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LABEC CENTURY IRON ORE INC.

Joyce Lake and Area DSO Project
Geotechnical Engineering Feasibility Study – Open Pit Design

Final Report

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LABEC CENTURY IRON ORE INC.

Joyce Lake and Area DSO Project Geotechnical Engineering Feasibility Study – Open Pit Design

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1 INTRODUCTION

1.1 MANDATE AND SCHEDULE OF WORK

In September 2014, Labec century Iron Ore inc. (LCIO) granted the mandate to WESA, a division of BluMetric, (WESA) and LVM inc., a Division of Englobe Corporation inc. (LVM) to respectively perform Hydrogeological and Geotechnical Feasibility Studies for the Joyce Lake and Area Direct Shipping Ore (Joyce Lake DSO) Project.

The mandate included site work consisting of drilling boreholes, logging cores and in situ testing for both the Hydrogeological and Geotechnical aspects. The site investigation work was followed by laboratory testing and a series of three study reports cover the site investigation. WESA is responsible for the Hydrogeology feasibility Study and LVM is responsible for the Geotechnical Feasibility Study. The geotechnical Feasibility Study is two folds: one part concerns the pit slope analysis and design and, the other one concern the mine infrastructures of the surrounding areas. This report presents the results of the pit slope analysis and design.

The three stand-alone reports are:

- Joyce Lake and Area DSO Project - Hydrogeological Study;
- Joyce Lake and Area DSO Project – Geotechnical Engineering Feasibility Study – Open Pit Design (Current Report);
- Joyce Lake and Area DSO Project – Geotechnical Feasibility Study – Surrounding Areas.

The site investigation work, the study and the reporting have been completed during Fall 2014.

1.2 PROJECT DESCRIPTION

The Joyce Lake property is located in the western part of the Labrador Trough iron range and about 1,200 km northeast of Montreal and 20 km north east of the town of Schefferville (see Appendix 1). The Joyce Lake DSO project mainly consists of an Open Pit Mining, Beneficiation Plant, Access roads, Workers Camp, Haul road leading to a railway loop and loading station. The ore is extracted from the pit, sent to a dry plant to be processed, loaded on trucks, hauled to the loading railway loop and loaded on train for shipment to the Pointe Noire Harbour facility near Setp-Îles, Québec. The general layout of the installations is shown on Appendix 1.

1.3 REPORT ORGANIZATION

The report is composed of 10 chapters. The current chapter introduces the scope and schedule of the project and the structure of the report. The general site characteristics and geological settings are presented in chapter 2. The field investigation work is described in chapter 3. The geotechnical characteristic of the lithology, of the intact rock and the rock mass are presented in chapter 4. Chapters 6 and 7 address the pit slope design and stability issues. Finally, chapters 8 and 9 present the recommendations and conclusion of the report. While chapter 10 presents the list of references.

2 SITE PHYSICAL SETTING

Most of the background and geological information was obtained from previous studies and reports, conducted for the Joyce Lake project. This includes reports prepared by CIMA+ (*Preliminary Economic Assessment (PEA) Study Report for the Joyce Lake DSO Project*), SRK (*Independent Technical Report, Attikamagen Iron Project, Schefferville Area, Québec*) and SGS (*Mineral Resource Update Joyce Lake DSO Iron Project Newfoundland & Labrador / NI 43-101 Technical Report Joyce Lake DSO Iron Project NewfoundLand & Labrador*). Some excerpts from these reports are presented in this chapter.

2.1 LOCATION

The Joyce lake property is located on a peninsula, bordered by the Attikamagan Lake. The peninsula is about 3.5 km wide where Joyce Lake is located. The lake itself is oblong and oriented approximately N300 with roughly a length of 1360 m and a width of 340 m. The proposed open pit mine is located north-west of Joyce Lake and intercepts the lake in its West part.

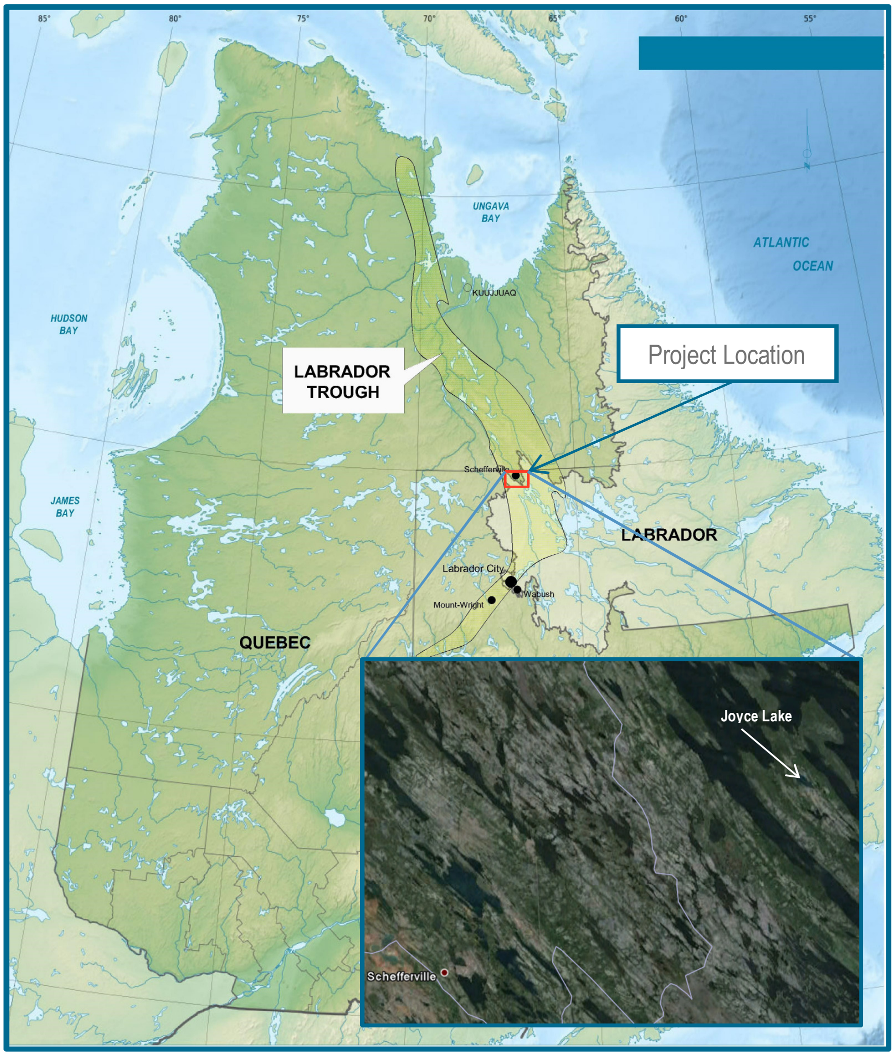
The South part of the Attikamagan Lake, named Iron Arm range, separates the Joyce Lake peninsula from the South shore of Attikamagan Lake.

There is no access road connecting the Joyce Lake property to western Labrador or elsewhere in Quebec. There is a gravel road connecting Schefferville to Iron Arm South shore. Some locals have seasonal cabins along the Iron Arm range south shore.

There are presently no roads connecting the Iron Arm Camp South shore to Joyce Lake property on its North Shore. Helicopter or floatplane can access Joyce Lake at Summer time or skidoos can be used to cross Iron Arm range during winter time.

Figure 1 shows the location of the project.

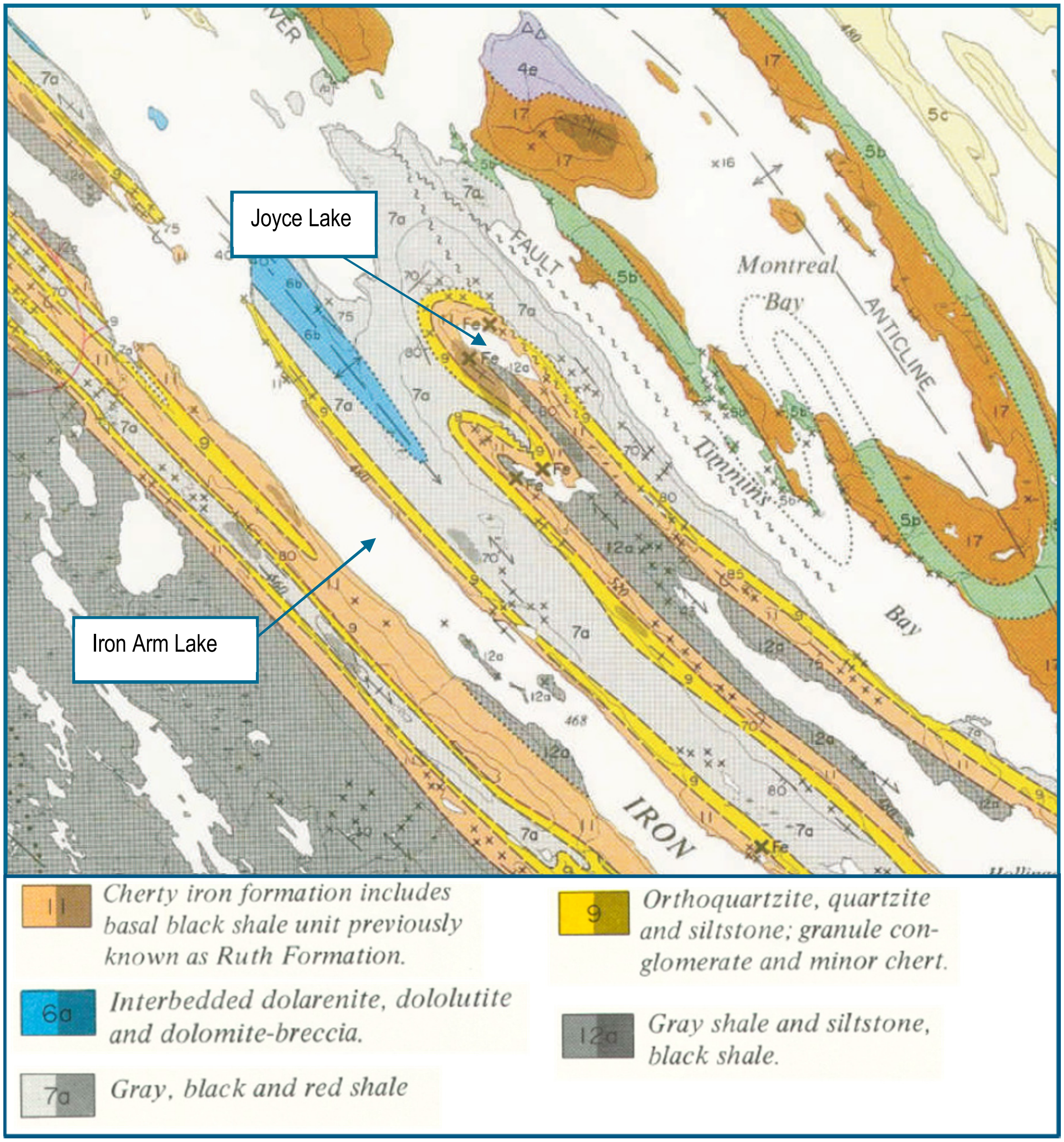
Figure 1: Project Location



2.2 REGIONAL GEOLOGY

Figure 2 shows regional geology and major geological structures (faults, foliation and bedding) around Joyce Lake.

Figure 2: Regional geology around Joyce Lake (after Geology of the South-Central Labrodor Trough, Map 82-5, Government of Canada)



2.2.1 Lithology

The Labrador Trough, that is also called the Labrador-Quebec Fold Belt, extends North-South for more than 1,000 km along the eastern margin of the Superior craton from Ungava Bay to Lake Pletipi, Quebec. The belt is about 100 km wide in its central part and becomes narrower at the north and south.

The Labrador Trough is a sequence of Proterozoic sedimentary rocks including iron formation, volcanic rocks and mafic intrusions forming the Kaniapiskau Supergroup. The Kaniapiskau Supergroup is comprised of the Knob Lake Group in the western part and the Doublet Group which is primarily volcanic in the eastern part. To the west of Schefferville, rocks of the Knob Lake Group lie unconformably on Archean gneisses and, to the east; they pass into the eugeosynclinal facies of the Labrador Trough. The Kaniapiskau Supergroup has been intruded by numerous diabase dikes known as the Montagnais Intrusive Suite. These dikes along with the Nimish volcanic rocks are the only rock types representing igneous activity in the western part of the central Labrador Trough.

The Knob Lake Group includes the Sokoman Formation which is the main exploration target of the Joyce Lake Iron Project.

2.2.2 Deposit Geology

The iron formations of the Sokoman Formation are classified as Lake Superior type. They consist of a banded sedimentary unit composed principally of bands of magnetite and hematite within chert-rich rocks and variable amounts of silicate-carbonate-sulphide. Such iron formations have been the principal sources of iron throughout the world. Superior-type iron formations with low iron tenor can be locally brought to “ore grade” through the process of enrichment by leaching and deep weathering processes due to seepage of meteoric and syn-orogenic fluids. Hydrothermal and meteoric fluids circulating through the banded iron formation during the Hudsonian orogenesis recrystallized iron minerals to hematite, and leached silica and carbonate gangue. The result is a residually enriched iron formation that may be further enriched, whereby iron oxides (goethite, limonite), hematite and manganese are redistributed into the openings left by the primary leaching phase, and/or deposited along fracture/cleavage surfaces and in veinlets. Almost all the iron deposits near surface in the Labrador Trough are enriched to some degree by these processes. The minimum iron content required to be considered as economic at a given market price is generally greater than thirty percent iron. Iron oxides must also be amenable to concentration (beneficiation) and the concentrates produced must be low in manganese, aluminum, phosphorus, sulphur and alkalis. Beneficiation involves segregating the silicate and carbonate gangue and other rock types inter-bedded within the iron formation from the iron-rich oxides.

The iron formation occurring on the Joyce Lake Iron Project consists mostly of subunits of the Sokoman Formation characterized by recrystallized chert and jasper with bands and disseminations of magnetite, hematite and martite; a type of hematite pseudomorph after magnetite and specularite. Other gangue minerals are a series of iron silicates comprised of minnesotaite, pyrolusite and stilpnomelane and iron carbonate, mainly siderite.

2.2.3 Major Structures

Three major structural zones have been identified in the area of Joyce Lake:

- Western marginal zone (Howells River area);
- Zone of close spaced folds and thrust faults (Schefferville Mining District);
- Eastern zone of more widely spaced folds and faults.

The Iron Arm - Attikamagen Lake area is within the Eastern Zone and lies on the eastern limb of the Petitsikapau Synclinorium, a major structural feature in the central part of this zone.

The Eastern Zone lies to the northeast of the Knob Lake thrust fault and extends to the Iron Arm - Attikamagen Lake area (Harrison et al., 1972). It is believed to be underlain by strata of the Attikamagen, Denault, Dolly, Wishart, Ruth, Sokoman and Menihek Formations. Apart from the Knob Lake fault, only one other major thrust fault was defined by Harrison et al. (1972) in this area. This fault lies about 3.2 km east of the Knob Lake fault and brings strata of the Denault against the Sokoman Formation.

As shown on figure 2, the structural picture is a confused one around Joyce Lake. At least three episodes of deformation have identified on previous field exploration.

2.3 CLIMATE AND PHYSIOGRAPHY

The Schefferville area has a subarctic continental taiga climate with very harsh winters. Daily average temperatures exceed 0°C for only five months a year. Daily mean temperatures for Schefferville average - 24.1°C and -22.6°C in January and February respectively. Mean daily average temperatures in July and August are 12.4°C and 11.2°C, respectively. Snowfall in November, December and January generally exceeds 50 cm per month and the wettest summer month is July with an average rainfall of 106.8 mm.

The Joyce Lake Property is located within a relatively rugged physiography with rolling hills and valleys reflecting the structure of the underlying bedrock. Elevation in the Project Area can vary from 472 m on the shores of Iron Arm up to 583 m at the high point. Joyce Lake surface is about 502 m in elevation. The natural overburden material in the area is mainly composed of till and glacial deposits are present throughout the area, except on the ridgelines.

2.4 PERMAFROST

Permafrost in the area of Schefferville is described as Sporadic. Usually, permafrost is found in high grounds where snow cover is minimized by winds and is not generally present near and under wetlands and lakes. Visual observations at the open pit site have shown that the overburden thickness is not important and that rock outcrops are well present.

3 GEOTECHNICAL SITE INVESTIGATION

3.1 PLANNED OPEN PIT MINE

An optimized open pit shell was developed by others based on the block model of the resource for Joyce Lake project. The optimised open pit constitutes the minimal excavation required for access to the iron ore, meeting the DSO mining criteria. The optimized open pit layout as of September 22nd 2014 is shown in Appendix 1. The proposed open pit reaches a depth of about 150 m and it extends approximately 700 m in East-West and 600 m in North-South direction.

3.2 SITE INVESTIGATION PROGRAM

The geotechnical site investigation for the feasibility study of the open pit consisted of four inclined boreholes (BH-P-01 to BH-P-04), driven to a vertical depth of 150m. The field work campaign took place from September 22nd to October 13th, 2014. This investigation included:

- Drilling of four inclined HQ-3 size diamond coring geotechnical holes with core orientation;
- Geotechnical core logging including description and orientation of discontinuities;
- Core photographs; and
- Collection of rock samples for laboratory testing.

A total of 653 m core was drilled. The geotechnical boreholes were oriented against the pit wall slopes. The locations of the four boreholes are shown in Appendix 1 along with the locations of the four vertical boreholes performed by WESA within the scope of the hydrogeological feasibility study. Rock description of the WESA boreholes were taken into consideration within this study.

In order to respect the schedule and to meet the high quality requirement of the project, three senior geologists of LVM were mobilized on the site. The drilling work was undertaken 24 hours a day under the supervision of two senior geologists (day and night shifts). A first logging was performed by one of these senior geologists at the drill shack as drilling proceeds. A second logging and verification was done by a third senior geologist, after transporting the core boxes by helicopter to Schefferville at the LCIO core shack.

3.3 BOREHOLE DRILLING

The boreholes were drilled using a Boart-Longyear LF-70 drill rig. The LF-70 modular design consists of seven sections that can be moved by helicopter for reaching remote locations. The drilling core size was HQ-3 (triple core barrel) and occasionally HQ size was used in highly crushed rock zones. The diameter of the rock cores are 61.1 and 63.5 mm, respectively.

Core orientation is considered an essential piece of data in order to assess the main orientation of discontinuities and estimate geomechanical properties of rock masses. It allows identifying precisely the original orientation of a core sample prior to its extraction from the ground. The CorientR device developed by Fordia inc. in Canada was used to identify the bottom of the core in order to determine its original orientation in the rock mass. Based on the orientation data collected from these holes, stereographic projections were prepared and are presented in chapter 4.

3.4 BOREHOLES SURVEY

Initials boreholes ground survey was performed using a hand held GPS and by measuring the elevation of the surface ground on the LIDAR 3D topographic model available for the project. The drilling sites were flat and horizontal. The precision of the location and elevation using this method is satisfactory in view of the open pit size and depth.

Final survey was performed by LCIO at the end of site investigation work using high precision differential GPS (DGPS).

3.5 DOWNHOLE SURVEY

Deviation of the inclined holes during drilling advancement is sometimes significant, especially with long boreholes and small drilling sizes. A Ranger Borehole Survey System was used to monitor the plunge angle and azimuth deviations along the full boreholes lengths. The instrument is inserted in the borehole after completion.

Deviations from the hole alignment were measured and represent less than 2% of the angles which is considered acceptable.

3.6 GEO-MECHANICAL CORE LOGGING

The core logging was performed in two steps. A first core logging was performed by a senior geologist at the drill rig, as drilling proceeds. It consisted in documenting the rock cores and nature of the rock formation, the run length and the depth of the beginning and the end of the run. The following parameters were recorded and measured at this stage:

- Rock Type and Geological Description.
- TCR: Total Core Recovery (%) is the total length of the core recovered, including broken zones, divided by the total length of the core drilled.
- RQD: Rock Quality Designation- is determined from the following expression proposed by Deere et al. (1969): RQD (%) =100 times the sum of the lengths of core in pieces equal to or longer than 10 cm divided by the length of core run.
- Fracture frequency is the number of natural fractures which occur over the length of core examined or per unit length (Mechanical breaks and fractures with length of persistence less than the core diameter is not included in this calculation).

Once these parameters were included in the borehole log, the rock cores were photographed to document the state of the cores prior to shipment to the core shack located in Schefferville. The Core boxes were transported by helicopter directly from the drill rig to the core shack.

A second geologist, in Schefferville, completed the core logging by assessing the strength of intact rock and its weathering and/or alteration indices as well as measuring the structural properties of discontinuities of the cores.

The hardness scale shown in Table 1, based on the International Society of Rock Mechanics (ISRM, 1981), was employed for field estimation of intact rock strength.

The ISRM strength classification is based on simple mechanical tests, which can be easily performed in the field. Wherever possible, the full range of tests was performed to determine hardness, including hitting the core with a rock hammer, scraping or peeling with a knife and scratching with the thumbnail, as per the procedures described in the table.

Table 1: Strength Index description (after ISRM, 1981)

GRADE	DESCRIPTION	FIELD IDENTIFICATION	APPROXIMATIVE RANGE OF UNIAXIAL COMPRESSIVE STRENGTH (MPa)
R0	Extremely weak rock	Indented by thumbnail	0.25 – 1.0
R1	Very weak rock	Crumbles underfirm blows with point of geological hammer, can de peely by a pocket knife	1.0 – 5.0
R2	Weak rock	Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with point of geological hammer	5.0 – 25
R3	Medium strong rock	Cannot be scraped or peeled with a pocket knife, specimen can be fractured with single firm blow or geological hammer	25 – 50
R4	Strong rock	Specimen requires more than one blow of geological hammer to fracture it	50 – 100
R5	Very strong rock	Specimen requires many blows of geological hammer to fracture it	100 – 250
R6	Extremely strong rock	Specimen can only be chipped with geological hammer	> 250

The degree of weathering and/or alteration was recorded on a per run basis during the geotechnical core logging. The weathering process describes the breakdown of rock by physical processes, while the hydrothermal and/or supergene alteration processes cause the alteration and breakdown of the intact rock by chemical processes. The degree of weathering or alteration tends to cause a reduction in the rock strength and competency. Table 2 was used to describe the degree of weathering as defined by the ISRM (1981).

Table 2: Weathering Index determination (after ISRM, 1981)

TERM / SYMBOL	DESCRIPTION	DISCOLORATION EXTENT	FRACTURE CONDITION / SURFACE CHARACTERISTICS
Fresh / W1	No visible sign of rock material weathering.	None	Closed or Discolored / Unchanged
Slightly weathered / W2	Discoloration indicates weathering of rock material on discontinuity surfaces. Less than 5% of rock mass altered.	< 20 % of fracture spacing on both sides of fracture	Discolored, may contain thin filling / Partial discoloration
Moderately weathered / W3	Less than 50% of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones.	> 20 % of fracture spacing on both sides of fracture	Discolored, may contain thin filling / Partial to complete discoloration, not friable except poorly cemented rocks
Highly weathered / W4	More than 50% of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones.	Throughout	Filled with alteration minerals / Friable and possibly pitted
Completely weathered / W5	100% of the rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.	Throughout	Filled with alteration minerals / Resembles soil
Residual soil / W6	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.	Throughout	Non available / Resembles soil

All intercepted natural discontinuities were described and when possible oriented. The following fracture types will be used to identify each discontinuity measured in the core interval:

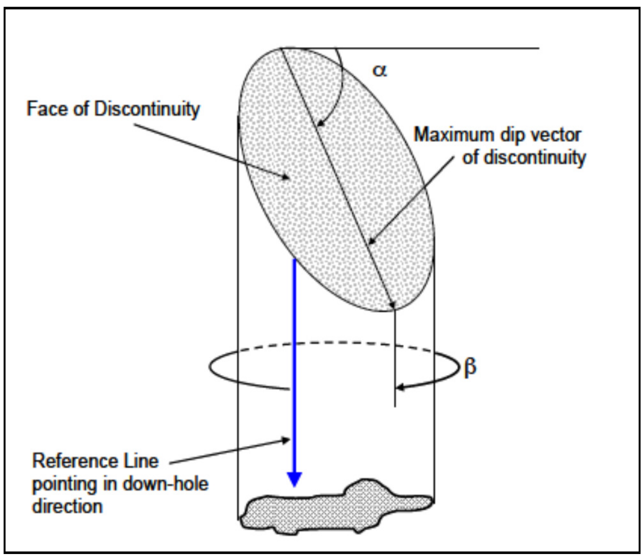
- **Fracture (FR):** A discontinuity of uncertain origin (e.g., possible mechanical break).
- **Joint (JN):** A discontinuity with no infilling and no evidence of previous movement.
- **Fault (FLT):** A discontinuity across which there has been substantial movement. Infill will be relatively thick.
- **Shear (SHR):** A discontinuity across which there has been limited movement. Infill will be relatively thin, generally associated with polished or slicken sided surfaces.
- **Bedding (BD):** A discontinuity associated with sedimentary processes (e.g. mud seam in sandstone).

- **Foliation (FO):** A preferential direction of structural weakness in the rock due to alignment of weak minerals, caused by metamorphism.
- **Vein (VN):** A discontinuity infilled or healed by another mineral (e.g. quartz). Veins are generally of limited interest unless material is particularly weak or broken.
- **Contact (CO):** A discontinuity that represents a change between two geological bedrock units.

The orientation of discontinuities measured when it was possible. The discontinuities angles were measured using a cylindrical Ezi-logger core goniometer. The measured angles are defined as follow, (see Figure 3):

- The dip angle (alpha) is measured for each natural discontinuity observed in the core. This angle is measured relative to the core axis, where 0° = parallel to core axis and 90° = perpendicular to core axis.
- The dip direction (beta) angle is measured for each natural discontinuity observed in the core. This angle is measured clockwise to the reference line looking down the core axis in the direction of drilling.

Figure 3: Measurement of angles Alpha and Beta



The discontinuities conditions were measured for each natural discontinuity observed and is based on the joint shape and roughness which describe the joint surface irregularity. The shape of the discontinuity is described using the following terms: Planar (PL), Curved (CU), Undulating (UN), Stepped (ST) and Irregular (IR). The surface roughness of the fracture is described using the following terms: Polished (PO), Slickensided (K), Smooth (SM), Rough (RO, Very Rough (VR) and Closed (C).

The discontinuities infill material is described as the material contained within the discontinuities: Broken rock; minerals such as biotite, chlorite, calcite, hematite, quartz, sulfide, iron, epidote; Gravel, sand, clay; Gouge, intrusive material such as chert.

Finally, Fault Gouge & Breccia intervals and intervals of broken core are also noted on the log.

4 ENGINEERING GEOLOGY MODEL

The aim of the site investigations was to gather geotechnical rock mass characteristics for the preparation of a preliminary Engineering Geology Model. Pit slope design parameters will be engineered based on the information and conclusions presented in the geotechnical model.The following sections present the main results of the site investigation that address the various aspects of the preliminary engineering model.

4.1 SUMMARY OF STRATIGRAPHY

The stratigraphic conditions encountered within boreholes consist typically of a downward sequence of overburden or highly weathered bedrock followed by bedrock.

Table 3 illustrates the stratigraphy encountered at each borehole location in terms of depths and elevations. Detailed descriptions of materials encountered in boreholes may be consulted on individual borehole reports in Appendix 2.

Table 3: Subsoil stratigraphy observed in boreholes

BOREHOLE ELEVATION (m)	LENGTH GEODESIC ELEVATION (m)			
	OVERBURDEN OR HIGHLY WEATHERED BEDROCK *	IRON FORMATION	SHALE	SANDSTONE
BH-P-01 [527.85]	0.00 – 7.00 [527,85 – 520,85]	7.00 – 118.90 [520,85 – 416.12]	118.90 – 134.10 [416,12 – 401,84]	134.10 - ≥160.00 [401.84 - ≤377,50]
BH-P-02 [522,18]	0.00 – 3.00 [522,18 – 519,18]	3.00 – ≥173.00 [519,18 – ≤372.36]	---	---
BH-P-03 [526,33]	0.00 – 9.00 [526,33 – 517,87]	9.00 – 78.00 [517,87 – 453.03]	78.00 – 108.50 [453,03 – 424,37]	108.50 - ≥160.70 [424.37 - ≤375,32]
BH-P-04 [519,26]	0.00 – 1.50 [519,26 – 517,85]	1.50 – ≥160.00 [517,85 – ≤368.91]		
* *Thickness of overburden may be lower than indicated*				

4.2 OVERBURDEN

From 3 to 9 meters thick of either overburden or highly weathered rock was found at the surface within boreholes BH-P-01 to BH-P-04.

It should be noted that in all boreholes location, visual observations showed that overburden seems to be thin and that rock outcrops are frequent. No recovery was possible down to a certain depth when initiating the boreholes. It is therefore impossible to assess if the first runs are in highly weathered bedrock or in overburden.

4.2.1 Bedrock

4.2.1.1 *Iron Formation (rock type A and B and group I)*

Iron Formation consists of iron oxide with white and red chert, fine to medium grained, dark grey, with centimetric bands of white to reddish medium grained chert and millimetric bands of fine grained red chert. We note the presence of nodules of white chert and pockets of iron oxide.

This formation is highly fractured with limonite in most fracture. Mostly non-magnetic with few weakly magnetic zone were observed.

This formation is also highly weathered as illustrated in histograms presented in Appendix 3 with very low RQD values were measured.

Two mains lithology have been identified within Iron Formation:

- Massive, weakly to highly hydroxidized (limonite, goethite) Iron Oxide (Hematite) with chert (white, gray or red) - rock type A;
- Mainly massive, weakly to highly hydroxidized (limonite, goethite) Iron Oxide (Hematite) – rock type B.

No thickness of more than 5 meters has been identified for rock type A and B From a geomechanical point of view, these 2 lithology were grouped (group I).

In the Preliminary Economic Assessment (PEA), 3 members of units have been identified within the Iron Formation for a geological point of view. From a geomechanical point of view, all these members were grouped in one lithology (Group I).

4.2.1.2 *Shale (rock type C and group II) from Ruth Formation*

This rock unit was only intercepted in BH-P-01 and BH-P-03. The shale unit consists generally of black shale with zone of interbedded siltstone. This formation is not weathered as illustrated in histograms presented in Appendix 3 and medium to high RQD values were measured.

4.2.1.3 *Sandstone (rock type D and group III) from Wishart Formation*

As mentioned in the PEA document, the lithology was described as a sedimentary quartzite (metamorphic sandstone) and arkose, a quartz and feldspar clastic deposit. For the purpose of this study, this unit was described as grey sandstone from on-site geologists since no petrographic analysis has been performed on sample.

Similar to Shale rock unit, the Sandstone was only intercepted by BH-P-01 and BH-P-03. Grey Sandstone, fine to medium grain centimetric interdedded with black shale. This formation is not weathered as illustrated in histograms in Appendix 3 and high RQD values were measured.

4.2.2 Classification of Rock units

Arising from the previous section, three (3) principals lithology have been identified in the Pit area:

- Banded Iron Formation (Group I);

- Shale (Group II);
- Sandstone (Group III).

4.3 INTACT ROCK LABORATORY TEST

4.3.1 Introduction

An essential part of a rock mass characterization program is the evaluation of intact rock strength for the various geological units. Laboratory testing of selected rock samples was carried out to measure the intact rock properties. This section presents the laboratory rock test results, carried out at Rock Mechanics Laboratory of Laval University, Quebec City, and at LVM's rock and soil laboratory at Boucherville using the core samples obtained from the geotechnical holes including: BH-P-01, BH-P-02, BH-P-03 and BH-P-04. The geotechnical drilling program was performed during the fall 2014. The results of the tests are presented in this section.

4.3.2 Rock Strength Testing

Rock laboratory testing was performed on the selected samples obtained from Iron oxide (Group I), Shale (Group II) and Sandstone (Group III) rock units of the site under investigation in the Joyce Lake project. The samples were selected to cover all major rock units at the site. The samples were sent to the Rock Mechanics Laboratory of Laval University in three different shipments. The first batch of samples was sent on October 14th 2014, the second batch was sent on October 22th 2014 and finally the third batch was sent on October 28th 2014. From the three batches of rock samples sent to the Rock Mechanics Laboratory of Laval University, overall 66 samples were strength tested. In addition to the samples that were tested at Laval University, one batch of rock samples was sent to the LVM's rock and soil laboratory at Boucherville. Among the total samples that were sent to Boucherville 31 samples were subjected to strength tests.

Of the 66 tested rock samples at Laval University (including the first, the second and the third batch of samples), 27 rock samples were tested for uniaxial compressive strength (UCS), 33 samples for Brazilian Indirect Tensile Strength and 6 samples for triaxial compressive strength. The results of the strength tests are summarized in Tables 4 and 5. In addition, the reports of Laval University testing program results for the current geotechnical investigation are included in Appendix 4. The report includes the picture of samples before and after testing.

Of 31 tested samples at Boucherville laboratory, 3 rock samples were tested for uniaxial compressive strength (UCS), 9 samples for Brazilian Indirect Tensile Strength and 19 samples for point load test. Table 5 summarizes the results of the strength tests performed at Boucherville laboratory.

The core samples collected from the geotechnical drilling program are of the HQ-3 and HQ size (61.1 mm and 63.5 mm of diameter). These core sizes are larger than the NQ (50 mm) size recommended by the International Society for Rock Mechanics (ISRM), as a standard size for compressive strength tests, Ulusay and Hudson (2007). Consequently, a specimen size correction factor proposed by Hoek and Brown (1980) was used to correct the strength results recorded for the larger samples. This correction was mainly done for the UCS tests, while for the triaxial strength tests the samples had to be trimmed to the NX size in order to be fitted in the pressure cell. Therefore, no size effect correction was performed for these results.

Table 4: Summary of UCS, Triaxial, and Brazilian Laboratory Tests performed at Laval University

SAMPLE	ROCK TYPE	DEPTH (m)	TEST TYPE[1]	DENSITY (kN/m^3)	σ_1 (MPa)	σ_3 (MPa)	TENSILE STRENGTH σ_T (MPa)	TEST VALIDITY
PLT-07-A	A	76.60 -76.90	UCS	31.5	105.1	0	-	Yes
PLT-07-B	A	76.60 -76.90	TRX	32.7	256.7	8.2	-	Yes
PLT-03	A	61.50-61.75	UCS	28.9	***20.1****	0		No
RS-41	A	69.65-69.90	TRX	27.0	112.4	4.9	-	Yes

Table 4: Summary of UCS, Triaxial, and Brazilian Laboratory Tests performed at Laval University (suite)

SAMPLE	ROCK TYPE	DEPTH (m)	TEST TYPE[1]	DENSITY (kN/m^3)	σ_1 (MPa)	σ_3 (MPa)	TENSILE STRENGTH σ_T (MPa)	TEST VALIDITY
RS-39	A	63.50-63.85	BRZ	29.1	-	-	***5.371****	No
RS-51-A	A	149.0-149.27	TRX	30.9	***5.4****	***91.2****	-	No
RS-51-B	A	149.0-149.27	BRZ	33.2	-	-	7.17	Yes
RS-03	A	170.40-170.60	BRZ	30.3	-	-	6.7	Yes
RS-08	A	142.65-142.85	BRZ	31.2	-	-	9.72	Yes
RS-13A	A	133.25-133.6	UCS	31.1	106.74	0	-	Yes
RS-13B	A	133.25-133.6	BRZ	27.9	-	-	9.00	Yes
RS-16A	A	114.65-115.15	UCS	34.3	98.34	0	-	Yes
RS-16B	A	114.65-115.15	BRZ	33.4	-	-	7.20	Yes
RS-17	A	87.60-87.80	UCS	30.1	96.09	0	-	Yes
RS-19	A	87.45-87.65	BRZ	28.9	-	-	***2.70***	No
RS-01A	B	161.02-161.33	BRZ	28.8	-	-	5.20	Yes
RS-01B	B	161.02-161.33	BRZ	34.8	-	-	10.40	Yes
RS-02	B	164.47-164.76	BRZ	44.3	-	-	16.30	Yes
RS-09	B	139.65-139.85	BRZ	37.9	-	-	6.10	Yes
RS-11	B	143.75-144.0	UCS	34.7	***120.28****	0	-	No
RS-14	B	139.25-139.42	BRZ	41.3	-	-	7.80	Yes
RS-15A	B	119.80-120.20	BRZ	35.4	-	-	23.20	Yes
RS-15B	B	119.80-120.20	BRZ	47.2	-	-	28.10	Yes
RS-18	B	60.65-60.84	BRZ	28.7	-	-	4.80	Yes

SAMPLE	ROCK TYPE	DEPTH (m)	TEST TYPE[1]	DENSITY (kN/m³)	σ₁ (MPa)	σ₃ (MPa)	TENSILE STRENGTH σ_T (MPa)	TEST VALIDITY
RS-04A	B	148.10-148.33	UCS	26.3	30.62	0	-	Yes
RS-04B	B	148.10-148.33	BRZ	26.2	-	-	2.97	Yes
RS-05	B	148.55-148.71	BRZ	26.7	-	-	2.90	Yes
RS-06A	B	157.12-157.39	UCS	28.3	***39.25****	0	-	**No**
RS-06B	B	157.12-157.39	BRZ	29.5	-	-	***2.33****	**No**
RS-07	B	157.50-157.67	UCS	28.4	51.35	0	-	Yes
RS-10A	B	137.80-138.10	UCS	23.9	15.84	0	-	Yes
RS-10B	B	137.80-138.10	BRZ	30.1	-	-	10.32	Yes
RS-12A	B	135.05-135.30	UCS	24.6	25.63	0	-	Yes
RS-12B	B	135.05-135.30	BRZ	27.5	-	-	3.25	Yes
PLT-11A	B	161.40-161.70	UCS	26.8	24.32	0	-	Yes
PLT-11B	B	161.40-161.70	BRZ	27.6	-	-	1.62	Yes
PLT-12A	B	161.70-161.95	UCS	32.9	***39.49****	0	-	**No**
PLT-12B	B	161.70-161.95	BRZ	28.5	-	-	4.52	Yes

Table 4: Summary of UCS, Triaxial, and Brazilian Laboratory Tests performed at Laval University (suite)

SAMPLE	ROCK TYPE	DEPTH (m)	TEST TYPE[1]	DENSITY (kN/m³)	σ₁ (MPa)	σ₃ (MPa)	TENSILE STRENGTH σ_T (MPa)	TEST VALIDITY
PLT-16A	B	123.85-124.10	UCS	30	51.26	0	-	Yes
PLT-16B	B	123.85-124.10	BRZ	48.8	-	-	13.69	Yes
PLT-16C	B	123.85-124.10	BRZ	46.9	-	-	11.09	Yes
PLT-17A	B	138.20-138.50	BRZ	37.3	-	-	3.47	Yes
PLT-17B	B	138.20-138.50	TRX	37.9	58.4	8.1	-	Yes
RS-50	B	123.10-123.27	TRX	38.3	39.3	3.4	-	Yes
RS-46	B	123.0-123.23	UCS	38.2	29.29	0	-	Yes
RS-52	B	157.80-158	UCS	40.5	88.39	0	-	Yes
RS-45	B	121.70-121.87	TRX	41.4	71.4	5.7	-	Yes
RS-54A	C	81.0-81.26	UCS	27.2	44.86	0	-	Yes
RS-54B	C	81.0-81.26	BRZ	27.5	-	-	19.99	Yes
RS-58A	C	89.60-89.96	UCS	27.7	68.21	0	-	Yes
RS-58B	C	89.60-89.96	UCS	29	137.67	0	-	Yes
RS-58C	C	89.60-89.96	BRZ	30.6	-	-	4.11	Yes
RS-57A	C	87.0-87.20	UCS	30.2	114.36	0	-	Yes
RS-57B	C	87.0-87.20	BRZ	30.7	-	-	10.41	Yes

SAMPLE	ROCK TYPE	DEPTH (m)	TEST TYPE[1]	DENSITY (kN/m^3)	σ_1 (MPa)	σ_3 (MPa)	TENSILE STRENGTH σ_T (MPa)	TEST VALIDITY
RS-27	C	125.25-125.50	UCS	26.7	138.18	0	-	Yes
RS-28	C	125.70-125.90	UCS	26.3	134.53	0	-	Yes
RS-29A	C	126.25-126.55	UCS	26.1	137.15	0	-	Yes
RS-29B	C	126.25-126.55	BRZ	26.0	-	-	12.05	Yes
RS-30	C	128.05-128.2	BRZ	25.9	-	-	16.97	Yes
RS-32A	D	135-135.35	UCS	26.2	228.63	0	-	Yes
RS-32B	D	135-135.35	BRZ	25.3	-	-	12.06	Yes
RS-33	D	148.04-148.46	BRZ	26.2	-	-	19.19	Yes
RS-34	D	148.26-148.50	UCS	26.4	237.40	0	-	Yes
RS-37A	D	154.83-155.20	UCS	26.7	340.19	0	-	Yes
RS-37B	D	154.83-155.20	BRZ	26.6	-	-	28.51	Yes
RS-38	D	159.43-159.60	UCS	27.7	256.84	0	-	Yes

[1] The size corrected test results are presented for the UCS tests in the Table.
***Rock Types**: A= Hematite with White Chert; B= Mainly Iron Oxide (massive or with limonite alteration); C= Shale; D= Sandstone*
***Test Types**: UCS: Unconfined Compressive Strength Test; BRZ: Indirect Tensile Brazilian Test; TRX: Triaxial Compressive Strength Test; PLT: Point Load Test*
** Invalid test (broke along foliation or bedding)*

Table 5: Summary of UCS, Point Load, and Brazilian Laboratory Tests performed at LVM's Boucherville lab

SAMPLE	ROCK TYPE	DEPTH (m)	TEST TYPE[1]	σ_1 (MPa)	Is_{50}	σ_C (MPa)	TENSILE STRENGTH (MPa)
21	A	60.82	PLT	-	1.93	46.32	-
22	A	61.00	PLT	-	6.88	165.12	-
23	A	70.00	PLT	-	4.89	117.36	-
24	A	69.05	PLT	-	0.60	14.40	-
25	A	81.50	PLT	-	1.60	38.40	-
26	A	82.40	PLT	-	0.65	15.60	-
27A	A	90.30	PLT	-	1.82	43.68	-
27B	A	90.30	BRZ	-	-	-	8.60
30	A	74.10	PLT	-	4.28	102.72	-
28A	B	67.95	PLT	-	0.13	3.12	-
28B	B	67.95	BRZ	-	-	-	7.00
29A	B	68.70	PLT	-	0.55	13.20	-
29B	B	68.70	BRZ	-	-	-	1.40
31A	B	77.35	PLT	-	0.90	21.60	-

SAMPLE	ROCK TYPE	DEPTH (m)	TEST TYPE[1]	σ_1 (MPa)	Is_{50}	σ_C (MPa)	TENSILE STRENGTH (MPa)
31B	B	77.35	BRZ	-	-	-	3.30
32A	B	99.30	PLT	-	0.15	3.60	-
32B	B	99.30	BRZ	-	-	-	5.40
33A	B	101.80	PLT	-	0.09	2.16	-
33B	B	101.80	BRZ	-	-	-	1.70
39A	C	131.54	PLT	-	3.16	75.84	-
39A	C	131.54	UCS	22.55	-	-	-
34A	C	119.1	PLT	-	0.7	16.80	-
34B	C	119.1	BRZ	-	-	-	4.90
35A	C	122.45	PLT	-	1.84	44.16	-
35B	C	122.45	UCS	88.43	-	-	-
36A	C	124.03	PLT	-	2.78	66.72	-
36B	C	124.03	UCS	44.06	-	-	-
37A	C	126.85	PLT	-	2.84	68.16	-
37B	C	126.85	BRZ	-	-	-	2.50
38A	C	128.15	PLT	-	3.31	79.44	-
38A	C	128.15	BRZ	-	-	-	12.10

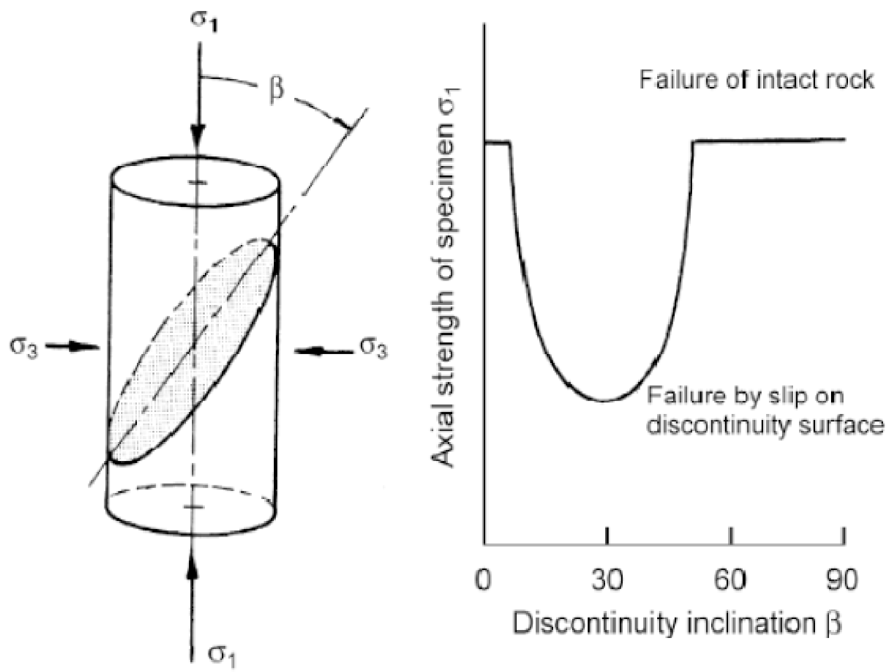
[1] The size corrected test results are presented for the UCS tests in the Table.
***Rock Types**: A= Hematite with White Chert; B= Mainly Iron Oxide (massive or with limonite alteration); C= Shale; D= Sandstone*
***Test Types**: UCS: Unconfined Compressive Strength Test; BRZ: Indirect Tensile Brazilian Test; TRX: Triaxial Compressive Strength Test; PLT: Point Load Test*

Due to the banding nature of the iron formation, in some of the collected iron oxide samples it was observed that the banding angle varies importantly. This can be associated with the dip angle of the drilled boreholes with respect to the banding iron formation. Most of the iron oxide samples with dominant banding structure, used for the compressive strength tests, were either totally or partially failed along a plane parallel to the banding (See Figure 4 for sample RS-11). This has resulted in low intact strength values particularly when the angle between the core axis and the banding planes is ranging between 30 and 45 degree. It was further observed that presence of white or red chert in iron oxide samples could change the behavior of rock samples under the compressive loading conditions and reduce the influence of bandings on the intact rock strength.

Figure 4: Rock sample RS-11 (iron oxide-massive) failed along a surface parallel to the banding structures

Determination of compressive strengths of anisotropic rocks that include weakness planes has its particular difficulties. Hoek (2006) suggested that the uniaxial compressive strength of anisotropic rock units can vary by a factor of five depending on the direction of loading with respect to the plane of weakness. The maximum compressive strength is generally recorded when the loading direction is perpendicular to the weakness plane. On the other hand, the lowest strength occurs when the angle of weakness plane with respect to loading direction varies from 30 to 45 degree, Figure 5. Therefore, it can be argued that most of the compressive strength values obtained for the samples of iron oxide, with well-developed banding structures, represent the minimum strength values.

Figure 5: Effect of plane of weakness on intact rock strength (after, Hoek (1983))



4.3.2.1 *UCS Test Results*

A total of 30 samples were subjected to UCS testing. Four tests out of the 30 tests were considered invalid as the samples were failed along a pre-existing joint. The invalid test results were not taken into consideration. A summary of the UCS results by rock type is shown in Table 6. The table shows the minimum, maximum, mean, standard deviation, coefficient of variance and the number of tests for each rock unit. The iron oxide rock unit samples with white or red chert (Rock type A) were treated separately from the other iron oxide samples such as massive hematite, hematite with hydroxide or hematite with limonite (Rock type B). The Shale rock unit samples collected from the BH-P-01 and BH-P-03 were grouped together, same as the sandstone samples.

Table 6: Summary of UCS tests by Rock Type

ROCK GROUP	ROCK TYPE	NUMBER OF TESTS	AVERAGE UCS (MPa)	STANDARD DEVIATION (MPa)	COEFFICIENT OF VARIATION (%)	MAXIMUM UCS (MPa)	MINIMUM UCS (MPa)
I	A	4	101.5	5.1	5.0	106.7	96.1
	B	8	23.4	23.4	59.1	88.4	15.8
II	C	10	93.0	45.3	48.7	138.1	22.5
III	D	4	265.7	51.0	19.1	340.2	228.6
Rock Types: A= Hematite with White Chert; B= Mainly Iron Oxide (massive or with limonite alteration); C= Shale; D= Sandstone							

The results of UCS tests show that:

- For rock type A, presence of white and red cherts in the iron oxide samples generally improves the strength of the intact rock samples. The samples of this rock unit show a very low variation in strength (CoV = 5.0%).
- For rock type B, presence of limonite alterations in iron oxide samples has highly degraded the compressive resistance of samples and consequently the ultimate strength of the samples with higher percentage of limonite are lower.
- For rock type B, the relatively low strength values for the iron oxide rock unit is also attributed to the pre-existing banding structures in the rock samples, which have resulted in failure of samples parallel to these weakness planes.
- For rock type B, Mainly iron oxide, a very high coefficient of variation was recorded (CoV = 59.1%). This implies the complex mineralogical composition and alteration of the rock samples collected for this rock unit.
- The highest average UCS was recorded for the Sandstone (rock type D), while the lowest average UCS was obtained for the mainly iron oxide samples (rock type B).

4.3.2.2 *Brazilian Test Results*

A total of 42 samples were selected for Brazilian tensile strength testing. Three tests out of the 42 Brazilian tests were considered invalid. The invalid test results were discarded. A summary of the Brazilian testing by rock type is shown in Table 7. This includes 6 samples of the iron oxide with cherts rock unit (rock type A), 22 samples of the mainly iron oxide rock unit (rock type B), 8 samples of the Shale rock unit and 3 samples of the Sandstone rock unit. The table 7 shows the mean, standard deviation, coefficient of variance, the number of tests and the range of tensile strength for each rock unit.

Table 7: Summary of Brazillian tests by rock type

ROCK GROUP	ROCK TYPE	NUMBER OF TESTS	AVERAGE TENSILE STRENGTH (MPa)	STANDARD DEVIATION (MPa)	COEFFICIENT OF VARIATION (%)	RANGE OF TENSILE STRENGTH (MPa)
I	A	6	8.0	1.2	15	6.7 - 9.7
	B	22	7.9	7.0	88.6	1.4 - 28.1
II	C	8	10.3	6.2	60.1	2.5 – 19.9
III	D	3	19.9	8.2	41.4	12.1 - 28.5
Rock Types*: A= Hematite with White Chert; B= Mainly Iron Oxide (massive or with limonite alteration); C= Shale; D= Sandstone*						

The results of Brazilian indirect tensile strength tests show that:

- The average indirect tensile strength of both the hematite with chert (rock type A) and mainly iron oxide (rock type B) are almost the same. However, the variation of the values measured for the mainly iron oxide (rock type B) is significant with a CoV= 88.6%.
- The highest average indirect tensile strength was recorded for the Sandstone (rock type D), following by Shale (rock type C).

4.3.2.3 *Triaxial Test Results*

A summary of the triaxial testing by rock type is shown in Table 8. A total of 6 samples were selected from the geotechnical investigation boreholes for triaxial testing. Only 5 test results were considered valid. This includes 2 samples from the rock unit A (Hematite with white Chert) and 3 samples from the rock unit B (Mainly Iron Oxide (massive or with limonite alteration)). The confining pressures for the triaxial testing were between 3.4 and 8.2 MPa. No triaxial test was carried out on the Shale and Sandstone samples.

Table 8: Summary of Triaxial tests by rock type

ROCK GROUP	ROCK TYPE	σ_3 (MPa)	NUMBER OF TESTS	σ_1 (MPa)
I	A	8.2	1	256.7
		4.9	1	112.4
	B	8.1	1	58.4
		3.4	1	39.2
		5.7	1	71.4
Rock Types*: A= Hematite with White Chert; B= Mainly Iron Oxide (massive or with limonite alteration)*				

The results of triaxial strength tests show that:

- For rock type A, by increasing the confining stresses, the ultimate strength of rock samples increase.
- For rock type B, the results do not clearly show an increase of ultimate strength with increasing of confining stresses. This can be attributed to the heterogeneous mineralogical composition of the samples taken from rock type B.

4.3.2.4 *Point Load Test Results*

A summary of the point load testing by rock type is shown in Table 9. Point load index test was carried out on 19 samples at Boucherville laboratory on the rock samples collected from the four geotechnical drill holes. The number of tests for each rock type, and average index test results are presented in Table 9. The compressive strength of rock samples were estimated based on the Is_{50} values based on the correlation proposed by Bieniawski (1975), $\sigma_C = 24 \times Is_{50}$.

Table 9: Summary of Point Load tests by rock type

ROCK GROUP	ROCK TYPE	NUMBER OF TESTS	AVERAGE Is_{50}	AVERAGE σ_C (MPa)	RANGE OF σ_C (MPa)
I	A	8	2.83	67.9	14.4 – 165.1
	B	5	0.36	8.7	2.1 – 21.6
II	C	6	2.43	58.5	16.8 – 79.4
***Rock Types**: A= Hematite with White Chert; B= Mainly Iron Oxide (massive or with limonite alteration); C= Shale; D= Sandstone*					

The results of Point Load tests show that:

- The average sig-c values obtained for the three rock types (A, B, and C) are lower than the average values of UCS test results presented in Table 6. This can be attributed to the limited number of point load tests performed for each rock type which statistically not enough to draw an appropriate conclusion from the results. In addition, index to strength conversion factors are site-specific and the common factor used in this case may not be representative for the site under investigation.
- Due to the inconsistency of the point load test results and the UCS results, the results of point load index tests were discarded at this stage for estimating UCS average value. These results could be used with more confidence once statistically enough samples were tested for each rock type.

4.3.2.5 *Tilt test*

Because the length of intact rock samples was short, no direct shear test were performed on rock core samples to evaluate friction angle. In order to preserve a larger number of samples for triaxial and uniaxial compressive tests, tilt test (non-destructive) were performed on Iron Formation cores at Rock Mechanics Laboratory at Laval University. Table 10 summarizes the results of the tilt tests.

Table 10: Summary of Tilt test results

SEGMENT	BOREHOLE	DEPTH (m)		WITH CORE SEGMENT	Φ BASE (DEGREE)
		FROM	TO		
RS-01	BH-02	161,02	161,33	RS-02	35
RS-01	BH-02	161,02	161,33	RS-15	36
RS-01	BH-02	161,02	161,33	RS-09	36
RS-12	BH-02	135,05	135,30	RS-04	37
RS-12	BH-02	135,05	135,30	RS-06	37
RS-12	BH-02	135,05	135,30	RS-07	39
RS-12	BH-02	135,05	135,30	RS-10	37
RS-13	BH-02	133,25	133,60	RS-03	31
RS-13	BH-02	133,25	133,60	RS-08	30
RS-13	BH-02	133,25	133,60	RS-11	30
RS-13	BH-02	133,25	133,60	RS-16	29
RS-17	BH-02	87,60	87,80	RS-18	24
RS-17	BH-02	87,60	87,80	RS-19	29

The results of tilt tests indicate that the basic friction angle for Iron Oxide rock units is varying between 24 and 39 degree.

4.3.3 Intact Rock Strength Material Properties

The UCS, triaxial and Brazilian testing data for rock type A and B (Hematite with White Chert and Mainly Iron Oxide) were used to develop the strength envelops for the iron oxide rock units. The laboratory test results were entered into RocData® (distributed by Rocscience Inc.) for defining appropriate Hoek-Brown rock strength envelope parameters (Hoek et al., 2002).

Investigation by the four geotechnical drillholes indicates that, at present stage of the project, it is not possible to clearly delineate the spatial distribution of rock types A and B. The iron oxide with cherts (rock type A) is randomly intercepted along the geotechnical boreholes similar as the iron oxide with limonite alteration or hematite with hydroxide (rock type B); resulting in an extremely heterogeneous rock mass. This complexity needs to be addressed in the future geotechnical investigations. Due to the lack of information regarding the approximate distribution of the rock type A and B in the iron oxide zone, for this study, it was decided to combine the laboratory strength results for the rock types A and B and to deal with a broader range of rock matrix properties. In is recognized that the average values obtained by combining the test results for the rock type A and B would be more influenced by the results of rock type B, due to the greater number of tests available for this rock type.

Table 11 summarizes the lab testing results for the main rock units in the pit area.

Table 11: Intact rock strength material properties

PROPERTIES		LITHOLOGY		
PARAMETER	VALUE	IRON FORMATION	SHALE	SANDSTONE
Unconfined Compressive Strength, σ_{ci} (MPa)	***Mean***	***60***	***96***	***195***
	Min	25	44	104
	Max	105	138	256
Brazilian Test, σ_T (MPa)	***Mean***	***7***	***10***	***14***
	Min	3	4	10
	Max	14	17	19
Unit Weight, γ (kN/m^3)	***Mean***	***32,5***	***27,6***	***26,4***
	Min	23,9	25,9	25,3
	Max	48,8	30,7	27,7
m_i		8	9	14

The m_i values obtained for the Shale and Sandstone rock units (Rock type C and D) were found to be characteristic when compared to typical values usually encountered for similar rock types. Typical m_i values reported for the Shale and Sandstone rock units range between 4-8 and 13-21, respectively, (Brady and Brown 2004). The derived m_i value for the iron oxide rock unit (rock type A+B) is relatively in the range of the m_i values typically reported for fine to very fine grain sedimentary rocks.

4.3.4 Highlights

- The evaluation of the intact strength of anisotropic rocks is more complex than that of isotropic rocks and requires testing of rock samples at different orientations with respect to the weakness planes. At this stage of the project, it was not practical to collect samples at orientations other than the one selected, and drilling perpendicular to the banding structures was not possible. It is recognized that the UCS results from this drilling campaign more likely represent the lowest values for the "mainly iron oxide" rock type (rock type B).
- The value of σ_{ci} obtained from the combination of all testing results for iron oxide samples (combination of rock type A and B), including UCS, triaxial and Brazilian test data, is slightly lower than the corresponding average UCS value of all tested samples. Therefore, at this stage, the average UCS value of all tested samples for rock types A and B (~ 60 MPa), was used to represent the intact rock strength of the iron oxide rock unit in the geomechanical pit design procedure.
- In the next geomechanical investigation program and during the open pit progress, there will be opportunities to collect more samples of iron oxide at different orientations to the banding structures and to conduct a more in depth strength testing and analysis campaign.

If during the future geological or geomechanical campaign, the spatial distribution of iron oxide with white chert (rock type A) could be identified, it is recommended to separately consider the strength test results for rock type A and B.

4.4 ROCK MASS CHARACTERISTICS

4.4.1 Lithology

As mentioned previously, three principals lithology have been identified in the Pit area, a Banded **Iron Formation** (Sokoman Formation) overlying **Shale** and **Sandstone** from the Ruth Formation.

The Iron Formation is interbeded bands of red and grey to white chert. Many zones, regardless of the depth, present strong ferric alteration. Hydroxides (limonite and goethite) are presents throughout the Iron Formation in variable quantity.

4.4.2 Structural Analysis

Structural description of discontinuities was performed on oriented rock core. These descriptions can be found in Appendix 2. It is important to note that the majority of the described oriented joints were done in Shale and Sandstone units. As mentioned earlier, the iron oxide rock mass in the pit area has been subjected to many deformation phases and at least two series of folding. Consequently, the iron oxide rock unit is highly fractured and altered. From the 530 meters core drilled in the Iron Formation, overall, only 10 meters of core were described. Therefore, the majority of the structural data comes from the Shale and Sandstone rock types.

All of the measured discontinuity data were analyzed statistically using the software DIPS, distributed by RocScience, and the discontinuity sets were selected from contour plot stereographic projections. Figure 6 shows the stereographic projections of the oriented core data for all lithologies, presented based on the type of discontinuities. As can be seen only two types of discontinuities have been observed including joints (JN) and bedding (BD). Two (2) to Five (5) joint sets can potentially be present as indicated in Figures 6 and 7. Figure 7 presents the same discontinuity data as a function of drillholes (borehole BH-P-01 to BH-P-04). Table 12 summarizes the dip and dip direction of the potential five joint sets. Three sub-horizontal and two sub-vertical joint sets could be seen.

Table 12: Summary of Possible Average Joint Sets Orientations

POTENTIAL DISCONTINUITY/DEFECT SET MEAN PLANE	DIP DIRECTION (°)	DIP (°)
J1	189	28
J2	25	86
J3	302	18
J4	118	35
J5	57	75

Figure 6: Stereonet of potential joint sets for all lithology based on discontinuity types

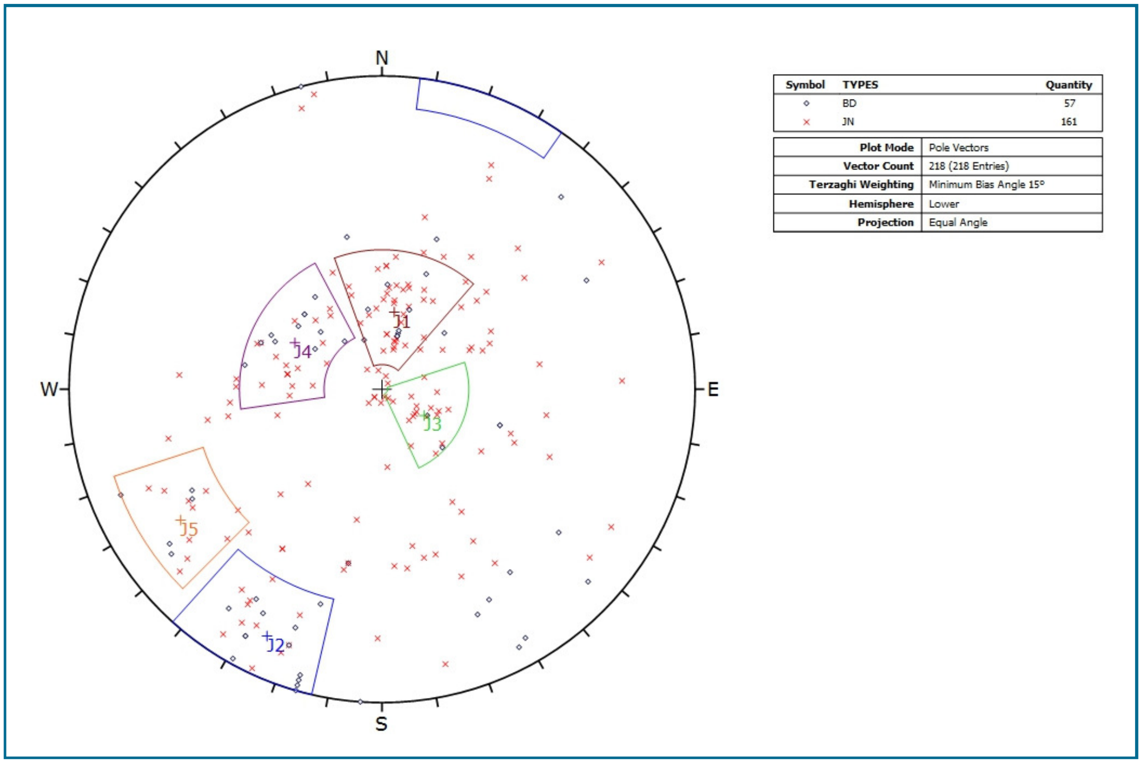
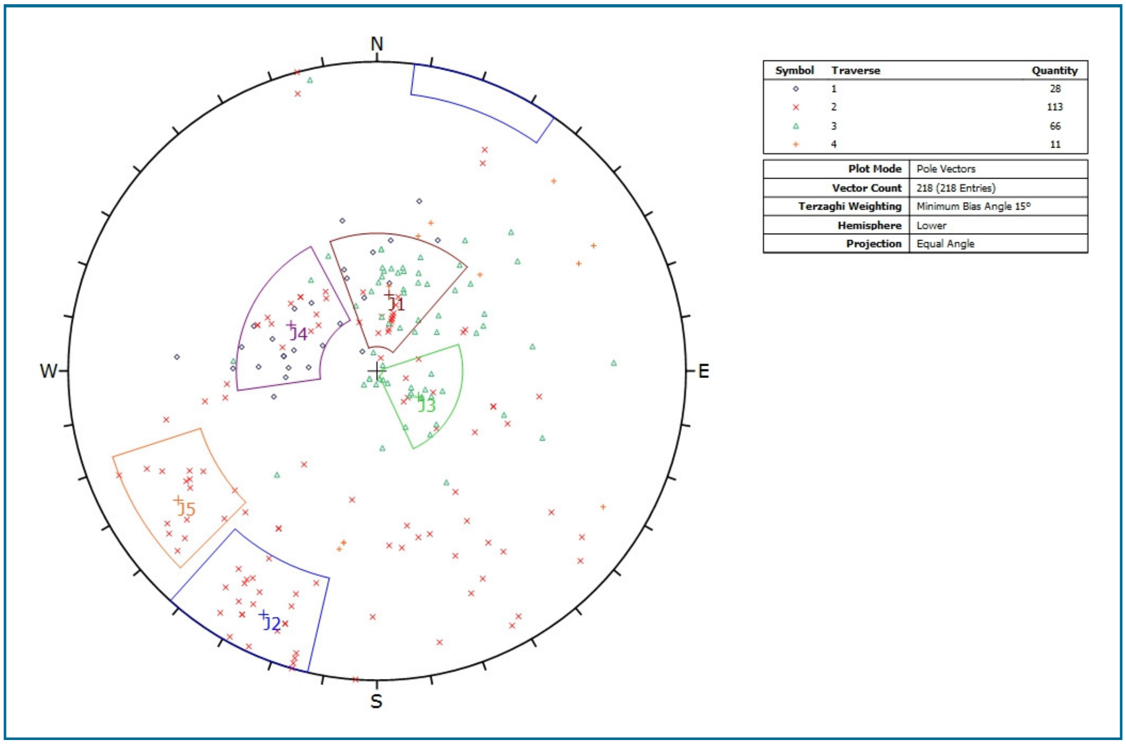


Figure 7: Stereonet of potential joint sets based on boreholes (borehole BH-P-01 to BH-02



From figure 7, it is noted that joint sets J2 and J5 are only present in borehole BH-P-02.

The structural data analysis indicates that:

- Due to the limited number of discontinuity measurement for the iron oxide rock type in the structural database, the developed stereographic projects cannot fully describe the entire structural complexity of the Iron Formation. Because of multiphase deformation of the iron oxide rock mass in the pit area, joint sets orientation measured for shale and sandstone cannot be representative of the upper Iron Formation.
- The number of structural data representing the Iron Formation is not sufficient to draw a comprehensive understanding of the Iron Formation rock mass structure.

4.4.3 Summary of Rock Mass Classification

Rock mass classification systems are frequently used for rock engineering projects. The rock mass classification systems provide a quantitative index of rock mass quality based on measurements and observations of rock mass parameters. An assessment of the overall quality of the rock masses that comprise the Joyce Lake project area has been prepared using the Geological Strength Index (GSI), Hoek et al. (1995 and 2013).

During the geotechnical site investigation, the Rock Quality Designation (RQD) values were estimated per each drilling run along the four geotechnical drillholes. The statistical analysis of the RQD data indicates that:

- The RQD values of iron oxide rock type ranges from 0 to 100 with an average value of 37 and a standard deviation of 32. This implies that the iron oxide rock mass is highly fractured with a significant structural heterogeneity. The histograms of the RQD values for the Iron Oxide rock type is presented in Appendix 3.
- The RQD values of Shale and Sandstone rock units are much higher than the iron oxide rock mass with a mean RQD value of 74 and a standard deviation of 24. The histograms of the RQD values for the Shale and Sandstone rock type is presented in Appendix 3.

During the geotechnical site investigation, characteristics of the discontinuities were collected in the field. In general, for the iron oxide rock unit, discontinuities were characterized as planar and closed and planar and rough, while for the Shale and Sandstone rock types, discontinuities were characterized as planar and smooth. The histograms associated with the characteristics of the discontinuities are presented in Appendix 3. The joint surfaces in iron oxide rock are mainly coated or infilled with white chert while the joint surfaces in Shale and Sandstone are mainly coated with iron oxide.

Based on field assessment of the rock hardness in the geotechnical drillholes, the rock units are on average strong to very strong, with a mean rock hardness value of about R4 and R5 for iron oxide rock type (group I) and Shale and Sandstone (group II and III), respectively.

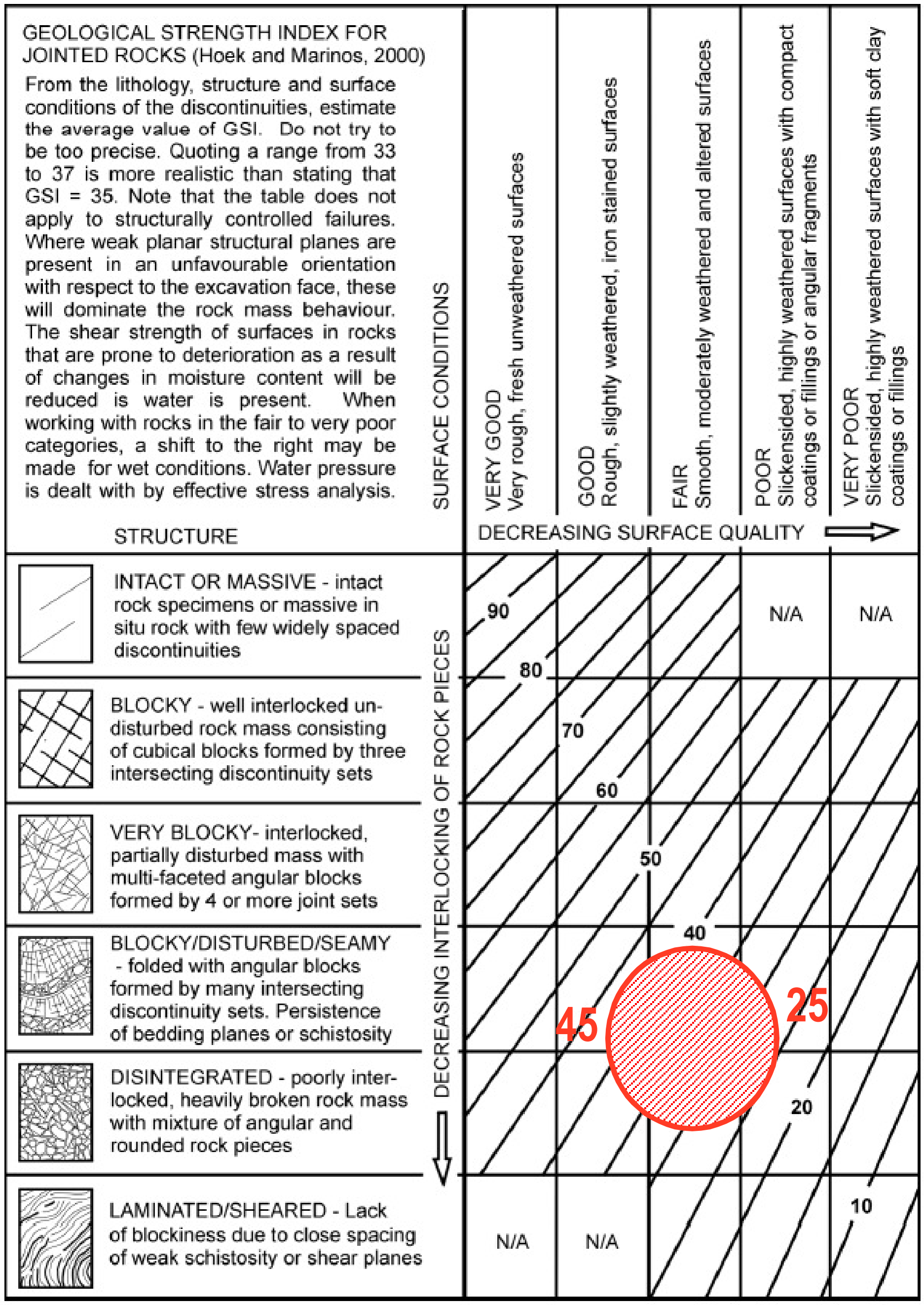
The results of weathering index indicate that the iron oxide rock has a weathering index mostly between W3 and W4, (moderately to highly weathered), while the Shale and Sandstone rock types have a mean weathering index of W2, (slightly weathered).

The Geological Strength Index (GSI) for the iron oxide rock mass was estimated based on two different approaches:

- Descriptive estimation based on RQD and Rock Joint Conditions (J_{cond}) (Hoek, Carter and Diederichs, 2013)
- Qualitative estimation based on overall observation and consensus of experts using general Guidelines for estimating GSI factor on the basis of Structure and joint conditions.

Although, there weren't enough information to apply the descriptive method (i.e. limited number of Joint Condition J_{cond89} values are available for the iron oxide), the result of both descriptive and qualitative methods showed a good coherent and agreement to evaluate the GSI between 25 and 45 for the iron oxide rock mass. The estimated range of GSI is presented on the figure 8.

Figure 8: Evaluated range of GSI based on both descriptive and qualitative method (after Hoek et al., 1995)



4.4.4 Rock Mass Strength

The rock mass strength is estimated using the Hoek-Brown failure criterion, which is expressed by:

$$\sigma_1 = \sigma_3 + \sigma_{ci}\left(m_b \frac{\sigma_3}{\sigma_{ci}} + s\right)^a$$

Where:

- m_b is the value of the constant *m* for the rock mass;
- *s* and *a* are constants which depend upon the characteristics of the rock mass;
- σ_{ci} is the uniaxial compressive strength (UCS) of the intact rock; and
- σ_1 and σ_3 are the axial and confining principal stresses, respectively.

With aid of the RocData software, intact rock properties were downgraded to get rock mass properties. For the purpose of the calculation, disturbance factor D=0.7 was assumed, corresponding to good quality blasting for the final pit walls.

Table 13 presents the Hoek-Brown parameters obtained for the different rock masses at the project area. The same Table shows the equivalent Mohr-Coulomb cohesion and friction angle for the same rock masses.

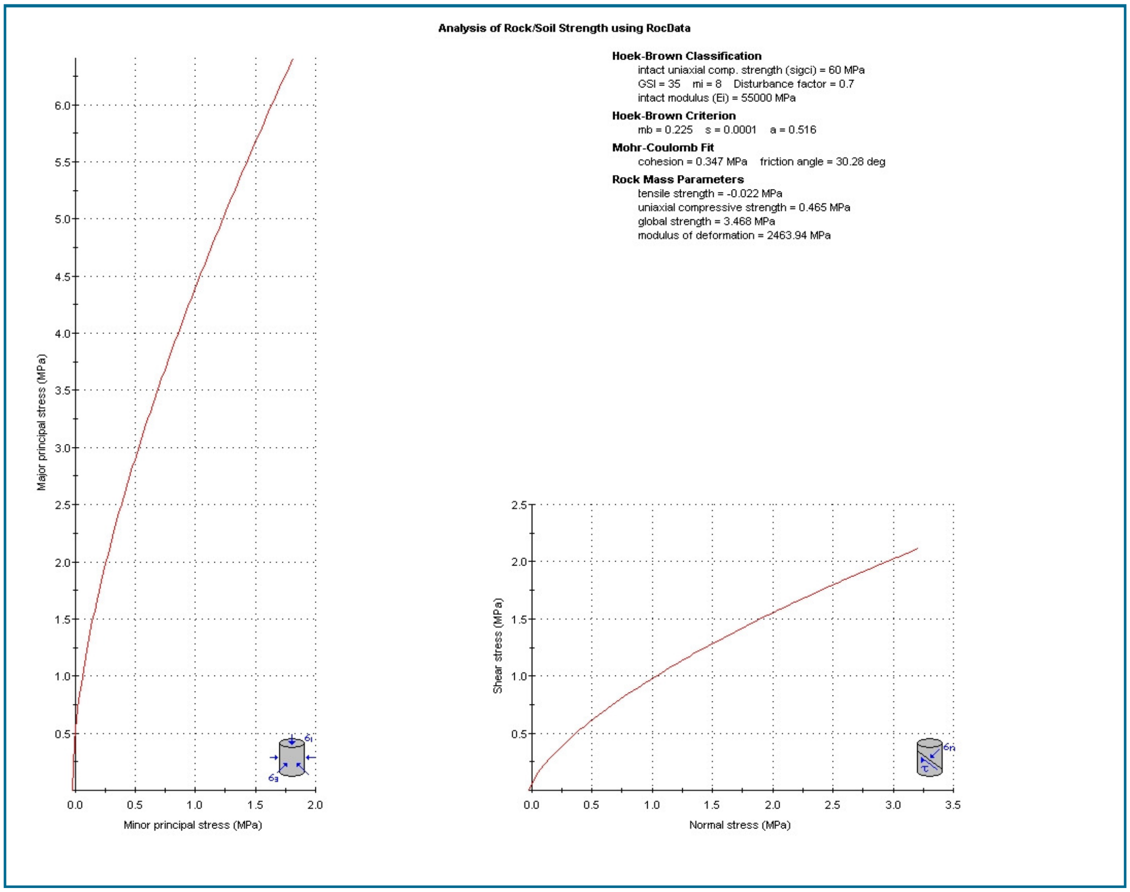
It should be noted that the influence of blast damage on the near surface rock mass properties has been taken into account using D factor, which depends upon the degree of disturbance due to blast induced damage and stress relaxation. Based on the evaluation of excavation method, this factor is considered equal to 0.7.

Hoek Brown Failure Envelopes for iron oxide rock mass are presented in figure 9. This figure shows a rock mass strength of 3.468 MPa. The rounded value of 3.5MPa is retained.

Table 13: Summary of Inferred Rock Mass Strength Parameters

<table>
<tr><th colspan="2">PROPERTY</th><th>VALUE</th><th>COMMENTS</th></tr>
<tr><td colspan="4">Intact Rock Properties –Iron Formation</td></tr>
<tr><td colspan="2">Unit Weight (kN/m^3)</td><td>32,5</td><td>Average Lab Test</td></tr>
<tr><td colspan="2">Intact Uniaxial Compressive Strength, σ_c (MPa)</td><td>60</td><td>Average Lab Test</td></tr>
<tr><td colspan="2">mi</td><td>8</td><td>Calculated</td></tr>
<tr><td colspan="4">Rock Mass Properties –Iron Formation</td></tr>
<tr><td colspan="2">Geological Strength Index (GSI)</td><td>35</td><td>Evaluated Based on Observation</td></tr>
<tr><td colspan="2">Disturbance factor D</td><td>0,7</td><td>Mechanical Excavation [1]</td></tr>
<tr><td rowspan="3">Generalised Hoek-Brown failure criterion</td><td>a</td><td>0,516</td><td rowspan="3">Estimated with RocData</td></tr>
<tr><td>m_b</td><td>0,225</td></tr>
<tr><td>s</td><td>1,00E-04</td></tr>
<tr><td rowspan="2">Mohr-Coulomb</td><td>c, (MPa)</td><td>0,347</td><td rowspan="2">Estimated with RocData</td></tr>
<tr><td>ϕ (°)</td><td>30,28</td></tr>
<tr><td colspan="4">Intact Rock Properties – Shale</td></tr>
<tr><td colspan="2">Unit Weight (kN/m^3)</td><td>27,6</td><td>Average Lab Test</td></tr>
<tr><td colspan="2">Intact Uniaxial Compressive Strength, σ_c (MPa)</td><td>96</td><td>Average Lab Test</td></tr>
<tr><td colspan="2">mi</td><td>9</td><td>Calculated</td></tr>
<tr><td colspan="4">Rock Mass Properties – Shale</td></tr>
<tr><td colspan="2">Geological Strength Index (GSI)</td><td>50</td><td>Evaluated Based on Observation</td></tr>
<tr><td colspan="2">Disturbance factor D</td><td>0</td><td>No effect</td></tr>
<tr><td rowspan="3">Generalized Hoek-Brown failure criterion</td><td>a</td><td>0,506</td><td rowspan="3">Estimated with RocData</td></tr>
<tr><td>m_b</td><td>1,509</td></tr>
<tr><td>s</td><td>0,0039</td></tr>
<tr><td rowspan="2">Mohr-Coulomb</td><td>c, (MPa)</td><td>1,453</td><td rowspan="2">Estimated with RocData</td></tr>
<tr><td>ϕ (°)</td><td>45,62</td></tr>
<tr><td colspan="4">[1] See figure 10 and 11 for justification of mechanical excavation</td></tr>
</table>

Figure 9: Hoek Brown Failure Envelopes for the Iron Oxide Formation



4.4.4.1 ***Mechanical excavation***

The final geometry of benches shall be obtained by mechanical excavation. According to Abdullatif and Cruden (1983) and more recently Tsiambaos and Saroglou (2010), the highly fractured rock mass can be excavated by digging and/or ripping. Figures 10 and 11 show respectively the study results of the first and second publications.

Figure 10 : Average rock mass strength (3.5 MPa) –vs- average GSI (35)

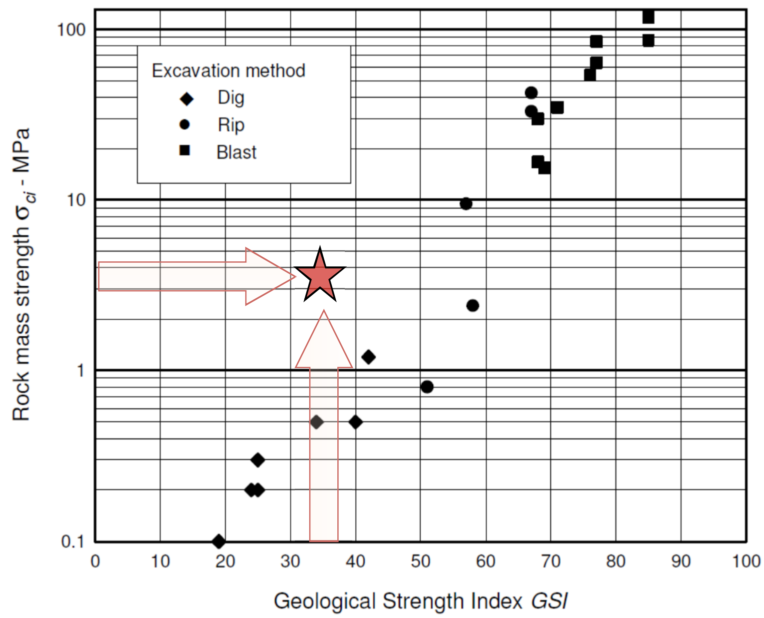
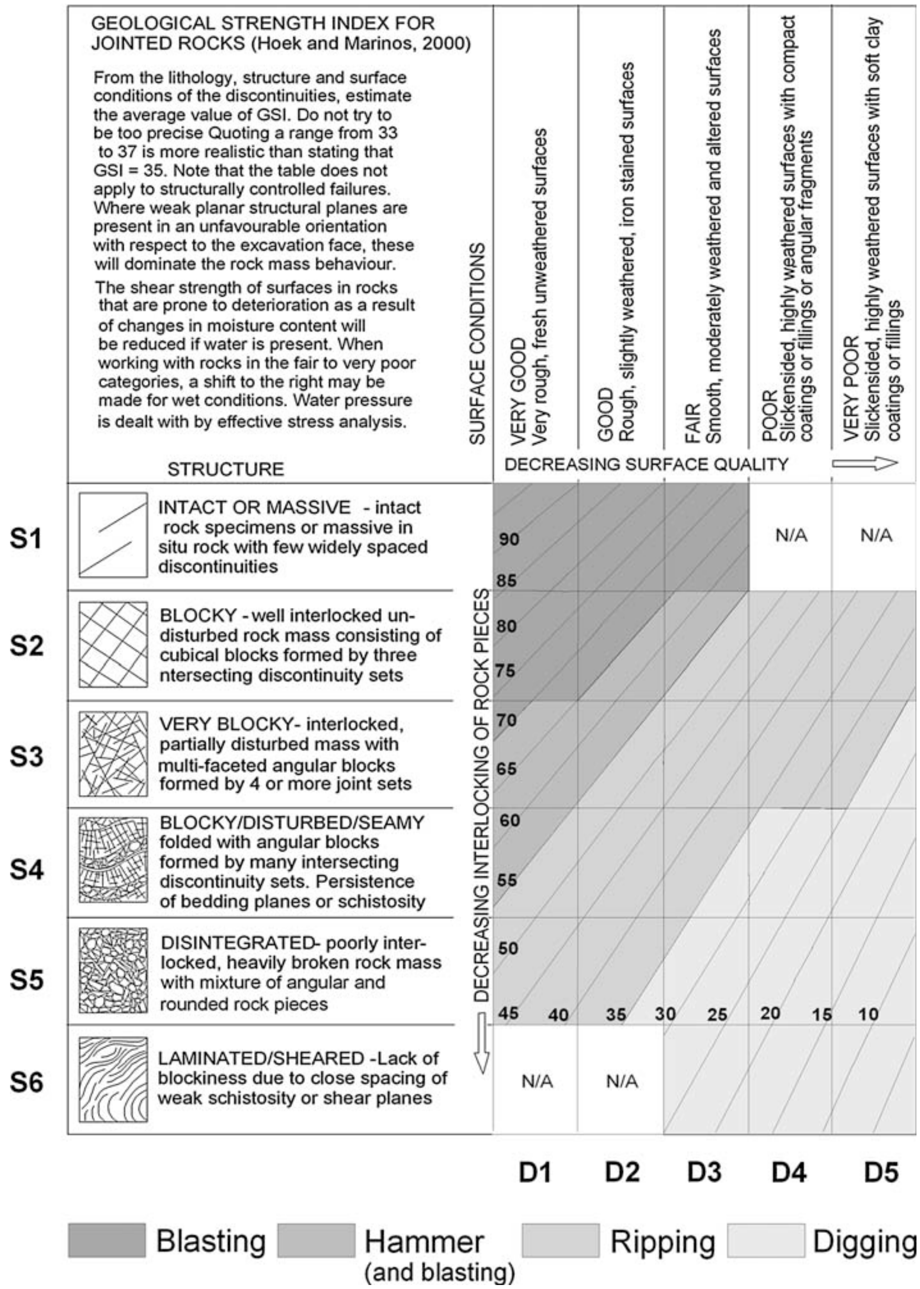


Figure 11 shows typical areas in term of GSI for Point load index smaller than 3 MPa. All Point Load Index measured on the Iron Formation are smaller than 3.0 MPa. The figure 11 shows that for an average GSI of 35 and extreme values of 25 to 45, the Iron Formation can be dug and/or ripped.

Figure 11 : Excavation methods in term of GSI for Point load index smaller than 3 MPa



4.4.5 Hydrogeology

For detail hydrogeological site condition, the reader can refer to Hydrogeological Report mentioned in section 1.1.

5 PIT SLOPE CONCEPTS AND ACCEPTABILITY CRITERIA

5.1 PIT SLOPE GEOMETRIES

Pit walls consist of many slope elements, which require separate design decisions. The basic unit of the pit design is the bench, formed by a single cut or lift.

The bench configuration, controlled by the bench face angle, bench height and bench width, defines the inter-ramp angle. The overall slope angle consists of inter-ramp sections separated by wide ramps.

Bench configurations, recommended by LVM, are given based on a bench height of 9 meters, as set by the block model for optimized open pit mine.

Benches widths should be sufficient to provide effective protection against rockfall. The following modified Ritchie criteria (Ryan and Pryor, 2000) is commonly used for initial estimates of design of bench width:

$$\text{Bench Width (m)} = (0.2 * \text{Bench Height}) + 4.5\ \text{m}$$

In the present case, this will yield 6.3 m bench width.

5.2 DESIGN CRITERIA

Slope stability analyses are generally performed using the Limit Equilibrium Method, where the safety factor is represented by the ratio of resisting forces to the acting forces. A general guidance to pit slope design acceptance criteria is summarized in Table 14 (after Read and Stacey, 2009) and suggested factor of safety and probability of failures are highlighted.

Table 14: Acceptance criteria for the pit slope design (after Read and Stacy, 2009)

SLOPE SCALE	CONSEQUENCES OF FAILURE	ACCEPTANCE CRITERIA		
		FOS (min) (Static)	FOS (min) (Dynamic)	POF (max) P[FOS≤1]
Bench	Low to High	1.1	N/A	25%-50%
Inter-ramp	Low	1.15-1.2	1.0	25%
	Medium	1.2	1.0	20%
	High	1.2-1.3	1.1	10%
Overall	Low	1.2-1.3	1.0	15%-20%
	Medium	1.3	1.05	5%-10%
	High	1.3-1.5	1.1	≤5%

The slope angles were determined based on the acceptance criteria for probability of failure (PoF), to ensure that the design slope angles were optimal based on a quantitative evaluation of alternative designs. The PoF value incorporates the variations associated with the input parameters data set. In the present study the available data set is quite small and variable. A probabilistic analysis has been conducted to assess this feature.

6 OPEN PIT ROCK SLOPE STABILITY ASSESSMENT

6.1 POTENTIAL MODES OF FAILURE

6.1.1 Kinematic Analysis

Kinematic failure modes in rock slopes typically include planar, wedge and toppling failures. These failure modes can be identified by using stereographic analysis of peak pole concentrations of the discontinuity data. These failure modes will occur if the discontinuities are continuous over the bench scale or more, if weak infilling is present along the measured discontinuities or the geometry of the discontinuities is conducive to failure. A brief description of each mode of failure is provided below:

6.1.1.1 *Wedge Failure Analysis*

Wedge sliding is defined as a translation of a tetrahedral-shaped failure mass on either of the two lower bounding geologic structures, or on both, along the line of their intersection. The rock wedge is bounded by the slope face, the essentially flat upper surface and two geologic structures, each oriented obliquely to the slope face.

6.1.1.2 *Planar Failure Analysis*

Planar sliding is defined as a translation (sliding) of a failure mass on a single geologic structure, oriented approximately parallel with the slope being modeled.

6.1.1.3 *Toppling*

Flexural Toppling is defined as a mode of failure, involving the bending of interacting rock columns formed by a single set of steeply dipping discontinuities, such as regular bedding planes, foliation, or joints. In such cases, the rock columns bend forward under their own weight and transfer load to the underlying columns, thus giving rise to tensile and compressive bending stresses. Failure is initiated when the tensile (bending) stress in the toe column exceeds the tensile strength of the rock.

Direct Toppling is defined as the forward rotation out of the slope of mass of soil or rock about a point or axis below the centre of gravity of the displaced mass. Toppling is sometimes driven by gravity exerted by material upslope of the displaced mass and sometimes by water or ice in cracks in the mass.

6.1.2 Rock Mass Stability Analysis

The maximum overall rock slope angle of large open pit mines is usually determined by rock mass strength. The rock mass strength parameters were derived using the Hoek-Brown failure criterion (Hoek, et. al., 2002). This criterion utilizes the characteristics of the rock mass to downgrade the measured intact rock properties to rock mass scale values. The mechanical characteristics of the rock mass are set by lithology, intact rock strength and rock mass quality. Rock mass disturbance is of importance. It is typically caused by blast damage, vertical unloading and strain resulting from stress changes and rotation in the pit walls rock mass.

6.2 FACTOR AFFECTING PIT SLOPE DESIGN

6.2.1 Ground water

Open pit slope drainage and depressurization is a key factor in presence of highly fractured rock masses. Water pressure in discontinuities diminishes the overall resistance of the rock mass.

6.2.2 Ice formation

Deep depressurisation of rock slope, especially in cold climate where frost penetration can reach decametric order of magnitude, is important in order to avoid rock mass disturbance due to ice formation and water pressure build up behind the iced zone.

6.2.3 Blasting

Hoek et al, 2002 recommends that the rock mass strengths be downgraded to disturbed values to account for rock mass disturbance associated with heavy production blasting and vertical stress relief and stress rotation. Hoek indicates that, in deep open pits, a disturbance factor of 0.7 would be appropriate for a mechanical excavation where no blasting damage is expected. Experience indicates that a disturbance factor approaching the value of 0.7 may be achievable for moderate height slopes with the application of excellent controlled blasting practices. A disturbance factor of 1.0 is assumed for conventional production blasting.

In the present case, mechanical excavation is foreseen and if blasting proves to be necessary, precautions must be used. The blasting strategy should keep blast holes a certain distance from the bench slope surfaces. It should consider excavating with mechanical means the zone in between the blast holes and the bench faces. The intensive presence of discontinuities in the rock mass will quite obviously absorb the blasting energy rapidly thus limiting the range of damages penetration to the rock slope. With this procedure, it is expected that the disturbance factor should be minimized.

6.3 METHODOLOGY FOR PIT SLOPE STABILITY ASSESSMENT

Based on the preliminary Engineering Geological Model developed for the rock masses encountered in the Joyce Lake pit area and presented in chapter 4, the iron oxide rock mass quality is considered as “weak”. Consequently, the potential instability mode in the pit slopes is likely to be controlled by rock mass strength rather than structure, even at bench scale. For this reason, the slope design process was started with analyses of the overall and inter-ramp slope angles, to determine a slope angle that meets the stability acceptance criteria presented in Table 14.

Conventional Limit Equilibrium Analyses (LEA) are often conducted to evaluate the maximum overall slope angle for pit walls with an acceptable factor of safety. LVM performed a slope stability assessment using limited equilibrium analysis software Slide 6.0, developed by Rocscience. This software was used to generate Factors of Safety according to the Morgenstern-Price solution for circular slip surfaces.

The inputs for the LEA analysis are listed below:

- Slope configuration, defined by the slope height and inter-ramp slope angle.
- Material properties, assigned to entire slope based on the dominant rock type (weighted density, cohesion and friction angle, obtained from the rock mass properties).
- Water Table, coinciding with the surface of the pit, to simulate the worst-case scenario.
- Seismic loading, simulated by an application of static forces, that represent seismic inertial forces resulting from potential ground accelerations caused by an earthquake (pseudo-static method).

The seismic loading requires the input of seismic parameters such as peak ground acceleration (PGA) and the seismic coefficient (k).

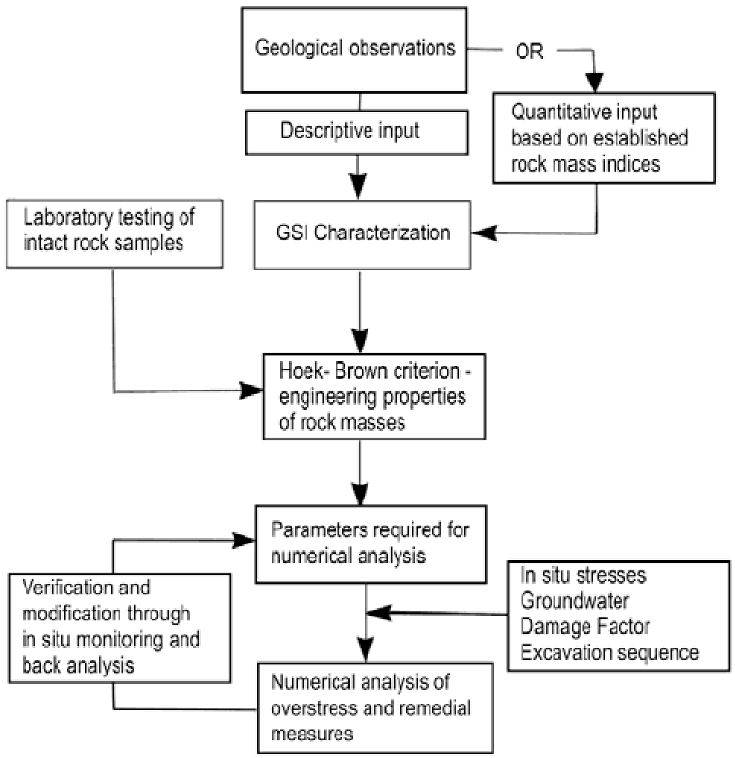
The PGA value was determined from Natural Resources Canada – Earthquakes Canada, 2013. Based on the interpolation using the Shepard's method from a 10km spaced grid of points. The value of PGA in the area of the proposed pit is 0.036 g, determined for a 2% in 50 years (0.000404) probability of exceedance according to Canadian National Building Code 2010.

7 PIT WALL STABILITY ANALYSES

7.1 RATIONALE AND INPUT DATA FOR STABILITY ANALYSES

One of the input parameters for the slope stability assessment using LEA is the material properties. Figure 12 shows the flow chart for estimation of rock mass parameters required for stability analysis using GSI and Hoek-Brown method.

Figure 12: Data flow for using Hoek-Brown and GSI system for estimation rock mass properties



In order to use this criterion for estimating the strength of jointed rock masses, three following 'properties' of the rock have to be estimated:

- Uniaxial compressive strength σ_{ci} of the intact rock pieces;
- Value of the Hoek-Brown constant m_i;
- Value of the Geological Strength Index GSI for the rock mass (Hoek (1994) and Hoek, Kaiser and Bawden (1995)) for estimating the reduction in rock mass strength for different geological conditions.

These parameters, σ_{ci}, m_i and GSI, were estimated and discussed in the section 4.

7.2 LIMIT EQUILIBRIUM STABILITY ANALYSIS

7.2.1 General

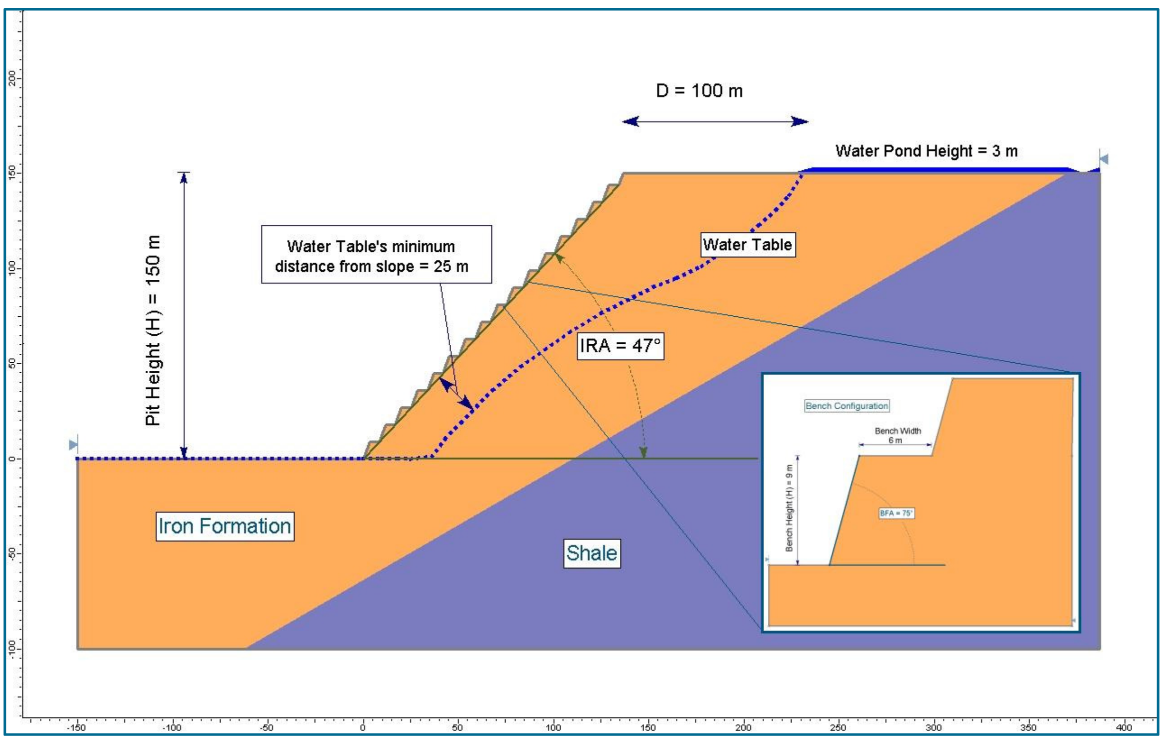
The limit equilibrium analyses were conducted to evaluate the maximum achievable overall slope angle for each design section with an acceptable factor of safety of 1.3.

7.2.2 Geotechnical Model

As stated in section 6, the Iron Formation rock mass quality is such that LEA represents the mode of slope failure independently of the pit slope dip orientation. A generic open pit mine slope of 150 m high for which the Iron Formation compose essentially the slope material and where the shale formation is more deeply imbedded has been considered as the base case. This corresponds to a bottom of pit at an elevation of roughly 380m. Also, the base case considers that Joyce Lake will be emptied completely from water, exception made of a water pond used to pump collected runoff. The analyses were conducted in both static and seismic loading conditions.

These analyses are used to assess the Inter Ramp Angle (IRA) meeting the required 1.3 safety factor. Figure 13 shows the geometry of the base case model.

Figure 13: Geometry of the generic pit slope model



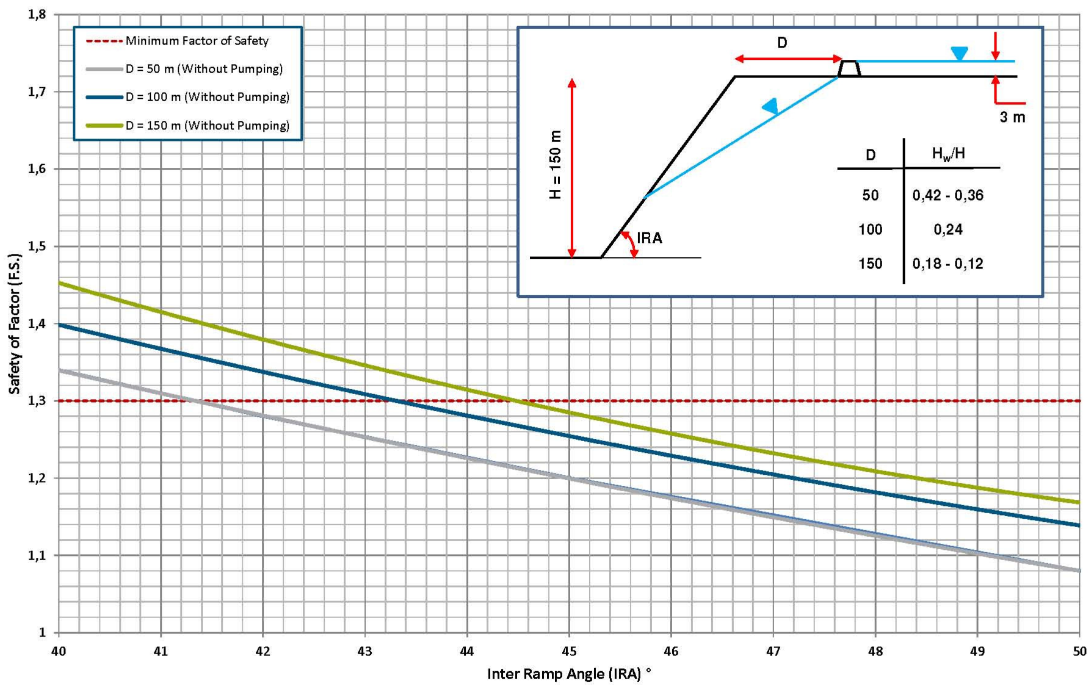
The evaluated GSI values were used to estimate the parameters for generalized Hoek-Brown failure criterion. The parameters used in the rock mass stability analysis for pit slopes are summarized in Table 13.

7.2.3 Analyses Results

7.2.3.1 *Static Analysis*

A stability sensitivity analysis has first been performed to assess the impact of the presence of the water pond collecting runoff for pumping in the Joyce lake bed. It was assumed that the groundwater can seep through the pit slope wall with different H_W/H values depending on the distance from the pit slope edge and the water pond. The groundwater profile has been determined using finite element seepage analysis to determine the seepage surface extent on the pit slope. The results of multiple analyses are presented in figure 14 where safety factors are plotted for different distances and different IRA slope angles.

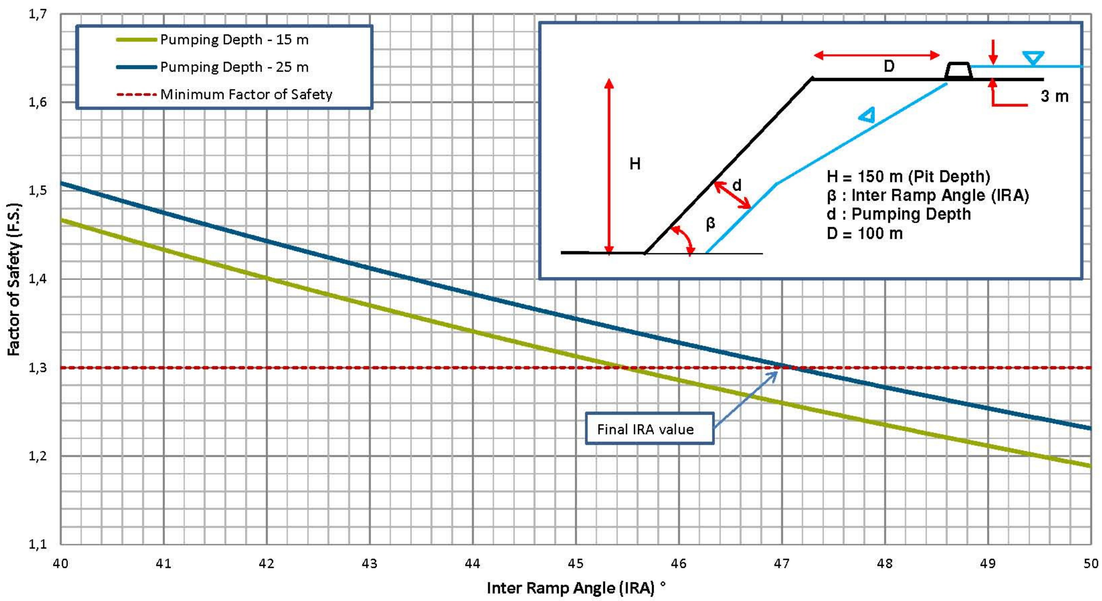
Figure 14: Safety Factor Vs Inter-Ramp Angle depending on distance (50, 100 and 150m) from water pond



Based on the appreciation of these results and considering field logistic operation, a distance of 100 m between the crest and the water pond was selected.

A second sensitivity composed of multiple analyses was conducted to assess the influence of the underground water table position in regard with the pit slope surface. A distance of 15 meters was set as a minimum distance to avoid frost penetration to mitigate icing damages in the rock mass and also to avoid water pressure buildup in the slope wall due to icing restriction to seepage flow. At the present stage of the hydrogeological study, a peripheral system of deep wells is considered for the underground water table control. Therefore, respecting a distance of 25 meters between the slope and the water table was considered feasible and was retained for the base case. Figure 15 presents the plotted curves where safety factors are plotted for 15 m and 25 m distances and different IRA slope angles.

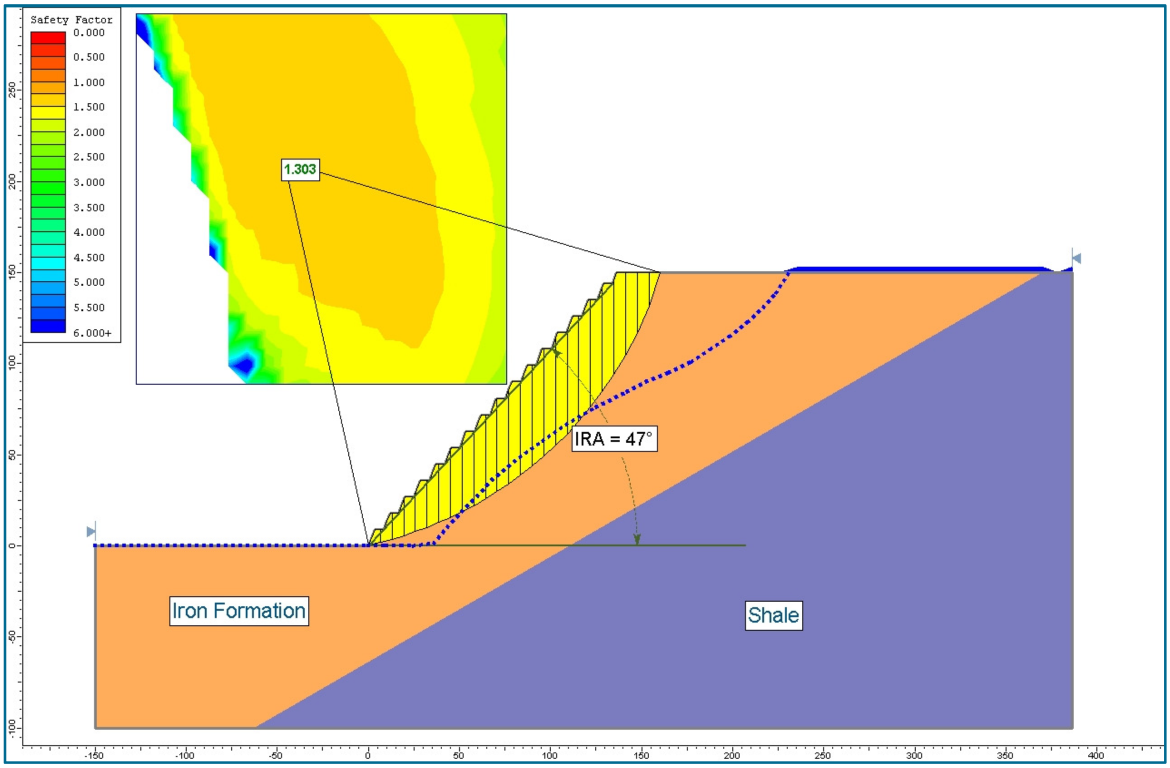
Figure 15: Safety Factor Vs Inter-Ramp Angle depending on distance (15m and 25m) between slope and water table



It can be seen that for the last case, an IRA of 47^0 is acceptable. The IRA does not take into account the presence of the Hauling Ramp.

Based on the assumptions of using good controlled production blasting practices and trimming and forming of the final benches with mechanical excavation (D=0.7), the minimum safety factors obtained from the analyses is found to meet the required minimum safety factor based on common engineering practice for static loading conditions. Figure 16 shows the results of static analysis based on the mean values of rock mass properties.

Figure 16: Minimum safety factor of static analysis (deterministic approach)

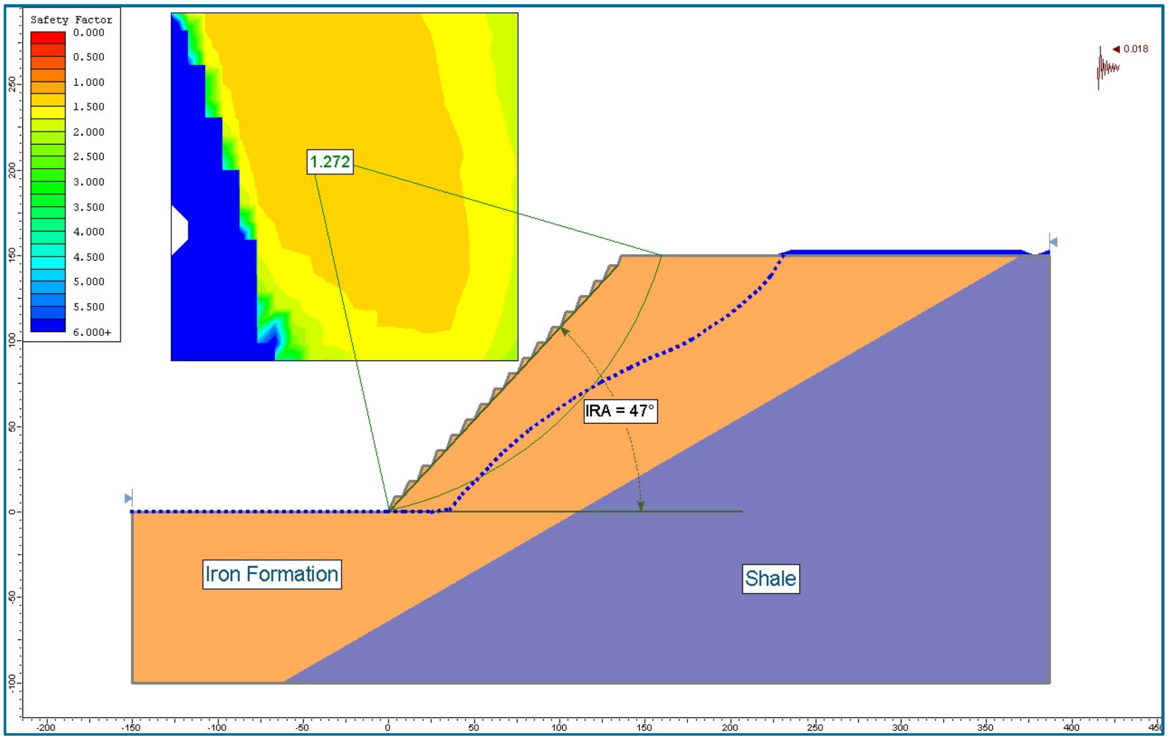


7.2.3.2 *Pseudo-Static Analysis*

The seismic stability of the base case slope was analyzed using the pseudo-static method. Seismic data was taken from the 2010 National Building Code Seismic Hazard Calculation data base which is reproduces in Appendix 5. A seismicity event with 2500 years return period was selected for the seismic analysis, which is considered appropriate for the open pit. The analyses were performed using a peak ground acceleration value (PGA) of 0.036 g which yields the pseudo-static parameter k = 0.5 x PGA = 0.018.

As shown on figure 17, the minimum safety factor obtained from the analyses is much greater than the required minimum factors of safety for pseudo-static slope stability analyses are selected based on common engineering practice as 1.1 for high consequences as presented in table 14.

Figure 17: Minimum safety factor of pseudo-static analysis (deterministic approach)



7.2.3.3 *Probabilistic Analysis*

Since the rock mass strength parameters are variable and a high degree of uncertainty is always predictable, a probabilistic approach to the analysis of slope stability can be useful to assess the risk of failure. Assigning a normal distribution to the rock mass parameters allows to simulate the degree of uncertainty in these values. The Monte-Carlo technique is used to randomly generate input data samples, based on the normal distribution. Therefore, for a given slip surface which is calculated based on the mean values, variable safety factor values can be generated. This results in a distribution of safety factors, from which a Probability of Failure for the slope can be calculated. This is an essential parameter in risk assessment.

The probabilistic slope stability analysis is performed using the variation of geo-mechanical parameters of Iron Formation summarized in table 15. Based on the design criteria explained in section 5.2, the probability of failure (P [FOS≤1]) obtained from the probabilistic analyses is found to be less than the required criteria of 5%.

Table 15: Variation of Geo-mechanical Parameters of Iron Formation

ROCK MASS AND INTACT ROCK PARAMETERS	MIN	MEAN	MAX	COMMENTS
GSI	25	35	45	Evaluated by - Figure 8
Unit Weight, (kN/m^3)	23,9	32,5	48,8	Laboratory Test
UCS, (MPa)	15	60	106	Laboratory Test

Figure 18 shows the results of the probabilistic analysis. Also, cumulative probability plot of factor of safety is presented in Figure 19. As it can be seen, the probability of factor of safety less than 1.0, 1.2 and 1.3 are <3%, <24% and <47% respectively. This means that the existing database on the Iron Formation presents variations for which in 47% of the cases, the real Safety Factor doesn't meet the safety requirements. It also means that there is a 3% risk of slope failure. Further information on rock mass quality and increasing the number of tests on the rock could diminish the standard deviation. This would reduce the probability not to meet the required Safety Factor value.

Figure 18: Summary of results after probabilistic analysis

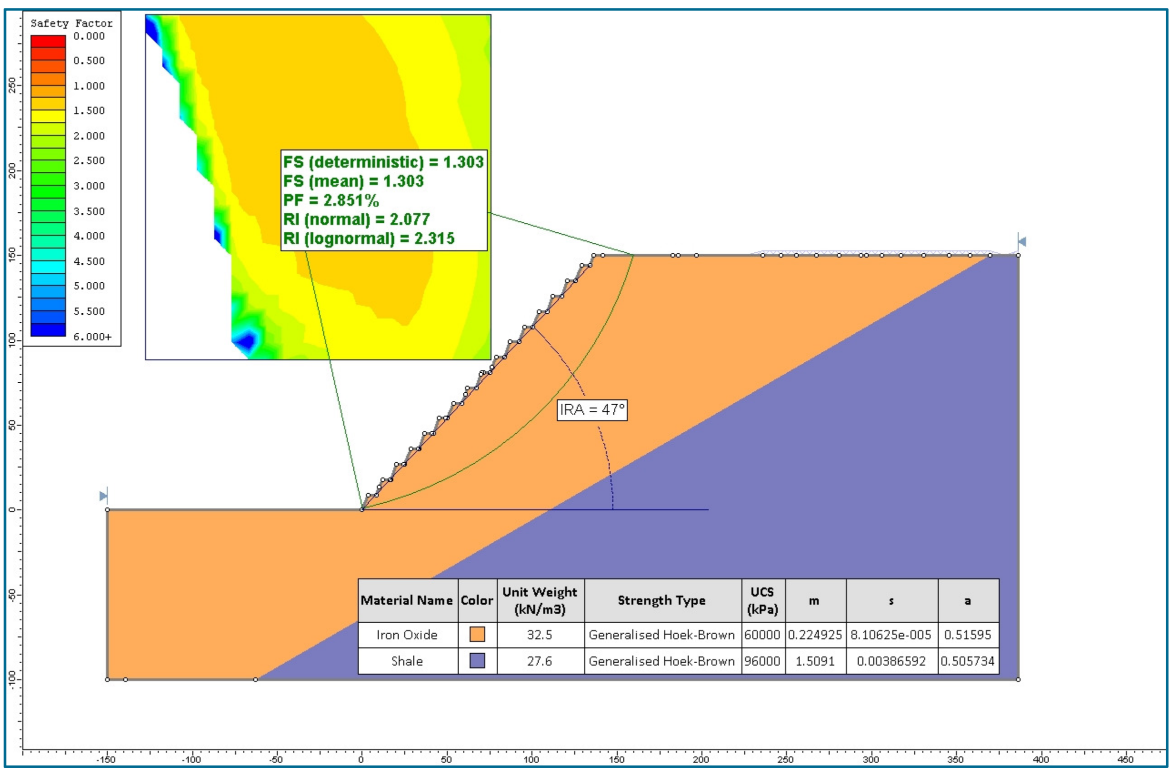
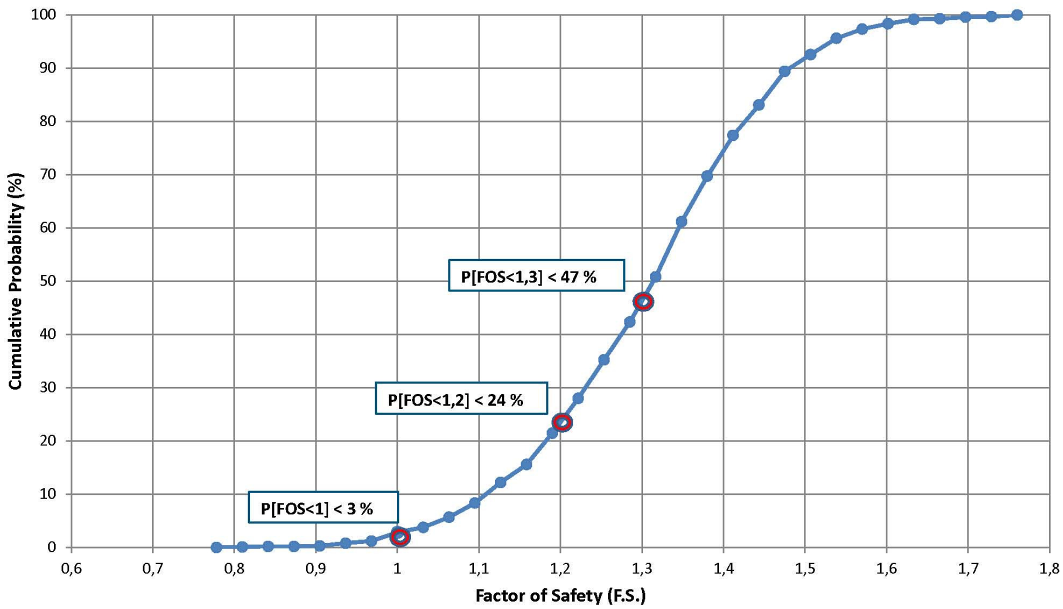


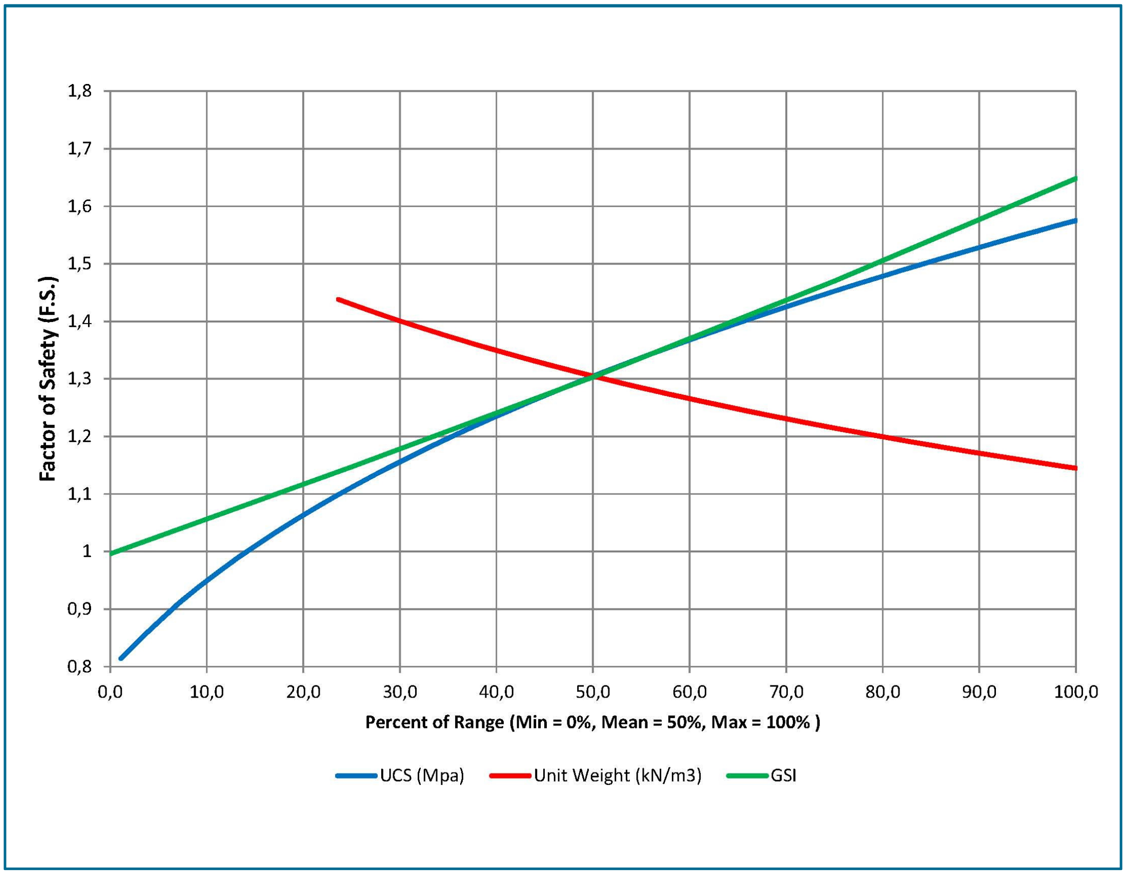
Figure 19: Cumulative probability plot of factor of safety



7.2.3.4 *Sensitivity Analysis*

For this study a sensitivity analysis has been performed to determine which geo-mechanical parameters of Iron Formation have the greatest effect on safety factor. To do so, individual input parameters are varied between the minimum and maximum values presented in table 15 which results in a plot of safety factor versus the geo-mechanical parameter value shown on figure 20. The three parameters shown have the most significant influence on the safety factor. Consequently, efforts should be put on collecting more data on these parameters.

Figure 20: Plot factor of safety versus the variation of geo-mechanical parameters of Iron Formation (see table 15)



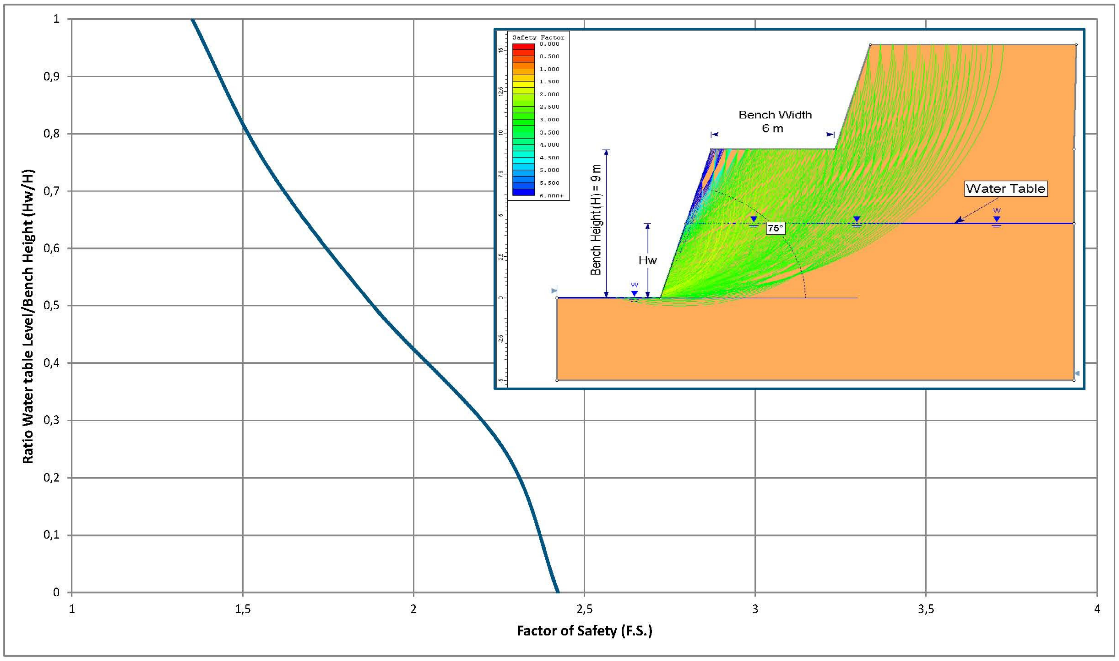
7.2.3.5 *Benches Static Stability Analysis*

For this study a sensitivity analysis has been performed to determine minimum factor of safety on a local bench (H) when water table (Hw) vary using static stability analysis. To do so, the (Hw/H) ratio is varied between 0 and 1 to measure the influence on factor of safety.

The minimum safety factors obtained from the analyses met the required minimum F.S. based on common engineering practice for static loading conditions as presented in table 14.

Figure 21 shows the results of static analysis on local bench based on the mean values of rock mass properties.

Figure 21: Minimum safety factor of static analysis varying water table on a local bench



7.3 STRUCTURAL STABILITY CONSIDERATIONS AND KINEMATICS ANALYSIS

During the geo-mechanical field investigation, some rock discontinuity data including joint orientation, joint roughness, joint planarity, joint alteration and joint infill were collected. These data were recorded from the cores as part of core logging process and are presented on the borehole logs in Appendix 2. The joint orientation data collected as alpha (α) and beta (β) angles were analyzed using Dips Version 6, developed by RocScience to infer the potential mean joint/fracture planes that may trigger unstable structural failure during mine excavations. Stereographic plot of the data is presented in Figures 6 and 7. Disregarding the geological units and based on available orientation data from 4 inclined boreholes drilled on the pit wall, five (5) discrete joint sets were potentially identified as summarized in Table 12 in section 4.4.2.

The failure mode of this highly fractured rock mass should primarily be governed by rock mass strength properties applied to the overall slope. Kinematic failure modes could also be an issue but the number and location of structural data representing the Iron Formation is not sufficient to carry out the kinematic analysis. Kinematic analysis generally addresses the potential of local structural instability in the scale of one or several benches. In the present case the local stability has been checked using LEA.

8 RECOMMENDATIONS

8.1 PIT WATER MANAGEMENT

8.1.1 Joyce Lake Pumping facility

The base case concerning the infringement of the mining open pit within the footprint of Joyce Lake is to temporarily empty the lake during the pit operation. To maintain the lake empty through time, runoff from the lake watershed will need to be pumped out on an ongoing manner. Pumping facilities will have to include a water ponding basin for pumps operations. This basin should be kept away from the open pit slope crest in order to avoid feeding unfavorably the underground water table. A preliminary sensitivity analysis (see chapter 7) has shown that a minimum distance of 100m between the water ponding and the crest of the pit slope would be reasonable.

8.1.2 Surface diversion ditches

Diversion ditches along the pit crest are required to divert the surface runoff away from the pit during operations.

8.1.3 Pit slope depressurization

Stability analyses of the rock mass for optimization of the pit slope have shown that the safety factor is very sensitive to the position of the water table. Also, deep frost penetration in exposed pit slope surface is to be considered. This consideration shall enforce that the water table be maintain as far as possible from the slope surface in order to avoid ice formation in joints that will diminish the rock mass permeability and promote the rise of the water table around the pit. This would result in pressurization of the pit slope and would be very detrimental to the slope stability. A minimum perpendicular distance of 25 meters from the inter ramp angle line measured between the toes of benches faces and the water was considered for stability analyses and is recommended to be always maintained during mine operation.

8.1.3.1 *Vertical Pumping Wells*

The installation of pumping wells will be of great importance to control and depressurize the rock mass. The water table lowering can be achieved either by the installation of staged peripheral medium depth wells or by peripheral deep wells system installed at ground surface level. The later might prove to be more cost effective. It can progressively lower the water table as excavation proceeds without possibly delaying production as would the implementation of the former system might do. Indeed, the stage wells system would have to be installed on the slope benches as excavation proceeds. This might interfere with operations. Also, with a stage wells system, upper stages can become obsolete as the water table is drawn down while the deep wells system remains always functional. Finally one further advantage for peripheral deep well system is that additional wells can be added at any time at ground surface if unpredicted water seepage condition develops in the pit walls.

One of the advantages of well pumping compared to bottom of pit pumping is the potential superior water quality of wells outflow compared to surface water. The later will definitively require water treatment before release in the environment while the former might very likely be adequate for direct release in the environment.

8.1.3.2 *Horizontal drains*

Horizontal drains are not, in the present project, the favoured solution for open pit slope depressurization and drainage. This is due mainly to the following different considerations:

- Due to the deep frost penetration in exposed rock mass, they should be drilled with an upward slope to insure free gravity flow without water remaining inside the drains and they shall be long enough to reach unfrozen rock mass.
- They would increase potentially the frost penetration depth in the rock mass by intrusion of cold air.
- Due to the highly fractured rock mass, they need to be lined with slotted piles to avoid local collapse or plugging by falling pieces of rock within the hole.
- The water released by a horizontal drain system will runoff on benches (if not connected directly to header pipes) and will quite probably pick up suspended iron oxide particles. Therefore, it will have to be pumped to a treatment facility before release in the environment. Also the permanent water runoff will promote benches saturation and increase their instability.

Horizontal drains should be used only locally and in exceptional cases where no other solution is available.

8.2 SLOPE GEOMETRY

8.2.1 Benches and IRA

Benches height has been set at 9m by the main engineering consultant when optimizing the pit profile in regard of the actual block model. Stability analyses have shown that the maximum IRA is to be 45^0 if the water table is drawn down sufficiently to insure a distance of 15 m between the slope face and the water table. The IRA can be increased to 47^0 if this distance is increased to 25 m. Drawing down the water table to this level is possible but additional pumping effort will imply a trade off with the economy on the stripping ratio at a later phase in the project. Meanwhile, the IRA of 47° is recommended at this phase of the project. Benches face angles varying between 65^0 and 75^0 are recommended and can be adapted to the local rock mass characteristics observed during excavation. For bench faces of 75°, bench width is 6.0m which is 5% less than 6.3 m required bench width mentioned in section 5.1. At this stage of the study, bench width 6.0m was considered acceptable.

8.2.2 Rockfall Protection

The rock mass being highly fractured, the possibility of loose blocks falling down the 9 m high benches faces is to be foreseen.

For benches width smaller than 6.0m, catch fences installed on the benches should be considered every two to four benches depending on local rock mass quality and as benches width gets narrower, safety berms meeting this dimension should be inserted at regular benches intervals. Also, wire mesh protection could provide an alternative solution for Rockfall.

8.3 OPERATIONAL CONSIDERATIONS

8.3.1 Excavation and slope protection

Most of excavation will be done by ripping and/or digging.

Any blasting if required should be kept at as minimum distance of 50m from benches faces. Some of the rock mass material could locally be erodible by runoff water. Local protection using membranes to intercept runoff might prove to be necessary. Proper management of runoff water is to be implemented to avoid surface erosion of benches and saturation of the rock mass in the benches.

Regular inspection and cleaning of water diversion systems (surface diversion ditches, collection ditches and sumps, etc.) have to be implemented on a regular basis.

8.3.2 Slope depressurization

Slope depressurization is a key element for the open pit slope stability. The system shall be robust and some redundancy of wells has to be integrated to the system to insure its effectiveness in case of partial shutdowns. Also, backup of key elements of the system related to energy delivery, piping, pumps and electrical equipment should be envisaged.

8.3.3 Geotechnical monitoring

The rock mass of the iron formation is very heterogeneous in terms of intact rock and in term of rock mass mechanical properties. Monitoring of local slope movements and of water table position is of prime interest.

Slope movements can be monitored on continuous basis using one or several slope stability radar units aiming at the critical sectors of the open pit. The radar system is mainly used for operational safety because it’s rapid response and wide area coverage. Radar data is transmitted to central computers that can analyse the response and be programmed to trigger alarms if pre-specified levels are reached. Radar technology has to be used along with precise periodical land survey of monitoring monuments to complement the radar data by defining the direction of displacements and covering larger areas than the radar.

During excavation operations, some local slope areas could prove to be critical and might need special monitoring such as installation of inclinometers installed at certain benches levels.

Extensive water table monitoring is to be considered. Multi-level piezometers will have to be installed in numerous places and monitored on a regular basis. The minimum number of piezometers shall be at least equal to the number of dewatering wells and they should be staggered with the peripheral wells and located downstream of the wells line. Also, continuous records of wells discharge rates have to be implemented.

Temperature monitoring is also a concern to assess frost penetration in the exposed rock mass. The installation of thermistors is to be considered.

8.4 NEXT PHASE STUDY REQUIREMENTS

Out of 529 m of drilling length in the Iron Formation only 110 meters of runs showed an RQD larger than 50% and only 10 meters of core were presenting lengths sufficiently long to be tested in laboratory. This yields a database of rock joints orientation which proves to be variable and limited in number.

The next phase study shall aim at defining more accurately the joints database and the overall geometry of the contact between competent shale and sandstone formations with the Iron Formation. In order to achieve this, additional boreholes will be needed and additional methods of investigation should be deployed.

Geophysical methods such as seismic reflexion coupled with seismic refraction should be promising and relatively cheap to execute. Four parallel 1km long lines oriented North-East / South-West and two perpendicular lines of the same length should yield needed information of the Iron Formation to shale interface position. Also, a geophysical study of blasting energy absorption by the Iron Formation could at the same time be executed. It would help to assess the minimum distance between blasting holes and the future faces of the pit slope, in order to protect the rock mass if blasting is deemed to be used.

To adequately enhance the knowledge of the joint orientation data base, the execution of acoustic and optical geo-camera surveys in additional boreholes should permit to measure joints orientations and the in-situ joints geometry and bedding characteristics. Such a survey is, on the other hand, perilous due to the risk of losing the cameras if pieces of rock fall down the hole behind the camera. Innovative methods of providing shelter to the camera against fallouts might have to be experimented.

A minimum of 6 additional HQ3 size vertical geotechnical boreholes phase with acoustic and optical camera survey should be envisaged for detail engineering. Vertical holes will quite probably yield better recovery than incline holes.

8.4.1 Laboratory tests for next phase study

Rigorous statistical procedures exist to determine the number of specimen to test in order to build a database sufficiently robust to meet requirement for detail engineering design.

Gill et al. (2004) proposed an algorithm based on small – sampling theory to determine the minimal number of specimen to achieve the required precision index (figure 22) with respect to a given target confidence interval. The precision index is defined as the ratio of upper and lower bounds of the number of mean interval as estimated from a group of samples. For permanent mining works and civil engineering applications, it is suggested to insure that P≤1.35.

The minimal number of specimens then is determined using this algorithm which relates the required precision index and the coefficient of variation (100 × average value / standard deviation) obtained after testing.

Based on the number of laboratory tests done for Iron Formation (chapter 4), the coefficient of variation of 60 % and 78 % are evaluated for uniaxial compression strength and tension strength respectively. With respect to the confidence interval of 95 %, the minimal number of samples for laboratory testing using small-sampling theory for two different precision indexes of 1.35 and 1.5, are determined and presented in table 16. Table 17 presents the current amount of data obtained during this campaign.

For permanent mine opening, a precision index 1.35 is desirable, which means that a total of about 109 UCS test and 66 Brazilian tests should be required to build a robust database.

Figure 22: The precision index and maximum relative error suggested for different application

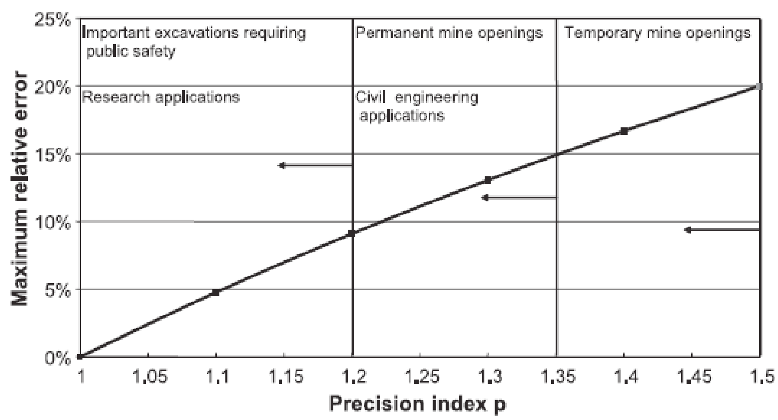


Table 16: Minimal number of laboratory testing for different Precision index

PRECISION INDEX	NUMBER OF SPECIMENS FOR UCS TEST	NUMBER OF SPECIMENS FOR BRAZILIAN TEST
P ≤ 1.3	66	109
P ≤ 1.5	38	62

Table 17: Current Database

NUMBER OF UCS TEST PERFORMED	NUMBER OF BRAZILIAN TEST PERFORMED
26	39
Note : These numbers exclude tests that were considered invalid	

9 CONCLUSION

The primary considerations for the design of the open pit slopes are related to maximum inter-ramp and overall slope angles. These angles will affect the stripping ratio and the amount of ore that can be economically removed from the mineralized zone. The basis incorporated for the design of the open pit slopes is consistent with typical practices for open pit mines. Overall inter-ramp slope stability analyses have been conducted to ensure a minimum factor of safety of at least 1.3. The slope angles have been set based on overall rock mass characteristic which take into consideration the highly fractured Iron Formation and its intact rock physical and mechanical properties. The overall rock mass characteristics showed that essentially the primary mode of failure would be an overall circular slope failure similar to a soil failure.

The highly fractures rock mass of the Iron Formation greatly limited the possibility of orienting intact core recovery and therefore limited the possibility to identify with confidence families of discontinuities. Therefore the small data set of discontinuity characteristics which was collected limits the possibility of kinematic analyses for the assessment of local failure modes in the benches.

The overall stability analyses suggest the recommended pit slope angles are reasonable and appropriate. However, this design has a number of operational constraints including keeping water ponding away from the slope, careful mechanical excavation, slope surface water runoff control and effective slope depressurization. It also requires extensive monitoring and on-going commitments to data collection throughout the operational life of the mine.

As optimization of the open pit outline progresses the final bottom depth of the open pit is to be increased by 66m. An update of the safety factor for this additional depth will be included in this report at a later stage. This will diminish the safety factor of the slope. The minimum acceptance criteria of 1.2 for the safety factor is actually well met with the 1.3 present value. It is believed that the update will show that the minimum acceptance criteria will still be met.

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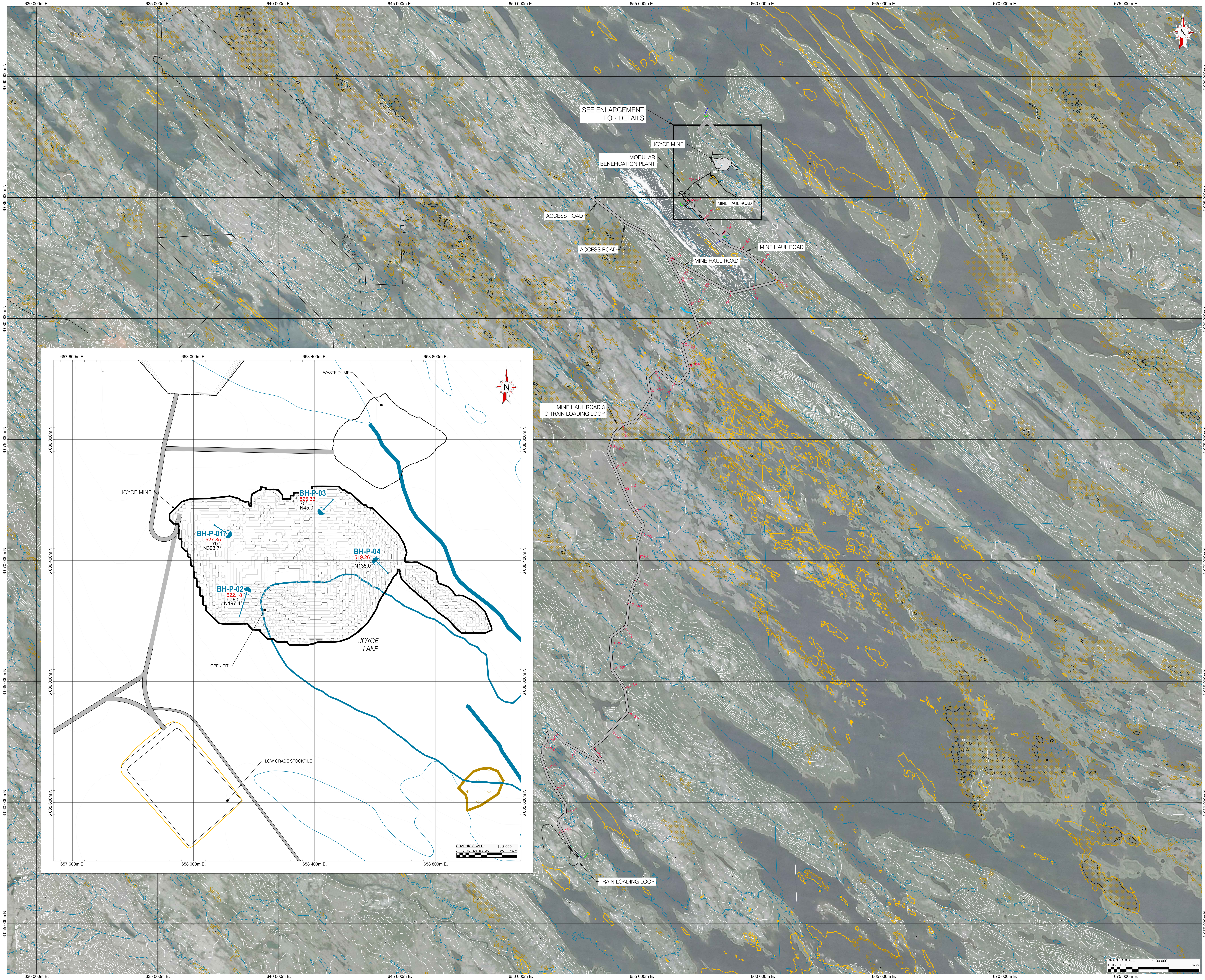
Appendix 1 Installations layout and benches details

LVM



LEGEND:

BH-NN / 00,00 / Dip / Azimut — BOREHOLE-NUMBER, ELEVATION (m), DIP (°), AZIMUT (°)

BOREHOLE COORDINATES, DIPS AND AZIMUTS - NAD83 UTM ZONE 19

BOREHOLE N°	NORTHING (Y)	EASTING (X)	ELEVATION	DIP	AZIMUT
BH-P-01	6 086 486.969	658 114.121	527.85	70°	33.700
BH-P-02	6 086 299.006	658 177.634	522.18	60°	287.400
BH-P-03	6 086 562.697	658 422.620	526.33	70°	135.000
BH-P-04	6 086 397.562	658 603.194	519.26	70°	225.000

NOTES:
1. REFERENCES: TOPOGRAPHY, HYDROGRAPHY, ORTHOPHOTOGRAPHY AND THE INSTALLATIONS LOCATIONS WERE PROVIDED BY BBA inc. ON SEPTEMBER 16 2014.
2. REFERENCES: PIT SHELL GEOMETRY WAS PROVIDED BY BBA inc. ON SEPTEMBER 25 2014, FILE NAME: "Pit 70".

This document must be used jointly with the recommendations formulated in the geotechnical study report

REV.	Y - M - D DATE	DESCRIPTION	Prepared By	Checked By
00	14-12-19	GEOTECHNICAL SUTDY	G.J.	P.G.

ISSUES / REVISIONS

ALL DIMENSIONS MUST BE TAKEN AND CHECKED BEFORE BEGINNING THE WORKS

Seal

Client

LABEC CENTURY IRON ORE INC.

Client's references

Project

JOYCE LAKE AND AREA DSO PROJECT

Title

OPEN PIT BOREHOLE LOCATION

LVM inc.
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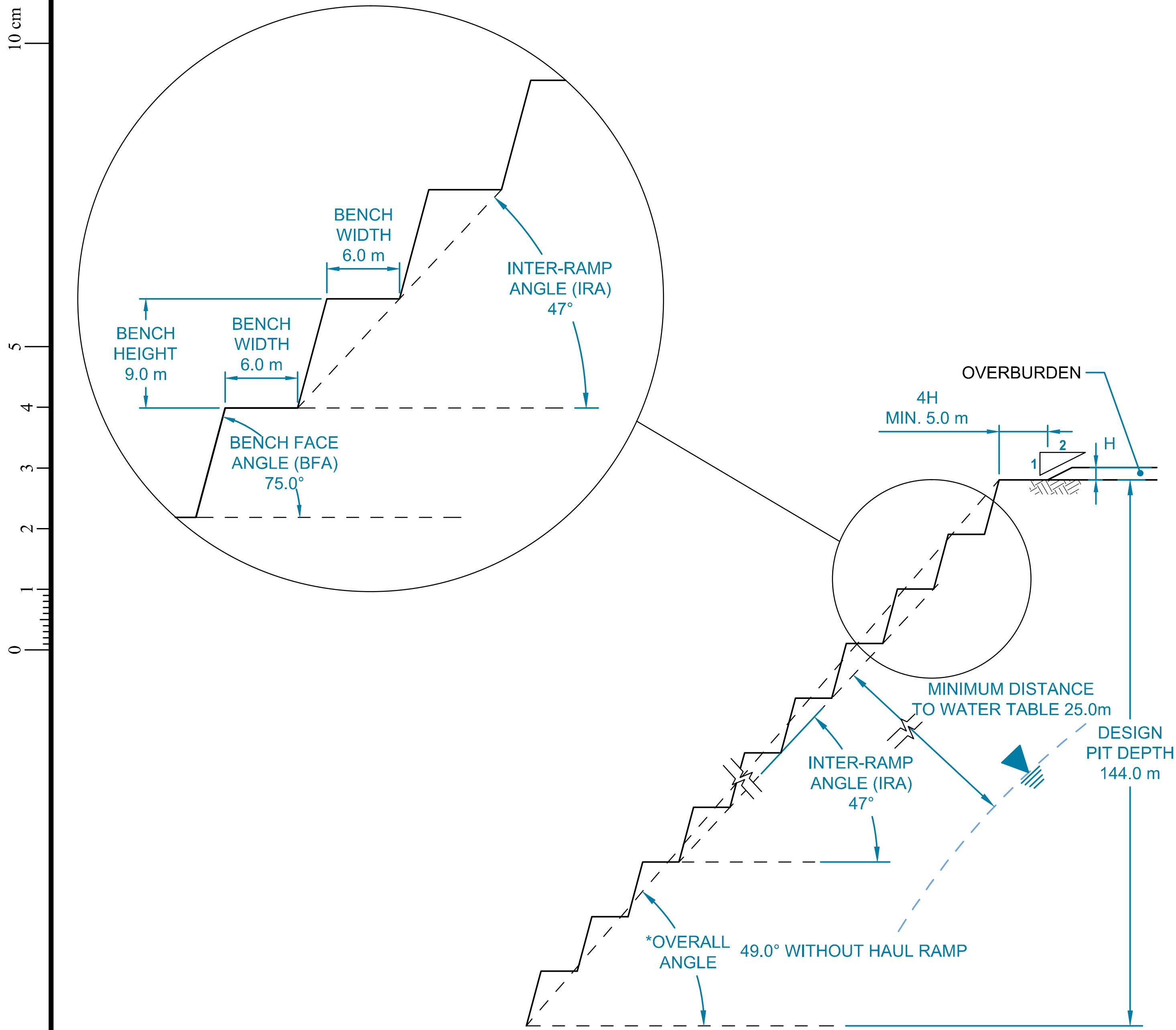
Checked	P. Garand	Date	2014-11-21
Project Manager	P. Garand	Sequence No.	01 of 01

Serv. char.	Project	Wbs	Disc.	Type	Drawing No.	Rev.
025	B-0010504	3	GE	D	0001	00



*(TO BE DETERMINED BY FINAL GEOMETRY OF HAULING RAMP)

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Project

LABEC CENTURY IRON ORE inc.
PIT SLOPE DESIGN
JOYCE LAKE IRON MINE

Title

BENCH AND INTER-RAMP SLOPE CONFIGURATION

LVM
A Division of EnGlobe Corp.
1200, Saint-Martin Blvd West, suite 300
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Fax : 450.668.5532

Prepared **G. Joyal**
Drawn **B. Thibaudeau**
Checked **P. Garand**

Discipline **GEOTECHNICAL**
Scale **N.T.S**
Date **2014-11-26**

Project Manager
P. Garand
Extract from: Rev.:

Serv. char.	Project	Wbs	Disc.	Type	Drawing No.	Rev.
025	B-0010504	3	GE	D	0003	01

Appendix 2 Boreholes logs, photos and structural description

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-01

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086486.969	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658114.121	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	527.85	Azimut:	303.70°	Drillers:	
Inclination:	70°	Bit type:	Flush: / Feed:	Drill Rig:	LF-70

B-0010504-3

ROCK TYPE

ELEV./ Length(m)	DESCRIPTION
527.85 / 0.00	**Casing**
520.81 / 7.50	**Iron oxyde** interbeded with millimetric bands of red chert and millimetric to centimetric bands of white chert.
515.45 / 13.20	20 to 40% of white chert.

INTERVAL REC. DATA / STRENGTH DATA

Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index
0.5	100	0		R4	W3
1.0	25	0			
1.5	27	0			
1.0	85	0		R4	
0.5	100	20		R4	
1.2	65			R4	
0.9	100	20	22	R5	W2
0.9	100	33	22		

DISCONTINUITY DATA

Depth (m) | Type & Number (#) | Orientation: ALPHA (°), BETA (°) | Surface Description: Shape, Roughness, Infill | Jr | Ja | Jn | Fault Breccia/ Gouge | Broken Core

NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS

Bedding at 50°
Joints at 20,45 and 60°

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

HOLE #:

BH-P-01

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-01

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086486.969	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658114.121	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	527.85	Azimut:	303.70°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Casing&Core Diameter/Depth (m)	Water Notes	ELEV./ Length(m)	DESCRIPTION (ROCK TYPE)	Depth (m)	Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index	Depth (m)	Type & Number (#)	ALPHA (°)	BETA (°)	Shape	Roughness	Infill	Jr	Ja	Jn	Fault Breccia/ Gouge	Broken Core	NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS
		15.00	**Iron oxyde** interbeded with millimetric bands of red chert and millimetric to centimetric bands of white chert.	16, 17	3.0	13	0																
		510.28 / 18.70	**Highly weathered zone**	18, 19, 20	3.0	27	0																
		508.12 / 21.00	**Iron oxyde** interbeded with millimetric bands of red chert and millimetric to centimetric bands of white chert.	21, 22, 23	3.0	3	0																
				24, 25, 26	3.0	8	0																
		502.48 / 27.00	**Highly weathered zone**	27																			
		502.20 / 27.30	**Iron oxyde** interbeded with millimetric bands of red chert and millimetric to centimetric bands of white chert.	28, 29	2.2	36			R3														
					0.8	4																	

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja:			
Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

LVM

HOLE #: **BH-P-01**

B.T.

Vertical Scale = 1 : 100

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-01

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086486.969	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658114.121	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	527.85	Azimut:	303.70°	Drillers:	
Inclination:	70°	Bit type:	Flush: / Feed:	Drill Rig:	LF-70

ROCK TYPE

ELEV./ Length(m)	DESCRIPTION
498.25 / 31.50 – 498.06 / 31.70	**Highly weathered zone**
498.06 / 31.70	**Iron oxyde** interbeded with millimetric bands of red chert and millimetric to centimetric bands of white chert.
495.39 / 34.55 – 495.25 / 34.70	**Highly weathered zone** 20 to 30% of white chert.
494.59 / 35.40 – 494.02 / 36.00	**Iron oxyde** interbeded with millimetric bands of red chert and millimetric to centimetric bands of white chert. [Weathered massive Iron oxyde]"/b"
489.89 / 40.40 – 486.04	**Iron oxyde** interbeded with millimetric bands of red chert and millimetric to centimetric bands of white chert.

Depth (m): 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44

INTERVAL REC. DATA / STRENGTH DATA

Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index
1.5	10				
1.5	16				
1.7	80	28	30	R4	W4
1.3	100	23			
1.0	50			R4	W4
0.5	100			R4	W4
1.3	50			R4	W4
1.6	19				
1.6	25	19		R4	W4
1.5	0	0			
1.5	66	13.5		R4	W4

DISCONTINUITY DATA

Depth (m)	Type & Number (#)	Orientation: ALPHA (°)	Orientation: BETA (°)	Surface Description: Shape	Surface Description: Roughness	Surface Description: Infill	Jr	Ja	Jn	Fault Breccia/ Gouge	Broken Core	NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS
												Joints at 10 to 30°
												Bedding at 25° Joints at 5 to 35°
												Bedding N/A Joints at 40 to 75°

Columns: Casing&Core Diameter/Depth (m); Water Notes

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja:			
Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

LVM

HOLE #:

BH-P-01

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-01

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086486.969	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658114.121	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	527.85	Azimut:	303.70°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

ROCK TYPE

ELEV./ Length(m)	DESCRIPTION
485.47 / 45.10	**Highly weathered zone**
485.10 / 45.50	**Iron oxyde** interbeded with millimetric bands of red chert and millimetric to centimetric bands of white chert.
	Highly weathered zone
481.24 / 49.60	[Weathered massive Iron oxyde]"/b"
476.92 / 54.20	**Highly weathered zone**
476.64 / 54.50	**Iron oxyde** interbeded with millimetric bands of red chert and millimetric to centimetric bands of white chert.
471.85	

Depth (m): 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59

INTERVAL REC. DATA / STRENGTH DATA

Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index
0.5	80	100	18	R3	W4
2.5	40	0		R2	W5
1.5	0	0		R2	W5
1.5	13	0			
1.5	33	10			
1.5	13				
1.5	13				
0.7	42			R4	W3
0.8	19				
1.5	0	0			
1.3	15				

DISCONTINUITY DATA

Depth (m)	Type & Number (#)	Orientation ALPHA (°)	Orientation BETA (°)	Surface Description Shape	Surface Description Roughness	Infill	Jr	Ja	Jn	Fault Breccia/ Gouge	Broken Core	NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS
												Bedding at 65° Joints at 65 to 80°

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

LVM

HOLE #: **BH-P-01**

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-01

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086486.969	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658114.121	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	527.85	Azimut:	303.70°	Drillers:	
Inclination:	70°	Bit type:	Flush: / Feed:	Drill Rig:	LF-70

ROCK TYPE

Depth (m)	ELEV. (m)	DESCRIPTION
59.60	471.47	**Highly weathered zone**
60.00	470.91	**Iron oxyde** interbeded with millimetric bands of red chert and millimetric to centimetric bands of white chert.
60.60	470.81	**Highly weathered zone**
60.70	466.02	**Iron oxyde** interbeded with millimetric bands of red chert and millimetric to centimetric bands of white chert.
65.80	465.83	**Highly weathered zone**
66.00	464.42	**Iron oxyde** interbeded with millimetric bands of red chert and millimetric to centimetric bands of white chert.
67.50	464.00	>50% of white chert.
67.95	463.30	**Iron oxyde** interbeded with millimetric bands of red chert and millimetric to centimetric bands of white chert.
68.70	463.11	
68.90	462.83	**Highly weathered zone**
69.20	462.36	**Iron oxyde** interbeded with millimetric bands of red chert and millimetric to centimetric bands of white chert.
69.70	462.07	
70.00	461.60	4 centimetric bands of earthy material.
70.50	461.32	**Iron oxyde** interbeded with millimetric bands of red chert and millimetric to centimetric bands of white chert.
70.80	461.23	**Highly weathered zone**
70.90		**Iron oxyde** interbeded with millimetric bands of red chert and millimetric to centimetric bands of white chert.

INTERVAL REC. DATA / STRENGTH DATA

Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index	NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS
1.2	75	8.3		R4	W4	
0.5	60			R4	W3	
0.5	20	0		R4	W3	
1.0	60	12		R4	W3	
1.0	70	50	16	R4	W3	Bedding at 70° Joints at 45,70 and 85°
1.5	66	47	24	R4	W3	Bedding at 65° Joints at 65 to 75°
0.3	100			R4	W3	
0.2	100			R0	W5	
1.5	20					
1.5	83	44	19	R4	W5	Bedding at 70° Joints at 70 to 90°
1.8	89	31	20	R5	W3	Bedding at 70° Joints at 70 to 90°; Bedding at 70° Joints at 70 to 90°
1.2	100	63	9	R5	W5	Bedding at 60° Joints at 70 to 85°
1.0	85	65		R5	W3	
0.2	100					
1.6	94	60	13	R5	W3	Bedding at 60 to 70° Joints at 60 to 70°

DISCONTINUITY DATA: Depth (m) | Type & Number (#) | Orientation: ALPHA (°), BETA (°) | Surface Description: Shape, Roughness, Infill | Jr | Ja | Jn | Fault Breccia/ Gouge | Broken Core

B.T.

Vertical Scale = 1 : 100

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

LVM

HOLE #: **BH-P-01**

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-01

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086486.969	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658114.121	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	527.85	Azimut:	303.70°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Casing&Core Diameter/Depth (m): B.T.

ROCK TYPE

ELEV./ Length(m)	DESCRIPTION
74.60	**Highly weathered zone**
457.56 / 74.80	**Iron oxyde** interbedded with millimetric bands of red chert and millimetric to centimetric bands of white chert.
456.62 / 75.80	50% of white chert. **Iron oxyde** interbedded with millimetric bands of red chert and millimetric to centimetric bands of white chert.
455.50 / 77.00	30 to 40% of white chert.
454.32 / 78.25	**Iron oxyde** interbedded with millimetric bands of red chert and millimetric to centimetric bands of white chert.
453.99 / 78.60	30% of white chert.
453.15 / 79.50	**Iron oxyde** interbedded with millimetric bands of red chert and millimetric to centimetric bands of white chert.
452.68 / 80.00	**Highly weathered zone**
	Iron oxyde interbedded with millimetric bands of red chert and millimetric to centimetric bands of white chert.
450.80 / 82.00	40 to 50% of white chert.
450.23 / 82.60	**Iron oxyde** interbedded with millimetric bands of red chert and millimetric to centimetric bands of white chert.
446.95 / 86.10	**Highly weathered zone**
446.85 / 86.20	**Iron oxyde** interbedded with millimetric bands of red chert and millimetric to centimetric bands of white chert.
444.60 / 88.60	**Iron enriched** dark grey zone.

Depth (m): 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89

INTERVAL REC. DATA / STRENGTH DATA

Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index
1.0	100	10		R4	W3
1.7	67	88	48	R5	
0.8	100	13		R5	
1.8	86	5		R5	W5
1.0	80	30	10	R5	W3
1.6	50	28	16	R5	W3
1.4	100	24	19	R5	W3
1.5	100	27	30	R5	W3
1.5	100	20	18	R1	W4
1.5	100	61	18	R3	W4
1.6	94	25	35	R5	W3
1.1	73	9		R5	W2

DISCONTINUITY DATA

Depth (m)	Type & Number (#)	ALPHA (°)	BETA (°)	Shape	Roughness	Infill	Jr	Ja	Jn	Fault Breccia/ Gouge	Broken Core

NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS

- Bedding at 60 to 70° Joints at 60°
- Bedding N/A Joints at 80°
- Bedding at 5 to 40° Joints at 10 and 60 to 70°
- Bedding at 20° Joints at 20 to 45° and 80°
- Bedding at 80° Joints at 45 to 80°
- Bedding at 80° Joints at 80°
- Bedding N/A Joints at 60 to 70°
- Bedding N/A Joints at 45,60 and 85°
- Bedding at 70° Joints at 70°

Vertical Scale = 1 : 100

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

HOLE #: **BH-P-01**

B.T.

Vertical Scale = 1 : 100

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-01

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086486.969	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658114.121	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	527.85	Azimut:	303.70°	Drillers:	
Inclination:	70°	Bit type: Flush:	Feed:	Drill Rig:	LF-70

ROCK TYPE

ELEV./ Length(m)	DESCRIPTION
443.37 / 89.90	**Iron oxyde** interbeded with millimetric bands of red chert and millimetric to centimetric bands of white chert.
443.19 / 90.10	80% of white chert.
442.95 / 90.35	**Iron oxyde** interbeded with millimetric bands of red chert and millimetric to centimetric bands of white chert.
442.81 / 90.50	**Highly weathered zone**
442.72 / 90.60	**Iron oxyde** interbeded with millimetric bands of red chert and millimetric to centimetric bands of white chert.
442.34 / 91.00	N/A
441.68 / 91.70	**Iron oxyde** interbeded with millimetric bands of red chert and millimetric to centimetric bands of white chert.
439.52 / 94.00	**Highly weathered zone**
439.33 / 94.20	**Iron oxyde** interbeded with millimetric bands of red chert and millimetric to centimetric bands of white chert.

INTERVAL REC. DATA / STRENGTH DATA

Depth (m)	Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index
90	1.0	100	100	23	R5	W3
91	1.0	0	0			
92	1.3	31	0			
93–94	1.5	80	66	15	R5	W3
95	1.2	60	20	18		
96	1.3	76	15		R5	W3
97	0.3	50				
98	1.7	24				
99	0.8	100			R5	W3
100	1.2	100	46			
101	1.0	60	23			
102–103	1.5	51			R5	W3
104	1.5	20				

DISCONTINUITY DATA

Columns: Depth (m) | Type & Number (#) | Orientation: ALPHA (°), BETA (°) | Surface Description: Shape, Roughness, Infill | Jr | Ja | Jn | Fault Breccia/ Gouge | Broken Core | NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS

Notes/Comments:
- Bedding at 80° Joints at 70 to 80°
- Bedding N/A Joints at 20,45, 60 and 85°
- Bedding N/A Joints at 10,30, 55 and 70°

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

LVM

HOLE #: **BH-P-01**

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-01

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086486.969	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658114.121	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	527.85	Azimut:	303.70°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

ROCK TYPE

ELEV./ Length(m)	DESCRIPTION
424.96 / 109.50 – 424.67 / 109.80	Altered black mineralized material
424.02 / 110.50	**Weathered Iron oxyde** interbeded with millimetric bands of red chert and millimetric to centimetric bands of white chert.
423.78 / 110.75	**Iron oxyde** interbeded with millimetric bands of red chert and millimetric to centimetric bands of white chert.
422.23 / 112.40	Altered black mineralized material
420.73 / 114.00	**Weathered Iron oxyde** interbeded with millimetric bands of red chert and millimetric to centimetric bands of white chert.
419.51 / 115.30	Altered black mineralized material
419.04 / 115.80	Altered black mineralized material & **Iron oxyde** interbeded with millimetric bands of red chert and millimetric to centimetric bands of white chert.
416.12 / 118.90	**Iron oxyde** blackish interbeded with millimetric bands of red chert and millimetric to centimetric

INTERVAL REC. DATA / STRENGTH DATA

Depth (m)	Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index
105–106.3	1.3	100	0		R5	W3
106.3–108	1.7	20				
108–109.5	1.5	33	17		R4	W3
109.5–110.5	1.0	100	60		R0	W5
110.5–111	0.5	100	50		R2	W4
111–112.7	1.7	60	19		R0	W5
112.7–114	1.3	100	100		R2	W5
114–115.5	1.5	80	40			
115.5–117.2	1.7	88	88	15	R4	W5
117.2–117.7	0.5	80				
117.7–118.7	1.0	80	80	12	R4	W5
118.7–119.2	0.5	100	80	5		

DISCONTINUITY DATA

Columns: Depth (m) | Type & Number (#) | Orientation: ALPHA (°), BETA (°) | Surface Description: Shape, Roughness, Infill | Jr | Ja | Jn | Fault Breccia/ Gouge | Broken Core | NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS

NOTES/COMMENTS (at approx. 117.7–118.7 m): Bedding N/A
Joints at 10,45 and 70°

Legend

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

HOLE #: **BH-P-01**

Y:\Style_LVM\Log\Log_Geotec_80Log_Forage_LVM_AN_Joyce_Lake.sty- Printed : 2014-11-17 15h
B-0010504-3

B.T.

Vertical Scale = 1 : 100

EQ-09-Ge-66A R.1 04.03.2009

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-01

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086486.969	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658114.121	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	527.85	Azimut:	303.70°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

ROCK TYPE / INTERVAL REC. DATA / STRENGTH DATA / DISCONTINUITY DATA

ELEV./ Length(m)	DESCRIPTION	Depth (m)	Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index	NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS
	bands of white chert. **Black Shale**		0.8	100	80	21			Bedding N/A Joints at 10,45 and 70°
		120	1.5	100	90	15	R4	W2	Bedding N/A Joints at 10,45 and 70°; Bedding N/A Joints at 10,45 and 70°
		121–122	1.5	100	67	13			Bedding N/A Joints at 10,45 and 70°
		123–124	1.5	100	59	19	R4	W2	Bedding N/A Joints at 10,45 and 70°
		125	1.5	100	93	6	R4	W2	Bedding N/A Joints at 10,45 and 70°
		126–127	1.5	100	87	8	R4	W2	Bedding N/A Joints at 15,45 and 70°
408.09 / 127.45	**Bed of Siltstone**								
408.04 / 127.50	**Black Shale**	128	1.5	100	100	4	R4	W2	Bedding at 75° Joints at 15,45 and 70°
406.63 / 129.00	Interbedded Grey Siltstone / Blackshale	129–130	1.5	100	93	14	R4	W2	Bedding at 80° Joints N/A; Bedding at 75° Joints at 10,45, 60 and 85°
		131	1.5	100	90	15	R4	W2	
		132–133	1.5	93	51	10	R4	W2	Bedding at 75° Joints at 10,45, 65 and 85°
401.84		134							

Other column headers: Casing&Core Diameter/Depth (m); Water Notes; Depth (m); Type & Number (#); Orientation: ALPHA (°), BETA (°); Surface Description: Shape, Roughness, Infill; Jr; Ja; Jn; Fault Breccia/ Gouge; Broken Core.

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

LVM

HOLE #: **BH-P-01**

B.T.

Vertical Scale = 1 : 100

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-01

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086486.969	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658114.121	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	527.85	Azimut:	303.70°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

ROCK TYPE / INTERVAL REC. DATA / STRENGTH DATA

Casing&Core Diameter/Depth (m)	Water Notes	ELEV./ Length(m)	DESCRIPTION	Depth (m)	Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index
		134.10	Grey Sandstone, fine to medium grain		1.5	97	80	6	R4	W2
				135	1.5	100	90	5	R4	W2
				136						
				137	1.5	100	53	10	R4	W2
				138	1.5	80	10	12	R4	W2
				139						
				140	1.5	100	95	5		
				141	1.5	100	40	17	R4	W2
				142						
				143	1.5	100	73	7		
				144	1.5	100	13	93	R4	W2
		391.13		145						
		145.50	Grey Sandstone, fine to medium grain centimetric interdedded with black shale.	146	1.5	100	93	8		
				147	1.5	100	73	11	R4	W2
				148						

DISCONTINUITY DATA

Depth (m)	Type & Number (#)	Orientation: ALPHA (°)	Orientation: BETA (°)	Surface Description: Shape	Surface Description: Roughness	Infill	Jr	Ja	Jn	Fault Breccia/ Gouge	Broken Core
147.60	JN	58	315	PL	SM	QZ					
147.69	JN	78	280	UN	SM	QZ					
147.80	JN	70	290	PL	SM	FR					
147.82	JN	73	310	PL	SM	FR					
147.94	JN	73	310	PL	SM	FR					
147.98	JN	64	310	PL	SM	FR					
148.06	JN	73	310	PL	SM	FR					

NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS

Bedding N/A
Joints at 5 to 15,45, 60 and 85°

Bedding N/A
Joints at 5 to 15,45, 60 and 85°

Bedding N/A
Joints at 5 to 15,45, 60 and 85°

Fine Bedding at 90°
Joints at 5 to 10,20, 60 to 70°

Well marked Beddings at 60 to 90°
Joints at 20,40, 60 and 80°

Orientation test

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

LVM

HOLE #:

BH-P-01

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B-0010504-3

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-01

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086486.969	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658114.121	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	527.85	Azimut:	303.70°	Drillers:	
Inclination:	70°	Bit type: Flush:	Feed:	Drill Rig:	LF-70

B.T.

Vertical Scale = 1 : 100

ROCK TYPE

ELEV./ Length(m)	DESCRIPTION
384.74 / 152.30	Grey Sandstone
377.50 / 160.00	End of borehole at a length of 160.0m.

Depth (m) scale: 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163

INTERVAL REC. DATA / STRENGTH DATA

Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index
1.5	100	100	5		
1.5	100	100	8		
1.5	100	93	5	R4	W2
0.2	100	100	0		
0.5	80	80	2	R4	W2
0.6	100	100	4	R4	W2
0.9	100	100	3	R4	W2
0.8	100	100	4	R4	W2
1.0	100	80	7	R4	W2
0.5	100	100	2	R4	W2
1.5	100	100	8	R4	W2
1.0	100	100	6	R4	W2

DISCONTINUITY DATA

Depth (m)	Type & Number (#)	Orientation ALPHA (°)	Orientation BETA (°)	Surface Description Shape	Surface Description Roughness	Surface Description Infill	Jr	Ja	Jn
148.06	JN	73	310	PL	SM	FR			
148.28	JN	64	340	PL	SM	FR			
148.50	BD	60	305-360	PL	C	QZ			
148.50	JN	75	30	PL	SM	FR			
149.05	JN	70	330	PL	SN	QZ			
149.25	BD	70-76	10	PL	PO	QZ			
149.54	JN	63	285	PL	PO	CH			
150.00	JN	42	325	IR	RO	FR			
150.08	JN	57	290	PL	SM	FE			
150.27	BD	83	90	UN	C	C			
150.27	JN	78	165	IR	SM	QZ			
150.46	JN	67	70	CU	SM	FE			
150.58	JN	65	67	CU	SM	QZ			
150.83	JN	56	80	PL	PO	FR			
150.86	JN	50	85	PL	PO	FR			
151.01	JN	36	85	UN	C	C			
151.07	BD	37-63	60	UN	C	C			
151.07	JN	61	100	CU	PO	FR			
151.08	JN	40	100	PL	PO	FR			
151.14	JN	71	95	PL	RO	FE			
151.40	JN	77	315	IR	SM	EP			
151.50	JN	73	295	PL	PO	FR			
154.10	JN	76	50	CU	SM	FR			
154.28	JN	10	215	PL	SM	FR			
154.65	JN	81	70	PL	RO	QZ			
154.83	JN	70	195	PL	RO	QZ			
155.20	JN	78	65	PL	RO	FE			

Fault Breccia/ Gouge | Broken Core

NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS

Orientation test

Variation of Bedding 70 to 90° Joints at 60 to 75°

Orientation test

Bedding at 75° Joints at 75°

Bedding N/A Joints at 5 to 10,40 to 50 and 75°

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

HOLE #: **BH-P-01**

EQ-09-Ge-66A R.1 04.03.2009

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-01

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086486.969	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658114.121	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	527.85	Azimut:	303.70°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

HOLE #: **BH-P-01**

LVM

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Vertical Scale = 1 : 0

B.T.

EQ-09-Ge-66A R.1 04.03.2009

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-01

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086486.969	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
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HOLE #: **BH-P-01**

LVM

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-01

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Elevation:	527.85	Azimut:	303.70°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Length (m)

41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64

HOLE #: BH-P-01

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-01

File n°:	B-0010504-3	Project Name:	**Joyce Lake - Open Pit**	Date drilled & Logged:	
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Elevation:	527.85	Azimut:	303.70°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Length (m)

65
66
67
68
69
70
71
72
73
74

HOLE #: **BH-P-01**

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CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-01

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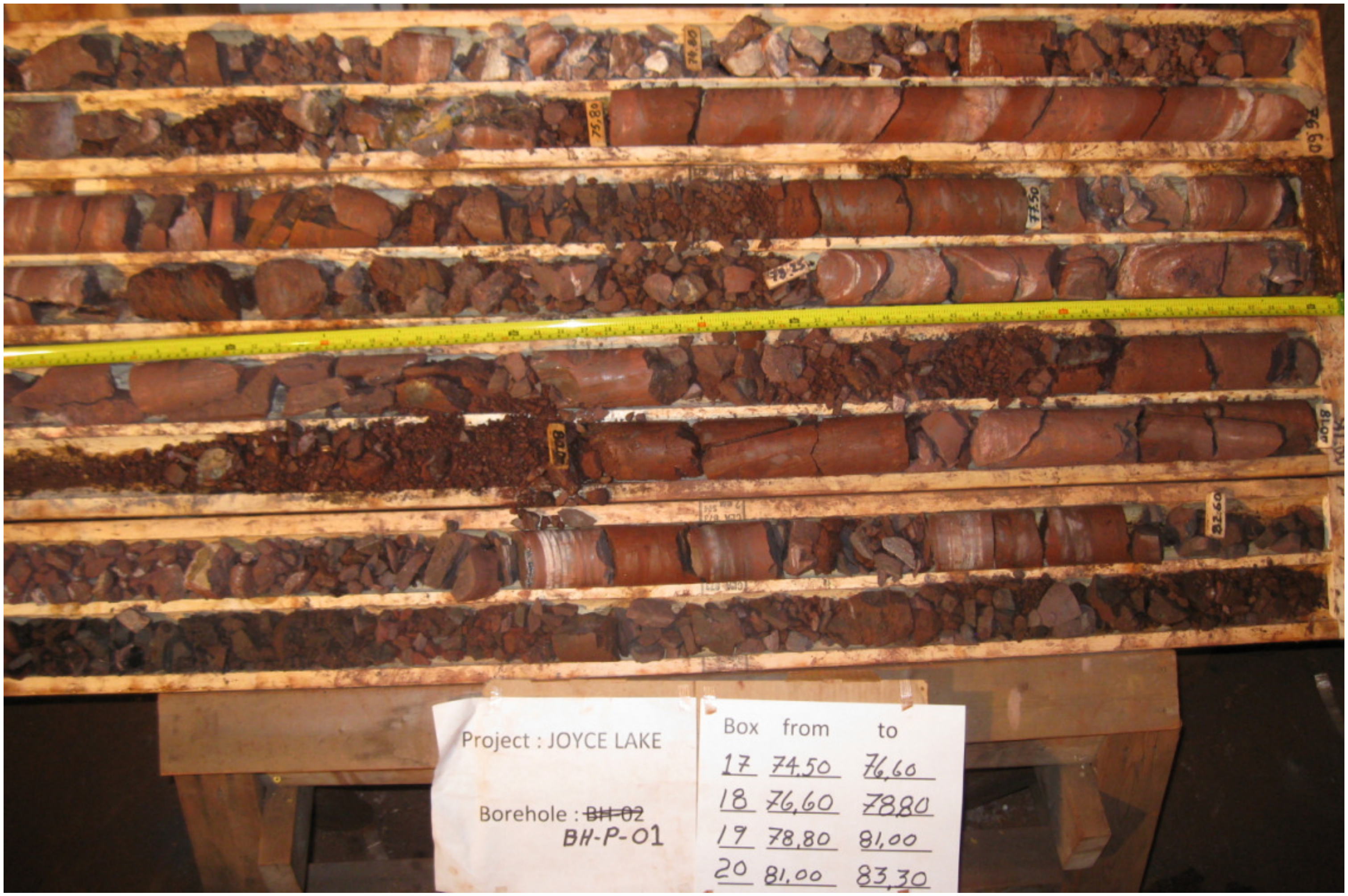
File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086486.969	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658114.121	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	527.85	Azimut:	303.70°	Drillers:	
Inclination:	70°	Bit type: / Flush: / Feed:		Drill Rig:	LF-70

Length (m)

75
76
77
78
79
80
81
82
83



HOLE #: **BH-P-01**

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Vertical Scale = 1 : 0

B.T.

EQ-09-Ge-66A R.1 04.03.2009

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B.T.

EQ-09-Ge-66A R.1 04.03.2009

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-01

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Easting:	658114.121	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	527.85	Azimut:	303.70°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Length (m)

84 85 86 87 88 89 90 91 92 93 94

HOLE #:

BH-P-01

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-01

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
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Easting:	658114.121	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	527.85	Azimut:	303.70°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Length (m)

95
96
97
98
99
100
101
102
103
104
105
106

HOLE #: BH-P-01

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Vertical Scale = 1 : 0

B.T.

EQ-09-Ge-66A R.1 04.03.2009

CORE PHOTOGRAPHY - BOREHOLE N°:	BH-P-01			Page:	8 of 12
File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086486.969	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658114.121	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	527.85	Azimut:	303.70°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Length (m)

107
108
109
110
111
112
113
114
115
116
117
118

HOLE #: **BH-P-01**

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Vertical Scale = 1 : 0

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Easting:	658114.121	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	527.85	Azimut:	303.70°	Drillers:	
Inclination:	70°	Bit type: Flush: Feed:		Drill Rig:	LF-70

Length (m)

120
121
122
123
124
125
126
127
128

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Vertical Scale = 1 : 0

B.T.

EQ-09-Ge-66A R.1 04.03.2009

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HOLE #: BH-P-01

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Vertical Scale = 1 : 0

B.T.

EQ-09-Ge-66A R.1 04.03.2009

CORE PHOTOGRAPHY - BOREHOLE N°: **BH-P-01**

File n°:	**B-0010504-3**	Project Name:	**Joyce Lake - Open Pit**	Date drilled & Logged:	
Northing:	6086486.969	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658114.121	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	527.85	Azimut:	303.70°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Length (m)

129
130
131
132
133
134
135
136

HOLE #: **BH-P-01**

LVM

CORE PHOTOGRAPHY - BOREHOLE N°:	BH-P-01			Page: 11 of 12	
File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086486.969	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658114.121	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	527.85	Azimut:	303.70°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Length (m)

139 – 140 – 141 – 142 – 143 – 144 – 145 – 146 – 147 – 148

LVM

HOLE #: **BH-P-01**

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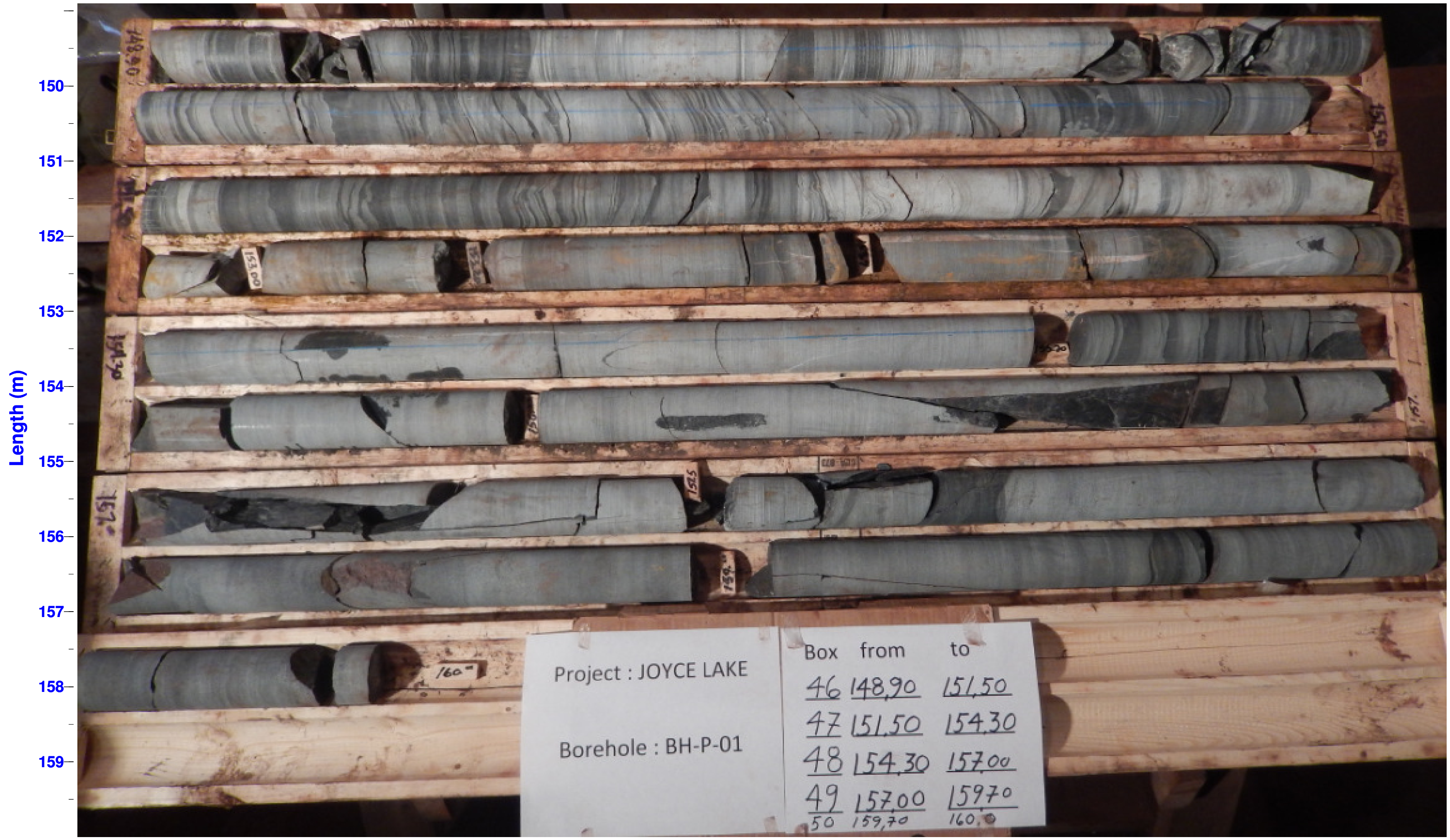
Vertical Scale = 1 : 0

B.T.

EQ-09-Ge-66A R.1 04.03.2009

CORE PHOTOGRAPHY - BOREHOLE N°: **BH-P-01**

File n°:	**B-0010504-3**	Project Name:	**Joyce Lake - Open Pit**	Date drilled & Logged:	
Northing:	6086486.969	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658114.121	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	527.85	Azimut:	303.70°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70



HOLE #: **BH-P-01**

Y:\Style_LVM\Log\Log_Geotec_80Log_Rock_Photos_LVM_AN_Joyce_Lake.sty- Printed : 2014-11-19 09h

Vertical Scale = 1 : 0

B.T.

EQ-09-Ge-66A R.1 04.03.2009

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design **FILE N° :** B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) **BOREHOLE N° :** BH-P-01

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
7,50	8,00	100	0								
8,00	9,00	25	0								
9,00	10,50	27	0								
10,50	11,50	85	0								
11,50	12,00	100	20								
12,00	13,20	65	50								
13,20	14,10	100	20								
14,10	15,00	100	33								
15,00	18,00	13	0								
18,00	21,00	27	0								
	24,00	3	0								
	27,00	8	0								
	29,20	36	0								
	30,00	4	0								
	31,50	10	0								
	33,00	16	0								
	34,70	80	28								
	36,00	100	23								
	37,00	50	0								
	37,50	100	0								
	38,80	50	0								
	40,40	19	0								
	42,00	25	19								

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

LVM

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design FILE N° : B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) BOREHOLE N° : BH-P-01

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
	43,50	0	0								
	45,00	66	14								
	45,50	80	0								
	48,00	40	0								
	49,50	0	0								
	51,00	13	0								
	52,50	33	10								
	54,00	13	0								
	55,50	13	0								
	56,20	42	0								
	57,00	19	0								
	58,50	0	0								
	59,80	15	0								
	61,00	75	8								
	61,50	60	0								
	62,00	20	0								
	63,00	60	12								
	64,00	70	50								
	65,50	66	47								
	66,00	100	0								
	67,50	20	0								
	69,00	83	44								
	70,80	89	31								

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design **FILE N° :** B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) **BOREHOLE N° :** BH-P-01

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
	72,00	100	63								
	73,00	85	65								
	73,20	100	0								
	74,80	94	60								
	75,80	100	10								
	77,50	67	88								
	78,25	100	13								
78,25	80,00	86	5								
80,00	81,oo	80	30								
81,00	82,60	50	28								
82,60	84,00	100	24								
84,00	85,50	100	27								
85,50	87,00	94	25								
87,00	88,60	94	25								
88,60	89,70	73	9								
89,70	90,70	100	100								
90,70	91,70	0	0								
91,70	93,00	31	0								
93,00	94,50	80	66								
94,50	95,70	60	20								
95,70	97,00	76	15								
97,00	97,30	50	0								
97,30	99,00	24	0								

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design **FILE N° :** B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) **BOREHOLE N° :** BH-P-01

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
99,00	99,80	100	0								
99,80	101,00	100	16								
101,00	102,00	60	23								
102,00	103,50	51	0								
103,50	105,00	20	0								
105,00	106,30	100	0								
106,30	108,00	20	0								
108,00	109,50	33	17								
109,50	110,50	100	60								
110,50	111,00	100	50								
111,00	112,70	60	19								
112,70	114,00	100	100								
114.00	115,50	80	40								
115,5	117,2	88	88								
117,2	117,7	80	0								
117,7	118,7	80	80								
118,7	119,2	100	80								
119,2	120	100	80								
120	121,5	100	90								
121,5	123	100	67								
123	124,5	59	19								
124,5	126	93	6								
126	127,5	100	87								

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design **FILE N° :** B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) **BOREHOLE N° :** BH-P-01

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
127,50	129,00	100	100								
129,00	130,00	100	93								
130,00	130,50										
130,50	132,00	100	90								
132,00	133,50	93	51								
133,50	135,00	97	80								
135,00	136,50	100	90								
136,50	138,00	100	53								
138,00	139,50	80	100								
139,50	141,00	100	95								
141,00	142,50	100	40								
142,50	144,00	100	73								
144,00	145,50	100	13								
145,50	147,00	100	93								
147,00	148,50	100	73								
				147,60	148,50	BD	60	305-360	PL		QZ
					147,60	1 JN	56	315	PL	SM	QZ
					147,69	1 JN	78	280	UN	SM	QZ
					147,80	1 JN	70	290	PL	SM	
					147,82	1 JN	73	310	PL	SM	
					147,94	1 JN	73	310	PL	SM	
					147,98	1 JN	64	310	PL	SM	
					148,06	1 JN	73	310	PL	SM	

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design   FILE N° : B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec)   BOREHOLE N° : BH-P-01

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
					148,28	1 JN	64	340	PL	SM	
					148,50	1 JN	75	30	PL	SM	
148,50	150,00	100	100								
					149,05	1 JN	70	330	PL	SN	QZ
				149,10	149,25	BD	70-76	10	PL	PO	QZ
					149,54	1JN	63	285	PL	PO	CH
					150,00	1 JN	42	325	IR	RO	
150,00	151,50	100	100								
					150,08	1 JN	87	290	PL	SM	FE
				150,08	150,27	BD	83	90	UN		
					150,27	1 JN	78	165	IR	SM	QZ
				150,40	151,07	BD	37-63	60	UN		
					150,46	1 JN	67	70	CU	SM	FE
					150,58	1 JN	65	67	CU	SM	QZ
					150,83	1 JN	56	80	PL	PO	
					150,86	1 JN	50	85	PL	PO	
					151,01	1 JN	36	85	UN		
					151,07	1 JN	61	100	CU	PO	
					151,08	1 JN	40	100	PL	PO	
					151,14	1 JN	71	95	PL	RO	FE
					151,40	1 JN	77	315	IR	SM	EP
					151,50	1 JN	73	295	PL	PO	
151,50	153,00	100	93								

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design **FILE N° :** B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) **BOREHOLE N° :** BH-P-01

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
153,00	153,20	100	100								
153,20	153,70	80	80								
153,70	154,30	100	100								
154,30	155,20	100	100								
					154,10	1 JN	76	50	CU	SM	
					154,28	2 JN	10	215	PL	SM	
					154,65	1 JN	81	70	PL	RO	QZ
					154,83	1 JN	70	195	PL	RO	QZ
					155,20	1 JN	78	65	PL	RO	FE
155,20	156,00	100	100								
156,00	157,00	100	80								
157,00	157,50	100	100								
157,50	159,00	100	100								
159,00	160,00	100	100								
End of hole											

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-02

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-09-25
Northing:	6086299.006	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658177.634	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	522.18	Azimut:	197.40°	Drillers:	
Inclination:	60°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

ELEV./ Length(m)	ROCK TYPE – DESCRIPTION	Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index	NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS
522.18 / 0.00	**Casing**	3.0						
519.58 / 3.00	**Iron oxyde** with white and red chert, fine to medium grained, dark grey, with centimetric bands of white to reddish medium grained chert and millimetric bands of fine grained red chert. Presence of nodules of white chert and pockets of iron oxyde. Fractured rock with limonite in most fracture. Mostly non magnetic with few weakly magnetic zone.	1.5	70	0		R5	W2	
		0.9	60	10		R5	W2	Bedding at 15° Joint at 20°
		0.6	66	17		R5	W2	Bedding at 30° Joint at 30°
		0.5	70	20		R5	W2	Bedding at 0° Joint at 20°
		0.5	80	20		R5	W2	
		0.5	100	40	10	R5	W2	Bedding at 40 to 50° Joint at 5 to 50°
		0.5	60	0		R5	W2	
		1.5	17	0		R5	W2	No recuperation from 8.0 to 9.0m
		1.2	29	0		R5	W2	
		0.3	57	0		R5	W2	
		1.0	0	0				
		0.7	21	0		R5	W2	
		2.0	35	10		R5	W3	Bedding at 35° Joint at 25 and 50°

DISCONTINUITY DATA: Depth (m) | Type & Number (#) | Orientation: ALPHA (°), BETA (°) | Surface Description: Shape, Roughness, Infill | Jr | Ja | Jn | Fault Breccia/ Gouge | Broken Core

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint: JN		Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

HOLE #: **BH-P-02**

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-02

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-09-25
Northing:	6086299.006	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658177.634	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	522.18	Azimut:	197.40°	Drillers:	
Inclination:	60°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

B.T.

Vertical Scale = 1 : 100

ROCK TYPE

ELEV./ Length(m)	DESCRIPTION
	Banded (3) white chert at 59.44° and 34° White chert and hematite nodules. White 60° chert bands from 20 to 20.1m and 60° red chert from 20.1 to 20.2m.
504.86 20.00	**Gradual contact**
502.69 22.50	**Iron oxyde** with much more red chert, few white chert, fine to medium grained, dark grey to reddish, centimetric (1 to 5cm) bands of granulated white chert. Presence of nodules and small veins of white chert Highly weathered zone from 25.4 to 25.5m. 2 white chert bands at ±30°.
498.10 27.80	Highly weathered zone from 27.5 to 27.8m.
497.32 28.70	Well defined bands (millimetric to centimetric) of hematite white chert and red chert at ±30°.

Depth (m): 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29

INTERVAL REC. DATA / STRENGTH DATA

Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index
0.3	83	47		R5	W2
0.2	100	0		R5	W2
0.1	100	0		R5	W2
0.8	81	71	16	R5	W2
0.5	60	0		R5	W2
1.4	57	31		R5	W2
1.7	0	0			
0.4	100	65	5	R5	W2
0.3	83	73		R5	W2
0.2	100	0		R5	W2
0.5	89	33		R5	W2
0.9	100	0		R5	W2
0.3	100	0		R5	W2
0.9	94	30		R5	W2
0.3	100	0		R5	W2
0.6	45	0		R0	W45
0.7	36	0		R5	W2
0.2	100	0		R5	W2
0.5	40	0		R5	W2
0.6	55	0		R1	W4
0.4	100	29		R5	W2
0.2	75	0			
1.3	65	27		R5	W3
0.9	100	46	15	R5	W2
0.7	86	33		R2	W3

DISCONTINUITY DATA

Depth (m)	Type & Number (#)	Orientation: ALPHA (°)	Orientation: BETA (°)	Surface Description: Shape	Surface Description: Roughness	Surface Description: Infill	Jr	Ja	Jn	Fault Breccia/ Gouge	Broken Core

NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS

- Joints at 0°
- Joints at 5 to 20°
- Bedding at 3 to 60°
  Joints at 30 to 40°
- Bedding at 65°
  Joints at 40 to 90°
- Joints at 30°
- Bedding at 30°
  Joints at 30 and 45°
- Smalls zones R1 and W4 at 24.6 and 25.2m
- Joints at 10 to 35°
- Joints at 30° few at 65°

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja:			
Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

LVM

HOLE #:

BH-P-02

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-02

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-09-25
Northing:	6086299.006	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658177.634	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	522.18	Azimut:	197.40°	Drillers:	
Inclination:	60°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

ROCK TYPE — DESCRIPTION

Depth (m): 30 to 44

29.6 to 29.9m: weathered band.
30.0 to 30.2m: weathered band.
30.35 to 31.3m: mostly white chert with hermatite as a secondary component..

Weakly magnetic around 36.5 and 37.8m.

39.0 to 39.3m: weathered band.

40.0 to 41.0m: weathered band.

Weakly magnetic around 41.0 and 41.2m.

INTERVAL REC. DATA / STRENGTH DATA

Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index
1.9	95	42	26	R0	W2
2.1	100	32		R1	W3
1.0	100	13		R1	W3
0.2	100	0		R2	W3
0.2	100	0		R5	W2
1.2	100	70		R5	W2
0.4	86	0			
1.2	82	41	20		
0.2	100	50	20		
0.3	100	90	22		
1.2	91	41	17		
1.2	52	10			
0.4	62	0			
1.5	100	27			
0.3	100	0			
1.2	54	13			
1.6	12	0			

DISCONTINUITY DATA

Depth (m)	Type & Number (#)	Orientation ALPHA (°)	Orientation BETA (°)	Surface Description Shape	Surface Description Roughness	Infill	Jr	Ja	Jn
30.70	JN	30	265	PL	SM	FE			
30.90	JN	23	80	PL	SM	QZ			
30.90	JN	0	15	PL	RO	QZ-FE			
31.08	JN	28	45	ST	SM	QZ-FE			
32.10	BD	30	85	PL	C	C			
32.80	JN	30	85	PL	SM	FR			

NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS

Bedding of Iron Oxyde and red Chert

Joints at 20 to 40°

Bedding at 30°
Joints at 30 to 45°
some at 5 to 10°

Bedding at 25°
Joints at 25 and 45°

Beddings at 20°
Joint at 20°

Fine Bedding at 5°
Joints at 5°

Fine Bedding at 5°
Joints at 5°
and 50 to 90°

Bedding at 5°
Joint at 5°

Bedding at 10°
Joints at 10 and 30°

Bedding at 5°
Joint at 5°

Bedding at 45°
Joint at 30,45
and 90°

B.T.

Vertical Scale = 1 : 100

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

LVM

HOLE #: **BH-P-02**

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-02

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-09-25
Northing:	6086299.006	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658177.634	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	522.18	Azimut:	197.40°	Drillers:	
Inclination:	60°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Columns (not filled on this page): Casing&Core Diameter/Depth (m); Water Notes; ELEV./ Length(m); DISCONTINUITY DATA: Depth (m), Type & Number (#), Orientation (ALPHA (°), BETA (°)), Surface Description (Shape, Roughness, Infill), Jr, Ja, Jn, Fault Breccia/ Gouge, Broken Core.

Depth (m) scale: 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59

ROCK TYPE: DESCRIPTION	Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index	NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS
							Bedding at 45° Joint at 30,45 and 90°
	1.7	15	0		R5	W3	
	0.3	100	0		R5	W3	
	0.7	100	58	7	R5	W2	Joints at 60 and 5°
	1.0	100	62	80	R5	W2	Joints at 40,60 and 20°
49.0 to 49.8m: weathered band.	0.8	31	0		R1	W4	
	1.2	43	0		R2	W3	
51.05 to 51.10m: weathered band. 52.0 to 52.2m: weathered band.	1.2	67	43	5	R2	W4	Joints at 30 and 60°
	0.2	75	0		R4	W2	
	0.4	63	0		R4	W2	
	1.2	8	0				
	1.0	100	22		R3	W3	Joints at 10,20 and 45°
	0.5	50	0		R4	W3	
	0.6	50	0		R1	W3	
56.0 to 56.1m, 56.2 to 56.6m and 56.9 to 57.0m: weathered band.	0.9	100	0		R1	W4	
	0.4	100	38	12	R4	W2	
58.3 to 59.0m: weathered band.	1.6	58	30		R3	W2	Joints at 0 and 45°
	0.7	70	0		R5	W3	

B.T.

Vertical Scale = 1 : 100

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

LVM

HOLE #: **BH-P-02**

Vertical Scale = 1 : 100

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-02

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-09-25
Northing:	6086299.006	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658177.634	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	522.18	Azimut:	197.40°	Drillers:	
Inclination:	60°	Bit type:	Flush: / Feed:	Drill Rig:	LF-70

Casing&Core Diameter/Depth (m) B-0010504-3 | Water Notes | ELEV./ Length(m)

ROCK TYPE

DESCRIPTION

Thinly bedded (Iron oxyde and mostly red and some white chert) from 60.40 to 65.57m.

64.3 to 64.4m: weathered band.
64.8 to 64.9m: band of white chert.

68.0 to 74.0m: centimetric (2 to 5cm) bands of white chert. About 5 per meter.

70.5 to 75.5m: fine bedding of chert and iron oxyde.

Depth (m): 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74

INTERVAL REC. DATA / STRENGTH DATA

Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index
0.7	11	0		R3	W3
0.6	100	83	13	R3	W3
0.6	100	48	33	R3	W3
1.6	100	6		R3	W3
1.0	100	47	20	R5	W3
0.9	100	30		R3	W3
0.5	100	0		R3	W3
1.5	40	0		R5	W2
0.1	100	0		R5	W2
2.1	100	67	16	R5	W2
0.8	53	37		R5	W2
0.8	100	64	20	R5	W2
0.8	100	41		R5	W2
0.2	50	0		R5	W2
1.0	100	31	41	R5	W2
0.8	44	0		R5	W3
1.0	100	56	11	R5	W2

DISCONTINUITY DATA

Depth (m)	Type & Number (#)	Orientation ALPHA (°)	Orientation BETA (°)	Surface Description Shape	Surface Description Roughness	Infill	Jr	Ja	Jn
68.63	BD	30	345	PL	C	C			
68.64	JN	45	90	PL	SM	FR			
68.78	JN	43	95	PL	SM	FR			
68.78	JN	40	295	PL	SM	FR			
68.88	JN	40	55	IR	ST	FR			
68.95	JN	90	42	IR	SM	FR			
69.04	JN	46	38	IR	RO	FR			
69.11	JN	33	40	IR	RO	FR			
69.19	JN	52	20	PL	RO	FR			
69.21	JN	42		PL	RO	FR			

Fault Breccia/ Gouge | Broken Core

NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS

- No core between 59.70 and 60.10m
- Bedding at 50° Joints at 45 to 60°
- Bedding at 5 to 10° Joints at 5 to 10° and 30, 70°
- Bedding at 30°
- Bedding at 30° Joints at 30,45 and 55°
- Bedding at 40° Joint at 40°
- Bedding at 30° Joints at 10 and 45°
- From 69.64 to 70.24m: fine bedding
- Bedding at 45° Vein at 0°
- Bedding at 40° Joints at 30° and 50 to 6°
- Bedding at 35 to 45° Joints at 45 and 5°
- Bedding at 25 to 35° Joints at 40 to 60°
- Bedding at 35° Joints at 60°

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

HOLE #: **BH-P-02**

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-02

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-09-25
Northing:	6086299.006	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658177.634	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	522.18	Azimut:	197.40°	Drillers:	
Inclination:	60°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

B.T.

ROCK TYPE

DESCRIPTION:

Presence of centimetrics beds of iron, black and fissile. Mineralisation from 75.0 to 75.5m. Presence of beds of yellow limonite.

From 87.3 to 97.1, the white chert represente 30° to 50° of rock. It is oriented randomly.

Depth (m): 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89

INTERVAL REC. DATA / STRENGTH DATA

Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index
1.0	100	36	20	R5	W3
1.3	100	100	20	R2	W2
1.1	60	18	18	R1	W4
1.8	83	32	10	R1	W4
1.2	100	28	18	R1	W4
1.4	100	34		R2	W4
1.6	96	25	30	R1	W4
1.3	100	10		R1	W4
1.7	88	34	8	R1	W2
0.4	100	30		R1	W4
0.2	100	70		R4	W4

DISCONTINUITY DATA

Depth (m) | Type & Number (#) | Orientation: ALPHA (°), BETA (°) | Surface Description: Shape, Roughness, Infill | Jr | Ja | Jn | Fault Breccia/Gouge | Broken Core

NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS

- Bedding at 25 to 30°
- Bedding at 30° Joints at 30,45 and 60°
- Bedding at 30° Joint at 30°
- Bedding at 30 to 35° Joints at 25 to 45°
- Bedding at 30 to 35° Joints at 30 to 35°
- Bedding at 30° Joint at 30°
- Bedding at 30 to 40° Joints at 5,30 and 45°
- Bedding and Joints at 30 to 60°
- Bedding at 4° Joint at 25,50 and 70°
- Joints at 40 to 70°

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

HOLE #: **BH-P-02**

Vertical Scale = 1 : 100

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-02

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-09-25
Northing:	6086299.006	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658177.634	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	522.18	Azimut:	197.40°	Drillers:	
Inclination:	60°	Bit type: Flush: Feed:		Drill Rig:	LF-70

B.T.

Depth (m)	Description	Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index	Notes/Comments /Imprint Depth/ Infill Type & Thickness
89.5–90.4		0.9	100	63	15	R4	W2	
90.4–91.6	Concentration of yellowish limonite from 90.6 to 91.1.	1.2	100	45	17	R4	W2	Joints at 25 to 35°
91.6–92.7		1.1	100	0	14	R4	W2	Joints at 5,20, 40 and 65 to 90°
92.7–93.4		0.7	100	38		R2	W3	Bedding at 20 to 35° Joints at 20 to 35°
93.4–94.4		1.0	85	14		R4	W3	
94.4–95.6		1.2	100	36	15	R3	W3	Bedding at 30° Joints at 15 to 20, 30 and 45°
95.6–97.3		1.7	88	0		R3	W2	Joints at 15 to 45 Vein at 5°
97.3–97.5		0.2	100	0		R2	W2	
97.5–98.9		1.4	100	68	19	R2	W3	Bedding at 30° Vein at 20° Joints at 20,30 and 45°
98.9–100.6	From 98.7 the white chert represents 50% of the mass.	1.7	100	41	12	R2	W3	Bedding at 30 and 45° Joints at 30 and 45°
100.6–101.4		0.8	100	50	14	R2	W3	Bedding at 20° Joints at 25 to 35 and 70°
101.4–102.1		0.7	100	50	14	R3	W3	Bedding at 20° Joint at 20°
102.1–103.7		1.6	100	36	25	R4	W3	Bedding at 30° Joints at 30 and 85°
103.7–104.9		1.2	100	21	32	R4	W5	

Depth scale: 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104

Other column headings: Casing&Core Diameter/Depth (m); Water Notes; ELEV./ Length(m); Depth (m); Type & Number (#); Orientation: ALPHA (°), BETA (°); Surface Description: Shape, Roughness, Infill; Jr; Ja; Jn; Fault Breccia/ Gouge; Broken Core

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

LVM

HOLE #: **BH-P-02**

Vertical Scale = 1 : 100

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-02

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-09-25
Northing:	6086299.006	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658177.634	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	522.18	Azimut:	197.40°	Drillers:	
Inclination:	60°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

B.T.

Vertical Scale = 1 : 100

ROCK TYPE

Casing&Core Diameter/Depth (m) | Water Notes | ELEV./ Length(m) | DESCRIPTION | Depth (m)

From 106.0m, the white chert is pratically absent and the rock is altered.

Depth scale: 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119

INTERVAL REC. DATA / STRENGTH DATA

Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index
0.5	100	60		R3	W5
1.6	90	25	27	R3	W3
1.4	27	8		R3	W3
1.7	39	0		R1	W5
1.3	69	0	12	R2	W5
0.8	67	0		R2	W4
1.0	50	30		R2	W4
0.1	100	90		R2	W4
1.1	100	90	12	R4	W4
1.3	100	73		R2	W2
0.1	100	100		R4	W2
0.2	100	100		R4	W2
1.4	64	43		R4	W2
0.9	100	89	18	R4	W2
0.7	86	0		R3	W3

DISCONTINUITY DATA

Depth (m)	Type & Number (#)	Orientation ALPHA (°)	Orientation BETA (°)	Surface Description Shape	Surface Description Roughness	Infill	Jr	Ja	Jn	Fault Breccia/ Gouge	Broken Core
114.40	JN	19	75	IR	VR	QZ					
114.43	BD	25	53	UN	C	QZ					
114.51	BD	25	35	UN	C	QZ					
114.57	BD+JN	21	35	PL	RO	QZ					
114.63	JN	32	35	PL	C	QZ					
114.66	BD	36	55	PL	C	QZ					
114.68	BD	36	50	PL	C	QZ					
114.76	BD	36	65	PL	C	QZ					
114.81	BD	25	50	PL	C	QZ					
114.89	BD	19	70	PL	C	QZ					
114.91	JN	58	35	IR	C	FE					
114.99	BD	27	80	PL	C	QZ					
115.13	BD	40	118	PL	C	QZ					
115.14	JN	48	70	IR	RO	FE					
115.16	BD	40	118	PL	C	QZ					
115.19	BD	60	118	PL	C	QZ					
115.30	JN	32	285	IR	RO	QZ-FE					

NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS

Bedding at 25°
Joints at 20 and 45°

Joints at 20 and 50°

Bedding at 25°
Joints at 25°

Orientation test.

Bedding at 30°
Joint at 30 and 70°

Bedding at 45°
Joints at 45 and 60°

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Chl	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

HOLE #: BH-P-02

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-02

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-09-25
Northing:	6086299.006	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658177.634	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	522.18	Azimut:	197.40°	Drillers:	
Inclination:	60°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

ROCK TYPE

Casing&Core Diameter/Depth (m)	Water Notes	ELEV./ Length(m)	DESCRIPTION	Depth (m)
				120
				121
				122
				123
				124
				125
				126
				127
				128
				129
				130
				131
				132
			50% white chert	133
				134

INTERVAL REC. DATA / STRENGTH DATA

Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index
1.6	100	38		R3	W3
1.3	23	0		R5	W2
1.6	88	75	17	R5	W2
0.5	100	72	17	R5	W2
1.2	100	17		R4	W2
1.3	100	100	10	R4	W3
1.6	100	69	10	R4	W3
0.3	100	33		R1	W5
1.1	100	50	18	R1	W5
1.4	100	17	18	R1	W5
1.5	100	20		R2	W4
1.6	100	69	11	R3	W3

DISCONTINUITY DATA

Depth (m)	Type & Number (#)	Orientation: ALPHA (°)	Orientation: BETA (°)	Surface Description: Shape	Surface Description: Roughness	Surface Description: Infill	Jr	Ja	Jn
119.60	JN	38	45	PL	RO	FE-QZ			
119.67	BD	33	45	PL	C	QZ			
119.75	JN	33	60	PL	SM	FE			
119.75	BD	33	40-45	PL	C	FE+QZ			
119.80	JN	73	55	PL	RO	FQ			
119.91	JN	39	57	PL	C	C			
119.91	BD	40	57	PL	C	QZ			
120.11	JN	24	55-60	PL	C	C			
120.20	BD			PL	C	FE-QZ			
132.35	JN	74	345	PL	RO	LI			
132.37	JN	47	125	IR	RO	FE			
132.42	BD	33	165	IR	C	QZ			
132.43	JN	33	180	IR	C	C			
132.53	BD	30-51	140	IR	C	QZ+FE			
132.56	BD	33	140	PL	C	QZ			
132.62	JN	43	60	PL	C	C			
132.63	BD	33	140	IR	C	QZ			
132.71	JN	40	85	IR	RO	FE+QZ			

Fault Breccia/ Gouge | Broken Core

NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS

Orientation test.

Bedding at 35 to 45°
Joints mostly between
25 to 40°
some at 60°

Bedding at 25 and 35°
Joints at 30,45, 60 and 70°

Few visible Bedding
at 35°
Joints at 35 to 50 and 75 to 85°

Orientation test.

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja:			
Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

HOLE #: **BH-P-02**

B.T.

Vertical Scale = 1 : 100

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-02

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-09-25
Northing:	6086299.006	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658177.634	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	522.18	Azimut:	197.40°	Drillers:	
Inclination:	60°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

ROCK TYPE

Columns: Casing&Core Diameter/Depth (m) | Water Notes | ELEV./ Length(m) | DESCRIPTION | Depth (m)

Depth scale: 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148

DESCRIPTION:

Bands of limonite.

138.0m to 139.0m, black, very altered.

139.0m to 146.2m, 20 to 30% of white chert.

146.2m to 149.3m mostly limonite.

INTERVAL REC. DATA / STRENGTH DATA

Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index
1.4	100	71	11	R3	W4
1.6	94	83	11	R3	W4
1.4	100	57		R3	W4
1.6	94	34	1	R5	
1.4	100	50	12	R4	W3
1.5	100	57	12	R5	W2
1.5	93	40	12	R5	W2
1.5	67	33		R3	W3
1.5	100	37		R3	W3
1.5	100	63	14	R3	W2

DISCONTINUITY DATA

Depth (m)	Type & Number (#)	Orientation: ALPHA (°)	Orientation: BETA (°)	Surface Description: Shape	Surface Description: Roughness	Surface Description: Infill	Jr	Ja	Jn
132.78	BD	40	145	PL	C	QZ			
132.94	JN	36	120	PL	RO	FE+QZ			
132.94	BD	36	120	PL	C	QZ+FE			
134.08	JN	33	210	PL	RO	FE			
134.12	JN	31	10	UN	RO	QZ			
134.17	BD	31	15	IR	C	QZ			
134.22	BD	36	15	PL	C	QZ			
134.25	BD	36	15	PL	C	QZ			
134.26	JN	33	20	PL	SM	FE			
134.33	BD	33	0	PL	C	QZ			
134.37	BD	32	0	PL	C	QZ			
134.41	BD	30	0	PL	C	QZ			
134.47	JN	55	220	IR	RO	FE+QZ			
134.54	JN	26	245	IR	SM	FE+QZ			
134.74	BD	41-43	15	PL	C	FE+QZ			
134.80	BD	34	0	PL	C	QZ			
134.88	JN	38	5	IR	RO	LI			
134.92	BD	42	5	PL	C	FE			
134.96	BD	38	5	PL	C	FE			
135.00	JN	45	5	IR	RO	LI+QZ			
140.45	JN	39	0	C	C	C			
140.59	BD	36-41	0	C	C	C			
140.68	JN	40	0	C	C	C			
140.72	BD	40-43	0	C	C	C			
141.22	BD	38-40	0	C	C	C			
141.22	JN	39	0	C	C	C			
141.31	BD	39	0	C	C	C			
141.33	JN	38	0	C	C	C			
141.40	BD	39	0	C	C	C			
141.64	BD	36-39	0	C	C	C			
141.70	BD	43	0	C	C	C			
141.88	BD	43	0	C	C	C			
142.03	BD	40	0	C	C	C			
142.20	JN	35	0	C	C	C			
142.45	JN	31	0	C	C	C			
142.45	BD	49	0	C	C	C			
146.79	JN	48	250	PL	SM	LI			
146.85	JN	51	50	PL	SM	LI			
146.93	JN	34	135	PL	SM	LI			
147.00	JN	36	40	PL	SM	LI			
147.00	JN	38	250	PL	SM	LI			
147.66	JN	41	175	IR	RO	QZ			
147.74	BD	44	165	PL	C	FE+QZ			
147.78	JN	42	340	IR	RO	FE			
147.82	JN	47	175	IR	RO	FE			
147.83	BD	50	0	PL	C	QZ			
147.86	JN	56	180	PL	SM	FE			

Columns: Fault Breccia/ Gouge | Broken Core

NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS

Orientation test.

Orientation test.

Bedding at 35 to 40°
Joints at 35 to 40°

Bedding at 40°
Joint at 40°

Orientation test.

Orientation test.

B.T.

Vertical Scale = 1 : 100

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

HOLE #: **BH-P-02**

B.T.

Vertical Scale = 1 : 100

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-02

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-09-25
Northing:	6086299.006	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658177.634	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	522.18	Azimut:	197.40°	Drillers:	
Inclination:	60°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

ROCK TYPE

Columns: Casing&Core Diameter/Depth (m) | Water Notes | ELEV./ Length(m) | DESCRIPTION | Depth (m)

Depth scale: 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163

DESCRIPTION:

Presence of limonite.

Iron oxyde with few bands of white chert up to 155,0m.

Iron oxyde with 5 to 10% of white chert and 50% of limonite.

INTERVAL REC. DATA / STRENGTH DATA

Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index
1.5	100	93		R3	W2
1.5	60	11		R3	W2
1.0	50	0		R4	W2
0.5	100	100		R4	W2
1.5	93	0	12	R4	W2
0.5	80	40		R4	W4
1.0	50	12		R4	W4
1.0	100	16		R3	W4
0.5	90	80		R3	W3
1.5	90	56	12	R3	W3
0.5	100	50	12	R3	W3
1.0	100	70	9	R3	W3
1.5	80	77	9	R3	W3
0.3	100	50	8	R4	W3
2.7	100	92	8	R4	W3

DISCONTINUITY DATA

Depth (m)	Type & Number (#)	Orientation ALPHA (°)	Orientation BETA (°)	Surface Description Shape	Surface Description Roughness	Infill	Jr	Ja	Jn
148.08	JN	37	180	IR	RO	LI			
148.33	JN	58	200	PL	RO	LI			
148.43	JN	65	210	PL	SM	LI			
148.50	BD	38	20-25	PL	C	LI			
148.51	JN	63	210	PL	SM	LI			
152.45	JN	39	15	IR	RO	QZ			
152.54	JN	49	20	IR	RO	FE			
152.64	JN	44	145	IR	RO	FR			
152.65	JN	36	5	PL	SM	FE			
152.75	JN	41	20	PL	SM	FE			
152.79	BD	43	20	PL	C	QZ			
152.86	JN+BD	42	25	PL	RO	QZ			
152.94	JN	32	210	PL	RO	FR			
153.24	JN	50	200	IR	VR	FE			
157.06	BD	40	60	PL	C	LI			
157.12	JN	56	310	PL	SM	LI			
157.39	JN	56	320	PL	SM	LI			
157.50	JN	54	280	PL	SM	LI			
157.61	BD	36	125	PL	C	FE+LI			
157.64	JN	61	310	IR	RO	LI			
157.79	JN	33	150	IR	RO	LI			
157.81	JN	13	10	PL	SM	FE+LI			
157.85	JN	46	180	IR	RO	FR			
157.88	JN	16	10	PL	SM	FE+QZ			
157.90	BD	36-41	125	PL	C	FE+LI			
160.93	JN	43	180	PL	C	C			
160.95	JN	42	180	PL	C	C			
161.01	JN	45	305	IR	RO	FR			
161.33	JN	36	180	PL	SM	FE+LI			
161.36	BD	41	180	PL	C	FE			
161.39	BD	41	180	PL	C	QZ			
161.48	JN	45	180	PL	C	FE			
161.64	JN	54	305	IR	BR	FE+LI			
161.82	BD	39	180	PL	C	FE+LI			
161.95	JN	57	25	PL	SM	FE+LI			
162.00	JN	57	25	PL	SM	FE+LI			

Columns: Fault Breccia/ Gouge | Broken Core

NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS

Joints at 30 and 60°

Orientation test.

Bedding at 35°
Joints at 35 and 60°

Orientation test.

Bedding at 35 to 45°
Joints at 5,30, 40 and 60°

Bedding at 40°
Joint at 30 to 40°

Orientation test.

Bedding at 35 to 45°
Joint at 35 to 45, 60 and 90°

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

LVM

HOLE #:

BH-P-02

B.T.

Vertical Scale = 1 : 100

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-02

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-09-25
Northing:	6086299.006	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658177.634	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	522.18	Azimut:	197.40°	Drillers:	
Inclination:	60°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

B-0010504-3

ROCK TYPE

ELEV./ Length(m)	DESCRIPTION
	Iron oxyde with less then 5% of white chert and few bands of limonite. Concentration of limonite from 165,9 to 166,6m.
	Iron oxyde with 30 to 50% of white chert.
	Highly weathered zone from 170,70 to 171,0m.
372.36 173.00	End of borehole at a length of 173.0m.

Depth (m): 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178

INTERVAL REC. DATA / STRENGTH DATA

Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index
1.5	100	70		R3	W3
1.0	85	70	10	R3	W3
0.5	80	80	10	R4	W3
1.5	93	67	10	R4	W3
0.6	50	33		R3	W3
0.3	67	0		R3	W3
1.6	81	53	9	R3	W3
1.0	100	40		R3	W3

DISCONTINUITY DATA

Columns: Depth (m) | Type & Number (#) | Orientation: ALPHA (°), BETA (°) | Surface Description: Shape, Roughness, Infill | Jr | Ja | Jn | Fault Breccia/ Gouge | Broken Core

NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS

Bedding at 35 to 45°
Joint at 35 to 45, 60 and 90°

Bedding at 40 to 45°
Joints at 30,45 and 60°

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

LVM

HOLE #:

BH-P-02

CORE PHOTOGRAPHY - BOREHOLE N°: **BH-P-02**

File n°:	**B-0010504-3**	Project Name:	**Joyce Lake - Open Pit**	Date drilled & Logged:	2014-09-25
Northing:	6086299.006	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658177.634	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	522.18	Azimut:	197.40°	Drillers:	
Inclination:	60°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

HOLE #: **BH-P-02**

LVM

Y:\Style_LVM\Log\Log_Geotec_80Log_Rock_Photos_LVM_AN_Joyce_Lake.sty- Printed : 2014-11-18 10h

Vertical Scale = 1 : 0

B.T.

EQ-09-Ge-66A R.1 04.03.2009

CORE PHOTOGRAPHY - BOREHOLE N°: **BH-P-02**

File n°:	**B-0010504-3**	Project Name:	**Joyce Lake - Open Pit**	Date drilled & Logged:	2014-09-25
Northing:	6086299.006	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658177.634	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	522.18	Azimut:	197.40°	Drillers:	
Inclination:	60°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Length (m)

30

31

32

33

34

35

36

LVM

HOLE #: **BH-P-02**

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Vertical Scale = 1 : 0

B.T.

EQ-09-Ge-66A R.1 04.03.2009

Y:\Style_LVM\Log\Log_Geotec_80Log_Rock_Photos_LVM_AN_Joyce_Lake.sty- Printed : 2014-11-18 10h

CORE PHOTOGRAPHY - BOREHOLE N°: **BH-P-02**

File n°:	**B-0010504-3**	Project Name:	**Joyce Lake - Open Pit**	Date drilled & Logged:	2014-09-25
Northing:	6086299.006	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658177.634	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	522.18	Azimut:	197.40°	Drillers:	
Inclination:	60°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Length (m)

37 38 39 40 41 42 43 44 45 46 47

Vertical Scale = 1 : 0

B.T.

EQ-09-Ge-66A R.1 04.03.2009

HOLE #:

BH-P-02

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-02

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-09-25
Northing:	6086299.006	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658177.634	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	522.18	Azimut:	197.40°	Drillers:	
Inclination:	60°	Bit type: / Flush: / Feed:		Drill Rig:	LF-70

Length (m)

48
49
50
51
52
53
54
55
56
57
58

HOLE #: **BH-P-02**

LVM

Y:\Style_LVM\Log\Log_Geotec_80Log_Rock_Photos_LVM_AN_Joyce_Lake.sty- Printed : 2014-11-18 10h

Vertical Scale = 1 : 0

B.T.

CORE PHOTOGRAPHY - BOREHOLE N°: **BH-P-02**

File n°:	**B-0010504-3**	Project Name:	**Joyce Lake - Open Pit**	Date drilled & Logged:	2014-09-25
Northing:	6086299.006	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658177.634	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	522.18	Azimut:	197.40°	Drillers:	
Inclination:	60°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Length (m)

59 60 61 62 63 64 65 66 67 68

HOLE #: **BH-P-02**

LVM

Y:\Style_LVM\Log\Log_Geotec_80Log_Rock_Photos_LVM_AN_Joyce_Lake.sty- Printed : 2014-11-18 10h

Vertical Scale = 1 : 0

B.T.

EQ-09-Ge-66A R.1 04.03.2009

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-02

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-09-25
Northing:	6086299.006	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658177.634	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	522.18	Azimut:	197.40°	Drillers:	
Inclination:	60°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Length (m)

70
71
72
73
74
75
76

HOLE #: **BH-P-02**

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-02

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-09-25
Northing:	6086299.006	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658177.634	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	522.18	Azimut:	197.40°	Drillers:	
Inclination:	60°	Bit type: Flush: Feed:		Drill Rig:	LF-70

HOLE #:

BH-P-02

Y:\Style_LVM\Log\Log_Geotec_80Log_Rock_Photos_LVM_AN_Joyce_Lake.sty- Printed : 2014-11-18 11h

Vertical Scale = 1 : 0

B.T.

EQ-09-Ge-66A R.1 04.03.2009

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-02

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-09-25
Northing:	6086299.006	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658177.634	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	522.18	Azimut:	197.40°	Drillers:	
Inclination:	60°	Bit type: / Flush: / Feed:		Drill Rig:	LF-70

Length (m)

86
87
88
89
90
91
92

LVM

HOLE #: BH-P-02

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-02

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-09-25
Northing:	6086299.006	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658177.634	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	522.18	Azimut:	197.40°	Drillers:	
Inclination:	60°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Length (m)

93
94
95
96
97
98
99
100
101

HOLE #: **BH-P-02**

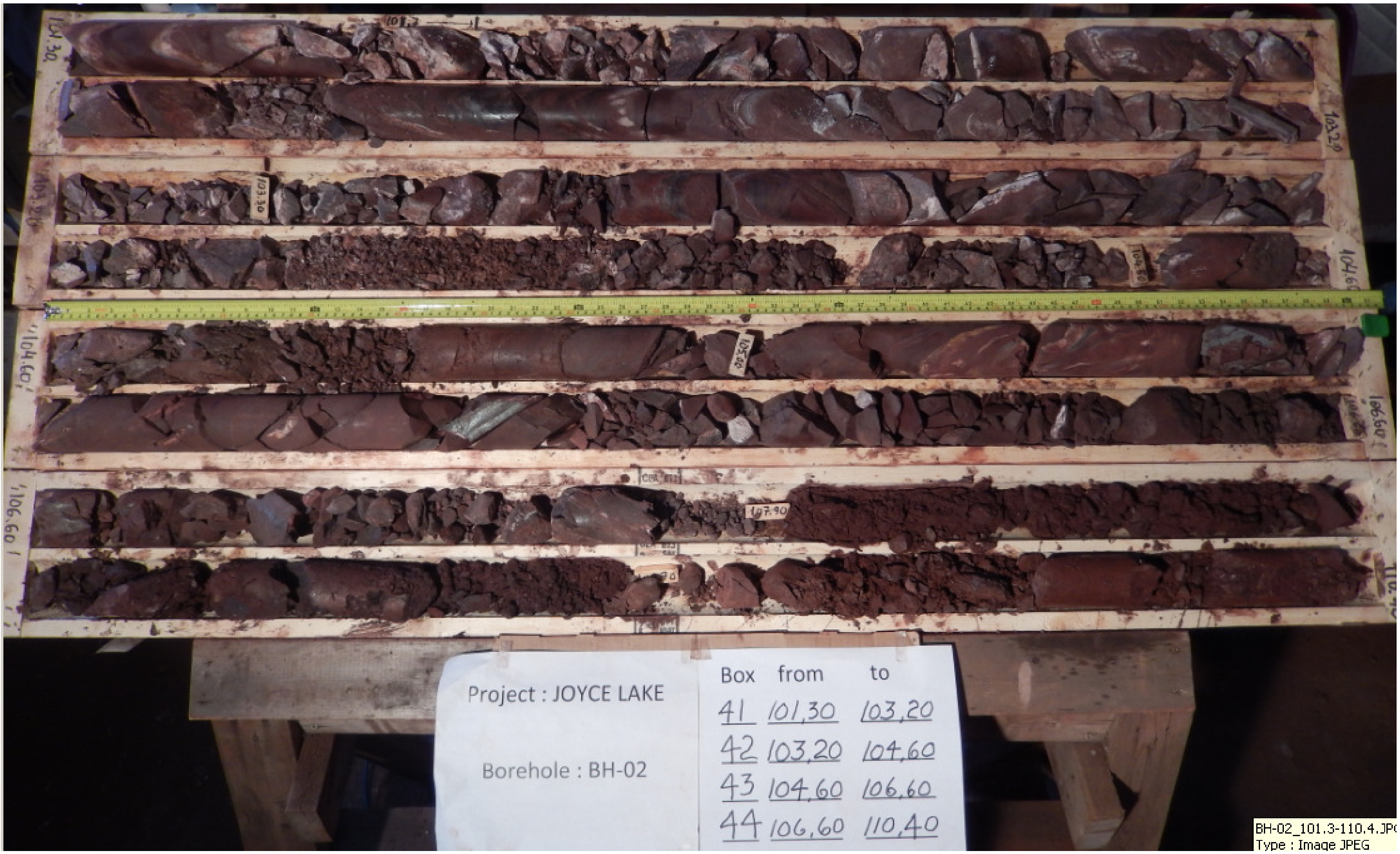
LVM

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-02

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-09-25
Northing:	6086299.006	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658177.634	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	522.18	Azimut:	197.40°	Drillers:	
Inclination:	60°	Bit type: / Flush: / Feed:		Drill Rig:	LF-70

Length (m)

102
103
104
105
106
107
108
109
110



HOLE #: BH-P-02

LVM

Vertical Scale = 1 : 0

B.T.

CORE PHOTOGRAPHY - BOREHOLE N°: **BH-P-02**

File n°:	**B-0010504-3**	Project Name:	**Joyce Lake - Open Pit**	Date drilled & Logged:	2014-09-25
Northing:	6086299.006	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658177.634	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	522.18	Azimut:	197.40°	Drillers:	
Inclination:	60°	Bit type: / Flush: / Feed:		Drill Rig:	LF-70

Length (m): 111 – 112 – 113 – 114 – 115 – 116 – 117 – 118 – 119 – 120

HOLE #: **BH-P-02**

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-02

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-09-25
Northing:	6086299.006	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658177.634	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	522.18	Azimut:	197.40°	Drillers:	
Inclination:	60°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Length (m)

121
122
123
124
125
126
127
128
129
130

HOLE #: **BH-P-02**

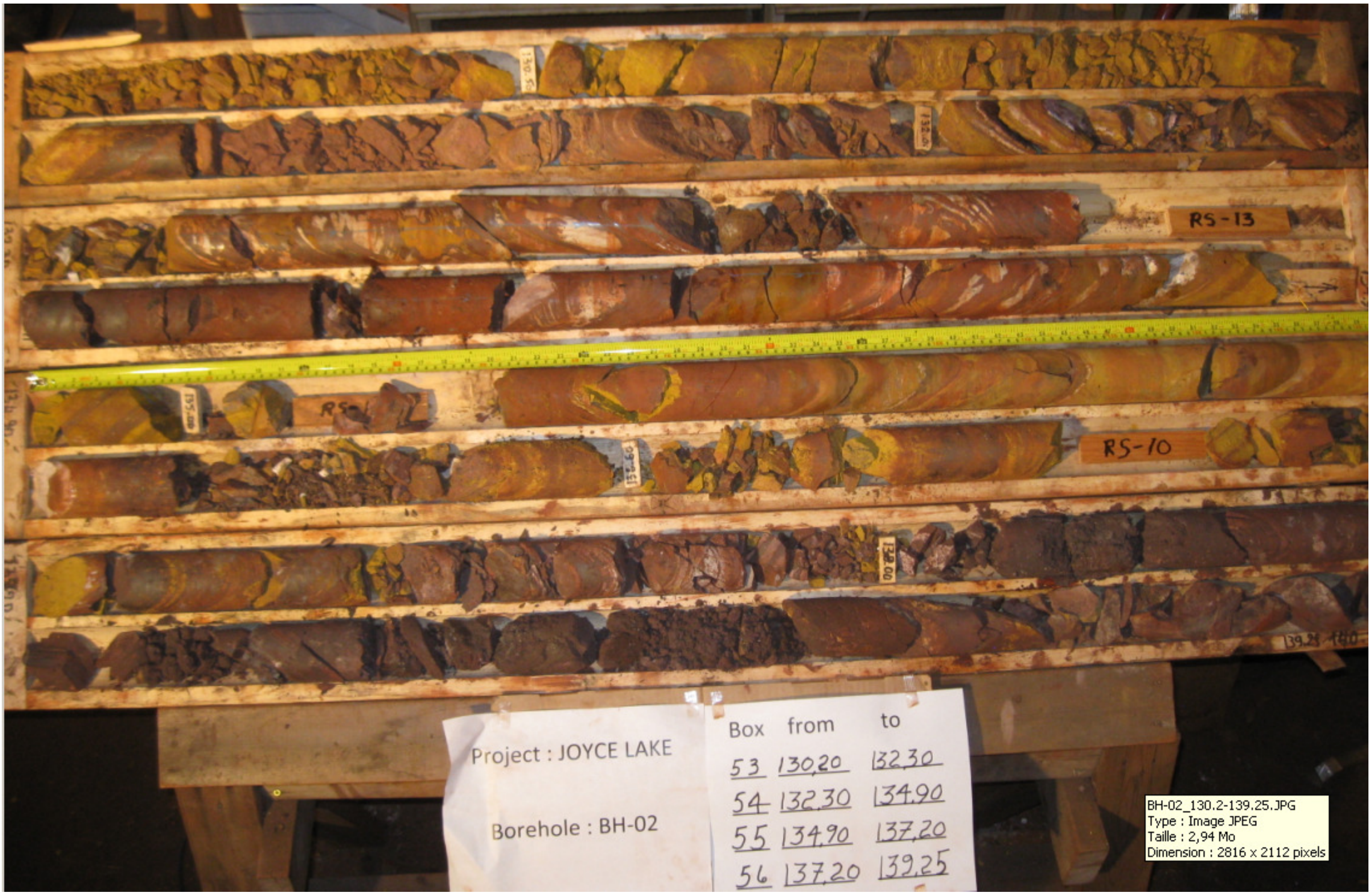
LVM

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-02

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-09-25
Northing:	6086299.006	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658177.634	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	522.18	Azimut:	197.40°	Drillers:	
Inclination:	60°	Bit type: / Flush: / Feed:		Drill Rig:	LF-70

Length (m)

131
132
133
134
135
136
137
138
139



HOLE #: **BH-P-02**

LVM

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-02

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-09-25
Northing:	6086299.006	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658177.634	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	522.18	Azimut:	197.40°	Drillers:	
Inclination:	60°	Bit type: / Flush: / Feed:		Drill Rig:	LF-70

Length (m)

139

140

141

HOLE #: BH-P-02

CORE PHOTOGRAPHY - BOREHOLE N°: **BH-P-02**

File n°:	**B-0010504-3**	Project Name:	**Joyce Lake - Open Pit**	Date drilled & Logged:	2014-09-25
Northing:	6086299.006	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658177.634	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	522.18	Azimut:	197.40°	Drillers:	
Inclination:	60°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Length (m)

143
144
145
146
147
148
149
150
151
152

HOLE #: **BH-P-02**

LVM

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-02

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-09-25
Northing:	6086299.006	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658177.634	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	522.18	Azimut:	197.40°	Drillers:	
Inclination:	60°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Length (m)

153
154
155
156
157
158
159
160
161
162

LVM

HOLE #:
BH-P-02

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-02

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-09-25
Northing:	6086299.006	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658177.634	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	522.18	Azimut:	197.40°	Drillers:	
Inclination:	60°	Bit type: Flush: Feed:		Drill Rig:	LF-70

Length (m)

163
164
165
166

167
168
169
170

HOLE #: **BH-P-02**

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design FILE N° : B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) BOREHOLE N° : BH-P-02

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
3,00	4,50	97	0								
4,50	5,40	60	10								
5,40	6,00	66	17								
6,00	6,50	70	20								
6,50	7,00	80	20								
7,00	7,50	100	40								
7,50	8,00	60	0								
8,00	9,50	17	0								
9,50	10,70	29	0								
10,70	11,00	57	0								
11,00	12,00	0	0								
12,00	12,70	21	0								
12,70	14,70	35	10								
14,70	15,00	83	47								
15,00	15,20	100	0								
15,20	15,30	100	0								
15,30	16,10	81	71								
16,10	16,60	60	0								
16,60	18,00	57	31								
18,00	19,70	0	0								
19,70	20,10	100	65								
20,10	20,40	83	73								
20,40	20,55	100	0								

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design

FILE N° : B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec)

BOREHOLE N° : BH-P-02

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
20,55	21,00	89	33								
21,00	21,90	100	0								
21,90	22,20	100	0								
22,20	23,10	94	30								
23,10	23,40	100	0								
23,40	24,00	45	0								
24,00	24,70	36	0								
24,70	24,90	100	0								
24,90	25,40	40	0								
25,40	25,95	55	0								
25,95	26,30	100	29								
26,30	26,50	75	0								
26,50	27,80	65	27								
27,80	28,70	100	46								
28,70	29,40	86	33								
29,40	31,30	95	42								
31,30	33,40	100	32								
33,40	34,40	100	13								
34,40	34,60	100	0								
34,60	34,80	100	0								
34,80	36,00	100	70								
36,00	36,35	86	0								
36,35	37,50	82	41								

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design **FILE N° :** B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) **BOREHOLE N° :** BH-P-02

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
37,50	37,70	100	50								
37,70	38,00	100	90								
38,00	39,15	91	41								
39,15	40,30	52	10								
40,30	40,70	62	0								
40,70	42,20	100	27								
42,20	42,50	100	0								
42,50	43,70	54	13								
43,70	45,30	12	0								
45,30	47,00	15	0								
47,00	47,30	100	0								
47,30	48,00	100	58								
48,00	49,00	100	62								
49,00	49,80	31	0								
49,80	51,00	43	0								
51,00	52,20	67	43								
52,20	52,40	75	0								
52,40	52,80	63	0								
52,80	54,00	8	0								
54,00	55,00	100	22								
55,00	55,50	50	0								
55,50	56,00	50	0								
56,00	57,00	100	0								

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

LVM

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design **FILE N° :** B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) **BOREHOLE N° :** BH-P-02

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
57,00	57,40	100	38								
57,40	59,00	58	30								
59,00	59,70	70	0								
59,70	60,40	11	0								
60,40	61,00	100	83								
61,00	61,63	100	48								
61,63	63,20	100	6								
63,20	64,70	100	47								
64,70	65,10	100	30								
65,10	65,57	100	0								
65,57	67,04	40	0								
67,04	67,74	100	0								
67,74	69,24	100	57								
				68,64	69,24	BD	30	345	PL		Fine bedding
					68,64	1 JN	45	90	PL	SM	
					68,78	1 JN	43	95	PL	SM	
					68,78	1 JN	40	295	PL	SM	
					68,88	1 JN	40	55	IR	ST	
					68,95	1 JN	90		IR	SM	
					69,04	1 JN	46	42	IR	RO	
				69,05	69,11	4 JN	33	38	IR	RO	
					69,19	1 JN	52	40	PL	RO	
				69,19	69,24	4 JN	42	20	PL	RO	

Type	
Joint:	**JN**
Fault:	**FLT**
Shear	**SHR**
Vein:	**VN**
Bedding:	**BD**
Foliation:	**FO**
Contact:	**CO**

Roughness	
Polished:	**PO**
Slickinsided:	**K**
Smooth:	**SM**
Rought:	**RO**
Very rought:	**VR**

Shape	
Planar:	**PL**
Curved:	**CU**
Undulating:	**UN**
Stepped:	**ST**
Irregular:	**IR**

Infilling	
Broken rock:	**BR**
Sand:	**SA**
Silt:	**SI**
Clay:	**CL**
Gouge:	**GO**
Biotite:	**BT**
Calcite:	**CA**
Chlorite:	**CH**
Iron:	**FE**
Hématite:	**HE**
Quartz:	***QZ***
Limonite:	***LI***

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design **FILE N° :** B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) **BOREHOLE N° :** BH-P-02

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
69,24	70,00	53	37								
70,00	70,78	100	64								
70,78	71,58	100	41								
71,58	71,78	50	0								
71,78	72,78	100	31								
72,78	73,58	44	0								
73,58	74,58	100	56								
74,58	75,58	100	36								
75,58	76,90	100	100								
76,90	78,00	60	18								
78,00	79,80	83	32								
79,80	81,00	100	28								
81,00	82,40	100	34								
82,40	84,00	96	25								
84,00	85,30	100	10								
85,30	86,80	100	20								
86,80	88,50	88	34								
88,50	88,90	100	30								
88,90	89,10	100	70								
89,10	90,00	100	63								
90,00	91,20	100	45								
91,20	92,30	100	0								
92,30	93,00	100	38								

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design   **FILE N° :** B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec)   **BOREHOLE N° :** BH-P-02

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
93,00	94,00	85	14								
94,00	95,60	100	36								
95,60	96,90	88									
96,90	97,10	100	0								
97,10	98,50	100	68								
98,50	100,20	100	41								
100,20	101,70	100	40								
101,70	103,30	100	36								
103,30	104,50	100	21								
104,50	105,00	100	60								
105,00	106,60	90	25								
106,60	107,90	27	8								
107,90	109,70	39	0								
109,70	111,00	69	0								
111,00	111,76	67	0								
111,76	112,80	50	30								
112,80	112,92	100	90								
112,92	114,00	100	90								
114,00	115,30	100	73								
					114,40	1JN	19	75	IR	VR	QZ
					114,43	1BD	25	53	UN		QZ
					114,51	1BD	25	35	UN		QZ
					114,57	1BD+1JN	21	35	PL	RO	QZ

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

LVM

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design FILE N° : B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) BOREHOLE N° : BH-P-02

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
					114,63	1JN	32	35	PL		QZ
					114,66	1BD	36	55	PL		QZ
					114,68	1BD	36	50	PL		QZ
					114,76	1BD	36	65	PL		QZ
					114,81	1BD	25	50	PL		QZ
					114,89	1BD	19	70	PL		QZ
					114,91	1JN	58	35	IR		FE
					114,99	1BD	27	80	PL		QZ
					115,13	1BD	40	118	PL		QZ
					115,14	1JN	48	70	IR	RO	FE
					115,16	1BD	40	118	PL		QZ
					115,19	1BD	60	118	PL		QZ
					115,30	1JN	32	285	IR	RO	QZ+FE
115,30	115,40	100	100								
115,40	115,60	100	100								
115,60	117,00	64	43								
117,00	117,90	100	89								
117,90	118,60	86	0								
118,60	120,20	100	38								
					119,60	1JN	38	45	PL	RO	FE+QZ
					119,67	1BD	33	45	PL		QZ
					119,75	1JN	33	60	PL	SM	FE
				119,67	119.83	> 20 BD	33	40 TO 45	PL		FE+QZ

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design **FILE N° :** B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) **BOREHOLE N° :** BH-P-02

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
					119,80	1JN	73	55	PL	RO	FE
					119,91	1JN	39	57	PL		
					119,91	1BD	40	57	PL		QZ
				120,10	120,20	> 20 BD	24	55 TO 60	PL		FE+QZ
					120,11	1JN	30	60	PL		
120,20	121,50	23	0								
121,50	123,10	88	75								
123,10	123,60	100	72								
123,60	124,80	100	17								
124,80	126,10	100	100								
126,10	127,70	100	69								
127,70	128,00	100	33								
128,00	129,10	100	50								
129,10	130,50	100	17								
130,50	132,00	100	20								
132,00	133,60	100	69								
					132,35	1JN	74	345	PL	RO	LI
					132,42	1BD	33	165	IR		QZ
					132,43	1JN	33	180	IR		
					132,56	1BD	33	140	PL		QZ
					132,62	1JN	43	60	PL		
					132,63	1BD	33	140	IR		QZ
					132,71	1JN	40	85	IR	RO	FE+QZ

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design FILE N° : B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) BOREHOLE N° : BH-P-02

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
					132,78	1BD	40	145	PL		QZ
				132,91	132,94	4JN	36	120	PL	RO	FE+QZ
				132,91	132,94	4BD	36	120	PL		QZ+FE
					132,37	1JN	47	125	IR	RO	FE
				132,47	132,53	9BD	30 to 51	140	IR		QZ+FE
133.6	135,00	100	71								
					134,08	1JN	33	210	PL	RO	FE
					134,12	1JN	31	10	UN	RO	QZ
					134,17	1BD	31	15	IR		QZ
					134,22	1BD	36	15	PL		QZ
					134,25	1BD	36	15	PL		QZ
					134,26	1JN	33	20	PL	SM	FE
					134,33	1BD	33	0	PL		QZ
					134,37	1BD	32	0	PL		QZ
					134,41	1BD	30	0	PL		QZ
					134,47	1JN	55	220	IR	RO	FE+QZ+LI
					134,54	1JN	26	245	IR	SM	FE+QZ+LI
				134,58	134,74	15BD	41 to 43	15	PL		FE+QZ
					134,80	1BD	34	0	PL		QZ
					134,88	1JN	38	5	IR	RO	LI
					134,92	1BD	42	5	PL		FE
					134,96	1BD	38	5	PL		FE
					135,00	1JN	45	5	IR	RO	LI+QZ

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design FILE N° : B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) BOREHOLE N° : BH-P-02

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
135,00	136,60	94	83								
136,60	138,00	100	57								
138,00	139,60	94	34								
139,60	141,00	100	50								
					140,45	1JN	39				
				140,45	140,59	15BD	36 to 41				
					140,59	1JN	41				
				140,59	140,72	9BD	40 to 43				
					140,68	1JN	40				
					140,72	1JN	40				
				140,72	141,09	Broken rock					
				141,09	141,22	16BD	38 to 40				
					141,22	1JN	39				
				141,22	141,40	16BD	39				
					141,33	1JN	38				
					141,40	1JN	34				
				141,40	141,64	17BD	36 to 39				
					141,64	1JN	39				
					141,70	1BD	43				
					141,88	1BD	43				
					142,03	1BD	40				
					142,20	1JN	35				
					142,45	1JN	31				

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design **FILE N° :** B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) **BOREHOLE N° :** BH-P-02

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
					142,45	2BD	49				
141,00	142,50	100	87								
142,50	144,00	93	40								
144,00	145,50	67	33								
145,50	147,00	100	37								
					146,79	1JN	48	250	PL	SM	LI
					146,85	1JN	51	50	PL	SM	LI
					146,93	1JN	34	135	PL	SM	LI
					147,00	1JN	36	40	PL	SM	LI
					147,00	1JN	38	250	PL	SM	LI
147,00	148,50	100	63								
					147,66	1JN	41	175	IR	RO	QZ
				147,66	147,74	8BD	44	165	PL		FE+QZ
					147,78	1JN	42	340	IR	RO	FE
					147,82	1JN	47	175	IR	RO	FE
					147,83	1BD	50	0	PL		QZ
					147,86	1JN	56	180	PL	SM	FE
					148,08	1JN	37	18O	IR	RO	LI
				148,10	148,50	>20 BD	38	20 to 25	PL		LI
					148,33	1JN	58	200	PL	RO	LI
					148,43	1JN	65	210	PL	SM	LI
					148,51	1JN	63	210	PL	SM	LI
148,50	150,00	100	93								

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design **FILE N° :** B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) **BOREHOLE N° :** BH-P-02

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
150,00	151,50	60	11								
151,50	152,50	50	0								
152,50	153,00	100	100								
					152,45	1JN	39	15	IR	RO	QZ
					152,54	1JN	49	20	IR	RO	FE
					152,64	1JN	44	145	IR	RO	
					152,65	1JN	36	5	PL	SM	FE
					152,75	1JN	41	20	PL	SM	FE
					152,79	1BD	43	20	PL		QZ
					152,86	1JN+1BD	42	25	PL	RO	QZ
					152,94	1JN	32	210	PL	RO	
					153,24	1JN	50	200	IR	VR	FE
153,00	154,50	93	85								
154,50	155,00	80	40								
155,00	156,00	50	12								
156,00	157,00	100	16								
					157,06	1BD	40	60	PL		LI
					157,12	1JN	56	310	PL	SM	LI
					157,39	1JN	56	320	PL	SM	LI
				157,50	157,61	> 20 BD	36	125	PL		FE+LI
					157,50	1JN	54	280	PL	SM	LI
				157,64	157,90	> 20 BD	36 at 41	125	PL		FE+LI
					157,64	1JN	61	310	IR	RO	LI

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design FILE N° : B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) BOREHOLE N° : BH-P-02

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
					157,79	1JN	33	150	IR	RO	LI
					157,81	1JN	13	10	PL	SM	FE+LI
					157,85	1JN	46	180	IR	RO	
					157,88	1JN	16	10	PL	SM	FE+QZ
					157,90	1JN	35	150	PL	SM	FE+LI
157,00	157,50	90	80								
157,50	159,00	90	56								
159,00	159,50	100	50								
159,50	160,50	100	70								
160,50	162,00	80	77								
				160,80	161,33	> 20 BD	38 to 42	180	PL		FE + QZ
					160,93	1JN	43	180	PL		
					160,95	1JN	42	180	PL		
					161,01	1JN	45	305	IR	RO	
					161,33	1JN	36	180	PL	SM	FE + LI
					161,36	1BD	41	180	PL		FE
					161,39	1BD	41	180	PL		QZ
					161,48	1JN	45	180	PL		FE
					161,64	1JN	54	305	IR	VR	FE + LI
				161,64	162,00	> 20 BD	39	180	PL		FE+QZ+LI
					161,95	1JN	57	25	PL	SM	FE + LI
					162,00	1JN	57	25	PL	SM	FE + LI
162,00	162,30	100	50								

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design

FILE N° : B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec)

BOREHOLE N° : BH-P-02

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
162,30	165,00	100	92								
165,00	166,50	100	70								
166,50	167,50	85	70								
167,50	168,00	80	80								
168,00	169,50	93	67								
169,50	170,10	50	33								
170,10	170,40	67	0								
170,40	172,00	81	53								
172,00	173,00	100	40								

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

B.T.

Vertical Scale = 1 : 100

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-03

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086562.697	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658422.620	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	526.33	Azimut:	45.00°	Drillers:	
Inclination:	70°	Bit type: / Flush: / Feed:		Drill Rig:	LF-70

Casing&Core Diameter/Depth (m)	Water Notes	ELEV./ Length(m)	DESCRIPTION	Depth (m)	Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index	Depth (m)	Type & Number (#)	ALPHA (°)	BETA (°)	Shape	Roughness	Infill	Jr	Ja	Jn	Fault Breccia/ Gouge	Broken Core	NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS
		526.33 0.00	**Casing**	0–9																			
		517.87 9.00	Completely weathered grey to reddish **Iron Oxyde** with milimetric and centimetrics bands of red and white chert.	10	2.0	2	20																
				11	1.0	20	40																
				12–13	1.5	40	0		R0	W5												Broken core	
				13–14	1.5	40	0		R0	W5												Broken core	

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

LVM

HOLE #: **BH-P-03**

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B-0010504-3

B.T.

Vertical Scale = 1 : 100

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-03

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086562.697	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658422.620	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	526.33	Azimut:	45.00°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Columns: Casing&Core Diameter/Depth (m) | Water Notes | ROCK TYPE: ELEV./ Length(m), DESCRIPTION, Depth (m) | INTERVAL REC. DATA: Inertval No. & Depth (from-to)(m), TCR (%), RQD (%), Fractures per_1_m | STRENGTH DATA: Strength Index, Weathering Index | DISCONTINUITY DATA: Depth (m), Type & Number (#), Orientation (ALPHA (°), BETA (°)), Surface Description (Shape, Roughness, Infill), Jr, Ja, Jn | Fault Breccia/ Gouge | Broken Core | NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS

Depth markers: 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29

Interval length (m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index
1.5	47	0		R0	W5
0.2	100	0		R0	W5
1.3	92	70		R0	W5
1.3	100	50		R0	W5
0.2	50	0		R0	W5
1.5	6	0			
1.5	13	0			
1.5	33	0		R0	W5
1.2	100	80	17	R0	W5
0.3				R0	W5
1.5	47	0		R0	W5
1.5	13	0			
1.5	33	0		R3	W4

Rock type at 499.74 / 28.30: Grey to blackish massive **Iron Oxyde** , weathered. Medium grain.

Notes/comments:
- Bedding at 50° Joints at 60 to 80°
- Bedding at 60° Joints at 55 to 65°

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

HOLE #: **BH-P-03**

EQ-09-Ge-66A R.1 04.03.2009

B.T.

Vertical Scale = 1 : 100

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-03

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086562.697	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658422.620	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	526.33	Azimut:	45.00°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

B-0010504-3

ROCK TYPE

ELEV./ Length(m)	DESCRIPTION
497.20 / 31.00	**Highly weathered zone**
497.01 / 31.20	Grey to blackish massive **Iron Oxyde**, weathered. Medium grain.
496.82 / 31.40	**Highly weathered zone**
496.73 / 31.50	Grey to blackish massive **Iron Oxyde**, weathered. Medium grain.
493.44 / 35.00	**Iron Oxyde** interbedded with milimetrics band of red chert and milimetrics to centimetrics band of white chert.
486.21 / 42.70	Completely weathered [Iron Oxyde]"/b" interbeded with milimetrics band of red chert and milimetrics to centimetrics band of white chert.
485.64 / 43.30	
484.80 / 44.20	
484.70	

INTERVAL REC. DATA / STRENGTH DATA

Depth (m)	Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index
30–31.5	1.5	33	0		R3	W4
31.5–33	1.5	20	0			
33	0.8	100	37		R3	W4
34	0.7	71	0		R3	W4
35	0.8	75	0		R3	W4
35–36	0.7	43	0		R3	W4
36–37	1.0	15	0			
37	0.5	40	0		R3	W4
38	1.5	53	0		R3	W4
39–40	1.5	33	0		R3	W4
41	1.5	13	0			
42–43	1.5	100	0		R3	W4
44	1.5	100	0		R5	W5

DISCONTINUITY DATA

Depth (m)	Type & Number (#)	Orientation: ALPHA (°)	Orientation: BETA (°)	Surface Description: Shape	Surface Description: Roughness	Surface Description: Infill	Jr	Ja	Jn	Fault Breccia/ Gouge	Broken Core	NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS
												Bedding at 75° Joints at 75°

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

LVM

HOLE #: **BH-P-03**

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-03

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086562.697	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658422.620	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	526.33	Azimut:	45.00°	Drillers:	
Inclination:	70°	Bit type: Flush:	Feed:	Drill Rig:	LF-70

ROCK TYPE

ELEV./ Length(m)	DESCRIPTION
484.42 / 44.60 – 483.86 / 45.20	Altered **Iron Oxyde** interbeded with milimetrics band of red Chert and milimetrics to centimetrics band of white Chert.
	Quartz vein
	Highly weathered zone
	Quartz vein
	Iron Oxyde interbeded with milimetrics band of red Chert and milimetrics to centimetrics band of white Chert. Interbeded with 5 to 10 cm earth zones bands.
475.02 / 54.60 – 474.65 / 55.00	**Iron Oxyde** with 70% of white Chert.
	Iron Oxyde interbeded with milimetrics band of red Chert and milimetrics to centimetrics band of white Chert. Interbeded with 5 to 10 cm earth zones bands.
473.71 / 56.00 – 473.52 / 56.20	**Iron Oxyde** with 70% of white Chert.
	Altered **Iron Oxyde** interbeded with milimetrics band of red Chert and milimetrics to centimetrics band of white Chert.

Depth (m): 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59

INTERVAL REC. DATA / STRENGTH DATA

Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index
1.5	17	0			
1.5	23	0		R4	W4
1.5	100	12	18	R4	W4
1.5	80	0		R4	W4
1.5	20	0	17	R4	W4
1.5	50	16		R4	W4
1.0	90	30	10	R4	W4
1.7	100	30		R4	W4
1.1	55	0		R4	W4
0.7	100	21	17	R4	W4
0.8	100	25		R4	W4
0.7	100	0		R4	W4

DISCONTINUITY DATA

Columns: Depth (m) | Type & Number (#) | Orientation: ALPHA (°), BETA (°) | Surface Description: Shape, Roughness, Infill | Jr | Ja | Jn | Fault Breccia/ Gouge | Broken Core | NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS

NOTES/COMMENTS:
- Bedding at 70° Joints at 5,30 and 70°
- Bedding at 70° Joints at 70°
- Bedding at 70 to 75° Joints at 10,50 and 70°
- Bedding at 70° Joints at 10,30 and 70°

B.T.

Vertical Scale = 1 : 100

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

HOLE #: **BH-P-03**

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-03

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086562.697	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658422.620	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	526.33	Azimut:	45.00°	Drillers:	
Inclination:	70°	Bit type:	Flush: / Feed:	Drill Rig:	LF-70

ROCK TYPE

ELEV./ Length(m)	DESCRIPTION
463.14 / 67.25 – 462.90 / 67.50	**Hematite** red and white Chert, Limonite.
462.15 / 68.30	Grey massive **Iron Oxyde** with few fine beddings of white Chert.
461.68 / 68.80	**Iron Oxyde** interbeded with milimetrics band of red Chert and milimetrics to centimetrics band of white Chert. More then 50% of white Chert.
461.30 / 69.20 – 461.02 / 69.50	
458.95 / 71.70	**Iron Oxyde** interbeded with milimetrics band of red Chert and milimetrics to centimetrics band of white Chert, Limonite.
458.67 / 72.00	**Iron Oxyde** interbeded with milimetrics band of red Chert and milimetrics to centimetrics band of white Chert. More then 50% of white Chert.
457.36 / 73.40	
456.42	

INTERVAL REC. DATA / STRENGTH DATA

Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index
0.7	100	0		R4	W4
0.2	100	0		R4	W4
1.3	30	0		R4	W4
1.5	100	30	26	R4	W4
0.6	83	0		R4	W4
1.5	100	0		R4	W4
0.3	100	67		R4	W4
0.6			20	R4	W4
1.5	53	23		R4	W4
0.8	100	88		R5	W2
0.7	100	50	22	R5	W2
1.5	53	40		R3	W4
1.2	58	0		R3	W4
0.3				R0	W5
1.5	47	0		R3	W4
0.9	78	56	12	R2	W4

Depth (m): 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74

DISCONTINUITY DATA

Depth (m) | Type & Number (#) | Orientation: ALPHA (°), BETA (°) | Surface Description: Shape, Roughness, Infill | Jr | Ja | Jn | Fault Breccia/ Gouge | Broken Core

NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS

- Bedding at 20 to 30° Joints at 20, 30 and 45°
- Bedding at 60 to 70° Joints at 10, 60 and 75°
- Bedding at 65 to 70° Joints at 5,10 and 65, 70°
- Bedding at 65° Joints at 40 and 65°

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

LVM

HOLE #: **BH-P-03**

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-03

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086562.697	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658422.620	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	526.33	Azimut:	45.00°	Drillers:	
Inclination:	70°	Bit type: / Flush: / Feed:		Drill Rig:	LF-70

ROCK TYPE

ELEV./ Length(m)	DESCRIPTION
455.85 / 75.00	Weathered **Iron Oxyde** interbedded with milimetrics band of red Chert and milimetrics to centimetrics band of white Chert.
	Highly weathered zone
	Weathered **Iron Oxyde** interbedded with milimetrics band of red Chert and milimetrics to centimetrics band of white Chert. With few 5cm Earthy zones.
453.03 / 78.00	Completely weathered, iron Oxyde, interbeded with milimetrics band of red Chert and milimetrics to centimetrics band of white Chert. weathered zone at depth of 74.0m.
451.25 / 79.90	**Hematite** red and white Chert, ±Limonite.
450.68 / 80.50	Weathered black **Shale** with bands of **Iron Oxyde** interbedded with milimetrics band of red Chert and milimetrics to centimetrics band of white Chert.
448.62 / 82.70	Black **Shale** with milimetrics beds of white Chert.
	Black **Shale** with more then 50% of white Chert.
	Black **Shale** with milimetrics beds of white Chert.
	Black **Shale** with more then 50% of white Chert.
445.89 / 85.60	Black **Shale** with milimetrics beds of white Chert.

Depth (m): 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89

INTERVAL REC. DATA / STRENGTH DATA / DISCONTINUITY DATA

Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index	Broken Core	NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS
0.6	100	33		R3	W5		Bedding at 65° Joints at 40 and 65°
1.5	80	10		R3	W5	X	
0.3	67	0		R3	W5	X	
0.7				R3	W5	X	
0.5				R3	W5	X	
1.5	100	93	7	R6	W3		Bedding at 70° Joints at 5, 20, 45 and 70°
1.5	100	77	11	R6	W2		Bedding at 65 to 70° Joints at 20 and 70°
1.5	100	75	9	R6	W2		Bedding at 70° Joints at 5, 45 and 70°
1.5	100	75	10	R6	W2		Bedding at 70° Joints at 30 and 70°
1.5	100	73	12	R6	W2		Bedding at 70 to 75° Joints at 5, 30 and 70, 75°
1.5	100	56	10	R6	W2		Bedding at 65 to 70° Joints at 5, 20 and 65, 70°
1.5	100	67	13	R6	W2		Bedding at 70° Joints at 5, 30 and 70°
1.5	87	80	3	R6	W2		Bedding at 70 to 75° Joints at 20 and 70°

Other columns (Casing&Core Diameter/Depth (m), Water Notes, Depth (m), Type & Number (#), Orientation: ALPHA (°), BETA (°), Surface Description: Shape, Roughness, Infill, Jr, Ja, Jn, Fault Breccia/Gouge): no entries.

Legend

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

LVM

HOLE #: **BH-P-03**

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-03

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086562.697	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658422.620	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	526.33	Azimut:	45.00°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

B.T.

Vertical Scale = 1 : 100

ROCK TYPE

ELEV./ Length(m)	Depth (m)	DESCRIPTION
438.47	93.50	Black **Shale** with motre then 50% of white chert. Crushed rock
438.19	93.80	Black **Shale** with milimetrics beds of white Chert.
436.16	95.96	Quartz/felspath vein.
436.12	96.00	Black **Shale** with milimetrics beds of white Chert.
435.93	96.20	Quartz/felspath vein.
435.79	96.35	Massive black shale
434.71	97.50	Black **Shale** with milimetrics beds of white Chert.
428.46		

INTERVAL REC. DATA / STRENGTH DATA

Depth (m)	Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index
90–91	1.5	100	67	12	R6	W2
92	1.5	100	40	11	R6	W2
93	0.5	100	31	16	R6	W2
94	1.0	100	31	17	R6	W2
95	1.5	97	54	10	R6	W2
96–97	1.5	100	40	10	R6	W2
98	1.5	100	50	10	R6	W2
99–100	1.5	100	63	6	R6	W2
101	1.5	100	59	18	R6	W2
102–103	1.6	100	69	12	R6	W2
104	1.4	100	27		R6	W2

DISCONTINUITY DATA

Columns: Depth (m) | Type & Number (#) | Orientation: ALPHA (°), BETA (°) | Surface Description: Shape, Roughness, Infill | Jr | Ja | Jn | Fault Breccia/ Gouge | Broken Core

NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS

- Bedding at 70 to 75° Joints at 20 and 70°
- Bedding at 70 to 75° Joints at 15, 30 and 70°
- Bedding at 70° Joints at 30 and 70°
- Bedding at 70° Joints at 30 and 70°
- Bedding at 70° Joints at 20, 30 and 70°
- Joints at 30 and 70°
- Bedding at 75° Joints at 40 and 70°
- Bedding at 70° Joints at 70°
- Bedding at 70° Joints at 5, 30 and 70°
- Bedding at 70° Joints at 5, 10 and 30, 70°

Legend

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

LVM

HOLE #: **BH-P-03**

B.T.

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-03

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086562.697	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658422.620	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	526.33	Azimut:	45.00°	Drillers:	
Inclination:	70°	Bit type:	Flush: / Feed:	Drill Rig:	LF-70

ROCK TYPE

ELEV./ Length(m)	DESCRIPTION
	Black **Shale** interbedded with grey sandstone.
427.47 / 105.20	Black **Shale** with milimetrics beds of white Chert.
424.37 / 108.50	Gray **Sandstone**, fine to medium grain.
419.67 / 113.50	Grey to yellow to brown, altered coarse grained sandstone.
419.02 / 114.20	Grey **Sandstone**, fine to medium grain.
415.26 / 118.20	Grey **Sandstone**, fine to medium grain interbedded with black shale.
414.98 / 118.50	

Depth (m): 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119

INTERVAL REC. DATA / STRENGTH DATA / DISCONTINUITY DATA

Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index	NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS
1.4	100	27		R6	W2	
1.5	100	93	11	R6	W2	Bedding at 70° Joints at 5, 45, 60 and 70°
1.5	83	83	5	R6	W2	Bedding at 70° Joints at 30 and 70°
1.5	100	70	13	R6	W2	Bedding at 70° Joints at 5, 10 and 30, 70°
1.5	100	100	4	R6	W2	Joints at 10, 15 and 30°
1.5	100	80	5	R6	W2	Joints at 5 and 30°
1.5	87	35	10	R6	W2	Joints at 5,10 and 60, 80°
0.7	100	29	20	R6	W2	Joints at 5,10 and 60, 70, 80°
0.8	100	30	11	R6	W2	Joints at 30,60 and 70°
1.5	93	73	10	R6	W2	Joints at 10, 20 and 70°
0.3	100	100	10	R6	W2	
1.2	100	100	10	R6	W2	Bedding at 75° Joints at 20 and 70°
1.5	93	87	9	R6	W2	

Discontinuity data columns: Depth (m), Type & Number (#), Orientation: ALPHA (°), BETA (°); Surface Description: Shape, Roughness, Infill; Jr, Ja, Jn; Fault Breccia/ Gouge; Broken Core (no entries)

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

HOLE #: **BH-P-03**

Vertical Scale = 1 : 100

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-03

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086562.697	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658422.620	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	526.33	Azimut:	45.00°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

B.T.

Vertical Scale = 1 : 100

ROCK TYPE

ELEV./ Length(m)	DESCRIPTION
414.04 / 119.50	Grey **Sandstone**, fine to medium grain.
	Interbedded with black shale.
413.38 / 120.20	Grey **Sandstone**, fine to medium grain.
412.63 / 121.00	Interbedded with black shale.
412.16 / 121.50	Grey **Sandstone**, fine to medium grain.
411.31 / 122.40	Interbedded with black shale.
411.03 / 122.70	Grey **Sandstone**, fine to medium grain.
406.52 / 127.50	Grey **Sandstone**, coarse grain altered.
404.55 / 129.60	**Siltstone**

Depth (m): 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134

INTERVAL REC. DATA / STRENGTH DATA / DISCONTINUITY DATA

Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index	NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS
1.5	93	87	9	R6	W2	Bedding at 50 to 75° Joints at 5, 30 and 50,70°
1.5	100	80	10	R6	W2	Bedding at 60 to 75° Joints at 15, 30 and 50,70°
1.1	100	100	17	R6	W2	
0.4	100	62		R6	W2	
1.5	100	100	8	R6	W2	Bedding at 60 to 75° Joints at 5, 30 and 60°
1.0	100	100	7	R6	W2	Bedding at 70° Joints at 30, 45 and 70°
0.5	100	100	7	R6	W2	
1.5	100	77	11	R6	W2	Bedding at 75° Joints at 20, 25 and 70°
1.5	93	100	12	R6	W2	Joints at 20, 60 and 70°
1.5	100	89	8	R4	W3	Joints at 50 and 70°
1.5	93	75	4	R4	W3	Joints at 30 and 90°
1.5	100	50	17	R6	W2	Joints at 10,40 and 60, 65°

Other column headings (no entries): Casing&Core Diameter/Depth (m); Water Notes; Depth (m); Type & Number (#); Orientation: ALPHA (°), BETA (°); Surface Description: Shape, Roughness, Infill; Jr; Ja; Jn; Fault Breccia/ Gouge; Broken Core

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

HOLE #:

BH-P-03

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B-0010504-3

B.T.

Vertical Scale = 1 : 100

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-03

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086562.697	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658422.620	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	526.33	Azimut:	45.00°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Casing&Core Diameter/Depth (m)	Water Notes	ELEV./ Length(m)	DESCRIPTION	Depth (m)	Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index	Depth (m)	Type & Number (#)	ALPHA (°)	BETA (°)	Shape	Roughness	Infill	Jr	Ja	Jn	Fault Breccia/ Gouge	Broken Core	NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS
				135	1.5	100	91	7	R6	W2													Bedding at 75° Joints at 20, 45 and 70°
				136	1.5	100	80	15	R6	W2													Bedding at 70° Joints at 15, 50 and 70°
				137	1.5	100	59	11	R6	W2													
				138–139	1.5	100	55	7	R6	W2													Joints at 10 an 65°
		394.77 140.00	Siltstone interbedded with black shale.	140	1.5	100	80	9	R6	W2													Joints at 40,50 and 70°
		392.89 142.00	Siltstone.	141–142	1.5	100	87	7	R6	W2													Bedding at 60 to 70° Joints at 30 and 60, 70°
				143	1.5	100	40	3	R6	W2													Bedding at 65 to 70° Joints at 5 and 60, 70°
				144–145	1.5	100	93	10	R6	W2													Joints at 40 60 and 70°
				146	1.5	100	56	5	R6	W2													Bedding at 75° Joints at 20, 30 and 70°
				147–148	1.5	100	0	9	R6	W2													Bedding at 75° Joints at 15, 25 and 65, 70°
					1.2	100	88	3	R6	W2													Joints at 65°

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja:			
Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

LVM

HOLE #:

BH-P-03

EQ-09-Ge-66A R.1 04.03.2009

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B-0010504-3

B.T.

Vertical Scale = 1 : 100

EQ-09-Ge-66A R.1 04.03.2009

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086562.697	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658422.620	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	526.33	Azimut:	45.00°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

ELEV./ Length(m)	DESCRIPTION	Depth (m)	Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index	NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS
386.03 149.30	Siltstone interbedded with black shale.		1.2	100	88	3	R6	W2	Joints at 65°
		150	1.7	100	82	7	R6	W2	Bedding at 70° Joints at 15, 45 and 65, 75°
		151, 152	1.6	100	100	7	R6	W2	Joints at 45 and 65, 75°
382.56 153.00	Siltstone.	153, 154	1.5	100	93	5	R6	W2	Joints at 15, 45 and 60, 65°
381.15 154.50	Siltstone interbedded with black shale.	155	1.5	88	88	5	R6	W2	Bedding at 60 to 65° Joints at 60 and 70°
379.27 156.50	Siltstone.	156, 157	1.5	100	70	14	R6	W2	Bedding at 70° Joints at 5 and 60, 70° / Joints at 50, 60 and 70°
		158	1.5	97	88	6	R6	W2	Joints at 30, 50 and 70, 75°
		159, 160	1.7	88	65	8	R6	W2	Joints at 30, 40 and 65, 75°
375.32 160.70	End of borehole at a length of 160.7m.	161, 162, 163							

Other columns: Casing&Core Diameter/Depth (m); Water Notes; DISCONTINUITY DATA: Depth (m), Type & Number (#), Orientation (ALPHA (°), BETA (°)), Surface Description (Shape, Roughness, Infill), Jr, Ja, Jn; Fault Breccia/ Gouge; Broken Core.

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

HOLE #:

BH-P-03

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-03

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086562.697	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658422.620	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	526.33	Azimut:	45.00°	Drillers:	
Inclination:	70°	Bit type: / Flush: / Feed:		Drill Rig:	LF-70

Length (m): 10 – 11 – 12 – 13 – 14 – 15 – 16 – 17 – 18 – 19 – 20 – 21 – 22 – 23 – 24 – 25

HOLE #: **BH-P-03**

LVM

CORE PHOTOGRAPHY - BOREHOLE N°: **BH-P-03**

File n°:	**B-0010504-3**	Project Name:	**Joyce Lake - Open Pit**	Date drilled & Logged:	
Northing:	6086562.697	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658422.620	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	526.33	Azimut:	45.00°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Length (m)

26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42

HOLE #: **BH-P-03**

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-03

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086562.697	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658422.620	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	526.33	Azimut:	45.00°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Length (m)

44 45 46 47 48 49 50 51 52 53 54 55 56

HOLE #: BH-P-03

LVM

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Vertical Scale = 1 : 0

B.T.

EQ-09-Ge-66A R.1 04.03.2009

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-03

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086562.697	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658422.620	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	526.33	Azimut:	45.00°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

HOLE #: **BH-P-03**

LVM

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-03

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086562.697	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658422.620	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	526.33	Azimut:	45.00°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Length (m)

66 67 68 69 70 71 72 73 74 75 76

HOLE #: BH-P-03

LVM

CORE PHOTOGRAPHY - BOREHOLE N°: BH-PP-03

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086562.697	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658422.620	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	526.33	Azimut:	45.00°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Length (m)

78 79 80 81 82 83 84 85 86 87

HOLE #: BH-P-03

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-03

File n°:	**B-0010504-3**	Project Name:	**Joyce Lake - Open Pit**	Date drilled & Logged:	
Northing:	6086562.697	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658422.620	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	526.33	Azimut:	45.00°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Length (m)

88
89
90
91
92
93
94
95
96

LVM

HOLE #: **BH-P-03**

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Vertical Scale = 1 : 0

B.T.

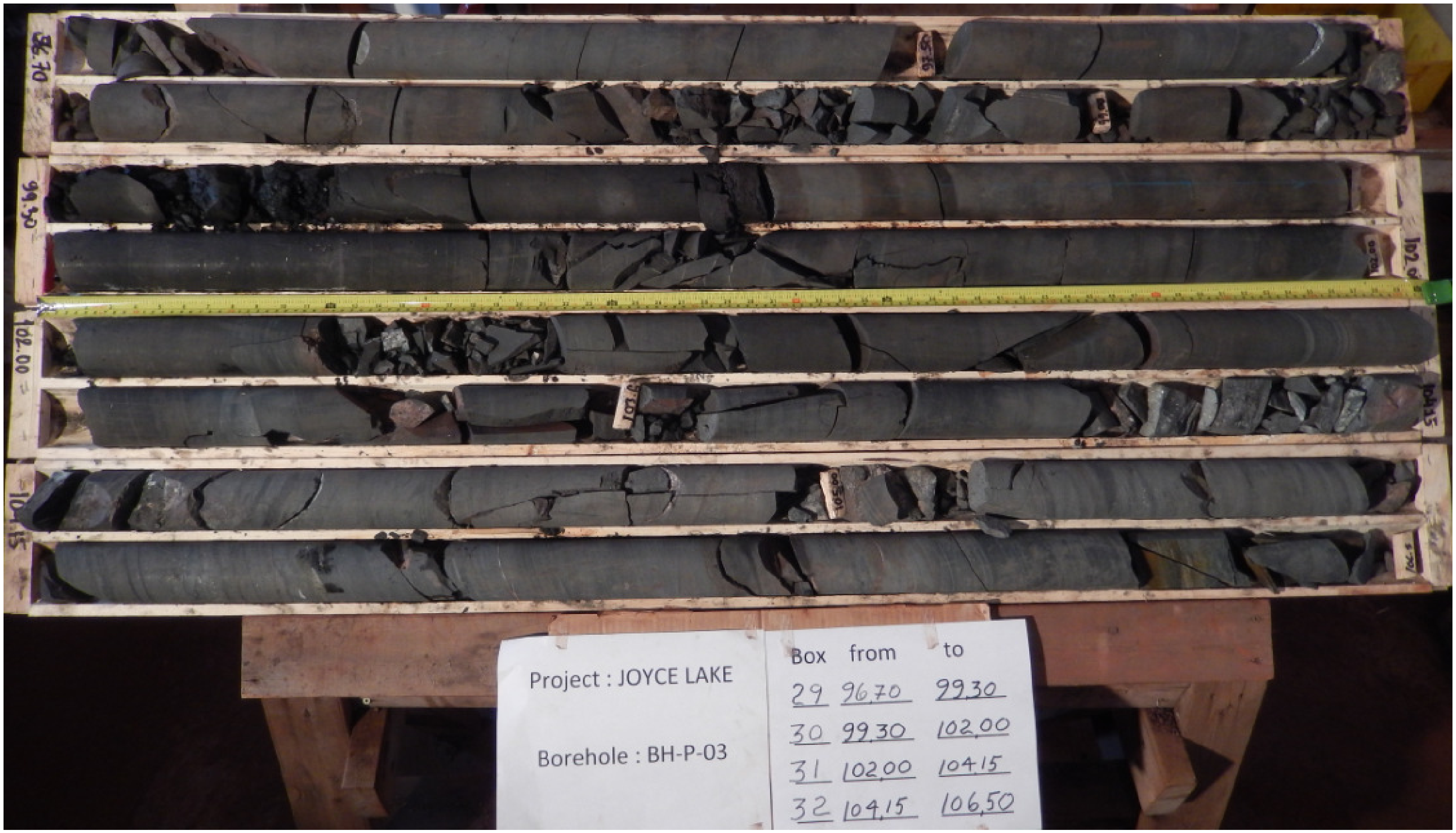
EQ-09-Ge-66A R.1 04.03.2009

CORE PHOTOGRAPHY - BOREHOLE N°: **BH-P-03**

File n°:	**B-0010504-3**	Project Name:	**Joyce Lake - Open Pit**	Date drilled & Logged:	
Northing:	6086562.697	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658422.620	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	526.33	Azimut:	45.00°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Length (m)

98
99
100
101
102
103
104
105
106



LVM

HOLE #: **BH-P-03**

CORE PHOTOGRAPHY - BOREHOLE N°: **BH-P-03**

File n°:	**B-0010504-3**	Project Name:	**Joyce Lake - Open Pit**	Date drilled & Logged:	
Northing:	6086562.697	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658422.620	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	526.33	Azimut:	45.00°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Length (m)

107
108
109
110
111
112
113
114
115
116
117

HOLE #: **BH-P-03**

LVM

Y:\Style_LVM\Log\Log_Geotec_80Log_Rock_Photos_LVM_AN_Joyce_Lake.sty - Printed : 2014-11-20 13h

Vertical Scale = 1 : 0

B.T.

EQ-09-Ge-66A R.1 04.03.2009

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-03

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086562.697	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658422.620	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	526.33	Azimut:	45.00°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Length (m)

118
119
120
121
122
123
124
125
126
127
128

HOLE #:

BH-P-03

LVM

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Vertical Scale = 1 : 0

B.T.

EQ-09-Ge-66A R.1 04.03.2009

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-03

File n°:	**B-0010504-3**	Project Name:	**Joyce Lake - Open Pit**	Date drilled & Logged:	
Northing:	6086562.697	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658422.620	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	526.33	Azimut:	45.00°	Drillers:	
Inclination:	60°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Length (m)

129
130
131
132
133
134
135
136
137
138

HOLE #: **BH-P-03**

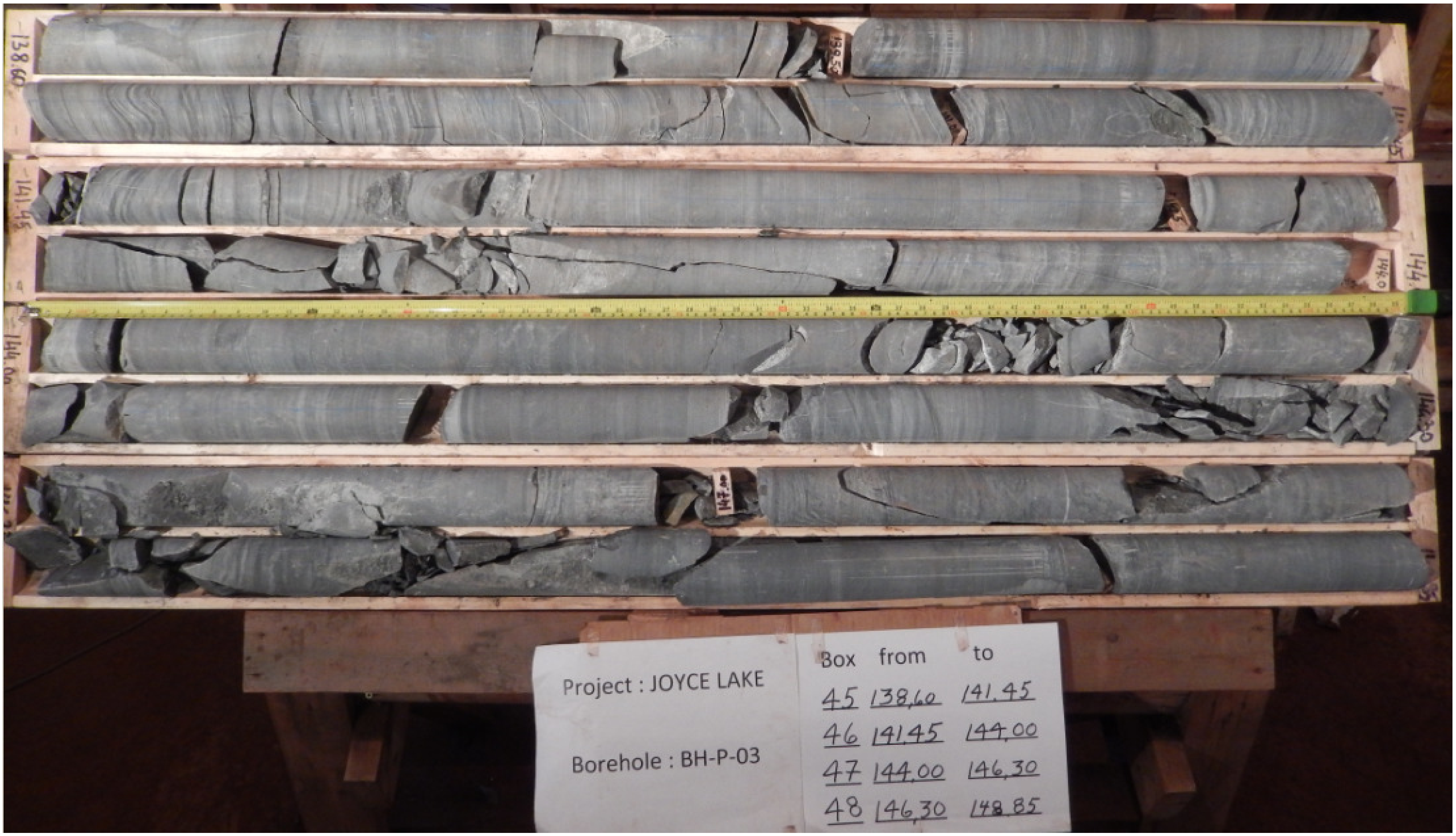
LVM

CORE PHOTOGRAPHY - BOREHOLE N°: **BH-P-03**

File n°:	**B-0010504-3**	Project Name:	**Joyce Lake - Open Pit**	Date drilled & Logged:	
Northing:	6086562.697	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658422.620	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	526.33	Azimut:	45.00°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Length (m)

140
141
142
143
144
145
146
147
148



Vertical Scale = 1 : 0

B.T.

HOLE #: **BH-P-03**

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Vertical Scale = 1 : 0

B.T.

EQ-09-Ge-66A R.1 04.03.2009

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-03

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086562.697	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658422.620	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	526.33	Azimut:	45.00°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Length (m)

150 151 152 153 154 155 156 157 158 159

LVM

HOLE #: **BH-P-03**

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design **FILE N° :** B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) **BOREHOLE N° :** BH-P-03

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
0,00	9,00	Casing									
9,00	11,00	20									
11,00	12,00	20	40								
12,00	13,50	40									
13,50	15,00	40									
15,00	16,50	47									
16,50	16,70	100									
16,70	18,00	92	70								
18,00	19,30	100	50								
19,30	19,50	50									
19,50	21,00	6									
21,00	22,50	13									
22,50	24,00	33									
24,00	25,20	100	80								
25,20	25,50										
25,50	27,00	47									
27,00	28,50	13									
28,50	30,00	33									
30,00	31,50	33									
31,50	33,00	20									
33,00	33,80	100	37								
33,80	34,50	71									
34,50	35,30	75									

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

LVM

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design **FILE N° :** B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) **BOREHOLE N° :** BH-P-03

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
35,30	36,00	43									
36,00	37,00	15									
37,00	37,50	40									
37,50	39,00	53									
39,00	40,50	33									
40,50	42,00	13									
42,00	43,50	100									
43,50	45,00	100									
45,00	46,50	17									
46,50	48,00	23									
48,00	49,50	100	12								
49,50	51,00	80									
51,00	52,50	20									
52,50	54,00	50	16								
54,00	55,00	90	30								
55,00	56,70	100	30								
56,70	57,80	55									
57,80	58,50	100	21								
58,50	59,30	100	25								
59,30	60,00	100									
60,00	60,20	100									
60,20	61,50	30									
61,50	63,00	100	30								

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

LVM

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design **FILE N° :** B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) **BOREHOLE N° :** BH-P-03

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
63,00	63,60	83									
63,60	65,10	100									
65,10	65,40	100	67								
65,40	66,00	N A	N A								
66,00	67,50	53	23								
67,50	68,30	100	88								
68,30	69,00	100	88								
69,00	70,50	53	40								
70,50	71,70	58									
71,70	72,00	N A	N A								
72,00	73,50	47									
73,50	74,40	56									
74,40	75,00	100	33								
75,00	76,50	80	10								
76,50	76,80	67									
76,80	77,50	100									
77,50	78,00	100									
78,00	81,00	100	93								
81,00	82,50	100	75								
82,50	84,00	100	75								
84,00	85,50	100	73								
85,50	87,00	100	56								
87,00	88,50	100	67								

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design FILE N° : B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) BOREHOLE N° : BH-P-03

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
88,50	90,00	87	80								
90,00	91,50	100	67								
91,50	93,00	100	56								
Corient	Test			92.55	93.00	BD	68		PL		WC
					92.55	1 JN	30		PL	SM	
					92.65	1 JN	70		PL	SM	
					92.71	1 JN	68		PL	SM	FE
					92.85	1 JN	69		PL	SM	WC - FE
					93.00	1 JN	68		PL	SM	FE
93.00	94.50	100	31								
94.50	96.00	97	54								
96.00	97.50	100	40								
97.50	99.00	100	50								
99.00	100.50	100	63								
Corient	Test			99.85	100.50	10 BD	72-77	55-80	PL		WC
					99.85	1 JN	76	35	PL	SM	FE
					91.00	1 JN	26	90	PL		WC
					100.04	1 JN	71	80	PL	SM	FE
					100.50	1 JN	73	100	PL	RO	FE
100.50	102.00	100	59								
102.00	103.60	100	69								
103.60	105.00	100	27								

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design **FILE N° :** B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) **BOREHOLE N° :** BH-P-03

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
105.00	106.50	100	93								
106.50	108.00	83	83								
108.00	109.50	100	70								
109.50	111.00	100	100								
111.00	112.50	100	80								
112.50	114.00	87	35								
114,00	114.70	100	29								
114.70	115.50	100	87								
115.5	117.00	93	73								
117.00	117.30	100	100								
117.30	118.50	100	100								
118.50	120,00	93	87								
				120.45	121.50	Corient Test					
					120.45	1 JN	71	0	PL	SM	WC-FE
					120.60	1 JN	13	300	UN	VR	WC-FE
					121.02	1 JN	37	120	IR	RO	FE
				121.06	121.50	BD	65-69	120-140			
					121.10	1 JN	56	120	PL	SM	FE
					121.14	1 JN	74	115	PL	SM	FE
					121.22	1 JN	47	150	ON	SM	FE
					121.29	1 JN	53	125	PL	SM	FE
					121.52	1 JN	66	130	ON	SM	FE
120.00	121.50	100	80								

Type		Roughness		Infilling	
Joint:	JN	Polished:	PO	Broken rock:	BR
Fault:	FLT	Slickinsided:	K	Sand:	SA
Shear	SHR	Smooth:	SM	Silt:	SI
Vein:	VN	Rought:	RO	Clay:	CL
Bedding:	BD	Very rought:	VR	Gouge:	GO
Foliation:	FO			Biotite:	BT
Contact:	CO	**Shape**		Calcite:	CA
		Planar:	PL	Chlorite:	CH
		Curved:	CU	Iron:	FE
		Undulating:	UN	Hématite:	HE
		Stepped:	ST	Quartz:	*QZ*
		Irregular:	IR	Limonite:	*LI*

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design FILE N° : B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) BOREHOLE N° : BH-P-03

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
121.50	122.60	100	100								
122.60	123.00	100	62								
123.00	124.50	100	100								
124.50	125.50	100	100								
				125.50	127.39	Corient Test					
					125.50	1 JN	49	85	PL	SM	
					125.78	1 JN	51	50	PL	RO	FE
					126.03	1 JN	83	50	PL	RO	FE
					126.10	1 JN	66	30	PL	SM	CL
					126.13	1 JN	67	40	PL	RO	FE
					126.15	1 JN	69	45	PL	RO	FE
					126.27	1 JN	70	140	PL	SM	FE
					126.30	1 JN	69	165	PL	SM	FE
					126.34	1 JN	69	170	PL	RO	WC-FE
					126.37	1 JN	66	172	ON	SM	FE
					126.40	1 JN	64	180	PL	SM	
					126.55	1 JN	29	50	ON	RO	FE
					126.86	1 JN	26	220	PL	RO	FE
					127.02	1 JN	69	125	PL	RO	WC-FE
					127.13	1 JN	67	140	IR	RO	FE
					127.14	1 JN	56	140	PL	RO	FE
					127.15	1 JN	68	140	PL	RO	FE
					127.27	1 JN	67	110	PL	SM	FE

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design **FILE N° :** B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) **BOREHOLE N° :** BH-P-03

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
					127.31	1 JN	66	120	ON	SM	FE
					127.39	1 JN	67	180	PL	SM	FE
125.50	126.00	100	100								
126.00	127.50	100	77								
127.50	129.00	73	100								
129.00	130.50	100	89								
				129.00	130.67	Corient Test					
					129.00	1 JN	73	320	PL	SM	WC
					129.05	1 JN	77	250	PL	RO	WC-FE
					129.13	1 JN	66	290	PL	RO	FE
					129.15	1 JN	90	175	IR	RO	FE
					129.18	1 JN	50	270	PL		FE
					129.35	1 JN	69	300	IR	RO	FE
					129.44	1 JN	67	250	PL	RO	FE
					129.56	BD	65	290	PL		
					129.58	1 JN	68	285	IR	VR	FE
					129.84	1 JN	75	300	IR	VR	FE
					130.26	1 JN	69	305	IR	RO	FE
					130.45	1 JN	86	330	IR	RO	FE
					130.48	1 JN	81	N A	PL	RO	FE
					130.67	1 JN	88	N A	PL	RO	FE
130.50	132.00	93	75								
132.00	133.50	100	50								

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design | FILE N° : B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) | BOREHOLE N° : BH-P-03

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
133.50	135.00	100	91								
				133.75	135.00	Corient Test					
					133.75	1 J	69	175	PL	SM	CL
					133.98	1 J	73	200	PL	SM	FE
					134.10	1 J	80	240	UN	SM	FE
					134.30	1 J	50	10	UN	RO	
					134.98	1 J	73	180	PL	SM	WC
					135.00	1 J	67	180	PL	RO	WC
135.00	136.50	100	80								
136.50	138.00	100	59								
138.00	139.50	100	55								
139.50	141.00	100	80								
141.00	142.50	100	87								
				141.80	142.50	Corient Test					
					141.86	BD	76	300	PL		WC
					141.84	1 J	21	180	UN	RO	WC-FE
					141.86	1J	73	330	PL	RO	WC-FE
142.50	144.00	100	40								
				143.50	143.80	BD	65	320	UN		WC
					143.50	1 JN	70	320	PL	SM	WC
					144.	1 JN	69	280	IR	RO	FE
144.00	145.50	100	73								
				145.20	145.50	Corient Test					

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design **FILE N° :** B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) **BOREHOLE N° :** BH-P-03

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
					145.20	1 JN	65	5	PL	RO	WC
					145.50	1 JN	67	295	PL	RO	FE
145.50	147.00	100	56								
147.00	148.50	100	0								
148.50	149.70	100	88								
				149.35	149.70	Corient Test					
				149.35	149.70	BD	74-84	10	UN		SI
					149.35	1 JN	68	305	PL	SM	WC
					149.70	1 JN	84	235	UN	SM	FE
149.70	151.00	100	82								
151.40	153.00	100	100								
				151.80	153.00	Corient Test					
					151.80	1 JN	69	270	UN	SM	WC
					152.10	1 JN	60	295	UN	RO	WC
					152.12	1 JN	60	295	UN	RO	WC
				152.12	152.85	BD	48-64	255	UN		WC
					152.22	1 JN	36	80	UN	PO	CH
					152.47	1 JN	47	0	PL	PO	CH
					152.60	1 JN	56	345	IR	RO	RO
					152.64	1 JN	63	350	IR	RO	RO
153.00	154.50	100	93								
154.50	156.00	88	88								
156.00	157.50	100	70								

Type		Roughness		Infilling	
Joint:	JN	Polished:	PO	Broken rock:	BR
Fault:	FLT	Slickinsided:	K	Sand:	SA
Shear	SHR	Smooth:	SM	Silt:	SI
Vein:	VN	Rought:	RO	Clay:	CL
Bedding:	BD	Very rought:	VR	Gouge:	GO
Foliation:	FO			Biotite:	BT
Contact:	CO	**Shape**		Calcite:	CA
		Planar:	PL	Chlorite:	CH
		Curved:	CU	Iron:	FE
		Undulating:	UN	Hématite:	HE
		Stepped:	ST	Quartz:	*QZ*
		Irregular:	IR	Limonite:	*LI*

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design FILE N° : B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) BOREHOLE N° : BH-P-03

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
157.50	159.00	97	88								
159.00	160.70	88	65								
EOH											

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-04

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-10-10
Northing:	6086397.562	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658603.194	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	519.26	Azimut:	135.00°	Drillers:	
Inclination:	70°	Bit type: / Flush: / Feed:		Drill Rig:	LF-70

B.T.

Vertical Scale = 1 : 100

ELEV./ Length(m)	DESCRIPTION (ROCK TYPE)	Interval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Strength Index	Weathering Index
519.26 / 0.00	**Casing**	1.5				
517.85 / 1.50	**Dark grey Iron Oxyde** with millimetric to centimetric beds of red an white chert.	1.5	26	13	R5	W2
		1.1	73	0	R5	W2
		0.4	100	10	R5	W2
		1.2	17	0	R5	W2
		0.8	27	10		W2
		0.7	71	50	R4	W2
		0.7	100	31	R4	W2
512.02 / 7.70	**Highly weathered zone**	0.4	100	0	R0	W6
511.65 / 8.10	**Dark grey Iron Oxyde** with millimetric to centimetric beds of red an white chert.	0.7	14	0	R4	W3
		1.3	100	38	R5	W3
		0.2	100	0	R5	W3
508.83 / 11.10	**Highly weathered zone**	1.5	100	8	R5	W3
508.55 / 11.40	**Dark grey Iron Oxyde** with millimetric to centimetric beds of red an white chert.	1.2	100	21	R5	W3
507.28 / 12.75	**Highly weathered zone**					
506.95 / 13.10	**Dark grey Iron Oxyde** with millimetric to centimetric beds of red an white chert.	0.8	100	50	R5	W3
		0.4	100	0	R5	W3
		0.6	100	10	R5	W3

Other columns: Casing&Core Diameter/Depth (m), Water Notes, Depth (m), Fractures per_1_m, DISCONTINUITY DATA (Depth (m), Type & Number (#), Orientation: ALPHA (°), BETA (°), Surface Description: Shape, Roughness, Infill, Jr, Ja, Jn), Fault Breccia/Gouge, Broken Core, NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS.

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

LVM

HOLE #: **BH-P-04**

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-04

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-10-10
Northing:	6086397.562	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658603.194	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	519.26	Azimut:	135.00°	Drillers:	
Inclination:	70°	Bit type: Flush: Feed:		Drill Rig:	LF-70

B.T.

Vertical Scale = 1 : 100

ROCK TYPE

ELEV./ Length(m)	DESCRIPTION
504.13 / 16.10	**Highly weathered zone**
503.76 / 16.50	**Dark grey Iron Oxyde** with millimetric to centimetric beds of red an white chert.
500.56 / 19.90	**Highly weathered zone**
500.47 / 20.00	**Dark grey Iron Oxyde** with millimetric to centimetric beds of red an white chert.
497.37 / 23.30	**White Chert**
496.71 / 24.00	**Dark grey Iron Oxyde** with millimetric to centimetric beds of red an white chert.
496.05 / 24.70	**Highly weathered zone**
495.77 / 25.00	**Dark grey Iron Oxyde** with millimetric to centimetric beds of red an white chert.
494.55 / 26.30	**Highly weathered zone**
494.26 / 26.60	**Dark grey Iron Oxyde** with millimetric to centimetric beds of red an white chert.
491.45	

Depth (m): 16 – 29

INTERVAL REC. DATA / STRENGTH DATA

Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index
1.3	75	10		R5	W3
0.2	100	0		R0	W6
1.3	100	77	21	R5	W3
0.5	51	0		R5	W3
0.3	100	0		R5	W3
1.2	100	17		R5	W3
1.2	90	0		R5	W3
1.5	68	0		R5	W2
0.2	100	60	18	R5	W2
1.3	100	54	22	R5	W2
0.5	100	0		R5	W3
0.5	100	0		R0	W6
1.5	30	0		R0	W6
0.5	100	0			W3
1.0	70	60	11		W3
1.0	100	50			W3
0.5	100	80			W3
0.5	100	0		R0	W6

DISCONTINUITY DATA

Depth (m)	Type & Number (#)	Orientation: ALPHA (°)	Orientation: BETA (°)	Surface Description: Shape	Surface Description: Roughness	Surface Description: Infill	Jr	Ja	Jn	Fault Breccia/ Gouge	Broken Core

Casing&Core Diameter/Depth (m) B-0010504-3 | Water Notes

NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS

- Bedding at 55°
  Joints at 15 to 30°
- Bedding N/A
  Joints at 15 to 30°
- Bedding N/A
  Joints at 5 to 20° and 45 to 60°

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

HOLE #: **BH-P-04**

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-04

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-10-10
Northing:	6086397.562	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658603.194	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	519.26	Azimut:	135.00°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

B.T.

Vertical Scale = 1 : 100

ROCK TYPE

ELEV./ Length(m)	DESCRIPTION
491.07 / 30.00	Highly weathered zone
490.88 / 30.20	Dark grey Iron Oxyde with millimetric to centimetric beds of red an white chert.
	Highly weathered zone
489.28 / 31.90	Dark grey Iron Oxyde with millimetric to centimetric beds of red an white chert.
488.34 / 32.90	Highly weathered zone
488.25 / 33.00	Dark grey Iron Oxyde with millimetric to centimetric beds of red an white chert.
486.46 / 34.90	Highly weathered zone
486.28 / 35.10	Dark grey Iron Oxyde with millimetric to centimetric beds of red an white chert.
481.25 / 40.45	Highly weathered zone
480.92 / 40.80	Dark grey Iron Oxyde with millimetric to centimetric beds of red an white chert.

INTERVAL REC. DATA / STRENGTH DATA

Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index
0.5	100	0		R0	W6
1.5	40	0		R0	W6
1.5	67	0		R4	W3
1.4	86	0		R4	W3
0.2	100	0		R4	W2
0.9	89	0		R3	W6
0.5	100	0		R5	W2
1.5	27	0		R5	W2
1.0		0		R5	W2
0.5	30	0		R5	W2
1.5	27	0		R5	W2
1.5	75	0		R0	W6
1.5	60	0		R5	W2
0.5	60	0		R5	W2
1.0	50	0		R5	W2

DISCONTINUITY DATA

Depth (m)	Type & Number (#)	ALPHA (°)	BETA (°)	Shape	Roughness	Infill	Jr	Ja	Jn	Fault Breccia/ Gouge	Broken Core	NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS
												N/A

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

LVM

HOLE #: **BH-P-04**

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-04

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-10-10
Northing:	6086397.562	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658603.194	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	519.26	Azimut:	135.00°	Drillers:	
Inclination:	70°	Bit type: Flush:	Feed:	Drill Rig:	LF-70

ROCK TYPE

ELEV./ Length(m)	Depth (m)	DESCRIPTION
475.09	47.00	Grey Massive Iron Oxyde, fine grain.
474.81	47.30	**Dark grey Iron Oxyde** with millimetric to centimetric beds of red an white chert.
474.53	47.60	Grey Massive Iron Oxyde, fine grain.
474.06	48.10	**Dark grey Iron Oxyde** with millimetric to centimetric beds of red an white chert.
473.87	48.30	**Highly weathered zone**
473.68	48.50	**Dark grey Iron Oxyde** with millimetric to centimetric beds of red an white chert.
471.34	51.00	Grey Massive Iron Oxyde, fine grain.
471.15	51.20	**Dark grey Iron Oxyde** with millimetric to centimetric beds of red an white chert.
470.30	52.10	**Highly weathered zone**
469.74	52.70	**Dark grey Iron Oxyde** with millimetric to centimetric beds of red an white chert.
467.48	55.10	**White Chert Band**
467.29	55.30	**Dark grey Iron Oxyde** with millimetric to centimetric beds of red an white chert.
466.92	55.70	**White Chert Band**
466.64	56.00	**Dark grey Iron Oxyde** with millimetric to centimetric beds of red an white chert.
466.36	56.30	**White Chert** >50%
465.79	56.90	**Dark grey Iron Oxyde** with millimetric to centimetric beds of red an white chert.

Depth scale (m): 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59

INTERVAL REC. DATA / STRENGTH DATA

Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index
1.5	26	0			
0.4	100	0		R5	
1.1	100	81	16	R5	W4
1.5	58	17		R3	W6
1.5	38	0		R3	W4
1.5	72	20		R3	W4
0.4	100	0		R0	W6
1.1	60	20		R3	W4
0.2	100	100		R3	W4
1.5	87	23	10	R5	W3
1.5	87	37	21	R5	W3
1.0	100	75	9	R5	W3
0.4	100	0		R5	W3
1.3	100	0		R5	W3

DISCONTINUITY DATA

Columns: Depth (m); Type & Number (#); Orientation: ALPHA (°), BETA (°); Surface Description: Shape, Roughness, Infill; Jr; Ja; Jn; Fault Breccia/ Gouge; Broken Core; NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS

NOTES/COMMENTS:
- Bedding N/A Joints at 30°
- Bedding at 30° Joints at 30°
- Bedding at 40° Joints at 45 to 50° and 80°
- Bedding at 5 to 10° Joints at 25,40 and 60°

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

HOLE #: **BH-P-04**

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B-0010504-3

B.T.

Vertical Scale = 1 : 100

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-04

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-10-10
Northing:	6086397.562	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658603.194	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	519.26	Azimut:	135.00°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

ROCK TYPE

ELEV./ Length(m)	DESCRIPTION
462.78 / 60.10	**White Chert Band**
462.64 / 60.25	**Dark grey Iron Oxyde** with millimetric to centimetric beds of red an white chert.
462.31 / 60.60	**2 White Chert Bands**
461.66 / 61.30	**Dark grey Iron Oxyde** with millimetric to centimetric beds of red an white chert.
457.05 / 66.20	**White Chert** >50%
453.01 / 70.50	**Dark grey Iron Oxyde** with millimetric to centimetric beds of red an white chert.
450.19 / 73.50	**White Chert Band**
449.72 / 74.00	**Dark grey Iron Oxyde** with

INTERVAL REC. DATA / STRENGTH DATA

Interval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index
1.6	100	88	12	R5	W3
0.5	100	0		R5	W3
1.0	100	50	17	R5	W3
1.0	100	80	11	R5	W3
0.5	100	70	4	R5	W3
1.4	100	35			W3
0.3	100	0		R5	W3
1.5	100	57	7	R5	W3
0.2	100	6	16	R5	W3
0.5	100	70	6	R5	W3
0.6	67	40		R5	W3
1.5	100	60	11	R5	W3
1.2	100	15	10	R5	W3
1.8	85	56	6	R5	W3
1.1	100	82	10	R5	W3

DISCONTINUITY DATA

Depth (m) | Type & Number (#) | Orientation: ALPHA (°), BETA (°) | Surface Description: Shape, Roughness, Infill | Jr | Ja | Jn | Fault Breccia/Gouge | Broken Core

NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS

- Beddings at 5 and 10°; Joints at 45,60 and 75°
- Bedding at 1°; Joints at 0 and 45°
- Bedding at 20°; Joints at 5,20 and 60°
- Bedding at 30°; Joints at 30°
- Bedding at 25°; Joints at 25 and 30°
- Bedding at 20°; Joints at 5,20 and 50 to 75°
- Bedding at 15 to 20°; Joints at 15 to 20°
- Bedding at 20°; Joints at 20,30 and 45°
- Bedding N/A; Joints at 20,30 and 45°
- Bedding at 20°; Joints at 20 and 50°
- Bedding at 20°; Joints at 30 and 50°

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

LVM

HOLE #: **BH-P-04**

EQ-09-Ge-66A R.1 04.03.2009

B.T.

Vertical Scale = 1 : 100

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-04

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-10-10
Northing:	6086397.562	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658603.194	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	519.26	Azimut:	135.00°	Drillers:	
Inclination:	70°	Bit type: / Flush: / Feed:		Drill Rig:	LF-70

ROCK TYPE

ELEV./ Length(m)	DESCRIPTION
74.60	millimetric to centimetric beds of red an white chert.
448.97 / 74.80	**Quartz Feldspath vein**
448.78 / 75.00	**Dark grey Iron Oxyde** with millimetric to centimetric beds of red an white chert.
448.03 / 75.80	**White Chert**
447.84 / 76.00	Hematite and White Chert >50%
	Dark grey Iron Oxyde with millimetric to centimetric beds of red an white chert.
445.96 / 78.00	**White Chert**
445.59 / 78.40	**Grey Iron Oxyde** with Quartz and white Chert.
441.17 / 83.10	**White Chert** 30 to 50%
440.80 / 83.50	**Dark grey Iron Oxyde** with millimetric to centimetric beds of red an white chert.
438.92 / 85.50	**White Chert** 30 to 50%
436.47 / 88.10	**Dark grey Iron Oxyde** with millimetric to centimetric beds of red an white chert.

Depth (m) scale: 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89

INTERVAL REC. DATA / STRENGTH DATA

Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index	NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS
1.5	100	30	14	R5	W3	Bedding N/A Joints at 20,30 and 60°
0.3	67	0		R3	W4	
1.6	85	45	13	R3	W4	Bedding at 10° Joints at 20,30 and 60°
1.5	100	18	11	R5	W2	Bedding at 25° Joints at 30 and 40°
1.5	16	0		R5	W2	
1.6	68	38	6	R5	W2	Bedding at 30° Joints at 10 and 30°
0.5	80	0		R5	W2	Bedding N/A Joints at 15°
0.4	100	0		R5	W3	
0.4	100	50		R5	W3	
1.6	100	80	22	R5	W3	Bedding at 80° Joints at 45 and 50 to 60°
1.6	100	50	17	R5	W3	Beddings at 5 to 20° Joints at 20 to 35°
0.5	100	0		R5	W3	
1.1	91	32		R5	W3	
1.4	86	79	7	R5	W3	Bedding at 5° Joints at 5 to 20° and 35 to 50°

DISCONTINUITY DATA

Depth (m)	Type & Number (#)	ALPHA (°)	BETA (°)	Shape	Roughness	Infill	Jr	Ja	Jn	Fault Breccia/ Gouge	Broken Core
88.40	JN			PL	SM	FE					
88.50	JN			PL	RO	FE					
88.60	JN			PL	C	C					

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

HOLE #: **BH-P-04**

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-04

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-10-10
Northing:	6086397.562	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658603.194	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	519.26	Azimut:	135.00°	Drillers:	
Inclination:	70°	Bit type: Flush: Feed:		Drill Rig:	LF-70

ROCK TYPE: ELEV./ Length(m)	DESCRIPTION	Depth (m)	Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index	DISCONTINUITY DATA: Depth (m)	Type & Number (#)	ALPHA (°)	BETA (°)	Shape	Roughness	Infill	Jr	Ja	Jn	NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS
		90																	° and 35 to 50°
		91	1.5	100	13	12	R5	W3											Bedding at 0 to 20° Joints at 20 and 50°
433.18 / 91.60	**White Chert** 30 to 50%	92	0.5	100	25	8	R5	W3											Bedding at 0 to 20° Joints at 10 to 45°
			0.5	100	0		R5	W3											
		93	0.4	100	100		R5	W3											
		94	1.3	92	92		R5	W3											
			0.2	100	0		R5	W3											
		95	1.5	100	80	11	R5	W3											Bedding at 20 to 35° Joints at 20,35 and 45°
		96	0.5	100	100		R5	W3											
		97	1.5	100	67		R5	W3	97.80 97.85 98.00	BD JN BD	41 41 9	70 70 265	PL PL UN	C RO C	QZ QZ QZ				Bedding at 30 to 40° Joints at 20,40 and 50°
		98	0.6	100	100	10		W3											
			0.4			20	R5	W3											Bedding at 30° Joints at 30°
		99 / 100	1.5	100	60	8	R5	W3											Bedding at 15 to 40° Joints at 30 and 45°
423.98 / 101.40	**Dark grey Iron Oxyde** with millimetric to centimetric beds of red an white chert.	101	1.5	100	53		R5	W3											
		102 / 103	1.5	100	0		R5	W3											
		104	1.2	100	0		R5	W3											

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

HOLE #:

BH-P-04

B.T.

Vertical Scale = 1 : 100

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-04

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-10-10
Northing:	6086397.562	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658603.194	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	519.26	Azimut:	135.00°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Rock type

ELEV./ Length(m)	DESCRIPTION
417.77 / 108.00	**White Chert** > 50%
416.08 / 109.80	**Dark grey Iron Oxyde** with millimetric to centimetric beds of red an white chert.
415.10 / 110.85	**Limonite band**
414.95 / 111.00	**White Chert** > 50%
410.07 / 116.20	Completely weathered reddish Iron Oxyde

Interval rec. data / Strength data

Depth (m)	Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index
105–106	1.2	96	3	11	R5	W3
106–108	2.1	71	0		R5	W3
108–109.5	1.5	100	13	8	R4	W3
109.5–111	1.5	100	0	15	R4	W4
111–112.5	1.5	50	0		R4	W3
112.5–114	1.5	0	0			
114–115.5	1.5	13	0			
115.5–117	1.5	100	30	12	R3	W5
117–118.5	1.5	100	0		R0	W5
118.5–	1.5	100	23	11	R0	W5

Discontinuity data

Columns: Depth (m), Type & Number (#), Orientation (ALPHA (°), BETA (°)), Surface Description (Shape, Roughness, Infill), Jr, Ja, Jn, Fault Breccia/Gouge, Broken Core — no entries.

Notes/Comments /Imprint depth/ Infill type & thickness

- Bedding at 30 to 35° Joints at 30 and 35°
- Bedding at 0 to 20° Joints at 0 to 20°
- Bedding at 20° Joints at 20 and 40°
- Bedding N/A Joints at 30 and 60°

Legend

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

HOLE #: **BH-P-04**

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-04

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-10-10
Northing:	6086397.562	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658603.194	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	519.26	Azimut:	135.00°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

B.T.

ELEV./ Length(m)	DESCRIPTION
406.68 / 119.80	[White Quartz Feldspath vein]"/b" well crystalized.
406.12 / 120.40	Completely weathered reddish Iron Oxyde
405.09 / 121.50	Dark grey Massive Iron Oxyde with red Chert veinlets.
394.28 / 133.00	Dark grey Massive Iron Oxyde Steel with more red Chert veinlets concentration

Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index
1.5	100	33	6	R5	W5
1.5	100	32	2	R6	W4
1.1	100	100		R6	W2
0.4	100	50		R6	W2
1.3	83	83		R6	W2
1.3	100	58	3	R6	W2
0.3	100	100		R6	W2
1.3	100	0		R6	W2
1.1	82	45	5	R6	W2
0.3	100	0		R6	W2
0.4	100	80	12	R6	W2
0.1	100	0		R6	W2
1.4	100	100	2	R6	W2
0.3	100	100		R6	W2
0.8	0	0			
0.4	100	50		R2	W2
1.6	100	59	12	R6	W4

Depth (m): 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134

DISCONTINUITY DATA: Depth (m) | Type & Number (#) | Orientation: ALPHA (°), BETA (°) | Surface Description: Shape, Roughness, Infill | Jr | Ja | Jn | Fault Breccia/ Gouge | Broken Core

NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS:
- Bedding at 50° Joints at 40 to 50° and 80°
- Joints at 15 to 60°
- Bedding N/A Joints at 50 to 60°
- Bedding N/A Joints at 40 to 55°
- Bedding N/A Joints at 5,20 and 60°
- Bedding at 20° Joints at 30 to 60°
- Bedding N/A Joints at 30 to 60°
- Loss of water
- Joints at 30,60 and 130°

Vertical Scale = 1 : 100

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

LVM

HOLE #: **BH-P-04**

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-04

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-10-10
Northing:	6086397.562	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658603.194	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	519.26	Azimut:	135.00°	Drillers:	
Inclination:	70°	Bit type: / Flush: / Feed:		Drill Rig:	LF-70

ROCK TYPE

ELEV./ Length(m)	DESCRIPTION
	and more alteration.
388.64 / 139.00	Highly weathered zones, 5 to 10cm each.
388.08 / 139.60	Alternance of slightly altered massive Iron Oxyde with extremely weathered Iron Oxyde.
384.23 / 143.70	**Massive Iron Oxyde** with white Chert.
382.30 / 145.75	**Highly weathered zone**
382.16 / 145.90	**Massive Iron Oxyde** with white Chert.

Depth (m): 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148

INTERVAL REC. DATA / STRENGTH DATA / DISCONTINUITY DATA

Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index	NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS
						Joints at 15,30,45 and 60°
1.5	100	0		R6	W4	
1.5	100	31		R6	W4	
0.6	100	100	5	R5	W3	Joints at 30°
1.0	100	35	9	R4	W4	Bedding at 35° Joints at 30°
1.0	50	10		R5	W4	
0.4	100	0		R4	W4	
1.2	100	54	4	R5	W4	Beddings at 25, 1 to 5° and 25 to 30°
1.2	100	50		R4	W4	
0.3	100	100		R5	W3	
1.3	100	92	3	R5	W3	Bedding at 20 to 30° Joints at 20 to 35°
0.5	100	60		R5	W3	
1.5	100	65	6	R5	W6	Bedding at 20 to 30° Joints at 30°
1.5	16	0		R5	W3	

Other columns: Casing&Core Diameter/Depth (m), Water Notes, Depth (m), Type & Number (#), Orientation: ALPHA (°), BETA (°), Surface Description: Shape, Roughness, Infill, Jr, Ja, Jn, Fault Breccia/ Gouge, Broken Core

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

HOLE #: **BH-P-04**

B.T.

Vertical Scale = 1 : 100

B.T.

Vertical Scale = 1 : 100

RECORD OF ROCK CORE DRILLING AND TESTING - BOREHOLE N°: BH-P-04

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-10-10
Northing:	6086397.562	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658603.194	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	519.26	Azimut:	135.00°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

ROCK TYPE

ELEV./ Length(m)	DESCRIPTION
378.02 / 150.30	**Dark grey Iron Oxyde** with millimetric to centimetric beds of red an white chert.
376.90 / 151.50	**N/A**
374.08 / 154.50	**Dark grey Iron Oxyde** with millimetric to centimetric beds of red an white chert. Presence of a few centimetric Massive Iron Oxyde bands.
372.67 / 156.00	**Dark grey Iron Oxyde** with millimetric to centimetric beds of red an white chert.
371.73 / 157.00	**Highly weathered zone**
371.45 / 157.30	**Dark grey Iron Oxyde** with millimetric to centimetric beds of red an white chert.
371.16 / 157.60	Grey Massive Iron Oxyde, no alteration.
369.75 / 159.10	**Highly weathered zone**
368.91 / 160.00	End of borehole at a length of 160.0m.

INTERVAL REC. DATA / STRENGTH DATA / DISCONTINUITY DATA

Inertval No. & Depth (from-to)(m)	TCR (%)	RQD (%)	Fractures per_1_m	Strength Index	Weathering Index	Broken Core	NOTES/COMMENTS /IMPRINT DEPTH/ INFILL TYPE & THICKNESS
1.5	100	80	7	R5	W3		Bedding at 25° Joints at 25 and 70°
1.5	100	70	20	R5	W3		Bedding at 20° Joints at 20°
1.5	0	0				Broken core	
1.5						Broken core	
1.5	87	55	14	R5	W4		Bedding at 20° Joints at 30 and 60°
1.5	100	20	7	R5	W6	Broken core (partial)	Bedding N/A Joints at 40°
1.5	100	33	5	R6	W2		Bedding N/A Joints at 35 and 45°
1.0	100	0		R0	W6	Broken core	

Discontinuity data columns: Depth (m), Type & Number (#), Orientation: ALPHA (°), BETA (°); Surface Description: Shape, Roughness, Infill; Jr, Ja, Jn; Fault Breccia/ Gouge; Broken Core.

Depth scale (m): 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163

Joint Roughness, Jr:	
Wavy and Rough	3.0
Wavy and Smooth	2.0
Planar and Rough	1.5
Planar/Smooth/Fill	1.0
Planar/Slickensided	0.5

Type:			
Joint:	JN	Bedding:	BD
Fault:	FLT	Foliation:	FO
Shear:	SHR	Contact:	CO
Vein:	VN	Orthogonal:	OR
Conjugate:	CJ	Cleavage:	CL

Roughness:					
Polished:	PO	Smooth:	SM	Very Rough:	VR
Slickinsided:	K	Rough:	Ro	Closed:	C

Joint Alteration, Ja: Unfilled:		Filled:	
Healed Fractures	0.75	Sand/Crushed Rock	4
Staining only	1	Stiff Clay < 5mm	6
Slightly altered wall	2	Soft Clay < 5mm	8
Silty/sandy coating	3	Swell. Clay < 5mm	12
Clay coating	4	Stiff Clay > 5mm	10
		Soft Clay > 5mm	15
		Swell. Clay > 5mm	20

Shape:					
Planar:	PL	Undulating:	UN	Irregular:	IR
Curved:	CU	Stepped:	ST	Closed:	C

Infilling:							
Broken Rock:	Br			Gouge:	Go	Sand:	Sa
Biotite:	Bt	Calcite:	Ca	Gravel:	Gr	Sericite:	Se
Clay:	Cl	Epiclote:	Ep	Hematite:	He	Silt:	Si
Chlorite:	Ch	Iron:	Fe	Quartz:	Qz	Sulphide:	Su
Fresh:	Fr	Closed:	C				

Joint Number, Jn:	
Massive	0.5
One set	2
One plus random	3
Two sets	4
Two sets plus random	6
Three sets	9
Three sets plus random	12
Four or more sets	15
Crushed rock	20

LVM

HOLE #: **BH-P-04**

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-04

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-10-10
Northing:	6086397.562	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658603.194	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	519.26	Azimut:	135.00°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

HOLE #: BH-P-04

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Vertical Scale = 1 : 0

B.T.

EQ-09-Ge-66A R.1 04.03.2009

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Vertical Scale = 1 : 0

B.T.

EQ-09-Ge-66A R.1 04.03.2009

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-04

File n°:	**B-0010504-3**	Project Name:	**Joyce Lake - Open Pit**	Date drilled & Logged:	2014-10-10
Northing:	6086397.562	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658603.194	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	519.26	Azimut:	135.00°	Drillers:	
Inclination:	70°	Bit type: / Flush: / Feed:		Drill Rig:	LF-70

Length (m): 13, 14, 15, 16, 17, 18, 19

HOLE #: **BH-P-04**

LVM

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-04

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-10-10
Northing:	6086397.562	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658603.194	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	519.26	Azimut:	135.00°	Drillers:	
Inclination:	70°	Bit type: Flush: Feed:		Drill Rig:	LF-70

Length (m)

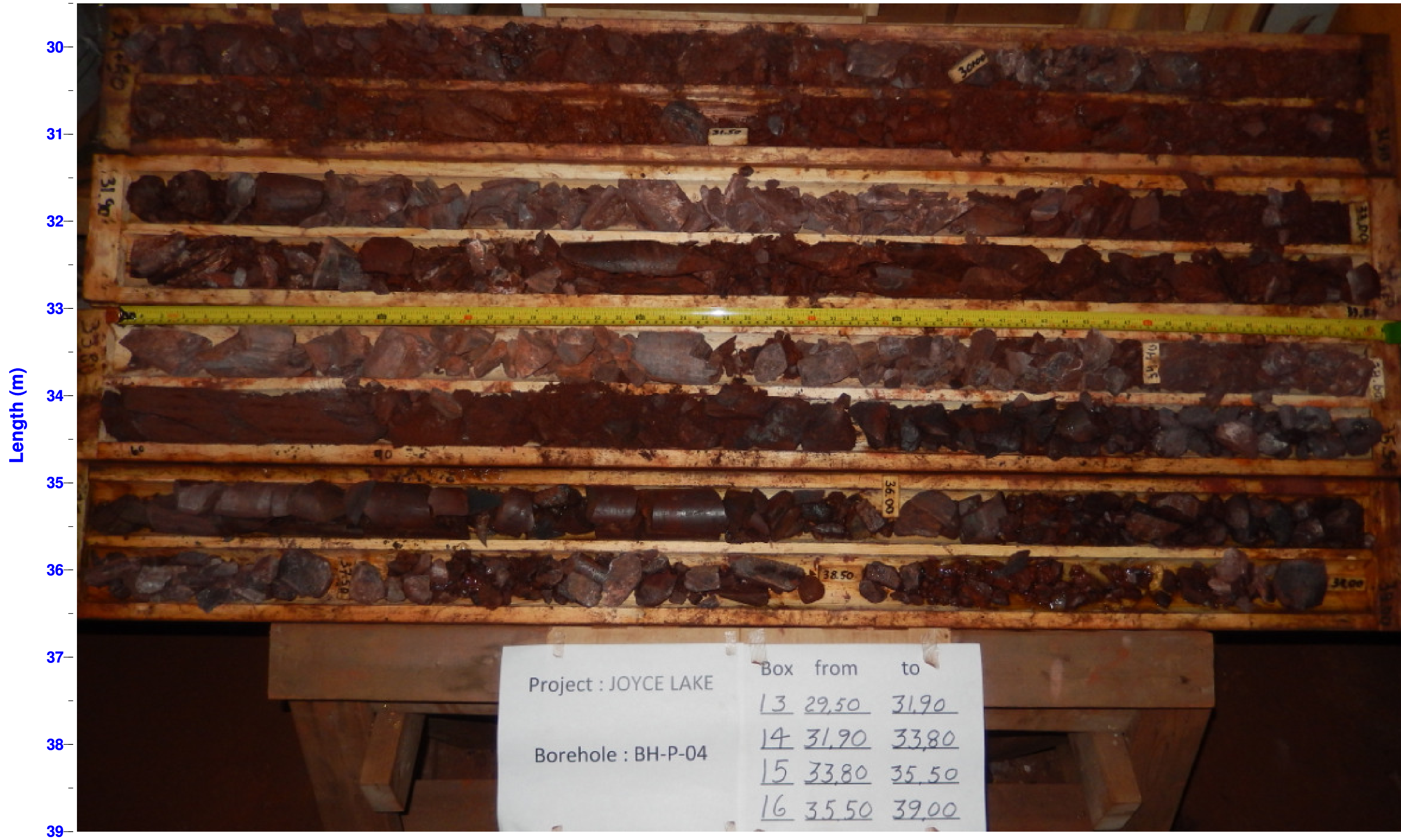
21
22
23
24
25
26
27
28
29

HOLE #: BH-P-04

LVM

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-04

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Page:	4 of 16
Northing:	6086397.562	Reference Point:	Precision GPS	Date drilled & Logged:	2014-10-10
Easting:	658603.194	Datum:	NAD83 UTM ZONE 19	Logged by:	Alain Lemonde
Elevation:	519.26	Azimut:	135.00°	Drilling Contractor:	Downing
Inclination:	70°	Bit type: Flush: Feed:		Drillers:	
				Drill Rig:	LF-70



HOLE #: BH-P-04

CORE PHOTOGRAPHY - BOREHOLE N°: **BH-P-04**

File n°:	**B-0010504-3**	Project Name:	**Joyce Lake - Open Pit**	Date drilled & Logged:	2014-10-10
Northing:	6086397.562	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658603.194	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	519.26	Azimut:	135.00°	Drillers:	
Inclination:	70°	Bit type: Flush:	Feed:	Drill Rig:	LF-70

Length (m)

40
41
42
43
44
45
46
47
48
49
50
51
52

HOLE #: **BH-P-04**

LVM

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-04

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-10-10
Northing:	6086397.562	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658603.194	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	519.26	Azimut:	135.00°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Length (m)

54
55
56
57
58
59
60
61
62

HOLE #: **BH-P-04**

LVM

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Vertical Scale = 1 : 0

B.T.

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-04

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-10-10
Northing:	6086397.562	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658603.194	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	519.26	Azimut:	135.00°	Drillers:	
Inclination:	70°	Bit type: Flush: Feed:		Drill Rig:	LF-70

Length (m)

63
64
65
66
67
68
69
70

HOLE #: **BH-P-04**

LVM

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-04

File n°:	**B-0010504-3**	Project Name:	**Joyce Lake - Open Pit**	Date drilled & Logged:	2014-10-10
Northing:	6086397.562	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658603.194	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	519.26	Azimut:	135.00°	Drillers:	
Inclination:	70°	Bit type: / Flush: / Feed:		Drill Rig:	LF-70

Length (m)

71
72
73
74
75
76
77
78
79

HOLE #: **BH-P-04**

LVM

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Vertical Scale = 1 : 0

B.T.

EQ-09-Ge-66A R.1 04.03.2009

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CORE PHOTOGRAPHY - BOREHOLE N°: **BH-P-04**

File n°:	**B-0010504-3**	Project Name:	**Joyce Lake - Open Pit**	Date drilled & Logged:	2014-10-10
Northing:	6086397.562	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658603.194	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	519.26	Azimut:	135.00°	Drillers:	
Inclination:	70°	Bit type: / Flush: / Feed:		Drill Rig:	LF-70

Length (m)

80 81 82 83 84 85 86 87 88 89 90

Vertical Scale = 1 : 0

B.T.

EQ-09-Ge-66A R.1 04.03.2009

LVM

HOLE #: **BH-P-04**

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CORE PHOTOGRAPHY - BOREHOLE N°: **BH-P-04**

File n°:	**B-0010504-3**	Project Name:	**Joyce Lake - Open Pit**	Date drilled & Logged:	2014-10-10
Northing:	6086397.562	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658603.194	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	519.26	Azimut:	135.00°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Vertical Scale = 1 : 0

B.T.

EQ-09-Ge-66A R.1 04.03.2009

HOLE #: **BH-P-04**

CORE PHOTOGRAPHY - BOREHOLE N°: **BH-P-04**

File n°:	**B-0010504-3**	Project Name:	**Joyce Lake - Open Pit**	Date drilled & Logged:	2014-10-10
Northing:	6086397.562	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658603.194	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	519.26	Azimut:	135.00°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Length (m)

100
101
102
103
104
105
106
107
108

HOLE #: **BH-P-04**

LVM

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Vertical Scale = 1 : 0

B.T.

EQ-09-Ge-66A R.1 04.03.2009

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-04

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-10-10
Northing:	6086397.562	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658603.194	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	519.26	Azimut:	135.00°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Length (m): 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119

HOLE #: **BH-P-04**

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-04

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-10-10
Northing:	6086397.562	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658603.194	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	519.26	Azimut:	135.00°	Drillers:	
Inclination:	70°	Bit type: Flush: Feed:		Drill Rig:	LF-70

HOLE #: BH-P-04

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Vertical Scale = 1 : 0

B.T.

EQ-09-Ge-66A R.1 04.03.2009

CORE PHOTOGRAPHY - BOREHOLE N°: **BH-P-04**

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-10-10
Northing:	6086397.562	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658603.194	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	519.26	Azimut:	135.00°	Drillers:	
Inclination:	70°	Bit type: Flush: Feed:		Drill Rig:	LF-70

Length (m)

131
132
133
134
135
136
137
138

HOLE #: **BH-P-04**

LVM

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-04

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-10-10
Northing:	6086397.562	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658603.194	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	519.26	Azimut:	135.00°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Length (m)

140
141
142
143
144
145
146
147
148

HOLE #: **BH-P-04**

LVM

CORE PHOTOGRAPHY - BOREHOLE N°: BH-P-04

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	2014-10-10
Northing:	6086397.562	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658603.194	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	519.26	Azimut:	135.00°	Drillers:	
Inclination:	70°	Bit type:	Flush: Feed:	Drill Rig:	LF-70

Length (m)

150
151
152
153
154
155
156
157
158
159

HOLE #: **BH-P-04**

LVM

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Vertical Scale = 1 : 0

B.T.

EQ-09-Ge-66A R.1 04.03.2009

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design FILE N° : B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) BOREHOLE N° : BH-P-04

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
Casing	1,50										
1,50	3,00	26	13								
3,00	4,10	73									
4,10	4,50	100	10								
4,50	5,70	17									
5,70	6,50	27	10								
6,50	7,20	71	50								
7,20	7,90	100	31								
7,90	8,30	100									
8,30	9,00	14									
9,00	10,30	100	38								
10,30	10,50	100									
10,50	12,00	100	8								
12,00	13,20	100	21								
13,20	14,00	100	50								
14,00	14,40	100									
14,40	15,00	100	10								
15,00	16,30	100									
16,30	16,50	100									
16,50	17,80	100	77								
17,80	18,30	51									
18,30	18,60	100									
18,60	19,80	100	17								

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

LVM

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design FILE N° : B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) BOREHOLE N° : BH-P-04

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
19,80	21,00	90									
21,00	22,50	68									
22,50	22,70	100	60								
22,70	24,00	100	54								
24,00	24,50	100									
24,50	25,00	100									
25,00	26,50	100	33								
26,50	27,00	100									
27,00	28,00	70	60								
28,00	29,00	100	50								
29,00	29,50	100	80								
29,50	30,00	100									
30,00	31,50	40									
31,50	33,00	67									
33,00	34,40	88									
34,40	34,60	100									
34,60	35,50	90	89								
35,50	36,00	100									
36,00	37,50	27									
37,50	38,50										
38,50	39,00	30									
39,00	40,50	2									
40,50	42,00	75									

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design

FILE N° : B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec)

BOREHOLE N° : BH-P-04

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
42,00	43,50	60									
43,50	44,00	60									
44,00	45,00	50									
45,00	46,50	26									
46,50	46,90	100									
46,90	48,00	100	81								
48,00	49,50	58	17								
49,50	51,00	38									
51,00	52,50	72	20								
52,50	52,90	100									
52,90	54,00	60	20								
54,00	54,20	100	100								
54,20	55,70	87	23								
55,70	57,20	87	37								
57,20	58,20	100	75								
58,20	58,60	100									
58,60	59,90	100									
59,90	61,50	100	88								
61,50	62,00	100									
62,00	63,00	100	50								
63,00	64,00	100	80								
64,00	64,50	100	70								
64,50	65,90	100	35								

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design FILE N° : B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) BOREHOLE N° : BH-P-04

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
65,90	66,20	30	100								
66,20	67,70	100	57								
67,70	67,90	100	70								
67,90	68,40	67	40								
68,40	69,00	67	40								
69,00	70,50	100	60								
70,50	71,70	100	15								
71,70	73,50	85	56								
73,50	74,60	85	56								
74,60	76,00	100	30								
76,00	76,40	67									
76,40	78,00	85	45								
78,00	79,50	100	18								
79,5	81	n-a	n-a								
81	82,6	68	38								
82,6	83,1	80									
83,1	83,5	100									
83,5	83,9	100	50								
83,9	85,5	100	80								
85,5	87,1	100	50								
87,1	87,6	100									
87,6	88,7	91	32								
				88,40	88,70	corient	test				

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design | FILE N° : B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) | BOREHOLE N° : BH-P-04

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
					88,40	1 JN	17	280	PL	SM	FE
					88,50	1 JN	45	215	PL	Roughness	FE
					88,60	1 JN	29	345	PL		
					88,60	1 BD	9	265	UN		QZ
88,70	90,10	100	13								
90,10	91,60	100	13								
91,60	92,10	100	25								
92,10	92,60	100	100								
92,60	93,00	100	100								
93,00	94,30	92	92								
94,30	94,50	100									
94,50	96,00	100	80								
96,00	96,50	100	100								
96,50	98,00	100	67								
				97,80	98,00	corient	test				
					98,00	1 BD	41	70	PL		QZ
					97,80	1 JN	41	70	PL	Roughness	QZ
					97,85	1 JN	38	70	PL	Roughness	QZ
98,00	98,60	100	100								
98,60	99,00	100	100								
99,00	100,50	100	60								
100,50	102,00	100	53								
102,00	103,50	100									

Type		Roughness		Infilling	
Joint:	**JN**	**Polished:**	**PO**	**Broken rock:**	**BR**
Fault:	**FLT**	**Slickinsided:**	**K**	**Sand:**	**SA**
Shear	**SHR**	**Smooth:**	**SM**	**Silt:**	**SI**
Vein:	**VN**	**Rought:**	**RO**	**Clay:**	**CL**
Bedding:	**BD**	**Very rought:**	**VR**	**Gouge:**	**GO**
Foliation:	**FO**			**Biotite:**	**BT**
Contact:	**CO**	**Shape**		**Calcite:**	**CA**
		Planar:	**PL**	**Chlorite:**	**CH**
		Curved:	**CU**	**Iron:**	**FE**
		Undulating:	**UN**	**Hématite:**	**HE**
		Stepped:	**ST**	**Quartz:**	***QZ***
		Irregular:	**IR**	**Limonite:**	***LI***

LVM

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design FILE N° : B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) BOREHOLE N° : BH-P-04

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
103,50	104,70	100									
104,70	105,90	96	3								
105,90	108,00	71									
108,00	109,50	100	13								
109,50	111,00	100									
111,00	112,50	50									
112,50	114,00	N-A	N-A								
114,00	115,50	13									
115,50	117,00	100	30								
117,00	118,50	100									
118,50	120,00	100	23								
120,00	121,50	100	33								
121,50	123,00	100	32								
123,00	124,10	100	100								
124,10	124,50	100	50								
124,50	125,80	83	83								
125,80	127,10	100	58								
127,10	127,40	100	100								
127,40	128,70	100									
128,70	129,80	82	45								
129,80	130,00	100									
130,00	130,50	100	80								
130,50	130,60	100									

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

LVM

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design **FILE N° :** B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec) **BOREHOLE N° :** BH-P-04

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
130,60	132,00	100	100								
132,00	133,00	20	10								
133,00	133,40	100	50								
133,40	135,00	100	59								
135,00	136,50	100									
136,50	138,00	100	31								
138,00	138,60	100	100								
138,60	139,60	100	35								
139,60	140,60	50	10								
140,60	141,00	100									
141,00	142,20	100	54								
142,20	143,70	100	50								
143,70	145,00	100	92								
145,50	147,00	100	65								
				146,50	147,00	BD	25-29	235	PL		WC
					146,50	1 JN	30	230	IR	Roughness	FE
					146,80	1 JN	39	255	PL	SM	FE
				151,38	151,50	Test Corient					
					151,44	1 BD	22	280	UN		FE
147,00	148,50	16									
148,50	150,00	100	80								
150,00	151,50	100	70								

Type	
Joint:	**JN**
Fault:	**FLT**
Shear	**SHR**
Vein:	**VN**
Bedding:	**BD**
Foliation:	**FO**
Contact:	**CO**

Roughness	
Polished:	**PO**
Slickinsided:	**K**
Smooth:	**SM**
Rought:	**RO**
Very rought:	**VR**

Shape	
Planar:	**PL**
Curved:	**CU**
Undulating:	**UN**
Stepped:	**ST**
Irregular:	**IR**

Infilling	
Broken rock:	**BR**
Sand:	**SA**
Silt:	**SI**
Clay:	**CL**
Gouge:	**GO**
Biotite:	**BT**
Calcite:	**CA**
Chlorite:	**CH**
Iron:	**FE**
Hématite:	**HE**
Quartz:	***QZ***
Limonite:	***LI***

DISCONTINUITY DATA

PROJECT : Geotechnical Feasibility Study – Open Pit Design

FILE N° : B-0010504-3

LOCATION : Joyce Lake, 20 km from Schefferville, (Québec)

BOREHOLE N° : BH-P-04

Run				Discontinuity							
Depth (m)		TCR (%)	RQD (%)	Depth (m)		Type & number	α angle	β angle	Shape	Roughness	Infill
from	to			from	to						
151,50	153,00	20									
153,00	154,50	N A	N A								
154,50	156,00	87	55								
156,00	157,50	100	20								
157,50	159,00	100	33								
159,00	100,00										
E O H											

Type	
Joint:	JN
Fault:	FLT
Shear	SHR
Vein:	VN
Bedding:	BD
Foliation:	FO
Contact:	CO

Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR

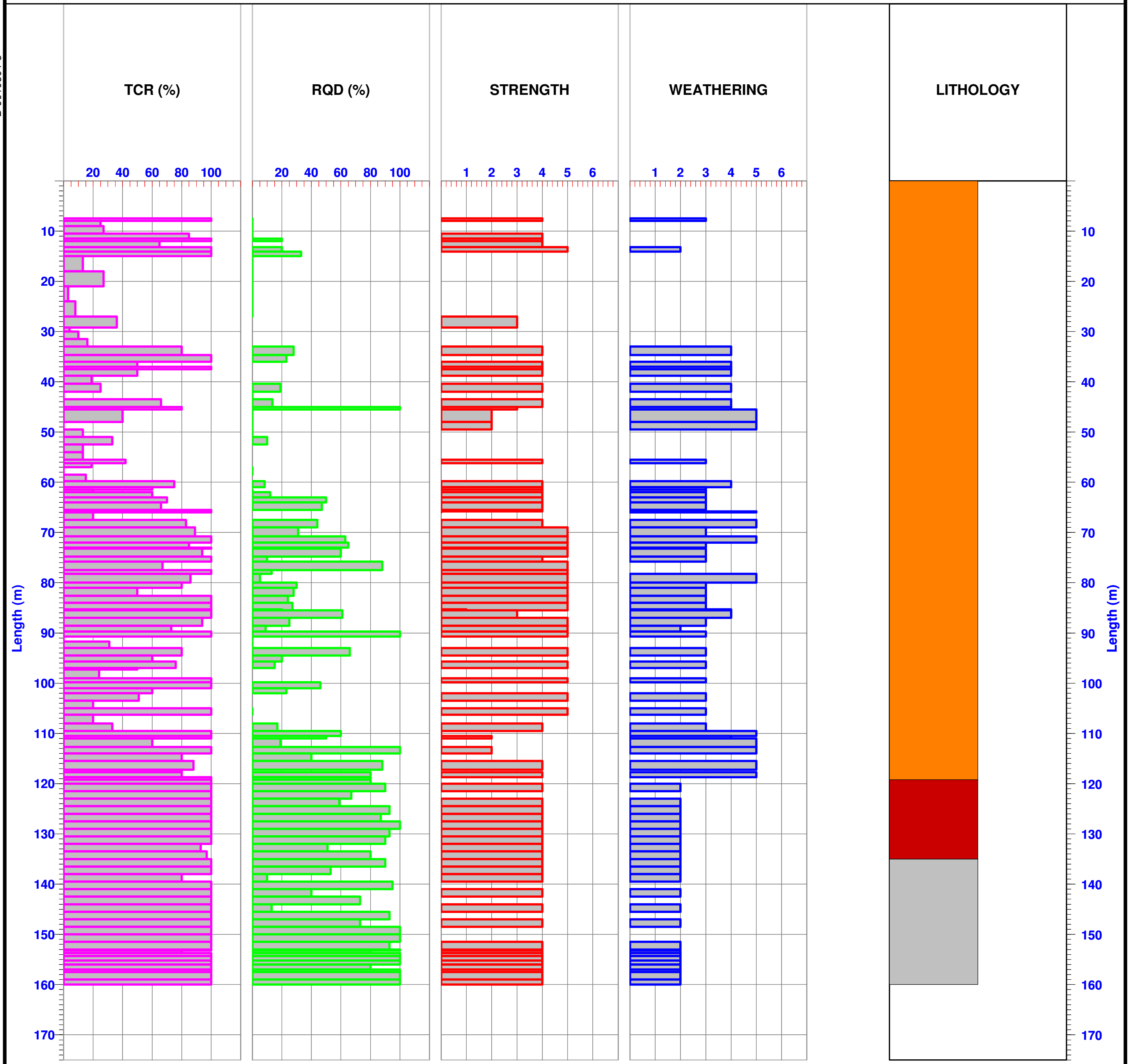
Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Infilling	
Broken rock:	BR
Sand:	SA
Silt:	SI
Clay:	CL
Gouge:	GO
Biotite:	BT
Calcite:	CA
Chlorite:	CH
Iron:	FE
Hématite:	HE
Quartz:	*QZ*
Limonite:	*LI*

Appendix 3 Rock joints characteristics histograms

RECORD OF ROCK HISTOGRAM SUMMARY - BOREHOLE N°: BH-P-01

File n°:	B-0010504-3	Project Name:	Joyce Lake - Open Pit	Date drilled & Logged:	
Northing:	6086486.969	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658114.121	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	527.85	Azimut:	303.70°	Drillers:	
Inclination:	70°	Bit type: Flush: Feed:		Drill Rig:	LF-70



LEGEND:

Lithologies:
- Banded Iron Formation (BIF)
- Shale
- Sandstone

HOLE #: **BH-P-01**

Y:\Style_LVM\Log\Log_Geotec_80Log_Rock_Histogram_LVM_AN_Joyce_Lake.sty- Printed : 2014-11-17 15h
B-0010504-3

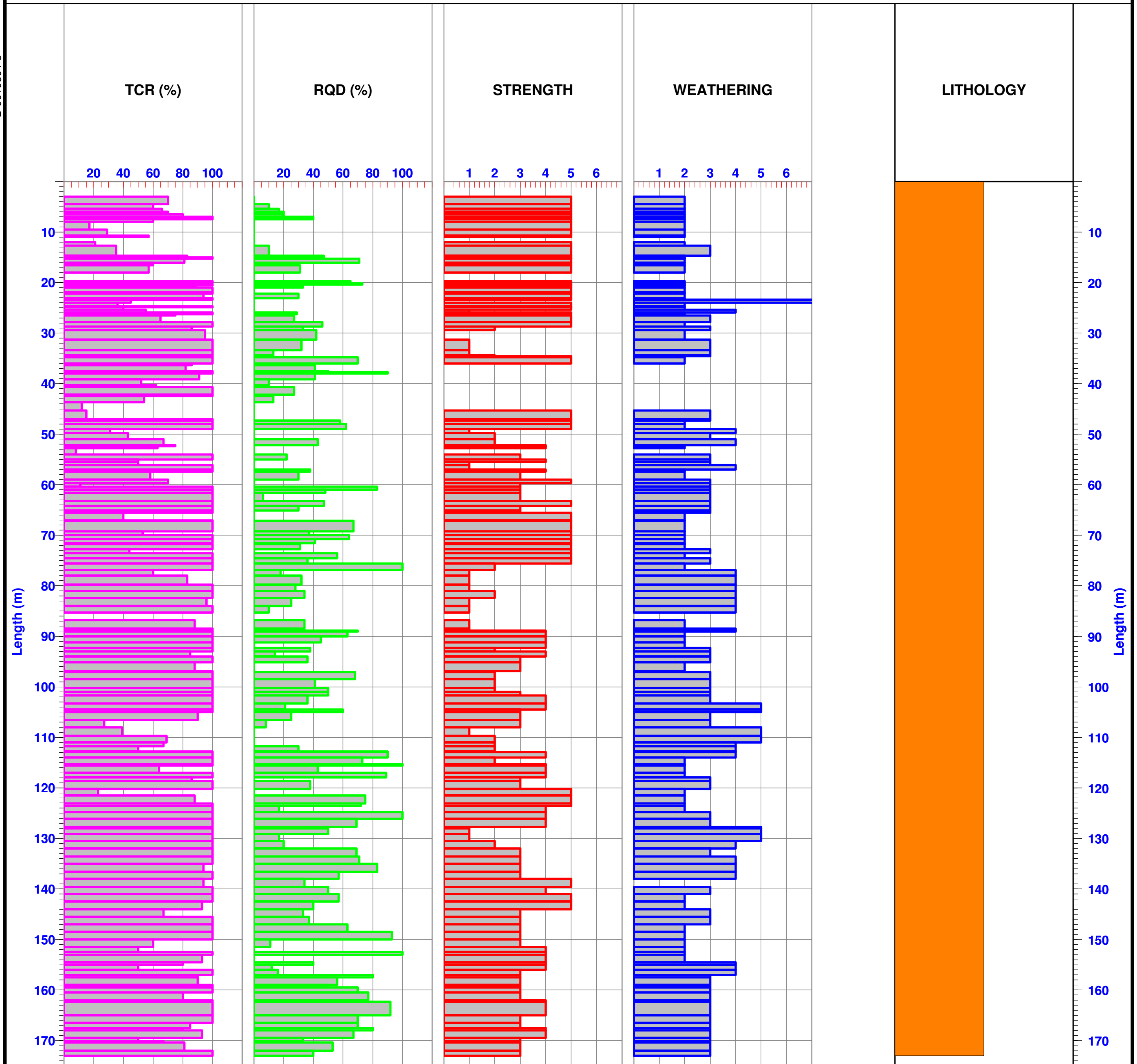
B.T.

Vertical Scale = 1 : 1175

EQ-09-Ge-66A R.1 04.03.2009

RECORD OF ROCK HISTOGRAM SUMMARY - BOREHOLE N°: BH-P-02

File n°:	**B-0010504-3**	Project Name:	**Joyce Lake - Open Pit**	Date drilled & Logged:	2014-09-25
Northing:	6086299.006	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658177.634	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	522.18	Azimut:	197.40°	Drillers:	
Inclination:	60°	Bit type: Flush: Feed:		Drill Rig:	LF-70



LEGEND:

Lithologies:
- Banded Iron Formation (BIF)
- Shale
- Sandstone

HOLE #:

BH-P-02

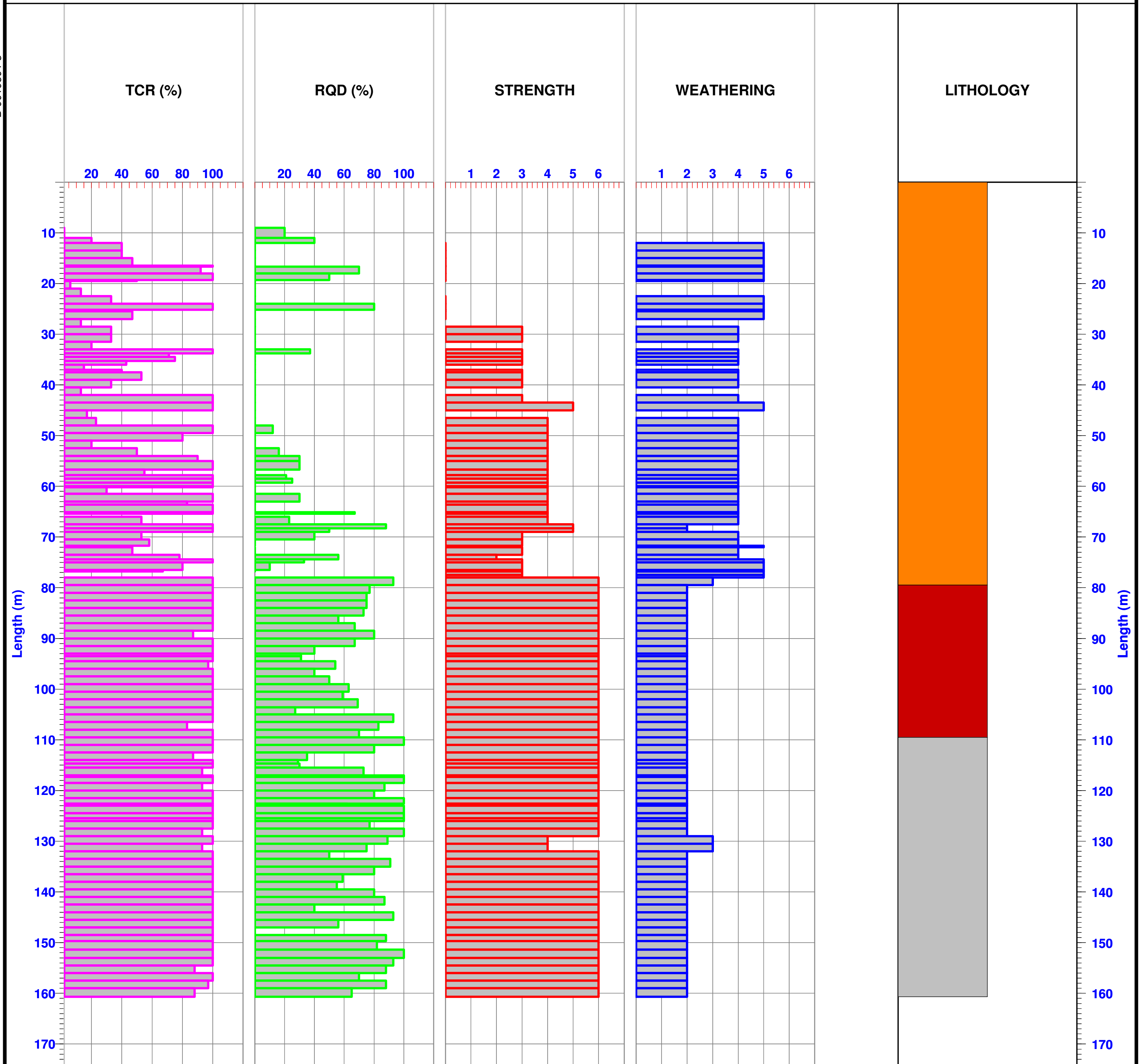
Y:\Style_LVM\Log\Log_Geotec_80Log_Rock_Histogram_LVM_AN_Joyce_Lake.sty- Printed : 2014-11-17 15h
B-0010504-3
B.T.
Vertical Scale = 1 : 1175
EQ-09-Ge-66A R.1 04.03.2009

B.T.

Vertical Scale = 1 : 1175

RECORD OF ROCK HISTOGRAM SUMMARY - BOREHOLE N°: BH-P-03

File n°:	**B-0010504-3**	Project Name:	**Joyce Lake - Open Pit**	Date drilled & Logged:	
Northing:	6086562.697	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658422.620	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	526.33	Azimut:	45.00°	Drillers:	
Inclination:	70°	Bit type: Flush:	Feed:	Drill Rig:	LF-70



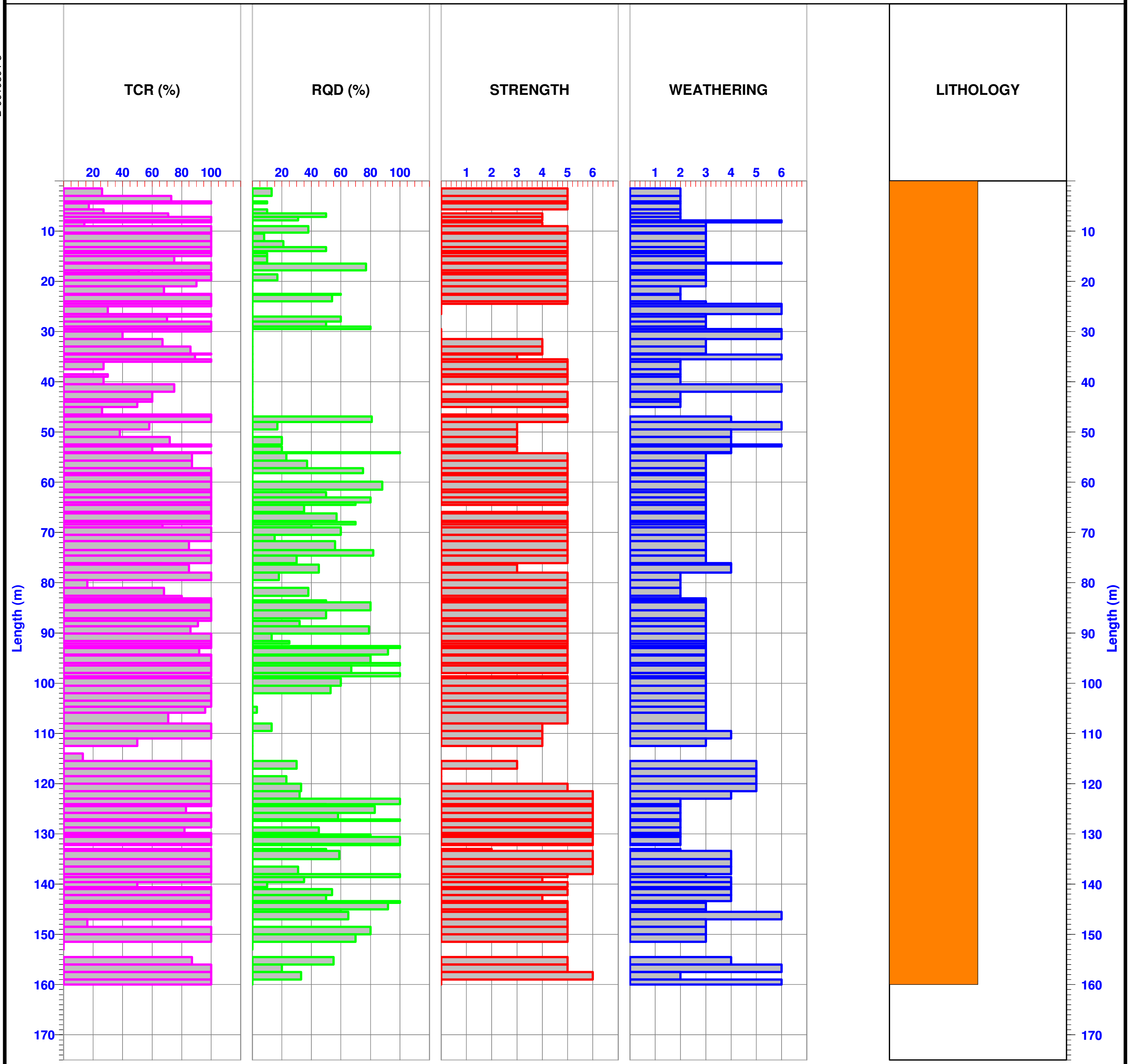
LEGEND:

Lithologies:
- Banded Iron Formation (BIF)
- Shale
- Sandstone

HOLE #: **BH-P-03**

RECORD OF ROCK HISTOGRAM SUMMARY - BOREHOLE N°: BH-P-04

File n°:	**B-0010504-3**	Project Name:	**Joyce Lake - Open Pit**	Date drilled & Logged:	2014-10-10
Northing:	6086397.562	Reference Point:	Precision GPS	Logged by:	Alain Lemonde
Easting:	658603.194	Datum:	NAD83 UTM ZONE 19	Drilling Contractor:	Downing
Elevation:	519.26	Azimut:	135.00°	Drillers:	
Inclination:	70°	Bit type: / Flush: / Feed:		Drill Rig:	LF-70



LEGEND:

Lithologies:
- Banded Iron Formation (BIF)
- Shale
- Sandstone

HOLE #: **BH-P-04**

Y:\Style_LVM\Log\Log_Geotec_80Log_Rock_Histogram_LVM_AN_Joyce_Lake.sty- Printed : 2014-11-17 15h
B-0010504-3

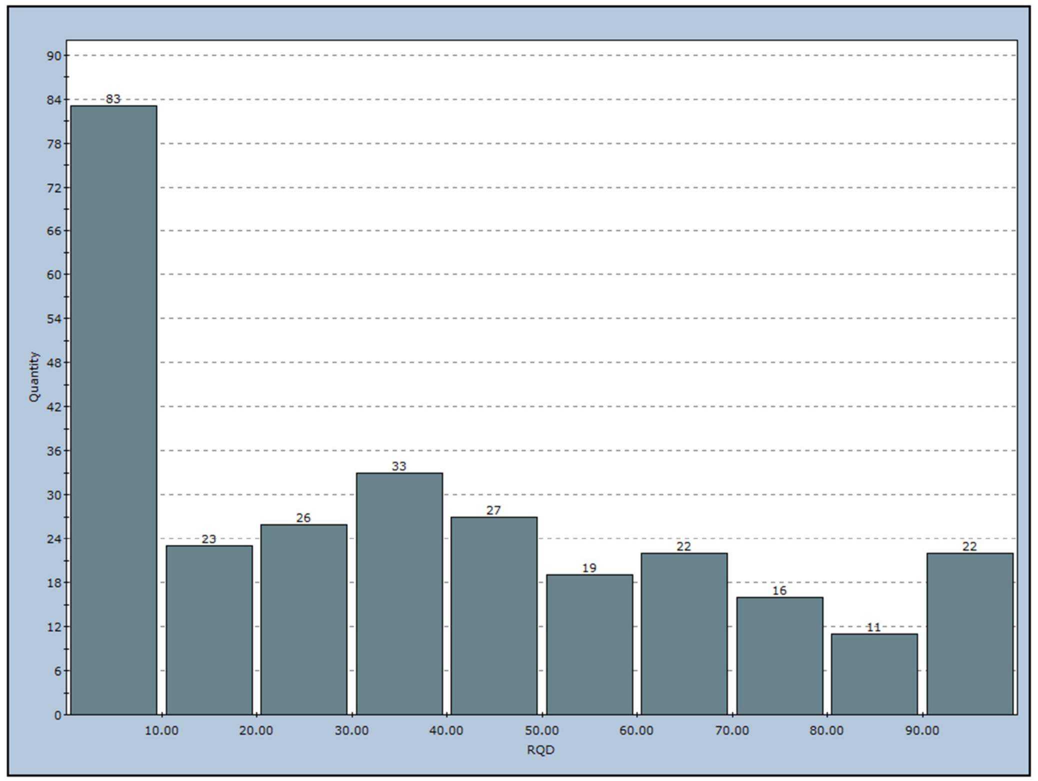
B.T.

Vertical Scale = 1 : 1175

EQ-09-Ge-66A R.1 04.03.2009

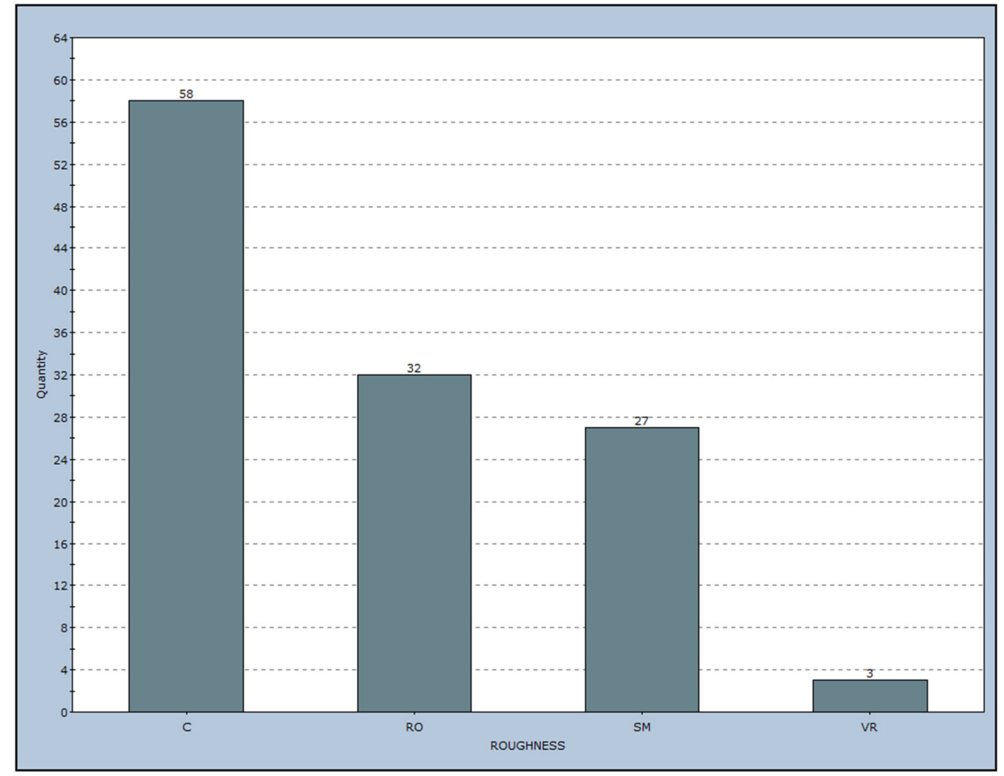
ROCK JOINTS CHARACTERISTICS	IRON FORMATION

Quantitative Chart of RQD



mean=37.344 s.d.=32.0443 min=0 max=100

Qualitative Chart of ROUGHNESS



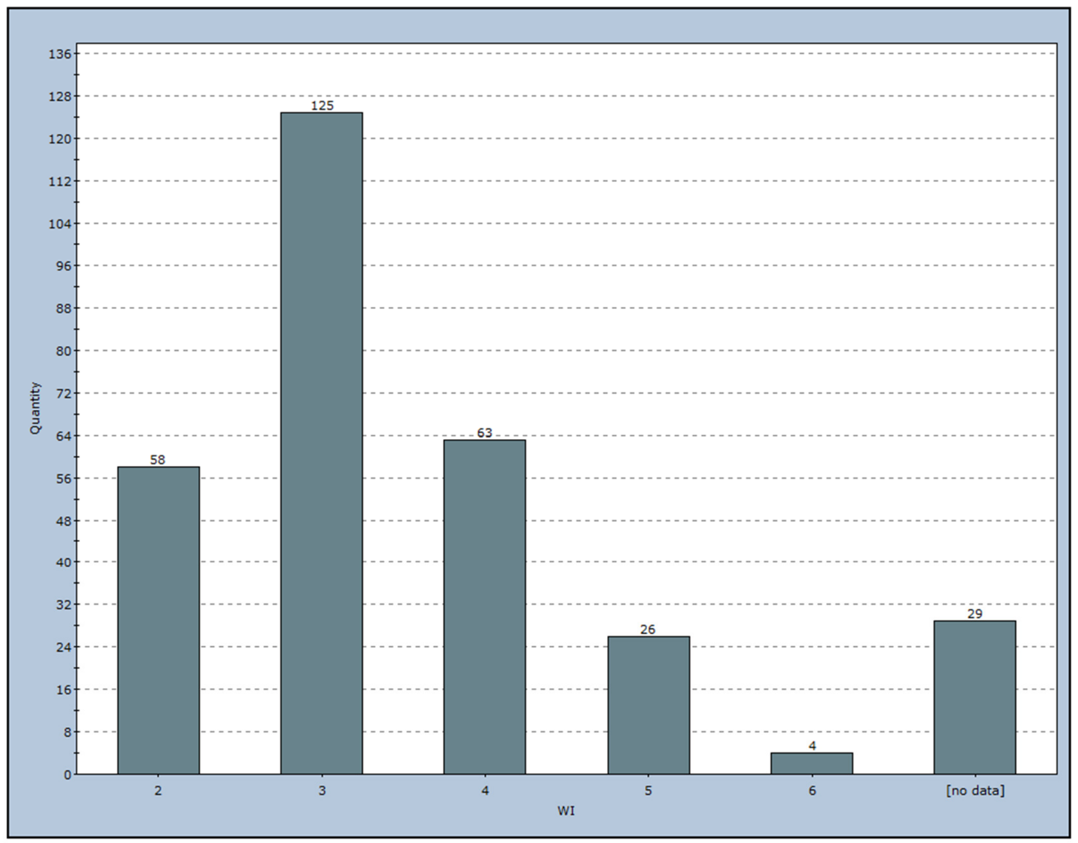
Roughness	
Polished:	PO
Slickinsided:	K
Smooth:	SM
Rought:	RO
Very rought:	VR
Closed	C

Client : Labec Century Iron Ore Inc.	**Scale**: Pas à l'échelle
Project : Joyce Lake and Area DSO Project – Geotechnical Feasability Study – Open Pit Design	**Ref**. : 025-B-0010504-3-GE-0001-0A
	Prepared by :G. Joyal
Histograms : RQD, Roughness,	**Date** : 2014-11-19

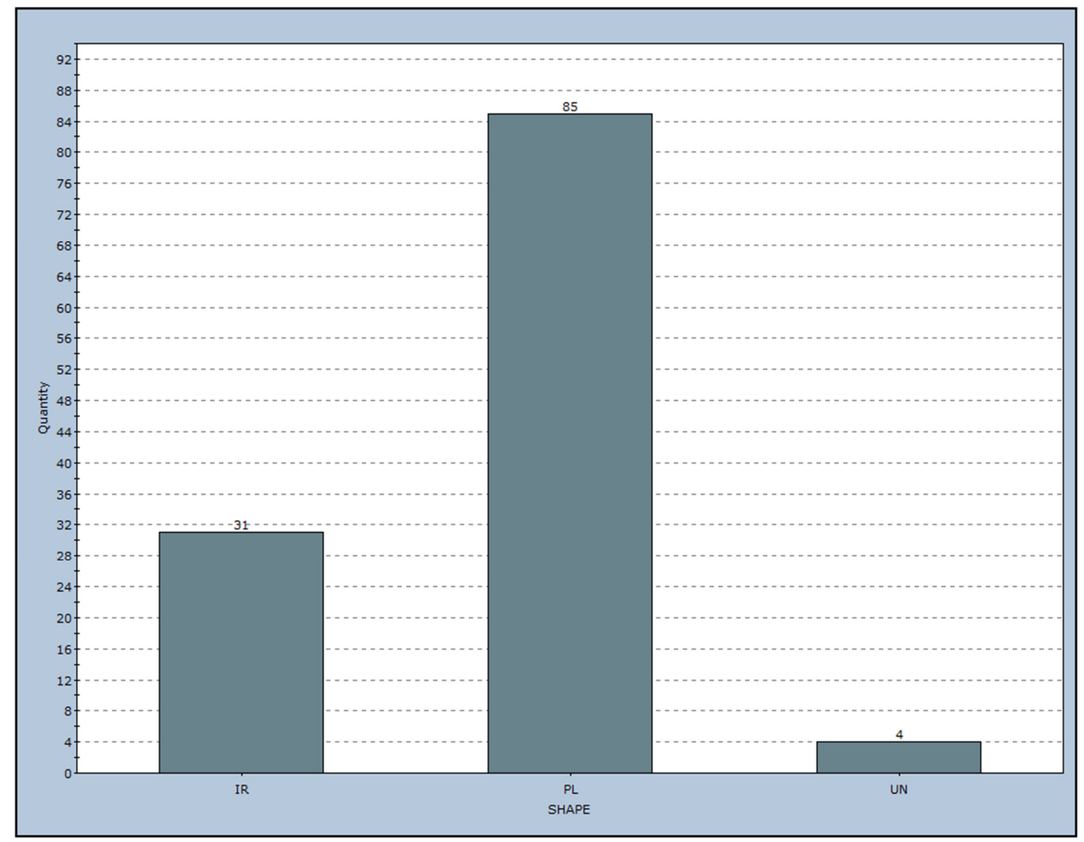
ROCK JOINTS CHARACTERISTICS

IRON FORMATION

Qualitative Chart of WI



Qualitative Chart of SHAPE



Shape	
Planar:	PL
Curved:	CU
Undulating:	UN
Stepped:	ST
Irregular:	IR

Client : Labec Century Iron Ore Inc.	**Scale**: Pas à l'échelle
Project : Joyce Lake and Area DSO Project – Geotechnical Feasability Study – Open Pit Design	**Ref.** : 025-B-0010504-3-GE-0001-0A
	Prepared by :G. Joyal
Histograms : Shape, Weathering Index	**Date** : 2014-11-19

Appendix 4 Université Laval Rock Mechanics Laboratory Report

LVM

Essais de laboratoire

Résistance en compression uniaxiale
Résistance en tension indirecte (brésilien)
Résistance en compression triaxiale

À l'attention de PASCAL GARAND, Ing. M.Sc. A
Directeur Expertise Géotechnique

LVM, une division d'EnGlobe Corp.
1200, boul. Saint-Martin ouest, bureau 300
Laval, QC, Canada, H7S 2E4

Laboratoire de mécanique des roches – Université Laval

Faculté des sciences et de génie
Département de génie des mines, de la métallurgie et des matériaux

Essais réalisés :

- 27 essais en compression uniaxiale
- 34 essais brésiliens
- 6 essais triaxiaux

Québec, le 17 novembre 2014

PASCAL GARAND, Ing. M.Sc. A
Directeur Expertise Géotechnique

LVM, une division d'EnGlobe Corp.
1200, boul. Saint-Martin ouest, bureau 300
Laval, QC, Canada, H7S 2E4

Objet : Essais de laboratoire – propriétés mécaniques

Monsieur,

Nous avons réalisé, à votre demande, une série d'essais mécaniques sur des échantillons de roc intact.

Les échantillons ont été préparés et testés selon les recommandations établies par la SIMR (Société internationale de mécanique des roches). Vous trouverez les détails relatifs aux résultats des tests dans ce rapport.

Pour de plus amples renseignements, n'hésitez pas à nous contacter.

Veuillez recevoir, monsieur, nos meilleures salutations.

Martin Grenon, professeur, ing., Ph.D.
Tél.: 418 656-7478
Télec.: 418 656-5343
Courriel: martin.grenon@gmn.ulaval.ca

Table des matières

Liste des tableaux

Résumé

Des échantillons des trous BH-01, BH-02, BH-03 et BH-04 ont été envoyés au Laboratoire de mécanique des roches (LMR) de l'Université Laval par LVM (Laval) pour déterminer :

- La résistance en compression uniaxiale (UCS);
- La résistance en tension (σ_t);
- La résistance en compression triaxiale (σ_1, σ_3).

Des segments de carottes de forage, provenant de 7 lithologies différentes, ont été reçus au LMR le 14, le 22 et le 28 octobre 2014. Par la suite, ces carottes ont servi à la préparation de :

- 27 échantillons pour des essais en compression uniaxiale;
- 34 échantillons pour des essais en tension indirecte (brésiliens);
- 6 échantillons pour des essais en compression triaxiale.

Les échantillons ont été préparés et testés suivant, dans la mesure du possible, les recommandations prescrites par la Société internationale de mécanique des roches (SIMR) :

> Brown, E.T., Suggested Methods: Rock Characterization, Testing and Monitoring, International Society for Rock Mechanics, E. Brown, Éd., London: Pergamon Press, 1981, p. 211.

Il est important de noter que même si les recommandations de la SIMR ont été suivies, l'état des échantillons n'a pas permis d'atteindre les standards quant à la planéité et à la rugosité des surfaces des échantillons. Aussi, l'échantillonnage étant restreint, le nombre d'essais par lithologie et par type d'essais est insuffisant.

Tous les essais ont été effectués à l'aide d'une presse SATEC 400RD PRISM.

La résistance en compression a été évaluée et les résultats sont présentés pour chacune des lithologies. Le même traitement a été fait pour la résistance en tension.

Description des échantillons

Le Laboratoire de mécanique des roches (LMR) de l'Université Laval a reçu des segments de carottes de forage le 14, le 22 et le 28 octobre 2014. Ces segments, provenant des trous BH-01, BH-02, BH-03 et BH-04, ont servi à la préparation d'échantillons pour la réalisation d'essais sur le roc intact. Au total, le LMR a effectué 27 essais de résistance en compression uniaxiale, 34 essais de résistance en tension indirecte (brésiliens) et 6 essais triaxiaux.

Les échantillons proviennent de carottes de forages (diamètre HQ) sondées dans 7 lithologies différentes :

- LITHO1: *Mainly Iron Oxyde*;
- LITHO2: *Iron Oxyde with White Chert*;
- LITHO3: *Iron Oxyde with Limonite*;
- LITHO4: *Iron Oxyde (Hematite) – Massive*;
- LITHO5: *Mix of Shale and White Chert*;
- LITHO6: *Shale*;
- LITHO7: *Sandstone*.

Les tableaux 1 ,2 et 3 répertorient les échantillons qui ont été préparés avec la lithologie, le numéro qui leur a été attribué, le numéro du forage duquel ils proviennent, leur profondeur, leurs dimensions et leur masse.

TABLEAU 1 : ÉCHANTILLONS POUR LES ESSAIS DE RÉSISTANCE EN COMPRESSION

Lithologie	Numéro de l'échantillon	Numéro du forage	Profondeur (m)		D (mm)	L (mm)	L/D	Masse (g)
			De	À				
Mainly Iron Oxyde	RS-11	BH-02	143,75	144,00	47,0	111,8	2,4	672,6
Iron Oxyde with White Chert	RS-13	BH-02	133,25	133,60	63,6	135,7	2,1	1341,6
	RS-16	BH-02	114,65	115,15	63,7	139,8	2,2	1526,8
	RS-17	BH-02	87,60	87,80	61,4	137,9	2,2	1228,8
	PLT-07	BH-02	76,60	76,90	61,33	126,34	2,1	1177,2
	PLT-03	BH-02	61,50	61,75	59,92	138,53	2,3	1129,2
Iron Oxyde with Limonite	RS-04	BH-02	148,10	148,33	63,2	134,4	2,1	1110,2
	RS-06	BH-02	157,12	157,39	63,5	140,2	2,2	1254,2
	RS-07	BH-02	157,50	157,67	47,5	111,8	2,4	563,0
	RS-10	BH-02	137,80	138,10	47,0	103,1	2,2	428,3
	RS-12	BH-02	135,05	135,30	63,4	129,7	2,0	1006,6
	PLT-11	BH-02	161,40	161,70	63,32	135,3	2,1	1142,5
	PLT-12	BH-02	161,70	161,95	63,18	136,47	2,2	1406,2
Iron Oxyde (Hematite)-Massive	PLT-16	BH-04	123,85	124,10	60,92	135,15	2,2	1715,2
	RS-46	BH-04	123,00	123,23	60,72	131,75	2,2	1458,1
	RS-52	BH-04	157,80	158,00	47,37	99,64	2,1	711,4
Mix of Shale and White Chert	RS-54	BH-03	81,00	81,26	63,55	136,84	2,2	1181,4
	RS-58A	BH-03	89,60	89,96	63,48	129,48	2,0	1135,2
	RS-58B	BH-03	89,60	89,96	63,40	132,62	2,1	1213,0
	RS-57	BH-03	87,00	87,20	63,51	134,90	2,1	1289,1
Shale	RS-27	BH-01	125,25	125,50	63,47	135,77	2,1	1147,0
	RS-28	BH-01	125,70	125,90	63,49	135,52	2,1	1128,8
	RS-29	BH-01	126,25	126,55	63,47	133,79	2,1	1105,4
Sandstone	RS-32	BH-01	135,00	135,35	63,49	132,85	2,1	1103,3
	RS-34	BH-01	148,26	148,50	63,53	140,9	2,2	1178,5
	RS-37	BH-01	154,83	155,20	63,36	136,86	2,2	1150,6
	RS-38	BH-01	159,43	159,60	63,25	136,33	2,2	1188,5

* Notez que le diamètre de certains échantillons varie car il était initialement prévu de faire des essais triaxiaux sur ceux-ci.

Approche

Préparation des échantillons

La préparation des échantillons s'est faite suivant les recommandations prescrites par la Société internationale de mécanique des roches (SIMR), (Brown, E.T., 1981). Chaque échantillon fourni a été coupé puis rectifié. La planéité des surfaces, leur parallélisme et leur perpendicularité ont été vérifiés. **Il est important de noter que même si les recommandations de la SIMR ont été suivies, l'état des échantillons n'a pas permis d'atteindre les standards quant à la planéité et à la rugosité des surfaces des échantillons.**

Les échantillons ont été préparés pour qu'ils aient un ratio L/D : compris entre 2,0 et 2,5 pour les essais en compression uniaxiale, de 0,5 pour les essais brésiliens et de 2,0 pour les essais triaxiaux. Pour ces derniers, le diamètre des échantillons NQ (47,6 mm) est imposé par l'équipement utilisé pour assurer le confinement.

Même si le diamètre des segments reçus était du HQ (63,5 mm), le diamètre de certains échantillons préparés pour les essais en compression et en tension indirecte diffère des autres. Quelques échantillons avaient été sélectionnés pour des essais triaxiaux alors qu'ils ont plutôt été testés autrement. Aussi les échantillons sélectionnés pour les essais triaxiaux ont été rectifiés pour en réduire le diamètre, passant ainsi du HQ au NQ.

Un fois préparés, les échantillons ont été photographiés avant que les tests ne soient effectués. Leurs photos, ainsi que leurs dimensions sont disponibles sur les feuilles de résultats présentées en annexe.

Méthodologie des essais

Les tests ont été effectués en suivant les recommandations présentées dans l'ouvrage "Suggested Methods: Rock Characterization, Testing and Monitoring", (Brown, E.T., 1981):

- Suggested Methods for Determining the Uniaxial Compressive Strength and Deformability of Rock Materials.
- Suggested Methods for Determining Tensile Strength of Rock Materials.
- Suggested Methods for Determining the Strength of Rock Materials in Triaxial Compression.

Les essais en compression uniaxiale, en tension indirecte et triaxiaux ont été réalisés à l'aide d'une presse SATEC 400RD PRISM servo contrôlée.

Les valeurs de résistance au moment de la rupture ont été enregistrées.

Il est important de noter que le nombre d'essais en compression uniaxiale, en tension indirecte et en compression triaxiale réalisés sont insuffisants selon les recommandations mises de l'avant par la SIMR.
Pour les essais en compression uniaxiale, un seul essai pour la lithologie *Mainly Iron Oxyde,* 3 essais pour la lithologie *Iron Oxyde (Hematite)-Massive*, 4 essais pour la lithologie *Mix of Shale and White Chert*, 3 essais pour la lithologie *Shale* et seulement 3 essais ont été réalisés pour la lithologie *Sandstone* alors que la norme prévoit 5 essais valides par lithologie. Pour les essais en tension indirecte, 8 essais pour la lithologie *Mainly Iron Oxyde*, 7 essais pour la lithologie *Iron Oxyde with White Chert, 7* essais pour la lithologie *Iron Oxyde with Limonite*, 3 essais pour la lithologie *Iron Oxyde (Hematite)-Massive,* 3 essais pour la lithologie *Mix of Shale and White Chert,* 3 essais pour la lithologie *Shale* et seulement 3 essais ont été réalisés pour la lithologie *Sandstone* alors que la norme prévoit 10 essais valides par lithologie. Pour les essais en compression triaxiale, 3 essais pour la lithologie *Iron Oxyde (Hematite)-Massive* et seulement 3 essais ont été réalisés pour la lithologie *Iron Oxyde with White Chert* alors que la norme prévoit 5 essais valides par lithologie.

Validité des essais de résistance en compression uniaxiale

Au total, six (6) échantillons (RS-11, PLT-03, RS-06, PLT-12, RS-54 et RS-58A) ont été qualifiés de non valides lors des essais en compression uniaxiale. La rupture s'est faite suivant les plans de sédimentation ou un plan pré-identifié.

Sommaire des valeurs de résistance en compression uniaxiale – essais valides

Un sommaire des résultats, pour les essais valides uniquement, est présenté au tableau 5. La résistance en compression uniaxiale de *Iron Oxyde with White Chert* est de 97,6 MPa avec un écart type de 4,9 MPa; celle de *Iron Oxyde with Limonite* est de 29,0 MPa avec un écart type de 13,6 MPa; celle de *Iron Oxyde (Hematite)-Massive* est de 55,7 MPa avec un écart type de 31,0 MPa; celle de *Mix of Shale and White Chert* est de 120,7 MPa avec un écart type de 15,8 MPa; celle de S*hale* est de 130,9 MPa avec un écart type de 1,8 MPa et celle de *Sandstone* est de 254,6 MPa avec un écart type de 48,8 MPa. Aucun résultat n'a été obtenu pour la lithologie *Mainly Iron Oxyde* car l'unique essai effectué a été non valide.

TABLEAU 5 : SOMMAIRE DES RÉSISTANCES EN COMPRESSION UNIAXIALE (σ_{ci}) – ESSAIS VALIDES

Lithologie	Nombre d'essai	σ_{ci} (MPa)				Coefficient de variation (%)
		Moyenne	Écart type	Min	Max	
Mainly Iron Oxyde	0	-	-	-	-	-
Iron Oxyde with White Chert	4	97,6	4,9	92,6	102,2	5,0
Iron Oxyde with Limonite	5	29,0	13,6	16,0	51,8	46,9
Iron Oxyde (Hematite)-Massive	3	55,7	31,0	28,3	89,3	55,6
Mix of Shale and White Chert	2	120,7	15,8	109,5	131,9	13,1
Shale	3	130,9	1,8	128,9	132,4	1,4
Sandstone	4	254,6	48,8	219,0	325,9	19,2

Total	17

Le coefficient de variation est utilisé afin d'évaluer la variabilité des données et il est défini comme le rapport entre l'écart-type (σ) et la moyenne(μ).

$$C_v = \frac{\sigma}{\mu}$$

En géotechnique minière, un coefficient de variation de moins de 10 % est considéré comme faible alors qu'un coefficient de variation supérieur à 30 % est considéré comme élevé (Read, J., Stacey, P., 2009).

Pour les essais de compression uniaxiale réalisés, *Iron Oxyde with White Chert* présente un coefficient de variation de 5,0 %, *Iron Oxyde with Limonite* présente un coefficient de variation de 46,9 %, *Iron Oxyde (Hematite)-Massive* présente un coefficient de variation de 55,6 %, *Mix of Shale and White Chert* présente un coefficient de variation de 13,1 %, *Shale* présente un coefficient de variation de 1,4 % et *Sandstone* présente un coefficient de variation de 19,2 %. Selon les résultats de résistance en compression obtenus, les lithologies *Iron Oxyde with Limonite, Iron Oxyde (Hematite)-Massive* présentent un coefficient de variation de plus de 30 %.

Sommaire des valeurs de résistance en tension indirecte

Un sommaire des résultats est présenté au tableau 7 en considérant uniquement les essais valides. La moyenne de la résistance en tension indirecte de *Mainly Iron Oxyde* est de 12,7 MPa avec un écart type de 8,9 MPa; celle de *Iron Oxyde with White Chert* est de 7,9 MPa avec un écart type de 1,3 MPa; celle de *Iron Oxyde with Limonite* est de 4,3 MPa avec un écart type de 3,1 MPa; celle de *Iron Oxyde (Hematite)-Massive* est de 9,4 MPa avec un écart type de 5,3 MPa; celle de *Mix of Shale and White Chert* est de 11,5 MPa avec un écart type de 8,0 MPa; celle de S*hale* est de 14,6 MPa avec un écart type de 2,5 MPa et celle de *Sandstone* est de 19,9 MPa avec un écart type de 8,2 MPa. Les coefficients de variations valent respectivement 69,8 %, 16,8 %, 73,1 %, 56,4 %, 69,5 %, 16,9 % et 8,2 %. Selon les résultats de résistance en tension obtenus, les lithologies *Mainly Iron Oxyde, Iron Oxyde with Limonite, Iron Oxyde (Hematite)-Massive et Mix of Shale and White Chert* présentent un coefficient de variation de plus de 30 %.

TABLEAU 7: SOMMAIRE DES RÉSISTANCES EN TENSION INDIRECTE (σ_T) – ESSAIS VALIDES

Lithologie	Nombre d'essai	σ_t (MPa)				Coefficient de variation (%)
		Moyenne	Écart type	Min	Max	
Mainly Iron Oxyde	8	12,7	8,9	4,8	28,1	69,8
Iron Oxyde with White Chert	5	7,9	1,3	6,7	9,7	16,8
Iron Oxyde with Limonite	6	4,3	3,1	1,6	10,3	73,1
Iron Oxyde (Hematite)-Massive	3	9,4	5,3	3,5	13,7	56,4
Mix of Shale and White Chert	3	11,5	8,0	4,1	20,0	69,5
Shale	3	14,6	2,5	12,0	17,0	16,9
Sandstone	3	19,9	8,2	12,1	28,5	8,2

Total	31

Résistance en compression triaxiale

Au total 6 valeurs de résistance en compression triaxiale ont été évaluées à partir des essais effectués sur des échantillons reçus. Pour chacun des essais réalisés, une feuille synthèse avec les photos, les caractéristiques de l'échantillon et les résultats de l'essai est présentée à l'annexe 3.

Validité des essais triaxiaux

Au total, deux essais ont été qualifiés de non valide (PLT-17 et RS-51).

Sommaire des valeurs de résistance en compression triaxiale

Un sommaire des résultats est présenté au tableau 8.

TABLEAU 8 : RÉSISTANCE EN COMPRESSION TRIAXIALE (σ_1,σ_3)

Lithologie	Numéro de l'échant	Numéro du forage	Profondeur (m)		σ_3 (MPa)	σ_1 (MPa)	Commentaire
			De	À			
Iron Oxyde (Hematite)-Massive	PLT-17	BH-04	138,20	138,50	8,1	58,4	Essai non valide
	RS-50	BH-04	123,10	123,27	3,4	39,3	Mixte
	RS-45	BH-04	121,70	121,87	5,7	71,4	Mixte
Iron Oxyde with White Chert	PLT-07	BH-03	76,60	76,90	8,2	256,7	Mixte
	RS-41	BH-03	69,65	69,90	4,9	112,5	Diagonale
	RS-51	BH-04	149,00	149,27	5,4	91,2	Essai non valide

Annexe 1 -
Résistance en compression uniaxiale : Feuilles-synthèses

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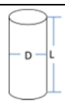	Échantillon	Essai	Forage	Profondeur (m)	Opérateur	Date
	RS-11	**UCS-005**	BH-02	143,75@144,00	CJ-JKM	23/10/2014

Caractéristiques de l'échantillon						Résultat du test	
D (mm)	L (mm)	L/D	Aire (mm^2)	Masse (g)	État	Force - rupture (kN)	σ_{ci} (MPa)
46,96	111,79	2,4	1731,99	672,6	SEC	210,7	121,65
Type de roche :	Mainly Iron Oxyde				Durée (min) :		2,7090
Note :					Validité :		**NON**

Cellule de charge : SATEC 400K	Taux : 0.75 MPa/sec

Remarque sur la rupture : Plan de rupture à environ 40° par rapport à l'axe de la carotte.

Type de rupture :	AXIALE ☐	DIAGONALE ☒	CONIQUE ☐	AUTRE ☐	MIXTE ☐
Rupture selon un plan pré identifié :	OUI ☐	NON ☐	PARTIELLEMENT ☐	PARALLÈLE ☐	SUIVANT LE CLIVAGE ☒
Nombre de fragments :	+ DE 3 ☐	- DE 3 ☒	ROCHE BROYÉE ☐		

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	Échantillon	Essai	Forage	Profondeur (m)	Opérateur	Date
	RS-16	**UCS-008**	BH-02	114,65@115,65	CJ-JKM	23/10/2014

Caractéristiques de l'échantillon						Résultat du test	
D (mm)	L (mm)	L/D	Aire (mm^2)	Masse (g)	État	Force - rupture (kN)	σ_{ci} (MPa)
63,66	139,80	2,2	3182,90	1526,8	SEC	299,7	94,16

Type de roche :	Iron Oxyde with white chert	Durée (min) :	2,106
Note :		Validité :	OUI

Cellule de charge : SATEC 400K	Taux : 0.75 MPa/sec
	
	

Remarque sur la rupture :

Type de rupture :	AXIALE ☐	DIAGONALE ☐	CONIQUE ☐	AUTRE ☐	MIXTE ☒
Rupture selon un plan pré identifié :	OUI ☐	NON ☒	PARTIELLEMENT ☐	PARALLÈLE ☐	SUIVANT LE CLIVAGE ☐
Nombre de fragments :	+ DE 3 ☒	- DE 3 ☐	ROCHE BROYÉE ☐		

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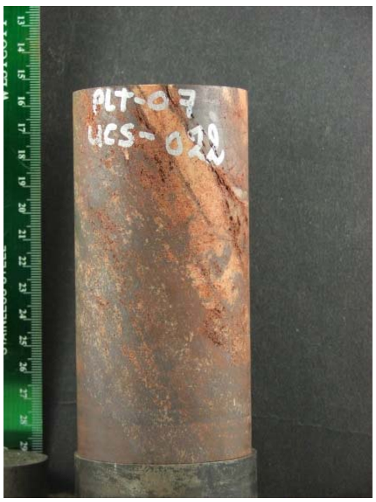
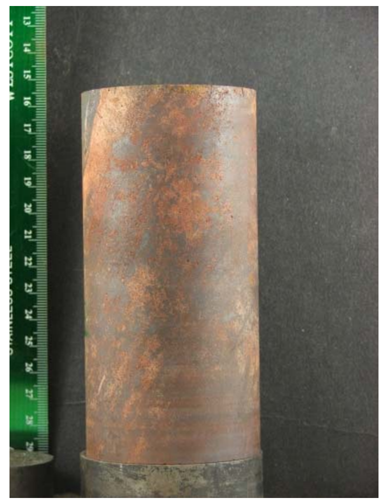
	Échantillon	Essai	Forage	Profondeur (m)	Opérateur	Date
	PLT-07	**UCS-022**	BH-02	76,60@76,90	CJ-JKM	11/11/2014

Caractéristiques de l'échantillon						Résultat du test	
D (mm)	L (mm)	L/D	Aire (mm^2)	Masse (g)	État	Force - rupture (kN)	σ_{ci} (MPa)
61,33	126,34	2,1	2954,2	1177,2	SEC	299,2	101,28

Type de roche :	Iron oxyde with white chert.	Durée (min) :	2,263
Note :	Foliation à 35 degrés par rapport à l'axe de la carotte.	Validité :	OUI

Cellule de charge : SATEC 400K	Taux : 0.75 MPa/sec





Remarque sur la rupture :

Type de rupture :	AXIALE ☒	DIAGONALE ☐	CONIQUE ☐	AUTRE ☐	MIXTE ☐
Rupture selon un plan pré identifié :	OUI ☐	NON ☐	PARTIELLEMENT ☒	PARALLÈLE ☐	SUIVANT LE CLIVAGE ☐
Nombre de fragments :	+ DE 3 ☒	- DE 3 ☐	ROCHE BROYÉE ☐		

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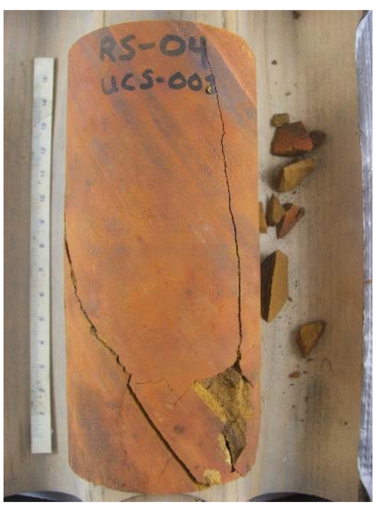
Échantillon	Essai	Forage	Profondeur (m)	Opérateur	Date
RS-04	**UCS-001**	BH-02	148,10@148,33	CJ-JKM	23/10/2014

Caractéristiques de l'échantillon						Résultat du test	
D (mm)	L (mm)	L/D	Aire (mm^2)	Masse (g)	État	Force - rupture (kN)	σ_{ci} (MPa)
63,20	134,44	2,1	3137,07	1110,2	SEC	92,1	29,36

Type de roche :	Iron oxyde with limonite	Durée (min) :	0,6570
Note :	Foliation à 30° par rapport à l'axe de la carotte.	Validité :	OUI

Cellule de charge : SATEC 400K	Taux : 0.75 MPa/sec






Remarque sur la rupture : Rupture à 30° suivant partiellement la foliation.

Type de rupture :	AXIALE ☒	DIAGONALE ☒	CONIQUE ☐	AUTRE ☐	MIXTE ☐
Rupture selon un plan pré identifié :	OUI ☐	NON ☐	PARTIELLEMENT ☒	PARALLÈLE ☐	SUIVANT LE CLIVAGE ☒
Nombre de fragments :	+ DE 3 ☒	- DE 3 ☐	ROCHE BROYÉE ☐		

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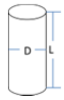	Échantillon	Essai	Forage	Profondeur (m)	Opérateur	Date
	RS-07	**UCS-003**	BH-02	157,50@157,67	CJ-JKM	23/10/2014

Caractéristiques de l'échantillon						Résultat du test	
D (mm)	L (mm)	L/D	Aire (mm²)	Masse (g)	État	Force - rupture (kN)	σ_{ci} (MPa)
47,49	111,84	2,4	1771,31	563,0	SEC	91,8	51,83

Type de roche :	Iron oxyde with limonite	Durée (min) :	1,17
Note :		Validité :	OUI

Cellule de charge : SATEC 400K	Taux : 0.75 MPa/sec

Remarque sur la rupture : Rupture suivant partiellement le clivage.

Type de rupture :	AXIALE ☒	DIAGONALE ☒	CONIQUE ☐	AUTRE ☐	MIXTE ☐
Rupture selon un plan pré identifié :	OUI ☐	NON ☐	PARTIELLEMENT ☒	PARALLÈLE ☐	SUIVANT LE CLIVAGE ☒
Nombre de fragments :	+ DE 3 ☒	- DE 3 ☐	ROCHE BROYÉE ☐		

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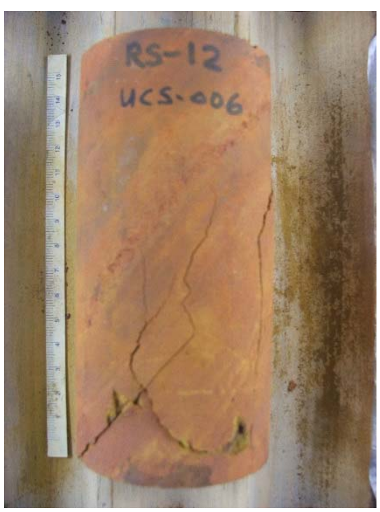
	Échantillon	Essai	Forage	Profondeur (m)	Opérateur	Date
	RS-12	**UCS-006**	BH-02	135,05@135,30	CJ-JKM	23/10/2014

Caractéristiques de l'échantillon						Résultat du test	
D (mm)	L (mm)	L/D	Aire (mm^2)	Masse (g)	État	Force - rupture (kN)	σ_{ci} (MPa)
63,35	129,67	2,0	3151,98	1006,6	SEC	77,4	24,56
Type de roche :	Iron oxyde with limonite					Durée (min) :	0,559
Note :	Foliation à 35° par rapport à l'axe de la carotte.					Validité :	OUI

Cellule de charge : SATEC 400K	Taux : 0.75 MPa/sec
	
	

Remarque sur la rupture : Rupture suivant partiellement le clivage

Type de rupture :	AXIALE ☒	DIAGONALE ☒	CONIQUE ☐	AUTRE ☐	MIXTE ☐
Rupture selon un plan pré identifié :	OUI ☐	NON ☐	PARTIELLEMENT ☒	PARALLÈLE ☐	SUIVANT LE CLIVAGE ☒
Nombre de fragments :	+ DE 3 ☒	- DE 3 ☐	ROCHE BROYÉE ☐		

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	Échantillon	Essai	Forage	Profondeur (m)	Opérateur	Date
	PLT-12	**UCS-011**	BH-02	161,70@161,95	CJ-JKM	06/11/2014

Caractéristiques de l'échantillon						Résultat du test	
D (mm)	L (mm)	L/D	Aire (mm^2)	Masse (g)	État	Force - rupture (kN)	σ_{ci} (MPa)
63,18	136,47	2,2	3135,1	1406,2	SEC	118,7	37,86
Type de roche :	Iron oxyde with limonite					Durée (min) :	0,849
Note :	Rubanement à 30 ° par rapport à l'axe de la carotte.					Validité :	**NON**

Cellule de charge : SATEC 400K	Taux : 0.75 MPa/sec

Remarque sur la rupture : Rupture suivant le clivage à environ 30°.

Type de rupture :	AXIALE ☐	DIAGONALE ☒	CONIQUE ☐	AUTRE ☐	MIXTE ☐
Rupture selon un plan pré identifié :	OUI ☐	NON ☐	PARTIELLEMENT ☐	PARALLÈLE ☐	SUIVANT LE CLIVAGE ☒
Nombre de fragments :	+ DE 3 ☒	- DE 3 ☐	ROCHE BROYÉE ☐		

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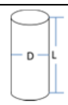	Échantillon	Essai	Forage	Profondeur (m)	Opérateur	Date
	RS-46	**UCS-013**	BH-04	123,00@123,23	CJ-JKM	06/11/2014

Caractéristiques de l'échantillon						Résultat du test	
D (mm)	L (mm)	L/D	Aire (mm^2)	Masse (g)	État	Force - rupture (kN)	σ_{ci} (MPa)
60,72	131,75	2,2	2895,7	1458,1	SEC	81,9	28,28

Type de roche :	Iron oxide (Hematite)-Massive	Durée (min) :	0,653
Note :	Échantillon très poreux, s'effrite facilement. Plusieurs fissures visibles avant l'essai.	Validité :	OUI

Cellule de charge : SATEC 400K	Taux : 0.75 MPa/sec

Remarque sur la rupture :

Type de rupture :	AXIALE ☒	DIAGONALE ☐	CONIQUE ☐	AUTRE ☐	MIXTE ☐
Rupture selon un plan pré identifié :	OUI ☐	NON ☒	PARTIELLEMENT ☐	PARALLÈLE ☐	SUIVANT LE CLIVAGE ☐
Nombre de fragments :	+ DE 3 ☐	- DE 3 ☒	ROCHE BROYÉE ☐		

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	Échantillon	Essai	Forage	Profondeur (m)	Opérateur	Date
	RS-54	**UCS-024**	BH-03	81,00@81,26	CJ-JKM	11/11/2014

Caractéristiques de l'échantillon						Résultat du test	
D (mm)	L (mm)	L/D	Aire (mm^2)	Masse (g)	État	Force - rupture (kN)	σ_{ci} (MPa)
63,55	136,84	2,2	3171,9	1181,40	SEC	136,3	42,97
Type de roche :	Mix of shale and white chert.					Durée (min) :	0,963
Note :	Foliation à 75 degrés par rapport à l'axe de la carotte. Fissures visibles avant l'essai.					Validité :	**NON**

Cellule de charge : SATEC 400K	Taux : 0.75 MPa/sec

Remarque sur la rupture :

Type de rupture :	AXIALE ☒	DIAGONALE ☐	CONIQUE ☐	AUTRE ☐	MIXTE ☐
Rupture selon un plan pré identifié :	OUI ☒	NON ☐	PARTIELLEMENT ☐	PARALLÈLE ☐	SUIVANT LE CLIVAGE ☐
Nombre de fragments :	+ DE 3 ☒	- DE 3 ☐	ROCHE BROYÉE ☐		

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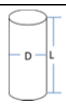	Échantillon	Essai	Forage	Profondeur (m)	Opérateur	Date
	RS-58B	**UCS-027**	BH-03	89,60@89,96	CJ-JKM	11/11/2014

Caractéristiques de l'échantillon						Résultat du test	
D (mm)	L (mm)	L/D	Aire (mm²)	Masse (g)	État	Force - rupture (kN)	σ_{ci} (MPa)
63,40	132,62	2,1	3157,0	1213,0	SEC	416,3	131,87

Type de roche :	Mix of shale and white chert.	Durée (min) :	2,939
Note :	Foliation à 75 degrés par rapport à l'axe de la carotte.	Validité :	OUI

Cellule de charge : SATEC 400K	Taux : 0.75 MPa/sec
	
	

Remarque sur la rupture :

Type de rupture :	AXIALE ☐	DIAGONALE ☐	CONIQUE ☐	AUTRE ☐	MIXTE ☒
Rupture selon un plan pré identifié :	OUI ☐	NON ☒	PARTIELLEMENT ☐	PARALLÈLE ☐	SUIVANT LE CLIVAGE ☐
Nombre de fragments :	+ DE 3 ☒	- DE 3 ☐	ROCHE BROYÉE ☐		

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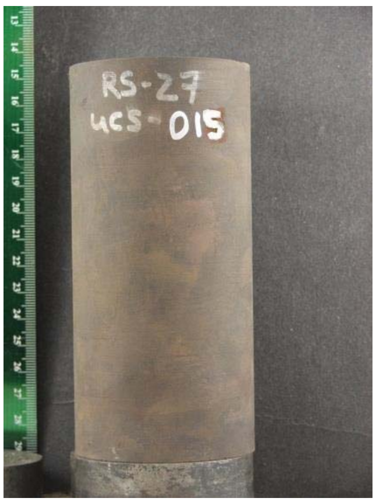
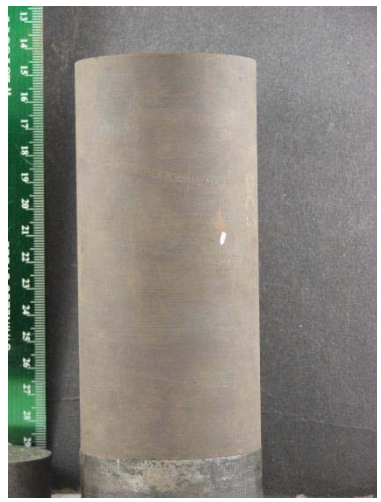
	Échantillon	Essai	Forage	Profondeur (m)	Opérateur	Date
	RS-27	**UCS-015**	BH-01	125,25@125,50	CJ-JKM	11/11/2014

Caractéristiques de l'échantillon						Résultat du test	
D (mm)	L (mm)	L/D	Aire (mm^2)	Masse (g)	État	Force - rupture (kN)	σ_{ci} (MPa)
63,47	135,77	2,1	3163,9	1147,0	SEC	418,8	132,37

Type de roche :	Shale.	Durée (min) :	2,949
Note :		Validité :	OUI

Cellule de charge : SATEC 400K	Taux : 0.75 MPa/sec
	
	

Remarque sur la rupture :

Type de rupture :	AXIALE ☒	DIAGONALE ☐	CONIQUE ☐	AUTRE ☐	MIXTE ☒
Rupture selon un plan pré identifié :	OUI ☐	NON ☒	PARTIELLEMENT ☐	PARALLÈLE ☐	SUIVANT LE CLIVAGE ☐
Nombre de fragments :	+ DE 3 ☒	- DE 3 ☐	ROCHE BROYÉE ☐		

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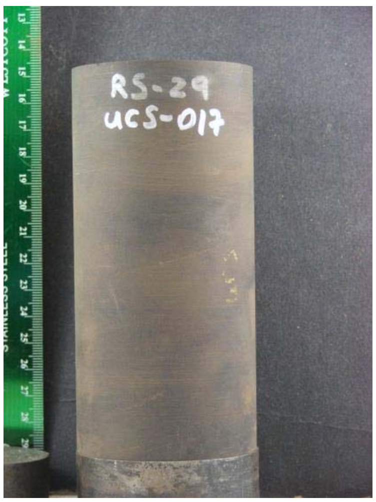
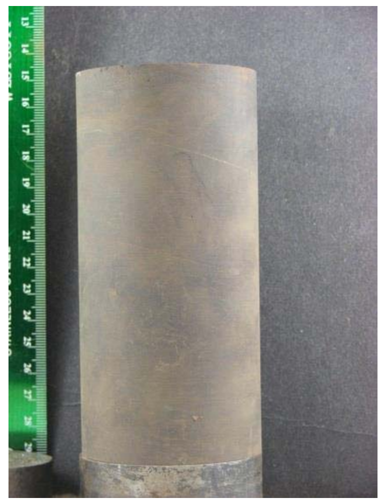
	Échantillon	Essai	Forage	Profondeur (m)	Opérateur	Date
	RS-29	**UCS-015**	BH-01	126,25@126,55	CJ-JKM	11/11/2014

Caractéristiques de l'échantillon						Résultat du test	
D (mm)	L (mm)	L/D	Aire (mm^2)	Masse (g)	État	Force - rupture (kN)	σ_{ci} (MPa)
63,47	133,79	2,1	3163,9	1105,4	SEC	415,7	131,39

Type de roche :	Shale.	Durée (min) :	2,933
Note :		Validité :	OUI

Cellule de charge : SATEC 400K	Taux : 0.75 MPa/sec





Remarque sur la rupture :

Type de rupture :	AXIALE ☒	DIAGONALE ☐	CONIQUE ☐	AUTRE ☐	MIXTE ☒
Rupture selon un plan pré identifié :	OUI ☐	NON ☒	PARTIELLEMENT ☐	PARALLÈLE ☐	SUIVANT LE CLIVAGE ☐
Nombre de fragments :	+ DE 3 ☒	- DE 3 ☐	ROCHE BROYÉE ☐		

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	Échantillon	Essai	Forage	Profondeur (m)	Opérateur	Date
	RS-34	**UCS-019**	BH-01	148,26@148,50	CJ-JKM	11/11/2014

Caractéristiques de l'échantillon						Résultat du test	
D (mm)	L (mm)	L/D	Aire (mm^2)	Masse (g)	État	Force - rupture (kN)	σ_{ci} (MPa)
63,53	140,90	2,2	3169,9	1178,5	SEC	720,8	227,39

Type de roche :	Sandstone.	Durée (min) :	5,076
Note :	Craquement vers 3 min. 35 sec. Foliation à 60° par rapport à l'axe de la carotte.	Validité :	OUI

Cellule de charge : SATEC 400K	Taux : 0.75 MPa/sec

Remarque sur la rupture :

Type de rupture :	AXIALE ☒	DIAGONALE ☐	CONIQUE ☐	AUTRE ☐	MIXTE ☒
Rupture selon un plan pré identifié :	OUI ☐	NON ☒	PARTIELLEMENT ☐	PARALLÈLE ☐	SUIVANT LE CLIVAGE ☐
Nombre de fragments :	+ DE 3 ☒	- DE 3 ☐	ROCHE BROYÉE ☐		

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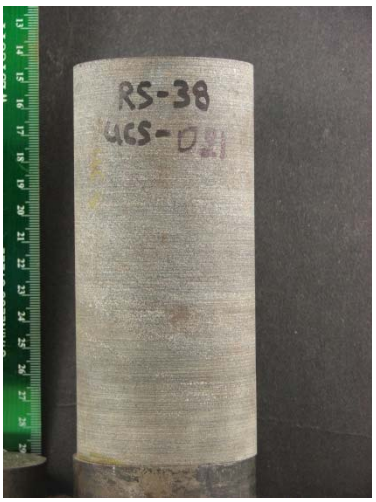
	Échantillon	Essai	Forage	Profondeur (m)	Opérateur	Date
	RS-38	**UCS-021**	BH-01	159,43@159,60	CJ-JKM	11/11/2014

Caractéristiques de l'échantillon						Résultat du test	
D (mm)	L (mm)	L/D	Aire (mm^2)	Masse (g)	État	Force - rupture (kN)	σ_{ci} (MPa)
63,25	136,33	2,2	3142,0	1188,5	SEC	773,0	246,02

Type de roche :	Sandstone.	Durée (min) :	5,48
Note :		Validité :	OUI

Cellule de charge : SATEC 400K	Taux : 0.75 MPa/sec





Remarque sur la rupture :

Type de rupture :	AXIALE ☒	DIAGONALE ☐	CONIQUE ☐	AUTRE ☐	MIXTE ☒
Rupture selon un plan pré identifié :	OUI ☐	NON ☒	PARTIELLEMENT ☐	PARALLÈLE ☐	SUIVANT LE CLIVAGE ☐
Nombre de fragments :	+ DE 3 ☒	- DE 3 ☐	ROCHE BROYÉE ☐		

Annexe 2 -
Résistance en tension indirecte (brésilien) : Feuilles-synthèse

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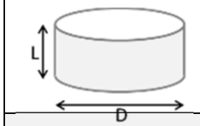
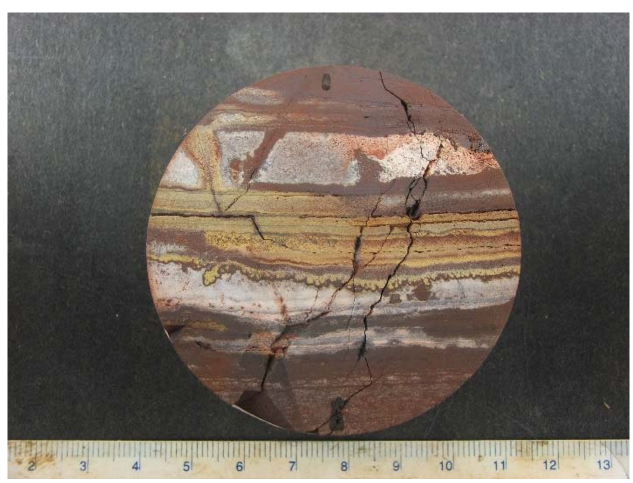


Échantillon	No. Essai	Forage	Profondeur (m)	Opérateur	Date
RS-01A	**BRE-007**	BH-02	161,02@161,33	CJ-JKM	24/10/2014

Caractéristiques de l'échantillon					Résultat du test	
D (mm)	L (mm)	L/D	Masse (g)	État	Force - rupture (kN)	σ_t (MPa)
63,23	28,75	0,5	260,6	SEC	14,8	5,18
Type de roche :	Mainly Iron Oxyde				Durée (min) :	1,26
Note :					Validité :	OUI

Cellule de charge : SATEC 400K	Taux : 200 N/sec



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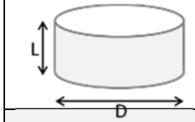
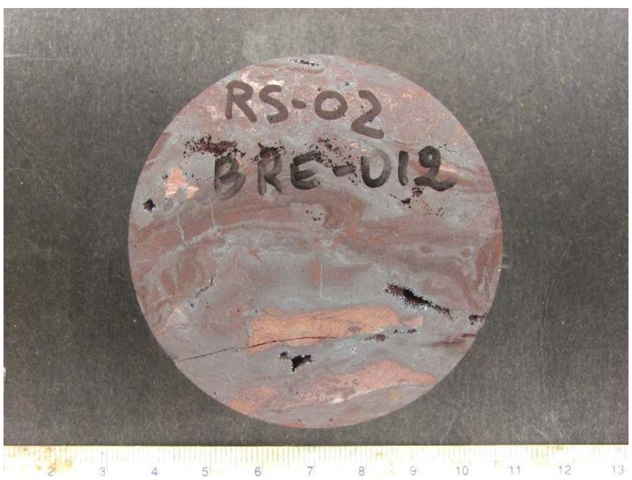


Échantillon	No. Essai	Forage	Profondeur (m)	Opérateur	Date
RS-02	**BRE-012**	BH-02	164,47@164,76	CJ-JKM	24/10/2014

Caractéristiques de l'échantillon					Résultat du test	
D (mm)	L (mm)	L/D	Masse (g)	État	Force - rupture (kN)	σ_t (MPa)
63,40	29,11	0,5	406,8	SEC	47,3	16,32
Type de roche :	Mainly Iron Oxyde				Durée (min) :	3,96
Note :					Validité :	OUI

Cellule de charge : SATEC 400K	Taux : 200 N/sec
	
	
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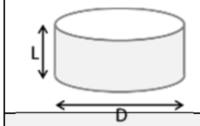
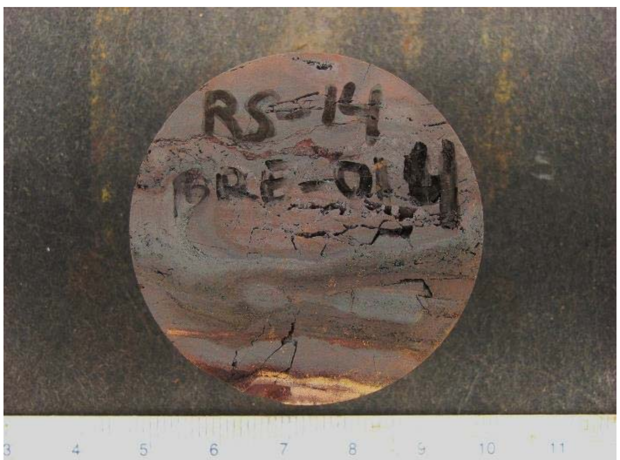
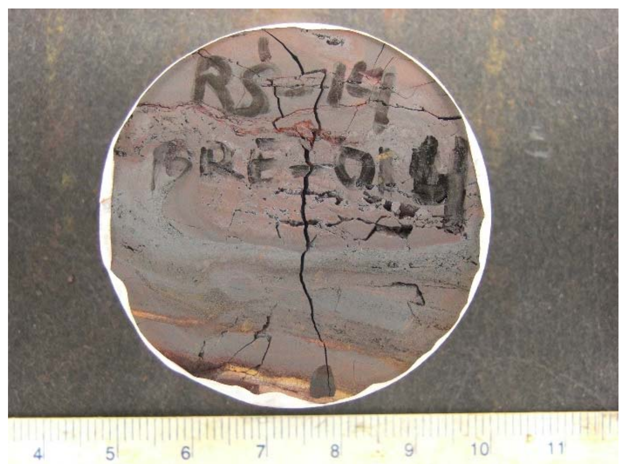


Échantillon	No. Essai	Forage	Profondeur (m)	Opérateur	Date
RS-14	**BRE-014**	BH-02	139,25@139,42	CJ-JKM	24/10/2014

Caractéristiques de l'échantillon					Résultat du test	
D (mm)	L (mm)	L/D	Masse (g)	État	Force - rupture (kN)	σ_t (MPa)
46,95	20,59	0,4	147,6	SEC	11,8	7,77
Type de roche :	Mainly Iron Oxyde				Durée (min) :	0,99
Note :					Validité :	OUI

Cellule de charge : SATEC 400K	Taux : 200 N/sec





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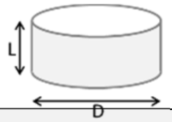	Échantillon	No. Essai	Forage	Profondeur (m)	Opérateur	Date
	RS-15B	**BRE-015**	BH-02	119,80@120,20	CJ-JKM	24/10/2014

Caractéristiques de l'échantillon					Résultat du test	
D (mm)	L (mm)	L/D	Masse (g)	État	Force - rupture (kN)	σ_t (MPa)
63,43	29,53	0,5	439,5	SEC	82,7	28,11
Type de roche :	Mainly Iron Oxyde				Durée (min) :	6,89
Note :					Validité :	OUI

Cellule de charge : SATEC 400K	Taux : 200 N/sec
	
	
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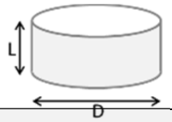

Échantillon	No. Essai	Forage	Profondeur (m)	Opérateur	Date
RS-03	**BRE-017**	BH-02	170,40@170,60	CJ-JKM	28/10/2014

Caractéristiques de l'échantillon					Résultat du test	
D (mm)	L (mm)	L/D	Masse (g)	État	Force - rupture (kN)	σ_t (MPa)
63,05	28,43	0,5	268,9	SEC	18,8	6,68
Type de roche :	Iron Oxyde with white chert				Durée (min) :	1,59
Note :					Validité :	OUI

Cellule de charge : SATEC 400K	Taux : 200 N/sec

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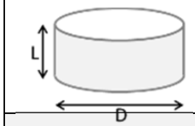

Échantillon	No. Essai	Forage	Profondeur (m)	Opérateur	Date
RS-13	**BRE-006**	BH-02	133,25@133,60	CJ-JKM	23/10/2014

Caractéristiques de l'échantillon					Résultat du test	
D (mm)	L (mm)	L/D	Masse (g)	État	Force - rupture (kN)	σ_t (MPa)
63,44	29,45	0,5	259,40	SEC	26,4	8,99
Type de roche :	Iron Oxyde with white chert				Durée (min) :	2,21
Note :					Validité :	OUI

Cellule de charge : SATEC 400K	Taux : 200 N/sec

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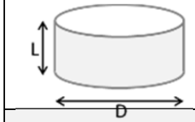

Échantillon	No. Essai	Forage	Profondeur (m)	Opérateur	Date
RS-19	**BRE-016**	BH-02	87,45@87,65	CJ-JKM	24/10/2014

Caractéristiques de l'échantillon					Résultat du test	
D (mm)	L (mm)	L/D	Masse (g)	État	Force - rupture (kN)	σ_t (MPa)
61,33	27,65	0,5	236,6	SEC	7,3	2,74
Type de roche :	Iron Oxyde with white chert				Durée (min) :	0,63
Note :					Validité :	**NON**

Cellule de charge : SATEC 400K	Taux : 200 N/sec

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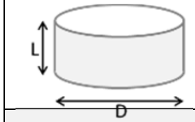

Échantillon	No. Essai	Forage	Profondeur (m)	Opérateur	Date
RS-51	**BRE-031**	BH-04	149,0@149,27	CJ-JKM	11/11/2014

Caractéristiques de l'échantillon					Résultat du test	
D (mm)	L (mm)	L/D	Masse (g)	État	Force - rupture (kN)	σ_t (MPa)
61,21	30,45	0,5	297,7	SEC	21,0	7,17
Type de roche :	Iron oxide with white chert.				Durée (min) :	1,76
Note :					Validité :	OUI

Cellule de charge : SATEC 400K	Taux : 200 N/sec

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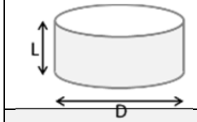
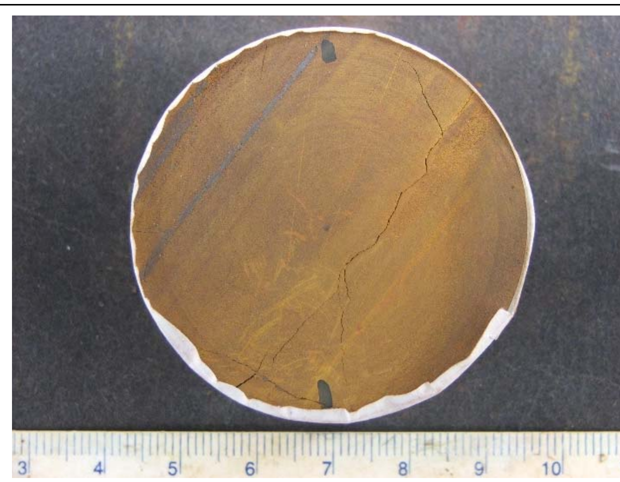


Échantillon	No. Essai	Forage	Profondeur (m)	Opérateur	Date
RS-05	**BRE-013**	BH-02	148,55@148,71	CJ-JKM	24/10/2014

Caractéristiques de l'échantillon					Résultat du test	
D (mm)	L (mm)	L/D	Masse (g)	État	Force - rupture (kN)	σ_t (MPa)
47,13	22,22	0,5	103,4	SEC	4,7	2,86
Type de roche :	Iron Oxyde with limonite				Durée (min) :	0,42
Note :					Validité :	OUI

Cellule de charge : SATEC 400K	Taux : 200 N/sec



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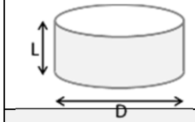
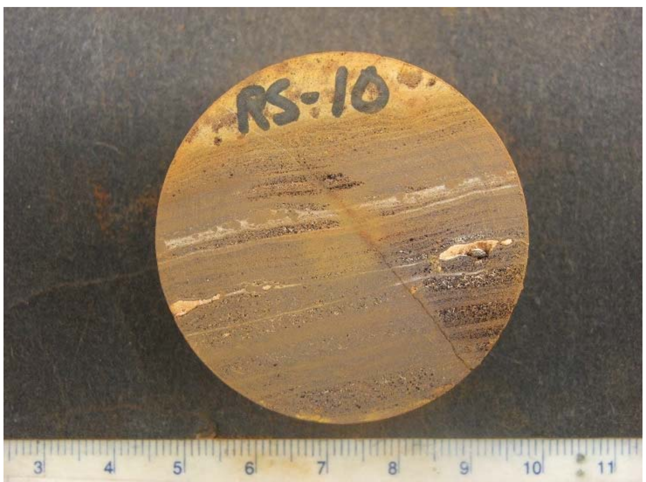
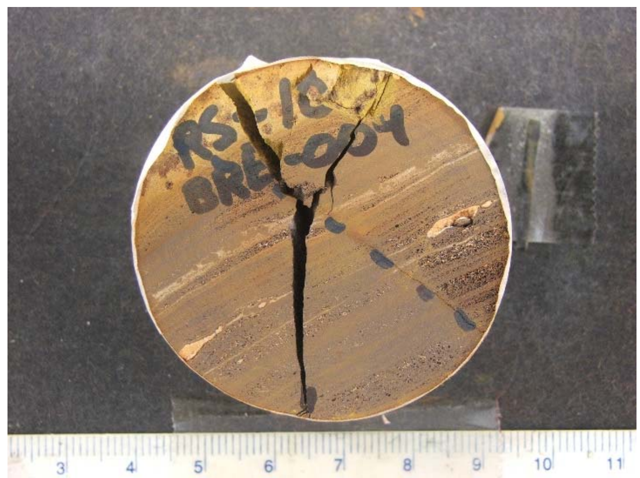
	Échantillon	No. Essai	Forage	Profondeur (m)	Opérateur	Date
	RS-10	**BRE-004**	BH-02	137,80@138,10	CJ-JKM	23/10/2014

Caractéristiques de l'échantillon					Résultat du test	
D (mm)	L (mm)	L/D	Masse (g)	État	Force - rupture (kN)	σ_t (MPa)
47,00	23,09	0,5	120,70	SEC	17,6	10,32
Type de roche:	Iron Oxyde with limonite				Durée (min) :	1,52
Note :					Validité :	OUI

Cellule de charge : SATEC 400K	Taux : 200 N/sec
	
	
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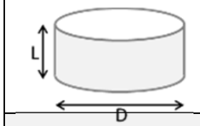
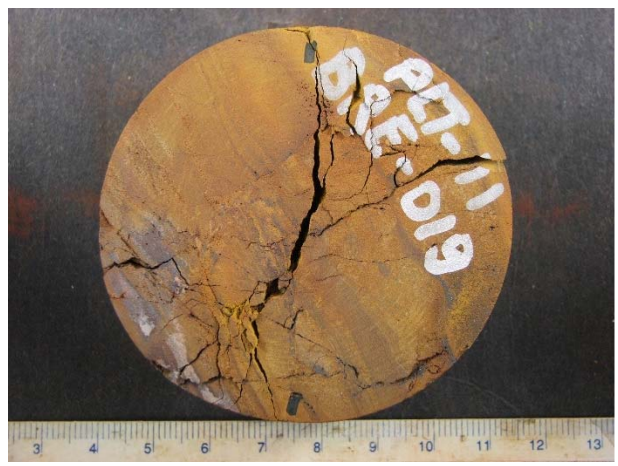


Échantillon	No. Essai	Forage	Profondeur (m)	Opérateur	Date
PLT-11	**BRE-019**	BH-02	161,40@161,70	CJ-JKM	06/11/2014

Caractéristiques de l'échantillon					Résultat du test	
D (mm)	L (mm)	L/D	Masse (g)	État	Force - rupture (kN)	σ_t (MPa)
63,30	29,72	0,5	258,0	SEC	4,80	1,62
Type de roche :	Iron Oxyde with limonite				Durée (min) :	0,58
Note :					Validité :	OUI

Cellule de charge : SATEC 400K	Taux : 200 N/sec
	
	
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	Échantillon	No. Essai	Forage	Profondeur (m)	Opérateur	Date
L / D	**PLT-16A**	**BRE-021**	BH-04	123,85@124,1	CJ-JKM	06/11/2014

Caractéristiques de l'échantillon					Résultat du test	
D (mm)	L (mm)	L/D	Masse (g)	État	Force - rupture (kN)	σ_t (MPa)
60,89	29,24	0,5	415,3	SEC	38,30	13,69
Type de roche :	Iron oxide (Hematite)-Massive				Durée (min) :	3,22
Note :					Validité :	OUI

Cellule de charge : SATEC 400K	Taux : 200 N/sec

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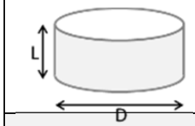

Échantillon	No. Essai	Forage	Profondeur (m)	Opérateur	Date
PLT-17	**BRE-023**	BH-04	138,2@138,5	CJ-JKM	06/11/2014

Caractéristiques de l'échantillon					Résultat du test	
D (mm)	L (mm)	L/D	Masse (g)	État	Force - rupture (kN)	σ_t (MPa)
60,96	28,56	0,5	311,30	SEC	9,50	3,47
Type de roche :	Iron oxide (Hematite)-Massive/with hydroxie				Durée (min) :	1,12
Note :					Validité :	OUI

Cellule de charge : SATEC 400K	Taux : 200 N/sec
	
	
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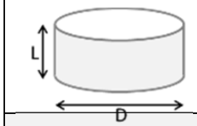
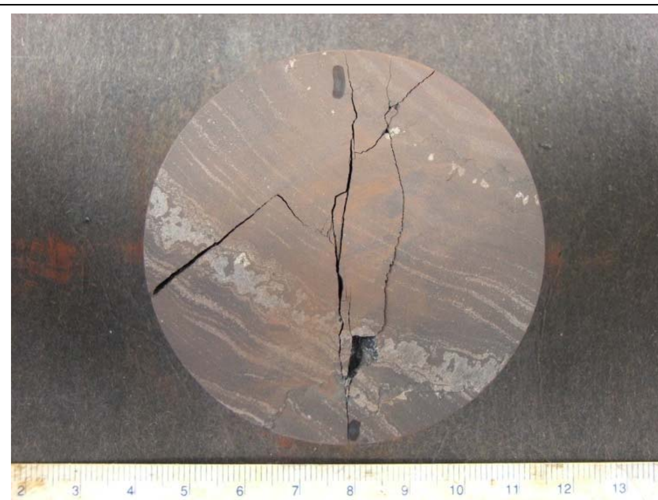


Échantillon	No. Essai	Forage	Profondeur (m)	Opérateur	Date
RS-58	**BRE-034**	BH-03	89,6@89,96	CJ-JKM	11/11/2014

Caractéristiques de l'échantillon					Résultat du test	
D (mm)	L (mm)	L/D	Masse (g)	État	Force - rupture (kN)	σ_t (MPa)
63,37	29,85	0,5	264,8	SEC	1282	4,106
Type de roche :	Mix of shale and white chert.				Durée (min) :	1,04
Note :					Validité :	OUI

Cellule de charge : SATEC 400K	Taux : 200 N/sec



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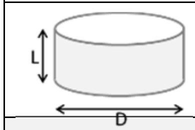
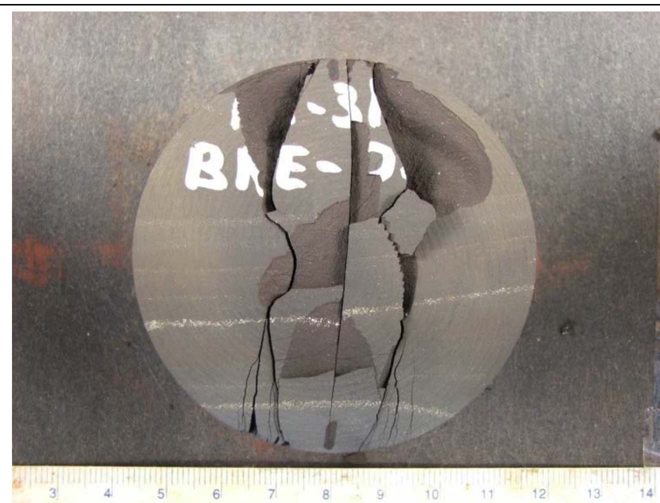
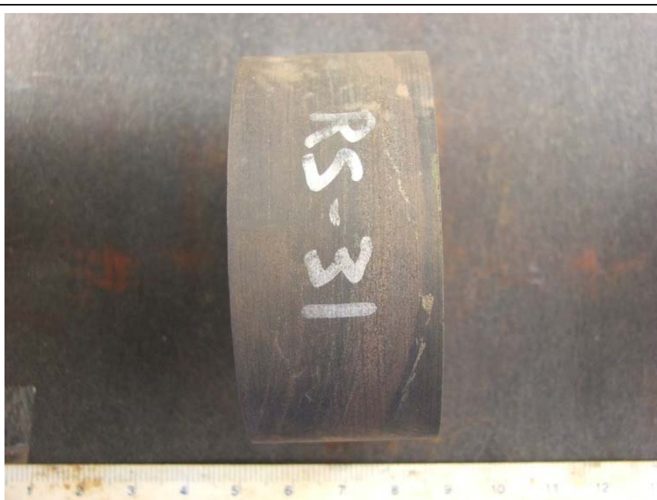
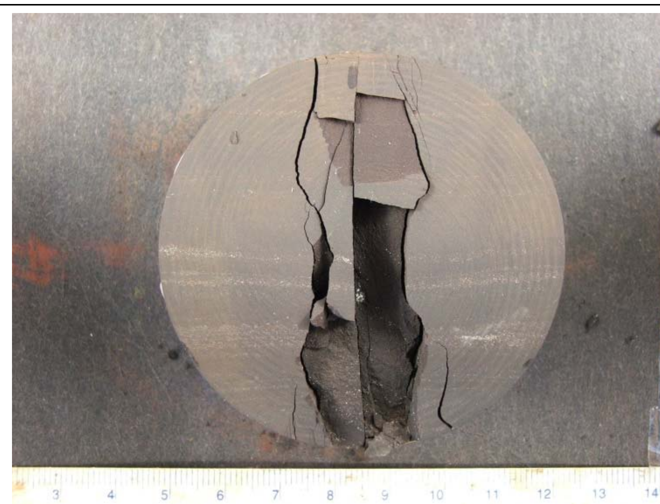
Québec (Québec) Canada G1K 7P4

Faculté des sciences et de génie

Essai en tension (Brésilien)

	Échantillon	No. Essai	Forage	Profondeur (m)	Opérateur	Date
	RS-31	**BRE-026**	BH-01	128,30@128,60	CJ-JKM	11/11/2014

Caractéristiques de l'échantillon					Résultat du test	
D (mm)	L (mm)	L/D	Masse (g)	État	Force - rupture (kN)	σ_t (MPa)
63,47	29,71	0,5	257,7	SEC	43,5	14,69
Type de roche :	Shale.				Durée (min) :	3,61
Note :					Validité :	OUI

Cellule de charge : SATEC 400K	Taux : 200 N/sec
	
	
AVANT	APRÈS

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Québec (Québec) Canada G1K 7P4

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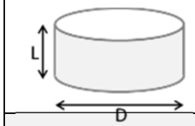
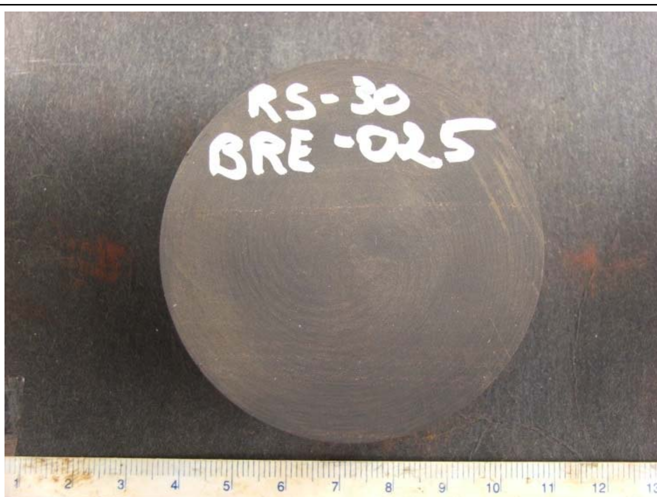
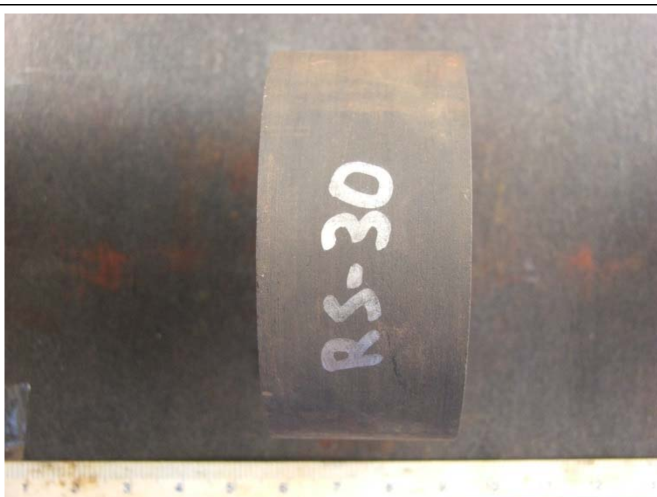
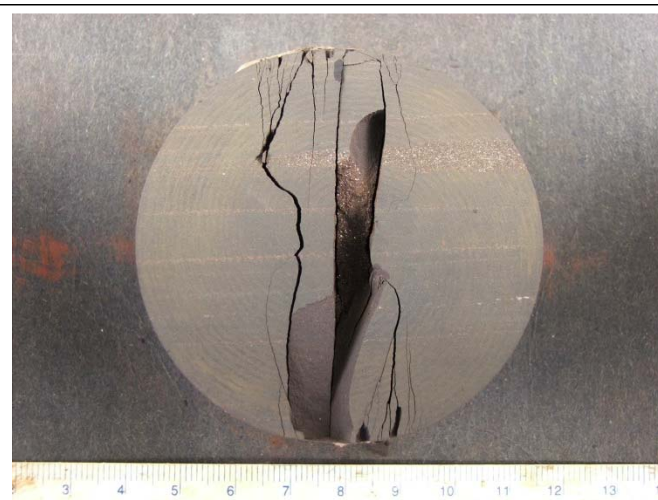
Faculté des sciences et de génie

Essai en tension (Brésilien)

	Échantillon	No. Essai	Forage	Profondeur (m)	Opérateur	Date
	RS-30	**BRE-025**	BH-01	128,05@128,2	CJ-JKM	11/11/2014

Caractéristiques de l'échantillon					Résultat du test	
D (mm)	L (mm)	L/D	Masse (g)	État	Force - rupture (kN)	σ_t (MPa)
63,41	29,75	0,5	242,9	SEC	50,3	16,97
Type de roche :	Shale.				Durée (min) :	4,21
Note :					Validité :	OUI

Cellule de charge : SATEC 400K	Taux : 200 N/sec
 	
 	
AVANT	APRÈS

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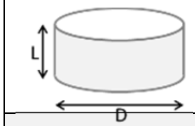
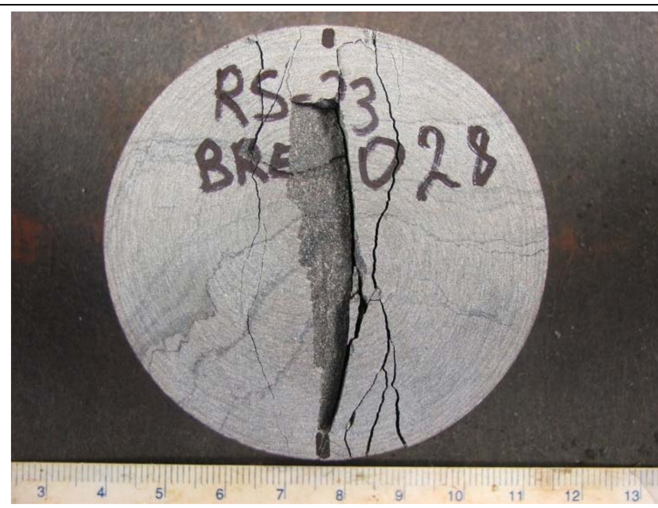
Essai en tension (Brésilien)

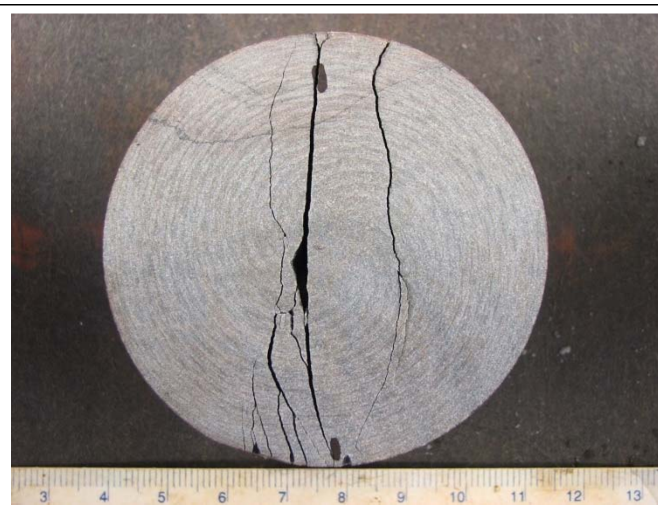


Échantillon	No. Essai	Forage	Profondeur (m)	Opérateur	Date
RS-33	**BRE-028**	BH-01	148,04@148,46	CJ-JKM	11/11/2014

Caractéristiques de l'échantillon					Résultat du test	
D (mm)	L (mm)	L/D	Masse (g)	État	Force - rupture (kN)	σ_t (MPa)
63,46	30,48	0,5	252,3	SEC	58,3	19,19
Type de roche :	Sandstone..				Durée (min) :	4,86
Note :					Validité :	OUI

Cellule de charge : SATEC 400K	Taux : 200 N/sec





AVANT	APRÈS

Annexe 3 -
Résistance en compression triaxiale : Feuilles-synthèse

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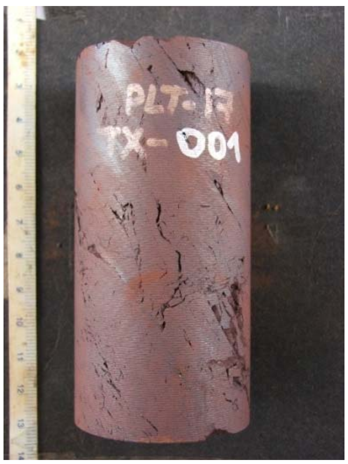
Essai en compression triaxiale

	Échantillon	No. D'essai	Forage	Profondeur (m)	Opérateur	Date
	PLT-17	**TX-001**	BH-04	138,20@138,50	CJ-JKM	06/11/2014

Caractéristiques de l'échantillon						Résultat du test		
D (mm)	L (mm)	L/D	Aire (mm^2)	Masse (g)	État	σ_1 (MPa)	σ_3 (MPa)	Force de rupture (kN)
47,10	97,51	2,1	1742,3	644,4	SEC	58,43	**8,08**	101,8
Roc :	Iron oxide (Hematite)-Massive with hydroxide.					Durée (min) :		4,1268
Note :	Échantillon très fissuré.					Validité :		**NON**

Cellule de charge : 400K	Taux : 0.75 MPa/sec



Remarque sur la rupture : Rupture suivant la foliation à 25 degrés par rapport à l'axe de la carotte

Type de rupture : AXIALE ☐ DIAGONALE ☒ CONIQUE ☐ AUTRE ☐ MIXTE ☐

Selon un plan pré identifié : OUI ☐ NON ☐ PARTIELLEMENT ☐ PARALLÈLE ☐ SUIVANT LE CLIVAGE ☒

Nombre de fragments : + DE 3 ☒ - DE 3 ☐ ROCHE BROYÉE ☐

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Essai en compression triaxiale

	Échantillon	No. D'essai	Forage	Profondeur (m)	Opérateur	Date
	RS-45	**TX-003**	BH-04	121,70@121,87	CJ-JKM	06/11/2014

Caractéristiques de l'échantillon						Résultat du test		
D (mm)	L (mm)	L/D	Aire (mm^2)	Masse (g)	État	σ_1 (MPa)	σ_3 (MPa)	Force de rupture (kN)
46,56	95,80	2,1	1702,6	675,8	SEC	71,36	**5,65**	121,5
Roc :	Iron oxide (Hematite)-Massive with hydroxide.					Durée (min) :		3,5902
Note :						Validité :		OUI

Cellule de charge : 400K	Taux : 0.75 MPa/sec

Remarque sur la rupture :

Type de rupture :	AXIALE ☐	DIAGONALE ☐	CONIQUE ☐	AUTRE ☐	MIXTE ☒
Selon un plan pré identifié :	OUI ☐	NON ☒	PARTIELLEMENT ☐	PARALLÈLE ☐	SUIVANT LE CLIVAGE ☐
Nombre de fragments :	+ DE 3 ☒	- DE 3 ☐	ROCHE BROYÉE ☐		

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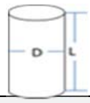
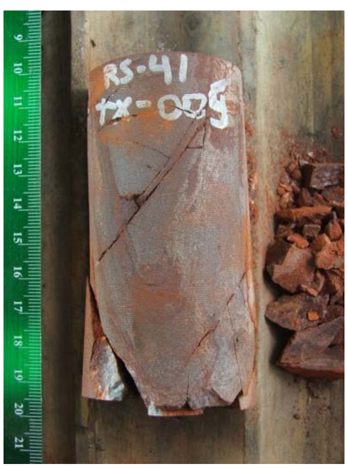
Essai en compression triaxiale

	Échantillon	No. D'essai	Forage	Profondeur (m)	Opérateur	Date
	RS-41	**TX-005**	BH-04	69,65@69,90	CJ-JKM	12/11/2014

Caractéristiques de l'échantillon						Résultat du test		
D (mm)	L (mm)	L/D	Aire (mm^2)	Masse (g)	État	σ_1 (MPa)	σ_3 (MPa)	Force de rupture (kN)
46,37	98,57	2,1	1688,7	449,9	SEC	112,45	**4,88**	189,90
Roc :	Iron oxide with white chert.					Durée (min) :		3,8802
Note :	Foliation à 20 degrés. Fissures visibles avant l'essai.					Validité :		OUI

Cellule de charge : 400K	Taux : 0.75 MPa/sec
	
	

Remarque sur la rupture : Échantillon coincé dans la membrane après essai.

Type de rupture : AXIALE ☐ DIAGONALE ☒ CONIQUE ☐ AUTRE ☐ MIXTE ☐

Selon un plan pré identifié : OUI ☐ NON ☐ PARTIELLEMENT ☒ PARALLÈLE ☐ SUIVANT LE CLIVAGE ☐

Nombre de fragments : + DE 3 ☒ - DE 3 ☐ ROCHE BROYÉE ☐

Appendix 5 2010 National Building Code Seismic Hazard Calculation

LVM

2010 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

Requested by: , November 25, 2014

Site Coordinates: 54.896 North 66.525 West

User File Reference:

National Building Code ground motions:
2% probability of exceedance in 50 years (0.000404 per annum)

Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA (g)
0.095	0.057	0.036	0.014	0.036

Notes. Spectral and peak hazard values are determined for firm ground (NBCC 2010 soil class C - average shear wave velocity 360-750 m/s). Median (50th percentile) values are given in units of g. 5% damped spectral acceleration (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are tabulated. Only 2 significant figures are to be used. ***These values have been interpolated from a 10 km spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the calculated values.***

Ground motions for other probabilities:

Probability of exceedance per annum	0.010	0.0021	0.001
Probability of exceedance in 50 years	40%	10%	5%
Sa(0.2)	0.011	0.035	0.055
Sa(0.5)	0.008	0.023	0.035
Sa(1.0)	0.006	0.015	0.024
Sa(2.0)	0.003	0.007	0.010
PGA	0.003	0.011	0.019

References

National Building Code of Canada 2010 NRCC no. 53301; sections 4.1.8, 9.20.1.2, 9.23.10.2, 9.31.6.2, and 6.2.1.3
Appendix C: Climatic Information for Building Design in Canada - table in Appendix C starting on page C-11 of Division B, volume 2

User's Guide - NBC 2010, Structural Commentaries NRCC no. 53543 (in preparation)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File xxxx
Fourth generation seismic hazard maps of Canada: Maps and grid values to be used with the 2010 National Building Code of Canada (in preparation)

See the websites *www.EarthquakesCanada.ca* and *www.nationalcodes.ca* for more information

Aussi disponible en français