should be suitable to produce various types of aggregates. The subsurface conditions observed in the two boreholes are summarized in Table 4 and the laboratory test results are provided in Table 5.

Site potential:

Fair – The encountered bedrock appears to be suitable to produce significant volumes of good-quality materials, but the presence of the power line ROW could cause operating constraints. The construction of a new access road section would also be required.



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Table 4 Summary of Observed Stratigraphy for Potential Quarry Site Q-55

Borehole ID	Total depth (m)	Stratigraphy (depth-m)
		Granite (m)
Q-55-BH22-01	10.39	0.00 – 10.39
Q-55-BH22-02	10.01	0.00 – 10.01

Table 5 Laboratory Results for Potential Quarry Site Q-55

Borehole ID	Sample	Depth (m)	Geotechnical laboratory test results	
			Micro-Deval (%) (LC 21-070)	Los Angeles (%) (LC 21-400)
Q-55-BH22-01	DC-01 to DC-03	0.13 – 4.78	16	33
Q-55-BH22-01	DC-04 to DC-07	4.78 – 10.39	14	29
Q-55-BH22-02	DC-01 to DC-03	0.00 – 4.67	18	45
Q-55-BH22-02	DC-04 to DC-07	4.67 – 10.01	18	37

4.2.2 Potential quarry site Q-58.6

Landform type: Rounded rocky hill

Material: Bedrock (garnet paragneiss with ± sillimanite, cordierite, generally migmatitized) (SIGÉOM, 2023)

Estimated average material thickness: 10 m

Estimated volume: 200 000 m³ (230 000 m³ including a swell ratio of 1.15 once compacted)

Site description:

The potential quarry site identified as Q-58.6 is located approximately 125 m north of KP 58.6 of the Eastmain Access Road. The site consists of a rounded rocky hill between 5 and 12 m above the surrounding terrain. The favorable area has an irregular shape, but its general dimensions are about 260 m long, and about 150 m wide with an approximate area of 4.0 ha. The site is sparsely vegetated, has never been exploited and is located at the western extremity of a previously exploited borrow pit (empty). Some wetlands are present north of the site, but it should not influence the potentially exploitable volume. No other environmental constraints were observed in the vicinity of the site.

Site access:

The site could be accessed from the previously exploited pit, but an access road would have to be rehabilitated (approximately 500 m long). Otherwise, a new access road of about 150 m long would need to be built to allow the exploitation of this site.



4.2.3 Potential quarry site Q-85.5

Landform type: Rounded rocky hill

Material: Bedrock (garnet paragneiss with sillimanite, cordierite, generally migmatitized) (SIGÉOM, 2023)

Estimated average material thickness: 6-8 m

Estimated volume: 80 000 m³ (92 000 m³ including a swell ratio of 1.15 once compacted)

Site description:

The potential quarry site Q-85.5 is located approximately 800 m north of KP 85.5 of the Eastmain Access Road. The site consists of a rounded rocky hill whose summit seems to reach almost 20 m above the lowest grounds located at the north. Otherwise, the rocky hill is surrounded by undulating rocky terrain. The site was the subject of an extraction lease (BEX) by the Québec Ministry of Transportation and Sustainable Mobility which expired in May 2021 (Gestim Plus, 2023). No site visits were conducted as part of the desktop analysis to this site and no recent photographs or images of the site are available. The current status of this quarry is therefore undetermined. Nevertheless, a significant volume of rock remains available north of the area that was previously targeted.

A wetland is located north of the site, but it does not represent an environment constraint with the current proposed shape of the potential quarry site.

Site access:

The condition of the site is undetermined, and the presence of an existing access is unknown. Minimally, a rudimentary trail reaching the site is visible in the available imagery (Maxar, 2018), but it would require major upgrading to allow the exploitation of the site.



5.0 Discussions and Conclusion

This assessment was undertaken to identify potential quarry sites to comply with the material needs for the upgrading of the Eastmain Access Road between the KP 350.8 of the Billy Diamond Highway and the Eastmain community village.

Using aerial photo interpretation, two (2) potential borrow source and three (3) potential quarry sites were identified, and one of the quarry sites (Q-55) was selected for further geotechnical investigations. Two boreholes were advanced within the potential site Q-55 to describe the bedrock and to perform additional laboratory testing (Micro-Deval and Los Angeles tests). Based on the additional information collected during and after the geotechnical investigation, the quality and quantity of the potentially suitable material were determined. As for other potential sites identified, their location, landform type and the materials they are expected to contain, their size, vegetation cover, and environmental and other constraints were described. Table 6 summarizes the potential exploitable volumes identified along the Eastmain Access Road.

Table 6 Summary of the Potentially Exploitable Volumes Identified Along the Eastmain Access Road

Site ID	Material Type	Estimated average material thickness (m)	Potential volume with respect to environmental constraints (m³)	Potential bedrock volume considering a swell ratio of 1.15 (once compacted)
GD-60.1	Sand and gravel	2	30 000	N/A
GD-72.4A	Sand and gravel	4	40 000	
GD-72.4B	Sand and gravel	4	15 000	
Q-55	Bedrock	8-10	100 000	115 000
Q-58.6	Bedrock	8-10	200 000	230 000
Q-88.5	Bedrock	6-8	80 000	92 000
Total - Granular materials (m ³)	85 000 m ³ considering environmental constraints			
Total - Bedrock	437 000 m ³ (including a swell ratio of 1.15 once compacted)			

Sites GD-60.1 and GD-72.4 appear to be a good potential borrow sources, since they seem to contain significant amounts of material and are located near the Eastmain Access Road.

As for the potential quarry site Q-55, it consisted of an unexploited site (new quarry). The laboratory results showed that the drilled bedrock in both boreholes was granite that would be suitable to produce a portion of the materials needed for the upgrade of the Eastmain Access Road. The exploitation of the site



LA GRANDE ALLIANCE FEASIBILITY STUDY – PHASE I POTENTIAL BORROW SOURCES AND QUARRY SITES ASSESSMENT - EASTMAIN ACCESS ROAD

is possible, although precautions could have to be taken due to the proximity of a power ROW south of the site. The potential quarry site Q-58.6 also appears to contain significant volumes of material but would require the construction of a new access road of about 150 m long or more if the site was to be exploited using the former borrow pit area.

Based on the actual material requirements, the volumes contained within the delineated potential borrow sources and quarry sites would be sufficient to meet the needs for the upgrade and paving of the Eastmain Access Road. However, an update of the potential borrow sources and quarry materials available should be conducted at later stages of the program since some material may have been used for other purposes in the meantime. Based on this update, a geotechnical investigation campaign should be conducted to confirm the quality and quantity (volumes) of available materials as well as the overburden thickness and the groundwater conditions of the sites that were not part of this geotechnical investigation. In addition, an assessment of the access road conditions should be carried out at the appropriate time to evaluate the extent of the rehabilitation work needed.

Finally, it must be noted that the location and the exploitation of borrow pits and quarries are submitted to the Regulation respecting sand pits and quarries (Chapter Q-2, r 7.1) of the Environment Quality Act (Gouvernement du Québec, 2022). The final selection and delineation of the sites should be done according to the applicable regulations in effect at the time of their exploitation.



6.0 References

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https://sigeom.mines.gouv.qc.ca/signet/classes/11108_afchCartelIntr



APPENDICES

Appendix A Statement of General Conditions



STATEMENT OF GENERAL CONDITIONS

USE OF THIS REPORT: This report has been prepared for the sole benefit of the Client or its agent and may not be used by any third party without the express written consent of Stantec Experts-conseils and the Client. Any use which a third party makes of this report is the responsibility of such third party.

BASIS OF THE REPORT: The information, opinions, and/or recommendations made in this report are in accordance with Stantec Experts-conseils present understanding of the site specific project as described by the Client. The applicability of these is restricted to the site conditions encountered at the time of the investigation or study. If the proposed site specific project differs or is modified from what is described in this report or if the site conditions are altered, this report is no longer valid unless Stantec Experts-conseils is requested by the Client to review and revise the report to reflect the differing or modified project specifics and/or the altered site conditions.

STANDARD OF CARE: Preparation of this report, and all associated work, was carried out in accordance with the normally accepted standard of care in the state or province of execution for the specific professional service provided to the Client. No other warranty is made.

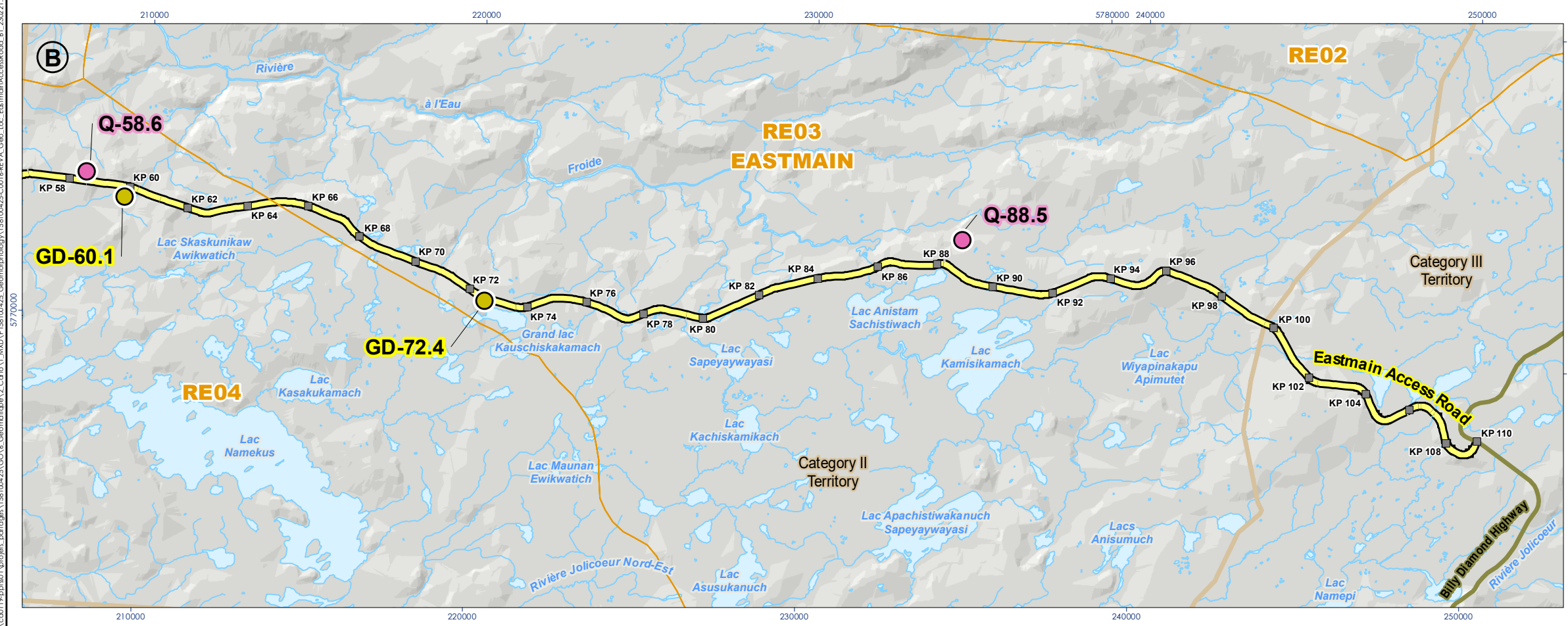
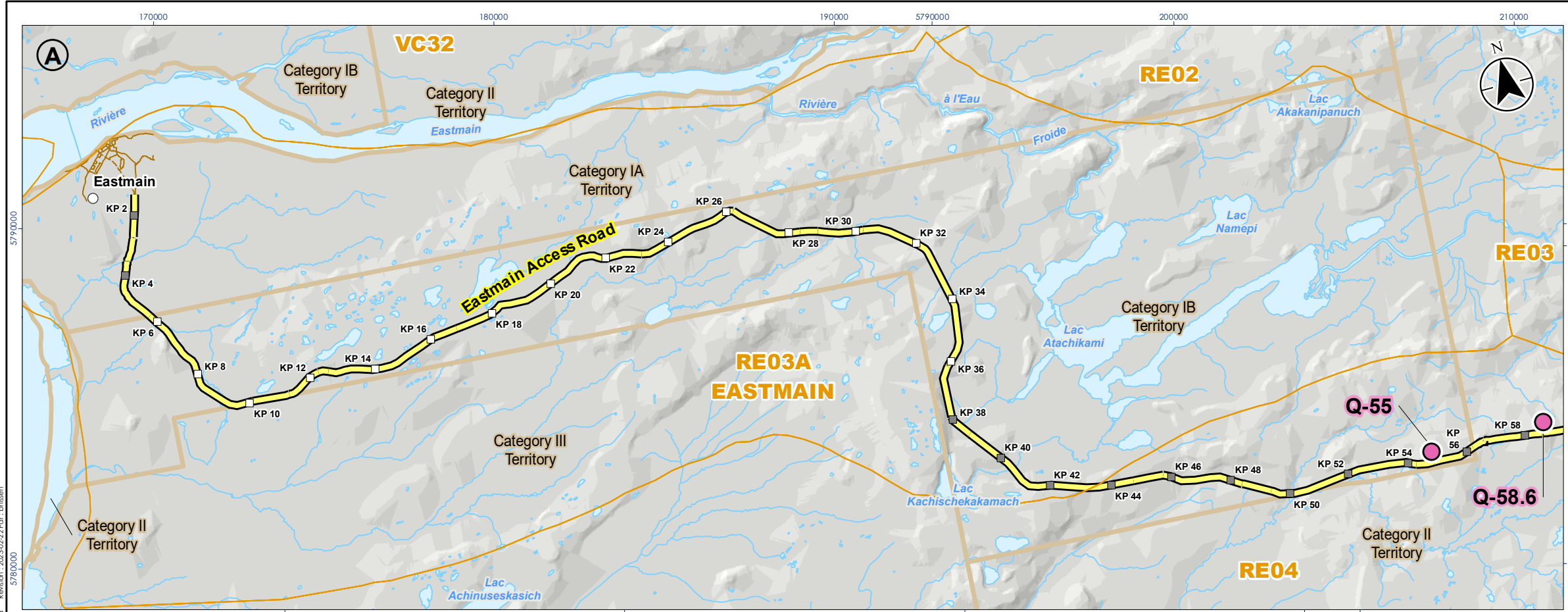
INTERPRETATION OF SITE CONDITIONS: Soil, rock, or other material descriptions, and statements regarding their condition, made in this report are based on site conditions encountered by Stantec Experts-conseils at the time of the work and at the specific testing and/or sampling locations. Classifications and statements of condition have been made in accordance with normally accepted practices which are judgmental in nature; no specific description should be considered exact, but rather reflective of the anticipated material behavior. Extrapolation of in situ conditions can only be made to some limited extent beyond the sampling or test points. The extent depends on variability of the soil, rock and groundwater conditions as influenced by geological processes, construction activity, and site use.

VARYING OR UNEXPECTED CONDITIONS: Should any site or subsurface conditions be encountered that are different from those described in this report or encountered at the test locations, Stantec Experts-conseils must be notified immediately to assess if the varying or unexpected conditions are substantial and if reassessments of the report conclusions or recommendations are required. Stantec Experts-conseils will not be responsible to any party for damages incurred as a result of failing to notify Stantec Experts-conseils that differing site or sub-surface conditions are present upon becoming aware of such conditions.

PLANNING, DESIGN, OR CONSTRUCTION: Development or design plans and specifications should be reviewed by Stantec Experts-conseils, sufficiently ahead of initiating the next project stage (property acquisition, tender, construction, etc), to confirm that this report completely addresses the elaborated project specifics and that the contents of this report have been properly interpreted. Specialty quality assurance services (field observations and testing) during construction are a necessary part of the evaluation of sub-subsurface conditions and site preparation works. Site work relating to the recommendations included in this report should only be carried out in the presence of a qualified geotechnical engineer; Stantec Experts-conseils cannot be responsible for site work carried out without being present.

Appendix B Figures





Map No. **B1**

Title **Potential Borrow Sources and Quarry Sites Eastmain Access Road**

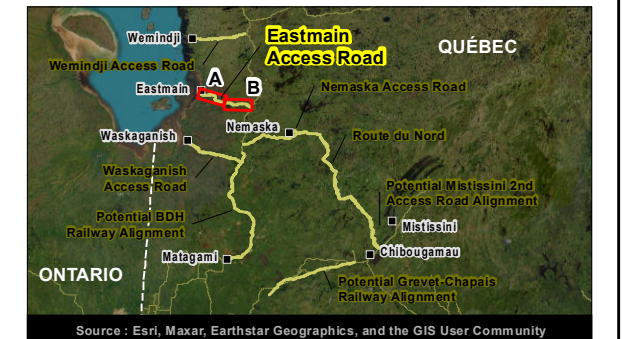
Client/Project
Cree Development Corporation
La Grande Alliance – Feasibility Study
Phase 1

Project Location
Eeyou Itchee, Québec

158100425-C0002 REVA
Prepared by Julie Brunette le 2023-02-22
Verified by E. Ferland on 2023-02-22
Independent Review by F. Vinet on 2023-02-22

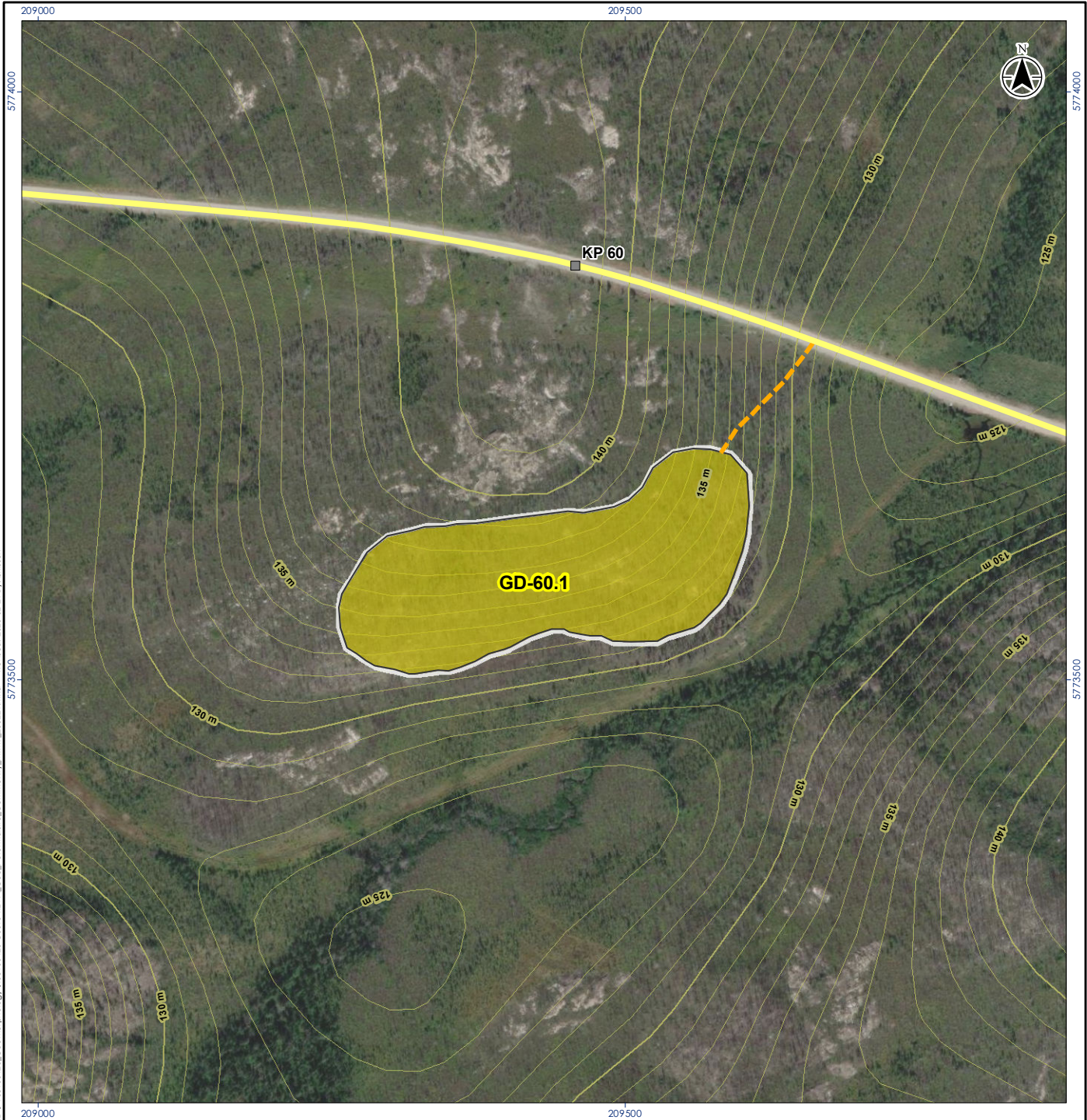
- Human Environment Component**
- Cree Village
 - ▭ Category I, II or III Territory
- Study Component**
- Eastmain Access Road
- Potential Material Source**
- Potential Quarry Site (Q)
 - Potential Borrow Source (GD)
- Trapline Limit and Community Name**
- ▭ Eastmain
- Hydrography**
- ▭ Body of water
 - - - Intermittent Watercourse
 - Permanent Watercourse
- Road Network**
- Kilometric Point (MTQ, 2021)
 - Kilometric Point (Created by Stantec)
- Road Classification**
- - - Collector
 - Local
 - - - Access Path

0 1,5 3 km
1:1 50 000
(At original document size of 11x17)



- Notes**
1. Coordinate System: NAD 1983 CSRS MTM 8
 2. Geotechnical Investigation: Stantec, 2023
 3. Road Network: Adresses Québec, 2021
 4. Hydrography: GRHQ, 2017
 5. Orthomogery: ESRI-World Imagery, 2017





- Study Component**
- Eastmain Access Road
- Projected Component**
- Proposed Access Road
- Potential Material Source**
- Potential Borrow Source (GD)

- Road Network**
- Kilometric Point (Created by Stantec)
- Hydrography**
- Body of Water
 - Watercourse
- Topography**
- Contour line (1 m)
 - Primary
 - Secondary



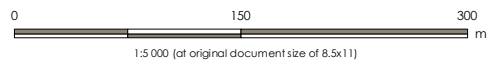
Project Location: 158100425-C0013 REV A
 Eeyou Istchee, Québec
 Prepared by J. Brunette on 2023-02-21
 Technical Review by E. Ferland on 2023-02-21
 Independent Review by F. Vinet on 2023-02-21

Client/Project: Cree Development Corporation
 La Grande Alliance – Feasibility Study
 Phase 1

Map No. **B2**

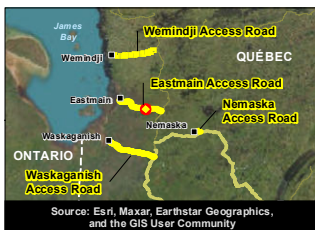
Title: **Potential Borrow Source GD-60.1**

- Notes**
- Coordinate System: NAD 1983 CSRS MTM 9
 - Geotechnical Investigation: Stantec, 2023
 - Road Network: Adresses Québec, 2021
 - Hydrography: GRHQ, 2017
 - Topography: Forêt Ouverte, 2023
 - Orthoimagery: ESRI-World Imagery, 2017



\\c00119\ppl\601\projets_potborge\158100425-C0013\Geo\Ortho\158100425-C0013.REVA_Geo_PotentialBorrow_Community_MTM9_230221.mxd - Revised: 2023-02-21 By: bnt/sen

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- Study Component**
- Eastmain Access Road
- Projected Component**
- Proposed Access Road
- Potential Material Source (GD)**
- Potential Borrow Source (GD)

- Road Network**
- Kilometric Point (Created by Stantec)
- Hydrography**
- Body of Water
 - Watercourse
- Topography**
- Contour line (1 m)
- Primary
 - Secondary



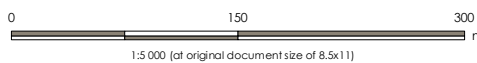
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 Prepared by J. Brunette on 2023-02-21
 Eeyou Istchee, Québec
 Technical Review by E. Ferland on 2023-02-21
 Independent Review by F. Vinet on 2023-02-21

Client/Project: Cree Development Corporation
 La Grande Alliance – Feasibility Study
 Phase 1

Map No. B3

Title: Potential Borrow Source GD-72.4

- Notes**
- Coordinate System: NAD 1983 CSRS MTM 9
 - Geotechnical Investigation: Stantec, 2023
 - Road Network: Adresses Québec, 2021
 - Hydrography: GRHQ, 2017
 - Topography: Forêt Ouverte, 2023
 - Orthoimagery: ESRI-World Imagery, 2017



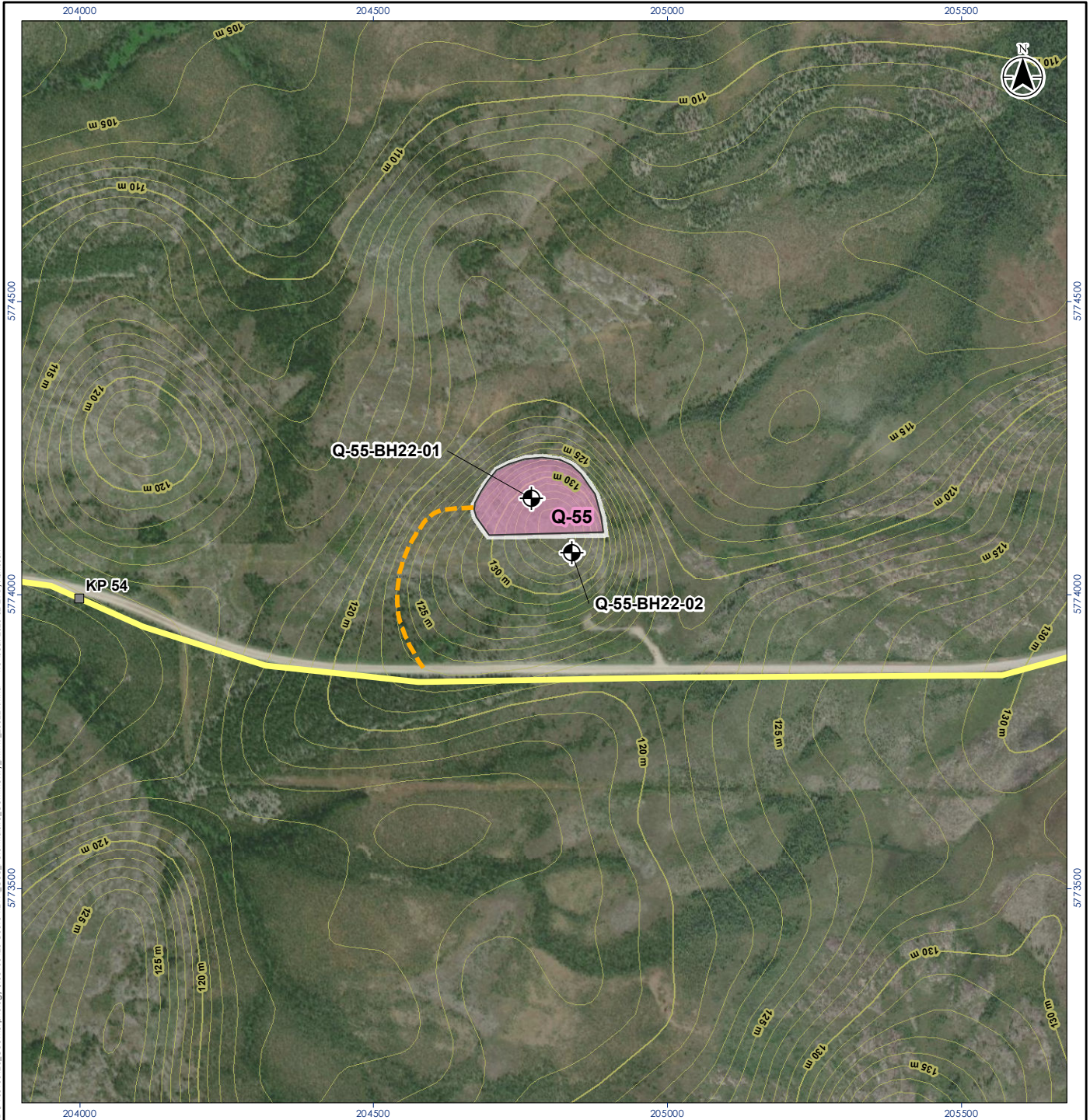
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 Revised: 2023-02-21 By: Dns/en



Notes
 1. Coordinate System: NAD 1983 CSRS MTM 9
 2. Geotechnical Investigation: Stantec, 2023
 3. Road Network: Adresses Québec, 2021
 4. Hydrography: GRHQ, 2017
 5. Topography: Forêt Ouverte, 2023
 6. Orthoimagery: ESRI-World Imagery, 2017
 Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

- Study Component**
- Eastmain Access Road
- Projected Component**
- Proposed Access Road
- Potential Material Source**
- Potential Quarry Site (Q)
- Geotechnical Investigation**
- Borehole

- Road Network**
- Kilometric Point (Created by Stantec)
- Hydrography**
- Body of Water
- Watercourse
- Topography**
- Contour line (1 m)**
- Primary
- Secondary

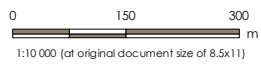


Project Location: 158100425-C0013 REV A
 Eeyou Istchee, Québec
 Prepared by J. Brunette on 2023-02-21
 Technical Review by E. Ferland on 2023-02-21
 Independent Review by F. Vinet on 2023-02-21

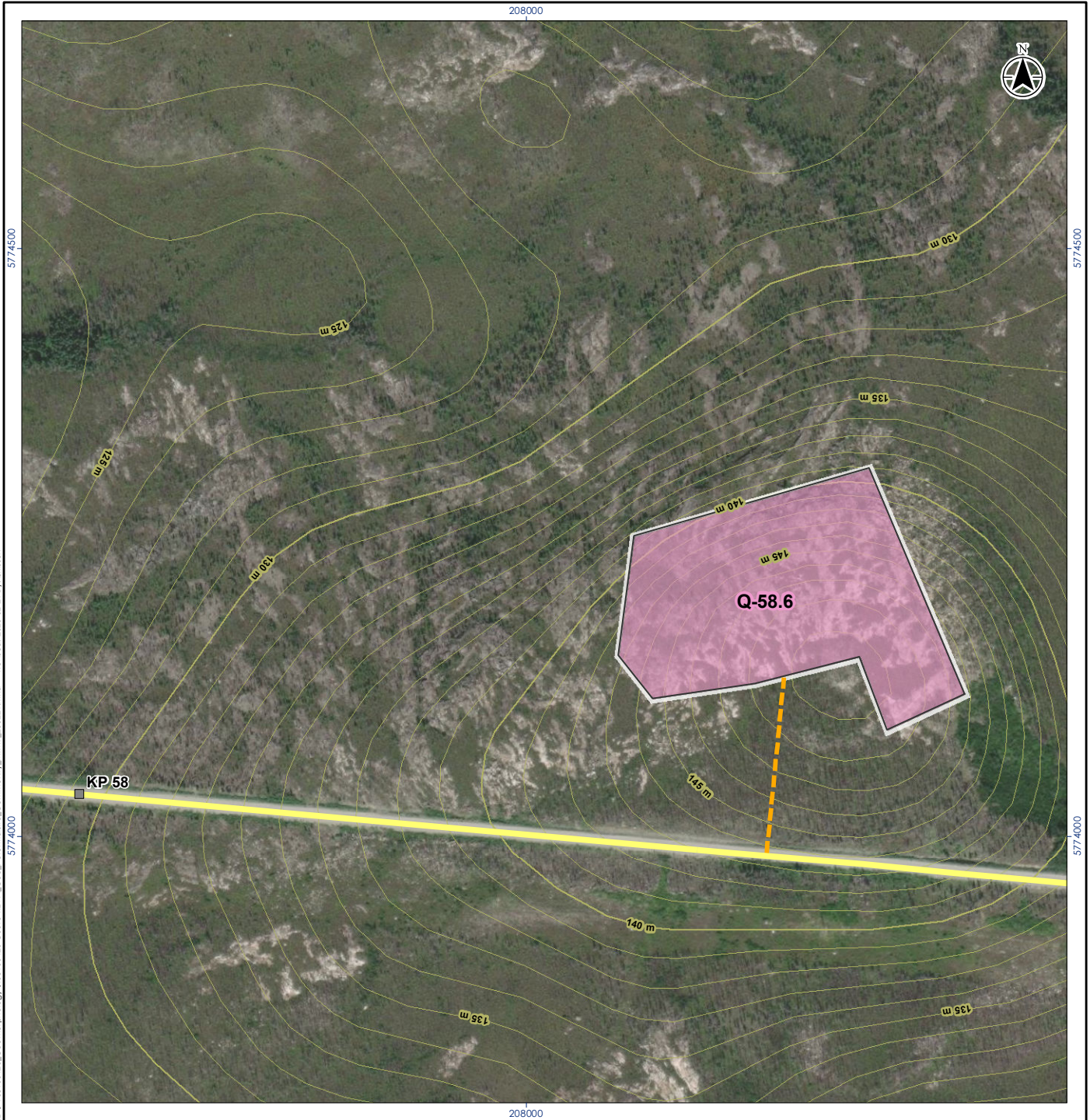
Client/Project: Cree Development Corporation
 La Grande Alliance – Feasibility Study
 Phase 1

Map No.: **B4**

Title: **Potential Quarry Site Q-55**



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- Study Component**
- Eastmain Access Road
- Projected Component**
- Proposed Access Road
- Potential Material Source**
- Potential Quarry Site (Q)

- Road Network**
- Kilometric Point (Created by Stantec)
- Hydrography**
- Body of Water
 - Watercourse
- Topography**
- Contour line (1 m)
 - Primary
 - Secondary



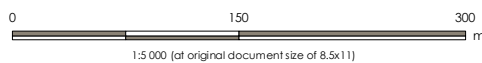
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 Prepared by J. Brunette on 2023-02-21
 Eeyou Istchee, Québec
 Technical Review by E. Ferland on 2023-02-21
 Independent Review by F. Vinet on 2023-02-21

Client/Project: Cree Development Corporation
 La Grande Alliance – Feasibility Study
 Phase 1

Map No. B5

Title: Potential Quarry Site Q-58.6

- Notes**
- Coordinate System: NAD 1983 CSRS MTM 9
 - Geotechnical Investigation: Stantec, 2023
 - Road Network: Adresses Québec, 2021
 - Hydrography: GRHQ, 2017
 - Topography: Forêt Ouverte, 2023
 - Orthomogney: ESRI-World Imagery, 2017



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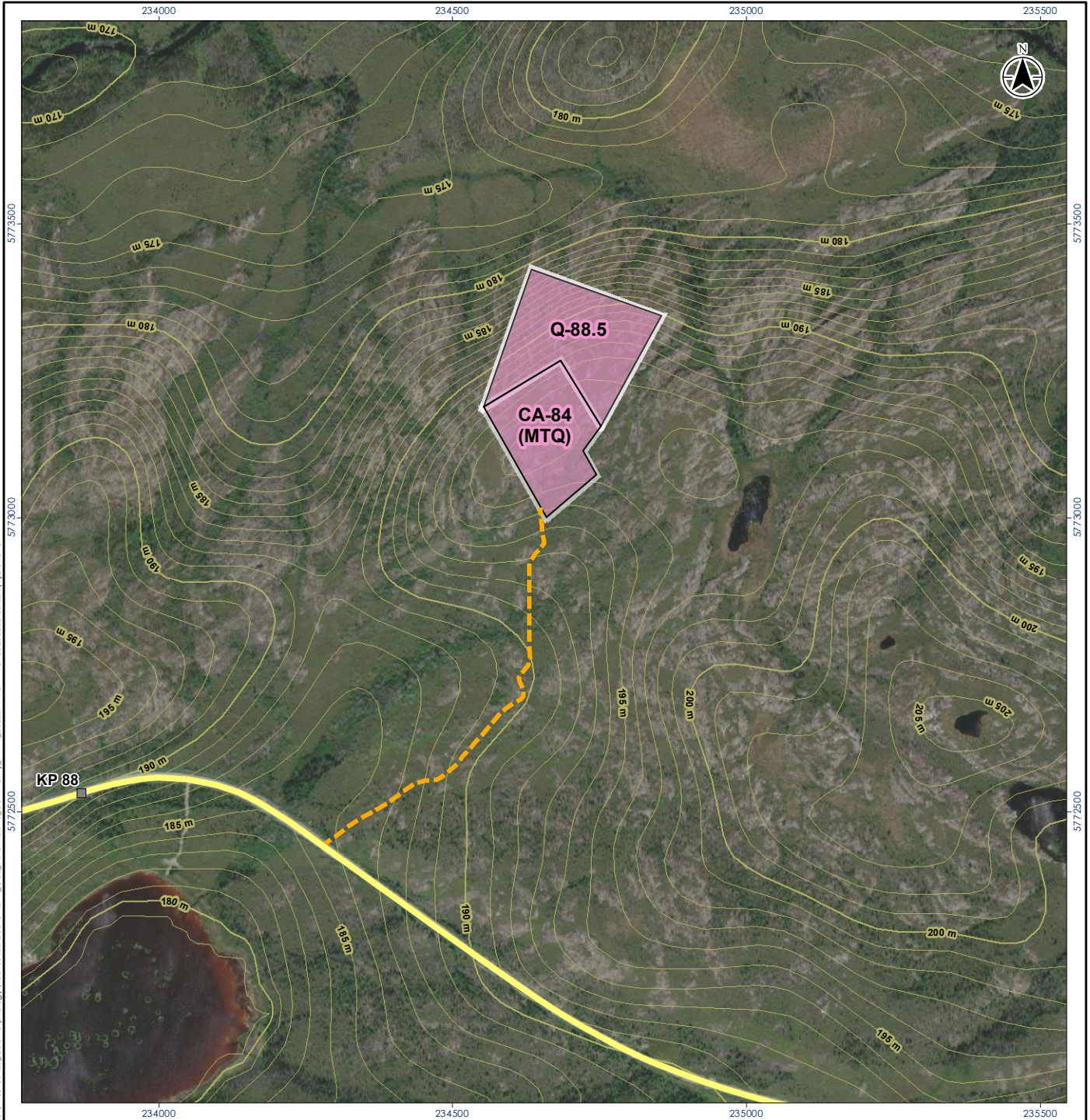
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- Study Component**
- Eastmain Access Road
- Projected Component**
- Proposed Access Road
- Potential Material Source**
- Potential Quarry Site (Q)

- Road Network**
- Kilometric Point (Created by Stantec)
- Hydrography**
- Body of Water
 - Watercourse
- Topography**
- Contour line (1 m)*
- Primary
 - Secondary



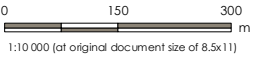
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 Prepared by J. Brunette on 2023-02-22
 Technical Review by E. Ferland on 2023-02-22
 Independent Review by F. Vinet on 2023-02-22

Client/Project: Cree Development Corporation
 La Grande Alliance – Feasibility Study
 Phase 1

Map No.: **B6**

Title: **Potential Quarry Site Q-88.5**

- Notes**
1. Coordinate System: NAD 1983 CSRS MTM 9
 2. Geotechnical Investigation: Stantec, 2023
 3. Road Network: Adresses Québec, 2021
 4. Hydrography: GRHQ, 2017
 5. Topography: Forêt Ouverte, 2023
 6. Orthoimagery: ESRI-World Imagery, 2017



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Appendix C Borehole Reports




STRATIGRAPHY			SAMPLES						TESTS		REMARKS		
DEPTH (m)	DEPTH (ft)	DEPTH (m)	DESCRIPTION OF SOILS AND ROCK	SYMBOL	STATE	TYPE N°	SUB - SAMPLE	CALIBER	RECOVERY (%)	N - RQD		Standard penetration test BLOWS/150mm	WATER LEVEL / WATER INFLOW
25	8			+									
30	9			+		DC-06		NQ	100	100			
35	10			+		DC-07		NQ	100	98			
35,39	11	10,39	END OF BOREHOLE										
40	12												
45	13												
50	14												
55	15												
60	16												

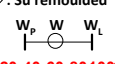
Project: La Grande Alliance - Feasibility Study - Phase I Project No.: 158100425.500.710.2 Client: Cree Development Corporation Site: Eastmain Access Road	Coordinate: X : 410 420 Y : 5 774 189 Type of borehole: Diamond Core Equipment: CME Sampling type: Corer : NQ	Geo. System : MTM-NAD83 Zone: 10 Borehole : Q-55-BH22-02 Page : 1 of 2 Start date : 2022-07-19 Inspector : H. Desrochers, CPI Depth : 10,01 m
---	---	---

SAMPLE TYPE	QUALITATIVE TERMINOLOGY	QUANTITATIVE TERMINOLOGY	SYMBOLS	GROUNDWATER						
SS Split spoon CS Continuous sampling DC Diamond rock core AS Auger TW Thin wall sampler ST Shelby tube MA Manual sample	Clay < 0.002 mm Silt 0.002 - 0.08 mm Sand 0.08 - 5 mm Gravel 5 - 80 mm Cobbles 80 - 200 mm Boulders > 200 mm	Traces < 10 % Some 10 - 20 % Adjective (...y) 20 - 35 % and (ex: and gravel) > 35 % Main word Dominant fraction	N Standard penetration value (ASTM D 1586) Nc Dynamic cone penetration value (BNQ 2501-145) RQD Rock Quality Designation (%)	<table border="1" style="width:100%"> <tr><th>Date</th><th>Depth</th></tr> <tr><td> </td><td>m</td></tr> <tr><td> </td><td>m</td></tr> </table> Remarks :	Date	Depth		m		m
Date	Depth									
	m									
	m									

SAMPLE STATE	MECHANIC CHARACTERISTICS OF SOILS	ROCK QUALITY DESIGNATION	JOINTS SPACING
<input type="checkbox"/> Remoulded <input checked="" type="checkbox"/> Intact (thin wall sampler) <input type="checkbox"/> Lost <input type="checkbox"/> Core (diamond rock core)	COMPACTION Very loose 0 - 4 Loose 4 - 10 Compact 10 - 30 Dense 30 - 50 Very dense > 50 INDEX "N" 0 - 4 4 - 10 10 - 30 30 - 50 > 50 CONSISTENCY Very soft Soft Firm Stiff Very stiff Hard	Cu OR Su (kPa) < 12 12 - 25 25 - 50 50 - 100 100 - 200 > 200 QUALIFICATIVE Very poor Poor Fair Good Excellent	RQD < 25 % 25 - 50 % 50 - 75 % 75 - 90 % 90 - 100 % JOINTS SPACING < 20 mm 20 - 60 mm 60 - 200 mm 200 - 600 mm 600 - 2000 mm 2000 - 6000 mm > 6000 mm

STRATIGRAPHY				SAMPLES						WATER LEVEL / WATER INFLOW		TESTS			REMARKS	
DEPTH (m)	DEPTH (ft)	DEPTH (m)	DESCRIPTION OF SOILS AND ROCK	SYMBOL	STATE	TYPE N°	SUB - SAMPLE	CALIBER	RECOVERY (%)	N - RQD	Standard penetration test BLOWS/150mm	Water Level / Inflow	GA : grain size analysis H : hydrometer test C : consolidation W : water content W _L : liquid limit W _p : plastic limit D _r : specific gravity k : permeability F _c : compressive str. OM : organic matter CA : chemical analyses SAV : soil aggressivity value	X : N (standard pen.) ∇ : Nc (dyn. pen.) ■ : Cu intact □ : Cu remoulded ◆ : Su intact ◇ : Su remoulded		W _p W W _L 20 40 60 80 100 120
		0.00	Bedrock : Grey and black GRANITE, of excellent quality.	+												
1		5		+		DC-01	NQ	100	95			LA + MD (0.00 - 4.67 m)				
2		10		+		DC-02	NQ	100	93							
3		15		+		DC-03	NQ	100	100							
4		20		+		DC-04	NQ	100	100			LA + MD (4.67 - 10.01 m)				
5				+		DC-05	NQ	100	100							

General remarks:	Verified by :  B. Cyr, géo. Date : 2023-02-08
-------------------------	--

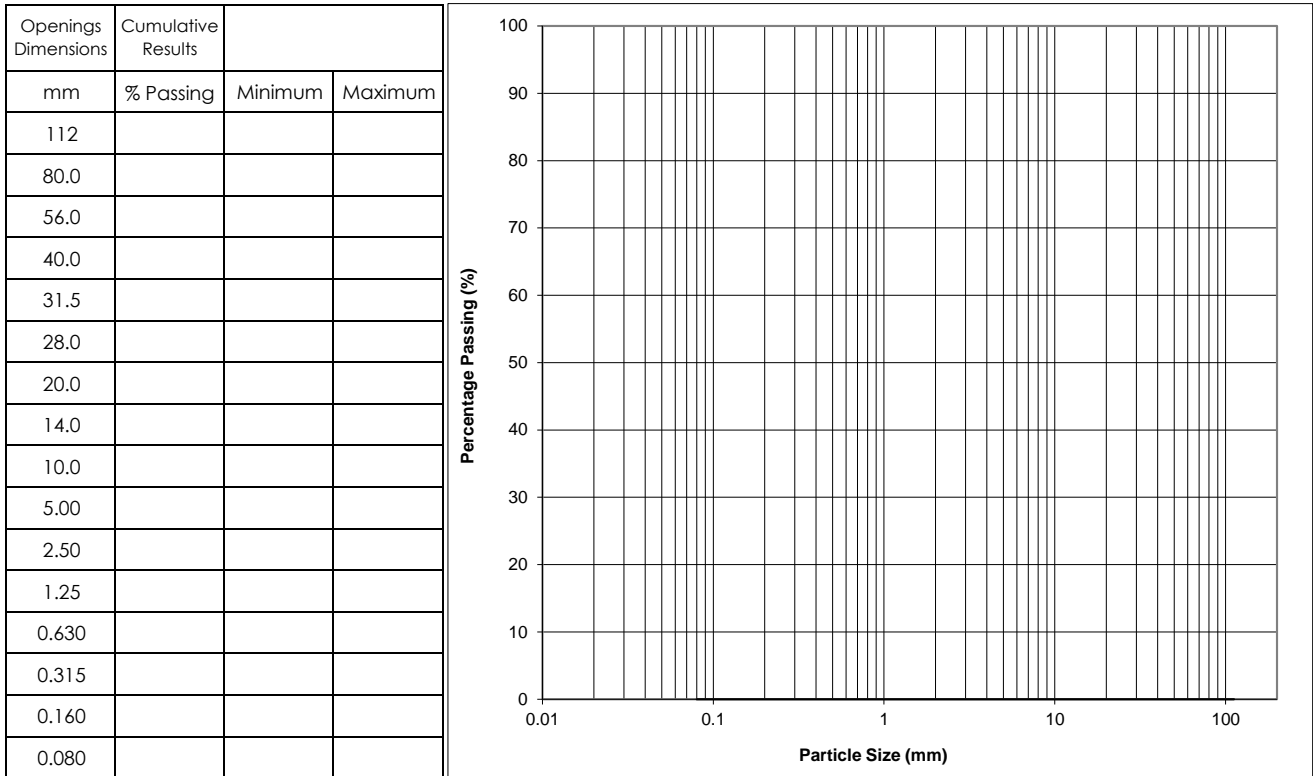
STRATIGRAPHY			SAMPLES						TESTS		REMARKS				
DEPTH (m)	DEPTH (ft)	DEPTH (m)	DESCRIPTION OF SOILS AND ROCK	SYMBOL	STATE	TYPE N°	SUB - SAMPLE	CALIBER	RECOVERY (%)	N - RQD		Standard penetration test BLOWS/150mm	WATER LEVEL / WATER INFLOW	GA : grain size analysis H : hydrometer test C : consolidation W : water content W _L : liquid limit W _p : plastic limit Dr : specific gravity k : permeability f _c : compressive str. OM : organic matter CA : chemical analyses SAV : soil aggressivity value × : N (standard pen.) ▽ : Nc (dyn. pen.) ■ : Cu intact □ : Cu remoulded ◆ : Su intact ◇ : Su remoulded W _p W W _L 	
25				+										20 40 60 80 100 120	
8				+											
30				+			DC-06	NQ	100	98					
9				+											
35				+			DC-07	NQ	100	100					
10		10,01	END OF BOREHOLE	+											
35															
11															
40															
12															
45															
14															
50															
15															
55															
17															
60															

Appendix D Laboratory Test Results



Client : Cree Development Corporation	Type of material : Crushed rock cores
Project : La Grande Alliance - Feasibility Study - Phase I Eastmain Access Road	Sampled by : Khaled Haiek
Project No : 158100425.500.710.2	Sampling Date : July 19, 2022
Sample No : Q-55-BH22-01 DC-01 to DC-03	
Depth : 0,13 - 4,78m	

Sieve Analysis (LC 21-040 / BNQ 2501-025)



Soils Classification		Modified Proctor (BNQ 2501-255)	
% Gravel		Testing Method used	
% Sand		Maximum Dry Unit Weight (kg/m ³)	
% Fine Particles		Optimum Moisture Content (%)	

Other Tests							
Test / Standard	Results	Requirements		Test / Standard	Results	Requirements	
		Min	Max			Min	Max
Los Angeles (grading B) (LC 21-400) (%)	33						
Micro Deval (grading F) (LC 21-070) (%)	16						

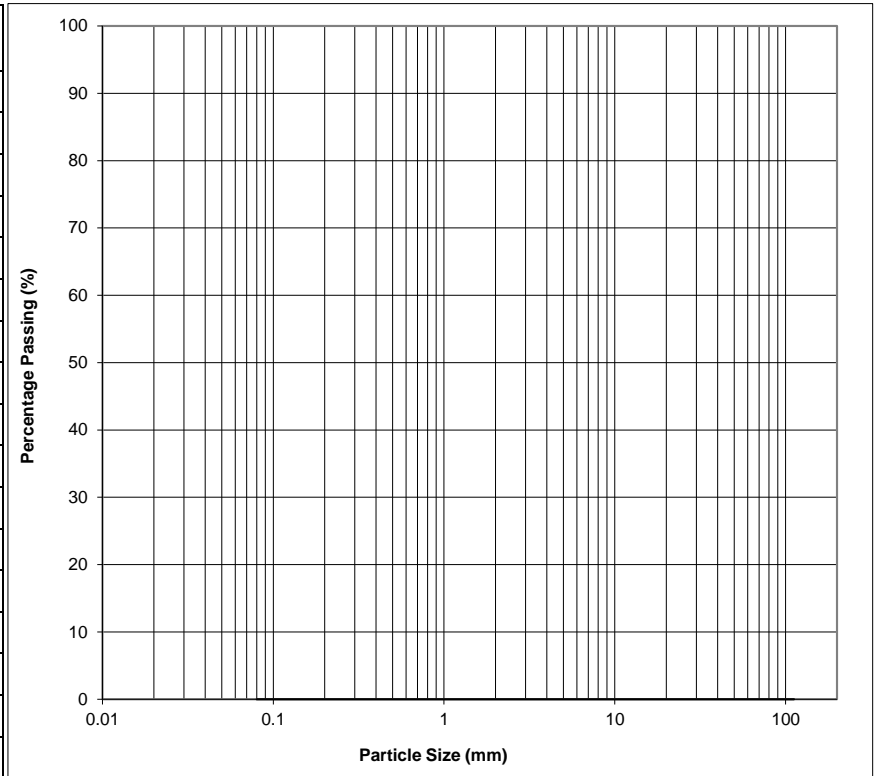
Remarks : _____

Prepared By: Benoit Cyr, Geo. *BJ* .Geo #786 _____ Date: January 27, 2023 _____

Client : Cree Development Corporation	Type of material : Crushed rock cores
Project : La Grande Alliance - Feasibility Study - Phase I	
Eastmain Access Road	Sampled by : Khaled Haiek
Project No : 158100425.500.710.2	Sampling Date : July 19, 2022
Sample No : Q-55-BH22-01 DC-04 to DC-07	
Depth : 4,78 - 10,39m	

Sieve Analysis (LC 21-040 / BNQ 2501-025)

Openings Dimensions	Cumulative Results		
mm	% Passing	Minimum	Maximum
112			
80.0			
56.0			
40.0			
31.5			
28.0			
20.0			
14.0			
10.0			
5.00			
2.50			
1.25			
0.630			
0.315			
0.160			
0.080			



Soils Classification		Modified Proctor (BNQ 2501-255)	
% Gravel		Testing Method used	
% Sand		Maximum Dry Unit Weight (kg/m ³)	
% Fine Particles		Optimum Moisture Content (%)	

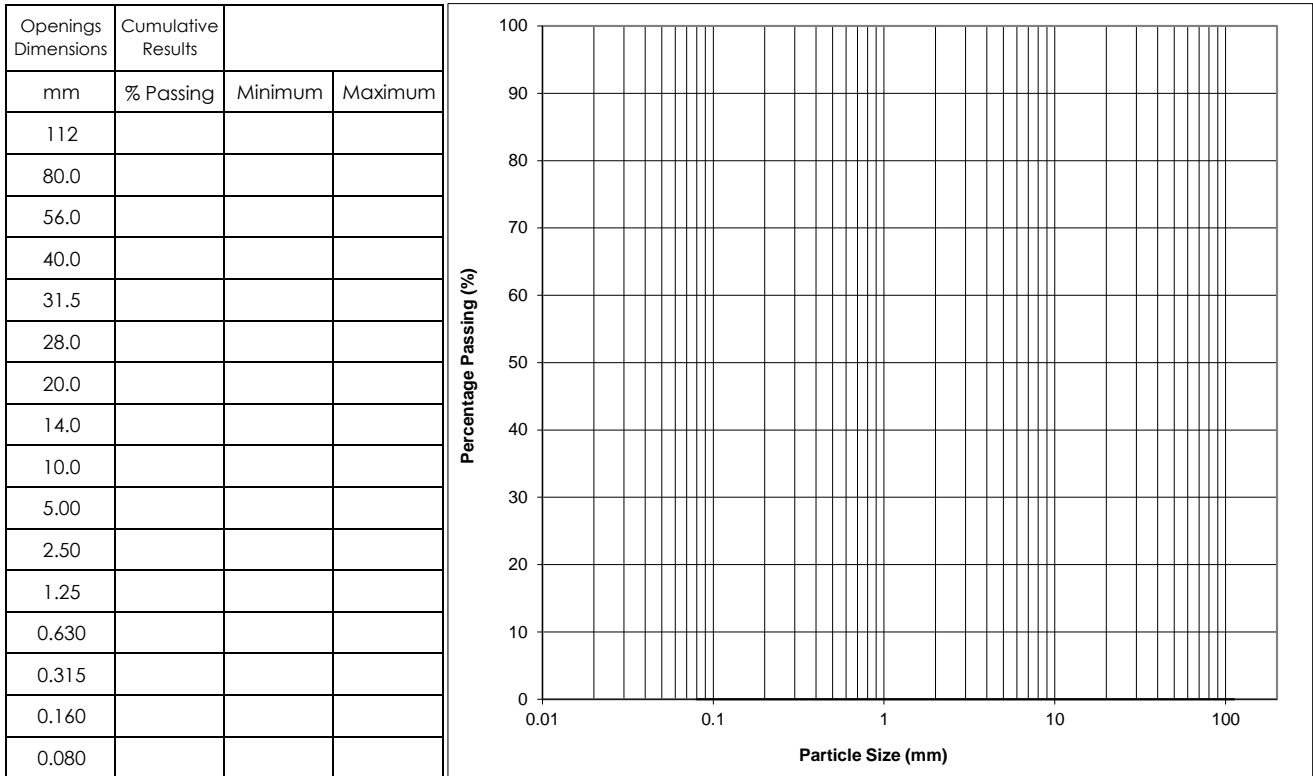
Other Tests							
Test / Standard	Results	Requirements		Test / Standard	Results	Requirements	
		Min	Max			Min	Max
Los Angeles (grading B) (LC 21-400) (%)	29						
Micro Deval (grading F) (LC 21-070) (%)	14						

Remarks : _____

Prepared By: Benoit Cyr, Geo. *BJ* .Geo #786 Date: January 27, 2023

Client : Cree Development Corporation	Type of material : Crushed rock cores
Project : La Grande Alliance - Feasibility Study - Phase I Eastmain Access Road	Sampled by : Khaled Haiek
Project No : 158100425.500.710.2	Sampling Date : July 19, 2022
Sample No : Q-55-BH22-02 DC-01 to DC-03	
Depth : 0,00 - 4,67m	

Sieve Analysis (LC 21-040 / BNQ 2501-025)



Soils Classification		Modified Proctor (BNQ 2501-255)	
% Gravel		Testing Method used	
% Sand		Maximum Dry Unit Weight (kg/m ³)	
% Fine Particles		Optimum Moisture Content (%)	

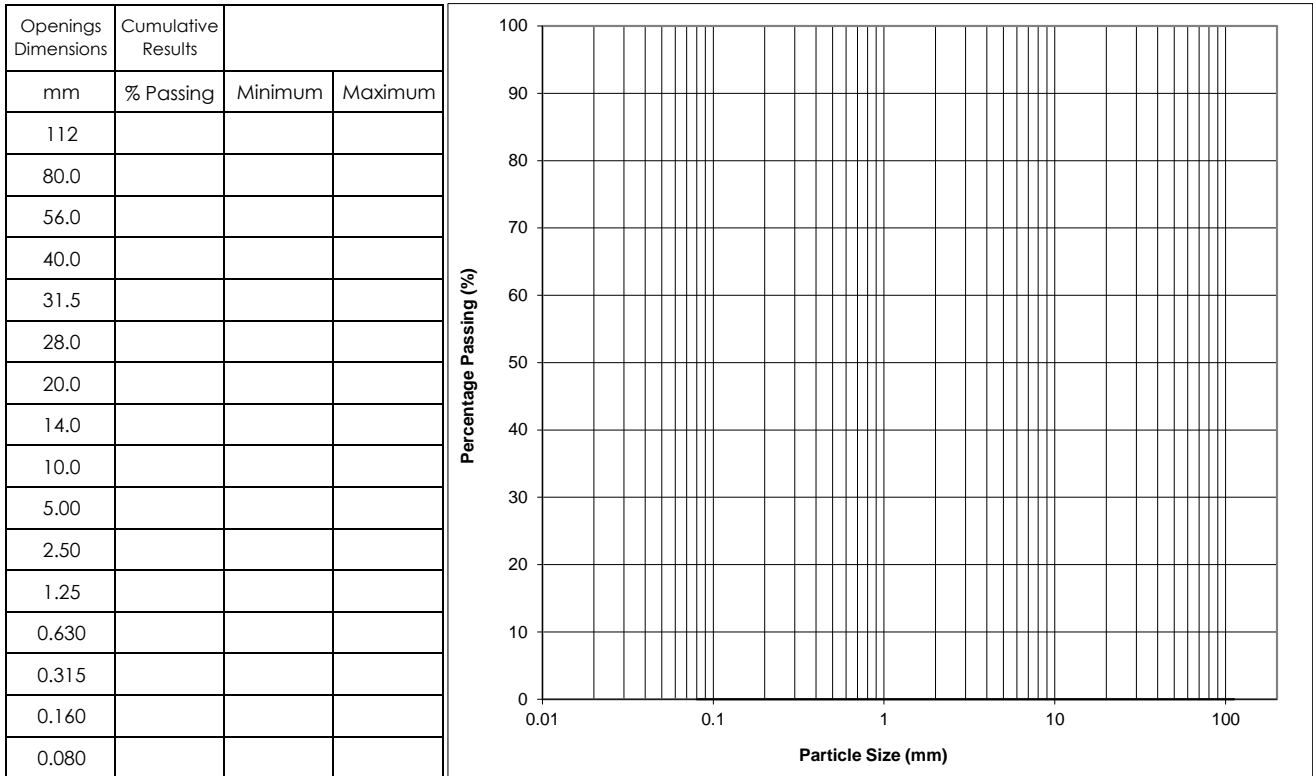
Other Tests							
Test / Standard	Results	Requirements		Test / Standard	Results	Requirements	
		Min	Max			Min	Max
Los Angeles (grading B) (LC 21-400) (%)	45						
Micro Deval (grading F) (LC 21-070) (%)	18						

Remarks : _____

Prepared By: Benoit Cyr, Geo. *BJ* .Geo #786 Date: January 27, 2023

Client : Cree Development Corporation	Type of material : Crushed rock cores
Project : La Grande Alliance - Feasibility Study - Phase I Eastmain Access Road	Sampled by : Khaled Haiek
Project No : 158100425.500.710.2	Sampling Date : July 19, 2022
Sample No : Q-55-BH22-02 DC-04 to DC-07	
Depth : 4,67 - 10,01m	

Sieve Analysis (LC 21-040 / BNQ 2501-025)



Soils Classification		Modified Proctor (BNQ 2501-255)	
% Gravel		Testing Method used	
% Sand		Maximum Dry Unit Weight (kg/m ³)	
% Fine Particles		Optimum Moisture Content (%)	

Other Tests							
Test / Standard	Results	Requirements		Test / Standard	Results	Requirements	
		Min	Max			Min	Max
Los Angeles (grading B) (LC 21-400) (%)	37						
Micro Deval (grading F) (LC 21-070) (%)	18						

Remarks : _____

Prepared By: Benoit Cyr, Geo. *BJ* .Geo #786 _____ Date: January 27, 2023

Appendix E Photographic Album





Photo 1: Q-55-BH22-01 (Wet)



Photo 2: Q-55-BH22-01 (Dry)



Photo 3: Q-55-BH22-02 (Wet)



Photo 4: Q-55-BH22-02 (Dry)